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February 2016

HCPL3700M AC/DC to Logic Interface Optocoupler

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

Applications

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

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.

Schematics

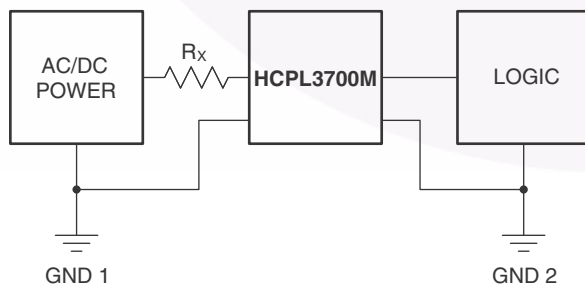
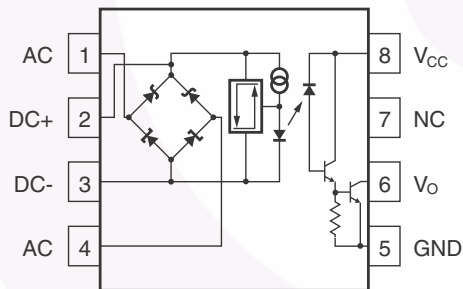


Figure 1. Schematic

Package Outlines

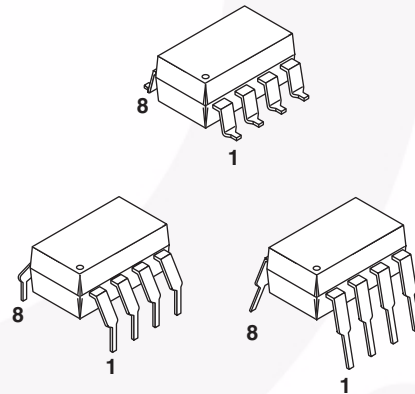


Figure 2. Package Outlines

TRUTH TABLE
(Positive Logic)

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

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

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 | 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 ⁽¹⁾ | 150 | °C |
| I _{S,INPUT} | Input Current ⁽¹⁾ | 25 | mA |
| P _{S,OUTPUT} | Output Power (Duty Factor ≤ 2.7%) ⁽¹⁾ | 250 | mW |
| R _{IO} | Insulation Resistance at T _S , V _{IO} = 500 V ⁽¹⁾ | > 10 ⁹ | Ω |

Note:

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

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. $T_A = 25^\circ\text{C}$ unless otherwise specified.

| Symbol | Parameter | Value | Unit |
|-----------------|--|---|------------------|
| T_{STG} | Storage Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_{OPR} | Operating Temperature | -40 to +85 | $^\circ\text{C}$ |
| T_J | Junction Temperature | -40 to +125 | $^\circ\text{C}$ |
| T_{SOL} | Lead Solder Temperature | 260 for 10 sec | $^\circ\text{C}$ |
| P_T | Total Package Power Dissipation ⁽²⁾ | 305 | mW |
| EMITTER | | | |
| I_{IN} | Input Current | Average | 50 |
| | | 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 ⁽³⁾ | 230 | mW |
| DETECTOR | | | |
| I_O | Output Current (Average) ⁽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 ⁽⁵⁾ | 210 | mW |

Notes:

2. Derate linearly above 70°C free-air temperature at a rate of $2.5 \text{ mW}/^\circ\text{C}$.
3. Derate linearly above 70°C free-air temperature at a rate of $1.8 \text{ mW}/^\circ\text{C}$.
4. Derate linearly above 70°C free-air temperature at a rate of $0.6 \text{ mA}/^\circ\text{C}$.
5. Derate linearly above 70°C free-air temperature at a rate of $1.9 \text{ mW}/^\circ\text{C}$.

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol | Parameter | Min. | Max. | Unit |
|----------|-------------------------------|------|------|------------------|
| V_{CC} | Supply Voltage | 2 | 18 | V |
| T_A | Ambient Operating Temperature | 0 | 70 | $^\circ\text{C}$ |
| f | Operating Frequency | 0 | 4 | kHz |

Electrical Characteristics ($T_A = 0^\circ\text{C}$ to 70°C Unless otherwise specified)

| Symbol | Parameter | | Test Conditions | Min. | Typ. | Max. | Unit |
|------------|---------------------------|-------------------|--|------|-------|------|---------------|
| I_{TH+} | Input Threshold Current | | $V_{IN} = V_{TH+}$, $V_{CC} = 4.5\text{ V}$ | 1.96 | 2.40 | 3.11 | mA |
| I_{TH-} | | | $V_O = 0.4\text{ V}$, $I_O \geq 4.2\text{ mA}^{(6)}$ | 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) $V_{CC} = 4.5\text{ V}$, $V_O = 0.4\text{ V}^{(6)}$ $I_O \geq 4.2\text{ mA}$ | 3.35 | 3.80 | 4.05 | V |
| V_{TH-} | | | $V_{IN} = V_2 - V_3$ (Pins 1 & 4 Open) $V_{CC} = 4.5\text{ V}$, $V_O = 2.4\text{ V}^{(6)}$ $I_O \geq 100\text{ }\mu\text{A}$ | 2.01 | 2.50 | 2.86 | V |
| V_{TH+} | | AC (Pins 1, 4) | $ V_{IN} = V_1 - V_4 $ (Pins 2 & 3 Open) $V_{CC} = 4.5\text{ V}$, $V_O = 0.4\text{ V}^{(6)}$ $I_O \geq 4.2\text{ mA}$ | 4.23 | 5.00 | 5.50 | V |
| V_{TH-} | | | $ V_{IN} = IV_1 - V_4 $ (Pins 2 & 3 Open) $V_{CC} = 4.5\text{ V}$, $V_O = 2.4\text{ V}^{(6)}$ $I_O \leq 100\text{ }\mu\text{A}$ | 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 |
| V_{IHC1} | Input Clamp Voltage | | $V_{IHC1} = V_2 - V_3$, $V_3 = \text{GND}$, $I_{IN} = 10\text{ mA}$, 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\text{ mA}$ (Pins 2 & 3 Open) | 6.1 | 7.0 | 7.3 | V |
| V_{IHC3} | | | $V_{IHC3} = V_2 - V_3$, $V_3 = \text{GND}$, $I_{IN} = 15\text{ mA}$ (Pins 1 & 4 Open) | | 12.5 | 13.4 | V |
| V_{ILC} | | | $V_{ILC} = V_2 - V_3$, $V_3 = \text{GND}$, $I_{IN} = -10\text{ mA}$ | | -0.75 | | V |
| I_{IN} | Input Current | | $V_{IN} = V_2 - V_3 = 5.0\text{ V}$ (Pins 1 & 4 Open) | 3.0 | 3.7 | 4.4 | mA |
| $V_{D1,2}$ | Bridge Diode | | $I_{IN} = 3\text{ mA}$ | | 0.65 | | V |
| $V_{D3,4}$ | Forward Voltage | | $I_{IN} = 3\text{ mA}$ | | 0.65 | | V |
| V_{OL} | Logic LOW Output Voltage | | $V_{CC} = 4.5\text{ V}$, $I_{OL} = 4.2\text{ mA}^{(6)}$ | | 0.04 | 0.40 | V |
| I_{OH} | Logic HIGH Output Current | | $V_{OH} = V_{CC} = 18\text{ V}^{(6)}$ | | | 100 | μA |
| I_{CCL} | Logic LOW Supply Current | | $V_2 - V_3 = 5.0\text{ V}$, $V_O = \text{Open}$, $V_{CC} = 5\text{ V}$ | | 1.0 | 4 | mA |
| I_{CCH} | Logic HIGH Supply Current | | $V_{CC} = 18\text{ V}$, $V_O = \text{Open}$ | | 0.01 | 4 | μA |
| C_{IN} | Input Capacitance | | $f = 1\text{ MHz}$, $V_{IN} = 0\text{ V}$ (Pins 2 & 3, Pins 1 & 4 Open) | | 50 | | pF |

Note:

6. Logic LOW output level at pin 6 occurs when $V_{IN} \geq V_{TH+}$ and when $V_{IN} > V_{TH-}$ once V_{IN} exceeds V_{TH+} .
Logic HIGH output level at pin 6 occurs when $V_{IN} \leq V_{TH-}$ and when $V_{IN} < V_{TH+}$ once decreases below V_{TH-} .

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

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|---|---|------|------|------|------------------------|
| t_{PHL} | Propagation Delay Time (to Output Low Level) | $R_L = 4.7\text{ k}\Omega$, $C_L = 30\text{ pF}^{(7)}$ | | 6.0 | 15 | μs |
| t_{PLH} | Propagation Delay Time (to Output High Level) | $R_L = 4.7\text{ k}\Omega$, $C_L = 30\text{ pF}^{(7)}$ | | 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 |
| $ CM_H $ | Common Mode Transient Immunity (at Output High Level) | $I_{IN} = 0\text{ mA}$, $R_L = 4.7\text{ k}\Omega$, $V_{O\text{ min}} = 2.0\text{ V}$, $V_{CM} = 1400\text{ V}^{(8)(9)}$ | | 4000 | | $\text{V}/\mu\text{s}$ |
| $ CM_L $ | Common Mode Transient Immunity (at Output Low Level) | $I_{IN} = 3.11\text{ mA}$, $R_L = 4.7\text{ k}\Omega$, $V_{O\text{ max}} = 0.8\text{ V}$, $V_{CM} = 1400\text{ V}^{(8)(9)}$ | | 600 | | $\text{V}/\mu\text{s}$ |

Isolation Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise specified.)

| Symbol | Parameter | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|-------------------------------|--|------|-----------|------|---------------------------|
| V_{ISO} | Withstand Isolation Voltage | $RH \leq 50\%$, $I_{I-O} \leq 10\text{ }\mu\text{A}$ $t = 1\text{ minute}$, $f = 50\text{ Hz}^{(10)(11)}$ | 5000 | | | VAC_{RMS} |
| R_{I-O} | Resistance (Input to Output) | $V_{IO} = 500\text{ V}_{\text{DC}}^{(10)}$ | | 10^{12} | | Ω |
| C_{I-O} | Capacitance (Input to Output) | $f = 1\text{ MHz}$, $V_{IO} = 0\text{ V}_{\text{DC}}$ | | 0.6 | | pF |

Notes:

- 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. 11)
- 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. 12.
- 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 .
- 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.
- The 5000 $\text{VAC}_{\text{RMS}}/1\text{ min.}$ capability is validated by a 6000 $\text{VAC}_{\text{RMS}}/1\text{ sec.}$ dielectric voltage withstand test.

Typical Performance Curves

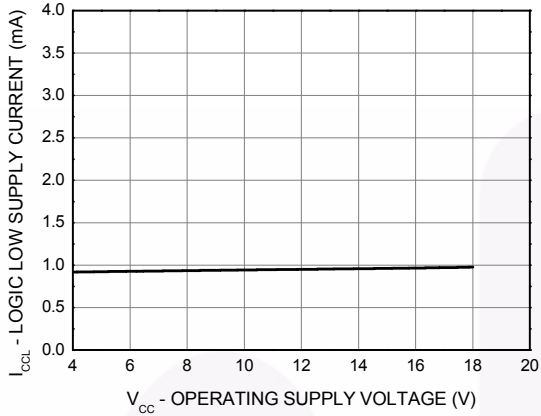


Figure 3. Logic Low Supply Current vs. Operating Supply Voltage

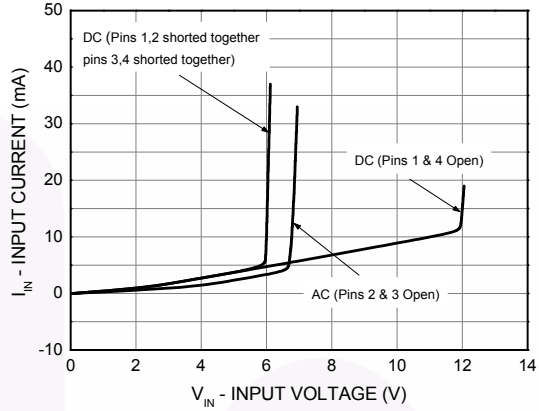


Figure 4. Input Current vs. Input Voltage

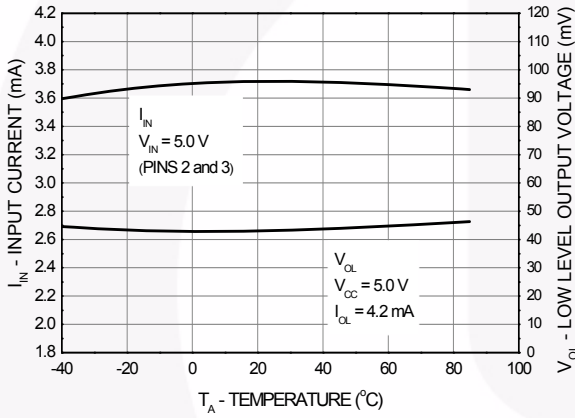


Figure 5. Input Current/Low Level Output Voltage vs. Temperature

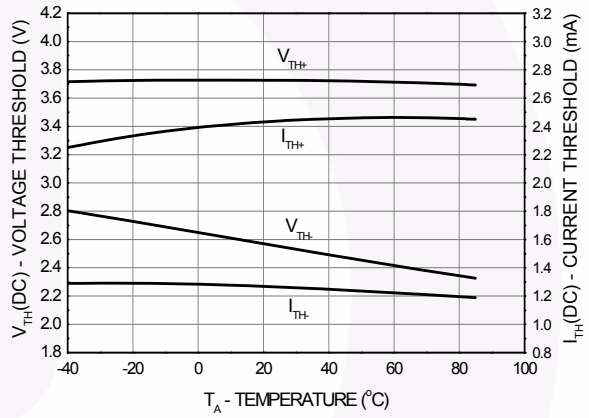


Figure 6. Current Threshold/Voltage Threshold vs. Temperature

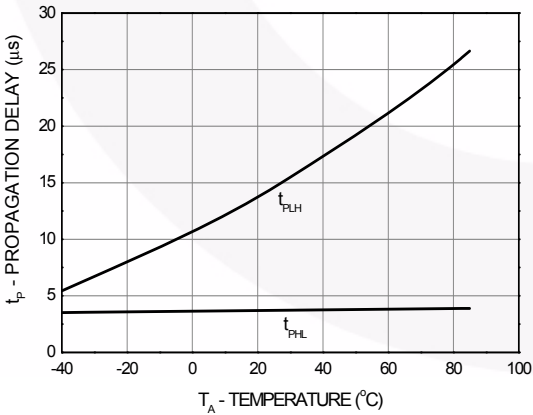


Figure 7. Propagation Delay vs. Temperature

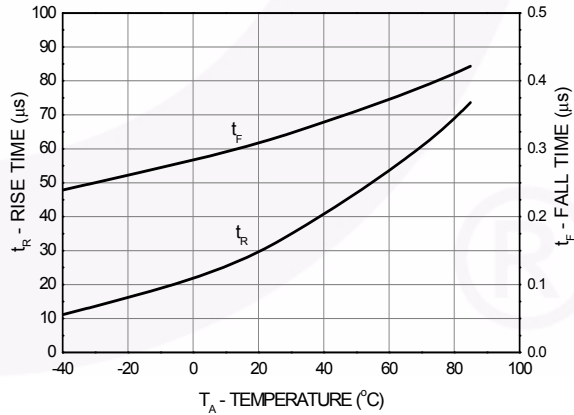


Figure 8. Rise and Fall Time vs. Temperature

Typical Performance Curves (Continued)

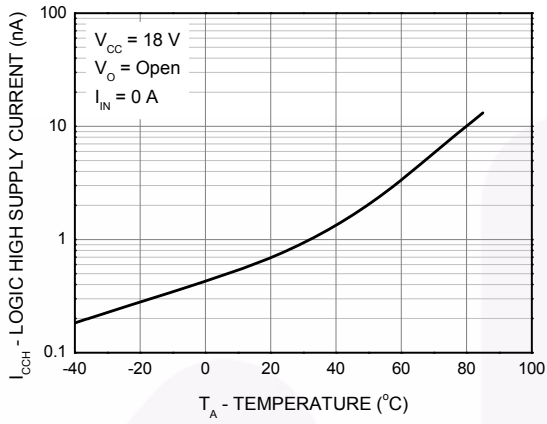


Figure 9. Logic High Supply Current vs. Temperature

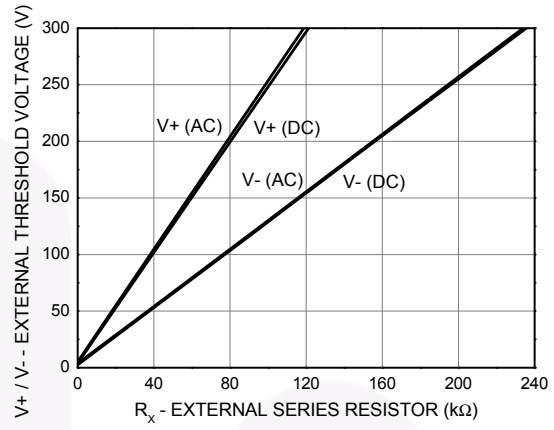
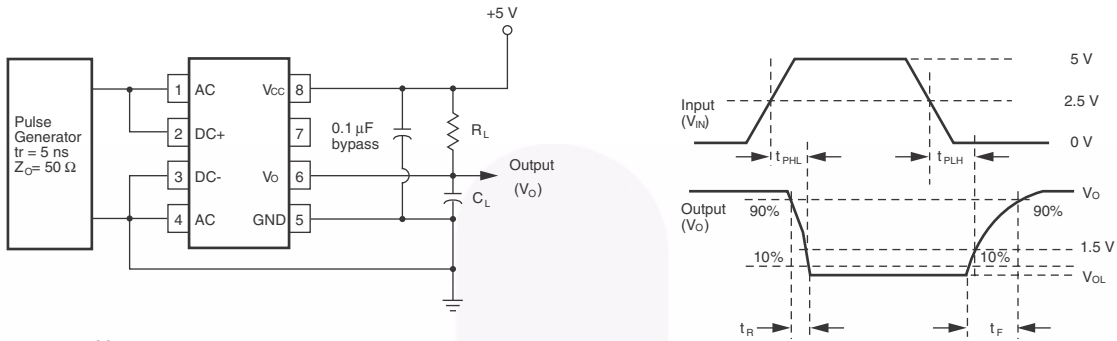


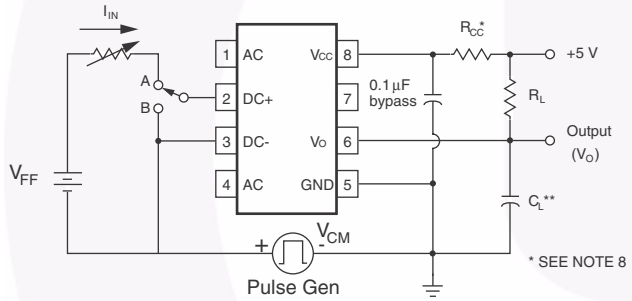
Figure 10. External Threshold Characteristics V_+/V_- vs. R_x

Test Circuits



V_{IN}
 Pulse Amplitude = 50 V
 Pulse Width = 1 ms
 f = 100 Hz
 $T_r = T_f = 1.0 \mu s$ (10%–90%)

Fig. 11. Switching Test Circuit



** C_L IS 30 pF, WHICH INCLUDES PROBE AND STRAY WIRING CAPACITANCE

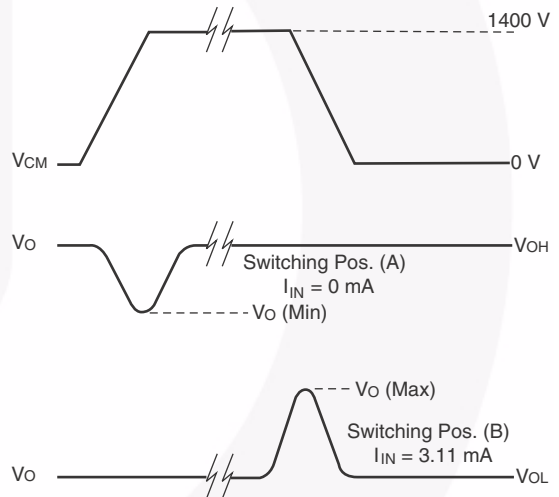
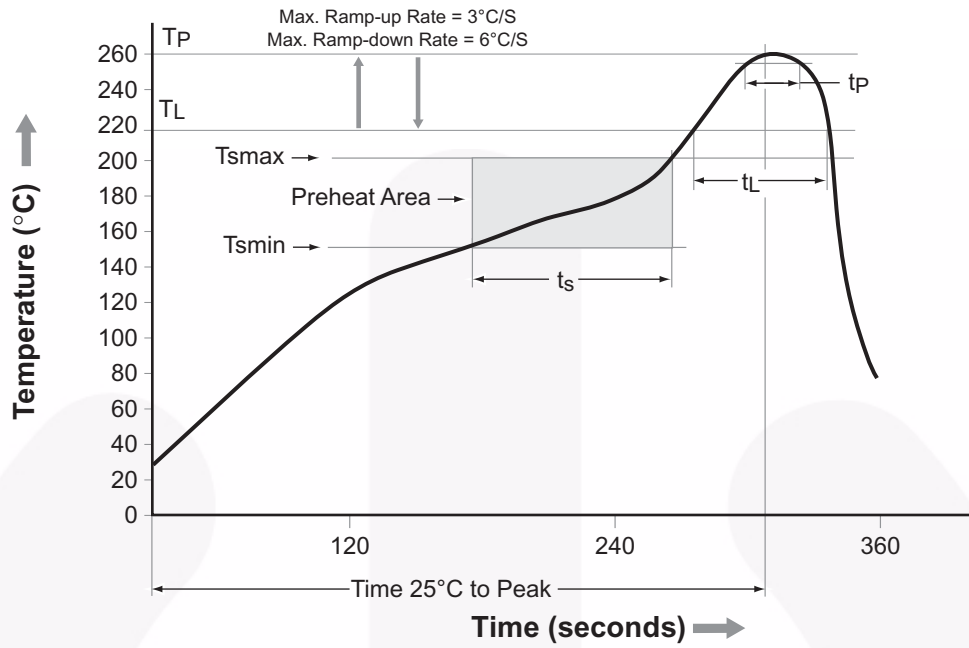


Fig. 12. Test Circuit for Common Mode Transient Immunity and Typical Waveforms

Reflow Profile



| Profile Feature | Pb-Free Assembly Profile |
|---------------------------------|--------------------------|
| Temperature Min. (Tsmín) | 150°C |
| Temperature Max. (Tsmáx) | 200°C |
| Time (ts) from (Tsmín to Tsmáx) | 60–120 seconds |
| Ramp-up Rate (tL to tp) | 3°C/second max. |
| Liquidous Temperature (TL) | 217°C |
| Time (tL) Maintained Above (TL) | 60–150 seconds |
| Peak Body Package Temperature | 260°C +0°C / -5°C |
| Time (tp) within 5°C of 260°C | 30 seconds |
| Ramp-down Rate (TP to TL) | 6°C/second max. |
| Time 25°C to Peak Temperature | 8 minutes max. |

Figure 13. Reflow Profile

Ordering Information

| Part Number | Package | Packing Method |
|--------------|---|-----------------------------|
| HCPL3700M | DIP 8-Pin | Tube (50 units) |
| HCPL3700SM | SMT 8-Pin (Lead Bend) | Tube (50 units) |
| HCPL3700SDM | SMT 8-Pin (Lead Bend) | Tape and Reel (1,000 units) |
| HCPL3700VM | DIP 8-Pin, DIN EN/IEC60747-5-5 option | Tube (50 units) |
| HCPL3700SVM | SMT 8-Pin (Lead Bend), DIN EN/IEC 60747-5-5 option | Tube (50 units) |
| HCPL3700SDVM | SMT 8-Pin (Lead Bend), DIN EN/IEC 60747-5-5 option | Tape and Reel (1,000 units) |
| HCPL3700TVM | DIP 8-Pin, 0.4" Lead Spacing, DIN EN/IEC 60747-5-5 option | Tube (50 units) |

Marking Information

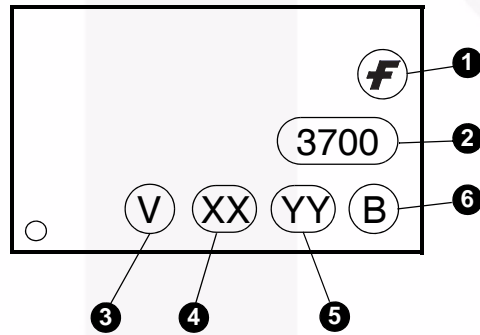


Figure 14. Top Mark

Definitions

| | |
|---|---|
| 1 | Fairchild Logo |
| 2 | Device Number |
| 3 | DIN EN/IEC60747-5-5 Option (only appears on component ordered with this option) |
| 4 | Two Digit Year Code, e.g., '15' |
| 5 | Two Digit Work Week Ranging from '01' to '53' |
| 6 | Assembly Package Code |



- 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
 - D) DRAWING FILENAME AND REVISION: MKT-N08GREV7



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