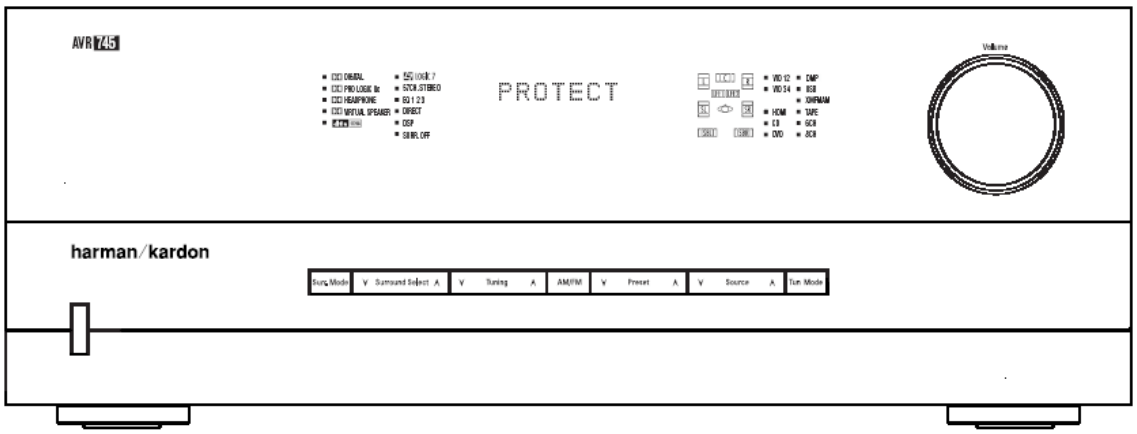
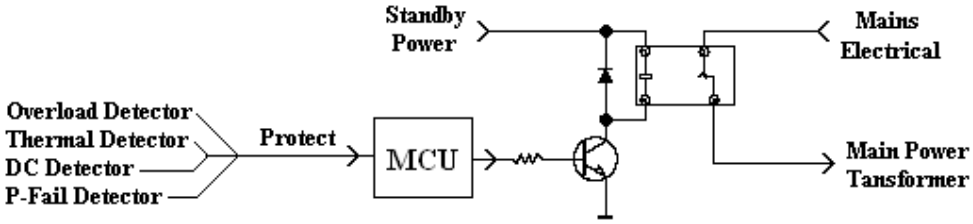
Protection Circuitry Servicing
&
Theory of Operation



In the event of a fault, an HK AVR will go into Protection. Protection is a condition where the AVR removes the main power from itself and returns to the standby state (amber indicator). The AVR does this in order to prevent further damage to the AVR or your loudspeakers. Protection related issues can happen at initial turn on or intermittently after hours of use. Sometimes the front display on the AVR will say the word “Protect” before returning to standby if there is a fault. However, it is possible for the AVR to go into protect without saying so on the front display. There are other possible reasons for an AVR to shut itself besides protection issues, but it is usually a primary suspect.

There are typically 4 fault detection mechanisms which are used. These mechanisms are Overload detection, thermal/temperature detection, DC detection and power failure (P-Fail) detection. In a typical protection scheme, the output of all 4 fault detection mechanisms combine to form the Protect line. The Protect line is monitored by the microcontroller. If the microcontroller detects a fault condition on the protect line, it will remove main power from the AVR which causes the AVR to go back into standby.



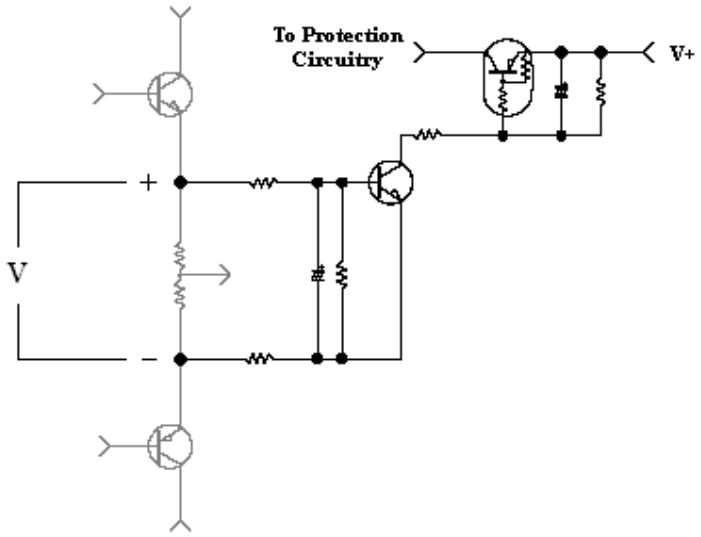
It helps to keep in mind that all transistors in the protect circuitry behave like a switch. They only work in an ON/OFF, Open/Close manner. The collector and emitter are like switch contacts. When the base receives a signal, the contacts close (i.e. short together).

Some faults will keep the protect line in a steady state fault condition. However, many other faults will only create a momentary pulse on the protect line. When checking the protect line for a fault, you should use an oscilloscope and keep a lookout for pulses as well as the DC steady state voltage. Storage Oscilloscopes and latching capable logic probes are very useful for detecting an infrequently occurring fault condition on the protect line.

Now that you have an idea of the protection circuitry topology, we will take a closer look at each of the 4 fault detection mechanisms.

Over-Load Detector

Overload detection detects if the amp is excessively loaded. It protects the amplifier from potential damage if its output sees impedance which is too low, or its output amplitude is too high. The circuit works by sensing the amount of voltage drop across the amplifiers output resistors. The more current flows through the amplifiers output, the larger the voltage that develops across the emitter resistors. Once enough voltage develops, it turns on the detect circuit.



Possible reasons for it to trip while playing are:

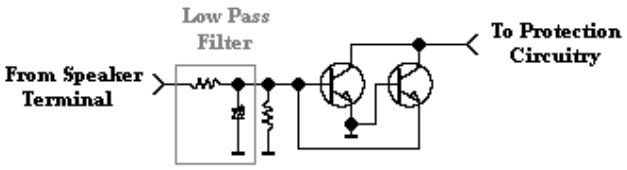
1) Volume to high.
2) Impedance too low.
3) Bad/shorted speaker wiring connected to speaker terminals.

Possible reasons for it to trip at turn on, with no load attached

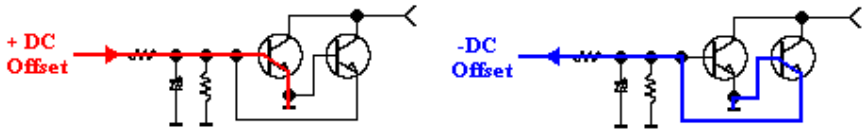
1) An output stage is blown, shorted output transistors and/or open amplifier emitter resistors.
2) One of the detector circuits has been damaged as the result of a previously blown up channel.
3) Faulty biasing component or bad wiring between amp and bias PCB. If the amplifiers bias circuit opens, it will cause the idle current to be extremely high.

DC Detector

The DC Detector looks for excessive amounts of DC offset on the amplifiers speaker terminals. This is a safety measure to protect the loudspeaker from damage if a fault should occur in the amplifier. The input of the DC detector uses a low pass filter to block the audio signal, allowing only DC to pass.



A positive DC offset will turn on the left side transistor, where as a negative DC offset will turn on the right side transistor. When one of the transistors turns on, it will pull the output down to ground potential.



Possible reasons for tripping while playing, but not at turn on

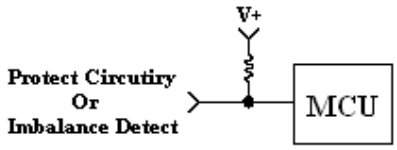
1) Excessive sub-sonic frequencies in audio content (playing a warped LP?)
2) Input filter component out of spec (most likely the cap)
3) Offset adjustment calibration needs to be made (on applicable models)

Possible reasons for tripping at turn on with no audio

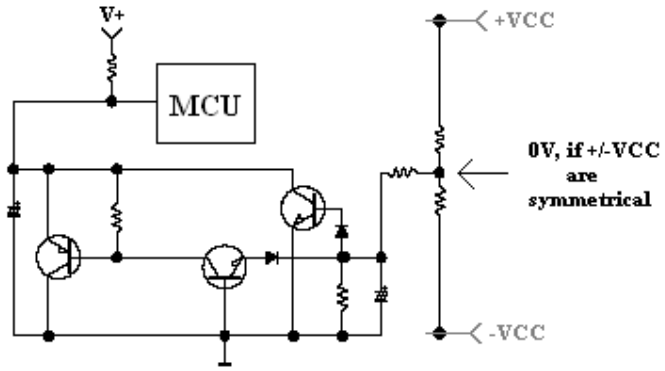
1) Blown amplifier output stage.
2) Defective component in detector.
3) Offset adjustment calibration needs to be made (on applicable models)

Power Fail (P-Fail) Detector

This detection senses for faults in the AVR's power supply. The detection is usually accomplished by a resistor which pulls up one of the MCU's pins to 5VD or 3.3V. On several models, this resistor pulls up the protect line which is shared with the other protect mechanisms. On some models "P-Fail" has it's own line which is independent from the other protect mechanisms.



Some AVR models also check for a failure in the amplifiers +/-VCC as part of their P-Fail detection. It does so by using a center tapped voltage divider to check symmetry between the +VCC and –VCC lines.



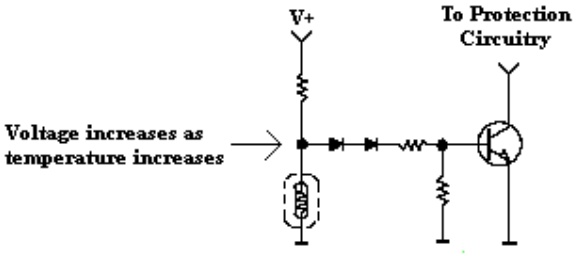
If the +/-VCC become imbalanced, it will cause a DC voltage to develop on the voltage dividers node. This will turn on either the negative or positive offset detect transistors. This circuit operates very similar to the DC Detector mechanism mentioned earlier.

Possible reasons for tripping

1) Defective component in the detected power supply.
2) Blown amplifier output stage (in models which check for VCC symmetry).
3) Defective main bridge rectifier (in models which check for VCC symmetry).
4) Defective component in VCC symmetry detection (if applicable).

Thermal Detector

The thermal protector detects the temperature of the amplifiers heat sink. If the temperature becomes too high, the thermal detection will trip. The typical circuit uses a voltage divider with a positive temperature coefficient on the ground side. As the temperature goes up, so does the thermistor's resistance. This causes a higher voltage to form at the voltage dividers output node. Once this voltage becomes high enough it will turn on the transistor in this circuit.



AVR1xx/2xx/3xx use one thermal detector for all 7 channels. AVR4xx/6xx/7xx use one detector for four channels and another detector for the other 3 channels.

Possible reasons for tripping while playing:

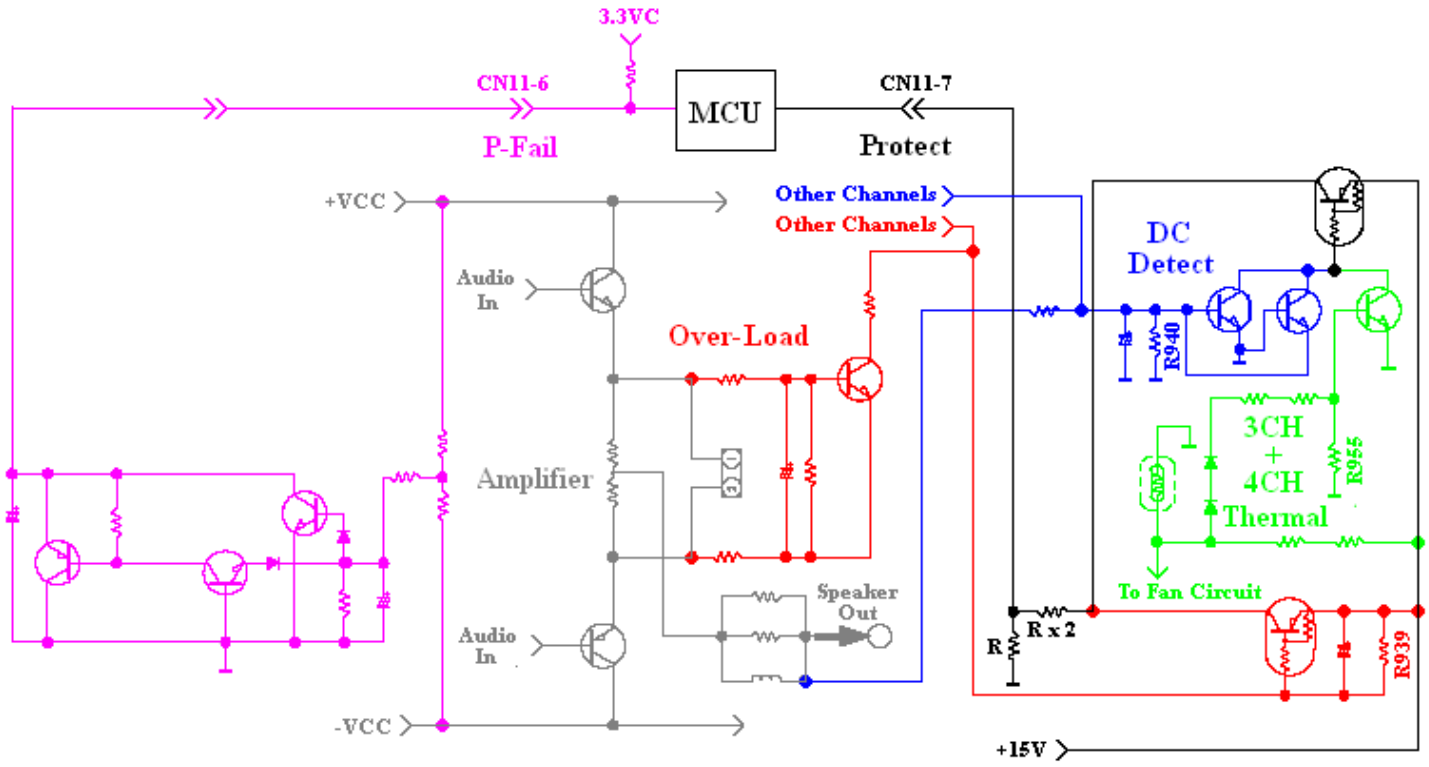
1) Fan is failing to turn on as unit heats up.
2) Inadequate ventilation.
3) Thermal instability in amp channel (idle current increasing with temperature).
4) One or more channels over-biased.

Possible reasons for tripping at turn on:

1) Open thermistor or thermistor wiring harness.
2) Loss of power to temp sensor (AVR445/645/745 only).
3) Other defective component in thermal detection circuitry.

Test Point Table

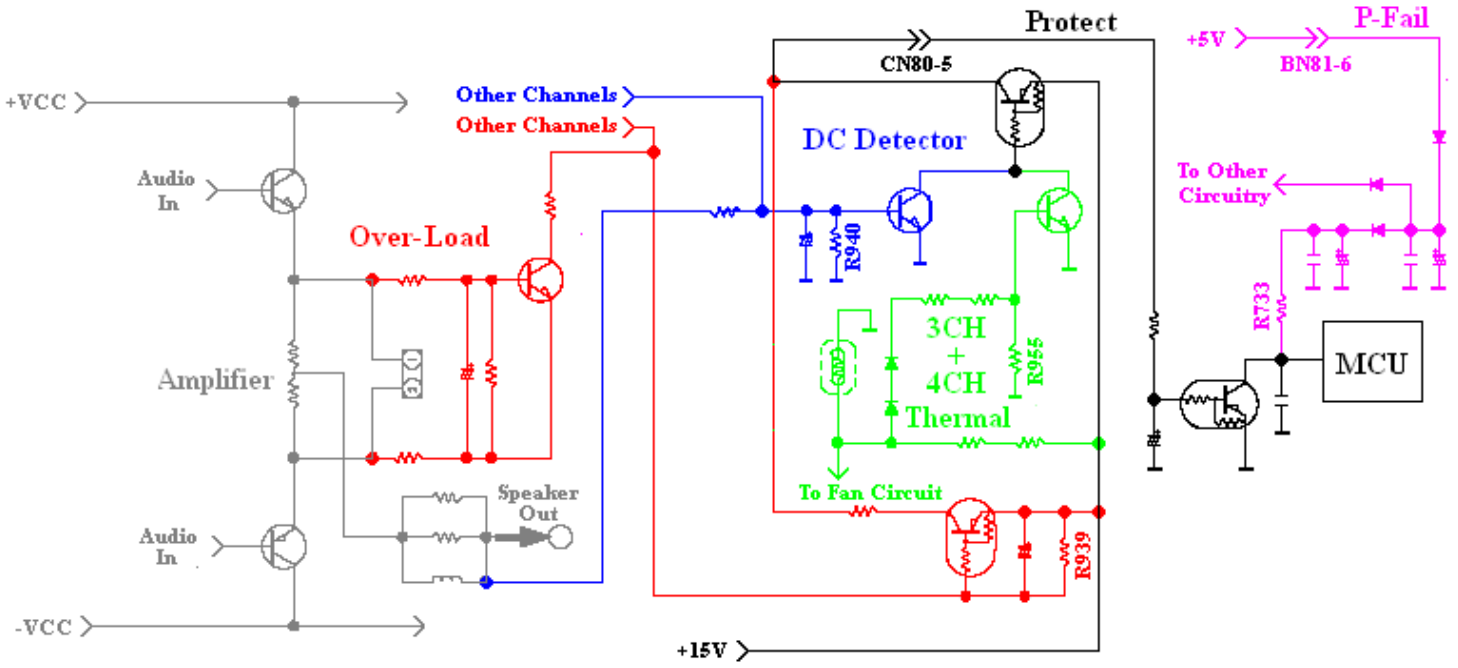
	Protect			3CH Thermal			4CH Thermal			P-Fail			DC DET			Over Load		
	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault
AVR130/230/330	CN80-5	0V	15V	Across R955	0V	.7V	Across R955	0V	.7V	BN81-6	5V	0V	Across R940	0V	.7V	Across R939	0V	.7V
AVR430/630	N403-18	5V	0V	N808-1	0V	.7V	N807-1	0V	.7V	Across R503	0V	.7V	P805-2	0V	.7V	P805-1	0V	.7V
AVR7300	P106-15	5V	0V	R964	0V	.7V	R964	0V	.7V	-	-	-	R969	0V	.7V	R961	0V	.7V
AVR135/235/335	CN80-5	0V	15V	Across R955	0V	.7V	Across R955	0V	.7V	BN81-6	5V	0V	Across R940	0V	.7V	Across R939	0V	.7V
AVR435/635	N802-2	5V	0V	N808-5	0V	.7V	N807-1	0V	.7V	Across R503	0V	.7V	N808-2	0V	.7V	N808-3	0V	.7V
AVR140/240/340	CN80-5	0V	15V	Across R955	0V	.7V	Across R955	0V	.7V	BN81-6	5V	0V	Across R940	0V	.7V	Across R939	0V	.7V
AVR145/245/345	CN11-7	0V	5V	Across R955	0V	.7V	Across R955	0V	.7V	CN11-6	3.3V	0V	Across R940	0V	.7V	Across R939	0V	.7V
AVR445/645/745	N702-2	5V	0V	N702-6	~1.2V	0V/5V	N702-5	~1.2V	0V/5V	N702-13	15V	0V	P812-10	0V	0.7V	P812-11	0V	0.7V
AVR147/247/347	CN11-7	0V	5V	Across R955	0V	.7V	Across R955	0V	.7V	CN11-6	3.3V	0V	Across R940	0V	.7V	Across R939	0V	.7V
AVR154/254/354	CN11-7	0V	5V	Across R955	0V	.7V	Across R955	0V	.7V	CN11-6	3.3V	0V	Across R940	0V	.7V	Across R939	0V	.7V



AVR144/145/245/345/146/147/247/347/350/154/254/354

Notes: It's recommended to start with the Protect and P-Fail test points. All 7 channels share 1 thermistor on this model.

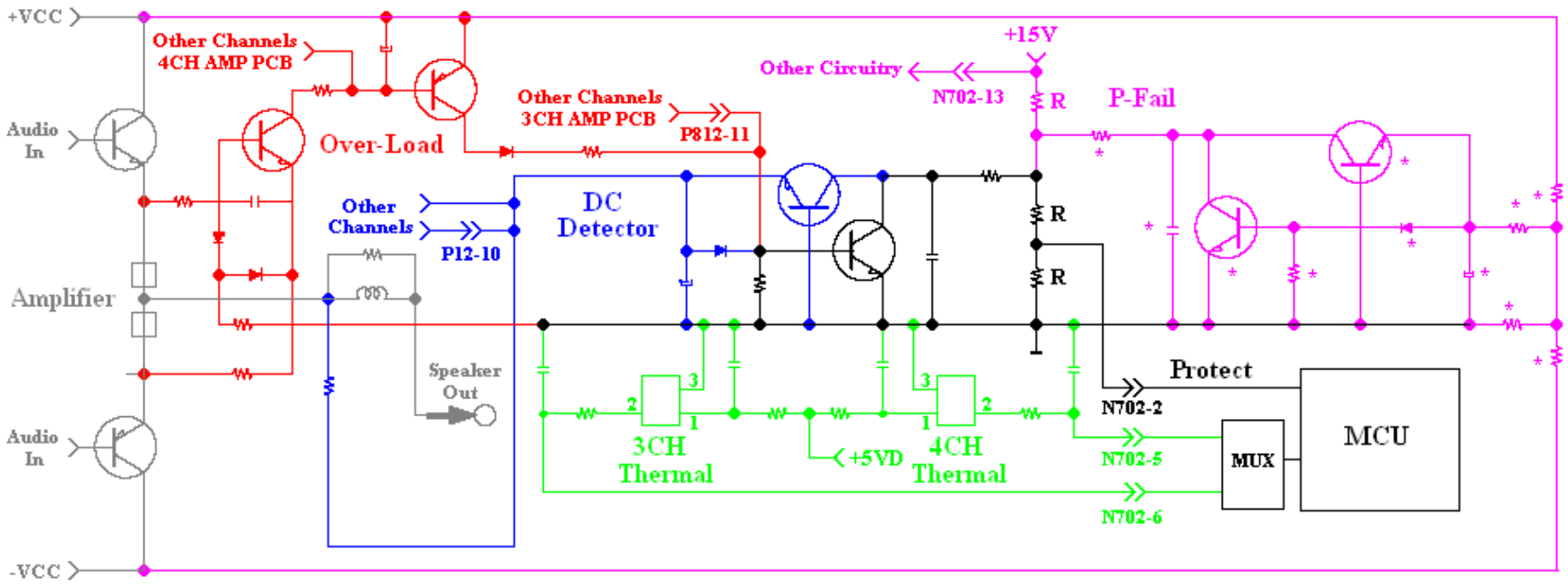
Protect			3CH Thermal			4CH Thermal			P-Fail			DC DET			Over Load		
Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault
CN11-7	0V	5V	Across R955	0V	.7V	Across R955	0V	.7V	CN11-6	3.3V	0V	Across R940	0V	.7V	Across R939	0V	.7V



AVR130/230/330/135/235/335/140/240/340

Notes: It's recommended to start with the Protect and P-Fail test points. This AVR is incapable of detecting a negative DC offset on the speaker terminals. If you get a 10V fault on the protect line instead of a 15V fault, it is most likely the Over-load which is tripping. All 7 channels share 1 thermistor on this model.

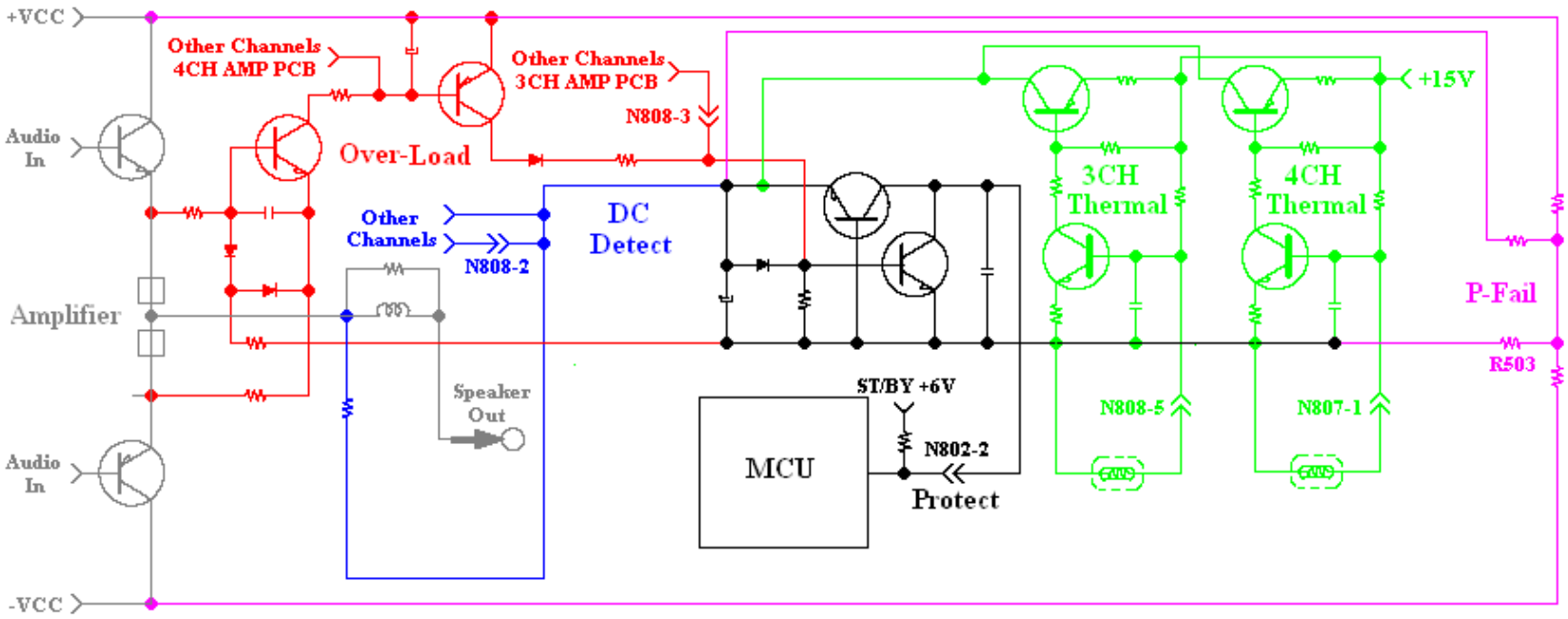
Protect			3CH Thermal			4CH Thermal			P-Fail			DC DET			Over Load		
Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault
CN80-5	0V	15V	Across R955	0V	.7V	Across R955	0V	.7V	BN81-6	5V	0V	Across R940	0V	.7V	Across R939	0V	.7V



AVR445/645/745

Notes: It's recommended to start with the Protect, 4CH & 3CH Thermal test points. The protect line is normally high and supplied off the main power. Look for a negative pulse to happen BEFORE the AVR shuts itself off. The Over-Load test point will measure fault also, if DC DET has tripped. Check both If Over-Load indicates a fault.

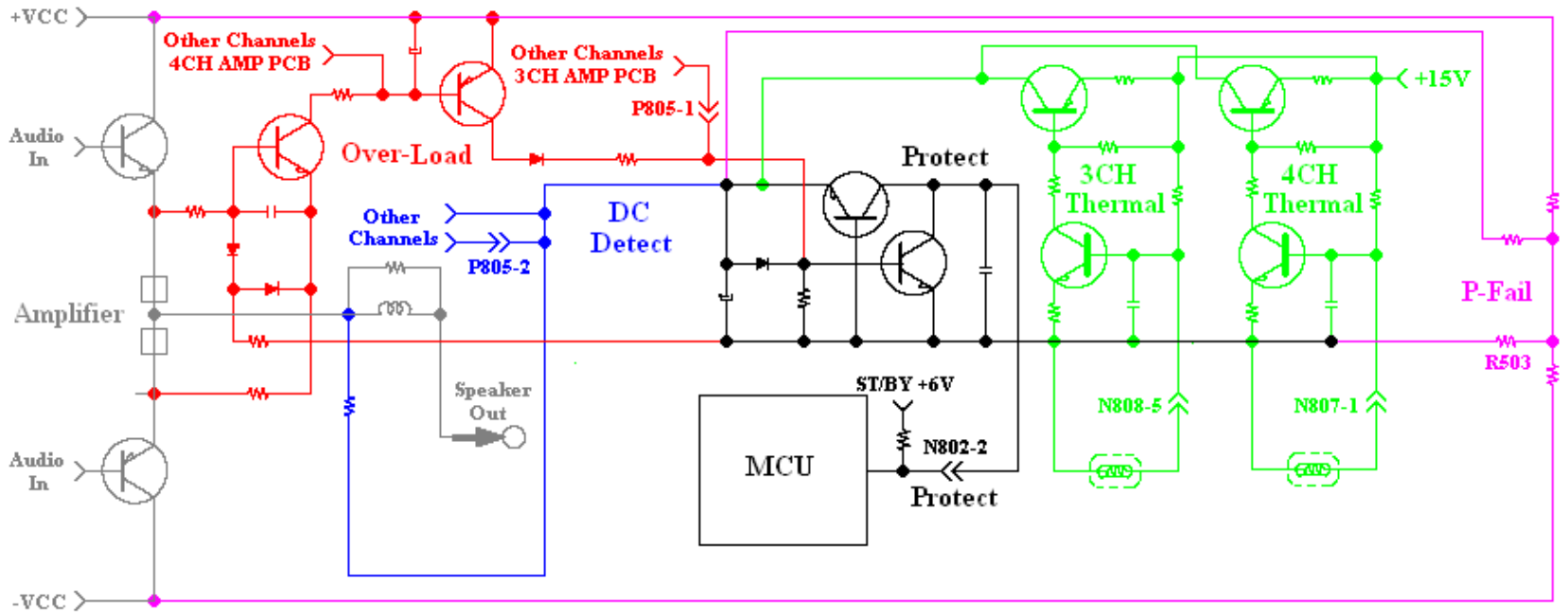
Protect			3CH Thermal			4CH Thermal			P-Fail			DC DET			Over Load		
Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault
N702-2	5V	0V	N702-6	~1.2V	0V/5V	N702-5	~1.2V	0V/5V	N702-13	15V	0V	P812-10	0V	0.7V	P812-11	0V	0.7V



AVR435/635

Notes: It's recommended to start with the Protect test point. DC DET test point will also indicate a fault if 3CH/4CH Thermal or P-fail detectors have tripped. Likewise Over-Load test point will measure fault if DC DET, 3CH/4CH Thermal or P-Fail has tripped. So for this model, you will have to check all test point IF the protect line is tripping.

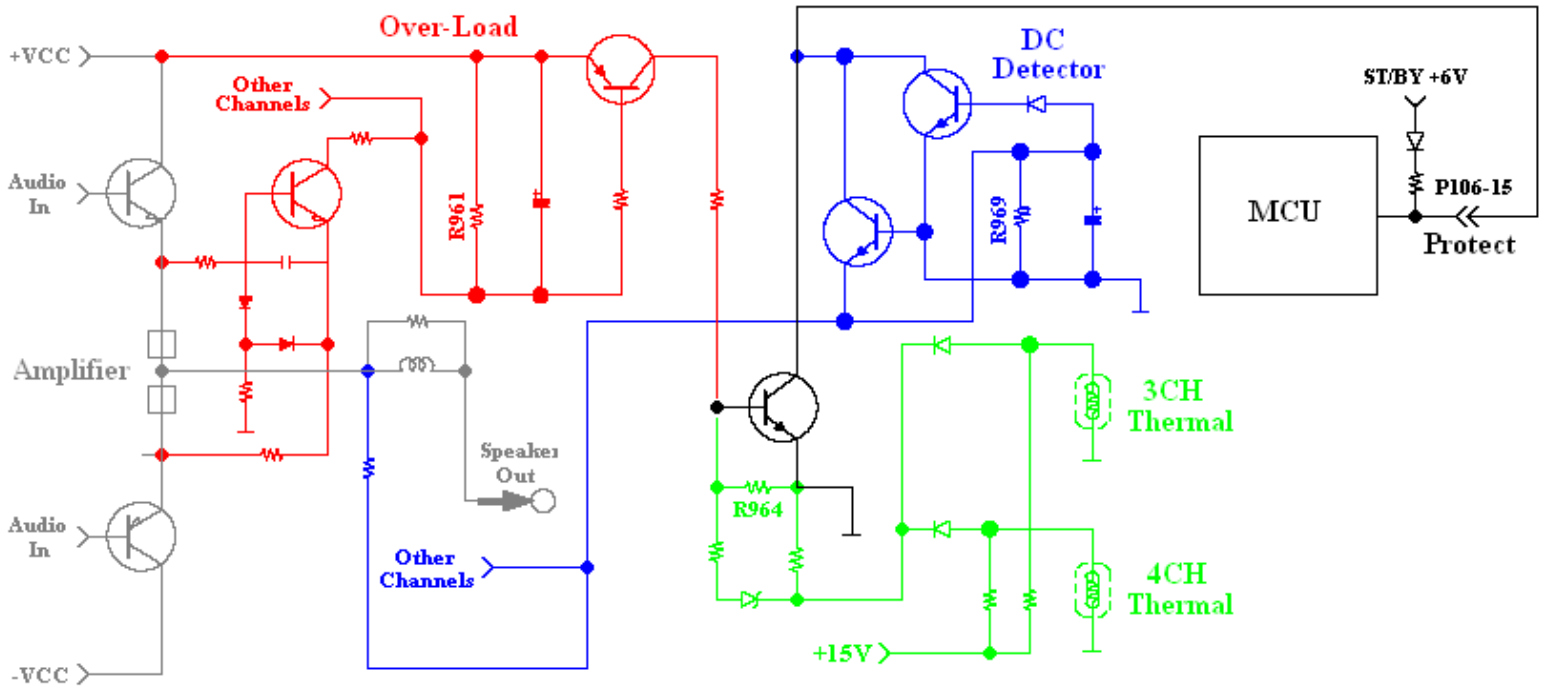
Protect			3CH Thermal			4CH Thermal			P-Fail			DC DET			Over Load		
Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault
N802-2	5V	0V	N808-5	0V	.7V	N807-1	0V	.7V	Across R503	0V	.7V	N808-2	0V	.7V	N808-3	0V	.7V



AVR430/630

Notes: It's recommended to start with the Protect test point. DC DET test point will also indicate a fault if 3CH/4CH Thermal or P-fail detectors have tripped. Likewise Over-Load test point will measure fault if DC DET, 3CH/4CH Thermal or P-Fail has tripped. So for this model, you will have to check all test point IF the protect line is tripping.

Protect			3CH Thermal			4CH Thermal			P-Fail			DC DET			Over Load		
Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault
N403-18	5V	0V	N808-1	0V	.7V	N807-1	0V	.7V	Across R503	0V	.7V	P805-2	0V	.7V	P805-1	0V	.7V



AVR7300

Notes: It's recommended to start with the Protect test point. The 3CH and 4CH thermal test point will also measure a fault if the Over-Load detector trips. If you find a fault condition for the 3CH & 4CH test point check and see if the Over-load test point also indicates a fault.

Protect			3CH Thermal			4CH Thermal			P-Fail			DC DET			Over Load		
Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault	Test Point	OK	Fault
P106-15	5V	0V	R964	0V	.7V	R964	0V	.7V	-	-	-	R969	0V	.7V	R961	0V	.7V