

# Low On Resistance Hot Swap Power Manager

## FEATURES

- Integrated 0.06Ω Power MOSFET
- 3V to 6V Operation
- External Analog control of Fault Current from 0A to 4A
- Independent Analog Control of Current Limit up to 5A
- Fast Overload Protection
- Uni-directional Switch
- Minimal External Components
- 1μA I<sub>CC</sub> when Disabled
- Programmable On Time
- Programmable Start Delay
- Fixed 3% Duty Cycle

## DESCRIPTION

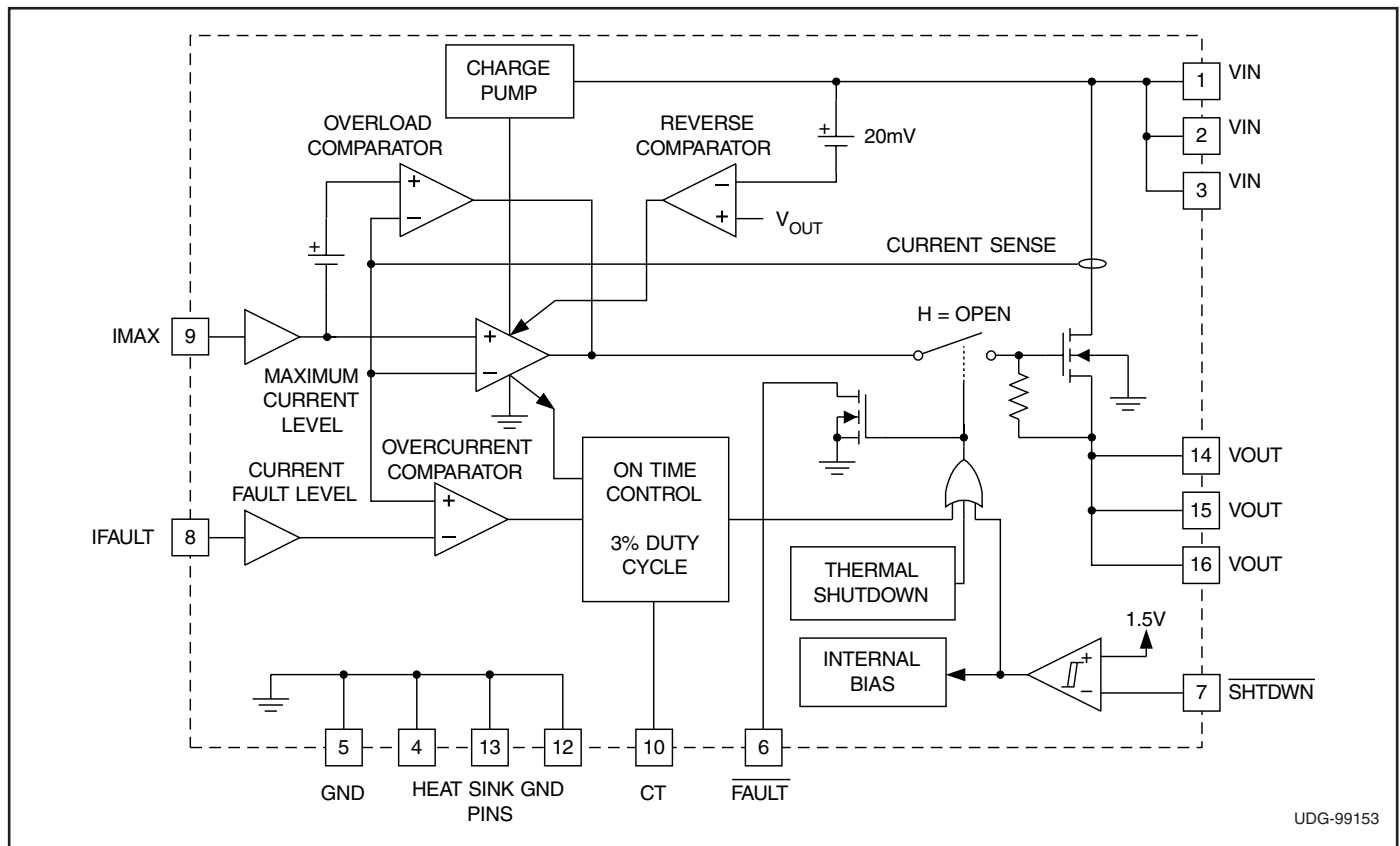
The UCC3918 Low on Resistance Hot Swap Power Manager provides complete power management, hot swap capability, and circuit breaker functions. The only components needed to operate the device, other than supply bypassing, are a timing capacitor, and 2 programming resistors. All control and housekeeping 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 3% duty cycle ratio limits the average output power. The IFAULT pin allows linear programming of the fault level current from 0A to 4A.

Fast overload protection is accomplished by an additional overload comparator. Its threshold is internally set above the maximum sourcing current limit setting. In the event of a short circuit or extreme current condition, this comparator is tripped, shutting down the output. This function is needed since the maximum sourcing current limit loop has a finite bandwidth.

When the output current is below the fault level, the output MOSFET is switched on with a nominal resistance of 0.06Ω. When the output current exceeds the fault level or the maximum sourcing level, the output remains on, but the fault timer starts charging CT. Once CT charges to a preset threshold, the switch is turned off, and remains off for 30 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

(continued)



UDG-99153

**DESCRIPTION (continued)**

The UCC3918 is designed for unidirectional current flow, emulating an ideal diode in series with the power switch. This feature is particularly attractive in applications where many devices are powering a common bus, such as with SCSI Termpwr. The UCC3918 can also be put into the sleep mode, drawing only 1µA of supply current.

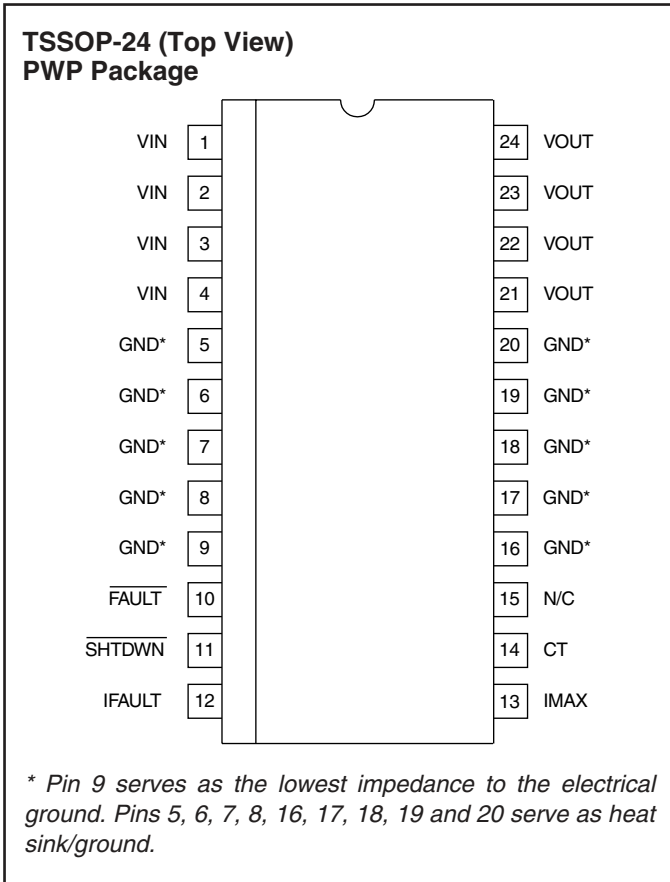
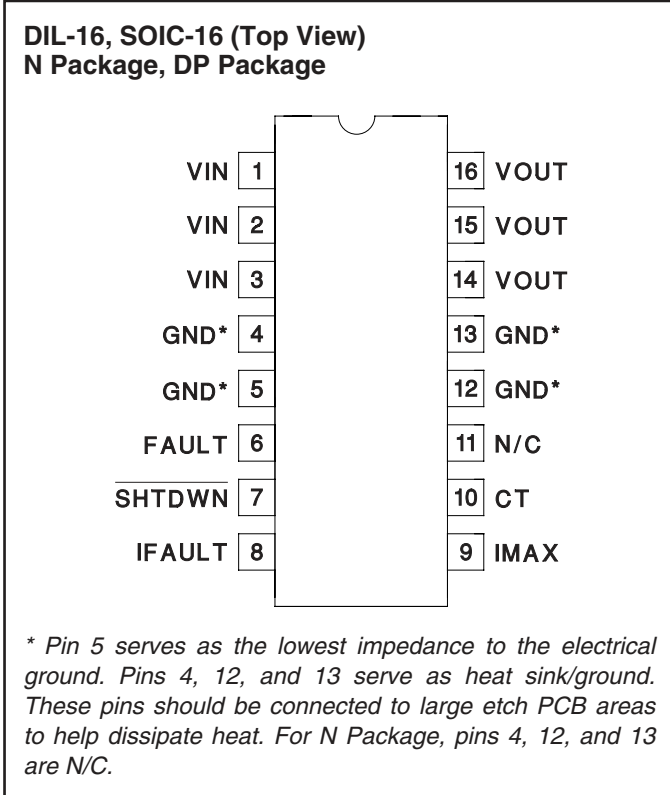
Other features include an open drain fault output indicator, thermal shutdown, undervoltage lockout, 3V to 6V operation, and a low thermal resistance small outline power package.

**ABSOLUTE MAXIMUM RATINGS**

Input Supply Voltage (VIN) ..... 8V  
 SOIC Power Dissipation ..... 2.5W  
 Fault Output Sink Current ..... 50mA  
 Fault Output Voltage ..... VIN  
 Output Current (DC) ..... Internally Limited  
 Input Voltage

SHTDWN, IFAULT, IMAX ..... -0.3V to VIN  
 Storage Temperature Range ..... -65°C to +150°C  
 Operating Junction Temperature Range .... -55°C to +150°C  
 Lead Temperature (Soldering, 10 sec.) ..... +300°C  
*Unless otherwise indicated, voltages are reference to ground and currents are positive into, negative out of the specified terminal. Pulsed is defined as a less than 10% duty cycle with a maximum duration of 500µS. Consult Packaging Section of Databook for thermal limitations and considerations of package.*

**CONNECTION DIAGRAM**



**ELECTRICAL CHARACTERISTICS:** Unless otherwise specified,  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$  for the UCC3918,  $-40^\circ\text{C}$  to  $85^\circ$  for the UCC2918,  $V_{IN} = 5\text{V}$ .  $R_{IMAX} = 42.2\text{k}$ ,  $R_{IFAULT} = 52.3\text{k}$ ,  $SHTDWN = 2.4$ .  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Supply Section</b>					
Voltage Input Range, $V_{IN}$		3	5	6	V
$V_{DD}$ Supply Current	No Load		1	2	mA
Sleep Mode Current	$SHTDWN = 0.2\text{V}$		0.5	5	$\mu\text{A}$
<b>Output Section</b>					
$R_{DSon}$	$I_{OUT} = 1\text{A to }4\text{A}$ , $V_{IN} = 5\text{V}$ , $T_A = 25^\circ\text{C}$		0.075	0.095	$\Omega$
	$I_{OUT} = 1\text{A to }4\text{A}$ , $V_{IN} = 3\text{V}$ , $T_A = 25^\circ\text{C}$		0.09	0.116	$\Omega$
	$I_{OUT} = 1\text{A to }4\text{A}$ , $V_{IN} = 5\text{V}$		0.75	0.125	$\Omega$
	$I_{OUT} = 1\text{A to }4\text{A}$ , $V_{IN} = 3\text{V}$		0.09	0.154	$\Omega$
Reverse Leakage Current	$V_{IN} = 0\text{V}$ , $V_{OUT} = 5\text{V}$ , $SHTDWN = 0\text{V}$			20	$\mu\text{A}$
Initial Startup Time	(Note 1)		100		$\mu\text{S}$
Thermal Shutdown	(Note 1)		170		DEG
<b>Output Section (cont)</b>					
Thermal Hysteresis	(Note 1)		10		DEG
Output Leakage	$SHTDWN = 0.2\text{V}$			20	$\mu\text{A}$
Trip Current	$R_{IFAULT} = 105\text{k}$	0.75	1	1.25	A
	$R_{IFAULT} = 52.3\text{k}$	1.7	2	2.3	A
	$R_{IFAULT} = 34.8\text{k}$	2.5	3	3.5	A
	$R_{IFAULT} = 25.5\text{k}$	3.3	4	4.7	A
Maximum Output Current	$R_{IMAX} = 118\text{k}$	0.3	1	1.7	A
	$R_{IMAX} = 60.4\text{k}$	1	2	3	A
	$R_{IMAX} = 42.2\text{k}$	2	3	4	A
	$R_{IMAX} = 33.2\text{k}$	2.5	3.8	5.1	A
	$R_{IMAX} = 27.4\text{k}$	3.0	4.6	6.2	A
<b>Fault Section</b>					
$C_T$ Charge Current	$V_{CT} = 1\text{V}$	-50	-36	-22	$\mu\text{A}$
$C_T$ Discharge Current	$V_{CT} = 1\text{V}$	0.5	1.2	2.0	$\mu\text{A}$
<b>Fault Section (cont.)</b>					
Output Duty Cycle	$V_{OUT} = 0\text{V}$	1.5	3	6	%
$C_T$ Fault Threshold		0.8	1.3	1.8	V
$C_T$ Reset Threshold		0.25	0.5	0.75	V
<b>Shutdown Section</b>					
Shutdown Threshold		1.1	1.5	2.0	V
Shutdown Hysteresis			100		mV
Input Low Current	$SHTDWN = 0\text{V}$	-500	0	500	nA
Input High Current	$SHTDWN = 2\text{V}$	-2	-1	-0.5	$\mu\text{A}$
<b>Open Drain Fault Output</b>					
High Level Output Current				1	$\mu\text{A}$
Low Level Output Voltage	$I_{OUT} = 1\text{mA}$		0.4	0.9	V

Note 1: Guaranteed by design. Not 100% tested in production.

## PIN DESCRIPTIONS

**CT:** A capacitor connected to this pin sets the maximum fault time. The maximum must be more than the time to charge external load capacitance. The maximum fault time is defined as

$$T_{FAULT} = 27.8 \cdot 10^3 \cdot C_T$$

Once the fault time is reached the output will shutdown for a time given by

$$T_{SD} = 0.833 \cdot 10^6 \cdot C_T,$$

this equates to a 3% duty cycle.

**FAULT:** Open drain output, which pulls low upon any condition which causes the output to open; Fault, Thermal Shutdown, Shutdown, and maximum sourcing current greater than the fault time.

**GND:** This is the most negative voltage in the circuit. All 4 ground pins should be used, and properly heat sunk on the PCB.

**IFAUULT:** A resistor connected from this pin to ground sets the fault threshold. The resistor vs fault current is set by the formula

$$R_{FAULT} = \frac{105k}{I_{TRIP}}$$

**IMAX:** A resistor connected from this pin to ground sets the maximum sourcing current. The resistor vs the output sourcing current is set by the formula,

$$R_{FAULT} = \frac{126k}{\text{Maximum Sourcing Current}}$$

**SHTDWN:** When this pin is brought low, the IC is put into sleep mode. The input threshold is hysteretic, allowing the user to program a startup delay with an external RC circuit.

**VIN:** This is the input voltage to the UCC3918. The recommended operating voltage range is 3V to 6V. All VIN pins should be connected together and to the power source.

**VOUT:** Output voltage for the circuit breaker. When switched the output voltage will be approximately  $V_{IN} - 0.06\Omega \cdot I_{OUT}$ . All VOUT pins should be connected together and to the load.

## APPLICATION INFORMATION

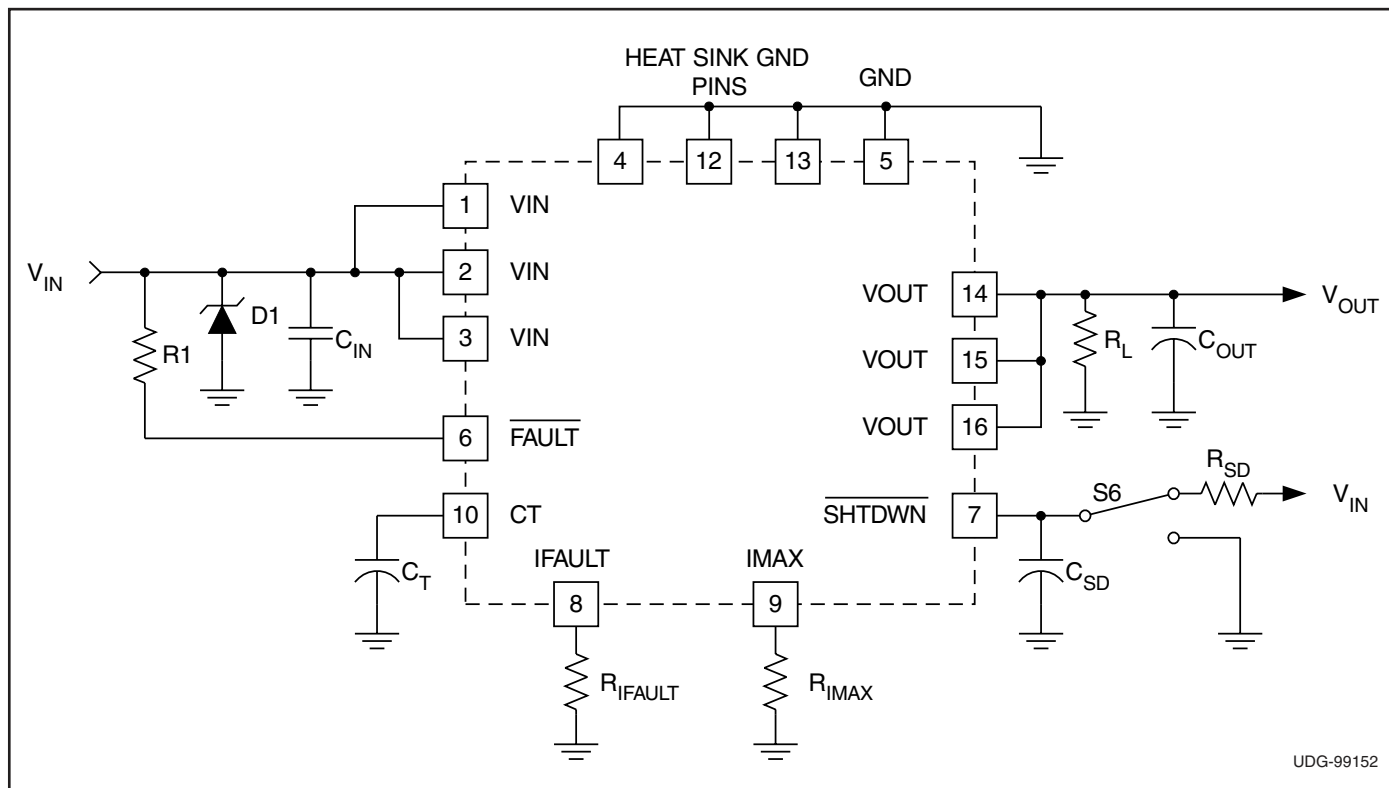


Figure 1. Evaluation circuit.

**APPLICATION INFORMATION (cont.)**

**Protecting The UCC3918 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 UCC3918. *It is important to limit the peak of this spike to less than 6V to prevent damage to the UCC3918.* 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 UCC3918 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  $1\mu F$  to limit the inrush current.
- Clamping the voltage at  $V_{IN}$  below 6V with a Zener diode, D1 (refer to Fig. 1), located close to the  $V_{IN}$  pin.

**Estimating Maximum Load Capacitance**

For circuit breaker 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 circuit breaker, 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 of the current-limited circuit breaker 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:

$$C_{OUT(max)} \approx (I_{MAX} - I_{LOAD}) \left( \frac{28 \cdot 10^3 \cdot C_T}{V_{OUT}} \right)$$

Where  $V_{OUT}$  is the output voltage and  $I_{MAX}$  is the maximum, sourcing current.

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

$$C_{OUT(max)} \approx \left( \frac{28 \cdot 10^3 \cdot C_T}{R_L \cdot \ln \left[ \frac{1}{1 - \frac{V_{OUT}}{I_{MAX} \cdot R_L}} \right]} \right)$$

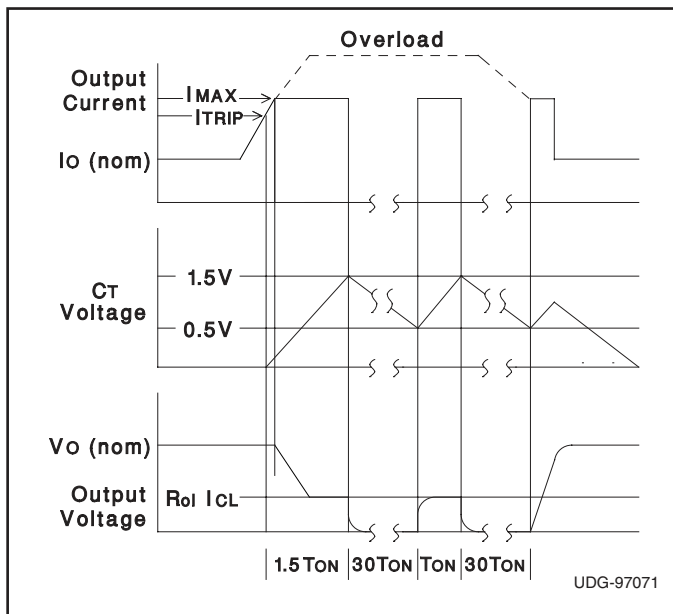


Figure 2. Load current, timing capacitor voltage and output voltage of the UCC3918 under fault.

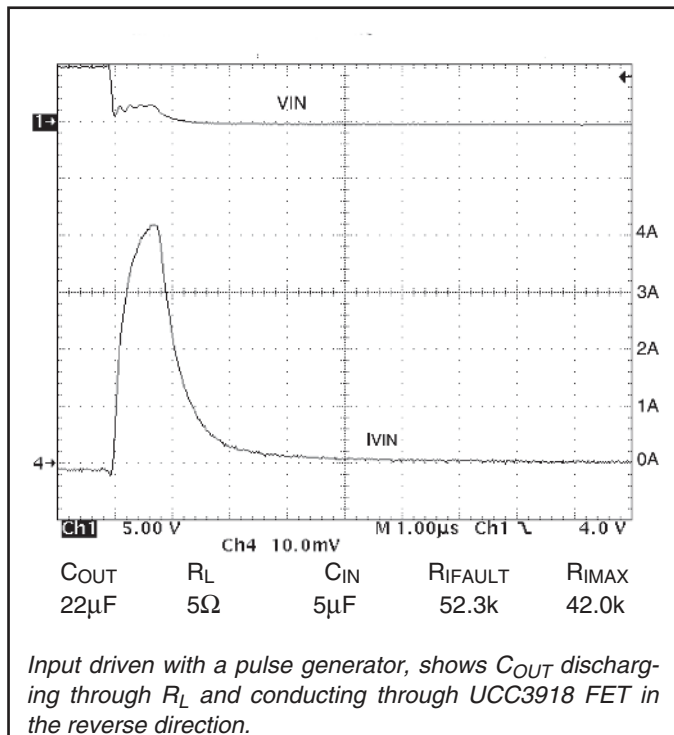


Figure 3.

APPLICATION INFORMATION (cont.)

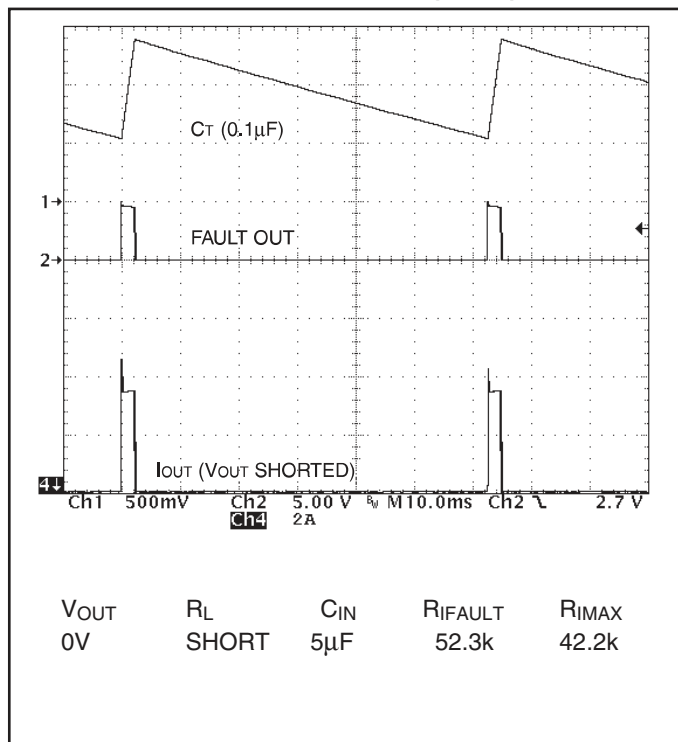


Figure 4. UCC3918 in shorted condition.

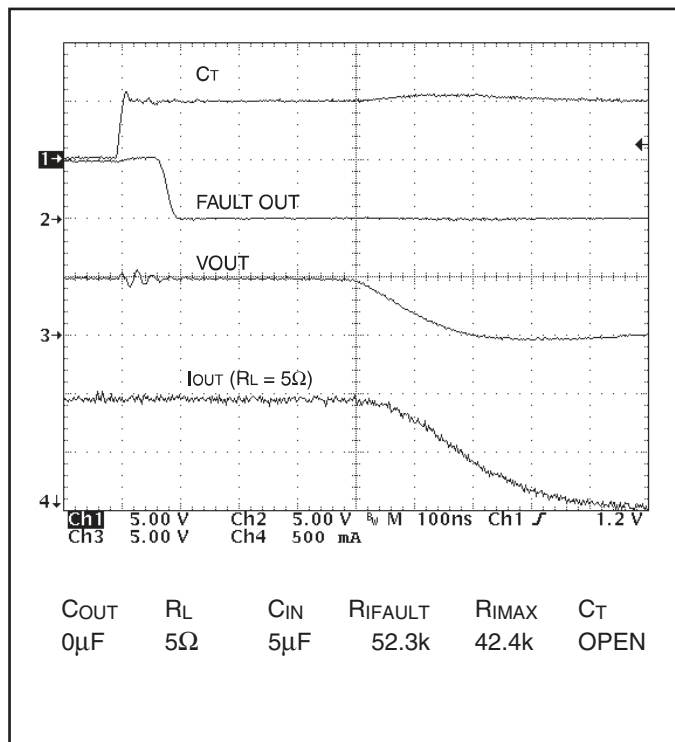


Figure 6. C<sub>T</sub> to V<sub>OUT</sub> delay (fault condition).

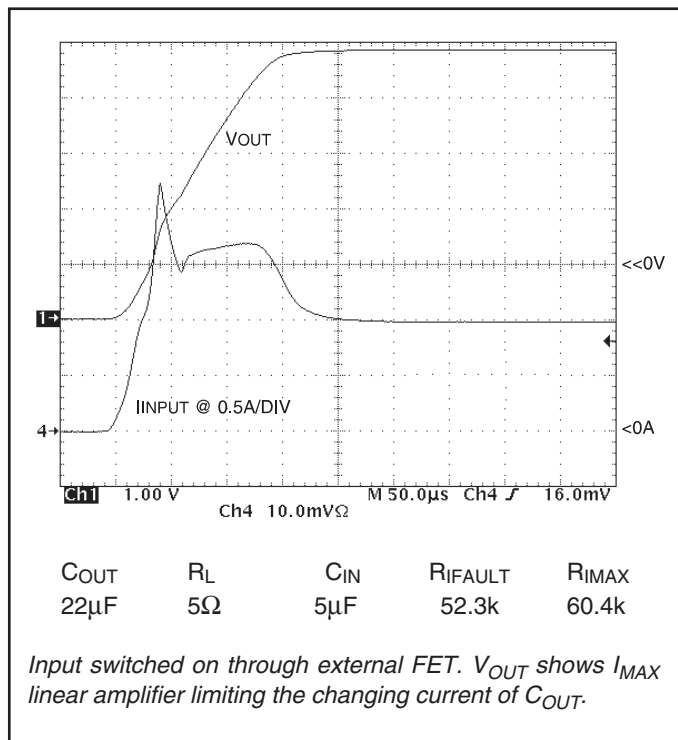


Figure 5. Input hot swap.

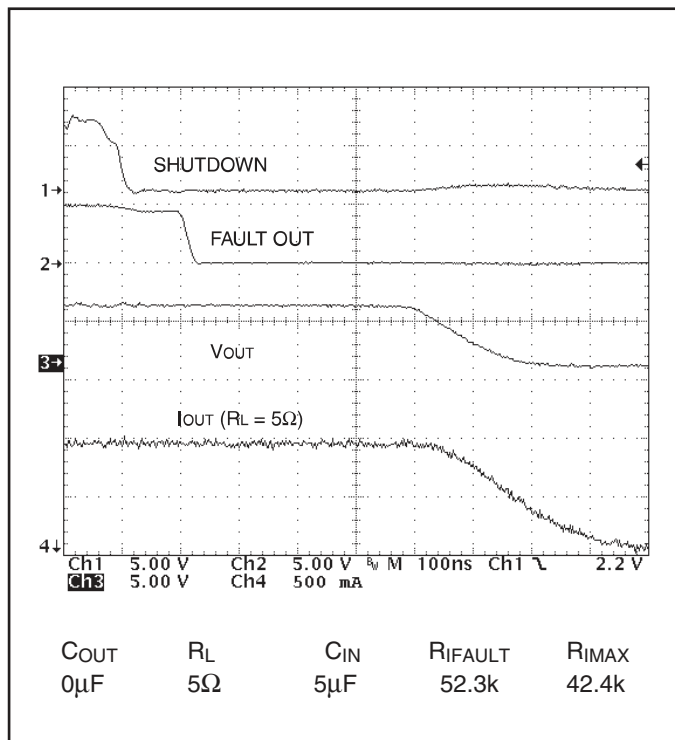


Figure 7. Shutdown delay to V<sub>OUT</sub> off.

APPLICATION INFORMATION (cont.)

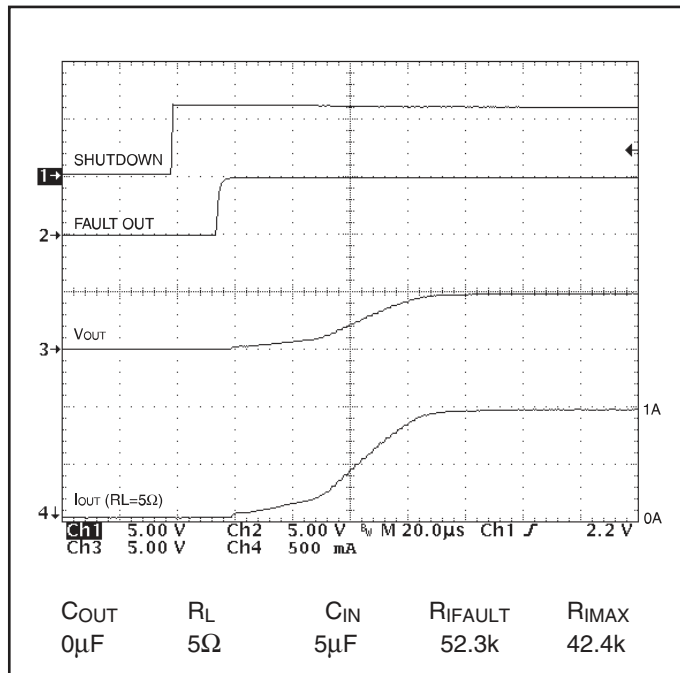


Figure 8. Shutdown delay to V<sub>OUT</sub> on.

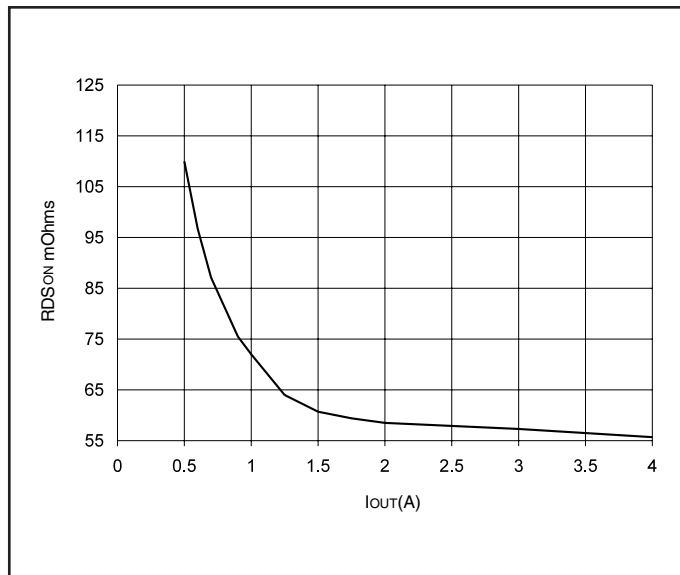


Figure 9. R<sub>DS(on)</sub> vs I<sub>OUT</sub>.

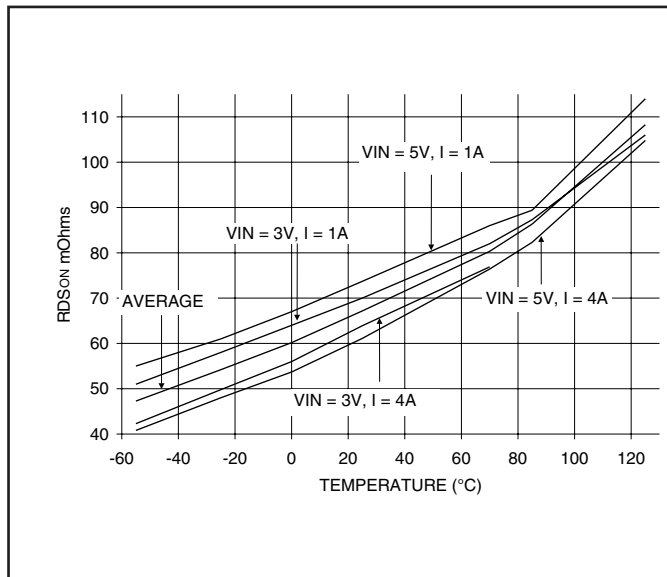


Figure 10. R<sub>DS(on)</sub> vs temperature.

SAFETY RECOMMENDATIONS

Although the UCC3918 is designed to provide system protection for all fault conditions, all integrated circuits can ultimately fail short. For this reason, if the UCC3918 is intended for use in safety critical applications where UL<sup>®</sup> or some other safety rating is required, a redundant safety device such as a fuse should be placed in series with the power device. The UCC3918 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.