

## Voltage Supervisor with 27 Selectable Thresholds

### FEATURES

- **9 Selectable Supply Voltages**  
12V, 5V, 3.3V, 2.5V, 1.8V  
1.5V, 1.2V, 1.0V, +ADJ (0.5V)
- **3 Selectable Tolerances**  
–5%, –10%, –15% (LTC2915)
- **Manual Reset Input (LTC2916)**
- **1.5V to 5.5V Supply Operation**
- **6.2V Shunt Regulator for High Voltage Operation**
- **Guaranteed Operation to 125°C**
- **Guaranteed Threshold Accuracy:  $\pm 1.5\%$**
- **Low Quiescent Current: 30 $\mu$ A Typical**
- **Power Supply Glitch Immunity**
- **Guaranteed RST for  $V_{CC} \geq 0.8V$**
- **Low Profile (1mm) 8-Lead TSOT-23 (ThinSOT™) and (3mm  $\times$  2mm) DFN Packages**

### APPLICATIONS

- Handheld Devices
- Cell Phone Base Stations
- Automotive Control Systems
- Network Servers
- Optical Networking Systems

### DESCRIPTION

The LTC®2915/LTC2916 are low voltage single-supply monitors with selectable thresholds. The parts operate from 1.5V to 5.5V and consume a quiescent current of only 30 $\mu$ A.

Two three-state inputs select one of nine internally programmed thresholds without the need for external resistors. For the LTC2915, an additional three-state input determines the tolerance (–5%, –10%, –15%). The tolerance for the LTC2916 is fixed at –5%. Threshold accuracy is guaranteed at  $\pm 1.5\%$  over the entire operating temperature range. Glitch filtering ensures reliable reset operation without false triggering.

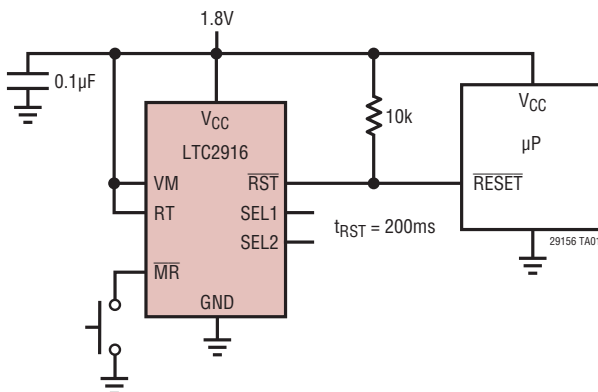
The reset timeout may be set to 200ms or adjusted using an external capacitor. A separate manual reset input on the LTC2916 allows a simple push button interface.

Operation to 125°C makes the LTC2915 and LTC2916 suitable for automotive applications.

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### TYPICAL APPLICATION

1.8V, –5% Tolerance Supply Monitor



Monitor Selection Table

| NOMINAL VOLTAGE | SEL1            | SEL2            |
|-----------------|-----------------|-----------------|
| 12V             | V <sub>CC</sub> | V <sub>CC</sub> |
| 5V              | V <sub>CC</sub> | Open            |
| 3.3V            | V <sub>CC</sub> | GND             |
| 2.5V            | Open            | V <sub>CC</sub> |
| 1.8V            | Open            | Open            |
| 1.5V            | Open            | GND             |
| 1.2V            | GND             | V <sub>CC</sub> |
| 1V              | GND             | Open            |
| ADJ (0.5V)      | GND             | GND             |

# LTC2915/LTC2916

## ABSOLUTE MAXIMUM RATINGS (Notes 1, 2)

### Terminal Voltages

|                                                     |                              |
|-----------------------------------------------------|------------------------------|
| $V_{CC}$ (Note 3)                                   | –0.3V to 5.7V                |
| SEL1, SEL2, TOL, $\overline{MR}$ , $\overline{RST}$ | –0.3V to 7.5V                |
| VM                                                  | –0.3V to 15V                 |
| RT                                                  | –0.3V to ( $V_{CC} + 0.3$ )V |

### Terminal Currents

|                   |            |
|-------------------|------------|
| $V_{CC}$ (Note 3) | $\pm 5$ mA |
|-------------------|------------|

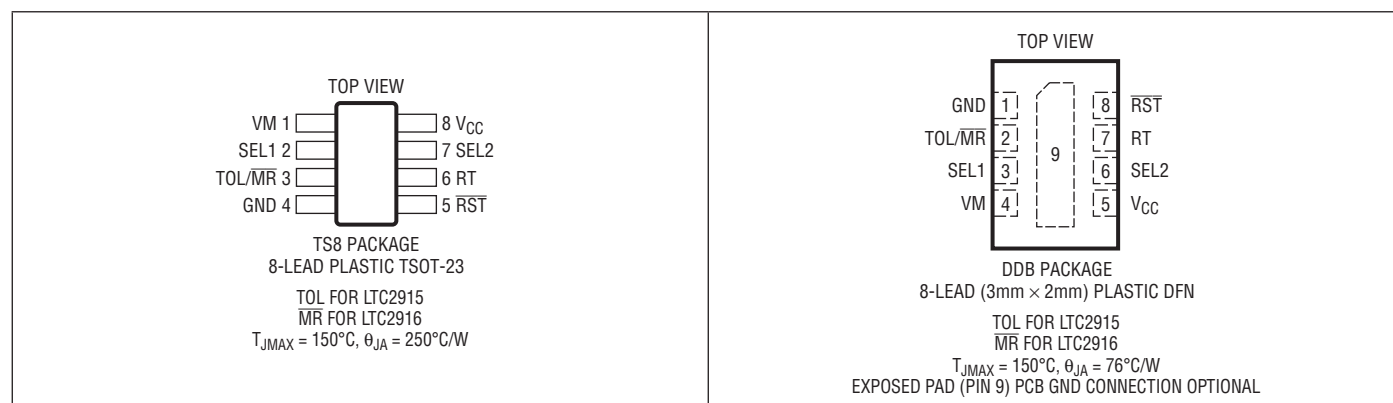
### Operating Temperature Range

|                   |                |
|-------------------|----------------|
| LTC2915C/LTC2916C | 0°C to 70°C    |
| LTC2915I/LTC2916I | –40°C to 85°C  |
| LTC2915H/LTC2916H | –40°C to 125°C |

### Storage Temperature Range

|                                          |       |
|------------------------------------------|-------|
| TS8 Lead Temperature (Soldering, 10 sec) | 300°C |
|------------------------------------------|-------|

## PIN CONFIGURATION



## ORDER INFORMATION

| LEAD FREE FINISH  | TAPE AND REEL       | PART MARKING* | PACKAGE DESCRIPTION                   | TEMPERATURE RANGE |
|-------------------|---------------------|---------------|---------------------------------------|-------------------|
| LTC2915CTS8-1#PBF | LTC2915CTS8-1#TRPBF | LTCVQ         | 8-Lead TSOT-23                        | 0°C to 70°C       |
| LTC2915ITS8-1#PBF | LTC2915ITS8-1#TRPBF | LTCVQ         | 8-Lead TSOT-23                        | –40°C to 85°C     |
| LTC2915HTS8-1#PBF | LTC2915HTS8-1#TRPBF | LTCVQ         | 8-Lead TSOT-23                        | –40°C to 125°C    |
| LTC2915CDDb-1#PBF | LTC2915CDDb-1#TRPBF | LCVR          | 8-Lead (3mm $\times$ 2mm) Plastic DFN | 0°C to 70°C       |
| LTC2915IDDb-1#PBF | LTC2915IDDb-1#TRPBF | LCVR          | 8-Lead (3mm $\times$ 2mm) Plastic DFN | –40°C to 85°C     |
| LTC2915HDDb-1#PBF | LTC2915HDDb-1#TRPBF | LCVR          | 8-Lead (3mm $\times$ 2mm) Plastic DFN | –40°C to 125°C    |
| LEAD FREE FINISH  | TAPE AND REEL       | PART MARKING* | PACKAGE DESCRIPTION                   | TEMPERATURE RANGE |
| LTC2916CTS8-1#PBF | LTC2916CTS8-1#TRPBF | LTDCW         | 8-Lead TSOT-23                        | 0°C to 70°C       |
| LTC2916ITS8-1#PBF | LTC2916ITS8-1#TRPBF | LTDCW         | 8-Lead TSOT-23                        | –40°C to 85°C     |
| LTC2916HTS8-1#PBF | LTC2916HTS8-1#TRPBF | LTDCW         | 8-Lead TSOT-23                        | –40°C to 125°C    |
| LTC2916CDDb-1#PBF | LTC2916CDDb-1#TRPBF | LDCX          | 8-Lead (3mm $\times$ 2mm) Plastic DFN | 0°C to 70°C       |
| LTC2916IDDb-1#PBF | LTC2916IDDb-1#TRPBF | LDCX          | 8-Lead (3mm $\times$ 2mm) Plastic DFN | –40°C to 85°C     |
| LTC2916HDDb-1#PBF | LTC2916HDDb-1#TRPBF | LDCX          | 8-Lead (3mm $\times$ 2mm) Plastic DFN | –40°C to 125°C    |

Consult LTC Marketing for parts specified with wider operating temperature ranges. \*The temperature grade is identified by a label on the shipping container. Consult LTC Marketing for information on non-standard lead based finish parts.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeandree/>

# ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .  $V_{CC} = 2.5\text{V}$ , unless otherwise noted. (Note 2)

| SYMBOL          | PARAMETER                                                 | CONDITIONS                                                                                                                     | MIN    | TYP      | MAX      | UNITS                          |
|-----------------|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------|----------|----------|--------------------------------|
| $V_{CC(MIN)}$   | Supply Voltage for Guaranteed $\overline{\text{RST}}$ Low | $\overline{\text{RST}}$ Driven Low                                                                                             | ● 0.8  |          |          | V                              |
| $V_{CC(UVLO)}$  | Supply Undervoltage Lockout                               |                                                                                                                                | ●      |          | 1.5      | V                              |
| $V_{CC(SHUNT)}$ | Shunt Regulation Voltage                                  | $I_{VCC} = 0.5\text{mA}$                                                                                                       | ● 5.7  | 6.2      | 7.0      | V                              |
| $I_{CC}$        | $V_{CC}$ Pin Current                                      | SEL1, SEL2, TOL, $\overline{\text{MR}}$ = Open<br>SEL1, SEL2, TOL = GND (LTC2915)<br>$\overline{\text{MR}} = V_{CC}$ (LTC2916) | ●<br>● | 30<br>45 | 50<br>80 | $\mu\text{A}$<br>$\mu\text{A}$ |

## Monitor Input (VM)

|               |                                                                                                      |                       |             |                         |                         |                         |                  |
|---------------|------------------------------------------------------------------------------------------------------|-----------------------|-------------|-------------------------|-------------------------|-------------------------|------------------|
| $V_{MT120}$   | 12V, 5% Reset Threshold<br>12V, 10% Reset Threshold<br>12V, 15% Reset Threshold                      |                       | ●<br>●<br>● | 11.04<br>10.44<br>9.84  | 11.22<br>10.62<br>10.02 | 11.40<br>10.80<br>10.20 | V<br>V<br>V      |
| $V_{MT50}$    | 5V, 5% Reset Threshold<br>5V, 10% Reset Threshold<br>5V, 15% Reset Threshold                         |                       | ●<br>●<br>● | 4.600<br>4.350<br>4.100 | 4.675<br>4.425<br>4.175 | 4.750<br>4.500<br>4.250 | V<br>V<br>V      |
| $V_{MT33}$    | 3.3V, 5% Reset Threshold<br>3.3V, 10% Reset Threshold<br>3.3V, 15% Reset Threshold                   |                       | ●<br>●<br>● | 3.036<br>2.871<br>2.706 | 3.086<br>2.921<br>2.756 | 3.135<br>2.970<br>2.805 | V<br>V<br>V      |
| $V_{MT25}$    | 2.5V, 5% Reset Threshold<br>2.5V, 10% Reset Threshold<br>2.5V, 15% Reset Threshold                   |                       | ●<br>●<br>● | 2.300<br>2.175<br>2.050 | 2.338<br>2.213<br>2.088 | 2.375<br>2.250<br>2.125 | V<br>V<br>V      |
| $V_{MT18}$    | 1.8V, 5% Reset Threshold<br>1.8V, 10% Reset Threshold<br>1.8V, 15% Reset Threshold                   |                       | ●<br>●<br>● | 1.656<br>1.566<br>1.476 | 1.683<br>1.593<br>1.503 | 1.710<br>1.620<br>1.530 | V<br>V<br>V      |
| $V_{MT15}$    | 1.5V, 5% Reset Threshold<br>1.5V, 10% Reset Threshold<br>1.5V, 15% Reset Threshold                   |                       | ●<br>●<br>● | 1.380<br>1.305<br>1.230 | 1.403<br>1.328<br>1.253 | 1.425<br>1.350<br>1.275 | V<br>V<br>V      |
| $V_{MT12}$    | 1.2V, 5% Reset Threshold<br>1.2V, 10% Reset Threshold<br>1.2V, 15% Reset Threshold                   |                       | ●<br>●<br>● | 1.104<br>1.044<br>0.984 | 1.122<br>1.062<br>1.002 | 1.140<br>1.080<br>1.020 | V<br>V<br>V      |
| $V_{MT10}$    | 1V, 5% Reset Threshold<br>1V, 10% Reset Threshold<br>1V, 15% Reset Threshold                         |                       | ●<br>●<br>● | 0.920<br>0.870<br>0.820 | 0.935<br>0.885<br>0.835 | 0.950<br>0.900<br>0.850 | V<br>V<br>V      |
| $V_{MTADJ}$   | ADJ (0.5V), 5% Reset Threshold<br>ADJ (0.5V), 10% Reset Threshold<br>ADJ (0.5V), 15% Reset Threshold |                       | ●<br>●<br>● | 460.0<br>435.0<br>410.0 | 467.5<br>442.5<br>417.5 | 475.0<br>450.0<br>425.0 | mV<br>mV<br>mV   |
| $R_{VM}$      | VM Input Impedance (Note 4)                                                                          | Fixed Threshold Modes | ●           | 0.5                     |                         | 8                       | $\text{M}\Omega$ |
| $I_{VM(ADJ)}$ | ADJ Input Current                                                                                    | $VM = 0.5\text{V}$    | ●           |                         |                         | $\pm 15$                | nA               |

## Three-State Inputs (SEL1, SEL2), (TOL, LTC2915)

|                 |                                 |                                |   |     |     |          |               |
|-----------------|---------------------------------|--------------------------------|---|-----|-----|----------|---------------|
| $V_{TPIN,LOW}$  | Low Level Input Voltage         |                                | ● |     |     | 0.5      | V             |
| $V_{TPIN,HIGH}$ | High Level Input Voltage        |                                | ● | 1.4 |     |          | V             |
| $V_{TPIN,Z}$    | Pin Voltage when Open           | $I_{TPIN} = 0\mu\text{A}$      |   |     | 0.9 |          | V             |
| $I_{TPIN,Z}$    | Allowable Leakage in Open State |                                | ● |     |     | $\pm 5$  | $\mu\text{A}$ |
| $I_{TPIN,H/L}$  | Pin Input Current               | $V_{TPIN} = 0\text{V}, V_{CC}$ | ● |     |     | $\pm 20$ | $\mu\text{A}$ |

# LTC2915/LTC2916

## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ .  $V_{CC} = 2.5\text{V}$ , unless otherwise noted. (Note 2)

| SYMBOL                              | PARAMETER                                                  | CONDITIONS                                             |   | MIN                | TYP  | MAX                | UNITS            |
|-------------------------------------|------------------------------------------------------------|--------------------------------------------------------|---|--------------------|------|--------------------|------------------|
| <b>Reset Timer Control (RT)</b>     |                                                            |                                                        |   |                    |      |                    |                  |
| $I_{RT(UP)}$                        | RT Pull-Up Current                                         | $V_{RT} = 0.25\text{V}$                                | ● | -2                 | -3   | -4                 | $\mu\text{A}$    |
| $I_{RT(DOWN)}$                      | RT Pull-Down Current                                       | $V_{RT} = 1.1\text{V}$                                 | ● | 2                  | 3    | 4                  | $\mu\text{A}$    |
| $I_{RT(INT)}$                       | Internal RT $V_{CC}$ Detect Current                        | $V_{RT} = V_{CC}$                                      | ● |                    | 1    | 8                  | $\mu\text{A}$    |
| $V_{RT(INT,LH)}$                    | RT Internal Timer Threshold                                | $V_{RT}$ Rising, Referenced to $V_{CC}$                | ● | -100               | -160 | -300               | mV               |
| <b>Reset Output (RST)</b>           |                                                            |                                                        |   |                    |      |                    |                  |
| $t_{RST(INT)}$                      | Internal Reset Timeout Period                              | $V_{RT} = V_{CC}$                                      | ● | 150                | 200  | 260                | ms               |
| $t_{RST(EXT)}$                      | Adjustable Reset Timeout Period                            | $C_{RT} = 2.2\text{nF}$                                | ● | 16                 | 20   | 25                 | ms               |
| $t_{UV}$                            | VM Undervoltage Detect to $\overline{\text{RST}}$ Asserted | VM Less Than Reset Threshold $V_{MTX}$ by More Than 5% | ● | 10                 | 80   | 150                | $\mu\text{s}$    |
| $V_{OL}$                            | Output Voltage Low $\overline{\text{RST}}$                 | $V_{CC} = 3.3\text{V}$ , $I_{RST} = 2.5\text{mA}$      | ● |                    | 0.15 | 0.4                | V                |
|                                     |                                                            | $V_{CC} = 1\text{V}$ , $I_{RST} = 100\mu\text{A}$      | ● |                    | 0.15 | 0.3                | V                |
|                                     |                                                            | $V_{CC} = 0.8\text{V}$ , $I_{RST} = 15\mu\text{A}$     | ● |                    | 0.05 | 0.2                | V                |
| $I_{OH(RST)}$                       | $\overline{\text{RST}}$ Output Voltage High Leakage        | $\overline{\text{RST}} = V_{CC}$                       | ● |                    |      | $\pm 1$            | $\mu\text{A}$    |
| <b>Manual Reset Input (LTC2916)</b> |                                                            |                                                        |   |                    |      |                    |                  |
| $V_{IL}$                            | Input Low Voltage                                          |                                                        | ● |                    |      | $0.2 \cdot V_{CC}$ | V                |
| $V_{IH}$                            | Input High Voltage                                         |                                                        | ● | $0.8 \cdot V_{CC}$ |      |                    | V                |
| $R_{PU}$                            | Pull Up Resistance                                         |                                                        | ● | 50                 | 100  | 150                | $\text{k}\Omega$ |
| $t_{PW}$                            | Pulsewidth                                                 |                                                        | ● | 250                |      |                    | ns               |

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

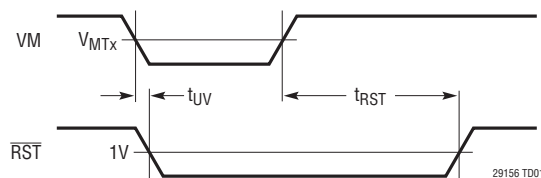
**Note 2:** All currents into pins are positive; all voltages are referenced to GND unless otherwise noted.

**Note 3:**  $V_{CC}$  maximum pin voltage is limited by input current. Since the  $V_{CC}$  pin has an internal 6.2V shunt regulator, a low impedance supply which exceeds 5.7V may exceed the rated terminal current. Operation from higher voltage supplies requires a series dropping resistor. See Applications Information.

**Note 4:** Input impedance is dependent on the configuration of the SEL pins.

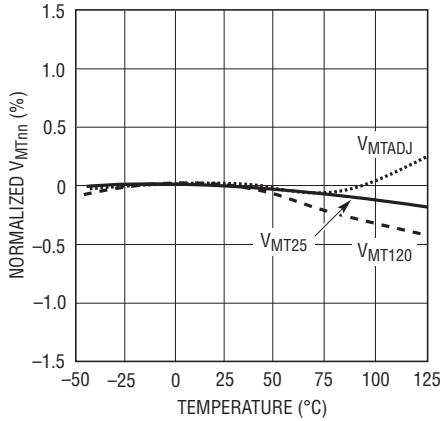
## TIMING DIAGRAM

Monitor Input Timing

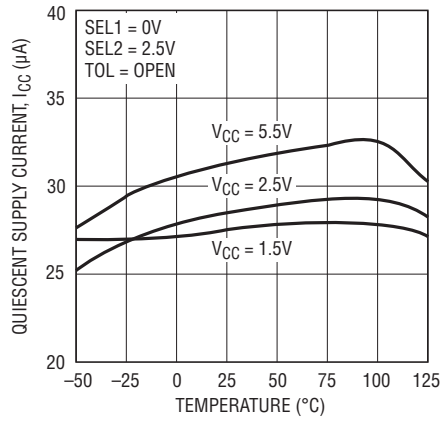


# TYPICAL PERFORMANCE CHARACTERISTICS $T_A = 25^\circ\text{C}$ unless otherwise noted.

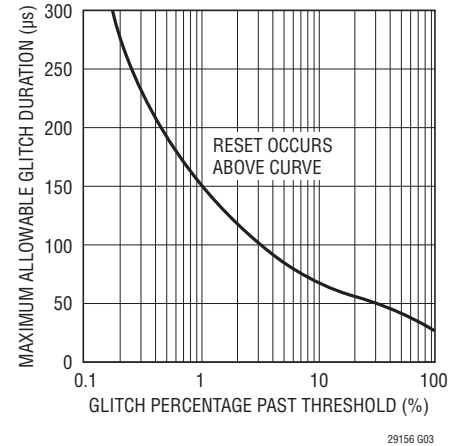
### Threshold Voltage vs Temperature



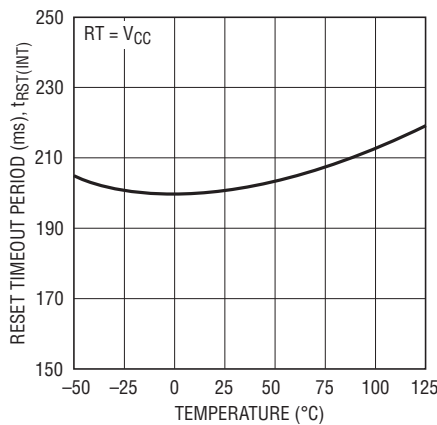
### Quiescent Supply Current vs Temperature



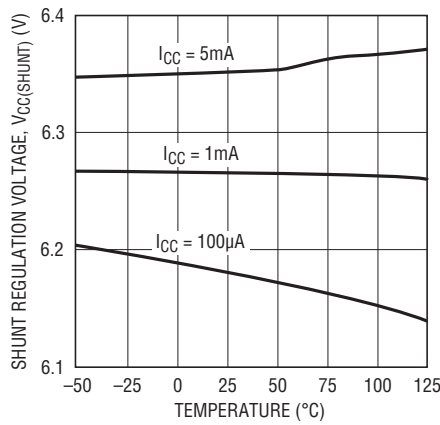
### Allowable Glitch Duration vs Magnitude



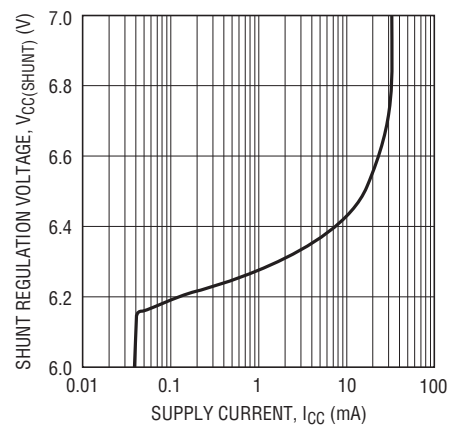
### Internal Reset Timeout Period vs Temperature



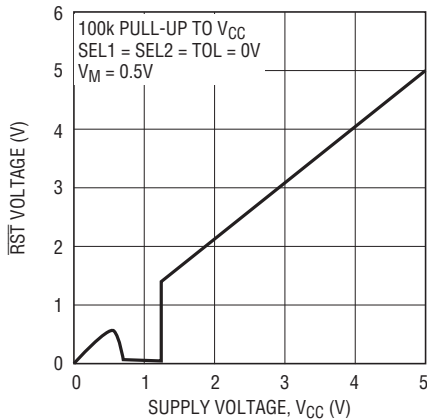
### Shunt Regulation Voltage vs Temperature



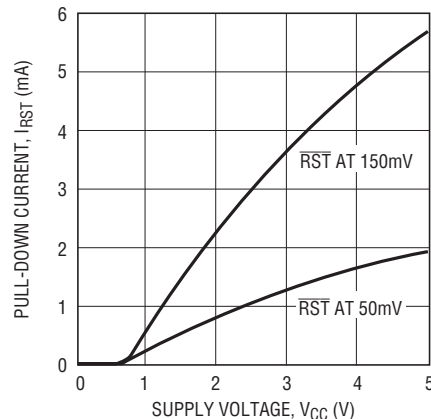
### Shunt Regulation Voltage vs Supply Current



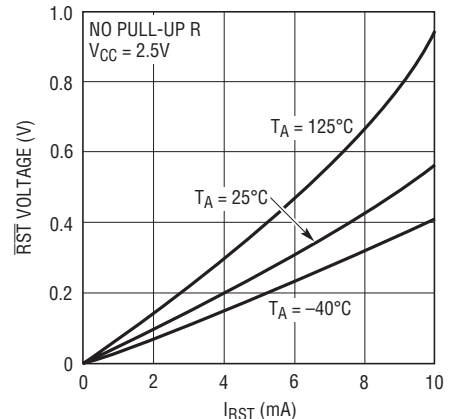
### RST Output Voltage vs V\_CC



### RST Pull-Down Current vs V\_CC



### RST V\_OL vs I\_RST



## PIN FUNCTIONS (TSOT/DFN)

**GND (Pin 4/Pin 1):** Device Ground.

**$\overline{\text{MR}}$  (Pin 3/Pin 2) (LTC2916 only):** Manual Reset Input (Active Low). A low level on the  $\overline{\text{MR}}$  input causes the part to issue a reset, which is released one reset timeout after the input goes high. The pin has an internal 100k pull-up to  $V_{\text{CC}}$ , and thus may interface directly to a momentary pushbutton. Leave open if unused.

**$\overline{\text{RST}}$  (Pin 5/Pin 8):** Open Drain  $\overline{\text{RST}}$  Output. Asserts low when VM is below the threshold selected by SEL1, SEL2 and TOL input pins. Held low for an adjustable timeout after VM input is above threshold.

**RT (Pin 6/Pin 7):** Reset Timeout Control Pin. Attach an external Capacitor ( $C_{\text{RT}}$ ) to GND to set a reset timeout of 9ms/nF. Floating RT generates a reset timeout of approximately 400 $\mu$ s. Tie RT to  $V_{\text{CC}}$  to generate a reset timeout of approximately 200ms.

**SEL1, SEL2 (Pins 2, 7/Pins 3, 6):** Monitor Voltage Select Three-State Inputs. SEL1 and SEL2 control the nominal threshold voltage that VM is set to monitor. Connect to  $V_{\text{CC}}$ , GND or leave unconnected in open state. (See Table 1).

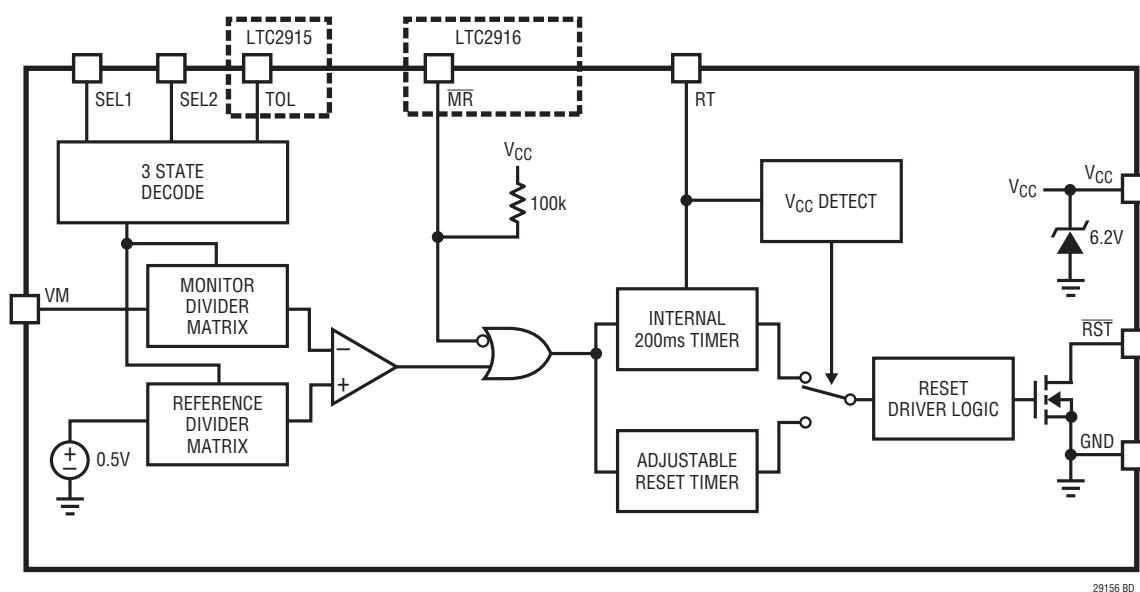
**TOL (Pin 3/Pin 2) (LTC2915 only):** Three-State Input for Supply Tolerance Selection (–5%, –10% or –15%). Controls the tolerance band at which the VM supply is monitored. Connect to  $V_{\text{CC}}$ , GND, or leave unconnected in open state. (See Table 2).

**$V_{\text{CC}}$  (Pin 8/Pin 5):** Power Supply Input. Bypass this pin to ground with a 0.1 $\mu$ F ceramic capacitor. A minimum of 1.5V on  $V_{\text{CC}}$  ensures that the part is out of under voltage lockout and that the voltage thresholds are accurate. Operates as a direct supply input for voltages up to 5.5V. Operates as a shunt regulator for supply voltages greater than 5.7V and should have a resistor between this pin and the supply to limit  $V_{\text{CC}}$  input current to no greater than 5mA. When used without a current-limiting resistor, pin voltage must not exceed 5.7V.

**VM (Pin 1/Pin 4):** Voltage Monitor Input to  $\overline{\text{RST}}$  Comparator. SEL1, SEL2 and TOL inputs select the exact threshold that asserts the  $\overline{\text{RST}}$  output.

**Exposed Pad (Pin 9, DFN Only):** Exposed Pad may be left open or connected to device ground.

## BLOCK DIAGRAM



## APPLICATIONS INFORMATION

### Supply Monitoring

The LTC2915/LTC2916 are low voltage single supply monitors with selectable thresholds. Two three-state inputs select one of nine internally programmed thresholds. For the LTC2915, a third three-state input selects the tolerance at which the supply connected to the VM pin is monitored (–5%, –10%, –15%). The tolerance for the LTC2916 is fixed at –5%. Threshold accuracy is guaranteed at  $\pm 1.5\%$  over the entire operating temperature range.

The LTC2915/LTC2916 asserts the  $\overline{\text{RST}}$  output low when VM is below the programmed threshold, and for a reset timeout ( $t_{\text{RST}}$ ) after VM goes above the threshold. The reset timeout can be configured to use an internal timer with no external components, or an adjusted timer programmed by placing an external capacitor from RT to ground.

### Power-Up

$V_{\text{CC}}$  powers the drive circuits for the  $\overline{\text{RST}}$  pin. Therefore, as soon as  $V_{\text{CC}}$  reaches 0.8V during power up, the  $\overline{\text{RST}}$  output asserts low.

Until  $V_{\text{CC}}$  reaches the undervoltage lockout threshold (guaranteed less than 1.5V),  $\overline{\text{RST}}$  is held low regardless of the state of VM.

Once  $V_{\text{CC}}$  is above the under voltage lockout threshold and VM is above the programmed threshold, the reset timer is started. After the reset timeout ( $t_{\text{RST}}$ ), the open drain pull-down releases  $\overline{\text{RST}}$  and the external pull-up resistor pulls high.

### Power-Down

On power-down, once VM drops below its threshold or  $V_{\text{CC}}$  drops below the undervoltage lockout,  $\overline{\text{RST}}$  asserts logic low.

### Monitor Threshold Control

The monitor threshold on the VM pin is controlled by the SEL1, SEL2 and TOL three-state pins. The SEL1 and SEL2 pins select one of nine preset nominal voltages (including one externally adjustable threshold) as shown in Table 1.

The SEL1 and SEL2 three-state input pins should be connected to GND,  $V_{\text{CC}}$  or left unconnected during normal operation. Note that when left unconnected, the maximum leakage allowable from the pin to either GND or  $V_{\text{CC}}$  is  $\pm 5\mu\text{A}$ .

The tolerance at which the monitored supply is measured is set by the TOL pin (LTC2915 only), as shown in Table 2. If desired (e.g. for margining purposes), the TOL pin may be driven by a three-state buffer. That three-state buffer must have a  $V_{\text{OL}}$  and  $V_{\text{OH}}$  which meet the  $V_{\text{IL}}$  and  $V_{\text{IH}}$  of the TOL pin specified in the Electrical Characteristics, and maintain less than  $5\mu\text{A}$  of leakage in the open state.

### Threshold Accuracy

The trip threshold for VM is selected by configuring the three-state input pins. When using the adjustable input, an external resistive divider sets the trip threshold, allowing the user complete control over the trip point. Selection of this trip voltage is crucial to the reliability of the system.

**Table 1. Voltage Threshold Settings**

| NOMINAL VOLTAGE | SEL1            | SEL2            |
|-----------------|-----------------|-----------------|
| 12V             | $V_{\text{CC}}$ | $V_{\text{CC}}$ |
| 5V              | $V_{\text{CC}}$ | Open            |
| 3.3V            | $V_{\text{CC}}$ | GND             |
| 2.5V            | Open            | $V_{\text{CC}}$ |
| 1.8V            | Open            | Open            |
| 1.5V*           | Open            | GND             |
| 1.2V*           | GND             | $V_{\text{CC}}$ |
| 1V*             | GND             | Open            |
| ADJ* (0.5V)     | GND             | GND             |

\*Require a separate supply for  $V_{\text{CC}}$

**Table 2. System Voltage Tolerance Settings**

| TOLERANCE | TOL             |
|-----------|-----------------|
| –5%       | $V_{\text{CC}}$ |
| –10%      | Open            |
| –15%      | GND             |



## APPLICATIONS INFORMATION

Any power supply has some tolerance band within which it is expected to operate (e.g.  $5V \pm 10\%$ ). It is generally undesirable that a supervisor issue a reset when the power supply is inside this tolerance band. Such a “nuisance” reset reduces reliability by preventing the system from functioning under normal conditions.

To prevent nuisance resets, the supervisor threshold must be guaranteed to lie outside the power supply tolerance band. To ensure that the threshold lies outside the power supply tolerance range, the nominal threshold must lie outside that range by the monitor’s accuracy specification.

All 27 of the selectable thresholds have the same relative threshold accuracy of  $\pm 1.5\%$  of the programmed nominal input voltage (over the full operating temperature range). Consider the example of monitoring a 5V supply with a 10% tolerance. The nominal threshold internal to the LTC2915 is 11.5% below the 5V input at 4.425V. With  $\pm 1.5\%$  accuracy, the trip threshold range is  $4.425V \pm 75mV$  over temperature (i.e. 10% to 13% below 5.0V). The monitored system must thus operate reliably down to 4.35V or 13% below 5.0V over temperature.

### Glitch Immunity

The above discussion is concerned only with the DC value of the monitored supply. Real supplies also have relatively high-frequency variation, from sources such as load transients, noise, and pickup. These variations should not be considered by the monitor in determining whether a supply voltage is valid or not. The variations may cause spurious outputs at  $\overline{RST}$ , particularly if the supply voltage is near its trip threshold.

Two techniques are used to combat spurious reset without sacrificing threshold accuracy. First, the timeout period helps prevent high-frequency variation whose frequency is above  $1/t_{RST}$  from appearing at the  $\overline{RST}$  output.

When the voltage at VM goes below the threshold, the  $\overline{RST}$  pin asserts low. When the supply recovers past the threshold, the reset timer starts (assuming it is not disabled), and  $\overline{RST}$  does not go high until it finishes. If the supply becomes invalid any time during the timeout

period, the timer resets and begins again when the supply next becomes valid.

While the reset timeout is useful at preventing toggling of the reset output in most cases, it is not effective at preventing nuisance resets due to short glitches (due to load transients or other effects) on a valid supply.

To reduce sensitivity to these short glitches, the comparator has additional anti-glitch circuitry. Any transient at the input of the comparator needs to be of sufficient magnitude and duration  $t_{UV}$  before it can change the monitor state.

The combination of the reset timeout and anti-glitch circuitry prevents spurious changes in output state without sacrificing threshold accuracy.

### Adjustable Input

When the monitor threshold is configured as ADJ, the internal comparator input is connected to the pin without a resistive divider, and the pin is high-impedance. Thus, any desired threshold may be chosen by attaching VM to a tap point on an external resistive divider between the monitored supply and ground, as shown in Figure 1.

The reference input of the comparator is controlled by the tolerance pin. The external resistive divider should make the voltage at  $VM = 0.5V$  when the supply is at nominal value. The actual threshold of VM accounts for the supply tolerance of  $\pm 1.5\%$  guaranteed over the full operating temperature range. The resulting tolerances are  $-6.5\%$ ,  $-11.5\%$ ,  $-16.5\%$  which correspond to 0.468V, 0.443V, 0.418V respectively.

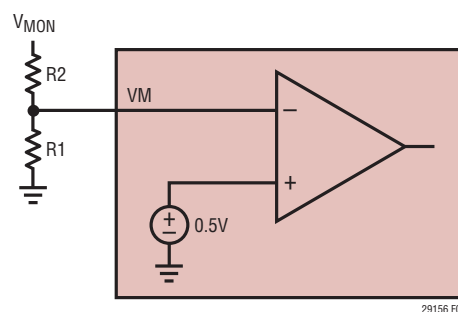


Figure 1. Setting the Trip Point Using the Adjustable Threshold



## APPLICATIONS INFORMATION

Typically, the user will pick a value of R1 based on acceptable current draw. Current used by the resistor divider will be approximately

$$R1 = \left( \frac{0.5V}{I} \right)$$

Recommended range of R1 is 1k to 1M. Higher values of resistance exacerbate the degradation of threshold accuracy due to leakage currents.

If the nominal value of the supply being monitored is  $V_{NOM}$ , then

$$R2 = R1(2V_{NOM} - 1)$$

Resistor tolerances must be taken into account when determining the overall accuracy.

### Selecting the Reset Timing Capacitor

The reset timeout period can be set to one of two fixed internal timers or set with a capacitor in order to accommodate a variety of applications. Connecting a capacitor,  $C_{RT}$ , between the RT pin and ground sets the reset timeout period,  $t_{RST}$ . The following formula approximates the value of capacitor needed for a particular timeout:

$$C_{RT} = t_{RST} \cdot 110 \text{ [pF/ms]}$$

For example, using a standard capacitor value of 2.2nF would give 20ms delay.

Figure 2 shows the reset timeout period as a function of the value of the timer capacitor.

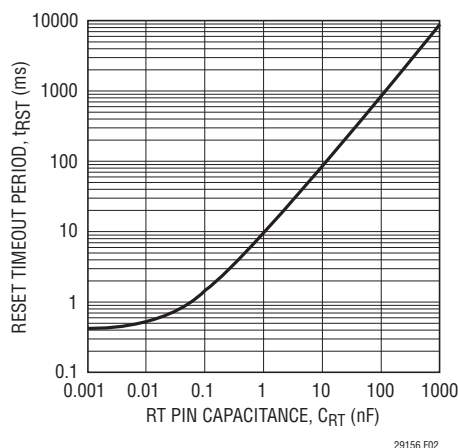


Figure 2. Reset Timeout Period vs RT Capacitance

Leaving RT open with no external capacitor generates a reset timeout of approximately 400 $\mu$ s. Shorting RT to  $V_{CC}$  generates a reset timeout of approximately 200ms.

### $\overline{RST}$ Output Characteristics

The DC characteristics of the  $\overline{RST}$  pull-down strength are shown in the Typical Performance Characteristics section.  $\overline{RST}$  is an open-drain pin and thus requires an external pull-up resistor to the logic supply.  $\overline{RST}$  may be pulled above  $V_{CC}$ , providing the voltage limits of the pin are observed.

The open-drain of the  $\overline{RST}$  pin allows for wired-OR connection of several LTC2915/LTC2916s.

As noted in the discussion of power up and power down, the circuits that drive  $\overline{RST}$  are powered by  $V_{CC}$ . During a fault condition,  $V_{CC}$  of at least 1V ensures that  $\overline{RST}$  pulls low.

### Manual Reset (LTC2916 Only)

The LTC2916 includes the  $\overline{MR}$  pin for applications where a manual reset is desired.  $\overline{MR}$  is internally pulled up, allowing it to interface with a push button with no external components required. Asserting  $\overline{MR}$  low when  $\overline{RST}$  is high, initiates a reset, resulting in  $\overline{RST}$  being asserted low for the set reset timeout.

### Shunt Regulator

The LTC2915 and LTC2916 contain an internal 6.2V shunt regulator on the  $V_{CC}$  pin to allow operation from a high voltage supply. To operate the part from a supply higher than 5.7V, the  $V_{CC}$  pin must have a series resistor,  $R_{CC}$ , to the supply. This resistor should be sized according to the following equation:

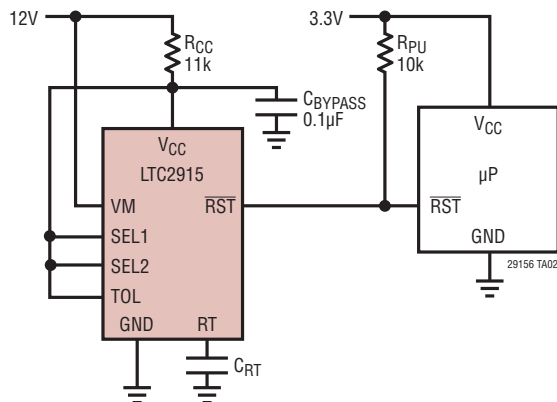
$$\frac{V_{S(MAX)} - 5.7V}{5mA} \leq R_{CC} \leq \frac{V_{S(MIN)} - 7V}{250\mu A}$$

where  $V_{S(MIN)}$  and  $V_{S(MAX)}$  are the operating minimum and maximum of the supply.

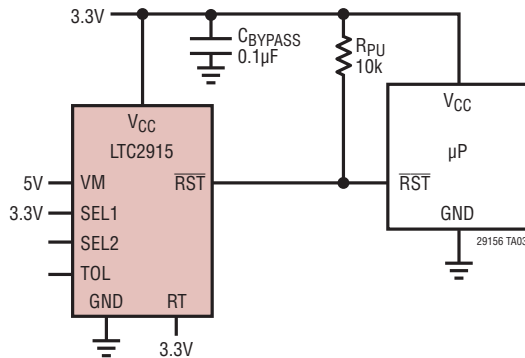
As an example, consider operation from an automobile battery which might dip as low as 10V or spike to 60V. We must then pick a resistance between 10.86k and 12k.

## TYPICAL APPLICATIONS

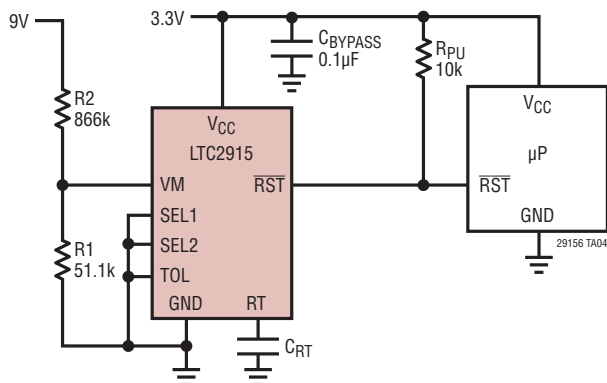
**12V Supply Monitor Powered from 12V, Utilizing Internal Shunt Regulator with 3.3V Logic Out**



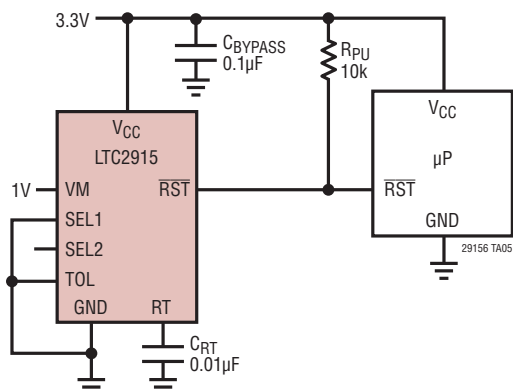
**5V, -10% Tolerance Supply Monitor with 200ms Internal Reset Timeout**



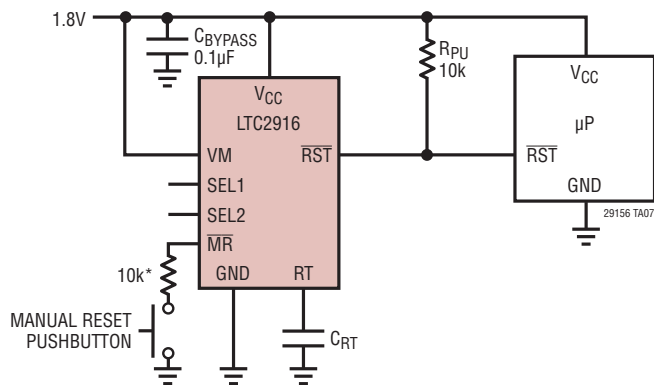
**9V, -15% Tolerance Supply Monitor with 3.3V Logic Out**



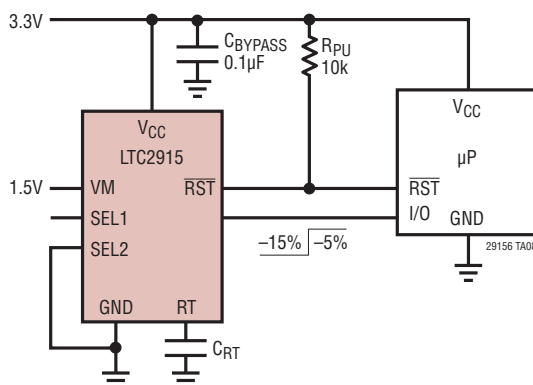
**1V, -15% Tolerance Supply Monitor with 90ms Timeout**



**1.8V, -5% Supply Monitor with Manual Reset**



**1.5V Supply Monitor with Tolerance Control for Margining, -5% Operation with -15% Margining**

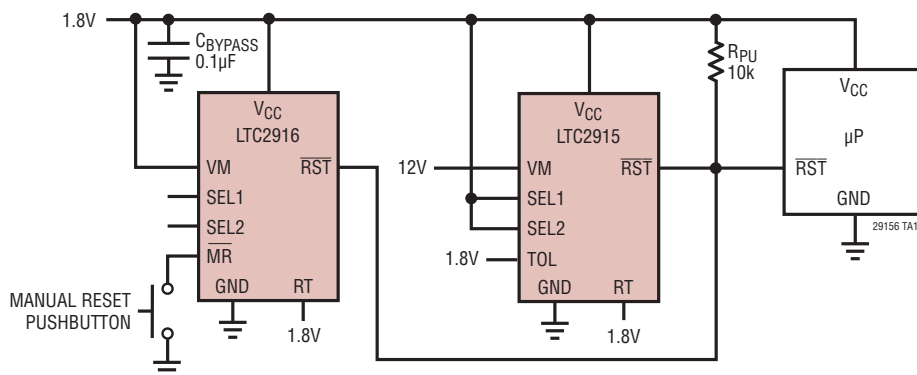


\*OPTIONAL RESISTOR RECOMMENDED TO EXTEND ESD TOLERANCE



## TYPICAL APPLICATION

Dual Supply Monitor (1.8V and 12V) with Manual Reset and 200ms Reset Timeout



## RELATED PARTS

| PART NUMBER     | DESCRIPTION                                                    | COMMENTS                                                                             |
|-----------------|----------------------------------------------------------------|--------------------------------------------------------------------------------------|
| LTC690          | 5V Supply Monitor, Watchdog Timer and Battery Backup           | 4.65V Threshold                                                                      |
| LTC694-3.3      | 3.3V Supply Monitor, Watchdog Timer and Battery Backup         | 2.9V Threshold                                                                       |
| LTC1232         | 5V Supply Monitor, Watchdog Timer and Push-Button Reset        | 4.37V/4.62V Threshold                                                                |
| LTC1326         | Micro Power Precision Triple Supply Monitor                    | 4.725V, 2.363V, 3.118V, 1V Threshold ( $\pm 0.75\%$ )                                |
| LTC1726         | Micro Power Triple Supply Monitor for 2.5V/5V, 3.3V and ADJ    | Adjustable $\overline{\text{RESET}}$ and Watchdog Time-Outs                          |
| LTC1727         | Micro Power Triple Supply Monitor with Open-Drain Reset        | Individual Monitor Outputs in MSOP                                                   |
| LTC1728         | Micro Power Triple Supply Monitor with Open-Drain Reset        | 5-Lead SOT-23 Package                                                                |
| LTC1985-1.8     | Micro Power Triple Supply Monitor with Push-Pull Reset         | 5-Lead SOT-23 Package                                                                |
| LTC2900         | Programmable Quad Supply Monitor                               | Adjustable $\overline{\text{RESET}}$ , 10-Lead MSOP and 3mm $\times$ 3mm 10-Lead DFN |
| LTC2901         | Programmable Quad Supply Monitor                               | Adjustable $\overline{\text{RESET}}$ and Watchdog Timer, 16-Lead SSOP Package        |
| LTC2902         | Programmable Quad Supply Monitor                               | Adjustable $\overline{\text{RESET}}$ and Tolerance, 16-Lead SSOP Package, Margining  |
| LTC2903         | Precision Quad Supply Monitor                                  | 6-Lead SOT-23 Package, Ultra Low Voltage Reset                                       |
| LTC2904/LTC2905 | 3-State Programmable Precision Dual Supply Monitor             | Adjustable $\overline{\text{RESET}}$ and Tolerance, 8-Lead SOT-23 Package            |
| LTC2906         | Precision Dual Supply Monitor 1 Selectable and 1 Adjustable    | Separate $V_{CC}$ Pin, RST/ $\overline{\text{RST}}$ Outputs                          |
| LTC2907         | Precision Dual Supply Monitor 1 Selectable and 1 Adjustable    | Separate $V_{CC}$ Pin, Adjustable Reset Timer                                        |
| LTC2908         | Precision Six Supply Monitor (Four Fixed and 2 Adjustable)     | 8-Lead SOT-23 and DDB Packages                                                       |
| LTC2909         | Precision Triple/Dual Input UV, OV Monitor                     | 2 ADJ Inputs, Monitors Negative Voltages                                             |
| LTC2910         | Octal Positive/Negative Voltage Monitor                        | 16-Lead SSOP and 5mm $\times$ 3mm DFN Packages                                       |
| LTC2912         | Single UV/OV Voltage Monitor, Adjustable UV and OV Trip Values | 8-Lead TSOT and 3mm $\times$ 2mm DFN Packages                                        |
| LTC2913         | Dual UV/OV Voltage Monitor                                     | 10-Lead MSOP and 3mm $\times$ 3mm DFN Packages                                       |
| LTC2914         | Qual UV/OV Positive/Negative Voltage Monitor                   | 16-Lead SSOP and 5mm $\times$ 3mm DFN Packages                                       |