TOTALFLOW
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PTC Fuses Being Added To Totalflow Electronic Circuit Boards

Totalflow Technical Bulletin

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1. **Purpose**

To describe the addition of PTC fuses to Totalflow electronic circuit boards. This bulletin will also define these components and discuss the added benefits of PTC devices.

Description

In order to maintain intrinsic safety classification and protect critical circuits from exposure to excessive current, *Totalflow*™ uses fuses on electronic circuit boards. Statistics on returned parts indicate that certain fuses are being blown repeatedly, causing excessive amount of boards to be returned. Therefore, *Totalflow™* has modified some of our electronic boards in order to add **PTC-*Positive Temperature Coefficient,*** switch fuses.

As shown in the provided ***FUSE TABLE***, we have replaced some fast acting fuses on 64XX and 67XX devices with PTC fast acting fuses. However, not all fuses have been replaced. We have replaced the fuses that we believe are most often blown. We will continually evaluate our fuse implementation to discern if further steps are required.

The remainder of this document is intended to help you better understand *Totalflow's™* fuse utilization and provide instruction on PTC fuses.

How does the polymer PTC effect work?

A polymer PTC device comprises a polymer matrix that is loaded with carbon black particles to make it conductive. Since it is conductive it will pass a given amount of current. If too much current is passed through the device, the device will begin to heat by I^2R effect. As the device heats it will expand. As it expands, the carbon particles will separate and the resistance of the device will increase. This will cause the device to heat faster and expand more, further raising the resistance. When the internal temperature of the device reaches 125°C, the change in resistance increases dramatically. This increase in resistance is sufficient to substantially reduce the current in the circuit. A small amount of current will still flow through the device sufficient to maintain the temperature of the device and keep the PolySwitch device at the high resistance level. When the power is cycled off and the fault removed the PolySwitch device is allowed to cool. As the device cools, it contracts to its original shape and reconnects the carbon particles thus lowering the resistance of the device to a level where it can hold the current as specified for the device. This cycle can be repeated multiple times.

What are the basic differences between a PolySwitch device and a fuse or other circuit protection device? How does a PolySwitch device work with overvoltage devices to provide protection? The most obvious difference between a PolySwitch device and a fuse is the feature of resettability. While both products provide overcurrent protection, a single PolySwitch device can provide this protection multiple times, whereas after the fuse has provided its protection, it must be replaced for the circuit to function properly. The typical performance of a PolySwitch device is similar to that of a time delay fuse. Both devices need to have the thermal derating of the device taken into account, but the PolySwitch device does not need to have an I^2t derating since it does not degrade as a fuse does under start-up conditions.

When comparing a PolySwitch device to a bi-metallic circuit breaker the main difference is latching, not resettability. Both devices are resettable, but the bi-metallic circuit breaker can reset itself even when the fault is still present. This can lead to large EMI spikes on resetting and when tripping and potentially reconnecting a fault condition that could damage equipment and be unsafe. The PolySwitch device will latch in the high-resistance state until the fault is cleared and the power is cycled off and on.

PolySwitch devices differ from ceramic PTC devices in their initial resistance, time to react to fault events, and size. Both products are resettable but the PolySwitch device, compared to a ceramic PTC device of the same hold current, will typically react (trip) much faster than the CPTC because the PolySwitch device is smaller and has a lower resistance.

The most common application where PolySwitch devices are used in combination with overvoltage devices are the telecom applications. Here over voltage devices such as thyristors, gas discharge tubes, MOVs, or diodes provide protection against lightning and power cross faults. The PolySwitch device protects the over voltage protection device in some of these fault events and can also provide protection against other over current events.

How many times can you trip a PolySwitch device at the maximum voltage and interrupt currents?

Each PolySwitch device is rated to handle a specified operating voltage. Each device can withstand a specified interrupt current as a fault event. To obtain UL recognition, the device must be tripped at least 6,000 times and still exhibit PTC characteristics. For the telecom devices TR, TS, TC, they have a rating for maximum surge voltage for specific fault events that can occur in telecom applications. This may be as few as ten times or as many as several hundred times with the device still meeting the original specification values. *Designers should keep in mind that the PolySwitch device is intended to protect against faults and failures and is not intended for use in applications where it will be expected to be tripped as the normal mode of functioning.*

What is the failure mode of a PolySwitch device?

The typical failure mode of the device is to fail in a high resistance state. This means that the device does not return to its original low resistance value such that it can maintain the original specified hold current. In order to achieve UL recognition, the device must be tripped 6,000 times and still exhibit PTC behavior and stay in a tripped state for over 1000 hours while exhibiting PTC behavior*. If a device is subjected to fault events that exceed its rated voltage and current, the device can fail in a fashion that can exhibit arcing and rupture into flame. Abuse beyond the expected use, as outlined by such things as the UL test requirements, can also cause this failure mode to occur as these devices are not recommended for intrinsically unsafe environments*.

Will I still be able to blow the non-resettable fast acting fuses?

Yes. Examples of such things that might blow non-resettable fuses include:

- Inserting a communications module with power applied to the device
- Removing or Attaching an AMU with power applied to the device
- Battery voltage wired with reverse polarity
- Battery voltage removed with high charge voltage (> 17Vdc) still present

In General, what is protected by the PTC fuses?

Circuit outputs providing VBATT (Battery Voltage) and SWVBATT (Switched Battery Voltage) to communications equipment and other end devices.

When an existing board is returned for repair, will it also be upgraded with PTC fuses?

Yes. Returned boards will be brought up to most current revision level, including the addition of PTCs as indicated in the ***FUSE TABLE***.

2. Conclusion

Addition of the PTC devices should reduce failures pertaining to field wiring errors on Totalflow's electronic boards. We continue to review our products and make improvements to provide reliable products to our customers. If you have any questions concerning this bulletin call Totalflow Customer Services at (918) 338-4819 or 1 (800) 442-3097 option 2, 2.

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FUSE TABLE – Totalflow™ Electronic Circuit Boards

Board	Application	Fuse Number	Type	Value	Purpose	Possible cause of premature failure
2017333	**EXIO-PIRTU**	F501	FA	500mA	inductor limit	Battery disconnected with solar attached / Communications module inserted / Wiring error
		F502	FA	250mA	zener limit	Communications module inserted / Wiring error with battery and/or solar active
2017245	**RTU**	F1	FA	500mA	inductor limit	Battery disconnected with solar attached / Wiring error with battery and/or solar active
		F2	FA	250mA	zener limit	Wiring error with battery and/or solar active
2017220	**EXIO/RTU TERM**	F1	FA	125mA	Analog output limit	Voltage greater that 26V supplied to AOPWR input
		F2	FA	4A	Digital 1-4 output limit	Wiring error when using external supply for DO power
		F3	FA	4A	Digital 5-8 output limit	Wiring error when using external supply for DO power
2012803	**6600**	F2	FA	500mA	inductor limit	Communications card inserted / Wiring error with battery and/or solar active
		F3	FA	4A	Term VBATT	Wiring error
		F4	FA	250mA	zener limit	Communications card inserted / Wiring error with battery and/or solar active
		F5	FA	62.5mA	over voltage limit	Battery disconnected with solar attached / Greater than 17V at battery connector
2015333 w/PTCs	**6400**	F500	FA	4A (*)	Term VBATT	Wiring error
		F501	FA	500mA	inductor limit	Communications module inserted / AMU connector attached / Wiring error with battery
		F502	FA	62.5mA	over voltage limit	Battery disconnected with solar attached / Greater than 17V at battery connector
		F503	FA	250mA	zener limit	Communications module inserted / AMU connector attached / Wiring error with battery
		F504	FA	4A (*)	Term SWVBAT	Wiring error
2015382 w/PTCs	**6700**	F1	FA	4A (*)	Term VBATT & SWVBAT	Wiring error
		F2	FA	4A (*)	Term VBATT & SWVBAT	Wiring error
		F3	FA	4A (*)	Term VBATT & SWVBAT	Wiring error
		F504	FA	500mA	inductor limit	Communications module inserted / AMU connector attached / Wiring error with battery
		F505	FA	250mA	zener limit	Communications module inserted / AMU connector attached / Wiring error with battery
		F506	FA	62.5mA	over voltage limit	Battery disconnected with solar attached / Greater than 17V at battery connector

FA: Fast Acting
SB: Slow Blo
(*) Fuses which have been replaced with 2.5A PTC's