

### *The Ultimate Coin-Op Arcade Games Video Monitor Troubleshooting & Repair Guide*



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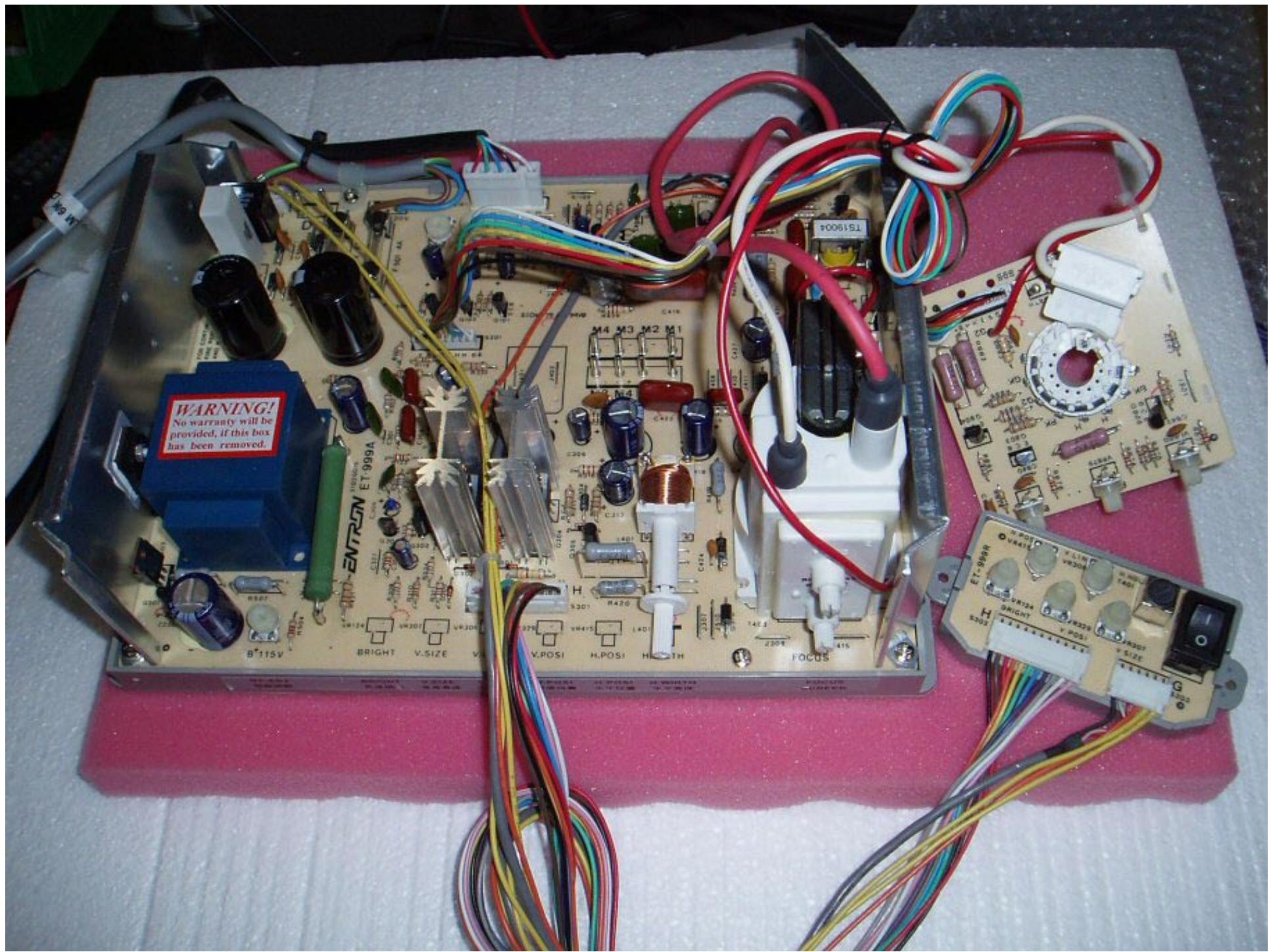
*The Ultimate Monitor Repair Guide*

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# **The Ultimate Coin-Op Arcade Games Video Monitor**

## **Troubleshooting & Repair Guide**

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02.25.07*

**Entron ET-999A**

# **Entron ET-999A Free Voltage 21" Toshiba CRT**

Notes: Many people have purchased these chassis and complete monitors that claim to be free voltage, this is partly correct as they will operate from 90v ~ 265v but "ONLY" when operated through an isolation transformer.

Many of these have been plugged in directly to mains voltage 110v or 230 / 240v and have blown fuses and rectifier diodes.

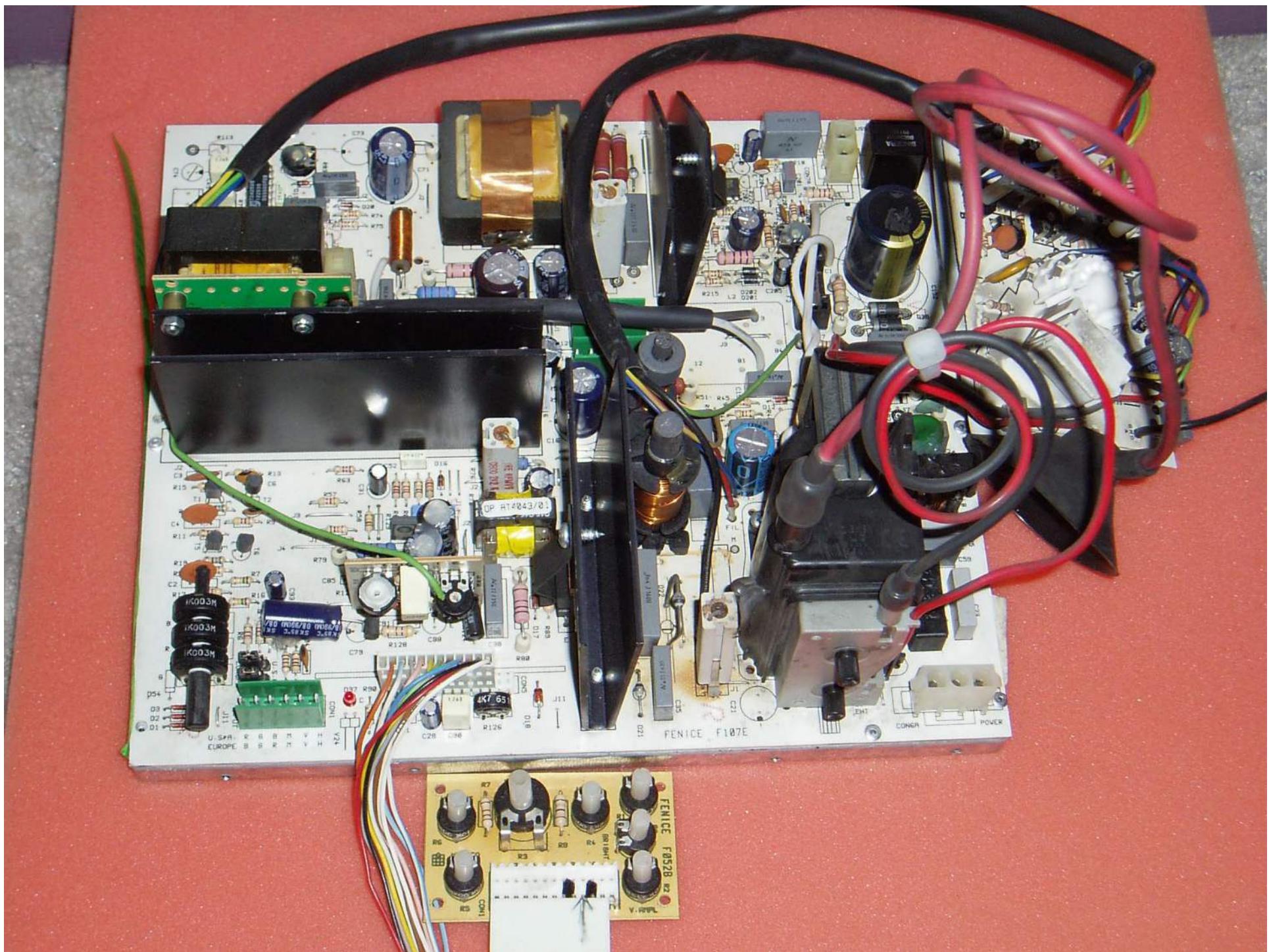
In a lot of cases if you are using an RCD "residual current device" for power protection it will trip this circuit breaker and not damage the chassis at all, While this is good, if you remove the chassis looking for a reason why your circuit breaker keeps tripping you will not find a fault on the chassis .

This is happening because they are not electrically isolated.

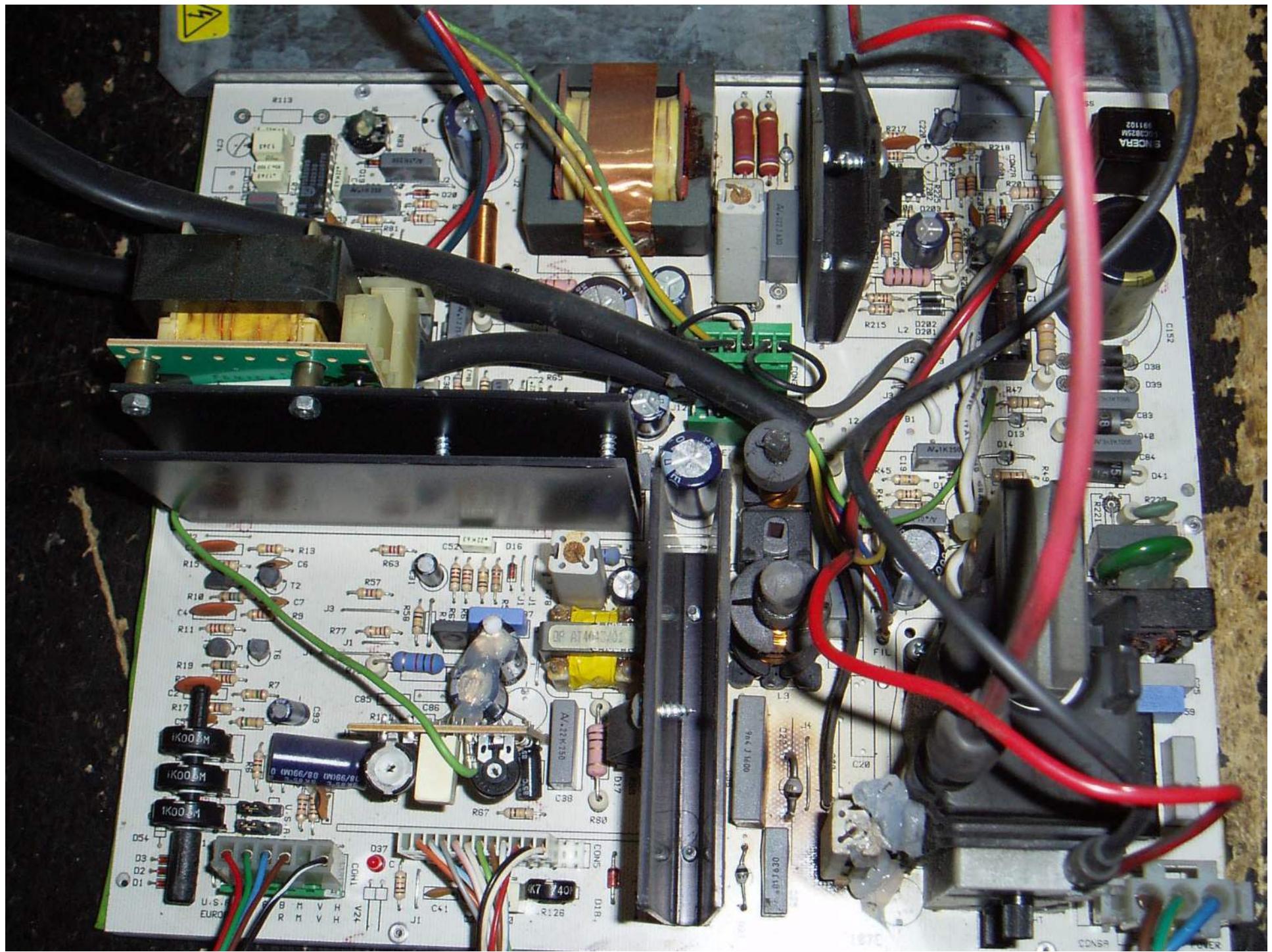
All other chassis that claim to be free voltage do not require an isolation transformer hence the confusion with the way these are labelled.

Always use an isolation transformer with these chassis!

## Fenice 14.28 CGA 240v 14"



## Fenice 14.28 CGA





## Fenice-14.28 CGA 240v 14"

Symptoms: Wont Power up

Cure: Replace C206 (100uf 35v), C205 (22uf 50v), Also check that White wire wrapped about ferrite of flyback is connected at both ends Marked C1 and S1.

Symptoms: Vertical Size to small

Cure: Common fault replace C24 (100uf 35v) located near flyback, Also check C80 (100uf 35v), If left can also cause Vertical IC marked 12 on chassis to fail (TDA1675A)

.

Symptoms: Vertical Fold

Cure: Replace C26 (100uf 50v)

Symptoms: Picture not stable, shaking or shrinking when displaying bright picture

Cure: Replace C71 (47uf 250v), C72 (10uf 250v), occasionally C63 main Filter cap with cause the same symptoms but is more noticeable due to noise coming from chassis (100uf 400v)

Symptoms: Pin Cushion problems (hour glass effect)

Cure: Replace C51 (10uf 160V)

Symptoms: Horizontal size won't adjust

Cure: Replace C18 (47uf 250v) if ok check for shorted transistor T16 (BD537) or broken solder connections under this transistor

Symptoms: Chirping Sound

Cure: Check for Shorted HOT T13 (BU508A) or Shorted D22 (BY228), if ok Check Flyback for Shorts, Flyback number HR-7368, sometimes these flybacks are visibly burnt out.

If Flyback has shorted out this will often burn up R50 (33 ohm 9 w) if not open circuit it may have burnt off where soldered.

Symptoms: Squealing while running, sometimes this will cause interference across screen

Cure: Resolder Coil L1, Put hot glue or silicon between coil and heat sink

Symptoms: Horizontal Collapse

Cure: Check small add on PCB where Horizontal Yoke wires connect, this section runs very hot and can burn the connectors

off or melt, Wires also become very brittle due to excess heat and can snap off easily.

Notes: Many of these chassis have been damaged when re-installing or simply wont power up although chassis is in perfect working order, This is due to the Remote Control wiring plugs being placed backwards or in the wrong position.

For Reference CON1 on Controls:

Pin 1 not used

Pin 2 Orange

Pin 3 White

Pin 4 Gray

Pin 5 Pink

Pin 6 Yellow

Pin 7 White/ Green

Pin 8 Brown

Pin 9 Red

Pin 10 Black

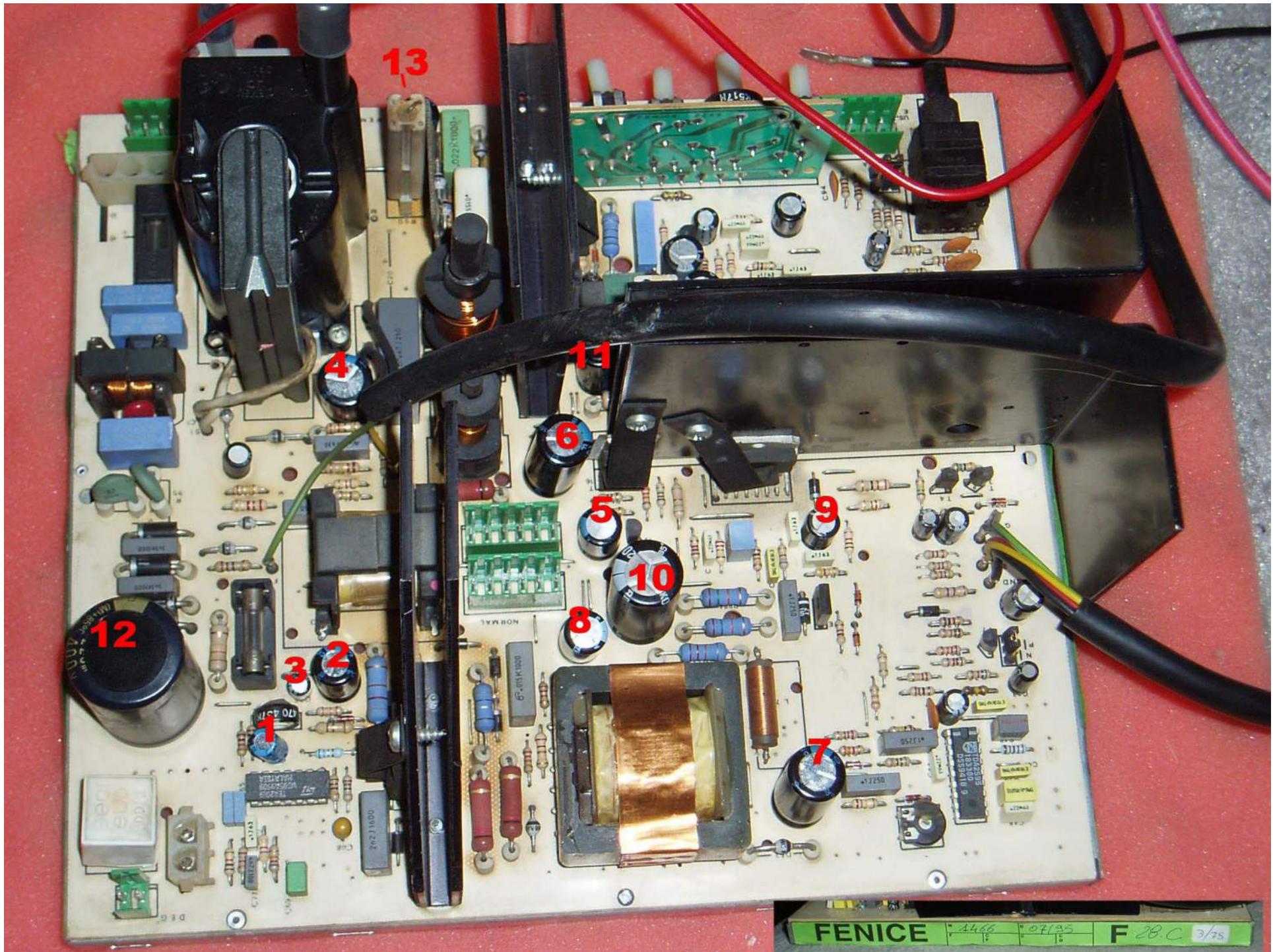
Pin 11 White

Pin 12 Not Used

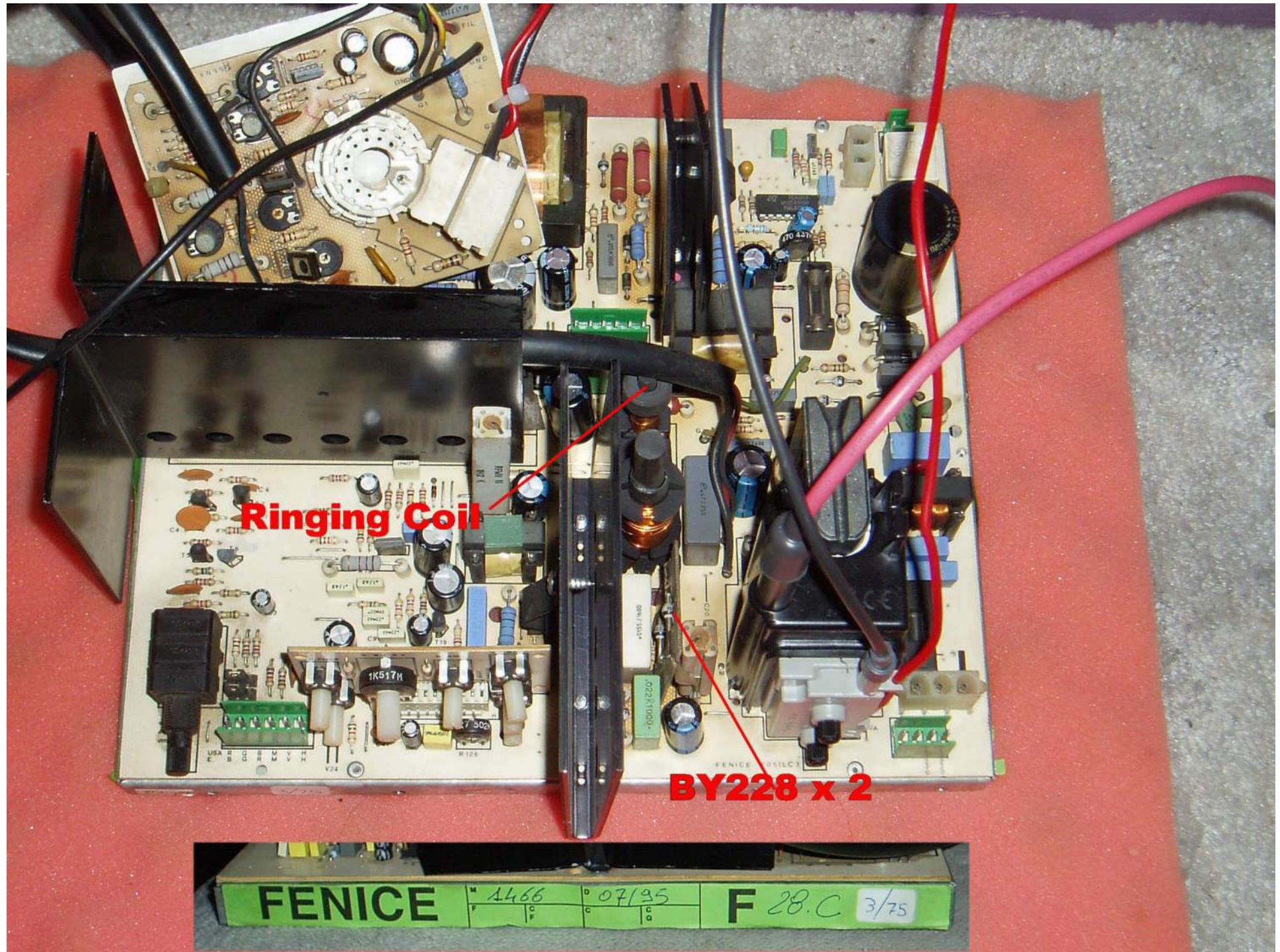
CON 5 on Chassis

Place Connector with Orange wire on first available pin on left side of CON5

There should be 2 unused or missing pins on right side of chassis connector CON5

**Fenice F28C Front**

## Fenice F28C Back



# Fenice F28C CGA 240v 27 - 28"

Special Note: This chassis has not Capacitor location number silk screen on the chassis so all Capacitors that correspond to listed faults have been given **RED** numbers.

Symptoms: Dead wont power up, fuse ok

Cure: Replace capacitors **1**(22uf 25v), **2** (470uf 25v), **3** (10uf 50v)

Symptoms: Ticking sound

Cure: Check for shorted HOT T43 (BU508A) also for shorts across the 2 Diodes labelled **BY228 x 2** If not shorted replace flyback HR-7368

Symptoms: Horizontal Tear

Cure: Replace Capacitor **13** (10uf 250v)

Symptoms: Horizontal Size wont adjust and Pin cushion problem (hourglass)

Cure: Replace Capacitor **11** (47uf 50v), Capacitor **5** (10uf 160v), Capacitor **8** (10uf 160v), if still not fixed replace T16 (BD709)

Symptoms: Brightness not stable

Cure: Replace Capacitor **4** (1000uf 35v) Always replace this cap, often swells

Symptoms: Picture shaking during scene changes of bright screen

Cure: Replace Capacitor **7** (47uf 250v)

Symptoms: Vertical Fold

Cure: Replace Capacitor **6** (47uf 160v), Capacitor **9** (100uf 35v)

Symptoms: Vertical Collapse

Cure: Check for burnt /open R41 (2.2 ohm 1/2w) located in front of capacitor **4** if open replace Vertical Drive IC (TDA1675A) located behind capacitor **9**

Symptoms: Picture jittering, unstable

Cure: Replace Capacitor **10** (2200uf 35v)

Symptoms: Picture has constant wobble

Cure: Replace Capacitor **12** (220uf 400v)

Symptoms: Load squealing noise while running, sometimes interference across

screen, static

Cure: See attached picture with label **Squealing Coil**, put silicon rubber between this coil and the heat sink it is almost touching

Symptoms: Intermittent shut down or wont come on after replacing suspect capacitors

Cure: Check large resistor R50 beside flyback, often burns track off under chassis or physically breaks off.

Notes: Be very careful when working on these chassis they are very fragile and easily cracked, components are also known to break off when handling.

Be sure to check around flyback and larger caps and resistors for broken tracks and bad solder

Neck board solder is also a problem area so be very gentle when removing or fitting to CRT.

Some of the wires get so hot on the neck board they become very brittle and often break off when moved to much, especially look out for the 24V Yellow wire .

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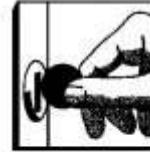
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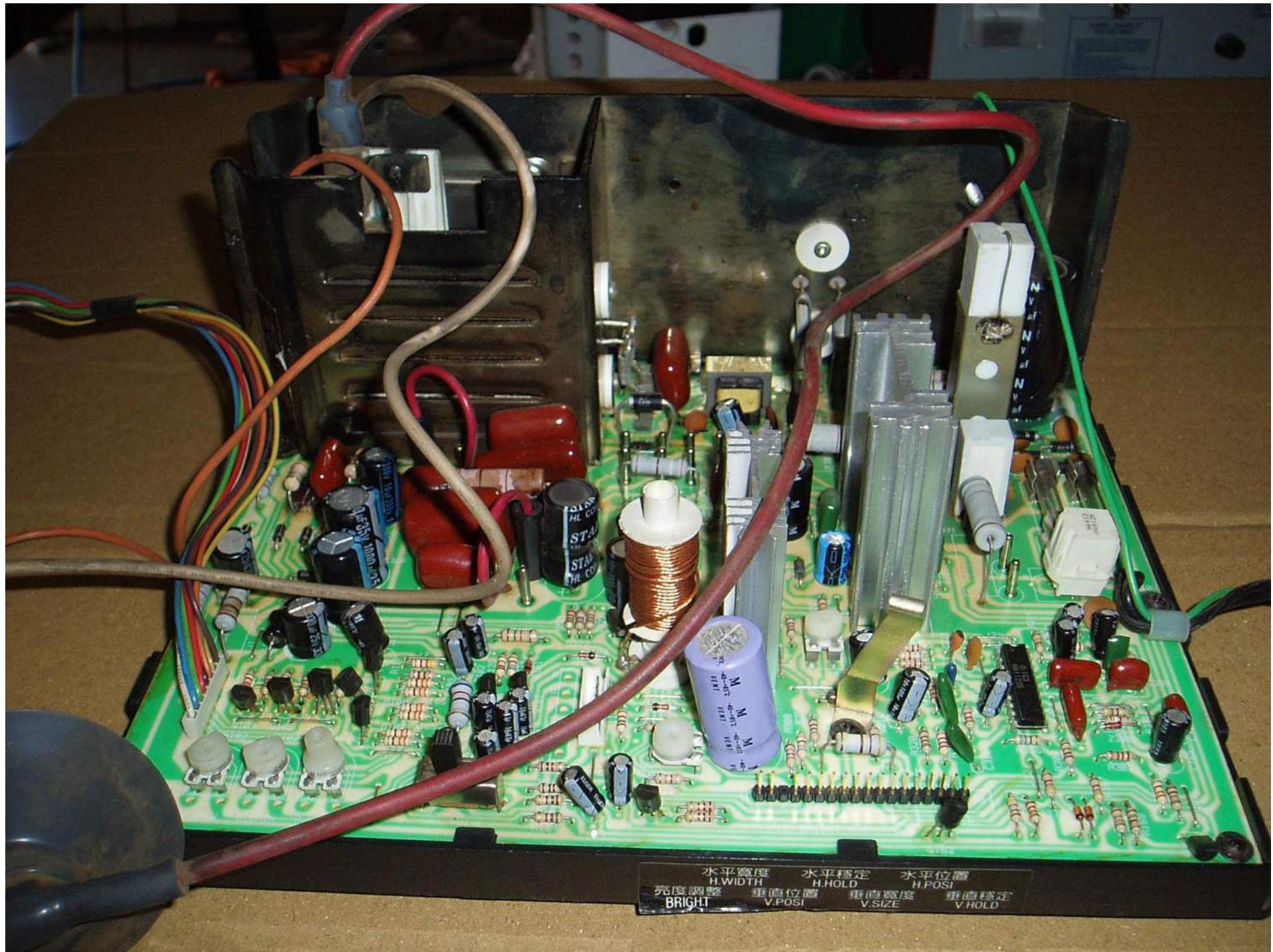
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# **Eygo 728 Glendale GE-728HR Rodo CH-28115K 110v 26~ 28"**

**Symptoms:** Dark on one side of screen

**Cure:** Replace C407 10uf 300v

**Symptoms:** Screen very bright with retrace lines

**Cure:** Check for open resistor R336 3.9ohm 1 watt

**Symptoms:** Picture to big and shaking, power supply won't adjust

**Cure:** Replace C313 100uf 160v and C802 1uf 160v located beside each other.

**Symptoms:** Wont power up, Fuses ok

**Cure:** Check for open resistor R331 6.8K 3 Watt

**Symptoms:** Pin Cushion won't adjust

**Cure:** Replace Q903 2SD1138

**Symptoms:** Hot shorted or failing after short period

**Cure:** Replace C314 10uf 160v

**Symptoms:** Vertical Collapse

**Cure:** Replace vertical output IC302, AN5521, some version used a slightly different IC that has the part numbers rubbed off, This IC is a less common LA7832, not interchangeable with some minor component changes.

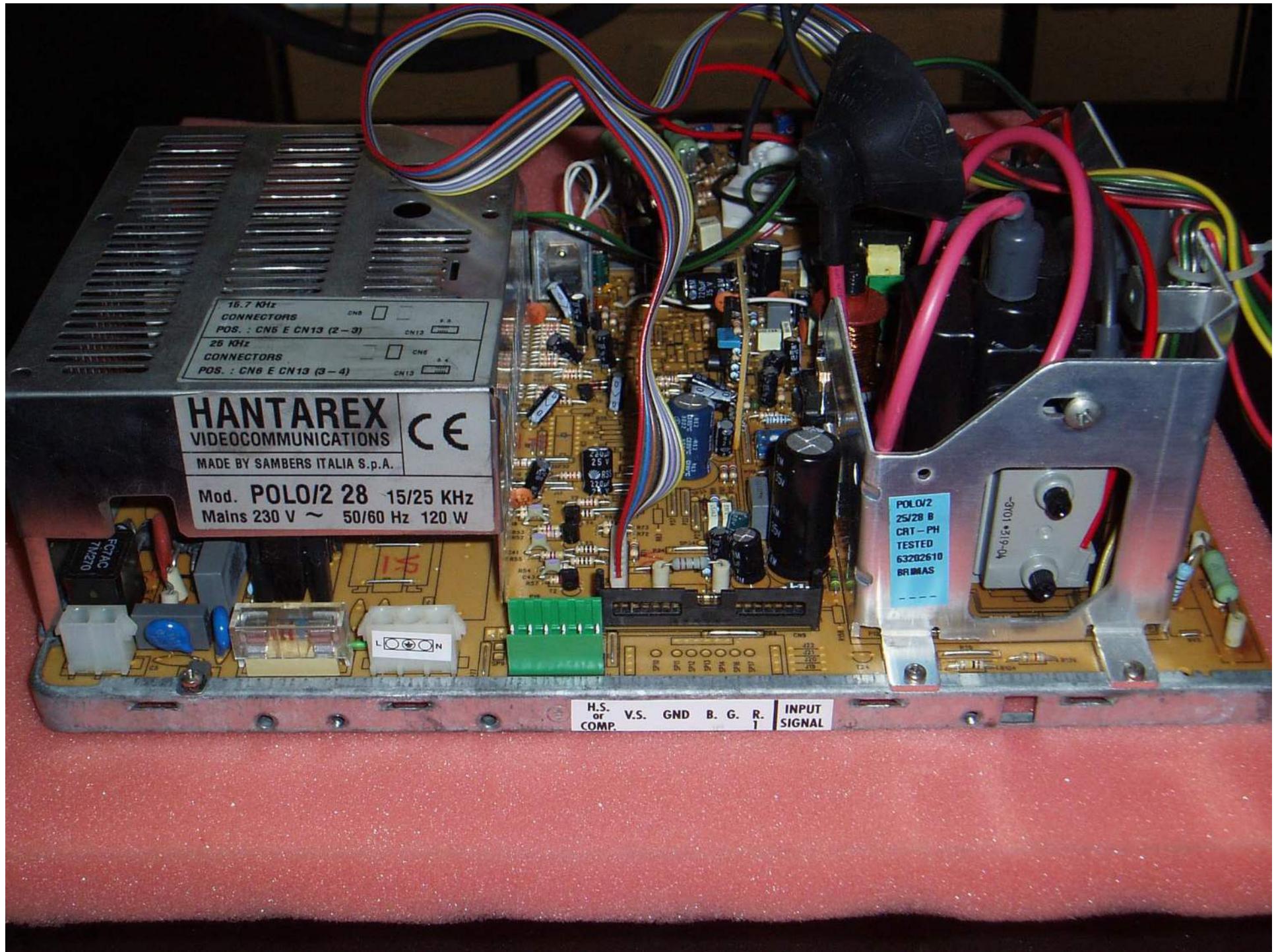
**Symptoms:** Vertical Fold

**Cure:** Replace C393 100uf50v also check or replace C392 22uf25v

**Notes:** Before replacing any suspect components always check these chassis for bad solder joints in suspect area, many display similar symptoms as faulty components.

If having problems in power supply section, check around area's that get really hot as they are known the get cracks through tracks in this area.

## Hantarex Polo/2



## Hantarex Polo/2 28, 15 / 25K 230v 25" – 28"

**Symptoms:** Ticking noise, wont power up

**Cure:** The most common fault with these chassis is flyback failure, If HOT is not shorted flyback will be dead, in some case a dead flyback will destroy HOT

Flyback part number 28020280 or HR 7375

**Symptoms:** Pin cushion won't adjust, picture to wide or to narrow, no horizontal size adjustment.

**Cure:** Check / Replace D47 and or D48, Also check for shorted T19 (BDX53C) If T19 Shorted check R135 (100ohms 1/2w)

**Symptoms:** Vertical Fold

**Cure:** Replace C66 (220uf25v)

**Symptoms:** Vertical Collapse / Severe fold not cures by replacing C66

**Cure:** Check for Open R105 (2.7 ohms 1/2w) if Open replace IC6 (TDA1675), occasionally this IC will partially fail causing severe fold that replacing C66 won't cure. Replace With later revision TDA1675A

**Symptoms:** Wont power up

**Cure:** Check R32 (1ohm 1/2w) Several times

I have seen this resistor open for no apparent reason. (Supply to 12VDC regulator IC3)

gluing or silicone rubber).

**Symptoms:** Taking long time to power up and making a hissing sound

**Cure:** Replace C17 (220uf 25v) & C25 (22uf 50v) & C18 (22uf 50v) all located under power supply cover / cage

**Symptoms:** Making fast click sound when switched on but wont power up

**Cure:** Check for Shorted power diodes D10, D13, D14, D15, if measuring short in circuit but ok out of circuit, check for short HOT or Dead flyback.

To check for dead flyback Remove link J25 beside flyback and check again for shorts across these diodes.

**Symptoms:** Picture shaking, sometimes blanking out, jumping in size with scene changes

**Cure:** Check and or replace C1 (100uf 250v) & C19 (100uf 250v)

C1 is often glued to chassis to prevent cap from breaking off, although this is often still a problem with both C1 and C19 (suggest re-

**Symptoms:** Picture wobbling all over, noticeable buzzing noise coming from under power supply cage.

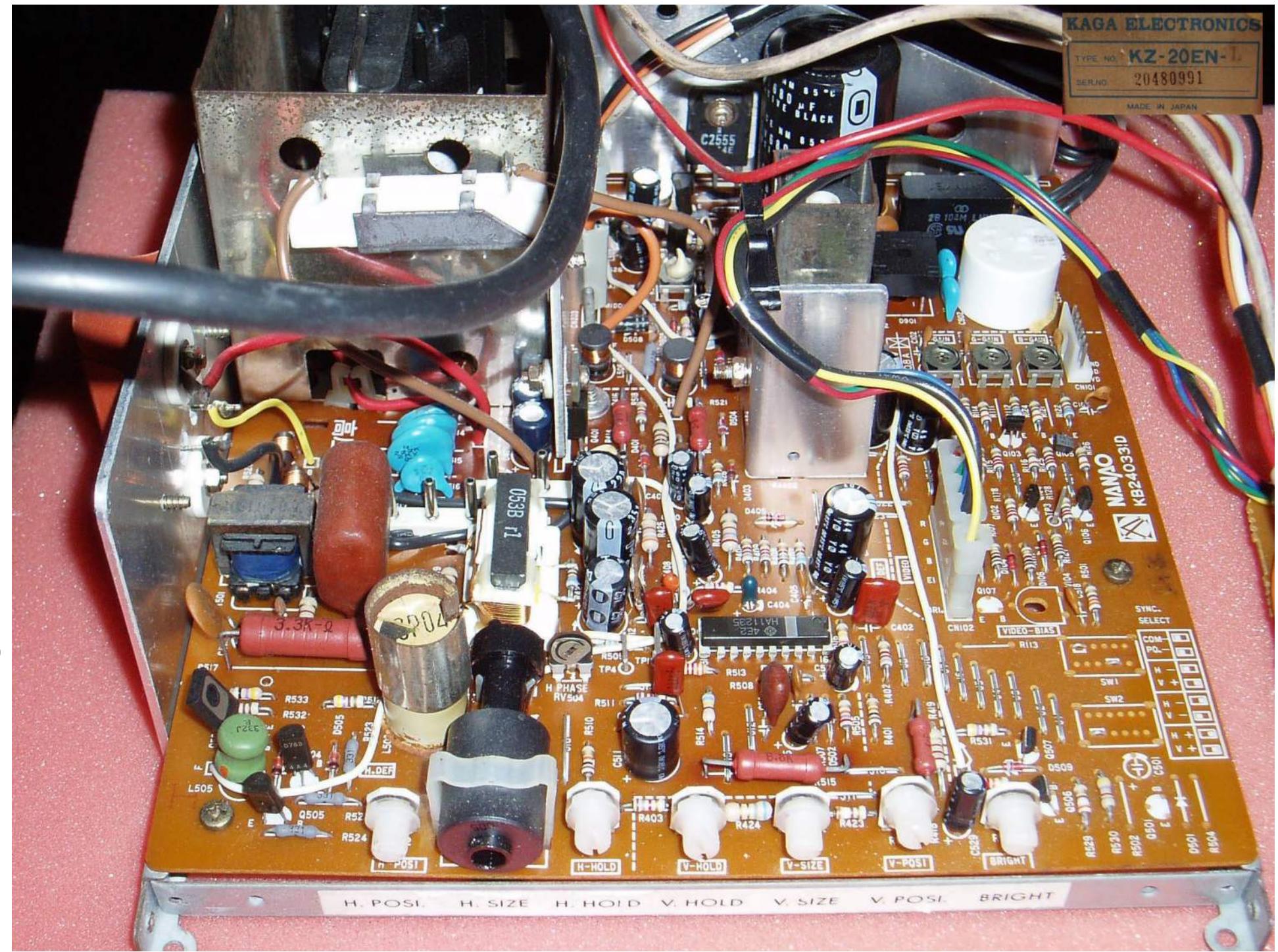
**Cure:** Replace C12 (150uf 400v) main filter cap

**Notes:** As shorted flybacks are very common in this model there is a simple test to find verify this if you are certain the HOT is not dead.

Remove Jumper J25 located beside flyback and connect 60W light bulb across where link should be ( If the light glows brightly and chassis sounds like it is operating normally flyback is dead. (not recommended to operate for more than a minute like this)

Another very common problem on this model is bad or cracked solder connections where control cable plugs into chassis (CN9), The cable between the controls and the chassis is very stiff cable and will often crack these pins off the chassis.

This will display many strange faults and that appear to be component failure, so before searching for any faults "always" check this connector first.



# Kaga Electronics / Nanao / Sega

## **Model: KZ-20EN-L / Sega MC-2000S / TSK-KV19** **(12 Pin CRT,) Flyback MSH1FAC02**

**(See special notes regarding model types)**

**Symptoms:** Vertical Fold

**Cure:** Replace C409 and C416 both (10uf 100v), C411 and C417 both (220uf 35v)

**Symptoms:** Screen Flaring

**Cure:** Remove top cover above flyback and replace C523 (100uf 50v), C526 (10uf 160v), C526 (1uf 160v), While cover is off flyback replace C524 (47uf 160v)

**Symptoms:** Horizontal Tear, Some confuse this for with vertical problems

**Cure:** For 12 Pin CRT type C412

(470uf 16v) not present on 10 Pin CRT "ES" model chassis

**Symptoms:** Vertical Collapse (Common Fault)

**Cure:** Check for Shorted Tantalum capacitor C408 (10uf 16v)

**Symptoms:** Horizontal Hold not locking or changing with heat

**Cure:** Replace C511 (220uf 16v)

**Symptoms:** No vertical hold

**Cure:** Replace C510 (1uf 50v)

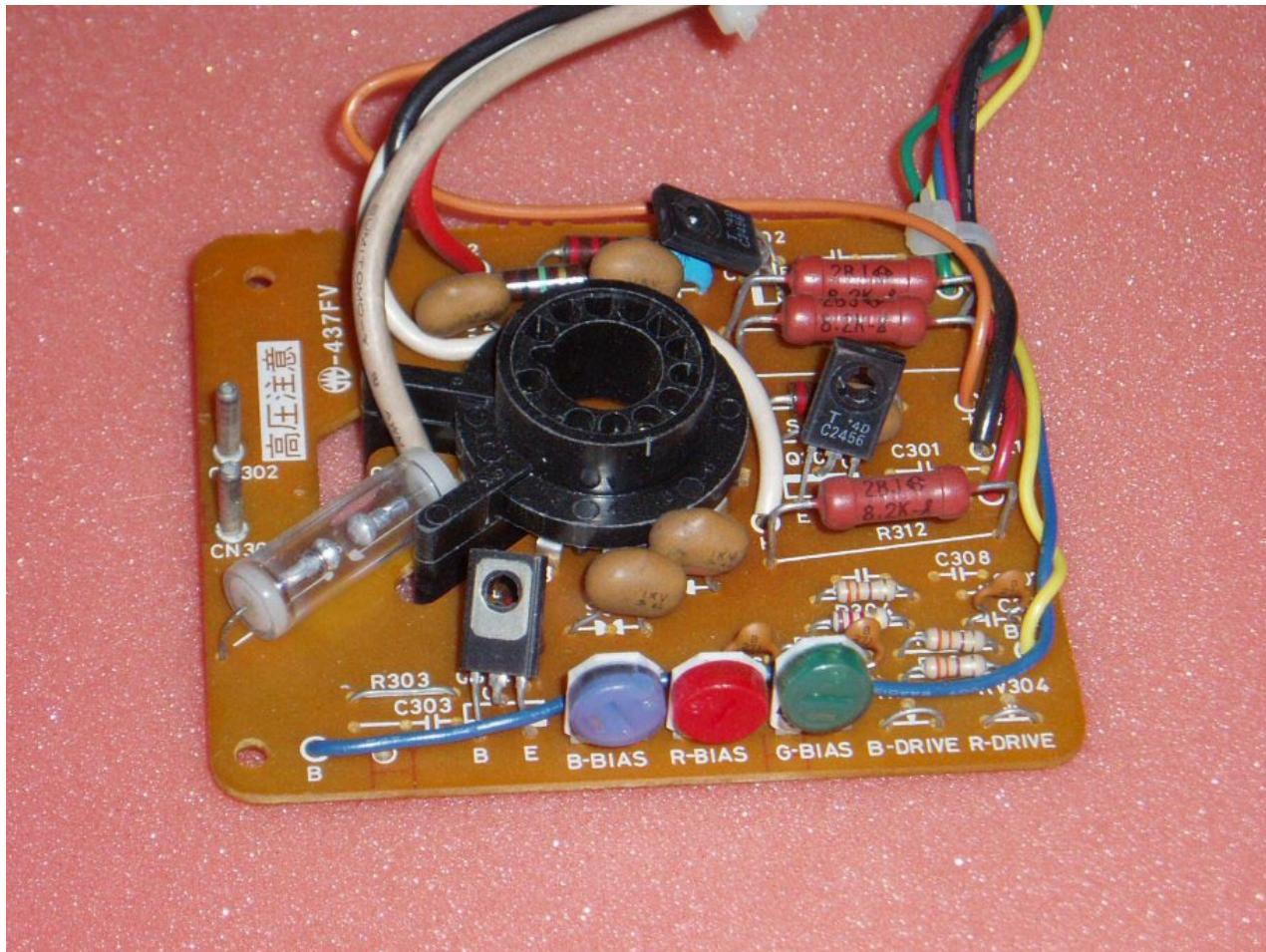
**Symptoms:** Blowing F902 secondary fuse

**Cure:** Check HOT for Short (mounted on side of chassis) if short is measured disconnect and measure again as quite often the short is across C514, C515, C516 (222nf 2KV) High voltage blue caps, these sometimes explode or split open when they short.

If these all appear ok check for physical signs of damage to flyback, they are known to swell, split and short out.

To measure Flyback for short, Disconnect RED wire that connects to flyback under chassis (Marked "G")

## Kaga-Nanao KZ-20EN-L 12pin



## Kaga Electronics / Nanao / Sega

Then measure between the pin on the flyback it was connected to and Ground.

This Model chassis uses a flyback known as a LO-BI 20KV type MSH1FAC02, For 12 Pin CRT only. (As apposed to more common 26KV unit used in the ES type 10 Pin CRT with MSH1FAC13 Flyback)

**Symptoms:** Horizontal position not working, picture shifted to one side

**Cure:** Check for shorted Q505 and Q504 both (2SD763)

**Symptoms:** Picture shaking violently, Sometimes chassis shuts down quickly after switch on

**Cure:** B+ should be Aprox 105 VDC, but sitting around 145 VDC, Check for shorted Q901 (2SC2555)

## **Model: KZ-20EN-L / Sega MC-2000S / TSK-KV19 (12 Pin CRT,) Flyback MSH1FACO2**

**Symptoms:** Not switching on, fuses ok but B+ high

**Cure:** Replace Q902 (2SA1091), Also check for shorted Q903 and Q904 both (2SC2610)

**Symptoms:** Vertical Jitter, Jumping

**Cure:** Replace C406 (470uf 16v)

### **Notes:**

As with many chassis this one is no stranger to bad solder joints, I have come across many of these chassis that have virtually self destructed due to poor solder.

Pay special attention to solder under L502 and L504, and all area's close to these coils.

Many intermittent faults are caused by bad solder joints under connectors

CN102 and CN201, and one that traps many people is a small jumper between the centre leg of Q901 and positive side of main filter cap C905, labelled J32 but often cant be seen.

### **SPECIAL NOTES:**

This chassis has been re-badged many times and causes a lot of confusion regarding model numbers, CRT types, flyback types etc

As a simple guide:  
All models work from 13" to 20" CRT

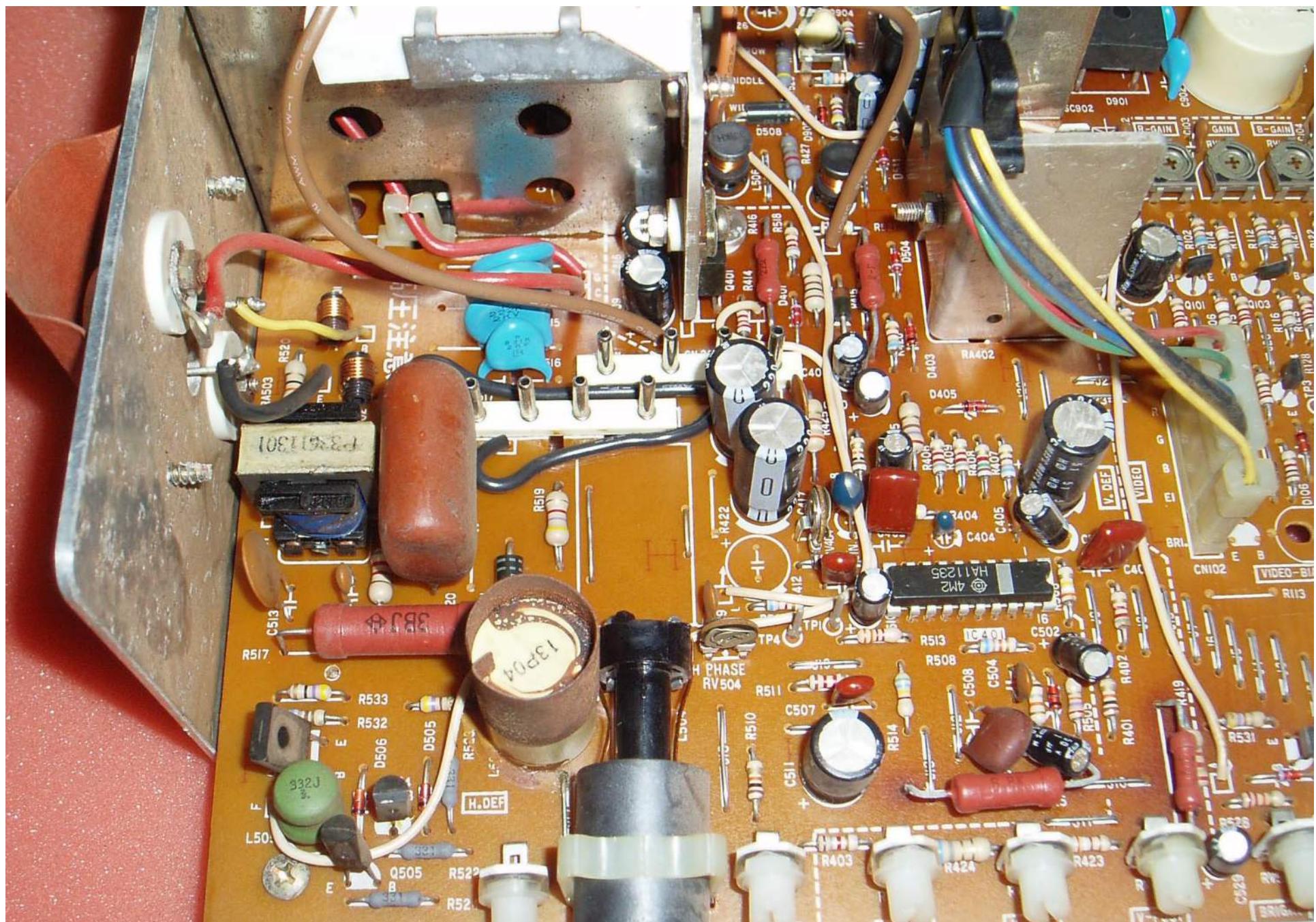
All version with 12 Pin CRT socket use Flyback MSH1FACO2  
EG: KZ-20EN/ L / KV

All Versions with 10 Pin CRT socket use Flyback MSH1FAC13  
EG: KZ-20ES / EV

All 12 pin versions have Coil / Transformer T503, R422 and C412 installed, these components are not installed in 10 Pin CRT versions like KZ-20ES, The KZ-20ES was later replaced and interchangeable with the Nanao MS7-20L

The 12 pin Version can be used on virtually any 12 pin CRT, including much older Kaga Densi, Toei etc, If you find there is a interference lines across screen when trying on different CRT, Add a 1K ohm 1/4w resistor across the Vertical output pins on the chassis ( in parallel with the vertical yoke )

## Kaga-Nanao KZ-20ES-L No-T503

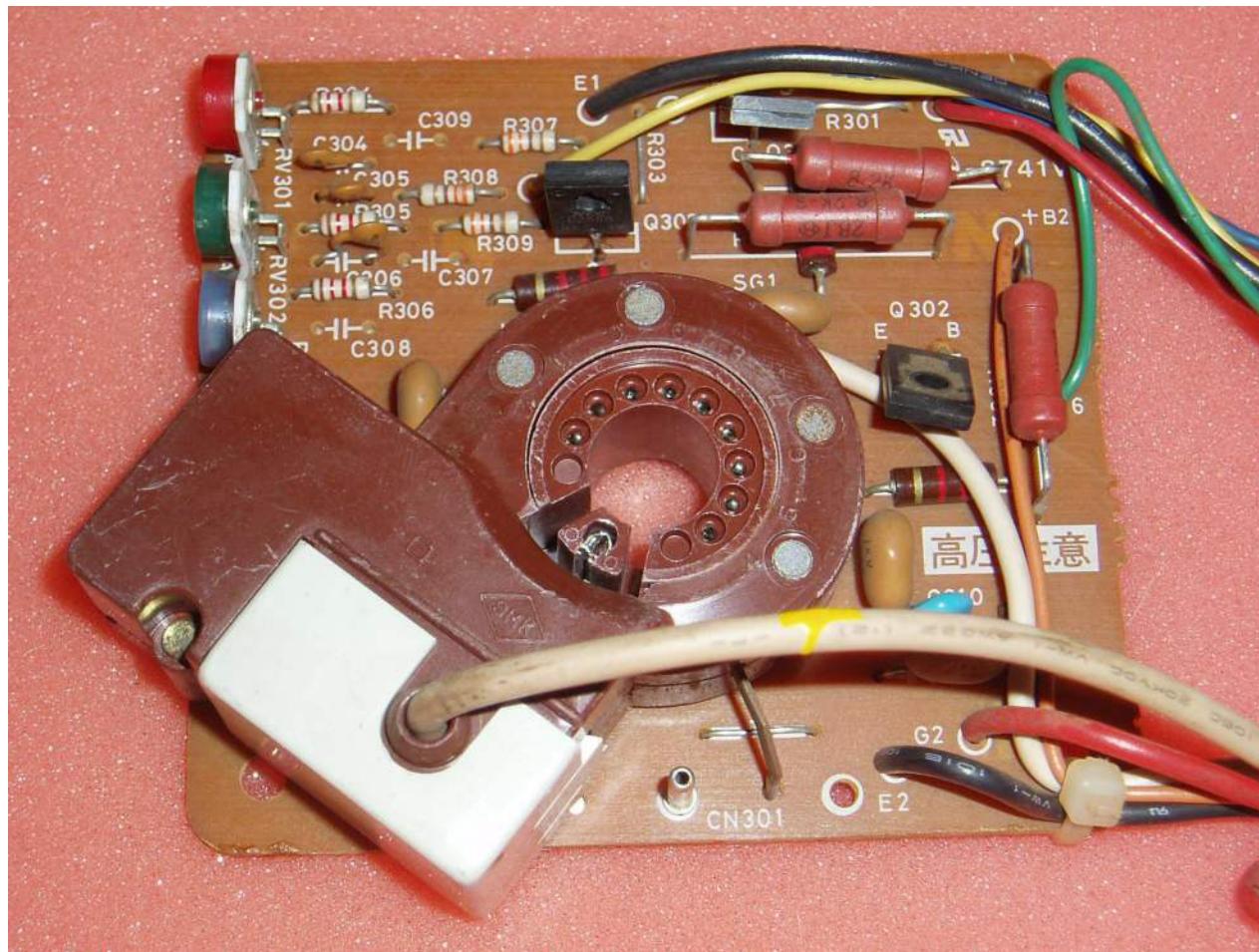


# Kaga / TSK / Nanao / Sega KZ-20ES

10 Pin Type CRT

Flyback MSH1FAC13A,

Some use MSH1FAC11A



**Kaga-Nanao KZ-20ES-L 10pin**

NOTE: These Faults /Solutions are specific to the 10 Pin CRT versions, for all other faults refer to the Kaga KZ-20EN-L etc

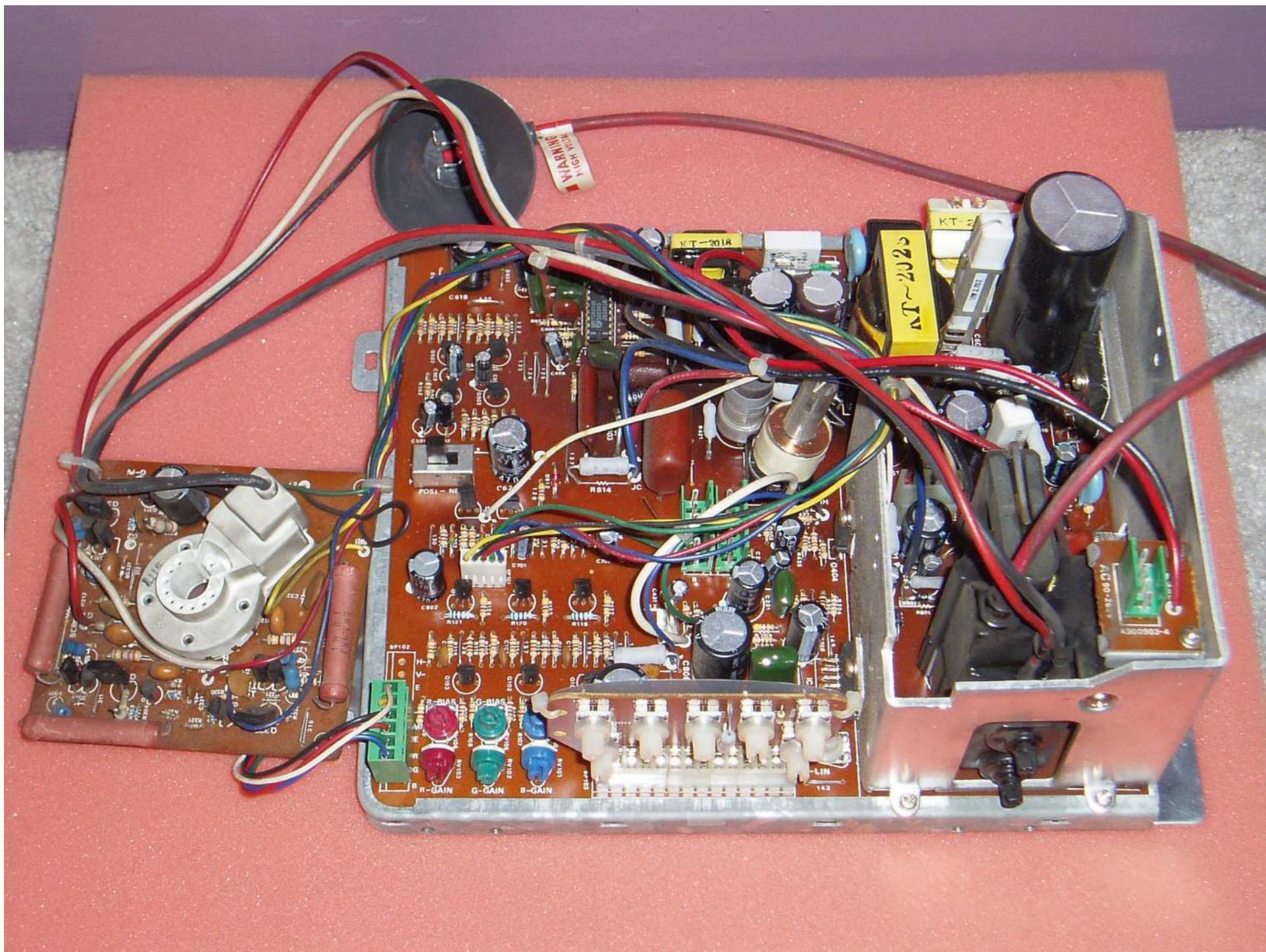
**Symptoms:** Poor Focus

**Cure:** Common fault with 10 Pin CRT socket (Brown Socket), remove cover from socket where focus wire solders to it , if there is any signs of green deposit / corrosion replace socket.

**Symptoms:** Blown fuse F901 (1.25A)  
Lift cover from flyback and check for visible signs of swelling or exploded flyback transformer , very common on this model and often shorts HOT as well .

See KZ-20EN for other faults or instructions to check for shorted flyback if unsure.

## Kortek 20" Free Voltage



## Kortek 20" Free Voltage CGA only

Symptoms: No Picture, High Pitched Squeal

Cure: On visible observation any or all of the filter caps C613, 614, 615 and C616 blown top off or swelled, Replace all 4 caps (100uf 160v)

The reason these caps fail is because 2 other caps in the power supply section fail allowing the B+ to go up to in some cases 200VDC.

Replace C610 (33uf 160v) and C611 (10uf 160v), Also check HOT Q402 (2SD1880) this is often damaged at the same time (Shorted)

Symptoms: Horizontal size won't adjust

Cure: Q404 (BDX53C) or Q403 (2N4403) shorted, sometimes both, caused by burnt / melted Coil L402, Also replace C433 (4.7uf 160v)

Symptoms: Switching off and on randomly

Cure: Check for broken solder under Q401

Symptoms: Blown main Fuse

Cure: First check bridge D601, if short measured across + and - remove IC1 regulator maybe shorted (STR-S5741), This regulator is sometimes damaged due to broken tracks that connect to it, Although they look to be soldered ok that are often broken so try moving each leg of the regulator to see if they move.

Symptoms: Sparking around flyback

Cure: Flyback overheated due to power supply problem above causing it to run way over specifications, flyback number (KFS-60291)

Symptoms: Brightness varying or shaded patch of screen

Cure: Replace C801 (10uf 250v)

Symptoms: Picture fading in and out

Cure: Check for cracked connections under connector BP801 near flyback

Symptoms: Vertical Fold

Cure: Replace C206 (220uf 35v), C202 (47uf 50v) also check C806 (1000uf 35v) Occasionally IC201 is Faulty causing the same symptoms (TDA1675A)

Symptoms: Vertical Collapse

Cure: Replace (TDA1675A) check for open R802 (3.9 ohm 1/2w) and for shorted D804 (IN4004)

Symptoms: Won't start up

Cure: Check for 12 VDC across D812 (12v zener1W) sometimes shorted, Also check for shorted Cap C804 near flyback, + marking

on PCB backward to pay attention to way it is installed (47uf 50v)

Symptoms: Picture has Horizontal interference or jumping in and out of sync

Cure: Check all caps around IC401, C409 (10uf 50v), C617 (220uf 16v) C408 (1uf 50v) C618 (470uf 25v), also note that POSI-NEGA Switch for sync is backwards.

Symptoms: Colour problem, colour locked on flat out

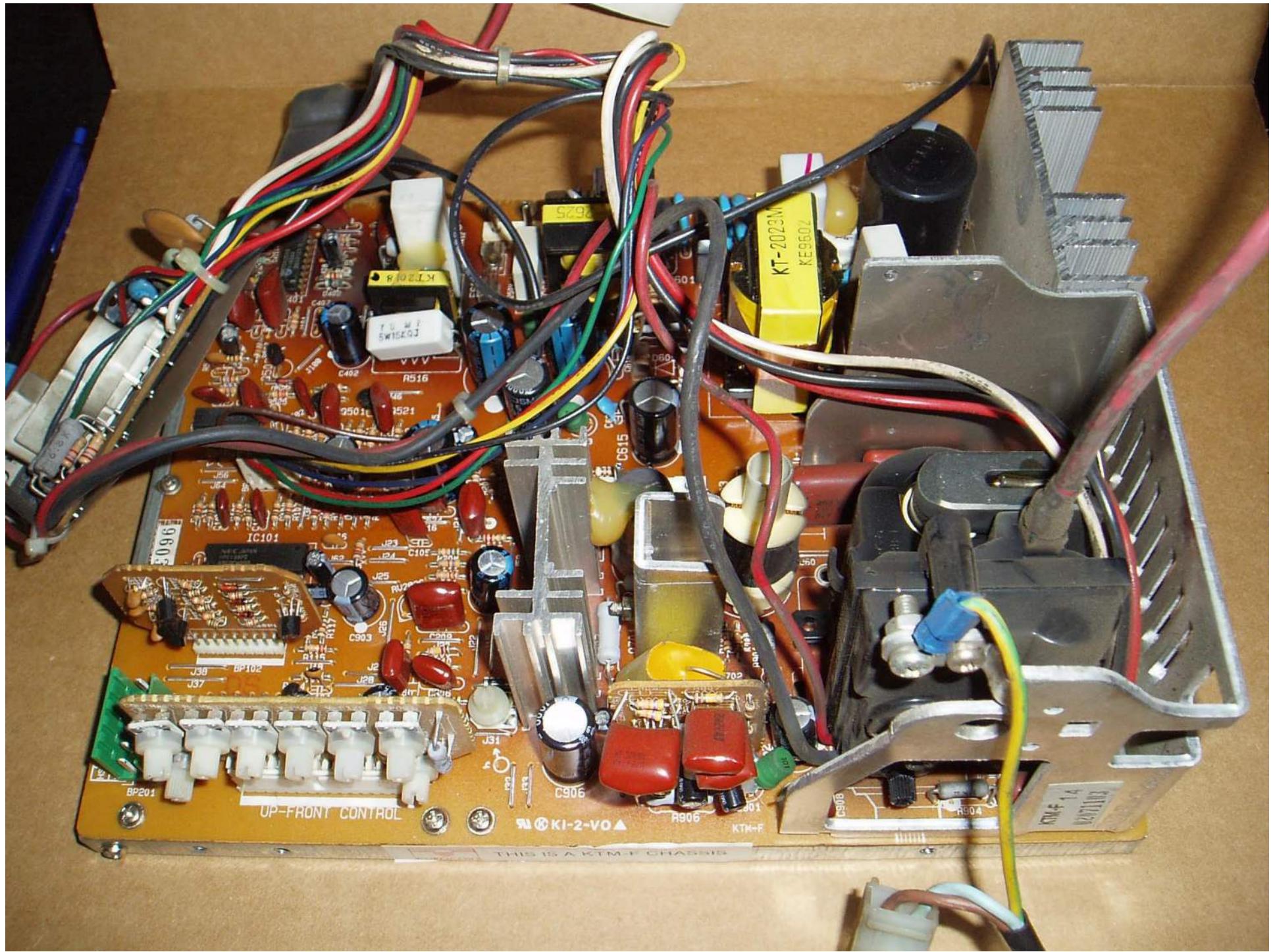
Cure: Check the 3 large resistors on Neck board R325, R305 and R315, they are mounted very close to edge of PCB and often break off or crack the solder, also check that parts on neck board are not bent over touching other parts, this neck board is very crowded and often parts short against others.

Notes: The RGB input and Yoke plug sockets are identical on this model.

If you are not paying attention as I have seen many times with these, people swap the RGB and Yoke plugs over when installing chassis causing major game board and chassis failure.

As with many older Kortek chassis interference is common, this is caused by bad grounding between chassis PCB and Frame, always check that all screws on frame are tight especially the screw under chassis near C805

## KTM-F KTX Sharp Image Sejoo



# Kortek / Sharp Image / Sejoo Corp / Vision

**Model:** KT-2502 / KTM F25 and Various Other model numbers for the same chassis, EG: this chassis is the same as Sharp Image SI-239 and many other model numbers.

**Symptoms:** Blown main Fuse

**Cure:** Check for short across D601 Bridge, if ok replace IC601 (STRS574)

**Symptoms:** Wont Power up, Fuse ok.

**Cure:** Before you do anything carefully check for stored voltage across C606, Replace R604 and R605 (200K 1/2W) one or both open circuit.

**Symptoms:** Picture changing in Size on bright screens (Normally when trying to display white)

**Cure:** Replace C610 (10uf160v) and C609 (33uf200v)

**Symptoms:** Horizontal size won't adjust

**Cure:** Check for short across Q701 (TIP122), if shorted replace and check L402 and L403 for visible burning this will cause Q701 to fail again after short period.

**Symptoms:** Vertical Fold

**Cure:** Replace C205 (220uf35v) if still folding replace IC201, (TDA1675) Replace with later revision (TDA1675A)

**Symptoms:** Vertical Collapse

**Cure:** Replace IC201 (TDA1675A) and R903 (15ohm 1w) and always replace C205 (220uf35v) when this cap fails it will destroy IC201

**Symptoms:** Vertical Hold not locking, picture rolling

**Cure:** Replace C202 (1000uf16v)

**Symptoms:** Colour missing

**Cure:** Check for cracked connections under small rider board BP102, many

of these where not pushed all the way though the holes before they were soldered.

**Symptoms:** No picture, High pitched squeal

**Cure:** Check for obvious burnt flyback, If ok check for shorted Q402 (2SD1880), check for shorts and splits across C418, C421, C422, C420, If any of these high voltage caps are blue in colour instead of standard brown colour they will if not already fail.

**Symptoms:** Vertical interference, band of vertical lines across screen

**Cure:** Check of Philips head screws under chassis that connect to tracks, especially ones in power supply and flyback sections. Check all screws on chassis frame they all must be tight

**Symptoms:** Dark on one side of screen, colours flaring

## Horizontal Tear KTX KTM



## Kortek / Sharp Image / Sejoo Corp / Vision

**Cure:** Replace C903 (33uf200v) some versions used a 10uf or 22uf, replace all with 33uf200v

**Notes:** These chassis used various flybacks; all are compatible with each other though they appear difference in physical appearance.

Can use KFS-61088 or TC8113, HR also make a replacement for these now

HR-46217, some components near flyback will need to be moved slightly to fit the HR replacement.

Many of these chassis have problems with the Horizontal Size and Pin cushion jumping around at random; this is caused by bad solder joints and or cracked tracks under Pincushion PCB mounted just behind R906 beside flyback.

Intermittently shutting down, Check for broken solder / tracks under R415, this resistor sits up high and often breaks off or vibrates loose.

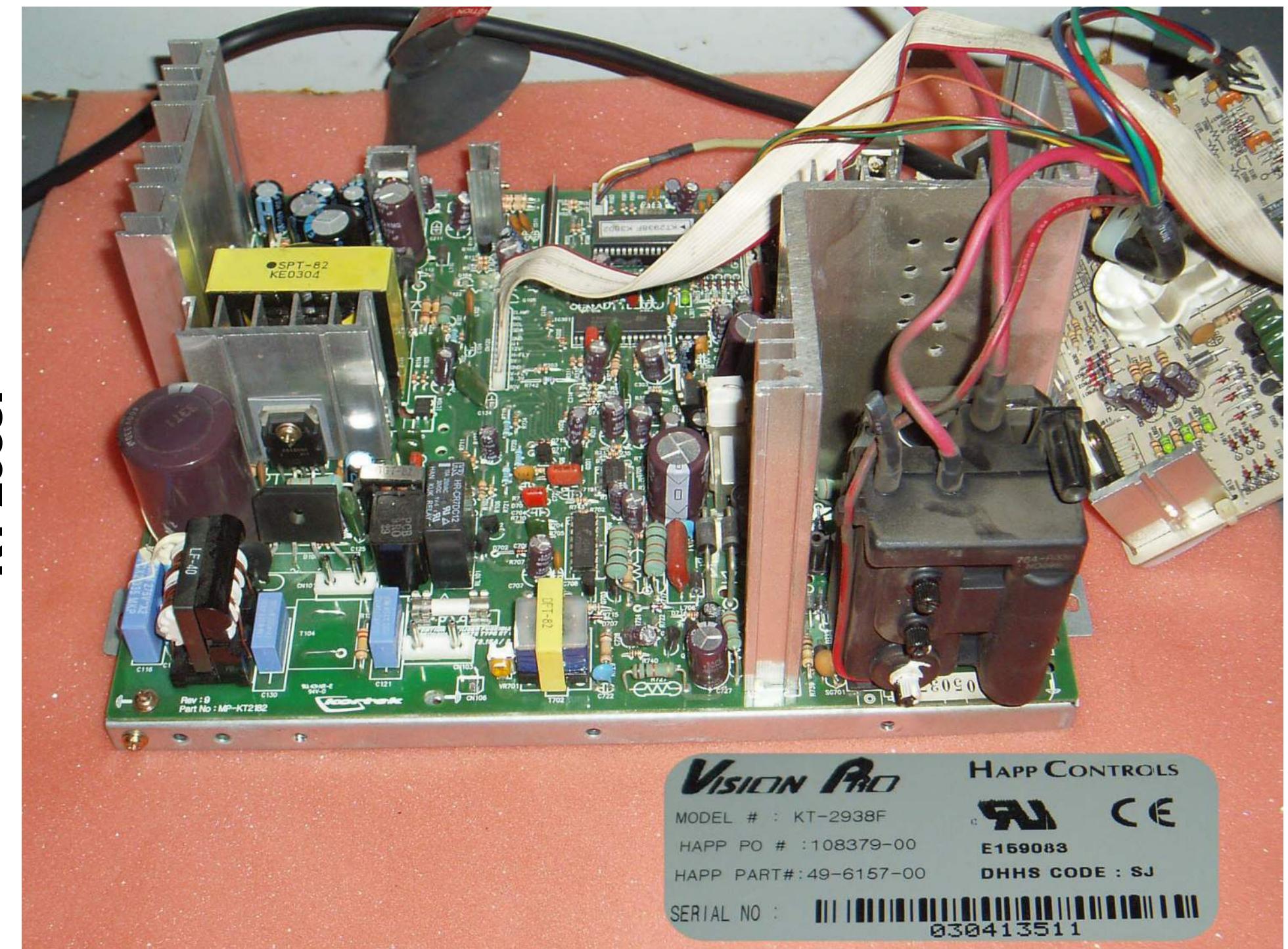
## Kortek-Sharp Additions

**Symptoms:** Wont power up, power supply appears normal

**Cure:** Replace C408 (10uf 50v)

**Symptoms:** Squiggly edges of picture

**Cure:** See photo left, This is the most severe case but starts off at top of picture and grows to cover all picture as cap fails C403 (1uf 50v )



## Kortek – Vision Pro VGA KT-2938F

**Symptoms**: Wont Power up / Clicking / Chirping

**Cure**: Check for shorted HOT Q302, if shorted replaced and also replaced C324 (10uf 63v) when this cap fails it will kill the HOT.

**Symptoms**: Dull Picture / Slow to come up with picture

**Cure**: Replace C118 (470uf 16v)

**Symptoms**: Vertical Lines top or bottom of picture (or slight fold)

**Cure**: Replace C113 (1000uf 35v), C203 (220uf 35v), C205 (470uf 16v)

**Symptoms**: Darker on one side of screen / shading effect

**Cure**: Replace C135 (100uf 100v)

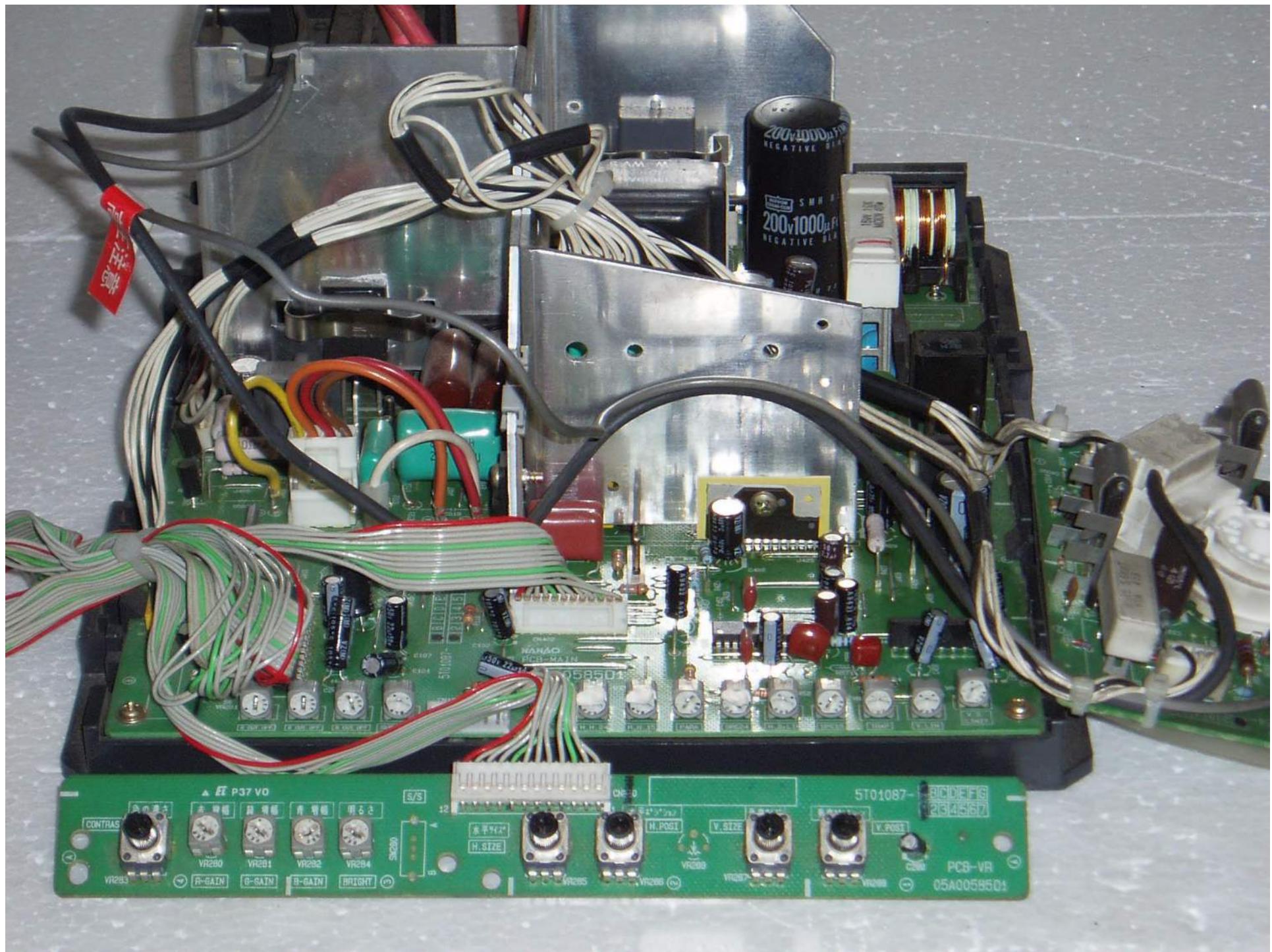
**Symptoms**: Intermittent power up

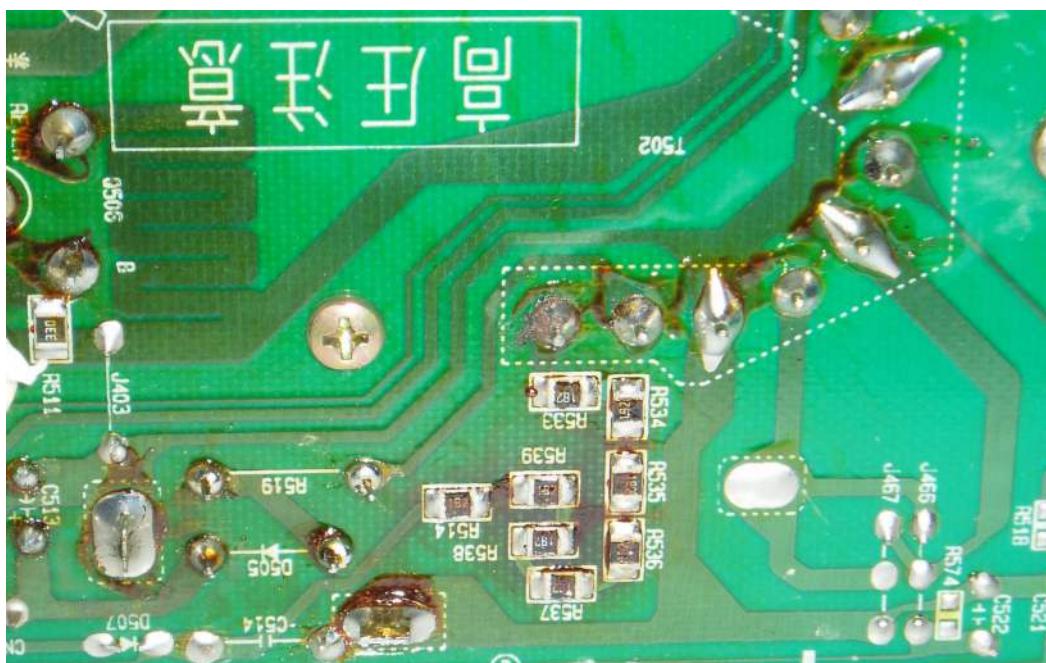
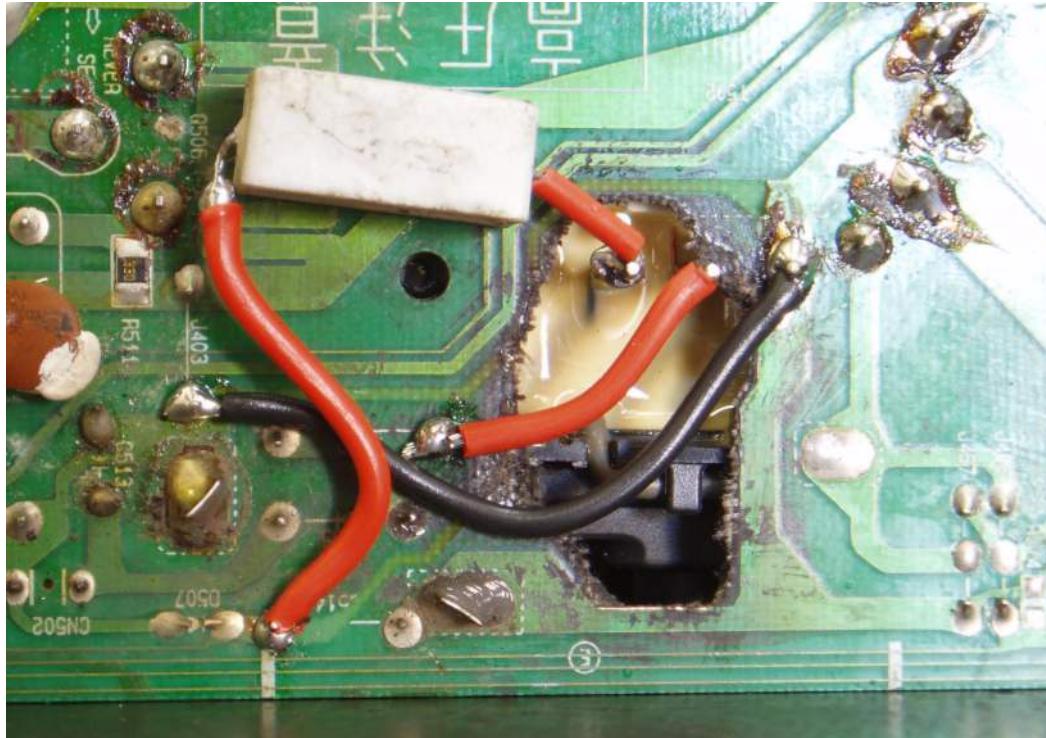
**Cure**: Replace C206 & C207 (470uf 16v) and C123 (33uf 50v)

**Notes**: As with most Kortek monitors this model uses poor quality caps that always fail even if they physically appear to be ok.

I suggest when doing any repairs on these chassis that you replace all electro caps in power supply section and always replace C324 .

# Nanao MS9-29A-T-SU





# **Nanao MS9-29A, T, SU Dual Res 110v, Used by Sega, Namco, Etc 29"**

### Symptoms: Blown main fuse

Cure: Check Q901 Mosfet (2SK1358), Sometimes will fail will HOT is shorted.

### Symptoms: Ticking Sound

Cure: Check for shorted HOT Q506 (2SC4692) or (2SC4188A)

Symptoms: Brightness level changing or picture dull with retrace lines

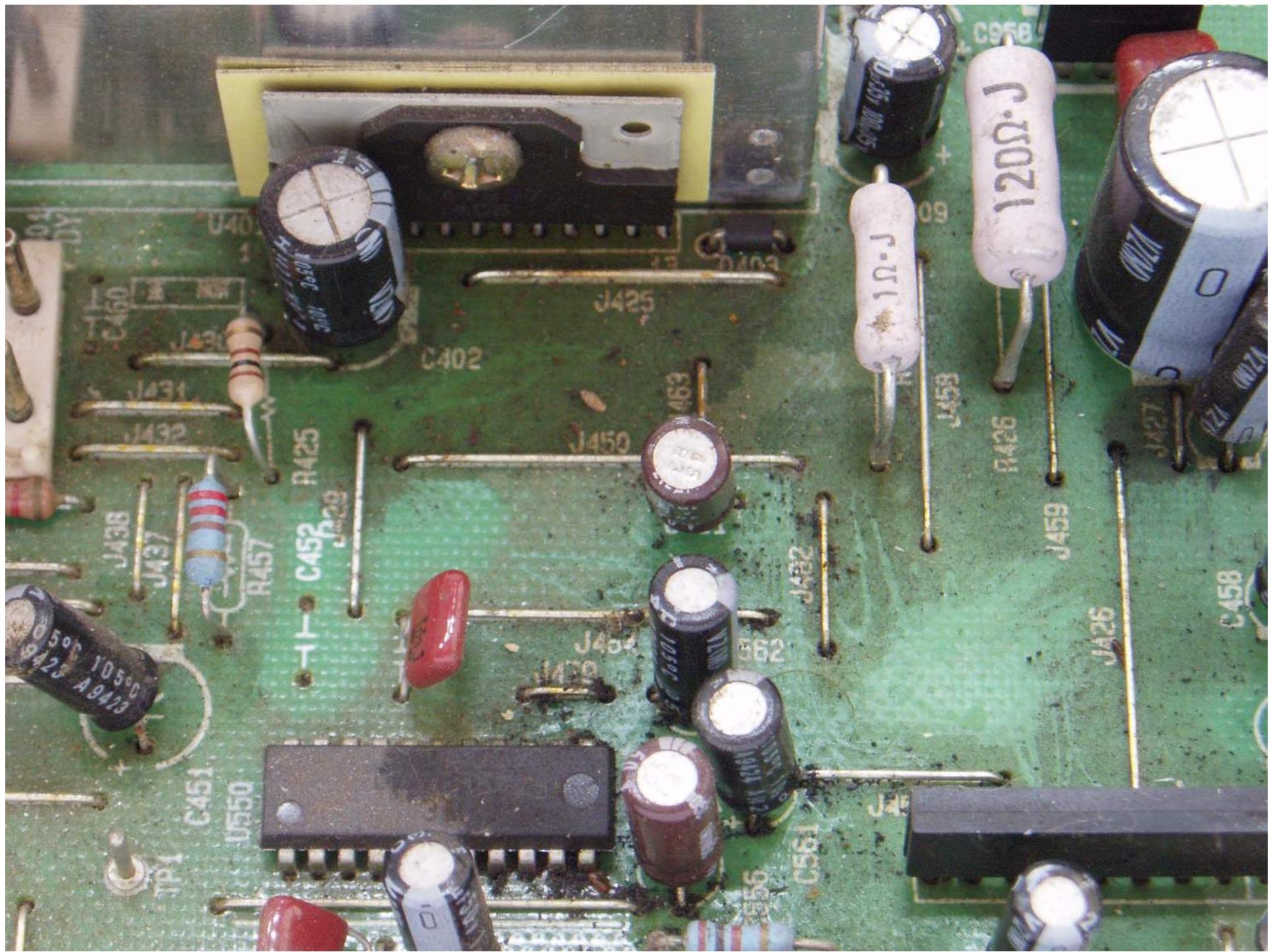
Cure: Replace C513 (10uf 250v) and C332 on neck board (10uf 250v)

Symptoms: One colour on flat out, EG: if blue, it will make screen a bright washed out blue colour with retrace line (occasionally image visible in background)

Cure: See Picture (Shorted Zener or diode) Check for shorted diode on neck board D303, D313 or D323, or Zener ZD301, ZD311 and ZD321 (12 v 1/4w)  
If one of these diodes is shorted remove and retest, monitor will operate fine without diode present.

Also Check for Open resistor R306, R316 and R326 (100 ohm 1/w)

## Leakage



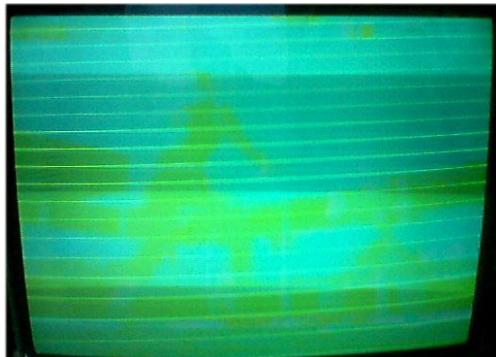
# Nanao MS9-29A, T, SU Dual Res 110v, Sega, Namco 29"

Symptoms: Interference across screen, sometimes noticeable after a clicking sound from neck board.

Cure: Check for broken solder on CRT Socket earth, this pin is located directly under socket where focus lead joins to socket.

Symptoms: Monitor not Starting or sounds like starting up before quickly shutting down. "Most common problem with this model"

Cure: Firstly have a close look at U550 and surrounding area (see picture) leakage.jpg, If it looks anything like this it needs to be cleaned up before proceeding or changing any components., Pay special attention to cleaning in and around the legs of the IC itself and also U401, in some cases you might need to remove them to clean properly.



When clean retest, if still shutting down perform the following test using a 6 volt battery. Connect + to pin 10 of neck board socket and – terminal to any ground point and wait for heater in tube to glow, quickly disconnect and power up monitor and look at screen for vertical collapse, If will only flash on screen quickly before shutting down, If you see this replace the following parts.

U401 (LA7837), C402 (470uf 25v) C407, 408 and 409 (100uf 35v), C958 (47uf 16v) and any smaller electro caps in this area that appear to have leaked, mainly 10uf and 22uf caps.

Symptoms: Picture rolling or not syncing

Cure: See attached picture leakage.jpg, this is the first symptom before you see before the vertical section fails due to problems listed above.

Symptoms: Vertical Fold

Cure: Replace C402 (470uf 25v)

Symptoms: monitor appears to be running, heater glowing but no picture

Cure: Check for Open R519 (4.7 ohm 1/2w), if open replace C513 (10uf 250v)

Symptoms: Monitor Dead, visible damage under flyback, See Picture (surface mount.jpg

Cure: There is a series of 8 x 1.8K surface mount resistors that supply the 12 volt section of the chassis, these run very hot and several times I have seen this area completely burnt up, see picture MS8-29\_Supply Burnt.JPG, these resistors can all be replaced with a single resistor ( 15K 5W).

Look carefully at picture of normal location of resistors and new location of replacement single resistor, also visible are the tracks that burn away when this fault occurs.

Notes: This Chassis will directly replace the SEGA / Sanwa PM1745 model used in many Sega games, only the vertical plug from the yoke will need to be changed to suit.

To date this is by far the most reliable version of any 29" Nanao, there is a later version but the only change is that it is auto switching between 15K& 25K, The normal selection plug has been replaced by a relay.

**Nanao MS8-29FAN**

## Nanao MS8-29 FAN

**NOTE:** This model is almost identical to the MS8-29FSG; please refer to this model for any faults not listed here.

Any Faults listed here are specific to this model

**Symptoms:** Colour problems

**Cure:** This version uses the older small neck board and is easily damaged around colour drive transistors, before looking anywhere else check that Q302, Q312 and Q322 are not broken off, in some case missing.

If ok and solder joints on neck board have been checked but colour missing, check for open resistors R306, R316 and R326, if open check for shorted corresponding zener diodes ZD301, ZD311 and ZD321, Chassis will work perfectly ok without these zener diodes in the circuit.

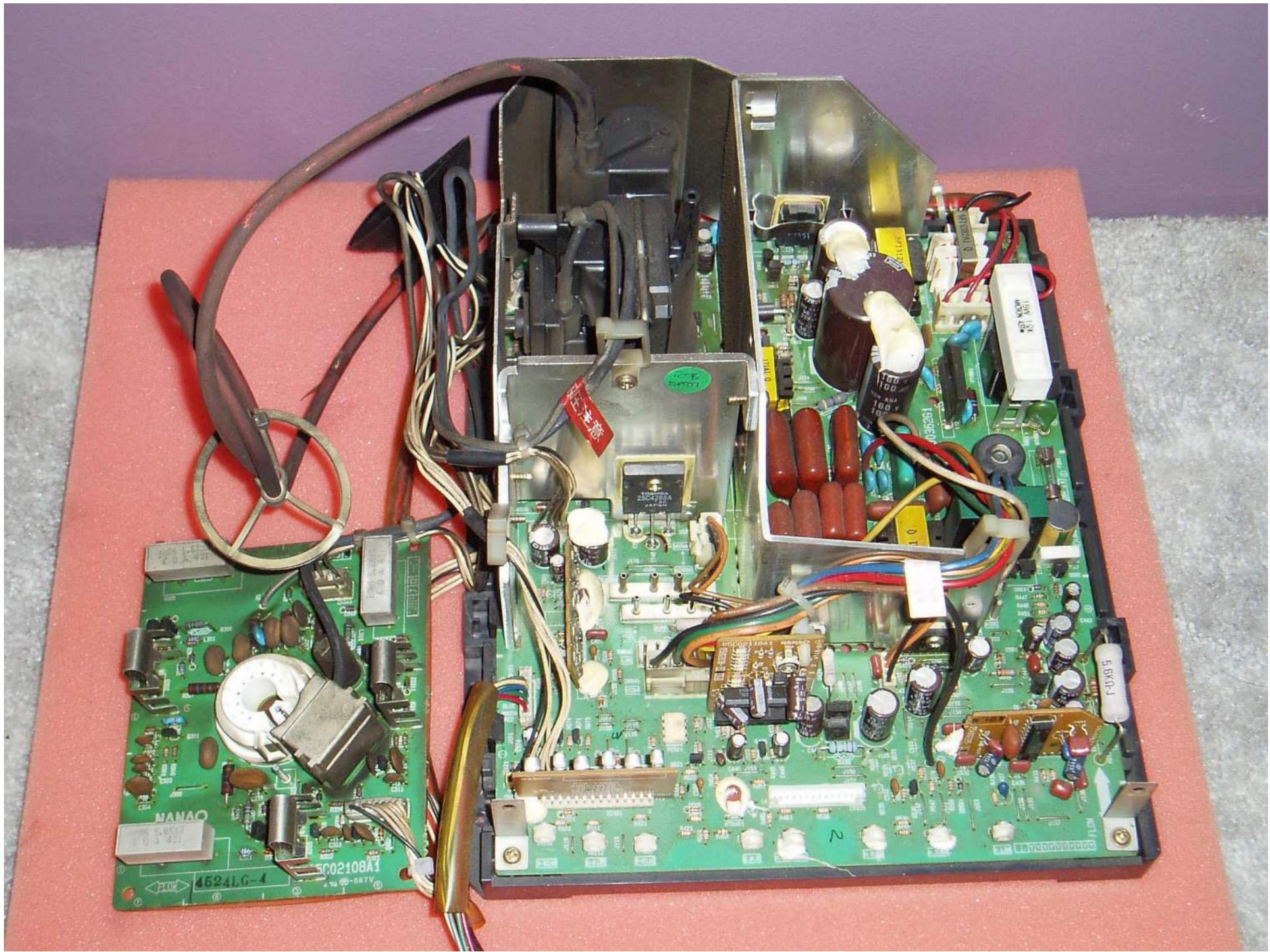
**Symptoms:** Picture fading in and out of running but no heater

**Cure:** Check for bad solder joints under connector CN570

## Nanao MS8-25FB

**NOTE:** This model is identical to the MS8-29FSG; please refer to this model for repair information.

While this model is listed as a 25" monitor, it is a Japanese measurement so it is not like a standard 25" monitor in the USA, and the true measurement is 23" or 59cm's.

**Nanao MS8-29FSG**

## Nanao MS8-29FSG

### Symptoms: Secondary Fuse Blown

Cure: Check HOT, Q533 for short (many types used) (2SC4288A), (BU2520A), (BU508A), Also check for shorted Q901 (2SC3306), can also short Q902 (2SA1091) and Q903 (2SC2482), Most often all this damage is caused by bad or burnt solder under Q532, occasionally when Q532 stops running R542 can burn open (47 ohm 1w)

### Symptoms: Sounds like chassis is running but no picture, heat sinks very hot!

Cure: Measure for 12.6 VDC at end of R913 (end closest to front of chassis), If between 10 and 12 volts solder wire link across coil L902 and measure again, if now 12.6 volts leave wire link in place .

### Symptoms: no power up fuses ok

Cure: Measure for 12.6 VDC at end of R913 as above, If between 0 and 7 volts check other end of R913 should read approx 90 to 105 VDC, (use rectifier negative for ground ref), If this voltage is ok remove zener diodes ZD901 and ZD903 one at a time under R913 (6.2v 1/4w) one or both of these zener's can be shorted.

If shorted check for open R914 (120 ohm 1/2w) and replace Caps C911 (220uf 16v) C913 (220uf 25v) and C422 (470uf 16v)

### Symptoms: Switching off straight after turn on

Cure: Replace Vertical IC401 (LA7832) and C432 (100uf 35v) Also check for Open R432 near flyback (4.7ohm 1/2w)

### Symptoms: Picture Slow to reach full brightness

Cure: Replace C570 (22uf 250v) and check C332 on neck board (10uf 250v)

### Symptoms: Picture won't Sync, Rolling horizontally or vertically

Cure: See note on Nanao Sync Faults (IC102)

### Symptoms: Pin cushion problems (hour glass) H-Size to small

Cure: Check for shorted Q408 (2SC3621) or broken / bad solder joints under this transistor, also check IC402 (SUB board used on this model) for obvious burnt components or broken solder joints under chassis.

### Symptoms: Intermittent shut down, sometimes on switch on

Cure: Replace C909 (100uf 160v)

### Symptoms: Continually blowing HOT after running for several hours or days

Cure: Check that Coil L531 is not touching the screw that mounts D530 to heatsink, if can wear through the enamel on the coil or even arc between gap causing HOT to blow instantly.

If above is ok and other cures ruled out, replace IC502 (HA11423), C430 (1uf 25v Tantalum), C420 and C532 both (1uf 50v) all located on small SUB PCB Marked IC103

### Symptoms: One or more colours missing

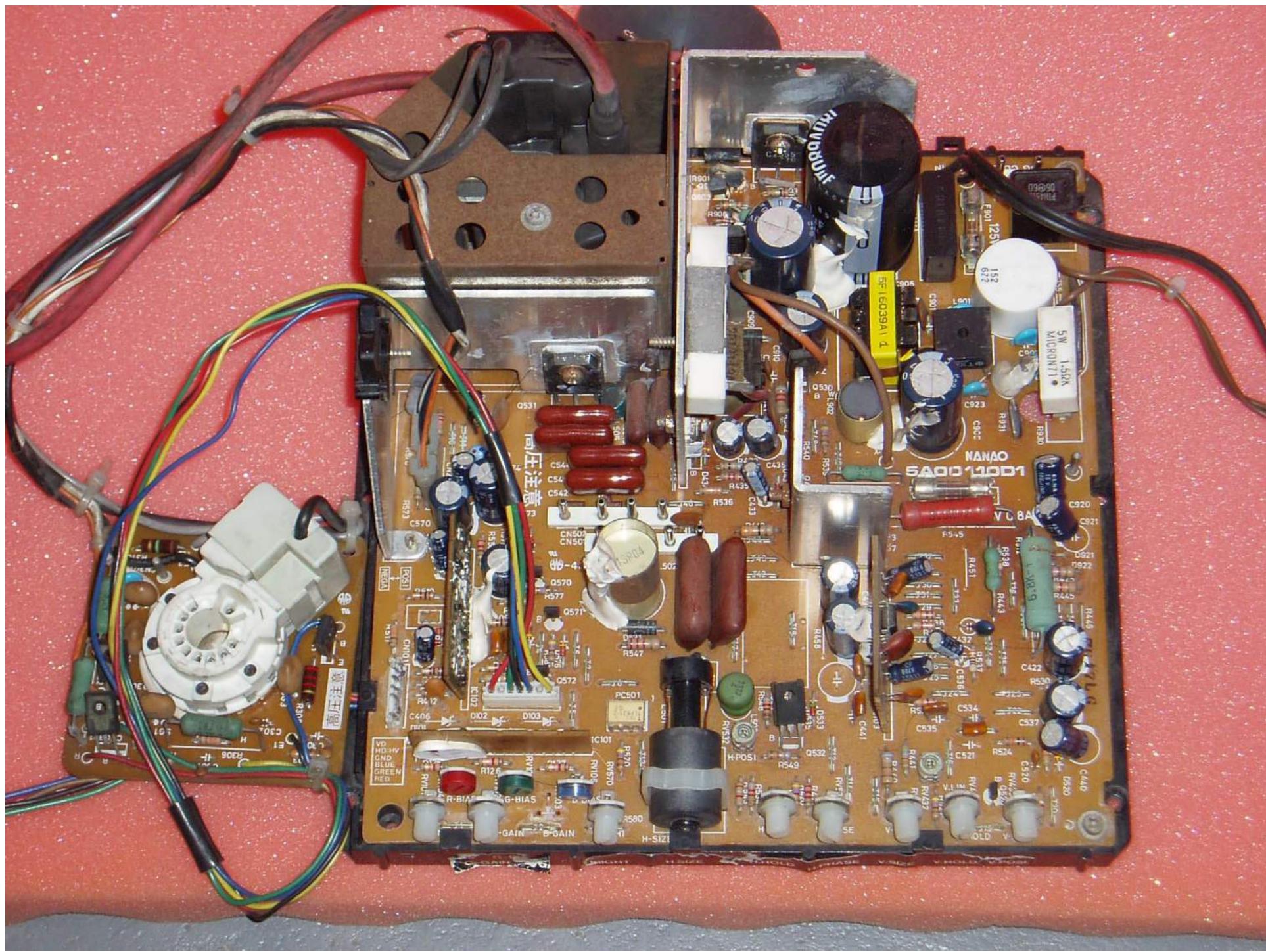
Cure: Lift one end of zener diodes ZD101, ZD111 and ZD121 one at a time, can be run perfectly without these zener's in circuit, they are there for protection but cause more problems than they protect.

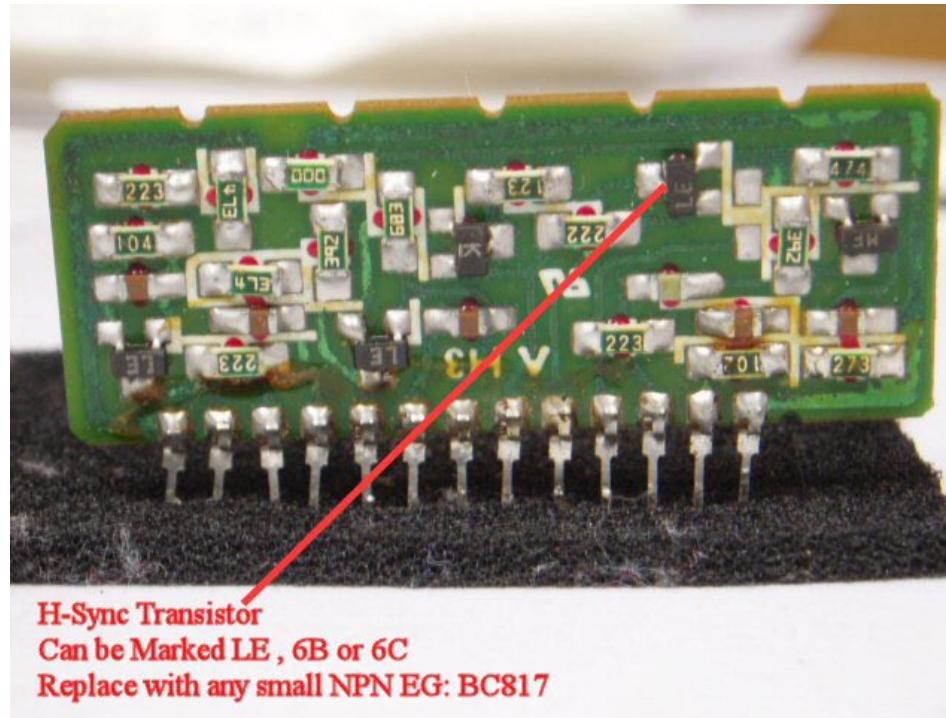
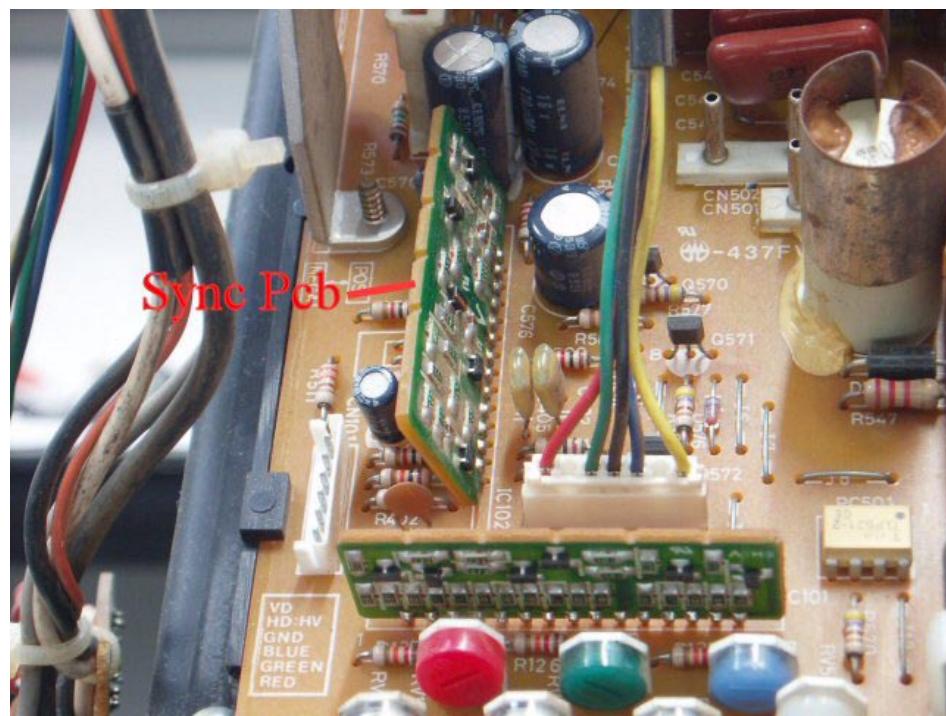
### Symptoms: Picture going black but chassis still running

Cure: Resolder Q572, even if it looks like it is soldered ok

Notes: These was the last of the 29" dual Res MS8 series, it was replaced by the MS9-29A. The MS8-29FSG and MS8-29FAN are almost identical except for a larger upgraded neck PCB and additional pin cushion control PCB on the FSG model, There are other very minor layout changes but on first inspection many people believe they are identical.

## Nanao MS720L





## Nanao / Kaga Denshi / Sega MS7 and MS8 Series all

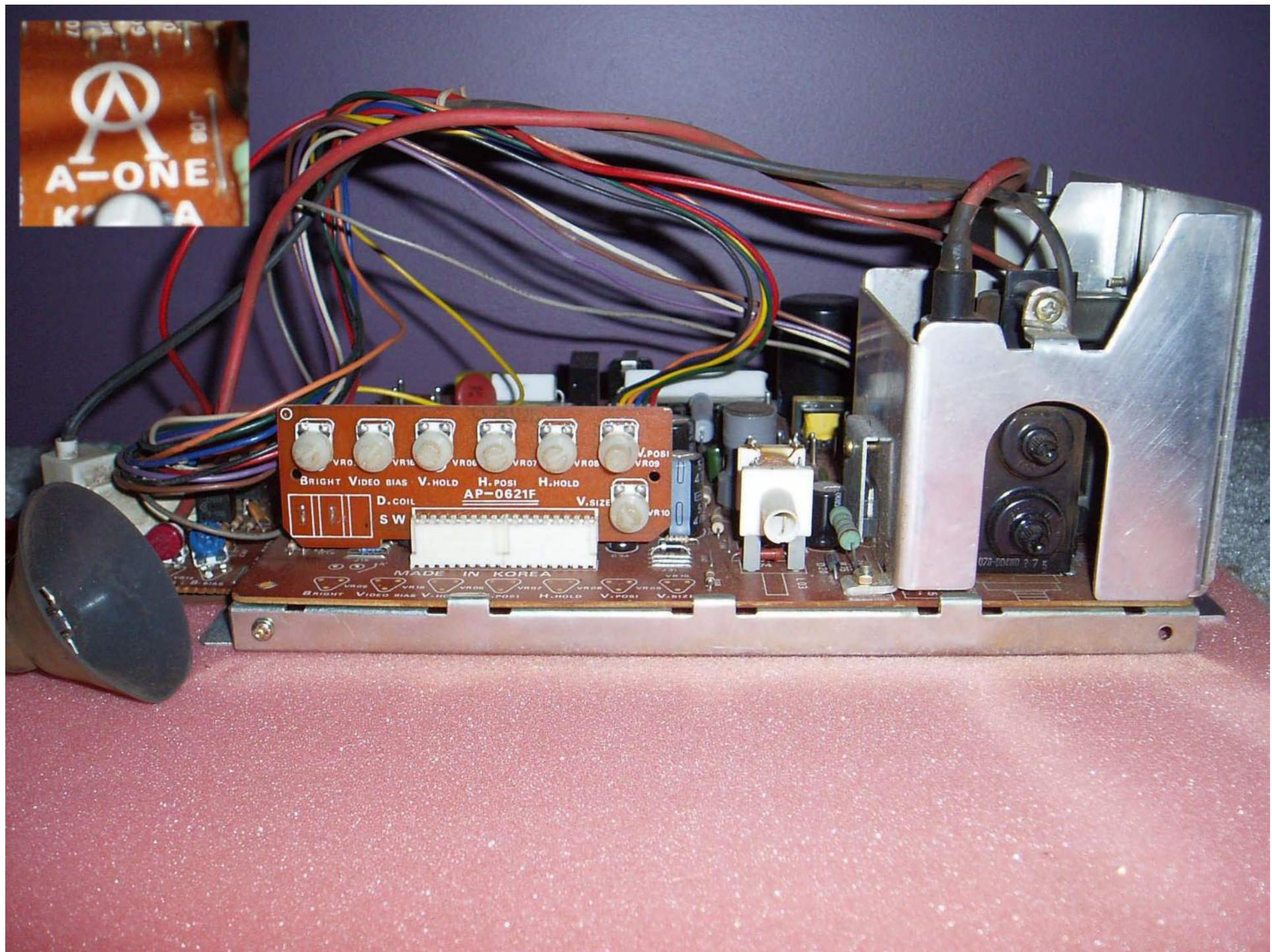
**Symptoms:** No Vertical or Horizontal Sync

**Cure:** This problem is seen on many of these chassis and often caused by leaking or cracked flyback, missing or bad CRT earth connections and also when attempting to run these monitors out of range EG: with newer 39 in 1 games on wrong sync settings, and when using with Mame applications on wrong settings.

These transistor can often read dead short or low resistance when damaged, they are only very small so are easily and regularly damaged.

It can be easily repaired by replacing a single Surface mount NPN transistor on the Sync PCB see attached Pictures.

The transistor is a very common standard NPN type like BC817; many other generic equivalents can be used.



## Orion (Korean) A-One

**Symptoms:** Vertical Fold

**Cure:** Replace C17 (100uf 50v)

**Symptoms:** Vertical Collapse

**Cure:** Replace U02 (LA7830)

**Symptoms:** Picture Shaking / Wobbling

**Cure:** Replace C05 (22uf 160v) and C03 (47uf 200v), Check for Shorted power transistor mounted on side frame of chassis (2N3055), if shorted will sometimes takeout Q02 (2SC2310)

**Symptoms:** Large Resistor (220 ohm 25w) mounted on side frame of chassis smoking or burnt out

**Cure:** Replace 2N3055 mounted on side of chassis; also check for shorted Q05 HOT (2SD1398) often shorts out causing power supply section to fail.

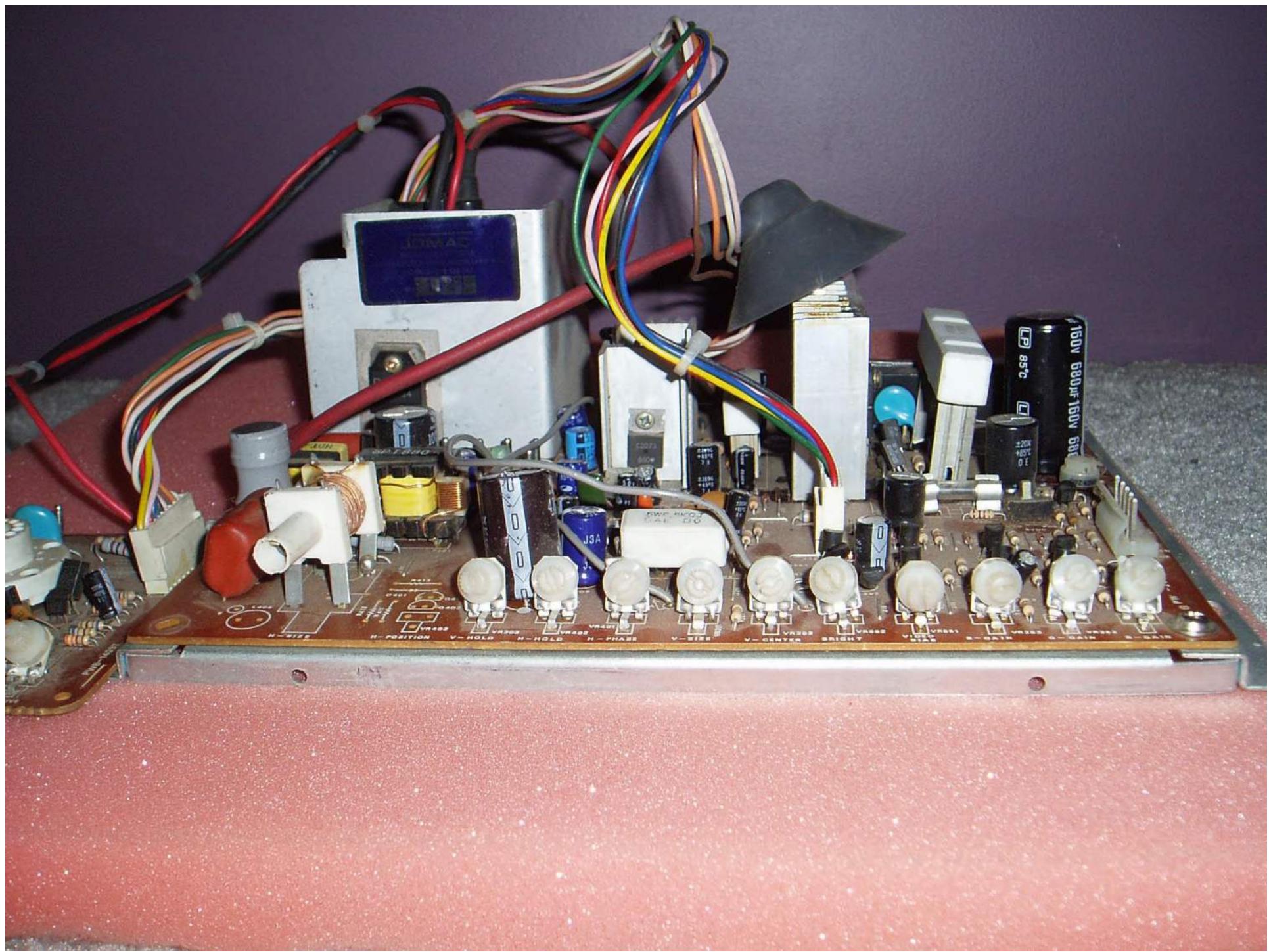
**Symptoms:** Wont power up, regulator on side frame very hot

**Cure:** Check for shorted HOT Q05 (2SD1398)

**Symptoms:** Picture very dull, no brightness or colours missing

**Cure:** unfortunately this is the most common problem with these monitors and is caused by CRT failure; This CRT is only an 8 pin type so not easily replaceable or checked with standard rejuvenator adaptors.

**Notes:** While the CRT's on this monitor are known to fail the chassis were very reliable, I have replaced faulty CRT's with many common types of CRT's used in 20" AKAI TV's and other cheaper brands, in some cases the Yoke did not even need changed so measure Yoke impedance before going to all the hassle of changing yoke and setting up convergence again.



## Orion (Korean) PWB-2012 PWB2022 14" to 20"

### Symptoms: Vertical Fold

Cure: Replace C421 (22uf 160v) and C309 (4.7uf 25v) and C314 (4.7uf 160v)

Symptoms: Very bright washed out picture before shutting down or blowing Fuse 802

Cure: Replace C420 (100uf 50v) C315 (220uf 16v) and C551 (10uf 63v) Always replace these caps when working on this chassis, if left faulty it often melts the flyback.

Also check C418 (1uf 250v)

Symptoms: Blown Main fuse PWB-2012

Cure: Replace bridge rectifier D801 with 4 amp type (KBL-404) as done in later PWB-2022

Symptoms: Horizontal hold and picture not stable

Cure: Replace C308 (220uf 16v)

### Symptoms: Pin Cushion fault

Cure: Replace C311 (470uf 25v)

Symptoms: Picture shaking /wobbling

Cure: Replace C807 (22uf 160v) and Check for open R802 (10K 1/2w) also check main filter cap for obvious leakage C805 (680uf 200v)

Symptoms: Fuse F802 Blown

Cure: Check for shorted HOT Q404 (2SD1398), if shorted also check for shorted Q801 (2SC3306), Check for obvious signs of blown flyback or measure for shorts.

2 types used KFS-60314 and later revisions KFS-60344A both are interchangeable.

Most common reason for above faults is shorted Yoke/Deflection Coil, To test for this leave yoke plug off and power up chassis, you should see a bright dot in the middle of the screen, then plug in yoke plug, if fuse blows again Yoke is dead.

### Symptoms: Vertical Collapse

Cure: Check for open R317 and R318 (3.3K 1/2w) also check for bad solder around Q301 and Q302, also check for broken track under C421

Symptoms: Shutting down when warm or after short time

Cure: Check that B+ is set to 110vdc at Fuse 802, if wont adjust check for shorted Q801 and for open R805 and R806 (47K 1/2w) if ok replace Q802 and Q803 (2SC2482)

Symptoms: Colours bleeding /flaring

Cure: Replace C254 (220uf 25v) and C251 (100uf 25v)

Symptoms: Colour missing

Cure: Check all transistors on neck PCB for bad solder, also check for broken pots.

If colour still missing check for open R226, 227, 228 (1K 1/2w)

## Orion (Korean) PWB-2012 \_ PWB2022 14" to 20"

Occasionally a transistor will fail on these neck boards so to identify the fault one swap parts from known working colour. Faulty transistor will more than likely be one of the larger types 2SC2383 in Q201, Q203, and Q205

Blue=Q201, Q202

Green= Q203, Q204

Red= Q205, Q206

Q202, 4, 6 are 2SC945

Q201, 3, 5 are 2SC2383

Symptoms: Picture fading in and out, or chassis running but no picture / no heater

Cure: Check heater connections to CRT, start from Pin3 of Flyback, Check R419 (1.2 Ohms 1w) and check for cracked connections under CN203 and on Neck PCB CN201, From CN201 Orange Wire marked S2 and Brown Wire marked S1, they go to Pins 6 and 7 of CRT socket, all of these points are known problems.

Symptoms: Vertical Hold won't lock

Cure: Replace C410 (1uf 50v)

Symptoms: No Power up, B+ ok 110vdc and fuse 802 ok

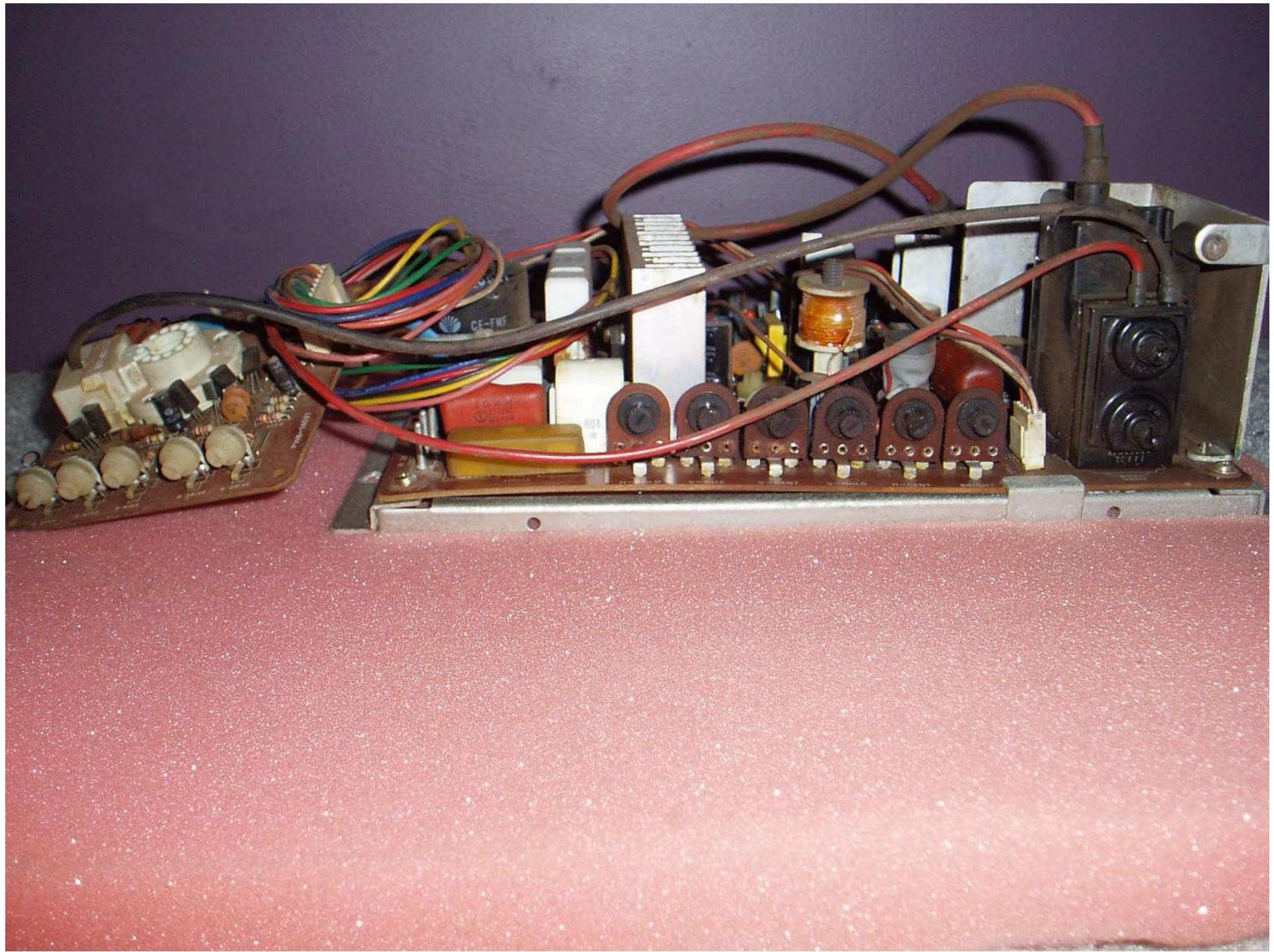
Cure: Check for B+ at one end of R405 (6.8K 5w ) and 12.6vdc at other end, if lower than 12.6 and R405 very hot remove IC101, if voltage comes back to normal replace IC (HA11235) also check that R405 is not bent over touching on link J19 this is cause of IC blowing.

Notes: This chassis is also a universal replacement for all 12 pin CRT's, as many of the original CRT's fail due to shorted Yokes these chassis can be used on many other CRT's.

It is also worth noting that although the Vertical Sync pin is not installed on these chassis, the wire can still be added to solder pad labelled Sync V. Very handy for replacement older chassis that needed dual sync like space invaders etc.

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	<a href="#">Praises &amp; Complaints</a> Experiences w/Mfg Customer Service, Distributor, etc.	22	6	12-26-06 12:19 am
	<a href="#">Buy It, Sell It</a> Coin-Op MarketPlace	117	58	2-19-07 11:44 am
	<a href="#">Game Technicians Wanted/Looking</a> Coin-Op Techs Wanted, Coin-Op Techs Looking	7	7	10-15-06 1:03 am
	<a href="#">Archives</a> Older (searchable) coin-op discussions	6569	1771	12-19-04 1:30 pm



## Orion (Korean) PWB-2018

Symptoms: Vertical Fold

Cure: Replace C311 (22uf 160v) and C306 (4.7uf 50v) Also change C310 (4.7uf 160v)

Symptoms: Vertical Hold won't lock (rolling)

Cure: Replace C503 (1uf 50v)

Symptoms: Vertical collapse

Cure: (first check Switch 301) should always be switched to Normal.  
Check for open R312 and R314 (3.3K 1/2w) and R317 (39 ohms 1/2 w), Check for cracked or broken solder under R315 and Q301 and Q302.

Symptoms: Side of picture distorted, looks like pin cushion problem.

Cure: Replace C312 (470uf 25v) and C414 (470uf 25v)

Symptoms: Picture flaring, brightness not stable

Cure: Replace C410 (4.7uf 160v) and C403 (470uf 25v)

Symptoms: Picture wobbling

Cure: Replace C406 (22uf 160v), Check R802 (10K 1/2w) and check that C413 is not broken off.

Symptoms: Power supply problems, Should be set to 110VDC at fuse FB02, Adjustment not working, voltage to high or to low

Cure: Check for broken solder under R804 (220 ohm 20w), lift one end of R805 and R806 to measure for open ( 47K 1/2w ), Check Q801 for Shorts (2SC3090) or (2SC3306) if all measures ok replace Q802 and Q803 (2SC2482)

Symptoms: Blown Fuse FB02 1.25A

Cure: Measure for shorted HOT Q402 (2SD1398) if blown always check for shorted Q801 in power supply before powering back up.

If fuse blows again remove Q402 and measure solder pad from where collector (centre pin of Q402) and Ground if you measure short remove flyback and test again, these flybacks often blow (KFS-60213)

Symptoms: Blowing Fuse FB02, Chassis appears to have no faults

Cure: Remove Yoke from CRT and look for physical signs of burning, this is also a very common problem with all 20" Orion CRT's

Symptoms: Power on but no picture

Cure: This model is known for bad solder joints, you will see these symptoms when R412 or R406 break off, both large brown 3watt resistors.

Symptoms: Colour missing

Cure: check all transistors on neck pcb for broken solder connections

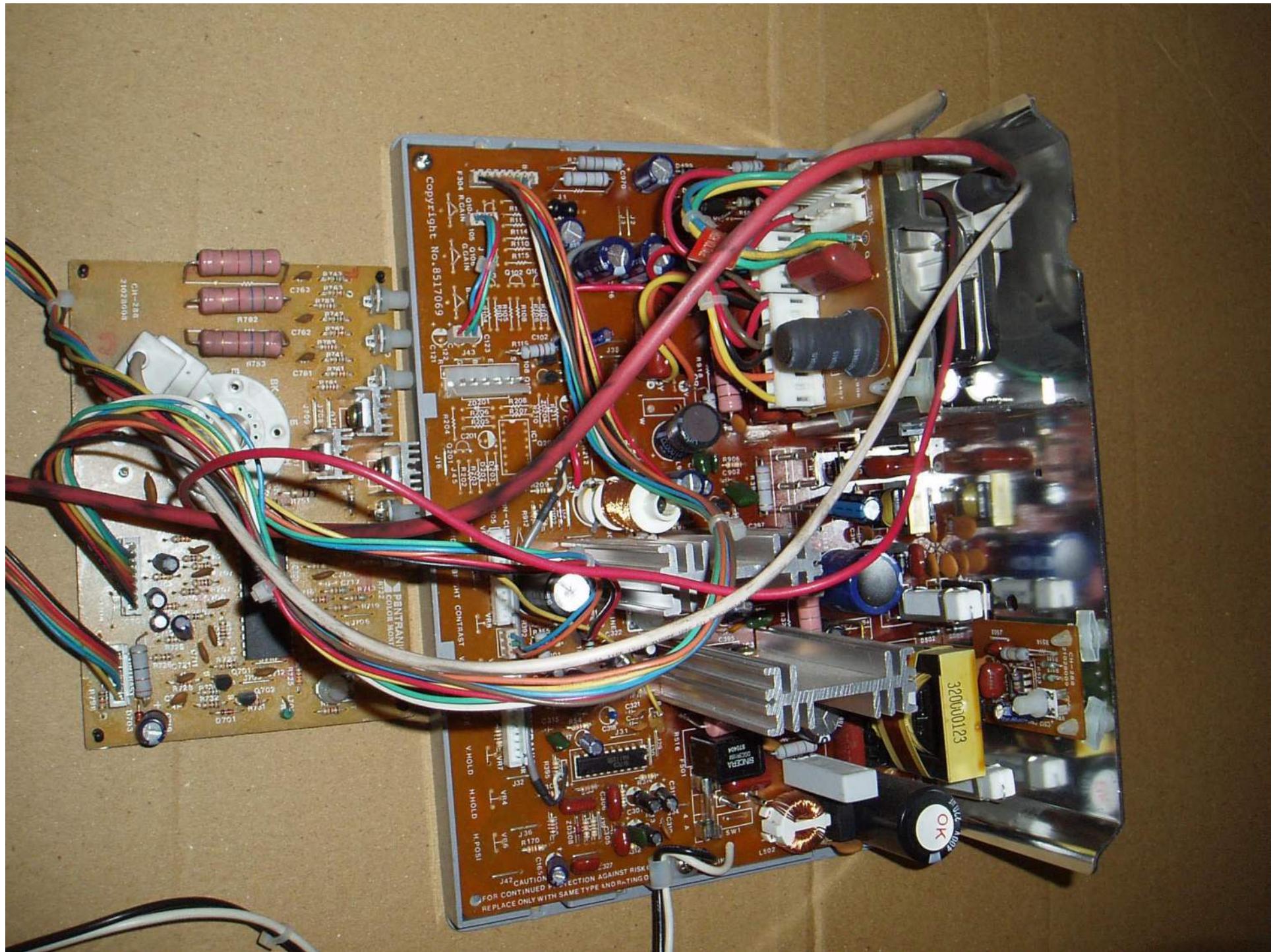
Symptoms: Picture chopped on sides

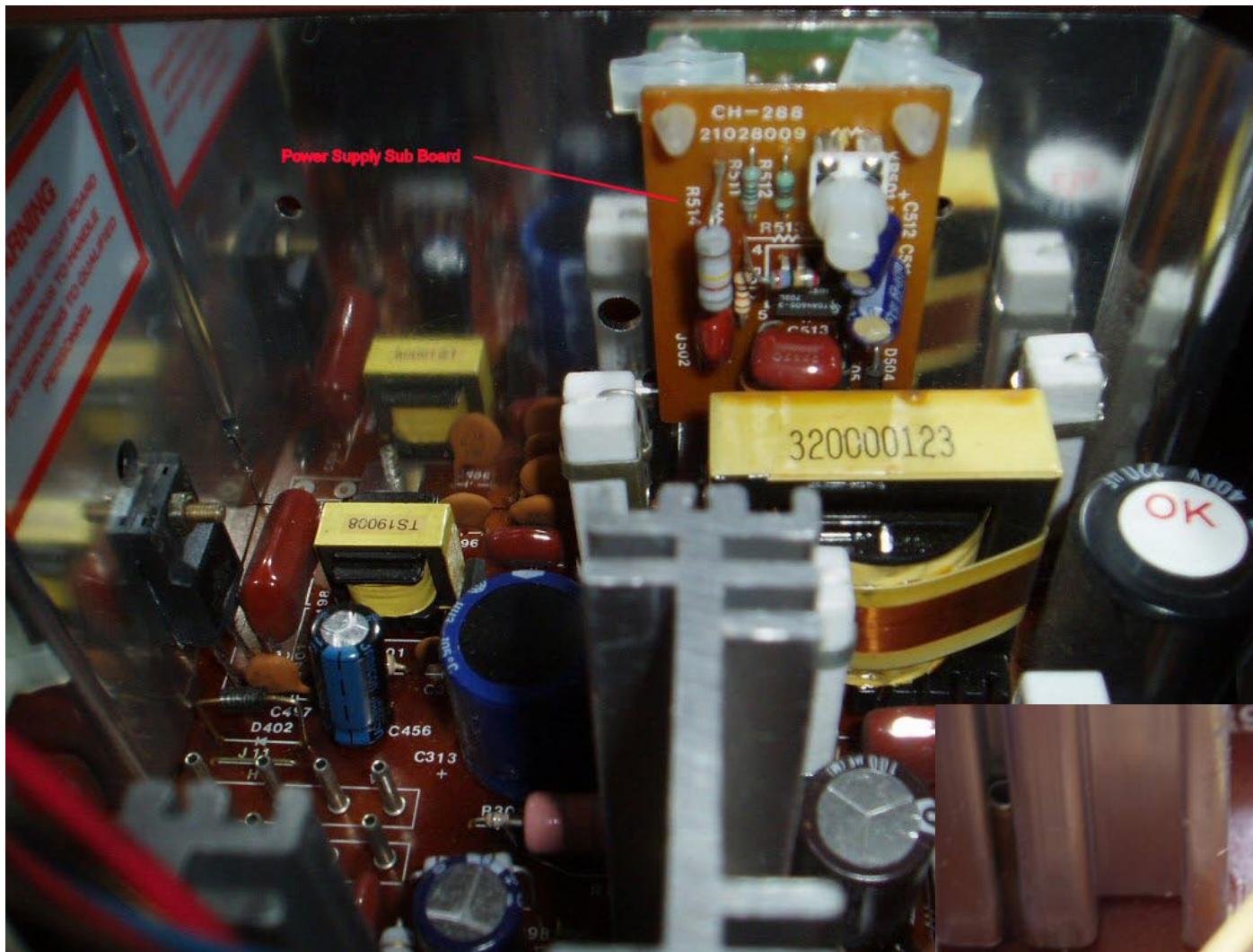
Cure: Check for broken CRT GND pin on neck board, the often snap off on this model

Notes: This model chassis was made to specifically replace older Kaga Densi chassis that used the separate flyback in the metal box that became unavailable.

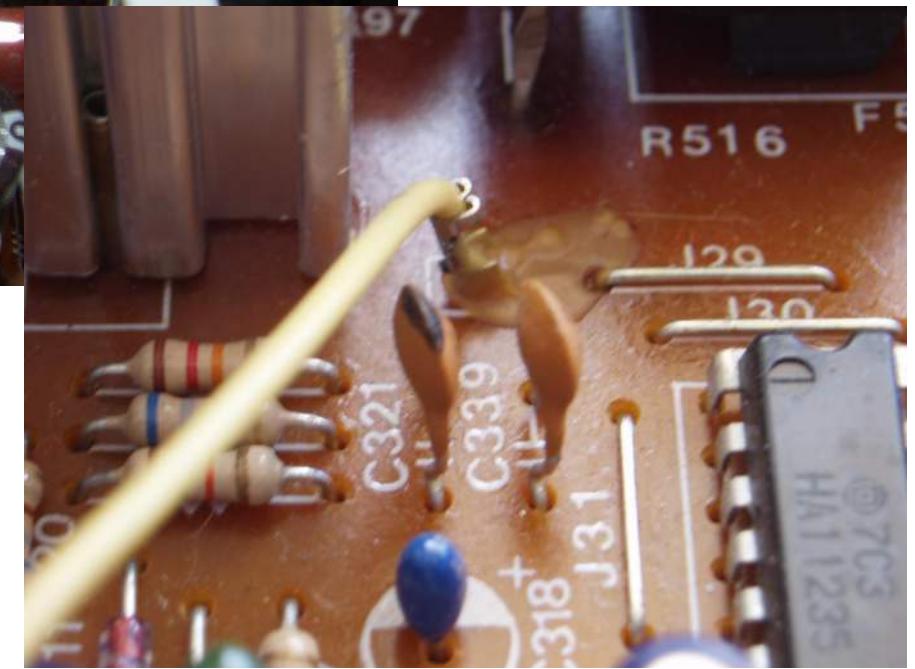
It was found that these chassis were compatible with all 12 Pin CRT's from 14" to 20" such as Toei, Awa, Orion, Kaga, Mitsubishi, Philips and many others .

## Pentranic\_RodoCH288

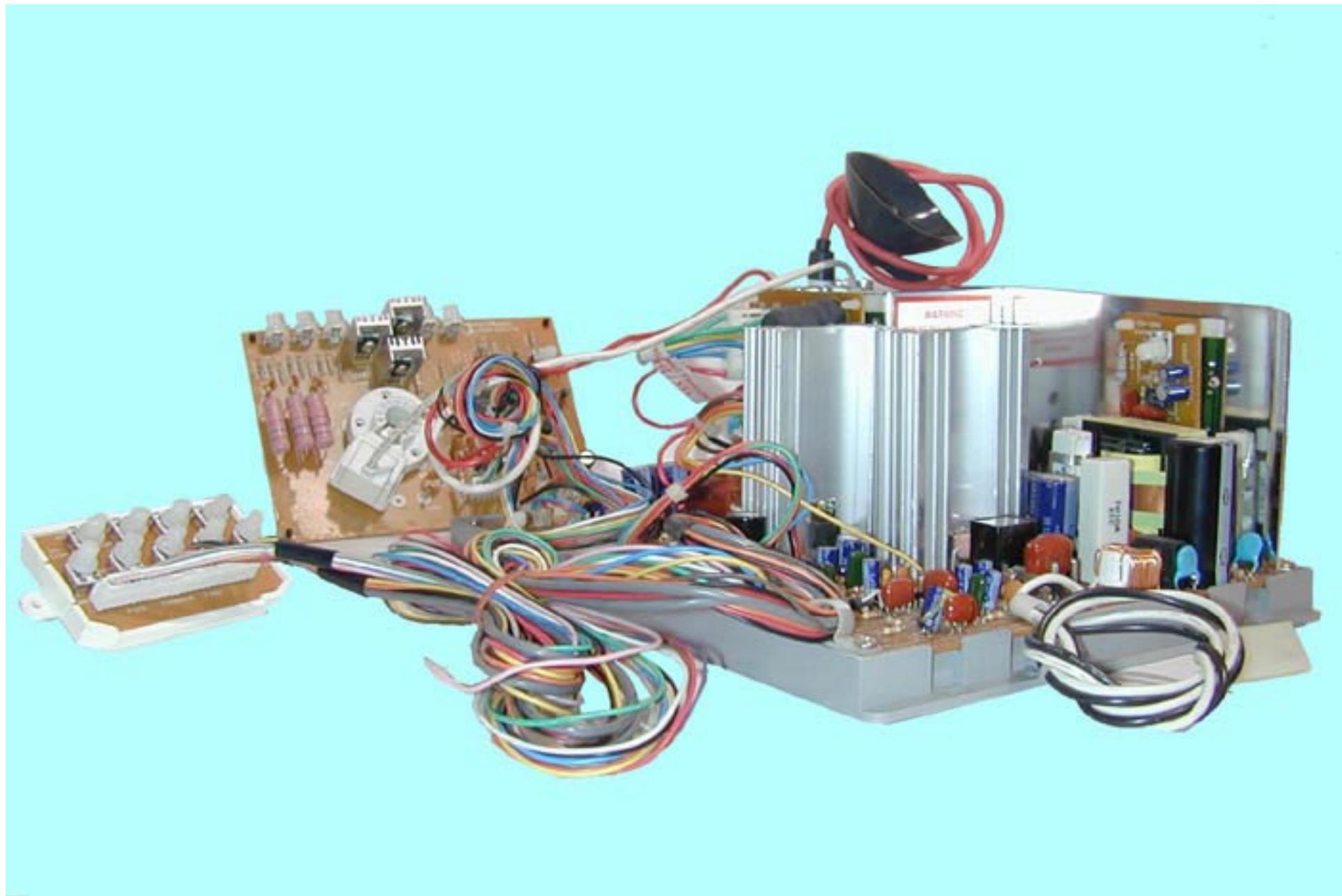




**Sub Board**



**Yellow Wire**



# Pentranic / Rodotron CH288, 15K only and 15/24K Dual Resolution

Symptoms: Main fuse blown

Cure: Replace FET (2SK1358 or 2SK1940) or (2SK1117 must be insulated from heat sink) Check Diode D502 always replace R513 (270K 1/2 W) on Small Power supply sub board. See Pic (Sub Board)

Symptoms: Wont power up fuses ok

Cure: Check for open Resistor R510 (22K 2w)

Symptoms: Wont power up ticking noise

Cure: Check for shorted HOT Q401 (BU508D) many other common types can be used like BU2520DX, 2SD1880 etc., if HOT is blown always replace C456 (10uf250v)

Symptoms: Wont power up or intermittent power up, sometime switching of and on at random.

Cure: Replace R513 (270K 1/2w)

Symptoms: Wont power up fuse ok

Cure: Check for open R516 (6.8K 3w) 12v supply to IC2

Symptoms: Picture shaking, unstable with scene changes

Cure: Replace C501 (100uf 200v) and also C313 (220uf 200v)

Symptoms: Dark side of screen, of shadowed bars on one side of screen

Cure: Replace C407 (10uf 250v)

Symptoms: Over bright screen, Screen voltage wont reduce

Cure: Check for open R401 (2.2ohms 1/2w)

Symptoms: Picture going off and on while monitor appears to be still running

Cure: See Picture, Yellow wire to neck PCB, the solder where it connects to chassis often cracks although surrounded by glue on top of chassis

Symptoms: Colours missing / overlapping, or chassis running but no picture.

Cure: Measure for 12VDC at D703 (12v Zener) on neck PCB, if low replace IC701 (LM1203N) Occasionally this Diode reads dead short, lift diode to check, short will be either across diode or IC701.

Symptoms: Vertical Collapse

Cure: Check for burnt D506, earlier models

used a small 1 amp diode that fails, later model use a larger 3amp diode like MR856, Upgrade to larger diode if necessary ( holes to fit larger diode need to be drilled )

If there has been any problems in this area it is because IC3 (AN5521) has failed, also replace C393 (100uf 35v) .

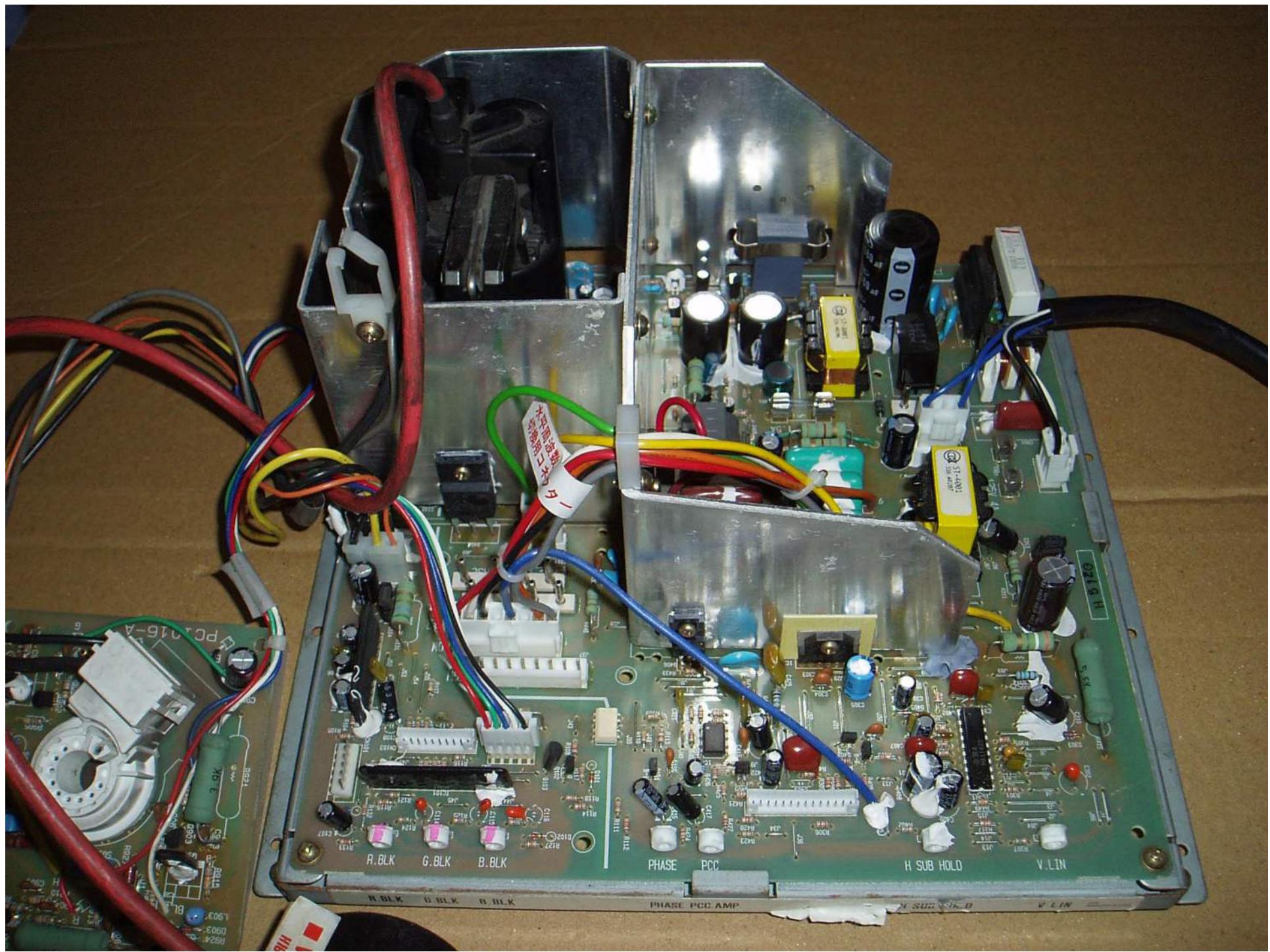
Symptoms: Vertical Fold

Cure: Replace C393 (100uf 35v) and also check C398 (1000uf 25v) often dried out by sitting against R398

Notes: There often problems with vertical collapsing and Horizontal pin cushion, before replacing any components always check for obvious solder problems caused by the large heat sinks on IC3 and Q302 breaking off .

If HOT has blown and after replacing still wont power up, check solder under R407 (beside flyback) this large ceramic resistor can desolder itself or burn off when HOT has shorted .

In all cases when working on these chassis Always replace old carbon film resistor R513 with Metal film 600mw or higher, this 270K resistor will fail if not already, causing many of the problems listed above due to B+ circuit going over voltage.

**Sanwa Sega PM11745**

# Sanwa / Sega PM1745 (B) & (C) 29" 110v Used in many Japanese Daytona, Sega Rally

**Symptoms:** Appears to start up but then shuts down before picture displays.

**Cure:** Replace Shorted IC302 (LA7832), C305 (100uf50v) and check R315 (3.9ohm1/2w) fusible resistor

**Symptoms:** Wont power up fuses ok.

**Cure:** First check for vertical problems as described, Check for open R415 (5.6k 3w), also check under chassis for obvious bad solder joints (very common problem)

**Symptoms:** Wont power up F802 blown 1.5amp

**Cure:** Shorted HOT Q404 2SD1880 or BU2520DX, Replace C441 (1uf300v) and check for bad solder around Q403.

**Symptoms:** Wont power up, one of both fuses blown, obvious power section burnt out.

**Cure:** Often happens when HOT has failed overloading Power Supply section.

First Check for shorted Q801 (2SC3306), If this is shorted it will quite often destroy most components around this section so is recommended all the following parts be changed at same time.

Q803 and Q804 (2SC2482), Q802 and Q805 (2SA1091), R819 (3.9ohm1/4), R817 (1.5K 1/4w)

**Symptoms:** Horizontal size or pin cushion won't adjust

**Cure:** Check for cracked tracks under Q406, if tracks /connection ok replace (2SD1944) this can not be replaced with equivalent.

**Symptoms:** Contrast / brightness appears like negative image

**Cure:** Replace C111 (47uf200v)

**Symptoms:** Wont power up fuses ok

**Cure:** Measure for continuity between Pins 1, 2 and 3 on flyback, if open in any direction flyback is faulty. Check for open winding on T401, Resolder Q403, R416 and R417 and R418

**Symptoms:** Black Screen although chassis appears to be running

**Cure:** Check for Open R130 (3.3ohm1/2w), check D401 for Short and also check for shorts and bad joints on Q104 and Q103, R130 will only burn if one of the above is shorted, but you will get similar symptoms from bad joints in these area's

**Symptoms:** High Pitched Squeal while running

**Cure:** Put Silicon between L403 and Frame, repeat for L404

## Notes:

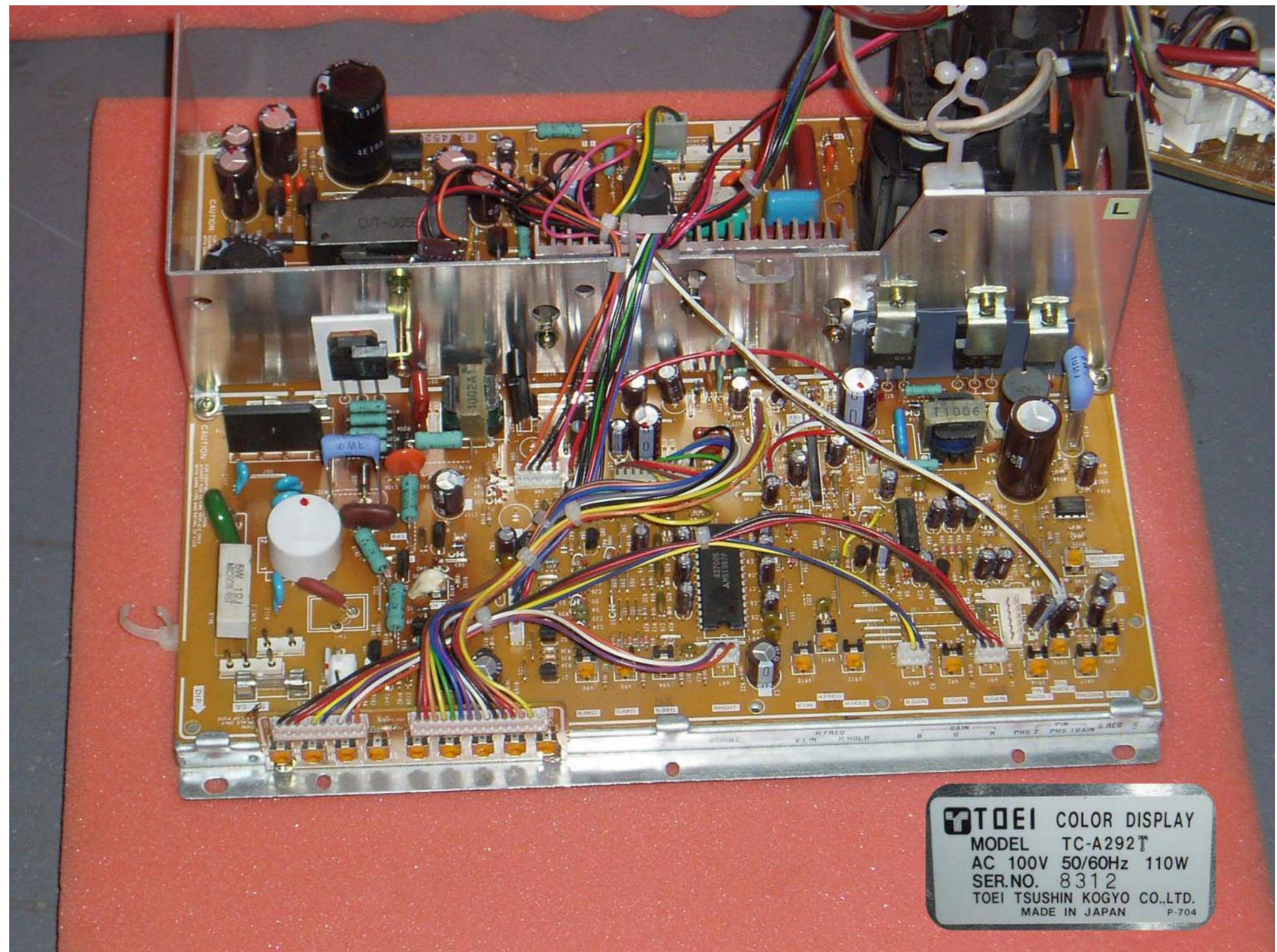
The Revision of these chassis is screened in a box after the part number, Rev C had improvements to the power supply section and also had minor changes to the location of some components, Very important to remember if working in the power supply section of the different models that you pay special attention to the orientation of the transistors EG: Q804 is in the same location but reversed, only the tracks underneath were changed.

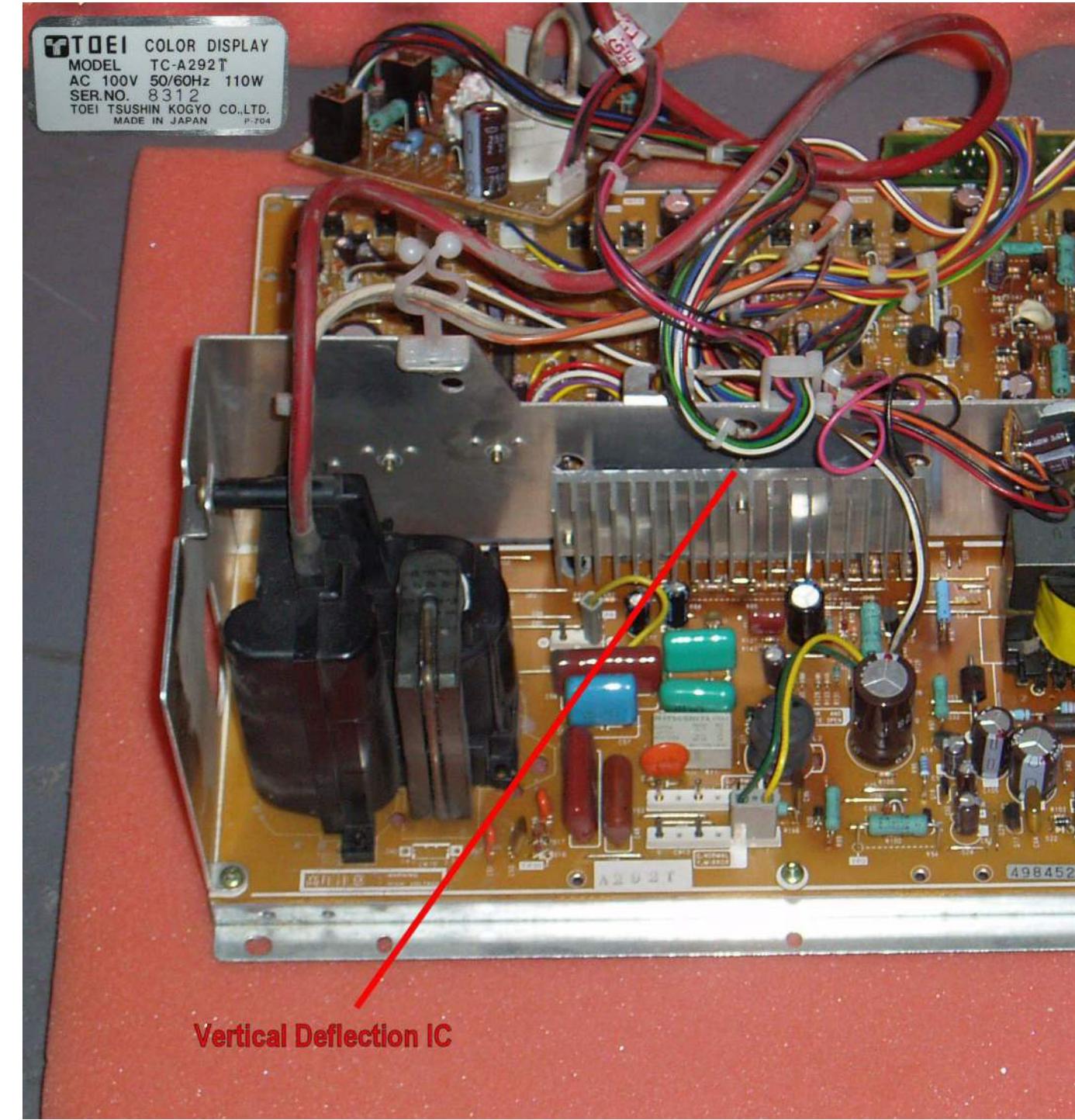
Never Adjust VR851 B+, in most cases the POT will break or crack, causing many intermittent problems as it heats up. A good indication that this POT is faulty is to watch the picture shrink in vertical size while making a squealing sound, followed by shutdown.

As the chassis cools it will restart itself and go through the above process continuously while only varying by about 6 volts



**PM1745C Label**



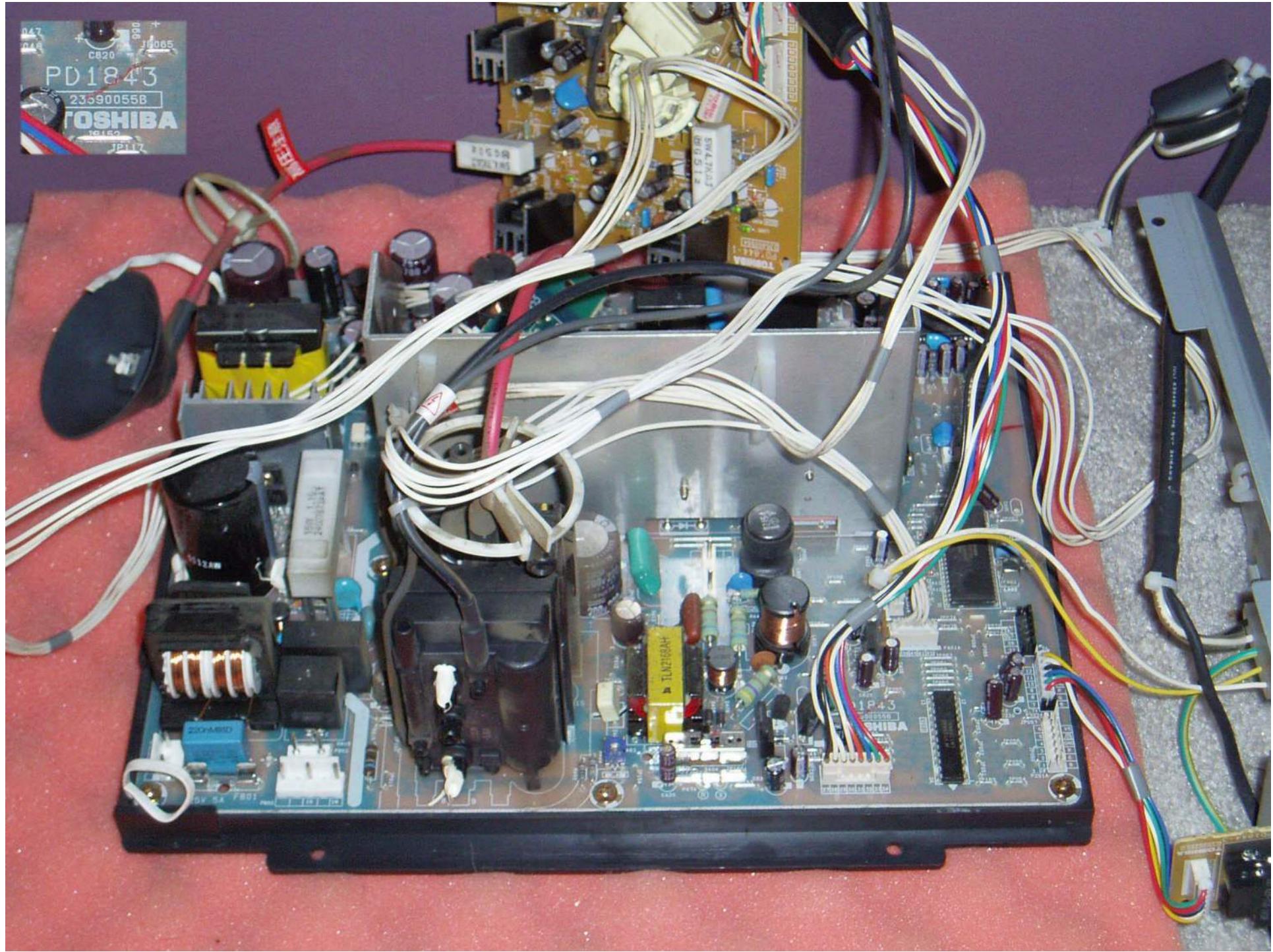


## Toei TC-A292-T

**Symptoms:** Vertical Collapse, Intermittent vertical size problems

**Cure:** Vertical IC is Dead, STK79915, mounted between 2 heat sinks see picture at left.

## Toshiba DS-7209A Pure Flat 29 Max Tune



# **Toshiba DS-7209A 29" Pure Flat CRT used in "Maximum Tune 2" 15~31 KHz**

Also another variation included in pictures is another version of the same Toshiba chassis used in Initial D 2, locations are parts are the same .

**Symptoms**: Chirping Sound, Partial Vertical Deflection

**Cure**: Replace Q301 (LA7846N) Vertical IC

**Symptoms**: Chirping Sound

**Cure**: Check for Shorted HOT, Q420 (2SC4288A)

**Symptoms**: Appears to be running but not high voltage

**Cure**: Replace FET Q427 (2SK1378) also Check Q428 (2SJ512) or (IRF9520)

**Symptoms**: Appears to be running, heater on but no picture

**Cure**: Check for open Coil L501 (can be bypass with wire link), Fuse F803 and Check C814 (2200uf 25v)

**Symptoms**: Running but no heater, or heater voltage low

**Cure**: Check Fuse 805 and C816 (2200uf 16v)

**Symptoms**: Unstable Picture, sometimes shutting down

**Cure**: Check C463 (220uf 200v) B+ should read 175vdc while operating

**Symptoms**: Wont Power up straight away of taking several minutes to switch on

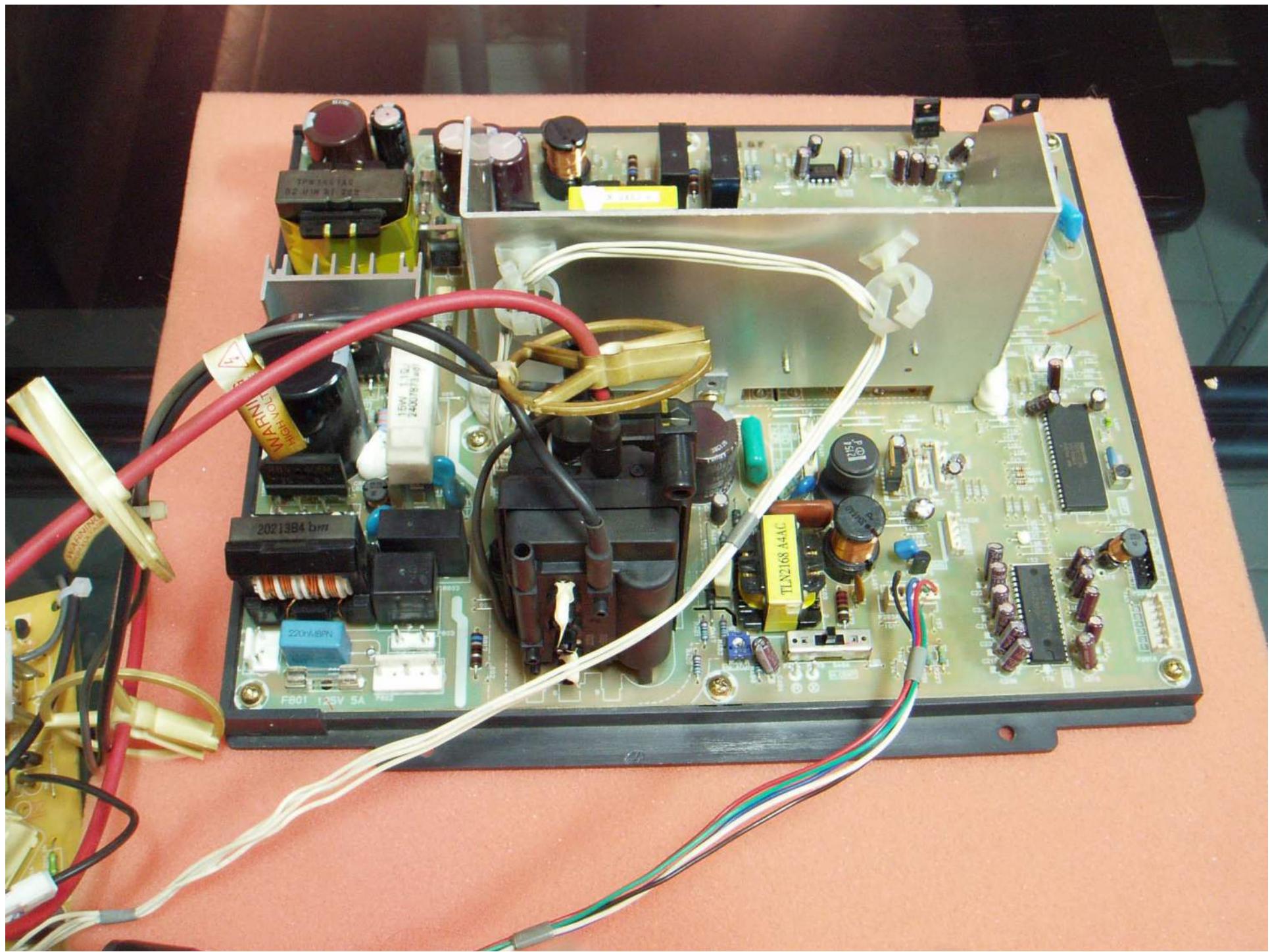
**Cure**: Replace C809 (220uf 35v)

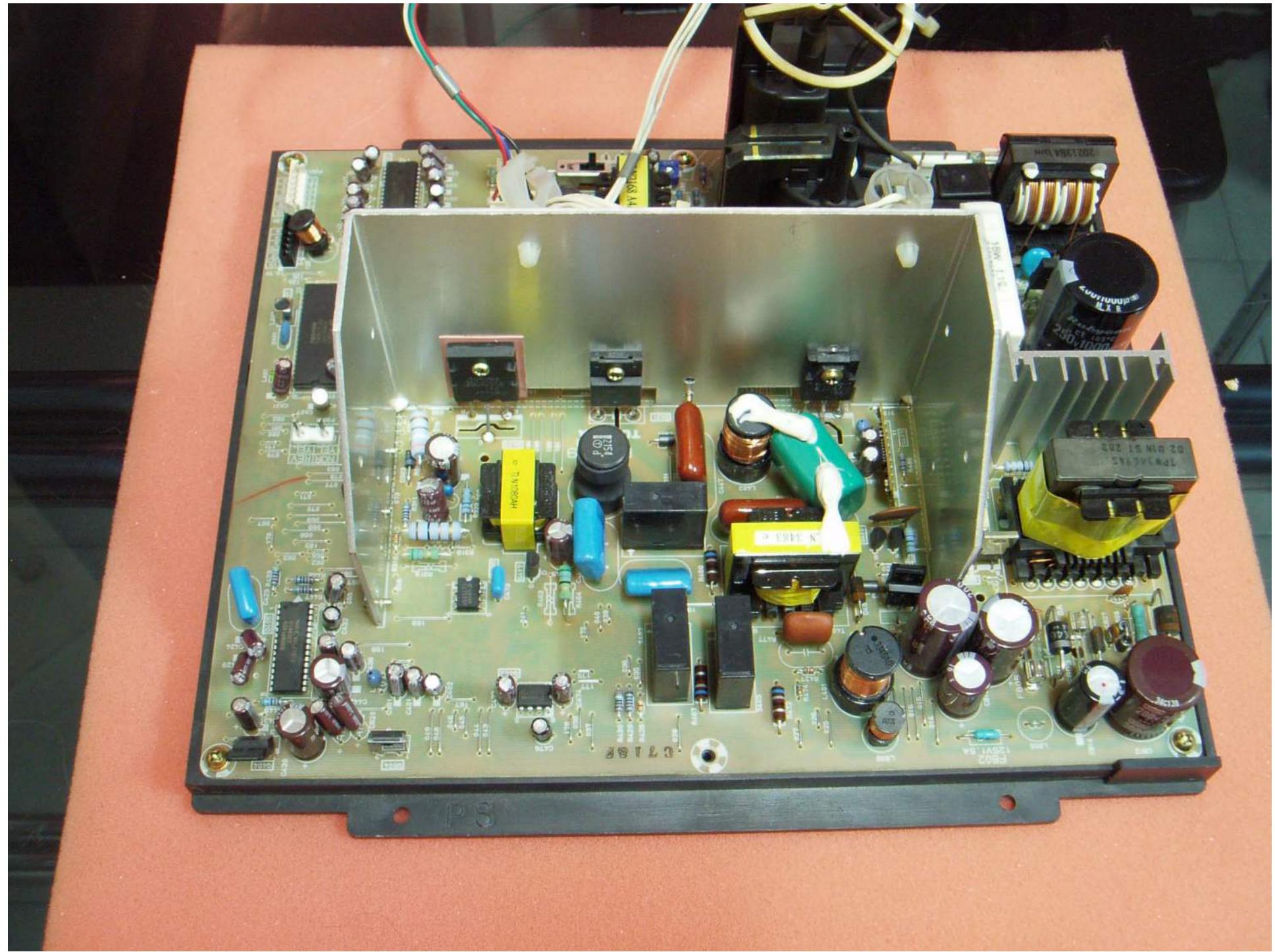
**Symptoms**: Main Fuse Blown

**Cure**: Check for shorts across main B+ Regulator Q801 (STR-6624), If shorted Check for open R807 and R808 both (0.33 Ohms 1w) and R811 (1.0 ohm 1w)

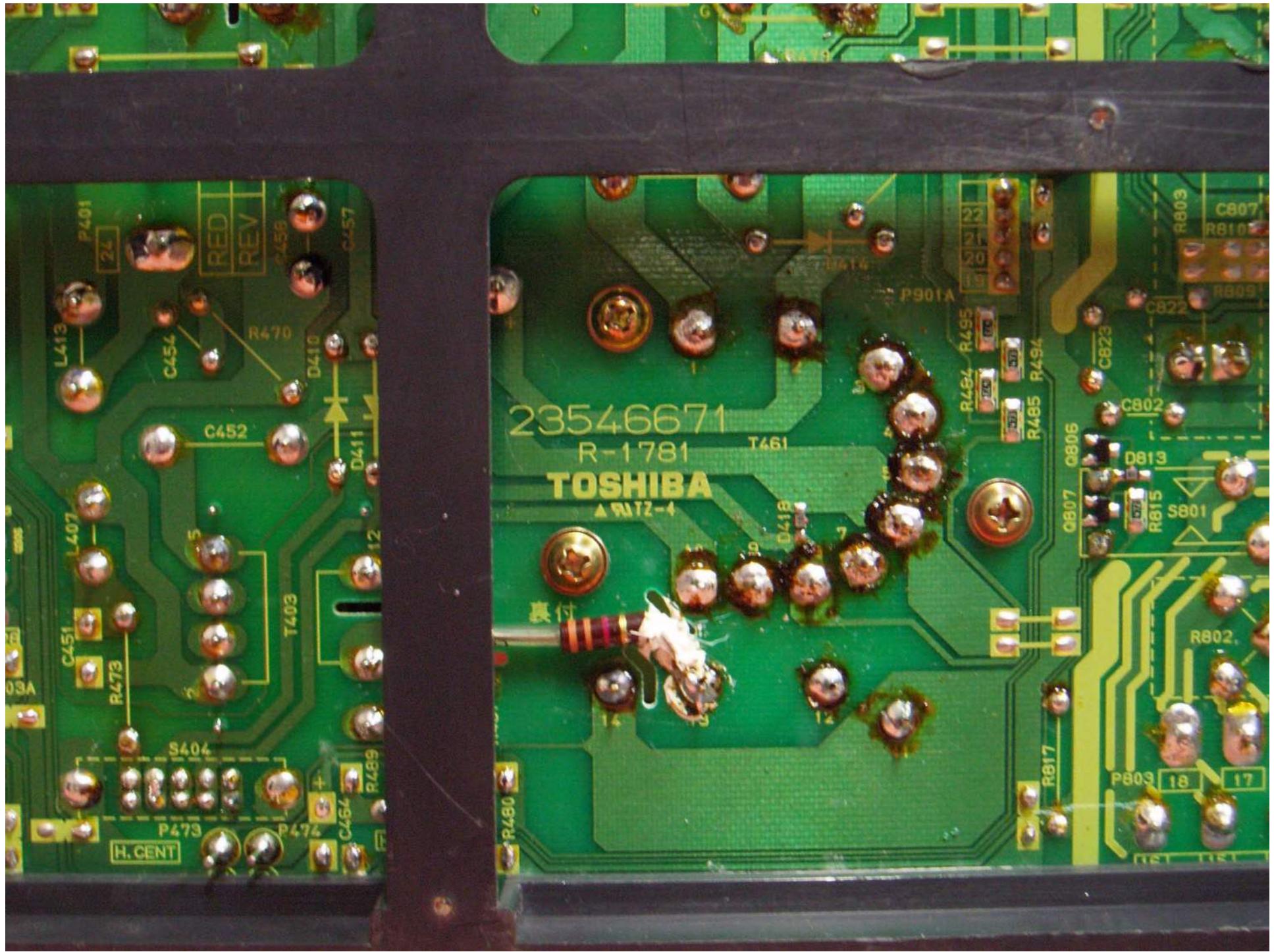
**Notes**: Very similar to the Toshiba Chassis used in Initial D, both 31Kz, be careful not to mistake for the Pure Flat screen Sanwa also used in these games.

## Toshiba 29inch PF chassis Used in Initial D2





## Toshiba R-1781 Part Number



# **Toshiba R-1781 29" Pure Flat CRT used in "Initial D 29" 15~31 KHz**

**Symptoms:** Chirping Sound, Partial Vertical Deflection

**Cure:** Replace Q301 (LA7846N) Vertical IC

**Symptoms:** Chirping Sound

**Cure:** Check for Shorted HOT, Q420 (2SC4288A)

**Symptoms:** Appears to be running but not high voltage

**Cure:** Replace FET Q427 (2SK1378) also Check Q428 (2SJ512) or (IRF9520)

**Symptoms:** Appears to be running, heater on but no picture

**Cure:** Check for open Coil L501 (can be bypass with wire link), Fuse F803 and Check C814 (2200uf 25v)

**Symptoms:** Running but no heater, or heater voltage low

**Cure:** Check Fuse 805 and C816 (2200uf 16v)

**Symptoms:** Unstable Picture, sometimes shutting down

**Cure:** Check C463 (220uf 200v) B+ should read 175vdc while operating

**Symptoms:** Wont Power up straight away of taking several minutes to switch on

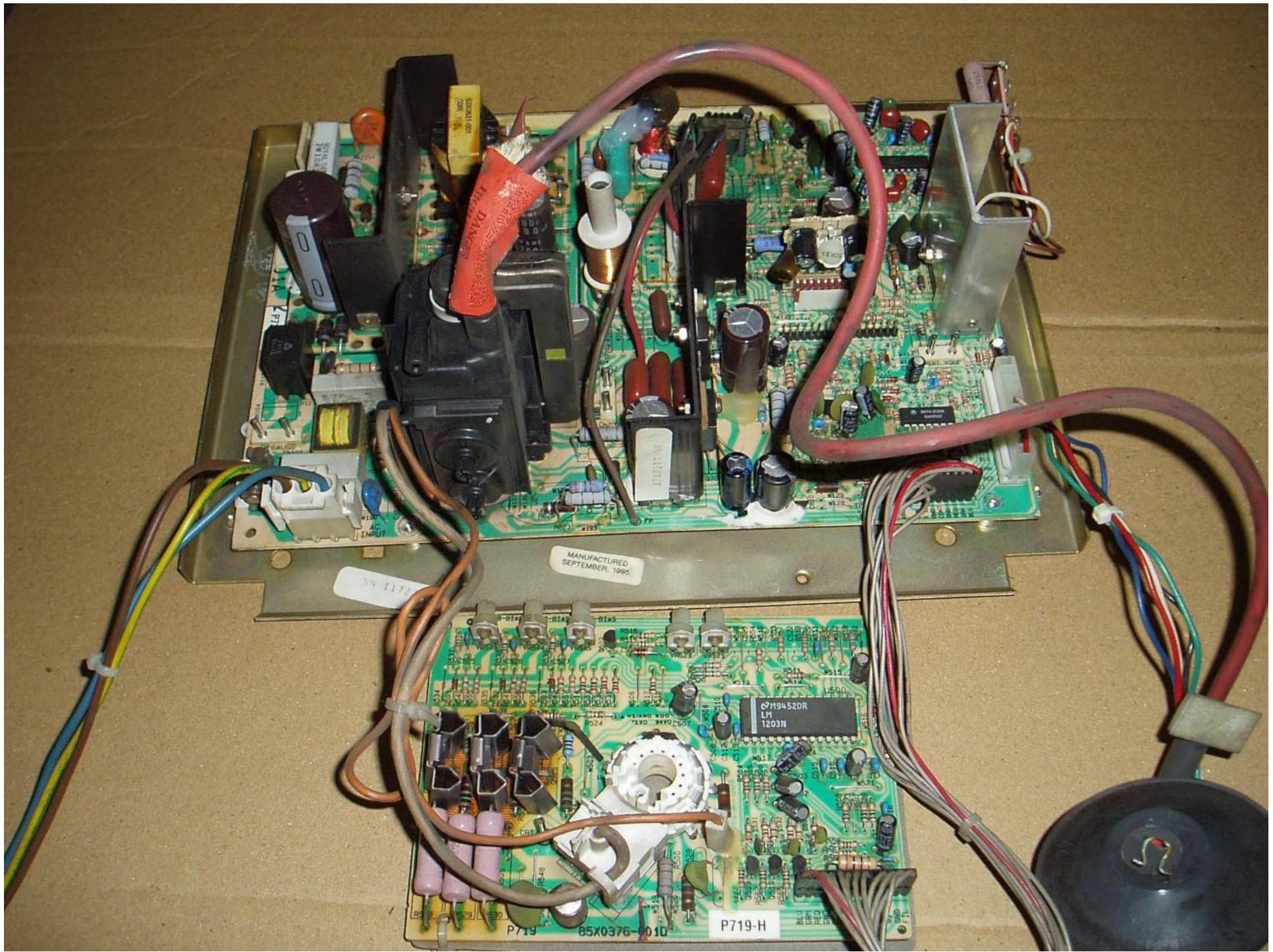
**Cure:** Replace C809 (220uf 35v)

**Symptoms:** Main Fuse Blown

**Cure:** Check for shorts across main B+ Regulator Q801 (STR-6624), If shorted Check for open R807 and R808 both (0.33 Ohms 1w) and R811 (1.0 ohm 1w)

**Notes:** Very similar to the Toshiba Chassis used in Maximum Tune 2, both 31Kz, be careful not to mistake for the Pure Flat screen Sanwa also used in these games.

WG-U5000



# Wells Gardner U5000, 25" ~ 33"

## Free Voltage 15/25K

Symptoms: Blown main fuse

Cure: Check for shorted Q101, (SSP6N60A) universal replacement (2SK1117), This can blow for numerous reasons so carefully check for shorts on all the following components and replace as necessary, D117, D106A, B & C, D105, D111, D110 & D109, if either or all of the last 4 are shorted U101 will also be dead (UA3842) always check C118 (1uf poly cap) if is U101 dead this cap can often explode.

If C118 is shorted R106 (1k 1/4w) will often go open and occasionally R117 (1k 1/4w)

As a general rule if Q101 is shorted it will most often damage U101.

Symptoms: Power supply problems

Cure: To isolate if the problem is being caused by power supply section, lift link W159, when lifted power supply should make 1 click sound when powered up,

if link is lifted and clicking noise heard, Check for shorted D106A, B & C and C115 (100uf 200v) if these check ok replace Switching transformer T101 .

To test power supply section is working, lift link W159 and place 60W light bulb across C115, if working correctly it should light, not pulse.

Symptoms: Intermittent shut down

Cure: Check solder under B+ adjustment VR101 or replace if suspect (1K), this fault can be easily located by spraying with freeze spray while operating, this is will often cause chassis to go on and off pot is faulty.

Symptoms: Slow to power up

Cure: Check for open or high value R120 (68K 2w)

Symptoms: Blowing main Fuse, Q101 ok

Cure: Check for Shorted Diodes D101,

102, 103 & 104, also D107 & D108 if either of these are shorted check for open R105 (470 ohm 3W) and R104 (10K 7W)

Symptoms: No power up, fuse ok and all above checks ok

Cure: Check for open R102 and R103 (68K 1W), one end needs to be lifted for correct measurement.

**SPECIAL NOTE:** All notes below assume power supply section has been tested and working correctly

Symptoms: Clicking sound, Won't power up

Cure: Check for shorted HOT Q704 (2SC3686) If blowing short time again after being replaced check all HV poly caps C718, C723 & C721, If any of these caps are out of tolerance it will destroy HOT either instantly or after running for some time depending on how bad they are.

## U5000 Screen Washed Out



## Wells Gardner U5000, 25" ~ 33"

Very important to always check / replace C716 (1uf 200v) part of H Oscillator Circuit

Symptoms: Wont power up R728 Very Hot

Cure: Check for shorted Z702 (13v 1 W Zener), if ok check for shorts across Q708, Q705 & Q703, If Q708 is shorted also replace Zener Z705 (9.1v 1/2w) and check for Open R760 (100 ohm 1/2w) Some versions have (470ohm 1/2w) is this location .

Symptoms: Wont Power up, all voltages appear ok.

Cure: Check for open R765 (33K 1/2w) Very Common

Symptoms: Vertical Collapse

Cure: Replace U601 (TDA1771) C613 (100uf 50v) and D603 (IN4007 or Equiv), Check for open R303 (1.2 ohm 2W) if open check for shorted D302 (RU2 600v 1amp Fast Recovery Diode )

SPECIAL NOTE: If R303 burns up after replacing and checking all above components, replace U601 again. (Many times I have replaced these IC's and they have failed instantly when switched on for no apparent reason ) Do not pay attention to the orientation of the writing on the IC itself only note the notch indicating Pin1, some manufactures of these IC's put the part number on the back of the IC which reverses the way where Pin 1 appears to be.

Symptoms: Intermittent Horizontal collapse

Cure: Check all solder connection under Res Change plugs CN15K and CN25K

Symptoms: Picture Shaking / wobbling

Cure: Check or replace C115 (100uf 200v)

Symptoms: Screen washed out, out of focus, Appears to be Dead CRT or

Flyback See: U5000 Screen washed out.JPG

Cure: These symptoms have fooled many people into thinking their monitor is worn out when in fact it is a very simple fix, Replace C310 (10uf 250v) and or C504 (4.7uf 200v) located in neck PCB.

Symptoms: occasional clicking sound with interference / flash across screen, sometime looks like vertical is rolling once.

Cure: This is an earthing / Gnd problem caused by a bad connection between chassis and metal mounting plate. It is very important to make sure these screws are tight and there is a star washer installed between where the chassis mounts to plate and chassis itself, secured tightly with both screws.

Symptoms: All colours appears mixed up or chassis running but no picture

## Wells Gardner U5000, 25" ~ 33"

Cure: Check for 12VDC on Pin 1 of U500, if below 12v replace U500 (LM1203N) If no 12V with Pin one disconnected check for Open R510 (30 ohms 1w) some versions also have a 12v zener diode across the +15v supply and GND which can also short.

Symptoms: Colour Missing or driving flat out

Cure: Replace associated driver transistor Q503 BLUE, Q504 GREEN, Q505 RED (2SC3782)

Symptoms: Colour dropping in and out at random

Cure: Replace C515, C516 & C517 all (0.1uf poly 25v or higher) these caps will often fall apart when trying to remove if they haven't already.

Symptoms: Colour on flat-out controls have no effect

Cure: Check for broken solder and broken tracks around Q503, 4 & 5 and Large 3w resistors R528, R529 & R530

Symptoms: H-Size will not adjust

Cure: Check for shorted Q710 (BDX53C or TIP102), also check or replace Q709 (2N4403), check for shorted diode D708

Symptoms: Can not focus screen

Cure: Replace flyback transformer 053X0624-001

Notes: There are several minor variations of this chassis; some don't have the Res change plug installed, some also have a Pin Cushion correction PCB located at CN202 as in Picture.

As a general rule with these chassis, always check for broken or cracked controls before delving into chassis repair, they are easily cracked on both the neck board and remote control boards.

It is also a good idea the look over the neck board around the area's that run very hot for bad solder joints if experiencing colour problems.

I have also noticed many of these chassis with a broken or cracked L701 coil; this can be glued with hot glue or silicon rubber.

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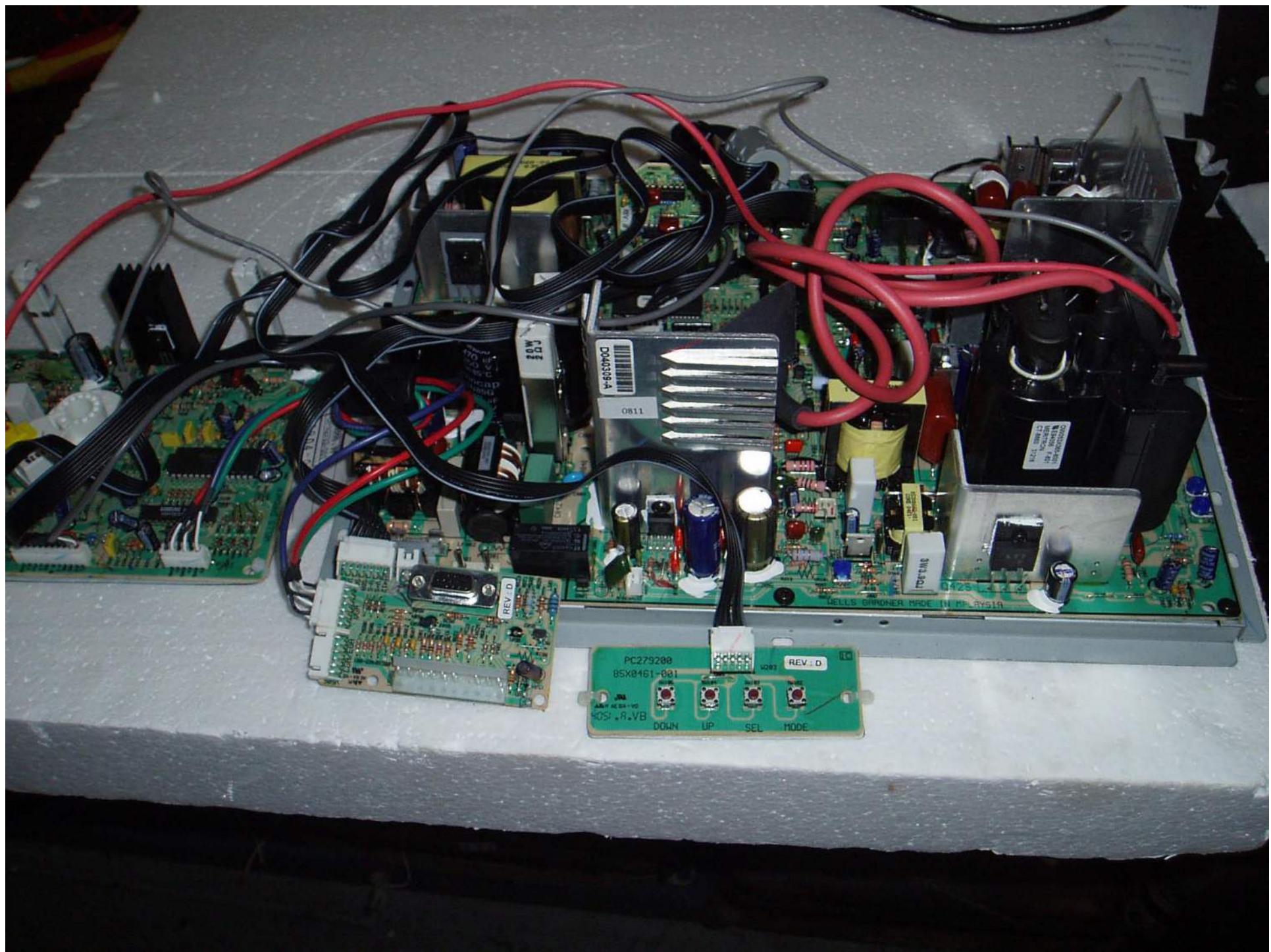
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## Wells Gardner D-9200



## Wells Gardner 9200 Series

**Symptoms:** Appears to be running but no picture (heater on)

**Cure:** Check for shorted HOT Q418 (2SC5144), If shorted check D417 for Short if also shorted check for open R854 (1.2 ohm 1w) and R462 (1.0 ohm 1/2w) If either of these resistors are open replace Q413 (IRF644A), D424 (IN4148) and Q411 (2N7000)

**Symptoms:** Horizontal Collapse, High Voltage working

**Cure:** Check for open R462, If open replace Q413 (IRF644A), D424 (IN4148) and Q411 (2N7000).

If these components check ok or are replaced and still no deflection, check for Aprox 170vdc at R854; if present replace IC404 (UC3842)

**Symptoms:** Vertical Fold

**Cure:** Replace C466 (470uf 25v)

**Symptoms:** Vertical Collapse

**Cure:** Check for Open R317 (1 ohm 1/2w), R855 (.1 ohm 1/2w), if open replace IC301 (TDA8172) and always check / replace C466 (470uf 25v)

**Symptoms:** Dark Picture, Factory Mode reset but still to dark.

**Cure:** Replace C828 (2200uf 16v) Cap in Power supply section (location number covered in glue) there is only 1 x 2200uf 16v cap in the power supply; you should be able to read Aprox 8vdc across this cap.

**Notes:** I have had many of these with failed Q413 (IRF644A) and associated components, so have upgraded Q413 to higher more robust (2SK1117) with no further failures.

If you want to isolate power supply section from rest of chassis lift one end of R854, End closest to edge of chassis. Can read up to 185vdc with no load connected.

Correct B+ is 170 VDC

Factory Reset instructions PDF included for reference.

# Wells Gardner 9200 Color Gain Adjustment

## FACTORY MODE COLOR GAIN ADJUSTMENT PROCEDURE:

### 1. Warm up Procedure:

Apply power and a video signal to the monitor so that there is a picture on the screen for about 20 minutes before making any adjustments. This will give the monitor a sufficient time to warm up so that the adjustments that are made will not change.

#### 1.1 Key Description

##### DOWN/UP

Scroll through various Icons on Main Factory Menu.

When in the COLOR GAIN icon mode - Toggle through the GAIN MODE, BIAS MODE and OSD MODE.

When in GAIN MODE, BIAS MODE and OSD MODE;

Adjust values after a parameter has been selected.

##### MODE

Saves adjusted value and return to Main **FACTORY MENU**.

##### SEL

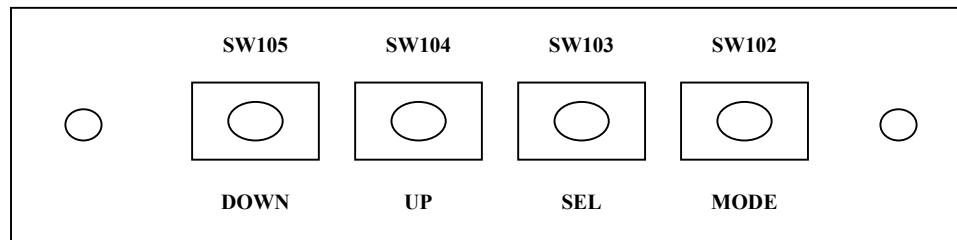
Selects Icon on Main **FACTORY MENU**.

When in GAIN MODE, BIAS MODE and OSD MODE, selects parameter to be adjusted.

When in **RE** "RECALL", saves all changes and exits **FACTORY MENU** Mode.

All adjustments are made by searching and selecting an icon using the digital control panel buttons.

### Digital Control Panel



# 1990

## Update: Monitors

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# Arachnid 6000 Scrambled Video

Bob Hade  
T.B.I. Games Unlimited  
Rockford, Illinois

## SYMPTOM

The video screen displays garbled information when a bullseye is hit.

## SOLUTION

Replace capacitor C19 on the logic board.

## SYMPTOM

The fuse blows immediately upon replacement.

## SOLUTION

Replace BR1 on the power supply board, (mount the bridge 3/4 inch above the circuit board for ventilation). Replace the 1-1/2 SB (slo-blo) line fuse that comes with the game to a 2 amp SB (we do this to all our Arachnid dart games). Many times a light bulb will burn out and take the 1-1/2 amp fuse with it. Sometimes, even replacing a bulb will take the fuse out!

It's a good practice, though rarely done, to turn the machine off before moving it out from the wall to get at the back door. This will lessen the chance of shorting out the hot bulb's filaments when moving the game.

## NOTE

Save your old matrixes! Those manufactured during the first two weeks of 1987 can be returned for exchange through your distributor.



# Taito Chase H.Q. Monitor Problem

Frank "The Crank" Seninsky  
Alpha-Omega Amusements & Sales  
Edison, New Jersey

## SYMPTOMS

Many of our Taito *Chase H.Q.*'s have a monitor brightness problem that can be easily corrected. When viewing the picture, it appears that the brightness control is set too high. The colors are good but the grey raster is too bright. No amount of contrast and/or brightness adjustment will correct the situation.

## SOLUTION

The problem turns out to be a defective disc capacitor on the monitor neck board at location C206. *Chase H.Q.* uses a Hantarex model MTC 9000 monitor. Change this cap and you're back in business!

# Wells Gardner 19K4600 Keystone

Frank "The Crank" Seninsky  
Alpha-Omega Amusements & Sales  
Edison, New Jersey

## SYMPTOMS

Several of our 19" Wells Gardner 19K4600 Series monitors (used in *Pac Man* and *Defender* for example), have developed a keystone problem. Keystoning is a lack of squareness to the picture—sometimes referred to as a warp in the picture.

## SOLUTION

As with many older monitors, this problem is caused by a defective capacitor. In this case it is C614 (33 mfd/25v), a radial cap that is the culprit. When looking at C614, it does not look defective but it probably has internally opened over time. C614 is located on the main PCB just to the right of where the Horizontal/Vertical board connects (right side).

## Hantarex Monitors Stable Sync Cure

James Beck  
Greater Southern Distributing Co.  
Atlanta, Georgia

### SYMPTOM

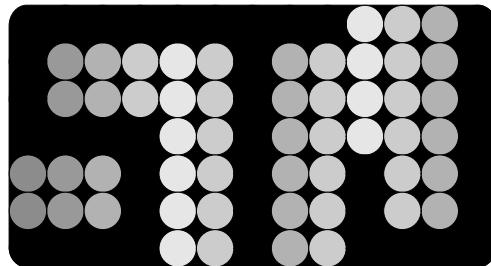
A problem with Hantarex *MTD 900/E* monitors seems to be widespread. Whenever you try to convert a Williams game that uses this monitor, the vertical sync is hard to lock in.

There is such a narrow range of lock, it drifts out on location and the video starts to roll. There was a bulletin about a component being reversed, but that checks out ok.

### SOLUTION

On the deflection half of the board check R205 (4.7K) and C201 (0.1uf @ 160V). Odds are, they aren't there due to the make of the original game. Add them!

Then, connect composite sync (or negative composite sync) to the horizontal (or negative horizontal) terminal ONLY. Do NOT jumper the horizontal and vertical sync pins together like you have to do on the Electrohome monitors. When you add these components into the sync circuitry, it will lock the vertical in solid.



## Electrohome G07 Keystone Problem

Kevin Mahler  
Western Music  
Twin Falls, Idaho

### PROBLEM

I changed cap C501 and the game still has this "Keystone" video problem. The video screen caves in about 2/3 of the way up the top. Using an Electrohome G07-CB monitor.

### SOLUTION

Replace C517 and C518 (100uf @ 25v, 220uf @ 25v). They are in the pincushion correction ckt (next to flyback). That should get it!

## Arachnid 6000 Dart Monitors.

Kevin Mahler and Russ Cantrel  
Western Music Company.  
Twin Falls, Idaho

### SYMPTOM

If you have a small wavy vertical line on your picture and it takes it five or ten minutes to come on or won't come on at all and you have already changed C9 on the power supply with no results.

### SOLUTION

Try changing C212 on the monitor board itself. This has happened to us twice and, so far, it has worked each time.



# Toei Monitor Vertical Deflection

Ronnie Belitz  
Lark Amusement  
Bristol, Tennessee

## SYMPTOM

The problem I had was that the vertical deflection on a Toei monitor was folded over so bad that half the screen looked like you were looking at it in a mirror.

## SOLUTION

After much t'shooting, I finally found the problem. It was caused by C55 which caused the vertical sweep to start in the wrong place. After replacement with an equivalent capacitor, things were back to normal.

# Toei Monitors: Symptoms/Fixes

Patrick Groom  
Harry Liaros Vending  
Buffalo, New York

## PROBLEM

There are three problems I have been encountering on these monitors. Symptoms involve caps.

**SYMPTOM:** Pincushion (pix bent downwards).

**SOLUTION:** Replace C57, 470uf/16v.

**SYMPTOM:** Vertical hold is out of tolerance. May have Vertical linearity problem. When it almost locks in, it looks like the frequency has doubled. And it may lock in after it warms up.

**SOLUTION:** Replace C62, 220uf/25v.

**SYMPTOM:** Horizontal hold is out of tolerance.

**SOLUTION:** Replace C41, 100uf/16v.

# Bally/Midway Rampage Rolling Video

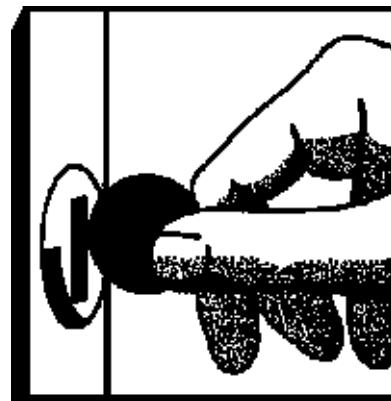
Matt J. McCullar  
Forum Fair Arcade  
Arlington, Texas

## PROBLEM

Recently I was working on a *Rampage* whose picture continually rolled either up or down, depending on where the vertical hold pot was set. Adjusting the pot would slow down the rolling, but not stop it. For some reason the monitor would not lock onto the picture and hold it steady.

## SOLUTION

My first thought was a bad vertical hold pot, but eventually I looked down at the computer assembly and noticed that its video output connector was seated cock-eyed in its socket. I pushed it back in and the monitor zoomed in and locked on the picture perfectly! Apparently the loose socket was still making contact with the color signals, but the vertical sync signal on the very end of the connector no longer reached the pin. Since this has happened on more than a couple occasions, anytime I find a monitor with a rolling picture I check the video cable from the computer to the monitor.



# Video Monitor Capacitor Types

Bruce Jellison  
Automatic Vending & Games  
Bangor, Maine

## PROBLEM

Regarding James Beck's article on Monitor Width Size Change in the January issue of *STAR★TECH Journal*. If the original cap is replaced with a general replacement type such as a polyester, it will usually fail in a short time due to dielectric heating

## SOLUTION

The replacement must be an equivalent polypropylene type designed for high a-c current and low dissipation factor. I got my replacements direct from Wells Gardner. They have a minimum order policy so you must order several.

## NOTE

Sprague makes a type 715P Orange Drop that is suitable. I have found few distributors that stock this series however, so it is usually a special order. By the way I have only found the .15 value in former Williams *Moon Patrols*.

# Kristel Monitor Wavy Video

Ken Layton  
Capitol Amusement and Vending  
Olympia, Washington

## PROBLEM

Model 600 series games. On monitors made by Kristel Corporation, the picture is poor, wavy and has vertical foldover at the top.

## SOLUTION

Replace C208 (1uf @ 50vdc), radial cap.

# Merit Pub Time Display Blanking

Jim Kelly, Customer Service Manager  
Merit Industries  
Bensalem, Pennsylvania

## PROBLEM

Some *Pub Time Darts* with overhead Cricket display have a blanking problem. During game play or between games, the overhead LED display goes completely blank or displays erratic information.

## SOLUTION

A modification kit is now available to cure this condition. Call Merit Customer Service at 800/445-9353. This kit will be sent through your local Merit Distributor.

# Wells Gardner 19K4914 Sizing

Tim Voyik  
Interspace Video Sales Inc.  
Sacramento, California

## PROBLEM

For those of you who are stuck with *Gauntlet* cabinets using the 19K4914 style monitor and are having problems expanding the picture size to full screen.

## SOLUTION

Above the horizontal output transistor is a terminal board with a diode and two caps. Remove this board and disconnect the 3 wires going to the monitor board. Replace C365 with a (0.39 or smaller polypropylene cap @ 200v or higher). I used a 0.153 @ 400v and achieved excellent sizing.

# Shifting & Expanding GO7 Monitor

James Beck  
Greater Southern Distributors  
Atlanta, Georgia

## PROBLEM

How do I shift the picture of an Electrohome GO-7 monitor farther than the pin adjustments allow? While we're at it, how can I expand the picture width beyond the horizontal width coil max adjustment?

## SOLUTION

Try this, it has worked well for me.

1. To get more vertical shift replace R421 (12K @ 2W) with a 10K @ 2W.
2. To get more horizontal shift replace C501 (.001uf @ 25V) with a .1 uf @ 25V. Then use the horizontal frequency control to shift the picture. You will find a *much* greater range of shift before the monitor loses sync.
3. To get more horizontal width, turn the B+ adjust fully clockwise. This will give you more horizontal width and the voltage won't be high enough to cause any X-Ray problems (your regulator will run cooler too).

If that's not enough, but I don't know why it wouldn't be, you might try taking a few windings off the horizontal width coil. That's a little drastic though and shouldn't be needed. You might need to boost up the vertical size after the B+ adjust.

# Atari Pole Position Disco Monitors

James Beck  
Greater Southern Distributing  
Atlanta, Georgia

## NOTE

When taking voltage measurements, be sure to use the "Zero-Volt Reference Test Point"; the chassis is *not* connected directly to the board ground. It goes through a 1K resistor!

## CAUTION

Although the chassis *is* at earth potential (unless you cut the ground strap) you will get out of spec voltage readings. If you have a jumper between the power supply and earth ground, the chassis will be connected through the loop to DC ground.

# Wells Gardner K4600 Neg Sync

James Beck  
Greater Southern Distributing  
Atlanta, Georgia

## PROBLEM

If you put a kit into a cabinet that uses one of WG's 4600 series monitors and you have problems getting a good lock onto negative composite sync, perform the following simple modification.

## SOLUTION

Cut the jumper on the Horiz/Vert board that shorts out C351. The jumper is located near the horizontal hold pot.

# Atari Asteroids Monochrome X-Y Monitor Problem & Solution

Matt J. McCullar  
Forum Fair Arcade  
Arlington, Texas

This is one of the weirdest problems I ever faced. It consisted of a monitor for an *Asteroids* game. Although it took several days to find, I'll concentrate it here.

*The problem: no picture on the screen.* High voltage was present, but the heater did not light up. This kind of monitor has separate power supplies for heater and high voltage, so I checked the 3-amp, slo-blo fuse in the transformer-heater circuit. Removing the fuse and using the continuity function on my DVM, the fuse looked good. The heater inside the neck of the CRT had not opened up and was also good. With no fuse in the circuit I got 6.3 volts A.C. from the transformer, which was normal. But every time I reconnected everything, the voltage to the heater dropped to about 3 volts. I checked all the wiring and it was good.

I did run across one interesting thing: the coin door lamps use the 6.3 VAC to light up, and their sockets appeared a bit faulty so I cut their wires and took them out of the circuit. But that did not help light up the picture tube's heater.

I finally got a break a few days later when the heater fuse blew. When I replaced it, the heater came on! *What happened?* I concluded that the fuse's internal resistance had slowly increased, thereby dropping the voltage across it. Instead of blowing the way it should have, this one just slowly weakened. I didn't notice this before because the beeper-continuity function on my DVM turns on the beeper when it finds anything under 30 ohms across the meter leads. Ideally, a fuse should be very close to zero ohms (although some fuses with very small current ratings are about 10 ohms), but this one had apparently slowly increased to several times what it should have been. Since its overall resistance had not yet gone over 30 ohms, however, the beeper on my meter turned on and I assumed

the fuse was good. So now, when I check a fuse, I don't use the continuity test and instead get a direct resistance measurement.

My dad is a retired engineer from a Texas electric power company and I asked him if he ever ran across a fuse doing this. he said an electrical substation in west Texas got knocked out for a while because a fuse developed a cold solder joint inside one of the endcaps and increased its resistance. But since it wasn't visible, no one caught it by just looking at it. He also says that the same thing can happen in circuit breakers.



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# Hantarex Herringbone Pattern Fix

Chris Richards  
Coin-Op, Inc.  
Webb City, Missouri

## PROBLEM

I've got a *World Series* in a counter-top version, that uses a Hantarex monitor, and it has a problem I have never seen before.

## SYMPTOM

It has Herringbone pattern reminiscent of the kind you get from power supplies, but the supply isn't the problem. I tried jumpering common to ground, and then swapped out the supplies, but that didn't do any good. In addition, the game has vertical bars in the picture, that are darker than the rest of the screen. They are very evenly spaced.

I'm curious if I've got bad B+ filtering here or what, but I don't know for sure where to look 'cause I don't have any Hantarex schematics, and right now I don't have the time to run circuit traces, unless it is absolutely necessary (translation: I'm lazy, and I'm hoping someone else has already figured this problem out!)

## SOLUTION

James Beck  
Greater Southern Dist. Co.  
Atlanta, Georgia

No problem, Chris,  
I have run across this one before...

## CULPRIT

Take A look at C25, (47uf @ 16V). It will cause that problem, and take a look at how it's connected to the 7905 (-5v regulator). Some of the boards were turned out with the silkscreen legend for the + and - reversed, and the parts stuffers put the part in backwards. Hence, no filtering!

## NOTE

Since it is a negative supply, the positive lead should run to the chassis ground.

# Wells Gardner 7900 Horizontal Collapse

Bill Eaton  
Nickles & Dimes Inc.  
Laguna Hills, California

## PROBLEM

Lately, I've been seeing some real "humdinger" problems with the 7900 series Wells Gardner monitor chassis.

## SYMPTOM

Horizontal Collapse, yes folks the word is horizontal and all you get on the screen is a Vertical line...

## SOLUTION

L1, L2 or D15, 16, 17, 18 —any or all bad.

## DETAILS

L1 or L2 start to work out of the board via heat. This problem is really apparent on Medium Resolution Monitors. Wells Gardner has attributed the problem to vibration and recommends reinforcing the coils on older units with "hot melt" or similar material. (Also, you should go over the solder connections at the same time.)

## NOTE

Great care should be taken to use a material that would be mechanically suitable and would not cause any additional damage to the coil because of some mechanical or chemical interaction.

## TRACKDOWN

Wells Gardner did not have a booth at the show (AMOA, 9/89), but I just caught a glimpse of a badge that said "Wells Gardner Electronics Co." and I homed in and, what do you know, it was Larry Brady, V.P. and Sales Manager. Well, what the heck, I'll rag on anyone (even V.P.s). Larry, thank you for your expedient and prompt answer that was waiting on the ole' fax upon my return.

This restores my faith in management that cares, I certainly did not expect such a quick response. Thanks again Larry, WG couldn't have a better Customer Service team!

# Hantarex MTC9000

## Low B+ Voltage

James Beck  
Greater Southern Distributing  
Atlanta, Georgia

### PROBLEM

Any suggestions for a low B+ problem. It's 65v vs. 130v. Have checked the current limiting resistors and replaced TR15 Horizontal Output xsistor, TR20 (pass xsistor), and TR19 (driver).

### SYMPTOM

Check the voltage drop across R81, better yet is the B+ doing a slow oscillation?

### SOLUTION

If either is true, you probably have a blown flyback transformer. I have gone the same route several times this past year and they have all have been bad flies.

If you take a look at the feedback loop made up from D18 and R100 you'll see the connection with the flyback. Pull the dude out and give it a good visual inspection: I'll bet you'll find a bulge on it somewhere.

# Electrohome GO7

## Vertical Deflection

James Beck  
Greater Southern Distributing Co.  
Atlanta, Georgia

### PROBLEM

Concerning an Electrohome GO7 *Robotron* monitor: No Vertical Deflection and FR401 (68 ohm, 2 watt fusible resistor) keeps opening. Known good: Deflection yoke, R414, R415 and C412.

### SOLUTION

Check these suspected parts for failure:

<b>X402</b>	(may be shorted)
<b>X401</b>	(may be shorted)
<b>D401</b>	(open or shorted will cause problems)
<b>C411</b>	(may be shorted)

### NOTE

Make sure you're replacing FR401 with a wire-wound replacement and NOT a carbon type.

# Electrohome GO7 Replacement Capacitor

Mike Cowen  
Video Images  
Scottsdale, Arizona

### PROBLEM

If you are having trouble finding a replacement capacitor for the main filter C604, try checking with your local Panasonic (Matsushita) parts distributor.

### SOLUTION

They should stock an exact replacement part or they can order it.

PART NUMBER:

### ECET200H600X (or Y)

Exact replacement 600uF/200V,  
About \$11.

### ECET200H800X

Better replacement 800uF/200V,  
About \$15.

# Hantarex Replacement Xsistors

Chris Richards  
Coin-Op Inc.  
Webb City, Missouri

## SYMPTOM

I recently had some problems with the red color amplifier on a Hantarex *MTC 9000*. The red input was totally saturated. No problem. I whip out my schematic, find the transistor in the amp section, check it out.

## PROBLEM

Sure enough, had a collector to emitter short. So I pulled out my handy dandy NTE reference and crossed the transistor. It crossed to a 123AP with the package rotated 180 degrees. This also crossed for a 2N2222, 2N3904, and a 2N4401. Well I just happened to have some 2N4401 transistors on hand so I put one in.

Now I've got almost no red! Replace it again, same story. Go to my NTE dealer, get the 123AP, same story. Finally called Hantarex, got THEIR transistors, put 'em in, everything worked. So what is my point?

## SOLUTION

If you have a Hantarex monitor, and something blows up, git-aholt-of Hantarex and get the factory part. Since this sucker uses European parts, there is no guarantee that a NTE or SK part will fill the bill properly.

# SNK/Tradewest Video Interference

Matt J. McCullar  
Forum Fair Arcade  
Arlington, Texas

## SUBJECT

Does your *Ikari Warriors*, *Guerilla War* or other S.N.K./Tradewest game have a very strong pattern of interference on the screen?

## CAUSE

The video connector for the monitor and the pins for the incoming signal lines. Two ground pins - 3 and 7 - are available, but Tradewest

# Disco Monitor Sync Lock

Evan Wessel  
Mercury Amusement  
Haverford, Pennsylvania

## PROBLEM

The sync lock is poor. Everytime the scene changes, the monitor loses sync.

## SOLUTION

I have discovered a cure for the poor sync lock on my converted Atari *I-Robot* with a "Disco" brand monitor (named in the 70's?).

## PROCEDURE

I was able to get normal lock by adding a 1K resistor in the sync line. Just splice it in series with the sync wire going to the monitor. I'm not sure why this monitor was overloaded by my conversion board, but it may be a problem in future conversions that use this brand monitor.

## NOTE

My conversion board worked fine on a Wells Gardner monitor, by the way. Keep this tip in mind if any of you encounter a problem like this in the future.

uses only pin 3. I have found on many occasions that the single ground wire was installed in pin 4, which is not connected to anything!

Inspect the gap between the video sockets? That's where pin 4 is! With no ground reference to the monitor, the video signals pick up all kind of Radio frequency Interference (RFI).

## SOLUTION

A sharp, pointed instrument will pop the black ground wire out of pin 4's hole. It then slides easily into the empty pin 3 socket and locks into place. This should eliminate the interference.

# Hantarex MTC 9000

## Current Limiting

Jean-Guy Hardy  
Service Coin Ltd.  
Saint John, N. B., Canada

### PROBLEM

Complete loss or low +130 volt output.

### CIRCUIT ID

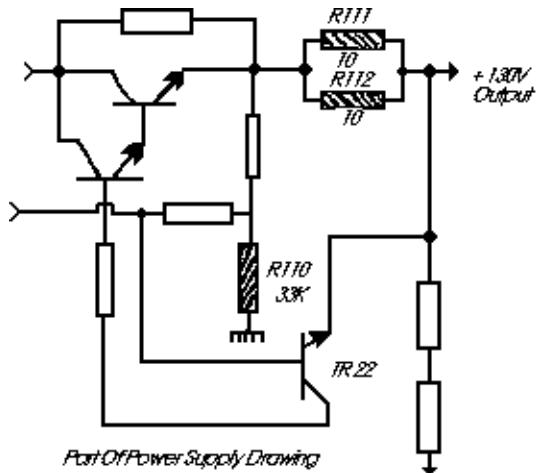
The *MTC 9000* monitors use a current limiting system to guard against excessive current flow from the regulator output transistor.

The two areas you should check in the power supply are resistor network R111, R112 and resistor R110, these resistors are part of the current limit sense circuit.

The two resistors R111, R112 are the ones that monitor current flow from the regulator and produce a voltage drop that provides bias to the emitter of Tr22, along with R110 which set the reference voltage to bias the base of Tr22.

If the value of R111, R112 increases, the voltage drop will also increase and limiting will take place, or if the value of R110 increases the same action takes place.

Replace these resistors with proper replacements specified by the manufacturer.



# Merit Pub-Time

## Jumpy Video

Michael T. Smythe  
Indy Amusements, Inc.  
Indianapolis, Indiana

### PROBLEM

If the monitor jumps or squeezes together when control lamps are flashing the probable cause is the switching power supply.

### SOLUTION

Replace it with a power supply that has 12 volt outputs at 2 amps.

### NOTE

If there is no picture at all, suspect the flyback transformer, as we have replaced several. Otherwise, this has been a very reliable machine.

## SERVICE MANUALS

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# 1991

## Update: Monitors

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# Electrohome/Wells Gardner Fading

## SYMPOTM

The left side of the monitor is dark while the right side displays normal video.

## CAUSE

The problem described is caused by a poorly filtered B+ boost coming from the flyback.

## SOLUTION

On an Electrohome GO7 chassis monitor the filter cap is located on the neck board. Check or replace cap C107, 10mfd at 250v. When it fails it causes excessive brightness, i.e., with the screen control turned all the way down, the picture still has retrace lines in it.

On the Wells Gardner K4900 series monitors chassis, the cap that will cause side-to-side fading is C702 (10uf, 100v) located near the flyback on the main board. Replace this cap with 10uf at 160 volts.

# Beware The Crystal Explosions!

## SUBJECT

Recently I had a really spooky experience. I had just removed the glass from a video game and turned to set it down when all of a sudden it exploded right in my hands as though it had been shot by a gun! It completely disintegrated into a pile of marble sized pieces on the floor, still crackling, leaving me dumbfounded.

When I related the incident to co-workers I found that some others had similar experiences involving thick (1/4 inch) sections of glass.

I've ruled out poltergeists sun spots, and bad karma, and there were no Memorex tapes anywhere in the vicinity. Does anyone know what causes this?

## EXPLANATION

What you had was a piece of tempered glass. It has excellent strength and durability. And that is exactly what it is designed for: Strength without the bulk.

## TEMPER TEMPER

When the original plate of glass was rolled it had many surface defects and is very brittle at room temperature. (I'm sure you've broken an ordinary glass window before, the cracks were formed along these defects.) It is these surface defects that provide the stress lines that cause the glass to break so easily. To avoid the surface defects and to increase overall strength a tempering process is used.

## THE PROCESS

After the rolling process, the sheet of glass was heated again to almost the melting point. That smooths out all of the surface defects, then the hot glass is exposed to a cold blast of air. That instantly solidifies the surface and yet keeps the interior hot. As the interior slowly cools it contracts and pulls the surface into a compressed state. That makes it one seriously stiff piece of glass!

Believe it or not, your average pinball glass has over 15,000 psi (pounds per square inch) of surface tension on it, and pressures of up to 35,000 psi aren't uncommon.

## IN REAL LIFE

Now, say you have one of these 15,000 psi pieces of glass that's been hit and scratched in several places (arcade wear). What you were carrying around was a 15,000 psi time bomb that had all kinds of stresses built up and focused on and around these little scratches. Add a little thermal stress from a pair of warm hands and a little mechanical flexing from the movement and BOOOOOMMMMM! Little bitty chunks of stress relief, that you will find in the strangest places for years to come, are flying.

## FOR YOU FACT NUTS

Surface stresses of 1,000,000 psi have been attained with heat and chemical tempering. How would you like to have some of that stuff go off in your hands!

# Sanyo Monitor Raster Shift

## SYMPTOM

Whole raster shifts to right hand side (monitor normally oriented) of picture tube. This is not foldover, not a sync problem. This monitor is found in Nintendo videos.

## CURE

Some technicians when using this type of monitor with a conversion kit, expand the picture by changing C470 (Note: C470 printed on PCB but shown as C480 on schematics) which is rated at .47 @ 400v to a lower value.

Too low a value, (example .2 @ 400 say), causes overheating of R479 and D475. Also, C485 which is positioned right below R479 fails. Replace C485 check R479 for 330 ohms.

## NOTE

Changing C470 (a.k.a. C480) for a much lower value causes discoloration of the trace on the PC board, a sure sign of impending failure of one of the above components.

# Nintendo Dual Interference Cure

A common complaint heard from dual-cabinet converters...

## PROBLEM

I am trying to convert a Nintendo dual cabinet (sit down) to two JAMMA wired games, one is *Eswat*, the other *UN Squadron*. The problem is interference between, I think, the two monitors.

I have used shielding between the monitors (metal), separate power supplies, and separate isolation transformers. I have also tried getting a little more distance between the monitors.

The yokes are about 5 inches apart. If I pull one monitor out about 6 more inches the problem stops, this is great but it makes it very difficult

to close the cabinet! Any help would be greatly appreciated.

## SOLUTION

The problem you're experiencing was covered here in *STAR\*TECH Journal* in the past year (by me), but I'll recover the quick version here.

The problem is caused by the magnetic flux of the yokes being so close together. The sync signals that produced by two different boards (even of the same type) are a little different. The monitors have no problem locking onto these signals, but the difference causes a magnetic "beating" of frequencies in the fields.

This beating is the ripple you see. The vertical sync is most noticeable because it is at a low enough frequency our eyes can perceive it. In the original game this was no problem because the two sides of the board set used the same master oscillator. The only solution I can give you is to use as much shielding as possible between the two yokes.

In the cocktail games you must make sheet metal cones to fit over the yoke assemblies and silicon them in place. In the uprights you can get away with a sheet between the monitors.

Make sure you ground the shields to earth ground and the chassis.

## NOTE

*Eswat* is a System 16 Sega pinout PCB but in the Sega USA kit they have included a Sega to JAMMA interface board and a JAMMA harness.

# Hantarex MTC 9000 Sync Problem

## PROBLEM

Try to lock in the composite sync on the monitor and all you get is garbage.

## SOLUTION

Most games today use the negative composite sync setup but when this monitor is hooked up that way there is no sync. The manual says that Pin 1 on jack CB is ground, Pin 2 is the negative vertical sync and Pin 3 is the negative horizontal sync. This is incorrect.

**CORRECT PINOUT**

Pin 1 is the negative horizontal sync, Pin 2 is the negative vertical sync and Pin 3 is ground. This should take care of the negative composite sync hookup. You will still have a problem with the vertical sync lock in. As with Hantarex's 9000 series monitors you must not connect the negative vertical sync Pin 2 to the negative composite sync line from the game board.

## Hantarex *MTC 9000* Blank Screen

**SYMPTOM**

Blank screen - no high voltage. This applies to all Hantarex monitors Model *MTC 9000*.

All transistors in B+ regulation section check good, as well as TR15 horizontal output. R105 turns into a toaster element, and the chassis becomes a sandy beach.

**CURE**

Watch out for this one gang! This is my third Hantarex Model *MTC 9000* that has done this. The problem is the EHT (flyback) transformer. TH2 Hantarex PN 28026030. This baby is gone south. If you look close, you might notice a nice little hole punched through the case along with a bit of melted plastic near the ferrite core. Better order an extra one for stock.

## Wells Gardner *19K4604* Vertical

**SYMPTOM**

Partial vertical collapse or small frame.

**SOLUTION**

Check resistor R317 on the top right hand side of the "VERT" board; it should be 2.2 ohms and is probably open circuit.



## Reduce Picture Width *WG 7601*

**SYMPTOM**

The picture on your newly converted game is too wide and the monitor is a Wells Gardner *7601*. Adjusting the horizontal width coil shrinks the picture, but not enough.

**TEST**

The next natural step is to measure the B+ voltage. B+ should be at 123 volts on this monitor. If can be measured at Pin 4 of the voltage regulator (IC4).

**CHECK**

If your B+ is higher than normal, but not high enough to activate the x-ray protection circuit, you would have a similar symptom. Our B+ checked OK...

**CURE**

Reducing the value of capacitance of C37 on the monitor easily solves the problem. Our symptom was originally encountered when a *Double Dragon II* was converted to an *MVP*.

Ramon, (our senior technician), found out that by increasing the value of C37, the picture got wider; by decreasing the value of C37, the picture shrunk.

**VALUE SELECTION**

In this case we ended up connecting a 0.22 MFD capacitor in series with the existing C37 which has a value of 0.15 MFD. This gave an equivalent value of approximately 0.09 MFD.

**FORMULA**

The formula for total capacitance of two capacitors in series is  $(CT)=C1 \times C2 / (C1+C2)$ . If you don't feel like doing the math, just use your capacitance tester.

The final step is to fine tune the picture by readjusting the horizontal width coil.

By the way, our *MVP* is doing great and we sold the *Double Dragon II* PCB and Header.

# Galaga Older WG Monitors

## SYMPTOM

The screen on the Midway *Galaga* video, which uses the Wells Gardner monitor, changes to a dominant green or blue background with vertical retrace lines. The color amp drivers are all ok.

## CAUSE

More than likely, it's CRT failure. The indication is that there is probably oxidation particles laying between the electron gun and either the heater or G1 grid.

## SOLUTION

Since this is a very old and used monitor, before you replace it (on what now is a marginally profitable game) try this: Blow it out!

I have had good results blowing off these shorts with a B&K brand CRT rejuvenator. This test unit provides a charge designed to free the internal tube elements of shorts from small particles and will either cure it or finish it for good!

# Electrohome GO7 Dead Monitor

## SYMPTOM

Monitor appears completely dead - power supply voltage too high.

## SOLUTION

Replace capacitor C511 (47 microfarad, 160 volts).

## CAUSE

Failure of C511 causes false triggering of the x-ray protector circuit in the monitor. This causes the monitor to shut down. This symptom may be intermittent, causing the monitor to operate some of the time but shut down occasionally. Examine C511. If it is the original capacitor, change it!

# Electrohome GO7 Curved Picture

## SYMPTOM

Sides of picture are curved instead of straight.

## SOLUTION

Replace capacitors C517 (100 microfarad, 16 volts) and C518 (220 microfarad, 16 volts).

## CAUSE

The curved sides of the picture are an effect known as "keystoning." The screen will appear to be narrower at one end than the other.

# Electrohome GO7 Power Supply

## SYMPTOM

Monitor appears completely dead; power supply voltage 0 volts.

## SOLUTION

Replace resistor R902 (2 ohms, 7 watts).

## CAUSE

Monitor fuses will be okay but nothing works. R902 is open!

# Electrohome GO7 Blank Screen

## SYMPTOM

Screen will appear blank but will show raster (white screen) when brightness (screen) control is turned up. Vertical retrace lines (diagonal lines) will also appear on the screen. No picture is visible.

## SOLUTION

Replace transistor X304 or X305 (or possibly both). X304 and X305 control the video output

transistors on the "neck" board of the monitor. When one or both of these transistors short circuit, the video output transistors will shut off.

## Electrohome GO7 Bright Picture

### SYMPTOM

Picture too bright - video appears "smeared" or of poor appearance.

### SOLUTION

Capacitor C107 (10 microfarad, 250 volts) bad or broken off. C107 is on the neck board of the monitor. This is a common failure item.

The capacitor will often be obviously bad with electrolyte leaking out of the bottom (looks similar to the appearance of a leaky dry cell battery).

## Electrohome GO7 Vertical Line

### SYMPTOM

Vertical line on the screen. Width coil (L502) broken.

### SOLUTION

Resolder the width coil or replace it.

## W-Gardner 4600 Keystoned Picture

### SYMPTOM

Picture "keystoned."

### SOLUTION

Replace capacitor C614 (33 microfarad, 25 volts).

### CAUSE

As with the Electrohome GO7 monitor, this capacitor failure will cause the sides of the picture to curve and be narrower at one end than the other. Capacitor C614 is on the main printed

circuit board of the monitor, directly beneath the plug-in board that contains the horizontal and vertical deflection circuitry. This capacitor must be mounted in a bent over position or it will interfere with the mounting of the plug-in board.

## Wells Gardner 4900 Horiz Line

### SYMPTOM

Horizontal line on the screen (loss of vertical deflection).

### SOLUTION

Replace resistor R313 (470 ohms, 7 watts).

### CAUSE

This is a very common problem in this monitor. Resistor R313 open circuits. It will not appear bad to look at it, but will test bad with a meter.

This resistor is vertically mounted on the corner of the printed circuit board.

## W-Gardner 4900 Jumpy Picture

### SYMPTOM

Jumpy picture. Bad solder joints on capacitor C313.

### SOLUTION

Resoldering capacitor C313 will stabilize the monitor.

## Wells Gardner Model 19K4914

### PROBLEM

Last year at Six Flags Over Texas, one of our Gauntlet machines baffled us with a very strange problem. When the game sat inside an arcade there was sound but no picture. I checked the fuses and B+ voltage, and both were okay.

After borrowing another department's truck, we brought it back to the shop. We turned it on and the picture appeared nice and clear, as if it has never been gone. First suspicions included a loose socket, so we checked it over and gave the game a pretty healthy jarring around. The picture stayed rock-solid. We even let it run for a day in the shop and found nothing wrong. So, like dummies, we trucked it back into the arcade.

Keep in mind that the only time games can be moved around at S.F.O.T. during the season is after two in the morning. We all had worked very hard that day and putting this *Gauntlet* game back into one of the arcades in the park was all that stood between us and going home.

Since it worked fine in the shop, we drove around, set it down, plugged it in...and rolled our eyes when the sound came on but the picture tube stayed dark! We roughhoused it a bit, but it didn't help. Back on the truck for a trip back to the repair shop.

The next day I plugged in the game. We are in the shop now, and you've guessed correctly: the blasted thing works in here! We checked it over again, beat the holy daylights out of it in hopes of causing it to screw up, and the picture never wavered once. So we trucked it back out into the park again that night.

#### *Guess what happened?*

By this time *Gauntlet*, a pretty massive game, enjoyed a free ride into and out of the park three times at ungodly hours. Each time it behaved like new in the shop, but shut off in the arcades. Other *Gauntlets* in the arcades worked fine, but not this one.

Finally I decided to let the machine have its fun and run in the shop until it gave up and shut off. Sure enough, the picture blinked out after 24 hours.

#### **SYMPTOMS**

One clue to work with: every time there was no picture, there would be no high voltage and the heater wouldn't light up. Both these voltages are driven from the high-voltage transformer whose primary connects to a chassis-mounted transistor, Q352.

The B+ voltage was still fine, and the oscilloscope proved the video signals were reaching the monitor.

An oscillator circuit uses Q352 to drive the high-voltage transformer. Sticking the 'scope probe on R364, an oscillating signal was definitely present; but when I touched the probe to the base lead of the transistor's mounting socket, the screen suddenly lit up! The heater came on, and the high voltage brought a nice, sharp picture to the screen.

But the instant I removed the probe, everything downstream shut off. Aha! I touched and removed the probe several times, and the screen responded simultaneously.

#### **INTERMITTENT VIDEO PROBLEM**

#### **SOLUTION**

I shut off the game and removed the monitor. After upending it on the bench, a close look revealed the problem: the base lead of the transistor socket had a cold solder joint where it joined the main PC board. I could clearly see a dark ring around the socket lead. I discharged everything, plugged in the solder iron, and sweated the joint. After remounting the monitor, I plugged in all the cables and turned on the game. This time the picture came on and stayed there, no matter how much vibration we gave it. It passed the acid test that night when we took it back to the arcades; it came on fine and has performed beautifully ever since.

#### **CAUSE**

A lot of games out there use this monitor. Its design says if transistor Q352 does not get a signal, it shuts off the heater voltage and the high voltage. The monitor as a whole is still electrically hot, however, because a loss of flyback-transformer action will not affect the B+ voltage (unless the flyback shorts out, in which case it will blow the fuse).

If you have any manuals for this monitor, check them to see if Q352 is labeled as such. Atari's first printing of their manual for it, TM-283, left out the reference number on the schematic.

Write in Q352 above the transistor if it is missing.

# Hantarex MTC 9000 Pix Width

## PROBLEM

Picture width has changed and there is no control of the horizontal amplitude control.

## SOLUTION

Replace capacitor C42, 4.7uf/50 volts.

## CAUSE

Hantarex makes use of transistors Tr 16 and Tr 17 as a resistive load control circuit in series with the bridge coil B3, horizontal linearity coil B1 and the horizontal yoke to control the amplitude of the picture width.

Capacitor C42, shunts the collector circuit of Tr 17, to provide an AC signal path. When C42 becomes open the picture will decrease in width and even with Rv 4 turned to maximum width amplitude, Tr 17 will still not provide the AC shunt required for the signal.

## NOTE

One of the reasons that C42 will become open is that it is located near R97 which gets warm and tends to dry this capacitor out.

# Wells Gardner 13K7801 No Raster

## MODEL

Wells Gardner Monitor Model 13K7801

## SYMPTOM

No raster.

## CAUSE

Burnt trace on monitor PCB between capacitor C36 and flyback transformer.

## SOLUTION

Repair trace and verify operation.

# De-Zapping CRT High Voltages

## SUBJECT

Here is another useful solution to an old problem, I am not the sole inventor; in fact, I am not even sure how long this has been around.

## PROBLEM

Getting zapped when disconnecting the high voltage lead to a CRT. This can occur even with the time-honored test lead/screwdriver set up.

## SOLUTION

The De-Zapper, make it yourself! Here's how:

- Take two to three feet of ground strap or ground braid, or even #10 stranded wire.
- Strip an inch of insulation off each end.
- Solder an alligator clamp to one end, and install an old probe on the other.
- Tape the entire length with electrical tape.

## PROCEDURE

With the clamp on chassis ground, the probe tip can be easily slipped under the rubber HV boot and the lead unclipped from the CRT without fear of being zapped. Also, it can be used for pulling "down" the collector tab of transistors (ex.: in pinballs/skeeballs) for momentary "on state" testing.

## BOTTOM LINE

It's easy to carry, handy to have and almost free (check your junk box). It's also safe. I have not been zapped for years (from a CRT anyway).

# Sanwa Monitor Sync Problem

## PROBLEM

When converting a Data East *Karate Champ* cabinet to Bally/Williams *Pigskin* you'll find that the Sanwa Monitor will not sync properly and will become jittery.

**SOLUTION**

Run an additional line from pin 6 on the monitor to the vertical sync output on the game board (for vertical sync).

**NOTE**

Upgrading the .47ufd capacitor on the power supply to 47ufd will stabilize the jittering.

## W-Gardner 7000 Series Vertical Roll

**PROBLEM**

Vertical rollover on the top (this is in a *Teenage Mutant Ninja Turtles*) and horizontal lines in the middle of the screen. Capacitors check good. Changed the vertical output transistor. Adjusted the 50-60 control. Still no luck.

**SOLUTION**

Check D25, it might be open. If that doesn't do it, try evaluating R80. It might be out of tolerance. Replace it if it has a slightly higher value than specified (even a couple ohms difference).

## W-Gardner 4900 Vertical Foldover

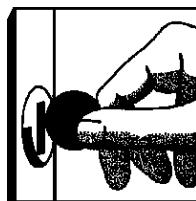
**PROBLEM**

The picture has a vertical cut off or a folded over edge on one side of the screen.

**SOLUTION**

This sounds like a Nintendo C407 capacitor problem, but this is a Wells Gardner monitor.

Well, the solution is also similar. Capacitor C311 4.7ufd 160vdc in the vertical section is baked open. Replacing the cap will restore your picture to normal again.



## W-Gardner 4600 Screen Control

**PROBLEM**

Little to no screen control (brightness).

**SYMPTOM**

Adjusting the screen control makes only little change on the screen, yet the black level control will bring up scan/retrace lines on the screen.

**SOLUTION**

Resistor R419 (330K ohm) is open.

**REASON**

With R419 open, the screen control circuit feeds off the black level line making the black level control act like the screen control to some degree. Replacing R419 will give you the screen control back again.

## Build a Monitor Test Station

**WHY SHOULD I HAVE A MONITOR TEST STATION**

Good question. One good reason would be to aid your troubleshooting efficiency. First off, simply because it is easier to troubleshoot a monitor on a bench than in a game. Second, you can do all those monitors that have been sitting around for years at one time, making your labor cost efficient.

I like to organize my week into: monitors one day, power supplies the next, and video problems after that. If you can do this, it makes your troubleshooting time easier on you, and more cost efficient.

Another reason for a monitor test station is to split video problems in half. By hooking up the monitor to the test station, you can establish whether it's the video board or the monitor. This can be done by mounting your Monitor Test Station on a cart with wheels. It then can be taken to any part of your shop quickly and easily. It could also be put into a box or a case and taken

on location to perform the same function as the shop model. It's light weight and relative small size makes it possible to take on the road.

In the shop, or on the road, it can perform the following functions:

- Converging a monitor
- Adjusting purity
- Verifying picture linearity
- Doing all monitor adjustments after making repairs (like changing electrolytic capacitors or changing transistors), before putting the monitor back in the game.

#### PARTS NEEDED FOR THE MONITOR TEST STATION

This monitor test station is easy to build with the aid of some junk videos that have been building up in your warehouse. It also makes the Monitor Test Station cost efficient, since most of it is from junk games.

The cost is somewhere from \$0 (if you're creative) to around \$50. Sure beats \$300-\$500 for a fancy cross-hatch generator. The first thing you will need is a CPU/video board, an interface board, and a ROM board from a Williams *Stargate*, *Bubbles*, or *Joust* video game. You probably kitted one of these games and have the boards around for spares.

Next, you need the AC end of a pinball or video game. The AC end includes the following:

- AC cord with a three prong plug
- Fuse holder
- 4 amp slow blow fuse
- DPST (double pole on/off switch)
- AC on/off switch
- AC line filter (refer to figure 1)

In addition, you need a normally open push button (any Williams video or pinball has them), a 5 amp or greater switching power supply with +5, -5, and +12 volts (Peter Chou or similar type), and an isolation transformer (can be taken from any video game but make sure you have the right terminals). Stranded wire and Molex or Panduit type connectors will be needed also (you can use the original Williams video game wiring harness).

#### PUTTING IT TOGETHER

Here's how to put it together. I took the original metal mounting bracket from Williams *Joust* game, with the CPU video board, interface board

and ROM board attached to it.

You can use a wooden board, a box, or whatever works to attach the boards, power supply, and the isolation transformer to.

Then mount the switching power supply (referred to as SPS from now on) and the isolation transformer. I mounted mine on the metal mounting bracket as shown in Figure 1. I also mounted the AC end (plug, cord, line filter, switch) and the push button on the front panel to be mounted anywhere it's convenient for you to use (under the bench, on the side of cart, or on a box to take with you).

Wire the AC end (plug, cord, line filter, switch) as shown in Figure 1. Then attach the AC end to the SPS and the isolation transformer as shown in Figure 1 (be sure to wire the earth or field ground as shown in Figure 1).

Attach one end of the push button switch to the ground terminal of the switching power supply (SPS) and the other end to 2JC.2 of the ROM board.

Attach a wire from the SPS +5 volt terminal to locations 2J2.6 and 2J2.4 of the ROM board, and 1J1.7 of the CPU/video board.

Then attach a wire from the ground terminal of the SPS to locations 2J2.1 of the ROM board and to 1J1.2 and 1J1.3.

Attach a wire from the -5 volt terminal (SPS) to location 1J1.9 of the CPU/video board.

Then attach a wire from +12 volt terminal (SPS) to locations 1J1.8 and 1J1.5, of the CPU/video board.

Now wire two long 16 gauge wires to the output side of the isolation transformer. This will be connected to the AC input of the monitor under test.

I use a whole bunch of different AC monitor connectors to interface the Monitor Test Station to different monitors. Make sure you have an earth ground hook up to connect to the monitor chassis.

Then connect a RGB cable to 1J3 of the CPU/

video board and the RGB input of the monitor under test.

#### OPERATION/TEST

Flip the AC switch on. When the picture comes up, it will say "High score table reset, bookkeeping totals cleared, and factory settings restored."

Now push the advance button (the push button) 7 times, waiting each time for the screen to display the test it's in. The next tests are monitor tests:

- Color RAM test (color intensity test)
- Cross-hatch pattern
- All red screen
- All green screen
- All blue screen
- Color bar generator (primary and secondary colors)

The advance button works forward through the tests, keep pushing it to get through the board diagnostics until you get to the monitor test you want. Works the same as all Williams video games with the push buttons.

#### WHAT MONITORS WILL IT TEST?

The monitor test station will work on the following monitors:

- Electrohome Go-7
- Wells Gardner 79XX's series
- Wells Gardner 49XX's series
- Pole Position* monitors
- Any monitors with positive sync

#### NOTES

You can add a 7404 to change it to negative sync, if needed. With an adapter plug for the RGB cable and a variac for the 100 Vac that Nintendo monitors require, you can test Nintendo monitors too.

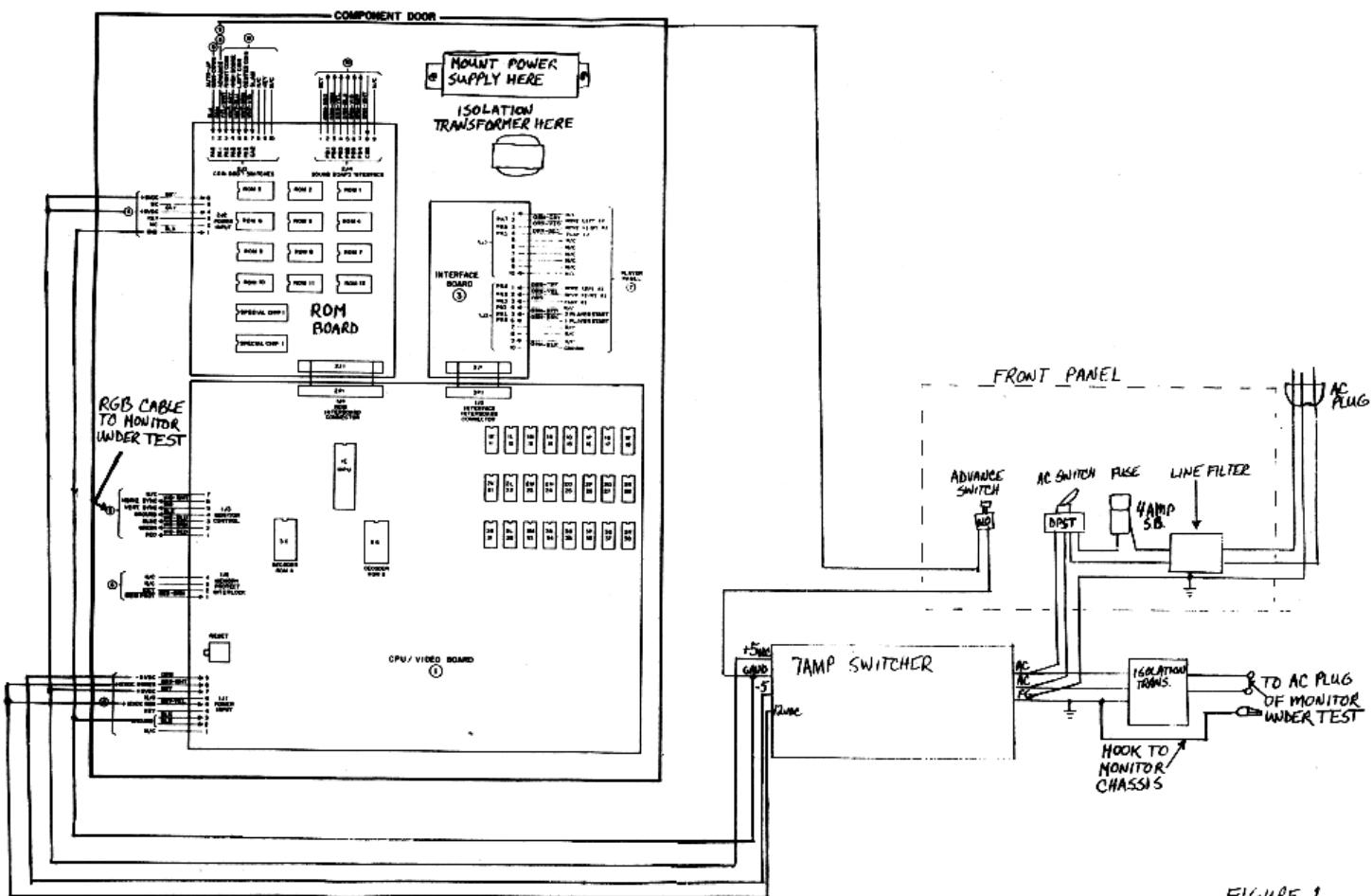


FIGURE 1

Figure 1

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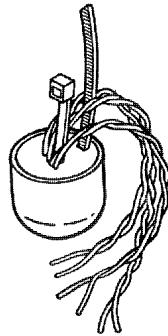
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# 1992

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# Atari *Tempest XY* Monitor Troub- shooting Missing XY Signal

## PROBLEM

No deflection on monitor, LED D800 on, monitor known good.

## CAUSE

Missing X or Y (or both) signal at monitor. But where to start you ask?

## PROCEDURE

Well, the first place to check is at P/J 100, the monitor input plug. Check pins 7 and 8 (X and Y outputs from board), and pins 10 and 11 (X and Y grounds).

On many occasions, I've found the male or female pins to be pushed outwards of their respective housings, making intermittent contact, if at all, or the female pins on P100 "reamed out" causing the same.

As many times as P/J 100 has been connected/disconnected over the past decade, I don't find that hard to believe at all. This condition will eventually "fry" that particular channel, so its a good thing to check when you have them in your shop.

Next check continuity between J100 and pins T and 17 (X and Y out) and 16 and U (X and Y grounds) at the board thus eliminating poorly crimped wires on the edge connector.

Well if you still have a problem, onto the board.

## SOLUTION

Check the +15vdc (VR3 7815), 15vdc (VR1 7915) and +6.8vdc (CR5 6.8v zener).

If all are present, replace IC D/E 12 (TL082 op amp) for the X channel or D/E 13 for the Y channel.

## NOTE

I have never had an X or Y channel problem that this procedure did not cure. But, if your's still exists, replace IC C12 then IC A/B 12 (MC 1495L) for X channel or IC C13 then IC A/B 13 for the Y channel. Happy hunting.

# Disco Monitors Failed Capacitor Symptoms & Solutions

Disco monitors models DMC-2090DT-2A/B. I've gathered up my notes and put together an electrolytic cap checklist of different problems I've encountered over the years.

## PROBLEM

Very hard to sync monitor horizontally with horizontal hold if at all.

## SOLUTION

Replace C503 (10u @ 16v).

## PROBLEM

Pix shifted slightly to left on right side of monitor.

## SOLUTION

Replace C510 (100u @ 16v).

## PROBLEM

Pix tends to "wave" inwards symmetrically from top to bottom on the top third or so of monitor.

## SOLUTION

Replace C533 (1u @ 50v).

## Note

Keystoning at the raster top is the condition occurring when cap is completely open.

## PROBLEM

Pix rolls top to bottom, and looks like it's being "poured" out of top left corner of monitor.

## SOLUTION

Replace C401 (330u @ 16v).

## PROBLEM

Vertical roll.

## SOLUTION

Replace C403 (1u @ 50v).

**Note**

You can't sync monitor vertically with vertical hold period if this cap is completely open.

**PROBLEM**

Horizontal lines across top quarter of monitor, but not quite a foldover effect.

**SOLUTION**

Replace C407 (10u @ 50v).

**PROBLEM**

Vertical collapse.

**SOLUTION**

Replace C412 (100u @ 160v).

**Note**

Dual parallel horizontal lines across center of monitor when open.

**PROBLEM**

No pix, high voltage low (@ 10KV) or "fuzzy" pix out of square.

**SOLUTION**

Replace C006 (22u @ 160v).

**Note**

No raster condition occurs when cap is completely open.

**PROBLEM**

Increase in vertical size.

**SOLUTION**

Replace C601 (22u @ 160v).

**Note**

Vertical size will usually take care of this on location.

**PROBLEM**

Pix shifting to right.

**SOLUTION**

Replace C602 (470u @ 25v).

**Note**

Horizontal center will usually take care of this on location.

*Also:* While you've got that monitor on your bench, here's a list of some caps that are probably "baked" open but don't really have any adverse effects on the

pix quality itself but do provide some filtering and you've already got it out, right, so...

C706 (4.7u @ 250v on neck board)

C005 (4.7u @ 160v)

C529 (4.7u @ 160v)

C203 (220u @ 25v)

## Electrohome GO-7 Brightness

**SUBJECT**

Capacitor C107 (10u @ 250v), as you may all know, when this cap located on the neck of the board opens or breaks, your pix is too bright. So your route man notices this and turns the brightness down, right!

**SYMPTOM**

Now when this machine makes it to the shop what you'll see is a horizontally mounted *GO7-CBO* with what appears to be a good pix except for the faint vertical bars running left to right.

**SOLUTION**

So here's the point! Before you go and swap out every electrolytic cap in the horizontal and vertical sections, to no avail I might add, change C107. It probably needs it anyway. I always replace them with caps rated @ 350v.

## Electrohome GO7-CBO Horizontal Width

**PROBLEM**

After converting a game you have insufficient horizontal width, and if you could adjust L503 (horizontal width coil) without it breaking, it wouldn't be enough anyway.

**SOLUTION 1**

Try adjusting your B+ fully clockwise. This will give you a little more width and it won't be enough to kick in the x-ray protection shut-down circuit.

**SOLUTION 2**

In situations requiring more (approximately 1 inch+ on each side) change C515 (0.53ufd) to 0.39ufd.

Use polypropylene types and, as always, observe your voltage ratings (equal or better).

**NOTE**

The 0.39u value has worked well for me several times although each situation varies.

**THE RULE**

My general rule of thumb regarding horizontal width circuits of all monitors I've encountered is the relationship between the capacitance on one side of the width coil and the horizontal width itself. Simply stated: More is Less, Less is More.

## Electrohome GO7 Poor Filtering & Vertical Collapse

**PROBLEM**

Video "wavers" slowly up and down.

**CAUSE**

Poor filtering of input to X901 (power driver).

**SOLUTION**

Replace C905 (10u @ 250v).

**PROBLEM**

Vertical collapse.

**CAUSE**

Poor filtering of input to deflection yoke.

**SOLUTION**

Replace C407 (4.7u @ 63v).

## Hantarex 19" MTC9000 Flybacks

**SUBJECT**

There was a problem with the flyback transformers going bad on a few of the 19" MTC9000 monitors.

**SOLUTION**

Hantarex has updated this transformer with one of two replacements. Eldor of Italy is the manufacturer and part numbers are as follows:

Original - 28026030

Replacement - 28026031 or 28018460 (smaller)

No problems have been reported with either one of the updated flybacks installed. The 18460 is identical electrically to the 26031 but physically smaller.

**NOTE**

This change applies to the 19" model only. The 13" and 25" have had no reported problems.

## Hantarex MTC9000 Horizontal Width

**PROBLEM**

Having problems getting your MTC9000's horizontal width back down to size?

**SOLUTION**

Replace C42 (4.7u @ 50v non-polarized). This problem is especially noticeable after replacing a bad flyback with the new replacement part.

## MTC9000 Hantarex Flyback Change

**SUBJECT**

Hantarex monitors seem to be plagued with flyback problems. A lot of them just fail for no apparent reason. They claim to have made a better flyback for the MTC9000 model now, but it is a royal pain to install.

**PROBLEMS**

The ground lug is not centered like the original, so a new hole has to be drilled to accommodate it.

The screen control hits the metal frame around the high voltage section so that has to also be cut.

A cap has to be changed also, to use the new one (C36).

I have installed 2 of them this week and only time will tell if they will hold together.

#### OTHER MODEL

Another Hantarex monitor that has mucho problems is the little *MT3000*. It is used on earlier Merit *Premier Darts*.

I would guesstimate that they have better than a 50% failure on the flyback. They claimed to have a better one for this model, but I found a lot of them die also. I wish they would have stuck to the original *MTC9000* model. That had fewer problems than the newer redesigned stuff, seems to me.

#### THE GOOD NEWS

Well, there is one bit of good news, they will sell to anyone directly and the flybacks are priced reasonably. The *MTC9000* flyback transformer is about \$35 and the *MT3000* is \$20.

## Hantarex *MTC9000* Composite Sync In- stallation Note

#### SUBJECT

I'm not sure if this is common knowledge or not, but it sure had me scratching my head for a while.

#### PROBLEM

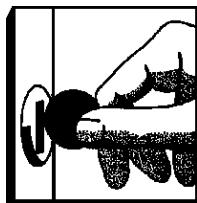
No vertical hold.

#### SOLUTION

With Hantarex *MTC9000* series monitors, if your game has composite sync output, be sure to connect it to the horizontal sync input only.

#### NOTE

If you hook it to both vertical and horizontal sync inputs, (like is done on most other monitors), the vertical hold will not lock properly.



## Hantarex *MTC9000* ECG Parts

#### SUBJECT

I don't mind the flybacks kicking out, it's all the strange problems that it causes:

Not locking the vertical correctly.

Only a red line across the screen, etc.

#### PROBLEM

The biggest pain in the a.. however, is that there are no ECG or SK cross reference numbers to the failed parts.

#### SOLUTION

I got lucky with a monitor that the factory repaired and they used ECG replacement parts with the numbers on them.

The horizontal output transistor and the regulator that I couldn't find in the books, but my supplier had them. The horizontal output is ECG2300, and the regulator is ECG2311.

## Kristel Monitor No Raster or High Voltage

#### PROBLEM

No raster or high voltage.

#### SYMPTOM

Checking the voltage at pin 2 of IC 202 measures around 8 volts, and the voltage at the base of Q202 is at near 0 volts.

#### SOLUTION

I've had this problem twice, and it has been C212 (4.7ufd 35vdc) that had gone bad each time, replace and your up and running again.

## Kristel Monitor Raster Loss Low DC Volts

### PROBLEM

Loss of raster.

### SYMPTOM

Loading down of the monitor +12vdc on the power supply.

### SOLUTION

Diode D204 (1N4936) has shorted, replace and you're back in business.

## Matsushita Monitor Bright Raster

### PROBLEM

Matsushita monitor #TM-202 G has picture that's too bright with horizontal retrace lines.

### SYMPTOM

B+ (180vdc) low (@ 125vdc).

### SOLUTION

Replace cap C559 (4.7u 250v), it's open.

## Matsushita TM-202G Improper Sync

### SUBJECT

Matsushita monitor *TM-202G* used in early/mid 1980's Atari Games.

### PROBLEM

When turned on, monitor will not sync for two minutes if at all.

### SOLUTION

Replace C805 (33u @ 160v) with one rated at 250v. Don't just check it, replace it as I've had them check fine in and out of circuit and still not function.

## Nintendo Monitor Retrace Lines

### SYMPTOM

I had a Nintendo monitor (20-EZV (RC)) mounted horizontally with a picture that faded from normal to too bright with retrace lines and so forth.

### CAUSE

Started checking the standard capacitors and found C471, 10ufd @ 160v baked completely open.

### SOLUTION

Change capacitor with equivalent value and equal or better rating.

### NOTE

Had no jail bars (i.e. hum bars indicating a filter capacitor failure) on picture.

## Nintendo Monitor Horizontal Tear

### PROBLEM

20 EZV(R-C) horizontal tear.

### SYMPTOM

Monitor appears to be out of sync. Adjusting horizontal hold causes high voltage to increase and shut down monitor.

Checked IC401 and sync amp. TR204; both checked fine.

### SOLUTION

Replace capacitor C459 (100u @ 16v). It's open.

## Nintendo Monitor Black Bars

### PROBLEM

Nintendo monitor 20-EZV(R-C) with black bars (jail bars) running vertically across monitor (mounted horizontally).

**CAUSE**

Capacitor C471, 10u @ 160v is baked open.

**SOLUTION**

Replace capacitor with component of equal or better rating.

## Nintendo Monitor Bad Pix Quality

**PROBLEM**

Nintendo monitor 20EZV(R-C) (mounted horizontally) with poor picture quality. Pix will appear to be normal at left and gradually become too bright on the right and sometimes appear to have a horizontal keystone effect.

**CAUSE**

Poor filtering of the horizontal input to the flyback.

**SOLUTION**

Replace C472 (100u @ 160v) it's open. While you're there change C471 (10u @ 160v) because as you may have noticed from previous articles, C471 can cause a couple problems.

**NOTE**

Replace these caps with those rated @ 250v.

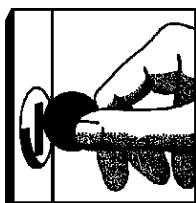
## Sanwa Monitor Vertical Foldover

**SYMPTOM**

Vertical foldover problem with Sanwa 20 inch color monitor #20116DU. Used in *Kung Fu Master* game or its conversion cabinet.

**SOLUTION**

Part C320, 4.7mfd @ 160v radial capacitor. Remove and replace.



## Sanyo Monitor Black Vertical Lines

**SYMPTOM**

Black vertical lines on Nintendo (Sanyo) monitor.

**SOLUTION**

Replace C302. Rating: 1mfd @ 50 volts.

## Sanyo Monitors Problems & Solutions

**SUBJECT**

After seeing a couple of articles on the Sanyo monitors (Model 20=EZV) that are used in Nintendo video games, I felt that some follow up was in order.

Following is a list of the more common problems associated with Sanyo monitors.

**PROBLEM**

Vertical foldover (also appears as a partial shrinking of the top of the screen). This is the most common Sanyo monitor problem.

**SOLUTION**

C407(10uf@ 160v) a high temp. range will extend the life of the cap. (i.e., -55 to +105 C).

**PROBLEM**

Black bars (jail bars) - mentioned in the July 1991 *STAR★TECH Journal*.

**SOLUTION**

C471 (10uf @ 160v); could also be C472 (100uf @ 160v), C467 (1uf@ 160v), C468 (330uf@ 25v), or C469 (220uf @ 25v).

**PROBLEM**

Wavy picture.

**SOLUTION**

Voltage regulation problem, most commonly Q901 or IC601.

**PROBLEM**

Horizontal tear.

**SOLUTION**

After checking the horizontal hold potentiometer, check C459 (100uf @ 16v) - this capacitor also causes multiple images before drying out completely.

**PROBLEM**

Brightness too high (can't adjust down).

**SOLUTION**

R478 (1 ohm, 1/4W).

The following are less-commonly reported problems as listed by our service technicians.

**PROBLEM**

Brightness too low (can't adjust up).

**SOLUTION**

C303 (10uf @ 50v).

**PROBLEM**

Black vertical lines.

**SOLUTION**

C302 (1uf @ 50v).

**PROBLEM**

Horizontal sync problem along the top edge of the screen that won't adjust out.

**SOLUTION**

Change R491 from 100k to 75k ohms.

## WG K4600 Vertical Deflection

**SYMPTOM**

No vertical deflection. Vertical/Horizontal PC board tests fine. Yoke tests fine.

**CAUSE**

-15v from flyback is shorted. -15v goes to Pin 3 of P301/J301 of vertical/horizontal PCB but we verified that the PCB was good.

**SOLUTION**

The 15 volts also supplies voltage to the neck board for the color cut-off circuit. One of the color drive cut-

off pots was bent and shorted. Replacing the pot solved the problem.

**NOTE**

This problem shouldn't occur too often, but if you are experiencing an intermittent problem with these symptoms, check these pots.

## Wells Gardner Horz Output Transistors

**PROBLEM**

We have received some complaints of horizontal output transistors failing more than once in the same chassis.

**CAUSE**

The problem appears to be related to the damper diode (D18).

**SOLUTION**

We highly recommend that anyone changing the horizontal output transistor (Q11) also change the damper diode (D18) at the same time. This takes care of the multiple failure mode.

If any operators or service personnel have questions regarding the proper diode to use, please contact Chuck Hedrick, Manager Parts and Services, Wells Gardner 312/252-8220. Fax 312/252-8072.

## Wells Gardner K7000 No Raster, No High Voltage

**PROBLEM**

No raster.

**SYMPTOM**

No high voltage, B+ high (130-160vdc).

IC2, IC4, Q10, Q11, D10, D12 and C36 known good.

**CAUSE**

Poor (if any) filtering of B+ out of regulator IC4.

**SOLUTION**

Replace C57 (47uf @ 160v) with one rated @ 200v).

**NOTE**

Check this cap. especially if high voltage is intermittent.

## Wells Gardner 19K6101 Low B+

**SUBJECT**

This tech tip pertains to the Wells Gardner 19K6101 monitors (*Tempest*).

**PROBLEM**

Monitors had low B+ (181vdc).

**SOLUTION**

Replace ZD 902 (150v zener).

**IN ADDITION**

Replace ZD 901 (12v zener) for same symptom.

**NOTE**

While repairing nine 19K6101 (*Tempest*) monitors, I had six with ZD 902 bad and two of the remaining three with ZD 901 bad. All were leaky and regulating at wrong voltages causing pot to vary between 110-165vdc.

## Wells Gardner 4900 Vertical Height, Ver- tical Collapse & Sync Problems

**SUBJECT**

A few problems I've encountered with the Wells Gardner 4900 series monitors (not covered in previous STAR\*TECH Journal articles).

**PROBLEM**

Vertical collapse (will appear as a fat horizontal line).

**SOLUTION**

Replace C313 (100u @ 160v).

**PROBLEM**

Lack of vertical height on top half of monitor that is too bright with horizontal retrace lines.

**SOLUTION**

Replace C701 (1000u @ 25v).

**PROBLEM**

Best description I can give on this one: Monitor is out of sync.

Displaying "squiggly" horizontal lines across the monitor approximately 2 inches in height at the center of the monitor.

**SOLUTION**

Replace C301 (330u @ 16v) or inspect PCB for cold solder joints or broken trace in this area.

## CRT Alignment

I'd like to say a few words on CRT alignment. Have you ever replaced a CRT only to find rainbows on screen? Tried degaussing with no help? Ok, let's go over it again.

After replacing the CRT, align the yoke back on the neck roughly where it was on the old CRT. Snag the clamp just enough to hold it.

Install the magnets in the same approximate place on the new CRT that were in the old one (roughly just ahead of the guns).

NOW, disconnect the RGB lines from the logic board and install a jumper from +5v to the red monitor input. Leave the sync connected. Power it up. This will give you a red screen (on most monitors - some AC coupled monitors this won't work, and it's back to the shop for the pattern generator). Gently loosen the yoke clamp and move the yoke back and forth on the neck to give a full solid color screen without rainbows. Also, level the screen with the tube outline.

Snug the clamp. Degauss the CRT at this point and then double check your yoke setting - picture square and mono colored? Fine. Go ahead and glue in the rubber yoke wedges.

If the game has an internal convergence generator, then power down, disconnect the +5v jumper, reconnect the RGB lines and use it to converge and purify

the screen. If not, and no pattern generator is handy, try this.

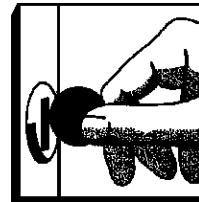
With the +5 jumper in place (RGB lines disconnected. Sync must be connected!), shrink the picture both horizontally and vertically to get a small square block.

Connect additional jumpers from +5v to B&G inputs. The square should now be white, on a black background. Align the convergence to a single white square. No R, G, or B "shadow lines" on the edges. Enlarge the picture horizontally noting any minor corrections and then vertically.

Power down, disconnect jumpers and reconnect RGB lines. Put up the game and check it out.

I've been told this method was kind or crude. It is, I admit it, but it has worked for me.

Happy game.



## How To Test For A Faulty Flyback Transformer

### SUBJECT

How to effectively diagnose a failed monitor flyback transformer.

### PROCEDURE

One "almost" sure-fire way to diagnose a bad flyback is to check to see if it has any ringing.

### WHAT TO LOOK FOR

It should give a sharp rise followed by a sharp fall followed by a smooth fall. If the area where it should be a smooth fall has ringing (up, down, up, down, up, down, etc.) after it, then the flyback is probably shot.

### VISUAL INSPECTION METHOD

Another way is simply by observation. Discharge the second anode to ground (power off, please!) and clean the flyback off so you can get a good look at it. Many times, when they fail, they will blow a slight hole, crack or swell up.

To do this, power the monitor up through an isolation transformer powered by a variac.

Ground your scope probe's ground lead to the monitor chassis.

Take your scope probe and place it near the deflection yoke.

Set the scope to 50 uS sweep and about 2 volts per division.

Slowly power the monitor up to about 70 or 80 volts and observe the waveform.

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# 1993

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# Arachnid 6000 Monitor No Hi-Volts

## SYMPTOM

Arachnid 6000 (9") monitor with no high voltage.

## SOLUTION

Check the peak-to-peak voltage at the base of the horizontal output transistor. If it is low (should be around 7 Vpp) replace C14 (4.7uf, 50v) capacitor located next to the horizontal output heat sink. It has probably opened up or changed value.

# Arachnid English Mark Darts Monitor Cap

## SUBJECT

The Omni Vision monitor. This monitor is used in *English Mark Dart* games.

## PROBLEM

When servicing, be aware of improperly marked polarity on the PC board for capacitor C48 (100uf @ 25v, radial). The silk-screened markings are wrong.

## SOLUTION

When reinstalling this capacitor, take note of the proper polarity. The minus side goes to the collector of transistor Q5.

# Data East *Lethal Enforcer* Fuzzy Video

## SYMPTOM

Video is not crisp or seeing double characters.

## CAUSE

The game uses a mirror to reflect the image from the monitor and this is the cause of the double imaging. There is nothing wrong with the game.

It appears almost as a ghosting problem on your

home television except it is up/down instead of left/right. The mirror is reflecting the monitor image from two points, one from the mirror material on the back of the glass and the other from the top surface of the glass itself.

The second image is much weaker than the first and should not cause any problems for players.

# Electrohome Temp Capacitor Fix

## PROBLEM

As you all may know, when C511 (47ufd @ 160v) fails, or is failing, it can cause a couple of problems from no raster to intermittent raster with an oscillating high voltage.

## SOLUTION

The solution, of course, is to replace C511. But here's a little "tech tip" you can pass on to your route men - or for your techs too busy to swap it out on location.

Simply take an electrolytic cap (even a value as low as 2ufd will work) rated @ 160v and connect the negative side to ground and the positive side to the monitor B+ (120v).

## NOTE

Although this will work for months, this is strictly a temporary repair procedure, for as you know, if C511 is failed or failing, it is probably one of 4 or 5 capacitors that are doing so (probably drying out).

## PROCEDURE

The easiest way to do this is to:

- Place a "horseshoe" terminal on the negative side of the cap.
- Loosen the screw on the mounting bracket for R01 (22052 @ 25w in the power regulator circuit on the chassis) and
- Connect the "horseshoe" terminal.
- Then solder the positive side of the cap to the side of R01 that goes to the emitter of X04 (Power Regulator).

## Hantarex MTC 9000 Squeal Off

### SYMPTOMS

On power up, monitor emits a high pitched squeal. No raster. B+ around 160v. Sometimes picture will come up, but it will be distorted and warped in some cases.

### SOLUTION

C34, (22ufd @ 160v) B+ filter cap gone south. While you're at it, you might as well replace C42 horizontal width amp cap (47 ufd @ 50v), it probably needs it.

## Hantarex MTC 9000 Excessive Width

### SYMPTOM

Cannot reduce width down far enough to view entire picture.

### PROBLEM

This particular monitor encountered was in a Taito *Chase HQ*.

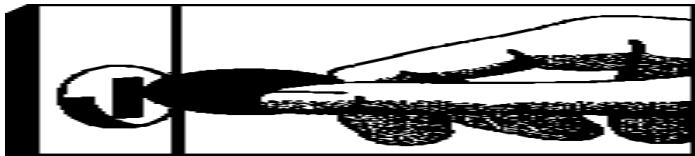
### PROCEDURE

After confirming that B+ was running at +130vdc, it was found that in the width coil circuits, C42, a 4.7uf @ 50v electrolytic, was open.

Replacing C42 brought the width down and was then completely controllable by the Horizontal Amplitude Control RV4, located on the stand up PCB with all of the other vertical and horizontal controls.

### LOCATION

C42 is located inside of the big metal heat sink, to the left of the flyback, and requires the use of a needlenose pliers to remove and replace.



## Hantarex MTC 9000 Sync Compatibility Modification

### SUBJECT

Most of us are aware by now that Hantarex MTC 9000 monitors will not lock vertically if composite sync is applied to both sync pins (#5 and 6 on CA connector).

### SOLUTION 1

The solution to this is to apply composite sync to the horizontal sync pin only. This works fine, but wouldn't it be nice to make the monitors compatible and interchangeable with the rest of the industry?

### SOLUTION 2

The addition of a couple of 1uf capacitors to the monitor board permits standard sync connections.

### PROCEDURE

Lift one end of R25. Attach a 1uf capacitor to the lifted end and solder the other end of the capacitor to the vacated hole. Solder a similar 1uf capacitor across R35. You should now experience a solid vertical lock.

### NOTE

Used was a 50v film type capacitor.

## Hantarex MTC 9110 Intermittent Video

### SUBJECT

Hantarex MTC 9110 25" Monitor.

### SYMPTOM

Intermittent loss of video, self correcting. Sometimes the monitor restarts voluntarily and other times only after it's been shut down for a day.

It was suspected that the overvoltage protection was kicking so, so D10 was snipped on the monitor board and no more shutdown.

**SOLUTION**

Add a 10k resistor in series with D10. It appears that the secondary voltages that the 25" monitor generates are 10%-15% higher than that of the MTC 9000 chassis after which the 9110 is modeled and may be causing random intermittent shutdown.

## Hantarex New *POLO* Monitors High Speed Diodes

**SUBJECT**

Hantarex has a new line of monitors out designated by the word *POLO*. The distinctive thing about them is that they are built around a switching power supply. The switcher takes up about a third of the circuit board and is covered by metal shielding.

**PROBLEM**

Hantarex *POLO* monitors, diode failure.

**OBSERVATION**

*POLOs* lately have a shorted D119 in the 12 volt supply. This completely shuts the unit down as the 12v supplies the horizontal oscillator.

**TEST**

A quick check for this is to find the 7812 regulator. Right next to that is a board jumper that leads to the switching section. This jumper is the input to the regulator and goes to Ov when the diode shorts.

**REPLACEMENT**

The diode is a BYV28/200T. The unit seems rather particular about what you put in there too. At first was used a similar size diode out of a scan-derived voltage source from a scrapped Hantarex 900 chassis. The *POLO* came up but a wisp of smoke from the "new" diode warned not to let it run more than a few seconds.

**SOLUTION**

The switching supply runs many times faster than the 15kHz horizontal frequency, so even many "fast switching" diodes are no fast enough. The original part cured the problem in both cases.

## Hantarex MTC 9000 Raster Lines

**SYMPTOM**

Horizontal lines at bottom or top of the raster.

**CAUSE**

This condition is caused by a non-linear vertical waveform as viewed with the oscilloscope at TP3.

**SOLUTION**

Change capacitor C9 (100uf, 35v) in the vertical amplifier circuit.

## Hantarex MT-3000 Common Failures & Causes Used In *Merit Premier Darts*

**FAILURE**

No Picture, No High Voltage.

**CAUSE/SOLUTION**

This is the most common problem with the monitor. It is often caused by a defective flyback transformer but other sections of the monitor can also cause this symptom.

Keep one thing in mind, this monitor is not like typical monitors, its filament voltage is directly driven off the B+ line and not from a derived voltage from the flyback. This means the filament can light even without high voltage present.

First covered will be the non-flyback failures because you will want to check these components out before changing the flyback.

**TROUBLESHOOTING**

- Start with a check of the power supply output voltage, it could be read at the lead of R28 that is closest to the back of the chassis.
- If it is below 9.5 volts then changes are your horizontal circuit is down somewhere.
- If it is zero volts check the fuse. The fuse is a 2

amp fuse of small dimension and sometimes blows when a bad flyback is present, most of the time however, the fuse will be intact.

- Take a good look at the circuit board and look for any hairline cracks.

- Take a reading of the voltage on the emitter of TR10. Also check it at R46 to make sure it didn't open. This is where the horizontal IC gets its power from. No juice here and you will get no picture.

- Next place to look is C10 and C11. Check them out physically and if they appear good, check them with a meter or cap tester. They are involved in the feedback loop to the main power supply regulator of the monitor.

- Also in the feedback loop is R32, check it.

- Next, take a look at the power supply section itself. This includes TR7, TR8, ZD1 and any resistors that are in the circuit.

- The last thing to check, before condemning the flyback, is TR11, the horizontal output transistor.

If all this checks out, then you could be fairly certain that the flyback is shot - replace it.

#### FAILURE

No Video, monitor has high voltage.

#### CAUSE/SOLUTION

This is another common problem. It is generally caused by a failure in one of the transistors in the video stages.

#### TROUBLESHOOTING

- Check TR1, TR2, TR3 and TR4.

- If you find these to be good, check the neckboard out for cracks and also,

- Check TR201 and TR202 while you are at it.

- Another possibility is the external contrast potentiometer although this is rare.

- Also check TR5 and TR9 which make up the blanking circuit when the monitor is configured for a dart game.

#### FAILURE

Poor or no sync.

#### CAUSE/SOLUTION

Usually caused by a bad TR1 and/or TR2.

#### TROUBLESHOOTING

- Check jumper configuration also. See chart below.

#### TRANSISTOR SUBSTITUTIONS

Original Part #	Substitute
BC548	2N5550*
BC558	2N5401*
BDX53A	TIP102 or TIP122

\* = Install transistor backwards.

#### FAILURE

Picture brightness too high and brightness controls have no or little effect.

#### TROUBLESHOOTING

- Check the derived flyback voltage circuits. The most common part to go is R75. It will open up.

- If it is good, check D9, D10, R64, R65 and ZD2.

#### Do ON EVERY REPAIR

- Check the condition of all electrolytic capacitors. You don't have to measure them but look at their casings to see if they are heat shrunk. If they are, you may want to consider changing them.

- In general, if C10 and C11 look like they are over a year old, change them on general principle. They seem to take a beating and commonly fail.

- Also, make sure the jumper configuration is correct, check it against the chart below.

- Most importantly, make sure the DAG (picture tube) ground is attached to the connector on the neckboard. If it is left off, it will usually trash TR1 thru TR4.

- When finishing up, make sure the B+ is set at 10.8 volts.

#### JUMPER CONFIGURATION FOR PREMIER DARTS

SP10 - FS2

SP11 - FS5

SP12 - FS7

# Hantarex *Polo 25"* Monitor Street *Fighter II CE* Horizontal Output

## GAME

*Street Fighter II Champion Edition*

## FAILURE

Horizontal Output Transistor (HOT) shorted.

## REPAIRS AND CHECKS

Hantarex customer service techs advised to check R229, a 1 meg ohm resistor for an open condition, T113 (horizontal drive xsistor) and D134, D135 for a short condition. None were defective. After replacing T114 (BU508A) with an EGC2302, the monitor was powered up, which takes a few seconds before the high voltage appears, and a bright blue screen came on. This was traced to R228, a high wattage resistor mounted on stilts on the neckboard. It had broken loose from the copper traces on the solder side, turning the blue gun on - all the way.

## CAUSE

This, of course, loads T114 via the flyback, which is probably why it failed. A good idea might be to reinforce R22 and R25 on the neckboard. Maybe something could be done at the factory level to reinforce this fragile area.

# Matsushita Monitors Dim Screen

## PROBLEM

When powered up, screen comes up real dim. After 10 to 15 minutes, screen is normal.

## SOLUTION

Replace C406 (1mfd, 160vdc) in the blanking section of the monitor.



# Matsushita Vertical Hold Cap For Atari *Pole Position*

## MONITOR

Matsushita 19" monitor.

## GAME

Used on Atari's *Pole Position* games.

## PROBLEM

Vertical Hold will not lock-in, getting a rotating/looping effect with the picture on the screen.

## SOLUTION

Found C405 (2.2ufd 25vdc) a Tantalum Capacitor in the vertical section of the monitor bad, replace and verify.

# Merit *Pub Time* *Darts* Vertical Height And Linearity Problems

## SYMPTOM

On *Pub Time Darts* by Merit Industries using the Hantarex 9" amber colored monitor, you may have insufficient vertical height and bad vertical linearity on the monitor.

That is, it has wide-spaced horizontal lines near the top, badly crunched two thirds of the way down, then too widely spaced the rest of the way to the bottom of the screen.

## PROBLEM

Thinking this was the monitor at fault, a different video signal was substituted and the monitor displayed a decent picture. The monitor was put back into the game and the voltage was turned up on the power supply. A decent picture appeared after a voltage of 5.35vdc was reached. Knowing this board did not have to be at this voltage to display a good picture, something must be going out (borderline operational) on the board.

**SOLUTION**

Eventually replaced was the TMS9118 Display Controller, U25, with a TMS9128 which is pin for pin compatible. The 5vdc adjustment was then able to be returned back to normal.

**SOURCE**

Merit has had problems with their TMS9118 chips and has begun to substitute the TMS9128 in it's place. It is available from the factory, parts supplier Semitech, or your favorite Texas Instrument dealer.

## Sharp XM-2001M Horizontal Problem

**SYMPTOMS**

- 1) Horizontal wrap-around of video image.
- 2) Horiz-Centering has no effect.
- 3) "Clattering" sound as Horiz-Hold is adjusted - sometimes triggering shutdown circuitry.

**SOLUTION**

Replace C609 (100uf 16v). This cap leaks (electrically speaking) although it will test good.

## Sharp Image 27" Monitor Purity Problem

**SUBJECT**

The degausser on the large 27" Sharp Image monitor is between bad and poor. (The degausser is an electro-magnetic device which demagnetizes the monitor and cleans up bad color areas caused by external magnetic fields - it is activated each time the monitor is turned on.)

**SOLUTION**

The only trustworthy way to have a good picture without a purity problem is to use a dedicated external degaussing coil.

**SOURCE**

Can be purchased from MCM Electronics (toll free at 800/824-8324). Their prices range from \$14.20 to \$29.95 per unit.

## Wells Gardner K7000 Hi Voltage Shutdown

**SYMPTOM**

Monitor goes into high voltage shutdown from unregulated B+ and the regulator (STR3130) is not shorted.

On power up, audible high voltage whine can be heard coming in, then, just as quickly, voltage drain can be heard. B+ around 160v. No raster.

**NOTE**

You can read the value of the high wattage, 180 ohm resistor mounted on the side of the chassis if it isn't shorted.

**SOLUTION**

C57, (47ufd @ 160v) is baked dry. Sometimes cap will be domed on top, but not always.

## Wells Gardner K7000 Blown Safety Caps

**PROBLEM**

Blue colored safety capacitor (C36) shots out and blows the line fuse and maybe the B+ Regulator. One side may be split or blown off. This problem may cause you to spend a lot of time, especially if you find the H.O.T. (horizontal output transistor), transformer and the AC rectifier diodes good.

**IDENTIFICATION**

The number on the cap, which is a four legged device, is .0061 @ 1600v. The Wells Gardner part number is 046X0551-003.

**SOLUTION**

Of course, this safety cap must be replaced with the exact part number.

# Wells Gardner 79XX Series: Shadows, No Pix, Blown Fuse, No Regulation, No Horizontal Sync

## PROBLEM

Shadows or what appears to be shadows on half the screen.

## SOLUTION

Replace C57, a 47uf/160v capacitor.

## PROBLEM

No picture. Fuse is good. Glow in the neck of the picture tube.

## SOLUTION

Replace C57, a 47uf/160v cap. Poor filtration of C57 on the output of the regulator causes the high voltage shutdown circuit to kick in.

This cap seems to account for many problems, since it filters the B+ voltage out of the regulator. This is a good place to start troubleshooting. It is the first thing to change in a no picture situation, where you have high voltage and no blown fuse.

## PROBLEM

No regulation. 157 volts at R301 instead of 123 volts.

## SOLUTION

Apply a load resistor (500 ohms, at least 5 watts) across R301 and the chassis (be careful! this is 123 volts dc) while measuring the voltage across load resistor. If it regulates to 123 volts, it is not the regulator but probably the horizontal output transistor.

## PROBLEM

Blown fuse F1, 2 amp SB.

## SOLUTION

This is usually the high voltage output transistor Q11. Take it out and take a resistance measurement and compare it to a known good transistor. Emitter to Base is around 47 ohms both ways

because of the biasing resistor internal to the transistor.

This could also be the regulator IC4, or diodes D19-D22, the bridge rectifier.

## PROBLEM

No horizontal sync.

## SOLUTION

If you have 19k volts at the picture tube anode, then it's IC2. Sync problems usually are generated at this IC or its associated circuitry.

# Wells Gardner K4914 Horizontal Tear

## PROBLEM

Horizontal tear when the monitor is cold, but seems to correct itself when it warms up.

## SOLUTION

Replace C354 (47uf @ 25v). Readjust horizontal hold and horizontal shift to properly center the picture.

# Wells Gardner 13K7842 Vertical Collapse

## PROBLEM

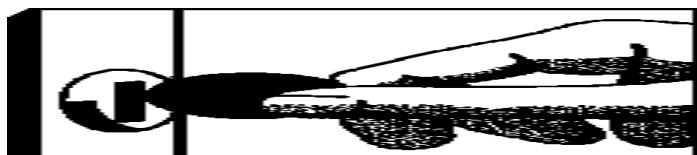
Intermittent vertical collapse on Wells Gardner 13" monitor.

## CAUSE

C40, a 2200mfd at 35vdc capacitor is drying up.

## SOLUTION

Replace it. This capacitor is in a hard to get to area - next to the flyback transformer and dries out because of the heat and little ventilation.



# Wells Gardner 4600 Vertical Centering

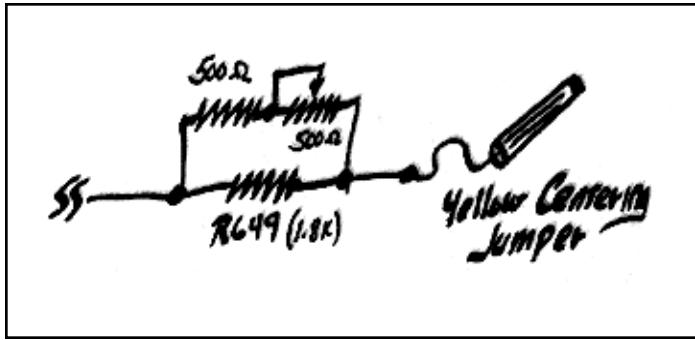
## SYMPTOM

Poor vertical centering.

## SOLUTION

If the yellow vertical centering jumper doesn't give you enough "up" displacement of the video, try adding a resistor in parallel with R649 (1.8K). A 680 ohm worked well.

A 500 ohm resistor in series with a 500 ohm potentiometer placed in parallel with R649 should give some fine adjustment range. Refer to the diagram below.



This breakage is sometimes deceiving. It looks OK at first glance but upon closer examination with a magnifying light glass, you can see the break around the pad of R89.

Checking with an ohmmeter is also deceiving because the pressure from your meter probes can "make" the circuit.

In fact, sometimes this problem manifests itself by way of an intermittent black screen, most of the time in a location that turns their games on/off at night and in the morning.

## THE CURE

The fix is simple enough, just wrap a wire around the leg of R89 and "electrically" reattach to the circuit with solder. "Electrically" reattach because the circuit goes to many points, make sure they ohm out.

# Well Gardner 79xx Series Component Upgrade

# Wells Gardner 79XX Series Black Monitor Plague

## No PIX

No Picture, No Raster.

## POSSIBLE SOLUTION

This is sometimes caused by a bad electrolytic capacitor @ C57 (47mfd @ 160v) but, sometimes not.

## CHECK

R89 has a cold solder joint from excess heating of R89 (not out of the ordinary for a right cabinet) or R89 has broken away from the pad or trace on the flip side of the circuit.

Wells Gardner has decided to upgrade C57 to a .47ufd at 220v. In addition, they are upgrading the temperature rating from 85 degrees C to 105 degrees C. Any repairs that you make in the field should have this change done as a matter of routine.

This should extend the usable life of the monitor chassis by several thousand hours.

Regarding R89, some monitor cabinets have inside temperatures that exceed the 55 degree C monitor ambient temperature specification. This can accelerate, or cause R89 to self-heat and reflow the solder in that circuit.

Electrically and thermally strain relieving the resistor should prevent or repair a circuit failure of R89. In addition, it is recommended that more ventilation be installed in cabinets, or positive ventilation be installed in such cabinets, i.e., a fan.

# Wells Gardner 25" Monitor Dim Display

## SYMPTOM

The symptom is that on a Wells Gardner 25" monitor, the display is going dim. You can turn the brightness all the way up, and if you turn the HV up the picture starts to fade. The monitor is fairly new, only a one year old model and you know that it's supposed to last longer than this.

## CAUSE

The Wells Gardner model #7000 and on up monitors use capacitor-coupled RGB input, and if your board has a lot of Vdc bias on the video signal it will "swamp" the monitor input.

## SOLUTION

If this is your case, (measure for Dc on these video lines) try putting 5K pulldown resistors on the RGB outputs from the PCB.

# Wells Gardner #7131 Out Of Focus Display

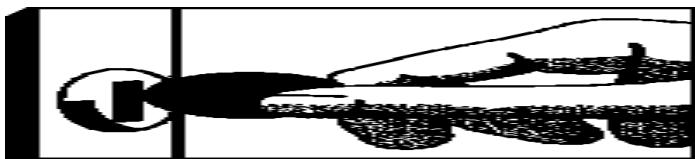
## SYMPTOM

This problem has happened on several Leland *Super Off Roads*. Left half (right down the middle) is darker, out of focus and has waves in the picture, the right half is crystal clear.

## SOLUTION

Change cap C57. This part has been upgraded to a 47uf capacitor at 200v DC and 105 degrees C.

This part is available from Wells Gardner under part number 45x0580-026. Replace the old C47 with this upgraded part.



# Zenith 9-227-01 Vertical Foldover

## SYMPTOM

Vertical foldover.

## CAUSE

Check C2103 100uf/35v radial capacitor. Replace and verify.

# Troubleshooting Monitors With An Audio Gen (Part 1)

## SUBJECT

Part of the problem is that big pile of monitors in the corner that aren't fixed but may be repairable. Until we know for sure they will continue to take up space and cost us time and money.

## TROUBLESHOOTING VERSATILITY

One of the most useful tools for your video bench is an audio function generator, also known as a sine and square wave generator.

Coupling this tool with your scope you can:

- Check electrolytics in circuit.
- Check flybacks in or out of circuit.
- Check entire horizontal circuit in seconds.
- Check diodes and transistor junctions.
- Decide whether to repair or junk chassis before you tie up precious hours!

## SELECTION

A usable generator should put out both sine and square waves, the sine being the one most used here. It should have a variable output from the millivolts up to about 10-12 Vpp. A frequency range of 10Hz to 100kHz is adequate, most will go higher. For your monitor bench, great sensitivity and incredible bandwidth are not needed. If that saves you any money it's good to know.

## CONNECTION

Referring to Figure 1, connection is very simple. The output of the generator is paralleled with the input of the 'scope, and the two lines come out as test leads. (Note that the 'scope is obviously an old model.)

The output of the function generator is normally 50 ohms or a little more and can safely be shorted to itself. This is the basis of most of the testing described here - noting what the device under test (DUT) does in terms of loading down the generator.

## SET-UP

Most electrolytic capacitors test well at 3kHz or a little more. To calibrate your system set the frequency here and set the output to maximum, or at the maximum before the output clips. Set the scope to a setting that just over-scans the screen, then back off the generator to give a full waveform.

## TESTING

Now, try touching the probes to several different values of electrolytics. In Figure 2C, a 1mfd cap will leave just a trace of a ripple. All higher values give a direct short indication - if they are good. Thus, you can go through a chassis, guided only by the symbols on the solder side, and check every cap on it in seconds, or at least not many minutes.

If you get a waveform, you have only to check topside to find that:

- 1) The hole was not stuffed in this model,
- 2) The cap is 1 mfd or less, or
- 3) You've found a bad cap.

## CAPACITOR NOTES

Sound too easy? There are a few cautions. The first is that this check is only for internal resistance. If the cap has merely changed value, this may not show it. However, electrolytics are not usually specified to be precision parts. This check finds more actual trouble making parts than most checkers that give value.

Another caution is that a shorted cap, or a very low impedance circuit can cause a reading that is erroneously good. If you suspect that might be the case, merely unsolder one of the leads and try the cap out of the circuit.

## OFFSET

Some generators have a feature that can help you

here, too. If your machine has a D.C. Offset control available, just set it off a half a volt. Then a short will give you a 0 volt reading, while a good cap will give you that offset. (This is assuming you are using D.C. coupling on your scope. See Figure 3). When in doubt, us an ohmmeter, although shorted caps in monitors are rare.

## SAFETY FIRST

Of course, a strong caution is in order here too. This device is strictly cold chassis! Make sure power is off each time you make a measurement. Beware of some of those big power caps too, which can hold charges for *weeks* if the fuse blow or the board is cracked. You just got that function generator - don't smoke it!

## GROUNDING

Another possibility for false indications is a ground path. Your test signal has a ground side, as most scopes and generators do. If you are working on a chassis that has other test equipment hooked up to it, then hooking the "hot" side of your probes to the grounded section will ground the waveform and make you think the cap is good. If you work with chassis that are completely disconnected from other units this will not be a problem.

## BOTTOM LINE

With all these cautions, there is one thing you can be sure of. A cap that fails to short out your signal is bad and should be replaced. As you stand looking at an unfamiliar chassis and wondering whether a cap job will help, such an inventory will tell you a lot in a short time.

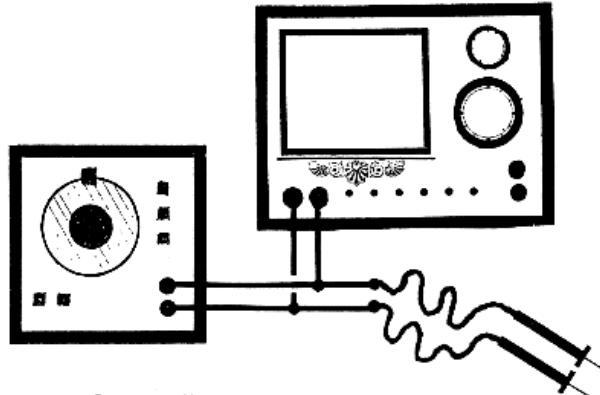


Figure 1 Connections

# Troubleshooting Monitors With An Audio Gen (Part 2)

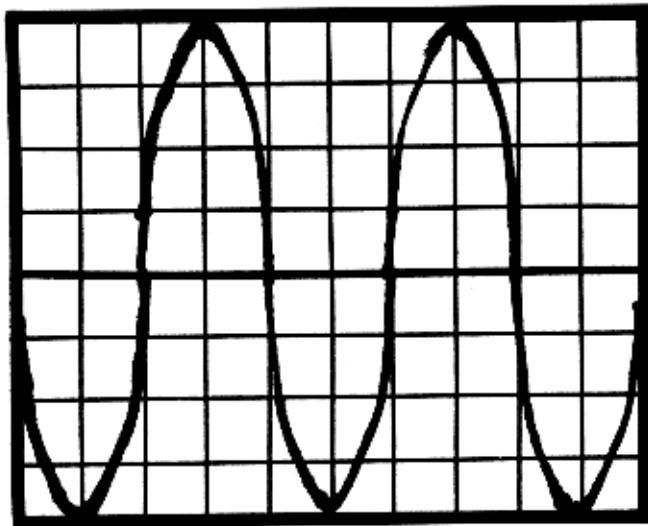


Figure 2A (Full Waveform)

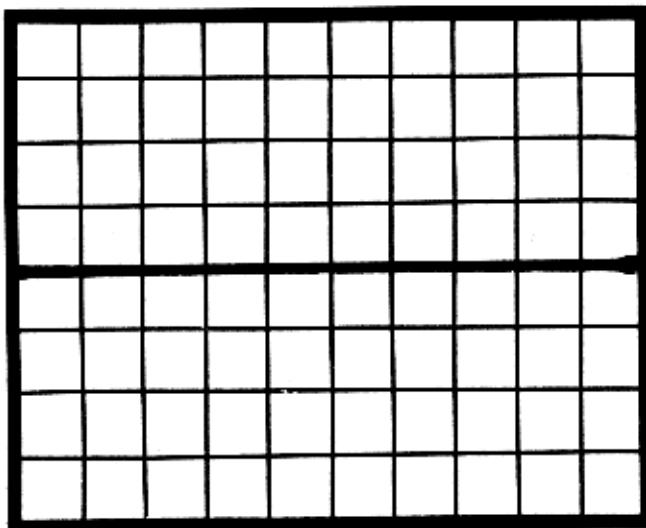


Figure 2B (Shorted Signal -Good Cap)

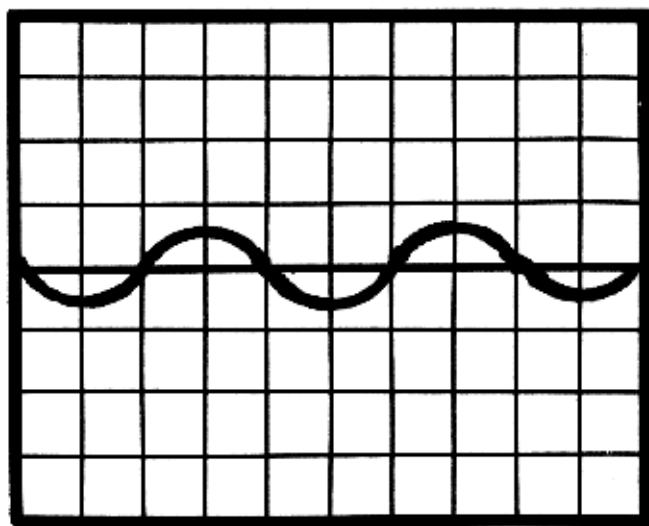


Figure 2C (1 mfd)

## FLYBACK TRANSFORMERS

Ah yes, the flyback! You've got a pile of those in the corner too, don't you? Some of them were replaced on a hunch, then you found another problem, and it just is not worth it to solder it back in for testing purposes, not to mention wear and tear on the circuit board. So here you are, stuck with junk that's too expensive to throw away!

Most flybacks can be easily tested on our little unit here, again with high accuracy. Referring to Figure 4, the input terminals are marked with the X's. These are the terminals to hook your probes to. If you don't know which these are, say for that used part on your shelf with the question mark on the side, then do an ohm check for continuity. Ring each set of pins that has continuity. A good reading anywhere in the unit would tend to indicate a good part.

To test the flyback, sweep the frequency between 10 and 100 kHz. Somewhere there should be a strong resonant peak, where the amplitude goes very high. This indicates a good transformer. At this point you can take that fearsome high voltage wire and short the clip to the pins on the bottom and see the waveform fall as you load it down. Due to the controlled voltage and current used, you can even shoot the voltage through your hand, but don't let that become a habit when the unit is operational.

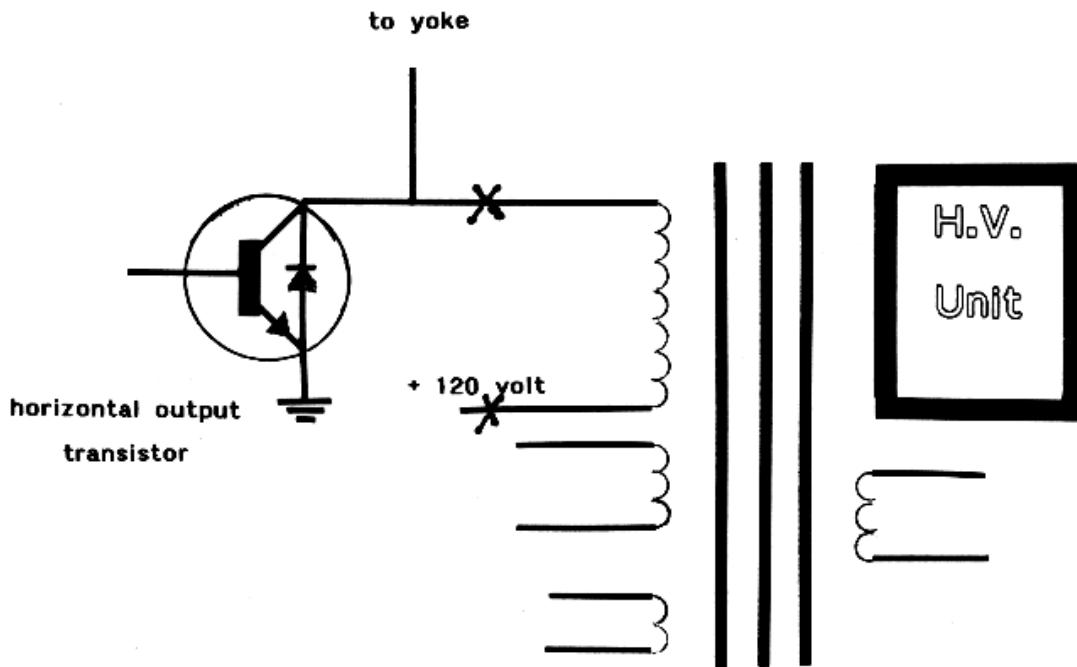
This test is most effective on line voltage monitors where the transformer input runs at about 120 volts. It will work on those little 12v dart monitors too, but the resonant peak will not be as high. In this case, it is a good idea to compare your suspect to a known good one before calling it good or bad.

## HORIZONTAL CIRCUIT

This test can be performed in-circuit by connecting between chassis ground and the collector of the horizontal output transistor.

In this case you are not only check the flyback, but the entire section, including:

Figure 4 (Flyback Circuit: "X" Marks the Primary)



- Output transistor (C-E shorts)
- Damper diode (often internal within transistor)
- Scan-derived voltages, associated diodes
- Deflection yoke

There are three main differences between checking this section as a whole and just ringing the flyback. First, some of the coils and capacitors are there to tune the flyback, and so the resonant frequency will change. The textbook norm is 47kHz, but it is very common to see them anywhere from 15-70 kHz. Secondly, there is now more "stuff" loading down the circuit, so the peak will have a lower amplitude. Nevertheless, there should be a definite peak. Thirdly, there is now a damper diode involved, so we should only expect to see half the waveform (Figure 5b). When in doubt, check your reading against a known good part or chassis.

If it fails to allow a peak, then steps should be taken to localize the problem. First disconnect the collector of the output transistor. This can often be done by just removing the mounting screws. Each time you disconnect anything, re-check the circuit to see if the short is gone.

It's a good idea to take about 90 seconds at this point and check any diodes on scan-derived sup-

plies - basically any diode tucked away in the flyback area. Again, you are looking for that diode waveform of Figure 5b. Any diode that reads as a direct shot should have a lead lifted and be re-tested. Although a shorted diode will tend to pull down the readings on all of these in circuit, there is often a subtle difference between the short and other diodes.

Don't allow this test to take up very much time, though, because the flyback is now your biggest suspect. You are only testing the diodes because they can be checked very quickly. Also in this category is the deflection yoke. It is rare for them to short on game monitors, but hey, a plug in part - pull the plug.

Most flybacks can be unsoldered cleanly enough to check them without even removing them from the board. Take any shortcuts that will work, but make sure of each step. Dogs, for the most part, tend to be technician created. Poor procedure, assumptions, installing wrong parts, making problems instead of fixing them - we all have our moments. Let's try to keep them farther apart.

Regarding dart monitors mentioned previously, there is another trick your little oscillator can do

Figure 5a (Good Flyback)



Figure 5b (In Circuit w/Damper Diode)

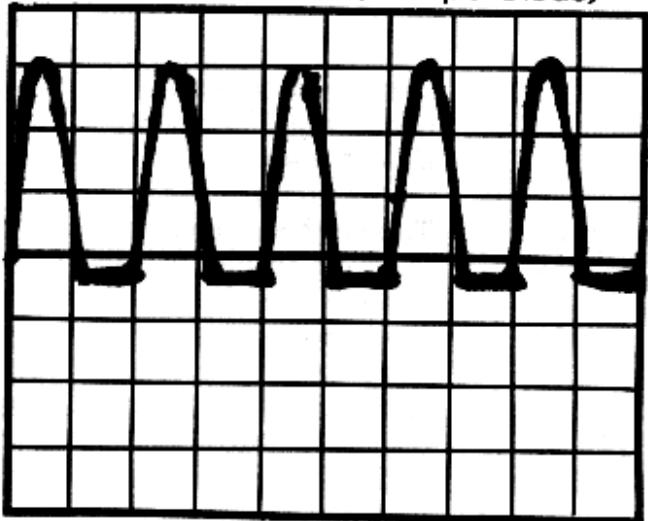
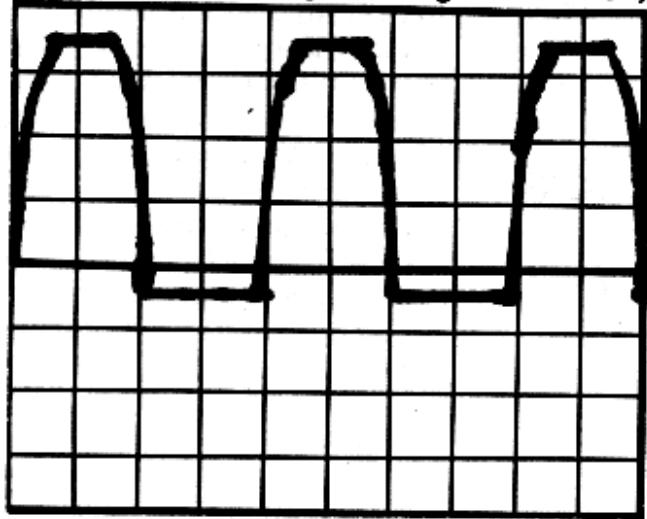


Figure 6 (Top Clipping:Zenering E-B Junction)



too. When the monitor is fixed (you hope) but you can't test it on your RGB fixture and the machine is on location, there is a way! Switch the generator to square waves and tune it to about 31kHz. Feed that into the input of the monitor and turn the output down a bit to give a good balance of light and dark. You will probably see a tweedy, out of sync pattern. Rock the frequency a bit and presto, two vertical black bars and two light bars! This is strictly a go/no go test and can be useful for checking brightness and contrast, but not for setting size. Do not try to set horiz or vert holds by this, instead adjust the frequency of the generator. If, however, the monitor fails to come up you just saved yourself a location trip, and your reputation as the company that "gets 'em fixed" is intact.

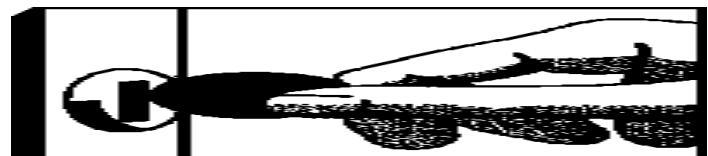
#### TRANSISTORS

We have already looked at diode testing. Closely related are transistors. This tester is of lesser value here, but the probe in the hand is often the fastest. A transistor is two diodes, the base being the middle of the sandwich. Thus, between the base and the other two legs one should get a diode reading. C-E should read open except for some of those fancy transistors with an internal diode. Some Darlintons also have an internal resistor E-B, so suspect parts should be checked against a known good one. Actually, in circuit resistance and especially capacitive coupling tends to make many such measurements involving transistors "iffy." You'll still find some this way, but watch your time. You may have better success with a VOM.

One aspect of transistors may be of interest. That is the tendency of the E-B junction to zener at 6-7 volts (Figure 6). If your oscillator puts out this high of a voltage you can see this happen. Aside from helping you identify the Emitter and the Collector, it doesn't help you much but it is interesting.

Other uses for this set up include amplifiers and power supplies. Even when repairing other problems it can be reassuring to give them a quick cap-scan before sending them out. The high frequency used is especially compatible with switching supplies. You can also test the diode on a pinball coil without desoldering it, at the same time checking the coil for short turns. Or run down the row of drivers on a pinball CPU and pick the shorted ones right out. Or check the traces on a logic board for continuity or shorts one to another.

Another caution would seem to be in order. If you are checking on a logic board it is probably a good idea to lower the oscillator voltage somewhat. Microprocessor parts get more sensitive all the time.



## Modifying Medium Resolution Monitors To Standard Resolution

### QUESTION

Is it possible to take a medium resolution monitor and downgrade it to a standard resolution monitor? The application might be useful for a conversion. What's the difference?

### ANSWER

Yes, medium resolution monitors differ from the standard resolution monitors used in video games in a couple areas.

For one, medium resolution monitors use a different horizontal frequency than standard resolution monitors. The reason? Better resolution (of course).

The "almost" NTSC standard resolution systems are so-so at best for 19" monitors and absolutely lousy at 25" and above.

Game designers who want to get a decent picture at 25" and to show off all the "little things" in their games, a higher resolution than the standard was needed. The medium resolution systems are the equivalent of EGA in the IBM world.

### MODIFYING

Yes, you can (sort of) convert those medium resolution monitors to "standard" frequencies. The easiest way to do it is by comparing a Wells 4915 (MedRes version) schematic to the 4902/03 (StandRes version) schematic and doing the appropriate changes to the horizontal oscillator circuit.

### BOTTOM LINE

The only snag is that the yoke may need to be

changed and the convergence may not be perfect. Although it can be done, it is not recommended for game use as the dot pitch will never be exact. Some applications, though, might not be fussy about the shortcomings: such as a test set-up, etc.

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## Capacitor Data Sheet for Monitors

MANUFACT	CHASSIS	PLACEMENT	QU	VALUE	VOLT	DIGIK
Electrohome	G07-CB	C504	1	1.0	50	P6260
Electrohome	G07-CB	C407,C408	2	4.7	100	P6292
Electrohome	G07-CB	C411	1	100.0	160	P6182
Electrohome	G07-CB	C506	1	33.0	25	P6237
Electrohome	G07-CB	C403,C701,C517	3	100.0	25	P6239
Electrohome	G07-CB	C518	1	220.0	25	P6240
Electrohome	G07-CB	C523	1	1.0	160	P6416
Electrohome	G07-CB	C521	1	2200.0	25	P6244
Electrohome	G07-CB	C412	1	3.3	160	P6418
Electrohome	G07-CB	C905,C107 neck brd	2	10.0	250	P6188
Electrohome	G07-CB	C511	1	47.0	160	P6181
Nanao	KB240331D	C523	1	100.0	50	P6268
Nanao	KB240331D	C524	1	47.0	160	P6181
Nanao	KB240331D	C527,C409,C416	3	10.0	100	P6293
Nanao	KB240331D	C526	1	1.0	160	P6416
Nanao	KB240331D	C906	1	22.0	160	P6179
Nanao	KB240331D	C910	1	47.0	16	P6226
Nanao	KB240331D	C413,C406,C412	3	470.0	16	P6230
Nanao	KB240331D	C418	1	2.2	160	P6417
Nanao	KB240331D	C407,C502	2	10.0	25	P6248
Nanao	KB240331D	C511,C417,C411	3	220.0	35	P6253
Nanao	KB240331D	C503,C505,C510,C401	4	1.0	50	P6260
Nanao	KB240331D	C410	1	1.0	50	P6260
Nintendo	20-EZV	C302	1	1.0	50	P6260
Nintendo	20-EZV	C301,C303,C406	3	10.0	50	P6264
Nintendo	20-EZV	C464	1	22.0	63	P6280
Nintendo	20-EZV	C458	1	47.0	50	P6267
Nintendo	20-EZV	C459	1	100.0	25	P6239
Nintendo	20-EZV	C469	1	220.0	25	P6240
Nintendo	20-EZV	C468	1	330.0	25	P6241
Nintendo	20-EZV	C467,C408	2	1.0	160	P6417
Nintendo	20-EZV	C407,C471	2	10.0	250	P6188
Nintendo	20-EZV	C410,C472	2	100.0	160	P6182
Wells-Gardner	19K4626	C201 input brd	1	1000.0	35	P6256
Wells-Gardner	19K4626	C407 input brd	1	470.0	35	P6255
Wells-Gardner	19K4626	C311 v/h brd	1	1000.0	35	P6256
Wells-Gardner	19K4626	C313 v/h brd	1	47.0	50	P6267
Wells-Gardner	19K4626	C315,C362 v/h brd	2	10.0	250	P6188
Wells-Gardner	19K4626	C359 v/h brd	1	4.7	160	P6419
Wells-Gardner	19K4626	C310 v/h brd	1	22.0	16	P6224
Wells-Gardner	19K4626	C306 v/h brd	1	2.2	50	P6261
Wells-Gardner	19K4626	C356 v/h brd	1	4.7	25	P6247
Wells-Gardner	19K4626	C610	1	47.0	160	P6181
Wells-Gardner	19K4626	C619,C617	2	1.0	50	P6260
Wells-Gardner	19K4626	C614	1	33.0	25	P6237
Wells-Gardner	19K4626	C613	1	220.0	25	P6240
Wells-Gardner	19K4626	C624	1	100.0	25	P6239
Wells-Gardner	19K4626	C625	1	10.0	160	P6188
Wells-Gardner	19K4626	C622	1	1000.0	35	P6256
Wells-Gardner	19K4626	C623	1	470.0	25	P6242
Wells-Gardner	19K4626	C633	1	2.2	50	P6261
Wells-Gardner	19K4901	C310,C702	2	10.0	250	P6188

# Capacitor Data Sheet For Monitors

## How To Use The Capacitor Data Sheet

- First, look up the monitor to be repaired by manufacturer or chassis number.
- Use Digi-Key (DIGIK) part number to order caps.
- All caps are SU-type with 85 degree Centigrade rating for temperature.
- Don't forget to check the QU column for quantity.
- Value (VALUE\_) and Voltage (VOLT) are given for convenience.
- Placement gives the location on chassis.

## NOTES

- On the Wells Gardner 19K4626 chassis, "input brd" refers to the Input board, "v/h brd" refers to the Vertical/Horizontal board.
- On Electrohome GO7-CB chassis, C107 is on the neckboard.
- On the Wells Gardner 19K4901 chassis, C351 is mounted over diode D306 ("D306ov Dio" on spec sheet).
- The capacitors for chassis 19K4901 are the same for most of the 19K49xx series of Wells Gardner monitors.

Parts Source: Digi-Key Corp 1-800/DIGI-KEY.

## Capacitor Data Sheet for Monitors (continued)

MANUFACT	CHASSIS	PLACEMENT	QU	VALUE_	VOLT	DIGIK
Wells-Gardner	19K4901	C308,303	2	2.2	160	P6417
Wells-Gardner	19K4901	C701,C201	2	1000.0	35	P6256
Wells-Gardner	19K4901	C507	1	47.0	160	P6181
Wells-Gardner	19K4901	C311	1	4.7	160	P6419
Wells-Gardner	19K4901	C313	1	100.0	160	P6182
Wells-Gardner	19K4901	C301	1	330.0	50	P6270
Wells-Gardner	19K4901	C306 tant	1	2.2	16	
Wells-Gardner	19K4901	C315,C351,D306ov Dio	3	1.0	50	P6260
Wells-Gardner	19K4901	C352,C354	2	47.0	50	P6267
Wells-Gardner	19K4901	C506	1	22.0	160	P6179
Wells-Gardner	19K4901	C366	1	22.0	25	P6236
Wells-Gardner	19K79XX	C57	1	47.0	160	P6181
Wells-Gardner	19K79XX	C56	1	22.0	160	P6179

# 1994

## Update: Monitors

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**HANTAREX** *Polo* 25" MONITOR TEST PATTERN & B+ FILTER

**HANTAREX** *MTC 9000* SHUT DOWN TEST

**ATARI** *World Rally* with 25" **HANTAREX** MONITOR

**KRISTEL** MONITOR **ARACHNID 6000 DARTS** No VIDEO

**KRISTEL** MONITOR W AVY VIDEO

**ARACHNID DARTS** **OMNI VISION** MONITOR REDUCED VIDEO

**ARACHNID DARTS MONITOR** UNSTABLE VIDEO

**ARACHNID 6000 SERIES DART GAMES** DART HEAD DEBRIS

**SHARP** MONITOR XM1801N DOUBLE IMAGE

**WELLS-GARDNER** 25" COLOR MONITOR TS SHOOTING

**WELLS-GARDNER** 4900 CAPACITOR KITS

**WELLS-GARDNER** 4900 VERTICAL FOLDOVER

**WELLS-GARDNER** K7000 No HIGH VOLTAGE

**WELLS-GARDNER** K7000 MONITORS WASHED OUT PIX

# HANTAREX POLO 25" MONITOR TEST PATTERN & B+ FILTER

## SYMPTOM

Noisy video.

## CAUSE

At first glance it's not clear if this is a monitor problem or possibly a bad ground or maybe even a faulty power supply. Hantarex now provides a slick way to quickly narrow down the cause of these types of problems by providing a built-in test pattern.

## PROCEDURE

To turn on the test pattern, find the remote adjustment board. On it you will find a 2 pin jumper labeled *Test*. Jumper the pins together.

## SOLUTION

After installing this jumper, it was found that the noise was present even on the test pattern. This indicated conclusively that the monitor was at fault.

The problem turned out to be C121. This 100mfd cap is the main 138 volt B+ filter. Hantarex was very helpful in explaining that this cap has a tendency to be bumped due to the handling of the monitor during game production since it sits out near the edge of the monitor board.

More than likely, one of the leads broke internally and was arcing, thus causing the noise on the video.

# HANTAREX MTC 9000 SHUT DOWN TEST

## SYMPTOM

Hantarex MTC 9000 was coming on for

a fraction of a second then shutting down. All the filter caps were OK and there was no garbage on any of the B+ lines.

## PROBLEM

Found R94 burned open, when replaced and the voltage on C57 was checked, it was found to be low (this should be about 26V), and R94 was starting to get hot again. The problem turned out to be IC 1 a TDA 1670 vertical deflection IC (sub with ECG 1862).

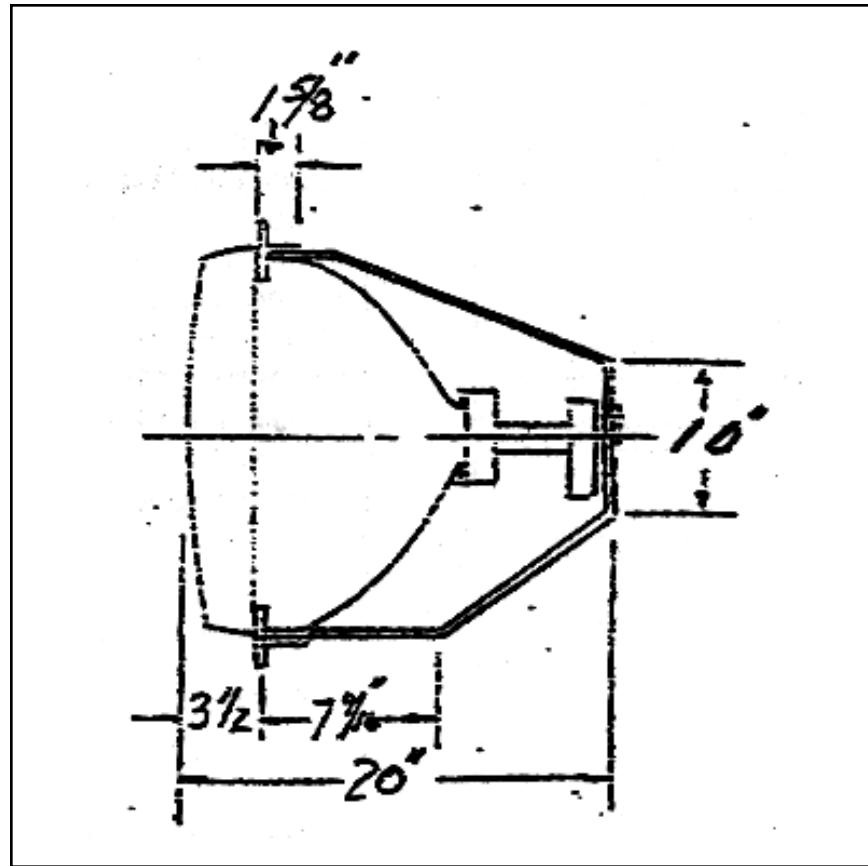
## SOLUTION

To confirm this, disconnect pin 14 of IC 1 and re-test voltage on C57, the monitor should also power up now without vertical deflection.

# ATARI WORLD RALLY WITH 25" HANTAREX MONITOR

## SUBJECT

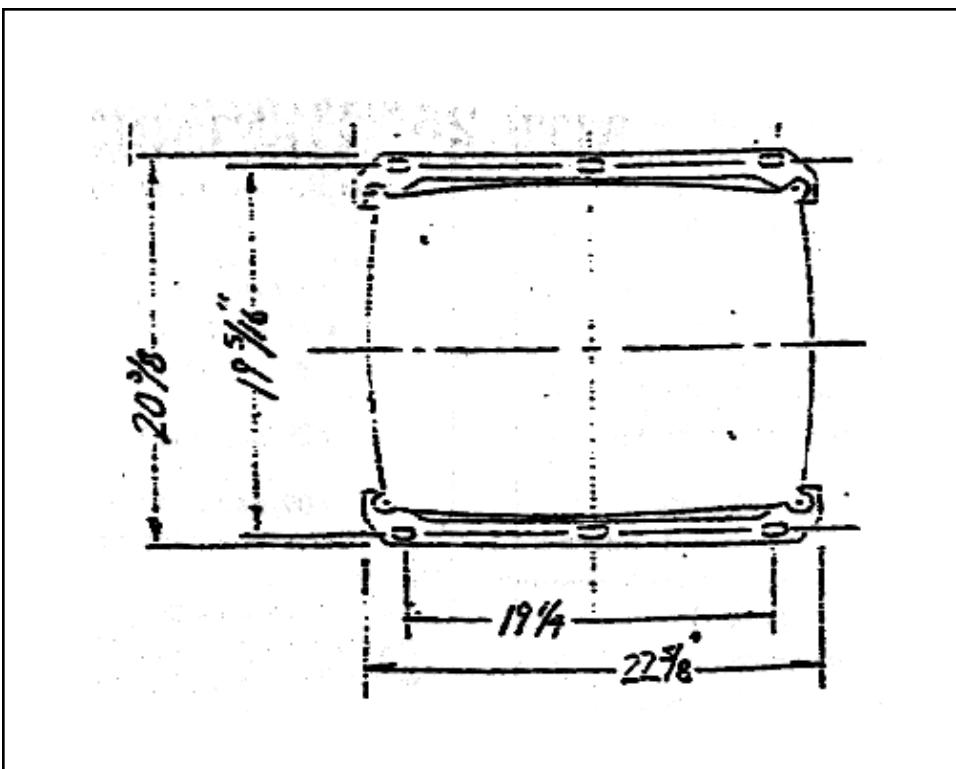
When doing your conversions with a game like



World Rally by Atari, it really pays to use a new 25 inch monitor. Driving games have a much longer life than most other video games. (Most operators are still running *Pole Positions* from 1980!)

#### CABINET/MONITOR

The big problem with doing a conversion with *World Rally* is choosing the right cabinet. If you install it in an ten year old cabinet your new game won't earn what it should. You might be better off giving your money to the Red Cross for flood relief. If you are serious about earning money, you need to have a new 25" big screen monitor for your game.

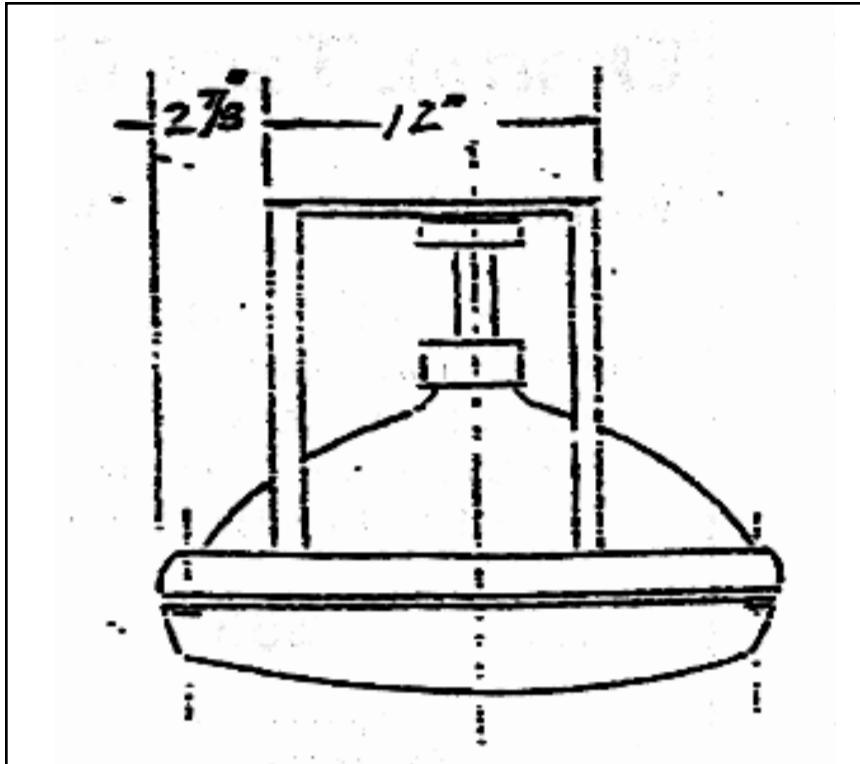


Two factors are of major importance with the monitor. The first is the size of the monitor. Not all 25" monitors are the same size! The difference is the angle of the CRT. Most sets have a 100 degree tube. The new Hantarex 25" *Polo* has a 110 degree tube which makes it about 2" shorter in depth. This can be very important when installing the game in a cabinet where a 19" monitor came out of.

#### BY THE NUMBERS

The numbers that are important are 22-5/8" wide and 16-5/8" deep and 20-5/8" high. This monitor weighs almost twice what a 19" monitor does. I do recommend using metal brackets and/or carriage bolts to properly secure the monitor. Most games were made with the front a little less than 24"

because they get the maximum yield from their wood. This gives an inch side clearance in the horizontal position. If you make a cardboard template of the side view of the monitor and hold it to the side of your potential kit cabinet, you can tell real quick if it is a good choice.



**"NOT ALL  
25" MONITORS  
ARE THE SAME  
SIZE!"**

# KRISTEL MONITOR ARACHNID 6000 DARTS No VIDEO

## PROBLEM

Raster, but no video.

## CAUSE

Upon repair of the monitor it was discovered what was believed to be the cause of the problem, a NUT! When removing the PCB from the monitor chassis a Dart Head Nut fell out from between the two assemblies. Although Dart Head nuts and washers fall down into the drawer on occasion, this is the first time it caused a problem like this.

## SOLUTION

As a result of the above, D301 (1N4627, and ECG137H will do also) a 6.2 volt Zener Diode shorted out, bringing the base of Q302 to near ground potential, resulting in turning Q301 off, cutting off the video signal.

# ARACHNID DARTS OMNI VISION MONITOR REDUCED VIDEO

## PROBLEM

Small or reduced in size picture on screen. B+ voltage check out O.K.

## SOLUTION

Found D14 (MR818 or ECG506) and C18 (330ufd, 16 Vdc used in monitor, although schematic shows it to be a 470ufd, 16 Vdc) to be bad.

# ARACHNID DARTS MONITOR UNSTABLE VIDEO

## SUBJECT

Arachnid 6000 Series Darts

## PROBLEM

Unstable picture and/or sync with little to no contrast screen control.

## SOLUTION

At first look you might think it's a monitor problem but it's not. Found Q1 (2N2222 or ECG123A) on the Main Game Board leaky, sending a video signal to the monitor that's weak and unstable.

# KRISTEL MONITOR WAVY VIDEO

## PROBLEM

Swiggly/wavy video at the top part of the screen. Hard to adjust out, if at all.

## SOLUTION

There are two possible causes, both related to each other, that have been found. First, you may have a broken solder joint on C206 (1 ufd 50 Vdc). Or second, C206 is open, which would have the same effect as a broken solder joint.

## NOTE

If you find it's a case of a broken solder joint, check C206 any way. If questionable, replace.

# ARACHNID 6000 SERIES DART HEAD DEBRIS

## PROBLEM

Nuts and washers coming loose from the Dart Head, fall down into the drawer, possibly causing major problems.

**SYMPTOM**

It's evident to see why this could happen because the cutouts are just below the Dart Head, which are right over the Power Supply and Monitor. Although I experienced a monitor problem from the above, you may experience other problems in the Monitor or even in the Power Supply.

**SOLUTION**

To eliminate this problem you need to get some nylon fly screen about 4" by 22", and some spray glue or rubber cement.

- Start by removing the cables that go through the cutouts on the dart game, and set them aside.
- Take the nylon fly screen and measure 2" down from each 4" side, then fold or crease to a 90 degree angle.
- Now measure 1-1/2" down from the 90 degree bend, then fold or crease to a 90 degree angle again. It should look like a long J strip, which will be used to cover the bottom cutouts.
- Apply the glue or cement to the area where the screen will meet around the back, bottom and lip of the cutouts.
- Install the screen so that the 2" part is on the back, the 1-1/2" part is on the bottom and the rest is on the bottom lip, cut off any excess passed the lip.
- When done, cut a slit horizontally just long enough to let the cables pass through over the cutout above the monitor.
- Keep it close to the left side and next to the lip of the cutout, all that's left is to reconnect the cables.

Now you have one less problem to worry about.

**NOTE**

Do not try to block off the cutouts completely, if you do you may have a serious over-heating problem then. The cutouts act as vents for the Power Supply and Monitor to reduce the heat build up in the drawer. The heat rises up through the cutouts up to the vents on top of the back door, like a chimney is used for a fireplace.

Some games may not have vents on the back door, simply cutout a couple of 4" squares about 6" down and from each side on top of the back door. Glue a 5" square of fly screen around the cutouts and your done.

# SHARP MONITOR XM1801N DOUBLE IMAGE

**SUBJECT**

Sharp Monitor XM1801N used in Nintendo VS Table Games.

**PROBLEM**

Rolling and/or double image picture on screen. Adjusting the V-hold will lock the sync in, but a double image picture still remains.

**SOLUTION**

C514 (100ufd/16vdc) has decreased in value. Suspect one finally stabilized at around 7ufd! Replace C514 to restore picture to normal.

# Wells Gardner 25" Color Monitor T-Shooting

**SYMPTOM**

A *Terminator2* video game with a 25" Wells Gardner color monitor that suddenly went "greenish white". The background got very light with a green tinge. In order to get the background neutral again the green screen must be turned all the way down. The other drive controls had to be remixed to get some sort of balance.

**PROBLEM**

Now, the background is black, but the color isn't right. It looks all blue and red and turning up the green drive screws the picture up. Obviously, something failed. Any clues? Where do you start?

**SOLUTION**

First thing to be done is to use the built-in monitor test patterns (very nice to have, thanks Williams!). Check the various color screens and color bars.

**T'SHOOTING**

If you want to determine where the problem is, simply switch the color wires around at the monitor connector. If the problem moves with the wire, the board is at fault, if it stays with the color then the monitor is at fault. From there, you then start to troubleshoot the bad unit (monitor, CPU or wiring harness).

- Check fuse F1

If F1 is open, replace it –but don't apply power to monitor yet.

- Check Q11 horizontal output transistor for short. Place your digital meter to Diode Check mode. With the positive (+) lead of your meter to ground and negative (-) lead to the collector of Q11. The collector of Q11 is the tab mounted on the heat sink. If Q11 shows shorted before you pull it out, check capacitor C36 for short. If shorted, replace it with Wells Gardner part #046x0551-003.

- After you replace C36, recheck for shorted condition of Q11. If it's okay, then...

- Check the voltage regulator (IC4) between pins 1 and 4 –should read on your meter about .184 with the positive lead on pin 1 and negative lead on pin 4. If shorted replace it.

**MONITOR AT THIS POINT SHOULD START UP.**

- With monitor running, check B positive IC4 pin 4 –should be between 123 Vdc and 130 Vdc.

- If monitor runs, then shuts down after about 5 minutes –replace D18 damper diode even if it checks okay.

This should solve most all your high voltage problems on this monitor.

## W ELLS GARDNER K7000 No HIGH VOLTAGE

**SYMPTOMS**

Wells Gardner K7000 series. No high voltage. B positive too high: 140 to 160 Vdc. High voltage shut down.

**SOLUTION**

Note: All checks done with no power to monitor.

## W ELLS-GARDNER K7000 WASHED OUT PIX

**PROBLEM**

Washed-out picture on K7000 series monitors. Contrast and brightness controls do not help.

**SOLUTION**

Q1, Q2, Q3 are bad. Although they measure good, replace all 3. On some 13" monitors there are 3 unmarked 9.1V Zener diodes above R7, R8 and R9. These may be open, also.

# 1995

## Update: Monitors

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Building An Observation Monitor

**ELECTROHOME GO7** Full Beam Symptom

**HANTAREX MTC9000** 33" Tube Shut-Down

**HANTAREX MTC9000** 25" Clicking

**HANTAREX Polo** Monitor Capacitor Change

**KORTEK** Monitor Parts Source

**PENTRANIC** Monitor Blooming Update Kit

**WELLS GARDNER** Horizontal Range Cap Change

**WELLS GARDNER** *Killer Instinct* FET Failures

**WELLS GARDNER** Horizontal Output Modification

Monitor Repair For Dummies: **WELLS GARDNER 7000** Chassis

# BUILDING AN OBSERVATION MONITOR

*The best way to show off that hot new game is to build and install an observation monitor. Even if a crowd has formed around the game, people passing by can still see the game being played with this additional monitor—mounted on top of the game.*

## THE GOAL

I originally built one for *Street Fighter II Champ* a few years ago. I knew that someday I would have to move it to the next new hot game that I wanted to feature. I designed it so it could be attached to cabinets with different pitches without the need for additional hardware and could be installed in minutes. Since then, it has been used on *Mortal Kombat*, *NBA Jam* and now *MKII*.

## CONSTRUCTION

The box that houses the 19" CRT (just grab any color RGB video game monitor) is of basic construction. Simply a box made of particle board and covered with a wood grain laminate. A groove has been cut into the front to hold the glass. Inside the box, mount the monitor with an isolation transformer. Attach a power cord to the isolation transformer and run it out the bottom of the box.

*The real secret to the design is the ability to adapt to any cabinet and the ease of wire hook up.*

## MECHANICAL

The monitor box is attached to the cabinet by a pair of hinges that are bolted to the front of the monitor box and screwed to the top of the game cabinet. The rear of the monitor box is supported by two turnbuckles which are screwed into eyebolts that are bolted to the box. So that no matter what the pitch happens to be, just unscrew the turnbuckle down until the proper angle is achieved.



## ELECTRICAL

The second feature is the ease at which the monitor plugs in without damage to the existing wiring. The monitor adapter board I made consists of a printed circuit board with two male connectors (a six pin and a three pin) which were removed from an old chassis board. Traces on the PCB run to both ends. Connected to both ends are a set of the appropriate wires (Red, Green, Blue, Gnd, CompSync). On the ends of the wires are the female connectors—a six pin and three pin.

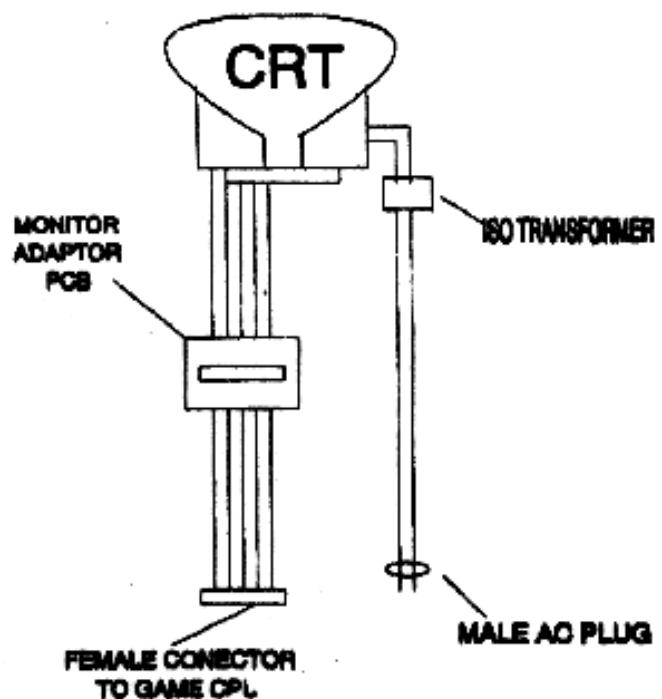
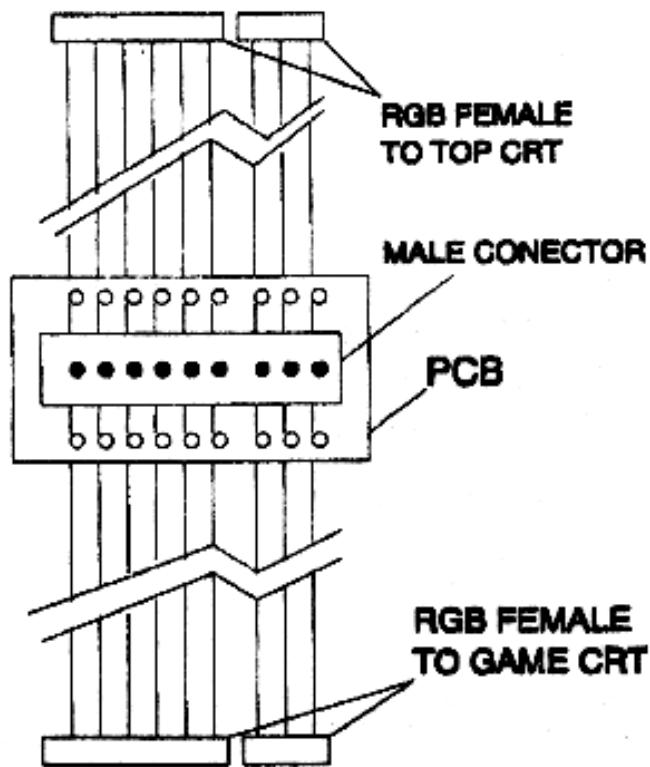
*After the adapter board is built, the installation goes as follows:*

## INSTALLATION

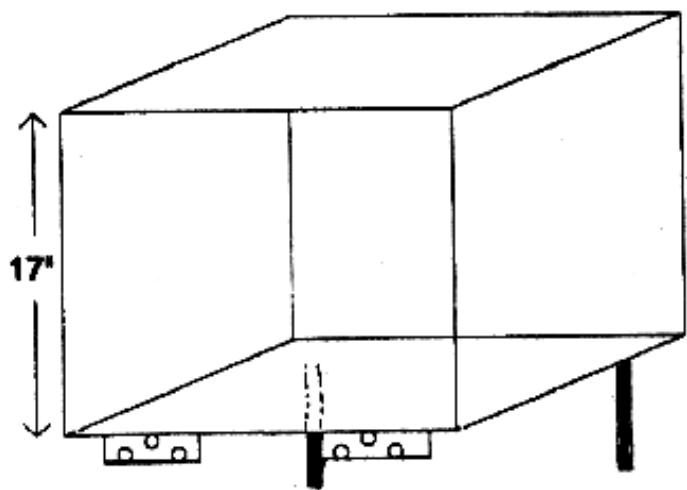
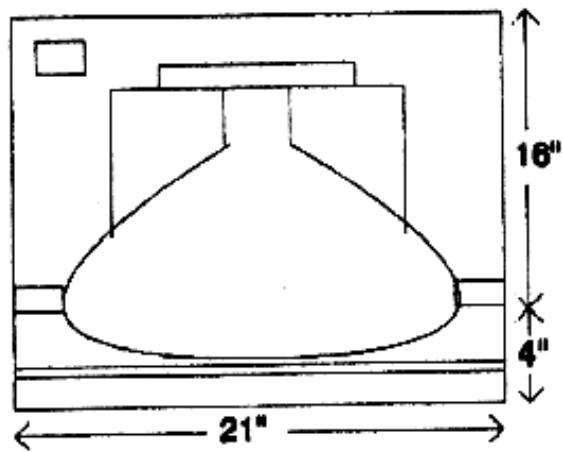
Remove the RGB connector from the game monitor and plug it into the male connector of the adapter board. Take one of the female connectors from the adapter board and plug it into the game monitor (lower). The other female connector runs up through the cabinet, out of a vent or hand hold in the cabinet and up into the bottom of the monitor box and plugs into the observation monitor (upper). Plug in the power cord of the upper monitor and tada, your done.

## IN THE END

At the trade shows, you will find manufacturers using observation monitors to help sell their games. Now you can use them to increase the money in your cash boxes and they also come in handy for tournament play.



## top view



## ELECTROHOME GO7 FULL BEAM SYMPTOM

### SYMPTOM

Trouble with a Electrohome GO7-CBO: The beam is at full strength.

### STATUS

Changed transistors X303 and X304, and all the capacitors that are normally associated with this circuit. The blanking pulse is present.

The only difference between this chassis and a

working chassis is that the 12v on the base of X303 drops to about 5 volts and in so doing, cuts X303 off to the point that it cannot control the beam.

### SOLUTION

Check C107. It's the 10mfd @ 250vdc capacitor on the neck board. It causes symptoms similar to those described above.

## HANTAREX MTC9000 33" TUBE SHUT-DOWN

### SYMPTOM

An MTC9000 33" monitor was brought in and on power-up, it would shut down immediately.

If the monitor was turned off and on in two second intervals, it would fire up. But when completely turned off, the same result again, it shuts down immediately.

### SOLUTION

I found C35 to measure only .89mfd when actually it was supposed to be 22mfd @ 25v. After this capacitor was changed, the monitor fired up every time.

### NOTE

This same symptom can also be caused by C34 (22mfd @ 160v) being off value and R94 burning open.

The reason for the R94 (3.9 ohm) resistor opening is usually because too much current is drawn. Check IC1 (TDA 1670) or C57 shorting out.

**STAR★TECH  
Journal**

# HANTAREX M TC9000 25" CLICKING

## SYMPTOM

I have some mystery trouble with this monitor. I had low High Voltage and replaced the flyback. Now I get a rapid clicking sound from the main board and corresponding flashes in the picture tube. When it stops, the picture is badly washed out and out of focus. I can't see any sparks even in the dark.

## SOLUTION 1

Did you look at that 22uF @ 160V cap in the B+ circuit? That will cause weird problems when it is on the way out. Value there is not too critical, you could sub a 33uF or 47uF @ 160v in its place. The cap is

located roughly dead center on the chassis.

## SOLUTION 2

I have encountered this on one occasion also, seems hopeless doesn't it? It drove me nutz for about 2 hours. Finally I got out my trusty scope and once again it saved the day.

Your problem lies in IC 1 (TDA 1670A) Check out pin 1 and 12 you will see the waveform is not steady, it will cut in and out along with the B+ voltage trying to reach its peak.

# HANTAREX POLO MONITOR CAPACITOR CHANGE

## SUBJECT

Hantarex Polo 27" monitor used in *Driver's Edge* (Strata) and *Under Fire* (Taito).

## PROBLEM

The capacitor in position C170 is the wrong type and may short out after a few months of operation. It is necessary to replace it with a double metalized capacitor.

## SOLUTION

To obtain a free replacement capacitor contact the Hantarex Service and Parts Department.

PHONE #: (800) 848-5065  
(708) 843-7226

## SPECIAL NOTE

Because of physical size, the original capacitor is located on the solder side of the PCB under the C170 board location. After removing the original, the replacement capacitor can be inserted on the top side of the PCB in the C170 position.

## EXCLUSIVE

This modification applies to the *Polo 27"* only. No other size Hantarex monitor requires this capacitor change.

FAX #: (708) 843-7244

## KORTEK MONITOR PARTS SOURCE

### PROBLEM

I am having trouble finding someone who knows anything about Kortek monitors. I have one that has a ripple or hum bar that runs vertical and pulses the screen. I've separated the power supply out of the circuit and put a load on it, and with a 'scope on the load I still have the ripple. I've replaced the zener diodes, transistors, and all the capacitors in the

power supply but none of that has helped. I also can not adjust B+.

### SOLUTION

Sounds like you need a "Get Well" kit. Zanen Electronics has get well kits for the Kortek monitors as well as tech help on same.

PHONE: 806/793-6337.

## PENTRANIC MONITOR BLOOMING UPDATE KIT

### PROBLEM

This monitor has had problems with blooming which was more noticeable with Jumbo 33" and 38" tubes.

### SYMPTOM

Quick changes in color have been a major problem; causing blooming effects.

### SOLUTION

Pentranic U.S.A. has released a free kit to enhance their monitor. Call 317/322-2345 for your free update. It's worth doing at this price.

Their monitors are very reasonably priced, but the monitors without this modification are marginal.

## WELLS GARDNER HORIZONTAL RANGE CAP CHANGE

### PROBLEM

To expand the horizontal range on Wells Gardner K7000 series.

### SOLUTION

If you are adjusting the horizontal frequency on this monitor, trying to eliminate that one side that has a

tear in it, and over-adjusting causes the picture to lose the horizontal sync, try the following capacitor change:

### CHANGE C22

FROM:	1 mfd/25 W volts
TO:	10 mfd/35 W volts.

# WELLS GARDNER

## KILLER INSTINCT FET FAILURES

### PROBLEM

FET Failures in U2000 *Killer Instinct* Monitors.

### CAUSE

A torrid choke was added to the U2000 monitor used in *Killer Instinct* to pass FCC requirements. This choke causes a voltage peak to occur across diode D107 and FET Q101 which can exceed their breakdown rating.

### MODIFICATION

If the monitor is working OK, it is recommended that R108 be changed from .22 ohm to .47 ohm, 2 watt, 5% metal oxide type, when convenient. This limits the amplitude of the pulse to safe levels.

If either the FET or diode has failed, it is recommended that both be changed along with R108.

### KIT AVAILABLE

A kit of parts consisting of fuse, FET, diode, and resistor can be obtained by calling Wells-Gardner service department at our toll free number: 800/336-6630.

### NOTE

It is important to note that the FET failures in the U2000 occur only in the *Killer Instincts*. All other U2000 are OK.

# WELLS GARDNER

## HORIZONTAL OUTPUT MODIFICATION

### SUBJECT

Horizontal Output Transistor on the U2000 and U5000.

### PROBLEM

In some cases, operating the monitor without the remote control board or if the cable is intermittent or has a broken potentiometer, can cause the Horizontal Output Transistor to fail. This happens because the horizontal frequency goes too low and the collector voltage on the H.O.T. can exceed its rating.

### SOLUTION

The cure is to change D712 to a germanium type diode. This will limit the frequency drop and protect the Output Device. A general purpose germanium such as IN34 will do quite nicely.

### CAUTION

It is recommended that the monitor *not* be operated without the remote cable or control board attached.

# MONITOR REPAIR FOR DUMMIES: WELLS GARDNER 7000 CHASSIS

*Use of the information from the following conversation requires advance level bench technician experience and a safe non-conductive work area, applying power to the chassis through an isolation transformer, and sometimes, good reflexes.*

## CAN YOU POWER UP THE CHASSIS WITHOUT CONNECTING IT TO A PICTURE TUBE?

Yeah.

## BUT WHAT ABOUT THE HIGH VOLTAGE LEAD?

I usually tape the high voltage anode lead to the table faraway from me, and if the tape comes loose, just get out of the way! The yoke needs to be connected on some models for the chassis to power up, but most 7000's tend to power up even without the yoke. It varies by submodel.

## WHAT'S THE HAZARD TO THE CHASSIS IF YOU DON'T PLUG IN THE YOKE?

No hazard—it may just go into shutdown.

## WHAT ABOUT NO NECKBOARD BEING CONNECTED?

You can still power it up—it will still run.

## AND THE SCHEMATIC VOLTAGES?

They'll be a little high, especially the B+ and focus—but you won't be poking at that with your fingers!

## WILL B+ FLOAT UP TO SHUTDOWN VOLTAGE?

No, they've got pretty good regulators on there. That's the reason why they'll run without a yoke. If it's got a good regulator it will usually power up.

## HOW DO YOU KNOW WHEN A PICTURE TUBE IS BAD—WHAT DOES IT DO TO THE CHASSIS?

Usually, I know the picture tube is bad when you're missing one color and you can't get it to come up by grounding out the problem gun.

## IF YOU CAN'T GET IT UP BY SWAPPING THE VIDEO COLOR LEADS FROM THE GAME BOARD?

No, you don't even have to do that—here's a way to test the tube directly: Take an insulated alligator clip lead, ground one end to the chassis, and touch the other end to the drive transistor on the neck board's collector, which is the tab. That'll kick that color wide open, as bright as it can go. If you touch the bad one and it's dim, it's suspected bad. If you touch one and it brings up the wrong color, there's a short. The easiest way to check a tube is with a picture tube analyzer. And rejuvenate away!

## HOW CAN YOU MEASURE WHETHER A PICTURE TUBE IS BAD? OR DOES IT HAVE TO BE IN CIRCUIT?

It has to be in operation, because of the voltages involved. A CRT analyzer does a fairly good job of simulating operation.

## IS THERE A SHORT IN THE TUBE THAT WILL CAUSE THE FUSE TO BLOW OR A FAILURE OF OTHER COMPONENTS?

For all practical purposes, No.

**SO IF THE PICTURE TUBE GOES, IT JUST DOESN'T DO ITS JOB, AND IT USUALLY DOESN'T TEAR THE BOARD DOWN WITH IT?**

Exactly.

**IN THE CASE OF A SUSPECTED BAD FLYBACK, CAN YOU DISCONNECT THE HORIZONTAL OUTPUT'S COLLECTOR LEAD AND POWER UP THE CHASSIS TO SEE IF THE OTHER COMPONENTS ARE ALL GOOD?**

No, because too many of the voltages are coming through there that are needed for the chassis to come up. Everything but the AC derived power would be dead if you did that.

**SO HOW DO YOU MEASURE A BAD FLYBACK? CAN YOU ISOLATE IT?**

You can measure if the primary windings are shorted together normally you'll measure a handful of ohms, maybe 2 or 3. If you're into zero or 1 ohm, you've got a problem... But on the 7000's they're notorious for blowing the safety capacitors.

**IS THAT C36?**

Yes, and C39. And all that stuff on the schematic under the flyback—you've got a handful of diodes and a couple of caps—any of that stuff will blow your fuse.

**CAN YOU MEASURE THE C36 CAP ON CHASSIS, OR DO YOU HAVE TO PULL IT?**

It's best to pull it to test it—it's a feed-through and a capacitor—the two right end legs are connected together and the two left end legs are connected together, with the capacitor in the middle. It acts as a fuse and a safety cap. If the voltage goes too high or the current goes too high, that cap blows. Note: Some models DON'T use the 4 lead caps.

**WHAT DO WE MEASURE THERE?**

Infinity. If you measure any resistance, it's shot. Replace it.

**WHAT OHM READING DO WE WANT ACROSS PINS 1 AND 4 OF THE VOLTAGE REGULATOR?**

150 to 220 ohms you might expect, but it varies by meter model.

**AND WHAT'S ACCEPTABLE MEASUREMENT OF Q11?**

With no power and in the diode test mode, you should see similar measurements of increasing ohms—just as if you were reading across an 1N4004 diode.

**SO WE SHOULD READ ONE OF THOSE TO GET A BETTER IDEA OF HOW OUR METER READS DIODES IN THE DIODE MODE AND RESISTANCE MODE.**

Also, D18 needs to be replaced if you blew a second Q11. It works like the diode across the pinball coil. It will run awhile and blow your Q11 again.

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# 1996

## Update: Monitors

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**A**TARI *Primal Rage* Color Output Impedance

**D**YNA**M**O 50" Monitor Auto Power-Up Program

**E**LECTROHOM**E** GO7 19" Deflection Problem

**H**ANTAREX *MTC-9000* Pulsing Hi-Freq Sound

**M**ERIT Video Driver Failure on *Touchscreens*

**M**ERIT *Touchscreen* Drifting Calibration

**M**ERIT *Megatouch* Blown Monitor Fuse

**S**EGA *Virtua Racer* Twin Monitor Failures

**W**ELLS **G**ARDNER 7000 Model 19K7689 Half Screen

**W**ELLS **G**ARDNER Vertical Output Device on *U5000*

**W**ILLIAMS *Cruisin' USA* Vertical Output 25" Monitor Failure

Adding an **AUXILIARY MONITOR**: Wiring Precautions

Helpful **SERVICE TIPS** for Troubleshooting Videogames

**MONITOR REPAIR** Without Schematics (part 1)

**MONITOR REPAIR** Without Schematics (part 2)

**RGB VIDEO INVERTER** Circuit Schematic

# ATARI PRIMAL RAGE LATEST SOFTWARE REV COLOR OUT IMPEDANCE & SELF TEST

## SOFTWARE

The latest version for Primal Rage is 2.3. This version adds some new finishing moves and tightens up the overall game play.

## IMPEDANCE

Primal Rage is available in three different formats:

1. Showcase: High impedance.
2. Family Cabinet: Low impedance.
3. Kit: High or Low impedance.

The impedance refers to the drive on the color output circuit. Most monitors that the kits will go into will accept high impedance. The impedance will affect the brightness of the game.

## SELF TEST

The motion object test shows ROMs 0-0 in red. The ROMs are OK if the checksum is 363E0.

## DYNAMO 50" MONITORS AUTO POWER-UP PROGRAMMING

## PROBLEM

The monitor on the 50" TV screen does not power up automatically on some games like on other games.

## POSSIBILITY

On the HS-13, 50" TV screen used by Dynamo on familiar games produced by American Laser Games, the power to the TV screen can be set to automatically Power On when the game is turned on - without having to use the remote.

## NOTE

You must have model number V5007R in order to institute this change.

## PROCEDURE

To make this software change to the TV, you must perform the following steps:

- a) Unplug the game PCB, so the games does not come up.
- b) Power up the game and make sure the Power to the TV is on.
- c) Press the <MENU> key on the remote.
- d) With the menu now on the screen, press the keys <0>, <0>, <8>. This will bring up the second menu screen.
- e) On the screen, you will have two choices:
  - i) LP (Last Power)
  - ii) Hotel
- f) Press #1 to toggle Last Power to (ON).
- g) Press <ENTER> to lock the setting.
- h) Press <MENU> to go back to the main screen.
- i) Press <MENU> again to go back to TV mode.
- j) Select <EXT1> as the input and the TV will stay set from now on.

## ELECTROHOME G07 19 INCH COLOR MONITOR DEFLECTION PROBLEM

## Problem

Maximum deflection does not fill the entire screen.

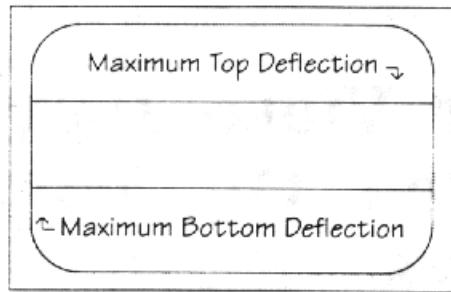


Figure 1

## SYMPTOM

See figure 1 for symptom on the screen. This is with potentiometer R408 adjusted to it's maximum.

## SOLUTION

A tough to find, but very simple problem to fix. The component in this case is C407 that has gone out of value. This component was measured with a capacitor meter and was found to measure 1.2 micro farad, the actual value is supposed to be 4.7 micro farad.

## REPAIR/VERIFY

This should be replaced with a 4.7 microfarad capacitor with a 250 working volt rating. See figure 2 for diagram.

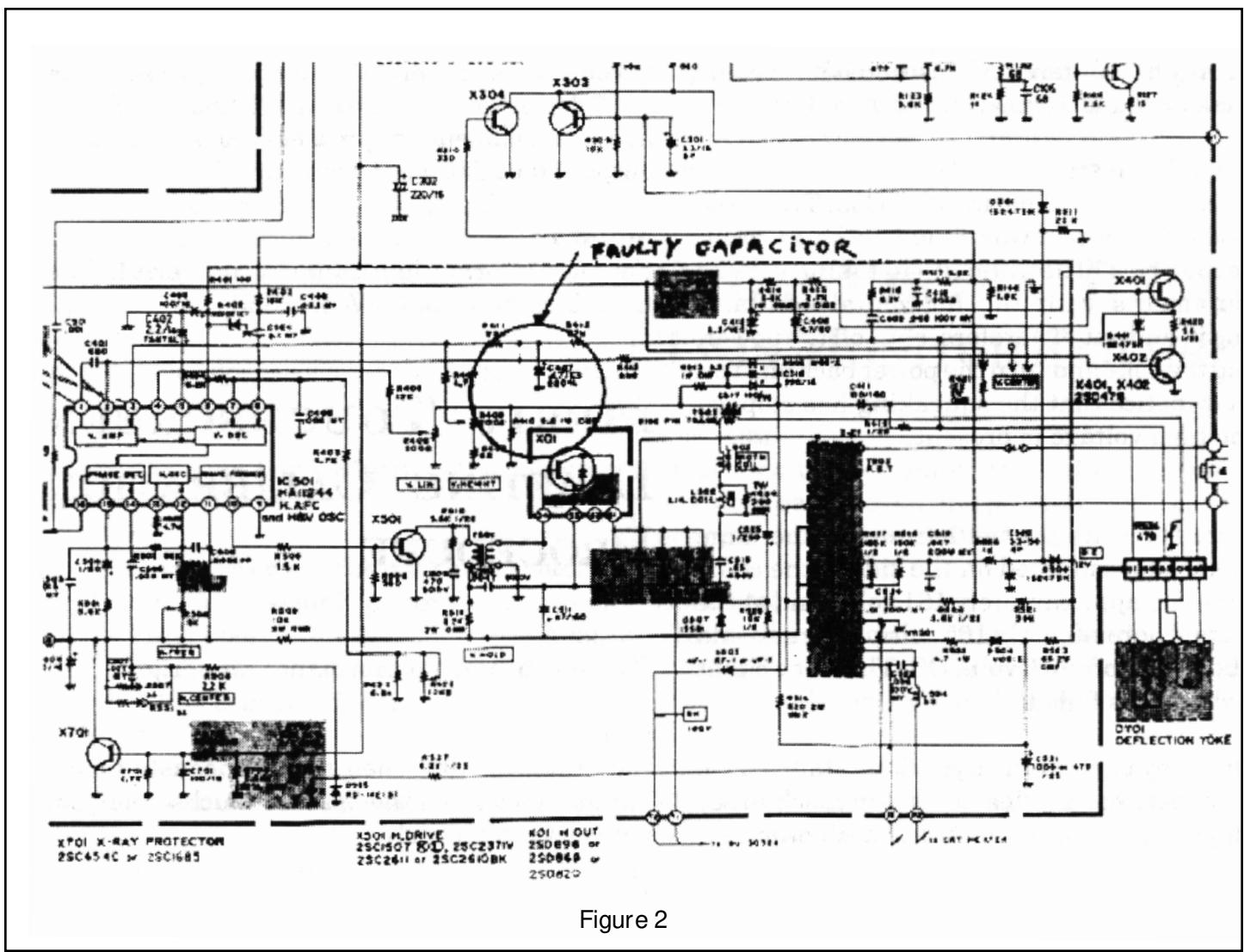


Figure 2

# HANTAREX MTC-9000 PULSING HIGH FREQUENCY SOUND

## SUBJECT

Hantarex MTC-9000 Color 28" monitor.

## PROBLEM

When the monitor is plugged in, there is a pulsing squeaking high frequency sound, like the horizontal oscillator trying to start up and shut down repeatedly.

## SOLUTION

The problem could be one of many capacitors. C34 (22 microfarad @ 200 volts) may be open, or C45 (1 microfarad @ 200 volts), or the B+ capacitor on the neck board. The capacitor on the neck board may be a different C position but its value is usually around 10 microfarad @ 200 volts.

## FLYBACK PROBLEM

After testing several parts: IC2, C35, TR14, the flyback transformer was found to be at fault. There may be a little difficulty in taking voltage measurements with the horizontal oscillator cutting in and out. Therefore, shut off the power, unplug the yoke and turn the power back on. You will now notice that the squeaking has stopped and no high voltage is present.

## TESTING

Measure the voltage at either end of the large power resistor mounted on the side of the chassis. One end approximately 161 volts, and at the other end approximately 165 volts. There should be a difference of 4 to 6 volts DC. This shows that the flyback has failed.

Another way to see if the flyback has failed, is to measure between the leads of the flyback to see which pins are still connected to each other.

## CHECK

Also test to make sure that D27 is not shorted. In

this case, the diode was shorted and replaced by a 1N4007 diode and pin nine of the flyback was open from the primary and shorted to pin ten of the secondary.

# MERIT VIDEO DRIVER FAILURE ON TOUCH SCREENS

## SUBJECT

Games with CRT-250 or CRT-260 CPU boards.

## PROBLEM

Unstable picture due to loss of vertical or horizontal sync.

## SOLUTION

If your game exhibits this problem, replace the 7406 driver (or U23 for the CRT-250 board) and add two transient suppresser diodes to the sync outputs for additional protection.

## MoINFO

For more information, contact your Merit Industries distributor at 800/445-9353.

# MERIT TOUCHSCREEN DRIFTING CALIBRATION PROCEDURE

## SUBJECT

Poor touchscreen performance on uprights.

## SYMPTOM

Calibration drifts when simultaneously touching the screen and the bezel or touchscreen just not working properly.

## CAUSE

Ineffective grounding of the monitor bezel door

or the monitor is not oriented properly in relation to the bezel door.

#### SOLUTION

Provide a better ground connection by removing the paint from under the ground strap screw on the bezel door hinge. Re-orient the monitor in relation to the bezel door.

**BEFORE PROCEEDING  
WITH THE FOLLOWING STEPS,  
POWER DOWN THE GAME.**

#### GROUNDING THE MONITOR

Open monitor bezel door. Locate the ground strap screw attached to the door hinge on the top of the machine. Remove the screw, scrape away the paint underneath screw head and reattach the screw. You must re-calibrate the touchscreen after opening the monitor door!

#### MONITOR POSITION

Repositioning the monitor to provide proper alignment with the bezel: Bezel door should rest firmly against the neoprene tape around the monitor without crushing the tape. The metal door cannot touch the monitor screen or the touchscreen will not calibrate.

#### PROCEDURE

- \* Open the rear door to access the monitor/CPU section.
- \* Loosen the four bolts securing the monitor shelf.
- \* Adjust the two screws at the back of the shelf to move the monitor assembly closer to, or farther from, the bezel door.
- \* Once the shelf is in position, re-secure the four mounting bolts.
- \* Close the rear door and power up the game.
- \* Re-calibrate the touchscreen.

## MERIT MEGATOUCH BLOWN MONITOR FUSE

#### PROBLEM

Monitor is inoperative after power-up.

#### GAMES AFFECTED

All Megatouch games using Type 19 Ducksan monitors.

#### SYMPTOMS

After power-up, you can hear the fan running and see the power supply light, but there is no picture.

#### CAUSE

Fuse on monitor chassis has blown.

#### SOLUTION

Replace existing fast-blow 3 amp 250V fuse. If you do not have the proper fuse, call Merit customer service for assistance: 800/445-9353. Part number is EC3004.

## SEGA VIRTUA RACER TWIN MONITOR FAILURES

#### PROBLEM

Solder joints on monitor connectors can cause monitor boards to fail and possibly cause chassis board and neck board damage.

#### SOLUTION

This problem is common on the Wells-Gardner 25K8000 series monitors which are issued with the Virtua Racer Twin by SEGA.

#### PROCEDURE

Open the back access panel to the monitor and with the power off.

First inspect the Power Supply PCB on the monitor. It will be located mounted vertically on

the right side of the access pane.

Check connectors P104 and P100 for cold, cracked, or burned solder joints. Most often, the solder joints will be burned looking and may possibly even have the solder melted out of the holes.

Next, inspect the Main Chassis PCB on the monitor.

Look at connectors P150, P200, P201, P500, P600, and P700. You are looking for the same symptoms as those on the Power Supply PCB.

If you have some bad connector pins, touch them up with a hot soldering iron and fresh solder.

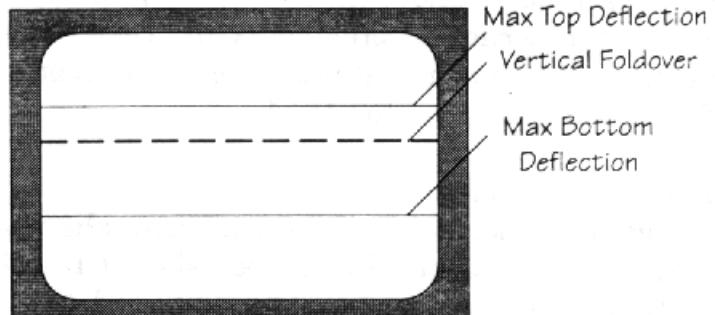
## WELLS GARDNER SERIES 7000 MODEL 19K7689 HALF SCREEN DEFLECTION

### PROBLEM

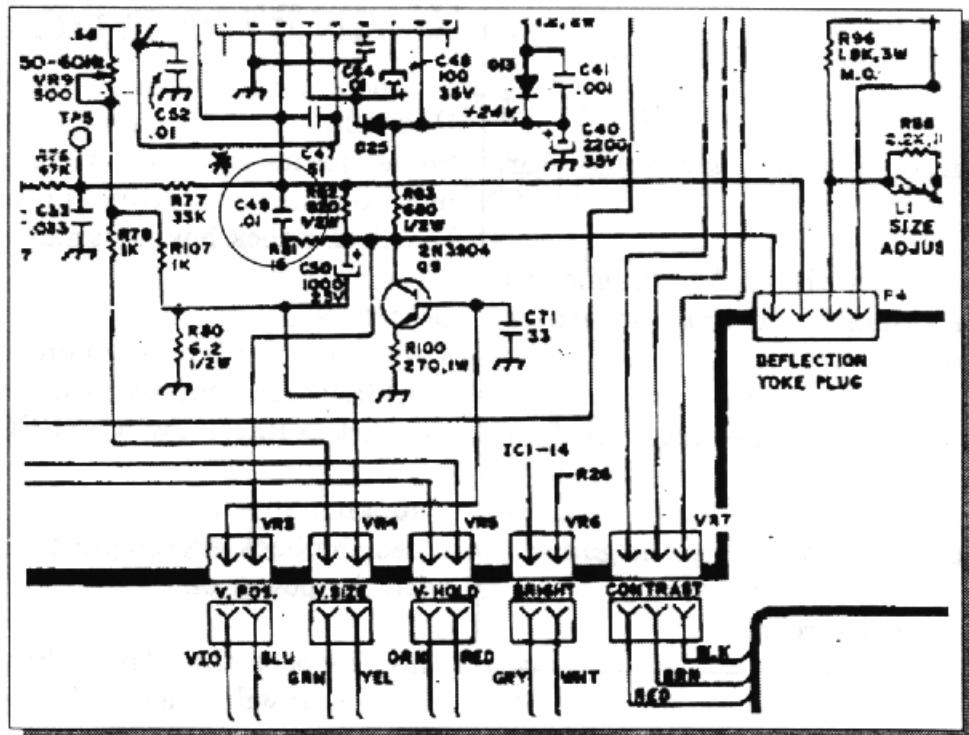
Maximum deflection on the screen is 1/2 with vertical foldover in the same picture.

### SOLUTION

This type of problem was a little hard to find, but after it was found, it made perfect sense to what was wrong. (See the diagram which is figure number two for component location.)



This Figure Shows the Total Deflection on the Screen  
When VR104 was Adjusted to its Maximum.



Capacitor C49 (.01ufd) Shown in Circled Area

IR82 is a 820 ohm resistor and when measured, had found to have a resistance of 16.23 ohms. (This measurement is done with the yoke unplugged from the chassis.) Therefore, it was obvious that R82 somehow was in parallel with R81 which has a resistance of 15 ohms.

Then C49 (which should have blocked the Vdc path between R81 and R82) in the deflection circuit was found to be at fault with a resistance measurement of 1.23 ohms. Replace and verify. Yep! That was it.

## WELLS-GARDNER VERTICAL OUTPUT DEVICE ON U5000

### SUBJECT

After 4 months in the field, we began to notice a higher than normal failure rate on the vertical output device (U601, TDA 1771) on certain models of the U5000. These were primarily used in Williams' Cruis'N USA.

### PROBLEM

After an exhaustive analysis, we discovered that some yoke versions were requiring higher output device dissipation and causing the output device to operate at or slightly above its maximum temperature rating. Note: This only occurs in the 25Khz mode.

### SOLUTION

The fix is to reduce the peak currents in the output device by adding a 24 ohm, 5W resistor in series with the 30V supply to the output device. This is accomplished by removing jumper W108 and inserting the resistor. To maintain 15Khz operation, this resistor should be shorted out.

### RETRO KITS

If you have a monitor that blows the vertical IC, we recommend that you install the retrofit kit along with a new IC. Retrofit kits for this fix are

available from Williams or Wells-Gardner free of charge.

### NOTE

When installing this kit, make sure the orange wire 15/25 Khz jumper is connected properly (no connection for 25Khz, connected for 15Khz) to the 30V post.

Wells-Gardner toll free number is 800/366-6630.

## WILLIAMS CRUISIN'USA VERTICAL OUTPUT MONITOR FAILURE

### PROBLEM

Vertical output premature failure on Wells Gardner 25K5108 monitor in a Williams Cruis'N USA.

### SYMPTOM

Horizontal line on screen.

### CAUSE

Vertical output chip U601 has shorted out.

### SOLUTION

Replace U601 available from any major distributor or get the replacement part from Wells Gardner. Also check R303, 1.2 ohm/2w flame-proof resistor and D302, the high speed rectifier.

### NOTE

To prevent this chip from failing, perform the following modification to the monitor board:

- \* Remove W108 near U601 at edge of board.
- \* Install a 25 ohm, 5w resistor in its place.

This should be done to all your monitors unless a terminal strip is installed near the chip - in which case the modification is already installed.

# ADDING AN AUXILIARY MONITOR

## SUBJECT

Need an auxiliary monitor? Want to show off that new video? Impress a new location? Draw passers-by?

## SOLUTION

Roll your own! Just make sure to use an isolation transformer for each slave you wire up.

## NOTE

Do Not parallel the new wiring with the existing monitor. Break into the signal cable of the main monitor and create a 'Y' to branch the color signals. (You might have to put resistors in series with each branch of the 'Y' to remove ghosting.)

## SIMPLE HELPFUL SERVICE TIPS FOR TROUBLESHOOTING VIDEOGAMES

You have a game on location and it stops functioning. Try to apply these simple rules before going into grave expense on the repair. Use these helpful hints in case of difficulty. These apply to any videogame.

### NO RASTER/NO VIDEO

Check A.C. line cord  
Check line fuse  
Check monitor brightness  
Check power switch and/or interlock switch  
Check solder connections on line filter & xformer  
Check for proper orientation of PCB connector

### RASTER/NO VIDEO

Check all PCB to monitor connections  
Check power supply voltage on PCB

### NO VIDEO/GAME SOUNDS CAN BE HEARD

Check monitor brightness  
Check all PCB to monitor connections

### WRONG COLORS

Monitor needs degaussing  
Check for proper wiring between PCB & monitor  
Check monitor adjustment and adjust if necessary

### WAVY PICTURE

Check ground is properly connected to monitor  
Be certain sync inputs are properly connected  
Check horizontal hold adjustment

### HORIZONTAL/VERTICAL ROLL

Check horizontal & vertical hold adjustments  
Check for proper wiring of sync PCB to monitor

### No SOUND

Check for -5 volts on edge connector or PCB  
Check volume control potentiometer adjustment  
Check for +12 volts on edge connector of PCB  
Check wiring from PCB to speaker  
Check speaker for low resistance between the + and - tabs

### BAD SOUND

Check wiring to speaker for bad connections  
Check sound with another speaker

**NO SWITCH INPUT**

Check ground connection to switch/es  
 Check wiring between PCB and switch/es  
 Check switch/es with an ohmmeter

**SWITCH OPERATES INCORRECT FUNCTION**

Check wiring between PCB and switches  
 Check wiring for shorts between switch inputs

**NO COIN METER**

Check wiring to coin meter  
 Check that +5 volts is on "+" side of meter  
 Verify a +5 volt meter is used

**WHEN COIN SWITCH IS MADE AND METER PULSES,  
 THE SCREEN BLANKS OUT AND/OR GAME RESETS**

Verify that a meter with a diode is used  
 If no diode is built into meter, a IN4004 can be used across the meter. Cathode to + side of meter and anode to - side of meter

has failed, then we find out why. Is it system wide? Is the unit dead? Does it try to start but can't? Or is the problem with the sweep? Vertical or horizontal? Complete loss of sweep or partial? Distorted? Video problem? Contrast, brightness, individual color problem? Missing color? One color stuck on full? Answering these questions leads us towards the repair. If we have a missing color, we need not look for a failure in the sweep circuits since sweep affects all colors equally. Is the problem constant or intermittent? Does the symptom occur right away, or does the unit have to warm up first.

**PRETEST NOTE**

I leave it to the reader to provide proper isolated power to the unit under test and suitable video signal for testing. This could be from your bench setup, or simply from the game the monitor came from.

**OBSERVE SAFETY PROCEDURES**

Please be careful working on any monitor. This article assumes basic electronic troubleshooting competence in the reader as well as at least some monitor experience. There are dangerous voltages

"The essence of troubleshooting  
 is isolation of the problem."

in any monitor, both high DC voltage and the AC line. Please use an isolation transformer: Always. You already expect high voltages to be present in operating monitors, but a monitor with a blown secondary fuse in the main DC supply can leave behind a fully charged main filter capacitor, and it can hold that charge for a long time. Don't let it catch you by surprise. Always check with a meter first. Remember to remove your rings and wristwatches before working on a live monitor.

**GATHER FACTS**

Any good repair starts with a visual inspection. Look for obvious broken parts or wires. Are there any burnt components? If the flyback transformer is cracked in half, we know it needs to be

**MONITOR REPAIR  
 WITHOUT SCHEMATICS  
 (PART 1)**

The essence of troubleshooting is isolation of the problem. Identify the symptom, what does and does not work. A monitor is a system. Power goes in, signals go in, pictures come out. It is a process. Troubleshooting is a linear process as well, in parallel with the system. If we follow the flow of the system it will lead us to the fault.

**OBSERVATION**

First we must isolate the area of the circuit that

replaced or the monitor retired. Is the unit mechanically sensitive? Give the chassis a whack with your hand, or tap the PC board with an insulated object (a stick). Does this affect your symptom? If so, you have a bad connection somewhere. Resoldering will likely fix it, I have found several intermittent connections over the years by turning off the lights in the shop, tapping on the board and watching for little sparks at the bad spot. Look on both sides of the board. This won't work often, but it is really impressive when it does.

### THE BIG THREE

At this point our approach depends upon the symptom. I sort problems into three broad categories. The unit blows fuses, the unit doesn't seem to function, or the unit functions however poorly with a problem in some specific area.

### MONITOR BLOWS FUSES

Monitors that blow fuses can often be fairly simply repaired. Most problems that cause fuses to blow can be found in two areas of the monitor: The power supply and the horizontal output transistor and transformer circuit. If your monitor has a secondary fuse in the DC supply line, it will tell you where the problem is. If the secondary fuse is blown, then the problem must be farther along in the system, i.e. in the horizontal section. If the horizontal section is bad, check the horizontal output transistor (or HOT) for collector to emitter short or low resistance. The HOT will be a large power transistor very near to the flyback. Flyback transformer and horizontal output transformer are the same thing. Since the emitter almost always is tied to ground, we can usually make this measurement from the transistor case (collector) to the chassis ground. The base drive to the HOT is almost always provided by a transformer with one side to ground. For this reason, we cannot check for base to emitter shorts in-circuit. Also check resistance to ground at the HOT collector lead with the transistor removed. If still shorted to ground, check for a bad damper diode or a bad cap, especially the four lead "safety" cap some models use. Follow the printed circuit traces from the

HOT collector directly to these parts. While you are at it, check any diode you see in the general vicinity of the flyback. If you replace the HOT, everything else seems OK, and it still takes out fuses or burns up the new HOT, we have to suspect the flyback. If the main fuse blows but not the secondary fuse, then the fault is likely in the power supply.

### POWER SUPPLIES

If your power supply blows fuses, check your main rectifier(s) and the voltage regulator. The rectifier could be one diode, a bridge of four discrete diodes, or a bridge. Whatever it is, it shouldn't be shorted.

Follow the traces from the rectifier to the main filter capacitor and on to the regulator. The big filters rarely go shorted, they usually just get leaky or open up.

The regulator will be either an IC regulator (which looks like a transistor but may have more legs) or a discrete regulator, which is to say one made up from individual transistors. Anything with an STR number on it is a regulator IC. Check the regulator IC for shorts between input and output, and either of those to ground.

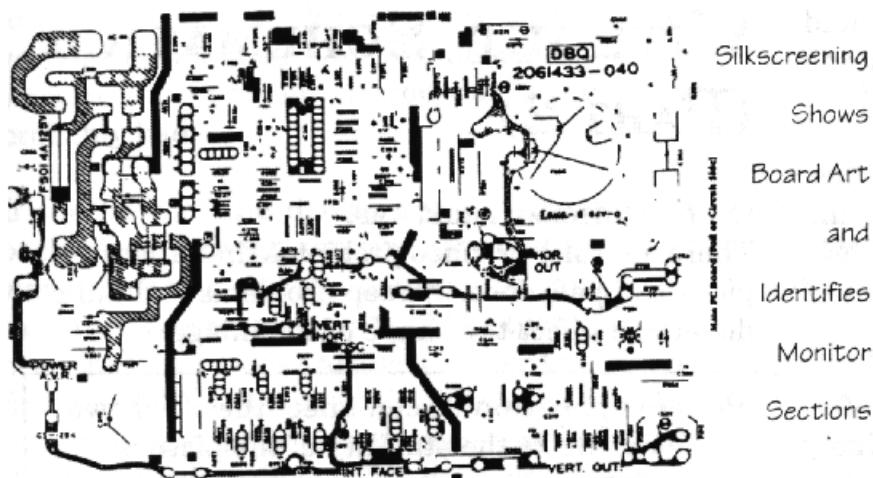
With discrete regulators, a shorted pass transistor usually shuts down a monitor, but often does not blow fuses, but check it anyway. Check the nearby transistors as well. Your DMM will work fine for this testing, since we are looking for short circuits in the transistor. Keep in mind that some other part of the monitor could have caused the power supply section to fail.

Monitors have AC line filters at the power input to prevent interference. A bad cap here would be right across the AC line. Your fuse problem could be as simple as that.

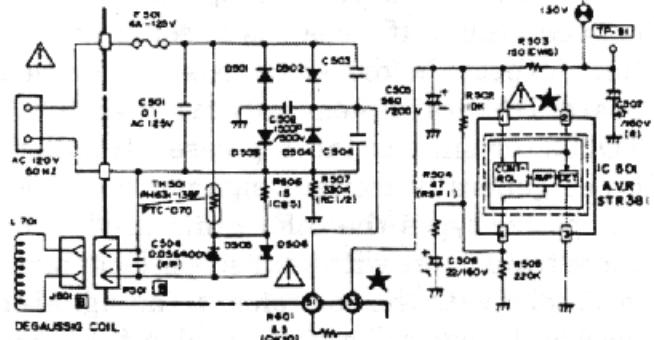
### Iso PROBLEMS

If you just built a conversion and the monitor gave out where you powered it up, or if you try to install a slave monitor, especially if you don't use a separate isolation transformer for the slave,

## Main PCB Silkscreen

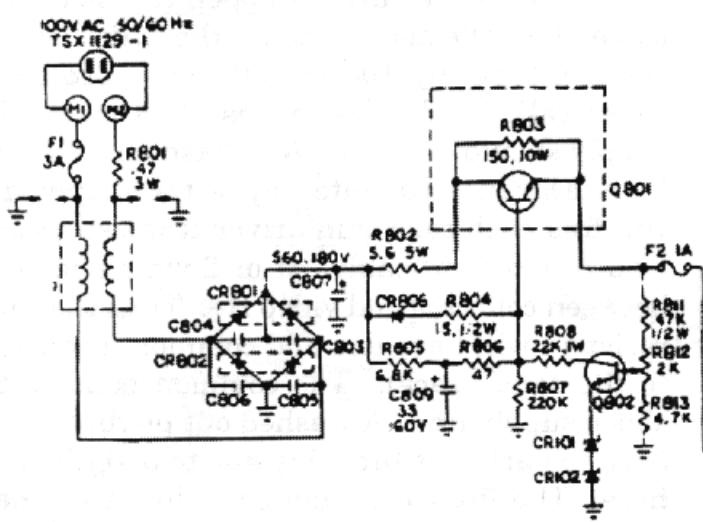


## Monitor Power Supply



Typical Monitor Power Supply Using Regulator IC

## Monitor Power Supply



Typical Monitor Power Supply With Discrete Regulator

and the same thing happens, you may have isolation problems and you can almost count on blown rectifiers and likely some traces burnt off the PC board. Ground traces are at risk, and they will burn out at the narrowest point(s).

### HMM...I'VE SEEN THAT BEFORE

My other problem categories require a more complicated approach. The best tool you have takes no space in your toolbox. It is experience. Your experience can help you. Monitors are all pretty similar under the skin, so if something looks familiar, there is some chance that it is what you think it is. When troubleshooting with a schematic, we use it to identify parts so that we might locate them in the unit. No diagrams, we use other clues.

Though a monitor circuit board looks complex, we are often concerned with only a small part of it at a time, and it is not too difficult to follow the printed circuit traces to make up your own schematic, even if it is just in your head.

Some manufacturers identify power supply traces on the PC board with silk screen hatch marks or a solder stripe down the center of an otherwise coated trace. Learning to trace out your own schematics will be valuable in many ways in your bench work. A little practice makes it fairly easy.

### NUMBER GROUPS

Many brands give different

number sequences to each section of the monitor. Part numbers might group horizontal section parts in the 600s, power supply in the 900s, and vertical in the 400s for example. Check the numbers silk screened on the PC board.

You may find not only these number groupings, but on some boards even lines surrounding the various sections with labels like VIDEO, SYNC, VERTICAL, etc. Component types and values can suggest their function.

Electrolytic caps of high voltage rating (160V, 250V) and a value of 10 ufd or more are likely filter caps or maybe a vertical output cap. Vertical sweep outputs are usually pairs of transistors on heatsinks, or on newer units a multi pin IC for the purpose. The HOT is readily identified, and the only other power semiconductors in most monitors will be the regulator in the power supply and the vertical sweep driver.

#### REFERENCES

Look up the part numbers in the ECG or NTE cross reference guide. Not only will the ECG book identify your vertical output IC, but it will provide the pinout as well. That is the function of each pin on the device.

Look up your voltage regulator IC and the book tells you the output voltage to expect. There are three color circuits in any monitor, so when you spot three similar looking circuits side by side on the PC board, you have probably found the video or color circuits.

#### SIMILAR PRINTS

Other schematics can be helpful. If you can find another monitor using the same oscillator IC, use that schematic for clues as to what voltages and waveforms to expect on the mystery unit. That will work for circuits close to the IC anyway. Even an unrelated schematic can be helpful to suggest component functions to look for.

# MONITOR REPAIR WITHOUT SCHEMATICS (PART 2)

#### ON TO SECTIONAL PROBLEMS.

There are color or video problems that affect the picture appearance. Sweep problems including deflection affect the shape of the image.

Power supply trouble can affect the other two.  
Sync affects the stability of the picture.

#### COLOR AND VIDEO PROBLEMS

Color problems have the built in advantage of multiple circuits. There are three color circuits so you can compare readings and waveforms between them. If a color is missing or stuck on full, suspect the driver transistors on the neck board. Drivers are generally in a TO126, TO220, TO202, or similar tab top case. Smaller case types generally contain signal transistors, no the power types the color guns need. Look at these transistors with your scope, comparing the good color with the bad color. If the signal on the base of the bad color driver is about the same as the others, then look at the collector.

A good waveform there probably means picture tube problems, but check for waveform at the CRT socket to be sure. An open transistor will leave the collector stuck at the video supply voltage, typically 100 to 200 Vdc. Also sometimes called video B+ by us old timers, this supply should be clean. Any hash on this video B+ line means a bad filter cap on the supply. You will find each color gun driver transistor has a load resistor, probably a 1 or 2 watt size or so, between collector and video B+. Thus the three resistors will have one end common (connected to the same trace). The common point is the Video supply line. A washed out picture that is hard to darken is probably due to bad filtration here. The filter cap may be right on the neck board or on the main board. Look for 10 ufd or more, probably at 250V. Not sure which cap it is

and you're having trouble following the traces? Use your scope to look at what is on the filter caps around the board. With the exception of the vertical output cap, you should expect to see smooth DC on them. If you don't, the cap is probably bad.

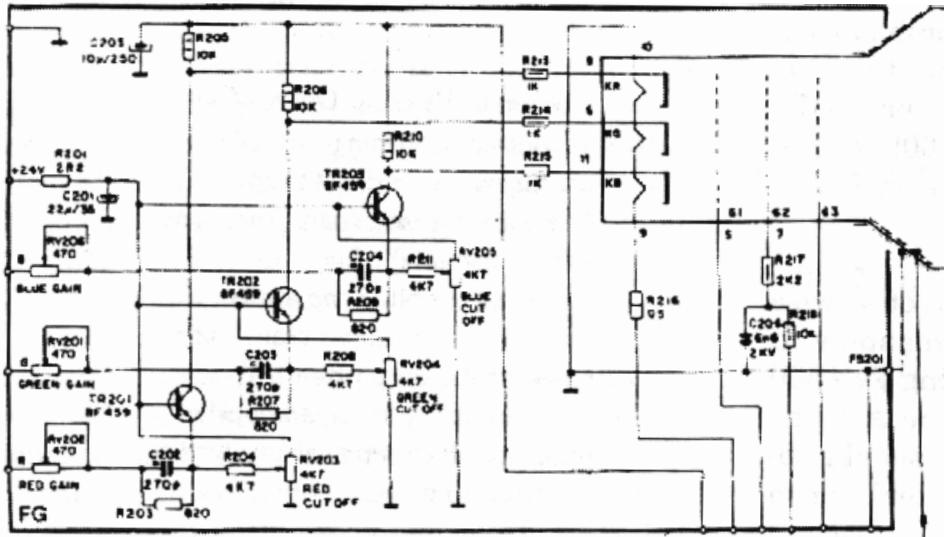
If the base of the driver has no signal, trace backwards through the circuitry by looking for waveforms at transistor leads and comparing to the other two color circuits. My experience has been that color woes are due to driver transistors first and CRTs (picture tubes) a close second. If the problem is in the signal portion of the circuit, the most likely culprit is the one closest (electrically) to the input. Get yourself a CRT tester/rejuvenator, even an older one, and use it. My old and utterly basic Heathkit model works great. It is simply amazing how many tubes can be saved and how few cannot. A few hundred dollars may sound like a lot for a piece of test gear, but save just a few CRTs and it has paid for itself.

The neck board, the little PC board with the CRT socket, is often silk screened with CRT pin identifications. These are real helpful. K means cathode, so KR or RK refers to the red gun cathode, KG is green, you figure out blue. Fila-

ments are labeled F or H for heater. One side of the filament is often ground. G1 and G2 are grids 1 and 2.

### VERTICAL SECTION

Vertical deflection or sweep problems are most often solved with capacitors. Anyone who uses "get well" kits for their monitors knows that changing caps can cure a boatload of symptoms. Of course if you can't identify a monitor, you can't buy a kit for it. What you can do is identify the caps in the vertical circuit and change them, or at least scope them out and change the leaky ones. Vertical sweep circuits tend to fall into two categories: high voltage (over 100 volts, typically the same as the main supply) and low voltage (25 to 30 volts or so). First find the vertical output device(s), whether special IC or just a pair of transistors, and see what kind of voltages you find there. This helps tell you what kind of caps to be looking for. Check the filter and bypass caps, probably 10 ufd or higher. Sweep is generated by charging and discharging a cap through the vertical yoke. Thus output cap needs to be much larger in the low voltage circuits to provide the same level of energy to the yoke, so we look for 1000 ufd or more rather than 100 ufd or less you might find a higher voltage circuit.



The above caps tend to cure the foldover and lack of size problems. The smaller value caps (under 5 ufd) may be more likely associated with stability symptoms. Look for caps small in both size and value when chasing away a jittery picture.

## HORIZONTAL SECTION

The horizontal section offers different challenges. Deflection problems can be simple. In most monitors, the horizontal sweep section also generates many of the operating supply voltages, so it has to be working for the thing to even light up at all. If you find a monitor with a bright vertical line and no horizontal deflection, there are only a few things it could be. Usually the pulses at the collector of the HOT are routed through width and linearity coils to the yoke. A lack of sweep here means one of those devices is open or the connections to them have failed. Check the solder around anything that looks like a coil. I am sure it happens, but I have not replaced a yoke in over twenty years. If you think the yoke is bad, check the wiring first.

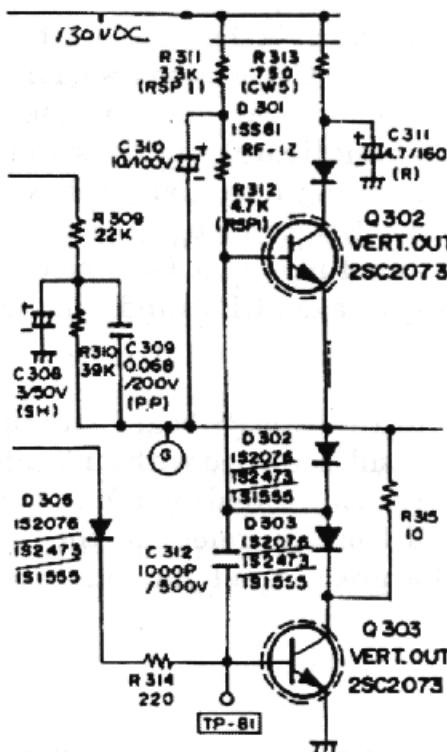
Pincushion is the term for a picture with the sides curved out or in, not straight. A pincushion problem will be stable. If the sides of your picture have a wiggle that moves up or down, you have a bad filter somewhere, not a pincushion problem. Pincushion correction circuits are often based upon a small transformer. They all look pretty much the same to me. Look at one in a monitor you know, then identify the similar thing in your repair unit. The usual problem will be the electrolytic cap or caps related to this transformer. This was a common problem on the Electrohome G07 and the Wells 4600 series. Some techs call the pincushion "keystone".

## BLANK SCREEN

If the monitor doesn't blow fuses, but otherwise appears dead, we start with the power supply. If the main DC supply is absent nothing else will work. Check for raw supply, i.e. the AC line rectified and filtered. This 160 Vdc should appear at the input to the voltage regulator IC or on one side of the pass transistor in a discrete regulator. If no raw supply, check for solderwork,

open traces in the AC line, fuse, or current limit resistor (a power resistor of low resistance value in the line with the bridge). Eyeball schematics are easy here. If this voltage is on the input of the regulator but no output is present, replace the regulator IC or check all the semiconductors in the regulator circuit.

When the sweep sections are not running, nothing else runs, so the load on the power supply



### PORTION OF VERTICAL OUTPUT CKT

Output comes from point "G" through yoke windings then through large value cap. (Yoke, cap, etc. not shown.)

Failure of the filter cap at the collector of the upper transistor causes foldover problems. The other electrolytic caps would be suspects in sweep stability, size or linearity problems.

disappears. Under these conditions, the main supply in some monitors can rise to the level of the primary supply: 160 Vdc or thereabouts. If the power supply fails and produces that high a voltage even under load, the sweep sections will shut down for safety. We need to decide if the failure is regulation or shutdown. Plug your monitor into a variac. You all have one by now, right? Watch the main supply, the output from the regulator, a.k.a. B+, while you dial down the AC line until the supply drops to what it should be, say 130 volts. Leave it set there. Power down for a few seconds to reset the shutdown circuit, then turn it back on at the reduced line level. If the monitor now comes alive, the problem is a lack of regulation in the power supply or hash on the supply line. Scope the line and replace the appropriate filter cap if

the DC is not clean. Check the regulator semiconductors and replace as necessary. I have to replace far more caps than regulators. If the unit still won't fire up, then you have a problem in the horizontal circuit or a bad shutdown circuit. Trace back from the HOT base, looking for drive signal. The base drive transformer and the driver transistor should be easy to find. The oscillator IC should be identifiable, see if it has any supply and if so, any output activity. Beyond that, it is a matter of how much patience you wish to apply.

There is an old rule of thumb that says, "if the filament is lit, then the monitor is working." While this is often true, there is obviously a lot more to monitor repair. If the horizontal sweep is running, just bringing your scope probe within a foot of the flyback will pick up the signal. If the flyback is happening and there is no lit filament, check the wiring and solder to the CRT socket filament connections.

Some symptoms only show up after the unit has warmed up. A monitor runs a lot cooler on your bench than it does in a closed up video game cabinet. If this difference affects your symptom, cover the unit with a towel or packing blanket. This will hold in the heat and warm the unit. It

is not likely to catch fire, but I wouldn't leave it running unattended and go to lunch. Thermal symptoms usually yield to the hot and cold approach, the electronic version of good cop, bad cop, I guess. If some function fails after warm up, locate the related area of circuitry on the PC board, and spray it with freeze spray. That's what the stuff is for. Hopefully, the symptom will immediately correct itself until it warms up again. If that works, you can direct your spray to specific components. A piece of cardstock or a business card can be used to keep cooling spray within an area or away from other components. Remember, isolate the problem. A heat gun or a hair dryer in a pinch can be used to heat an area if you don't want to wait for it to do it on its own.

These approaches to troubleshooting are ones I would use to service any monitor, schematic or no, but it is important to realize you have the ability to do the job even without good documentation. These are just general suggestions and rules of thumb. Obviously many situations can arise that I have not covered. From time to time in my career in troubleshooting a system, I have traced the symptom all the way through a unit and right on out the input connections, thus proving that the unit was working perfectly well, the problem then being elsewhere. At first I felt like I had just wasted my time...

*But troubleshooting skills will  
get you past a lack of  
schematics a lot better than  
schematics will carry you  
through a lack of  
troubleshooting skills.  
Good Luck!*

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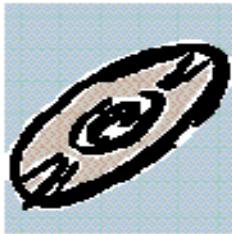
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# STARTECH

## J o u r n a l

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*Star★Tech Journal Volume 18 (1996 - 1997) Monitor Notes*

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Wells Gardner 7000 Over-Voltage Protection

T'Shooting Wells Gardner 33" Monitor Pincushion Problem

Bowling for Dollars! Repairing B&W Monitors

Merit TouchScreen Controller Modification

Sega VideoGame Medium Res Monitor Matchups

Wells Gardner 7000 Series Monitor Horizontal Modification

Merit TouchScreen Eygo Monitor Power Supply

Nintendo Monitor Color 20-EZV (R-C)

Wells Gardner 7000 Series Monitor Black Corner Symptom

## WELLS GARDNER 7000 OVER-VOLTAGE PROTECTION T'SHOOTING

### SYMPTOM

A 7000 series Wells Gardner monitor, with one end of D10 removed (over voltage protect). There is a vertical line in the center of the monitor, no horizontal deflection. With D10 in circuit, the monitor shuts down.

### TROUBLESHOOTING

There are possibly two problems in this Wells 7000. Check the B+ out of the main regulator, IC4. Should be 123 Vdc or close. Check it with a 'scope, it should be CLEAN DC.

If it is high, all the flyback transformer derived voltages will be also. This includes the 12 Volt supply which is sampled through D10 for the shutdown circuit. Bad power can cause shutdown, but a loss of sweep could possibly unload the power supply enough to lose regulation.

### WARNING

If you disable the shutdown, the too-high voltages could be making Xrays in the CRT. Don't stand too close if you are planning a family soon.

Loss of horizontal sweep is usually straightforward. Look for

## WELLS GARDNER 33" MONITOR PINCUSHION PROBLEM

### PROBLEM

Pincushion (hourglass shaped picture) problem on Midway's *Cruis'n World* deluxe videogame due to a fractured or broken leg on the diode at circuit Location D704.

### SOLUTION

Install diode replacement kit, which can be obtained at no charge through Wells Gardner Electronics Corp. Or Williams Electronic Games. Contact your distributor for more information.

### NOTE

Kit part #: S02G0000-000F

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## **BOWLING FOR DOLLARS! REPAIRING B&W MONITORS**

*Got some extra room on the bench and some free time? Check the local bowling alleys.*

### **IDENTIFICATION**

See if any of them are still using the older Brunswick video scoring system. This is the system that displays the scores on large monochrome (that's black and white) monitors over each lane and the scorers table has a pair of little 12" monochrome monitors.

### **LOOK FAMILIAR?**

The overhead monitors are Motorola M7000 types. This monitor uses the exact same chassis our video games used before color took over.

Atari, Midway, and many others used these monitors. These systems are fifteen years old anyway and the monitors often need service. This is easy money, boys. The bowling center has to send them back to Brunswick, and generally they send the whole monitor. This is expensive just to

ship. Brunswick charges an arm and a leg, with a heavy additional charge for advance replacement. They aren't even especially interested in fixing them, they would rather you upgrade to newer equipment. And just between

you and me, they don't always fix them so well, and the turn around time isn't the best.

### **YOUR CHANCE**

Now you come along. You are local, you can offer prompt turn around, you can make reasonable charges (actually you can charge a fair amount and still be cheaper than Brunswick), you can save them shipping. You prob'ly do better work. The Bowling center may already be one of your locations. If not, who do you think they will call when they need an operator to come in? Yep, it's you, the guy they know who provides good and timely service.

Service to these units is reasonably straightforward, you replace a lot of caps. Sound familiar? Some of the parts can be difficult to find or can be expensive. Last

*continued on next page...*

**"This is easy  
money, boys. The  
bowling center  
has to send them  
back to Brunswick,  
and generally they  
send the whole  
monitor. This is ex-  
pensive just to ship.  
Brunswick charges  
an arm and a  
leg..."**

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## BOWLING FOR DOLLARS! REPAIRING B&W MONITORS

...continued from previous page.

time I called Motorola they had a few things left, but they were pricey. I've learned to fix broken width coils rather than replace them. Rejuvenating the CRT does wonders. Spend a couple hours at their location with a rejuvenator and they will think they got all new monitors.

On the bench you need 120VAC, doesn't even have to be isolated since the monitors have power transformers. You also need composite video to feed the input. A pattern generator is best, but the output of a VCR will also work.

"The Bowling center may already be one of your locations. If not, who do you think they will call when they need an operator to come in? Yep, it's you, the guy they know who provides good and timely service."

The little Zenith 12" guys are very simple, and mostly they suffer from broken connections from people pounding the table. Simple solder work. Put extra pins in the edge connector and it won't fail as often.

There are two power supplies in each table, they are open frame, linear types. One puts out + and - 12 volts, the other is a 5V at 6A supply. I usually only see the 5V units. Half the time, the only

problem I find is that they fouled up the current foldback adjustment. In any case they are easy to fix.

I am not familiar with the newer color systems, nor am I aware of the level of service required there, but the old Motorolas provide me a steady extra income. Check it out.

### WANT MORE?

If you are interested in more detailed information about this subject please let us know. I will produce a tutorial if response is sufficient.

### OLDER REPAIRS?

I also wonder if any of you have an interest in the older jukeboxes with vacuum tube circuitry. Home juke repair and rebuilding can be lucrative, are you avoiding this work because you "can't work on tubes?" Let us know if you are interested in this area.

*Fax your comments to 609/654-1441, or write: Editor, Star Tech Journal, POB 35, Medford, NJ 08055. Email comments to [MeInfo@StarTechJournal.com](mailto:MeInfo@StarTechJournal.com)*

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# MERIT TOUCHSCREEN CONTROLLER MODIFICATION

## PROBLEM

UART chip blowing out.

## GAMES AFFECTED

All video games using the CRT-260 board.

## SYMPTOM

Touchscreen controller failure.

## CAUSE

Electro-static discharge feeding through the +5V line.

## INSTRUCTIONS

1. Turn off the game and unplug it from its power source.
2. Open the CPU section door and slide the CRT-260 into its service position.
3. Disconnect all wires, harnesses and ground straps attached to the CRT-260 and its daughter boards.
4. Remove the CRT-260 from the cabinet and turn it over to the solder side.
5. Place a piece of kapton tape between the pin rows for U41 (on the solder side), covering the traces and vias located between the pins. (This is to prevent the suppressor diode you are about to install from shorting any exposed vias.)

6. Attach a 22 AWG wire from Pin 12 of U41 (chip select 0 and chip select 1 of the UART) to the +5V pin of the capacitor at CX41 (when viewed from the solder side, the +5V pin of CX41 is on the left).
7. Attach a transient suppressor diode from Pin 13 of U41 (UART) to the ground pin of CX41 (when viewed from the solder side, the ground pin of CX41 is on the right; you can see that it is connected to the ground

plane). Make sure that the cathode end of the diode (the end with the band) is attached to the UART pin and the anode end is attached to the ground.

8. Using silicone, seal the diode in place.
9. Place the CRT-260 back into the cabinet and reconnect all wires, harnesses and ground straps. Close the CPU section door.
10. Plug in the game and power up.

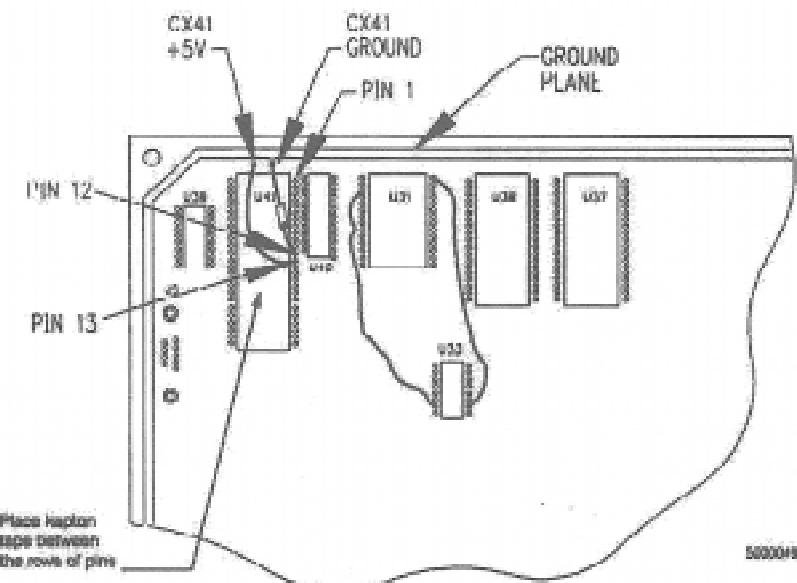


Figure 1 - Solder side CRT-260

## **SEGA VIDEOGAME MEDIUM RES...**

Sega Part Number: 999-0211  
Game Name: Virtua Racing  
Cabinet Type: U/R  
Monitor Size: 25"  
Resolution: Med(24Kx60)  
Monitor Maker: Wells Gardner

Sega Part Number: 200-5240-24  
Game Name: Virtua Racing  
Cabinet Type: Deluxe  
Monitor Size: 36" ( 16 x 9 )  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 2001-5187-15  
Game Name: Daytona  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 2001-5187-15  
Game Name: Daytona  
Cabinet Type: Twin  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 200-5242-15-02  
Game Name: Daytona (Japanese )  
Cabinet Type: Twin  
Monitor Size: 29"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 200-5265  
Game Name: Daytona  
Cabinet Type: Deluxe  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 2001-5265  
Game Name: Daytona  
Cabinet Type: Deluxe  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 200-5265  
Game Name: Daytona  
Cabinet Type: Special  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 200-5264  
Game Name: Daytona  
Cabinet Type: Special  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 200-5264-01  
Game Name: Daytona  
Cabinet Type: Special  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 200-5304  
Game Name: Indy 500  
Cabinet Type: Deluxe  
Monitor Size: 36" ( 16 x 9 )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 2001-5187-15  
Game Name: Indy 500  
Cabinet Type: Twin  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 200-5248  
Game Name: Virtua Formula  
Cabinet Type: Special  
Monitor Size: 70" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 200-5248  
Game Name: Indy Formula  
Cabinet Type: Special  
Monitor Size: 70" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 200-5248  
Game Name: Virtua Formula ( Live )  
Cabinet Type: Special  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 200-5248  
Game Name: Indy Formula ( Live )  
Cabinet Type: Special  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 999-0428  
Game Name: Daytona  
Cabinet Type: Twin  
Monitor Size: 25"  
Resolution: Med(24Kx60)  
Monitor Maker: Wells Gardner

Sega Part Number: 999-0211  
Game Name: Virtua Racing  
Cabinet Type: Twin  
Monitor Size: 25"  
Resolution: Med(24Kx60)  
Monitor Maker: Wells Gardner

Sega Part Number: 999-0211  
Game Name: Virtua Racing  
Cabinet Type: Live Monitor  
Monitor Size: 25"  
Resolution: Med(24Kx60)  
Monitor Maker: Wells Gardner

Sega Part Number: 2001-5187-15  
Game Name: Sega Rally  
Cabinet Type: Twin  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 2001-5187-15  
Game Name: Sega Rally  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 999-0403  
Game Name: Fighting Vipers  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Sharp Image

Sega Part Number: 999-0428  
Game Name: Fighting Vipers  
Cabinet Type: Titan Cabinet  
Monitor Size: 25"  
Resolution: Med(24Kx60)  
Monitor Maker: Wells Gardner

Sega Part Number: 2001-5187-15  
Game Name: Virtua Cop  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 2001-5187-15  
Game Name: Virtua Cop II  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 200-5374  
Game Name: Virtua Cop  
Cabinet Type: Pioneer Model  
Monitor Size: 18"  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 2001-5265  
Game Name: Virtua Cop  
Cabinet Type: 50 Inch Model  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

## ...MONITOR MATCHUPS

Sega Part Number: 2001-5265  
Game Name: Virtua Cop II  
Cabinet Type: 50 Inch Model  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 2001-5187-15  
Game Name: Virtua Fighter  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 2001-5187-15  
Game Name: Virtua Fighter II  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 999-0403  
Game Name: Virtua Fighter  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Sharp Image

Sega Part Number: 999-0403  
Game Name: Virtua Fighter II  
Cabinet Type: U/R  
Monitor Size: 26"  
Resolution: Med(24Kx60)  
Monitor Maker: Sharp Image

Sega Part Number: 2001-5265  
Game Name: Fighting Vipers  
Cabinet Type: 50 Inch Model  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 2001-5265  
Game Name: Virtua Fighter  
Cabinet Type: 50 Inch Model  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 2001-5265  
Game Name: Virtua Fighter II  
Cabinet Type: 50 Inch Model  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 2001-5265  
Game Name: Sega Rally  
Cabinet Type: Deluxe  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 200-5265  
Game Name: Desert Tank  
Cabinet Type: Deluxe  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 2001-5242-24-04  
Game Name: Manx TT  
Cabinet Type: Twin  
Monitor Size: 29"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 2001-5265  
Game Name: Manx TT  
Cabinet Type: Deluxe  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 200-5264-01  
Game Name: Manx TT  
Cabinet Type: Deluxe  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 200-5264-01  
Game Name: Manx TT  
Cabinet Type: Deluxe  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Hitachi

Sega Part Number: 2001-5265  
Game Name: Gun Blade NY  
Cabinet Type: 50 Inch Model  
Monitor Size: 50" ( PTV )  
Resolution: Med(24Kx60)  
Monitor Maker: Mitsubishi

Sega Part Number: 2001-5242-24-04  
Game Name: Virtual On  
Cabinet Type: Twin  
Monitor Size: 29"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

Sega Part Number: 2001-5242-24-04  
Game Name: Sky Target  
Cabinet Type: Sit Down  
Monitor Size: 29"  
Resolution: Med(24Kx60)  
Monitor Maker: Nanao

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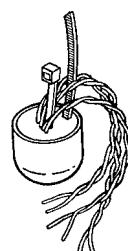
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# WELLS GARDNER 7000 SERIES MONITOR HORIZONTAL MODIFICATION

## Проблемы

On some games, the horizontal range is insufficient, creating a tear on one side of the monitor picture.

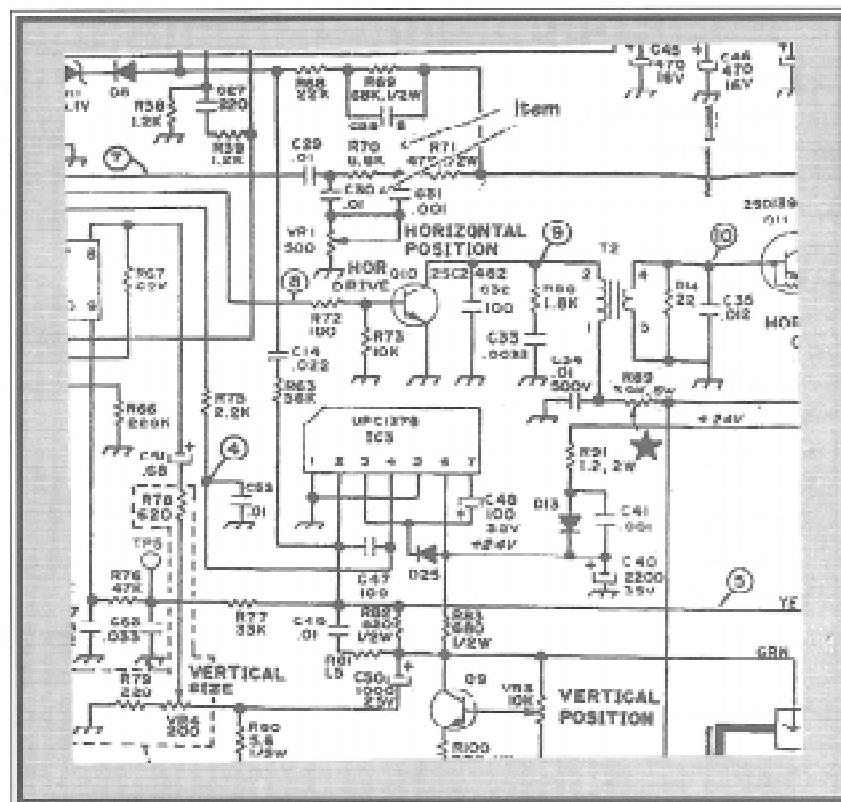
## ScrumON

There are some changes to extend the range of the horizontal frequency.

1. Change R70 from 6.8K ohm to 3.4K ohm

2. You can try to change C30 (.01 micro farad) higher or lower.

Either one of these adjustments will work. See schematic to right for component location.



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# MERIT TOUCHSCREEN EYGO MONITOR POWER SUPPLY SYMPTOM/ SOLUTION

## Subject

In my recent series on switching power supplies, I concentrated on the stand alone power supplies used to power game logic.

They show up in other places as well. I have repaired a couple of Merit touch screen games lately that illustrate this.

## Symptom

**NO PICTURE, BUT LOGIC  
AND SOUNDS WORKING.  
MONITOR IS DEAD.**

Some of these counter top games use an Eygo monitor. Unlike many monitors, this one does not have a linear power supply, it has its own integral switching supply.

This supply produces the operating voltage for the monitor. Except for the higher output voltage, this supply is really quite similar to the black box types we use for 5 volts.

In my Eygo's the fuses and the transistors were OK, and the primary side supply was present. The monitor was dead because the switcher wouldn't start, it wouldn't oscillate. Won't start, won't run.

In the switcher repair series (*STJ Sep, Oct, Nov '96*) our example was a switcher that had a low voltage transformer to provide working voltage for the controller IC. Not all switchers are so designed. Some derive the IC working voltage from the switcher itself. These need a "kick start." That was the problem with the Eygo, the kick start circuit had opened.

## Solution

In the switcher circuit there are two half watt, 75K resistors, R103, R104. They are in series, and they allow a small sample of the primary supply to power the controller IC to start. These resistors open, so the kick start voltage never gets there. Replace any that are open or off value. Considering the voltage they must drop, I think the half watt rating is marginal. I would recommend going to one watt resistors, or at least mounting them off the board so the longer leads can act as mini-heat sinks. Restore the kick start, you will hear that little "zick", and the monitor will take off. Once started, there is a separate winding on the transformer that takes over supplying the IC. Cool.

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# **NINTENDO MONITOR**

## **COLOR 20-EZV (R-C)**

### **SYMPTOMS & SOLUTIONS**

*This article contains fixes for a Nintendo monitor that is still used in the industry.*

#### **PROBLEM**

The screen deflects six inches in the centre only and produces a very small picture.

#### **SOLUTION**

Capacitor C410 is the problem in this situation.

#### **PROBLEM**

The picture will roll slowly and is very touchy when the vertical hold is adjusted.

#### **SOLUTION**

Capacitor C162 is the problem. This capacitor is a non-polarized 4.7 microfarad @ 25 working volts and can be replaced with a 4.7 microfarad @ 50 working volts polarized capacitor. The positive end of the capacitor will go towards the resistor R162 and the negative end of the capacitor goes towards pin number 23 of IC401 (LA1464).

#### **PROBLEM**

Picture is wavy and a cap. kit is installed but there is no improvement.

#### **SOLUTION**

Q901 will be the problem after the cap kit has been installed. This can be checked by measuring for A/C voltage across capacitor C472 or at the emitter of Q901 to ground.

**STAR★TECH**  
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# WELLS GARDNER 7000 SERIES MONITOR BLACK CORNER SYMPTOM

## PROBLEM

When the brightness or contrast controls are gradually adjusted, a black hole from the middle of the right hand side of the screen will overtake the whole screen.

## SOLUTION

Check Q8 to see if the transistor is leaky. If not, the chip IC1 is at fault (UPC1397C). See figure 1

for monitor picture problem illustration. See figure 2 for component locations.

## CHECK

To check this, short out the base to emitter connections of Q8. If the black spot disappears, then the chip UPC1397C is bad. Replace and verify correction operation.

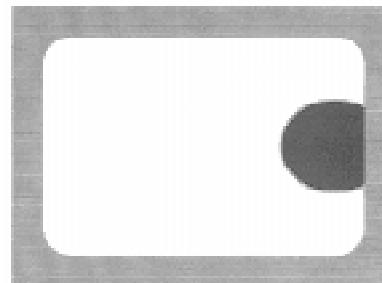
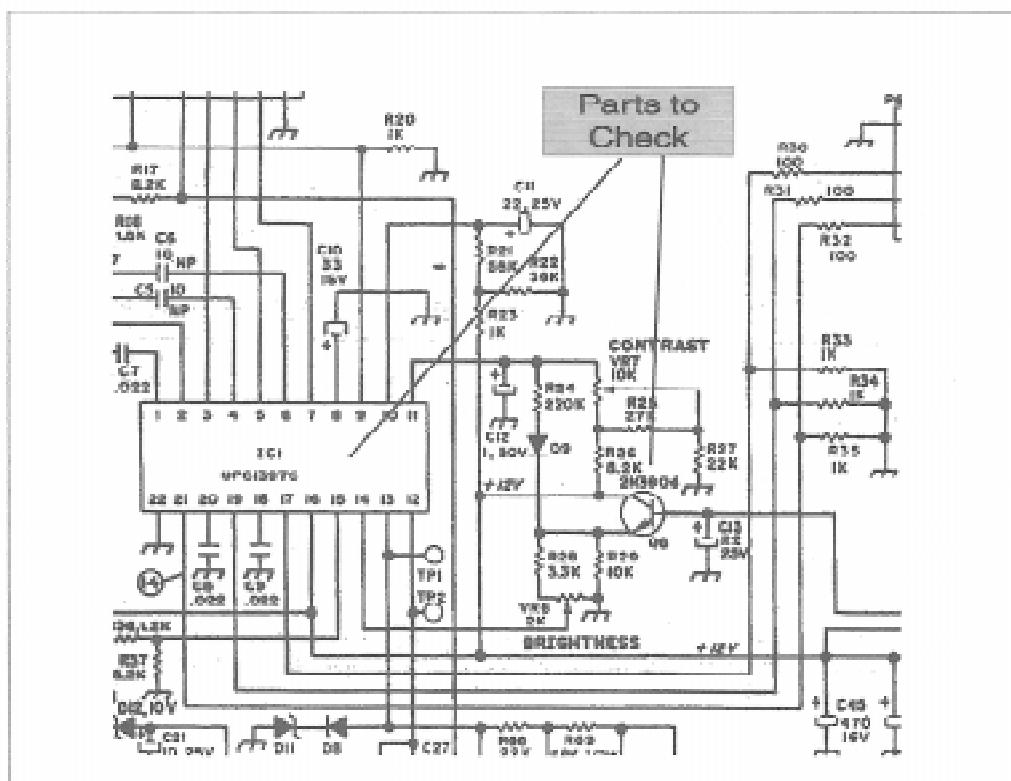
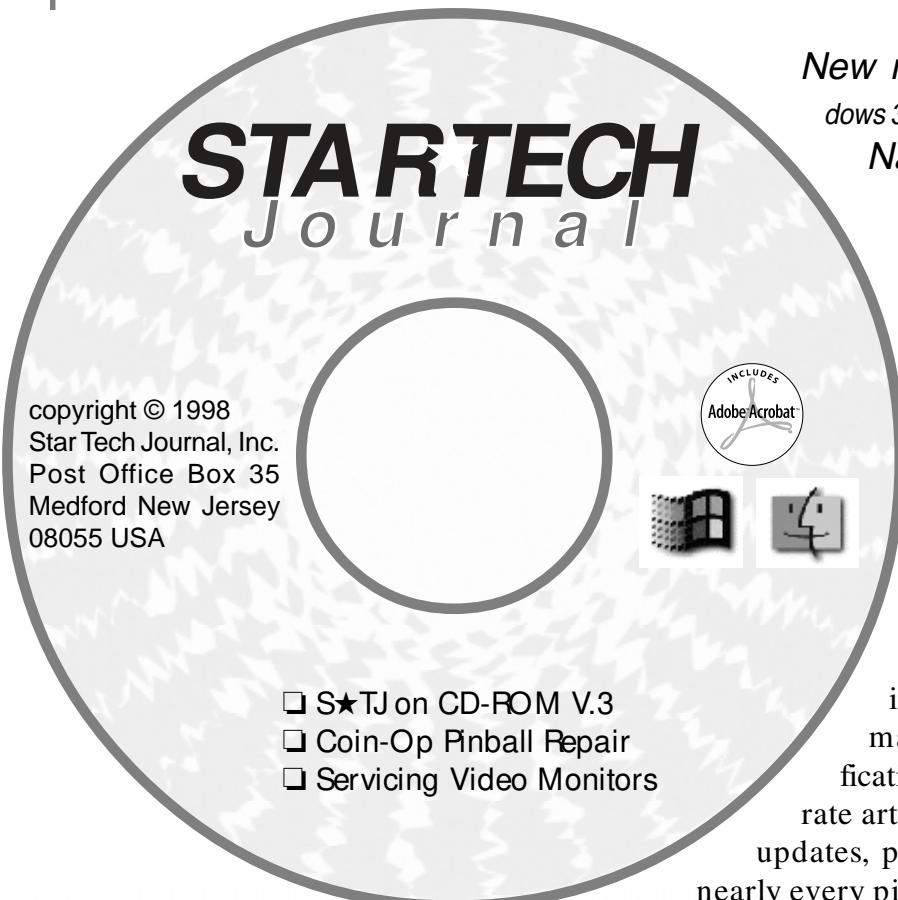


Figure 1

Figure 2



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## J o u r n a l

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*Star★Tech Journal Volume 19 (1997 - 1998) Monitor Notes*

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VideoGame Degaussing Procedure

Williams TouchMaster Faulty Screens

Equipping the Bench: Video Pattern Generator

Wells Gardner U5000 Symptom: Dead Monitor

Wells Gardner Monitor Horizontal Tear Problems

Electrohome GO7 Ringing in Picture

Wells Gardner U3000 High Volts Shutdown

Wells Gardner U2000 Weak Video

Wells Gardner U2000/5000 Fire Prevention

Horizontal Range Wells Gardner K7000 Series

# VideoGame Degaussing Procedure

## SUBJECT

Degaussing is a very significant step in the proper setup of any videogame.

## TYPICAL DEGAUSSING PROCEDURE

1. Stand about 7 feet from picture tube, turn degausser on.
2. With degaussing coil parallel to screen, move in a circular motion while moving slowly toward tube.
3. In a circular motion, move degausser across front, top and sides for approximately 2 minutes.
4. Continuing in a circular motion, holding degausser parallel to picture tube face, move backward from tube.
5. About 7 feet from unit, turn degausser off. Slowly back away.

STARTECH  
Journal

# Williams TouchMaster Faulty Screens

## SYMPTOMS

Game has to be recalibrated every morning, touch screen goes out of calibration for no apparent reason, cannot get the whole screen to calibrate properly.

## CAUSE

There has been a rash of problems with the touch screens and we have identified the problem.

Most of the faulty screens were confined to a batch that had a degenerating contact problem, which took several days/weeks to expose itself, but once exposed the game would go out of calibration and not be able to be recalibrated.

Plus, some had problems with the screen going out of calibration. If the cable between the screen and the controller was "wiggled" the game could be recalibrated.

## SOLUTION

A Touch screen replacement kit can be ordered for any customers that are experiencing these symptoms.

Please contact your distributor's service department if you require this kit. The part number is A-04-10692-2.

# Equipping the Bench: Adding a Video Pattern Generator

## MAJORITY

A lot of the work that comes across my bench is monitors. To work on monitors you need certain basics.

- You need the space to do it in.
- You need a source of power.
- Remember monitors MUST have isolated AC supplies. I naturally recommend the isolation transformer and Variac combination I have described earlier in this series.
- You also need a video pattern generator. A pattern generator is a source of video signals, which are applied to the monitor inputs so it can produce useful images on its screen.

## SELECTION

If you buy a commercial general purpose unit, it should have RGB outputs and the ability to turn off the individual colors so you can work on one gun at a time. RGB simply means separate Red, Green, and Blue signals.

The sync signals are also separate. Composite video is one signal that combines all the color and sync information onto one line. This is the sort of signal that comes out the "video" jack on the back of your VCR.

RF outputs are composite video modulated onto a standard TV channel for application to a tuner through its antenna connections.

## SHOP

Most commercial units provide composite video. A lot of them do not provide RGB outputs, so shop carefully.

There are applications for composite video, such as old monochrome monitors, converted big screen TVs and the like.

## PATTERNS

Pattern generators produce a variety of screen images. I use the cross hatch pattern almost exclusively, but the color bars and other patterns have their use.

## CROSSHATCH

The straight lines and resulting rectangles of the cross hatch facilitate convergence alignment

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# Adding a Video Pattern Generator

(cont)

*...continued from previous page*

and linearity adjustments. You might like dots better.

#### COLOR

Color bars and single color screens are useful for purity adjustments and color balance adjustments.

#### Pos/NEG

Switchable sync is a plus, since you sometimes don't know what sync you will need. I have a couple of old Wico units that I modified to bring out the various sync formats.

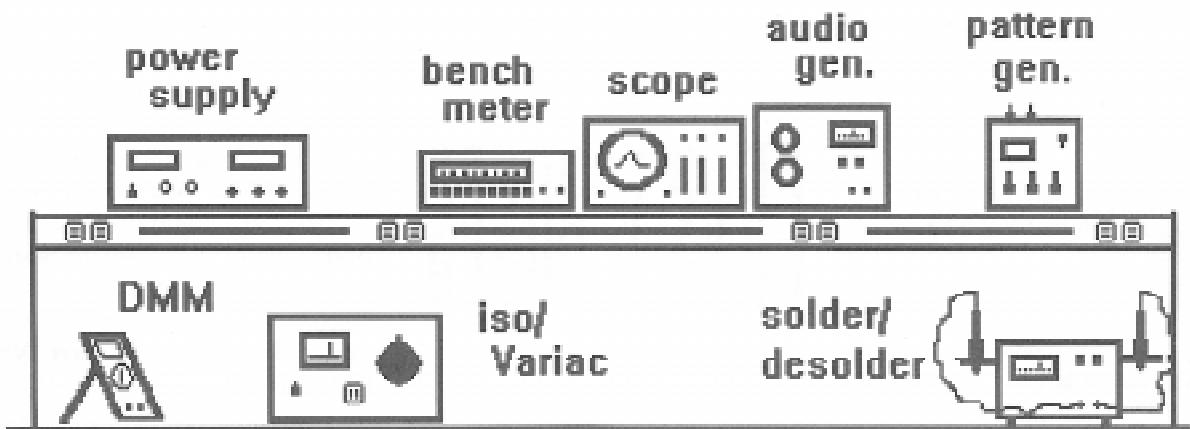
#### WANNA BUILD ONE?

Many video games have built in pattern generators as part of the diagnostics. Look through your collection of old retired boards for one of these.

Pattern generators produce a variety of screen images. I use the cross hatch pattern almost exclusively, but the color bars and other patterns have their use.

Mount it under the bench or somewhere out of the way, supply it with 5 volts, bring the video signal, sync lines, and the test button line up to the bench top, and viola!, you now have the poor man's pattern generator.

Finish it off with a little panel or project box. Make up appropriate cables to connect to your monitor under repair. (I invented one of these back in the Pong days!) Got a spare video PCB around. Well then, don't just sit there. Do it! Roll your own!



# Wells Gardner U5000

## Symptom: Dead Monitor

### PROBLEM

The main fuse in the power supply circuit is OK but the monitor will not power up in 15 KHz or 25 KHz mode.

### SOLUTION

After changing main components (ie: flyback, horizontal output transistor and other related components) and checking as much as possible and it still does not work, try doing this procedure.

### PROCEDURE

1) Check test point TP202 for approximately 117 volts DC and if this voltage is there then go to the H +12 Volt DC circuit.

2) At U701, pin number 10 there should be between 9.81 volts DC to 12 volts DC. If not, check these components :

R760,  
Z706,  
Z702 and  
Q708.

You will note that the R760 in the schematic is a 100 ohm, 1/2 watt resistor, where actually it is 470 ohms, 2 watt resistor.

If a 9.1 Zenier diode is not available for Z706 a 10 volt Zenier will do. Q708 is a 2SC2482. In its place, a 2SC2610 and ECG399 will work.

After this circuit is checked and repaired if necessary, go to the next repair procedure.

3) Use a 'scope to check oscillator signals. At U701 pin number 12, check for a square wave signal. See figure 1 for wave form and reference voltage.

If wave form is missing; U701 is at fault. If wave form is present, then check at the collector of Q703 for next wave form. See figure 2 for the proper wave form. If this signal is lower than normal or not present then Q703 is at fault.

Also check C716, a 1 micro Farad @ 2000 working volts.

After the monitor is plugged in for approximately 15 to 20 seconds, you may have noted that R728, (1K ohm) was getting very hot to the touch. This resistor current limits this circuit and provides the necessary voltage to operate the circuit.

After the circuit has been repaired, it should fire the horizontal drive circuit and the high voltage should be present again.

Now with your 'scope check the collector of Q703 for the proper signal.

*See Figure 1 and Figure 2 on next page...*

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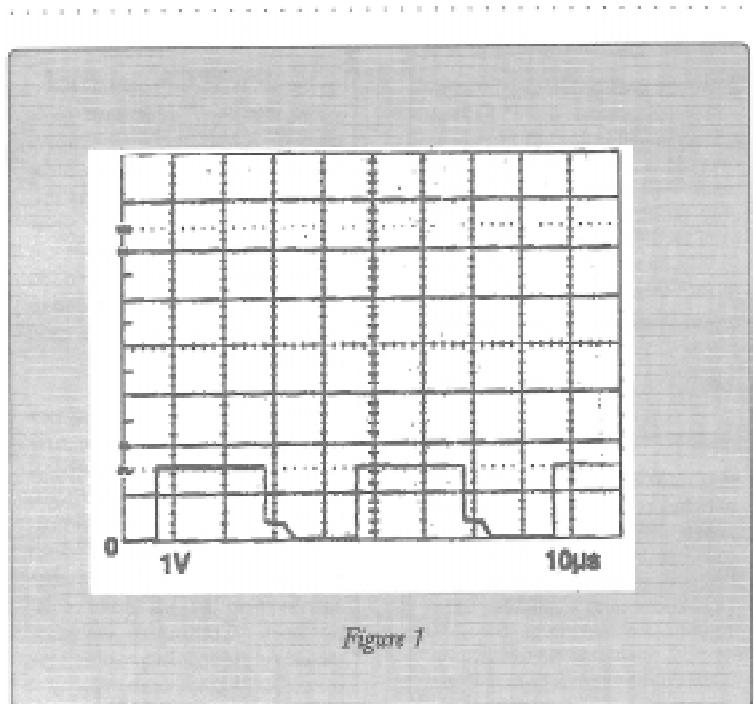
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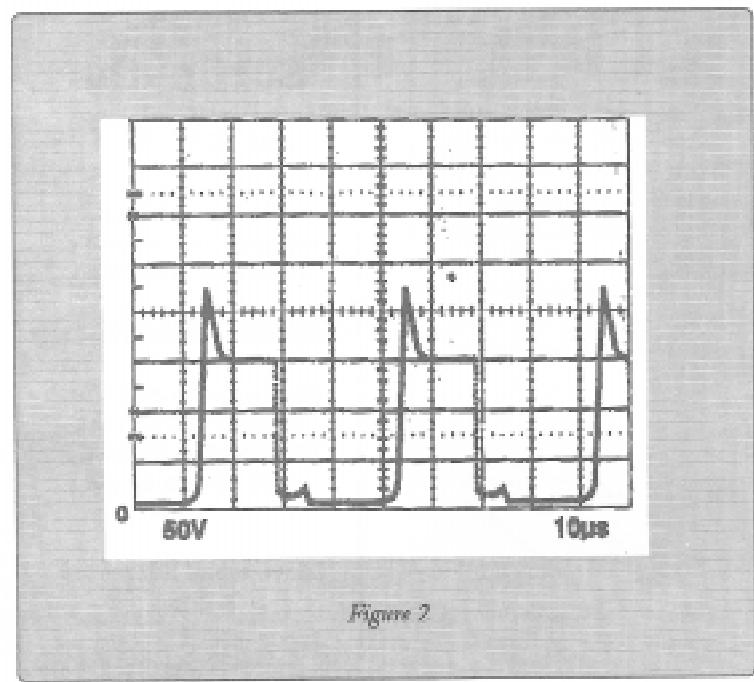
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# Wells Gardner U5000

## Symptom: Dead Monitor (con't)



*Figure 1*



*Figure 2*

# Wells Gardner Monitor Horizontal Tear Problems

## PROBLEM

There is a horizontal tear in the top left corner of the U5000 monitor and every week you have to adjust it out. Finally, you can not adjust the tear any more and you lose the horizontal sync of the picture. See figure 1 and 2 for picture symptoms on the monitor screen.

## SOLUTION

The solution for this problem is a simple one: Locate capacitor C722. Its value is 2200 pico farad or 222J. Even though this capacitor measures OK, the value will change when it is in circuit. Replace it and verify results.

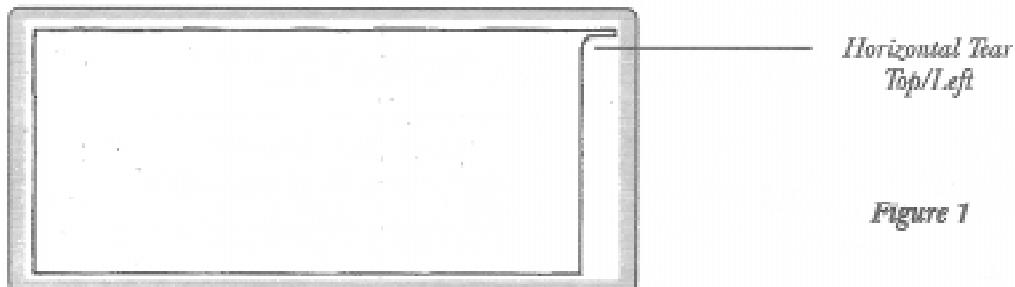


Figure 1

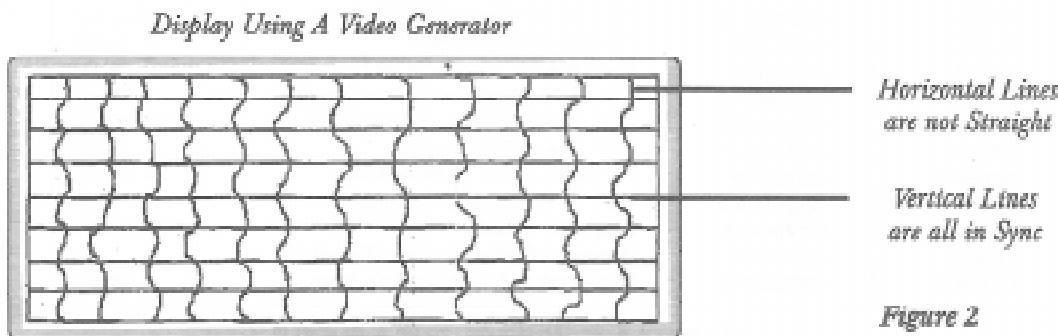


Figure 2

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# Electrohome GO7

## Ringing in Picture

### ELECTROHOME G07 RINGING IN PICTURE

#### PROBLEM

On the right side of the picture, there is a sine wave type ringing in the picture. It is like the picture is straight and then it starts to turn in a sine wave signal from the middle of the screen to the right of the tube. See figure 1 for picture distortion.

#### SOLUTION

The problem is between the phase detection and the horizontal oscillator. The component that is the suspect would be C504, 1 microfarad capacitor on pin 15 of IC 501. See figure 2 for component location.

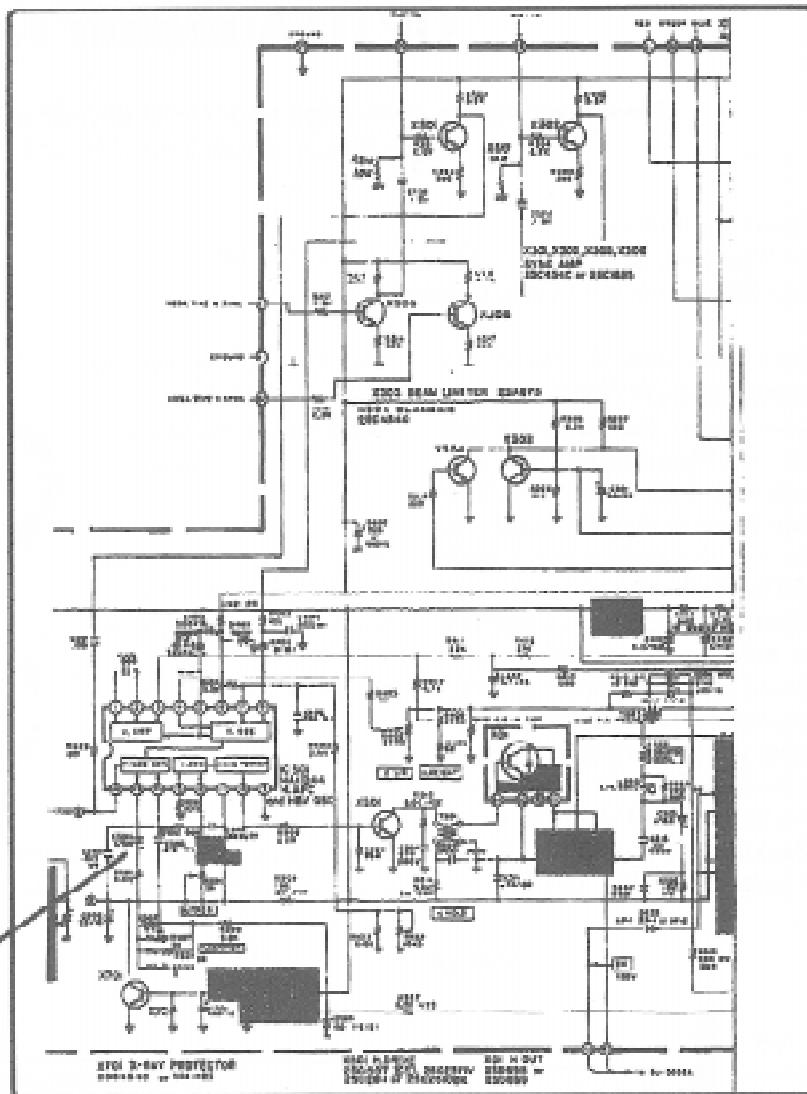
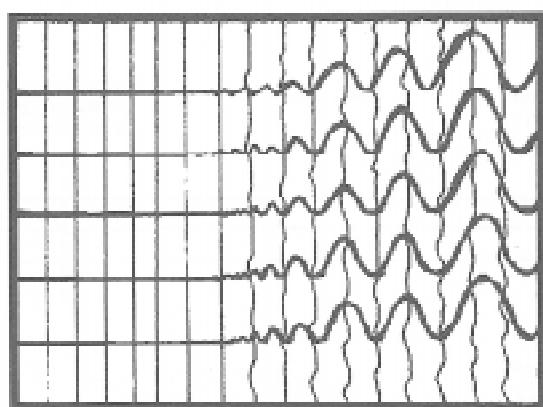


Figure 2  
Component Location.  
Capacitor C504 located in the  
Phase Detector/Horizontal  
Oscillator circuit.

Figure 1  
Picture Distortion.  
Ringing as seen on a cross-  
hatch pattern.



# Wells Gardner U3000 High Volts Shutdown

#### REPORTED PROBLEM

I have a U3000 WG Mod 14K3002 that keeps going into high voltage shutdown. If I adjust the HV pot just a little the unit will run fine. I have changed the hor. output transistor but still have the same problem. All voltages are within specs. Any help will be appreciated. Thank You.

#### ADVICE

Did you check your A/C voltage off the isolation transformer? If its more than 123VAC, it will cause that problem. I've had a bunch of isolation transformers "step up" the A/C voltage in some older video games.

This issue, answers to questions posted on STJ's online tech exchange center (Star Tech Journal Message Board on the World Wide Web). This service can be found at:

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# Wells Gardner U2000 Weak Video

#### REPORTED PROBLEM

I am having a problem with a Wells Gardner monitor which I have never seen before. With all the screen controls set to their maximum, the picture is just barely visible. All B+ and associated voltages are within normal specifications.

I have tried to contact Wells Gardner concerning this problem but I only get their answering machine in the tech dept. and they never call me back. Any and all help would be appreciated. Thanks

#### ADVICE

This is a simple problem. Either your voltage that supplies the colour processor is low or the chip itself is bad.

To isolate this problem try swaping the neck board with another U2000 or U5000 which has the same neck board. These are usual problems of faded video in a new U2000. The other extreme is maybe your tube is shorted at the colour guns .

# Wells Gardner U2000/ 5000 Fire Prevention

#### REPORTED CONDITION

In the IC power regulator circuit for U-701, the zener diode Z-705, 9.1v 1/2 watt, may short out. Even when the deflection circuits have stopped running, the switching regulator circuit continues to deliver the B+ until components heat up enough to either burn themselves open, or burn a dime-to-quarter sized hole in your PCB!

#### ADVICE

I have seen this problem many times and I wonder myself if there is not a better solution to this circuit failing all the time.

Here are some solutions you can use to better this circuit:

- Check to make sure R760 is a 470 ohms 2 watt flame proof resistor.
- Change R105 to 5 watts ceramic resistor 470 ohms.
- Z705 to 10 volts 1/2 watts.
- Q703 and Q708 to 2SC2610 or ECG399.
- Next Z702 to a 1N4742A zener.
- C712 to 220 25 volt capacitor.

This will improve the circuit to some extent, but use this mod at your own risk.

# Expanding the Horizontal Range

## Wells Gardner

### K7000 Series Monitors

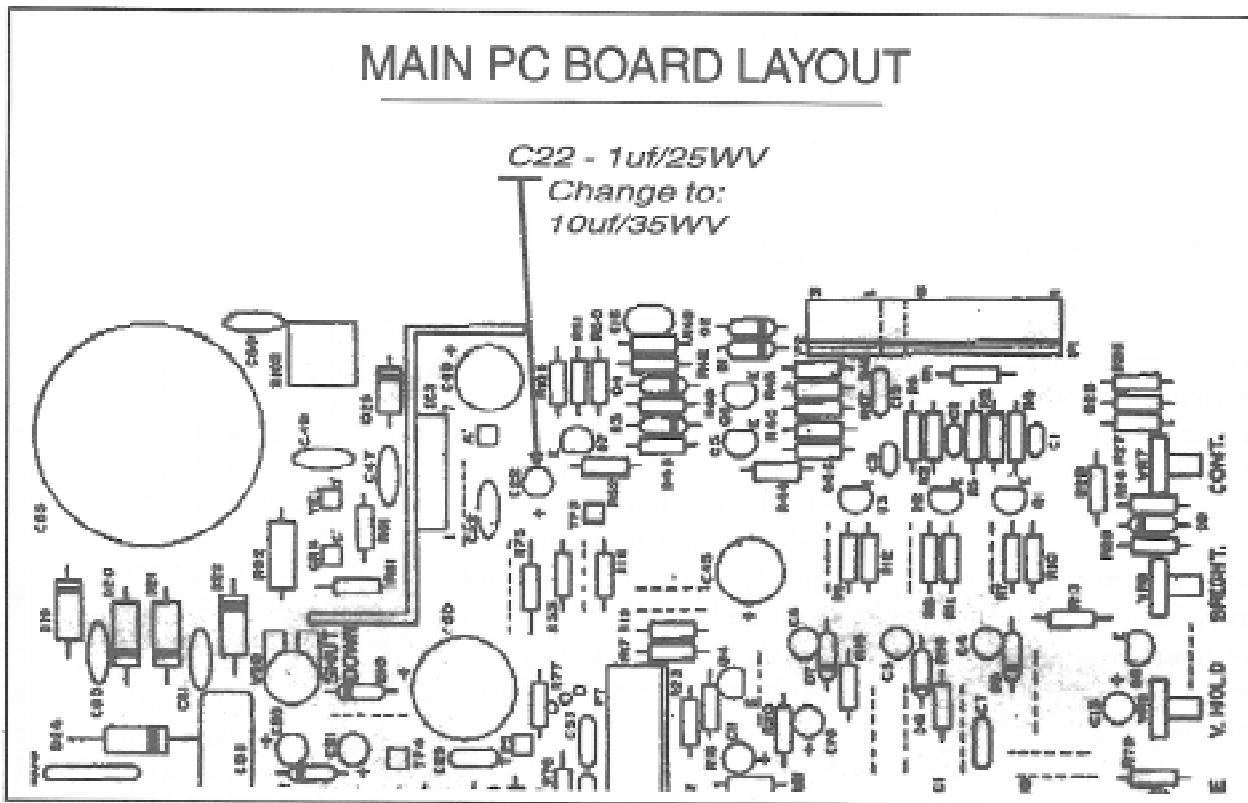
#### PROBLEM

If you are adjusting the horizontal frequency on this monitor, trying to eliminate that one side that has a tear in it, and over-adjusting causes the picture to lose the horizontal sync, try this fix:

#### SOLUTION

Change the C22 capacitor from 1 uf @ 25WVolts to 10 uf @ 35WVolts. See figure below for location of this component.

#### MAIN PC BOARD LAYOUT



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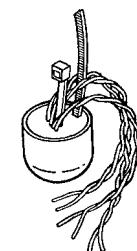
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**VIDEOGAME  
MONITOR  
Repair & Maintenance**

**1979 - 1989**



*Best of STAR★TECH Journal Series*



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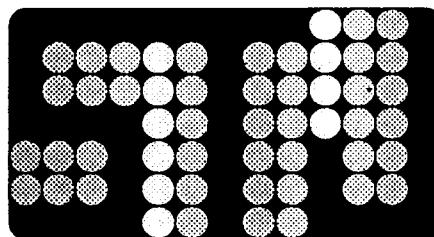
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# 1

## General Monitors Tips & Info

### Monitor Adjustments

#### The Picture is Important

All video games have one thing in common - a television monitor that is used to display computerized information in the format of a game that people will hopefully pay to play. Whether a game is successful or not depends on factors such as player interest, competitive stimulation and skill requirements.

But there is also the attractiveness of the game to consider. The most important think here is the quality of the picture that is being displayed on the game's monitor screen. Monitors, like home television sets, require occasional adjustments to maintain the best possible picture quality. Obviously a dull, out-of-focus, poorly centered picture will result in less attractiveness and less income for your game. The following will be a general explanation of the various adjustments that can be made to video game monitors.

*Vertical and Horizontal Hold are two adjustments that are performed similarly to home televisions.*

Vertical Hold adjustment is necessary if the picture rolls from either the top or bottom of the screen. Proper Vertical Hold adjustment is obtained by turning the control until the picture is stabilized, then slowly continuing to turn the control until the picture starts to roll the other way. Once this point is reached, you will know the range the control has between positions where the picture rolls - position the control in the approximate middle of this range for proper Vertical Hold adjustment.

By the way, Motorola XM5000 and XM7000series monitors have no Vertical Hold adjustment, so a rolling picture on these monitors is a result of either logic board or monitor circuitry failure.

Horizontal Hold adjustment is slightly more complicated on video game monitors than on home televisions. A need for Horizontal Hold adjustment is indicated by diagonal lines or dots on the screen of the monitor. This is especially common when the game is powered-on cold. As with Vertical Hold, adjust for a stable picture, then set the control in the approximate middle of the range between that and loss of picture stability. Horizontal Hold also shifts the picture somewhat from left to right on the screen before stability is lost - use this ability to help center your picture.

If adjustment of the Horizontal Hold control will not stabilize the picture, you may need to adjust the Horizontal Set Coil on the monitor's circuit board. This is a small rectangular metal can usually located in the approximate center of the circuit board. Use a plastic hex adjustment tool to turn the slug inside the coil. This tool is sometimes included with the monitor, or is readily available in any electronics shop such as Radio Shack.

If you swap a monitor between games of different manufacturers, you will usually have to make this adjustment to obtain Horizontal Hold, since Atari uses a slightly different sync frequency than Midway; and Midway is slightly different than Gremlin, and so forth.

Brightness and Contrast are extremely important adjustments for a good-looking game. Most games utilize a black background with white video information, for example, Atari's *Breakout*. For this type of picture, adjust the Brightness control until the background begins to lighten, then back the control off for a black background. Use Contrast to obtain the sharpest white video possible, without "smearing" or distorting the picture. Other games, such as *Kee's Tank*, utilize a grey background with white and black video information. To obtain this type of picture, adjust the Brightness control for a grey background, then adjust the Contrast control until the black video starts to get slightly light. In both of these cases, you have have to play with both controls slightly to obtain the best possible picture, since adjusting Contrast tends to affect the Brightness adjustment somewhat and vice-versa.

The remaining adjustments to be discussed are located on the monitor's circuit board. These are Vertical Size and Linearity, and Focus. Focus is self-explanatory. Use a plastic screwdriver to adjust this control for the sharpest possible picture - be careful as this control is carrying approximately 600 volts across its terminals. Vertical Size is also self-explanatory.

This control is used to place the picture properly at the top and bottom of the screen. Vertical Linearity is slightly more complex. This control affects the spacing between the lines on the face of the screen and is most important in games utilizing writing on the screen. Adjust this control for equal-sized lettering or objects at the top and bottom of the screen. Since the controls are sometimes located at the rear of the circuit board, once again it is a good idea to use a long plastic screwdriver to make adjustments so shock hazard will be avoided.

Also located on the monitor's circuit board will be a Power Supply adjustment and a Video Bias control. Do not attempt to adjust these controls without a good digital voltmeter. Motorola monitors operate at 73 volts, while TEC monitors operate at 100 volts. An under-sized or over-sized picture may indicate a need for power supply adjustment, but normally these controls are factory set and will not need readjustment. Video

Bias is also not normally readjusted after the monitor leaves the factory.

Width is another monitor adjustment that is self-explanatory. This adjustment usually located at the right-hand corner of the chassis, affects the width of the picture, and is used to place the video at the right and left boundaries of the screen.

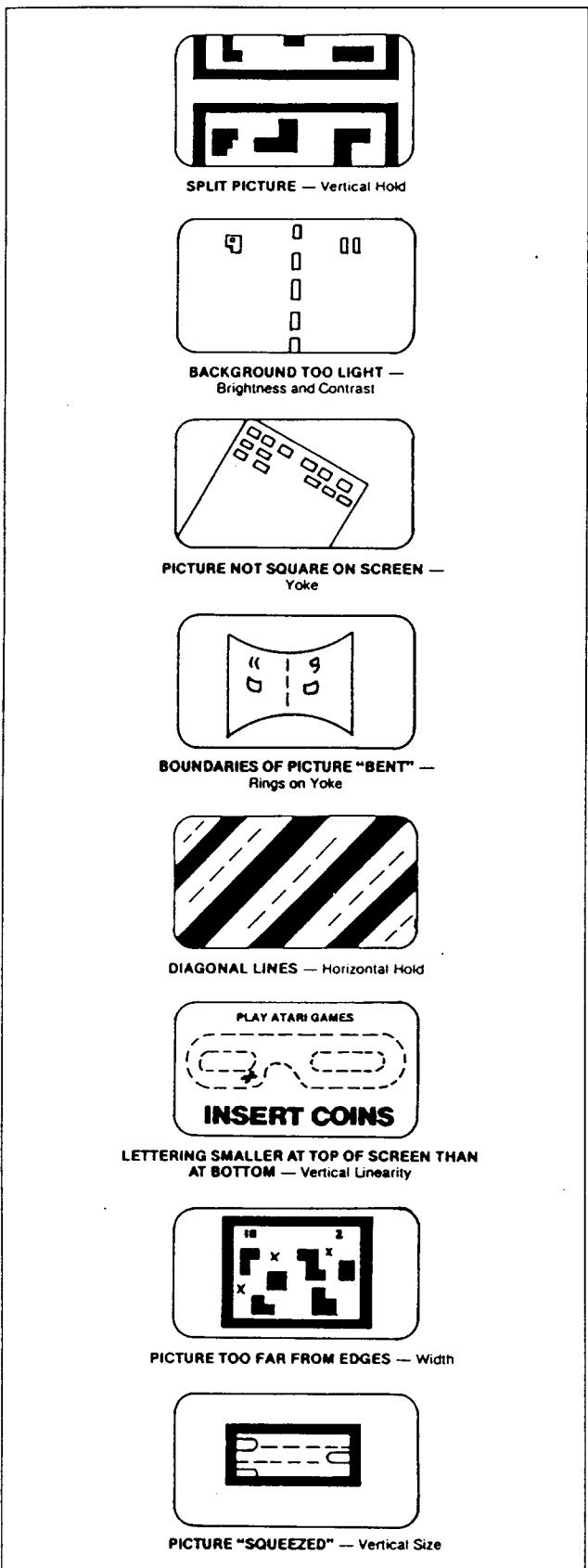
The Yoke located at the neck of the picture tube, is the last adjustment unit that we will discuss. The Yoke itself can be rotated to obtain a picture that is perfectly square on the face of the tube. There is a clamp around the Yoke that is used to hold it in its proper position - sometimes this loosens in shipment, allowing the yoke to slip back on the neck of the tube. This results in a picture with a "halo" effect. Make sure the Yoke is seated firmly as far forward on the neck of the Picture Tube (CRT) as it will go, and that its clamp is relatively tight. Do not over-tighten the clamp, or you will risk cracking the neck of the CRT.

The Yoke also contains two "rings" which have tabs that are used to slide the rings around the base of the Yoke. The rings are actually small magnets that bend the CRT's beam slightly, and are used to perfectly center the picture on the screen. Be very careful if you attempt to adjust the yoke, as there is high voltage present in the windings any time the monitor is powered on.

Finally - keep the monitor's screen clean. The high voltage, typically 14,000 volts, that is present around the picture tube acts as a magnet for dust, which will eventually coat the face of the CRT and result in an out-of-focus, smearable picture. There is no way to prevent this, so regular cleaning will be required.

A little elbow grease and a knowledge of the adjustments described above will keep your video game looking its best - and hopefully making money.

Following are some illustrations of out-of-adjustment monitors so you can see what adjustments are required when.



## Guide for Monitor Repair

Troubleshooting a monitor is not a matter of a thorough knowledge of the monitor circuitry. The first step in the troubleshooting process is to be able to identify the problem and then to proceed to the proper malfunctioning circuit. In some cases, such as a black screen, the malfunctioning circuit is unknown. Then the procedure is to start with the most common circuit and then by the process of elimination, locate the defective circuit.

The purpose of this article is to help you identify the symptom, guide you to the malfunctioning circuit and then to list the probable faulty components. This should eliminate most of the guessing and reduce the all important element of troubleshooting time.

Proper identification of a symptom will require some knowledge of what comprises a picture. A picture is made up with four components:

1. The **RASTER** is the brightness of the entire screen. It can be black or very bright and is controlled by the brightness potentiometer.
2. The **VIDEO** portion of the picture is the white, black & grey info superimposed on the Raster.
3. The **VERTICAL** is the motion from the top to the bottom of the screen.
4. The **HORIZONTAL** is the motion from the left to right of the screen.

Each picture component will have its own failure symptoms. So, we must define these symptoms.

1. **VERTICAL COLLAPSE** is seen as a narrow Raster line running from left to right. This is caused by no vertical motion.
2. **VERTICAL ROLL** is an unstable picture which moves up or down the screen.
3. **HORIZONTAL TEAR** appears as a picture which is diagonally torn in several places.
4. **HORIZONTAL COLLAPSE** is seen as a narrow Raster line running from top to bottom of the screen.

5. RETRACE LINES are four to eight thin white video lines running diagonally across the screen.

### USING THE CHARTS

The charts are labeled by symptom as seen on the picture tube. For each symptom, probable faulty circuits are listed and then the suspected faulty components are shown.

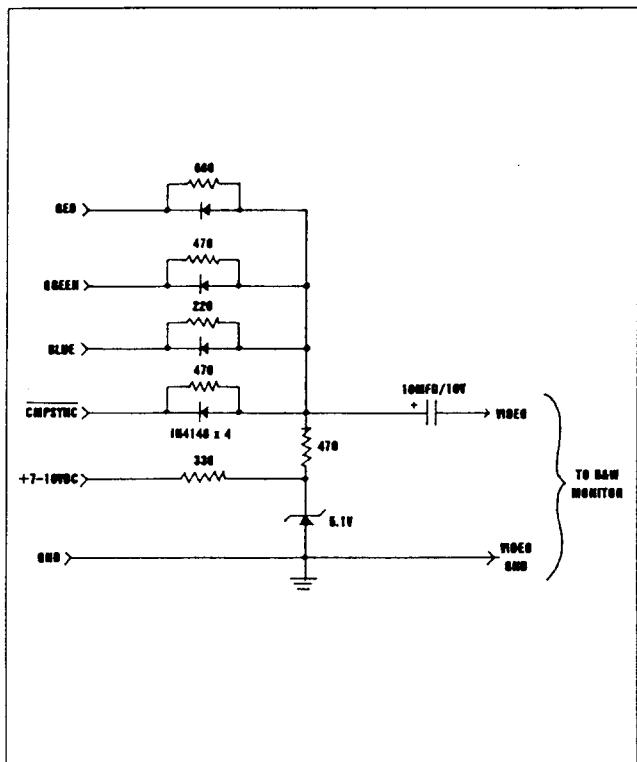
When two symptoms appear at the same time, the charts can pinpoint the circuit. For example, a monitor exhibits a horizontal tear and a vertical roll. Looking at the charts, the only common circuit is the Sync Separator.

	MOTOROLA XM501/701	MOTOROLA XM5000/7000	TEC	WELLS GARNER
<b>HORIZONTAL TEAR</b>				
A. SYNC SEPARATOR CIRCUIT				
1. SEPARATOR TRANSISTOR	Q5	Q10	Q301	Q206
2. AMPLIFIER TRANSISTOR	Q1	Q11	Q400	Q201
3. SHORTED DIODE	D23			D201
4. PHASE DIODES OPEN OR SHORTED	D7	D5,6	D401,402	D205
5. SHORTED CAPS	C2			C201
B. FEEDBACK INTEGRATOR CIRCUIT				
1. CAPACITORS OPEN OR SHORTED	C15,32	C12,14	C403,415	C207,210
2. RESISTOR OPEN	R45	R24	R408	R216
<b>BLACK SCREEN—FUSE BLOWN</b>				
A. HORIZONTAL OUTPUT STAGE				
1. OUTPUT TRANSISTOR SHORTED	Q9	Q9	Q403	Q103
2. DAMPER DIODE SHORTED	D1	D7	D403	D106
3. LIMITER DIODE SHORTED	D2	D6	D801	D206
4. HIGH VOLTAGE DIODE DEFECTIVE	D4	D11	D404	D105
5. HIGH VOLTAGE TRANSFORMER DEFECTIVE	T2	T2	T403	T102
B. LOW VOLTAGE POWER SUPPLY				
1. BRIDGE DIODE(S) SHORTED	D9,10,11,12	D16,17,18,19	D901—904	D101—104
2. POWER TRANSFORMER—INTERNAL SHORT	T4	T3	T901	T101
<b>BLACK SCREEN—FUSE OK</b>				
A. HORIZONTAL OUTPUT CIRCUIT				
1. OUTPUT TRANSISTOR OPEN	Q9	Q9	Q403	Q103
2. HIGH VOLTAGE TRANSFORMER OPEN	T2	T2	T403	T102
3. HIGH VOLTAGE DIODE OPEN	D4	D11	D404	D105
4. OPEN B+ RESISTOR		R43	R420	
B. HORIZONTAL DRIVER CIRCUIT				
1. TRANSFORMER OPEN	T1	T1	T402	T201
2. DRIVER TRANSISTOR OPEN OR SHORTED	Q8	Q8	Q402	Q209
C. PULSE SHAPER CIRCUIT				
1. SHAPER TRANSISTOR OPEN OR SHORTED	Q7	Q7		Q208
D. HORIZONTAL OSCILLATOR CIRCUIT				
1. OSCILLATOR TRANSISTOR OPEN OR SHORTED	Q6	Q6	Q401	Q207
2. TRANSFORMER DEFECTIVE	L1	L1	T401	L201
3. CAPACITORS OPEN	C18,19	C18,19	C408,409	C213,214
E. CRT AND SOCKET				
1. SPARK GAP SHORTED	PIN 2	PIN 2	PIN 6	PIN 2
2. SOCKET WIRE OPEN	PIN 2	PIN 2	PIN 6	PIN 2
<b>LOW VOLTAGE POWER SUPPLY TOO LOW</b>				
A. REFERENCE AMPLIFIER				
1. REFERENCE ZENER LOW	D6	D20	D906	ZD201
2. REFERENCE TRANSISTOR SHORTED	Q15	IC1,Q19	Q903	Q204
B. SERIES PASS AMPLIFIER				
1. DRIVER TRANSISTOR OPEN	Q14	Q18	Q902	Q102
2. SERIES PASS TRANSISTOR OPEN	Q16	Q17	Q901	Q101
<b>LOW VOLTAGE POWER SUPPLY TOO HIGH (NOTE 1)</b>				
A. REFERENCE AMPLIFIER				
1. REFERENCE ZENER OPEN	D6	D20	D906	ZD201
2. REFERENCE TRANSISTOR OPEN OR LEAKY	Q15	IC1,Q19	Q903	Q204
B. SERIES PASS AMPLIFIER				
1. DRIVER TRANSISTOR SHORTED	Q14	Q18	Q902	Q102
2. SERIES PASS TRANSISTOR SHORTED	Q16	Q17	Q901	Q101
<b>RASTER CANNOT BE TURNED OFF, RETRACE LINES</b>				
A. LOW VIDEO OUTPUT STAGE POWER SUPPLY VOLTAGE				
1. DIODE BREAKDOWN TOO LOW	D5	D10	D207	D107
2. CAPACITOR OPEN	C43D	C32D	C220	C101D

	MOTOROLA XM501/701	MOTOROLA XM5000/7000	TEC	WELLS GARNER
<b>B. VIDEO OUTPUT CIRCUIT</b>				
1. VIDEO OUTPUT TRANSISTOR LEAKY	Q3	Q5	Q202	Q203
2. VIDEO DRIVER TRANSISTOR LEAKY	Q4	Q4	—	Q205
3. BLANKING DIODE LEAKY	—	—	D204	—
<b>C. CRT SOCKET</b>				
1. SPARK GAP SHORTED	PIN 7 IN SOCKET	PIN 7 IN SOCKET	PIN 7 Z-801	PIN 7 IN SOCKET
2. OPEN BRIGHTNESS CONTROL	R-21			R-121
3. NO VOLTAGE TO BRIGHTNESS CONTROL	R-21			R-121
<b>D. SPOT KILLER</b>				
1. TRANSISTOR SHORT	Q21			
<b>NO OR DISTORTED VIDEO, RASTER OK</b>				
<b>A. VIDEO OUTPUT CIRCUIT</b>				
1. VIDEO OUTPUT TRANSISTOR HAS LOW GAIN	Q3	Q5	Q202	Q203
2. VIDEO DRIVER TRANSISTOR HAS LOW GAIN	Q4	Q4	—	Q205
3. COUPLING CAPACITOR SHORTED OR OPEN	—	—	C208	—
4. BYPASS CAPACITOR OPEN OR SHORTED	C6	C5	C207	C204
5. ZENER DIODE OPEN OR SHORTED	—	D1,D3	—	—
<b>B. AMPLIFIER CIRCUIT</b>				
1. VIDEO TRANSISTOR DEFECTIVE	Q2	Q2,3	Q201	Q202
2. COMPENSATION DIODES SHORTED OR OPEN	D8,13	—	—	D202,203
3. COUPLING CAPACITORS OPEN OR SHORTED	C4	C3,4	C203,205	C221
4. CONTRAST POT OPEN	R5	R6	R211	R116
<b>C. VIDEO INPUT CIRCUIT</b>				
1. VIDEO INPUT TRANSISTOR DEFECTIVE	Q1	Q1	Q200	Q201
2. INPUT COUPLING CAPACITOR OPEN OR SHORTED	C1	C1	C201	C202
<b>NO RASTER—VIDEO VISIBLE</b>				
<b>A. CRT CIRCUIT</b>				
1. BRIGHTNESS CONTROL OPEN		R73	R803	
2. SPARK GAP SHORTED OR OPEN LEAD		PIN 2	Z-802	
3. NO VOLTAGE TO BRIGHTNESS CONTROL		R73	R803	
<b>VERTICAL ROLL</b>				
<b>A. SYNC INTEGRATOR CIRCUIT</b>				
1. SYNC INTEGRATOR TRANSISTOR(S)		Q12,13		
2. INTEGRATOR CAPACITORS SHORT OR OPEN	C34,35	C34,35	C306,307	C226,227
<b>B. SYNC SEPARATOR CIRCUIT</b>				
1. SYNC SEPARATOR TRANSISTOR(S)	Q5	Q10,11	Q301	Q206
<b>C. INPUT VIDEO CIRCUIT</b>				
1. VOLTAGE TRANSIENT DIODE SHORTED	D23			D201
2. BYPASS CAPACITOR SHORTED OR OPEN	C2			C201
<b>D. VERTICAL OSCILLATOR CIRCUIT</b>				
1. VERTICAL OSCILLATOR TRANSISTOR(S)	Q10,11	D12	Q302	Q217,210
2. RAMP CAPACITORS	C37,38	C37,38	C313,314	C231
<b>HORIZONTAL COLLAPSE</b>				
<b>A. HORIZONTAL YOKE CIRCUIT</b>				
1. COUPLING CAPACITOR OPEN	C29	C25	C418	C105
2. LINEARITY COIL OPEN	L3	L3	L406	L202
3. WIDTH COIL OPEN	L4	L2	L405	L101
4. YOKE OPEN	L5	L4A	L401	NO NUMBER
<b>VERTICAL COLLAPSE</b>				
<b>A. VERTICAL OUTPUT CIRCUIT</b>				
1. VERTICAL OUTPUT TRANSISTOR(S)	Q13	Q15	Q304,305	Q215,216
2. COUPLING CAPACITOR OPEN		C40	C317	C234
3. OUTPUT TRANSFORMER OPEN	T3	—	—	—
4. CHOKES OPEN	—	L5	—	—
5. YOKE OPEN	L5	L4B	L401	NO NUMBER
<b>B. VERTICAL DRIVER CIRCUIT</b>				
1. DRIVER TRANSISTOR(S) OPEN OR LEAKY	Q12	Q14	Q303	Q211,212, 213,214
<b>C. VERTICAL OSCILLATOR CIRCUIT</b>				
1. OSCILLATOR TRANSISTOR(S) OPEN OR LEAKY	Q10,11	D12	Q302	Q210,217
2. RAMP CAPACITOR(S) OPEN OR SHORTED	C37,38	C37,38	C313	C231
3. HEIGHT CONTROL OPEN	R65	R60	R321	R256
4. VERTICAL HOLD CONTROL OPEN	R82	NONE	R319	R108
<b>D. VERTICAL POWER SUPPLY IS LOW OR HIGH</b>				
1. SHORTED CAPACITOR(S)	C33,36	—	C419	—
2. ZENER OPEN OR SHORTED	—	D21	—	—
3. DIODE OPEN OR SHORTED	—	D23	D203	—
4. RESISTOR(S) OPEN	R50,55,56	R95	R421	—

**Color to B&W Converter CKT**

This circuit can be assembled on a small perf board and mounted for bench-testing color video games on a black and white monitor.

**Raster Scan Monitor Tips**

There are actually only 6 sections in a raster scan monitor. In this brief summary I will attempt to outline a few basic problems and their solutions.

**CAUTION**

Be careful when checking voltages. The monitor contains some very high voltages even when turned off or when it doesn't seem to be working.

**SECTION 1 -****"LOW VOLTAGE" PRIMARY POWER SUPPLY****PROBLEM**

No Power.

**CHECK**

- A. AC input
- B. Fuses

If blown - check for shorted diodes (rectifier), voltage regulator, or horizontal output transistor. A shorted horizontal output transistor is the main cause of blown fuses.

**C. Voltage regulator input and output**

If the input is too high or too low check rectifiers and driver transistors.

If the input is good and output is too high, this will enable the overvoltage protection circuit which effectively cuts power to the rest of the circuits - check the voltage regulator. Check for bad connections to the flyback transformer. If the transformer is not connected properly, it will not draw enough current to allow the voltage regulator to function properly. Also check for shorts in the over voltage protection circuit.

**PROBLEM**

Hum Bars

**CHECK**

- A. Monitor filter capacitor and
- B. DC voltages to the game PCB.

**SECTION 2 - "HIGH VOLTAGE" (Flyback)****PROBLEM**

No high voltage (No high pitched squeal, no heater glow in the neck of the CRT, and no brightness)

**CHECK**

- A. Low Voltage Power Supply (Sec 1)
- B. Horizontal Section (Sec 3)
- C. Look for bad solder points
- D. Do not rule out a broken main monitor PCB or neck board
- E. Check for faulty brightness or focus pots

**SECTION 3 - HORIZONTAL SECTION****PROBLEM**

No horizontal deflection (In most cases this also means no high voltage because the horizontal section drives the high voltage section)

**CHECK**

- A. Horizontal Output Transistor and Driver
- B. Check horizontal oscillator circuit (in most cases - the IC on the board)

C. Check for leaky or bad capacitors

**PROBLEM**

Erratic or rolled horizontal deflection

**CHECK**

A. Loose or leaky capacitors in horizontal section. (On Nintendo type monitors the most common problem is C407 10uf/160V)

B. Sync (Sec 5)

**SECTION 4 - VERTICAL SECTION**

**PROBLEM**

Half or no vertical deflection

**CHECK**

Vertical deflection transistors. (These are the 2 transistors on large heat syncs on the monitor board) Note: Always check for loose connections or broken "legs."

**SECTION 5 - SYNC**

**PROBLEM**

Rolling or scrambled picture

**CHECK**

A. The sync requirements of the board and make sure they match the sync abilities of the monitor. Although most monitors will accept both negative and positive syncs, some do not. In this case you will need to invert the sync. (Just pick up any Romstar conversion manual for instructions.)

A few games use both negative vertical and positive horizontal. In this case it will be necessary to invert only one. Also, most completely negative syncs are composite syncs (vertical and horizontal on the same wire).

If your monitor will not accept composite sync it is best to call the game manufacturer to find where to split the signals.

B. Be sure you have a good ground or common from the game PCB to the monitor.

**SECTION 6 - VIDEO (Red, Green & Blue)**

**PROBLEM**

One color missing

**CHECK**

A. Connections

B. To find whether the problem is in the game PCB or the monitor, simply swap the wire from the missing color with one of the functional colors. If you gain the missing color and lose the "good" color, you are not getting a signal from the game PCB.

If the problem "follows" the wire - the problem is in the monitor. If your problem is indeed in the monitor, there are 2 or 3 transistors from each color (2 on the main PCB and one on the neck board). Check all of these and be sure to check continuity in the circuit.

Note: The Nintendo type monitors used in *Donkey Kong* and *Donkey Kong Jr.* use negative video inputs. Any conversion attempted on these monitors will need a video inverter board.

**Monitor Horizontal Tear**

**ELECTROHOME**

**PROBLEM**

When converting games with Electrohome GO7 monitors in them, you may have a horizontal tear that cannot be adjusted out with the horizontal hold control. This usually occurs when the kit uses negative composite sync.

**FIX**

Change C303 to a 10uf capacitor @ 25 volts with the positive lead facing the collector of X305. Then replace C501 with the capacitor removed from the C303 location. You should then be able to adjust the tear out.

**WELLS GARDNER**

**PROBLEM**

Wells Gardner K4600 series monitor intermittent loss of horizontal sync or intermittent horizontal tear.

**FIX**

Replace C356 (47uf @ 25V) on the Horiz/Vert board then center the horizontal hold pot.

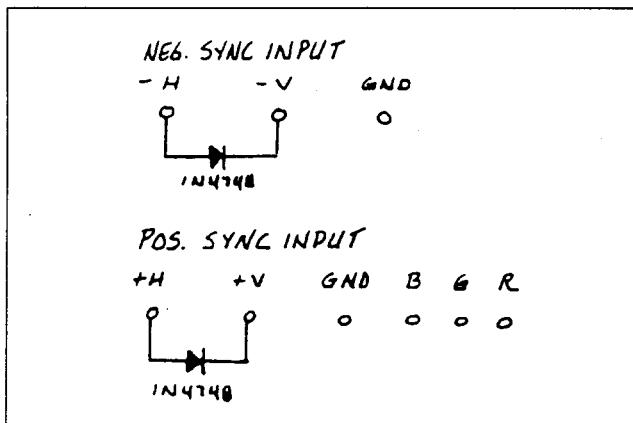
Turn L351 for best horizontal stability. Fine tune with horizontal hold pot.

**Monitor Horizontal Tearing Mod II**

Re: Previous article on "Monitor Horizontal Tear."

On Electrohome GO7 monitors with horizontal tearing, I tried this modification and found it to be unsatisfactory on the particular monitor that used. If this happens to you, I have an alternative method, described as follows:

I connect 1N4748 fast-switching diodes in both positive (+) and negative (-) sync inputs to this monitor in the following fashion:

**NOTE**

Both diodes must be installed or you will not get vertical stability.

I have been using this method for one year or more with no problems.

**Determining Sync Polarity With A Voltmeter**

In hooking up a logic board it is essential that the correct sync signals get to the monitor to lock the picture in place. Here is a listing of sync signals starting from the most commonly used to the least commonly used.

1) Negative composite sync - this signal consists of the vertical and horizontal sync signals mixed together.

2) Positive composite sync - vertical and horizontal signals mixed together.

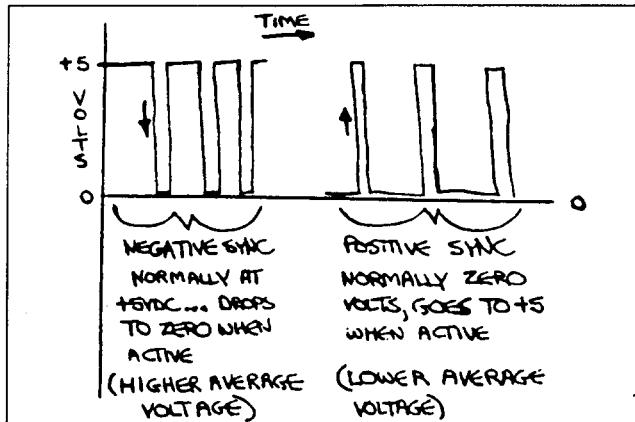
3) Separate positive vertical and horizontal - two separate lines, one for vertical sync and the other for horizontal sync.

4) Separate negative vertical and horizontal - two separate lines for each sync signal.

Both positive and negative sync signals are above ground signals. Positive gets its name from the signal normally at ground (inactive) and the sync pulse going to +5vdc when active. Negative sync is normally at +5vdc (inactive) and dropping to zero volts when active.

If two sync wires are provided from the logic board, it can be thought that separate vertical and horizontal signals are supplied. If there's only one wire given, assume composite sync is supplied.

Since negative sync is normally at +5vdc and dropping to ground when active, it's going to read a higher voltage than positive sync, which is a normally zero voltage which goes to +5vdc when active.



Here are the readings taken with a digital meter.

	NEGATIVE	POSITIVE
Composite Sync	4.20V	67.8MV
Vertical Sync	2.48V	156.6MV
Horizontal Sync	2.44 V	90.8MV

## Reduce Monitor Screen Dust

### SUBJECT

Reduce monitor dust on screen with 2 inch mattress foam. (From the like we've got nothing better to do department...)

### PROBLEM

I got tired of the hassle of cleaning the screens on the old Midway cabinets of the *Pac-Man* variety since we've tightened up the security of the control panel so much against Bernard Goetz's screwdriver-wielding buddies, it's a pain in the trigger sprayer finger to get the control panels off again!

### SOLUTION

Buy 2" high-density mattress foam from your mattress-maker at under \$31 for 4 games worth of flame-retardant stuff. It comes 24 inches wide by 106 inches long.

### PROCEDURE

Dig out the electric carving knife from Thanksgiving and cut it longer than you need it and it'll be snug. When you mark and cut the monitor hole, cut it too small so that the foam hugs the picture tube. If there are any odd holes, use aerosol adhesive like Scotch #44 or #47 or a trim adhesive from your auto parts store. Glue only foam-to-foam, so the whole thing can be removed and washed out in a few years.

### OPTIONS

Price-buster techs could trim costs by buying a less dense foam (but it may sag without support) or go non-flammable non-mattress foam. For higher quality techs, there is a blue non-flammable foam as well as the white flame-retardant stuff. You'd think you could save money by buying scraps, but the mattress guys shred these and make pillows!

## Monitor Sharpness Can Be Restored

### PROBLEM

I've got an older Wells Gardner monitor that I can't get a good focus on. When I turn the brightness down, focus is ok but then the picture is too dark.

### SOLUTION

The most probable cause is a weak picture tube.

You might try having someone with a Picture Tube Rejuvenator give it a blast (an actual high-voltage blast to clean the color cathode guns!). Fairly good results have been obtained with this method. At this point, what do you have to lose!

## Reduce Monitor Phosphor Burn

### PROBLEM

Monitor picture tube phosphor burns on games such as *Pole Position*, *pokers*, etc... that have clear plexi or glass fronts.

### SOLUTION

I have found a quick, easy and inexpensive way to reduce the sight of phosphor burns and improve the picture quality. Apply automobile window tint film onto the glass. It's easy to install and available at any auto parts store or K-Mart. The film comes in grey or bronze tint for about 5 bucks a roll. Sure beats a new picture tube!

## Medium Resolution Monitors

### QUESTION

What is it and how does it differ from regular low res monitors. Can a regular PCB feed a med res monitor?

### ANSWER

A "standard" monitor has specs that are close to NTSC (National Television Standards Code) standards. That is a 15KHz horizontal sweep and a vertical rate of 60Hz (non interlaced). These frequencies define the total number of lines that are displayed on the CRT. Then there is dot pitch, that is the smallest discrete group of RGB phosphorous that is on the face of the CRT itself. That defines the smallest "clean" pixel that can be enabled. The dimension of .41MM or so is a "normal" pitch. In a game, the sync chains and RGB outputs are designed to operate within these specs.

### MEDIUM RES

Now comes "Medium" resolution as opposed to the above standard resolution. First you up the horizontal frequency. That means you get more horizontal lines on the screen per each vertical scan. Sometimes the vertical rate is increased too. 25KHz horizontal rates are not uncommon. To take advantage of the higher number of lines

the dot pitch is decreased so each individual pixel is smaller. Hence, the resolution is higher. So on and so forth, into higher and higher frequencies.

#### COMPATIBILITY

The most obvious problem you see here is that due to frequency incompatibilities you can't put a standard res monitor into a medium res game. Anyone who has tried swapping with any of Atari's games like *Sprint* will first notice that there are two scrunched pictures on the screen. The boards are putting out at a higher rate and if the monitor does sync to one of the harmonics then you end up with funny results. It works in the opposite direction too. A medium res monitor can't be properly driven by a standard Pcb set.

#### BOTTOM LINE

To sum it up, the monitor and the boards have to be matched to obtain the higher resolutions and the matched set usually has to remain together.

### Monitor Width Size Change

#### PROBLEM

Have you got a Konami *Devastators* conversion with too tall a picture and no more adjustment on the width coil? (Horizontal width because of the turned picture tube). There is a way to modify your 1983 Wells Gardner 19K 4953 monitor so as to reduce the horizontal size. This is not the first time I've run into this problem, so I'm sure the info will be helpful to others.

#### SOLUTION

Change capacitor C365 to a 0.33uf @ 200V. Some units had a .22uf or a .15uf depending upon the original game. It can cause your picture to be too wide, and effect the horizontal linearity as well.

**NOTE:** The location of C365 is right behind the horizontal width coil.

### Hantarex PCB Screening Error

#### PROBLEM

Some Hantarex monitors have the parts silk screen, on the PC board, reversed for C25. The "+" marking is incorrect. If the part was ever replaced, it was probably put in backwards. Some even came from the factory reversed.

#### SYMPTOMS

The symptoms of a failed C25 are: A jitter in the raster like horizontal noise, and possibly what looks like a change in the vertical frequency.

#### SOLUTION

Check the schematic when replacing this capacitor. The "-" terminal should go to the center leg of IC1, a 7905 regulator. C25 is a 47uf @ 16V.

### Sharp 19" Monitor Retrace Lines

#### PROBLEM

Poor picture with retrace lines and no control over the screen adjustment.

#### SOLUTION

Replace R602 with a wire wound resistor. Value = 10 ohms @ 1/2w.

### Stern Bagman to Super Bagman Wavey Video Mod

Your *Bagman* to *Super Bagman* conversion might experience a wavey or curvey picture on the left side of the screen.

#### SOLUTION

Change resistor R78 on the main logic board from 4.7k ohms to 1k ohms.

### Romstar Battle Lane Video Mod

When converting games with older style Wells Gardner or Electrohome monitors, the picture may look "washed-out." To remedy this situation, clip and lift pin 1 of RA4 (Resistor Array 4) near the edge connector. If your picture is still a little too bright, tie pin 1 low (to ground).

### Nanao Monitor Deflection Problem

#### SYMPTOM

Loss or collapse of vertical deflection (Nanao MC-2000-R) that varies with the screen control, or begins to return to normal when the logic boards display bright characters.

#### SOLUTION

Replace C523 (47 uf @ 50V). It is located under the high voltage cage near the flyback transformer.

# 2

## Atari Monitors Tips & Info

### Atari's X-Y Monitor Adjustments

Atari's Quadrascan display system introduced in *Lunar Lander* should be adjusted correctly at the factory for maximum resolution. However, if brightness and contrast adjustments are required, please follow these procedures.

Adjustments are made on the deflection amplifier PCB located on the right side of the monitor when looking into the rear of the game.

1. Turn brightness (R516) and contrast (R526) all the way down (counter clockwise).
2. Turn up brightness until images are barely visible. NOTE: The stars may not be visible.
3. Turn up contrast for desired clarity.

This procedure will produce a very clear, bright picture while minimizing any chances of phosphor burn caused by over-adjustment of the brightness control.

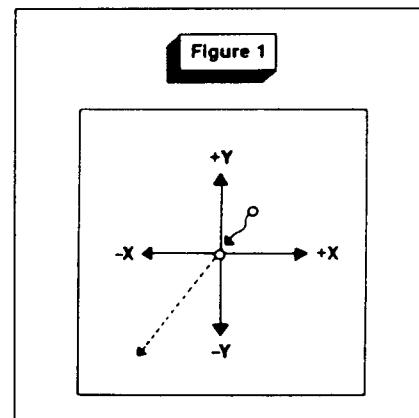
NOTE: Only the brightness control (R516) and contrast control (R526) on this PCB are "field adjustable." All other controls, including X and Y linearity have been factory adjusted and should NOT be tampered with.

### Quadrascan Monitor Repair (Part 1)

The new generation games are utilizing a video display monitor commonly known as the X-Y monitor. The reason behind this move is the greater flexibility for game designers to produce a finer detailed picture. As with any new component, general troubleshooting procedures must be defined.

The dissimilarity between the Raster Scan monitor and the X-Y monitor resulted in new terminology. We are all relaxed with Raster Scan terms such as Vertical, Horizontal and Video. We can, however, set up a loose relationship between both monitors as follows:

Horizontal - X axis  
Vertical - Y axis  
Video - Z



The relationship is shown in Figure 1. Note that all movements of the dot start at the center of the screen. This is the zero condition when both input voltages to the X and Y amplifiers are zero. Now if the Y input voltage to the Y amplifier is gradually increased from zero volts to +7 volts, the dot will move towards the top of the screen as indicated by the +Y arrow. Conversely, if the Y input voltage is gradually increased from 0 volts to -7 volts, the dot will gradually move towards the bottom of the screen. The movement of the dot in the X axis is to the right for plus voltage input and to the left for

## 2 - 2 • Atari Monitors

a negative voltage input. If both X and Y input voltages are increased from 0 volts to -7 volts, the dot will move in the direction indicated by the dashed line.

For troubleshooting purposes, we can now divide the monitor screen into four sections, as shown in Figure 2. Each quadrant has a different combination of X and Y input voltages. From this, we can easily define certain monitor problems.

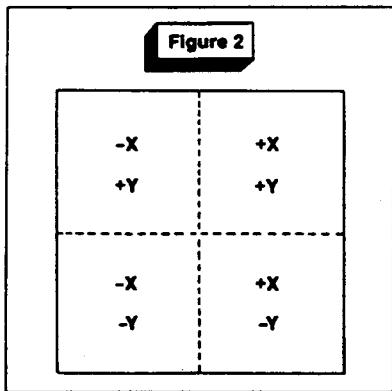
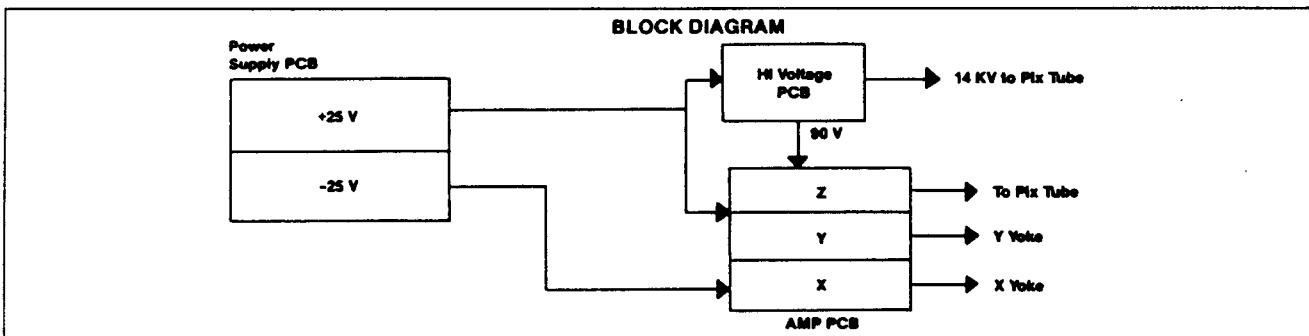
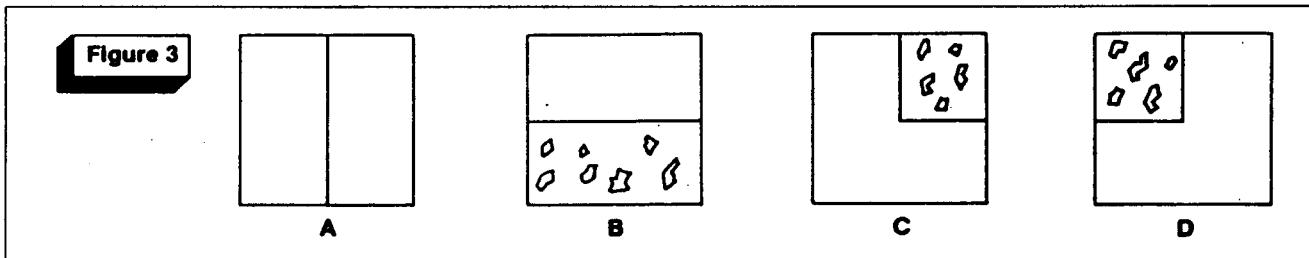


Figure 3 shows four separate symptoms. To determine where the problem lies, first determine what is present, then what is missing. Using Figure 2 as a guide:



SYMPTOM	PRESENT	MISSING	CAUSE
A. THIN LINE	+Y, -Y	+X, -X	X AMP
B. 1/2 PICTURE	+X, -X, -Y	+Y	Y AMP
C. 1/4 PICTURE	+Y, +X	-X, -Y	X OR Y
D. 1/4 PICTURE (YOU FIGURE THIS ONE)			AMP OR -25V POWER SUPPLY

The Quadrascansmonitor consists of three circuit boards. The power supply board, located on the bottom of the frame, supplies the +25V for the other two boards. The high voltage board, located inside the cage on the left panel, supplies all the high voltages necessary for picture tube operation. Additionally, 90V is generated for the Z amplifier. The amplifier board consists of three separate amplifiers. The X amplifier drives the X yoke windings, the Y amplifier drives the Y yoke and the Z amplifier supplies blanking and brightness for the picture tube.

To the top of the amplifier board are four power transistors mounted on a large heat sink. The upper transistor closest to the picture tube is the -Y driver (2N3792). The transistor below (2N3716) is the +Y driver. The transistors closest to you are the X drivers. The top transistor is -X and the bottom transistor is +X.

Now, we have all the information necessary to repair a Quadrascan monitor. Ninety percent of the problems can be diagnosed with three key voltage measurements.

1. +25 volts - measure on the case of the +X driver transistor (2N3716).

2. -25 volts - measure on the case of the -X driver transistor (2N3792). If one or both voltages are either low or high, proceed to power supply section.

3. +90 volts - measure this voltage on the amplifier board. Locate the Z amplifier transistor (Q504) right above the brightness control. Place meter lead on the tab (or nut holding down the tab) of the transistor. If the voltage is higher or lower than 90V, proceed to the high voltage board section. If all voltage measurements are correct, proceed to the XYZ amplifier board.

Remember - Make these three measurements first, each and every time. Troubleshooting the power supply board, high voltage board and the XYZ amplifier board to the faulty component will be explained in detail next month (Part 2).

### Quadrascan Monitor Repair (Part 2)

NOTE: Quadrascan Monitor Repair. Part 1 discussed theory and isolating problems to one of the PCB's. Part 2 deals with troubleshooting the board to the faulty component.

#### POWER SUPPLY BOARD

The following procedure is for the +25 volt power supply. Components in parenthesis are for the -25 volt power supply. (All voltage measurements to chassis)

##### PROBLEM

Fuse 100 (101) Open

##### PROCEDURE

1. Check bridge rectifier DB100 for shorted diodes.

2. Check capacitor C100 (101) for short.

1. Zener diode ZD100 (101) open.

1. Measure the voltage on the emitter of the transistor Q100(101). Should

25V is 40V

25V is low

read 40V. If this voltage is 30V or less, capacitor C100 (101) is open or one diode in DB100 bridge rectifier is open.

2. Remove the two screws holding in transistor Q100 (101) to the heat sink. Measure the base voltage. If 27 volts, replace Q100 (101). If less than 27 volts, Zener diode ZD100 (101) is defective or capacitor C102 (103) is leaky.

#### HIGH VOLTAGE BOARD

Remove the cover by removing the two screws on top of the cage.

##### PROBLEM

Fuse open F-900

##### PROCEDURE

1. This may be a matter of adjustment. Locate the high voltage adjust pot R912 (next to Q901). Rotate it completely clockwise. Replace fuse and apply power. Place positive lead of meter on pin 5 (grey wire) of the harness input connector P900. Slowly turn the H.V. adjust until the meter reads 90V. If the fuse opens again, the following components should be checked. Opens: ZD900, ZD901 and Q901. Shorts: Q900, Q902, Q903 and ZD903.

90V is less than 80V

1. Measure the voltage on the anode of the Zener ZD900 or the emitter of Q901. The voltage should read 9 volts. If less, replace diode.

2. A key voltage measurement now must be made. Locate resistor R901 near the top edge of the board between Q900 and Q901. This 1.2k ohm resistor stands up about a half

inch off the board. Place positive lead on the lead of the resistor closest to the edge of the board.

<i>Voltage</i>	<i>Probable Cause</i>
9V	Q901 shorted
Less than 15V	ZD901 shorted Q900 or Q902 low gain
25V	Open Q900, Q902, Q903, R906 or T900

3. If all components are OK, the oscillator circuit (Q903) may be loaded down by a defective component in the secondary of T900. With an ohmeter, check the following components for leakage: D903, C909, C906 and C907.

The other components D901, D902 and the doubler cannot be checked with an ohmeter. The following procedure may be used:

*NOTE: When working with the doubler, always make certain that the CRT anode is discharged to ground.*

Unsolder the wire going from the high voltage transformer to the terminal of the doubler. Apply power and measure the 90V (pin 5 of R900). If the 90V comes up, replace the doubler. To determine if D901 or D902 are loaded down in the oscillator, unsolder one end of the diode and note if the 90V comes up to 90V.

#### XYZ AMPLIFIER BOARD

Missing information can either be caused by the logic PCB or the X-Y amplifier. The easiest approach is with a scope. However, a scope is generally not available on location. Follow the steps listed below to determine faulty board. The Y measuring points are in parenthesis.

#### *Missing X (Y) Information*

1. Set your voltmeter on AC and on the 10 volt scale.

2. Measure the voltage at pin 1 (3) of P703. The meter should read 4.5V+-1V. If less or zero, the logic PCB is defective and the monitor is probably OK.

3. Measure the voltage at pin 2 (3) of P702. The meter should read 4.5+-1V. If zero, check for open fuse F-700 (600). This is a small pico fuse located near the side of P702. Replace with a 2 amp fast blow fuse. If the fuse is OK, and the voltage is low, check out Q705, 706, 707 and 708. (Q605, 606, 607 and 608). You could swap the +X driver transistor Q608 to see if the problem follows the transistor. Similarly, the -X (Q707) and -Y (Q607) can be swapped.

#### Z AMPLIFIER

Proper adjustment of the brightness and contrast controls is the same as the raster scan monitor.

1. Turn both brightness and contrast controls to minimum.

2. Turn up brightness until picture is barely visible.

3. Turn up contrast for desired picture.

Problems related to the Z amplifier are few. Remember! Make sure all power supplies are operating and the filaments of the picture tube are glowing.

#### SYMPTOM

Black Screen

#### PROCEDURE

1. Turn up the brightness control. One of three symptoms will appear and proceed.

- no picture
- a dot in the middle of picture
- interconnecting lines between objects

No Picture

1. R515 or brightness control R516 open.

A Dot

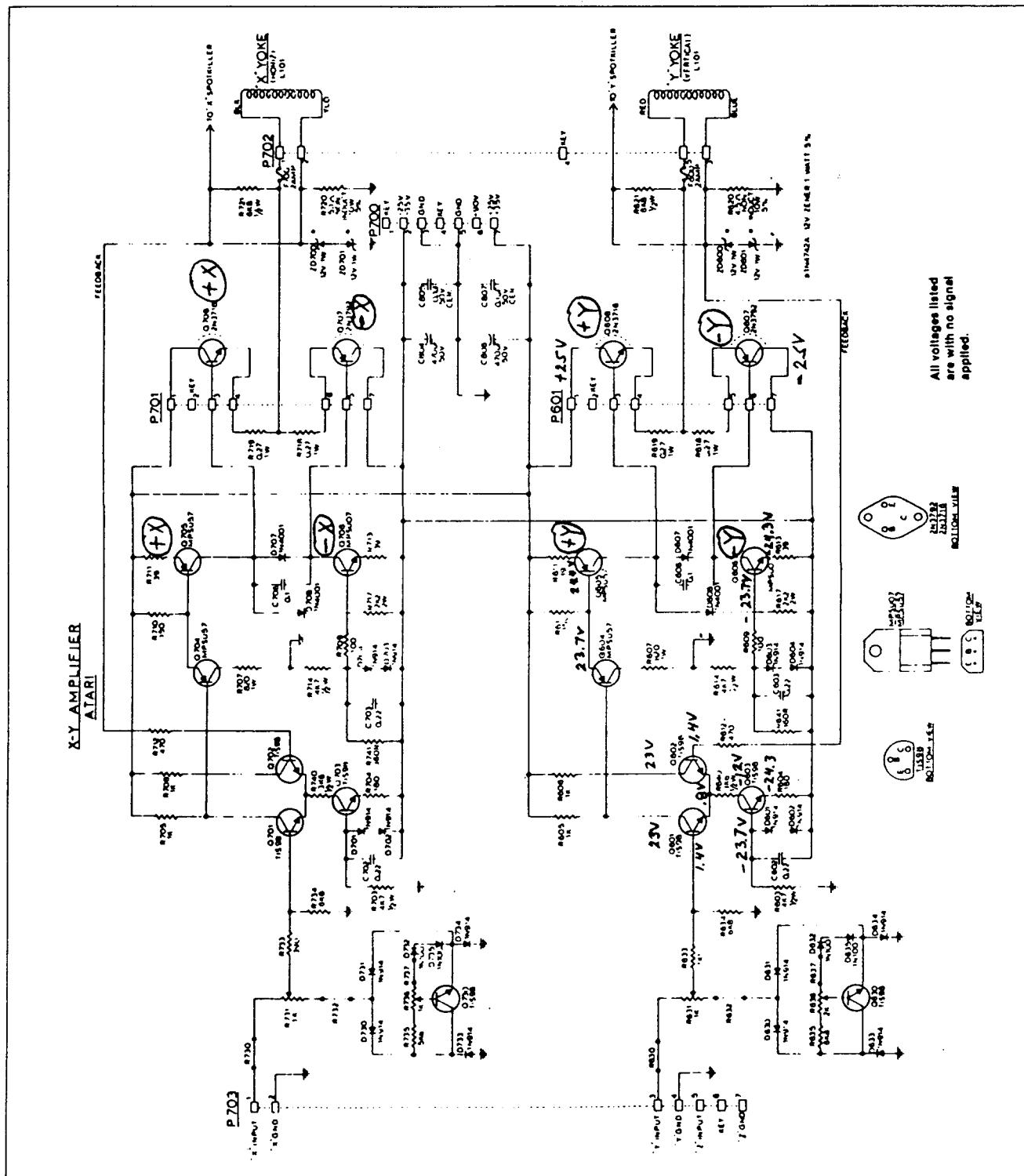
1. If the red LED is on, proceed to X-Y amplifier procedure.

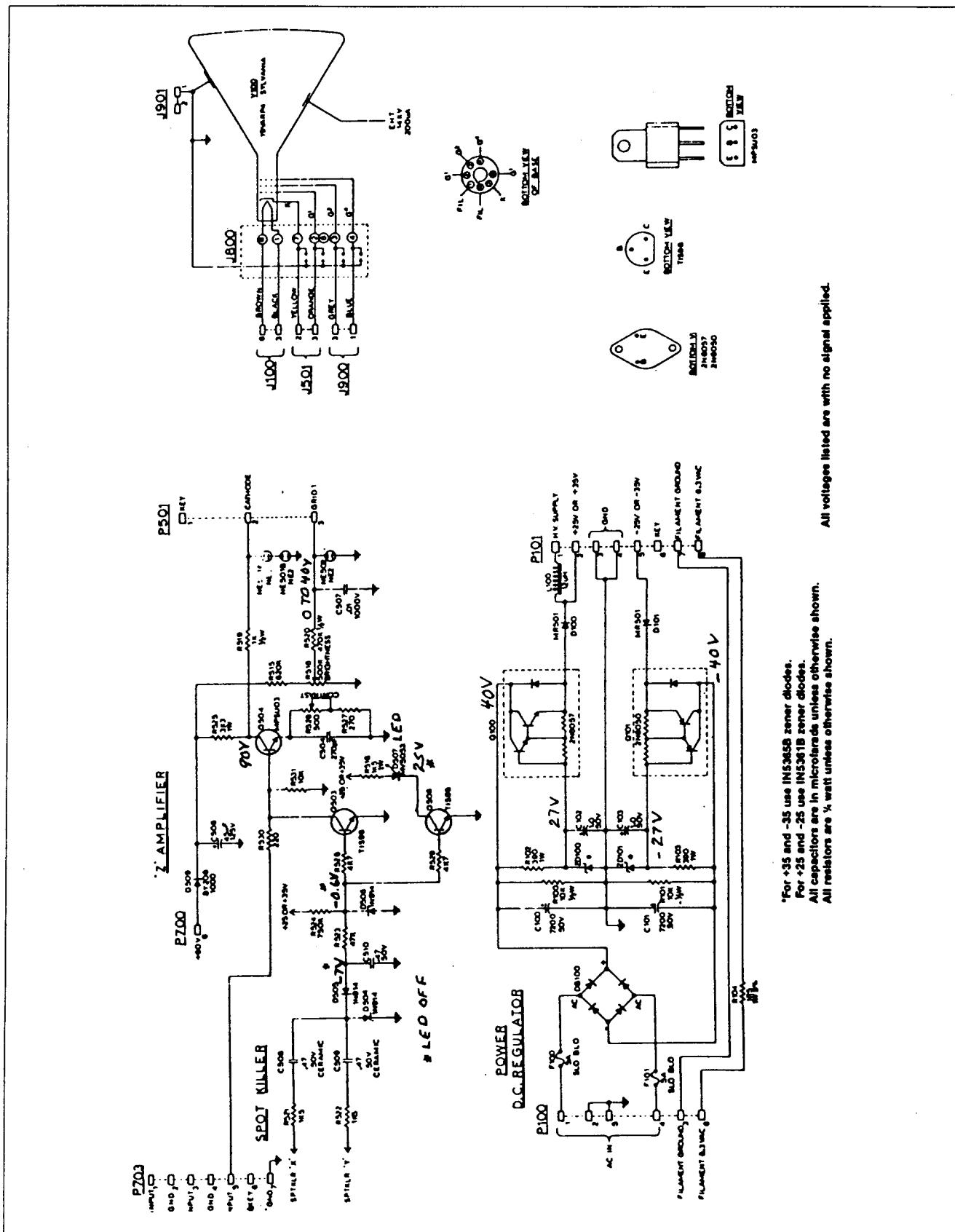
Interconnecting Lines 1. If the red LED (D507) is on, check the following

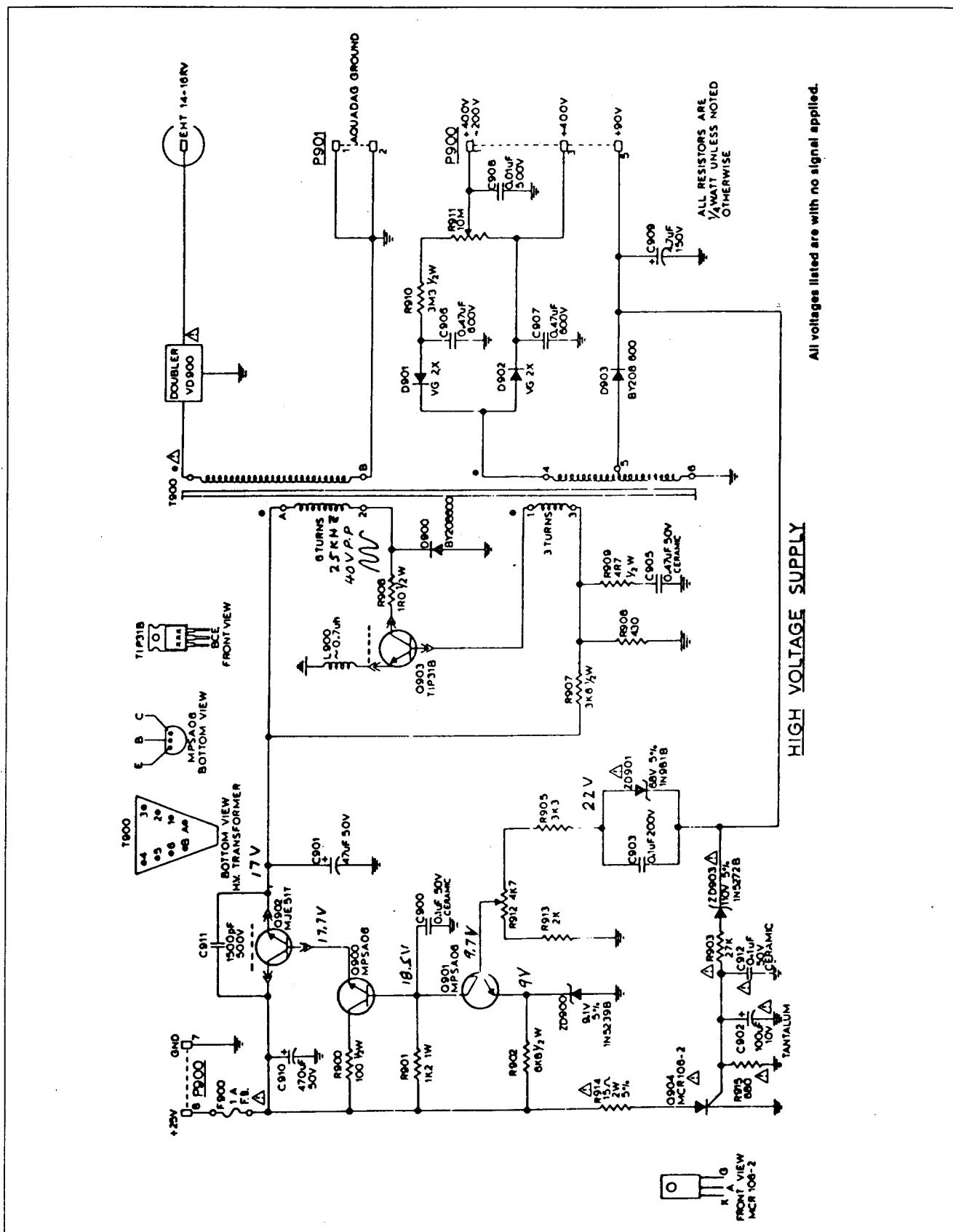
components for shorts or opens: D504, D505, D506 and C510.

This concludes the two-part series on Quadrascan Monitor Repair.

2. If the red LED is off, Q504 is open, Q503 is shorted, contrast control R526 is open or there is no Z input from the logic PCB.





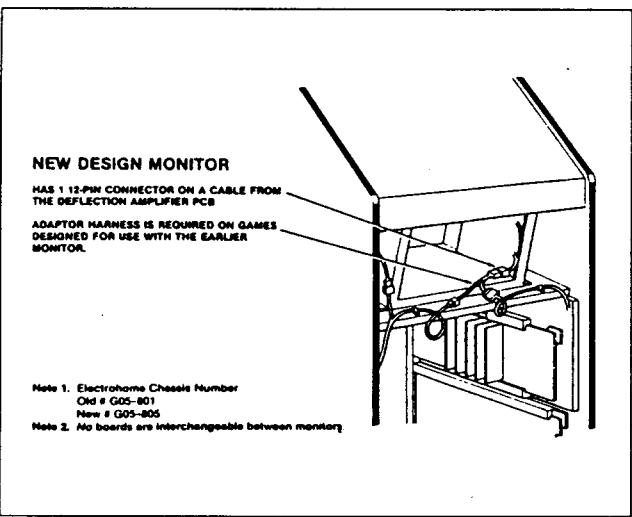
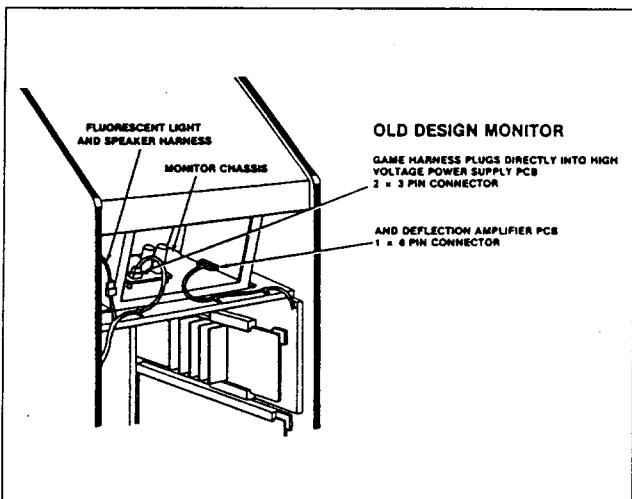


## Atari Quadrascan Monitor Change

The Atari *Quadrascan* X-Y Monitor used in new games has been redesigned and differs from the earlier model in its connection to the game wiring harness. The earlier model used two 6-pin connectors, the new design monitor has one 12-pin connector. An adaptor harness is provided on games designed for use with the earlier design monitor; see illustration.

When ordering a replacement monitor, check your game wiring harness. If your game has the two 6-pin connectors to the monitor, you will need to order the adaptor harness: Part Number A036240-01.

If you have any further questions, contact the Atari Customer Service office in your area.



## Atari Asteroids Display Problem

### PROBLEM

Interconnecting lines on the screen between objects.

### SOLUTION

A bad C.R. tube #19VAR P4 (G2 grid shorted), must be replaced with a new tube.

The problem just started to appear last month on 3 out of 10 of our *Asteroids*. The symptoms were a little different, but the problem was still interconnecting lines. Each time I had to replace the picture tube.

### SYMPTOMS

1. Lines appear only once in a while from the control panel movements.
2. All voltages are good on the monitor and the Red LED (D507) is off and Q504, Q503, R526 are good and the Z input is there, from the game logic. There is some control over the contrast and brightness.
3. A sharp tap on the pix tube neck and the lines come and go.

### SOLUTION

Check the picture tube with a C.R. tube checker. If not available, go to a local TV repair shop to confirm the problem.

## Atari Monitor Tech Tips

**Wells Gardner Color X-Y Display** For optimum reliability, three picture parameters must be periodically checked, as well as always checked after transportation. These three parameters are the size, centering and brightness. Proper adjustments will prolong the life of the yoke driver transistors and help prevent a fuse from popping.

Use the size and centering procedures listed on Sheet 2, Side B of the *Tempest* schematic DP-190-02. For brightness adjustment, refer to page 4 of the X-Y display service manual TM-183.

## Electrohome G07-904 Color Monitor

You may have found the video B+ Diode D503 to be burned. The cause could be on the CRT PCB. Check and make sure that capacitor C107 is not touching the adjacent terminal.

## Atari Color Rasterscan Monitors/Troubleshooting Guide

	ELECTROHOME GO-7	W/G 19KS SERIES
<b>I. Bright raster - some or no video</b>		
A. Video	X303, X304, C107	TR201, TR202 ZD201, ZD202 X608, C625
Horizontal output	D503	
<b>II. Raster - no video</b>		
A. Video	X303, X304	TR201, TR202 ZD201, ZD202
<b>III. One color missing</b>		
A. Video		
1. Green	X103, X104, X3103	TR205, TR208 TR402
2. Red	X101, X102, X3102	TR206, TR209 TR401
3. Blue	X105, X106, X3101	TR204, TR207 TR403
B. CRT socket	Spark Gap Short	Spark Gap Short
<b>IV. No raster - B+</b>		
Normal		
A. Horizontal output	Screen R-11	X607
B. Video		VR406
<b>V. No raster - B+ High</b>		
A. Horizontal		
Oscillator	IC501	TR351
B. Horizontal Driver	X501, T501	TR352, T602
C. Horizontal Output	X01, T01	TR601, T701
D. H.V.L. Stage	X701, D701	R353, TR354
<b>VI. Raster OK - B+ High</b>		
A. B+ Power Supply	X04, X901, X902, D905	TR501, TR502 X501
<b>VII. Raster OK - B+ Low</b>		
A. B+ Power Supply	X04, X901, X902, D905 FR901	TR501, TR502 X501
<b>VIII. Input Fuse Blows</b>		
A. Bridge Circuit	D901, D902, D903, D904 C904	X610, X611
<b>IX. No Vertical Sweep</b>		
A. Vertical OSC	IC 501	TR301, TR302 TR303
B. Vertical Output	FR401, X401, X402 C411 Yoke	TR304, TR305 TR306, C311 Yoke
C. Horizontal Output	D808 X609	
<b>X. No Horizontal Sweep</b>		
A. Horizontal Output	T503, L502, L503 C515 Yoke	T603, L702 C615 Yoke
<b>XI. No Vertical SYNC</b>		
A. SYNC Amplifier	X302, X306	TR308
B. Vertical Oscillator	IC 501	TR301, T302
<b>XII. No Horizontal SYNC</b>		
A. SYNC Amplifier	X301, X305	TR308
B. Phase Detector	IC501	X351, X352

### Atari Tempest Monitor Jitters

After fighting a problem in the Atari Tempest for three days and finding a silly mistake, I thought I should write to you.

Wells Gardner Monitors #19K6101 use a 1.5 ohm 10-watt resistor in location R610-R710. If you replace these resistors with standard wire-wound units, the monitor will exhibit the shakes or jitters referred to in STJ, Vol. 4, No. 7 Service Tips, but the symptoms will be misleading in that R610 and R710 must be non-inductive.

Please tell your readers about this problem as Atari and Wells do not point out this requirement in the parts listing, and only put down the initials "N.I." on the schematic.

### Atari Tempest Display Problems/ Solutions and Monitor Adjustments

#### SYMPTOM

Some of the rims between the tube rails are missing on some playfields. For example, the first circular playfield is missing the top rim. Self test shows an E; in the middle of the screen. This indicates that the EAROM at location C-3 on the Auxiliary PCB is defective. Replacing the EAROM does not correct the problem.

#### SOLUTION

The problem lies outside the Auxiliary PCB. Two probable causes exist. The interboard connector to J-19 on the main PCB has shorted or open wires; or, the transceiver IC H-2 (74LS245 or AM8304B) on the main board has failed.

#### NOTE

Any individual working on a display should be familiar with servicing procedures and precautions necessary for picture tube and high voltage equipment. Use extreme care when handling the picture tube. Wear safety goggles and heavy gloves for protection when handling the picture tube.

#### BRIGHTNESS ADJUSTMENT

*Improper screen (brightness) adjustment may cause phosphor burn.*

The brightness adjustment must not be made using the game or attract mode.

The brightness is adjusted only to the following procedure:

1. Set game to self test.
2. Activate SLAM Switch until display screen #5 (5 groups of colored bars) is displayed.
3. Using the center group of bars, adjust the screen control until the fifth and longest bar is visible. Too much brightness causes the sixth bar to become visible. Too little brightness causes the fifth bar to disappear.

It is recommended that the brightness be checked on new games and games which have been moved to a location. Also, a little RTV on the screen control knob will insure that the control will not inadvertently move due to vibration, etc.

#### Z AMPLIFIER

Field Service has received reports of a condition where the picture turns very bright and the addition of interconnecting lines between objects is apparent. The cause may be a failure in the video B+ supply due to an open PCB trace.

If you experience this problem, turn the game off immediately to prevent phosphor burn.

Proceed to troubleshoot as follows:

1. Disconnect the neck PCB assembly from the picture tube.
2. Disconnect connector on game logic board.
3. Power up game.
4. On the neck PCB, measure the voltage from chassis to the tab (collector) of one of the three color amplifier transistors (Q500, 501 or 502). The correct voltage is 180 volts.
5. If the voltage is considerably less, the video B+ power supply or associated wiring located in the high voltage unit is defective.
6. Remove the four chassis mounting screws of

the high voltage unit and remove the unit.

7. On the circuit side of the PCB, jumper pin 6 of the high voltage transformer to the anode of diode D901.

8. Remove the cage and check the capacitor C901 for a broken lead.

9. Reassemble HV unit and mount to the chassis.

10. Again, measure the voltage on the color amplifier transistor tab for the proper 180 volts.

#### DEFLECTION PCB

The loss of voltage in either 25-volt power supply has been diagnosed by some as open filter capacitors C901 or C902. Before replacing the capacitors, make sure that the PCB traces near the capacitor terminals are not cracked. It is recommended that the solder be removed for this inspection.

#### INPUT CONNECTOR (Monitor)

With new games, it is always a good practice to inspect the monitor input jackpins and the harness plug pins. Make certain the pins are fully inserted and properly seated. Pins making partial contact in high current lines may eventually corrode due to heat or arcing.

#### MAIN LOGIC PCB

Sometimes, you may have noticed, a short duration dot in the center of the screen when switching from self test to play mode. Over a period of time, phosphor burns may occur. To protect your monitor, perform the modification below on Rev A, B and C boards.

1. On the circuit side of the PCB, cut the trace which connects pin 9 of IC/C-9 to resistor R-32.

2. Jumper pin 9 of A9 to pin 10 of B-8.

#### OUTPUT TRANSISTORS SHORTING

#### SYMPTOM

Output transistors on Wells-Gardner color X-Y monitor shorted and fuses F100 and F101 blown.

#### SOLUTION

Perform the following steps:

1. Remove P100, 101, 600, 700.

2. Check D100, D101, D102, D103.

3. Check Q100, Q101, ZD100, ZD101, C100, C101.

\*\*\*Are fuses still popping?\*\*\*

\*\*\*Check for shorted traces\*\*\*

4. Check J100 pin #1 = 33.8vdc

#3 = 28.5vdc

#6 = 28.5vdc

#7 = 33.3vdc

5. Check Q102, 103.

6. Replace P100.

7. Check J100 pin 4 = 27.8vdc.

Check J100 pin 5 = 27.7vdc

#### NOTE

Installing the IPC Board will prevent the above problem. Contact your Atari Distributor for availability and further information.

#### Atari Dig-Dug Display Distortion

I know that I'm vending & not "into" videos anymore, but a problem has come up in some of the Atari *Dig-Dug* units that I feel you should be made aware of. The symptoms that you will notice will be a vertical bar with trash on both sides and will appear to be a problem in the Vertical Sync Circuitry of your monitor.

Troubleshooting the unit at the monitor and working your way to the problem will take four to six hours! It's been found (so far, only in the *Dig-Dug* units) that the filter capacitor (27.000 uf) in the power supply causes this problem when it becomes weak (starts leaking) and won't filter out the ripple.

There are three different colors of caps being used at present: green, blue and silver. The green caps seem to be causing most of the trouble, but the other colors are quite capable of going bad also!

I called the Atari West Coast Service Center to confirm this problem and they said, "Yes, that's it." So tell your friends...

### Atari Tempest Color X-Y Monitor

Tempest has had more than its share of problems. This game was Atari's first attempt at color X-Y. Several times I took monitor PCB's into my distributor for repairs and they found nothing wrong. The symptom - lines all over the screen. At times this problem was intermittent. The problem, as it turned out, was in the logic board. The adjustment pots for the X and Y channels were sealed with silicon. The silicon and pot would expand and contract at different rates as the game warmed up. The silicon was behind the adjustment tab on the pot and would lose continuity, causing the game to go wild. The monitors have had a history of destroying the driver transistors. This may be a contributing factor to the *Tempest* monitor problem.

### Atari Quantum Monitor Mod

Atari gave me a tip on the Atari Amplifone Monitor (*Quantum*). The -24vdc regulator (7924) on the high voltage board "blew up." Atari stated that in some of the early Amplifone monitors R18 was left out. If this happens to you, the following techniques should solve your problem:

- A) Insert R18 (27k or 33k 1/4 watt) resistor in the holes marked R18 on the high voltage PCB.
- B) Change the -24vdc regulator and C4.
- C) Install two diodes (1N 4001) across the leads of C3 and C4 (on the underside of the board) with the cathode attached to the positive lead of each cap and the anode to the negative lead.

I hope these mods help you!

### Atari Dangerous Display Harness

Immediately check all upright cabinets of the following games for an unsecured display connector on the main harness. Games with higher serial numbers have already had the display connectors properly secured at the factory.

Arabian UR00001-UR00500
Food Fight UR00001-UR01501
Millipede UR00001-UR09997
Xevious UR00001-UR05499

### WARNING

To avoid serious injury to anyone playing or even touching the game, you must secure the display connector as described below to prevent short circuiting with high-voltage components on the display.

On *Food Fight* games using the Disco or Matsushita displays, use a cable tie to secure the red display connector (J205B) as shown. On games using the Electrohome or Atari displays, use a cable tie to secure the white display connector (J205A).

Whenever you install a new display, be sure that the unused display connector is properly secured to the harness.

### NOTE

The *Xevious* connectors will look different from the connectors described. However, the unused connector(s) MUST be secured to the harness for safety.

### Atari Amplifone Color X-Y Monitor Voltage Regulator Circuit

Atari P/N A200000-01

On some *Gravitar* and *Quantum* games using the Amplifone Display, the VR1 (7824) and the VR2 (7924) on the High Voltage PCB may be overstressed during power up or power down.

Before replacing VR1 or VR2, check that blocking diodes CR5 and CR6 (1N4001) have been incorporated in the circuit of your display. If not, perform the following:

1. Install a diode (31-4001) from pin 3 (+24v) of VR1 (7824) to ground; position the cathode end at pin 3.
2. Install a diode (31-4001) from pin 3 (-24v) of VR2 (7924) to ground; position the anode end to pin 3.
3. Replace the associated electrolytic capacitor.

**Note:**

Unless otherwise specified -

1. All resistor values are in ohms, 1/4W, 5%
2. All capacitor values are in  $\mu$ f.

**WARNING**

Components identified by shading (schematic) have special characteristics important to safety and must be replaced only with identical parts.

### Atari's Star Wars Controls Monitor Hi-Voltage Board

This game has to be the finest game Atari has ever created. The income is initially the same as *Pole Position*. The massive amount of play it is getting has created a few problems with the controls. The biggest problem is simple: loose screws. The cover should be removed from the top of the controls. Inside are three screws that hold the top assembly to the shaft. Make sure these are tight. The screws on the handles must also be tightened. Early production games did not have Nylock bolts. Contact your distributor for these bolts if you don't have them. This control has an excellent feel for the player and wouldn't be as good a game without it. It would be wise to maintain this control since its cost is approaching \$500.

The monitor high-voltage board on the left side of the cabinet (from the back) fell toward the picture tube when the upper wooden bracket broke. This destroyed my picture tube. It became a rainbow of colors instead of specific colors. It would be wise to add another screw to this board to bolt it in place. I also didn't like the high voltage lead touching other wires in the game!

### Atari Star Wars Color X-Y Monitor Modifications

**High Voltage Board:** Change capacitors C3 and C4 from 100mfd at 35 volts to 220mfd at 35 volts, with a low E.S.R. rating (Equivalent Series Resistance). The Atari part number is #123009-227.

The following manufacturers' capacitors will work:

Illinois Capacitor - 227 RMR 050M (50 volts)  
Nichicon - UPA1V221M (35 volts)

**Deflection Board:** When servicing the deflection board, please change diodes CR2 and CR11 to 1N4148, Atari part number #131033-001. The old diodes, 1N914 open up, causing fuses F1 or F2 to blow.

### Troubleshooting the Atari Amplifone Color X-Y Display

The new Atari Amplifone monitor has been designed with the service tech in mind. Gone are the days when you had to remove the whole monitor just to remove the high voltage board. The new chassis-less system features two easily accessible PC boards containing all the monitor's components (even the X and Y drivers). Repairing this monitor is pretty straightforward and Chart 1 should help to put you in the right area.

There are two modifications you should be aware of if the monitor you are working on is from a *Star Wars* game. First, capacitor C3 and C4 on the high voltage board should be changed from 100mfd at 35 volts to 220mfd at 35 volts, with a low E.S.R. rating (Equivalent Series Resistance). The Atari part number for this cap is 123009-227.

Second, you should change diodes CR2 and CR11 on the deflection board from a 1N914 to a 1N4148. The 1N914s open up and will cause fuse F1 or F2 to blow.

Also you may notice two 50 ohm, 5-watt resistors on your high voltage board that are not listed in the monitor service manual. These were added to *Star Wars* monitors only, so use the monitor prints that come with your *Star Wars* schematic package and everything will match up.

#### Chart 1: Amplifone Troubleshooting Guide I. Missing Half of Picture

- A. Top Half Missing - Q4, Q6
- B. Bottom Half Missing - Q5, Q7
- C. Left Half Missing - Q14, Q16
- D. Right Half Missing - Q15, Q17

#### II. X or Y Collapse

- A. Horizontal Line - Y Collapse - Q1, Q2, Q3, CR2
- B. Vertical Line - X Collapse - Q11, Q12, Q13, CR11

**III. One Color Missing**

- A. Red - Q23
- B. Green - Q24
- C. Blue - Q25

**IV. No High Voltage**

- A. Voltage Regulators - VR1, VR2, C3, C4
- B. Check H.V. Overvoltage Adj.
- C. Check transformer pins for cold solder joints or broken wires.

**V. No Picture**

- H.V. and Deflection OK - Q26, CR19, CR20.

**Atari Tempest Wells-Gardner X-Y Monitor IPC Board Mod**

Atari P/N 92-053

To ensure continuous IPC board operation, perform the following modification:

1. Remove the lead connecting the IPC board to +27 volts on the display printed circuit board (PCB). The lead is located near Q1 and Q3.
2. In its place, connect a 1K ohm, 1/4W carbon resistor.

**Atari Star Wars Color X-Y Monitor**

**ZERO OHM RESISTOR JUMPERS**

The BROWN zero ohm jumpers used on the deflection and high voltage boards are bad and should be replaced with a piece of wire when servicing either of those boards. The WHITE and TAN jumpers are good and don't have to be replaced. Zero ohm resistors look like resistors but are designated on the board with a silkscreened "W" followed by a number. A common problem with the brown jumpers is W1 or W2 on the deflection board opening up.

**Atari Star Wars Display Problems**

**PROBLEM**

No filament voltage from the high voltage (HV) PCB.

**SOLUTION**

Check for a loose connection on the lugs that hold the HV transformer to the PCB.

**PROBLEM**

Can any other power transistors be used on the Deflection Board?

**SOLUTION**

Yes, MJ 15003 NPN replaces 2N3716 and MJ15004 PNP replaces 2N3792.

**PROBLEM**

What should the output of the 555 IC on the HV PCB be?

**SOLUTION**

The output at pin 3 on the IC should be a 20 khz square wave. This is adjusted with potentiometer R7.

**PROBLEM**

There is no high voltage. The positive and negative 24 volts are present.

**SOLUTION**

Check transistor Q3. The problem may be that the transistor tab (collector) may not be making good contact with the heat sink.

**PROBLEM**

The schematics for the HV cutoff circuit do not match the board assembly.

**SOLUTION**

There are three board revisions You can tell which one you have from the table here.

**DISPLAY REVISION INDICATORS**

PCB Revision	R16	R18
Original	470 ohms	27k ohms
First rev.	Zener	Missing or 27k ohms
Second rev.	470 ohms	33k ohms

**PROBLEM**

The schematic for the deflection board shows CR5 as a 1N714 diode.

**SOLUTION**

The schematic number is wrong. It should be labeled a 1N751A zener diode. The rating of 5.1 volts is correct, however.

**PROBLEM**

On the HV PCB, the output voltage of the regulator is good when the pin is lifted, but there is no voltage when the pin is connected to the board.

**SOLUTION**

Check for a bad 0.1uF glass capacitor across the voltage regulator. The decoupling capacitor may be shorted.

**PROBLEM**

The 24 volt regulator has failed.

**SOLUTION**

Check for cracking around the regulator leads on the PCB. Also check for cracking around the leads of C3 and C4.

**PROBLEM**

The voltage is low on the supply lines on either the Deflection PCB or the HV PCB.

**SOLUTION**

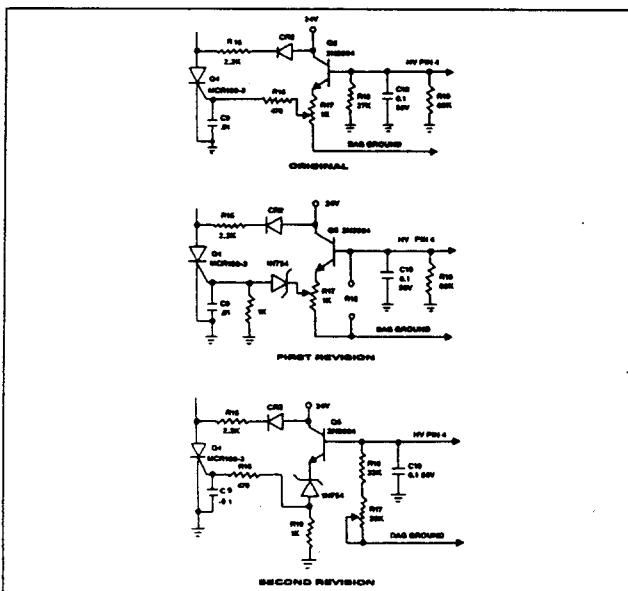
There are jumpers on the supply lines of both boards. The jumpers are marked with a "W" on the schematic. They look like resistors on the board and have a single black band on them. The jumpers should have no resistance. However, the brown jumpers may have created some resistance to them. They should be replaced with a piece of wire. The white and tan jumper should have no problems.

**PROBLEM**

The picture shrinks in from the negative X and Y sides of the screen.

**SOLUTION**

On some deflection boards, R35 and R12 may have a 15 ohm resistor and a 30 ohm resistor in parallel to get 10 ohms. If these come loose, then some picture shrinkage may occur.



## Atari Firefox Amplifone Raster Modification

*Step 1 is mandatory and must be done immediately.*

Steps 2 through 6 provide increased protection to the deflection board and should be installed by a qualified technician as soon as possible, but especially if the game fails.

1. Neck Board. Cut the trace between the pad at CRT socket pin 5 and the nearest pad. Install an insulated jumper (1000 volts or better insulation) between pad at CRT socket pin 5 and either of the pads at spade lug J9. Use a number 20 wire.

2. Cut the trace between connector J8 pin 9 pad and the base pad of Q10. Install a 330 ohm, +-5%, 1/4 watt, resistor between the base of Q10 and the connector J8 pin 9 pad.

**CAUTION**

To prevent arcing, it is absolutely necessary to use a carbon composition resistor in the following step.

3. Remove the focus terminal cover from the CRT socket and unsolder the focus lead from the terminal. Solder a 22 meg-ohm +-5%, 1/2 watt carbon composition resistor to the terminal with the end flush with the terminal and resistor parallel to the board. Solder the focus lead flush with the other end of the resistor, and trim the resistor lead. Route the focus lead back to the exit groove and replace the cover.

4. Deflection Board. Install a 1N751A zener diode (5.1v) to the vertical sync input, anode to ground, as follows:

a. Locate the first pad connected to J1 pin 5 on the trace or circuit side of the board.

*Note: PLL board is installed in place of J1.*

b. Locate the pad going to ground near J1 pin 6, between pin 6 and R10.

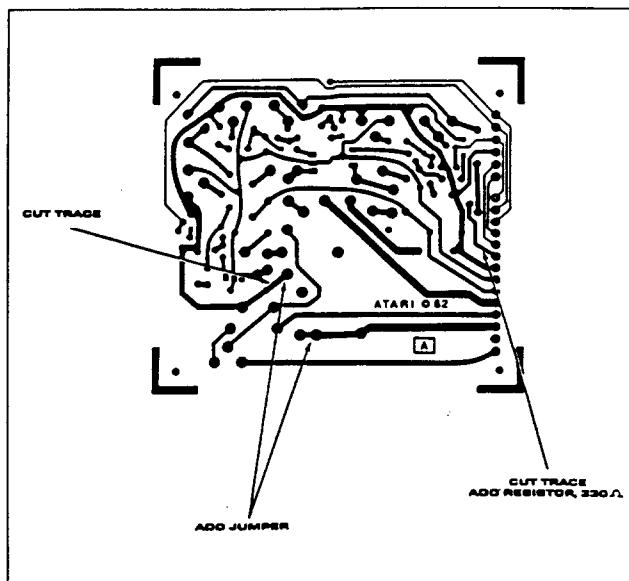
c. Install the zener diode (anode to ground) between these two pads on the circuit side of the PCB.

5. a. Remove C5 (0.1uF) axial cap.  
 b. Install a 0.22 uF (25 v) axial cap between the cathode and gate of Q4 (MCR101) soldering one lead of the cap to the cathode pad (square pad) of Q4 and the other lead to the pad of C5 connected to the gate of Q4. Install the cap on the circuit side of the PCB.

6. Route the high voltage anode lead away from the deflection board, and secure it with a wire tie wrap.

**NOTE**

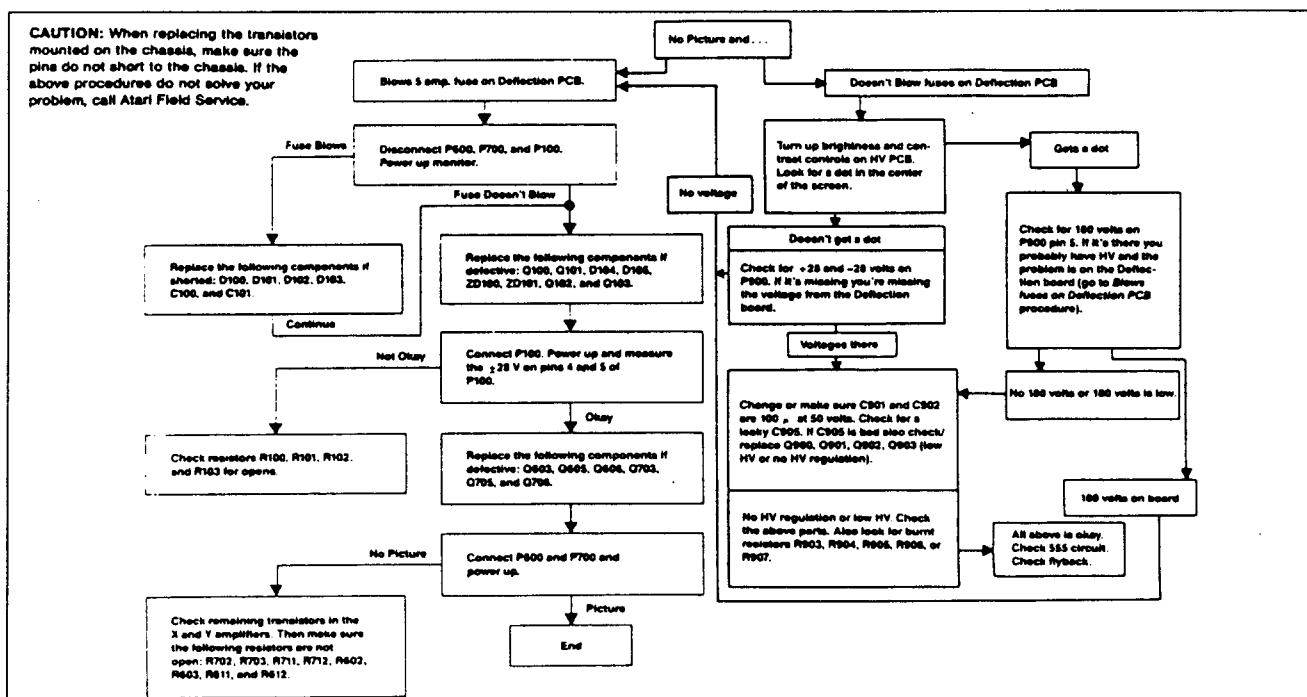
Upright *Firefox* games built after game serial number URO0802 will not need this modification. This modification has already been incorporated on all sitdown *Firefox* games.

**Atari Tempest Display**

Most problems in the *Tempest* display can be found by following the procedure shown in the chart below.

**CAUTION**

When replacing the transistors mounted on the chassis, make sure the pins do not short to the chassis.



## Atari Star Wars X-Y Display Modification

### ATARI COLOR X-Y DISPLAY DEFLECTION PCB

You should do the following modification to help prevent the Deflection PCB from failing. This modification should only be performed by a qualified technician.

1. Connect the two type 1N754A zener diodes together as shown in Figure 1. The connection is made as follows: bend the anode ends of both diodes into a "fish hook" pattern. Hook the two fish-hooked leads together, and solder them. Remember that too much heat will destroy the semiconductor material.
2. Connect the two type 1N756A zener diodes together as shown in Figure 1. Use the same technique as described in Step 1 above.
3. Remove diode CR2 and solder in a type 1N4002 diode in its place.
4. Remove diode CR11 and solder in a type 1N4002 diode in its place.
5. Remove resistor R12 and solder in a 12 ohm, 1/4 watt resistor in its place.
6. Remove resistor R35 and solder in a 12 ohm, 1/4 watt resistor in its place.
7. Find the Y-Deflection Circuit (upper left area of the schematic). Resistor R1 has two leads to it. Find the lead that goes to the yellow wire. Connect this lead to the cathode of one of the type 1N754A diodes. Connect the cathode of the other type 1N754A diode to ground.
8. Find resistor R24. It has two leads: one runs to an orange wire. Connect this lead to the cathode of one of the type 1N756A diodes. Connect the cathode of the other type 1N756A diode to ground.
9. Find the type 2N3792 transistor Q17. You will be installing a type 1N4002 diode across this transistor's emitter and collector. Solder the cathode lead of the type 1N4002 diode to the emitter, and solder the anode to the collector of this transistor.

10. Find the type 2N3617 transistor designated Q16. You will be installing a type 1N4002 diode across this transistor's emitter and collector. Solder the cathode lead of the type 1N4002 diode to the collector, and solder the anode to the emitter of this transistor.

11. Find the type 2N3792 transistor Q7. You will be installing a type 1N4002 diode across this transistor's emitter and collector. Solder the cathode lead of the type 1N4002 diode to the emitter, and solder the anode to the collector of this transistor.

12. Find the type 2N3716 transistor Q6. You will be installing a type 1N4002 diode across this transistor's emitter and collector. Solder the cathode lead of the type 1N4002 diode to the collector, and solder the anode to the emitter of this transistor.

### PARTS LIST

QTY	DESCRIPTION	PART NO.
6	1N4002 Diode	31-1N4002
2	1N754A 6.8v Zener	131002-001
2	1N756A 8.2v Zener	32-1N756A
2	12 ohm, 1/4 watt	110000-120

 FIGURE 1: MAKING FISH-HOOK CONNECTIONS

## Atari Star Wars Amplifone Monitor Flyback Test

### PROBLEM

A technician attempts to repair an Amplifone high voltage module from an X-Y monitor and it seems to be only a short time before it fails again.

### POSSIBLE CAUSE

The flyback may be bad, but how do you check it? I am fortunate enough to have a Sencore LC53 "Z" meter which checks both inductance and capacitance. I made sure that it was in calibration before I took these flyback readings at right. The LC53 also has a "ringing test" which indicates whether

turns are shorted inside. A ringing test of 10 or above indicates a good section in the flyback.

I used one good flyback to check against another suspect flyback I encountered. The suspect flyback showed to be bad on the ringing test. I have shown the readings of both flybacks listed side by side so you can compare readings. If you do not have an LC53 but do have an inductance checker you may use the inductance readings as a comparison and make an educated guess.

I will mention that the good flyback readings are from a flyback which is still operating in a game without problems. Remember these readings are not standards, but simply what I encountered with a good flyback.

Table 1

**Flyback Inductance Readings  
for Two Amplifone Flybacks  
(Out of Circuit)**

TERMINALS	GOOD	SUSPECT
1-9	Inductance 211 uH	136 uH
	Ringing 10↑	0-1
2-9	Inductance 186 uH	122 uH
	Ringing 10↑	0-1
4-8	Inductance 2.02 mH	1.86 mH
	Ringing 10↑	0-1

NOTE: Readings taken five times for each section of each transformer.

As a final note, all three flybacks looked good; they didn't have cracks or have any burnt markings.

**Atari Star Wars Monitor Problems**

If you have a problem with your Atari color X-Y monitor in your *Star Wars* game and the problem originates in the high voltage transformer assembly, you have really got a problem! The transformer in that assembly is no longer available. That is the official word from Atari. Atari is

suggesting that you purchase an entire monitor through your local distributor.

I would like to offer an alternative that might fit your requirements without buying a thing. If you have an old Atari *Tempest* or *Space Duel* that is not too critical to your route, you can use the monitor to get your *Star Wars* up and running.

The monitor in the above mentioned games is a Wells Gardner, and can still be repaired. Parts are still obtainable. Take the monitor out of *Tempest* and mount the whole thing in *Star Wars*. The connections are identical - so the *Tempest* monitor will just plug right in. All you need do is make some minor adjustments, and you will be back in business.

Unfortunately, this will not work in a sit-down cabinet because the screen is 25 inches. Some people are saving any working transformer assemblies for their sit-down cabinets, and using the Wells Gardner for their uprights. This type of action could keep both models up and running for an extended period, thus allowing extra life of all your *Star Wars* games.

I hope this bit of information helps some of you that have had *Star Wars* games out of order. Please remember that you can use the cabinet after removing the Wells Gardner monitor for a conversion by inserting a raster scan monitor. You can make two games, with the above suggestion, that will earn money out of pieces that were dead wood.

**Atari Paperboy Display Failures**

**GAME**

System II (*Paperboy*) Medium Resolution Display Failures.

**SYMPTOM**

The loss of one or more of the RGB colors on the raster of the ADI display model AGM-20M.

**PROBLEM**

Cold solder joints on transistors Q202, Q206 and Q210 of the RGB amplifier circuit located on the Main Circuit Board Assembly.

**SOLUTION**

Remove the Main Circuit Board Assembly mounting screws from the chassis. Slide the Assembly to the rear of the display frame and tilt the chassis up so that the front of the Assembly can be set on the bench.

Locate the pads of transistors Q202, Q206 and Q210 on the trace side of the board. Touch the tip of a hot soldering iron to each of the transistor pads (marked E, B, and C). Hold the tip of the soldering iron on the pad just long enough to melt the solder (approximately 5-6 seconds).

**CAUTION**

Holding the iron on the pads longer may cause permanent damage to the solder pad or transistor.

**NOTE**

Tinning the soldering iron with some solder prior to touching the pad will shorten the time the iron is required to touch the pad.

Reassemble the Assembly to the chassis of the display to check for proper operation. If this does not fix the problem, try resoldering the associated components in the amplifier circuit. If the color is still missing, troubleshoot the amplifier circuit.

**Atari Matsushita Monitor Shutdown**

I have run into some of these monitors which shut down at power-up or shortly thereafter. I have found C457, a 10 microfarad at 16vdc capacitor, on the chassis, to be the problem.

**Amplifone X-Y Replacement Flyback****SUBJECT**

Atari is releasing a new/improved (?) flyback for replacement use. According to Atari, they will be available after August 18th, 1988.

**GAMES**

So, you can now dig out that old *Star Wars* sitdown, with the 25" monitor, that you didn't have the heart to trash, and get it back on the

street. Also, any 19" uprights that you didn't convert over to the good old Wells-Gardner monitor can now be salvaged. Hell, these games have been off the streets for so long the kids might even think they are new!

**Atari Star Wars Color Modification****LIFE AFTER DEATH**

*Star Wars* has been around for several years and still enjoys a dedicated following. Since Atari has thankfully provided us with a new high-voltage transformer for the monitor, this game is now making money for us again. But there are hundreds of them out there, and every single one of them looks alike. To make your *Star Wars* stand out from the crowd and pull in some new players, this fifteen minute mod will clearly show a difference in how the on-screen graphics look as well as the amount in the cashbox. No parts are required, so this won't cost you anything. It will work on both stand-up and cockpit models.

**INITIAL CHECK**

Before we get started, keep in mind that this will work only with the original Amplifone color X-Y monitor. I have seen some *Star Wars* machines with Wells-Gardner monitors from *Tempest* and they are not compatible. I will cover how to work on the Wells-Gardner units in a later article. But this month will cover only the Amplifone.

**THE MODIFICATION**

The color X-Y monitor accepts three color signals from the game computer: red, green and blue. These signals pass through three separate color amplifiers, but the amps are exactly the same. The computer's output color signals have the same amplitude, and are almost exactly alike. Figure 1 helps illustrate this. All this system does is determine the color each onscreen object will have. If you disconnect the red and green color signals and swap them around, then the red signal will go into the green amplifier; conversely, the green signal will go into the red amplifier. This makes some of the on-screen characters different colors than your players are used to. This will grab their attention!

Simple, yes? Well, let's take it one step further and swap all three color signals. But before we do,

let's take a look at what *Star Wars* looks like before working on it. Here is a list of some of the more prominent objects and their colors:

#### RED

Bunkers (the things that shoot at you in the trench and tower sequence), and the flight instructions during the attract mode.

#### GREEN

T.I.E. fighters, the towers, and the trench.

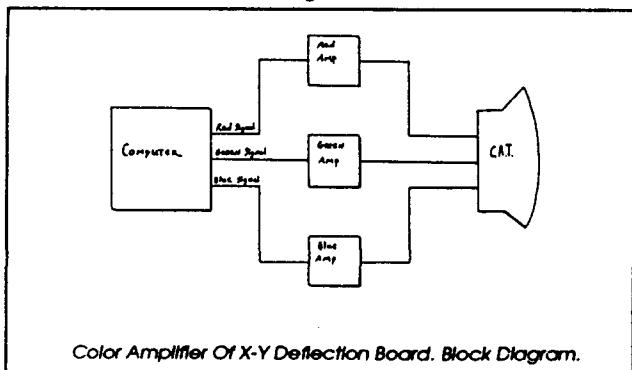
#### BLUE

High scores, the *Star Wars* logo during attract mode and the player's laser fire.

#### PROCEDURE

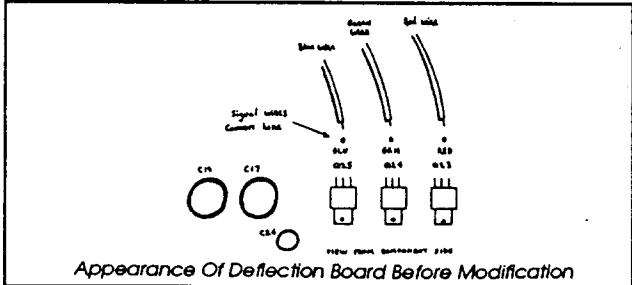
Now let's get our hands dirty and get to work. Warm up the soldering iron, then turn off the *Star Wars* machine you want to modify. Remove the X-Y deflection board and use Figure 2 to locate the general area to concentrate on. Look for a red wire, a green wire and a blue wire. They will have black wires entwined around them, but these are just ground wires and there is no need to worry about them. These color wires represent the inputs for the individual color amplifiers and the board is labeled BLU, GRN and RED where each wire connects to it. Figure 3 shows their exact location.

Figure 1



Color Amplifier Of X-Y Deflection Board. Block Diagram.

Figure 3



Appearance Of Deflection Board Before Modification

Now that you have found these wires, unsolder them (do not remove their black ground wires, as they are all connected together on the board anyway). With solder braid or a solder-sucker, clean the empty holes. If the bare ends of the wires still look clean and neat, you can go ahead and proceed to the next step. Otherwise, cut, strip and tin the ends. We are about to resolder them.

Using Figure 4 as a guide, solder each wire into its denoted hole:

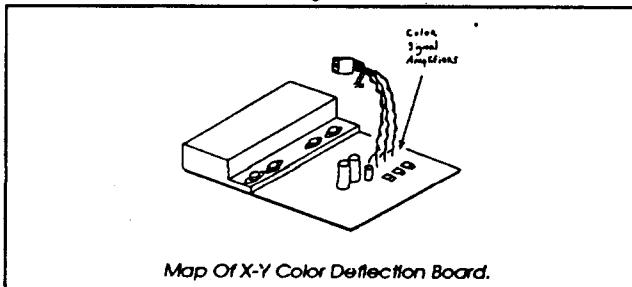
Green wire goes into RED hole.  
Blue wire goes into GRN hole.  
Red wire goes into BLU hole.

#### FINAL CHECK

Now reinstall the X-Y deflection board into the game and turn it on. You should see a big difference in the graphics. That is because the computer color signals are now driving difference color amps. Figure 5 shows a schematic version of the mod. The computer doesn't care, but does the game ever look different! You should now see the following:

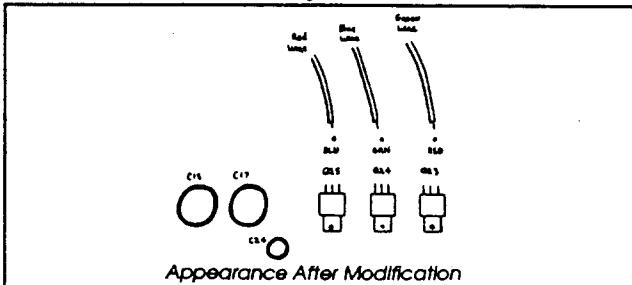
**RED**  
T.I.E. fighters and trench.  
**GREEN**  
High scores, logo and player's laser fire.  
**BLUE**  
Flight instructions and bunkers.

Figure 2



Map Of X-Y Color Deflection Board.

Figure 4



Appearance After Modification

**JAMMIN'**

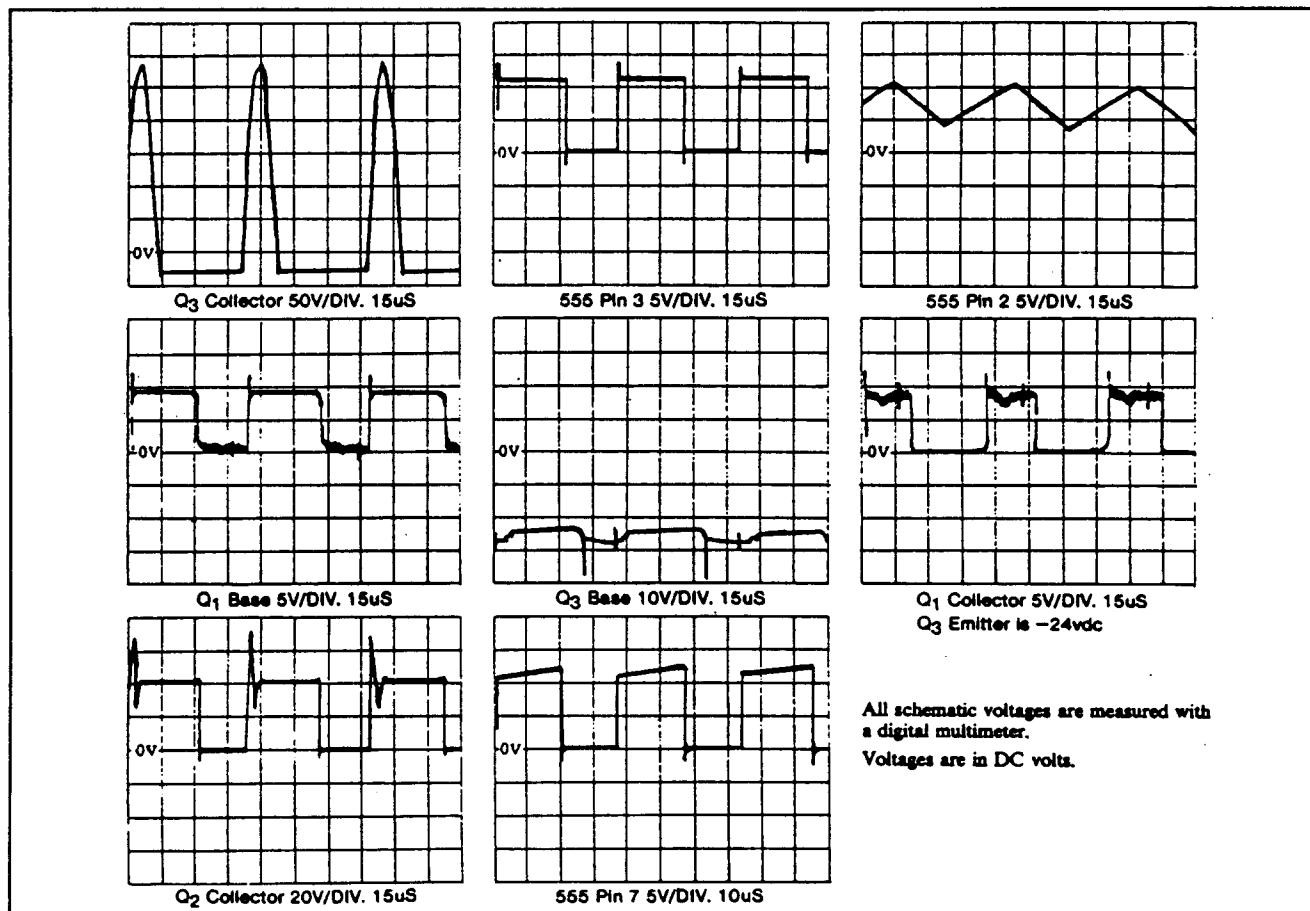
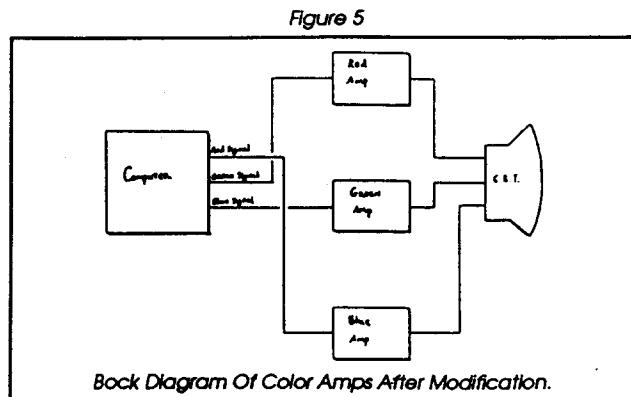
This is by no means the only color pattern to use. You may want to swap only two colors instead of three. At Six Flags Over Texas, we arranged all five of our *Star Wars* games so that no two have the same color arrangement! It keeps the regular players guessing and brings in new ones who know what the game should look like and play it because of its different look. If you have a supply of working X-Y boards in the workshop, you could rearrange each one's color pattern and simply swap out the board whenever you want to change its appearance. This can be done in less than five minutes and can be done from month to month.

**TECH NOTE**

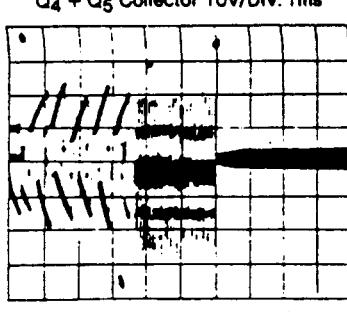
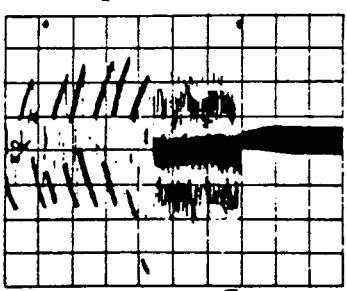
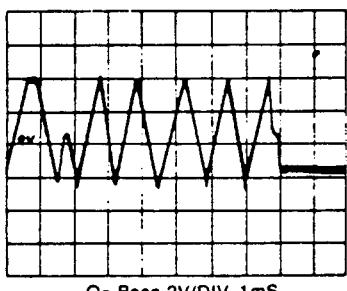
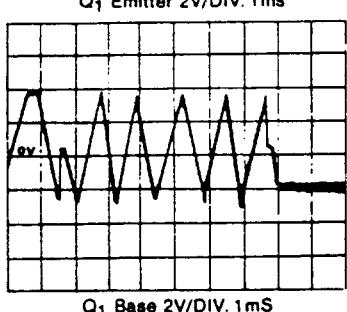
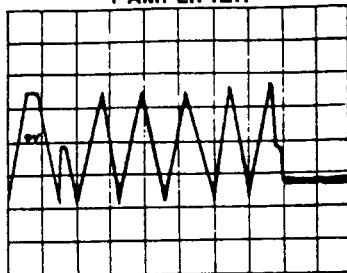
An Atari technician said they used Amplifone color X-Y monitors in *Gravitar*, *Space Duel*, *Quantum*, *Major Havoc* and *Black Widow*. He said they used both the Amplifone and the Wells-Gardner, depending on availability. This mod should work on all those games that use the Amplifone model.

**Atari Star Wars Amplifone X-Y Monitor Troubleshooting Waveforms**

To help troubleshoot the Atari Amplifone 19-inch Color X-Y Display Unit, the following waveforms are listed.

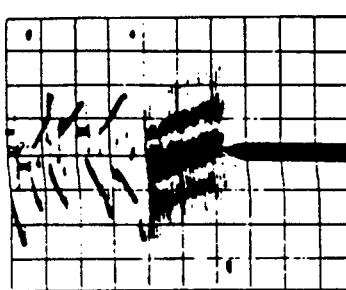
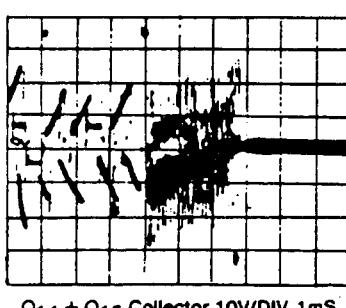
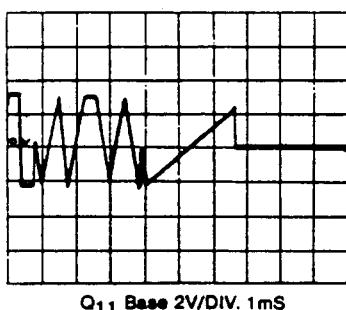
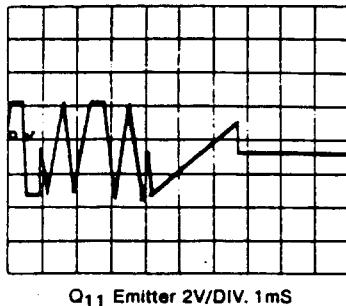


**Y AMPLIFIER**



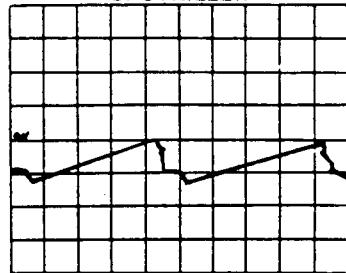
Q<sub>4</sub> Base is -30vdc  
Q<sub>5</sub> Base is +30vdc

**X AMPLIFIER**



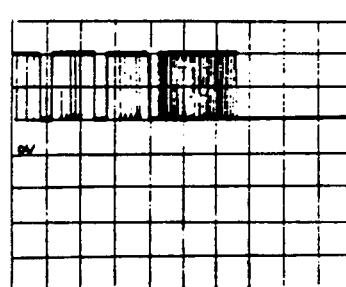
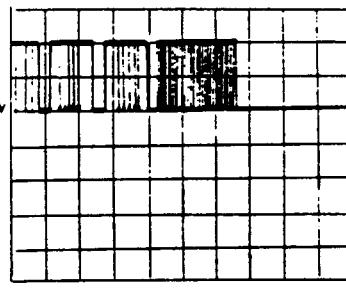
Q<sub>15</sub> Base is +30vdc  
Q<sub>14</sub> Base is -30vdc  
Q<sub>13</sub> Collector is -27vdc

**SPOTKILLER**



Q<sub>10</sub> Base 2V/DIV. 5mS  
Q<sub>8</sub> Emitter is 25vdc  
Q<sub>8</sub> Base is 27vdc

**Z AMPLIFIER**



Q<sub>26</sub> Base is +0.7vdc  
Q<sub>26</sub> Collector is 0vdc

All waveforms taken with the Star Wars Self Test Crosshatch pattern displayed.

# 3

## Bally Midway Monitors Tips & Info

### Bally Midway Troubleshooting Electrohome & Wells Gardner Monitors (Part 1)

#### POWER SUPPLY SECTION

##### Power Supply and Degaussing Circuit

Both Electrohome and Wells Gardner monitors use a power supply with a regulator circuit. Wells Gardner has a half-wave line power supply, whereas Electrohome has a full-wave bridge. Full wave means that both halves of the AC input wave (positive and negative) are used.

The DC voltage on both monitors leaving the power supply and arriving to the input of the regulator circuit is about one hundred forty/fifty volts DC. This could be easily checked on the monitors. On Wells Gardner, the test point would be on the collector of the power regulator transistor TR502. Electrohome also measures the collector of the power transistor X04, 2SC1106. The collector of both transistors is the case.

Fuse F901 should be checked on Electrohome if no voltage is present. Its value is one and a quarter amp. The B+ adjustment controls (VR501 on Wells Gardner and R909 on Electrohome) has been preset at the factory and should not necessarily be altered.

The test point for the monitors B+ is at the emitter of the power regulator transistor. Wells Gardner should measure one hundred twenty-seven VDC, and Electrohome will check normally at one hundred twenty VDC. A B+ voltage too high or low or none at all indicates a problem somewhere

other than the adjustment of the B+ pot.

The regulator circuit uses a series or "pass" transistor, which acts as a variable resistor in series with the load. The pass transistor's base is controlled by other components in the regulator circuit.

On Electrohome X902, the error amp samples the B+ line (B1). As B1 begins to increase, the increased voltage at the base of X902 also begins to increase the forward bias of X902. The collector of X902, forward bias X901, and the base current of X04 will all decrease, maintaining the B+ voltage around one hundred twenty VDC.

Going in the other direction with B1 decreasing, decreases the base voltage of X902. X902 forward bias is less; therefore, the collector of X902, the forward bias of X901 and the base current of X04 increases as needed. The Wells Gardner monitor operates in the same manner.

Let's look at the Audio/Power board on Wells Gardner. The transistor TR551 is not used. This device is to be used in conjunction with an audio circuit. Individuals can get this easily mistaken as part of the regulator circuit.

Resistors R501 on Wells Gardner and Electrohome R01 shunts some of the output current around the pass transistor. This provides less power (heat) to be dissipated in the device.

Wells Gardner monitor (K4600 series) is equipped with a three-amp line fuse, F601. Electrohome

has a three-amp line fuse (F902), and an amp-and-a-quarter fuse (F901). Usually when one of these fuses is open, possibly a power transistor may be defective (power regulator or horizontal output transistor). Check and replace if needed.

#### 1. MONITOR DOES NOT POWER UP

First check and make sure the AC line voltage is present to monitor. If so, look for open fuses on the monitor PC board. Suspect also the transistors, and current limiting resistors. Burnt foils or poor solder connection may be found on the PC board. Keep in mind, in case of an open fuse, the power regulator and horizontal output transistor may be shorted. This may save time by not having to change the fuse a second time.

#### 2. LOW B+ VOLTAGE

The monitor may not come on at all with a low enough B+. Other indications of low B+ would be a smaller than normal picture. This is with the sides, top and bottom of the picture not being completely filled out. There may be somewhat of a picture, but is probably wavy.

It could be the picture is full and looks good, but is wavy or exhibits hum bars. The problem could be in the logic board's power supply. To detect, listen for a noticeable hum in the speaker. If so, the game logic power supply is probably at fault.

The problem being in the monitor would be in the power supply. Suspected components are the transistors, diodes, and electrolytic capacitors.

#### 3. HIGH B+ VOLTAGE

A high B+ could activate the monitor's protection circuit. When the circuit is on, there is no load on the regulator. The B+ will not regulate without a load. The monitor is in a shut down condition, but remember, there is still power going to its circuits. Refer to the HVL (protection circuit) in regard to a high B+ problem.

The flyback transformer acts also as a secondary power supply. This transformer receives a large alternating current from the horizontal output circuit. The flyback then steps up the voltage through a number of windings in the transformer. Diodes are used to get the needed DC voltage. This leaves less strain upon the actual power supply.

The higher voltages go to the CRT's grids (screen and focus) and second anode. The color transistors on the neckboard require about two hundred volts from the flyback circuit. The vertical deflection circuit is powered up also. CRT filament voltage is taken straight from a winding in the transformer. The AC voltage to the filament is about 6.3 volts.

Finishing up the power supply is the degaussing circuit. This circuit is connected to, but separate from, the power supply. The power supply is not dependent upon the degaussing circuit in order to operate. The AC input voltage is paralleled to the degaussing circuit input.

The degausser's purpose is to demagnetize the shadow mask in the CRT, when powered up. The shadow mask is made of metal and has slotted holes through it. The CRT's electron beam, when scanning the front of the tube, passes through the slots of the mask. Each beam from its color gun strikes its own color phosphor. If part of the shadow mask is magnetized, the beam, instead of striking its own color phosphor, will strike one of the other two.

The monitor can be easily magnetized by turning the game's direction. Another way could be from the earth's rotation or an electromagnetic device interfering nearby. To correct, simply degauss the unit.

The degaussing circuit is automatic. When the monitor is first turned on, the degaussing circuit is on for a few seconds. A thermistor is connected in series between the AC input voltage and the degaussing circuit. Until the thermistor heats up to a certain temperature, the coil is on. The device is positive temperature co-efficient. The resistance of the thermistor increases with temperature.

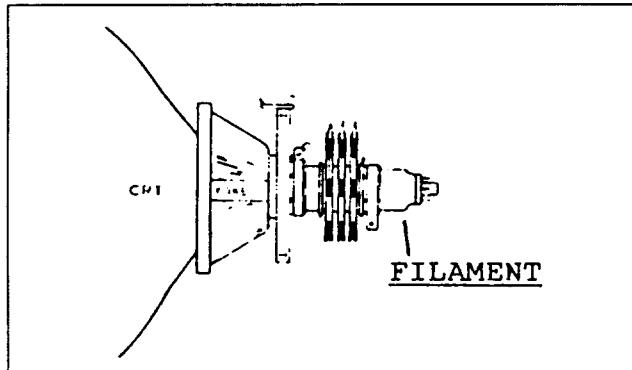
Sometimes an automatic degausser is not strong or close enough to counteract the magnetic field. In this case a manual degaussing is needed to demagnetize the monitor. To degauss manually, use an external degaussing coil.

#### No Raster (Lit Screen)

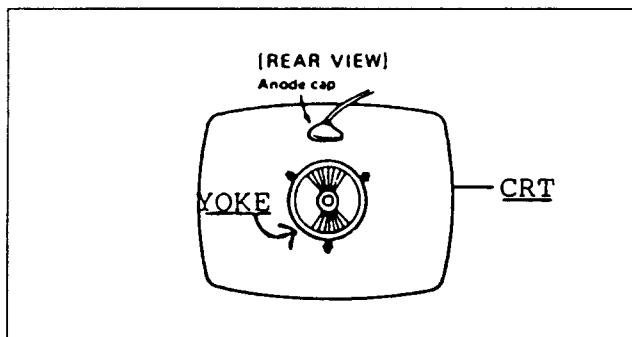
Under a no raster condition (meaning no lit screen), there are two major factors to check in

the monitor. Knowing whether either one, both or none of the factors are present begins to isolate the problem. Check to see if the monitor has the following:

1. Filament (or heater) lit inside the neck of the picture tube. To check, look through the glass neck of the tube located by the neckboard. The filament when lit will light up as an orange glow.



2. High voltage to the second anode plug of the picture tube. To measure the voltage, a high voltage probe would be needed. The voltage on both monitors' second anode will be about twenty-five kilovolts (25,000 volts).



If both the filament and high voltage are missing from the picture tube (also known as the CRT, CATHODE RAY TUBE), then measure the monitor's B+ voltage. The test point would be at the emitter of the power regulator transistor. Electrohome's transistor is labeled as X04 on the schematic and on Wells Gardner the part is marked as TR502. Each of these transistors is styled in a TO3 package and normally has a part number of 2SC1106 on its case.

The power regulator transistor is located on a metal bracket to allow heat transfer off the device.

This keeps the temperature in a range that will prevent overheating and destroying the transistor. There is also one other power transistor on the monitor. This is the horizontal output. It is mounted on a bracket also. These two transistors are not interchangeable with each other.

Looking from the back of the monitor onto the main PC board, find the AC line cord. The monitor's AC cord should be towards the back left side of the board. The metal bracket on the left side of the main PC board holds the power regulator transistor. The horizontal output transistor is located at the extreme right side of the board.

Measure the emitter of the power regulator transistor. The B+ voltage on Electrohome should measure 120vdc, Wells Gardner 127vdc.

A monitor with no raster, no filament or high voltage will have a B+ voltage of four different possibilities. The voltage will either be normal, zero, higher than normal, or too low.

#### 1. *LOW B+ VOLTAGE*

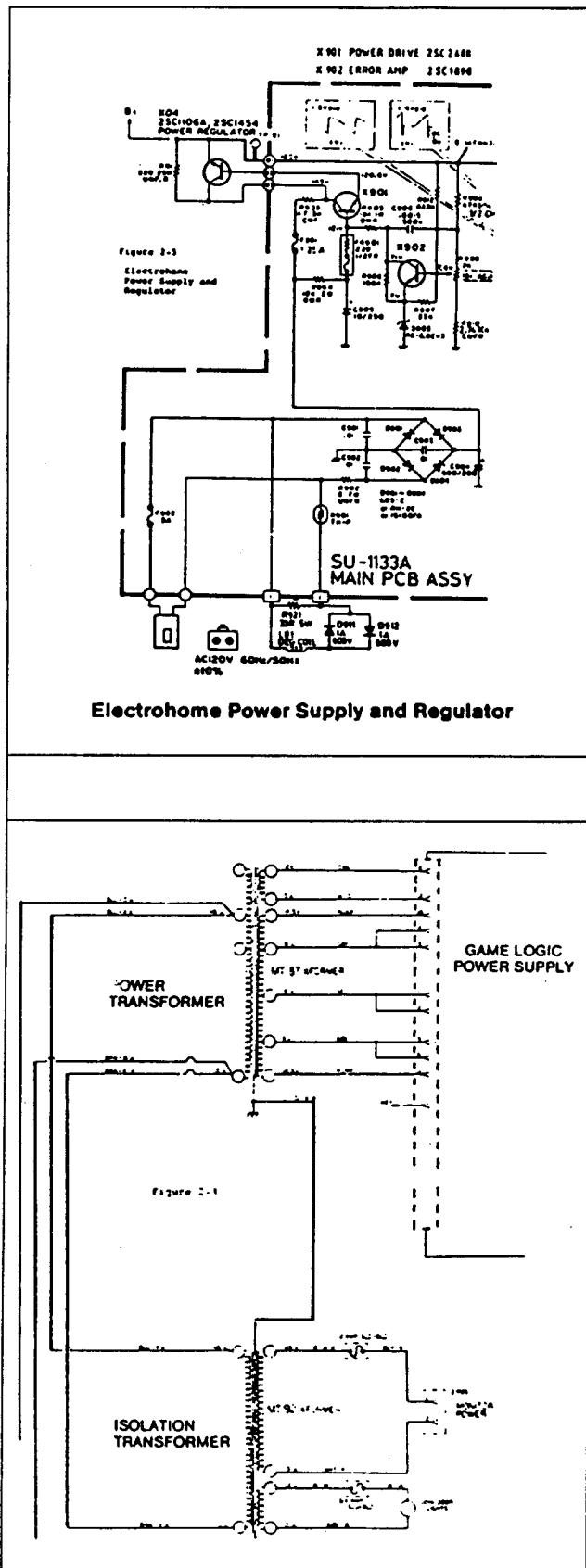
Low B+ voltage usually shows up as a different condition than no filament or high voltage. Refer to the power supply section where this problem is handled. Look in the table of contents under B+ voltage low.

#### 2. *NO B+ VOLTAGE*

In case of the B+ being zero, halve the problem by seeing whether the monitor is receiving its 115vac at the monitor's line cord.

Well, let's take the first half - no AC voltage to the monitor. Check the line fuse which is between the isolation transformer and the monitor. This fuse is located in the bottom of the game cabinet. Next, make sure the wiring from transformer to the fuse and monitor is good. Verify the 115vac to the input of the isolation transformer and 115vac is present on its secondary winding.

Missing 115vac to input of the isolation transformer could mean no power to the main power transformer. Loss of input to main transformer would result in no coin or play of the game. A problem in the monitor allows game play and sounds from logic, but no picture.



Check for bad wire with AC voltage to main transformer and loss of voltage to primary of isolation. If the primary of the isolation has 115vac present, and the secondary is zero volts AC, there is an open transformer, either in the primary or secondary winding.

AC voltage to the input with no B+ at the regulator transistor - suspect the fuse or fuses in the monitor. The fuses are located on the monitor's main PC board.

Electrohome has two fuses. The line fuse F902, which is rated at three amps, and another fuse F901 to the power regulator circuit which is rated at one-and-a-quarter amps. The Wells Gardner monitor has only one fuse marked F601 and rated at three amps. This is the line fuse.

With one of these fuses open in either unit, replace the fuse. But, before powering up again, check the two power transistors; one may be shorted. If the transistors are removed to test, when replacing make sure the clear mica insulator is placed between the transistor and the metal bracket. When checking a fuse use an ohmmeter. Sometimes the fuse looks good, but is open.

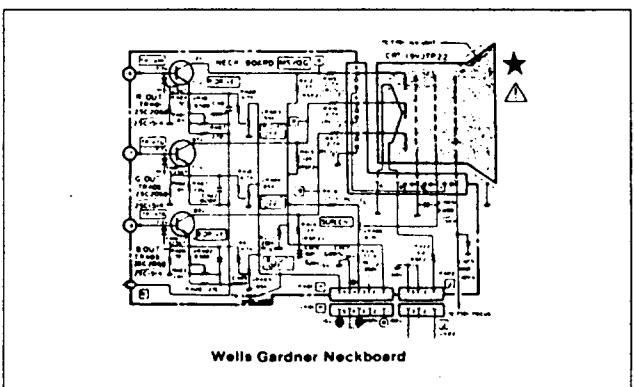
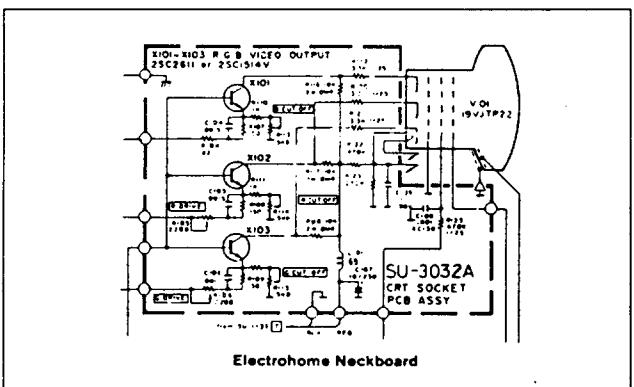
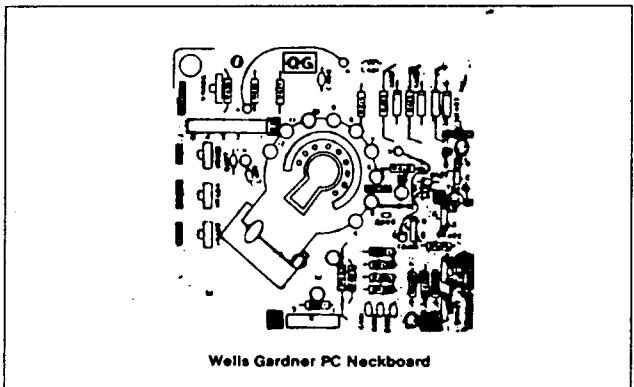
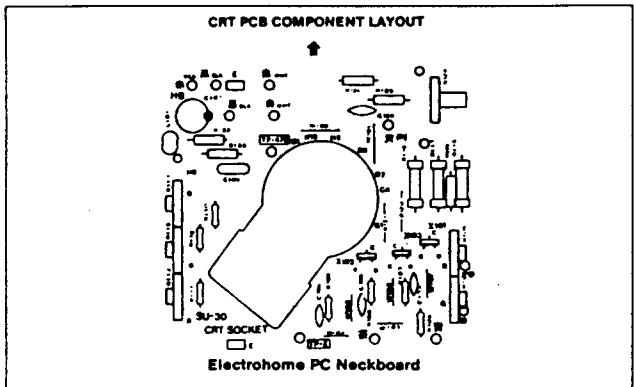
The monitor receiving the AC voltage and with the fuses not open - check for the DC voltage to the input of the regulator circuit. The voltage should be near 145 to 148vdc. This could be tested on the Wells Gardner at the collector of the power regulator transistor, same as on Electrohome. The case of this transistor is the collector. Usually with no B+, the DC voltage here would be absent. If so, check for an open current-limiting resistor, foil traces or poor solder connection.

### 3. B+ VOLTAGE TOO HIGH

In case of no filament or high voltage, and the B+ measures higher than normal, refer to HVL (protection circuit) section. When the B+ reaches 138.5vdc or more on Electrohome or around 145vdc on Wells Gardner, the high voltage limiter circuit is activated. This protection circuit being on prevents the horizontal oscillator from operating. Since no signal is fed into the flyback transformer, no filament or high voltage is obtained.

### 4. NORMAL B+ VOLTAGE

Here everything seems to be working properly and



the B+ checks good. The high voltage and filament are at the CRT, yet there is no raster (lit screen). First try turning up the brightness control. On Electrohome use the screen control. Wells Gardner has a black level control (VR201) located on the interface board. To bring up the brightness on Wells Gardner, rotate this control clockwise. Increase the brightness on the monitor.

With the front of the screen still dark, measure the voltage at pin 7 of the CRT socket. The voltage is normally between four hundred and fifty and five hundred volts DC (depending upon where the screen control is set). If the voltage measures zero or very low, turn off the monitor. Remove the neckboard from the picture tube and examine it for a bad connection. Look for either a bad trace, poor solder joint or possible crack in the board.

With the neckboard disconnected from the tube, situate the board so it's free from shorting to the chassis or anything else. Power up the monitor. Check the voltage once again at pin seven; if the voltage returns to normal, the picture tube may be defective. If the voltage is still low or zero, further troubleshooting is needed.

The Wells Gardner screen control (VR406) wiper should measure about four hundred seventy-five volts DC. The voltage supplied to the control arrives to the neckboard by a wire from the main monitor PC board. Connector J401 pin three brings on eight hundred ninety volts DC to the neckboard. A series resistor (R419) is connected between pin three of J401 and the screen control. Missing the 890 volts to pin three would lead one to check the diode (X607) on the main board, the flyback, or a poor connection.

Electrohome has the screen control mounted on the main monitor board bracket. It is a black assembly located by the flyback transformer. The assembly has two white adjustment controls. Top control is for the focus, bottom adjust the screen.

The assembly itself has four connections. The input voltage from the flyback feeds into the assembly at one point. This voltage is well up in the several thousands. Then another connection is held to ground. Two outputs (which are the wipers of the focus and the screen control) are the last connecting points.

The assembly device is a variable voltage divider. No input voltage to the assembly would be a problem with either the wiring or the flyback transformer itself. If the voltage is present, but there is no output, a new control assembly might be needed.

**5. NO RASTER OR FILAMENT HAS HI VOLTAGE**

The three cathodes inside the CRT emit electrons as the cathodes are heated up by the filaments (also called heaters). There is one filament for each cathode. In the picture tube, there are three filaments all together. The filaments are connected in parallel with each other. If only one or two filaments light up, the tube is bad. If none of the filaments light and the filament voltage reaches the heater pins on the neckboard, either the socket is not making a good connection to the CRT pins or the filament is open.

To check the filament voltage on the neckboard, measure pins nine and ten of the CRT socket. These should be the two top pins of the tube. This is an AC voltage and should measure around four to six volts. Voltage present indicates no continuity between the heater pins on the socket to the filament.

Unplug the monitor, and disconnect the neckboard from the tube. With an ohmmeter, check for an open filament by measuring pins nine and ten of the CRT. Replace the tube if the filaments test open.

Absence of the six volts AC to pins nine and ten - work back towards it supply. On the Wells Gardner neckboard a one-ohm resistor (R422) is in series with the filament voltage on the neckboard. Electrohome's filament voltage goes directly (via wires) to pins nine and ten of the CRT socket.

So, on Electrohome, trace back to pins four and five of the flyback transformer. Here the voltage should measure about six volts AC. If not, unplug the monitor and disconnect the neckboard from the tube. Measure for continuity across the flyback pins four and five. If open, replace.

On the Wells Gardner, filament voltage gets to the neckboard by connector J402, pins one and three. With no voltage at these pins, unplug monitor and J402 from the neckboard. Check for

continuity at these two pins of the connector J402. An open winding indicates a necessary flyback replacement.

**6. NO RASTER OR HI VOLTAGE, HAS FILAMENT**

Since both the filament and high voltage are taken off the flyback windings, missing one of these two voltages tells us the input signal is good to the flyback. However, that particular section of the transformer may be bad.

The high voltage lead which connects to the picture tube comes directly off the flyback. The secondary windings of the transformer for filament and high voltage are separate from each other. The focus and screen voltage come off the same winding as the high voltage. Test whether these voltages are present (focus measures with a high voltage probe). If not, suspect the transformer. With voltages present, unplug power to monitor and discharge high voltage from the second anode of the CRT to ground.

Disconnect the second anode cap from the CRT and place the cap by itself so it won't short to anything. Be cautious, this voltage is normally about 25,000 volts DC. Power up the monitor. If you hear it snapping, crackling, arcing or hissing, turn off the monitor. The high voltage is present, but the CRT is defective. If no arcing sounds can be heard when the monitor is powered up, measure the second anode cap with a high voltage probe. High voltage is present, suspect the CRT - if it is missing, it can possibly be a defective flyback transformer.

**High Voltage Limiter (Protection) Circuit**

The HVL circuit also known more commonly as the high voltage limiter, is a protection circuit. Federal regulations require all manufacturers to provide a way to protect individuals from receiving X-radiation, which can be emitted from the monitor by excessive high voltage.

Normally, as the B+ rises, so does the high voltage. To prevent excessive high voltage, a protection circuit is added to the monitor which samples the B+ voltage. The protection circuit acts as a triggering circuit, so that when the B+ reaches a certain increased amount, the HVL is activated, thus allowing no high voltage to the picture tube.

This symptom was mentioned earlier as no raster, no filament, no high voltage and finding that the B+ measured too high.

An activated HVL circuit (higher than normal B+) can be caused basically by one of three areas: the power regulator, protection, or horizontal circuits. To narrow down the problem, turn off the monitor and disconnect the triggering device. On Electrohome this would be the collector of X701. Wells Gardner is the collector of the transistor TR353.

After the collector lead has been disconnected from the rest of the board circuitry, power up the monitor. At this point, the screen will show one of two conditions: a raster (lit screen) or no raster. If

a no raster condition is seen, verify the no raster by turning up the brightness control.

Obtaining a raster, measure the B+ at the emitter of the power regulator transistor (Electrohome X04, Wells Gardner TR502). Normal B+ voltage on the Electrohome monitor is 120vdc. Wells Gardner is 127vdc.

Normal B+ with a raster - the problem will be in the protection circuit. B+ still high with raster indicates the problem is in the power regulator circuit. No raster condition - the problem will be definitely in the horizontal section.

Refer to the chart below for a breakdown of conditions and suspected components.

CONDITION	ELECTROHOME	WELLS GARDNER	FUNCTION
Raster, B+ High	D905, X902, X901, X04	X501, TR501 TR502	Regular Circuit
Raster, B+ Normal	X701, D-701	TR353, TR354	Protection Circuit
No Raster	IC501	TR351	Horizontal Oscillator
No Raster	X501, T501	TR352, T602	Horizontal Driver
No Raster	X01, T502	TR601, T701	Horizontal Circuit

Remember to reconnect disabled triggering component when finished (collector of X701 or TR353).

## Bally Midway Troubleshooting Electrohome & Wells Gardner Monitors (Part 2)

### LIGHTING THE SCREEN

#### CRT Construction and Operation

The picture or CRT is an output device. In other words, the end result of the circuits working inside the monitor is displayed on the screen. If the video information and sync signals are good feeding to the monitor's input, then the display should be normal (providing the monitor and wiring are good).

The physical structure of the CRT is a large glass envelope which is under a vacuum (inside, when made, the air has been removed). If air enters into the tube, the heater will not light. Never carry the CRT by its neck. This is the most fragile part. Being that no air is inside the tube, if broken, the air outside could rush inside the CRT and cause an implosion.

Elements inside the picture tube consist of the heaters. The heaters or filaments are used to heat up the cathodes. As the cathodes heat up, they

begin to boil off electrons. The cathodes also is where the video information is brought onto the tube to be displayed. An open cathode can cause the screen to be missing a color. Same as with an open filament. A shorted cathode would normally give the screen a dominate color with retrace lines.

The next grid approaching toward the front of the screen is the control grid. Very little can be said about this grid. It is connected to ground and is to control the amount of electrons being drawn to the front of the screen.

Moving on, we come to the next two grids. These are the first anodes: accelerator or velocity grids. They are more commonly known as the screen or G2 grid and are used to draw or attract the electron beams to the front of the screen where the focus voltage on the grid narrows the beams to give a sharp, focused picture.

The electrons are first boiled off the cathodes by the heaters. Then, the more positive voltage potential at the screen grid attracts the beam of electrons down the center of the neck towards the front of the screen. The focus makes the beams as fine as possible for good picture definition.

Finally, the electron beams arrive in the area of the bell of the CRT. As they approach the front of the tube, the beams come up to the shadow mask.

The shadow mask is a large metal sheet which is parallel to the inside front of the tube. Tiny slots in the mask allow the electron beams to pass through to strike the screen.

The mask is made and positioned inside the tube, so that the electrons strike its proper color phosphor. If the mask is loosened and shifts, the screen will exhibit a very bad purity problem which cannot be corrected except by tube replacement.

After the shadow mask is the front of the tube. Here on the glass, color phosphors are struck by the electron beams and colored light is illuminated on the screen.

There is a conductive coating on the inside of the bell of the tube. This coated material is connected

to the second anode. The second anode is where the high voltage is brought onto the CRT. The electron reaches its final destination when it has reached the second anode.

The outside of the tube is coated and connected to ground. The inside has a high voltage potential. Both sides are separated from each other by glass (an insulator). Because of this, the CRT acts as very large capacitor.

If ever the high voltage anode lead is to be removed, discharge the second anode to ground while the monitor is off. Use a jumper lead connected to the metal blade of a screwdriver. Attach the other end of the jumper lead to ground (chassis). Holding the insulated handle, place the metal blade of the screwdriver under the rubber cup to the second anode lead. A loud pop may be heard. Disconnect the high voltage lead from the tube.

Normally, as long as the proper voltages are present to the tube, the electron beams reach the front of the screen. This should light the front of the CRT. If a dark screen is obtained, try turning up the brightness. Still no lit screen and proper voltages are present - then it may be a defective CRT.

### **Brightness Problems**

#### *Brightness too high*

1. Screen or black level control adjusted up too high.
  - A. Electrohome - R11 screen control
  - B. Wells Gardner - VR201 black level control
2. Possible crack or open connection on neckboard.
3. Three color screen controls on neckboard set too high.
  - A. Electrohome controls (R113, R114, R115)
  - B. Wells Gardner (VR403, 404, 405)
4. Low DC voltage to collectors of color output transistors on neckboard:
  - A. Electrohome voltage on collectors of X101, X102 and X103 should be about

160 to 170 volts DC.

B. Wells Gardner measures normally around 95 to 115 volts DC (TR401, 402, 403).

5. On Electrohome monitor, check for shorted diode, D503 (located near the flyback transformer).

6. Beam limiter or blanking transistor leaky or shorted.

A. Electrohome - X303, X304  
B. Wells Gardner - TR201, TR202

7. Defective CRT (internal short)

**Brightness too low**

1. Screen or black level control adjusted too low.

A. Electrohome - R11, screen control  
B. Wells Gardner - VR201, black level control (located on interface board).

2. G2, screen grid bias voltage too low.

A. Check pin 7 of CRT socket for approximately 450-500 volts DC. If the voltage cannot be adjusted to this range, troubleshoot screen control circuitry.

#### **Weak Emission Cures**

For weak emission there are four possible ways to correct the problem. Whether or not any step will restore the monitor depends upon the condition of the picture tube itself.

Weak emission usually shows up as a washed out picture. The color is not quite as vivid as it could be. One of the colors may be weak or missing. The picture tube looks blurry or out of focus. These conditions can be exhibiting a possible problem of weak emission.

Checking the AC color signals at the collectors of the video output transistors should be about eighty volts peak-to-peak. This could be checked with an oscilloscope. With the proper amplitude of signal it may be the CRT has weak emission.

1. Turn the horizontal sync off frequency, and adjust the brightness and the three color screens (located on the neckboard) all the way up. Let the monitor run like this for about fifteen to twenty minutes. Then, go back and readjust the controls

to the normal positions. Sometimes this will clear up the weak emission.

2. The only sure way to have a sharp, crisp picture is to replace the CRT. Some technicians may use a CRT brightener, or rejuvenate the tube. This may resolve the weak emission, but brighteners and CRT restoring can shorten the life of the CRT. The last resort would be a new picture tube.

3. Heater voltage to CRT low.

A. Dim picture, check for four to five volts AC to heater pins on the CRT socket (pins 9 and 10).

#### **Raster Scan**

In the last section, we have seen how the electron beams are brought to the front of the screen. The CRT itself must be good and the proper voltages need to be present to bias the tube. Then, the front of the tube should light up.

The word "RASTER" means basically to rake. Its definition in regard to picture tubes is the pattern of illuminated horizontal scanning lines formed when no signal is applied. This is why, without any of the logic board signals connected to a raster scan monitor, a blank white screen can be obtained.

The X-Y monitor has a different way of putting up the picture than a raster screen monitor. The X-Y system requires that both the X and Y signals are present to the monitor inputs in order to get a picture. Then, of course, the Z amplifier (brightness) signal determines the amount of intensity each line drawn on the screen should be.

Well, let's get back to the raster scan monitor. Without the horizontal and vertical deflection circuitry inside the monitor, the electron beams would hit or strike only the center portion of the screen. This will display a white dot in the middle of the screen. The beams are attracted to the front of the screen, but they're at a standstill. Being not able to view the picture makes the game rather difficult to play.

The horizontal deflection scans the beams from the CRT's left to right side, while the vertical deflection moves the beams from the top to bottom of the screen.

Loss of vertical deflection causes the picture to collapse from top to bottom. The screen exhibits a thin line going down the middle of the tube. It's displayed from one side to the other, through the longest distance of the CRT.

Horizontal collapse causes the two sides to pull into the middle of the screen. Here the thin line appears, going through the shortest distance of the tube.

On the neck of the CRT, close to the bell, is where the yoke assembly is located. It has two separate coils of copper windings and is an electromagnetic device. One coil is for the vertical and the other is for the horizontal deflection. The horizontal and vertical output circuits feed into the deflection yoke.

Vertical deflection moves the electron beams from top to bottom on the screen, while the horizontal is scanning from left to right. When the beams reach the right side of the screen, horizontal blanking occurs and the beams are returned to the left side. Vertical blanking happens when the beams are returned from the bottom to the top of the screen. This procedure is repeated over and over again, when the monitor is on.

The time of blanking is also referred to as retrace. During blanking, a pulse arrives from either the vertical or horizontal circuit to the blanking transistor. The transistor cuts off and prevents any video information to be displayed on the screen.

Blanking cancels all retrace lines from appearing on the tube. Retrace lines are a few thin diagonal lines showing across the screen. For further information on this topic, refer to the section on blanking and beam limiter.

The horizontal signal entering its yoke winding deflects the beams from the left side of the screen to the right. Scanning is when the beams are moved from the left to right. During a scan of a horizontal line, the video information is displayed upon the screen. As the beams reach the right side, they're cut off and brought back to the left side of the screen.

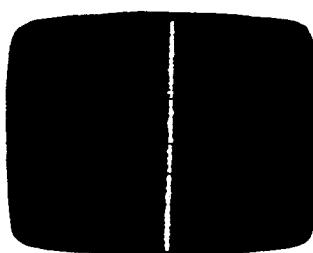
The horizontal signal entering its yoke winding deflects the beams from the left side of the screen to the right. Scanning is when the beams are moved from the left to right. During a scan of a horizontal line, the video information is displayed upon the screen. As the beams reach the right side, they're cut off and brought back to the left side of the screen.

The horizontal deflection scans the beams from left to right, while the vertical moves the beams from top to bottom. In the time it takes to move the beams from top to bottom, there are 262-1/2 horizontal lines scanned on the screen. Because of this, the horizontal frequency is much faster than the vertical.

The process of interface scanning is scanning the odd number of lines first, then the even lines on the picture tube. There are a total of 525 lines when one cycle of odd and even lines has been completed. There are 262-1/2 odd and 262-1/2 even lines on the screen.

The odd lines are referred to as a field and so are the even. Two fields (one of odd and one even) are called a frame. A frame has a total of 525 lines.

The frequency of the vertical circuit is a bit less than sixty cps (cycles per second). It takes 1/60



of a second to scan one field. However, one complete frame takes 1/30 of a second. So actually there are thirty complete pictures per second.

Since we know how many frames per second there are, taking the lines per second determines the frequency of the horizontal oscillator. Five hundred and twenty-five lines times thirty frames is equal to fifteen thousand, seven hundred fifty. This is the frequency of the horizontal oscillator.

Since the monitor's oscillators are set at the same frequency as the logic board's sync signals, the logic color circuit's output (RGB VIDEO) is displayed correctly on the monitor.

#### **Blanking and Beam Limiter**

At this point it would be good to mention briefly the purpose of the blanking and beam limiter circuit. The blanking circuit blanks or turns off the electron beams inside the CRT during horizontal and vertical retrace time. As the beams are moving from left to right across the screen, this is called trace or scanning time. When scanning, the electron beams are on, allowing the video information to be viewed on the screen. Retrace or blanking is the time when the beams move from a right to left direction. No video is wanted at this time, so the beams in the CRT are cut off.

The blanking circuit consists usually of a transistor circuit, which receives a horizontal and vertical sampling pulse from their respective circuits. This blanking transistor is connected directly to the color video output transistors on the neck-board. There are three transistors, one to drive the red, another for green and also one to drive the blue color guns (cathodes) in the CRT.

During blanking time, either the horizontal or vertical pulse is coupled to the blanking transistor. Then, its output turns or cuts off the video output transistors. Therefore, the beams of retrace time are not viewed.

The beam limiter also is connected to the video output transistors. Without the beam limiter circuit, as the picture changes from a dark to light, or light to dark screen, the beam current inside the CRT would change. The wide change of beam current will cause the picture to bloom out and have a blurry focus.

The beam limiter keeps the beam current within a given operating range to prevent this from happening. If the cathodes are made more positive, then less beam current flows and the brightness is decreased. The beam limiter samples the second anode current, then the CRT beam is increased or decreased as needed.

### **Bally Midway Troubleshooting Electrohome & Wells Gardner Monitors (Part 3)**

#### **DEFLECTION CIRCUITRY**

##### **Sync Signals**

The sync signals from the logic boards are needed to synchronize the video information from the logic boards to the monitor's vertical and horizontal oscillator for correct picture stability. The two signals are referred to as the vertical and horizontal.

The vertical frequency is running at approximately sixty Hertz (cps, cycles per second). While the horizontal is at a much faster rate (about fifteen thousand seven hundred and fifty cps 15,750).

At the point where the incoming vertical sync signal meets the monitor's vertical oscillator, the frequencies have to be at the same rate in order to have a stable picture. Being that either signal is faster or slower than the other causes the picture to roll up or down.

A vertical hold control is provided on the monitor to change the oscillator's frequency if needed to stop the picture from rolling. With the picture still rolling, isolate whether the problem is in the monitor or logic boards.

Here again, the horizontal incoming sync signal need to be at the same rate as the oscillator. If not, possible drifting of the picture across the screen may occur. The picture may be tearing or breaking up and causes the display to go into diagonal lines.

The horizontal hold or frequency adjustment on the monitor changes the frequency of the oscillator for stability. Not being able to correct the sync

back to normal, isolate whether the logic or monitor is at fault.

A raster scan monitor's vertical and horizontal oscillators are free running, meaning that no incoming sync signals are needed to the oscillator in order for it to operate. An oscillator circuit has a loop in which the output is connected to the input. This is known as feedback. An amplifier whose input is dependent upon its output is called an oscillator.

The two connectors arriving from the logic boards connect to the monitor's interface (input section) are a six and a three-pin connector. On the six-pin connector, the first three pins contain the color video information (red, green and blue). Pin four is for ground.

Both monitors are capable of receiving either positive or negative going sync. If the sync signals from the logic are positive going, then pin five would be used for the vertical incoming sync signal and pin six for horizontal.

The Bally/Midway games generate from the logic boards a negative going sync. Inputs to the monitor for the negative sync are on the three-pin jack. The six-pin video connector and the three-pin sync connector should plug in right beside each other on the interface section of the monitor.

On Electrohome, the incoming sync signals are amplified and inverted through the monitor's sync interface transistors. These transistors correspond with the schematic's X301, X302, X305 and X306. Two of the four are used for the vertical (X302, X306) and two also for the horizontal (X301, X305). The logic's incoming sync signals are then coupled from the transistors to the sync IC, IC501. Inside the IC package contains sections of the vertical and horizontal oscillator circuit.

The Wells Gardner monitor uses a diode network on the interface board to add together the sync signals. The combined sync signal then arrives to the horizontal/vertical board where the signal is applied to the base of the sync amp (TR308). Following the sync amp, the signal goes to the vertical and horizontal oscillators.

To separate the horizontal from the vertical sync signal, a low and high pass filter is used. A low pass filter before the vertical oscillator blocks high frequency signals and passes the low. The vertical sync being only about sixty cps, the signal passes to the oscillator. Before the horizontal oscillator circuit, a high pass filter is used to pass the highs and rejects all low frequencies.

#### Vertical Circuit

The vertical circuit can be divided into four groups. The vertical oscillator, driver, amplifier and output stages are needed to provide picture stability and vertical deflection.

One purpose of the oscillator is for vertical picture stability. The second is to produce the proper waveform to drive the output section for vertical deflection.

The oscillator is free running, meaning that no input signals are needed to trigger the oscillator on. This is why no signals from the logic boards have to be connected to the monitor in order to display a raster.

Frequency of the oscillator runs a little lower than sixty cps. When the oscillator is at the same frequency as the vertical sync signal, the picture will be synchronized (or stable).

Unstable vertical sync displayed on the screen has the picture rolling upward or downward. To correct, adjust the vertical hold control located on the monitor. With the picture still rolling, isolate whether the wiring, logic or monitor is at fault.

The waveform produced to drive the output stage is a sawtooth (ramp waveform). Its rise time should be linear. This allows the horizontal scanning lines to be evenly spaced from the top of the screen to the bottom.

A buffer is placed between the oscillator and the output. This is the purpose of the driver. Sometimes, the driver acts as another stage of amplification. The vertical amp gives the signal a boost.

Controls in the vertical circuit consists of the vertical hold, linearity, and height. The Wells Gardner monitor vertical circuit omits the linearity adjustment.

The hold control adjusts the oscillator's frequency to that of the vertical sync from the logic boards. This prevents the picture from rolling up or down.

A linearity control, if used, makes the ramp waveform linear. A non-linear picture causes the characters or images on one side of the screen to be larger or wider than those on the other side.

The height or size adjustment changes the amplitude of the vertical signal. To increase or decrease the size of the picture from top to bottom, this is the control to adjust.

#### **Electrohome's IC 501**

Let's briefly discuss the integrated circuit, IC 501. Inside the IC are many tiny circuits for the horizontal and vertical section of the monitor.

The horizontal side of the IC is powered up at pin eleven. Pin eleven is connected to a B plus feed resistor (R509). The B plus is also referred to as B1 on this monitor.

As the horizontal oscillator begins to run, the necessary drive signal is generated and sent to the input of the flyback transformer. At this time, the secondary windings are induced, supplying other voltages to different areas of the monitor.

The test point (B2) from off the flyback delivers the twelve volts DC to pin six of IC 501. This voltage provides the VCC (supply voltage) to the vertical half of the chip.

In the chip, the vertical oscillator and amp make up one half of the chip. The other half of the IC holds part of the horizontal circuit.

Components outside of the chip off of pin seven, determine the frequency of the oscillator - normally runs a tad lower than sixty cps. Off of pin five, capacitor (C402) affects the screen's linearity.

From pin five, the vertical waveform is sent on to an amplifier for more amplification. The output is pin two of the IC. Here should be a linear ramp waveform about 1.4 volts peak to peak. This waveform is sent on to drive the vertical output transistors (X401, X402).

The vertical output section purpose is to amplify the waveform and to drive the vertical windings in the deflection yoke. A linear waveform is sent from pin two of IC 501 to the output transistors (X401, X402). When one of these transistors is on, the top half (from top to middle) of the screen is deflected. While that transistor is off, the other is on controlling the electron beams from the middle half of the screen to the bottom.

A fusible resistor (FR401) passes power to the output transistors (X401, X402). With an open FR401, loss of vertical deflection will result. Here a thin white line will run down the middle of the screen. The line will be going across the longest distance of the CRT. If FR401 is open, check the output transistors, diode (D401) and possibly capacitor (C412). With one of the output transistors bad, replace the pair.

Other vertical collapse problems may be caused from the wiring to the yoke. Possibly the yoke itself. Capacitor (C411) is in series with the yoke and the side pin transformer. These components could bring a loss of vertical deflection.

How about the vertical height control? This either increases or decreases the amplitude of the signal feeding the output transistors. A bad control may be a good suspect to consider.

Finally, the vertical signal is looped back into IC 501 at pin three. If the chip is not producing a waveform to the outputs, no vertical deflection will result.

With no waveform at pin two, check the VCC voltage at pin six of the chip. If present, suspect the IC or a component off of pin two (in the circuit) loading down the waveform.

No VCC, troubleshoot back towards the flyback transformer. This is where the voltage is derived. The IC may be loading down the VCC. Resistor (R522) from off the flyback, if open, loses the VCC to the chip.

Wells Gardner monitors utilize a vertical-horizontal board. This is a small additional plug-in PC board. It connects directly to the main monitor board.

The plug-in boards are interchangeable with all K-4600 series monitors. By swapping with another good board, you can isolate whether the problem is here or not. This makes troubleshooting the vertical circuit more convenient.

Both monitors need to produce a vertical waveform which is at the same frequency as the logic vertical sync. Secondly, to provide the proper drive signal to the yoke for beam deflection.

The vertical circuit in the Wells Gardner monitor is designed with transistors, whereas the Electrohome uses both an IC and transistors. Here the stages of the circuitry are different between the monitors, but the purpose of the circuit is the same.

#### **Horizontal Circuit- General Description**

The horizontal circuit is much like the vertical in that the oscillator is free running. No input signals are needed to the oscillator in order to operate.

The frequency of the horizontal is much faster than the vertical. Frequency of the oscillator is at about 15,750 cps.

The purpose is to operate at the same rate as the logic's horizontal sync signal. This is needed for picture stability. Secondly, to generate the proper waveform for horizontal deflection, and to drive the flyback transformer for obtaining the high voltage.

After the oscillator is the driver. The driver circuit acts as a buffer between the oscillator and the output stage. Usually the circuit is a transistor followed by a transformer. Its circuit also is stage of amplification. The horizontal drive signal is coupled through the transformer to the base of the horizontal output transistor.

The horizontal signal off the output transistor is connected to a parallel circuit. This circuit is made up of the flyback transformer and the yoke circuit. The yoke is in series with the width and linearity coil, and also a few capacitors.

If an open exists in the series yoke circuit, then horizontal collapse results. This leaves the screen with a thin line going down the middle. The line is

displayed across the screen being the shortest distance of the CRT.

#### **Electrohome's Horizontal Section**

The second half of IC 501 is part of the horizontal circuitry. This portion is powered up by pin eleven (12vdc).

There are three stages for the horizontal inside the IC. These stages are the phase detector, horizontal oscillator and waveform.

#### **APC Circuit**

The phase detector, also known as the APC circuit (automatic phase control), works with the horizontal oscillator, but yet is independent of it, meaning that the APC causes the oscillator to change frequency as needed. However, a defective APC circuit will not prevent the oscillator from running.

The purpose of the APC circuit is to keep the oscillator in synchronization with the logic's horizontal sync signal. When this is done, a stable picture is displayed.

The circuit works by comparing the incoming sync signal to the horizontal sampling pulse. This pulse is taken any where after the oscillator's output.

A comparison or control network is a dual diode system (as used in Wells Gardner), or the circuit is contained in a chip (as in Electrohome).

The two signals coming into the APC circuit are checked for a phase difference. A difference between the two would cause the output of the APC circuit to swing either to a higher or lower voltage. The voltage determines whether the oscillator's frequency should be faster or slower. A defective APC circuit may display a number of symptoms. The picture may jitter, weave or have unstable sync.

#### **Horizontal Oscillator**

Following the APC circuit is the horizontal oscillator. The oscillator is inside the chip, connecting to pins twelve and thirteen. Outside of the IC, on pin twelve, is connected the frequency determining components. The horizontal frequency runs approximately at 15,750 cps.

From the oscillator, the signal is shaped and prepared for the horizontal driver circuit. The signal leaves at pin ten of the chip and arrives to the input of the horizontal driver transistor.

The driver amplifies the signal and also acts as a buffer between the oscillator and the horizontal output. Signal from the driver transistor is coupled through a driver transformer (T501) to the horizontal output transistor (X01).

The horizontal output transistor circuit amplifies its input signal tremendously, so that the output is about 900 volts peak to peak. This large AC signal feeds into the flyback and also the horizontal deflection yoke. High voltage is then generated off the flyback, and the yoke scans the beams across the screen.

#### **Protection Circuit**

A protection circuit is used to limit extreme high voltage which could cause x-ray emission. The base of X701 (transistor) is connected in line with the B+ (120vdc). When the B+ voltage begins to increase, so does the high voltage. As the voltage increases, the zener diode (D701) begins to avalanche. A larger base bias voltage begins to appear at X701. Soon as the base reaches .7vdc, the transistor conducts shorting the collector to ground.

The collector of X701 is connected to pin eleven of the IC, which is the chip's VCC supply. At this time, the horizontal oscillator is defeated, preventing any high voltage. The B+ will measure too high with the protection circuit on.

#### **Troubleshooting**

If the monitor has a raster, this means the oscillator is operating. Yet with the picture tearing horizontally, the oscillator is running at the wrong frequency. First, adjust the horizontal hold or frequency control. Getting the picture to tear to the right and left means the oscillator is good. The control not causing the picture to tear both ways may be caused by the oscillator circuit.

With the oscillator being completely dead (no output), no drive signal is produced. If the drive signal is absent, then the flyback transformer receives no input. Obviously, having no input allows no output.

All oscillators have a frequency determining network. This network is also called a feedback path. The monitor's frequency determining components are contained in the feedback circuit. Making up the circuit are specific values of capacitors, coils and resistors. This gives the feedback path a certain time constant.

#### **Oscillator Has No Output**

Check the waveform coming off the oscillator. With the oscillator not running, find whether the supply voltage is present to the oscillator transistor or IC. If not, trace back to its supply.

Being that the voltage is present, there may be a bad connection on the board or a defective component. Possibilities would be an open in the series feedback loop. Check also for a shorted component in parallel with the loop and ground (like a capacitor). A shorted or leaky driver or output may load down and prevent the oscillator from running.

As long as there is a picture, the oscillator transistor is good. However, an incorrect frequency of the oscillator will cause the picture to tear to the right or left. The problem would be in the area of the frequency determining components.

#### **Drivers**

Problems with driver circuit may result in no high voltage. This is because the horizontal output stage is not receiving the drive signal.

1. Check for an open or shorted driver transistor or transformer.
2. An open B+ resistor to the transformer or no supply to the stage will prevent the circuit from working.
3. Possibly a shorted or leaky capacitor connected from ground to the driver's output may be loading down the supply voltage.

#### **Horizontal Output Circuit**

There is a large variety of problems the horizontal output section may cause. This is because its output feeds into the yoke for deflection. Secondly, it feeds into the flyback to obtain other needed voltages for the monitor.

A shorted horizontal output transistor, damper diode, or the flyback transformer may cause the monitor's fuse to open immediately. Possibly a component (such as a capacitor), off the transformer may be leaky or shorted.

Other horizontal problems may be displayed as poor focus, low high voltage, dim brightness, blooming or a narrow picture. These are only a few to be mentioned.

A leaky horizontal output transistor or damper diode causes the screen to have a narrow width. The width also is affected by the monitor's B plus voltage.

A low B plus supply will cause the high voltage and all other voltages to be low. With low high voltage, the picture may bloom or be out of focus. Before jumping into a specific circuit, make sure the monitor's B plus is in tolerance.

The horizontal output transistor operates the sweep of the right side of the screen, whereas the damper controls the left. A problem which is only on one side of the screen will cause the component associated with that side to be suspect.

The horizontal output transistor in the Wells Gardner monitor can be checked out of circuit with an ohmmeter. Use the back-to-back ratio method.

Electrohome's output transistor (X04) is a special NPN package. It has a damper diode built inside of the case. To check, the emitter collector junction should read like a diode. The last junction is the base to emitter. Here, back-to-back, it should measure between forty and fifty ohms both ways.

#### High Voltage Section

The high voltage at the picture tube's second anode plug serves two functions. First, the voltage potential at the second anode attracts the electrons to the front of the CRT. This is needed to light up the screen. The second purpose is to allow the necessary current return path to ground.

Normal high voltage is between 22.5 KV (kilovolts) and 25.5 KV. To measure, a high voltage probe is needed.

In case of a lower than normal high voltage, the picture may show the symptom of blooming. As the high voltage decreases, the entire picture will enlarge in size. Sometimes the screen expands to a point where the picture gets dimmer and finally blanks out. Usually, turning the brightness control up makes the blooming condition worse. Refer to the symptom diagnosis in the General Troubleshooting section for causes of blooming.

#### Grid Bias Voltages

As in examining the flyback circuit, other voltages are needed for proper biasing of the CRT. This would consist of the focus and screen (G2) voltages.

The focus voltage is normally about twenty percent (20%) of the high voltage. Whereas the screen is between four and five hundred volts DC. The control grid in both monitors is kept at ground potential. The cathodes (electron guns) on Wells Gardner are biased at about one hundred volts DC. Electrohome is approximately one hundred and sixty.

On the cathodes, as the DC voltage decreases, the screen begins to light up brighter. An extremely bright screen which cannot be darkened by the brightness control to a black background may be caused by a low supply voltage to the cathodes. A dominant single color on the screen can be from a shorted output transistor or a shorted cathode inside the tube.

Finally, the last element inside the tube receiving voltage is the heater or filament. Its purpose is to boil off the electrons from the cathodes. There are three heaters (one for each color). Remember, they're connected in parallel with each other.

An external heater voltage is taken from a winding of the flyback transformer and is approximately six point three volts AC (6.3). The heater voltage can be measured at pins nine and ten of the CRT socket located on the neckboard.

In order to get the necessary voltages from the flyback transformer, the horizontal drive signal must be present at its primary winding. The horizontal output transistor provides the AC drive signal which is about nine hundred volts peak to peak.

An open circuit in the horizontal section, between the horizontal oscillator and the flyback, will cause no drive and thus no voltages from off the flyback. A problem here would result in no filament or high voltage and the B+ measures too high.

The flyback circuit also provides other voltages to specific stages in the monitor. On the schematic, look to the right of the flyback transformer (T502). A plus twelve volts is taken off the diode (D508). This twelve volts powers up the vertical side of the chip, IC501. Before the supply voltage reaches pin six of the IC, the twelve volts also branches off and feeds the sync and color interface transistors.

The sync interface transistors correspond to the schematic's components X301, X302, X305, X306, whereas the color transistors are labeled X101 through X106 on the main monitor PC board. The blanking and beam limiter (X303, X304) also requires this twelve volts DC.

A reference point (BH) off of diode (D503) supplies the neckboard with a hundred and eight volts DC. This source goes to the color video output transistors (X101, X102, X103).

The Wells Gardner monitor's flyback generates both a thirty and fifteen volt DC supply. The vertical section requires the two supplies in order to operate. On the interface PC board, only the fifteen volts supply is used to the color and CRT cut-off transistors.

The neckboard receives a variety of DC voltages. Fifteen volts to bias the base emitter junctions of the color output transistors (TR401, 402, 403). A hundred and sixty volts to the collectors of the output transistors. Eight hundred and ninety for the screen bias (G2), and about twenty percent of the high voltage is provided to the focus grid.

In essence, the flyback is in one aspect a secondary power supply. This leaves less strain upon the main power supply. Remember that in order to receive any of the output voltages, the drive signal must be present at the input.

### Troubleshooting

Troubleshooting the high voltage section is the

same concept as in checking the input and outputs of a transformer. If none of the output voltages are present, suspect an absence of the horizontal drive signal at the input. This could be a loss of drive beginning from the oscillator and through the driver circuit, or a loss to the horizontal output stage to the input of the flyback. If the primary winding is open, no B+ will be reaching the horizontal output transistor.

With some output voltages present and a few missing, check the components in common with the circuit that is associated with the missing voltage sources. Check for open windings, poor solder connections, open resistors and diodes.

Missing a certain voltage will be an open or break in the winding or anywhere to its designated output. If the output (load) itself is shorted, it may load down the source voltage very low or to zero.

The high voltage and focus voltage is to be measured with a high voltage probe. All other DC voltages can be checked by a standard VOM (volt-ohm-milliammeter).

## Bally Midway Troubleshooting Electrohome & Wells Gardner Monitors (Part 4)

### COLOR PROBLEMS

In the case of a video game having a color problem, the first step would be to isolate whether the boards or monitor is at fault. An RGB color service generator may be used to produce the proper color and sync signals to test the monitor. If a generator is not accessible, then the logic boards can be substituted from another identical game.

If the boards are not available, take a known working game which uses either the Electrohome (G07-CBO) nineteen-inch or (G07-FBO) thirteen-inch, or on the Wells Gardner (19K4600 or 13K4700 series) monitor. Substitute the working game (the one that uses a monitor listed above) and connect the video and sync cables to the suspected bad monitor. If the known working game is displayed properly, then it can be assured that the monitor is good. Here the logic boards are probably at fault.

What can be done now is to hook up the video cables from the logic boards which are suspected as bad. Connect the cables to the known good monitor in the other game. If the symptom shows up, then the wiring from or the logic boards themselves are defective.

#### 1. Weak Color

If the problem doesn't exist in the logic boards, check color signals with an oscilloscope at the picture tube cathodes. With the color signals about 80VP-P, the CRT has weak emission.

With the signal's amplitude being a lot lower than 80VP-P, then check the color interface transistors and bias voltages on the color output transistors. The output transistors are the three located on the neckboard.

In case of weak emission there are four possibilities to remedy the problem. First, by turning the horizontal sync off frequency, and bringing up the brightness and the three color screens all the way up for about fifteen or twenty minutes. This will sometimes boost up the color guns.

Replacement of the CRT will definitely take care of the problem. Though some technicians may try a picture tube brightener of rejuvenation, this may prolong the life of the CRT.

#### 2. Missing a Color

Knowing that the monitor is at fault, the problem will be in one of three areas. This is the color interface, color output section (on the neckboard), or the picture tube.

There are two types of a missing color. Either the color information is absent or the color missing upsets the screen's white balance.

1. Missing color information is a problem between the input of the monitor, through the base of the color output transistor on the neckboard.

The color information displays the characters and images on the screen. If the overall color of the screen looks normal, but certain parts of the picture (such as characters or letters) are missing, or the parts are of a different hue, then the in

formation is missing. The problem would like on the monitor between input and base of color output transistor.

2. The other way a color is missing is that the white balance is not producing a grayish white raster.

Improper white balance can be determined by turning up the color screen controls on the neckboard, one at a time. Each screen control, when turned up, increases the gain and brightens the screen that particular color.

If the red was missing, the white balance will be a shaded cyan colored screen. With blue missing, the screen will have a yellow tint. Absence of green gives a magenta colored overcast on the screen.

For an improper white balance, suspect on the monitor a problem with the neck board, the socket, or the picture tube. White balance set up procedure is outlined in detail; check table of contents.

First, with a color missing, make sure all three filaments are lit inside the neck of the tube. This can be checked visually by looking inside the rear neck of the CRT. With the three filaments lit, at least up to this point, the tube is good. However, a filament not lighting and being that they are in parallel, the CRT needs to be replaced (if one filament lights, they all should).

Knowing the filaments are good, the color guns (cathodes) can be tested. Each color gun can be turned on or saturated to light up the color on the screen. To do this little trick, it is highly suggested to make all hookups on the neckboard, while the power to the monitor is off. A jumper wire with an alligator clip at each end is preferred.

On the neckboard there are three color output transistors, one for each color, (red, blue, green). Just a reminder, when adding a jumper wire to the neckboard, remove all power first. Double check the wire hookup before applying power.

When the collector of each color output transistors is connected to its emitter, the front of the

screen goes to that particular color. At this time, the color gun inside the CRT is saturated. If the screen does light up the missing color, the CRT is good. Suspect the color output transistor to be bad (open base to collector). The color not appearing on the screen when the transistor is shorted (emitter to collector), check for an open between collector and cathode.

Further testing will find an open between the collector and cathode pin on the neckboard. Last of all is either a poor connection in CRT socket, or an open cathode.

Let's go back to problem #1. White balance is fine, but the picture has color information missing. The problem lies anywhere between the color input to the monitor through the base of the color output transistor. Most likely an interface transistor is defective. There are two transistors for each color, and a total of six altogether. Don't forget a possible open connection in this area.

### 3. Dominate Color

A dominate color symptom would be where the screen has a particular color overcast upon the entire picture. For a missing color, we made the screen put up a color by shorting the emitter to the collector of the color output transistor on the neckboard. Here we might suspect the transistor for that color to be leaky or shorted.

Measure the collector voltage of the color output transistor which pertains to the dominant color. The voltage on Electrohome should be about 160 to 170 volts DC. Wells Gardner measures in the area of 95 to 115 volts DC. If the collector measures very low as compared to the other two color output transistors, check the transistor.

The voltage at the collectors also splits off and goes to the color cathodes inside the picture tube. Before the voltage reaches the cathodes, a series resistor is connected between each of the three collectors and cathodes. These three resistors are referred to as the cathode resistors.

Now with the suspected transistor good and the collector voltage being low, the CRT may be at fault. To find out, lift one end of the cathode resistor from the neckboard. Power up monitor and measure the collector once again; if the low

voltage returns to normal, suspect the CRT as possibly being bad.

With the voltages on the color output transistors within the voltage tolerance, take a look at the color interface transistors. These are the six transistors before the color outputs. Remember, there are two for each color.

Any dominant color caused from the monitor will be either in the color interface section, video outputs (transistors on the neckboard) or maybe the picture tube. Always make sure the problem has been ruled out of not being in the logic boards or wiring to the monitor.

### DEGAUSSING

Picture tube purity allows the electron beams from each color gun to strike its own proper color phosphor dot on the screen of the CRT (Cathode Ray Tube). So when each color field is viewed on the screen only that particular color is seen and no other. A magnetic field can offset the purity of the picture tube. This purity offset will give the screen a discoloring in the picture. Most of the time, magnetization of either the shadow mask (inside the CRT), or the metal chassis brackets cause the purity to be off. An external degaussing coil often is used to eliminate any magnetization.

### DEGAUSSING PROCEDURE

Degauss the monitor while the game is on. Plug the degaussing coil into a 120-volt AC outlet. Holding the coil several feet (four to six) from in front of the monitor, turn the coil on. With the coil facing parallel to the game, begin moving the coil in a circular direction, as you're moving slowly towards the monitor. As the coil reaches close to the front of the CRT (six to twelve inches), move the coil over the top and sides of the screen. Do not hold the degausser near the back of the monitor while the coil is on. Also, avoid touching or letting the coil lay on the top of the CRT. This could permanently damage some of the magnetic components located on the neck of the tube, or magnetize the shadow mask.

Finally, as the sides and top of the monitor are degaussing, don't stop here! If the coil is turned off too close to the CRT, it will set up a magnetic field. So, continue to rotate the coil in a circular motion and begin to walk away from the monitor.

When you're back about six to seven feet away, turn the coil perpendicular to the game and turn off the coil. Degaussing the monitor is now completed. Anytime there is a purity problem before going through the set-up procedure, degauss the monitor first. This may be all that is needed.

#### PURITY SET UP

If after degaussing the monitor, the screen is still discolored in areas, follow through the set up. Electrohome suggests using a red field. Wells Gardner mentions a green field for purity adjustments. The red phosphors in the CRT require more brightness than green and blue to light up the red field.

Before aligning the purity, it may be easier to set up without a video signal arriving to the monitor from the logic boards. Disconnect the six pin video cable off the monitor. Turn down the blue and green screen controls on the neckboard. Bring up the red screen until the screen on the CRT is a good looking red field. Here no color blotches of green or blue should appear on the edges of the screen. If so, degauss the monitor. This may be all that is needed.

With correcting the problem, follow the procedure on white balance set up. With the purity still being off, try rotating the purity rings slightly on the neck of the tube. The purity rings are located on the sleeve assembly mounted between the deflection yoke and the neckboard.

There are three pairs of rings on the sleeve. The pair of rings nearest the yoke is for purity. If the slight adjustment does not clear up the problem, follow the outline given by the manufacturers.

**For reoccurring purity problems,  
check the following:**

1. Nearby electrical interference or magnet.
2. Loose deflection yoke slid away from or towards bell of picture tube on neck.
3. Purity clears up, but after awhile it is off again. Game may need to be repositioned. Because of the direction of the game, the earth's poles are pulling off the purity.

4. Loose shadow mask causes an extreme purity problem.

#### COLOR PURITY AND VERTICAL CENTERING ADJUSTMENT WELLS GARDNER

For best results, it is recommended that the purity adjustment be made in the final monitor location. If the monitor will be moved, perform this adjustment with it facing west or east. The monitor must have been operating 15 minutes prior to this procedure and the faceplate of the CRT must be at room temperature.

The monitor is equipped with an automatic degaussing circuit. However, if the CRT shadow mask has become excessively magnetized, it may be necessary to degauss it with manual coil. Do not switch the coil OFF while the raster shows any effect from the coil.

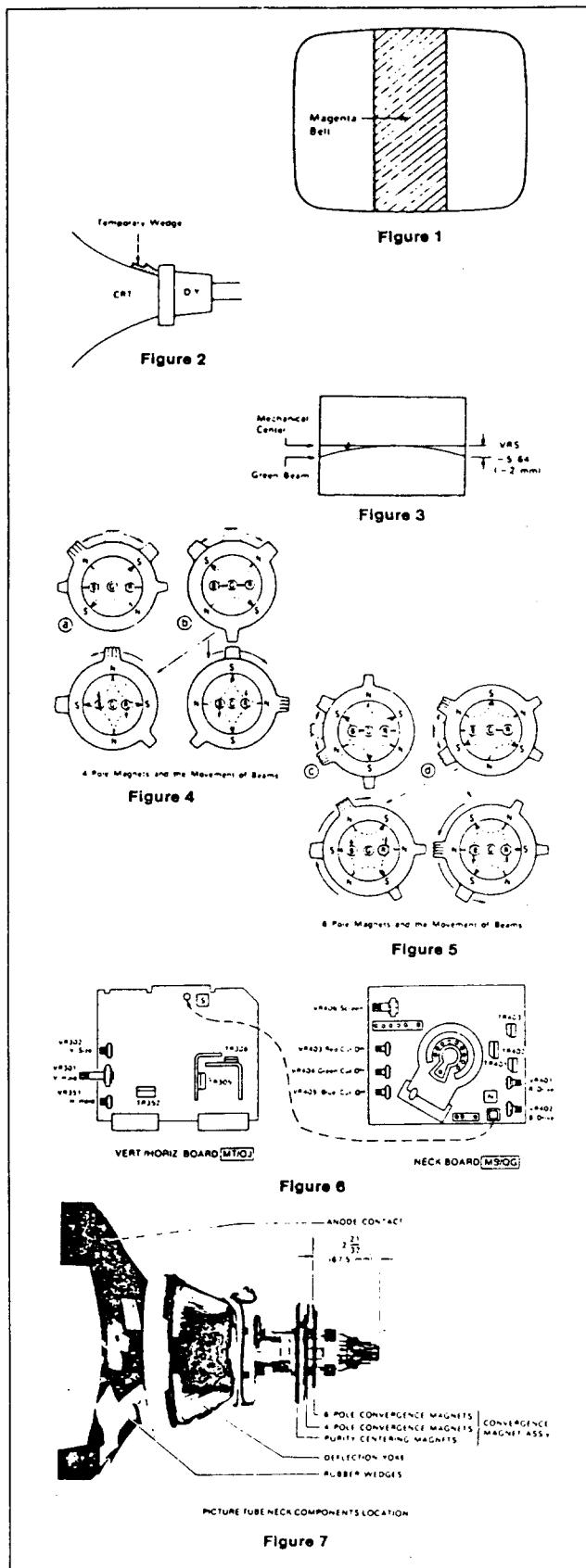
Purity Magnets are used for Color Purity and V Centering Adjustment.

Purity Adjustment procedure is as follows:

1. Remove R-G-B signal from monitor.
2. Turn Green Cut-off Control (VR404) on the neckboard fully CCW. Turn Red and Blue Cut-off Control (VR405) fully CW.
3. Pull the Deflection Yoke backward so that the Magenta belt will appear (see Figure 1).
4. Move the two Purity Magnets and bring the Magenta belt to the mechanical center of the screen (see Figure 2). The vertical center position should be set VRS to  $-5/64"$  (-2 mm) as shown in Figure 3.

Insert service tip "N" on Neck circuit board to "S" on Vert./Horiz. circuit board (see Figure 7). To check, use the Green raster at low intensity. Be sure to return the service tips to their original positions for the next check.

5. Push the Deflection Yoke forward gradually and fix it at the place where the Magenta screen becomes uniform throughout.



6. Turn Cut-off Control and Drive Control and confirm that each color is uniform.

7. If the color is not uniform, readjust it moving Purity Magnets slightly.

8. Move a pair of Purity Magnets at the same time (do no change the angle of the pair), and adjust the vertical center to center of screen.

9. Obtain the three colors and confirm whether white uniformity is balanced.

10. Insert the temporary wedge as shown in Figure 2 and adjust the angle of Deflection Yoke.

#### ELECTROHOME SERVICE SET-UP PROCEDURE

NOTE: All monitors are equipped with automatic degaussing coils which effectively demagnetize the picture tube each time the monitor is turned on. The degaussing coils will operate any time the set is turned on after having been off for at least five minutes.

The degaussing effect is confined to the picture tube since the coils are mounted on the ferrous tube shield. Should any part of the chassis or cabinet become magnetized, it will be necessary to degauss the affected area by means of a manual degaussing coil. Move the coil slowly around the CRT face area, then slowly withdraw for a distance of six feet before disconnecting the coil from the AC power supply.

Normally little, if any, adjustment should be necessary. However, when a picture tube, yoke or similar component is replaced, preliminary static convergence should be done before attempting purity adjustment, and so on.

Set up should be done in a north/south direction. Horizontal and vertical centering taps should be set to the center position if a major component has been changed.

#### Purity

1. Loosen yoke retaining clamp (Fig. 8), remove adhesive material fixing wedges to CRT. Remove wedges completely and clean off dried adhesive from picture tube and wedges.

2. A small quantity of "nail polish" has been used to lock the purity convergence rings in place. This seal must be broken with a sharp tipped instrument before any adjustments are attempted. Some models also use a locking ring at either end of the purity and convergence rings. This must be loosened before adjustments are made. It goes without saying that upon completion of all adjustments, the lock must be reset and/or a dab of paint or nail polish must be reapplied to edge of rings to prevent movement.

3. Connect an appropriate signal source, e.g., Electrohome RGB generator producing a white field plus individual red, green and blue fields.

4. Bring the long and short purity tab protrusions in line with each other to obtain near-zero magnetic field (Fig. 10). (In some cases, bring the flat and indented tabs together to obtain zero field). Protrusions can then be vertical, horizontal or at any convenient angle to start.

5. Turn off the green and blue fields and adjust set-up controls to produce a red field. (See Fig. 9)

6. Pull the deflection yoke back so that a red band appears in the center of the screen.

7. Spread the tabs apart as little as necessary and rotate both rings together to center the red band horizontally on the face of the CRT (approximate). (See Fig. 11)

8. Slide the yoke towards the bell of the picture tube slowly to obtain a uniform red field (pure in color) across the entire tube face. Joggle back and forth slightly as necessary. Lightly tighten yoke retaining clamp.

9. Momentarily switch on a crosshatch signal and rotate yoke to level the pattern on the face of CRT.

10. Return generator to regain red raster.

11. Turn off red field and check for pure field for each of the green and blue fields. Reposition yoke if necessary to obtain optimum purity all fields.

12. Tighten yoke retaining clamp to prevent yoke shift or rotation. (Do not install wedges at this time.)

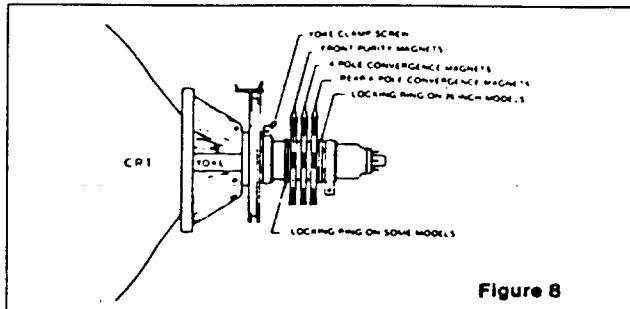


Figure 8

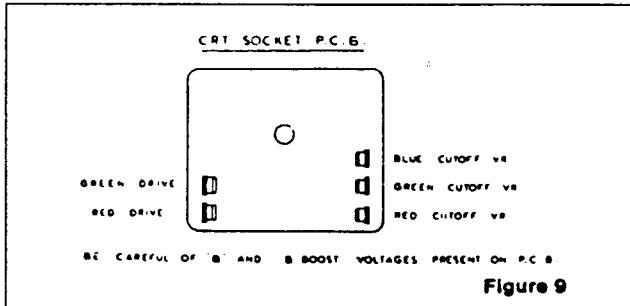


Figure 9

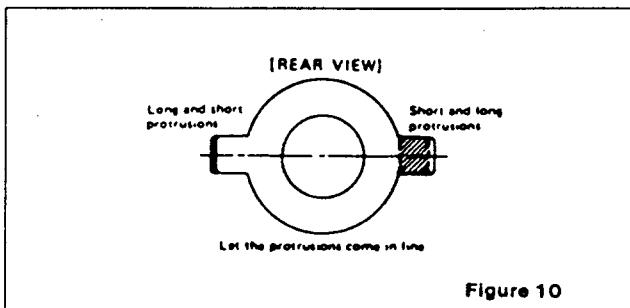


Figure 10

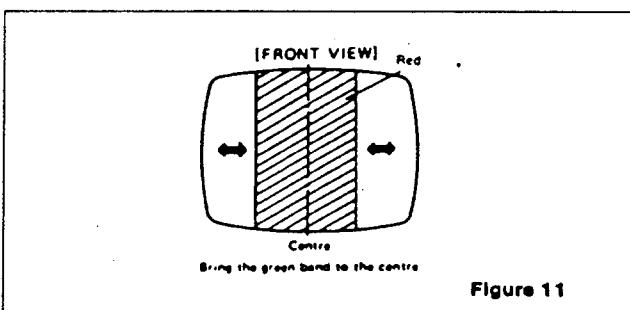


Figure 11

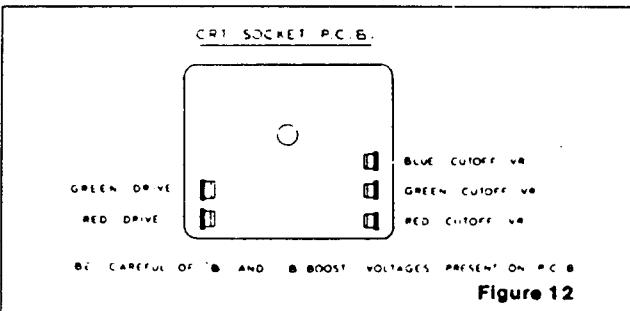


Figure 12

**WHITE BALANCE**

White balance give the raster a grayish white screen with the video cable disconnected. Proper adjustment makes the colors on the screen their correct hue (shade of color).

The adjustments for white balance are located on the neckboard. Here there are three controls next to each other. These are the red, blue and green screen controls. Two other controls together on the neckboard are for adjusting the highlights. This adjustment can be accomplished with no signal connected. First, set the two drive controls (these are the controls for setting the highlights) to their mechanical center. Turn the G2 screen control and three color screen controls (also referred to as cut-offs) to minimum (fully CCW).

Slowly turn up the G2 screen control until the first faint color appears, notice which color it is, back off the G2 control to the edge of visibility. Next, bring up the other two color cut-offs to match the appearing faint color. Adjust the two cut-offs so a faint grayish screen is obtained. After this is completed, turn down the G2 screen control just until the raster diminishes into black. Turn off monitor, reconnect video cable and power up. The colors of the game should now look as best as possible.

The two drives adjust the highlights of the images. These controls change the color tint of the white images or letters to a purer white.

**WELLS GARDNER**  
**BLACK AND WHITE TRACKING**  
**(With R/G.B. inputs grounded)**

1. Set Black Level Control (VR201) to mid point.
2. Set Red and Blue Drive Controls (VR401 and VR402) to their mechanical center.
3. Set the G2 Screen Control (VR406) and the 3 Cut-off Controls (VR403, VR404 and VR405) to minimum (CCW).
4. Slowly turn up G2 screen control until the first faint color appears.
5. Slowly turn up the other two color cut-off controls in turn to match the first.

6. Remove ground from R/G/B inputs. Adjust Red and Blue Drive Controls (VR401 and VR402) for white screen.

**ELECTROHOME WHITE BALANCE**  
**(Gray Scale Tracking)**

Refer to Figure 12.  
 Do the following in subdued light:

Note this adjustment can be accomplished with no signal connected; e.g., input connector open or if a signal generator is connected, switch off all 3 inputs at the generator.

Set red and green drive controls to their mechanical center and turn the common G2 screen control and 3 cut-off controls to minimum (fully counterclockwise).

Slowly turn up G2 screen control until the first faint color appears, then back off to edge of visibility. Do not touch the associated cut-off control - it should stay fully CCW for the remaining set-up.

Slowly turn up the other two cut-off controls in turn to match the first. This should result in the faintest gray.

Turn on the signal generator with all 3 inputs on. (A crosshatch pattern would be appropriate.)

Adjust the red and green drive controls for "neutral white" on high white picture areas. Generally these controls will be left at mechanical center.

Note: When monitor is reconnected with the game, the screen control (G2) may require a slight adjustment to obtain proper black level. (The black portion of picture just extinguished.)

**CONVERGENCE**

So far, we have discussed how purity is needed to give pure color screens. Now we need to discuss a little bit on the topic of convergence.

A Triad in the CRT is referred to one set of red, green and blue phosphor dots. There are many groups of triads on the screen, but only the color dots in each set of the particular triad must be the electron beams strike. If the electron beams strike the color phosphor outside of its color triad, then

the lines and images at that particular part of the screen will be misconverged. Misconvergence leaves a trailing edge of color (red, blue or green), alongside of an image in that area of where the convergence is off. The static convergence deals mainly with the center portion of the screen. The dynamic handles the outer edges of the CRT.

The deflection systems (horizontal and vertical) has least effect on the screen in the center. The static convergence is the process of aiming the three electron beams at the center of the screen.

During the time of converging a monitor, it is much easier done when a cross-hatch or dot-pattern is generated on the screen. In the game's self test mode, a cross-hatch pattern can be locked up on the screen. Working on the monitor on a bench a RGB service generator can be used. Once the pattern is displayed, the correction adjustments can then be made for proper convergence.

There are two kinds of color picture tubes: a delta and an in-line. These names are given from the configuration of the electron guns. The Electrohome G07-CBO and Wells Gardner K4600 series utilizes the in-line CRT, in-line meaning the three color guns are in-line with each other (in a horizontal plane). The way the guns are set-up in an in-line tube makes setting up convergence rather simple.

In order to converge the monitor, the purity should be completed first. Secondly, the static convergence, and then finally the dynamic convergence.

For static convergence, refer to the set-up procedures on the particular monitor being used. Find the figure which shows the convergence magnet rings on the neck of the tube. Remember the pair of rings nearest the bell of the tube is for purity. The middle pair converges the red and blue together.

There are two rings per pair. One ring will converge the red and blue horizontal lines. The other ring converges the vertical lines of the red and blue. To converge the green onto the red and blue, the last set of rings closest to the neckboard is used. Again, one ring will converge the green onto

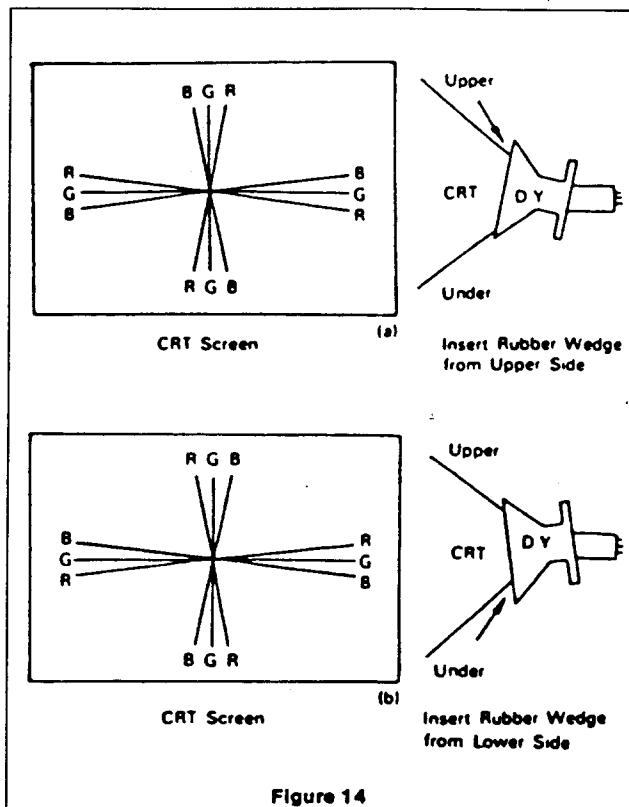


Figure 14

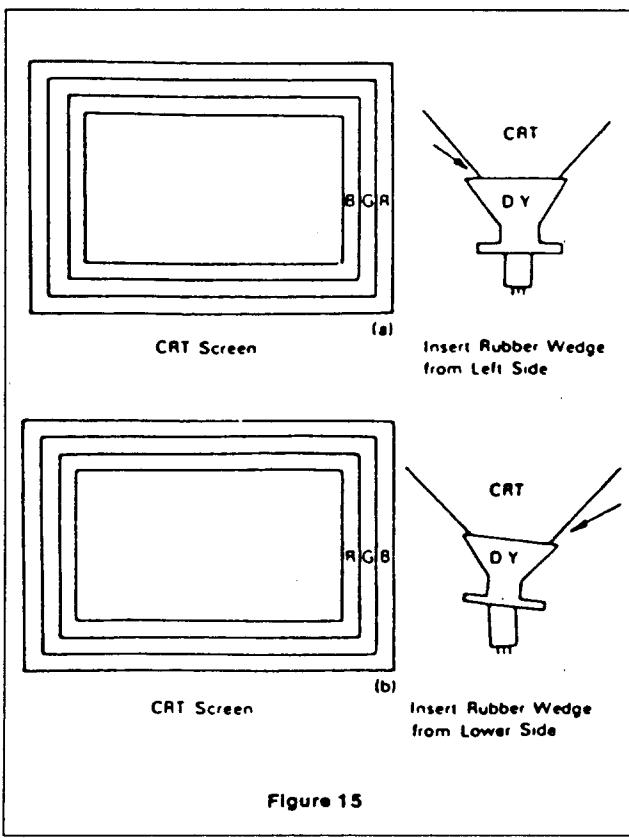
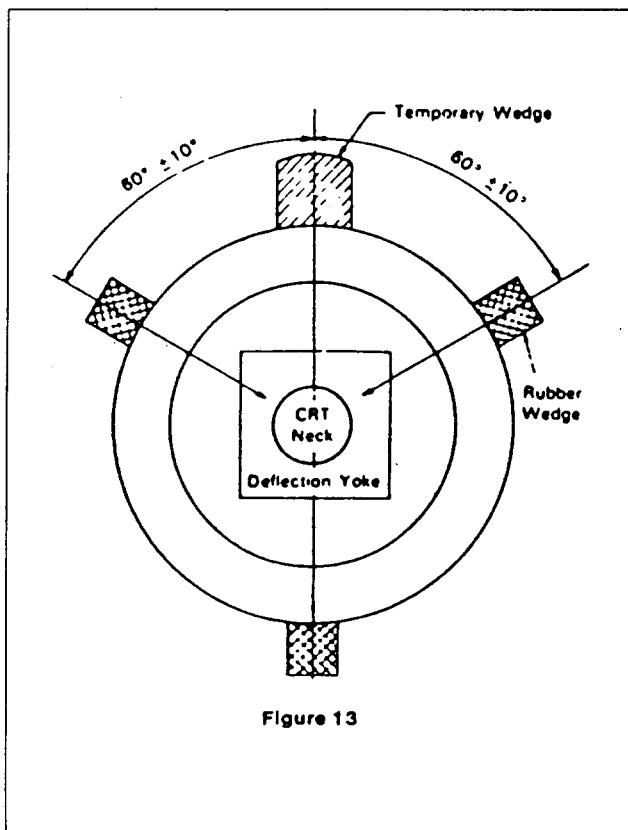


Figure 15

the red and blue horizontally, the other vertically. It may be needed to go back and touch up the red and blue rings.

The static convergence is only for adjusting the center portion of the screen. The dynamic convergence is for the outer edges of the CRT. This is done after purity, white balance and the static convergence is completed. With the rubber wedges being out from between the CRT and yoke, slightly loosen the yoke fastening screw. Tilting the yoke up or down and left or right causes the cross hatch pattern on the top, bottom and sides to separate the colors of red, blue and green. Position the yoke so the outer edges converge properly, then tighten the fastening screw on the yoke. If the entire yoke is turned on the neck of the tube, the screen will be on a slant. Replace the rubber wedges.

Normally, convergence is only needed during a CRT replacement. The following pages list the manufacturer's set-up procedures regarding convergence.



### WELLS GARDNER STATIC CONVERGENCE ADJUSTMENT

A recently developed Deflection Yoke and Electron Guns construction has been used on this equipment in combination with In-Line Guns and Black Stripe Screen to make a barrel-type magnetic-field distribution for vertical deflection and a pin cushion-type magnetic field for horizontal deflection with which a self-converging system can be obtained. This type is different from conventional unity-magnetic field distribution type deflection yoke. 4-Pole Magnets and 6-Pole Magnets are employed for static convergence instead of a Convergence Yoke.

1. A cross hatch signal should be connected to the monitor.

2. A pair of 4-Pole Convergence Magnets are provided and adjusted to converge the blue and red beams. When the Pole opens to the left and right 45 degrees symmetrically, the magnetic field maximizes. Red and blue beams move to the left and right oppositely. Variation of the angle between the tabs adjusts the convergence of red and blue vertical lines.

When both 4-Pole Convergence Magnet Tabs are rotated as a pair, the convergence of the red and blue horizontal lines is adjusted.

3. A pair of 6-Pole Convergence Magnets are also provided and adjusted to converge the magenta (red + blue) to green beams.

When the Pole opens to the left and right 30 degrees symmetrically, the magnetic field is maximized. Red and blue beams both move to the left and right.

Variation of the opening angle adjusts the convergence of magenta to green vertical lines. When both 6-Pole Convergence Magnet Tabs are rotated as a pair the convergence of magenta to green horizontal lines is adjusted.

**PRECISE ADJUSTMENT  
OF DYNAMIC CONVERGENCE  
(See Figures 14 and 15)**

1. Feed a cross hatch signal to the monitor.
2. Insert the temporary wedge and fix Deflection Yoke so as to obtain the best circumference convergence (see Figures 14 and 15).
- NOTE:** The temporary wedges may need to be moved during adjustments.
4. Insert three rubber wedges to the position as shown in Figure 13 to obtain the best circumference convergence.

**NOTE:**

1. Tilting the angle of the yoke up and down adjusts the crossover of both vertical and horizontal red and blue lines. See Figure 14(a) and (b).
2. Tilting the angle of the yoke sideways adjusts the parallel convergence of both horizontal and vertical lines at the edges of the screen. See Figure 15 (a) and (b).
3. Use three rubber wedges (thick and thin rubber wedges are used for a purpose).
4. The angle of each rubber wedge is shown in Figure 13.
5. After three rubber wedges have been inserted, pull out the temporary wedge.
6. Fix the rubber wedges with chloroprene rubber adhesive.

**ELECTROHOME STATIC AND  
DYNAMIC CONVERGENCE**

**NOTE:** Static convergence is achieved by four magnets located on the neck, nearest the base of the picture tube, Figure 8. The middle pair of magnetic rings are adjusted to converge the blue and red cross hatch lines. The rear pair of convergence rings (closest to the base of the picture tube) are adjusted to converge the magenta (blue/red) to the green cross hatch lines. Dynamic convergence is achieved by tilting the deflection yoke up-down and left-right.

1. Ensure that the controls misadjusted during purity setup (screen, cut-off, etc.) are set to give white balance.
2. Switch generator to the cross hatch pattern.
3. Adjust convergence around the edges of the picture tube by tilting the yoke up-down and left-right, and temporarily install one wedge at the top of the yoke or in a more optimum position (Figures 20, 21, 22).
4. Turn off green input and turn on the red and blue input.
5. Rotate the 4-pole (middle) pair of magnets as a unit to minimize separation of the red and blue cross hatch lines around the center of the screen (Figure 18). Variation of the angle between the tabs adjusts convergence of red and blue. (Tilt yoke as required to converge red and blue at the edges as in 3 above).
6. Turn on green input to obtain magenta (red/blue) and green cross hatch lines. Rotate the 6-pole (rear) pair of magnets as a unit to minimize separation of the magenta and green lines (Figure 19). Vary angle between the two tabs and further rotate as a unit to finalize.
7. When convergence of 3 colors is optimized (static in center and dynamic around edges), apply stripe of paint or nail polish to convergence magnet rings to prevent movement. If applicable, tighten locking ring carefully.
8. Remove temporary wedge from yoke. Tilt yoke in up-down and left-right direction for best circumference convergence and install 3 wedges. It is best to use 3 new wedges since they have adhesive backing. Simply pull off tape, slide wedge in place and press outer flap down firmly. For more permanency apply small quantity of silastic or similar material at junction of wedges and picture tube. Do not disturb while material is setting. (Order wedges by part number 39-1233-01)

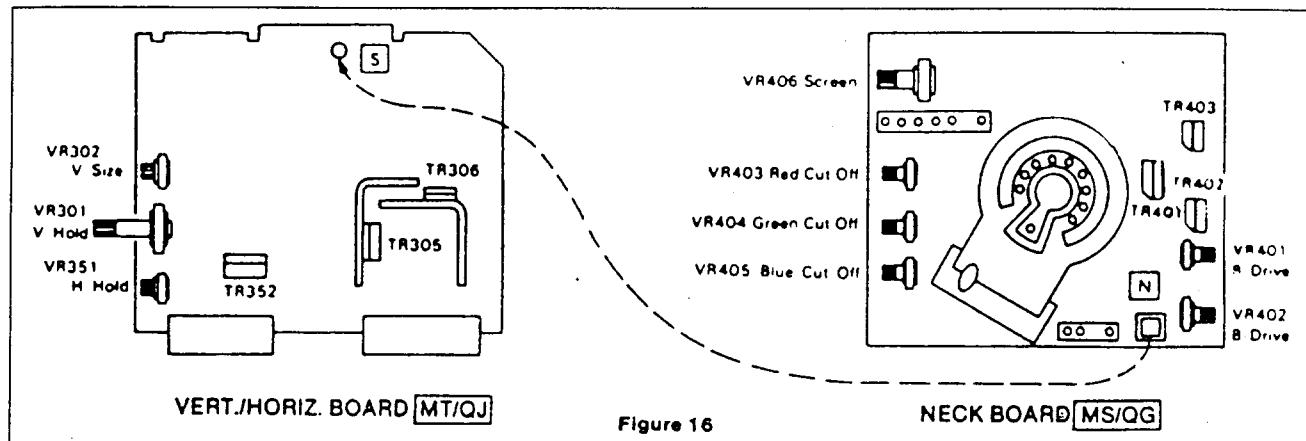


Figure 16

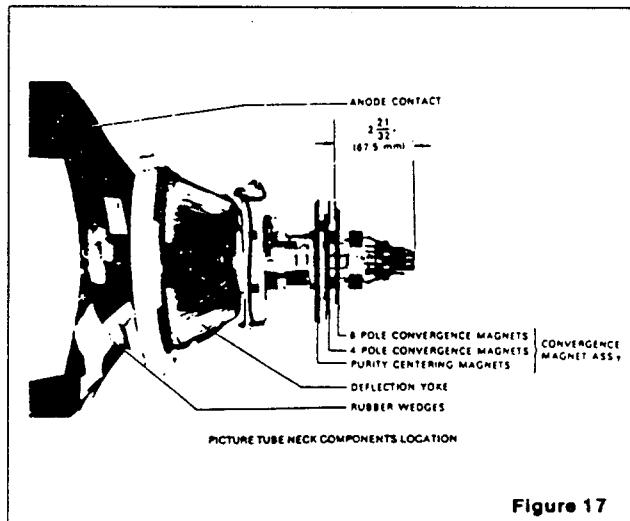


Figure 17

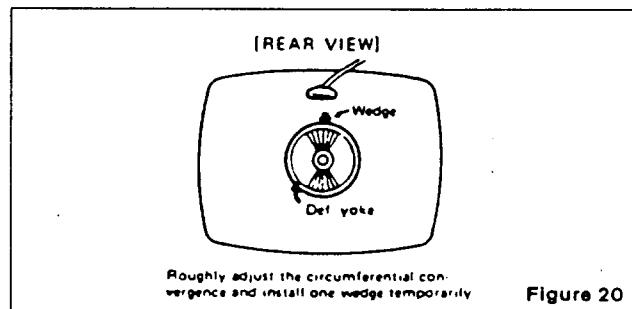


Figure 20

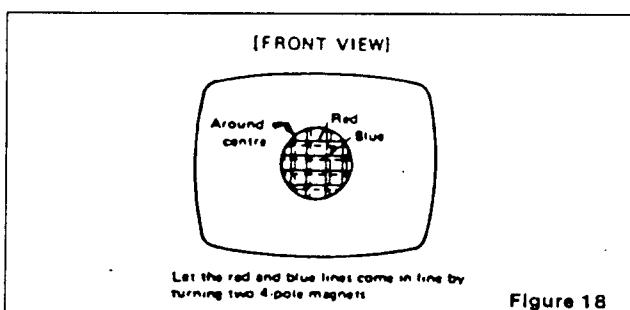


Figure 18

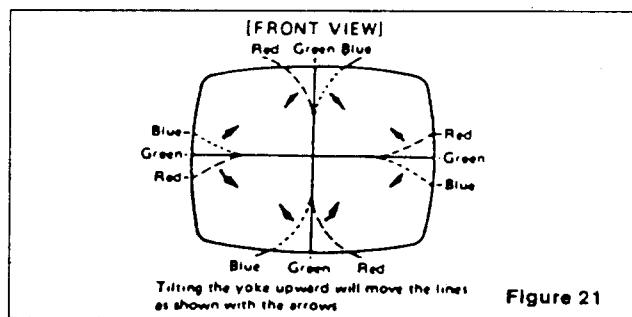


Figure 21

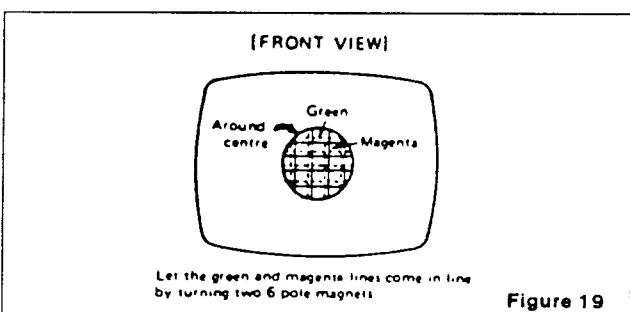


Figure 19

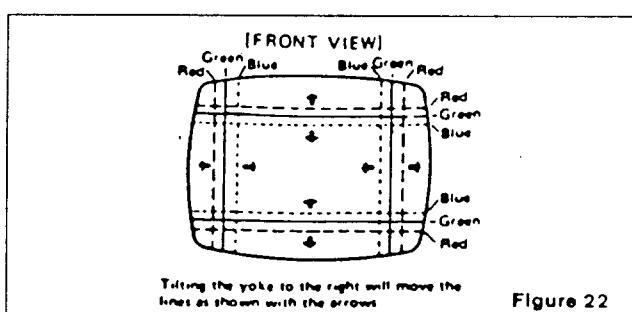


Figure 22

### Bally Midway NFL Football Vertical Roll with Slave Monitor

#### SUBJECT

Vertical roll condition when adding display monitor (Slave Monitor on Top of Game).

#### MODIFICATION

1. Check for proper wiring on monitor interface cable.
2. Change IPU Board ICs at location 11D, 12C and 12D from 14016 to 4066. (A080-91695-AA34).
3. If needed, adjust vertical rolling with vertical roll pot.

### Bally Midway Monitors Differences, Parts and Picture Tube Interchangeability

#### DIFFERENCES BETWEEN MONITORS

The easiest way to identify the brand of monitor you are working with is to find the manufacturer's name or model number printed on the chassis or chassis base. But what if the monitor was in a Texas dust storm or burned in volcanic ash and this information is no longer there? Fear not! Each monitor has its own peculiarities and the following should help to identify them:

The ELECTROHOME GO7-904 (19") and GO7-902 (13") have their horizontal and vertical processing IC hidden under a silver can. A shiny metal top behind the "VERTICAL HEIGHT" and "HORIZONTAL FREQUENCY" control prove this is an Electrohome monitor.

The WELLS GARDNER K4906 (19") and K4806 (13") have their horizontal and vertical processing IC out in the open directly behind the "VERTICAL HOLD" control.

The ZENITH CO19MXRFO6 (19") monitor has its horizontal and vertical processing IC way in back by the picture tube. The monitor also has large white cables going from the main board to the neck board.

**K4906 (1st TYPE)** - This monitor's identifying tags have BLACK ink printed on a white back-

ground. There is NO Vertical Damping Control. (This control would be next to the Vertical Hold Control, but this area is jumpered with a small wire instead.)

**K4906 (2nd TYPE)** - This monitor's identifying tags have RED ink printed on a white background. There IS a Vertical Damping Control next to the Vertical Hold Control. The Damping Control provides a few more lines on the top of the monitor screen (monitor viewed as a normal TV would be) for any video game that may need these lines to fit the picture on the screen. Moving the control may distort the top part of your picture (or the side, depending on the game and how the monitor is mounted) so go ahead and move it if you are having this type of problem. To accommodate this new feature, there are a few circuit changes.

*ONE MAJOR DIFFERENCE BETWEEN THESE TWO VERSIONS OF THE K4906 IS THE YOKE.* They look the same, but notice the part numbers:

K4906:  
WITHOUT the Damper Control: 2021111201

K4906:  
WITH the Damper Control: 2021111258

Since the companies like to change part numbers at the drop of a hat, the best thing to do is to request whatever part number is written on your yoke. If you should get the wrong yoke, the results will be:

Picture distortion  
Excessive brightness  
Too much or too little vertical picture size

#### CONTROLS YOU MAY NOT TOUCH

Basically, on the Electrohome monitor, you can move any control you want EXCEPT for the B1 control. This sets the power supply voltage (ideally at 120vdc) and is located right behind VERTICAL HOLD. The 13" Electrohome DOES NOT have this control. It may also be wise not to move the VERTICAL LINEARITY since this distorts the picture and is hard to reset perfectly. If you do move it, turn on the Crosshatch Test Pattern of your game and try to get the squares to the point where they are equal in size by readjusting this Linearity Control.

On the Wells Gardner monitor, brightness is adjusted by the "BLACK LEVEL" Control which is right next to the Horizontal Frequency Control. Under the Focus Control is the "SCREEN" Control which you DO NOT touch. Yes, this control does adjust the brightness, but it is used to set the CRT bias and is adjusted at the factory. When Wells Gardner sets it, they mark the position with a black mark on the knob. If you move it, be sure to realign the mark and THEN set the BLACK LEVEL Control to the brightness you desire. So, other than the SCREEN Control, you may adjust any of the controls.

The Zenith monitor has a 95-volt adjustment control. It is green and located behind the jack labeled 3D3. To discourage you from moving it, Zenith has placed a little glue on top of this control.

#### **PARTS INTERCHANGEABILITY**

Some parts can be interchanged on all of the monitors. Here are the rules:

1. You CAN swap any resistor between monitors that have the same resistance, wattage rating and tolerance.
2. You CAN swap any capacitor between monitors that has the same capacitance and voltage rating.
3. You CAN swap many of the parts between the 19" and 13" versions of each manufacturer's monitor. BUT, be certain to compare the manufacturer's part numbers to be positive the parts you want to interchange are identical. BE SURE you have read the section DIFFERENCES BETWEEN MONITORS.
4. You MAY BE ABLE to swap picture tubes between monitors. In the past you could swap any picture tube, but due to rampant engineering changes and new monitor models being introduced, you would need a computer to keep track of what could be swapped. For more information on this subject, go to "PICTURE TUBE INTERCHANGEABILITY."
5. You CANNOT charge any part that is a safety part, one that is shaded in gray on the schematic; it MUST be IDENTICAL to the original. To do otherwise IS DANGEROUS. For instance, the 13"

Electrohome (GO7-902) monitor "flyback" looks identical to the 19" Electrohome (GO7-904) monitor "flyback." In fact, there is even a 19" Electrohome (GO7-905) monitor (which is an obsolete model) with a similar looking "flyback." **NONE OF THESE ARE INTERCHANGEABLE!**

6. You CAN change any of the parts between the GO7-904 and GO7-907. They're essentially the same monitor except that the GO7-907 has a vertically mounted picture tube.

If there is any doubt about what parts can be swapped between each manufacturer's 19" and 13" models, compare the manufacturer's part number between each one. If they match up, they are the same part.

#### **PICTURE TUBE INTERCHANGEABILITY**

##### **13" MONITORS**

There are currently two 13" monitors being used: the Wells Gardner K4806 and the Electrohome GO7-902. The picture tubes used are NOT interchangeable. The pins on the neck of the CRT will not fit in the socket should you use the wrong CRT.

Here is a chart for all the 13" color monitors Bally Midway uses:

**ELECTROHOME - GO7-902-370ESB22  
WELLS-GARDNER - K4806-370KSB22**

##### **19" MONITORS**

Here it gets a little tricky. All of the picture tubes will fit no matter which is used. But if you use the wrong one, you will have problems with purity and/or dynamic convergence.

Purity trouble means that the color won't be true. If you turn up the color control for one color, instead of seeing that solid color, it will show blotches or blobs of other colors on the screen.

Trouble with dynamic convergence means that there will be color fringing around solid lines at the edges of the screen.

The only way to ensure that you avoid these problems is to get the right picture tube or the right substitute.

Here is a list of the 19" monitors and the CORRECT CRT numbers:

**ALL ELECTROHOME GO7-904 -**

19VMNP22 - RCA  
19VMJP22 - Rauland  
51OUJB22 - Hitachi

**WELLS GARDNER K4906 -**

19VLTP22 - RCA  
19VMLP22 - Zenith  
19VMKP22 - Phillips

**ZENITH CD19MXRF06 -**

19VMLP22 - Zenith  
19VLTP22 - RCA  
19VMKP22 - Phillips

**Bally Midway Monitor Connection Precaution**

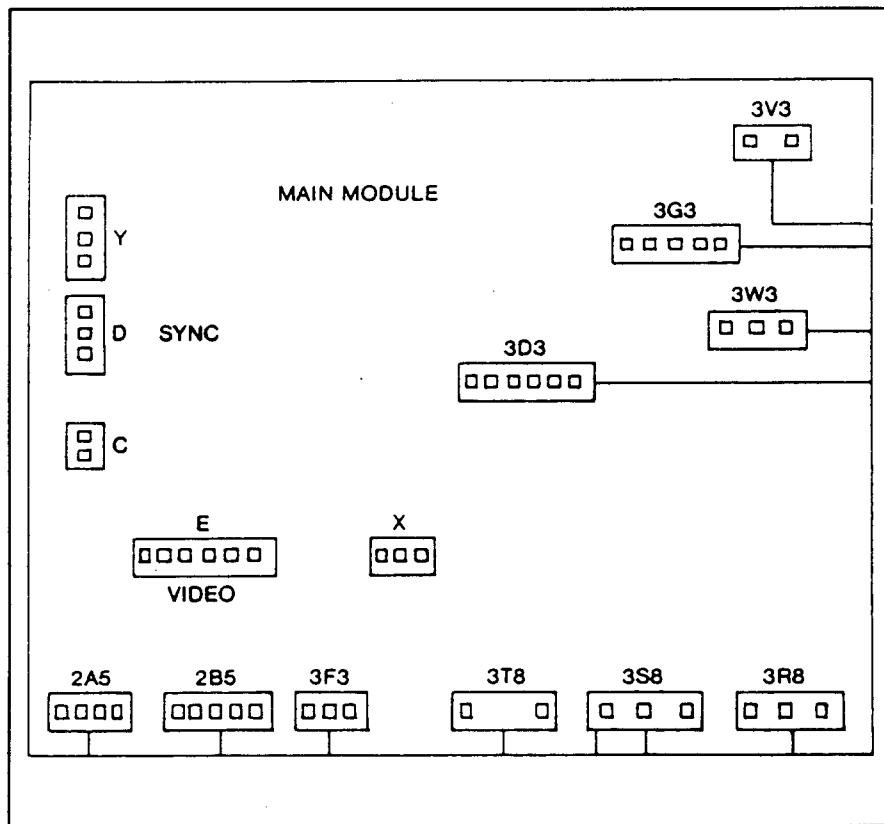
**SUBJECT**

Zenith Color Monitor- Model CD-19MXRF06  
(Sync Cable Hook-Up)

1. 6-pin video connector to jack labeled "E."
2. 3-pin video connector to jack labeled "D."

The pin jack marked as "X" is a 26 and 12 volt source from the monitor. Do not connect the sync connector to the "X" jack. Possible logic sync damage may occur (See figure below).

The factory-recommended CRT-type could change in the future for one reason or another, but the listed picture tubes will work. As a matter of fact, you can call another picture tube company to see if they have a replacement number to recommend but... caveat emptor - let the buyer beware.



# 4

## Cinematronics Monitors Tips & Info

### Vectorbeam Monitors Demystified (Part 1)

Finally, all you've ever wanted to know about vector displays but were afraid to ask! After reading this three part article, your sex life will improve, your car will never fail again, the price of gasoline will go down and the hostages will be released. Take it from some guys just like yourself who couldn't pour water out of a pail with the directions on the bottom:

"Who's Victor Bean, anyway?" - Larry Rosenthal, MIT Graduate Inventor of this system

"I see the light. Now get that match out of my face." -Don Wright, Customer Service Engineer

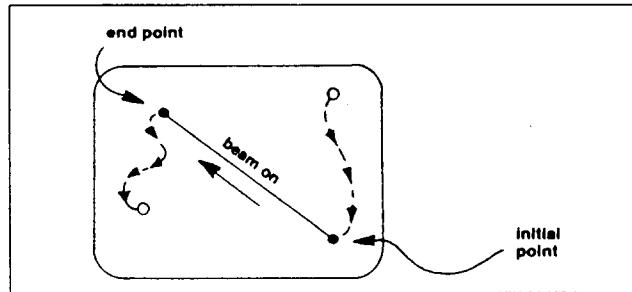
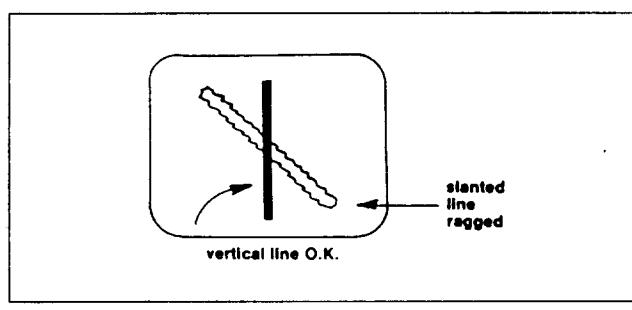
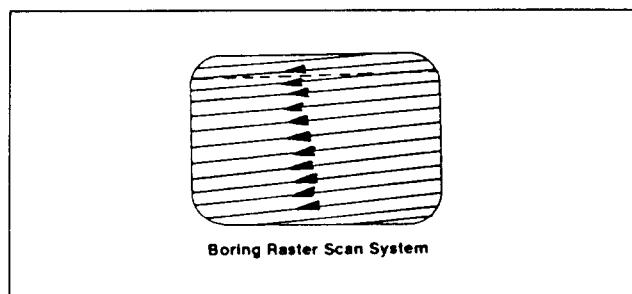
"Yes, uh, MacDonald's? Could you send me an application..." -Jim Larkin, Service Tech

#### VECTOR THEORY

#### Vector Vs. Raster

On a typical, boring raster system, the beam is constantly scanned horizontally across the face of the CRT as shown below. It takes about 525 sweeps for the beam to cover the entire picture; but only 425 lines comprise the actual viewfield. In order to draw a character on the raster display, the beam is turned on at the right point in the scan pattern, and turned off otherwise. Hence all images are displayed in horizontal "slices." The drawback is that slanted lines appear non-uniform and ragged due to this "slice" display technique, as shown:

On an exciting vector display, lines drawn at even smaller angles are perfect and exact. The resolution and detail possible is equivalent to that found on a good oscilloscope, and, as a matter of fact, the operation of both are identical when the scope is used in the X-Y mode! This is because when a line is drawn on a vector system, the beam is



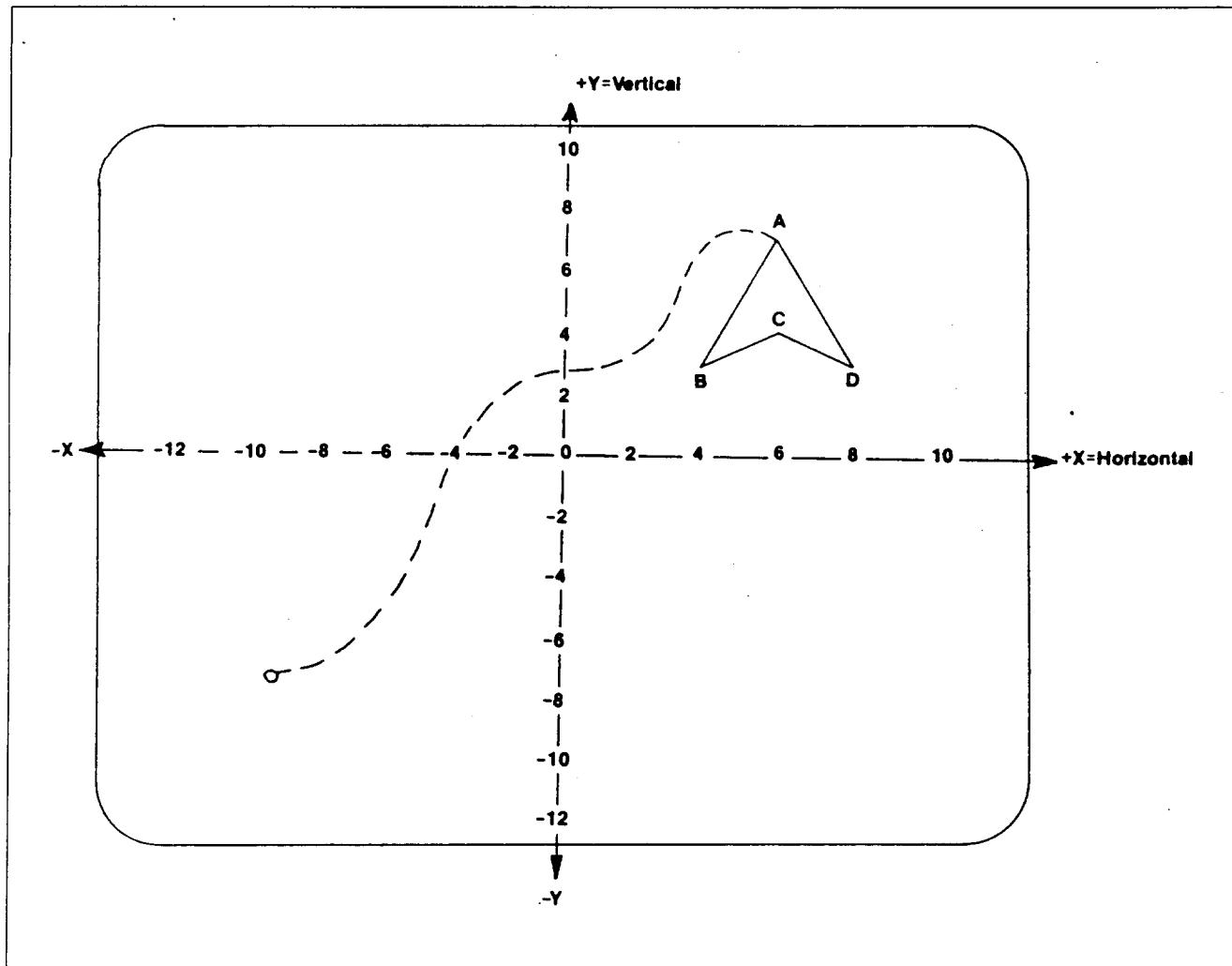
initialized at one end of the line, turned on, and deflected smoothly to the end point of the line resulting in a perfectly smooth, scope quality vector. Whom would you want your daughter going out with: a raster man or a vectorbeam man?

### Vector Math

A vector system is so named because all the characters are made of straight lines termed "vectors" in math-talk. A vector is simply a line that has an initial starting point and a final end point. If the face of the picture tube is divided into so many horizontal counts and so many vertical counts, the end points of a vector can be found by starting in the center and going so many counts horizontal and so many counts vertical. A piece of cake, eh?

Let's divide the screen into horizontal and vertical counts as shown:

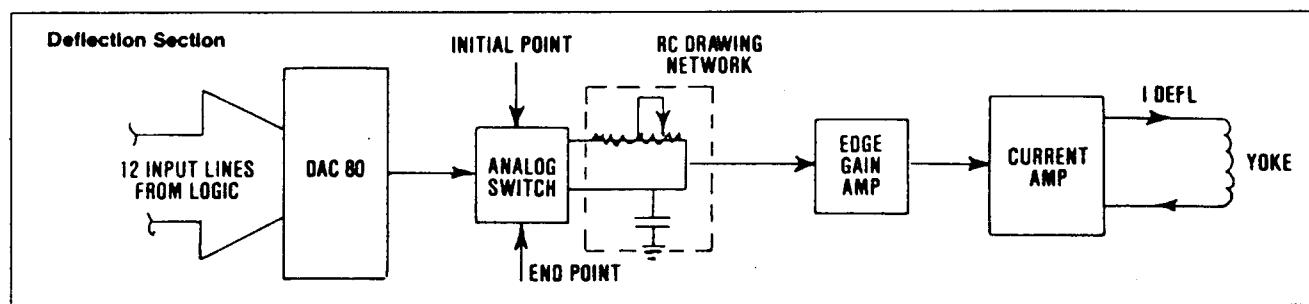
In order to draw the ship, we need to specify the initial point of the vector segment AB. To get to point A from the origin, we need to go 6 counts positive horizontally and 7 counts positive vertically. Point A therefore has coordinates (6,7). Similarly, B has coordinates (4,3). If the beam was screwing off somewhere else in the picture, feeding the deflection section of the monitor the initial point A coordinates (6,7) would cause the beam to fly to that point. Next we simply turn the beam on and feed in endpoints (4,3) and the beam proceeds to that point. To complete the picture, we just specify the coordinates for C and D. Now wasn't that easy!



### The Beginning

Some smart guy discovered that a magnet placed close to a beam of electrons caused the beam to bend or deflect slightly off a straight course. The stronger the magnet, the more the deflection. From this he decided to take a beam of electrons, a coil of wire, and some electronics to provide a variable current source and make a device for watching commercials. He now has no more friends - but with his bucks, who needs 'em. Anyway, the figure below illustrates the device he came up with:

The filament heats up a piece of metal called the cathode. This excites the electrons which are attracted by the 18KV potential at the face (anode) of the CRT. What we actually see is the energy released from the electrons when they strike the phosphors at the tube face. Current entering the horizontal and vertical deflection coils can position the beam at any coordinate point on the face of the tube. A focus voltage narrows the beam into a fine diameter.

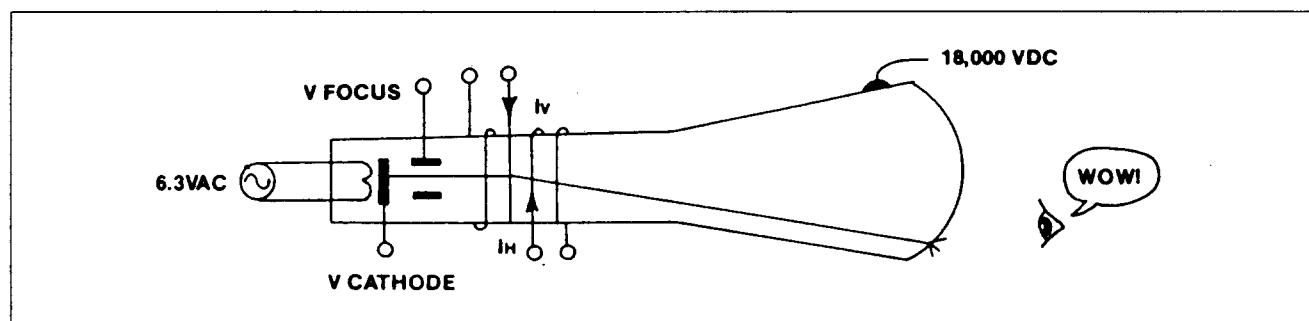


### Vectorbeam Monitors Demystified (Part 2)

#### MONITOR THEORY & TEST PROCEDURE

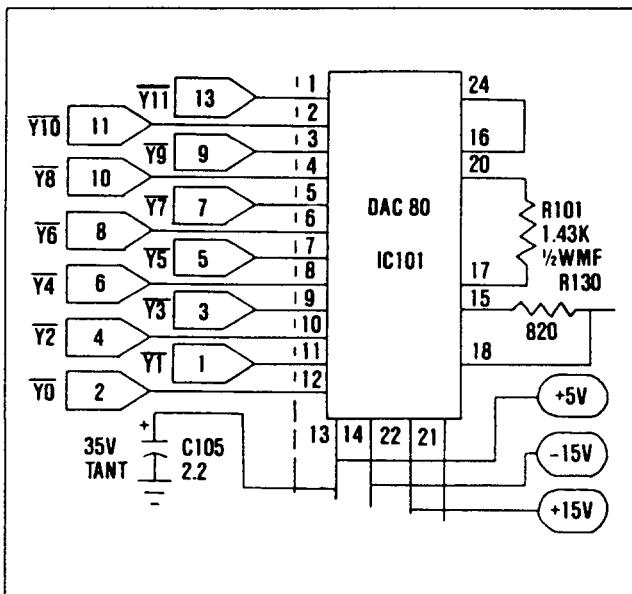
The circuits on the vector monitor can be grouped into 3 categories: the deflection circuit, high voltage oscillator, and intensity control. The most common failure mode is blowing +25V circuit breakers CB1 & CB2. The breakers limit the current going into the yoke to about 3 amps. To troubleshoot, disconnect the yoke winding, reset breakers and power up. The breakers should not blow. If they do, the problem is one of the power transistors on the left side panel heat sinks.

The deflection circuit receives numbers from the logic board in digital form that represent the coordinates for the beginning and end points of each line segment. The output is a current to the yoke windings that is proportional to this number. So the purpose of the deflection circuitry is to convert a binary coded number into a current.



**DAC-DIGITAL TO ANALOG CONVERTOR**

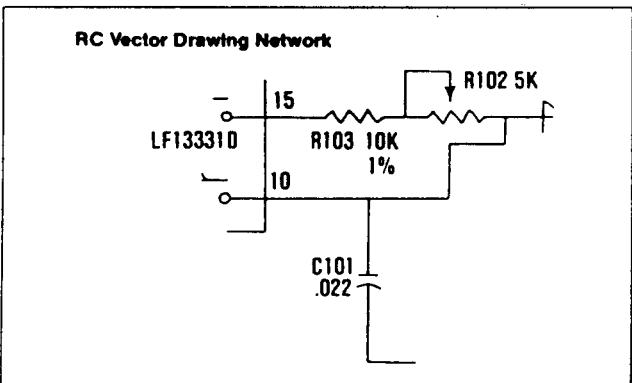
The first step is to convert the digital coordinate number into an analog voltage. The DAC 80 is a device that does this.



Pins 1 thru 12 can represent any number between -2,048 and +2,047. The output voltage range is from -5 volts to +5 volts. When a DAC is operating properly, the output signal is centered about 0 volts and bounded between +-5 volts.

**TEST PROCEDURE**

Verify proper power on pins 13, 14 and 22. Remove analog switch. A DC meter should read approximately 0 volts at pin 15. Check pins 1 thru 12 with a logic probe, most of the lines should be pulsing.

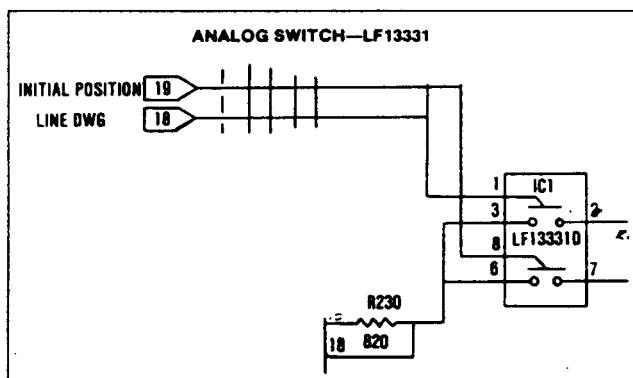


The analog switch is the most active component on the monitor. Both horizontal and vertical DAC output voltages pass through this switch and then become converted into currents to deflect the beam to proper positions on the screen. It is mounted in a socket for easy removal and should be a prime suspect for a monitor that blows circuit breakers.

The switch passes the voltage output of the DACs through either of 2 channels: the lower channel is for the initial position coordinate of a line segment, and the upper channel for the final coordinate. The channels are controlled by the CPU: initial position on pin 8 and line drawing (final coordinate) on pin 1. If the upper channel in the switch is defective, say, in the vertical section, then there will be no vertical lines on the display. The same is true for the horizontal.

**TEST PROCEDURE**

There should be a charging waveform centered about 0 volts on the switch output pins. The upper channel waveform should be of greater peak to peak magnitude than the lower channel. Replace the switch.



The RC network is responsible for drawing smooth, straight and precisely positioned vectors. It combines the 2 channels of the analog switch in the manner necessary to draw the vertical and horizontal line segments.

Initial position voltages enter from the lower switch channel directly across C101, which charges to that level extremely rapidly. This voltage is converted to an initial position current that

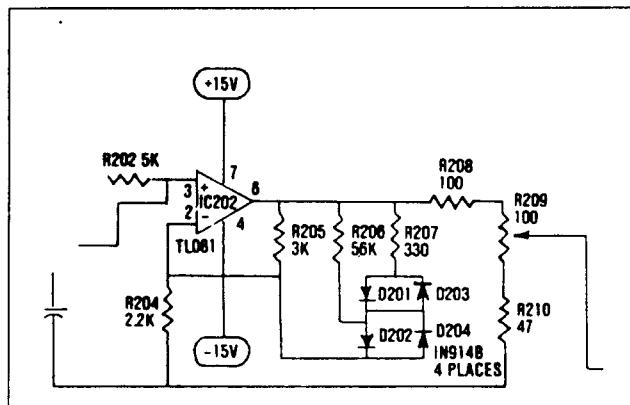
positions the beam at the beginning point of a line segment.

Final position data from the upper switch channel slowly charges C101 through R103 and line length pot R102. As C101 charges from its initial point value to its final value, a straight vector is drawn. It's as simple as that!

Pot R102 varies the charge rate of the network, and can lengthen (faster charge) or shorten (slower charge) the vector for the "on" period of the beam.

#### TEST PROCEDURE

If line segments are adjustable but bowed, replace C101. If line segments cannot be adjusted to intersect, verify proper resistance of R103 and R102 as R102 is rotated.



The edge gain amplifier is the final stage before the voltage to current conversion process. The input on pin 3 is a waveform that is the composite initial position and final position data signals. The amplifier has an overall gain of about 2 at output pin 6. The waveform should resemble the DAC output but is bounded between +2 volts, centered about 0 volts.

It is a property of the CRT that, near the edges, the amount of current needed to move the beam, say, an inch, is less than the amount required to deflect the beam an inch off the center. Therefore, less gain is required near the edges of the CRT.

The amplifier circuit reduces gain as the output voltage increases, indicating a larger beam dis-

placement, by switching on diodes D201 and D202 for the left half of the screen, and D203 and D204 for the right half. This places R206 and R207 in parallel with R205, reducing its value and consequently the gain. If a figure increases in size near the display edges a diode is open.

R209 is the horizontal picture size control. By picking off larger or smaller voltages, the width of the picture is controlled.

#### TEST PROCEDURE

Observe signal at pin 3. Waveform at pin 6 should be the same with an average gain of 2. Signal should be centered and bounded between +2 volts. Check D201-D204. (See illustration)

The deflection amplifier converts the pick off voltages from the size pot into a current to drive the yoke winding. The input is a differential stage consisting of transistors Q101, Q103, and Q102. Q102 is a constant current source and a fixed amount of current always flows through it. If this current varies, the picture will be offset from center. Too much offset will cause circuit breakers to blow.

This reference current is determined by the voltage drop across R119. Diodes D105 and D106 determine this drop. The voltage across one of the diodes is cancelled by the base-emitted voltage of Q102. R119 should constantly read .6 volts DC. This means a constant flow of about 3ma through Q102.

This 3ma bias must come from the emitters of Q102 and Q103. Excess current is picked off at the collector of Q101 and feeds pre-driver Q104. The constant current source for pre-driver Q104 is Q105, D107, D108 and R116. Bias current through R116 is about .22ma.

Current is delivered to the yoke in a push-pull manner by transistor pairs Q108 and Q110 for positive current transitions and Q109 and Q111 for negative current transitions. Q110 and Q111 are power drivers mounted on humongous heatsinks on the left side panels.

Diodes D109, D110 and D111 set up a crossover voltage threshold to prevent both halves of the push-pull output from turning on at the same

time. Should one of the diodes open, only half of a display will be generated. Should they become resistive, both power transistors will turn on simultaneously and generate excessive heat.

If more than 3 amps are drawn through sense resistors R120 and R121, transistors Q106 and Q107 turn on and shoot off the power driver by sinking the base current to drivers Q108 and Q109. This protects the hardware against further damage.

Voltage wise, the CRT is bounded according to the above drawing. If there is a problem with the upper half of the picture, it is with the circuit elements connected to the -25 volt line in the deflection amplifier. If, say, the last half of the picture is missing, suspect the elements connected to the +25 volt side of the horizontal deflection amplifier.

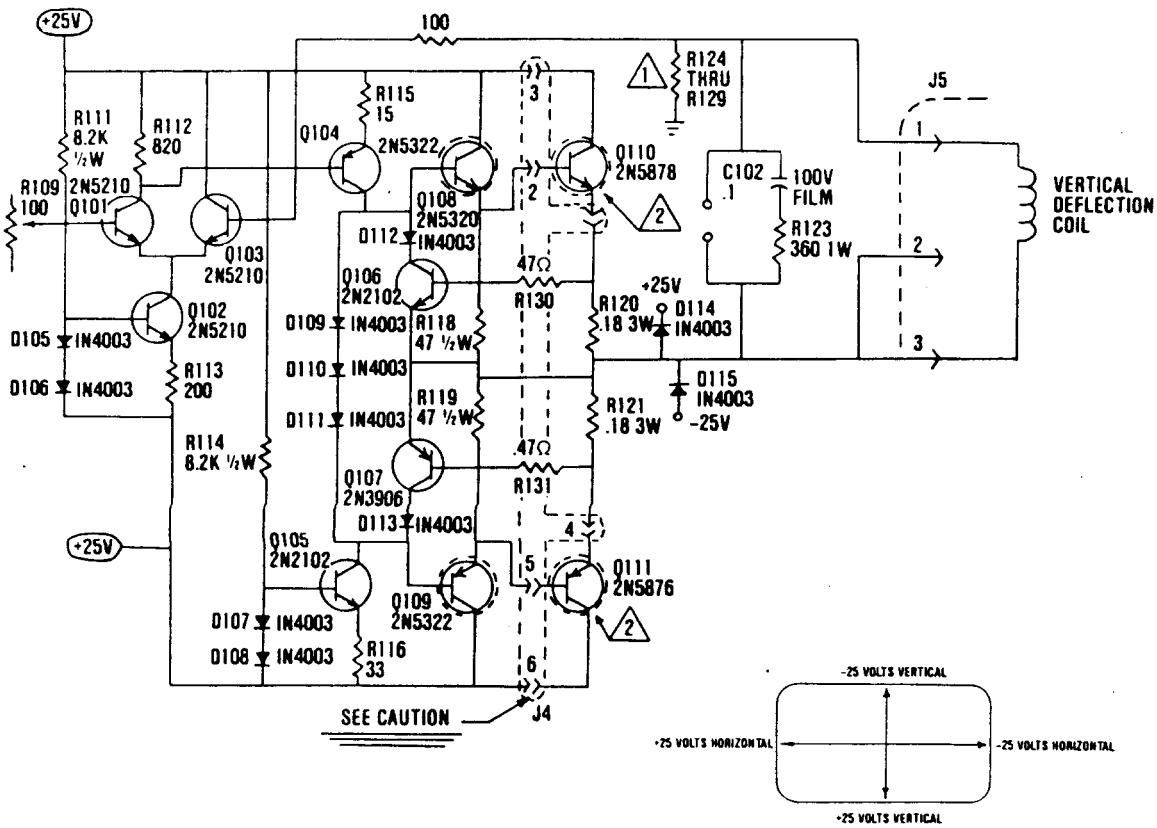
#### TEST PROCEDURE

If the game is blowing circuit breakers the problem 9 times out of 10 is a transistor in the deflection section. Recommended procedure is to check each transistor in circuit with a transistor checker. Lift diodes D112 and D113 to check transistors Q106 and Q107, D212 and D213 in the horizontal section.

If a scope is available, the defective channel can easily be located. Step 1: Remove yoke connector from display board. Step 2: Reset breakers and power up game. With scope, probe the cases of transistors Q104 and Q204. There should be pulses clipped at +25 volts and -25 volts. The defective channel will not have these.

Replace the analog switch, IC1. This is the quickest manner to verify proper operation. Once the channel is located, start at the DAC's and proceed forward according to the aforementioned theory.

#### Deflection Amplifier



# Vectorbeam Monitors Demystified (Part 3)

### INTENSITY CIRCUIT

The beam can be turned on and off by applying the proper voltage level to the CRT cathode. Beam cut off is +90 volts DC. At this potential, the electrons excited by the filament prefer to remain on the cathode and none make it to the CRT. Lowering this potential allows more electrons to escape to the anode. We can then produce a Normal Intensity level by lowering the cathode potential to 40vdc and a Hi Intensity by lowering the potential to, say, 20vdc.

The computer produces two intensity levels by sending low pulses to pins 1 and 3 of IC7. Pin 1 is the HI INTENSITY channel and consists of IC7 and Q1. The NORMAL INTENSITY channel consists of another part of IC7 and Q3.

A beam blanking voltage of +90vdc is generated from pin 8 of the H.V.XFMR secondary winding, D6 and C17. This half wave rectifier supplies this +90 volts to one terminal of the brightness pot. The wiper of this pot picks off the proper voltage and sends it through the yellow cathode wire to the CRT plug socket.

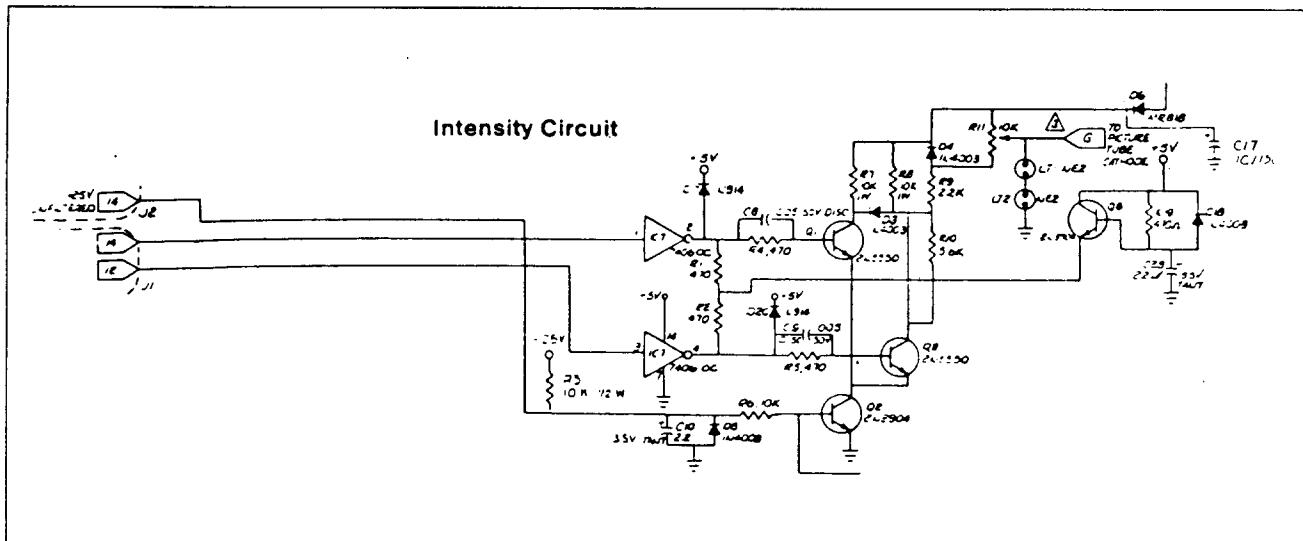
With Q1 and Q3 both off or Q2 off, current has no path to ground and the wiper voltage will be +90 volts regardless of the brightness pot setting. For a NORMAL INTENSITY vector, pin 3 of IC7 pulses

low. Pin 4 then pulses high to 2.75 volts, turning on Q3. Current flows through R11, R9, R10 and through Q3 to ground via Q2. This drops the voltage at the cathode to about +40 volts with the brightness pot full clockwise.

For a HI INTENSITY vector, pin 1 of IC7 pulses low. Output pin 2 pulses high to 2.75 volts, turning on Q1. Current flows through R11, R9, through Q1 and to ground via Q2. This drops the cathode level to about 20 volts with the brightness pot full clockwise.

The yellow wire to the cathode should show a 90 volt DC base with negative going pulses that vary as the brightness pot is turned. For a no display condition, suspect IC7(7406). The chip is an open collector inverter and must have a pull-up resistor on its output. Verify that 4-5 volts is always present at the junction of R1 and R2. This voltage is supplied by Q8, which is in an RC delay circuit to allow all voltages to settle on power up before a picture is displayed.

Q2 is designed to open the intensity circuit immediately after power is removed from the game. This prevents the +90 volt blanking voltage from bleeding off before the high voltage bleeds off, thus preventing a spot when the game is unplugged. Q2 is kept on continually by a full wave rectified, unfiltered signal from the power supply through fuse F1 (.5A). For a no display condition eliminate Q2 as a source of trouble by jumpering its collector to emitter.



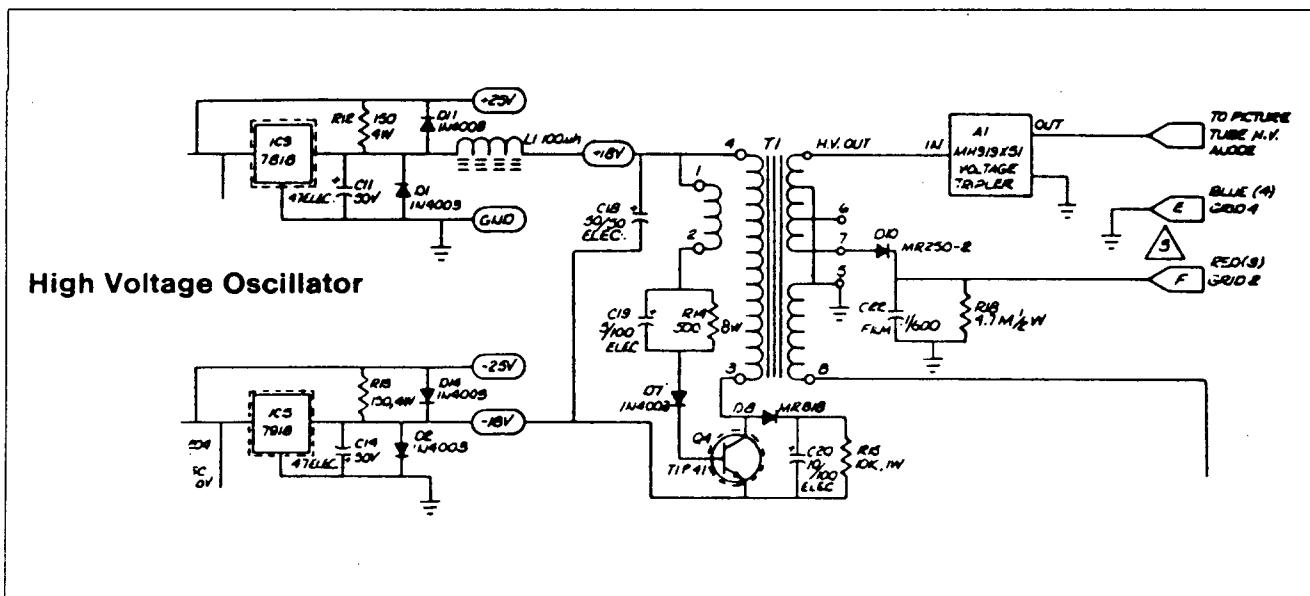
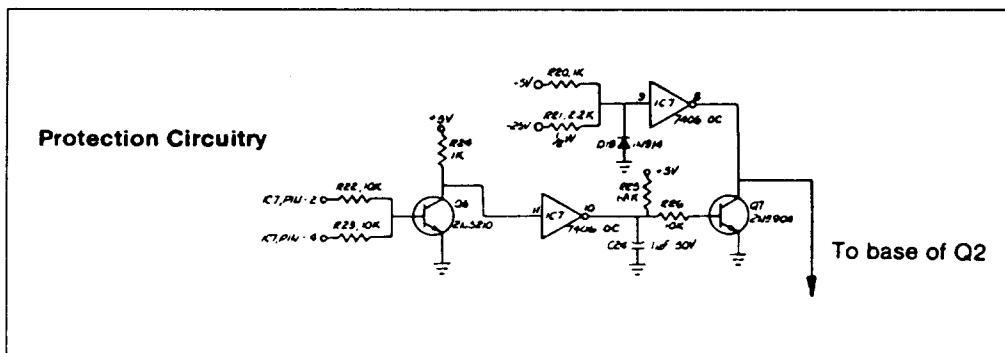
## PROTECTION CIRCUITRY

Q2 can be considered as the master intensity control switch. When it is deprived of its base drive, the collector-emitter junction opens and eliminates the ground path for the intensity channels, cutting off the beam. The logic board can fail in such a way as to cause the beam to remain on continuously, burning the CRT phospher.

R25 and C24 form an RC time constant of about 6.8ms. Since most of the vectors on the display require only microseconds of beam time, any turn on pulse from the CPU 6.8 ms or wider constitutes a failure mode. The outputs of IC7-2,4 are sampled by Q6, which inverts the pulses and feeds them to IC7 pin 11. IC7 is an open collector inverter and its output stage looks as follows:

When the input is high, the output transistor turns on and essentially shorts pin 10 to ground. When the input is low, the transistor turns off and opens the circuits. So, for example, a high pulse at IC7-4 of 10ms duration becomes a low pulse at the collector of Q6. This causes IC7 pin 10 to open the circuit, allowing C24 to charge. Since the pulse width is greater than 6.8ms, C24 has ample time to charge and turns on Q7, which shorts the base of the master intensity switch Q2, killing the display.

Another protection circuit involves R20, R21 and pins 9 and 8 of IC7. Pin 9 is normally held negative by the voltage divider of R20 and R21. Should the circuit breakers blow and we lose -25 volts, pin 9 goes positive causing pin 8 to short the base of Q2, again killing the display.



**TEST PROCEDURES**

To isolate a no display condition to the intensity circuit, probe the yellow cathode wire at the CRT plug, turn the brightness full clockwise and observe a +90 volt base with pulses at 40 volts. If pulses are missing, jumper Q2 collector to emitter. If picture returns, check F1 in power supply. Replace Q2.

Observe 2.75 volt pulses at pin 4 of IC7. If missing, verify pulses at input pin 3. Check for +5 volts at junction of R1 and R2. Replace IC7.

If pulses are at +4 volts, replace Q2. The output of pin 4 will exceed 2.75 volts if there is no load due to a failed transistor.

**HIGH VOLTAGE OSCILLATOR**

The integral elements of the HV oscillator section are IC9, IC5, Q4 and flyback XFMR T1. The +8 volt regulators IC9 and IC5 deliver 36 volts across C18. The frequency of oscillation is dependent on the winding characteristics of HV XFMR T1. As current begins to flow through pin 4, a reverse potential is induced in the tickler coil at pins 1 and 2, tending to shut off Q4. Q4 turns on again after the R14/C19 time constant discharges, repeating the cycle. The tank circuit of D8, R15 and C20 provide a protective sink circuit against inductive spikes that must otherwise cripple the TIP41C. Diode D7 protects against reverse currents.

The secondary windings generate an 800 volt p-p waveform at pin 7 that is half wave rectified by D10 and filtered by C22 to provide +400 volts DC of focus control.

Beam cutoff voltage (+90 vdc) is supplied by a 200 volt p-p signal on pin 8, rectified by D6 and filtered by C17.

**TEST PROCEDURES**

The vast majority of HV failures will be the TIP41C. When this component fails, it will cause the +18 volt regulator to shut down internally due to a now excessive load request, say, if Q4 shorted. Remove pin 3 of the transformer winding. With the load removed, the +18 volt regulator should read +18 volts. The -18 volt regulator will read -18 or -25 volts. Replace Q4, C17, D7 and the defective regulator all at once.

D10 and D6 are high voltage, fast recovery diodes that will not read with an ordinary meter. To test, lift cathode from circuit and observe rectifying properties.

Congratulations. This is the end. You made it.

**Cinematronics Monitor  
Ribbon Cable Orientation**

In Cinematronics monitors, the ribbon cable connector (J1) may be mounted on the display board facing front or back. Regardless of the connector positioning, the ribbon cable is attached to the display PCB in such a way as to travel directly away from the monitor to its destination, the logic board.

If this cable is installed incorrectly to the monitor, it can damage both the display Pcb & logic Pcb.

**Cinematronics Monitor Service  
Notes and Modifications****RIP OFF TEST PATTERN**

There exists a test pattern in your *Rip Off* game that is enabled by switch 7 on the dip switch located in position E2 of the main CPU board (see page 2-2 of manual).

The test pattern is for alignment purposes and should be adjusted to fill the playfield.

To control the width of the display, adjust potentiometer R209 on the monitor. R109 adjusts the height of the picture.

Adjust potentiometers R102 and R202 so that all vectors (line segments) neatly intersect. R202 controls horizontal line lengths. R102 adjusts the length of all vertical lines. To center the picture, adjust the magnetic positioning tabs on the yoke housing.

**CONTRAST ADJUSTMENT ON RIP OFF**

There may be too great an intensity difference between the fuel cells and the ships if your *Rip Off* game is positioned in a low ambient light environment. This contrast problem can be solved by the

insertion of a variable resistor in the intensity network.

Replace R10 (5.6K) with a 5K ohm potentiometer. This will allow the fuel cells to be adjusted to an acceptable level.

#### **HIGH VOLTAGE SECTION- REGULATORS**

On older Cinematronics monitors incorporating a high voltage cage and associated components, a substitution may be made for the +18 (7818) and -18 (7918) volt regulators if unavailable.

IC3, the +18 volt regulator, may be replaced by a +15 volt regulator, 7815. IC5, the -18 volt regulator, may be replaced by a -15 volt regulator, 7915.

There will be a 20% decrease in overall output levels that does not degrade game performance. Potentiometers R102 and R209 may be adjusted to compensate for increased screen size. Verify that resistors R12 and R13 are rated at 4 watts as there will be a 20% increase in power dissipation.

### **Cinematronics Cosmic Chasm Monitor Cooling Problems**

#### **ASSEMBLY**

*Cosmic Chasm Cabinet/Electrohome X-Y Monitor.*

#### **PROBLEM**

Inadequate ventilation in rear of cabinet, causing Electrohome X-Y monitor failure.

#### **SOLUTION**

Cut two 2", 45 degree notches in the wooden monitor mounting bezel, one at each corner at the rear of the cabinet. This will allow adequate upward airflow along the back door of the cabinet.

### **Cinematronics Cosmic Chasm Monitor Power Problems**

#### **ASSEMBLY**

*Cosmic Chasm Power Supply Plate/Electrohome X-Y Monitor*

#### **PROBLEM**

Short circuit between +10vdc and frame ground on modified Datapower power supply(PSI), causing Electrohome X-Y monitor failure.

#### **SOLUTION**

Measure resistance between case of Q1 (2N6577) power transistor and frame of power supply. If they are shorted, remove transistor and insure that nylon insulating shoulder washers are correctly installed on the transistor mounting screws.

This problem may damage the Electrohome X-Y monitor, causing the picture to "swim" off center on the screen. Check if ground trace on underside of main circuit board near Q703 is burnt and replace if necessary with insulated wire between R735 and W19.

### **Cinematronics Dragon's Lair Intermittent Vertical Roll**

All of our *Dragon's Lair* games have exhibited an annoying tendency for the picture to "roll" vertically during the first few frames of each episode. This is very distracting and if the game is set for increased difficulty, the player can be dead before the picture stops rolling.

Changing the 0.33 uf capacitor C105 on the NTSC decoder board to a value of 0.01 uf will stop this vertical instability completely.

This vertical roll is due to a temporary loss of sync caused by an incompatibility between the disc player and the sync separator circuit of the NTSC decoder board.

When the disc player is searching for a particular frame, it blanks the video, but maintains the sync signal so that loss of sync should not occur. The problem stems from the fact that the DC level of the sync signal changes when the video is blanked. This change interferes with the normal operation of the sync separator and several sync pulses are lost.

Reducing the value of coupling capacitor C105 solves the problem by making the circuit more tolerant of low-frequency changes in the DC level of the sync signal.

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## Electrohome Monitors Tips & Info

### Troubleshooting The Electrohome GO7 HVL Circuit

Servicing the monitor with a B+ voltage of 138.5vdc or more could be quite time consuming. The troubleshooting method described below is intended to facilitate repair.

1. Remove all power from monitor.
2. Disconnect the collector of transistor X701.
3. Apply power to monitor.
4. Check for a raster (lit screen). If no raster is obtained, turn up the brightness control to verify a no-raster condition.
5. With a raster, measure B+ at the emitter of the power regulator transistor X04.
6. B+ normal with a raster, the problem will be in the protection circuit. Check X701 and D701.
7. B+ still high with raster indicates the problem is in the power regulator circuit. Check X04, X901, X902, D905 and C905.
8. With a no-raster condition, the problem will be in the horizontal section. Check from the oscillator to the horizontal output (IC501, X501, T501, X01 and T502).

#### NOTE:

Remember to reconnect the collector of X701.

### Electrohome GO7-CBO DC Voltage Measurements

#### IC501

PIN	VDC	PIN	VDC
1	4V	9	GND
2	1V	10	1.8V
3	4V	11	12.5V
4	3.5V	12	6.6V
5	6.7V	13	0V
6	11V	14	3V
7	5V	15	6.6V
8	10.5V	16	12.2V

Protector	Beam Limiter	Blanking
X701	X303	X304
E 0V	E 6V	E 0V
B .4V	B 7V	B .35V
C 12.6 V	C 0V	C 6V

### NECKBOARD TRANSISTORS

X101	X102	X103
E 7V	E 7V	E 7V
B 6V	B 6V	B 6V
C 166V	C 160V	C 167V

### TRANSISTOR DC VOLTAGES ON MAIN BOARD

#### Regulator Section

<u>X04</u>	<u>X901</u>	<u>X902</u>
E 120V	E 120.6V	E 7V
B 120.6V	B 121V	B 7.6V
C 145V	C 145V	C 71V

#### Vertical Section

<u>X401</u>	<u>X402</u>
E 45V	E 0V
B 45.5V	B .6V
C 112V	C 44.5V

#### Horizontal Section

<u>X501</u>	<u>X01</u>
E 0V	E 0V
B .3V	B .02V
C 67V	C 120V

### Electrohome Monitor Modification Horizontal Sync Adjustment

#### PROBLEM

Horizontal sync will not adjust enough to properly straighten out the picture.

#### CURE

On the monitor deflection board, replace the 390 ohm resistor at location R303 to a 1.8k ohm resistor.

Replace the .1mfd mylar cap at location C303 to a 10mfd 35 volt electrolytic cap with the positive side facing X305.

Replace the .001mfd cap at location C501 with a .53mfd 50 volt capacitor. (A .47mfd cap will also work.)

If you are experiencing trouble with the size of the picture also being too small, then replace the .53mfd cap at location C515 to a .68mfd 200 volt capacitor.

This modification was received from the Taito Service Dept., and they advised us that they received it from Electrohome.

### Older Monitor Alert

On Electrohome GO7 type monitors, the capacitor on much older games (*Super Cobra Cabinets* for instance) are baking their capacitors dry. Not the largest one in the 130V B+ section, but at least five in the horizontal and vertical sections.

Typical symptoms are a distorted picture in the form of the raster being not quite rectangular. If you are converting games, you might want to change almost all of the electrolytic caps in the horizontal and vertical sections.

I know that I'm not mentioning specifics, but if you have a cap checker of any sort, you can check them before replacing them if you like.

### Electrohome Monitor Horizontal Wave

#### SUBJECT

Electrohome Monitor GO7-COB

#### RE:

Negative signal mismatch.

#### PROBLEM

Horizontal wave or curl.

#### LOGIC

The negative sync signal of most logic sets are slightly different than the GO7-CBO monitor negative sync inputs. The result of this mismatch is a horizontal wave or curl.

#### CORRECTIVE ACTION

Join negative sync signal inputs J2 and J3 together using a jumper wire, then locate W102. Solder a jumper wire from W 102 to J2 or J3. This simple modification will result in perfect video.

### Electrohome Monitor Keystone Image Fix

#### SYMPTOM

On early Electrohome monitors, the raster is not perfectly square. This is NOT the slight pull associated with conversion kit sync problems.

Instead, it is a lack of squareness on the whole picture. This problem can probably best be described as a very slight "keystone" of the image.

On games where the monitors are mounted vertically, the scores across the top of the screen will appear to "sag" down (from left to right) and anything across the bottom of the screen will appear to bow upward.

#### PROBLEM FOUND

C518 (a 220mfd, 16v electrolytic) dried out and opened up. This cap is in the side pincushion transformer circuit and is in parallel with C517 (a 100mfd, 16v electrolytic). If only one has dried out, chances are the other is on the verge of failing also.

#### SOLUTION

Change C518 and C517 with equivalent replacements.

### Tips & Tricks Electrohome Horizontal Tear

#### PROBLEM

Horizontal Tear that cannot be adjusted out.

#### EXAMPLE

Picture tends to wrap around screen.

#### CAUSE

When this monitor is used in a game or conversion with Composite Sync, you may experience this problem. This monitor was not intended to work with Composite Sync, although they are used as such in many games.

Most of the conversions I have done have Composite Sync and the Horizontal section has to be beefed up to correct this mismatch. Component values have to be changed in a few parts to remedy the situation.

#### SOLUTION

There is a simple modification that can correct this problem.

1. Change resistor R314 from 390 ohms to 1.8k.
2. Change capacitor C501 from .001 Mfd to .027 Mfd at 50v (mylar).

3. Change capacitor C303 from .1 Mfd ceramic to 10 Mfd at 16v electrolytic. (The positive side of the new cap should go to the collector of transistor X305.)

#### NOTE

When removing the old cap at C303, notice that there is an empty hole (which is soldered over). Open this hole to accomodate the closer lead spacing of the electrolytic.

This modification is frequently needed when doing conversions. You may also have to readjust the horizontal frequency control after the component change.

### Electrohome GO-7 Chassis Capacitors

The caps most likely to go out on an aged GO-7 chassis are mentioned below. Replace for improved picture if baked open.

C517 100 ufd @ 16V (Pincushion Problems)  
C518 220 ufd @ 16V (Pincushion Problems)  
C408 4.7 ufd @ 50V  
C412 3.3 ufd @ 160V  
C511 47 ufd @ 160V (If bad monitor will shut down.)

### Electrohome GO7 Monitor Picture Lock

#### PROBLEM

The picture cannot be locked into the correct orientation. The particular monitor I encountered would only lock in horizontally in such a way that the ends of the picture would be in the center, (i.e., the picture would be split in half horizontally with the ends of the picture at the center of the screen with a large black space separating it).

#### POSSIBLE CAUSE

The HA11244 horizontal/vertical processor hasn't, in my experience, failed very often - but in this case the monitor was mounted in a cabinet in such a way that some kids stuck a screwdriver through the vent screen and adjusted the controls.

The controls for the Vertical Linearity and the Vertical Height had to be replaced because they came apart and some of the pieces were missing. After I replaced these controls and readjusted the other ones, I could get sufficient vertical height and it would lock in vertically - yet the only way the picture would lock in horizontally was in the way described above.

In addition, the Horizontal Frequency control almost had to be totally counterclockwise before it would lock in, and even then it was none too stable horizontally.

After checking everything I decided to replace IC501, the HA11244 chip under the silver box. This proved to be the problem, as I resubstituted back in the suspect HA11244 and it went back to the same problem.

The failure in this case was obviously the result of tampering, but there is a tendency for a small screwdriver to slip too far through the Vertical Height control and make contact with the silver box when the adjuster is trying to turn this control.

### **Electrohome GO7 Five Year Capacitor Clean-up**

#### *Electrohome GO7's - Round 'em up!*

Well pardner, I believe it's time to corral all the Electrohome GO7 monitors for their routine five year capacitor change!

These monitors are dropping like flies now. If you want your monitor to be looking as good-as-new and trouble-free on the route, you need to order a parcel full of each of the capacitors listed below and install them all at once when you have the chassis out on the bench.

#### *C511*

47 microfarads at 160vdc with radial leads. When this cap bakes open you're on the down-and-out until you replace it. Causes the high voltage to come up then shut down. C511 serves a critical function of regulating the 125vdc B+ voltage.

#### *C517*

100 microfarads at 16vdc with radial leads. This cap, along with C518, provides the proper amount of signal throughout in the pincushion

section. When these dry out, the whole picture becomes real hunkerjawed - you know, not rectangular.

#### *C518*

220 microfarads at 16vdc with radial leads. See 517 description above. Don't want to be repeatin' myself.

#### *C408*

4.7 microfarads at 50vdc with radial leads. Associated with the vertical section. Not essential, but when the chassis is out, why not replace it. Probably bakes open due to the heat from the vertical section.

#### *C412*

3.3 microfarads at 160vdc with radial leads. Provides some filtering in the vertical section.

#### *C523*

1 microfarad at 160vdc with radial leads. Concerned with the width section.

#### *C107*

10 microfarads at 250vdc with radial leads. This one's perched up on the neck board and causes uneven intensity problems when it goes bad, which is quite often.

Before you apply power to your recapped chassis, check the correct polarity of the caps or you might have a real blast powering it up! Happy Trails.

### **Electrohome GO7 Flyback Failure**

**WHEN THE FLYBACK FLYS OUT THE WINDOW.** If you should, by the unfortunate chance, come upon this chassis with F901, a small 1.25 amp fast-blow/solder-tail fuse blown, in a majority of cases this means that the flyback has gone out.

You shouldn't touch this fuse until you, WITH THE POWER OFF AND THE MONITOR UNPLUGGED, have jumped across it momentarily with a shorting cable, as the unregulated B+ capacitor is fully charged and is ever-so-willing to have you break-dancing on the floor should you come into contact with it!

After you have done this, ever-so-closely examine the flyback for the tiniest of cracks with red stuff oozed out and dried. If it is, you have a bad flyback and it must be replaced before the monitor will work again. If you only replaced F901 and power it up, there is a very good chance the flyback will go off with the sound of an M80 firecracker!

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## Midway Monitors Tips & Info

### Midway Super Speed Race and Sea Wolf II Color Monitor Connections

#### Reversed Image on GO-2 Color Monitor

Both *Super Speed Race* and *Sea Wolf II* use the Electrohome GO-2color monitor. In *Sea Wolf II* a mirror reverses the image from the monitor.

But in *Super Speed Race* the monitor is viewed directly. If the monitor in either game is changed and the image comes up backwards, switch the yellow and green wires at pins #1 and #2 on the round male connector coming from the yoke assembly to the geometry PCB #82-230010-05. Pin #1 should be yellow and pin #2 green for "direct" viewing.

### Midway Galaxian Monitor Service Notes

#### Color Monitors

1. The Wells Gardner 19 inch color monitor model 19K 4500is in the upright games.
2. The Electrohome 19 inch color monitor model GO7901is used in the cocktail table games.

#### Wells Gardner 19 Inch Color Monitor

The four controls contrast, brightness, color and tint are not used. These controls are located in the upper right side of the monitor panel.

The brightness control is located on the interface PC Board (85-X0134-001).

#### Color Monitor 117 Volt Line Cords

1. The Wells Gardner Monitor uses a Line Cord Type plug and the Electrohome Monitor uses a Molex Type Connector.
2. Since production uses either type monitor, each game will have a Line Cord that is not used (just hanging).

### Midway Space Encounters Monitor Adjustment

#### SUBJECT

Special Wells Gardner Monitor Adjustment to prevent distortion.

1. Measure collector voltage at Transistor Q203 and adjust to 64vdc using the Video Biaspot R206 (with contrast control at minimum setting).
2. Adjust brightness control to a minimum setting (counter-clockwise).
3. Adjust contrast control to 20 degrees of maximum (clockwise).

### Midway Rally-X Monitor Fuse Rating

To prevent intermittent fuse blowing, change the 117v line and monitor fuses located at the bottom of the cabinet to two amp slow blow.

### **Midway Pac-Man & Rally-X Brightness Adjustment**

1. To set the brightness level on a Wells Gardner Color Monitor, use the Black Level Control located on the interface PC Board. (P297)
2. Location of the Black Level Control can be found by following the logic board video cable which will be connected to the Interface PC Board.
3. Do not alter the screen control on the neck board, this can distort the picture when used as a brightness control.

### **Midway's X-Y Monitor Troubleshooting Guide (Part 1)**

#### **INTRODUCTION**

Welcome to the world of the X-Y monitor, an electronic device that strikes terror into the heart of many a technician. The main reason it is so intimidating is that the Vector Beam, Quadrascan, or X-Y monitor is **TOTALLY UNLIKE** the Rasterscan monitor, or T.V. set as you probably call it. Since many technicians are generally unfamiliar with the circuit operation, they may not be able to figure out when a symptom correlates with (points to) a particular circuit. If you are a technician, this information will certainly be a life-saver (a modest opinion). If you don't know anything about electronics, just relax, because these monitors are a lot simpler than a regular monitor or T.V. set.

Vectorbeam or X-Y monitors are used because a regular Rasterscan monitor constructs the picture in a different way. For example, your T.V. set has 525 horizontal lines on the screen from top to bottom. Each line is a slice of the picture. If you stare really close at the edge of a picture of a curved object (a large ball) or an angular object (the peak of a roof) on the screen of your T.V., you will be able to see the individual slices that the object's edge is made up of. The edge of the curved or angular objects will not appear to be completely smooth, but will look like they are stepped. However, at normal viewing distance, these same curved or angular lines will appear to be smooth

or straight and not stepped. To make sure that the pieces or slices of the picture stay together just like they were transmitted, T.V. sets have synchronization circuits. Vectorbeam monitors don't use ANY of this. Here, the electron beam smoothly goes anywhere it is told to paint the picture. It DOES NOT go across the screen 525 times to paint the picture in slices. Because of this shortcut, the circuitry is less complex and the detail in the figures will appear smoother. One drawback is that the brightness level is intentionally designed to be at a level high enough to burn or etch right into the picture tube face. This will be covered in more detail later.

If your X-Y monitor develops a problem, you can go directly to the "SYMPTOM DIAGNOSIS" section where you can match up your problem to the problem described and the circuit that may be causing it. From there you go to the schematic diagrams for your particular brand of monitor and troubleshoot the circuits mentioned in the "SYMPTOM DIAGNOSIS" section.

If you are a technician who is unfamiliar with X-Y monitors, you will want to read the "THEORY OF OPERATION" section. This section IS NOT a rigorous description of circuit operation, but a simplified general description of major circuit blocks. Some literature has been written on this subject.

Electrohome's instruction and service manual on the G05-801 is an analysis on one X-Y monitor (which Midway Mfg. Co. does not use) described from a engineering standpoint. All that is necessary to understand it is a battery of U.N. interpreters! Electrohome's instruction and service manual on the G05-802 and G05-805 monitors (which Midway Mfg. Co. does use) is simpler and more condensed. The best manual we have found on this subject so far is Wells Gardner's publication on their Graphic Display Unit, model 19V2000 (which Midway Mfg. Co. also uses). Most technicians will understand it and it is very complete. The above manuals are available on request from your distributor or monitor manufacturer.

For those who know nothing of electronics, we suggest that you read the "THEORY OF OPERATION" section, and we definitely recommend that you read the "TROUBLESHOOTING" section.

**SYMPTOM DIAGNOSIS****1. Insufficient width or height:**

- A. Horizontal line (due to "Y" amplifier defect).
  - Bad yoke.
  - Bad "Y" amplifier output transistors.
  - Blown "Y" amplifier fuse.
  - Open fusible resistor in the "Y" amplifier.
  - Yoke pins not making good contact (very common).

**B. Vertical line (due to "X" amplifier defect):**

- Bad yoke.
- Bad "X" amplifier output transistors.
- Blown "X" amplifier fuse.
- Open fusible resistor in the "X" amplifier.
- Yoke pins not making good contact (very common).

**2. Picture spread out too far and/or crushed in certain areas:**

- A. Controls for linearity (located on the deflection board and set at the factory) are misadjusted.
- B. Bad yoke.

**3. Poor focus:**

- A. Low focus voltage from the high voltage board.
- B. Defective diode off the flyback.
- C. Defective focus control.
- D. Defective picture tube (CRT).

**4. Picture not bright enough:**

- A. If the CRT voltages are present, the picture tube is probably bad. The surest way to cure this on an X-Y monitor is to replace the picture tube (CRT).
- B. Weak 90 volt supply from the EHT power supply.
- C. Loose wire to socket of CRT for G2 voltage.

**5. Silvery effect to the white lines, or picture looks dim, washed out:**

- A. If the CRT voltages are present, the picture tube is probably bad. The surest way to cure this on an X-Y monitor is to replace the picture tube (CRT).

**6. Increasing brightness causes an increase in****picture size and weakens focus:**

- A. For the most part, this is normal in X-Y monitors. But if this should occur at normal view levels, either:
  - The CRT is defective.
  - The high voltage rectifier is weak.
  - Or the high voltage circuitry has poor regulation.

**7. Picture rapidly blinks on and off:**

- A. Internal short in the picture tube (arc ing).

**8. A dot on the middle of the screen - Red LED is turned on (located on the deflection board):**

- A. The "X" and "Y" signals are not making it into the monitor.
- B. Check cabling, jacks, and logic boards.
- C. "X" and "Y" amplifier failure. See Number 1 above and check the fuses first.

**9. Monitor won't turn on:**

- A. Open fuse(s).
- B. A defect in the power supply, check:
  - Fuse(s).
  - Transistors.
  - Open fusible resistor.
- C. Check jack to make certain all pins are obtaining their voltage from the other game circuitry.
- D. Check for loose foil, especially by D 100.

**10. Blown 5 amp fuses:**

- A. Caused by bad luck. Change fuses.
- B. If they keep blowing, check all power transistors that are heat-sinked on the side (as in the 19" version) or the bottom (as in the 13" version) of the monitor.

**11. Extremely bright picture; spider web-like retrace lines floating around on the picture:**

- A. Defective "Z" amplifier circuitry; check:
  - The brightness and contrast controls.
  - For peeled foil on the deflection board.
  - Semiconductors, etc.
- B. See symptom 4, diagnosis "B" and "C" ONLY. A bad EHT power supply or loose G2 wire can cause the same thing.

**12. Hazy blob of light that shimmers on the screen:**

- A. Open secondary on flyback winding.
- B. Failure of some component in the high voltage section.

**13. Corners of the picture are missing:**

- A. Yoke is too far back on the picture tube neck.

**14. Picture is too far up, down, or not centered properly:**

- A. Metallic yoke tabs need to be adjusted.

**15. A shadowy image of the game remains on the screen, even after monitor is off:**

- A. Picture tube has burnt phosphor.

**16. 2-amp fuses keep blowing:**

- A. Check the large heat-sinked power transistors.
- B. Check D608 and D708.
- C. Check semiconductors, especially the transistors in the "X" and "Y" amplifiers.
- D. Bad yoke.

**17. Video information is distorted; letters and figures are "crinkly" - like crumpled paper, and it shakes slightly:**

- A. Bad 90 volt power being supplied by the EHT unit. If everything looks good, check the electrolytics.
- B. The regulator control (R905) may need adjusting.
  - On the Wells Gardner monitor, the anode voltage is supposed to read 14.5KV High Voltage. That's 14,500 volts with the beam current at zero. R905 adjusts this output voltage. To read this voltage, your meter needs a separate high voltage probe. Follow the directions EXACTLY as stated with the literature that comes with the probe. If you don't, or you touch something you shouldn't, you're dead. If this scares you, have someone qualified (a technician) perform this adjustment for you. Better SAFE than sorry.

- In the case of the Electrohome monitor, the adjustment is complex and, of course, potentially DANGEROUS. Basically, the Electrohome anode voltage from the flyback and rectifier is supposed to be set at 12,000 volts with the beam current at zero. That's right - THOUSANDS of volts! To read this voltage, your meter needs a separate high voltage probe. Follow the directions EXACTLY as stated with the

literature that comes with the probe. If you don't or you touch something you shouldn't, you're dead. If this scares you, have someone qualified (a technician) perform this adjustment for you. Better SAFE than sorry.

If you are still unsure, it may be best if you call Electrohome at (519) 744-7111 and obtain exact information from one of their staff engineers.

## **Midway's X-Y Monitor Troubleshooting Guide (Part 2)**

We continue this 3-part article with Part 2 - Theory of Operation. Part 1 - Introduction, Symptom Diagnosis, appeared in S\*TJ's last issue. Part 3 - Troubleshooting, will appear in our next issue.

### **THEORY OF OPERATION**

To understand what goes on inside the monitor, large general groups of circuits will be examined instead of laboriously analyzing the branches and small circuits that make up these groups. This will help avoid confusion and aid in a basic, concrete knowledge of what makes up a monitor.

### **THE POWER SUPPLY**

The best way to begin explaining the innards of the X-Y monitor is at its beginning, or the inputs to the monitor. Ignoring the ground or common tie points for many of the components, which represents zero voltage, there are 30 volts AC going in pins seven and ten of P100 - the input jack. These voltages meet at DB100 which is a device that has four diodes in it. The 30 volts AC means the voltage and current alternate, or jump up and down, going positive and negative with zero voltage in between. DB100 and the capacitors immediately after it make up the power supply. Most of the circuits in the monitor can't use power that jumps up and down, since your picture would do the same thing. DB100 chops up the wave form and capacitors C100 and C101 build up the power that DB100 chops up. The capacitors then leak it out so the power is smooth and not varying. If any component fails in the circuit, the usual result is blown fuses, burning in this area, or just less power. The power supply starts the whole ball rolling, but remember that other circuits build up voltages that can be

tapped for those circuits that need more than this thirty plus thirty volts AC from the game transformer.

#### THE "X" AND "Y" AMPLIFIERS

Let's go back to the input jack, P100, again. Along with the grounds and the two 30 volt AC inputs is the "X" and "Y" channel video information. The "X" input is about 10 volts AC and the "Y" input is about 7.5 volts AC. The "X" channel information represents parts of objects from LEFT to RIGHT on the screen. The "Y" channel information represents parts of objects from TOP to BOTTOM on the screen. To get complete objects, then, you MUST HAVE both the "X" and "Y" inputs. If this is so, then why aren't the input voltages equal? Well, notice how a TV tube is shorter than it is wide? The up and down voltages ("Y" input = +/- 7.5 volts AC) don't need as much as the side to side voltages ("X" input = +/- 10 volts AC).

If we divide the picture into four quadrants, the responsibilities of the "X" and "Y" amplifiers may be seen more clearly:

The upper left quadrant is represented by  
"-X" and "+Y" information.

The upper right quadrant is represented by  
"+X" and "+Y" information.

The lower left quadrant is represented by  
"-X" and "-Y" information.

The lower right quadrant is represented by  
"+X" and "-Y" information.

So let's say your monitor only has the right side of the picture and the left side is missing. The top and bottom right of the screen has "+X", "+Y" and "-Y" information. The left side has "-X", "+Y" and "-Y" information. But since the right side is OK, obviously the only information missing is "-X." Therefore, there's got to be a problem somewhere in the "X" amplifier.

From P100, the "X" or "Y" signals each go through a resistor and the linearity control of their respective channels. The Wells Gardner monitor only has one linearity control per channel while the Electrohome monitor has two linearity controls

per channel. These controls are supposed to be set at the factory. But sometimes they need additional adjusting. The best way to do this is to get a test pattern on the monitor screen, remove the glue holding the control adjustments in place, vary the controls until the size is right and the lines are nice and straight, and then re-glue the control adjustments so they cannot move.

After the linearity controls, the rest of the circuitry just corrects the signal for the picture tube and amplifies it. The output power transistors (two for each channel) are heat-sunked on the bottom or the side of the monitor chassis. These feed the "X" and "Y" signals in the form of current to the yoke. The yoke then puts out two invisible electromagnetic fields or forces. These fields pull the stream of electrons that is spit out of the neck of the picture tube to the various quadrants of the monitor screen where they will write or paint a picture. Just as you may use a magnet to pull nails across a table, so does the yoke's magnetic field pull the electron beam all over the picture tube screen to write the picture. The "X" and "Y" information we talked about earlier is what tells the electron beam WHERE to write or paint the picture. When the electron beam hits the phosphor coating on the back side of the front of the picture tube or screen, the phosphor glows in proportion to the electron beam intensity. In other words, the more electrons in the beam, the brighter the light that comes from the screen of the picture tube where it is being hit by the electron beam. This varying beam intensity is the function of the "Z" amplifier.

#### THE "Z" AMPLIFIER

At pin one of P100, the "Z" amplifier signal voltage is sent to the base of Q504 in the "Z" amplifier circuit. This circuit amplifies the AC "Z" signal and is then sent to the cathode of the picture tube. This varying "Z" signal voltage in turn varies the intensity of the electron beam producing at least eight different amounts of brightness or "eight gray scale steps" as the engineers would say.

In case the "X" and "Y" signals are missing, there is a 90 volt DC power failure - from the high voltage circuitry that feeds the "Z" amplifier, or if any other missing signal condition should occur, the "spot killer" circuitry comes on to effectively turn off the electron beam, thus keeping the

phosphor from being burned. At the same time, the light emitting diode turns on informing you of this. If the "spot killer" didn't come on when any of the above conditions exist, the electron beam wouldn't be moved around and the phosphor in the center of the screen would be burned from the intense electron beam that is hitting it without moving. Transistors Q500 through Q502 and their circuitry affect the voltages on Q503 to turn the beam current off. This DOES NOT mean you have automatic protection against CRT burns from too much brightness. In fact, it would probably be a good idea to keep the brightness and contrast controls TURNED DOWN to the point where the game looks good but not too bright. If the picture is way too bright, fine spider web-like retrace lines will follow the figures wherever they move and you are headed for a burnt CRT. The brightness control affects the DC voltage between the cathode and G1 of the picture tube. The contrast control varies the amount of signal to the cathode. Both control picture intensity.

#### THE HIGH VOLTAGE GENERATOR - OR - EHT SUPPLY

On the side of your monitor is a box-like cage with a wire that goes to the CRT. This is the EHT supply. It performs several functions, one of which is to supply the high voltage for the CRT.

The input to the EHT supply is at pin eight of P900 where 40 volts of AC are fed through a large resistor, R900. Actually, this is a VERY important resistor because it limits the current to the oscillator, keeping it from taking off on its own and increasing the high voltage to the point where X-rays are emitted from the CRT, which is DEFINITELY NOT GOOD.

Did we mention an oscillator? What's an oscillator? Well, in this case, it is made up of: transistor Q903, the primary winding of the "flyback" transformer, and a few other components that toss the voltage back and forth (oscillate) 25,000 times each second. By doing this, it electromagnetically induces a bigger voltage in the "flyback" transformer's secondary winding since it is bigger. This voltage is rectified (chopped up) by diode D904 to get 12,000 volts DC in Electrohome monitors and 14,500 volts DC in Wells Gardner monitors. This voltage is used to light up the CRT (picture tube). The other transistors, from Q900 to Q902 and

their circuit components keep the power to the oscillator steady or regulated, as they say in engineering. There is an adjustment control, R905, to make certain the oscillator is fed the proper power.

The "flyback" transformer also has an additional secondary winding which generates more voltage to power other circuits. At pin three of P900 there is about 400 volts DC for focus voltage to the CRT. This can be adjusted with R909, the focus control. From pin five at the other side of the "flyback" transformer secondary winding, there is 90 volts DC for the "Z" amplifier circuit. In between pins three and five of P900 there are two diodes and capacitors that change the AC from the "flyback" secondary winding to DC just like the power supply. In fact, that's just what it is, a "mini" power supply.

#### THE CRT - (PICTURE TUBE)

The CRT has already been described indirectly. However, to make a picture or turn the CRT on, certain voltages are needed. Otherwise, it won't work. These are: about 6 volts AC (note that's AC) is needed for the heater filament in the tube neck to light up; the electron beam's intensity must be controlled by the "Z" amplifier's signal, which is applied to the CRT's cathode; there must be voltage at G1 of the CRT for brightness; there should be about 400 volts DC at G2; there should be focus voltage, which varies, but can go as high as 400 volts DC; and there should be high voltage at the anode of the CRT which runs into the thousands of volts (this voltage can jump almost one inch - so BE CAREFUL!).

Always remember that a monitor can bite like a snake. Even when it is turned off, capacitors hold voltage and will discharge it to you should you be touching chassis ground. The CRT or picture tube itself is a giant capacitor, so avoid the flyback anode plug hole. With the monitor on, the power supply circuit and/or the flyback, which puts out at least 12,000 volts, CAN BE KILLERS! Avoid handling power transistors (usually output transistors), yoke terminals, and other high power components when the monitor is on.

**WARNING: THAT PICTURE TUBE IS A BOMB!**  
When it breaks, first it implodes, then it explodes. Large pieces of glass have been known to fly in

excess of 20 feet in all directions. DO NOT carry it by the long thin neck. Discharge its voltage to ground by shorting the anode hole to ground. Use a plastic handled screwdriver, connect one end of a wire with an alligator clip at each end to chassis ground and the other end to the metal shaft of the screwdriver. Using ONE HAND ONLY (put the other in your pocket) and touching ONLY the plastic handle of the screwdriver (DO NOT TOUCH THE METAL SHAFT) stick the blade of the screwdriver into the anode hole. Be prepared for a fairly loud pop and a flash. But BE CAREFUL, picture tubes will hold a very healthy charge for at least a week if not longer. Even after you've discharged it once, it may still carry a residual charge. It's better to be too careful than dead, which is why electronic equipment always carries stickers referring servicing to qualified personnel. Handle the side with the viewing screen against your chest when changing it. ALWAYS wear safety goggles when handling the picture tube.

### Midway's X-Y Monitor Troubleshooting Guide (Part 3)

Troubleshooting monitors requires experience, patience and luck. The first step is to match the symptom the monitor displays to the diagnosis next to it in the SYMPTOM-DIAGNOSIS subsection. This will pinpoint the circuit the problem is probably in, and often the parts to check. Next, the circuit should be visually inspected to see if there are any parts broken, burned or if something is there that shouldn't be, like a loose screw, etc. Some parts go bad before others and should be checked first. In fact, following is the general order in which parts usually go bad:

1. Semiconductors (like transistors, diodes and integrated circuits).
2. Fusible resistors.
3. Electrolytic capacitors.
4. Resistors.
5. Capacitors and coils.

Always remember that a monitor can bite like a snake. Even when it is turned off, capacitors hold voltage and will discharge it to you should you be touching chassis ground. The picture tube or CRT, itself, is a giant capacitor, so avoid the flyback anode plug hole. With the monitor on, the

power supply circuit and/or the flyback, which puts out at least 12,000 volts, CAN BE KILLERS! Avoid handling power transistors (usually output transistors), yoke terminals and other high power components when the monitor is on.

**WARNING:** That picture tube is a bomb! When it breaks, first it implodes, then it explodes. Large pieces of glass have been known to fly in excess of 20 feet in all directions. DO NOT carry it by the long, thin neck. Discharge its voltage to ground by shorting the anode hole to ground. Using a plastic handled screwdriver, connect one end of a wire with an alligator clip at each end to chassis ground and the other end to the metal shaft of the screwdriver. Using ONE HAND ONLY (put the other in your pocket) and touching ONLY the plastic handle of the screwdriver (DO NOT TOUCH THE METAL SHAFT), stick the blade of the screwdriver into the anode hole. Be prepared for a fairly loud pop and a flash. The longer the monitor has been turned off, the smaller the pop and dimmer the flash. But BE CAREFUL. Picture tubes will hold a very healthy charge for at least a week if not longer. Even after you've discharged it once, it may still carry a residual charge. It's better to be too careful than dead, which is why electronic equipment always carries stickers referring servicing to qualified personnel. Handle the side with the viewing screen against your chest when changing it. ALWAYS wear safety goggles when handling the picture tube.

To maintain the safety and performance of the monitor, always use exact replacement parts. For instance, the wrong components in the power supply can cause a fire, or picture distortion may result from the wrong transistor being placed in the deflection circuitry. Component manufacturers offer specification sheets which are useful for "mixing and matching," but why go through all the trouble? Order exact replacement parts! Service your monitor on a nonconductive firm table like wood, NOT METAL, and take off all of your jewelry just in case. With all this in mind, you are ready to begin troubleshooting.

Observe the picture carefully. Try to vary the appropriate control that would most likely affect your particular symptom. For example, if there is poor brightness or no picture, try turning up the brightness or contrast control. If the controls

have no effect at all, chances are there is trouble with the control itself, the circuit it controls or a nearby circuit that may be upsetting voltages. Go to the list of symptoms and determine with the schematic where the bad circuit is.

**CAUTION: KEEP IN MIND THAT CAPACITORS HOLD A CHARGE AS CAN THE PICTURE TUBE (FOR AT LEAST A WEEK AND USUALLY LONGER), AND COULD SHOCK YOU.**

First, check for obvious visual defects such as broken or frayed wires, solder where it is not supposed to be, missing components, burned components or cracked printed circuit boards. If everything looks good up to this point, make sure that diodes, electrolytic capacitors and transistors have their leads connected in the right polarity as shown on the schematic and the circuit board.

Turn on the power and measure the voltages at the leads of the active devices such as tubes, transistors or integrated circuits. Any voltage that does not come within at least 10% to 15% of the voltage specified on the schematic indicates either a problem with that device or a component connected with it in the circuit. The next step is to use the ohmmeter to narrow down the field of possible offenders.

To test a transistor, one lead of the ohmmeter is placed on the base; and the other lead placed just on the emitter, then on the collector. A normal transistor will read either high resistance (infinite), or little resistance (400 to 900 ohms), depending on the polarity of this type transistor. Then the leads should be switched, one remaining on the base, and the other switched from the emitter to the collector. Now the opposite condition should result: the resistance should be infinite if it was lower when the other lead was on the base.

Consistently infinite readings indicate an open, and a short is demonstrated by 0-30 ohms on most of these test readings. Finally, place one lead on the collector, then the other on the emitter. No matter which lead is used, there should be infinite resistance. Any lower reading, such as 50 ohms (which is typical on a bad transistor), indicates a short.

This all sounds pretty confusing, but a little experience on a good transistor will make you an expert in no time. Usually, the lowest ohmmeter setting is used for testing transistors. Once in a great while a transistor may check out good on this test, but may actually be "leaky" or break down only on higher voltages. If in doubt, change it. It is also wise to check the transistor out of the circuit just in case some component in the circuit is affecting the ohmmeter reading.

A diode is tested like a transistor except it only has two leads. Again, there should be high resistance one way and little resistance the other. If it tests bad, take one lead out of the circuit in case some component is messing up the ohmmeter reading.

**NOTE: DO NOT leave soldering equipment on the leads too long since all semiconductors, especially integrated circuits, are easily destroyed by heat.**

Without special equipment, integrated circuits are checked by verifying the proper DC voltage on the pins and the correct AC wave form using an oscilloscope. BE CAREFUL: shorting their pins can easily destroy them.

Resistors are checked with an ohmmeter and should usually be within ten percent of the value stated on them and on the schematic. You may have to desolder one lead from the printed circuit board. If you wreck the foil on the board, carefully solder a small wire over the break to reconnect the conductive foil.

Capacitors are tricky. Their resistance goes up when checked with an ohmmeter which shows a charging action. As they suck up current from the meter, the voltage goes up and so does the resistance. If you are sure a particular circuit is giving you a problem and everything else checks out OK, electrolytic capacitors are prime suspects. Substitute a new one and keep your fingers crossed.

#### **What to do when you don't know what to do - and other tips**

If you are totally confused about where to begin to hunt for a problem, and can't find the problem in the SYMPTOM DIAGNOSIS subsection, there may be another way to proceed.

Take a VOLTmeter and (if possible) an oscilloscope and begin probing the jacks. You can start with the input jack to the monitor. Using the oscilloscope, make sure both the "X" and "Y" information is present (which it isn't during the "SOUND" test).

**NOTE:** It is advisable to use one of the game's test patterns (obtained when you put the game in the Self-Test mode) when using the oscilloscope. The simple diamond one is a good choice. This way the "X" and "Y" information at the above jack isn't changing and a recognizable wave form is easy to see if it's there. The DC voltages tend to jump around like crazy when the game is being played or is running through its ATTRACT mode, so using the test pattern tends to keep them still.

Next, use the volt meter to make sure the other voltages are present at each pin. Similarly, you proceed to P500 on the deflection board, and P900 on the EHT unit to make sure all the correct voltages are present. Use the schematic to determine what the correct voltages should be.

Check the pins on the CRT to be sure the voltages are getting this far. If everything looks good to this point, perhaps the CRT is bad. DO NOT check the anode voltage unless you have a special high voltage probe or you may wind up repairing X-Y monitors in heaven.

DO NOT BE FOOLED by the silent operation of the monitor. Regular TV sets and monitors buzz and crackle a lot when they're operating - this is normal for them. BUT, vectorbeam monitors are noiseless unless something is wrong.

Whatever you do, ALWAYS read the literature that comes with any test equipment you use so that you will not damage the equipment, the monitor, and most of all, YOURSELF.

#### **PARTS INTERCHANGEABILITY**

Quite a few of the parts between the Electrohome and the Wells-Gardner monitors may be swapped. The CRTs, for example, are completely interchangeable. Also, many of the transistors used in each monitor are the same. Certain critical components in the power supply and the EHT unit are dangerous to interchange. The best thing to do is to compare both monitors' parts lists

to see if the descriptions of any two particular parts you want to swap match exactly. Substitution manuals are available for transistors and semiconductors, but you never know about them. Sometimes they work and sometimes they don't, depending on the critical circuit parameters. If in doubt, order exact replacement parts.

#### **Midway's X-Y Monitor Troubleshooting Tips (Continued)**

##### **SOLVING VERY DIFFICULT MONITOR PROBLEMS**

Based on practical experience and a loud response from the field, it would seem that the "X-Y" monitor may be easy to understand but difficult to fix. And it is! While in service it may develop the usual easy-to-fix problems, most of which have already been covered in previous parts of this series in Star\*Tech Journal.

BUT - sometimes it develops almost impossible-to-fix catastrophes. On one day they may be found fairly easily; the next, you may not be so lucky. To try to give you some insight into some of these "catastrophes" and their cures, let's peruse the monitor circuit by circuit.

THE SPOT KILLER doesn't seem to cause much trouble with the exception of the LED, D 504. It can't be checked by the usual ohmmeter method because it reads infinite resistance both ways.

If your dipswitch test pattern does not want to come in, or your brightness just doesn't seem bright enough, and EVERYTHING EVERYWHERE ELSE checks good, pull out D 504. Chances are you'll have plenty of brightness.

Poor brightness with retrace lines could mean a defective D 504, or perhaps the "Z" signal wire isn't connected properly to the base of Q 504.

#### **EHT OR HIGH VOLTAGE UNIT**

It is reported that the weakest part of these monitors is the EHT or High Voltage Unit. This may be because the secondary windings tend to open up or arc due to poor mechanical connections.

#### POWER SUPPLY

If your picture appears as if the "Omegeans" are having a 4th of July fireworks display, it is probably a bad power supply.

Trouble with C100 or C101 will cause the lines to brightly streak around, possibly coming from a spot in the center. If a proper picture is present on the monitor but moves around and blooms, it could be a partially open C100 or C101. The other circuits are starving for voltage and not totally doing their jobs.

#### "X" AND "Y" AMPLIFIERS

If the top, bottom or sides of the display flutter and try to move toward the center, again, check the power supply. More often, though, this situation is due to a bad transistor in the "X" Amplifier (sides) or the "Y" Amplifier (top and bottom). Sometimes these circuits will check good with an ohmmeter.

So, if a team of engineers with sophisticated test equipment are not available, this is our suggestion: change Q707 and Q706 for the "X" Amplifier - or - Q607 and Q606 for the "Y" Amplifier. Q605 and Q705 are also suspicious characters. If the above doesn't work, try them next.

When changing Q706, Q707, Q606 and Q607, **ALWAYS** make sure you have each one in its proper place with the correct lead placement. If you do not, you may as well break out the hot dogs because you **WILL** have a barbecued Deflection P.C. Board.

If you should happen to barbecue a Deflection Board, **CHECK ALL SEMICONDUCTORS** in that particular amplifier. Also check all resistors from R721 at least as far back as R705 ("X" amplifier circuit) or R621 back as far as R605 ("Y" amplifier circuit). Otherwise, you may live to regret not having done it.

Remember this. If at first you do not get a picture and the LED on the monitor (D504) stays lit, every time you go back to determine what else has failed in this amplifier circuit, **ALWAYS** check the output transistors Q608, Q609, Q708 and Q709 because you can destroy them as fast as you replace them.

#### SEMICONDUCTORS

A defective semiconductor that checks good on the ohmmeter may also drag down the power supply voltage. Check the collectors of the output transistors. If two voltages are high and the other two are low, it could be a defective transistor at Q602, Q603, Q702 or Q703.

#### WELLS-GARDNER MONITOR

The Wells-Gardner Monitor has two large resistors in the power supply, R100 and R101. R101 just loves to smoke and burn up. **WHY?** Check the 30-volt lines from the game. If one is open, there will be a **NORMAL** picture and **ONE VERY HOT** resistor.

Another symptom that can cause R101 to start smoking is when the Daughter Board of the game has an "X" or "Y" signal riding on an excessively high DC level.

Then again, any one of the conditions mentioned previously pertaining to problems in the "X" or "Y" amplifiers can cause R101 to burn up. Depending on the problem, it may burn fast or it may burn slow. Jumping these resistors may stop them from burning up but it **WILL NOT** solve the problem.

#### TRANSISTORS

Transistors that **CHECK GOOD** with a meter but are **NOT GOOD** in the circuit is a condition that is generally rare elsewhere. But maybe not so rare in the "X-Y" monitor. This is mentioned because we know it is a problem encountered frequently with the "X-Y" monitor and we want to bring it to your attention.

#### VOLTAGES

For any of you who would like to try a little voltage measuring to analyze the problem, the following list contains **EVERY** Electrohome and Wells-Gardner "X-Y" monitor transistor voltage. These voltages were measured on correctly functioning monitors with a hand-held portable digital multimeter. So, these readings are accurate (but not laboratory accurate) and will be closer to your actual expected voltage measurement results.

For a test display, the diamond shaped test pattern is used so that the voltage readings will stay stable and not jump around as they would

with a moving game picture. Of course, you cannot see a picture with a defective monitor, so connect a DC voltmeter to the "X" channel on the Daughter Board output. When you have the correct diamond shaped test pattern, you should be reading a steady - 2.23 volts on your meter.

### ELECTROHOME "X-Y" MONITOR

*All Readings are DC Level Voltages*  
 "X" INPUT DC LEVEL FOR DIAMOND TEST  
 PATTERN = -2.32 VOLTS DC  
 "Y" INPUT DC LEVEL FOR DIAMOND TEST  
 PATTERN = -0.08 VOLTS DC  
 B = BASE E = Emitter C = Collector

Q 601 B - 0.3	Q 701 B - 1.40	Q 500 B - 1.3
E - 0.6	E - 1.88	E 0.0
C + 0.5	C + 0.528	C +38.7
Q 602 B - 0.034	Q 702 B - 0.6	Q 501 B - 0.655
E - 0.629	E - 1.2	E 0.0
C +38.8	C +39.0	C +38.7
Q 603 B - 0.627	Q 703 B - 0.6	Q 502 B +38.8
E - 0.034	E - 1.2	E +39.8
C +38.6	C +38.8	C + 1.4
Q 604 B -39.3	Q 704 B -39.3	Q 503 B + 2.1
E -39.9	E -39.9	E + 1.4
C -27.4	C -27.1	C + 1.4
Q 605 B +38.8	Q 705 B +39.0	Q 504 B + 2.3
E +39.5	E +39.7	E + 1.8
C +36.0	C +36.2	C +75.3
Q 606 B +35.4	Q 706 B +34.1	Q 900 B +23.0
E +36.0	E +36.2	E +22.1
C + 0.22	C - 1.0	C +32.1
Q 607 B -39.4	Q 707 B -39.4	Q 901 B +23.6
E -40.0	E -40.0	E +22.9
C - 0.4	C - 1.72	C +31.8
Q 608 B + 0.246	Q 708 B - 1.0	Q 902 B + 9.2
E - 0.075	E - 1.34	E + 8.7
C +41.1	C +41.0	C +24.1
Q 609 B - 0.464	Q 709 B - 1.7	Q 903 B - 3.4
E - 0.069	E - 1.3	E 0.0
C -41.2	C -41.1	C +22.4

Q 602 B - 0.105	Q 702 B - 0.772	Q 500 B - 3.5
E + 0.72	E - 1.39	E 0.0
C +32.2	C -28.9	C +34.6
Q 603 B - 0.096	Q 703 B - 0.783	Q 501 B - 2.6
E - 0.710	E - 1.37	E 0.0
C +32.4	C +32.4	C +34.6
Q 604 B -29.5	Q 704 B -29.7	Q 502 B +34.5
E -30.2	E -30.4	E + 1.6
C -29.6	C -28.9	C +33.2
Q 605 B +32.3	Q 705 B +32.5	Q 503 B + 0.733
E +32.9	E +33.2	E - 0.16
C +30.5	C +30.5	C + 0.16
Q 606 B +30.0	Q 706 B +30.0	Q 504 B + 2.3
E +30.6	E -30.4	E + 1.74
C + 0.222	C - 1.34	C +77.0
Q 607 B - 0.54	Q 707 B -30.4	Q 900 B +16.0
E -30.4	E -29.7	E +15.3
C -29.7	C - 2.09	C +24.2
Q 608 B + 0.20	Q 708 B - 1.34	Q 901 B +16.6
E - 0.13	E - 1.67	E +16.0
C +34.6	C +34.7	C +24.0
Q 609 B - 0.54	Q 709 B - 2.08	Q 902 B + 9.7
E - 0.14	E - 1.68	E + 9.2
C -31.5	C -31.7	C +16.6
		Q 903 B - 3.8
		E 0.0
		C +15.0

### Midway CRT Substitutions

#### GAME

All games with 19" color monitors

#### SUBJECT

CRT Replacements

Reviewing the difference in 19" in-line CRTs with internal degaussing shield versus exterior degaussing shield with CRT manufacturers and

with vendors (Electrohome and Wells-Gardner), it was found that the CRT with internal degaussing shield can be used as a replacement in a monitor with an external shield with no need to modify the monitor in any manner.

This being the case, it is recommended that you purchase only 19" in-line color CRTs with internal shields for replacement purposes. This will simplify Midway's stocking requirement as well as reduce possible replacement errors.

Any of the below listed 19" in-line CRTs with internal degaussing shield can be used as a substitute for each other:

19VMNP22 (RCA)  
19VMJP22 (Rauland)  
510UJB22 (Hitachi)

Any of the above CRTs can also be used as a substitute for below listed CRTs, designed to be used with external degaussing shield:

19VJTP22 (RCA)  
19VMBP22 (Rauland)  
19VMAP22 (Vendor not known)  
MV19VLGP22 (Vendor not known)

### Midway's Color TV Monitor Repair (Part 1)

This begins a three-part article which will be published consecutively for the next three months.

*Part 1 - Introduction  
and Symptom Diagnosis  
Part 2 - Theory of Operation  
Part 3 - Troubleshooting  
and Differences Between Monitors*

#### INTRODUCTION

This series has been designed to simply familiarize you with one of the more mystical components in your game - the TV monitor. If you are an electronics technician who is quite knowledgeable on the subject, you may decide to just go to the schematics and start troubleshooting the defective monitor. But if you are like most people, a monitor is a TV set, and that means a complex doo-dad that means big buck repairs. This isn't necessarily so. This multi-part series will acquaint you with the monitor and could just help you repair it if you feel adventurous enough to give it a try. If you have any knowledge of electronics, especially the use of a voltmeter, the repairs you can make are astonishing. Just keep in mind that ELECTRICITY CAN BE DANGEROUS, SO BE CAREFUL!!

If you want to understand how a monitor works, Part 2 will contain the "Theory of Operation"

section. If you wish, you can follow along with the schematics. The information is presented in a very basic manner, but more complete treatment of the subject can be found in the technical sections of bookstores.

Pay attention to all warnings and take them seriously. The more equipment you have the better, but a low cost Volt-Ohm-Milliammeter can often do the trick. Here are the steps to take:

1. Find the symptom that matches the problems your monitor has in the "System Diagnosis" section. The diagnosis tells the circuit or area the problem may be in and possibly even the actual component causing it.
2. Once you have the circuit that is causing the trouble, Part 3 contains the "Troubleshooting" section to learn the procedure for finding the bad part.
3. Next, find the schematic that matches your monitor. It may be helpful to read the "Differences Between Monitors" section (Part 3) if you are unsure of which monitor you have. Use the schematic to see what parts are in the offending circuit.

That really is all there is to it. Just remember that there are some bizarre or rare symptoms not covered, or that a monitor may have two or more different problems that only a genius, the experienced, or an experienced genius can figure out. But be patient, follow safety precautions, and remember that there is also literature available from the monitor companies through your distributor or from Midway Manufacturing Company on request (1-800-323-7182).

#### SYMPTOM DIAGNOSIS

##### 1. Insufficient width or height:

- A. Horizontal line (due to VERTICAL CIRCUIT DEFECT).
  - Bad yoke.
  - Bad vertical output section.
  - Open fusible resistor in vertical section.
  - Bad height control.
  - Bad flyback.
- B. Vertical line (due to HORIZONTAL CIRCUIT DEFECT).
  - Bad yoke.

- Open width coil.
- Open part in horizontal output section.

2. *Picture spread out too far or crushed in certain areas:*

- A. Horizontal/Vertical output transistor.
- B. Bad component in output circuitry.

3. *Line too close with black spacing:*

- A. Problem in vertical section causing poor linearity.

4. *Poor focus and convergence:*

- A. Bad high voltage transformer ("flyback") or control.
- B. Focus voltage wire not connected to neckboard terminal.

5. *Colors missing, check:*

- A. Interface color transistors.
- B. Color output transistors.
- C. Cracked printed circuit board.
- D. Color circuits.
- E. Video input jack.

6. *Picture not bright enough:*

- A. Weak emission from picture tube.  
(Turn horizontal sync off frequency and put brightness all the way up for about 15 minutes. Occasionally this cures the problem.)

7. *Silvery effect in white areas; check:*

- A. Beam current transistors.
- B. Weak picture tube emission.

8. *Too much brightness with retrace lines; check:*

- A. Beam limiter transistors.
- B. Brightness and/or color blanking control set too high.

9. *Increasing brightness causes an increase in size and poor focus:*

- A. Weak high voltage rectifier or regulation (high voltage unit).

10. *Small picture and/or poor focus:*

- A. Low B+ voltage (power supply trouble).

11. *Vertical rolling:*

- A. Vertical oscillator transistor, IC, or circuit.

- B. No sync from logic board.

12. *Horizontal line across center:*

- A. Vertical output circuit is dead (see symptom No. 1 A).
- B. Vertical oscillator is not putting out the right wave form.

13. *Picture bends:*

- A. Horizontal sync needs adjusting.
- B. Magnetic or electromagnetic interference.

14. *Flashing picture, visible retrace lines:*

- A. Broken neck board.
- B. Internal short circuit in the picture tube (arcing).

15. *Unsymmetrical picture or sides of picture:*

- A. Defective yoke.

16. *No brightness, power supply operating - no high voltage for the picture tube; check:*

- A. Horizontal oscillator.
- B. Horizontal amplifier and output.
- C. Flyback transformer (high voltage unit).

17. *No brightness, high voltage present; check:*

- A. Heater voltage to the tube at the neck board.
- B. Screen-grid voltage for the tube.
- C. Focus voltage.
- D. Grid to cathode picture tube bias.

18. *No high voltage; check:*

- A. For AC input to the "flyback."
- B. Horizontal deflection stages.
- C. Flyback transformer.
- D. Yoke.
- E. Power supply.

19. *No horizontal and vertical hold; check:*

- A. Sync transistors and circuit.
- B. Wires and jack from logic board to the monitor.

20. *Wavy picture - (power supply defect); check:*

- A. Transistors, diodes, electrolytic capacitors in the power supply.

21. *Moving bars in picture:*

- A. Ground connector off between monitor and logic boards.
- B. Defect in the power supply (see wavy picture symptom).

22. *Washed out picture (see picture not bright enough):*

- A. Check video signal at the cathode pins with an oscilloscope. If there is about 80 volts peak to peak, the picture tube has weak emission.

23. *Monitor won't turn on:*

- A. Problem in the power supply: check fuse, transistors, open fusible resistor.
- B. Shorted horizontal output transistor.
- C. Defective high voltage disabling circuit.
- D. Crack(s) somewhere on main chassis board.

24. *Can't adjust purity or convergence:*

- A. Use a degausser to demagnetize the picture tube carefully following your de gausser's instructions.
- B. Picture tube defective.
- C. Metal foreign material is in picture tube shield.
- D. Nearby equipment is electromagnetically interfering.
- E. The poles of the earth are pulling off the purity.
- F. Poor focus or width of picture.

## Midway's Color TV Monitor Repair (Part 2)

### THEORY OF OPERATION

To understand what goes on inside the monitor, large general groups of circuits will be examined instead of laboriously analyzing the branches and small circuits that make up these groups. This will help avoid confusion and aid in a basic, concrete knowledge of what makes up a monitor.

### THE POWER SUPPLY

The AC going to the monitor from the game transformer is just like the voltage and current from your wall outlet. It jumps up and down going positive and negative sixty times a second. But a monitor needs nice, smooth DC; direct current,

not alternating. So diodes chop up the AC and a big electrolytic capacitor filters it out to make it even smoother. Since the monitor is a big piece of electronic equipment, with many circuits demanding a lot of power from the power supply, there are also zener diodes and transistors to help maintain a nice, constant, smooth voltage so that the monitor circuits don't jump around. And this is what happens when you see a wavy picture. There is AC creeping through the power supply, so it must be malfunctioning. If the voltage from the power supply is too low, the other circuits will be starved for power and you may see a small, wavy picture, or none at all.

Some circuits receive voltages that are higher than what the power supply should put out. But they come from the flyback transformer which will be discussed later.

### THE INTERFACE SECTION OF THE CHASSIS

The interface section of the chassis is fairly easy to identify. It is right by the place where the video jack(s) from the logic board(s) plug into. There are sets of transistors that receive the separate red, green, blue, and sync information from the cables that come from the logic boards. The circuits jack up the voltage and match impedances, or in other words, prepare the logic board outputs for the circuits that will really amplify them for the output devices such as the yoke in the case of the sync, or the picture tube that shows the colors.

An interesting aside is that our sync is composite negative sync. That means two things:

1. The sync is a negative going wave form.
2. There are two pulses going at different speeds over the same wire:
  - a. Vertical wave forms at 60 times per second (or Hertz) and
  - b. Horizontal wave forms at about 15,750 times per second (Hz).

The sync is amplified by a sync amplifier transistor and sent on its way to the oscillators. The sync or timing information will be explained along with the oscillator shortly.

The color information is sent via wires to the neck board where the main amplification occurs. This will also be discussed later.

#### VERTICAL AND HORIZONTAL DEFLECTION

After the sync signal is amplified by the sync amp, it goes to two different sections, the vertical and horizontal circuits. Basically, the sync signals are for timing so the picture doesn't mess up since it is assembled like an orderly jigsaw puzzle, but so fast that you can't see the electron beams for each color painting the picture on the screen. This will all become clear soon. For now, we will follow the 60 cycle component of the sync as it goes on its journey to the deflection yoke.

The 60 cycle pulse goes to the vertical oscillator to make sure this circuit goes back and forth (or oscillates) at 60 times a second. Without this pulse keeping the circuit at the correct speed, it may get lazy and oscillate at 58 cycles or lower, or get ambitious and oscillate at 62 cycles or higher. At the wrong speed, the picture will start to roll up or down.

A Wells-Gardner 13" or 19" color monitor uses transistors for its sync section. An Electrohome 13" or 19" color monitor uses an integrated circuit IC501 for its sync section. The idea is all the same. The output of the vertical amplifying transistors for all monitors must be a sawtooth wave form, sort of like a bunch of pyramids, racing to the yoke's vertical coils at 60 times a second.

Along the way to the output transistors, the 60 cycle pulse is shaped and amplified to do the job: the yoke magnetically pushes the electron beam to fill the screen out sideways looking at the screen with the greatest length going up and down. Or viewing the screen sitting like a home television set. The amplified vertical output fills the screen up and down. Watching a monitor like this, seeing only a horizontal line means a problem with the vertical coils of the yoke or anything from the vertical output section on back to the oscillator.

The horizontal section is very similar with a few exceptions. The horizontal wave shape is more like a square and has a frequency of 15,750 cycles a second. Again, Wells-Gardner uses transistors for the horizontal oscillator, and Electrohome uses the other side of IC501. Still, the effect is the same. If the oscillator isn't going at the correct speed, the picture may move sideways, start to slant, or tear up with slanted thin figures. With

both the vertical and horizontal of all monitors, there are variable resistors that change the speed of the oscillators up and down. This way you have controls that can make the correct frequencies to keep the electronic jigsaw puzzle nicely locked in place. If you're driving in a car and next to you someone else is driving their car at exactly the same speed, it will appear that they are not moving. And this is why the sync frequency and the oscillators' frequencies must match, so the picture doesn't appear to move.

The correct wave form is shaped and amplified in the circuitry just like in the vertical section. But the horizontal output transistor is a large power transistor and not only serves to give current to the horizontal yoke windings, it also feeds the flyback transformer.

#### THE FLYBACK TRANSFORMER (OR HIGH VOLTAGE UNIT)

The picture tube needs high voltage to light up, and the power supply can't meet this demand. The flyback transformer receives current alternating at about 15,750 times per second from the horizontal output transistor. The "flyback" jacks up its input voltage and puts out a higher voltage alternating at the same speed. But, in your "flyback" there are diodes that chop up the alternating voltage to make it a smooth DC output just like in the power supply. This is what goes through that thick red wire to your picture tube. THIS AREA HAS ABOUT 18,000 VOLTS ON IT AND IT CAN KILL YOU!

The "flyback" may be dangerous, but it is also generous. It has extra output windings which give voltage to the heater pins of the picture tube, voltage for the vertical deflection circuits, and picture tube screen-grid voltage. So in a way, the high voltage "flyback" is like a second power supply.

#### COLOR CIRCUITS

The color circuits are pretty straightforward. The signals go into the interface section where some amplification and impedance matching occurs. These circuits are pretty sparse and simple. Each color just has two transistors and a diode with some resistors and capacitors. From here, the AC color signal is sent by wires to the neck board.

The color output circuits are on the neck board. The color signals going to the transistors are controlled by two variable resistors called drive controls. There are only two, one for the red and one for the green. The blue doesn't have one. In the emitter part of each transistor is another variable resistor that is the cut off control. These controls vary the amount of amplified AC signal that goes to the cathodes of the picture tube. The more signal, the more color. The bases of each of these transistors are connected together and all connected to the blanking and beam limiting transistors which are in the interface section.

The beam limiter helps control the brightness level, and the blanking transistor rapidly turns the picture tube on and off so that retrace lines don't show up on the screen. By turning up the brightness on a good monitor, these four to six retrace lines can be seen slanting diagonally across the picture.

#### PROTECTION CIRCUIT

To protect the high voltage section against voltages that are too high coming from the power supply which could cause X-rays to be emitted from the "flyback," a circuit senses the higher power supply voltage, and using a transistor, turns off the horizontal oscillator. Since the horizontal oscillator doesn't work, the horizontal output transistor has nothing to feed the "flyback" which in turn has nothing to feed the picture tube. The monitor will be silent, have no picture, and will appear to be off. BUT DON'T BE FOOLED. There is still that excessive amount of voltage coming from the power supply. To find out, check the emitter on TR502 of the Wells-Gardner monitors; or the emitter of X04 for the Electrohome monitor. Here are the voltages you should receive:

Wells-Gardner = 127VDC
Electrohome = 120VDC

The best place to measure this voltage on an Electrohome monitor is at a pin marked B1 on the chassis. This is because a 13-inch color Electrohome monitor, the GO7-FBO or GO7-902, has an integrated circuit and very little else in the power supply. Still, there should be 120VDC at B1.

#### THE PICTURE TUBE (OR CRT)

The picture tube or CRT is an output device. In other words, the end result of the circuits' work is displayed by this part. Actually, the output of other circuits is in the neck of the picture tube.

First, there is the heater. The heater boils off electrons from the cathodes so that they (the electrons) shoot up to the screen to excite the phosphors so that the three phosphors emit three colors of light.

The cathodes are next, and again they emit electrons to turn on the tube phosphors, making it glow. The cathode can arc or short to the heater resulting in no picture and a defective picture tube.

Next come the grids. The first grid is grounded. The following grid is the screen grid which receives about 300VDC depending on the brightness setting. The next grid closest to the picture tube screen is the focus grid which gets about one fifth the amount of voltage that is applied to the picture tube anode.

After jetting from the cathode through all these grids, the electrons speed through a mask, a sheet of material with tiny holes, and then excite the tiny dots of phosphor in the inside surface of the picture tube screen. The green electron gun (or cathode and circuitry) spits out electrons which head for the green phosphors only. The same goes for the red and blue guns. The way the phosphor light blends determines the color seen. Should these electron beams become too intense, they may burn the phosphor. With the monitor off, this can be seen as a dark permanent image of the video information on the tube screen.

#### Midway's Color TV Monitor Repair (Part 3)

#### TROUBLESHOOTING

Troubleshooting monitors requires experience, patience and luck. The first step is to match the symptom the monitor displays to the diagnosis next to it in the "SYMPTOM-DIAGNOSIS" subsection. This will pinpoint the circuit the problem is probably in, and often the parts to check. Next,

the circuit should be visually inspected to see if there are any parts broken, burned or if something is there that shouldn't be, like a loose screw, etc. Some parts go bad before others and should be checked first. In fact, following is the general order in which parts usually go bad:

1. Semiconductors  
(transistors, diodes & integrated circuits).
2. Fusible resistors.
3. Electrolytic capacitors.
4. Resistors.
5. Capacitors and coils.

Always remember that a monitor can bite like a snake. Even when it is turned off, capacitors hold voltage and will discharge it to you should you be touching chassis ground. The picture tube, or CRT, itself is a giant capacitor, so avoid the flyback anode plug hole. With the monitor on, the power supply circuit and/or the flyback, which puts out at least 18,000 volts, CAN BE KILLERS! Avoid handling power transistors (usually output transistors), yoke terminals and other high power components when the monitor is on.

**WARNING:** That picture tube is a bomb! When it breaks, first it implodes, then it explodes. Large pieces of glass have been known to fly in excess of 20 feet in all directions. DO NOT carry it by the long, thin neck. Discharge its voltage to ground by shorting the anode hole to ground. Use a plastic handled screwdriver, connect one end of a wire with an alligator clip at each end to chassis ground and the other end to the metal shaft of the screwdriver. Using ONE HAND ONLY (put the other in your pocket) and touching ONLY the plastic handle of the screwdriver (DO NOT TOUCH THE METAL SHAFT) stick the blade of the screwdriver into the anode hole. Be prepared for a fairly loud pop and a flash. The longer the monitor has been turned off, the smaller the pop and dimmer the flash. But BE CAREFUL, picture tubes will hold a very healthy charge for at least a week if not longer. Even after you've discharged it once, it may still carry a residual charge. It's better to be too careful than dead, which is why electronic equipment always carries stickers referring servicing to qualified personnel. Handle the side with the viewing screen against your chest when changing it. ALWAYS wear safety goggles when handling the picture tube.

To maintain the safety and performance of the monitor, always use exact replacement parts. For instance, the wrong components in the power supply can cause a fire, or the wrong color output transistor may give a funny color to the picture. Service your monitor on a nonconductive firm table like wood, NOT METAL, and take off all of your jewelry just in case. With all this in mind, you are ready to begin troubleshooting.

Observe the picture carefully. Try to vary the appropriate control that would most likely affect your particular symptom. For example, if there is poor brightness or no picture, try turning up the brightness or contrast control. If the controls have no effect at all, chances are there is trouble with the control itself, the circuit it controls or a nearby circuit that may be upsetting voltages. Go to the list of symptoms and determine with the schematic where the bad circuit is.

**CAUTION:** Keep in mind that capacitors hold a charge as can the picture tube (for at least a week and usually longer), and could shock you.

First, check for obvious usual defects such as broken or frayed wires, solder where it is not supposed to be, missing components, burned components, or cracked printed circuit boards. If everything looks good up to this point, make sure that diodes, electrolytic capacitors and transistors have their leads connected in the right polarity as shown on the schematic and the circuit board.

Turn on the power and measure the voltages at the leads of the active devices such as tubes, transistors or integrated circuits. Any voltage that does not come within at least 10% to 15% of the voltage specified on the schematic indicates either a problem with that device or a component connected with it in the circuit. The next step is to use the ohmmeter to narrow down the field of possible offenders.

To test a transistor, one lead of the ohmmeter is placed on the base; and the other lead placed just on the emitter, then on the collector. A normal transistor will read either high resistance (infinite) or little resistance (400 to 900 ohms), depending on the polarity of this type transistor. Then the leads should be switched, one remain-

ing on the base, and the other switched from the emitter to the collector. Now the opposite condition should result: the resistance should be infinite if it was lower when the other lead was on the base. Consistently infinite readings indicate an open, and a short is demonstrated by 0-30 ohms on most of these test readings. Finally, place one lead on the collector, then the other on the emitter. No matter which lead is used, there should be infinite resistance. Any lower reading, such as 50 ohms (which is typical on a bad transistor), indicates a short.

This all sounds pretty confusing, but a little experience on a good transistor will make you an expert in no time. Usually, the lowest ohmmeter setting is used for testing transistors. Once in a great while a transistor may check out good on this test, but may actually be "leaky" or break down only on higher voltages. If in doubt, change it. It is also wise to check the transistor out of the circuit just in case some component in the circuit is affecting the ohmmeter reading.

A diode is tested like a transistor except it only has two leads. Again, there should be high resistance one way and little resistance the other. If it tests bad, take one lead out of the circuit in case some component is messing up the ohmmeter reading.

**NOTE:** DO NOT leave soldering equipment on the leads too long since all semiconductors, especially integrated circuits, are easily destroyed by heat.

Without special equipment, integrated circuits are checked by verifying the proper DC voltage on the pins and the correct AC wave form using an oscilloscope. **BE CAREFUL:** Shorting their pins can easily destroy them.

Resistors are checked with an ohmmeter and should usually be within ten percent of the value stated on them and on the schematic. You may have to desolder one lead from the printed circuit board. If you wreck the foil on the board, carefully solder a small wire over the break to reconnect the conductive foil.

Capacitors are tricky. Their resistance goes up when checked with an ohmmeter which shows a charging action. As they suck up current from the

meter, the voltage goes up and so does the resistance. If you are sure a particular circuit is giving you a problem and everything else checks out O.K., electrolytic capacitors are prime suspects. Substitute a new one & keep your fingers crossed.

#### DIFFERENCES BETWEEN MONITORS

The easiest way to identify the brand of monitor you are working with, assuming you can't find the brand name written on it anywhere, is to see if there are two circuit boards rising up from the chassis toward to picture tube neck. In other words, they stand up, or are perpendicular to the chassis, with a black plastic bracket holding them in place. This is a description of a Wells-Gardner monitor. They use separate boards for main chunks of circuitry. Therefore, you have a "power board" (the power supply), an "interface board" (the interface section), and a "horizontal/vertical board" (for the deflection circuitry). Still, there are a few parts on the chassis, but most can be found on the board. An Electrohome monitor has no separate boards, except for the neck board, and just has a flat chassis.

Another good way to determine which monitor you have is to check the transistor call out numbers that are printed on the chassis next to the part. For instance, on the neck board, one of the color output transistors is TR401. If you look through the schematics or the parts lists, you will find TR401 in the Wells-Gardner literature. On the other hand, the neck board transistor may say X101. X101 can be found in the Electrohome literature. So, all Wells-Gardner transistor call outs begin with TR, and Electrohome transistor call outs start with an "X."

#### PARTS INTERCHANGEABILITY

Some parts can be interchanged on all of the monitors. Here are the rules:

1. You CAN swap the voltage regulator TR502 or X01 on any Wells-Gardner or Electrohome 19-inch monitor. You CANNOT swap the voltage regulator on the 13-inch Wells-Gardner or Electrohome (GO7-902) since the Electrohome uses an integrated circuit for the power supply.

2. You CAN swap any resistor between monitors that has the same resistance, wattage rating and tolerance.

3. You CAN swap any capacitor between monitors that has the same capacitance, and voltage rating.

#### 4. PICTURE TUBES:

Due to the fact that Electrohome is now (October, 1981) using a picture tube with an internal shield, these picture tubes can be used in either Wells-Gardner or Electrohome monitors.

However, a Wells-Gardner picture tube can ONLY be used in a Wells-Gardner monitor. It will not function properly if installed in an Electrohome monitor. The picture purity will be off.

5. You CANNOT change any part that is a safety part, one that is shaded in gray on the schematic; it MUST be IDENTICAL to the original. To do otherwise IS DANGEROUS. For instance, the 13-inch Electrohome (GO7-904) monitor "flyback" looks identical to the 19-inch Electrohome (GO7-905) monitor "flyback." In fact, there is even a 19-inch Electrohome (GO7-905) monitor (which is an obsolete model) with a similar looking "flyback." NONE OF THESE ARE INTERCHANGEABLE!

6. You CAN change any of the parts between the G07-904 and G07-907. They're essentially the same monitor except that the G07-907 has a vertically mounted picture tube.

If there is any doubt about what parts can be swapped between each manufacturer's 19-inch and 13-inch models, compare the manufacturer's part number between each one. If they match up, they are the same part.

3. The I/O sound board 9-pin jack is for the audio cable. (A084-90009-A968)

## HUM BAR AND MS. PAC-MAN

### SYMPTOM

One of my Midway *Ms. Pac-Man* games has developed a hum bar in the video. My first thought was that the monitor had developed a problem. Substituting a different monitor did not eliminate this. The PCB also checked out fine. After checking out the static board, I still could not locate the problem.

### PROBLEM

"What is wrong then?" you may ask. The problem was in one of the fuse blocks. The game will work with one of the fuses missing!

### HOW'S THAT?

This is because they use a center-tapped transformer with fused 7vac and 15vac outputs. This is rectified and filtered for the +5vdc and the +12vdc regulator inputs. With half of the input wave missing, the filter cap may not produce a high enough DC voltage. This was causing the +5vdc regulator to "drop out" and the resulting hum bar in the video display.

### SOLUTION

Simply replace the fuse and restore full wave power to the transformer assembly. Sometimes the solutions are of the simple variety!

## Midway Tron Notes Video Cable

### SUBJECT

Monitor Video Cable



1. The 9-pin monitor video cable interfaces the monitor with the logic board.

2. The monitor video cable must be inserted to the 9-pin jack of the CPU board J2. (A084-90009-A968)

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# 7

## Various Monitors Tips & Info

### Arachnid 6000 Monitor Cures

#### **SYMPTOM**

Do you often get service calls saying that the monitor is out but when you get there everything is running fine. What usually happens is that the bar owner turns the machine on, sees that the monitor is not on, and calls. Five or ten minutes later the monitor mysteriously comes up.

#### **SOLUTION**

When you arrive on location what you should do is turn the machine on and off quickly.

What you should find is a thin horizontal line two or three inches across that eventually expands to a normal raster. Replace C9 on the power supply board and this will take care of the problem.

#### **SYMPTOM**

Another complaint is that the monitor's brightness changes or fluctuates during the course of the game, or it jitters, breaks up or turns yellow.

#### **SOLUTION**

This can be caused not by the monitor but by the connection on the power supply. Resolder the connections on the power supply board and these should take care of the problems.



### Centuri *Eagle* Monitor Notes

#### **MONITOR**

Electrohome GO-2

#### **SYMPTOM**

Loss of vertical deflection

#### **CURE**

Close visual inspection of monitor chassis will disclose problem. Generally located on geometry PCB coils mounted on this board break, or poor solder connections found on bottom of geometry PCB.

#### **SYMPTOM**

Loss of video focus or blows fuses.

#### **CURE**

Dynamic convergence PCB cracked or components broken or loose. (Caution should be taken not to disturb any adjustments on this PCB.

### Centuri *Targ* Cocktail and Maxi *Eagle* Monitor Modifications

The Sanyo Monitor used in the Centuri *Targ* Cocktail Table and Maxi *Eagle* is designed to operate at 100 volts AC line voltage. Due to an error in the wiring harness, early production of these games may have been wired for 120 volts AC operation. When the game in question has been placed in a location with a higher than normal line voltage, the picture may appear for a short time and then disappear until the game is shut off and turned back on. This process will repeat itself until corrected.

The cure is to find the unused secondary tap on the isolation transformer which usually is extended to the power connector at the monitor and terminated with shrink tubing. This wire should replace the wire on pin 1 of this connector for 100 volts AC operation.

### **Centuri/Konami Track & Field Missing Video Cure**

#### **PROBLEM**

Lower half of picture missing.

#### **CAUSE**

Because of excessive vibration of the panel from people pounding on it, usually on games not equipped with the special buttons, a certain capacitor in the vertical section of the Wells Gardner monitor, C313, a large electrolytic capacitor, will tend to break loose by either breaking a leg off or breaking loose from the copper traces on the bottom of the monitor PCB.

#### **CURE**

Repair the capacitor's failure condition and install pound-proof buttons on the game, or cushion the capacitor against vibration.

### **Centuri Games Toei Monitor Model CM-A20 Vertical Crunch**

#### **PROBLEM**

Crunched vertically rolling picture May stop rolling after warm-up but vertical height still insufficient.

#### **POSSIBLE CAUSE**

There are many caps in this monitor which bake open, but the capacitor that is involved with the common problem mentioned above is C62.

#### **CURE**

Replace C62 with an exact or equivalent value capacitor.

### **Data East Monitor Spark Gap Cleaning & Monitor Grounding Kits**

#### **MODEL**

Deco Cassette System

#### **GAMES**

All machines with Nanao monitors (Neck board #KC920524(1/2), KB240163)

#### **SUBJECT**

Assorted loading problems, random freeze-ups and random resets, caused by arcing of the spark gap.

#### **SOLUTION**

CAUTION, the following procedure should be done by a qualified technician, due to the possible presence of VERY HIGH VOLTAGE.

1. Remove the monitor neck board.
2. Using compressed air or component freeze spray, clean out the spark gap thoroughly, and the entire board.
3. Allow condensation to dry completely.
4. Reinstall monitor neck board.

#### **MODEL**

Deco Cassette System

#### **GAMES**

All Cassette Systems

#### **SUBJECT**

Desensitize system due to monitor noise.

#### **SOLUTION**

Grounding of the CRT. Please specify monitor type. Send for your FREE grounding kits which contain wire and two special grounding clips. CAUTION. This task should be done by a qualified technician.

### **Data East Last Mission No Vertical Deflection**

#### **SYMPTOM**

No vertical deflection.

**SOLUTION**

Resolder connections on monitor PCB. Data East's Service Department has received several calls regarding failure of the Wells Gardner 19K5603 monitor chassis used in the *Last Mission* upright.

The *Last Mission* games that may be affected are serial numbers 279800 to 280055.

The monitor suffers from bad solder connections on the main PCB. This causes some components to crack their solder connections and the monitor may not operate when the game is received. The usual failure mode is no vertical deflection, just a horizontal line across the center of the screen.

Check and resolder the capacitor leads on C313, and 100mf @ 160vdc electrolytic. This capacitor is 2 inches tall and is subject to vibration. Wells Gardner applies a silicon rubber adhesive around the base of this component to prevent it from moving, however, some of the defective monitor PCBs did not have this compound applied. Secure this capacitor with glue if it has not been done.

Wells Gardner will no longer be supplying the 19K5603 chassis as they have developed a new unit; the 19K7602 series. All subsequent shipments of upright cabinets from Data East USA, Inc. will be using the new Wells-Gardner monitor or the *Hantarex* MTC900/E.

**Data East Kid Niki Screen Size Tip****PROBLEM**

We have received several calls regarding players not being able to find their way out or complete various screens in the *Kid Niki* game. This is usually diagnosed to be a program problem or a defective pcb, but this is not the case!

Chances are good that the player cannot see the entire picture due to i.improper monitor adjustments;

**SYMPTOM**

*Kid Niki* contains scenes that have exits that are at the extreme right side of the screen, thus if the video is offset or adjusted too wide, the player may not be able to see the exit.

**SOLUTION**

It is normal to adjust the vertical and horizontal size of the monitor so that the picture extends to the four corners and does not over-shoot the viewing area of the screen. This will ensure that all of the picture will be visible to the player.

**Data East Heavy Barrel Video Wave****SUBJECT**

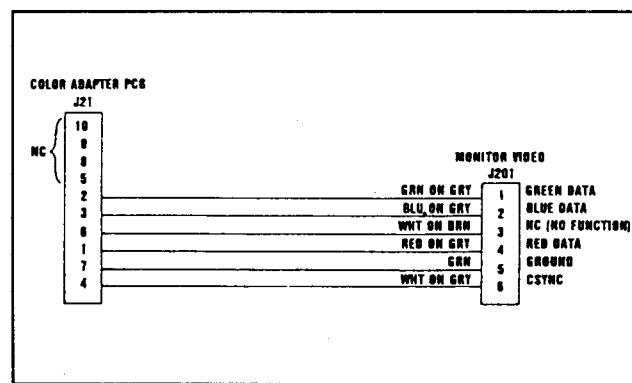
Wavy lines in picture.

**SYMPTOM**

New game kit when installed develops wiggly lines and cannot be adjusted out. A conflict of grounds exists.

**SOLUTION**

Remove the earth ground strap going to the monitor chassis.

**Exidy Targ Monitor Harness Mod****ELECTROHOME TO WELLS GARDNER MAIN HARNESSMODIFICATION**

On J201, 6 Pin TV monitor connector:

1. Remove all Pins from connector housing.
2. Reinsert Pins as follows:

Green on Gray to Pin 1, Blue on Gray to Pin 2  
White on Brown to Pin 3, Red on Gray to Pin 4  
Green to Pin 5, White on Gray to Pin 6

On J21, 10 Pin color adapter PCB connector:

1. Remove Pin 5 and insert in Pin 4.

NOTE: With these alterations the sync split-pad jumper on the color Pcb must be cut.

## Exidy Monitor Adjustment Procedure

### To Freeze Picture for Monitor Adjustment

If you have to adjust the color on your monitor or make other adjustments, you may wish to "freeze" the picture. The easiest way to do this is to activate one of the coin switches. While the switch is activated, the picture will "freeze" on the screen, and as long as you hold down the coin switch it will remain frozen. Another way of doing this is to jump the switch terminals together or remove either of the wires and place it on the empty terminal. Do your adjustments and then disengage your coin switch.

## Gremlin/Sega Space Fury Color (G-80) X-Y System Redesign

Gremlin/Sega reports that all of the problems encountered with the industry's first color X-Y game *Space Fury* have been identified and solved.

The problems are centered around the deflection (X-Y) amps. Underrated power transistors combined with an extended "on" time during the power-up routine resulted in damaging the amplifier circuit.

The remedy includes a modification to the card cage and replacement of the Electrohome Monitor with a redesigned unit.

Gremlin/Sega will have replaced all defective monitors and modified all game card cages by the end of October.

Initial field fixes did not resolve the problem entirely and Gremlin/Sega decided to undertake the monitor replacement program.

Electrohome, the monitor manufacturer, will replace monitors in the Eastern U.S., while Gremlin/Sega will handle the Western U.S.

## Gremlin/Sega X-Y Timing PCB Mod

In order to eliminate occasional extraneous vectors from the right edge of the Color X-Y monitor display, please make the following corrections to your Owner's Manual (P.N. 420-0605), and the X-Y Timing Board:

1. Add to the Parts List:

Item	Part #	Qty
40	151-0002	2
Description		Ref
Cap Ceramic		C32, C33 100pf

2. On page 40, sheet 5, zone D4 & B4 of your Owner's Manual, add the capacitors to the schematic and;

3. Install C32 between pin 2 and pin 6 of U2. Install C33 between pin 2 and pin 6 of U3.

To insure that the vertical and horizontal outputs of the G-80 X-Y Timing Board do not exceed a preset level, the addition of 2 diodes is recommended. The diodes, type 1N914, are installed as follows:

1. Remove the G-80 Timing Board from the card cage.

2. Solder the ANODE of one diode to pin 1 of the Molex connector located on the front edge of the Timing Board. It is recommended that the diode be installed on the underside of the board.

3. Solder the CATHODE of the diode to a +5 volt pad on the back of the board. This can be found at the +5 volt pin on the closest IC.

4. Install the CATHODE of the second diode to +5, in the same way. Then, solder the ANODE of this diode to pin 4 of the Molex connector.

## Gremlin/Sega GO8-003 Color X-Y Monitor Voltage Analysis

## DEFLECTION PCB

## P 900 (EHT)

Pin 1	2.8 VAC		
2	3.5 VAC		
3	-9.1 VDC		
4	9.1 VDC		
5	GRD		
6	GRD		
7	5.0 VAC		
8	120 VDC		
9	OPEN		
10	400 VDC		
D 401 — cathode	63 VDC		
D 403 — cathode	63 VDC		
D 400 — anode	-63 VDC		
D 402 — anode	-63 VDC		
ZD 400	59 VDC		
ZD 401	9.0 VDC		
ZD 402	-9.1 VDC		
Q 400 — base	59 VDC	— emitter	58.8 VDC
Q 401 — base	9.7 VDC	— emitter	9.1 VDC
IC 600	— collector	63.5 VDC	
Q 402 — base	17 VDC	— collector	
IC 600			
Pin 1	0	10	0
2	4.2 VDC	11	0
3	0	12	-9.1 VDC
4	0	13	0
5	0	14	0
6	9.1 VDC	15	0
7	7.5 VDC	16	0
8	0	17	0
9	0	18	4.2 VDC
Q 600 — collector	34.5 VDC	Q 700 — collector	35.9 VDC
Q 601 — collector	0.8 VDC	Q 701 — collector	0.5 VDC
Q 602 — collector	-0.5 VDC	Q 702 — collector	-0.8 VDC
Q 603 — collector	63.5 VDC	Q 703 — collector	63.5 VDC
Q 604 — collector	-63.9 VDC	Q 704 — collector	-63.5 VDC
Q 605 — collector	63.9 VDC	Q 705 — collector	63.9 VDC
— base	0.1 VDC	— base	0.1 VDC
— emitter	0.1 VDC	— emitter	0.1 VDC
Q 606 — collector	-63.9 VDC	Q 706 — collector	-63.9 VDC
— base	-0.1 VDC	— base	-0.1 VDC
— emitter	-0.1 VDC	— emitter	-0.1 VDC

## EHT PCB

## IC 900

Pin 1	0.4 VDC	10	1.7 VDC
2	0	11	8.7 VDC
3	0.1 VDC	12	8.7 VDC
4	-9.1 VDC	13	2.3 VDC
5	9.0 VDC	14	9.0 VDC
6	0.7 VDC	15	0.5 VDC
7	1.7 VDC	16	0.1 VDC
8	7.5 VDC	17	8.7 VDC
9	0.1 VDC	18	0
Q 901 — emitter	8.0 VDC		
— base	7.5 VDC		
— collector	0.3 VDC		
Q 902 — emitter	0		
— base	0.3 VDC		
— collector	0.5 VDC		
Q 903 — emitter	0		
— base	0.5 VDC		
— collector	3.0 VDC		

### Leland Viper Vertical And Horizontal Alignment

Although The Leland Corporation's *Viper* is a unique and exciting piece of equipment, it will not reach its maximum earning potential unless a little time is taken to insure a correct player/game (hardware/software) interface.

The following checks should be made each time the game is collected:

**A.** Both horizontal and vertical encoders must be set at approximately 512 as per the manual when the moving monitor of the action cabinet is centered and level. (Refer to your *Viper* manual and enter the buttons and controls test - page 15 - from the diagnostics menu.)

**B.** The horizontal and vertical indexes or flags must be positioned so that the slot in these flags is in the center of the optical sensor when the moving monitor of the action cabinet is centered and level. (The flags are the metal or plastic pieces which move through the optical sensors on the small encoder driver boards. See pages 24 & 25 of the manual.)

**C.** All gears (or sprockets on early versions of *Danger Zone*) should be mounted securely. They should have no "play."

**D.** The monitor should be clean and properly adjusted.

**E.** Audio volume should be adjusted to each location. It is a must that the audio is loud enough to be heard.

**NOTE:** Check that the integrated circuit (IC) on each shaft encoder driver board is a 74LS14. Some early versions of *Danger Zone* contained encoder driver boards populated with 74HC14's. These must be replaced with 74LS14's.

The 74HC14's, if left in place, will fail and cause failure of the opto couplers, resulting in loss of vertical or horizontal scrolling. When replacing IC's, it is recommended that an IC socket also be installed to facilitate ease of maintenance.

### Adjusting the Matsushita Monitor Overvoltage Protection

The Matsushita 14-inch color monitor has a crowbar overvoltage protection circuit that kills the high voltage power supply when the horizontal hold adjustment is not set properly. The coarse horizontal hold adjustment is accessible from the front of the monitor through a slot in the mounting bracket. Use the following procedure to properly adjust the monitor. Refer to the monitor manual for the position of the controls and fuse.

1. Misadjust the coarse horizontal hold until the picture loses sync, or the picture flips diagonally.
2. Rotate the coarse horizontal hold back slowly until the picture straightens plus an additional 5 degrees of rotation.
3. Turn the game on and off several times to ensure that the game will hold the adjustment when it is first powered up.

Another possible cause of the screen blacking out is the B+ supply being adjusted too high. The 115 volt DC power supply can only be adjusted when there is a picture on the screen. This is because a load for the power supply is needed. When the crowbar circuit kills the high voltage, the B+ supply will probably be running at about 170 volts. To properly adjust the B+ supply, perform the following steps.

1. Turn the game off with the AC interlock switch.
2. Set a DC voltmeter on the 250 volt range, and attach the positive lead to F2 (the small 1A fuse near the center of the monitor PCB). Attach the negative lead to ground.
3. Find R812, the B+ adjustment. It is accessible through the slot on the CRT bracket on the front of the monitor.
4. Turn on the game power and adjust the B+ to 114 volts DC as soon as you can see the screen light up with a picture.
5. Turn the game off and on to ensure that all the monitor adjustments are properly set.

## Memetron Mat Mania Washed-Out Video

### PROBLEM

When converting machines with old style Wells Gardner monitors (19K4600 Series) to Memetron's *Mat Mania*, the picture is "washed out" with many lighter colors appearing as white.

### SOLUTION

The remedy is to remove R3, R4 and R6 from the logic boards. These are located on the top board next to TR1, 2, 3 and 4. This should be done to all boards prior to installation for best picture definition.

*Note:* Don't remove R5 or you will lose your sync signal.

## Nintendo Monitor Vertical Rollover

### PROBLEM

Vertical rollover on Nintendo monitors, especially older Nintendo games such as *Donkey Kong* and *Radarscope*. In these games with the monitor placed vertically, the vertical foldover will appear on the left hand side. Attempts to adjust this condition out by the use of the vertical height or vertical linearity controls will result in frustration. This problem is also likely to appear in later games such as *Popeye* and *Mario Bros.* only the foldover will appear at the top instead of the left side because the monitor is placed horizontally.

### CAUSE

C407, a 10mfd, 160v electrolytic capacitor with radial leads has failed. Also, C410, a 100mfd, 160v electrolytic with radial leads may need replacing.

### CURE

Replace these above mentioned capacitors with the same types and the same or higher voltage ratings. Both are located near the back of the monitor PCB. We have had enough of these monitors come through the shop with the same problem to warrant issuing a service notice.

## Monroe Birdie King 2 Video Display Tearing

### PROBLEM

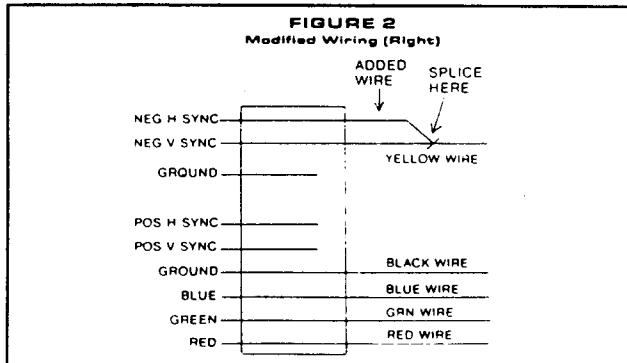
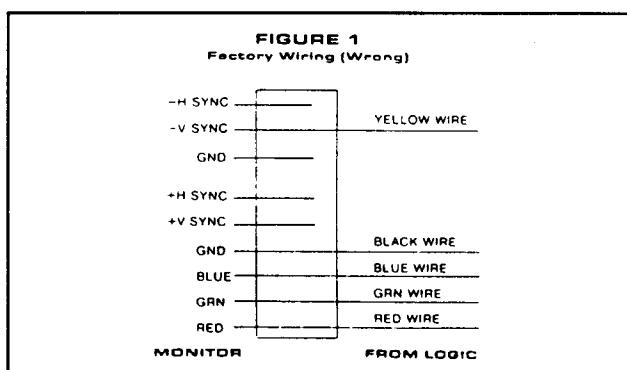
The right-most part of the *Birdie King 2* display starts tearing down or up and cannot be adjusted out successfully with the horizontal hold control.

### CAUSE

At the factory where the games are assembled, only one line is used for the sync signal from the board. This is a mistake, because the Wells Gardner monitor requires a composite sync signal, which is negative for the *Birdie King 2* logic board to go to both the negative horizontal and the negative vertical input. From the factory, only the negative vertical sync input is fed by the logic. The factory tries to hide the jagged right edge by excessive vertical height adjustment, but this sometimes hides the stroke information.

### CURE

Connect a jumper wire from the sync line to the negative horizontal input so that both negative sync inputs are fed. Consult the old figure (1) as the way it comes from the factory and the correct as shown in Figure 2.



### Nintendo VS System Upright Monitor Interchangeability

The monitors in the VS. System Upright are essentially the same as the monitor used in Nintendo's previous games except for two minor differences: (1) the brackets which support the CRT are angled differently so as to allow easier mounting; (2) the right-hand monitor, as you look at the front of the game, has the vertical and horizontal deflection yoke wires swapped. This allows the monitors to be mounted "top-to-top".

The monitors are labeled "left" and "right." To use an older monitor to replace the left monitor, simply change the CRT support brackets. To change the right monitor, replace the CRT support brackets and swap the vertical (yellow and green) wires & horizontal (red and blue) wires.

**CAUTION:** Do not get the horizontal and vertical wires crossed as this can cause damage to the electronic components.

### Nintendo Playchoice 10 Top Monitor

It seems that for some reason the upper monitor on a Playchoice 10 loses horizontal sync after several months on location. I have encountered this problem three times myself and another routeman said this has happened to him on six occasions.

Whether it's in the board or the monitor is not important - what remedies the problem is adjusting the horizontal hold control on the upper monitor for a stable picture. This control is between the flyback and the picture tube on the PC board - it is not grouped with the other controls. There is another control called "sub brite" that's in the near center of the board, but the horizontal hold control is between the flyback and the CRT; you could probably use a flashlight and most likely a pocket screwdriver for this one.

### Nintendo Sanyo Monitor Distortion

#### PROBLEM

Large bright objects distort the horizontal lines. Looks like a cap could be the problem.

#### POSSIBLE CAUSE

I have encountered this problem several times. The cap which is responsible for this is C166.

#### CURE

Replace C166 with an exact or equivalent value.

### Nintendo Sanyo Monitor Capacitor Failure (Pix Brightness)

#### TYPE

Nintendo Sanyo Monitor 20-EZV (R-C)

#### SYMPTOM

A new capacitor to replace: In addition to C407, a 10 microfarad at 160vdc capacitor with radial leads baking open and causing vertical foldover on one side of the screen, another capacitor is going bad, causing bad picture brightness.

#### SOLUTION

This capacitor is C472, a 100 microfarad at 160vdc capacitor with radial leads. It is located near the flyback transformer. Replace to restore good picture quality.

### Nintendo Monitor Video Inversion Modification

#### PROBLEM

When using Nintendo cabinets for conversions, a problem always occurs; the video is inverted (video not sync). Since the video is an analog signal, a simple TTL inverter cannot be used and the old *Popeye* inverter boards have become scarce.

#### SOLUTION

As an alternative, a modification to correct the problem right on the monitor chassis is provided.

#### PROCEDURE

First remove the jumpers installed in place of TR 201 through 203, also remove R213 through 215. Now you are ready to install the inverting section on the monitor.

*Install the parts as follows:*

R201 through 203	100 K Ohms
R210 through 212	100 K Ohms

R213 through 215	820 Ohms
R217 through 219	560 Ohms
TR201 through 203	2 SC 1815
C202	220 uf 16 V
D210	IN 4004

Now the monitor will be ready to be used with most new conversion kits.

### Nintendo VS Hum Bars

#### PROBLEM

When installing two conversion boards into the Nintendo, dual monitor, VS cabinets, you get a very noticeable "hum bar" that rolls through each monitor, that wasn't there prior to the conversion.

#### REASON

Small differences in the sync frequencies between the boards cause the magnetic fields of the yokes to "beat" against each other (i.e., influence the deflection of each other). This is due to the fact that the open frame monitors aren't shielded from each other. Shielding wasn't needed originally because the "Main" and "Sub" sides of the VS board were run from a master clock.

#### SOLUTION

Place a piece of heavy sheet metal between the monitors and make sure that it is well grounded to both monitors, and that it has a direct line running to the earth ground.

### Sega Turbo Interface PCB Display Solutions

#### TURBO-MINI INTERFACE PCB

There have been two models of video monitors employed in *Turbo-Mini*, the Electrohome model G07-902(P.N. 200-0065) and the Nanao model CI-20014(P.N. 200-0075). Please note that the RGB Interface Board (P.N. 834-0277), located on the left-hand side of the cabinet (viewed from the rear compartment door), although present in all games, is utilized only with the Electrohome monitor. The Interface Board has been left in all cabinets in the event that an Electrohome model is used in a future replacement.

#### TURBO DISPLAY SOLUTIONS

If you are experiencing moving white vertical bars over or at the location of buildings and/or cars in the display, Sega recommends you perform the following procedure:

1. Turn the game off and visually inspect the 16 (sixteen) 100pf capacitors located in the area of U50, U51, U43, U44 and U45 on the PROM Board (P.N. 834-0111). This is the bottom board of the stack, and the Component Location Diagram can be found on page 112 of the Turbo Owner's Manual (P.N. 420-0681). The PROM Board schematic is on page 143, Sheet 1 of 10, Zone 4B-D.
2. You should be looking for a physical separation (splitting) of one or more of these caps, primarily C21, C27 or C28. If a faulty capacitor is found, it should be replaced with a 100pf 1KV ceramic cap (P.N. 151-0002) or equivalent.
3. If all caps appear good, reassemble the game, turn it on and while watching the video display, adjust VR1 and/or VR2 until the bars disappear. These two potentiometers are bias level adjustments and as such may have to be "tweaked" from time to time as the components in the circuit age.

### Sega Color X-Y Monitor Zener Replacement

RE: 19" Color X-Y Electrohome Monitor  
G08-003(P/N 200-0025)

A higher than acceptable failure rate has been noted for the Thompson CSF version of the 1N4739 Zener Diode used in the Deflection Amp PCB Assembly. Sega recommends, therefore, that future replacements of ZD402 be made with the Motorola version (available through Sega Customer Service Parts). Additionally, please amend the part description to specify manufacturer, as in the following example:

Part #	Description	Ref. Des.
481-0179	Zener Diode 9.1V, 1W, 5%, Motorola 1N4739	ZD402

This addendum applies to the following games:  
*Space Fury, Eliminator, 4-Player Eliminator, Zektor, and TAC/SCAN.*

### Sega Monitor Nanao MC-2000-S Vertical Collapse

#### POSSIBLE CAUSE

More than anything else, the first thing to check on the monitor with this problem is R416, a 22 ohm fusible resistor in the vertical section. If open, it will result in no vertical deflection.

#### CAUSE

The cause of this resistor opening can be attributed to the failure or near fatigue of Q401 or Q402, the vertical deflection transistors.

#### NOTE

Of course these transistors as a matter of routine should be checked before replacing R416 and trying the monitor again.

### Sega Electrohome Color X-Y Monitor Deflection Amp Mod

*Game/Assembly Affected: 19" Color X-Y Monitor (P/N 200-0025-00) Electrohome G08-003*

#### SUBJECT

Deflection Amp PCB; R635 equivalent

#### ACTION

A single 3-ohm 20-watt resistor (P/N 474-0003-00) may be used interchangeable with the existing pair of 1.5-ohm resistors (P/N 474-0150-00) in the event of failure. The G08-003 Color X-Y Monitor was used in the following games: *Space Fury, Eliminator, Zektor, Tac/Scan, Star Trek*.

### Sega Space Fury Moving Lines

#### SYMPTOM

Every once in a while *Space Fury* gets faded, moving lines on the right side of the screen.

#### SOLUTION

In order to eliminate occasional extraneous vectors from the right edge of the color X-Y monitor display, please make the following corrections to your Owners Manual (P/N 420-0605) and the X-Y Timing Board:

1. Add to the Parts List:

<u>Item No.</u>	<u>Part No.</u>	<u>Qty. Req'd.</u>	<u>Description</u>	<u>Ref. Des.</u>
40	151-0002	2	CAP Ceramic 100 pf, 50V	C32, C33

2. On page 40, sheet 5, zone D4 and B4 of your Owner's Manual, add the capacitors to the schematic and;

3. Install C32 between pin 2 and pin 6 of U2. Install C33 between pin 2 and pin 6 of U3.

# 8

## Wells Gardner Monitors Tips & Info

### Wells Gardner Monitor Blooming Mod

A condition which is normally described as "blooming" has been found in some Wells Gardner 15V2000 and 19V2000 chassis series

This condition is caused by arcing within the high voltage rectifier connectors. To cure this problem, follow this procedure.

1. Switch off AC power and remove the monitor from the game.
2. Remove H.V. cover secured by two screws.
3. Unplug the H.V. rectifier from its holders and inspect the holders to insure that the springs are inside the holder.
4. Replace the rectifier with a new rectifier W.G. part number 66X0067-002. The leads of the rectifier must be cut and formed in the same manner as the original.
5. Insert the rectifier firmly in its holders, banded side toward CRT.
6. Inspect the lead dress of the transformer H.V. wire. Wire must be dressed.
7. Inspect fuse F102 on main deflection PC board. The fuse value should be 1.5 amp.
8. Replace the H.V. cover which was removed in step No. 2.

### New Input Protection Circuit for Wells-Gardner Color X-Y Display

This display contains an additional small printed-circuit board (PCB). The PCB is mounted in "piggy-back" style on top of the Deflection PCB.

An input protection board was added to protect the fuses in the display from damaging input voltage conditions. Without this board, the display fuses might blow in the event of an intermittent or long-term game PCB failure.

With this board, the screen will momentarily go blank if the average X or Y axis voltage(s) exceed a certain level. The screen then automatically recovers for normal game play and earning when the voltage(s) return to normal.

If this display is used in Atari *Tempest* games, be sure to correctly adjust the X and Y SIZE and CTR video pots on the *Tempest Analog Vector-Generator* (main) PCB. The instructions for these adjustments are printed on the *Tempest* schematics - Sheet 2, Side B - 3rd printing or later. Improper adjustment may cause the screen to go blank during normal game play.

### Wells-Gardner Color X-Y Shaky Display Tech Tip

#### SYMPTOM

Characters on the display are shaky or made up of small dots, instead of smooth lines.

### SOLUTION

Replace capacitor C901 or C902, 100uf at 35 volts, in the high-voltage power supply.

## Technical Tips Wells-Gardner Color X-Y Display

### SYMPTOM

After replacing a shorted transistor in the +28 volt power supply (Q100 or Q102), the 5-amp fuse blows again.

### CAUSE

You probably have shorted diodes ZD100 and D104. After replacing a defective component, it is always good practice to check all components in the power supply prior to power up.

The same applies to the -28 voltage power supply components Q101, Q103, ZD101 and D105.

### SYMPTOM

Glitches or spikes on video display objects.

### CAUSE

Defective components C901 and C902 capacitors located on the circuit board in the high voltage cage. Recommended replacement is a 100 uF, 50v electrolytic capacitor.

## Wells-Gardner Vertical Deflection Circuit Revision

### Identification

This bulletin applies to those monitors with serial numbers of 400001 and above.

They can be identified by the following:

- A) The model number on the shipping carton and on the monitor is printed in red.
- B) The part number on the deflection yoke is either 202111258 or 202111264.
- C) The flyback transformer stabilizing bracket is labeled 611X0005-008.
- D) There is an additional control, the VERTICAL DAMPING CONTROL, immediately to the right of the Vertical Hold Control.

### Reason

The applicable monitors have an improved deflec-

tion yoke which provides for faster vertical retrace. This permits more lines of video to be displayed. The VERTICAL DAMPING CONTROL permits the user to adjust the uniformity of spacing of the additional lines.

### Adjustment of the Vertical Damping Control

The adjustment of the VERTICAL DAMPING CONTROL is important only if the vertical size is adjusted such that the additional lines appear on the screen. Turn up the Black Level Control such that the raster lines can be seen. Adjust the Vertical Damping Control such that the top raster lines are spaced uniformly and not folded over. Return Black Level Control to the desired setting.

### Yoke Replacement

It is IMPERATIVE that deflection yokes with part numbers 202111258 and 202111264 be used only with the chassis identified above. They may not be substituted for deflection yokes with part numbers 202111194 or 202111201. Conversely, deflection yokes numbered 202111194 and 202111201 may not be substituted for deflection yokes numbered 202111258 and 202111264. Improper matching of chassis and yokes will result in insufficient vertical deflection or improper blanking operation.

**NOTE:** When requesting service parts or information, be sure to mention the monitor's model number and serial number.

## Wells Gardner CRT Replacements

The Wells-Gardner color monitor (19" 19K4900 and 13" 13K4800 series) is equipped with a special CRT, which is not interchangeable with any 19" 19K4600 or 13" 13K4700 series CRT.

### CONDITION

Pin cushion distortion and dynamic convergence (outer edges) will be incorrect.

### Newer Wells-Gardner Monitors

19" 19K4900 series CRT# 19VLTP22  
13" 13K4800 series CRT# 370KSB22

### Earlier Wells-Gardner Monitors

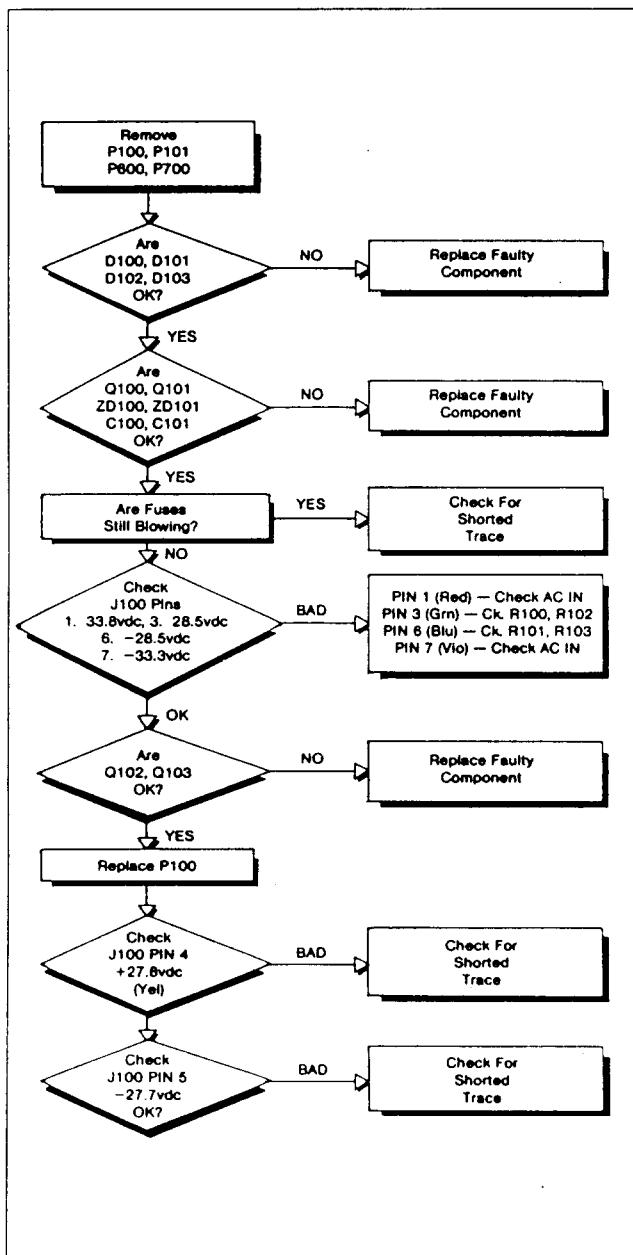
19" 19K4600 series CRT# 19VJTP22,  
19VMBP22, 19VMAP22, VM19VLGP22.  
13" 13K4700 series CRT# 37DJB22

## Troubleshooting the Wells-Gardner Color X-Y Monitor Power Supply

Troubleshooting problems in the low voltage power supply will be greatly simplified by following the flow chart provided.

A good quality volt-ohmmeter and basic soldering equipment will be required to perform the tests.

*Blows F100, F101, 5-Amp fuses - faulty low voltage power supply.*



## Purity, Convergence and Tracking Adj for W-G Color X-Y Monitor

All the adjustments can be made while the monitor is mounted in the game. Allow 15 minutes warm-up time before attempting these adjustments. Remember to observe the precautions regarding high voltages when you make any adjustments on this display.

### A. PURITY PROBLEMS

#### 1. Preliminary.

Turn the monitor so it faces north or south. In the case of cocktail games, all adjustments should be made with the monitor facing up. Then degauss the picture tube with a hand-held degaussing coil. Enter the self-test mode and advance the screens until the horizontal and vertical checkerboard pattern is displayed. Then rotate the encoder wheel on the control panel of the game until only the green pattern appears.

#### 2. Green Purity Adjustment

Loosen the yoke-retaining clamp so that the yoke can move. Slide the yoke toward the back. Now, remove the rubber deflection yoke wedges. These are the small rubber wedges between the yoke and the tube. These are glued to the tube, so you will probably have to peel them off. These will be used later in the final dynamic convergence procedure. Now, remove any glue that may be holding the purity and convergence rings in place. These are 3 sets of 2 rings each, located behind the yoke. The first set (the pair closest to the front of the tube) are the purity rings, the second or center pair are the red and blue convergence rings, and the last pair are the green convergence rings. Working with one set of rings at a time, rotate one or both rings in a line so that they face opposite directions from each other. In this position, they are set for minimum deflection.

Slowly slide the yoke toward the front of the CRT until the pattern displayed is an overall pure green. Tighten the yoke clamp lightly, then rotate the yoke to level the pattern on the face of the CRT.

#### 3. Red and Blue Purity Adjustments

Turn the encoder wheel until only the red pattern is displayed, and slightly readjust the yoke for a uniform and pure red. Then turn the wheel to the blue pattern and adjust that the same way. Go

back and check the green and red patterns, and check to be sure they are as pure as you can get them. Some compromise will have to be made here, as all 3 colors will probably not be pure, but get them as close as you can. Now tighten the yoke in place, and you are ready to make the fine purity adjustments. This is done by adjusting the purity rings for the best overall purity of each color. When all 3 colors are pure, put a small amount of glue on them to keep them in place.

## B. STATIC CONVERGENCE ADJUSTMENTS (CENTER AREA):

### 1. Preliminary

Put the game into self-test mode and advance the screens until the horizontal and vertical checkerboard appears. Advance the encoder wheel until only the red and blue lines are displayed.

### 2. Convergence

Adjust the tabs on the center pair of adjusting magnets so that the red and blue lines are superimposed on each other (Do this at the center of the screen). Next, turn the encoder wheel on the control panel until the red, blue and green lines are displayed. Adjust the tabs on the pair of magnetic rings closest to the neck PCB (the green convergence rings), so that the green line is superimposed on the red and blue lines. (Do this at the center of the screen). At this point, with all 3 guns on, the checkerboard pattern in the center of the screen should be pure white. When this is completed, put a small amount of glue on the rings to keep them in place.

## C. DYNAMIC CONVERGENCE (OUTER AREA):

### 1. Preliminary

Put the game into self-test mode and advance the screens until the horizontal and vertical checkerboard is displayed. Advance the encoder wheel until the red, blue and green lines are displayed.

### 2. Convergence

Up/down movement of the yoke causes the outer edges of the screen image to swivel clockwise or counterclockwise. Side-to-side movement causes the lines at the outer edges to expand and contract. Move the yoke in the up/down and side-to-side directions until the outer lines on the screen are pure white. Then secure the deflection yoke by putting the rubber deflection yoke wedges back in between the picture tube and the yoke's white

collar. Secure the wedges with glue or RTV, and then tighten all screws holding the deflection yoke clamp and magnets in place.

## D. TRACKING ADJUSTMENTS (NECK PCB)

### 1. Preliminary

Put the game into self-test mode and advance to screen #5 (seven groups of colored bars of various intensities). Next, turn on all the pots on the neck PCB to their full clockwise position. Turn the brightness control to a level that clearly displays the fifth line from the right of the center group of lines. If the sixth line from the right is visible, reduce the brightness. If the fifth line from the right is not clearly visible, increase the brightness. There are six pots on the neck board - 3 for red, green and blue bias, and 3 for red, green and blue drive. The bias pots are for controlling the low intensity color mix, and the drive pots are for the high intensity color mix. When properly adjusted, the color of a line should remain the same whether it is bright or dim. In actual practice, a line that is bright white will probably appear blue-white when the intensity is decreased.

### 2. Bias Adjustments

Adjust the red, green and blue bias potentiometers until the fifth line from the right (the high intensity line) is pure white. These pots are labeled R bias, G bias and B bias.

### 3. Drive Adjustments

Adjust the red, green and blue drive potentiometers until the first line on the right (the high intensity line) is pure white. Drive pots are labeled R drive, G drive and B drive. If you find it impossible to get both the low and high intensity lines pure white, adjust for pure white at the high intensity level, and just get the low intensity level as close as you can.

This completes the alignment procedures for the Wells Gardner color X-Y monitor.

## Wells Gardner Color X-Y High Voltage Supply

I recently spent several hours diagnosing a problem with a Wells Gardner color X-Y high voltage power supply. Transistors Q901 and Q902, and resistors R903, R901 and R907 were burned.

After replacing the bad components, Q901 and Q902 became very hot and burned out in less than a minute. The defective component turned out to be C905, a 33mfd/150v cap. When measured out of circuit, this capacitor had deteriorated down to approximately 1.4mfd! The solution is to replace C905 with a 50mfd/200v cap of good quality. (I used a Mallory brand electrolytic.)

I have experienced this particular problem twice in the last month; upgrading this cap has solved the problem both times.

### Wells Gardner X-Y Monitor Final Solution

We all pride ourselves on the service we have been able to offer our customers. The following modifications are, in our estimation, a final solution to the Wells Gardner X-Y monitor problems.

Over the past three months, we have modified every Wells Gardner X-Y monitor to cross our bench and the rate of repeated failure is such that only one has returned with a deflection problem. These changes make the 19K6101 and 19K6103 very reliable monitors and much better suited for the environments in which they are operated.

#### MODIFICATIONS FOR WELLS GARDNER QUADRASCAN COLOR X-Y

##### 1. INPUT PROTECTION CIRCUIT PCB ASSEMBLY

To ensure continued circuit operation, Atari Field Service suggests that you perform the following modifications:

- Remove the lead connecting the IPC board to +27 volts on the display printed circuit board. The lead is located near Q1 and Q3 (see Figure 1.1).
- Replace this lead with a 1K ohm, 1/4 watt resistor (see schematic of Figure 1.1).

##### 2. POWER SUPPLY CIRCUIT

The Low Voltage Power Supply is to be bypassed in this modification. The input stages of the deflection circuits used in this monitor are of the differential type and exhibit a high common mode rejection. This characteristic will filter out any noise or ripple of the power supply.

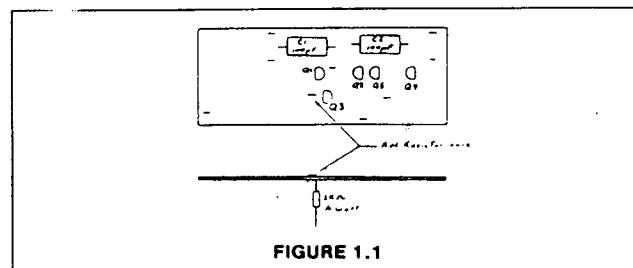
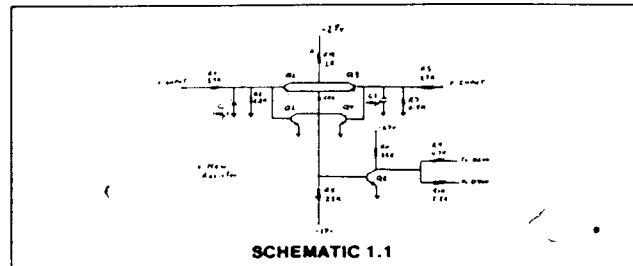
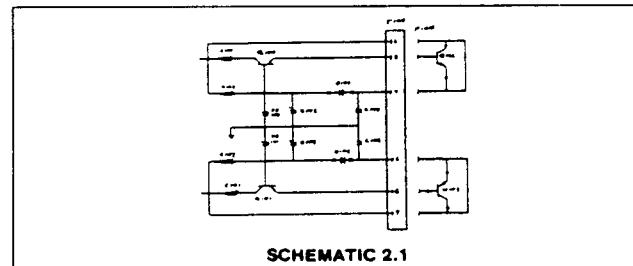
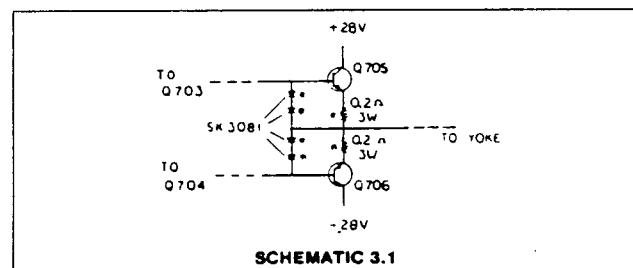


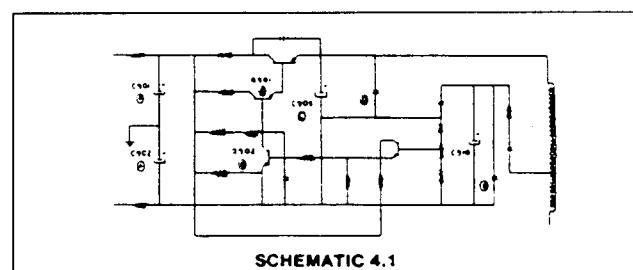
FIGURE 1.1



SCHEMATIC 2.1



SCHEMATIC 3.1



SCHEMATIC 4.1

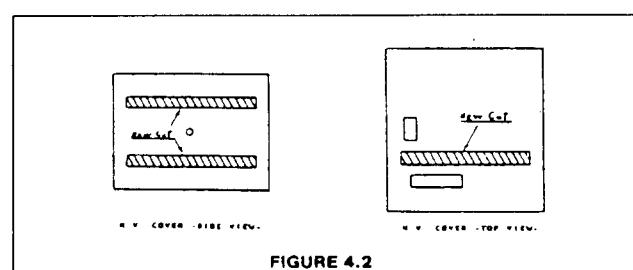


FIGURE 4.2

- A. Cut diodes D104 and D105 out of the power supply circuit (schematic 2.1).
- B. Cut the wires at P100 leaving about two inches at the plug.
- C. Make a Rat Tail splice connecting the leads at pins 1 & 4; also, splice the leads at pins 5 and 7.
- D. Solder and cover the exposed wire with electrical tape or shrink tubing.
- E. Cut the remaining wires flush with the plug (leads at pins 3 and 6).

**NOTE:** This modification will require readjustment of monitor color, focus and the signal level from the logic board. This is due to the higher supply voltage now available at the deflection and color drive stages. This modification will remove about 45 watts of power from the bottom plate of the monitor chassis and cause a noticeable reduction in temperature.

### 3. X CHANNEL CURRENT LIMITER

The X channel of this monitor must do more work than the Y channel. This modification limits the amount of current that can be delivered to the load and the X channel output transistors are moved so they may be more efficiently cooled by convection currents.

- A. Remove the plug from J700 and reconnect at J600. The cable of P700 will need to be lengthened before this can be done. This move connects the transistors on the bottom chassis plate to the Y channel.
- B. Transistors mounted on the side chassis panel may now be connected to J700. These are now the X channel output transistors. The side panel allows more air currents to pass over the transistors and consequently more efficient cooling.
- C. Remove the emitter lead from the transistor sockets on the side panel and place a 0.2 ohm, 3 watt resistor in series with emitters of Q705 and Q706 (as in schematic 3.1).
- D. Place two SK3081 diodes in parallel with the base-emitter-resistor circuits (schematic 3.1).

**NOTE:** When the currents through the emitter resistors reach 3 amps the voltage drop is such that the diodes across the base-emitter circuit will start to turn on. This action will drain current away from the base circuit and prevent transistors Q705 and Q706 from passing too much current.

### 4. HIGH VOLTAGE POWER SUPPLY

These changes to the high voltage power supply should reduce incidence of failure due to high temperatures and/or low voltage power supply failures.

- A. Replace capacitors C901 and C902 with 220MF 50V capacitors (schematic 4.1).
- B. Replace transistors Q901 and Q902 (schematic 4.1) with transistor type 2N2102. Place a heat sink for a TO-39 package on Q901. Take care not to allow the two transistors to touch.
- C. Replace C905 with a 50 MF 200V capacitor.
- D. Solder an SK3081 diode across capacitors C910 and C905 with the polarity of the diodes opposite that of the capacitors.
- E. Cut vents into the aluminum cover of the high voltage unit (as illustrated in Figure 4.2).

**NOTE:** The last procedure is the most important of these modifications. The vents will allow convection currents to cool the high voltage section reducing the thermal stress to these circuits. Also, if the power supply modifications are performed, this entire modification becomes mandatory.

## Wells Gardner 19K4901 Flyback Xformer

For those of you that haven't memorized monitor numbers, this is the later model monitor by this company whose earlier more popular monitor was the one with the parallel boards.

This model 19K4901 was a supposed improvement over the older type of monitor except for one thing - the older monitor seemed to have a sturdier flyback transformer. This newer model has a flyback transformer that with age loses its potential to develop a strong focus voltage, resulting in a picture that cannot be focused sharply after a while.

This note most concerns operators and converters who, after they install a new kit, can't seem to focus the picture. I regret that the only solution is to replace the flyback, which is an expensive item.

## Wells Gardner Sync Board Modification

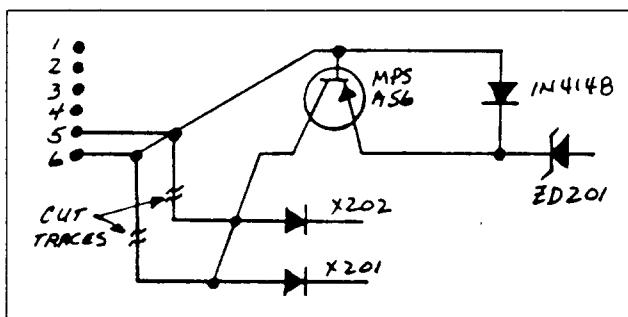
### RE:

Modification to Wells Gardner Color Monitor Positive Sync Board (vertical mount boards). 85x140B.

### PROCEDURE

To change this board from a positive sync to a negative sync board do the following:

- Cut the traces on solder side of board between input pins 5 & 6 to the unbanded ends of diodes X201 and X202.
- Add MPSA56 transistor as follows: Collector to unbanded ends of diodes X201 and X202, base to pins 5 & 6, emitter to banded end of zener diode ZD201.
- Place a IN4148 diode banded end to emitter of MPSA56 and unbanded end to the base of this transistor.



## Wells Gardner High Voltage Shutdown

### WELLS GARDNER K7000 MONITORS

Particularly those used in Sega's *Alien Syndrome* games. It seems that the high voltage shutdown circuit is adjusted too close at the factory and will cause shutdown at line voltages over 130Vac.

I've had to remove VR8, the 2000 ohm adjustable pot, clean the sealing glue from it, and adjust it upwards SLIGHTLY, just enough so that it won't shut the monitor down at this higher line voltage. *Caution:* Don't try to adjust it in circuit or you will most likely break it.

## Wells Gardner 19K4615 Sync Problems

### SUBJECT

Sync problems.

### PROBLEM

Even though the proper negative sync is supplied, the monitor still won't produce a stable picture.

### CURE

Because of a possible hardware problem, the sync signal isn't strong enough to synchronize the monitor.

One solution which has worked for me is to place a 1 microfarad axial-lead capacitor across resistor R219 on the monitor interface board.

There are several different interface boards for this monitor, so it may not be labeled R219, but the resistor discussed is the first resistor encountered attached to either the negative vertical or negative horizontal sync input.

The capacitor provides a signal bypass around the resistor. I will also add, as a means of identification, that this is the monitor with the two stand-up boards on it.

## Wells Gardner 19K4675 Warped Picture

### MONITOR ID

Two parallel boards type.

### CAUSE

C613, a 220 microfarad at 25vdc radial-lead capacitor and C614, a 33 microfarad at 25vdc radial-lead capacitor are not performing their proper function in the pincushion correction ckt.

Replacement of these capacitors is needed even though they may check good with a capacitor meter.

Note the unusual mounting of one of these capacitors (if not installed correctly, the horizontal/vertical board will not seat properly when replaced).

## Wells Gardner 4600 Series Capacitor Change

### SYMPTOM

On these older Wells Gardner monitors you will find that the picture is not rectangular. On a vertically mounted unit the right side of the screen will be the most effected. If it is mounted horizontally the top of the screen is the worst.

### PROBLEM

C614 has become leaky due to heat from R608.

### SOLUTION

Replace C614, a 33mf at 25v. This capacitor is located on main board under the horiz/vert Pcb.

## Wells Gardner 4600 Black Level Control

### PROBLEM

Over the past few months I have had many of these monitors come into the shop with the same problem. The monitor is running, but no picture.

### SOLUTION

Replace the black level control. It is VR201, a 1.5k ohm potentiometer located on the interface board. I have had a hard time finding an exact replacement for this pot, so I have been using Wico #36-0011. This is a 1k ohm pot, but it works fine in this circuit.

### NOTE

On some monitors the black level control will be mounted on the front of the board, and on some it will be mounted on the back. If you will install the new pot on the back of the board it will make it easier to adjust the brightness in the future.

## Wells Gardner 19K4901 Brightness Problem

### PROBLEM

Rippled brightness or problems with brightness.

### CAUSE

C702, a 10 microfarad capacitor at 100vdc with radial leads has failed, causing bad filtering on the B+ boost voltage supply to the final color output transistors.

## Wells Gardner 19K 7901 Intermittent Fix

### GAMES

*After Burner U/R, Top Speed* and all other games that use the Wells Gardner 19K7901 monitor.

### PROBLEM

Games come on ok, but after period of time the picture goes blank. Logic and power are present, but no CRT filament voltage can be seen

### SYMPTOMS

This can be a very nagging and annoying problem because often times the game will seem to work fine, then when moved on location, or left on, the monitor will go out. I first suspected that the over-voltage protection had kicked in (high line volts).

### CAUSE

However, this is not the case. I removed the monitor chassis and gave it a physical exam and noticed that on T1, the high voltage transformer, Pin 1 had broken loose from the solder pad and was making an intermittent contact with pad.

### SOLUTION

I re-established a good solder connection with this pad, and with some of the other pads, which seemed to be breaking loose and I have had no problems since. This problem has happened to 3 of the *U/R After Burners* and 2 of the *Top Speed* monitors, possibly because of the high amount of vibration & current demands put on these pads.

## Wells Gardner 19K 7901 Cold-Solder Area

There is an additional area on the Wells Gardner monitor where cold-solder problems have been the cause of much downtime.

### PROBLEM

Cold solder joints on R105, (thermistor, located on the bottom left corner of the K7000 Color Monitor Schematic Diagram), will cause arcing to the monitor chassis just the same as when the linearity coil (L2) has a cold solder connection. The arcing will burn a hole in the PCB and shut down the monitor.

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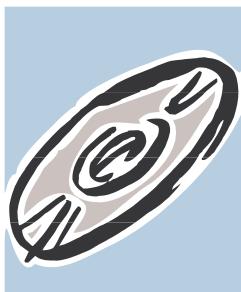
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