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**MOTOROLA**
**SEMICONDUCTOR TECHNICAL DATA**

**Order this document by MJ21193/D**

# Silicon Power Transistors

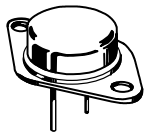
**PNP**
**MJ21193***
**NPN**
**MJ21194***

*Motorola Preferred Device

The MJ21193 and MJ21194 utilize Perforated Emitter technology and are specifically designed for high power audio output, disk head positioners and linear applications.

- Total Harmonic Distortion Characterized
- High DC Current Gain – $h_{FE}$ = 25 Min @ $I_C$ = 8 Adc
- Excellent Gain Linearity
- High SOA: 2.5 A, 80 V, 1 Second

**16 AMPERE COMPLEMENTARY SILICON POWER TRANSISTORS 250 VOLTS 250 WATTS**



**CASE 1–07**
**TO–204AA**
**(TO–3)**

## MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector–Emitter Voltage | $V_{CEO}$ | 250 | Vdc |
| Collector–Base Voltage | $V_{CBO}$ | 400 | Vdc |
| Emitter–Base Voltage | $V_{EBO}$ | 5 | Vdc |
| Collector–Emitter Voltage – 1.5 V | $V_{CEX}$ | 400 | Vdc |
| Collector Current — Continuous<br>Peak (1) | $I_C$ | 16<br>30 | Adc |
| Base Current — Continuous | $I_B$ | 5 | Adc |
| Total Power Dissipation @ $T_C$ = 25°C<br>Derate Above 25°C | $P_D$ | 250<br>1.43 | Watts<br>W/°C |
| Operating and Storage Junction Temperature Range | $T_J$, $T_{stg}$ | – 65 to +200 | °C |

## THERMAL CHARACTERISTICS

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$ | 0.7 | °C/W |

## ELECTRICAL CHARACTERISTICS ($T_C$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typical | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Collector–Emitter Sustaining Voltage<br>($I_C$ = 100 mAdc, $I_B$ = 0) | $V_{CEO(sus)}$ | 250 | — | — | Vdc |
| Collector Cutoff Current<br>($V_{CE}$ = 200 Vdc, $I_B$ = 0) | $I_{CEO}$ | — | — | 100 | μAdc |

(1) Pulse Test: Pulse Width = 5 μs, Duty Cycle ≤10%.

(continued)

**Preferred** devices are Motorola recommended choices for future use and best overall value.

**REV 1**



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**ELECTRICAL CHARACTERISTICS** ($T_C$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typical | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Emitter Cutoff Current ($V_{CE}$ = 5 Vdc, $I_C$ = 0) | $I_{EBO}$ | — | — | 100 | μAdc |
| Collector Cutoff Current ($V_{CE}$ = 250 Vdc, $V_{BE(off)}$ = 1.5 Vdc) | $I_{CEX}$ | — | — | 100 | μAdc |
| **SECOND BREAKDOWN** | | | | | |
| Second Breakdown Collector Current with Base Forward Biased ($V_{CE}$ = 50 Vdc, t = 1 s (non–repetitive)) | $I_{S/b}$ | 5 | — | — | Adc |
| ($V_{CE}$ = 80 Vdc, t = 1 s (non–repetitive)) | | 2.5 | — | — | |
| **ON CHARACTERISTICS** | | | | | |
| DC Current Gain ($I_C$ = 8 Adc, $V_{CE}$ = 5 Vdc) | $h_{FE}$ | 25 | — | 75 | |
| ($I_C$ = 16 Adc, $I_B$ = 5 Adc) | | 8 | — | | |
| Base–Emitter On Voltage ($I_C$ = 8 Adc, $V_{CE}$ = 5 Vdc) | $V_{BE(on)}$ | — | — | 2.2 | Vdc |
| Collector–Emitter Saturation Voltage ($I_C$ = 8 Adc, $I_B$ = 0.8 Adc) | $V_{CE(sat)}$ | — | — | 1.4 | Vdc |
| ($I_C$ = 16 Adc, $I_B$ = 3.2 Adc) | | — | — | 4 | |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| Total Harmonic Distortion at the Output $V_{RMS}$ = 28.3 V, f = 1 kHz, $P_{LOAD}$ = 100 $W_{RMS}$ $h_{FE}$ unmatched | $T_{HD}$ | — | 0.8 | — | % |
| (Matched pair $h_{FE}$ = 50 @ 5 A/5 V) $h_{FE}$ matched | | — | 0.08 | — | |
| Current Gain Bandwidth Product ($I_C$ = 1 Adc, $V_{CE}$ = 10 Vdc, $f_{test}$ = 1 MHz) | $f_T$ | 4 | — | — | MHz |
| Output Capacitance ($V_{CB}$ = 10 Vdc, $I_E$ = 0, $f_{test}$ = 1 MHz) | $C_{ob}$ | — | — | 500 | pF |

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤2%

**PNP MJ21193**

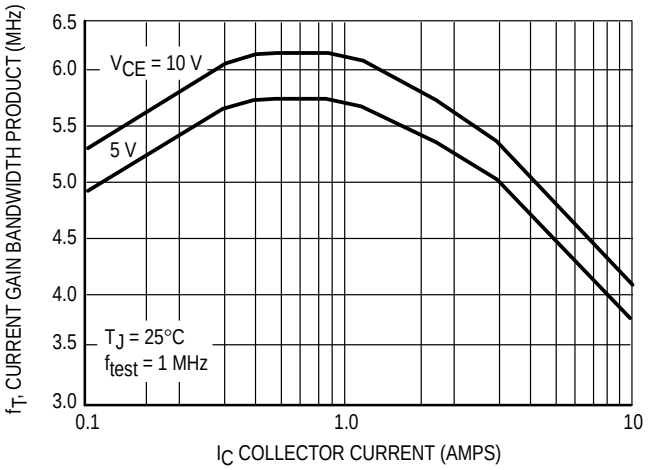


**Figure 1. Typical Current Gain Bandwidth Product**

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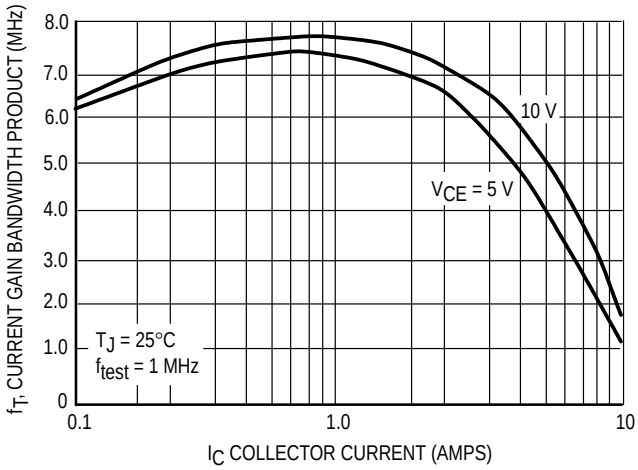


**Figure 2. Typical Current Gain Bandwidth Product**



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## TYPICAL CHARACTERISTICS

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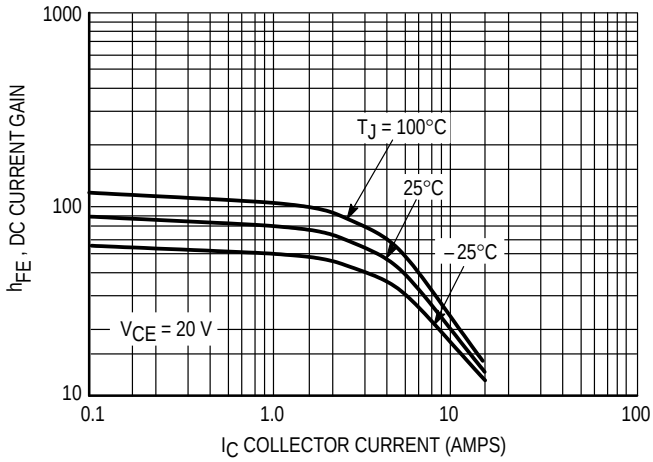


**Figure 3. DC Current Gain, $V_{CE}$ = 20 V**

NPN MJ21194

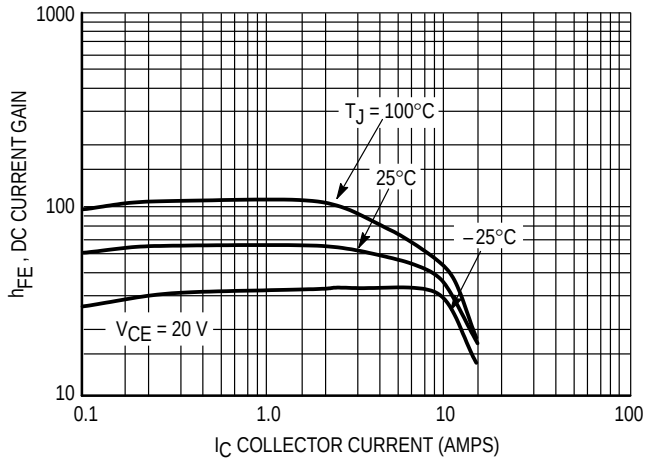


**Figure 4. DC Current Gain, $V_{CE}$ = 20 V**

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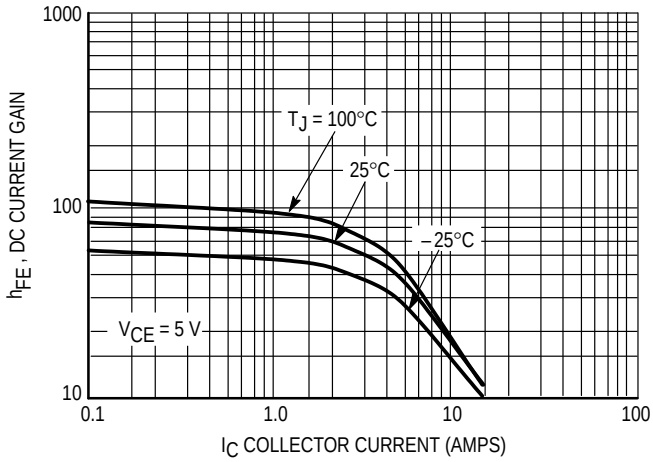


**Figure 5. DC Current Gain, $V_{CE}$ = 5 V**

NPN MJ21194

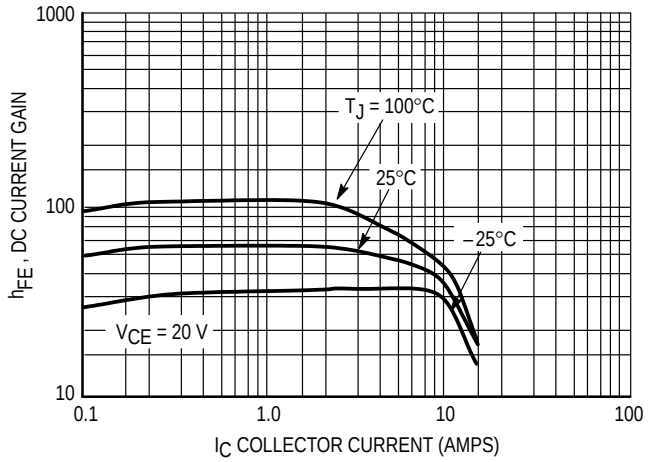


**Figure 6. DC Current Gain, $V_{CE}$ = 5 V**

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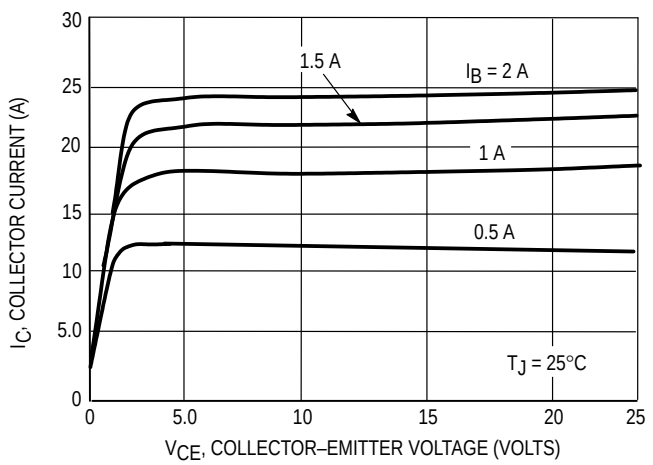


**Figure 7. Typical Output Characteristics**

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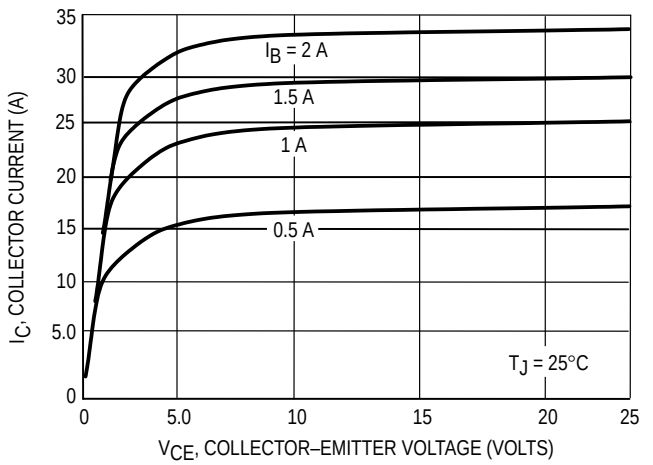


**Figure 8. Typical Output Characteristics**




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## TYPICAL CHARACTERISTICS

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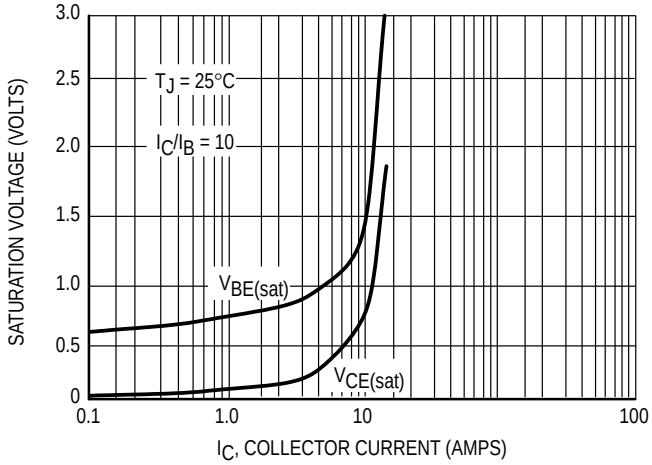


**Figure 9. Typical Saturation Voltages**

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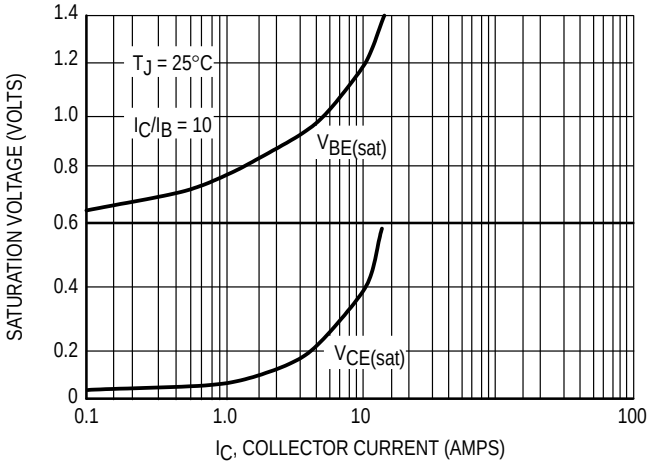


**Figure 10. Typical Saturation Voltages**

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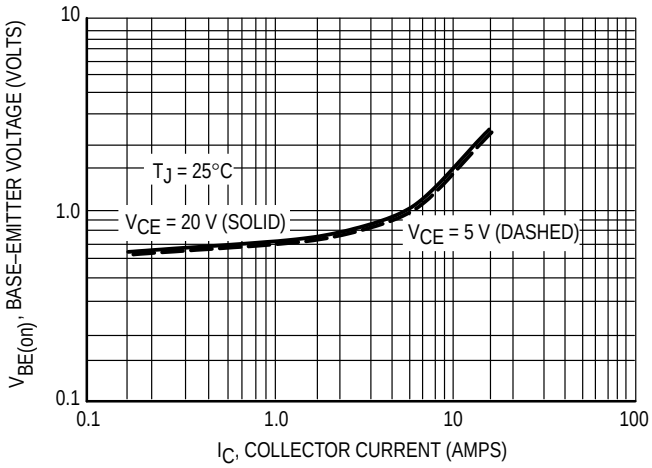


**Figure 11. Typical Base–Emitter Voltage**

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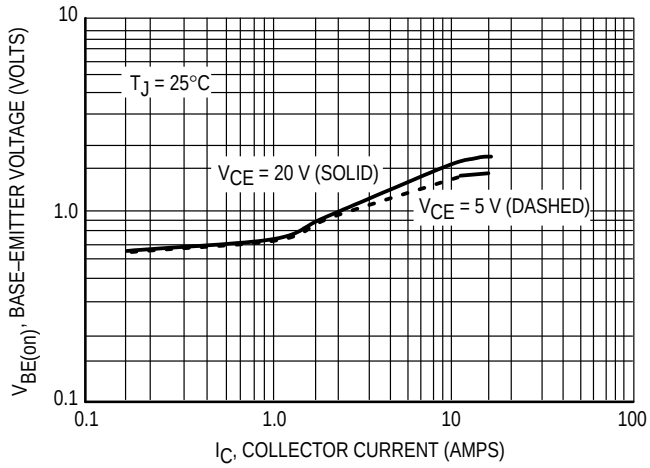


**Figure 12. Typical Base–Emitter Voltage**

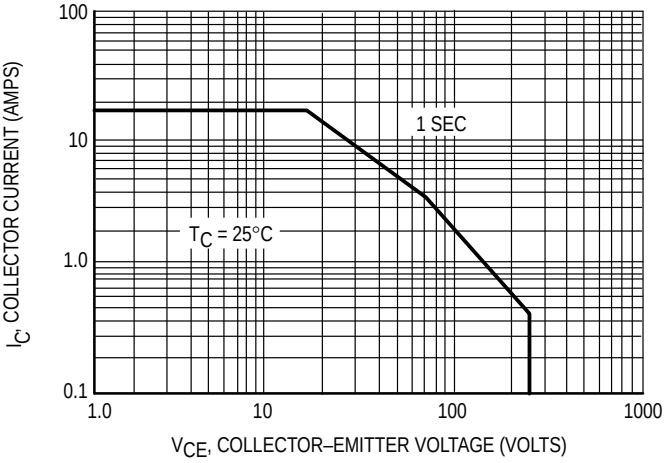


**Figure 13. Active Region Safe Operating Area**

There are two limitations on the power handling ability of a transistor; average junction temperature and secondary breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 13 is based on $T_{J(pk)}$ = 200°C; $T_C$ is variable depending on conditions. At high case temperatures, thermal limitations will reduce the power than can be handled to values less than the limitations imposed by second breakdown.



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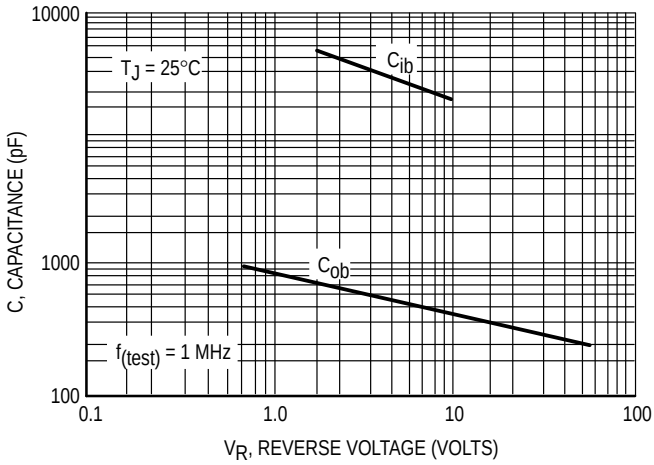


**Figure 14. MJ21193 Typical Capacitance**

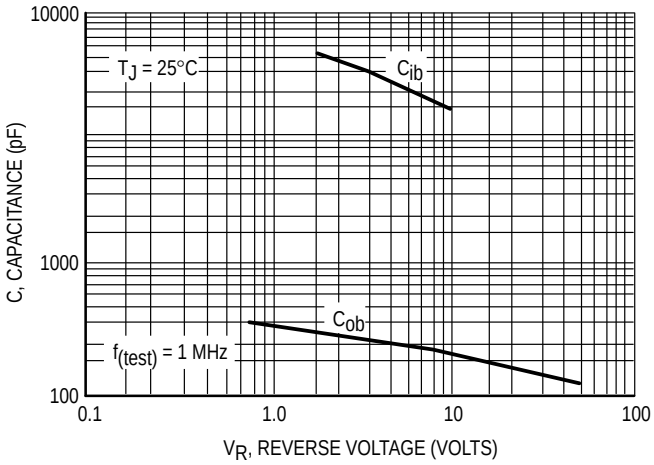


**Figure 15. MJ21194 Typical Capacitance**

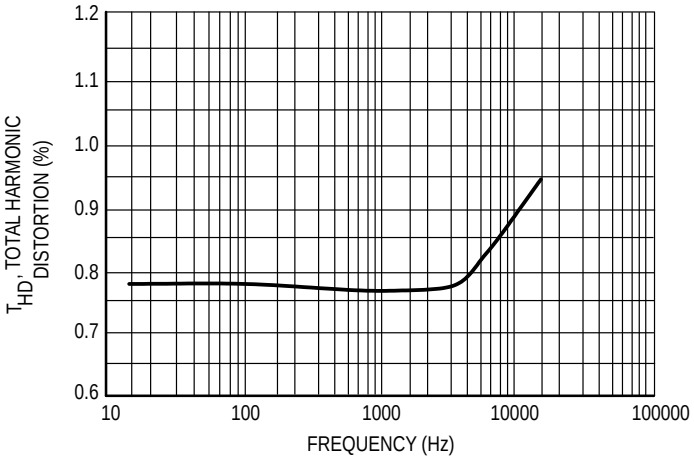


**Figure 16. Typical Total Harmonic Distortion**

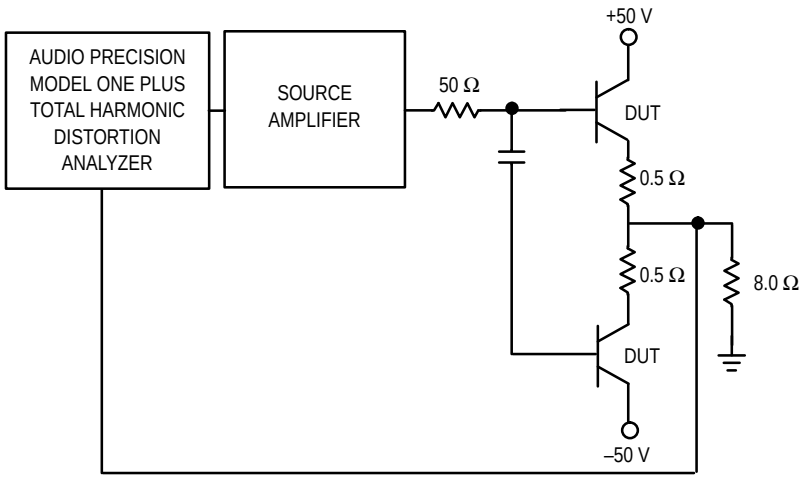


**Figure 17. Total Harmonic Distortion Test Circuit**




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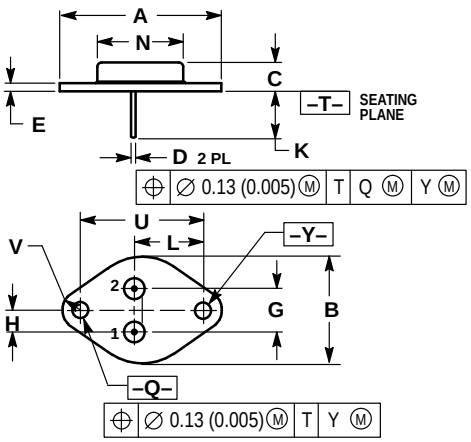
## PACKAGE DIMENSIONS




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. ALL RULES AND NOTES ASSOCIATED WITH REFERENCED TO–204AA OUTLINE SHALL APPLY.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 1.550 REF | | 39.37 REF | |
| B | — | 1.050 | — | 26.67 |
| C | 0.250 | 0.335 | 6.35 | 8.51 |
| D | 0.038 | 0.043 | 0.97 | 1.09 |
| E | 0.055 | 0.070 | 1.40 | 1.77 |
| G | 0.430 BSC | | 10.92 BSC | |
| H | 0.215 BSC | | 5.46 BSC | |
| K | 0.440 | 0.480 | 11.18 | 12.19 |
| L | 0.665 BSC | | 16.89 BSC | |
| N | — | 0.830 | — | 21.08 |
| Q | 0.151 | 0.165 | 3.84 | 4.19 |
| U | 1.187 BSC | | 30.15 BSC | |
| V | 0.131 | 0.188 | 3.33 | 4.77 |

STYLE 1:
PIN 1. BASE
2. EMITTER
CASE: COLLECTOR

**CASE 1–07**
**TO–204AA (TO–3)**
**ISSUE Z**



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