# High Speed Transistor Optocouplers

## Single Channel:
## HCPL0453, HCPL0500, HCPL0501
## Dual Channel:
## HCPL0531, HCPL0534

# HCPL0453, HCPL0500, HCPL0501, HCPL0531, HCPL0534

### Description

The HCPL05XX, and HCPL04XX optocouplers consist of an AlGaAs LED optically coupled to a high speed photo−detector transistor housed in a compact 8−pin small outline package.

A separate connection for the bias of the photodiode improves the speed by several orders of magnitude over conventional phototransistor optocouplers by reducing the base−collector capacitance of the input transistor. The HCPL04XX devices do not have the base bonded out to a lead for additional noise margin. The HCPL053X devices have two channels per package for optimum mounting density.

### Features

- High Speed − 1 MBit/s
- 15 kV/μs Minimum Commone Mode Transient Immunity at $V_{CM}$ = 1500 V (HCPL0453/0534)
- Open Collector Output
- Guaranteed Performance Over Temperature: 0°C to 70°C
- U.L. Recognized (File # E90700)
- VDE0884 Recognized (File # 136616)
  - Approval Pending for HCPL0531/0453
  - Ordering Option V, e.g., HCPL0500V
- BSI Recognized (File # 8661, 8662)
  - HCPL0500/0501 only

### Applications

- Line Receivers
- Pulse Transformer Replacement
- Output Interface to CMOS−LSTTL−TTL
- Wide Bandwidth Analog Coupling

**TRUTH TABLE** (Positive Logic)

| LED | $V_O$ |
|---|---|
| ON | LOW |
| OFF | HIGH |

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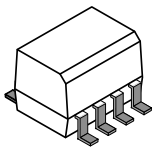

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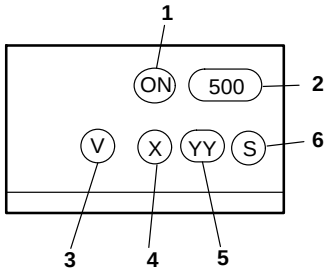
**CASE 751DZ**

### MARKING DIAGRAM




1. ON = ON Semiconductor Logo
2. 500 = Device Number
3. V = VDE mark indicates DIN EN/IEC60747−5−5 approval (Note: Only appears on parts ordered with VDE option – See Ordering Information Table)
4. X = One−Digit Year Code, e.g. ‘3’
5. YY = Two Digit Work Week Ranging from ‘01’ to ‘53’
6. S = Assembly Package Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

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## SCHEMATICS

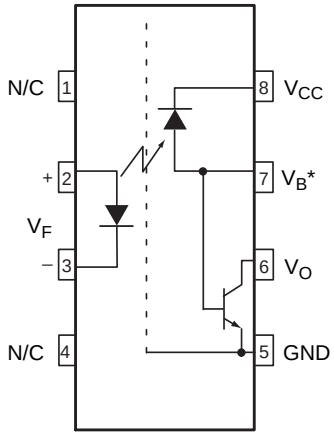



**Figure 1. Single−channel Circuit Schematics (HCPL0500, HCPL0501 *Base Not Connected for HCPL0453)**

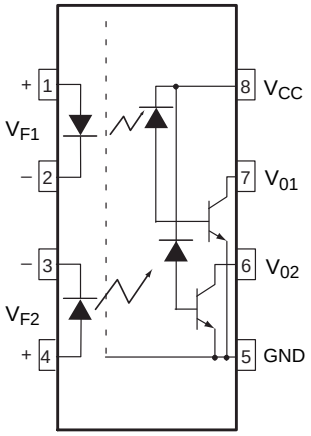



**Figure 2. Dual−channel Circuit Schematics (HCPL0531, HCPL0534)**

**ABSOLUTE MAXIMUM RATINGS** ($T_A$ = 25°C unless otherwise specified)

| Symbol | Parameter | Value | Units |
|---|---|---|---|
| $T_{STG}$ | Storage Temperature | −40 to +125 | °C |
| $T_{OPR}$ | Operating Temperature | −40 to +85 | °C |
| | Reflow Temperature Profile (Refer to page 7) | | |
| **EMITTER** | | | |
| $I_F$ (avg) | DC/Average Forward Input Current | 25 | mA |
| $I_F$ (pk) | Peak Forward Input Current (50% duty cycle, 1 ms P.W.) | 50 | mA |
| $I_F$ (trans) | Peak Transient Input Current (t ≤ 1 μs P.W., 300 pps) | 1.0 | A |
| $V_R$ | Reverse Input Voltage | 5.0 | V |
| $P_D$ | Input Power Dissipation | 45 | mW |
| **DETECTOR** | | | |
| $I_O$ (avg) | Average Output Current (Pin 6) | 8 | mA |
| $I_O$ (pk) | Peak Output Current | 16 | mA |
| $V_{EBR}$ | Emitter−Base Reverse Voltage (HCPL0500/0501 only) | 5 | V |
| $V_{CC}$ | Supply Voltage | −0.5 to 30 | V |
| $V_O$ | Output Voltage | −0.5 to 20 | V |
| $I_B$ | Base Current (HCPL0500/0501 only) | 5 | mA |
| $P_D$ | Output Power Dissipation | 100 | mW |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## ELECTRICAL CHARACTERISTICS ($T_A$ = 0°C to 70°C unless otherwise specified)

### INDIVIDUAL COMPONENT CHARACTERISTICS

| Symbol | Parameter | Test Conditions | Device | Min. | Typ.* | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **EMITTER** | | | | | | | |
| $V_F$ | Input Forward Voltage | $I_F$ = 16 mA, $T_A$ = 25°C | All | | 1.45 | 1.7 | V |
| | | $I_F$ = 16 mA | | | | 1.8 | |
| $BV_R$ | Input Reverse Breakdown Voltage | $I_R$ = 10 μA | All | 5.0 | | | V |
| $\Delta V_F / \Delta T_A$ | Temperature Coefficient of Forward Voltage | $I_F$ = 16 mA | All | | −1.6 | | mV/°C |
| **DETECTOR** | | | | | | | |
| $I_{OH}$ | Logic High Output Current | $I_F$ = 0 mA, $V_O$ = $V_{CC}$ = 5.5 V, $T_A$ = 25°C | All | | 0.001 | 0.5 | μA |
| | | $I_F$ = 0 mA, $V_O$ = $V_{CC}$ = 15 V, $T_A$ = 25°C | All | | 0.005 | 1 | |
| | | $I_F$ = 0 mA, $V_O$ = $V_{CC}$ = 15 V | All | | | 50 | |
| $I_{CCL}$ | Logic Low Supply Current | $I_F$ = 16 mA, $V_O$ = Open, $V_{CC}$ = 15 V | HCPL0453/ 0500/1 | | 120 | 200 | μA |
| | | | HCPL0531/4 | | | 400 | |
| $I_{CCH}$ | Logic High Supply Current | $I_F$ = 0 mA, $V_O$ = Open, $V_{CC}$ = 15 V, $T_A$ = 25°C | All | | 0.01 | 1 | μA |
| | | $I_F$ = 0 mA, $V_O$ = Open, $V_{CC}$ = 15 V | HCPL0453/ 0500/1 | | | 2 | |
| | | | HCPL0531/4 | | | 4 | |

### TRANSFER CHARACTERISTICS

| Symbol | Parameter | Test Conditions | Device | Min. | Typ.* | Max. | Unit |
|---|---|---|---|---|---|---|---|
| **COUPLED** | | | | | | | |
| CTR | Current Transfer Ratio (Note 1) | $I_F$ = 16 mA, $V_O$ = 0.4 V, $V_{CC}$ = 4.5 V, $T_A$ = 25°C | HCPL0500 | 7 | 27 | 50 | % |
| | | | HCPL0453 | 19 | 27 | 50 | |
| | | | HCPL0501/0531 | | | | |
| | | $I_F$ = 16 mA, $V_O$ = 0.5 V, $V_{CC}$ = 4.5 V | HCPL0500 | 5 | 30 | | |
| | | | HCPL0453 | 15 | 30 | | |
| | | | HCPL0501/0534 | | | | |
| $V_{OL}$ | Logic Low Output Voltage | $I_F$ = 16 mA, $I_O$ = 1.1 mA, $V_{CC}$ = 4.5 V, $T_A$ = 25°C | HCPL0500 | | 0.18 | 0.4 | V |
| | | $I_F$ = 16 mA, $I_O$ = 3 mA, $V_{CC}$ = 4.5 V, $T_A$ = 25°C | HCPL0453 | | 0.25 | 0.4 | |
| | | | HCPL0501/0531/4 | | | | |
| | | $I_F$ = 16 mA, $I_O$ = 0.8 mA, $V_{CC}$ = 4.5 V | HCPL0500 | | 0.13 | 0.5 | |
| | | $I_F$ = 16 mA, $I_O$ = 2.4 mA, $V_{CC}$ = 4.5 V | HCPL0453 | | 0.23 | 0.5 | |
| | | | HCPL0501/0531/4 | | | | |

*All typicals at $T_A$ = 25°C

## ELECTRICAL CHARACTERISTICS (CONTINUED) ($T_A$ = 0°C to 70°C unless otherwise specified)

### SWITCHING CHARACTERISTICS ($TV_{CC}$ = 5 V)

| Symbol | Parameter | Test Conditions | Device | Min. | Typ.* | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $T_{PHL}$ | Propagation Delay Time to Logic LOW | $T_A$ = 25°C, $R_L$ = 4.1 kΩ, $I_F$ = 16 mA (Note 2) (Fig. 9) | HCPL0500 | | 0.45 | 1.5 | μs |
| | | $R_L$ = 1.9 kΩ, $I_F$ = 16 mA, $T_A$ = 25°C (Note 3) (Fig. 9) | HCPL0453 | | 0.45 | 0.8 | |
| | | | HCPL0501/0531/4 | | | | |
| | | $R_L$ = 4.1 kΩ, $I_F$ = 16 mA (Note 2) (Fig. 9) | HCPL0500 | | | 2.0 | |
| | | $R_L$ = 1.9 kΩ, $I_F$ = 16 mA (Note 3) (Fig. 9) | HCPL0453 | | | 1.0 | |
| | | | HCPL0501/0531/4 | | | | |
| $T_{PLH}$ | Propagation Delay Time to Logic HIGH | $T_A$ = 25°C, $R_L$ = 4.1 kΩ, $I_F$ = 16 mA (Note 2) (Fig. 9) | HCPL0500 | | 0.5 | 1.5 | μs |
| | | $R_L$ = 1.9 kΩ, $I_F$ = 16 mA, $T_A$ = 25°C (Note 3) (Fig. 9) | HCPL0453 | | 0.3 | 0.8 | |
| | | | HCPL0501/0531/4 | | | | |
| | | $R_L$ = 4.1 kΩ, $I_F$ = 16 mA (Note 2) (Fig. 9) | HCPL0500 | | | 2.0 | |
| | | $R_L$ = 1.9 kΩ, $I_F$ = 16 mA (Note 3) (Fig. 9) | HCPL0453 | | | 1.0 | |
| | | | HCPL0501/0531/4 | | | | |
| $\|CM_H\|$ | Common Mode Transient Immunity at Logic HIGH | $I_F$ = 0 mA, $V_{CM}$ = 10 $V_{P-P}$, $R_L$ = 4.1 kΩ, $T_A$ = 25°C (Note 4) (Fig. 10) | HCPL0500 | 1,000 | 10,000 | | V/μs |
| | | $I_F$ = 0 mA, $V_{CM}$ = 10 $V_{P-P}$, $R_L$ = 1.9 kΩ $T_A$ = 25°C (Note 4) (Fig. 10) | HCPL0501/31 | 1,000 | 10,000 | | |
| | | | HCPL0534 | 15,000 | 40,000 | | |
| | | $I_F$ = 0 mA, $V_{CM}$ = 1500 $V_{P-P}$, $R_L$ = 1.9 kΩ, $T_A$ = 25°C (Note 4) (Fig. 10) | HCPL0453 | 15,000 | 40,000 | | |
| $\|CM_L\|$ | Common Mode Transient Immunity at Logic LOW | $I_F$ = 16 mA, $V_{CM}$ = 10 $V_{P-P}$, $R_L$ = 4.1 kΩ, $T_A$ = 25°C (Note 4) (Fig. 10) | HCPL0500 | 1,000 | 10,000 | | V/μs |
| | | $I_F$ = 16 mA, $V_{CM}$ = 10 $V_{P-P}$, $R_L$ = 1.9 kΩ (Note 4) (Fig. 10) | HCPL0501/31 | 1,000 | 10,000 | | |
| | | | HCPL0534 | 15,000 | 40,000 | | |
| | | $I_F$ = 16 mA, $T_A$ = 25°C, $V_{CM}$ = 1500 $V_{P-P}$, $R_L$ = 1.9 kΩ (Note 4) (Fig. 10) | HCPL0453 | 15,000 | 40,000 | | |

### ISOLATION CHARACTERISTICS

| Symbol | Characteristics | Test Conditions | Min. | Typ.* | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{ISO}$ | Input−Output Isolation Voltage | f = 60 Hz, t = 1.0 min., $I_{I-O} \le 2$ μA (Notes 5, 6) | 2500 | | | $Vac_{RMS}$ |
| $R_{ISO}$ | Isolation Resistance | $V_{I-O}$ = 500V (Note 5) | $10^{11}$ | | | |
| $C_{ISO}$ | Isolation Capacitance | $V_{I-O}$ = 0 V, f = 1.0MHz (Note 5) | | 0.2 | | pF |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

*All typicals at $T_A$ = 25°C

1. Current Transfer Ratio is designed as a ratio of output collector current, $I_O$, to the forward LED input current, $I_F$, times 100%.
2. The 4.1 kΩ load represents 1 LSTTL unit load of 0.36 mA and 6.1 kΩ pull−up resistor.
3. The 1.9 kΩ load represents 1 TTL unit load of 1.6 mA and 5.6 kΩ pull−up resistor.
4. Common mode transient immunity in logic high level is the maximum tolerable (positive) $dV_{cm}/dt$ on the leading edge of the common mode pulse signal $V_{CM}$, to assure that the output will remain in a logic high state (i.e., $V_O$ > 2.0 V). Common mode transient immunity in logic low level is the maximum tolerable (negative) $dV_{cm}/dt$ on the trailing edge of the common mode pulse signal, $V_{CM}$, to assure that the output will remain in a logic low state (i.e., $V_O$ < 0.8 V).
5. Device is considered a two terminal device: Pins 1, 2, 3 and 4 are shorted together and Pins 5, 6, 7 and 8 are shorted together.
6. 2500 VAC RMS for 1 minute duration is equivalent to 3000 VAC RMS for 1 second duration.

## TYPICAL PERFORMANCE CURVES

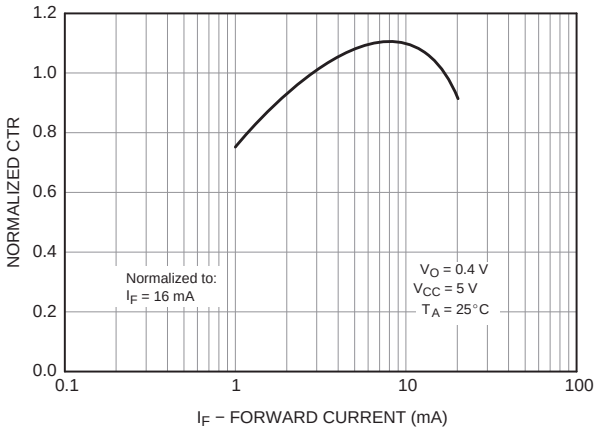



**Figure 3. Normalized CTR vs. Forward Current**

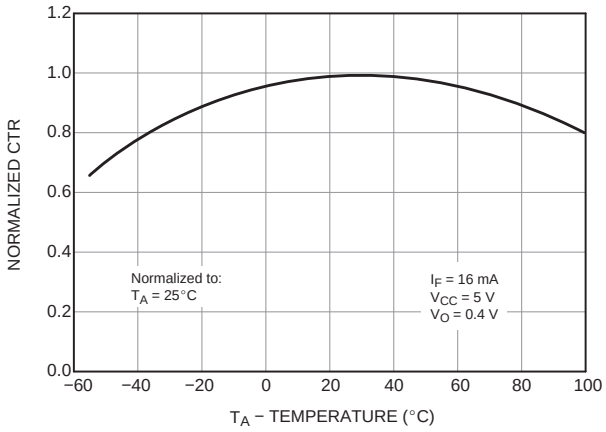



**Figure 4. Normalized CTR vs. Temperature**

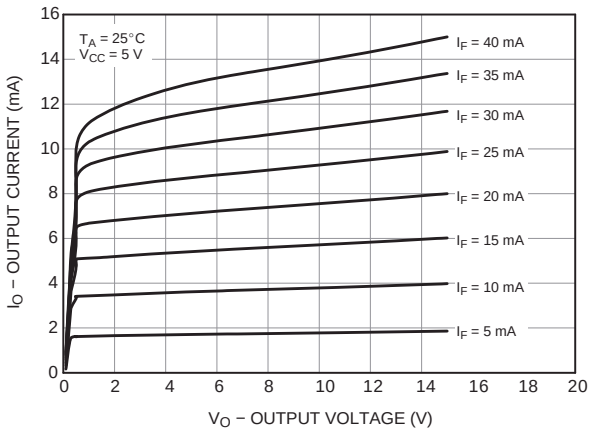



**Figure 5. Output Current vs. Output Voltage**

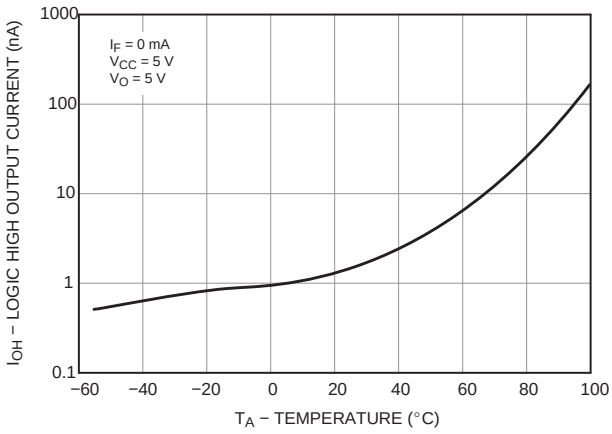



**Figure 6. Logic High Output Current vs. Temperature**

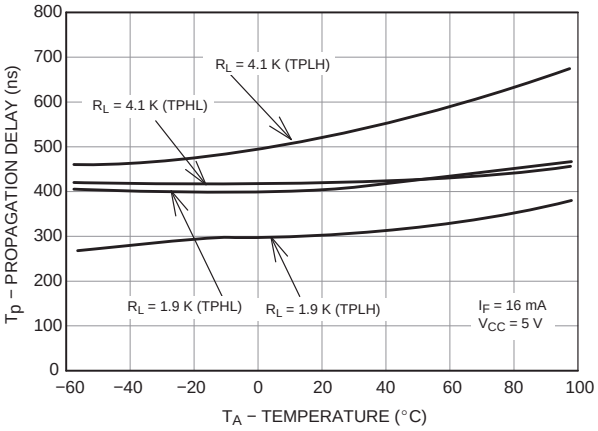



**Figure 7. Propagation Delay vs. Temperature**

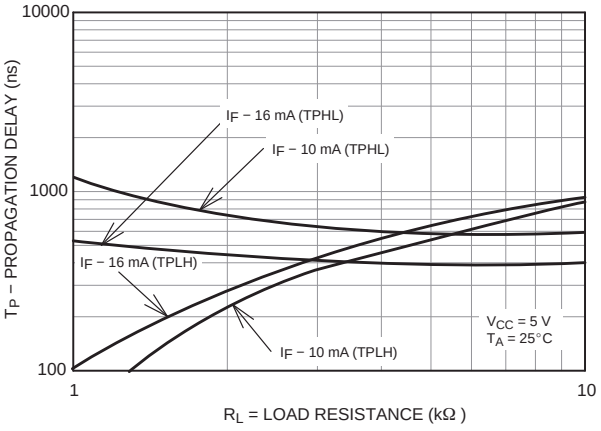
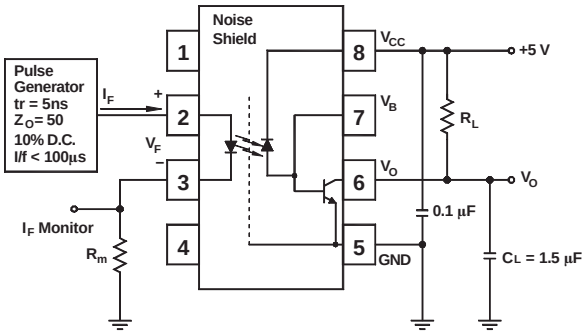
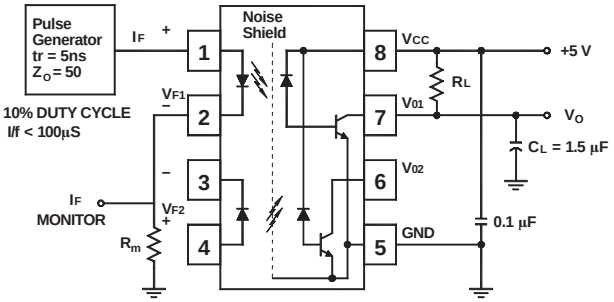



**Figure 8. Propagation Delay vs. Load Resistance**




Test Circuit for HCPL0453, HCPL0500 and HCPL0501




Test Circuit for HCPL0531 and HCPL0534

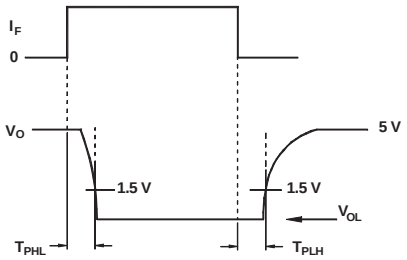
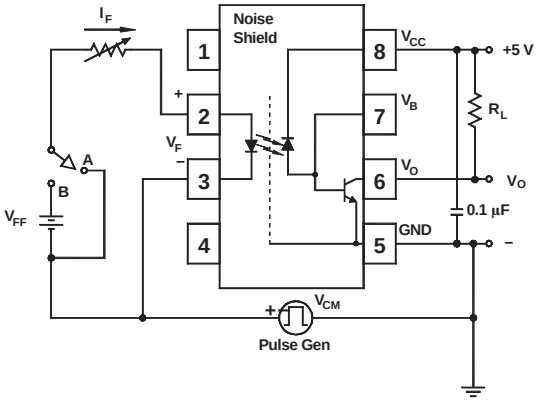
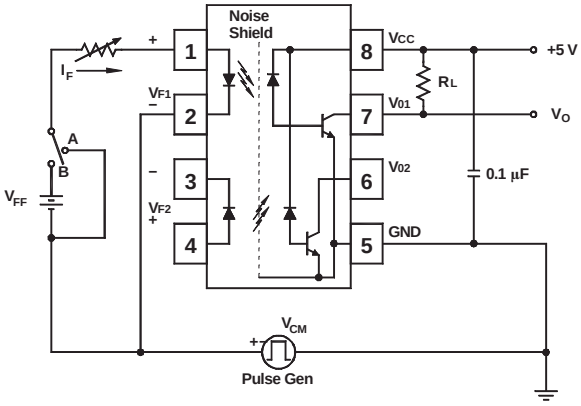



**Figure 9. Switching Time Test Circuit**




Test Circuit for HCPL0453, HCPL0500 and HCPL0501




Test Circuit for HCPL0531 and HCPL0534

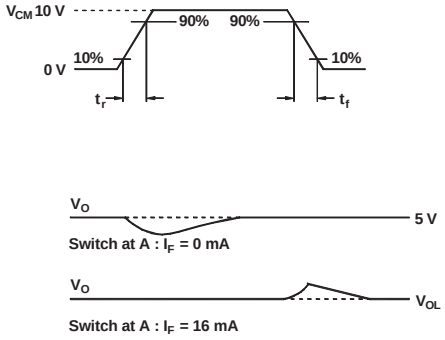



**Figure 10. Common Mode Immunity Test Circuit**

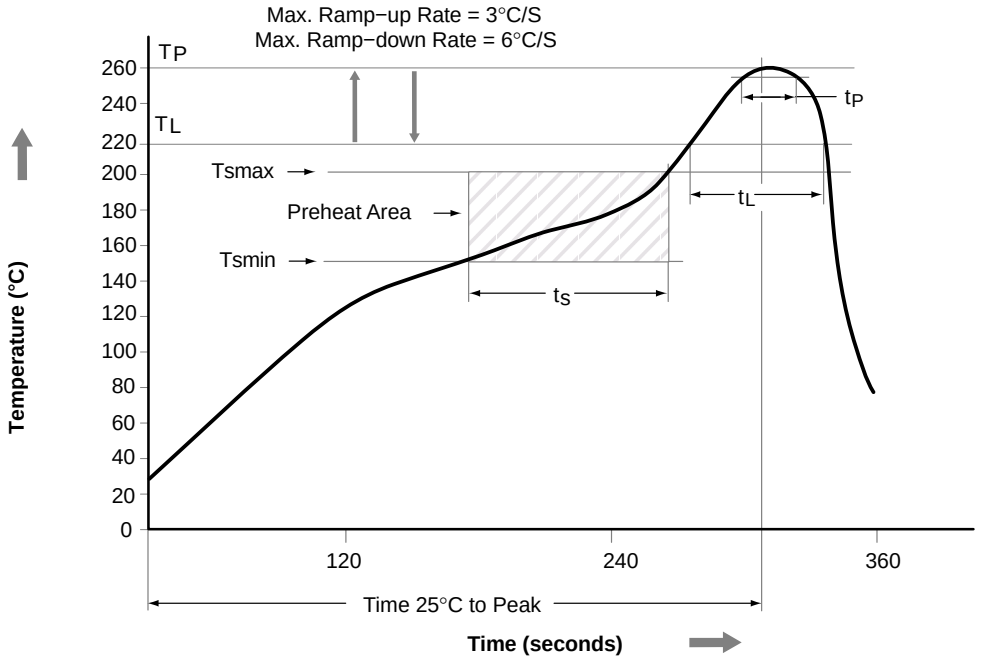
## ORDERING INFORMATION

| Part Nr./ Option (Note 7) | Order Entry Identifier | Package | Description | Packing Method† |
|---|---|---|---|---|
| HCPL0xxx**V** | V | SOIC8 | VDE 0884 (approval pending for HCPL0531 & HCPL0534) | Tube (3000 Units) |
| HCPL0xxx**R2** | R2 | SOIC8 | | Tape and Reel (2500 Units) |
| HCPL0xxx**R2V** | R2V | SOIC8 | VDE 0884 (approval pending for HCPL0531 & HCPL0534) | Tape and Reel (2500 Units) |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

7. The product orderable part number system listed in this table also applies to the HCPL0453, HCPL0500, HCPL0501, HCPL0531 and HCPL0534 product.

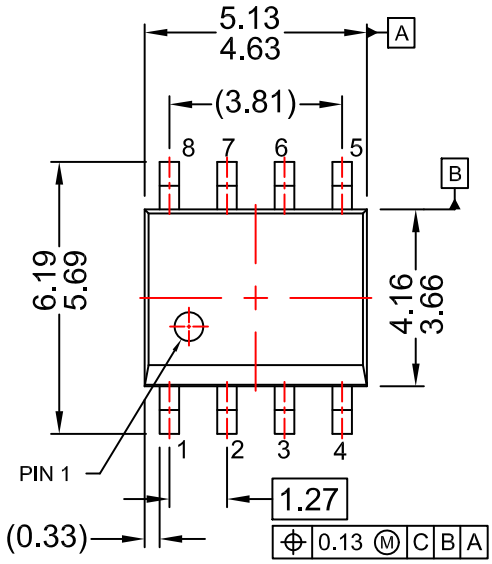
## REFLOW PROFILE

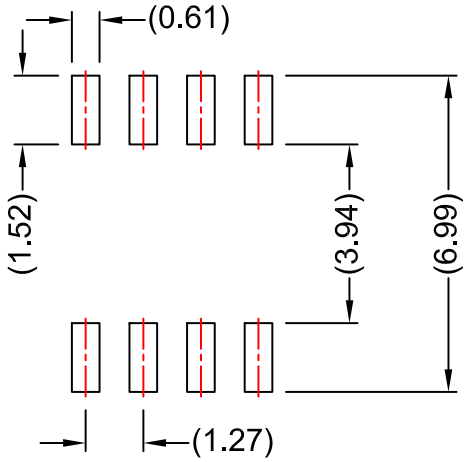



| Profile Freature | Pb−Free Assembly Profile |
|---|---|
| Temperature Min. (Tsmin) | 150°C |
| Temperature Max. (Tsmax) | 200°C |
| Time ($t_S$) from (Tsmin to Tsmax) | 60–120 seconds |
| Ramp−up Rate ($t_L$ to $t_P$) | 3°C/second max. |
| Liquidous Temperature ($T_L$) | 217°C |
| Time ($t_L$) Maintained Above ($T_L$) | 60–150 seconds |
| Peak Body Package Temperature | 260°C +0°C / –5°C |
| Time ($t_P$) within 5°C of 260°C | 30 seconds |
| Ramp−down Rate ($T_P$ to $T_L$) | 6°C/second max. |
| Time 25°C to Peak Temperature | 8 minutes max. |

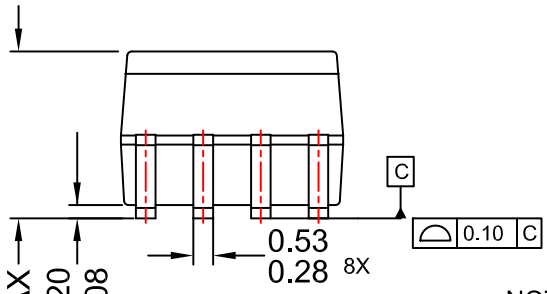
**SOIC8**
CASE 751DZ
ISSUE O

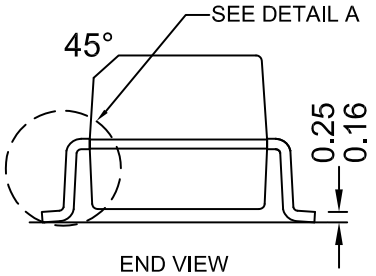
DATE 30 SEP 2016



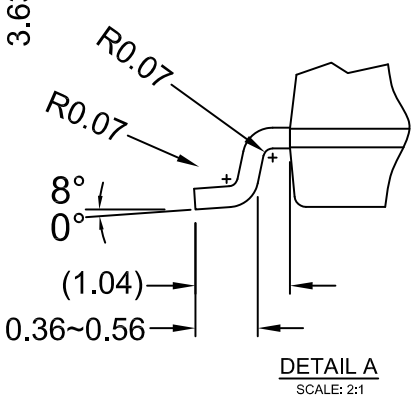




LAND PATTERN RECOMMENDATION




END VIEW




DETAIL A
SCALE: 2:1

NOTES:

A) NO STANDARD APPLIES TO THIS PACKAGE
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DIMENSIONS DO NOT INCLUDE MOLD FLASH OR BURRS.
D) LANDPATTERN STANDARD: SOIC127P600X175-8M.

| | | | |
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