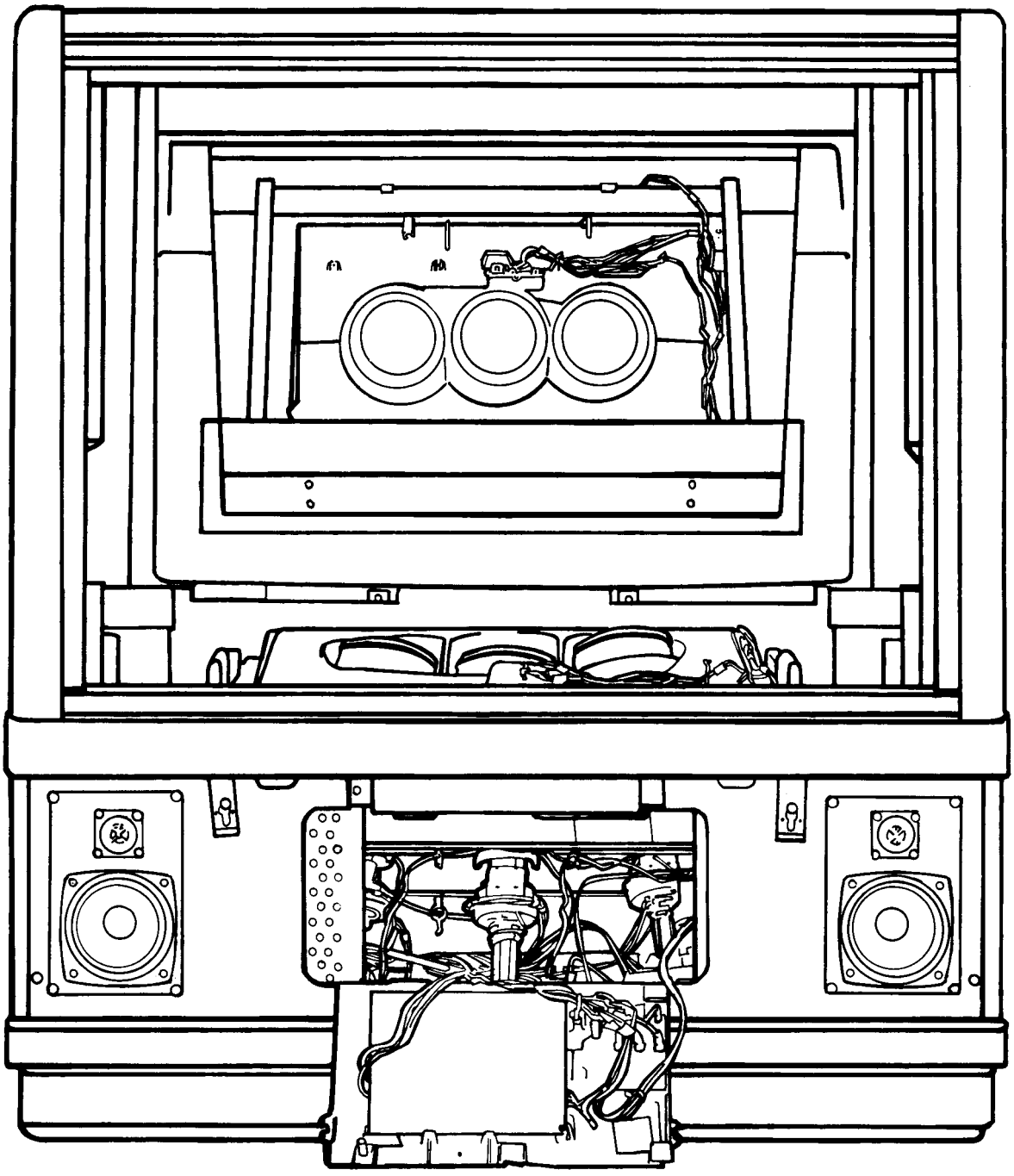
RCA

TROUBLESHOOTING GUIDE

CTC 169 Projection Television



THOMSON CONSUMER ELECTRONICS INC./TECHNICAL TRAINING/P.O. BOX 1976 INDIANAPOLIS, IN 46206

FOREWORD

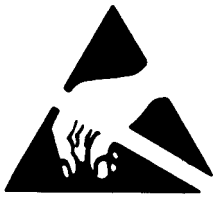
This publication is intended to aid the service technician in servicing Projection Televisions equipped with the CTC169 chassis. This publication is a supplement to the CTC168/169 Technical Training Manual (Cat.No.T-CTC168/169-1/2) and should be used along with the appropriate Thomson Consumer Electronics Service Data. This guide will assist in disassembling the projection set, locating instrument assemblies, placing the chassis in the service position, servicing the circuitry and removing the Chassis/Optic kit for bench service when necessary. Circuit descriptions and theory of operations are contained in the CTC168/169 Technical Training Manual. This troubleshooting manual emphasizes key test points, waveforms and voltages of the respective circuits in order to expedite a timely repair. This manual will help the technician become more familiar with the chassis layout, increase confidence and improve overall efficiency in servicing the chassis.

The Tech Tips included in this manual are unconfirmed reports received from the field. They are intended to aid the technician in the troubleshooting and repair of the set. They should not be relied upon exclusively or used as the basis for parts orders or repair estimates.

Note: This publication is intended to be used only as a training aid. It is not intended to replace service data. Thomson Consumer Electronics Service Data for these instruments contains specific information about parts, safety and alignment procedures and must be consulted before performing any service. The information in this publication is as accurate as possible at the time of publication. Circuit designs and drawings are subject to change without notice.

SAFETY INFORMATION CAUTION

Safety information is contained in the appropriate Thomson Consumer Electronics Service Data. All product safety requirements must be compiled with prior to returning the instrument to the consumer. Servicers who defeat safety features or fail to perform safety checks may be liable for any resulting damages and may expose themselves and others to possible injury.



All integrated circuits, all surface mounted devices, and many other semiconductors are electrostatically sensitive and therefore require special handling techniques.

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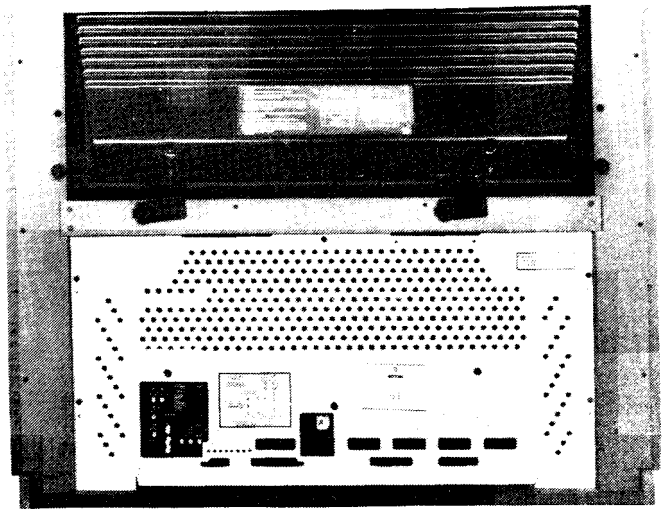


Figure 1, Cabinet Back

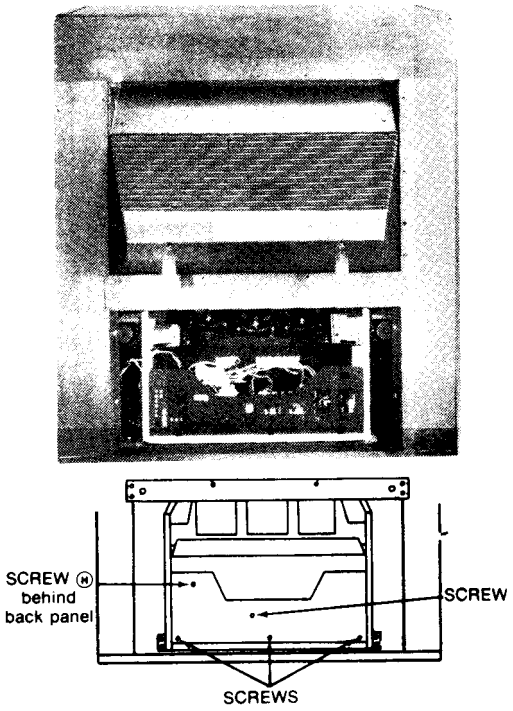


Figure 2, Chassis Rear Panel

Servicing the Chassis

The first step in servicing any product is to verify the symptom with the customer before even attempting to troubleshoot the problem. The problem may just require some customer education or maybe it can be corrected with the remote control if it relates to one of the video or audio adjustments. If an electronic problem is confirmed, the Projection TV, or PTV can be positioned for troubleshooting.

To gain access to the back of the set, position the PTV so that there is ample lighting to see and enough room to sit comfortably behind the set. Once this has been accomplished, the PTV can be disassembled and placed in the service position.

Most servicing will involve the main chassis Printed Circuit Board (PCB). To gain access to the chassis, the back cover of the PTV must be removed. Instructions for complete disassembly of the entire PTV are in the appropriate service data. This publication covers the necessary steps for attempting common troubleshooting procedures.

It must be remembered that the CTC169 Projection TV uses the same CTC169 chassis as the direct view sets. The only difference is that extra circuits unique to projection TV are used in conjunction with the main chassis. These circuits include convergence, high voltage splitting and regulation, connections for three yokes instead of one, three kine boards, an auxiliary power supply to power the projection circuits, a scan loss circuit and a dynamic focusing circuit. These circuits are covered in the troubleshooting portion of this manual.

Back Removal

Begin by removing the cabinet back, Figure 1. Once the cabinet back is off, remove the three screws along the bottom of the plastic chassis rear panel to release the panel from the wooden PTV kit frame, Figure 2. Remove the screw in the center of the chassis cover next to the AC Line input assembly. Slide out the main circuit board far enough (pull out using the rear panel) to remove the screw from the inside. This will release the chassis rear panel from the External Speaker Jack Assembly.

Main Circuit/PTV Auxiliary Board Service Position

Once the rear chassis panel has been removed, the Main PCB and the PTV Auxiliary PCB can be accessed by releasing the wire ties and wire guides and then sliding the boards out. There is sufficient wire length to enable the boards to be turned over to allow access to the foil side as well. The circuitry can be fully serviced in this position, Figure 3.

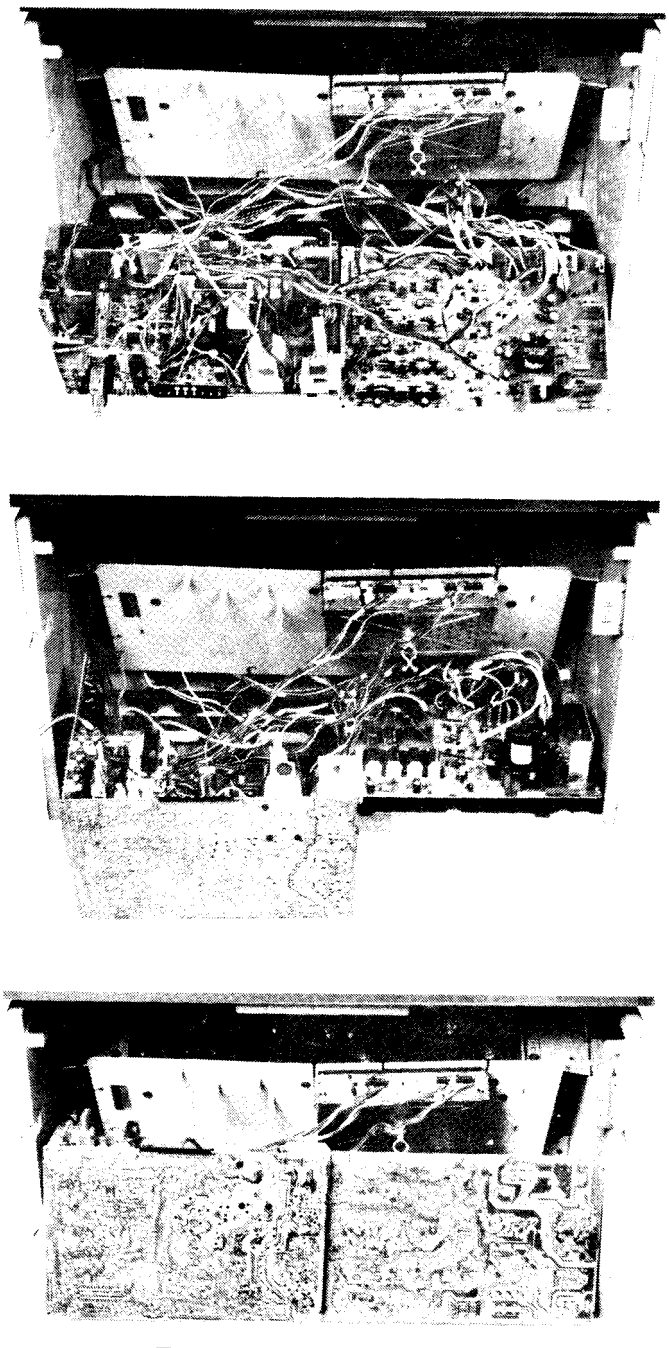


Figure 3, Service Positions

Speaker Grille Removal/Convergence Control Access

Speaker grill removal varies depending on the screen size and version of PTV. On some models, pull the lower edge of the speaker grille out and down. On others, pull the metal tabs (located along the upper edge of the speaker grille) out to remove the grille. Finally, some models require nothing more than grasping the grill from the top area and pulling out. Regardless of which method is used, the speaker grille must be removed to access the convergence controls, Figure 4. See the section on convergence troubleshooting in this publication for the convergence alignment procedure.

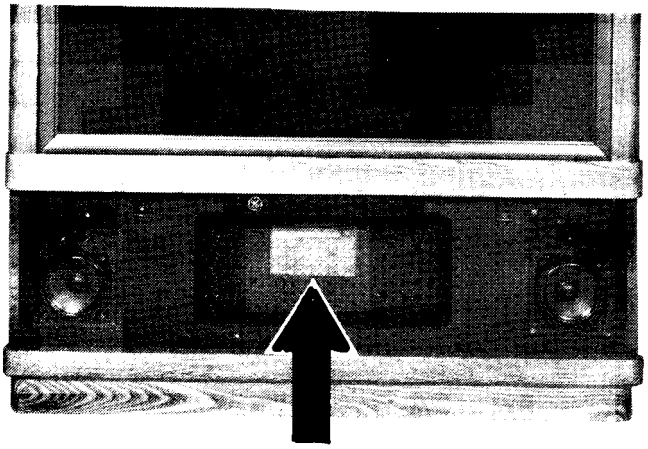
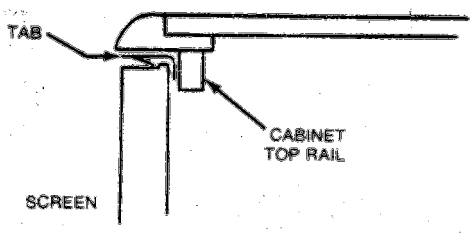


Figure 4, Convergence Controls



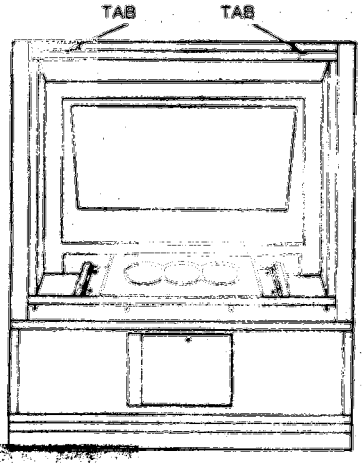


Figure 5, Screen Mount (A)

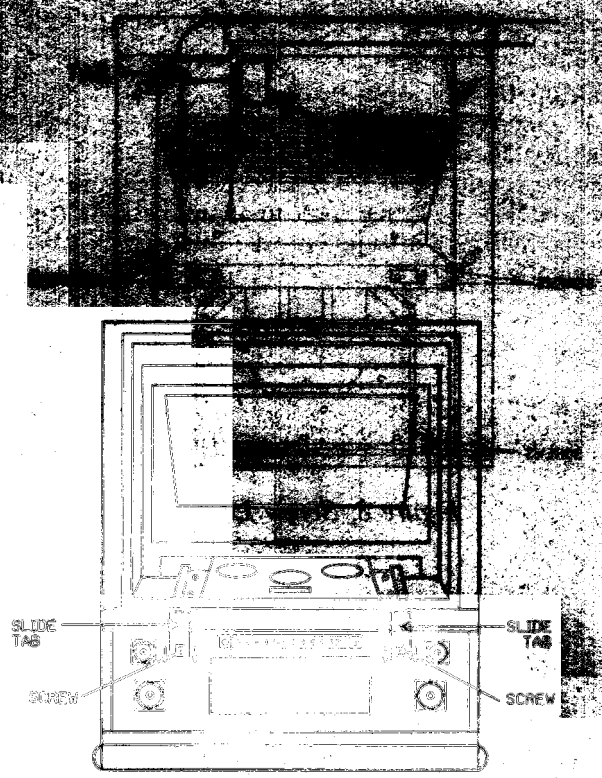


Figure 6, Screen Mount (B)

Screen Removal

In some circumstances it may become [illegible] remove the screen. This can occur when the [illegible] or mirror need cleaning or when the PTV [illegible] removed for bench service on some models. [illegible] different procedures depending on the [illegible]

Screen Mount A

1. One procedure is to [illegible] tabs along the bottom edge [illegible] Insert a small flat-blade screwdriver or [illegible] tool between the screen and the [illegible] to [illegible] metal retaining ta[illegible]
2. [illegible] edge of the screen ou[illegible]

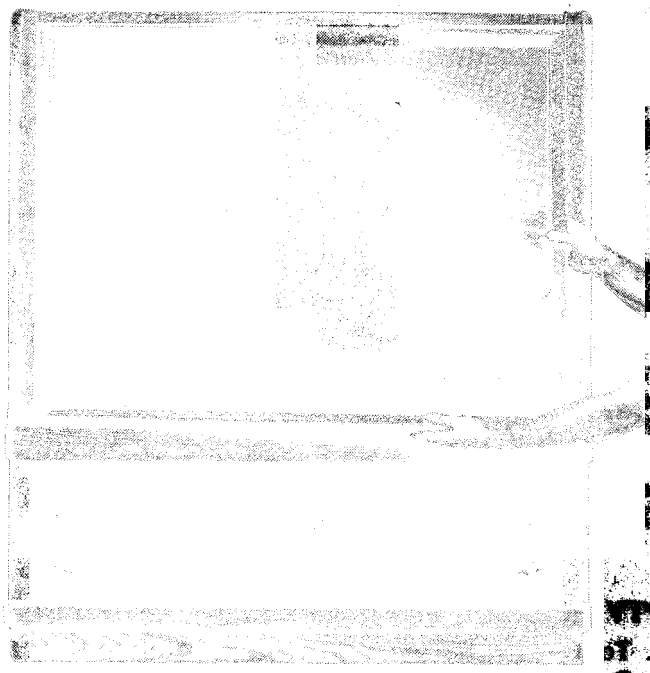


Figure 7, Screen Removal

[illegible] circuit board and lay it on the top [illegible] can. DO NOT PUSH OR PRESS THE PICTURE TUBE CONTROL. In some versions the [illegible] be operated. On sets [illegible] mounted on the [illegible] clocks.

3. [illegible] the bottom edge of the screen out and remove [illegible] it down and out, Figure 7. Be [illegible] careful not to scratch or otherwise damage [illegible]

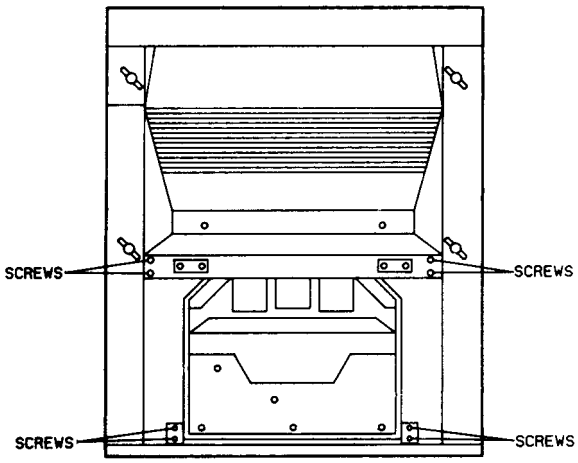


Figure 8, Screw Location

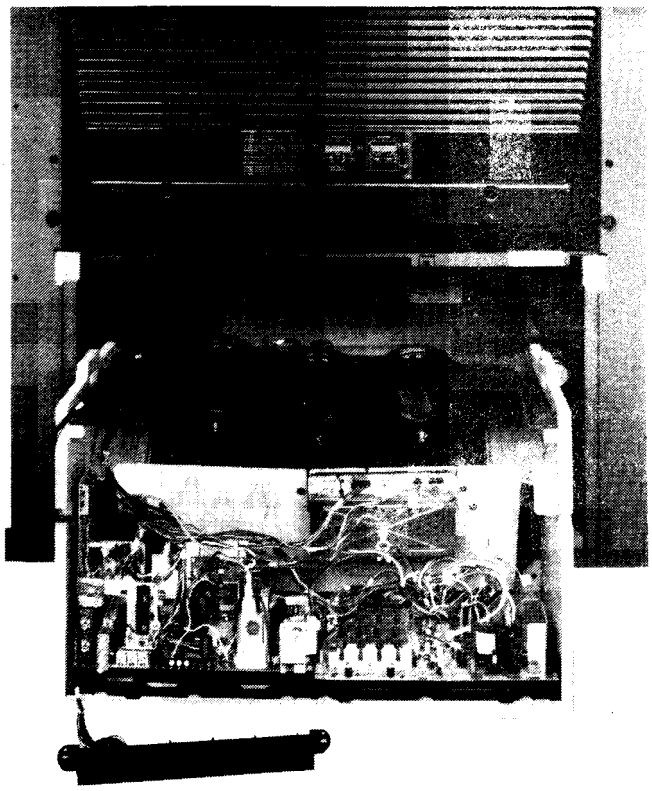


Figure 9, PTV Kit Removal

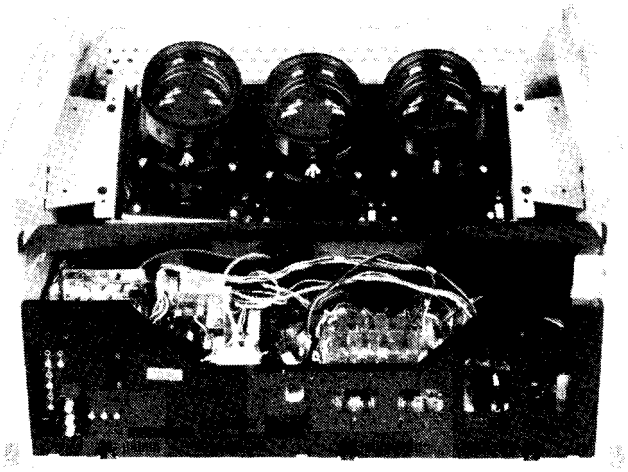


Figure 10, Kit

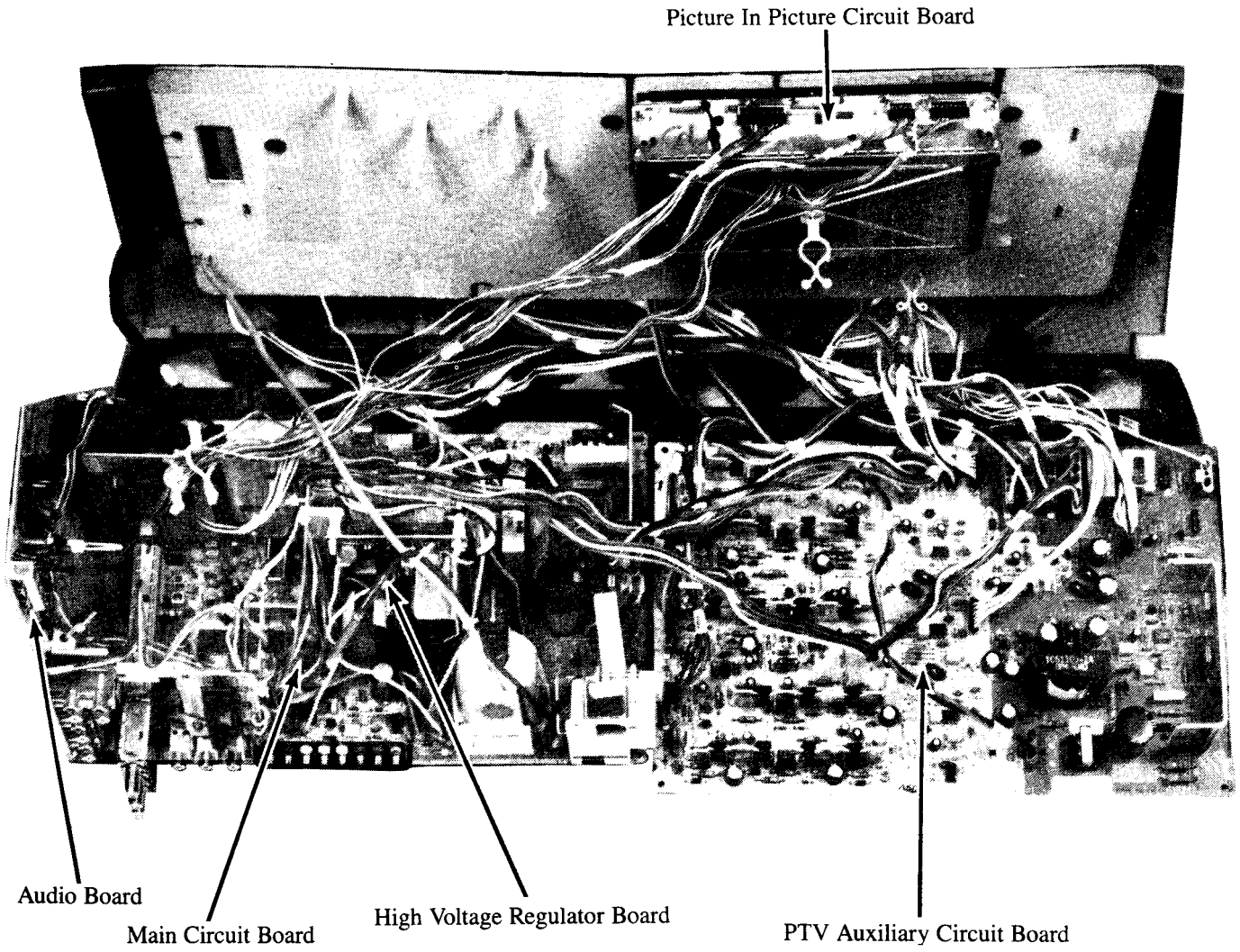
PTV Kit

The CTC169 Projection Television is built in a wooden frame that is mounted inside the cabinet. This wooden frame is referred to as the "PTV Kit". The PTV Kit can be removed from the cabinet to allow the PTV to be serviced in much the same manner as its direct view counter part. The kit weighs about 69 pounds and can be operated outside the projection television cabinet, Figure 10.

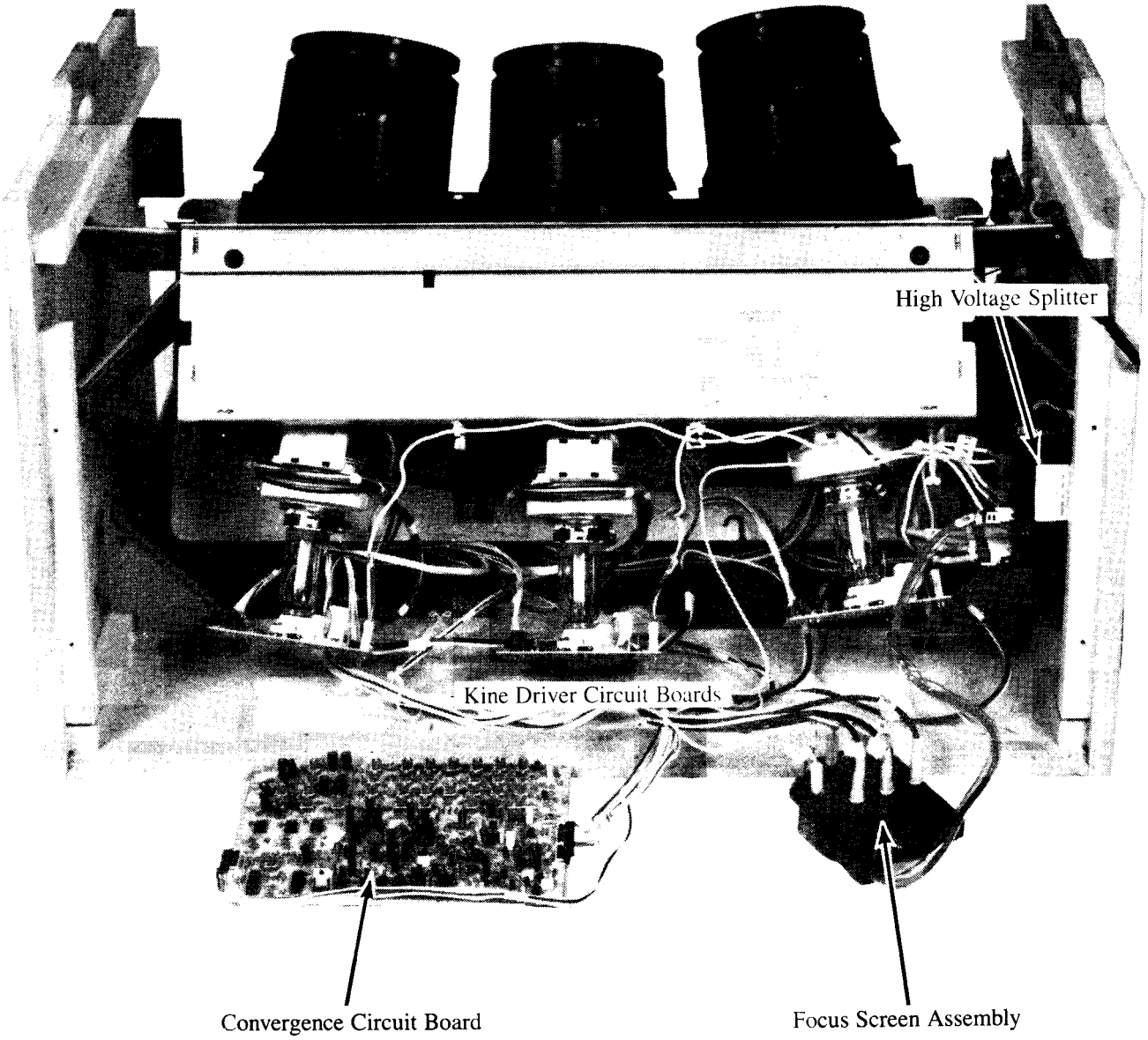
PTV Kit Removal

1. To remove the PTV Kit, remove the cabinet back. Remove the speaker grille cover and release the Front Panel circuit board. On some versions, the screen will have to be removed first to gain access to the screws securing the Front Panel circuit board. If the screws cannot be seen after removing the speaker grille, the screen will have to removed.
2. Remove the cabinet back brace (cross beam). The number of screws will vary depending on the version of PTV.
3. Release the four screws securing the L-brackets that fasten the PTV Kit frame to the cabinet, Figure 8. These are located at the back corners of the Kit.
4. Disconnect the speakers from the Audio circuit board.
5. Lift the rear edge of the PTV Kit slightly and then slide the Kit out the back, Figure 9. On some versions, once space is available, remove the Front Panel circuit board and lay it on the top lens barrier. In any case, DO NOT FORGET THE FRONT PANEL CONTROL. In some versions the IR remote sensor is in the front panel. If it is left behind, the set cannot be operated. On sets that have the IR receiver mounted on the lens barrier, the PTV can be operated via the remote control without the Front Panel circuit board.

Major Assembly Location



Major Assembly Location (continued)



Shutdown

Five circuit areas in the CTC169 projection TV will cause the set to turn off or "shutdown" in the event of a problem in their respective circuits. These circuit areas along with their type of shutdown can be classified into five categories:

- Power Supply Overcurrent/Overvoltage Shutdown
- Horizontal X-Ray Protect Shutdown
- 9-Volt Run Supply Shutdown
- Audio Fault Detect Shutdown
- System Control Reset Shutdown

Since all these circuits will cause the set to shutdown, it is necessary to quickly determine which one is causing the problem so the defect can be isolated and repaired.

The following steps are for quickly isolating the shutdown symptom. If it is obvious to the technician which circuit is causing the problem, skip this section and proceed to the section that applies to the failure.

The following steps assume the AC line fuse is good and Raw B+ is present. If raw B+ is not found, proceed to the "Dead Set" troubleshooting procedure in the "Power Supply" section of this manual.

1. Plug the set in to an isolation transformer and confirm the presence of approximately 137 volts regulated B+ on the collector of Q4401, the horizontal output transistor (location 13-JJ on the main chassis).

   Yes - Proceed to step 2.

   No - There is a power supply problem. Refer to "Power Supply" section in this manual.

2. Press the power button and listen for high voltage to come up at least momentarily.

   Yes - Proceed to step 3.

   No - Check the voltage on pin 26 of U1001 for +9 volts when the power button is pressed. If it's not there see "On/Off Circuit Troubleshooting" in this manual. If it's there, see "Horizontal Circuit Troubleshooting" in this manual.

3. Jumper pin 4 of T4101 to hot ground. This will keep the regulator from going into the run mode and will cause the B+ to run at a lower level with the load of the horizontal. Apply power and press the power button. Does high voltage stay on?

   Yes - The set is going into X-ray shutdown. See "Horizontal Circuit Troubleshooting" in this manual.

   No - Proceed to step 4.

4. Remove the jumper off of T4101, unplug J1903 from the audio board, apply AC and press the power button. Does high voltage come up and stay?

   Yes - There is a failure on the Audio board. See the "Audio Troubleshooting" section of this manual.

   No - Go to step 5.

5. Ground the collector of Q4304 (on/off buffer) and apply AC. Does high voltage come up and stay?

   Yes - There is a system control problem directly or the Fault Detect, pin 2 of U3100 is low for some reason. See the "System Control Troubleshooting" section in this manual.

   No - There is most likely a horizontal failure. See "Horizontal Circuit Troubleshooting" section in this manual.

Intermittent Shutdown

For intermittent shutdown problems, see Service Bulletin SB-CTC168/169 SI4 in the back of this publication on page 85.

Power Supply Troubleshooting

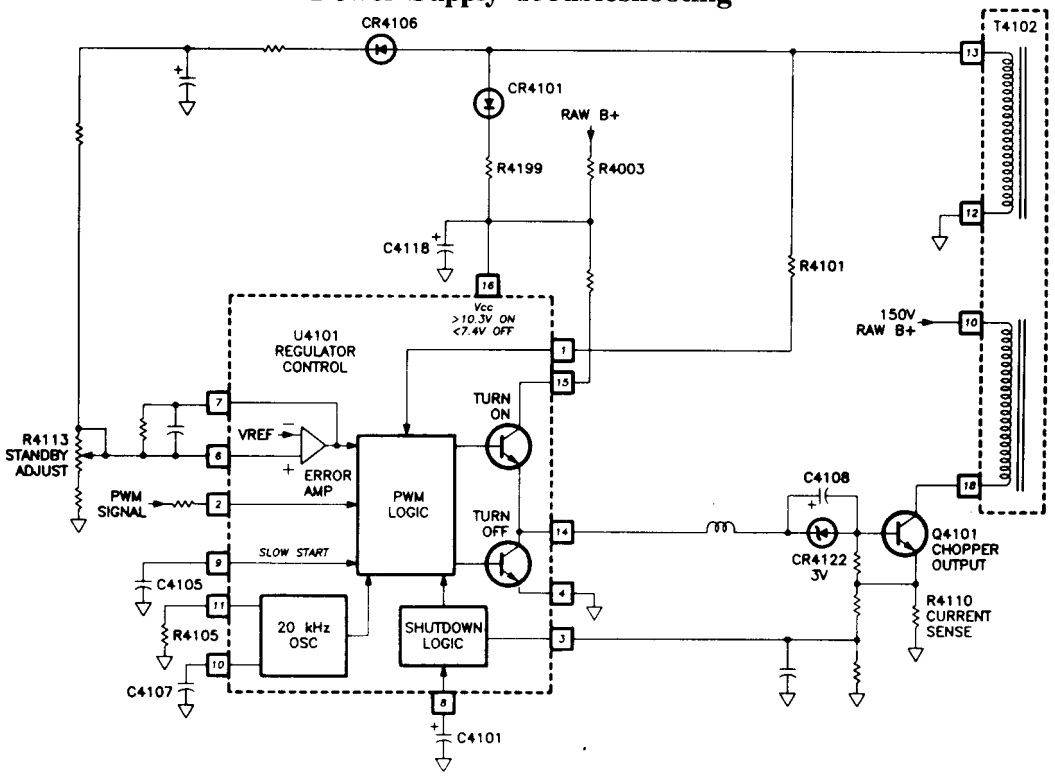


Figure 11, Power Supply

Dead Set

For power supply circuit theory of operation, see "B+ Regulator Operation" beginning on page 8 of the CTC168/169 Training Manual.

Troubleshooting dead set symptoms is sometimes difficult since any of the five major circuit areas can cause a dead set symptom. While the signal processing and audio circuits could cause a dead set symptom, the majority of circuit malfunctions occur in the power supply, deflection, and system control areas. Begin troubleshooting by sectionalizing the malfunction to one of the major circuit areas.

1. With the set off, check the Reg B+ at the collector of the horizontal output transistor Q4401. The voltage should be approximately 140 volts.
   a. *If the reg B+ is present*, it indicates the switching regulator is operating in the standby mode. If the reg B+ is present, see the section on system control and horizontal troubleshooting.
   b. *If the reg B+ is missing*, the switching regulator is a likely cause of the malfunction. If the reg B+ is missing, disconnect J1001 from the PTV AUX PCB. If reg B+ returns, see the PTV AUX section of this manual, page 55. If B+ does not come up, proceed to step 2.
2. Check for 150 volt raw B+ at the collector of the chopper output transistor Q4101.
   a. *If the raw B+ is present*, suspect either an overcurrent or overvoltage shutdown of the switching regulator. See the section on shutdown troubleshooting.
   b. *If the raw B+ is missing* at the collector of the chopper output transistor, check for an open fuse or surge resistor R4001.If either is open, suspect a shorted Q4101, shorted bridge rectifier CR4001-CR4004, or an open circuit in T4102.

      Note: If the chopper output transistor is shorted, it is possible the regulator control IC has been damaged. After replacing Q4101, check the DC voltage at pin 16 of U4101. The new chopper output transistor will not be damaged by placing it in the circuit with a shorted regulator IC.

- If the voltage is less than 2.5 volts, the IC is shorted.

  If the voltage bounces between 7 and 10 volts, the IC is not driving the chopper output device (suspect an open circuit from the output of the regulator IC to the base of the chopper transistor) or an overcurrent condition. To clear a momentary overcurrent shutdown and reset U4101, remove AC and momementarily ground U4101 pins 8 & 14.

- If the voltage is constant and between 7.5 and 15 volts, the regulator is operating in the standby mode.

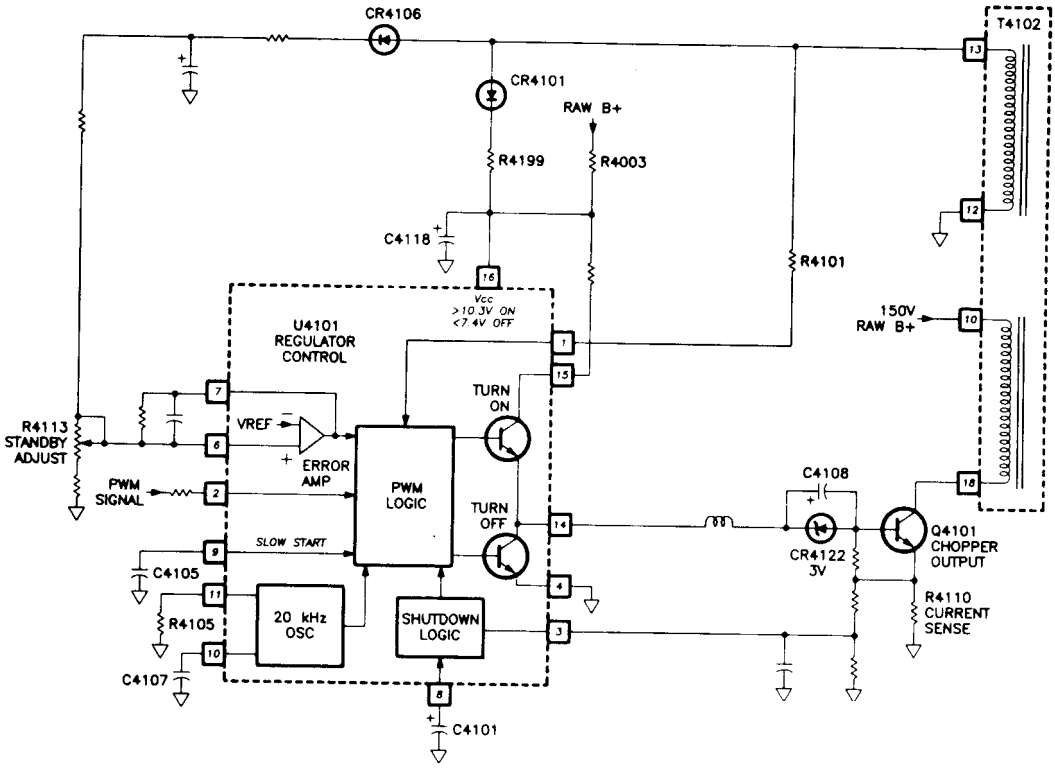


Figure 12, Power Supply (repeated)

The chopper output transistor is well protected from shorts or overloads on the secondary of the output transformer. If the output transistor fails repeatedly, check the following:

- Snubber Circuit - CR4105, C4112, R4118
- Overcurrent Circuit - R4110, R4109, R4108
- Base Turnoff Circuit - CR4122, C4108

Shutdown Troubleshooting

There are two different shutdown modes for the switching power supply, overcurrent and overvoltage. Both shutdown conditions cause the same symptom. In both cases, the raw B+ is present at the collector of the chopper output transistor and Vcc is present at the input of the regulator control IC. However, the regulator control IC does not generate the drive pulses for the chopper transistor (the standby supplies are missing).

Begin troubleshooting by confirming the presence of raw B+ at the collector of the chopper output transistor Q4101. If the voltage is missing, refer to the dead set troubleshooting section of this publication. If the raw B+ is present, confirm that the Vcc voltage at pin 16 of U4101 is between 7.4 and 15 volts.

The regulator IC shuts down when the voltage at pin 8 reaches 2.5 volts. Since the shutdown is immediate, the voltage at pin 8 does not stay at 2.5 volts and so the voltage can not be checked with a voltmeter. During shutdown, the power supply stops drive pulses at pin 14. The oscillator continues to operate, with a 20kHz ramp at pin 10. The Vcc voltage oscillates between 7.3 and 10.3 volts.

1. If the raw B+ is present and the secondary supplies are missing, connect a voltmeter to pin 8. Momentarily short Vcc to ground and release. If the overcurrent shutdown is being activated, the voltage at pin 8 will rise briefly.

   CAUTION - accidentally shorting pin 15 to pin 16 or to reg B+ will destroy both the output transistor and the regulator control IC. A very good place to ground Vcc is to connect the ground end of R4111 to the adjacent lead of R4126.

2. If an overcurrent shutdown is indicated, the usual cause is a shorted rectifier on the secondary of the output transformer or a shorted horizontal output transistor. Check the resistance to cold ground of the secondaries of T4102.

   The resistance to ground from the cathode of all the secondary supplies except the fifteen volt line should be greater than 100k ohms. The resistance from the cathode of CR4118 to ground should be greater than 4k ohms. If any resistance measurement is less than this, correct the problem on that supply before restoring power to the set.

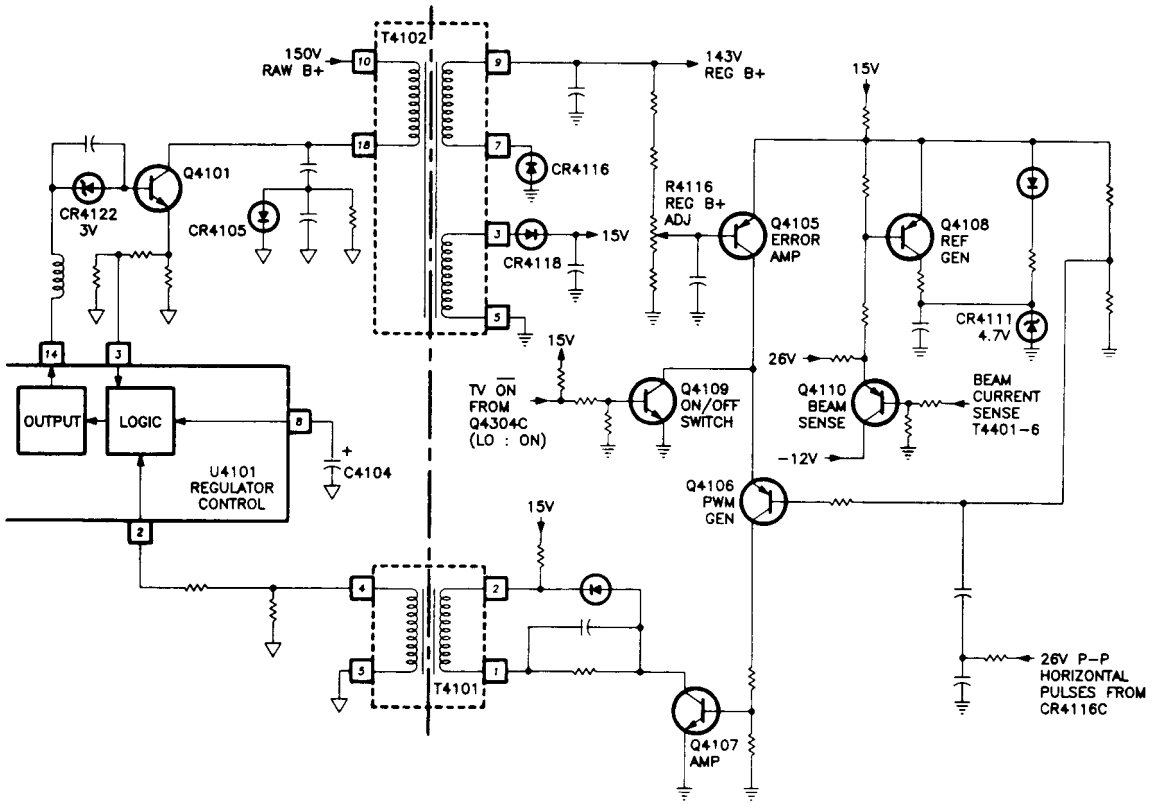


Figure 13, Run Regulator

3. If the power supply operates in the standby mode but not in the run mode, suspect a malfunction in the run regulator. The cold side regulator can cause an overvoltage shutdown if the malfunction causes the chopper output transistor to stay on too long.

   If the cold side regulator does not operate at all, the hot side regulator will take over. In this case, the reg B+ will be low, but the chassis may still operate.

4. If an overvoltage shutdown occurs when the power is turned on, disconnect the cold side regulator. To disconnect the regulator, short pin 2 of U4101 to hot ground (pins 4 and 5).

   Monitor the level of the reg B+ supply when the power button is pressed. The hot side (standby) regulator circuit should continue to operate and supply reg B+.

   If the regulator still enters a shutdown mode, suspect a malfunction in the run Vcc supply or the standby adjust circuits. Both are supplied from pin 13 of T4102.

   If the set continues to shut down even with the cold side regulator disconnected suspect a problem with the audio (10 and 20 watt systems only) or an X-ray shutdown.

   If the set operates with the cold side regulator disconnected, the malfunction is located in the regulator control or horizontal circuit. A typical horizontal problem would be a defective retrace capacitor causing the high voltage to be too high with full run B+ applied. Running the set on the hot side (standby) regulator will lower the deflection B+ far enough to keep from triggering an X-ray shutdown.

Run Regulator

The standby circuit must operate normally before malfunctions in the regulator control circuit can be diagnosed. See the section on "Dead Set" troubleshooting before attempting to diagnose a problem in the regulator control circuit.

1. If a problem in the regulator control circuit is suspected, confirm the presence of the PWM feedback signal at U4101 pin 2, Figure 13. If the pulses are present, the regulator control circuit is probably operating normally and the problem is in some other circuit area, most likely the horizontal deflection circuit.
2. If the PWM signal is missing, check for a 2Vp-p horizontal rate ramp at the base of Q4106. If the ramp is missing, suspect a problem in the horizontal deflection circuit.
3. If the pulses are present, check the DC voltage at the emitter of Q4106. If the voltage is low, suspect a defective Q4109 or a malfunction in the on/off circuit.In addition, the reference voltage circuit could be defective.

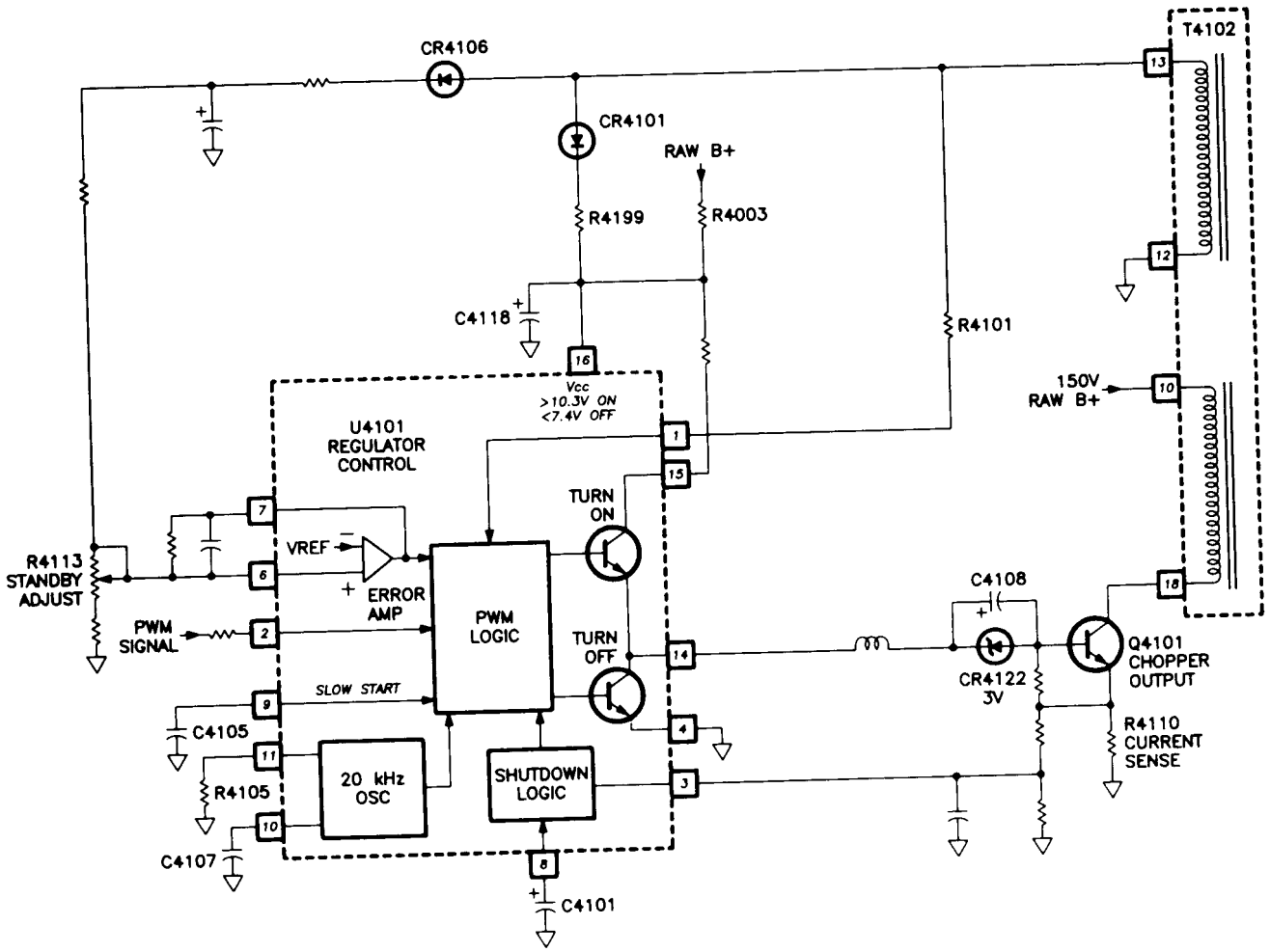


Figure 14, Power Supply (repeated)

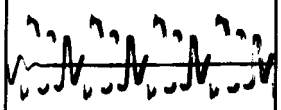
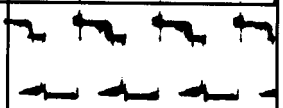
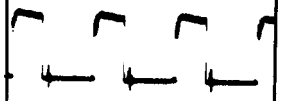
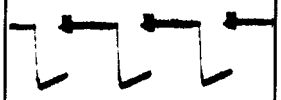
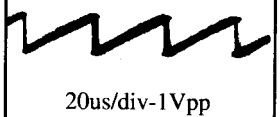
If the voltage is approximately 5 volts, suspect a malfunction in Q4106, Q4107, or the primary circuit of T4101.

No Output from U4101

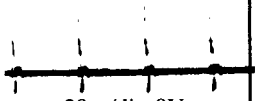
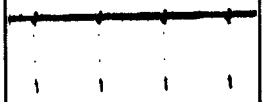
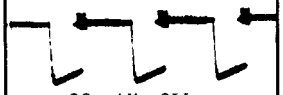
If there is no output from U4101 and there is no overcurrent or overvoltage condition, use an external DC power supply to confirm operation of the IC.

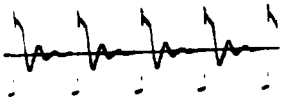
1. Remove AC power and connect a DC supply to pin 16 of U4101. Monitor the output of the IC at pin 14.
2. Raise the DC input above 10.5 volts and check for an output waveform. If the output is present, check for base drive directly on the base of the chopper transistor.
3. If the output pulses are missing at pin 14 of U4101, check for the 20kHz clock signal at pins 10 and 11. If the signal is missing, suspect C4107, R4105, or U4101.
4. If the IC operates normally when using an external DC supply but does not operate when AC power is applied, check the voltage at pin 3 for an overcurrent shutdown condition. The IC latches off if the peak voltage input at pin 3 rises above 0.9 volts.
5. Measure the Vcc input. The voltage at pin 16 must rise above 10.5 volts before the IC will begin operation. Once the IC turns on, the voltage at pin 16 can drop as low as 7.5 volts before the IC shuts off. If the input voltage is too low, suspect a leaky C4118. If the Vcc input is greater than 10.5 volts and there is no overcurrent condition, but the IC still does not produce an output, suspect a defective U4101.

Power Supply Waveforms and Voltage

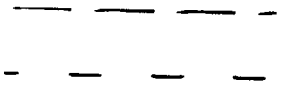
U4101 Pin	Ohms to Hot Ground (+, -)	Volts - Standby	Waveforms Standby	Volts - Run	Waveforms - Run
1	21.9k, 21.9k	.019	 20us/div-1.5Vpp	.13	 20us/div-2Vpp
2	9.8k, 9.8k	0	-	.5	 20us/div-3Vpp
3	534, 534	0	-	.09	 20us/div-1.5Vpp
4	0, 0	-	-	-	-
5	0, 0	-	-	-	-
6	1.7k, 1,7k	2.26	-	3.08	-
7	53.5k, 53.5k	2.88	-	1.23	-
8	~, ~	0	-	0	-
9	~, ~	1.09	-	.76	-
10	~, ~	2.44	 20us/div-1Vpp	2.44	 20us/div-1Vpp
11	74.5k, 74.5k	2.45	-	2.44	 20us/div-1.5Vpp

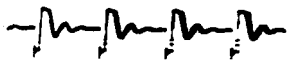
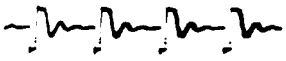
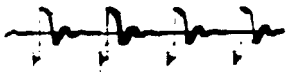
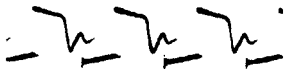
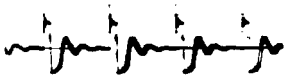
Power Supply Waveforms and Voltage

U4101 Pin	Ohms to Hot Ground + -	Volts - Standby	Waveforms Standby	Volts - Run	Waveforms - Run
12	0, 0	-	-	-	-
13	0, 0	-	-	-	-
14	~, ~	.53	 20us/div-8Vpp	2.11	 20us/div-8Vpp
15	~, ~	10.09	 20us/div-3.5Vpp	8.9	 20us/div-3Vpp
16	~, Charging	9.87	-	10.38	-

Q4101	Volts - Standby	Waveforms - Standby	Volts - Run	Waveforms - Run
B	-.13	 20us/div - 40mvPP	-1.07	 20us/div - 100mvPP
E	0	 20us/div - 15mvPP	.23	 20us/div 40mvPP
C	156.7	 20us/div - 2Vpp	128.3	 20us/div 2.9Vpp
Q4105				
B	4.58	-	4.67	-
E	5.19	-	5.22	-
C	0	-	4.61	-

Power Supply Waveforms and Voltage

Q4106	Volts - Standby	Waveforms - Standby	Volts - Run	Waveforms - Run
B	4.6	-	4.6	 20us/div - 2Vpp
E	0	-	4.6	-
C	0	-	1.5	 20us/div - 30mvPP
Q4107				
B	0	-	.19	-
E	0	-	0	-
C	12.6	-	9.4	 20us/div 15 Vpp

T4102 Waveforms *	Waveforms - Standby	Waveforms - Run
Pin 9	 20us/div - 2.8Vpp	 20us/div - 2.8Vpp
Pin 3	 20us/div - 200mvPP	 20us/div - 200mvPP
Pin 4	 20us/div - 100mvPP	 20us/div - 100mvPP
Pin 1	 20us/div - 300mvPP	 20us/div - 300mvPP
Pin 2	 20us/div - 300mvPP	 20us/div - 300mvPP

*Note: The resistance of the windings on T4102 measure less than .1 ohms out of circuit and are therefore not included in the chart.

Tech Tips

Symptom	Solution
Intermittent Start-up.	Found an open C4118 (47ufd at U4101-16) Standby power cycles on and off. Replaced shorted C4146 located across CR4119 off T4102-1.
Q4101 shorts after running hot for about three hours. With TV turned off, the regulator will run all day without overheating Q4101.	The only discrepancy found in the voltages and the waveforms was the voltage on U4101-14 measured 2.6 volts. Corrected bad solder connection on L4101 (U4101-14).
Picture small - pulled in on all sides.	Regulated B+ voltage was running at approximately 118V when the set was turned on. Checking voltages in the error amplifier PWM: Q4106-C measured 2.6 volts, Q4107-C measured 0V. Found T4102 open internally at pin 2.
Dead set.	No B+ to U4101-16. CR4101 was shorted.
Set shutdown.	Faulty T4102 (open winding, pin 12 and 13)
Audio OK, Video missing.	Found Regulated B+ at 110V. No pulses at pin 2 of U4101. Q4107 had no voltage on any lead. Found Q4111 with an open collector cutting off the voltage to the error amp.
Video Missing.	143 volt line measured low. Traced fault to Q4107 (B-E short). Regulator U4101 had no PWM feedback pulse at pin 2.
When using PIP, the small picture would roll through the big picture (rolling small pix). Both the big and small pictures showed normal horizontal and vertical.	Found +5 volt run supply at 6.4 volts. CR4606 was zenering at 6.8 volts.
Dead Set - U3101 pin 38 would go high then low.	CR4606 measured 8.6 volts instead of 5.6, causing the 5 volt standby to be 3 volts.

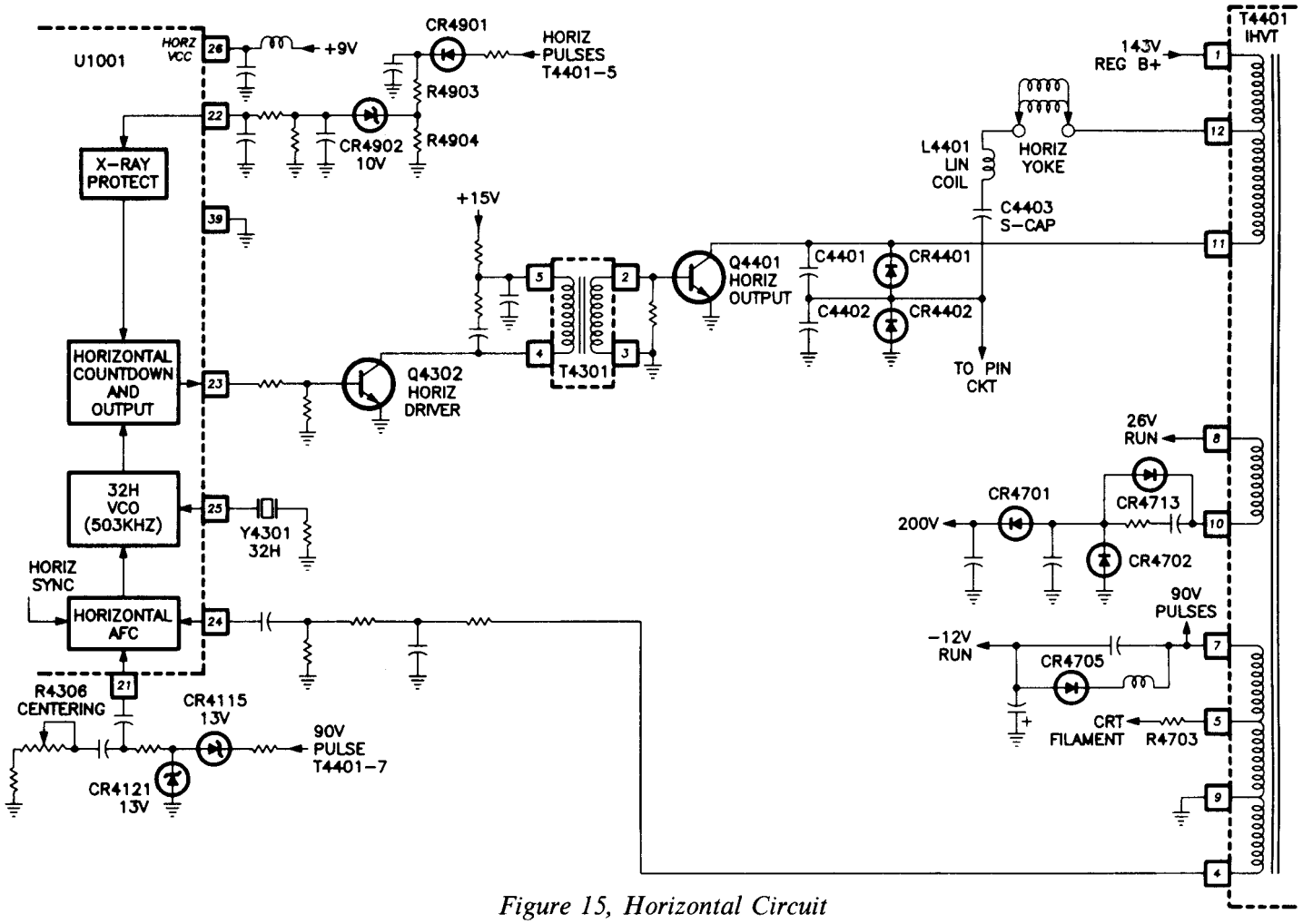


Figure 15, Horizontal Circuit

Problems in the horizontal deflection circuit can cause an overcurrent shutdown of the switching regulator and X-ray shutdown of the chassis.

Check for the presence of the standby supplies and reg B+.

If these supplies are missing, the problem is associated with the switching regulator and could indicate an overcurrent shutdown.

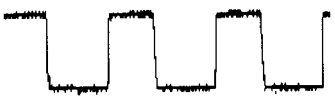
If the supplies are present and the chassis does not operate, the problem could be an X-ray shutdown.

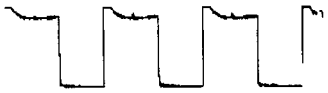
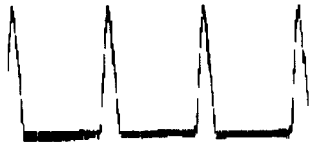
The system control microcomputer monitors the 9-volt run supply. When the X-ray protection circuit in U1001 is activated, the horizontal drive pulses stop. The 9-volt run supply drops, and the system control microcomputer detects a problem in the horizontal circuit.

The microcomputer turns the set off to reset the X-ray latch in U1001, and then attempts to restart the horizontal circuit. If the microcomputer detects the loss of the 9-volt run supply three times in less than one minute, it keeps the set off until the power button is pressed.

The input pin of the microcomputer used to monitor the 9-volt run supply is also used to monitor the DC sense output of the audio output IC. The DC sense line is used to turn the set off if there is a DC offset in the audio output circuit. This protects the speakers in the event of a malfunction in the audio output stage.

Horizontal Waveforms

Test Point	Waveform
U1001-23	 5Vpp 20us/div
U1001-25	 150mVpp 20us/div
U1001-21	 2Vpp 20us/div
Q4302-B	 1Vpp 20us/div

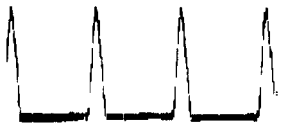
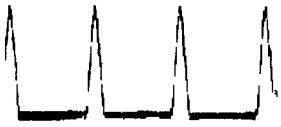
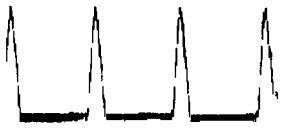
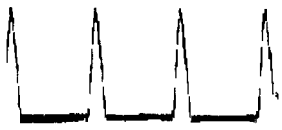
Test Point	Waveform
Q4302-C	 20Vpp 20us/div
Q4401-B	 10Vpp 20usec/div
Q4401-C	 1200Vpp 20us/div

1. In order to isolate between the X-ray protect circuit and the DC sense circuit, ground the base of Q1907 on the audio SIP.

   If the set stays on, immediately turn off the set and troubleshoot the audio power output circuit.

   If the set continues to shut down, the problem is either in the X-ray protect circuit or the 9-volt supply.

2. To check the operation of the horizontal portion of U1001, connect a +9 volt supply to U1001 pin 26. This allows the horizontal portion of the IC to operate even though no AC power is applied. Horizontal drive pulses will be present at pin 23 of U1001.

Horizontal Circuit Test Mode		
AC Line Voltage	**Q4401 Collector DC Voltage**	**Q4401 Collector Waveform**
25VAC	32VDC	 240Vpp 20us/div
50VAC	64VDC	 535Vpp 20us/div
70VAC	90VDC	 750Vpp 20us/div
110VAC	140VDC	 1200Vpp 20us/div

To check the remainder of the horizontal circuit it is necessary to bypass the regulator and run the horizontal section on a variac and a DC power supply. To do this, perform the following steps:

1. Remove the chopper, Q4101. This is a good idea to prevent any accidental damage to the transistor during testing.
2. Connect the collector of Q4304 to ground. This turns on the +9-volts to the horizontal oscillator inside U1001.
3. Jumper T4102 pin 12 to pin 5. This connects hot ground to cold ground.
4. Jumper T4102 pin 10 to T4401-1. This connects Raw B+ to Reg B+.
5. Apply +15 volts to the cathode of CR4118. This will provide power to the +15 volts line off the power supply. The current draw on the external supply will be approximately .25 amps.

   At this point the horizontal drive circuit should be active with horizontal drive at the collector of Q4302.
6. Next, apply AC via a variac. Monitor the DC voltage as well as the waveform on the collector of Q4401, the horizontal output transistor.

Running deflection at reduced current will allow you to find problems without damaging components that would otherwise fail at full power. Refer to the chart for voltages and corresponding waveforms.

Tech Tips

Symptoms	Solutions
1″ band of lines across the raster. Varying the brightness or contrast would improve the picture quality.	Readjusting the horizontal centering control corrected the problem.
Dead Set.	Found foil breaks affecting pins 2, 3, 4, 10, 11, and 12 of the IHVT.
Picture bowed in on both sides (width narrow). No control of width. Q4802 collector voltage measured 25 volts.	Found C4812 leaky. (collector-base circuit of Q4802)
Pin Distortion	Collector of Q4802 measured low. Replacement fixed the set.
Dead set on full line voltage. Lowering the line voltage using a variac produced a small picture without color.	Yoke was breaking down at a reduced line voltage. A shorted Q4802 (pincushion) was also discovered.
H.O.T. shorts at turn on (dead set).	C4402 checked open on a capacitor checker.
Pix flashing on and off.	Reseat yoke plug J7007.

For vertical circuit theory of operation see page 22 in the CTC168/169 Technical Training Manual.

No Vertical Deflection

1. Check SCR501, CR4504 and C4503. A blown C4503 indicates that SCR501 did not turn on because it is either open or there is no gate drive to the SCR.
2. Open JW312 and scope U4501 pin 2 for 5.7 VDC and a 1.25 Vpp horizontal pulse. If either is missing, trace back through the circuit and find out where the signal and/or voltage is lost.
3. By opening JW312, the B+ for yoke operation is removed which will result in 0 VDC at T4401 pin 2 (IHVT). This will also cause U4501 pin 3 to have 0 VDC, but the sawtooth waveform will still be there. There will also be no drive out of U4501 pin 1.
4. Next, apply 11 to 18 VDC to E4502, the high side of the yoke connected to pin 2 of T4401. This voltage will cause the voltage on U4501 pin 3 to vary from approximately 4.4 to 6.8 VDC respectively.

At this point, the voltage on pin 3 is greater than the voltage on pin 2 which will produce an output at U4501 pin 1. With 11 VDC applied to E4502, the output on U4501 pin is a positive pulse. As the voltage approaches 18 VDC, the pulse width increases. There is no pulse output from U4501 pin 1 when E4502 is below 10.9 VDC or above 18 VDC.

Symptoms
An open C4503 will cause no vertical deflection.

If C4518 opens, the bottom of the picture will compress to the center and the top of the picture will expand.

If C4520 opens, the bottom three inches of the picture will be black and the rest of the bottom half of the picture will compress to the center of the screen. The vertical sawtooth at U4501 pin 3 will demonstrate a non-linear curve instead of linear ramp.

The height control, R4522, will change the voltage on the cathode of CR4502 from approximately 25 VDC to 38 VDC. The DC voltage on U4501 pin 3 does not change much but the waveform will vary slightly from about .8Vpp to approximately 1.25 Vpp.

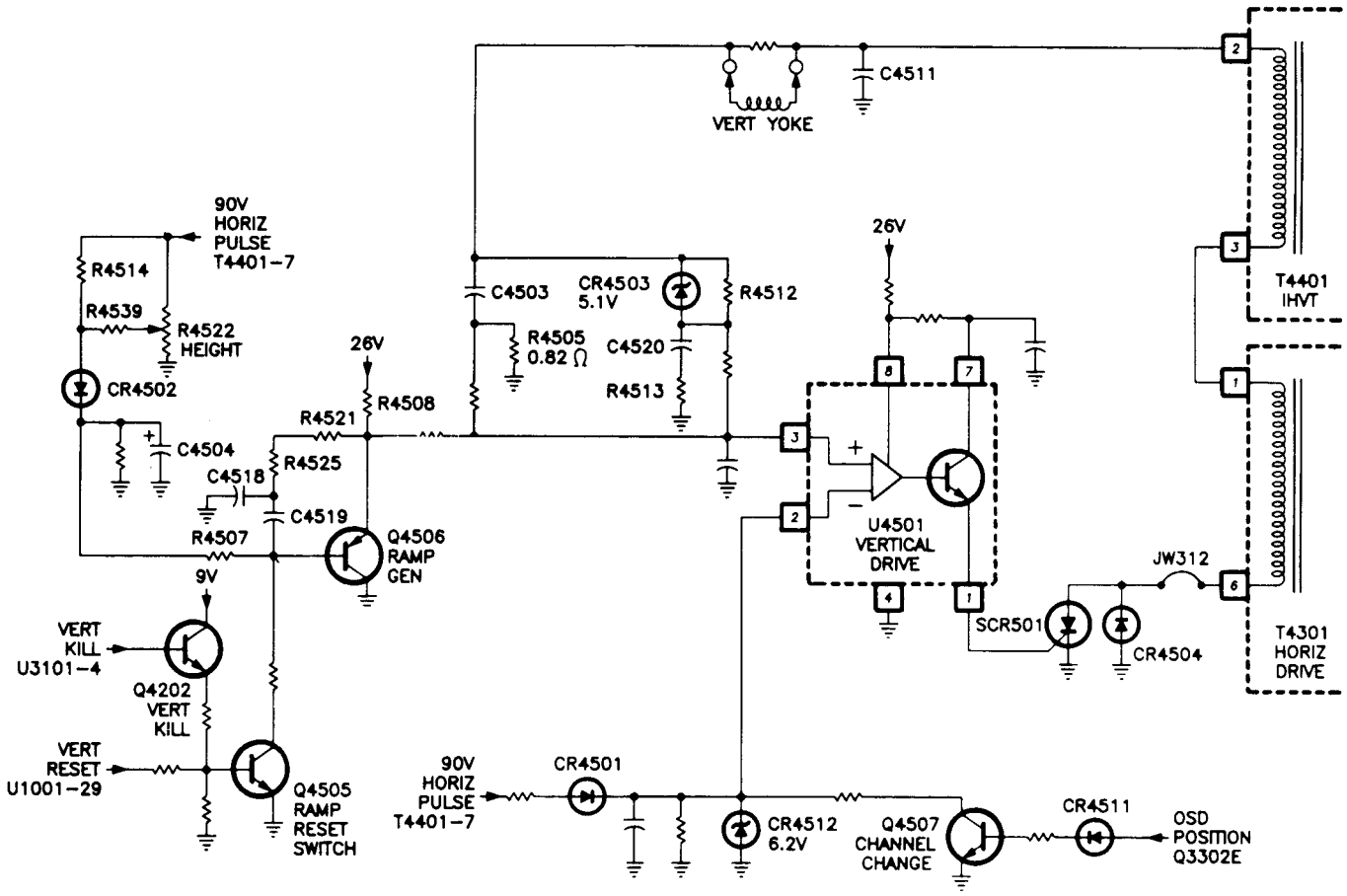
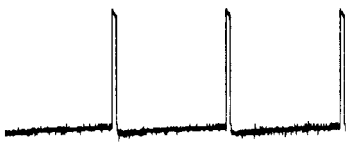
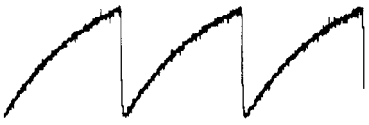
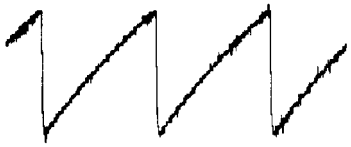
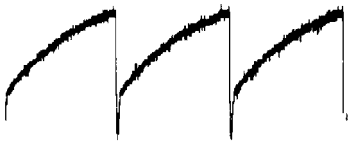
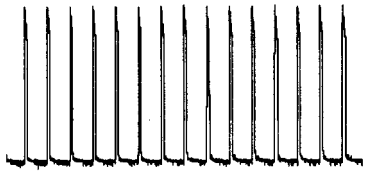
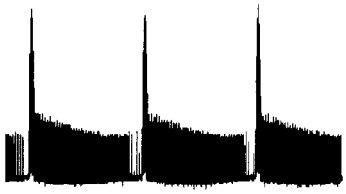
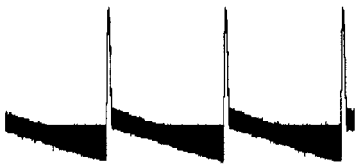


Figure 16, Vertical Circuit

Vertical Waveforms

Test Point	Waveform
U1001-29	 6Vpp 5msec/div
Q4505-B	 4.5Vpp 5msec/div
Q4506-B	 4Vpp 5msec/div
Q4506-E	 4Vpp 5msec/div
U4501-2	 2Vpp 20us/div

Test Point	Waveform
U4501-3	 1.3Vpp 5msec/div
U4501-1	 23Vpp 100us/div
SCR501-A	 200Vpp 5msec/div
T4401-2	 175Vpp 5msec/div
E4502	 2Vpp 5msec/div

Tech Tips

Symptom	Solution
Vertical Collapse - Found that there were no pulses out of U4501-1 to turn on SCR501.	Checking the DC around U4501, found there was no DC on pins 7 and 1 and that R4518 was getting warm. Checking the resistance reading from pin 7 to ground revealed a short. Disconnecting C4523 (SMD) still left the short. The glue that was behind the capacitor became conductive. Removing the glue restored normal operation.
Vertical Collapse.	Found the collector voltage on Q4505 was 0.6 volts. Further checking revealed the emitter Q4202 was 8 volts and the base of Q4201 measured 11 volts. Replaced leaky Q4202 and a shorted Q4201 (collector to base).
Vertical Height 1".	Q4505 collector voltage measured near 0 volts. Changed leaky C4518.
Set would intermittently get two 6" jagged lines in the lower right and left corners of the screen and then clear up. The problem seemed heat related.	Found internal arcing of the yoke causing vertical and jagged lines. Also, the yoke would vibrate when the failure would occur.

Pincushion Circuit Troubleshooting

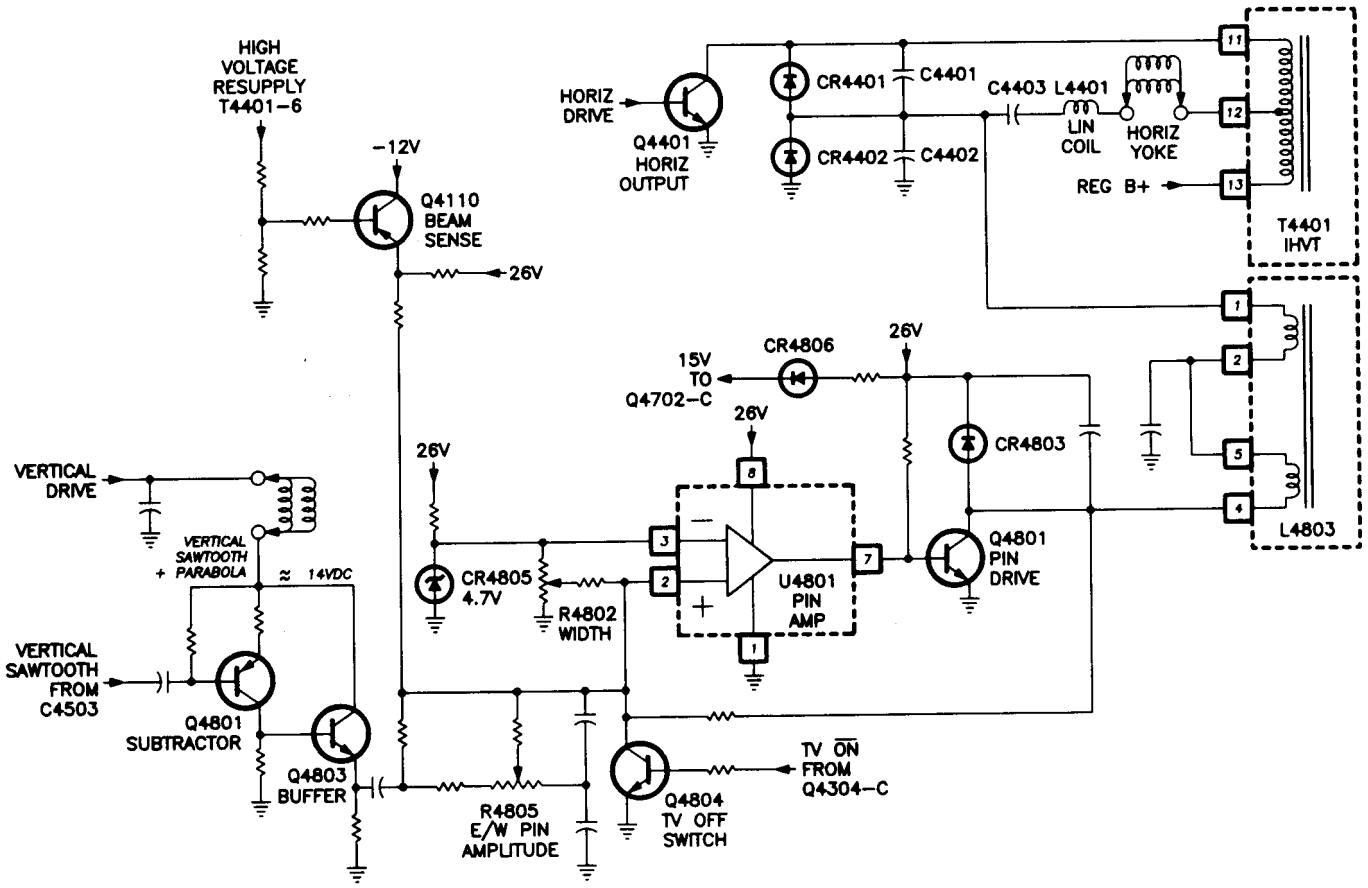


Figure 17, Pincushion Circuit

For pincushion circuit theory of operation, refer to page 21 of the CTC168/169 Technical Training Manual.

Most malfunctions in the pin correction circuit result in the same symptom, the raster goes to minimum width and appears to be bowed inward towards the center.

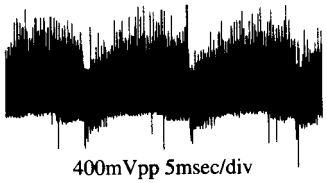
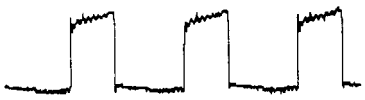
1. Begin troubleshooting by varying the settings of both the width and the E/W Pin Amplitude controls and monitoring the screen. If there is no change in the picture, the malfunction is most likely to be located after the input to the pin amplifier U4801. Suspect a defective pin output transistor Q4801.
2. To confirm proper DC operation of the pincushion circuit: set the E/W pin adjustment, R4805, to the center of its range and turn the width control, R4802 (located at the back of the chassis), fully clockwise. The voltage on the collector of Q4802 should go up to approximately 24 volts. Turn R4802 control fully counter clockwise and the collector voltage should go down to approximately 8 volts. If this DC control cannot be obtained, suspect CR4805 or Q4802. These components may check good with a meter but fail under operating conditions.
3. If changing the controls changes the picture but the raster cannot be set to the correct width or always appears bowed, suspect a malfunction in the vertical parabola, either Q4801, Q4803, or a leaky CR4805. Check the following chart for the correct waveform and voltage.

Pincushion Voltage and Waveforms

Q4802	Voltage R4805 center R4802 clockwise	Voltage R4805 center R4802 counterclockwise	Normal Voltage	Normal Waveform
collector	24	8.2	13.7	 30 Vpp 20us/div

Q4801	Voltage	Waveform
B	15.1	 2Vpp 5msec/div
E	15.8	 2Vpp 5msec/div
C	9.8	 2Vpp 5msec/div
Q4803	**Voltage**	**Waveform**
B	9.8	 2Vpp 5msec/div
E	9.3	 2Vpp 5msec/div
C	24.5	

Pincushion Voltage and Waveforms

U4801 Pin	Voltage	Waveform - Horizontal Rate	Waveform - Vertical Rate
1	0	-	-
2	4.4	 1.3Vpp 20us/div	 1.3Vpp 5msec/div
3	4.6	 400mVpp 20us/div	 400mVpp 5msec/div
4	0	-	-
5	24.5	-	-
6	24.5		-
7	.37	 400mVpp 20us/div	 400mVpp 5msec/div
8	24.6	-	-

Symptoms	Solutions
Pix bowed.	Measured the signal at U4801 pin 3. The voltage measured 4.4 volts on pin 3. Q4802 collector measured 20 volts. Replaced zener diode CR48801. This diode checked good out of circuit.

Convergence Troubleshooting

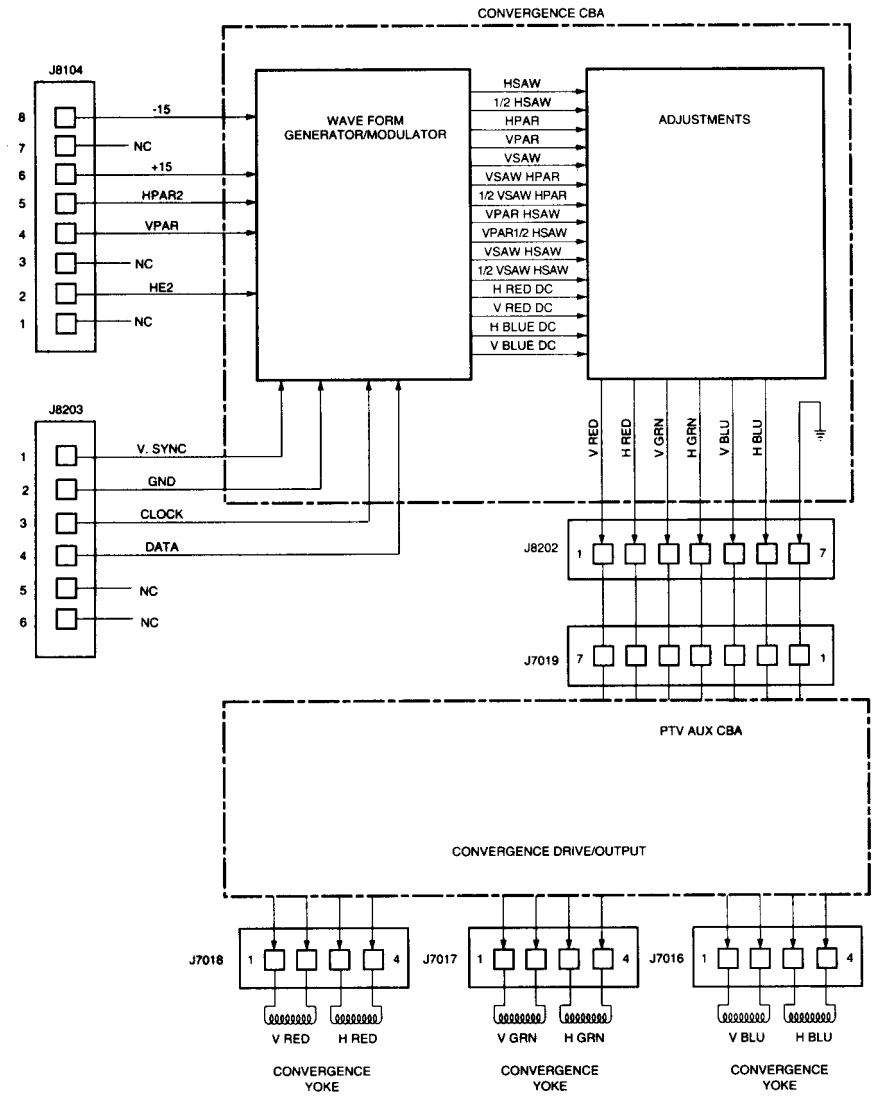


Figure 18, Convergence Block Diagram

For circuit theory of operation on the convergence circuit, refer to page 97 of the CTC168/169 Technical Training Manual.

Convergence problems can be classified into two categories. The first category is alignment problems. These problems do not involve a component failure and require only an alignment of the convergence controls, yokes and magnets. The second category is component failure. These problems typically demonstrate a pronounced convergence distortion and are usually the direct result of a component failure causing the convergence circuit to malfunction. This type of failure usually cannot be compensated for with an alignment.

Determining which type of problem is occurring involves examining the picture closely. See if the customer convergence controls react properly throughout their range. If they do not, the problem is most likely a circuit failure. Display a full cross hatch pattern and see if the problem affects more than one color. If more than one color is affected the same way, the problem is most likely a component problem and not an adjustment. It is unlikely the same adjustment would go out on all three colors.

If one color is affected slightly, suspect an alignment problem first. If one or more colors are severely out of alignment and the adjustments have little effect, suspect a circuit defect of some kind.

Before any adjustments are made or components replaced, it is a good practice to check the +15, -15, +12, -12 and -5 volt supplies to the convergence circuits and to verify the vertical and horizontal parabola. The +15 and -15 volts supplies can be found at J8104 on pins 6 and 8 respectively. The +12 and -12 volt supplies can be found at pin 3 of U8109 and U8108 respectively. The -5 volt supply can be found at pin 3 of U8106.

All of these test points are located on the convergence board. Once the convergence controls are accessed, the convergence alignment can be performed by adjusting the necessary controls. There are illustrations on the convergence control panel that indicate the geometric effect each control will have. Be warned that the controls are interactive with one another. In other words, one control may adjust what was intended and mis-adjust another part of the screen. Because the adjustments are not an exact science, extreme patience must be exercised while making convergence adjustments, Figure 4. The convergence alignment should not be attempted without the appropriate cross hatch/dot generator.

The test pattern can be generated with the internal crosshatch generator or with the conventional bench pattern generator. The internal generator is activated on some models by pressing the setup and video buttons together and releasing the video button first. On other models press the menu and "+" buttons and release the "+" button first. Once the internal cross hatch generator has been activated, pressing the "Setup" button (on the "Setup/Video" combinations) or "Menu" button (on the "menu/+" combinations) will step you through seven different color combinations. This allows you to select the necessary tube combination for the convergence alignment. The conventional method for doing this involves covering the tubes with opaque lens covers.

Convergence Alignment

Adjusting the convergence is not an exact science. Like tuning an automobile, convergence takes practice. The primary objective in convergence is to get the red and blue tubes aligned to the green tube. Cover the red tube while adjusting the blue tube and cover the blue tube while adjusting the red tube (or use the built-in pattern generator to set up the appropriate combination). This will achieve a more accurate convergence by limiting the colors on the screen to just two primary colors.

Most convergence alignments will involve minor touch-ups. If the red or the blue tube is replaced, the convergence for the respective tube only should require adjusting. If the green tube is replaced, the entire set may have to be converged. *If the entire set needs to be converged, follow the steps in the "SERVICE ADJUSTMENTS" section of this manual in the order they are outlined.*

Do not become frustrated if the convergence doesn't pop right in the first pass through the adjustments. More than one pass may prove to be necessary. If you run in to a situation where the convergence doesn't want to fine tune, take a break and come back to it later. Continuing on with a freshened approach will improve results.

Alignment Problems

1. Display a full cross hatch pattern. Look to see if the convergence problem is limited to one color. If only one color is affected, go to step 3.
2. *If the overall convergence of all three colors is slightly off, check the pincushion circuit on the main chassis before making any convergence adjustments. Pin distortion may be mistaken for a convergence problem. If the pincushion circuit checks out, follow the procedures in the exact order as outlined in the "SERVICE ADJUSTMENTS" SECTION OF THIS MANUAL.* Begin with the High Voltage adjustment and proceed in order through all the alignments. All the adjustments will have an effect on convergence and therefore must be set correctly to achieve optimum results.
3. If only one color is a problem, decide what kind of geometric problem is being produced by looking at the chart on the front of the convergence adjustment board or in the service data. (bow, skew, pin etc).
4. Once the type of distortion is decided, see if the corresponding control can adjust out the problem. Pay close attention to where the control was set so it can be returned to its original position if the problem is not corrected.
5. If the distortion is severe and the adjustment will not correct the problem, see component failure section.

Component Failure

If severe convergence distortion is present, it is unlikely that an adjustment has drifted that far. A defective component or power supply is most likely at fault.

1. If only one color is affected, the suspected problem is after the convergence modulators. If the modulators were malfunctioning, all three colors would be affected since the waveforms generated by the modulators are used for all three tubes. The respective vertical or horizontal convergence circuit should be investigated beginning with the output stages. Remember, vertical lines are affected by the horizontal convergence circuits and horizontal lines are affected by the vertical convergence circuits. Check the output driver transistors, their supplies and their emitter resistors. If more than one color is affected, go to step 4.
2. Compare waveforms and voltages with service data and the waveform chart on page 34 in this publication for correct operating parameters.
3. Confirm the connections to the convergence yokes, etc.
4. If more than one color is affected in the same way, check for a loose wire harness connection, cracked PCB or a defective solder connection. Double check the power supplies and input waveforms as previously mentioned. Check the outputs of the convergence modulator IC's and the parabola buffer and clamp transistors. The service data and voltage/waveform chart show the correct output.

SERVICE ADJUSTMENTS

Note: Service adjustment procedures must be performed in the following sequence, unless specified otherwise. AC line voltage should be approximately 120VAC. Customer controls should be set to nominal (PICTURE RESET in the *Video* menu) unless specified otherwise.

HV Regulator Adjustment

Test Point:	Q4752-D (HV Boost)	HV REG PCB
Adjust:	R4766 (HV Reg Adj)	HV REG PCB

1. Preset the *Red, Green* and *Blue Screen* controls fully counterclockwise.
2. Preset the *HV Regulator Adjust* (R4766) fully counterclockwise.
3. Select channel 92 (blank screen for minimum beam current).
4. Connect a scope probe (20V/20μsec/div, AC coupled) to the drain tab of Q4752; use stake E12 as ground reference.
5. Adjust R4766 clockwise until the peak-to-peak amplitude of the pulse at Q4752-D increases by 20 volts (±10 volts).

Screen Adjustment

Test Point:	Observe Display	
Adjust:	Red Screen control	Focus/Screen
	Green Screen control	Focus/Screen
	Blue Screen control	Focus/Screen

1. Preset the *Red, Green* and *Blue Screen* controls fully counterclockwise.
2. Preset the *Bias* and *Drive* controls to midrange.
3. Select channel 92 (no signal - blank screen).
4. Looking directly at the red lens, turn the *Red Screen* control clockwise until a dim raster appears. Then adjust the control counterclockwise until the raster just disappears.

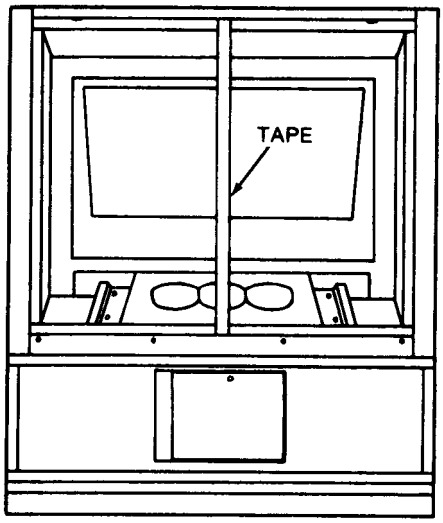


Fig. 1 - Focus Adjustment

5. Looking directly at the green lens, turn the *Green Screen* control clockwise until a dim raster appears. Then adjust the control counterclockwise until the raster just disappears.
6. Looking directly at the blue lens, turn the *Blue Screen* control clockwise until a dim raster appears. Then adjust the control counterclockwise until the raster just disappears.

Focus Adjustment

Test Point:	Observe Display	
Adjust:	Red Focus control	Focus/Screen
	Green Focus control	Focus/Screen
	Blue Focus control	Focus Screen
	Red Lens	Red CRT
	Green Lens	Green CRT
	Blue Lens	Blue CRT

1. Tune the instrument to display a crosshatch signal.
2. Remove the screen assembly to gain access to the picture tube lenses.

Electrical Focus Coarse Adjustment

3. Look directly into the red lens and adjust the *Red Focus* control for best focus.
4. Look directly into the green lens and adjust the *Green Focus* control for best focus.
5. Look directly into the blue lens and adjust the *Blue Focus* control for best focus.

Optical Focus Adjustment

6. Extend a length of masking tape (1/2" wide) vertically from the cabinet top rail to the cabinet FPA rail (see Fig. 1) to simulate the screen assembly. Align the tape with the vertical crosshatch line at the center of the display.
7. Cover the green and blue lenses. Loosen the red lens wing nut and adjust (rotate) the red lens for best focus.
8. Cover the red and blue lenses. Loosen the green lens wing nut and adjust (rotate) the green lens for best focus.
9. Cover the red and green lenses. Loosen the blue lens wing nut and adjust (rotate) the blue lens for best focus.

Electrical Focus Fine Adjust

10. Cover the green and blue lenses. Adjust the *Red Focus* control for best focus.
11. Cover the red and blue lenses. Adjust the *Green Focus* control for best focus.
12. Cover the red and green lenses. Adjust the *Blue Focus* control for best focus.

Green Raster Adjustment

Test Point:	Observe Display	
Adjust:	Centering Rings	Yoke Assembly
	Yoke Tilt	Yoke Assembly
	R4306 (H Phase)	Main PCB
	R4522 (V Height)	Main PCB
	R4802 (H Width)	Main PCB
	R4805 (Pin Amp)	Main PCB
	R8210 (GV Pin)	Conv Gen PCB
	R8212 (GH Pin)	Conv Gen PCB
	R8399 (GV Ctr)	Conv Gen PCB
	R8423 (GV Lin)	Conv Gen PCB

1. Cover the red and blue lenses.
2. Tune the instrument to receive a crosshatch signal.

Yoke Tilt Adjustment

3. Slightly loosen the yoke clamp screw. While viewing the center horizontal crosshatch line, rotate the yoke assembly to eliminate any tilt in the display. Check to make sure that the yoke assembly has not moved away from the bell of the picture tube and tighten the yoke clamp screw.

Centering Adjustment

4. Adjust the *Vertical Linearity* control (R8423) so that the crosshatch blocks near the top of the display are the same height as the blocks near the bottom of the display (coarse adjustment).
5. Adjust the *Vertical Height* control (R4522) and the *Horizontal Width* control (R4802) so that the edges of the raster are visible.
6. Adjust the *Green Centering* rings for minimum correction (see Fig. 2).

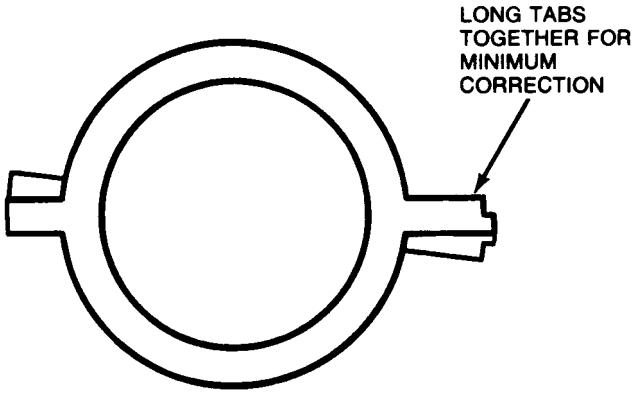


Fig. 2 - Centering Rings

7. Viewing the top and bottom edges of the display, adjust the *Green Vertical Centering* control (R8399) to center the raster vertically.
8. Viewing the left and right edges of the display, adjust the *Green Centering* rings to center the raster horizontally. Spreading the tabs increases the amount of correction and rotating both tabs together changes the direction of the correction.

Pincushion Adjustment

9. Preset the *Green Horiz Pin* control (R8212) to midrange.
10. Adjust the *Pincushion Amp* control (R4803) for straight vertical lines at the left and right edges of the display (coarse adjustment).
11. Adjust the *Green Horiz Pin* control (R8212) for straight vertical lines at the left and right edges of the display (fine adjustment).
12. Adjust the *Green Vert Pin* control (R8210) for straight horizontal lines at the top and bottom edges of the display.

Vertical Linearity Adjustment

13. Adjust the *Horizontal Width* control (R4802) so that the raster just fills the screen.
14. Adjust the *Vertical Height* control (R4522) so that the raster just fills the screen.
15. Adjust the *Green Vert Linearity* control (R8423) so that the crosshatch blocks near the top of the display are the same height as the blocks near the bottom of the display (final adjustment). If necessary, readjust the *Green Vertical Centering* control (R8399) to center the raster vertically.

Video Centering Adjustment

16. Using the *Setup* menu, set the time display for 1 o'clock.
17. Select channel 90 (S-Video Input) for a blank raster.
18. Adjust the *Horizontal Phase* control (R4306) to center the Time/Channel display as shown in Figure 3.

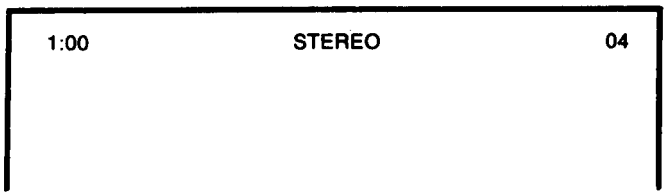


Fig. 3 - Time/Channel Display

Size Adjustment

19. Tune the instrument to receive a crosshatch signal.
20. Adjust the *Horizontal Width* control (R4802) for approximately 1" overscan at the left and right edges of the display.
21. Adjust the *Vertical Height* control (R4522) for approximately 1 1/2" overscan at the top and bottom edges of the display.

Red Raster (Convergence) Adjustment

Test Point:	Observe Display	
Adjust:	Centering Rings	Yoke Assembly
	Yoke Tilt	Yoke Assembly
	R8206 (RV Pin)	Conv Gen PCB
	R8208 (RH Pin)	Conv Gen PCB
	R8220 (RV Key)	Conv Gen PCB
	R8222 (RH Key)	Conv Gen PCB
	R8230 (RV Bow)	Conv Gen PCB
	R8232 (RH Lin)	Conv Gen PCB
	R8238 (RV Skew)	Conv Gen PCB
	R8240 (RH Size)	Conv Gen PCB
	R8246 (RV Sub Key)	Conv Gen PCB
	R8248 (RH Sub Pin)	Conv Gen PCB
	R8254 (RV Size)	Conv Gen PCB
	R8256 (RH Skew)	Conv Gen PCB
	R8262 (RV Lin)	Conv Gen PCB
	R8264 (RH Bow)	Conv Gen PCB
	R8272 (RH Sub Lin)	Conv Gen PCB
	R8276 (RV Sub Pin)	Conv Gen PCB

1. Select channel 90 (S-Video Input) for a blank raster.
2. Using the VIDEO menu, display the customer static convergence pattern.
3. Set the red centering adjustments to midrange. This can be accomplished by marking the range of the horizontal and vertical adjustments, then setting each to midrange.
4. Tune the instrument to receive a crosshatch signal and cover the blue lens.
5. Preset the *Red Convergence Controls* to midrange.

Raster Tilt

6. Adjust the *Red Horiz Bow* control (R8264) for a straight vertical centerline (coarse adjust).
7. Adjust the *Red Vert Bow* control (R8230) for a straight horizontal centerline (coarse adjust).
8. Slightly loosen the yoke clamp screw and rotate the yoke assembly to balance any vertical and horizontal skew error, leaving the vertical centerline and the horizontal centerline tilted in opposite directions.

Centering Adjustment

9. Adjust the red centering rings to align the red crosshatch display with the green crosshatch display. Adjust for best convergence at the *center* of the display only.

Skew/Bow Adjustment

10. While viewing the top and bottom edges of the display, adjust the *Red Horiz Skew* control (R8256) and the *Red Horiz Bow* control (R8264) to converge the vertical centerline.
11. While viewing the left and right edges of the display, adjust the *Red Vert Skew* control (R8238) and the *Red Vert Bow* control (R8230) to converge the horizontal centerline.
12. Recheck *Centering Adjustment* and readjust if necessary.

Keystone Adjustment

13. While viewing the top left and right corners of the display, adjust the *Red Vert Key* control (R8220) so that red misconvergence is the same in both corners (either above green in both corners or below green in both corners).
14. While viewing the bottom left and right corners of the display, adjust the *Red Vert Sub Key* control (R8246) so that red misconvergence is the same in both corners (either above green in both corners or below green in both corners).
15. While viewing the top right and bottom right corners of the display, adjust the *Red Horiz Key* control (R8222) so that red misconvergence is the same in both corners (either left of green in both corners or right of green in both corners).
16. Recheck *Centering Adjustment* and *Skew/Bow Adjustment* and readjust if necessary.

Pincushion Adjustment

17. While viewing the top horizontal crosshatch line, adjust the *Red Vert Pin* control (R8206) for a straight red line.
18. While viewing the bottom horizontal crosshatch line, adjust the *Red Vert Sub Pin* control (R8276) for a straight red line.
19. While viewing the far right vertical crosshatch line, adjust the *Red Horiz Pin* control (R8208) for a straight red line.
20. While viewing the far left vertical crosshatch line, adjust the *Red Horiz Sub Pin* control (R8248) for a straight red line.
21. Recheck *Centering Adjustment*, *Skew/Bow Adjustment* and *Keystone Adjustment* and readjust if necessary.

Size/Linearity Adjustment

22. While viewing the top and bottom of the display, adjust the *Red Vert Linearity* control (R8262) to balance the misconvergence between the top and bottom crosshatch lines.
23. Adjust the *Red Vert Size* control (R8254) to converge the top and bottom horizontal crosshatch lines.
24. Repeat steps 22 and 23 and readjust the *Red Centering Rings* as necessary to converge the horizontal crosshatch lines.
25. While viewing the vertical crosshatch lines located halfway between center and the sides of the display, adjust the *Red Horiz Sub Linearity* control (R8272) so that the misconvergence on the left is the same magnitude (but opposite direction) as the right side.
26. While viewing the left and right sides of the display, adjust the *Red Horiz Linearity* control (R8232) to balance the misconvergence between the far left and right vertical crosshatch lines.

SERVICE ADJUSTMENTS (Continued)

24. Repeat steps 22 and 23 and readjust the *Blue Centering Rings* as necessary to converge the horizontal crosshatch lines.
25. While viewing the vertical crosshatch lines located halfway between center and the sides of the display, adjust the *Blue Horiz Sub Linearity* control (R8270) so that the misconvergence on the left is the same magnitude (but opposite direction) as the right side.
26. While viewing the left and right sides of the display, adjust the *Blue Horiz Linearity* control (R8228) to balance the misconvergence between the far left and right vertical crosshatch lines.
27. Adjust the *Blue Horiz Size* control (R8236) to converge the far left and right vertical crosshatch lines.
28. Repeat steps 25, 26 and 27 and readjust the *Blue Centering Rings* as necessary to converge the vertical crosshatch lines.
29. Recheck *Centering Adjustment*, *Skew/Bow Adjustment*, *Keystone Adjustment* and *Pincushion Adjustment* and readjust if necessary.

Note: Refer to the CONVERGENCE SCHEMATIC (2 OF 2) for the location and function of the convergence controls. This information is also shown on the label attached to the front of the convergence panel.

Color Temperature

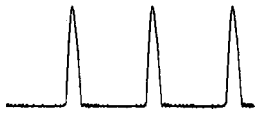
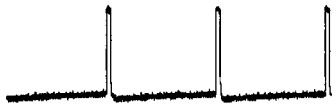
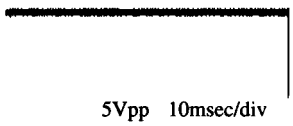
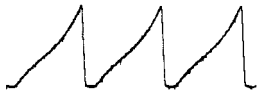
Test Point:	Observe Display	
Adjust:	R2913 (Red Bias)	Main PCB
	R2921 (Green Bias)	Main PCB
	R2917 (Blue Bias)	Main PCB
	R2926 (R/B Drive)	Main PCB
	R2928 (G Drive)	Main PCB

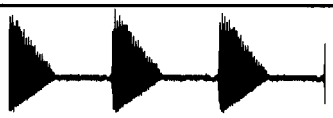
1. Tune the instrument to receive a color bar signal.
2. Preset the *Drive* controls to midrange and the *Bias* controls to minimum.
3. Defeat the chroma portion of the signal by either A) turning off the chroma at the signsl generator, or B) shorting pin 42 of U1001 (located on the Main PCB) to ground.
4. Observe the darkest bar and note which color (red, green or blue) is predominate. Adjust the *Bias* controls (R2913, R2921 and R2917) to obtain a gray bar.
5. Observe the brightest bar and adjust the *Red/Blue Drive* control (R2926) and the *Green Drive* control (R2928) to obtain a white bar.
6. Repeat steps 3 and 4 as necessary to obtain good white tracking.

Tech Tips

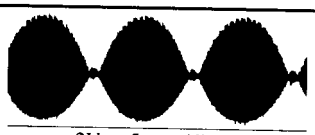
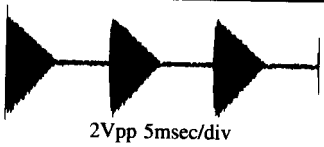
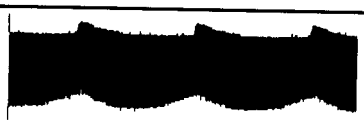
Symptom	Solution
No picture for several minutes after turning the TV on (scan loss active). When the video did appear the raster was distorted. Secondaries off T7100 were 50% low (15V=8V, 45V=24V). The waveform on the drain of Q7037 was 360Vpp (correct). Q7037 source had .3 volts indicating heavy current draw. Lifting CR7061 allowed all secondary voltages to return to normal.	Traced current draw to the green horizontal convergence output amp. Found open R7016 causing the amp to conduct heavily. Replacing the resistor restored normal operation. Even though the PTV AUX supplies were pulled down by half, the supply was not going into overcurrent shutdown.
Set had no N/S pin correction and vertical convergence controls had little effect.	R8107 increased in value to 80K.
Vertical bow at the top with foldover along with a triangular distortion in the upper right corner.	Open R8429.
Green convergence way off.	Replaced shorted Q7012, green vertical convergence output, and D7009.
The center of the picture would converge but the outer edges would bow way out. About half of the convergence controls would not work. Checking waveforms on the convergence board showed the vertical sawtooth missing on the base of Q8123.	We found that C8227 was shorted. This capacitor goes from the base of Q8123 to ground. Replacement restored normal operation.

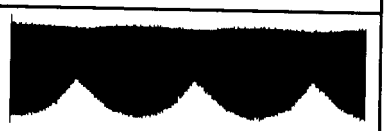
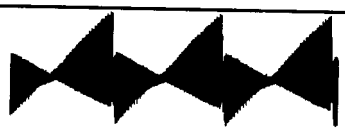
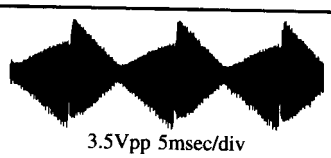
Convergence Waveforms

Test Point	Waveform
J8104-2	 25Vpp 20us/div
J8104-5	 10Vpp 20us/div
J8104-4	 3.5Vpp 5msec/div
J8203-1	 5Vpp 10msec/div
J8203-3	 5Vpp 10msec/div
J8203-4	 5Vpp 10msec/div
Q8128-B	 3Vpp 20us/div
Q8114-B	 4Vpp 20us/div
Q8123-B	 5Vpp 5msec/div
U8107-1	 6Vpp 20us/div

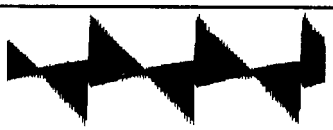
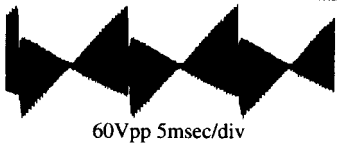
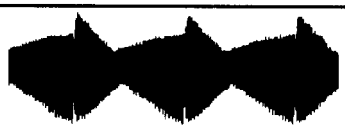
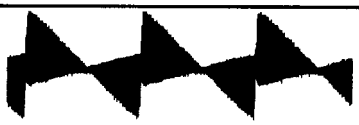
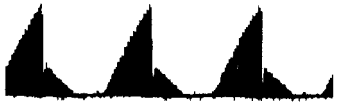
Test Point	Waveform
Q8106-E	 3.2Vpp 20us/div
Q8110-B	 3.2Vpp 20us/div
R8132	 1.5Vpp 20us/div
Q8111-E	 4Vpp 5msec/div
Q8120-E	 5Vpp 5msec/div
Q8109-E	 1.4Vpp 20us/div
Q8132-E	 9Vpp 20us/div
Q8133-E	 4Vpp 5msec/div
Q8101-E	 2Vpp 5msec/div
Q8116-E	 1.5Vpp 5msec/div

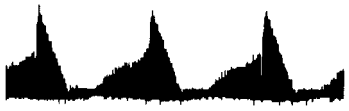
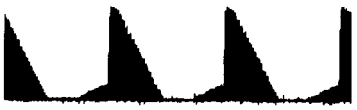
Convergence Waveforms

Test Point	Waveform
Q8102-E	 2Vpp 5msec/div
Q8113-E	 .75Vpp 5msec/div
Q8103-E	 2Vpp 5msec/div
Q8104-E	 2Vpp 5msec/div
J8202-1	 2Vpp 5msec/div
J8202-2	 1Vpp 5msec/div
J8202-3	 1Vpp 5msec/div
J8202-4	 .2Vpp 5msec/div
J8202-5	 2Vpp 5msec/div
J8202-6	 1Vpp 5msec/div

Test Point	Waveform
J7018-2	 75Vpp 5msec/div
J7018-4	 30Vpp 5msec/div
J7017-2	 25Vpp 5msec/div
J7017-3	 1.5Vpp 5msec/div
J7016-2	 65Vpp 5msec/div
J7016-4	 35Vpp 5msec/div
U7002-7	 8Vpp 5msec/div
U7002-1	 6.5Vpp 5msec/div
U7001-7	 3.5Vpp 5msec/div
U7001-1	 2Vpp 5msec/div

Convergence Waveforms

Test Point	Waveform
U7003-7	 12Vpp 5msec/div
U7003-1	 4Vpp 5msec/div
Q7023-B	 60Vpp 5msec/div
Q7017-B	 45Vpp 5msec/div
Q7011-B	 30Vpp 5msec/div
Q7005-B	 15Vpp 5msec/div
Q7035-B	 8Vpp 5msec/div
Q7029-B	 30Vpp 5msec/div
Q7021-B	 30Vpp 5msec/div
Q7015-B	 17Vpp 5msec/div

Test Point	Waveform
Q7009-B	 8Vpp 5msec/div
Q7033-B	 30Vpp 5msec/div
Q7027-B	 15Vpp 5msec/div

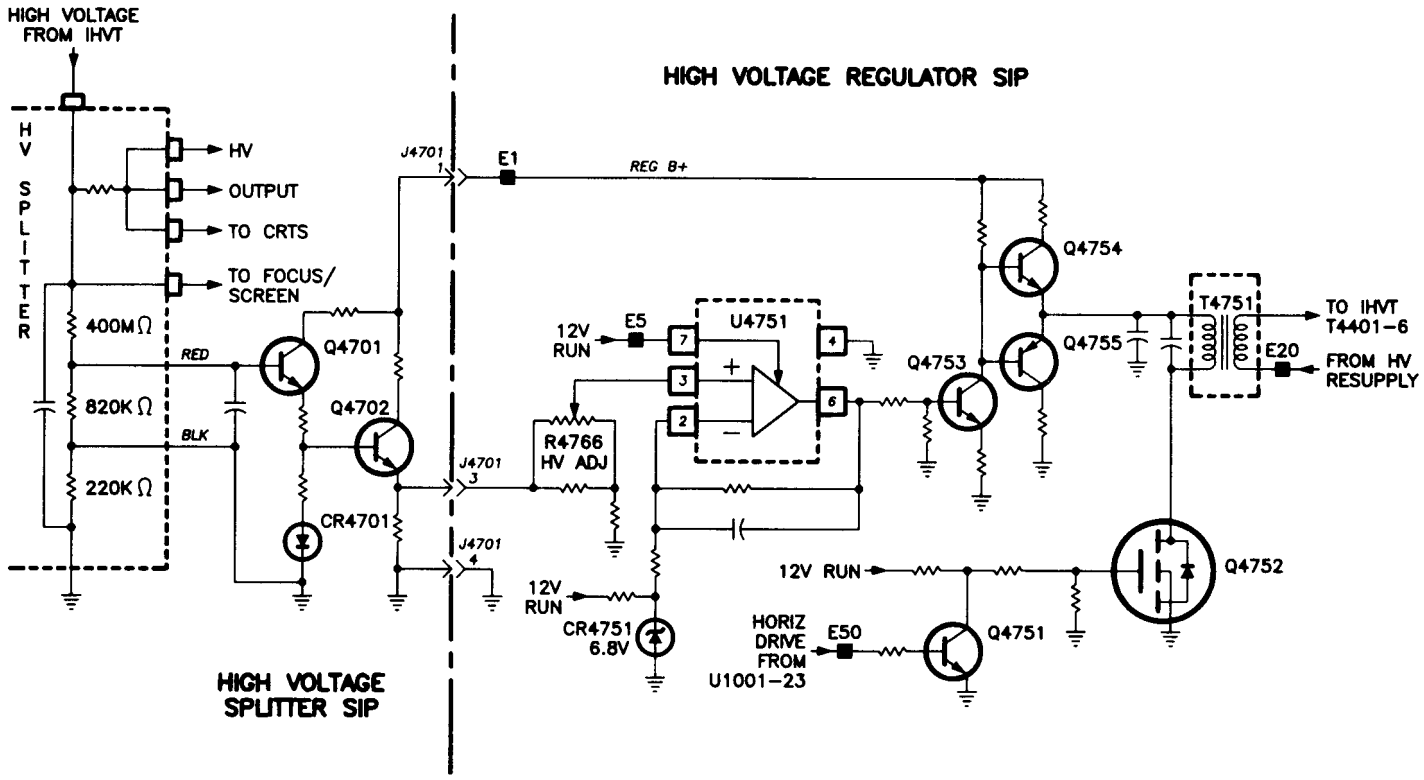


Figure 19, High Voltage Regulator Circuit

For circuit theory of operation on the High Voltage Regulation circuit, see page 101 in the CTC168/169 training manual.

A malfunction in the high voltage regulator circuit will most likely be displayed as raster distortions (bending) and will be more noticeable on scenes with large beam current changes. While a catastrophic failure of the switching devices in the circuit will cause the set to go into overcurrent shutdown, these instances are rare and would be troubleshot as a power supply shutdown problem.

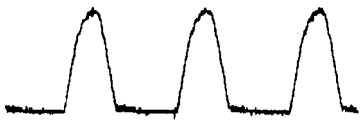
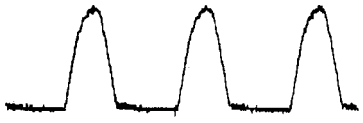
High Voltage Regulator Circuit Confirmation

1. To confirm proper operation of the High Voltage Regulator Circuit, perform the High Voltage Regulator alignment by tuning the TV to channel 91 (blank screen for no beam current) and turning the HV adjustment control, R4766, fully counterclockwise.
2. Monitor the waveform on the drain of Q4752.
3. Turn R4766 clockwise until the waveform increases 20Vpp (+ or - 10Vpp). Note: The adjustment may not be very linear. This is normal.
4. If you are able to perform the adjustment, the circuit is functioning normally. If a problem is still suspected, check the high voltage reference on J4701-3 against the voltage in the voltage waveform chart on page 38.

If the adjustment cannot be performed as explained, proceed to the following steps.

1. Remove Q4752 from circuit.
2. Confirm the + 12 volts run supply on pin 7 of U4751.

High Voltage Regulator Voltage and Waveforms

Test Point	Voltage R4766 clockwise	Voltage R4766 counterclockwise
U4751-3	4.3	7.7
U4751-6	1.8	11.3
Q4753-C	135	22.6
Q4754-E Q4755-E	139	22.2
J4701-3	8.7	8.3
Q4752-D	 410Vpp 20us/div	 65Vpp 20us/div
Q4751-B	 6Vpp 20us/div	
Q4751-C	 100Vpp 20us/div	

3. Confirm the +6.8 volt reference to pin 2 of U4751. If this is wrong or missing, suspect CR4751.
4. Turn R4766 fully counterclockwise. Compare voltages on U4751 pins 3 & 6, Q4753 collector and the emitters of Q4754/4755 to the voltage/waveform chart. The voltages should be within a few tenths of a volt of the given voltages.
5. Turn R4766 fully clockwise and repeat the measurements comparing the new voltages to the chart. If the voltages track accordingly, the comparator circuit and Q4754/Q4755 are functioning correctly.
6. Re-install Q4752 and compare waveforms on Q4751 and Q4752. The peak to peak level of the waveform on the drain Q4752 will of course vary with the setting of R4766.

Scan Loss Troubleshooting

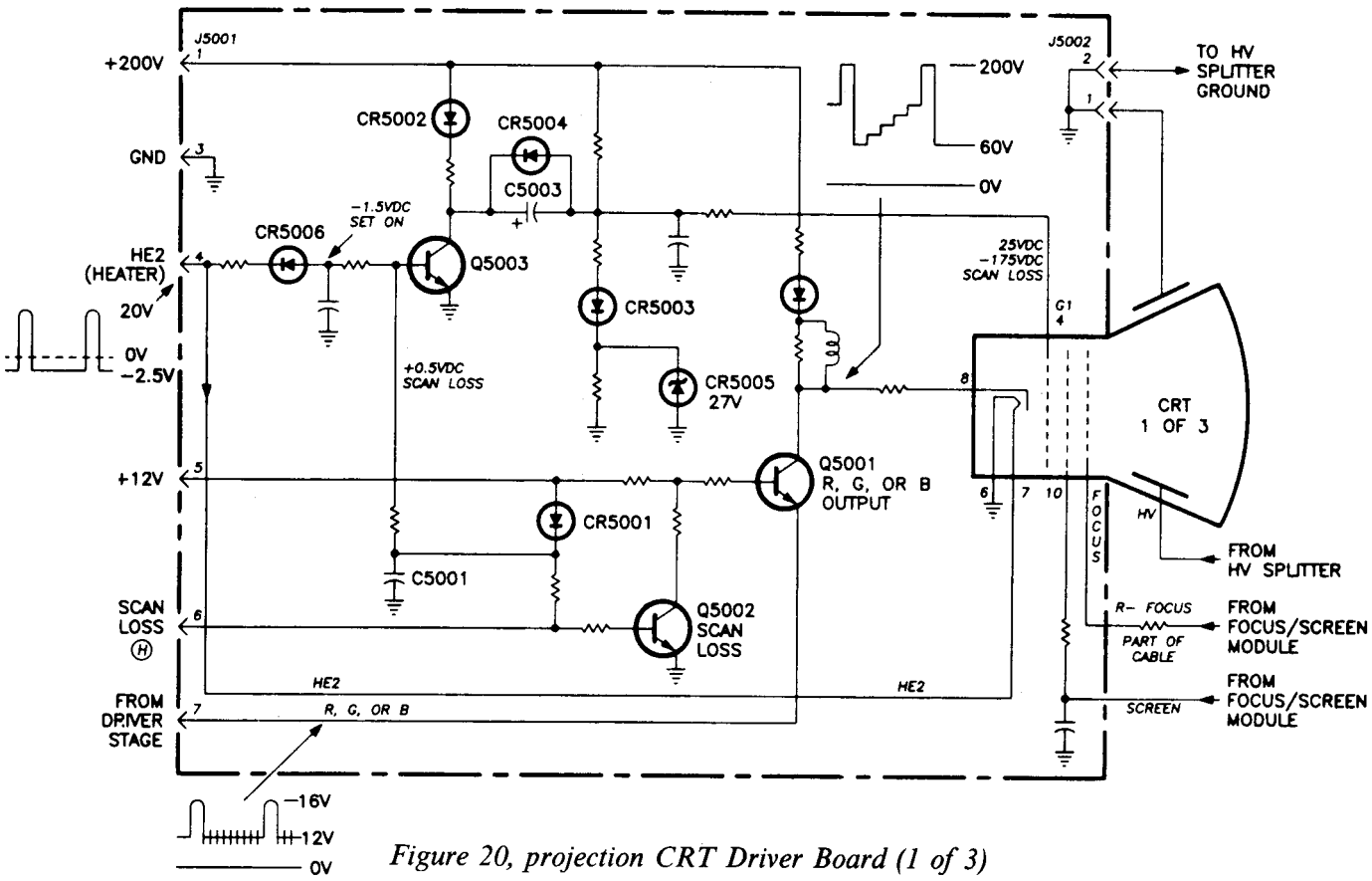


Figure 20, projection CRT Driver Board (1 of 3)

For Scan Loss Circuit theory of operation, refer to page 58 and 103 in the CTC169/169 Technical Training Manual.

Scan Loss Verification

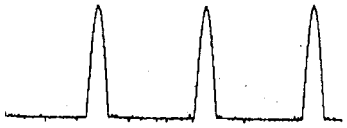
With set running, check for 25 VDC at the grid 1 (anode of CR5004) of the CRT and for a low at pin 6 of J5001. Check for -1.5 VDC at anode of CR5006.

When the set turns off, check for -175 VDC at grid 1 of the CRT. This voltage will slowly discharge to zero volts. Also check for a high at J5001 pin 6 when the set first turns off. This voltage will slowly discharge when the set is off since it is derived from the + 12 VDC run supply.

No Video

1. Measure the DC voltage on the collector of Q7048, location 11-F on the PTV AUX PCB. The voltage should be essentially 0 volts with Q7048 turned on. If Q7048 is turned off, the Scan Loss circuit is active.
2. Check for the presence of a vertical and horizontal pulse at J7007-3 and J7012-4 respectively. If any one of these pulses is missing, the CRT's will be blanked.
3. Check for the presence of the + 15 volts supply to Pin 4 of U7005. If this voltage is wrong or missing, the comparator will malfunction.

Scanloss Waveforms

Test Point	Waveform
J7012-4	 25Vpp 20us/div
J7007-3	 2Vpp 5msec/div

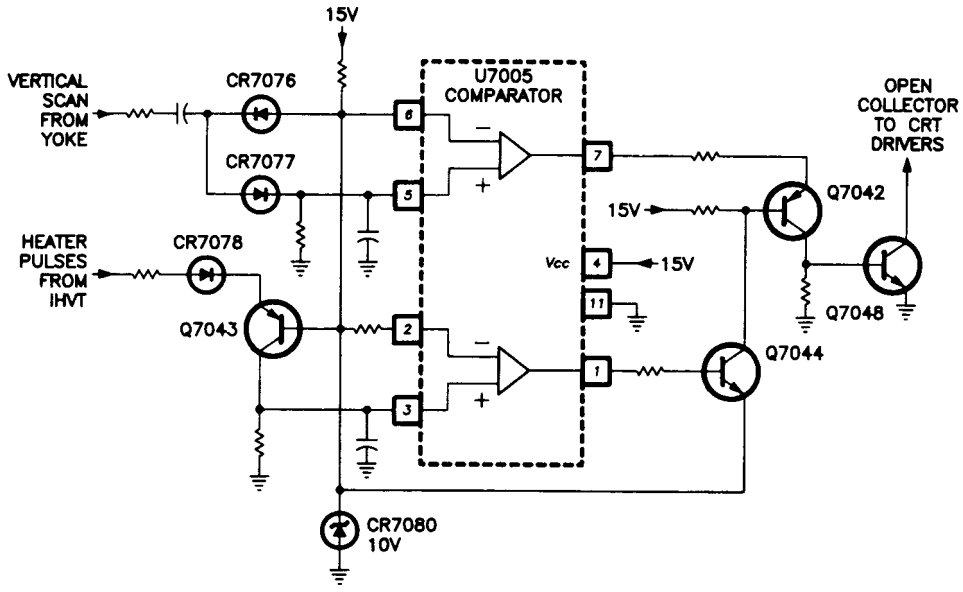


Figure 21, Scan Loss Circuit

Intermittent or Flashing Video

1. Measure the voltage on the collector of Q7048, location 11-F on the PTV AUX PCB. The voltage should be essentially 0 with Q7048 turned on.
2. If the voltage on the collector of Q7048 is not 0 volts, check the + 15 volts on pin 4 of U7005. If this voltage is incorrect, suspect a problem with the PTV AUX Power Supply.

Note: An excessive load on the PTV AUX Power Supply can pull the supply down causing the Scan Loss Circuit to false trigger. For example, a failure in the convergence circuit like a shorted convergence output transistor will cause such a problem.

Signal Processing Troubleshooting

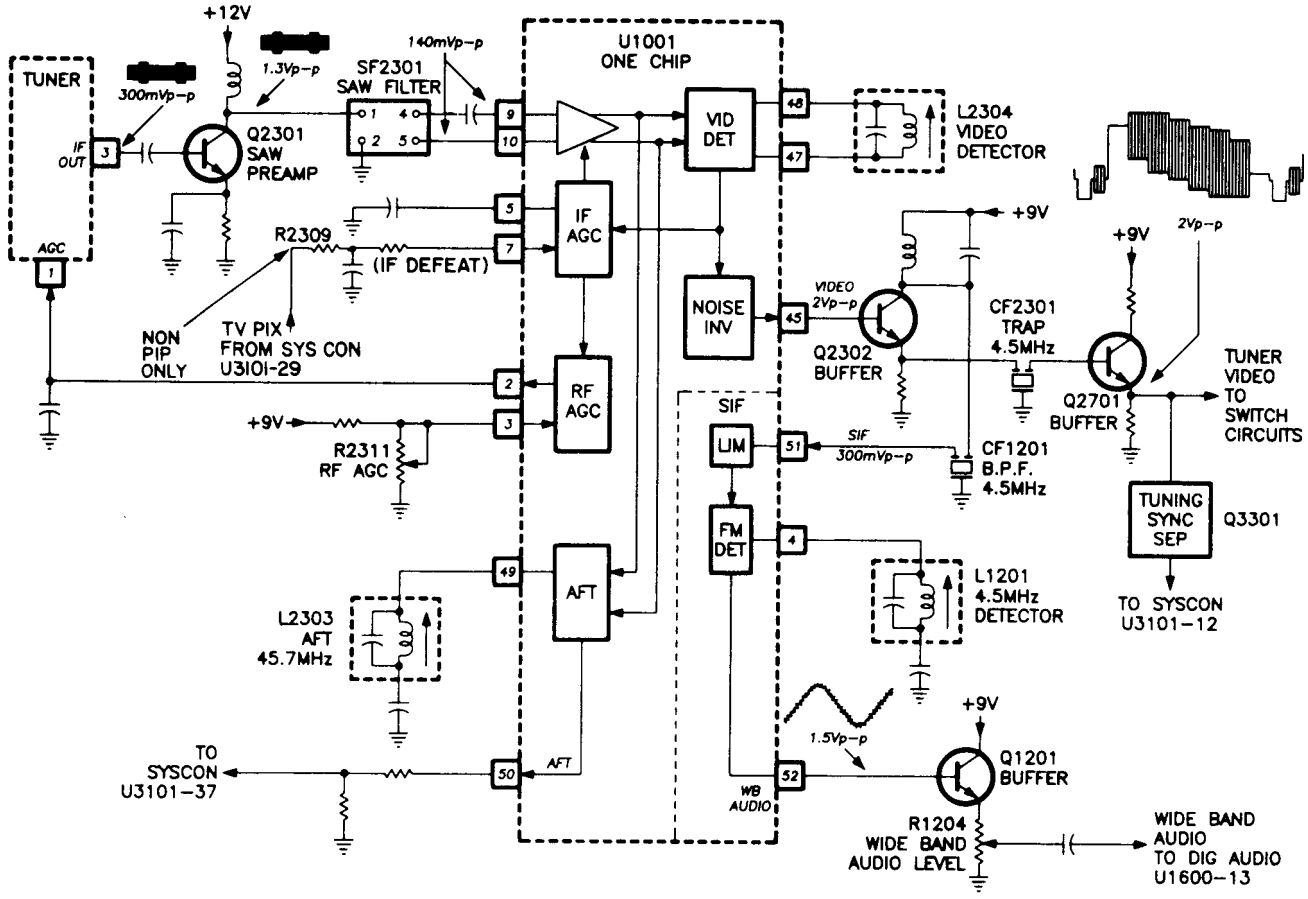


Figure 22, Video IF/Sound IF

For Signal Processing circuit theory of operation, see page 40 through 58 in the CTC168/169 Technical Training Manual.

Signal Processing Troubleshooting requires an oscilloscope and a signal generator in addition to a digital volt meter. Whether the problem is "abnormal video" or "no video", the troubleshooting procedure is the same.

1. Begin by sectionalizing what stage the problem is located in. This can be as easy as looking at the screen and listening to the audio. If audio is present from the tuner, the problem would have to be after Q2302 since the audio IF is taken off after that point. If necessary, apply a composite video signal to the input of AUX 1 or AUX 2.
2. If normal video is achieved through the auxiliary inputs, the problem is before U1401. If the video still exhibits the problem it can be assumed that the problem is after video selection.
3. Once the general location of the problem is sectionalized, apply an NTSC color bar generator signal to either one of the auxiliary inputs or the tuner (depending on the nature of the problem) and begin signal tracing through the signal path.

It is important to use a generator signal so there is a reference as to what the signal should look like on the oscilloscope. Once the area of the problem is discovered with the oscilloscope, voltage and resistance measurements will aid in locating the defective component.

See the following steps for specific troubleshooting procedures.

Video IF Troubleshooting

Symptom: No video, audio OK.

1. Since audio is taken from Q2302, the circuits prior to this stage must be OK. Check for video before and after the 4.5 MHz trap CF2301. If present, check for video at the emitter of Q2701. If present, the problem must lie beyond this circuit.

Symptom: No video or audio.

1. Check for video at the emitter of Q2701 and for audio at the emitter of Q1201 to verify if the problem lies in this stage. If neither is present, the problem must lie in this stage. If they were present, the problem would lie beyond this point. Go to step 2.

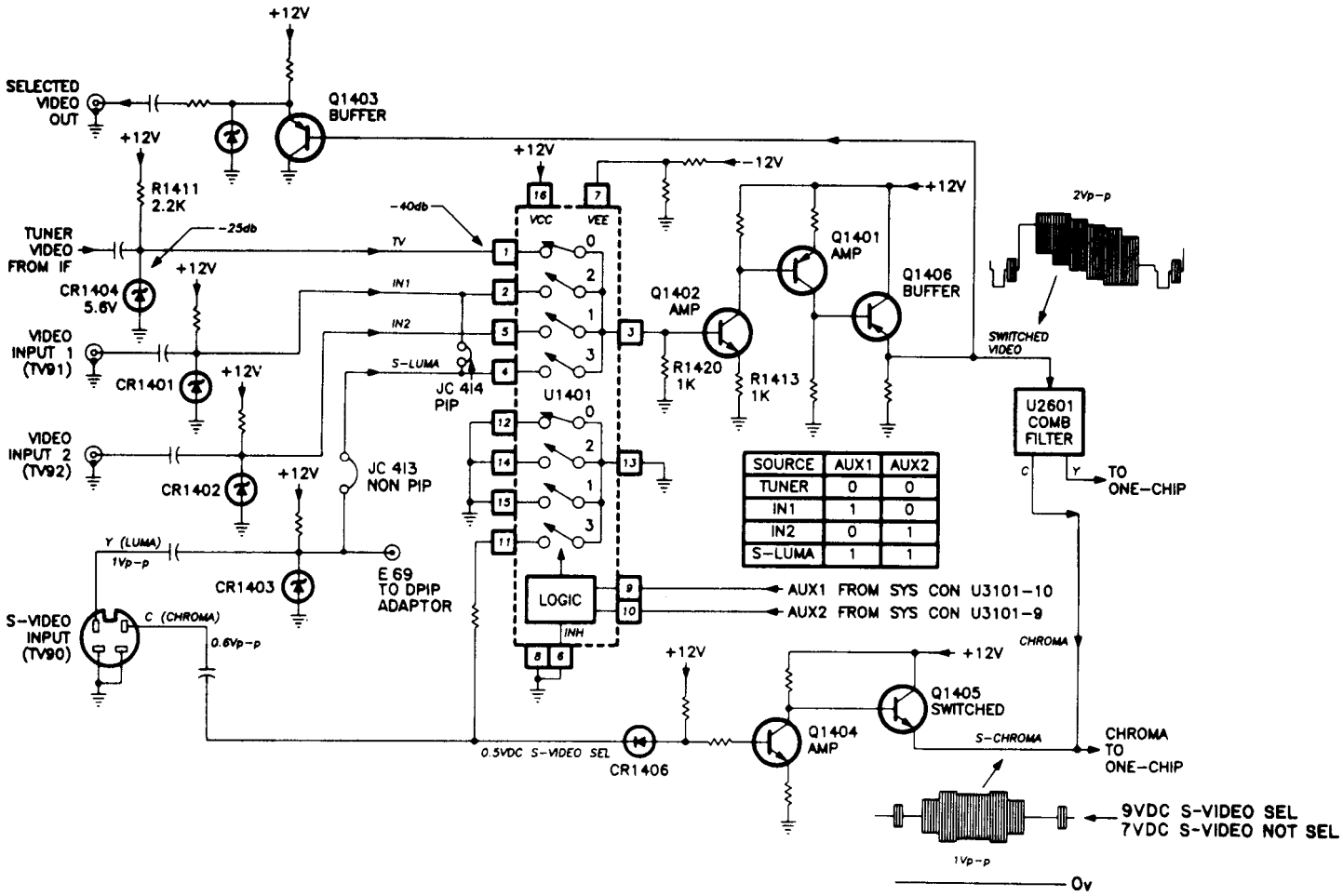


Figure 23, Video Input Selection (Non-PIP)

2. Check for a 300 mVp-p IF signal at pin 3 of the tuner. If present, trace the signal through the SAW preamp and SAW filter to pins 9 and 10 of the one-chip. If present up to pin 9 and 10, go to step 3. If not present at pins 9 and 10, replace SAW preamp or SAW filter.
3. Check to see if the AGC line going to pin 1 of the tuner is greater than 2 VDC. If AGC voltage is 2 VDC, the gain of the tuner will be too low to receive a signal. If AGC is OK, go to step 4.
4. Make sure Video Detector is aligned according to service data. If alignment is OK, suspect a defective One chip.

AFT troubleshooting is covered in the tuner portion of this manual.

Video Input Selection Troubleshooting

Non PIP Sets

Symptom: No video.

1. Check for composite video at the emitter of Q1406. If present, the problem must lie beyond this point. If not present, check for video at input of selection IC. If present, check logic levels at pins 9 and 10 according to chart in figure 23. If OK, check for shorted zener diodes at inputs of U1401.

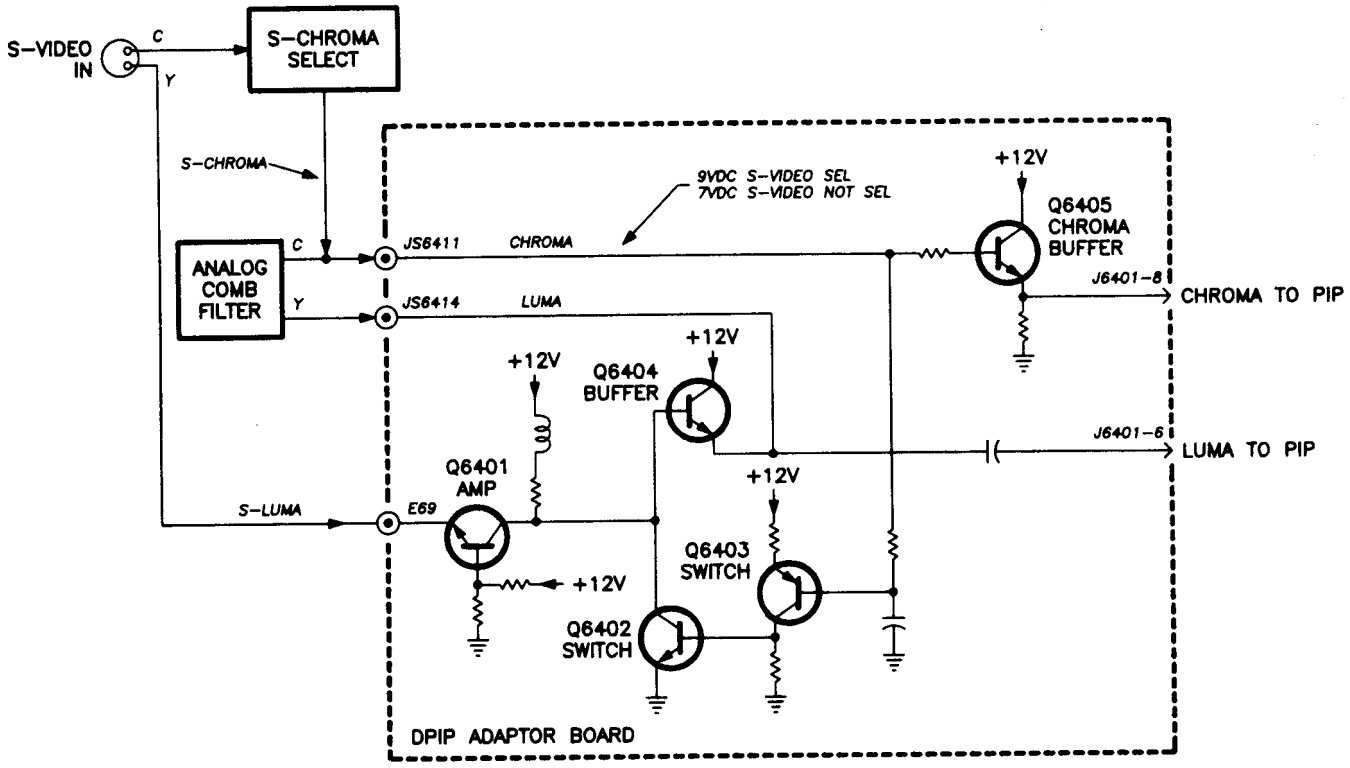


Figure 24, S-Luma Selection with Analog Comb and PIP

Symptom: Two video sources on screen.

1. Check for open zener diodes at inputs of U1401.

Symptom: Chroma distorted or missing.

1. With S-Video selected, check for low at U1404-11. If not low, S-Chroma will not be selected. Trace chroma signal through Q1401 to Q1405.
2. With composite video selected, make sure Q1405 is turned off and check for chroma signal from comb filter.

PIP Sets with Analog Comb

Symptom: No video.

1. Check for Y and C signals at input of PIP module or at output of the PIP Adaptor board. If present, refer to PIP module troubleshooting in later section of this manual. If no Y/C signals at output of the PIP adaptor board, go to step 2.
2. Check for Y and C signals from comb at input of PIP adaptor board at JS6411 and JS6414. If not present, check comb filter. If present go to step 3.
3. Trace chroma signal to buffer Q6405. Also check for DC offset on chroma line as shown in figure 24. Check operation of switch transistors Q6403 and Q6402. Check Luma Amp Q6401 and Buffer Q6404.

Luma Processing Troubleshooting

Symptom: No video.

1. Check for -Y signal at emitter of Q2906. If present, the problem lies beyond this point. If not present go to step 2.
2. Check for composite video input at pin 1 of the comb filter U2601. Trace composite signal from pin 2 and 3 of U2601 through 1H delay line to pin 5. Check for Y and C signals from comb. If present, go to step 3.
3. Check for luma at pins 43 and 40 of U1001. Make sure Sync Kill line is not active except during channel change. Check TV Pix control bias at pin 31. If OK, go to step 4.
4. Trace luma signal from U1001-38 to pin 35. Check brightness and contrast controls and associated limiting circuits. Make sure U1001-19 is not stuck low.

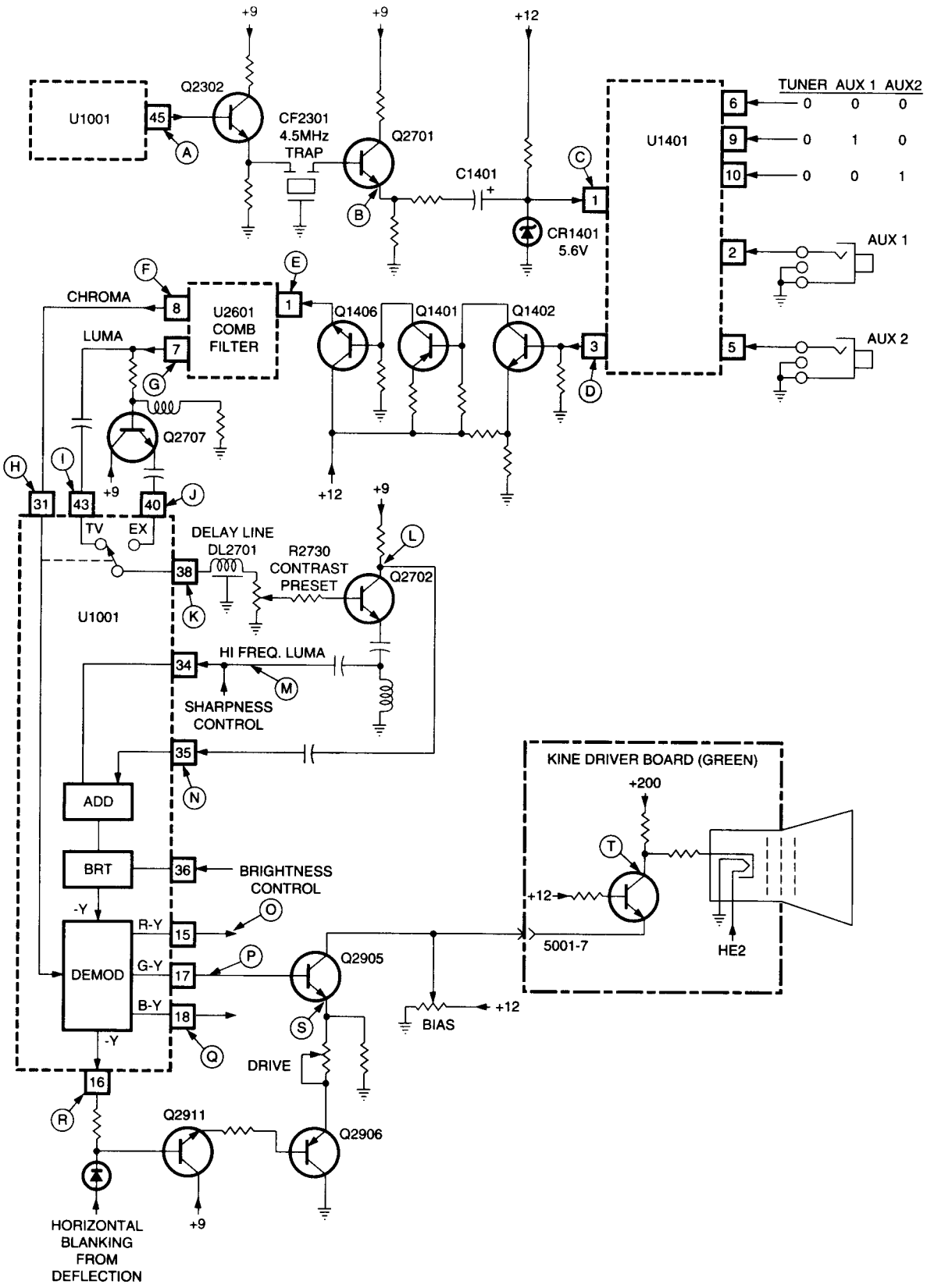
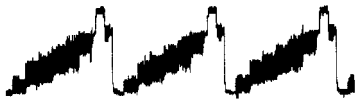
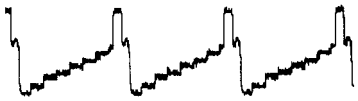
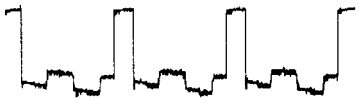


Figure 25, Signal Path Block Diagram (Non-PIP Set with Analog Comb Filter)

Signal Waveforms - Non-PIP Set with Analog Comb Filter

Test Point	Waveform
A	 2Vpp 20us/div
B	 2Vpp 20us/div
C	 .7Vpp 20us/div
D	 .65Vpp 20us/div
E	 1.9Vpp 20us/div
F	 2Vpp 20us/div
G	 1.9Vpp 20us/div
H	 150mVpp 20us/div
I	 2Vpp 20us/div
J	 1Vpp 20us/div

Test Point	Waveforms
K	 2Vpp 20us/div
L	 1.5Vpp 20us/div
M	 50mVpp 20us/div
N	 1Vpp 20usdiv
O	 1.5Vpp 20us/div
P	 .6Vpp 20us/div
Q	 2Vpp 20us/div
R	 6Vpp 20us/div
S	 2Vpp 20us/div
T	 150Vpp 20us/div

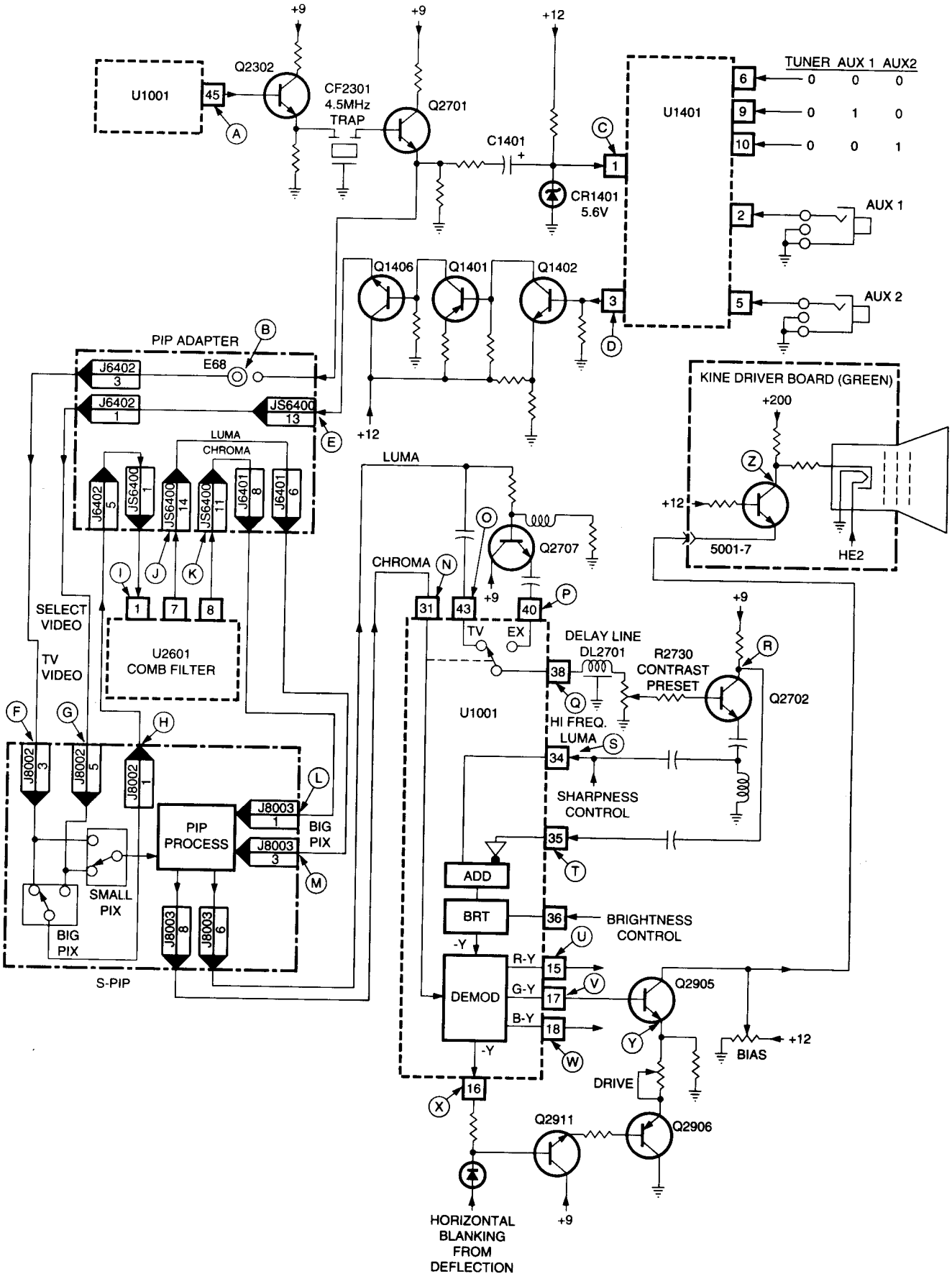
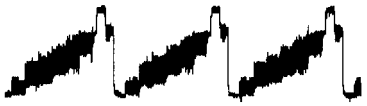
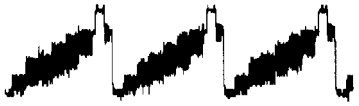
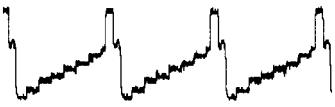


Figure 26, Signal path Block Diagram (PIP Set with Analog Comb Filter)

Signal Waveforms - PIP Set with Analog Comb Filter

Test Point	Waveform
A	 2Vpp 20us/div
B	 2Vpp 20us/div
C	 .7Vpp 20us/div
D	 .65Vpp 20us/div
E	 2Vpp 20us/div
F	 2Vpp 20us/div
G	 2Vpp 20us/div
H	 2Vpp 20us/div
I	 1.9Vpp 20us/div
J	 1.9Vpp 20us/div

Test Point	Waveforms
K	 2Vpp 20us/div
L	 1.9Vpp 20us/div
M	 1.9Vpp 20us/div
N	 150mVpp 20usdiv
O	 2Vpp 20us/div
P	 1Vpp 20us/div
Q	 2Vpp 20us/div
R	 .5Vpp 20us/div
S	 50mVpp 20us/div
T	 1Vpp 20us/div

Test Point	Waveform
U	1.5Vpp 20us/div
V	1.5Vpp 20us/div
W	2Vpp 20us/div

Test Point	Waveforms
X	6Vpp 20us/div
Y	2Vpp 20us/div
Z	150Vpp 20us/div

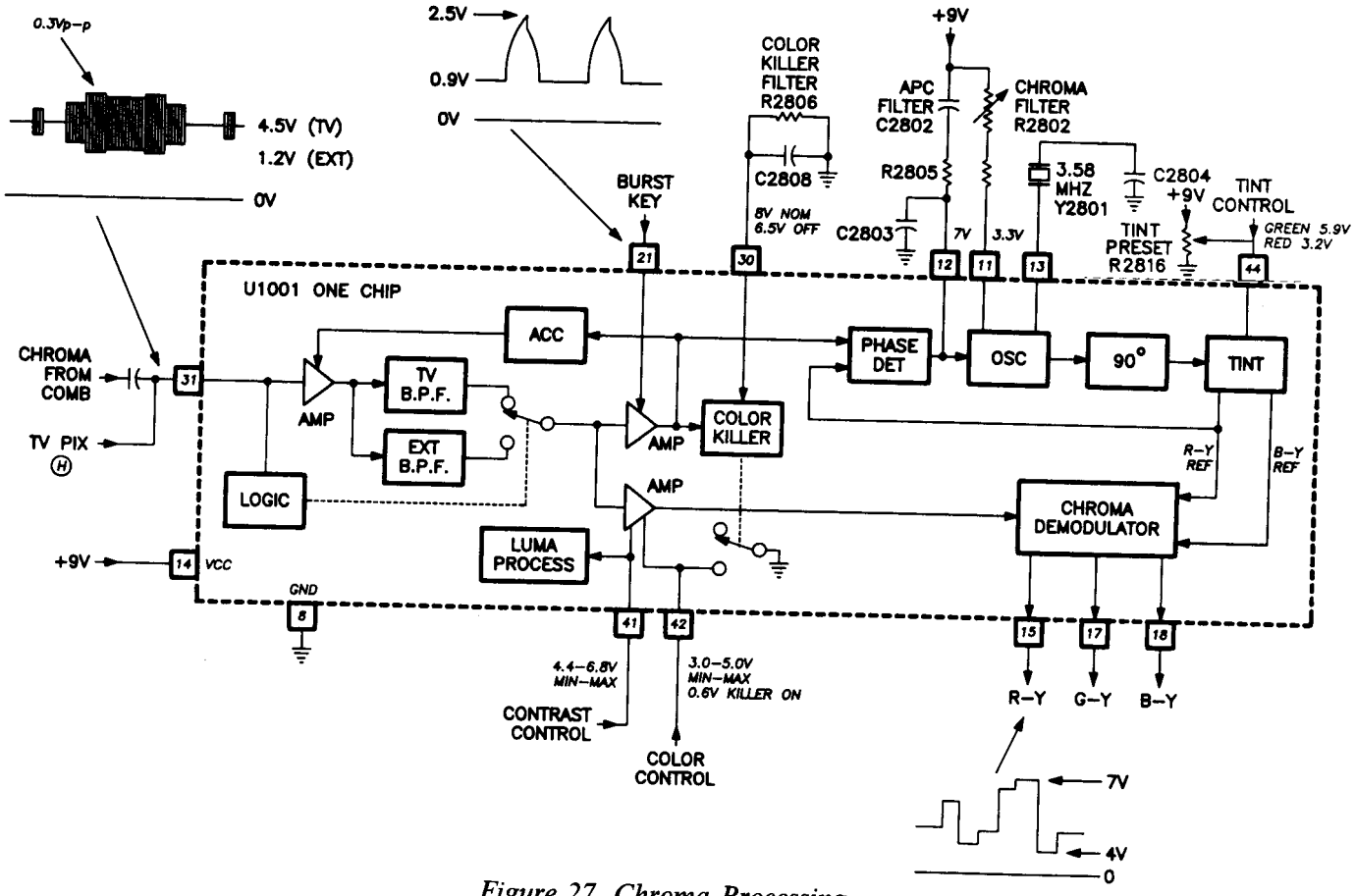


Figure 27, Chroma Processing

Chroma Troubleshooting

Since most problems in the chroma stages result in loss of chroma, DC voltage and signal verification is the best way to troubleshoot this stage, Figure 26.

1. Check for R, G, or B-Y outputs at pins 15, 17, and 18. If not present, check for chroma input as well as DC offset at pin 31.
2. Check for burst key at pin 21.
3. Check color killer voltage at pin 30.
4. Check for leaky or open APC Filter C2802 at pin 12. Also check the 3.58 MHz oscillator.

U1001 CTV PROCESSOR (ONE-CHIP)

PIN NO	I/O	SIGNAL NAME	IN CKT RES	VOLTAGE	DESCRIPTION
1	O	AUDIO OUT	>20M	NC	Not used
2	O	RF AGC OUT	69K	9.15 W/SIG 2.93 WO/SI	RF gain control voltage for tuner.
3	I	RF AGC IN	2.3K	1.69	Adjusts the operation point of the RF AGC circuit.
4	-	SIF DET	>20M	3.66	Connection for audio detection tank.
5	-	PIF AGC 1	>20M	5.47 W/SIG 7.42 WO/SI	High frequency IF AGC filter.
6	I	EXT AUDIO IN	37K	NC	Not used.
7	-	PIF AGC AGC 2	>20M	5.46 W/SIG 7.34 WO/SI	Low frequency IF AGC filter and IF defeat connection point.
8	-	P/S GND	0	GND	PIF/SIF ground.
9	I	IF IN	20K	4.01	IF input from SAW filter.
10	I	IF IN	20K	4.01	IF input from SAW filter.
11	I	FC ADJUSTMENT	41K	3.20	Chroma oscillator and filter adjustment.
12	-	APC FILTER	>20M	7.16	Controls phase (tint) of chroma signal.
13	-	X'TAL 3.58MHz	>20M	6.55	3.58 MHz chroma oscillator.
14	I	V/C/D VCC	1.8K	9	9 VDC VCC for video, chroma and deflection circuits within U1001.
15	O	R-Y	4.3K	5.45	R-Y color difference signal output.
16	O	-Y	1.5M	5.77	Luminance output.
17	O	G-Y	4.2K	5.46	G-Y color difference signal output.
18	O	B-Y	4.2K	5.46	B-Y color difference signal output.
19	I	RED OSD	>20M	4.85	Red OSD input which is connected to the Blank (bar) line from system control to produce the black border around OSD characters.
20	I	GREEN OSD	>20M	NC	Not used.
21	I	FB PULSE	>20M	1.09	Input for chroma burst amp and horizontal centering control.
22	I	X-RAY PROTECT	32K	.09	When voltage at this pin reaches approximately 1.5 VDC, X-Ray protect activates and stops horizontal drive pulses from pin 23 of U1001.
23	O	H OUT	440	2.02	Horizontal output pulses which are applied to the horizontal deflection stage.
24	I	H AFC	>20M	7.24	Horizontal AFC input.
25	-	32H OSC	>20M	-	503 kHz oscillator for horizontal countdown stage.
26	I	H VCC	81K	8.99	VCC for sync stages.
27	O	V OUT	1K	NC	Not used.

U1001 CTV PROCESSOR (ONE CHIP)

PIN NO	I/O	SIGNAL NAME	IN CKT RES	VOLTAGE	DESCRIPTION
28	-	V NFB	49K	.01	Negative feedback for vertical ramp stage.
29	O	V RAMP	3.2K	.2	Vertical reset output applied to vertical deflection stage
30	-	COLOR KILLER	2.7M	8.24 W/CO 5.93WO/CO	Disables chroma circuits when chroma burst is not received. Color killer activates at about 6.5 VDC at pin 30.
31	I	TV/EXT SW CHROMA IN	40K	4.49 TV 1.42 EXT	Chroma input in addition to control line for TV/EXT video switching at pins 40 and 43. DC level of chroma level is used to perform the switching. The DC offset is 4.5 VDC for TV video and 1.2 VDC for external video.
32	I	S-VHS SW	0	GND	Not used.
33	-	OSD BRIGHT	1.8K	9	Voltage at this pin is transferred to the -Y output of U1001 whenever the red OSD pin 19 is pulled low. This technique is used to produce the black border around the OSD characters.
34	I	SHARP	17K	6.86	DC control and high frequency control luma input for sharpness control. 5.8 VDC to 7.9 VDC min to max (approx).
35	I	DELAYED VIDEO	210K	5.48	Delayed low frequency luma input for sharpness control circuit.
36	I	BRIGHT CTRL	16K	5.55	DC control input for brightness. 5.2 VDC to 5.6 VDC min to max (approx).
37	O	V SEP FILTER	>20M	6.17	Filter connection for horizontal/vertical sync separation.
38	O	VIDEO OUT	3.3K	2.53	Luma output of contrast control amp.
39	-	V/C/D GND	0	GND	Ground for video, chroma and deflection circuits within U1001.
40	I	EXT VIDEO	>20M	2.08	Luma input used for video source other than TV tuner.
41	I	CONT CTRL	15K	6.33	DC control input for contrast. 4.4 VDC to 6.5 VDC min to max (approx).
42	I	COLOR	>20M	4.11 W/CO .65 WO/CO	DC control input for color. 3 VDC to 5 VDC min to max (approx).
43	I	VIDEO IN	>20M	2.59	Luma input used for TV tuner source only.
44	I	TINT CTRL	33K	4.74	DC control input for tint. 3.2 VDC to 5.9 VDC red to green (approx).
45	O	VIDEO DET OUT	>20M	3.33 W/SIG 3.79 WO/SI	Composite video output of IF video detector.
46	I	P/C VCC	1.8K	9.21	VCC for Pix IF and Sound IF circuits.
47	-	PIF	3.6K	6.73	Connection for video detector tank.
48	-	PIF	3.6K	6.72	Connection for video detector tank.
49	-	AFT TANK	>20M	3.07	Connection for AFT tank.
50	O	AFT OUT	91K	4.68 W/SIG 2.93 WO/SI	AFT output to system control micro which swings from 0 to 9 VDC. Divided down to 0 to 5 VDC swing for system control micro AFT input. Nominal tuning represented by 2.5 VDC at AFT input of system control micro U3101.
51	I	SIF INPUT	2.9K	2.01	4.5MHz input for sound IF circuit.
52	O	WIDEBAND AUDIO OUT	35K	4.85	Wideband audio output of FM sound detector. The audio at this point is not volume controlled.
53	I	EXT AUDIO IN	39K	NC	Not used.
54	I	EXT AUDIO ATTEN CTRL	>20M	NC	Not used.

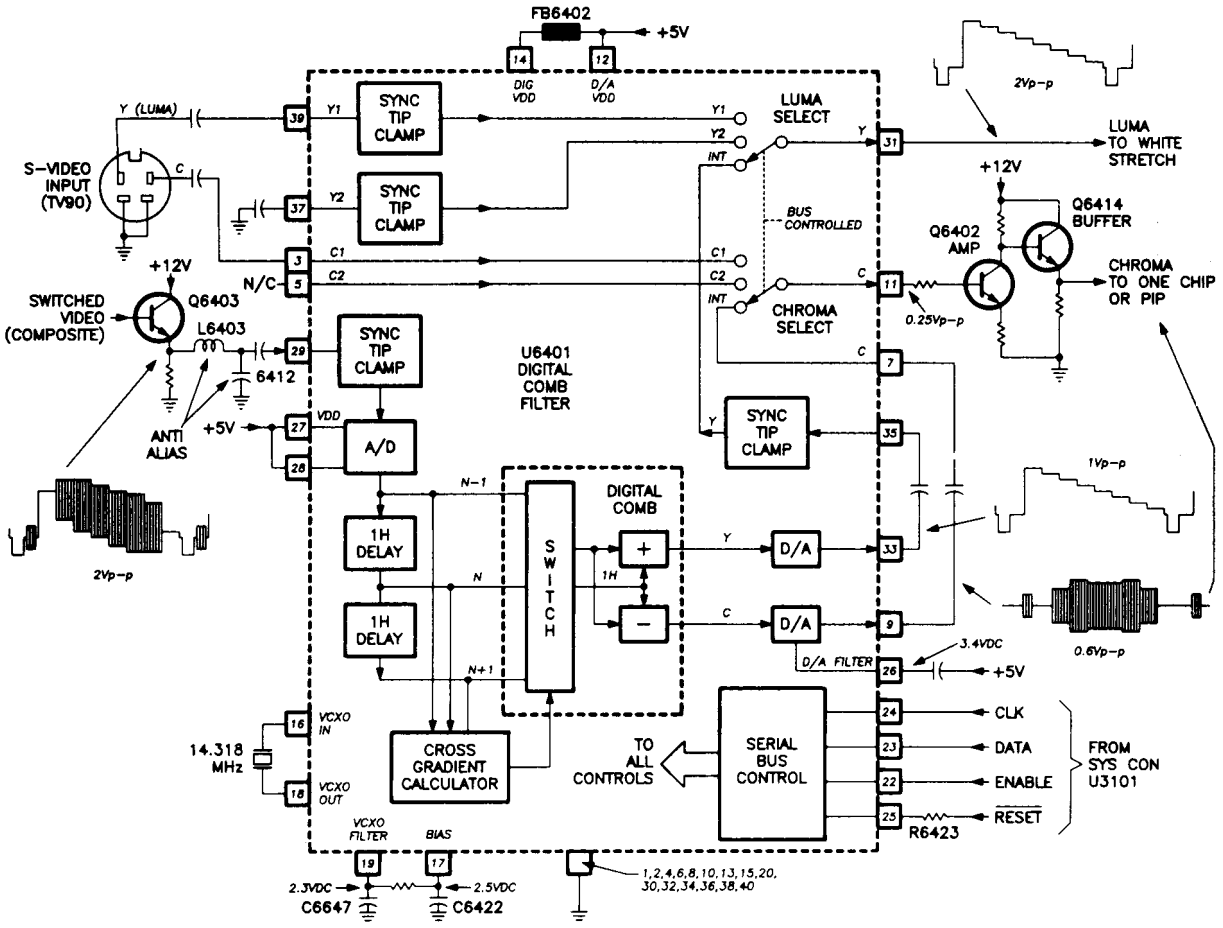


Figure 28, Digital Comb Filter

Digital Comb Troubleshooting

Symptom: No Video

1. Check for luma and chroma signals at U6401-33 and 11. If present, the problem lies beyond the digital comb. If No signals are present, go to step 2.
2. Check for composite video at input pin 29. If missing, the problem lies prior to digital comb. If signal is present, go to step 3.
3. Check for Y and C signals at pins and 33 and 9. If present, check for Y and C at pin 35 and 7. If present, selection circuit or serial bus control at pins 22-24 may be defective. If no signals were present at pins 9 and 33, go to step 4.
4. Check for 14.318 MHz at pin 18. If not oscillating, check VCXO Bias and filter voltages at pin 17 and 19.

White Stretch Troubleshooting

Symptom: No Video.

1. Check for luma at emitter of Q6412. If present, the problem lies beyond the white stretch circuit. If luma is not present, check for luma at emitter of Q6401. If not present, check circuits prior to Q6401. If luma is present at Q6401, go to step 2.
2. Check DC level of luma signal at collector of clamp Q6426 according to waveform in figure 29. If DC offset is very high, check operation of clamp circuit by checking for clamp pulse at base of Q6426. If not present, check for clamp pulse from ringer Q6421. If luma level at collector of Q6426 is OK, go to step 3.
3. Check for luma signal at base of Q6412. If present, Q6412 may be defective. If luma is not present on the base, check transistor stages between Q6404 and Q6405 up to base of Q6412.

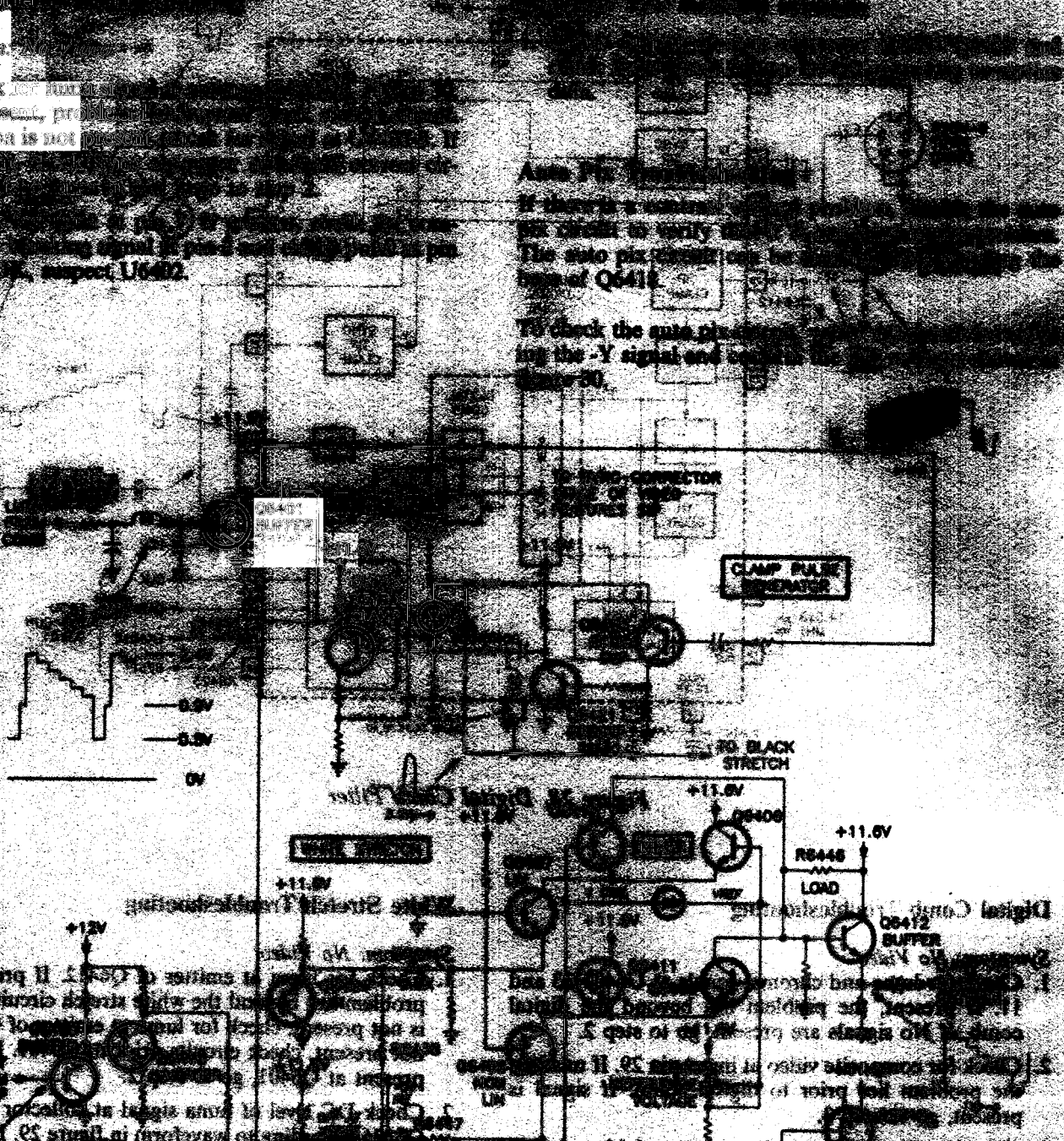


Figure 29. White Stretch Circuit

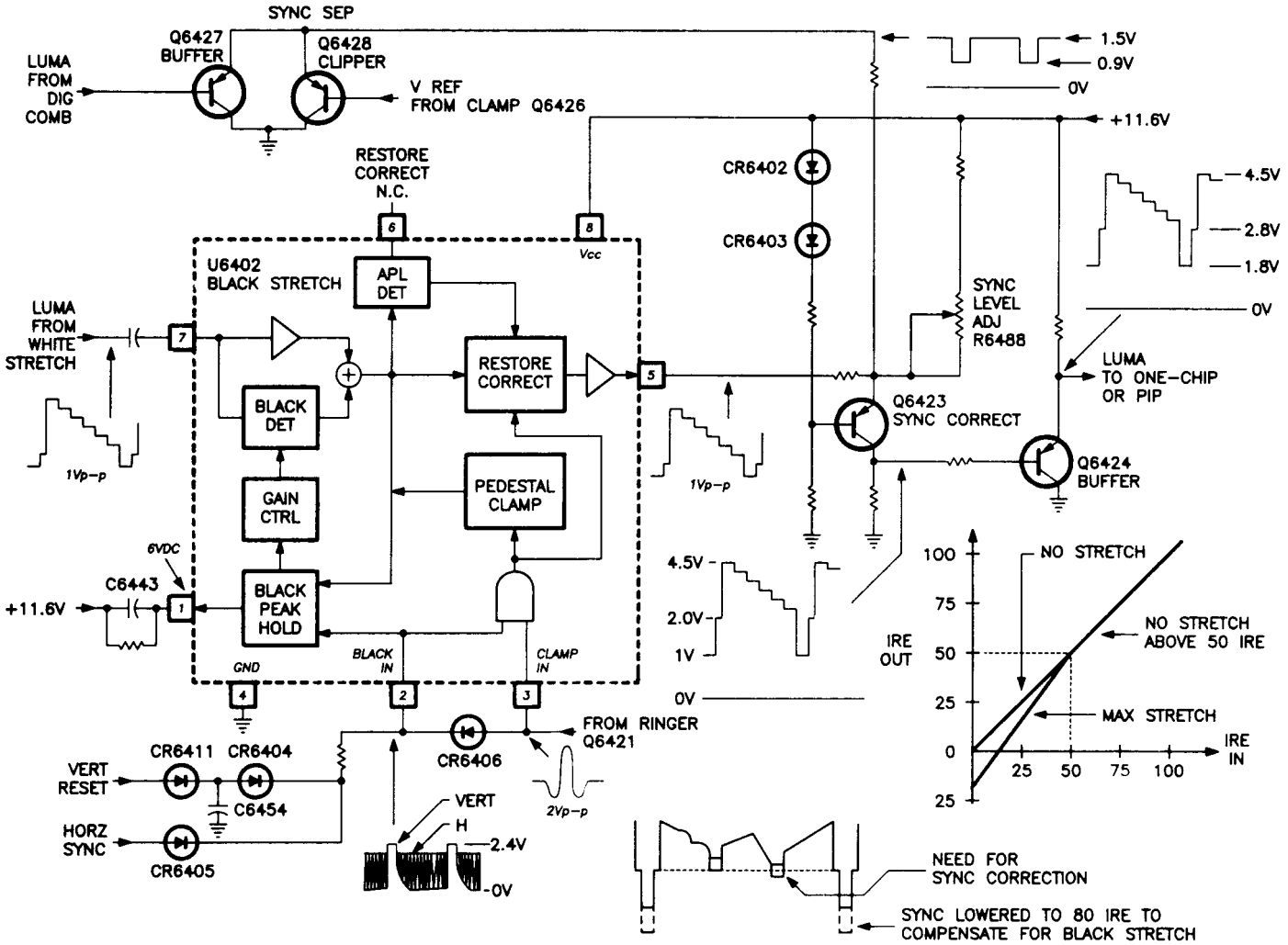


Figure 30, Black Stretch Circuit

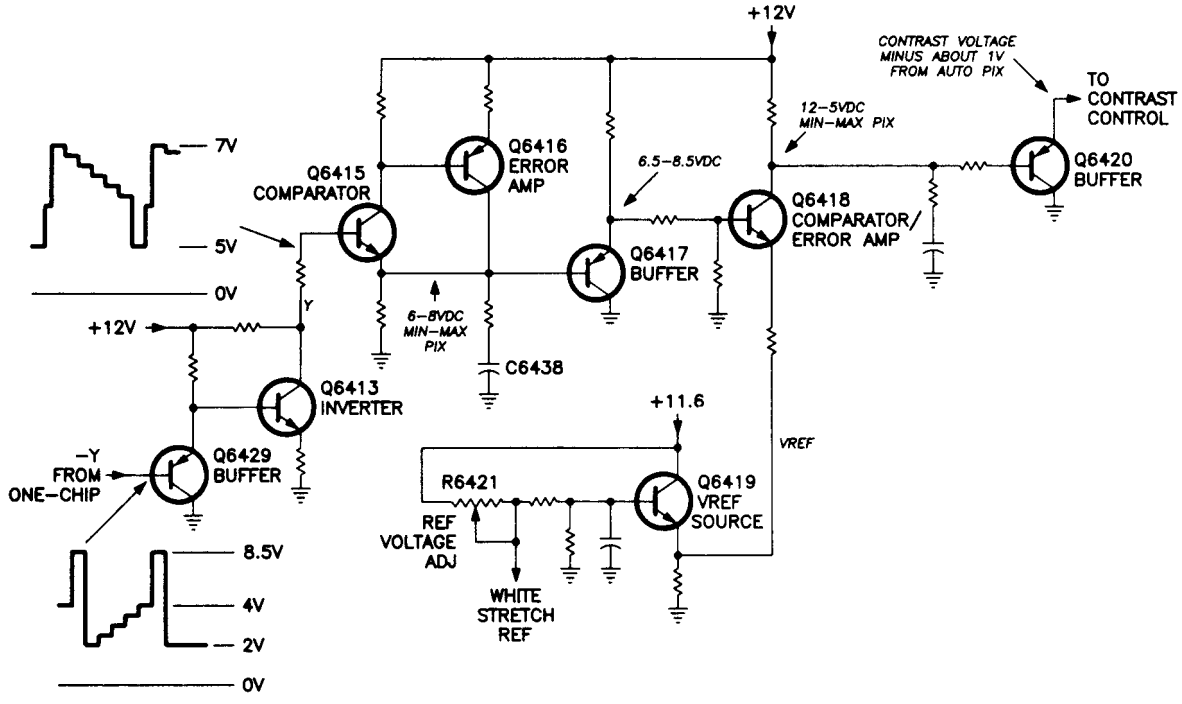


Figure 31, Auto PIX Circuit

Tech Tips

Symptoms	Solutions
Picture too bright at turn on. Set would then shutdown. If the picture socket was removed from the tube, the set would continue to play without shutting down.	Q2906 was shorted from emitter to collector.
At turn-on, screen gets bright and then the set shuts down. The 200V at E9 measured low and the collector of the kine drivers measured 7 volts.	Q2906 was shorted emitter to collector. Jail bars on left. Most noticeable on a blank scene with the brightness turned all the way up.
Video was flashing intermittently.	Video at U1401-3 was normal but showed "flashing" at Q1402C. Although all the components associated with Q1402 checked good, replacing C1407 restored normal operation.
Pink or red colors bleed. Flesh tones off.	Defective U1001.

PTV AUX Power Supply Troubleshooting

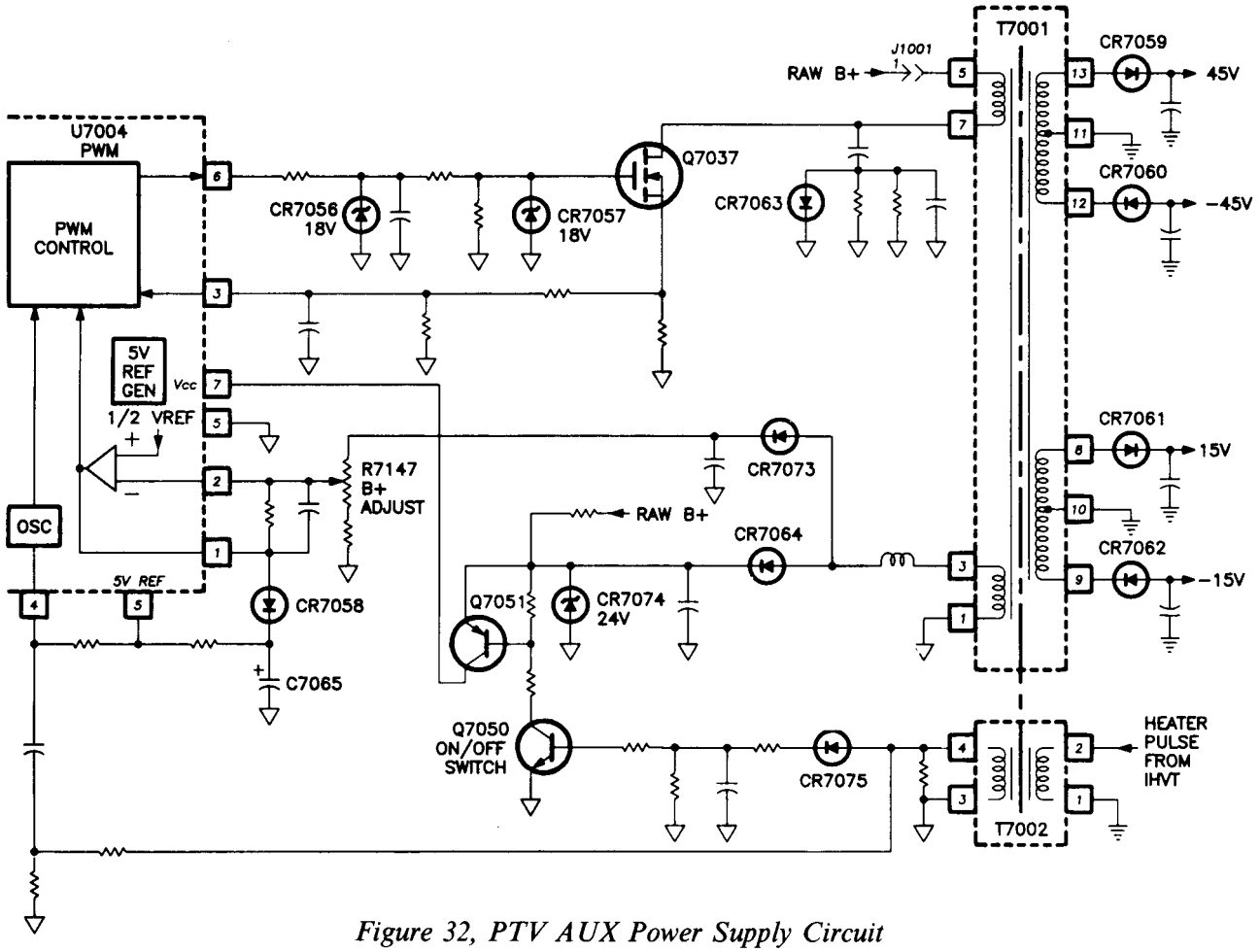


Figure 32, PTV AUX Power Supply Circuit

For circuit theory of operation on the PTV AUX Power supply, refer to page 104 in the CTC168/169 Technical Training Manual.

Dead - Line fuse Open

Problems in the PTV Aux Power Supply are sometimes difficult to diagnose since the switching regulator on the chassis and the PTV AUX Power Supply can cause the same symptom. There is only one fuse on the main chassis, and a short on the chopper output device or a shorted output FET in the PTV Aux Power Supply causes the line fuse to open. The surge resistor on the chassis is also likely to open.

1. In the event of an open fuse or surge resistor, disconnect the raw B+ input to the aux board and measure the resistance from the raw B+ connection on the PTV AUX PCB to hot ground.
2. If the resistance is less than one megohm, suspect a short or leakage in Q7037, T7001, or the snubber network. If the resistance is greater than one megohm, suspect a malfunction in the chopper supply on the main chassis.

The set can be turned on with the raw B+ to the aux board disconnected. The screen will be blanked since the scan loss detect circuit is turned on. The audio operates normally. If the audio operates normally and the chopper supply produces the correct reg B+, the malfunction must be in the aux board power supply. If the audio is not correct, the problem is on the chassis and the aux board power supply is probably operating normally.

If the raw B+ and the heater pulses are present and the power supply is pulsing on and off, suspect loss of feedback/run Vcc or overcurrent shutdown.

Pulsing On and Off

1. If the feedback/run Vcc is missing, the voltage at pin 7 of U7004 will cycle above the under voltage lock out point (greater than 14.5 volts) to below the turn off voltage (less than 11.5 volts). Suspect an open CR7073 or a leaky capacitor.
2. If an overcurrent shutdown is suspected, suspect a short or leakage in CR7059, CR7060, CR7061, or CR7062, a filter capacitor, or a short in the convergence output circuit.

A short circuit or severe leakage in T7001 can also cause an overcurrent shutdown. This condition is difficult to detect because all windings have very low resistance. The process of elimination must be used to determine if T7001 is at fault. All other components in the power supply must be checked before T7001 is replaced. If any measurable resistance occurs between any of the windings of T7001 when T7001 is measured out of the circuit, T7001 should be replaced. Confirming U7004. In order to confirm U7004 good, an external DC supply can be used to operate the IC without energizing the rest of the circuit.

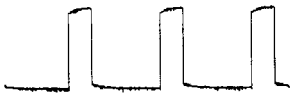
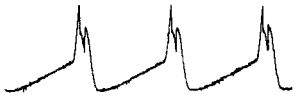
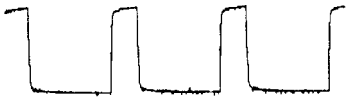
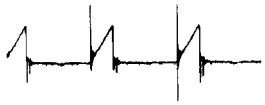
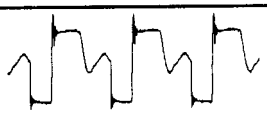
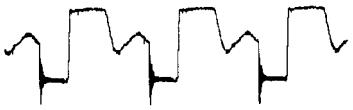
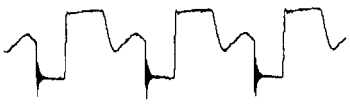
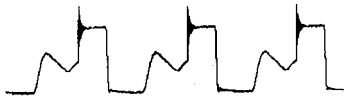
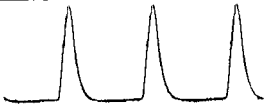
1. Begin by connecting the negative lead of the external DC power supply to HOT ground (the heat sink of Q7037 is hot ground).
2. Make sure the external power supply is off or turned all the way down and then connect the positive lead to pin 7 of U7004.
3. Connect the oscilloscope to U7004 pin 4.
4. Turn on the power supply and raise the voltage on pin 7 to 14 volts.
5. Monitor the waveform on pin 4 of U7004 and slowly raise the voltage up until the under voltage lockout is cleared (just above 16 volts).
6. As soon as a waveform appears on pin 4, immediately lower the DC voltage to +15 volts. Do not raise the voltage any higher than +18 volts.
7. The waveforms on pins 6 and 4 should correspond to those in the chart.
8. If there are no waveforms present, disconnect power and check the components off of 4, 6 and 8.
9. If the components check good, repeat steps 1-6. If the IC still does not generate an oscillator at pin 4, it is probably defective.

No Video

The PTV AUX Power Supply can cause a no video symptom if the supplies drop far enough. The PTV AUX Power Supply supplies B+ to the scan loss circuit. If the 15 volt supply drops, the scan loss will activate and blank the picture and in some cases cause the picture to flash.

Test Point	Waveform
U7004-6	 15Vpp 20us/div
U7004-4	 2Vpp 20us/div

PTV Auxilary Power Supply Voltage and Waveforms

Test Point	Voltage	Waveform
U7004-6	3.68	 15Vpp 20us/div
U7004-4	.89	 3.5Vpp 20us/div
Q7037-G	3.67	 15Vpp 20us/div
Q7037-D	152	 350Vpp 20us/div
Q7037-S	.16	 2Vpp 20us/div
T7001-3	152	 50Vpp 20us/div
T7001-12	NA	 150Vpp 20us/div
T7001-13	NA	 150Vpp 20us/div
T7001-8	NA	 50Vpp 20us/div
T7001-9	NA	 50Vpp 20us/div
T7002-4	NA	 10Vpp 20us/div

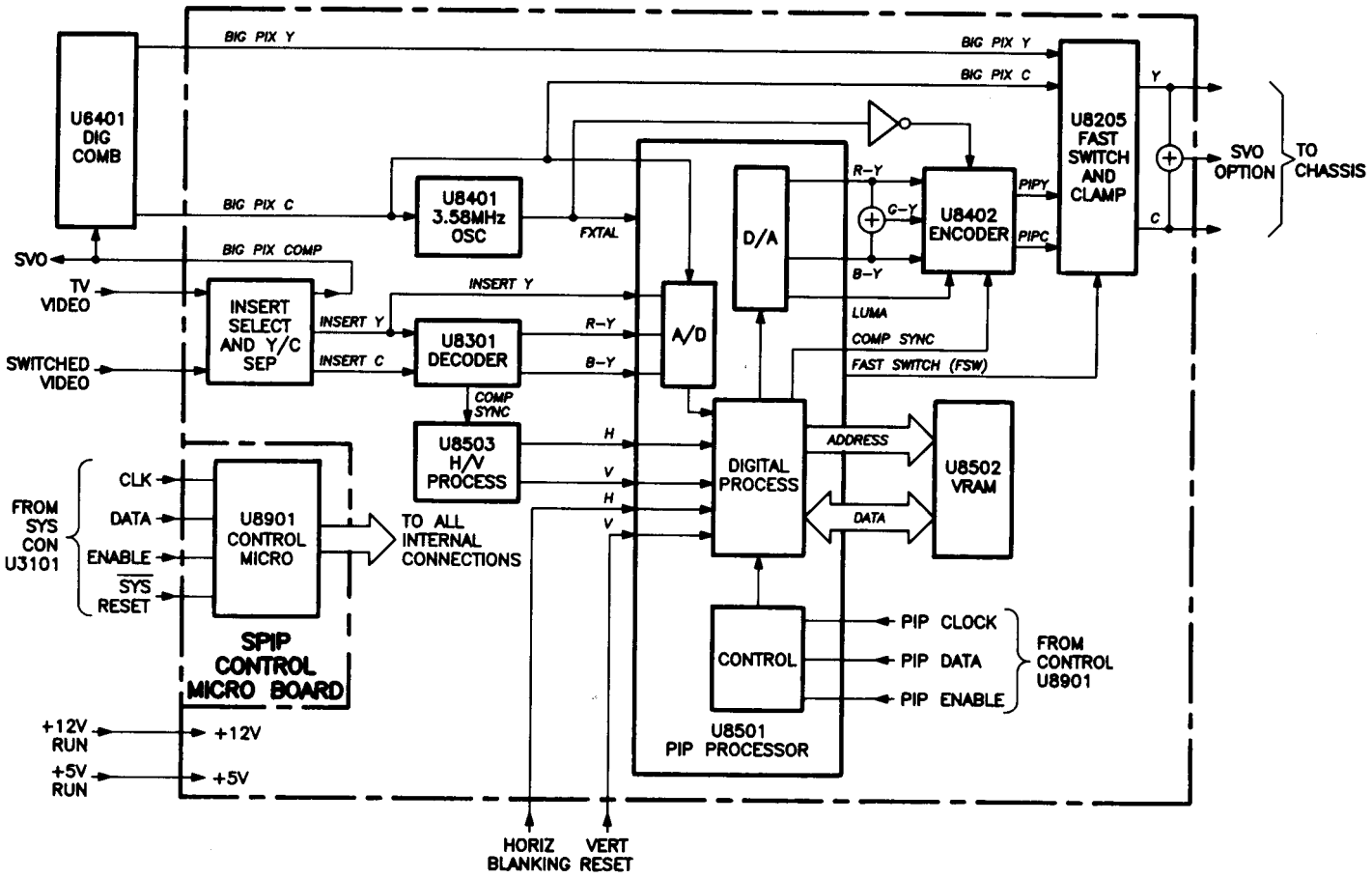


Figure 33, S-PIP Block Diagram

Because of the complexity of PIP, it is strongly recommended that a working knowledge of the circuitry be obtained before attempting to service the circuit. Refer to pages 66 through 88 in the CTC168/169 Technical Training Manual for circuit theory of operation.

PIP Module Verification

Note: Some SPIP modules may have different connector numbers than shown in figure 35. Use the following cross reference or refer to service data for the connector number that applies to the module being worked with.

CONNECTOR	ALTERNATE NAME
J8101	J8001
J8201	J8002
J8202	J8003

Before the PIP module is blamed for a malfunction, it is a good practice to confirm PIP module operation first. The following procedure should be used to determine whether the problem is PIP related.

1. Remove AC power from the chassis. Remove all connectors from the PIP module.
2. Jumper the TV video signal at J8201-3 (P6402) to the luma J8202-6 (P6401) and chroma J8202-8 (P6401) inputs to the one-chip. This bypasses the video switching within the PIP module.
3. Turn the set on. There should be a color picture since the the composite TV video signal was jumpered to the luma and chroma inputs of the one-chip. The picture quality may not be perfect beause composite video is being jumpered into points which require component luma and chroma signals.

If the problem still exists after bypassing the module, troubleshoot the chassis since the PIP module is probably not causing the problem.

If the problem did disappear after bypassing the PIP module, the technician CANNOT assume the PIP module is defective until the signals going to and from the module are verified. There are some cases where loss of external signals to the module make it appear to be defective when it really isn't. If the signals going to the module appear to be OK, begin troubleshooting to the component level inside the module.

SPIP Module Troubleshooting

Symptom: No PIP functions, normal picture OK.

1. Always check signals on connectors J8201, J8202, and J8101 before getting into the module. If they are OK, go to step 2.
2. Check for vertical pulse at pin 16 of U8901. If present, go to step 3.
3. Check for high on reset pin 6 of U8901 and for 8 MHz oscillator at pin 2 and 3 of U8901. If present, go to step 4.
4. Check for low going pulses on PIP clock, data, and enable lines from U8901 when attempting to turn on small pix. If present, the problem is probably on the main board of the PIP module.

The following chart lists the logic level of the Main Pix select line at U8901-58 under various modes of PIP operation.

Main Pix	Insert Pix	Main Pix Select
Tuner	OFF	Low
Tuner	Tuner	High
Tuner	EXT	High
EXT	OFF	Low
EXT	Tuner	Low

The following chart lists the logic level of the Insert Pix Select line at U8901-57 under various modes of PIP operation.

Main Pix	Insert Pix	Insert Pix Select
Tuner	OFF	High
Tuner	Tuner	High
Tuner	EXT	Low
EXT	OFF	Low
EXT	Tuner	High

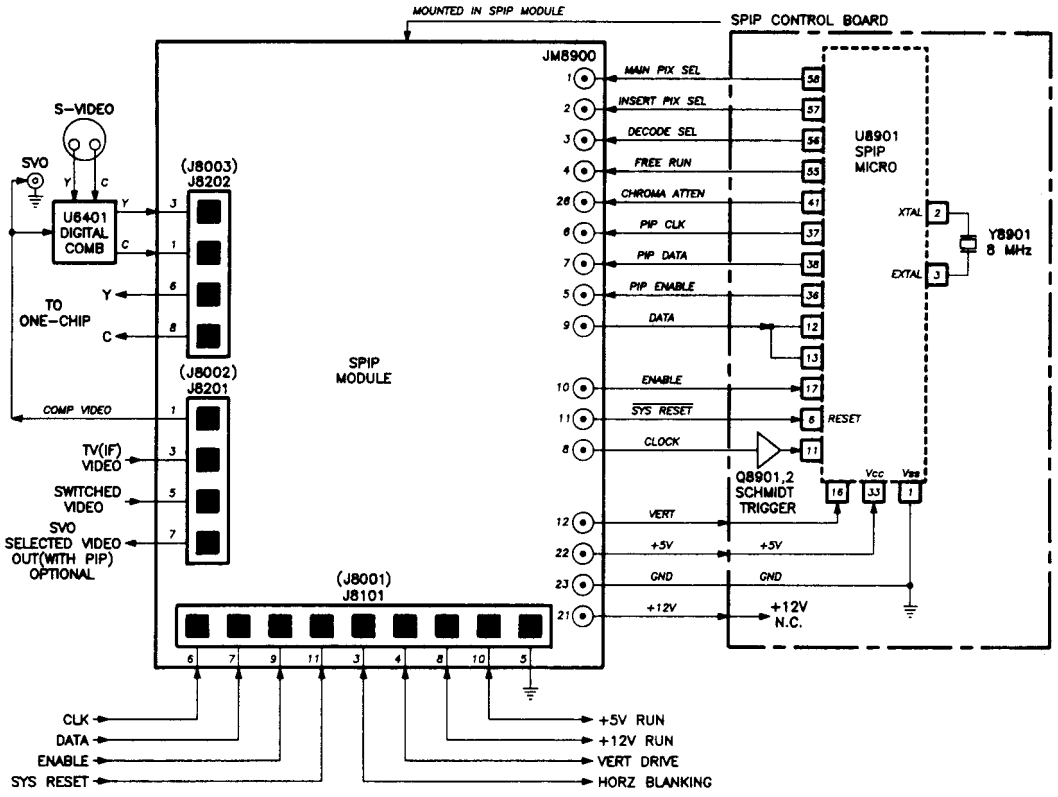


Figure 34, S-PIP Interconnect and Control Board

Input Selection Troubleshooting

Symptom - No big or small pix Video

1. Check for Insert Y/C signals from U8203, and U8204. Also check for Big Pix luma and chroma signals at the output of the Input Selection stages. If all signals are present, the Input Selection stage is probably not the problem. If not present, go to step 2.
2. Check for composite video at TV and Switched video inputs at J8201 pins 3 and 5. If present, go to step 3.
3. Trace composite video from U8201 to comb filter and trace output of comb through input selection stages. Also trace insert composite signal from U8202 through Chroma BPF and Luma notch filter to Y and C switches U8203 and 4. Also check for proper logic levels at switching ICs.

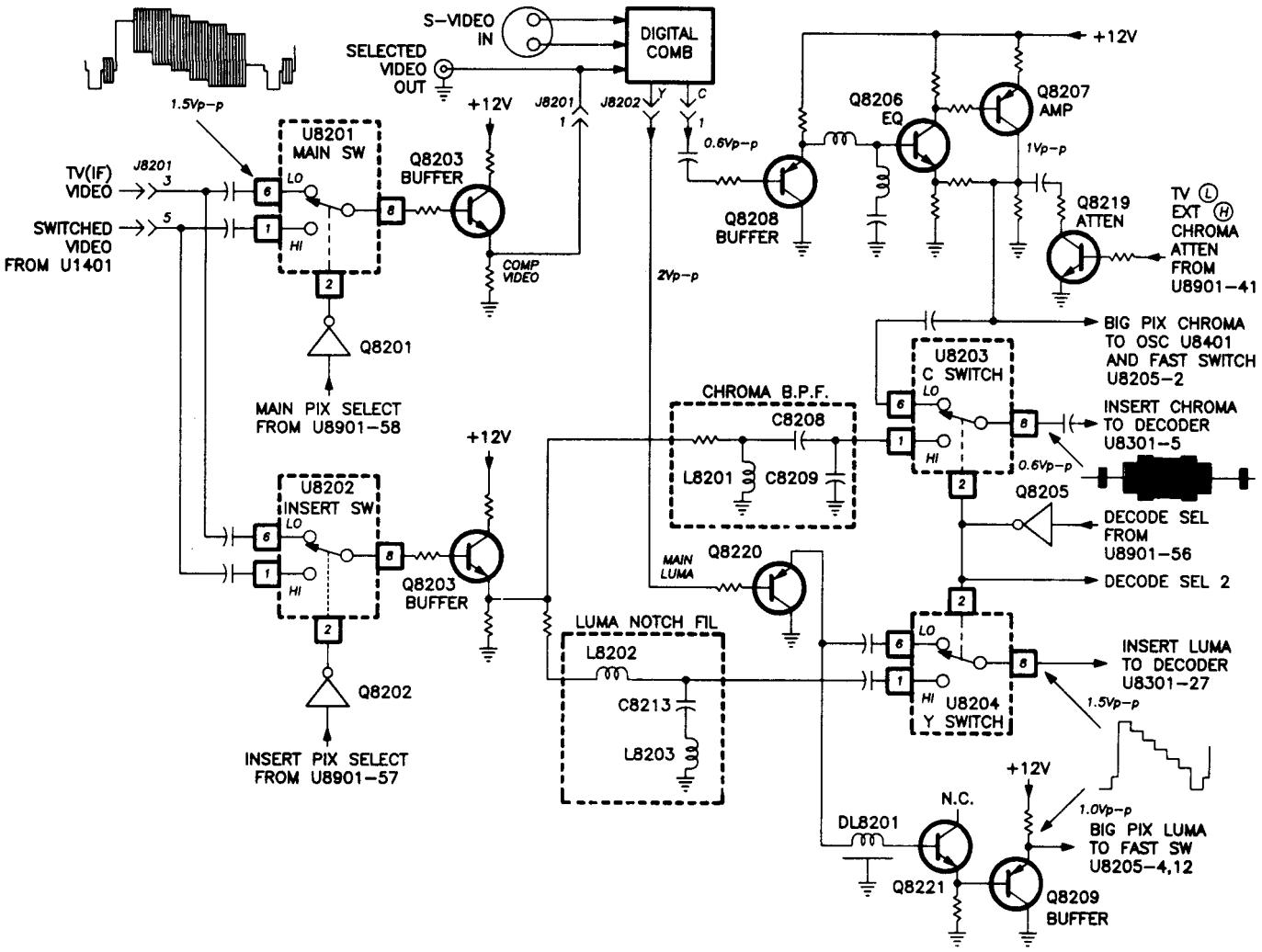


Figure 35, Input Selection Circuit (S-PIP)

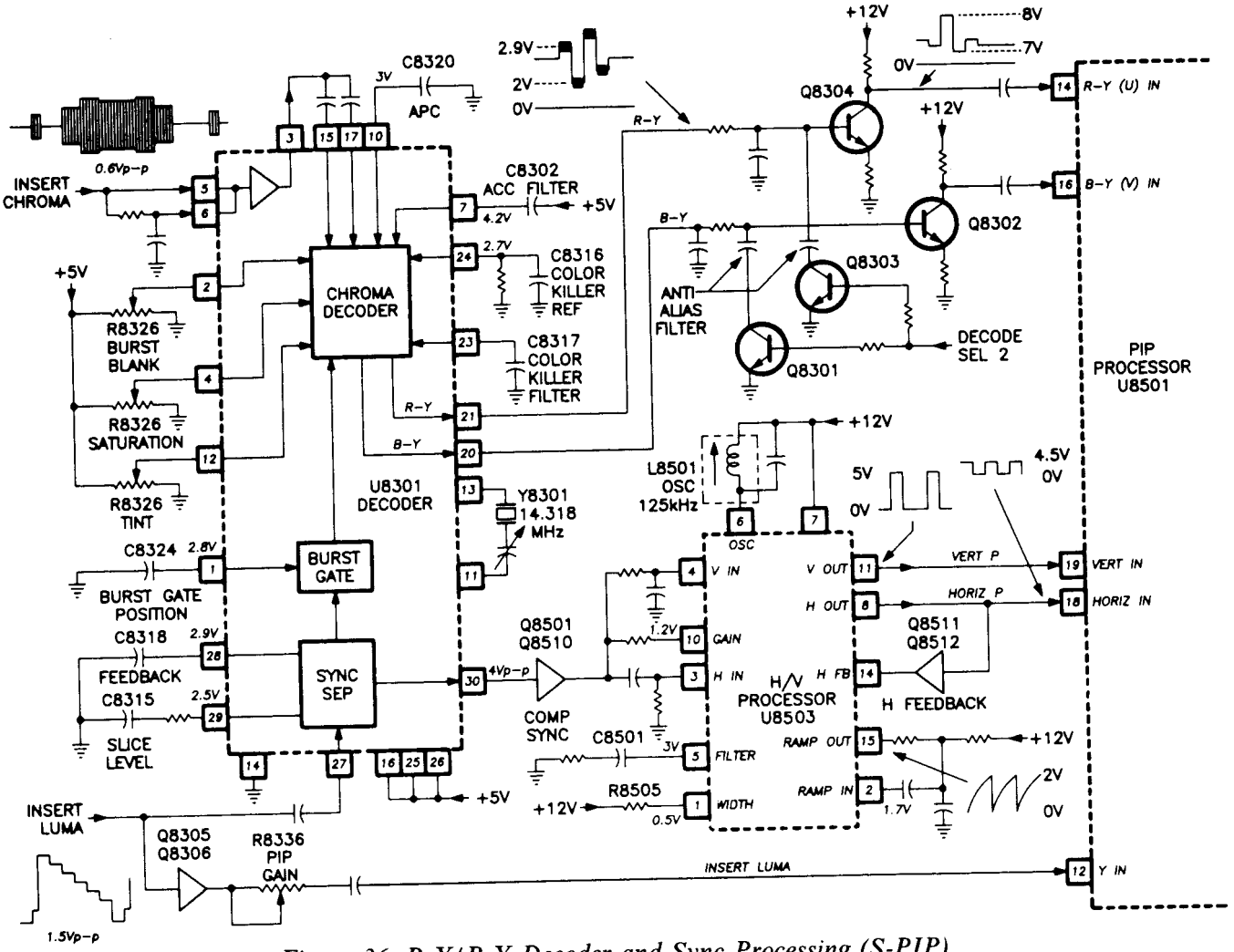


Figure 36, R-Y/B-Y Decoder and Sync Processing (S-PIP)

Chroma Troubleshooting

Symptom: Small Pix Color and Tint don't match Big Pix.

1. Adjust SAT and TINT controls at U8301.
2. If small pix cannot be adjusted correctly, verify proper setting of Burst Blank adjustment. Also check APC cap at UK8301-10.

Symptom: Small Pix chroma not in sync.

1. Check burst gate DC voltage at U8301-1 and check C8324.

Symptom: No small pix chroma.

1. Verify chroma input at U8301-5,6. If present, check for B-Y and R-Y outputs at U8301-20,21. Make sure big pix is a color signal. If not, the small pix will also be monochrome.
2. Check 14.318 MHz oscillator.
3. Check color killer reference and killer filter voltage. Also check ACC and APC filter caps at U8301-10, 7.

Sync Troubleshooting

Symptom: Small pix takes time to lock horizontally.

1. Verify adjustment of L8501 on U8503.

Symptom: Small pix rolls vertically or tears horizontally within pix border. Insert border is stable on screen.

1. Check for H and V outputs of U8503-8, 11. If present, check for H and V inputs at U8503-3, 4. Check for composite sync at output of U8301-30.
2. Check for H ramp at U8503-15. Also check other DC voltages and signals on pins of U8503.

PIP Processor Troubleshooting Tips

Signal Lost	*Resulting Symptom*
H at Pin 18	Small pix is black with no video.
H at Pin 20	Big pix normal, small pix tears across width of screen.
V at Pin 19	White bars in big pix with no video with all PIP functions disabled.
V at Pin 21	Small pix rolls vertically through big pix and cannot be turned off.

Signal	*PIP Off*	*PIP On*
TAS	Inactive	Low going Pulse
SAS	Inactive	Low going Pulse
SAD	Inactive	High going Pulse
WE	Inactive	High going Pulse
CGW	Inactive	Low going Pulse
CGR	Inactive	High going Pulse

The write enable (WE) line is a good starting point when troubleshooting the VRAM. When the small pix is turned off, the WE line is high. With the small pix turned on, the WE line should pulse high to signify that the PIP processor U8501 is attempting to write and read data from the VRAM. If this signal is not present, small pix video information may appear outside of the small pix border.

Data In and Out lines except for Data Out bit 1 (U8501-30) are inactive when the small pix is turned off and active when small pix is turned on. With the small pix on, the Data Out lines of U8501 contain continuous square wave activity. When the small pix is turned on, the Data In lines of U8501 are inactive during the vertical sync interval of the big pix. This can be viewed on a scope when troubleshooting. A defective data line will produce distorted or mosaic video effects in the small pix or frozen big pix. The amount of distortion is dependent upon which data line is defective. If all data lines are defective, no PIP functions will operate. Defective control lines (TAS, SAS, WE, etc.) produce noise glitches outside of the small pix border.

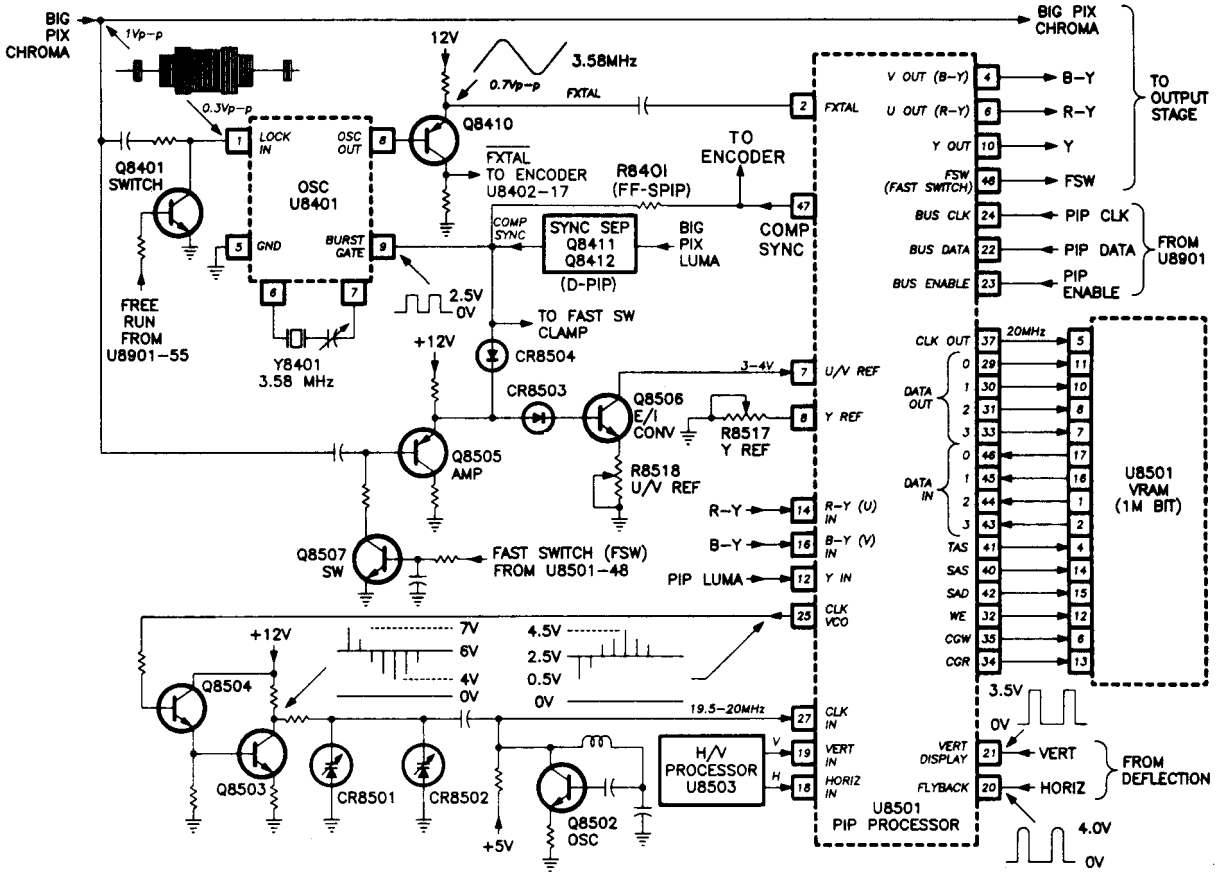


Figure 37, PIP Processor Circuit

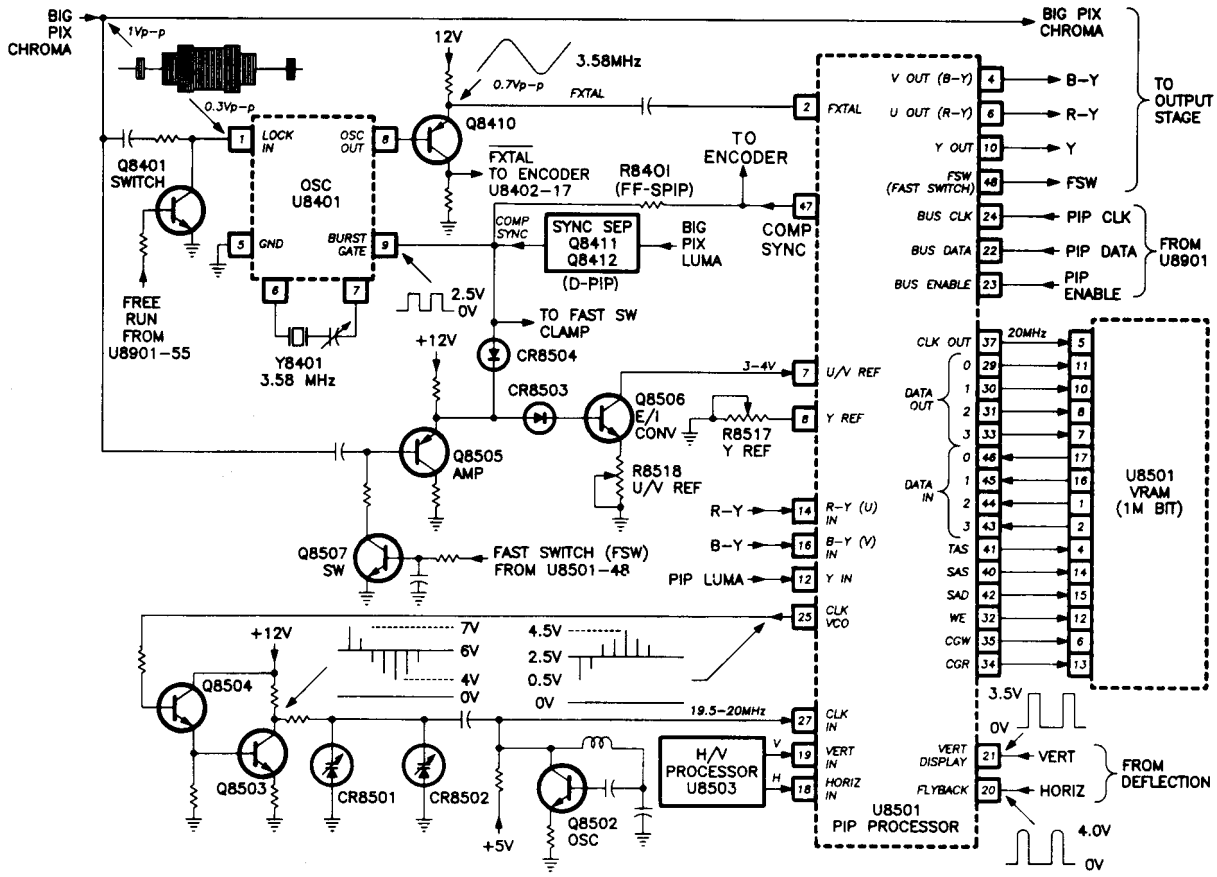


Figure 38, PIP Processor (repeated)

Symptom: No small Pix chroma.

1. Make sure big pix contains chroma burst, if not, small pix will be monochrome. Check for 3.58 MHz from U8401. Verify color reference at U8501-7. Make sure decoder stage is providing R-Y/B-Y signals to U8501.

Symptom: Small pix chroma is not sync locked, floats through picture.

1. Verify burst gate pulse at U8401-9.
2. Check burst gate position at decoder U8301-1 in previous section.

Symptom: No PIP features.

1. Check for activity on PIP clock, data, and enable lines on U8501 according to explanation given in this section.
2. Check for 20 MHz VCO and VRAM operation as described in this section.

Symptom: Small pix rolls vertically through the big pix or tears horizontally across big pix.

1. Check H and V inputs to pins 18, 19, 20, and 21 of U8501.

Encoder Troubleshooting

Symptom: Small pix color temperature doesn't match big pix.

1. Try to adjust R-Y and B-Y Null controls. If match still cannot be made, check for R-Y, B-Y and G-Y inputs to Encoder U8402. If OK, check Burst Blank adjustment on Decoder U8301.

Symptom: No PIP features, normal viewing OK.

1. Check Fast switch signal. If always low, only big pix picture can be selected.

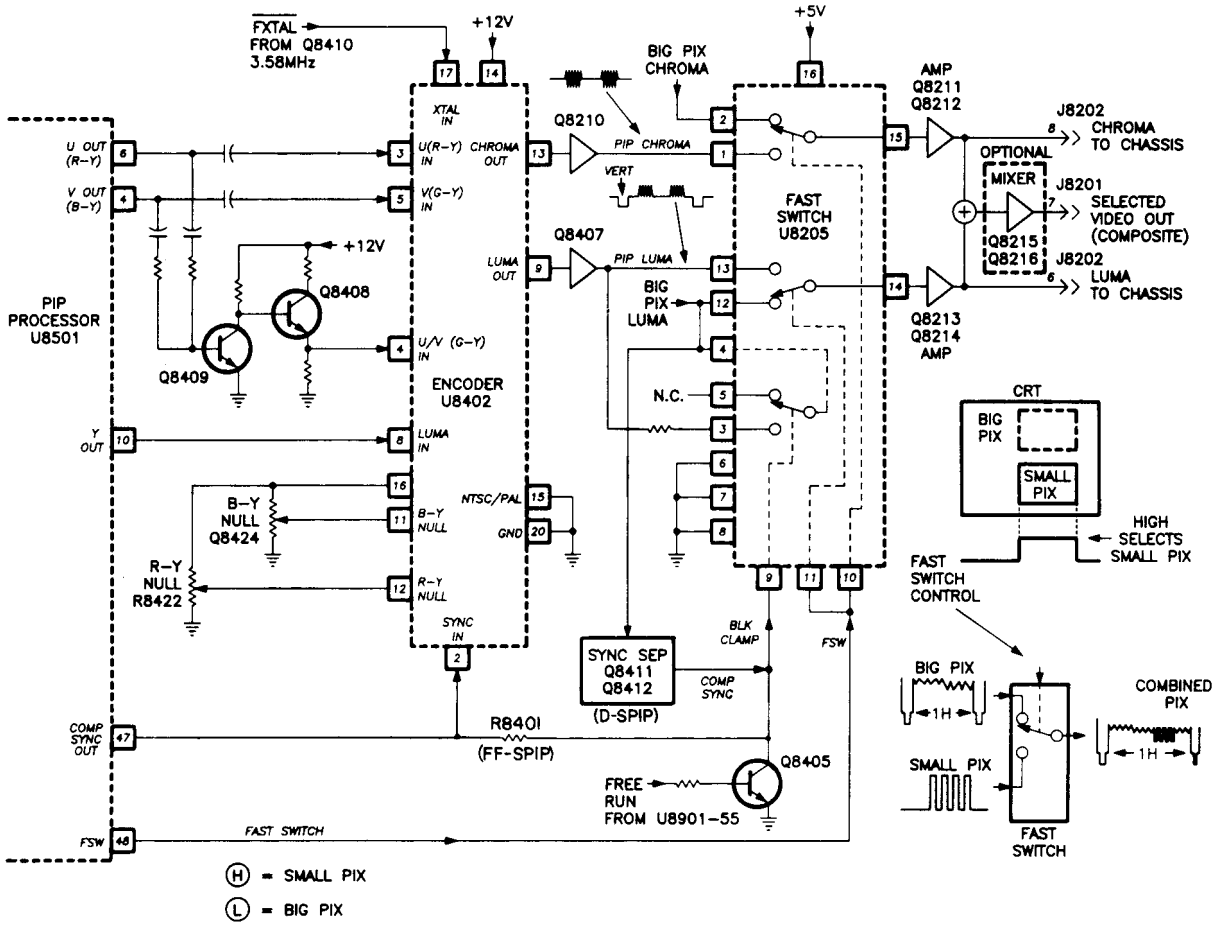


Figure 39. Encoder

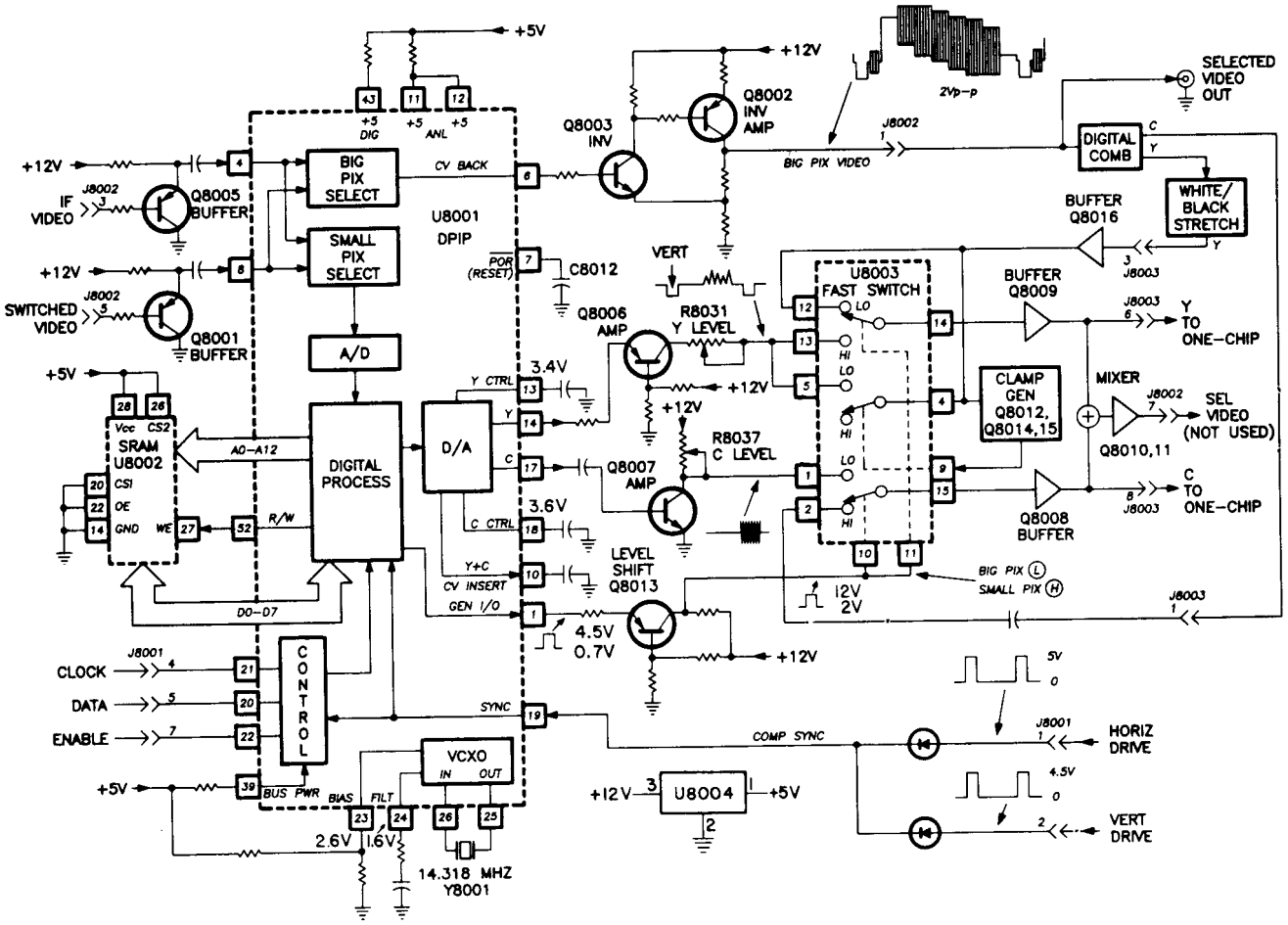


Figure 40, D-PIP Circuit Block Diagram

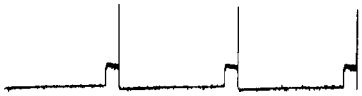
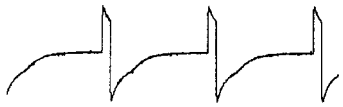
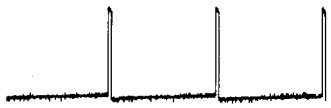
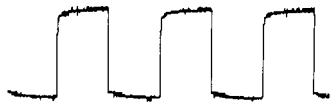
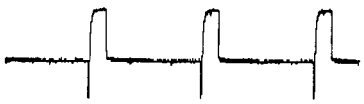
DPIP Troubleshooting

Just as with SPIP, the DPIP module may be bypassed by removing the module and jumpering the TV video source at J8002-3 to the Y and C inputs of the one-chip at J8003 pins 6 and 8. If this does not eliminate the problem, troubleshoot the chassis instead of the PIP module. If it does eliminate the problem, verify all signals going to and from the DPIP module before troubleshooting the module to the component level.

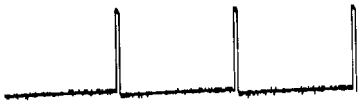
Since the DPIP module is much simpler and integrated than the SPIP module, troubleshooting is performed by simply signal tracing the "Big Pix" or "Insert Pix" through the circuit as shown in figure 40.

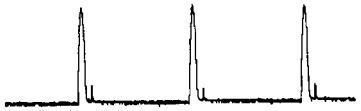
S-PIP Waveforms

Test Point	Waveform
J8002-1	 2Vpp 20us/div
J8002-3	 2Vpp 20us/div
U8203-1	 400mVpp 20us/div
U8203-6	 700mVpp 20us/div
U8204-1	 2Vpp 20us/div
U8204-6	 2Vpp 20us/div
Q8101-E	 4Vpp 5msec/div
Q8102-C	 5Vpp 5msec/div
U8301-20	 700mVpp 20us/div
U8301-21	 800mVpp 20us/div

Test Point	Waveform
U8301-30	 5Vpp 20us/div
U8301-13	 600mVpp 20us/div
U8301-11	 450mVpp 20us/div
U8503-4	 4Vpp 5msec/div
U8503-3	 2.5Vpp 20us/div
U8503-11	 5Vpp 5msec/div
U8503-8	 5Vpp 20us/div
U8503-14	 5Vpp20us/div
U8501-27	 250mVpp 5msec/div
U8501-12	 2Vpp 20us/div

S-SPIP Waveforms

Test Point	Waveform
U8501-19	 5Vpp 5msec/div
U8501-18	 5Vpp 20us/div
U8501-20	 4.5Vpp 20us/div
U8501-21	 4Vpp 20us/div
U8501-4	 1Vpp 5msec/div
U8501-6	 1Vpp 5msec/div
U8501-10	 750mVpp 20us/div
U8501-47	 5Vpp 20us/div
U8501-2	 1Vpp 20us/div
U8401-8	 1Vpp 20us/div

Test Point	Waveform
U8401-7	 200mVpp 20us/div
U8401-9	 3Vpp 20us/div
J8003-8	 .5Vpp 20us/div
J8003-6	 2Vpp 20us/div
U8901-2	 5Vpp 20us/div

Tech Tips

Symptom	Solution
No pix/pix. The Pix box would come up but the video was washed out. Found the voltage on pin 12 of U8501 was 5 volts of 1.85 called for.	Found leaky C8528.
Picture zoom, freeze, channel guide and the small pix were out of horizontal sync. U8503 pin 6 and 7 were low.	Replaced leaky C8507 and performed the small PIP sync adjustment.
No video. U8501 had incorrect voltages on most pins. No oscillator on pins 2 and 3.	Replaced defective Y8901.
No PIP functions. The 12 and 5 volt run supplies were 2 volts too high.	Replaced defective CR4606 that was zenering at 7.7 volts.
Big pix normal, small pix solid green with no video. DC at U8205-15 was almost zero. No 12 volt source to R8255.	Re-soldered JC218 and replaced R8255.
Loss of brightness intermittently. Jumping the PIP module brought back normal picture. DC voltage on Q8221 was almost zero volts. Resistance to ground from the base was 110 ohms. Lifting the ground on DL 8201 removed low resistance path to ground.	Replaced defective DL8201.
Distorted video/sync on normal picture. Chroma coming out of the PIP module was good but the luminance was poor.	Re-soldered bad connection on R8248.
When using PIP, the small picture would roll through the big picture. Both the big and small picture had good horizontal and vertical sync. Found the 5 volt run supply to be at 6.4 volts. CR4606 was zenering at 6.8 volts instead of 5.6 volts.	Replace CR4606.
No color in small picture.	Replaced leaky C8208 (IC8203-1).
After pix swap, the big pix pulled up 2 inches from the bottom and the small pix would roll once and lock in.	Replaced leaky Q4507.

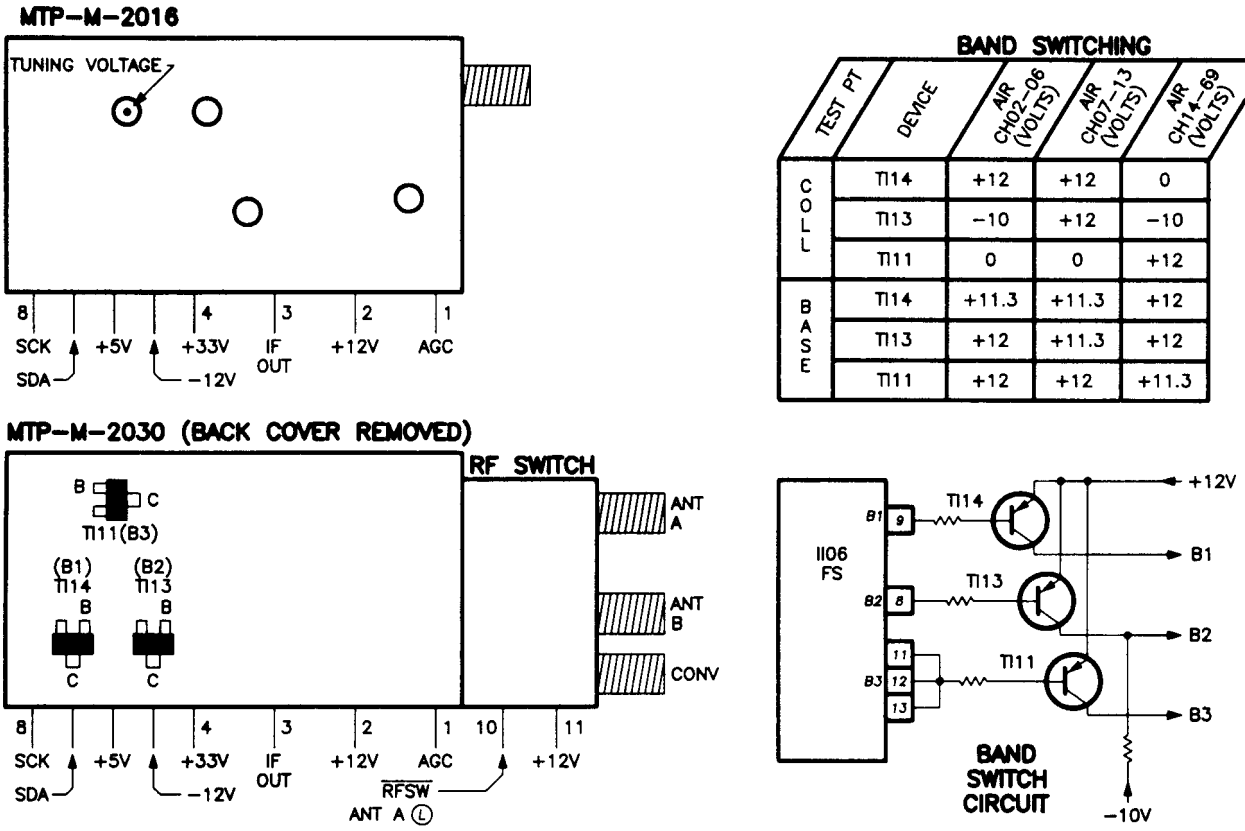


Figure 41, Tuner/Band Switching

For Tuner Circuit theory of operation, refer to page 33 in the CTC168/169 Technical Training Manual.

Figure 39 shows the MTP-M-2016 and 2030 tuners. There are a few checks that can be made to determine whether the tuner is defective.

Note: Always check power supplies to the tuner before getting too involved in tuner troubleshooting.

1. Monitor the tuning voltage at the test point through the hole in the tuner shield as shown in figure 40. The tuning voltage should vary anywhere from 1 VDC to about 30 VDC while attempting to tune a channel. If it does change when you select various channels, you can be sure the tuner is receiving commands from system control.
2. If the voltage does not vary, connect a variable DC supply to the tuning voltage test point. Apply an RF signal to the tuner and select an active channel. Vary the DC supply from 0 to about 15 VDC. If you can see a picture being tuned as you vary the supply, the RF section of the tuner and the IF stages can be assumed to be operational.
3. Verify the band switches are operational. This is a difficult procedure because of the location of the band switching transistors. Figure 41 shows the band switching chart and the location of the band switch transistors on the tuner module. Select the air channels as shown in the chart and verify voltages on the base and collectors of transistors TI11, 13, and 14.

Tuning Problems

No Signal or Picture

1. If OSD responds to user channel change commands, Check Clock and Data lines going to tuner.
2. If OK, perform tuning voltage verifications as described in step 2 above.
3. If OK, check band switching as described in step 3 above.
4. If OK, check for about 300 mV IF signal out of tuner pin 3.

If OSD does not respond to user channel command inputs, suspect a system control problem.

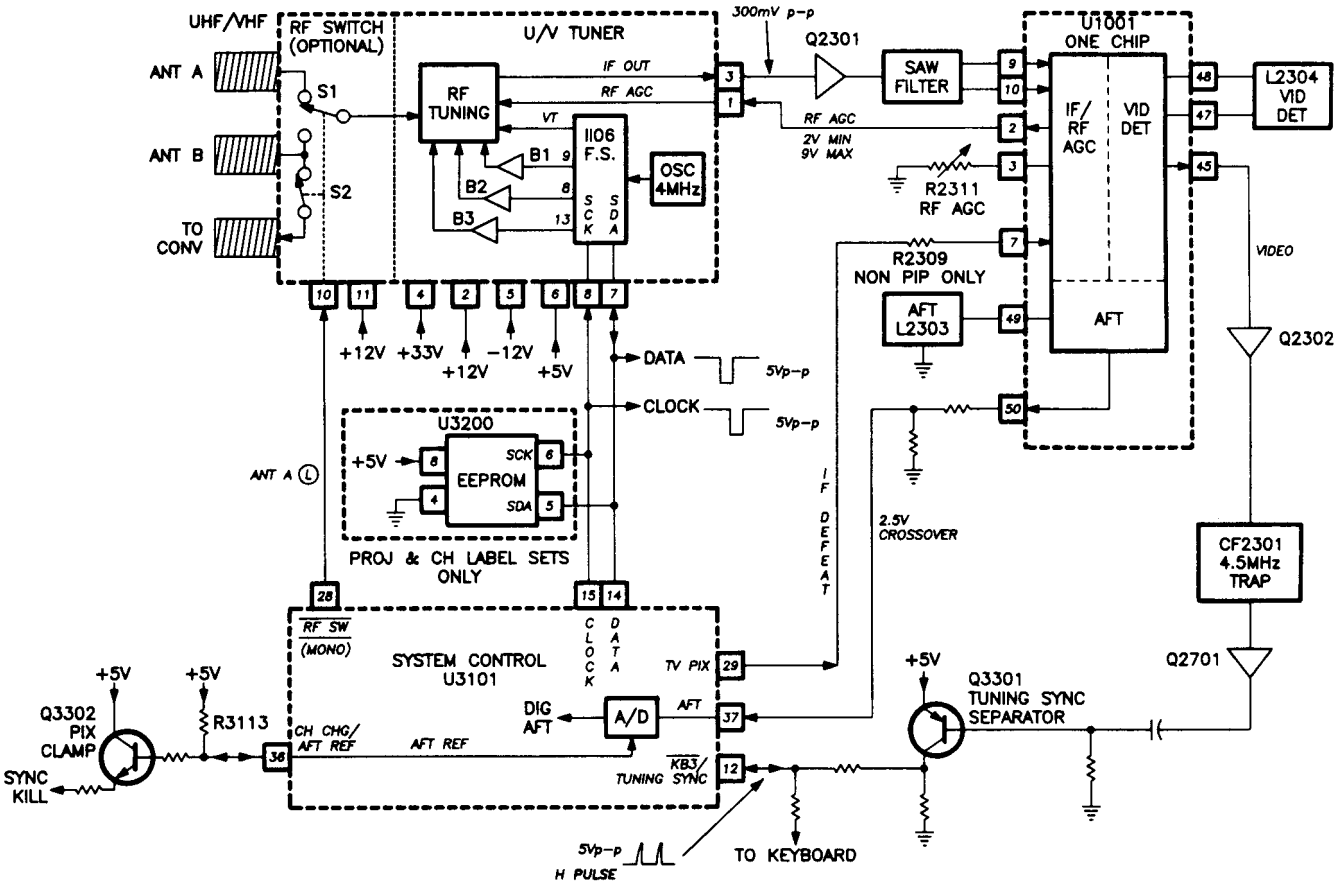


Figure 42, Tuning Control

Slow Tuning

1. If slow tuning occurs in cable mode but not air mode, check the tuning sync input to the system control micro U3101-12. There will be a high going pulse less than 8 sec wide repeated at 68 sec intervals.
2. If tuning is slow in both cable and air modes, AFT alignment or the AFT reference voltage at U3101-36 needs verification. Check the circuits and align according to service data.

Drifting

1. If a channel is momentarily tuned and immediately drifts off frequency, suspect AFT alignment or AFT reference problems. Align according to service data.

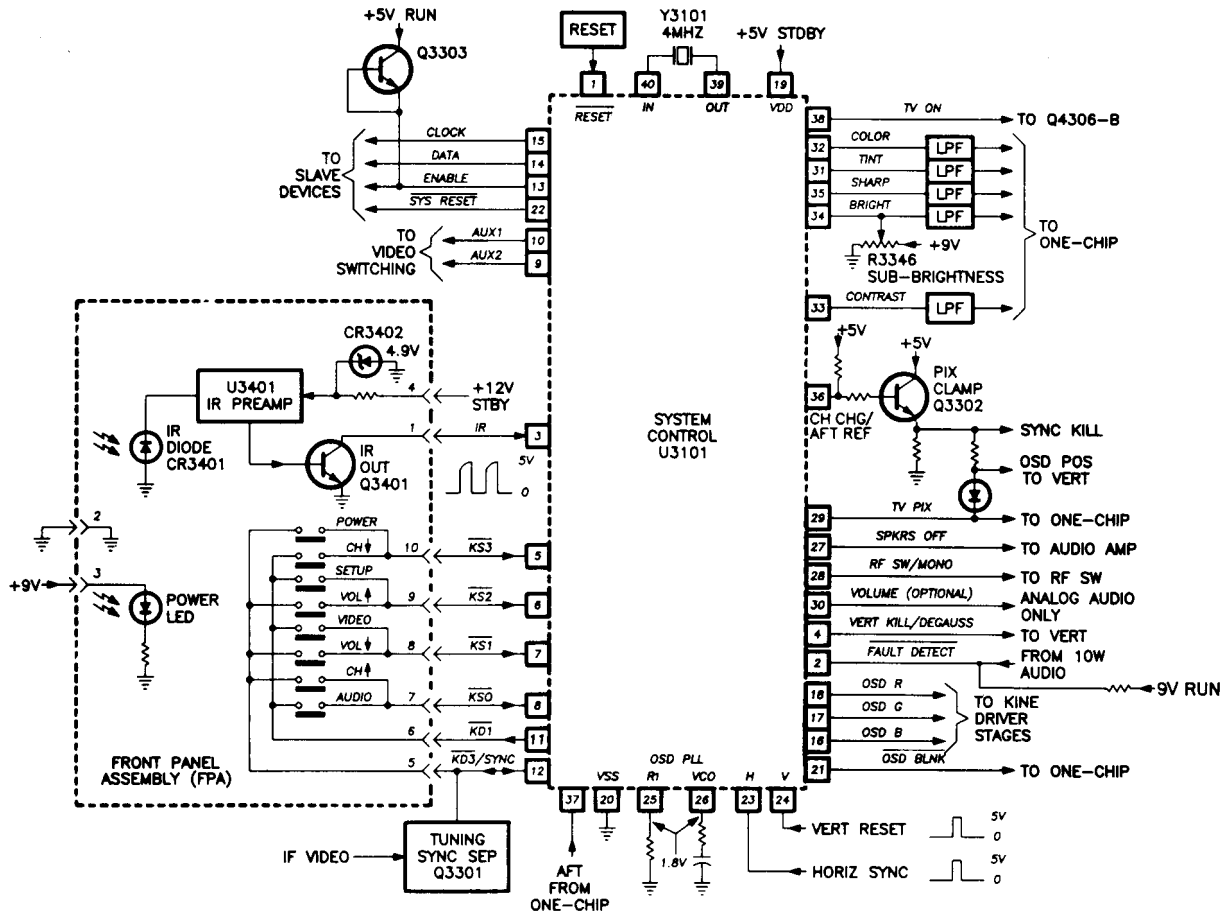


Figure 43, System Control

U3101 Confirmation

In most cases, the System Control Circuit either works or it doesn't. In rare instances an isolated failure such as "no remote control function" will be encountered, however, the exclusiveness of the failure itself isolates the problem down to a few possibilities. In the majority of cases a System Control Circuit failure results in a dead set. It is therefore important to determine if U3101 is defective or whether it is malfunctioning due to a peripheral component or circuit failure. All too often microprocessors are replaced only to discover that the new IC reacts the same as the original. While it is not possible to completely test and confirm the microprocessor at the servicenter level, there are procedures that will confirm whether or not the IC is functioning in the majority of cases.

1. Check for +5 volts VDD on pin 19. This voltage MUST be within a few tenths of a volt of 5 volts or U3101 will malfunction. An analog meter is not accurate enough for this measurement. Make sure the DC is clean with an oscilloscope. Noise riding on the DC can cause problems.
2. Check for the +5 volt reset on pin 1. This voltage should go high immediately after pin 19 goes high.
3. Make sure pin 20 is connected to ground.
4. Check for the presence of the 4MHz oscillator at pins 39 and 40. The signal should be 5Vpp when measured with a X10 probe. A X1 probe will load the oscillator down. If the +5 volts VDD and reset are present on pins 19 and 1 and the oscillator will not run, check the components off of pins 39 and 40. A defective crystal or a leaky capacitor will kill the oscillator. If the components check good, the IC is defective.
5. If all the previous measurements check out ok but the microprocessor will not operate the set, make voltage and resistance measurements on all the pins of the IC and compare them to the service data or the voltage waveform chart in this manual. Again, voltages must be within a few tenths of the specified voltage or the IC will not function correctly. A leaky capacitor pulling a pin low or a bad connection on a pin can lock up U3101.

Only after performing the above steps should U3101 be considered to be defective.

U3101 SYSTEM CONTROL/OSD MICROPROCESSOR

PIN NO	I/O	SIGNAL NAME	IN CKT RES	VOLTAGE	DESCRIPTION
1	I	PWR-ON RESET	10K	4.80	Micro reset - Active Low
2	I	FAULT DETECT	15K	4.26	When a low is sensed at this input, system control turns the set off for two seconds and then turns it back on. If pin 2 goes low three times in one minute, system control keeps the set off.
3	I	IR	38K	.03	Receives 5 Vpp IR signal from remote receiver.
4	O	VERT KILL/DEGAUS	>20M	.01	Goes high to kill vertical deflection degaussing and produces the service line in direct view sets.
5	I	KS3	900K	4.85	Keyboard scan input.
6	I	KS2	900K	4.85	Keyboard scan input
7	I	KS1	900K	4.85	Keyboard scan input.
8	I	KS0	900K	4..85	Keyboard scan input.
9	O	AUX 2	>20M	.01(TV,AUX1) 4.90(SVID,A2)	Video select control line.
10	O	AUX 1	>20M	.01(TV,AUX1) 4.9(SVID,AUX	Video select control line.
11	O	KD1	10K	.01	Keyboard scan output.
12	I/O	KD3/TUNING SYNC	9K	.03	Keyboard scan output / tuning sync input.
13	O	ENABLE	>20M	4.89	Serial communications control line which goes high during data transmission and low during address transmission.
14	I/O	DATA	111K	4.89	Serial communications data line
15	O	CLOCK	>20M	4.89	Serial communications clock line.
16	I	BLUE	16M	.0 .3(MEN/ON)	Blue OSD output. Active high.
17	I	GREEN	14M	.0 .14(MEN/ON)	Green OSD output. Active high.
18	I	RED	11M	.0 .01(MEN/ON)	Red OSD output. Active high.
19	-	VDD	1.4M	4.91	+5VDC.
20	-	VSS	0	GROUND	GND
21	O	BLNK	>20M	4.91 4.43(MEN/ON	OSD black surround out . Low = Black.
22	O	SYS RST	>20M	4.89	System reset line connected to bus devices. Goes low when set is off and high when set is on.
23	I	H-SYNC	16K	.91	Horizontal timing input for OSD.
24	I	V-SYNC	11K	.19	Vertical timing for OSD.
25	-	R1	10K	2.01	OSD PLL external control pin.
26	-	VCO	>20M	2.01	OSD VCO external control pin.
27	O	SPKRS OFF	110K	.02(ON) 2.29(OFF)	Goes high to turn speakers off and low to turn them on.
28	O	RFSW/MONO	>20M	.08(ANT A) 8.51(ANT B)	RF switch control line. Low selects ANT. A. Mono function currently not used.
29	O	TV PIX	>20M	5.36	Goes high when TV tuner is selected and low when external video is selected.
30	O	VOLUME	>20M	.02	PWM for volume control (currently not used).
31	O	TINT	11K	4.12 NOM 0 - 5.6	PWM for Tint control.

U3101 SYSTEM CONTROL/OSD MICROPROCESSOR

PIN NO	I/O	SIGNAL NAME	IN CKT RES	VOLTAGE	DESCRIPTION
32	O	COLOR	19K	2.4 NOM 0 - 5.6 .75 COLOR KILL	PWM for Color control.
33	O	CONTRAST	33K	5.12 NOM 0 - 7.5	PWM for Contrast control.
34	O	BRIGHTNESS	97K	2.72 NOM 0 - 5.5	PWM for Brightness control.
35	O	SHARPNESS	12K	4.22 NOM .1 - 8.8	PWM for Sharpness control.
36	I/O	CH CHG/AFT REF	105K	.08	At start of channel change, voltage at pin 36 is read by micro for use in AFT A/D converter. During channel change, line goes high until channel change is executed.
37	I	AFT	73K	2.54 W/SIG 1.28 WO/SIG	Automatic Fine Tuning input. Crossover detected at 2.5 VDC.
38	O	TV ON	>20M	4.91 TV ON .0 TV OFF	Power on/off control. High = ON, Low = OFF.
39	O	OSC OUT	5M	2.52	4 MHz oscillator output.
40	I	OSC IN	4M	2.47	4 MHz oscillator input.

Tech Tips

Symptom	Solution
No OSD. System control acted odd like a reset problem. No sync at U3101-12 with video present on the screen. The waveform into Q3301B was normal. The collector waveform was non-existent.	R3326 was shorted to about 3.8 ohms.
OSD characters shifted to the right. 5 volt B+ to U3200-8 at 5.25 volts - too high.	Leaky CR4709 to the base of Q4703 causing the 5 volt A & B sources to be high.
No video, no audio, OSD shifted to the left and folded over.	Leaky C3302 off pin 5 of U3200.
Dead Set. Pin 7 of U3101 was low.	Pinched wires to the keyboard.
Dead set. U3101-19 at 10 volts.	Q4601 shorted emitter to collector causing the 5 volt standby supply to go up. U3101 was damaged as a result.
Dead Set. U3101-38 would not go high.	Q4306 leaky base to emitter.
There was a hum in the audio and then the set went dead. U3101-2, the fault detect, was low.	There was a short between pin 1 & 3 of U1901 in the audio section.
The picture and audio were missing. The OSD were blocks instead of characters. The only viewable graph was the volume which was smeared. No +5 volts on U3200-8.	Bad solder connection on JW325 which removed +5 volts to 5VB, 5VC, 5VE and 5VF.

ON/OFF Circuit Troubleshooting

The on/off operation is controlled by the system control microcomputer. The microcomputer monitors the inputs from the remote receiver and the front panel keyboard to determine when a power on command is issued. The chassis is turned on by applying power to the horizontal oscillator section of U1001. After the horizontal circuit begins operation, the scan-derived power supplies provide power to the remainder of the chassis.

1. Confirm the presence of the 5V standby supply. If the standby supply is missing, refer to the section on shutdown troubleshooting.
2. Press the front panel power button and check for approximately 4.8 volts on pin 38 of the system control microcomputer. If the voltage is missing, suspect a malfunction in the system control reset circuit.
3. If the 4.8 volts is present, suspect a malfunction in the on/off circuit (Q4306, Q4304, Q4301, Q4305, and U1001) or a problem in the horizontal drive/output circuit.
4. If the set comes on and shuts off immediately, suspect either an X-ray shutdown condition or a malfunction in the audio output circuit.

To bypass the system control circuit and force the chassis on, connect a jumper from the emitter to collector of Q4304. The horizontal circuit should operate normally. The raster may be blank since the system control circuit has not issued the TV ON command and the tuner may not be on an active station.

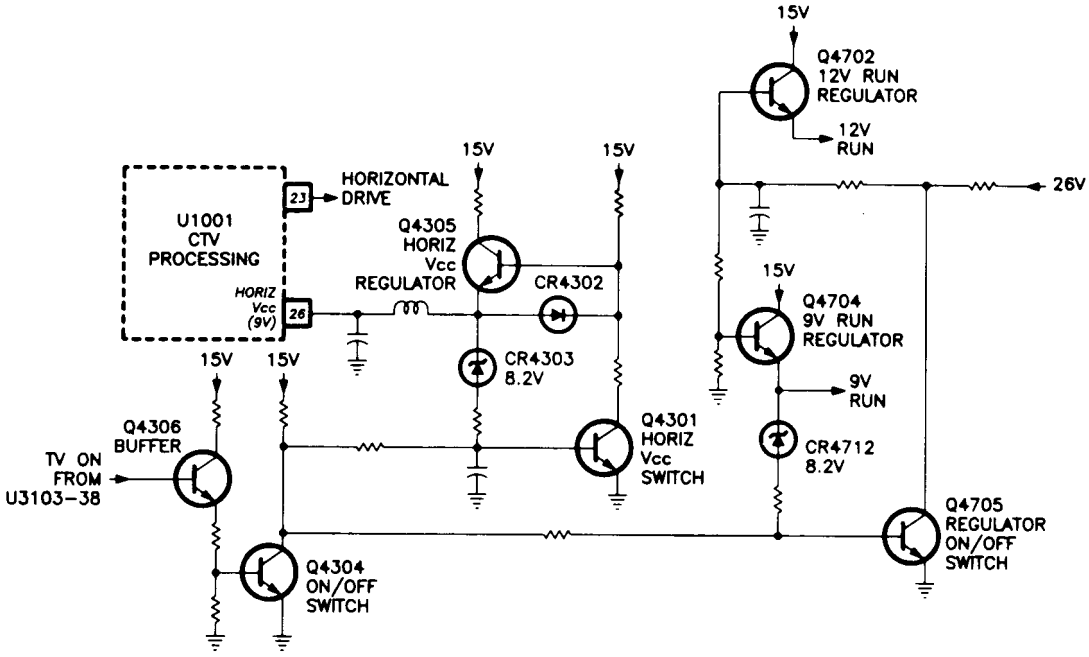


Figure 44, On/Off Circuit

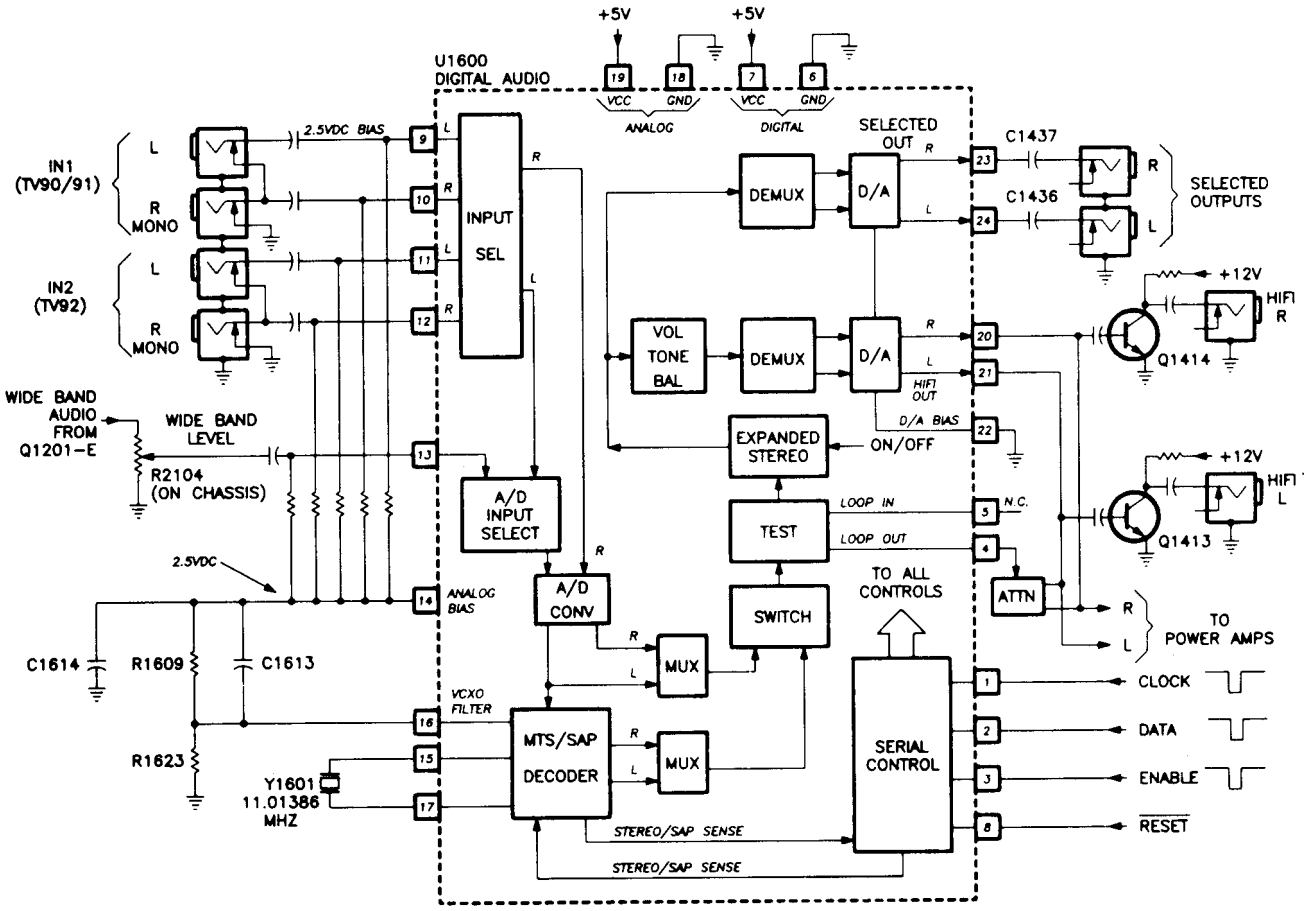


Figure 45, Digital Audio IC

For Digital Audio Circuit theory of operation, refer to page 59 of the CTC168/169 Technical Training Manual.

Two types of audio designs are used in the CTC169 Projection Televisions: Digital Audio Processing and Analog Audio Processing. While the processing IC's are different, the troubleshooting strategy is the same.

No Audio

1. Make sure there is a good signal from the tuner present (clear picture). If not, troubleshoot the tuner and IF circuits.
2. Look to see if the "Stereo" indicator responds to stereo broadcasts. If it does, it indicates the wideband audio is making it from the IF to the decoder stages. If it does not, check for the wide band audio signal at pin 13 of U1600 in the digital audio circuit and pin 2 of U1600 on the analog audio circuit.
3. Apply line level audio to the AUX 1 or AUX 2 and select those sources.
4. *Analog Audio Circuit:* If the audio returns, the audio circuit from U1410 to the audio output IC's has been confirmed. If it does not, check the switching logic to U1410 pins 6, 9, and 10.

   Digital Audio Circuit: If the audio returns, U1600 is operating for the most part. A peripheral component, such as a capacitor, is causing a decoding problem.
5. If the audio does not return, use an oscilloscope and trace the audio through the decoder circuitry and isolate the point where the audio stops.
6. Perform DC voltage checks on all the pins of the IC's to isolate the defective component.

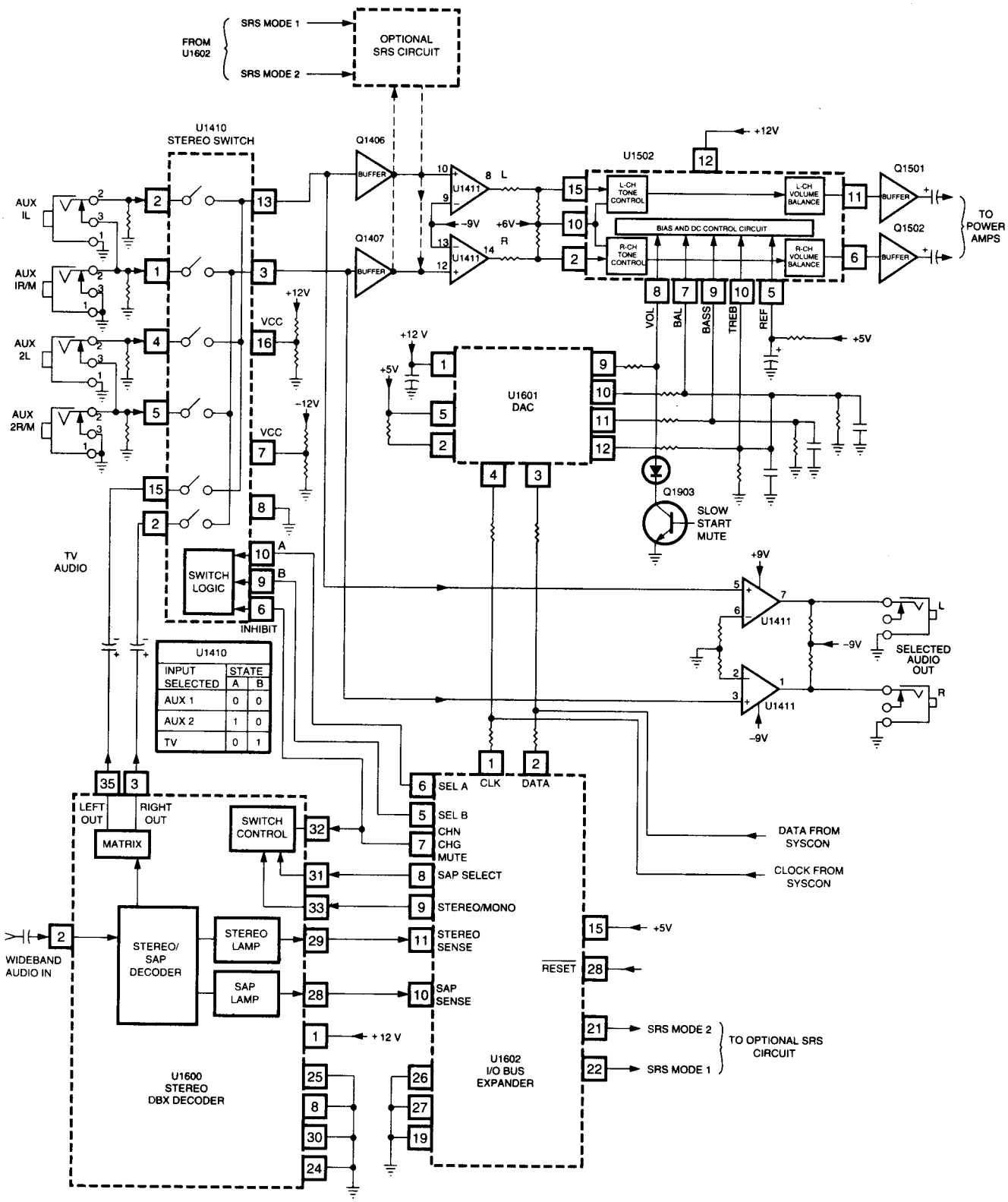


Figure 46, Analog Audio Circuit Block Diagram

Distorted Audio

One of the more difficult audio problems to isolate is distorted audio. In order to effectively diagnose such a problem, an oscilloscope, audio signal generator and an RF/IF generator are required.

1. Confirm a good signal from the tuner. Make sure the picture is clear with no beats in it.
2. Apply an audio signal to the input of AUX 1 or 2. If the distortion continues, the problem is after the decoder stages. If there is no distortion, the problem is most likely in the IF stages.
3. If the problem is after the decoder stage, apply a sine-wave signal to one of the AUX inputs and trace the signal with an oscilloscope. Locate the point where the distortion first appears and check the associated components.
4. If the distortion is originating in the audio IF stages, apply an appropriate RF or IF signal with a sin-wave modulated audio signal. Trace the signal to the point where the distortion begins and check the associated components. Typical IF problems include bad ceramic filters, de-tuned coils and leaky capacitors.

Tech Tips

Symptoms	Solutions
Mono sound low, stereo was normal. When in mono, the audio level is half the level of stereo. Also, audio distorted.	The wideband audio from pin 52 of U1001 was normal. Traced fault to C1203 (connected to the wiper of R1204, WBA Level adjustment.
Dead set. Removing P1903 allowed the set to come on and run.	Replacement of U1902 fixed the set.
Audio distorted with volume at low level.	Checking wideband audio from the CTV processor, U1001 pin 52, revealed some distortion. Adjustment of the audio detector coil, L1201, offered no improvement. Replacing U1001 restored normal audio. *See also Service Bulletin SB-CTC168/169-SI-1A in the back of this publication.*

SERVICE BULLETINS

RCA/GE Television Service Data SERVICE INFORMATION

CTC168/169

RCA GE PROSCAN

CONTAINS ADDITIONAL SERVICE DATA INFORMATION.

CTC 168/169 Series

Thomson Consumer Electronics, Inc.
Technical Publications
P.O. Box 1976 | Indianapolis, Indiana 46206

Date: February 27, 1991

Subject: Audio Hiss/Audio Pop/Non-linear Volume Control—CTC168/CTC169 Chassis

Note: THIS IS AN UPDATE TO THE SERVICE INFORMATION BULLETIN (SB-CTC168/169-SI-1) DATED FEBRUARY 7, 1991. DISCARD THE PREVIOUS BULLETIN.

Symptom: Some quantities of early production CTC168/169 chassis may exhibit potentially objectionable audio performance. Audio hiss (background noise) becomes noticeable as the volume level exceeds the mid-point on the volume level display. An audio "pop" may be heard at power turn on. The volume control taper is non-linear; nominal volume occurs at a high control setting.

Corrective Action: The audio board and the system control microcomputer must be replaced to correct the symptom. It will be necessary to replace **both** the audio circuit board and U3101 system control IC in all chassis' listed below.

Never perform the modification unless both parts are changed at the same time. The volume control circuit has been changed and the new audio board will not operate with the old microcomputer. It is necessary to check the chassis version to determine the proper parts needed. The chassis version is printed on the label located on the heat sink for the horizontal output transistor. The following table gives the stock numbers for the various combinations of audio boards and ICs. This modification is required *only* on models equipped with the specific chassis versions listed below.

Model(s)	Chassis	Stock No.	Description
20XT9006 FX209002	CTC168C	205999 206395	Audio Circuit Board U3101 Microcomputer
F20705	CTC168E	205991 206395	Audio Circuit Board U3101 Microcomputer
PS20110	CTC168F	205994 206395	Audio Circuit Board U3101 Microcomputer
F27187 F27188	CTC169AB	205991 206395	Audio Circuit Board U3101 Microcomputer
F27191 F27193 G27390 G27391	CTC169AC	205991 205995	Audio Circuit Board U3101 Microcomputer

Product Safety Information

Product safety information is contained in the appropriate RCA/GE Service Data covering specific chassis/models referenced in this bulletin. All specified Product Safety requirements and testing shall be complied with prior to returning equipment to the customer. Servicers who defeat safety features or fail to perform safety checks may be liable for any resulting damages, and may expose themselves and others to possible injury.

PS27110	CTC169AF	205994 206395	Audio Circuit Board U3101 Microcomputer
PS27120	CTC169AG	205994 205995	Audio Circuit Board U3101 Microcomputer
F27194 G27396 G27399	CTC169AH	205991 205995	Audio Circuit Board U3101 Microcomputer
PS27150	CTC169AJ	205998 205997	Audio Circuit Board U3101 Microcomputer
F27196	CTC169AK	205996 205997	Audio Circuit Board U3101 Microcomputer
PS31150	CTC169AL	205998 205997	Audio Circuit Board U3101 Microcomputer
F31221	CTC169AM	205991 206395	Audio Circuit Board U3101 Microcomputer
F31222 G31121 G31129	CTC169AN	205991 205995	Audio Circuit Board U3101 Microcomputer
F31400 G31163	CTC169AP	205996 205997	Audio Circuit Board U3101 Microcomputer
G35300	CTC169BA	205996 205997	Audio Circuit Board U3101 Microcomputer
46GW950 P46100	CTC169BL/BN	206000 206395	Audio Circuit Board U3101 Microcomputer
P46150 P52150	CTC169BM/BP	206000 205995	Audio Circuit Board U3101 Microcomputer

Refer to the SPS packed with each microcomputer for instructions on expanded stereo operation. The expanded stereo feature has been deleted from later production versions of the models covered in this bulletin.

Once the audio modification is completed, mark a black line through the bar code label located on the horizontal output transistor heatsink to indicate the modification has been performed.

RCA/GE
Television Service Data
SERVICE INFORMATION

CTC168/169

RCA GE PROSCAN

CONTAINS ADDITIONAL SERVICE DATA INFORMATION.

CTC168/169 Series

Thomson Consumer Electronics, Inc.
Technical Publications
P.O. Box 1976 | Indianapolis, Indiana 46206

DATE: MARCH 22, 1991

SUBJECT: Pin Circuit RFI—CTC169 (PTV and DV)

SYMPTOM: A band of interference appears in a backwards "C" shape from the upper left hand corner, curving to the center of the screen and down to the lower left hand corner of the screen. The problem is more pronounced when the color intensity is turned to maximum. The symptom is most apparent on projection sets with the analog comb filter, however it can appear on direct view sets as well.

CORRECTIVE ACTION:

1. Connect a 0.22 μF, 63-volt capacitor (stock number 190520) between the 26-volt supply and cold ground. The capacitor is installed at pad E51 and TP4706. Make sure the leads of the capacitor are through the holes in the chassis. The two pads are located at the left edge and about 1.5" behind the horizontal output transistor heatsink.
2. Change delay line DL2701. The stock number of the delay line is 206397.

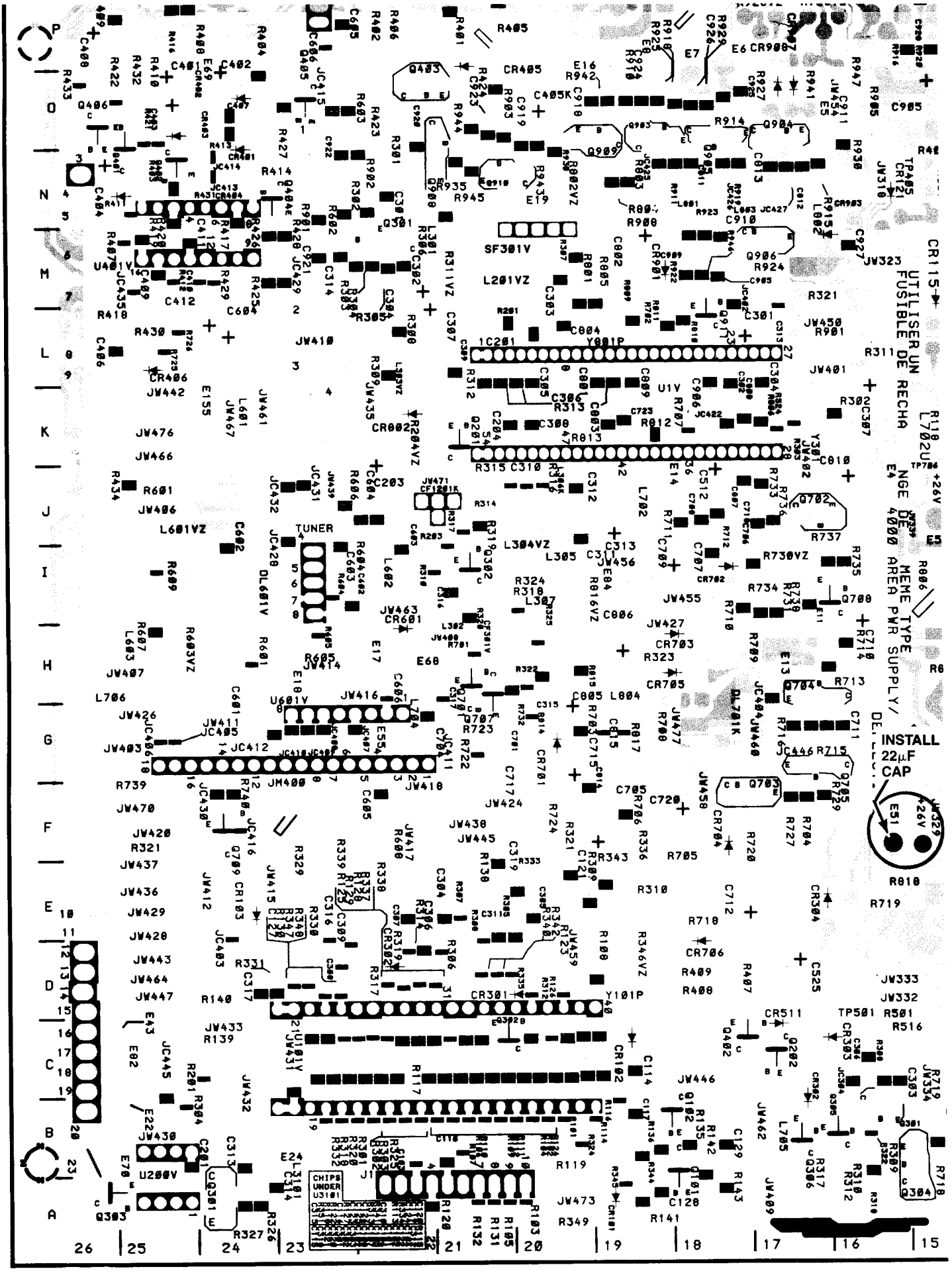
Note: The addition of the capacitor and the delay line will minimize the interference on the screen but may not completely eliminate it.

On some sets there are 4 or 5 vertical lines on the left side of the screen. These lines are less the 1/4" wide. To eliminate the lines, replace JW2 on the high voltage regulator board with a 220 micro henry coil (stock number 175411). The high voltage regulator board is mounted on the horizontal output transistor heatsink on the master board.

Product Safety Information

Product safety information is contained in the appropriate RCA/GE Service Data covering models/chassis referenced in this bulletin. All specified Product Safety requirements and testing shall be complied with prior to returning equipment to the customer. Servicers who defeat safety features or fail to perform safety checks may be liable for any resulting damages and may expose themselves and others to possible injury.

First Edition — First Printing


UTILISER UN FUSIBLE DE RECHANGE DE 4000 AMP TYPE MEME AREA PWR SUPPLY/
INSTALL 22µF CAP
TUNER
CHIPS UNDER

RCA/GE
Television Service Data
SERVICE INFORMATION

CTC168/169

RCA GE PROSCAN

CONTAINS ADDITIONAL SERVICE DATA INFORMATION.

CTC168/169 Series

Thomson Consumer Electronics, Inc.
Technical Publications
P.O. Box 1976 | Indianapolis, Indiana 46206

Date: March 22, 1991

Subject: Dead Set/Shutdown, C4401 — CTC168/CTC169 (DV & PTV)

Symptom: From a cold start (AC disconnected then connected to reset the microcomputer), when the set is turned on high voltage comes up momentarily then X-ray protection shutdown occurs.

Possible Cause: The horizontal retrace capacitor C4401 may have changed value causing the high voltage to increase resulting in activation of the X-ray protection circuit. The type of capacitor has been changed in production to improve reliability. Early production units used a box type capacitor which was blue in color. (On a small percentage of the box style capacitors, the end termination inside the capacitor would become loose, resulting in a change of value of the capacitor). The improved version has been changed to a brown, dipped type capacitor.

Refer to the CTC169/169 Technical Training Manual for complete troubleshooting procedures.

Corrective Action: Check by substitution C4401.

Note: The value of C4401 is critical and varies with the chassis version. Refer to Service Data for the correct part number for the chassis version being serviced.

* Parts must be replaced only with TCE approved replacements.

After the capacitor is replaced, test the X-Ray shutdown circuit by setting the brightness and contrast controls to maximum, and shorting stakes TP4902 (XRP1) and TP4901 (XRP2) together. The set must shut-down. The set will cycle three times and then remain off. Remove the jumper and press the power button to restore normal operation.

Product Safety Information

Product safety information is contained in the appropriate RCA/GE Service Data covering models/chassis referenced in this bulletin. All specified Product Safety requirements and testing shall be complied with prior to returning equipment to the customer. Servicers who defeat safety features or fail to perform safety checks may be liable for any resulting damages and may expose themselves and others to possible injury.

First Edition — First Printing

SB-CTC168/169 SI3
Service Information No. 3

CTC168/169 Series

Thomson
Consumer Electronics, Inc.
Technical Publications
P.O. Box 1976 | Indianapolis, Indiana 46206

Date: March 22, 1991

Subject: CTC169 Chassis Intermittent Shutdown

The CTC169 chassis is equipped with a number of shutdown circuits to protect the chassis from damage in the event of a malfunction. These circuits include the over current and over voltage shutdown of the switching regulator and the X-ray protection circuit. In addition, the system control microcomputer has a reset circuit to prevent lockup of the microcomputer during brief power interruptions caused by kine arcs, etc. It is not unusual for a new picture tube to arc briefly when it is new. The microcomputer reset circuit protects the set from any damage from these arcs by turning the set off and then back on approximately two seconds later. In some cases the shutdown circuits may be too sensitive, causing momentary shutdowns when there is no actual problem with the chassis.

Corrective Action:

To reduce the sensitivity of the reset circuit:

1. Add a 150 Ohm chip resistor (stock number 179379) in parallel with R3141. R3141 is located on the bottom of the master board in location A-19 and is marked with the numbers 102 on top of it.
2. Add a 560 pf chip capacitor (stock number 195688) in parallel with R3142. R3142 is located on the bottom of the main board at location A-18 and has the numbers 104 on top of it.

Refer to the component location guide for the correct placement of the two components. To add these parts in parallel, solder the new part on top of the chip resistor on the master board.

On some models, the speakers are located very close to the picture tube. The speaker baskets (metal frames) on these models are not grounded. A charge can build on the speaker basket and arc over to the speaker voice coil, again causing the reset circuit to momentarily shut the set off. To prevent the charge from building on the speaker basket, connect a 1.0 Meg Ohm 1/4W resistor (stock number 829510) between the negative speaker lead and the speaker frame. The negative speaker leads are identified by the green or brown wire from the chassis. Attach the resistor to the speaker frame by soldering the resistor lead to the rivet holding the terminal block. Solder the other resistor lead to the negative lead on the speaker terminal block.

Note: Even after this modification is performed, it is still possible for the set to shut down. There may be a fault in either the switching regulator circuit or the high voltage circuit which could activate a shut down circuit. In addition, the set will still shut down to protect from kine arcs. Kine arcs are common in new picture tubes, and decrease in number as the tube is used. If the set continues to exhibit momentary shut down symptoms, suspect a defective retrace capacitor C4401 or perhaps a faulty emitter resistor in the chopper circuit. The chopper emitter resistor is used to sense the current through the chopper output transistor to protect from an over current condition. If the resistor increases in value, the set may shut down too soon, before there is an actual fault. R4110 is difficult to accurately measure since it is only 0.18 Ohms, and so replacement is recommended if the switching regulator exhibits a shutdown symptom and no other fault is found.

Product Safety Information

Product safety information is contained in the appropriate RCA/GE Service Data covering models/chassis referenced in this bulletin. All specified Product Safety requirements and testing shall be complied with prior to returning equipment to the customer. Servicers who defeat safety features or fail to perform safety checks may be liable for any resulting damages and may expose themselves and others to possible injury.

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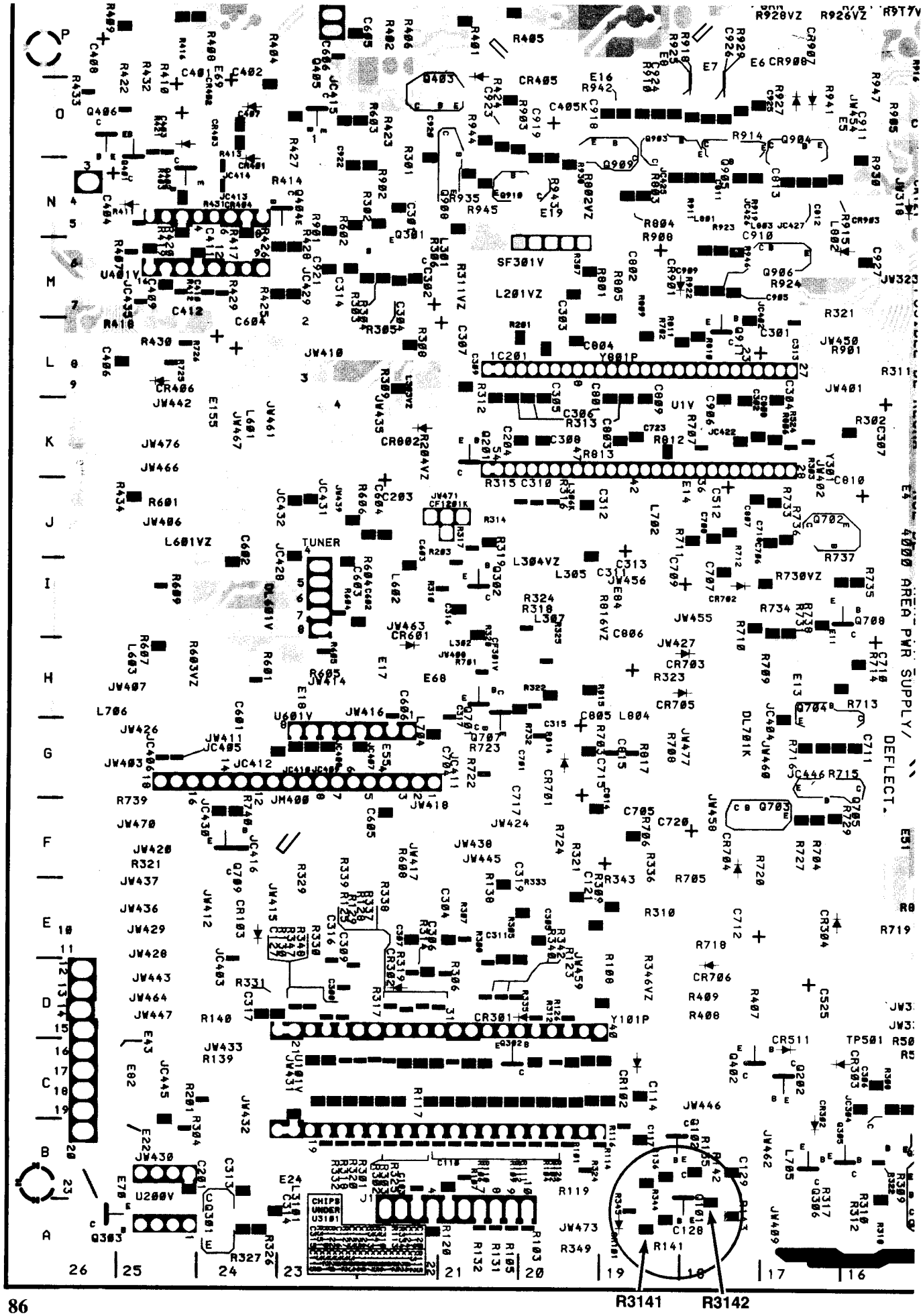
R3141
R3142

199351 PTV SERVICE KIT
CTC169 PROJECTION TELEVISION FAST MOVING PARTS KIT
LIST OF CONTENTS

Stock Numbers	Descriptions
146847	Transistor (multiple uses)
175722	U1901/U1902 Audio Output IC
179379	150 ohm Chip Resistor (5 per pkg.)
190520	.22 μF 63 Volt Capacitor
195688	560 pf Chip Capacitor (5 per pkg.)
***199348**	**CTC168/169 Component Service Kit**
200137	U1001 Signal/Deflection/Processing IC
200149	C4401 Retrace Capacitor
200183	R4110 .18 ohm 2 Watt Resistor
200419	U4101 Regulator Control IC
200420	U4501 Vertical Switch & U4801 Pincushion IC
200450	T4401 IHVT
201620	C4401 Retrace Capacitor
203098	Q4101 Regulator Transistor
203533	Circuit, Tuner
205064	High Voltage Splitter Assembly

Contact your local TCE parts distributor to order these service kits.

199348 COMPONENT KIT
COMPONENT KIT FOR CTC168/169 TELEVISION PRODUCT
LIST OF CONTENTS

*Note: This kit is available separately or as part of the 199351 PTV Service Kit

Qty	Stock Numbers	Description	Schematic Symbol Numbers
4	147015	Diode	CR4001, CR4002, CR4003, CR4004
1	153672	Diode	CR4702, CR4713
1	161871	Diode	CR4303, CR4712
1	164589	Diode	CR4402
1	164590	Diode	CR4118, CR4119, CR4120
2	175425	Fuse	F4001
1	176296	Diode	CR4117, CR4701, CR4705
1	176746	Diode	CR4606
2	190487	Resistor	R4001
2	200167	Transistor	Q4401
1	198596	Diode	CR4401
1	200156	Diode	CR4105
1	200157	Diode	CR4116
2	200165	Transistor	Q4101
2	200168	Transistor	Q4802

Notes

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