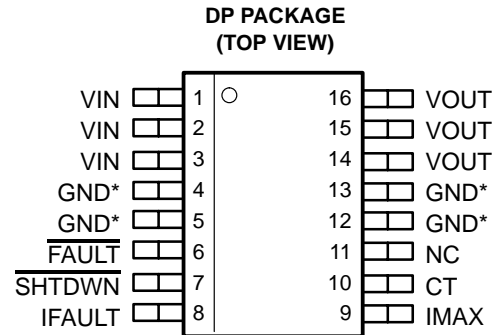


- **Integrated 0.075-Ω Power MOSFET**
- **3 V to 6 V Operation**
- **External Analog Control of Fault Current from 0 A to 4 A**
- **Independent Analog Control of Current Limit Up to 5 A**
- **Fast Overload Protection**
- **Unidirectional Switch**
- **Minimal External Components**
- **1-μA I<sub>CC</sub> When Disabled**
- **Programmable On Time**
- **Programmable Start Delay**
- **Fixed 3% Duty Cycle**



Pin 5 serves as the lowest impedance to the electrical ground. Pins 4, 12, and 13, serve as heat sink/ground. These pins should be connected to large etch PCB areas to help dissipate heat.

## 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 two 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 0 A to 4 A.

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 0.075 Ω. When the output current exceeds the fault level or the maximum sourcing level, the output remains on, but the fault timer starts charging a capacitor connected to the CT pin (C<sub>T</sub>). Once C<sub>T</sub> 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.

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 termination power (Term<sub>pwr</sub>). The UCC3918 can also be put into the sleep mode, drawing only 1 μA of supply current.

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



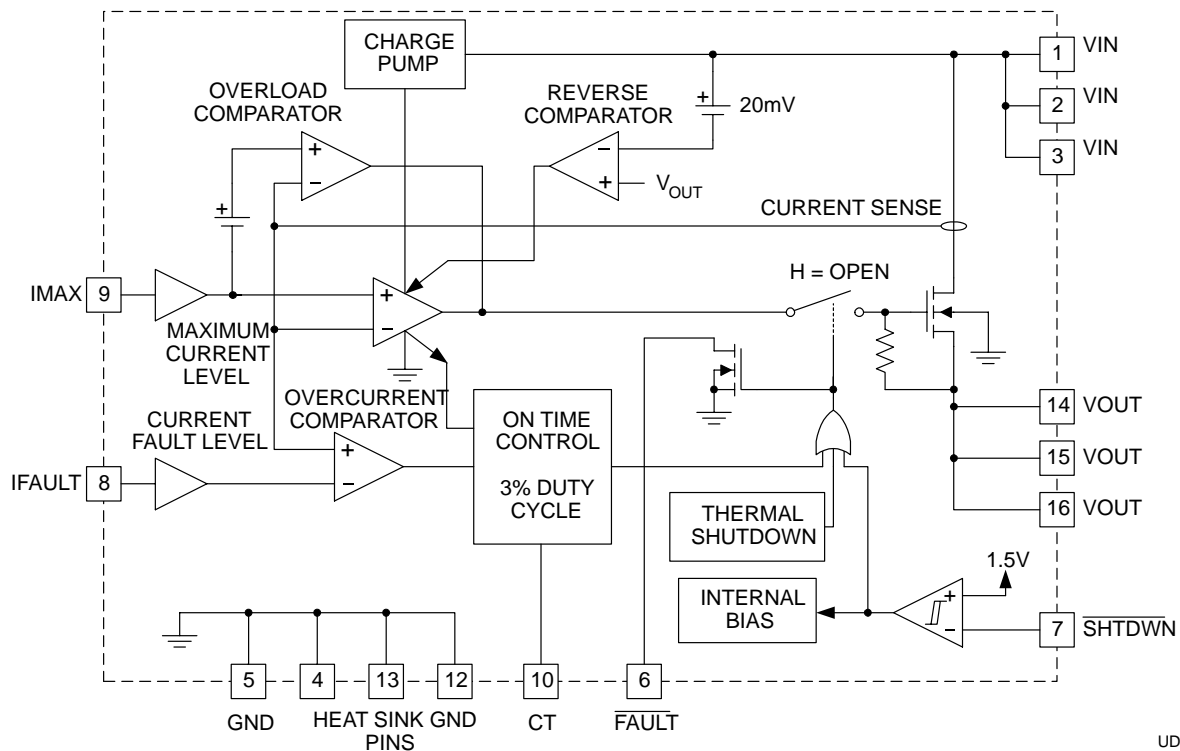
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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

# UCC3918 LOW ON-RESISTANCE HOT SWAP POWER MANAGER

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## functional block diagram



UDG-99153

### absolute maximum ratings over operating free-air temperature (unless otherwise noted)<sup>†‡</sup>

Input Voltage	8 V
SOIC Power dissipation	2.5 W
Fault output sink current	50 mA
Fault output voltage	VIN
Output Current (dc)	Internally Limited
Input Voltage <u>SHTDWN</u> , <u>IFault</u> , <u>IMAX</u>	-0.3 V to VIN
Storage temperature range T <sub>stg</sub>	-65°C to 150°C
Operating virtual junction temperature T <sub>J</sub>	-55°C to 150°C
Lead temperature (soldering, 10 seconds)	300°C

<sup>†</sup> Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

<sup>‡</sup> 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 500 μs. Consult *Packaging Section* of Databook for thermal limitations and considerations of package.

# UCC3918

## LOW ON-RESISTANCE HOT SWAP POWER MANAGER

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**electrical characteristics at  $T_A = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ,  $V_{IN} = 5\text{ V}$ ,  $R_{I\text{MAX}} = 42.2\text{ k}\Omega$ ,  $R_{I\text{FAULT}} = 52.3\text{ k}\Omega$ ,  $\overline{\text{SHTDWN}} = 2.4\text{ V}$ ,  $T_A = T_J$  (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Supply Section</b>					
Voltage input range, $V_{IN}$		3	5	6	V
VDD supply current	No load		1	2	mA
Sleep mode current	$\overline{\text{SHTDWN}} = 0.2\text{ V}$		0.5	5	$\mu\text{A}$
<b>Output Section</b>					
$R_{DS(on)}$	$I_{OUT} = 1\text{ A to }4\text{ A}$ , $V_{IN} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$		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	$\Omega$
	$I_{OUT} = 1\text{ A to }4\text{ A}$ , $V_{IN} = 5\text{ V}$		0.075	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	$\overline{\text{SHTDWN}} = 0\text{ V}$ , $V_{IN} = 0\text{ V}$ , $V_{OUT} = 5\text{ V}$			20	$\mu\text{A}$
Initial startup time	See Note 1		100		$\mu\text{s}$
Thermal shutdown	$V_{IN} = 5\text{ V}$ , See Note 1		170		$^\circ\text{C}$
Thermal hysteresis	See Note 1		10		$^\circ\text{C}$
Output leakage	$\overline{\text{SHTDWN}} = 0.2\text{ V}$ , $V_{OUT} = 0\text{ V}$			20	$\mu\text{A}$
Trip current	$R_{I\text{FAULT}} = 105\text{ k}\Omega$	0.75	1	1.25	A
	$R_{I\text{FAULT}} = 52.3\text{ k}\Omega$	1.7	2	2.3	A
	$R_{I\text{FAULT}} = 34.8\text{ k}\Omega$	2.5	3	3.5	A
	$R_{I\text{FAULT}} = 25.5\text{ k}\Omega$	3.3	4	4.7	A
Maximum output current	$R_{I\text{MAX}} = 118\text{ k}\Omega$	0.3	1	1.7	A
	$R_{I\text{MAX}} = 60.4\text{ k}\Omega$	1	2	3	A
	$R_{I\text{MAX}} = 42.2\text{ k}\Omega$	2	3	4	A
	$R_{I\text{MAX}} = 33.2\text{ k}\Omega$	2.5	3.8	5.1	A
	$R_{I\text{MAX}} = 27.4\text{ k}\Omega$	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	$\mu\text{A}$
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	$\overline{\text{SHTDWN}} = 0\text{ V}$	-500	0	500	nA
Input high current	$\overline{\text{SHTDWN}} = 2\text{ V}$	-2	-1	-0.5	$\mu\text{A}$
<b>Open Drain Fault Output Section</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: Ensured by design. Not production tested.

# UCC3918

## LOW ON-RESISTANCE HOT SWAP POWER MANAGER

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### pin descriptions

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

$$T_{\text{FAULT}} = 22.2 \times 10^3 \times C_T \quad (1)$$

Once the fault time is reached the output shuts down for a time given by:

$$T_{\text{SD}} = 0.667 \times 10^6 \times C_T \quad (2)$$

This equates to a 3% duty cycle. The recommended minimum value for the  $C_T$  capacitor is 0.1  $\mu\text{F}$ .

**FAULT:** Open-drain output, which pulls low on any condition that 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.

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

$$R_{\text{FAULT}} = \frac{105 \text{ k}\Omega}{I_{\text{TRIP}}} \quad (3)$$

**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:

$$R_{\text{IMAX}} = \frac{126 \text{ k}\Omega}{\text{Maximum Sourcing Current}} \quad (4)$$

**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.

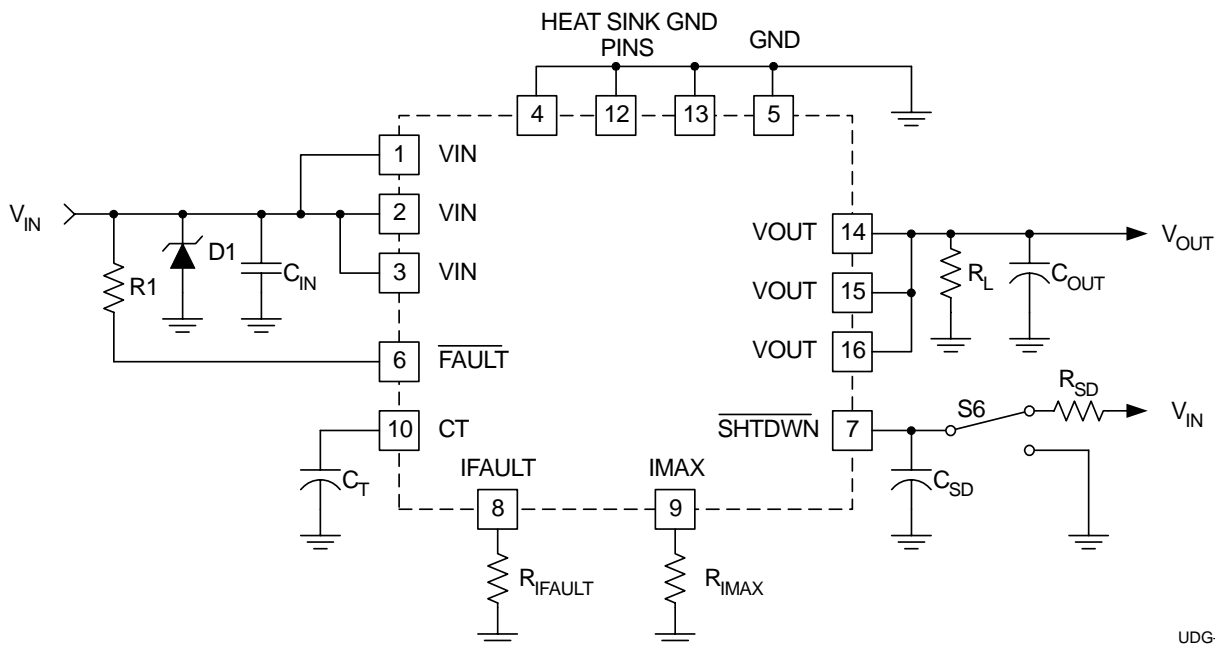
**VIN:** This is the input voltage to the UCC3918. The recommended operating voltage range is 3V to 6V. All VIN pins should be connected together and to the power source.

**VOU:** Output voltage for the circuit breaker. When switched the output voltage will be approximately:

$$V_{\text{OUT}} = V_{\text{IN}} - 0.075\Omega \times I_{\text{OUT}} \quad (5)$$

All VOUT pins should be connected together and to the load.

**APPLICATION INFORMATION**



UDG-99152

**Figure 1. Typical Application**

**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 6 V 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 Figure 1), located close to the  $V_{IN}$  pin. This capacitor is typically less than 1  $\mu\text{F}$  to limit the inrush current.
- Clamping the voltage at  $V_{IN}$  below 6 V with a Zener diode, D1 (refer to Figure 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 comes up if the load requires less than the maximum available short-circuit current.

To ensure recovery of a duty-cycle of the current-limited circuit breaker from a short-circuited load condition, there is a maximum total output capacitance that 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  $C_T$ .

# UCC3918 LOW ON-RESISTANCE HOT SWAP POWER MANAGER

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## APPLICATION INFORMATION

### estimating maximum load capacitance

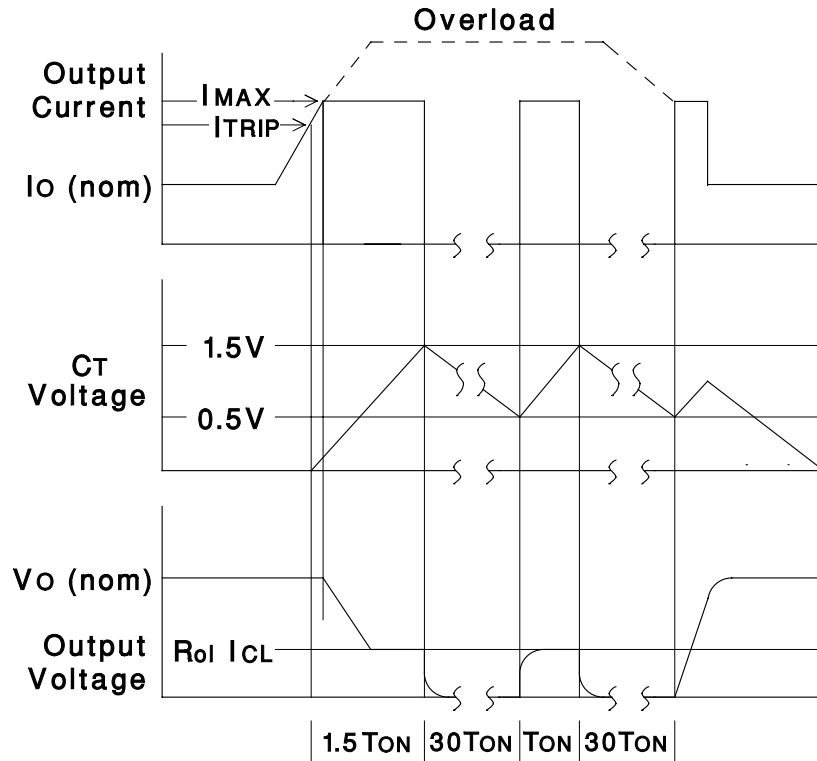
For worst-case constant-current load of value just less than the trip limit;  $C_{OUT(max)}$  can be estimated from:

$$C_{OUT(max)} = (I_{MAX} - I_{LOAD}) \left( \frac{22 \times 10^3 \times C_T}{V_{OUT}} \right) \quad (6)$$

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

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

$$C_{OUT(max)} = \left[ \frac{22 \times 10^3 \times C_T}{R_{LOAD} \times \ln \left[ \frac{1}{1 - \frac{V_{OUT}}{I_{MAX} \times R_{LOAD}}} \right]} \right] \quad (7)$$

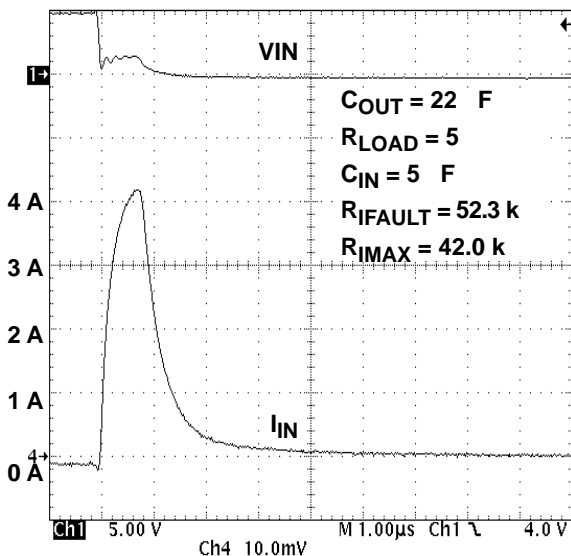


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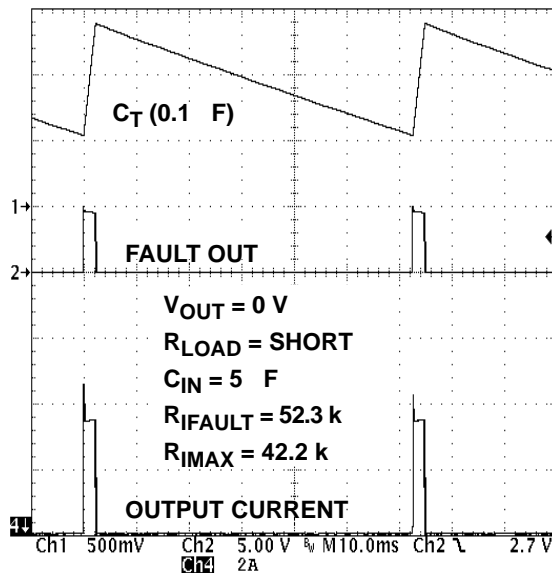
Figure 2. Load Current, Timing Capacitor Voltage and Output Voltage of the UCC3918 Under Fault

**TYPICAL CHARACTERISTICS**

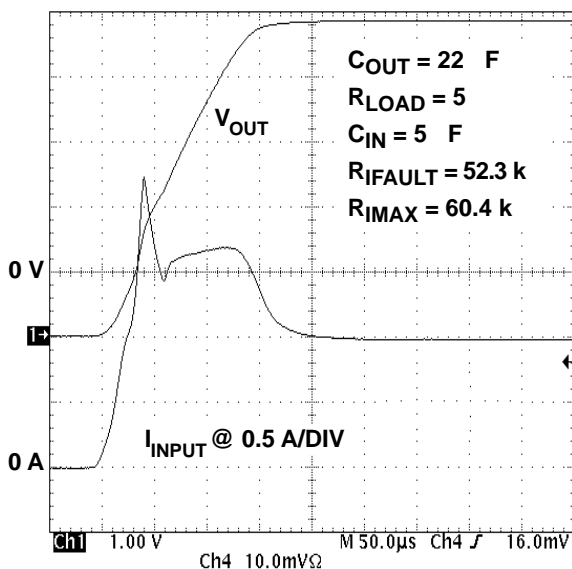
**REVERSE VOLTAGE COMPARATOR  
RESPONSE TIME**



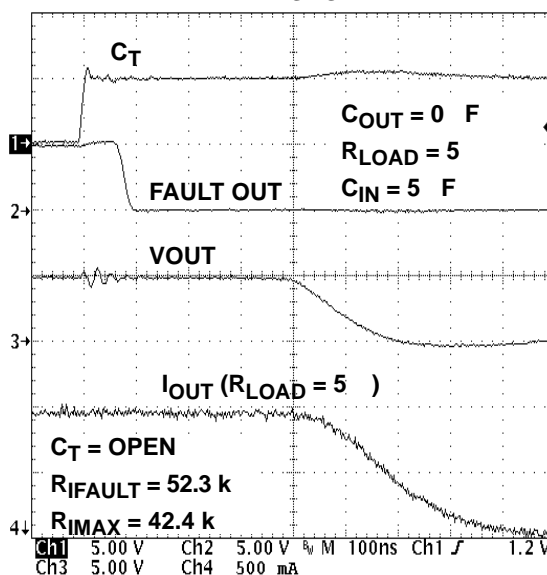
**FAULT TIMING WAVEFORMS**



**INRUSH CURRENT LIMITING**



**FAULT AND OUTPUT TURN-OFF  
DELAY FROM CT FAULT  
THRESHOLD**



# UCC3918 LOW ON-RESISTANCE HOT SWAP POWER MANAGER

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## TYPICAL CHARACTERISTICS

PROPAGATION DELAY  
SHUTDOWN TO FAULT AND  
OUTPUT RAMP-DOWN

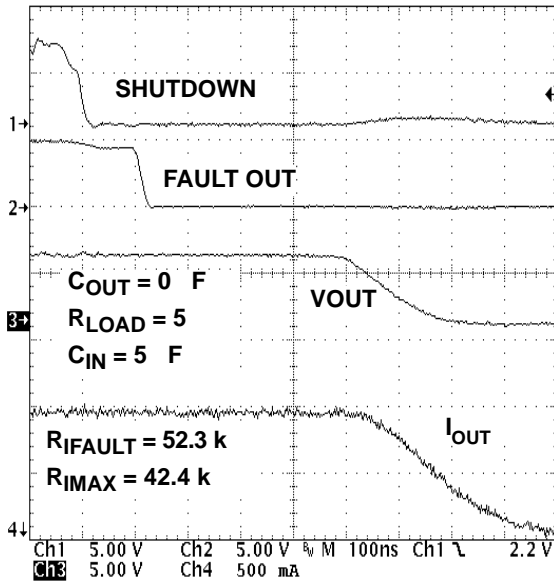


Figure 7

PROPAGATION DELAY  
ENABLE TO FAULT AND  
OUTPUT RAMP-UP

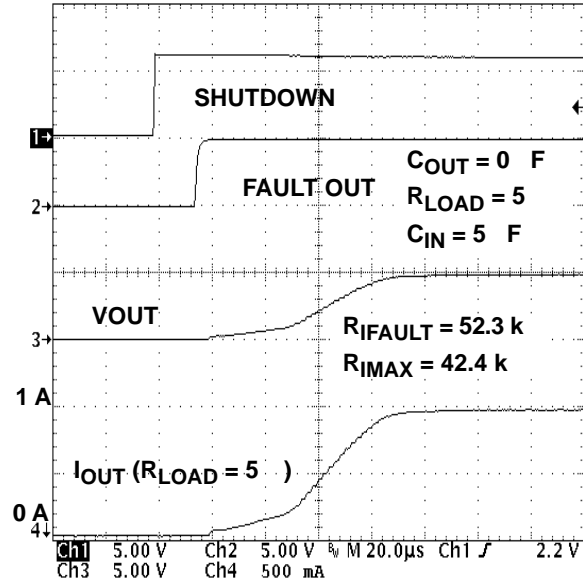


Figure 8

ON-STATE RESISTANCE  
vs  
OUTPUT CURRENT

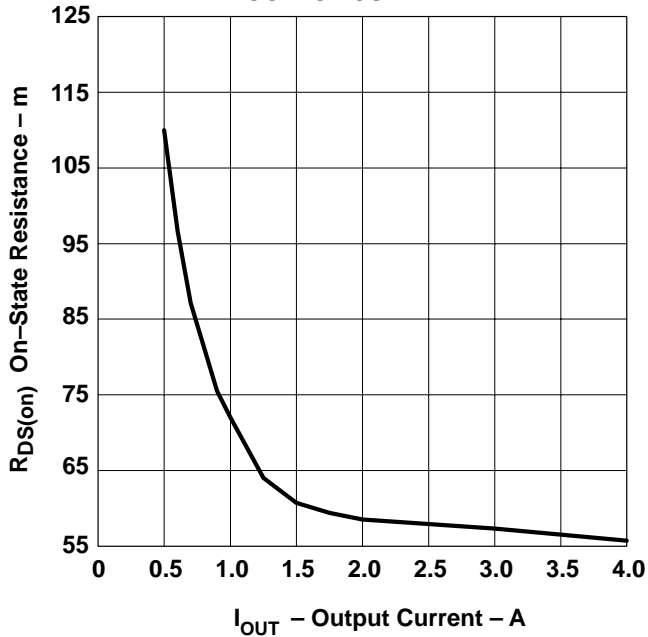


Figure 9

ON-STATE RESISTANCE  
vs  
TEMPERATURE

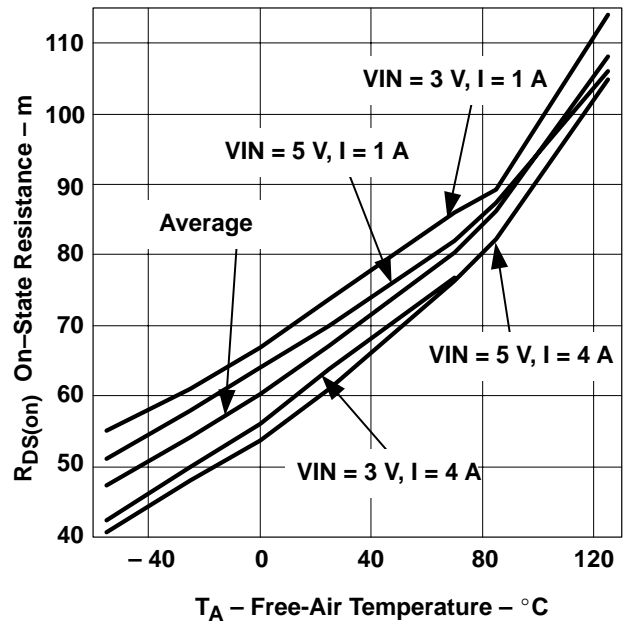


Figure 10



## APPLICATION INFORMATION

### **safety considerations**

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 prevents 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.

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
UCC3918DP	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3918DPG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3918DPTR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3918DPTRG4	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

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**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
UCC3918DPTR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
UCC3918DPTR	SOIC	D	16	2500	346.0	346.0	33.0

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