ACPL-M49T

Wide Operating Temperature Automotive R²Coupler™ 20kBd Digital Optocoupler Configurable as Low Power, Low Leakage Phototransistor

Data Sheet

Lead (Pb) Free
RoHS 6 fully compliant

RoHS 6 fully compliant options available;
-xxxE denotes a lead-free product

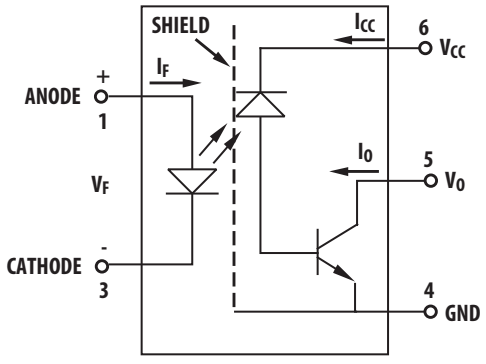
Description

The ACPL-M49T is a single channel, high temperature, high CMR, 20kBd digital optocoupler, configurable as a low power, low leakage phototransistor, specifically for use in the automotive applications. The SO-5 JEDEC registered (MO-155) package outline is surface mountable.

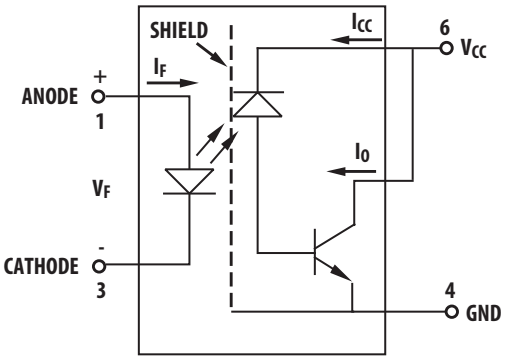
This digital optocoupler uses an insulating layer between the light emitting diode and an integrated photo detector to provide electrical insulation between input and output. Separate connections for the photodiode bias and output transistor collector in a 5-pin configuration increase the speed up to a hundred times over that of a conventional phototransistor by reducing the base-collector capacitance. Common connections with the supply and output pins shorted in a 4-pin configuration delivers low power, low leakage performance as a phototransistor. The ACPL-M49T has an increased common mode transient immunity of 15kV/µs minimum at V_{CM} = 1500V over extended temperature range.

Avago R²Coupler isolation products provide the reinforced insulation and reliability needed for critical in automotive and high temperature industrial applications.

Functional Diagrams



Note: The connection of a 0.1 µF bypass capacitor between pins 4 and 6 is recommended for 5-pin configuration



Note: Pins 5 and 6 are externally shorted for 4-pin configuration.

Features

- High Temperature and Reliable low speed digital interface for Automotive Application.
- 30 kV/µs High Common-Mode Rejection at V_{CM} = 1500 V (typ)
- Low Power, Low Leakage Phototransistor in a 4-Pin Configuration"
- Compact, Auto-Insertable SO5 Packages
- Wide Temperature Range: -40°C ~ 125°C
- Low LED Drive Current: 4mA (typ)
- Propagation Delay: 20µs (max)
- Worldwide Safety Approval:
  - UL 1577, 4000 V_{RMS} /1 min.
  - CSA File CA88324, Notice #5
  - IEC/EN/DIN EN 60747-5-2
- Qualified to Automotive AEC-Q100 Grade 1 Stress Test Guidelines

Applications

- Automotive Low Speed Digital Signal isolation Interface
- Inverter fault feedback signal isolation
- Switching Power Supplies feedback circuit

LED	Vo
ON	LOW
OFF	HIGH

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.*

Ordering Information

Part Number	Option (RoHS) Compliant	Package	Surface Mount	Tape & Reel	IEC/EN/DIN EN 60747-5-2	Quantity
ACPL-M49T	-000E	SO-5	X			100 per tube
	-060E		X		X	100 per tube
	-500E		X	X		1500 per reel
	-560E		X	X	X	1500 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.

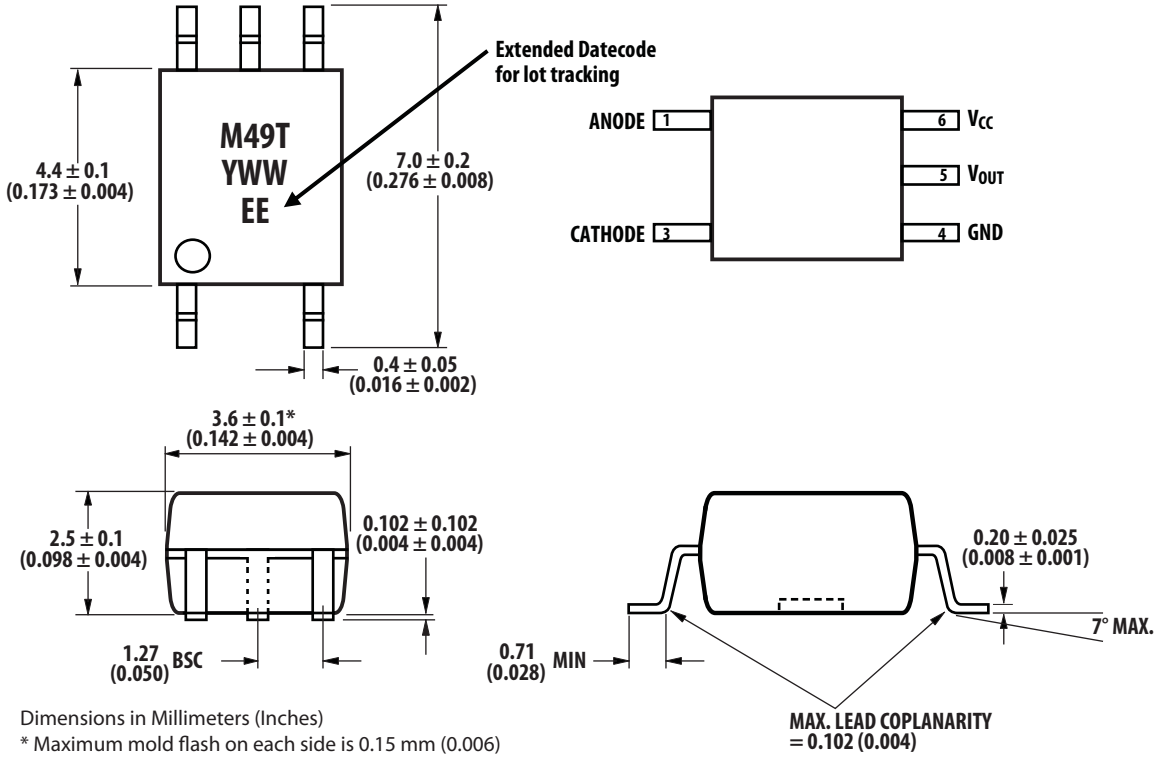
Example:

ACPL-M49T-500E to order product of Mini-flat Surface Mount 5-pin package in Tape and Reel packaging with RoHS compliant.

Option datasheets are available. Contact your Avago sales representative or authorized distributor for information.

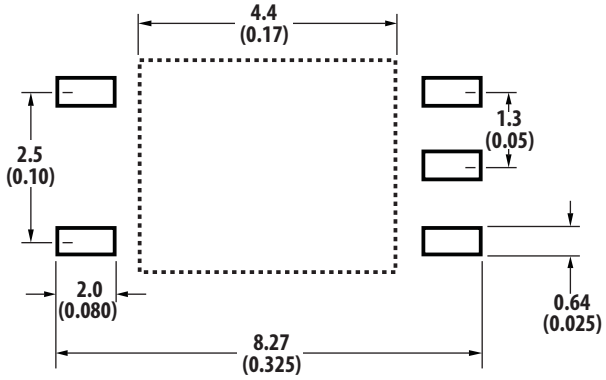
Package Outline Drawings

ACPL-M49T Small Outline SO-5 Package (JEDEC MO-155)



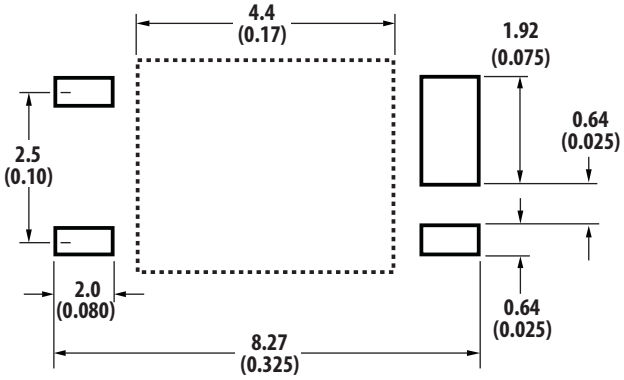
Dimensions in Millimeters (Inches)
* Maximum mold flash on each side is 0.15 mm (0.006)
Note: Floating lead protrusion is 0.15 mm (6 mils) max.

Land Pattern Recommendation



Dimension in Millimeters (Inches)

Land Pattern Recommendation (4-pin Configuration)



Dimension in Millimeters (Inches)

Recommended Pb-Free IR Profile

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

Note: Non-halide flux should be used.

Regulatory Information

The ACPL-M49T is approved by the following safety regulatory organizations:

UL

Approved under UL 1577, component recognition program up to V_{ISO}=4000 V_{RMS}

CSA

Approved under CSA Component Acceptance Notice #5.

IEC/EN/DIN EN 60747-5-2

IEC 60747-5-5

EN 60747-5-2

DIN EN 60747-5-2

IEC/EN/DIN EN 60747-5-2 Insulation Characteristics*

Description	Symbol	Characteristic	Unit
Installation classification per DIN VDE 0110/1.89, Table 1			
for rated mains voltage ≤ 150 V_{rms}		I – IV	
for rated mains voltage ≤ 300 V_{rms}		I – III	
for rated mains voltage ≤ 600 V_{rms}		I – II	
Climatic Classification		55/125/21	
Pollution Degree (DIN VDE 0110/1.89)		2	
Maximum Working Insulation Voltage	V_{IORM}	567	V_{peak}
Input to Output Test Voltage, Method b* V_{IORM} x 1.875 = V_{PR}, 100% Production Test with t_m = 1 sec, Partial discharge < 5 pC	V_{PR}	1063	V_{peak}
Input to Output Test Voltage, Method a* V_{IORM} x 1.6 = V_{PR}, Type and Sample Test, t_m = 10 sec, Partial discharge < 5 pC	V_{PR}	907	V_{peak}
Highest Allowable Overvoltage (Transient Overvoltage t_{ini} = 60 sec)	V_{IOTM}	6000	V_{peak}
Safety-limiting values – maximum values allowed in the event of a failure.			
Case Temperature	T_S	175	°C
Input Current	$I_{S, INPUT}$	230	mA
Output Power	$P_{S, OUTPUT}$	600	mW
Insulation Resistance at T_S, V_{IO} = 500 V	R_S	$>10^9$	Ω

* Refer to the optocoupler section of the Isolation and Control Components Designer's Catalog, under Product Safety Regulations section, (IEC/EN/DIN EN 60747-5-2) for a detailed description of Method a and Method b partial discharge test profiles.

Insulation and Safety Related Specifications

Parameter	Symbol	ACPL-M49T	Units	Conditions
Minimum External Air Gap (Clearance)	L(101)	≥ 5	mm	Measured from input terminals to output terminals, shortest distance through air.
Minimum External Tracking (Creepage)	L(102)	≥ 5	mm	Measured from input terminals to output terminals, shortest distance path along body.
Minimum Internal Plastic Gap (Internal Clearance)		0.08	mm	Through insulation distance conductor to conductor, usually the straight line distance thickness between the emitter and detector.
Tracking Resistance (Comparative Tracking Index)	CTI	175	V	DIN IEC 112/VDE 0303 Part 1
Isolation Group (DIN VDE0109)		IIIa		Material Group (DIN VDE 0109)

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Note
Storage Temperature		T_S	-55	150	°C	
Operating Temperature		T_A	-40	125	°C	
Lead Soldering Cycle	Temperature			260	°C	
	Time			10	s	
Average Forward Input Current		$I_{F(avg)}$		20	mA	1
Peak Forward Input Current (50% duty cycle, 1ms pulse width)		$I_{F(peak)}$		40	mA	2
Peak Transient Input Current (<=1us pulse width, 300ps)		$I_{F(trans)}$		100	mA	2
Reversed Input Voltage		V_R		5	V	Pin 3 - 1
Input Power Dissipation		P_{IN}		30	mW	3
Output Power Dissipation		P_O		100	mW	4
Average Output Current		I_O		8	mA	
Peak Output Current		$I_{o(pk)}$		16	mA	
Supply Voltage (Pins 6-4)		V_{CC}	-0.5	30	V	
Output Voltage (Pins 5-4)		V_O	-0.5	20	V	
Solder Reflow Temperature Profile				See Reflow Temperature Profile		

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units	Note
Supply Voltage	V_{CC}		20.0	V	
Operating Temperature	T_A	-40	125	°C	

Electrical Specifications (DC) for 5-Pin Configuration

Over recommended operating T_A = -40°C to 125°C, unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions			Fig.	Note
Current Transfer Ratio	CTR	32	45	80	%	T_A=25°C	V_O=0.4V	V_{CC}=4.5V, I_F=10mA	1, 2	5
		20	45				V_O=0.5V			
			58			T_A=25°C	V_O=0.5V	V_{CC}=4.5V, I_F=4mA	1, 2	5
Logic Low Output Voltage	V_{OL}		0.1	0.4	V	T_A=25°C	I_O=3mA	V_{CC}=4.5V, I_F=10mA	3	
				0.5			I_O=2.4mA			
Logic High Output Current	I_{OH}		0.003	0.5	µA	T_A=25°C	V_O=V_{CC}=5.5V	I_F=0mA	7	
			0.01	1		T_A=25°C	V_O=V_{CC}=15V			
				5						
Logic Low Supply Current	I_{CCL}		50	200		I_F=10mA, V_O=open, V_{CC}=15V				
Logic High Supply Current	I_{CCH}		0.02	1		T_A=25°C	I_F=0mA, V_O=open, V_{CC}=15V			
				2.5						
Input Forward Voltage	V_F	1.45	1.5	1.75	V	I_F=10mA, T_A=25°C			5	
		1.25	1.5	1.85		I_F=10mA, T_A= Across Temperature				
			1.5			I_F=4mA, T_A=25°C				
Input Reversed Breakdown Voltage	BV_R	5				I_R=10µA				
Temperature Coefficient of Forward Voltage	$\Delta V/\Delta T_A$		-1.5		mV/°C	I_F=10mA				
Input Capacitance	C_{IN}		90		pF	F=1MHz, V_F=0				

Switching Specifications (AC) for 5-Pin Configuration

Over recommended operating (T_A = -40°C to 125°C), V_{CC} = 5.0 V unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions		Fig.	Note
Propagation Delay Time to Logic Low at Output	t_{PHL}	–	–	20	µs	Pulse: f=10kHz, Duty cycle = 50%, I_F=4mA, V_{CC}=5.0 V, R_L=8.2kΩ, C_L=15pF V_{THHL}=1.5V		9	
Propagation Delay Time to Logic High at Output	t_{PLH}	–	–	20	µs	Pulse: f=10kHz, Duty cycle = 50%, I_F=4mA, V_{CC}=5.0 V, R_L=8.2kΩ, C_L=15pF V_{THLH}=2.0V		9	
Common Mode Transient Immunity at Logic High Output	$\|CM_H\|$	15	30		kV/µs	I_F=0mA	V_{CM}=1500V_{p-p}, T_A=25°C, R_L=8.2kΩ	10	9
Common Mode Transient Immunity at Logic Low Output	$\|CM_L\|$	15	30		kV/µs	I_F=10mA	V_{CM}=1500V_{p-p}, T_A=25°C, R_L=8.2kΩ		
Common Mode Transient Immunity at Logic Low Output	$\|CM_L\|$	–	15		kV/µs	I_F=4mA	V_{CM}=1500V_{p-p}, T_A=25°C, R_L=8.2kΩ		

Electrical Specifications (DC) for 4-Pin Configuration

Applicable for $V_{CC} = V_O$. Over recommended operating T_A = -40°C to 125°C, unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions	Fig.	Note
Current Transfer Ratio	CTR		120		%	T_A=25°C, I_F=5mA, V_{CC}=V_O=5V	4	5, 8
Current Transfer Ratio	CTR (Sat)	20	45		%	I_F=10mA, V_{CC}=V_O=0.5V	5	5, 8
			58			I_F=4mA		
Logic Low Output Voltage	V_{OL}		0.1	0.4	V	T_A=25°C, I_O=3mA, I_F=10mA	5	8
				0.5		I_O=2.4mA		
Off-State Current	$I_{(CEO)}$		0.0001	5	µA	V_O=V_{CC}=15V, I_F=0mA	8	8
Input Forward Voltage	V_F	1.45	1.5	1.75	V	I_F=10mA, T_A=25°C	6	
		1.25	1.5	1.85		I_F=10mA, T_A= Across Temperature		
			1.45			I_F=4mA, T_A=25°C		
Temperature Coefficient of Forward Voltage	$\Delta V/\Delta T_A$		-1.5		mV/°C	I_F=10mA		
Input Reversed Breakdown Voltage	BV_R	5				I_R=10µA		
Input Capacitance	C_{IN}		90		pF	F=1MHz, V_F=0		
Output Capacitance	C_{CE}		35		pF	F=1MHz, V_F=0, V_O=V_{CC}=0V		8

Switching Specifications (AC) for 4-Pin Configuration

Over recommended operating (T_A = -40°C to 125°C), V_{CC} = 5.0 V unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Propagation Delay Time to Logic Low at Output	t_{PHL}	–	2	100	µs	Pulse: f=1kHz, Duty cycle = 50%, I_F=4mA, V_{CC}=5.0 V, R_L=8.2kΩ, C_L=15pF V_{THHL}=1.5V	10	8
Propagation Delay Time to Logic High at Output	t_{PLH}	–	19	100	µs	Pulse: f=1kHz, Duty cycle = 50%, I_F=4mA, V_{CC}=5.0 V, R_L=8.2kΩ, C_L=15pF V_{THLH}=2.0V	10	8
Common Mode Transient Immunity at Logic High Output	$\|CM_H\|$	15	30		kV/µs	I_F=0mA, V_{CM}=1500V_{p-p}, T_A=25°C, R_L=8.2kΩ	12	8, 9
Common Mode Transient Immunity at Logic Low Output	$\|CM_L\|$	15	30		kV/µs	I_F=4mA, V_{CM}=1500V_{p-p}, T_A=25°C, R_L=8.2kΩ		

Package Characteristics

*The Input-Output Momentary Withstand Voltage is a dielectric voltage rating that should not be interpreted as an input-output continuous voltage rating.

Parameter	Symbol	Min.	Typ.	Max.	Units	Test Conditions	Fig.	Note
Input-Output Momentary Withstand Voltage*	V_{ISO}	4000			V_{RMS}	RH ≤ 50%, t = 1 min; T_A = 25°C		6, 7
Input-Output Resistance	R_{I-O}		10^{14}		Ω	V_{I-O} = 500 V_{DC}		6
Input-Output Capacitance	C_{I-O}		0.6		pF	f = 1 MHz; V_{I-O} = 0 V_{DC}		6

Notes:
1. Derate linearly above 85°C free-air temperature at a rate of 0.25mA/°C.
2. Derate linearly above 85°C free-air temperature at a rate of 0.30mA/°C.
3. Derate linearly above 85°C free-air temperature at a rate of 0.375mW/°C.
4. Derate linearly above 85°C free-air temperature at a rate of 1.875mW/°C.
5. 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.
6. Device considered a two terminal device: pins 1 and 3 shorted together, and pins 4,5,and 6 shorted together.
7. In accordance with UL 1577, each optocoupler is proof tested by applying an insulation test voltage ≥ 4800V_{RMS} for 1 second.
8. This is in a 4-pin configuration where the V_{CC} and V_O pin are shorted together.
9. 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 ouput will remain in a Logic High state (i.e., Vo > 2.0V). 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 will remain in a Logic Low state (i.e., Vo < 0.8V).

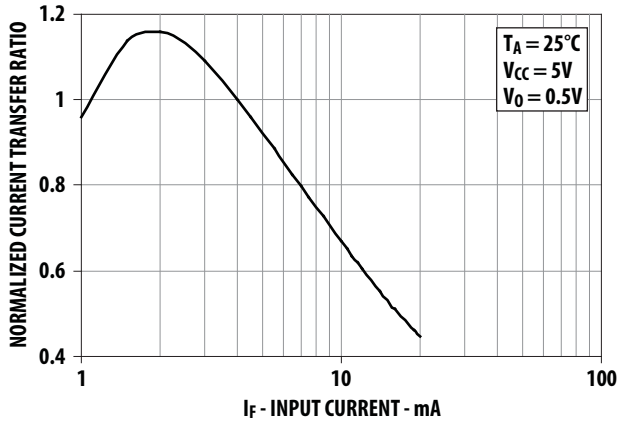


Figure 1. Normalized Current Transfer Ratio (I_F = 4mA as reference) vs Input Current

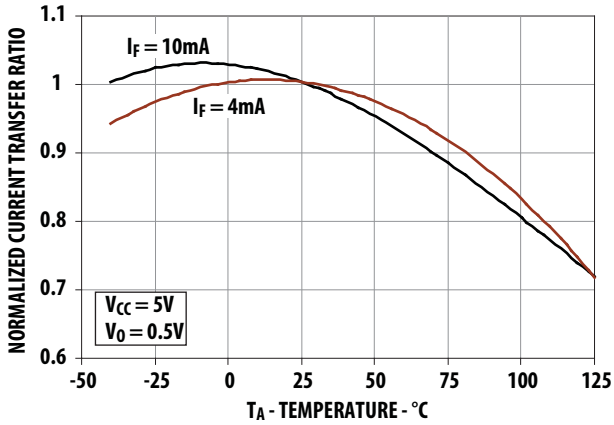


Figure 2. Normalized Current Transfer Ratio (T_A = 25°C as reference) vs Temperature

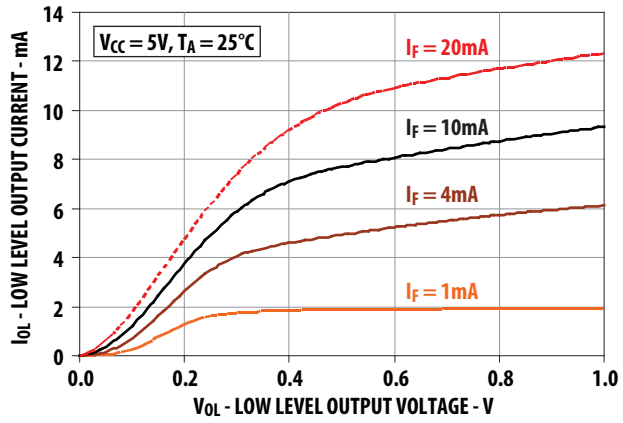


Figure 3. Typical Low Level Output Current vs Output Voltage

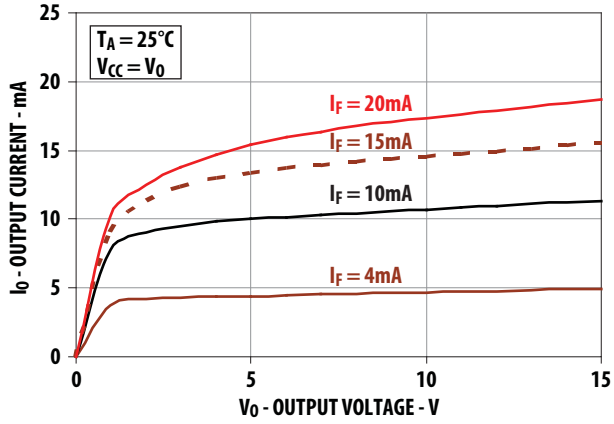


Figure 4. Output Current vs Output Voltage (4-Pin Configuration)

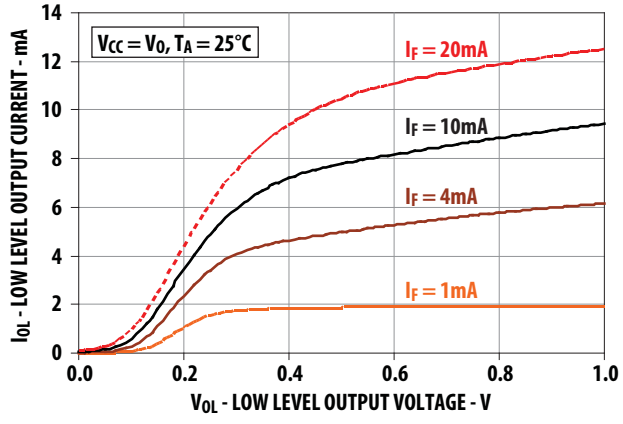


Figure 5. Typical Low Level Output Current vs Output Voltage (4-Pin Configuration)

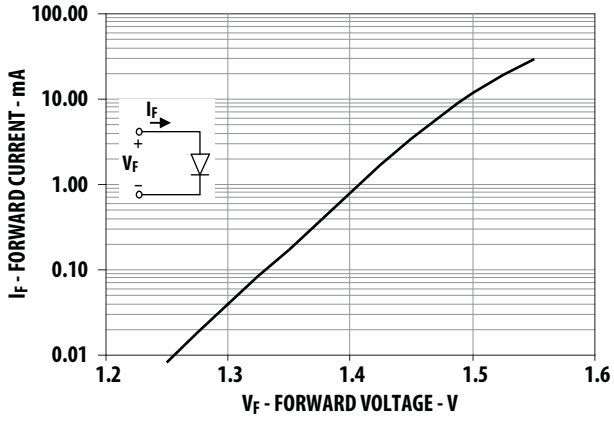


Figure 6. Typical Input Current vs Forward Voltage

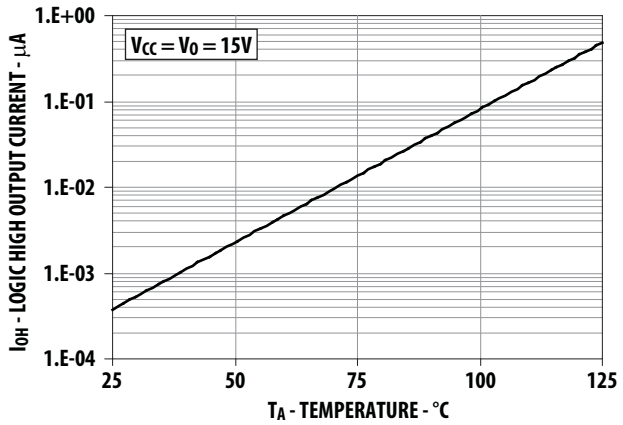


Figure 7. Typical High Level Output Current vs Temperature

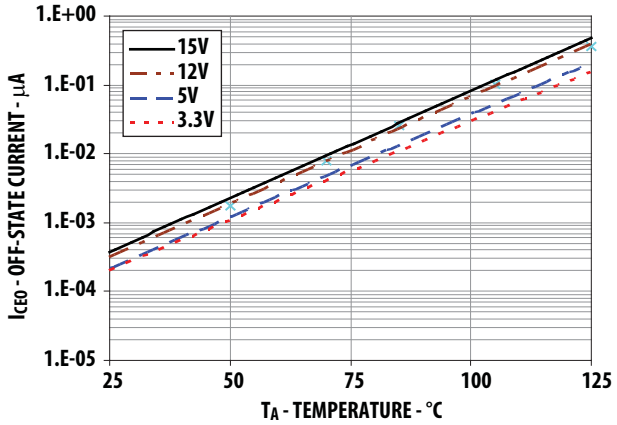


Figure 8. Typical Off-State Current vs Temperature (4-Pin Configuration)

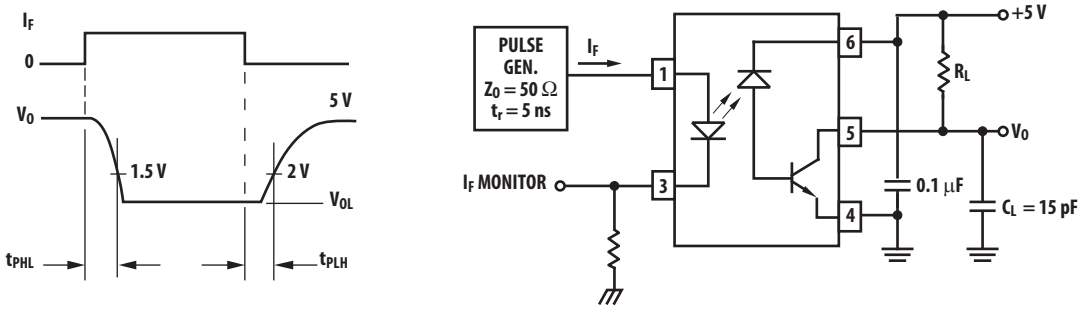


Figure 9. Switching Test Circuit

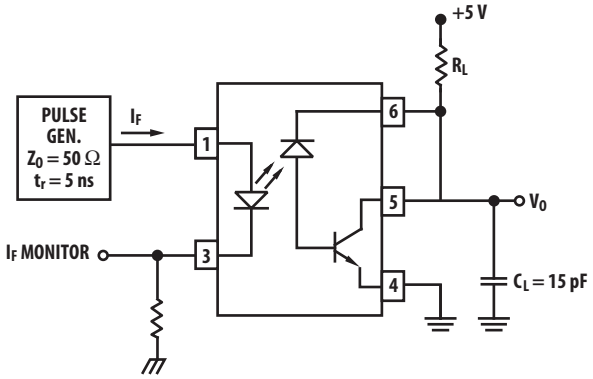


Figure 10. Switching Test Circuit (4-pin configuration)

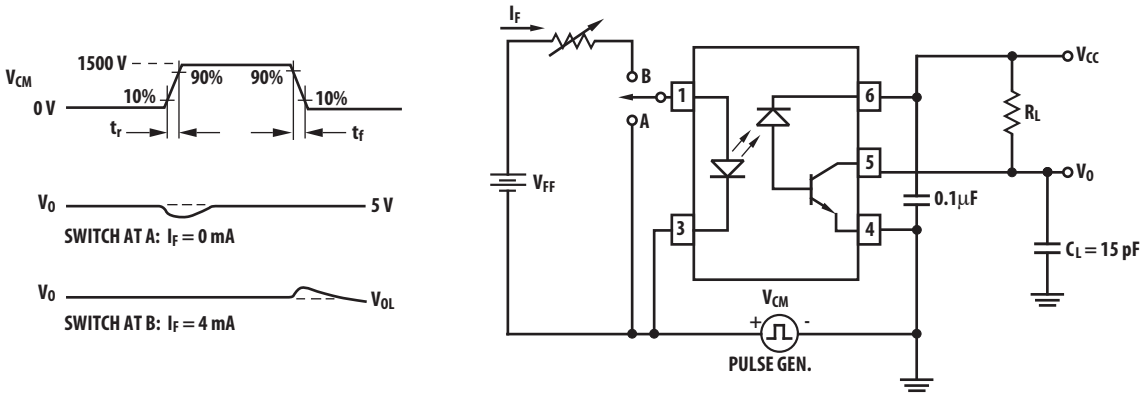


Figure 11. Test Circuit for Transient Immunity and Typical Waveforms

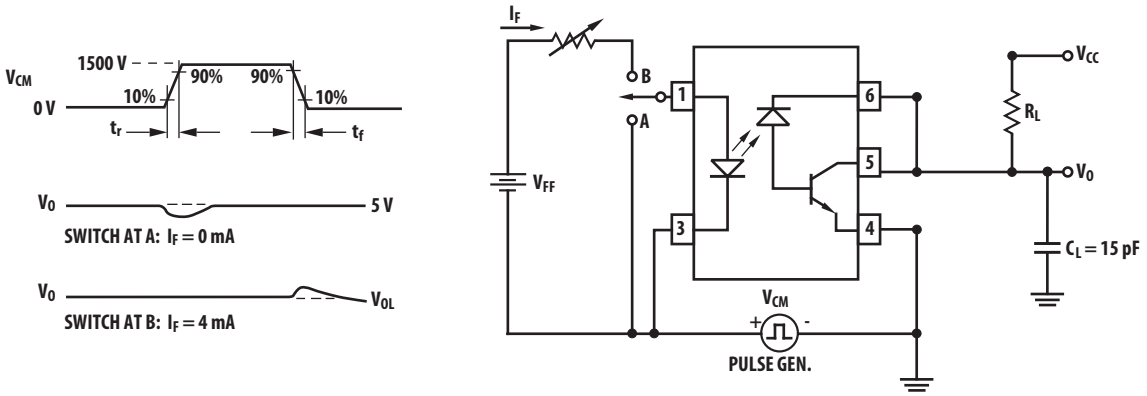


Figure 12. Test Circuit for Transient Immunity and Typical Waveforms (4-Pin Configuration)

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

AV02-2373EN - September 16, 2011