

## MAX16140/MAX16142/MAX16144/ MAX16146/MAX16156–MAX16159

## nanoPower, Tiny Supervisor with Manual Reset Input

### General Description

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 are ultra-low-current, single-channel supervisory ICs that monitor the  $V_{CC}$  voltage from 1.7V to 4.85V in approximately 50mV increments and asserts a reset when  $V_{CC}$  voltage falls below the reset threshold. The reset output remains asserted for the reset timeout period after the  $V_{CC}$  voltage rises above the factory-set  $V_{CC\_TH} + V_{HYS}$ . See the [Selector Guide](#) for available reset timeout options.

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 include a factory-programmable manual reset input (MR) that can be configured to assert a reset when it receives a rising-edge, falling-edge, active-low, or active-high input signal. The MAX16140/MAX16144/MAX16156/MAX16157 feature an open-drain reset output, while the MAX16142/MAX16146/MAX16158/MAX16159 feature a push-pull reset output. See the [Selector Guide](#) for reset output configurations.

All devices are specified over the  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  temperature range. The MAX16140/MAX16142/MAX16156/MAX16158 are available in a tiny 0.73mm x 0.73mm x 0.5mm, 4-bump WLP. The MAX16144/MAX16146/MAX16157/MAX16159 are available in 5-pin SOT23 package.

### Applications

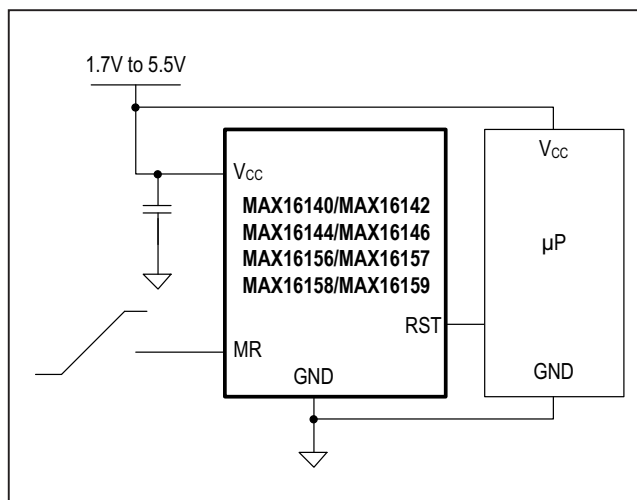
- Chargers
- Portable/Battery-Powered Equipment
- e-Readers/Tablets
- Wearable/Portable Accessories
- Smart Phones

### Benefits and Features

- 370nA Quiescent Current, Extends Battery Life
- Edge/Level Trigger MR Input
- Factory-Set Reset Timeout Period
- MR Debounce Circuitry
- Factory-Set Threshold: 1.7V to 4.85V
- WLP and SOT23 Packages
- $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  Temperature Range

[Ordering Information](#) appears at end of data sheet.

### Simplified Block Diagram



MAX16140/MAX16142/MAX16144/  
MAX16146/MAX16156–MAX16159

nanoPower, Tiny Supervisor  
with Manual Reset Input

**Absolute Maximum Ratings**

V<sub>CC</sub> to GND .....-0.3V to +6V  
MR, RST to GND.....-0.3V to +6V  
Continuous Sink/Source Current (All Pins) ..... -20mA to +20mA  
Continuous Power Dissipation (Multilayer Board)  
WLP (T<sub>A</sub> = +70°C, derate 9.58mW/C above +70°C ....766.4mW  
Continuous Power Dissipation (Multilayer Board) SOT23-5  
(T<sub>A</sub> = +70°C, derate 3.90mW/C above +70°C .....312.60mW

Operating Temperature Range..... -40°C to +125°C  
Junction Temperature ..... +150°C  
Soldering Temperature (reflow) ..... +300°C  
Storage Temperature Range ..... -65°C to +150°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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

**Package Information**

**WLP**

PACKAGE CODE	N40C0+1
Outline Number	<a href="#">21-100103</a>
Land Pattern Number	<a href="#">Application Note 1891</a>
<b>THERMAL RESISTANCE, FOUR-LAYER BOARD:</b>	
Junction to Ambient (θ <sub>JA</sub> )	104.41°C/W
Junction to Case (θ <sub>JC</sub> )	N/A

**SOT23**

PACKAGE CODE	U5+2
Outline Number	<a href="#">21-0057</a>
Land Pattern Number	<a href="#">90-0174</a>
<b>THERMAL RESISTANCE, MULTI-LAYER BOARD:</b>	
Junction to Ambient (θ <sub>JA</sub> )	255.90°C/W
Junction to Case (θ <sub>JC</sub> )	81°C/W

For the latest package outline information and land patterns (footprints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to [www.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

## Electrical Characteristics

( $V_{CC} = 1.7V$  to  $5.5V$ ,  $T_A = T_J = -40^{\circ}C$  to  $125^{\circ}C$ , unless otherwise noted. Typical Values are at  $T_A = +25^{\circ}C$ .)

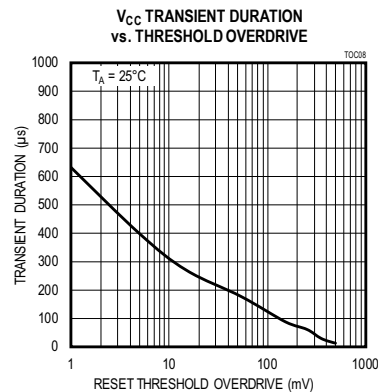
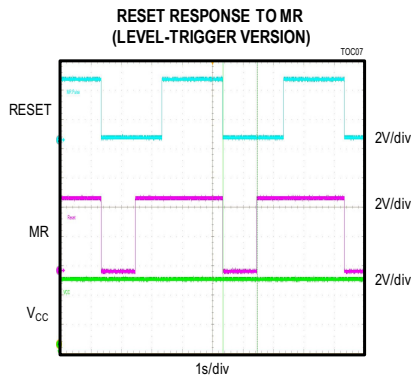
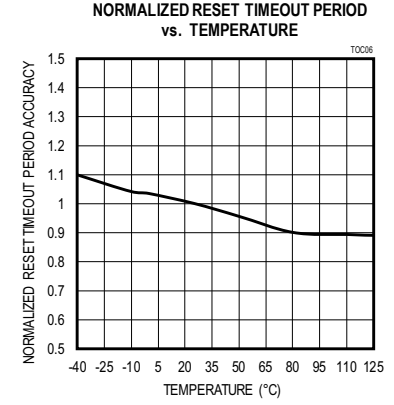
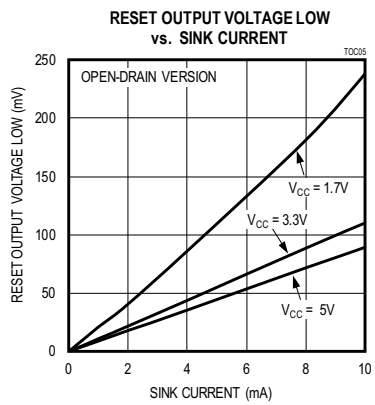
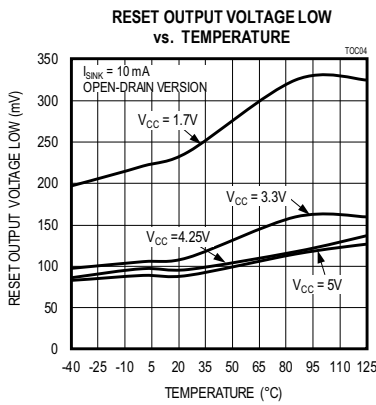
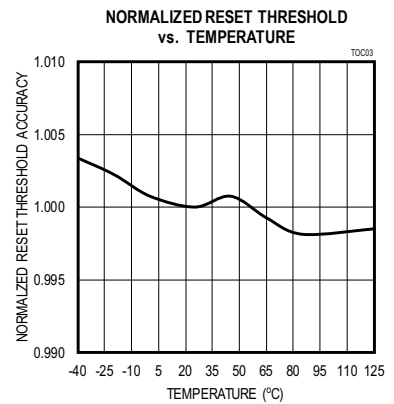
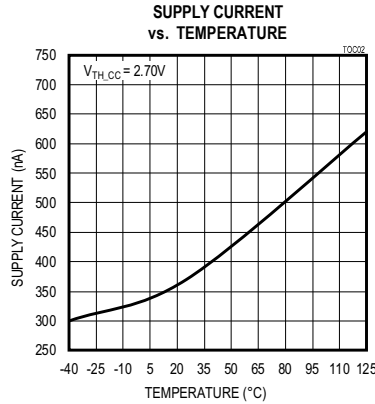
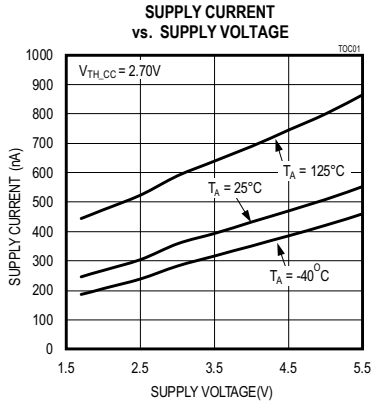
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>INPUT VOLTAGE</b>						
Input Voltage Range	$V_{CC}$	Operating range	1.7		5.5	V
		Reset output is guaranteed to be at known state	1.5			
Supply Current	$I_{CC}$	$T_A = -40^{\circ}C$ to $+85^{\circ}C$ , reset not asserted, $V_{CC} = V_{TH} + 10\%$		370	1200	nA
$V_{CC}$ Threshold Accuracy	$V_{TH}$	$V_{CC}$ falling	-1.5		+1.5	%
$V_{CC}$ Threshold Resolution		Threshold range = 1.7V to 4.85V		50		mV
$V_{CC}$ Threshold Hysteresis	$V_{TH\_HYS}$	$V_{CC} =$ rising, $1.7V \leq V_{CC} \leq 4.85V$		36		mV
$V_{CC}$ to Reset Output Delay	$t_D$	Measured with 2.5% threshold overdrive		50		$\mu s$
Reset Timeout Period Accuracy	$t_{RP}$	Measured from point where $V_{CC}$ is above $V_{TH}$ (Note 1)	-25		+25	%
<b>RESET OUTPUT VOLTAGE</b>						
Reset Output Voltage Low (Note 2)	$V_{OL}$	$V_{CC} = 4.25V$ , $I_{SINK} = 10mA$			0.4	V
		$V_{CC} = 2.5V$ , $I_{SINK} = 3.2mA$			0.4	
		$V_{CC} = 1.7V$ , $I_{SINK} = 1mA$			0.4	
Reset Output Voltage High	$V_{OH}$	$V_{CC} = 4.50V$ , $I_{SOURCE} = 800\mu A$	$0.8 \times V_{CC}$			V
		$V_{CC} = 2.50V$ , $I_{SOURCE} = 500\mu A$	$0.8 \times V_{CC}$			
<b>MANUAL RESET INPUT</b>						
Reset Output Leakage Current (Open Drain)		$T_A = -40^{\circ}C$ to $+125^{\circ}C$			1	$\mu A$
Manual Reset Debounce Period	$MR_{DB}$	MR input configured as level trigger	$t_{RP} = 0.01s - 2s$	20		ms
			$t_{RP} = 310\mu s$	0.6		
MR to Reset Delay		MR configured as edge triggered input		1.1		$\mu s$
MR Input Voltage Low	$V_{IL}$				$0.3 \times V_{CC}$	V
MR Input Voltage High	$V_{IH}$		$0.7 \times V_{CC}$			V
MR Internal Pullup Resistor		MR configured as active-low input		50		k $\Omega$
MR Internal Pulldown Resistor		MR configured as active-high input		50		

**Note 1.** The reset timeout period is affected by the  $V_{CC}$  rise time during power-up. For a  $V_{CC}$  rise time of  $10\mu s$  or faster, the additional  $t_{RP}$  is about 8.5ms(typ).

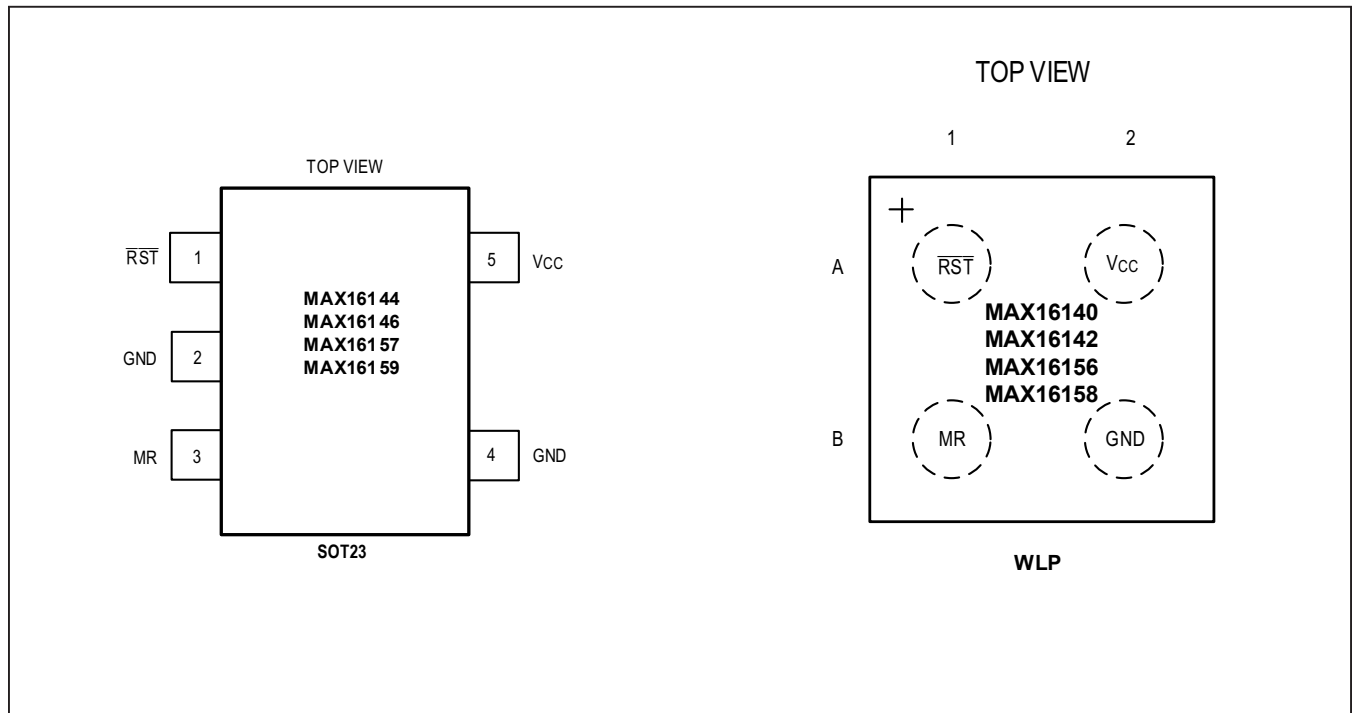
**Note 2.** The Reset Output Voltage Low spec applies to open-drain and push-pull versions

### Typical Operating Characteristics

( $V_{CC} = 5V$ ,  $T_A = 25^\circ C$ , otherwise noted)



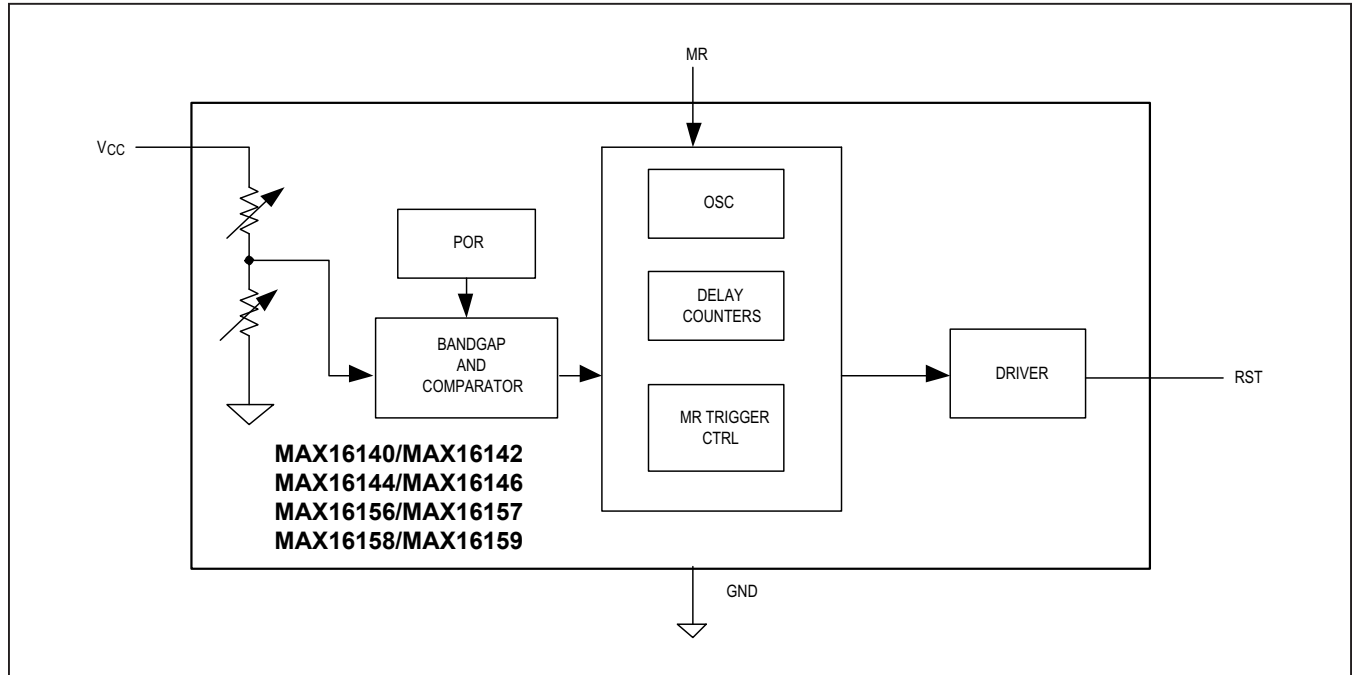
## Bump/Pin Configuration



## Bump/Pin Descriptions

PIN		NAME	FUNCTION
SOT23	WLP		
1	A1	RST	Reset Output. Reset asserts when $V_{CC}$ drops below factory set threshold or when MR receives either an edge-triggered or level-triggered signal. For the open-drain version, the MAX16140, connect a pullup resistor for active-low option and a pulldown resistor for active-high option.
5	A2	$V_{CC}$	Positive Supply Input Voltage. Connect $V_{CC}$ to the positive side of the input voltage. Bypass $V_{CC}$ with a $0.1\mu\text{F}$ ceramic capacitor to GND.
3	B1	MR	Manual Reset Input. See <a href="#">Manual Reset Input</a> for more details.
4	B2	GND	Ground
2	—	N.C.	No Connect. Not internally connected.

## Functional Diagrams



## Detailed Description

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 are 370nA supervisor ICs that monitors the  $V_{CC}$  voltage from 1.7V to 4.85V in approximately 50mV increments. The manual reset input is factory-programmable to assert the reset output using an edge-trigger or level-trigger input. During normal operation when the  $V_{CC}$  voltage falls below the factory-set threshold, the reset output asserts and remains asserted for the reset timeout period after the  $V_{CC}$  voltage rises above the threshold voltage. The MAX16140/MAX16144/MAX16156/MAX16157 feature an open-drain reset output, while the MAX16142/MAX16146/MAX16158/MAX16159 feature a push-pull reset output. See [Table 1](#) for more detail.

## Manual Reset Input

Many  $\mu$ P-based products require manual reset capability, allowing the operator, a test technician, or external logic circuit to initiate a reset. The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 feature four factory-programmable manual reset input configurations. See [Table 2](#) for available options.

For the edge-triggered manual reset input configuration, the MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 assert the reset output on either the falling or rising of the MR input (see the [Selector Guide](#) table for MR configurations. Any subsequent transition on MR is ignored until after the expiration of the reset timeout period. See [Figure 1](#) and [Figure 2](#) for more detail.

For the level-trigger manual reset input configuration, the MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 assert the reset output after MR stays in active state longer than the debounce period ( $t_{DB}$ ). The reset output deassert after the reset timeout period when MR becomes inactive. See [Figure 3](#) and [Figure 4](#) for more detail.

**Manual Reset Input Configurations**

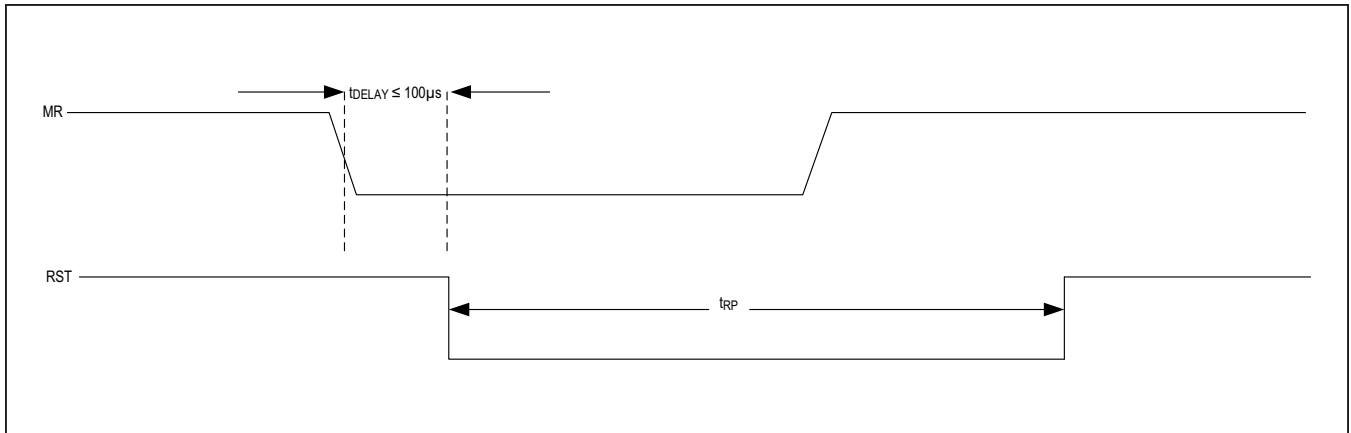


Figure 1. Falling-Edge Trigger Manual Reset Input

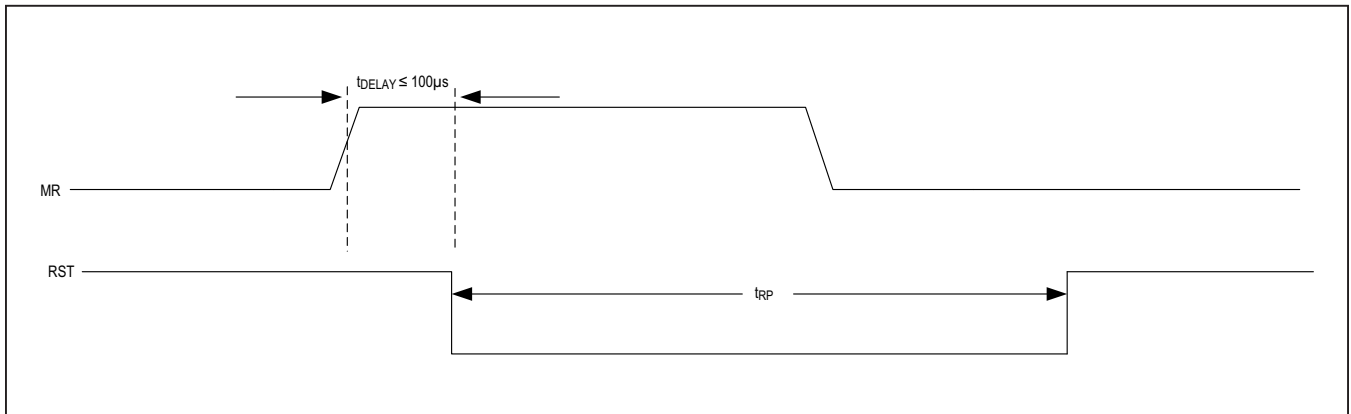


Figure 2. Rising-Edge Trigger Manual Reset Input

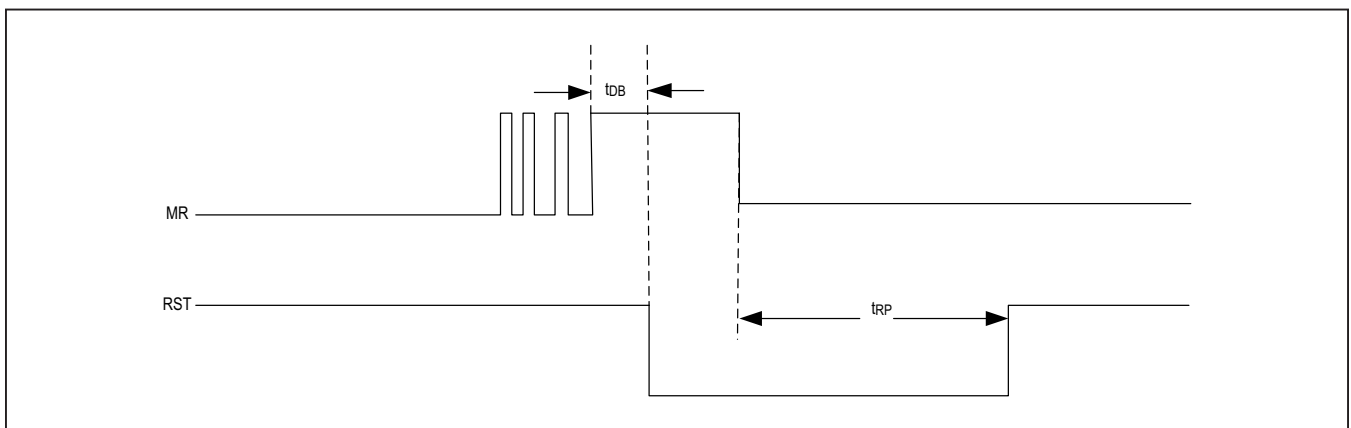


Figure 3. Active-High Trigger Manual Reset Input

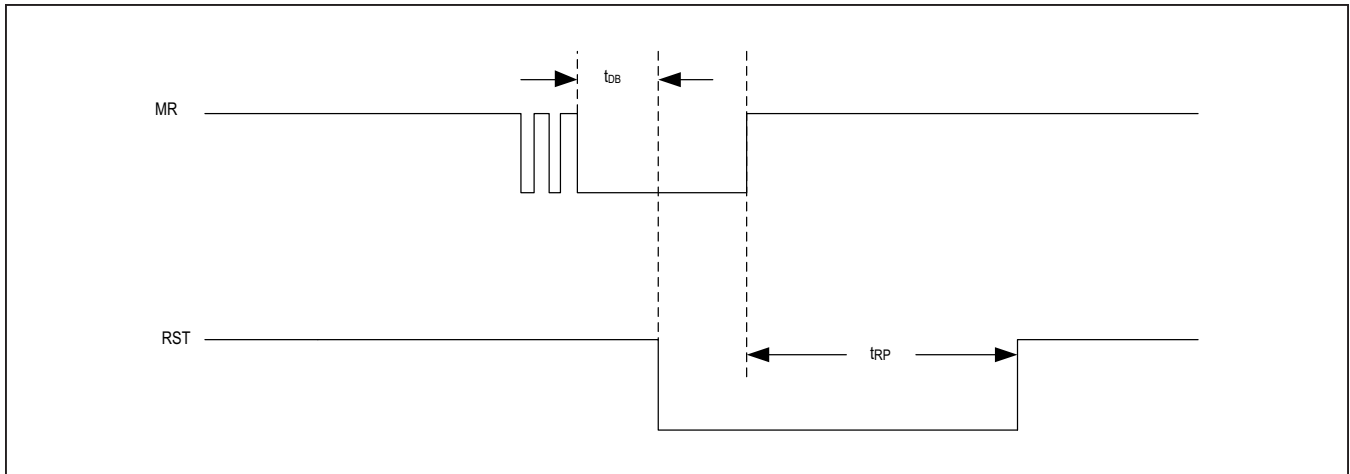


Figure 4. Active-Low Trigger Manual Reset Input

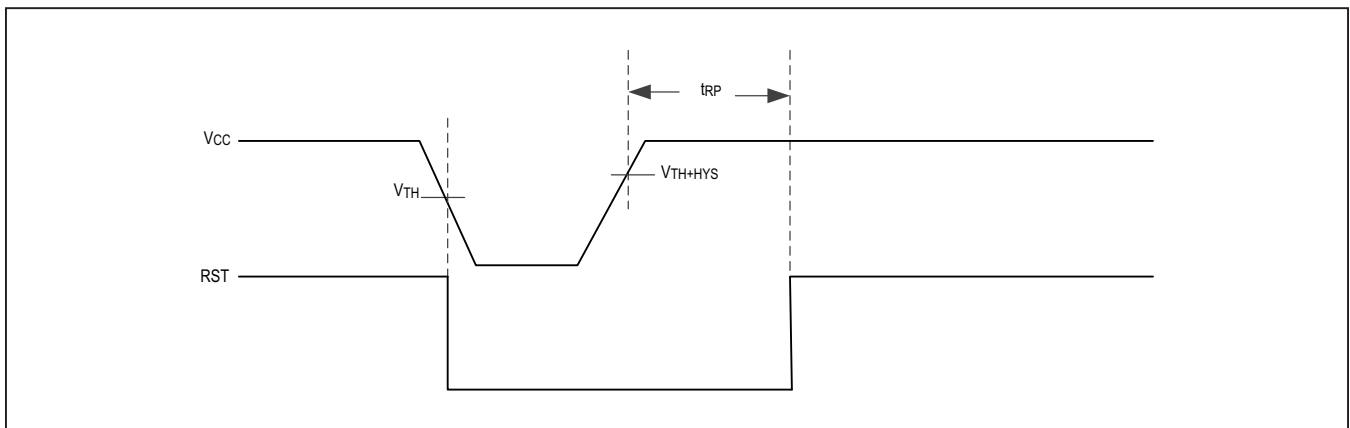


Figure 5. Reset Response to  $V_{CC}$  Rising-Edge Above Threshold Voltage + Hysteresis

### **$V_{CC}$ Threshold Input**

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 monitor  $V_{CC}$  from 1.7V to 4.85V in approximately 50mV increments. The reset output asserts when  $V_{CC}$  falls below  $V_{TH}$ . See [Table 3](#) for threshold options.

The reset output stays asserted for the reset timeout period when  $V_{CC}$  rises above  $V_{TH} + V_{HYS}$ . See the timing diagram in [Figure 5](#).

### **Reset Output**

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159  $\mu P$  supervisor circuits assert a reset to prevent code execution error during power-up, power-down, and brownout conditions. For active-low reset output configuration, the reset output is guaranteed to be valid for  $V_{CC}$  down to 1.1V. For active-high reset output configuration, the reset output is guaranteed to be valid for  $V_{CC}$  down 1.5V.

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 offer eight factory-programmable reset timeout period option from 0 to 2s. See [Table 4](#) for available options.



## Applications Information

### Power Supply Bypassing and Grounding

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 operate from a 1.70V to 5.5V supply. An undervoltage lockout ensures that the outputs are in the correct states when the UVLO is exceeded. Bypass  $V_{CC}$  to ground with a 0.1 $\mu$ F capacitor as close to the device as possible. The additional capacitor improves transient immunity. For fast rising  $V_{CC}$  transients, additional capacitance may be required.

## Configuration Tables

**Table 1. Factory-Set Reset Output Configuration Options**

SUFFIX	RESET OUTPUT CONFIG.
M	Active-Low
N	Active-High

Minimum order quantity of 10k required. Contact factory for available options.

**Table 2. Factory-Set Manual Trigger Input Options**

SUFFIX	MR TRIGGER INPUT
I	Falling Edge
J	Rising Edge
K	Active-Low
L	Active-High

Minimum order quantity of 10k required. Contact factory for available options.

**Table 3.  $V_{CC}$  Threshold Options**

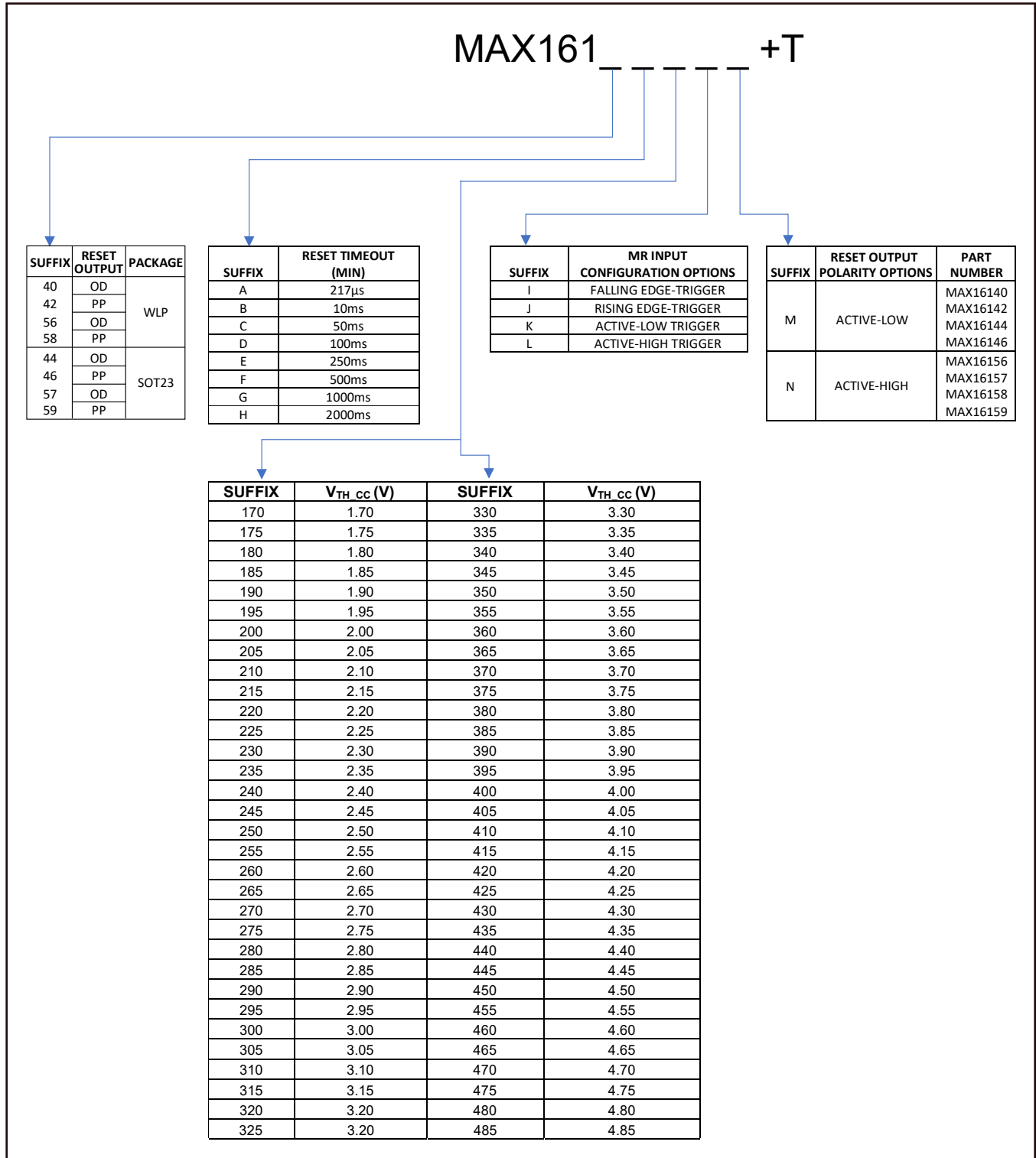
SUFFIX	$V_{TH\_CC}$ (V)	SUFFIX	$V_{TH\_CC}$ (V)
170	1.70	330	3.30
175	1.75	335	3.35
180	1.80	340	3.40
185	1.85	345	3.45
190	1.90	350	3.50
195	1.95	355	3.55
200	2.00	360	3.60
205	2.05	365	3.65
210	2.10	370	3.70
215	2.15	375	3.75
220	2.20	380	3.80
225	2.25	385	3.85
230	2.30	390	3.90
235	2.35	395	3.95
240	2.40	400	4.00
245	2.45	405	4.05
250	2.50	410	4.10
255	2.55	415	4.15
260	2.60	420	4.20
265	2.65	425	4.25
270	2.70	430	4.30
275	2.75	435	4.35
280	2.80	440	4.40
285	2.85	445	4.45
290	2.90	450	4.50
295	2.95	455	4.55
300	3.00	460	4.60
305	3.05	465	4.65
310	3.10	470	4.70
315	3.15	475	4.75
320	3.20	480	4.80
325	3.25	485	4.85

**Table 4. Reset Timeout Period Options**

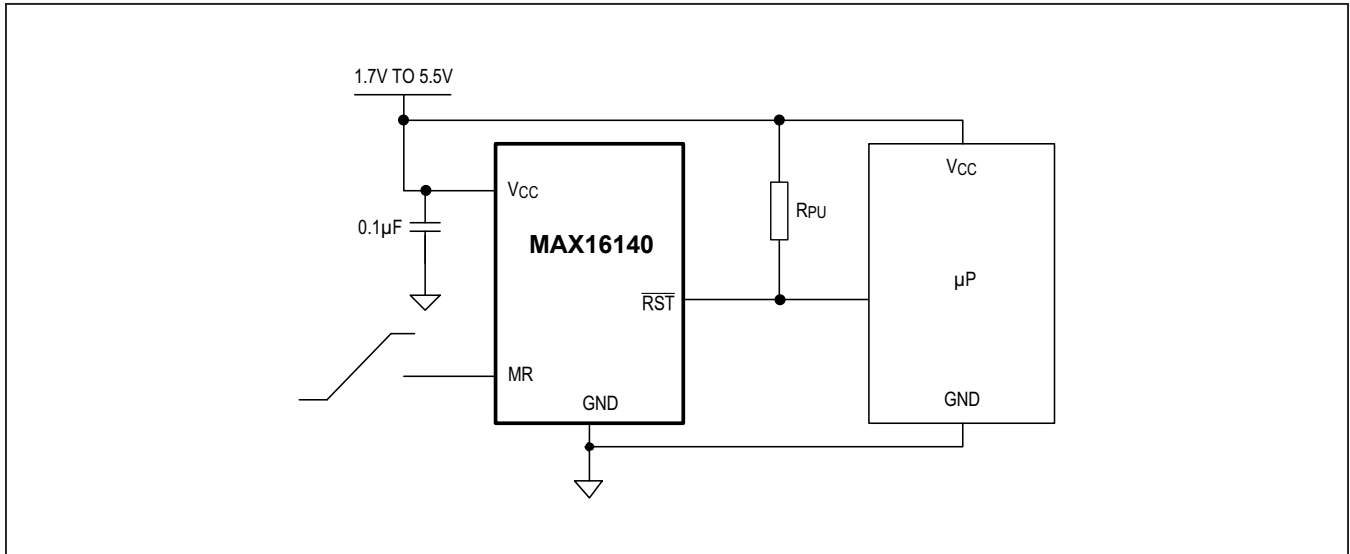
SUFFIX	RESET TIMEOUT PERIOD			UNITS
	$T_A = +25^\circ\text{C}$	$T_A = -40^\circ\text{C TO } +125^\circ\text{C}$		
	TYP	MIN	MAX	
A	0.31	0.24	0.24	$\mu$ s
B	10	7.5	12.5	ms
C	50	35.5	62.5	ms
D	100	75	125	ms
E	250	187.5	312.5	ms
F	500	475	625	ms
G	1000	750	1250	ms
H	2000	1500	2500	ms

Minimum order quantity of 10k required. Contact factory for available options.

Selector Guide



### Typical Application Circuit



### Ordering Information

PART NUMBER	TEMP RANGE	PIN-PACKAGE
MAX16140B220KM+T	-40°C to +125°C	4-BUMP WLP
MAX16140D220JM+T	-40°C to +125°C	4-BUMP WLP
MAX16140D220LM+T	-40°C to +125°C	4-BUMP WLP
MAX16142B180KM+T	-40°C to +125°C	4-BUMP WLP
MAX16144_____+T*	-40°C to +125°C	5-PIN SOT23
MAX16146_____+T*	-40°C to +125°C	5-PIN SOT23
MAX16156_____+T*	-40°C to +125°C	4-BUMP WLP
MAX16157_____+T*	-40°C to +125°C	5-PIN SOT23
MAX16158F400KN+T	-40°C to +125°C	4-BUMP WLP
MAX16159_____+T*	-40°C to +125°C	5-PIN SOT23

Minimum Order Quantity: 5k

+ Denotes a lead(Pb)-free/RoHS-compliant package.

T = Tape and reel.

\*Future product—contact factory for availability.

## Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	6/17	Initial release	—
1	10/17	Updated <i>Selector Guide</i>	10
2	11/17	Corrected typo in <i>Typical Operating Characteristics</i> section	4
2.1	4/18	Updated <i>Outline Number</i> link	2
3	11/18	Added MAX16142 to data sheet	1–12
4	2/19	Add MAX16140D220JM+T to <i>Ordering Information</i>	11
5	10/19	Added MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 part numbers and associated information	1–12
6	11/19	Updated <i>General Description</i> , <i>Package Information</i> , <i>Detailed Description</i> , <i>V<sub>CC</sub> Threshold Input</i> , and <i>Ordering Information</i>	1, 2, 6, 11

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