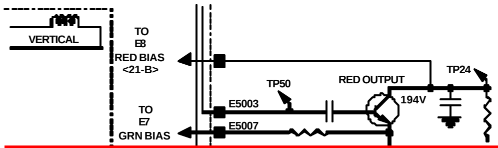
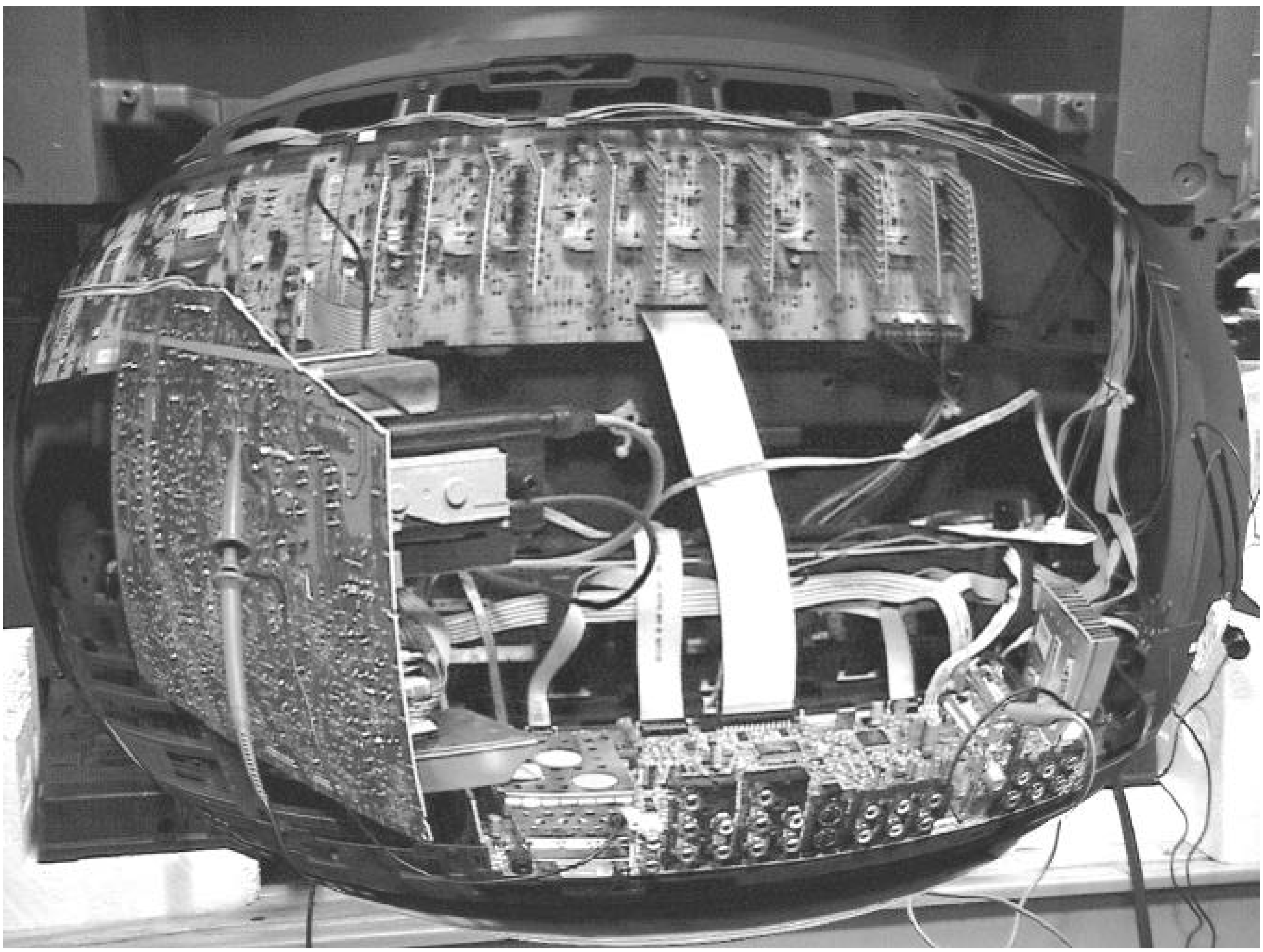


TECHNICAL TRAINING

ITC222

PTV Troubleshooting Guide



TTE

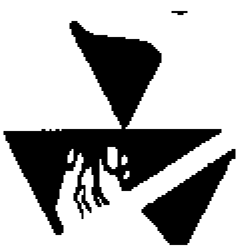
FOREWORD

This publication is intended to aid the technician in servicing the ITC222 television chassis. Directed at the safety circuitry and based on the previous ATC221 Safety Circuit Troubleshooting Manual, it will explain the theory of operation of those circuits highlighting new and different technologies associated with this digitally controlled chassis. It is designed to assist the technician to become more familiar with the safety circuit operation, increase confidence, and improve overall efficiency in servicing the product.

Note: This publication is intended to be used only as a training aid. It is not meant to replace service data. Thomson 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 manual 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 Service Data. All product safety requirements must be complied 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.

First Edition - First Printing

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Prepared by
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PO Box 1976
Indianapolis, Indiana 46206 U.S.A.

Contents

Introduction

The ITC222 Troubleshooting Guide will cover the different shutdown circuits and how to troubleshoot each. It will concentrate on each circuit individually but provide an overall starting point to isolate each shutdown when possible.

Also include in this manual is detailed information about each shutdown. Flow charts and procedures are used to isolate down to a circuit and, where possible, components. Some of the procedures require disabling a shutdown and possible safety issue if not performed correctly. It is the responsibility of the servicing technician to return the set back to safe operation.

An Appendix provides additional information on test points and Op-Amp operation.

This training material assumes a knowledge of the television chassis ITC222. The material has been prepared using general values of components. Components and other circuitry may change over time so in all cases Electronic Service Data for the instrument should be consulted for the most accurate component values and voltages.

Typical nomenclature for component ID and references to ground and supply voltages will be used throughout. To designate individual pin assignments of an IC and active components the following formats are used.

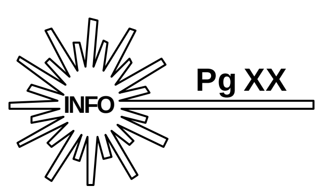
IR001-115 designates IC IR001, pin 115.

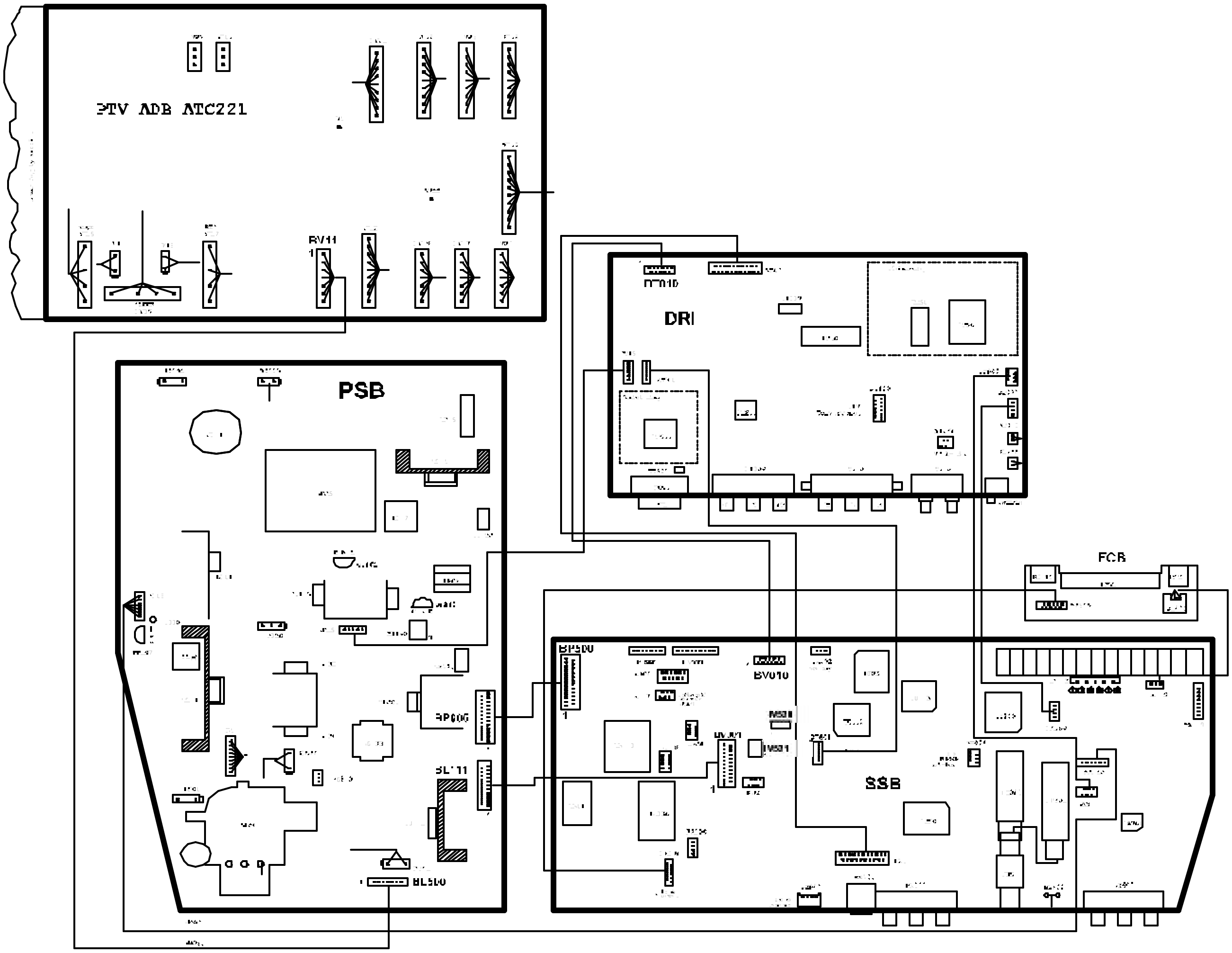
TR198-B designates the Base of transistor TR198.

Power supply labels will be used whenever possible. S for standby operation and R for run. Normal operating voltages and signal designations will be used. For example: SAFETY ENABLE would stand for a signal that under normal run conditions would be a logic HIGH, in most cases near +5V. $\overline{\text{SAFETY ENABLE}}$ would signify a signal whose normal operating level is LOW, in most cases near ground.

EEPROM's or ***E****lectrically* ***E****rasable* ***P****rogrammable* ***R****ead* ***O****nly* ***M****emory*, are sometimes referred to as NVM's or ***N****on*___V___*olatile* ***M****emory* devices. They are the same device simply called by different names.

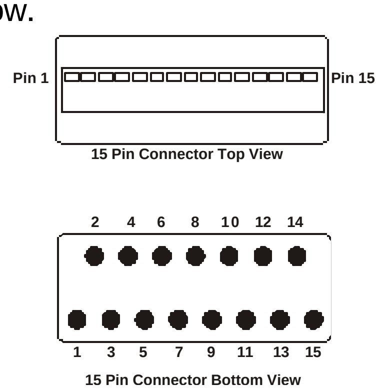
The following symbol is used to reference additional information. It has the page number were the additional information can be found.





Tthe ITC222 PCB's maybe referenced during troubleshooting. The Board layout view above will be used to navigate to the various test points referred to in this troubleshooting guide. The view is from the top of the PCB with reference connectors shown in **BOLD** lettering and pin **1** marked for further ease of identification. The technician may count away from pin one from either the top or bottom of the board. In most cases the test points are easier to access from the bottom of the board.

Some connectors may appear inline from the top, but may have staggered pinouts on the solder side as in the figure below.

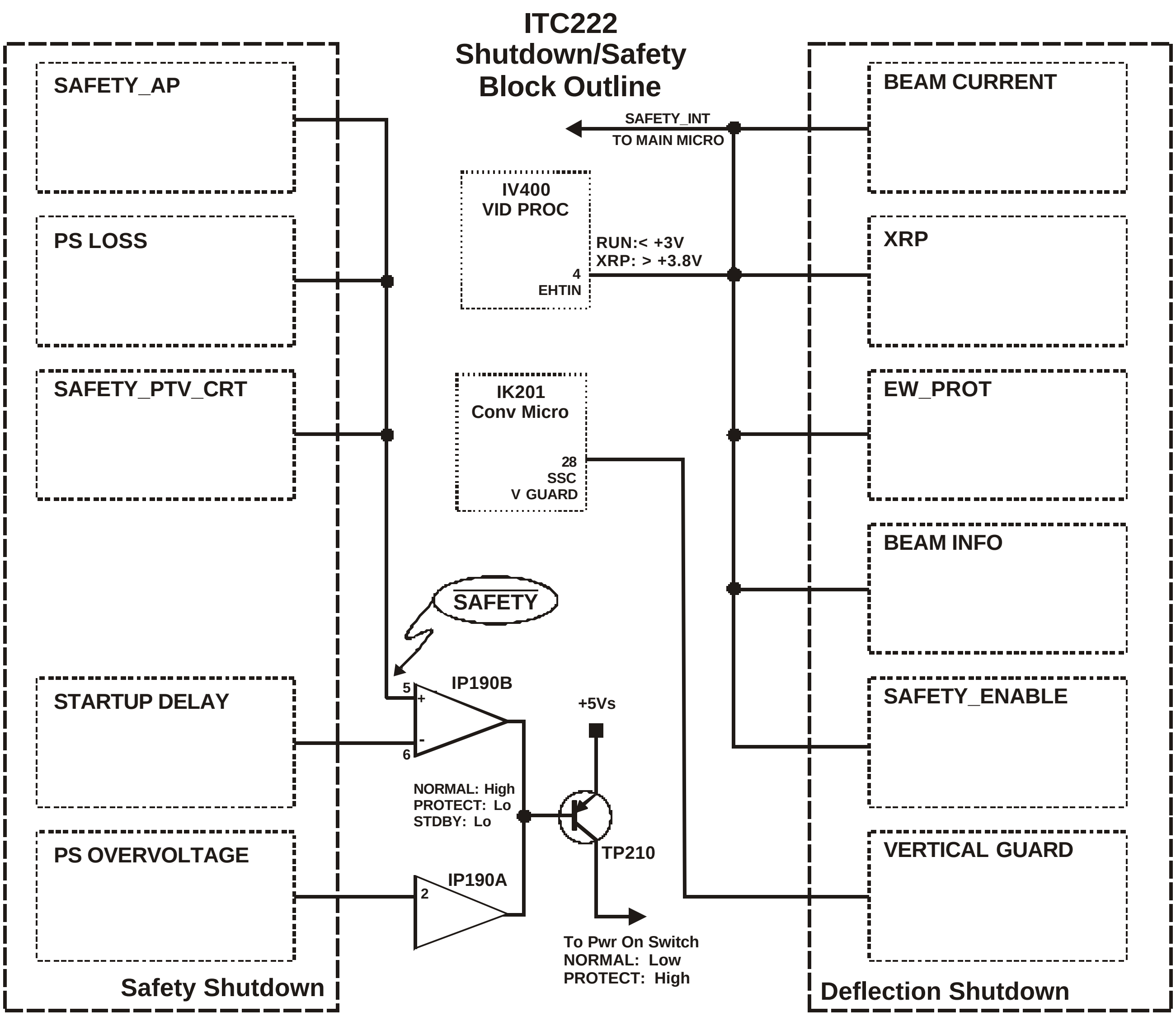


Note from the top of the board pin one through pin fifteen is sequential. However from the bottom of the board the pins are staggered with pin one starting from the larger row at the lower left, pin 2 diagonally up, then diagonally back to pin 3 and so on.

Overview

As the ATC221 did previously the ITC222 uses two independant legs of safety and operational shutdown circuits closely tied together. These legs are made up of other circuits that protect individual sections to prevent catastrophic failure in circuits such as the power supplies, deflection, convergence and others. The individual sections are connected to one of two main branches of protection circuitry: one for safety related shutdowns of the main run supply (Safety Shutdown) and another for deflection related failure shutdown including XRP Deflection Shutdown).

The two branches operate independantly of each other and although performing different functions both result in a shutdown of the set which may or may not provide error code data. In many cases recovering from shutdown is automatic. Other times an AC recycle of the instrument is required. If there are three deflection restarts within 2 minutes a special warmstart is performed. After the third deflection restart the system will switch to Standby-mode and stay there for a minimum of one minute. During this minute all FPA and remote IR commands are ignored which means the set cannot be turned on. This is implemented due to safety reasons and to avoid overheating components.



In many areas multiple signal lines converge into one point. Most times those converging lines are isolated by a diode. New for the ITC222 is the use of open collector comparitors allowing direct connection of multiple signal lines. Since one shutdown can affect other safety or protection lines it complicates troubleshooting. This manual will attempt to show where common checkpoints and measurement locations are along with nominal voltages expected during run or shutdown situations.

Below are the shutdown circuits and the signal lines that connect to the different shutdowns.

The Safety shutdown may be broken into five distinct sections:

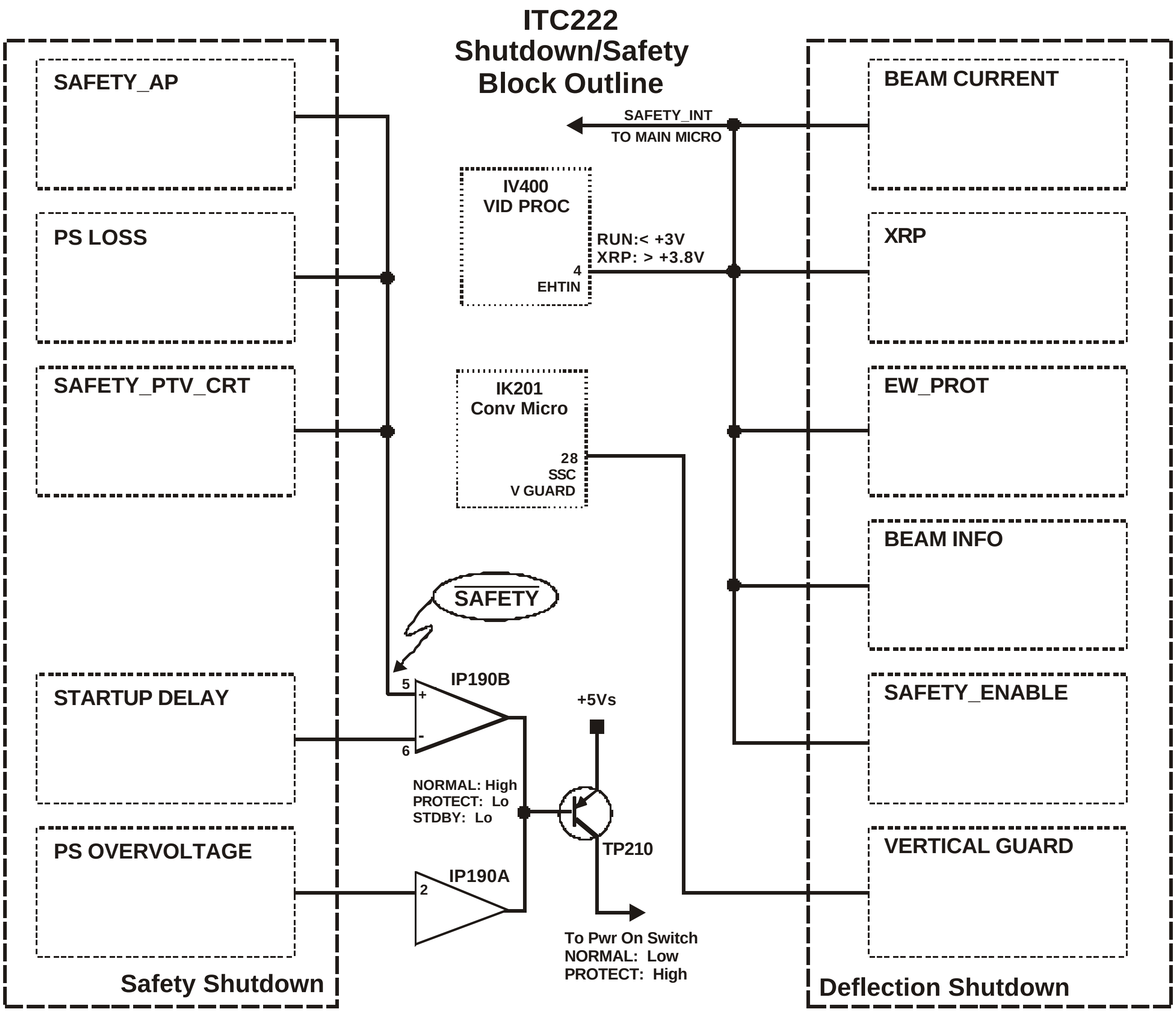
- Audio Power Supply and Audio Output Monitoring
- Main Run Power Supply Loss (PS LOSS)
- Rear Projection Instrument Safety (CRT Scan Loss protection)
- Startup Delay
- Power Supply Overvoltage

Deflection Shutdown may also be broken into six distinct sections:

- Beam Current monitoring
- XRP
- East West Circuitry Power Dissipation
- General Deflection Safety
- Micro based suspension of the Safety Monitoring during deflection startup (Safety_Enable)
- Vertical Guard to shut down CRT drive in the event of vertical scan failure

Because many of the sensors are looking at voltages that could cause shutdown circuits to activate, there are typically threshold voltages causing the actual shutdown trip. In this manual many voltages provided are "nominal". In other words the voltages may change during operation, or may not be exactly as indicated depending upon circuit tolerances, alignments and adjustments. When nominal voltages are indicated study the surrounding circuits to determine how close to the nominal the voltage should be. Every attempt will be made to provide the range expected however due to accumulative circuit tolerances nominal voltages are interdependant on the circuits feeding them and may vary over a wide range yet still be valid. The most important indication of circuit activity will usually be the relationship of the input voltages of the opamps or comparitors and whether the output of those devices logically follow the inputs.

Threshold voltages are generally more accurate since they have been set specifically to shutdown operation if the threshold is reached. The only exception to the specific threshold voltage is XRP, which must be adjusted according to specific circuit reaction to many interelated conditions.


ITC222
Shutdown/Safety
Block Outline
SAFETY_AP
PS LOSS
SAFETY_PTV_CRT
STARTUP DELAY
PS OVERVOLTAGE
Safety Shutdown
SAFETY_INT
TO MAIN MICRO
IV400
VID PROC
4
EHTIN
RUN:< +3V
XRP: > +3.8V
IK201
Conv Micro
28
SSC
V GUARD
SAFETY
IP190B
5
6
+5Vs
NORMAL: High
PROTECT: Lo
STDBY: Lo
TP210
IP190A
2
To Pwr On Switch
NORMAL: Low
PROTECT: High
BEAM CURRENT
XRP
EW_PROT
BEAM INFO
SAFETY_ENABLE
VERTICAL GUARD
Deflection Shutdown

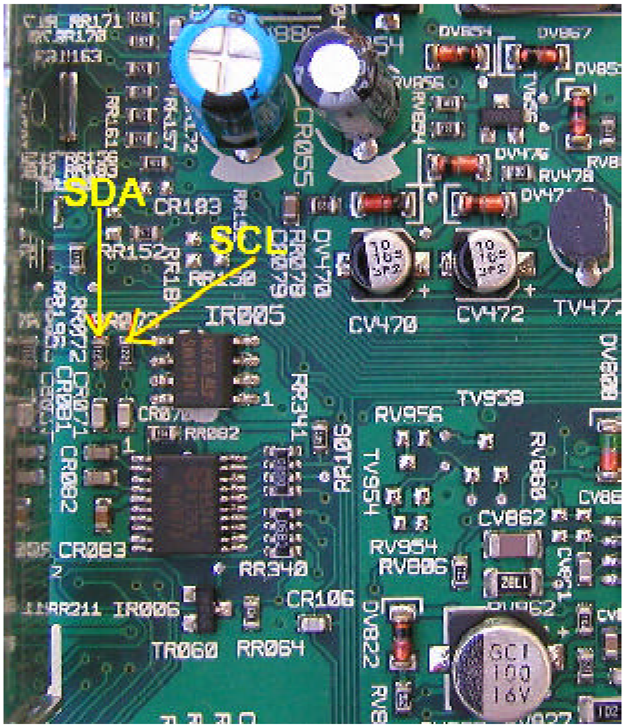
ITC222 Dead Set Troubleshooting

The first step in all troubleshooting is to determine what is or is not working. The following information should be used when the set is totally dead or nothing happens when the power button is pushed.

1 Once the main fuse has been eliminated as a potential problem, measure the +1.8Vs supply at IP551 on the SSB board:

The +1.8Vs voltage is the main supply for the main microprocessor, IR001. Without it, nothing will fire up. If missing troubleshoot the Standby Power Supply.

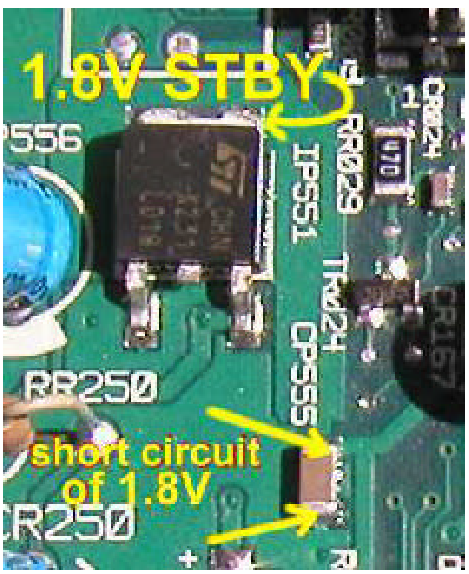
2 Once the +1.8Vs supply has been confirmed as operational, check the clock (pin 6) and data (pin 5) lines to the main NVM, IR005.

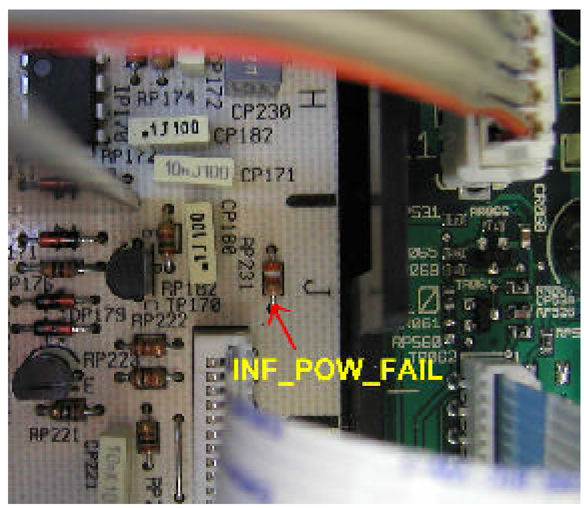


In the first 100mS after AC power is applied the CLOCK and DATA lines must rise to very near +5V and have at least few cycles of data. This indicates communication between the main microprocessor and NVM (EEPROM). Note only a limited amount of information is transferred when AC is applied. Then communications will cease until the power ON button is pressed to start the chassis. However the short amount of data transfer between the microprocessor and NVM is a good indication that communications between the main microprocessor, ROM and RAM were successful and the main microprocessor is alive.

From observing clock and data activity, there are two failure indications. First, if there were no signs of data or clock suspect the main microprocessor is defective. However if there is constant communications it indicates the microprocessor is trying to communicate with the NVM and cannot. Suspect a defective NVM (EEPROM). In either case the SSB should be replaced.

NOTE: In some cases it may be required to check this communications again. To do so requires the main micro be in a zero voltage state. Be aware the mains doubler can hold a significant voltage for a long period of time. AC must be removed for at least several minutes to give the +1.8Vs supply time to completely bleed off. To save time the +1.8Vs supply may be bled by shorting CP555 on the SSB module. Check the +1.8Vs supply to make certain it is less than +0.2V before attempting to reapply AC power.





Power Fail (INF_POW_FAIL)

Another useful preliminary check is the INF_POW_FAIL voltage located on the PSD board. The voltage monitors an unregulated rectified output from the +7Vs winding. This can be located on one end of RP231 as shown. During normal operation this voltage will be less than -1V and normally stays around -2V. INF_POW_FAIL can indicate severe loading problems on the standby supplies. Absence of a negative INF_POW_FAIL signal will not allow the chassis to start.

Troubleshooting flow charts and procedures

Shutdown or Three Strikes

Start

Apply AC power and Press the power switch

Does the FPA LED flash?
- No → Check standby power supply voltages per chart →
- Yes → System Reset

Device	Voltage
DP220-C	+7.2V
IP250-3	+4.99V
DP240-C	+3.4V

Voltages correct?
- Yes → System Reset
- No → Troubleshoot the Standby power supply

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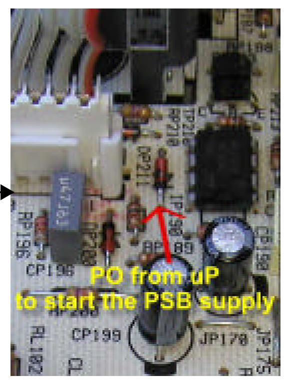
See Bottom of Page for System Reset

Monitor the PO (Power ON) line at DP211-A and press the power switch — Location INFO →



Did the PO line change state (go from low to high)?
- No → Troubleshoot System control
- Yes → System Reset

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See Bottom of Page for System Reset

System Control is trying to turn on the run supply. Monitor the Safety shutdown at TP210-C and press the power switch.

Does TP210-C go high (Protect)?
- No → Troubleshoot Deflection Shutdown
- Yes → Troubleshoot Safety Shutdwon

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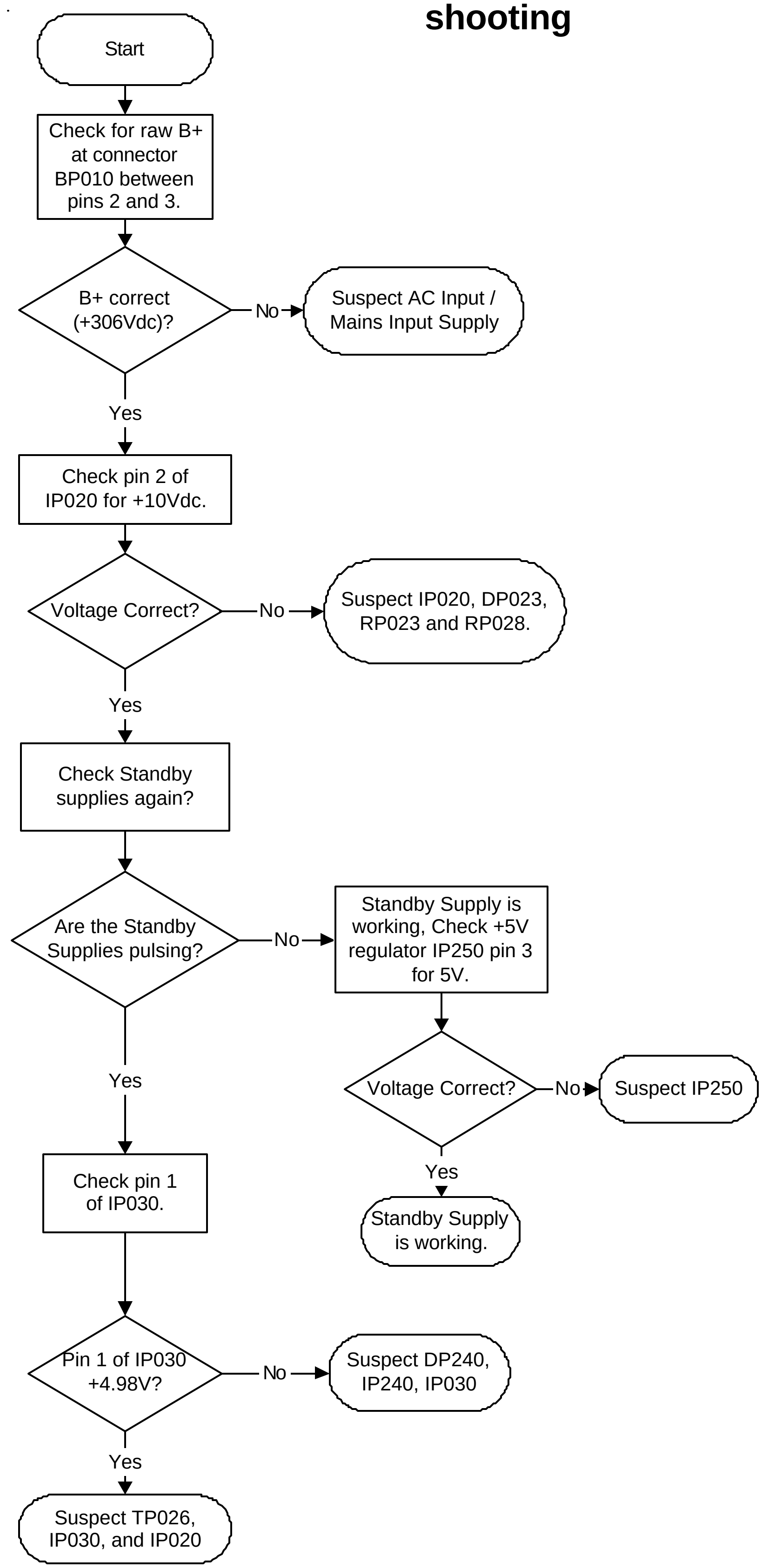
System Reset: *Remove AC power and short out CP555 for 10 seconds then reapply AC power. See page 11 for details.*

Troubleshooting flow charts and procedures

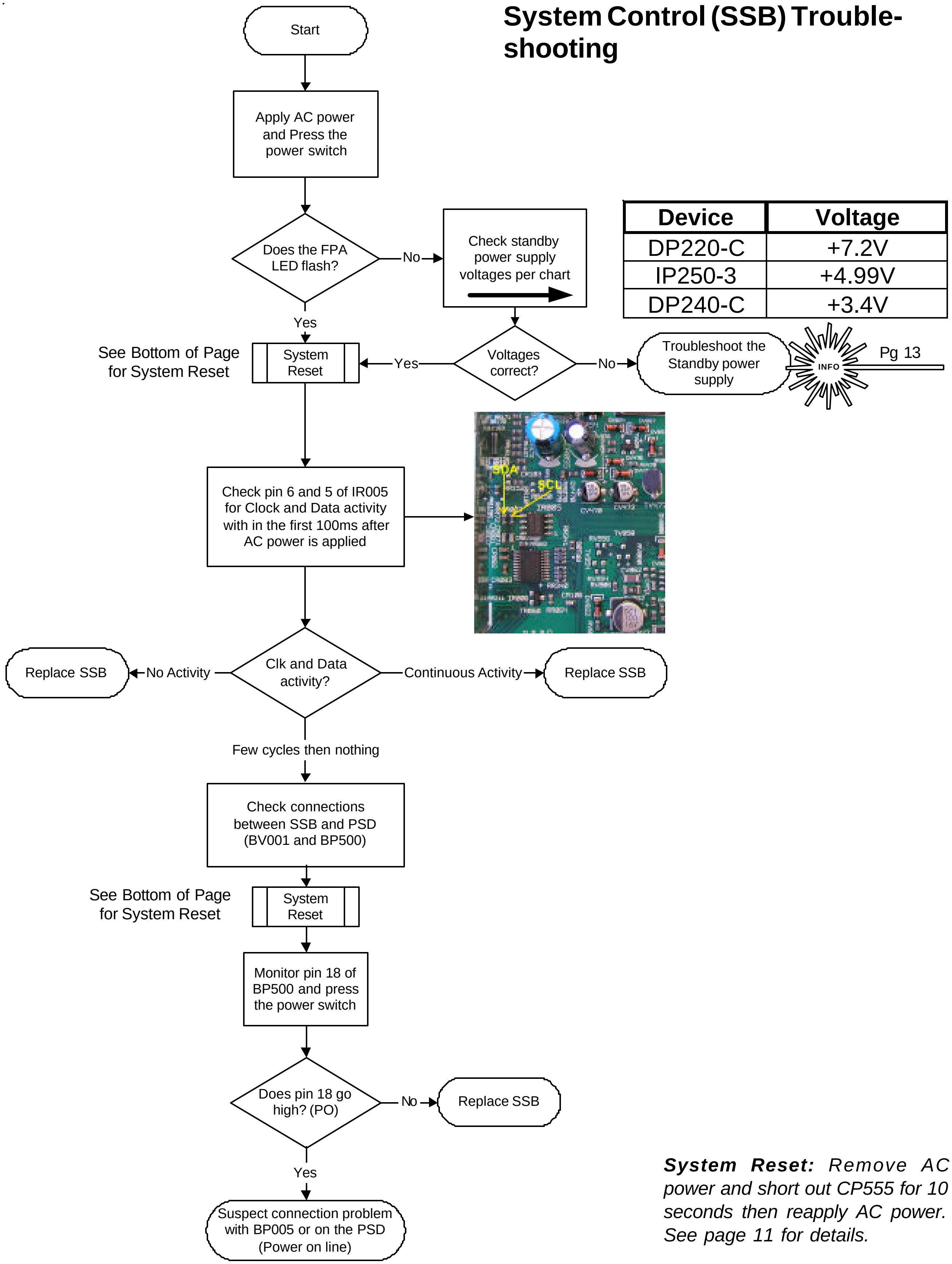
Standby Power Supply Trouble-shooting



Troubleshooting flow charts and procedures

System Control (SSB) Trouble-shooting

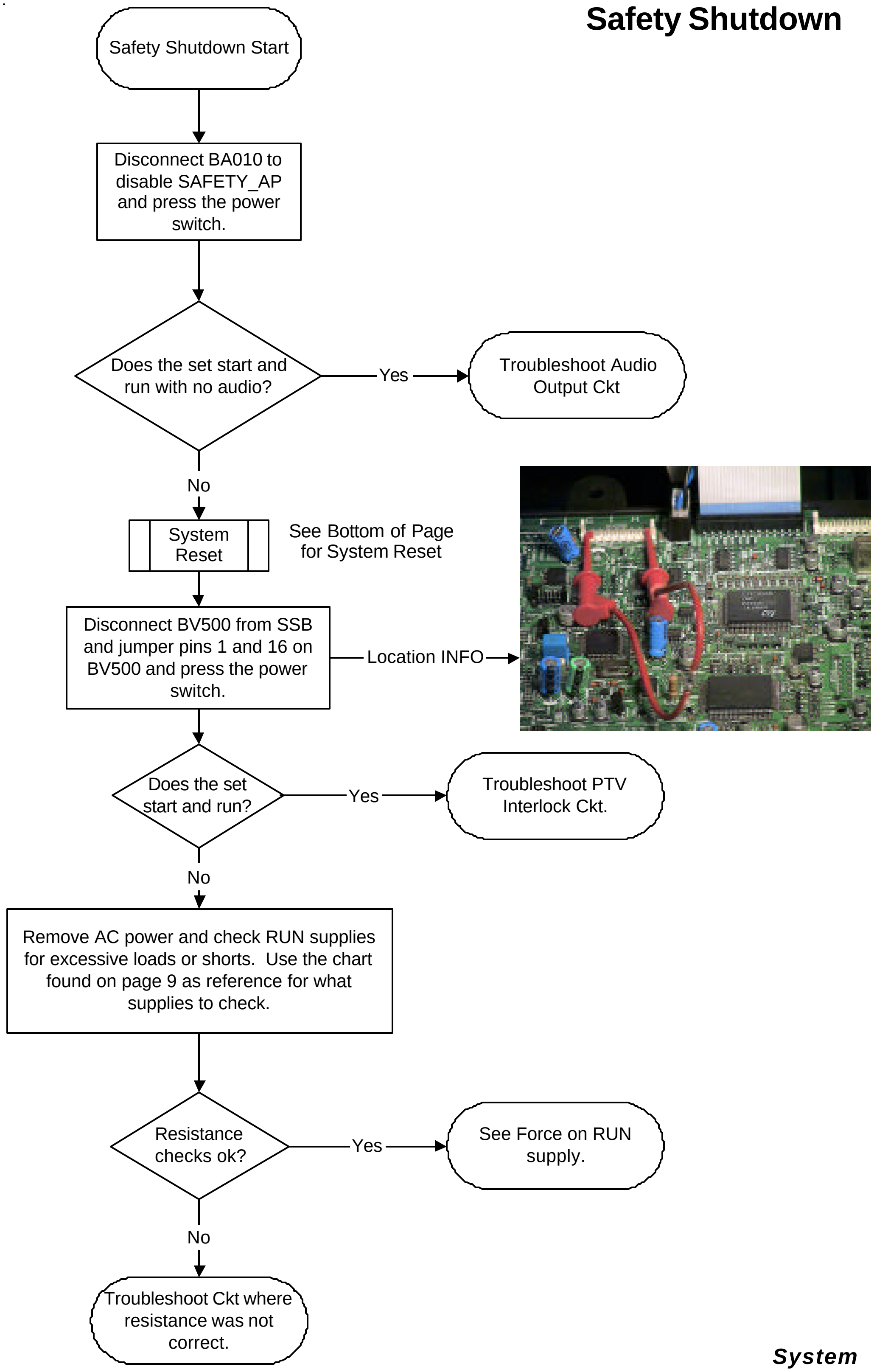
Device	Voltage
DP220-C	+7.2V
IP250-3	+4.99V
DP240-C	+3.4V



System Reset: *Remove AC power and short out CP555 for 10 seconds then reapply AC power. See page 11 for details.*

Troubleshooting flow charts and procedures

Safety Shutdown



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INFO Pg 16

System Reset: *Remove AC power and short out CP555 for 10 seconds then reapply AC power. See page 11 for details.*

Troubleshooting flow charts and procedures

ITC222 Force ON RUN supply

1. Unsolder collector of TL010 (Horizontal Output)
2. Short base to emitter of TP210
3. Short emitter to collector of TP150
4. Apply AC power

Note: Without horizontal drive (H_DRIVE), regulation is disabled. The +137Vr will vary from +140V to +160V. This is considered normal operation for the Run Supply when forced to operate without Horizontal feedback.

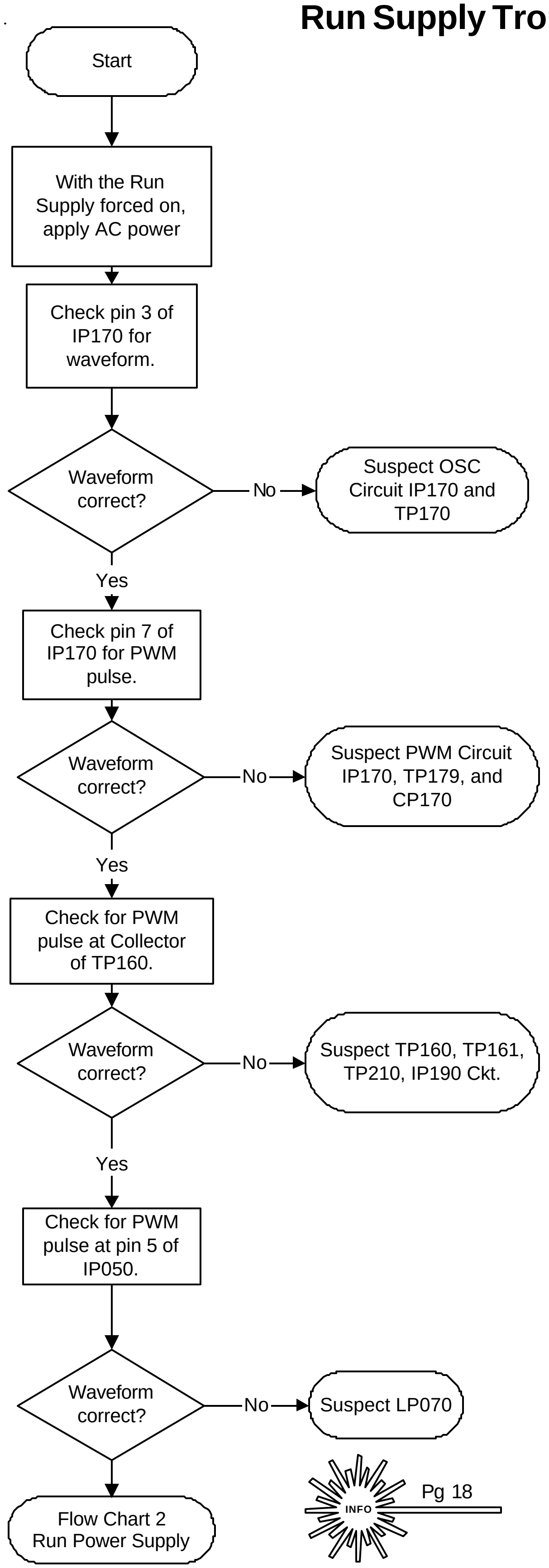
5. With the run power supply forced on, check the following voltages per the chart below. If all voltages are ok, suspect system control or power ON problem. If one or more voltages are incorrect or all are missing, troubleshoot the missing or incorrect voltage from the run supply.

Device	Voltage
DP110-C	+142.5V
DP130-C	+15.9V
DP135-A	-15.7V
DP120-C	+20.5V
DP140-C	+11.0V
DP150-C	+6.2V
IP540-3	+9.0V
IP510-3	+7.9V
TP520-S	+5.1V
IP530-2	+3.2V
IP531-2	+1.8V

Safety Shutdown	Device	Resistance to GND
Sense_3V3	IC001-2	.5K
Sense_2V5	IC006-2	.4K
+3V3	IP530-2	.57K
+5V	TP520-S	160 Ohms
+8V	IP510-3	1.5K
+9V	IP540-3	1.2K
USYS	DP110-C	27K
20V	DP120-C	3K
10V	DP140-C	1.3M
6V	DP150-C	1.2M

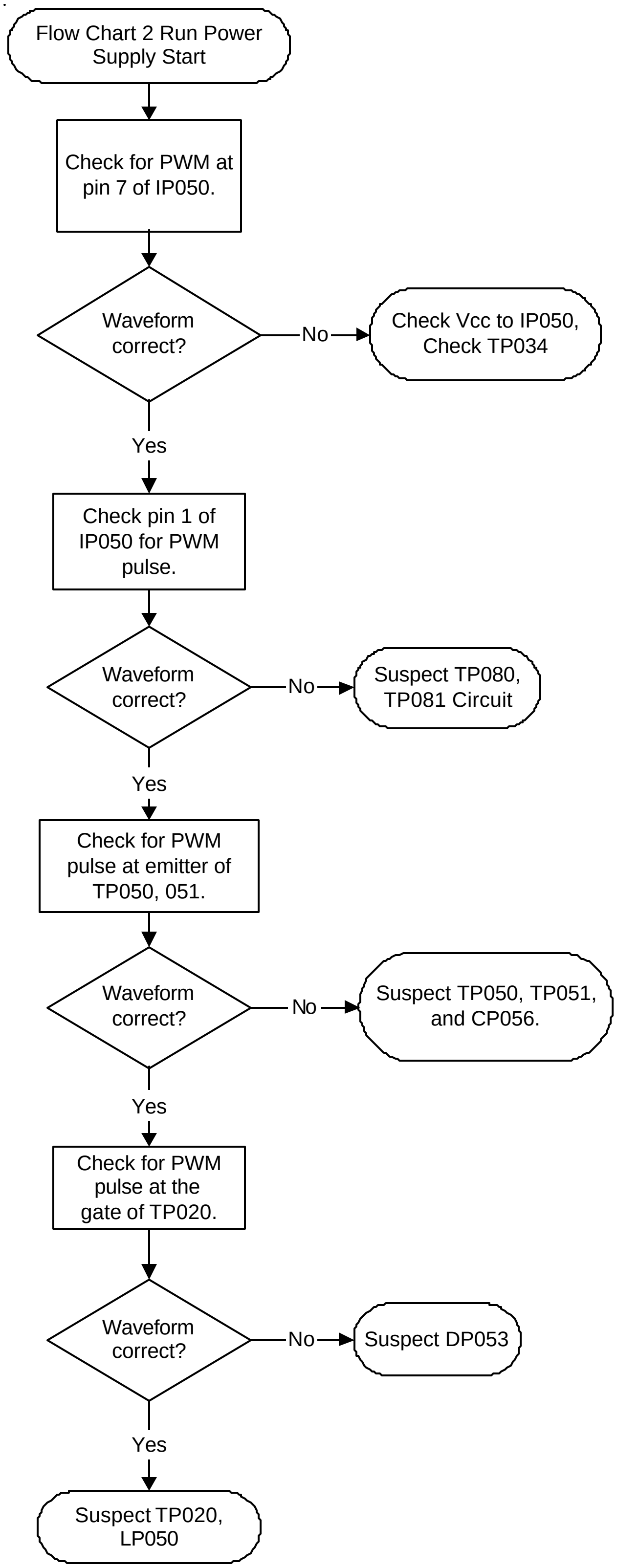
Troubleshooting flow charts and procedures

Run Supply Troublehsooting



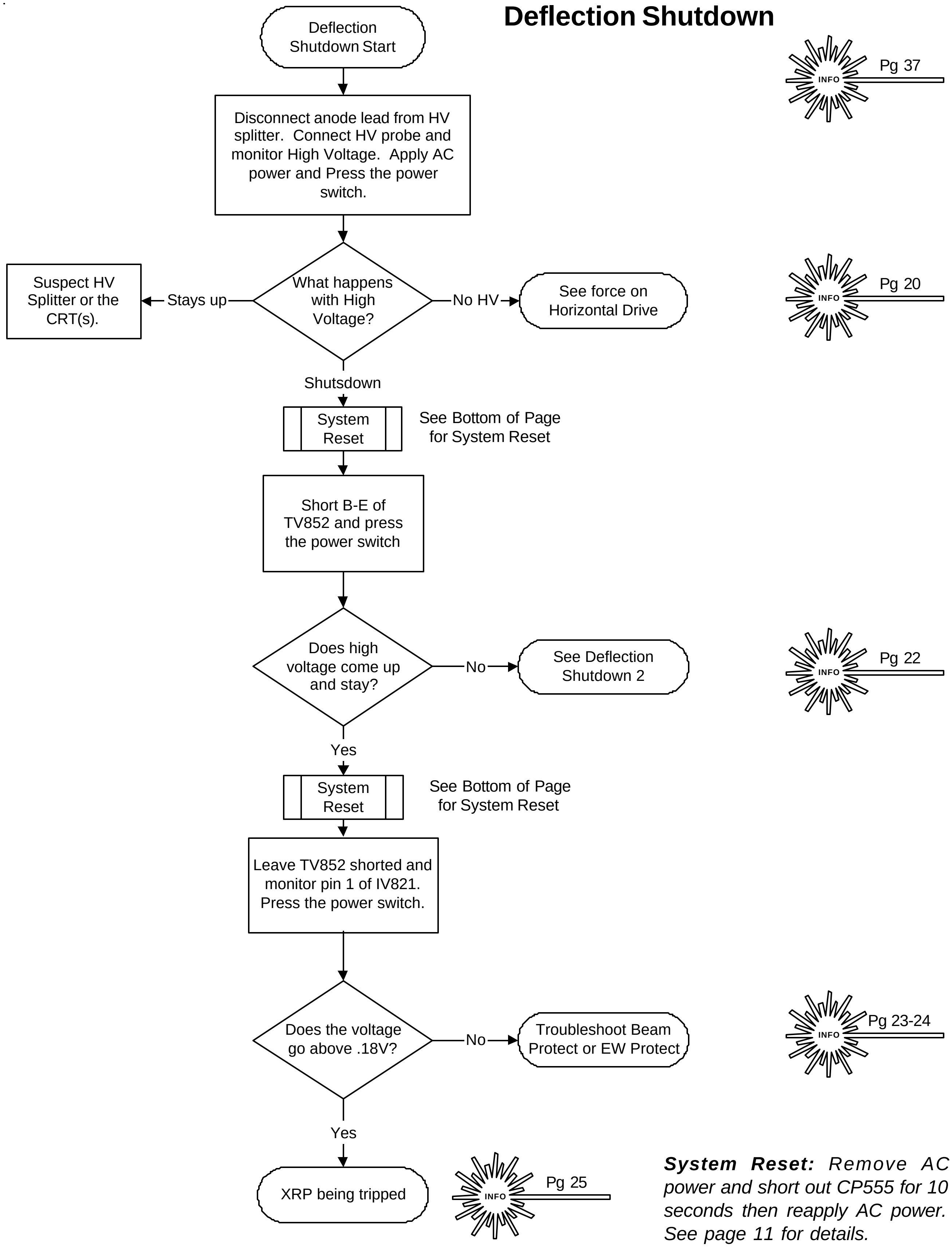
Troubleshooting flow charts and procedures

Run Supply Troublehsooting Continued



Troubleshooting flow charts and procedures

Deflection Shutdown



System Reset: *Remove AC power and short out CP555 for 10 seconds then reapply AC power. See page 11 for details.*

Troubleshooting flow charts and procedures

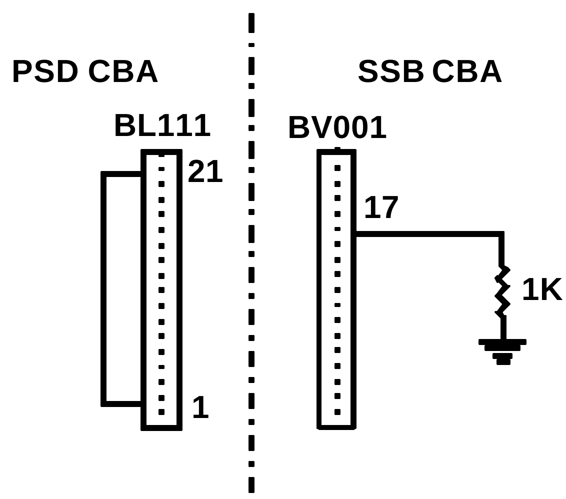
ITC222 Force on Horizontal Drive

This procedure will verify if the SSB is generating horizontal drive or not. If drive is present from the SSB, then see Deflection Shutdown 2 Troubleshooting, if not suspect the SSB as the problem.

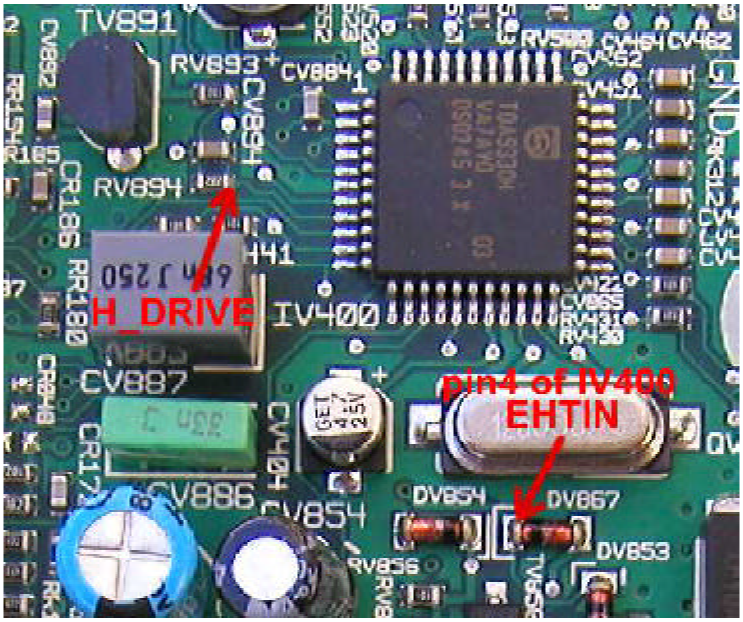
1. Remove ribbon cable BL111 to BV001
2. Jumper pins 1 and 21 on BL111 PSD CBA
3. Add 1K resistor to ground (Cold) from pin 17 of BV001
4. Monitor waveform at pin 8 of IV400 or DC voltage. Voltage or waveform will remain for about 1.5 seconds when power is pushed.

DC reading on pin 8 of IV400:

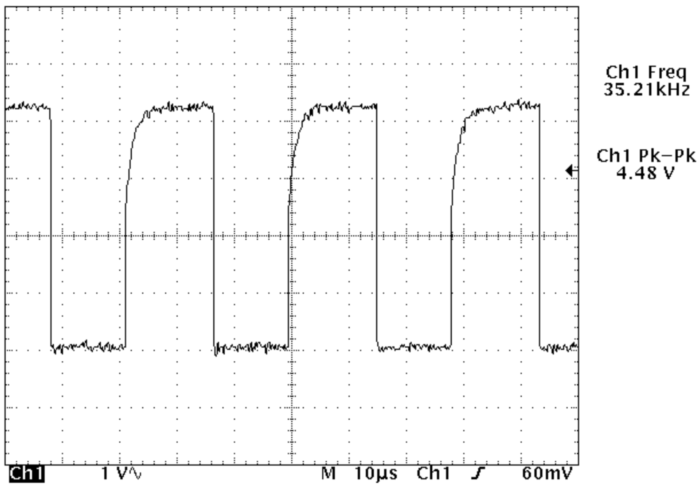
4Vdc = no drive
2Vdc = drive



Troubleshooting flow charts and procedures

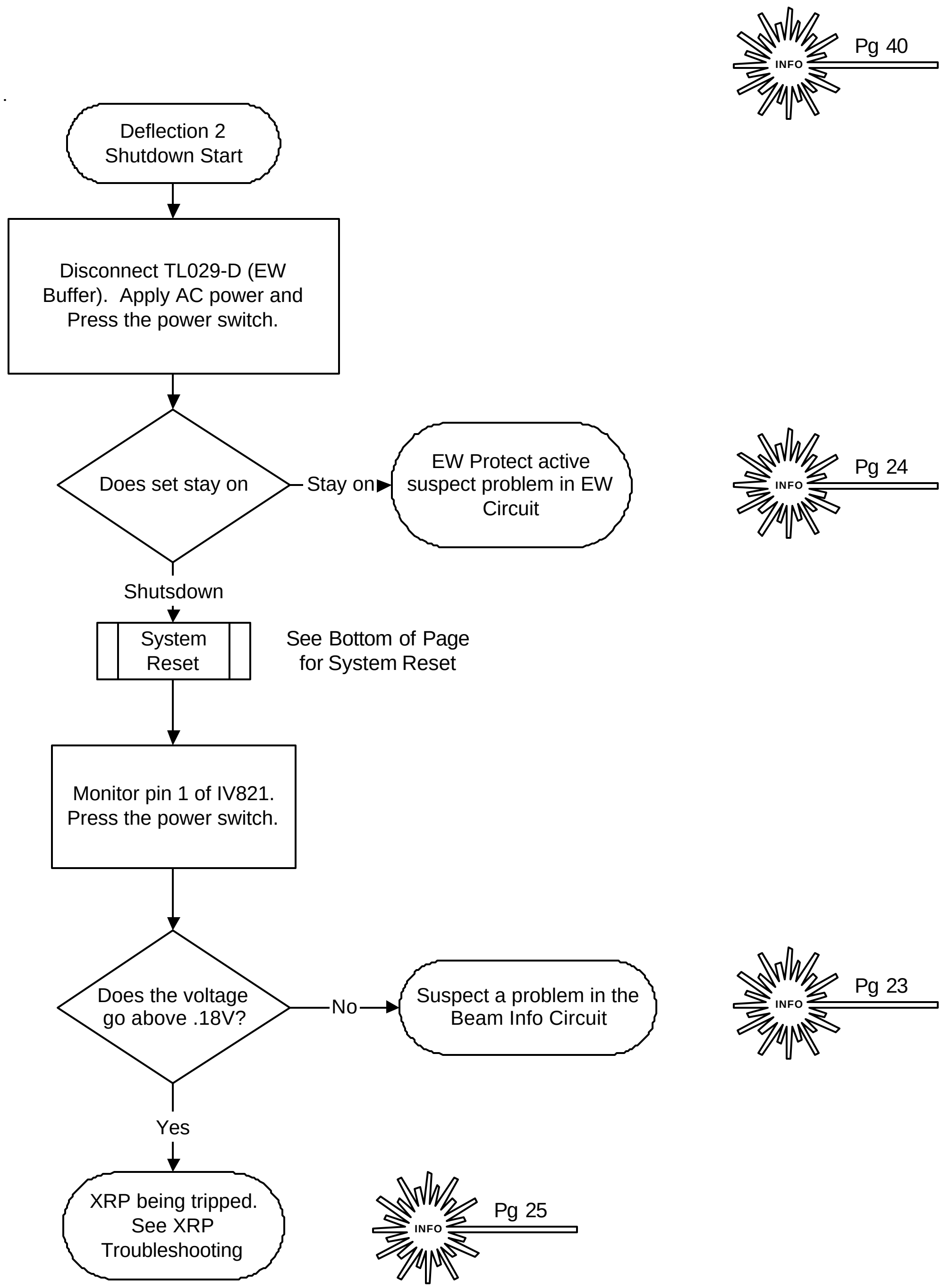


H_DRIVE when forced on



Troubleshooting flow charts and procedures

Deflection Shutdown 2



System Reset: *Remove AC power and short out CP555 for 10 seconds then reapply AC power. See page 11 for details.*

Troubleshooting flow charts and procedures

Beam Info Troubleshooting

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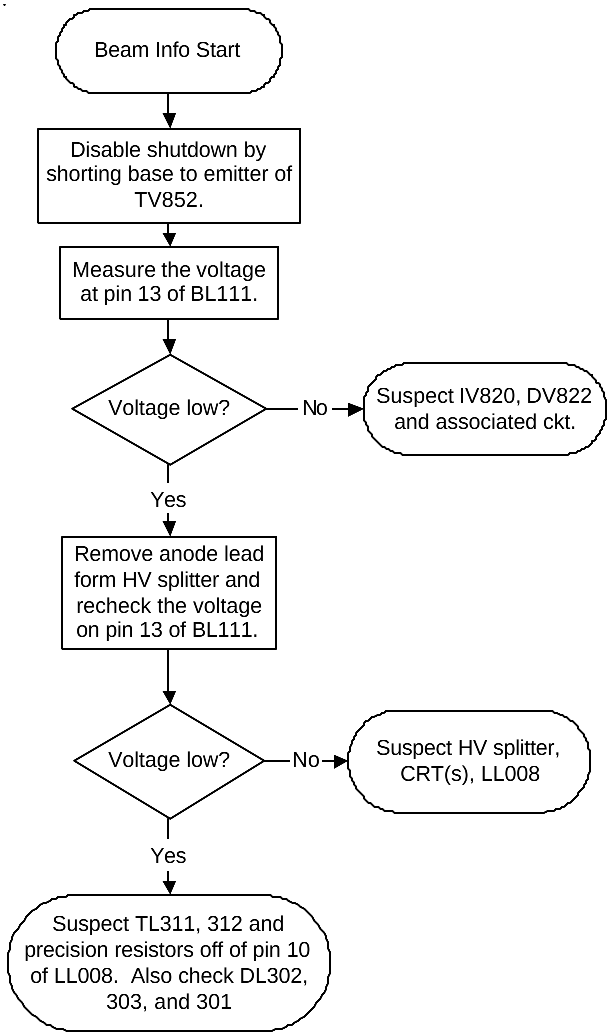
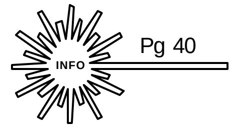
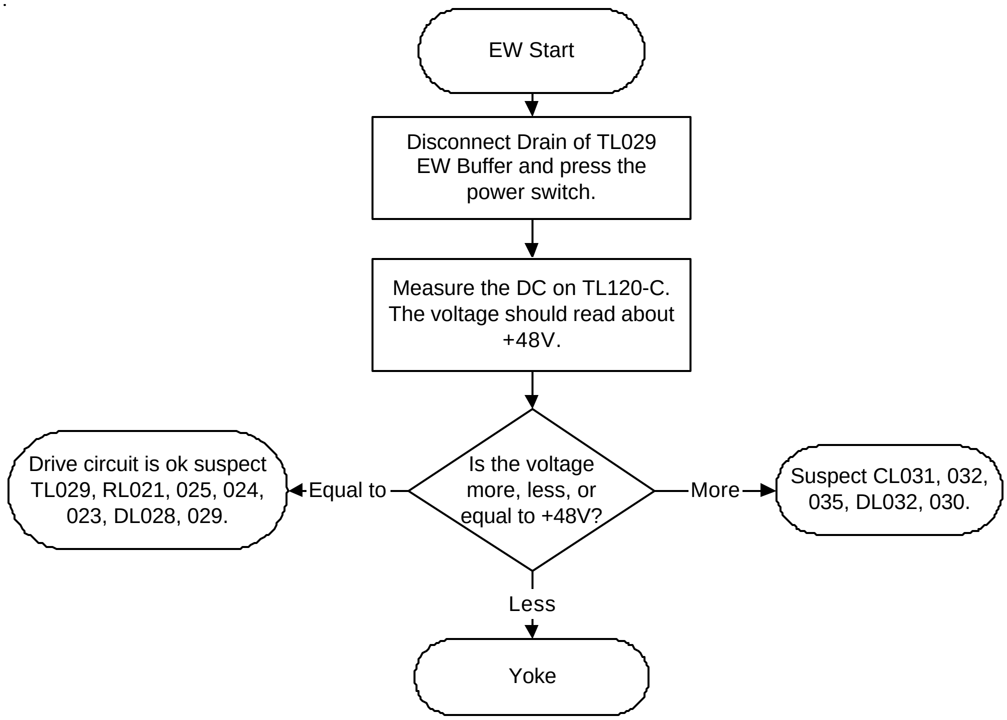


Troubleshooting flow charts and procedures

EW Troubleshooting





Troubleshooting flow charts and procedures

XRP Troubleshooting

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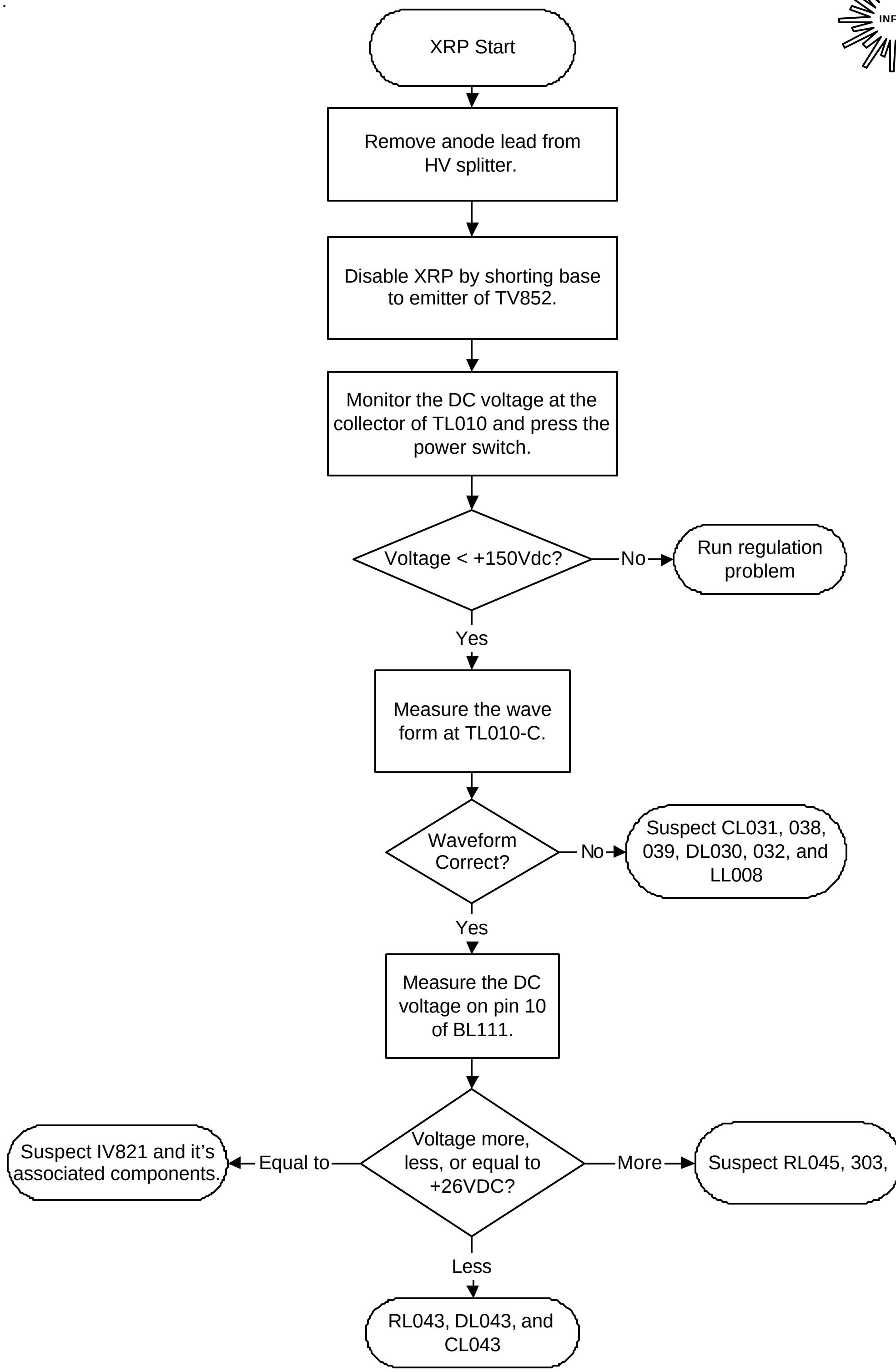

Troubleshooting flow charts and procedures

Vertical Troubleshooting

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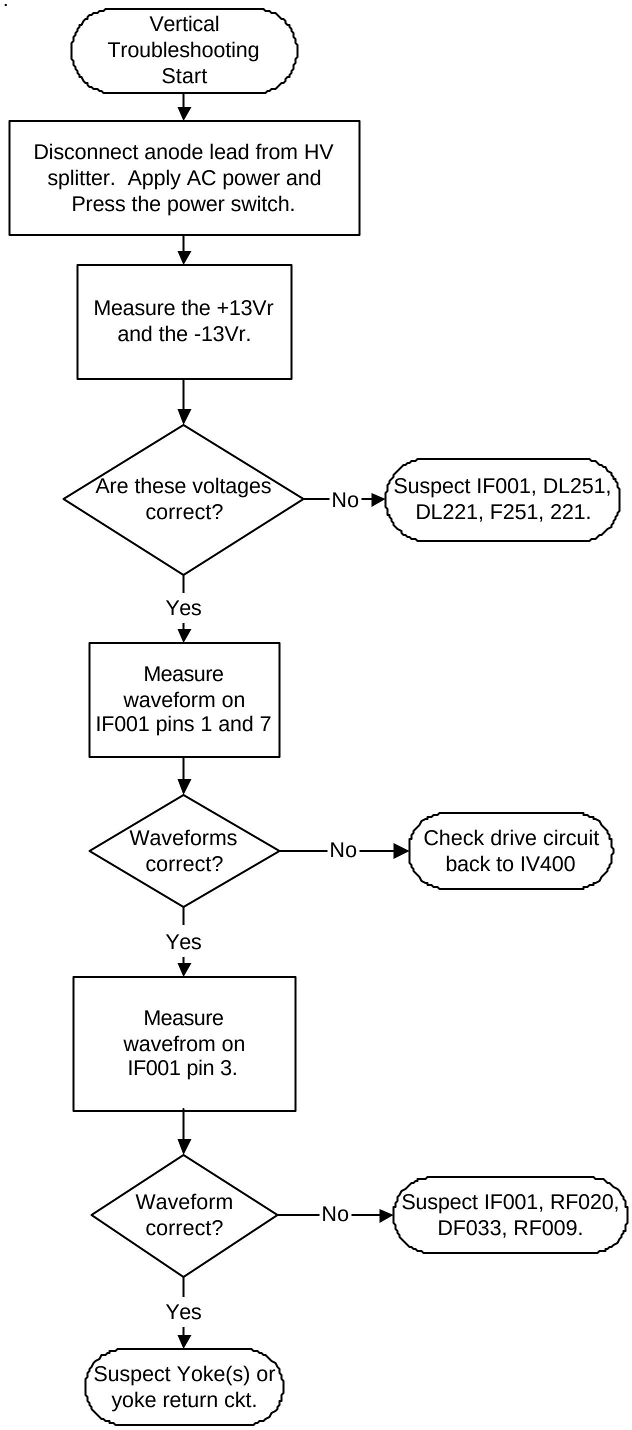
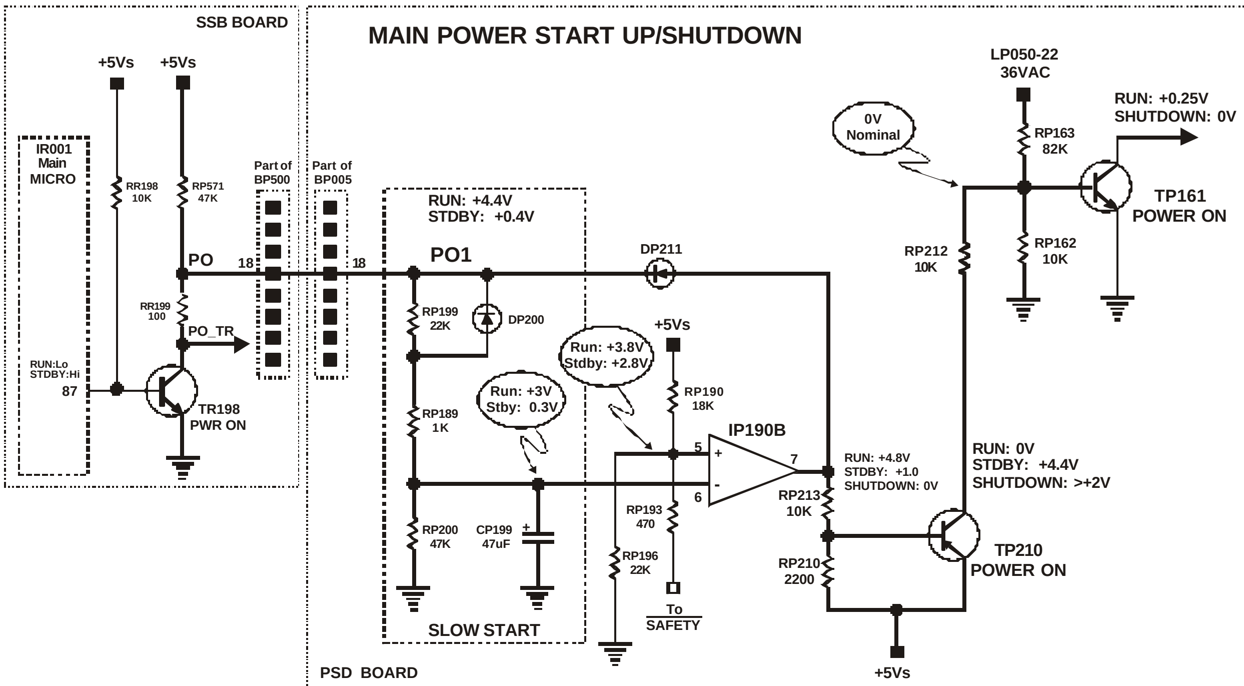


Startup and Shutdown Informataion



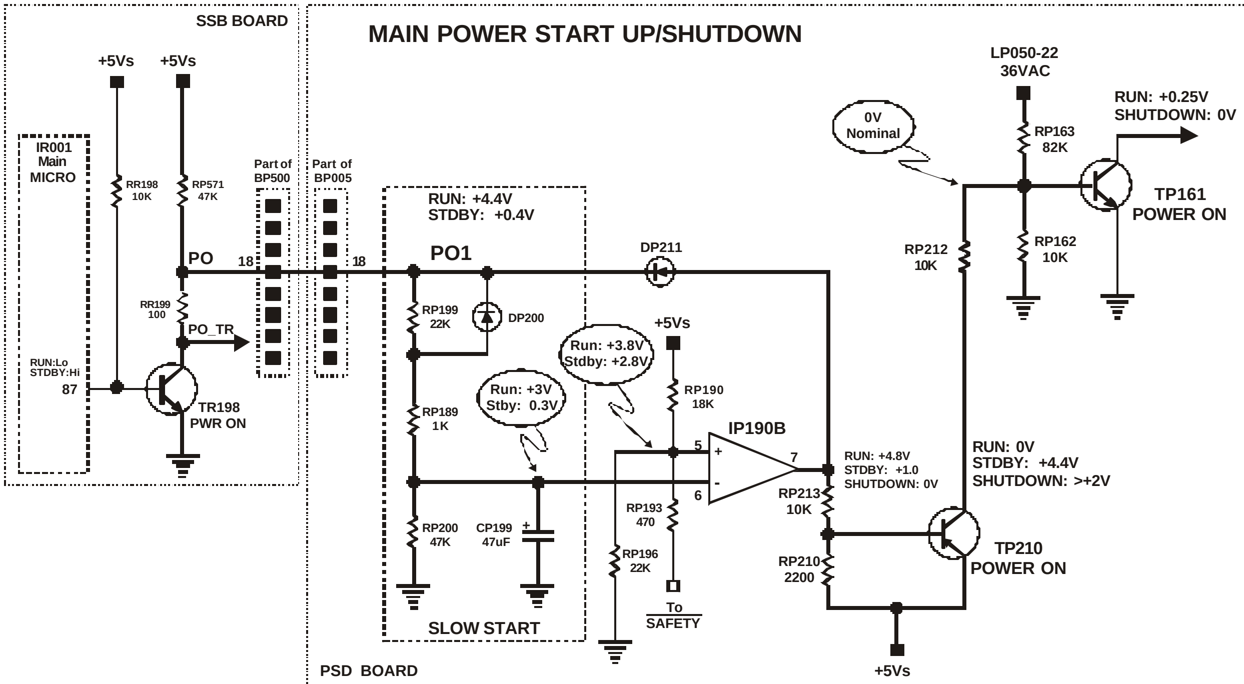
Power On/Off

The ITC222 startup sequence and circuitry varies little from the ATC221. The startup circuits are also the same circuitry that shut the chassis down during any Safety Shutdown event. The PO (Power On) signal starts the run supplies.

The basic startup active component circuit consists of IR001-87 (the main micro), TR198, DP211, TP210 and TP161. When in standby mode IR001-87 is HI turning on TR198 grounding the cathode of DP211. That turns on TP210 which turns on TP161 grounding the main power supply PWM waveform and holding the main run supplies off. (See other training material for the complete operation of the run supply.)

When a remote control IR or Front Panel Keypress initiates the Power On sequence, TR198 turns OFF allowing the PO/PO1 line to go high. That would normally instantly turn the PO Switch TP210 OFF allowing the main PWM supply to operation. However as soon as TP198 turns OFF, CP199 begins charging through a divider consisting of RP189, RP199, RP571 and the +5Vs supply. When the cathode of DP211 reaches about +4.2V it turns OFF. With DP211 OFF, TP210-B is biased OFF by the divider network of RP213, RP210 and the +5Vs supply which places about +4.8V on TP210-B. When TP210 turns OFF the run supplies start. The cathode of DP211 eventually reaches about +4.4V and it continues to decouple the main startup/shutdown switch, TR198, allowing safety protection from IP190B. The time delay to start the main supplies is 2-5 seconds depending upon component tolerances.

To shut the run supplies off IR001-87 again initiates the command this time by going HI. That turns ON TR198 which turns ON DP211. That turns on TP210 shutting down the main run supplies. CP199 maintains a residual charge for a period of time, discharging through a divider consisting of RP189, DP200, RR199 and TR198. If a false start occurs,

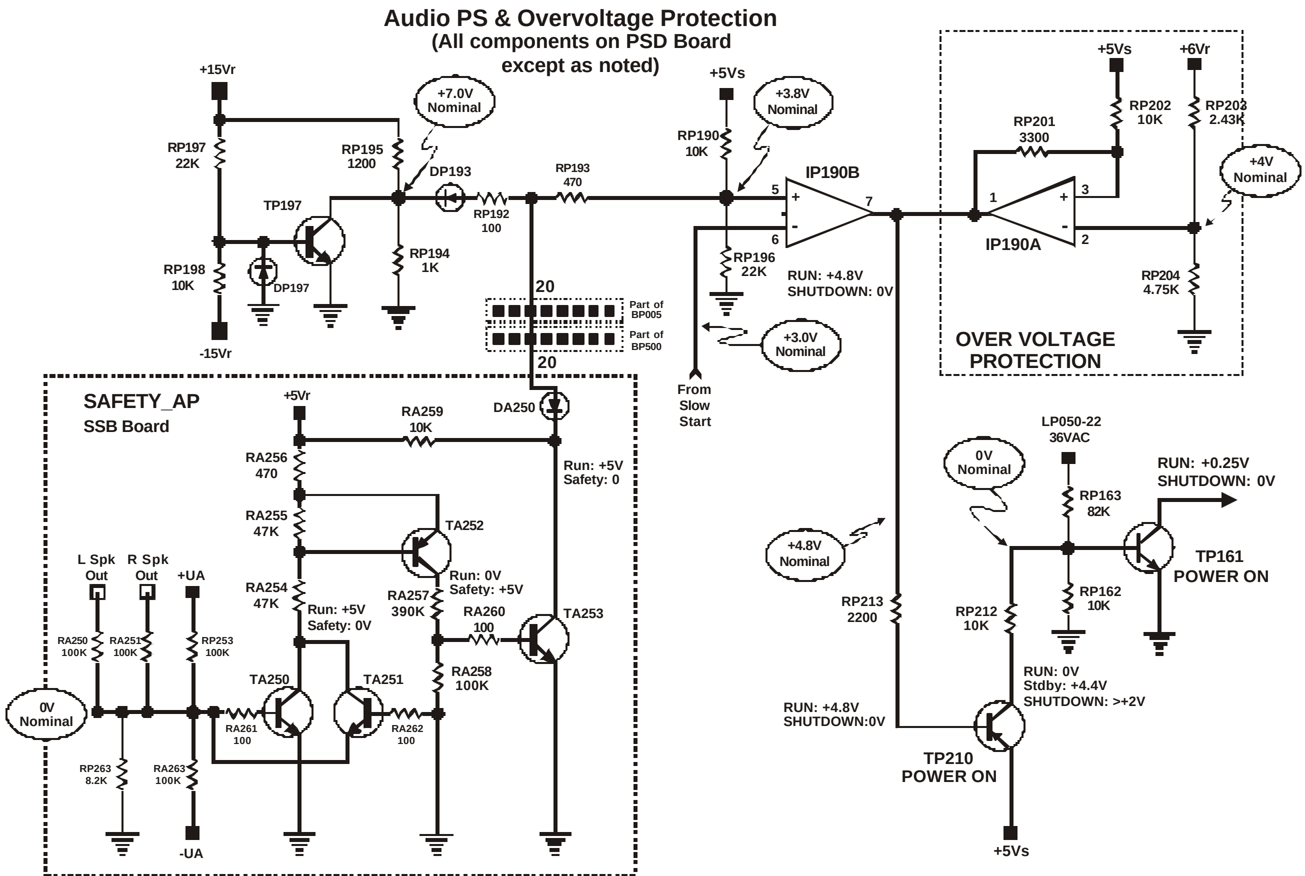


as long as CP199 has greater than +0.8V, the Run supplies will continue shutting down.

The voltage on CP199 is also the voltage on IP190B-6, the inverting input of the IC. When the run supplies shut down, the non-inverting input, IP190B-5 immediately goes to +0.8V by a network consisting of RP190, RP192, DP193 and RP196. As long as the inverting pin is greater than the non-inverting pin, the output of IP190B-7 will remain low. Only when CP199 is less than approximately +0.8V can TR198 take control of a new startup sequence.

During any safety related event the $\overline{\text{SAFETY}}$ line connected to IP190B-5, the non-inverting input will be drawn low. When it slips under the normal run voltage on IP190B-6 (~ +3V) the output goes toward the negative supply, in this case ground. With TP210-B now low it turns on turning on TP161 and shutting down the main PWM supply.

The PO signal itself can be a good indication of whether startup problems are caused by a direct shutdown from the micro or safety shutdown. The PO signal from the micro will follow typical logic switching characteristics, either being high (+5V) or low (0V). Note the safety shutdown circuitry does not control this line directly! The quiescent voltages in the circuit will cause IP190B-6 to reach a nominal run voltage of around +3V. During standby the output of IP190B on pin 7 will normally be around +1V. But during a shutdown event triggered by IP190 the IC is slammed towards the negative rail (in this case ground) providing good indication the chassis is in shutdown from the protection circuits rather than in standby.



Audio Protection

New to the ITC222 is a monitor circuit on the audio power output device, IA002. That makes two independant circuits monitoring either the audio power supply or the audio outputs.

Audio Power Supply Shutdown

The audio power supplies are monitored directly by TP197. When the chassis is running, the nominal voltage is ±17V on the ends of a resistor divider network consisting of RP197/98. With both voltages at nominal values, TP197-B is about -0.6V and the transistor is OFF.

The positive supply is monitored by voltage divider RP194/95 placing about +7.0V at the cathode of DP193. The Safety Line connected to IP190B-5 normally runs at a nominal +3.8V so DP193 is reversed bias. If the positive supply is reduced or fails DP193 becomes forward biased by the +5Vs supply. That causes the non-inverting input of IP190B-5 to go lower than the inverting input (pin 6, approximately +3.0V) and the output on pin 7 will go low. When that line is pulled low the safety circuit trips (previously described) shutting down the main power supply. This is the same protection mechanism in the event both audio rails begin to dip. Even though the bias on TP197-B may remain at -0.6V, at some point the positive rail will dip far enough to trip DP193 and a shutdown will occur.

If the negative supply is drawn down or disappears TP197-B is forward biased by the remaining positive audio supply turning it on. When TP197 turns on, DP193 is forward biased causing the same results as loss of the positive supply.

AUDIO OUTPUT SAFETY SHUTDOWN (SAFETY_AP)

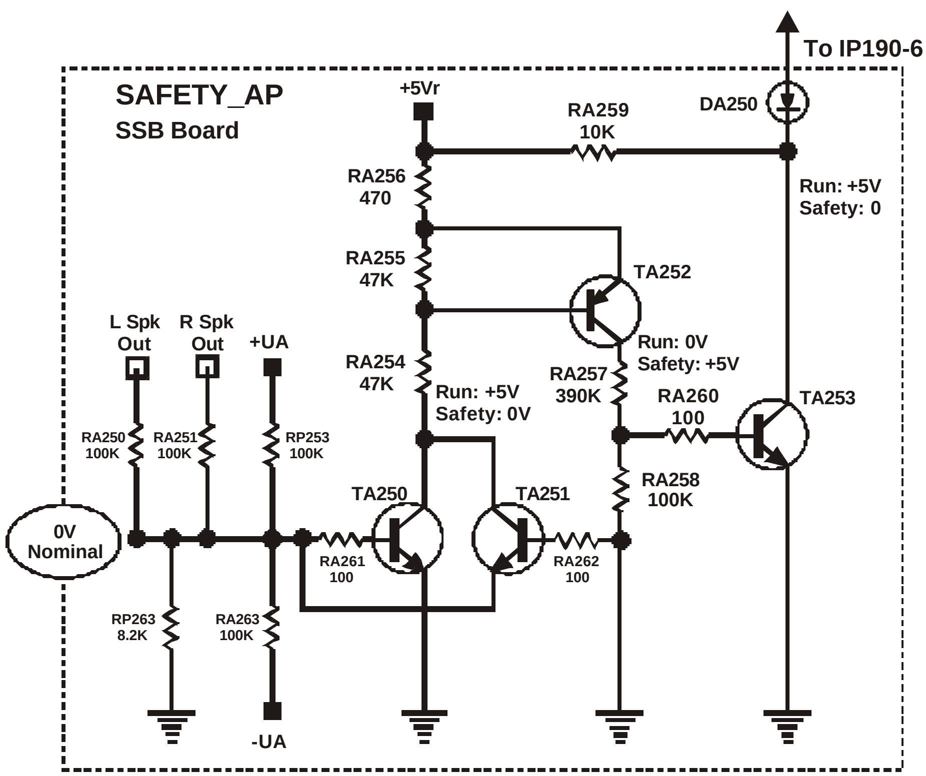
The audio output safety shutdown consists of four discrete transistors that monitor the voltage on the audio IC output lines, IA002-2 and IA002-4. The transistor network when tripped signals a safety shutdown via the SAFETY line previously described.

TA253 is the main output shutdown device and is normally OFF. When OFF the +5Vr supply is pressent on the cathode of DA250. The nominal voltage on its anode is about +3.7V so it is turned OFF and the audio safety circuit is in monitor mode. When TA253 is turned ON, its collector goes to ground turning DA250 ON and pulling the non-inverting input of IP190B low. IP190B-7 now follows the inverting pin and goes low causing TP210 to turn on and the main supply shuts down as previously described.

To monitor the audio IC output a voltage divider between the IC outputs on IA002-2 and IA002-4 is set up consisting of RA250/RP263 for the left output, IA002-2, and RA251/RP263 for the right output IA002-4. If either output shorts during high current demand the output could either go towards the positive supply rail (+UA) or the negative supply rail (-UA). If the the line goes positive TA250 will turn on turning on TA252. When TA252 turns on, TA253 also turns on and the safety circuit is enabled. If the line goes negative TA251 turns on turning on TA252 and TA253 enabling the safety circuit.

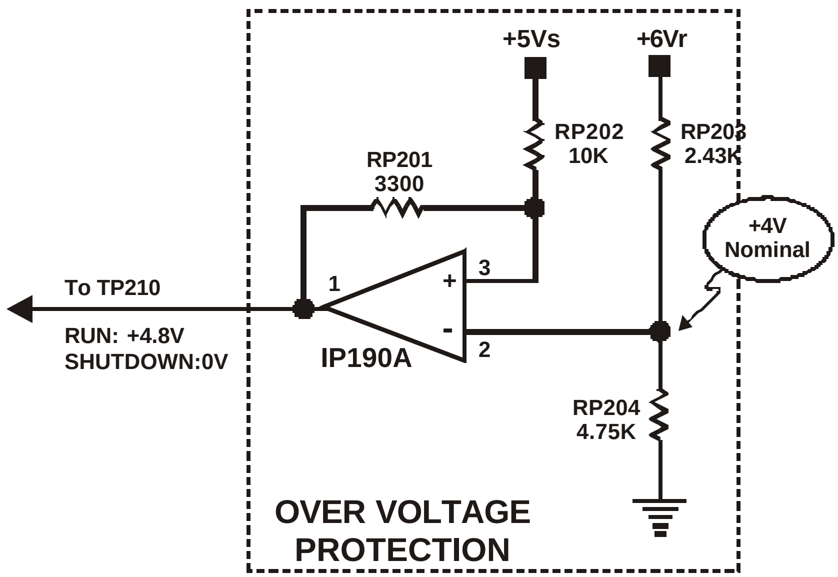
There is also additional protection against loss of either Audio Power Supply or conditions that may put the negative or positive supply rails out of regulation. The two rails are connected via voltage divider RP253/RP263 with the common point connected to TA250-B and TA251-E. If the negative rail disappears or dips too far TA251 will turn on activating the Safety circuit. If the positive rail disappears or dips too far TA250 turns on again activating the Safety Circuit.

All audio safety modes are self healing. Once the condition is corrected the safety circuit will reset itself allowing normal chassis operation.



Over Voltage Protection

To monitor the standby supplies and protect against overvoltage conditions, 1/2 of IP190 is used to compare voltages between the +6Vr supply and the +5Vs supply. The noninverting input, IP190A-3, is connected to the +5Vs supply and normally runs at about +4.8V. The inverting input, IP190A-2, is connected to the junction of a precision voltage divider network, RP203/204 that is directly across the +6Vr supply. IP190A-2 rests at a nominal +4V when the supply is properly regulated. If that supply increases IP190A-2 also increases. If it rises above IP190A-3 the output, IP190A-1, will be pulled LOW. That turns on TP210 turning on TP161 causing shutdown of the main PWM run supplies.

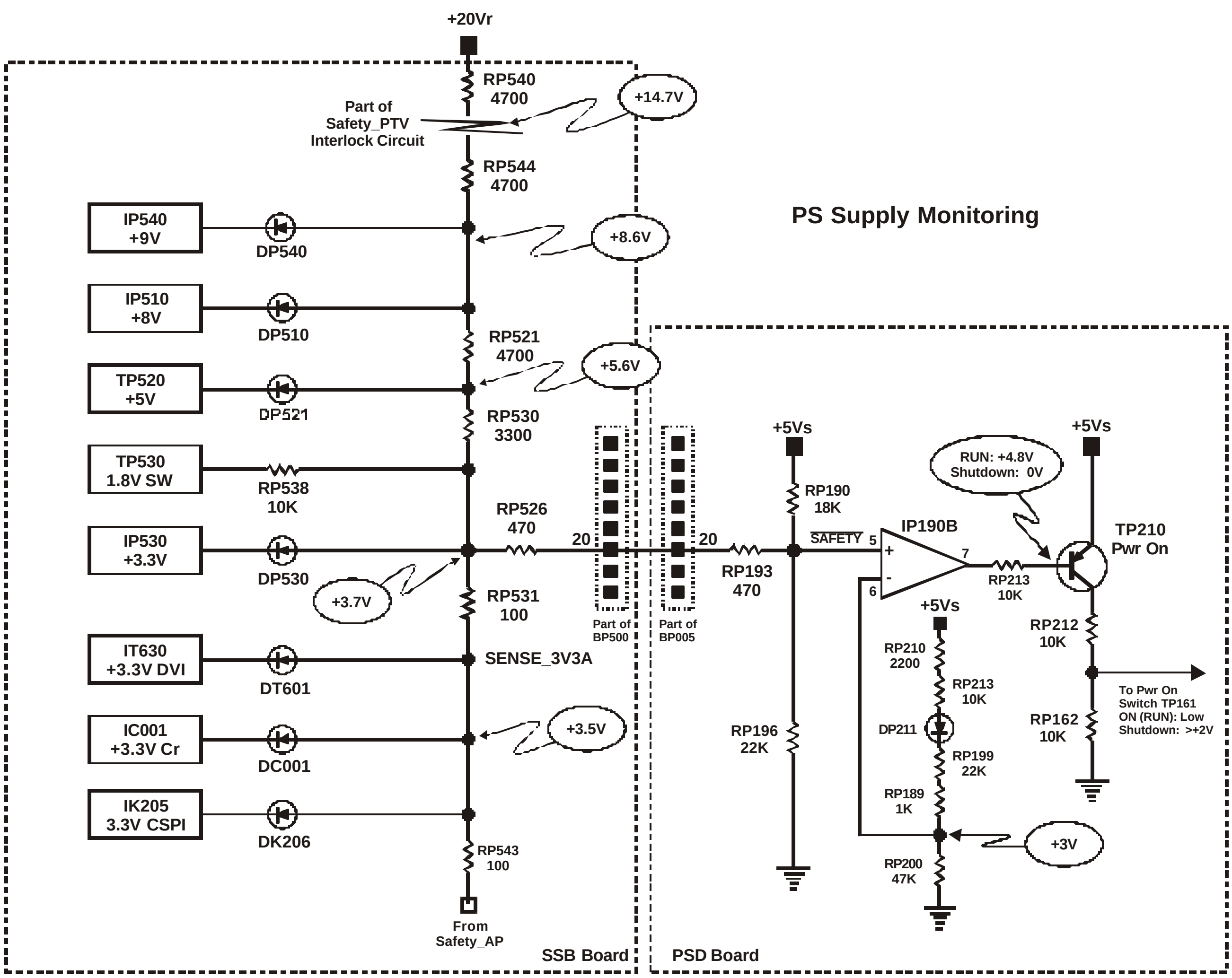


The final part of the start up protection circuit is the other half of OpAmp IP190, IP190A. The inverting pin, IP190A-2, is tied to a reference voltage consisting of resistor divider network, RP203/204 between the +6Vr supply and ground. That places about +4.0V on IP190A-2. The non-inverting pin, IP190A-3, has the +5Vs supply on it. If the +6Vr supply increases, the voltage on IP190A-2 also increases. When it increases to about +7.8V the opamp inverting pin rises above the noninverting pin and pulls the output, IP190A-1, to ground. 0V on the output will trigger the shutdown circuit via TP210 as previously described.

Again, an indication the set is in shutdown rather than normal standby is the output voltage on IP190. During run operation it is around +4.8V. During standby it will stay around +1.0V. But during shutdown the opamp will pull the output very close to ground.

POWER SUPPLY VOLTAGE LOSS–SAFETY PTV CRT

New to the ITC222 is the addition of a CRT board interconnect that will shutdown the chassis in the event any single CRT board is disconnected. While the protection circuit itself is relatively simple, tracing voltages across two main circuit boards, through the CRT boards and back again is somewhat tedious. Note the +20Vr supply is interconnected via the three CRT boards. That interconnect will be described in greater detail later.



All run supply voltages are monitored either directly or indirectly so that in the event one supply short circuits, all other supplies will be shut down while there is time to prevent other catastrophic damage from cascading failures. The circuit can only protect against further catastrophic damage in the event of a power supply short circuit. Overvoltage conditions are monitored by other circuitry.

The supply monitor line consists of a simple voltage divider network: RP540, RP544, RP521, RP530, and RP531 on the SSB board. Those components are connected directly across the +20Vr supply (through the interconnect circuit) and common. Diodes DP540, DP510, DP521, DP510, DP530, DT601, DC001 and DK206 isolate the supplies from each other. There is also an input from the Audio Safety circuit (Safety_AP). That circuit is isolated by a diode and is out of the circuit (showing a high impedance) unless a protection condition turns the device on. At that point it becomes a low impedance to ground.

The main run supply switch noninverting input, IP190B-5, monitors the voltage divider via RP193 and RP526. Note the voltage divider low side voltage will be provided by the various +3.3V supplies. If all supplies are working the nominal voltage at the junction of R526/530/531 and on noninverting pin 5 of IP190B will be +3.7V. The inverting pin 6 is around +3V so the output of IP190B-7 is high allowing run supply operation.

Under normal run conditions all the diodes except DP530, DT601, DC001 and DK206 are reversed biased by the lower voltages present on the protection line allowing the voltage divider to supply a nominal signal to IP190B-5 that does not disturb the normal run voltage provided by other bias circuits.

However, if any supply shorts or otherwise stops functioning providing no output, the junction of RP530/531 goes low pulling the non-inverting input IP190B-5 low. IP190B output on pin 7 will now track the inverting input and go low, triggering the shutdown circuit.

The +3.3V supply on the SSB board would give similar action as would a short in any of the supplies on the SSB board. RP540 is a current limiter to make certain there is always a current path from any short circuit on the power supply sides of the protection diodes.

If shutdown occurs the voltage at IP190B-5 may be monitored giving some indication of the condition of the supply monitoring circuits. If any supply voltage on the SSB board shorts, pin 5 will measure different voltages depending on which supply is shorted. The voltage chart in the table below will assist the technician in determining the problem supply.

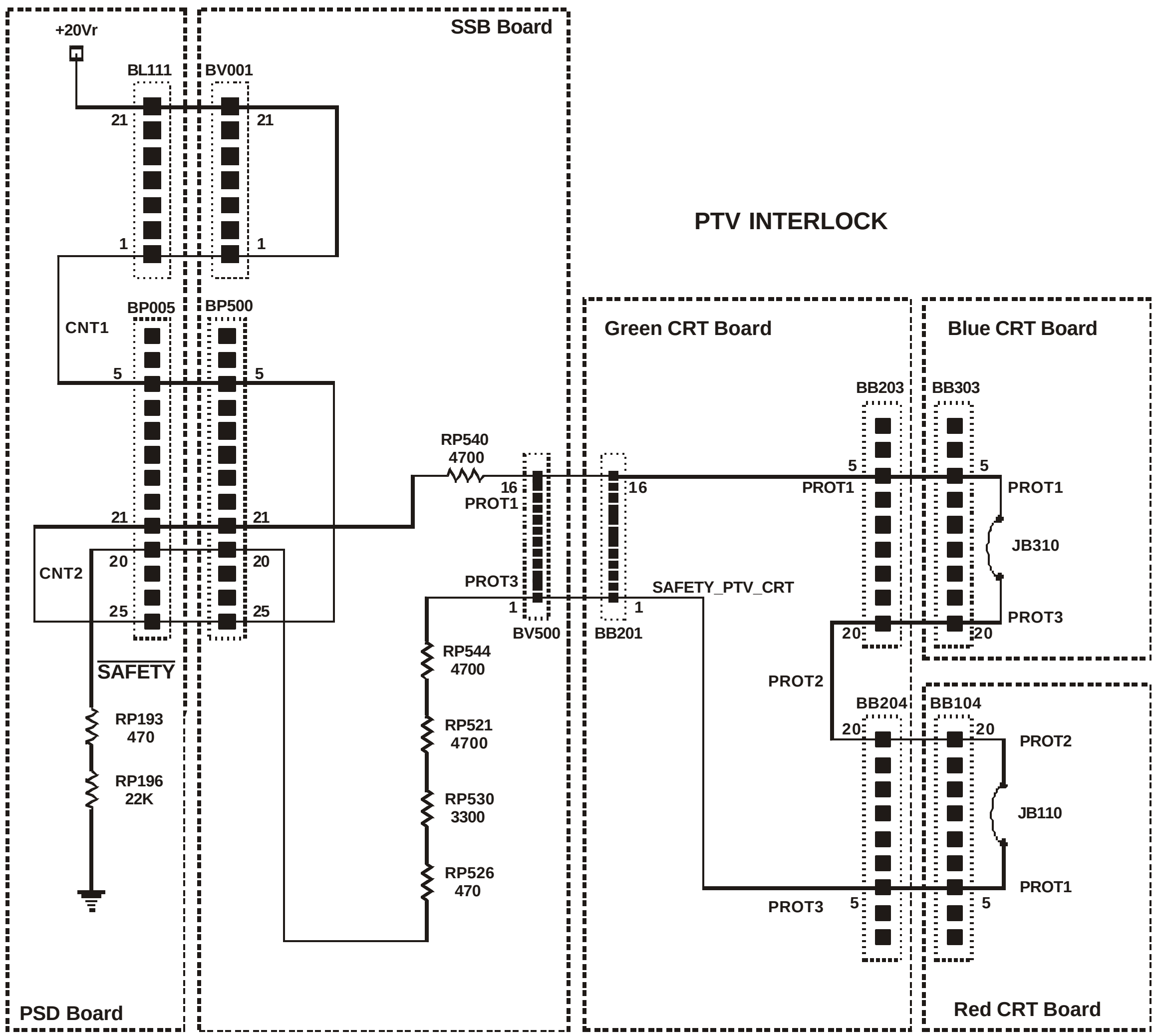
Once it is determined one of the supplies in the string is defective, the diodes may be lifted one by one to determine which supply is shutting the chassis down. It should also be noted overvoltage conditions cannot be detected by this system. Overvoltage simply continues to reverse bias the blocking diodes in the system and must be detected by other means. Overvoltage shutdowns will not occur as a result of this monitoring circuit.

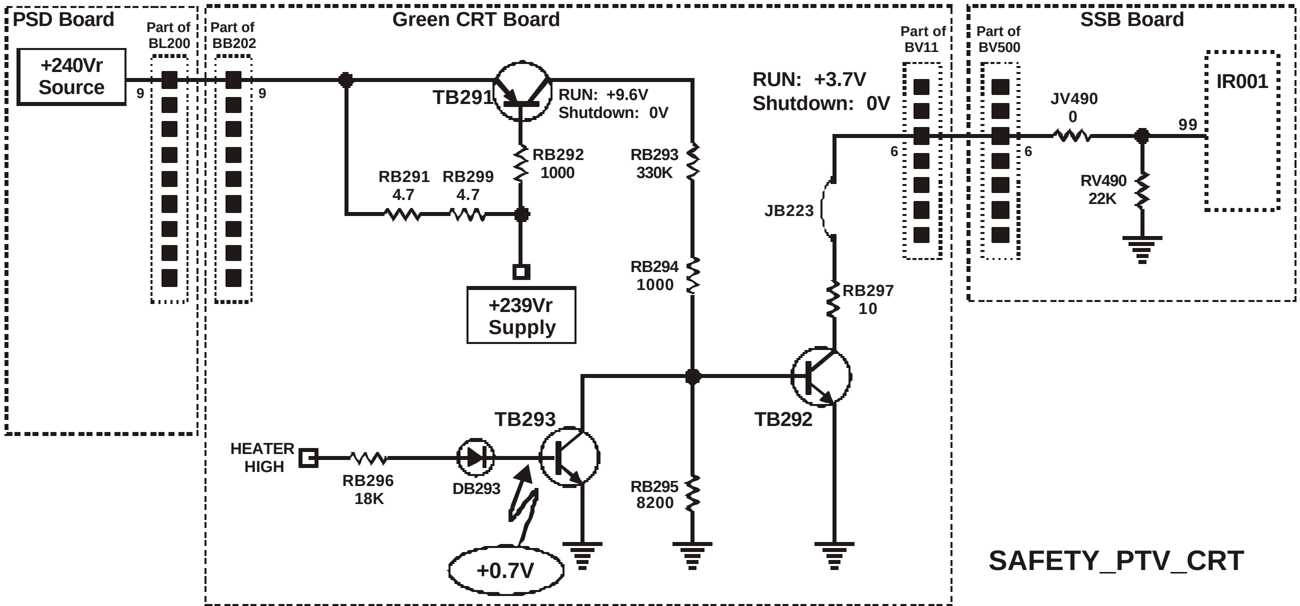
Safety Shutdown	Device	Resistance to GND
Sense_3V3	IC001-2	.5K
Sense_2V5	IC006-2	.4K
+3V3	IP530-2	.57K
+5V	TP520-S	160 Ohms
+8V	IP510-3	1.5K
+9V	IP540-3	1.2K
USYS	DP110-C	27K
20V	DP120-C	3K
10V	DP140-C	1.3M
6V	DP150-C	1.2M

SAFETY_PTV INTERLOCK

As previously mentioned there is an interconnect safety circuit that prevents beam current in all three CRT's if any of the kine boards are disconnected. If any part of the interconnect is broken there will be no +20Vr available to the Power Supply Monitor circuit. As the voltage is lost the monitor circuit stops the run supplies and the chassis shuts down, or refuses to start.

The interconnect circuit may be monitored at any of the connectors noted on the diagram below. The voltage begins to drop significantly once it enters the SSB board at BV500-1. At that point it should measure a little less than +20V. On the other side of the SSB it will have dropped to around +3.8V.





SAFETY_PTV_CRT (REAR PROJECTION ONLY)

To protect against CRT damage when voltages (or lack of voltages) are present that could contribute to such damage, rear projection instruments use a specific safety circuit that triggers a shutoff event under conditions that could lead to damage. The circuit has been changed considerably from the ATC221. The safety circuit is now monitored by the main micro IR001 pin 99. Pin 99 may be an output or input depending upon whether the instrument is a DV or PTV. For PTV it is normally high. A safety shutdown must pull it low. That can only happen when TB292 is turned on by the safety circuits. If it does usually Error Code 61 will be logged in the service menu.

Under normal circuit operation the main safety switch, TB292, is biased off by TV293. TB293 is turned on from a rectifier circuit creating a bias voltage from the CRT Heater power supply. TB291 is also biased on by the UVid source. TB291-C runs at around +9.6V.

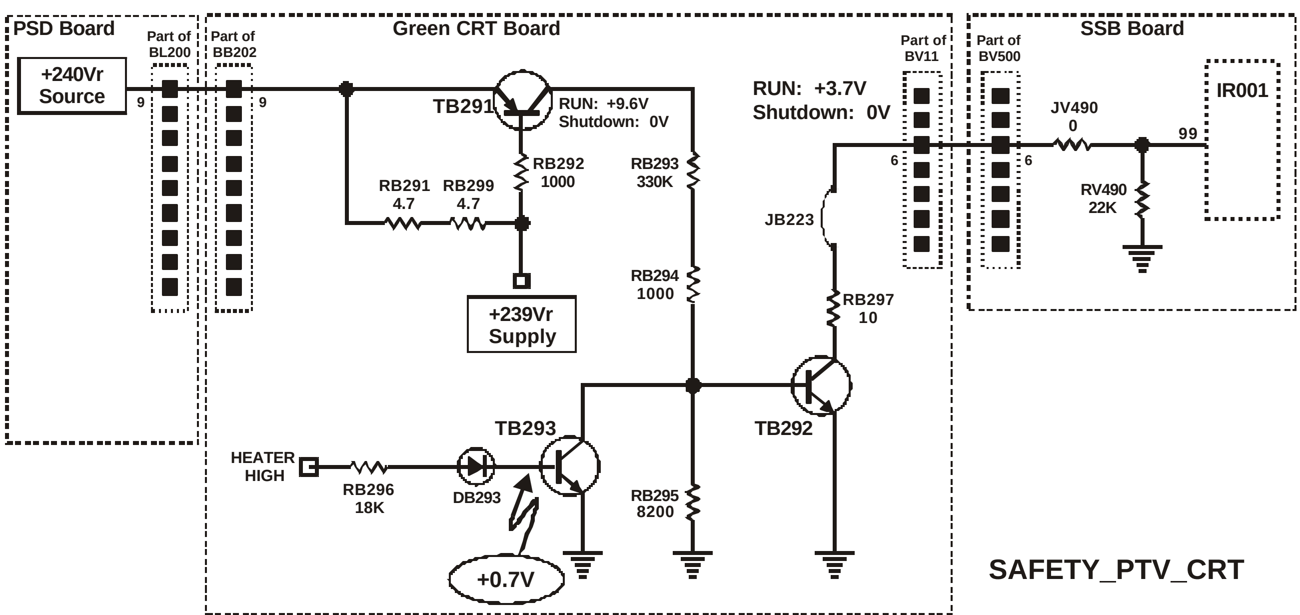
First note to there are now two conditions which can trigger the safety circuit. The heater voltage is being monitored by TB293 and beam current is monitored by TB291. TB292 is configured as an OR switch such that problems in either area will trigger it ON causing shutdown of the chassis.

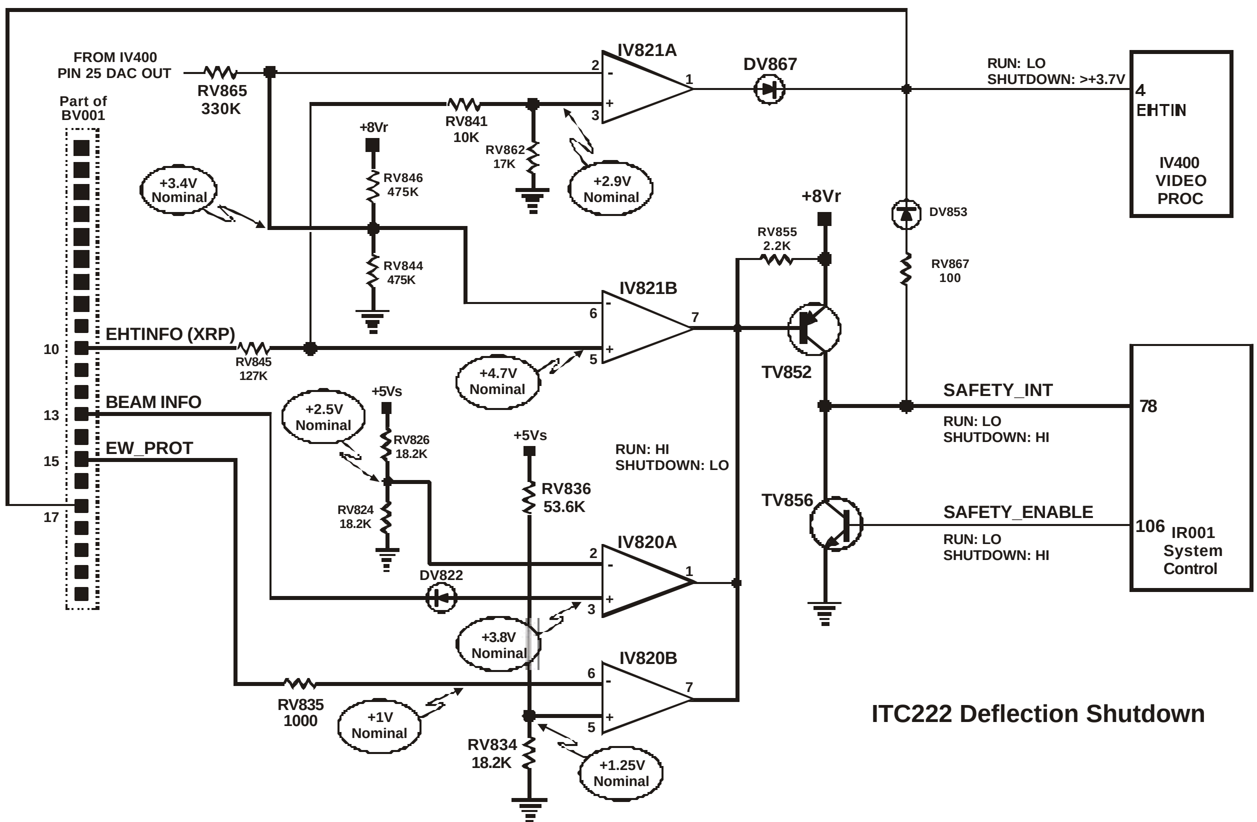
The heater supply voltage is tapped and rectified by DB293 and RB296. The resulting bias voltage keeps TB293 turned ON. If the heater voltage disappers, TB293 will turn OFF and the bias voltage developed from TB291 will turn on TB292 causing IT001-99 to be pulled low triggering a safety shutdown of the chassis.

Under normal operation the +240Vr supply feeds current to the CRT drivers. If excessive beam current is drawn, current through RB291/299 also increases dropping the +239Vr supply faster than the +240Vr side. As current increases TB291 is turned on harder resulting in higher and higher voltage on its collector. This current passes through RB293/294 and TB293. As current increases in this network the voltage drop across the E-C junction of TB293 also increases. Once the voltage across TB293 increases greater than +0.6V TB292 turns on and activates the shutdown circuit.

It is important to note that the Heater protection circuit does not function for overvoltage conditions. If the heater voltage is too high, it will simply turn TB293 on harder keeping TB292 OFF.

Also, if the Uvid source disappears due to malfuction there will be no supply voltage to turn TB292 ON so that condition must be monitored by other means.





Deflection Shutdown Overview

There are 6 circuit monitors on the deflection side of the chassis. They are:

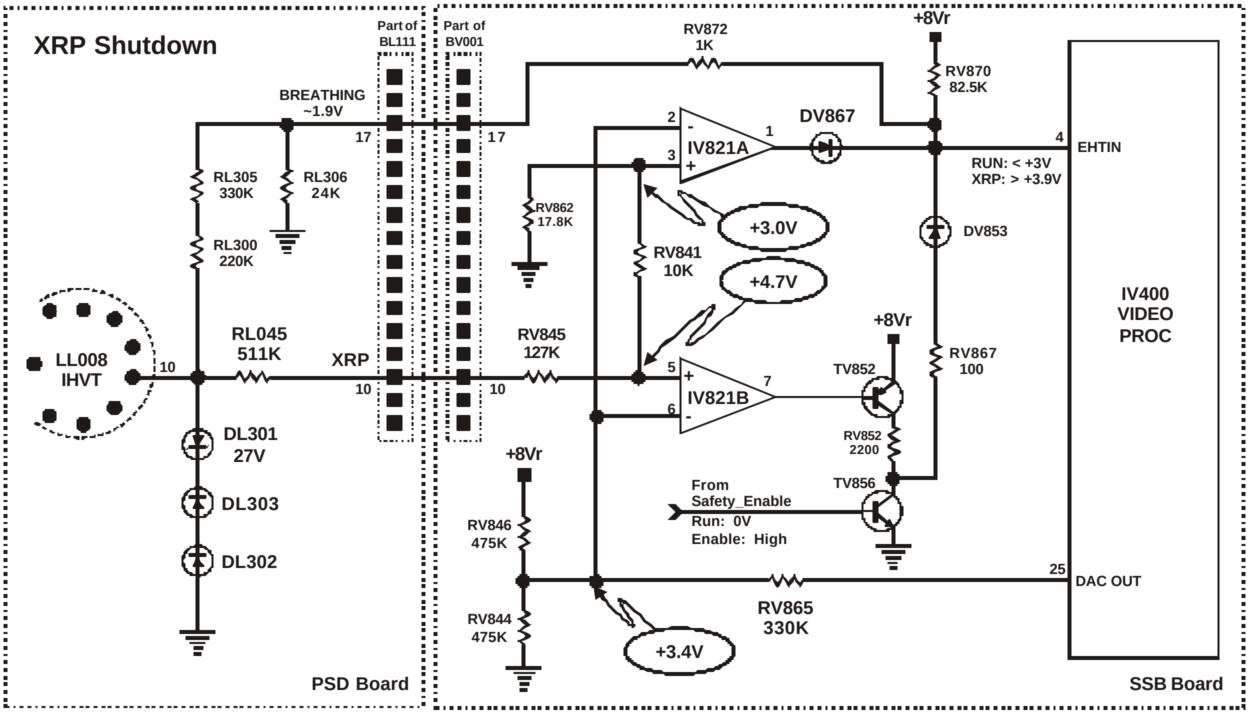
- BEAM PROT (Beam Current Undervoltage)
- XRP (excessive HV or beam current)
- EW PROT (excessive power disappation in the EW circuitry or loss of deflection)
- BEAM (EHT) INFO (HV too Low)
- SAFETY_ENABLE (Turns the safety feature off during certain conditions to prevent false triggers)
- V_GUARD (Monitors Vertical Deflection)

For the ITC222 all deflection safety circuits are monitored by the deflection processor, IV400 via the EHT_INFO input on pin 4. Generally the circuits are engineered such that any voltage greater than +3.9 $\pm$0.2 will cause shutdown of the chassis.

Vertical deflection (Vertical Guard) is monitored by Pin 9. Any of the inputs will trigger a shutdown of the entire chassis.

Pin 5, "FLASH", which monitored the deflection safety circuits in the ATC221 is not used in the ITC222.

New to the ITC222 is the use of true differential voltage comparitors rather than the opamps used in the ATC221. This provides an open-collector configuration on the output pins offering the operation of a true switch on the output rather than a voltage rail as in the previous design. The most noticable advantage of the IC is the open collector outputs may be connected directly together to achive true OR logic operation.



Excessive High Voltage

IV821 provides both undervoltage and overvoltage protection for the High Voltage circuits. IV821A monitors the XRP voltage generated by pin 10 of the IHVT, the bottom side of the HV winding. All beam current must pass through this pin. Under normal operation there is about 30VAC at this point creating about +26V of DC bias. The +26V is divided by a resistor network consisting of RL045, RV845, RV841 and RV862 providing about +3V on IV821A-3, the non-inverting input. XRP is tripped if the DC bias voltage is either >+30V or <+22V.

To monitor the voltage, a reference voltage is set up by the junction of a divider network consisting of RV846/844 between the +8Vr supply and ground. That voltage is set more precisely by a trimmer voltage output from IV400-25. It results in a reference of about +3.4V on the non-inverting pin IV821B-6 and inverting pin IV821A-2.

The voltages present on the input pins during run operation result in an output from IV821A-1 near ground. Since the normal output range of EHTIN is from 0V to about +3.0V, DV867 decouples it from EHTIN. This allows EHTIN to monitor operation of the CRT and high voltage and monitor beam current for normal variances. EHTIN provides beam current compensation or “Breathing”. With the non-inverting input of IV821B higher than the inverting input, IV821B-7 output is high. When IV821B-7 is high TV852 is held OFF. With no current in the network consisting of TV852/856, DV853 is also OFF and normal circuit operation of the EHTIN circuitry is allowed.

If excessive beam current is drawn, the output of the IHVT at pin 10 also increases. As that voltage increases the DC bias voltage generated from it also increases raising the voltage at IV821B-6 and IV821A-3. In this case IV821A-7 is already high so increasing the voltage will not make a difference in the output. However when the non-inverting input, IV821A-3, increases to greater than the inverting input, IV821-2, the output IV821A-1 goes high. In this case, when it increases to higher than the reference voltage, +3.4V on IV821A-2, the output on pin 1 goes high. EHTIN trips when pin 1 goes above +3.9V shutting the set down.

If HV decreases too much, the non-inverting pin, IV821B-5 will drop below the reference voltage on the inverting input, IV821B-6, and IV821B-7 will be pulled low turning ON TV852. When TV852 turns on TV852-C goes high forward biasing DV853 triggering the EHTIN input, IV400-4, to shutdown deflection.

Note that although both conditions result in chassis shutdown, there are very distinct differences in how they perform their shutdown routines. Those differences can lead to better diagnosis.

ABL & XRP

The EHTIN input at IV400-4 also performs two additional functions. First it is the compensation for beam current variations, also known as "breathing" or ABL (Automatic Beam Limiting). ABL operation generally provides voltages at pin 4 between +0.1 and +3.0V. That variation is translated into horizontal output control which can adjust high voltage to compensate for differing beam current conditions. In most cases as beam current increases, HV would tend to dip. The EHTIN input senses that increase in beam current and raises HV proportionately to keep horizontal width (along with all other IHVT derived voltage supplies) constant. If beam current decreases HV would tend to rise so EHTIN would lower HV accordingly.

The secondary function of the IHTIN input is to monitor the status of XRP related operation and shut down high voltage in the event of improper operation. If the input voltage rises above +3.9V it would indicate excessive beam current and shutdown of horizontal deflection results. A shutdown initiated by IV400-4 will stop deflection and place it in "Standby" mode. **A restart is possible only via microprocessor command typically initiated by a manual restart of the instrument.**

Safety Enable

The safety enable circuit acts as a safety defeat during the period of startup when supply voltages may be unstable and false shutdowns could occur. At startup Pin 106 of the main microprocessor, IR001, goes to high impedance and TV856 is turned on as CV854 charges through RR180. Once the voltage on TV856-B goes above +0.6V it turns ON grounding EHTIN, pin 4 of IV400. When EHTIN is low normal run operation is allowed and the main safety switch, TV852 is effectively removed from the circuit preventing false safety shutdowns from any of the comparitors.

Once CV854 charges, current flow stops and TV856 shuts off allowing normal safety operation. CV854 also prevents false shutdown by the microprocessor. If pin 106 goes to low impedance the only discharge path would be the B-E junction of TV856 which is reversed bias by the voltage on CV854 preventing it from turning on. Eventually CV854 will discharge to the low impedence pin 106 but it provides enough reserve to prevent false triggering of the Safety Enable line.

VERTICAL GUARD

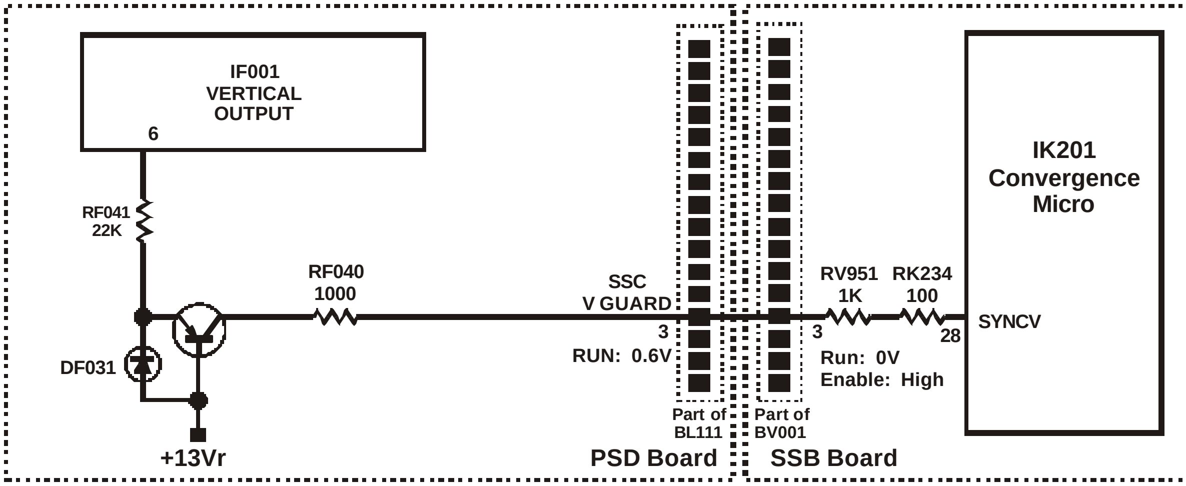
Beam current without vertical deflection may result in almost instantaneous burns of the phosphor coating of a CRT. To stop beam current in the event of vertical scan failure or if deflection problems exist which could result in loss of vertical scan, the ITC222 now monitors the vertical flyback pulse from the vertical output IC and the vertical IC power supply. The circuit is straightforward and depends on the vertical flyback pulse generated by pin 6 of the vertical output IC. A sample of that pulse is supplied to the convergence microprocessor, IK201 to provide sync and for the monitor circuit. If the pulse disappears IK201 assumes problems with vertical deflection and signals the deflection processor IV400 of the event. IV400 immediately shuts down beam current by turning off the RGB drivers via the SSC_Vertical_Guard line.

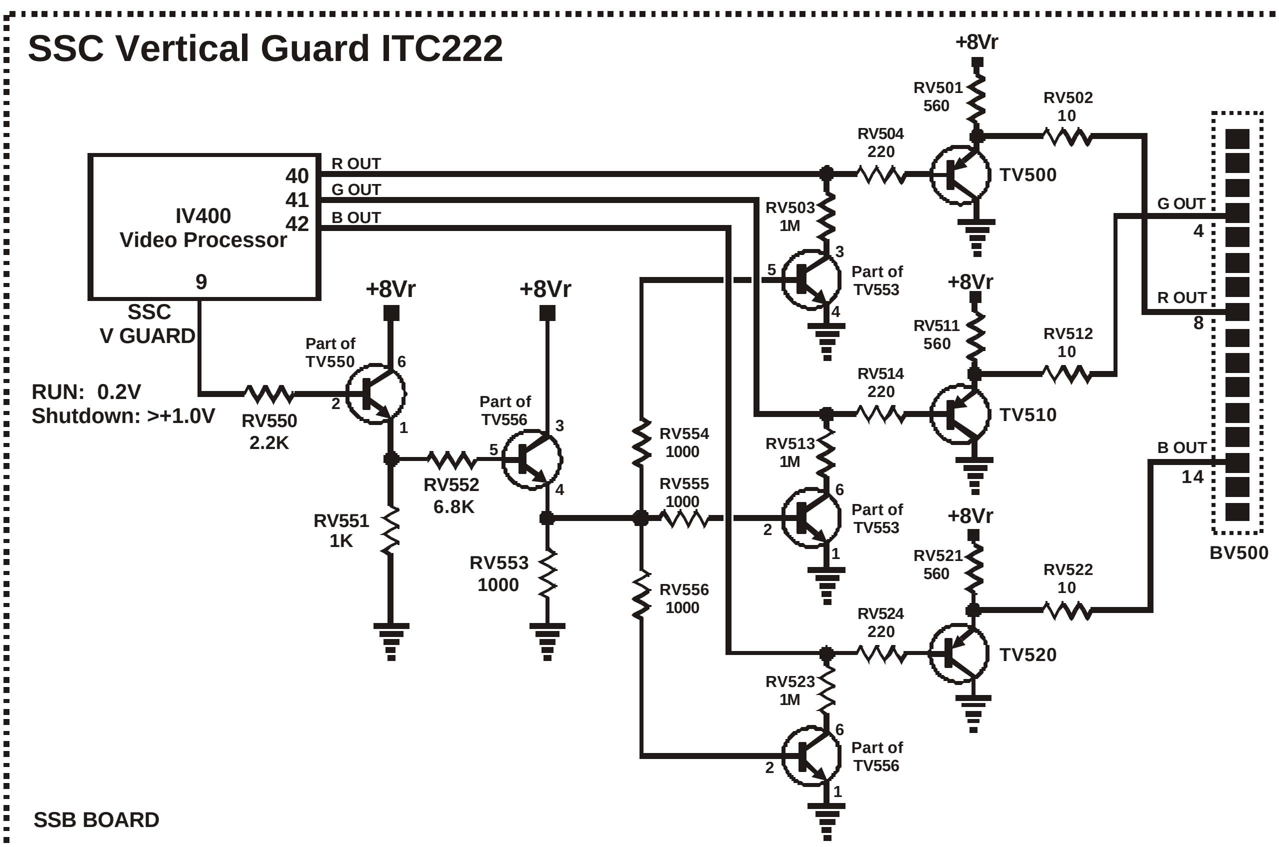
SSC_VERTICAL_GUARD

The SSC_Vertical_Guard signal from IV400-9 is normally LOW. When a condition exists that could cause harmful beam current due to loss of scan the signal goes HIGH. Although the circuitry looks complex it amounts to a simple switch. When IV400-9 goes HIGH TV550 turns ON turning ON TV556. TV556 then turns on TV503/13/23 effectively opening the RGB output circuits TV500/10/20. With no drive the CRT amplifiers shut off beam current.

Note several of the transistors used in this switching circuit are contained in a dual package configuration. Pinouts for those devices are noted.

Vertical Guard

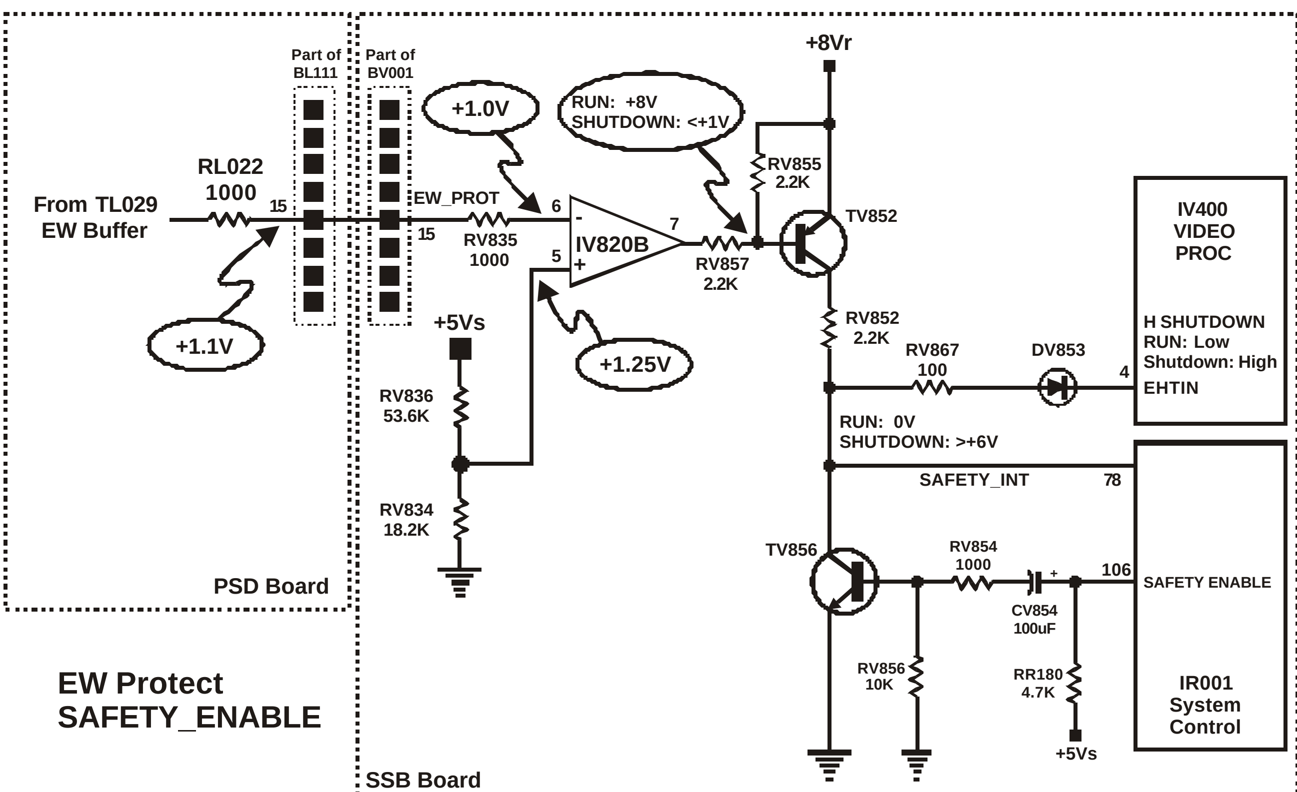




East-West Protect

Excessive power disappation in the EW correction circuits can signal dangerous deflection operation or failure of high current components in the EW circuit itself. A signal, EW_PROT, is generated from the voltage on and around the drain of the EW output FET, TL029 and the EW current sensed at the source of TL029. The sensing components are carefully chosen to provide a consistant signal at the junction of CL023, RL023 and RL024 in the EW circuitry for all valid operating conditions of the EW correction circuitry. That voltage is monitored by the inverting input, IV820B-6 and is typically +1.0V. A reference voltage of +1.25V is placed on the non-inverting input, IV820B-5 which results in an open output condition on IV820B-7 allowing normal operation of the remainder of the deflection safety comparitors and of deflection.

If either current or voltage increases at the sense points of TL029 the voltage at IV820B-6 increases. If pin 6 becomes greater than Pin 5 the output of IV820B-7 goes LOW turning on TV852. That places a HIGH on TV852-C and IV200-4 initiating a shutdown of horizontal deflection.



Summary

This manual has attempted to cover all safety related shutdown circuitry that could cause shutdown of the ITC222 chassis or prevent it from starting up. Always remember the circuits themselves are only monitoring circuits such as those in the deflection and power supply sections for dangerous operation or catastrophic failure. Understanding the monitor circuits and following the safety shutdown indications should lead to the actual circuit failure. Troubleshooting of the failure is still required.

The takeaway from this manual should be that all normal protection related shutdowns of the ITC222 chassis are governed by six devices; TP210, IP190, IV400, IV820, IV821 and the main micro (via TP198) plus circuitry associated with the six devices. In most cases these devices are monitoring the shutdown circuitry indirectly by monitoring other devices or voltages that are directly monitoring the circuits.

IP190 monitors the safety shutdown circuitry that is in turn monitoring the power supplies. When it detects dangerous operation or catastrophic failure it uses TP210 to shut down the main PWM waveform causing the chassis to shutdown.

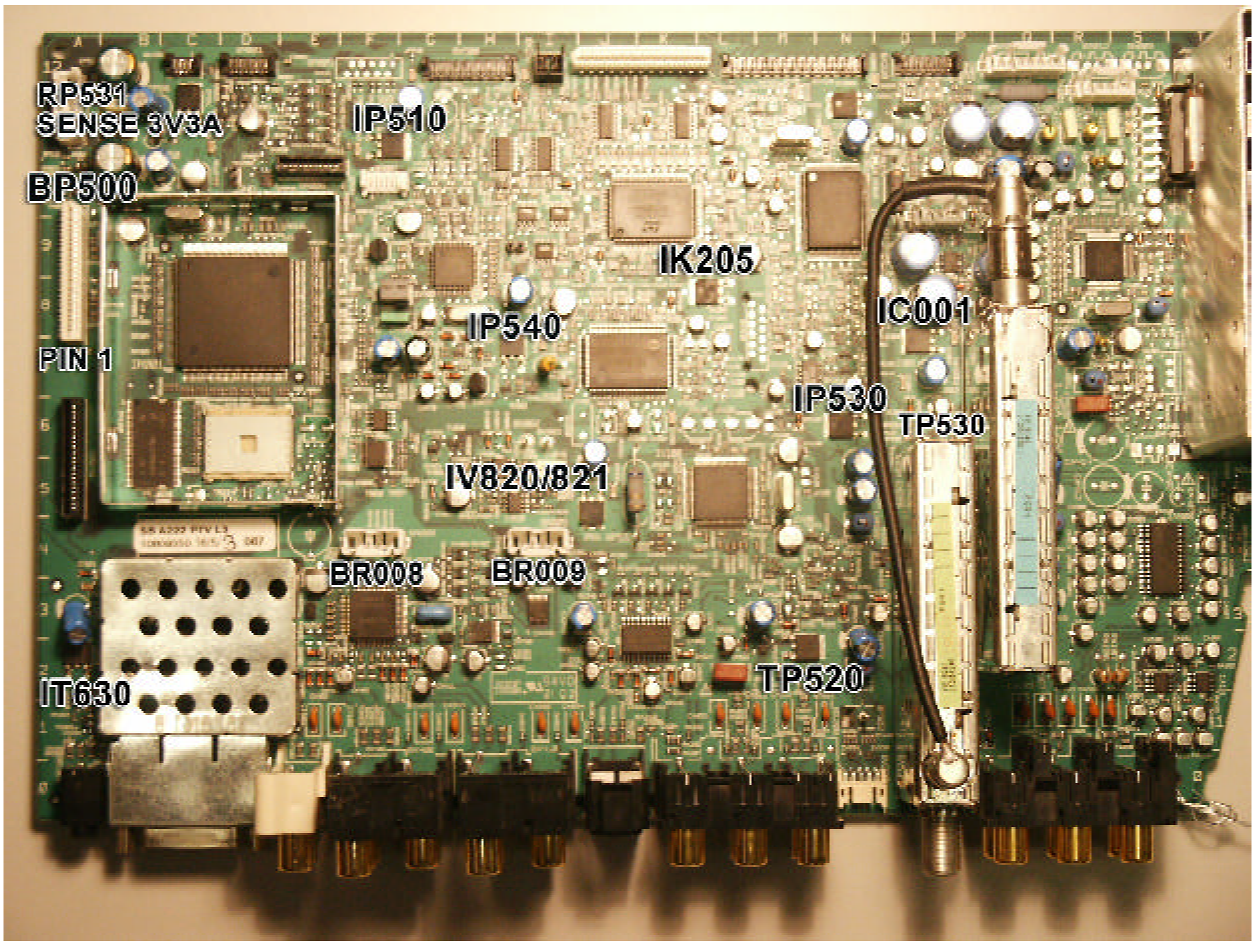
IP820 and IP821 monitor deflection circuitry and the high voltage generation circuits shutting down deflection when detecting improper operation. It does so by shutting down the horizontal output waveform.

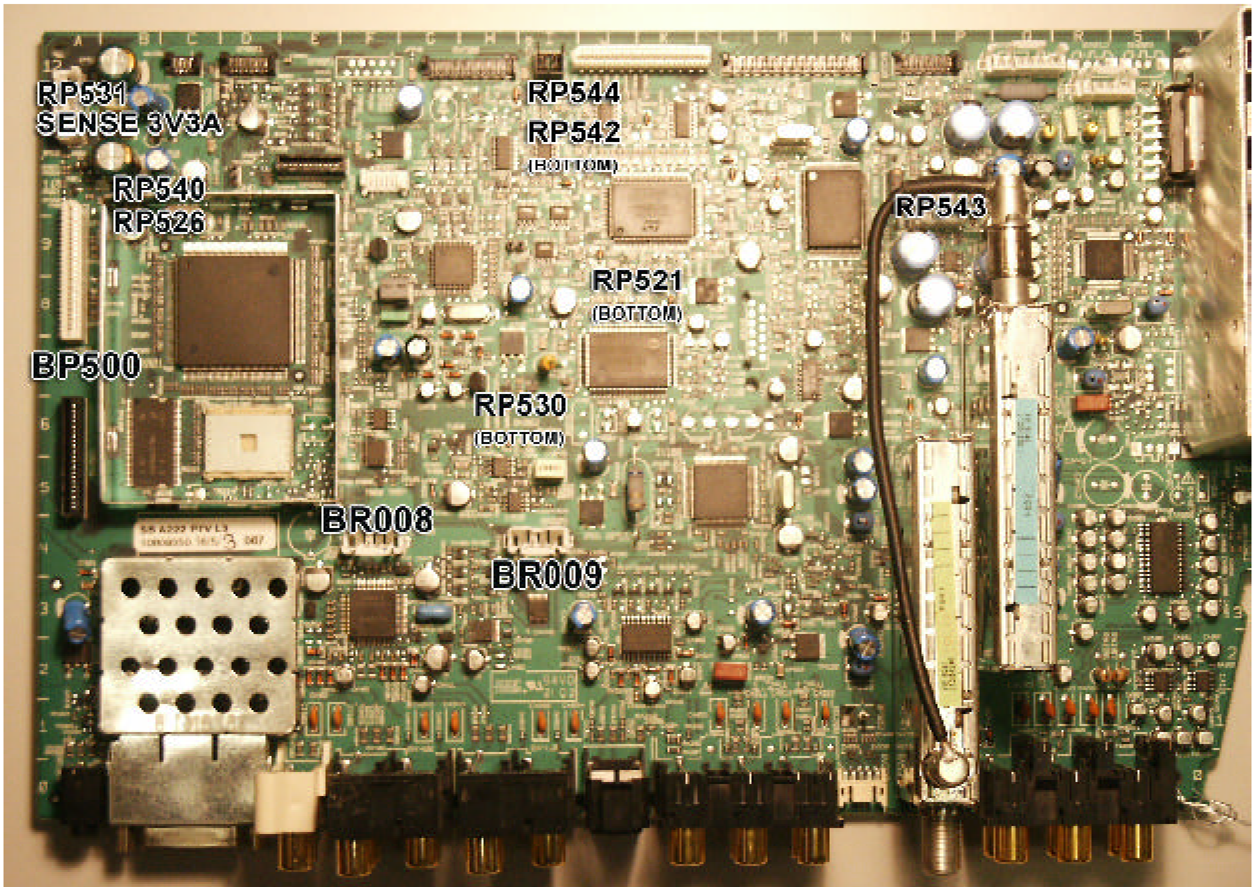
All active and passive components listed are accessible from the top of the circuit boards except TV04 on the bottom of the PTV Adapter board. Although the connectors are also accessible from the top, it may be more convenient for the technician to make voltage readings from the bottom.

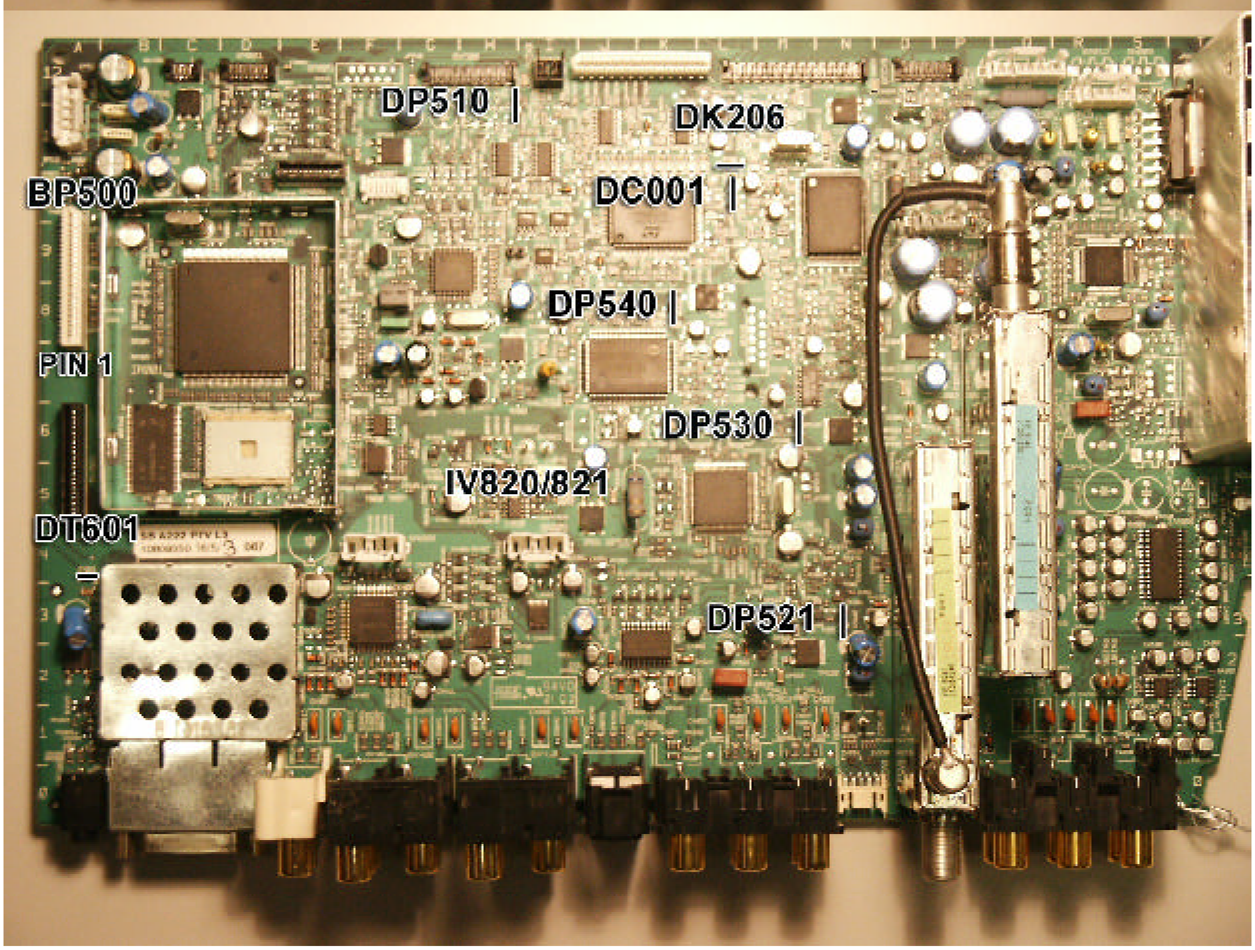
Appendix

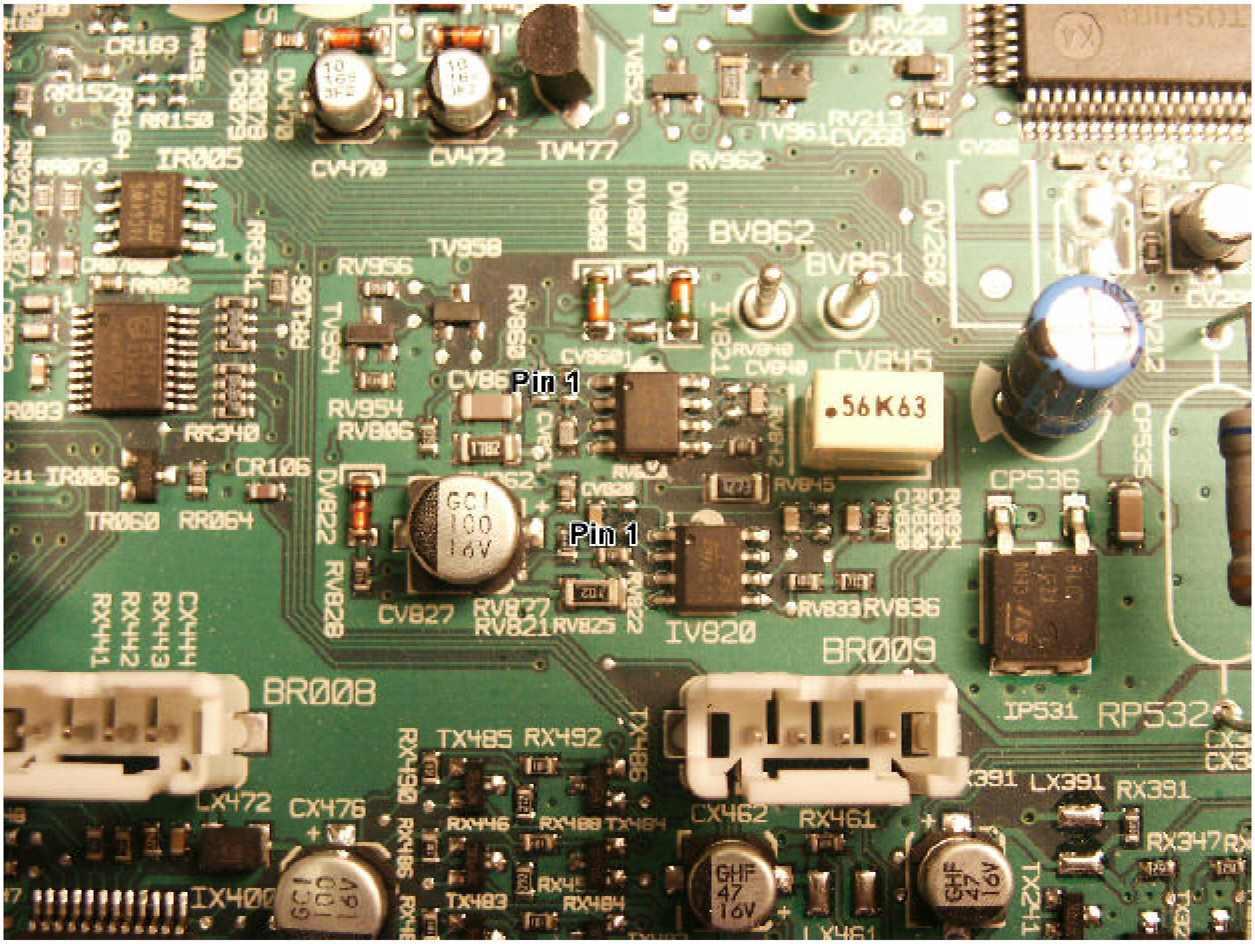
SSB Component and Test Point Locations

The test points needed to troubleshoot power supply shutdowns are noted on the following graphics. The graphic may be used as a roadmap to locate the proper devices. Although connectors BR008/009 are not used for troubleshooting they are shown to better guide the technician to IV820/821.

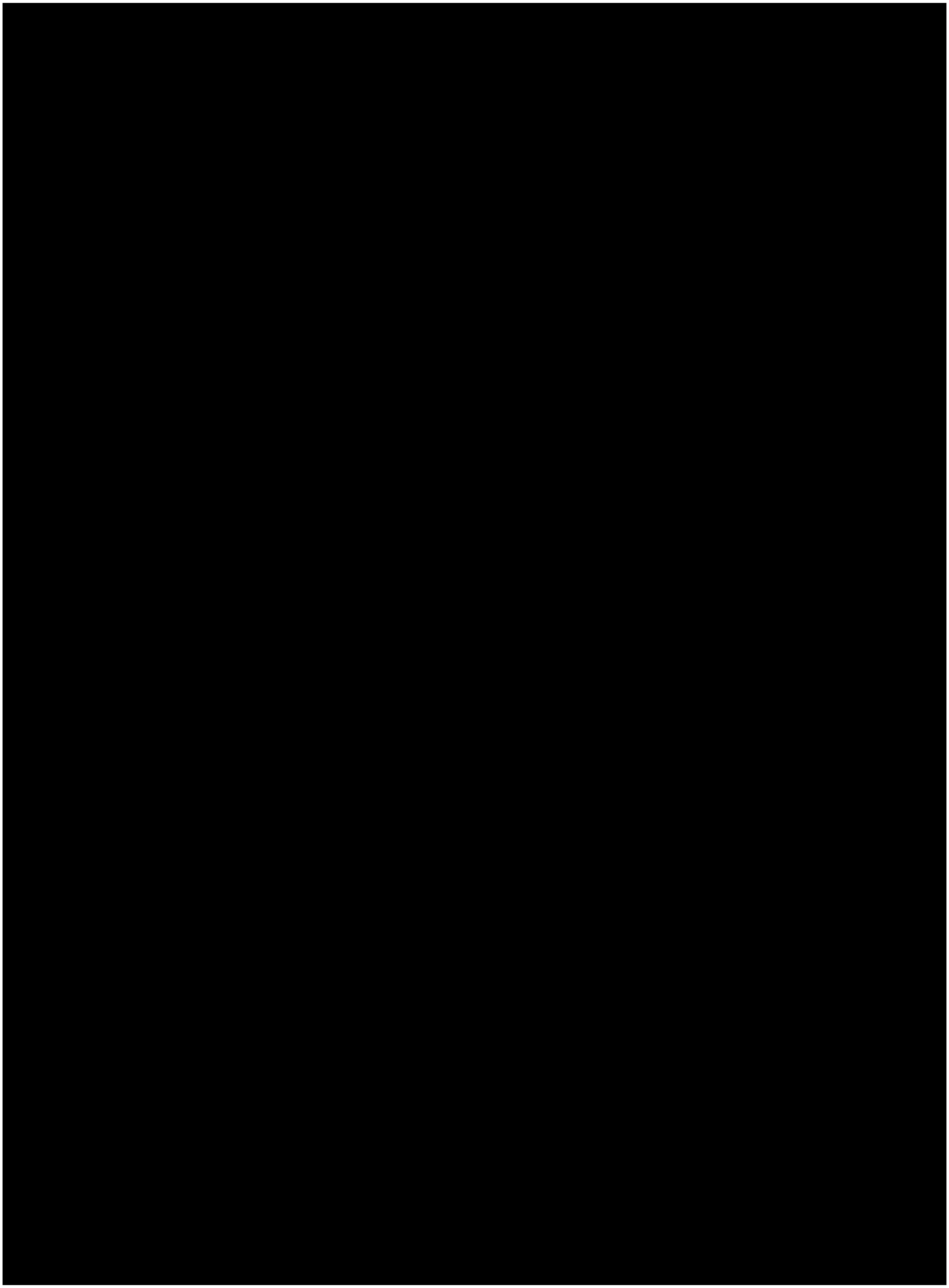



RP531
SENSE 3V3A
RP544
RP542
(BOTTOM)
RP540
RP526
RP543
RP521
(BOTTOM)
BP500
RP530
(BOTTOM)
BR008
BR009


DP510
DK206
BP500
DC001
DP540
PIN 1
DP530
IV820/821
DT601
DP521



The above picture is showing the position of IV820 and IV821 for quick reference.



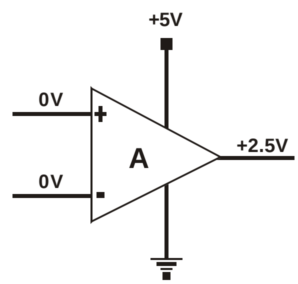
Interconnect Wiring Diagram

OpAmps

The safety circuits of the ITC222 make wide use of IC operational amplifiers or “OpAmps”. They are used for their extremely high impedance output when off and low impedance (to ground) when on. It enables them to become very reliable voltage comparitors with an almost digital output between the low supply rail and high.

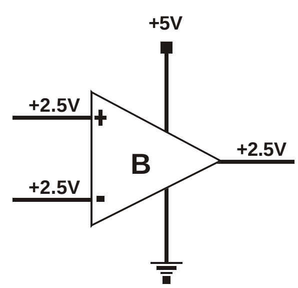
The term “Inverting” (-) and “Non-Inverting” (+) must be understood in order to successfully troubleshoot opamp circuitry. It also may be helpful to think of the outputs as Low Impedance and High Impedance rather on or off.

For example, OpAmp A:



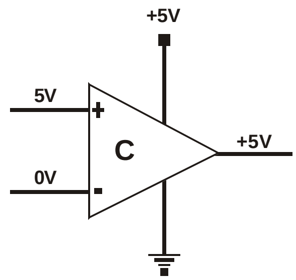
uses a single ended +5V supply so its output will rail between +5V and ground. If the inverting and non-inverting input voltages are the same the output amplifier will deliver a quiescent voltage of around 1/2 the supply or +2.5V. In the ITC222 equal input voltages are never used and its an input situation undefined. The idea is to use the opamp as a switch that compares two inputs. So the output usually switches between the available supply voltage and ground.

In OpAmp B:

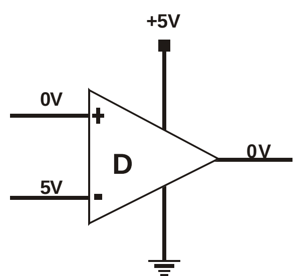


both inputs are still equal even though they are no longer 0V. The output will still reach an average level of around 1/2 the supply voltage.

OpAmp C,



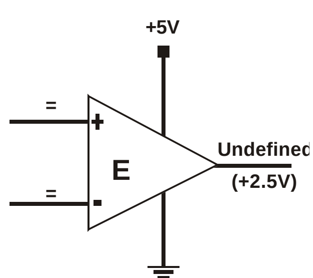
begins to change things and operate as it is used in this chassis. The non-inverting input has a larger voltage than the inverting. That drives the output towards the power supply, or a larger impedance. If the inverting input had a reference voltage fixed on it of +2.5V, the output would still be very close to the supply rail. But if the inverting input was more than the non-inverting input as in OpAmp D,



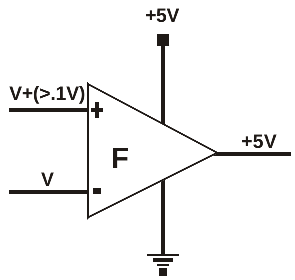
the output now goes towards the other rail, or ground. The output impedance is very low. Again, even if the non-inverting input rises to +2.5V or higher, as long as the inverting input is a higher voltage the output will remain low.

To simplify the opamps usage in the ITC222 Safety circuitry, refer to the following three diagrams.

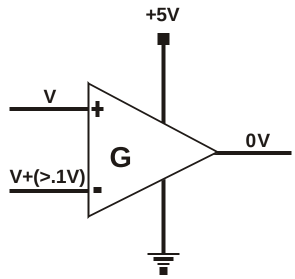
OpAmp E shows that if any two voltages on the inputs of the opamp are equal, the output is around 1/2 the supply voltage, in this case +2.5V. As designed, the ITC222 does not use this condition.



If the non-inverting input (+) is 0.1V higher than the inverting input (-), the output will go high, in this case the supply voltage, +5V.



If the inverting input (-) goes at least 0.1V higher than the non-inverting input (+), the output of the opamp will go low, in this case ground.



In this way any voltage may be compared to another using an opamp as a truth table essentially becoming a digital OR gate with the important difference being the inputs may be any voltage within the specifications of the IC. So the IC is simply comparing two inputs to see which is higher than the other and outputting a high (Vcc+) when the non-inverting input is higher and a low (generally reference ground) when the inverting input is higher.

Active Device State

It is also important to note that in many cases output impedance is the important state of a device rather than ON or OFF. Remember that when an active device is off it may still have an output impedance that could affect circuit operation.

For instance a transistor that is turned OFF has a high impedance from emitter to collector. So any circuitry connected to the collector is in an “uncontrolled” state, at least by that device. Other devices on the line would now be able to exert control. In some cases the line is allowed to float. If the device is turned ON, the device impedance is typically very low and the collector will follow the emitter usually taking over control of the line. This makes it possible to “OR” different circuits together using two or more active devices.

TITC222PTVTroubleshootingGuide

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