4N45, 4N46
OPTOCOUPLERS/OPTOISOLATORS

D3347, OCTOBER 1989—REVISED FEBRUARY 1990

T-41-85

- **High Current-Transfer Ratio . . . 1100% Typ at I_F = 0.5 mA (4N46)**
- **Low Input-Current Requirement . . . 0.5 mA (4N46)**
- **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 4N45 and 4N46 high-gain optocouplers each consists of a light-emitting diode and an integrated high-gain photon detector. An integrated emitter-base bypass resistor is provided for low leakage at high temperature and faster turn-off switching time.

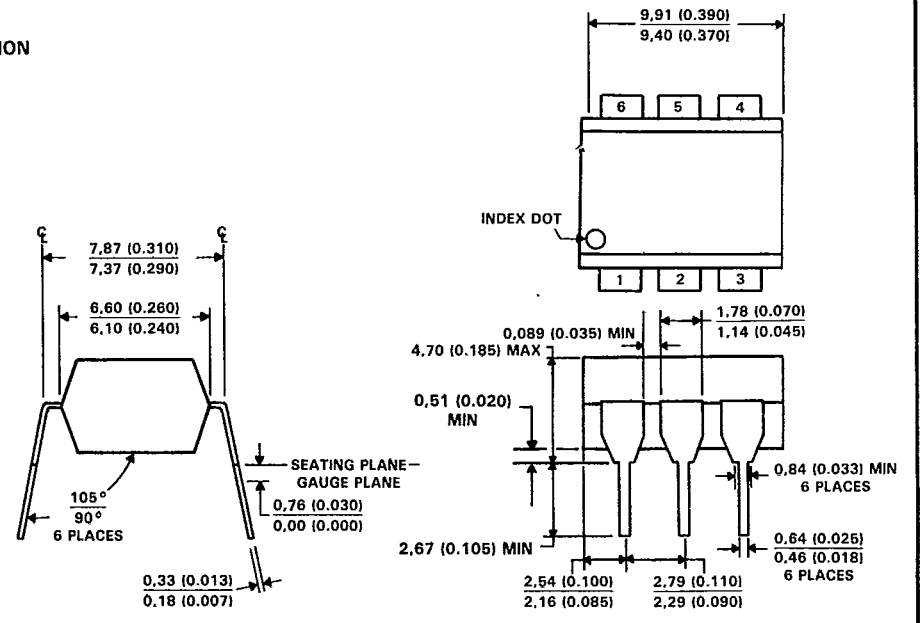
The 4N45 is designed for use primarily in applications with an LED input current of 1 mA and a minimum current-transfer ratio of 250% from 0°C to 70°C.

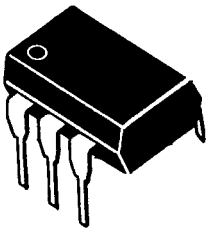
The 4N46 is designed for use in CMOS, LSTTL, or other low-power applications. This device has a minimum current-transfer ratio of 350% for only 0.5-mA input current over an operating temperature range of 0°C to 70°C.

Access to the second-stage base is provided to allow adjustment of the current-transfer ratio and switching time using an external resistor or capacitor.

*mechanical data

1. ANODE
2. CATHODE
3. NO CONNECTION
4. GND
5. OUTPUT
6. BASE





ALL LINEAR DIMENSIONS ARE IN MILLIMETERS AND PARENTHETICALLY IN INCHES

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

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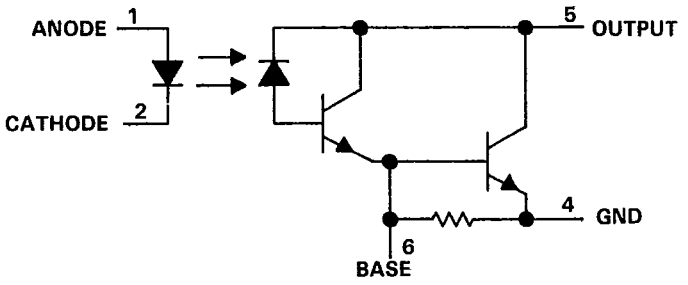
schematic



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

Output voltage range, V_O: 4N45 . . . . . −0.5 V to 7 V
4N46 . . . . . −0.5 to 20 V
Reverse input voltage . . . . . 5 V
Peak transient input current (pulse duration ≤ 1 ns, f ≤ 300 Hz) . . . . . 1 A
Peak input forward current per channel (pulse duration = 1 ms, 50% duty cycle) . . . . . 40 mA
Average forward input current per channel at (or below) 50°C free-air temperature (see Note 1) . . . . . 20 mA
Output current per channel at (or below) 25°C free-air temperature (see Note 2) . . . . . 60 mA
Input power dissipation per channel at (or below) 50°C free-air temperature (see Note 3) . . . 35 mW
Output power dissipation per channel at (or below) 25°C free-air temperature (see Note 4) . . . . . 100 mW
Operating temperature range . . . . . −40°C to 70°C
Storage temperature range . . . . . −55°C to 125°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

*JEDEC registered data.

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.

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

PARAMETER		TEST CONDITIONS	4N45			4N46			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
*V_F	Input forward voltage	I_F = 1 mA, T_A = 25°C		1.5	1.7		1.5	1.7	V
α_{VF}	Temperature coefficient of forward voltage	I_F = 1 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	I_F = 0.5 mA, I_B = 0, I_{OL} = 1.75 mA						1	V
		I_F = 1 mA, I_B = 0, I_{OL} = 5 mA						1	
		I_F = 1 mA, I_B = 0, I_{OL} = 2.5 mA		0.95	1				
		I_F = 10 mA, I_B = 0, I_{OL} = 20 mA		1.08	1.2			1.2	
*I_{OH}	High-level output current	I_F = 0, I_B = 0, V_O = 5 V		0.001	250				μA
		I_F = 0, I_B = 0, V_O = 18 V					0.001	100	
*CTR	Current transfer ratio	I_F = 0.5 mA, I_B = 0, V_O = 1 V, See Note 5				350%	1100%		
		I_F = 1 mA, I_B = 0, V_O = 1 V, See Note 5	250%	500%		500%	850%		
		I_F = 10 mA, I_B = 0, V_O = 1.2 V, See Note 5	200%	440%		200%	440%		
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_A = 25°C, 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

†All typical values are at T_A = 25°C, unless otherwise noted.
*JEDEC registered data.
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 1 and 2 shorted together and pins 4, 5, and 6 shorted together.

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

PARAMETER		TEST CONDITIONS	4N45			4N46			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
t_{PHL}	Propagation delay time, high-to-low-level output	I_F = 1 mA, R_L = 10 kΩ, See Figure 1		32			13		μs
*t_{PHL}	Propagation delay time, high-to-low-level output	I_F = 10 mA, R_L = 220 Ω, See Figure 1		2.2	50		1.2	50	μs
t_{PLH}	Propagation delay time, low-to-high-level output	I_F = 1 mA, R_L = 10 kΩ, See Figure 1		160			176		μs
*t_{PLH}	Propagation delay time, low-to-high-level output	I_F = 10 mA, R_L = 220 Ω, See Figure 1		25	500		34	500	μs
$\frac{dV_{CM}}{dt}$ (H)	Common-mode input transient immunity, high-level output	V_{CM} = 10 V_{p-p}, I_F = 0, R_L = 10 kΩ, See Note 7, See Figure 2		500			500		V/μs
$\frac{dV_{CM}}{dt}$ (L)	Common-mode input transient immunity, low-level output	V_{CM} = 10 V_{p-p}, I_F = 1.6 mA, R_L = 10 kΩ, See Note 7, See Figure 2		−500			−500		V/μs

*JEDEC registered data.

NOTE 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.

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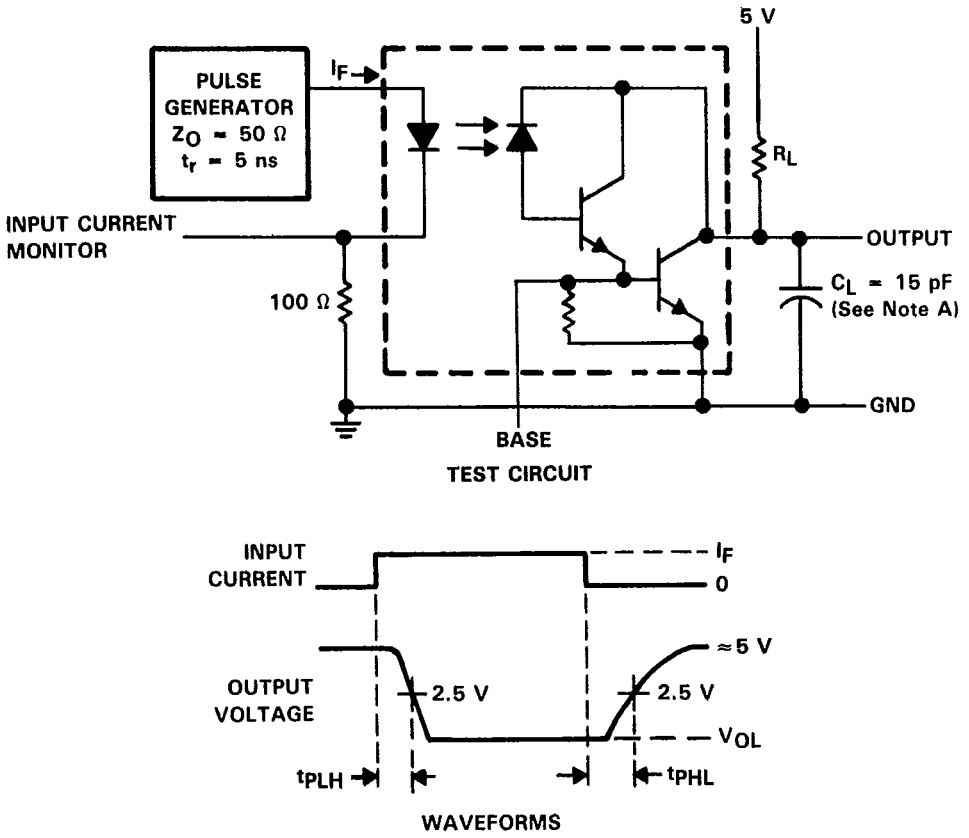
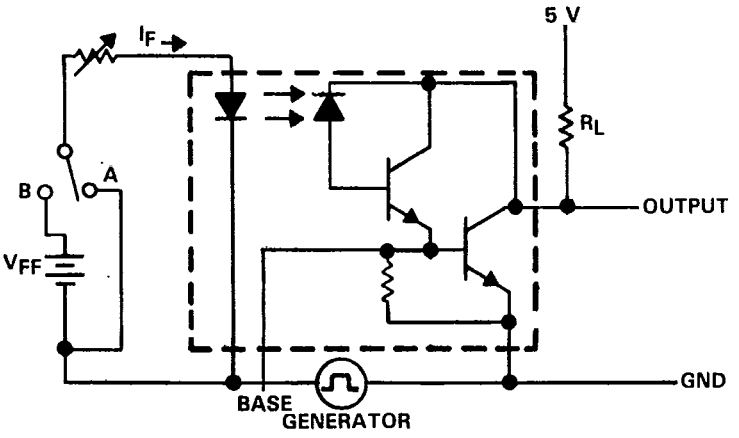
PARAMETER MEASUREMENT INFORMATION



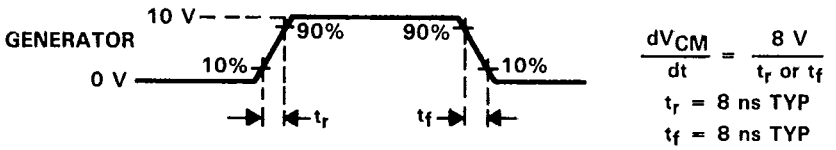
NOTE A: C_L includes probe and stray capacitances.

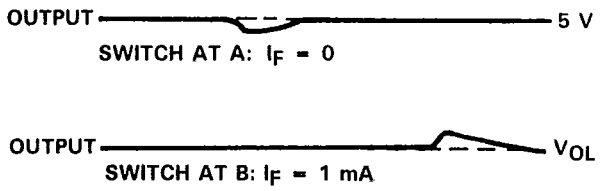
FIGURE 1. SWITCHING TEST CIRCUIT AND WAVEFORMS

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT





WAVEFORMS

FIGURE 2. TRANSIENT IMMUNITY TEST CIRCUIT AND WAVEFORMS

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TYPICAL CHARACTERISTICS

INPUT DIODE FORWARD CURRENT
vs
FORWARD VOLTAGE

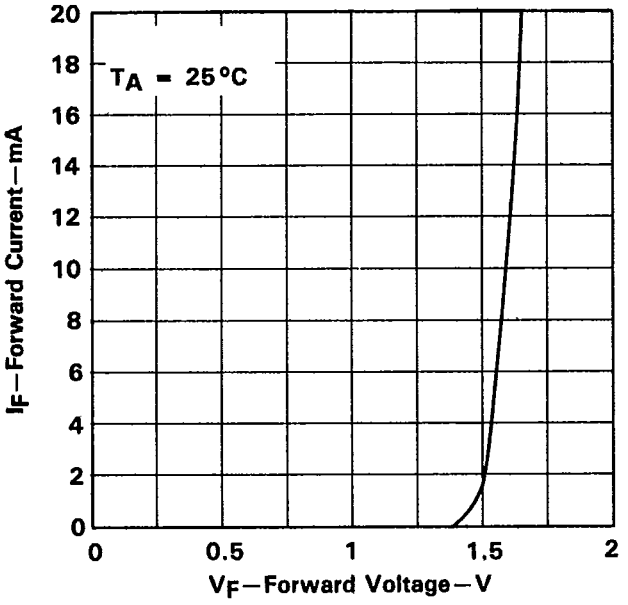

FIGURE 3

4N45
CURRENT TRANSFER CHARACTERISTICS

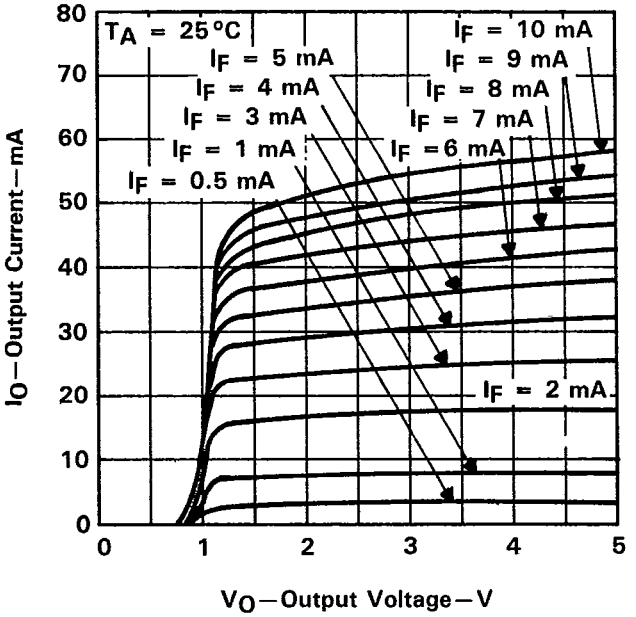

FIGURE 4

4N46
CURRENT TRANSFER CHARACTERISTICS

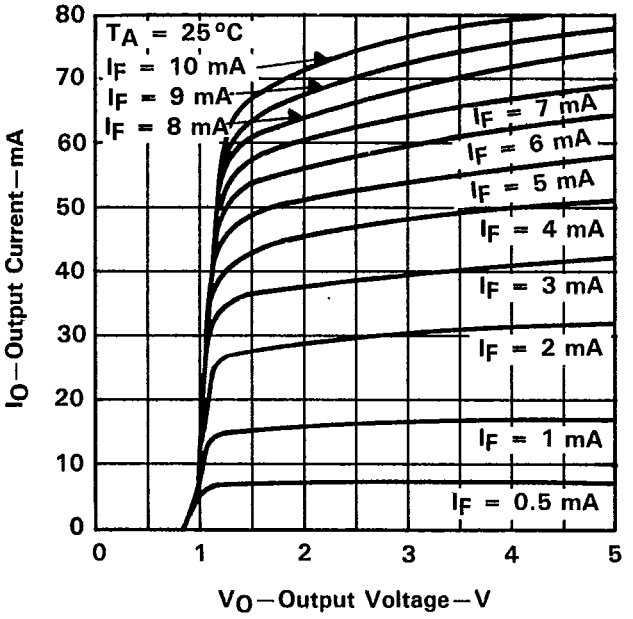

FIGURE 5

RELATIVE CURRENT TRANSFER RATIO
vs
FREE-AIR TEMPERATURE

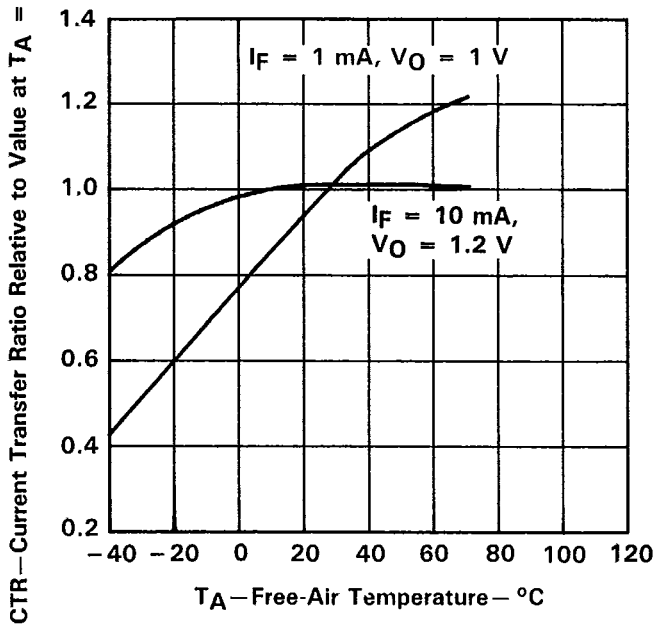

FIGURE 6

TYPICAL CHARACTERISTICS

4N46
RELATIVE CURRENT TRANSFER RATIO
vs
FREE-AIR TEMPERATURE

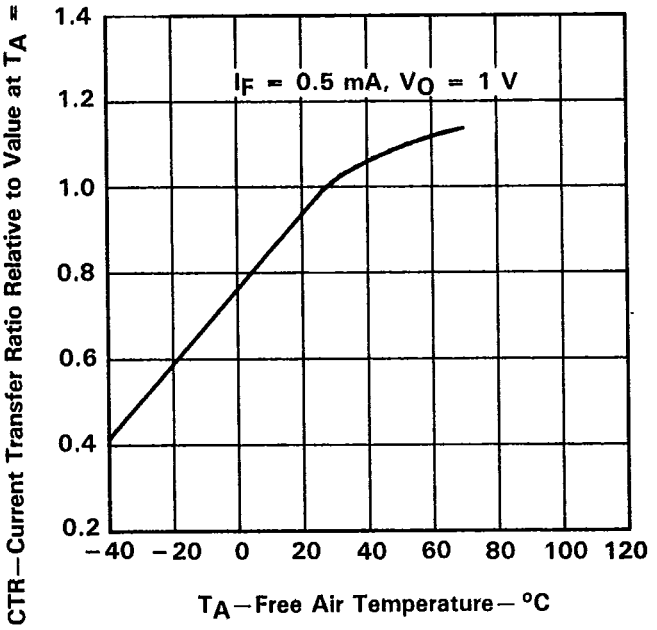

FIGURE 7

PROPAGATION DELAY TIME
vs
FREE-AIR TEMPERATURE

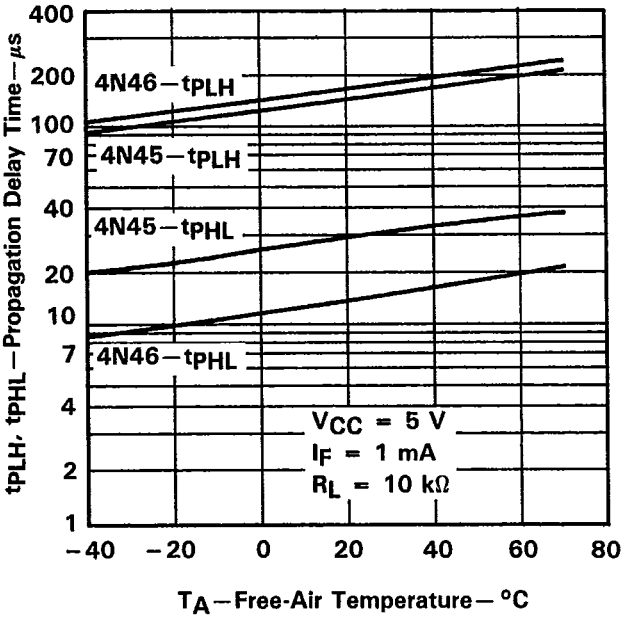

FIGURE 8

PROPAGATION DELAY TIME
vs
FREE-AIR TEMPERATURE

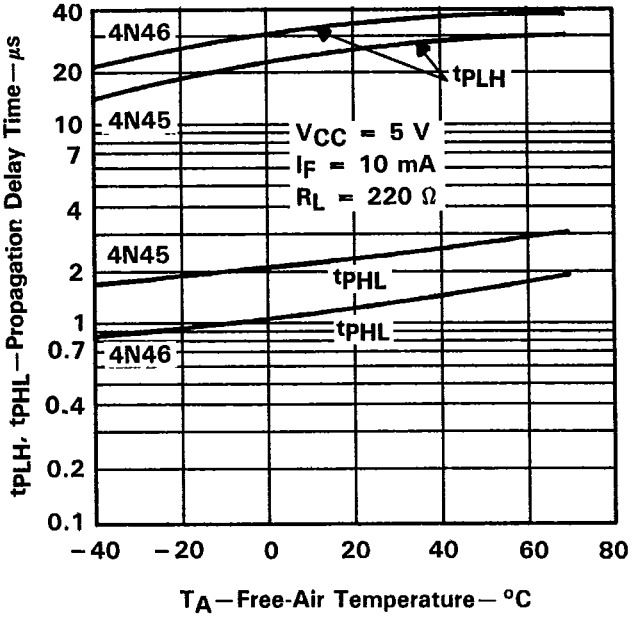

FIGURE 9

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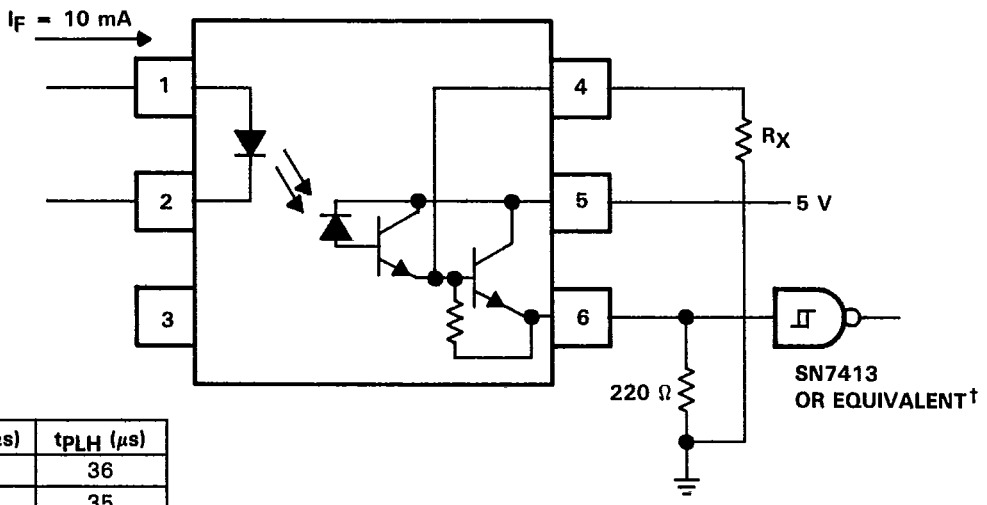
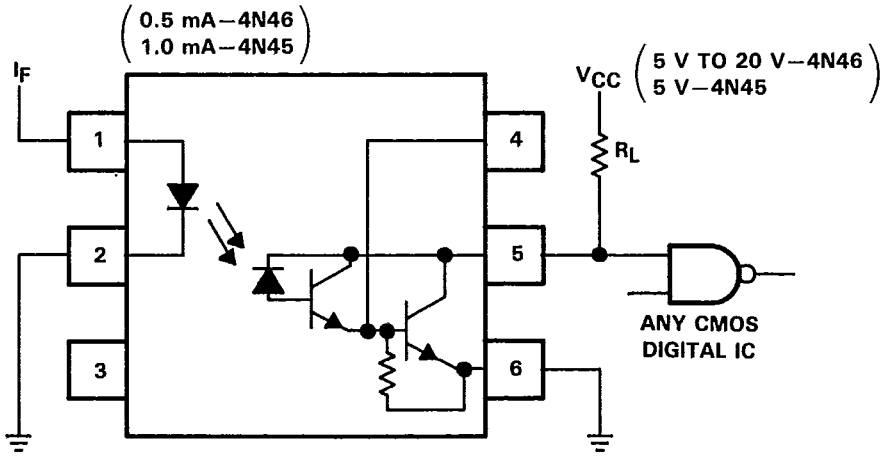
TYPICAL APPLICATION DATA



R_X (kΩ)	t_{PHL} (μs)	t_{PLH} (μs)
∞	1	36
100	1	35
47	1	34
20	1	32
10	1	29

†Schmidt trigger recommended because of long t_r and t_f.

TTL INTERFACE



CMOS INTERFACE