Amplifier Protection

Amplifier protection is not one of the items which an installer or consumer think about. It is another thing for us as designers as we must attempt to anticipate what may happen to the electronics in the field. The automobile is a hostile environment for electronics and so we must incorporate several protection mechanisms in the amplifiers to keep them operating. At Zed Audio we have always paid attention to this fact and incorporate several protection circuits in our amplifiers.

Thermal protection is the first line of defense against heat – the arch enemy of electronic components. Transistors, Mosfets and diodes will operate quite happily at 100 deg C (Yes they must be temperature de-rated at these elevated temperatures), Integrated circuits, capacitors, resistors, connectors are not to keen to have their operating temperature exceed about 80 deg C. The reliability of ALL components is reduced when exposed to high temperatures so it is in our interest as designers to keep them low.

Large heatsinks are a must if forced air cooling is not employed. Class A-B amplifiers are not that efficient and they will generate lots of heat when driven hard especially into low impedances. Multi-rail (Class-G) can be employed and this allows the use of smaller heatsinks but at the expense of more complex electronics.

I would imagine that almost all mobile amplifiers have some sort of thermal protection. A thermal sensor is mounted to the heatsink and it is either in the form of an electro-mechanical switch or a thermistor. The switch is simple in that the remote turn on line can be simply switched off when the sensor reaches its cut out temperature. Some have hysteresis built in, others do not. A thermisitor is a device whose resistance will change with change in temperature. The type Zed Audio use goes lower in resistance as temperature rises. We incorporate it in a bridge circuit with hysteresis. What the hysteresis does is once the amplifier has shut down (we do this at about 75 deg C) it shall only turn on when the heatsink temperature has dropped to 65 deg C.

DC protection is a form of protection which monitors the signal on the speaker outputs, removes the AC component (The music) and checks if the residual DC is less than a specified value which the designer chooses. Typically a DC level of about 4 to 7 volts is considered safe for speakers. So we have a sensing circuit which monitors the DC component at the speaker, and if this DC component is greater than 5.2v (either positive or negative), the power supply is shut down and latched off. The only way to reset the system is to turn the amplifier off, wait a few seconds and turn it on again. If the amplifier clips hard with non symmetrical waveforms and the net DC component due to this clipping exceeds the 5.2v the amplifier is shut down.

Reverse polarity protection is to protect the power supply if the power leads are connected the wrong way to the battery. The old method was a great big fat diode connected across the power supply terminals in a reverse direction. If the leads were reversed, the diode would be in the forward conducting mode and would instantly blow the fuse (and hopefully not itself). The net of about 1v of reverse polarity (the conducting diode would have about a 1 volt forward drop) was insufficient to damage the power supply. Fortunately Mosfets have a built in diode which can carry the same current as the Mosfet. The Drain – Source junction is essentially across the incoming 12 volt and so the body diode does the same job as an external one would.

The remote turn on line suffers the same fate as the main +12v would if polarity is reversed. A simple series diode (0.6v forward drop) does the job. Zed uses a three transistor circuit in this application as we use it to control other functions in the power supply.

Short circuit protection is probably the most difficult to implement. We must attempt to protect the output devices in the amplifier as well as the power supply. In addition the output devices must be protected against very low impedance loads. The way this has been done for the past 30 years is to use what is known as V-I limiters. Their name implies what they do for a living. The circuit shall monitor the volt-amp relationship in the output stage, and if the safety limit is exceed, the circuit would remove drive from the output stage. There is a problem however. When the circuit is activated and the drive to the output stage is removed, the shorted or mismatched load is not being driven with signal (remember it has been removed). The V-I limiter then says to itself "hey no more work to do, stop removing drive from the output transistors"). So the drive is instantly restored. Well the V-I limiter immediately senses the shorted/mismatched load and does its thing again. This on-off cycle continues and what it does is causes high frequency artifacts to be superimposed on the output waveform. BAD FOR TWEETERS is the result. How can this be prevented? In a mobile amplifier we have a switching power supply. Zed does not limit the drive to the output devices but we take the V-I limiter's error signal and inform the power supply politely that there is some sort of problem on the speaker line and that we will shut the power supply down – which we do. Once the power supply is shut off, and latched off, NO damage can occur to either section of the amplifier. In Zed amplifiers we also employ a static and dynamic V-I limiter. We allow the limiter to let the amplifier continue to operate into sub 1 ohm loads for a "few milliseconds" with a music signal but with a sinewave test signal the static threshold is what causes the V-I circuits to activate.

Radio Frequency (RF) protection is done in several places within the signal path of our amplifiers. The first line of defense is at the inputs where we use a low pass filter set at 338KHz and again at the level control amplifier another low pass filter at 338KHz.