50-V 7-Channel Low-Side Driver Array

Features

- 7-Channel Darlington Array
- 500-mA Rated Channel Current
- Power Efficient with Low Output Impedance
- Extended Temperature Range: T_A = –40°C to 125°C
- High-Voltage Outputs: 50 V
- Compatible with TTL, 3.3-V to 5.0-V Logic Interface
- Integrated Free-Wheeling Diodes for Inductive Load
- Enhanced ESD Protection Exceeds JESD 22 – 2-kV HBM, 1.5-kV CDM
- Available in SOP16 and TSSOP16 Packages

Applications

- Inductive Loads
  - Relays
  - Unipolar Stepper & Brushed DC Motors
  - Solenoids & Valves
- LED Indicators
- Logic Level Shifting
- Gate & IGBT Drive

Description

The TPM2003C is a high-voltage, high-current Darlington bipolar junction transistor array. This device consists of seven channels of low-side Darlington NPN transistors with high-voltage outputs and free-wheeling diodes for inductive loads.

The maximum drain-current rating of a single Darlington NPN bipolar junction transistor channel is 500 mA. The device supports a 2.7-kΩ series base resistor for each Darlington pair for operation directly with TTL or 3.3-V/5-V CMOS devices, and withstands voltage up to 30 V. The transistors can drive in parallel for higher current capability. Enhanced ESD performance enhances system-level reliability.

Typical Application Circuit

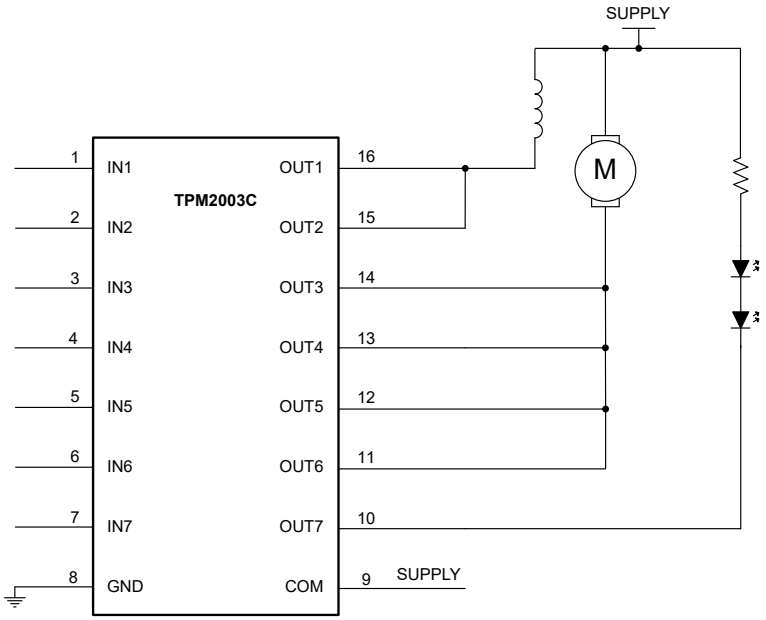


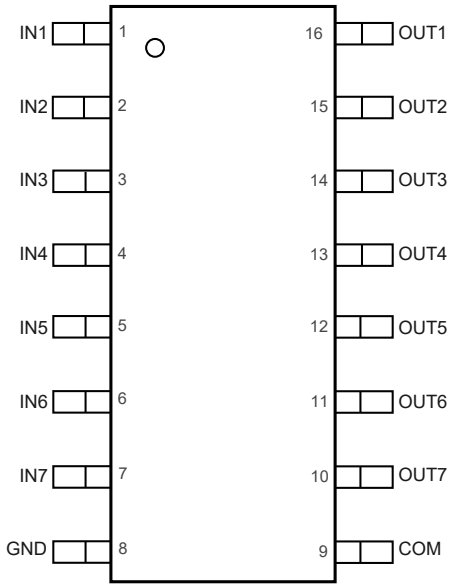
Table of Contents

Revision History

Date	Revision	Notes
2024-11-07	Rev.A.0	Initial release.

Pin Configuration and Functions

TPM2003C
SOP16
Top View



TPM2003C
TSSOP16
Top View

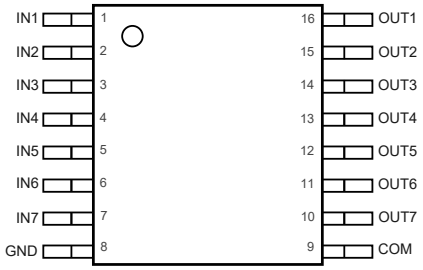


Table 1. Pin Functions: TPM2003C

Pin No	Pin Name	I/O	Description
9	COM	Power	Device supply voltage.
8	GND	Ground	Device ground.
1	IN1	I	Logic input. High-active to pull down OUT1.
2	IN2	I	Logic input. High-active to pull down OUT2.
3	IN3	I	Logic input. High-active to pull down OUT3.
4	IN4	I	Logic input. High-active to pull down OUT4.
5	IN5	I	Logic input. High-active to pull down OUT5.
6	IN6	I	Logic input. High-active to pull down OUT6.
7	IN7	I	Logic input. High-active to pull down OUT7.
16	OUT1	O	Low-side driver output, IN1 high to pull down OUT1.
15	OUT2	O	Low-side driver output, IN2 high to pull down OUT2.
14	OUT3	O	Low-side driver output, IN3 high to pull down OUT3.
13	OUT4	O	Low-side driver output, IN4 high to pull down OUT4.
12	OUT5	O	Low-side driver output, IN5 high to pull down OUT5.
11	OUT6	O	Low-side driver output, IN6 high to pull down OUT6.
10	OUT7	O	Low-side driver output, IN7 high to pull down OUT7.

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
V_{COM}	Power Supply Voltage, COM	−0.3	55	V
V_{OUTx}	Output Voltage Range, OUT1 to OUT7	−0.3	55	V
V_{INx}	Input Voltage Range, IN1 to IN7	−0.3	30	V
I_{OUTx}	Continuous Output Channel Current, OUT1 to OUT7		500	mA
I_{GND}	Continuous Ground Current GND-Pin		2	A
T_J	Operating Junction Temperature Range	−40	125	°C
T_{STG}	Storage Temperature Range	−65	150	°C
T_L	Lead Temperature (Soldering, 10 sec)		260	°C

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.
(2) The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300 mV beyond the power supply, the input current should be limited to less than 10 mA.
(3) Power dissipation and thermal limits must be observed.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001	±2	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002	±1.5	kV

Recommended Operating Conditions

Parameter		Min	Max	Unit
V_{COM}	Power Supply Voltage, COM	0	50	V
V_{OUTx}	Output Voltage Range, OUT1 to OUT7	0	50	V
I_{OUTx}	Continuous Output Current, OUT1 to OUT7		500	mA
T_A	Operating Ambient Temperature Range	–40	125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
TSSOP16	114.5	50.5	°C/W
SOP16	84.3	30.5	°C/W

Electrical Characteristics

All test conditions: V_{COM} = 12 V, T_A = −40 °C to 125 °C, unless otherwise noted.

Parameter		Conditions	Min	Typ	Max	Unit
V_{FWD}	Clamp Forward Voltage	I_F = 350 mA		1.217		V
$V_{I(ON)}$	On-State Input Voltage	I_C = 200 mA, V_{CE} = 2 V			2.7	V
		I_C = 250 mA, V_{CE} = 2 V			2.9	V
		I_C = 300 mA, V_{CE} = 2 V			3	V
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_I = 250 μA, I_C = 100 mA		0.9	1.2	V
		I_I = 350 μA, I_C = 200 mA		1	1.4	V
		I_I = 500 μA, I_C = 350 mA		1.2	1.7	V
I_{CEX}	Collector Cutoff Current	V_{CE} = 50 V, I_I = 0			10	μA
V_F	Clamp Forward Voltage	I_F = 350 mA		1.7	2	V
I_R	Clamp Reverse Current	V_R = 50 V		15		nA
$I_{I(off)}$	Off-State Input Current	V_{CE} = 50 V, I_C = 500 μA	30	65		μA
I_I	Input Current	V_I = 3.85 V		0.93	1.35	mA
t_{PLH}	Propagation Delay Time, Low- to High-Level Output	C_L = 15 pF, R_L = 125 Ω, V_S = 12 V, 50% to 50%		1.4	3	μs
t_{PHL}	Propagation Delay Time, High- to Low-Level Output			0.25	1	μs

Typical Performance Characteristics

All test conditions: V_{OUT} = 12 V, T_A = +25°C, unless otherwise noted.

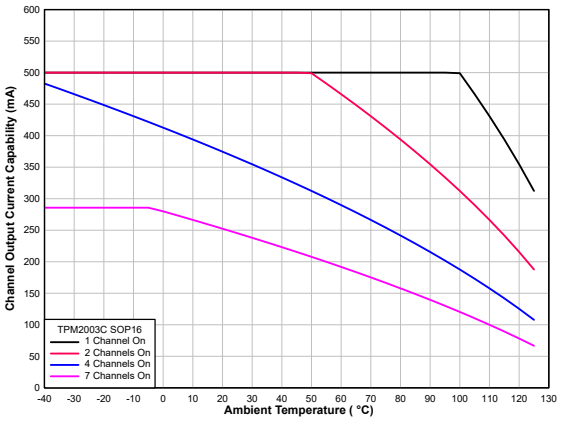


Figure 1. Output Current Capability vs. Ambient Temperature

SOP16

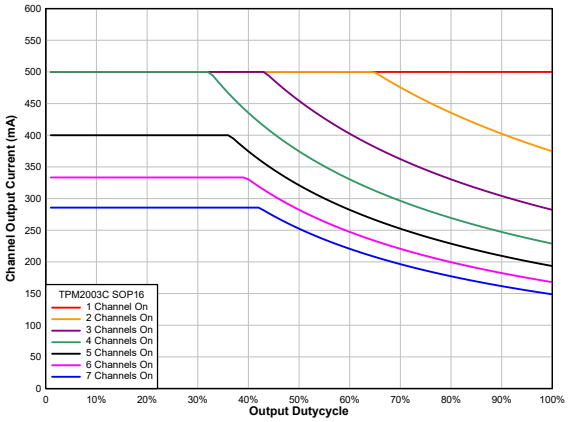


Figure 2. Output Current Capability vs. Dutycycle,

T = 85 °C, SOP16

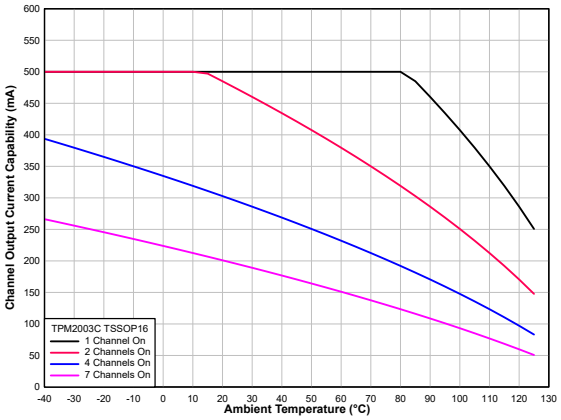


Figure 3. Output Current Capability vs. Ambient Temperature

TSSOP16

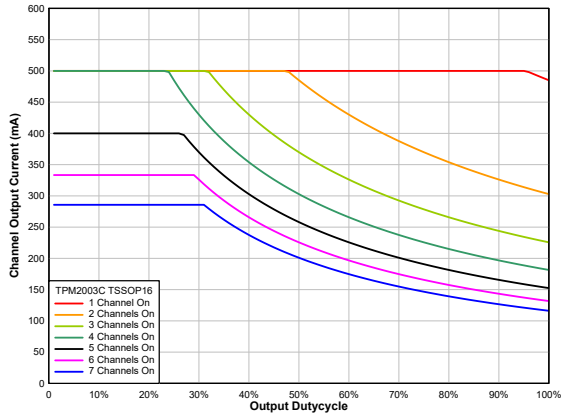


Figure 4. Output Current Capability vs. Dutycycle

T = 85 °C, TSSOP16

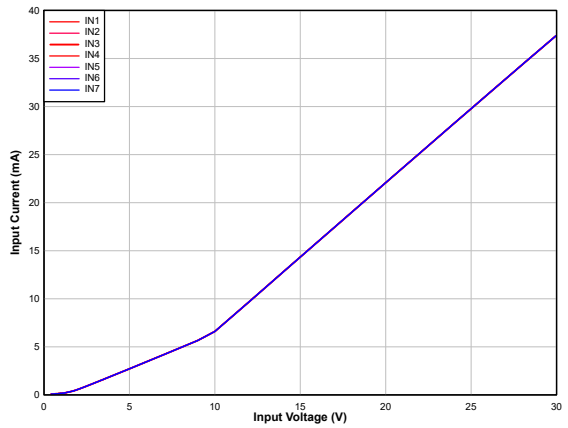


Figure 5. Input Current vs. Input Voltage

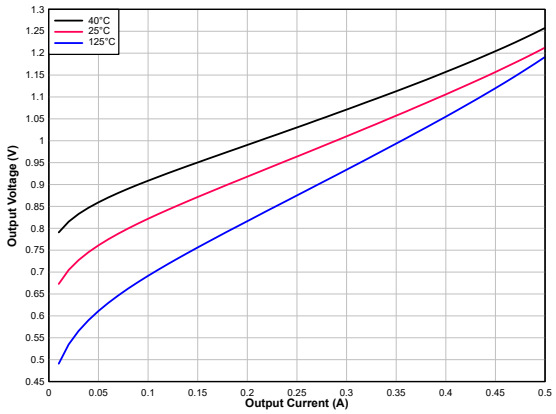


Figure 6. Output Voltage vs. Output Current

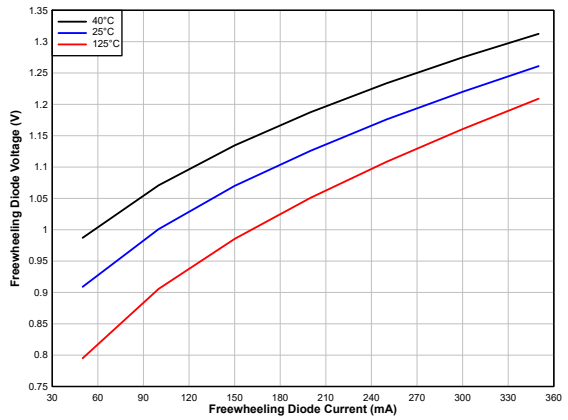


Figure 7. Output Diode Forward Voltage Drop vs. Diode Current

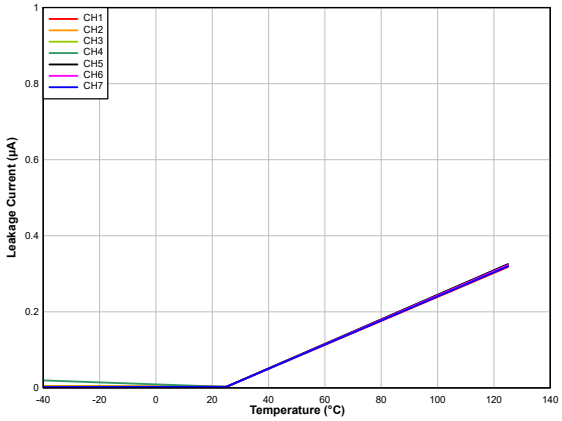


Figure 8. Output Leakage Current vs. Temperature

INx = 0 V

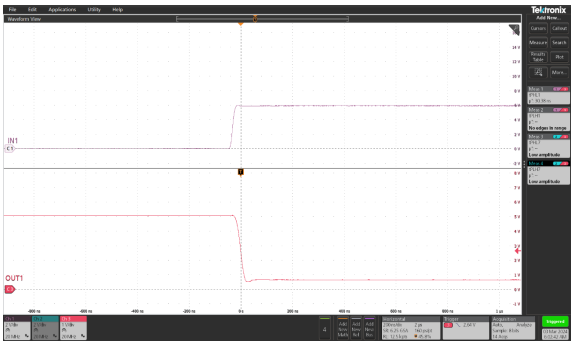


Figure 9. Output Falling Edge

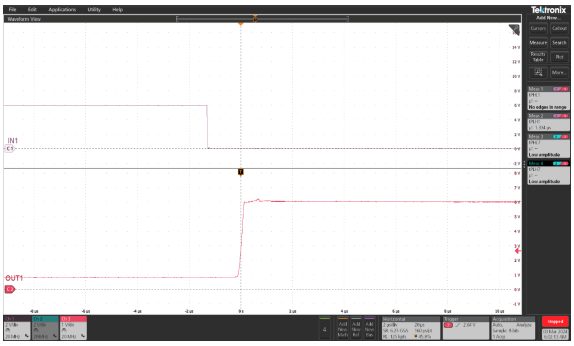


Figure 10. Output Rising Edge

Detailed Description

Overview

The TPM2003C is a high-voltage, high-current Darlington transistor array. This device consists of seven channels of low-side NPN Darlington bipolar junction transistors with high-voltage outputs and free-wheeling diodes for inductive loads.

The maximum drain-current rating of a single Darlington channel is 500 mA. The device supports a wide I/O voltage range of TTL, 3.3-V/5-V CMOS, and withstands voltage up to 30 V. The transistors can drive in parallel for higher current capability. Enhanced ESD performance enhances system-level reliability.

Functional Block Diagram

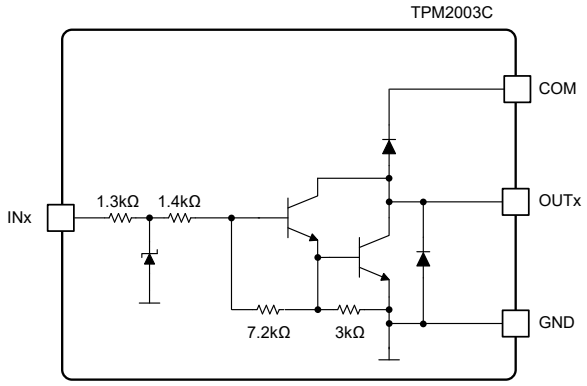


Figure 11. Functional Block Diagram

Feature Description

The TPM2003C device features 7 channels, each comprising a pair of Darlington-configured NPN transistors. This configuration produces a single transistor with an exceptionally high current gain, enabling the device to deliver substantial output current with minimal input current, facilitating operation at low GPIO voltage levels.

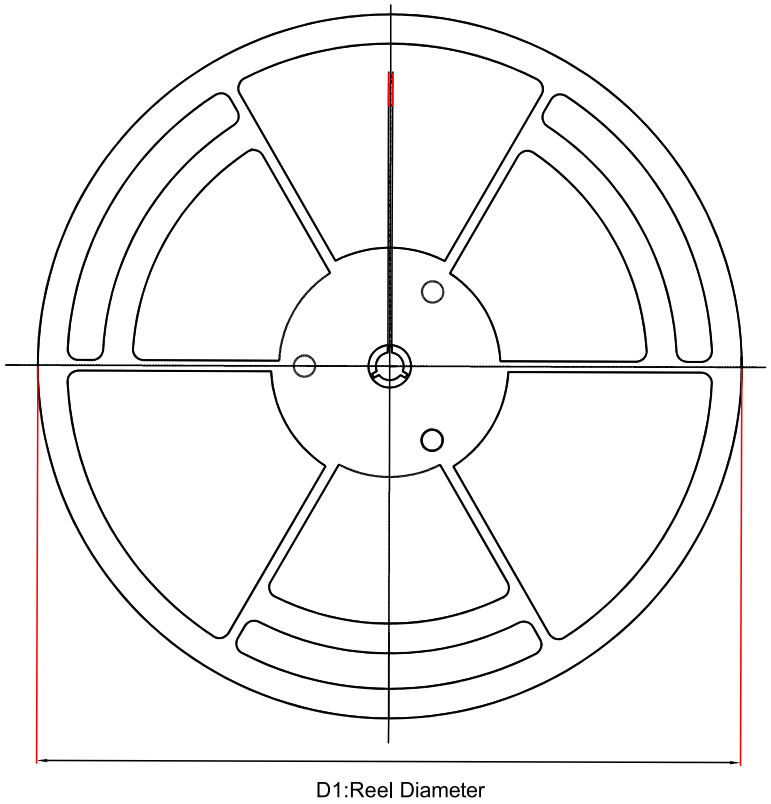
The GPIO voltage is transformed into base current via a 2.7-kΩ resistor that bridges the gap between the input and the base of the Darlington NPN transistor of the predriver. The 7.2-kΩ and 3-kΩ resistors, positioning between the base and emitter of the respective NPN transistors, serve to pull down the voltage and mitigate potential leakage from the input.

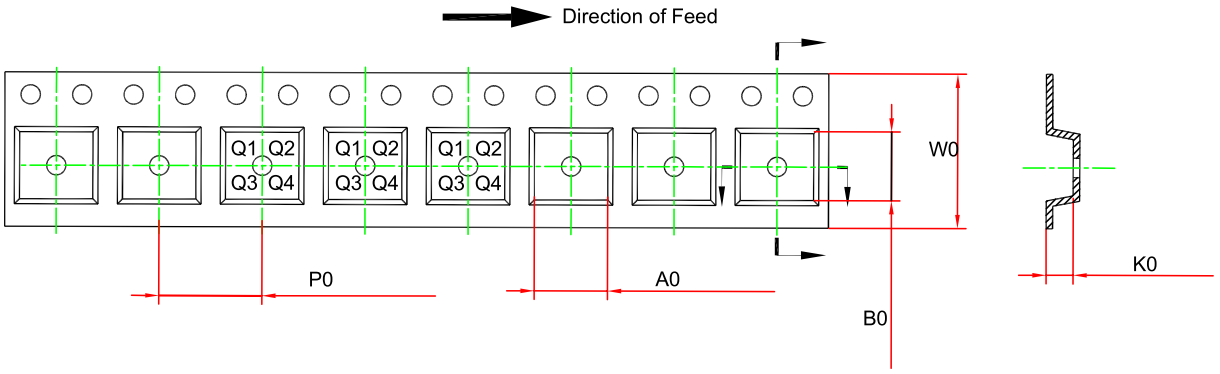
The diodes that link the output to the COM pin are designed to counteract the kickback voltage that arises from inductive loads when the NPN drivers are deactivated. The energy stored in the coils causes a reverse current to flow back through the kickback diode when the drivers stop to sink current.

Under typical operating conditions, the diodes on the base and collector pins are in a reverse-biased state. If these diodes become forward-biased, the internal parasitic NPN transistors draw current from adjacent device pins.

The device can work without a dedicated power source. If the COM pin is connected to the main power supply, it is essential to keep the output voltage from being much higher than the COM pin voltage. Failure to do so can cause the flyback diodes to conduct heavily, leading to a large current that damages the device or causes it to overheat.

Tape and Reel Information



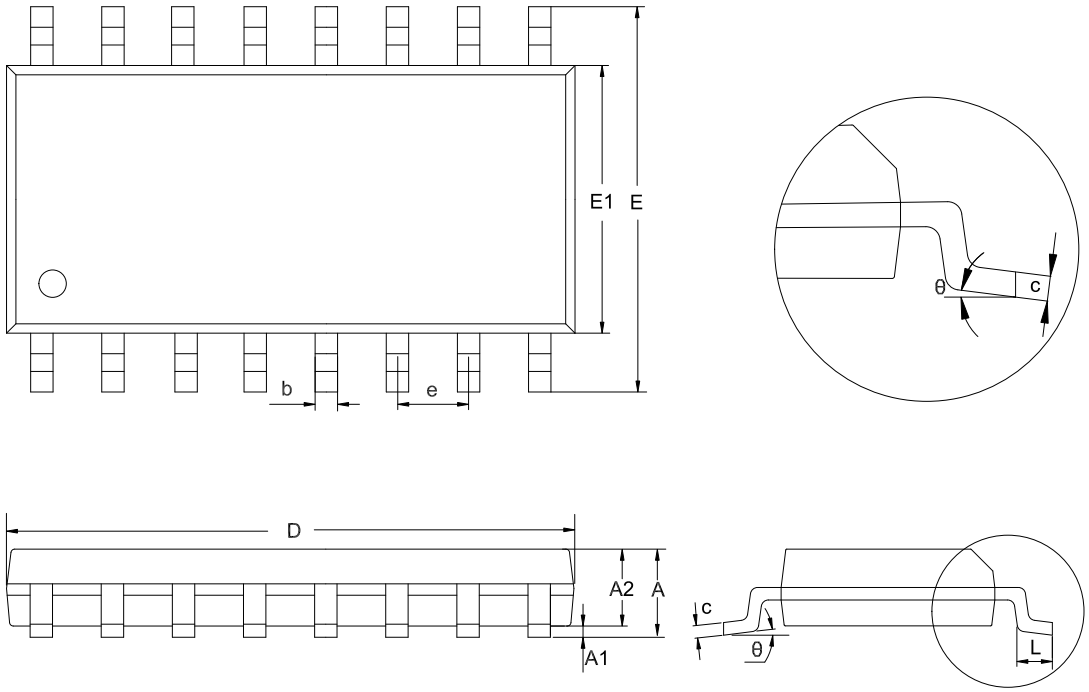


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPM2003C-SO3R	SOP16	330.0	21.6	6.6	10.4	2.1	8.0	16.0	Q1
TPM2003C-TS3R	TSSOP16	330.0	17.6	6.8	5.5	1.3	8.0	12.0	Q1

Package Outline Dimensions

SOP16

Package Outline Dimensions SO3(SOP-16-A)



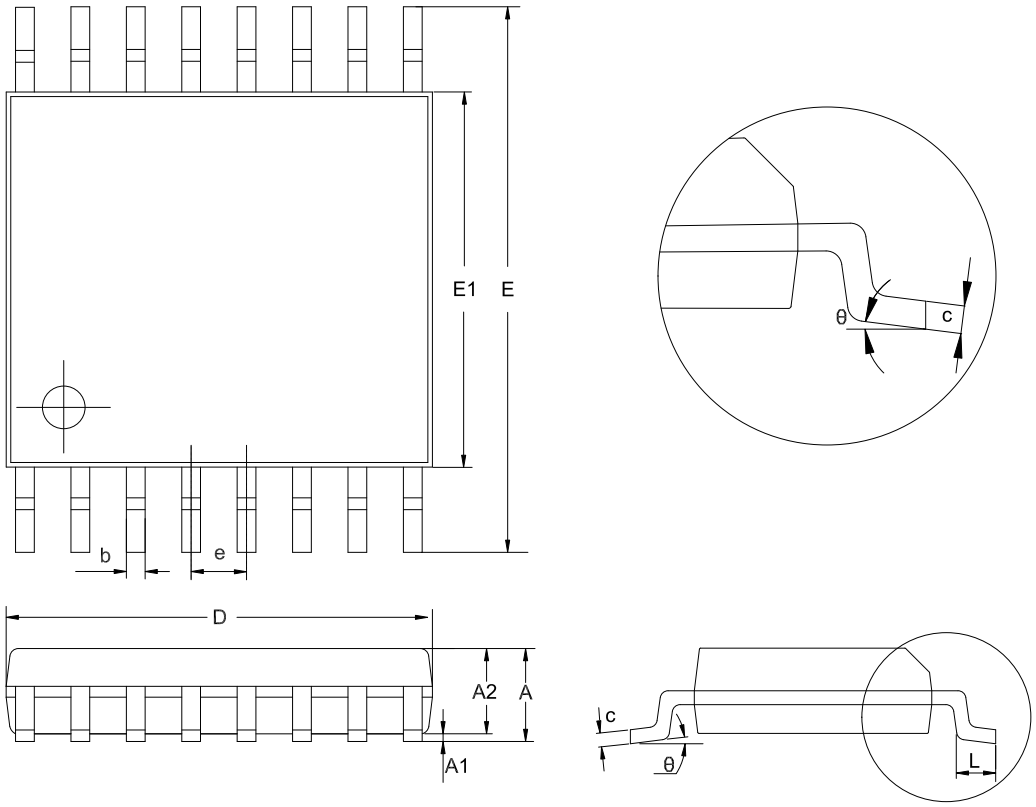
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.300	1.600	0.051	0.063
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.000	0.386	0.394
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 BSC		0.050 BSC	
L	0.400	1.000	0.016	0.039
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

TSSOP16

Package Outline Dimensions TS3(TSSOP-16-A)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.200	0.035	0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
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	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
e	0.650 BSC		0.026 BSC	
L	0.450	0.750	0.018	0.030
θ	0	8°	0	8°

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Order Information

Order Number	Operating Ambient Temperature Range (1)	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPM2003C-SO3R	–40 °C to 125 °C	SOP16	2003C	3	Tape and Reel, 2500	Green
TPM2003C-TS3R (2)	–40 °C to 125 °C	TSSOP16	2003C	3	Tape and Reel, 3000	Green

(1) The ambient temperature indicates the device operation condition range. Application thermal behavior needs to be taken care of when operating in high-temperature scenarios.
(2) Contact 3PEAK sales representatives for more information.

Green: 3PEAK defines "Green" to mean RoHS compatible and free of halogen substances.

IMPORTANT NOTICE AND DISCLAIMER

Performance Information. Performance tests or performance range contained in this document/material are either results of design simulation or actual tests conducted under designated testing environment. Any variation in testing environment or simulation environment, including but not limited to testing method, testing process or testing temperature, may affect actual performance of the product.

Disclaimer. 3PEAK provides technical and reliability data (including data sheets), design resources (including reference designs), application or other design recommendations, networking tools, security information and other resources "As Is". 3PEAK makes no warranty as to the absence of defects, and makes no warranties of any kind, express or implied, including without limitation, implied warranties as to merchantability, fitness for a particular purpose or non-infringement of any third-party's intellectual property rights. Unless otherwise specified in writing, products supplied by 3PEAK are not designed to be used in any life-threatening scenarios, including critical medical applications, automotive safety-critical systems, aviation, aerospace, or any situations where failure could result in bodily harm, loss of life, or significant property damage. 3PEAK disclaims all liability for any such unauthorized use.

This page intentionally left blank