

# LP3470

## Tiny Power On Reset Circuit

### General Description

The LP3470 is a micropower CMOS voltage supervisory circuit designed to monitor power supplies in microprocessor ( $\mu\text{P}$ ) and other digital systems. It provides maximum adjustability for power-on-reset (POR) and supervisory functions. It is available in the following six standard reset threshold voltage ( $V_{\text{RTH}}$ ) options: 2.63V, 2.93V, 3.08V, 3.65V, 4.00V, 4.38V, and 4.63V. If other voltage options between 2.4V and 5.0V are desired please contact your National Semiconductor representative.

The LP3470 asserts a reset signal whenever the  $V_{\text{CC}}$  supply voltage falls below a reset threshold. The reset time-out period is adjustable using an external capacitor. Reset remains asserted for an interval (programmed by an external capacitor) after  $V_{\text{CC}}$  has risen above the threshold voltage.

The device is available in the tiny SOT23-5 package.

### Key Specifications

- $\pm 1\%$  Reset Threshold Accuracy Over Temperature
- Standard Reset Threshold Voltages: 2.63V, 2.93V, 3.08V, 3.65V, 4.00V, 4.38V, and 4.63V
- Custom Reset Threshold Voltages: For other voltages between 2.4V and 5.0V contact your National Semiconductor representative
- Very Low Quiescent Current (16  $\mu\text{A}$  typical)
- Guaranteed  $\overline{\text{Reset}}$  valid down to  $V_{\text{CC}}=0.5\text{V}$

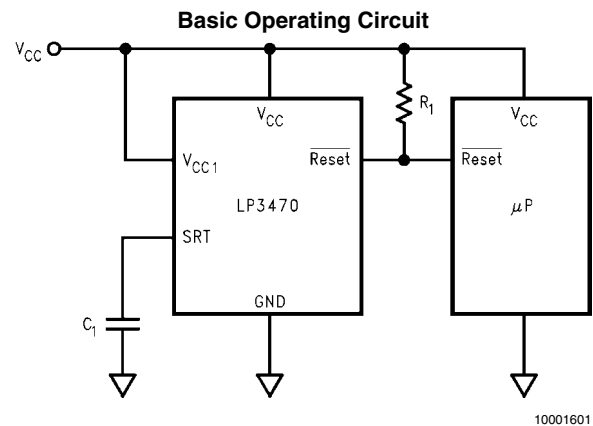
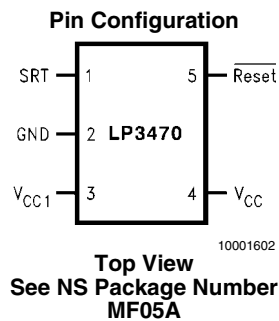
### Features

- Tiny SOT23-5 Package
- Open Drain  $\overline{\text{Reset}}$  Output
- Programmable Reset Timeout Period Using an External Capacitor
- Immune to Short  $V_{\text{CC}}$  Transients

### Applications

- Critical  $\mu\text{P}$  and  $\mu\text{C}$  Power Monitoring
- Intelligent Instruments
- Computers
- Portable/Battery-Powered Equipments

## Pin Configuration and Basic Operating Circuit



## Ordering Information

| Operating Temperature Range | Nominal $V_{RTH}$ (V) | Order Number    | Package Marking | Package Type                | Supplied As                 |                             |
|-----------------------------|-----------------------|-----------------|-----------------|-----------------------------|-----------------------------|-----------------------------|
| -20°C to +85°C              | 2.63                  | LP3470M5-2.63   | D25B            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470M5X-2.63  | D25B            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
|                             | 2.93                  | LP3470M5-2.93   | D26B            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470M5X-2.93  | D26B            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
|                             | 3.08                  | LP3470M5-3.08   | D28B            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470M5X-3.08  | D28B            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
|                             | 4.00                  | LP3470M5-4.00   | D29B            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470M5X-4.00  | D29B            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
|                             | 4.38                  | LP3470M5-4.38   | D30B            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470M5X-4.38  | D30B            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
|                             | 4.63                  | LP3470M5-4.63   | D31B            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470M5X-4.63  | D31B            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
|                             | -40°C to +85°C        | 2.63            | LP3470IM5-2.63  | D25C                        | SOT23-5                     | 1000 Units on Tape and Reel |
|                             |                       |                 | LP3470IM5X-2.63 | D25C                        | SOT23-5                     | 3000 Units on Tape and Reel |
| 2.75                        |                       | LP3470IM5-2.75  | D38C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
| 2.83                        |                       | LP3470IM5-2.83  | D39C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470IM5X-2.83 | D39C            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
| 2.93                        |                       | LP3470IM5-2.93  | D26C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470IM5X-2.93 | D26C            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
| 3.08                        |                       | LP3470IM5-3.08  | D28C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470IM5X-3.08 | D28C            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
| 3.65                        |                       | LP3470IM5-3.65  | D37C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470IM5X-3.65 | D37C            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
| 4.00                        |                       | LP3470IM5-4.00  | D29C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470IM5X-4.00 | D29C            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
| 4.38                        |                       | LP3470IM5-4.38  | D30C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             |                       | LP3470IM5X-4.38 | D30C            | SOT23-5                     | 3000 Units on Tape and Reel |                             |
| 4.63                        |                       | LP3470IM5-4.63  | D31C            | SOT23-5                     | 1000 Units on Tape and Reel |                             |
|                             | LP3470IM5X-4.63       | D31C            | SOT23-5         | 3000 Units on Tape and Reel |                             |                             |
| 4.80                        | LP3470IM5X-4.8        | D15C            | SOT23-5         | 1000 Units on Tape and Reel |                             |                             |

## Absolute Maximum Ratings *(Note 1)*

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                       |                |
|---------------------------------------|----------------|
| $V_{CC}$ Voltage                      | -0.3V to +6V   |
| Reset Voltage                         | -0.3V to +6V   |
| Output Current (Reset)                | 10 mA          |
| Operating Temperature Range<br>LP3470 | -20°C to +85°C |

|  |                 |
|--|-----------------|
| LP3470I  | -40°C to +85°C  |
| Junction Temperature ( $T_{Jmax}$ )                            | 125°C           |
| Power Dissipation ( $T_A = 25^\circ\text{C}$ ) <i>(Note 2)</i> | 300 mW          |
| $\theta_{JA}$ <i>(Note 2)</i>                                  | 280°C/W         |
| Storage Temp. Range  | -65°C to +150°C |
| Lead Temp. (Soldering, 5 sec)                                  | 260°C           |
| ESD Rating <i>(Note 3)</i>                                     | 2 kV            |

## Electrical Characteristics

Limits in standard typeface are for  $T_J = 25^\circ\text{C}$ , and limits in **boldface** type apply over the full operating temperature range, unless otherwise specified.  $V_{CC} = +2.4\text{V}$  to  $+5.0\text{V}$  unless otherwise noted.

| Symbol     | Parameter                               | Conditions  | Typ<br><i>(Note 4)</i> | Min<br><i>(Note 5)</i>                         | Max<br><i>(Note 5)</i>                         | Units         |
|------------|---|---|------------------------|--|--|---------------|
| $V_{CC}$   | Operating Voltage Range                 |   |                        | <b>0.5</b>                                     | <b>5.5</b>                                     | V             |
| $I_{CC}$   | $V_{CC}$ Supply Current                 | $V_{CC} = 4.5\text{V}$                                      | 16                     |  | <b>30</b>                                      | $\mu\text{A}$ |
| $V_{RTH}$  | Reset Threshold Voltage <i>(Note 6)</i> | LP3470  | $V_{RTH}$              | 0.99<br>$V_{RTH}$<br><b>0.99</b><br>$V_{RTH}$  | 1.01<br>$V_{RTH}$<br><b>1.01</b><br>$V_{RTH}$  | V             |
|            |   | LP3470I   | $V_{RTH}$              | 0.99<br>$V_{RTH}$<br><b>0.985</b><br>$V_{RTH}$ | 1.01<br>$V_{RTH}$<br><b>1.015</b><br>$V_{RTH}$ |               |
| $V_{HYST}$ | Hysteresis Voltage <i>(Note 7)</i>      |   | 35                     | <b>15</b>                                      | <b>65</b>                                      | mV            |
| $t_{PD}$   | $V_{CC}$ to Reset Delay                 | $V_{CC}$ falling at 1 mV/ $\mu\text{s}$                     | 100                    |  | <b>300</b>                                     | $\mu\text{s}$ |
| $t_{RP}$   | Reset Timeout Period <i>(Note 8)</i>    | $C_1 = 1\text{ nF}$   | 2                      | <b>1.0</b>                                     | <b>3.5</b>                                     | ms            |
| $V_{OL}$   | Reset Output Voltage Low                | $V_{CC} = 0.5\text{V}$ ; $I_{OL} = 30\text{ }\mu\text{A}$   |                        |  | <b>0.1</b>                                     | V             |
|            |   | $V_{CC} = 1.0\text{V}$ ; $I_{OL} = 100\text{ }\mu\text{A}$  |                        |  | <b>0.1</b>                                     |               |
|            |   | $V_{CC} = V_{RTH} - 100\text{ mV}$ ; $I_{OL} = 4\text{ mA}$ |                        |  | <b>0.4</b>                                     |               |
| $R_1$      | External Pull-up Resistor               |   | 20                     | 0.68   | 68   | k $\Omega$    |
| $I_{LEAK}$ | Reset Output Leakage Current            |   | 0.15                   |  | 1<br><b>6</b>                                  | $\mu\text{A}$ |

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its operating conditions.

**Note 2:** The maximum power dissipation must be derated at elevated temperatures and is dictated by  $T_{Jmax}$  (Maximum Junction Temperature),  $\theta_{JA}$  (Junction to Ambient Thermal Resistance), and  $T_A$  (Ambient Temperature). The maximum allowable power dissipation at any temperature is  $P_{Dmax} = (T_{Jmax} - T_A) / \theta_{JA}$  or the number given in the Absolute Maximum Ratings, whichever is lower.

**Note 3:** The Human Body Model is a 100 pF capacitor discharged through a 1.5 k $\Omega$  resistor into each pin.

**Note 4:** Typical numbers are at 25°C and represent the most likely parametric norm.

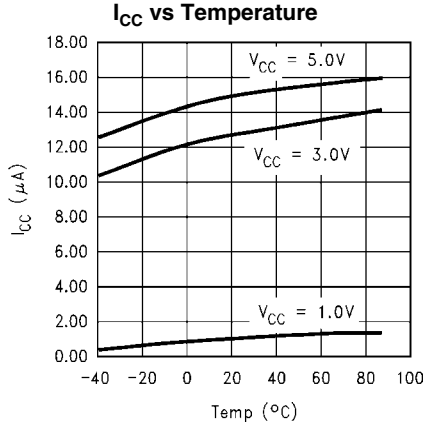
**Note 5:** Min. and Max. limits in standard typeface are 100% production tested at 25°C. Min. and Max. limits in boldface are guaranteed through correlation using Statistical Quality Control (SQC) methods. The limits are used to calculate National's Average Outgoing Quality Level (AOQL).

**Note 6:** Factory-trimmed reset thresholds are available in 50 mV increments from 2.4V to 5.0V. Contact your National Semiconductor representative.

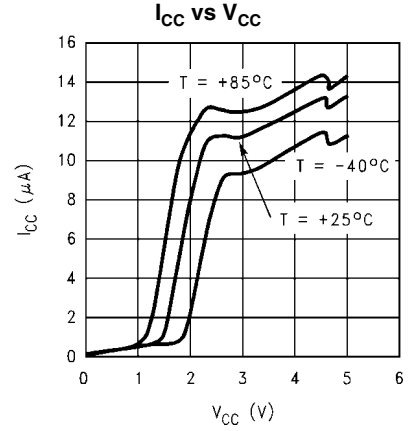
**Note 7:**  $V_{HYST}$  affects the relation between  $V_{CC}$  and Reset as shown in the timing diagram.

**Note 8:**  $t_{RP}$  is programmable by varying the value of the external capacitor ( $C_1$ ) connected to pin SRT. The equation is:  $t_{RP} = 2000 \times C_1$  ( $C_1$  in  $\mu\text{F}$  and  $t_{RP}$  in ms).

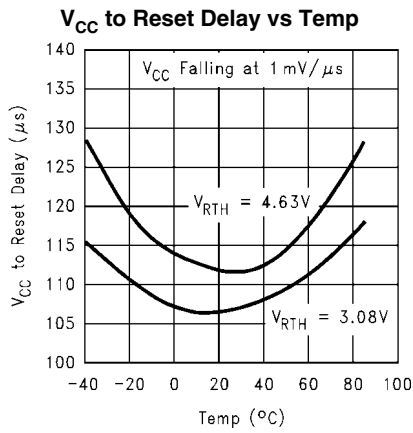
**Typical Operating Characteristics**  $T_A = +25^\circ\text{C}$ , unless otherwise specified.



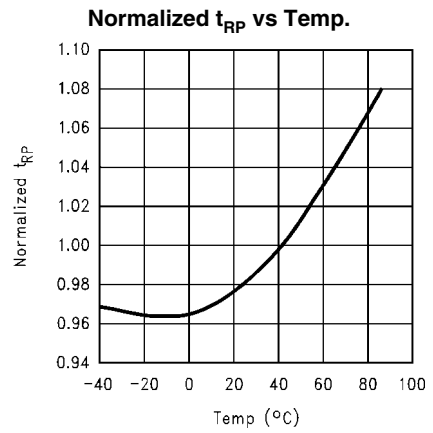
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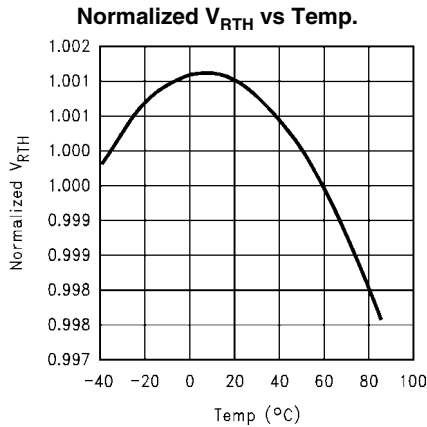
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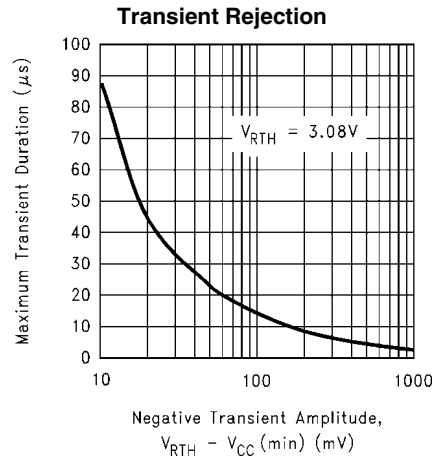
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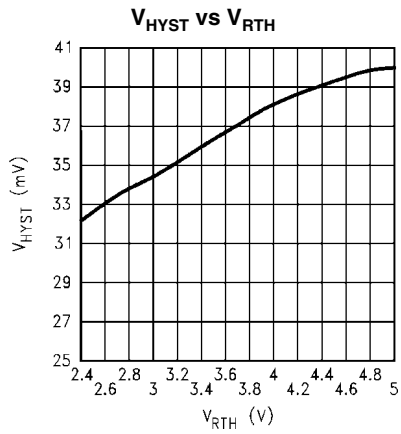
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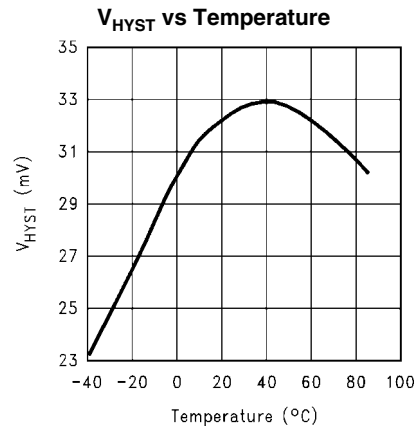
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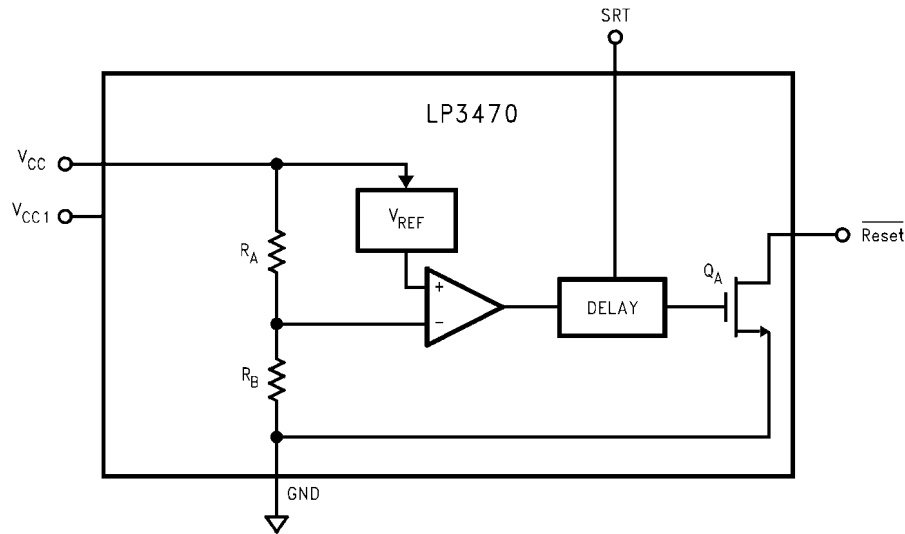


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## Pin Descriptions

| Pin | Name             | Function  |
|-----|------------------|---|
| 1   | SRT              | Set Reset Time-out Input. Connect a capacitor between this input and ground to select the Reset Time-out period ( $t_{RP}$ ). $t_{RP} = 2000 \times C_1$ ( $C_1$ in $\mu\text{F}$ and $t_{RP}$ in ms). If no capacitor is connected, leave this pin floating.   |
| 2   | GND              | Ground pin.   |
| 3   | V <sub>CC1</sub> | Always connect to pin V <sub>CC</sub> (Pin 4).  |
| 4   | V <sub>CC</sub>  | Supply voltage, and reset threshold monitor input.  |
| 5   | Reset            | Open-Drain, Active-Low reset output. Connect to an external pull-up resistor. Reset changes from high to low whenever the monitored voltage (V <sub>CC</sub> ) drops below the reset threshold voltage (V <sub>RTH</sub> ). Once V <sub>CC</sub> exceeds V <sub>RTH</sub> , Reset remains low for the reset timeout period ( $t_{RP}$ ) and then goes high. |

## Functional Block Diagram



10001603

## Application Information

### RESET TIMEOUT PERIOD

The Reset Timeout Period ( $t_{RP}$ ) is programmable using an external capacitor ( $C_1$ ) connected to pin SRT of LP3470. A Ceramic chip capacitor rated at or above 10V is sufficient. The Reset Timeout Period ( $t_{RP}$ ) can be calculated using the following formula:

$$t_{RP} \text{ (ms)} = 2000 \times C_1 \text{ (\mu F)}$$

For example a  $C_1$  of 100 nF will achieve a  $t_{RP}$  of 200 ms. If no delay due to  $t_{RP}$  is needed in a certain application, the pin SRT should be left floating.

### RESET OUTPUT

In applications like microprocessor ( $\mu P$ ) systems, errors might occur in system operation during power-up, power-down, or brownout conditions. It is imperative to monitor the power supply voltage in order to prevent these errors from occurring.

The LP3470 asserts a reset signal whenever the  $V_{CC}$  supply voltage is below a threshold ( $V_{RTH}$ ) voltage.  $\overline{\text{Reset}}$  is guaranteed to be a logic low for  $V_{CC} > 0.5V$ . Once  $V_{CC}$  exceeds the reset threshold, the reset is kept asserted for a time period ( $t_{RP}$ ) programmed by an external capacitor ( $C_1$ ); after this interval  $\overline{\text{Reset}}$  goes to logic high. If a brownout condition occurs (monitored voltage falls below the reset threshold minus a small hysteresis),  $\overline{\text{Reset}}$  goes low. When  $V_{CC}$  returns above

the reset threshold,  $\overline{\text{Reset}}$  remains low for a time period  $t_{RP}$  before going to logic high.

### PULL-UP RESISTOR SELECTION

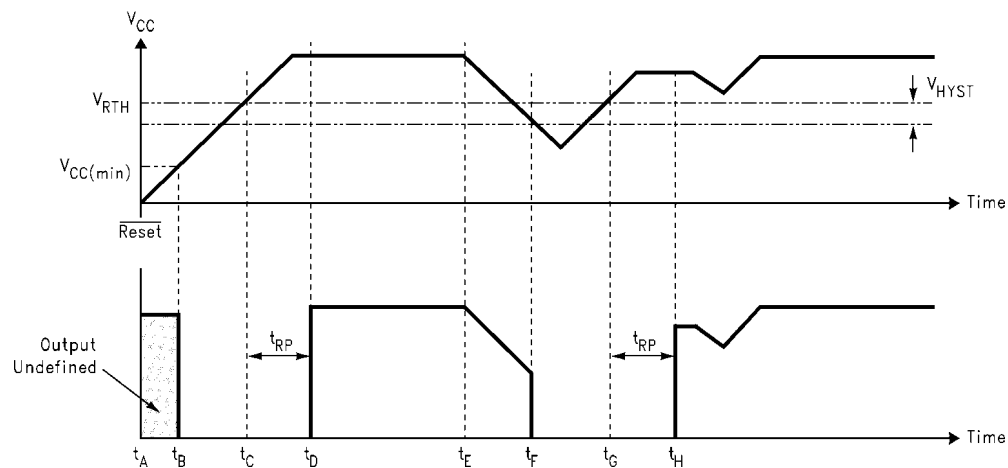
The LP3470's  $\overline{\text{Reset}}$  output structure is a simple open-drain N-channel MOSFET switch. A pull-up resistor ( $R_1$ ) should be connected to  $V_{CC}$ .

$R_1$  should be large enough to limit the current through the output MOSFET ( $Q_1$ ) below 10 mA. A resistor value of more than  $680\Omega$  guarantees this.  $R_1$  should also be small enough to ensure a logic high while supplying all the leakage current through the  $\overline{\text{Reset}}$  pin. A resistor value of less than  $68k\Omega$  satisfies this condition. A typical pull-up resistor value of 20 k $\Omega$  is sufficient in most applications.

### NEGATIVE-GOING $V_{CC}$ TRANSIENTS

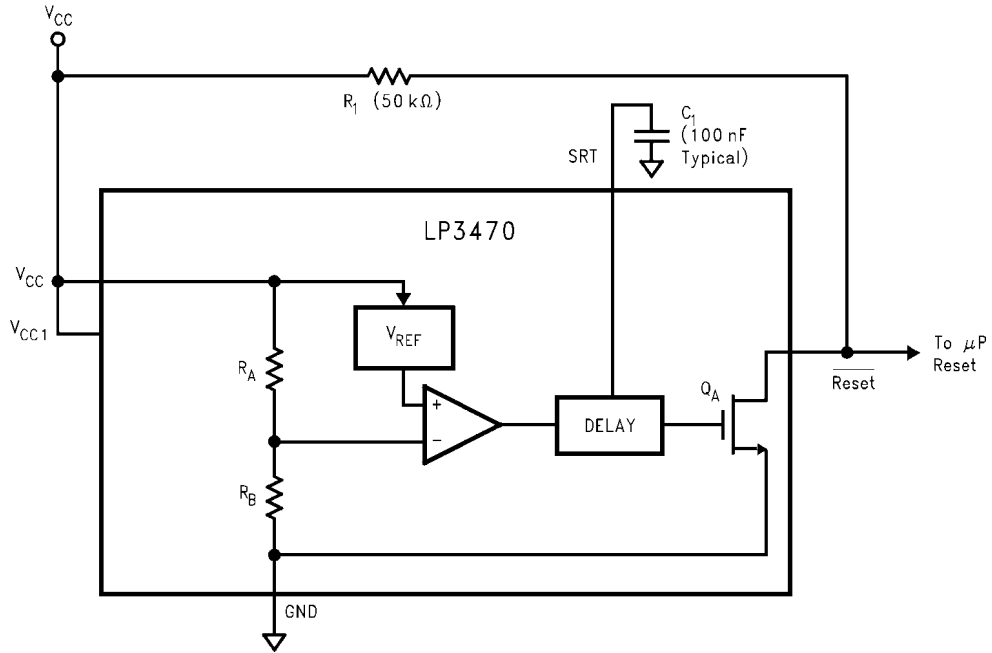
The LP3470 is relatively immune to short duration negative-going  $V_{CC}$  transients (glitches). The Typical Operating Characteristics show the Maximum Transient Duration vs. Negative Transient Amplitude (graph titled Transient Rejection), for which reset pulses are not generated. This graph shows the maximum pulse width a negative-going  $V_{CC}$  transient may typically have without causing a reset pulse to be issued. As the transient amplitude increases (i.e. goes farther below the reset threshold), the maximum allowable pulse width decreases. A 0.1  $\mu F$  bypass capacitor mounted close to  $V_{CC}$  provides additional transient immunity.

## Timing Diagram



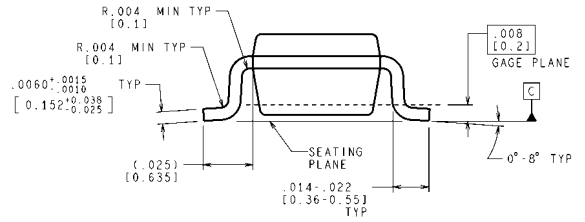
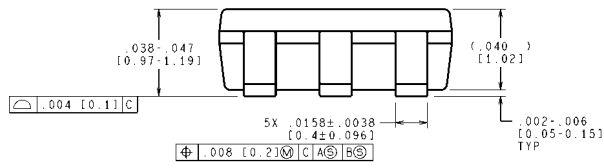
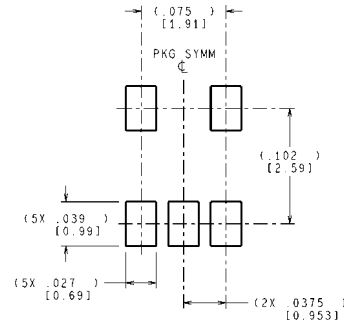
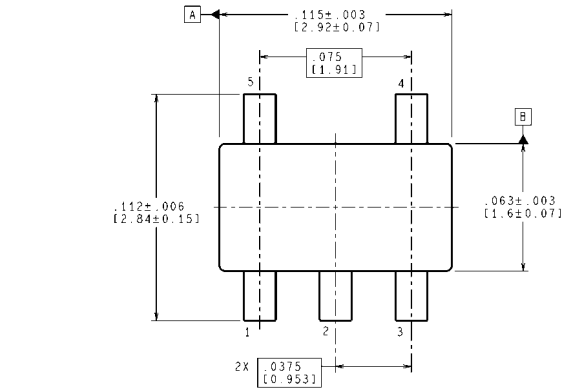
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### Typical Application Circuit



10001605

**Physical Dimensions** inches (millimeters) unless otherwise noted



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VALUES IN [ ] ARE MILLIMETERS  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

MF05A (Rev D)

**5-Lead Small Outline Package (M5)**  
For Ordering Information See *Ordering Information Table* In This Data Sheet  
NSPackage Number MF05A



# Notes

LP3470

## Notes

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| Data Converters                | <a href="http://www.national.com/adc">www.national.com/adc</a>               | Samples                      | <a href="http://www.national.com/samples">www.national.com/samples</a>             |
| Interface                      | <a href="http://www.national.com/interface">www.national.com/interface</a>   | Eval Boards                  | <a href="http://www.national.com/evalboards">www.national.com/evalboards</a>       |
| LVDS                           | <a href="http://www.national.com/lvds">www.national.com/lvds</a>             | Packaging                    | <a href="http://www.national.com/packaging">www.national.com/packaging</a>         |
| Power Management               | <a href="http://www.national.com/power">www.national.com/power</a>           | Green Compliance             | <a href="http://www.national.com/quality/green">www.national.com/quality/green</a> |
| Switching Regulators           | <a href="http://www.national.com/switchers">www.national.com/switchers</a>   | Distributors                 | <a href="http://www.national.com/contacts">www.national.com/contacts</a>           |
| LDOs                           | <a href="http://www.national.com/ldo">www.national.com/ldo</a>               | Quality and Reliability      | <a href="http://www.national.com/quality">www.national.com/quality</a>             |
| LED Lighting                   | <a href="http://www.national.com/led">www.national.com/led</a>               | Feedback/Support             | <a href="http://www.national.com/feedback">www.national.com/feedback</a>           |
| Voltage Reference              | <a href="http://www.national.com/vref">www.national.com/vref</a>             | Design Made Easy             | <a href="http://www.national.com/easy">www.national.com/easy</a>                   |
| PowerWise® Solutions           | <a href="http://www.national.com/powerwise">www.national.com/powerwise</a>   | Solutions                    | <a href="http://www.national.com/solutions">www.national.com/solutions</a>         |
| Serial Digital Interface (SDI) | <a href="http://www.national.com/sdi">www.national.com/sdi</a>               | Mil/Aero                     | <a href="http://www.national.com/milaero">www.national.com/milaero</a>             |
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