Data Sheet

# ACNT-H511/H511C

## Open-Collector Output Optocoupler in 15-mm Stretched SO8 Package

## Overview

The ACNT-H511/H511C is a single-channel open-collector output optocoupler in Stretched SO8 footprint. The ACNT-H511C is a high CTI optocoupler that can meet a wider range of creepage values for a higher working voltage or rated insulation voltage. With high CTI, material group upgrade to I, the overall creepage requirements will reduce by half.

The ACNT-H511/H511C uses an insulating layer between the light emitting diode and an integrated photon 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 photo-transistor coupler by reducing the base-collector capacitance.

The ACNT-H511/H511C with 15-mm creepage/clearance and high-voltage insulation capability is suitable for isolated communication logic interface and control in high-voltage power systems such as 690VAC drives, renewable inverters, energy storage, and medical equipment.

**Figure 1: Functional Diagram**

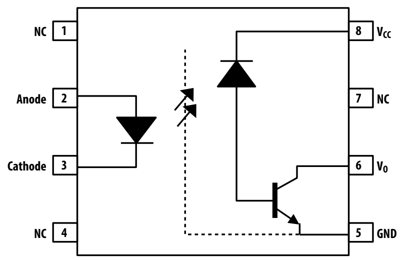



**Table 1: Truth Table**

| LED | Output |
|---|---|
| ON | L |
| OFF | H |

A 0.1-µF bypass capacitor must be connected between pins $V_{CC}$ and GND.

## Features

- CTI 600V, Material Group I (ACNT-H511C)
- TTL compatible
- Package: 15-mm stretched SO8 package
- Open-Collector Output
- 40 kV/µs typical common-mode rejection at $V_{CM}$ = 1500V
- Guaranteed performance within temperature range: –40°C to +105°C
- Worldwide safety approval:
  - UL1577 recognized: 7500$V_{RMS}$ for 1 minute
  - CSA approval
  - IEC 60747-5-5 approval for reinforced insulation

## Applications

- High-voltage power systems, for example, 690V AC drives
- Renewable energy inverters
- Feedback elements in switching power supplies
- Digital isolation for A/D, D/A conversion digital field
- Communications interface
- MCU interface

**CAUTION!** It is advised that normal static precautions be taken in handling and assembly of this component to prevent damage and/or degradation that may be induced by ESD. The components featured in this data sheet are not to be used in military or aerospace applications or environments.

# Ordering Information

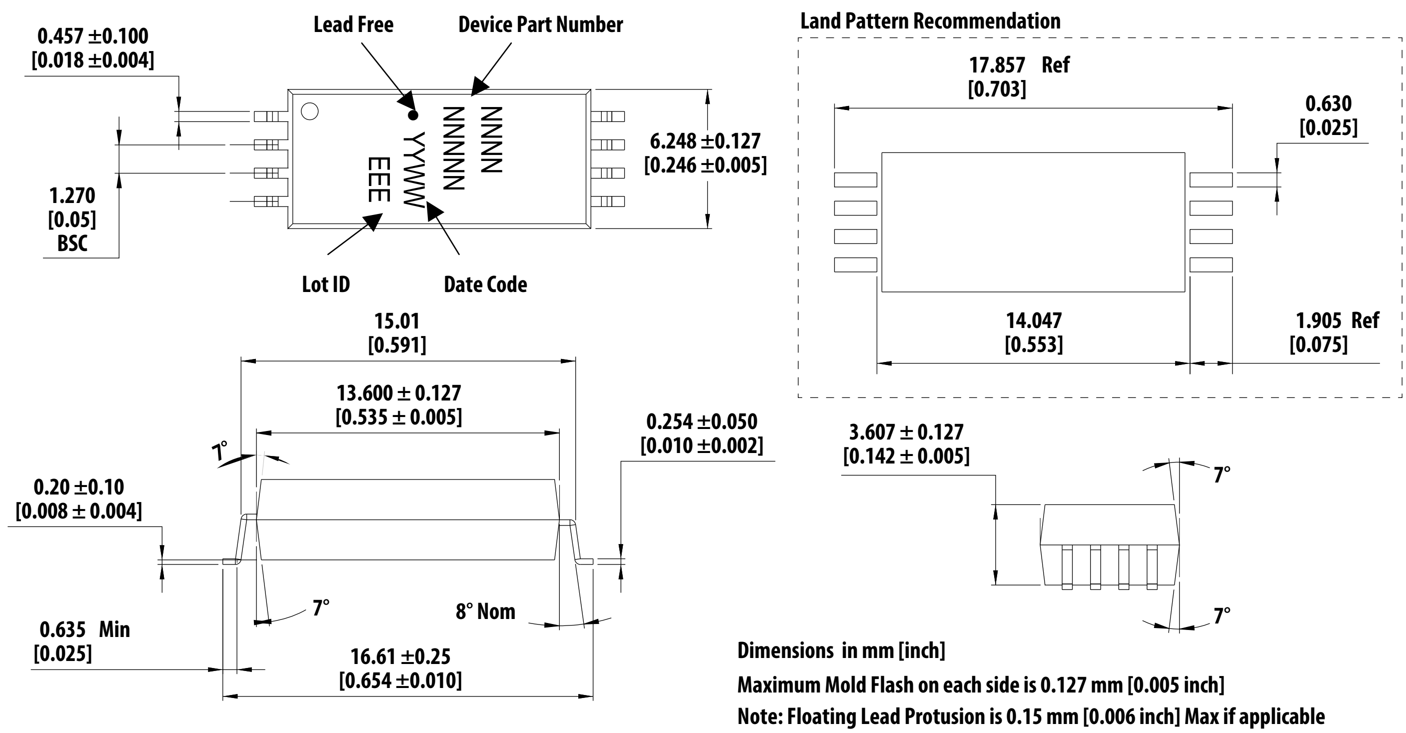
ACNT-H511/H511C is UL Recognized with $7500V_{rms}$ for 1 minute per UL1577.

| Part Number | Option RoHS Compliant | Package | Surface Mount | Tape and Reel | UL 1577 | IEC 60747-5-5 | Quantity |
|---|---|---|---|---|---|---|---|
| ACNT-H511/H511C | -000E | 15-mm Stretched SO8 | X | | X | X | 80 per tube |
| | -500E | | X | 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.

# Package Outline Drawing

## ACNT-H511/H511C Stretched SO8 Package




# Solder Reflow Profile

Recommended reflow conditions are as per JEDEC Standard, J-STD-020 (latest revision). Non-halide flux should be used.

# Regulatory Information

The ACNT-H511/H511C is approved by the following organizations:

| | |
|---|---|
| **UL** | Approval under UL 1577, component recognition program up to $V_{ISO}$ = 7500$V_{RMS}$ File E55361. |
| **CSA** | Approval under CSA Component Acceptance Notice #5, File CA 88324. |
| **IEC 60747-5-5** | Maximum Working Insulation Voltage $V_{IORM}$ = 2262$V_{PEAK}$ |

# Insulation and Safety Related Specifications

| Parameter | Symbol | ACNT-H511 | ACNT-H511C | Unit | Conditions |
|---|---|---|---|---|---|
| Minimum External Air Gap (External Clearance) | L(101) | 14.2 | | mm | Measured from input terminals to output terminals, shortest distance through air. |
| Minimum External Tracking (External Creepage) | L(102) | 15 | | mm | Measured from input terminals to output terminals, shortest distance path along body. |
| Minimum Internal Plastic Gap (Internal Clearance) | | 0.5 | | mm | Through insulation distance conductor to conductor, usually the straight line distance thickness between the emitter and detector. |
| Tracking Resistance (Comparative Tracking Index) | CTI | >300 | ≥600 | V | DIN IEC 112/VDE 0303 Part 1 |
| Isolation Group | | IIIa | I | | Material Group (DIN VDE 0110, 1/89, Table 1) |

# IEC 60747-5-5 Insulation Characteristics[a]

| Description | Symbol | Characteristic | Unit |
|---|---|---|---|
| Installation Classification per DIN VDE 0110/39, Table 1<br>for rated mains voltage ≤ 600$V_{RMS}$<br>for rated mains voltage ≤ 1000$V_{RMS}$ | | <br>I – IV<br>I – IV | |
| Climatic Classification | | 40/105/21 | |
| Pollution Degree (DIN VDE 0110/39) | | 2 | |
| Maximum Working Insulation Voltage | $V_{IORM}$ | 2262 | $V_{peak}$ |
| Input to Output Test Voltage, Method b[a]<br>$V_{IORM}$ x 1.875 = $V_{PR}$, 100% Production Test with $t_m$ = 1 sec, Partial Discharge < 5 pC | $V_{PR}$ | 4241 | $V_{peak}$ |
| Input to Output Test Voltage, Method a[a]<br>$V_{IORM}$ x 1.6 = $V_{PR}$, Type and Sample Test, $t_m$ = 10 sec, Partial Discharge < 5 pC | $V_{PR}$ | 3619 | $V_{peak}$ |
| Highest Allowable Overvoltage (Transient Overvoltage $t_{ini}$ = 60 sec) | $V_{IOTM}$ | 12000 | $V_{peak}$ |
| Safety-limiting values – Maximum Values Allowed in the Event of a Failure<br>Case Temperature<br>Input Current<br>Output Power | <br>$T_S$<br>$I_{S, INPUT}$<br>$P_{S, OUTPUT}$ | <br>150<br>230<br>1000 | <br>°C<br>mA<br>mW |
| Insulation Resistance at $T_S$, $V_{IO}$ = 500V | $R_S$ | $>10^9$ | Ω |

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

**NOTE:** These optocouplers are suitable for safe electrical isolation only within the safety limit data. Maintenance of the safety limit data shall be ensured by means of protective circuits.

# Absolute Maximum Ratings

| Parameter | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage Temperature | $T_S$ | –55 | 125 | °C |
| Operating Temperature | $T_A$ | –40 | 105 | °C |
| Average Forward Input Current | $I_{F(avg)}$ | — | 20 | mA |
| Peak Forward Input Current (<1 µs Pulse Width, <10% Duty Cycle) | $I_{F(peak)}$ | — | 80 | mA |
| Peak Transient Input Current (≤1 µs pulse width, <300 ps) | $I_{F(trans)}$ | — | 1 | A |
| Reversed Input Voltage | $V_R$ | — | 5 | V |
| Input Power Dissipation | $P_{IN}$ | — | 35 | mW |
| Output Power Dissipation | $P_O$ | — | 100 | mW |
| Output Current | $I_O$ | — | 12 | mA |
| Supply Voltage | $V_{CC}$ | –0.5 | 30 | V |
| Output Voltage | $V_O$ | –0.5 | 24 | V |
| Lead Solder Temperature | $T_{LS}$ | 260°C for 10 sec, 1.6 mm below seating plane | | |
| Solder Reflow Temperature Profile | | Refer to the Solder Reflow Profile section. | | |

# Recommended Operating Conditions

| Parameter | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 4.5 | 24 | V |
| Input Current, High Level | $I_{FH}$ | 10 | 18 | mA |
| Operating Temperature | $T_A$ | –40 | 105 | °C |
| Forward Input Voltage (OFF) | $V_{F(OFF)}$ | — | 0.8 | V |

# Electrical Specifications (DC)

Over recommended operating $T_A$ = –40°C to +105°C, supply voltage (4.5V ≤ $V_{CC}$ ≤ 24V) and unless otherwise specified. All typical values are at $T_A$ = 25°C.

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions | | | Figure |
|---|---|---|---|---|---|---|---|---|---|
| Current Transfer Ratio | CTR[a] | 31 | 50 | 80 | % | $T_A$ = 25°C | $V_O$ = 0.4V | $V_{CC}$ = 5V<br>$I_F$= 12 mA | 3 |
| | | 21 | — | — | % | | $V_O$ = 0.5V | | |
| Logic Low Output Voltage | $V_{OL}$ | — | 0.2 | 0.4 | V | $T_A$ = 25°C | $I_O$ = 3 mA | $V_{CC}$ = 5V<br>$I_F$ = 12 mA | |
| | | — | 0.2 | 0.5 | V | | $I_O$ = 1.6 mA | | |

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions | | | Figure |
|---|---|---|---|---|---|---|---|---|---|
| Logic High Output Current | $I_{OH}$ | — | 0.014 | 0.5 | µA | $T_A$ = 25°C | $V_O = V_{CC}$ = 5.5V | $I_F$ = 0 mA | 5 |
| | | — | 0.06 | 1 | | | $V_O = V_{CC}$ = 24V | | |
| | | — | — | 80 | | | $V_O = V_{CC}$ = 24V | | |
| Logic Low Supply Current | $I_{CCL}$ | — | 200 | 400 | µA | | $I_F$ = 12 mA, $V_O$ = open, $V_{CC}$ = 24V | | |
| Logic High Supply Current | $I_{CCH}$ | — | — | 2 | µA | | $I_F$ = 0 mA, $V_O$ = open, $V_{CC}$ = 24V | | |
| Input Forward Voltage | $V_F$ | 1.10 | 1.45 | 1.70 | V | | $I_F$ = 12 mA | | 2 |
| Input Reversed Breakdown Voltage | $BV_R$ | 7 | — | — | V | | $I_R$ =10 µA | | |
| Temperature Coefficient of Forward Voltage | $\Delta V_F/\Delta T_A$ | — | –1.5 | — | mV/°C | | $I_F$ =12 mA | | |
| Input Capacitance | $C_{IN}$ | — | 20 | — | pF | | f = 1 MHz, $V_F$ = 0 | | |

a. 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%.

# Switching Specifications

Over recommended operating ($T_A$ = –40°C to +105°C), $I_F$ = 12 mA, (4.5V ≤ $V_{CC}$ ≤ 24V), unless otherwise specified.

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions | | Figure |
|---|---|---|---|---|---|---|---|---|
| Propagation Delay Time to Logic Low at Output | $T_{PHL}$ | — | 0.1 | 2.0 | µs | $T_A$ = 25°C | Pulse: f = 10 kHz, Duty cycle = 50%, $V_{CC}$ = 5.0V, $R_L$= 1.6 kΩ, $C_L$ = 15 pF, $V_{THHL}$ = 1.5V | 13 |
| | | — | — | 2.0 | µs | | | 6, 13 |
| | | — | 0.15 | 2.0 | µs | $T_A$ = 25°C | Pulse: f = 10 kHz, Duty cycle = 50%, $V_{CC}$ = 24V, $R_L$= 8.2 kΩ, $C_L$ = 15 pF, $V_{THHL}$ = 1.5V | 13 |
| | | — | — | 2.0 | µs | | | 7, 13 |
| Propagation Delay Time to Logic High at Output | $T_{PLH}$ | — | 0.4 | 2.0 | µs | $T_A$ = 25°C | Pulse: f = 10 kHz, Duty cycle = 50%, $V_{CC}$ = 5.0V, $R_L$ = 1.6 kΩ, $C_L$ = 15 pF, $V_{THLH}$ = 2.0V | 13 |
| | | — | — | 2.0 | µs | | | 6, 13 |
| | | — | 0.4 | 2.0 | µs | $T_A$ = 25°C | Pulse: f = 10 kHz, Duty cycle = 50%, $V_{CC}$ = 24V, $R_L$ = 8.2 kΩ, $C_L$ = 15 pF, $V_{THLH}$ = 2.0V | 13 |
| | | — | — | 2.0 | µs | | | 7, 13 |
| Propagation Delay Difference Between Any Two Parts[a] | tpsk | — | 0.3 | 2.0 | µs | $T_A$ = 25°C | Pulse: f = 10 kHz, Duty cycle = 50%, $V_{CC}$ = 5.0V, $R_L$ = 1.6 kΩ, $C_L$ = 15 pF, $V_{THHL}$ = 1.5V, $V_{THLH}$ = 2.0V | |
| | | — | 0.3 | 2.0 | µs | $T_A$ = 25°C | Pulse: f = 10 kHz, Duty cycle = 50%, $V_{CC}$ = 24V, $R_L$ = 8.2 kΩ, $C_L$ = 15 pF, $V_{THHL}$ = 1.5V, $V_{THLH}$ = 2.0V | |

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions | | Figure |
|---|---|---|---|---|---|---|---|---|
| Common-Mode Transient Immunity at Logic High Output[b] | $\|CM_H\|$ | — | 40 | — | kV/µs | $T_A = 25°C$ | $V_{CM} = 1500V$, $I_F = 0$ mA, $R_L = 1.0$ kΩ or 1.6 kΩ, $V_{CC} = 5V$ | 14 |
| Common-Mode Transient Immunity at Logic Low Output[c] | $\|CM_L\|$ | — | 40 | — | kV/µs | $T_A = 25°C$ | $V_{CM} = 1500V$, $I_F = 12$ mA, $R_L = 1.6$ kΩ, $V_{CC} = 5V$ | 14 |

a. The difference between $t_{PLH}$ and $t_{PHL}$ between any two parts under the same test condition.

b. Common transient immunity in a Logic High level is the maximum tolerable (positive) $dV_{CM}/dt$ on the rising edge of the common-mode pulse, $V_{CM}$, to assure that the output remains in a Logic High state.

c. Common-mode transient immunity in a Logic Low level is the maximum tolerable (negative) $dV_{CM}/dt$ on the falling edge of the common-mode pulse signal, $V_{CM}$ to assure that the output remains in a Logic Low state.

# Package Characteristics

All Typical at $T_A = 25°C$.

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Test Conditions |
|---|---|---|---|---|---|---|
| Input-Output Momentary Withstand Voltage[a] | $V_{ISO}$ | 7500 | — | — | $V_{RMS}$ | RH ≤ 50%, t = 1 min., $T_A = 25°C$ |
| Input-Output Resistance[a] | $R_{I-O}$ | — | $10^{14}$ | — | Ω | $V_{I-O} = 500V$ DC |
| Input-Output Capacitance[a] | $C_{I-O}$ | — | 0.6 | — | pF | f = 1 MHz, $T_A = 25°C$ |

a. Device considered a two terminal device: pins 2 and 3 shorted together and pins 5, 6, and 8 shorted together.

**Figure 2: Input Current vs. Forward Voltage**

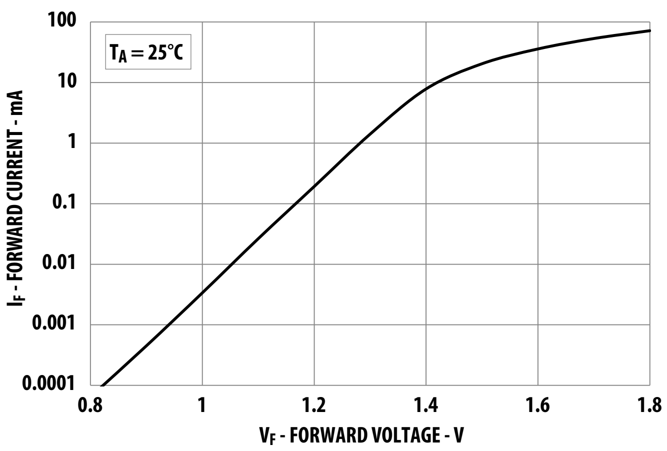



**Figure 3: Typical Current Transfer Ratio vs. Temperature**

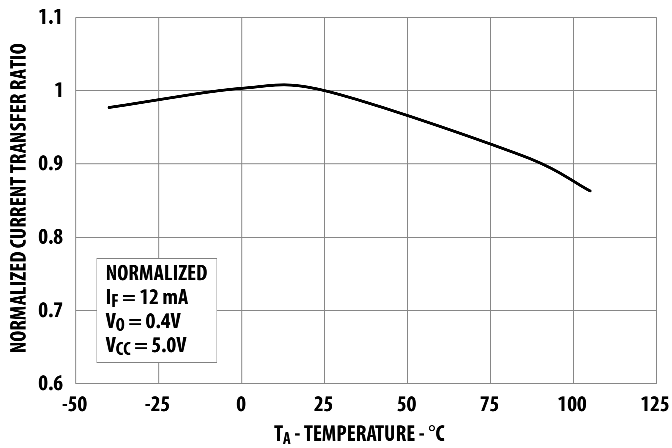



**Figure 4: Typical Current Transfer Ratio vs. Temperature**

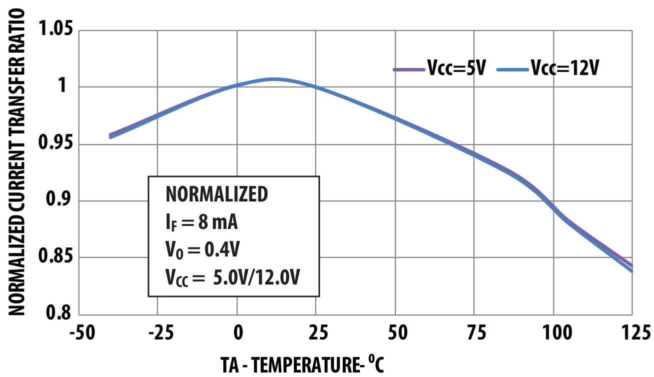



**Figure 5: Typical Logic High Output Current vs. Temperature**

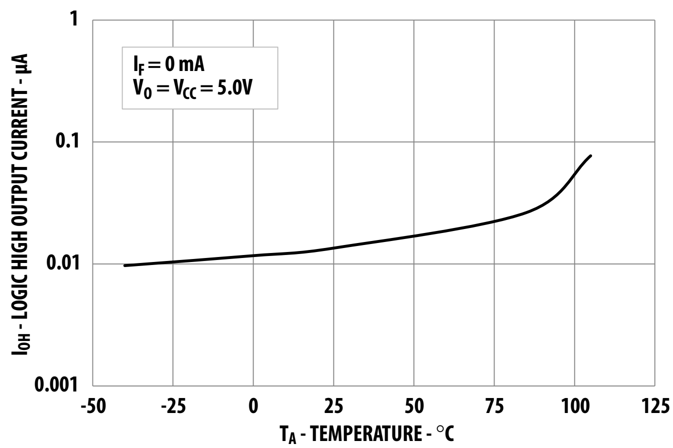



**Figure 6: Typical Propagation Delay vs. Temperature**

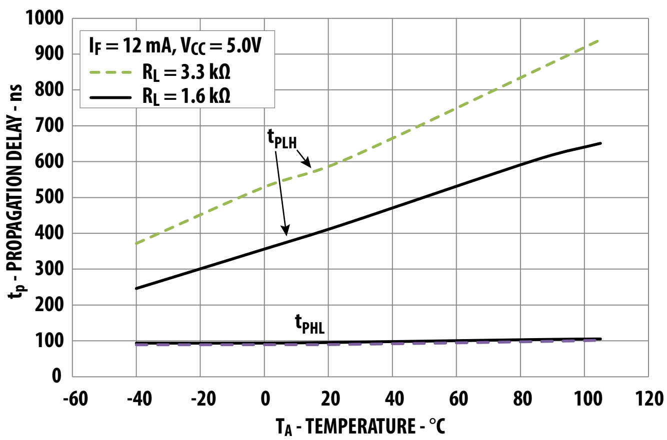



**Figure 7: Typical Propagation Delay vs. Temperature**

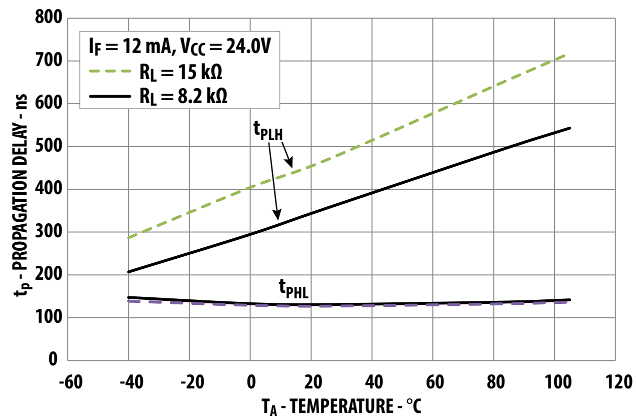


**Figure 8: Typical Propagation Delay vs. Load Resistance**

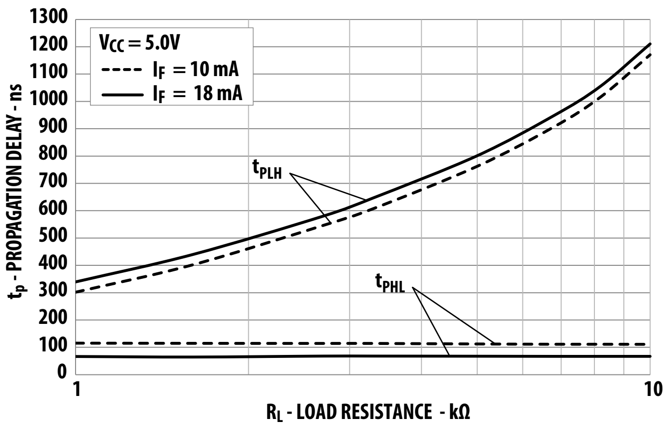



**Figure 9: Typical Propagation Delay vs. Supply Voltage**

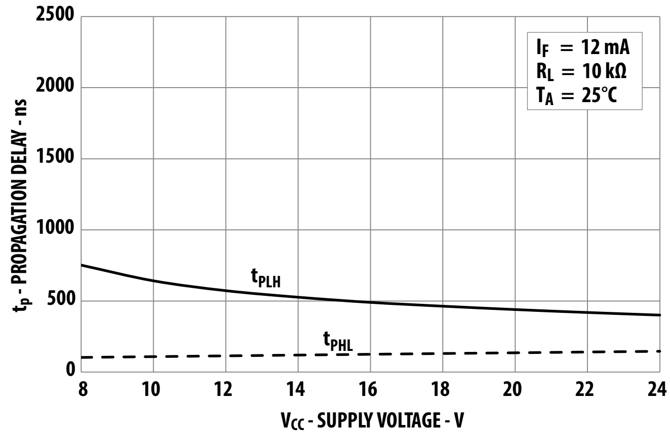



**Figure 10: Typical Propagation Delay vs. Input Current**

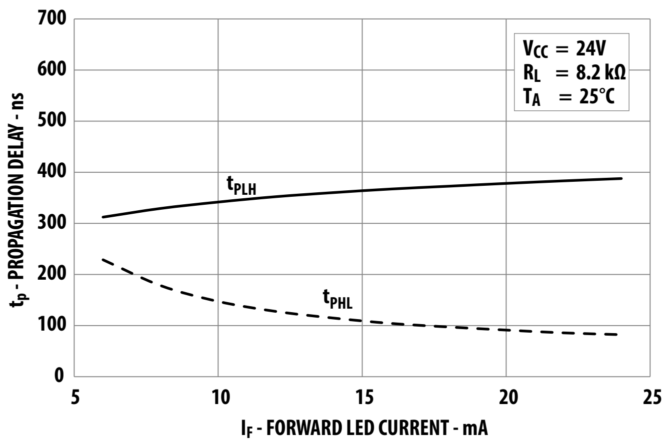



**Figure 11: Current Transfer Ratio vs Input Current**

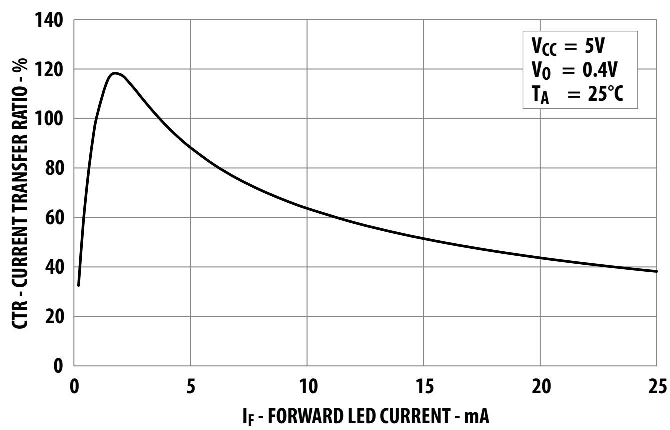
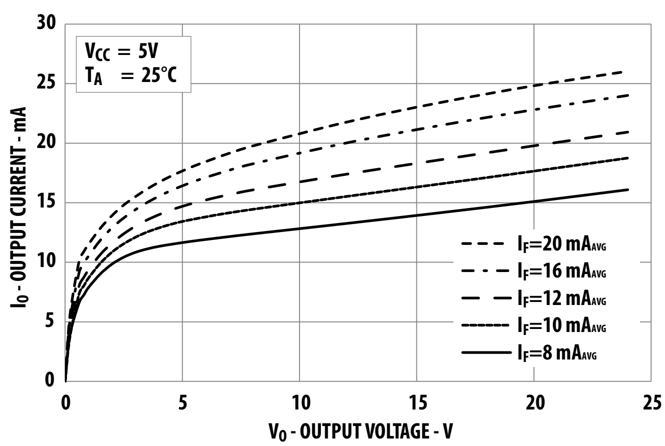
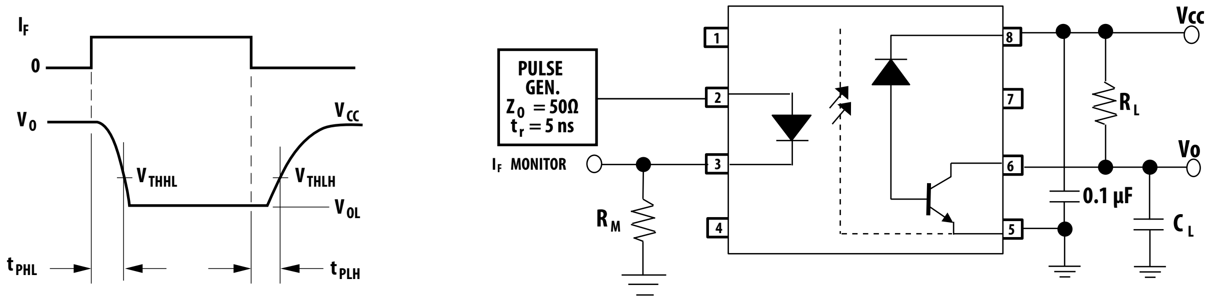



**Figure 12: DC Pulse Transfer Characteristic**



# Test Circuits

### Figure 13: Switching Test Circuits




### Figure 14: Test Circuit for Transient Immunity and Typical Waveforms