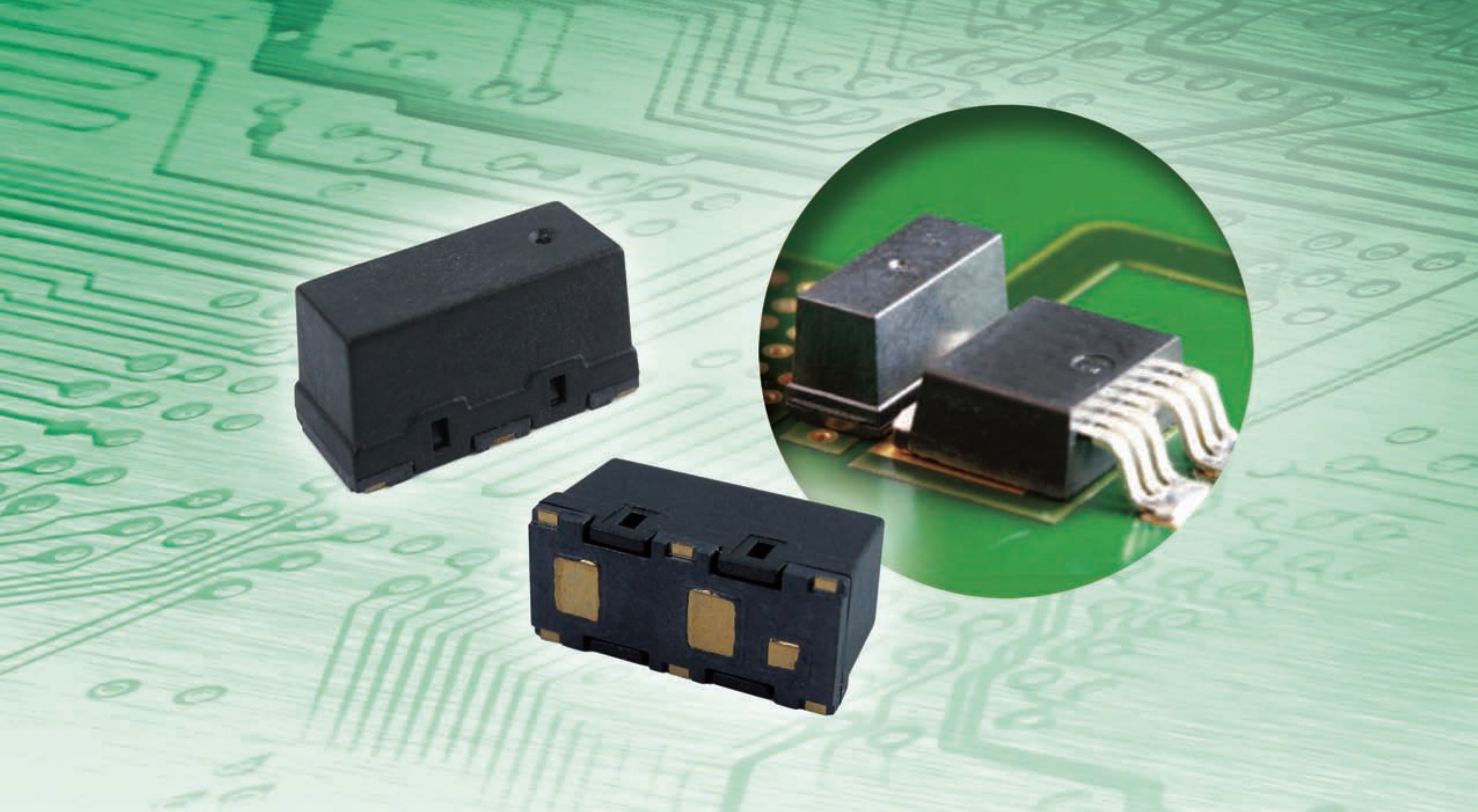


Product Overview

Reflowable Thermal Protection Solutions for Power Electronics Designs in Rugged Environments

TE Reflowable Thermal Protection (RTP) device is a low resistance, robust surface mountable thermal protector. It has a set open temperature and can be installed using reliable, lead-free, Surface Mount Device (SMD) assembly and reflow processes.

TE connectivity

The RTP device described in this overview can withstand the demanding environmental, life, and reliability requirements of automotive and industrial applications, including shock, vibration, temperature cycling, and humidity exposures. In the field, the RTP device opens if its internal junction exceeds the device's specified open temperature. Temperature increases can have multiple sources, one of which is component failure (i.e. when using power components such as a power FET, capacitor, resistor, triac, etc.). The RTP device open temperature is selected so that the device does not open within normal component operating windows, but it does open in a thermal runaway event and before the melt temperature of typical lead free solders.

To simplify installation, improve reliability, and optimize thermal coupling with the PCB, the RTP device is surface mountable. No special SMD installation is required. Instead, after installation, the RTP device utilizes a one time electronic arming process to become thermally sensitive. Before the arming procedure, the device can go through installation temperatures up to 260°C without going open. After arming, the device will open when the critical junction exceeds the open temperature. Arming can occur during test, or in the field.

KEY FEATURES

- Opens at temperature below critical thermal threshold
- Compatible with up to 3 Pb-free solder reflow processes with peak temperatures up to 260°C
- Low series resistance
- DC interrupt voltage capable
- Robust design for harsh environment tested per stringent qualification specification
- RoHS compliant, lead and halogen free

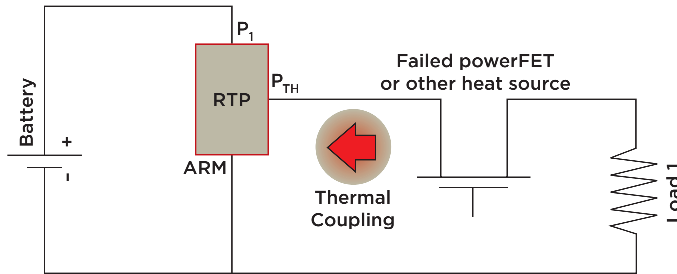
APPLICATIONS

- Helps provide protection against thermal runaway for power FETs and other components if failure occurs in applications such as automotive HVAC, ABS, power steering, DC/DC converters, PTC heaters, etc. or IT servers, telecom power, converters, etc.
- Other DC thermal protection

BENEFITS

- Helps prevent failed components from smoking, and or de-soldering in case of a thermal event
- Allows use of standard surface-mount production methods with no special assembly costs
- Low power dissipation and voltage drop
- Supports DC electronic circuits
- Suitable for rugged environment applications (automotive and industrial)
- Green design

TYPICAL APPLICATION BLOCK DIAGRAM

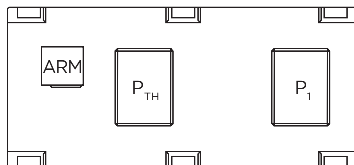


PIN CONFIGURATION & DESCRIPTION PAD LAYOUT RECOMMENDATIONS

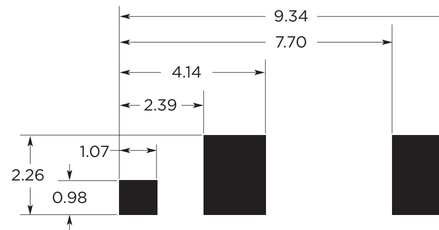
Pin Description

Pin Number	Pin Name	Pin Function
1	P_1	Power I/O pin (Main power current path)
2	P_{TH}	Thermally sensitive power I/O pin - Intended to share protected component heat sink
3	ARM	Electronic arming pin

Pin Configuration
(Bottom View of Device)

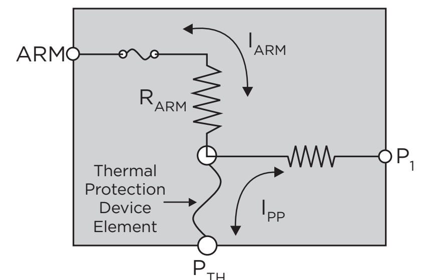


Pad Dimensions in mm
(Top View – Through Component)



DEFINITION OF TERMS / DEVICE BLOCK DIAGRAM

Junction	The internal interface which must achieve the “Open Temperature” for the RTP device to open thermally after arming. This interface (thermal element) is located directly above the P_{TH} pad.
Open Temp	The device will open when the junction temperature achieves this value.
I_{ARM} and R_{ARM}	Current and resistance levels measured between the ARM pin and either the P_1 or P_{TH} pin. These values are relevant only pre device arming.
R_{PP} and I_{PP}	Current and resistance levels measured between the P_1 and P_{TH} pins.



TE connectivity

METHOD OF OPERATION – ELECTRONIC ARMING

The RTP device is a unique thermal protector. It can be reflowed at temperatures up to 260°C without opening, yet in operation it will open at temperatures well below 260°C. To achieve this functionality, the RTP device uses an electronic arming mechanism.

Electronic arming must be done after reflow, and can be done during final test.

The device is armed by sending a specified arming current through the ARM pin of the device. Arming is a time- & current-dependent event. Arming times vs. current are provided in the "Arming Characteristics" section of this overview. Current can flow in either direction through the ARM pin.

Prior to arming, R_{ARM} should have resistance levels as specified in the "Arming Characteristics" section. Once armed, the ARM pin will be electrically open relative to the P_1 or P_{TH} pins.

Arming has been successful once R_{ARM} exceeds the post-arming minimum resistance specified in the "Arming Characteristics" section. RTP devices must be armed individually and cannot be armed simultaneously in series.

Once "armed", the RTP device will permanently open when the device junction achieves its specified opening temperature.

Although multiple options exist, below is one simple arming option.

Sample Arming Options

During Test	Current Flow	Description
P_1, P_{TH}, PowerFET, RTP, ARM, Test Point 1, Test Point 2	P_{TH} ⟷ ARM = Arming	**ARM pin connected between two test points** In this case, pin P_1 is left "floating", and arming can occur during test, at a user defined time, by connecting to the Test Points and applying sufficient current (I_{ARM}) between Test Point 1 and Test Point 2 until the device is armed.

PRELIMINARY ABSOLUTE MAX RATINGS

Absolute Max Ratings		RTP200R060SA Max	Units
Max DC Open Voltage (1)		32	V_{DC}
Max DC Interrupt Current (1)	@ 16 V_{DC}	200	A
	@ 24 V_{DC}	130	
	@ 32 V_{DC}	100	
ESD rating (Human Body Model)		25	KV
Max Reflow Temperature (pre-arming)		260	°C
Operating temperature limits, post-arming, non-opening		-55 +175	°C

(1) Performance capability at these conditions can be influenced by board design. Performance should be verified in the user's system.

PRELIMINARY PERFORMANCE CHARACTERISTICS (TYPICAL UNLESS OTHERWISE SPECIFIED)

Resistance and Open Characteristics P_1 to P_{TH}		RTP200R060SA			Units
		Min	Typ	Max	
R_{PP} (Resistance from P_1 to P_{TH})	@ 23+/-3°C	–	0.6	0.8	mΩ
	@ 175+/-3°C	–	0.8	1.2	
Operating Voltage	-	-	32	-	V_{DC}
Open Temperature, post-arming	I_{PP} = 0	196	205	213	°C
Thermal Resistance: Junction to Case	Case = P_{TH} pad	–	0.5	–	°C/W
Installation dependent Operating Current, post-arming (2)(3)	@ 23+/-3°C	32	34	–	A
	@ 100+/-3°C	27	28	–	
	@ 175+/-3°C	–	10	–	
Moisture Sensitivity Level Rating (4)	–	–	1	–	–

ARMING CHARACTERISTICS

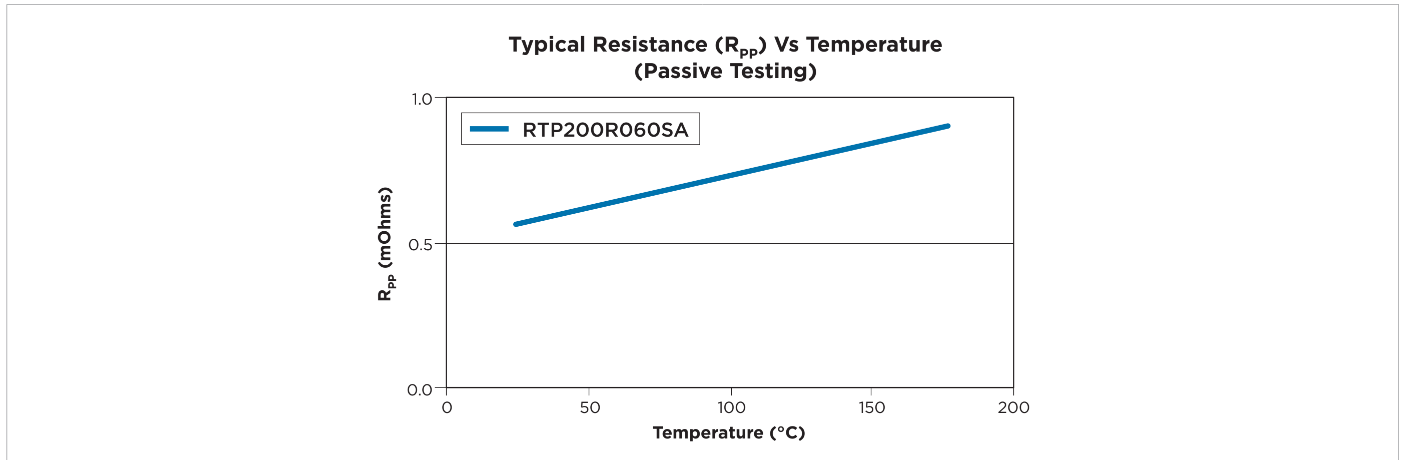
Arming Characteristics ARM		RTP200R060SA			Units
		Min	Typ	Max	
Arming Type		Electronically Armed			–
R_{ARM} (Resistance from ARM to P_1 or P_{TH})	Pre-Arming	–	300	–	mΩ
	Post-Arming	10	–	–	KΩ
Arming Current (I_{ARM}) (2)	@ 23 +/-3°C	2	–	5	A
Arming Time (@23 +/-3°C) (2)	@ 2A	–	0.10	–	Sec
	@ 5A	–	0.01	–	

(2) Results obtained on 44.5 x 57.2 x 1.6 (in mm) single layer FR4 boards with 70µm (2oz) Cu traces, a 645mm², 70µm (2oz) Cu heat spreader connected to the P_{TH} pad, and a 387mm² Cu heat spreader connected to the P_1 pad of the RTP device.
(See RTP device test board drawing) Results are highly installation dependent.

(3) Operating current is measured on the RTP test boards at the specified temperature. It is a highly installation dependent value.

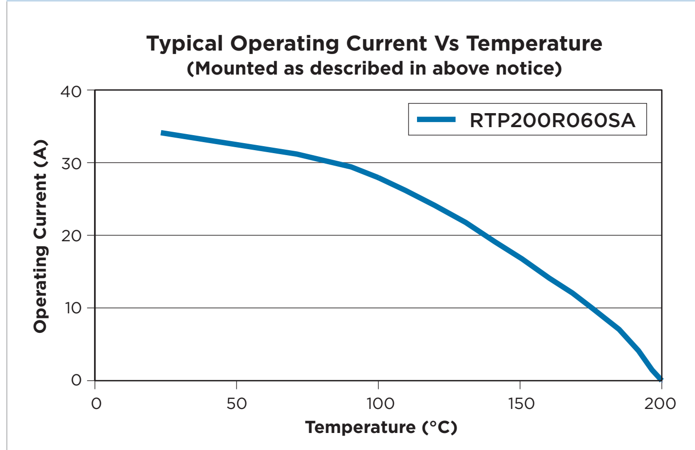
(4) As per JEDEC J-STD-020C.

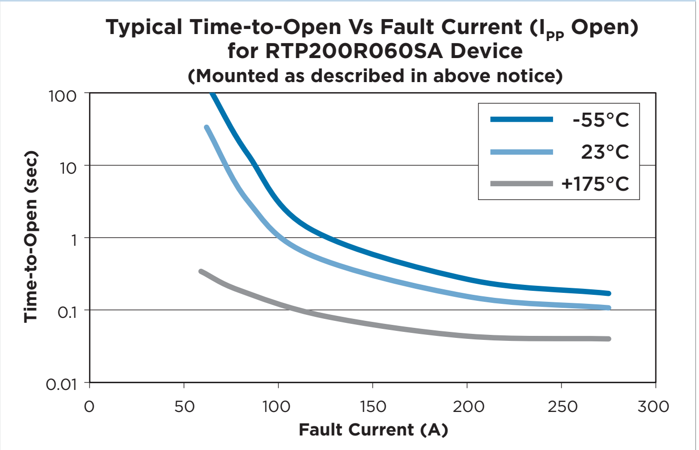
TYPICAL ELECTRICAL PERFORMANCE CHARACTERISTICS

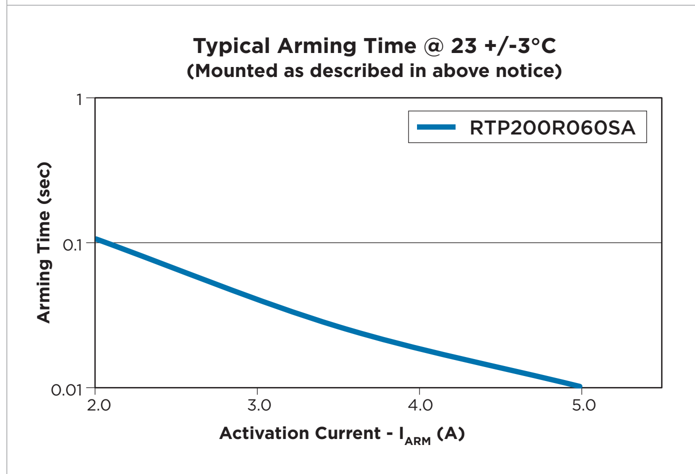


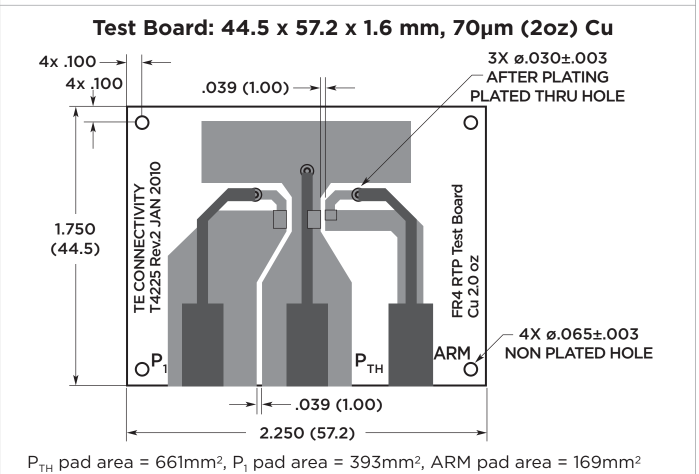
INSTALLATION DEPENDENT PERFORMANCE CHARACTERISTICS

Note: Results were obtained on 44.5 x 57.2 x 1.6 (in mm) single layer FR4 boards with 2mOhm, 70µm (2oz) Cu traces, and a 645mm², 70µm (2oz) Cu heat spreader connected to the P_{TH} pad of the RTP device. (See RTP device test board drawing)
Results will vary based on user's configuration and should be validated by the user in the end system.





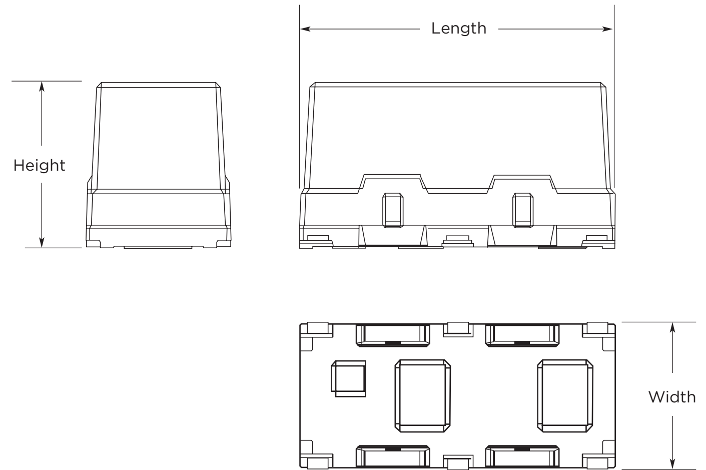




P_{TH} pad area = 661mm², P_1 pad area = 393mm², ARM pad area = 169mm²

MECHANICAL DIMENSIONS

	RTP200R060SA		Units
	Min	Max	
Height	6.00	6.35	mm
Length	11.60	12.00	mm
Width	5.25	5.50	mm



MATERIAL CONSTRUCTION

RoHS Compliant

Directive 2002/95/EC Compliant

ELV Compliant

Directive 2000/53/EC Compliant

Pb-Free

Halogen Free*

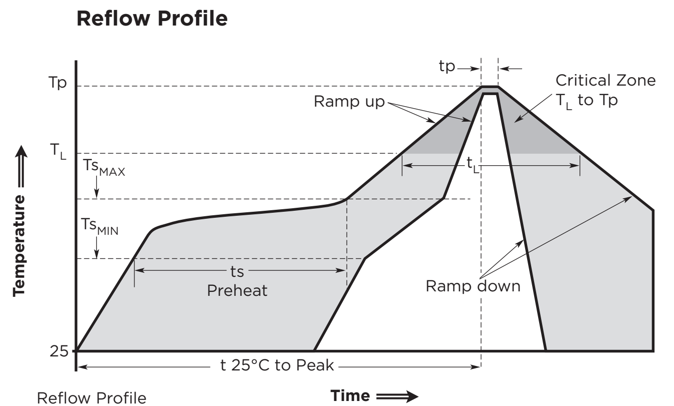
* Halogen Free refers to: Br≤900ppm, Cl≤900ppm, Br+Cl≤1500ppm.

RECOMMENDED REFLOW PROFILE

Classification Reflow Profiles

Profile Feature	Pb-Free Assembly
Average Ramp-Up Rate (Ts_{MAX} to Tp)	3°C/second max.
Preheat • Temperature Min (Ts_{MIN}) • Temperature Max (Ts_{MAX}) • Time (ts_{MIN} to ts_{MAX})	 150°C 200°C 60-180 seconds
Time maintained above: • Temperature (T_L) • Time (t_L)	 217°C 60-150 seconds
Peak/Classification Temperature (Tp)	260°C
Time within 5°C of actual Peak Temperature Time (tp)	 20-24 seconds
Ramp-Down Rate	6°C/second max.
Time 25°C to Peak Temperature	8 minutes max.

Reflow Profile



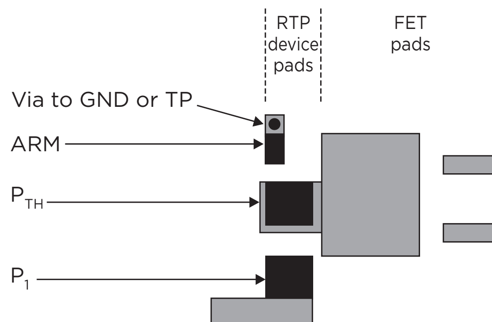
Reflow Profile

LAYOUT RECOMMENDATIONS

Intimate thermal contact with the potential heat source is critical to achieve the desired protection performance. The RTP device should be used so that the P_{TH} pin shares a copper mounting pad with the primary thermal pin or heat sink of the FET or protected component. Board layout recommendations for appropriate thermal coupling are provided below.

1. The RTP device P_{TH} pad must be placed as close to the FET heat sink as practical.
2. Connect the P_{TH} pad to the FET heat sink with as thick and wide a copper trace as practical.
3. Additional copper layers should NOT be placed directly underneath the P_{TH} pad, and if possible, pull additional copper layers away from the RTP device P_{TH} pad. These additional copper layers work to pull heat away from the RTP device and decrease its thermal sensitivity.
4. Pull top layer “cooling” traces as far away from RTP device P_{TH} pad as practical.

Example layout of an RTP device mounted near to a typical powerFET package on an FR4 type PCB



Note: Thermal conductivity between the RTP device and the heat source is highly dependent on board layout, heat sink structures, and relative placement and design of co-located components. It is the responsibility of the user to verify that the RTP device provides sufficient protection in the user’s specific final device implementation.

TE connectivity

ALTERNATE & MULTI-FET SCHEMATIC IMPLEMENTATIONS

	Schematic	Solution Considerations
Low Side, N-Channel Single FET Protection	Load Resistance; Battery; RTP; P_1; P_{TH}; ARM; N-Channel PowerFET; D; S; G	• Low side N-Channel FET architectures allow only one FET to be installed per RTP device. • Note: Load may limit "arming" current.
Low Side, N-Channel FET Protection — Single FET	Battery; RTP; P_1; P_{TH}; ARM; D; S; G; Load 1	• High Side FET designs allow multiple FETs to be installed with 1 RTP device while all sharing the same copper mounting pad (heat sink). • In the Multi-FET configuration, care must be taken to assure proper thermal response can be achieved with each FET.
Low Side, N-Channel FET Protection — Multi FET	Battery; Load 2; S; D; G; RTP; P_1; P_{TH}; ARM; D; S; G; Load 1	

Note: The degree of thermal connectivity between the heat source and the RTP device is highly dependent on board layouts, PCB material, heat sink structures, and relative placement and design of co-located components. It is the responsibility of the user to verify that the RTP device provides sufficient protection in the user's specific final device implementation.

QUALIFICATION TESTING

The Qualification testing plan for this series of RTP devices is built upon AEC automotive grade testing for ICs (AEC-Q100), discrete semiconductors (AEC-Q101), and passive components (AEC-Q200), with the intent to demonstrate survivability to the most stringent of the relevant requirements.

Contact TE Circuit Protection for updated qualification status and detailed procedures.

*A specific list of tests and conditions is available upon request.

FOR MORE INFORMATION

te.com/RTP-Launch/

TE Circuit Protection
308 Constitution Drive
Menlo Park, CA USA 94025-1164
Tel : (800) 227-7040, (650) 361-6900
Fax : (650) 361-4600
Email : RTP@TE.COM

www.circuitprotection.com
www.circuitprotection.com.hk (Chinese)
www.te.com/japan/bu/circuitprotection/ (Japanese)

Brazil
Tel : 55-11-2103-6090
Fax: 55-11-2103-6216

UK / Eire / Benelux / Israel
South Africa / Nordic / Baltic / Others
Tel : 49-89-6089485
Fax: 49-89-6089394

Germany / Austria / Switzerland / Eastern Europe / Russia
Tel : 49-89-6089584
Fax: 49-89-6089394

France / Italy / Iberia / Greece / Turkey
Tel : 33-1-34208455
Fax: 33-1-34208479

Japan
Tel : 81-44-900-5110
Fax: 81-44-900-5140

Korea
Tel : 82-2-3415-4654
Fax: 82-2-3486-1786

Taiwan
Tel : 886-2-8768-2788 x 211
Fax: 886-2-8768-1277

China, Hong Kong
Tel : 852-2738-8181
Fax: 852-2735-1185

China, Beijing
Tel : 86-10-6569-3488 x 16526
Fax: 86-10-6569-3206

China, Shanghai
Tel : 86-21-6106-7379
Fax: 86-21-6485-3255

China, Shenzhen / Guangzhou
Tel : 86-755-2515-4797
Fax: 86-755-2598-0419

Singapore / Indonesia
Tel : 65-6590-5089
Fax: 65-6481-9377

Thailand / Malaysia / Vietnam
Tel : 6-04-217-8112
Fax: 6-04-229-8177

Australia / Philippines
Tel : 63-2-988-9465
Fax: 63-2-848-0205

India
Tel : 91-80-4161-3745
Mobile : 91-99-0248-8886

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*as defined www.te.com/leadfree

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