1.5 Technical descriptions and theory of operation

Note: Some of these descriptions concern circuitry that is duplicated in the amplifier's two channels. For the sake of simplicity, the descriptions are of Channel 1 only. Components in Channel 1 have a 3-digit designation with "1" as the first digit; their equivalents in Channel 2 have a "2" as the first digit, followed by the same two numerals. For example, R122 and R222 have identical functions in their respective channels.

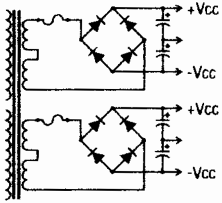
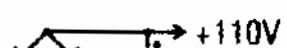


Figure 1.7

Power supplies

Unlike other recent QSC amplifiers, the RMX line uses strictly conventional power supplies, with large transformers that operate at the 50 or 60 Hz frequency of the AC line. The electrical current in the secondary circuitry is converted to DC through a full-wave bridge rectifier. The resulting 100 or 120 Hz ripple is filtered out by large capacitors that also serve as current reservoirs for short-term, transient demands.

The supply provides a bipolar set of supply rails for each channel, with equal quiescent positive and negative voltages, as shown in Figure 1.7. Note that unlike many bipolar supplies for complementary transistor arrangements, the secondary windings are not connected to ground at the center. This is because the output transistors are directly mounted to the heat sink, metal-to-metal, to maximize heat transfer; this grounds the collectors, requiring somewhat different output and power supply arrangements. The grounded-collector concept is described later in this chapter.



dependent on a close match between the input resistors (R100 and R101 in Figure 1.9) and between the feedback resistor and the shunt resistor (R105 and R106). The circuitry uses 1% precision resistors to ensure at least 40 dB of common-mode rejection.

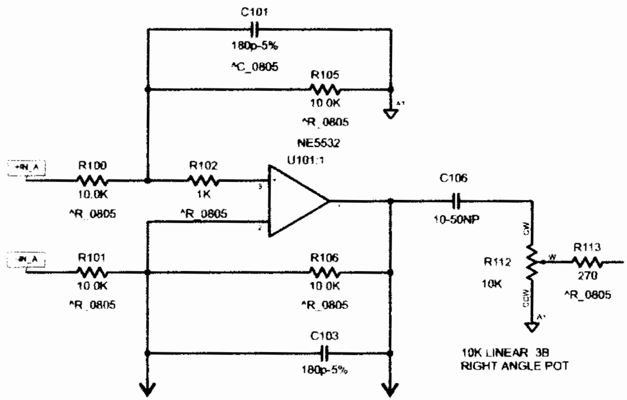


Figure 1.9

The feedback and shunt capacitors, C101 and C103, add a first-order high-frequency roll-off, down 3 dB at 88.4 kHz (over two octaves above the high end of the audio spectrum). This makes the amplifier less susceptible to RF interference, high-frequency oscillations, etc.

Also in this stage, the feedback loop contains one half of a 13600 dual operational transconductance amplifier (Figure 1.10). The OTA is part of the clip limiter circuitry; when the clip limiter is activated, a control voltage increases the transconductance of the OTA, which essentially decreases the impedance of the feedback loop and reduces the gain of the stage in order to reduce the amount of clipping.

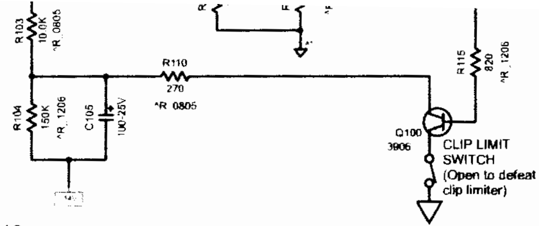


Figure 1.10

the transistor pair to keep crossover distortion minimal. In parallel with the trimpot is a 50-ohm thermistor with a negative temperature coefficient; as the circuitry warms, its resistance decreases. This reduces V_{BE} on both Q105 and Q106, decreasing the bias current to reduce the threat of thermal runaway. The base of each driver transistor is tied to ground through a diode and a 2.2K trimpot in series; these set the current limiting threshold for their respective signal polarities.

The collector of each driver transistor directly drives the bases of its output transistors, which are the main power-handling signal devices. If you're not familiar with the grounded-collector scheme, the arrangement of the output transistors might look somewhat strange: the positive voltage swings are handled by PNP transistors, while the negative swings are handled by NPN devices. The collectors all connect to ground, which allows them to be mounted directly to the heat sink—metal-to-metal, without insulators in between—for the best possible transfer of heat away from the transistors. The emitters of the PNP and NPN transistors are coupled through resistors to the positive and negative supply rails, respectively, forming banks of common-emitter circuits driving the supply rails. Consequently, the devices drive the rails with the audio signal, which rides atop the DC. The output to the speaker load is taken from the point between the positive and negative reservoir capacitors; this is also where the negative feedback is taken from. The nature of this arrangement, with audio signal riding on the

indicator LED, LD100. The current exiting the full-wave rectifier passes to ground through R127 and also drives the base of transistor Q100 through R115. If the clip limiter is switched on, Q100's emitter is grounded, and when the voltage across R127 goes sufficiently negative to forward-bias Q100, which sends current through R111 and R103 into the amplifier bias input of the operational transconductance amplifier (OTA), U10:1. The OTA is in the negative feedback loop of U101:1, and increasing its transconductance essentially reduces the impedance of the feedback loop, which reduces the gain of the op amp stage. This reduces the signal level until the amount of clipping is minimal. When the clipping stops, Q100 is no longer forward-biased, and the gain returns to normal.

DC protection

The RMX 2450 has a crowbar circuit, based on a triac and two silicon controlled rectifiers, on the output to protect against DC faults. If an amp channel puts out a DC voltage, which could be the result of a component or circuit failure, it will first trigger either D119 or D120, depending on the polarity of the voltage. The triggered SCR will in turn trigger triac Q113, shorting the output to ground through fuse F100. The fuse will blow, safeguarding the speaker load from the DC fault.

The output sections of the RMX 850 and RMX 1450 are AC coupled.

Class H

The RMX 2450 utilizes a two-step Class H output section. It is essentially a Class AB+B circuit but with two sets of bipolar supply rails. On both the positive and the negative sets of rails, a comparator circuit, called a "step driver," compares the audio signal to the lower rail voltage. When necessary to fully reproduce the signal's voltage swing—just before the signal voltage reaches the lower rail voltage—the step driver turns on a TMOS power FET to pull the on Channel 1 to the BR_RET bus on Channel 2. The BR_RET bus drives the non-inverting input of op amp U201:2 directly.

With two channels operating as one, but each having its own feedback and protection circuitry, it is vital to keep both running as mirror images. A protection circuit monitors the balance between Channel 1's and Channel 2's signals. Resistors R22 and R23 (R22A, R22B, R23A, and R23B on the RMX 2450) are equal in value and

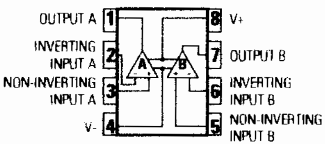
same time, the emitter current from Q8 will flow through R25 and into the emitter of Q7, forward-biasing it, too. The collector of Q7 will then collapse the -15V rail.

Similarly, if BR_BAL goes sufficiently negative, it will forward-bias Q6, in turn forward-biasing Q9, and these will collapse the ±15V rails.

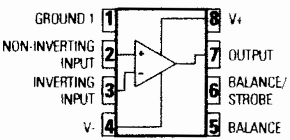
With the rails collapsed, the op amp and the input circuitry will not function, which will mute the audio.

2. Component identification and pinout

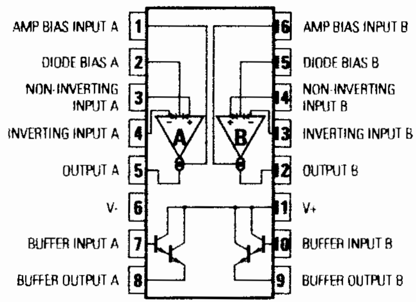
NE5532AN Dual operational amplifier



LM311 Voltage comparator



LM13600 Dual operational transconductance amplifier



2N5064 Sensitive gate thyristor