19-1508; Rev 1; 10/99

MAXIM

Dual/Triple-Voltage µP Supervisory Circuits

General Description

The MAX6351–MAX6360 microprocessor (µP) supervisors with multiple reset voltages significantly improve system reliability and accuracy compared to separate ICs or discrete components. If any input supply voltage drops below its associated preset threshold, all reset outputs are asserted. In addition, the output(s) is valid as long as either input supply voltage remains greater than +1.0V.

All devices in this series have an active-low debounced manual reset input. In addition, the MAX6358/MAX6359/MAX6360 offer a watchdog timer input with a 46.4sec start-up timeout period and a 2.9sec timeout period. The MAX6355/MAX6356/MAX6357 offer an additional voltage monitor input to monitor a third voltage.

The MAX6351 features both 3V and 5V active-low push-pull reset outputs. The MAX6353/MAX6356/MAX6359 offer a 5V active-low push-pull reset. The MAX6354/MAX6357/MAX6360 offer a 3V active-low push-pull reset. The MAX6352/MAX6355/MAX6358's reset is active-low open-drain.

All of these devices are offered with a wide variety of voltage threshold levels, as shown in the *Voltage Threshold Levels* table below. They are available in 5- and 6-pin SOT23 packages and operate over the extended (-40°C to +85°C) temperature range.

Applications

Computers
Controllers
Portable/Battery-Powered Equipment
Intelligent Instruments
Multivoltage Systems

Voltage Threshold Levels

PART NO. SUFFIX (_ _)	V_{CC}5 NOMINAL VOLTAGE THRESHOLD (V)	V_{CC}3 NOMINAL VOLTAGE THRESHOLD (V)
LT	4.63	3.08
LS	**4.63**	**2.93**
LR	4.63	2.63
MT	4.38	3.08
MS	4.38	2.93
MR	4.38	2.63
TY	3.08	2.19
SY	**2.93**	**2.19**

Note: *Standard versions are shown in bold and have a required order increment of 2500 pieces. Sample stock is generally held on the standard versions only. The required order increment for non-standard versions is 10,000 pieces. Contact factory for availability.*

Features

- **Precision Monitoring of Multiple +2.5V, +3.0V, +3.3V, and +5V Power-Supply Voltages**
- **Precision Factory-Set Power-Supply Reset Thresholds**
- **20µA Supply Current**
- **100ms min Power-On Reset Pulse Width**
- **Fully Guaranteed Over Temperature**
- **Guaranteed $\overline{\text{RESET}}$ Valid to V_{CC}5 = 1V or V_{CC}3 = 1V**
- **Power-Supply Transient Immunity**
- **No External Components for Dual-Voltage Systems**
- **Small 5- and 6-Pin SOT23 Packages**
- **Debounced TTL/CMOS-Compatible Manual-Reset Input**
- **Watchdog Timer**
  - **46.4sec Start-Up Timeout**
  - **2.9sec Normal Timeout**
- **Low Cost**

Ordering Information

PART*	TEMP. RANGE	PIN-PACKAGE
MAX6351_ _UT-T	-40°C to +85°C	6 SOT23-6
MAX6352_ _UK-T	-40°C to +85°C	5 SOT23-5
MAX6353_ _UK-T	-40°C to +85°C	5 SOT23-5
MAX6354_ _UK-T	-40°C to +85°C	5 SOT23-5
MAX6355_ _UT-T	-40°C to +85°C	6 SOT23-6
MAX6356_ _UT-T	-40°C to +85°C	6 SOT23-6
MAX6357_ _UT-T	-40°C to +85°C	6 SOT23-6
MAX6358_ _UT-T	-40°C to +85°C	6 SOT23-6
MAX6359_ _UT-T	-40°C to +85°C	6 SOT23-6
MAX6360_ _UT-T	-40°C to +85°C	6 SOT23-6

**The _ _ are placeholders for the threshold voltage levels of the devices. Substitute the part number suffix in the Voltage Threshold Levels table for the desired voltage level. There are two standard versions for each of the above part numbers. All devices are available in tape-and-reel only.*

Pin Configurations appear at end of data sheet.
Selector Guide appears at end of data sheet.

Dual/Triple-Voltage µP Supervisory Circuits

ABSOLUTE MAXIMUM RATINGS

$V_{CC}5$, $V_{CC}3$ to GND .....-0.3V to +6V
$\overline{RST}$ (MAX6352/55/58) ..... -0.3V to +6V
$\overline{RST}$, $\overline{MR}$, WDI, $\overline{RST5}$, RSTIN (MAX6351/53/56/59).....-0.3V to ($V_{CC}5$ + 0.3V)
$\overline{RST}$, $\overline{RST3}$ (MAX6351/54/57/60) .....-3V to ($V_{CC}3$ + 0.3V)
Input/Output Current, All Pins 20mA

Continuous Power Dissipation (T_A = +70°C)
5-Pin SOT23-5 (derate 7.1mW/°C above +70°C) 571mW
6-Pin SOT23-6 (derate 7.1mW/°C above +70°C) 571mW
Operating Temperature Range .....-40°C to +85°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10sec) .....+300°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.

ELECTRICAL CHARACTERISTICS

($V_{CC}3$ = $V_{CC}5$ = +1.2V to +5.5V, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range (Note 2)	V_{CC}	T_A = 0°C to +70°C		1.0		5.5	V
		T_A = -40°C to +85°C		1.2		5.5	
Supply Current	$I_{CC}5$ + $I_{CC}3$	$V_{CC}5$ = 5.5V, $V_{CC}3$ = 3.6V, all I/O pins open			20	50	µA
$V_{CC}5$ Threshold (Note 3)	$V_{TH}5$	MAX63_ _L_	T_A = +25°C	4.54	4.63	4.72	V
			T_A = -40°C to +85°C	4.5		4.75	
		MAX63_ _M_	T_A = +25°C	4.3	4.38	4.46	
			T_A = -40°C to +85°C	4.25		4.50	
		MAX63_ _T_	T_A = +25°C	3.03	3.08	3.14	
			T_A = -40°C to +85°C	3.00		3.15	
		MAX63_ _S_	T_A = +25°C	2.88	2.93	2.98	
			T_A = -40°C to +85°C	2.85		3.00	
$V_{CC}3$ Threshold (Note 3)	$V_{TH}3$	MAX63_ _ _T	T_A = +25°C	3.03	3.08	3.14	V
			T_A = -40°C to +85°C	3.00		3.15	
		MAX63_ _ _S	T_A = +25°C	2.88	2.93	2.98	
			T_A = -40°C to +85°C	2.85		3.00	
		MAX63_ _ _R	T_A = +25°C	2.58	2.63	2.68	
			T_A = -40°C to +85°C	2.55		2.70	
		MAX63_ _ _Y	T_A = +25°C	2.16	2.19	2.22	
			T_A = -40°C to +85°C	2.13		2.25	
Reset Threshold Tempco	ΔV_{TH}/°C				20		ppm/°C
Reset Threshold Hysteresis					V_{TH}/500		V
V_{CC} to Reset Delay		100mV overdrive			20		µs
Reset Timeout Period	t_{RP}	$V_{CC}5 > V_{TH}5_{(MAX)}$, $V_{CC}3 > V_{TH}3_{(MAX)}$		100	180	280	ms
$\overline{RESET}$ Output Voltage Low	V_{OL}	$V_{CC}5$ or $V_{CC}3$ ≥ 2.7V, I_{SINK} = 1.2mA				0.3	V
		$V_{CC}5$ or $V_{CC}3$ ≥ 4.5V, I_{SINK} = 3.2mA				0.4	
		$V_{CC}5$ or $V_{CC}3$ < 1V, I_{SINK} = 50µA, T_A = 0°C to +70°C				0.3	
		$V_{CC}5$ or $V_{CC}3$ < 1.2V, I_{SINK} = 50µA				0.3	V

ELECTRICAL CHARACTERISTICS (continued)

($V_{CC}3 = V_{CC}5 = +1.2V$ to $+5.5V$, $T_A = -40°C$ to $+85°C$, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
$\overline{RESET}$ Output Voltage High	V_{OH}	MAX6351/MAX6353/ MAX6354/MAX6356/ MAX6357/MAX6359/ MAX6360 (_Y versions only), $V_{CC}5 > V_{TH}5_{(MAX)}$, $V_{CC}3 > V_{TH}3_{(MAX)}$	$I_{SOURCE} = 500µA$	$0.8V_{CC}$			V
		MAX6351/MAX6353/ MAX6354/MAX6356/ MAX6357/MAX6359/ MAX6360 (L_, M_ versions only), $V_{CC}5 > V_{TH}5_{(MAX)}$, $V_{CC}3 > V_{TH}3_{(MAX)}$	$I_{SOURCE} = 800µA$	V_{CC} - 1.5			
WATCHDOG INPUT (MAX6358/MAX6359/MAX6360)							
Watchdog Timeout Period	t_{WD}	First timeout period after reset		25.6	46.4	72.0	sec
		After first WDI falling edge		1.6	2.9	4.5	
WDI Pulse Width (Note 4)	t_{WDI}	$V_{IL} = 0.4V$, $V_{IH} = 0.8V_{CC}$		50			ns
WDI Input Threshold (Note 5)	V_{IL}	$V_{CC}3 = 5V$		$0.3V_{CC}$			V
	V_{IH}					$0.7V_{CC}$	
WDI Input Current (Note 6)		$V_{WDI} = V_{CC}$			120	160	µA
		$V_{WDI} = 0$		-20	-15		
MANUAL RESET INPUT							
$\overline{MR}$ Input	V_{IL}	MAX63_ _L_, MAX63_ _M_, $V_{CC}5 > V_{TH}5_{(MAX)}$		0.8			V
	V_{IH}	MAX63_ _L_, MAX63_ _M_, $V_{CC}5 > V_{TH}5_{(MAX)}$				2.3	
	V_{IL}	MAX63_ _ _Y, $V_{CC}5 > V_{TH}5_{(MAX)}$		$0.3V_{CC}$			
	V_{IH}	MAX63_ _ _Y, $V_{CC}5 > V_{TH}5_{(MAX)}$				$0.7V_{CC}$	
$\overline{MR}$ Pull-Up Resistance				32	63.5	100	kΩ
$\overline{MR}$ Minimum Pulse Width	t_{RP}			10			µs
$\overline{MR}$ Glitch Rejection					100		ns
$\overline{MR}$ to Reset Delay	t_{MD}				0.1		µs
ADJUSTABLE RESET COMPARATOR INPUT (MAX6355/MAX6356/MAX6357)							
RSTIN Input Threshold	V_{RSTIN}	$V_{CC}5 > V_{TH}5_{(MAX)}$, $V_{CC}3 > V_{TH}3_{(MAX)}$	$T_A = +25°C$	1.20	1.22	1.24	V
			$T_A = -40°C$ to $+85°C$	1.19		1.25	
RSTIN Input Current	I_{RSTIN}	$0 < V_{RISTIN} < V_{CC}5 - 0.3V$		-25		25	nA
RSTIN Hysteresis					2.5		mV

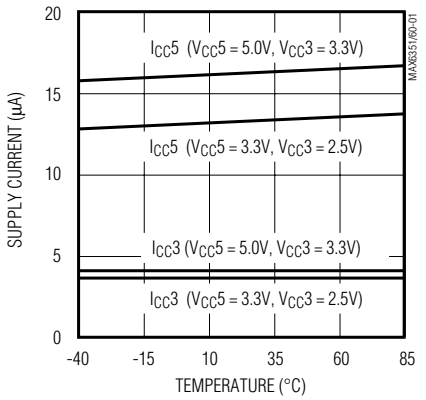
Note 1: Overtemperature limits are guaranteed by design and not production tested.
Note 2: The reset output is guaranteed to be in the correct state if either $V_{CC}3$ or $V_{CC}5$ is within its specified region of operation.
Note 3: The reset output(s) is asserted if either $V_{CC}5$ or $V_{CC}3$ drops below its associated trip point.
Note 4: Guaranteed by design. Not production tested.
Note 5: WDI is internally serviced within the watchdog timeout period if WDI is left unconnected.
Note 6: The WDI input current is specified as the average input current when the WDI input is driven high or low.

Dual/Triple-Voltage µP Supervisory Circuits

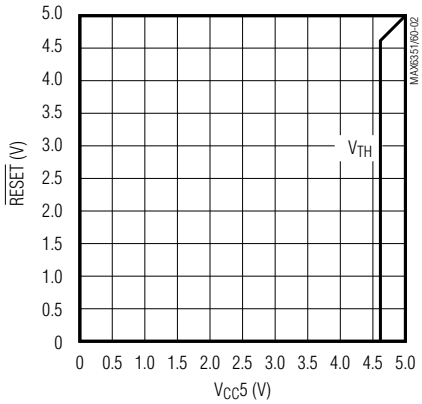
Typical Operating Characteristics

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

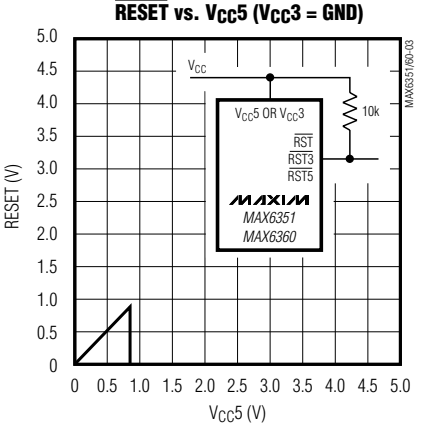
SUPPLY CURRENT vs. TEMPERATURE



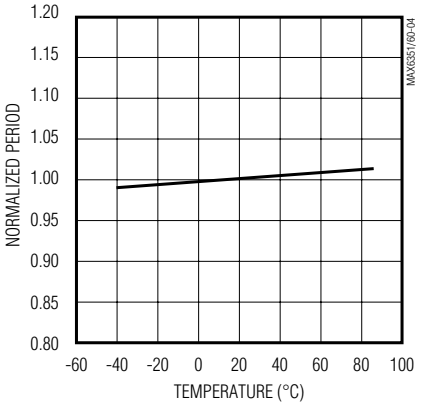
$\overline{RESET}$ vs. $V_{CC}5$ ($V_{CC}3$ = 3V)



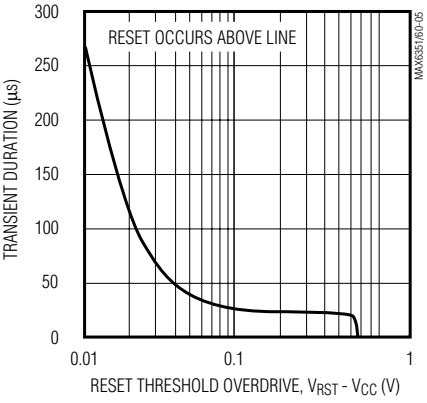
$\overline{RESET}$ vs. $V_{CC}5$ ($V_{CC}3$ = GND)



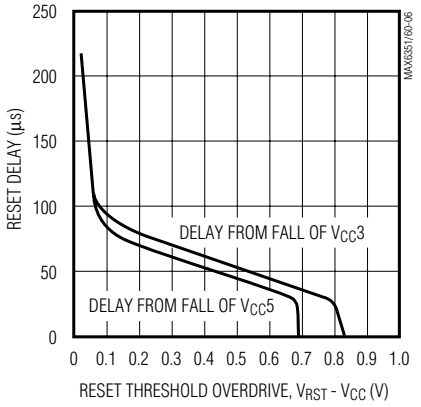
NORMALIZED RESET/WATCHDOG PERIOD vs. TEMPERATURE



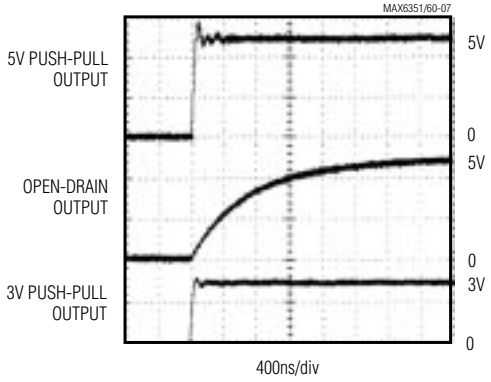
MAXIMUM V_{CC} TRANSIENT DURATION vs. RESET THRESHOLD OVERDRIVE



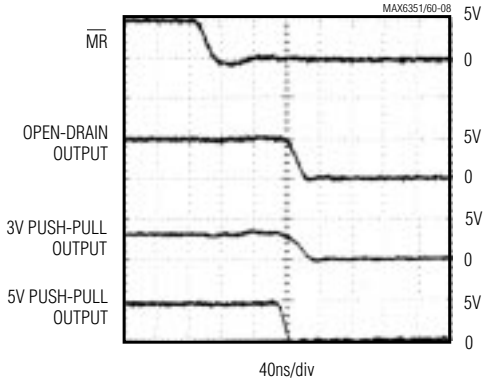
RESET DELAY vs. RESET THRESHOLD OVERDRIVE



PULL-UP CHARACTERISTICS



PULL-DOWN CHARACTERISTICS AND MANUAL RESET DELAY



Pin Description

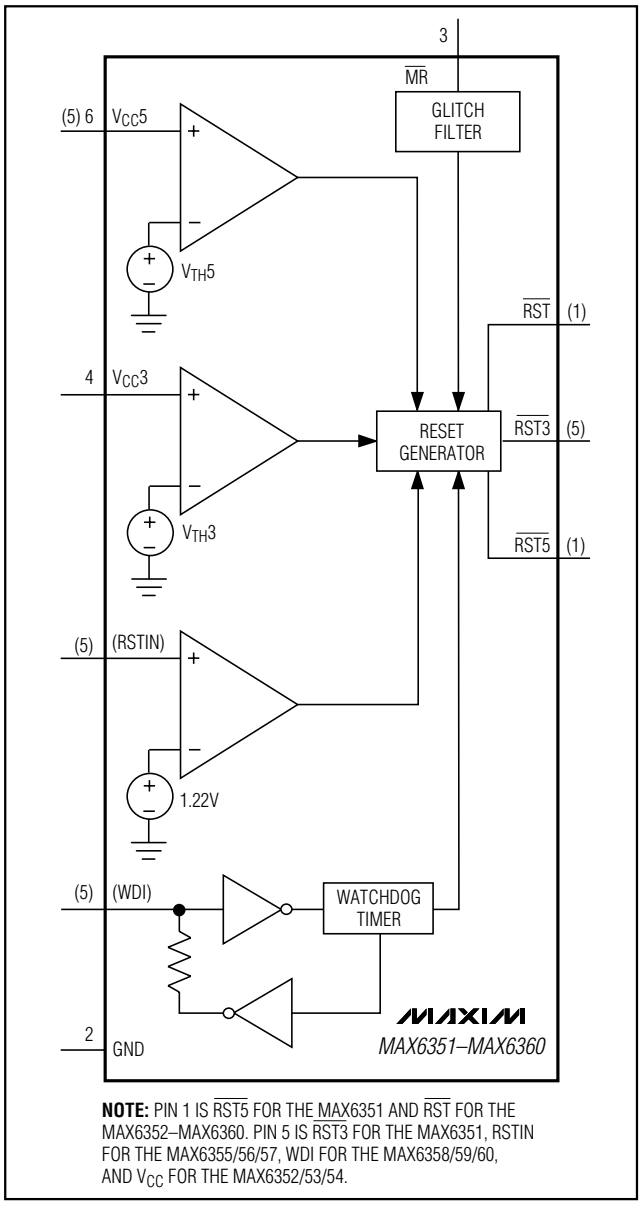
PIN				NAME	FUNCTION
MAX6351	MAX6352 MAX6353 MAX6354	MAX6355 MAX6356 MAX6357	MAX6358 MAX6359 MAX6360		
1	—	—	—	$\overline{RST5}$	Active-Low, 5V CMOS Reset Output
—	1	1	1	$\overline{RST}$	Active-Low Reset Output. Open-drain for the MAX6352/MAX6355/MAX6358, 5V push-pull for the MAX6353/MAX6356/MAX6359, and 3V push-pull for the MAX6354/MAX6357/MAX6360.
2	2	2	2	GND	Ground
3	3	3	3	$\overline{MR}$	Manual-Reset Input. Pull low to force a reset. $\overline{RST}$, $\overline{RST5}$, and $\overline{RST3}$ remain active as long as $\overline{MR}$ is low and for the timeout period after $\overline{MR}$ goes high. Leave unconnected or connect to $V_{CC}5$ if unused. $V_{\overline{MR}}$ must be below $V_{CC}5$.
4	4	4	4	$V_{CC}3$	+3.3V/+3.0V Supply Input. Powers the device when it is above $V_{CC}5$ and monitors its own voltage.
5	—	—	—	$\overline{RST3}$	Active-Low, 3V CMOS Reset Output
—	—	5	—	RSTIN	Undervoltage Reset Comparator Input. Asserts reset when the monitored voltage falls below 1.23V. Set the reset threshold with an external resistor-divider. Connect to $V_{CC}5$ if unused. V_{RSTIN} must be below $V_{CC}5$.
—	—	—	5	WDI	Watchdog Input. If WDI remains either high or low longer than the timeout period, then reset is triggered. The timer clears when reset is asserted or whenever WDI sees a rising or falling edge. Leave floating to disable it if unused.
6	5	6	6	$V_{CC}5$	+5V Supply Input. Powers the device when it is above $V_{CC}3$ and monitors its own voltage.

Dual/Triple-Voltage µP Supervisory Circuits

Detailed Description

Supply Voltages

The MAX6351–MAX6360 microprocessor (µP) supervisory circuits maintain system integrity by alerting the µP to fault conditions. These ICs monitor multiple-supply systems and derive their internal power from the highest voltage source present at $V_{CC}5$ and $V_{CC}3$. In addition, the output reset state is guaranteed to remain viable while either $V_{CC}5$ or $V_{CC}3$ is above +1V.



NOTE: PIN 1 IS $\overline{RST5}$ FOR THE MAX6351 AND $\overline{RST}$ FOR THE MAX6352–MAX6360. PIN 5 IS $\overline{RST3}$ FOR THE MAX6351, RSTIN FOR THE MAX6355/56/57, WDI FOR THE MAX6358/59/60, AND V_{CC} FOR THE MAX6352/53/54.

Figure 1. Functional Diagram

Threshold Levels

All the possible input voltage threshold level combinations are indicated by a two-letter code in *Voltage Threshold Levels*. The two standard combinations are LS and SY. LS parts monitor one +5V ±5% supply and one +3.3V ±10% supply. SY parts monitor one +3.3V ±10% supply and one +2.5V ±10% supply. The other combinations also monitor +5V ±10% supplies, +3.3V ±5% supplies, and +3V ±5% supplies.

Reset Outputs

The MAX6351 provides a 5V active-low reset and a 3V active-low reset. The MAX6353/MAX6356/MAX6359 provide a 5V active-low push-pull reset and the MAX6354/MAX6357/MAX6360 provide a 3V active-low push-pull reset. The MAX6353/MAX6355/MAX6358 provide an active-low open-drain reset. The higher input voltages of $V_{CC}5$ and $V_{CC}3$ maintain the sinking capability of the low reset-output state. The reset outputs are maintained as long as either supply is above +1V.

Negative-Going V_{CC} Transients

The MAX6351–MAX6360 are designed to ignore short negative-going $V_{CC}5$ and $V_{CC}3$ transients. See *Typical Operating Characteristics* for a glitch immunity graph.

Third Input Voltage (MAX6355/MAX6356/MAX6357)

The MAX6355/MAX6356/MAX6357 provide an additional input to monitor a third voltage. The threshold voltage at RSTIN is typically 1.22V. To monitor a voltage higher than 1.22V, connect a resistor-divider to the circuit as shown in Figure 2. The threshold at V_3 is:

$$V_{3TH} = 1.22\left(\frac{R1 + R2}{R2}\right)$$

Note that RSTIN is powered by $V_{CC}5$, and its voltage must therefore remain lower than $V_{CC}5$.

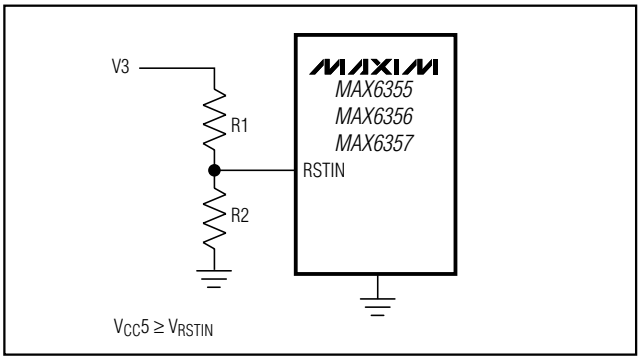


Figure 2. Monitoring a Third Voltage

Watchdog Input (MAX6358/MAX6359/MAX6360)

The MAX6358/MAX6359/MAX6360 include a WDI to provide a reset if the µP goes into an infinite loop. After a reset, the start-up timeout period and the initial timeout period is nominally 46.4sec to allow the µP time to initialize. After the first transition on the WDI and after any toggle of the watchdog thereafter, the timeout period is nominally 2.9sec.

Applications Information

Ensuring a Valid $\overline{RESET}$ Output Down to V_{CC} = 0

In some systems, it is necessary to ensure a valid reset even if V_{CC} falls to 0. In these applications, use the circuit shown in Figure 3. Note that this configuration does not work for the open-drain outputs of the MAX6352/MAX6355/MAX6358.

Monitoring a Negative Voltage

To monitor a negative supply rail using RSTIN or the MAX6355/MAX6356/MAX6357, use the circuit shown in Figure 4. In this configuration, a reset is issued when the negative supply falls below V_{INTH}.

Interfacing to µPs with Bidirectional Reset Pins

Microprocessors with bidirectional reset pins will contend with the push-pull outputs of these devices. To prevent this, connect a 4.7kΩ resistor between $\overline{RESET}$ and the µP's reset I/O port, as shown in Figure 5. Buffer $\overline{RESET}$ as shown in the figure if this reset is used by other components in the system.

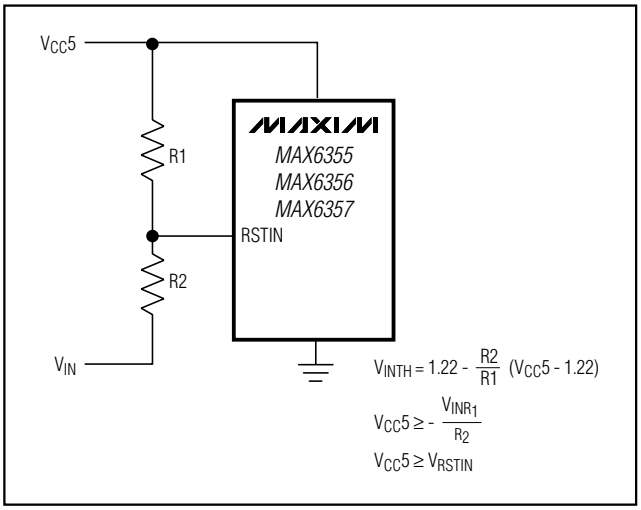


Figure 4. Monitoring a Negative Voltage

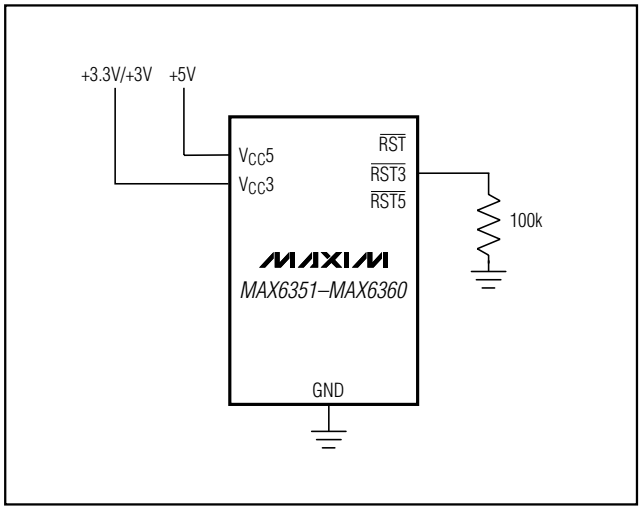


Figure 3. Ensuring a Valid Reset Low to V_{CC}5 and V_{CC}3 = 0

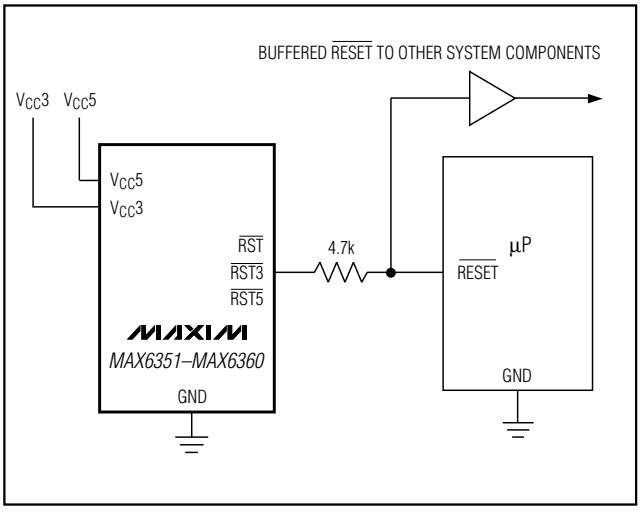


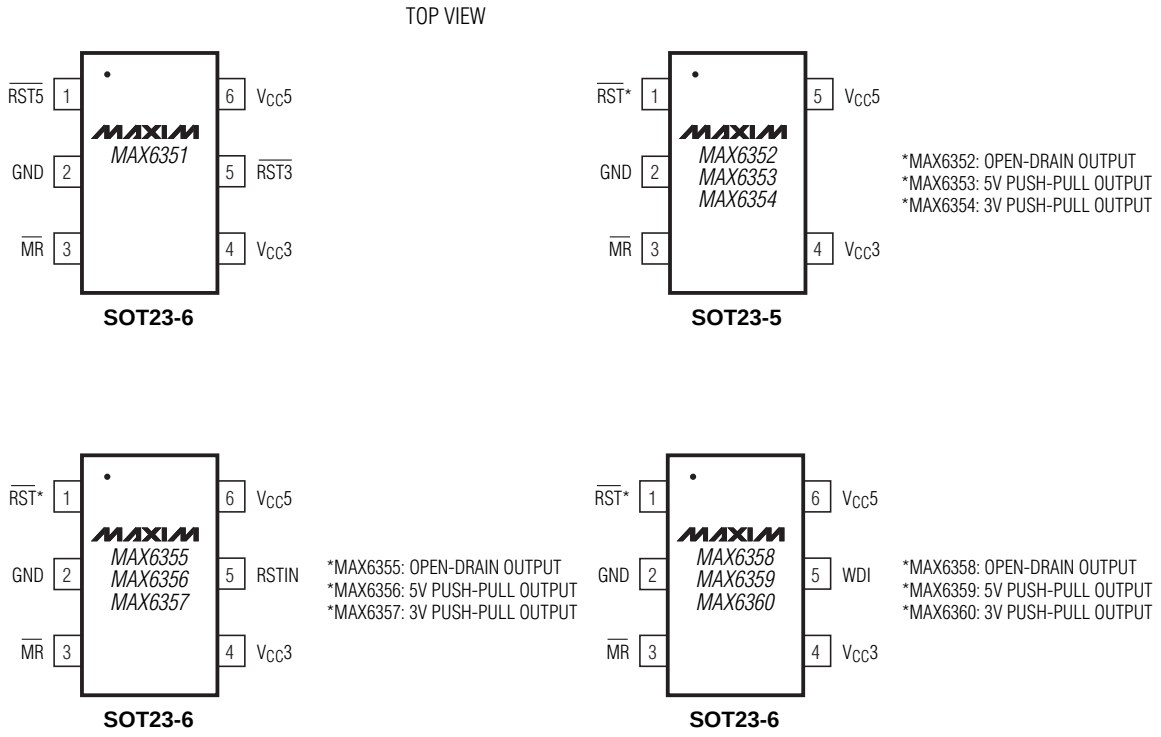
Figure 5. Interfacing to µPs with Bidirectional Reset I/O

Chip Information

TRANSISTOR COUNT: 855

Dual/Triple-Voltage µP Supervisory Circuits

Pin Configurations



Selector Guide

PART	PIN COUNT	NUMBER OF SUPPLIES MONITORED	5V $\overline{\text{RESET}}$	3V $\overline{\text{RESET}}$	OPEN-DRAIN $\overline{\text{RESET}}$	WATCHDOG TIMER	MANUAL RESET
MAX6351	6	2	✔	✔	—	—	✔
MAX6352	5	2	—	—	✔	—	✔
MAX6353	5	2	✔	—	—	—	✔
MAX6354	5	2	—	✔	—	—	✔
MAX6355	6	3	—	—	✔	—	✔
MAX6356	6	3	✔	—	—	—	✔
MAX6357	6	3	—	✔	—	—	✔
MAX6358	6	2	—	—	✔	✔	✔
MAX6359	6	2	✔	—	—	✔	✔
MAX6360	6	2	—	✔	—	✔	✔