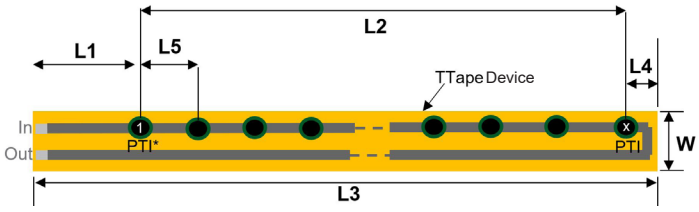
TTape™ Distributed Temperature Monitoring Device

TTape Overview

Lithium Ion battery packs require thermal monitoring not to exceed safe operating conditions or result in battery cell degradation. Existing temperature sensors, particularly conventional NTC thermistors, lack the rapid response time and accuracy needed for critical applications.

The TTape platform provides the opportunity to place many sensing points throughout a multi-cell pack increasing temperature monitoring spatial resolution and simplifying the installation process. The TTape device provides a two-wire interface to sense if any of the cells in a battery pack exceeds a critical operational temperature (for example, 60 °C).
The device activates at a temperature of 58±3 °C and resets at a temperature of 42±3 °C.

TTape Device Illustration and Terminology



Note:
* Printed Temperature Indicator (individual sensing element on TTape device)

Figure 2: Customizable Dimensions of the TTape Platform

Parameter		Dimensions for customer/application specific design
Number of Printed Thermal Indicators (PTIs)		≤50
Position of the first thermal indicator from the tape edge	L1	≥15 mm
Distance between first and last thermal indicator	L2	depending on design
TTape device total length	L3	<1 m (typical)
< 8 m (stitching option available)		
Distance between the last thermal indicator and the end of the tape	L4	≥10 mm
Pitch between Printed Thermal Indicators (PTIs) (can vary from PTI to PTI)	L5	≥10 mm
Tape width	W	10 mm/8 mm
Diameter of Printed Thermal Indicators (PTIs)		≤5 mm

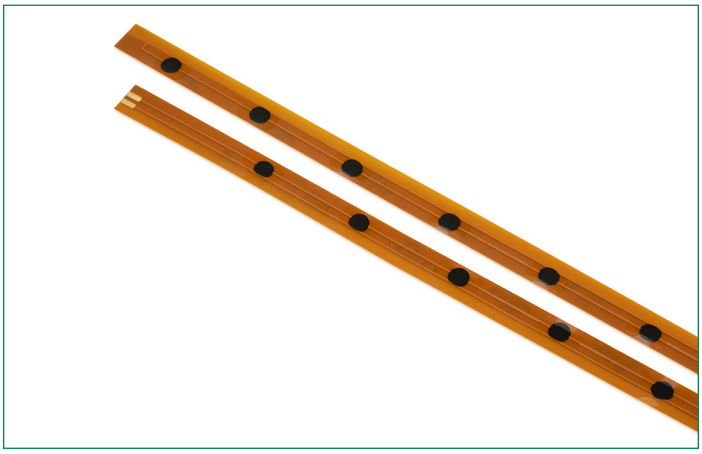


Figure 1: Littelfuse TTape™ Device

Recommended TTape Test Setup for Simulating Over-temperature Conditions and Firmware Testing

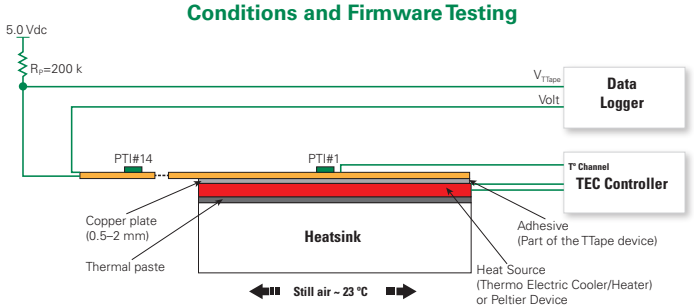


Figure 3: TTape test setup for simulating over-temperature conditions & firmware testing

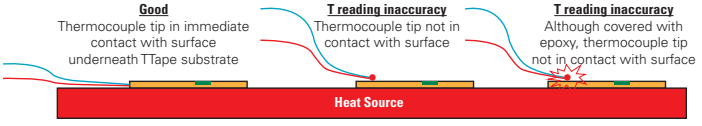


Figure 4: Recommended Method for attaching thermocouples during, for example the device testing to ensure correct temperature reading of the heated surface

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Installation Guidance

The TTape platform uses pressure-sensitive adhesives (PSA) for bonding with the surface where it is applied. The PSA is compatible with metal, polyamide, PET, and polyimide surfaces.

1. Clean the surface where the TTape device is to be attached with isopropyl alcohol and a lint-free cloth
2. Ensure that the surface is dry before peeling off the tape and attaching it to the surface
3. Apply pressure to the TTape device to ensure good bonding, max. pressure: 1500Pa

Notes:
1. TTape devices are for one-time installation only; removing the TTape device after installation will cause damage and make the device unusable.
2. PSA tape is qualified according to the following automotive (OEM) specifications: MS-CC240 (Chrysler), WSS-M11P62 (Ford), WSS-M99P48-A3, M8506 (Nissan)

Bending of TTape Devices During Installation

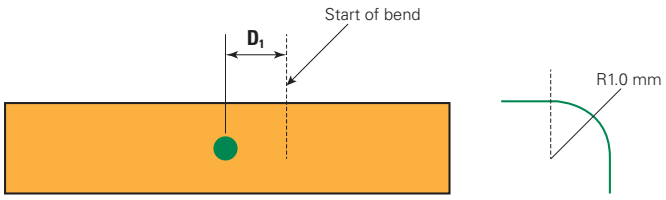

Figure 5: Bending of TTape Devices

Notes:
1. Minimum distance from center of PTI (Printed Temperature Indicator) to start of bend = 5 mm.
2. Minimum bend radius = 1 mm.
3. Maximum number of flex cycles allowed per bend location = 50.

TTape Circuit Implementation

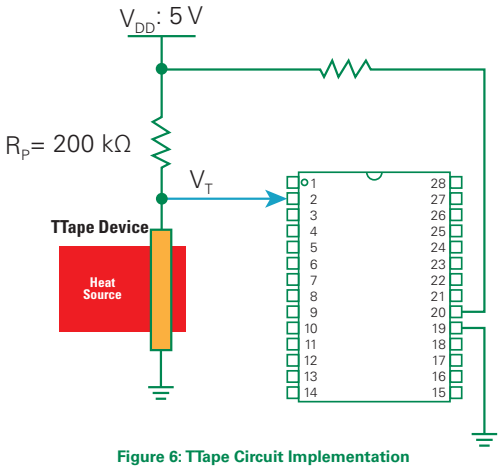

Figure 6: TTape Circuit Implementation

Notes:
1. Circuit is shown with a microchip 10-bit microcontroller implementation.
2. ADC value can be changed to interpret Logic 1 and Logic 0 at different input voltages. MCU may use an internal reference voltage or an external reference as shown by using voltage devider circuit.

- We recommend reference voltage (V_{DD}) to be 5 V. In the table, we assume V_{DD} to be 5 V
- We recommend a 10-bit or higher microcontroller
  - Assuming a 10-bit microcontroller is implemented, following logic values will be represented

Logic State	Voltage Rating: V_{DD} (Volts)	ADC Value (10-bit µcontroller)
Logic 1 or Logic 'High'	5 V	1023
	4 V (80% V_{DD})	818
	3.5 V (70% V_{DD})	716
Logic 0 or Logic 'Low'	1.5 V (30% V_{DD})	307

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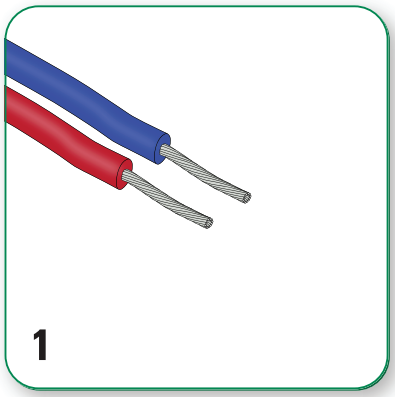
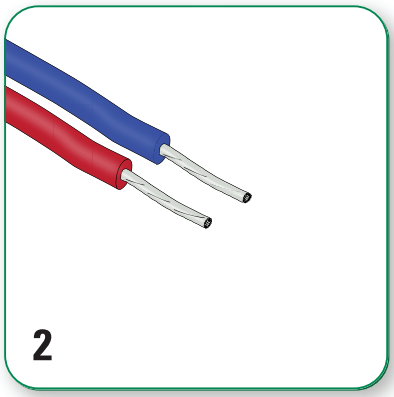
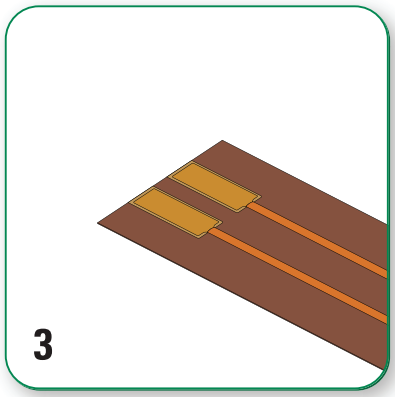
Soldering Process to Attach Leads to TTape Devices



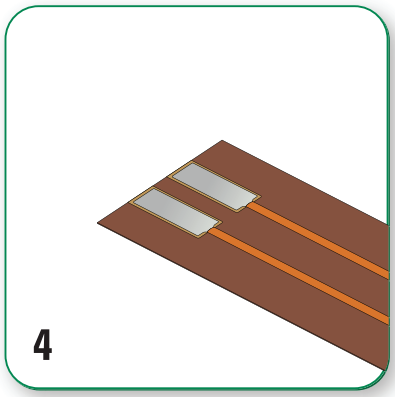
- Strip the wire at a minimum of 7 mm/AWG 20–26



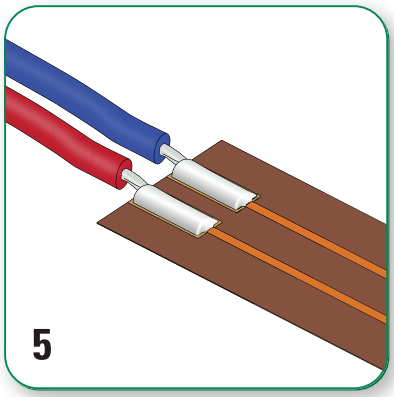
- Tin the wire with SAC305
  - SAC305 is a lead-free solder
  - 96.5% tin
  - 3% silver
  - 0.5% copper
- Solder tin wire for 3 seconds



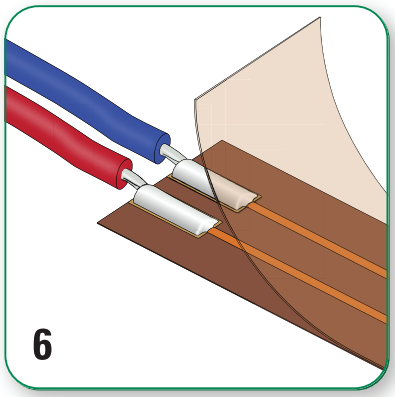
- Clean the flex circuit with isopropyl alcohol and a lint-free cloth



- Tin the pads on the flex circuit with lead-free solder
- The tin process takes less than 3 seconds
- Clean the residual flux after tinning with isopropyl alcohol



- Place the leads on the pads and apply heat with a soldering iron until the solder melts and flows onto the pads and leads
- Remove the heat and let the solder cool
- Make sure the solder pencil is at 260 °C
- Process should not take more than 3 seconds



- We recommend the use of polyimide dielectric tape to protect the solder joint

Figure 7: TTape Device Soldering Instructions

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