48-V 4-Ch 3-A Low-side Driver Array

Features

- 40-V Max Recommended Operating Voltage, 48-V Absolute Max Voltage
  - 250-mΩ Low-$R_{DS(ON)}$ with Maximum 3-A Driver Capability
  - Integrated Free-wheeling Diodes for Inductive Loads
  - Parallel Channel Driving Capability
  - Dual Supply VM and VCLAMP for Inductive Loads
- Protection
  - Power On Reset
  - Over-Current Protection
  - Short-Circuit Protection
  - Over-Temperature Protection
  - Open-drain Fault Alarm

Description

The TPM8803 provides a 4-ch low-side driver with channel-independent protection. It has a low $R_{DS(ON)}$ MOSFET array with free-wheeling diodes to support all kinds of loads, resistive, inductive, and capacitive. It supports dual high-voltage supplies, VM, and VCLAMP.

It has a simple parallel interface with direct inputs. Over-current protection and short-circuit protection allow the controller to protect the system. Open-drain fault output allows the controller to respond to fault scenario with interrupt input.

The device also provides undervoltage lockout, and over-temperature shutdown protection. The device is available in a 16-pin ETSSOP package with enhanced thermal performance.

Applications

- Relays, Solenoids, Unipolar Stepper Motors
- Electric Expansion Valves, Linear Valves
- LEDs and Heaters
- PLC Digital Outputs
- Electromagnetic Loads

Typical Application Circuit

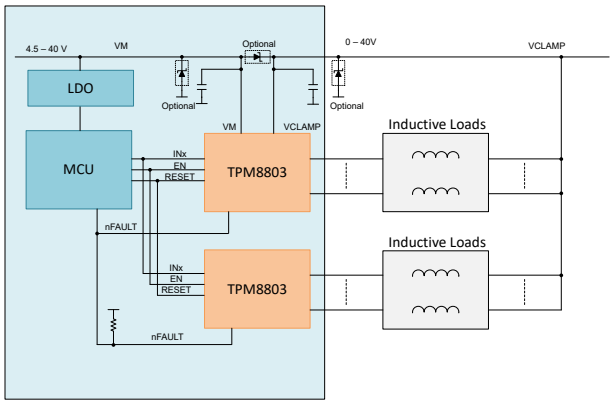


Table of Contents

Revision History

Date	Revision	Notes
2024-04-12	Rev.A.0	Initial release

Pin Configuration and Functions

TPM8803-TSBR
ETSSOP16 Package
Top View

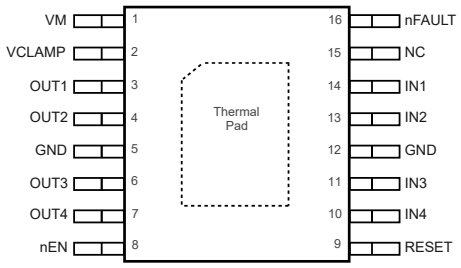


Table 1. Pin Functions: TPM8803

Pin	Name	I/O	Description
1	VM	P	Motor power supply, connect to a 10-μF capacitor with a 0.1-μF capacitor close to the VM pin.
2	VCLAMP	P	Connect directly or through a zenner diode to VM
3	OUT1	O	Output channel 1
4	OUT2	O	Output channel 2
5	GND	G	Device ground
6	OUT3	O	Output channel 3
7	OUT4	O	Output channel 4
8	nEN	I	Internal pull-down, active-low output enable.
9	RESET	I	Internal pull-down active-high device reset
10	IN4	I	Internal pull-down, active low IN4 input
11	IN3	I	Internal pull-down, active low IN3 input
12	GND	G	Device ground
13	IN2	I	Internal pull-down, active low IN2 input
14	IN1	I	Internal pull-down, active low IN1 input
15	NC	NC	Not Connected
16	nFAULT	O	Open-drain output, active low when in a fault condition

Specifications

Absolute Maximum Ratings

Parameter		Min	Max	Max
VM, VCLAMP	Power Supply Voltage	−0.3	48	V
	Power Supply Voltage (100-ns Pulse)	−0.3	50	V
nEN, INx, RESET	Input Voltage	−0.3	5.75	V
nFAULT	Logic Output Voltage	−0.3	5.75	V
V_{OUTx}	Output Voltage	−0.3	48	V
	Output Voltage (100-ns Pulse)	−0.3	50	V
I_{OUT}	DC Current		3	A
	Peak Current	Internally Limited		
I_{CLAMP}	Total Clamp Current		4	A
I_{GND}	Total GND Current		4	A
T_J	Maximum Junction Temperature		150	°C
T_A	Operating 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.

ESD, Electrostatic Discharge Protection

Parameter		Condition	Minimum Level	Unit
HBM	Human Body Model ESD	ANSI/ESDA/JEDEC JS-001 (1)	4	kV
CDM	Charged Device Model ESD	ANSI/ESDA/JEDEC JS-002 (2)	1	kV

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Parameter		Min	Max	Unit
VM, VCLAMP	Power Supply Voltage	5	40	V
INx, RESET, nEN	Logic Input Voltage	0	5	V
nFAULT	Open Drain Output Voltage	0	5	V
V_{OUTx}	Output Voltage	0	40	V
I_{OUTx}	Continuous Output Current		3	A
	Peak Output Current	Internally Limited		
I_{CLAMP}	Clamp Current		4	A
I_{GND}	Ground Current		4	A
T_J	Maximum Junction Temperature		150	°C
T_A	Operating Temperature Range	−40	125	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
ETSSOP16	40	20	°C/W

Electrical Characteristics

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

Parameter		Conditions	Min	Typ	Max	Unit
Power Supply						
I_{VM}	VM Operating Supply Current	VM = 24 V		1	4	mA
V_{UVLO_rising}	VM Under-voltage-lock-out Rising Edge	VM rising edge			4.4	V
$V_{UVLO\_falling}$	VM Under-voltage-lock-out Falling Edge	VM rising edge			4.4	V
Logic Inputs / Outputs (nEN, RESET, nFAULT)						
V_{IL}	Input Low Voltage				0.7	V
V_{IH}	Input High Voltage		1.5			V
I_{IL}	Input Low Current	V_{IN} = 0 V	-20		20	μA
I_{IH}	Input High Current	V_{IN} = 3.3 V			100	μA
R_{PD}	Input Pull-down Resistance			100		kΩ
V_{OL}	Output Low Voltage, nFAULT	I_O = 5 mA			0.5	V
$I_{OH(nFAULT)}$	nFAULT Output High Leakage Current	V_O = 3.3 V	-1		1	uA
Outputs						
$R_{ds(ON)}$	Output Low-side MOSFET on-resistance	VM = 24 V, I_O= 500 mA, T_J= 25°C		0.25		Ω
$R_{ds(ON)}$	Output Low-side MOSFET on-resistance	VM = 24 V, I_O= 500 mA, T_J= 150°C		0.4	0.6	Ω
V_F	High-side Diode Forward Voltage	VM = 24 V, I_{SINK}= 500 mA, T_J = 25°C		0.9		V
I_{HSD_lkg}	High-side Diode Leakage Current	VM = 24 V, T_J = 25°C	0		50	μA
$t_{OUT\_risetime}$	Output Rise time	VM = 24 V, T_J = 25°C, Resistive load	50		300	ns
$t_{OUT\_falltime}$	Output Fall time	VM = 24 V, T_J = 25°C, Resistive load	50		300	ns
Diagnostics and Protection						
$I_{(OCP\_TH)}$	Over-current Protection Threshold		3.3		5.6	A
$t_{(OCP\_deg)}$	Over-current Protection Deglitch Time			3.5		μs
t_{RETRY}	Over-current Retry Timer			1		ms
t_{TSD}	Thermal Shutdown Threshold		150	175		°C
t_{TSD_HYS}	Thermal Shutdown Threshold Hysteresis			15		°C

Typical Performance Characteristics

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

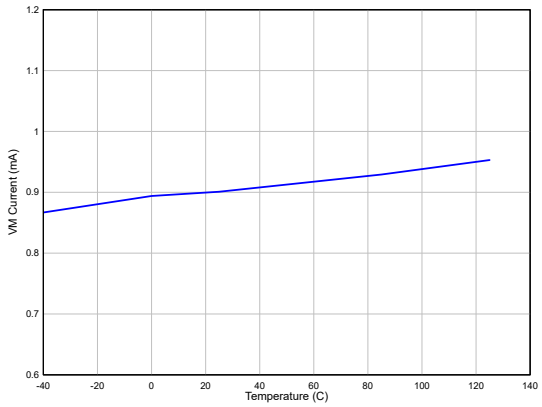


Figure 1. Quiescent Current vs. Temperature

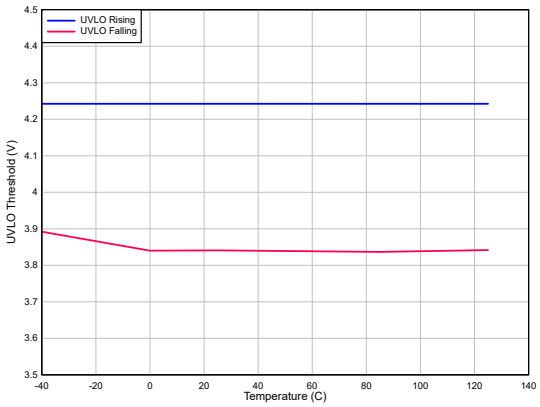


Figure 2. UVLO Threshold vs. Temperature

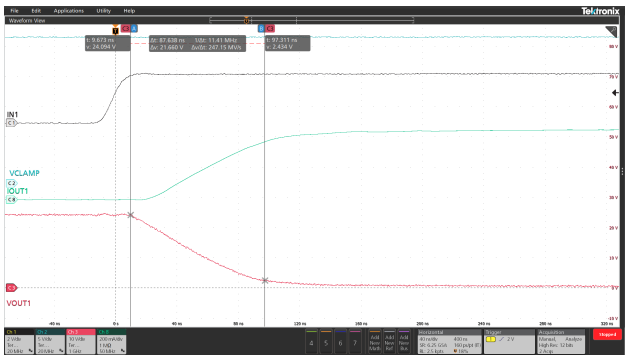


Figure 3. Output Rising Edge

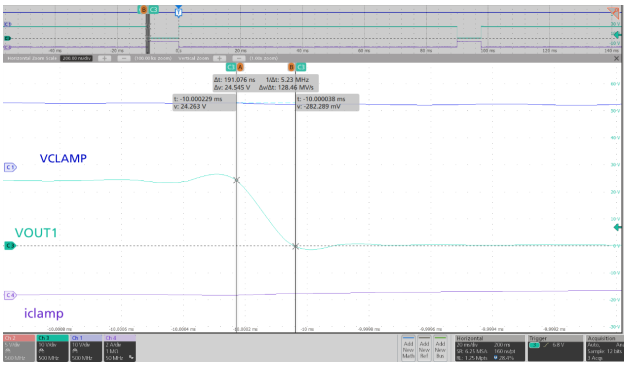


Figure 4. Output Falling Edge

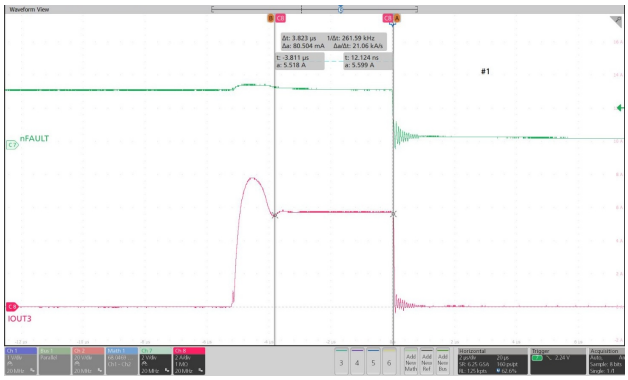


Figure 5. Over Current Protection

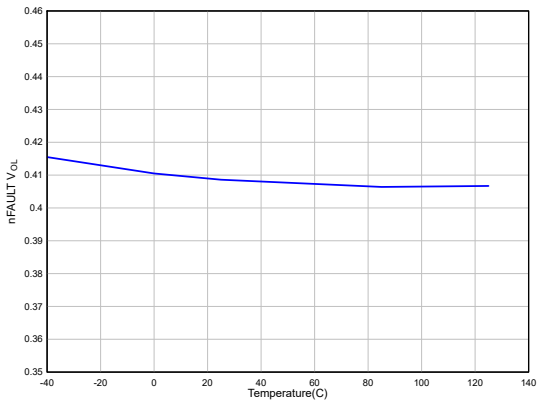


Figure 6. nFAULT V_{OL} vs. Temperature

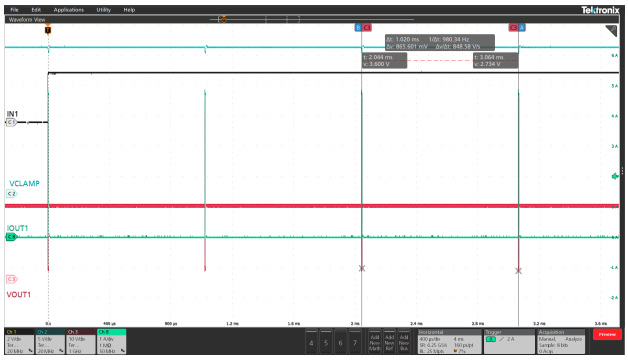


Figure 7. Over Current Protection & Retry

Detailed Description

Overview

The TPM8803 is a high-voltage high-current low-side driver array with short-circuit diagnostics and protection. The device supports a maximum 40-V separated supply and driver voltage. 4-Ch low-side driver can be controlled individually via direct parallel inputs. Each output channel has an integrated free-wheeling diode path for inductive loads such as solenoids, motors, electric expansion valves, and relays. The device has protection features including supply undervoltage monitoring, over-current protection, short-circuit diagnostics, and over-temperature protection. Open-drain fault bus allows hardware interrupt for MCU to handle fault scenarios easily.

The device also supports an isolated interface with 3PEAK digital isolators.

Functional Block Diagram

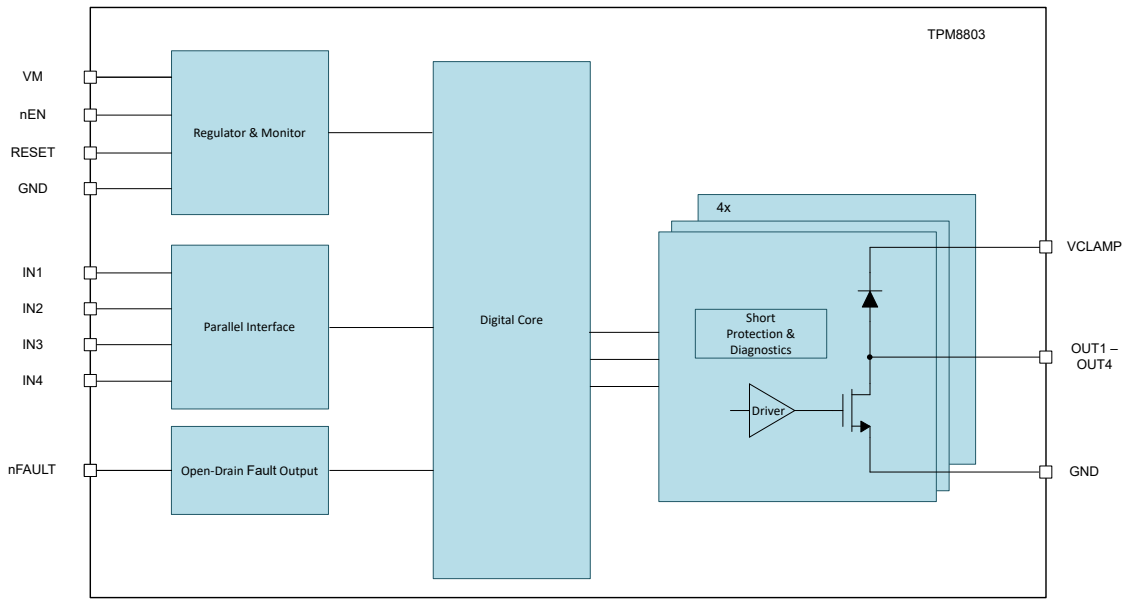


Figure 8. Functional Block Diagram

Feature Description

Supply and Reference

The TPM8803 supports two voltage rails: VM and VLCAMP. VM includes an undervoltage lockout (UVLO) monitor to prevent issues at low supply voltages. VCLAMP operates independently from VM and can range from 0 V to 40 V. The internal control circuit is powered by VM, while the driver is powered by VCLAMP. Separating these rails helps prevent reverse currents from inductive loads. However, VM and VCLAMP can also be connected if needed. It is recommended to use 10-μF capacitors on each rail to suppress voltage transients when driving inductive loads.

The device has a RESET input with an internal pull-down. When RESET is high, the device is in a reset state. When RESET is low, the device is in normal operation.

Output Enable

The TPM8803 provides an active low output enable, nEN, to control the device outputs. When nEN is high, the outputs are disabled, and when nEN is low, the outputs are enabled. It's important to note that nEN does not reset internal registers. It has an internal pull-down resistor and can be left unconnected or connected to the ground for desired functionality.

Output Driver

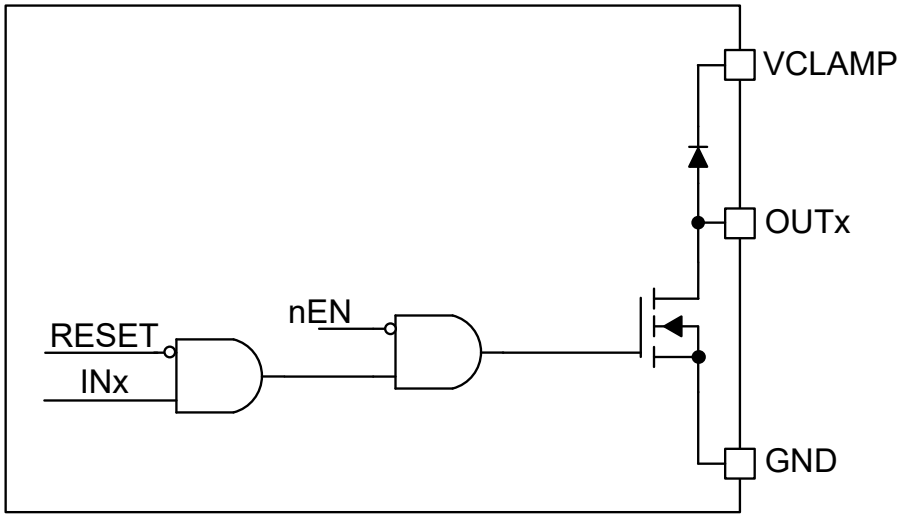
The device features an array of 4 low-side drivers, each consisting of a low-side MOSFET and a high-side recirculation diode. Each channel can handle a maximum current of 3 A, although the total device current should also consider thermal effects. The drivers can accommodate both inductive and resistive loads.

When a channel is turned on, the low-side MOSFET conducts, allowing current to flow from the external load through the low-side MOSFET to the device ground. When the channel is turned off, the inductive current will continue to flow, but it will be recirculated through the internal diode to the VCLAMP pin.

It is crucial to ensure that the VCLAMP pin can handle the inductive energy. To protect against overvoltage, we recommend using an external clamp diode connected to the VCLAMP pin. The other side of the external clamp diode can be connected to either the VM or GND, depending on the specific application requirements.

Parallel Input

Each input INx controls outputs individually.



Output Diagnostics

Short & Over Current Protection Diagnostics

Each channel of the device is equipped with a short-circuit protection circuit to limit the output current and shut down the channel if an overcurrent fault is detected. If an output channel is shorted to the supply, the output current will be internally clamped to protect the channel.

During the on-time of the channel, it continuously monitors the output current. If the current exceeds a predefined threshold for a duration longer than the deglitch timer, an overcurrent fault is triggered. The channel is turned off to prevent further damage.

In the event of an OCP fault on any channel, the nFAULT pin will be pulled low to indicate the fault condition.

Any channel that experiences an overcurrent fault will automatically retry after a 100-ms delay. During the retry time, the nFAULT remains set. The retry timer is synchronized between channels, eliminating the need for separate timers for each channel.

Thermal Protection

The TPM8803 device includes thermal protection to prevent damage from excessive temperatures. When the junction temperature surpasses a certain threshold, the thermal shutdown feature is triggered, turning off all output channels. Once the temperature drops below the threshold, normal operation resumes. Thermal protection ensures safe operation by monitoring and reacting to high temperatures.

Application and Implementation

> Note
>
> Information in the following application sections is not part of the 3PEAK's component specification and 3PEAK does not warrant its accuracy or completeness. 3PEAK's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

Application Information

PLC Digital Output

The TPM8803 is designed for digital output control in industrial PLC (Programmable Logic Controller) applications. It features a parallel communication interface and integration with digital isolators to provide reliable output control.

In industrial PLC applications, digital outputs are commonly used to control various external devices such as motors, valves, lights, etc. The TPM8803 offers a 4-channel low-side driver array, with each channel capable of independent switching control.

Typical Application

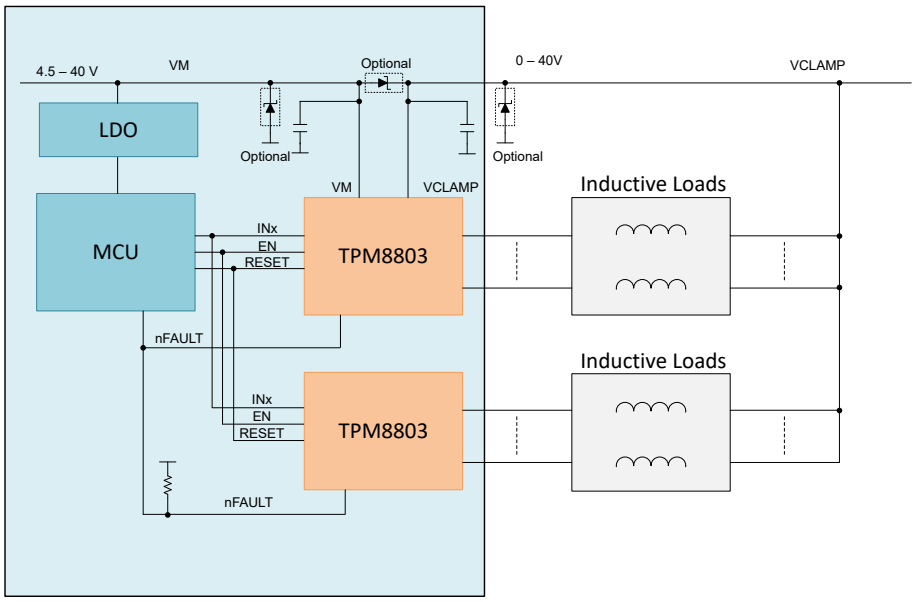
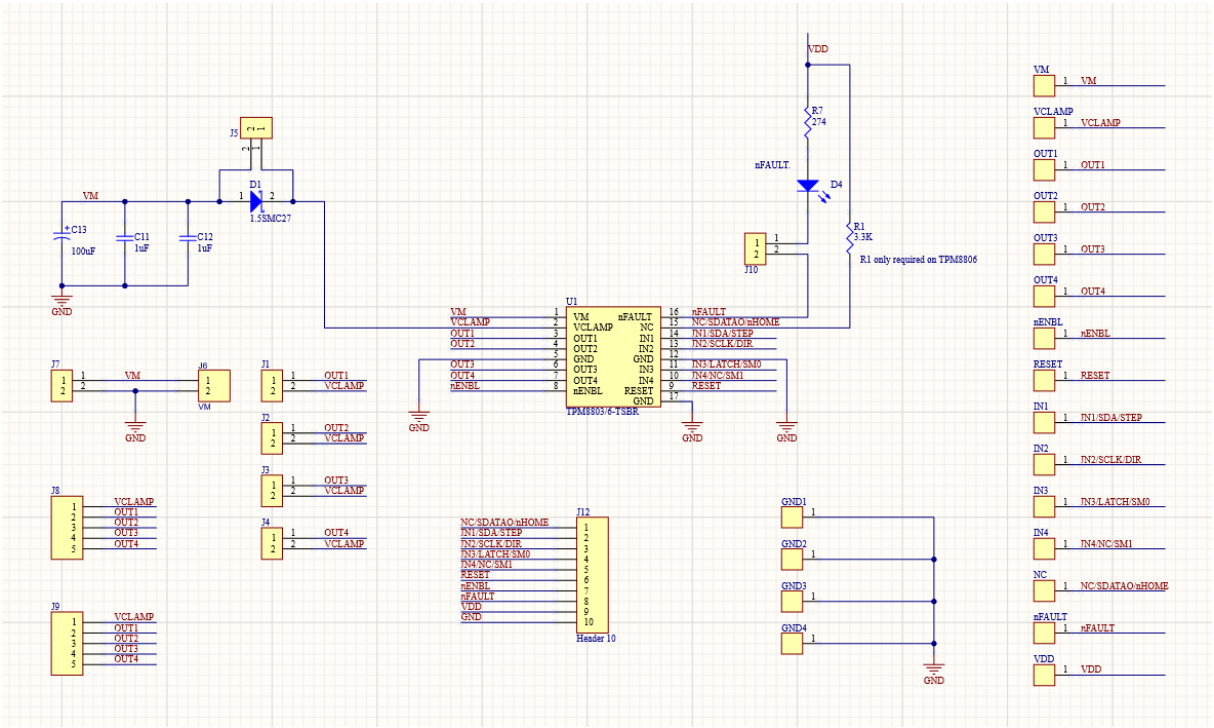


Figure 9. Typical Application Circuit


VDD
R7
274
nFAULT
D4
R1
3.3K
R1 only required on TPM8806
J10
J5
D1
1.5SMC27
VM
C13
100uF
C11
1uF
C12
1uF
GND
U1
TPM8803/6-TSBK
VM
VCLAMP
OUT1
OUT2
OUT3
OUT4
nENBL
nFAULT
NC/SDATAO/nHOME
IN1/SDA/STEP
IN2/SCLK/DIR
IN3/LATCH/SM0
IN4/NC/SM1
RESET
GND
J7
J6
J1
J2
J3
J4
J8
J9
J12
Header 10
GND1
GND2
GND3
GND4
NC
VM
VCLAMP
OUT1
OUT2
OUT3
OUT4
nENBL
RESET
IN1
IN2
IN3
IN4
NC
nFAULT
VDD

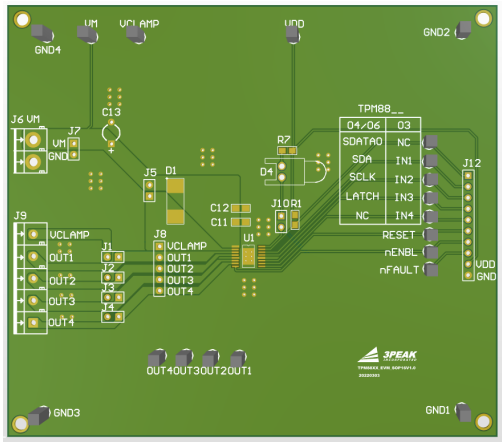
Layout

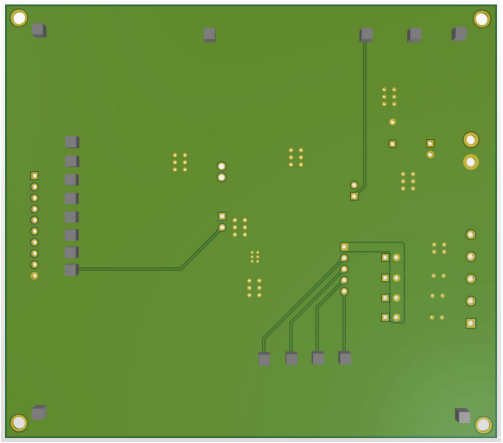
Layout Guideline

- Both input capacitors and output capacitors must be placed to the device pins as close as possible.
- It is recommended to bypass the input pin to ground with a 0.1-μF bypass capacitor.
- It is recommended to use wide and thick copper to minimize I×R drop and heat dissipation.
- Exposed pad must be connected to the PCB ground plane directly, the copper area must be as large as possible.

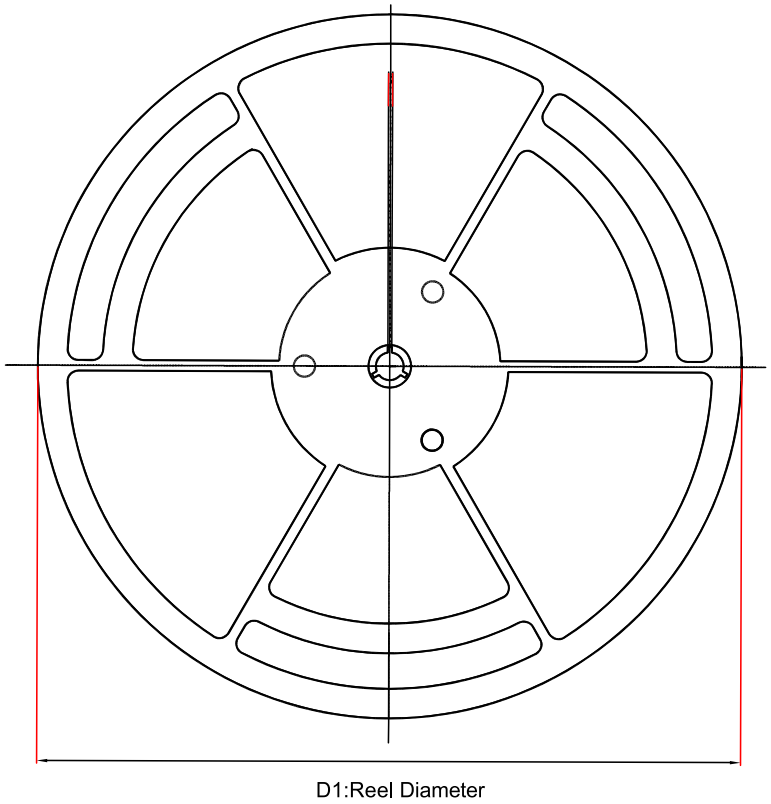
Layout Example

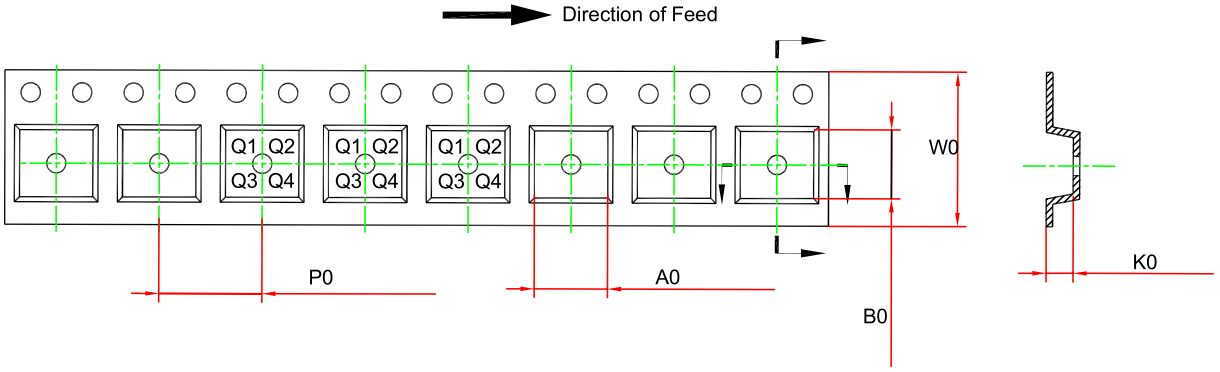
Figures below show layout examples of evaluation module





Tape and Reel Information



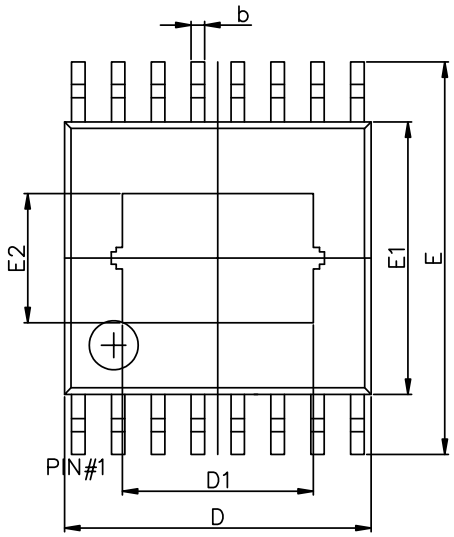


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPM8803-TSBR	ETSSOP-16	330	17.6	6.8	5.4	1.5	8	12	Q1

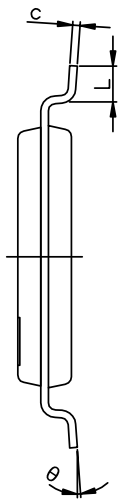
Package Outline Dimensions

ETSSOP-16

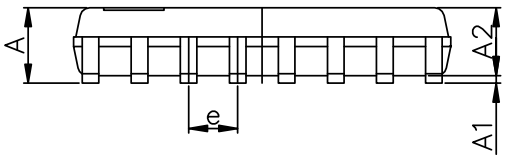
Package Outline Dimensions TSB(ETSSOP-16-D)



Top View



Side View



Bottom View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	---	1.100	---	0.043
A1	0.050	0.150	0.002	0.006
A2	0.850	0.950	0.033	0.037
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
D1	3.015	3.215	0.119	0.127
E	6.200	6.600	0.244	0.260
E1	4.300	4.500	0.169	0.177
E2	2.005	2.205	0.079	0.087
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.020	0.028
θ	1°	7°	1°	7°

NOTES

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

Order Information

Order Number	Operating Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPM8803-TSBR	−40 to 125°C	ETSSOP16	M8803	MSL3	Tape and Reel,3000	Green

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

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