MIC2774

Dual Micropower Low Voltage Supervisor

Features

- Monitors Two Independent Power Supplies for Undervoltage Conditions
- One Fixed and One User-Adjustable Input
- Choice of Ten Factory-Programmed Thresholds
- Adjustable Input can Monitor Supplies as Low as 0.3V
- Generates 140 ms (min.) Power-On Reset Pulse
- Manual Reset Input
- Choice of Active-High, Active-Low, or Open-Drain Active-Low Reset Outputs
- Inputs May be Pulled Above V_{DD} (7V abs. max.)
- /RST Output Valid Down to 1.2V
- Ultra-Low Supply Current, 3.5 µA Typical
- Rejects Brief Input Transients
- IttyBitty 5-pin SOT-23 Package
- Pin-Compatible upgrade for MAX6306/09/12

Applications

- Monitoring Processor ASIC or FPGA Core and I/O Voltages
- PDAs, Handheld PCs
- Embedded Controllers
- Telecommunications Systems
- Power Supplies
- Wireless/Cellular Systems
- Networking Hardware

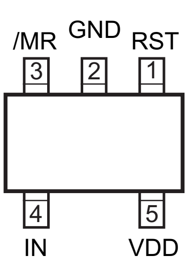
General Description

The MIC2774 is a dual power supply supervisor that provides undervoltage monitoring, manual reset capability, and power-on reset generation in a compact 5-pin SOT-23 package. Features include two undervoltage detectors, one fixed and one adjustable, and a choice of reset outputs. One undervoltage detector compares V_{DD} against a fixed threshold. Ten factory-programmed thresholds are available. The second, user-adjustable input is compared against a 300 mV reference. This low reference voltage allows for the monitoring of voltages lower than those supported by previous supervisor ICs.

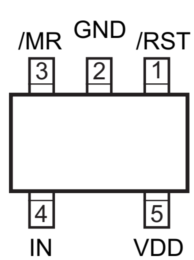
The reset outputs are asserted at power-on and at any time either voltage drops below the programmed threshold voltage and remains asserted for 140 ms (min.) after they subsequently rise back above the threshold boundaries. Manual reset functionality can be provided by a switch connected between ground and the /MR input. A wide choice of voltage thresholds provides for a variety of supply voltages and tolerances. Hysteresis is included to prevent chattering due to noise. Typical supply current is a low 3.5 µA.

Package Types

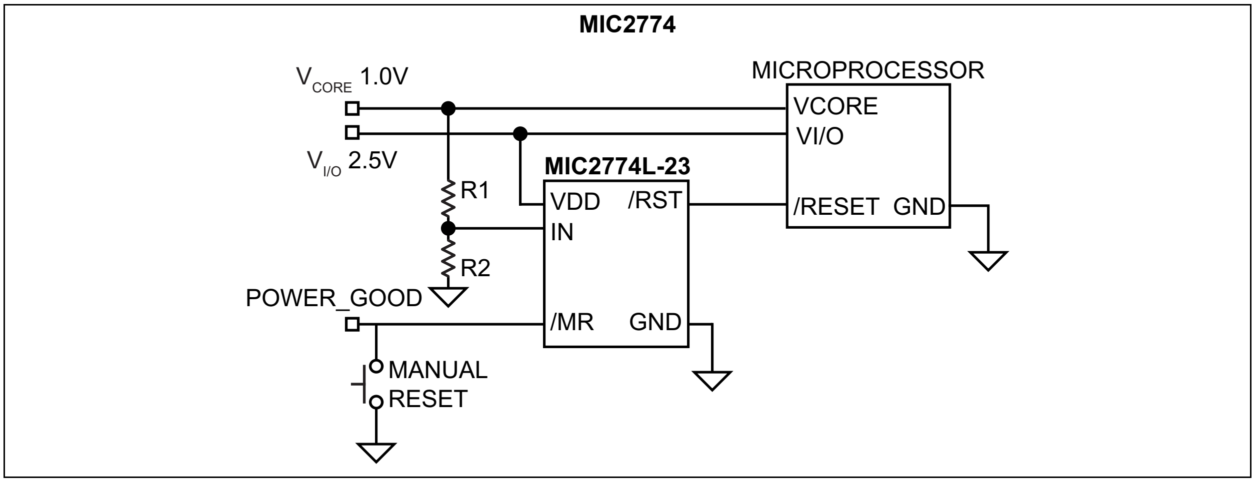
MIC2774
5-Lead SOT-23 (M5)
(H Version)



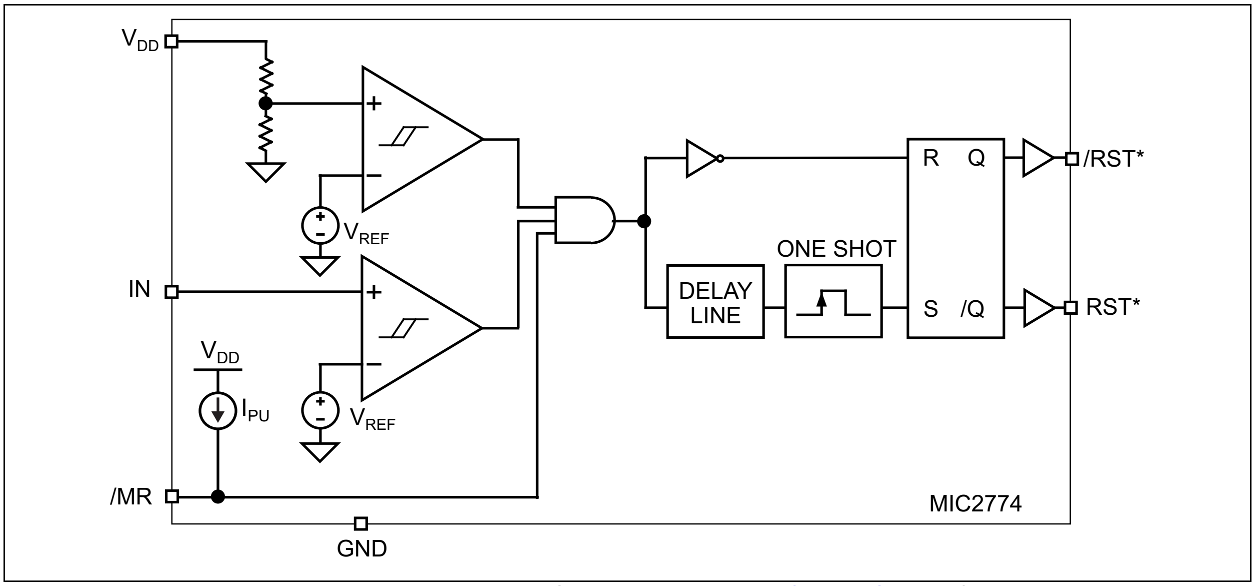
MIC2774
5-Lead SOT-23 (M5)
(L and N Versions)



Typical Application Circuit



Functional Block Diagram



Note: Pinout and polarity vary by device type. See the Product Identification System for details.

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{DD}) .... –0.3V to +7.0V
Input Voltages (V_{IN}, $V_{/MR}$) .... –0.3V to +7.0V
Output Voltages ($V_{/RST}$, V_{RST}) .... –0.3V to +7.0V
RST, (/RST) Current .... 20 mA
ESD Rating (Note 1) .... 1.5 kV

Operating Ratings ††

Supply Voltage (V_{DD}) .... +1.5V to +5.5V
Input Voltages (V_{IN}, $V_{/MR}$) .... –0.3V to +6.0V
Output Voltage ($V_{/RST}$, N Version) .... –0.3V to +6.0V
Output Voltage ($V_{/RST}$, V_{RST}, H & L Versions) .... –0.3V to V_{DD} + 0.3V

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

†† Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: T_A = +25°C, **bold** values valid for –40°C ≤ T_A ≤ +85°C, unless noted. Note 1, Note 2

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Supply Current	I_{DD}	—	3.5	—	µA	$V_{DD} = V_{IN} = V_{TH}$ + 1.6%; Note 2; /MR, RST, /RST open
V_{DD} Voltage Threshold						
Undervoltage Threshold on V_{DD}	V_{UV_THR}	**V_{TH} – 1.5%**	V_{TH}	**V_{TH} + 1.5%**	V	See Table 5-1
Hysteresis Voltage	V_{HYST}	—	1	—	%	—
IN, Undervoltage Detector Input						
Undervoltage Threshold	V_{REF}	**295**	300	**305**	mV	Note 2
Hysteresis Voltage	V_{HYST}	—	3	—	mV	—
Input Current	I_{IN}	—	5	—	pA	—
		—	—	**10**	nA	$T_{MIN} \le T_A \le T_{MAX}$
RST, /RST Outputs						
Propagation Delay	t_{PROP}	—	20	—	µs	$V_{IN} = (V_{REF(MAX)}$ + 100 mV) to $V_{IN} = (V_{REF(MIN)}$ – 100 mV), /MR = open
Reset Pulse Width	t_{RST}	**140**	—	**280**	ms	$T_{MIN} \le T_A \le T_{MAX}$
RST or /RST Output Voltage Low	V_{OL}	—	—	**0.3**	V	I_{SINK} = 1.6 mA; $V_{DD} \ge$ 1.6V
		—	—	**0.3**		I_{SINK} = 100 µA; $V_{DD} \ge$ 1.2V; Note 3

Note 1: Specification for packaged product only.
2: V_{DD} equals nominal “Typical Application (V_{DD})” as shown in Table 5-1.
3: V_{DD} operating range is 1.5V to 5.5V. Output is guaranteed to be asserted down to V_{DD} = 1.2V.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: T_A = +25°C, **bold** values valid for –40°C ≤ T_A ≤ +85°C, unless noted. Note 1, Note 2

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
RST or /RST Output Voltage High (H and L versions)	V_{OH}	**0.8 × V_{DD}**	—	—	V	I_{SOURCE} = 500 µA; V_{DD} ≥ 1.5V
		0.8 × V_{DD}	—	—		I_{SOURCE} = 10 µA; V_{DD} ≥ 1.2V; Note 3
/MR Inputs						
Input High Voltage	V_{IH}	**0.7 × V_{DD}**	—	—	V	Note 2
Input Low Voltage	V_{IL}	—	—	**0.3 × V_{DD}**	V	Note 2
Propagation Delay	t_{PROP}	—	5	—	µs	$V_{/MR}$ < (V_{IL} – 100 mV) Note 2
Minimum Input Pulse Width	t_{MIN}	—	33	—	ns	Reset occurs, $V_{/MR}$ < V_{IL}
Internal Pull-Up Current	I_{PU}	—	100	**250**	nA	—
Input Current, /MR	I_{IN}	—	100	**250**	nA	$V_{/MR}$ < V_{IL}

Note 1: Specification for packaged product only.

2: V_{DD} equals nominal "Typical Application (V_{DD})" as shown in Table 5-1.

3: V_{DD} operating range is 1.5V to 5.5V. Output is guaranteed to be asserted down to V_{DD} = 1.2V.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Ambient Temperature Range	T_A	–40	—	+85	°C	Note 1
Storage Temperature Range	T_S	–65	—	+150	°C	—
Package Thermal Resistance						
Thermal Resistance, SOT-23 5-Ld	θ_{JA}	—	256	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +85°C rating. Sustained junction temperatures above +85°C can impact the device reliability.

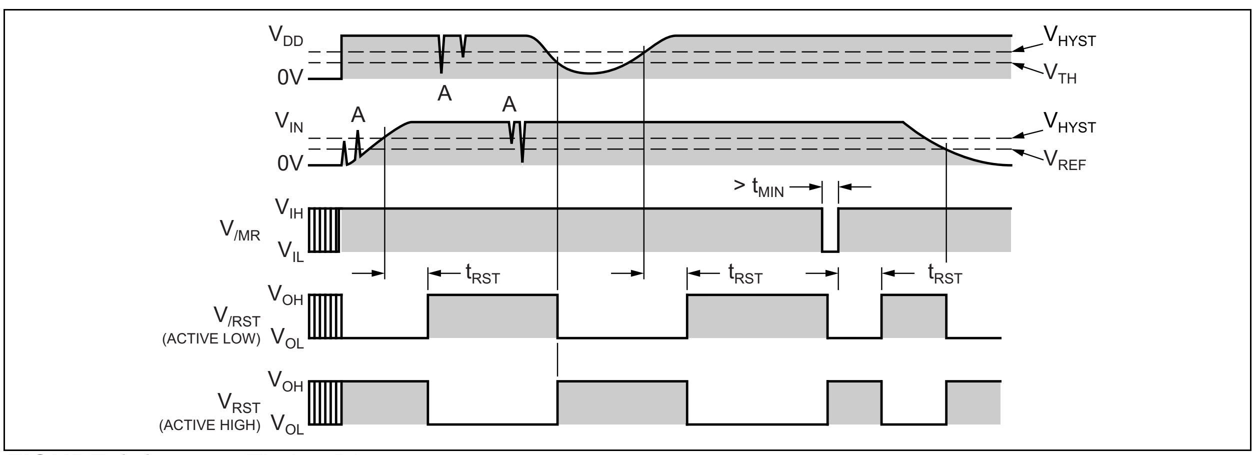


FIGURE 1-1: Timing Diagram.

Note 1: Propagation delays not shown for clarity.

2: The MIC2774 ignores very brief transients. See the Application Information section for details.

2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number MIC2774H	Pin Number MIC2774L MIC2774N	Pin Name	Description
1	—	RST	Digital (Output): Asserted high whenever V_{IN} or V_{DD} falls below the threshold voltage. It will remain asserted for no fewer than 140 ms after V_{IN} and V_{DD} return above the threshold limits.
—	1	/RST	Digital (Output): Asserted low whenever V_{IN} or V_{DD} falls below the threshold voltage. It will remain asserted for no fewer than 140 ms after V_{IN} and V_{DD} return above the threshold limits. (Open-drain for "N" version, requires an external pull-up resistor).
2	2	GND	Ground.
3	3	/MR	Digital (Input): Driving this pin low initiates immediate and unconditional reset. Assuming V_{IN} and V_{DD} are above the thresholds when /MR is released (returns high), the reset output will be de-asserted no fewer than 140 ms later. /MR may be driven by a logic signal or a mechanical switch. /MR has an internal pull-up to V_{DD} and may be left open if unused.
4	4	IN	Analog (Input): The voltage on this pin is compared to the internal 300 mV reference. An undervoltage condition will trigger a reset sequence.
5	5	VDD	Analog (Input): Power supply input for internal circuitry and input to the fixed voltage monitor. The voltage on this pin is compared against the internal reference. An undervoltage condition will trigger a reset sequence.

3.0 FUNCTIONAL DESCRIPTION

3.1 IN, Undervoltage Detector Input

The voltage present at the IN pin is compared to the internal 300 mV reference voltage. A reset is triggered if and when V_{IN} falls below V_{REF}. Typically, a resistor divider is used to scale the input voltage to be monitored such that V_{IN} will fall below V_{REF} as the voltage being monitored falls below the desired trip-point. Hysteresis is employed to prevent chattering due to noise. The comparator on the IN pin is relatively immune to very brief negative-going transients.

3.2 VDD Input

The VDD pin is both the power supply terminal and a monitored input voltage. The voltage at this pin is continually compared against the internal reference. The trip-point at which a reset occurs is factory-programmed. A reset is triggered if and when V_{DD} falls below the trip-point. Hysteresis is employed to prevent chattering due to noise. The comparator on the VDD input is relatively immune to very brief negative-going transients.

3.3 RST, /RST Reset Output

Typically, the MIC2774 is used to monitor the power supplies of intelligent circuits such as microcontrollers and microprocessors. By connecting the appropriate reset output of an MIC2774 to the reset input of a µC or µP, the processor will be properly reset at power-on, power-down, and during brown-out conditions. In addition, asserting /MR, the manual reset input, will activate the reset function.

The reset output is asserted any time /MR is asserted, or if V_{IN} or V_{DD} drops below the corresponding threshold voltage. The reset output remains asserted for $t_{RST(min)}$ after V_{IN} and/or V_{DD} subsequently return above the threshold boundaries and/or /MR is released. A reset pulse is also generated at power-on. Hysteresis is included in the comparators to prevent chattering of the output due to noise.

3.4 /MR, Manual Reset Input

The ability to initiate a reset via external logic or a manual switch is provided in addition to the MIC2774's automatic supervisory functions. Driving the /MR input to a logic low causes an immediate and unconditional reset to occur. Assuming V_{IN} and V_{DD} are within tolerance when /MR is released (returns high), the reset output will be de-asserted no less than t_{RST} later. /MR may be driven by a logic signal or mechanical switch. Typically, a momentary push-button switch is connected such that /MR is shorted to ground when the switch contacts close. Switch de-bouncing is performed internally; the switch may be connected directly between /MR and GND. /MR is internally pulled up to V_{DD} and may be left open if unused.

4.0 APPLICATION INFORMATION

4.1 Programming the Voltage Threshold

Referring to the Typical Application Circuit, the voltage threshold on the IN pin is calculated as follows:

EQUATION 4-1:

$$V_{IH} = V_{REF} \times \frac{R1 + R2}{R2}$$

Where:

V_{REF} = 0.300V

In order to provide the additional criteria needed to solve for the resistor values, the resistors can be selected such that the two resistors have a given total value; that is, R1 + R2 = R_{TOTAL}. Imposing this condition on the resistor values provides two equations that can be solved for the two unknown resistor values. A value such as 1 MΩ for R_{TOTAL} is a reasonable choice because it keeps quiescent current to a generally acceptable level while not causing any measurable errors due to input bias currents. The larger the resistors, the larger the potential errors due to input bias current (I_{IN}). The maximum recommended value of R_{TOTAL} is 3 MΩ.

Applying this criteria and rearranging the V_{IH} expression to solve for the resistor values gives:

EQUATION 4-2:

$$R2 = \frac{R_{TOTAL} \times V_{REF}}{V_{IH}}$$

$$R1 = R_{TOTAL} - R2$$

4.2 Application Example

Figure 4-1 illustrates a hypothetical MIC2774L-23 application in which the MIC2774L-23 is used to monitor the core and I/O supplies of a high-performance CPU or DSP. The core supply, V_{CORE}, in the example is 1.0V ±5%. The main power rail and I/O voltage, $V_{I/O}$, is 2.5V ±5%. As shown in Figure 4-1, the MIC2774 is powered by $V_{I/O}$. The minimum value of $V_{I/O}$ is 2.5V – 5% = 2.375V; the maximum is 2.5V + 5% = 2.625V. This is well within the device's supply range of 1.5V to 5.5V.

Resistors R1 and R2 must be selected to correspond to the V_{CORE} supply of 1.0V. The goal is to ensure that the core supply voltage is adequate to ensure proper operation; i.e., V_{CORE} ≥ (1.0V – 5%) = 0.950V. Because there is always a small degree of uncertainty due to the accuracy of the resistors, variations in the device's voltage reference, etc., the threshold will be set slightly below this value. The potential variation in the MIC2774's voltage reference (V_{REF}) is specified as ±1.5%. The resistors chosen will have their own tolerance specifications. This example assumes the use of 1% accurate resistors. The potential worst-case error contribution due to input bias current can be calculated once the resistor values are chosen. If the guidelines above regarding the maximum total value of R1 + R2 are followed, this error contribution will be very small thanks to the MIC2774's very low input bias current.

To summarize, the various potential error sources are:

- Variation in V_{REF}: specified at ±1.5%
- Resistor tolerance: chosen by designer (typically ≤±1%)
- Input bias current, I_{IN}: calculated once resistor values are known, typically very small

Taking the various potential error sources into account, the threshold voltage will be set slight below the minimum V_{CORE} specification of 0.950V so that when the actual threshold voltage is at its maximum, it will not intrude into the normal operating range of V_{CORE}. The target threshold voltage will be set as follows:

Given that the total tolerance on V_{TH} for the IN pin is [V_{REF} tolerance] + [resistor tolerance]

= ±1.5% + ±1% = ±2.5%,

and $V_{TH(max)}$ = $V_{CORE(min)}$,

then $V_{CORE(min)}$ = V_{TH} + 2.5% V_{TH} = 1.025 V_{TH},

therefore, solving for V_{TH} results in

EQUATION 4-3:

$$V_{TH} = \frac{V_{CORE(MIN)}}{1.025} = \frac{0.950}{1.025} = 0.9268V$$

Solving for R1 and R2 using this value for V_{TH} and the equations above yields:

R1 = 676.3 kΩ ≈ 673 kΩ

R2 = 323.7 kΩ ≈ 324 kΩ

The resulting circuit is shown in Figure 4-1.

4.3 Input Bias Current Effects

Now that the resistor values are known, it is possible to calculate the maximum potential error due to input bias current, I_{IN}. As shown in the Electrical Characteristics table, the maximum value of I_{IN} is 10 nA. Note that the typical value is a much smaller 5 pA. The magnitude of the offset caused by I_{IN} is given by:

EQUATION 4-4:

$$V_{ERROR} = I_{IN(max)} \times (R1||R2)$$

$$V_{ERROR} = \pm 1\times10^{-8}A \times 2.189\times10^{5}\Omega$$

$$V_{ERROR} = \pm 2.189\times10^{-3}V$$

$$V_{ERROR} = \pm 2.189\ mV$$

The typical error is about three orders of magnitude lower than this—close to one microvolt. Generally, the error due to input bias can be discounted. If it is to be taken into account, simply adjust the target threshold voltage downward by this amount and recalculate R1 and R2. The resulting value will be very close to optimum. If accuracy is more important than the quiescent current in the resistors, simply reduce the value of R_{TOTAL} to minimize offset errors.

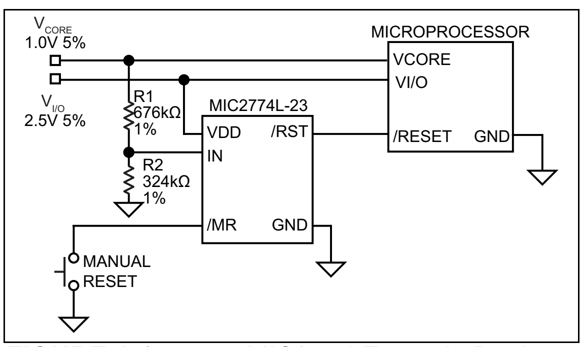


FIGURE 4-1: MIC2774 Example Design.

4.4 Interfacing to Processors with Bidirectional Reset Pins

Some microprocessors have reset signal pins that are bidirectional, rather than input-only. The Motorola 68HC11 family is one example. Because the MIC2774N's output is open-drain, it can be connected directly to the processor's reset pin using only the pull-up resistor normally required. See Figure 4-2.

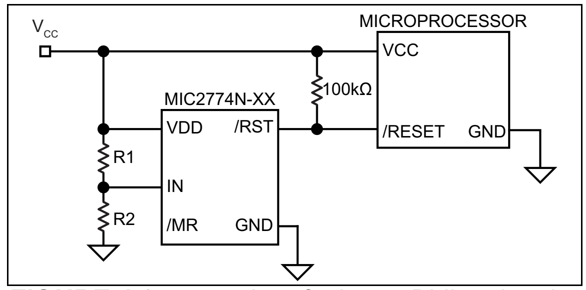


FIGURE 4-2: Interfacing to Bidirectional Reset Pin.

4.5 Transient Response

The MIC2774 is inherently immune to very short negative-going glitches. Very brief transients may exceed the voltage thresholds without tripping the output.

In general, as shown in Figure 4-3 and Figure 4-4, the narrower the transient, the deeper the threshold overdrive that the MIC2774 will ignore. The graphs represent the typical allowable transient duration for a given amount of threshold overdrive that will not generate a reset.

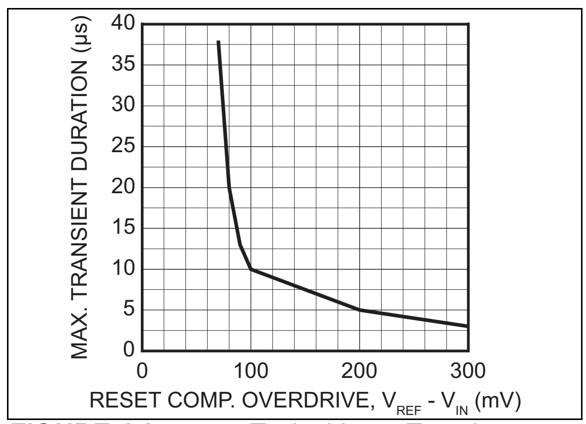


FIGURE 4-3: Typical Input Transient Response.

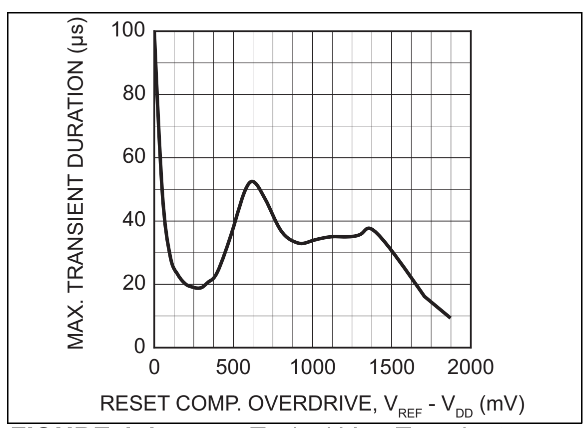


FIGURE 4-4: Typical V_{DD} Transient Response.

4.6 Ensuring Proper Operation at Low Supply

At V_{DD} levels below 1.2V, the MIC2774's reset output cannot turn on sufficiently to produce a valid logic-low on /RST. In this situation, circuits driven by /RST could be allowed to float, causing undesired operation. In most cases, however, it is expected that the circuits driven by the MIC2774L will be similarly inoperative at $V_{DD} \leq 1.2V$.

If a given application requires that /RST be valid below V_{DD} = 1.2V, this can be accomplished by adding a pull-down resistor to the /RST output. A value of 100 kΩ is recommended because this is usually an acceptable compromise of quiescent current and pull-down current. The resistor's value is not critical, however. See Figure 4-5.

These statements also apply to the MIC2774H's RST output. That is, to ensure valid RST signal levels at V_{DD} < 1.2V, a pull-up resistor (as opposed to a pull-down) should be added to the RST output. A value of 100 kΩ is typical for this application, as well. See Figure 4-6.

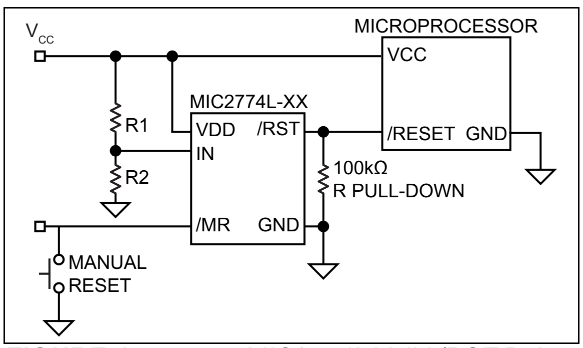


FIGURE 4-5: *MIC2774L Valid /RST Below 1.2V.*

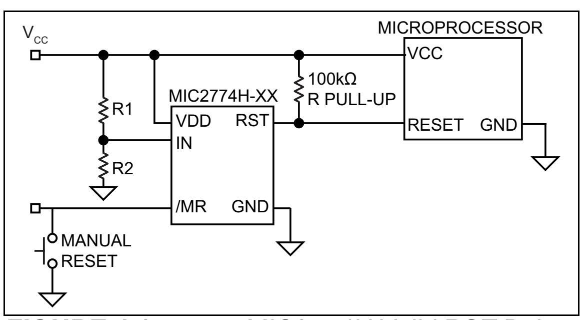


FIGURE 4-6: *MIC2774H Valid RST Below 1.2V.*

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

5-Lead SOT-23* H Version, Front	Example	5-Lead SOT-23* H Version, Back	Example
XXXX	UH22	NNN	4L4

5-Lead SOT-23* L Version, Front	Example	5-Lead SOT-23* L Version, Back	Example
XXXX	UI31	NNN	T08

5-Lead SOT-23* N Version, Front	Example	5-Lead SOT-23* N Version, Back	Example
XXXX	UG46	NNN	92F

Legend:		
	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

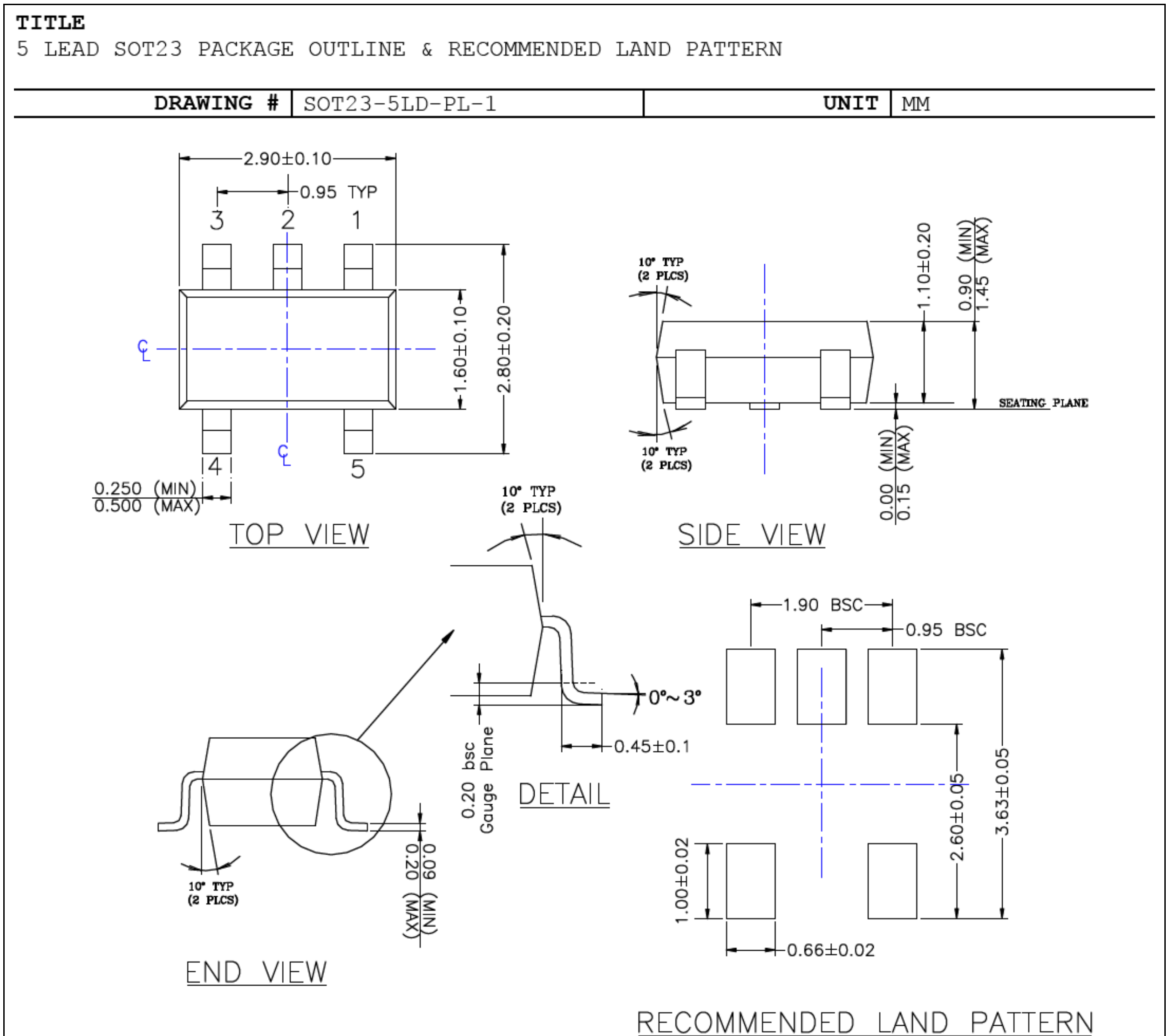
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

TABLE 5-1: STANDARD VOLTAGE OPTIONS

Voltage Code	Typical Application (V_{DD})	Nominal Threshold Voltage (V_{TH})
46	5.0V ±5%	4.68V
44	5.0V ±10%	4.43V
31	3.3V ±5%	3.09V
29	3.3V ±10%	2.93V
28	3.0V ±5%	2.81V
26	2.85V ±5%	2.67V
25	2.7V ±5%	2.53V
23	2.5V ±5%	2.34V
22	2.4V ±5%	2.25V
17	1.8V ±5%	1.69V

5-Lead SOT-23 Package Outline and Recommended Land Pattern



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.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

APPENDIX A: REVISION HISTORY

Revision A (May 2022)

- Converted Micrel document MIC2774 to Microchip data sheet template DS20006527A.
- Minor grammatical text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

Device	X	-XX	X	XX	-XX
Part No.	Reset Output	Voltage Code	Temp. Range	Package	Media Type

Device:	MIC2774:		Dual Micro-Power Low Voltage Supervisor
Reset Output:	H	=	Push-Pull Active-High (RST)
	L	=	Push-Pull Active-Low (/RST)
	N	=	Open-Drain Active-Low (/RST)
Voltage Code:	46	=	4.68V
	44	=	4.43V
	31	=	3.09V
	29	=	2.93V
	28	=	2.81V
	26	=	2.67V
	25	=	2.53V
	23	=	2.34V
	22	=	2.25V
	17	=	1.69V
Temperature Range:	Y	=	–40°C to +85°C
Package:	M5	=	5-Lead SOT-23
Media Type:	TR	=	3,000/Reel

Examples:

a) MIC2774H-17YM5-TR: MIC2774, Push-Pull Active-High, 1.69V, –40°C to +85°C, 5-Lead SOT-23, 3,000/Reel

b) MIC2774H-31YM5-TR: MIC2774, Push-Pull Active-High, 3.09V, –40°C to +85°C, 5-Lead SOT-23, 3,000/Reel

c) MIC2774L-23YM5-TR: MIC2774, Push-Pull Active-Low, 2.34V, –40°C to +85°C, 5-Lead SOT-23, 3,000/Reel

d) MIC2774L-46YM5-TR: MIC2774, Push-Pull Active-High, 4.68V, –40°C to +85°C, 5-Lead SOT-23, 3,000/Reel

e) MIC2774N-26YM5-TR: MIC2774, Open-Drain Active-Low, 1.69V, –40°C to +85°C, 5-Lead SOT-23, 3,000/Reel

f) MIC2774N-44YM5-TR: MIC2774, Open-Drain Active-Low, 4.43V, –40°C to +85°C, 5-Lead SOT-23, 3,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
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