12-V 1-A H-Bridge Driver

Features

- 12-V H-bridge Driver
- MOSFET On-Resistance $R_{ds(on)}$ HS + LS 1 Ω
- 1-A Max Output Current
- Supports 2-V to 11-V Operating Supply Voltage
- Supports 1.8-V, 3.3-V, 5-V Logic Voltage
- PWM (IN1/IN2) Interface
- Protection
  - Undervoltage Lockout Protection (UVLO)
  - Over-Current Protection (OCP)
  - Thermal Shutdown (TSD)
- Small Package Footprint
  - DFN2X2-8 Package

Applications

- Surveillance Cameras
- E-Lock
- Consumer Devices
- Toys

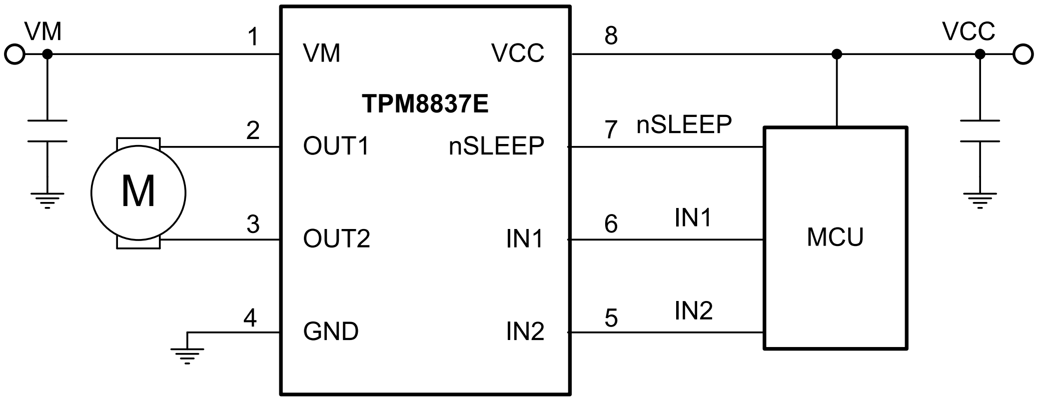
Description

The TPM8837E is a H-bridge driver. It is designed to control inductive loads such as DC motors, solenoids, and relays. It can provide up-to 1-A drive current with maximum 12-V power supply.

The TPM8837E features a solution for motors used widely in consumer products, toys, and other low-to-mid voltage or battery-powered motion control applications. The output driver is an H-bridge with VM voltage ranging from 2 V to 12 V. Control logic can operate on 1.8-V, 3.3-V, and 5-V rails.

Internal protection features such as overcurrent protection, short circuit protection undervoltage lockout, and over-temperature improved reliability of the whole system.

Typical Application Circuit



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Revision History

Date	Revision	Notes
2023-10-15	Rev.A.0	Initial released.

Pin Configuration and Functions

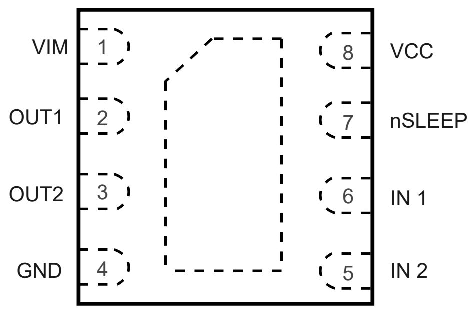


Table 1. Pin Functions: TPM8837E

Pin No.	Name	I/O	Description
4	GND	Ground	Device ground
6	IN1	Input	Bridge input 1
5	IN2	Input	Bridge input 2
7	nSLEEP	Input	Device enable, active high
2	OUT1	Output	H-Bridge output 1
3	OUT2	Output	H-Bridge output 2
8	VCC	I/O Power	Device power supply
1	VM	Motor Power	Motor power supply

Specifications

Absolute Maximum Ratings (1)

Parameter		Min	Max	Unit
VM	Power Supply Voltage, VM	−0.3	12	V
VCC	Device Power Supply Voltage	−0.3	6	V
V_{OUT}	Output OUT1, OUT2	−0.3	VM+0.3	V
	Digital Input Voltage, IN1, IN2 (2)	−0.3	6	V
	Peak Output Current	Internally limited	Internally limited	A
	Continuous Motor Drive Output Current		1	A
	Output Short-Circuit Duration (3)	Infinite	Infinite	
	Maximum Junction Temperature		150	°C
T_J	Operating Junction Temperature Range (4)	−40	150	°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) A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.
(4) 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 (1)	±2	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 JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions

Parameter	Min	Max	Unit
Power Supply Voltage, VM	2	11	V
Power Supply Voltage, VCC	1.8	5.5	V
Input Voltage Range, IN1, nSLEEP, N2	0	5.5	V
Frequency Range, PWM	0	250	kHz
Peak Output Current, I_{OUTx}	–1	1	A
Operating Ambient Temperature Range	–40	125	°C
Operating Junction Temperature Range	–40	150	°C

Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
DFN2X2-8	103	55	°C/W

Electrical Characteristics

All test conditions: V_M = 5 V, T_A = −40 °C to 125 °C, unless otherwise noted.

Parameter		Conditions	Min	Typ	Max	Unit
Power Supply						
V_M	V_M Operating Voltage		2		11	V
I_{VM}	V_M Operating Supply Current	V_M = 5 V, VCC = 3 V, IN1/IN2 low, nSLEEP = 5 V		340	500	μA
I_{VMQ}	V_M Quiescent Supply Current	V_M = 5 V, VCC = 3 V, IN1/IN2 low, nSLEEP = 0 V		0.01	0.6	μA
V_{UVLO}	V_{CC} Under Voltage Lockout	V_{CC} rising	1.5	1.62	1.75	V
		V_{CC} falling	1.45	1.55	1.65	
V_{CC}	V_{CC} Operating Voltage		1.8		5.5	V
I_{VCC}	V_{CC} Operating Supply Current	V_M = 5 V, VCC = 3 V, IN1/IN2 low, nSLEEP = 5 V		135	250	μA
I_{VCCQ}	V_{CC} Quiescent Supply Current	V_M = 5 V, VCC = 3 V, IN1/IN2 low, nSLEEP = 0		0.01	0.5	μA
Input Characteristics						
V_{IL}	Input Low Voltage	VCC = 5 V			1.15	V
		VCC = 3 V			0.75	V
V_{IH}	Input High Voltage	VCC = 5 V	2.5			V
		VCC = 3 V	1.5			V
I_{IL}	Input Low Current	V_{IN} = 0 V	−5		5	μA
I_{IH}	Input High Current	V_{IN} = 3.3 V			50	μA
R_{PD}	Pull-Down Resistance			100		kΩ
H-Bridge FETs						
$R_{DS(ON)}$	HS+LS FET ON Resistance	V_M = 5 V, I_O = 250 mA, T_J = 25°C		1.1		Ω
		V_M = 11 V, I_O = 250 mA, T_J = 25°C		1.1		
I_{OFF}	OFF-State Leakage Current		-1	0	1	μA
Protection Circuits						
I_{OCP}	Overcurrent Protection Trip Level		1.1	1.5	1.8	A
t_{DEG}	Overcurrent Deglitch Time		0.7	1	1.6	μs
t_{OCR}	Overcurrent Protection Retry Time		0.7	1	1.5	ms
t_{DEAD}	Output Dead Time			200		ns
T_{SD}	Thermal Shutdown Temperature	Junction temperature	150	160	180	°C
Timing						
t_7	Output Enable Time	R_L = 20 Ω			300	ns

Parameter		Conditions	Min	Typ	Max	Unit
t_8	Output Disable Time	R_L = 20 Ω			300	ns
t_9	Delay Time, INx High to OUTx High	R_L = 20 Ω			280	ns
t_{10}	Delay Time, INx Low to OUTx Low	R_L = 20 Ω			280	ns
t_R	Output Rise Time	R_L = 20 Ω	30		188	ns
t_F	Output Fall Time	R_L = 20 Ω	30		188	ns

Timing characteristics are guranteed by design.

Typical Performance Characteristics

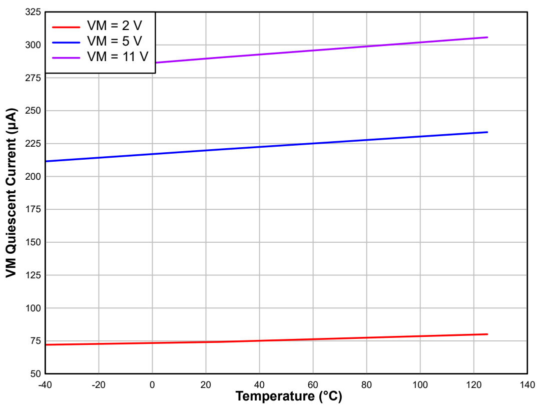


Figure 1. VM Quiescent Current vs Ambient Temperature

VCC = 3.3 V, nSLEEP = 0 V

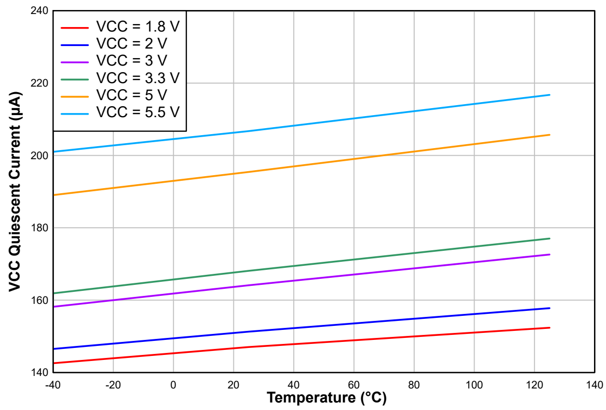


Figure 2. V_{CC} Quiescent Current vs Ambient Temperature

VM = 5 V, nSLEEP = 0 V

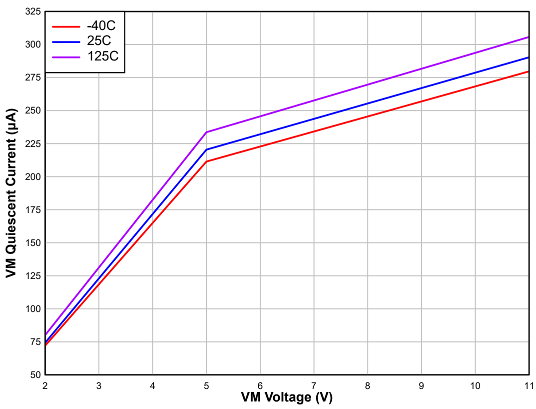


Figure 3. VM Quiescent Current vs VM Voltage

VCC = 3.3 V, nSLEEP = 0 V

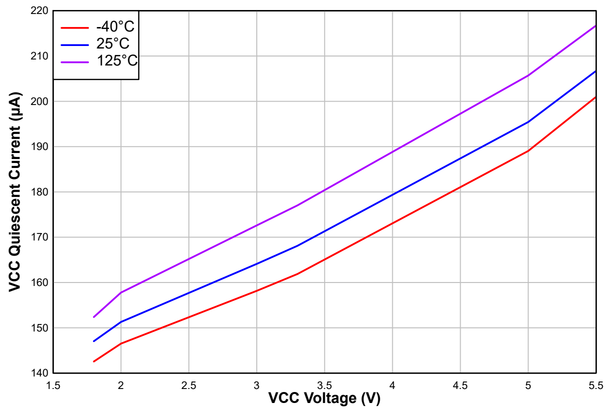


Figure 4. V_{CC} Quiescent Current vs V_{CC} Voltage

VM = 5 V, nSLEEP = 0 V

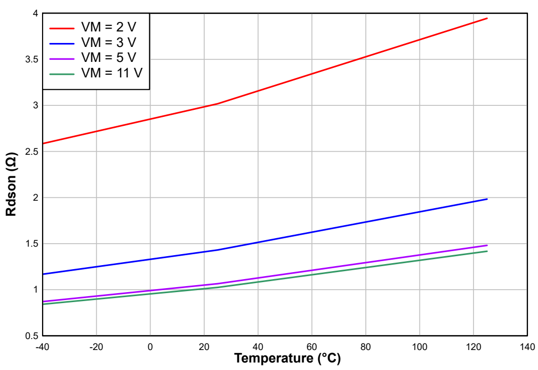


Figure 5. HS + LS $R_{DS(ON)}$ vs Ambient Temperature

VCC = 3.3 V, nSLEEP = 3.3 V

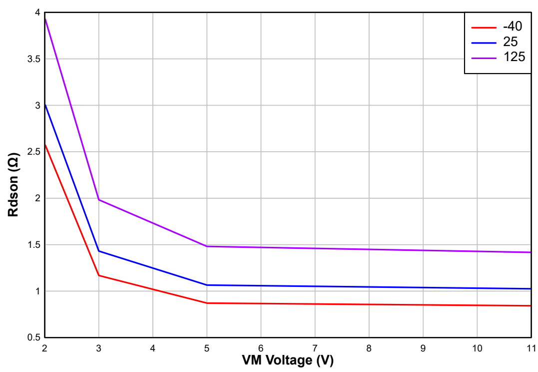


Figure 6. HS + LS $R_{DS(ON)}$ vs VM

VCC = 3.3 V, nSLEEP = 3.3 V

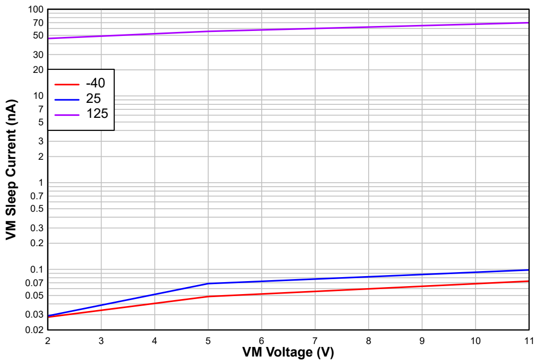


Figure 7. VM Sleep Current vs. VM Voltage

VCC = 3.3 V, nSLEEP = 0 V

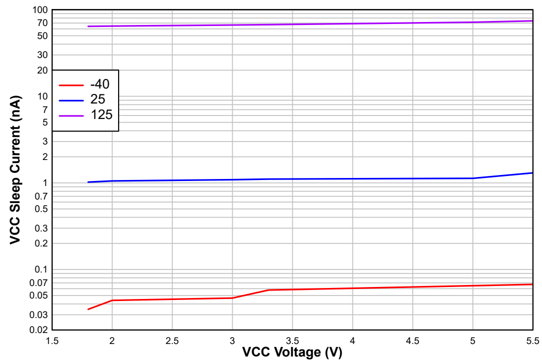


Figure 8. V_{CC} Sleep Current vs. V_{CC} Voltage

VM = 5 V, nSLEEP = 0 V

Detailed Description

Overview

The TPM8837E is a high-voltage H-bridge driver. It is designed to control inductive loads such as DC motors, solenoids, and relays. It can provide up-to 1-A drive current with maximum 11-V power supply.

The TPM8837E features a solution for motors used widely in consumer products, toys, and other low-to-mid voltage or battery-powered motion control applications. The output driver is an H-bridge with VM voltage ranging from 2 V to 11 V. Control logic can operate on 1.8-V, 3.3-V, and 5-V rails.

Internal protection features such as overcurrent protection, short circuit protection, undervoltage lockout, and overtemperature improved reliability of the whole system.

The protection features include:

- Over-Current Protection
- Short Circuit Protection
- Over-Temperature Protection
- Under-Voltage Lockout

Functional Block Diagram

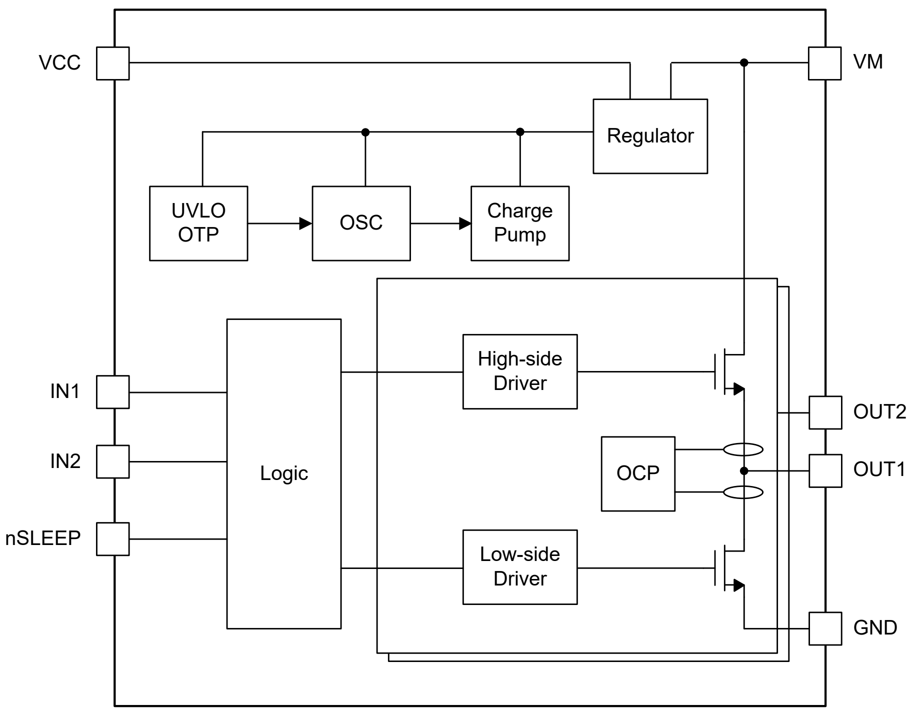


Figure 9. Functional Block Diagram

Feature Description

Timing

- All logic inputs have a deglitch circuitry to prevent noise from affecting the output state. The input deglitch time is around 100 ns.
- The output slew delay time is the delay contributed by gate drivers. To control the output rise/fall time, the gate drive limits the slew rate of gate voltage of output FETs. Typical slew delay time is around 50 ns.
- The rise-and-fall time of the outputs depend on VM voltage and load conditions and are controlled slowly to reduce EMI. Typical rise-and-fall time are 100 ns.
- The dead time is measured as the time when OUTx is Hi-Z between turning off one of the H-bridge FETs and turning on the other. When sourcing current out of the pin, the output falls to one diode drop below ground during dead time. When sinking current into the pin, the output rises to one diode drop above VM. The typical dead time is 100 ns.
- The propagation time is measured as the time between an input edge and an output edge. This time is the sum of the input deglitch time, output slew delay, and output rise/fall time. The propagation time is around 350 ns.

Bridge Control

The TPM8837E uses IN1/IN2 to control H-bridge:

IN1	IN2	OUT1	OUT2	Function
0	0	Z	Z	Coast
0	1	L	H	Reverse
1	0	H	L	Forward
1	1	L	L	Brake

Protections

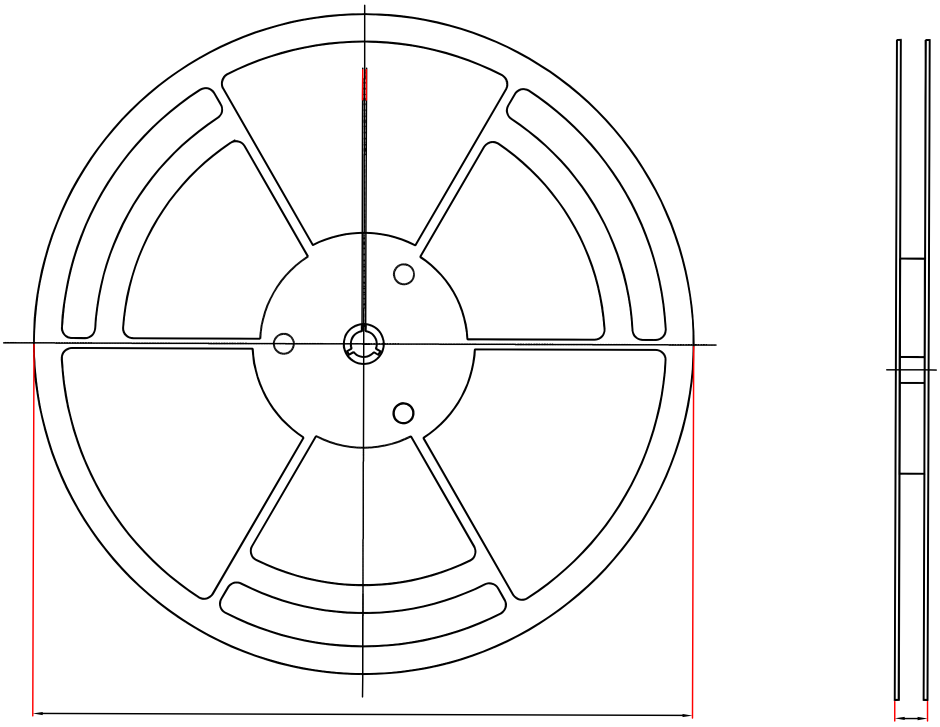
- Over-Current Protection (OCP): All FETs are protected by current limit circuitry. Whenever the channel current of anyone of FETs exceeds overcurrent protection trip level, I_{OCP}, and persists for longer than the overcurrent deglitch time, t_{DEG}, the H-bridge is disabled. After about 1 ms, t_{OCR}, all bridges are re-enabled automatically.
- Short-Circuit Protection: thanks to the OCP function, the device is protected from OUT1 to OUT2 short-circuit, OUT1/OUT2 to ground short-circuit, and OUT1/OUT2 to VM short-circuit. When short-circuit occurs, there is no damage on IC and IR-CUT.
- Thermal Shutdown (TSD): If the die temperature exceeds safe limits, all FETs in the H-bridge are disabled. Operation automatically resumes once the die temperature falls to a safe level.
- Under-Voltage Lockout (UVLO): If at any time the voltage on the VCC pins falls below the under-voltage lockout threshold voltage, all circuitry in the device is disabled, and internal logic resets. Operation resumes when VCC rises above the UVLO threshold.
- During power-up, it is recommended to keep IN1/IN2 to GND to ensure clean start up.

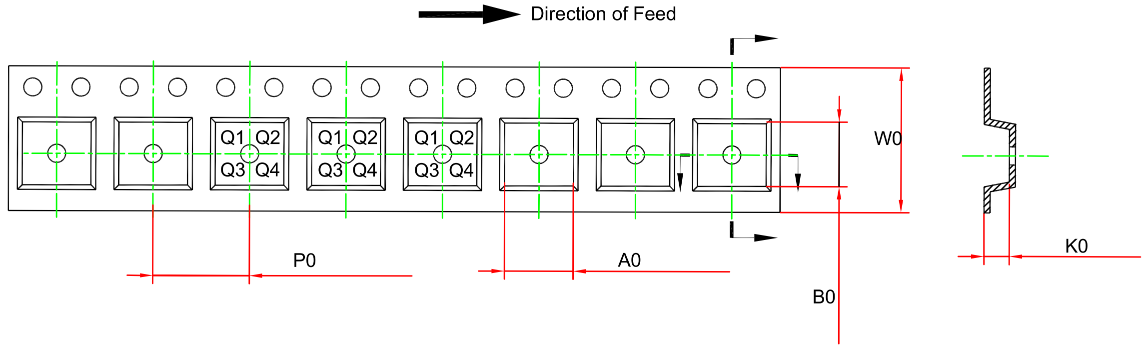
Fault	Condition	Error Report	H-bridge	Internal circuits	Recovery
VCC UVLO	VCC < UVLO	None	Disabled	Disabled	VCC > UVLO
Overcurrent (OCP)	$I_{OUT} > I_{OCP}$	None	Disabled	Operating	t_{OCR}
Thermal Shutdown (TSD)	$T_J > T_{SD}$	None	Disabled	Operating	$T_J < T_{SD} - T_{HYS}$

Device Functional Modes

Operating Mode	Condition	H-Bridge	Internal Circuits
Operating	VCC > UVLO	Operating	Operating
Sleep Mode	nSLEEP = 0V	Disabled	Disabled
Fault encountered	Any fault conditions met	Disabled	See previous table

Tape and Reel Information



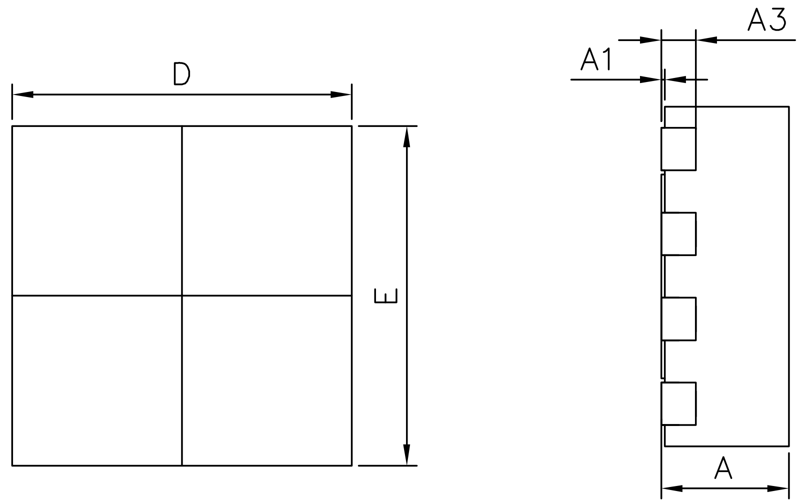


Order Number	Package	D1 (mm)	W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	W0 (mm)	Pin1 Quadrant
TPM8837E-DF4R	DFN2X2-8	180.0	12.5	2.2	2.2	1.0	4.0	8.0	Q1

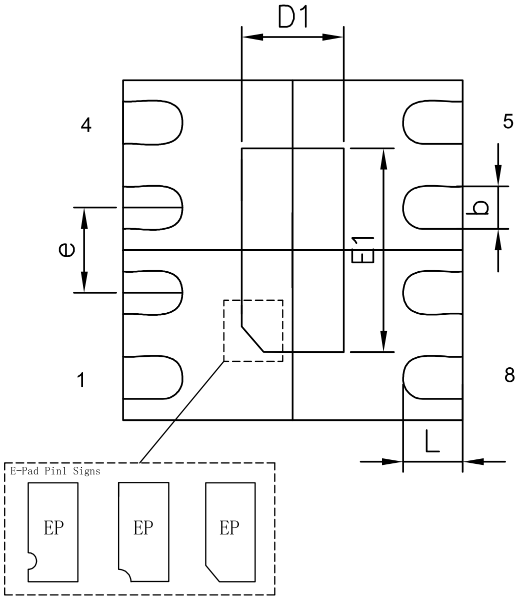
Package Outline Dimensions

DFN2X2-8-D

Package Outline Dimensions DF4(DFN2X2-8-D)



Top View Side View



Bottom View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
b	0.180	0.300	0.007	0.012
A3	0.150	0.250	0.006	0.010
D	1.900	2.100	0.075	0.083
D1	0.800	1.000	0.031	0.039
E	1.900	2.100	0.075	0.083
E1	1.500	1.700	0.059	0.067
e	0.500 BSC		0.020BSC	
L	0.250	0.350	0.010	0.014

NOTES

1. Do not include mold flash or protrusion.
2. This drawing is subject to change without notice.
3. The many types of E-pad Pin1 signs may appear in the product.

Order Information

Order Number	Operating Ambient Temperature Range	Package	Marking Information	MSL	Transport Media, Quantity	Eco Plan
TPM8837E-DF4R	-40 °C to 125 °C (1)	DFN2X2-8	37E	3	Tape and Reel, 3000	Green

(1) Ambient temperature indicates device operation condition range. Application thermal behavior needs to be taken care of when operating in high-temperature scenarios.

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

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