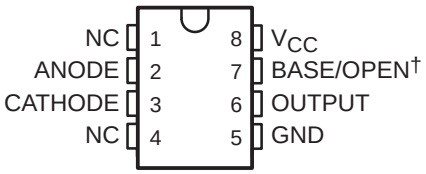
SOES022A – JULY 1986 – REVISED APRIL 1998

- **Compatible with TTL Inputs**
- **High-Speed Switching . . . 1 Mbit/s Typ**
- **Bandwidth . . . 2 MHz Typ**
- **High Common-Mode Transient Immunity . . . 1000 V/μs Typ**
- **High-Voltage Electrical Insulation . . . 3000 Vdc Min**
- **Open-Collector Output**
- **UL Recognized . . . File Number 65085**

6N135, 6N136, OR HCPL4502 PACKAGE
(TOP VIEW)



† Terminal 7 is BASE on the 6N135 and 6N136 and OPEN on the HCPL4502

NC – No internal connection

description

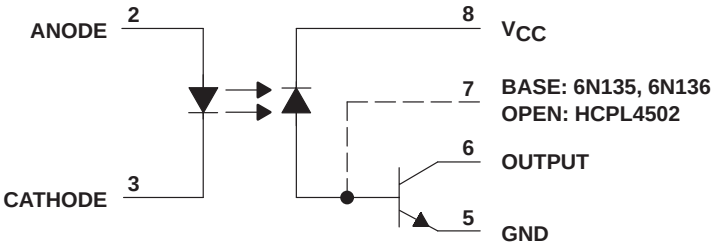
These high-speed optocouplers are designed for use in analog or digital interface applications that require high-voltage isolation between the input and output. Applications include line receivers that require high common-mode transient immunity, and analog or logic circuits that require input-to-output electrical isolation.

The 6N135, 6N136, and HCPL4502 optocouplers each consists of a light-emitting diode and an integrated photon detector composed of a photodiode and an open-collector output transistor. Separate connections are provided for the photodiode bias and the transistor-collector output. This feature, which reduces the transistor base-to-collector capacitance, results in speeds up to one hundred times that of a conventional phototransistor optocoupler.

The 6N135 is designed for TTL/CMOS, TTL/LSTTL, and wide-band analog applications.

The 6N136 and HCPL4502 are designed for high-speed TTL/TTL applications. The HCPL4502 has no base connection.

schematic



PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)†‡

Supply and output voltage range, V_{CC} and V_O	–0.5 V to 15 V
Reverse input voltage	5 V
Emitter-base reverse voltage	5 V
Peak input forward current (pulse duration = 1 ms, 50% duty cycle, see Note 1)	50 mA
Peak transient input forward current (pulse duration 1 μs, 300 Hz)	1 A
Average forward input current(see Note 2)	25 mA
Peak output current	16 mA
Average output current	8 mA
Base current	5 mA
Input power dissipation at (or below) 70°C free-air temperature (see Note 3)	45 mW
Output power dissipation at (or below) 70°C free-air temperature (see Note 4)	100 mW
Storage temperature range, T_{stg}	–55°C to 125°C
Operating free-air temperature range, T_A	–55°C to 100°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

‡ JEDEC registered data for 6N135 and 6N136

NOTES: 1. Derate linearly above 70°C free-air temperature at the rate of 1.67 mA/°C.
2. Derate linearly above 70°C free-air temperature at the rate of 0.83 mA/°C.
3. Derate linearly above 70°C free-air temperature at the rate of 1.50 mW/°C.
4. Derate linearly above 70°C free-air temperature at the rate of 3.33 mW/°C.

electrical characteristics over operating free-air temperature range of 0°C to 70°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		6N135			6N136, HCPL4502			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_F‡	Input forward voltage	I_F = 16 mA,	T_A = 25°C		1.6	1.7		1.6	1.7	V
$\propto V_F$	Temperature coefficient of forward voltage	I_F = 16 mA			–1.8			–1.8		mV/°C
V_{BR}‡	Input breakdown voltage	I_R = 10 μA,	T_A = 25°C	5			5			V
V_{OL}	Low-level output voltage	V_{CC} = 4.5 V, I_F = 16 mA, I_B = 0	I_{OL} = 1.1 mA		0.1	0.4				V
			I_{OL} = 2.4 mA					0.1	0.4	
I_{OH}‡	High-level output current	I_F = 0, I_B = 0, T_A = 25°C	V_{CC} = V_O = 5.5 V		3	500		3	500	nA
			V_{CC} = V_O = 15 V		0.01	1		0.01	1	μA
I_{OH}	High-level output current	V_{CC} = 15 V, I_F = 0,	V_O = 15 V, I_B = 0			50			50	μA
I_{CCH}‡	Supply current, high-level output	V_{CC} = 15 V, I_F = 0, T_A = 25°C	I_O = 0, I_B = 0,		0.02	1		0.02	1	μA
I_{CCH}	Supply current, high-level output	V_{CC} = 15 V, I_F = 0,	I_O = 0, I_B = 0			2			2	μA
I_{CCL}	Supply current, low-level output	V_{CC} = 15 V, I_F = 16 mA,	I_O = 0, I_B = 0		40			40		μA
h_{FE}	Transistor forward current transfer ratio	V_O = 5 V,	I_O = 3 mA		100			100 (6N136 only)		
CTR‡	Current transfer ratio	V_{CC} = 4.5 V, I_F = 16 mA, T_A = 25°C,	V_O = 0.4 V, I_B = 0, See Note 5	7%	18%		19%	24%		
CTR	Current transfer ratio	V_{CC} = 4.5 V, I_F = 16 mA, See Note 5	V_O = 0.5 V, I_B = 0,	5%			15%			
r_{IO}	Input-output resistance	V_{IO} = 500 V, See Note 6	T_A = 25°C,		10^{12}			10^{12}		Ω
I_{IO}‡	Input-output insulation leakage current	V_{IO} = 3000 V, T_A = 25°C, See Note 6	t = 5 s, RH = 45%,			1			1	μA
C_i	Input capacitance	V_F = 0,	f = 1 MHz		60			60		pF
C_{io}	Input-output capacitance	f = 1 MHz,	See Note 6		0.6			0.6		pF

† All typical values are at T_A = 25°C.
‡ JEDEC registered data for 6N135 and 6N136
NOTES: 5. Current transfer ratio is defined as the ratio of output collector current I_O to the forward LED input current I_F times 100%.
6. These parameters are measured with terminals 2 and 3 shorted together and terminals 5, 6, 7, and 8 shorted together.

operating characteristics, V_{CC} = 5 V, I_F = 16 mA, T_A = 25°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS	6N135			6N136, HCPL4502			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
BW Bandwidth (–3 dB)	R_L = 100 Ω, See Note 7		2			2		MHz

NOTE 7: Bandwidth is the range of frequencies within which the ac output voltage is not more than 3 dB below the low-frequency value.

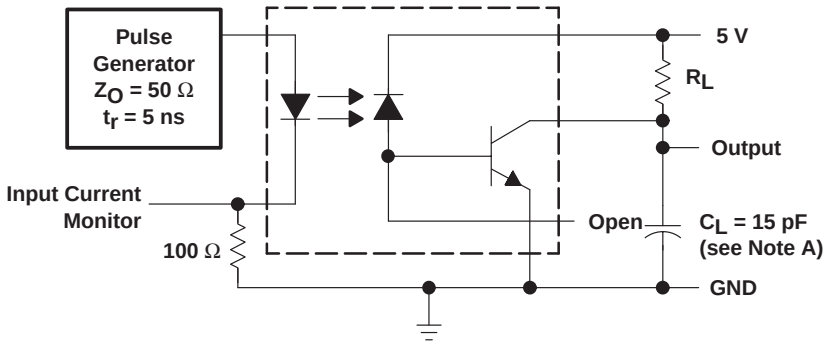
switching characteristics at V_{CC} = 5 V, I_F = 16 mA, T_A = 25°C

PARAMETER		TEST CONDITIONS		6N135			6N136, HCPL4502			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
t_{PLH}†	Propagation delay time, low-to-high-level output	R_L = 4.1 kΩ, See Figure 1	See Note 8,		1	1.5				µs
		R_L = 1.9 kΩ, See Figure 1	See Note 9,					0.6	0.8	
t_{PHL}†	Propagation delay time, high-to-low-level output	R_L = 4.1 kΩ, See Figure 1	See Note 8,		0.7	1.5				µs
		R_L = 1.9 kΩ, See Figure 1	See Note 9,					0.6	0.8	
$\frac{dV_{CM}}{dt}$(H)	Common-mode input transient immunity, high-level output	ΔV_{CM} = 10 V, R_L = 4.1 kΩ, See Figure 2	I_F = 0, See Notes 8 and 10,		1000					V/µs
		ΔV_{CM} = 10 V, R_L = 1.9 kΩ, See Figure 2	I_F = 0, See Notes 9 and 10,					1000		
$\frac{dV_{CM}}{dt}$(L)	Common-mode input transient immunity, low-level output	ΔV_{CM} = 10 V, See Notes 9 and 10,	R_L = 4.1 kΩ, See Figure 2		1000					V/µs
		ΔV_{CM} = 10 V, See Notes 9 and 10,	R_L = 1.9 kΩ, See Figure 2					1000		

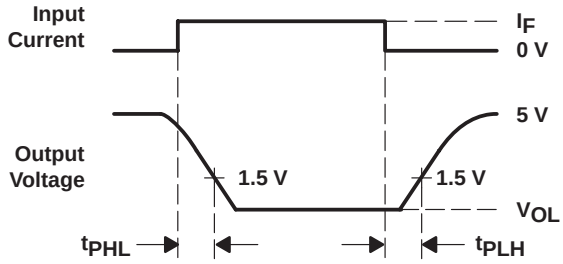
† JEDEC registered data for 6N135 and 6N136

NOTES: 8. The 4.1-kΩ load represents one LSTTL unit load of 0.36 mA and a 6.1-kΩ pullup resistor.
9. The 1.9-kΩ load represents one TTL unit load of 1.6 mA and a 5.6-kΩ pullup resistor.
10. Common-mode transient immunity, high-level output, is the maximum rate of rise of the common-mode input voltage that does not cause the output voltage to drop below 2 V. Common-mode input transient immunity, low-level output, is the maximum rate of fall of the common-mode input voltage that does not cause the output voltage to rise above 0.8 V.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



WAVEFORMS

NOTE A: C_L includes probe and stray capacitance.

Figure 1. Switching Test Circuit and Waveforms

PARAMETER MEASUREMENT INFORMATION

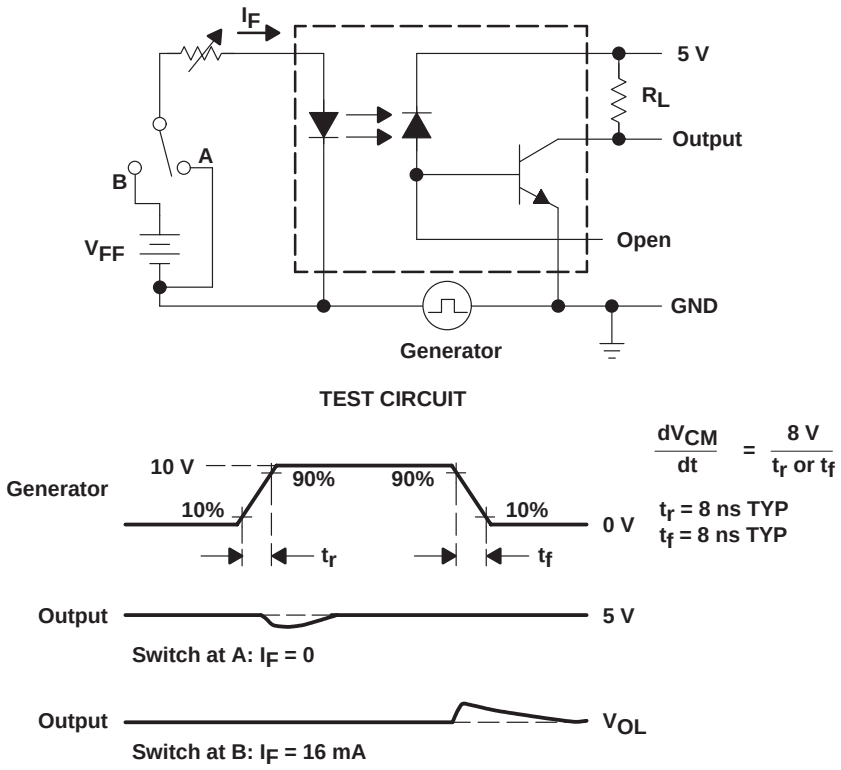


Figure 2. Transient Immunity Test Circuit and Waveforms

TYPICAL CHARACTERISTICS

INPUT-DIODE FORWARD CURRENT vs FORWARD VOLTAGE

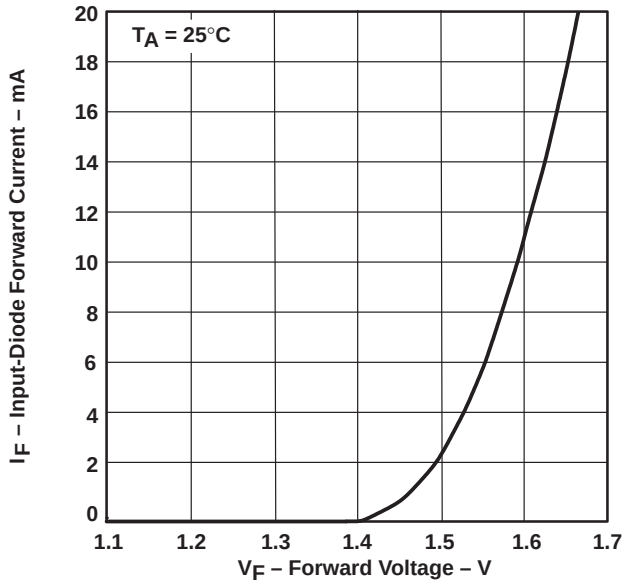


Figure 3

6N135 CURRENT TRANSFER CHARACTERISTICS

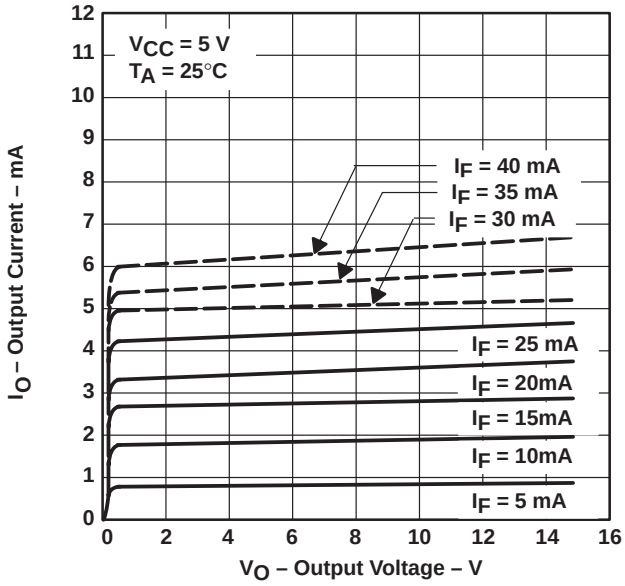


Figure 4

CURRENT TRANSFER RATIO (NORMALIZED) vs INPUT DIODE FORWARD CURRENT

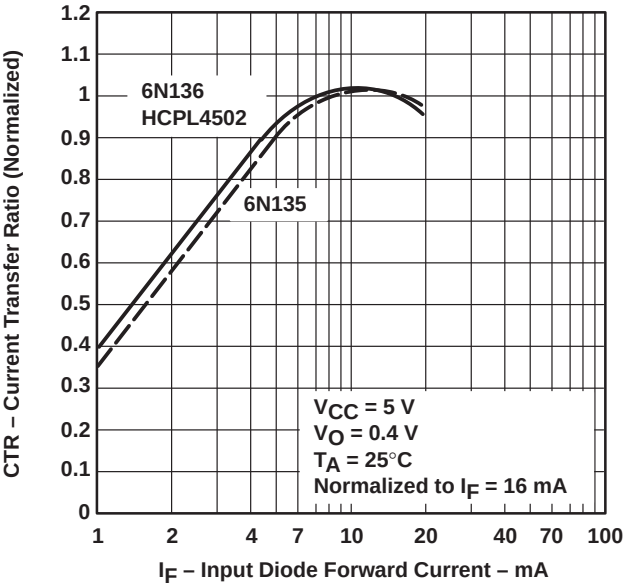


Figure 5

CURRENT TRANSFER RATIO (NORMALIZED) vs FREE-AIR TEMPERATURE

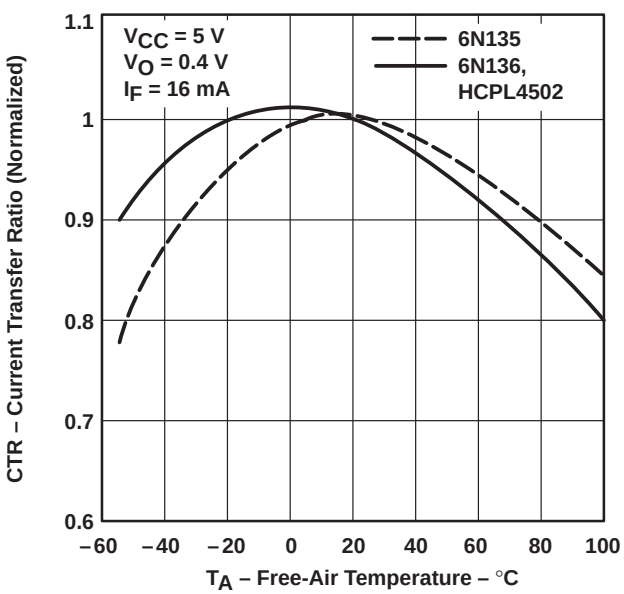


Figure 6

TYPICAL CHARACTERISTICS

HIGH-LEVEL OUTPUT CURRENT vs FREE-AIR TEMPERATURE

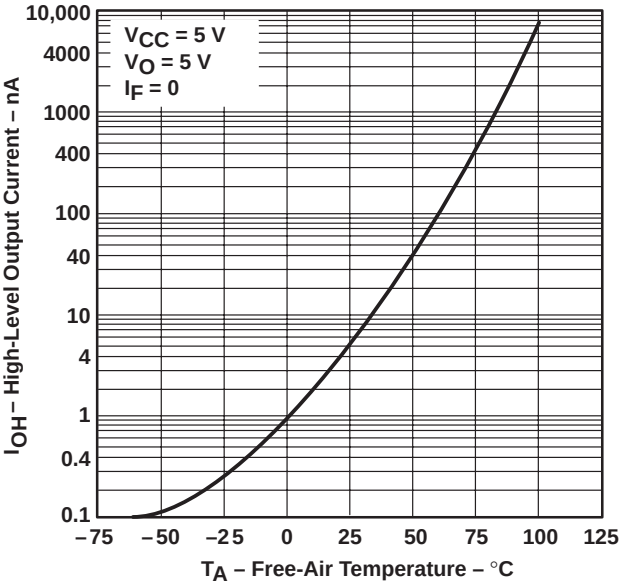


Figure 7

DIFFERENTIAL CURRENT TRANSFER RATIO vs INPUT-DIODE QUIESCENT FORWARD CURRENT

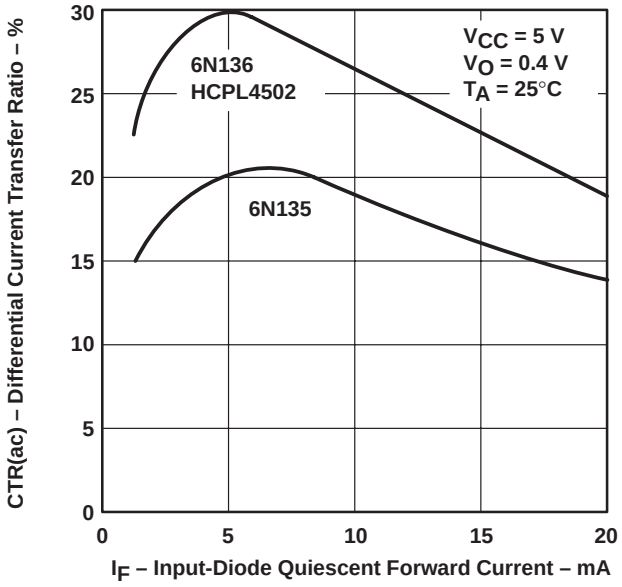


Figure 8

FREQUENCY RESPONSE (NORMALIZED) vs FREQUENCY

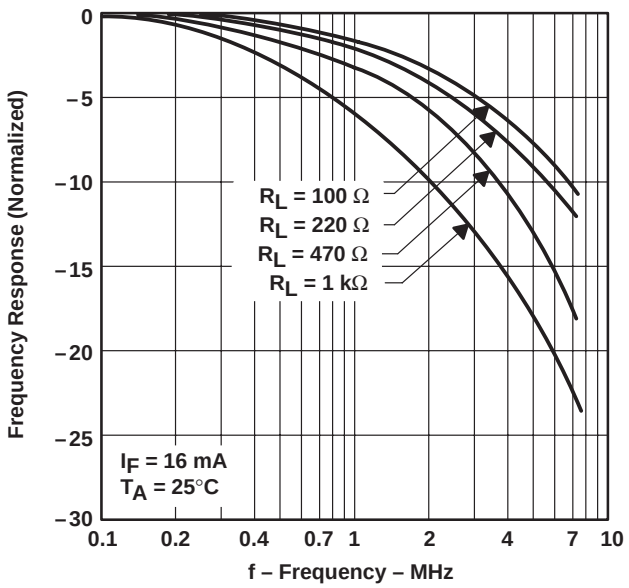


Figure 9

PROPAGATION DELAY TIME vs FREE-AIR TEMPERATURE

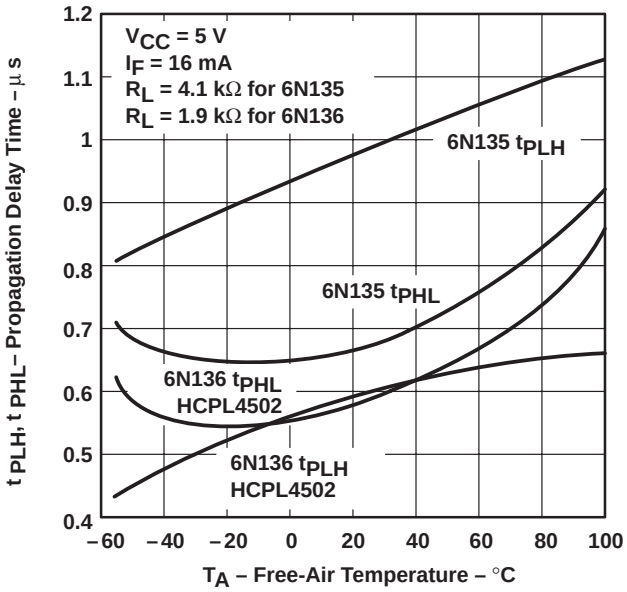
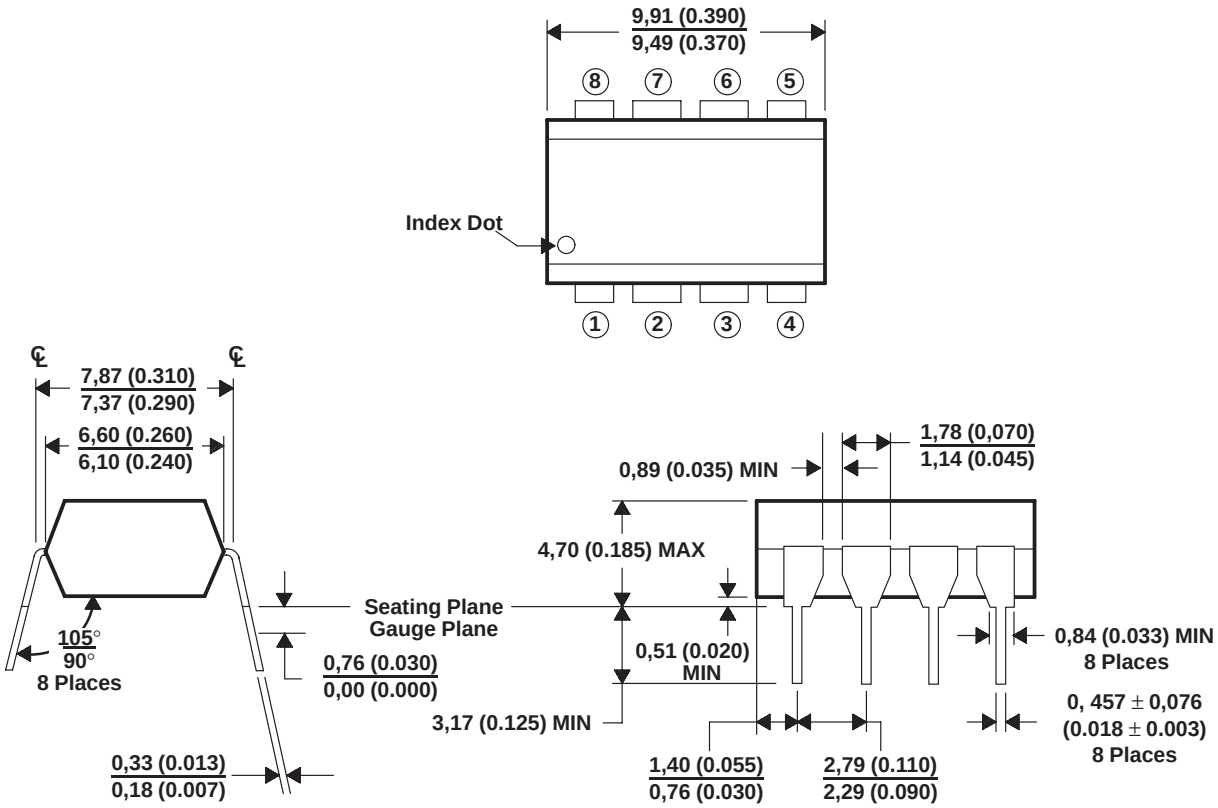


Figure 10

MECHANICAL INFORMATION



NOTES: A. JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.
B. All linear dimensions are given in millimeters and parenthetically given in inches.

Figure 11. Packaging Specifications

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