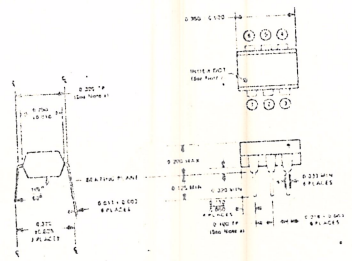
BULLETIN NO. DL-S 7312030, NOVEMBER 1973

COMPATABLE WITH STANDARD DTL AND TTL INTEGRATED CIRCUITS

- Gallium Arsenide Diode Infrared Source Optically Coupled to a Silicon N-P-N Phototransistor
- High Direct-Current Transfer Ratio
- Base Lead Provided for Conventional Transistor Biasing
- High-Voltage Electrical Isolation . . . 1.5-kV or 2.5-kV Rating
- Plastic Dual-In-Line Package
- High-Speed Switching: $t_r = 2\ \mu s$, $t_f = 2\ \mu s$ Typical

mechanical data

The package consists of a gallium arsenide infrared-emitting diode and an n-p-n silicon phototransistor mounted on a 6-lead frame encapsulated within an electrically nonconductive plastic compound. The case will withstand soldering temperature with no deformation and device performance characteristics remain stable when operated in high-humidity conditions. Unit weight is approximately 0.52 grams.



NOTES:
a. Leads are within 0.005 radius of true position (TP) at the gauge plane with maximum material condition and unit installed.
b. All dimensions are in inches unless otherwise noted.
c. Pin 1 identified by index dot.
d. Terminal connections:
1. Anode } Infrared-emitting diode
2. Cathode
3. No internal connection
4. Emitter } Phototransistor
5. Collector
6. Base

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

Input-to-Output Voltage: TIL111	±1.5 kV
TIL114, TIL116, TIL117	±2.5 kV
Collector-Base Voltage	70 V
Collector-Emitter Voltage (See Note 1)	30 V
Emitter-Collector Voltage	7 V
Emitter-Base Voltage	7 V
Input-Diode Reverse Voltage	3 V
Input-Diode Continuous Forward Current at (or below) 25°C Free-Air Temperature (See Note 2)	100 mA
Continuous Power Dissipation at (or below) 25°C Free-Air Temperature:	
Infrared-Emitting Diode (See Note 3)	150 mW
Phototransistor (See Note 4)	150 mW
Total, Infrared-Emitting Diode plus Phototransistor (See Note 5)	250 mW
Storage Temperature Range	−55°C to 150°C
Lead Temperature 1/16 Inch from Case for 10 Seconds	260°C

NOTES: 1. This value applies when the base-emitter diode is open-circuited.
2. Derate linearly to 100°C free-air temperature at the rate of 1.33 mA/°C.
3. Derate linearly to 100°C free-air temperature at the rate of 2 mW/°C.
4. Derate linearly to 100°C free-air temperature at the rate of 2 mW/°C.
5. Derate linearly to 100°C free-air temperature at the rate of 3.33 mW/°C.

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electrical characteristics at 25°C free-air temperature

PARAMETER			TEST CONDITIONS	TIL111 TIL114			TIL116			TIL117			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{(BR)CBO}$	Collector Base Breakdown Voltage		I_C = 10 µA, I_E = 0, I_F = 0	70			70			70			V
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage		I_C = 1 mA, I_B = 0, I_F = 0	30			30			30			V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage		I_E = 10 µA, I_C = 0, I_F = 0	7			7			7			V
I_R	Input Diode Static Reverse Current		V_R = 3 V			10			10			10	µA
$I_{C(on)}$	On-State Collector Current	Phototransistor Operation	V_{CE} = 0.4 V, I_F = 16 mA, I_B = 0	2	7								mA
			V_{CE} = 10 V, I_F = 10 mA, I_B = 0				2	5		5	9		
		Photodiode Operation	V_{CB} = 0.4 V, I_F = 16 mA, I_E = 0	10	20		10	20		10	20		µA
$I_{C(off)}$	Off State Collector Current	Phototransistor Operation	V_{CE} = 10 V, I_F = 0, I_B = 0		1	50		1	50		1	50	nA
		Photodiode Operation	V_{CB} = 10 V, I_F = 0, I_E = 0		0.1	20		0.1	20		0.1	20	
h_{FE}	Transistor Static Forward Current Transfer Ratio		V_{CE} = 5 V, I_C = 10 mA, I_F = 0	100	300					200	550		
			V_{CE} = 5 V, I_C = 100 µA, I_F = 0				100	300					
V_F	Input Diode Static Forward Voltage		I_F = 16 mA		1.2	1.4					1.2	1.4	V
			I_F = 60 mA					1.25	1.5				
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage		I_C = 2 mA, I_F = 16 mA, I_B = 0		0.25	0.4							V
			I_C = 2.2 mA, I_F = 15 mA, I_B = 0					0.25	0.4				
			I_C = 0.5 mA, I_F = 10 mA, I_B = 0								0.25	0.4	
r_{IO}	Input-to-Output Internal Resistance		V_{in-out} = ±1.5 kV for TIL111, ±2.5 kV for all others, See Note 6	10^{11}			10^{11}			10^{11}			Ω
C_{io}	Input-to-Output Capacitance		V_{in-out} = 0, f = 1 MHz, See Note 6		1	1.3		1	1.3		1	1.3	pF

NOTE 6: These parameters are measured between both input-diode leads shorted together and all the phototransistor leads shorted together.

switching characteristics at 25°C free-air temperature

PARAMETER			TEST CONDITIONS	TIL111 TIL114			TIL116			TIL117			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
t_r	Rise Time	Phototransistor Operation	V_{CC} = 10 V, $I_{C(on)}$ = 2 mA, R_L = 100 Ω, See Test Circuit A of Figure 1		2	5		2	7		2	9	µs
t_f	Fall Time				2	5		2	7		2	9	
t_r	Rise Time	Photodiode Operation	V_{CC} = 10 V, $I_{C(on)}$ = 20 µA, R_L = 1 kΩ, See Test Circuit B of Figure 1		1			1			1		µs
t_f	Fall Time				1			1			1		

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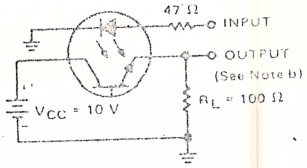
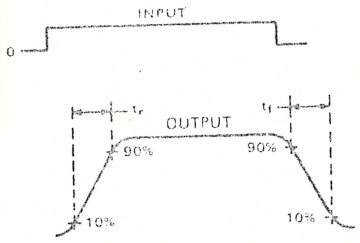
PARAMETER MEASUREMENT INFORMATION

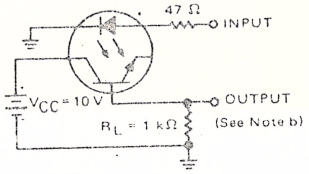
Adjust amplitude of input pulse for:
$I_{C(on)}$ = 2 mA (Test Circuit A) or
$I_{C(on)}$ = 20 μA (Test Circuit B)



TEST CIRCUIT A
PHOTOTRANSISTOR OPERATION



VOLTAGE WAVEFORMS



TEST CIRCUIT B
PHOTODIODE OPERATION

NOTES: a. The input waveform is supplied by a generator with the following characteristics: Z_{out} = 50 Ω, $t_r \leq 15$ ns, duty cycle ≈ 1%, t_w = 100 μs.
b. The output waveform is monitored on an oscilloscope with the following characteristics: $t_r \leq 12$ ns, $R_{in} \geq 1$ MΩ, $C_{in} \leq 20$ pF.

FIGURE 1–SWITCHING TIMES

TYPICAL CHARACTERISTICS

TIL111, TIL114
COLLECTOR CURRENT
vs
INPUT-DIODE FORWARD CURRENT

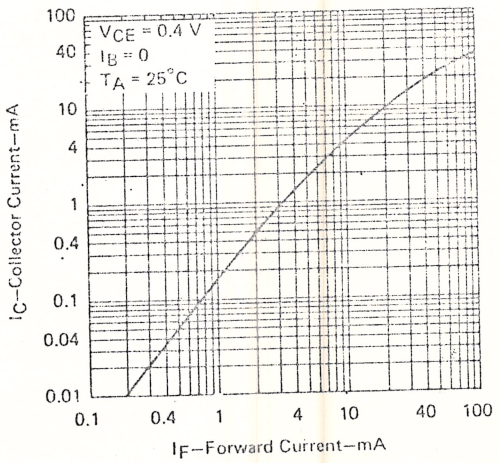


FIGURE 2

TIL116, TIL117
COLLECTOR CURRENT
vs
INPUT-DIODE FORWARD CURRENT

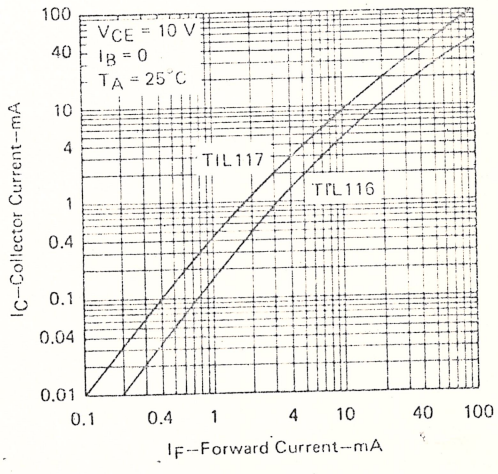


FIGURE 3

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TYPICAL CHARACTERISTICS

TIL111, TIL114

COLLECTOR CURRENT
vs
COLLECTOR-EMITTER VOLTAGE

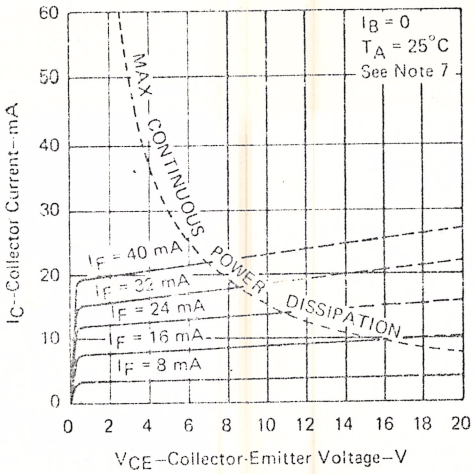

FIGURE 4

TIL116

COLLECTOR CURRENT
vs
COLLECTOR-EMITTER VOLTAGE

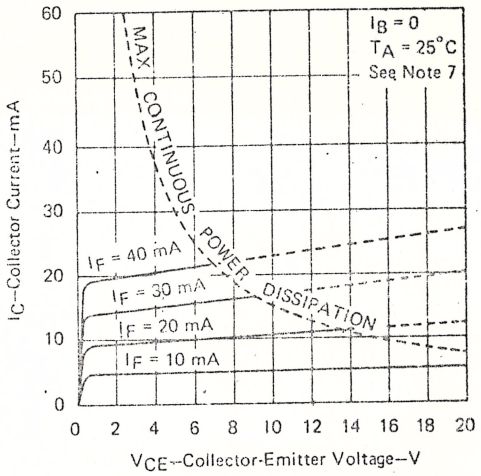

FIGURE 5

TIL117

COLLECTOR CURRENT
vs
COLLECTOR-EMITTER VOLTAGE

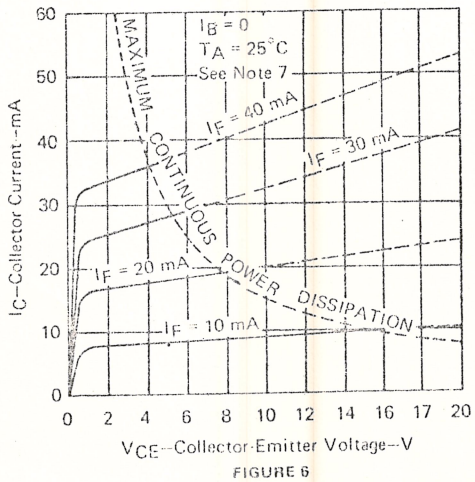

FIGURE 6

RELATIVE ON-STATE COLLECTOR CURRENT
vs
FREE-AIR TEMPERATURE

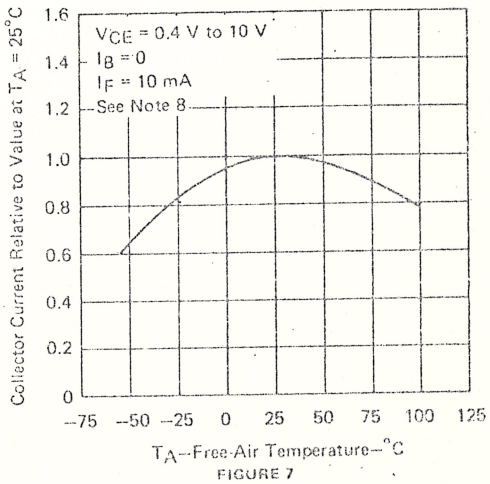

FIGURE 7

NOTES: 7. Pulse operation of input diode is required for operation beyond limits shown by dotted lines.
8. These parameters were measured using pulse techniques. t_w = 1 ms, duty cycle ≤ 2%.

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TYPICAL CHARACTERISTICS

OFF-STATE COLLECTOR CURRENT
vs
FREE-AIR TEMPERATURE

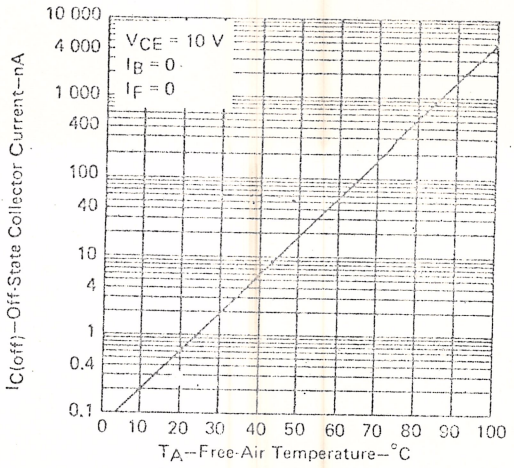

FIGURE 8

NORMALIZED TRANSISTOR STATIC FORWARD
CURRENT TRANSFER RATIO
vs
ON-STATE COLLECTOR CURRENT

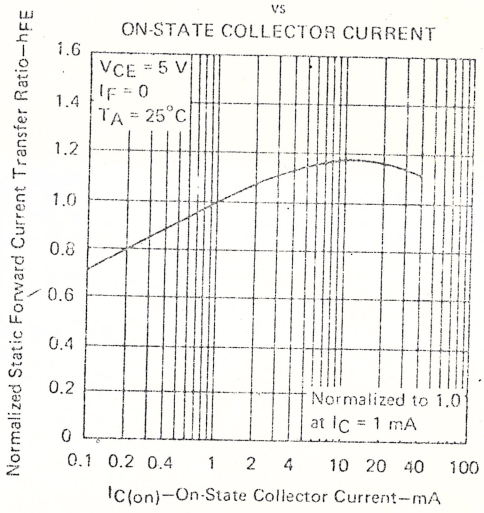

FIGURE 9

INPUT DIODE FORWARD
CONDUCTION CHARACTERISTICS

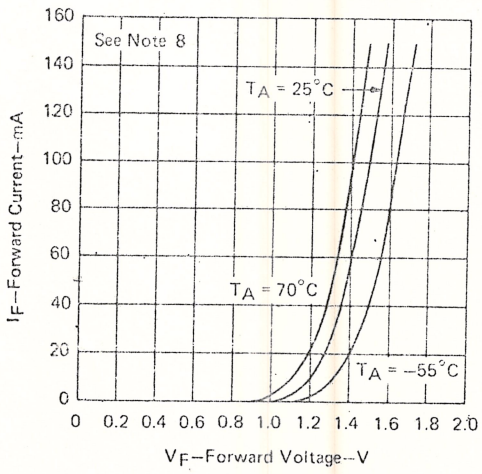

FIGURE 10

COLLECTOR CURRENT
vs
MODULATION FREQUENCY

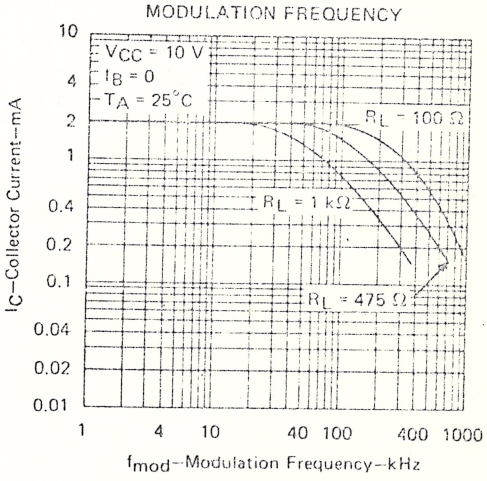

FIGURE 11

NOTE 8: These parameters were measured using pulse techniques. t_w = 1 ms, duty cycle ≤ 2%

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