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Low-power amplifier IC's

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IF YOU'VE BEEN FRUSTRATED IN YOUR efforts to complete an electronics project or experiment by the lack of a small, low-power audio amplifier, I urge you to consider building one around either of two power-amplifier IC's recently introduced by the Sprague Electronic Company.

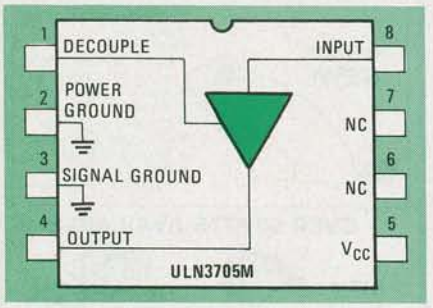

FIG. 1

First we'll look at the ULN-3705M—its pinout is shown in Fig. 1. That class-AB amplifier is housed in an 8-pin mini-DIP and has a voltage gain of 42 dB. Its operating temperature can vary between −20 and +85°C.

The typical power-output of the unit can range from 60 to 600 milliwatts, depending on supply voltage and speaker impedance. For example, operating from a 9-volt supply and driving a 16-ohm load, the unit's output power is 600 milliwatts. Audio power output levels for three different speaker impedances (8, 16, and 32 ohms) and supply voltages appear in Table 1.

The recommended supply voltage for the ULN-3705M can range from 4.5 to 9 volts with a 6- to 10-mA quiescent current-drain. However, the amplifier operates (at reduced volume) with supplies as low as 1.8 volts without a notable increase in harmonic distortion. Total harmonic distortion is specified at from 0.4–1.0% and 0.5–1.0% for 32- and 16-ohm loads, respectively.

TABLE 1—ULN-3705

Characteristic	Symbol	Test Conditions	Limits Min.	Typ.	Max.	Units
Supply Voltage Range	V_{CC}		1.8	6.0	9.0	V
Quiescent Supply Current	I_{CC}	V_{CC} = 4.5 V	—	6.0	—	mA
		V_{CC} = 6.0 V	—	7.0	15	mA
		V_{CC} = 9.0 V	—	10	20	mA
Voltage Gain	A_V		—	42	—	dB
Audio Power Output	P_{OUT}	R_L = 8Ω, V_{CC} = 4.5 V, THD = 10%	—	220	—	mW
		R_L = 8Ω, V_{CC} = 6.0 V, THD = 10%	250	430	—	mW
		R_L = 16Ω, V_{CC} = 4.5 V, THD = 10%	—	125	—	mW
		R_L = 16Ω, V_{CC} = 6.0 V, THD = 10%	150	240	—	mW
		R_L = 16Ω, V_{CC} = 9.0 V, THD = 10%	—	600	—	mW
		R_L = 32Ω, V_{CC} = 4.5 V, THD = 10%	—	60	—	mW
		R_L = 32Ω, V_{CC} = 6.0 V, THD = 10%	85	110	—	mW
		R_L = 32Ω, V_{CC} = 9.0 V, THD = 10%	—	310	—	mW
Distortion	THD	P_{OUT} = 50 mW, R_L = 32Ω	—	0.4	1.0	%
		P_{OUT} = 50 mW, R_L = 16Ω	—	0.5	—	%
Output Noise	V_{OUT}	Input Shorted, BW = 80kHz	—	225	—	μV
Input Resistance	R_{IN}	Pin 8	—	250 K	—	Ω
Power Supply Rejection	PSRR	C_D (Pin 1) = 500 μF, f = 120 Hz	—	34	—	dB

The ULN-3705M is recommended for use as a headphone driver in battery-powered portable radios and tape recorders. It is, therefore, ideally suited for use in audio signal-tracers and bench amplifiers, and is intended as a low-cost alternative to designs using discrete transistors.

Figure 2 shows a typical application for the ULN3705. The circuit's performance is influenced by the values of two external electrolytic capacitors (C3 and C4). One is used for output coupling and the other for feedback and ripple decoupling.

The output-coupling capacitor, C4, works with the speaker impedance to control the low-frequency cutoff. The −10-dB points are about 20, 30, and 60 Hz when driving an 8-ohm speaker through coupling capacitors of 500 μF, 250 μF, and 100 μF, respectively.

Capacitor C3 is used for feedback decoupling and power-supply ripple rejection. The 500-μF capacitor specified provides 34 dB of rejection at 120 Hz. The ampli-

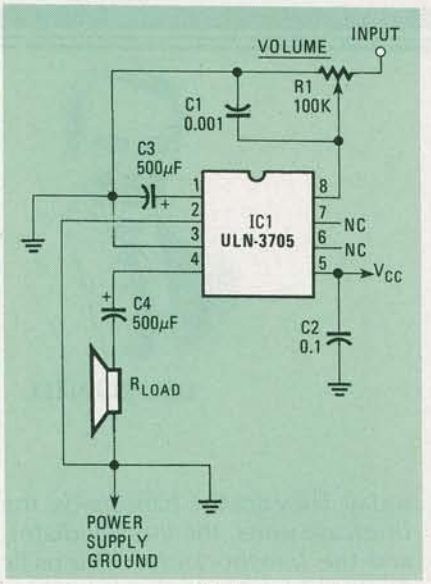

FIG. 2

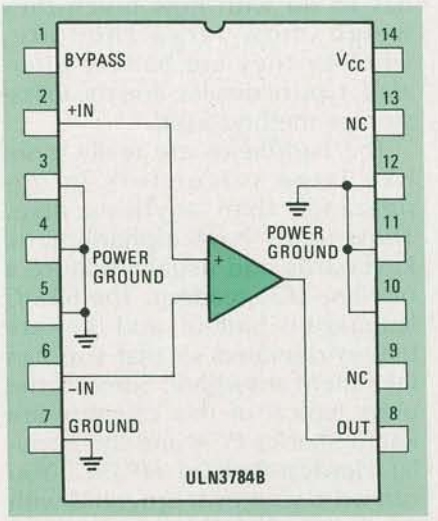

FIG. 3

fier input (pin 8) must be provided with a DC return path to ground for a current of approximately 1 μA. That current produces a voltage (IR) drop that, when multiplied by the circuit's closed-loop DC gain, appears as an error in the output offset-centering. The value of resistance between the input and ground is ideally 100 kilohms or less, although up to 200 kilohms may be used.

The other amplifier, the ULN-3784B, is housed in a 14-pin DIP and is designed for such applications as automotive, communications, and consumer electronics that require a high-quality audio output. The device's pinout is shown in Fig. 3.

The ULN-3784B is a pin-compatible improvement on several earlier designs and is a direct replacement for National Semiconductor's LM380N and LM384N, and Sprague's ULN-2280B and ULN-2281B IC's. However, it provides a wider margin of protection against supply-voltage transients. Table 2 shows the electrical characteristics of the IC.

The ULN-3784B operates from a single supply that can range from 9 volts up to about 28 volts. The unit has a 34-dB internally fixed gain. Operating from a 24-volt supply, its typical output power is 4-watts minimum when working into an 8-ohm load. With a 28-volt supply, its power output is 4.8 watts working into 16 ohms.

The ULN-3784B's typical quiescent current is 20 mA, and it has a bandwidth of 100 kHz and its

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TABLE 2—ULN-3784B

Characteristic	Symbol	Test Conditions	Limits Min.	Typ.	Max.	Units
Supply Voltage Range	V_{CC}		9.0	24	28	V
Quiescent Supply Current	I_{CC}	$V_{IN}=0$ V	—	20	—	mA
Quiescent Output Voltage	V_{OQ}	$V_{IN}=0$ V, See Note 1	—	12	—	V
Voltage Gain	A_V	$P_{OUT}=0$ W	31	34	37	dB
Total Harmonic Distortion	THD	$P_{OUT}=50$ mW, $R_L=8\Omega$, $V_{CC}=24$V	—	0.2	—	%
		$P_{OUT}=50$ mW, $R_L=16\Omega$, $V_{CC}=28$V	—	<0.2	—	%
		$P_{OUT}=4$ W, $R_L=8\Omega$, $V_{CC}=24$V	—	<0.3	5.0	%
Audio Output Power	P_{OUT}	$R_L=8\Omega$, $V_{CC}=24$ V, THD=5%	4.0	5.0	—	W
		$R_L=16\Omega$, $V_{CC}=28$ V, THD=5%	4.0	4.8	—	W
Input Impedance	Z_{IN}	Each Input	140 K	170 K	—	Ω
Power Supply Rejection	PSRR	$P_{OUT}=0$ W, $f=120$ Hz	—	30	—	dB
Equiv. Input Noise Voltage		$f=20$ Hz to 20kHz	—	60	—	μV_{RMS}
Bandwidth (−3 dB)	BW	$P_{OUT}=1$ W, See Note 2	—	100	—	kHz

NOTES: 1. The quiescent output voltage typically equals ½ the supply voltage.
2. Unity gain typically occurs between 10 MHz and 100 MHz.

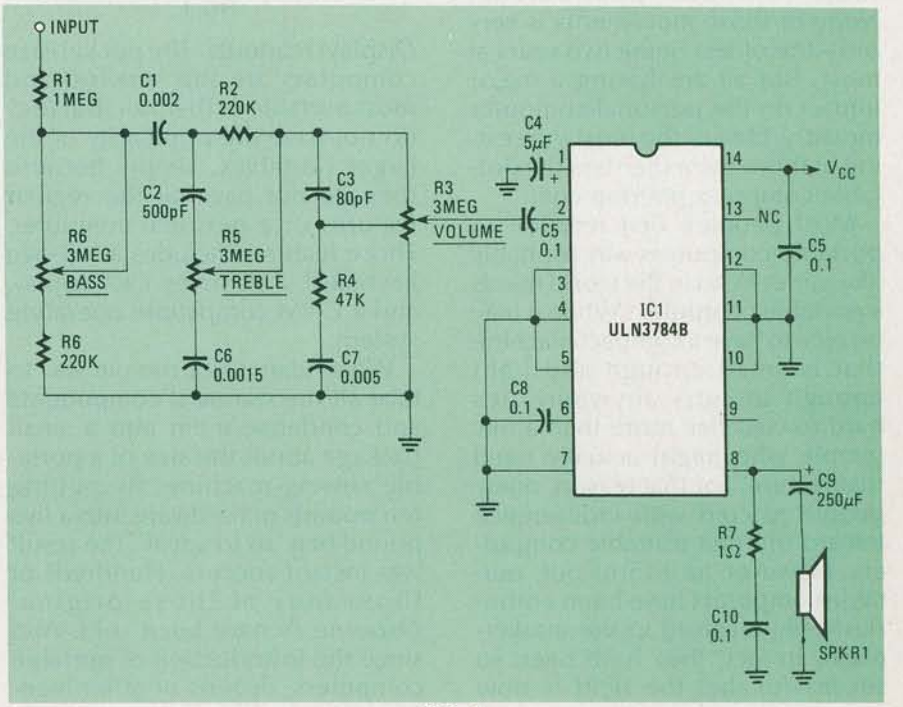

FIG. 4

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power-supply rejection ratio (PSRR) is 30 dB.

Figure 4 shows how the ULN-3784B is used as an amplifier with bass and treble controls.

Additional information on both devices is available on request from **Sprague Electric Company**, Semiconductor Division, 115 Northeast Cutoff, Worcester, MA 01606. Refer to Engineering Bulletin 21717.12 for the ULN-3784B and to Engineering Bulletin 21717.23 for the ULN-3705M low-voltage amplifier. **R-E**