ELECTRONIC INNOVATIONS IN MOTION
SEMICONDUCTORS

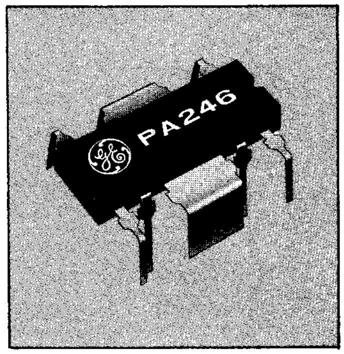
Integrated Circuit
5-Watt Power Amplifier

PA246

DH 1.80

The General Electric PA246 is a monolithic power amplifier designed to deliver 5 watts of continuous power to a 16-ohm load. It can, however, be operated from a wide variety of supply voltages and load impedances, thereby providing user versatility.

The PA246 is housed in a specially designed power package having 8 leads plus two heat sink tabs. The leads are staggered to allow proper printed circuit board design and external heat sinking can be readily attached to the tabs during the flow soldering of the PC board.

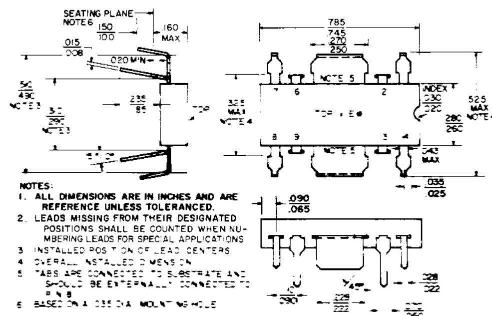


FEATURES

- 5 Watt rms Output, 10 Watt Peak
- Staggered Lead Plastic Package
- High Sensitivity
- −55°C to +125°C Operating Temp.
- Usable Power from a Wide Range of Power Supply Voltages and Load Impedances
- High Output Voltage Swing: 30 Volts Peak-to-Peak

APPLICATIONS

Monaural & Stereo Phonographs
Tape Players/Recorders
Intercoms
FM, AM & TV Receivers
Movie Projectors
Servo Amplifiers
Op Amp Boosters



Package Outline

maximum ratings: (25°C)

Supply Voltage	37	Volts
Output Current (peak)	1.25	Amp
Package Dissipation (Tabs at 70°C) (Derate 11°C/W above 70°C)	5	Watts
Temperature		
Storage	−65 to 150°C	
Operating	−55 to 125°C	

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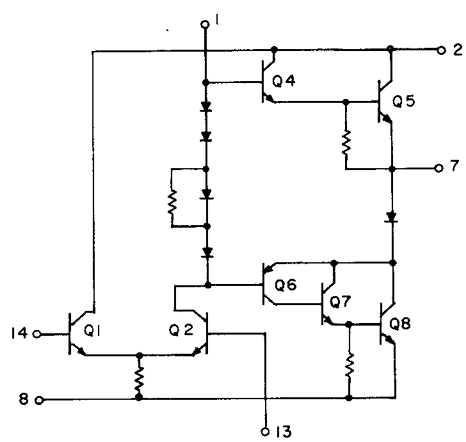
electrical characteristics: (25°C) (34V supply in Test Circuit)

	Min.	Typ.	Max.	
Audio Power Output (continuous) (<5% total harmonic distortion)	5.0			Watts
Input Voltage for P_o = 5 watts*				
($R_6 = 0$)		12		mV
($R_6 = 6.8k$)		180	200	mV
Efficiency (P_o = 5 watts)		58		%
Distortion at 1 kHz*				
(5 watts P_o)		0.7	5	%
(0.05 watts P_o)		0.5	2	%
Output Quiescent Voltage* (pin 7)		17		V
Quiescent Current	3	10	20	mA
Frequency Response* (± 3 dB at P_o = 2.5W)		30 to 100k		Hz
Noise Output Level Relative to 5 watts output (Input open) BW = 30 Hz to 100kHz		−70		dB
Output Impedance*		0.6		ohms

*Performance is determined by external components used in the test circuit.



Circuit Diagram

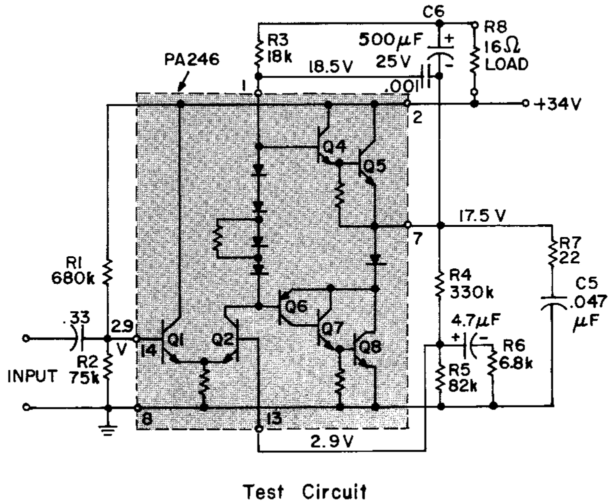


Figure 1. 5-Watt Power Amplifier Test Circuit

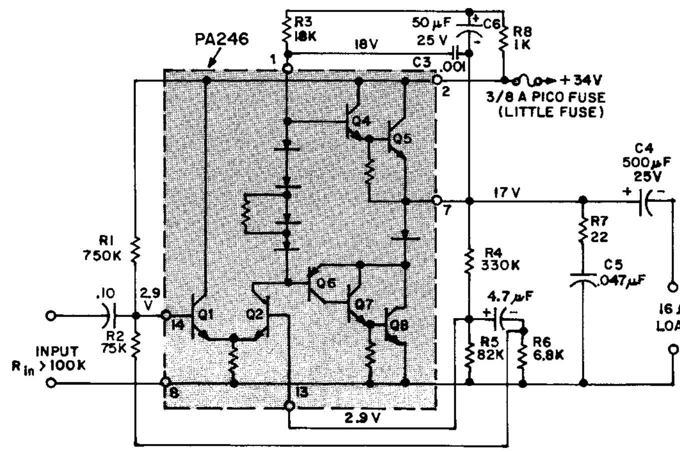


Figure 2. Circuit Modified for Grounded Load and Input Bootstrapping

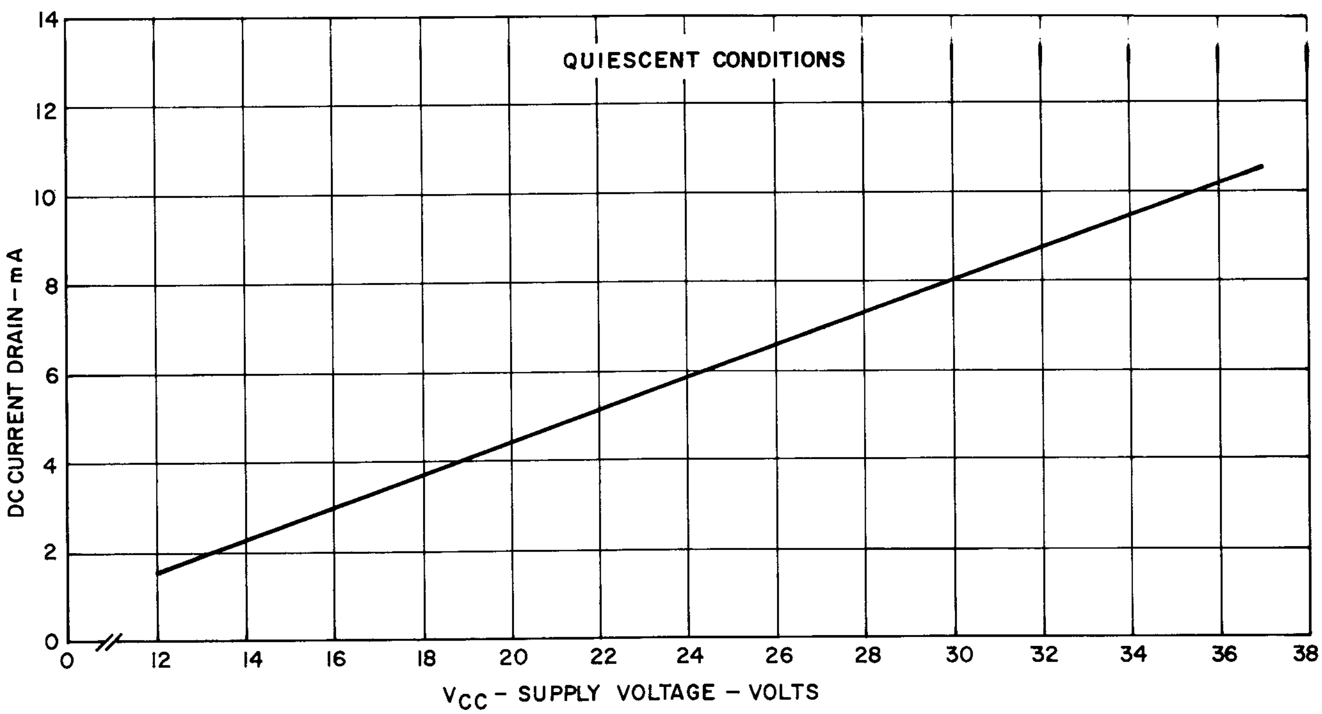


Figure 3. DC Current Drain vs. Supply Voltage

5-WATT POWER AMPLIFIER

GENERAL DESCRIPTION

The PA246 monolithic amplifier is a general purpose power driver for use in consumer and industrial systems requiring up to five watts of power output. While the primary application of this device is intended to be in audio equipment, it will be found useful also as a voltage supply regulator, servo motor driver, relay and lamp driver, and op amp booster, to name a few examples.

In order to deliver five watts output from a monolithic chip, General Electric developed an improved plastic package based on a modification of the standard dual-in-line package (DIP). This new package contains two heat sink tabs and eight leads in a staggered arrangement. The staggering of leads provides a spacing of 140 mils between mounting holes. The two tabs extend from each side of the package, along with the leads, and are made of copper for good heat transfer. The tabs can be readily attached to an external heat sink during the flow solder run of the printed circuit board used for mounting.

The power device will operate from a wide range of supply voltage up to 37 volts and can drive a wide range of loads with up to 1.25 amps peak. The five watt rating is based on a 34 volt supply and a 16-ohm load operating in Test Circuit of Figure 1. Under other conditions, power output can be found from Figures 7, 8, 9.

CIRCUIT CONFIGURATION

The circuit consists of a differential pair at the input which provides the total amplifier gain followed by an emitter follower output stage. The output is a quasi-complementary push-pull circuit composed of a composite NPN transistor formed by Q_4, Q_5 and a composite PNP transistor formed by Q_6, Q_7, Q_8. The bias current in the output is determined by the current which flows through the diode string at the collector of Q_2. By means of matching the forward voltage drop of the output base-emitter junctions to the diode string, sufficient quiescent current will flow to insure elimination of crossover distortion. The diode in the emitter of Q_5 acts to provide uniform dc bias from unit to unit and to supply ac degeneration. Standby current is low, typically 10 mA, and operation is essentially class B. Figure 2 shows the variation of dc current drain with supply voltage.

The input differential stage can be biased using conventional operational amplifier techniques. The base voltage of Q_1 is set by the voltage divider R_1, R_2. The feedback network of R_4, R_5 determine the dc output voltage at pin 7 so that the base voltage at Q_2 equals the voltage at pin 14. The circuit resistors are chosen to keep pin 7 voltage at ½ the supply voltage. The resistor in the emitters of Q_1, Q_2 then sets the bias current level at the input stage.

The open loop ac gain depends upon the value of R_3 which is external to the amplifier. The closed loop gain is set by the ratio of R_4/R_6. Amplifier stability is maintained by a roll off capacitor connected between pins 1 & 7. Positive feedback is provided by means of C_6 & R_8 in order to have sufficient drive on the positive peak swing of the output.

The amplifier is recommended to be used in either of the circuit configurations shown in Figure 1 and Figure 2. The specified values are based on the circuit of Figure 1 which shows the load connected to the power supply terminal. Figure 2 shows the load when it must be tied to ground and the addition of two extra components in order to accomplish this. Also, input bootstrapping is illustrated for raising the input impedance to over 100K. Power performance will be the same for both circuits.

TEMPERATURE STABILITY

Amplifier operation over temperature extremes is illustrated in Figure 4. The curves show the effect of temperature on quiescent current, output quiescent voltage, gain, and distortion. Good temperature stability is maintained because the monolithic structure contains matched transistors and diodes that track with ambient changes.

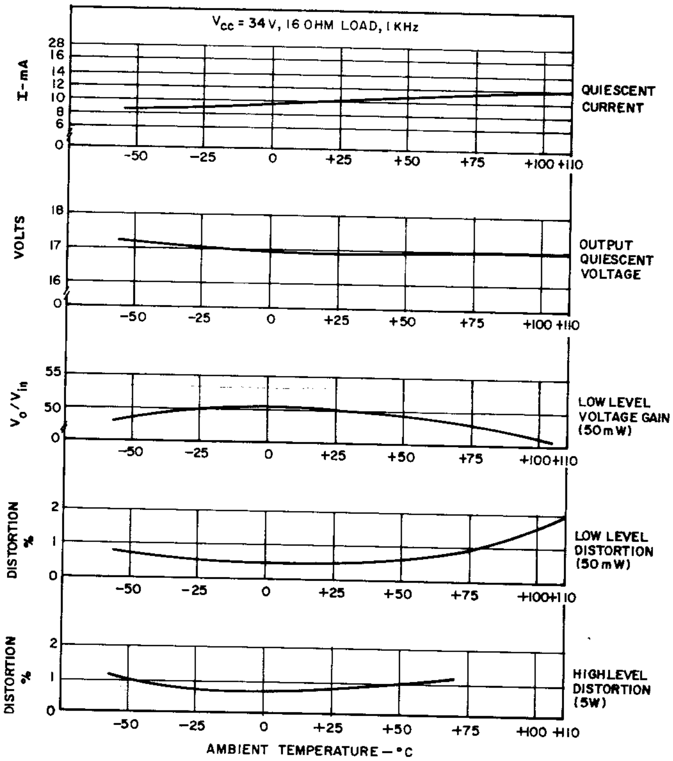


Figure 4. Stability of Performance Characteristics with Ambient Temperature

DISTORTION PERFORMANCE

Disortion is kept low by means of the ac feedback network shown in Figures 1 and 2 and by the circuit biasing arrangement that eliminates any crossover discontinuity. The typical total harmonic distortion (THD) at full power over the audio range is given in Figure 5. The increase of distortion at the frequency extremes as shown depends upon the external circuit elements rather than on the PA246 device. The frequency range can be improved at the low end by using larger coupling capacitors C_1, C_4 and at the high end by increasing the roll-off as determined by C_3, R_7, C_5.

Typical distortion at different power output levels is shown in Figure 6. Both THD and intermodulation distortion are presented.

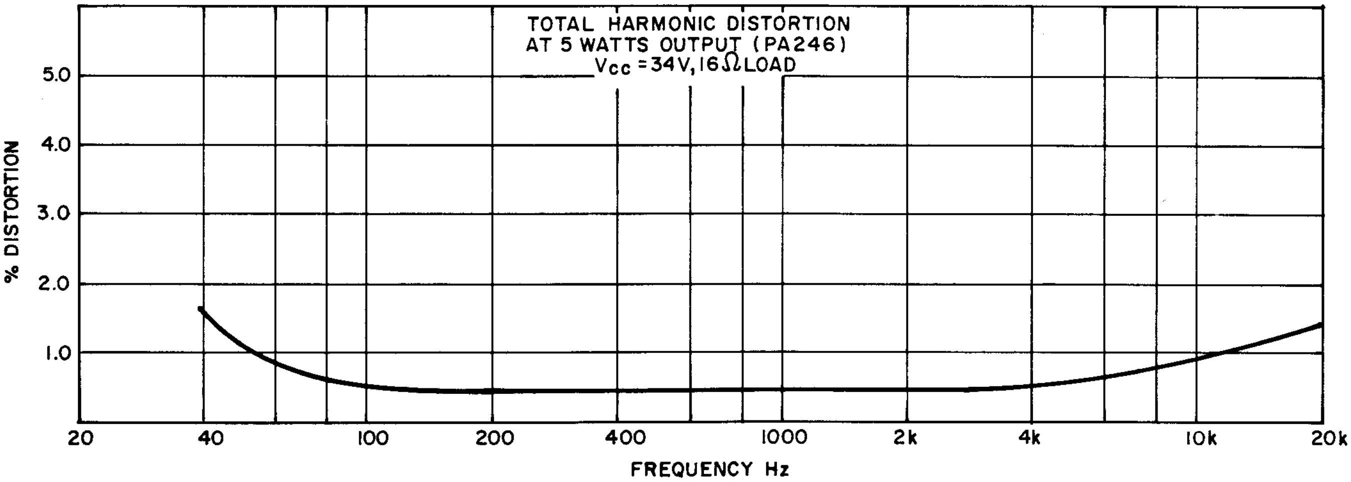


Figure 5. Typical Distortion Over the Audio Range

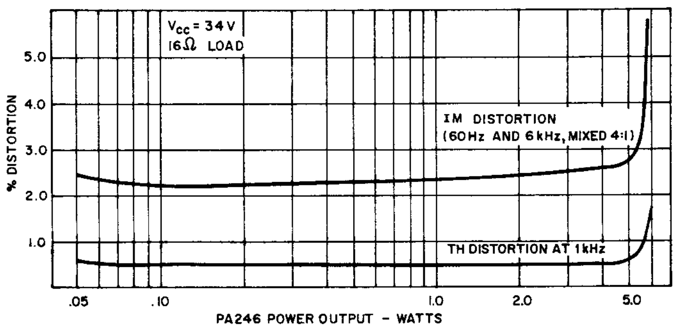


Figure 6. Typical Distortion vs. Power Output Level

POWER OUTPUT FOR DIFFERENT LOADS & SUPPLY VOLTAGES

The PA246 is rated at 5 watts output when operated into a 16-ohm load at 34 volts supply voltage. For operation at other supply voltages, a graph is presented in Figure 7 to show available power output and the corresponding device dissipation. The dotted line indicates the points of maximum available power for 3% THD which is approximately the onset of clipping. For each voltage curve there is a point of maximum power dissipation which occurs for some output power below the maximum level. The heat sink requirements are based on this maximum dissipated power as will be shown later.

Operating conditions at different voltages for 8-ohms and 22-ohm loads are given in Figures 8 and 9. Power output for the 22-ohm load falls under 5 watts in order to stay within the device voltage ratings.

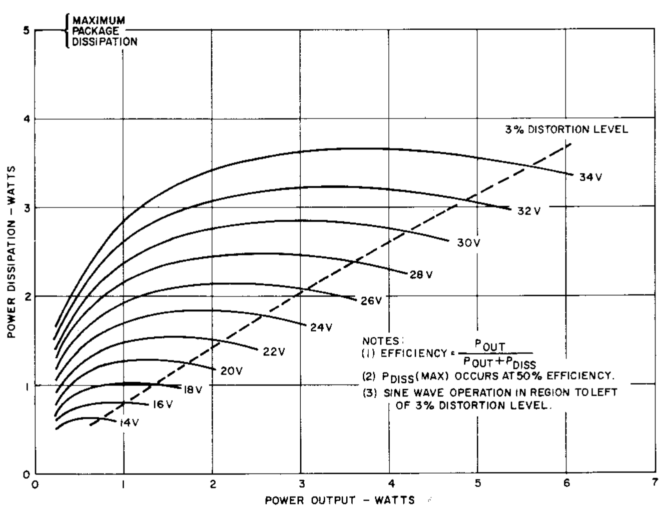


Figure 7. Internal Dissipation vs. Power Output Delivered to a 16-ohm Load

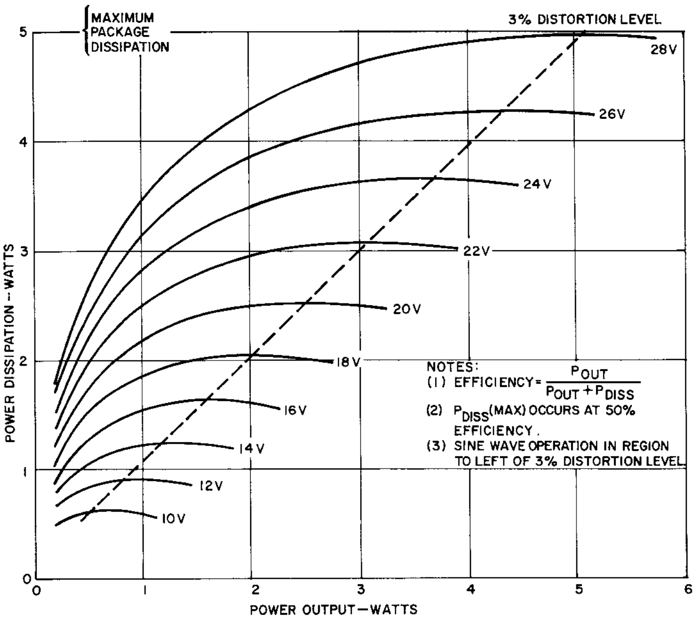


Figure 8. Internal Dissipation vs. Power Output Delivered to an 8-ohm Load

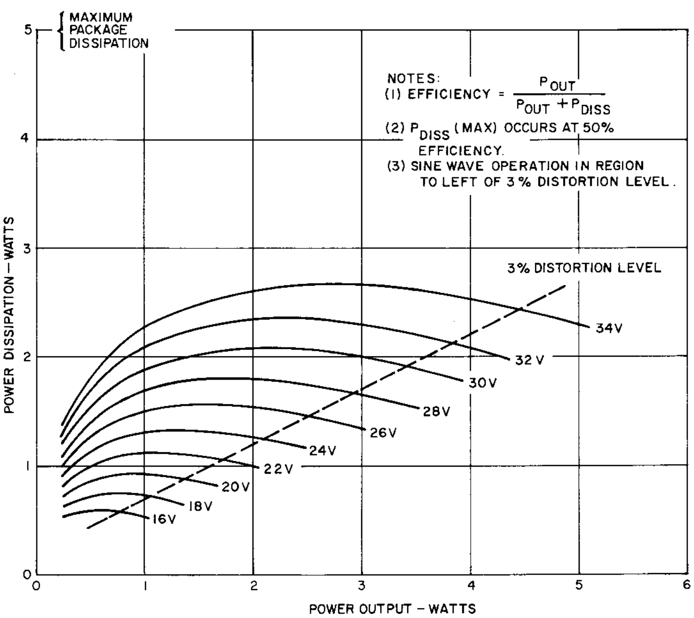


Figure 9. Internal Dissipation vs. Power Output Delivered to a 22-ohm Load

HEAT SINK CONSIDERATIONS

The two heat sink tabs are intended to be cooled to maintain device operation within the dissipation—tab temperature curve presented in Figure 10. The package thermal resistance is 11°C/watt, junction to tabs, as indicated by the slope of the curve. Power derating is based on a maximum pellet temperature of 125°C to assure device reliability.

Heat sink design is based on worst case power dissipation as found from the curves of Figures 7, 8, and 9. For example, consider the amplifier operating from a 34 volt supply into a 16-ohm load. Full power output before clipping will be 5 watts with 3.55 watts device dissipation (58% efficiency). However, on a worst case basis the maximum dissipation indicated is 3.7 watts. Referring to Figure 10, with 3.7 watts of package dissipation the tab temperature must be maintained below 84°C at the highest operating ambient. Tab temperature should be measured at the high ambient with the selected heat sink soldered in place in order to check for safe operation.

As a starting point in determining heat sink area, Figure 11 is given as a guide. Because heat sink effectiveness depends upon many factors, such as the nature and shape of the heat sink material and its environment, it is emphasized that any design should be final checked with a tab temperature measurement. For the example amplifier with 3.7 watts dissipation to operate at a maximum ambient of 50°C, Figure 11 indicates that a sink of 2 inch^2 per tab (.035 inch thick copper) might be suitable.

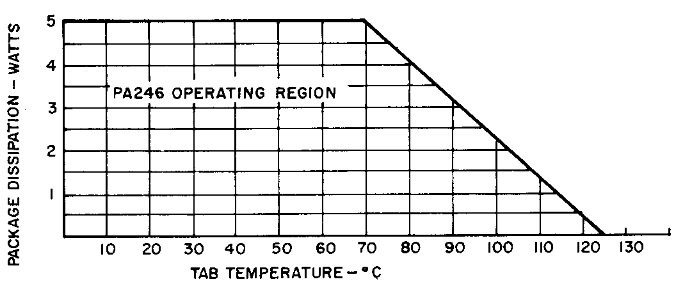


Figure 10. Allowable Package Dissipation as Determined by Measured Tab Temperature

PRINTED CIRCUIT BOARD CONSTRUCTION FOR DEVICE EVALUATION

A printed circuit board (PCB) layout of the circuit in Figure 2 is shown in Figure 12. Heat radiating fins are inserted into the tab slots along with the PA246 and are soldered together. The heat sink fins are copper (other solderable metals are also suitable) with an area of 2 square inches. Some heat sinking is also available from the copper ground plane of the PCB. The illustrated board will handle conservatively 5 watts of continuous power (34 volt supply, 16-ohm load) in ambients up to 50°C. A Photograph of the completed

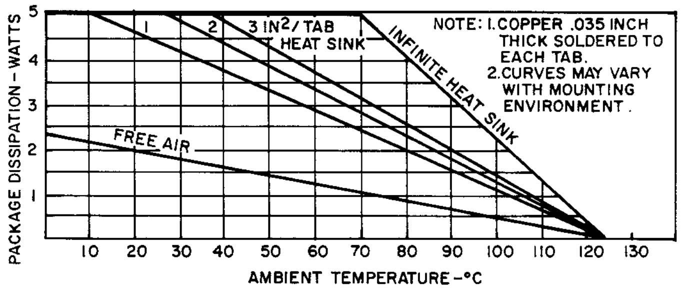


Figure 11. Allowable Package Dissipation vs. Ambient Temperature

board with all parts soldered in place is shown in Figure 13.

Smaller heat sink size might be used if the signal input is from an audio program source. Because of the low duty cycle the average package dissipation will be well below the maximum dissipation. The heat sink area would then be found as before based on an estimated average dissipation. This approach, of course, is less conservative than the worst-case design.

An outline of a suggested heat fin is shown in Figure 14.

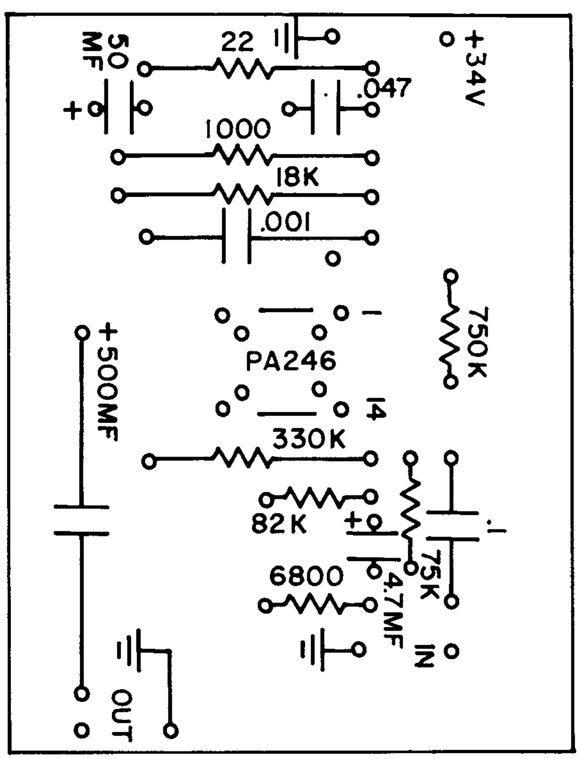


Figure 12a. Parts Layout—Component Side of PC Board

PA-
OUT
The
slot
Th
Fig
inch
Codes: 40,
SEMIC
ELECT

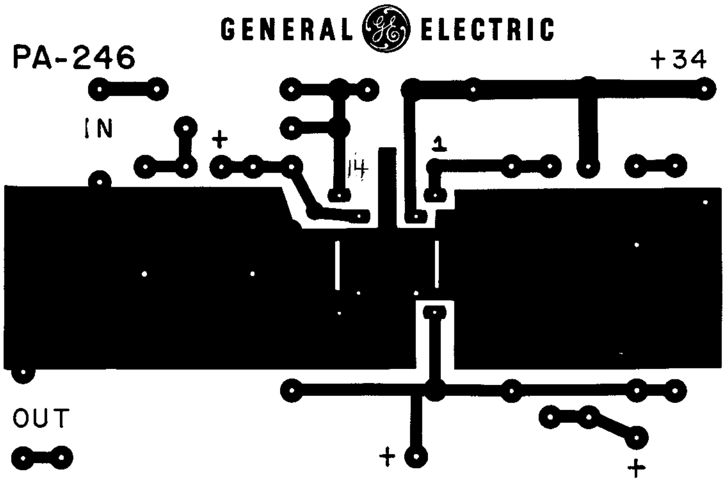


Figure 12 b. Pattern for Printed Circuit Side of Board

The mounting tab is dimensioned to fit into the same mounting slot as the device, but it will still clear the adjacent leads.

The dimensions of the mounting hole layout will be found in Figure 15. The width of the heat sink slot should be .025 inches plus the thickness of the external heat sink fin material.

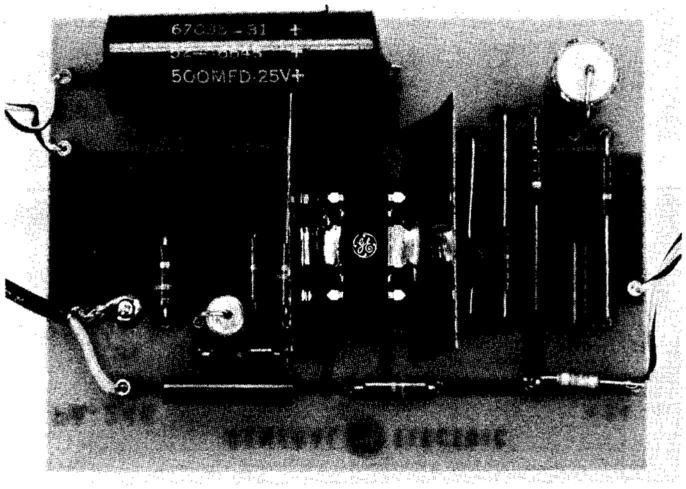


Figure 13. Completed Circuit Assembly of Amplifier Shown in Figure 2

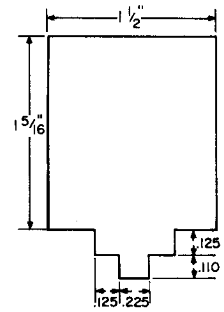
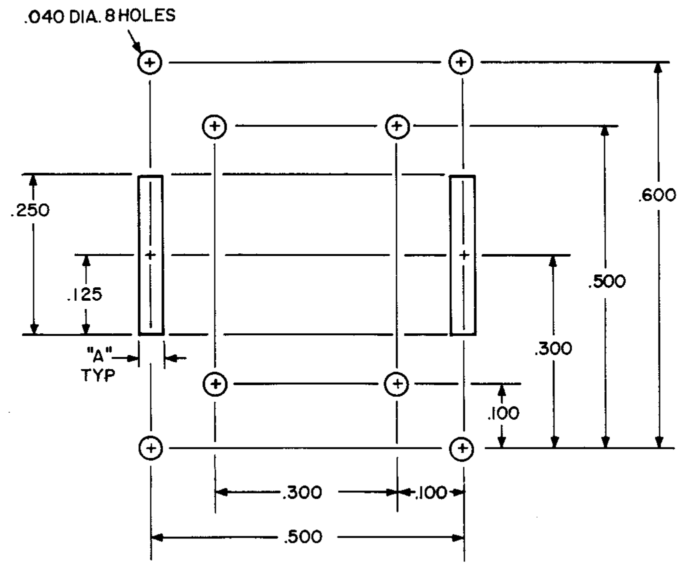


Figure 14. Heat Radiating Fin (.015" thick copper)



A	HEAT SINK FIN THICK*
.040	.015
.060	.035

* SLOT WIDTH BASED ON FIN THICKNESS

Figure 15. Device Mounting Hole Layout Dimensions

Codes: 40, 44, 45, 50, 52, 54

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