



# UNITRODE

**UCC2915**  
**UCC3915**

# 15V Programmable Hot Swap Power Manager

## FEATURES

- Integrated 0.15 Ohm Power MOSFET
- 7V to 15V Operation
- Digital Programmable Current Limit from 0A to 3A
- 100 $\mu$ A I<sub>CC</sub> when Disabled
- Programmable ON Time
- Programmable Start Delay
- Fixed 2% Duty Cycle
- Thermal Shutdown
- Fault Output Indicator
- Maximum Output Current can be set to 1A above the Programmed Fault Level or to a full 4A
- Power SOIC and TSSOP, Low Thermal Resistance Packaging

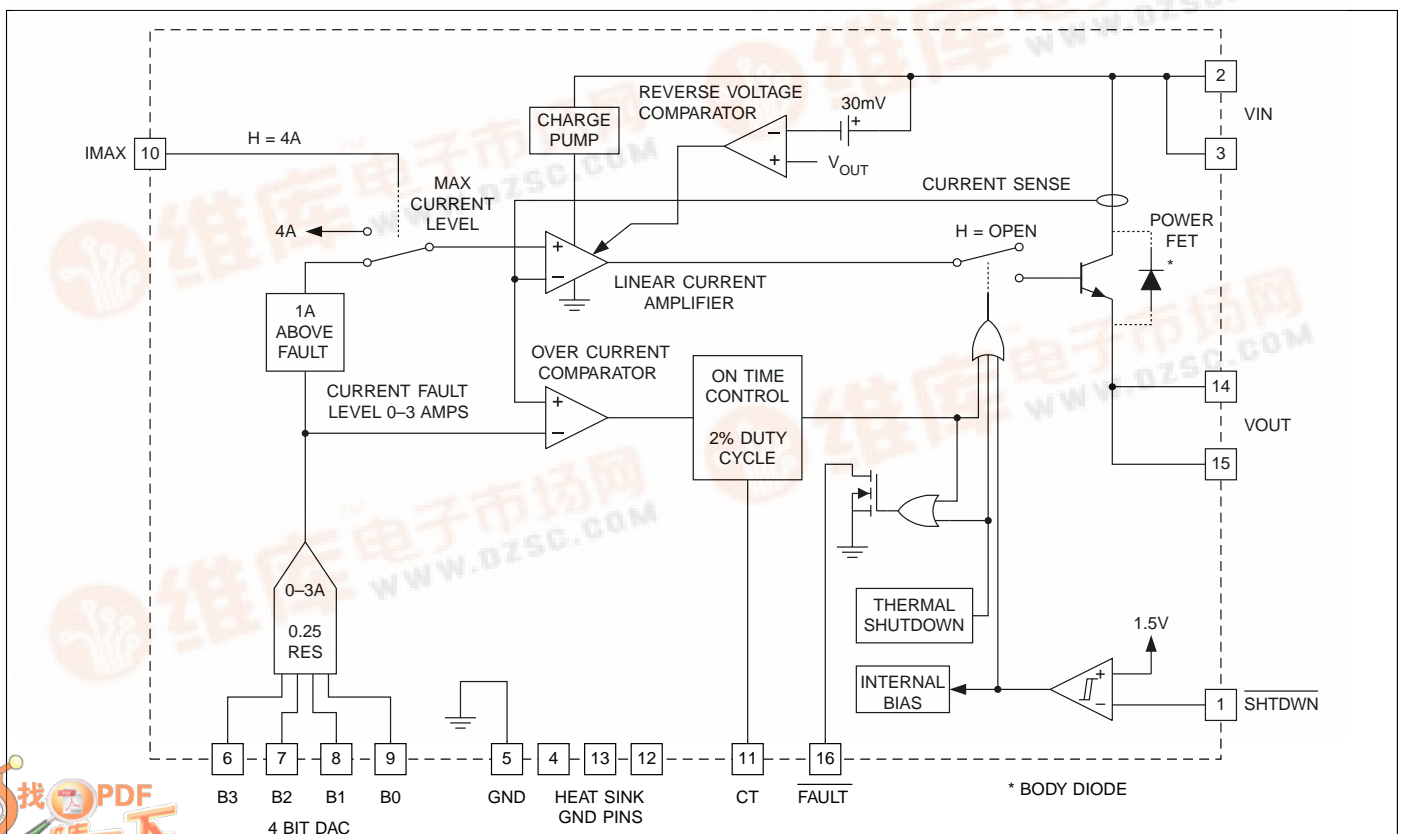
## DESCRIPTION

The UCC3915 Programmable Hot Swap Power Manager provides complete power management, hot swap capability, and circuit breaker functions. The only external component required to operate the device, other than power supply bypassing, is the fault timing capacitor,  $C_T$ . All control and housekeeping functions are integrated, and externally programmable. These include the fault current level, maximum output sourcing current, maximum fault time, and startup delay. In the event of a constant fault, the Internal fixed 2% duty cycle ratio limits average output power.

The internal 4 bit DAC allows programming of the fault level current from 0 to 3A with 0.25A resolution. The IMAX control pin sets the maximum sourcing current to 1A above the trip level or to a full 4A of output current for fast output capacitor charging.

When the output current is below the fault level, the output MOSFET is switched ON with a nominal ON resistance of  $0.15\Omega$ . When the output current exceeds the fault level, but is less than the maximum sourcing level, the output remains switched ON, but the fault timer starts, charging CT. Once CT charges to a preset threshold, the switch is turned OFF, and remains OFF for 50 times the programmed fault time. When the output current reaches the maximum sourcing level, the MOSFET transitions from a switch to a constant current source.

## BLOCK DIAGRAM



Note: Pin numbers refer to DIL-16 and SOIC-16 packages.

# ABSOLUTE MAXIMUM RATINGS

|                                       |                 |
|---------------------------------------|-----------------|
| VIN                                   | +15.5 Volts     |
| VOUT – VIN                            | .0.3V           |
| FAULT Sink Current                    | 50mA            |
| FAULT Voltage                         | –0.3 to 8V      |
| Output Current                        | Self Limiting   |
| TTL Input Voltage                     | –0.3 to VIN     |
| Storage Temperature                   | –65°C to +150°C |
| Junction Temperature                  | –55°C to +150°C |
| Lead Temperature (Soldering, 10 sec.) | +300°C          |

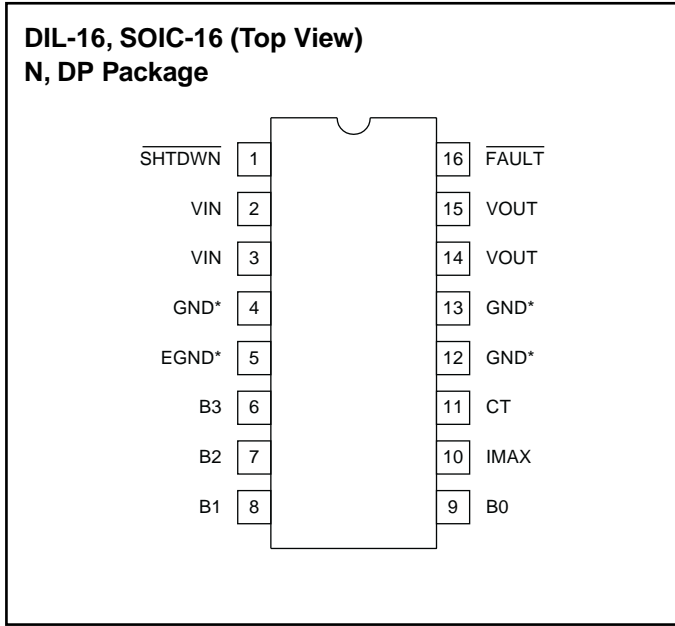
*Currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages.*

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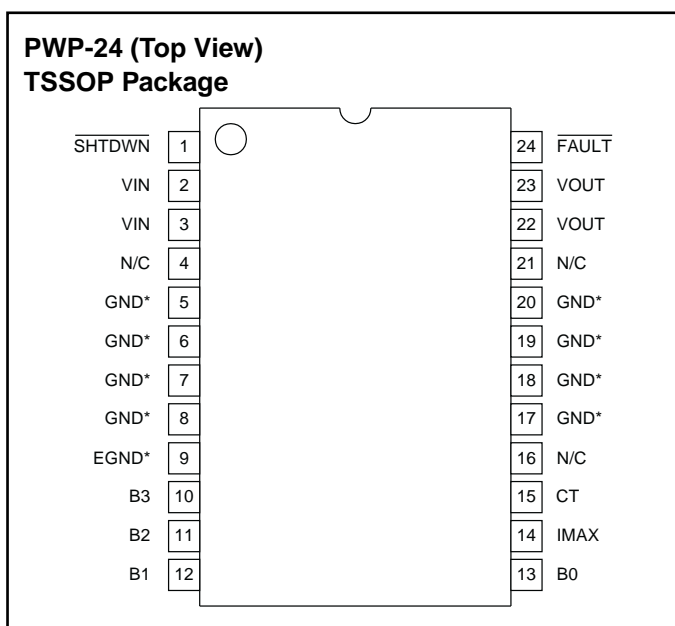
# DESCRIPTION (cont.)

The UCC3915 can be put into sleep mode, drawing only 100µA of supply current. Other features include an open drain Fault Output Indicator, Thermal Shutdown, Under-

# CONNECTION DIAGRAMS



*\*Pin 5 serves as lowest impedance to the electrical ground; Pins 4, 12, and 13 serve as heat sink/ground. These pins should be connected to large etch areas to help dissipate heat. For N Package, pins 4, 12, and 13 are N/C.*



*\*Pin 9 serves as lowest impedance to the electrical ground; other GND pins serve as heat sink/ground. These pins should be connected to large etch areas to help dissipate heat.*

**ELECTRICAL CHARACTERISTICS** Unless otherwise stated, these specifications apply for TA = –40°C to +85°C for the UCC2915 and 0°C to 70°C for the UCC3915, VIN = 12V, IMAX = 0.4V, SHTDWN = 2.4V, TA = TJ.

| PARAMETER             | TEST CONDITIONS        | MIN | TYP  | MAX  | UNITS |
|-----------------------|------------------------|-----|------|------|-------|
| <b>Supply Section</b> |                        |     |      |      |       |
| Voltage Input Range   |                        | 7.0 |      | 15.0 | V     |
| Supply Current        |                        |     | 1.0  | 2.0  | mA    |
| Sleep Mode Current    | SHTDWN = 0.2V, No load |     | 100  | 150  | µA    |
| Output Leakage        | SHTDWN = 0.2V          |     |      | 20   | µA    |
| <b>Output Section</b> |                        |     |      |      |       |
| Voltage Drop          | IOUT = 1A (10V to 12V) |     | 0.15 | 0.3  | V     |
|                       | IOUT = 2A (10V to 12V) |     | 0.3  | 0.6  | V     |
|                       | IOUT = 3A (10V to 12V) |     | 0.45 | 0.9  | V     |

**ELECTRICAL CHARACTERISTICS** Unless otherwise stated, these specifications apply for  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  for the UCC2915 and  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  for the UCC3915,  $V_{IN} = 12\text{V}$ ,  $I_{MAX} = 0.4\text{V}$ ,  $SHTDWN = 2.4\text{V}$ ,  $T_A = T_J$ .

| PARAMETER  | TEST CONDITIONS  | MIN  | TYP  | MAX  | UNITS              |
|--|--|------|------|------|--------------------|
| <b>Output Section (cont.)</b>                      |  |      |      |      |                    |
| Voltage Drop (cont).                               | $I_{OUT} = 1\text{A}$ , $V_{IN} = 7\text{V}$ and $15\text{V}$    |      | 0.2  | 0.4  | V                  |
|  | $I_{OUT} = 2\text{A}$ , $V_{IN} = 7\text{V}$ and $15\text{V}$    |      | 0.4  | 0.8  | V                  |
|  | $I_{OUT} = 3\text{A}$ , $V_{IN} = 7\text{V}$ , $12\text{V}$ Max. |      | 0.6  | 1.2  | V                  |
| Initial Startup Time                               | Note 2   |      | 100  |      | $\mu\text{s}$      |
| Short Circuit Response                             | Note 2   |      | 100  |      | ns                 |
| Thermal Shutdown                                   | Note 2   |      | 165  |      | $^{\circ}\text{C}$ |
| Thermal Hysteresis                                 | Note 2   |      | 10   |      | $^{\circ}\text{C}$ |
| <b>DAC Section</b>                                 |  |      |      |      |                    |
| Trip Current                                       | Code = 0000-0011 (Device Off)                                    |      |      |      |                    |
|  | Code = 0100  | 0.07 | 0.25 | 0.45 | A                  |
|  | Code = 0101  | 0.32 | 0.50 | 0.70 | A                  |
|  | Code = 0110  | 0.50 | 0.75 | 0.98 | A                  |
|  | Code = 0111  | 0.75 | 1.00 | 1.3  | A                  |
|  | Code = 1000  | 1.0  | 1.25 | 1.6  | A                  |
|  | Code = 1001  | 1.25 | 1.50 | 1.85 | A                  |
|  | Code = 1010  | 1.5  | 1.75 | 2.15 | A                  |
|  | Code = 1011  | 1.70 | 2.00 | 2.4  | A                  |
|  | Code = 1100  | 1.90 | 2.25 | 2.7  | A                  |
|  | Code = 1101  | 2.1  | 2.50 | 2.95 | A                  |
|  | Code = 1110  | 2.30 | 2.75 | 3.25 | A                  |
|  | Code = 1111  | 2.50 | 3.0  | 3.50 | A                  |
| Max Output Current Over Trip (Current Source Mode) | Code = 0100 to 1111, $I_{MAX} = 0\text{V}$                       | 0.35 | 1.0  | 1.65 | A                  |
| Max Output Current (Current Source Mode)           | Code = 0100 to 1111, $I_{MAX} = 2.4\text{V}$                     | 3.0  | 4.0  | 5.2  | A                  |
| <b>Fault Output Section</b>                        |  |      |      |      |                    |
| CT Charge Current                                  | $V_{CT} = 1.0\text{V}$   | -83  | -62  | -47  | $\mu\text{A}$      |
| CT Discharge Current                               | $V_{CT} = 1.0\text{V}$   | 0.8  | 1.2  | 1.8  | $\mu\text{A}$      |
| Output Duty Cycle                                  | $V_{OUT} = 0\text{V}$  | 1.0  | 1.9  | 3.3  | %                  |
| CT Fault Threshold                                 |  | 1.2  | 1.5  | 1.7  | V                  |
| CT Reset Threshold                                 |  | 0.4  | 0.5  | 0.6  | V                  |
| <b>Shutdown Section</b>                            |  |      |      |      |                    |
| Shutdown Threshold                                 |  | 1.1  | 1.5  | 1.9  | V                  |
| Shutdown Hysteresis                                |  |      | 150  |      | mV                 |
| Input Current                                      |  |      | 100  | 500  | nA                 |
| <b>Open Drain Output Section</b>                   |  |      |      |      |                    |
| High Level Output Current                          | $\overline{\text{FAULT}} = 5\text{V}$                            |      |      | 250  | $\mu\text{A}$      |
| Low Level Output Voltage                           | $I_{OUT} = 5\text{mA}$   |      | 0.2  | 0.8  | V                  |
| <b>TTL Input DC Characteristics Section</b>        |  |      |      |      |                    |
| TTL Input Voltage High                             |  | 2.0  |      |      | V                  |
| TTL Input Voltage Low                              |  |      |      | 0.8  | V                  |
| TTL Input High Current                             | $V_{IH} = 2.4\text{V}$   |      | 3    | 10   | $\mu\text{A}$      |
| TTL Input Low Current                              | $V_{IL} = 0.4\text{V}$   |      |      | 1    | $\mu\text{A}$      |

Note 1: All voltages are with respect to GND. Current is positive into and negative out of the specified terminal.

Note 2: Guaranteed by design. Not 100% tested in production.

## PIN DESCRIPTIONS

**SB0 - B3:** These pins provide digital input to the DAC, which sets the fault current threshold. They can be used to provide a digital soft-start and adaptive current limiting.

**CT:** A capacitor connected to ground sets the maximum fault time. The maximum fault time must be more than the time required to charge the external capacitance in one cycle. The maximum fault time is defined as  $T_{FAULT} = 16.1 \cdot 10^3 \cdot CT$ . Once the fault time is reached the output will shutdown for a time given by  $T_{SD} = 833 \cdot 10^3 \cdot CT$ , this equates to a 1.9% duty cycle.

**FAULT:** Open drain output, which pulls low upon any fault or interrupt condition, Fault, or Thermal Shutdown.

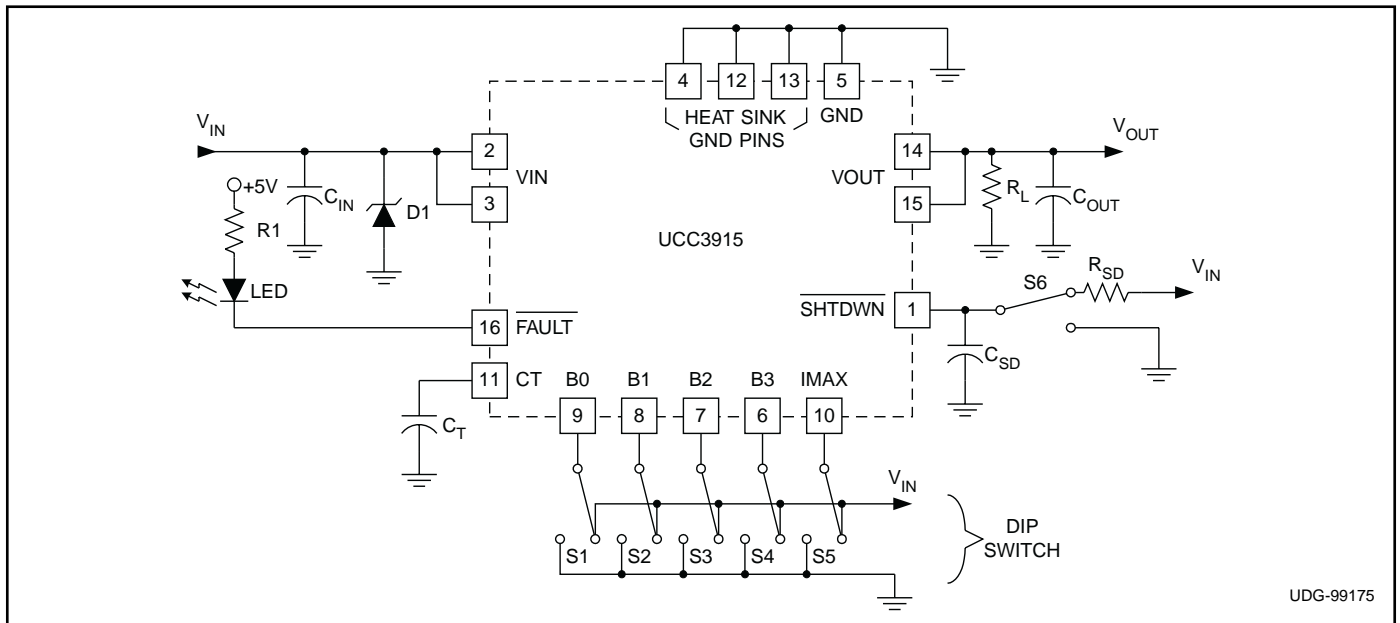
**IMAX:** When this pin is set to a logic low, the maximum sourcing current will always be 1A above the programmed fault level. When set to a logic high, the maximum sourcing current will be a constant 4A for applications which require fast charging of load capacitance.

**SHTDWN:** When this pin is brought to a logic low, the IC is put into a sleep mode drawing typically less than 100µA of  $I_{CC}$ . The input threshold is hysteretic, allowing the user to program a startup delay with an external RC circuit.

**VIN:** Input voltage to the UCC3915. The recommended voltage range is 7 to 15 volts. Both VIN pins should be connected together and connected to power source.

**VOUT:** Output voltage from the UCC3915. Both VOUT pins should be connected together and connected to the load. When switched the output voltage will be approximately  $V_{IN} - (0.15\Omega \cdot I_{OUT})$ . VOUT must not exceed VIN by greater than 0.3V.

## APPLICATIONS INFORMATION



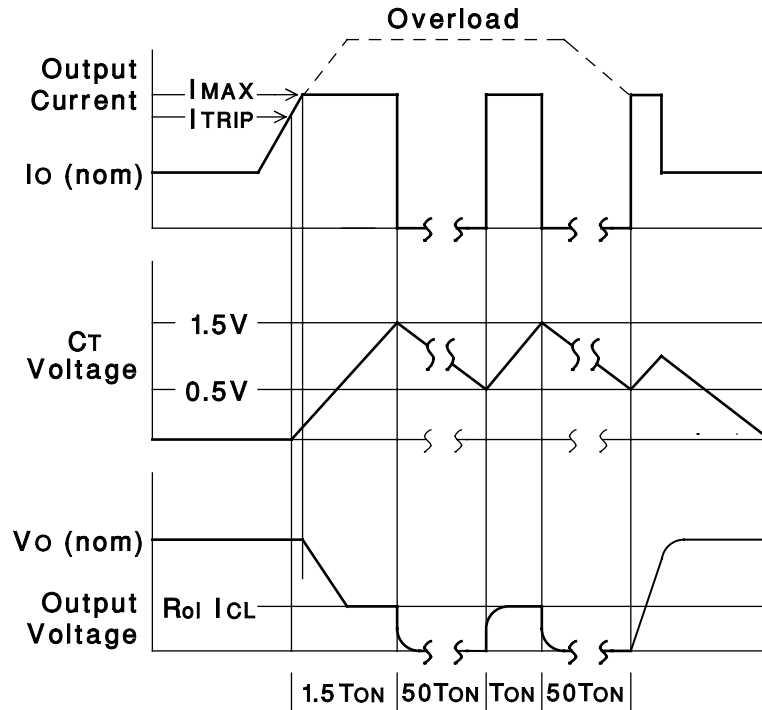
**Figure 1. Evaluation circuit.**

### Protecting The UCC3915 From Voltage Transients

The parasitic inductance associated with the power distribution can cause a voltage spike at  $V_{IN}$  if the load current is suddenly interrupted by the UCC3915. *It is important to limit the peak of this spike to less than 15V to prevent damage to the UCC3915.* This voltage spike can be minimized by:

- Reducing the power distribution inductance (e.g., twist the positive (+) and negative (–) leads of the power supply feeding  $V_{IN}$ , locate the power supply close to the UCC3915 or use a PCB ground plane).
- Decoupling  $V_{IN}$  with a capacitor,  $C_{IN}$  (refer to Fig. 1), located close to the  $V_{IN}$  pin. This capacitor is typically less than 1µF to limit the inrush current.
- Clamping the voltage at  $V_{IN}$  below 15V with a Zener diode, D1 (refer to Fig. 1), located close to the  $V_{IN}$  pin.

## APPLICATION INFORMATION (cont.)



UDG-94138

### Estimating Maximum Load Capacitance

For hot swap applications, the rate at which the total output capacitance can be charged depends on the maximum output current available and the nature of the load. For a constant-current, current-limited application, the output will come up if the load asks for less than the maximum available short-circuit current.

To guarantee recovery of a duty-cycle from a short-circuited load condition, there is a maximum total output capacitance which can be charged for a given unit ON time (Fault time). The design value of ON or Fault time can be adjusted by changing the timing capacitor  $C_T$ .

For worst-case constant-current load of value just less than the trip limit;  $C_{OUT(max)}$  can be estimated from:

$$C_{OUT(max)} \approx (I_{MAX} - I_{LOAD}) \cdot \left( \frac{16.1 \cdot 10^3 \cdot C_T}{V_{OUT}} \right)$$

Where  $V_{OUT}$  is the output voltage.

For a resistive load of value  $R_L$ , the value of  $C_{OUT(max)}$  can be estimated from:

$$C_{OUT(max)} \approx \left( \frac{16.1 \cdot 10^3 \cdot C_T}{R_L \cdot \ln \left[ \frac{1}{1 - \frac{V_{OUT}}{I_{MAX} \cdot R_L}} \right]} \right)$$

Figure 2. Load current, timing capacitor voltage, and output voltage of the UCC3915 under fault conditions.

## SAFETY RECOMMENDATIONS

Although the UCC3915 is designed to provide system protection for all fault conditions, all integrated circuits can ultimately fail short. For this reason, if the UCC3915 is intended for use in safety critical applications where UL or some other safety rating is required, a redundant

safety device such as a fuse should be placed in series with the device. The UCC3915 will prevent the fuse from blowing for virtually all fault conditions, increasing system reliability and reducing maintenance cost, in addition to providing the hot swap benefits of the device.

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