nanoSmart® Battery Management Under-Voltage Load Switch

DESCRIPTION

The TS12001 Off-Active™ battery management load switch is used to protect a battery from excessive discharge. It consists of an internally generated threshold voltage (V_{THRESH}), comparator with hysteresis, slew rate control for the load switch, a P-Channel load switch, and an open-drain indicator pin. When the input battery voltage is above V_{THRESH}, the load switch is on-active. When the input battery voltage falls to V_{THRESH}, the load switch is Off-Active™ and the quiescent current draw is approximately 100pA.

APPLICATIONS

- Portable Battery
- Industrial
- Medical
- SmartCard
- RFID
- Energy Harvesting Systems

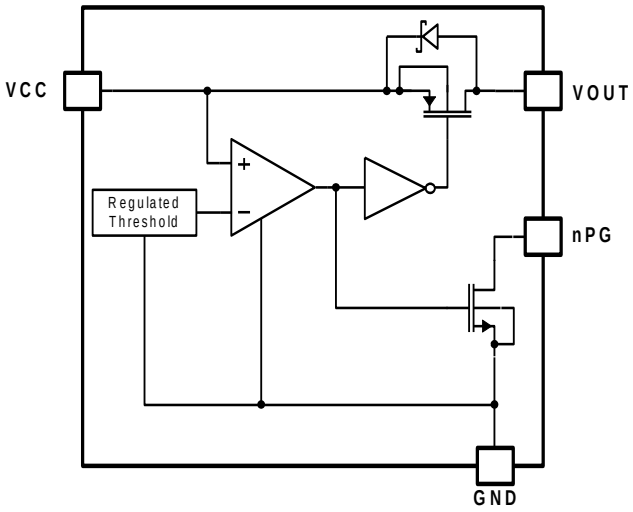
FEATURES

- **Off-Active™ feature with ultra-low pico-amp current**
- **Best-in-class Off-active™ quiescent current of 100pA**
- **Ultra-low on-active quiescent current of 70nA**
- **Accurate on to Off-active™ voltage threshold**
- **Threshold voltage options of 1.2V - 4.2V in 100mV steps (programmed at manufacturing)**
- **Supervisory over-current limit shutdown**
- Low Rds(on): 175mΩ typical @ 5V
- Low drop out disconnect from VBAT to loads
- Turn-on slew rate controlled
- 500mV off to on-active hysteresis

SUMMARY SPECIFICATIONS

- Wide input voltage range: 1.2V – 5.5V
- Packaged in a 8pin DFN (2x2)

Block Diagram



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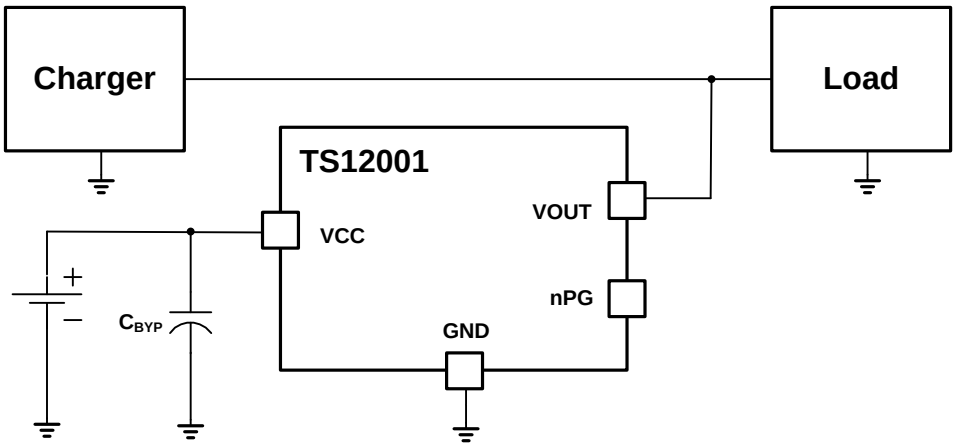
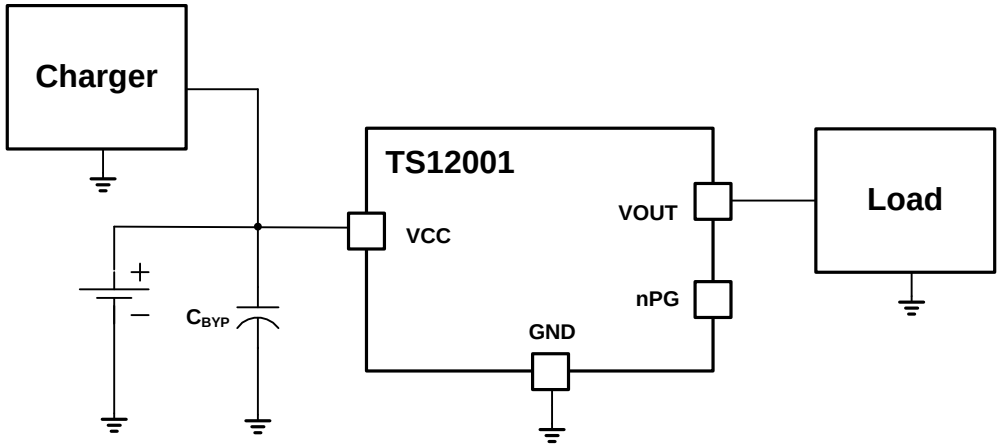
TYPICAL APPLICATIONS

Disconnect the Battery



Note: When the TS12001 is Off-Active™, the battery will continue to charge through the body diode between VOUT and VCC.

Disconnect the Load



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PIN-OUT CONFIGURATION

PIN #	NAME	I/O/P	DESCRIPTION
1	GND	P	GND
2	V_{OUT}	O	Output to System Load
3	NC		No Connect (connect to GND or float)
4	NC		No Connect (connect to GND or float)
5	NC		No Connect (connect to GND or float)
6	V_{CC}	I/P	Supply Input
7	V_{CC}	I/P	Supply Input
8	nPG	O	Open-Drain N-Channel Output (low indicates Power Good)

ABSOLUTE MAXIMUM RATINGS

Over operating free–air temperature range unless otherwise noted(1,2,3)

PIN / PARAMETER	VALUE	UNIT
V_{CC}, V_{OUT}, nPG	-0.3 to 6.0	V
Electrostatic Discharge – Human Body Model	2	kV
Operating Junction Temperature Range, T_J	-20 to 85	°C
Storage Temperature Range, T_{STG}	-65 to 150	°C
Lead Temperature (soldering, 10 seconds)	260	°C

Note 1: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute–maximum–rated conditions for extended periods may affect device reliability.

Note 2: All voltage values are with respect to network ground terminal.

Note 3: ESD testing is performed according to the respective JESD22 JEDEC standard.

THERMAL CHARACTERISTICS

Package DFN	θJA (°C/W) (See Note 4)	θJC (°C/W) (See Note 5)
8 pin	73.1	10.7

Note 4: This assumes a FR4 board only.

Note 5: This assumes a 1 Oz. Copper JEDEC standard board with thermal vias – See Exposed Pad section and application note for more information.

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RECOMMENDED OPERATING CONDITIONS

Parameter	Min	Typ	Max	Unit
Unregulated Supply Input Voltage (V_{CC})	1.2		5.5	V
Operating Ambient Temperature, T_A (Note 6)	-20		55	°C
Operating Junction Temperature, T_J	-20		85	°C
Input Bypass Capacitor (C_{BYP})		100		nF

Note 6: T_A Max shown here is a guideline. Higher T_A can be tolerated if T_J does not exceed the Absolute Maximum Rating.

CHARACTERISTICS

Electrical characteristics, V_{CC} = 1.2V to 5.5V, T_J = 25C, unless otherwise noted

Symbol	Parameter	Condition	Min	Typ	Max	Unit
Input Supply						
V_{CC}	Input Supply Voltage		1.2		5.5	V
$I_{q\text{-}ON}$	Quiescent current: on-active Mode	V_{CC} = 5V, No Load		70	150	nA
$I_{q\text{-}OFF}$	Quiescent current: Off-Active™ Mode	$V_{CC} < V_{THRESH}$, No Load		100		pA
Load Switch						
I_{OC}	Over Current Shutdown	V_{CC} = 5.0V		3		A
T_{OC}	Over Current Retry Period	V_{CC} = 5.0V		1.7		ms
$I_{LEAK\text{-}SW}$	Output Switch Leakage Current	$V_{CC} < V_{THRESH}$; V_{OUT} Grounded		100		pA
Rds-on	Switch On Resistance	V_{CC} = 5.0V		175		mΩ
		V_{CC} = 3.3V		200		mΩ
		V_{CC} = 1.8V		350		mΩ
Transition times						
t_{d1}	Transition delay: on-active to Off-Active™	V_{OFF} = 2.0V, V_{CC} = 3.0V → 1.5V		650		µs
t_{d2}	Transition delay: Off-Active™ to on-active	V_{OFF} = 2.0V, V_{CC} = 1.5V → 3.0V		1.7		ms
T_{ON}	Output turn-on rise time	V_{CC} = 2.5V, R_{LOAD} = 50Ω		200		µs
nPG Output						
$I_{LEAK\text{-}nPG}$	Output Leakage	V_{CC} = 5.0V, V_{nPG} = 5.5V			100	nA
$V_{OL\text{-}nPG}$	Low-Level Output Voltage	I_{nPG} = 5 mA			0.4	V
Off-Active Thresholds						
V_{OFF}	Off-Active™ Threshold	V_{THRESH} = 1.2V to 3.3V	0.95* V_{THRESH}	V_{THRESH}	1.05* V_{THRESH}	V
V_{Hys}	Off-Active™ to on-active Hysteresis	Rising Transition: Off-Active™ to on-active		500		mV

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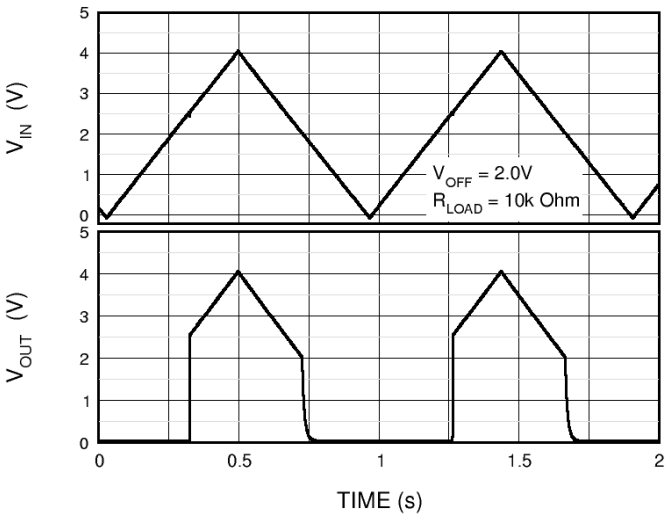
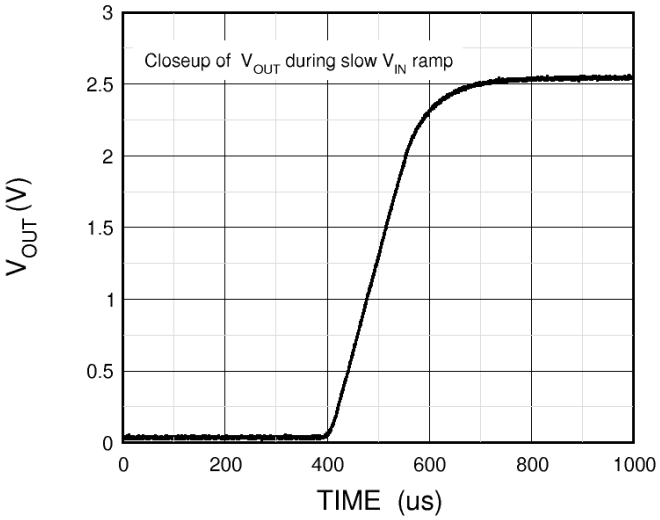
TYPICAL CHARACTERISTICS

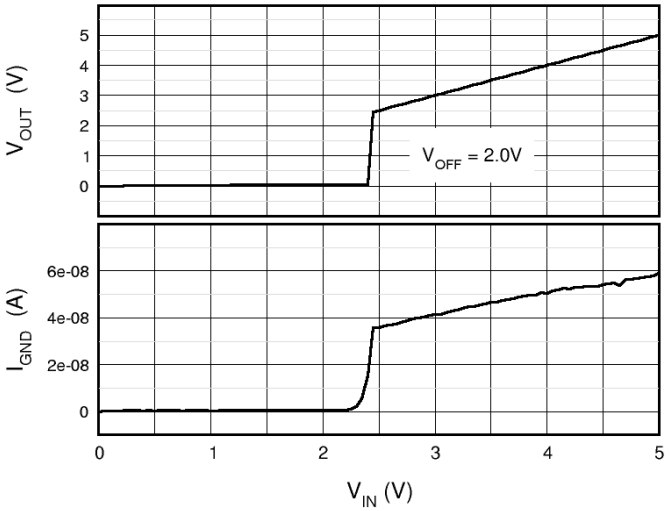
On-Active / Off-Active™ Characteristics



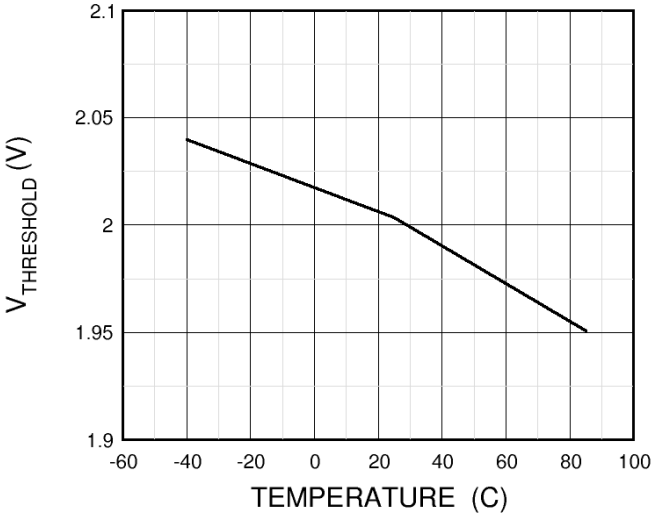
On-Active Switching Behavior



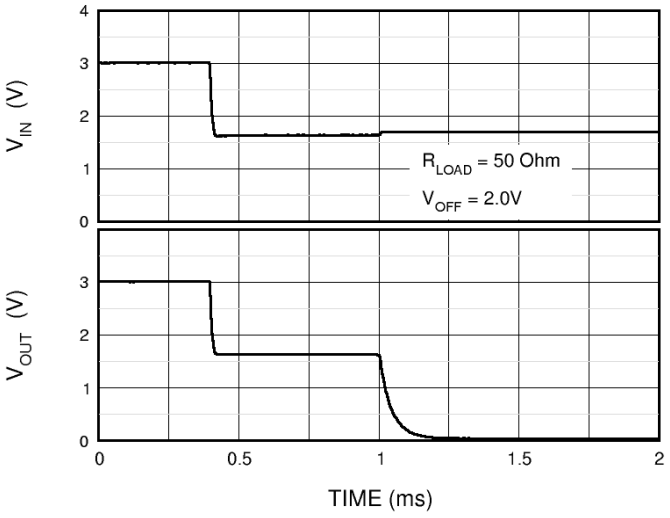
On-Active / Off-Active™ I_q



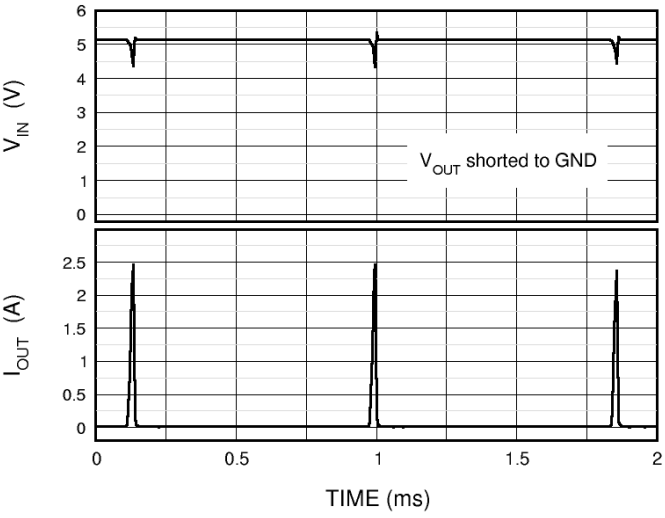
Off-Active™ V_{THRESH} Temperature Performance



On-Active / Off-Active™ Transition Delay



Over Current Retry Performance



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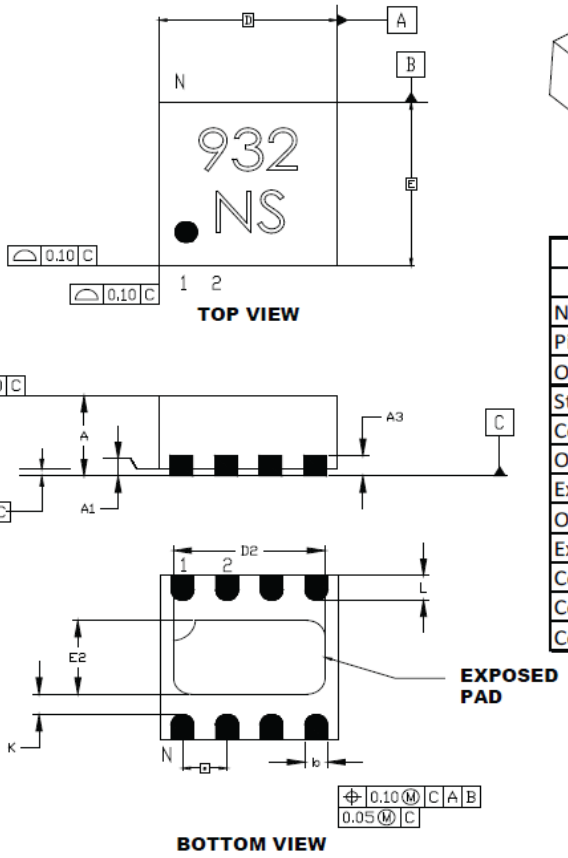
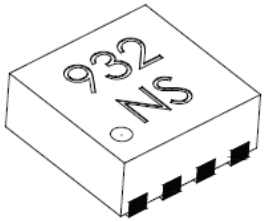
PACKAGE MECHANICAL DRAWINGS





Units		MILLIMETERS		
Dimensions Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.50 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.20 REF	
Overall Length	D		2.00 BSC	
Exposed Pad Width	E2	0.75	0.90	1.00
Overall Width	E		2.00 BSC	
Exposed Pad Length	D2	1.55	1.70	1.80
Contact Width	b	0.18	0.25	0.30
Contact Length	L	0.20	0.30	0.40
Contact-to-Exposed Pad	K	0.20	-	-

Notes:

Dimensions and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Refernce Dimension, usually without tolerance, for information only.

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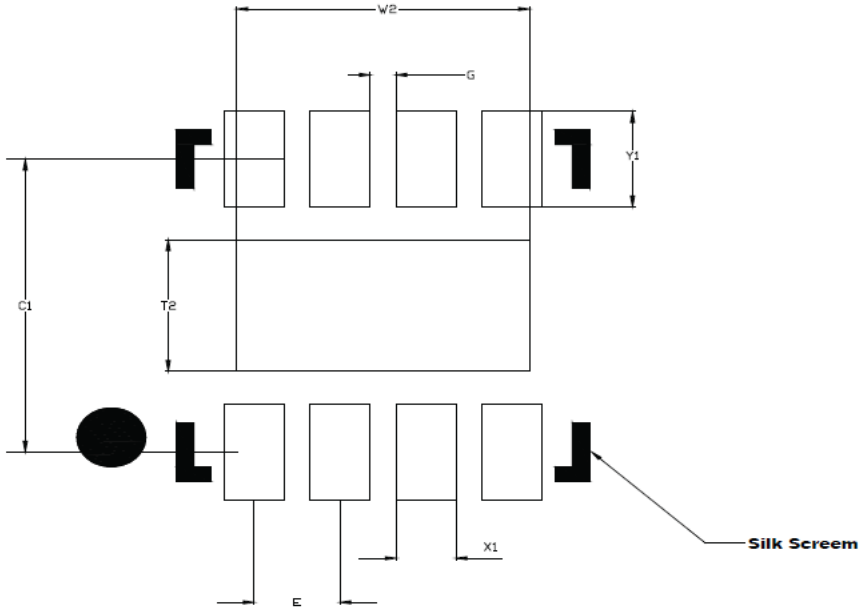
RECOMMENDED PCB LAND PATTERN



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.50 BSC	
Optional Center Pad Width	W2	-	-	1.70
Optional Center Pad Length	T2	-	-	0.90
Contact Pad Spacing	C1	-	2.00	-
Contact Pad Width (X8)	X1	-	-	0.35
Contact Pad Length (X8)	Y1	-	-	0.65
Distance Between Pads	G	0.15	-	-

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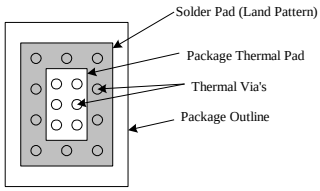
APPLICATION USING A MULTI-LAYER PCB

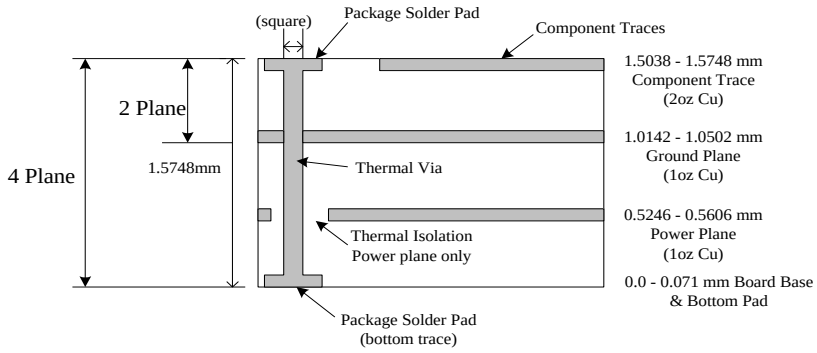
To maximize the efficiency of this package for application on a single layer or multi-layer PCB, certain guidelines must be followed when laying out this part on the PCB.

The following are guidelines for mounting the exposed pad IC on a Multi-Layer PCB with ground a plane.



Package and PCB Land Configuration
For a Multi-Layer PCB

JEDEC standard FR4 PCB Cross-section:



Multi-Layer Board (Cross-sectional View)

In a multi-layer board application, the thermal vias are the primary method of heat transfer from the package thermal pad to the internal ground plane. The efficiency of this method depends on several factors, including die area, number of thermal vias, thickness of copper, etc.

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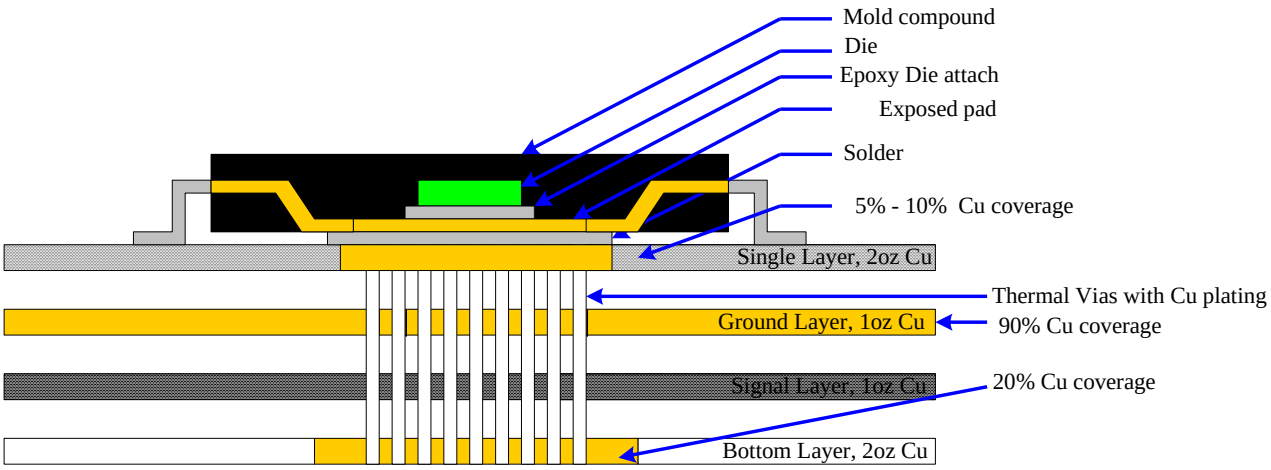
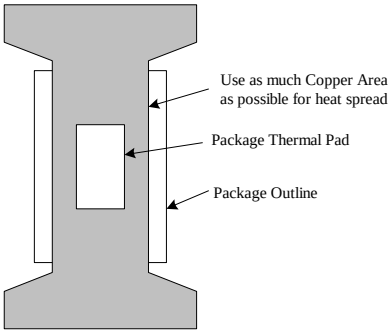


Note: NOT to Scale

The above drawing is a representation of how the heat can be conducted away from the die using an exposed pad package. Each application will have different requirements and limitations and therefore the user should use sufficient copper to dissipate the power in the system. The output current rating for the linear regulators may have to be de-rated for ambient temperatures above 85C. The de-rate value will depend on calculated worst case power dissipation and the thermal management implementation in the application.

APPLICATION USING A SINGLE LAYER PCB



Layout recommendations for a Single Layer PCB: utilize as much Copper Area for Power Management. In a single layer board application the thermal pad is attached to a heat spreader (copper areas) by using low thermal impedance attachment method (solder paste or thermal conductive epoxy).

In both of the methods mentioned above it is advisable to use as much copper traces as possible to dissipate the heat.

IMPORTANT:

If the attachment method is NOT implemented correctly, the functionality of the product is not guaranteed. Power dissipation capability will be adversely affected if the device is incorrectly mounted onto the circuit board.

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ORDERING INFORMATION

TS12001-CvvvDFNR

vvv	Threshold Voltage (V_{THRESH})*
017	1.7 V
021	2.1 V
023	2.3 V
024	2.4 V
025	2.5 V
026	2.6 V
028	2.8 V
030	3.0 V

* Custom values also available (1.2V - 4.2V typical in 100mV increments)

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