MCP6L71/1R/2/4

2 MHz, 150 µA Op Amps

Features

- Gain Bandwidth Product: 2 MHz (typical)
- Supply Current: I_Q = 150 µA (typical)
- Supply Voltage: 2.0V to 6.0V
- Rail-to-Rail Input/Output
- Extended Temperature Range: -40°C to +125°C
- Available in Single, Dual and Quad Packages

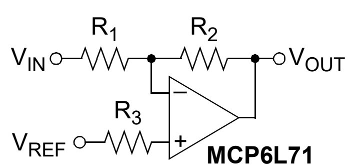
Typical Applications

- Portable Equipment
- Photodiode Amplifier
- Analog Filters
- Notebooks and PDAs
- Battery-Powered Systems

Design Aids

- FilterLab® Software
- MAPS (Microchip Advanced Part Selector)
- Analog Demonstration and Evaluation Boards
- Application Notes

Typical Application



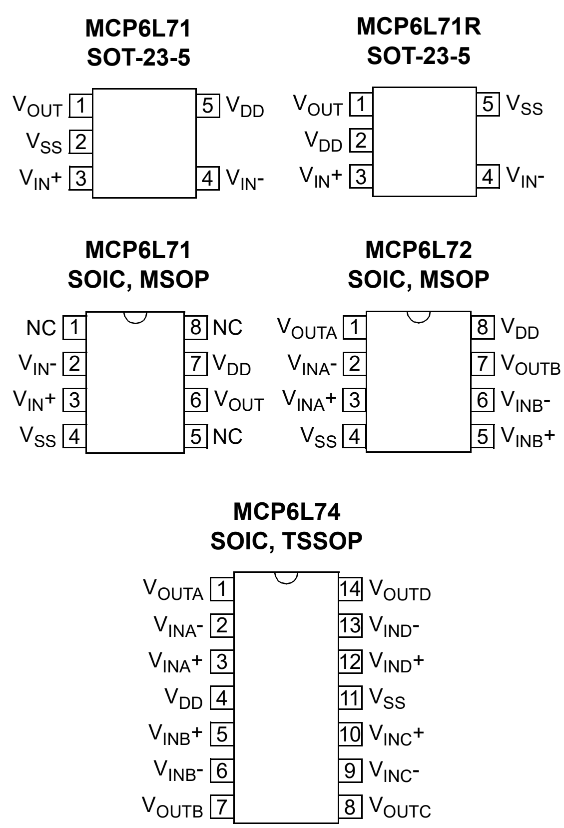
Inverting Amplifier

Description

The Microchip Technology Inc. MCP6L71/1R/2/4 family of operational amplifiers (op amps) supports general purpose applications. The combination of rail-to-rail input and output, low quiescent current and bandwidth fit into many applications.

This family has a 2 MHz Gain Bandwidth Product (GBWP) and a low 150 µA per amplifier quiescent current. These op amps operate on supply voltages between 2.0V and 6.0V, with rail-to-rail input and output swing. They are available in the extended temperature range.

Package Types



NOTES:

1.0 ELECTRICAL CHARACTERISTICS

1.1 Absolute Maximum Ratings†

$V_{DD} - V_{SS}$ 7.0V
Current at Input Pins ....±2 mA
Analog Inputs (V_{IN}+ and V_{IN}-)†† ...... V_{SS} – 1.0V to V_{DD} + 1.0V
All Other Inputs and Outputs .... V_{SS} – 0.3V to V_{DD} + 0.3V
Difference Input Voltage .... $|V_{DD} - V_{SS}|$
Output Short-Circuit Current ....Continuous
Current at Output and Supply Pins ....±30 mA
Storage Temperature ....-65°C to +150°C
Junction Temperature (T_J) ....+150°C
ESD Protection on All Pins (HBM/MM)................ ≥ 4 kV/400V

† 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 listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

†† See **Section 4.1.2 “Input Voltage and Current Limits”**.

1.2 Specifications

TABLE 1-1: DC ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = 5.0V, V_{SS} = GND, $V_{CM} = V_{DD}/2$, $V_{OUT} \approx V_{DD}/2$, $V_L = V_{DD}/2$ and R_L = 10 kΩ to V_L. (Refer to Figure 1-1.)

Parameters	Sym	Min[1]	Typ	Max[1]	Units	Conditions
Input Offset						
Input Offset Voltage	V_{OS}	–4	±1	+4	mV	
Input Offset Temperature Drift	$\Delta V_{OS}/\Delta T_A$	—	±1.3	—	µV/°C	T_A = -40°C to +125°C
Power Supply Rejection Ratio	PSRR	—	89	—	dB	
Input Bias Current and Impedance						
Input Bias Current	I_B	—	1	—	pA	
	I_B	—	50	—	pA	T_A = +85°C
	I_B	—	2000	—	pA	T_A = +125°C
Input Offset Current	I_{OS}	—	±1	—	pA	
Common-mode Input Impedance	Z_{CM}	—	10^{13}‖6	—	Ω‖pF	
Differential Input Impedance	Z_{DIFF}	—	10^{13}‖3	—	Ω‖pF	
Common-mode						
Common-mode Input Voltage Range	V_{CMR}	-0.3	—	+5.3	V	
Common-mode Rejection Ratio	CMRR	—	91	—	dB	V_{CM} = -0.3V to 5.3V
Open-Loop Gain						
DC Open-Loop Gain (large signal)	A_{OL}	—	105	—	dB	V_{OUT} = 0.2V to 4.8V, $V_{CM} = V_{SS}$
Output						
Maximum Output Voltage Swing	V_{OL}	—	—	0.020	V	G = +2 V/V, 0.5V input overdrive
	V_{OH}	4.980	—	—	V	G = +2 V/V, 0.5V input overdrive
Output Short-Circuit Current	I_{SC}	—	±25	—	mA	

Note 1: For design guidance only; not tested.

TABLE 1-1: DC ELECTRICAL SPECIFICATIONS (CONTINUED)

Parameters	Sym	Min(1)	Typ	Max(1)	Units	Conditions
Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = 5.0V, V_{SS} = GND, V_{CM} = V_{DD}/2, V_{OUT} ≈ V_{DD}/2, V_L = V_{DD}/2 and R_L = 10 kΩ to V_L. (Refer to Figure 1-1.)						
Power Supply						
Supply Voltage	V_{DD}	2.0	—	6.0	V	
Quiescent Current per Amplifier	I_Q	50	150	240	µA	I_O = 0

Note 1: For design guidance only; not tested.

TABLE 1-2: AC ELECTRICAL SPECIFICATIONS

Parameters	Sym	Min	Typ	Max	Units	Conditions
Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = +2.0V to +5.5V, V_{SS} = GND, V_{CM} = V_{DD}/2, V_{OUT} ≈ V_{DD}/2, V_L = V_{DD}/2, R_L = 10 kΩ to V_L and C_L = 60 pF. (Refer to Figure 1-1.)						
AC Response						
Gain Bandwidth Product	GBWP	—	2.0	—	MHz	
Phase Margin	PM	—	65	—	°	G = +1 V/V
Slew Rate	SR	—	0.9	—	V/µs	
Noise						
Input Noise Voltage	E_{ni}	—	4.6	—	$µV_{P-P}$	f = 0.1 Hz to 10 Hz
Input Noise Voltage Density	e_{ni}	—	19	—	nV/√Hz	f = 10 kHz
Input Noise Current Density	i_{ni}	—	3	—	fA/√Hz	f = 1 kHz

TABLE 1-3: TEMPERATURE SPECIFICATIONS

Parameters	Sym	Min	Typ	Max	Units	Conditions
Electrical Characteristics: Unless otherwise indicated, V_{DD} = +2.0V to +5.5V and V_{SS} = GND.						
Temperature Ranges						
Specified Temperature Range	T_A	-40	—	+125	°C	
Operating Temperature Range	T_A	-40	—	+125	°C	**Note 1**
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 5-Lead SOT-23	θ_{JA}	—	256	—	°C/W	
Thermal Resistance, 8-Lead SOIC	θ_{JA}	—	163	—	°C/W	
Thermal Resistance, 8-Lead MSOP	θ_{JA}	—	206	—	°C/W	
Thermal Resistance, 14-Lead SOIC	θ_{JA}	—	120	—	°C/W	
Thermal Resistance, 14-Lead TSSOP	θ_{JA}	—	100	—	°C/W	

Note 1: The Junction Temperature (T_J) must not exceed the absolute maximum specification of +150°C.

1.3 Test Circuits

The circuit used for most DC and AC tests is shown in Figure 1-1. This circuit can independently set V_{CM} and V_{OUT}; see Equation 1-1. Note that V_{CM} is not the circuit's Common-mode voltage (($V_P + V_M$)/2), and that V_{OST} includes V_{OS} plus the effects (on the input offset error, V_{OST}) of temperature, CMRR, PSRR and A_{OL}.

EQUATION 1-1:

$$G_{DM} = R_F / R_G$$
$$V_{CM} = (V_P + V_{DD}/2)/2$$
$$V_{OST} = V_{IN-} - V_{IN+}$$
$$V_{OUT} = (V_{DD}/2) + (V_P - V_M) + V_{OST}(1 + G_{DM})$$

Where:

G_{DM}	=	Differential-mode Gain	(V/V)
V_{CM}	=	Op Amp's Common-mode Input Voltage	(V)
V_{OST}	=	Op Amp's Total Input Offset Voltage	(mV)

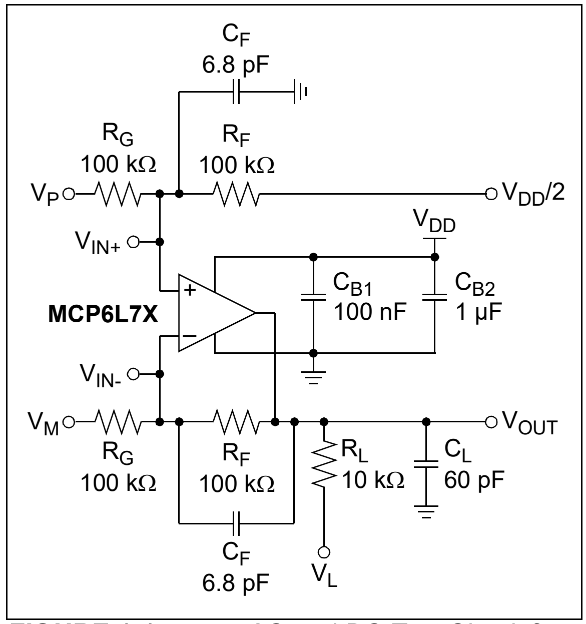


FIGURE 1-1: AC and DC Test Circuit for Most Specifications.

NOTES:

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

Note: Unless otherwise indicated, T_A = +25°C, V_{DD} = 5.0V, V_{SS} = GND, V_{CM} = $V_{DD}/2$, $V_{OUT} \approx V_{DD}/2$, V_L = $V_{DD}/2$, R_L = 10 kΩ to V_L and C_L = 60 pF.

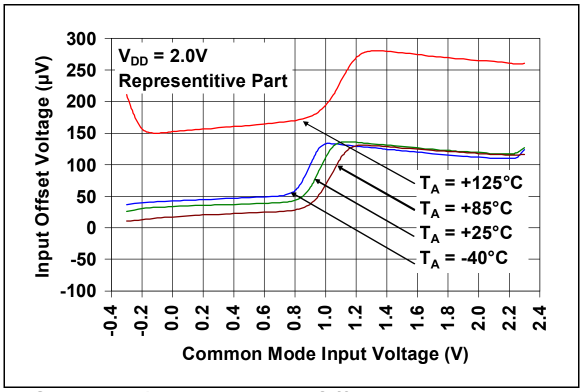


FIGURE 2-1: Input Offset Voltage vs. Common-mode Input Voltage at V_{DD} = 2.0V.

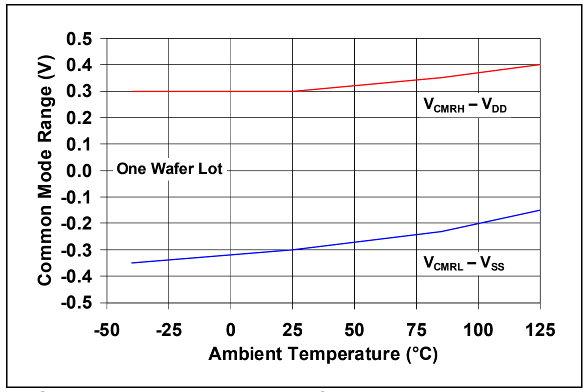


FIGURE 2-4: Input Common-mode Range Voltage vs. Ambient Temperature.

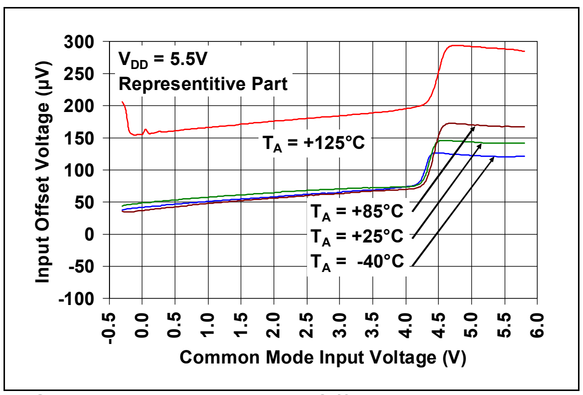


FIGURE 2-2: Input Offset Voltage vs. Common-mode Input Voltage at V_{DD} = 5.5V.

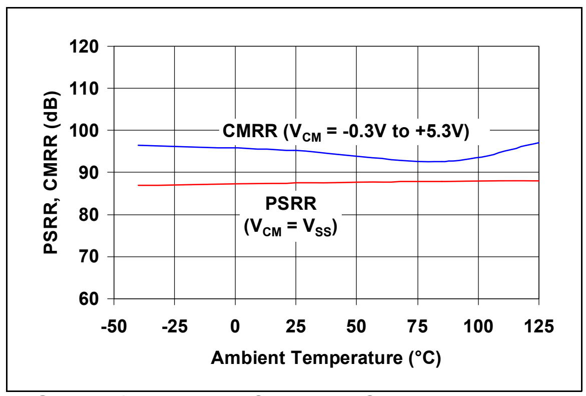


FIGURE 2-5: CMRR, PSRR vs. Temperature.

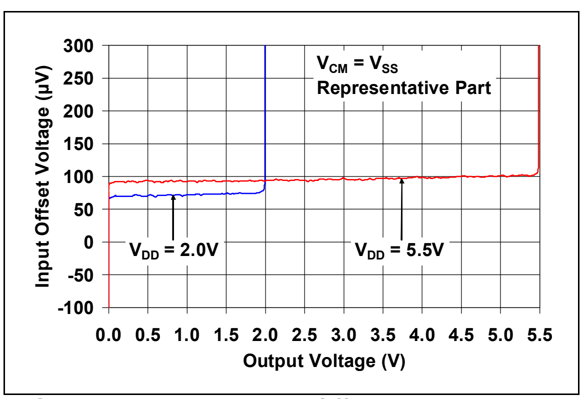


FIGURE 2-3: Input Offset Voltage vs. Output Voltage.

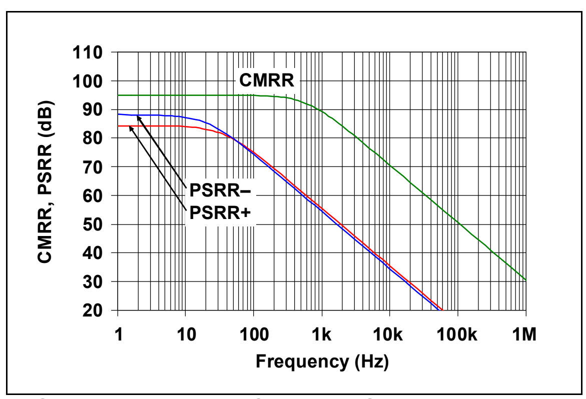


FIGURE 2-6: CMRR, PSRR vs. Frequency.

Note: Unless otherwise indicated, T_A = +25°C, V_{DD} = 5.0V, V_{SS} = GND, V_{CM} = $V_{DD}/2$, $V_{OUT} \approx V_{DD}/2$, V_L = $V_{DD}/2$, R_L = 10 kΩ to V_L and C_L = 60 pF.

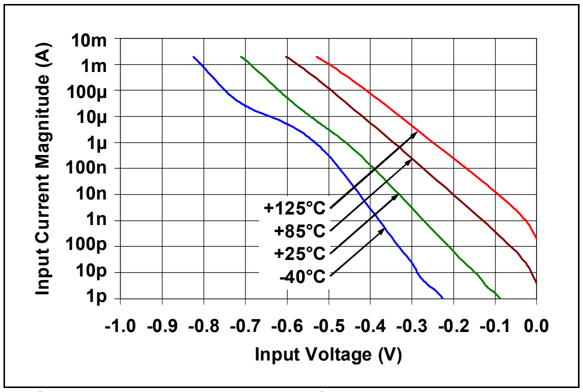


FIGURE 2-7: *Input Current vs. Input Voltage.*

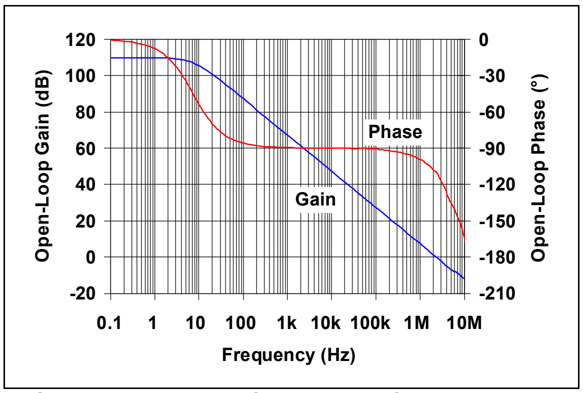


FIGURE 2-8: *Open-Loop Gain, Phase vs. Frequency.*

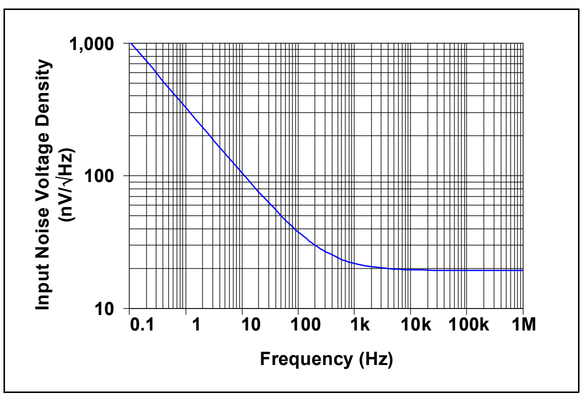


FIGURE 2-9: *Input Noise Voltage Density vs. Frequency.*

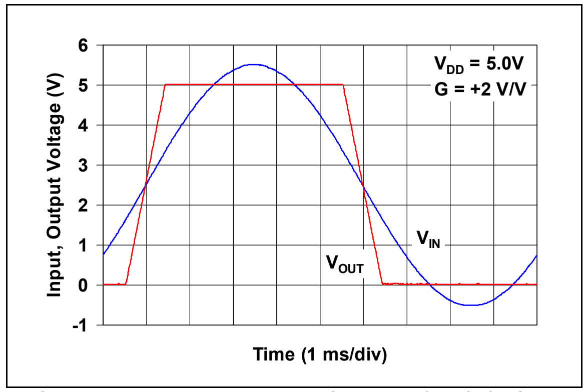


FIGURE 2-10: *The MCP6L71/1R/2/4 Show No Phase Reversal.*

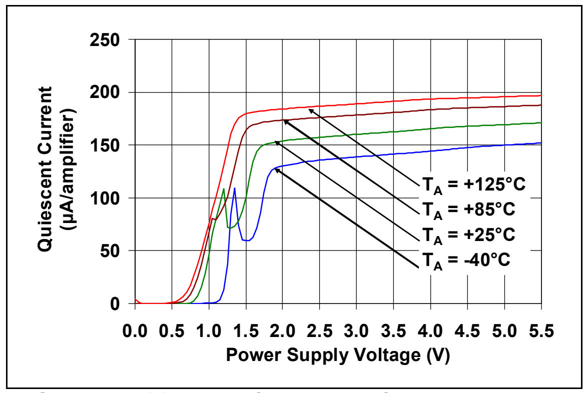


FIGURE 2-11: *Quiescent Current vs. Supply Voltage.*

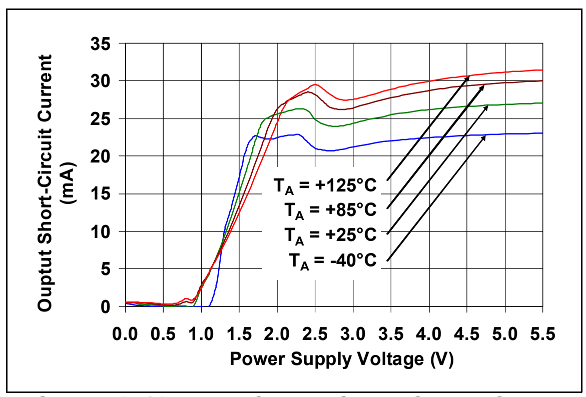


FIGURE 2-12: *Output Short-Circuit Current vs. Supply Voltage.*

Note: Unless otherwise indicated, T_A = +25°C, V_{DD} = 5.0V, V_{SS} = GND, V_{CM} = V_{DD}/2, $V_{OUT} \approx V_{DD}$/2, V_L = V_{DD}/2, R_L = 10 kΩ to V_L and C_L = 60 pF.

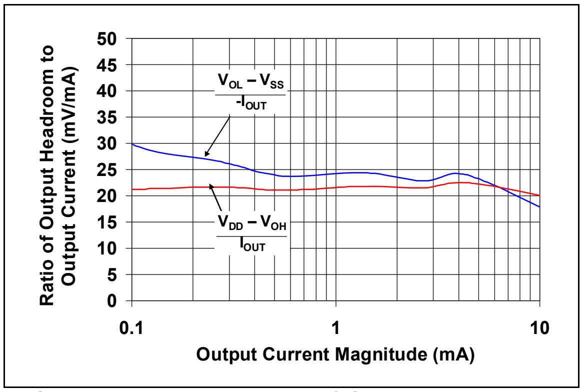


FIGURE 2-13: *Ratio of Output Voltage Headroom vs. Output Current Magnitude.*

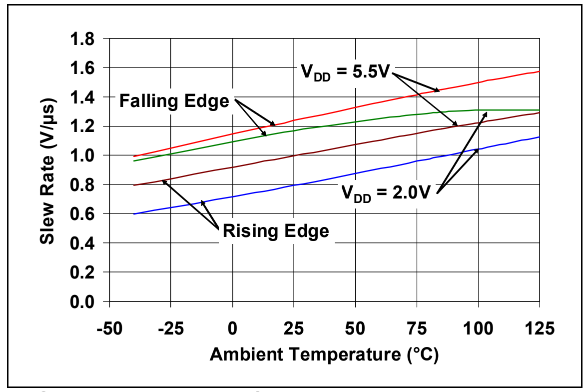


FIGURE 2-16: *Slew Rate vs. Ambient Temperature.*

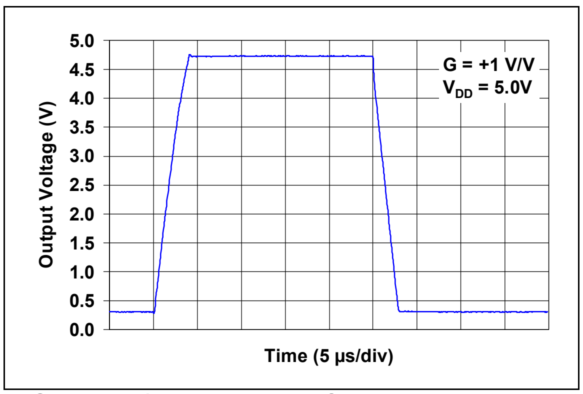


FIGURE 2-14: *Large-Signal Noninverting Pulse Response.*

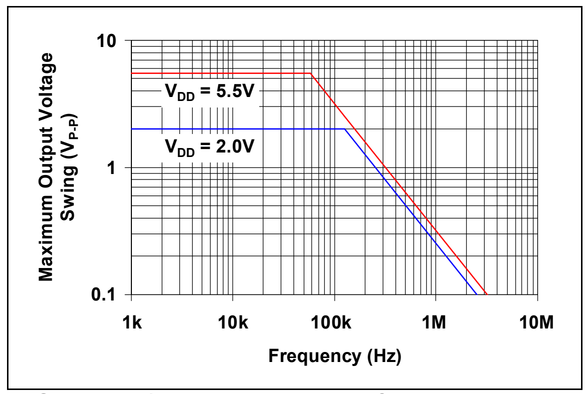


FIGURE 2-17: *Maximum Output Voltage Swing vs. Frequency.*

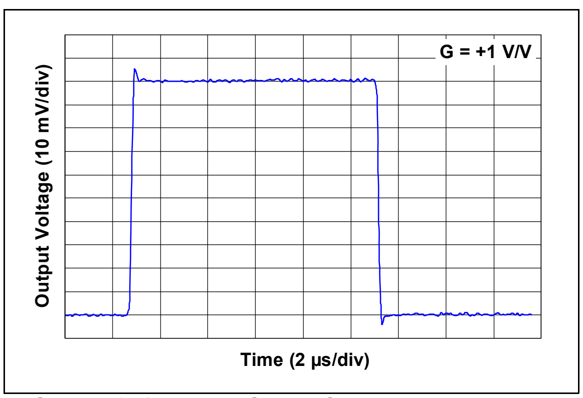


FIGURE 2-15: *Small-Signal Noninverting Pulse Response.*

NOTES:

3.0 PIN DESCRIPTIONS

Descriptions of the pins are listed in Table 3-1 (single op amps) and Table 3-2 (dual and quad op amps).

TABLE 3-1: PIN FUNCTION TABLE FOR SINGLE OP AMPS

MCP6L71		MCP6L71R	Symbol	Description
MSOP, SOIC	SOT-23	SOT-23		
2	4	4	$V_{IN}-$	Inverting Input
3	3	3	$V_{IN}+$	Noninverting Input
4	2	5	V_{SS}	Negative Power Supply
6	1	1	V_{OUT}	Analog Output
7	5	2	V_{DD}	Positive Power Supply
1,5,8	—	—	NC	No Internal Connection

TABLE 3-2: PIN FUNCTION TABLE FOR DUAL AND QUAD OP AMPS

MCP6L72	MCP6L74	Symbol	Description
MSOP, SOIC	SOIC, TSSOP		
1	1	V_{OUTA}	Analog Output (Op Amp A)
2	2	$V_{INA}-$	Inverting Input (Op Amp A)
3	3	$V_{INA}+$	Noninverting Input (Op Amp A)
8	4	V_{DD}	Positive Power Supply
5	5	$V_{INB}+$	Noninverting Input (Op Amp B)
6	6	$V_{INB}-$	Inverting Input (Op Amp B)
7	7	V_{OUTB}	Analog Output (Op Amp B)
—	8	V_{OUTC}	Analog Output (Op Amp C)
—	9	$V_{INC}-$	Inverting Input (Op Amp C)
—	10	$V_{INC}+$	Noninverting Input (Op Amp C)
4	11	V_{SS}	Negative Power Supply
—	12	$V_{IND}+$	Noninverting Input (Op Amp D)
—	13	$V_{IND}-$	Inverting Input (Op Amp D)
—	14	V_{OUTD}	Analog Output (Op Amp D)

3.1 Analog Outputs

The output pins are low-impedance voltage sources.

3.2 Analog Inputs

The noninverting and inverting inputs are high-impedance CMOS inputs with low bias currents.

3.3 Power Supply Pins

The positive power supply (V_{DD}) is 2.0V to 6.0V higher than the negative power supply (V_{SS}). For normal operation, the other pins are at voltages between V_{SS} and V_{DD}.

Typically, these parts are used in a single (positive) supply configuration. In this case, V_{SS} is connected to ground and V_{DD} is connected to the supply. V_{DD} will need bypass capacitors.

4.0 APPLICATION INFORMATION

The MCP6L71/1R/2/4 family of op amps is manufactured using Microchip's state-of-the-art CMOS process, specifically designed for low-cost, low-power and general purpose applications. The low supply voltage, low quiescent current and wide bandwidth make the MCP6L71/1R/2/4 ideal for battery-powered applications.

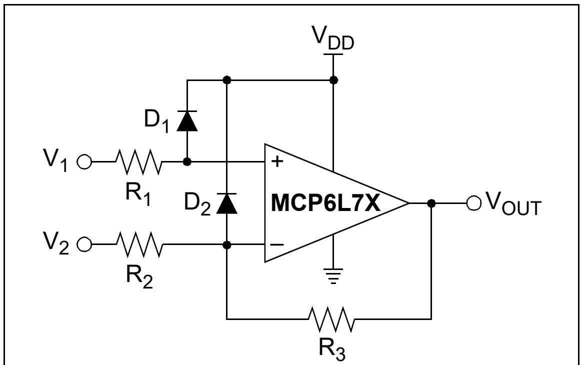
4.1 Rail-to-Rail Inputs

4.1.1 PHASE REVERSAL

The MCP6L71/1R/2/4 op amps are designed to prevent phase inversion when the input pins exceed the supply voltages. Figure 2-10 shows an input voltage exceeding both supplies without any phase reversal.

4.1.2 INPUT VOLTAGE AND CURRENT LIMITS

In order to prevent damage and/or improper operation of these amplifiers, the circuit they are in must limit the currents (and voltages) at the input pins (see **Section 1.1 "Absolute Maximum Ratings†"**). Figure 4-1 shows the recommended approach to protecting these inputs. The internal ESD diodes prevent the input pins (V_{IN}+ and V_{IN}-) from going too far below ground, and the resistors, R_1 and R_2, limit the possible current drawn out of the input pins. Diodes, D_1 and D_2, prevent the input pins (V_{IN}+ and V_{IN}-) from going too far above V_{DD}, and dump any currents onto V_{DD}.



$$R_1 > \frac{V_{SS} - (\text{minimum expected } V_1)}{2\ mA}$$

$$R_2 > \frac{V_{SS} - (\text{minimum expected } V_2)}{2\ mA}$$

FIGURE 4-1: *Protecting the Analog Inputs.*

A significant amount of current can flow out of the inputs (through the ESD diodes) when the Common-mode voltage (V_{CM}) is below ground (V_{SS}); see Figure 2-7. Applications that are high-impedance may need to limit the usable voltage range.

4.1.3 NORMAL OPERATIONS

The input stage of the MCP6L71/1R/2/4 op amps uses two differential CMOS input stages in parallel. One operates at low Common-mode input voltage (V_{CM}), while the other at high V_{CM}. With this topology, and at room temperature, the device operates with V_{CM} up to 0.3V above V_{DD} and 0.3V below V_{SS} (typically at +25°C).

The transition between the two input stages occurs when $V_{CM} = V_{DD} - 1.1V$. For the best distortion and gain linearity, with noninverting gains, avoid this region of operation.

4.2 Rail-to-Rail Output

The output voltage range of the MCP6L71/1R/2/4 op amps is V_{DD} – 20 mV (minimum), and V_{SS} + 20 mV (maximum) when R_L = 10 kΩ is connected to V_{DD}/2 and V_{DD} = 5.0V. Refer to Figure 2-13 for more information.

4.3 Capacitive Loads

Driving large capacitive loads can cause stability problems for voltage feedback op amps. As the load capacitance increases, the feedback loop's phase margin decreases and the closed-loop bandwidth is reduced. This produces gain peaking in the frequency response, with overshoot and ringing in the step response.

When driving large capacitive loads with these op amps (e.g., > 100 pF when G = +1), a small series resistor at the output (R_{ISO} in Figure 4-2) improves the feedback loop's phase margin (stability) by making the output load resistive at higher frequencies. The bandwidth will be generally lower than the bandwidth with no capacitive load.

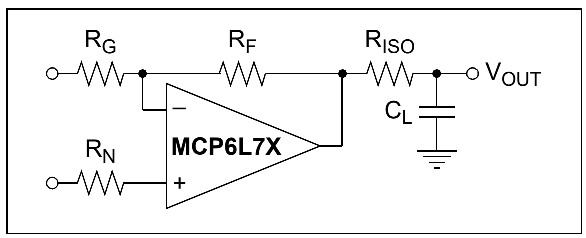


FIGURE 4-2: *Output Resistor, R_{ISO} Stabilizes Large Capacitive Loads.*

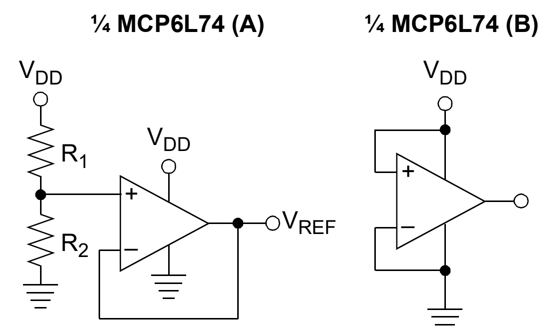
Bench measurements are helpful in choosing R_{ISO}. Adjust R_{ISO} so that a small-signal step response (see Figure 2-15) has reasonable overshoot (e.g., 4%).

4.4 Supply Bypass

With this family of operational amplifiers, the power supply pin (V_{DD} for single supply) should have a local bypass capacitor (i.e., 0.01 µF to 0.1 µF) within 2 mm for good, high-frequency performance. It also needs a bulk capacitor (i.e., 1 µF or larger) within 100 mm to provide large, slow currents. This bulk capacitor can be shared with nearby analog parts.

4.5 Unused Amplifiers

An unused op amp in a quad package (MCP6L74) should be configured as shown in Figure 4-3. These circuits prevent the output from toggling and causing crosstalk. In Circuit A, R_1 and R_2 produce a voltage within its output voltage range (V_{OH}, V_{OL}). The op amp buffers this voltage, which can be used elsewhere in the circuit. Circuit B uses the minimum number of components and operates as a comparator.



$$V_{REF} = V_{DD} \cdot \frac{R_2}{R_1 + R_2}$$

FIGURE 4-3: *Unused Op Amps.*

4.6 PCB Surface Leakage

In applications where low input bias current is critical, Printed Circuit Board (PCB) surface leakage effects need to be considered. Surface leakage is caused by humidity, dust or other contamination on the board. Under low humidity conditions, a typical resistance between nearby traces is $10^{12}\Omega$. A 5V difference would cause 5 pA of current to flow. This is greater than the MCP6L71/1R/2/4 family's bias current at +25°C (1 pA, typical).

The easiest way to reduce surface leakage is to use a guard ring around sensitive pins (or traces). The guard ring is biased at the same voltage as the sensitive pin. Figure 4-4 shows an example of this type of layout.

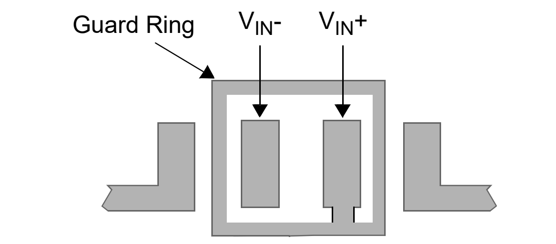


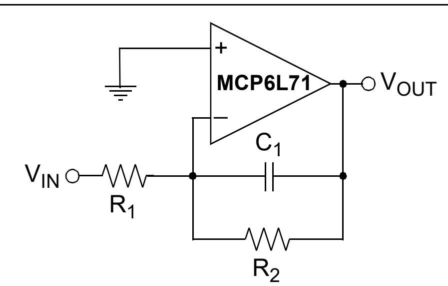
FIGURE 4-4: *Example Guard Ring Layout.*

1. For Inverting Gain and Transimpedance Amplifiers (convert current to voltage, such as photo detectors):
   a) Connect the guard ring to the noninverting input pin ($V_{IN}+$). This biases the guard ring to the same reference voltage as the op amp (e.g., $V_{DD}/2$ or ground).
   b) Connect the inverting pin ($V_{IN}-$) to the input with a wire that does not touch the PCB surface.
2. Noninverting Gain and Unity Gain Buffer:
   a) Connect the guard ring to the inverting input pin ($V_{IN}-$). This biases the guard ring to the Common-mode input voltage.
   b) Connect the noninverting pin ($V_{IN}+$) to the input with a wire that does not touch the PCB surface.

4.7 Application Circuits

4.7.1 INVERTING INTEGRATOR

An inverting integrator is shown in Figure 4-5. The circuit provides an output voltage that is proportional to the negative time integral of the input. The additional resistor R_2 limits DC gain and controls output clipping. To minimize the integrator's error for slow signals, the value of R_2 should be much larger than the value of R_1.



$$V_{OUT} = -\frac{1}{R_1 C_1}\int_0^t V_{IN} dt$$

$$R_2 \gg R_1$$

FIGURE 4-5: *Inverting Integrator.*

5.0 DESIGN TOOLS

Microchip provides the basic design tools needed for the MCP6L71/1R/2/4 family of op amps.

5.1 FilterLab® Software

Microchip's FilterLab® software is an innovative software tool that simplifies analog active filter (using op amps) design. Available at no cost from the Microchip website at www.microchip.com/filterlab, the FilterLab design tool provides full schematic diagrams of the filter circuit with component values. It also outputs the filter circuit in SPICE format, which can be used with the macro model to simulate actual filter performance.

5.2 MAPS (Microchip Advanced Part Selector)

MAPS is a software tool that helps efficiently identify Microchip devices that fit a particular design requirement. Available at no cost from the Microchip website at www.microchip.com/maps, the MAPS is an overall selection tool for Microchip's product portfolio that includes Analog, Memory, MCUs and DSCs. Using this tool you can define a filter to sort features for a parametric search of devices and export side-by-side technical comparison reports. Helpful links are also provided for data sheets, purchase and sampling of Microchip parts.

5.3 Analog Demonstration and Evaluation Boards

Microchip offers a broad spectrum of Analog Demonstration and Evaluation Boards that are designed to help you achieve faster time to market. For a complete listing of these boards, and their corresponding user's guides and technical information, visit the Microchip website at www.microchip.com/analogtools.

Some boards that are especially useful are:

- MCP6XXX Amplifier Evaluation Board 1
- MCP6XXX Amplifier Evaluation Board 2
- MCP6XXX Amplifier Evaluation Board 3
- MCP6XXX Amplifier Evaluation Board 4
- Active Filter Demo Board Kit
- 5/6-Pin SOT-23 Evaluation Board, P/N VSUPEV2
- 8-Pin SOIC/MSOP/TSSOP/DIP Evaluation Board, P/N SOIC8EV
- 14-Pin SOIC/TSSOP/DIP Evaluation Board, P/N SOIC14EV

5.4 Application Notes

The following Microchip Application Notes are available on the Microchip website at www.microchip.com/appnotes and are recommended as supplemental reference resources.

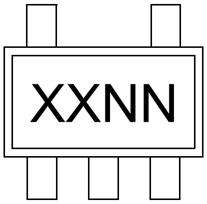
- **ADN003:** *"Select the Right Operational Amplifier for your Filtering Circuits",* DS21821
- **AN722:** *"Operational Amplifier Topologies and DC Specifications",* DS00722
- **AN723:** *"Operational Amplifier AC Specifications and Applications",* DS00723
- **AN884:** *"Driving Capacitive Loads With Op Amps",* DS00884
- **AN990:** *"Analog Sensor Conditioning Circuits – An Overview",* DS00990

NOTES:

6.0 PACKAGING INFORMATION

6.1 Package Marking Information

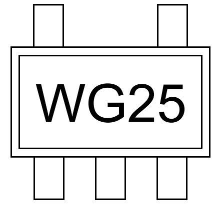
5-Lead SOT-23 **(MCP6L71, MCP6L71R)**



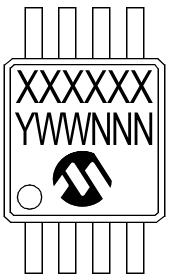
Device	Code
MCP6L71	WGNN
MCP6L71R	WFNN

Note: Applies to 5-Lead SOT-23.

Example

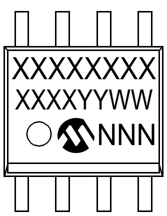


8-Lead MSOP **(MCP6L71, MCP6L72)**

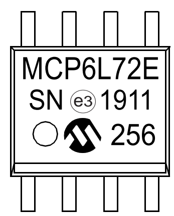


Example

8-Lead SOIC (3.90 mm) **(MCP6L71, MCP6L72)**



Example

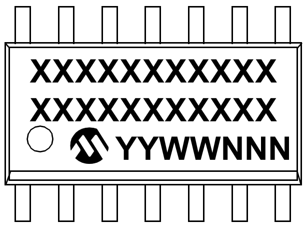


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

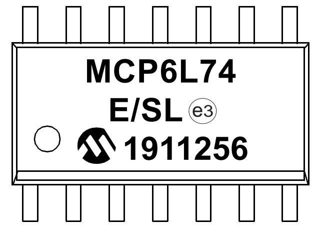
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

Package Marking Information (Continued)

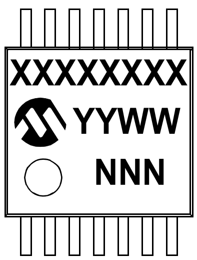
14-Lead SOIC (3.90 mm) **(MCP6L74)**



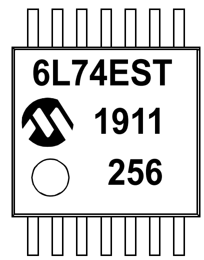
Example



14-Lead TSSOP (4.4 mm) **(MCP6L74)**

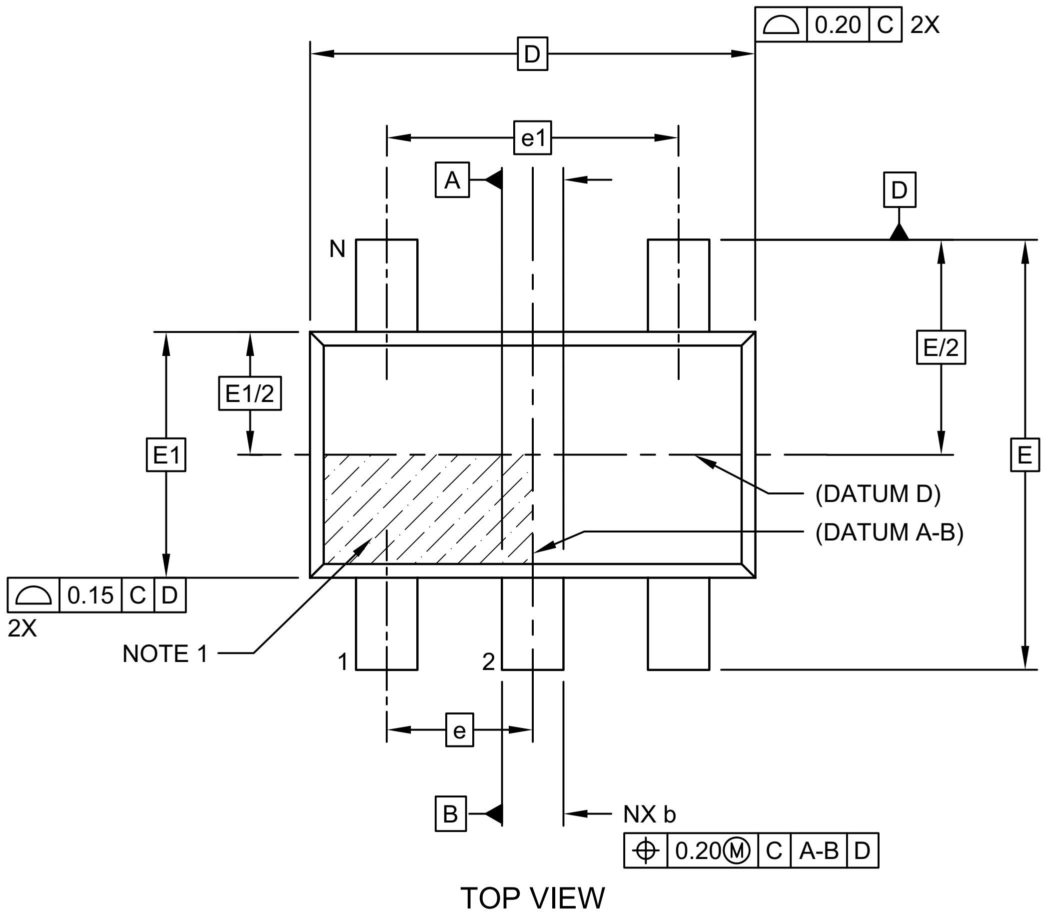


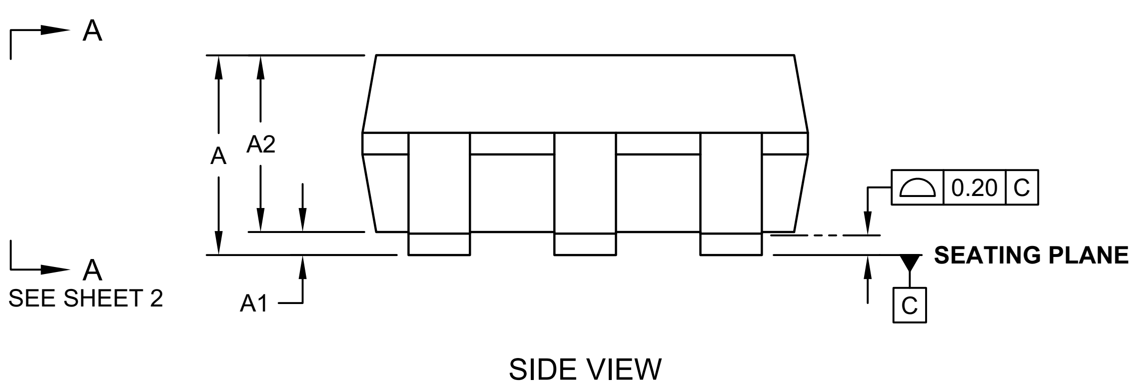
Example



5-Lead Plastic Small Outline Transistor (OT) [SOT23]

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

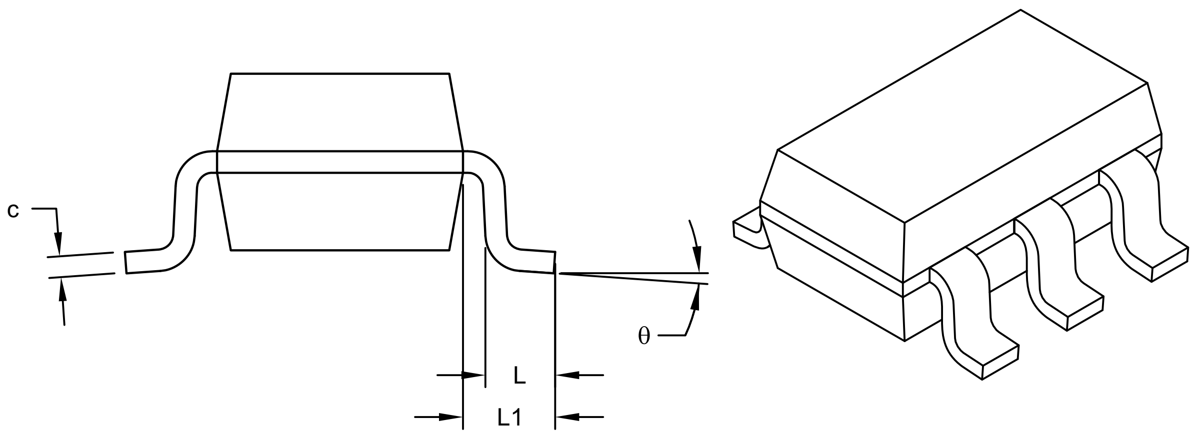




Microchip Technology Drawing C04-091-OT Rev F Sheet 1 of 2

5-Lead Plastic Small Outline Transistor (OT) [SOT23]

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



VIEW A-A
SHEET 1

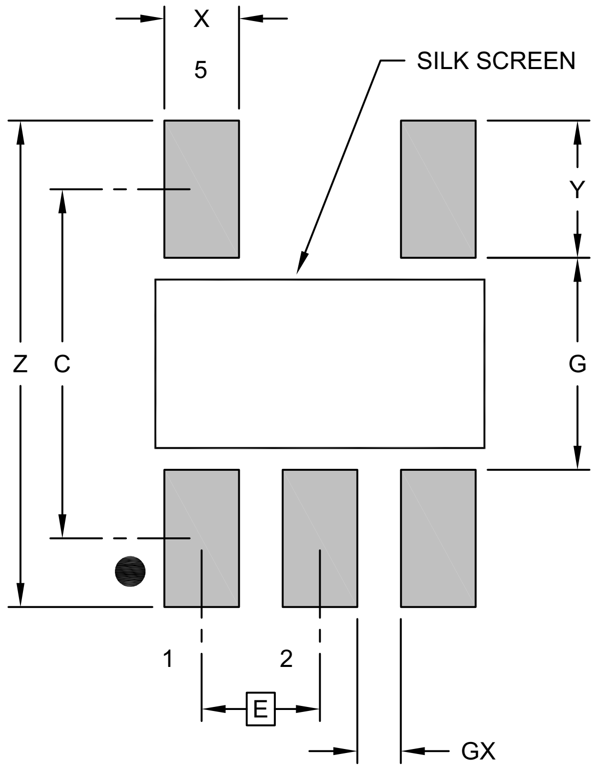
Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N	5		
Pitch	e	0.95 BSC		
Outside lead pitch	e1	1.90 BSC		
Overall Height	A	0.90	-	1.45
Molded Package Thickness	A2	0.89	-	1.30
Standoff	A1	-	-	0.15
Overall Width	E	2.80 BSC		
Molded Package Width	E1	1.60 BSC		
Overall Length	D	2.90 BSC		
Foot Length	L	0.30	-	0.60
Footprint	L1	0.60 REF		
Foot Angle	ϕ	0°	-	10°
Lead Thickness	c	0.08	-	0.26
Lead Width	b	0.20	-	0.51

Notes:
1. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25mm per side.
2. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-091-OT Rev F Sheet 2 of 2

5-Lead Plastic Small Outline Transistor (OT) [SOT23]

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



RECOMMENDED LAND PATTERN

	Units	MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.95 BSC		
Contact Pad Spacing	C		2.80	
Contact Pad Width (X5)	X			0.60
Contact Pad Length (X5)	Y			1.10
Distance Between Pads	G	1.70		
Distance Between Pads	GX	0.35		
Overall Width	Z			3.90

Notes:

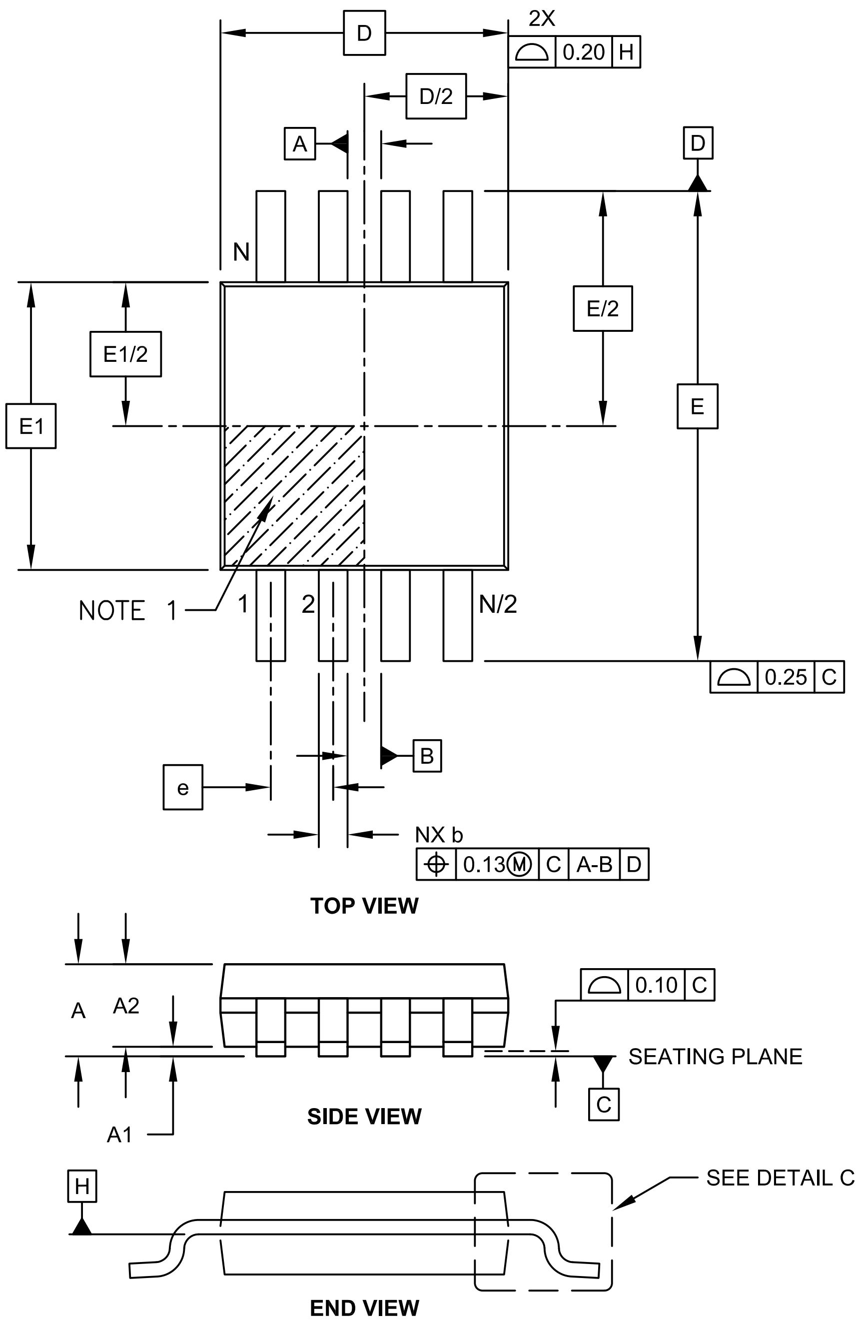
1. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2091-OT Rev F

8-Lead Plastic Micro Small Outline Package (MS) [MSOP]

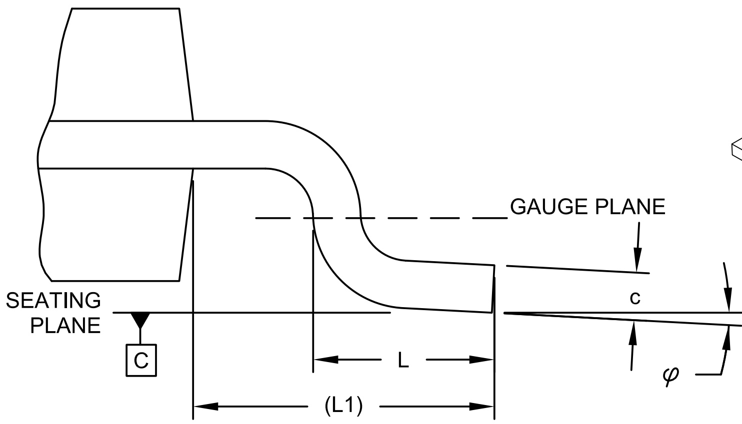
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



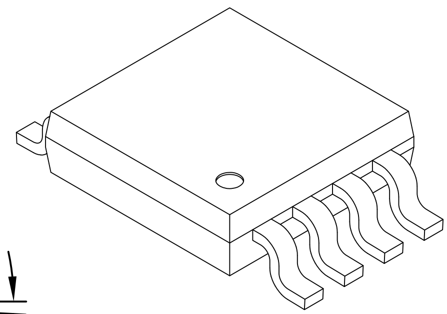
Microchip Technology Drawing C04-111C Sheet 1 of 2

8-Lead Plastic Micro Small Outline Package (MS) [MSOP]

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



DETAIL C



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.65 BSC	
Overall Height	A	-	-	1.10
Molded Package Thickness	A2	0.75	0.85	0.95
Standoff	A1	0.00	-	0.15
Overall Width	E		4.90 BSC	
Molded Package Width	E1		3.00 BSC	
Overall Length	D		3.00 BSC	
Foot Length	L	0.40	0.60	0.80
Footprint	L1		0.95 REF	
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.08	-	0.23
Lead Width	b	0.22	-	0.40

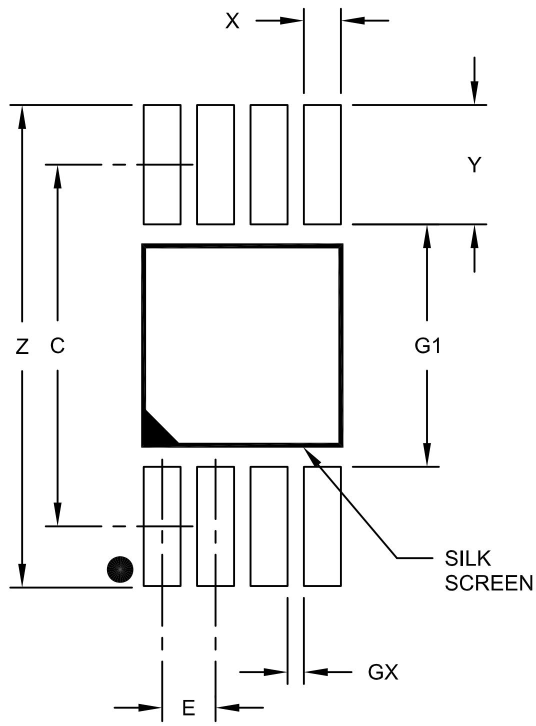
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M.
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-111C Sheet 2 of 2

8-Lead Plastic Micro Small Outline Package (MS) [MSOP]

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.65 BSC		
Contact Pad Spacing	C		4.40	
Overall Width	Z			5.85
Contact Pad Width (X8)	X1			0.45
Contact Pad Length (X8)	Y1			1.45
Distance Between Pads	G1	2.95		
Distance Between Pads	GX	0.20		

Notes:

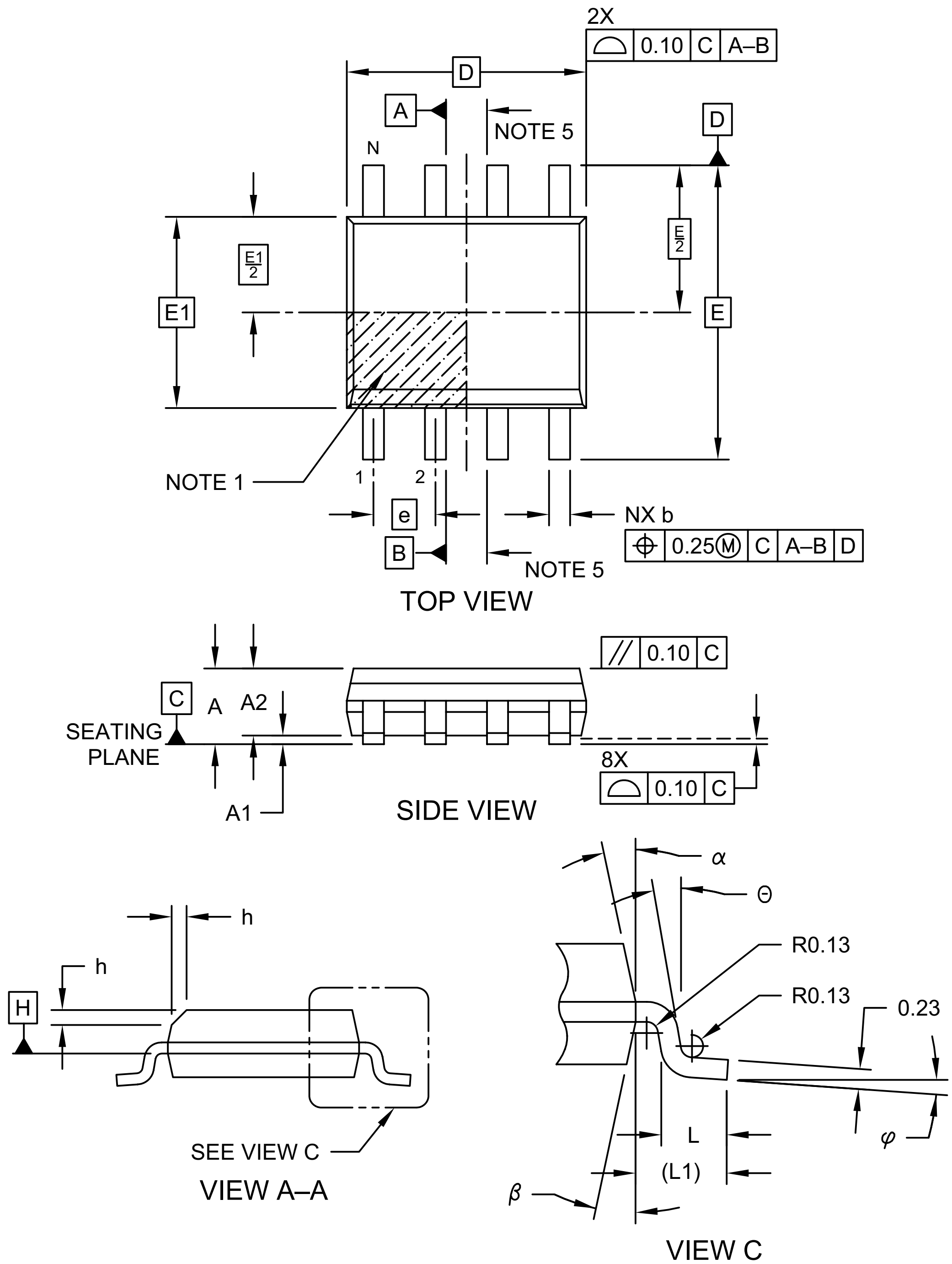
1. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2111A

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm (.150 In.) Body [SOIC]

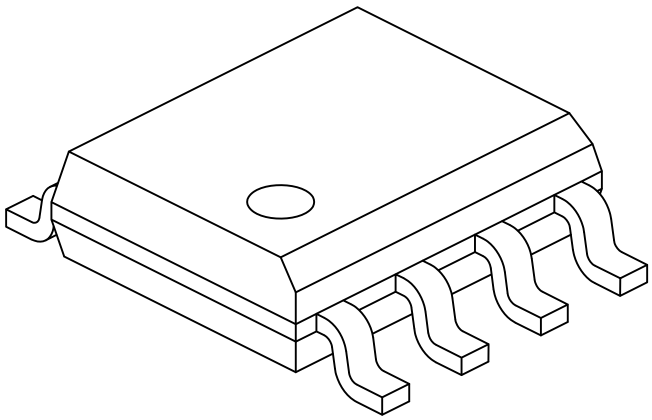
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing No. C04-057-SN Rev E Sheet 1 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm (.150 In.) Body [SOIC]

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



	Units	MILLIMETERS		
	Dimension Limits	MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	-	-	1.75
Molded Package Thickness	A2	1.25	-	-
Standoff §	A1	0.10	-	0.25
Overall Width	E		6.00 BSC	
Molded Package Width	E1		3.90 BSC	
Overall Length	D		4.90 BSC	
Chamfer (Optional)	h	0.25	-	0.50
Foot Length	L	0.40	-	1.27
Footprint	L1		1.04 REF	
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.17	-	0.25
Lead Width	b	0.31	-	0.51
Mold Draft Angle Top	α	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M

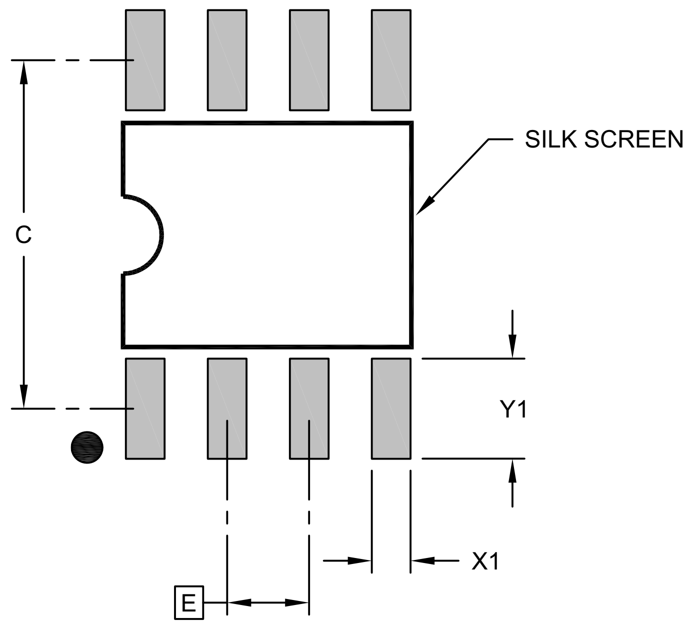
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-057-SN Rev E Sheet 2 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm Body [SOIC]

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	1.27 BSC		
Contact Pad Spacing	C		5.40	
Contact Pad Width (X8)	X1			0.60
Contact Pad Length (X8)	Y1			1.55

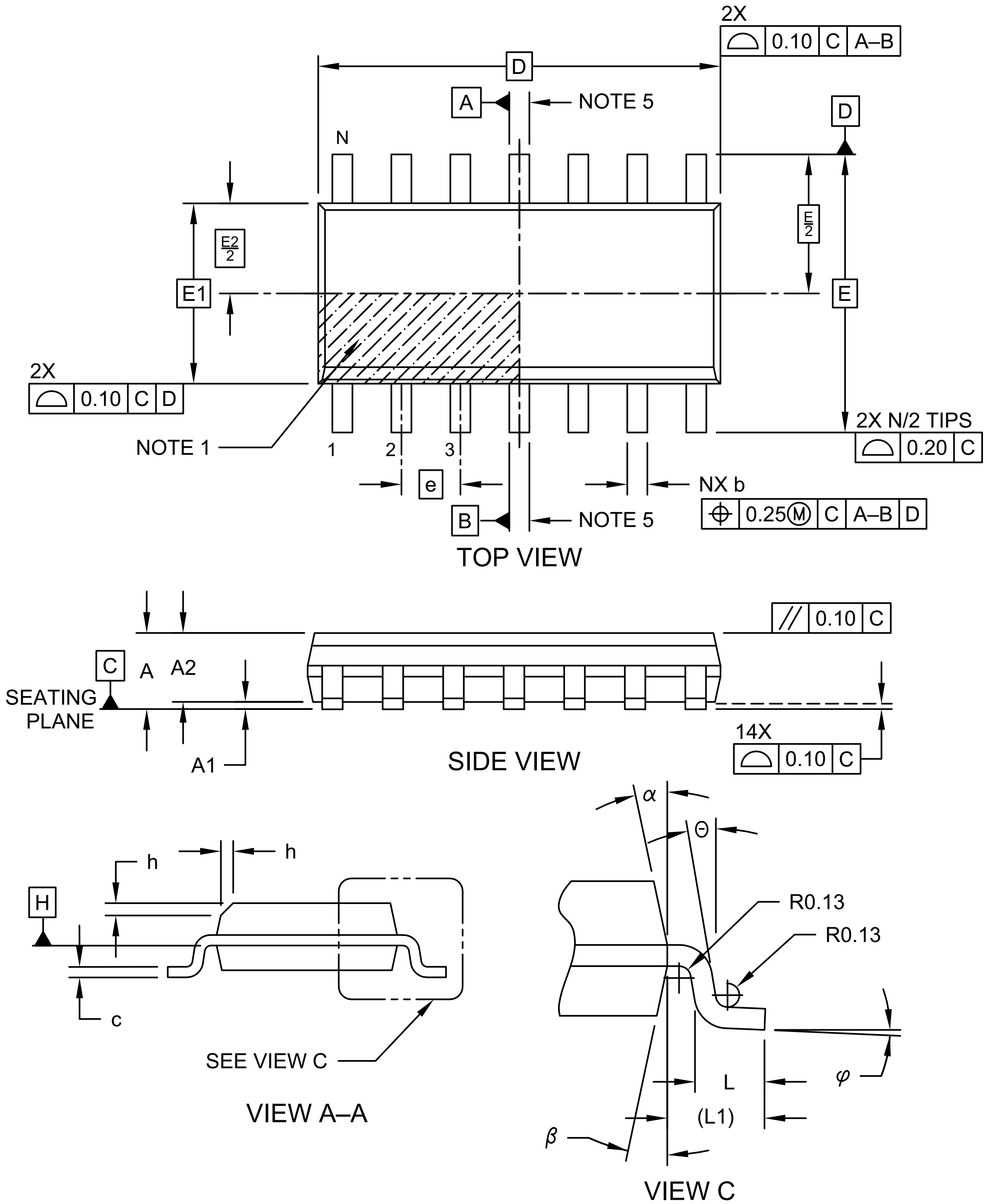
Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-2057-SN Rev E

14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

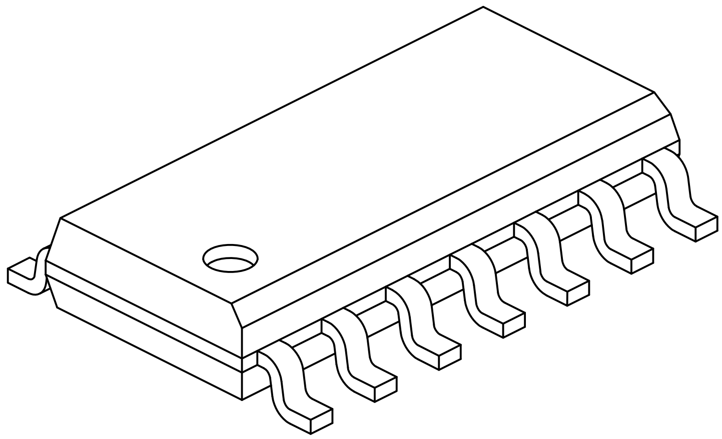
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing No. C04-065-SL Rev D Sheet 1 of 2

14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

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



	Units	MILLIMETERS		
	Dimension Limits	MIN	NOM	MAX
Number of Pins	N	14		
Pitch	e	1.27 BSC		
Overall Height	A	-	-	1.75
Molded Package Thickness	A2	1.25	-	-
Standoff §	A1	0.10	-	0.25
Overall Width	E	6.00 BSC		
Molded Package Width	E1	3.90 BSC		
Overall Length	D	8.65 BSC		
Chamfer (Optional)	h	0.25	-	0.50
Foot Length	L	0.40	-	1.27
Footprint	L1	1.04 REF		
Lead Angle	Θ	0°	-	-
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.10	-	0.25
Lead Width	b	0.31	-	0.51
Mold Draft Angle Top	α	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°

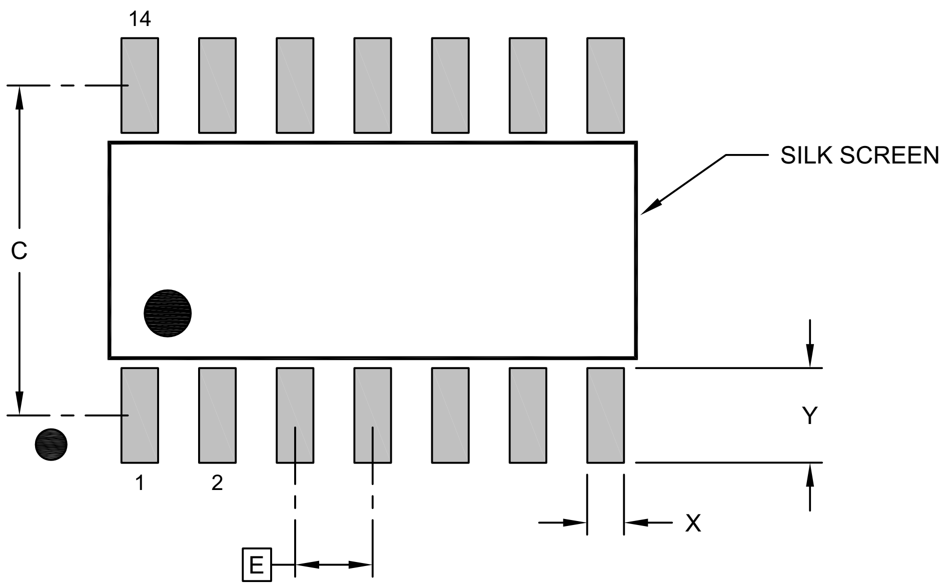
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-065-SL Rev D Sheet 2 of 2

14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		1.27 BSC	
Contact Pad Spacing	C		5.40	
Contact Pad Width (X14)	X			0.60
Contact Pad Length (X14)	Y			1.55

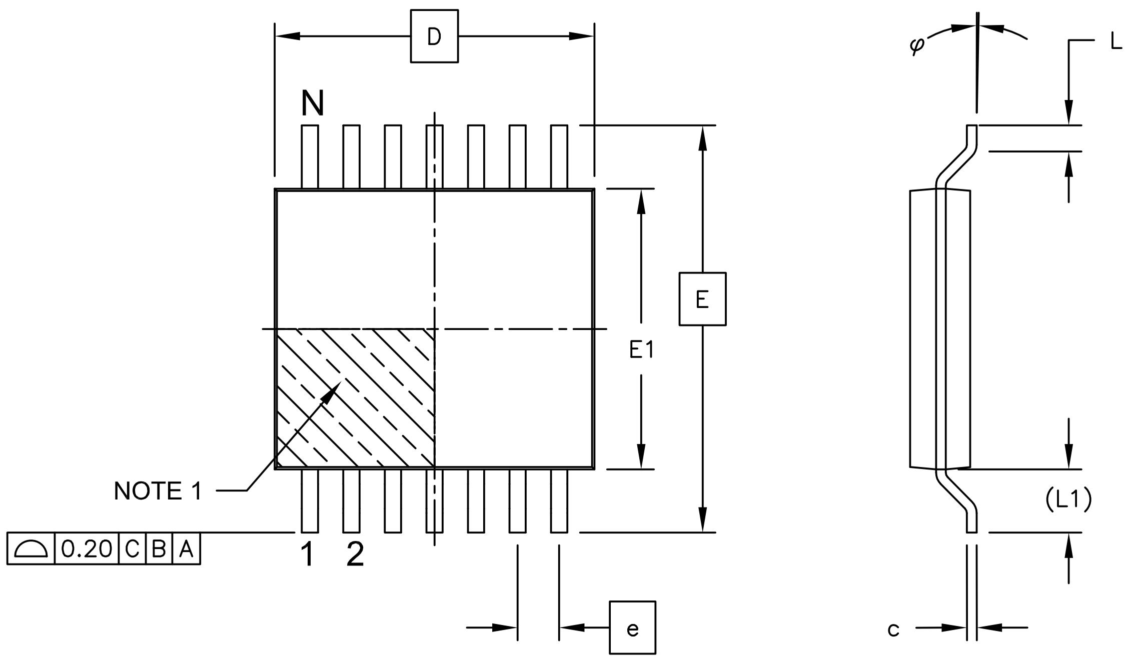
Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

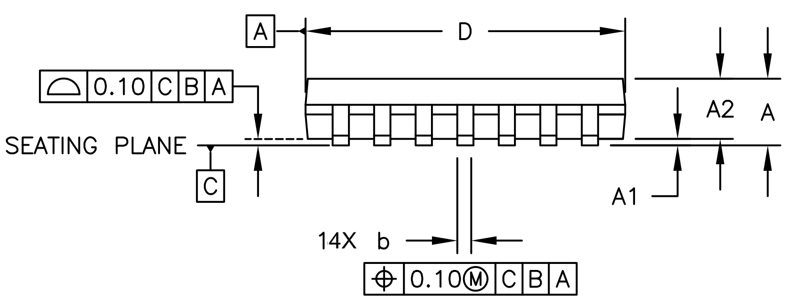
Microchip Technology Drawing No. C04-2065-SL Rev D

14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

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



TOP VIEW

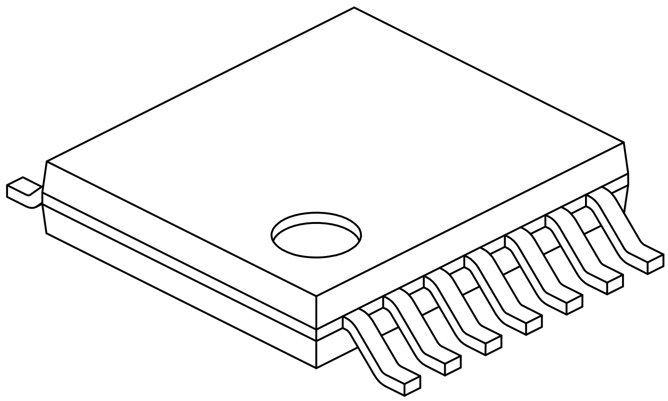


SIDE VIEW

Microchip Technology Drawing C04-087C Sheet 1 of 2

14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		14	
Pitch	e		0.65 BSC	
Overall Height	A	-	-	1.20
Molded Package Thickness	A2	0.80	1.00	1.05
Standoff	A1	0.05	-	0.15
Overall Width	E		6.40 BSC	
Molded Package Width	E1	4.30	4.40	4.50
Molded Package Length	D	4.90	5.00	5.10
Foot Length	L	0.45	0.60	0.75
Footprint	(L1)		1.00 REF	
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.09	-	0.20
Lead Width	b	0.19	-	0.30

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M

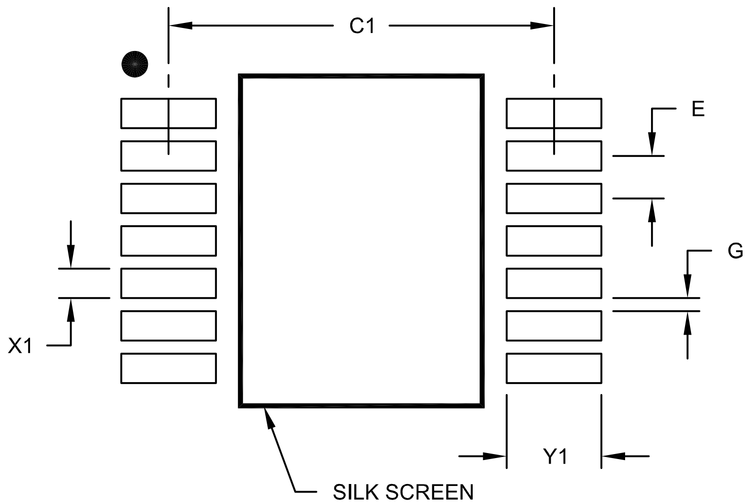
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing No. C04-087C Sheet 2 of 2

14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

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



RECOMMENDED LAND PATTERN

		Units	MILLIMETERS		
Dimension Limits			MIN	NOM	MAX
Contact Pitch	E		0.65 BSC		
Contact Pad Spacing	C1			5.90	
Contact Pad Width (X14)	X1				0.45
Contact Pad Length (X14)	Y1				1.45
Distance Between Pads	G		0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2087A

NOTES:

APPENDIX A: REVISION HISTORY

Revision B (October 2019)

The following is the list of modifications:

1. Updated **Section 6.0 “Packaging Information”**.

Revision A (March 2009)

- Original data sheet release.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO. **–** **X** **/XX**

Device | **Temperature Range** | **Package**

Device:	MCP6L71T:	Single Op Amp (Tape and Reel) (MSOP, SOIC, SOT-23)
	MCP6L71RT:	Single Op Amp (Tape and Reel) (SOT-23)
	MCP6L72T:	Dual Op Amp (Tape and Reel) (MSOP, SOIC)
	MCP6L74T:	Quad Op Amp (Tape and Reel) (SOIC, TSSOP)
Temperature Range:	E	= -40°C to +125°C
Package:	OT	= Plastic Small Outline Transistor (SOT-23), 5-Lead (MCP6L71, MCP6L71R)
	MS	= Plastic MSOP, 8-Lead
	SN	= Plastic SOIC (3.90 mm Body), 8-Lead
	SL	= Plastic SOIC (3.90 mm Body), 14-Lead
	ST	= Plastic TSSOP (4.4 mm Body), 14-Lead

Examples:

a) MCP6L71T-E/OT: Tape and Reel, 5-Lead SOT-23 package.
b) MCP6L71T-E/MS: Tape and Reel, 8-Lead MSOP package.
c) MCP6L71T-E/SN: Tape and Reel, 8-Lead SOIC package.

a) MCP6L71RT-E/OT: Tape and Reel, 5-Lead SOT-23 package.

a) MCP6L72T-E/MS: Tape and Reel, 8-Lead MSOP package.
b) MCP6L72T-E/SN: Tape and Reel, 8-Lead SOIC package.

a) MCP6L74T-E/SL: Tape and Reel, 14-Lead SOIC package.
b) MCP6L74-E/ST: Tape and Reel, 14-Lead TSSOP package.

NOTES:

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

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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