TS2003, High-Voltage, High-Current Darlington Transistor Arrays

FEATURES

- **Rated Collector Current for 500mA Single Output**
- **High-Voltage Output: 50V**
- **Integrated Clamp Diode at Output**
- **Inputs Compatible with Various Types of Logic**

APPLICATIONS

- **Relay Drivers**
- **Stepper and DC Brushed Motor Drivers**
- **Logic Buffers**
- **Lamp Drivers**
- **Display Drivers**
- **High Power Switching Circuits**

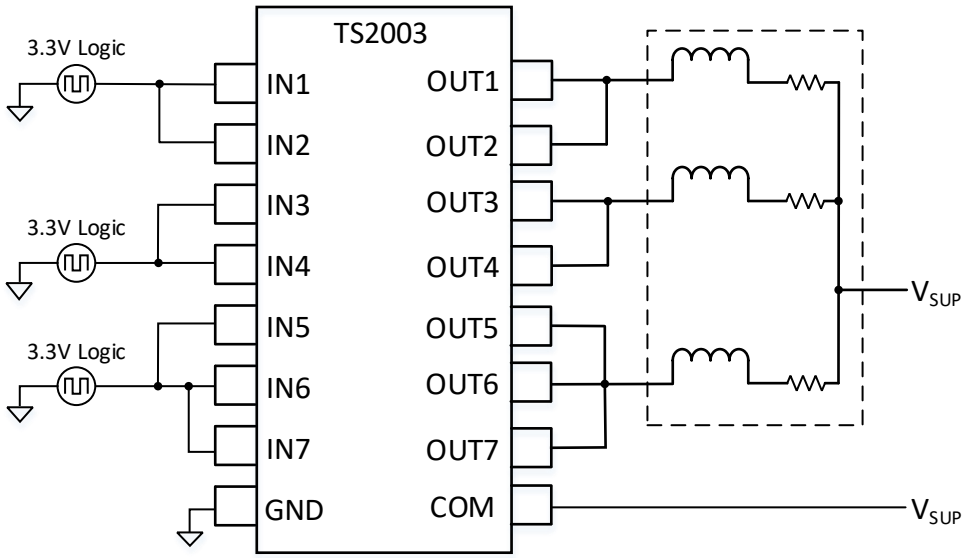
PRODUCT DESCRIPTION

The TS2003 is high-voltage, high-current Darlington transistor array. Each consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads.

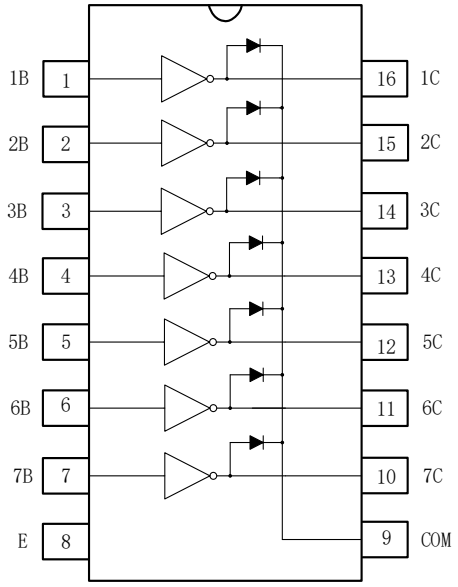
All units feature a common emitter and open collector outputs. To maximize their effectiveness, these units contain suppression diodes for inductive loads. The TS2003 has a series base resistor to each Darlington pair, thus allowing operation directly with TTL or CMOS operating at supply voltages of 5V or 3.3V. The TS2003 offers solution to a great many interface needs, including solenoids, relays, lamps, small motors, and LEDs. Applications requiring sink currents beyond the capability of a single output may be accommodated by paralleling the outputs.

This standard device has proven ubiquity and versatility across a wide range of applications. This is due to integration of seven Darlington transistor of the device that are capable of sinking up to 500mA and wide GPIO range capability.

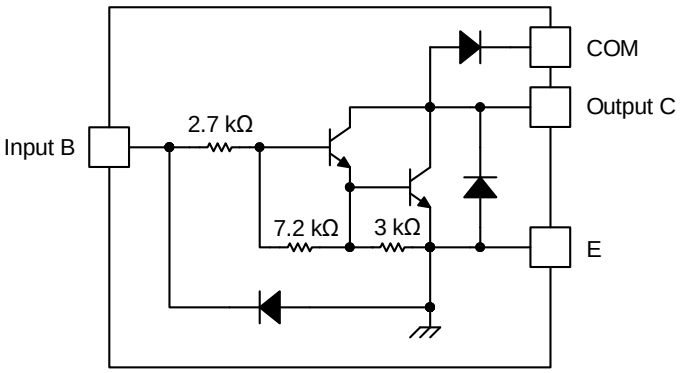
Typical Application



PIN DESCRIPTION AND BLOCK DIAGRAM



SOP16



BLOCK Diagram

PIN		I/O	DESCRIPTION
NAME	NO.		
1B	1	I	Channel 1 through 7 Darlington base input
2B	2		
3B	3		
4B	4		
5B	5		
6B	6		
7B	7		
1C	16	O	Channel 1 through 7 Darlington collector output
2C	15		
3C	14		
4C	13		
5C	12		
6C	11		
7C	10		
COM	9		Common cathode node for flyback diodes (required for inductive loads)
E	8		Common emitter shared by all channels (typically tied to ground)

ORDERING INFORMATION

Model	Part Number	Eco Plan	Package	Container, Pack Qty
TS2003	TS2003SOP16R	RoHS	SOP16	Reel,2500
TS2003	TS2003TSSOP16R	RoHS	TSSOP16	Reel,4000

ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range (unless otherwise noted) (1)

Parameter		Min	Max	Unit
V_{CC}	Collector-emitter voltage		50	V
	Clamp diode reverse voltage(2)		50	V
V_I	Input voltage(2)		30	V
	Peak collector current		500	mA
I_{OK}	Output clamp current		500	mA
	Total emitter-terminal current		-2.5	A
T_J	Junction temperature		+150	°C
T_{stg}	Storage temperature	-65	+150	°C
ESD HBM			±2000	V
ESD CDM			±1000	V

(1) Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.

RECOMMENDED OPERATING CONDITIONS

Parameter		Min	Typ	Max	Unit
V_{CC}	Collector-emitter voltage (non-V devices)			50	V
T_J	Junction temperature	-40		+125	°C
θ_{JA}	Thermal Resistance Junction-to-Ambient		64		°C/W
θ_{JC}	Thermal Resistance Junction-to-Case		12		°C/W

ESD CAUTION

ESD (Electrostatic Discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjects to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

ELECTRICAL CHARACTERISTICS

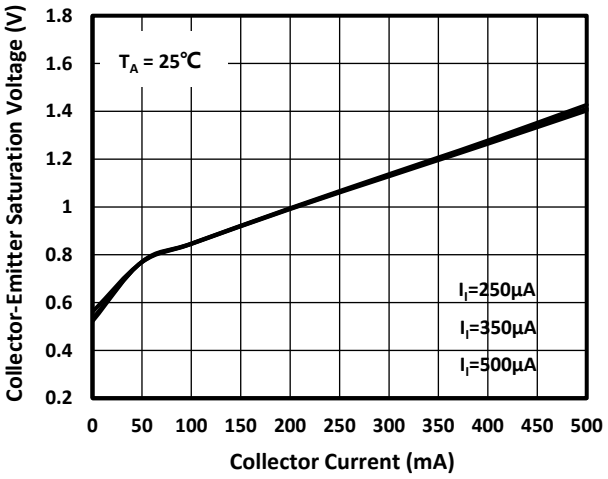
Boldface limits apply over the specified temperature range, **T_A = −40℃ to +125℃**.

At T_A = +25℃ (unless otherwise noted)

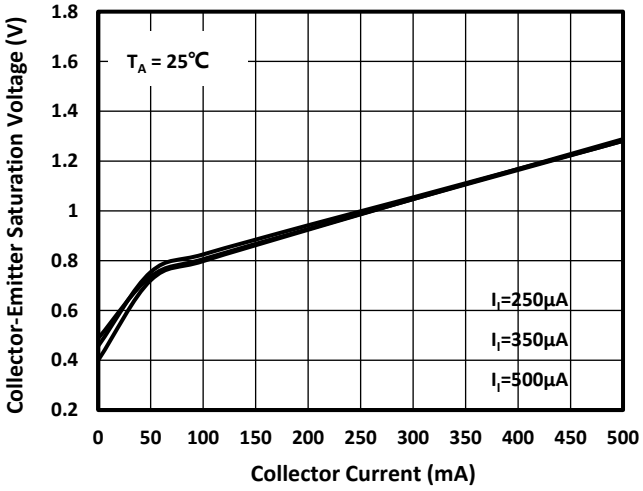
Parameter		Test Figure	Test Conditions		Min	Typ	Max	Unit
$V_{I(on)}$	ON-state input voltage	Figure 1	V_{CE}=2V	I_C = 200mA			2.4	V
							2.7	
				I_C = 250mA			2.7	
							2.9	
				I_C = 300mA			3	
							3	
$V_{CE(sat)}$	Collector-emitter saturation voltage	Figure 2	I_I = 250μA, I_C = 100mA			0.9	1.1	V
							1.2	
			I_I = 350μA, I_C = 200mA			1	1.3	
							1.4	
			I_I = 500μA, I_C = 350mA			1.2	1.6	
							1.7	
I_{CEX}	Collector cutoff current	Figure 3	V_{CE} = 50V, I_I = 0				50	μA
							100	
V_F	Clamp forward voltage	Figure 4	I_F = 350mA			1.7	2	V
							2.2	
$I_{I(off)}$	Off-state input current	Figure 5	V_{CE} = 50V, I_C = 500μA		50	65		μA
					30			
$I_{I(on)}$	Input current	Figure 6	V_I = 2.4V, I_C = 350mA			0.4	0.7	mA
							0.7	
I_R	Clamp reverse current	Figure 7	V_R = 50V				50	μA
							100	
C_I	Input capacitance		V_I = 0, f = 1MHz			15	25	pF
							25	
Switching Characteristics								
t_{PLH}	Propagation delay time, low to high level output	Figure 8				0.45	1	μs
							10	μs
t_{PHL}	Propagation delay time, high to low level output					0.04	1	μs
							10	μs

TYPICAL CHARACTERISTICS

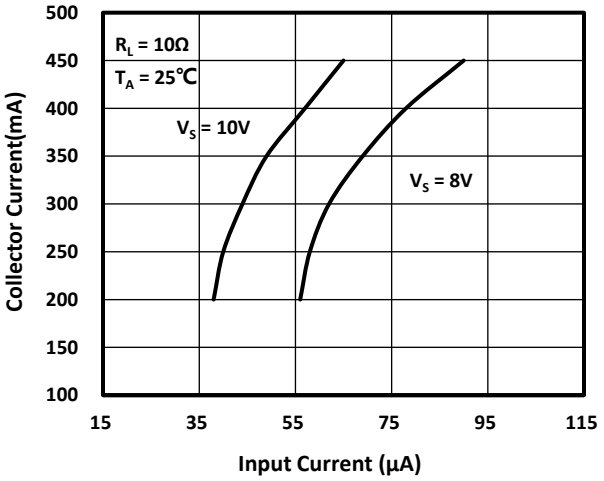
Collector-Emitter Saturation Voltage vs Collector Current (One Darlington)



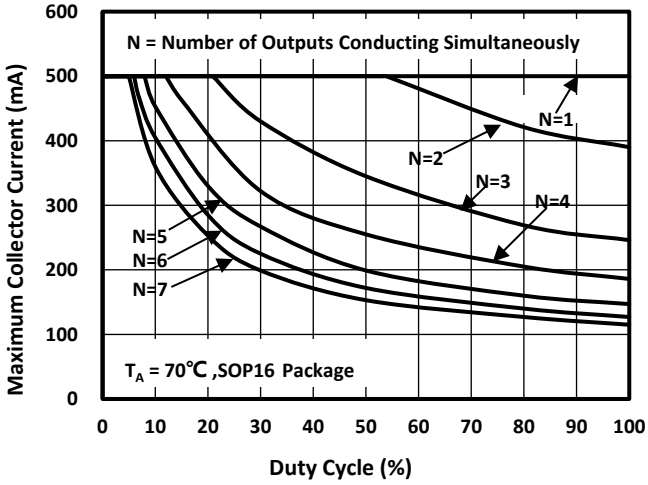
Collector-Emitter SaturationVoltage vs Collector Current (Two Darlingtons in Parallel)



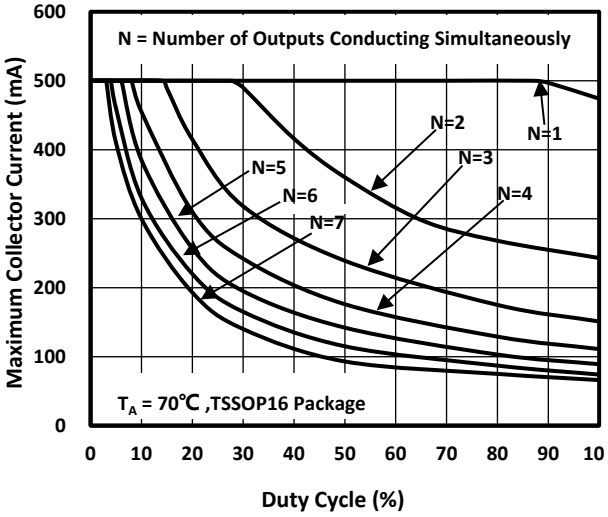
Collector Current vs Input Current



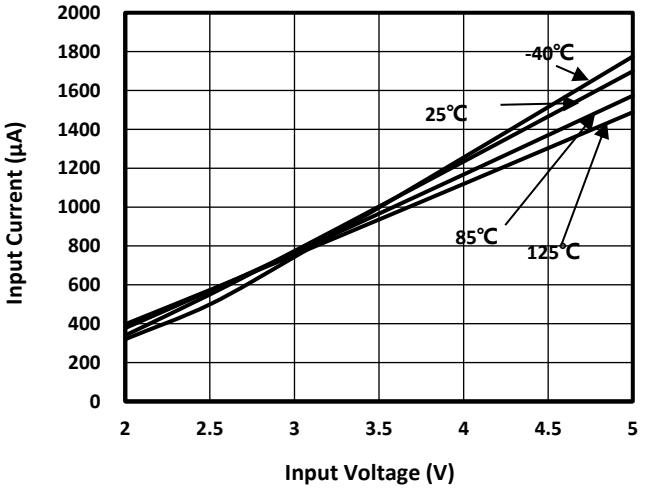
Maximum Collector Current vs Duty Cycle



Maximum Collector Current vs Duty Cycle

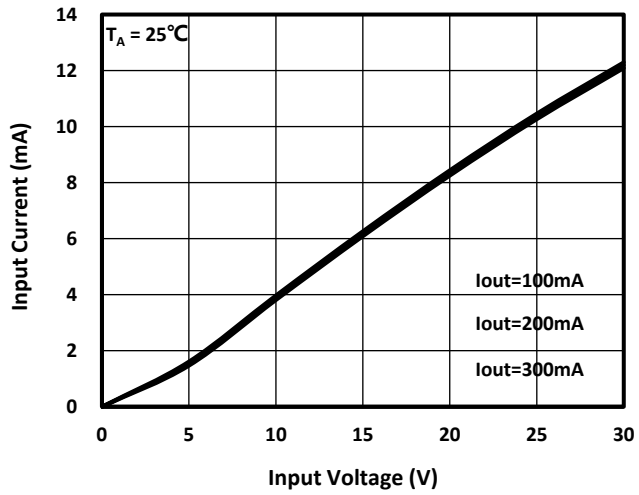


Input Current vs Input Voltage

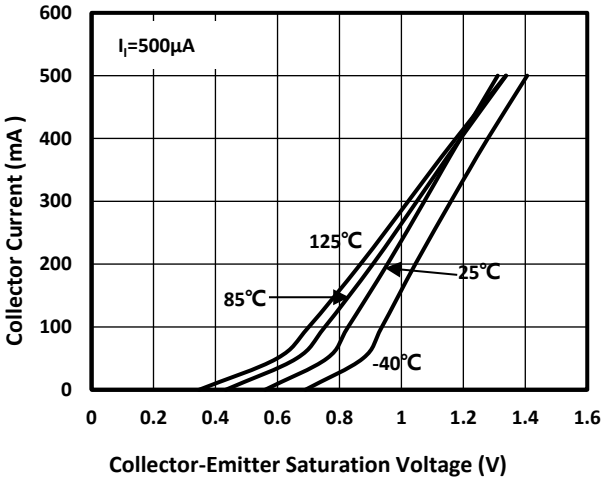


TYPICAL CHARACTERISTICS

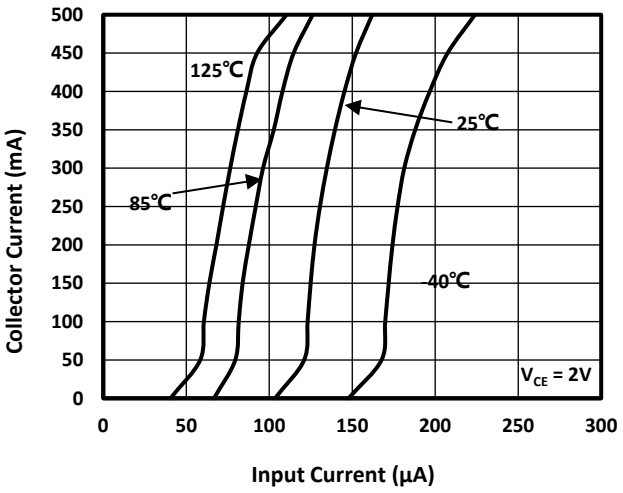
Input Current vs Input Voltage



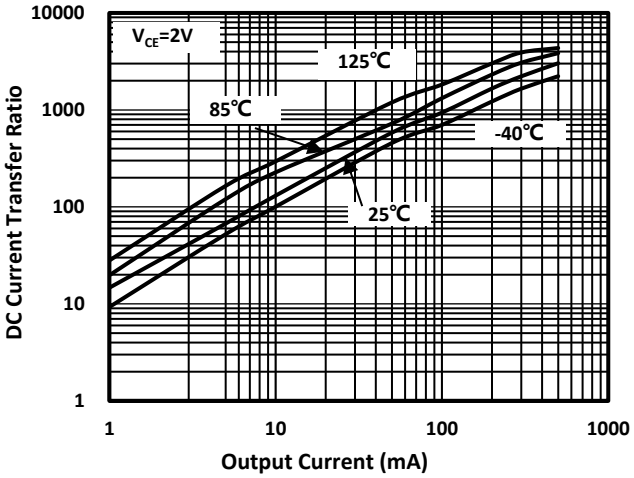
Collector Current vs Saturation Voltage



Collector Current vs Input Current



h_{FE} vs Output Currtent



TEST CIRCUITS

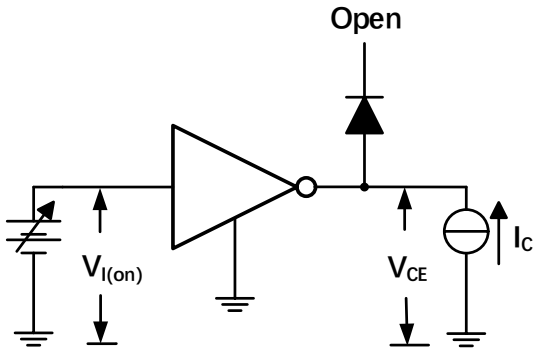


Figure 1 $V_{I(on)}$ Test Circuit

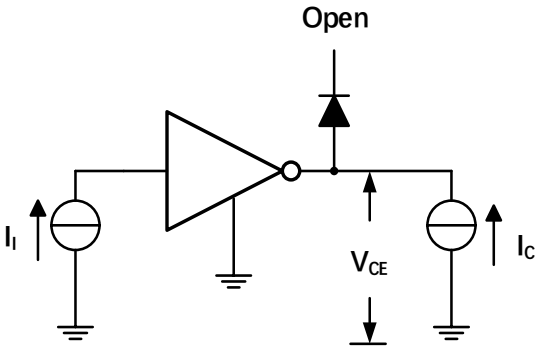


Figure 2 h_{FE}, $V_{CE(sat)}$ Test Circuit

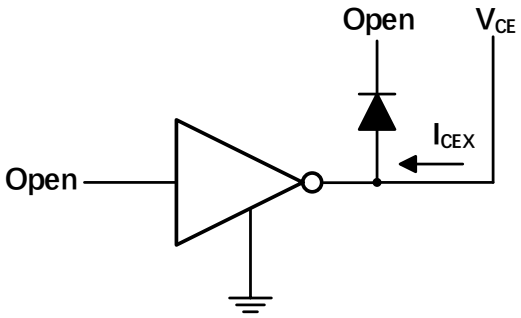


Figure 3 I_{CEX} Test Circuit

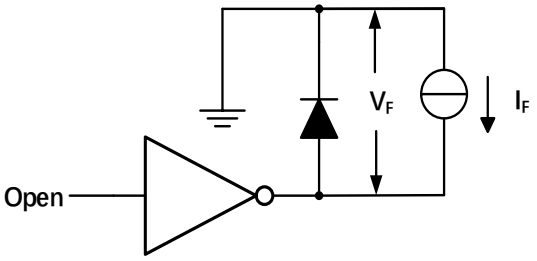


Figure 4 V_F Test Circuit

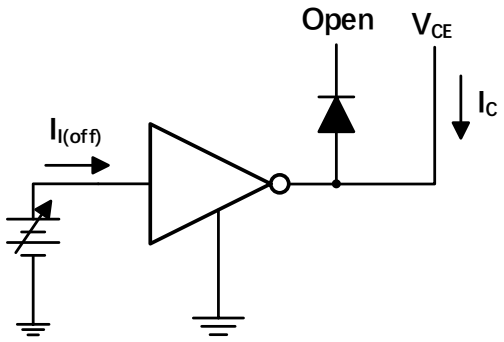


Figure 5 $I_{I(off)}$ Test Circuit

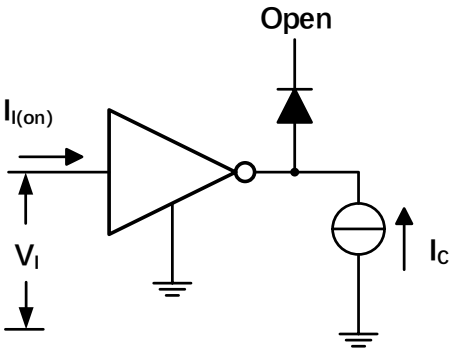


Figure 6 $I_{I(on)}$ Test Circuit

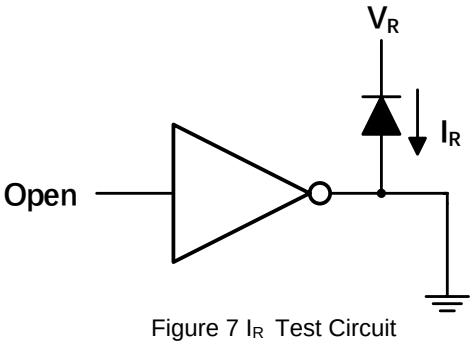


Figure 7 I_R Test Circuit

TEST CIRCUITS

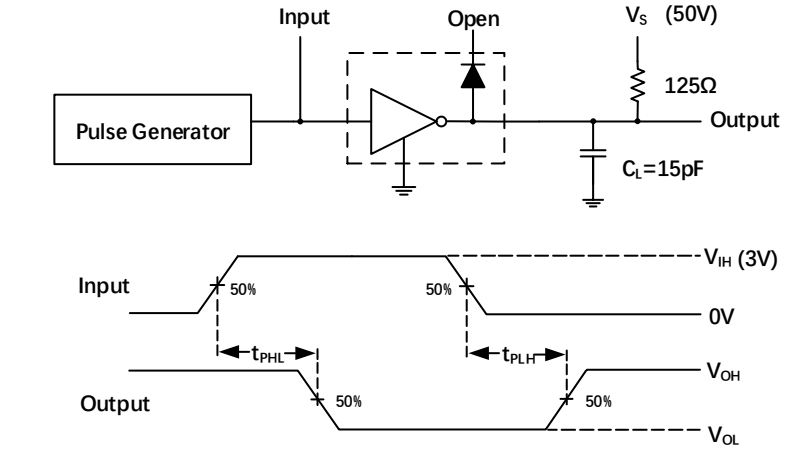


Figure 8 Propagation Delay-Time Test Circuit and Voltage Waveforms

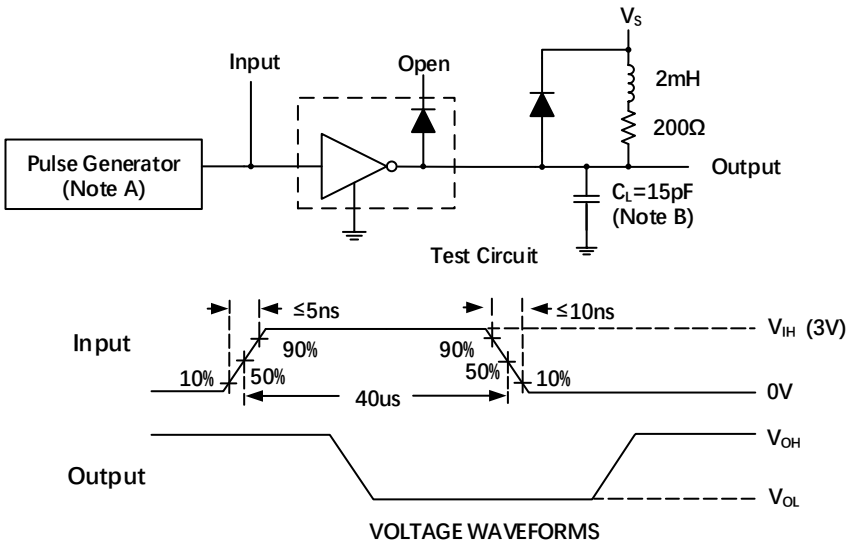
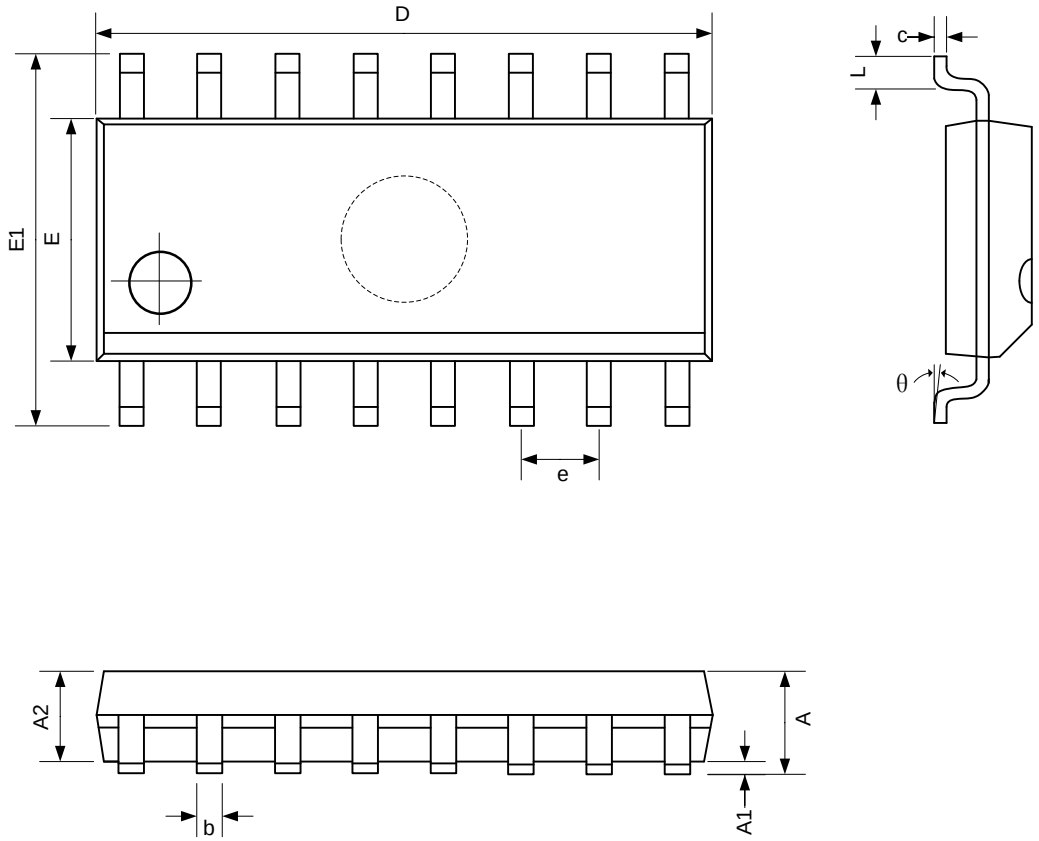


Figure 9 Latch-Up Test Circuit and Voltage Waveforms

Notes: A. The pulse generator has the following characteristics: Pulse Width = 12.5Hz, output impedance 50Ω, t_R ≤ 5ns, t_F ≤ 10ns.
B. C_L includes prove and jig capacitance.

MECHANICAL DIMENSIONS

SOP16 PACKAGE MECHANICAL DRAWING

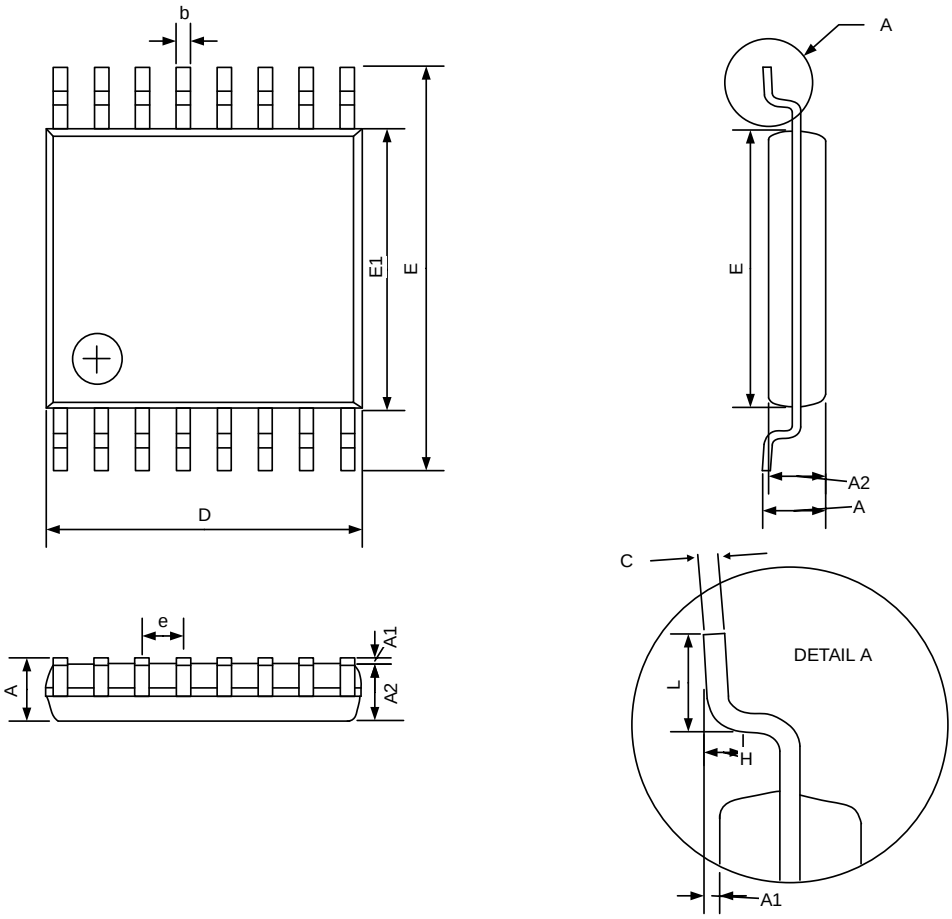


SOP16 PACKAGE MECHANICAL DATA

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

MECHANICAL DIMENSIONS

TSSOP16 PACKAGE MECHANICAL DRAWING

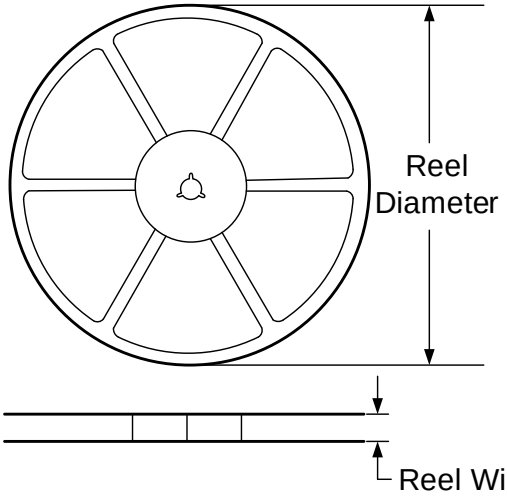


TSSOP16 PACKAGE MECHANICAL DATA

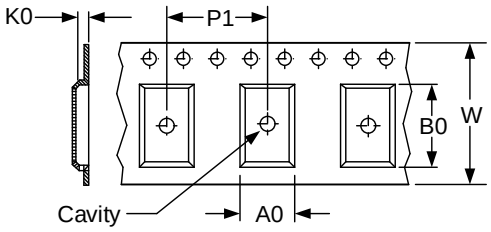
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	6.250	6.550	0.246	0.258
E1	4.300	4.500	0.169	0.177
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.250(TYP)		0.010(TYP)	
θ	1°	7°	1°	7°

TAPE AND REEL INFORMATION

REEL DIMENSIONS

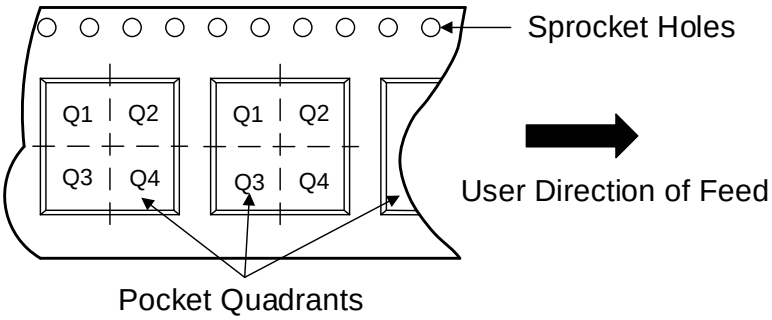


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component width thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TS2003SOP16	SOP16	16	2500	330.0	16.4	6.7	10.4	2.1	8.0	16.0	Q1
TS2003TSSOP16	TSSOP16	16	4000	330.0	17.6	3.18	3.28	0.84	4.0	8.0	Q1

REVISION HISTORY

NOTE: Page numbers for previous revisions may be different from that of the current version.

2023/3/7 — REV KY1.0.0A to REV KY1.1.0A

Updated ABSOLUTE MAXIMUM RATINGS and ELECTRICAL CHARACTERISTICS ..……..3,4,7

2023/7/12— REV KY1.1.0A to REV KY1.2.0A

Added package TSSOP16……..3,10,11

2023/10/16— REV KY1.2.0A to REV KY1.3.0A

Updated SOP16 Pack Qty and TAPE and REEL INFORMATION……..……...……..3,11

2023/11/2— REV KY1.3.0A to REV KY1.4.0A

Updated TYPICAL CHARACTERISTICS……...……...……..5

CONTACT INFORMATION

Trusignal Microelectronics

Phone: +86 512-65923982
Fax: +86 512-65923995
Email: support@kunyuanic.com; sales@kunyuanic.com