MCP6546/7/8/9

Open-Drain Output Sub-Microamp Comparators

Features

- Low Quiescent Current: 600 nA/comparator (typ.)
- Rail-to-Rail Input: V_{SS} - 0.3V to V_{DD} + 0.3V
- Open-Drain Output: $V_{OUT} \leq 10V$
- Propagation Delay 4 µs (typ.)
- Wide Supply Voltage Range: 1.6V to 5.5V
- Single available in SOT-23-5, SC-70-5 packages
- Available in Single, Dual and Quad
- Chip Select ($\overline{CS}$) with MCP6548
- Low Switching Current
- Internal Hysteresis: 3.3 mV (typ.)
- Industrial Temperature: -40°C to +85°C

Typical Applications

- Laptop Computers
- Mobile Phones
- Metering Systems
- Hand-held Electronics
- RC Timers
- Alarm and Monitoring Circuits
- Windowed Comparators
- Multi-vibrators

Related Devices

- CMOS/TTL-Compatible Output: MCP6541/2/3/4

Description

The Microchip Technology Inc. MCP6546/7/8/9 family of comparators is offered in single (MCP6546), single with chip select (MCP6548), dual (MCP6547) and quad (MCP6549) configurations. The outputs are open-drain and are capable of driving heavy DC or capacitive loads.

These comparators are optimized for low power, single-supply application with greater than rail-to-rail input operation. The output limits supply current surges and dynamic power consumption while switching. The open-drain output of the MCP6546/7/8/9 family can be used as a level-shifter for up to 10V using a pull-up resistor. It can also be used as a wired-OR logic. The internal Input hysteresis eliminates output switching due to internal noise voltage, reducing current draw. These comparators operate with a single-supply voltage as low as 1.6V and draw less than 1 µA/comparator of quiescent current.

The related MCP6541/2/3/4 family of comparators from Microchip has a push-pull output that supports rail-to-rail output swing and interfaces with CMOS/TTL logic.

Package Types
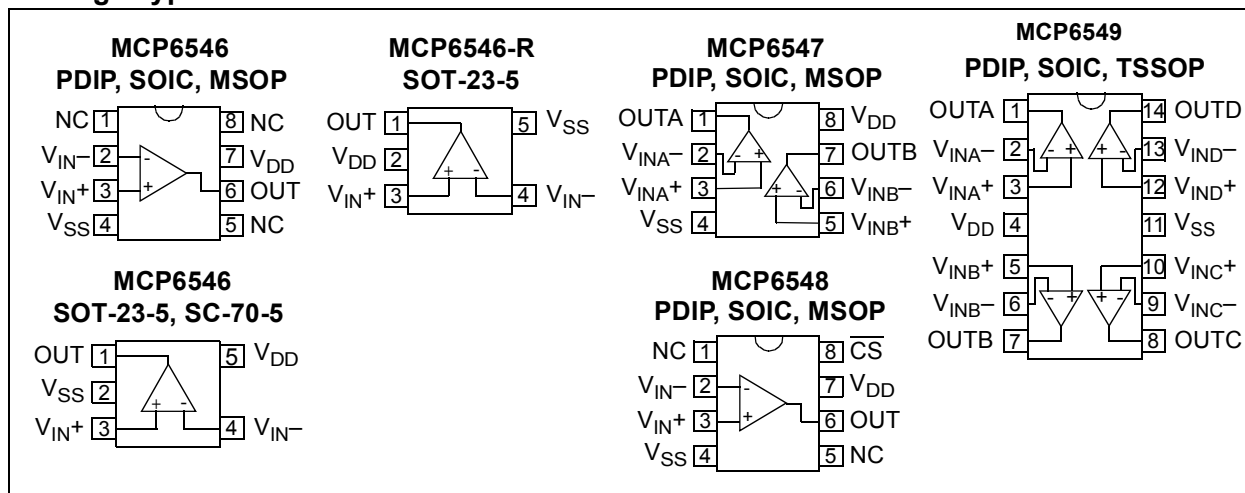
MCP6546/7/8/9

1.0 ELECTRICAL CHARACTERISTICS

1.1 Absolute Maximum Ratings †

V_{DD} - V_{SS} 7.0V

Open-Drain output.....................................V_{SS} +10.5V

All 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 Input Pins ....±2 mA

Current at Output and Supply Pins ....±30 mA

Storage temperature ....-65°C to +150°C

Maximum Junction Temperature (T_J) ....+150°C

ESD protection on all pins (HBM;MM)..........4 kV;200V

† Notice: Stresses above those listed under "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.

PIN FUNCTION TABLE

NAME	FUNCTION
V_{IN}+, V_{INA}+, V_{INB}+, V_{INC}+, V_{IND}+	Non-Inverting Inputs
V_{IN}−, V_{INA}−, V_{INB}−, V_{INC}−, V_{IND}−	Inverting Inputs
V_{DD}	Positive Power Supply
V_{SS}	Negative Power Supply
OUT, OUTA, OUTB, OUTC, OUTD	Outputs
$\overline{CS}$	Chip Select
NC	Not Connected

DC CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, V_{DD} = +1.6V to +5.5V, V_{SS} = GND, T_A = 25°C, V_{IN}+ = V_{DD}/2, V_{IN}− = V_{SS}, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD} (Refer to Figure 1-3).

Parameters	Sym	Min	Typ	Max	Units	Conditions
Power Supply						
Supply Voltage	V_{DD}	1.6	—	5.5	V	
Quiescent Current per comparator	I_Q	0.3	0.6	1	µA	I_{OUT} = 0
Input						
Input Voltage Range	V_{CMR}	V_{SS} – 0.3	—	V_{DD} + 0.3	V	
Common Mode Rejection Ratio	CMRR	55	70	—	dB	V_{DD} = 5V, V_{CM} = -0.3V to 5.3V
Common Mode Rejection Ratio	CMRR	50	65	—	dB	V_{DD} = 5V, V_{CM} = 2.5V to 5.3V
Common Mode Rejection Ratio	CMRR	55	70	—	dB	V_{DD} = 5V, V_{CM} = -0.3V to 2.5V
Power Supply Rejection Ratio	PSRR	63	80	—	dB	V_{CM} = V_{SS}
Input Offset Voltage	V_{OS}	-7.0	±1.5	+7.0	mV	V_{CM} = V_{SS} **(Note 1)**
Drift with Temperature	$\Delta V_{OS}/\Delta T_A$	—	±3	—	µV/°C	T_A = -40°C to +85°C, V_{CM} = V_{SS}
Input Hysteresis Voltage	V_{HYST}	1.5	3.3	6.5	mV	V_{CM} = V_{SS} **(Note 1)**
Drift with Temperature	$\Delta V_{HYST}/\Delta T_A$	—	10	—	µV/°C	T_A = -40°C to +25°C, V_{CM} = V_{SS}
Drift with Temperature	$\Delta V_{HYST}/\Delta T_A$	—	5	—	µV/°C	T_A = +25°C to +85°C, V_{CM} = V_{SS}
Input Bias Current	I_B	—	1	—	pA	V_{CM} = V_{SS}
Over Temperature	I_B	—	—	100	pA	T_A = -40°C to +85°C, V_{CM} = V_{SS} **(Note 3)**
Input Offset Current	I_{OS}	—	±1	—	pA	V_{CM} = V_{SS}
Common Mode Input Impedance	Z_{CM}	—	10^{13}||4	—	Ω||pF	
Differential Input Impedance	Z_{DIFF}	—	10^{13}||2	—	Ω||pF	
Open-Drain Output						
Output Pull-Up Voltage	V_{PU}	V_{DD}	—	10	V	**(Note 2)**
High-Level Output Current	I_{OH}	-100	—	—	nA	V_{DD} = 1.6V to 5.5V, V_{PU} = 10V **(Note 2)**
Low-Level Output Voltage	V_{OL}	V_{SS}	—	V_{SS} + 0.2	V	I_{OUT} = 2 mA, V_{PU} = V_{DD} = 5V
Short-Circuit Current	I_{SC}	—	±50	—	mA	V_{PU} = V_{DD} = 5.0V **(Note 2)**
Output Pin Capacitance	C_{OUT}	—	8	—	pF	

Note 1: The input offset voltage is the center of the input-referred trip points. The input hysteresis is the difference between the input-referred trip points.

2: Do not short the output above V_{SS} + 10V. Limit the output current to Absolute Maximum Rating of 30 mA. The comparator does not function properly when V_{PU} < V_{DD}.

3: Input bias current overtemperature is not tested for the SC-70-5 package.

AC CHARACTERISTICS

Electrical Specifications: Unless otherwise indicated, V_{DD} = +1.6V to +5.5V, V_{SS} = GND, T_A = 25°C, $V_{IN}+$ = $V_{DD}/2$, Step = 200 mV, Overdrive = 100 mV, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF (Refer to Figure 1-2 and Figure 1-3).

Parameters	Sym	Min	Typ	Max	Units	Conditions
Fall Time	t_F	—	0.7	—	µs	**(Note 1)**
Propagation Delay (High-to-Low)	t_{PHL}	—	4.0	8.0	µs	
Propagation Delay (Low-to-High)	t_{PLH}	—	3.0	8.0	µs	**(Note 1)**
Propagation Delay Skew	t_{PDS}	—	-1.0	—	µs	**(Notes 1 and 2)**
Maximum Toggle Frequency	f_{MAX}	—	225	—	kHz	V_{DD} = 1.6V
	f_{MAX}	—	165	—	kHz	V_{DD} = 5.5V
Input Noise Voltage	E_N	—	200	—	μV_{P-P}	10 Hz to 100 kHz

Note 1: t_R and t_{PLH} depend on the load (R_L and C_L); these specifications are valid for the indicated load only.

2: Propagation Delay Skew is defined as: $t_{PDS} = t_{PLH} - t_{PHL}$.

SPECIFICATIONS FOR MCP6548 CHIP SELECT

Electrical Specifications: Unless otherwise indicated, V_{DD} = +1.6V to +5.5V, V_{SS} = GND, T_A = 25°C, $V_{IN}+$ = $V_{DD}/2$, $V_{IN}-$ = V_{SS}, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF (Refer to Figures 1-1 and 1-3).

| Parameters	Sym	Min	Typ	Max	Units	Conditions
$\overline{CS}$ Low Specifications						
$\overline{CS}$ Logic Threshold, Low	V_{IL}	V_{SS}	—	$0.2V_{DD}$	V	
$\overline{CS}$ Input Current, Low	I_{CSL}	—	5	—	pA	$\overline{CS}$ = V_{SS}
$\overline{CS}$ High Specifications						
$\overline{CS}$ Logic Threshold, High	V_{IH}	$0.8V_{DD}$	—	V_{DD}	V	
$\overline{CS}$ Input Current, High	I_{CSH}	—	1	—	pA	$\overline{CS}$ = V_{DD}
$\overline{CS}$ Input High, V_{DD} Current	I_{DD}	—	18	—	pA	$\overline{CS}$ = V_{DD}
$\overline{CS}$ Input High, GND Current	I_{SS}	—	-20	—	pA	$\overline{CS}$ = V_{DD}
Comparator Output Leakage	$I_{O(LEAK)}$	—	1	—	pA	V_{OUT} = V_{SS}+10V
$\overline{CS}$ Dynamic Specifications						
$\overline{CS}$ Low to Comparator Output Low Turn-on Time	t_{ON}	—	2	50	ms	$\overline{CS}$ = $0.2V_{DD}$ to V_{OUT} = $V_{DD}/2$, $V_{IN}-$ = V_{DD}
$\overline{CS}$ High to Comparator Output High Z Turn-off Time	t_{OFF}	—	10	—	µs	$\overline{CS}$ = $0.8V_{DD}$ to V_{OUT} = $V_{DD}/2$, $V_{IN}-$ = V_{DD}
$\overline{CS}$ Hysteresis	V_{CS_HYST}	—	0.6	—	V	V_{DD} = 5V
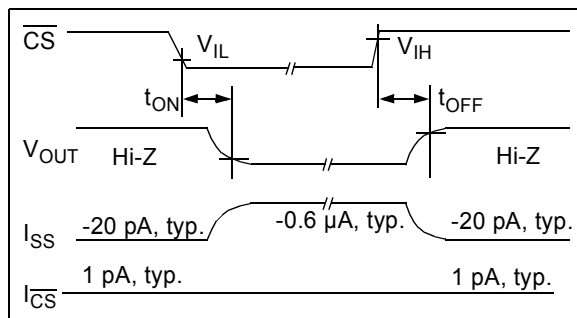
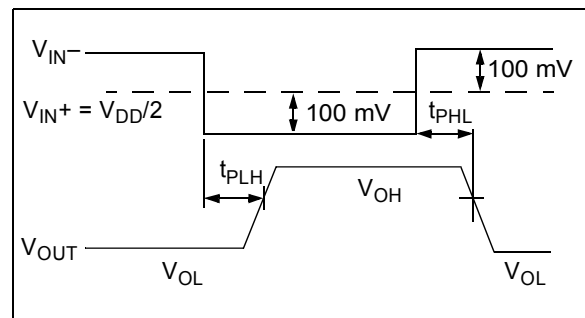**FIGURE 1-1:** Timing Diagram for the $\overline{CS}$ pin on the MCP6548.

FIGURE 1-2: Propagation Delay Timing Diagram.

TEMPERATURE SPECIFICATIONS

Electrical Specifications: Unless otherwise indicated, V_{DD} = +1.6V to +5.5V and V_{SS} = GND.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Temperature Ranges						
Specified Temperature Range	T_A	-40	—	+85	°C	
Operating Temperature Range	T_A	-40	—	+125	°C	**Note**
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 5L-SC-70	θ_{JA}	—	331	—	°C/W	
Thermal Resistance, 5L-SOT-23	θ_{JA}	—	256	—	°C/W	
Thermal Resistance, 8L-PDIP	θ_{JA}	—	85	—	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	163	—	°C/W	
Thermal Resistance, 8L-MSOP	θ_{JA}	—	206	—	°C/W	
Thermal Resistance, 14L-PDIP	θ_{JA}	—	70	—	°C/W	
Thermal Resistance, 14L-SOIC	θ_{JA}	—	120	—	°C/W	
Thermal Resistance, 14L-TSSOP	θ_{JA}	—	100	—	°C/W	

Note: The MCP6546/7/8/9 operates over this extended temperature range, but with reduced performance. In any case, the Junction Temperature (T_J) must not exceed the absolute maximum specification of +150°C.

1.2   Test Circuit Configuration

This test circuit configuration is used to determine the AC and DC specifications.
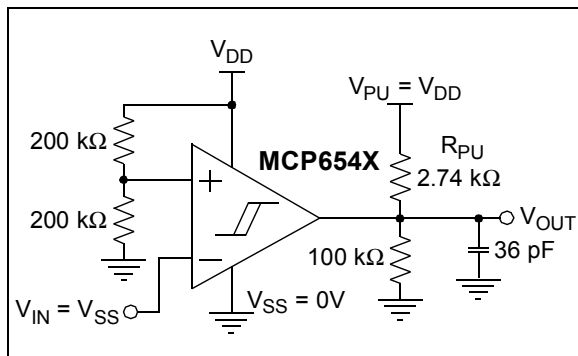
FIGURE 1-3:   *AC and DC Test circuit for the open- drain output comparators.*

2.0 TYPICAL PERFORMANCE CURVES

Note: Unless otherwise indicated, V_{DD} = +1.6V to +5.0V, V_{SS} = GND, T_A = +25°C, V_{IN}+ = V_{DD}/2, V_{IN}− = GND, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF.
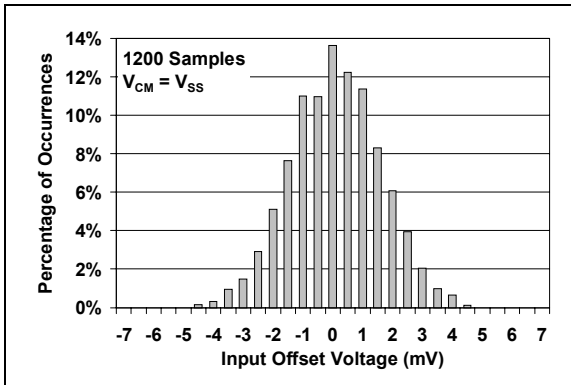
FIGURE 2-1: Input Offset Voltage Histogram at $V_{CM} = V_{SS}$.

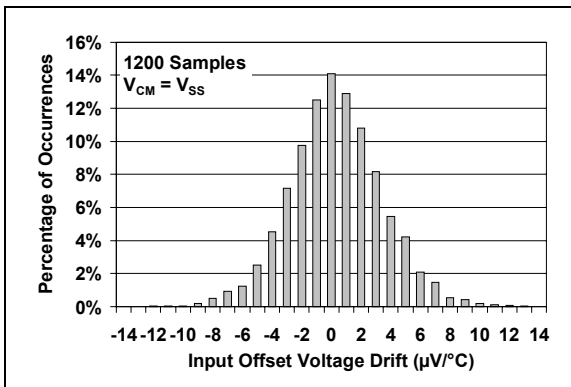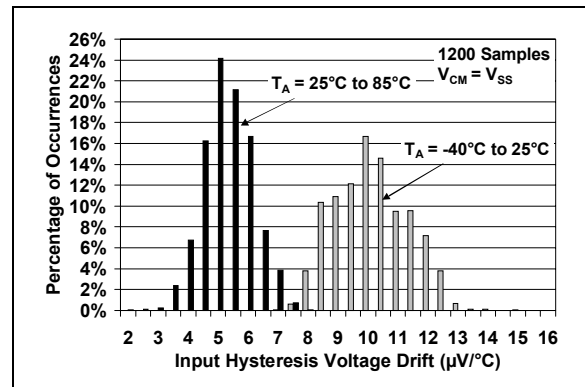**FIGURE 2-2:** Input Offset Voltage Drift Histogram at $V_{CM} = V_{SS}$.
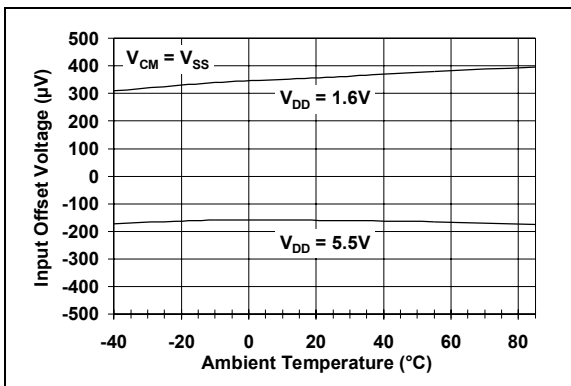
FIGURE 2-3: Input Offset Voltage vs. Ambient Temperature at $V_{CM} = V_{SS}$.

FIGURE 2-4: Input Hysteresis Voltage Histogram at $V_{CM} = V_{SS}$.

FIGURE 2-5: Input Hysteresis Voltage Drift Histogram.
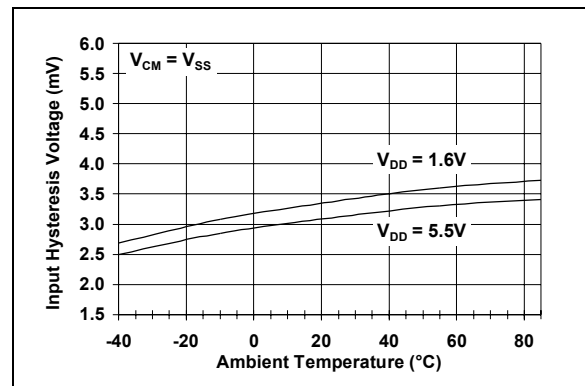
FIGURE 2-6: Input Hysteresis Voltage vs. Ambient Temperature at $V_{CM} = V_{SS}$.

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Note: Unless otherwise indicated, V_{DD} = +1.6V to +5.0V, V_{SS} = GND, T_A = +25°C, V_{IN}+ = V_{DD}/2, V_{IN}– = GND, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF.
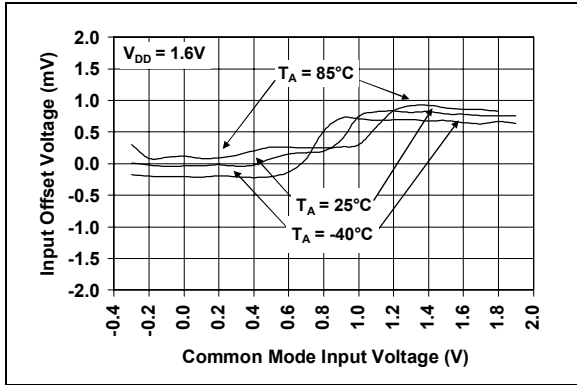
FIGURE 2-7: *Input Offset Voltage vs. Common Mode Input Voltage at V_{DD} = 1.6V.*

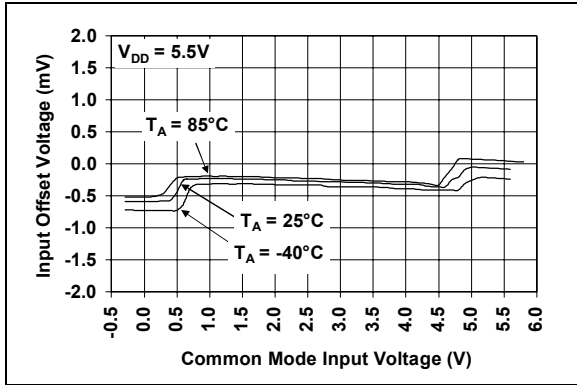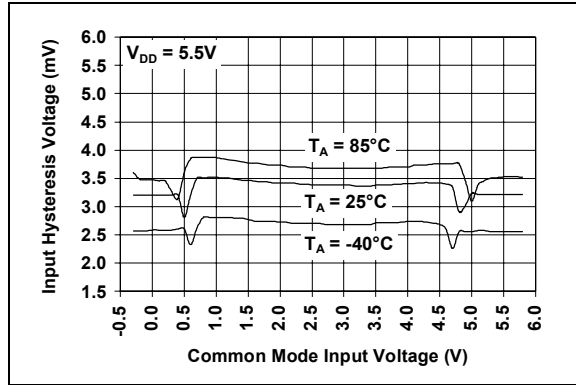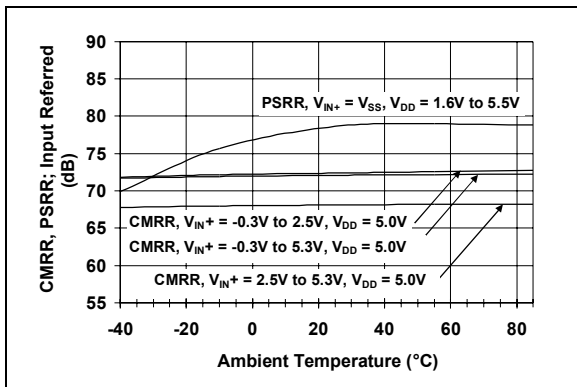**FIGURE 2-8:** *Input Offset Voltage vs. Common Mode Input Voltage at V_{DD} = 5.5V.*

FIGURE 2-9: *CMRR, PSRR vs. Ambient Temperature at V_{CM} = V_{SS}.*
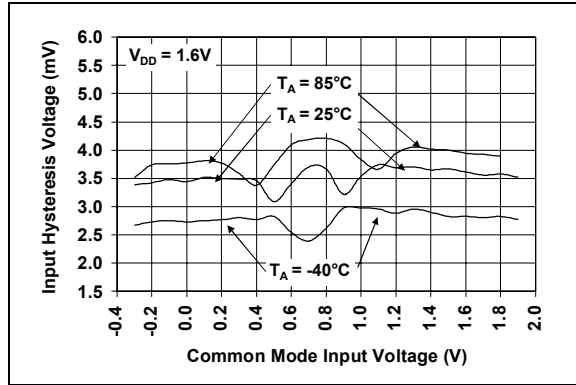
FIGURE 2-10: *Input Hysteresis Voltage vs. Common Mode Input Voltage at V_{DD} = 1.6V.*

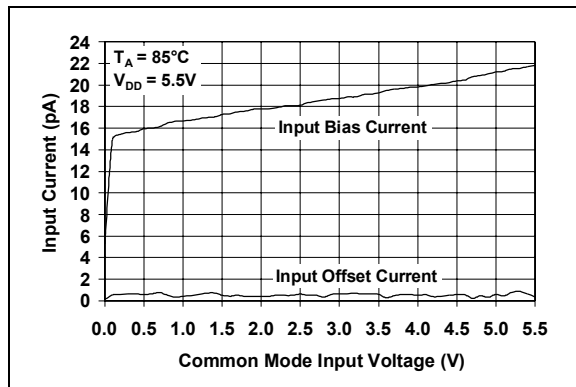**FIGURE 2-11:** *Input Hysteresis Voltage vs. Common Mode Input Voltage at V_{DD} = 5.5V.*

FIGURE 2-12: *Input Bias Current, Input Offset Current vs. Common Mode Input Voltage at +85°C.*

Note: Unless otherwise indicated, V_{DD} = +1.6V to +5.0V, V_{SS} = GND, T_A = +25°C, V_{IN}+ = V_{DD}/2, V_{IN}– = GND, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF.
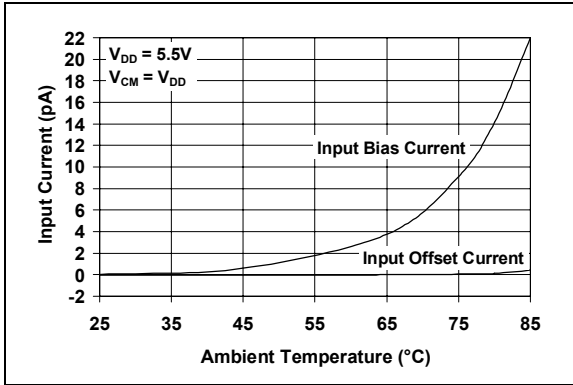
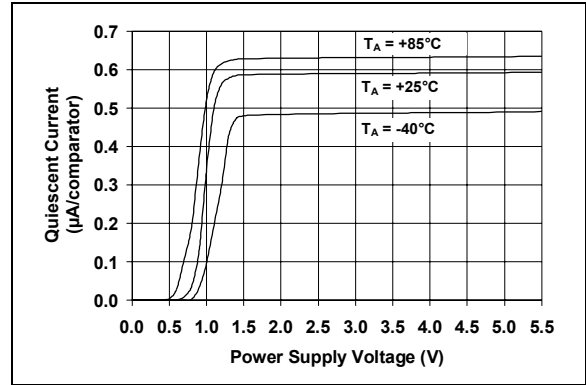**FIGURE 2-13:** *Input Bias Current, Input Offset Current vs. Ambient Temperature.*
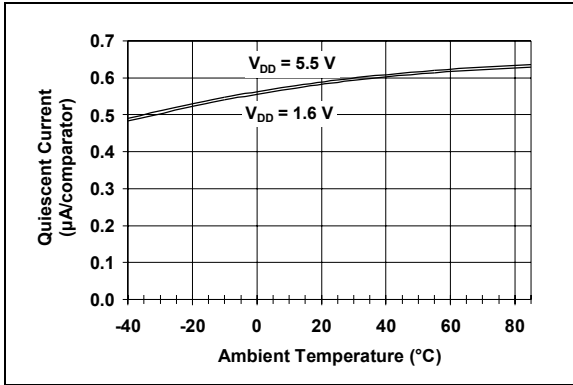

FIGURE 2-14: *Quiescent Current vs. Ambient Temperature vs. Power Supply Voltage.*

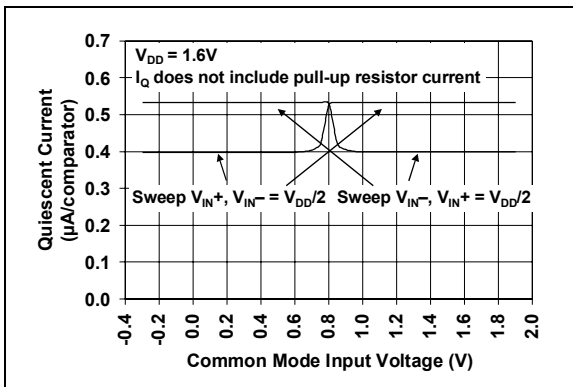**FIGURE 2-15:** *Quiescent Current vs. Common Mode Input Voltage at V_{DD} = 1.6V.*

FIGURE 2-16: *Quiescent Current vs. Power Supply Voltage.*

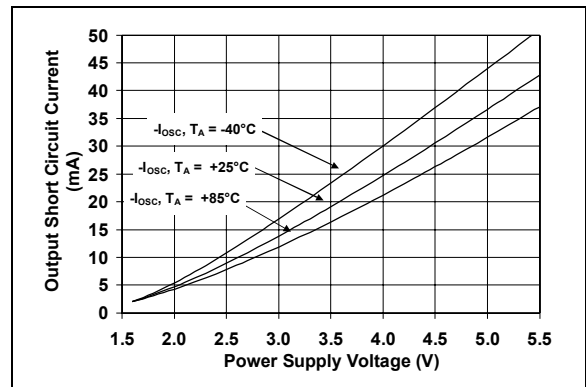**FIGURE 2-17:** *Quiescent Current vs. Common Mode Input Voltage at V_{DD} = 5V.*

FIGURE 2-18: *Output Short-Circuit Current vs. Power Supply Voltage.*

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Note: Unless otherwise indicated, V_{DD} = +1.6V to +5.0V, V_{SS} = GND, T_A = +25°C, V_{IN}+ = V_{DD}/2, V_{IN}– = GND, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF.
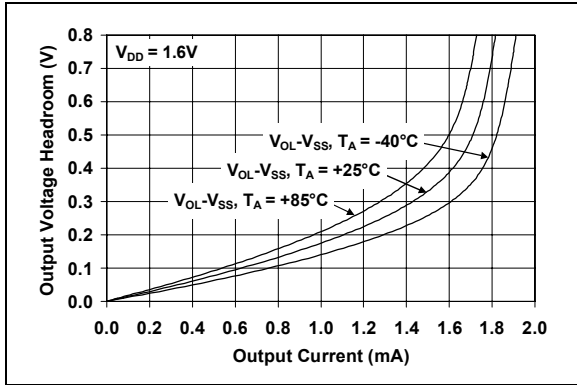

FIGURE 2-19: *Output Voltage Headroom vs. Output Current at V_{DD} = 1.6V.*
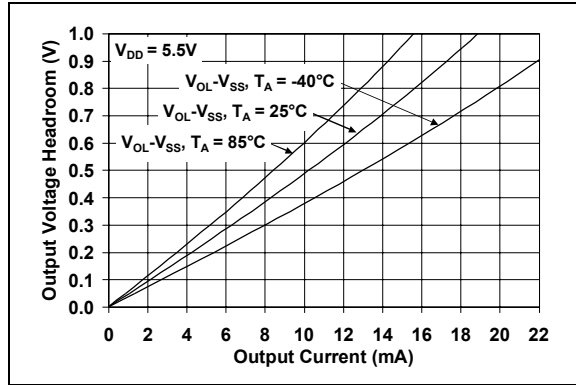

FIGURE 2-22: *Output Voltage Headroom vs. Output Current at V_{DD} = 5.5V.*

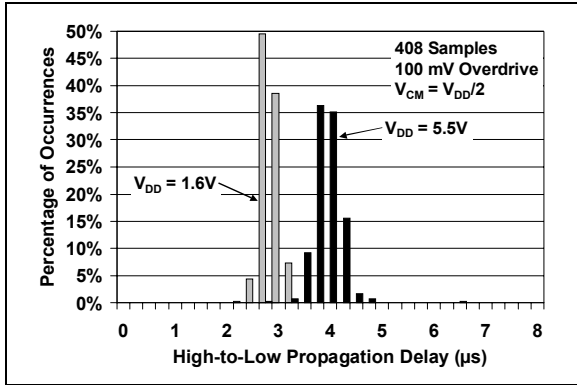
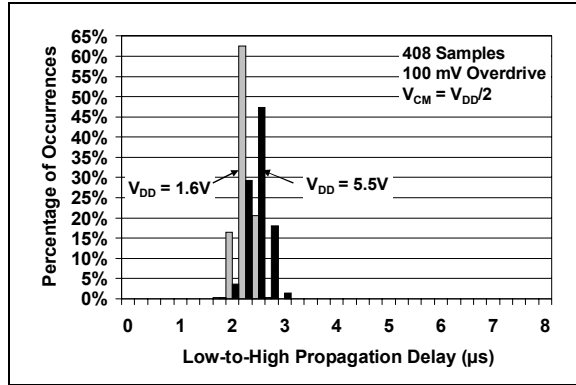**FIGURE 2-20:** *High-to-Low Propagation Delay Histogram.*

FIGURE 2-23: *Low-to-High Propagation Delay Histogram.*
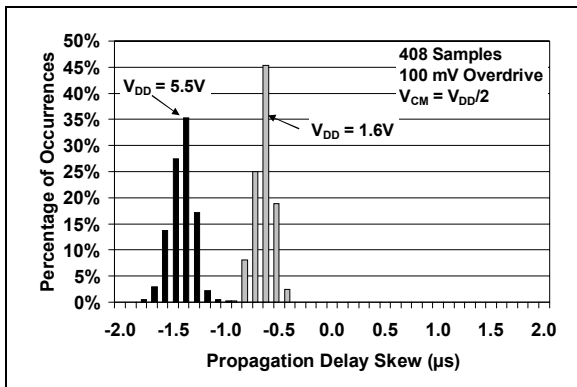
FIGURE 2-21: *Propagation Delay Skew Histogram.*
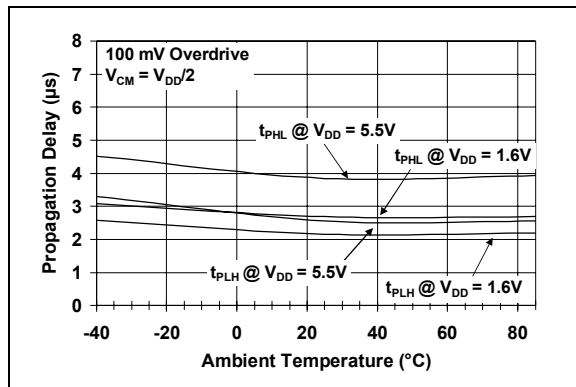
FIGURE 2-24: *Propagation Delay vs. Ambient Temperature.*

Note: Unless otherwise indicated, V_{DD} = +1.6V to +5.0V, V_{SS} = GND, T_A = +25°C, V_{IN}+ = V_{DD}/2, V_{IN}− = GND, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF.
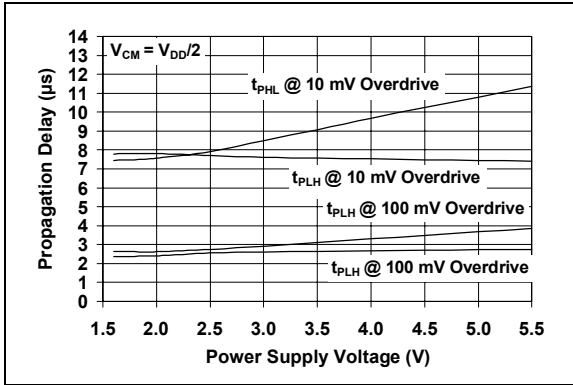
FIGURE 2-25: *Propagation Delay vs. Power Supply Voltage.*

FIGURE 2-26: *Propagation Delay vs. Common Mode Input Voltage at V_{DD} = 1.6V.*

FIGURE 2-27: *Propagation Delay vs. Load Capacitance.*

FIGURE 2-28: *Propagation Delay vs. Input Overdrive.*

FIGURE 2-29: *Propagation Delay vs. Common Mode Input Voltage at V_{DD} = 5.5V.*
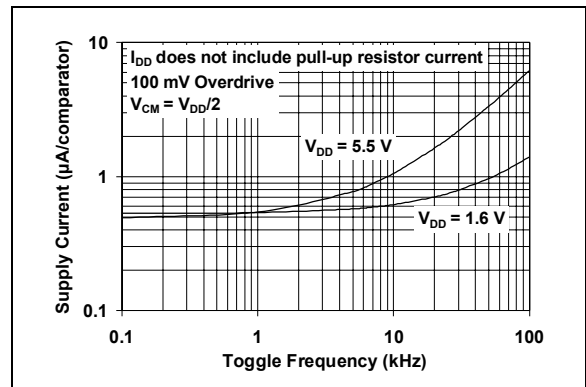
FIGURE 2-30: *Supply Current vs. Toggle Frequency.*

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Note: Unless otherwise indicated, V_{DD} = +1.6V to +5.0V, V_{SS} = GND, T_A = +25°C, $V_{IN}+$ = $V_{DD}/2$, $V_{IN}-$ = GND, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF.
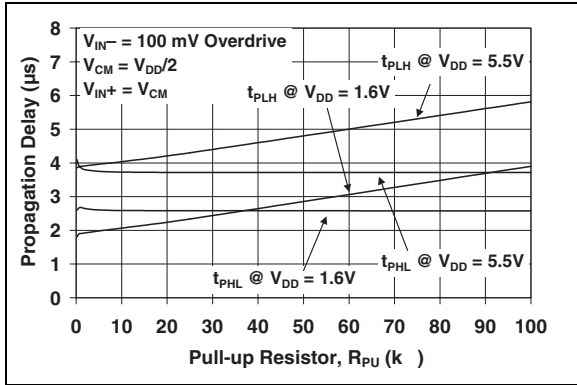
FIGURE 2-31: *Propagation Delay vs. Pull-up Resistor.*

FIGURE 2-32: *Supply Current (shoot through current) vs. Chip Select ($\overline{CS}$) Voltage at V_{DD} = 1.6V (MCP6548 only).*

FIGURE 2-33: *Supply Current (charging current) vs. Chip Select ($\overline{CS}$) pulse at V_{DD} = 1.6V (MCP6548 only).*
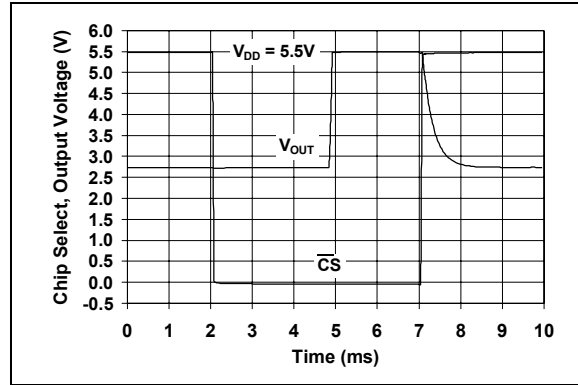
FIGURE 2-34: *Chip Select ($\overline{CS}$) Step Response (MCP6548 only).*
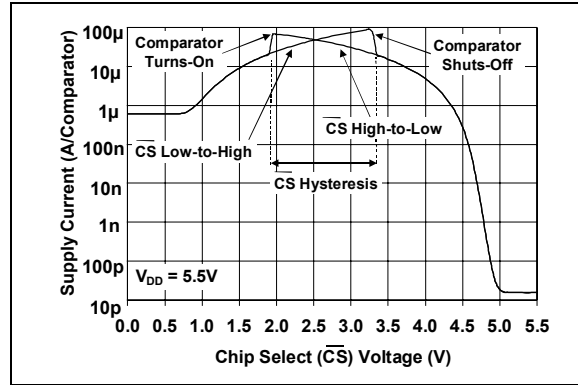
FIGURE 2-35: *Supply Current (shoot through current) vs. Chip Select ($\overline{CS}$) Voltage at V_{DD} = 5.5V (MCP6548 only).*
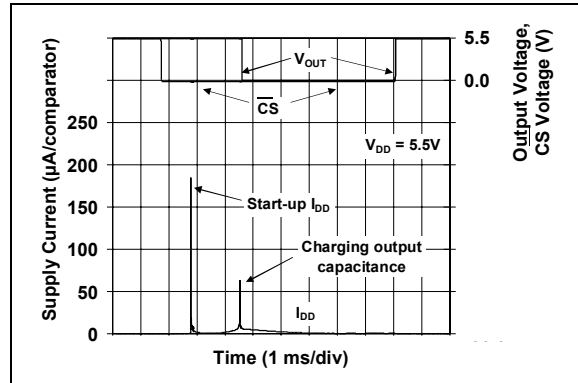
FIGURE 2-36: *Supply Current (charging current) vs. Chip Select ($\overline{CS}$) pulse at V_{DD} = 5.5V (MCP6548 only).*

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Note: Unless otherwise indicated, V_{DD} = +1.6V to +5.0V, V_{SS} = GND, T_A = +25°C, $V_{IN}+$ = $V_{DD}/2$, $V_{IN}-$ = GND, R_{PU} = 2.74 kΩ to V_{PU} = V_{DD}, and C_L = 36 pF.
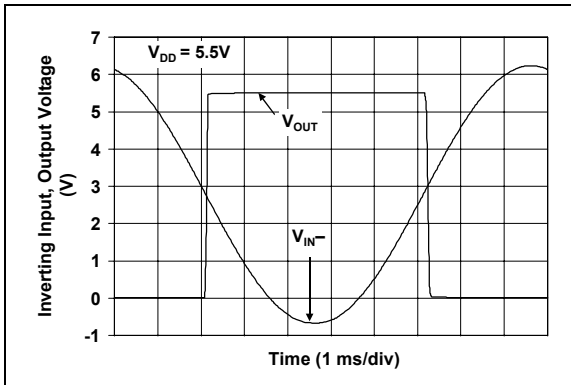
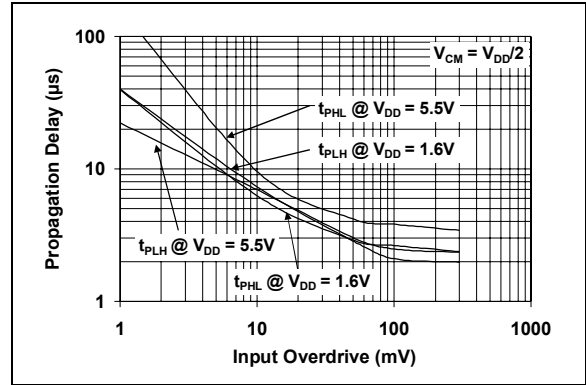**FIGURE 2-37:** *The MCP6546/7/8/9 comparators show no phase reversal.*
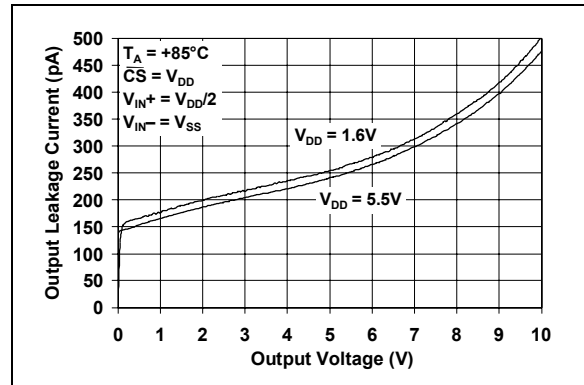
FIGURE 2-38: *Output Leakage Current ($\overline{CS}$ = V_{DD}) vs. Output Voltage (MCP6548 only)*

MCP6546/7/8/9

3.0 APPLICATIONS INFORMATION

The MCP6546/7/8/9 family of push-pull output comparators are fabricated on Microchip's state-of-the-art CMOS process. They are suitable for a wide range of applications requiring very low power consumption.

3.1 Comparator Inputs

The MCP6546/7/8/9 comparator family uses CMOS transistors at the input. They are designed to prevent phase inversion when the input pins exceed the supply voltages. Figure 2-37 shows an input voltage exceeding both supplies with no resulting phase inversion.

The input stage of this family of devices uses two differential input stages in parallel: one operates at low input voltages and the other at high input voltages. With this topology, the input voltage is 0.3V above V_{DD} and 0.3V below V_{SS}. Therefore, the input offset voltage is measured at both V_{SS} - 0.3V and V_{DD} + 0.3V to ensure proper operation.

The maximum operating input voltages that can be applied are V_{SS} - 0.3V and V_{DD} + 0.3V. Voltages on the inputs that exceed this absolute maximum rating can cause excessive current to flow and permanently damage the device. In applications where the input pin exceeds the specified range, external resistors can be used to limit the current below ±2 mA, as shown in Figure 3-1.

$$R_{IN} \geq \frac{(Maximum\ expected\ V_{IN}) - V_{DD}}{2\ mA}$$

$$R_{IN} \geq \frac{V_{SS} - (Minimum\ expected\ V_{IN})}{2\ mA}$$
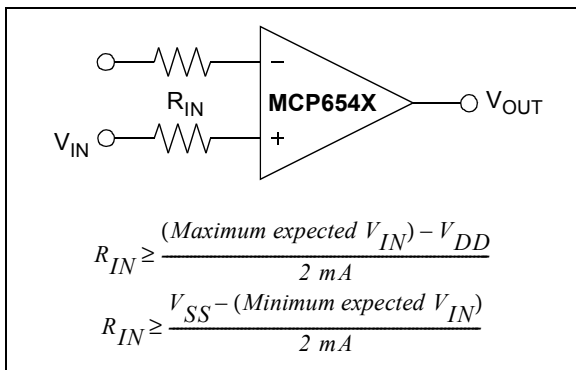
FIGURE 3-1: *An input resistor (R_{IN}) should be used to limit excessive input current if either of the inputs exceeds the absolute maximum specification.*

3.2 Open-Drain Output

The open-drain output is designed to make level-shifting and wired-OR logic easy to implement. The output can go as high as 10V for 9V battery-powered applications. The output stage minimizes switching current (shoot-through current from supply-to-supply) when the output changes state. See Figures 2-15, 2-17 and 2-32 through 2-36, for more information.

3.3 MCP6548 Chip Select ($\overline{CS}$)

The MCP6548 is a single comparator with a chip select ($\overline{CS}$) option. When $\overline{CS}$ is pulled high, the total current consumption drops to 20 pA (typ). 1 pA (typ) flows through the $\overline{CS}$ pin, 1 pA (typ) flows through the output pin and 18 pA (typ) flows through the V_{DD} pin, as shown in Figure 1-1. When this happens, the comparator output is put into a high-impedance state. By pulling $\overline{CS}$ low, the comparator is enabled. If the $\overline{CS}$ pin is left floating, the comparator will not operate properly. Figure 1-1 shows the output voltage and supply current response to a $\overline{CS}$ pulse.

The internal $\overline{CS}$ circuitry is designed to minimize glitches when cycling the $\overline{CS}$ pin. This helps conserve power, which is especially important in battery-powered applications.

3.4 Externally Set Hysteresis

Greater flexibility in selecting hysteresis, or input trip points, is achieved by using external resistors.

Input offset voltage (V_{OS}) is the center (average) of the (input-referred) low-high and high-low trip points. Input hysteresis voltage (V_{HYST}) is the difference between the same trip points. Hysteresis reduces output chattering when one input is slowly moving past the other, thus reducing dynamic supply current. It also helps in systems where it is best not to cycle between states too frequently (e.g., air conditioner thermostatic control). The MCP6546/7/8/9 family has internally-set hysteresis that is small enough to maintain input offset accuracy (<7 mV), and large enough to eliminate output chattering caused by the comparator's own input noise voltage (200 µVp-p).

FIGURE 3-2: *The MCP6546/7/8/9 comparators' internal hysteresis eliminates output chatter caused by input noise voltage.*

3.4.1   INVERTING CIRCUIT

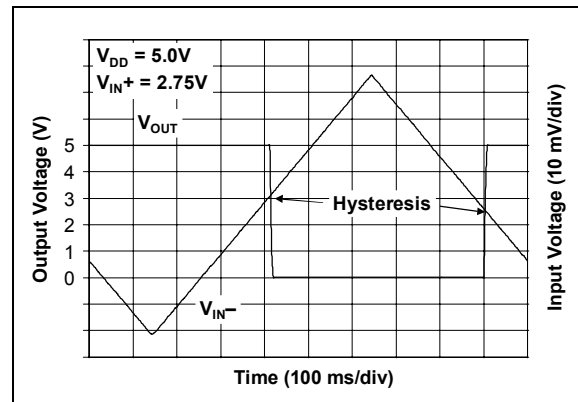Figure 3-3 shows an inverting circuit for a single-supply application using three resistors, besides the pull-up resistor. The resulting hysteresis diagram is shown in Figure 3-4.
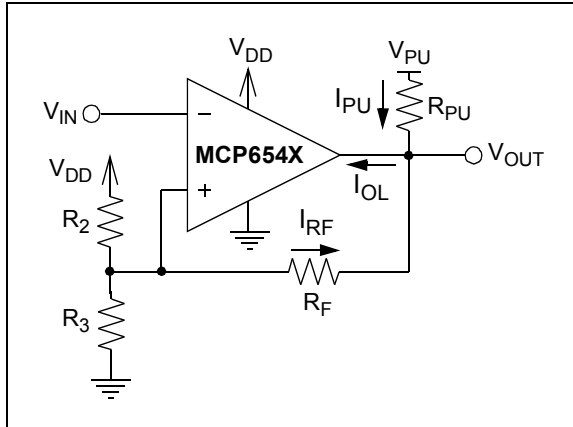
FIGURE 3-3:   *Inverting circuit with hysteresis.*

V_{TLH} = trip voltage from low to high

V_{THL} = trip voltage from high to low
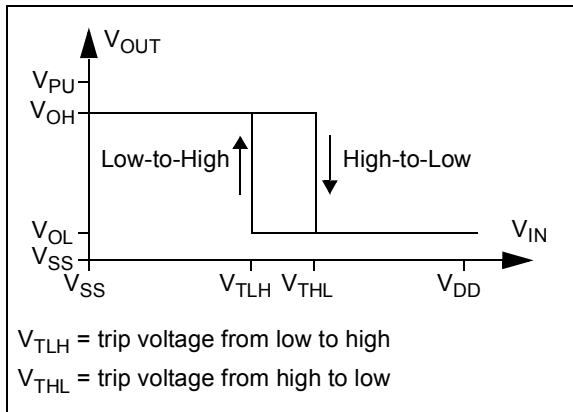
FIGURE 3-4:   *Hysteresis diagram for the inverting circuit.*

In order to determine the trip voltages (V_{THL} and V_{TLH}) for the circuit shown in Figure 3-3, R_2 and R_3 can be simplified to the Thevenin equivalent circuit with respect to V_{DD}, as shown in Figure 3-5.
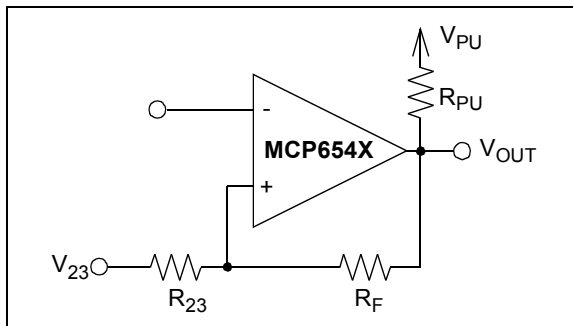
FIGURE 3-5:   *Thevenin Equivalent Circuit.*

Where:

$$R_{23} = \frac{R_2 R_3}{R_2 + R_3}$$

$$V_{23} = \frac{R_3}{R_2 + R_3} \times V_{DD}$$

Using this simplified circuit, the trip voltage can be calculated using the following equation:

EQUATION

$$V_{THL} = V_{PU}\left(\frac{R_{23}}{R_{23} + R_F + R_{PU}}\right) + V_{23}\left(\frac{R_F + R_{PU}}{R_{23} + R_F + R_{PU}}\right)$$

$$V_{TLH} = V_{OL}\left(\frac{R_{23}}{R_{23} + R_F}\right) + V_{23}\left(\frac{R_F}{R_{23} + R_F}\right)$$

V_{TLH} = trip voltage from low to high

V_{THL} = trip voltage from high to low

Figure 2-19 and Figure 2-22 can be used to determine typical values for V_{OL}. This voltage is dependent on the output current I_{OL} as shown in Figure 3-3. This current can be determined using the equation below:

EQUATION

$$I_{OL} = I_{PU} + I_{RF}$$

$$I_{OL} = \left(\frac{V_{PU} - V_{OL}}{R_{PU}}\right) + \left(\frac{V_{23} - V_{OL}}{R_{23} + R_F}\right)$$

V_{OH} can be calculated using the equation below:

EQUATION

$$V_{OH} = (V_{PU} - V_{23}) \times \left(\frac{R_{23} + R_F}{R_{23} + R_F + R_{PU}}\right)$$

As explained in Section 3.1, "Comparator Inputs", it is important to keep the non-inverting input below V_{DD}+0.3V when $V_{PU} > V_{DD}$.

3.5   Supply Bypass

With this family of comparators, 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 edge rate performance.

3.6   Capacitive Loads

Reasonable capacitive loads (e.g., logic gates) have little impact on propagation delay (see Figure 2-27). The supply current increases with increasing toggle frequency (Figure 2-30), especially with higher capacitive loads.

MCP6546/7/8/9

3.7 Battery Life

In order to maximize battery life in portable applications, use large resistors and small capacitive loads. Also, avoid toggling the output more than necessary and do not use chip select ($\overline{CS}$) to conserve power for short periods of time. Capacitive loads will draw additional power at start-up.

3.8 PCB Surface Leakage

In applications where low input bias current is critical, PCB (Printed Circuit Board) 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. If current-to-flow, this is greater than the MCP6546/7/8/9 family's bias current at 25°C (1 pA, typ).

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. An example of this type of layout is shown in Figure 3-6.
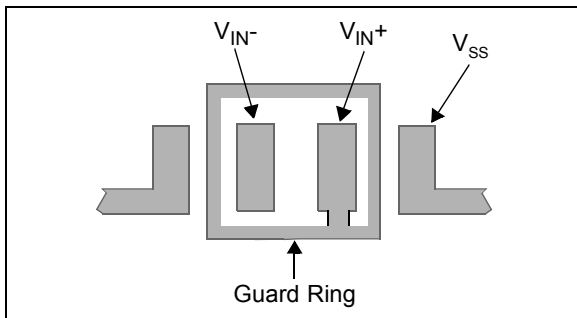
FIGURE 3-6: *Example Guard Ring Layout for Inverting Circuit.*

1. Inverting Configuration (Figures 3-3 and 3-6):
    a. Connect the guard ring to the non-inverting input pin ($V_{IN}+$). This biases the guard ring to the same reference voltage as the comparator (e.g., $V_{DD}/2$ or ground).
    b. Connect the inverting pin ($V_{IN}-$) to the input pad without touching the guard ring.

3.9 Typical Applications

3.9.1 PRECISE COMPARATOR

Some applications require higher DC precision. An easy way to solve this problem is to use an amplifier (such as the MCP6041) to gain-up the input signal before it reaches the comparator. Figure 3-7 shows an example of this approach.
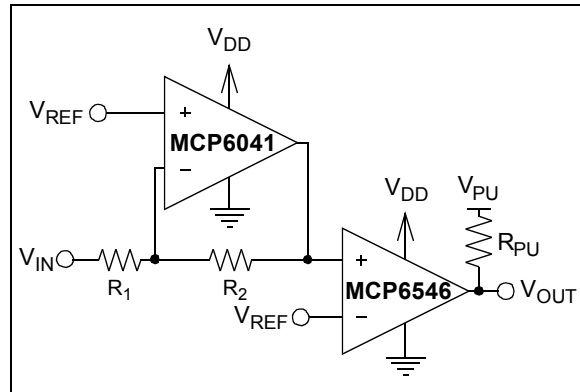
FIGURE 3-7: *Precise Inverting Comparator.*

3.9.2 WINDOWED COMPARATOR

Figure 3-8 shows one approach to designing a windowed comparator. The wired-OR connection produces a high output (logic 1) when the input voltage is between V_{RB} and V_{RT} (where $V_{RT} > V_{RB}$).
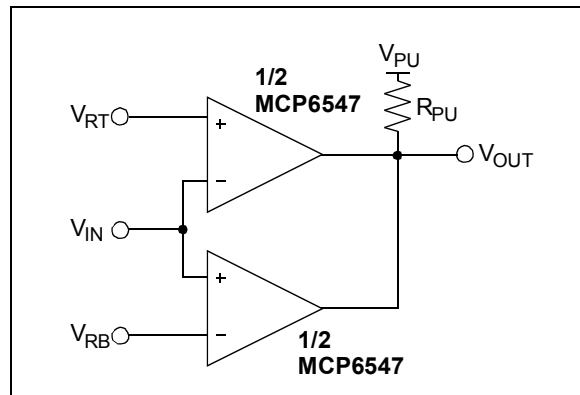
FIGURE 3-8: *Windowed comparator.*

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

5-Lead SC-70 (**MCP6546**)
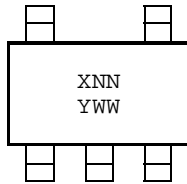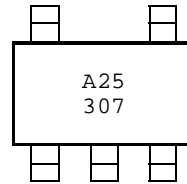
```
XNN
YWW
```

Example:

```
A25
307
```

5-Lead SOT-23 (**MCP6546**)
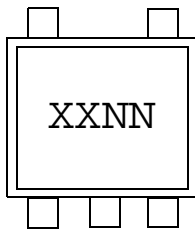
```
XXNN
```

Example:

```
AB37
```

8-Lead PDIP (300 mil)

```
XXXXXXXX
XXXXXNNN
   YYWW
```

Example:

```
MCP6546
I/P256
   0307
```

8-Lead SOIC (150 mil)

```
XXXXXXXX
XXXXXYYWW
    NNN
```

Example:

```
MCP6546
I/SN0307
   256
```

8-Lead MSOP

```
XXXXXX
YWWNNN
```

Example:

```
6546I
307256
```
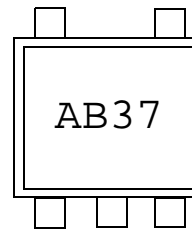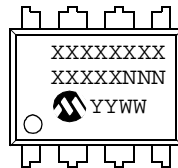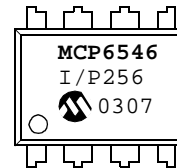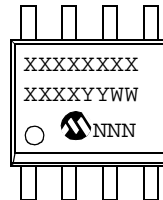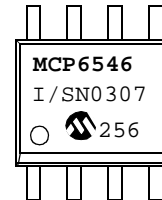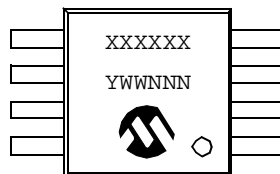
Legend:	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code

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.

* Standard marking consists of Microchip part number, year code, week code, traceability code (facility code, mask rev#, and assembly code). For marking beyond this, certain price adders apply. Please check with your Microchip Sales Office.

Package Marking Information (Continued)

14-Lead PDIP (300 mil) (**MCP6549**)

```
XXXXXXXXXXXXX
XXXXXXXXXXXXX
       YYWWNNN
```

Example:

```
MCP6549-I/P

      0307256
```
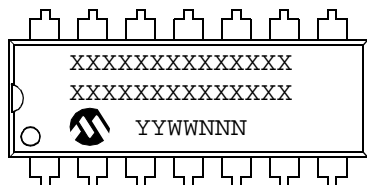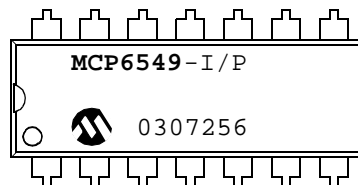
14-Lead SOIC (150 mil) (**MCP6549**)

```
      XXXXXXXXXX
      XXXXXXXXXX
        YYWWNNN
```

Example:

```
        MCP6549ISL

            0307256
```

14-Lead TSSOP (**MCP6549**)

```
XXXXXXXX
     YYWW
     NNN
```

Example:

```
MCP6549I
     0307
     256
```
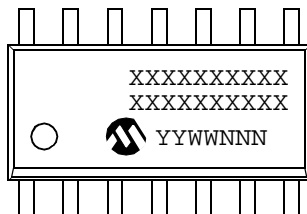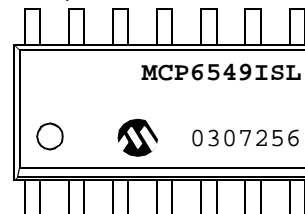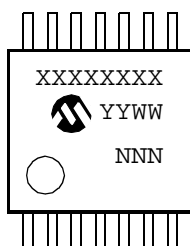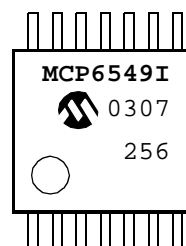
5-Lead Plastic Package (LT) (SC-70)
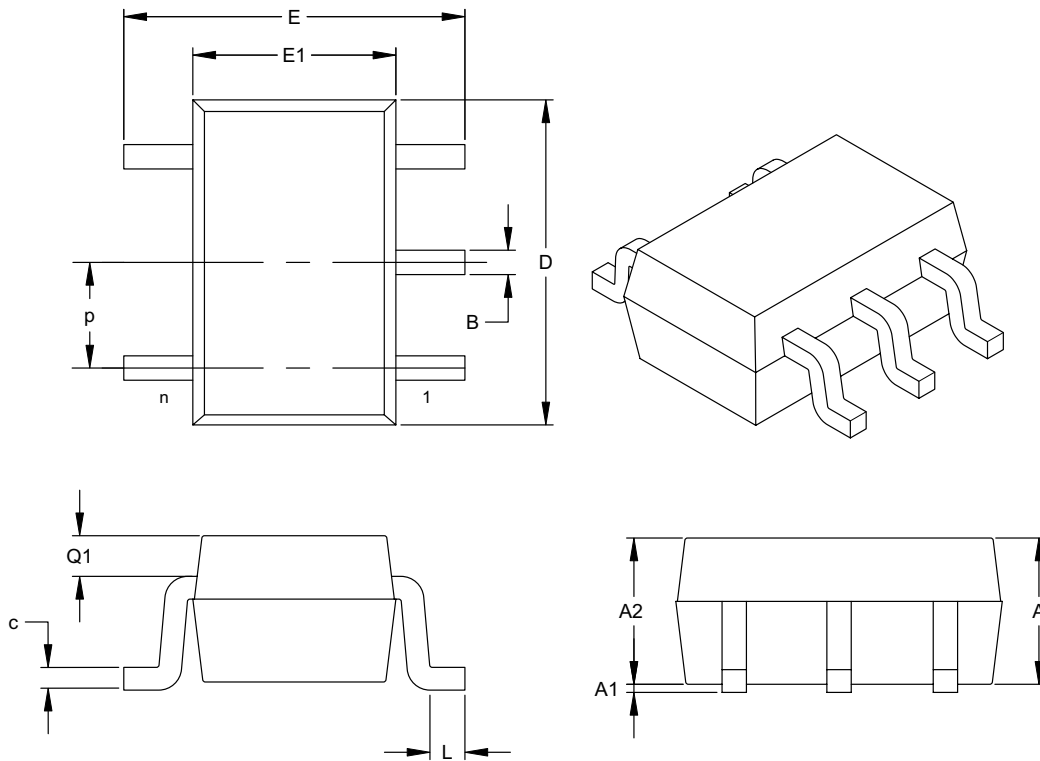
	Units	INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		5			5	
Pitch	p		.026 (BSC)			0.65 (BSC)	
Overall Height	A	.031		.043	0.80		1.10
Molded Package Thickness	A2	.031		.039	0.80		1.00
Standoff	A1	.000		.004	0.00		0.10
Overall Width	E	.071		.094	1.80		2.40
Molded Package Width	E1	.045		.053	1.15		1.35
Overall Length	D	.071		.087	1.80		2.20
Foot Length	L	.004		.012	0.10		0.30
Top of Molded Pkg to Lead Shoulder	Q1	.004		.016	0.10		0.40
Lead Thickness	c	.004		.007	0.10		0.18
Lead Width	B	.006		.012	0.15		0.30

*Controlling Parameter

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" (0.127mm) per side.

JEITA (EIAJ) Standard: SC-70

Drawing No. C04-061

MCP6546/7/8/9

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

	Units	INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		5			5	
Pitch	p		.038			0.95	
Outside lead pitch (basic)	p1		.075			1.90	
Overall Height	A	.035	.046	.057	0.90	1.18	1.45
Molded Package Thickness	A2	.035	.043	.051	0.90	1.10	1.30
Standoff §	A1	.000	.003	.006	0.00	0.08	0.15
Overall Width	E	.102	.110	.118	2.60	2.80	3.00
Molded Package Width	E1	.059	.064	.069	1.50	1.63	1.75
Overall Length	D	.110	.116	.122	2.80	2.95	3.10
Foot Length	L	.014	.018	.022	0.35	0.45	0.55
Foot Angle	φ	0	5	10	0	5	10
Lead Thickness	c	.004	.006	.008	0.09	0.15	0.20
Lead Width	B	.014	.017	.020	0.35	0.43	0.50
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed
.010" (0.254mm) per side.
JEDEC Equivalent: MO-178
Drawing No. C04-091

8-Lead Plastic Dual In-line (P) – 300 mil (PDIP)

	Units	INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.313	.325	7.62	7.94	8.26
Molded Package Width	E1	.240	.250	.260	6.10	6.35	6.60
Overall Length	D	.360	.373	.385	9.14	9.46	9.78
Tip to Seating Plane	L	.125	.130	.135	3.18	3.30	3.43
Lead Thickness	c	.008	.012	.015	0.20	0.29	0.38
Upper Lead Width	B1	.045	.058	.070	1.14	1.46	1.78
Lower Lead Width	B	.014	.018	.022	0.36	0.46	0.56
Overall Row Spacing §	eB	.310	.370	.430	7.87	9.40	10.92
Mold Draft Angle Top	a	5	10	15	5	10	15
Mold Draft Angle Bottom	b	5	10	15	5	10	15

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed
.010" (0.254mm) per side.
JEDEC Equivalent: MS-001
Drawing No. C04-018

MCP6546/7/8/9

8-Lead Plastic Small Outline (SN) – Narrow, 150 mil (SOIC)

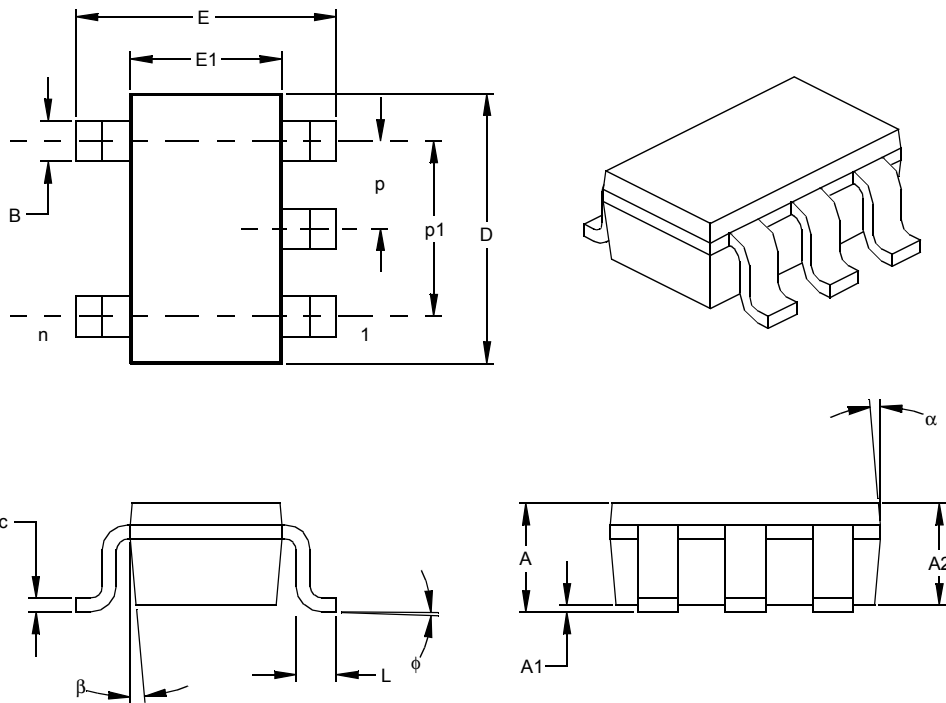|	Units		INCHES*			MILLIMETERS	
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.050			1.27	
Overall Height	A	.053	.061	.069	1.35	1.55	1.75
Molded Package Thickness	A2	.052	.056	.061	1.32	1.42	1.55
Standoff §	A1	.004	.007	.010	0.10	0.18	0.25
Overall Width	E	.228	.237	.244	5.79	6.02	6.20
Molded Package Width	E1	.146	.154	.157	3.71	3.91	3.99
Overall Length	D	.189	.193	.197	4.80	4.90	5.00
Chamfer Distance	h	.010	.015	.020	0.25	0.38	0.51
Foot Length	L	.019	.025	.030	0.48	0.62	0.76
Foot Angle	φ	0	4	8	0	4	8
Lead Thickness	c	.008	.009	.010	0.20	0.23	0.25
Lead Width	B	.013	.017	.020	0.33	0.42	0.51
Mold Draft Angle Top	α	0	12	15	0	12	15
Mold Draft Angle Bottom	β	0	12	15	0	12	15

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.
JEDEC Equivalent: MS-012
Drawing No. C04-057

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

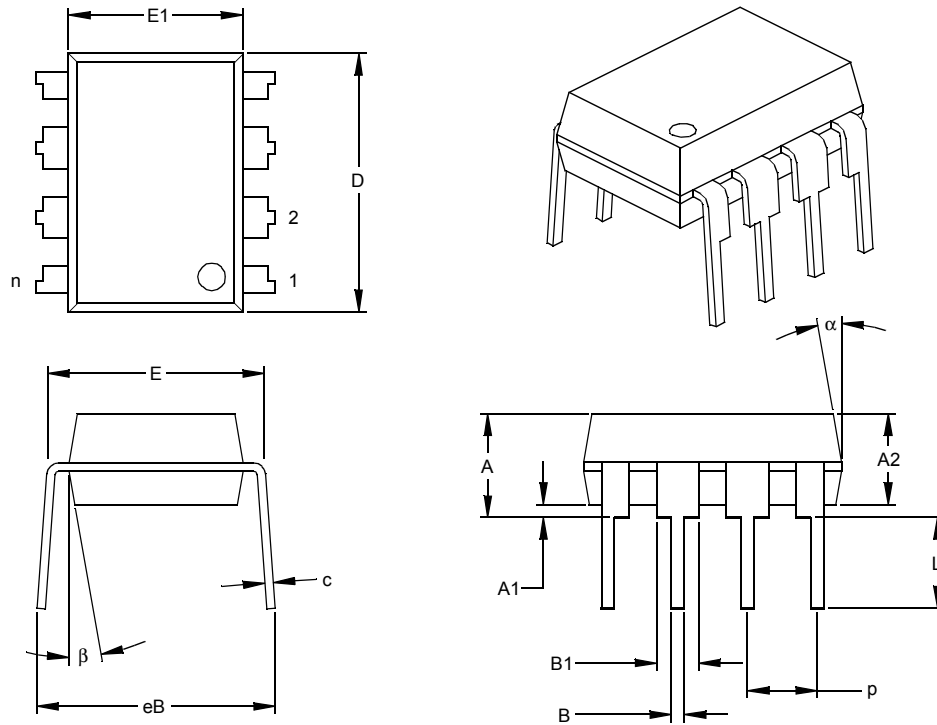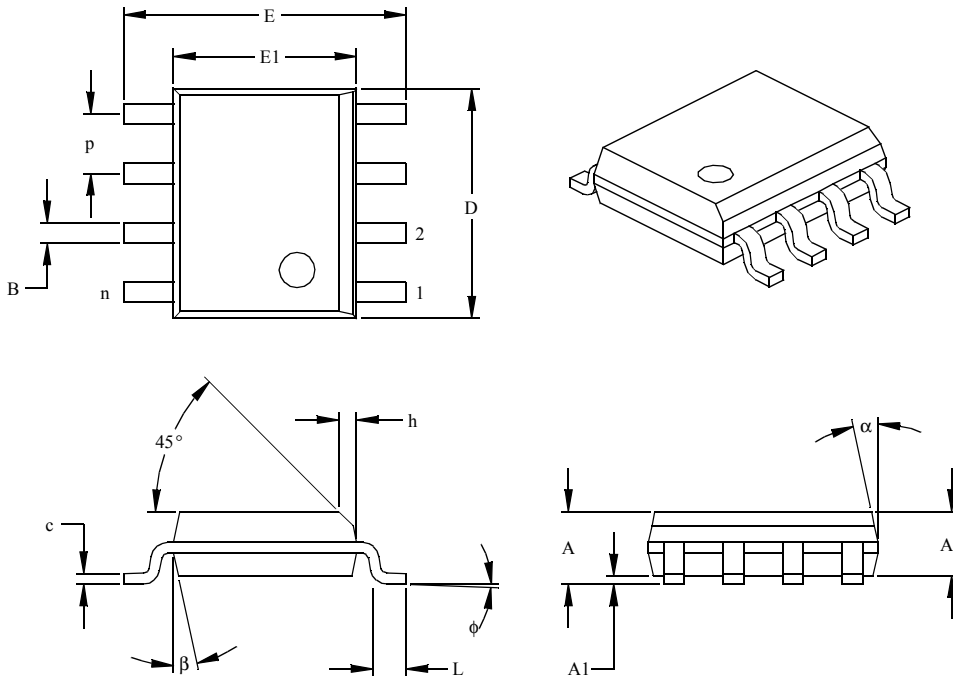|	Units		INCHES			MILLIMETERS*	
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.026 BSC			0.65 BSC	
Overall Height	A	-	-	.043	-	-	1.10
Molded Package Thickness	A2	.030	.033	.037	0.75	0.85	0.95
Standoff	A1	.000	-	.006	0.00	-	0.15
Overall Width	E		.193 TYP.			4.90 BSC	
Molded Package Width	E1		.118 BSC			3.00 BSC	
Overall Length	D		.118 BSC			3.00 BSC	
Foot Length	L	.016	.024	.031	0.40	0.60	0.80
Footprint (Reference)	F		.037 REF			0.95 REF	
Foot Angle	φ	0°	-	8°	0°	-	8°
Lead Thickness	c	.003	.006	.009	0.08	-	0.23
Lead Width	B	.009	.012	.016	0.22	-	0.40
Mold Draft Angle Top	α	5°	-	15°	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°	5°	-	15°

*Controlling Parameter

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MO-187

Drawing No. C04-111

MCP6546/7/8/9

14-Lead Plastic Dual In-line (P) – 300 mil (PDIP)
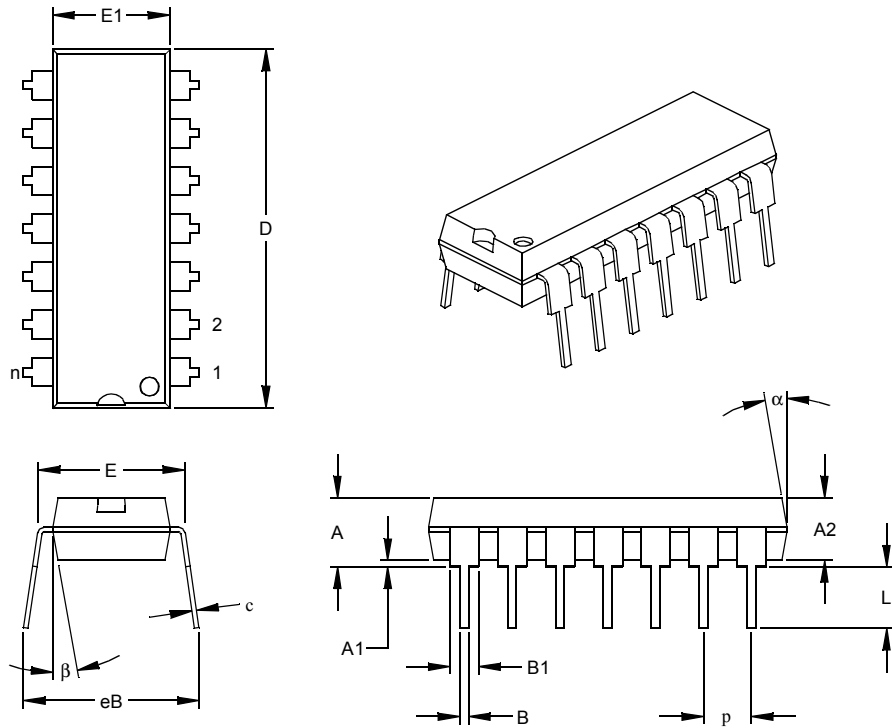
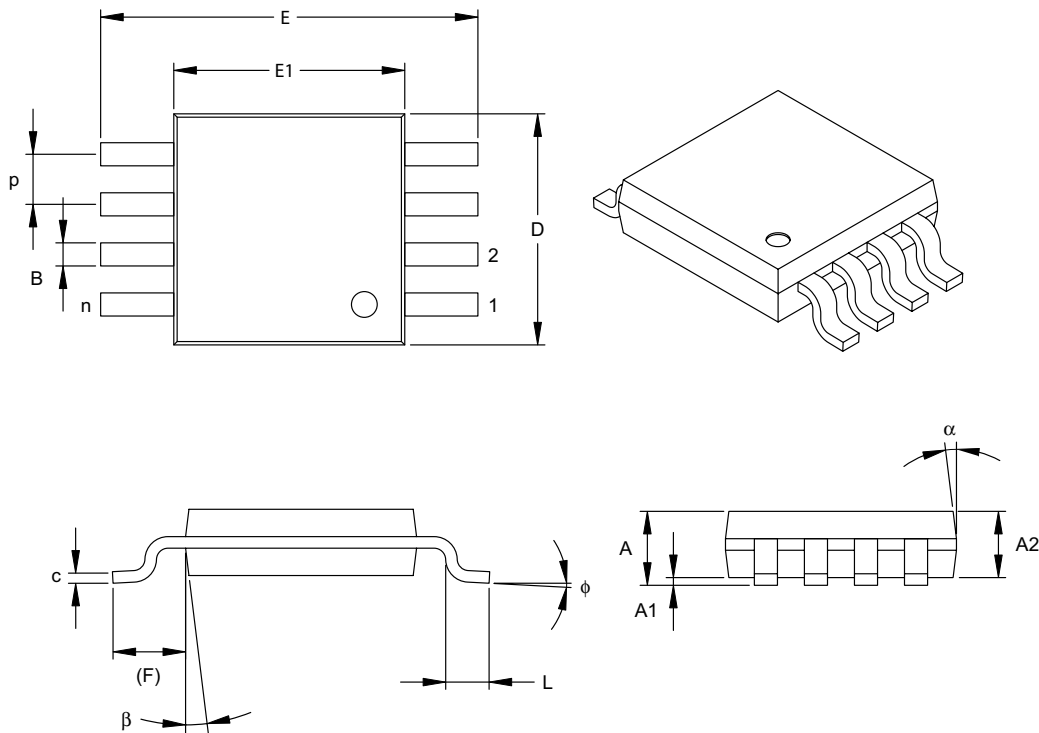|	Units		INCHES*			MILLIMETERS	
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		14			14	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.313	.325	7.62	7.94	8.26
Molded Package Width	E1	.240	.250	.260	6.10	6.35	6.60
Overall Length	D	.740	.750	.760	18.80	19.05	19.30
Tip to Seating Plane	L	.125	.130	.135	3.18	3.30	3.43
Lead Thickness	c	.008	.012	.015	0.20	0.29	0.38
Upper Lead Width	B1	.045	.058	.070	1.14	1.46	1.78
Lower Lead Width	B	.014	.018	.022	0.36	0.46	0.56
Overall Row Spacing §	eB	.310	.370	.430	7.87	9.40	10.92
Mold Draft Angle Top	α	5	10	15	5	10	15
Mold Draft Angle Bottom	β	5	10	15	5	10	15

* Controlling Parameter
§ Significant Characteristic
Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed
.010" (0.254mm) per side.
JEDEC Equivalent: MS-001
Drawing No. C04-005

14-Lead Plastic Small Outline (SL) – Narrow, 150 mil (SOIC)
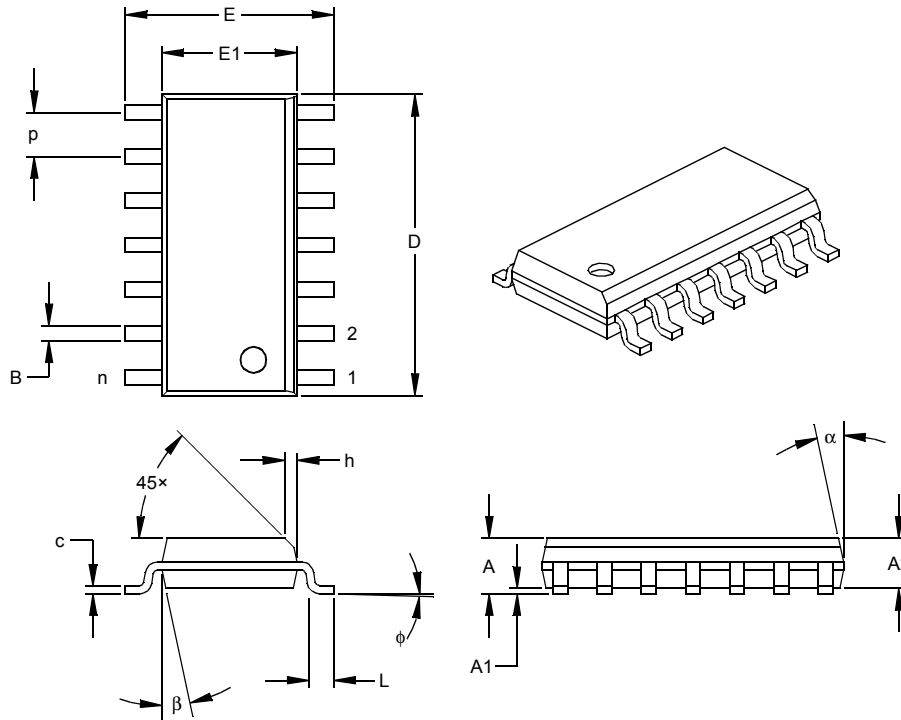
	Units	INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		14			14	
Pitch	p		.050			1.27	
Overall Height	A	.053	.061	.069	1.35	1.55	1.75
Molded Package Thickness	A2	.052	.056	.061	1.32	1.42	1.55
Standoff §	A1	.004	.007	.010	0.10	0.18	0.25
Overall Width	E	.228	.236	.244	5.79	5.99	6.20
Molded Package Width	E1	.150	.154	.157	3.81	3.90	3.99
Overall Length	D	.337	.342	.347	8.56	8.69	8.81
Chamfer Distance	h	.010	.015	.020	0.25	0.38	0.51
Foot Length	L	.016	.033	.050	0.41	0.84	1.27
Foot Angle	φ	0	4	8	0	4	8
Lead Thickness	c	.008	.009	.010	0.20	0.23	0.25
Lead Width	B	.014	.017	.020	0.36	0.42	0.51
Mold Draft Angle Top	α	0	12	15	0	12	15
Mold Draft Angle Bottom	β	0	12	15	0	12	15

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.
JEDEC Equivalent: MS-012
Drawing No. C04-065

14-Lead Plastic Thin Shrink Small Outline (ST) – 4.4 mm (TSSOP)
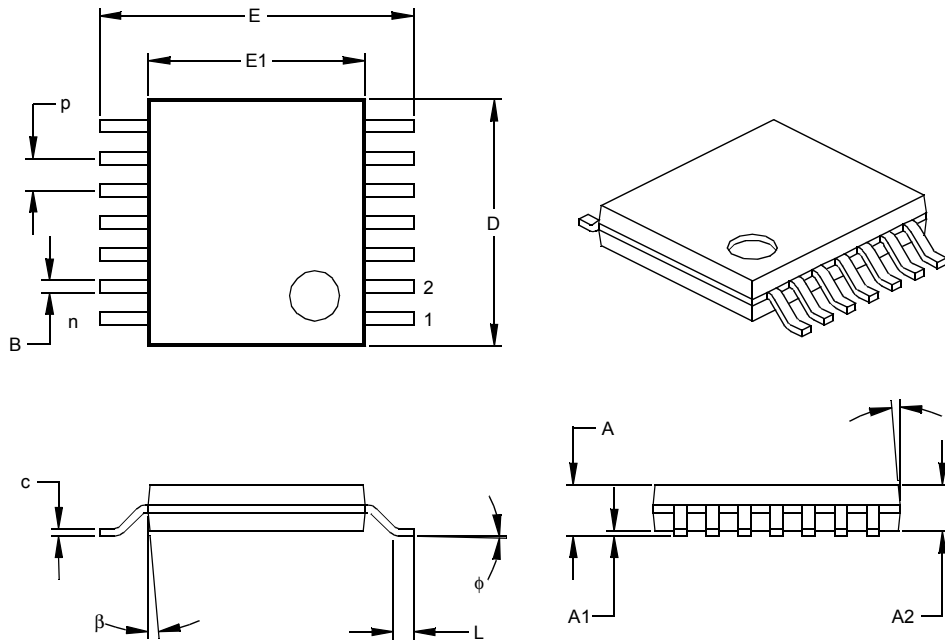
	Units	INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		14			14	
Pitch	p		.026			0.65	
Overall Height	A			.043			1.10
Molded Package Thickness	A2	.033	.035	.037	0.85	0.90	0.95
Standoff §	A1	.002	.004	.006	0.05	0.10	0.15
Overall Width	E	.246	.251	.256	6.25	6.38	6.50
Molded Package Width	E1	.169	.173	.177	4.30	4.40	4.50
Molded Package Length	D	.193	.197	.201	4.90	5.00	5.10
Foot Length	L	.020	.024	.028	0.50	0.60	0.70
Foot Angle	φ	0	4	8	0	4	8
Lead Thickness	c	.004	.006	.008	0.09	0.15	0.20
Lead Width	B1	.007	.010	.012	0.19	0.25	0.30
Mold Draft Angle Top	α	0	5	10	0	5	10
Mold Draft Angle Bottom	β	0	5	10	0	5	10

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" (0.127mm) per side.
JEDEC Equivalent: MO-153
Drawing No. C04-087

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   Package
Range

Device:
- MCP6546: Single Comparator
- MCP6546T: Single Comparator (Tape and Reel) (SC-70, SOT-23, SOIC, MSOP)
- MCP6546RT: Single Comparator (Rotated - Tape and Reel) (SOT-23 only)
- MCP6547: Dual Comparator
- MCP6547T: Dual Comparator (Tape and Reel for SOIC and MSOP)
- MCP6548: Single Comparator with CS
- MCP6548T: Single Comparator with CS (Tape and Reel for SOIC and MSOP)
- MCP6549: Quad Comparator
- MCP6549T: Quad Comparator (Tape and Reel for SOIC and TSSOP)

Temperature Range: I   =   -40°C to +85°C

Package:
- LT = Plastic Package (SC-70), 5-lead
- OT = Plastic Small Outline Transistor (SOT-23), 5-lead
- MS = Plastic MSOP, 8-lead
- P = Plastic DIP (300 mil Body), 8-lead, 14-lead
- SN = Plastic SOIC (150 mil Body), 8-lead
- SL = Plastic SOIC (150 mil Body), 14-lead (MCP6549)
- ST = Plastic TSSOP (4.4mm Body), 14-lead (MCP6549)

Examples:

a) MCP6546T-I/LT: Tape and Reel, Industrial Temperature, 5LD SC-70.

b) MCP6546T-I/OT: Tape and Reel, Industrial Temperature, 5LD SOT-23.

c) MCP6546-I/P: Industrial Temperature, 8LD PDIP.

d) MCP6546RT-I/OT: Tape and Reel, Industrial Temperature, 5LD SOT23.

a) MCP6547-I/MS: Industrial Temperature, 8LD MSOP.

b) MCP6547T-I/MS: Tape and Reel, Industrial Temperature, 8LD MSOP.

c) MCP6547-I/P: Industrial Temperature, 8LD PDIP.

a) MCP6548-I/SN: Industrial Temperature, 8LD SOIC.

b) MCP6548T-I/SN: Tape and Reel, Industrial Temperature, 8LD SOIC.

c) MCP6548-I/P: Industrial Temperature, 8LD PDIP.

a) MCP6549T-I/SL: Tape and Reel, Industrial Temperature, 14LD SOIC.

b) MCP6549T-I/SL: Tape and Reel, Industrial Temperature, 14LD SOIC.

c) MCP6549-I/P: Industrial Temperature, 14LD PDIP.

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Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

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• Microchip is willing to work with the customer who is concerned about the integrity of their code.

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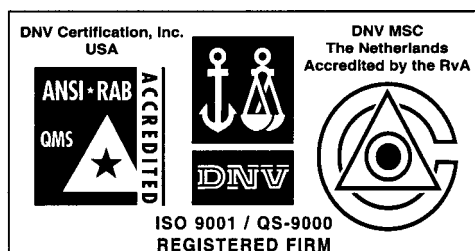
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