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°C to +125°C temperature range. The MAX16140/MAX16142/ MAX16156/MAX16158 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

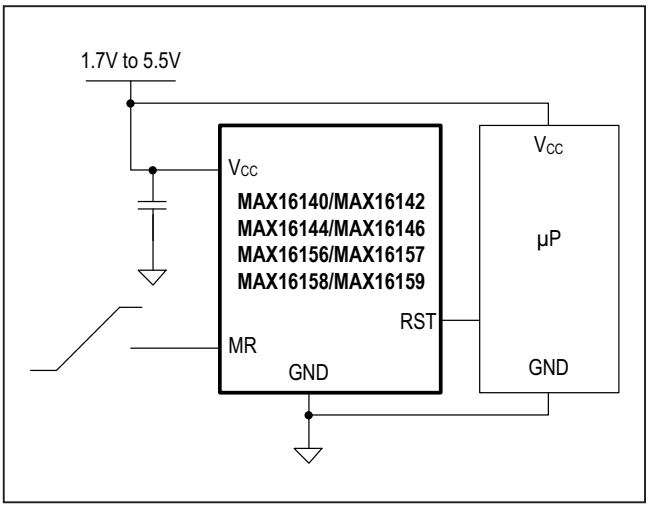
- Chargers
- Portable/Battery-Powered Equipment
- e-Readers/Tablets
- Wearable/Portable Accessories
- Smart Phones

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°C to +125°C Temperature Range

***Ordering Information** appears at end of data sheet.*

Simplified Block Diagram



maxim integrated™

Absolute Maximum Ratings

V_{CC} to GND .....-0.3V to +6V
MR, RST to GND.....-0.3V to +6V
Continuous Sink/Source Current (All Pins) ..... -20mA to +20mA
Continious Power Dissipation (Multilayer Board)
WLP (T_A = +70°C, derate 9.58mW/C above +70°C 766.4mW
Continious Power Dissipation (Multilayer Board) SOT23-5
(T_A = +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	21-100103
Land Pattern Number	Application Note 1891
THERMAL RESISTANCE, FOUR-LAYER BOARD:	
Junction to Ambient (θ_{JA})	104.41°C/W
Junction to Case (θ_{JC})	N/A

SOT23

PACKAGE CODE	U5+2
Outline Number	21-0057
Land Pattern Number	90-0174
THERMAL RESISTANCE, MULTI-LAYER BOARD:	
Junction to Ambient (θ_{JA})	255.90°C/W
Junction to Case (θ_{JC})	81°C/W

For the latest package outline information and land patterns (footprints), go to **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**.

Electrical Characteristics

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT VOLTAGE						
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°C to +85°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 ≤ V_{CC} ≤ 4.85V		36		mV
V_{CC} to Reset Output Delay	t_D	Measured with 2.5% threshold overdrive		50		µs
Reset Timeout Period Accuracy	t_{RP}	Measured from point where V_{CC} is above V_{TH} (Note 1)	-25		+25	%
RESET OUTPUT VOLTAGE						
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} = 800µA	0.8 x V_{CC}			V
		V_{CC} = 2.50V, I_{SOURCE} = 500µA	0.8 x V_{CC}			
MANUAL RESET INPUT						
Reset Output Leakage Current (Open Drain)		T_A = -40°C to +125°C			1	µA
Manual Reset Debounce Period	MR_{DB}	MR input configured as level trigger, t_{RP} = 0.01s -2s		20		ms
		MR input configured as level trigger, t_{RP} = 310µs		0.6		
MR to Reset Delay		MR configured as edge triggered input		1.1		µs
MR Input Voltage Low	V_{IL}				0.3 x V_{CC}	V
MR Input Voltage High	V_{IH}		0.7 x V_{CC}			V
MR Internal Pullup Resistor		MR configured as active-low input		50		kΩ
MR Internal Pulldown Resistor		MR configured as active-high input		50		

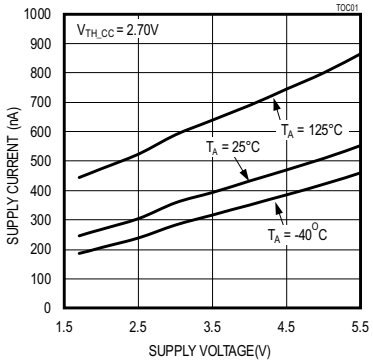
Note 1. The reset timeout period is affected by the V_{CC} rise time during power-up. For a V_{CC} rise time of 10µs or faster, the additional t_{RP} is about 8.5ms(typ).

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

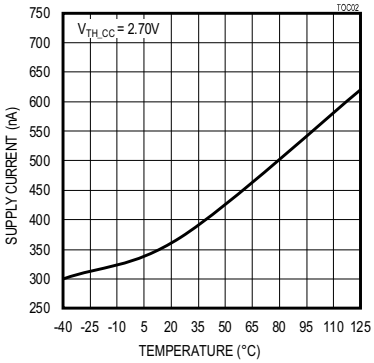
Typical Operating Characteristics

(V_{CC} = 5V, T_A = 25°C, unless otherwise noted)

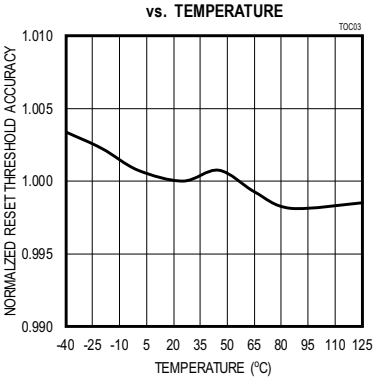
SUPPLY CURRENT vs. SUPPLY VOLTAGE



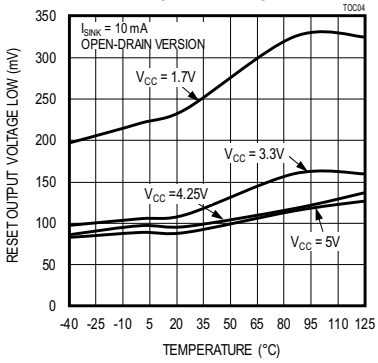
SUPPLY CURRENT vs. TEMPERATURE



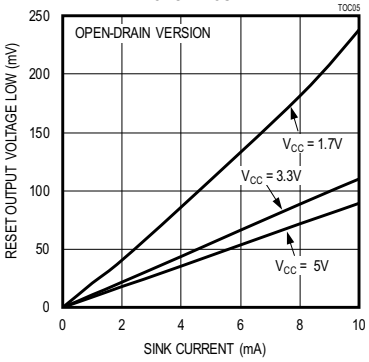
NORMALIZED RESET THRESHOLD vs. TEMPERATURE



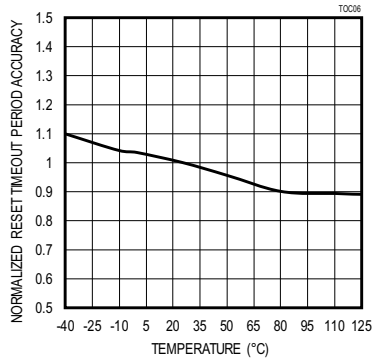
RESET OUTPUT VOLTAGE LOW vs. TEMPERATURE



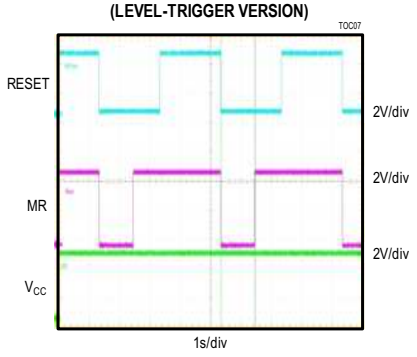
RESET OUTPUT VOLTAGE LOW vs. SINK CURRENT



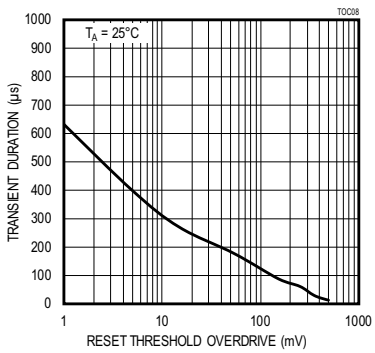
NORMALIZED RESET TIMEOUT PERIOD vs. TEMPERATURE



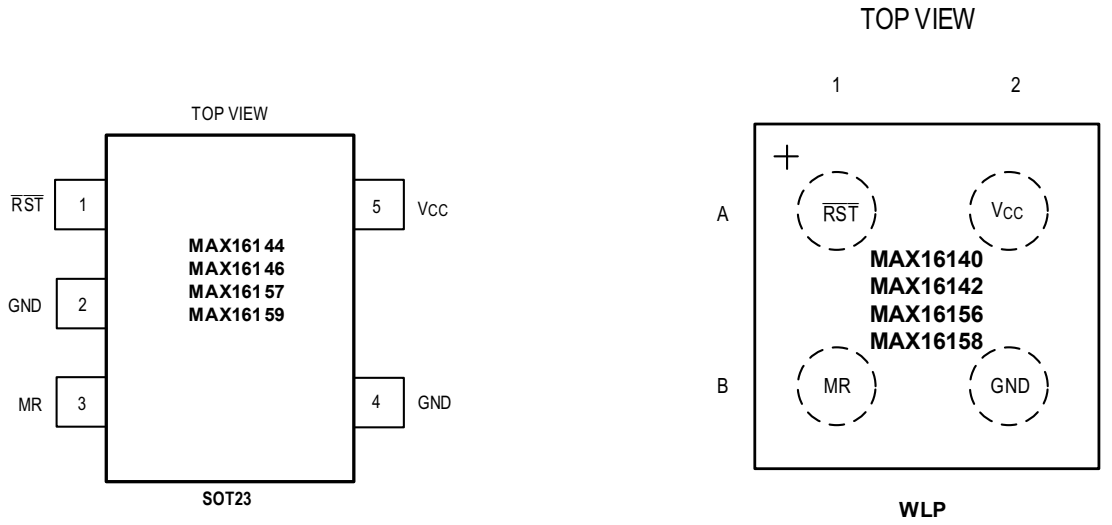
RESET RESPONSE TO MR (LEVEL-TRIGGER VERSION)



V_{CC} TRANSIENT DURATION vs. THRESHOLD OVERDRIVE



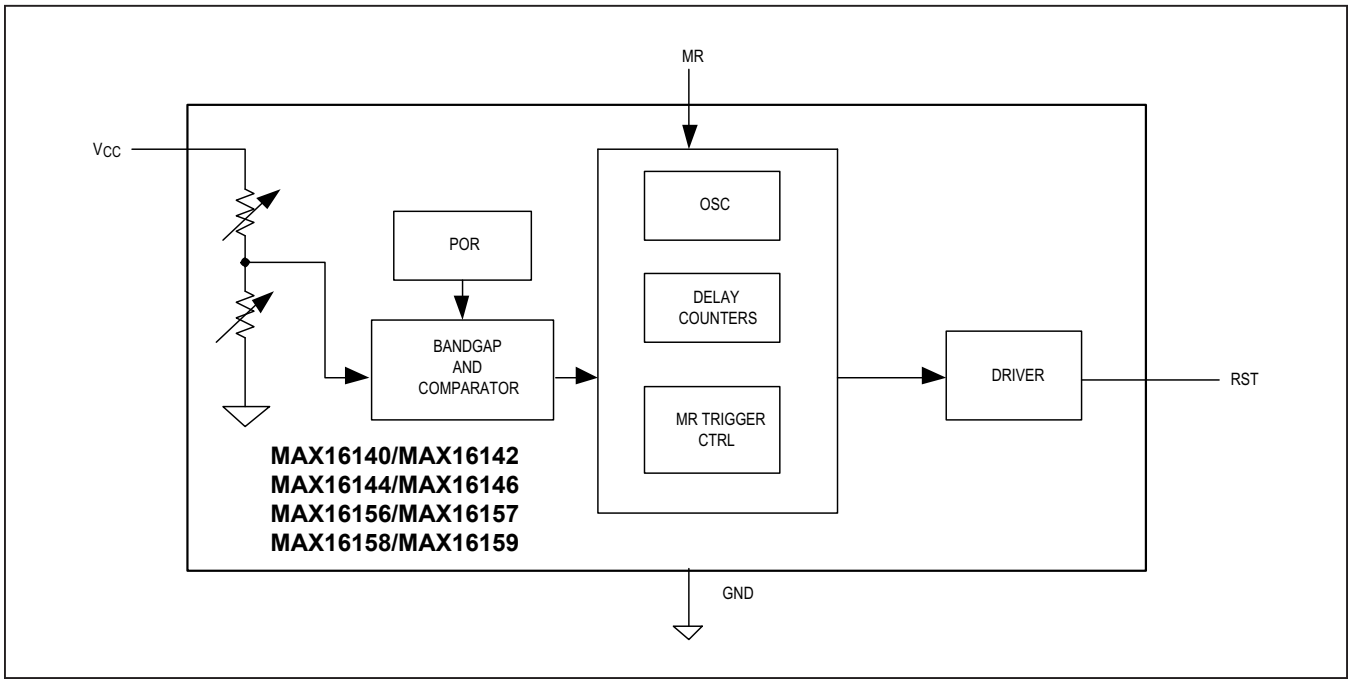
Bump/Pin Configuration



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 0.1µF ceramic capacitor to GND.
3	B1	MR	Manual Reset Input. See *Manual Reset Input* 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 µP-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

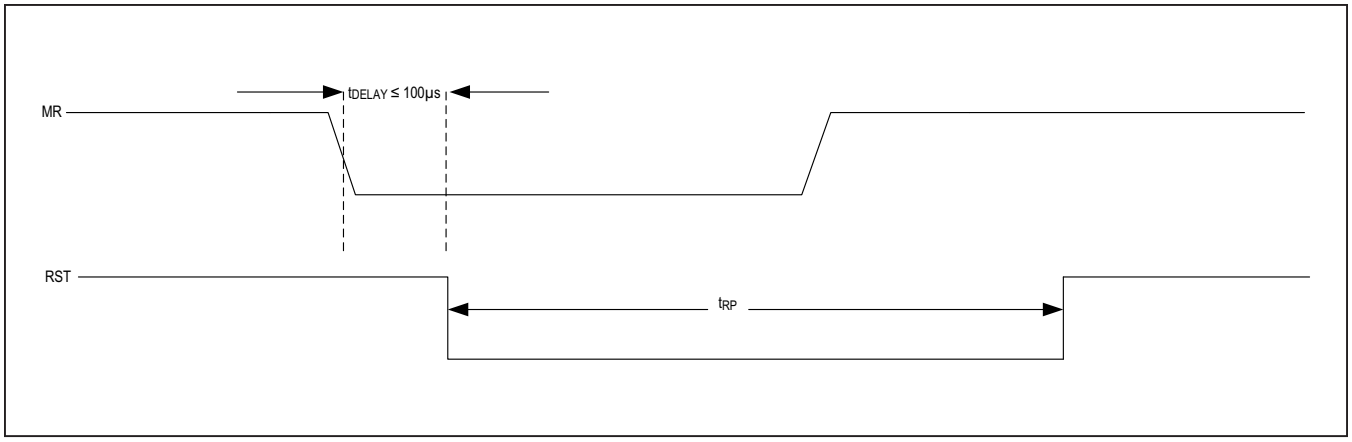


Figure 1. Falling-Edge Trigger Manual Reset Input

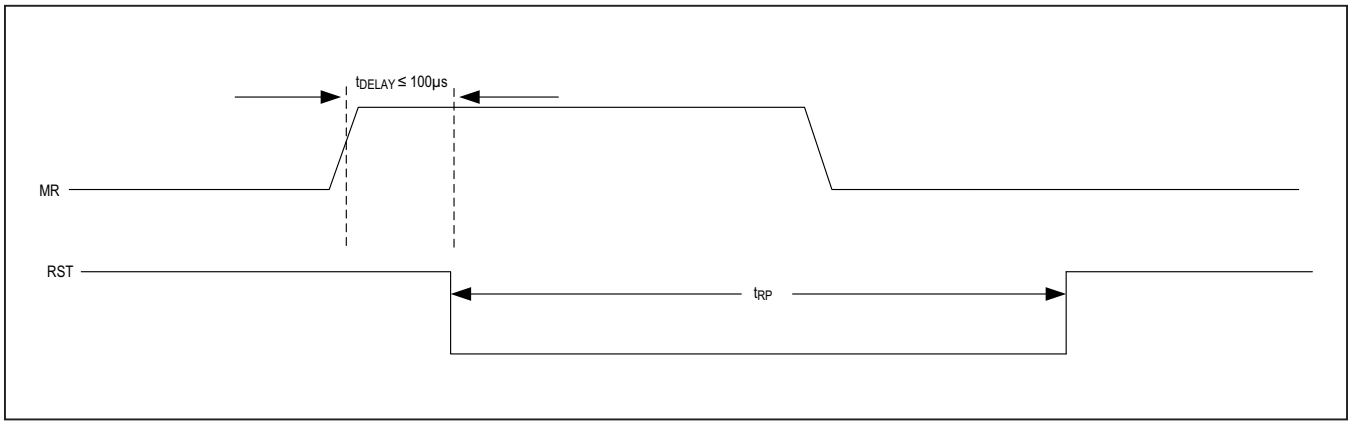


Figure 2. Rising-Edge Trigger Manual Reset Input

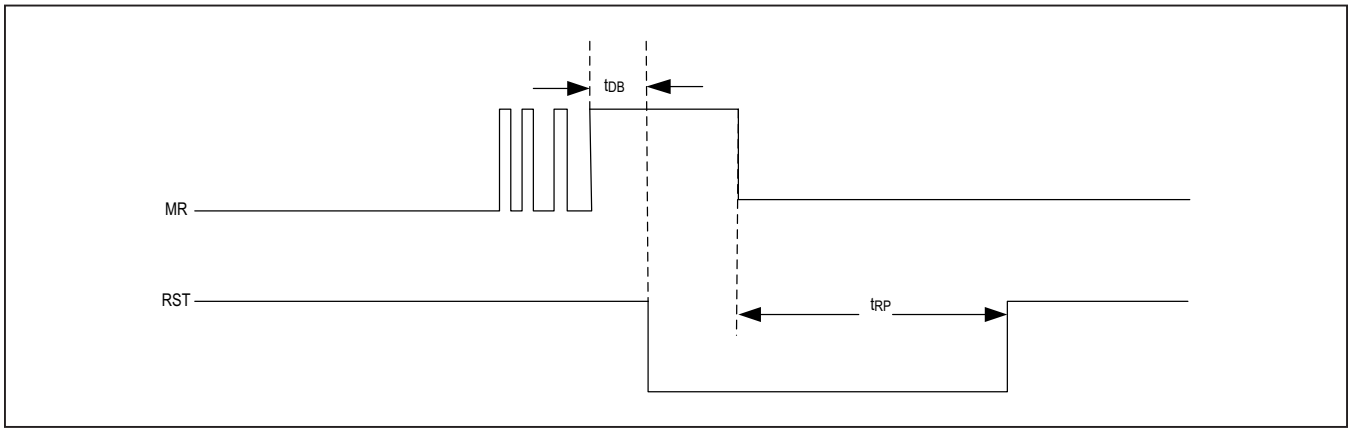


Figure 3. Active-High Trigger Manual Reset Input

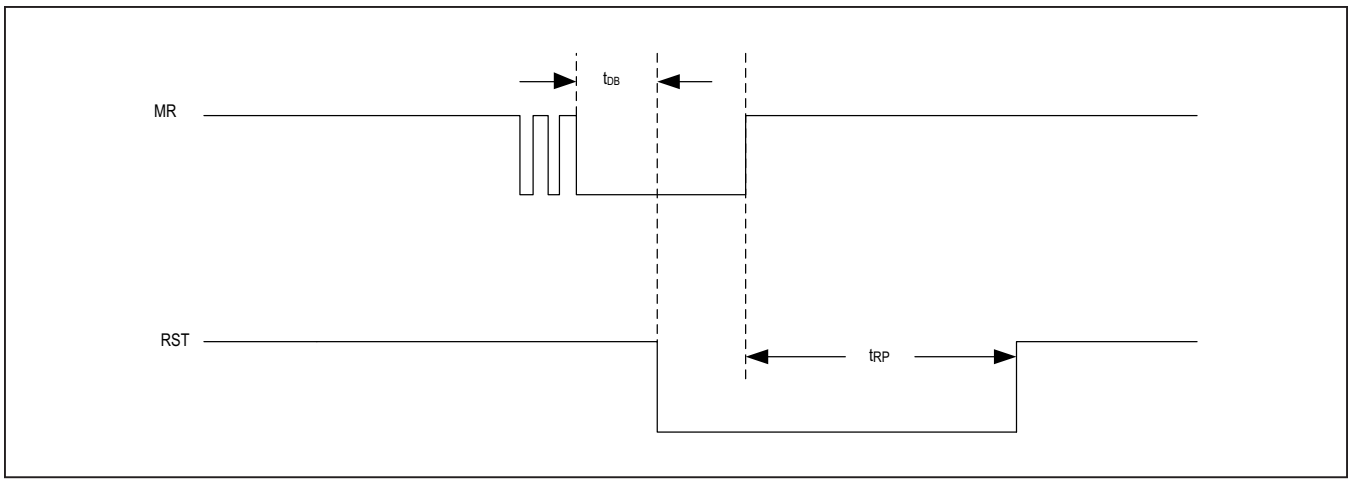


Figure 4. Active-Low Trigger Manual Reset Input

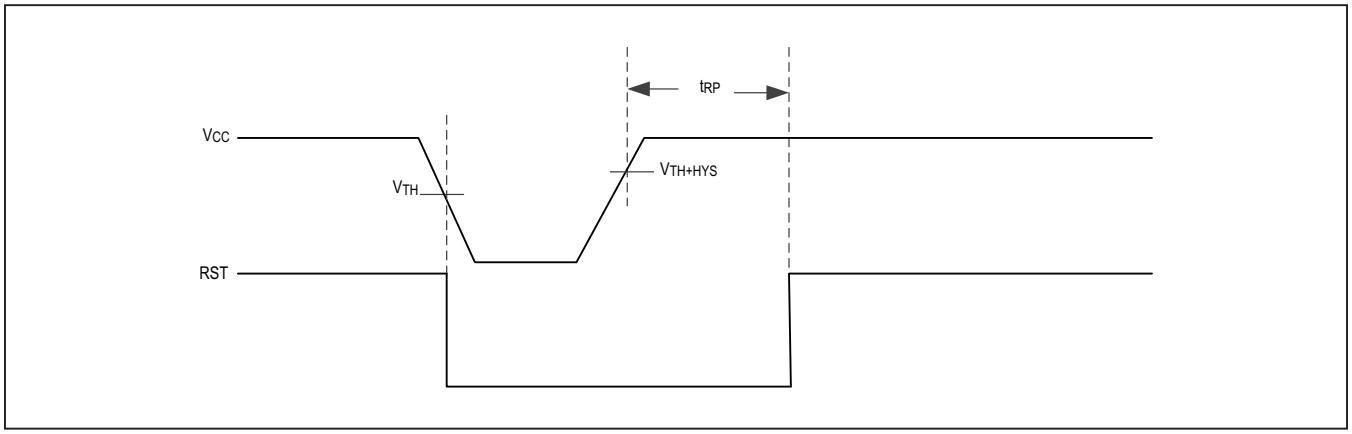


Figure 5. Reset Response to V_{CC} Rising-Edge Above Threshold Voltage + Hysteresis

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 $V_{TH} + V_{HYST}$. See the timing diagram in Figure 5.

Reset Output

The MAX16140/MAX16142/MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 µP 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 0.1µF 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°C	T_A = -40°C TO +125°C		
	TYP	MIN	MAX	
A	0.31	0.24	0.24	µs
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

MAX161_ _ _ _ _ +T

SUFFIX	RESET OUTPUT	PACKAGE
40	OD	WLP
42	PP	
56	OD	
58	PP	
44	OD	SOT23
46	PP	
57	OD	
59	PP	

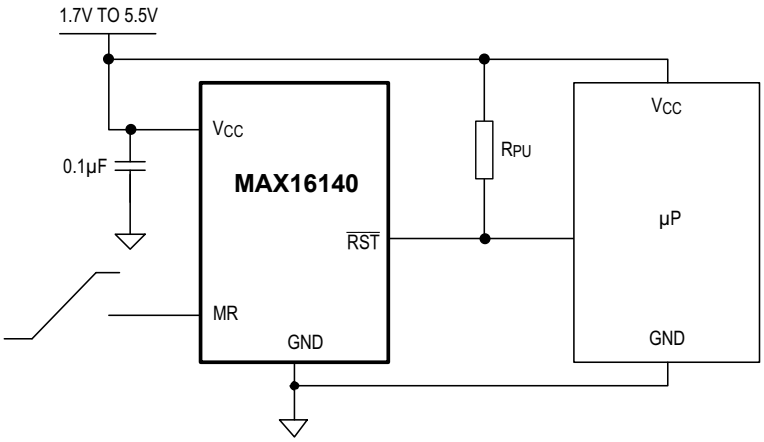
SUFFIX	RESET TIMEOUT (MIN)
A	217µs
B	10ms
C	50ms
D	100ms
E	250ms
F	500ms
G	1000ms
H	2000ms

SUFFIX	MR INPUT CONFIGURATION OPTIONS
I	FALLING EDGE-TRIGGER
J	RISING EDGE-TRIGGER
K	ACTIVE-LOW TRIGGER
L	ACTIVE-HIGH TRIGGER

SUFFIX	RESET OUTPUT POLARITY OPTIONS	PART NUMBER
M	ACTIVE-LOW	MAX16140 MAX16142 MAX16144 MAX16146
N	ACTIVE-HIGH	MAX16156 MAX16157 MAX16158 MAX16159

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	3.20	485	4.85

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 *Selector Guide*	10
2	11/17	Corrected typo in *Typical Operating Characteristics* section	4
2.1	4/18	Updated *Outline Number* link	2
3	11/18	Added MAX16142 to data sheet	1–12
4	2/19	Add MAX16140D220JM+T to *Ordering Information*	11
5	10/19	Added MAX16144/MAX16146/MAX16156/MAX16157/MAX16158/MAX16159 part numbers and associated information	1–12
6	11/19	Updated *General Description, Package Information, Detailed Description, V_{CC} Threshold Input*, and *Ordering Information*	1, 2, 6, 11

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at https://www.maximintegrated.com/en/storefront/storefront.html.

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