THOMSON TECHNICAL TRAINING

FOREWORD

This publication is intended to aid the technician in servicing the ATC221 television chassis. Directed at the safety circuitry, 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 0431 - First Printing

Printed in U.S.A.

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ATC221 Shutdown Circuits

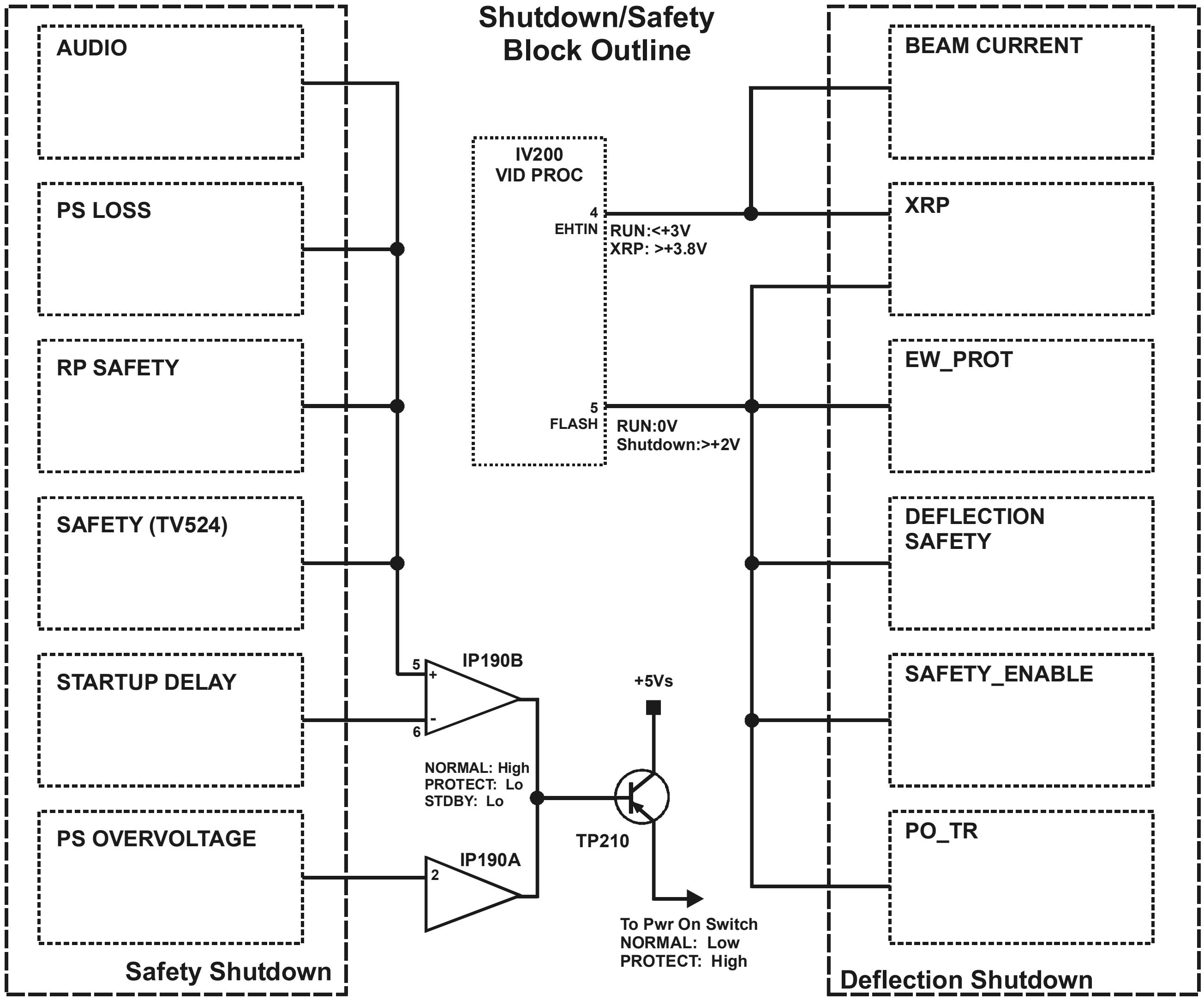
This training material assumes a knowledge of the current Thomson television chassis ATC221. The material has been prepared using general values of components. Components and other circuitry may change over time so in all cases Electronic Service Data for the instrument should be consulted for the most accurate component values and voltages.

Typical Thomson 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.



Overview

The ATC221 uses two independant legs of safety and operational shutdown circuits closely tied together. Of course there are many other circuits that protect individual sections to prevent catastrophic failure in circuits such as the power supplies, deflection, convergence and others. However to monitor general operation and particularly to provide XRP protection there are two main branches of protection circuitry: one for safety related shutdowns of the main run supply and another for deflection related failure shutdown including XRP.

The two branches operate totally independant of each other and although performing different functions both result in a “Three Strikes” shutdown syndrome 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. The different sections within each branch are interdependant sometimes making troubleshooting efforts difficult.

In many areas multiple signal lines converge into one point. Most times those converging lines are isolated by a diode. Since shutdowns may pull other safety or protection lines down it complicates troubleshooting. However by pulling the isolating diodes the proper circuit may be identified. This manual will attempt to show where those isolating diodes are located and whether they may be pulled or not.

The Safety shutdown may be broken into six distinct sections:

- Audio Power Supply Monitoring,
- Main Run Power Supply Loss,
- Rear Projection Instrument Safety (CRT Scan Loss protection),
- Main Safety,
- Startup Delay,
- Power Supply Overvoltage.

Deflection Shutdown may also be broken into six distinct sections:

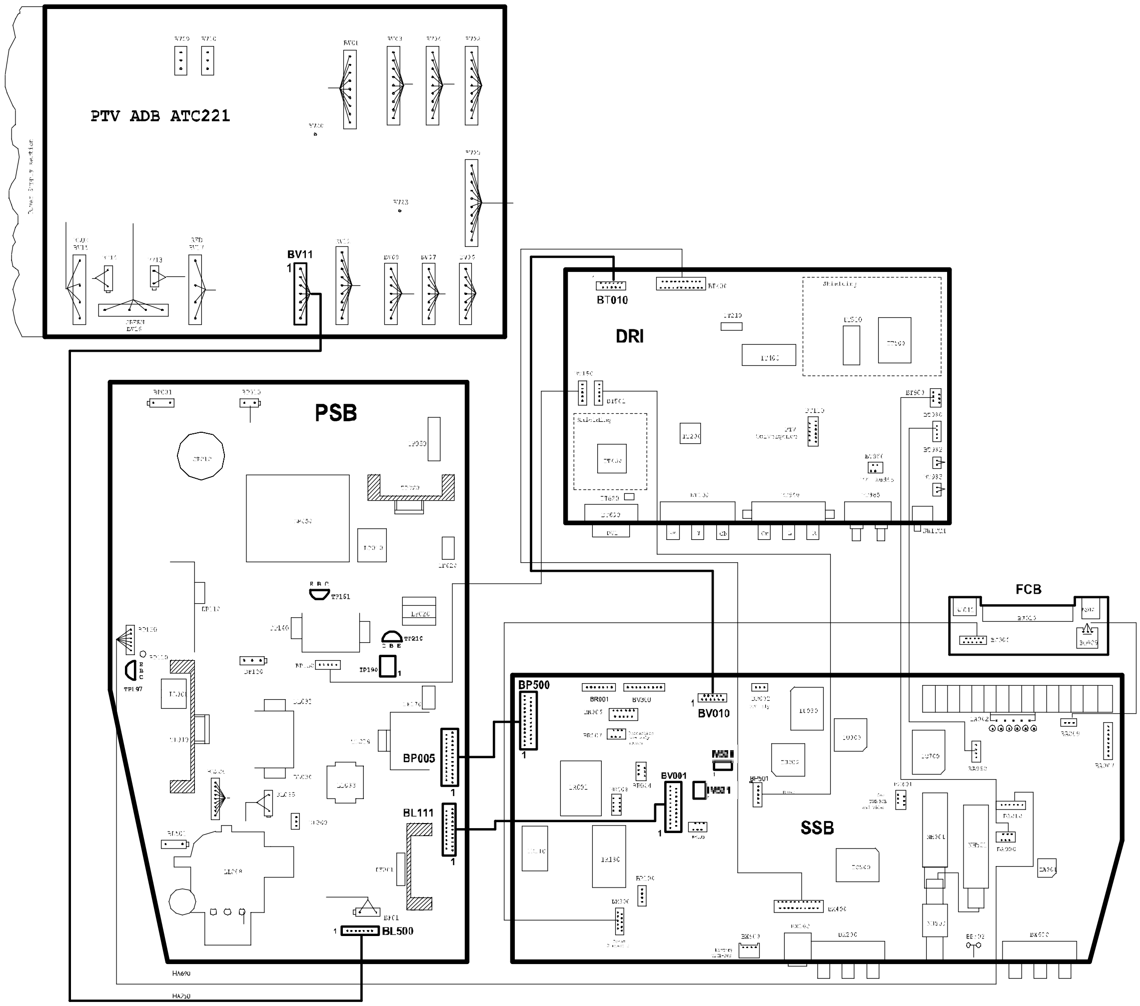
- Beam Current monitoring,
- XRP,
- East West Circuitry Power Dissipation,
- General Deflection Safety,
- Micro based suspension of the Safety Monitoring during deflection startup (Safety_Enable),
- Micro based suspension of Safety during Instrument Turn On (PO_TR).

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 and whether the output of those opamps follow the inputs.

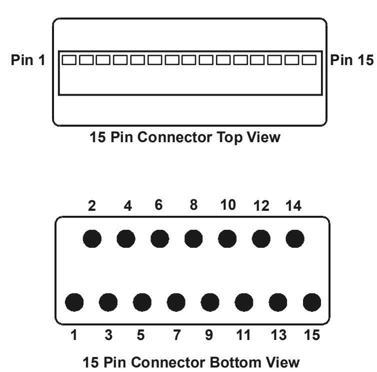
Threshold voltages are generally more accurate since they have been set specifically to shutdown operation if failure conditions, indicated by the threshold being reached, are indicated. The only exception to the specific threshold voltage is XRP, which must be adjusted according to specific circuit reaction to many interelated conditions. ***XRP is set during the manufacture of the SSB module and cannot be changed in the field.***

The discussions will begin “backwards” explaining first how the shutdowns occur, then moving backwards to show what the actual trigger vehicles are. This is also the way troubleshooting must begin. The first step in troubleshooting suspected safety related shutdowns is to confirm the standby supply operation, then move to the run supplies. Checking run supplies during safety shutdowns may not be possible other than to check all output legs for direct shorts.

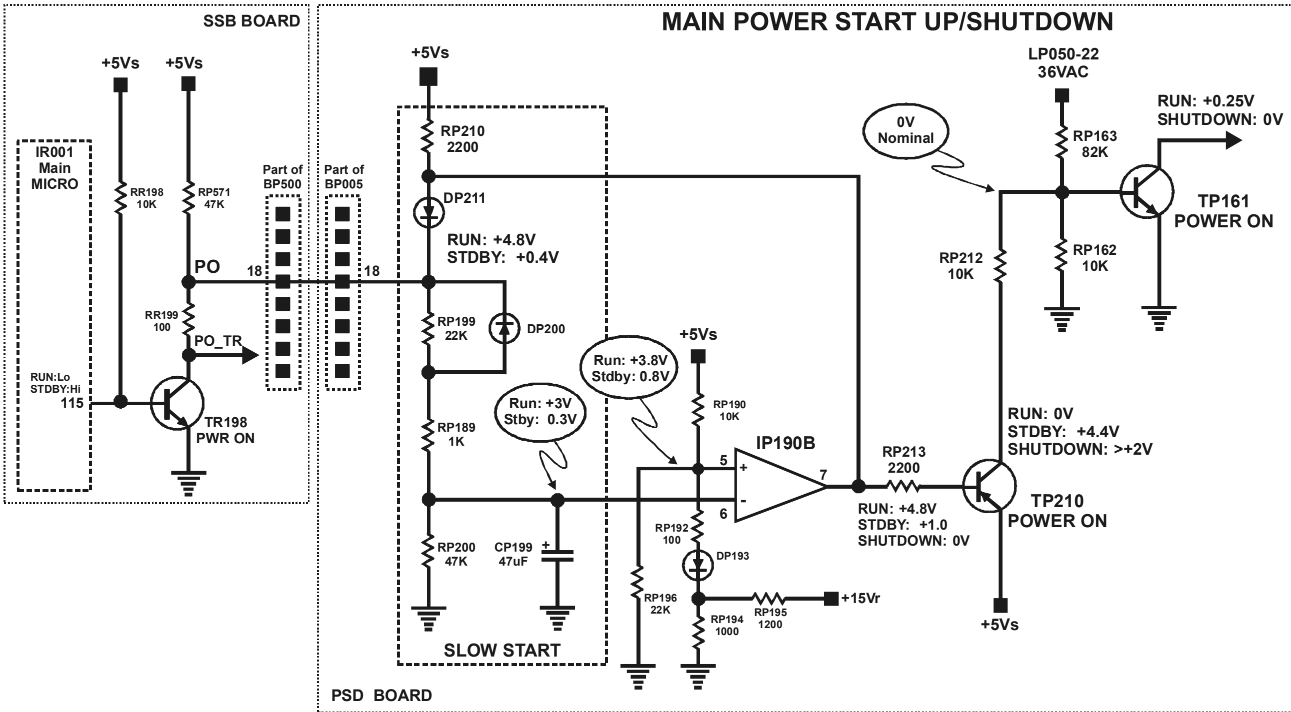
Once the power supplies are confirmed to be active, the first check if a set fails to come up or goes into “Three Strikes” is to check the main Safety shutdown devices, TP210, IV200-5 and IV200-4. If those devices show active shutdowns, the technician must work backwards into the sections that may cause safety trips.



Four of the ATC221 PCB’s will be 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.



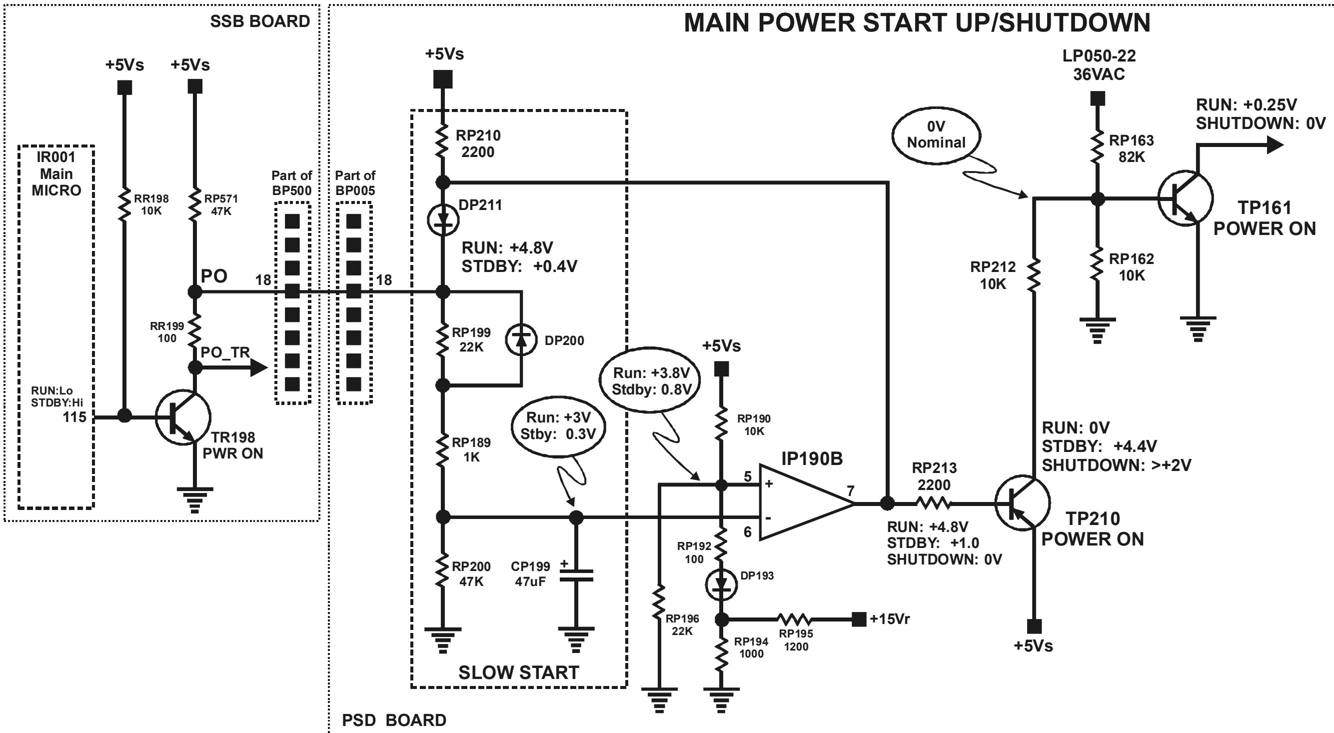
Power On/Off

The basic startup sequence of the chassis is also the same circuitry that shuts it down during any Safety Shutdown event. There are two circuits required to start or shut down the chassis. First the PO (Power On) signal that starts up the run supplies. Then the PO_TR (Power On_Transistor) that signals deflection to start and/or shutdown. PO_TR will be discussed during the deflection safety circuit descriptions later.

The basic startup active component circuit consists of IR001-115 (the main micro), TR198, DP211, TP210 and TP161. When in standby mode IR001-115 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.) At the same time PO_TR is also holding off the horizontal deflection waveform keeping deflection from generating any supply voltages.

When a remote control IR or Front Panel Keypress initiates the Power On sequence, TR198 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.

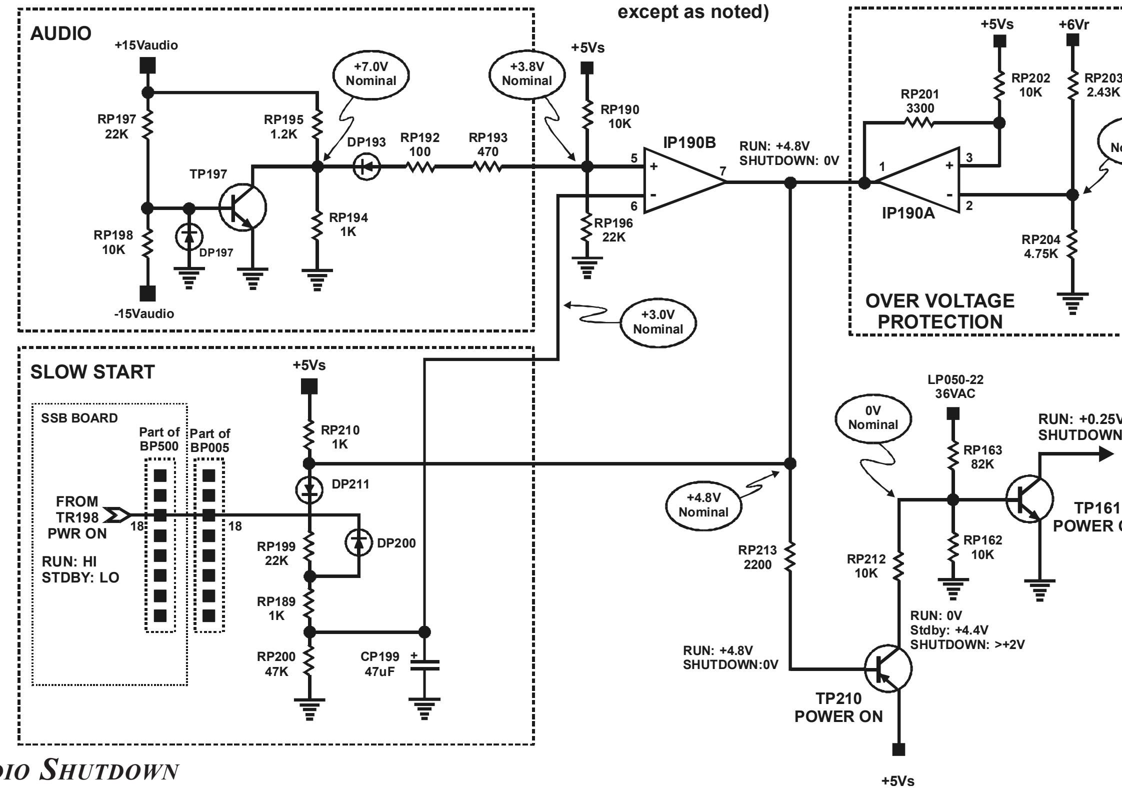
To shut the run supplies off IR001-115 again initiates the command this time by going HI. That turns ON TR198 which turns ON DP211. That turns on TP210 shutting down the main run supplies. CP199 maintains a residual charge for a period of time, discharging through a divider consisting of RP189, DP200, 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.

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 audio protection supplies rather than standby.

Audio PS & Overvoltage Protection
(All components on PSD Board except as noted)



Audio Shutdown

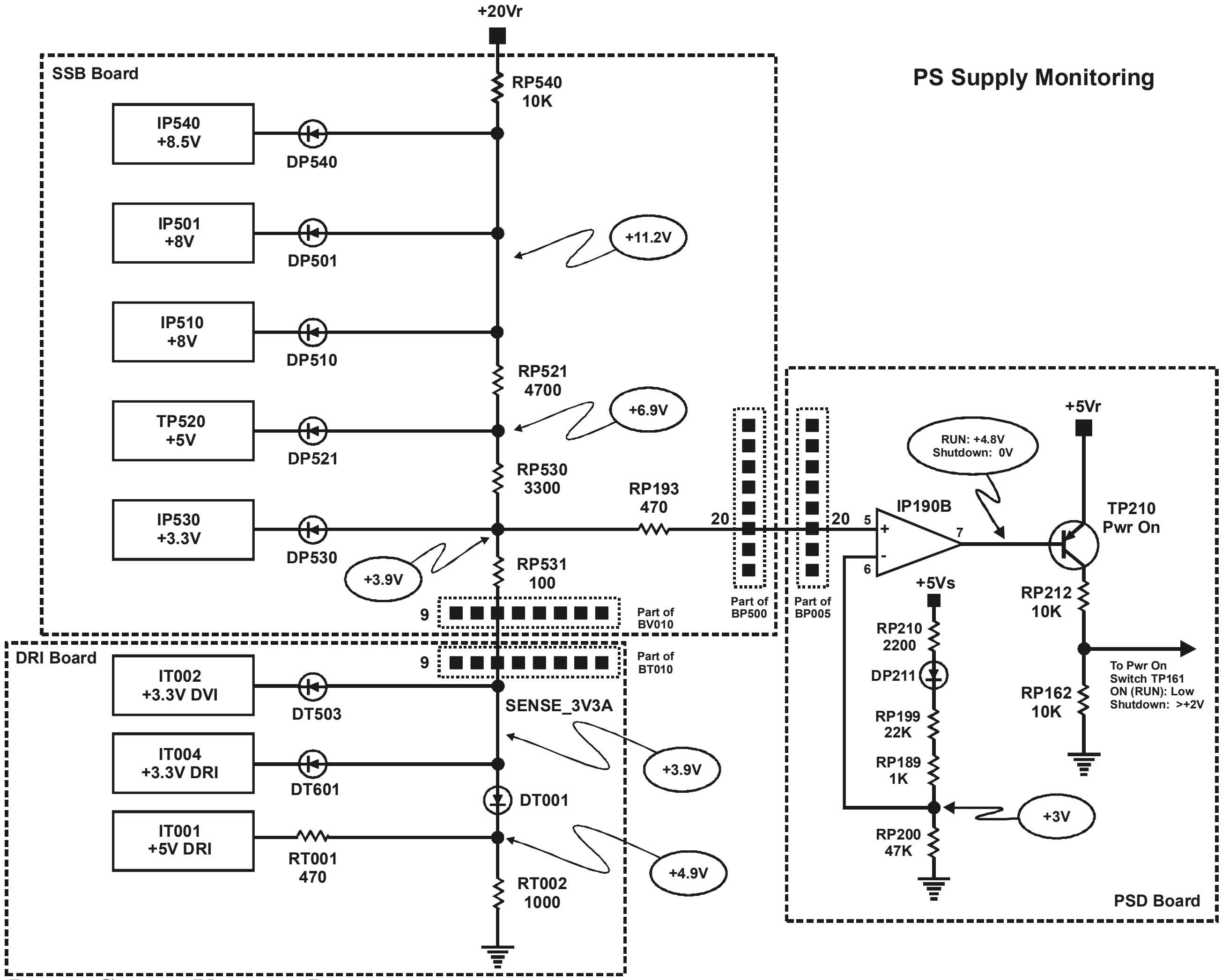
The audio power supplies are monitored directly by TP197. When the chassis is running, the nominal voltage is ±15V on the ends of a resistor divider network consisting of RP197/98. With both voltages at their nominal values, TP197-B is about -0.6V and the transistor is OFF.

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.

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. As it drops TL210-B also drops turning on TP210 which increases the collector voltage, turning on TP161 causing shutdown of the run supplies.



Power Supply Voltage Loss

All run supply voltages are monitored so that in the event one supply is lost, all other supplies will be shut down while there is time to prevent other catastrophic damage. The monitor circuit itself is reasonably simple however tracing voltages across three circuit boards and back again is somewhat tedious. The supply monitor line consists of a simple voltage divider network: RP540, RP521, RP530, and RP531 on the SSB board, and completing the network in the +3.3V supplies on the DRI Board. Those components are connected directly across the +20Vr supply to the two +3.3V DVI supplies and a +3.3V regulator on the PSD board, IP530. Diodes DP530, DT503 and DT601 isolate the three supplies from each other.

The main run supply switch noninverting input, IP190B-5, monitors the voltage divider via RP193. However note the voltage divider low side voltage will be provided by the +3.3V supplies. If all supplies are working the nominal voltage at the junction of R530/531 will be +3.9V and on noninverting pin 5 of IP190B, +3.8V. 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 DT503, DT601 and DP530 are reversed biased by the higher 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. For example, DT001 is reversed biased by the +5V DRI supply and the +3.9V present on the protection line.

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 operation previously described.

If the +5V DRI supply shorts or otherwise ceases to function DT001 will be turned on by the +20Vr supply completing a voltage divider consisting of RT002, DT001, RP531, RP530, RP521 and RP540. That drops the junction of RP530/531 to around +1.7V pulling noninverting pin IP190B-5 low, triggering a shutdown. The same event occurs if either of the +3.3V supplies on the DRI board become inactive, the only difference being there would be a lower voltage present at the RP530/531 junction. That may be a clue to which supply is defective. (See the table below.)

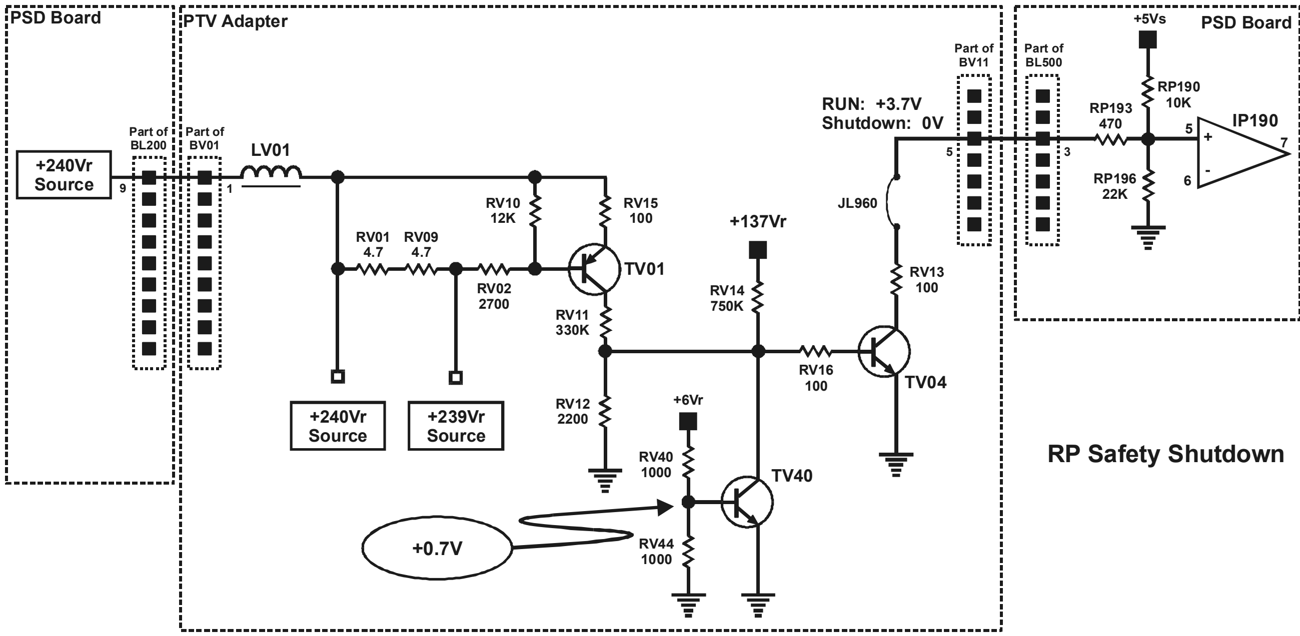
The +3.3V supply on the SSB board would give similar action as would a short in any of the supplies on the SSB board. RP540 is a current limiter to make certain there is always a current path from any short circuit on the power supply sides of the protection diodes.

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. If the +5V regulator on the DRI board shorts, pin 5 will be about +1.7V. If either of the two +3.3V supplies on the DRI board short pin 5 will around +0.7V.

Once it is determined one of the supplies in the string are 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.

NOTE: The DRI board may also be removed from the chassis for further troubleshooting. The +3.9V bias for IP190B-5 will be provided by Regulator IP530 on the SSB board. No other safety/shutdown operation depends on the DRI board allowing normal operation of the chassis, simply without any functions provided by the DRI circuitry.

RP530/531 Junction Voltage	Defective Supply
+1.7V	+5V DRI
+0.7V	+3.3V DRI
+0.7V	+3.3V DVI
+0.6V	+3.3Vr
+1.5V	+5Vr
+2.8V	+8Vr (IP510)
+2.8V	+8Vr (IP501)
+2.8V	+8.5Vr (IP540)



RP Safety (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.

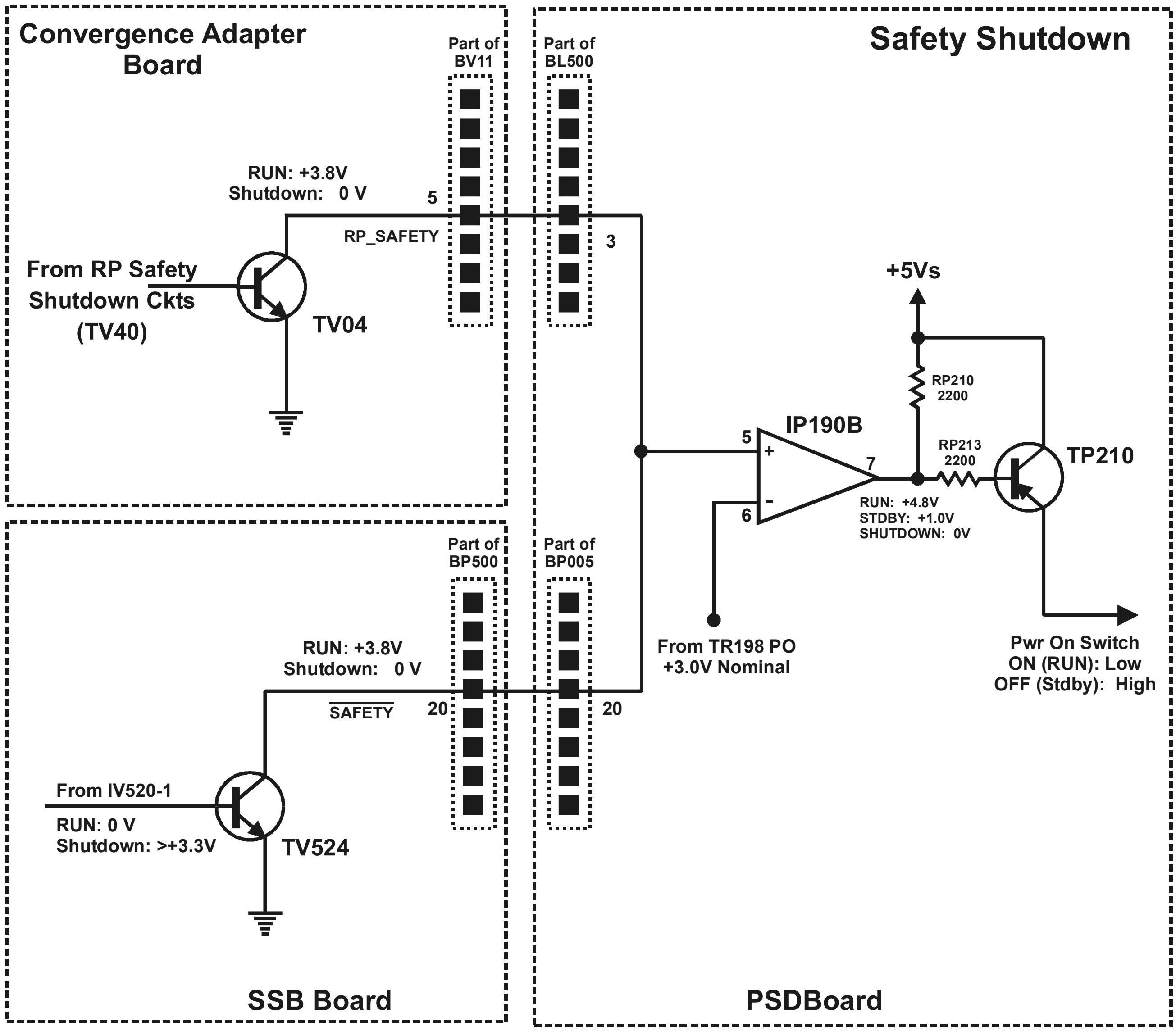
Under normal circuit operation TV01 is biased off and TV40 is turned on by a simple voltage divider between the +6Vr supply and ground. That keeps TV04 off and its high impedance allows the remainder of the safety circuit feeding IP190-5 to function as previously described. Under most circuit conditions TV40 will not allow TV04 to turn on. There are two exceptions.

First note TV40 prevents any action from TV01 as long as the +6Vr supply is up and stable. Any action being monitored by TV01 can only shutdown the power supply prior to the +6Vr supply being established or after it has failed. If the +6Vr supply is operational TV40 is held ON grounding TV04-B preventing TV04 from turning on and allowing normal IP190 shutdown operation. During startup and shutdown, the +6Vr supply establishes itself very quickly when compared to the more demanding B+ and CRT supplies. During that period of unstable operation, TV40 prevents false shutdowns.

When the safety circuit is allowed to operate, it prevents possible damage during startup due to excessive beam current that might occur when supply voltages are not stable. The output of TV01 is still active and continues to feed the ABL circuit monitoring beam current for conditions that could harm the CRT's.

Under normal operation the +240Vr supply feeds current to the CRT drivers. If excessive beam current is drawn, current through RV01/09 also increases dropping the +239Vr supply faster than the +240Vr side. Once the voltage drops enough (and TV40 is inactive) TV01 turns on turning on TV04 and activating the shutdown circuit.

Second, if the +137V run supply increases beyond +200V the increasing voltage drop from TV40-C to TV40-E will turn on TV04 activating the shutdown circuit.

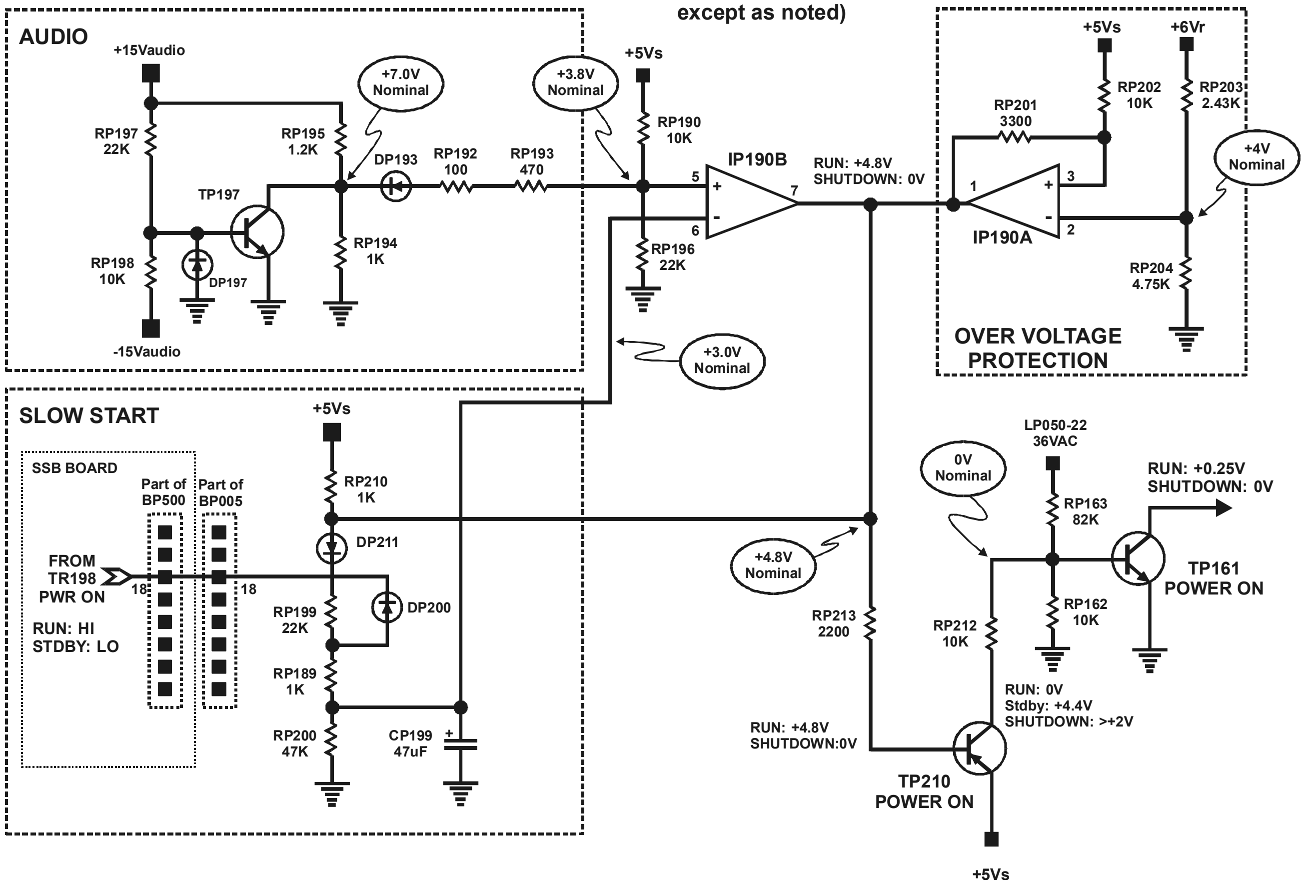


Safety Shutdown

There are two branches to the safety shutdown circuit. The RP Safety circuit has been discussed. The Safety leg driven by TV524 monitors the deflection shutdown circuits, shutting down the power supply if trouble is indicated. TV524-B is driven by IV520-1 which will be discussed later.

In either case the shutdown circuits can be monitored at IP190B-5. If pin 5, the non-inverting input, is high during run operation the safety circuits are operating normally and the output of IP190B on pin 7 is high. If pin 5 is low, near 0V or at least lower than the reference voltage on pin 6, the output of IP190B pin 7 goes low following the inverting input. That turns on TP210 shutting down the main PWM as described previously.

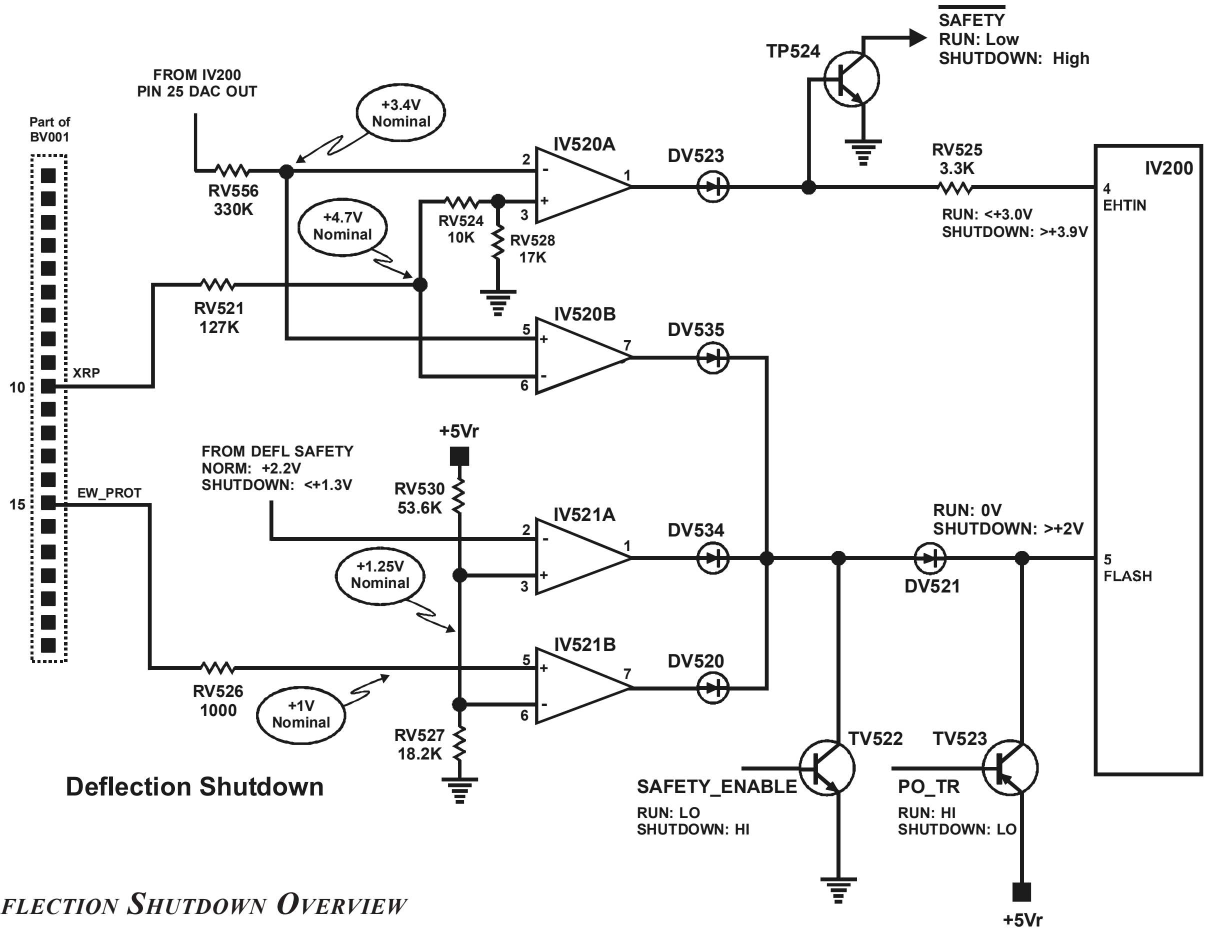
Audio PS & Overvoltage Protection
(All components on PSD Board except as noted)



OverVoltage Protection

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.



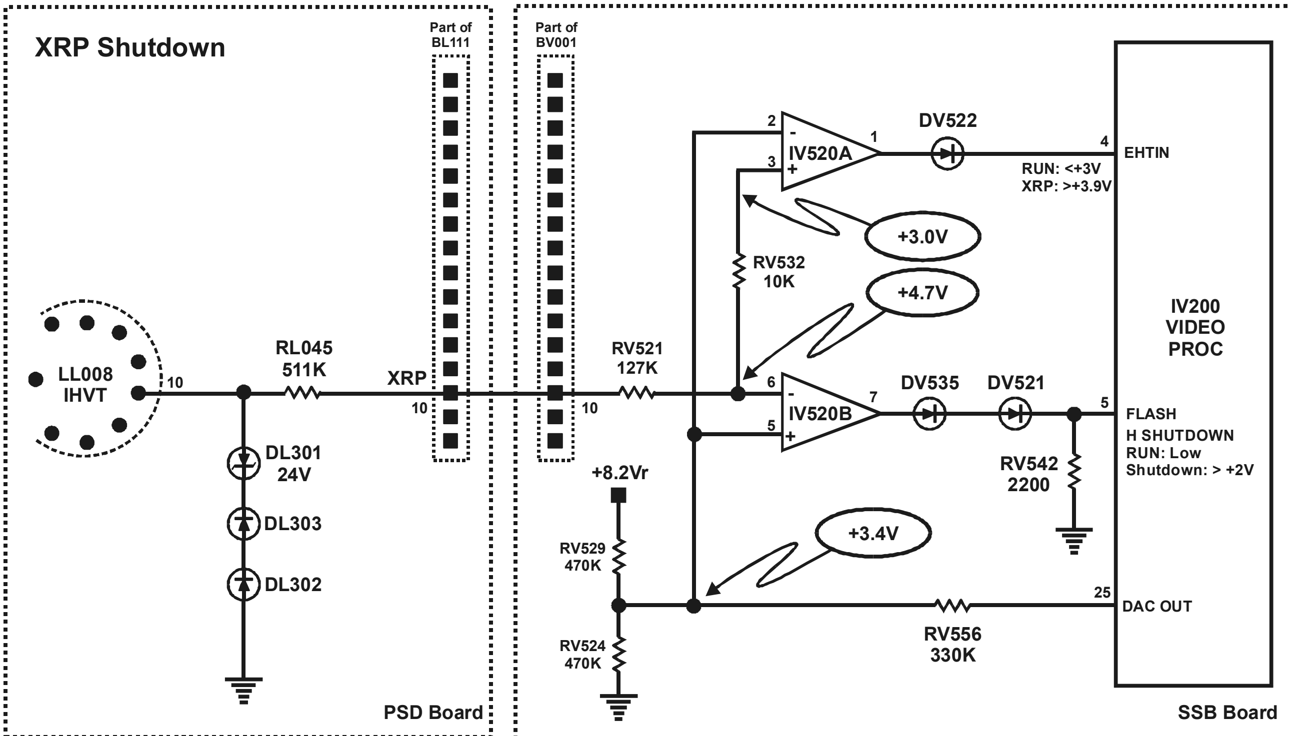
Deflection Shutdown Overview

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

- Beam Current Undervoltage (IV520A),
- XRP (excessive HV or beam current),
- EW Protect (excessive power disappation in the EW circuitry or loss of deflection),
- Deflection Safety (Excessive beam current),
- Safety Enable (Turns the safety feature off during certain conditions to prevent false triggers),
- PO_TR (Power On switch monitor for IV200)

Any of the six will trigger a shutdown of the entire chassis. All six are monitored by the Video Processor, IV200. Pin 4, "EHTIN" monitors beam current for abnormal operation. It typically reacts to excessive HV indicated by beam current by shutting down the horizontal waveform. Under normal Run operation the voltage on Pin 4 is less than +3V.

Pin 5, "FLASH", monitors the other 5 legs of the monitor circuit. Any trigger will immediately shut down deflection operation by cutting off the waveform to horizontal drive. Typically a voltage greater than +2V on this pin will trigger horizontal shutdown. As horizontal shutdown occurs, other circuit monitoring shuts down the run supply in order to minimize circuit damage in the event of catastrophic failure. IV520 and IV521 provide monitoring for the key circuitry in the deflection area. XRP is monitored by IV520 while IV521 monitors EW Pincussion and High Voltage generation.



Excessive High Voltage

IV520A 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. XRP is tripped if the voltage is either >+30V or <+22V. A voltage divider consisting of RL045 and RV521 drops that voltage to about +4.7V at the inverting input IV520B-6 and about +3.0V at the non-inverting input IV520A-3.

To monitor the voltage, a reference voltage is set up by the junction of a divider network consisting of RV524/529 between the +8.2Vr supply and ground. That voltage is set more precisely by a trimmer voltage output from IV200-25. ***This voltage is set at manufacturing and cannot be adjusted!!!*** It results in a reference of about +3.4V on the non-inverting pin IV520B-5 and inverting pin IV520A-2.

The normal voltages on the input pins result in an output from IV520A-1 of near ground. The EHTIN input at pin 4 of IV200 assumes normal operation when its input is less than +3V. With the inverting input of IV520B higher than the non-inverting input, IV520B-7 output is also low. The FLASH input, IV200-5, sees a low as normal operation.

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 IV520B-6 and IV520A-3. In this case IV520A-7 is already low so increasing the voltage will not make a difference in the output. However when the non-inverting input, IV520A-3, increases to greater than the inverting input, IV520A-2, the output IV520A-1 goes high. In this case, when it increases to higher than the reference voltage, +3.4V, on IV520A-2, the output on pin 1 goes high. EHTIN trips when pin 1 goes above +3.9V shutting the set down.

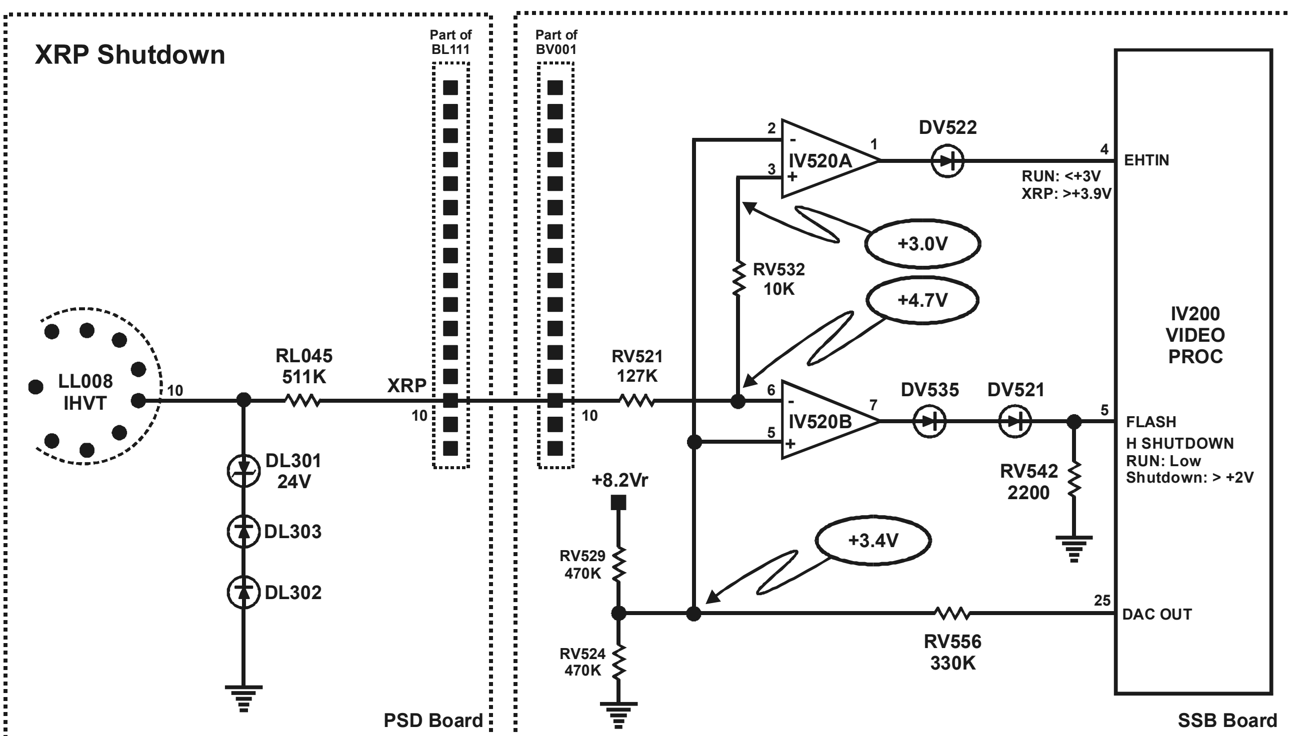
If HV decreases too much, the inverting pin, IV520B-6 will drop below the reference voltage on the non-inverting input, IV520B-5, and IV520B-7 will go high triggering the FLASH input, IV200-5, to shutdown deflection.

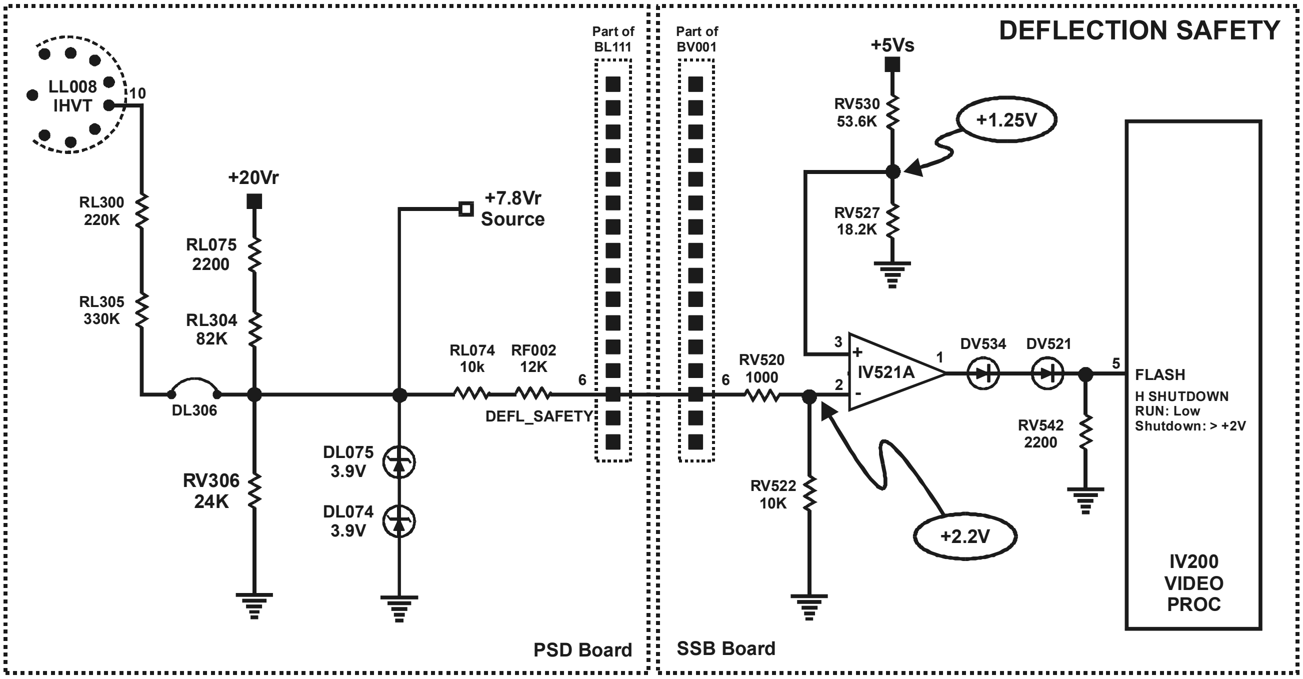
Note that although both conditions result in chassis shutdown, there are very distinct differences in how they perform their shutdown routines which can lead to better diagnosis.

Also understand the EHTIN input at IV200-4 performs two essential 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 +1.0 and +2.8V. That variation is translated into horizontal output control which can adjust high voltage to compensate for differing beam current conditions.

The secondary function is to monitor the status of XRP related operation and shut high voltage down in the event of improper operation. If the input voltage rises above +3.9V shutdown of horizontal deflection results. A shutdown initiated by IV200-4 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.**

The FLASH input, IV200-5, stops horizontal drive immediately if the input voltage climbs above the threshold of +2.0V. **If the input voltage drops below the threshold, after a short delay, an automatic reset will occur and the chassis will restart without manual intervention.**





Defl Safety

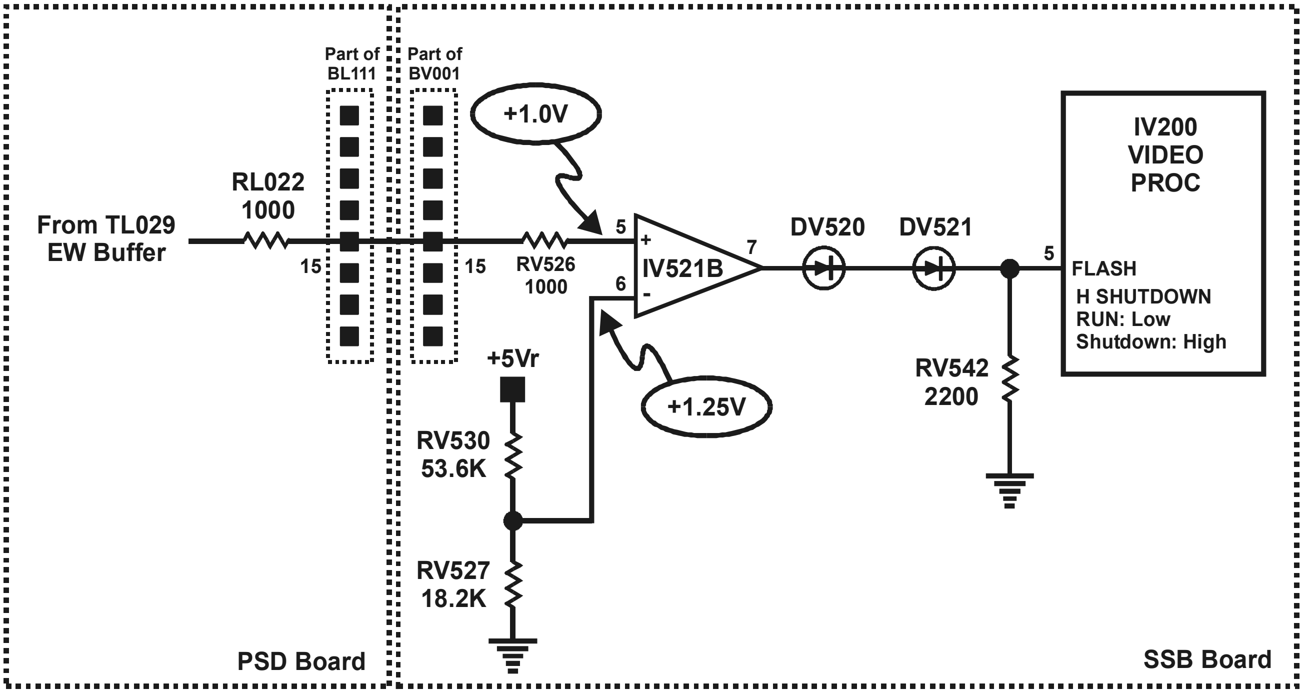
IV521 monitors EW Pincussion and High Voltage generation. IV521A monitors the +7.8Vr supply developed from Pin 10 of the IHVT, LL008. During normal operation the inverting input of IV521A-2 develops about +2.2V from a voltage divider network consisting of RL074, RF002, RV520, and RV522 between the +7.8Vr supply and ground. The non-inverting input, IV521A-3 is locked at +1.25V by a voltage divider RV527/530 between the +5Vs supply and ground. This locks the output, IV521A-1 at ground removing it from any circuit control of the FLASH input IV200-5. Pin 5 is now controlled by other circuits which keep it low and normal operation occurs.

If a failure develops in the HV section due to deflection issues two things may occur.

If the IHVT fails to develop voltage, the +7.8Vr supply disappears allowing IV521A-2 to drop below the non-inverting input, IV521A-3 and the output goes high. That turns on DV534 and DV521 raising IV200-5 enough to trigger deflection shutdown.

If beam current increases beyond the generation capability of the IHVT, the voltage will also begin to drop. Again, once it drops far enough so the inverting input of IV521A drops below the non-inverting voltage, IV521A output goes high triggering deflection shutdown.

EW Protect



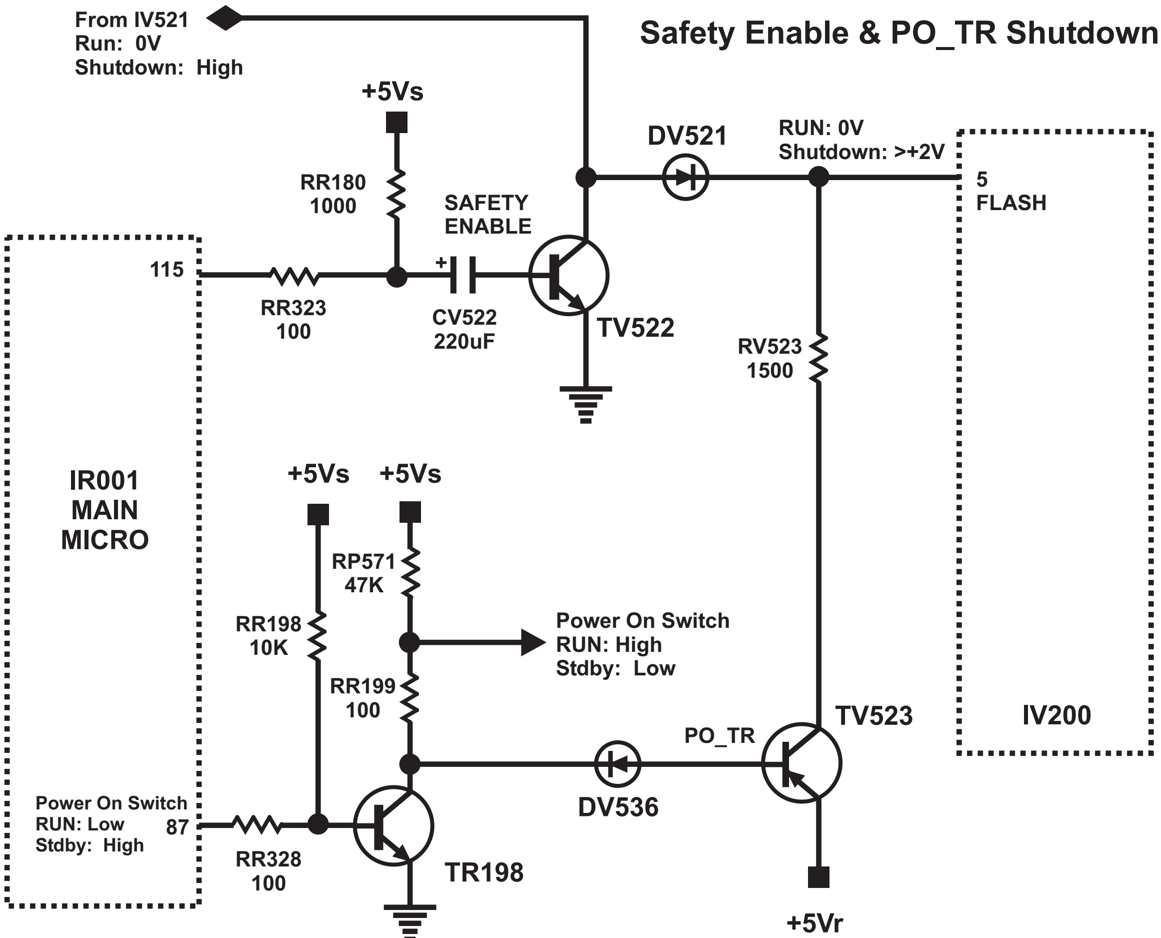
East-West Protect

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 voltages on and around the EW output FET, TL029. The sensing components are carefully chosen to provide a consistant signal at the junction of CL023 and RL022 in the EW circuitry. That voltage is monitored by the non-inverting input, IV521B-5 and is typically +1.0V. A reference voltage of +1.25V is placed on the inverting input, IV521B-6 which results in an output of 0V on IV521B-7 allowing normal operation of deflection.

If either current or voltage increases at the sense points of TL029 the voltage at IV521B-5 increases. If pin 5 becomes greater than Pin 6 the output of IV521B-7 goes high initiating a shutdown of horizontal.

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 115 of the main microprocessor, IR001, goes to high impedance and TV522 is turned on as CV522 charges through RR180. That grounds the anode of DV521 disabling any shutdown signal coming from IV520B, IV521A or IV521B preventing false safety shutdowns. Once CV522 charges, current flow stops and TV522 shuts off allowing normal safety operation. CV522 also prevents false shutdown by the microprocessor. If pin 115 goes to low impedance the only discharge path would be the B-E junction of TV522 which is reversed bias by the voltage on CV522 preventing it turning on and disabling the shutdown circuits for a period of time. Eventually CV522 will discharge to the low impedence pin 115. But it provides enough reserve to prevent false triggering of the Safety Enable line.



TV522 can be difficult to troubleshoot. At the instant of startup TV522-B can be seen going towards the +5V supply. However the cap charges TV522 shuts off. Since TV522-E is at ground and TV522-C is also very near ground there is no indication of whether TV522 may be shorted. It may safely be removed from the circuit for testing of the other safety shutdowns.

Standby

During standby operation pin 87 of the microprocessor is HIGH turning TR198 ON. That turns ON DV536 turning ON TV523. It is important to note TV523 can only be active when the chassis is running. TV523 passes the +5Vr supply from emitter to collector placing a HIGH on the FLASH input IV200-5 turning the horizontal waveform off quickly. But as soon as the run supplies decay, TV523 has no way to turn the chassis back on.

Power On

When pin 87 of the micro is pulled low by a power on (PO_TR) command, TR198 turns OFF, placing the +5Vs supply on the cathode of DV536 and shutting off TV523. But that doesn't happen immediately due to the action of CP199 as explained previously. When the +5Vr supply comes up, it is passed by TV523 which is biased on by the increasing voltage generated by the slow charging of CP199. So the FLASH input now has something over +2V on it and holds horizontal OFF. When CP199 charges enough, DV536 is reversed biased and TV523 shuts off removing the +5Vr supply from IV200-5, (which has been holding the horizontal waveform off), allowing normal deflection operation.

Summary

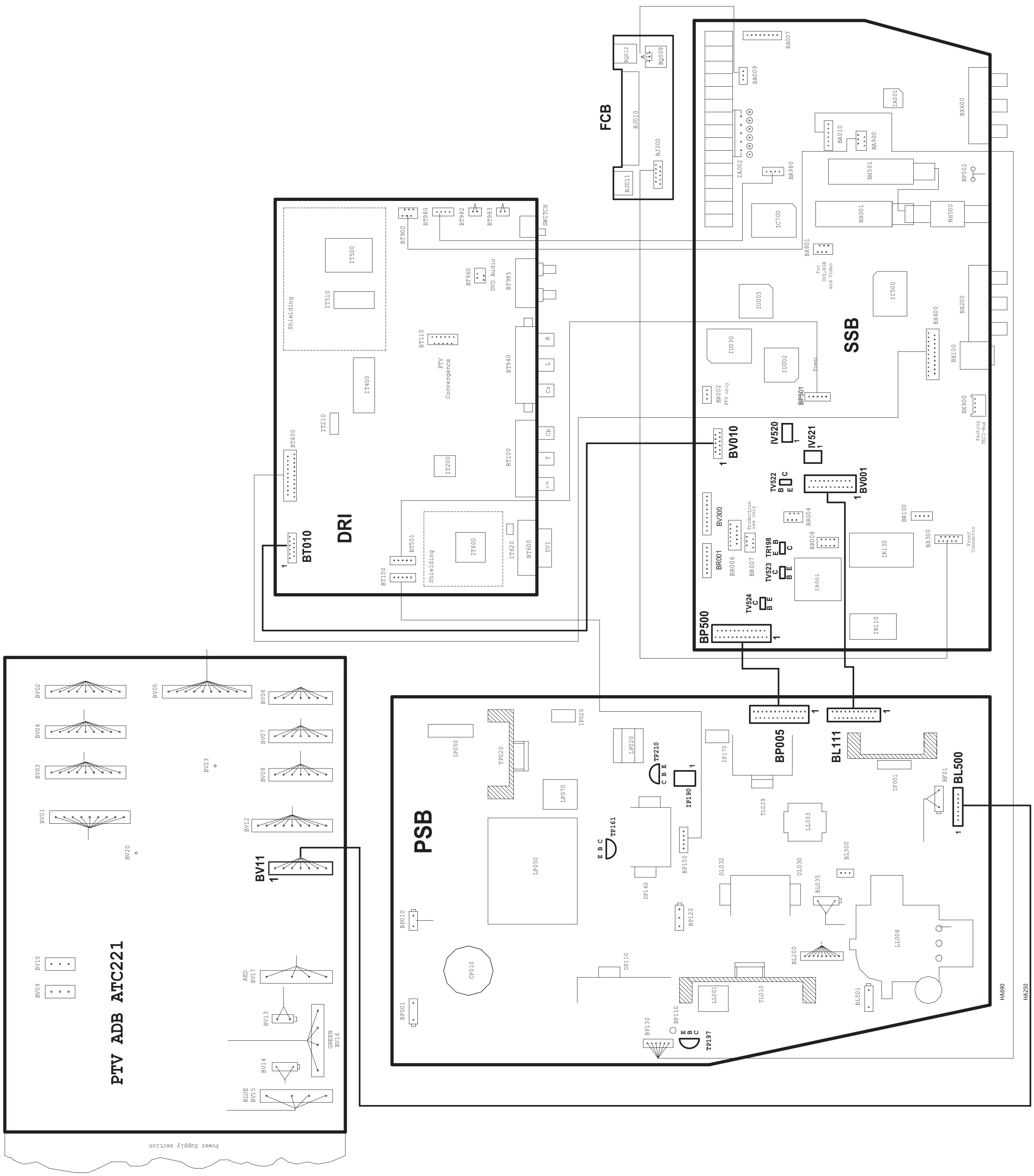
This manual has attempted to cover all safety related shutdown circuitry that could cause shutdown of the ATC221 chassis or prevent it from starting up. Always remember the circuits themselves are only monitoring circuits such as those in the deflection and power supply sections for dangerous operation 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 ATC221 chassis are governed by six devices; TP210, IP190, IV200, IV520, IV521 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.

IP520 and IP521 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.

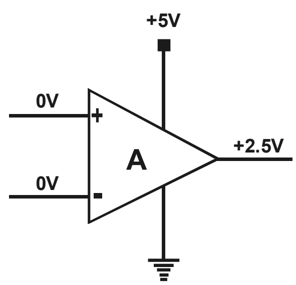

FCB
SSB
DRI
PSB
PTV ADB ATC221
BV010
BT010
BV001
BP500
BP005
BL111
BL500
BV11
Power Supply section

OpAmps

The safety circuits of the ATC221 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.

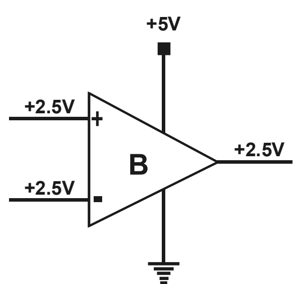
The term “Inverting” (-) and “Non-Inverting” (+) must be understood in order to successfully troubleshoot opamp circuitry. It also may be helpful to think of the outputs as Low Impedance and High Impedance rather on or off.

For example, OpAmp A:



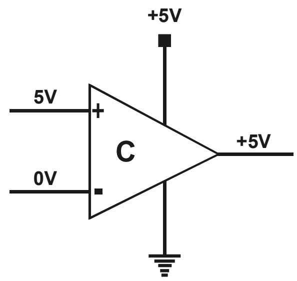
uses a single ended +5V supply so its output will rail between +5V and ground. If the inverting and non-inverting input voltages are the same the output amplifier will deliver a quiescent voltage of around 1/2 the supply or +2.5V. In the ATC221 equal input voltages are never used and its an input situation 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:

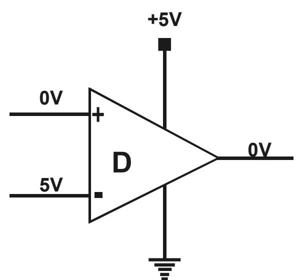


both inputs are still equal even though they are no longer 0V. The output will still reach an average level of around 1/2 the supply voltage.

OpAmp C,



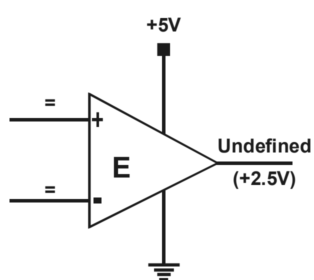
begins to change things and operate as it is used in this chassis. The non-inverting input has a larger voltage than the inverting. That drives the output towards the power supply, or a larger impedance. If the inverting input had a reference voltage fixed on it of +2.5V, the output would still be very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



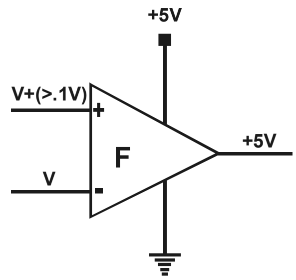
the output now goes towards the other rail, or ground. The output impedance is very low. Again, even if the non-inverting input rises to +2.5V or higher, as long as the inverting input is a higher voltage the output will remain low.

To simplify the opamps usage in the ATC221 Safety circuitry, refer to the following three diagrams.

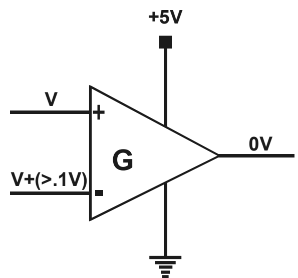
OpAmp E shows that if any two voltages on the inputs of the opamp are equal, the output is around 1/2 the supply voltage, in this case +2.5V. As designed, the ATC221 does not use this condition.



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.

T-ATC221 Safety

First Edition 0431 - First Printing

Printed in U.S.A.