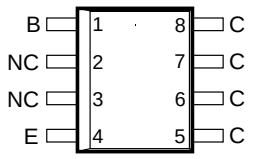
BULD25D, BULD25DR, BULD25SL
NPN SILICON TRANSISTOR WITH INTEGRATED DIODE

 JULY 1994 - REVISED SEPTEMBER 1997

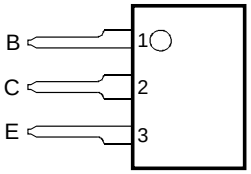
- **Designed Specifically for High Frequency Electronic Ballasts**
- **Integrated Fast t_{rr} Anti-parallel Diode, Enhancing Reliability**
- **Diode t_{rr} Typically 500 ns**
- **New Ultra Low-Height SOIC Power Package**
- **Tightly Controlled Transistor Storage Times**
- **Voltage Matched Integrated Transistor and Diode**
- **Characteristics Optimised for Cool Running**
- **Diode-Transistor Charge Coupling Minimised to Enhance Frequency Stability**
- **Custom Switching Selections Available**
- **Surface Mount and Through-Hole Options**

D PACKAGE
(TOP VIEW)



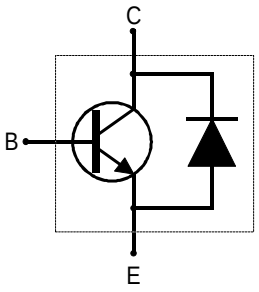
NC - No internal connection

SL PACKAGE
(TOP VIEW)



PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Single-in-line	SL

device symbol



description

The new BULDxx range of transistors have been designed specifically for use in High Frequency Electronic Ballasts (HFEB's). This range of switching transistors has tightly controlled storage times and an integrated fast t_{rr} anti-parallel diode. The revolutionary design ensures that the diode has both fast forward and reverse recovery times, achieving the same performance as a discrete anti-parallel diode plus transistor.

The integrated diode has minimal charge coupling with the transistor, increasing frequency stability, especially in lower power circuits where the circulating currents are low. By design, this new device offers a voltage matched integrated transistor and anti-parallel diode.

This device is available in the now well established 8 pin low height surface mount D package, and the TO-220 pin compatible SL package. Use of the SL package allows for a 40% height saving, making it ideal for compact ballast applications.

absolute maximum ratings at 25°C ambient temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Collector-emitter voltage (V_{BE} = 0)	V_{CES}	600	V
Collector-base voltage (I_E = 0)	V_{CBO}	600	V
Collector-emitter voltage (I_B = 0)	V_{CEO}	400	V
Emitter-base voltage	V_{EBO}	9	V

absolute maximum ratings at 25°C ambient temperature (unless otherwise noted) (continued)

RATING		SYMBOL	VALUE	UNIT
Continuous collector current (see Note 1)		I_C	2	A
Peak collector current (see Note 2)		I_{CM}	4	A
Continuous base current (see Note 1)		I_B	1.5	A
Peak base current (see Note 2)		I_{BM}	2.5	A
Continuous device dissipation at (or below) 25°C ambient temperature	BULD25D BULD25SL	P_{tot}	see Figure 10 see Figure 11	W
Maximum average continuous diode forward current at (or below) 25°C ambient temperature		$I_{E(av)}$	0.5	A
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTES: 1. This value applies for t_p = 1 s.
2. This value applies for t_p = 10 ms, duty cycle ≤ 2%.

electrical characteristics at 25°C ambient temperature

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
$V_{CEO(sus)}$	Collector-emitter sustaining voltage	I_C = 0.1 A			400			V
I_{CES}	Collector-emitter cut-off current	V_{CE} = 600 V	V_{BE} = 0				10	µA
I_{EBO}	Emitter cut-off current	V_{EB} = 9 V	I_C = 0				1	mA
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 0.1 A	I_C = 0.5 A	(see Notes 3 and 4)		0.9	1.1	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 0.1 A I_B = 0.2 A	I_C = 0.5 A I_C = 1 A	(see Notes 3 and 4)		0.3 0.6	0.5 1	V
h_{FE}	Forward current transfer ratio	V_{CE} = 10 V V_{CE} = 1.5 V V_{CE} = 5 V	I_C = 0.01 A I_C = 0.5 A I_C = 1 A	(see Notes 3 and 4)	10 10 10	18 15 15	 20 20	
V_{EC}	Anti-parallel diode forward voltage	I_E = 1 A		(see Notes 3 and 4)		1.5	1.7	V

NOTES: 3. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
4. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts, and located within 1 mm from the device body for the D package and 3.2 mm from the device body for the SL package.

thermal characteristics

PARAMETER			MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	D package SL Package			165 115	°C/W

switching characteristics at 25°C ambient temperature

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{rr}	Anti-parallel diode reverse recovery time	Measured by holding transistor in an off condition, V_{EB} = -3 V	(see Note 5)		0.5	1	µs
t_s	Storage time	(see Note 5)		2	3.5	5	µs
t_f	Fall time	(see Note 5)			0.25	0.35	µs

NOTE 5: Refer to Figures 12, 13 and 14 for Functional Test Circuit and Switching Waveforms.

PRODUCT INFORMATION

TYPICAL CHARACTERISTICS

FORWARD CURRENT TRANSFER RATIO vs COLLECTOR CURRENT

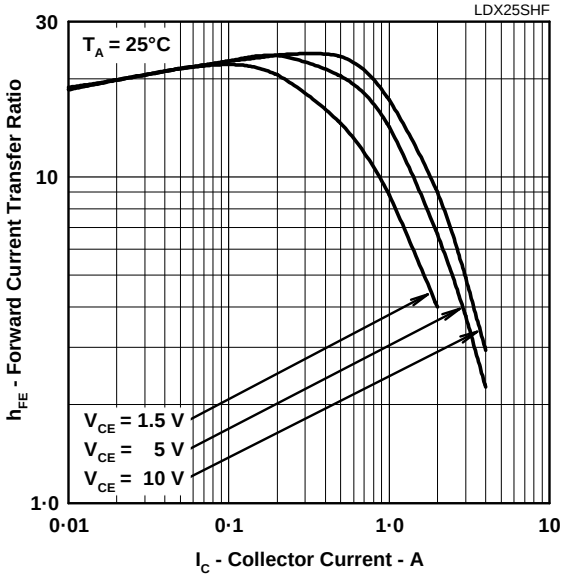


Figure 1.

ANTI-PARALLEL DIODE INSTANTANEOUS FORWARD CURRENT vs INSTANTANEOUS FORWARD VOLTAGE

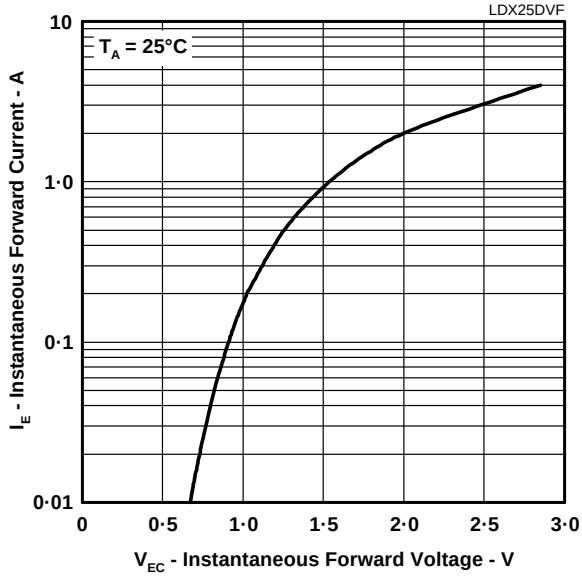


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs AMBIENT TEMPERATURE

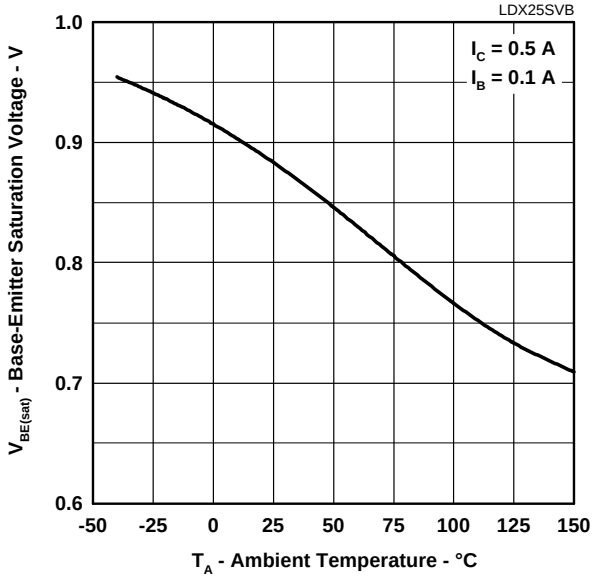


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

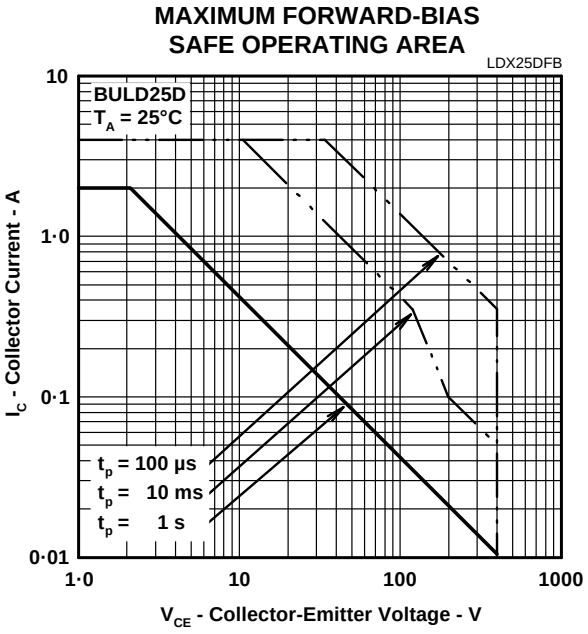


Figure 4.

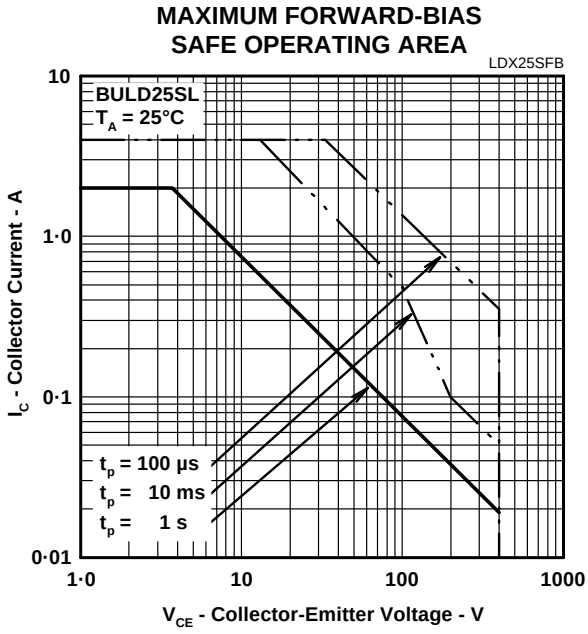


Figure 5.

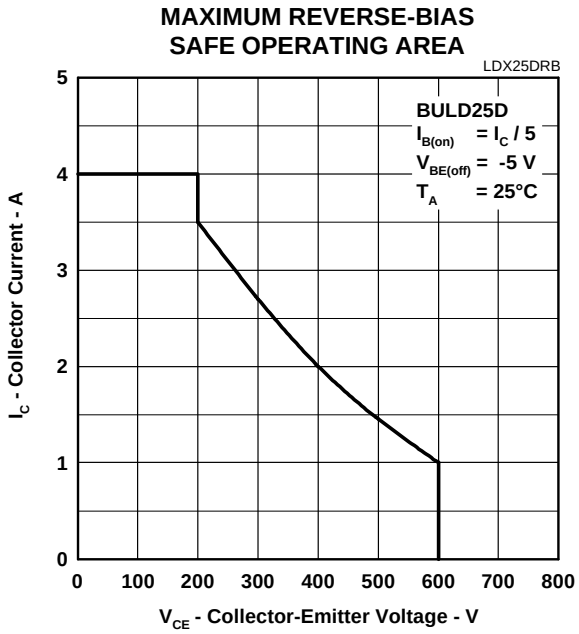


Figure 6.

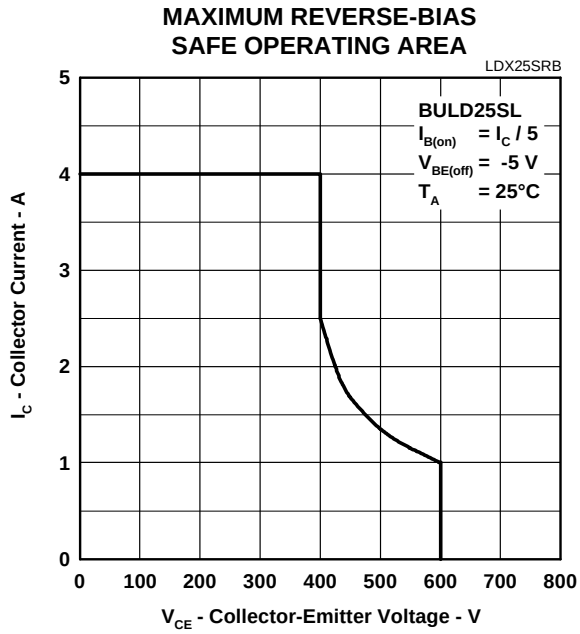


Figure 7.

THERMAL INFORMATION

THERMAL RESPONSE JUNCTION TO AMBIENT
vs
POWER PULSE DURATION

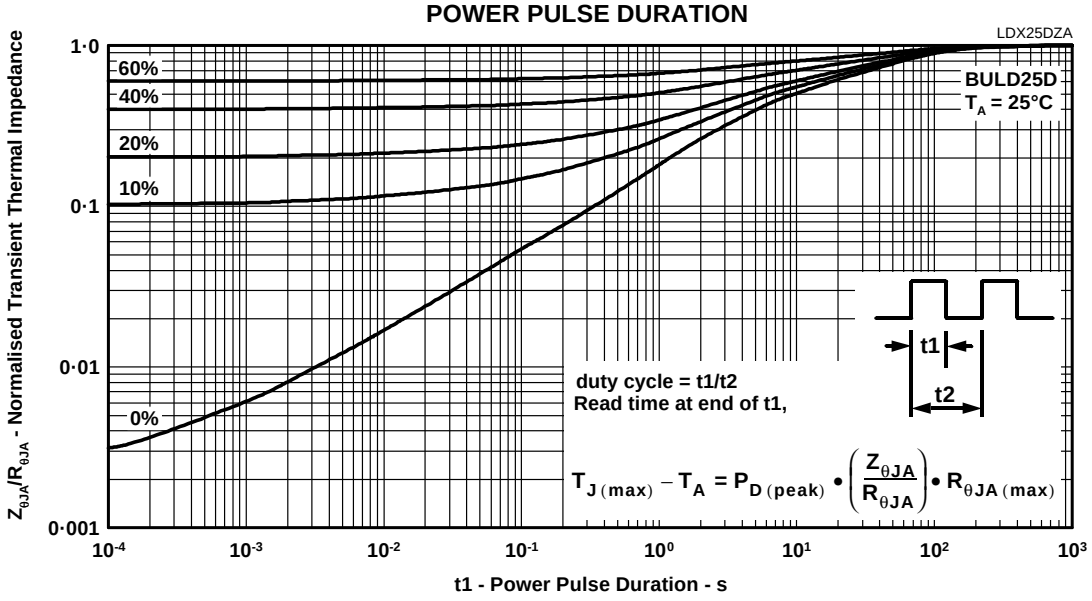


Figure 8.

THERMAL RESPONSE JUNCTION TO AMBIENT
vs
POWER PULSE DURATION

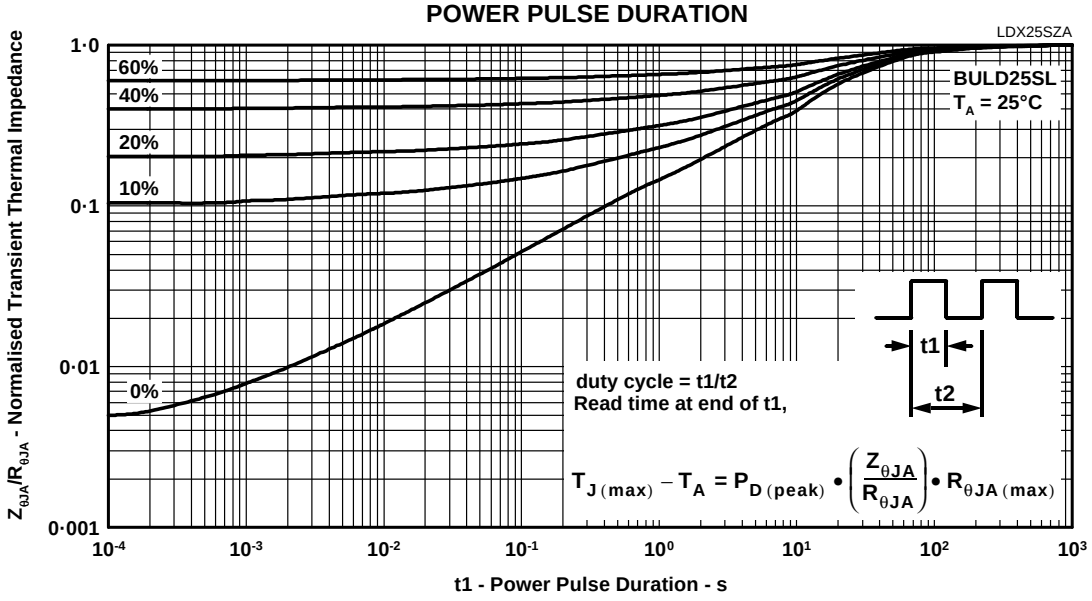


Figure 9.

THERMAL INFORMATION

MAXIMUM POWER DISSIPATION JUNCTION TO AMBIENT
vs
POWER PULSE DURATION

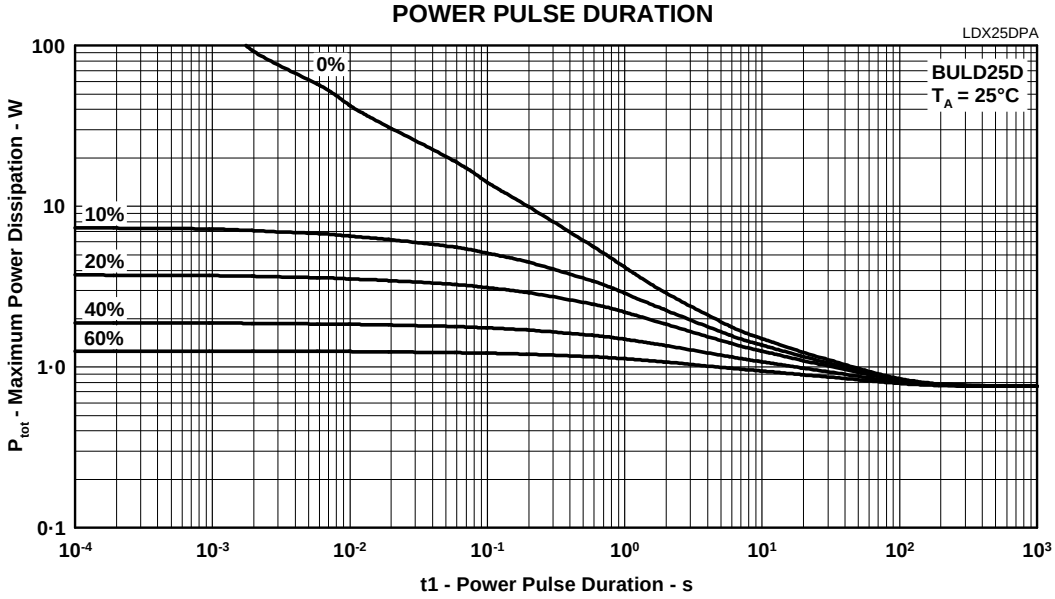


Figure 10.

MAXIMUM POWER DISSIPATION JUNCTION TO AMBIENT
vs
POWER PULSE DURATION

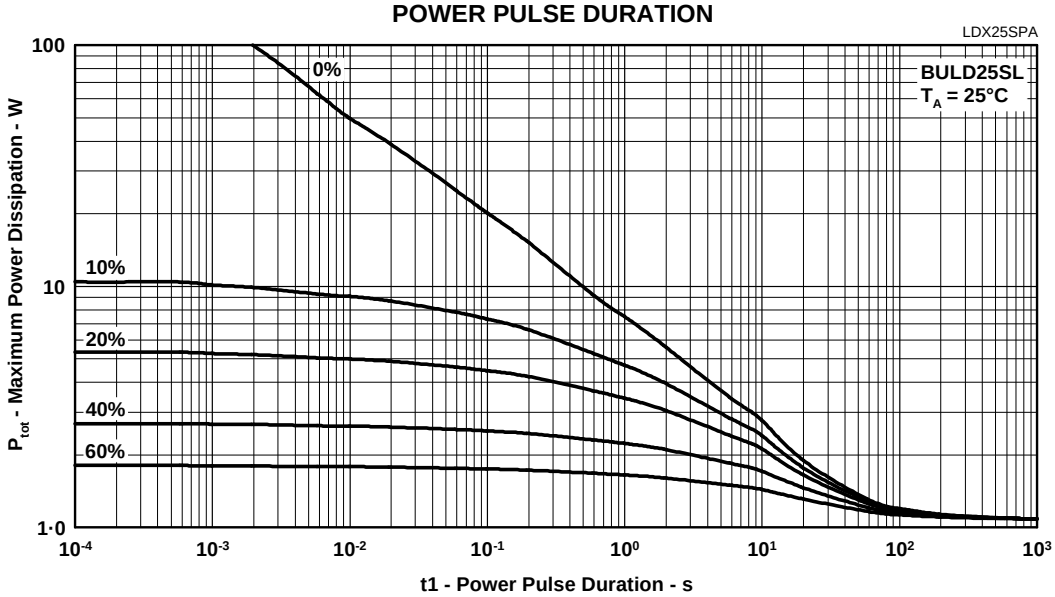


Figure 11.

FUNCTIONAL TEST CIRCUIT

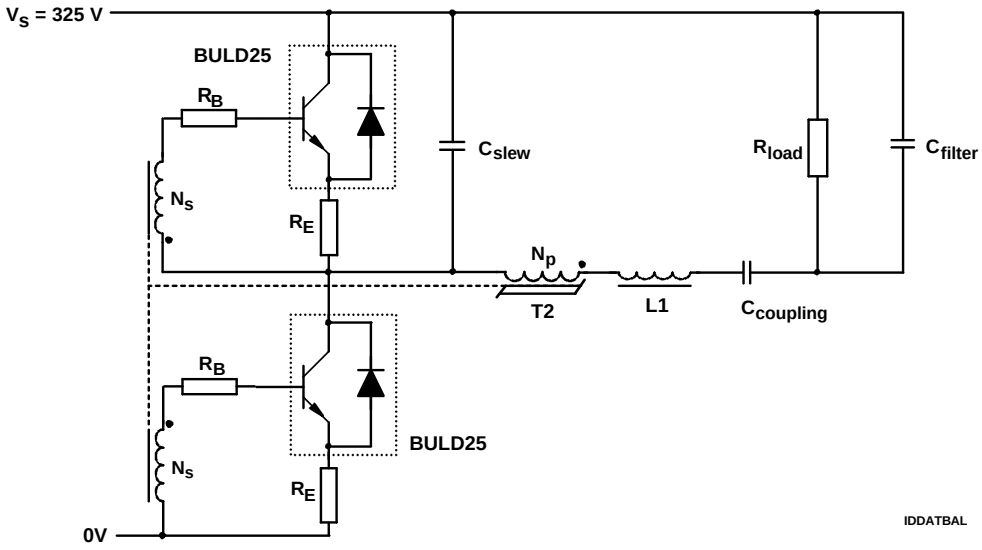


Figure 12.

COMPONENT VALUES USED IN FUNCTIONAL TEST CIRCUIT	
R_B	22 Ω
R_E	1.8 Ω
R_{load}	470 Ω
$C_{coupling}$	47 nF
C_{slew}	1.5 nF
C_{filter}	3.2 nF
L1	2.5 mH
T2 N_P : N_S	5 : 3

Figure 13.

FUNCTIONAL TEST SWITCHING WAVEFORMS

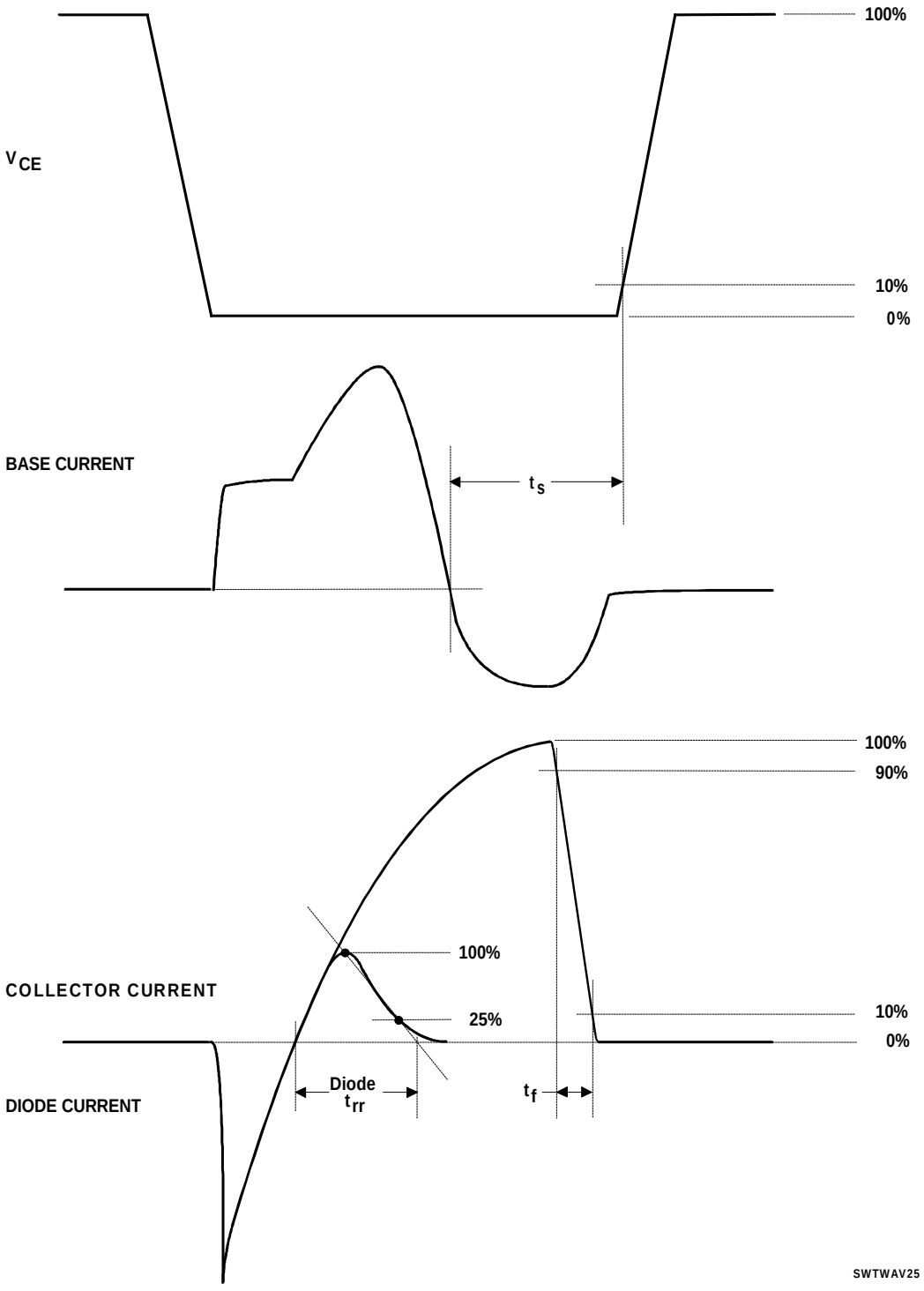


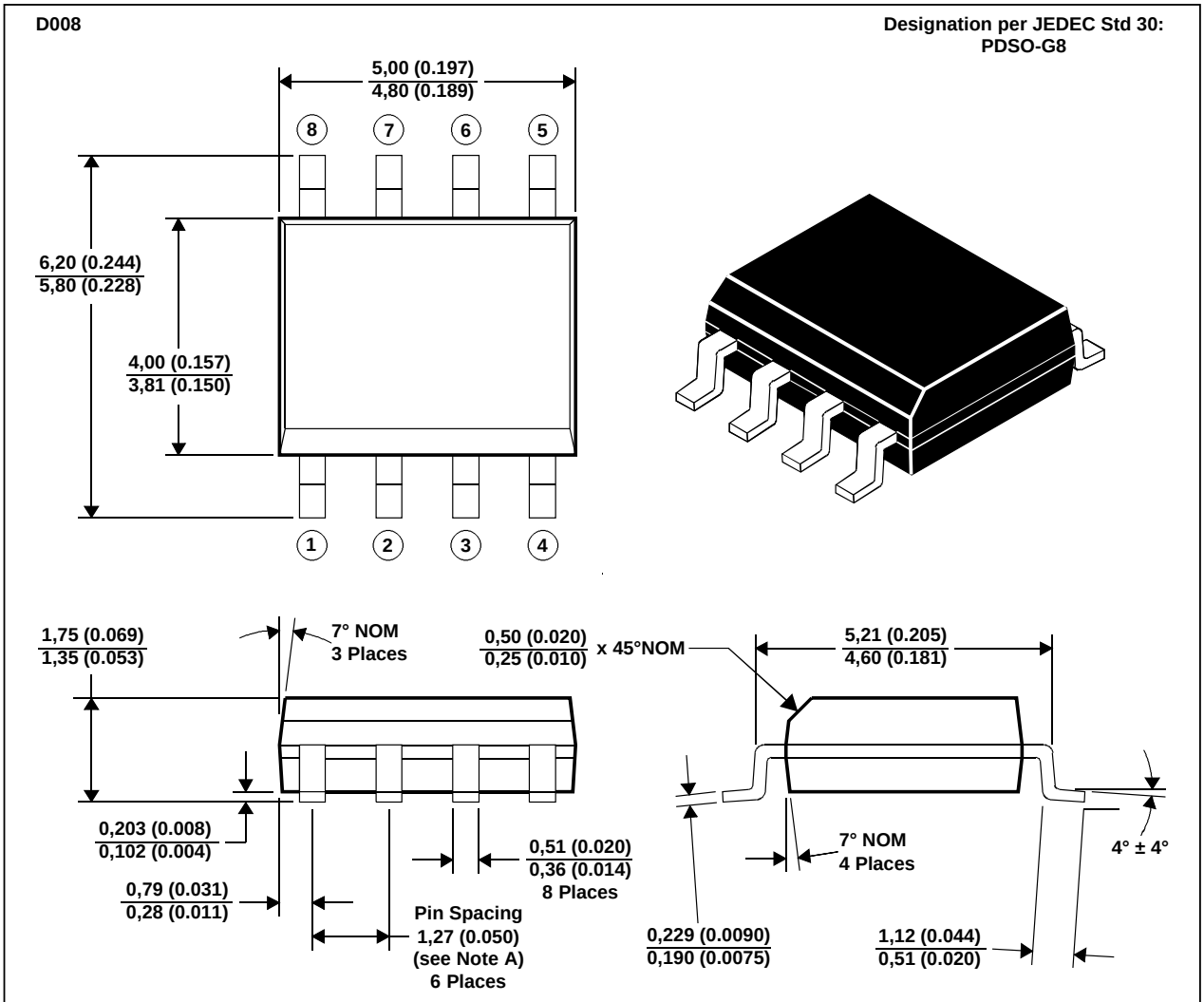
Figure 14. Switching Waveforms of device in Functional Test Circuit

MECHANICAL DATA

D008

plastic small-outline package

This small-outline package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.



MDXXAA

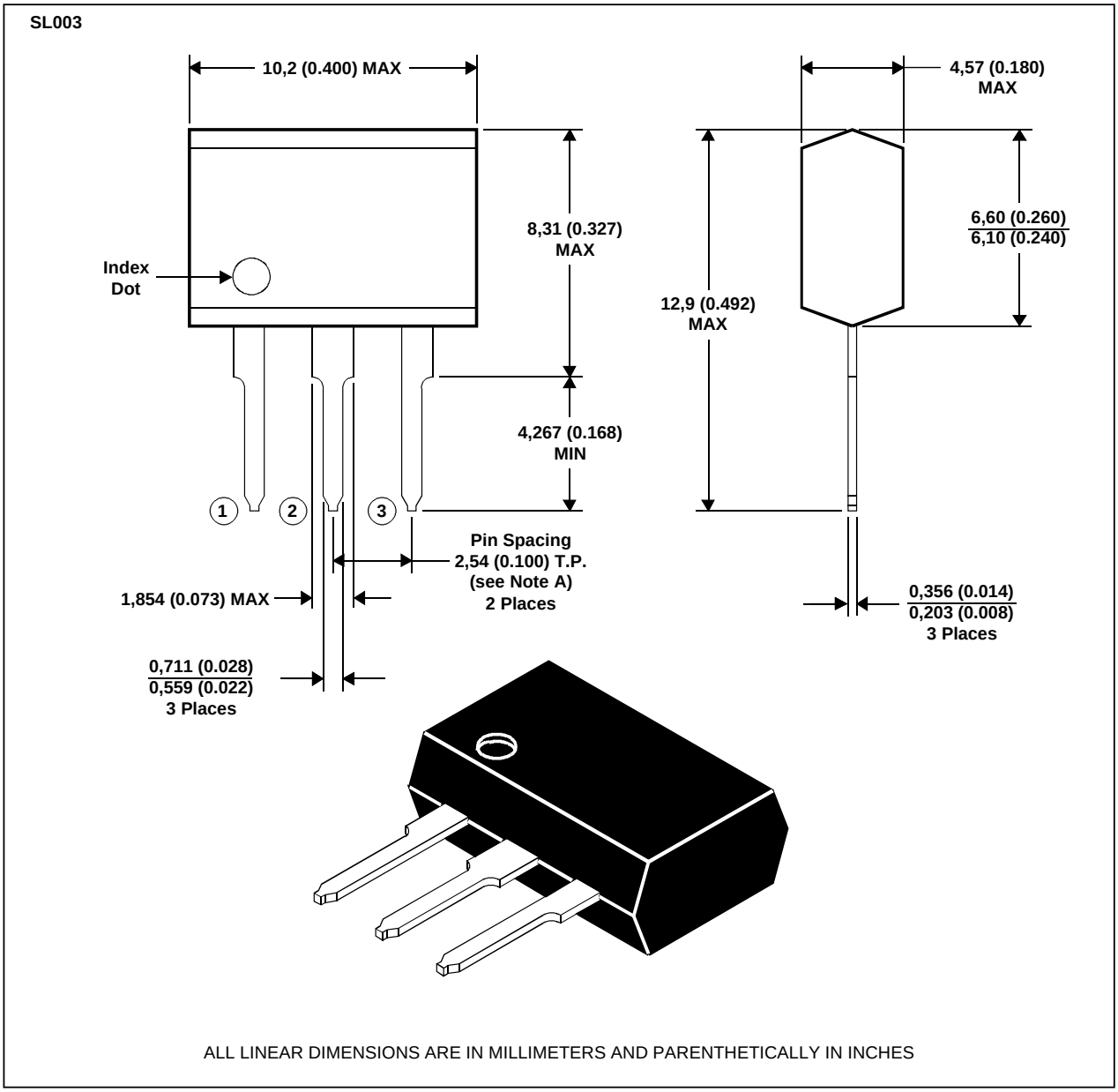
NOTES: A. Leads are within 0,25 (0.010) radius of true position at maximum material condition.
B. Body dimensions do not include mold flash or protrusion.
C. Mold flash or protrusion shall not exceed 0,15 (0.006).
D. Lead tips to be planar within ±0,051 (0.002).

MECHANICAL DATA

SL003

3-pin plastic single-in-line package

This single-in-line package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.



NOTES: A. Each pin centerline is located within 0,25 (0.010) of its true longitudinal position.
B. Body molding flash of up to 0,15 (0.006) may occur in the package lead plane.

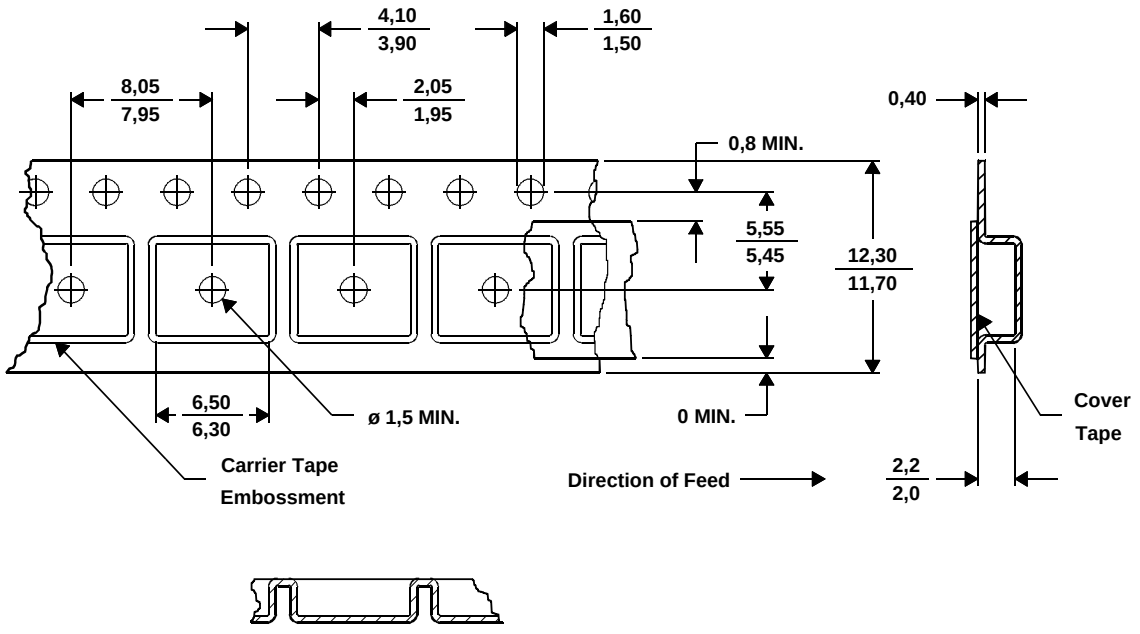
MDXXAD

MECHANICAL DATA

D008

tape dimensions

D008 Package (8 pin SOIC) Single-Sprocket Tape



ALL LINEAR DIMENSIONS IN MILLIMETERS

NOTES: A. Taped devices are supplied on a reel of the following dimensions:- MDXXAT

Reel diameter:	330 +0,0/-4,0 mm
Reel hub diameter:	100 ±2,0 mm
Reel axial hole:	13,0 ±0,2 mm

B. 2500 devices are on a reel.

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