Bally Midway's

Monitor Systems

Troubleshooting Procedures
Monitor Part Two

Bally MIDWAY MFG. CO.
10601 W. Belmont Avenue
Franklin Park, Illinois 60131
U.S.A.

Phone: (312) 451-9200 Cable Address: MIDCO Telex No.: 72-1596
VIDEO 800/323-7182 PINBALL 800/323-3555

July, 1983

FORM 00380-8306

WARNING
THIS GAME MUST BE GROUNDED. FAILURE TO DO SO MAY RESULT IN DESTRUCTION TO ELECTRONIC COMPONENTS.

WARNING: This equipment generates. uses. and can radiate radio frequency energy and if not and used in accordance with the instructions manual. may cause interference to radio communications. It has been tested and found to comply with the limits for a CLASS A computing device pursuant to SUBPART J of PART 15 of FCC RULES. which are designed to provide reasonable protection against such interference when operated in a commerical environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

ELECTRICAL BULLETIN: FOR ALL APPARATUS COVERED BY THE CANADIAN STANDARDS ASSOCIATION (CSA) STANDARD C22.2 NO. 1, WHICH EMPLOYS A SUPPLY CORD TERMINATED WITH A POLARIZED 2-PRONG ATTACHMENT PLUG.

CAUTION: TO PREVENT ELECTRIC SHOCK DO NOT USE THIS (POLARIZED) PLUG WITH AN EXTENSION CORD, RECEPTACLE OR OTHER OUTLET UNLESS THE BLADES CAN BE FULLY INSERTED TO PREVENT BLADE EXPOSURE.

ATTENTION: POUR PREVENIR CHOCS ELECTRIQUES NE PAS UTILISER CETTE FICHE POLARISEE AVEC UN PROLONGATEUR. UNE PRISE DE COURANT OU UNE AUTRE SORTIE DE COURANT, SAUF SI LES LAMES PEUVENT ETRE INSEREES A FOND SANS EN LAISSER AUCUNE PARTIE A DECOUVERT.

Bally/MIDWAY T.M.

Invites You To Use

OUR TOLL FREE NUMBERS FOR SERVICE INFORMATION CONCERNING THIS GAME, OR ANY OTHER BALLY/MIDWAY™ GAME YOU NOW HAVE ON LOCATION.

CALL US FOR PROMPT, COURTEOUS ANSWERS TO YOUR PROBLEMS.

Continental U.S. 800-323-7182
Illinois Only 1-800-942-0497

Printed in U.S.A.

TABLE OF CONTENTS

INTRODUCTION

This manual was written specifically for the Electrohome model GO7-CBO, and the Wells Gardner 19K4600 series monitor. These are the two most common color monitors used inside of the Bally/ Midway video games.

The information presented should give the repairman a thorough understanding of the operation of the monitor. Hopefully, the techniques given will also carry over to the other monitors for efficient troubleshooting.

Contents of this manual has been divided into six categories. The first section prepares the technician to begin to repair the monitor. Topics on safety are dealt with. This is a major concern for yourself and others. Then, there is a list of suggested service equipment. These are a few of the testing devices which will assist you to isolate a problem down to the component level.

The general troubleshooting sub-section is very practical in giving a monitor's symptom, then by making known in what part of a circuit to check. Sometimes, this may list the specific part which is defective.

Section two goes into detail on the power supply. Many times a monitor may not be receiving the AC line voltage, or if it is the B+ DC voltage is too low or high. The monitor's B+ supply is also handled in the "NO RASTER" and "H.V.L." circuit description.

The third section describes how the picture tube is illuminated, and mentions problems with the screen's brightness. Raster Scan tells how the electron beams are deflected on the front of the CRT. This section sets a good foundation for the next category.

In section number four, the two deflection circuits are covered. This would be the vertical and horizontal stages. The high voltage section input is taken from the horizontal output signal. High voltage is provided by the monitor to the picture tube in order to light the screen. (obtain a raster.)

Color problems are explained in section five. Such as a missing or having a dominate color on the screen. Degaussing and purity set-up enables the picture to have no color blotches upon it. White balance allows the color blend (tint or hues) to be correctly viewed. Convergence eliminates having separate colored fringes beside any of the images on the screen.

The last section has the schematic and parts list for both monitors. A number of technical service tips are also given to help you fix the monitor, so the games down time is at the very least.

I. Getting Started

Safety

The safety tips given will provide the repairman with an adequate amount of information to begin trouble-shooting the monitor. Learn and practice the safety procedures until it's known backwards and forwards before repairing the monitor.

The monitor has a much greater voltage potential, than the logic boards. Some voltages range up to twenty-five thousand volts, so by all means be careful.

In some cases, the technician may want to let the distributor, or have a television man, handle the repairs. For those who repair monitors, here are some helpful hints.

Before servicing the monitor, remove all jewelry such as rings, watch, etc. Many of these items are made from a conductive material.

While the monitor is on, work only with one hand inside the monitor. Keep the other hand inside your pocket. If the monitor is on, avoid handling or resting your hand on the metal chassis, chassis is ground.

Current always travels fastest through the lowest resistance path. So, avoid touching high voltage areas especially while the monitor is on. These areas would be such as the high voltage lead going to the CRT's second anode, or the flyback (high voltage transformer) area. Avoid also the wires and terminals at the deflection yoke. The horizontal output section, particularly the transistor, carries a great amount of current.

The neckboard on the back of the CRT has a lot of high voltage points. Many traces are for screen and focus grids on the tube. The voltage is between four hundred and five thousand volts. The collectors of the color outputs has about two hundred volts.

Familiarize yourself with the manufacturer's schematic and follow all safety precautions listed. Use exact replacement parts when one is called for and never underrate a component. If replacing parts such as electrolytic capacitors and diodes, double check polarity before soldering into board. On transistors, observe their leads for correct insertion.

Repair the monitor and keep the unit as neat as possible. Don't leave frayed wires, or wires laying up against power resistors. These resistors dissipate a lot of heat. Avoid dressing the wires close to a transformer. When soldering, use the correct temperature iron for the job. A messy repair could result in a more costly one later down the road.

When removal of the monitor is necessary, watch for possible sharp edges and burrs on the metal chassis. You may want to wear protective gloves, when carrying the monitor.

Use a isolation transformer, when the monitor is taken out of the game cabinet and powered up.

For work bench, make sure the top is non-conductive, such as wood.

In regards to CRT's, follow the instructions given in the manufacturer's monitor service manual.

Test Equipment

SUGGESTED MONITOR SERVICE EQUIPMENT

1) Volt ohm meter
2) Oscilloscope
3) High voltage probe
4) R.G.B. signal service generator
5) Degaussing coil
6) Isolation transformer
7) Mirror
8) Frequency counter (Optional)

General Troubleshooting

This section of the manual 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 VERY DANGEROUS, SO BE CAREFUL!!**

1. Find the symptom that matches the problems your monitor has in the "SYSTEM—DIAGNOSIS" subsection. 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, read the "TROUBLESHOOTING" subsection to learn the procedure for finding the bad part.
3. Next, go to the schematic section and find the schematic that matches your monitor. It may be helpful to read the "DIFFERENCES BETWEEN MONITORS" subsection 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. (There is a toll free number on the back side of the front cover of this manual.)

Symptom Diagnosis

1. Insufficient width or heighth:

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 or vertical output transistor.
B. Bad Component in output circuitry.
C. Vertical linearity or damper control needs adjustment.

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 neck-board terminal.

5. Colors missing; check:

A. Interface color transistors.
B. Color output transistors.
C. Cracked printed circuit board (neck Board).
D. Color circuits.
E. Video input jack.
F. Defective picture tube.

6. Picture not bright enough:

A. Weak emission from picture tube.

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).
B. Bad component in monitor's power supply.

10. Small picture and/or poor focus:

A. Low B+ voltage (power supply trouble).

11. Vertical rolling:

A. Vertical oscillator in the IC, vertical sync. transistor, or circuit.

B. No sync from logic board.

C. Three pin sync. jack is loose or plugged in wrong.

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, visable 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. Wavey 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 degausser's instructions.

B. Picture tube defective.

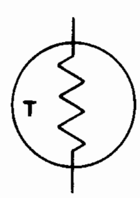
C. Nearby equipment is electromagnetically interferring.

D. The poles of the earth are pulling off the purity — see "A" above.

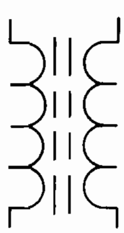
E. Poor focus or width of picture.

F. Make sure you have the correct CRT number for that brand of monitor.

Guide To Schematic Symbols



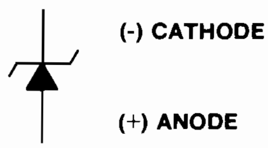
THERMISTOR
(POLARITY DOESN'T MATTER)



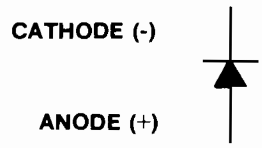
IRON CORE TRANSFORMER
(SUCH AS A FLYBACK)

INDUCTOR, COIL, CHOKE
(POLARITY DOESN'T MATTER)

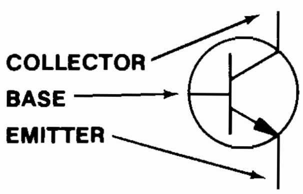
FUSE
(POLARITY DOESN'T MATTER)



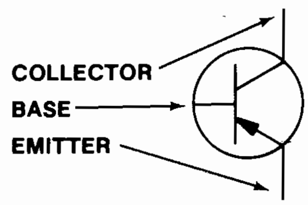
ZENER DIODE



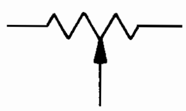
DIODE



NPN TRANSISTOR

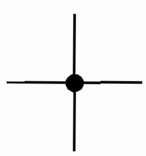


PNP TRANSISTOR

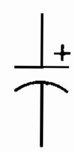


VARIABLE RESISTOR, POT, CONTROL
(POLARITY DOESN'T MATTER)

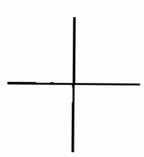
RESISTOR
(POLARITY DOESN'T MATTER)



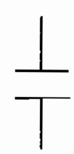
LINES ARE CONNECTED



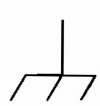
ELECTROLYTIC CAPACITOR



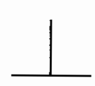
LINES ARE NOT CONNECTED



CAPACITOR
(POLARITY DOESN'T MATTER)



OR



GROUND

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 (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 23,000 volts, **CAN BE KILLERS!!** Avoid handling power transistors (usually output transistors) or ICs, 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.

IMPORTANT! The side brackets of the monitor are chassis ground as is the aquadag, the picture tube's dark conductive coating. **BUT,** on the ZENITH MONITOR there are metalic mounting parts which **ARE NOT** chassis ground. Discharging the CRT to these will damage the monitor!

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 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 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. Consistantly 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 oscilliscope. **BE CAREFUL:** Shorting their pins can easily destroy them.

Resistors are checked with an ohmeter 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 and 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 the 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".

NOTES

This space is provided for personal notes.

II. 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+ adjust 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 (B_1). As B_1 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 B_1 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 (model 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 P.C. board. Suspect also the transistors, and current limiting resistors. Burnt foils or poor solder connection may be found on the P.C. 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 boards 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 H.V.L. (protection circuit) in regards 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 thru it. The CRT's electron beam when scanning the front of the tube passes thru 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 games 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's output is connected to a thick coil and is mounted around the bell of the picture tube. When the coil is activated, an electromagnetic field is induced and neutralizes any magnetization developed on the tube.

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 monitor's second anode will be about twenty-five kilovolts. (25,000 volts)

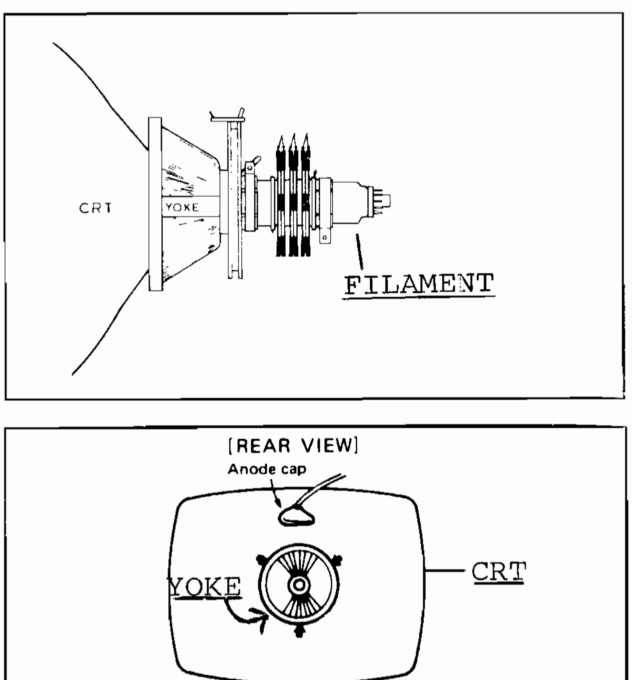


Figure 2-1

If both the filament and high voltage are missing from the picture tube (also known as the CRT, CATHODE RAY TUBE), then measure the monitors 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 T03 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 also on a bracket. These two transistors are not interchangeable with each other.

Looking from the back of the monitor onto the main P.C. 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 P.C. 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 120 VDC, Wells Gardner 127 VDC.

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.

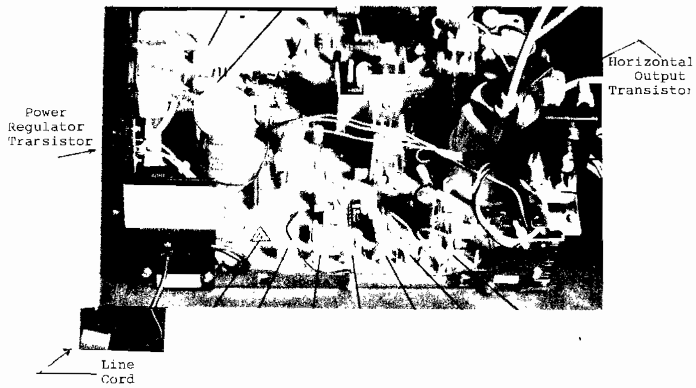


Figure 2-2

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 115 VAC at the monitor's line cord.

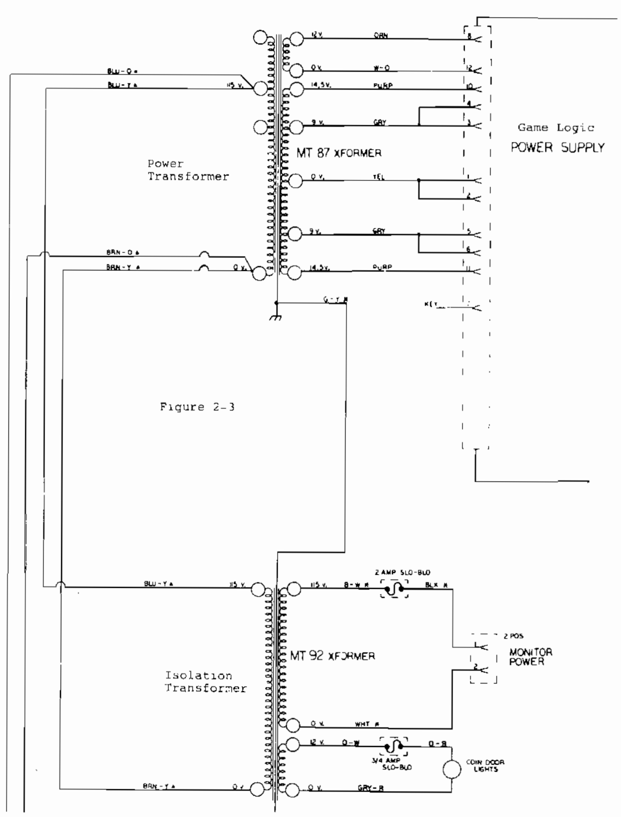


Figure 2-3

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 115 VAC to the input of the isolation transformer and 115 VAC on its secondary winding is present.

Missing 115 VAC 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 115 VAC present, and the secondary is zero volts AC, here 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 P.C. board.

Electrohome has two fuses. The line fuse F902 which is rated at three amps. Another fuse to the power regulator circuit is F901 and is rated at one and a quarter amps. The Wells Gardner monitor has only one fuse marked F601 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.

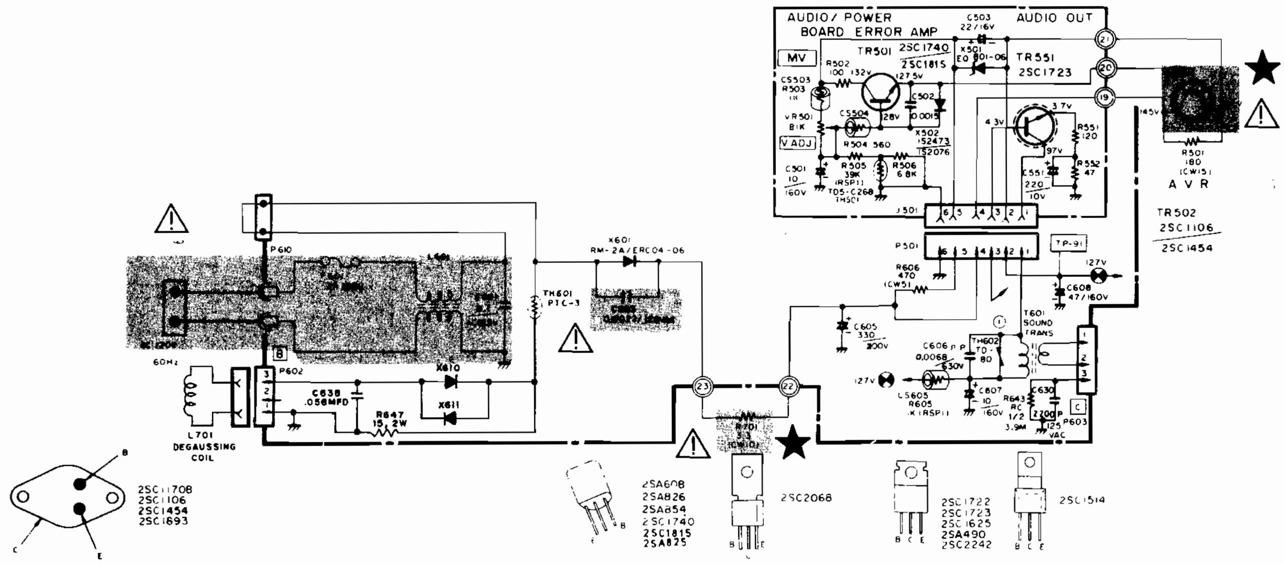


Figure 2-4
Wells Gardner Power Supply and Regulator

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 148 VDC. 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.

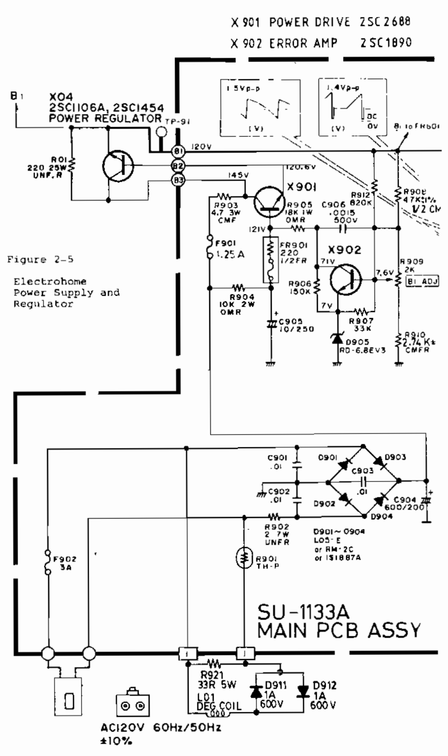


Figure 2-5
Electrohome
Power Supply
and Regulator

3. **B+ voltage too high**
   In case of no filament or high voltage and the B+ measures higher than normal, refer to H.V.L. (protection circuit) section. When the B+ reaches 138.5 VDC or more on Electrohome or around 145 VDC 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.

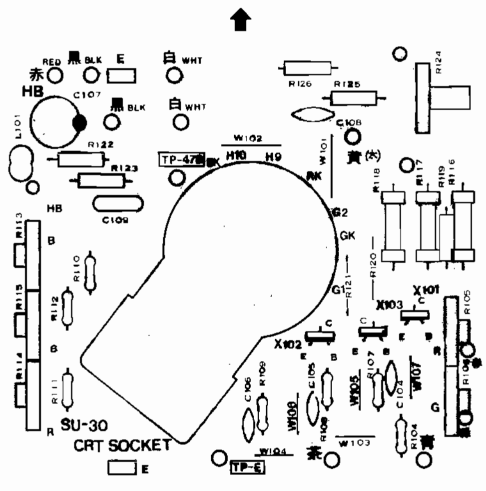
4. **Normal B+ voltage**
   Here everything seems to be working properly and the B+ checks good. The high voltage and filament is at the CRT, yet there is no raster (lit screen).

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.

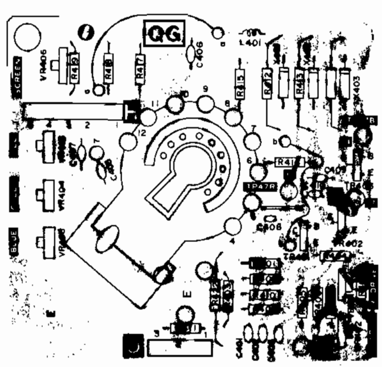
With the front of screen still dark, measure the voltage at pin 7 of the CRT socket. The voltage is normally between four hundred fifty and five hundred volts DC (depending upon where the screen control is set). If the voltage measures zero or very low, turn off the monitor. Remove the neckboard from off 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.

C.R.T. P.C.B. COMPONENT LAYOUT



Electrohome PC Neckboard



Wells Gardner PC Neckboard

Figure 2-6

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 P.C. 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 adjusts 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 either a problem with the wiring or the flyback transformer itself. If the voltage is present, but no output—a new control assembly may be needed.

5. No raster or filament has high voltage

The three cathodes inside the CRT emits 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 altogether. 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.

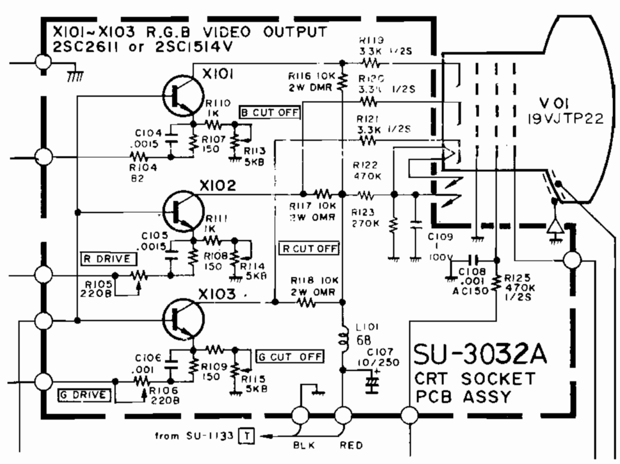
To check the filament voltage on the neckboard, measure pins nine and ten of the CRT socket. These should be the two top pins of the tube. This is an AC voltage and should measure around four to six volts. Voltage present indicates no continuity between the heater pins on the socket to the filament.

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 its 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.

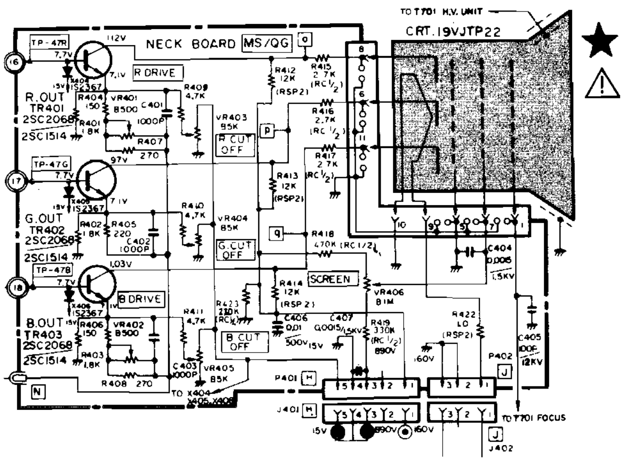
So, on Electrohome trace back to pins four and five of the flyback transformer. Here the voltage should measure about six volts AC. If not, unplug the monitor and disconnect the neckboard from the tube. Measure for continuity across the flyback pins four and five. If open, replace.

On 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.



Electrohome Neckboard

Figure 2-7



Wells Gardner Neckboard
Figure 2-7

6. **No raster or high voltage, has filament**
   Since both the filament and high voltage is 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 to prevent high voltage.

   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 comes off the same winding as where the high voltage is taken from. 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 second anode of CRT to ground.

   Disconnect second anode cap from 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 snap, 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 with a high voltage probe the second anode cap. High voltage present suspect CRT—missing can possibly be a defective flyback transformer.

High voltage limiter (protection) circuit

The H.V.L. 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, in turn, 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 H.V.L. is activated, thus allowing no high voltage to the picture tube.

This symptom was mentioned earlier as no raster, no filament, or high voltage and finding that the B+ measured too high.

An activated H.V.L. 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 Electrohome monitor is 120 VDC. Wells Gardner is 127 VDC.

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 chart for breakdown of condition and suspected components.

CONDITION	ELECTROHOME	WELLS GARDNER	FUNCTION
Raster, B+ High	D905, X902 X901, X04	X501, TR501 TR502	Regulator 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)

III. Lighting the Screen

CRT Construction and Operation

The picture tube 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 is good.)

The physical structure of the CRT is a large glass envelop 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 of 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 towards 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, gives us 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 is used to draw or attract the electron beams to the front of the screen. Whereas, 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 into the area of the bell of the CRT. As it approaches closer to the front of the tube, the beams come up to the shadow mask.

The shadow mask is a large metal sheet which is paralleled to the inside front of the tube. Tiny slots in the mask allows the electron beams to pass through to strike the screen.

The mask is made and positioned inside the tube, so that the electrons strikes its proper color phosphor. If the mask is loosen and shifted, the screen will exhibited 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. Final destination of the electron is 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 a 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 screens 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. Electronhome 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 which 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 that 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. If not, try the other solutions listed.
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, yet 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 regards 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.

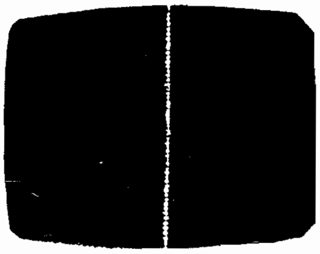
Well, let's get back to the raster scan monitor. Without the horizontal and vertical deflection circuitry inside the monitor, the electron beams would hit or strike only the center portion of the screen. This will display a white dot in the middle of the screen. The beams are attracted to the front of the screen, but they're at a standstill. Being then, not able to view the picture, makes the game rather difficult to play.

The horizontal deflection scans the beams from the CRTs 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.

No Vertical Deflection



No Horizontal Deflection

Figure 3-1

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 electro magnetic device. One coil is for the vertical and the other is for the horizonal 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 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 262½ horizontal lines scanned on the screen. Because of this, the horizontal frequency is much faster than the vertical.

The process of interlace scanning is by 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 262½ of odd and 262½ of 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 one sixtieth (1/60) of a second to scan one field. However, one complete frame takes one thirtieth (1/30) of a second. So actually, there are thirty complete frames or pictures per second.

Since we know how many frames per second there are, by taking the number of lines per second, determines the frequency of the horizontal oscillator. Five hundred and twenty-five lines times thirty frames are equal to fifteen thousand, seven hundred and 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 circuits 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 respected circuits. This blanking transistor is connected directly with the color video output transistors on the neckboard. There are three transistors, one to drive the red, another for green and one also 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 at 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.

NOTES

This space is provided for personal notes.

IV. 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 needs 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 monitors 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) is 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 is 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 is 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 monitors 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.

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 circuitry 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 receive 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. Next, the vertical amp gives the signal a boost.

Controls in the vertical circuit consist of the vertical hold, linearity, and height. The Wells Gardner monitor vertical circuit omits the linearity adjustment.

The hold control adjusts the oscillators 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.

Electrohomes IC 501

Let's discuss briefly about the integrated circuit, IC 501. Inside the IC contains 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 makes 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, determines 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 screen to the bottom.

A fusible resistor (FR401) supplies 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 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, looses 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 is designed with transistors, whereas, the Electrohome uses both an IC and transistors. Here the stages of the circuitry is 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.

Its purpose is to operate at the same rate as the logic's horizontal sync signal. This is needed for picture stability. Secondly, generates 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 a 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 short 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 waveformer.

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 anywhere 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 apc circuit to swing either to a higher or lower voltage. The voltage determines whether the oscillator's frequency should be faster or to slow down.

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 emit x-ray emission.

The base of X701 (transistor) is connected in line with the B+ (120 VDC). 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 chips 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 the 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, 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, suspect the component associated with that side.

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. Also the base to collector will check as 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 as 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 is biased at about one hundred volts D.C., Electrohome is approximately one hundred and sixty.

On the cathodes as the DC voltage decreases, the screen begins to light up brighter. An extreme 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 dominate 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 and high voltage and the B+ measures too high.

The Electrohome's 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-millimeter)

NOTES

This space is provided for personal notes.

V. 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) is missing, or the parts are of a different hue, then the information is missing. The problem would lie 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 neckboard, 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 neckboard, remove all power first. Double check wire hookup before applying power.

When the collector of each color output transistor 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 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 dominate 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 dominate 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 none 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 degaussed, 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. Loosen 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 Neck Board 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 Fig. 4)
4. Move the two Purity Magnets and bring the Magenta belt to the mechanical center of the screen (See Fig. 5). The vertical center position should be set VRS to −5/64" (−2 mm) as shown in Fig. 6.
   Insert service tip "N" on Neck circuit board to "S" on Vert./Horiz. circuit board (See Fig. 13). 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, re-adjust it moving Purity Magnets slightly.
8. Move a pair of Purity Magnets at the same time (do not change the angle of the pair), and adjust the vert. 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 Fig. 5 and adjust the angle of Deflection Yoke.

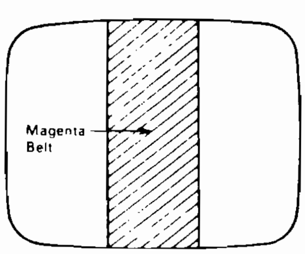


Figure 4

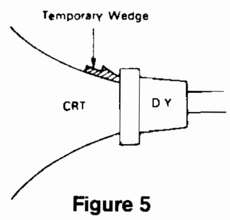


Figure 5

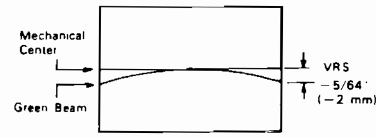
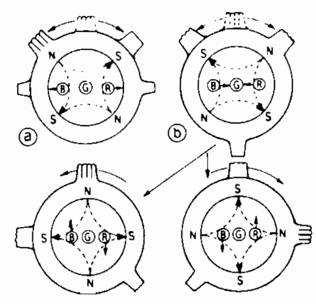
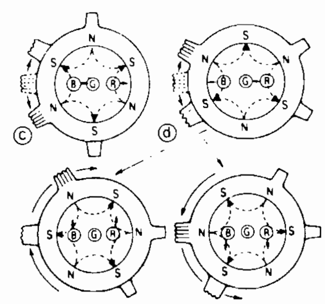


Figure 6



4-Pole Magnets and the Movement of Beams

Figure 7



6-Pole Magnets and the Movement of Beams

Figure 8

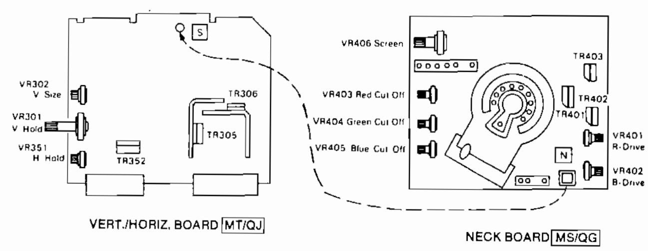
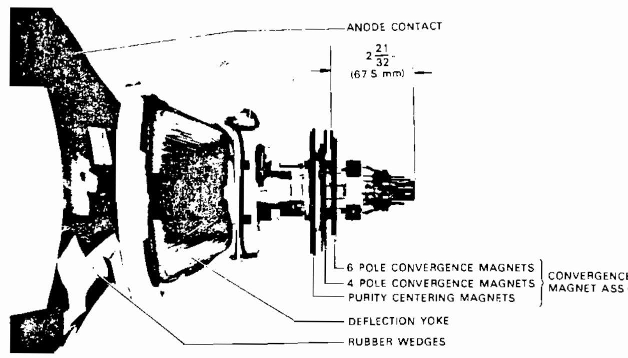


Figure 12



PICTURE TUBE NECK COMPONENTS LOCATION

Figure 13

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 centre position if a major component has been changed.

1.0 Purity

1.1 Loosen yoke retaining clamp (Fig. 2), remove adhesive material fixing wedges to CRT. Remove wedges completely and clean off dried adhesive from picture tube and wedges.

1.2 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.

1.3 Connect an appropriate signal source, e.g.. Electrohome RGB generator producing a white field plus individual red, green and blue fields.

1.4 Bring the long and short purity tab protrusions in line with each other to obtain near-zero magnetic field (Fig. 4). (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.

1.5 Turn off the green and blue fields and adjust set-up controls to produce a red field. (See Fig. 3)

1.6 Pull the deflection yoke back so that a red band appears in the centre of the screen.

1.7 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. 5)

1.8 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. Juggle back and forth slightly as necessary. Lightly tighten yoke retaining clamp.

1.9 Momentarily switch on a cross-hatch signal and rotate yoke to level the pattern on the face of CRT.

1.10 Return generator to regain red raster.

1.11 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 on all fields.

1.12 Tighten yoke retaining clamp to prevent yoke shift or rotation. (Do not install wedges at this time.)

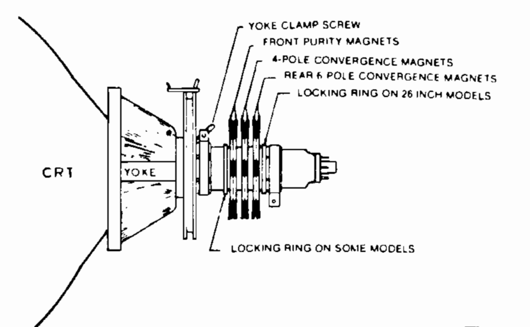


Figure 2

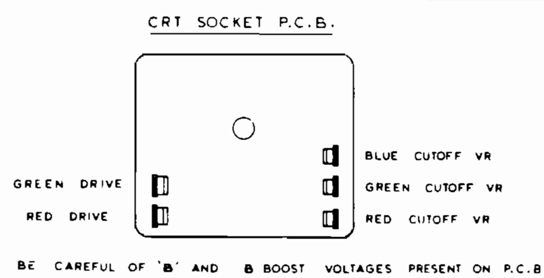


Figure 3

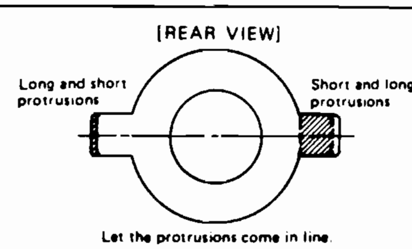


Figure 4

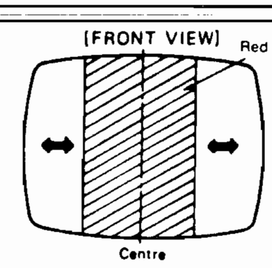


Figure 5

White Balance

White balance gives the raster a grayish white screen with the video cable disconnected. Properly adjusted 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 counter clockwise).

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 greyish 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 & VR402) to their mechanical center.
3. Set the G2 Screen Control (VR406) and the 3 Cut-off Controls (VR403, VR404, & VR405) to miniumum (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 & VR402) for white screen.

Electrohome

White Balance (Grey Scale Tracking)

Refer to figure 3. 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 grey.

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 mech. centre.

Note: When monitor is re-connected with the game the screen control (G2) may require a slight adjustment to obtain proper black level. (The black portion of picture just extinguished.)

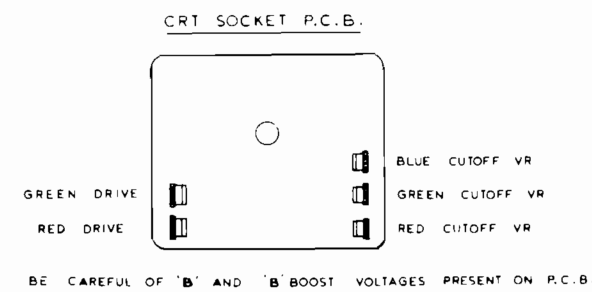


Figure 3

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 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 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° symmetrically, the magnetic field maximizes. Red and blue beams move to the left and right oppositely (See Figs. 7-a and 7-b). 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° symmetrically, the magnetic field is maximized. Red and blue beams both move to the left and right (See Figs. 8-c and 8-d).
   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 Figs. 10 and 11)

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 Figs. 10 and 11).
   NOTE:
   The temporary wedges may need to be moved during adjustments.
4. Insert three rubber wedges to the position as shown in Fig. 9 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 Fig. 10 (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 Fig. 11-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 Fig. 9.
5) After three rubber wedges have been inserted, pull out the temporary wedge.
6) Fix the rubber wedges with chloroprene rubber adhesive.

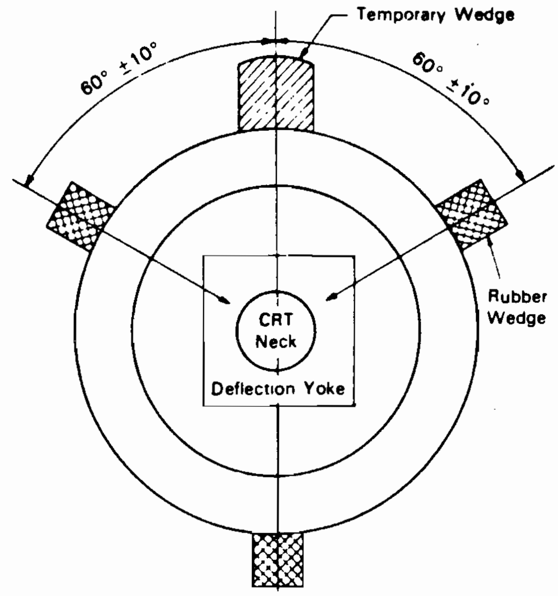


Figure 9

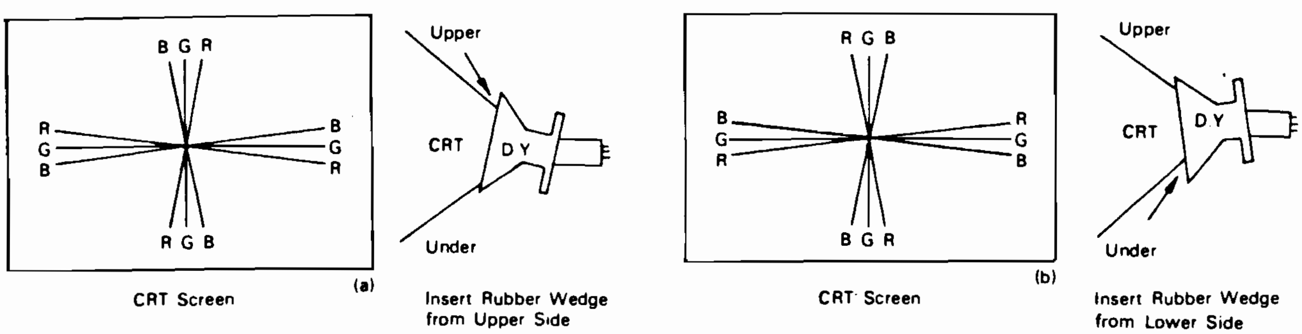


Figure 10

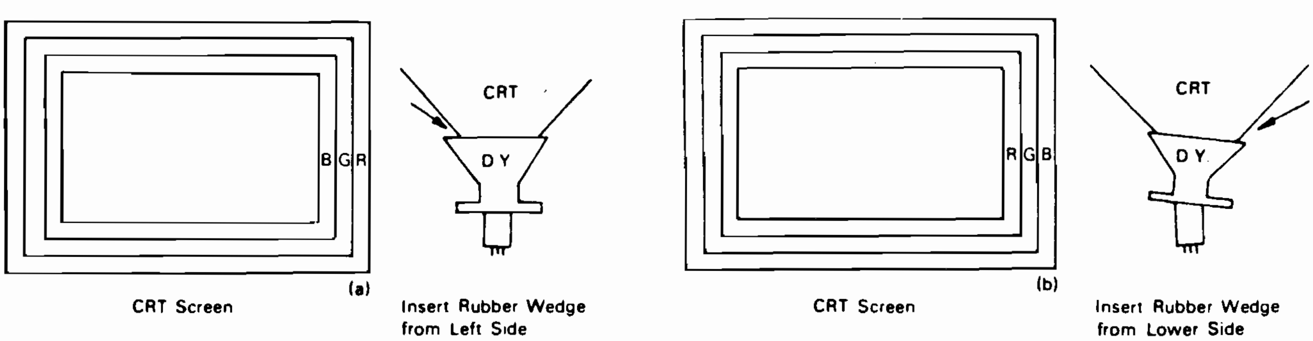


Figure 11

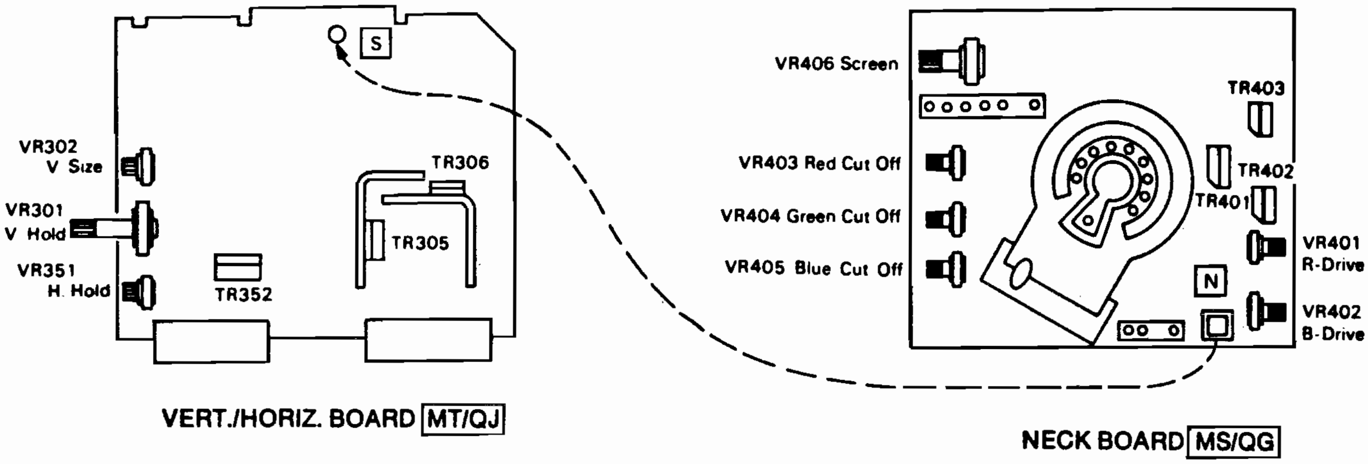
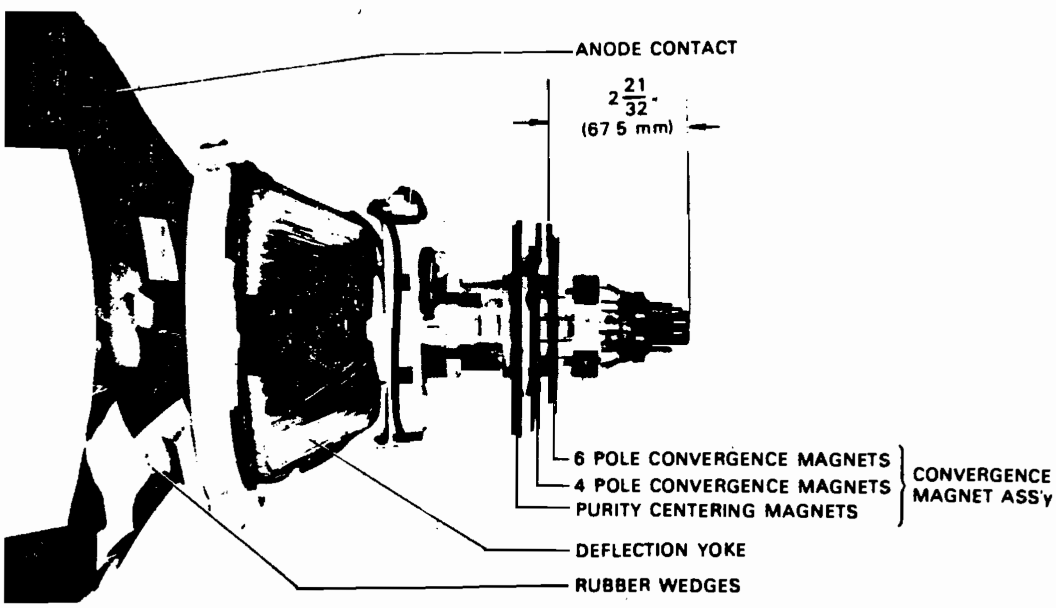


Figure 12



PICTURE TUBE NECK COMPONENTS LOCATION

Figure 13

2.0 Static and Dynamic Convergence

NOTE: Static convergence is achieved by four magnets located on the neck, nearest the base of the picture tube, Fig. 2. The middle pair of magnetic rings are adjusted to converge the blue and red crosshatch 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 crosshatch lines. Dynamic convergence is achieved by tilting the deflection yoke up-down and left-right.

2.1 Ensure that the controls misadjusted during purity setup (screen, cut-off, etc.) are set to give white balance. See 3.0 below

2.2 Switch generator to the crosshatch pattern.

2.3 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. (Figs. 8, 9, 10)

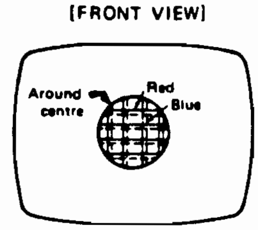
2.4 Turn off green input and turn on the red and blue input.

2.5 Rotate the 4-pole (middle) pair of magnets as a unit to minimize separation of the red and blue crosshatch lines around the center of the screen (Fig. 6). 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 2.3 above.)

2.6 Turn on green input to obtain magenta (red/blue) and green crosshatch lines. Rotate the 6-pole (rear) pair of magnets as a unit to minimize separation of the magenta and green lines (Fig. 7). Vary angle between the two tabs and further rotate as a unit to finalize.

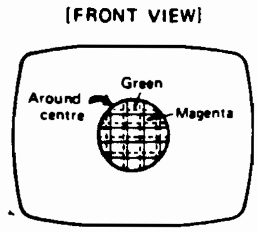
2.7 When convergence of 3 colors is optimized (static in center and dynamic around edges) apply stripe of paint or nail polish to convergence magnet rings to prevent movement. If applicable, tighten locking ring carefully.

2.8 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).



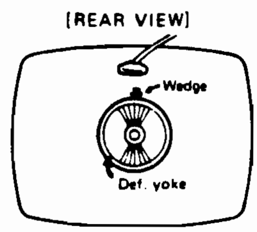
Let the red and blue lines come in line by turning two 4-pole magnets.

Figure 6



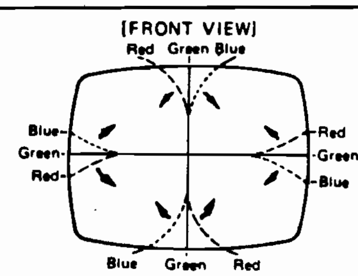
Let the green and magenta lines come in line by turning two 6-pole magnets

Figure 7



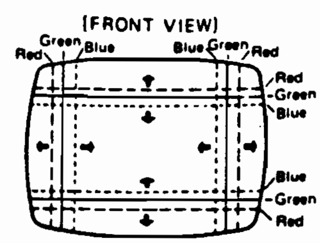
Roughly adjust the circumferential convergence and install one wedge temporarily.

Figure 8



Tilting the yoke upward will move the lines as shown with the arrows.

Figure 9



Tilting the yoke to the right will move the lines as shown with the arrows.

Figure 10

NOTES

This space is provided for personal notes.

NOTES

REPLACEMENT PARTS LIST—ELECTROHOME 19" MONITOR

Components identified by the △ symbol in the PARTS LIST and on the Schematic have special characteristics important to safety.

DO NOT degrade the safety of the set through improper servicing.

Abbreviations for Resistors and Capacitors

Resistor

C R	:	Carbon Resistor
Comp. R	:	Composition Resistor
OM R	:	Oxide Metal Film Resistor
V R	:	Variable Resistor
MF R	:	Metal Film Resistor
CMF R	:	Coating Metal Film Resistor
UNF R	:	Nonflammable Resistor
F R	:	Fusible Resistor

Capacitor

C Cap.	:	Ceramic Capacitor
M Cap.	:	Mylar Capacitor
E Cap.	:	Electrolytic Capacitor
BP E Cap.	:	Bi-Polar (or Non-Polar) Electrolytic Capacitor
MM Cap.	:	Metalized Mylar Capacitor
PP Cap.	:	Polypropylene Capacitor
MPP Cap.	:	Metalized PP Capacitor
PS Cap.	:	Polystyrol Capacitor
Tan. Cap.	:	Tantal Capacitor

NOTE: When ordering replacement parts please specify the part number as shown in this list including part name, and model number. Complete information will help expedite the order.

Use of substitute replacement parts which do not have the same safety characteristics as specified, may create shock, fire or other hazards. For maximum reliability and performance, all parts should be replaced by those having identical specifications.

SERVICE REPLACEMENT PARTS LIST

Symbol	Description	Part Number
	Main P.C.B. Ass'y	SU-1133A
	CRT Socket P.C.B. Ass'y	SU-3032A
	Purity Shield Ass'y	07-220083-03

Outside of the P.C.B. Ass'y

Symbol	Description	Part Number
	Picture Tube 19"	17-7198-03
△	△Deflection Yoke	A29779-D=21-141-01
	PC Magnet	A75034-B=29-32-01
△	△Flyback Transf.	A29951-B
△	△HVR	A46600-A
R05	UNF Resistor 220Ω,25W K	QRF258K-221
C04	C Capacitor 150pF, AC1.5KV	QCZ0101-005
X01	Si. Transistor	2SD870
X02	Si. Transistor	2SC1106A
SC	Screw #8-¾	31-610818-06
SC	Screw ¼ x ¾ Pix Tube Mtg. (4)	31-601418-12
WA	Pyramidal Lock Washer (4)	33-255-01
	Nut Retainer, Pix Tube Mtg. (4)	33-494-01
	Clip—P.C.B. Support	33-629-02
	Standoff	33-670-010R-02
	Wire Terminal (Gnd. Strap)	34-228-03
	Terminal Lug (Gnd.)	34-33-04
	Groundstrap Assy.	34-574-02
	Grounding Spring	35-212-03
	Wire Hook (Gnd. Strap)	35-3053-02
	Purity Shield Holddown Clamp	35-2348-01
	Support Brkt. RH	35-3890-01
	Support Brkt. LH	35-3890-02
	Chassis Base	38-449-02
	Yoke Wedge (3)	39-1233-01

Purity Shield Ass'y. Parts List

Symbol	Description	Part Number
	Degaussing Coil	21-1007-30
D911,		
D912	Rectifier 1 Amp 600V (2)	28-22-27
	Pin Terminal (2)	34-708-01
	Pin Terminal Housing	34-709-01
	Purity Shield (2 pcs.)	35-3847-01
	Purity Shield (2 pcs.)	35-3847-02
C911	Capacitor 100nF 10% 400V	48-171544-62
R921	Resistor, Wirewound 33Ω, 4W	42-113301-03
	Fire Retardant Term. Strip 4 Lug	34-492-09

CRT Socket P.C.B. Ass'y (SU-3032A) Parts List

Resistors

Symbol	Description			Part Number
R3105	V	R	200	QVZ3234-022
R3106	V	R	200	QVZ3234-022
R3113	V	R	5K	QVZ3234-053
R3114	V	R	5K	QVZ3234-053
R3115	V	R	5K	QVZ3234-053
R3116	OM	R	10KΩ2W J	QRG029J-103
R3117	OM	R	10KΩ2W J	QRG029J-103
R3118	OM	R	10KΩ2W J	QRG029J-103
R3119	Comp.	R	3.3KΩ½W K	QRZ0039-332
R3120	Comp.	R	3.3KΩ½W K	QRZ0039-332
R3121	Comp.	R	3.3KΩ½W K	QRZ0039-332

Capacitors

Symbol	Description		Part Number
C3107	E	Cap. 10uF 250V A	QEW53EA-106
C3108	C	Cap. 1000pF DC1400V P	QCZ9001-102M

CRT Socket P.C.B. Ass'y (SU-3032A) Parts List (Cont.)

Coils

Symbol	Description	Part Number
L3101	Peaking Coil	QQL043K-101

Semi-conductors

Symbol	Description	Part Number
X3101	Si. Transistor	2SC1514VC
X3102	Si. Transistor	2SC1514VC
X3103	Si. Transistor	2SC1514VC

Miscellaneous

Symbol	Description	Part Number
△	△CRT Socket	A76068

Main PCB Ass'y (SU-1133A) Parts List

Resistors

Symbol	Description			Part Number
R1406	V	R	200Ω	QVZ3230-002
R1408	V	R	200Ω	QVZ3230-002
R1410	CMF	R	6.8Ω1W J	QRX019J-6R8
R1414	OM	R	3.3KΩ1W J	QRG019J-332
R1415	OM	R	2.7KΩ1W J	QRG019J-272
R1421	OM	R	12KΩ2W J	QRG026J-123Z
R1422	V	R	10KΩ	QVZ3230-014
△FR1401	△F	R	68Ω2W K	QRH024K-680M
△R1503	△CMF	R	11.8KΩ¼W+1%	QRV142F-1182
R1504	V	R	5KΩ	QVZ3230-053
R1509	OM	R	10KΩ2W J	QRG026J-103Z
R1512	OM	R	8.2KΩ2W J	QRG026J-822Z
R1514	OM	R	820Ω2W J	QRG026J-821Z
R1515	CMF	R	8.2Ω1W J	QRX019J-8R2
R1522	CMF	R	4.7Ω1W J	QRX019J-4R7
R1523	OM	R	68Ω2W J	QRG026J-680Z
R1528	OM	R	390Ω1W J	QRG019J-391
R1534	ZN	R		ERZ-C05ZK471
VR1501	ZN	R		ERZ-C05ZK271
△R1703	△CMF	R	39Ω½W+1%	QRV122F-3902
△R1704	△CMF	R	7.68KΩ¼W+1%	QRV142F-7681
△R1901	△Posistor			A75414
R1902	UNF	R	2Ω7W K	QRF076K-2R0
R1903	CMF	R	4.7Ω3W J	QRX039J-4R7
R1904	OM	R	10KΩ2W J	QRG026J-103Z
R1905	OM	R	18KΩ1W J	QRG019J-183
△Q1908	△CMF	R	47Ω½W+1%	QRV122F-470Z
△R1909	V	R	2KΩ	QVP5A0B-023E
R1910	△CMF	R	2.74KΩ¼W+1%	QRV142F-274I
△FR1901	△F	R	220Ω½W K	QRH124K-221M

Capacitors

Symbol	Description		Part Number
C1301	BPE	Cap. 3.3uF 50V A	QEN61HA-335Z
C1402	Tan	Cap. 2.2uF 16V K	QEE51CK-225B
C1407	E	Cap. 4.7uF 6.3V A	QEW51JA-475
C1411	E	Cap. 100uF 160V A	QEW52CA-107
C1412	E	Cap. 3.3uF 160V A	QEW52CA-335
C1508	PP	Cap. 5600uF 50V J	QFP31HJ-562
△C1512	△PP	Cap. 2000pF DC1500V J	QFZ0082-202
△C1513	△PP	Cap. 2000pF DC1500V J	QFZ0082-202
△C1514	△PP	Cap. 2000pF DC1500V J	QFZ0082-202
C1515	PP	Cap. 0.53uF DC1200V J	QFZ0067-534
C1520	BPE	Cap. 3.3uF 50V A	QEN61HA-335Z
C1523	E	Cap. 1uF 160V A	QEW62CA-105Z
C1524	M	Cap. 0.1uF 200V K	QFM720K-104M
△C1531	△PP	Cap. 2000pF DC1500V J	QFZ0082-202
△C1532	△PP	Cap. 1500pF DC1500V J	QFZ0082-152
C1904	E	Cap.	QEY0034-001
C1905	E	Cap. 10uF 250V A	QEW52EA-106

Main PCB Ass'y (SU-1133A) Parts List (Cont.)

Coils

Symbol	Description	Part Number
L1502	Linarity Coil	A39835
L1503	Width Coil	C30380-A
L1504	Heater Choke	C30445-A

Transformers

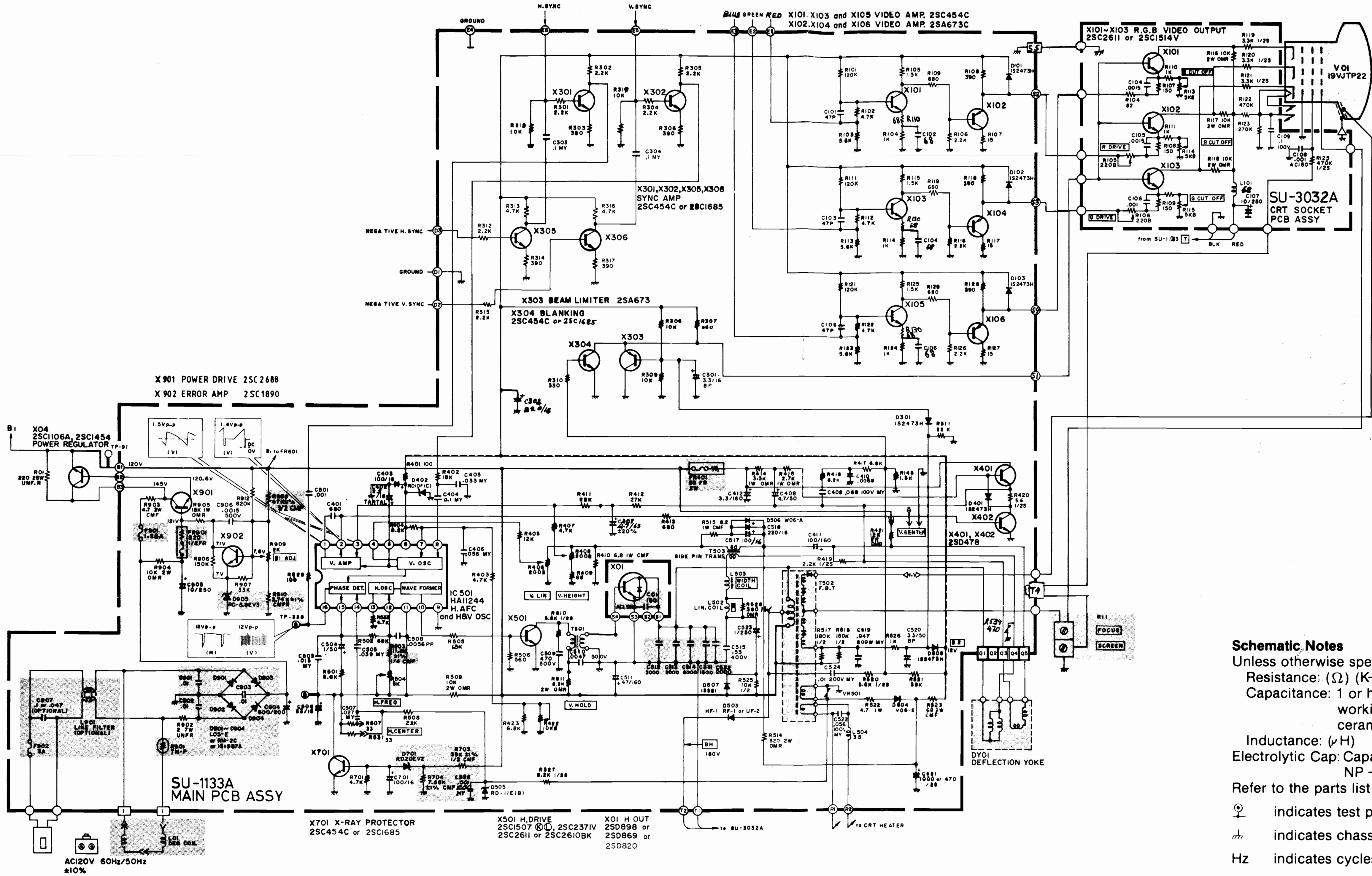
Symbol	Description	Part Number
T1501	Hor. Drive Transf.	A46022-BM
T1503	Side Pin Transf.	C39050-A

Semi-conductors

Symbol	Description	Part Number
IC1501	IC	HA11244
X1101	Si. Transistor	2SC1685(R)
X1102	Si. Transistor	2SA673(C)
X1103	Si. Transistor	2SC1685(R)
X1104	Si. Transistor	2SA673(C)
X1105	Si. Transistor	2SC1685(R)
X1106	Si. Transistor	2SA673(C)
X1301	Si. Transistor	2SC1685(R)
X1302	Si. Transistor	2SC1685(R)
X1303	Si. Transistor	2SA673(C)
X1304	Si. Transistor	2SC1685(R)
X1305	Si. Transistor	2SC1685(R)
X1401	Si. Transistor	2SD478
X1402	Si. Transistor	2SD478
X1501	Si. Transistor	2SC2610BK
X1901	Si. Transistor	2SC2688 (K.L.M.)
X1902	Si. Transistor	2SC1890A (E.F.)
D1101	Si. Diode	W06A
D1102	Si. Diode	W06A
D1103	Si. Diode	W06A
D1301	Si. Diode	1SZ473H
D1401	Si. Diode	1SZ473H
D1402	Zener Diode	RD10F(C)
D1503	Si. Diode	HF-1
D1504	Si. Diode	V09E
D1505	Zener Diode	RD11E(B)
D1506	Si. Diode	W06A
D1507	Si. Diode	1SS81
D1508	Si. Diode	1SZ473H
△D1701	△Zener Diode	RD20EV2
△D1901	△Si. Diode	1S1887A
△D1902	△Si. Diode	1S1887A
△D1903	△Si. Diode	1S1887A
△D1904	△Si. Diode	1S1887A
△D1905	△Zener Diode	RD6.8EV3

Miscellaneous

Symbol	Description	Part Number
△F1901	△Fuse 1.25A	QMF53U1-1R25S
△F1902	△UL Fuse 3A	QMF66U1-3R0S



Schematic Notes

Unless otherwise specified

Resistance: (Ω) (K→KΩ, M→MΩ), 1/4 (W) carbon resistor

Capacitance: 1 or higher→ (pF), less than 1→ (μF)
working voltage→ 50 (V)
ceramic capacitor

Inductance: (μH)

Electrolytic Cap: Capacitance Value (μF)/working voltage (V),
NP → non-polar (or bipolar) electrolytic cap.

Refer to the parts list for additional component information.

⦿ indicates test point connection

⏚ indicates chassis ground unless otherwise specified

Hz indicates cycles per second

For **safety** purposes (and continuing reliability)

⚠ replace all components marked with safety symbol with identical type.

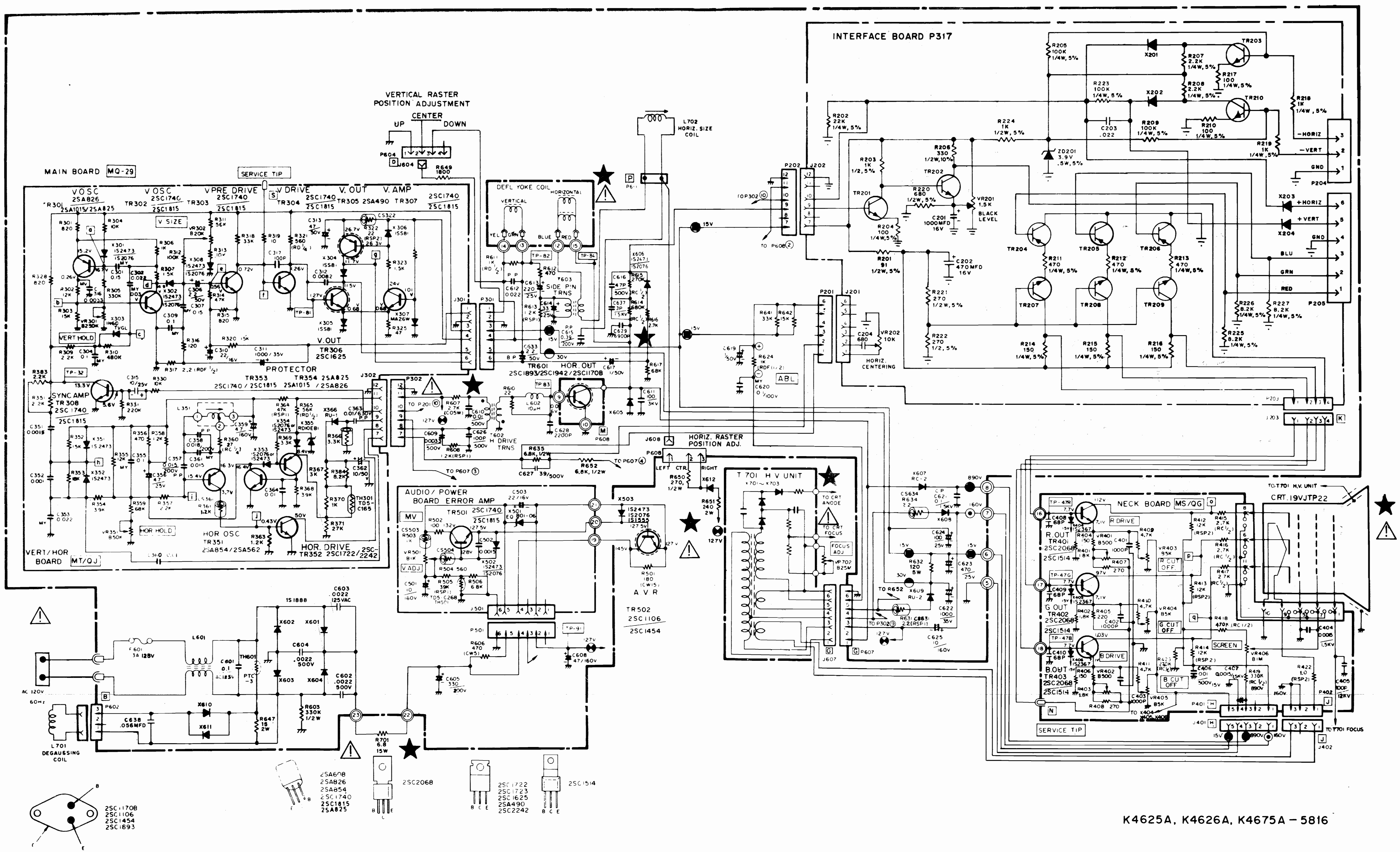
NOTE: FR → fusible resistor

Parts identification on circuit boards:
e.g. SU1126A (R107 = **R1**107)
SU3030A (R113 = **R3**113)

00-4147-04
G07-CB0

WELLS-GARDNER 19" COLOR MONITOR SCHEMATIC DIAGRAM

M051-00087-A012



K4625A, K4626A, K4675A — 5816

VERT/HOR BOARD (MT/QJ)

RESISTORS

Ref. No.	Part No.	Description
R301	203X6500-628	820 Ohm, ± 5%, 1/8W Carbon
R302	203X6500-902	12k Ohm, ± 5%, 1/8W Carbon
R303	203X6500-927	15k Ohm, ± 5%, 1/8W Carbon
R304	203X6500-886	10k Ohm, ± 5%, 1/8W Carbon
R305	203X6501-241	330k Ohm, ± 5%, 1/8W Carbon
R306	203X6500-645	1k Ohm, ± 5%, 1/8W Carbon
R307	203X6500-689	1.5k Ohm, ± 5%, 1/8W Carbon
R309	203X6500-724	2.2k Ohm, ± 5%, 1/8W Carbon
R310	203X6501-285	470k Ohm, ± 5%, 1/8W Carbon
R311	203X6501-065	56k Ohm, ± 5%, 1/8W Carbon
R312	203X6501-126	100k Ohm, ± 5%, 1/8W Carbon
R313	203X6001-326	10k Ohm, ± 5%, 1/8W Carbon
R314	203X6501-044	47k Ohm, ± 5%, 1/8W Carbon
R315	203X6500-628	820 Ohm, ± 5%, 1/8W Carbon
R316	203X6500-420	120 Ohm, ± 5%, 1/8W Carbon
R317	203X6206-441	2.2 Ohm, ± 5%, 1/2W Carbon
R319	203X6500-169	100 Ohm, ± 5%, 1/8W Carbon
R320	203X6500-927	15k Ohm, ± 5%, 1/8W Carbon
R321	203X6700-509	560 Ohm, ± 5%, 1/2W Carbon
R322	203X9100-121	22 Ohm, ± 5%, 2W M.O.
R323	203X6500-689	1.5K Ohm, ± 5%, 1/8W Carbon
R324	203X6500-988	27k Ohm, ± 5%, 1/8W Carbon
R325	203X6500-326	47 Ohm, ± 5%, 1/8W Carbon
R328	203X6500-628	820 Ohm, ± 5%, 1/8W Carbon
R330	203X6500-886	10k Ohm, ± 5%, 1/8W Carbon
R331	203X6501-209	220k Ohm, ± 5%, 1/8W Carbon
R351	203X6500-724	2.2k Ohm, ± 5%, 1/8W Carbon
R352	203X6500-927	15k Ohm, ± 5%, 1/8W Carbon
R353	203X6500-944	18k Ohm, ± 5%, 1/8W Carbon
R354	203X6500-783	3.9k Ohm, ± 5%, 1/8W Carbon
R355	203X6500-902	12k Ohm, ± 5%, 1/8W Carbon
R356	203X6500-561	470 Ohm, ± 5%, 1/8W Carbon
R357	203X6500-724	2.2k Ohm, ± 5%, 1/8W Carbon
R358	203X6500-666	1.2k Ohm, ± 5%, 1/8W Carbon
R359	203X6501-088	68k Ohm, ± 5%, 1/8W Carbon
R360	203X5500-471	27 Ohm, ± 5%, 1/4W Comp.
R361	203X6000-998	1.2k Ohm, ± 5%, 1/8W Carbon
R363	203X6500-666	1.2k Ohm, ± 5%, 1/8W Carbon
R364	203X9014-988	47k Ohm, ± 5%, 1W M.O.
R365	203X6700-989	56k Ohm, ± 5%, 1/2W Carbon
R366	203X6001-148	3.3k Ohm, ± 5%, 1/8W Carbon
R367	340X2222-734	2.2k Ohm, ± 5%, 1/2W Carbon
R368	203X6500-785	3.9k Ohm, ± 5%, 1/8W Carbon
R369	203X6500-762	3.3k Ohm, ± 5%, 1/4W Carbon
R370	302X6100-961	1k Ohm, ± 5%, 1/4W Carbon
R371	203X6104-751	2.7k Ohm, ± 5%, 1/4W Carbon
VR301	204X2122-093	Varistor, 250K Ohm, Vert. Hold
VR302	204X2114-065	Varistor, 20K Ohm, Vert. Size
VR351	204X2114-059	Varistor, 50K Ohm, Hor. Hold

CAPACITORS

Ref. No.	Part No.	Description
C301	203X1100-928	0.15 uF, 50V, ± 10% Mylar
C302	203X1100-573	0.022 uF, 50V, ± 10% Mylar
C304	203X1100-858	0.1 uF, 50V, ± 10% Mylar
C306	203X0025-026	2.2 uF, 50V, Electrolytic
C307	203X1100-928	0.15 uF, 50V, ± 10% Mylar
C309	203X1100-858	0.1 uF, 50V, ± 10% Mylar
C310	203X0010-011	22 uF, 16V Electrolytic
C311	203X0020-099	1000 uF, 35V Electrolytic
C312	202X7000-469	0.0082 uF, 50V, ± 10% Ceramic

CAPACITORS (CONT.)

Ref. No.	Part No.	Description
C313	203X0025-087	47 uF, 50V Electrolytic
C315	203X0015-082	10 uF, 25V Electrolytic
C316	203X1100-220	3300 uF, 50V, ± 10% Mylar
C317	202X8000-616	100 pF, 50V, ± 10% Ceramic
C351	202X7000-281	1500 pF, 50V, ± 10% Ceramic
C352	202X7000-247	1000 pF, 50V, ± 10% Ceramic
C353	203X1100-573	0.022 uF, 50V, ± 10% Mylar
C355	203X1100-858	0.1 uF, 50V, ± 10% Mylar
C356	203X0015-105	4.7 uF, 25V Electrolytic
C357	203X1201-013	0.015uF, 200V ± 10% PP
C358	203X1201-034	0.018 uF, 200V, ± 10% PP
C359	203X0040-013	4.7 uF, 160V Electrolytic
C360	202X7000-482	0.01 uF, 50V, ± 10% Ceramic
C361	203X1100-509	0.015 uF, 50V, ± 10% Mylar
C362	203X0025-058	10 uF, 50V Electrolytic
C363	203X1205-487	0.01 uF, 630V, ± 10% PP
C364	202X7000-482	0.01 uF, 50V, ± 10% Ceramic

SEMICONDUCTORS

Ref. No.	Part No.	Description
TR301	200X4082-614	Transistor, 2SA826Q
TR302	200X3174-006	Transistor, 2SC1740Q
TR303	200X3174-006	Transistor, 2SA1740Q
TR304	200X3174-006	Transistor, 2SC1740Q
TR305	200X4049-081	Transistor, 2SA490YLBGLI
TR306	200X3162-538	Transistor, 2SC1625YLBGLI
TR307	200X3174-014	Transistor, 2SC1740R
TR308	200X3174-006	Transistor, 2SC1740Q
TR351	200X4085-415	Transistor, 2SA854Q
TR352	200X3172-208	Transistor, 2SC1722BKS
TR353	200X3174-006	Transistor, 2SC1740Q
TR354	200X4082-614	Transistor, 2SA826Q
X301	201X2010-144	Diode, (SI) IS2473-T72
X302	201X2010-144	Diode, (SI) IS2473-T72
X303	200X8000-026	Diode, (GE), IN60TVGL
X304	200X8010-165	Diode (SI) ISS81
X305	201X2010-165	Diode (SI) ISS81
X306	201X2010-165	Diode (SI) ISS81
X307	200X8010-102	Diode (SI) MA26W
X308	200X8010-094	Diode (SI) IS2473
X351	201X2010-144	Diode (SI) IS2473-T72
X352	201X2010-144	Diode (SI) IS2473-T72
X353	201X2010-144	Diode (SI) IS2473-T72
X354	201X2010-144	Diode (SI) IS2473-T72
X355	200X8220-851	Diode (Zener) RD10EBI
X366	200X8100-130	Diode (HS) RU-1 0.3 US

MISCELLANEOUS

Ref. No.	Part No.	Description
J301	204X9300-958	Socket, 6 Pin
J302	204X9300-958	Socket, 6 Pin
P301	204X9601-195	Plug, 6 Pin
P302	204X9601-195	Plug, 6 Pin
TH301	201X0000-534	Thermistor

TRANSFORMERS & COILS

Ref. No.	Part No.	Description
L351	201X5200-091	Coil, Horiz. Osc.

POWER BOARD (MV)

RESISTORS

Ref. No.	Part No.	Description
R501	204X1725-052	180 Ohm, ± 10%, 15W WW
R502	203X6000-608	100 Ohm, ± 5%, 1/8W Carbon
R503	203X6000-960	1k Ohm, ± 5%, 1/8W Carbon
R504	203X6000-879	560 Ohm, ± 5%, 1/8W Carbon
R505	203X9014-965	39k Ohm, ± 5%, 1W M.O.
R506	203X6500-842	6.8k Ohm, ± 5%, 1/8W Carbon
R551	203X6500-420	120 Ohm, ± 5%, 1/8W Carbon
VR501	204X2050-001	Varistor Vert. Adj.

CAPACITORS

Ref. No.	Part No.	Description
C501	203X0040-020	10 uF, 160V Electrolytic
C502	202X7000-281	1500 pF, 50V, ± 10% Ceramic
C503	203X0010-011	22 uF, 16V Electrolytic
C551	203X0005-046	220 uF, 10V Electrolytic

SEMICONDUCTORS

Ref. No.	Part No.	Description
TR501	200X3174-006	Transistor, 2SC1740Q
△★TR502	200X3145-404	Transistor, 2SC1454
TR551	200X3172-305	Transistor, 2SC1723
X501	201X2230-042	Diode, (SI) Zener EQB01-06V
X502	201X2010-144	Diode, (SI) IS2473-T72

MISCELLANEOUS

Ref. No.	Part No.	Description
J501	204X9300-958	Socket, 6 Pin
P501	204X9601-195	Plug, 6 Pin
TH501	201X0000-618	Thermistor

NECK BOARD (MS/QG)

RESISTORS

Ref. No.	Part No.	Description
R401	203X6500-709	1.8k Ohm ± 5% 1/8W Carbon
R402	203X6500-709	1.8k Ohm ± 5% 1/8W Carbon
R403	203X6500-709	1.8k Ohm ± 5% 1/8W Carbon
R404	203X6500-447	150 Ohm ± 5% 1/8W Carbon
R405	203X6500-481	220 Ohm ± 5% 1/8W Carbon
R406	203X6500-447	150 Ohm ± 5% 1/8W Carbon
R407	203X6500-508	270 Ohm ± 5% 1/8W Carbon
R408	203X6500-508	270 Ohm ± 5% 1/8W Carbon
R409	203X6500-800	4.7k Ohm ± 5% 1/8W Carbon
R410	203X6500-800	4.7k Ohm ± 5% 1/8W Carbon
R411	203X6500-800	4.7k Ohm ± 5% 1/8W Carbon
R412	203X9104-809	12k Ohm ± 5% 2.0W Metal Oxide
R413	203X9104-809	12k Ohm ± 5% 2.0W Metal Oxide
R414	203X9104-809	12k Ohm ± 5% 2.0W Metal Oxide
R415	203X5601-313	2.7k Ohm ± 10% 1/2W Comp.
R416	203X5601-313	2.7k Ohm ± 10% 1/2W Comp.
R417	203X5601-313	2.7k Ohm ± 10% 1/2W Comp.
R418	203X5602-254	470k Ohm ± 10% 1/2W Comp.
R419	203X5602-185	330k Ohm ± 10% 1/2W Comp.
R422	203X9105-117	1.0 Ohm ± 10% 2W Metal Oxide
R423	203X5102-155	270k Ohm ± 5% 1/4W Carbon
VR401	204X2115-014	500 Ohm Varistor R Drive
VR402	204X2115-014	500 Ohm Varistor B Drive
VR403	204X2115-006	5k Ohm Varistor R Cutoff
VR404	204X2115-006	5k Ohm Varistor G Cutoff
VR405	204X2115-006	5k Ohm Varistor B Cutoff
VR406	204X2000-025	1M Ohm Varistor Screen

CAPACITORS

Ref. No.	Part No.	Description
C401	202X7000-247	1000 pF, 50V, 10% Ceramic
C402	202X7000-247	1000 pF, 50V, 10% Ceramic
C403	202X7000-247	1000 pF, 50V, 10% Ceramic
C404	202X7110-019	1500 pF, 2kV ± 10% Ceramic
C405	202X7150-018	100 pF, 12kV, ± 10% Ceramic
C406	202X7050-483	.01 uF, 500V, ± 10% Ceramic
C407	202X7110-019	1500 pF, 2kV ± 10% Ceramic
C408	202X8000-550	68 pF, 50V, ± 10% Ceramic
C409	202X8000-550	68 pF, 50V, ± 10% Ceramic
C410	202X8000-550	68 pF, 50V, ± 10% Ceramic

SEMICONDUCTORS

Ref. No.	Part No.	Description
TR401	200X3206-800	Transistor, 2SC2068, 2SC1514 (R output)
TR402	200X3206-800	Transistor, 2SC2068, 2SC1514 (G output)
TR403	200X3206-800	Transistor, 2SC2068, 2SC1514 (B output)
X404	201X2100-126	Diode, IS2367 (protector)
X405	201X2100-126	Diode, IS2367 (protector)
X406	201X2100-126	Diode, IS2367 (protector)

MISCELLANEOUS

Ref. No.	Part No.	Description
J401	206X5003-729	Socket, 5 Pin
J402	206X5003-983	Socket, 3 Pin
P401	204X9600-329	Plug, 5 Pin
P402	204X9600-254	Plug, 3 Pin

△★ 297X2000-072 HIGH VOLTAGE ASSEMBLY (T701)

Ref. No.	Part No.	Description
△★R701	204X1625-058	3.3 Ohm, ± 10% 10W WW Resistor
VR702	204X3901-125	Focus Control
X701		Diode (SI HV) } Part of T701
X702		Diode (SI HV) } Part of T701
X703		Diode (SI HV) } Part of T701

FINAL ASSEMBLY PARTS

Part No.	Description
△★88X-0129-506	19VJTP22 Pix Tube
38A5554-000	Assy. Purity Shld/Degaussing
205X9800-256	Lateral/Purity Assembly
△★202X1110-810	Yoke, Deflection
208X2000-946	CRT Socket
297X2000-072	HV Unit (T701)
6A0397	Plug, Line Cord
9A2753-003	Degaussing Coil (L701)

INTERFACE BOARD (P305)

(MODEL 19K4606)

RESISTORS

Ref. No.	Part No.	Description
R201	340X3910-934	91 Ohm, 5%, 1/2W Carbon
R203	340X3102-934	1k Ohm, 5%, 1/2W Carbon
R204	340X2101-934	100 Ohm, 5%, 1/4W Carbon
R206	340X3331-944	330 Ohm, 10%, 1/2W Carbon
R207	340X3102-934	1k Ohm, 5%, 1/2W Carbon
R208	340X2152-934	1.5k Ohm, 5%, 1/4W Carbon
R209	340X2101-934	100 Ohm, 5%, 1/4W Carbon
R210	340X3102-934	1k Ohm, 5%, 1/2W Carbon
R211	340X2331-934	330 Ohm, 5%, 1/4W Carbon
R212	340X2331-934	330 Ohm, 5%, 1/4W Carbon
R213	340X2331-934	330 Ohm, 5%, 1/4W Carbon
R214	340X2201-934	200 Ohm, 5%, 1/4W Carbon
R215	340X2201-934	200 Ohm, 5%, 1/4W Carbon
R216	340X2201-934	200 Ohm, 5%, 1/4W Carbon
VR201	40X0590-017	1.5k Ohm, Black Level Control

CAPACITORS

Ref. No.	Part No.	Description
C201	45X0524-038	1000 uF, 16V Electrolytic

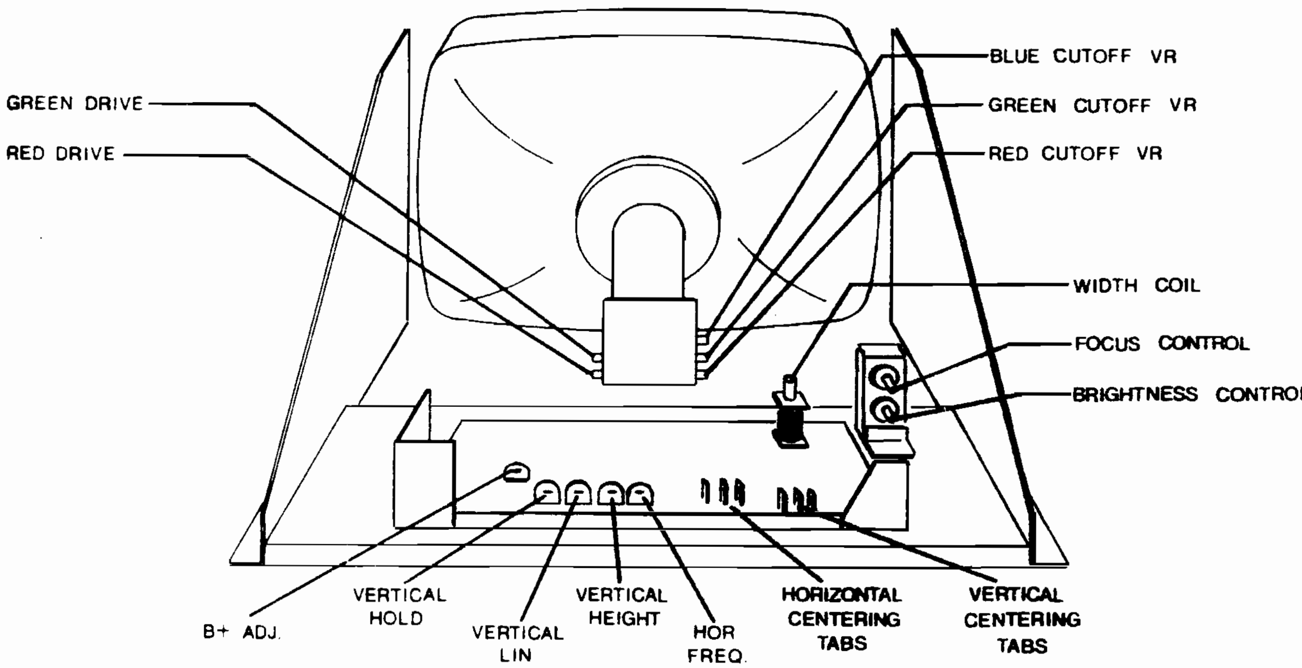
SEMICONDUCTORS

Ref. No.	Part No.	Description
TR201	86X0121-001	Transistor (NPN)
TR202	86X0121-001	Transistor (NPN)
TR203	86X0121-001	Transistor (NPN)
TR204	86X0066-001	Transistor (PNP)
TR205	86X0066-001	Transistor (PNP)
TR206	86X0066-001	Transistor (PNP)
TR207	86X0121-001	Transistor (NNP)
TR208	86X0121-001	Transistor (NPN)
TR209	86X0121-001	Transistor (NPN)
ZD201	66X0040-018	Diode, Zener, 6.8v, 5%, 0.5W
ZD202	66X0040-019	Diode, Zener, 3.9v, 5%, 0.5W

MISCELLANEOUS

Ref. No.	Part No.	Description
J201	204X9300-958	Socket, 6 Pin
J202	204X9300-958	Socket, 6 Pin
J203	206X5019-207	Socket, 4 Pin
P201	204X9601-195	Plug, 6 Pin
P202	204X9601-195	Plug, 6 Pin
P203	204X9600-845	Plug, 4 Pin
P205	6A0393-006	Plug, 6 Pin

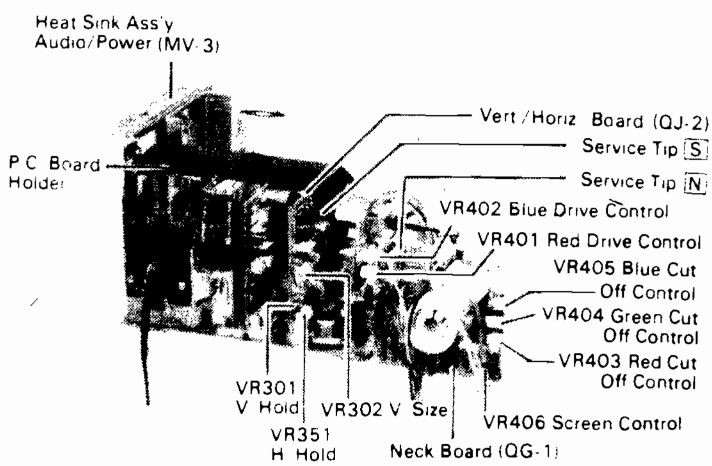
CAUTION: BE CAREFULL OF 'B' AND 'B' BOOST VOLTAGES PRESENT ON C.R.T. SOCKET P.C.B.

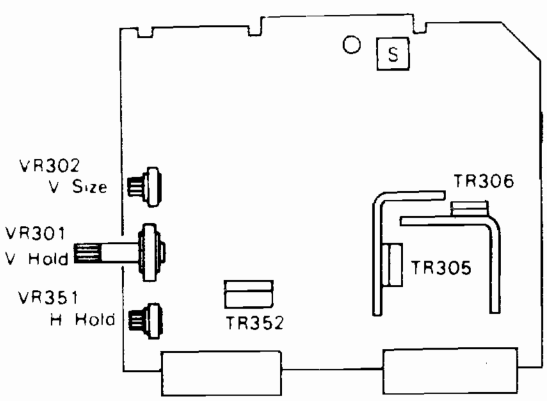


ELECTROHOME 19" COLOR MONITOR M051-00092-0000

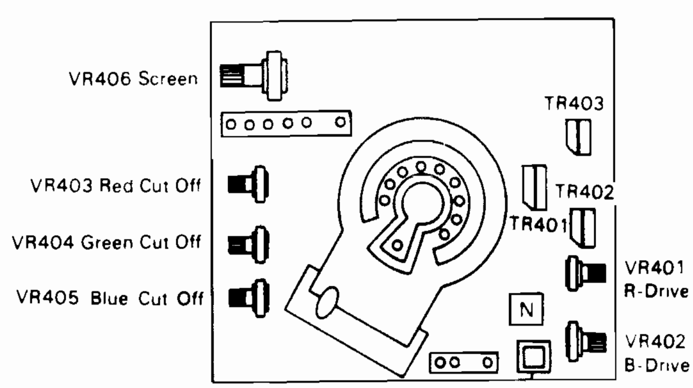
Service Set-Up Controls

A. V. Adjustment VR501 set for 127V DC
B. Vertical Size Cont = VR302
C. Vertical Hold Cont = VR301
D. Horizontal Hold Cont = VR351
E. Horizontal Width Cont = L702
F. Focus Control = VR702
G. Screen Control = VR406
H. Video Drive Controls - Red Drive = VR401
Green Drive = VR402
I. CRT Cut Off Controls - Red Cutoff = VR403
Green Cutoff = VR404
Blue Cutoff = VR405





VERT./HORIZ. BOARD MT/QJ



NECK BOARD MS/QG

CABLE – MIDCO
TELEX NO. 72-1596

MIDWAY MFG. CO.
A BALLY COMPANY
10750 W. GRAND AVENUE • FRANKLIN PARK, ILL. 60131

PHONE: AREA CODE 312 451-1360
CHICAGO PHONE: 992-2250

May 15, 1981

S E R V I C E   B U L L E T I N

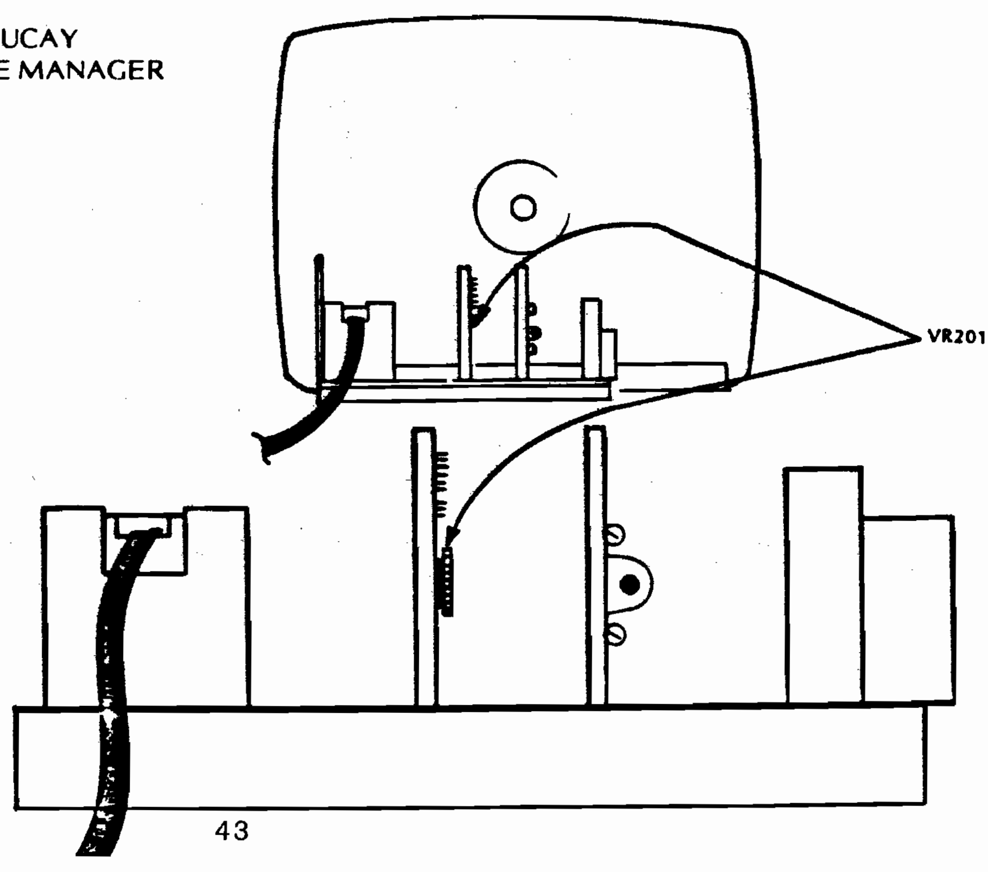
GAME: PAC-MAN & RALLY X

SUBJECT: BRIGHTNESS ADJUSTMENT
WELLS GARDNER COLOR MONITOR (K4604 - 4)

1. To set the brightness level on a Wells Gardner Color Monitor, use the Black Level Control located ont the interface PC Board.
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.

ANDY DUCAY
SERVICE MANAGER

AD/dd



Bally
MIDWAY MFG. CO.

10601 W. Belmont Avenue
Franklin Park, Illinois 60131
Telephone (312) 451-9200

October 21, 1982

SERVICE BULLETIN

SUBJECT: ELECTROHOME G07 HVL CIRCUIT

Servicing the monitor with a B+ voltage of 138.5 VDC or more could be quite time consuming.

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 & D701.
7. B+ still high with raster indicates the problem is in the power regulator circuit. Check X04, X901, X902, D905 & 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, T-501, X01 & T-502).
9. Remember to reconnect the collector of X701.

Kevin Moeller
Service Technician

KM/dd

Bally

MIDWAY MFG. CO.

10601 W. Belmont Avenue
Franklin Park, Illinois 60131
Telephone (312) 451-9200

January 12, 1982

SERVICE BULLETIN

GAME: ALL GAMES WITH 19" COLOR MONITORS

SUBJECT: CRT REPLACEMENTS

Reviewing the difference in 19" in-line CRT's 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 CRT's with internal shields for replacement purposes. This will simplify our stocking requirement as well as reduce possible replacement errors.

Any of the below listed 19" in-line CRT's with internal degaussing shield can be used as a substitute for each other:

19VMNP22	(RCA)
19VMJP22	(Rauland)
510UJB22	(Hitachi)

Any of the above CRT's can also be used as a substitute for below listed CRT's, designed to be used with external degaussing shield:

19VJTP22	(RCA)
19VMBP22	(Rauland)
19VMAP22	(Vendor not known)
MV19VLGP22	(Vendor not known)

Andy Ducay
Service Manager

AD/dd

MONITOR WITH A MIRRORED GAME

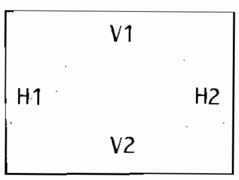
There may come a time when you will want to invert your Monitor's picture—or—turn it upside down. What would you do? Well, you could call our Service Department, accidently copy down the wrong information, and blow up your Monitor. OR, you could follow this clear and easy method of "flipping around the video" without giving yourself Excedrin Headache number 183.

To begin with, this is a somewhat special application and requires that some minor modifications be made to the HIGH VOLTAGE wires leading to the yoke of the picture tube that is in your Monitor. The reason for the modifications is that without them, you would need a mirror to read what was displayed on the picture tube of your Monitor when it is connected with this type of game.

NECESSARY MODIFICATIONS

BE **POSITIVE** THAT THE **MONITOR** IS UNPLUGGED FROM ITS A.C. WALL OUTLET **BEFORE** STARTING THIS PROCEDURE!!

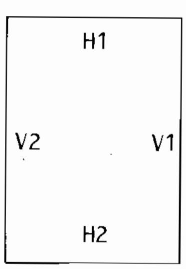
LOOK AT THIS TV SCREEN.



If you want to see a **MIRROR IMAGE (or GET RID OF ONE),** you have to swap V1 and V2 so that the picture will be inverted.

V1 and V2 merely represent the VERTICAL CIRCUITS of the monitor.

Now, if your monitor has its TV screen mounted on its side **LIKE THIS:**



it doesn't matter because the **SAME RULES** are going to work. If you want to see an **UPSIDE DOWN PICTURE (or GET RID OF ONE),** you have to swap H1 and H2 so that the picture's top and bottom will trade places on the screen.

The coils in the Yoke on the TV Tube's neck determine **WHAT** goes **WHERE** on your TV screen. Swapping the wires leading to these coils is like swapping the "V's" and the "H's." **BUT . . .** If you connect **ANY** "V" wire with **ANY** "H" wire, **P L A N** ON CALLING A TV repairman.

To help reduce the need for TV repairmen in this industry, **FOLLOW THESE SIMPLE RULES** when preparing to perform these modifications:

1. **DO NOT** work on the monitor or attempt to swap any wires while it is "ON" unless your life insurance is paid up.
2. **DO NOT** move the Yoke or solder on it unless you want a distorted picture.
3. You may remove the Yoke Wire Pins going to the Yoke Jack and swap them around in this manner; OR:
4. You may cut the appropriate wires, make the swap, and solder them back together. **DON'T FORGET to use electrical tape to insulate the freshly soldered joint!**
5. And this is important: **REREAD RULE #1!**

MODIFICATIONS BY MONITOR

Now lets get down to business. Following are the rules for swapping "V's" and "H's" for each individual color monitor.

BE **POSITIVE** THAT THE **MONITOR** IS UNPLUGGED FROM ITS A.C. WALL OUTLET **BEFORE** STARTING THIS PROCEDURE!!

ELECTROHOME G07-904:
VERTICAL DEFLECTION: Swap the Gray and the Brown wires (Q3 and Q5 respectively on the chassis) to swap the "V's" for a **MIRRORED IMAGE (or TO GET RID OF ONE).**

HORIZONTAL DEFLECTION: Swap the Red and the White wires (Q1 and Q4 respectively on the chassis) to swap the "H's" for an **UPSIDE DOWN or RIGHT SIDE UP** picture depending on how you are standing.

IF YOU DID ANY SOLDERING AND/OR WIRE-NUTTING, BE SURE TO WRAP CONNECTIONS IN ELECTRICAL TAPE TO PREVENT SHORTING WHEN FINISHED.

WELLS GARDNER K4906, K4956, K4901, & K4801:
VERTICAL DEFLECTION: Swap the Green and the Yellow wires (3 and 4 respectively on the chassis) to swap the "V's" for a **MIRRORED IMAGE (or TO GET RID OF ONE).**

HORIZONTAL DEFLECTION: Swap the Red and Blue wires (1 and 2 respectively on the chassis) to swap the "H's" for an **UPSIDE DOWN or RIGHT SIDE UP** picture depending on how you are standing.

IF YOU DID ANY SOLDERING AND/OR WIRE-NUTTING, BE SURE TO WRAP CONNECTIONS IN ELECTRICAL TAPE TO PREVENT SHORTING WHEN FINISHED.

ZENITH CD19MXRF01:
VERTICAL DEFLECTION: Swap the White and the Yellow wires (going to the side board by the width coil) to swap the "V's" for a **MIRRORED IMAGE (or TO GET RID OF ONE).**

HORIZONTAL DEFLECTION: Swap the Blue and the red wires (going to the small, uppermost board) to swap the "H's" for an **UPSIDE DOWN or RIGHT SIDE UP** picture depending on how you are standing. See

IF YOU DID ANY SOLDERING AND/OR WIRE-NUTTING, BE SURE TO WRAP CONNECTIONS IN ELECTRICAL TAPE TO PREVENT SHORTING WHEN FINISHED.

IF THIS IS UNCLEAR TO YOU:
GO BACK OVER THE DIAGRAMS WITH THE "V's" AND THE "H's" ON THE TV SCREEN. **READ THEM SLOWLY** AND **ONLY** READ THE ABOVE SECTION THAT APPLIES TO **YOUR PARTICULAR MONITOR.** If you make a mistake and swap "V" wires instead of the "H" wires, **NO PROBLEM.** Just put them back the way they were and start over.

ABOVE ALL, KEEP IN MIND that there are **only 2 things** that you MUST NEVER **NEVER** do: 1) **NEVER** connect a "V" wire with an "H" wire, and 2) **NEVER** attempt to do any of this with the monitor still plugged into its wall outlet!!