



# MAX823/4/5

## Voltage Supervisor with Watchdog Timer and Manual Reset

Revision 1.0

### General Description

The MAX823/4/5 voltage supervisory circuits combine low-current, manual reset input, watchdog timer, active-high and active-low push-pull outputs. The reset outputs are asserted and held when the supply voltage falls below the factory-programmed threshold voltage, when the /MR pin is pulled low, or if the watchdog times out. Reset is asserted for the reset timeout delay after the supply voltage increases above the rising threshold voltage or when manual reset input is asserted high.

The MAX823/4/5 features an integrated pull-up resistor on the /MR pin. An active-low push-pull reset output (/RESET) and an active-high reset output (RESET) provide flexibility when interfacing with various microcontrollers, PMICs, or load switches. The watchdog input can be left unconnected for applications that do not require watchdog monitoring.

The MAX823/4/5 consumes a quiescent current of only 3.8µA and is offered in standard SOT23-5 and SC70-5 packages. It is rated for the -40°C to +125°C temperature range.

Datasheets and support documentation are available on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

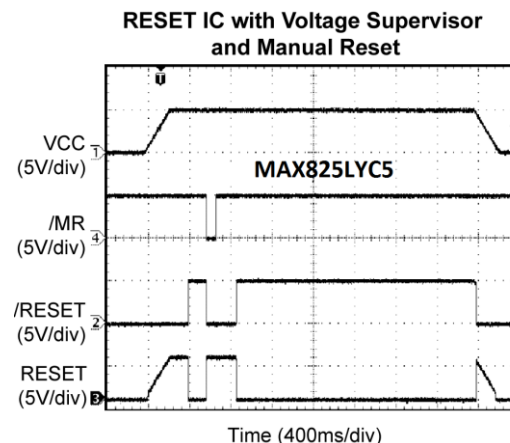
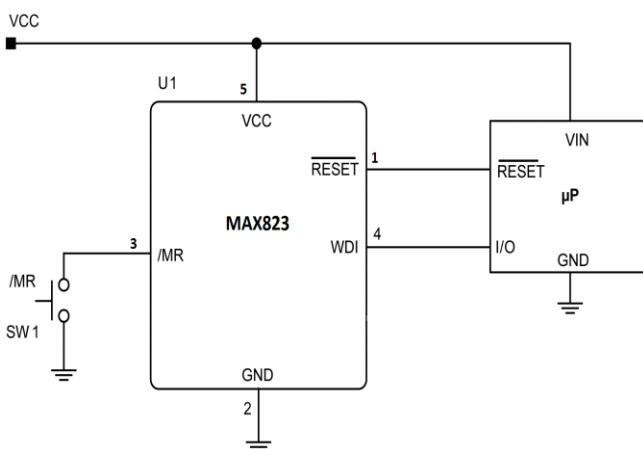
### Features

- Precision 1.665V to 4.625V power supply monitor
- ±0.5% threshold accuracy at TA = +25°C
- ±1.5% threshold accuracy from TA = -40°C to +125°C
- 3.8µA supply current (S,R,T,W,Y,Z options)
- 4.8µA supply current (L,M options)
- Manual reset input (MAX823/5)
- 140ms (min.) reset timeout period
- 1.6s (typ.) watchdog timeout period
- Active-high and active-low push-pull outputs
- Guaranteed reset output valid to VCC = 1V
- -40°C to +125°C junction temperature range
- 5-pin SOT23 & SC70 packages
- 8x lower watchdog input current than competition

### Applications

- Computers and Controllers
- Embedded Controllers
- Intelligent Instruments
- Automotive Systems
- Critical µP Monitoring
- Portable/ Battery-Powered Equipment

### Typical Application



FUNCTION	MAX823	MAX824	MAX825
Active-Low Reset	✓	✓	✓
Active-High Reset	-	✓	✓
Watchdog Input	✓	✓	-
Manual Reset Input	✓	-	✓

## Ordering Information<sup>(1)</sup>

Part Number	Top Marking	V <sub>RST</sub> : Nominal Threshold Voltage (V)	Package
MAX823LEUK	X3L	4.625	SOT23-5
MAX823MEUK	X3M	4.375	SOT23-5
MAX823REUK	X3R	2.625	SOT23-5
MAX823SEUK	X3S	2.925	SOT23-5
MAX823TEUK	X3T	3.075	SOT23-5
MAX823WEUK	X3W	1.665	SOT23-5
MAX823YEUK	X3Y	2.188	SOT23-5
MAX823ZEUK	X3Z	2.315	SOT23-5
MAX823LEXK	XA	4.625	SC70-5
MAX823MEXK	XB	4.375	SC70-5
MAX823REXK	XF	2.625	SC70-5
MAX823SEXK	XE	2.925	SC70-5
MAX823TEXK	XC	3.075	SC70-5
MAX823WEXK	XL	1.665	SC70-5
MAX823YEXK	XK	2.188	SC70-5
MAX823ZEXK	XJ	2.315	SC70-5

**Ordering Information (Continued)<sup>(1)</sup>**

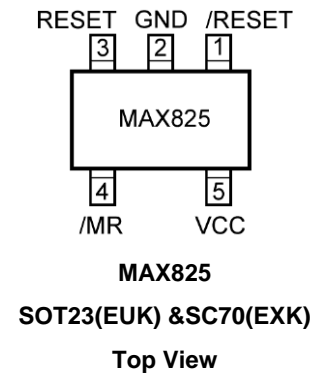
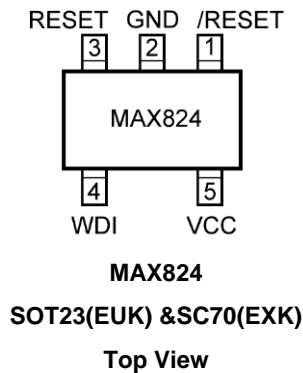
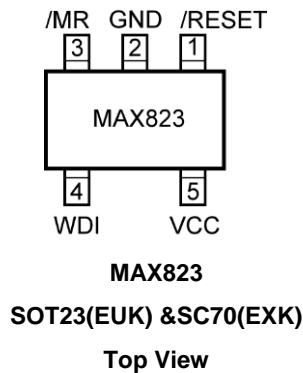
Part Number	Top Marking	V <sub>RST</sub> : Nominal Threshold Voltage (V)	Package
MAX824LEUK	X4L	4.625	SOT23-5
MAX824MEUK	X4M	4.375	SOT23-5
MAX824REUK	X4R	2.625	SOT23-5
MAX824SEUK	X4S	2.925	SOT23-5
MAX824TEUK	X4T	3.075	SOT23-5
MAX824WEUK	X4W	1.665	SOT23-5
MAX824YEUK	X4Y	2.188	SOT23-5
MAX824ZEUK	X4Z	2.315	SOT23-5
MAX824LEXK	4Y	4.625	SC70-5
MAX824MEXK	YA	4.375	SC70-5
MAX824REXK	YD	2.625	SC70-5
MAX824SEXK	YC	2.925	SC70-5
MAX824TEXK	YB	3.075	SC70-5
MAX824WEXK	YG	1.665	SC70-5
MAX824YEXK	YF	2.188	SC70-5
MAX824ZEXK	YE	2.315	SC70-5

Part Number	Top Marking	V <sub>RST</sub> : Nominal Threshold Voltage (V)	Package
MAX825LEUK	X5L	4.625	SOT23-5
MAX825MEUK	X5M	4.375	SOT23-5
MAX825REUK	X5R	2.625	SOT23-5
MAX825SEUK	X5S	2.925	SOT23-5
MAX825TEUK	X5T	3.075	SOT23-5
MAX825WEUK	X5W	1.665	SOT23-5
MAX825YEUK	X5Y	2.188	SOT23-5
MAX825ZEUK	X5Z	2.315	SOT23-5
MAX825LEXK	YE	4.625	SC70-5
MAX825MEXK	YI	4.375	SC70-5
MAX825REXK	YO	2.625	SC70-5
MAX825SEXK	YK	2.925	SC70-5
MAX825TEXK	YJ	3.075	SC70-5
MAX825WEXK	YT	1.665	SC70-5
MAX825YEXK	YS	2.188	SC70-5
MAX825ZEXK	YR	2.315	SC70-5

**Note:**

1. All devices are available in tape-and-reel only. Contact Micrel for tape-and-reel options.

## Pin Configuration



## Pin Description

Pin Number MAX823	Pin Number MAX824	Pin Number MAX825	Pin Name	Pin Function
1	1	1	/RESET	Active-Low Reset Output. Pulses low for 200ms when triggered, and remains low whenever V <sub>CC</sub> is below the reset threshold or when /MR is a logic low. It remains low for 200ms after one of the following occurs: V <sub>CC</sub> rises above the reset threshold, the watchdog triggers a reset, or /MR goes low to high.
2	2	2	GND	Ground.
-	3	3	RESET	Active-High Reset Output. Pulses high for 200ms when triggered, and remains high whenever V <sub>CC</sub> is below the reset threshold or when /MR is a logic low. It remains high for 200ms after one of the following occurs: V <sub>CC</sub> rises above the reset threshold, the watchdog triggers a reset, or /MR goes low to high. RESET is the inverse of /RESET.
4	4	-	WDI	Watchdog Input. If WDI remains either high or low for longer than the watchdog timeout period, the internal watchdog timer runs out and a reset is triggered. The internal watchdog timer clears whenever reset is asserted, or whenever WDI sees a rising or falling edge. If WDI is left unconnected or is connected to a three-stated buffer output, the watchdog feature is disabled.
3	-	4	/MR	Manual Reset Input. A logic low on /MR asserts reset. Reset remains asserted as long as /MR is held low and for 200ms after /MR returns high. The active-low input has an internal 52kΩ pull-up resistor. It can be driven from a CMOS logic line or shorted to ground with a switch. Leave open or connect to VCC if unused.
5	5	5	VCC	Supply Voltage Pin. VCC is the input to the supply voltage monitor. When the supply voltage falls below the reset threshold voltage, reset outputs (/RESET and RESET) are triggered immediately. When the supply voltage rises above the reset threshold plus hysteresis voltage, the reset outputs remain asserted for the duration of the reset timeout period. An optional 0.1μF bypass capacitor mounted close to VCC provides additional transient immunity.

**Absolute Maximum Ratings<sup>(2)</sup>**

Supply Voltage ( $V_{CC}$ )	-0.3V to +6.0V
/MR, WDI, RESET, /RESET	-0.3V to $V_{CC}$ +0.3V
Input Current (All Pins except RESET, /RESET)	20mA
Output Current (RESET, /RESET)	20mA
Junction Temperature ( $T_J$ )	-40°C to +150°C
Storage Temperature ( $T_s$ )	-65°C to +150°C
ESD Rating <sup>(4)</sup> (Human Body Model)(MAX823/4/5)	3kV

**Operating Ratings<sup>(3)</sup>**

Supply Voltage ( $V_{CC}$ )	+1.0V to +5.5V
Watchdog Input (WDI)	0V to $V_{CC}$
Junction Temperature ( $T_J$ )	-40°C to +125°C
Junction Thermal Resistance	
5-Pin SOT23	215°C/W
5-Pin SC70	250°C/W

**Electrical Characteristics<sup>(5)</sup>**

$V_{CC}$  = 4.7V to 5.5V for MAX823/4/5L,  $V_{CC}$  = 4.5V to 5.5V for MAX823/4/5M,  $V_{CC}$  = 3.15V to 3.6V for MAX823/4/5T,  $V_{CC}$  = 3.0V to 3.6V for MAX823/4/5S,  $V_{CC}$  = 2.7V to 3.6V for MAX823/4/5R,  $V_{CC}$  = 2.38V to 2.75V for MAX823/4/5Z,  $V_{CC}$  = 2.25V to 2.75V for MAX823/4/5Y,  $V_{CC}$  = 1.75V to 2.0V for MAX823/4/5W;  $T_J$  = +25°C, bold values<sup>(6)</sup> indicate -40°C ≤  $T_J$  ≤ +125°C, unless otherwise noted.

Parameter	Condition	Min.	Typ.	Max.	Units
<b>Power Supply Input</b>					
Supply Voltage ( $V_{CC}$ )		<b>1.0</b>		<b>5.5</b>	V
Supply Current ( $I_{VCC}$ )	L/M (WDI and /MR unconnected)		4.8	<b>14</b>	μA
	T/S/R/Z/Y/W (WDI and /MR unconnected)		3.8	<b>8.4</b>	μA
<b>Reset Threshold Voltage</b>					
Reset Threshold Voltage ( $V_{RST}$ )	L (falling) $T_A = 25^\circ\text{C}$	4.602	4.625	4.648	V
	L (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>4.556</b>		<b>4.694</b>	V
	M (falling) $T_A = 25^\circ\text{C}$	4.353	4.375	4.397	V
	M (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>4.309</b>		<b>4.441</b>	V
	T (falling) $T_A = 25^\circ\text{C}$	3.060	3.075	3.090	V
	T (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>3.029</b>		<b>3.121</b>	V
	S (falling) $T_A = 25^\circ\text{C}$	2.910	2.925	2.940	V
	S (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>2.881</b>		<b>2.969</b>	V
	R (falling) $T_A = 25^\circ\text{C}$	2.612	2.625	2.638	V
	R (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>2.586</b>		<b>2.664</b>	V
	Z (falling) $T_A = 25^\circ\text{C}$	2.303	2.315	2.327	V
	Z (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>2.280</b>		<b>2.350</b>	V
	Y (falling) $T_A = 25^\circ\text{C}$	2.177	2.188	2.199	V
	Y (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>2.155</b>		<b>2.221</b>	V
	W (falling) $T_A = 25^\circ\text{C}$	1.657	1.665	1.673	V
	W (falling) -40°C ≤ $T_A$ ≤ +125°C	<b>1.640</b>		<b>1.690</b>	V
Reset Threshold Hysteresis	L, M		10		mV
	T, S, R, Z, Y, W		5		mV
Reset Threshold Tempco			40		ppm/°C

**Electrical Characteristics (Continued)<sup>(5)</sup>**

$V_{CC} = 4.7V$  to  $5.5V$  for MAX823/4/5L,  $V_{CC} = 4.5V$  to  $5.5V$  for MAX823/4/5M,  $V_{CC} = 3.15V$  to  $3.6V$  for MAX823/4/5T,  $V_{CC} = 3.0V$  to  $3.6V$  for MAX823/4/5S,  $V_{CC} = 2.7V$  to  $3.6V$  for MAX823/4/5R,  $V_{CC} = 2.38V$  to  $2.75V$  for MAX823/4/5Z,  $V_{CC} = 2.25V$  to  $2.75V$  for MAX823/4/5Y,  $V_{CC} = 1.75V$  to  $2.0V$  for MAX823/4/5W;  $T_J = +25^\circ C$ , bold values<sup>(6)</sup> indicate  $-40^\circ C \leq T_J \leq +125^\circ C$ , unless otherwise noted.

Parameter	Condition	Min.	Typ.	Max.	Units
Reset Timeout Period ( $t_{RP}$ )		<b>140</b>	200	<b>280</b>	ms
<b>Reset Time</b>					
VCC to /RESET Delay ( $t_{RD}$ )			10		$\mu s$
<b>Reset Outputs (/RESET, RESET)</b>					
/RESET Output Voltage High ( $V_{OH}$ )	L, M: $V_{CC} = V_{RST(MAX)}$ , $I_{SOURCE} = 120\mu A$	<b><math>V_{CC} - 1.5</math></b>			V
	T, S, R, Z, Y: $V_{CC} = V_{RST(MAX)}$ , $I_{SOURCE} = 30\mu A$	<b><math>0.8 \times V_{CC}</math></b>			V
	W: $V_{CC} = V_{RST(MAX)}$ , $I_{SOURCE} = 20\mu A$	<b><math>0.8 \times V_{CC}</math></b>			V
/RESET Output Voltage Low ( $V_{OL}$ )	L, M: $V_{CC} = V_{RST(MIN)}$ , $I_{SINK} = 3.2mA$			<b>0.4</b>	V
	T, S, R, Z, Y, W: $V_{CC} = V_{RST(MIN)}$ , $I_{SINK} = 1.2mA$			<b>0.3</b>	V
	$T_A = 0^\circ C$ to $+70^\circ C$ , $V_{CC} = 1V$ , $I_{SINK} = 50\mu A$			<b>0.3</b>	V
	$V_{CC} = 1.2V$ , $I_{SINK} = 100\mu A$			<b>0.3</b>	V
/RESET Output Short-Circuit Current <sup>(7)</sup>	L, M: /RESET = 0V, $V_{CC} = 5.5V$			<b>800</b>	$\mu A$
	T, S, R, Z, Y, W: /RESET = 0V, $V_{CC} = 3.6V$			<b>400</b>	$\mu A$
RESET Output Voltage High ( $V_{OH}$ )	$V_{CC} > 1.6V$ , $I_{SOURCE} = 150\mu A$	<b><math>0.8 \times V_{CC}</math></b>			V
RESET Output Voltage Low ( $V_{OL}$ )	L, M: $V_{CC} = V_{RST(MAX)}$ , $I_{SINK} = 3.2mA$			<b>0.4</b>	V
	T, S, R, Z, Y, W: $V_{CC} = V_{RST(MAX)}$ , $I_{SINK} = 1.2mA$			<b>0.3</b>	V
<b>Watchdog Input (WDI)<sup>(8)</sup></b>					
Watchdog Timeout Period ( $t_{WD}$ )		<b>1.12</b>	1.60	<b>2.40</b>	s
Watchdog Pulse Width		<b>50</b>			ns
Watchdog Input Low Voltage ( $V_{IL}$ )				<b><math>0.3 \times V_{CC}</math></b>	V
Watchdog Input High Voltage ( $V_{IH}$ )		<b><math>0.7 \times V_{CC}</math></b>			V
Watchdog Input Current	WDI = $V_{CC}$		15	<b>25</b>	$\mu A$
	WDI = 0V	<b>-20</b>	-15		$\mu A$

**Electrical Characteristics (Continued)<sup>(5)</sup>**

$V_{CC} = 4.7V$  to  $5.5V$  for MAX823/4/5L,  $V_{CC} = 4.5V$  to  $5.5V$  for MAX823/4/5M,  $V_{CC} = 3.15V$  to  $3.6V$  for MAX823/4/5T,  $V_{CC} = 3.0V$  to  $3.6V$  for MAX823/4/5S,  $V_{CC} = 2.7V$  to  $3.6V$  for MAX823/4/5R,  $V_{CC} = 2.38V$  to  $2.75V$  for MAX823/4/5Z,  $V_{CC} = 2.25V$  to  $2.75V$  for MAX823/4/5Y,  $V_{CC} = 1.75V$  to  $2.0V$  for MAX823/4/5W;  $T_J = +25^\circ C$ , bold values<sup>(6)</sup> indicate  $-40^\circ C \leq T_J \leq +125^\circ C$ , unless otherwise noted.

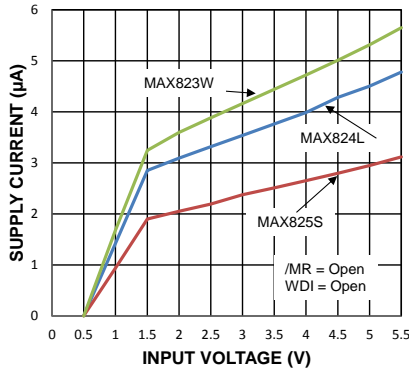
Parameter	Condition	Min.	Typ.	Max.	Units
<b>Manual Reset Input (/MR)</b>					
Input Low Voltage ( $V_{IL}$ )				<b><math>0.3 \times V_{CC}</math></b>	V
Input High Voltage ( $V_{IH}$ )		<b><math>0.7 \times V_{CC}</math></b>			V
/MR Pulse Width		<b>1.0</b>			$\mu s$
/MR Noise Immunity (pulse width with no reset)			100		ns
/MR to RESET Delay			500		ns
/MR Internal Pull-Up Resistor		<b>35</b>	52	<b>75</b>	k $\Omega$

**Notes:**

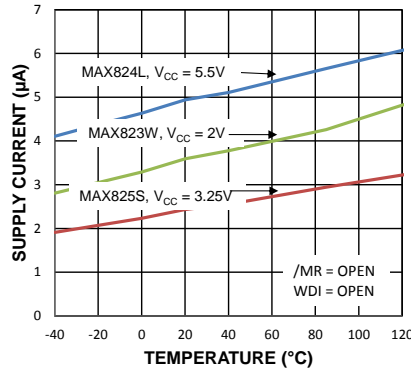
- Exceeding the absolute maximum ratings may damage the device.
- The device is not guaranteed to function outside its operating ratings.
- Devices are ESD sensitive. Handling precautions are recommended. Human body model,  $1.5k\Omega$  in series with  $100pF$ .
- Specification for packaged product only.
- Overtemperature limits are guaranteed by design and not product tested.
- The /RESET short-circuit current is the maximum pull-up current when /RESET is driven low by  $\mu P$  bidirectional reset pin.
- The WDI input is designed to drive a three-state output device with a  $10\mu A$  maximum leakage current and a maximum capacitance of  $200pF$ .

# Typical Characteristics

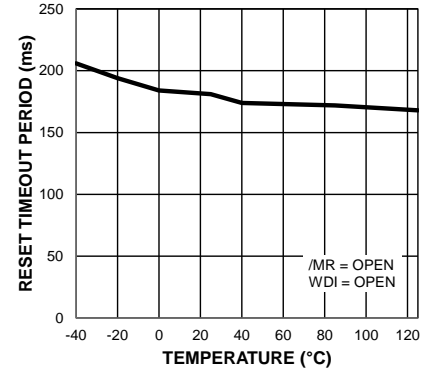
**Supply Current vs. Input Voltage**



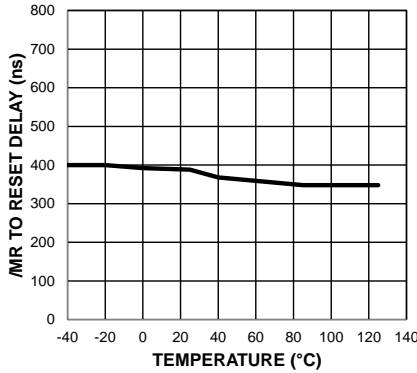
**Supply Current vs. Temperature**



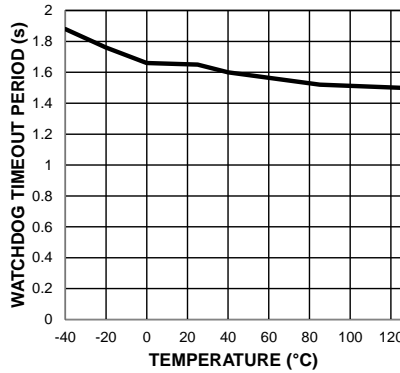
**RESET Timeout Period vs. Temperature**



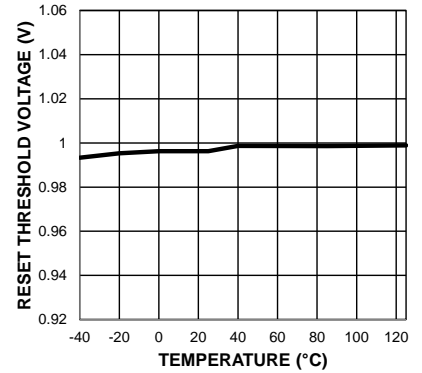
**/MR to RESET Delay vs. Temperature**



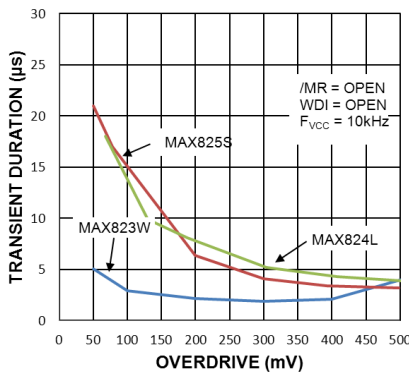
**Watchdog Timeout Period vs. Temperature**



**Normalized Reset Threshold vs. Temperature**

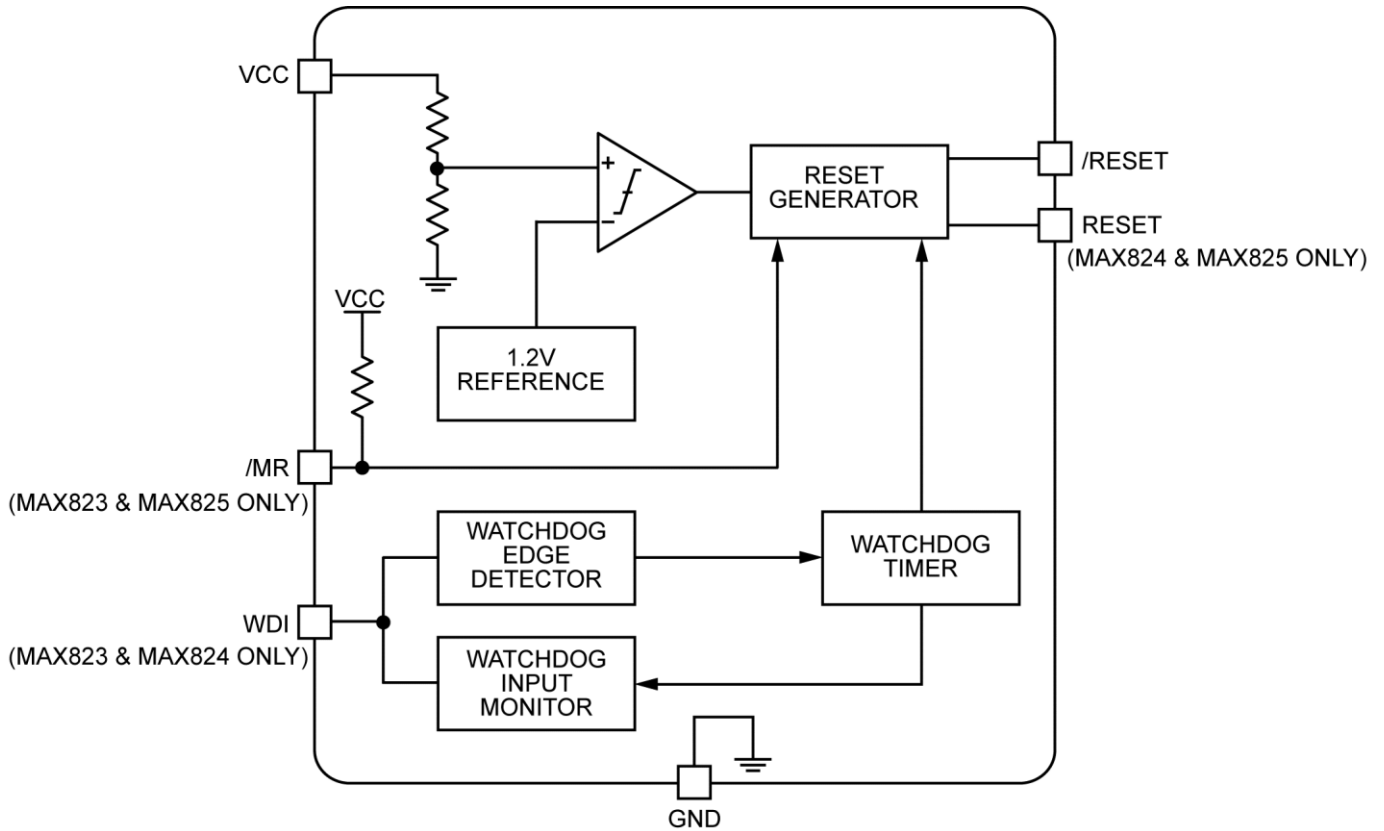


**Supply Transient Duration vs. Overdrive**

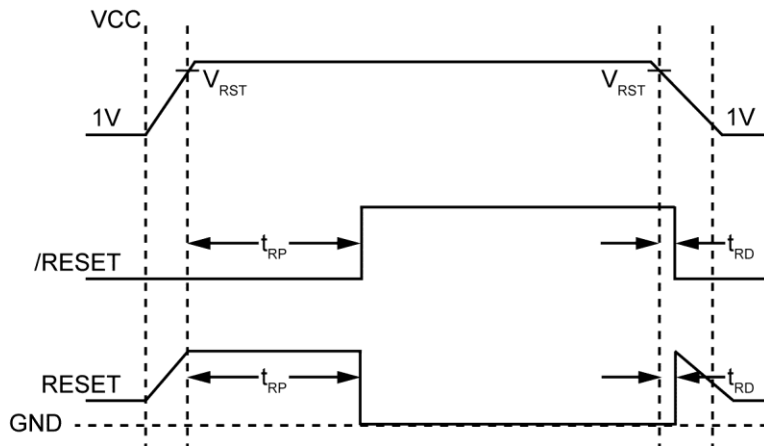




### Functional Diagram



### Timing Diagram



## Functional Description

### Design and Product Advantages

The MAX823/4/5 is series of a voltage supervisor reset IC with a manual reset input, watchdog input, and dual reset outputs. The MAX823/4/5 asserts and holds a reset when the supply voltage falls below the factory-programmed threshold voltage, when /MR is at low logic level, or when watchdog input times out. Reset is asserted for a fixed reset timeout period after the supply voltage increases above the rising threshold voltage or when the manual reset input is asserted high.

The MAX823/4/5 features an active-low, push-pull reset output (/RESET) and an active-high, push-pull reset output (RESET). It also contains 52kΩ pull-up resistors on the /MR input to make it easy to connect to pushbutton inputs. The MAX823/4 also features a watchdog input (WDI).

### Manual Reset Input (/MR)

The /MR input pin has integrated pull-up resistors to keep the current consumption low when the pushbutton switch is pressed.

### Reset Outputs (/RESET and RESET)

There are two reset outputs: /RESET and RESET. Both outputs are push-pull, which eliminates the need for pull-up resistors. The RESET output is the inverse of the /RESET output.

### Asserting /RESET and RESET Outputs

#### When Functioning as a Manual Reset

The reset outputs /RESET and RESET are asserted while the /MR pin is driven low. Both reset outputs remain asserted for a factory-programmed reset timeout delay time,  $t_{RP}$ . The typical value of a reset timeout period is 200ms. The /RESET pin is driven low while the RESET pin is driven high whenever /MR is pulled low.

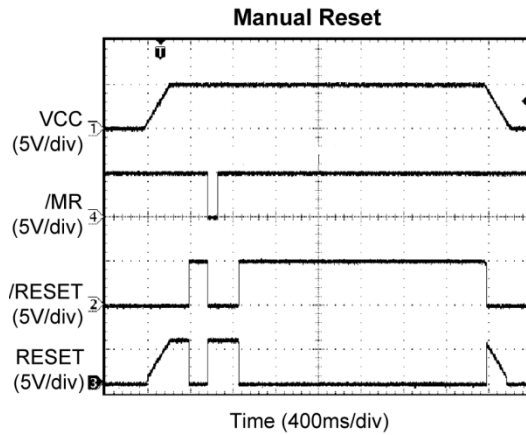


Figure 1. Manual Reset Function

#### When Functioning as a Voltage Supervisor

The /RESET pin is asserted whenever  $V_{CC}$  falls below the reset threshold voltage,  $V_{RST}$  ( $V_{CC} < V_{RST}$ ). The VCC pin circuitry includes hysteresis to prevent /RESET or RESET pin chattering due to noise. The /RESET pin remains asserted for the duration of the reset timeout delay ( $t_{RP}$ ) after  $V_{CC}$  has risen above the reset threshold voltage plus the hysteresis. The reset function ensures that a microprocessor is properly reset and powers up in a known condition after a power failure. The /RESET remains valid with  $V_{CC}$  as low as 1V. The RESET output is a complement of the /RESET output.

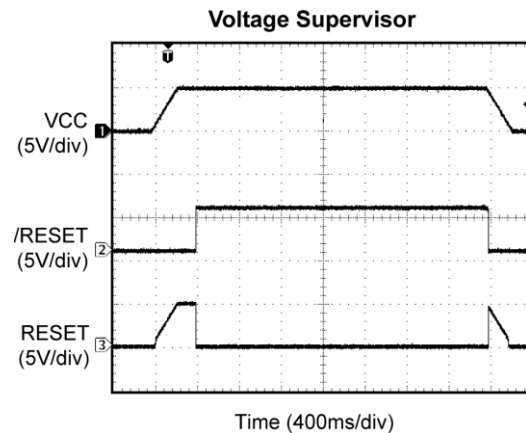


Figure 2. Voltage Supervisor Function

### Watchdog Input

The MAX823/4 has an on-chip watchdog timer that can reset the microprocessor if it fails to strobe the WDI input within a preset timeout period ( $t_{WD}$ ). If the WDI pin is left unconnected, this function is disabled. The watchdog timeout period starts when the reset outputs are deasserted or either a high-to-low or low-to-high transition occurs before the watchdog timeout period ( $t_{WD}$ ). If the watchdog timer times out, then the reset outputs will assert and stay asserted for a reset timeout period ( $t_{RP}$ ). The watchdog timer is also cleared whenever the reset outputs are asserted by /MR, or if  $V_{CC}$  falls below  $V_{RST}$ . The watchdog timer starts again whenever the reset outputs are de-asserted.

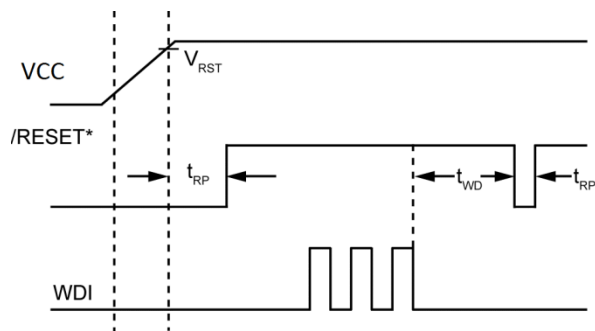


Figure 3. Watchdog Input

### Watchdog Input Current

The WDI input current is the current sourced or sunk by the WDI pin when the WDI input is driven low or high, respectively. The WDI input is designed to drive a tri-state output device with a  $10\mu A$  maximum leakage current and a maximum capacitance of  $200pF$ .

### $V_{CC}$ Transient

The MAX823/4/5 is relatively immune to small negative-going  $V_{CC}$  glitches below the reset threshold. As shown in Figure 4, the overdrive voltage is the difference between the threshold voltage and the minimum point of the  $V_{CC}$  glitch. Typically, an overdrive of  $100mV$  with duration of  $2\mu s$  or less will not cause a reset.

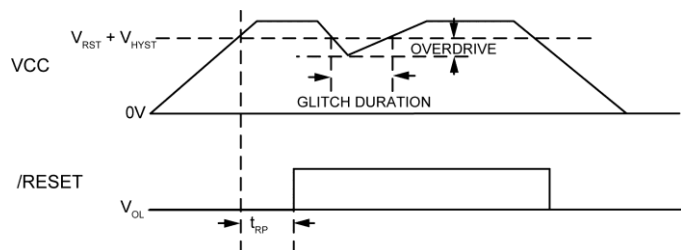


Figure 4.  $V_{CC}$  Transient

### Reset Valid up to $V_{CC} = 1V$

The MAX823/4/5 is a supervisory circuit that monitors the power supply voltage level. If the power supply voltage level falls below the factory-programmed threshold level, then the reset signals are asserted. The MAX823/4/5 maintains the reset states with  $V_{CC}$  as low as  $1V$ .

### Supply Bypass Capacitor

An optional  $0.1\mu F$  input bypass capacitor can be placed from  $V_{CC}$  (Pin 6) to  $GND$  (Pin 2) to increase glitch rejection and provides additional transient immunity.

## Typical Applications

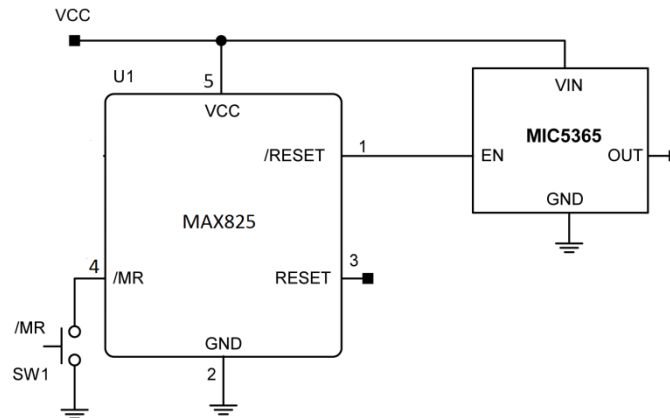


Figure 5. MAX825 for Precision Power Good Function

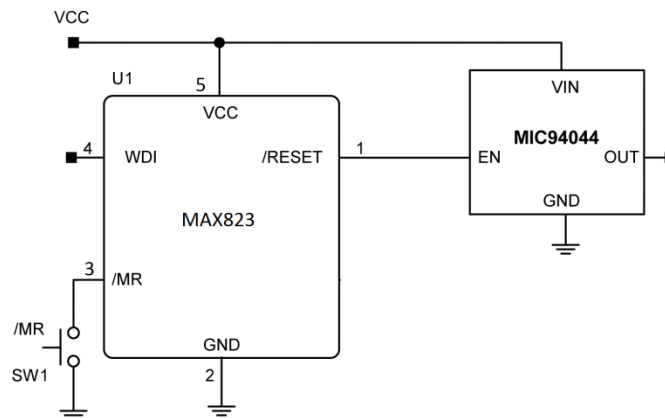


Figure 6. MAX823 Used for Load Switch

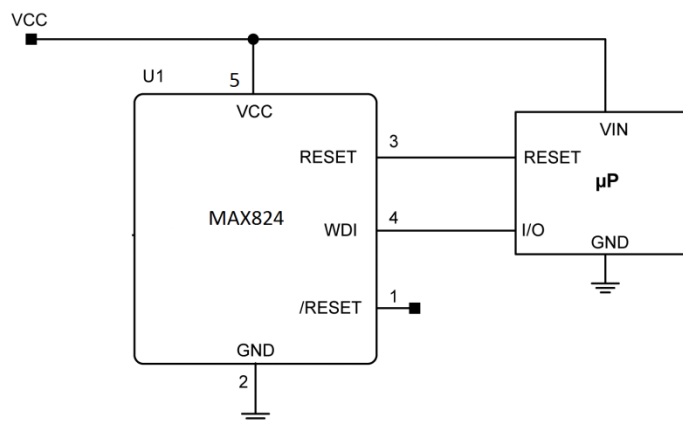
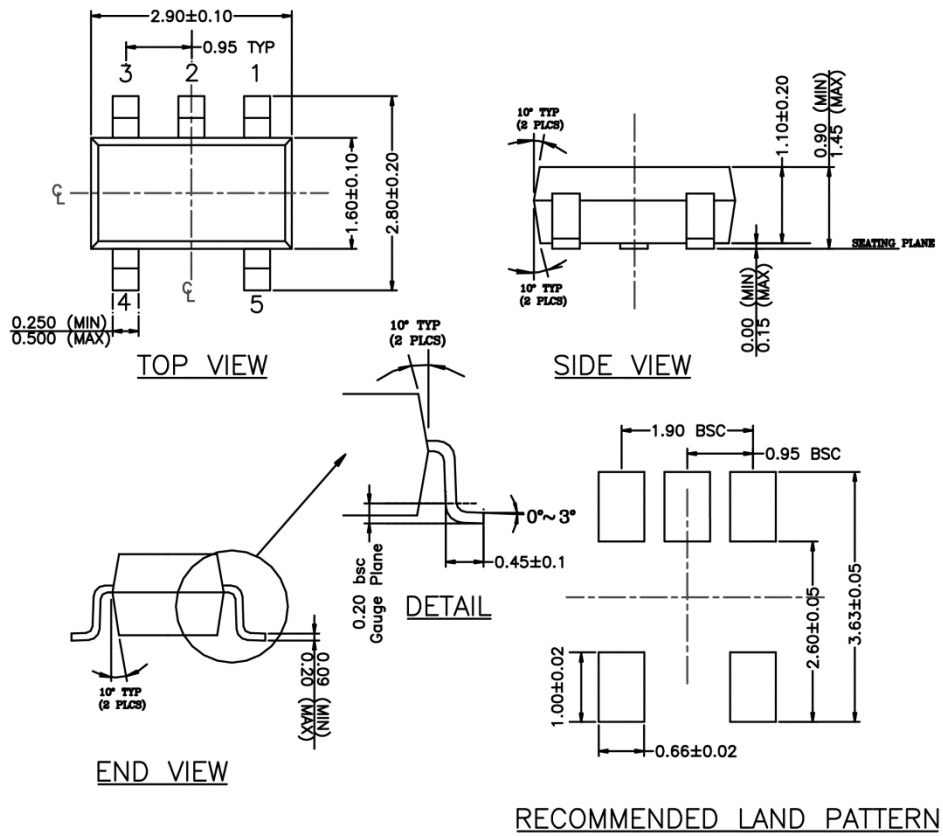


Figure 7. MAX824 Used for Microcontroller Reset with Watchdog Input

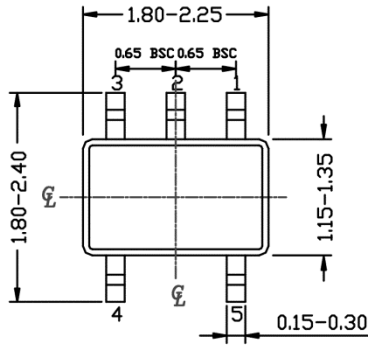
Package Information<sup>(9)</sup>



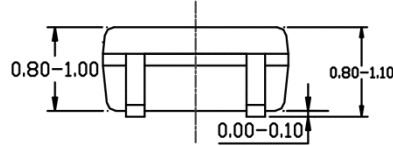
- NOTE:
1. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & BURR.
  2. PACKAGE OUTLINE INCLUSIVE OF SOLER PLATING.
  3. DIMENSION AND TOLERANCE PER ANSI Y14.5M, 1982.
  4. FOOT LENGTH MEASUREMENT BASED ON GAUGE PLANE METHOD.
  5. DIE FACES UP FOR MOLD, AND FACES DOWN FOR TRIM/FORM.
  6. ALL DIMENSIONS ARE IN MILLIMETERS.

5-Pin SOT23 (EUK)

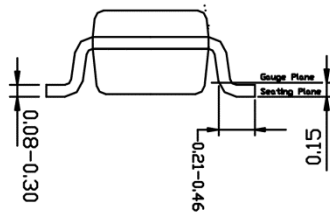
**Package Information (Continued)<sup>(9)</sup>**



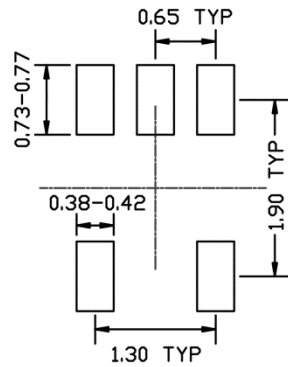
TOP VIEW



SIDE VIEW



END VIEW



RECOMMENDED LAND PATTERN

**NOTE:**

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.

**5-Pin SC70 (EXK)**

**Note:**

9. Package information is correct as of the publication date. For updates and the most current information, go to [www.micrel.com](http://www.micrel.com).

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