

## Features

- Superior circuit protection
- Overcurrent protection
- Blocks surges up to rated voltage limit
- High-speed performance
- Small SMT package
- RoHS compliant\*

## Applications

- RS-485 interfaces
- Exposed sense and data lines
- Factory automation
- Protection modules and dongles
- Process control equipment
- Test and measurement equipment
- General electronics

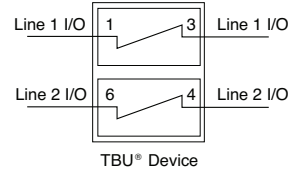
# TBU-DF Series - TBU® High-Speed Protectors

## General Information

The TBU-DF Series of Bourns® TBU® products are low capacitance dual bidirectional high-speed Electronic Current Limiters (ECLs), constructed using MOSFET semiconductor technology, and designed to protect against faults caused by short circuits, overvoltage transients and faults in battery cells, up to rated limits.

The TBU® high-speed protector placed in the system circuit will monitor the current with the MOSFET detection circuit triggering to provide an effective barrier behind which sensitive electronics will not be exposed to large voltages or currents during transient events.

The TBU® device is provided in a surface mount DFN package and meets industry standard requirements such as RoHS and Pb Free solder reflow profiles.



## Absolute Maximum Ratings (@ T<sub>A</sub> = 25 °C Unless Otherwise Noted)

| Symbol            | Parameter  | Part Number                          | Value       | Unit |
|-------------------|--|--------------------------------------|-------------|------|
| V <sub>imp</sub>  | Peak impulse voltage withstand with duration less than 10 ms | TBU-DF055-xxx-WH<br>TBU-DF085-xxx-WH | 550<br>850  | V    |
| V <sub>rms</sub>  | Continuous A.C. RMS voltage                                  | TBU-DF055-xxx-WH<br>TBU-DF085-xxx-WH | 250<br>425  | V    |
| T <sub>op</sub>   | Operating temperature range                                  |                                      | -55 to +125 | °C   |
| T <sub>stg</sub>  | Storage temperature range                                    |                                      | -65 to +150 | °C   |
| T <sub>amax</sub> | Maximum Ambient Temperature                                  |                                      | +125        | °C   |

## Electrical Characteristics (@ T<sub>A</sub> = 25 °C Unless Otherwise Noted)

| Symbol               | Parameter   | Part Number  | Min.                           | Typ.             | Max.                             | Unit |
|----------------------|---|--|--------------------------------|------------------|----------------------------------|------|
| I <sub>trigger</sub> | Current required for the device to go from operating state to protected state           | TBU-DFxxx-050-WH<br>TBU-DFxxx-300-WH<br>TBU-DFxxx-500-WH   | 50<br>300<br>500               | 75<br>450<br>750 | 100<br>600<br>1000               | mA   |
| R <sub>device</sub>  | Series resistance of the TBU® device  | V <sub>imp</sub> = 550 V I <sub>trigger</sub> (min.) = 50 mA<br>V <sub>imp</sub> = 550 V I <sub>trigger</sub> (min.) = 300 mA<br>V <sub>imp</sub> = 550 V I <sub>trigger</sub> (min.) = 500 mA<br>TBU-DF055-050-WH<br>TBU-DF055-300-WH<br>TBU-DF055-500-WH<br>V <sub>imp</sub> = 850 V I <sub>trigger</sub> (min.) = 50 mA<br>V <sub>imp</sub> = 850 V I <sub>trigger</sub> (min.) = 300 mA<br>V <sub>imp</sub> = 850 V I <sub>trigger</sub> (min.) = 500 mA<br>TBU-DF085-050-WH<br>TBU-DF085-300-WH<br>TBU-DF085-500-WH | 12<br>6<br>5<br>23<br>15<br>12 |                  | 26<br>14<br>13<br>38<br>26<br>25 | Ω    |
| R <sub>match</sub>   | Package resistance matching of the TBU® device #1 - TBU® device #2                      |  |                                |                  | +0.5                             | Ω    |
| t <sub>block</sub>   | Time for the device to go from normal operating state to protected state                |  |                                | 1                |                                  | μs   |
| I <sub>Q</sub>       | Current through the triggered TBU® device with 50 Vdc circuit voltage                   |  |                                | 0.5              |                                  | mA   |
| V <sub>reset</sub>   | Voltage below which the triggered TBU® device will transition to normal operating state |  | 12                             | 16               | 20                               | V    |
| R <sub>th(j-a)</sub> | Junction to ambient - FR4 using JESD51-3 board  |  |                                | 125              |                                  | °C/W |
| R <sub>th(j-a)</sub> | Junction to ambient - FR4 using JESD51-7 board  |  |                                | 50               |                                  | °C/W |

## Environmental Characteristics

| Parameter                  | Value |
|----------------------------|-------|
| Moisture Sensitivity Level | 1     |
| ESD Classification (HBM)   | 1B    |



**WARNING Cancer and Reproductive Harm - [www.P65Warnings.ca.gov](http://www.P65Warnings.ca.gov)**

\*RoHS Directive 2015/863, Mar 31, 2015 and Annex.

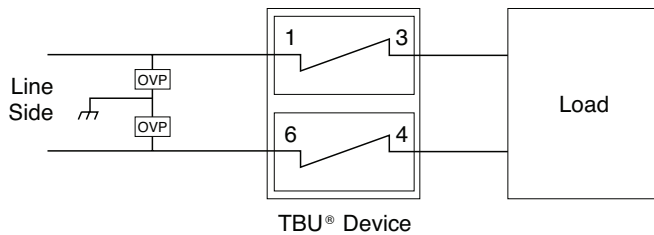
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## Reference Application

The TBU<sup>®</sup> devices are general use protectors used in a wide variety of applications, including telecommunications, industrial communications and automotive battery management systems. The maximum voltage rating of the TBU<sup>®</sup> device should never be exceeded. Where necessary, an OVP device should be employed to limit the maximum voltage. A cost-effective protection solution combines Bourns<sup>®</sup> TBU<sup>®</sup> protection devices with a pair of Bourns<sup>®</sup> TISP<sup>®</sup> Overvoltage Protectors or MOVs. For bandwidth sensitive applications, a Bourns<sup>®</sup> GDT may be substituted for the MOV.



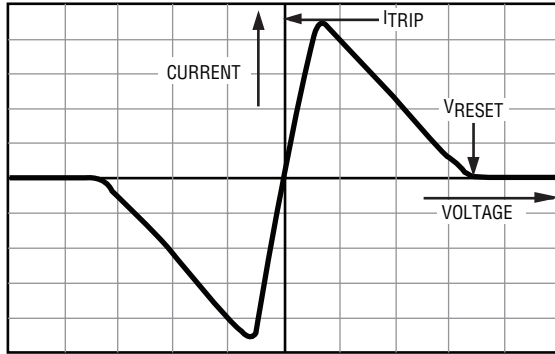
## Basic TBU Operation

The TBU<sup>®</sup> device, constructed using MOSFET semiconductor technology, placed in the system circuit will monitor the current with the MOSFET detection circuit triggering to provide an effective barrier behind which sensitive electronics are not exposed to large voltages or currents during transient events. When operated, the TBU<sup>®</sup> device will limit the current to less than the  $I_{\text{trigger}}$  value within the  $t_{\text{block}}$  duration. If voltage above  $V_{\text{reset}}$  is continuously sustained, the TBU<sup>®</sup> device will subsequently reduce the current to a quiescent current level within a period of time that is dependent upon the applied voltage.

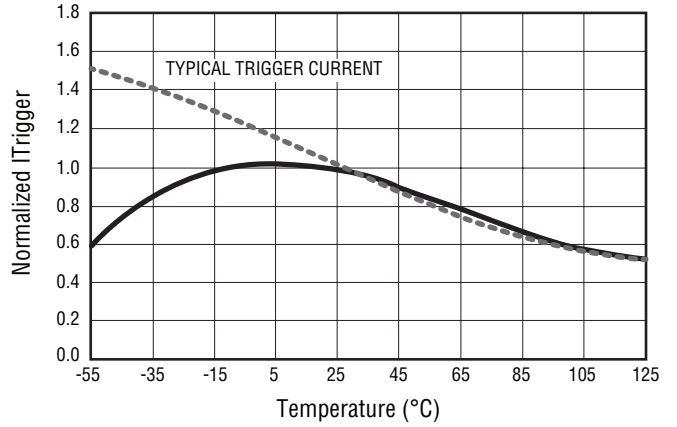
After the surge, the TBU<sup>®</sup> device resets when the voltage across the TBU<sup>®</sup> device falls to the  $V_{\text{reset}}$  level. The TBU<sup>®</sup> device will automatically reset on lines which have no DC bias or have DC bias below  $V_{\text{reset}}$  (such as unpowered signal lines).

## Performance Graphs

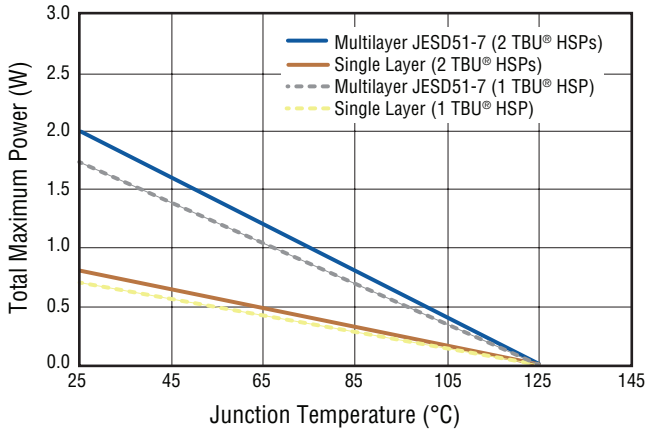
### Typical V-I Characteristics



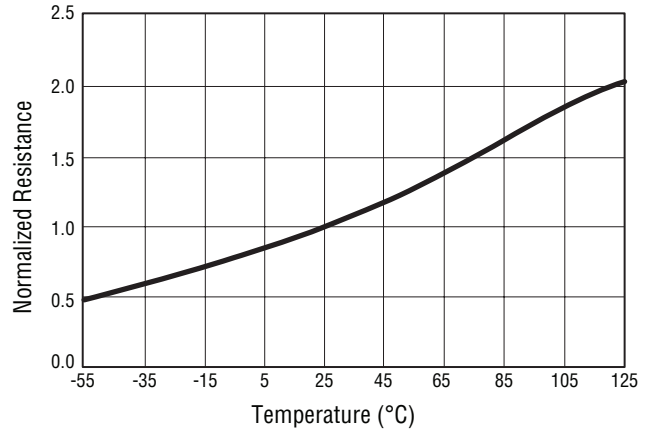
### Normalized Itrigger vs. Temperature



### Power Derating Curve



### Normalized Resistance vs. Temperature

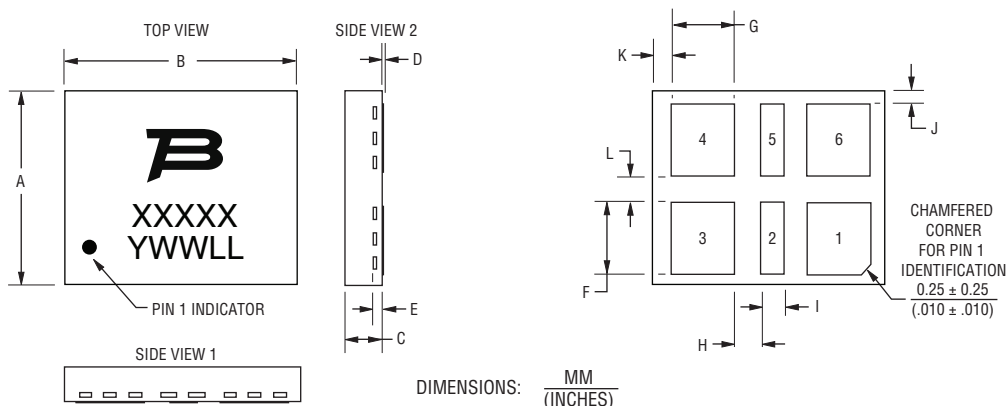


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## Product Dimensions



| Dim. | Min.                       | Nom.                  | Max.                  |
|------|----------------------------|-----------------------|-----------------------|
| A    | $\frac{5.40}{(.213)}$      | $\frac{5.50}{(.217)}$ | $\frac{5.60}{(.220)}$ |
| B    | $\frac{6.40}{(.252)}$      | $\frac{6.50}{(.256)}$ | $\frac{6.60}{(.260)}$ |
| C    | $\frac{0.80}{(.031)}$      | $\frac{0.90}{(.035)}$ | $\frac{1.00}{(.039)}$ |
| D    | $\frac{0.00}{(.000)}$      | --                    | $\frac{0.05}{(.002)}$ |
| E    | $\frac{0.20}{(.008)}$ REF. |                       |                       |
| F    | $\frac{1.90}{(.075)}$      | $\frac{2.00}{(.079)}$ | $\frac{2.10}{(.083)}$ |
| G    | $\frac{1.75}{(.069)}$      | $\frac{1.85}{(.073)}$ | $\frac{1.95}{(.077)}$ |
| H    | $\frac{0.65}{(.026)}$      | $\frac{0.70}{(.028)}$ | $\frac{0.75}{(.030)}$ |
| I    | $\frac{0.70}{(.028)}$      | $\frac{0.80}{(.031)}$ | $\frac{0.90}{(.035)}$ |
| J    | $\frac{0.30}{(.012)}$      | $\frac{0.35}{(.014)}$ | $\frac{0.40}{(.016)}$ |
| K    | $\frac{0.25}{(.010)}$      | $\frac{0.30}{(.012)}$ | $\frac{0.35}{(.014)}$ |
| L    | $\frac{0.75}{(.030)}$      | $\frac{0.80}{(.031)}$ | $\frac{0.85}{(.033)}$ |

| Pad # | Pin Out       |
|-------|---------------|
| 1     | Line 1 In/Out |
| 2     | NU (Not Used) |
| 3     | Line 1 In/Out |
| 4     | Line 2 In/Out |
| 5     | NU (Not Used) |
| 6     | Line 2 In/Out |

### NOTES:

- Pin 1 Indicator is laser marked; radius and location within the Pin 1 terminal.  
Pin 1 dot size:  $0.500 \pm 0.125$  mm /  $(.020 \pm .005$  in.).
- Pin 2 and 5 are NU (Not Used) and must be left unconnected; do not connect to In/Out lines, do not connect to system Ground.
- Coplanarity on exposed pads shall not exceed 0.08 mm / (.003 in.).
- Warpage shall not exceed 0.10 mm / (.004 in.) on all surfaces.
- Exposed tie bars at package side are not plated.

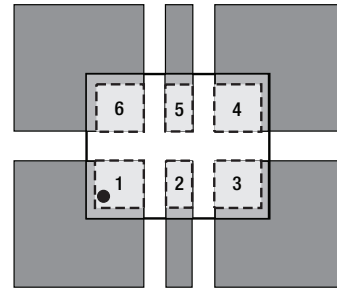
# TBU-DF Series - TBU® High-Speed Protectors

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## Recommended Pad Layout

TBU® High-Speed Protectors have a 100 % matte-tin termination finish. For improved thermal dissipation, the recommended layout uses PCB copper areas which extend beyond the exposed solder pad. The exposed solder pads should be defined by a solder mask which matches the pad layout of the TBU® device in size and spacing. It is recommended that they should be the same dimension as the TBU® pads but if smaller solder pads are used, they should be centered on the TBU® package terminal pads and not more than 0.10-0.12 mm (0.004-0.005 in.) smaller in overall width or length. Solder pad areas should not be larger than the TBU® pad sizes to ensure adequate clearance is maintained. The recommended stencil thickness is 0.10-0.12 mm (0.004-0.005 in.) with a stencil opening size 0.025 mm (0.0010 in.) less than the solder pad size. Extended copper areas beyond the solder pad significantly improve the junction to ambient thermal resistance, resulting in operation at lower junction temperatures with a corresponding benefit of reliability. All pads should soldered to the PCB, including pads marked as NC or NU but no electrical connection should be made to these pads. Care should be taken to assure no resistive path exists between the NC or NU pins to any other point to avoid

unexpected performance issues. For minimum parasitic capacitance, it is recommended that signal, ground or power signals are not routed beneath any pad. For minimum parasitic capacitance, it is recommended that signal, ground or power signals are not routed beneath any pad.



Dark grey areas show added PCB copper area for better thermal resistance.

## Reflow Profile

| Profile Feature   | Pb-Free Assembly |
|---|------------------|
| Average Ramp-Up Rate (T <sub>smax</sub> to T <sub>p</sub> ) | 3 °C/sec. max.   |
| Preheat   |                  |
| - Temperature Min. (T <sub>sm</sub> )                       | 150 °C           |
| - Temperature Max. (T <sub>smax</sub> )                     | 200 °C           |
| - Time (t <sub>sm</sub> to t <sub>smax</sub> )              | 60-180 sec.      |
| Time maintained above:                                      |                  |
| - Temperature (T <sub>L</sub> )                             | 217 °C           |
| - Time (t <sub>L</sub> )                                    | 60-150 sec.      |
| Peak/Classification Temperature (T <sub>p</sub> )           | 260 °C           |
| Time within 5 °C of Actual Peak Temp. (t <sub>p</sub> )     | 20-40 sec.       |
| Ramp-Down Rate  | 6 °C/sec. max.   |
| Time 25 °C to Peak Temperature                              | 8 min. max.      |



## How to Order

TBU - DF xxx - yyy - WH

TBU® Product \_\_\_\_\_

Series \_\_\_\_\_  
DF = Dual Bidirectional Series

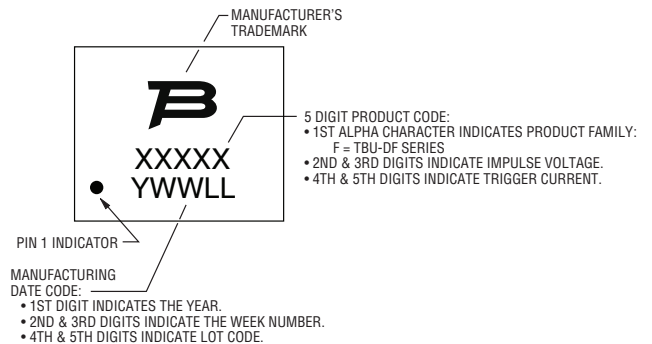
Impulse Voltage Rating \_\_\_\_\_  
055 = 550 V  
085 = 850 V

Trigger Current \_\_\_\_\_  
050 = 50 mA  
300 = 300 mA  
500 = 500 mA

Hold to Trip Ratio Suffix \_\_\_\_\_  
W = Hold to Trip Ratio

Package Suffix \_\_\_\_\_  
H = DFN Package

## Typical Part Marking



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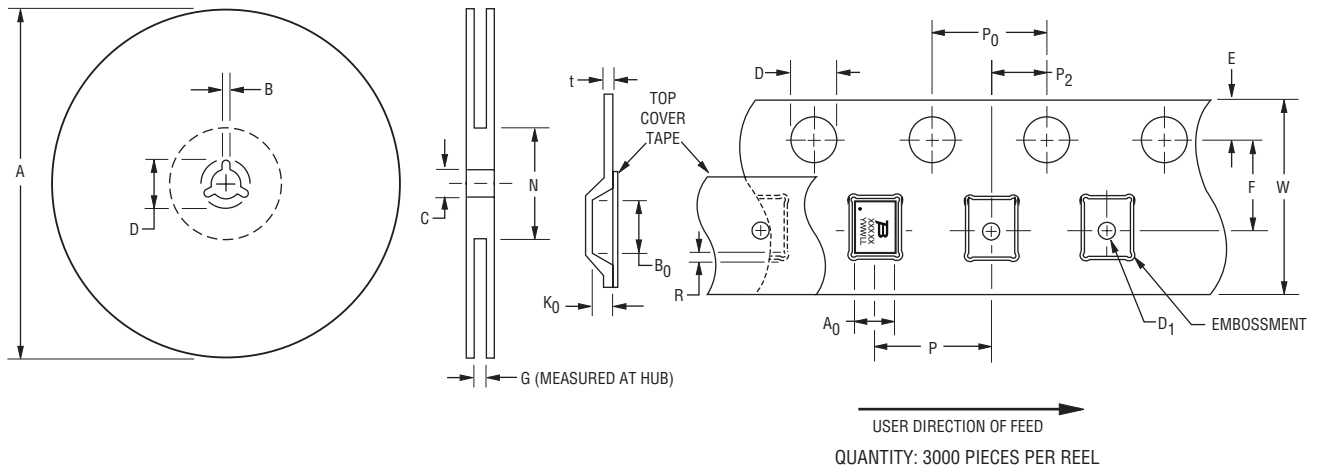
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# TBU-DF Series - TBU® High-Speed Protectors

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## Packaging Specifications



| A       |         | B       |         | C       |        | D       |         | G       | N              |
|---------|---------|---------|---------|---------|--------|---------|---------|---------|----------------|
| Min.    | Max.    | Min.    | Max.    | Min.    | Max.   | Min.    | Max.    | Ref.    | Ref.           |
| 328.5   | 331     | 2.0     | 2.4     | 12.8    | 13.5   | 17.0    | 17.4    | 16.5    | 100 ± 1.5      |
| (12.93) | (13.05) | (0.079) | (0.094) | (0.504) | (.531) | (0.669) | (0.690) | (0.650) | (3.94 ± 0.059) |

| A0      |         | B0      |         | D0      |         | D1      |         | E       |         | F       |         |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| Min.    | Max.    | Min.    | Max.    | Min.    | Max.    | Min.    | Max.    | Min.    | Max.    | Min.    | Max.    |
| 5.75    | 5.95    | 6.75    | 6.95    | 1.5     | 1.6     | 1.5     | -       | 1.65    | 1.85    | 7.4     | 7.6     |
| (0.224) | (0.234) | (0.266) | (0.274) | (0.059) | (0.063) | (0.059) |         | (0.065) | (0.073) | (0.291) | (0.299) |
| K0      |         | P       |         | P0      |         | P2      |         | R       |         | t       |         |
| Min.    | Max.    | Min.    | Max.    | Min.    | Max.    | Min.    | Max.    | Min.    | Max.    | Min.    | Max.    |
| 1.05    | 1.25    | 7.9     | 8.1     | 3.9     | 4.1     | 1.9     | 2.1     | 0       | 0.5     | 0.25    | 0.35    |
| (0.041) | (0.049) | (0.311) | (0.319) | (0.159) | (0.161) | (0.075) | (0.083) | (0)     | (.020)  | (0.010) | (0.014) |
| W       |         |         |         |         |         |         |         |         |         |         |         |
| Min.    | Max.    |         |         |         |         |         |         |         |         |         |         |
| 15.7    | 16.3    |         |         |         |         |         |         |         |         |         |         |
| (0.618) | (0.642) |         |         |         |         |         |         |         |         |         |         |

DIMENSIONS:  $\frac{\text{MM}}{\text{(INCHES)}}$

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