single-chip AF power amplifier

A Burr-Brown Application

If you're looking for an audio amplifier that produces a lot of power using an absolute minimum number of components, this one is for you.

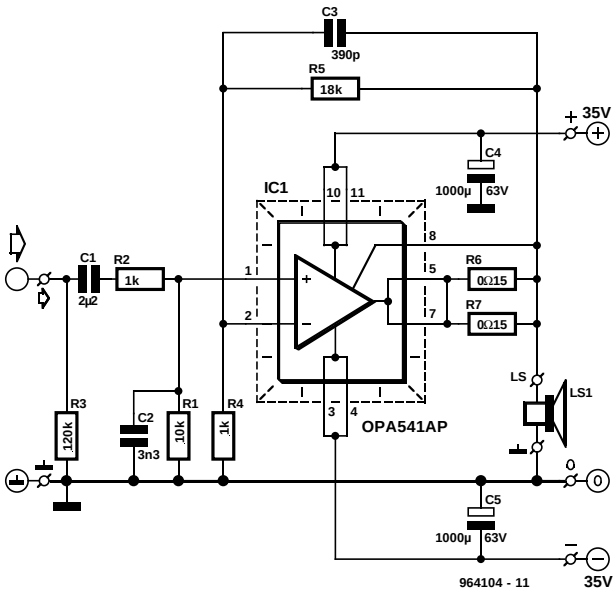
Burr-Brown's OPA541 is a power opamp capable of operation from power supplies up to ±40 V and delivering continuous output currents of up to 5 A. Internal current limit circuitry can be user-programmed with a single external resistor, protecting the amplifier and the load from fault conditions. The OPA541 is available in an 11-pin power plastic package and an industry-standard TO-3 hermetic package. The former is used here.

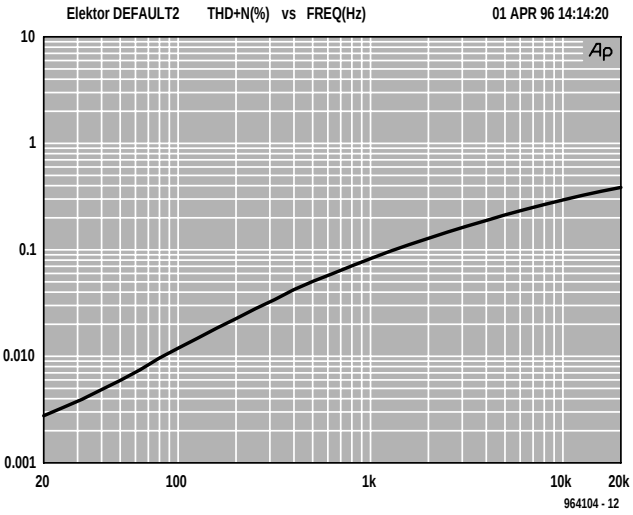
Although the OPA541 is primarily intended for applications like motor drivers, servo amplifiers and programable power supplies (says B-B), it is also fine for a medium-power AF amplifier with reasonable specifications. The design shown here is capable of supplying about 60 watts into an 8-Ω load. This is achieved with an audio drive level of $1.3V_{rms}$ and a symmetrical supply voltage of ±35 V. The on-chip current limiter is set to an actuation level of about 8.5 A by parallel-connected resistors R6/R7. This level ensures that the maximum drive margin can also be achieved with a load of 4 Ω. Note, however, that R6 and R7 do not make the amplifier short-circuit proof, because that would require a current limiter threshold of 1.8 A, assuming that the IC is operated within its SOA (safe operating area, for details consult the B-B datasheets). The value of the resistor, R_{cl}, that determines the current limiter actuation level is calculated from

$$R_{cl} = (0.813/I_{abs}) - 0.02\ [\Omega]$$

In practice, the positive half-cycle of the output current will be limited somewhat earlier, at about 10% below the calculated level. The opposite is true for the negative current, which will be about 10% higher than the calculated level.

The amplifier is not a bad performer as regards distortion. The graph shows that the THD level remains well below 0.5% over the full audio spectrum, assuming that a gain of ×6 is programmed (R5 approx. 5 kΩ) and a supply voltage of ±35 V. The curve applies to an output power of 50 watts into 8 Ω.





Because the IC operates at a quiescent current of only 20 mA, cross-over distortion occurs readily. The theoretical bandwidth is, therefore, limited to about 22 kHz by capacitor C3. Input filter R2-C2 serves to reduce IMD (intermodulation distortion), and reduces the actual bandwidth to about 16.6 kHz. The low-frequency roll-off is set to 6.6 Hz by R1-C1.

The IC must be fitted on to a fairly large heatsink with a thermal resistance of 1.2 K/W or better. A suggested type is Fischer's SK85SA/75mm, which will be just about sufficient for music into a 4-Ω load.

(964104)

COMPONENTS LIST

Resistors:
R1 = 10kΩ
R2,R4 = 1kΩ
R3 = 120kΩ
R5 = 18kΩ
R6,R7 = 0Ω15 5W

Capacitors:
C1 = 2µF2, MKT, 5mm
C2 = 3nF3
C3 = 390pF, 160V, polystyrene
C4,C5 = 1000µF 63V radial

Semiconductors:
IC1 = OPA541AP (Burr-Brown)

Miscellaneous:
5 spade terminals, screw mount
Heatsink, approx. 1°K/W
Printed circuit board, order code 964104-1 (see Readers Services page)