

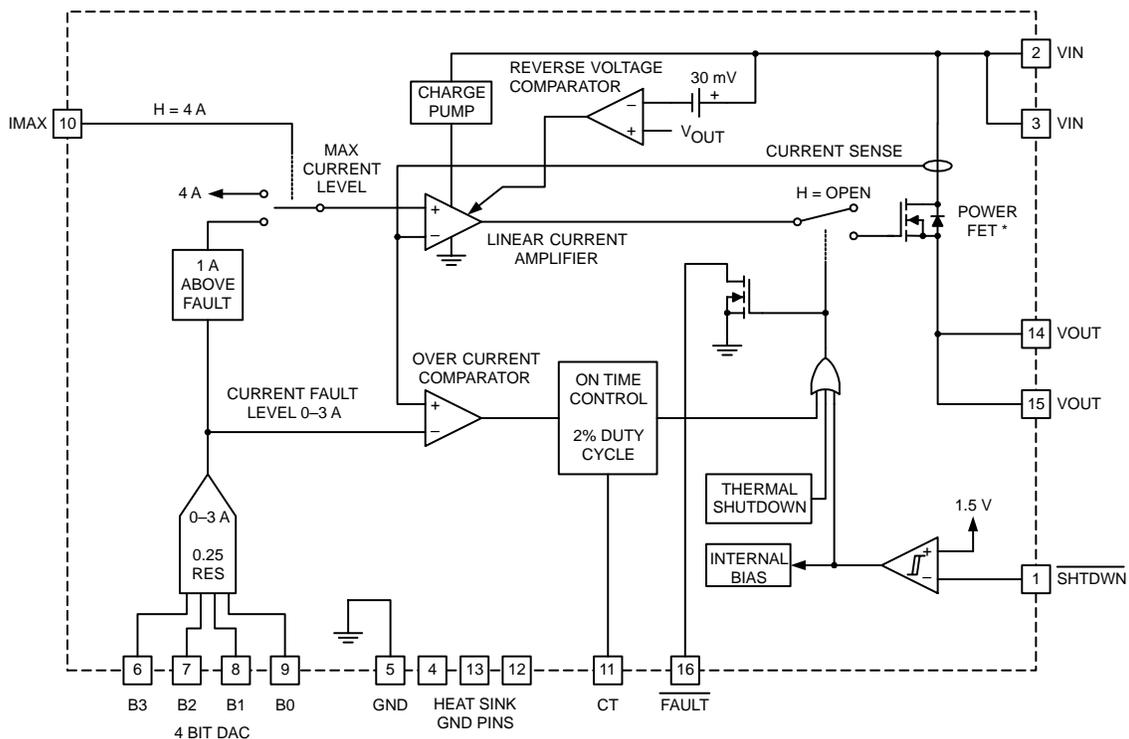
- Integrated 0.15-Ω Power MOSFET
- 7-V to 15-V Operation
- Digital-Programmable Current Limit from 0 A to 3 A
- 100-μA  $I_{CC}$  When Disabled
- Programmable On Time
- Programmable Start Delay
- Fixed 2% Duty Cycle
- Thermal Shutdown
- Fault-Output Indicator
- Maximum-Output Current Can Be Set to 1 A Above the Programmed-Fault Level or to a Full 4 A
- 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 A to 3 A with 0.25-A resolution. The IMAX control pin sets the maximum-sourcing current to 1 A above the trip level or to a full 4 A of output current for fast output capacitor charging. (continued)

**block diagram**



UDG-99174

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



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# UCC2915, UCC3915 15-V PROGRAMMABLE HOT SWAP POWER MANAGER

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## description (continued)

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.

The UCC3915 can be put into sleep mode, drawing only 100  $\mu$ A of supply current. Other features include an open-drain fault-output indicator, thermal shutdown, undervoltage lockout, 7-V to 15-V operation, and low-thermal resistance SOIC and TSSOP power packages.

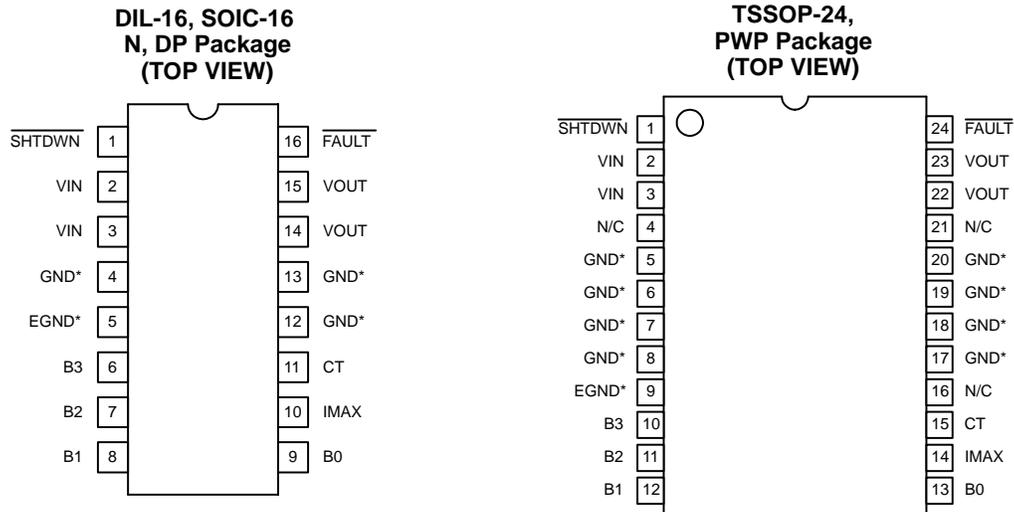
## absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

VIN	15.5 V
VOUT – VIN	.0.3 V
FAULT sink current	50 mA
FAULT voltage	–0.3 V to 8 V
Output current	Self limiting
TTL input voltage	–0.3 to VIN
Storage temperature, T <sub>stg</sub>	–65°C to 150°C
Junction temperature, T <sub>J</sub>	–55°C to 150°C
Lead temperature (soldering, 10 sec.)	300°C

† 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.

‡ Currents are positive into, negative out of the specified terminal. Consult Packaging Section of the *Interface Products Data Book* (TI Literature Number SLUD002) for thermal limitations and considerations of packages.

## package information



\*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.



# UCC2915, UCC3915

## 15-V PROGRAMMABLE HOT SWAP POWER MANAGER

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electrical characteristics, 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,  $V_{IN} = 12\text{ V}$ ,  $I_{MAX} = 0.4\text{ A}$ ,  $SHTDWN = 2.4\text{ V}$ ,  $T_A = T_J$ , (unless otherwise stated)

### supply

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Voltage input range		7.0		15.0	V
Supply current			1.0	2.0	mA
Sleep mode current	$\overline{SHTDWN} = 0.2\text{ V}$ , no load		100	150	$\mu\text{A}$
Output leakage	$\overline{SHTDWN} = 0.2\text{ V}$			20	$\mu\text{A}$

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

### output

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Voltage drop	$I_{OUT} = 1\text{ A}$ (10 V to 12 V)		0.15	0.3	V
	$I_{OUT} = 2\text{ A}$ (10 V to 12 V)		0.3	0.6	V
	$I_{OUT} = 3\text{ A}$ (10 V to 12 V)		0.45	0.9	V
	$I_{OUT} = 1\text{ A}$ , $V_{IN} = 7\text{ V}$ 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	See Note 2		100		$\mu\text{s}$
Short circuit response	See Note 2		100		ns
Thermal shutdown	See Note 2		165		$^{\circ}\text{C}$
Thermal hysteresis	See Note 2		10		$^{\circ}\text{C}$

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

NOTE 2: Ensured by design. Not production tested.

### DAC

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
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

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



# UCC2915, UCC3915

## 15-V PROGRAMMABLE HOT SWAP POWER MANAGER

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electrical characteristics, 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,  $V_{IN} = 12\text{ V}$ ,  $I_{MAX} = 0.4\text{ V}$ ,  $SHTDWN = 2.4\text{ V}$ ,  $T_A = T_J$ , (unless otherwise stated)

### DAC (continued)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Trip current	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

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

### fault timer

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
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

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

### shutdown

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Shutdown threshold		1.1	1.5	1.9	V
Shutdown hysteresis			150		mV
Input current			100	500	nA

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

### open drain output ( $\overline{\text{FAULT}}$ )

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
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

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

### TTL input dc characteristics

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
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.



# UCC2915, UCC3915

## 15-V PROGRAMMABLE HOT SWAP POWER MANAGER

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### pin descriptions

**B0 – 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  $T_{\text{FAULT}} = 16.1 \times 10^3 \times C_T$ . Once the fault time is reached the output will shutdown for a time given by  $T_{\text{SD}} = 833 \times 10^3 \times C_T$ , this equates to a 1.9% duty cycle.

**FAULT:** Open-drain output, which pulls low upon any fault or interrupt condition, or thermal shutdown.

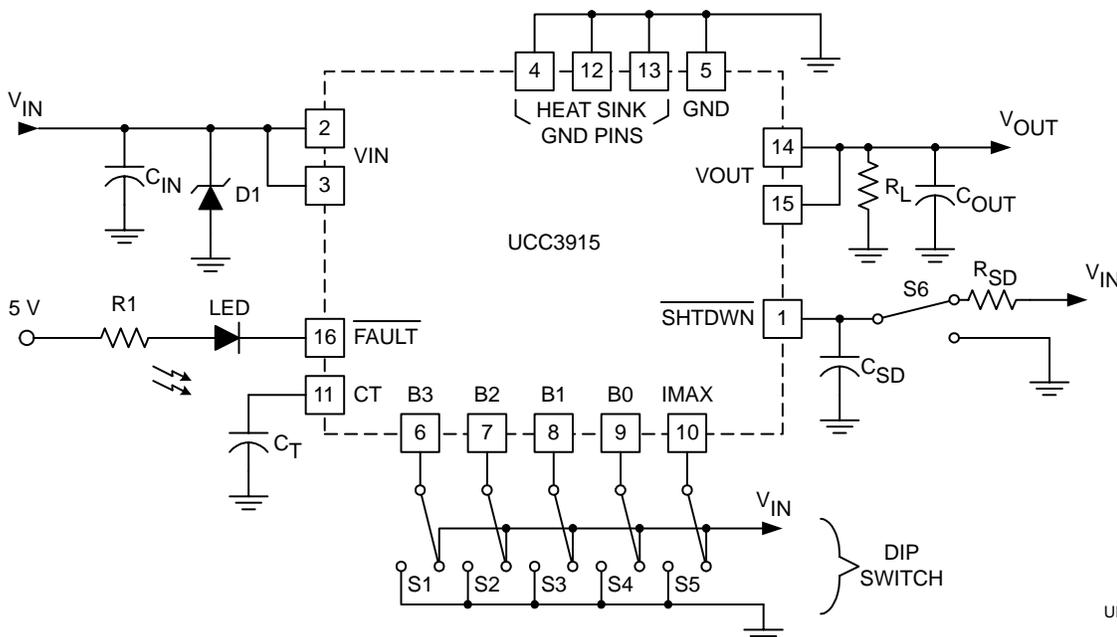
**IMAX:** When this pin is set to a logic low, the maximum-sourcing current will always be 1 A above the programmed-fault level. When set to a logic high, the maximum-sourcing current will be a constant 4 A for applications which require fast charging of load capacitance.

**SHTDWN:** When this pin is brought to a logic low, the IC is put into a sleep mode drawing typically less than 100  $\mu\text{A}$  of  $I_{\text{CC}}$ . 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 V to 15 V. Both VIN pins should be connected together and connected to the 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  $V_{\text{IN}} - (0.15 \Omega \times I_{\text{OUT}})$ . VOUT must not exceed VIN by greater than 0.3 V.

### APPLICATION INFORMATION



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**Figure 1. Evaluation Circuit**

# UCC2915, UCC3915 15-V PROGRAMMABLE HOT SWAP POWER MANAGER

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## APPLICATION INFORMATION

### 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 15 V 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 PCB power and ground planes).
- Decoupling  $V_{IN}$  with a capacitor,  $C_{IN}$  (refer to Figure 1), located close to the  $V_{IN}$  pins. This capacitor is typically 1  $\mu$ F or less to limit the inrush current.
- Clamping the voltage at  $V_{IN}$  below 15 V with a Zener diode, D1 (refer to Figure 1), located close to the  $V_{IN}$  pins.

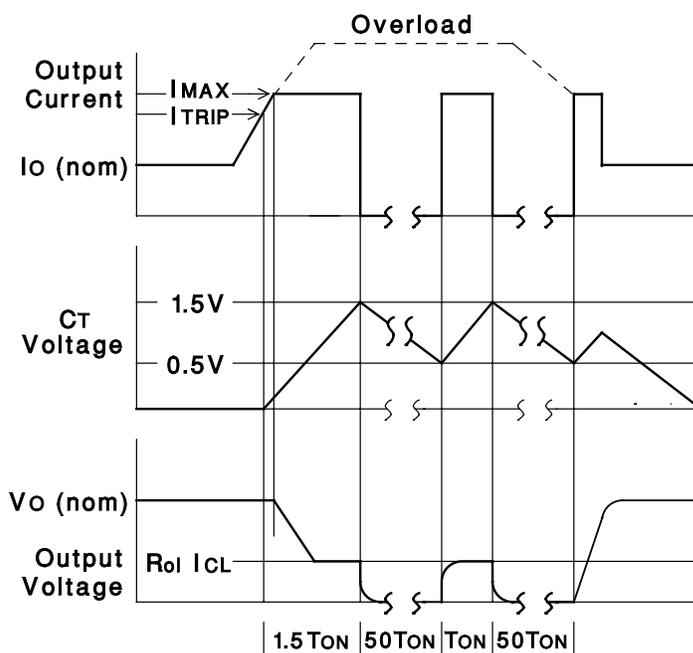


Figure 2. Load Current, Timing-Capacitor Voltage, and Output Voltage of the UCC3915 Under Fault Conditions

### 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 ensure 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  $C_T$ .

### APPLICATION INFORMATION

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

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

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:

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

Long  $C_T$  times must consider the maximum temperature. Thermal shutdown protection may be the limiting fault time.

#### **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.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
UCC2915DP	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	UCC2915DP	<a href="#">Samples</a>
UCC3915DP	ACTIVE	SOIC	D	16	40	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	0 to 70	UCC3915DP	<a href="#">Samples</a>
UCC3915DPTR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	0 to 70	UCC3915DP	<a href="#">Samples</a>

(1) 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.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

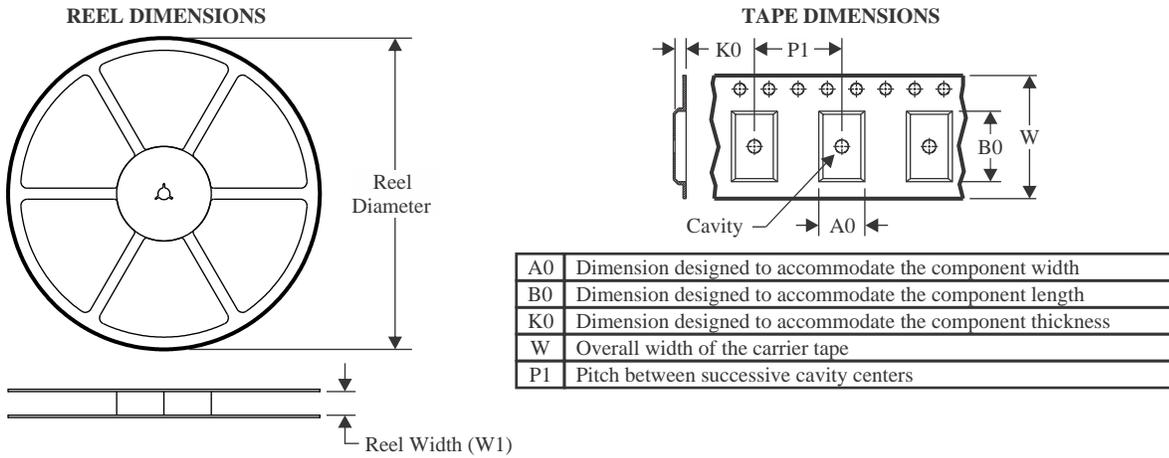
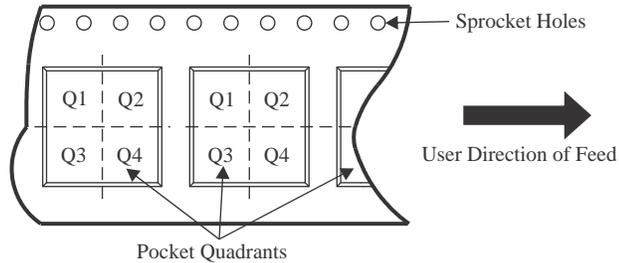
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


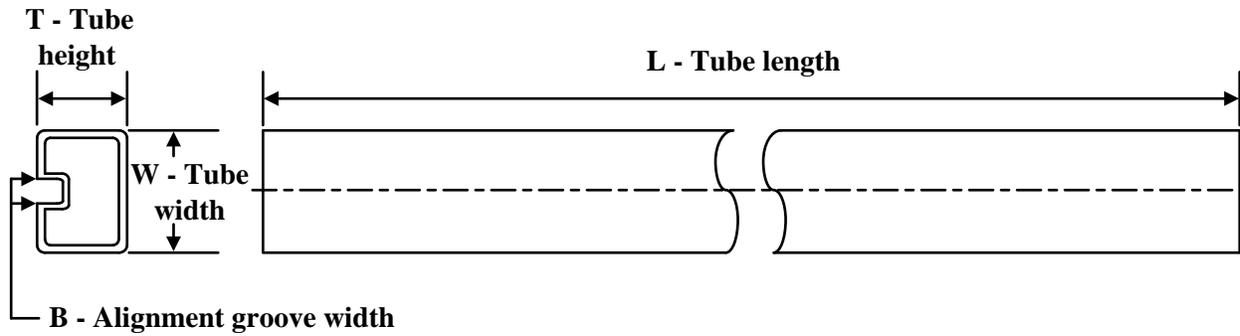
\*All dimensions are nominal

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
UCC3915DPTR	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)
UCC3915DPTR	SOIC	D	16	2500	356.0	356.0	35.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
UCC2915DP	D	SOIC	16	40	506.6	8	3940	4.32
UCC3915DP	D	SOIC	16	40	506.6	8	3940	4.32

## GENERIC PACKAGE VIEW

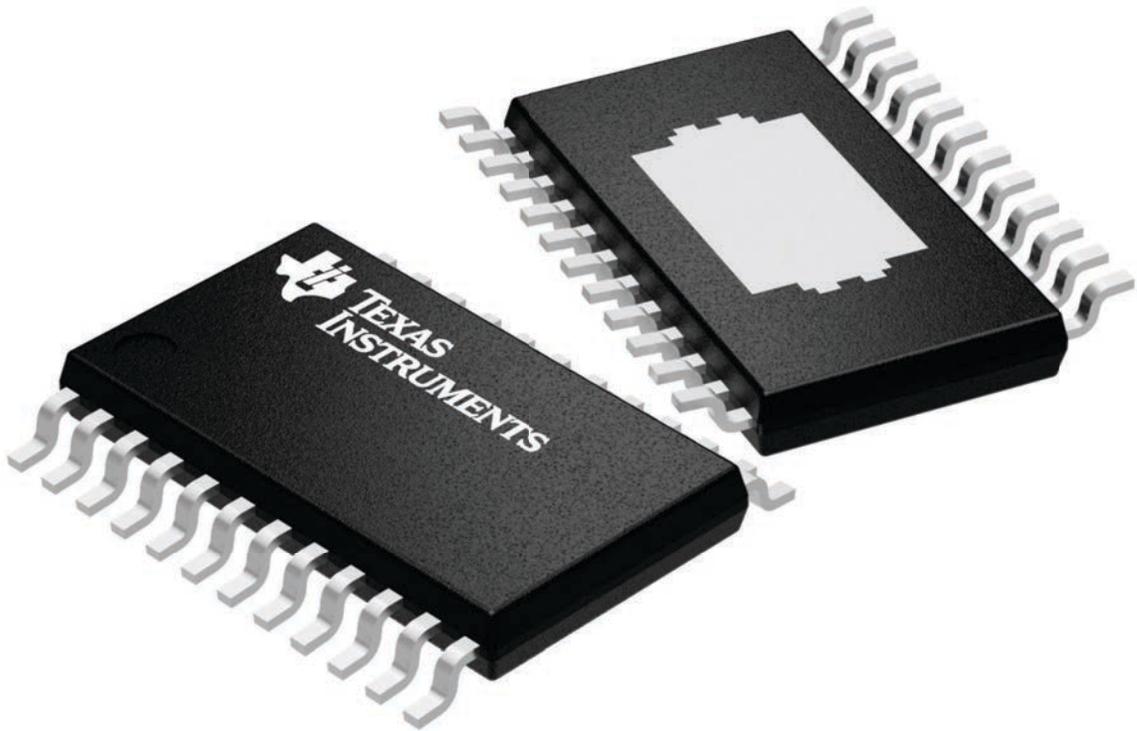
**PWP 24**

**PowerPAD™ TSSOP - 1.2 mm max height**

4.4 x 7.6, 0.65 mm pitch

PLASTIC SMALL OUTLINE

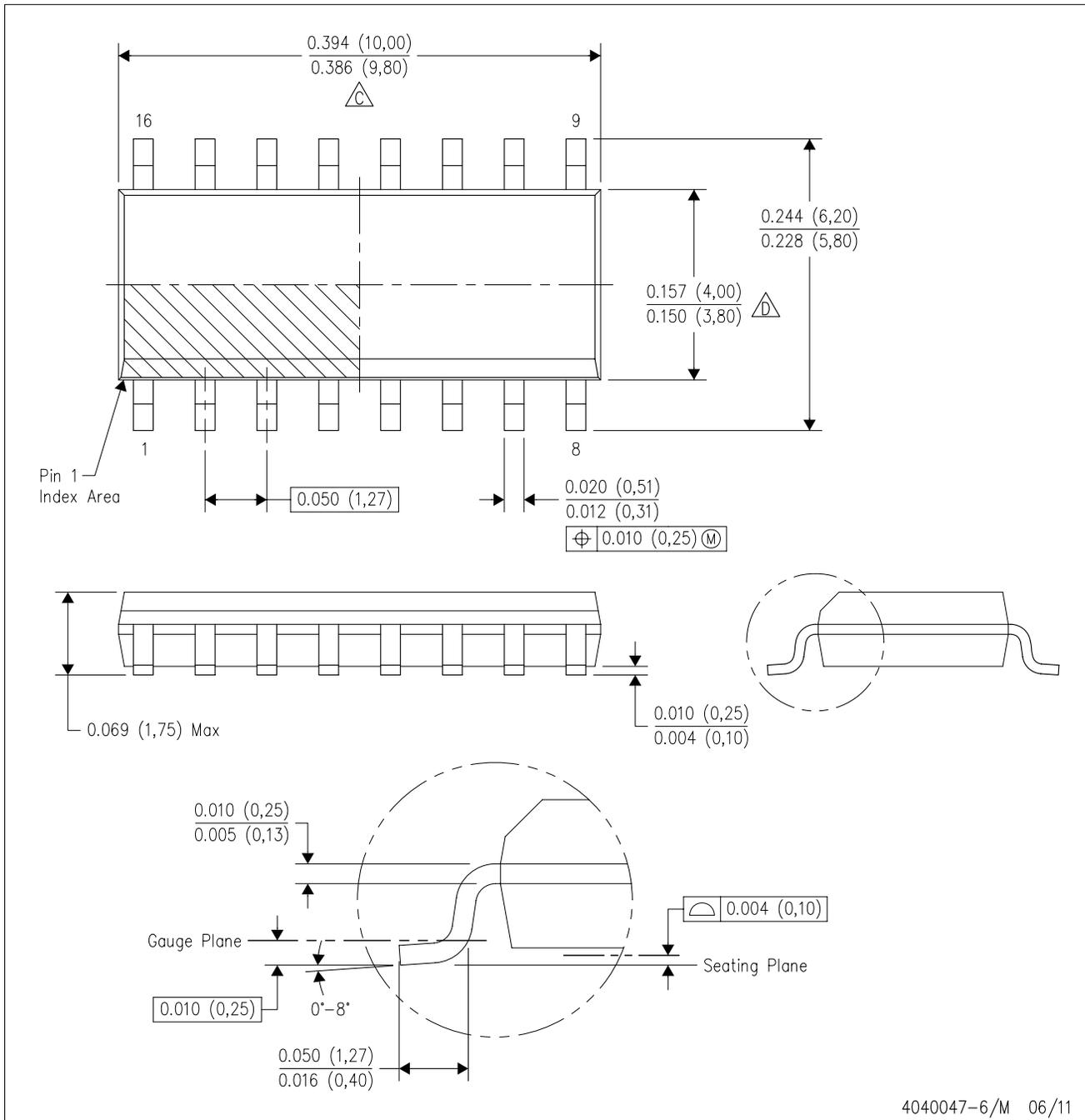
This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



4224742/B

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  -  D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AC.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.

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