

AC/DC to Logic Interface Optocoupler

HCPL3700M

Description

The HCPL3700M voltage/current threshold detection optocoupler consists of an AlGaAs LED connected to a threshold sensing input buffer IC which are optically coupled to a high gain darlington output. The input buffer chip is capable of controlling threshold levels over a wide range of input voltages with a single resistor. The output is TTL and CMOS compatible.

Features

- AC or DC Input
- Programmable Sense Voltage
- Logic Level Compatibility
- Threshold Guaranteed Over Temperature (0°C to 70°C)
- Safety and Regulatory Approvals
 - ◆ UL1577, 5,000 VAC_{RMS} for 1 Minute
 - ◆ DIN EN/IEC60747-5-5
- These are Pb-Free Devices

Applications

- Low Voltage Detection
- 5 V to 240 V AC/DC Voltage Sensing
- Relay Contact Monitor
- Current Sensing
- Microprocessor Interface
- Industrial Controls

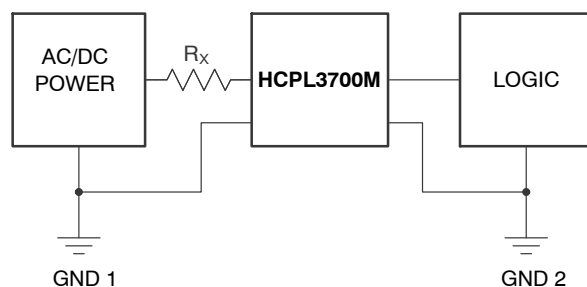
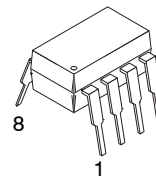
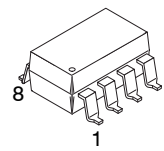


Figure 1. Schematic

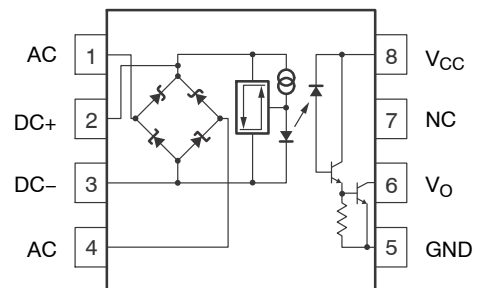


PDIP8 9.655x6.6, 2.54P
CASE 646CQ



PDIP8 GW
CASE 709AC

ELECTRICAL CONNECTION



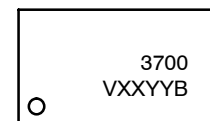
TRUTH TABLE

(Positive Logic)

| Input | Output |
|-------|--------|
| H | L |
| L | H |

A 0.1 μ F bypass capacitor must be connected between pins 8 and 5.

MARKING DIAGRAM



- 3700 = Device Number
 V = DIN EN/IEC60747-5-5 Option
 (only appears on component ordered with this option)
 XX = Two-Digit Year Code
 YY = Two-Digit Work Week
 B = Assembly Package Code

ORDERING INFORMATION

See detailed ordering and shipping information on page 10 of this data sheet.

HCPL3700M

SAFETY AND INSULATION RATINGS (As per DIN EN/IEC 60747-5-5, this optocoupler is suitable for “safe electrical insulation” only within the safety limit data. Compliance with the safety ratings shall be ensured by means of protective circuits.)

| Parameter | | Characteristics |
|---|-------------------------------------|-----------------|
| Installation Classifications per DIN VDE 0110/1.89 Table 1, For Rated Mains Voltage | < 150 V _{RMS} | I–IV |
| | < 300 V _{RMS} | I–IV |
| | < 450 V _{RMS} | I–III |
| | < 600 V _{RMS} | I–III |
| | < 1000 V _{RMS} (Option TV) | I–III |
| Climatic Classification | | 40/85/21 |
| Pollution Degree (DIN VDE 0110/1.89) | | 2 |
| Comparative Tracking Index | | 175 |

| Symbol | Parameter | Value | Unit |
|-----------------------|--|-------------------|-------------------|
| V _{PR} | Input-to-Output Test Voltage, Method A, V _{IORM} × 1.6 = V _{PR} , Type and Sample Test with t _m = 10 s, Partial Discharge < 5 pC | 2,262 | V _{peak} |
| | Input-to-Output Test Voltage, Method B, V _{IORM} × 1.875 = V _{PR} , 100% Production Test with t _m = 1 s, Partial Discharge < 5 pC | 2,651 | V _{peak} |
| V _{IORM} | Maximum Working Insulation Voltage | 1,414 | V _{peak} |
| V _{IOTM} | Highest Allowable Over-Voltage | 6,000 | V _{peak} |
| | External Creepage | ≥ 8.0 | mm |
| | External Clearance | ≥ 7.4 | mm |
| | External Clearance (for Option TV, 0.4" Lead Spacing) | ≥ 10.16 | mm |
| DTI | Distance Through Insulation (Insulation Thickness) | ≥ 0.5 | mm |
| T _S | Case Temperature (Note 1) | 150 | °C |
| I _{S,INPUT} | Input Current (Note 1) | 25 | mA |
| P _{S,OUTPUT} | Output Power (Duty Factor ≤ 2.7%) (Note 1) | 250 | mW |
| R _{IO} | Insulation Resistance at T _S , V _{IO} = 500 V (Note 1) | > 10 ⁹ | Ω |

1. Safety limit value – maximum values allowed in the event of a failure.

HCPL3700M

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 |
| T _J | Junction Temperature | –40 to +125 | °C |
| T _{SOL} | Lead Solder Temperature | 260 for 10 s | °C |
| P _T | Total Package Power Dissipation (Note 2) | 305 | mW |

EMITTER

| | | | | |
|-----------------|----------------------------------|-------------------------------------|------|----|
| I _{IN} | Input Current | Average | 50 | mA |
| | | Surge, 3 ms, 120 Hz Pulse Rate | 140 | |
| | | Transient, 10 μs, 120 Hz Pulse Rate | 500 | |
| V _{IN} | Input Voltage (Pins 2–3) | | –0.5 | V |
| P _{IN} | Input Power Dissipation (Note 3) | | 230 | mW |

DETECTOR

| | | | | |
|-----------------|-----------------------------------|--|------------|----|
| I _O | Output Current (Average) (Note 4) | | 30 | mA |
| V _{CC} | Supply Voltage (Pins 8–5) | | –0.5 to 20 | V |
| V _O | Output Voltage (Pins 6–5) | | –0.5 to 20 | V |
| P _O | Output Power Dissipation (Note 5) | | 210 | 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.

- Derate linearly above 70°C free-air temperature at a rate of 2.5 mW/°C.
- Derate linearly above 70°C free-air temperature at a rate of 1.8 mW/°C.
- Derate linearly above 70°C free-air temperature at a rate of 0.6 mA/°C.
- Derate linearly above 70°C free-air temperature at a rate of 1.9 mW/°C.

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Min | Max | Unit |
|-----------------|-------------------------------|-----|-----|------|
| V _{CC} | Supply Voltage | 2 | 18 | V |
| T _A | Ambient Operating Temperature | 0 | 70 | °C |
| f | Operating Frequency | 0 | 4 | kHz |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

HCPL3700M

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

| Symbol | Parameter | | Test Conditions | Min. | Typ. | Max. | Unit |
|-------------------|------------------------------|----------------|--|------|-------|------|------|
| I _{TH+} | Input Threshold Current | | V _{IN} = V _{TH+} , V _{CC} = 4.5 V | 1.96 | 2.40 | 3.11 | mA |
| I _{TH-} | | | V _O = 0.4 V, I _O ≥ 4.2 mA (Note 6) | 1.00 | 1.20 | 1.62 | |
| V _{TH+} | Input Threshold Voltage | DC (Pins 2, 3) | V _{IN} = V ₂ – V ₃ (Pins 1 & 4 Open) V _{CC} = 4.5 V, V _O = 0.4 V (Note 6) I _O ≥ 4.2 mA | 3.35 | 3.80 | 4.05 | V |
| V _{TH-} | | | V _{IN} = V ₂ – V ₃ (Pins 1 & 4 Open) V _{CC} = 4.5 V, V _O = 2.4 V (Note 6) I _O ≥ 100 μA | 2.01 | 2.50 | 2.86 | V |
| V _{TH+} | | AC (Pins 1, 4) | V _{IN} = V ₁ – V ₄ (Pins 2 & 3 Open) V _{CC} = 4.5 V, V _O = 0.4 V (Note 6) I _O ≥ 4.2 mA | 4.23 | 5.00 | 5.50 | V |
| V _{TH-} | | | V _{IN} = V ₁ – V ₄ (Pins 2 & 3 Open) V _{CC} = 4.5 V, V _O = 2.4 V (Note 6) I _O ≤ 100 μA | 2.87 | 3.70 | 4.20 | V |
| I _{HYS} | Hysteresis | | I _{HYS} = I _{TH+} – I _{TH-} | – | 1.2 | | mA |
| V _{HYS} | | | V _{HYS} = V _{TH+} – V _{TH-} | – | 1.3 | | |
| V _{IHC1} | Input Clamp Voltage | | V _{IHC1} = V ₂ – V ₃ , V ₃ = GND I _{IN} = 10 mA Pins 1 & 4 Connected to PIN 3 | 5.4 | 6.3 | 6.6 | V |
| V _{IHC2} | | | V _{IHC2} = V ₁ – V ₄ , I _{IN} = 10 mA (Pins 2 & 3 Open) | 6.1 | 7.0 | 7.3 | V |
| V _{IHC3} | | | V _{IHC3} = V ₂ – V ₃ , V ₃ = GND I _{IN} = 15 mA (Pins 1 & 4 Open) | – | 12.5 | 13.4 | V |
| V _{ILC} | | | V _{ILC} = V ₂ – V ₃ , V ₃ = GND I _{IN} = –10 mA | – | –0.75 | – | V |
| I _{IN} | Input Current | | V _{IN} = V ₂ – V ₃ = 5.0 V (Pins 1 & 4 Open) | 3.0 | 3.7 | 4.4 | mA |
| V _{D1,2} | Bridge Diode Forward Voltage | | I _{IN} = 3 mA | – | 0.65 | | V |
| V _{D3,4} | | | I _{IN} = 3 mA | – | 0.65 | | V |
| V _{OL} | Logic LOW Output Voltage | | V _{CC} = 4.5 V, I _{OL} = 4.2 mA (Note 6) | – | 0.04 | 0.4 | V |
| I _{OH} | Logic HIGH Output Current | | V _{OH} = V _{CC} = 18 V (Note 6) | – | – | 100 | μA |
| I _{CCL} | Logic LOW Supply Current | | V ₂ – V ₃ = 5.0 V V _O = Open V _{CC} = 5 V | – | 1.0 | 4 | mA |
| I _{CCH} | Logic HIGH Supply Current | | V _{CC} = 18 V, V _O = Open | – | 0.01 | 4 | μA |
| C _{IN} | Input Capacitance | | f = 1 mHz, V _{IN} = 0 V (Pins 2 & 3, Pins 1 & 4 Open) | – | 50 | | 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.

6. Logic LOW output level at pin 6 occurs when V_{IN} ≥ V_{TH+} and when V_{IN} > V_{TH-} once V_{IN} exceeds V_{TH+}.

Logic HIGH output level at pin 6 occurs when V_{IN} ≤ V_{TH-} and when V_{IN} < V_{TH+} once decreases below V_{TH-}.

HCPL3700M

SWITCHING CHARACTERISTICS ($T_A = 25^\circ\text{C}$, $V_{CC} = 5\text{ V}$ unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|-----------|---|--|------|------|------|------------------------|
| t_{PHL} | Propagation Delay Time (to Output Low Level) | $R_L = 4.7\text{ k}\Omega$, $C_L = 30\text{ pF}$ (Note 7) | | 6.0 | 15 | μs |
| t_{PLH} | Propagation Delay Time (to Output High Level) | $R_L = 4.7\text{ k}\Omega$, $C_L = 30\text{ pF}$ (Note 7) | | 25.0 | 40 | μs |
| t_R | Output Rise Time (10%–90%) | $R_L = 4.7\text{ k}\Omega$, $C_L = 30\text{ pF}$ | | 45 | | μs |
| t_F | Output Fall Time (90%–10%) | $R_L = 4.7\text{ k}\Omega$, $C_L = 30\text{ pF}$ | | 0.5 | | μs |
| ICM_H | Common Mode Transient Immunity (at Output High Level) | $I_{IN} = 0\text{ mA}$, $R_L = 4.7\text{ k}\Omega$, $V_{Omin} = 2.0\text{ V}$, $V_{CM} = 1400\text{ V}$ (Notes 8, 9) | | 4000 | | $\text{V}/\mu\text{s}$ |
| ICM_L | Common Mode Transient Immunity (at Output Low Level) | $I_{IN} = 3.11\text{ mA}$, $R_L = 4.7\text{ k}\Omega$, $V_{Omax} = 0.8\text{ V}$, $V_{CM} = 1400\text{ V}$ (Notes 8, 9) | | 600 | | $\text{V}/\mu\text{s}$ |

ISOLATION CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Units |
|-----------|-------------------------------|---|-------|-----------|------|--------------------|
| V_{ISO} | Withstand Isolation Voltage | $RH \leq 50\%$, $I_{I-O} \leq 10\text{ }\mu\text{A}$, $t = 1\text{ min}$, $f = 50\text{ Hz}$ (Note 10, 11) | 5,000 | – | – | VAC_{RMS} |
| R_{I-O} | Resistance (Input to Output) | $V_{IO} = 500\text{ V}_{DC}$ (Note 10) | – | 10^{12} | – | Ω |
| C_{I-O} | Capacitance (Input to Output) | $f = 1\text{ MHz}$, $V_{IO} = 0\text{ V}_{DC}$ | – | 0.6 | – | pF |

7. T_{PHL} propagation delay is measured from the 2.5 V level of the leading edge of a 5.0 V input pulse (1 μs rise time) to the 1.5 V level on the leading edge of the output pulse. T_{PLH} propagation delay is measured on the trailing edges of the input and output pulse. (Refer to Fig. 10)
8. 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., $V_O > 2.0\text{ V}$). 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., $V_O < 0.8\text{ V}$). Refer to Fig. 11.
9. In applications where dV_{cm}/dt may exceed 50,000 $\text{V}/\mu\text{s}$ (Such as static discharge), a series resistor, R_{CC} , should be included to protect the detector chip from destructive surge currents. The recommended value for R_{CC} is 240 Ω per volt of allowable drop in V_{CC} (between pin 8 and V_{CC}) with a minimum value of 240 Ω .
10. 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.
11. The 5000 $\text{VAC}_{RMS}/1\text{ min.}$ capability is validated by a 6000 $\text{VAC}_{RMS}/1\text{ sec.}$ dielectric voltage withstand test.

TYPICAL PERFORMANCE CURVES

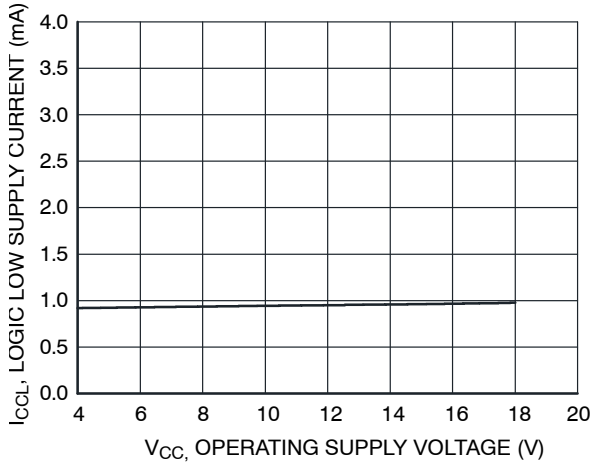


Figure 2. Logic Low Supply Current vs. Operating Supply Voltage

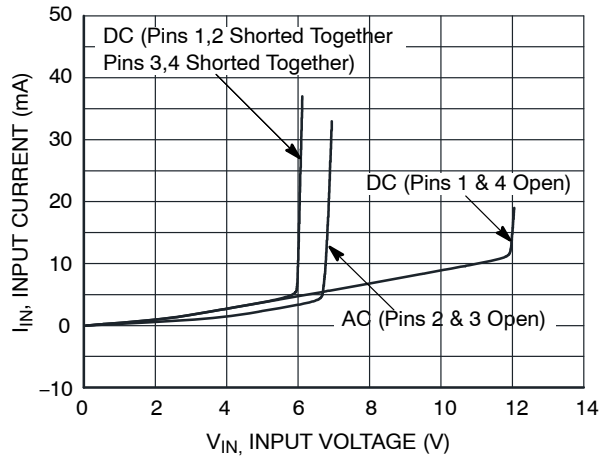


Figure 3. Input Current vs. Input Voltage

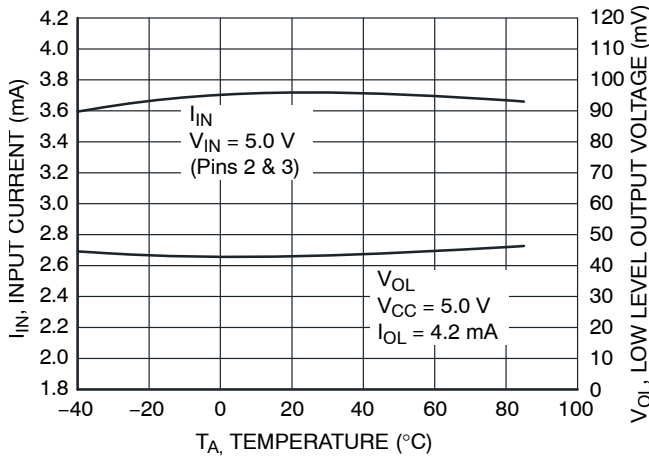


Figure 4. Input Current/Low Level Output Voltage vs. Temperature

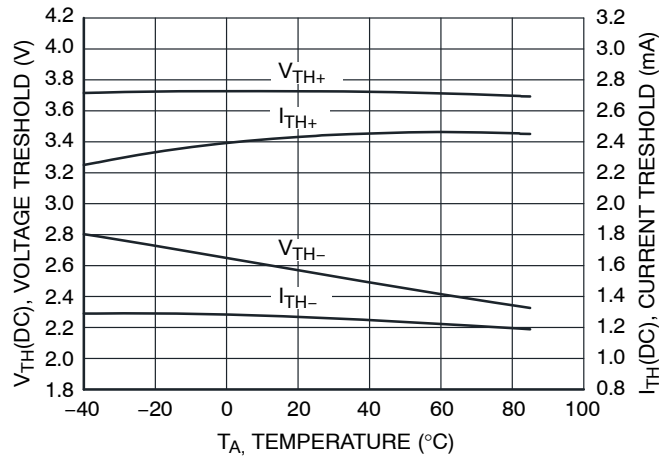


Figure 5. Current Threshold/Voltage Threshold vs. Temperature

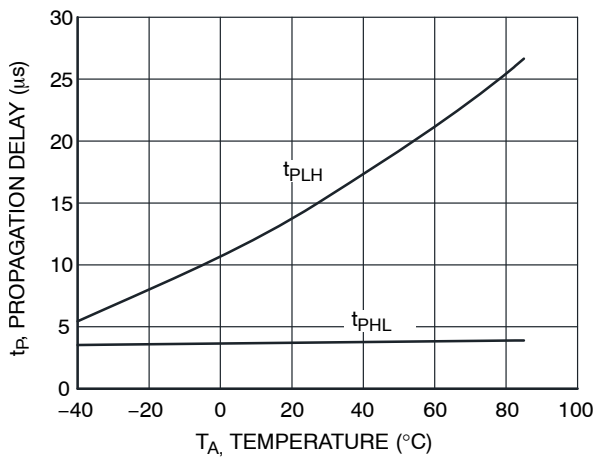


Figure 6. Propagation Delay vs. Temperature

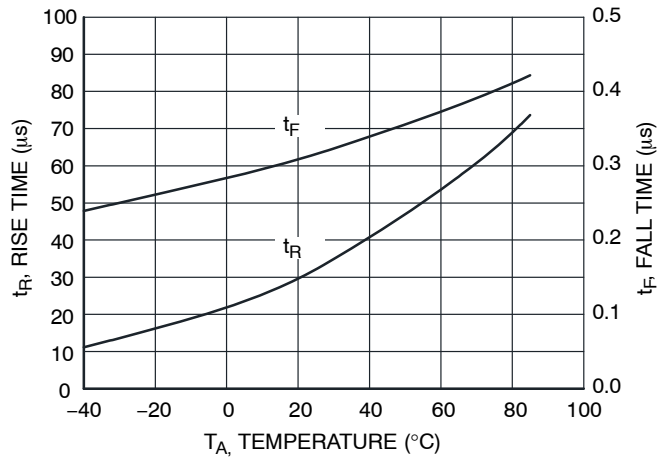


Figure 7. Rise and Fall Time vs. Temperature

TYPICAL PERFORMANCE CURVES (continued)

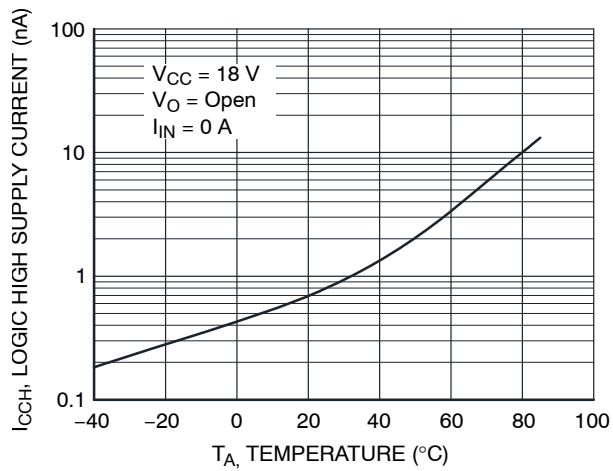


Figure 8. Logic High Supply Current vs. Temperature

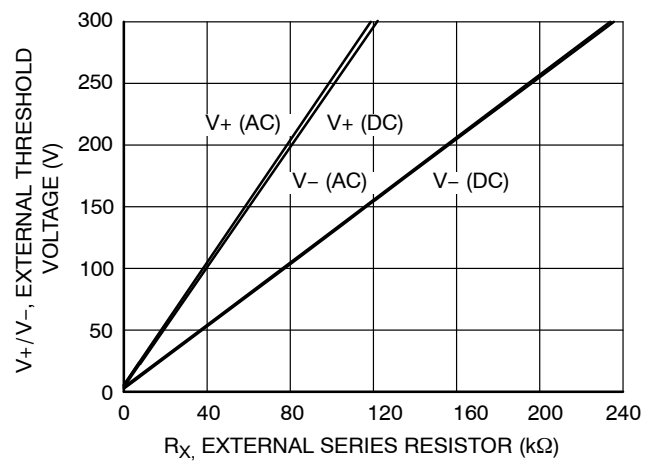


Figure 9. External Threshold Characteristics V_+/V_- vs. R_X

HCPL3700M

TEST CIRCUITS

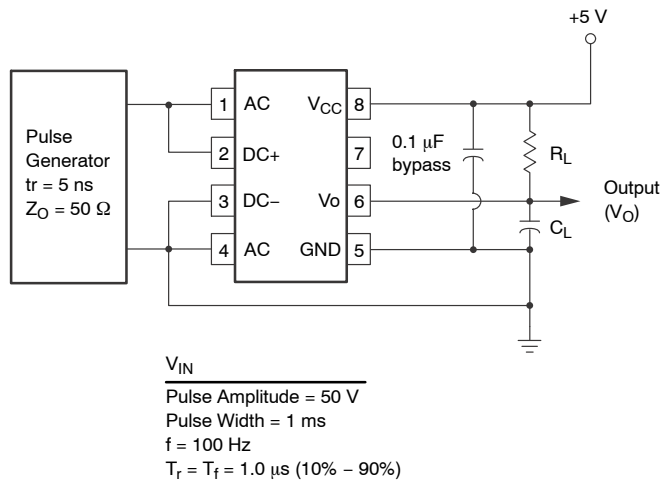


Figure 10. Switching Test Circuit

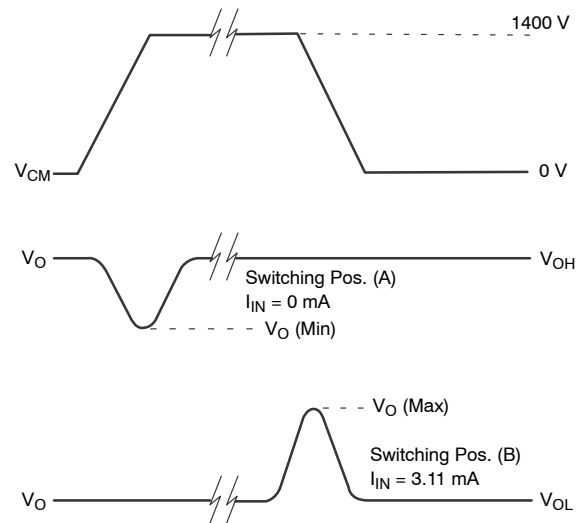
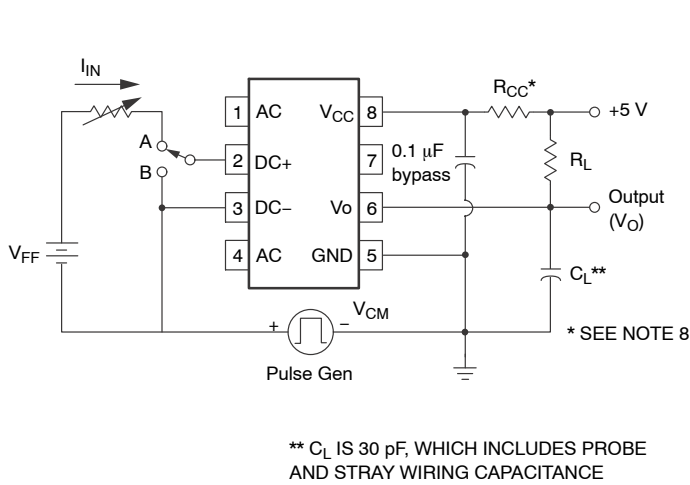
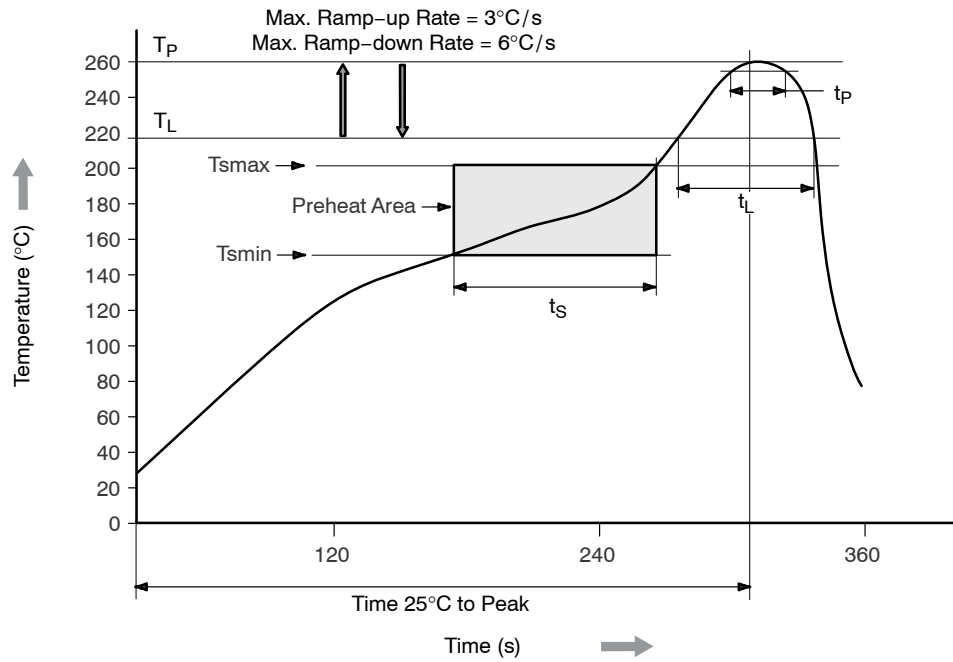


Figure 11. Test Circuit for Common Mode Transient Immunity and Typical Waveforms

HCPL3700M

REFLOW PROFILE



| Profile Feature | Pb-Free Assembly Profile |
|---|--------------------------|
| Temperature Minimum (T _{smin}) | 150°C |
| Temperature Maximum (T _{smax}) | 200°C |
| Time (t _s) from (T _{smin} to T _{smax}) | 60 to 120 s |
| Ramp-up Rate (t _L to t _p) | 3°C/s maximum |
| Liquidous Temperature (T _L) | 217°C |
| Time (t _L) Maintained Above (T _L) | 60 to 150 s |
| Peak Body Package Temperature | 260°C +0°C/-5°C |
| Time (t _p) within 5°C of 260°C | 30 s |
| Ramp-down Rate (T _P to T _L) | 6°C/s maximum |
| Time 25°C to Peak Temperature | 8 minutes maximum |

Figure 12. Reflow Profile

HCPL3700M

ORDERING INFORMATION

| Part Number | Package | Packing Method† |
|--------------|--|--------------------|
| HCPL3700M | DIP 8-Pin | 50 Units / Tube |
| HCPL3700SM | SMT 8-Pin (Lead Bend) | 50 Units / Tube |
| HCPL3700SDM | SMT 8-Pin (Lead Bend) | 1000 / Tape & Reel |
| HCPL3700VM | DIP 8-Pin, DIN EN/IEC60747-5-5 option | 50 Units / Tube |
| HCPL3700SVM | SMT 8-Pin (Lead Bend), DIN EN/IEC 60747-5-5 option | 50 Units / Tube |
| HCPL3700SDVM | SMT 8-Pin (Lead Bend), DIN EN/IEC 60747-5-5 option | 1000 / Tape & Reel |

†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.

MECHANICAL CASE OUTLINE

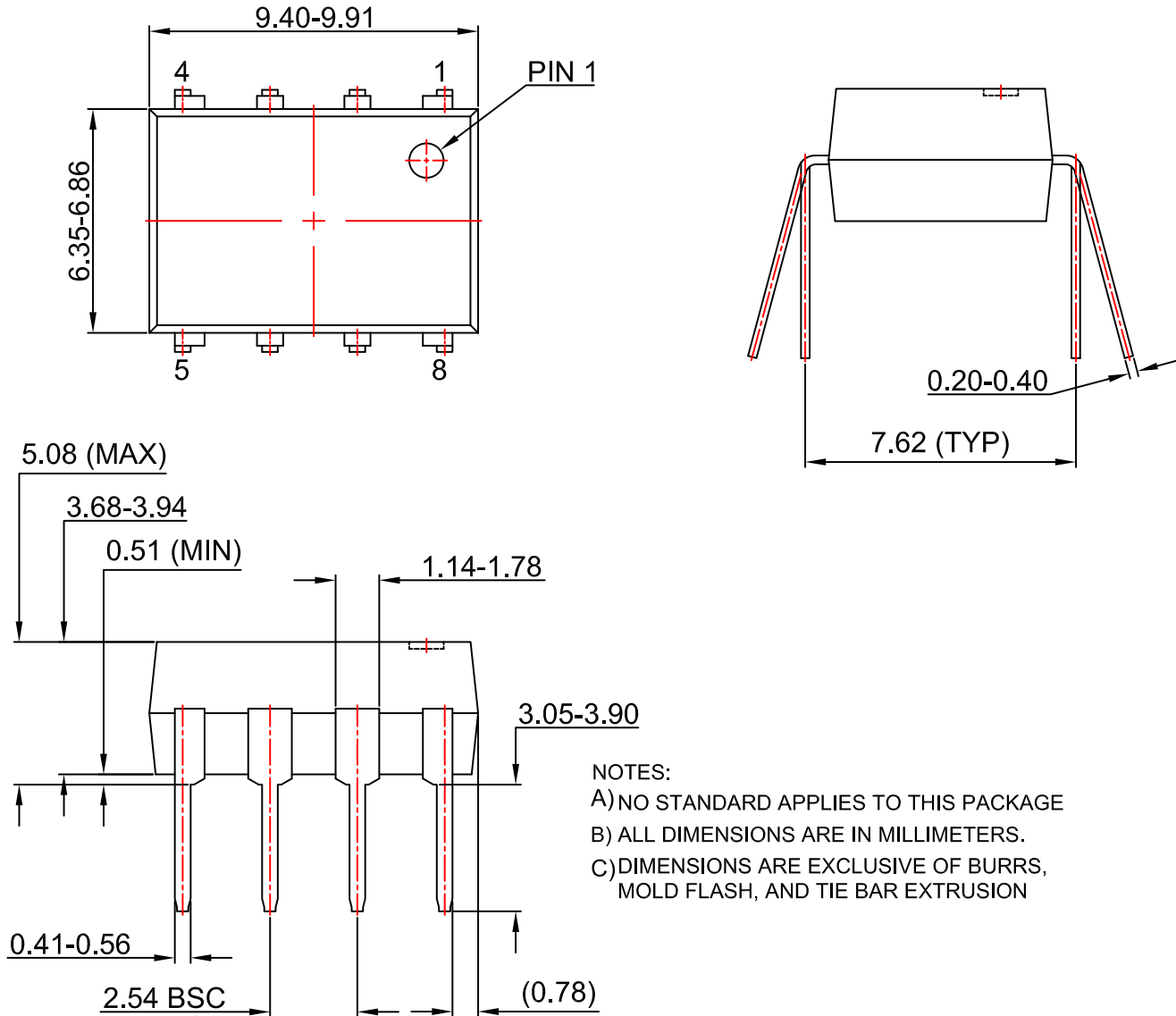
PACKAGE DIMENSIONS

ON Semiconductor®

ON

PDIP8 9.655x6.6, 2.54P
CASE 646CQ
ISSUE O

DATE 18 SEP 2017

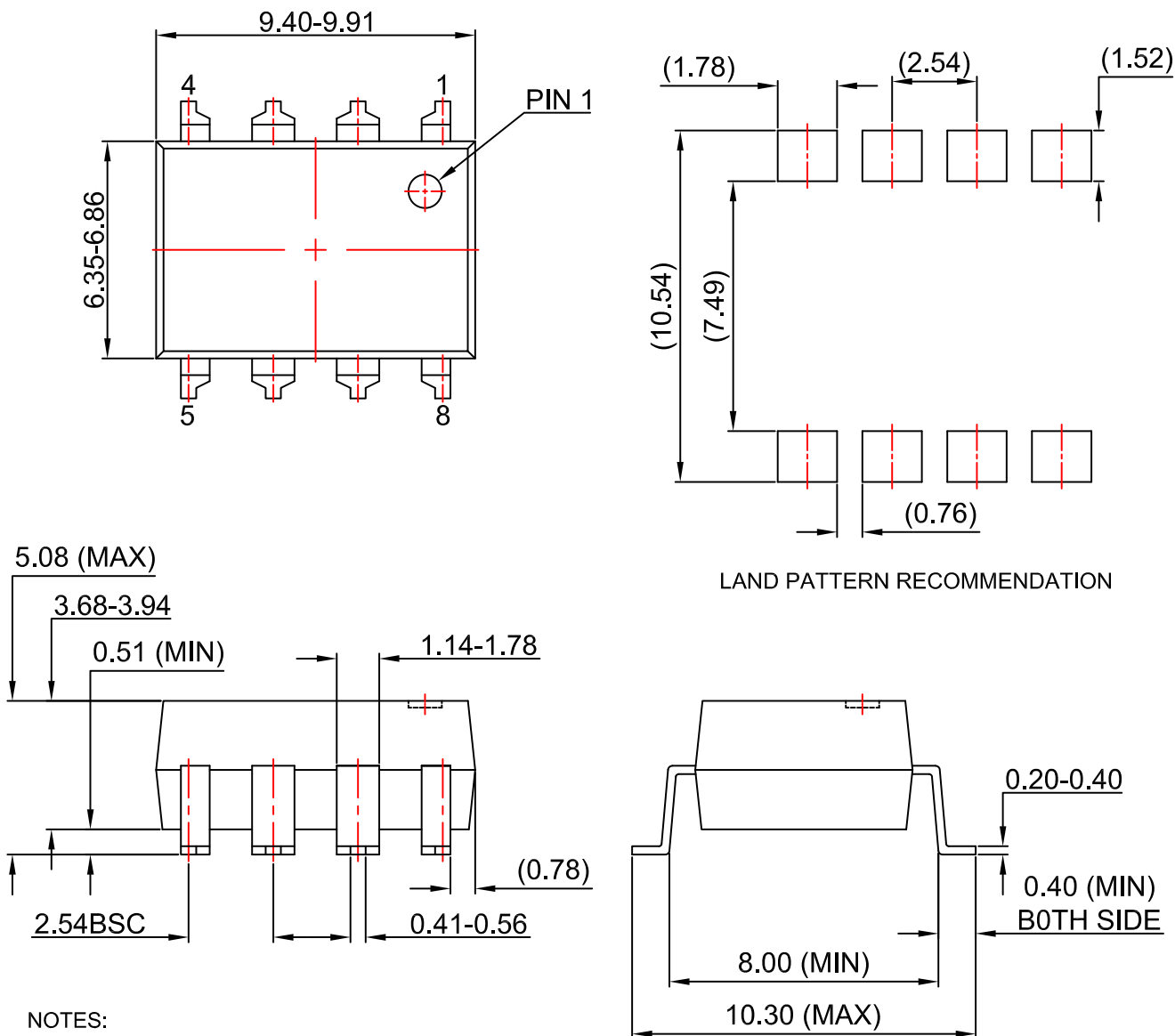


| | | |
|-------------------------|-------------------------------|---|
| DOCUMENT NUMBER: | 98AON13446G | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| DESCRIPTION: | PDIP8 9.655X6.6, 2.54P | PAGE 1 OF 1 |

ON Semiconductor and are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

PDIP8 GW
CASE 709AC
ISSUE O


DATE 31 JUL 2016



NOTES:

- A) NO STANDARD APPLIES TO THIS PACKAGE
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSION

| | | |
|-------------------------|--------------------|---|
| DOCUMENT NUMBER: | 98AON13447G | Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red. |
| DESCRIPTION: | PDIP8 GW | PAGE 1 OF 1 |

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

onsemi, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:

Technical Library: www.onsemi.com/design/resources/technical-documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support

For additional information, please contact your local Sales Representative at
www.onsemi.com/support/sales

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[onsemi:](#)

[HCPL3700M](#) [HCPL3700SVM](#) [HCPL3700VM](#) [HCPL3700SDM](#) [HCPL3700SDVM](#)