

LM3722/LM3723/LM3724 5-Pin Microprocessor Reset Circuits

Check for Samples: [LM3722](#), [LM3723](#), [LM3724](#)

FEATURES

- Precise Monitoring of 2.5V, 3.3V, and 5V Supply Voltages
- Fully Specified Over Temperature
 - Industrial: -40°C to $+85^{\circ}\text{C}$
 - Extended: -40°C to $+125^{\circ}\text{C}$
- 100 ms Minimum Power-On Reset pulse Width, 190 ms Typical:
 - Active-Low RESET Output (LM3722)
 - Active-High RESET Output (LM3723)
 - Active-Low RESET Open Drain Output (LM3724)
- Guaranteed RESET Output Valid for $V_{CC} \geq 1\text{V}$
- Low Supply Current, 6 μA Typical
- Power Supply Transient Immunity
- Compatible with MAX811/812 Applications

APPLICATIONS

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

Typical Application Circuits

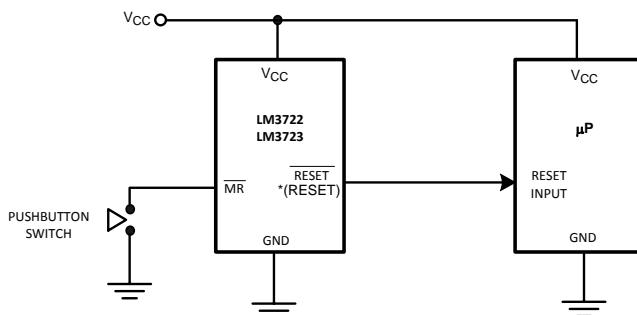


Figure 1. Typical Application Circuit

DESCRIPTION

The LM3722/LM3723/LM3724 microprocessor supervisory circuits monitor the power supplies in microprocessor and digital systems. They provide a reset to the microprocessor during power-up, power-down, brown-out conditions, and manual reset.

The LM3722/LM3723/LM3724 asserts a reset signal whenever the supply decreases below the factory-programmed reset threshold. Reset will be asserted for at least 100ms even after V_{CC} rises above the reset threshold.

The LM3722 has an active-low RESET push-pull output. The LM3723 has an active-high RESET push-pull output. The LM3724 has an active-low open-drain RESET output.

Three standard reset voltage options are available, suitable for monitoring 5V, 3.3V, and 2.5V supply voltages. Additional reset voltages are also available; contact Texas Instruments for details.

With a low supply current of only 6 μA , the LM3722/LM3723/LM3724 are ideal for use in portable equipment. The LM3722/LM3723/LM3724 are available in the 5-pin SOT-23 package.

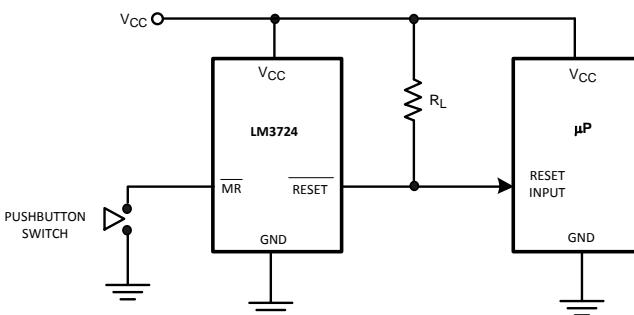


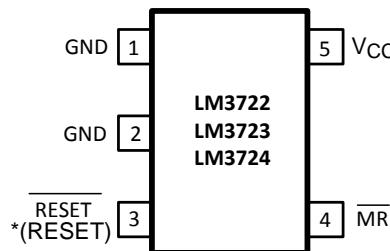
Figure 2. Typical Application Circuit with R_L Connection



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Connection Diagram



*() are for LM3723

Figure 3. SOT-23-5

PIN DESCRIPTIONS

PIN	NAME	FUNCTION
1	GND	Ground reference
2	GND	Ground reference, device substrate, connect to ground.
3	RESET LM3722/LM3724	Active-low output. RESET remains low while V_{CC} is below the reset threshold voltage, and for 190 ms after V_{CC} rises above the reset threshold voltage.
	RESET LM3723	Active-high output. RESET remains high while V_{CC} is below the reset threshold, and for 190 ms after V_{CC} rises above the reset threshold.
4	MR	Active-low input. Reset is asserted whenever this pin is pulled low and remains asserted for 190 ms after the MR pin goes high. May be left open.
5	V_{CC}	Supply Voltage (+5V, +3.3V, or +2.5V, nominal)

Block Diagram

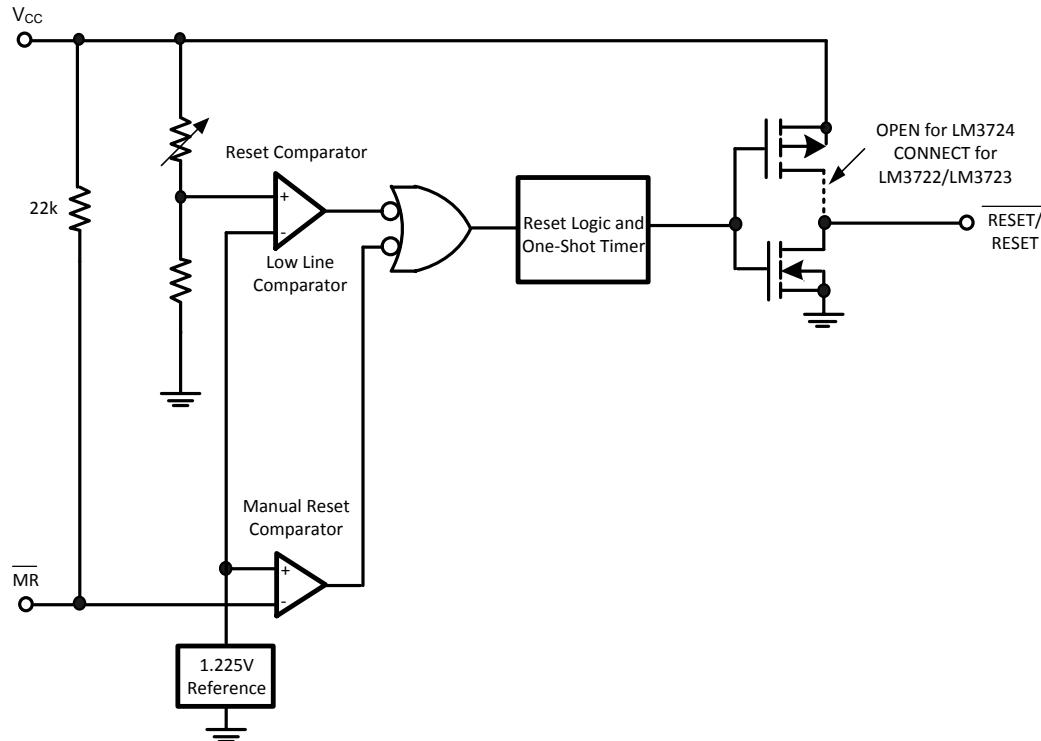


Figure 4. LM3722/LM3723/LM3724 Block Diagram



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings ⁽¹⁾⁽²⁾

V_{CC} , \overline{MR}	–0.3V to 6.0V
RESET, \overline{RESET}	–0.3V to $(V_{CC} + 0.3V)$
Input Current, V_{CC} Pin	20mA
Output Current, RESET, \overline{RESET} Pin	20mA
ESD Rating ⁽³⁾	2kV
Continuous Power Dissipation ($T_A = +70^\circ C$)	
SOT-23 ⁽⁴⁾	320mW
Operating Temperature Range	
Industrial:	–40°C to +85°C
Extended:	–40°C to +125°C
Maximum Junction Temperature	125°C
Storage Temperature Range	–65°C to +160°C
Lead Temperature (soldering, 10sec)	+300°C

- (1) Absolute Maximum Ratings are limits beyond which damage to the device may occur. Operating Ratings are conditions under which the device operates correctly. Operating ratings do not imply guaranteed performance limits. For guaranteed performance limits and associated test conditions, see the Electrical Characteristics.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.
- (3) The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin.
- (4) At elevated temperatures, devices must be derated based on package thermal resistance. The device in the SOT-23-5 package must be derated at 4.5mW/°C at ambient temperatures above 70°C. The device has internal thermal protection.

Electrical Characteristics

Typical values are at $T_A = +25^\circ C$. Limits with standard typeface are for $T_A = +25^\circ C$, and limits in boldface type apply for the operating temperature range (–40°C to +85°C) for LM372_IM5X, and (–40°C to +125°C) for LM372_EM5X, unless otherwise noted. ⁽¹⁾

Symbol	Parameter	Conditions		Min	Typ	Max	Units
V_{CC}	V_{CC} Range			1.0		5.5	V
I_{CC}	Supply Current ($I_{LOAD} = 0A$)	LM372 _ -4.63	$V_{CC} = 5.5V$		8	15	μA
		LM372 _ -3.08	$V_{CC} = 3.6V$		7	10	
		LM372 _ -2.32	$V_{CC} = 2.5V$		6	10	
V_{TH}	Reset Threshold	LM372 _ -4.63		4.54 4.50	4.63	4.72 4.75	V
		LM372 _ -3.08		3.03 3.00	3.08	3.14 3.15	
		LM372 _ -2.32		2.27 2.25	2.32	2.37 2.40	
V_{TH} Tempco	Reset Threshold Temperature Coefficient				30		ppm/°C
t_{RD}	V_{CC} to Reset Delay ⁽²⁾	$V_{CC} = V_{TH}$ to $(V_{TH} - 100mV)$			20		μs
t_{RP}	Reset Active Timeout Period			100	190	560	ms
t_{MR}	\overline{MR} Minimum Pulse Width			10			μs
t_{MD}	\overline{MR} to Reset Propagation Delay				2		μs
	\overline{MR} Glitch Immunity ⁽³⁾				100		ns

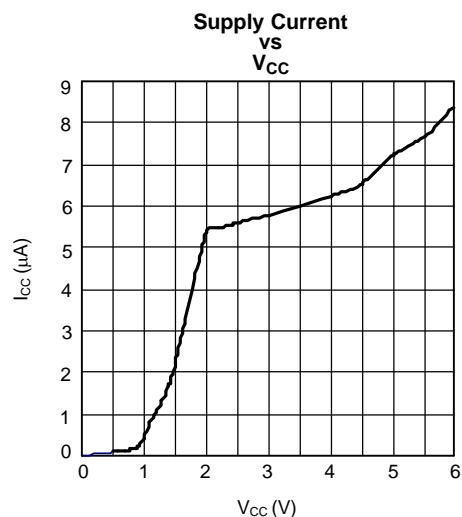
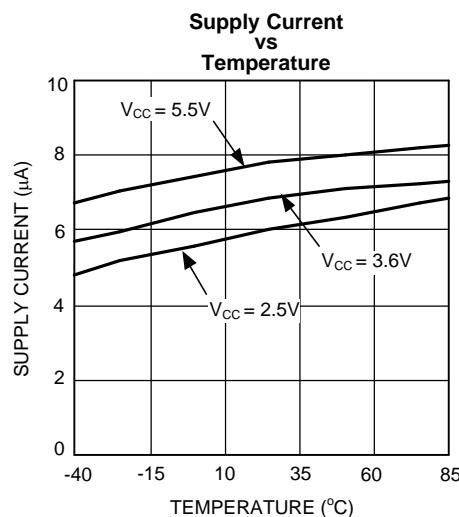
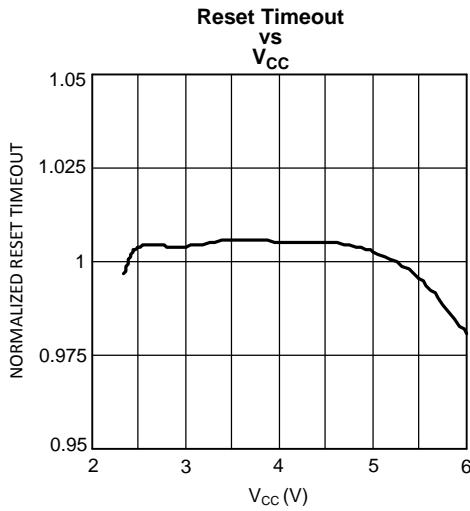
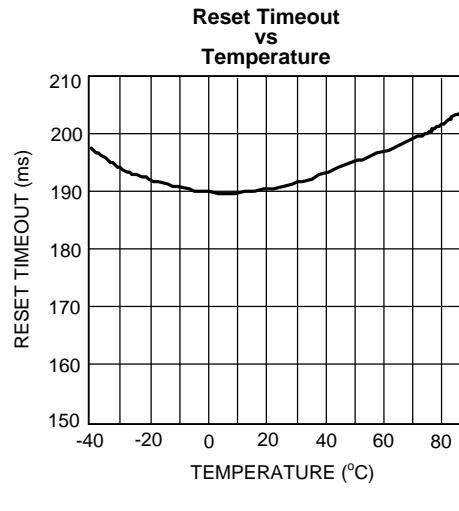
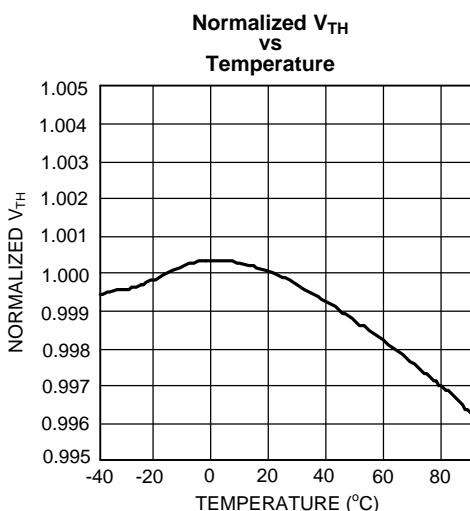
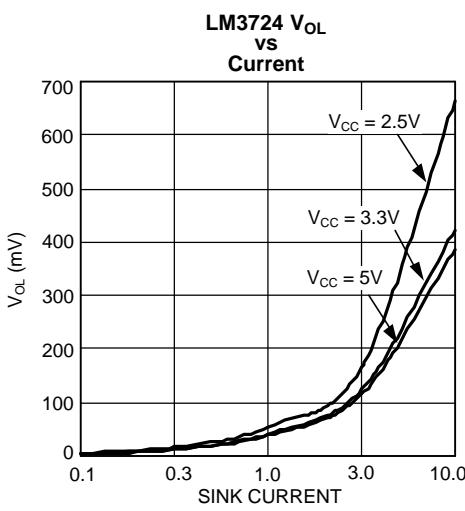
- (1) Production testing done at $T_A = +25^\circ C$. Limits over the operating temperature range are guaranteed through correlation using Statistical Quality Control (SQC) methods.
- (2) RESET Output for LM3722 and LM3724, RESET output for LM3723.
- (3) Glitches of 100 ns or less typically will not generate a reset pulse.

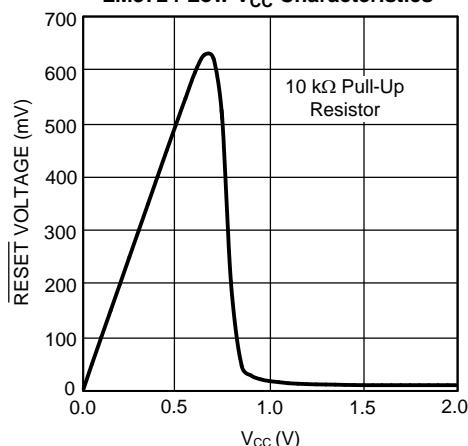
Electrical Characteristics (continued)

Typical values are at $T_A = +25^\circ\text{C}$. Limits with standard typeface are for $T_A = +25^\circ\text{C}$, and limits in boldface type apply for the operating temperature range (-40°C to $+85^\circ\text{C}$) for LM372_IM5X, and (-40°C to $+125^\circ\text{C}$) for LM372_EM5X, unless otherwise noted. ⁽¹⁾

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{IH}	MR Input Threshold	$V_{CC} > V_{TH(MAX)}$, LM372_-4.63	2.3			V
V_{IL}					0.8	
V_{IH}		$V_{CC} > V_{TH(MAX)}$, LM372_-3.08, LM372_-2.32	0.7 V_{CC}			
V_{IL}					0.25 V_{CC}	
	MR Pull-Up Resistance			22		k Ω
V_{OL}	RESET Output Voltage Low (LM3722)	$V_{CC} = V_{TH}$ min, $I_{SINK} = 1.2\text{mA}$, (LM3722-2.32/3.08)			0.3	V
		$V_{CC} = V_{TH}$ min, $I_{SINK} = 3.2\text{mA}$, (LM3722-4.63)			0.4	
		$V_{CC} > 1\text{V}$, $I_{SINK} = 50\mu\text{A}$			0.3	
V_{OH}	RESET Output Voltage High (LM3722)	$V_{CC} > V_{TH}$ max, $I_{SOURCE} = 500\mu\text{A}$, (LM3722-2.32/3.08)	0.8V_{CC}			V
		$V_{CC} > V_{TH}$ max, $I_{SOURCE} = 800\mu\text{A}$, (LM3722-4.63)	V_{CC}-1.5			
V_{OL}	RESET Output Voltage Low (LM3723)	$V_{CC} = V_{TH}$ max, $I_{SINK} = 1.2\text{mA}$ (LM3723-2.32/3.08)			0.3	V
		$V_{CC} = V_{TH}$ max, $I_{SINK} = 3.2\text{mA}$ (LM3723-4.63)			0.4	
V_{OH}	RESET Output Voltage High (LM3723)	$1.8\text{V} < V_{CC} < V_{TH}$ min, $I_{SOURCE} = 150\mu\text{A}$	0.8V_{CC}			V
V_{OL}	RESET Output Voltage Low (LM3724)	$V_{CC} = V_{TH}$ min, $I_{SINK} = 1.2\text{ mA}$ (LM3724-2.32/3.08)			0.3	V
		$V_{CC} = V_{TH}$ min, $I_{SINK} = 3.2\text{ mA}$ (LM3724-4.63)			0.4	
		$V_{CC} > 1\text{V}$, $I_{SINK} = 50\mu\text{A}$			0.3	
I_{IN}	RESET Output Leakage Current (LM3724)	$V_{CC} > V_{TH}$, RESET = 5.5V			0.5	μA

Typical Performance Characteristics


Figure 5.

Figure 6.

Figure 7.

Figure 8.

Figure 9.

Figure 10.

Typical Performance Characteristics (continued)
LM3724 Low V_{CC} Characteristics**Figure 11.**

Timing Diagram

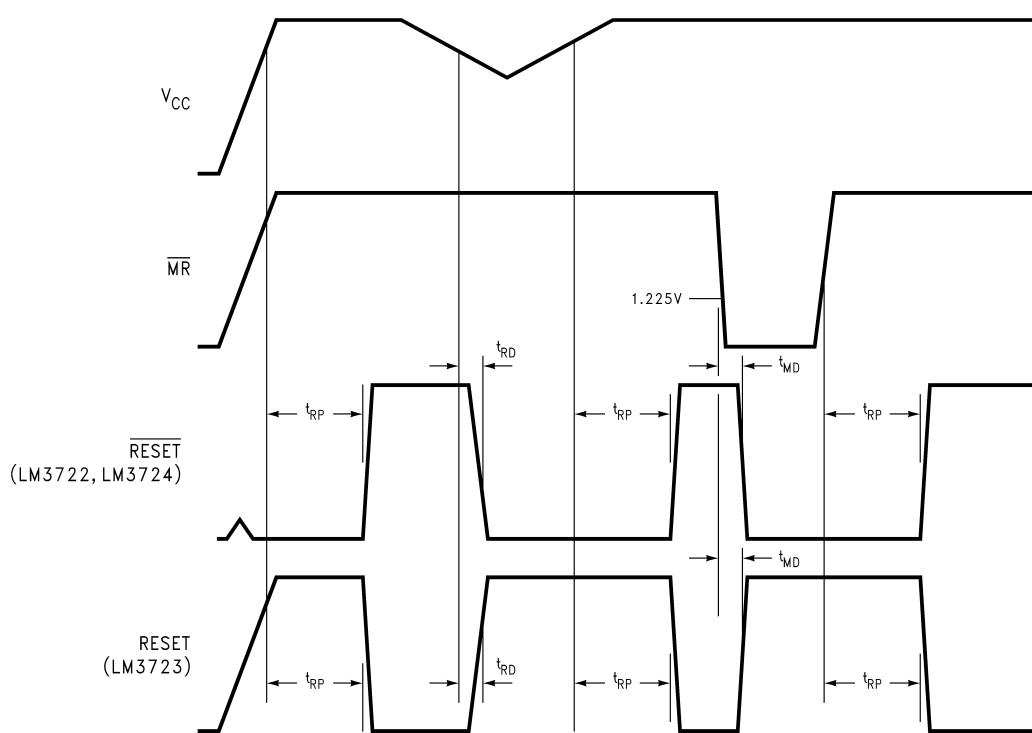


Figure 12. Timing Diagram

Circuit Information

RESET OUTPUT

The reset input of a μ P initializes the device into a known state. The LM3722/LM3723/LM3724 microprocessor voltage monitoring circuits assert a forced reset output to prevent code execution errors during power-up, power-down, and brownout conditions.

$\overline{\text{RESET}}$ is guaranteed valid for $V_{CC} \geq 1\text{V}$. Once V_{CC} exceeds the reset threshold, an internal timer maintains the output for the reset timeout period. After this interval, reset goes high and the microprocessor initializes itself into a known state. The LM3722 and LM3724 offer an active-low RESET; the LM3723 offers an active-high RESET.

As V_{CC} drops below the reset threshold (such as during a brownout), the reset activates (see the [NEGATIVE-GOING \$V_{CC}\$ TRANSIENTS](#) section). When V_{CC} again rises above the reset threshold, the internal timer starts. Reset holds until V_{CC} exceeds the reset threshold for longer than the reset timeout period. After this time, reset releases.

Additionally, the Manual Reset input ($\overline{\text{MR}}$) will initiate a forced reset. See the [MANUAL RESET INPUT \(\$\overline{\text{MR}}\$ \)](#) section.

The LM3722/LM3723/LM3724 reset outputs ignore short duration glitches on V_{CC} and $\overline{\text{MR}}$. See the [Applications Information](#) section for details.

RESET THRESHOLD

The LM3722/LM3723/LM3724 are available with reset voltages of 4.63V, 3.08V, and 2.32V which are suitable for monitoring 5.0V, 3.3V, and 2.5V supplies respectively. Other reset thresholds in the 2.20V to 5.0V range, in 10 mV steps, are available; contact Texas Instruments for details.

MANUAL RESET INPUT (\overline{MR})

Many μ P-based products require a manual reset capability, allowing the operator to initiate a reset. The \overline{MR} input is fully debounced and provides an internal 22 k Ω pull-up. When the \overline{MR} input is pulled below V_{IL} (0.25V_{CC}) for more than 100 ns, reset is asserted after a typical delay of 2 μ s. Reset remains active as long as \overline{MR} is held low, and releases after \overline{MR} rises above V_{IH} and the reset timeout period expires. Use \overline{MR} with digital logic to assert reset or to daisy chain supervisory circuits.

APPLICATIONS INFORMATION

BENEFITS OF PRECISION RESET THRESHOLDS

A microprocessor supply supervisor must provide a reset output within a predictable range of the supply voltage. A common threshold range is between 5% and 10% below the nominal supply voltage. The 4.63V, 3.08V and 2.32V options of the LM3722/LM3723/LM3724 use highly accurate circuitry to ensure that the reset threshold occurs only within this range (for 5.0V, 3.3V and 2.5V supplies). [Table 1](#) shows how the standard reset thresholds apply to 5.0V, 3.3V, and 2.5V nominal supply voltages.

Table 1. Monitored Tolerance Table

Reset Threshold	Supply Voltage		
	2.5V	3.3V	5.0V
4.63 \pm %			90.8-94.4%
3.08 \pm %		91.8-95.2%	
2.32 \pm %	90.8-94.8%		

ENSURING A VALID RESET OUTPUT DOWN TO $V_{CC} = 0V$

When V_{CC} falls below 1V, the LM3722 \overline{RESET} output is unable to sink the rated current. A high-impedance CMOS logic input connected to \overline{RESET} can therefore drift to undetermined voltages. To prevent this situation, a 100k Ω resistor should be connected from the \overline{RESET} output to ground, as shown in [Figure 13](#).

A 100k Ω pull-up resistor to V_{CC} is also recommended for the LM3723, if \overline{RESET} is required to remain valid for $V_{CC} < 1V$.

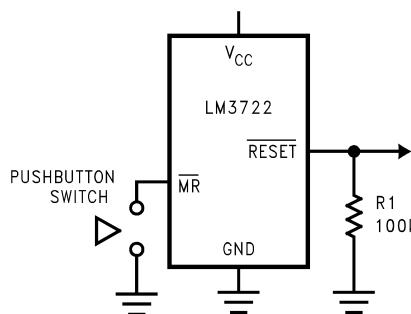


Figure 13. Circuit for \overline{RESET} Valid from $V_{CC} = 0V$

OPEN DRAIN OUTPUT (LM3724)

An open drain output allows easy paralleling of multiple microprocessor reset circuits without requiring additional logic gates. Open drain outputs also allow interfacing devices of differing logic levels or families, since the output pull-up resistor may be connected to any supply voltage up to 5.5V, regardless of LM3724 V_{CC} .

The pull up resistor is calculated so that maximum current flow into \overline{RESET} is less than 10 mA when activated. The resistor must be small enough so that the leakage current of all connected devices does not create an excessive voltage drop when the output is not activated. A resistor value of 100 k Ω will generally suffice.

NEGATIVE-GOING V_{CC} TRANSIENTS

The LM3722/LM3723/LM3724 are relatively immune to short negative-going transients or glitches on V_{CC} . Figure 14 shows the maximum pulse width a negative-going V_{CC} transient can have without causing a reset pulse. In general, as the magnitude of the transient increases, going further below the threshold, the maximum allowable pulse width decreases. Typically, a V_{CC} transient that goes 125 mV below the reset threshold and lasts 40 μ s or less will not cause a reset pulse. A 0.1 μ F bypass capacitor mounted as close as possible to the V_{CC} pin will provide additional transient rejection.

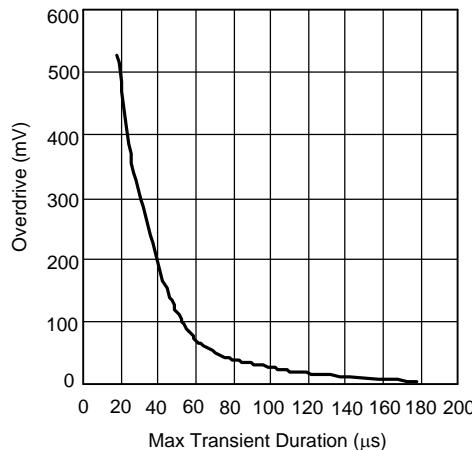


Figure 14. Maximum Transient Duration without Causing a Reset Pulse vs. Reset Comparator Overdrive

INTERFACING TO μ PS WITH BIDIRECTIONAL RESET PINS

Microprocessors with bidirectional reset pins, such as the Motorola 68HC11 series, can be connected to the LM3722 RESET output. To ensure a correct output on the LM3722 even when the microprocessor reset pin is in the opposite state, connect a 4.7k Ω resistor between the LM3722 RESET output and the μ P reset pin, as shown in Figure 15. Buffer the LM3722 RESET output to other system components.

Typical Application Circuits

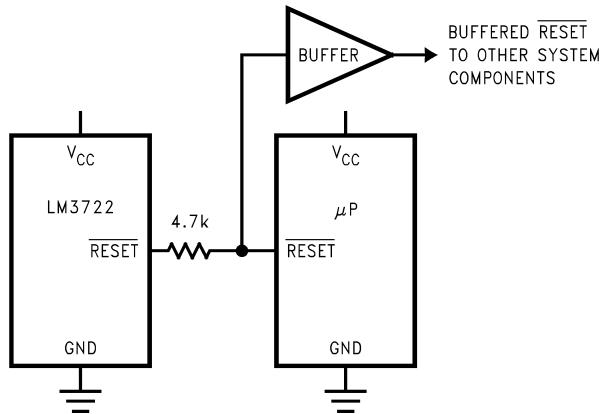


Figure 15. Interfacing to Microprocessors with Bidirectional Reset I/O

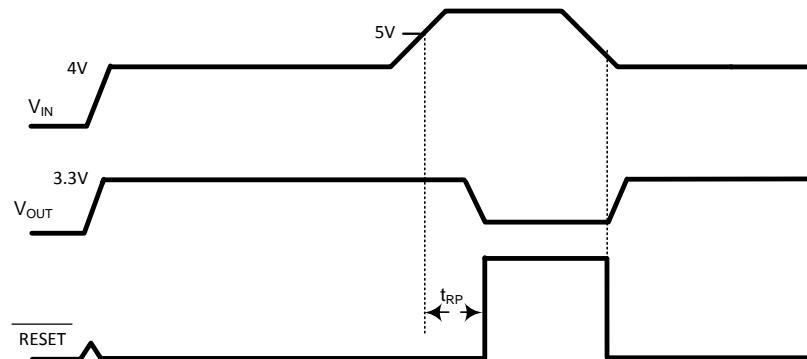
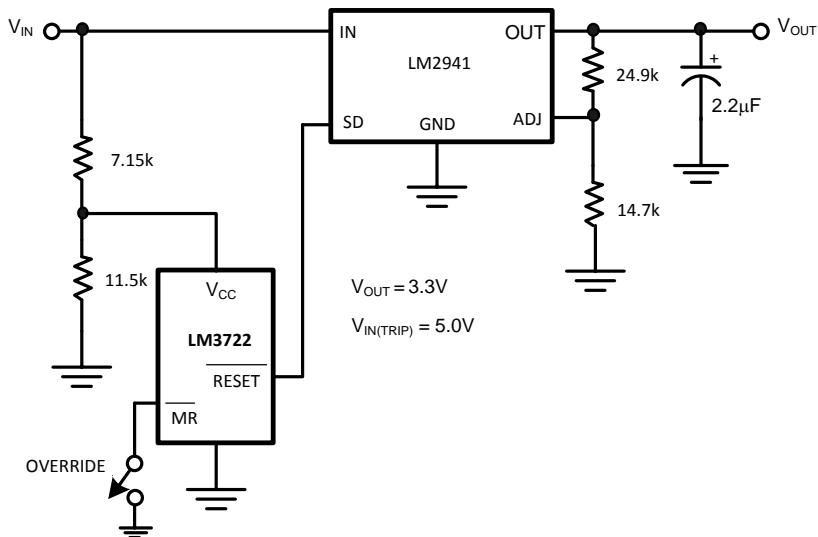


Figure 16. Regulator/Switch with Long-Term Overvoltage Lockout Prevents Overdissipation in Linear Regulator

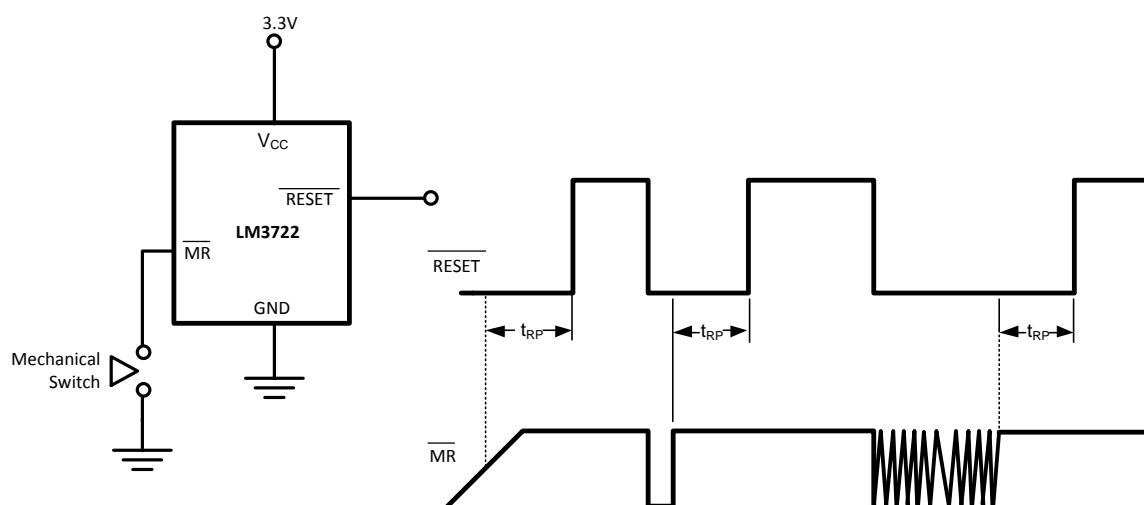


Figure 17. LM3722 Switch Debouncer

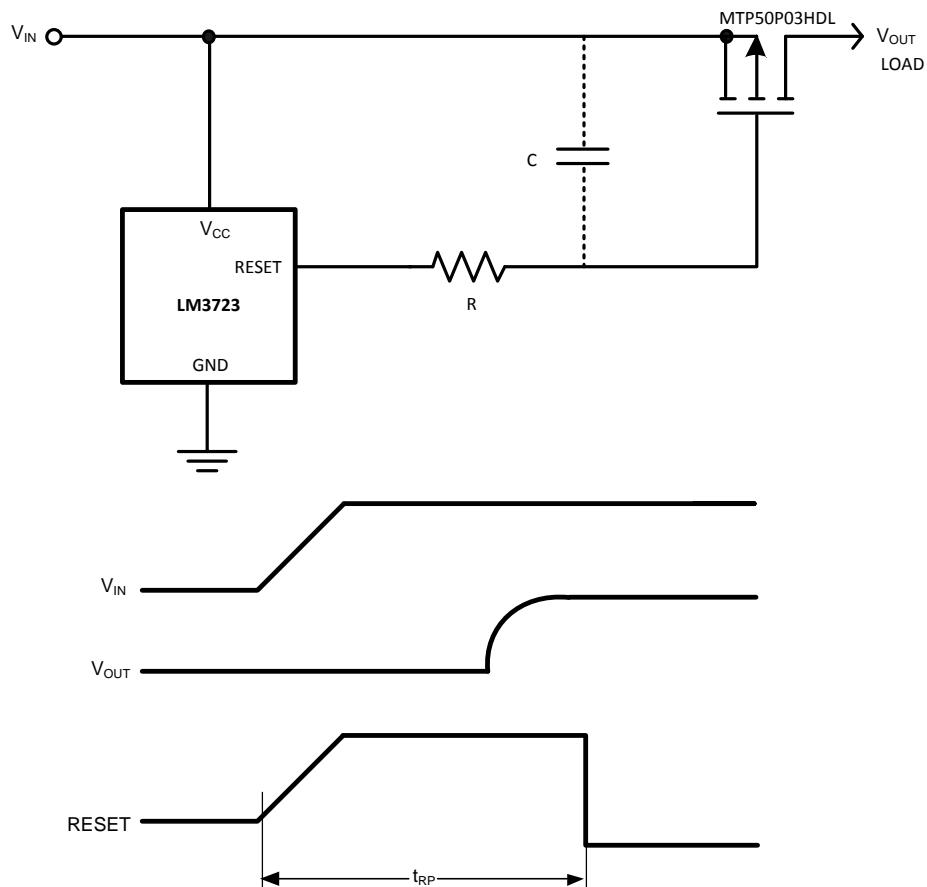


Figure 18. LM3723 Power-On Delay

REVISION HISTORY

Changes from Revision D (March 2013) to Revision E	Page
• Changed layout of National Data Sheet to TI format	11

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LM3724EM5-3.08/NO.A	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R63B
LM3724EM5-3.08/NOPB	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R63B
LM3724EM5-4.63/NO.A	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R62B
LM3724EM5-4.63/NOPB	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R62B
LM3724IM5-2.32/NO.A	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R50B
LM3724IM5-2.32/NOPB	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	R50B
LM3724IM5-3.08/NO.A	Active	Production	SOT-23 (DBV) 5	1000 SMALL T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R53B
LM3724IM5-3.08/NOPB	Active	Production	SOT-23 (DBV) 5	1000 SMALL T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	R53B
LM3724IM5-4.63/NO.A	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R55B
LM3724IM5-4.63/NOPB	Active	Production	SOT-23 (DBV) 5	1000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	R55B
LM3724IM5X-3.08/NO.A	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	R53B
LM3724IM5X-3.08/NOPB	Active	Production	SOT-23 (DBV) 5	3000 LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	R53B

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

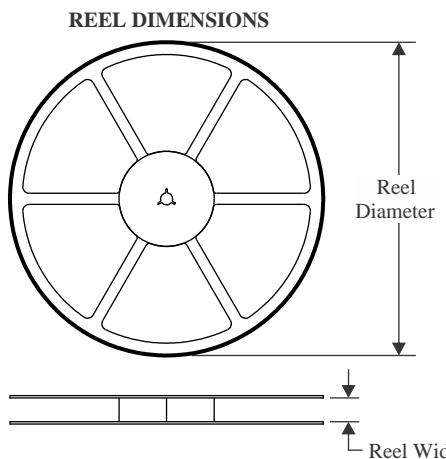
⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

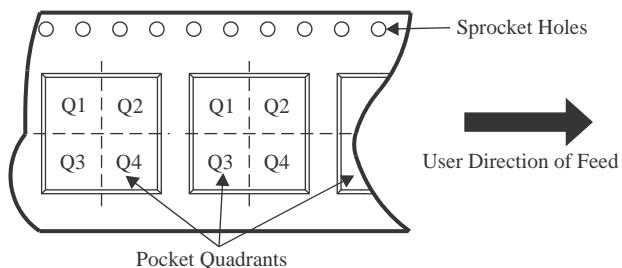
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TAPE AND REEL INFORMATION


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LM3724EM5-3.08/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM3724EM5-4.63/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM3724IM5-2.32/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM3724IM5-3.08/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM3724IM5-4.63/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM3724IM5X-3.08/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM3724EM5-3.08/NOPB	SOT-23	DBV	5	1000	208.0	191.0	35.0
LM3724EM5-4.63/NOPB	SOT-23	DBV	5	1000	208.0	191.0	35.0
LM3724IM5-2.32/NOPB	SOT-23	DBV	5	1000	208.0	191.0	35.0
LM3724IM5-3.08/NOPB	SOT-23	DBV	5	1000	208.0	191.0	35.0
LM3724IM5-4.63/NOPB	SOT-23	DBV	5	1000	208.0	191.0	35.0
LM3724IM5X-3.08/NOPB	SOT-23	DBV	5	3000	208.0	191.0	35.0

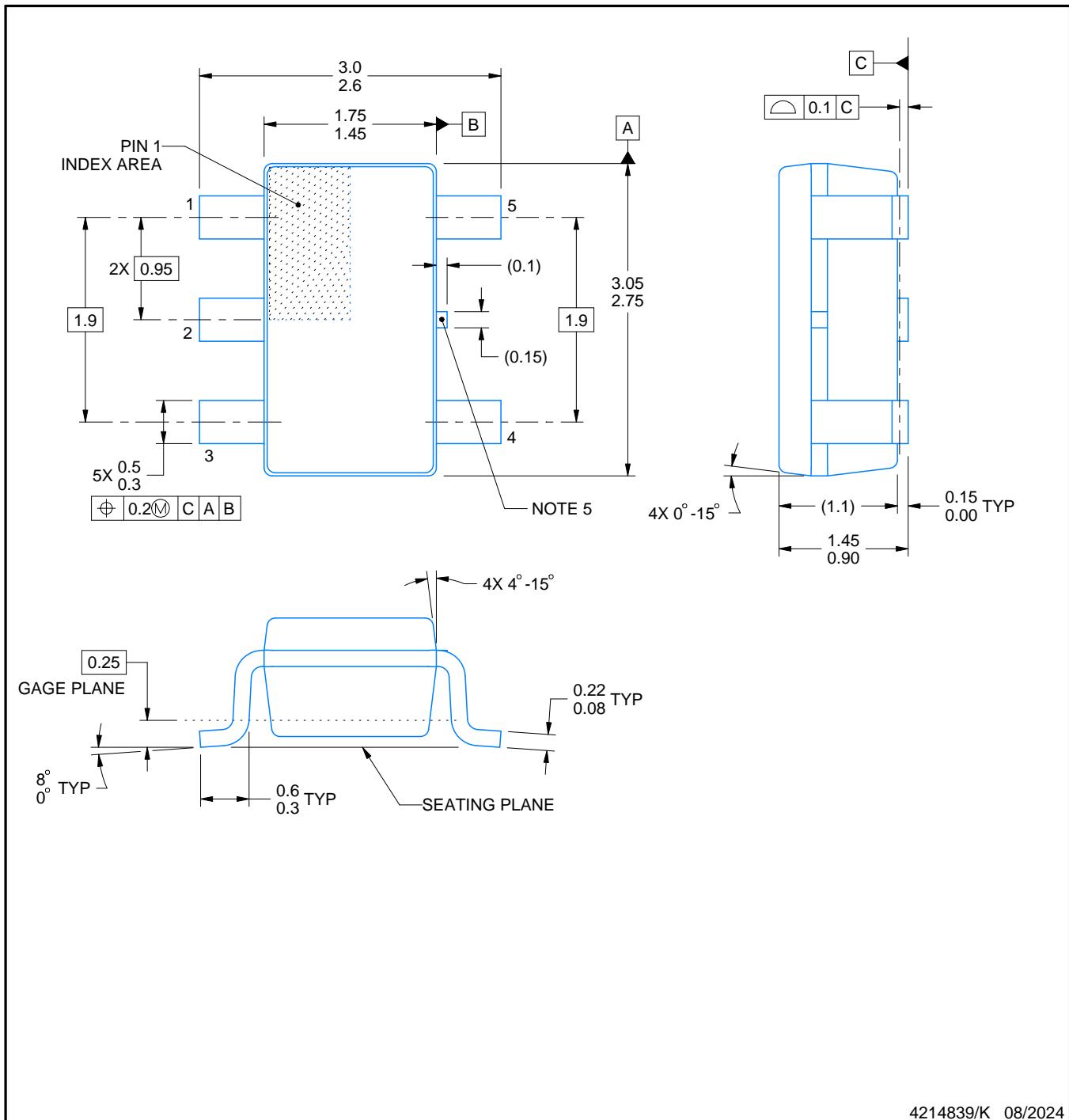
PACKAGE OUTLINE

DBV0005A



SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



4214839/K 08/2024

NOTES:

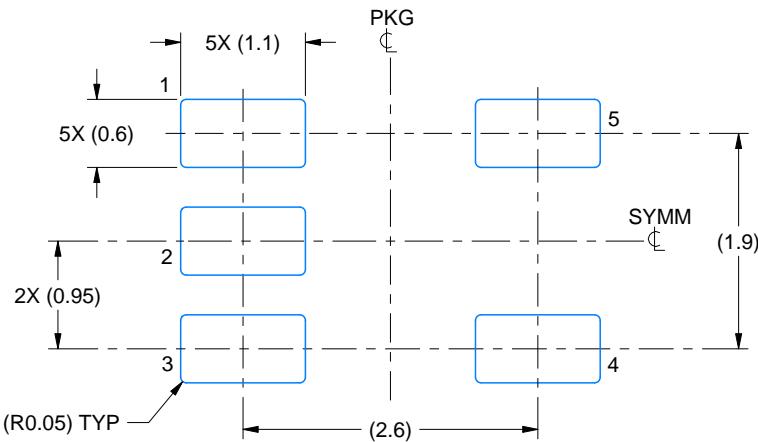
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.

EXAMPLE BOARD LAYOUT

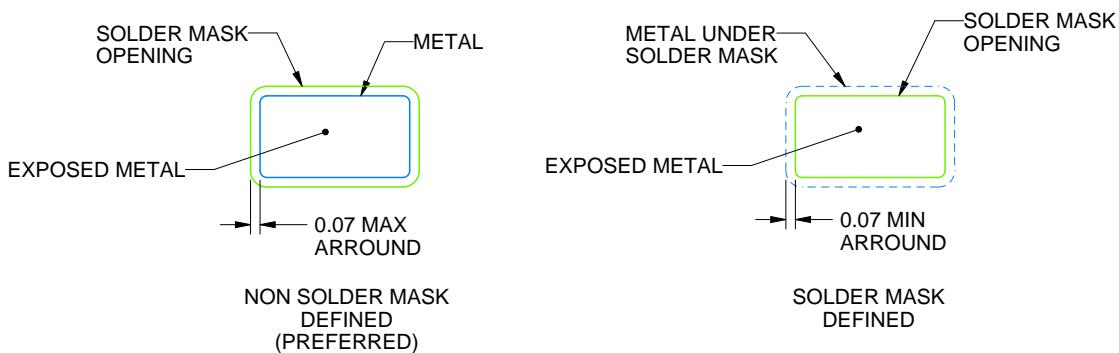
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

4214839/K 08/2024

NOTES: (continued)

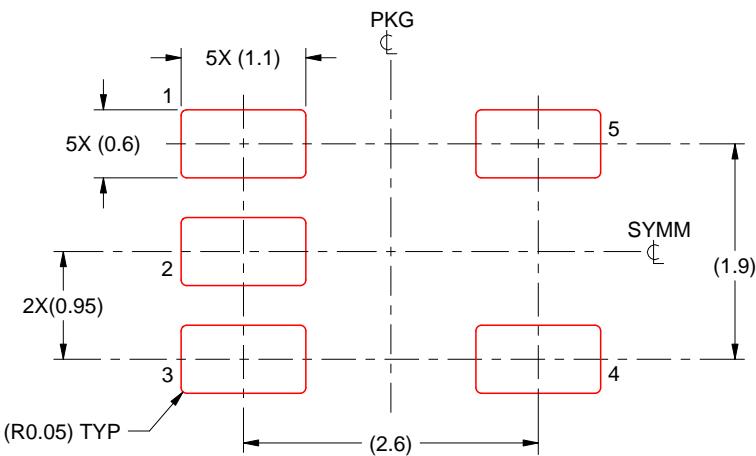
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214839/K 08/2024

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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