- Compatible with TTL Inputs

- High Current Transfer Ratio . . . 800% Typ at I_F = 0.5 mA

- High-Speed Switching . . . 100 kbit/s Typ

- High Common-Mode Transient Immunity . . . 500 V/μs Typ

- High-Voltage Electrical Insulation . . . 3000 V DC Min

- High Output Current Rating of 60 mA

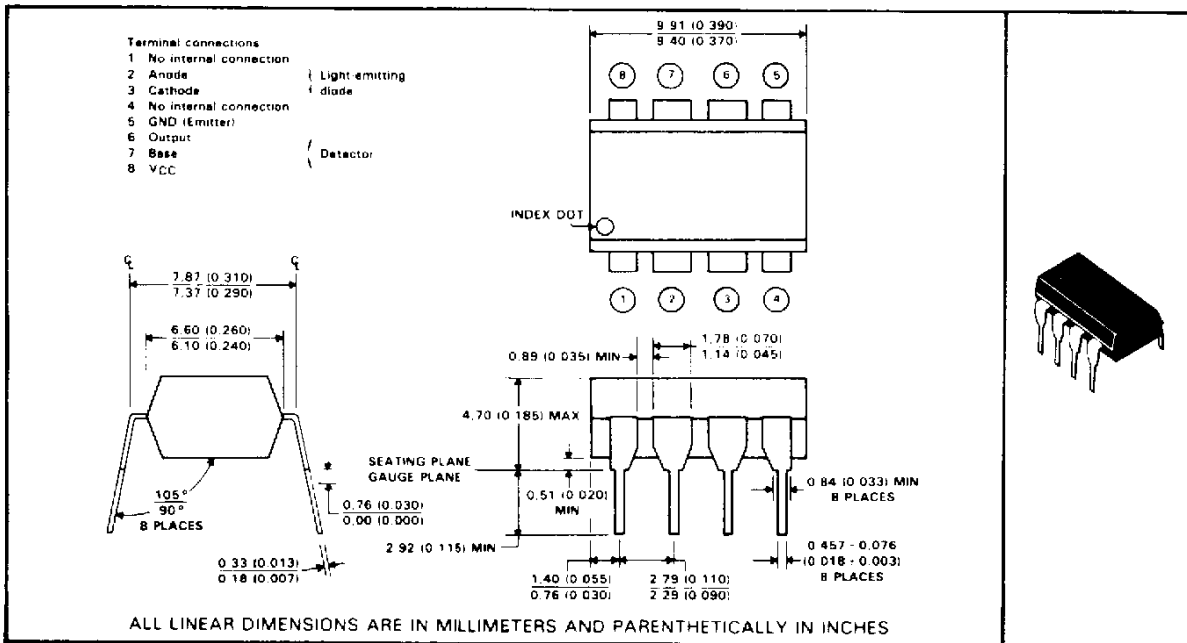- UL Recognized . . . File Number 65085

description

These devices are useful where large common-mode input signals exist, and in applications that require high-voltage isolation between circuits. Applications include line receivers, telephone ring detectors, power line monitors, high-voltage status indicators, and circuits that require isolation between input and output.

The 6N138 and 6N139 high-gain optocouplers each consists of a GaAsP light-emitting diode and an integrated high-gain photon detector composed of a photodiode and a split-Darlington output stage. The V_{CC} and output terminals may be tied together to achieve conventional photodarlington operation. A separate base access terminal allows gain-bandwidth adjustments.

The 6N138 is designed for use primarily in TTL applications. An LED input current of 1.6 milliamperes and a current-transfer ratio of 300% from 0 °C to 70 °C allows operation with one TTL load input and one TTL load output utilizing a 2.2-kΩ pullup resistor.

The 6N139 is designed for use in CMOS, LSTTL, or other low-power applications. This device has a minimum current-transfer ratio of 400% for only 0.5 milliampere input current over an operating temperature range of 0 °C to 70 °C.

*mechanical data

Terminal connections
1 No internal connection
2 Anode   ) Light emitting
3 Cathode   (diode
4 No internal connection
5 GND (Emitter)
6 Output
7 Base   (Detector
8 V_{CC}

9.91 (0.390)
9.40 (0.370)

INDEX DOT

7.87 (0.310)
7.37 (0.290)

6.60 (0.260)
6.10 (0.240)

1.78 (0.070)
1.14 (0.045)

0.89 (0.035) MIN

4.70 (0.185) MAX

SEATING PLANE
GAUGE PLANE

105°
90°
8 PLACES

0.76 (0.030)
0.00 (0.000)

0.51 (0.020)
MIN

0.84 (0.033) MIN
8 PLACES

0.33 (0.013)
0.18 (0.007)

2.92 (0.115) MIN

1.40 (0.055)
0.76 (0.030)

2.79 (0.110)
2.29 (0.090)

0.457 - 0.076
(0.018 - 0.003)
8 PLACES

ALL LINEAR DIMENSIONS ARE IN MILLIMETERS AND PARENTHETICALLY IN INCHES

*JEDEC registered data. This data sheet contains all applicable registered data in effect at the time of publication.

TEXAS
INSTRUMENTS

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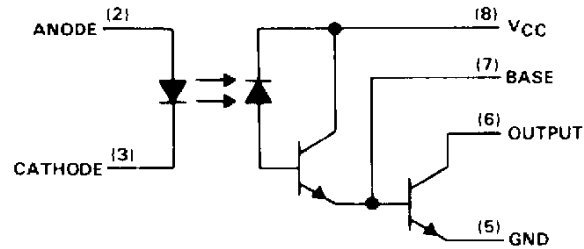
*absolute maximum ratings at 25 °C free-air temperature (unless otherwise noted)

Supply and output voltage range, V_{CC} and V_O: 6N138 . . . . −0.5 V to 7 V

6N139 . . . . −0.5 to 18 V

Reverse input voltage . . . . 5 V

Emitter-base reverse voltage . . . . 0.5 V

Peak input forward current (pulse duration = 1 ms, 50% duty cycle) . . . . 40 mA

Peak transient input forward current (pulse duration ≤ 1 μs, 300 pps) . . . . 1 A

Average forward input current at (or below) 50 °C free-air temperature (see Note 1) . . . . 20 mA

Output current at (or below) 25 °C free-air temperature (see Note 2) . . . . 60 mA

Input power dissipation at (or below) 50 °C free-air temperature (see Note 3) . . . . 35 mW

Output power dissipation at (or below) 25 °C free-air temperature (see Note 4) . . . . 100 mW

Storage temperature range . . . . −55 °C to 125 °C

Operating temperature range . . . . 0 °C to 100 °C

Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . 260 °C

NOTES   1. Derate linearly above 50 °C free-air temperature at a rate of 0.4 mA/°C.
          2. Derate linearly above 25 °C free air temperature at a rate of 0.8 mA/°C.
          3. Derate linearly above 50 °C free air temperature at a rate of 0.7 mW/°C.
          4. Derate linearly above 25 °C free-air temperature at a rate of 1.33 mW/°C.
*JEDEC registered data.

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

PARAMETER		TEST CONDITIONS		6N138			6N139			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
*V_F	Input forward voltage	$I_F = 1.6$ mA, $T_A = 25°C$			1.5	1.7		1.5	1.7	V
αV_F	Temperature coefficient of forward voltage	$I_F = 1.6$ 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, $I_F = 1.6$ mA, $I_{OL} = 4.8$ mA, $I_B = 0$			0.1	0.4				V
		$V_{CC} = 4.5$ V, $I_F = 1.6$ mA, $I_{OL} = 6.4$ mA, $I_B = 0$						0.1	0.4	
		$V_{CC} = 4.5$ V, $I_F = 5$ mA, $I_{OL} = 15$ mA, $I_B = 0$						0.1	0.4	
		$V_{CC} = 4.5$ V, $I_F = 12$ mA, $I_{OL} = 24$ mA, $I_B = 0$						0.2	0.4	
*I_{OH}	High-level output current	$V_{CC} = 7$ V, $V_O = 7$ V, $I_F = 0$, $I_B = 0$			0.1	250				µA
		$V_{CC} = 18$ V, $V_O = 18$ V, $I_F = 0$, $I_B = 0$						0.05	100	
*I_{CCH}	Supply current, high-level output	$V_{CC} = 5$ V, V_O open, $I_F = 0$, $I_B = 0$			10			10		nA
I_{CCL}	Supply current, low-level output	$V_{CC} = 5$ V, V_O open, $I_F = 1.6$ mA, $I_B = 0$			0.2			0.2		mA
*CTR	Current transfer ratio	$V_{CC} = 4.5$ V, $V_O = 0.4$ V, $I_F = 0.5$ mA, $I_B = 0$, See Note 5					400%	1650%		
		$V_{CC} = 4.5$ V, $V_O = 0.4$ V, $I_F = 1.6$ mA, $I_B = 0$, See Note 5		300%	1300%		500%	1400%		
r_{IO}	Input-output resistance	$V_{IO} = 500$ V, See Note 6			10^{12}			10^{12}		Ω
*I_{IO}	Input-output insulation leakage current	$V_{IO} = 3000$ V, $t = 5$ s, $T_A = 25°C$, RH = 45%, See Note 6				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

*JEDEC registered data
†All typical values are at $V_{CC} = 5$ V, $T_A = 25°C$, unless otherwise noted.
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 between pins 2 and 3 shorted together and pins 5, 6, 7, and 8 shorted together.

*switching characteristics at V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		6N138			6N139			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
*t_{PHL}	Propagation delay time, high-to-low level output	I_F = 1.6 mA, See Figure 1	R_L = 2.2 kΩ,		2	10				μs
		I_F = 0.5 mA, See Figure 1	R_L = 4.7 kΩ,					4	25	
		I_F = 12 mA, See Figure 1	R_L = 270 Ω,					0.3	1	
*t_{PLH}	Propagation delay time, low-to-high-level output	I_F = 1.6 mA, See Figure 1	R_L = 2.2 kΩ,		4	35				μs
		I_F = 0.5 mA, See Figure 1	R_L = 4.7 kΩ,					10	60	
		I_F = 12 mA, See Figure 1	R_L = 270 Ω,					3.5	7	
$\frac{dV_{CM}}{dt}$ (H)	Common-mode input Transient immunity, high-level output	V_{CM} = 10 Vp-p, R_L = 2.2 kΩ, See Figure 2	I_F = 0, See Notes 7 and 8.		500			500		V/μs
$\frac{dV_{CM}}{dt}$ (L)	Common-mode input transient immunity, low-level output	V_{CM} = Vp-p, See Figure 2,	R_L = 2.2 kΩ, See Notes 7 and 8		-500			500		V/μs

*JEDEC registered data

NOTES: 7. 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.
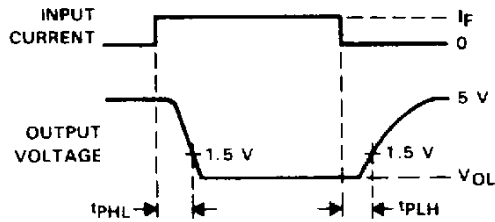
8. In applications where dV/dt may exceed 50,000 V/μs (such as static discharge) a series resistor, R_{CC}, should be included to protect the detector IC from destructively high surge currents. The recommended value is:

$$R_{CC} \approx \frac{1}{0 15 I_F (mA)} \text{ kΩ}$$
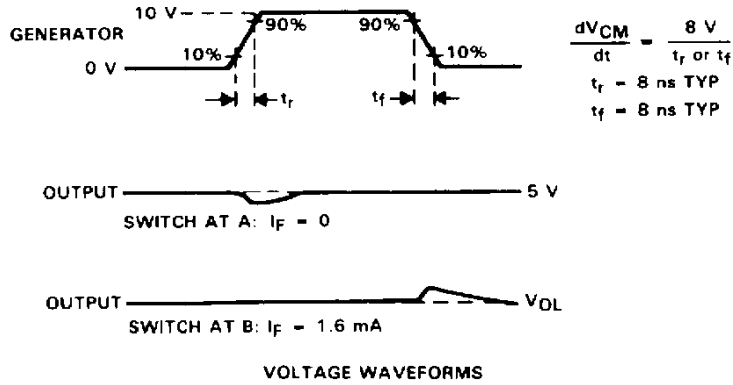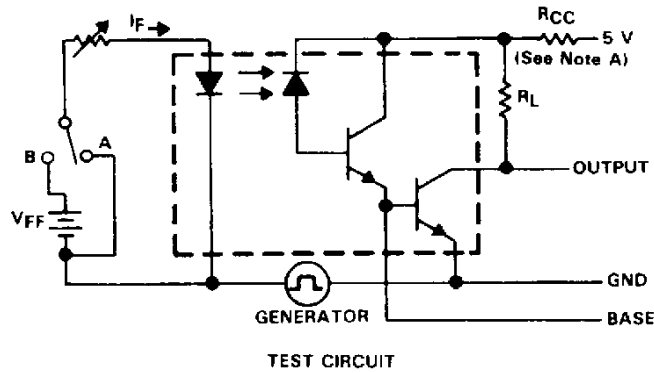
PARAMETER MEASUREMENT INFORMATION
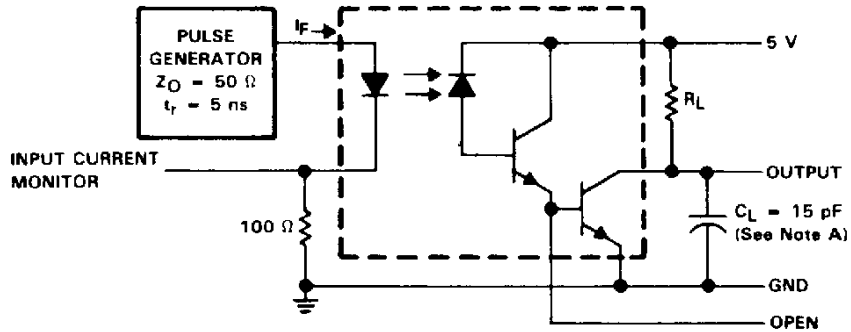
TEST CIRCUIT

WAVEFORMS

NOTE A C_L includes probe and stray capacitances.

FIGURE 1. SWITCHING TEST CIRCUIT AND WAVEFORMS

PARAMETER MEASUREMENT INFORMATION

TEST CIRCUIT

$$\frac{dV_{CM}}{dt} = \frac{8\ V}{t_r\ or\ t_f}$$

t_r = 8 ns TYP

t_f = 8 ns TYP

OUTPUT ——————————————— 5 V
SWITCH AT A: I_F = 0

OUTPUT ——————————————— V_{OL}
SWITCH AT B: I_F = 1.6 mA

VOLTAGE WAVEFORMS

NOTE A: In applications where dV/dt may exceed 50,000 V/µs (such as static discharge) a series resistor, R_{CC}, should be included to protect the detector IC from destructively high surge currents. The recommended value is:

$$R_{CC} = \frac{1}{0.15\ I_F\ (mA)}\ k\Omega$$

FIGURE 2. TRANSIENT IMMUNITY TEST CIRCUIT AND WAVEFORMS
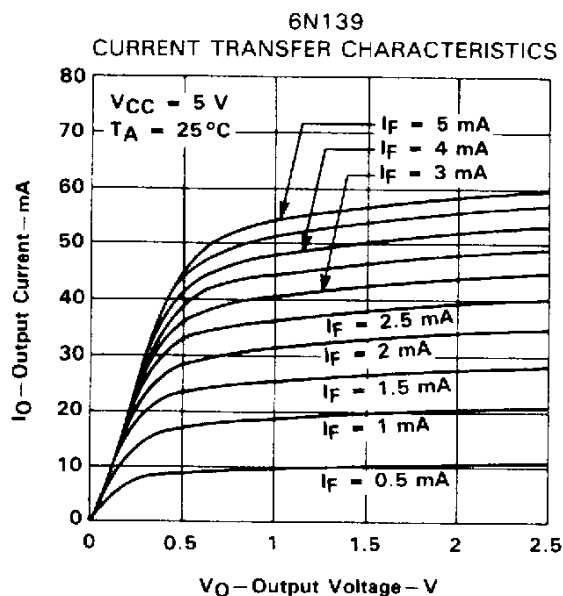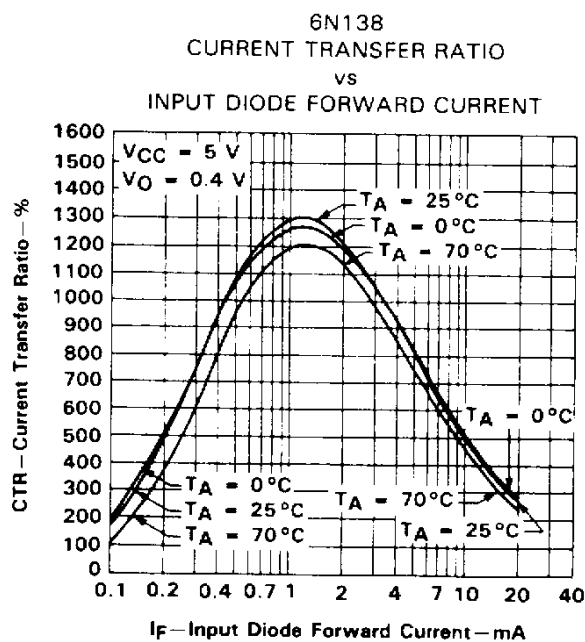
TYPICAL CHARACTERISTICS
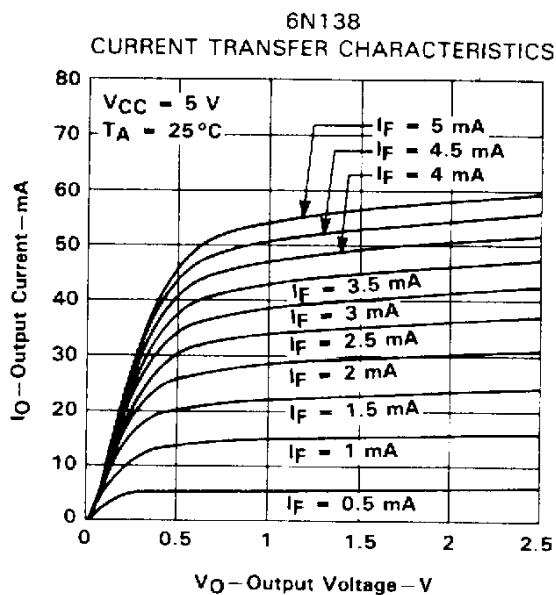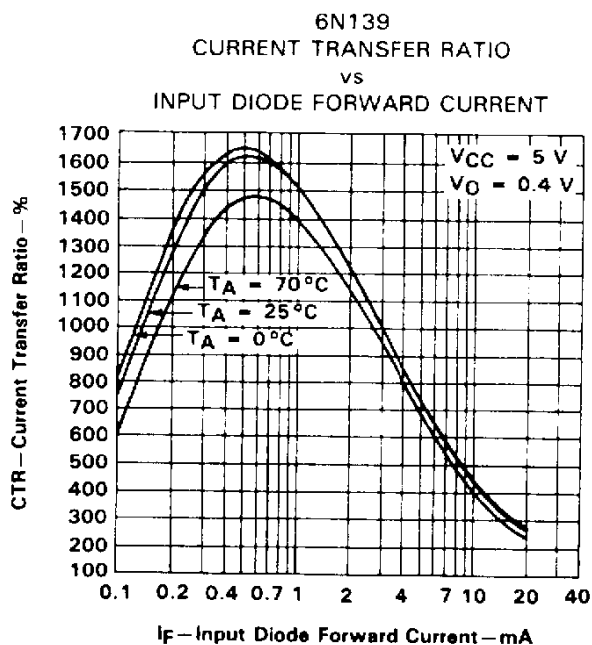
6N138
CURRENT TRANSFER CHARACTERISTICS

FIGURE 3

6N139
CURRENT TRANSFER CHARACTERISTICS

FIGURE 4

6N138
CURRENT TRANSFER RATIO
vs
INPUT DIODE FORWARD CURRENT

FIGURE 5

6N139
CURRENT TRANSFER RATIO
vs
INPUT DIODE FORWARD CURRENT

FIGURE 6

TYPICAL CHARACTERISTICS

6N138
OUTPUT CURRENT
vs
INPUT DIODE FORWARD CURRENT

FIGURE 7

6N139
OUTPUT CURRENT
vs
INPUT DIODE FORWARD CURRENT

FIGURE 8

INPUT DIODE FORWARD CURRENT
vs
FORWARD VOLTAGE

FIGURE 9

6N138
PROPAGATION DELAY TIMES
vs
FREE-AIR TEMPERATURE
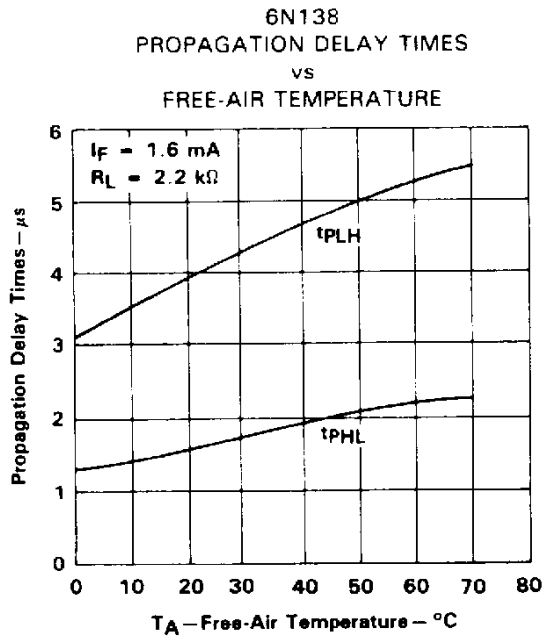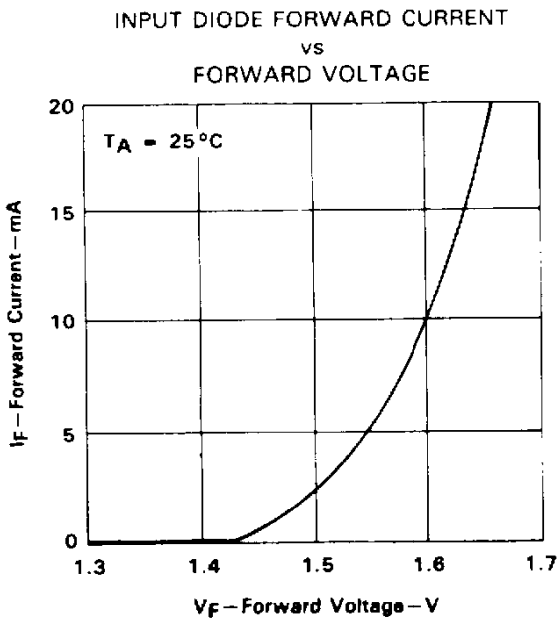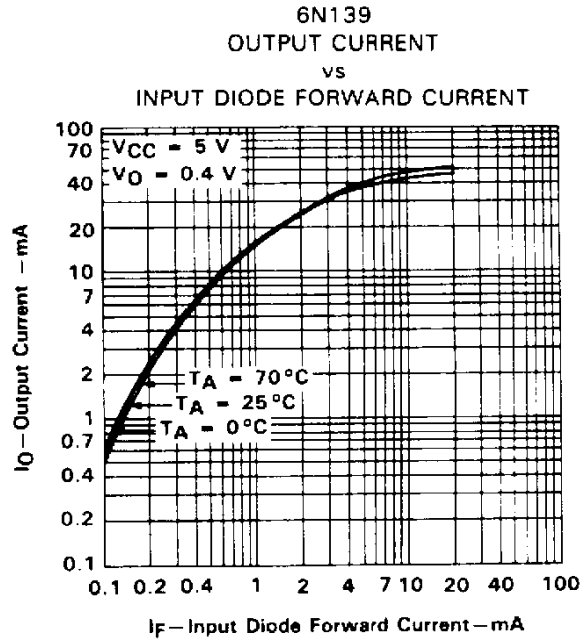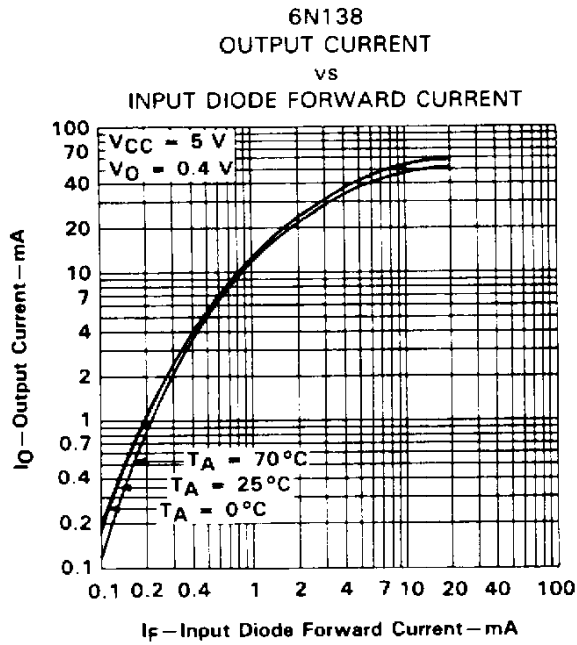
FIGURE 10

TYPICAL CHARACTERISTICS

6N139
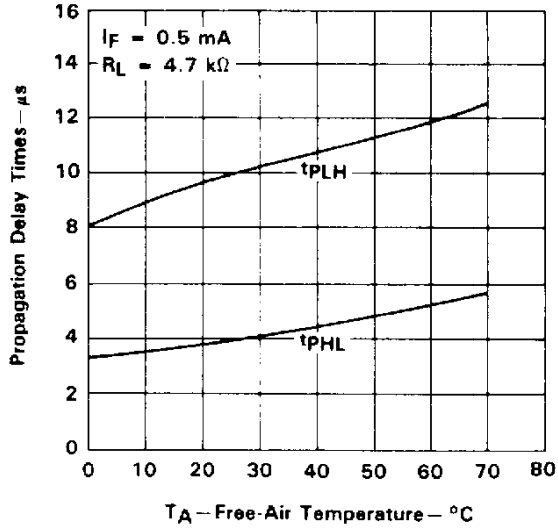PROPAGATION DELAY TIMES
vs
FREE-AIR TEMPERATURE

6N139
PROPAGATION DELAY TIMES
vs
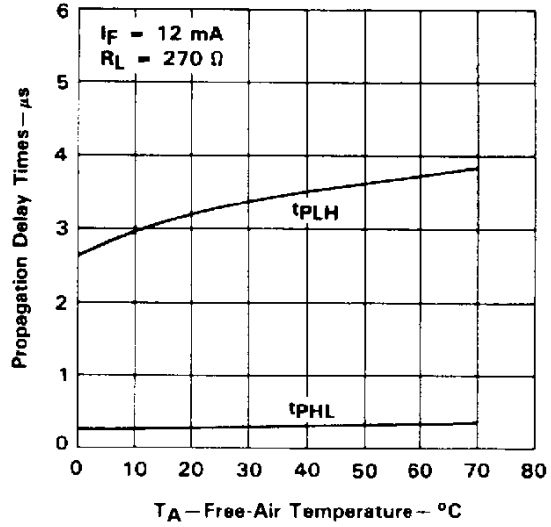FREE-AIR TEMPERATURE

FIGURE 11

FIGURE 12

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Orderable Device	Status [1]	Package Type	Package Drawing	Pins	Package Qty	Eco Plan [2]	Lead/Ball Finish	MSL Peak Temp [3]
6N138	OBSOLETE	PDIP	N	8		TBD	Call TI	Call TI
6N139	OBSOLETE	PDIP	N	8		TBD	Call TI	Call TI

[1] The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
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OBSOLETE: TI has discontinued the production of the device.

[2] Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
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[3] MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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