# MDC3205

*Advance Information*

# Integrated Relay/Solenoid Driver

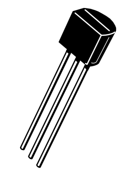
- Optimized to Switch 3 V to 5 V Relays from a 5 V Rail
- Compatible with "TX" and "TQ" Series Telecom Relays Rated up to 625 mW at 3 V to 5 V
- Features Low Input Drive Current
- Internal Zener Clamp Routes Induced Current to Ground Rather Than Back to Supply
- Guaranteed Off State with No Input Connection
- Supports Large Systems with Minimal Off–State Leakage
- ESD Resistant in Accordance with the 2000 V Human Body Model
- Provides a Robust Driver Interface Between Relay Coil and Sensitive Logic Circuits

**Applications include:**

- Telecom Line Cards and Telephony
- Industrial Controls
- Security Systems
- Appliances and White Goods
- Automated Test Equipment
- Automotive Controls

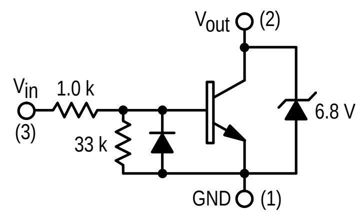
This device is intended to replace an array of three to six discrete components with an integrated part. It can be used to switch other 3 to 5 Vdc Inductive Loads such as solenoids and small DC motors.

**RELAY/SOLENOID DRIVER**
**SILICON MONOLITHIC**
**CIRCUIT BLOCK**



**CASE 29–04, STYLE 14**
**TO–92**

**INTERNAL CIRCUIT DIAGRAM**




**MAXIMUM RATINGS**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | 6.0 | Vdc |
| Recommended Operating Supply Voltage | $V_{CC}$ | 2.0–5.5 | Vdc |
| Input Voltage | $V_{in(fwd)}$ | 6.0 | Vdc |
| Reverse Input Voltage | $V_{in(rev)}$ | –0.5 | Vdc |
| Output Sink Current — Continuous | $I_O$ | 300 | mA |
| Junction Temperature | $T_J$ | 150 | °C |
| Operating Ambient Temperature Range | $T_A$ | –40 to +85 | °C |
| Storage Temperature Range | $T_{stg}$ | –65 to +150 | °C |

**THERMAL CHARACTERISTICS**

| Characteristic | Symbol | Max | Unit |
|---|---|---|---|
| Total Device Dissipation(1)<br>Derate above 25°C | $P_D$ | 625 | mW |
| Thermal Resistance Junction to Ambient | $R_{\theta JA}$ | 200 | °C/W |

1. FR–5 PCB of 1″ x 0.75″ x 0.062″, $T_A$ = 25°C

This document contains information on a new product. Specifications and information herein are subject to change without notice.





MOTOROLA

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Output Zener Breakdown Voltage<br>(@ IT = 10 mA Pulse) | $V_{(BRout)}$<br>$V_{(–BRout)}$ | 6.4<br>— | 6.8<br>–0.7 | 7.2<br>— | V |
| Output Leakage Current @ 0 Input Voltage<br>($V_{out}$ = 5.5 Vdc, $V_{in}$ = O.C., $T_A$ = 25°C)<br>($V_{out}$ = 5.5 Vdc, $V_{in}$ = O.C., $T_A$ = 85°C) | $I_{OO}$ | <br>—<br>— | <br>—<br>— | <br>5.0<br>30 | μA |
| **ON CHARACTERISTICS** | | | | | |
| Input Bias Current @ $V_{in}$ = 4.0 Vdc<br>($I_O$ = 250 mA, $V_{out}$ = 0.4 Vdc, $T_A$ = –40°C)<br>(correlated to a measurement @ 25°C) | $I_{in}$ | — | 2.5 | — | mAdc |
| Output Saturation Voltage<br>($I_O$ = 250 mA, $V_{in}$ = 4.0 Vdc, $T_A$ = –40°C)<br>(correlated to a measurement @ 25°C) | | — | 0.2 | 0.4 | Vdc |
| Output Sink Current — Continuous<br>($T_A$ = –40°C, $V_{CE}$ = 0.4 Vdc, $V_{in}$ = 4.0 Vdc )<br>(correlated to a measurement @ 25°C) | $I_{C(on)}$ | 250 | — | — | mA |

**TYPICAL APPLICATION–DEPENDENT SWITCHING PERFORMANCE**

**SWITCHING CHARACTERISTICS**

| Characteristic | Symbol | $V_{CC}$ | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| Propagation Delay Times: | | | | | | ns |
| High to Low Propagation Delay; Figures 1, 2 (5.0 V 74HC04) | $t_{PHL}$ | 5.5 | — | 55 | — | |
| Low to High Propagation Delay; Figures 1, 2 (5.0 V 74HC04) | $t_{PLH}$ | 5.5 | — | 430 | — | |
| High to Low Propagation Delay; Figures 1, 3 (3.0 V 74HC04) | $t_{PHL}$ | 5.5 | — | 85 | — | |
| Low to High Propagation Delay; Figures 1, 3 (3.0 V 74HC04) | $t_{PLH}$ | 5.5 | — | 315 | — | |
| High to Low Propagation Delay; Figures 1, 4 (5.0 V 74LS04) | $t_{PHL}$ | 5.5 | — | 55 | — | |
| Low to High Propagation Delay; Figures 1, 4 (5.0 V 74LS04) | $t_{PLH}$ | 5.5 | — | 2385 | — | |
| Transition Times: | | | | | | ns |
| Fall Time; Figures 1, 2 (5.0 V 74HC04) | $t_f$ | 5.5 | — | 45 | — | |
| Rise Time; Figures 1, 2 (5.0 V 74HC04) | $t_r$ | 5.5 | — | 160 | — | |
| Fall Time; Figures 1, 3 (3.0 V 74HC04) | $t_f$ | 5.5 | — | 70 | — | |
| Rise Time; Figures 1, 3 (3.0 V 74HC04) | $t_r$ | 5.5 | — | 195 | — | |
| Fall Time; Figures 1, 4 (5.0 V 74LS04) | $t_f$ | 5.5 | — | 45 | — | |
| Rise Time; Figures 1, 4 (5.0 V 74LS04) | $t_r$ | 5.5 | — | 2400 | — | |
| Input Slew Rate(1) | ΔV/Δt in | 5.5 | TBD | — | — | V/ms |

1. Minimum input slew rate must be followed to avoid overdissipating the device.

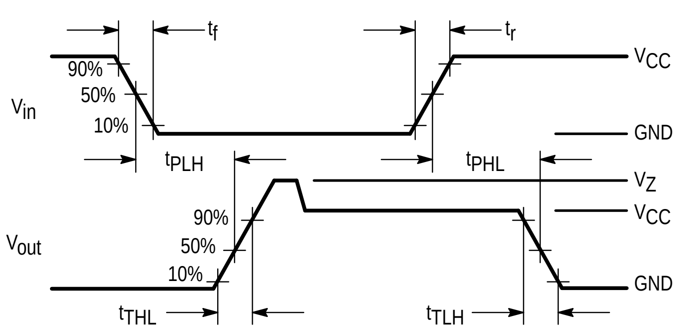



**Figure 1. Switching Waveforms**

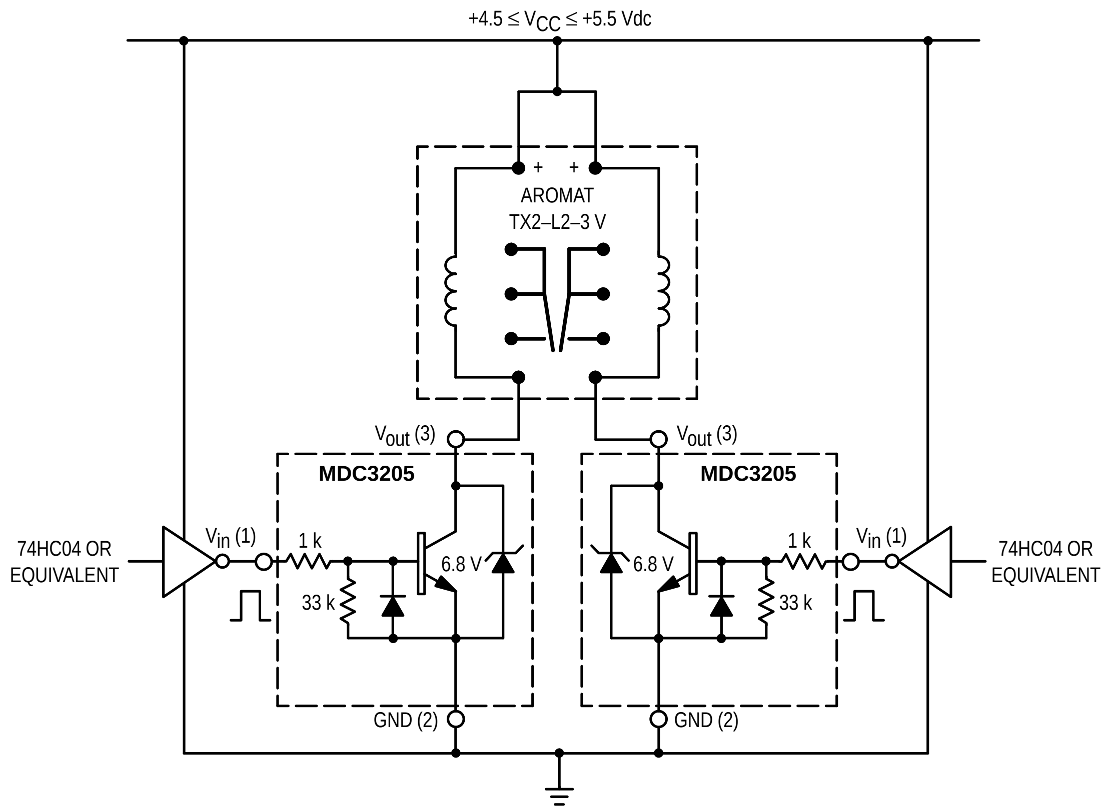



**Figure 2. A 3.0–V, 200–mW Dual Coil Latching Relay Application with 5.0 V–HCMOS Interface**

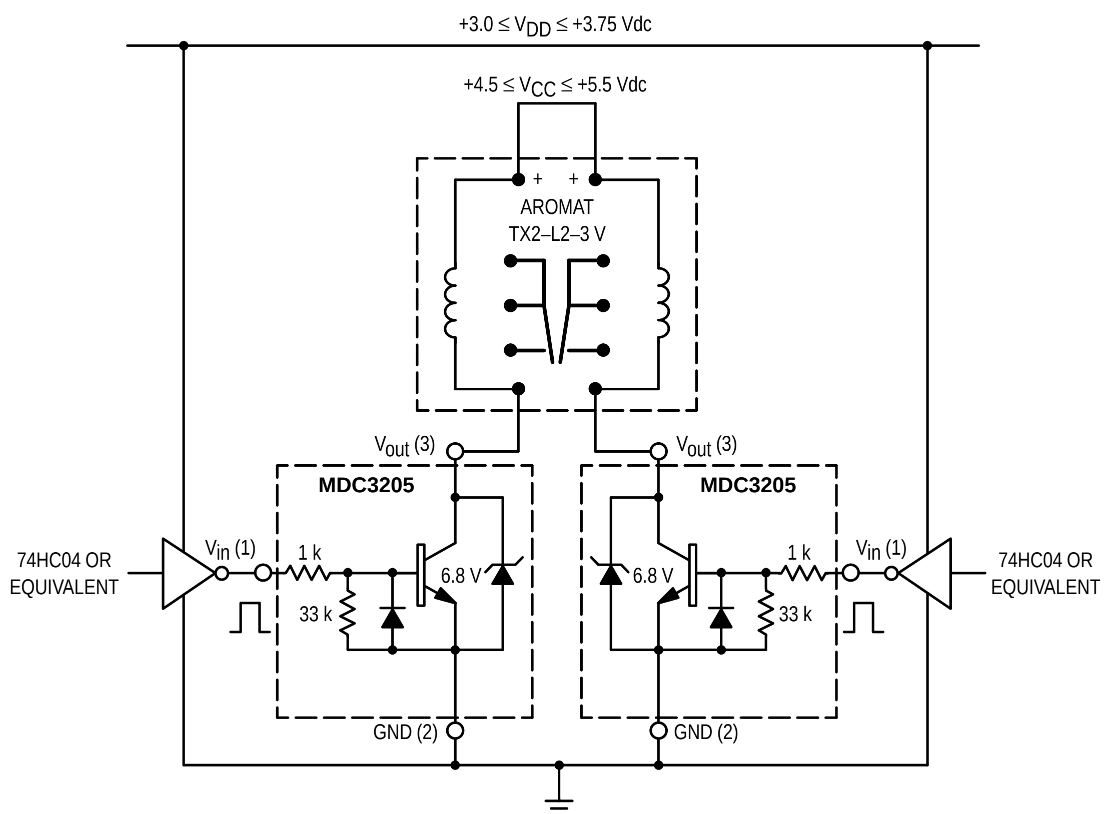



**Figure 3. A 3.0–V, 200–mW Dual Coil Latching Relay Application with 3.0 V–HCMOS Interface**

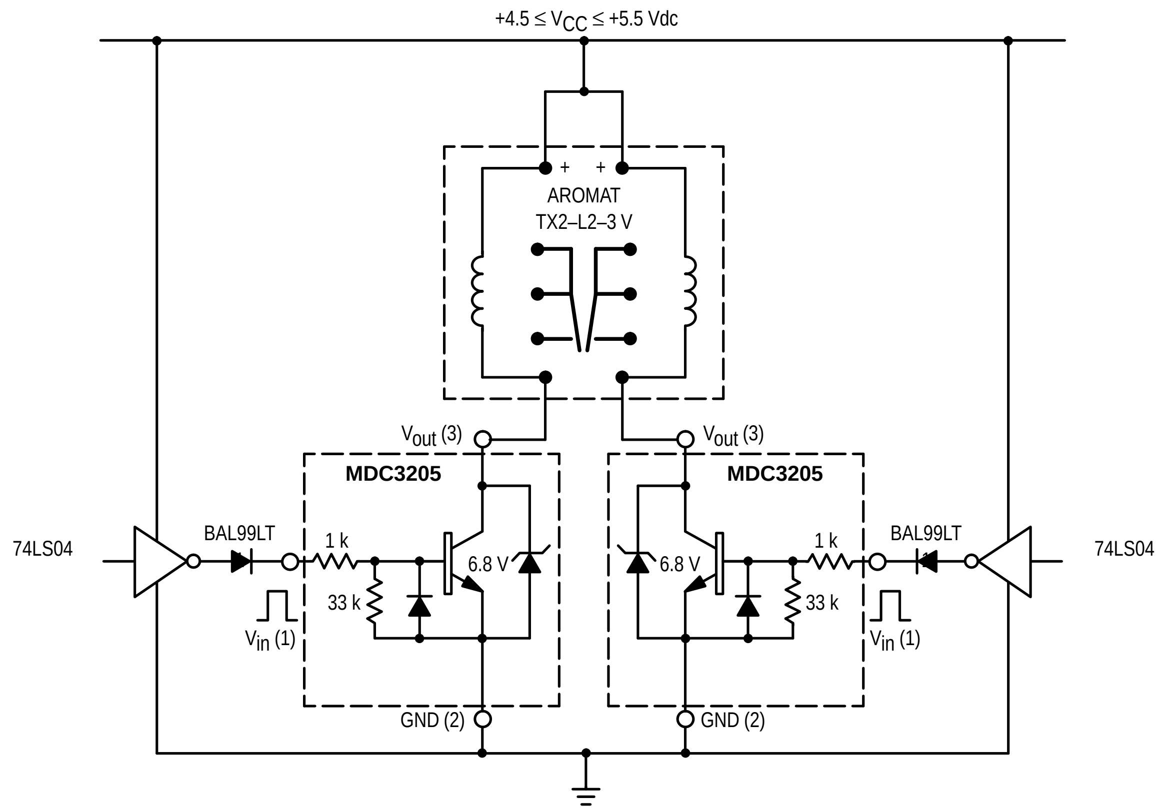
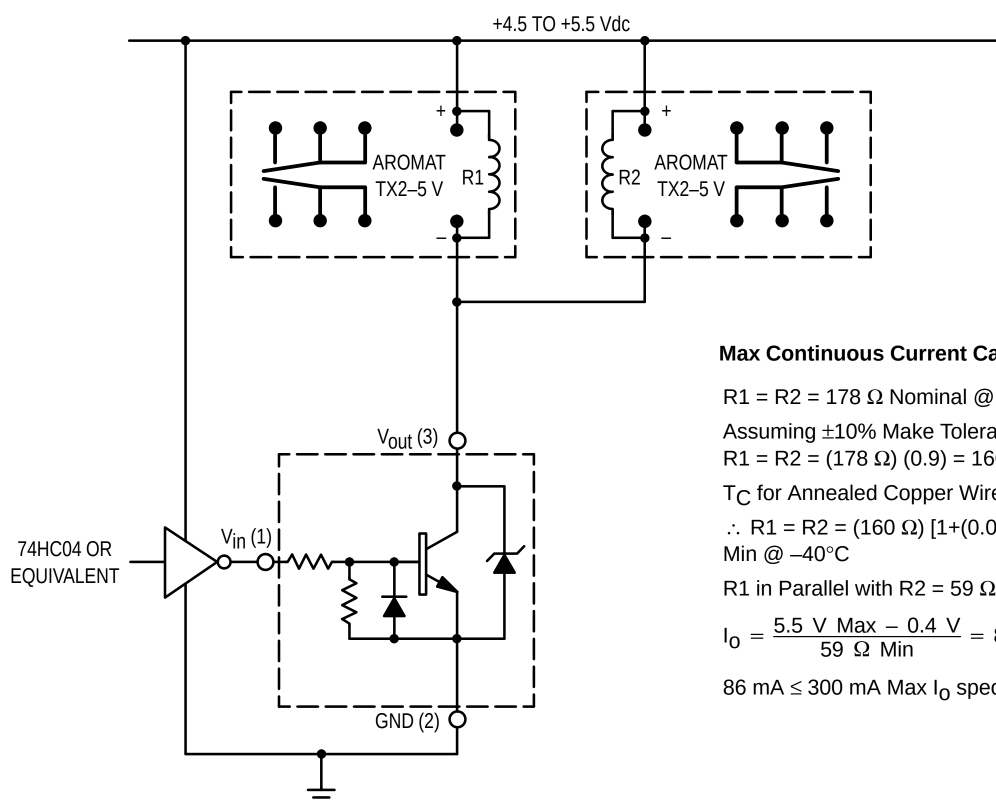



**Figure 4. A 3.0–V, 200–mW Dual Coil Latching Relay Application with TTL Interface**




**Max Continuous Current Calculation**

R1 = R2 = 178 Ω Nominal @ $T_A$ = 25°C

Assuming ±10% Make Tolerance,
R1 = R2 = (178 Ω) (0.9) = 160 Ω Min @ $T_A$ = 25°C

$T_C$ for Annealed Copper Wire is 0.4%/°C

∴ R1 = R2 = (160 Ω) [1+(0.004) (–40°–25°)] = 118 Ω Min @ –40°C

R1 in Parallel with R2 = 59 Ω Min @ –40°C

$$I_O = \frac{5.5\ \text{V Max} - 0.4\ \text{V}}{59\ \Omega\ \text{Min}} = 86\ \text{mA Max}$$

86 mA ≤ 300 mA Max $I_O$ spec.

**Figure 5. Typical 5.0 V, 140 mW Coil Dual Relay Application**

## TYPICAL OPERATING WAVEFORMS

(Circuit of Figure 5)

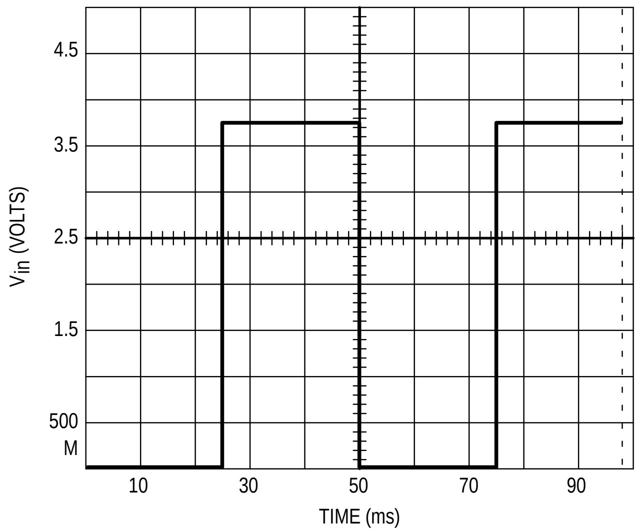



**Figure 6. 20 Hz Square Wave Input**

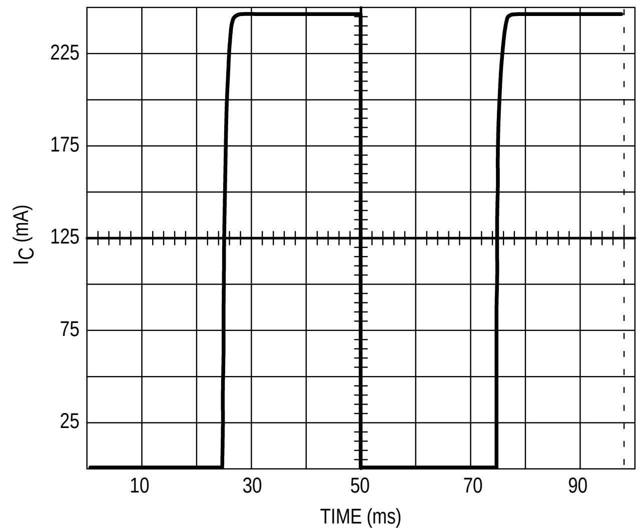



**Figure 7. 20 Hz Square Wave Response**

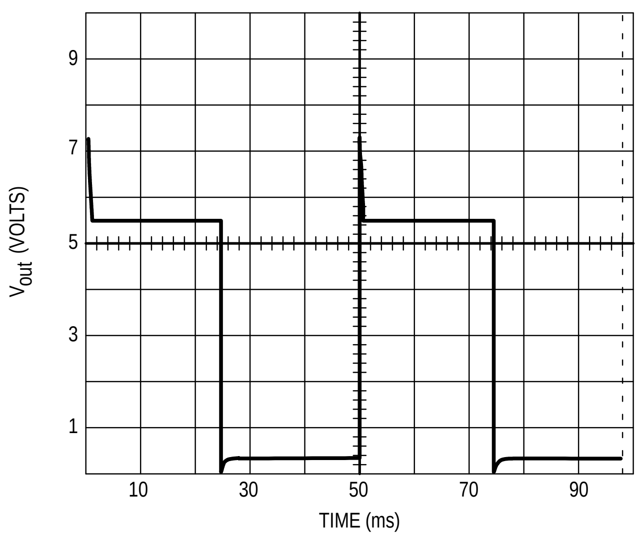



**Figure 8. 20 Hz Square Wave Response**

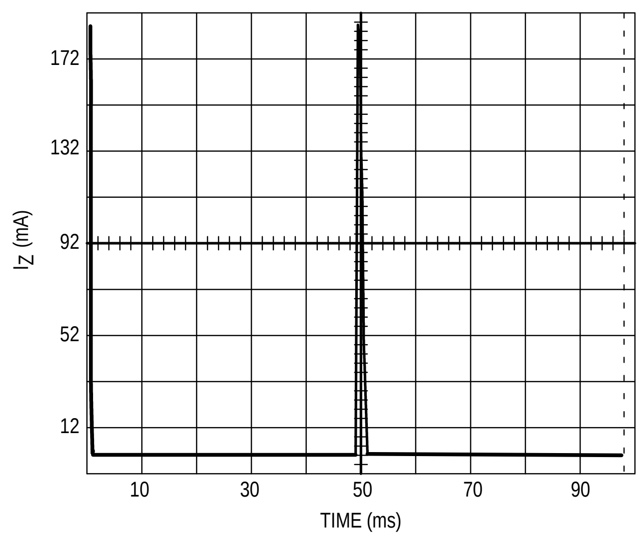



**Figure 9. 20 Hz Square Wave Response**

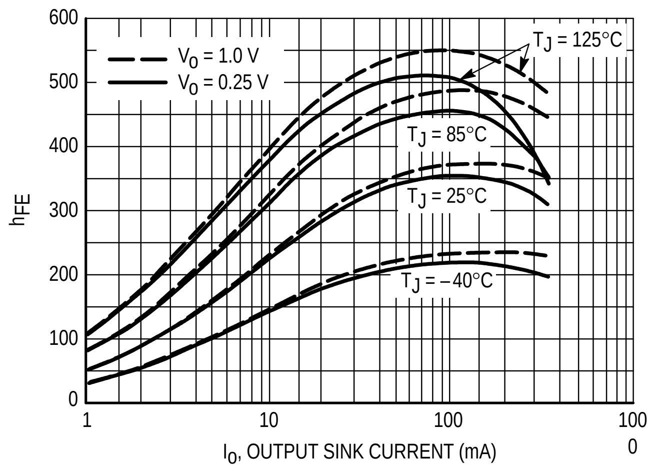



**Figure 10. Pulsed Current Gain**

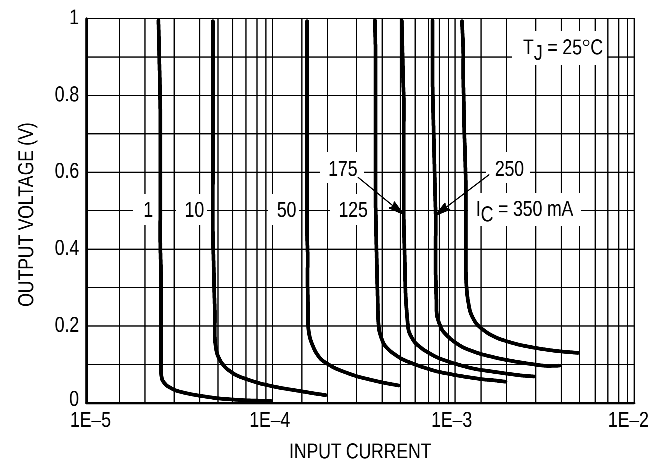
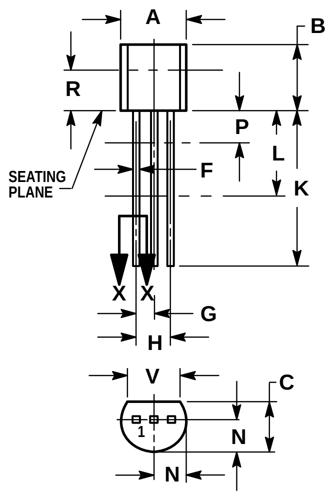
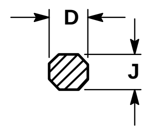



**Figure 11. Collector Saturation Region**

## PACKAGE DIMENSIONS




SECTION X–X

STYLE 14:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSION D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.175 | 0.205 | 4.45 | 5.20 |
| B | 0.170 | 0.210 | 4.32 | 5.33 |
| C | 0.125 | 0.165 | 3.18 | 4.19 |
| D | 0.016 | 0.022 | 0.41 | 0.55 |
| F | 0.016 | 0.019 | 0.41 | 0.48 |
| G | 0.045 | 0.055 | 1.15 | 1.39 |
| H | 0.095 | 0.105 | 2.42 | 2.66 |
| J | 0.015 | 0.020 | 0.39 | 0.50 |
| K | 0.500 | — | 12.70 | — |
| L | 0.250 | — | 6.35 | — |
| N | 0.080 | 0.105 | 2.04 | 2.66 |
| P | — | 0.100 | — | 2.54 |
| R | 0.115 | — | 2.93 | — |
| V | 0.135 | — | 3.43 | — |

**CASE 29–04**
**ISSUE AD**



**How to reach us:**
**USA / EUROPE / Locations Not Listed**: Motorola Literature Distribution; P.O. Box 5405, Denver, Colorado 80217. 303–675–2140 or 1–800–441–2447

**Mfax**™: RMFAX0@email.sps.mot.com – TOUCHTONE 602–244–6609
**INTERNET**: http://Design–NET.com

**JAPAN**: Nippon Motorola Ltd.; Tatsumi–SPD–JLDC, 6F Seibu–Butsuryu–Center, 3–14–2 Tatsumi Koto–Ku, Tokyo 135, Japan. 81–3–3521–8315

**ASIA / PACIFIC**: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park, 51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852–26629298