

Data Sheet

Description

The ACPL-W454/P454 is similar to Broadcom's other high speed transistor output optocouplers, but with shorter propagation delays and higher CTR. The ACPL-W454/P454 also has a guaranteed propagation delay difference ($t_{PLH} - t_{PHL}$). These features make the ACPL-W454/P454 an excellent solution to IPM inverter dead time and other switching problems.

The ACPL-W454/P454 CTR, propagation delays, and CMR are specified both for TTL load and drive conditions and for IPM (Intelligent Power Module) load and drive conditions. Specifications and typical performance plots for both TTL and IPM conditions are provided for ease of application.

This diode-transistor optocoupler uses an insulating layer between the light emitting diode and an integrated photo detector to provide electrical insulation between input and output. Separate connections for the photodiode bias and output transistor collector increase the speed up to a hundred times over that of a conventional phototransistor coupler by reducing the base-collector capacitance.

CAUTION It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation which may be induced by ESD.

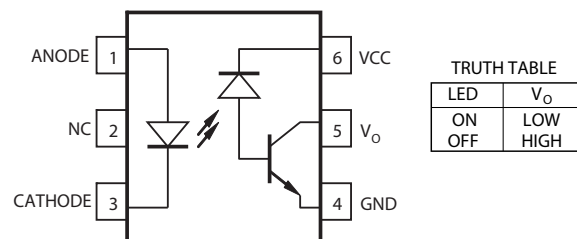
Features

- Package clearance/creepage at 8 mm (ACPL-W454)
- Function compatible with HCPL-4504
- Surface mountable in 6-pin stretched SO-6
- Short propagation delays for TTL and IPM applications
- Very high common mode transient immunity: guaranteed 15 kV/ μ s at $V_{CM} = 1500V$
- High CTR: >25% at 25°C
- Guaranteed specifications for common IPM applications
- TTL compatible
- Guaranteed AC and DC performance over temperature: 0°C to 70°C
- Open collector output
- Safety approval
 - UL recognized 3750V_{RMS} for 1 minute (5000V_{RMS} for 1 minute under ACPL-W454 devices) per UL1577
 - CSA approved
 - IEC/EN/DIN EN 60747-5-5 approved with $V_{IORM} = 1140V_{peak}$ (ACPL-W454) and $V_{IORM} = 891V_{peak}$ (ACPL-P454) for Option 060.

Applications

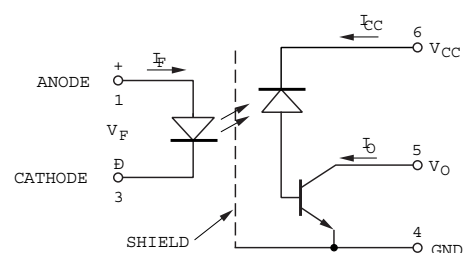
- Inverter circuits and intelligent power module (IPM) Interfacing – Shorter propagation delays and guaranteed ($t_{PLH} - t_{PHL}$) specifications.
- High-speed logic ground isolation – TTL/TTL, TTL/LTTL, TTL/CMOS, TTL/LSTTL
- Line receivers – High common mode transient immunity (>15 kV/ μ s for a TTL load/drive) and low input-output capacitance (0.6 pF).
- Replace pulse transformers – Save board space and weight
- Analog signal ground isolation – Integrated photo detector provides improved linearity over phototransistors

Functional Diagram



A 0.1 μ F bypass capacitor between pins 4 and 6 is recommended.

Schematic



Ordering Information

ACPL-P454 and ACPL-W454 are UL Recognized with 3750V_{RMS} (5000V_{RMS} under ACPL-W454) for 1 minute per UL1577 and are approved under CSA Component Acceptance Notice #5, File CA 88324.

| Part Number | Option RoHS Compliant | Package | Surface Mount | Tape and Reel | IEC/EN/DIN EN 60747-5-5 | Quantity |
|------------------------|-----------------------|----------------|---------------|---------------|-------------------------|---------------|
| ACPL-P454 ACPL-W454 | -000E | Stretched SO-6 | X | | | 100 per tube |
| | -500E | | X | X | | 1000 per reel |
| | -060E | | X | | X | 100 per tube |
| | -560E | | X | X | X | 1000 per reel |

To order, choose a part number from the part number column and combine with the desired option from the option column to form an order entry.

Example 1:

ACPL-P454-560E to order product of Stretched SO-6 package in Tape and Reel packaging with IEC/EN/DIN EN 60747-5-5 Safety Approval in RoHS compliant.

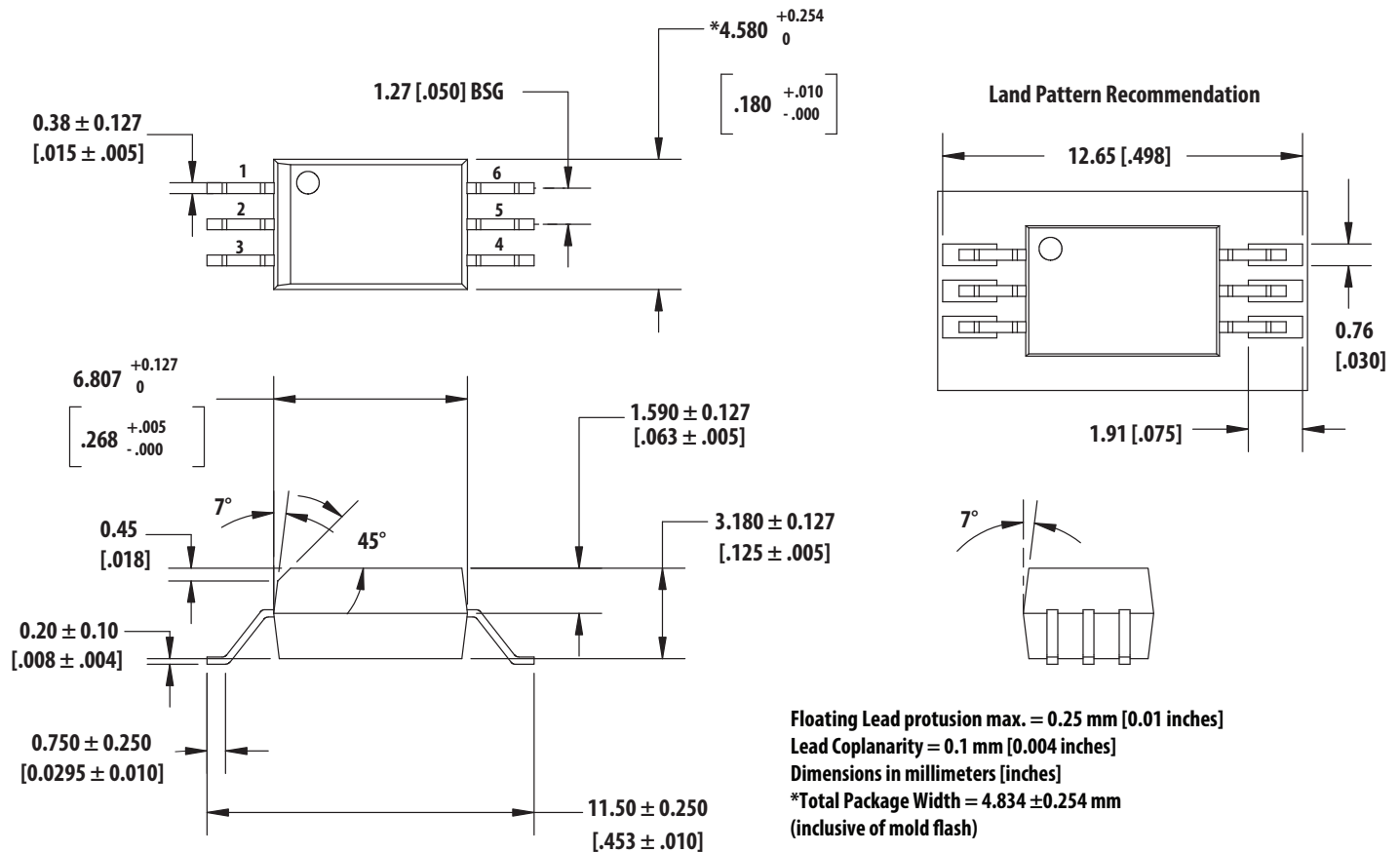
Example 2:

ACPL-P454-000E to order product of Stretched SO-6 package in tube packaging and RoHS compliant.

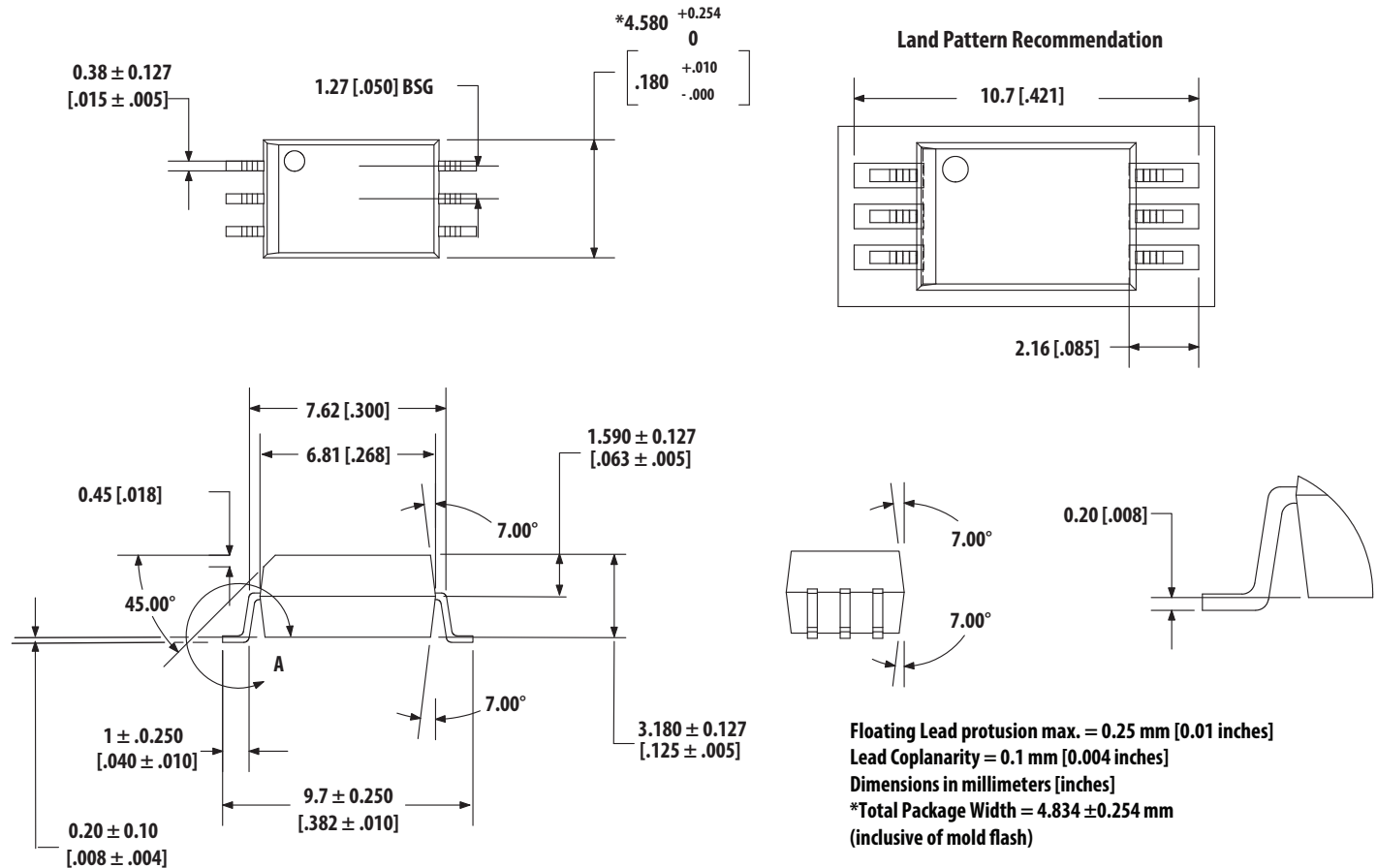
Option data sheets are available. Contact your Broadcom sales representative or authorized distributor for information.

Package Outline Drawings

ACPL-W454 (Stretched SO-6, 8 mm Clearance)



ACPL-P454 (Stretched SO-6, 7 mm Clearance)



Recommended Pb-Free IR Profile

Recommended reflow condition as per JEDEC Standard, J-STD-020 (latest revision). Use non-halide flux.

Regulatory Information

The ACPL-W454/P454 are approved by the following organizations:

- **IEC/EN/DIN EN 60747-5-5 (Option 060 only)**
- **UL** – Approval under UL 1577, component recognition program up to $V_{ISO} = 3750V_{RMS}$ (5000 V_{RMS} for ACPL-W454). File E55361.
- **CSA** – Approval under CSA Component Acceptance Notice #5, File CA 88324.

Insulation Related Specifications

| Parameter | Symbol | ACPL-W454 | ACPL-P454 | Units | Conditions |
|--|--------|-----------|-----------|-------|--|
| Min External Air Gap (Clearance) | L(IO1) | 8 | 7 | mm | Measured from input terminals to output terminals |
| Min. External Tracking Path (Creepage) | L(IO2) | 8 | 8 | mm | Measured from input terminals to output terminals |
| Min. Internal Plastic Gap (Clearance) | | 0.08 | 0.08 | mm | Through insulation distance conductor to conductor |
| Tracking Resistance | CTI | 175 | 175 | V | DIN IEC 112/VDE 0303 Part 1 |
| Isolation Group (per DIN VDE 0109) | | IIIa | — | — | Material Group DIN VDE 0109 |

IEC/EN/DIN EN 60747-5-5 Insulation Characteristics

| Description | Symbol | ACPL-P454 Option 060 | ACPL-W454 Option 060 | Unit |
|---|-----------------|-------------------------|-------------------------|------------|
| Installation classification per DIN VDE 0110/39, Table 1 | | | | |
| for rated mains voltage $\leq 150V_{RMS}$ | | I-IV | I-IV | |
| for rated mains voltage $\leq 300V_{RMS}$ | | I-IV | I-IV | |
| for rated mains voltage $\leq 600V_{RMS}$ | | I-III | I-III | |
| for rated mains voltage $\leq 1000V_{RMS}$ | | | I-III | |
| Climatic Classification | | 55/85/21 | 55/85/21 | — |
| Pollution Degree (DIN VDE 0110/39) | | 2 | 2 | — |
| Maximum Working Insulation Voltage | V_{IORM} | 891 | 1140 | V_{peak} |
| Input to Output Test Voltage, Method b ^a $V_{IORM} \times 1.875 = V_{PR}$, 100% Production Test with $t_m=1$ sec, Partial discharge < 5 pC | V_{PR} | 1671 | 2137 | V_{peak} |
| Input to Output Test Voltage, Method a ^a $V_{IORM} \times 1.6 = V_{PR}$, Type and Sample Test, $t_m=10$ sec, Partial discharge < 5 pC | V_{PR} | 1426 | 1824 | V_{peak} |
| Highest Allowable Overvoltage (Transient Overvoltage $t_{ini} = 60$ sec) | V_{IOTM} | 6000 | 8000 | V_{peak} |
| Safety-limiting values - maximum values allowed in the event of a failure. | | | | |
| Case Temperature | T_S | 175 | 175 | °C |
| Input Current | $I_{S, INPUT}$ | 230 | 230 | mA |
| Output Power | $P_{S, OUTPUT}$ | 600 | 600 | mW |
| Insulation Resistance at TS, $V_{IO} = 500V$ | R_S | $\geq 10^9$ | $\geq 10^9$ | Ω |

- a. Refer to the optocoupler section of the Isolation and Control Components Designer's Catalog, under Product Safety Regulations section, (IEC/EN/DIN EN 60747-5-5) for a detailed description of Method a and Method b partial discharge test profiles.

Absolute Maximum Ratings

| Parameter | Value |
|---|---|
| Storage Temperature | -55°C to +125°C |
| Operating Temperature | -55°C to +100°C |
| Average Input Current – I_F | 25 mA ^a |
| Peak Input Current – I_F | 50 mA ^b (50% duty cycle, 1 ms pulse width) |
| Peak Transient Input Current – I_F | 1.0A (\leq 1 ms pulse width, 300 pps) |
| Reverse Input Voltage – V_R (Pin 3-1) | 5V |
| Input Power Dissipation | 45 mW ^c |
| Average Output Current – I_O (Pin 5) | 8 mA |
| Peak Output Current | 16 mA |
| Output Voltage – V_O (Pin 5-4) | -0.5V to +20V |
| Supply Voltage – V_{CC} (Pin 6-4) | -0.5V to +30V |
| Output Power Dissipation | 100 mW ^d |
| Solder Reflow Temperature Profile | See Package Outline Drawings section |

- Derate linearly above 70°C free-air temperature at a rate of 0.8 mA/°C.
- Derate linearly above 70°C free-air temperature at a rate of 1.6 mA/°C.
- Derate linearly above 70°C free-air temperature at a rate of 0.9 mW/°C.
- Derate linearly above 70°C free-air temperature at a rate of 2.0 mW/°C.

DC Electrical Specifications

Over recommended temperature ($T_A = 0^\circ\text{C}$ to 70°C) unless otherwise specified.

| Parameter | Symbol | Min. | Typ. ^a | Max. | Unit | Test Conditions | | | Fig. | Note |
|--|----------------------------------|------|-------------------|------|-------|-------------------------------|---|--|---------|------|
| Current Transfer Ratio | CTR | 25 | 32 | 60 | % | T _A = 25°C | V _O = 0.4V | I _F = 16 mA V _{CC} = 4.5V | 1, 2, 4 | b |
| | | 21 | 34 | — | | — | V _O = 0.5V | | | |
| Current Transfer Ratio | CTR | 26 | 35 | 65 | % | T _A = 25°C | V _O = 0.4V | I _F = 12 mA V _{CC} = 4.5V | | b |
| | | 22 | 37 | — | | — | V _O = 0.5V | | | |
| Logic Low Output Voltage | V _{OL} | — | 0.2 | 0.4 | V | T _A = 25°C | I _O = 3.0 mA | I _F = 16 mA V _{CC} = 4.5V | 1 | |
| | | | 0.2 | 0.5 | | — | I _O = 2.4 mA | | | |
| Logic High Output Current | I _{OH} | — | 0.003 | 0.5 | μA | T _A = 25°C | V _O = V _{CC} = 5.5V | I _F = 0 mA | 5 | |
| | | | 0.01 | 1 | | T _A = 25°C | V _O = V _{CC} = 15.0V | | | |
| | | | — | 50 | | — | | | | |
| Logic Low Supply Current | I _{CCL} | — | 50 | 200 | μA | I _F = 16 mA, | V _{CC} = 15V | V _O = Open | | c |
| Logic High Supply Current | I _{CCH} | — | 0.02 | 1 | μA | T _A = 25°C | I _F = 0 mA, V _O = Open | V _{CC} = 15V | | c |
| | | | 0.02 | 2 | | — | | | | |
| Input Forward Voltage | V _F | — | 1.5 | 1.7 | V | T _A = 25°C | I _F = 16 mA | | 3 | |
| | | | 1.5 | 1.8 | | — | | | | |
| Input Reverse Breakdown Voltage | BV _R | 5 | — | — | V | I _R = 10A | | | | |
| Temperature Coefficient of Forward Voltage | ΔV _F /ΔT _A | — | −1.6 | — | mV/°C | I _F = 16 mA | | | | |
| Input Capacitance | C _{IN} | — | 60 | — | pF | f = 1 MHz, V _F = 0 | | | | |

a. All typicals at $T_A = 25^\circ\text{C}$.

b. CURRENT TRANSFER RATIO in percent is defined as the ratio of output collector current (I_O), to the forward LED input current (I_F), times 100.

c. Use of a 0.1 μF bypass capacitor connected between pins 4 and 6 is recommended.

Switching Specifications

Over recommended temperature ($T_A = 0^\circ\text{C}$ to 70°C) unless otherwise specified

| Parameter | Symbol | Min. | Typ. ^a | Max. | Unit | Test Conditions | | Fig. | Notes |
|--|-----------------------------------|------|-------------------|------|-------------------------|--------------------------|--|----------|-------|
| Propagation Delay Time to Logic Low at Output | t_{PHL} | — | 0.2 | 0.3 | μs | $T_A = 25^\circ\text{C}$ | Pulse: $f = 20\text{ kHz}$, Duty Cycle = 10% $I_F = 16\text{ mA}$, $V_{\text{CC}} = 5.0\text{V}$ $R_L = 1.9\text{ k}\Omega$, $C_L = 15\text{ pF}$, $V_{\text{THHL}} = 1.5\text{V}$ | 6, 8, 9 | b |
| | | — | 0.2 | 0.5 | | — | | | |
| | | 0.2 | 0.5 | 0.7 | | $T_A = 25^\circ\text{C}$ | Pulse: $f = 10\text{ kHz}$, Duty Cycle = 50% $I_F = 12\text{ mA}$, $V_{\text{CC}} = 15.0\text{V}$ $R_L = 20\text{ k}\Omega$, $C_L = 100\text{ pF}$, $V_{\text{THHL}} = 1.5\text{V}$ | 6, 10–14 | c |
| | | 0.1 | 0.5 | 1.0 | | — | | | |
| Propagation Delay Time to Logic High at Output | t_{PLH} | — | 0.3 | 0.5 | μs | $T_A = 25^\circ\text{C}$ | Pulse: $f = 20\text{ kHz}$, Duty Cycle = 10% $I_F = 16\text{ mA}$, $V_{\text{CC}} = 5.0\text{V}$ $R_L = 1.9\text{ k}\Omega$, $C_L = 15\text{ pF}$, $V_{\text{THHL}} = 1.5\text{V}$ | 6, 8, 9 | b |
| | | — | 0.3 | 0.7 | | — | | | |
| | | 0.3 | 0.8 | 1.1 | | $T_A = 25^\circ\text{C}$ | Pulse: $f = 10\text{ kHz}$, Duty Cycle = 50% $I_F = 12\text{ mA}$, $V_{\text{CC}} = 15.0\text{V}$ $R_L = 20\text{ k}\Omega$, $C_L = 100\text{ pF}$, $V_{\text{THHL}} = 2.0\text{V}$ | 6, 10–14 | c |
| | | 0.2 | 0.8 | 1.4 | | — | | | |
| Propagation Delay Difference Between Any 2 Parts | $t_{\text{PLH}} - t_{\text{PHL}}$ | –0.4 | +0.3 | +0.9 | μs | $T_A = 25^\circ\text{C}$ | Pulse: $f = 10\text{ kHz}$, Duty Cycle = 50% $I_F = 12\text{ mA}$, $V_{\text{CC}} = 15.0\text{V}$ $R_L = 20\text{ k}\Omega$, $C_L = 100\text{ pF}$ $V_{\text{THHL}} = 1.5\text{V}$, $V_{\text{THLH}} = 2.0\text{V}$ | 6, 10–14 | d |
| | | –0.7 | +0.3 | +1.3 | μs | — | | | |
| Common Mode Transient Immunity at Logic High Level Output | $ CM_H $ | 15 | 30 | — | kV/s | $T_A = 25^\circ\text{C}$ | $V_{\text{CC}} = 5.0\text{V}$, $R_L = 1.9\text{ k}\Omega$ $C_L = 15\text{ pF}$, $I_F = 0\text{ mA}$, $V_{\text{CM}} = 1500\text{ V}_{\text{P-P}}$ | 7 | b, e |
| | | 15 | 30 | — | | $T_A = 25^\circ\text{C}$ | $V_{\text{CC}} = 15.0\text{V}$, $R_L = 20\text{ k}\Omega$ $C_L = 100\text{ pF}$, $I_F = 0\text{ mA}$ $V_{\text{CM}} = 1500\text{ V}_{\text{P-P}}$ | 7 | c, f |
| Common Mode Transient Immunity at Logic Low Level Output | $ CM_L $ | 15 | 30 | — | $\text{kV}/\mu\text{s}$ | $T_A = 25^\circ\text{C}$ | $V_{\text{CC}} = 5.0\text{V}$, $R_L = 1.9\text{ k}\Omega$ $C_L = 15\text{ pF}$, $I_F = 16\text{ mA}$ $V_{\text{CM}} = 1500\text{ V}_{\text{P-P}}$ | 7 | b, e |
| | | 15 | 30 | — | | $T_A = 25^\circ\text{C}$ | $V_{\text{CC}} = 15.0\text{V}$, $R_L = 20\text{ k}\Omega$ $C_L = 100\text{ pF}$, $I_F = 12\text{ mA}$ $V_{\text{CM}} = 1500\text{ V}_{\text{P-P}}$ | 7 | c, f |
| | | 15 | 30 | — | | $T_A = 25^\circ\text{C}$ | $V_{\text{CC}} = 15.0\text{V}$, $R_L = 20\text{ k}\Omega$ $C_L = 100\text{ pF}$, $I_F = 16\text{ mA}$ $V_{\text{CM}} = 1500\text{ V}_{\text{P-P}}$ | 7 | c, f |

- All typicals at $T_A = 25^\circ\text{C}$.
- The $1.9\text{ k}\Omega$ load represents 1 TTL unit load of 1.6 mA and the $5.6\text{ k}\Omega$ pull-up resistor.
- The $R_L = 20\text{ k}\Omega$, $C_L = 100\text{ pF}$ load represents an IPM (Intelligent Power Mode) load.
- The difference between t_{PLH} and t_{PHL} , between any two ACPL-W454/P454 parts under the same test condition. (See Power Inverter Dead Time and Propagation Delay Specifications section).
- Under TTL load and drive conditions: Common mode transient immunity in a Logic High level is the maximum tolerable (positive) dV_{CM}/dt on the leading edge of the common mode pulse, V_{CM} , to assure that the output will remain in a Logic High state (that is, $V_O > 2.0\text{V}$). Common mode transient immunity in a 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 (that is, $V_O < 0.8\text{V}$).
- Under IPM (Intelligent Power Module) load and LED drive conditions: Common mode transient immunity in a Logic High level is the maximum tolerable dV_{CM}/dt on the leading edge of the common mode pulse, V_{CM} , to assure that the output will remain in a Logic High state (that is, $V_O > 3.0\text{V}$). Common mode transient immunity in a Logic Low level is the maximum tolerable 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 that is, $V_O < 1.0\text{V}$.

Package Characteristics

Over recommended temperature ($T_A = 0^\circ\text{C}$ to 70°C) unless otherwise specified. All typicals at $T_A = 25^\circ\text{C}$.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Test Conditions | Fig. | Notes |
|---|------------------|------------------------|------------------|------|------------------|--|------|-------|
| Input-Output Momentary Withstand Voltage ^a | V _{ISO} | 3750 | — | — | V _{rms} | RH ≤ 50%, t = 1 min, T _A = 25°C | | b, c |
| | | 5000 (For “ACPL-W454”) | | | | | | |
| Input-Output Resistance | R _{I-O} | — | 10 ¹² | — | Ω | V _{I-O} = 500V _{DC} | | b |
| Input-Output Capacitance | C _{I-O} | — | 0.6 | — | pF | f = 1 MHz; V _{I-O} = 0V _{DC} | | b |

- The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating. For the continuous voltage rating refer to the IEC/EN/DIN EN 60747-5-5 Insulation Characteristics Table (if applicable).
- Device considered a two-terminal device: Pins 1 and 3 shorted together and Pins 4, 5, and 6 shorted together.
- In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage $\geq 4500 V_{RMS}$ for 1 second (leakage detection current limit, $I_{I-O} \leq 5 \mu\text{A}$); each optocoupler under ACPL-W454 is proof tested by applying an insulation test voltage $\geq 6000 V_{RMS}$ for 1 second (leakage detection current limit, $I_{I-O} \leq 5 \mu\text{A}$).

Figure 1 DC and Pulsed Transfer Characteristics

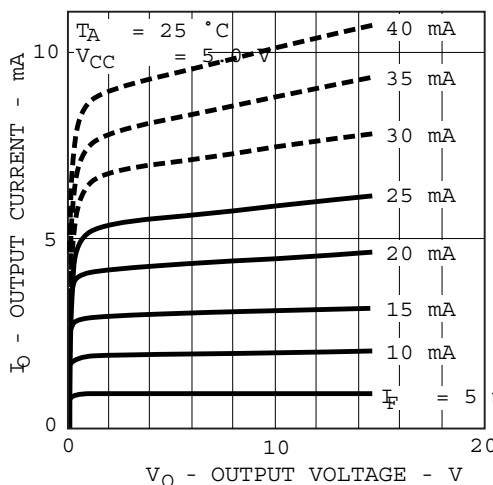


Figure 2 Current Transfer Ratio vs. Input Current

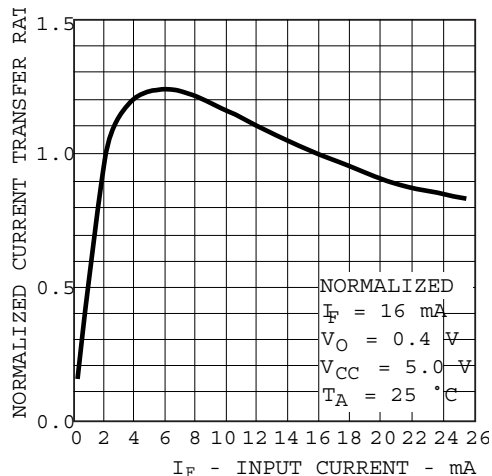


Figure 3 Input Current vs. Forward Voltage

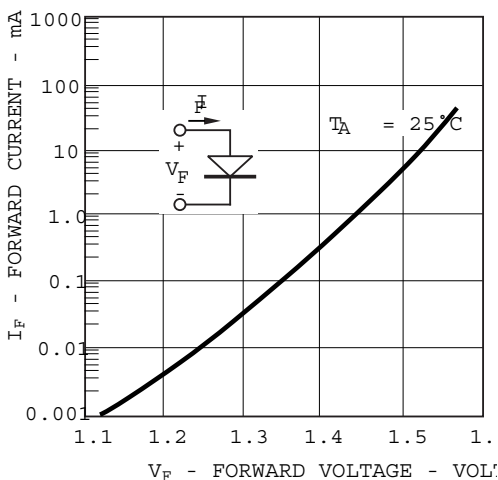


Figure 4 Current Transfer Ratio vs. Temperature

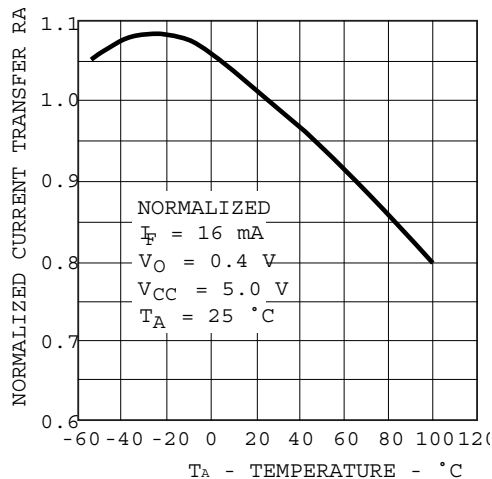


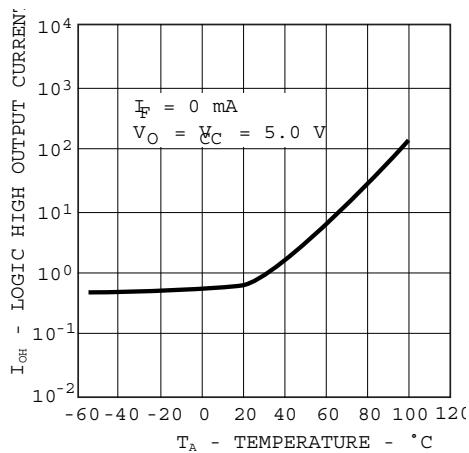
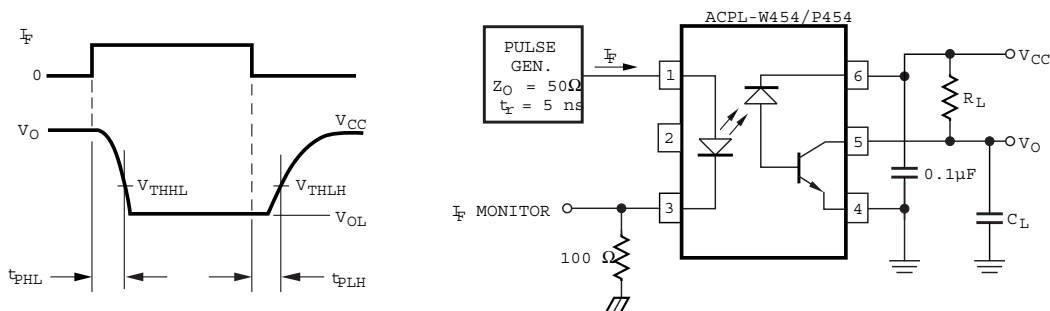
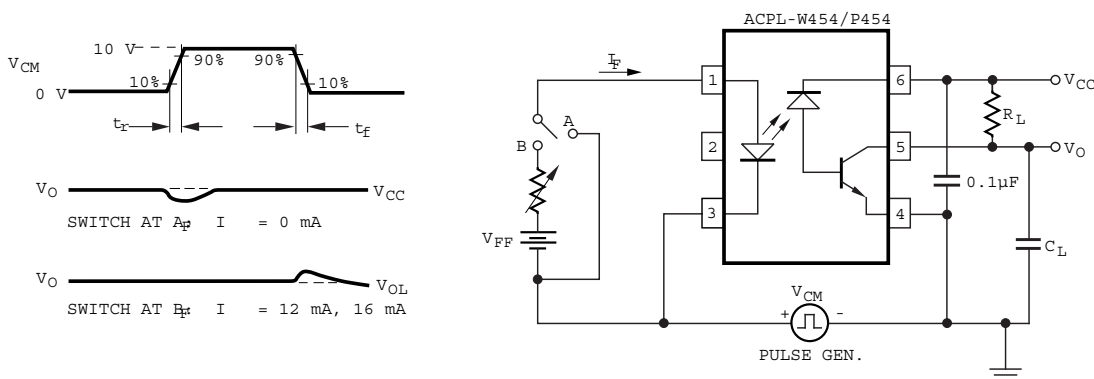
Figure 5 Logic High Output Current vs. Temperature**Figure 6 Switching Test Circuit****Figure 7 Test Circuit for Transient Immunity and Typical Waveforms**

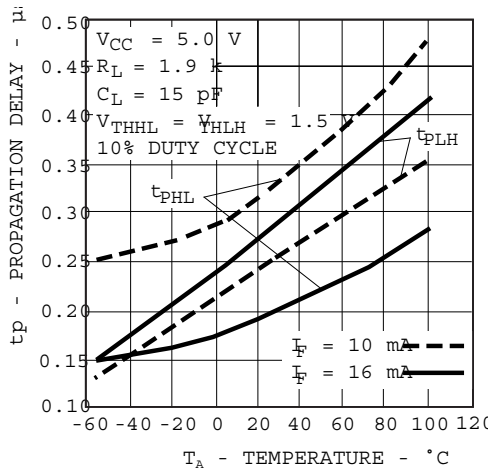
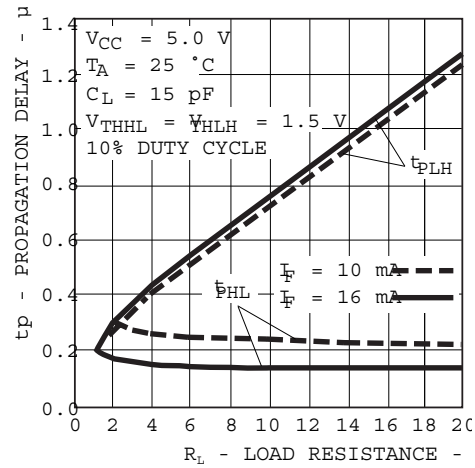
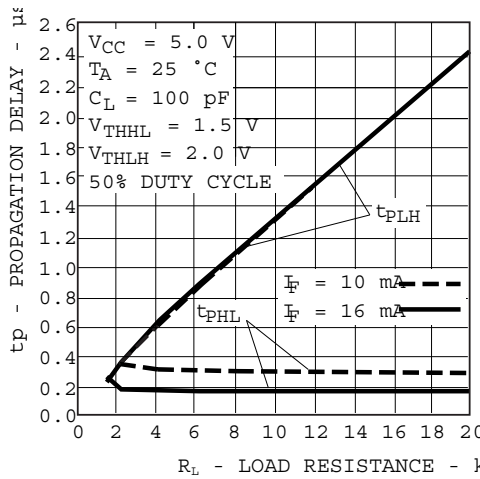
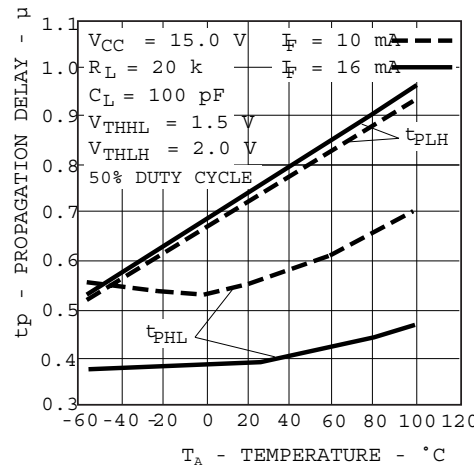
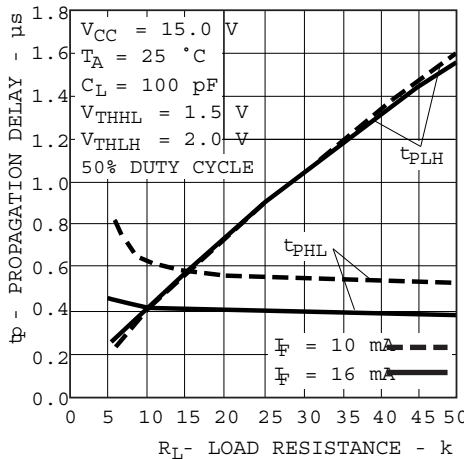
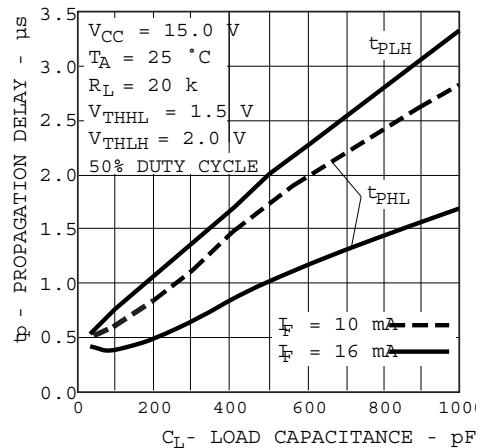
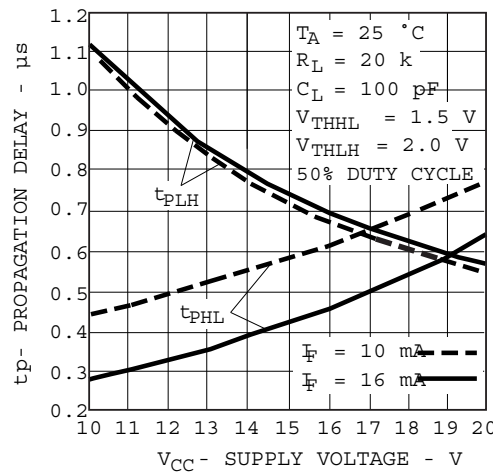
Figure 8 Propagation Delay Time vs. Temperature**Figure 9 Propagation Delay Time vs. Load Resistance****Figure 10 Propagation Delay Time vs. Load Resistance****Figure 11 Propagation Delay Time vs. Temperature****Figure 12 Propagation Delay Time vs. Load Resistance****Figure 13 Propagation Delay Time vs. Load Capacitance**

Figure 14 Propagation Delay Time vs. Supply Voltage



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