T-74-05-01

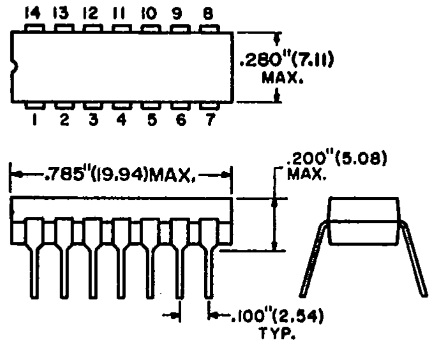
ECG® Semiconductors

ECG828

Audio Power Amp, 1.5 W

Features

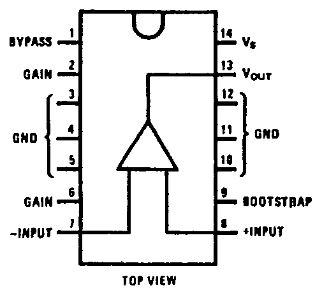
- Minimum external parts
- Wide supply voltage range
- Excellent supply rejection
- Ground referenced input
- Self-centering output quiescent voltage
- Variable voltage gain
- Low distortion
- Low voltage operation, 4 V



Applications

- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems
- Lamp drivers
- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

Connection Diagram



The ECG828 is an audio amplifier designed for use in medium power consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 2 and 6 will increase the gain to any value up to 200.

The inputs are ground referenced while the output is automatically biased to one half the supply voltage.

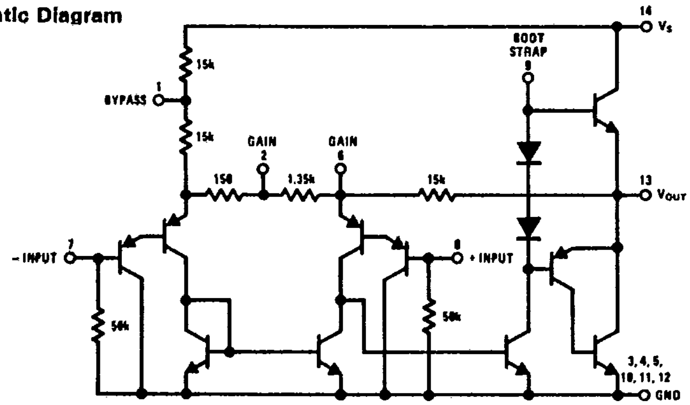
Absolute Maximum Ratings

Characteristic	Symbol	Rating	Unit
Supply Voltage	V_S	15	V
Package Dissipation*	P_D	8.3	W
Input Voltage	V_I	±0.4	V
Storage Temperature	Tstg	−65 to +150	0C
Operating Temperature	Topg	0 to +70	°C
Junction Temperature	T_J	150	°C
Lead Temperature (Soldering, 10 seconds)		300	°C

* Pins 3, 4, 5, 10, 11, 12 at 25°C. Derate at 15°C/W above 25°C case.

T-74-05-01

Schematic Diagram



Electrical Characteristics (T_A = +25°C, V_S = 12 unless otherwise specified, Figure 1)

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit
Operating Supply Voltage	V_S		4	--	12	V
Quiescent Current	I_Q	V_I=0	--	16	23	mA
Output Power	P_O	R_1=R_2=180 Ω, R_L=8 Ω, THD=10%, Note 1	1.5	2.2	--	W
Voltage Gain	G_V	f=1 kHz, 10 μF from Pin 2 to 6	23 --	26 46	30 --	dB dB
Bandwidth	BW	Pins 2 and 6 Open	--	300	--	kHz
Total Harmonic Distortion	THD	R_L=8 Ω, P_O=500 mW f=1 kHz, Pins 2 & 6 Open	--	0.1	1	%
Power Supply Rejection	PSRR	f=1 kHz, C_{bypass}=10 μF, Pins 2 and 6 Open, Referred to Output, Note 2	--	50	--	dB
Input Resistance	R_I		10	50	--	kΩ
Input Bias Current	I_{bias}	Pins 7 and 8 Open	--	250	--	nA

Notes

1. The amplifier should be in high gain for full swing on higher supplies due to input voltage limitations.
2. If load and bypass capacitor are returned to V_S (Figure 2), rather than ground (Figure 1), PSRR is typically 30 dB.

Application Hints

Gain Control

To make the ECG828 a more versatile amplifier, two pins (2 and 6) are provided for gain control. With pins 2 and 6 open, the 1.35 kΩ resistor sets the gain at 20 (26 dB). If a capacitor is put from pin 2 to 6, bypassing the 1.35 kΩ resistor, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. A low frequency pole in the gain response is caused by the capacitor working against the external resistor in series with the 150 Ω internal resistor. If the capacitor is eliminated and a resistor connects pin 2 to 6 then the output dc level may shift due to the additional dc gain. Gain control can also be done by capacitively coupling a resistor (or FET) from pin 6 to ground, as in Figure 7.

T-74-05-01

Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications. For example, we can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 6 to 13 (paralleling the internal 15 kΩ resistor). For 6 dB effective bass boost: R≅15 kΩ, the lowest value for good stable operation is R = 10 kΩ if pin 2 is open. If pins 2 and 6 are bypassed then R as low as 2 kΩ can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9 V/V.

Input Biasing

The schematic shows that both inputs are biased to ground with a 50 kΩ resistor. The base current of the input transistors is about 250 nA, so the inputs are at about 12.5 mV when left open. If the dc source resistance driving the ECG828 is higher than 250 kΩ it wil contribute very little additional offset (about 2.5 mV at the input, 50 mV at the output). If the dc source resistance is less than 10 kΩ, then shorting the unused input to ground will keep the offset low (about 2.5 mV at the input, 50 mV at the output. For dc source resistances between these values we can eliminate excess offset by putting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset problems are eliminated if the input is capacitively coupled.

When using the ECG828 with higher gains (bypassing the 1.35 kΩ resistor between pins 2 and 6) it is necessary to bypass the unused input, preventing degradation of gain and possible instabilities. This is done with a 0.1 μF capacitor or a short to ground depending on the dc source resistance on the driven input.

Bootstrapping

The base of the output transistor of the ECG828 is brought out to pin 9 for Bootstrapping. The output stage of the amplifier during positive swing is shown in Figure 3 with its external circuitry.

R1 + R2 set the amount of base current available to the output transistor. The maximum output current divided by Beta is the value required for the current in R1 and R2:

$$(R1 + R2) = \beta_O \frac{(V_S/2) - V_{BE}}{I_{O\ MAX}}$$

Good design values are V_{BE} = 0.7 V and β_O = 100.

Example: 1_{WATT} into 8Ω load with V_S = 12 V.

$$I_{O\ MAX} = \sqrt{\frac{2\ P_O}{R_L}} = 500\ \text{mA}$$

$$(R1 + R2) = 100\ \frac{(12/2) - 0.7}{0.5} = 1060\ \Omega$$

To keep the current in R2 constant during positive swing capacitor C_B is added. As the output swings positive C_B lifts R1 and R2 above the supply, maintaining a constant voltage across R2. To minimize the value of C_B, R1 = R2. The pole due to C_B and R1 and R2 is usually set equal to the pole due to the output coupling capacitor and the load. This gives:

$$C_B \cong \frac{4C_C}{\beta_O} \cong \frac{C_C}{25}$$

Example: for 100 Hz pole and R_L = 8 Ω; C_C = 200 μF and C_B = 8 μF, if R1 is made a diode and R2 increased to give the same current, C_B can be decreased by about a factor of 4, as in Figure 4.

For reduced component count the load can replace R1. The value of (R1 + R2) is the same, so R2 is increased. Now C_B is both the coupling and the bootstrapping capacitor (see Figure 2).

Typical Applications

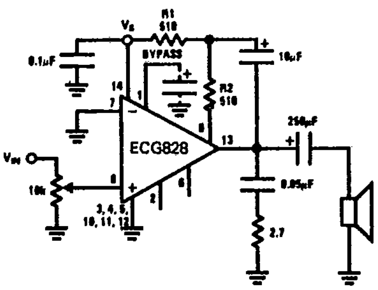


FIGURE 1. Load Returned to Ground (Amplifier with Gain = 20)

T-74-05-01

Typical Applications (cont.)

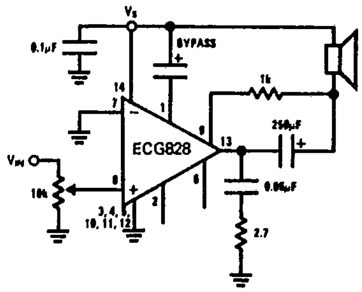


FIGURE 2. Load Returned to V_S (Amplifier with Gain = 20)

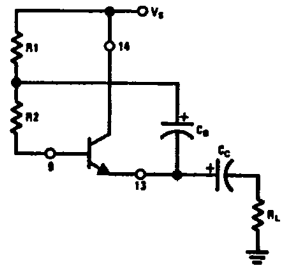


FIGURE 3.

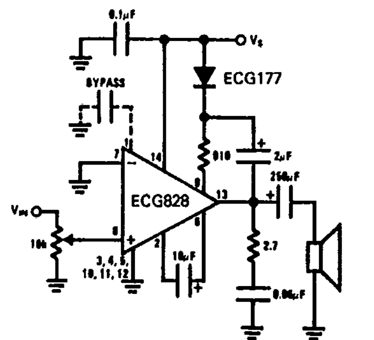
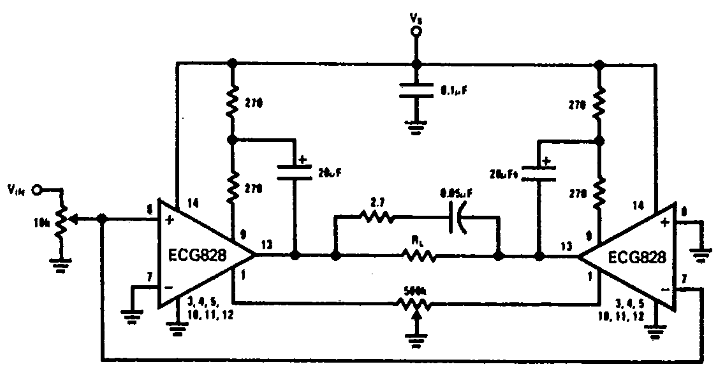


FIGURE 4. Amplifier with Gain = 200 and Minimum C_B



V_S = 6V R_L = 4Ω P_O = 1.0W
V_S = 12V R_L = 8Ω P_O = 4W

FIGURE 5. Bridge Amp

Typical Applications (cont.)

T-74-05-01

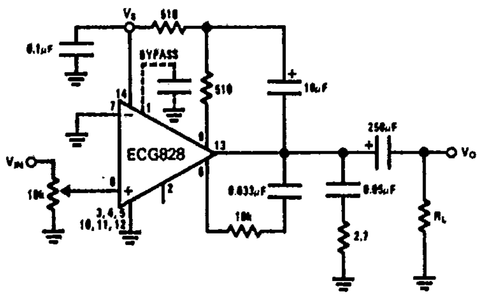


FIGURE 6a. Amplifier with Bass Boost

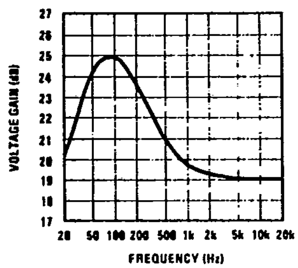


FIGURE 6b. Frequency Response with Bass Boost

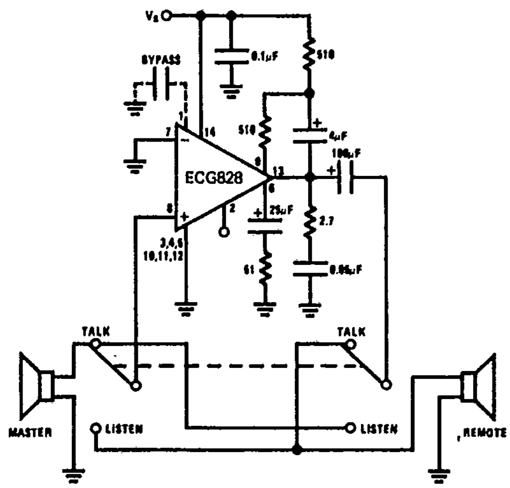


FIGURE 7. Intercom

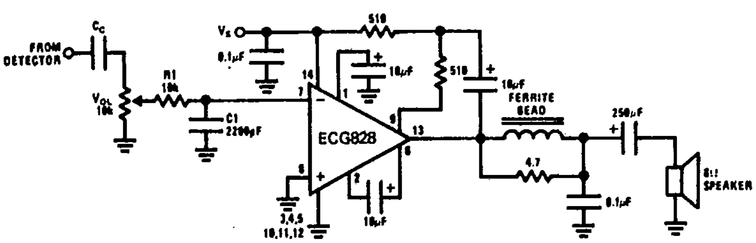


FIGURE 8. AM Radio Power Amplifier

Note 1: Twist supply lead and supply ground very tightly.

Note 2: Twist speaker lead and ground very tightly.

Note 3: Ferrite bead is Ferroxcube K5-001-001/3B with 3 turns of wire.

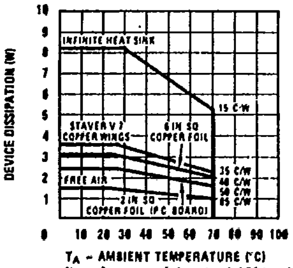
Note 4: R1C1 band limits input signals.

Note 5: All components must be spaced very close to IC.

T-74-05-01

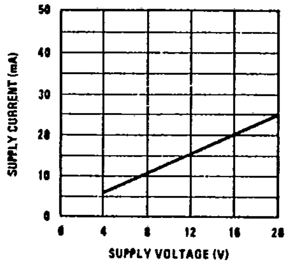
Typical Performance Characteristics

Maximum Device Dissipation vs Ambient Temperature

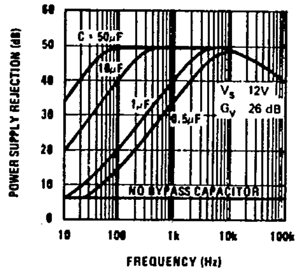


Note: 2 oz. copper foil, single sided PC board.

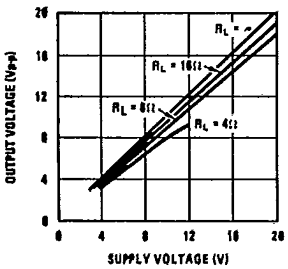
Quiescent Supply Current vs Supply Voltage



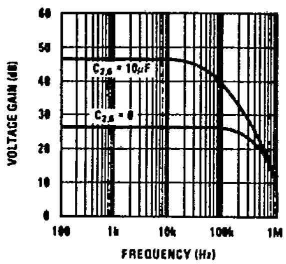
Power Supply Rejection Ratio (Referred to the Output) vs Frequency



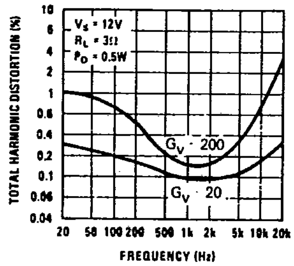
Peak-to-Peak Output Voltage Swing vs Supply Voltage



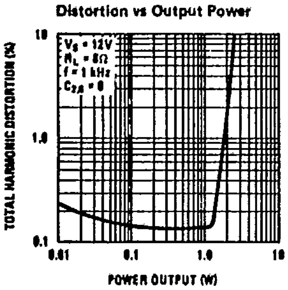
Voltage Gain vs Frequency



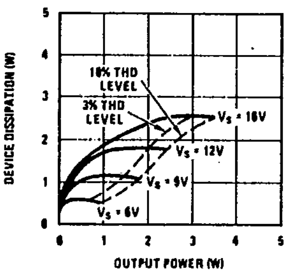
Distortion vs Frequency



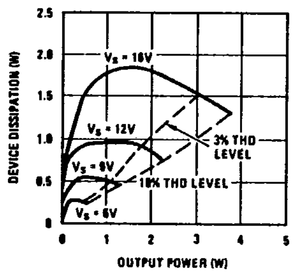
Distortion vs Output Power



Device Dissipation vs Output Power—4Ω Load



Device Dissipation vs Output Power—8Ω Load



Device Dissipation vs Output Power—16Ω Load