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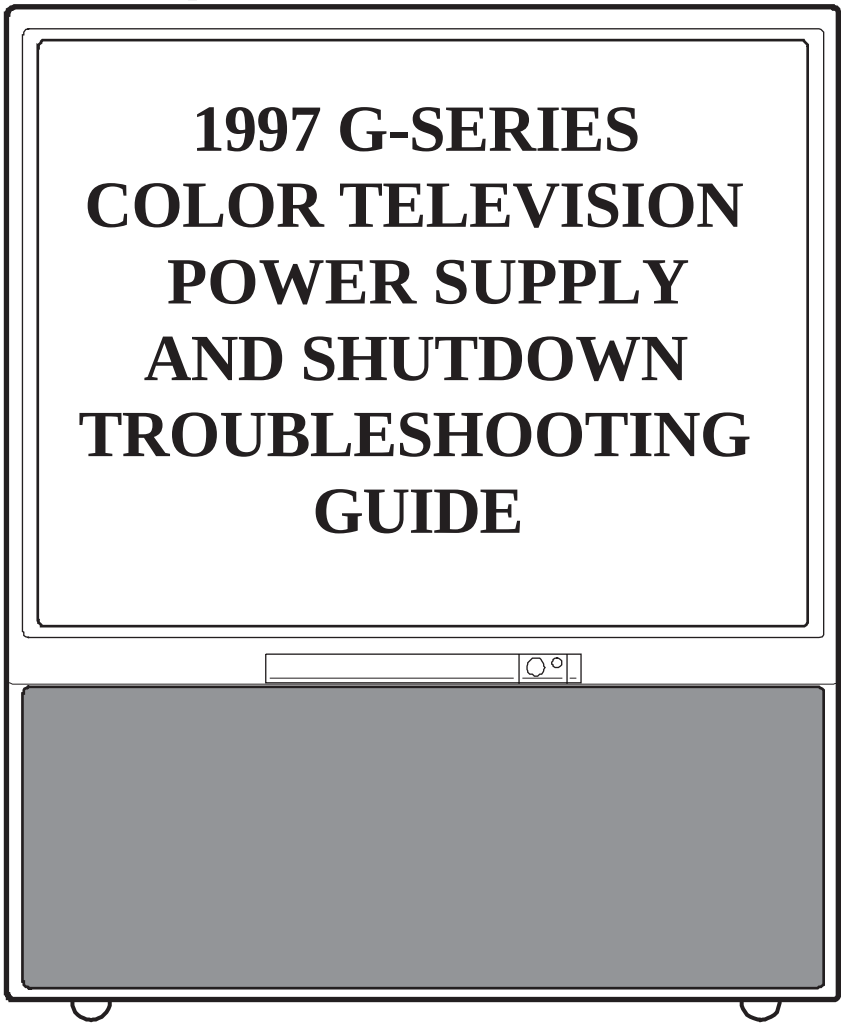


1997 G-SERIES COLOR TELEVISION POWER SUPPLY AND SHUTDOWN TROUBLESHOOTING GUIDE

TOSHIBA AMERICA CONSUMER PRODUCTS, INC.
NATIONAL SERVICE DIVISION
TRAINING DEPARTMENT
1420-B TOSHIBA DRIVE
LEBANON, TENNESSEE 37087
PHONE: (615) 449-2360
FAX: (615) 444-7520

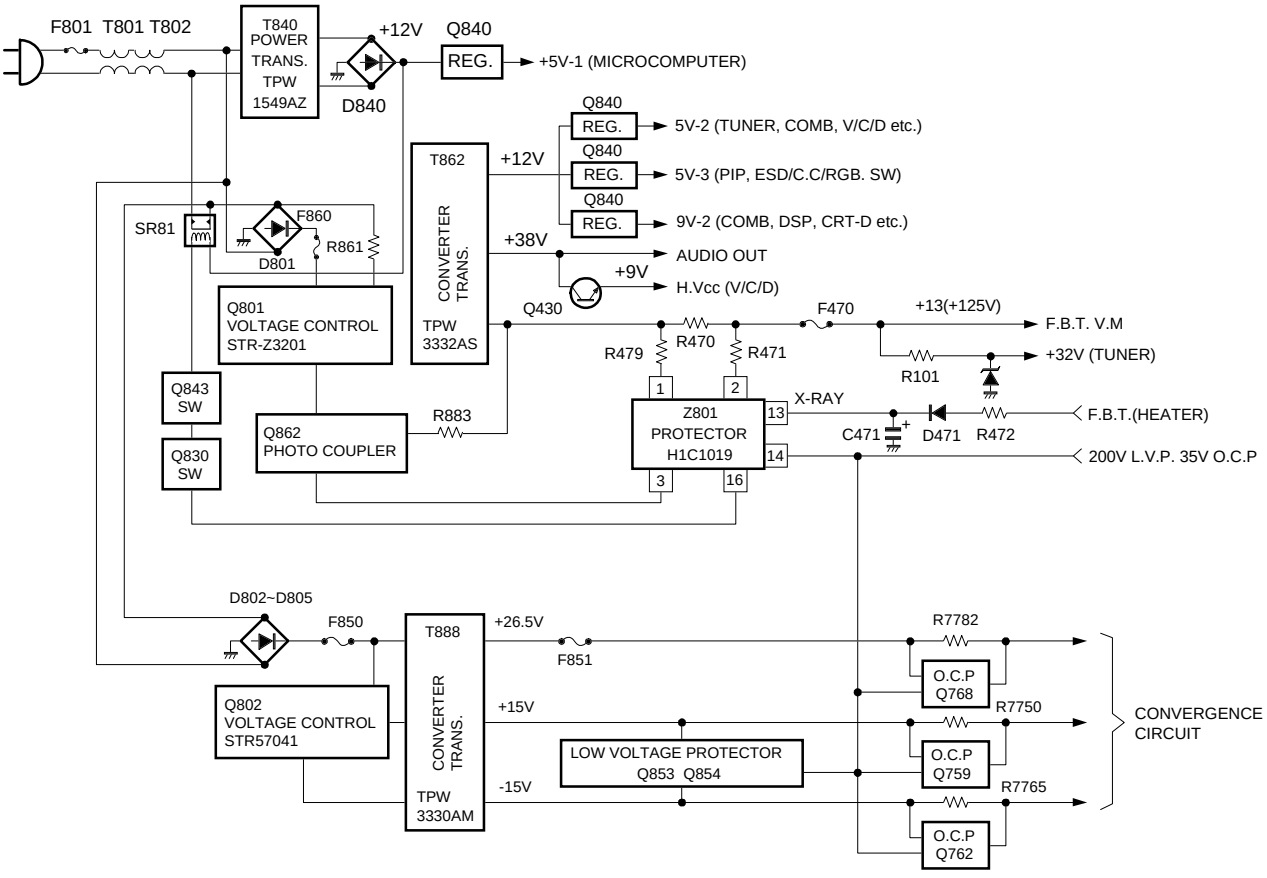
Contents

POWER SUPPLY CIRCUIT

1. Outline of system

The block diagram of the power supply is shown in Fig. 1. The N7 chassis consists of the standby power supply which supplies power to the microcomputer, and the main power supply which supplies power to the horizontal output and audio output. This chassis also has a scan driven supply from the flyback which supplies power to the vertical output, video output, and signal processing circuts.

The main supply is a current resonating type supply. It is small in size, highly efficient and reliable.



2. Stand-by Power Supply

The stand-by power supply supplies 12Vdc to the relay SR81, 5V to the microprocessor, 5V to the protect IC, and a reset 5V to the microprocessor. T840 supplies a low AC signal to D840. D840 rectifies the signal and C840 filters it to produce 12Vdc. The 12V is applied to Q840. Q840 outputs a regulated 5V on pin 5 and supplies a reset 5V at pin 4. Reset occurs when power is first applied to Q840. The 5V on pin 5 comes up first while pin 4 stays low. This is the reset condition. After C843 fully charges, pin 4 goes to 5V for normal operation.

** Troubleshooting Tip:*
A loss of the 5 V or reset 5V will prevent the microprocessor from operating.

3. Main Power Supply

1. Main Power Rectifier Circuit

D801 and C810, the rectifier and filter for the main switching supply, produce 165V. R810 suppresses the rush current at turn on. SR81 is a relay that turns on the main supply. The relay is controlled by the microprocessor through the relay drivers: QB30 and Q843.

** Troubleshooting Tip:*
Because the microprocessor controls the relay, the main power supply may not turn on if the microprocessor does not operate properly.

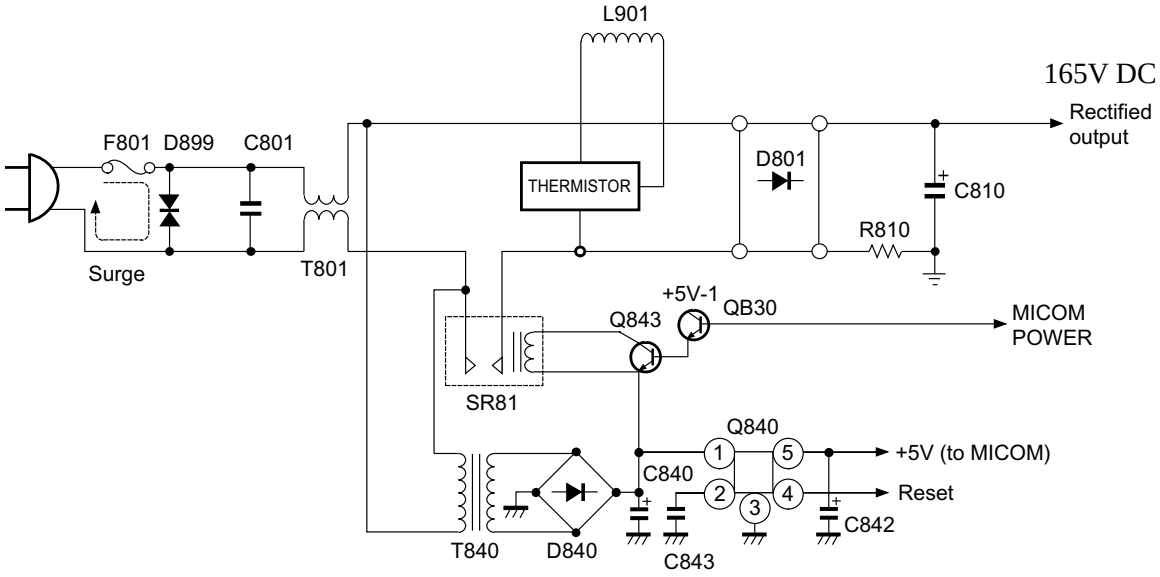


Fig. 2 Rectifying circuit and standby power

4. Outline of the Current Resonant Type Supply

Fig. 3 shows the block diagram for the current resonant switch mode power supply. The primary side is an LC series circuit. It consists of the primary winding of the transformer and a resonant capacitor in series. Two power MOS FET's in a push-pull configuration drive the primary side of the transformer.

The switching action on the primary side of the transformer produces the main B+ on the secondary side. The main B+ is regulated by negative feedback. The main B+ is fed into an error amplifier and outputted to a photo coupler. The output of the photo coupler is applied to the primary side of the power supply to control the switching speed.

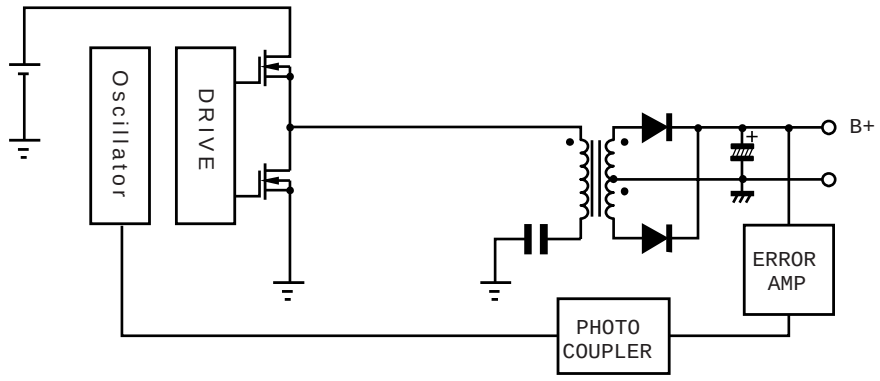


Fig. 3 Basic configuration

5. Fundamental Theory of LC Series Resonant Circuit

The LC series resonant switch mode power supply is a frequency regulated power supply operating above resonance. When the the load increases on the secondary side of the transformer, the frequency decreases (operates closer to resonance) and the current increases. Conversely, when the load decreases, the frequency increases and the current decreases.

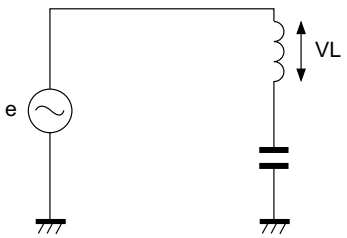


Fig. 4 LC series resonant circuit

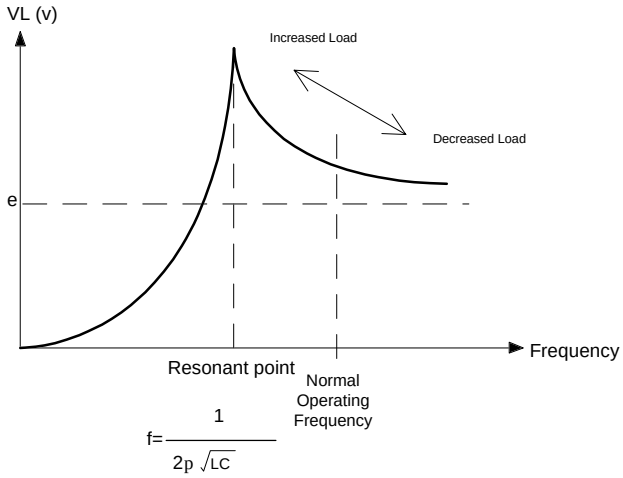
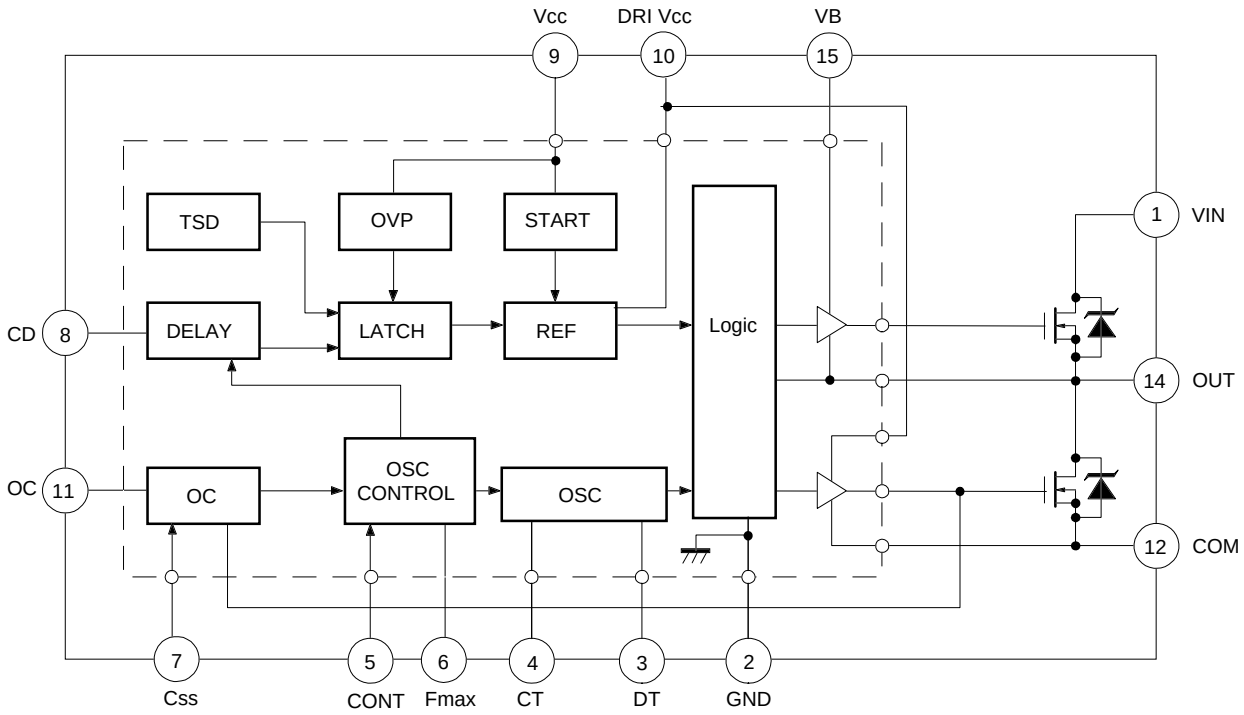


Fig. 5 Characteristics

STR-Z415, STR-Z415, and STR-Z4201 Block Diagram



Pin No.	Symbol	Function
1	V_{IN}	Half bridge power input
2	Gnd	Ground
3	DT	Dead time resistor terminal
4	CT	Oscillator capacitor terminal
5	CONT	Oscillator control terminal
6	F_{MAX}	Maximum frequency determining resistor terminal
7	C_{SS}	Soft start capacitor terminal
8	CD	Capacitor for delay latch: ON-OFF terminal
9	V_{CC}	Power source terminal for control section
10	DRI V_{CC}	Gate drive power supply output terminal
11	OC	Over current detect terminal
12	COM	Half bridge GND
14	OUT	Half bridge output
15	V_B	High side gate drive power source input

Table 2 Pin function

6. Main Supply Actual operation

Refer to Figure 7 diagram and waveforms.

1. **Start-up**

When power is applied to the set, a start-up pulse of 16V is applied to **pin 9** of IC Q801. At the same time, the charging of **C869 (pin 8)** induces a delay to the internal latch circuit to prevent the Over Voltage Protect (OVP) from engaging, and **C866 (pin 7)** sets the switching frequency high to reduce the surge current. After the initial start-up, the circuit operates at its nominal frequency (70-80 kHz), and the Drive Circuit (see page 9) supplys 17V to **pin 9.**

2. **Output switching element**

Two power MOSFETs in push-pull configuration, operate the switching. The on-off timing of each MOSFET is controlled by the logic inside Q801. To avoid shorting the MOSFETs, they are never turned on at the same time. Between the time one transistor turns off and the other turns on, both MOSFETs are off. This off time is called dead time, and is determined by **R867(pin3).**

3. **Basic Oscillation**

The frequency of the internal oscillator is determined by the charge and discharge of capacitor **C862 (pin 4)**, and is controlled by the feedback into **pin 5** through the Oscillator control block. The oscillator generates a ramp waveform at Pin 4. The ramp waveform charges up to 4 V (typical) and discharges to about 2.5 V. The charging time is the output-on period for one of the MOSFETs, and the discharging time is the off period for both MOSFETs (see OSC OUT SIGNAL waveform of Figure 7). The lowest oscillation frequency is determined by capacitor C862 and resistor R867.

4. **Frequency Control**

Current flowing out of the CONT terminal **(Pin 5)** varies the charging time of oscillator capacitor C862, which in turn, controls the frequency of the Output **(Pin 14)** signal. The control current is determined by the photocoupler. The photocoupler phototransister side current is determined by the feedback current of the photodiode side. The photodiode current is determined by the error amp inside of Z801, which is monitoring the +125V source. Thus, the terminal current (CONT) corresponds to the feedback from the +125V output.

5.**CD terminal (Pin 8) - Latch Delay**

The Latch circuit shuts the power supply off (shut-down) when a fault is detected. Shut-down occurs by detecting errors from the following:

• Over voltage protection (OVP) circuit

• Thermal shock detection (TSD) circuit

• Over current protection (OCP) circuit

• Loss of and no recovery of Main B+

The charging time of capacitor C869 connected to the CD terminal **(Pin 8)** is used to delay the operation of the latch circuit when power is initially applied. If the unit goes into shut-down, temporarily remove AC power to reset the latch circuit.

7.**OC terminal (Pin 11) - Over Current Detect**

This is to detect over-current in the LC series resonant circuit.

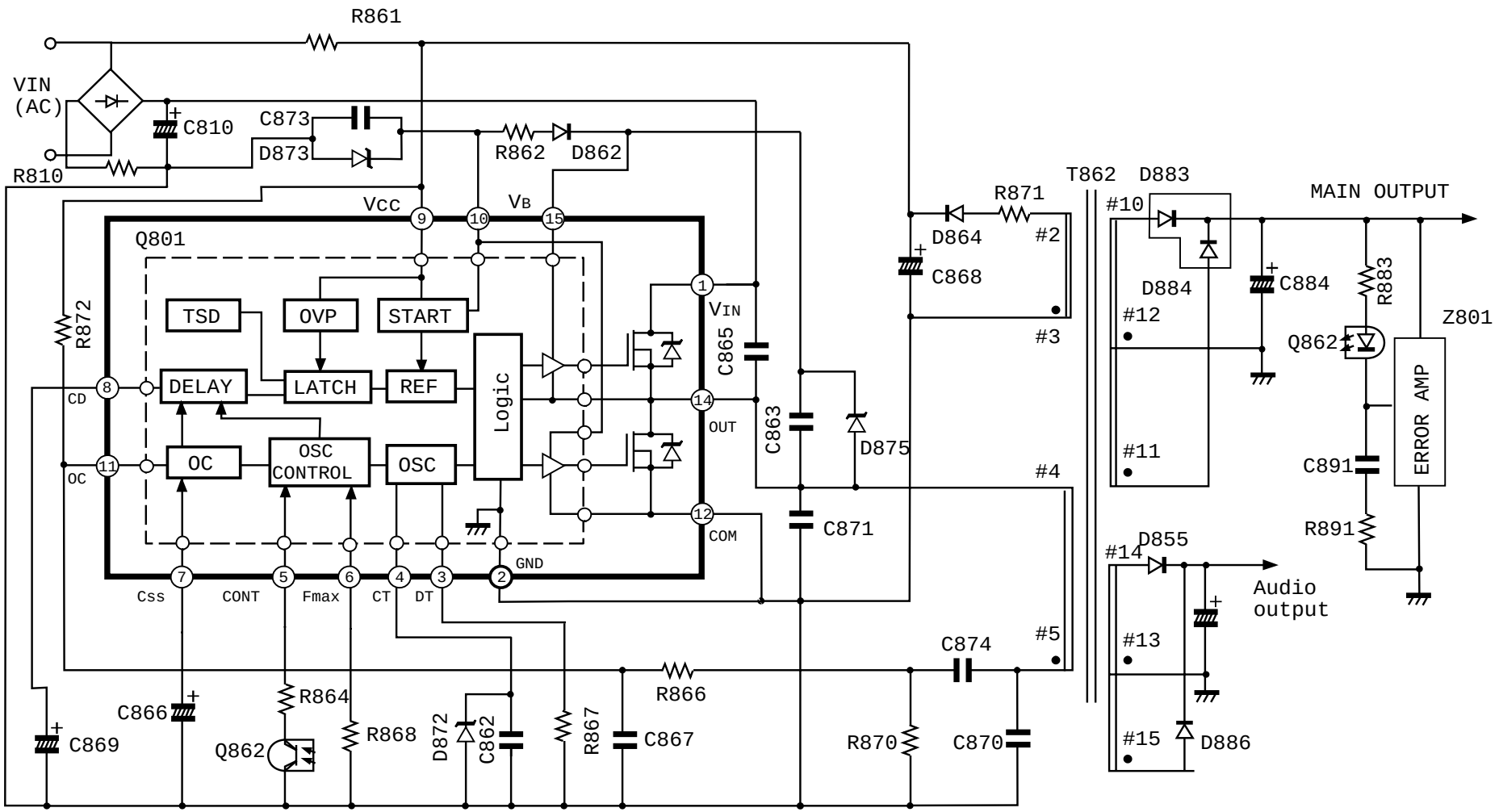
8.**Over voltage protection (OVP) circuit**

If the Vcc terminal **(Pin 9)** exceeds **22V** (typical), the latch circuit is engaged (shutdown) .

9.**Thermal shock detection (TSD) circuit**

This is to make the Latch circuit operate when the IC's internal temperature exceeds 150°C.

Actual Circuit



Voltages On IC801

Using a 100 W light bulb as a Losd

Pin	Voltage	Pin	Voltage
1	150 Vdc	9	17.7 Vdc
2	0 Vdc	10	7.8 Vdc
3	5.8 Vdc	11	0.9 Vdc
4	2.3 Vdc	12	0 Vdc
5	5.8 Vdc	13	NC
6	5.8 Vdc	14	75 Vdc
7	3.6 Vdc	15	83 Vdc
8	0.4 Vdc		

Fig. 8 DC voltages on IC801

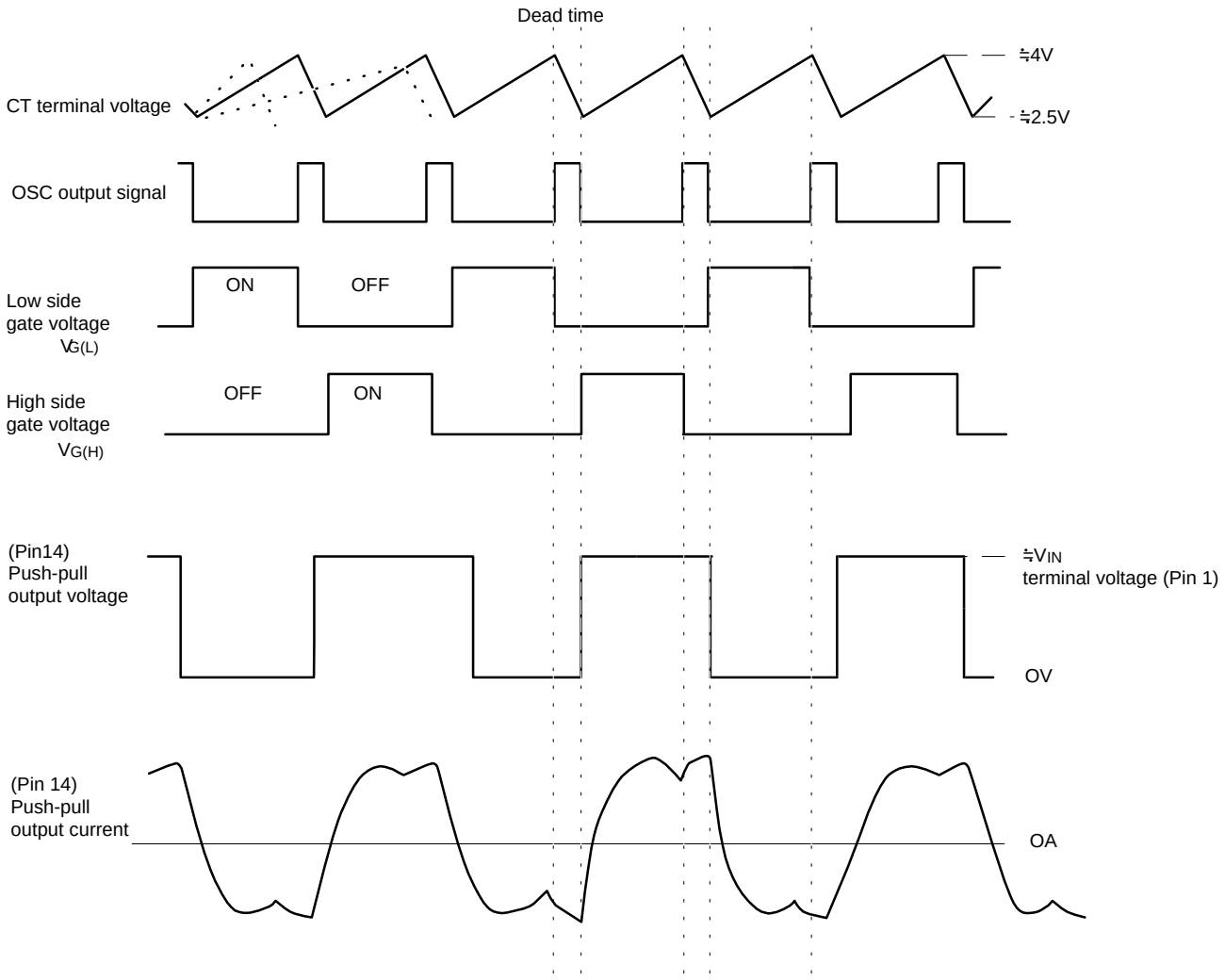
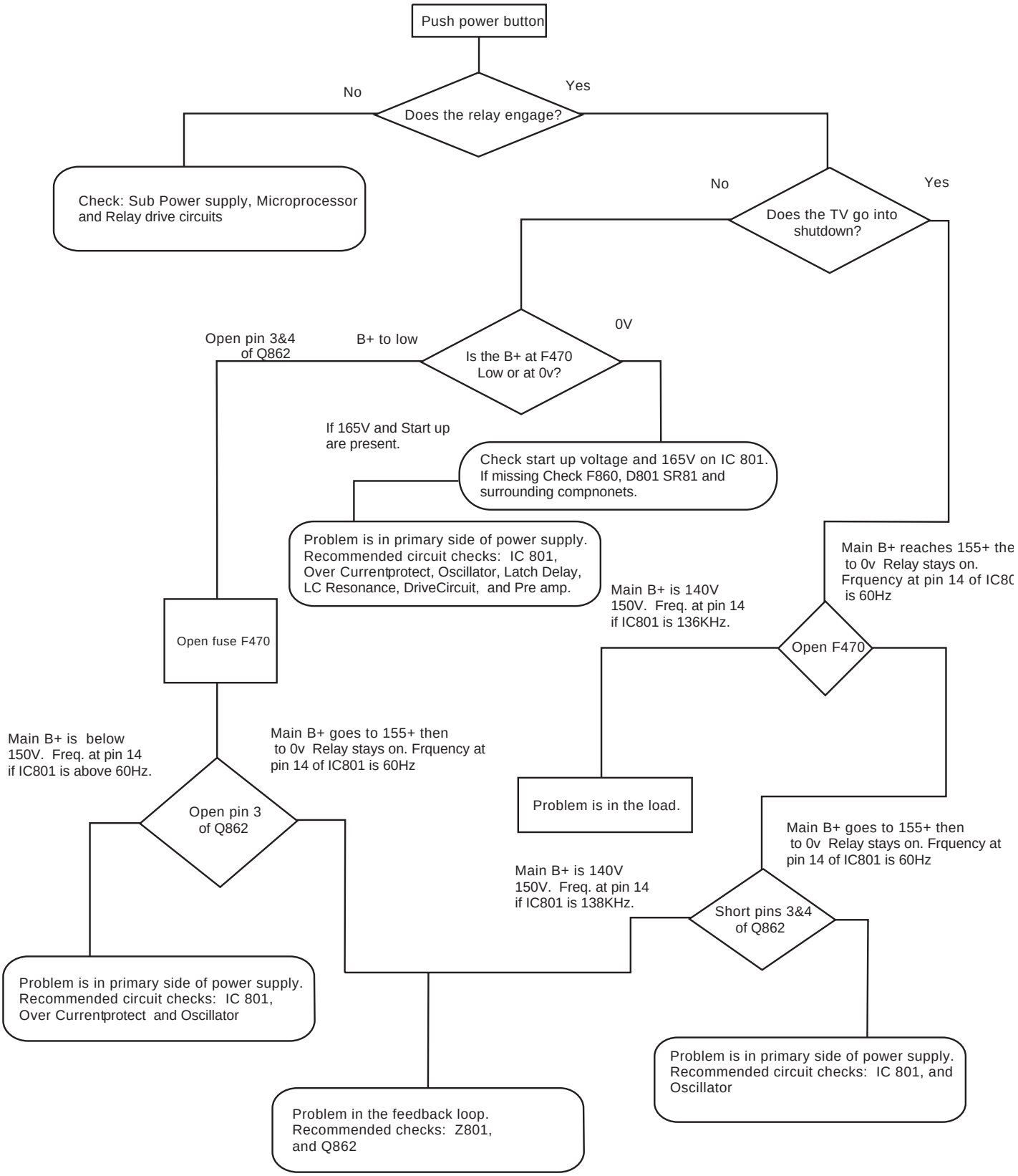


Figure 7 Terminal waveforms

Power Supply Troubleshooting Guide.



7. Main Power Supply Troubleshooting Guide

Poor Regulation:

The Main Power Supply is a looped circuit. In order to troubleshoot the circuit, the loop must be broken. By interrupting the feedback portion of the loop, it can be determined if a problem exists in the primary or secondary side of the supply. Table 3 and 4 shows the switching frequencies of IC801 and the secondary voltages of the supply with various feedbacks. If the main supply is not regulating properly, open F470 and check the switching frequency of IC801. Using the tables below, interrupt the feedback. If the frequencies are as shown, the primary side of the power supply is good. If the frequencies are off, the primary side of the power supply is bad. Notice that once the feedback is interrupted, the load has no bearring on the switching frequency.

If the problem is on the primary, C866, R864, D872,C862, R866,C870 and IC801 should be checked.

If the proplem is on the secondary side, Q862, and Z801 should be checked.

100W light for a load	Frequency at pin 14 of IC801:	Seconday Voltage at F470:	Notes:
Good feedback	68Khz	124V	
Open Feedback: Pins 3 & 4 of Q862 open.	60Hhz	140v	Engages Overvoltage protect on pin 9 of IC801
Shorted feedback: Pins 3 & 4 of Q862 shorted	138Khz	92V	
3K Resistor feedback inplace of pins 3 & 4 of Q862.	90Khz	103V	

Table 3

No load	Frequency at pin 14 of IC801:	Seconday Voltage at F470:	Notes:
Good feedback	136Khz	140V	
Open Feedback: Pins 3 & 4 of Q862 open.	60Hhz	160V	Engages Overvoltage protect on pin 9 of IC801
Shorted feedback: Pins 3 & 4 of Q862 shorted	138Khz	140V	
3K Resistor feedback inplace of pins 3 & 4 of Q862.	90Khz	174V	

Table 4

No Start-up:

A failure in one of the sub-circuits on the primary side of the power supply can prevent IC 801 from switching properly and starting-up. If IC801 is not operating, first check for 160V on pin 1 of IC801. If this is missing, check D801,C810,R810 and the relay. If the 160V is present, refer to Figure 10 and check the following circuits:

Start-up Resistor

Check for a 16V start-up pulse at pin 9. If this is missing, check R68,1 the start-up resistor and D876 (not shown).

Drive Circuit

Once IC801 starts running, the Drive Circuit supplys pin 9 with a constant 17V. Therefore, if it fails, IC801 will not run properly. Check D864, R871, and C868.

LC Resonance

If either C870 or T862 opens, no current will flow through the transformer. All secondary voltages, including the Drive Circuit, will not be present. (**See Drive Circuit**)

Latch Delay

To prevent IC801 from going into over-voltage protect during start-up, the charging of C869 will temporarily disable the latch. When a DC voltage is applied to the cap, it acts like a short and it disables the latch. When it's fully charged, it is an open to DC, and the latch will operate normally. If the capacitor is open, IC801 will not start-up. Check C869

Over Current Protect

If excessive current flows through the LC Resonance Circuit, the over-current protect kicks in to protect IC801. If R866 or R870 fail, it can give a false reading and shut off the IC801.

Oscillator

C862 is a reference for the oscillator inside IC801. D872 is for protection. A problem here could damage IC801.

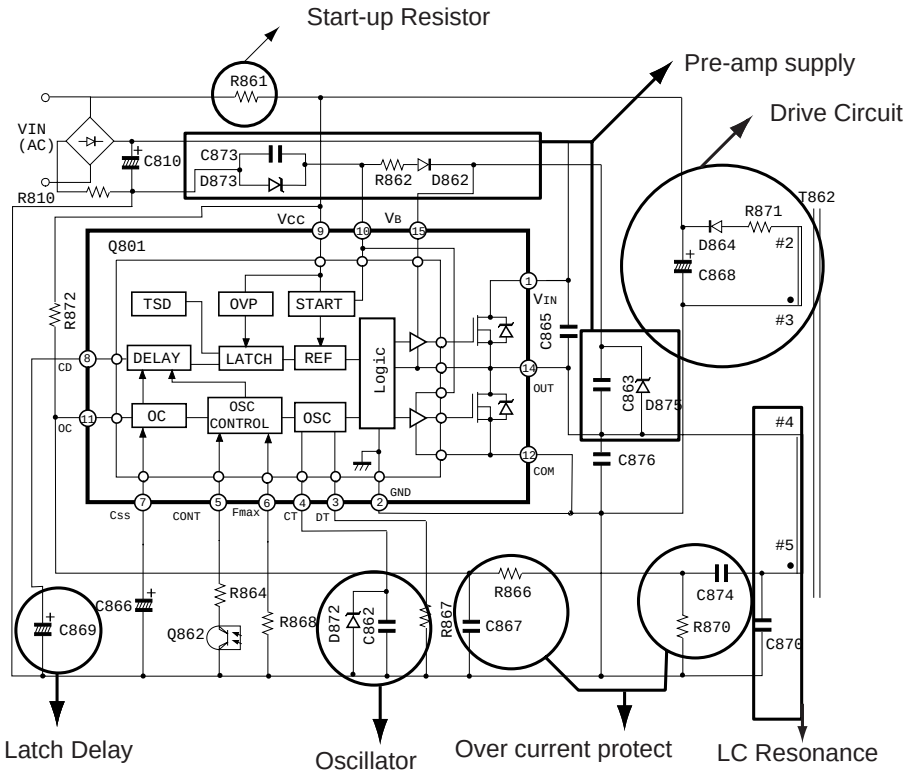
Pre-amp Supply

Internal to IC801 are two pre-amps that drive the MOSFETs. When pin 9 has voltage, 9V is supplied from pin 10 to pin 15. This 9V is used to power the internal pre-amps. Check D873, R862, D862, D875, C873 and C863.

IC801

Check Pins 1,14, and 12 of IC801. If any one of them is shorted to ground, the IC is bad.

Fig10



8. Scan driven supply

The flyback transformer develops a scan driven supply (T461), shown in Fig. 11. The Flyback supplies 200V for video output from pin 3, 27V for vertical output from pin 6, -27V for side DPC from pin 5, and 12V from pin 7. The 12V line produces a regulated 5V and 9V line. The 5V supplies the tuner and PIP, the 9V supplies the Video Processing. Resistors and fuses are in each line for circuit protection

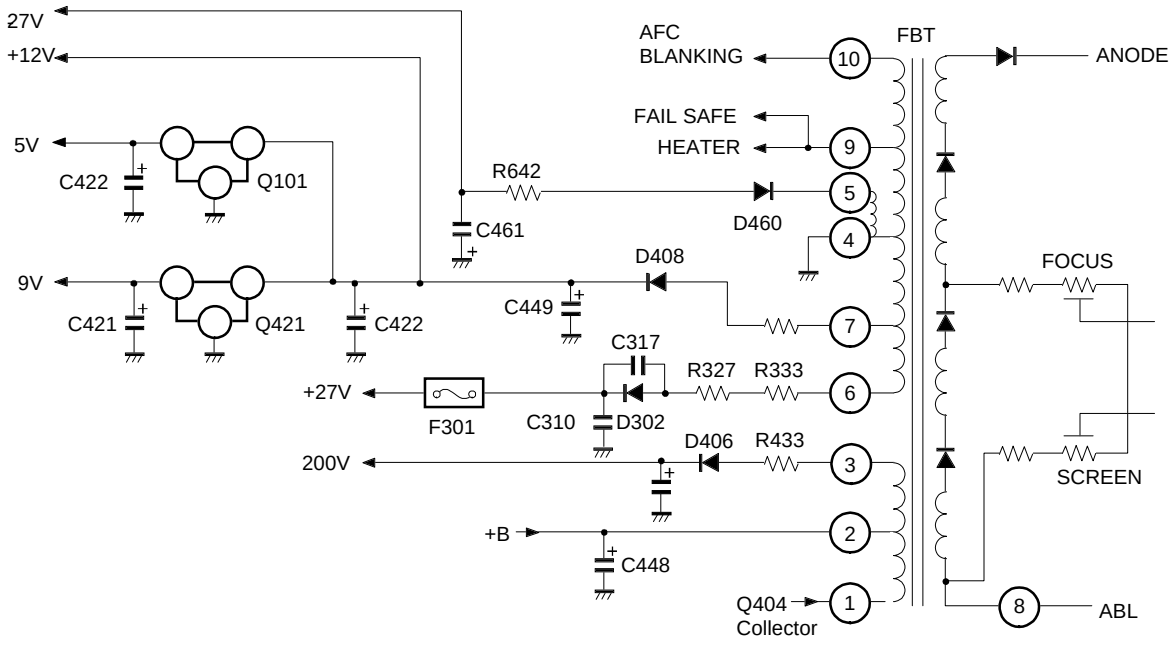


Fig. 11 Other power supply circuit

NOTES

10. SUB POWER SUPPLY.

The Sub Power Supply is a switching supply. It uses a Free-Running Oscillator made up of Q802, T888 and C855. R852 supplies the start-up voltage, and C855 supplies a positive feedback to maintain switching (Fig.14). The Sup Power Supply supplies a 16V, -16V and 29V to the Convergence Outputs and the Convergence Digital Control. This supply also operates as a Main Power Supply in some of the 19" TVs and is similar in operation to the supplies used in Toshiba's VCRs and DVD players.

Basic operation:

Refer to Figure 12. RS supplies a start-up voltage to the base of Q1 turning Q1 on. With Q1 on, current slowly increases through the primary winding of the transformer. An electromagnetic field builds while the current increases. This field will induce an electromagnetic field and a positive voltage across the Base winding of the transformer increasing the current through the Base of Q1.

Eventually, the current through the Collector of Q1 saturates, stops increasing and levels off. At that point, the electromagnetic field across the Base Winding collapses, supplies a negative voltage to the Base of Q1, and charges C1.

The negative voltage on the Base of Q1 turns Q1 off. The electromagnetic field on the primary collapses, induces current in the secondary winding, and induces a potential on the detection winding which continues to hold Base of Q1 low.

After the electomagnetic field is fully collapsed, C1 discharges truning Q1 on. and this starts the process over again.

The start up voltage in no longer used once the supply starts switching.

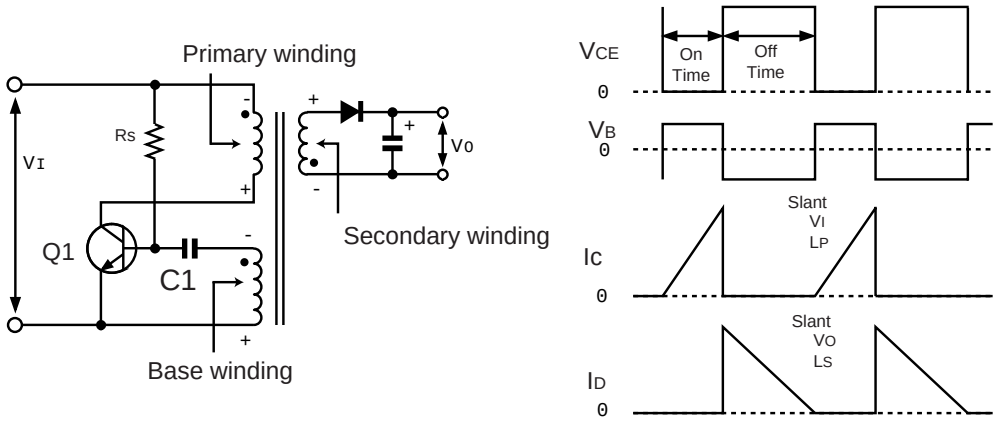


Fig. 12

Feedback.

For stabilization, a negative feedback is supplied to the Base of Q1. The feedback signal is developed form the Detection winding, rectified by D856 and controls the bias of Q1. If the output is too high, the frequency of Q1 increases resulting in decreased on-time of Q1. This will then decrease the output voltage. If the output is too low, the frequency of Q1 decreases. In return, it increases the on-time of Q1

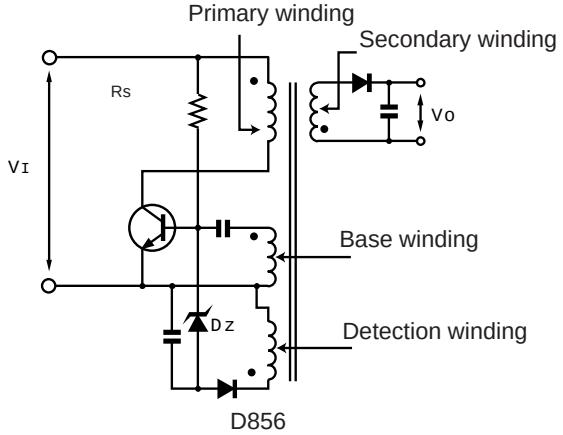
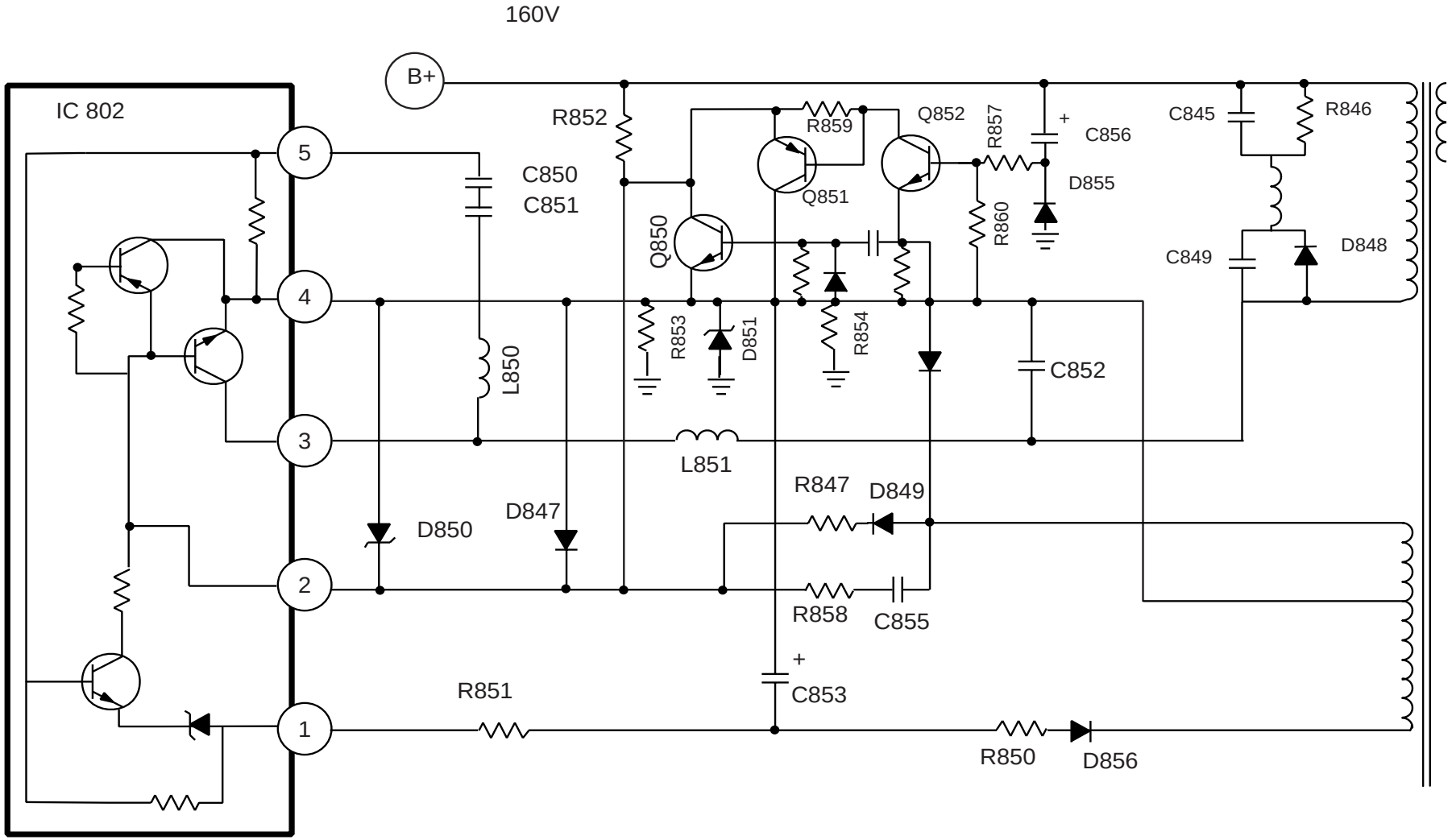


Fig. 13


160V
B+
IC 802
5
4
3
2
1
R852
C850
C851
L850
Q850
R853
D851
R859
Q851
Q852
R857
C856
D855
R860
R854
C852
C845
R846
C849
D848
L851
R847
D849
D847
D850
R858
C855
C853
R851
R850
D856

11. Troubleshooting Sub-Power Supply.

Refer to fig 14. To troubleshoot the Sup-Power Supply, it must be isolated from the load. It is necessary to hookup an external load to the secondary, and use a Variac. With the Variac set to 40 Vpp and a 100W light bulb hooked up for a load, the relay has to be shorted to supply the 40Vpp to the Sub-Power supply.

Dead

First, check the 160 volts Main B+ and Fuse F850.

If the 160V is good and the fuse is open, the transistor in IC802 maybe shorted. Check for shorts between pins 2,3, and 4 of IC802. If IC802 is good or after replacing IC 802, make the following checks before restoring the 120V:

** Note: If IC802 is bad, the feedback circuit must be checked.*

Check for switching at pin 2 of IC801.

If the switching is missing, the Start-up circuit maybe bad. Check R852 for an open, check Q851, Q850 and Q852 for shorts, and check IC802 for a base emitter open on Q1. Lastly, check T888 and C855. After restoring the switching, check the feedback: D856, R851, R820, and C853.

If the switching is good, Check the feedback: D856, R851,R850, and C853.

Wrong secondary voltage or improper regulation

A loss of feedback will cause the secondary voltage to increase and can damage IC802 resulting in no power.

Check the following components of the Secondary voltages are to low:

R853 and R854 the Over Current protect resistors.

Q850, Q851, and Q852 the Soft Start transistors and surrounding circuit.

C855 Oscillator Capacitor.

SHUT DOWN CIRCUITS

1. Summary of Shut down circuits.

Figure 14 is a block diagram of the eleven shut down circuits. When any of the shut down conditions occur, the latch in Z801 holds the power relay off as long as the set is plugged in. Neither the front panel power switch, nor the remote power switch will restore power to the set. The front panel power LED will blink at approximately 1/2 second intervals. To reset the shut down condition, the AC main power cord must be unplugged.

Plug the AC cord back in. While listening carefully for the click of the power relay activating, turn the power on. If the power relay clicks on, then immediately off, and the power LED starts blinking, then a shut down condition has occured.

If the relay doesn't energize at all, check the AC input circuits, fuse F801, and the standby power supply.

If the relay clicks on and the power LED remains steady on, the set is not in shut down.

When the set does go into shut down, the problem becomes how to determine which conditioned caused it.

Peak Response Meter.

Each shut down circuit has a "Trigger Voltage", which will cause shut down. The trigger voltage lasts for just a brief moment before the power supply shuts off. A Peak-Response Meter is required to troubleshoot the shut down circuits. A peak response meter measures and holds the highest voltage that occurs at a test point.

Nine circuits are connected to pin 14 of Z801. Each of these circuits operate in a similar manner. Normally, all "triggers" are approximately zero volts. When an abnormal condition occurs, the appropriate shut down circuit triggers a "high" to pin 14 of Z801. Z801 sets and holds pin 16 low (0 volts). This causes relay SR81 to de energize, dropping all power in the TV, except the standby power. This means the trigger voltage also goes away. There is now no means to determine which circuit caused the shut down. The only way to reset Z801 is to pull the AC plug.

To determine which cicuit triggered the shut down, connect the peak response meter to each shut down circuit Trigger monitor point in turn, while applying power to the set. Any voltage at a monitor point above aproximately 2 volts is a clear indication that the circuit being monitored is in shut down, narrowing the search for the actual fault.

X-ray Protect.

The X-ray protect is connected to pin 13 of Z801. Z801 compares this voltage to the reference voltage on pin 11 (aproximately 25 volts). If the voltage on pin 13 rises to a value GREATER than pin 11, shut down occurs and all power goes away, except the standby supply.

A peak response meter connected at pin 13 of Z801, while power is applied to the set, will capture a voltage greater than the reference voltage, indicating excessive High Voltage.

+125V Over Current Protect.

The peak hold meter is connected across resistor R470, and NOT referenced to ground to monitor for a momentary increase in voltage. The normal voltage across R470 is about 0.4Volts. An increase in current will cause the voltage across R470 to increase. When Z801 detects this voltage increase, it puts the set into shut down.

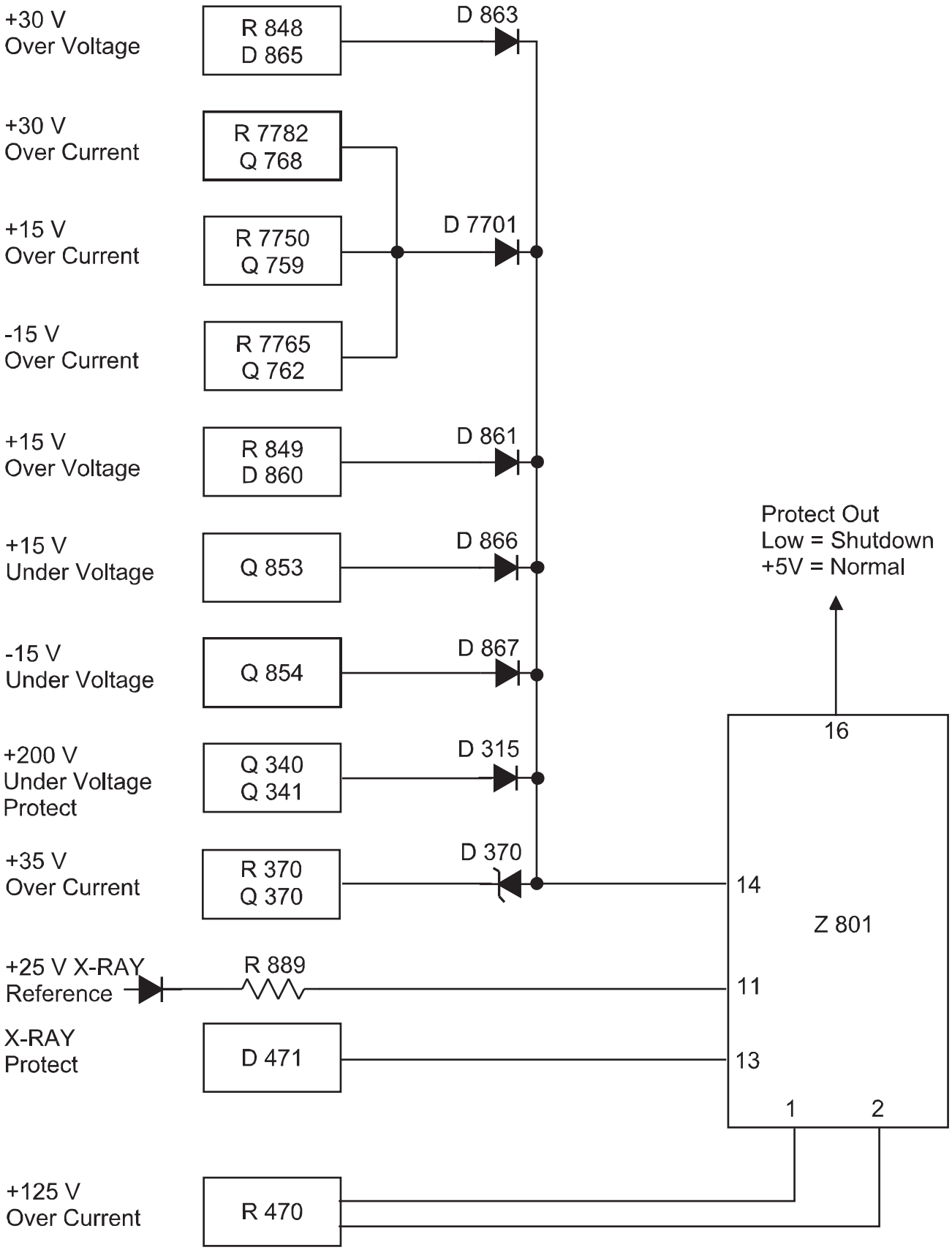
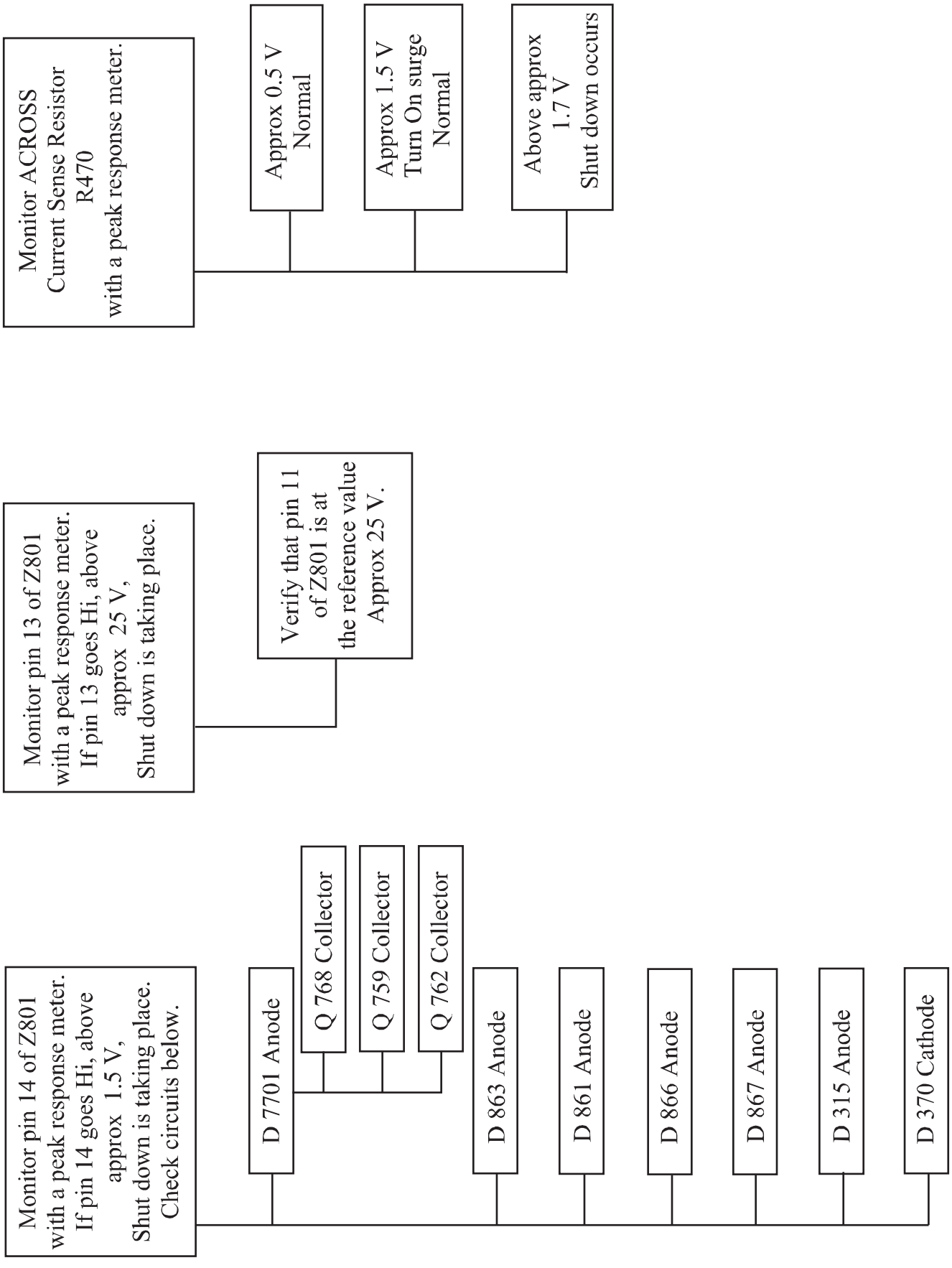


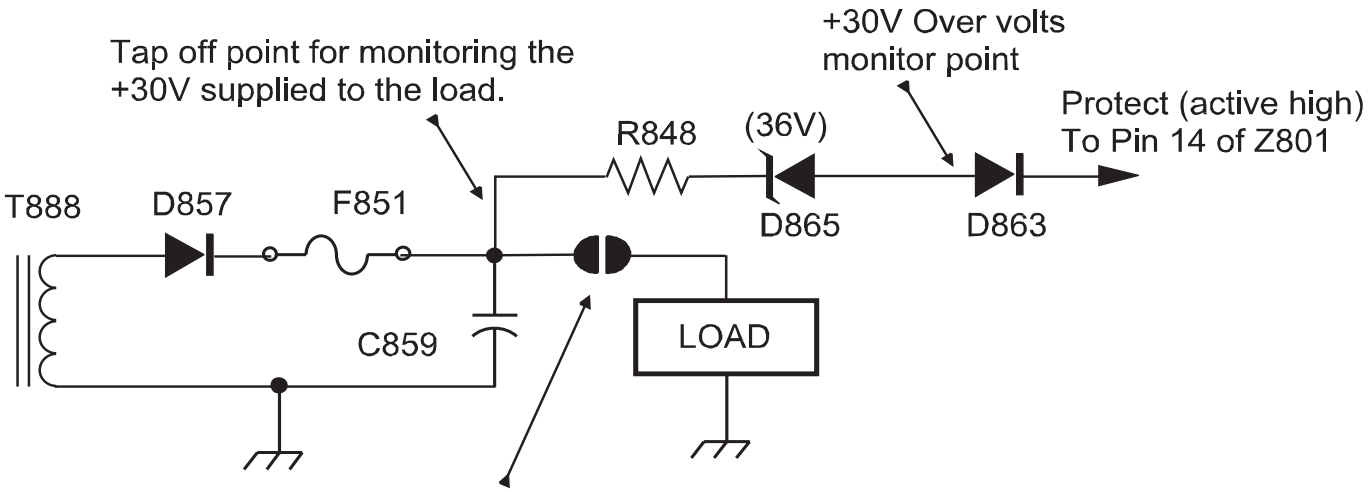
Figure 14. Summary of Shutdown circuits.

2. Power shut down troubleshooting guide.



3. +30 Volt Over Voltage Protect.

When the supply voltage goes beyond the zener votage, the zener diode conducts and delivers a voltage to the anode of D 863. This passes through the diode switch, D863, to pin 14 of Z801, and shut down takes place. Normal voltage at the monitor point is about 0. A voltage of about 2.5V or greater will result in shut down.

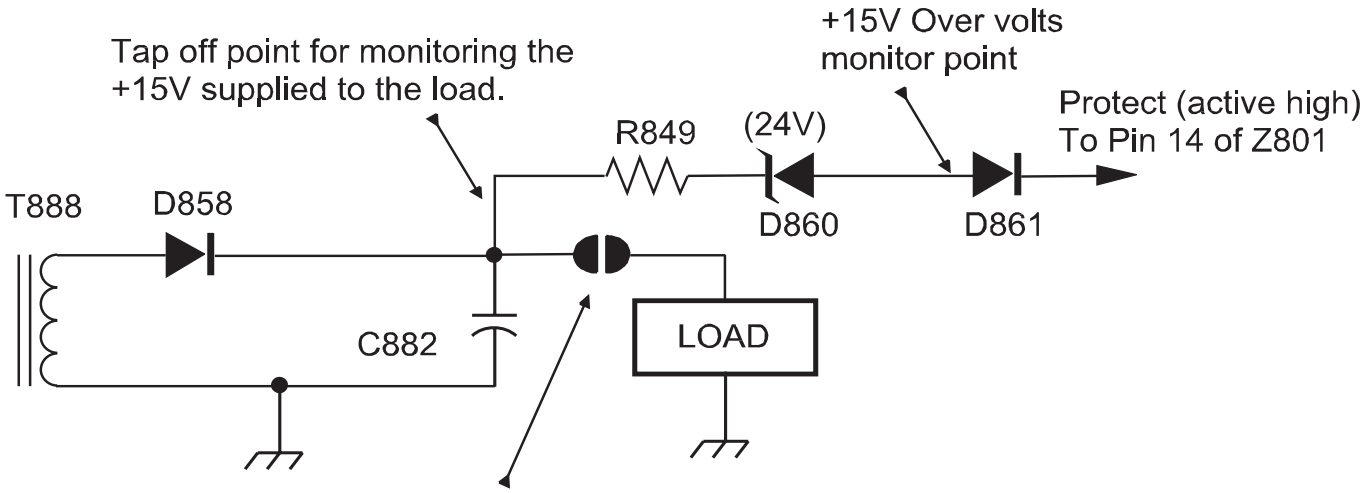


This Link is normally soldered to complete the circuit. Open it for testing. Connect an external DC supply to the load side and monitor the load and the TV while the supply is "seperated." Place an ammeter in line to monitor the load current.

Figure 15. +30V Over Voltage Protect.

4. +15V Over Voltage Protect.

The +15V over voltage protect operates in a similar fashion as the +30V over votage protect.



This Link is normally soldered to complete the circuit. Open it for testing. Connect an external DC supply to the load side and monitor the load and the TV while the supply is "seperated." Place an ammeter in line to monitor the load current.

Figure 16. +15V Over Voltage Protect.

5. +30 V Over Current Protect.

Resistor R 7782 is the Sensing Resistor. It is a very small value. It can cause intermittent shut down problems.

The current flow to the convergence circuits flow through this resistor. Too much current will cause an increase in the voltage across the resistor. Transistor Q768 is biased just below cutoff. A slight increase in voltage across R 7782 will turn on Q768. The collector then goes to about 30V. This is the monitor point for shut down. The normal collector voltage is Zero.

This trigger voltage will turn on Q758. It's collector will go low, to about 0V. This, in turn, causes transistor Q757 to turn off. Q757's collector rises to about 5V, causing shut down to occur.

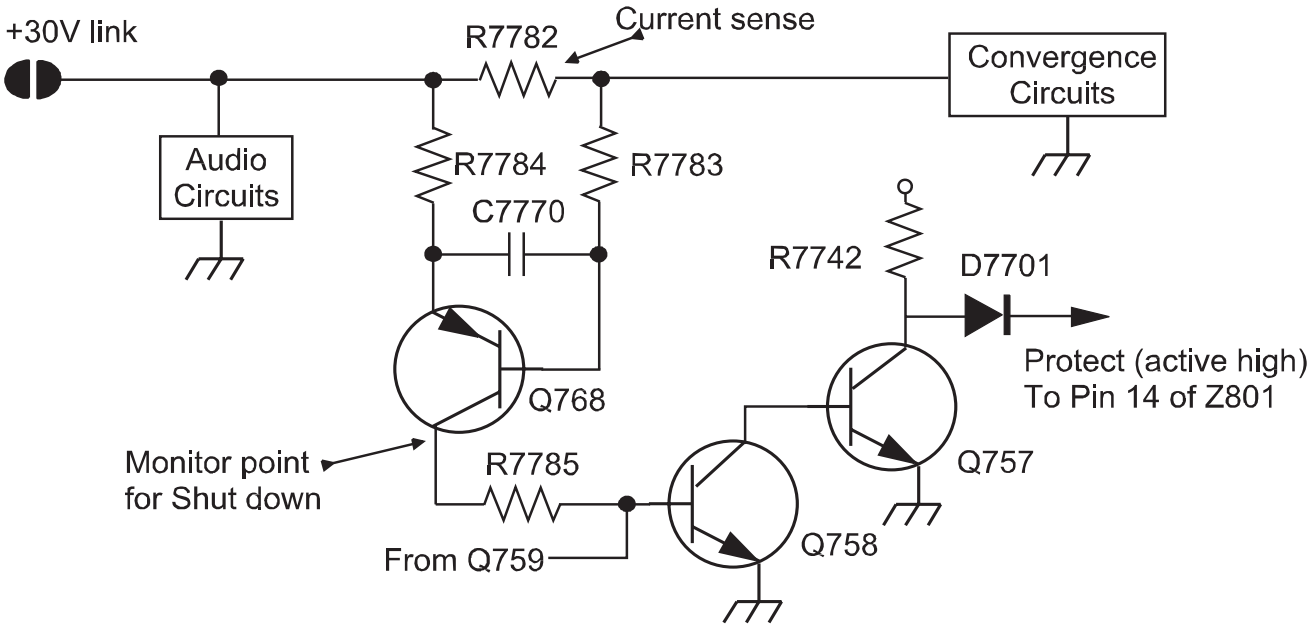


Figure 17. +30V Over Current Protect.

6. +15V Over Current Protect.

The +15V over current protect operates in a similar fashion as the +30V over current protect.

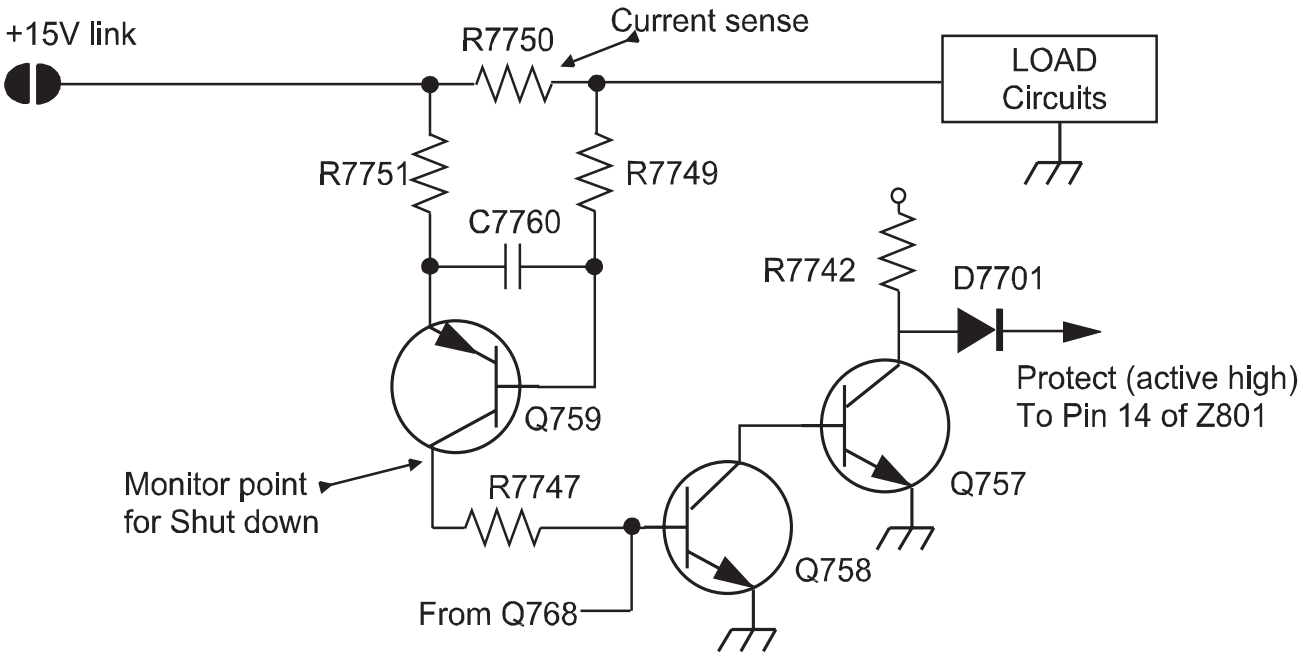


Figure 18. +15V Over Current Protect.

7. -15V Over Current Protect.

The -15V over current protect operates in a manner similar to the +15V over current protec circuit.

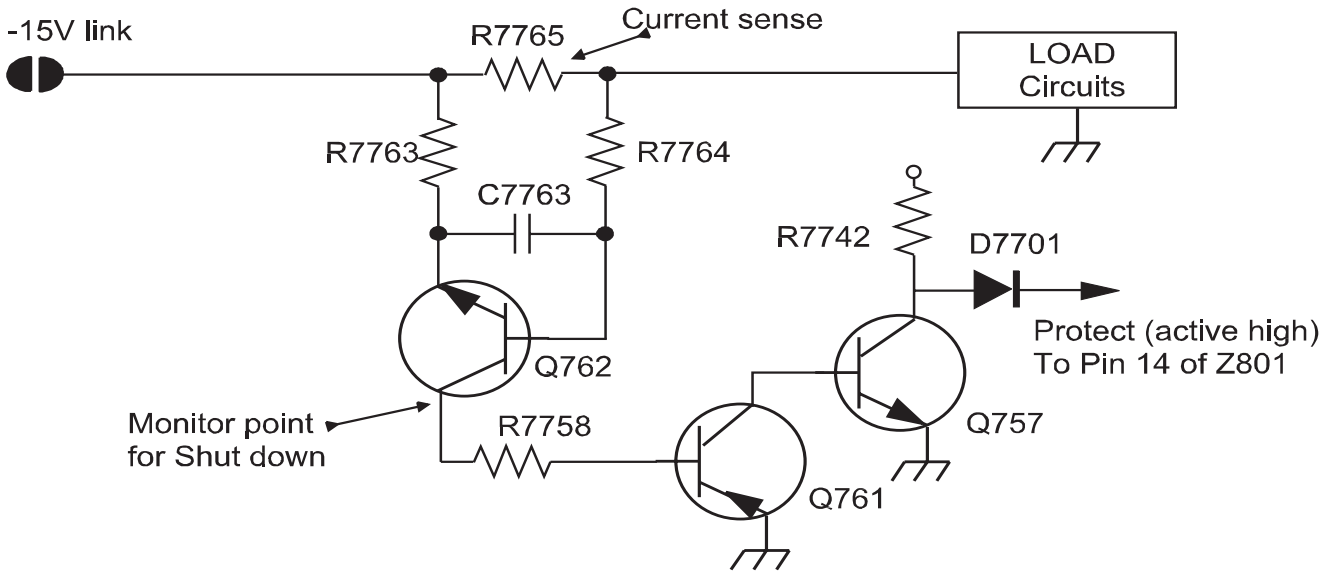


Figure 19. -15V Over Current Protect.

8. +35V Over Current Protect.

A +35V source is developed at the cathode of Diode D302. The load current is carried through current sense resistor R370. If the load current exceeds a certain limit, the voltage drop across R370 increases and turns on transistor Q370.

When Q370 turns on, the collector will go high, towards the +35V supply. This is the monitor point for shut down.

The Zener diode D370 goes into breakdown, and a high voltage is delivered to pin 14 of Z801.

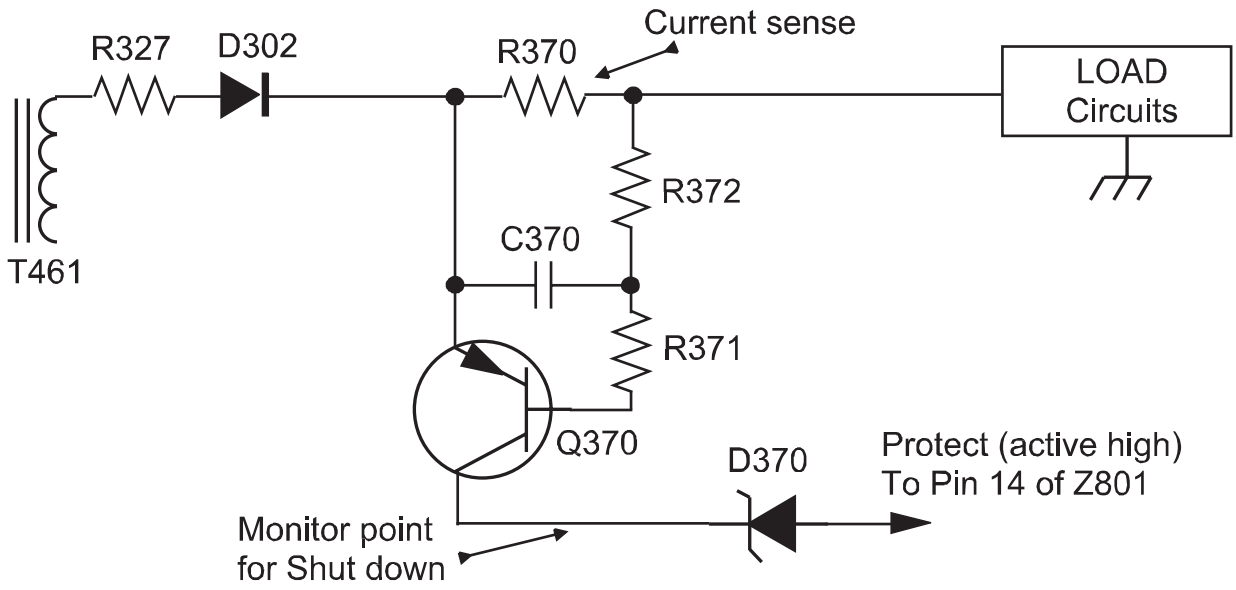


Figure 20. +35V Over Current Protect.

9. +/-15V Under Voltage Protect.

The two circuits work independantly, and do not affect each other.

The +15V turns on transistor Q853. This causes the collector of Q853 to stay low, about 0V. If the +15V goes low, Q853 will turn off, and the collector will go high, to about 5. This will pass through the diode switch, D 866, and shut down will take place.

The -15V turns on transistor Q854. This causes the collector of Q854 to go to about -15V. If the -15V goes low, Q854 will turn off, the collector will go towards the 12V supply. Thios will pass through the diode switch, D867, and shut down will take place.

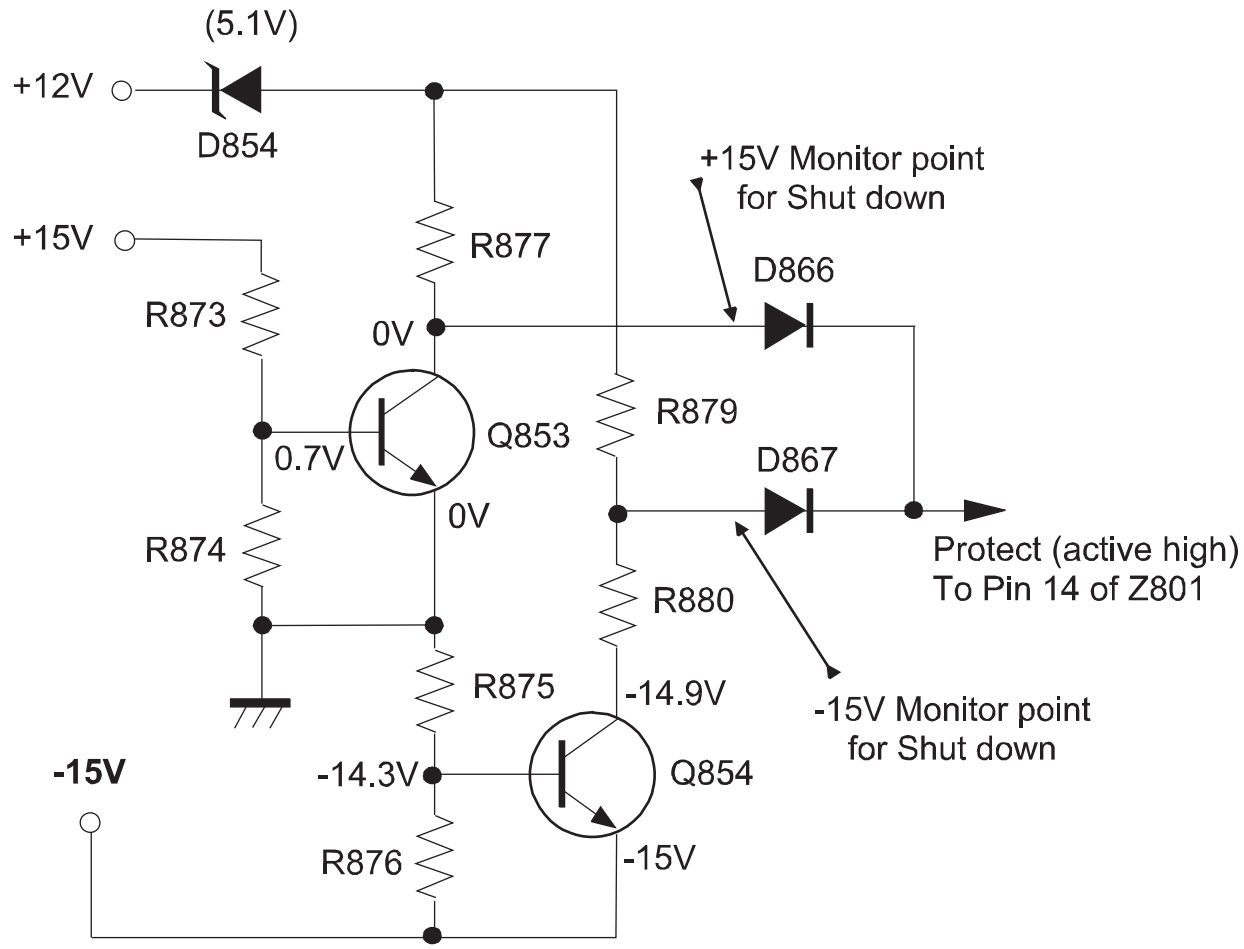


Figure 21. +/-15V Under Voltage Protect.

10. 200V Under Voltage Protect.

The flyback transformer T 461 produces about 200V at the cathode of D406. This is dropped to about 6.8 V on the base of Q340. Under normal operation, Q340 is turned on. This keeps Q341 turned off. The collector of Q341 is about 0 V.

When the 200V drops to about 160V, Q340 turns off, and Q341 will turn on. When Q 341 turns on, its collector voltage will go to about 6 V, sending the high to pin 14 of Z801, resulting in shut down.

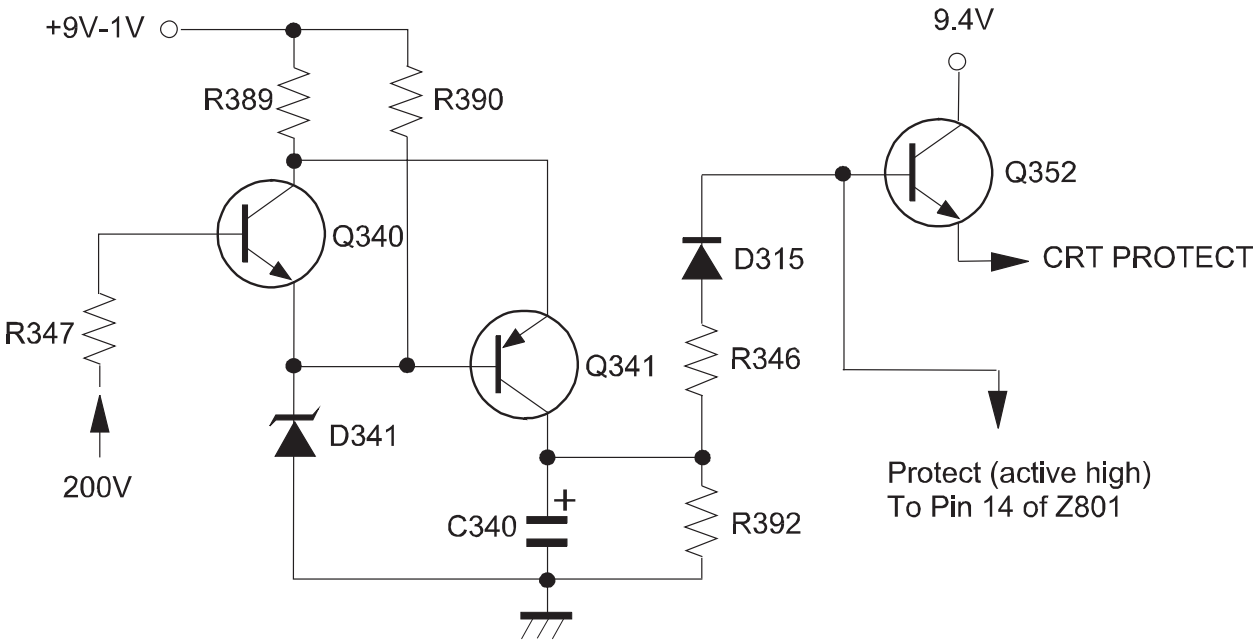


Figure 22. 200V Under Voltage Protect.

11. X-Ray (High Voltage) Protect.

The cathode of D885 is about +40V. This developes a +25V reference to pin 11 of Z801. The cathode of D471 developes a nominal voltage of +22V to pin 13 of Z801.

As long as the X-Ray monitor point voltage is LESS than the reference voltage at pin 11 of Z801, operation is normal.

If the cathode voltage of D471 increases, excessive High Voltage may also be occuring.

When D471 cathode voltage goes GREATER than the reference voltage, shut down occurs.

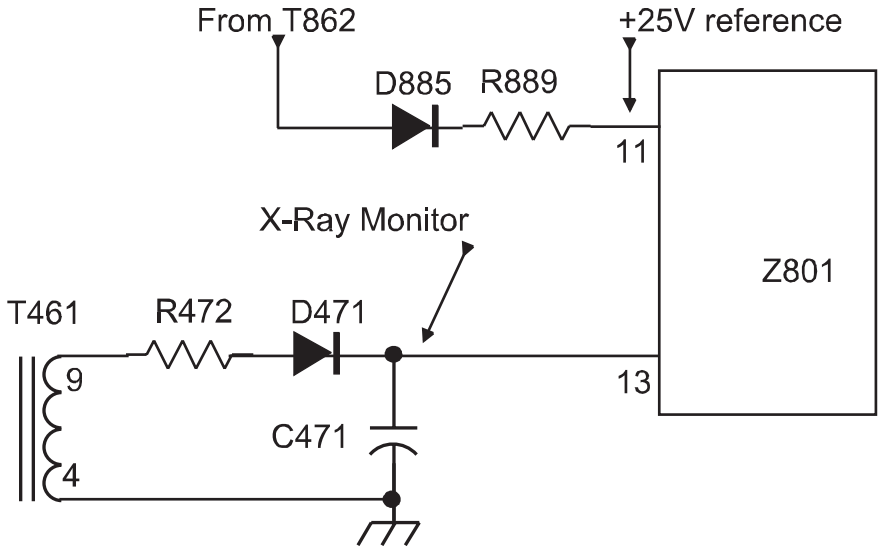


Figure 23. X-Ray (High Voltage) Protect.

12. +125V Over Current Protect.

The current sensing resistor, R470, is in series with the +125V supply.

If the supply current exceeds a certain level, the increased voltage drop across R470 causes shut down to take place.

During normal operation, the voltage drop across R470 is approximately 0.5V. The turn on surge voltage drop is approximately 1.5V.

If the voltage across R470 exceeds about 1.8V, shut down will occur.

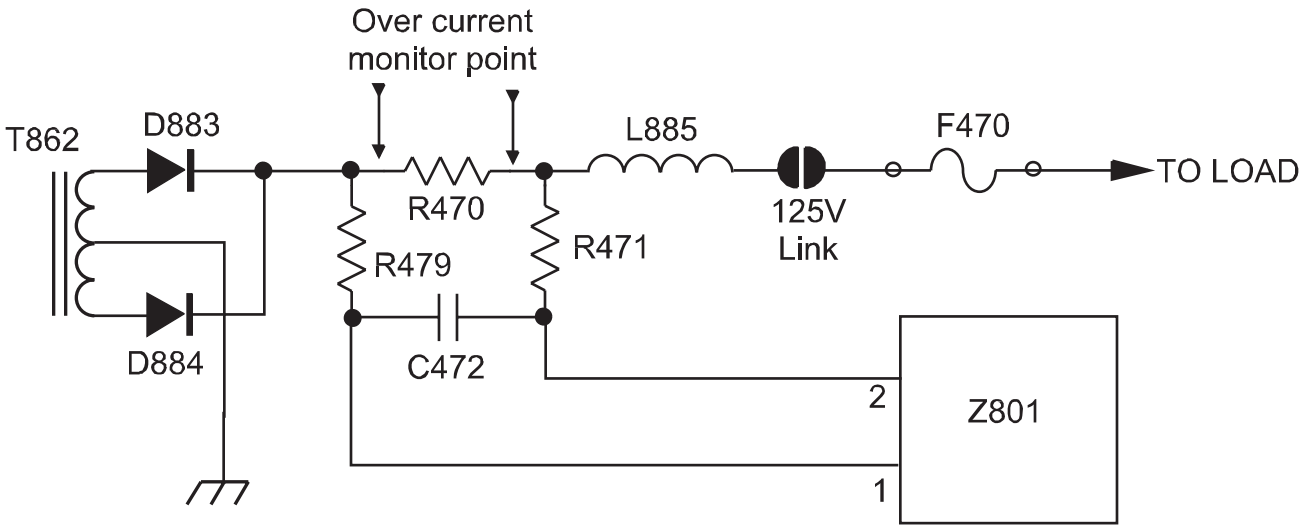


Figure 24. +125V Over Current Protect.