



# MICROCHIP MCP6546/6R/6U/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  $\mu s$  (typ., 100 mV Overdrive)
- 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.)
- Temperature Range:
  - Industrial:  $-40^{\circ}C$  to  $+85^{\circ}C$
  - Extended:  $-40^{\circ}C$  to  $+125^{\circ}C$

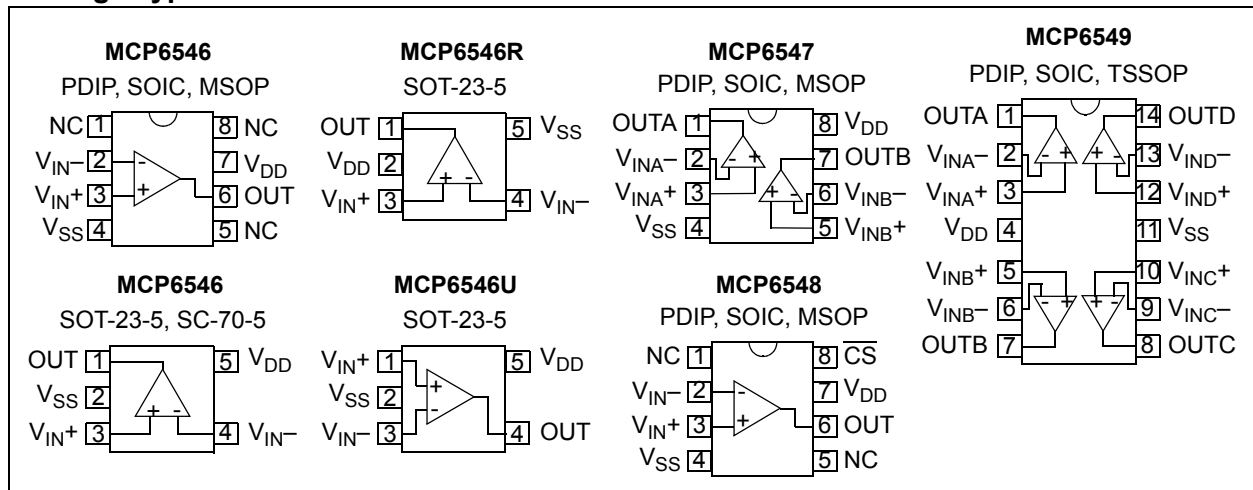
### Typical Applications

- 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

### Package Types



### Description

The Microchip Technology Inc. MCP6546/6R/6U/7/8/9 family of comparators is offered in single (MCP6546, MCP6546R, MCP6546U), single with chip select ( $\overline{CS}$ ) (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 MCP6546/6R/6U/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 a quiescent current of less than 1  $\mu A$ /comparator.

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.

\* SC-70-5 E-Temp parts not available at this release of the data sheet.

MCP6546U SOT-23-5 is E-Temp only.

# MCP6546/6R/6U/7/8/9

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

$V_{DD} - V_{SS}$ .....	7.0V
Open-Drain output.....	$V_{SS} + 10.5V$
Analog Input ( $V_{IN+}$ , $V_{IN-}$ )†† .....	$V_{SS} - 1.0V$ 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 Input Pins .....	$\pm 2$ mA
Current at Output and Supply Pins .....	$\pm 30$ mA
Storage temperature .....	$-65^{\circ}C$ to $+150^{\circ}C$
Maximum Junction Temperature ( $T_J$ ).....	$+150^{\circ}C$
ESD protection on all pins:	
(HBM;MM) .....	2 kV;200V (MCP6546U)
(HBM;MM) .....	4 kV; 200V (all other parts)

† **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”**

### DC CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated,  $V_{DD} = +1.6V$  to  $+5.5V$ ,  $V_{SS} = GND$ ,  $T_A = 25^{\circ}C$ ,  $V_{IN+} = V_{DD}/2$ ,  $V_{IN-} = V_{SS}$ ,  $R_{PU} = 2.74$  k $\Omega$  to  $V_{PU} = V_{DD}$  (Refer to **Figure 1-3**).

Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Power Supply</b>						
Supply Voltage	$V_{DD}$	1.6	—	5.5	V	$V_{PU} \geq V_{DD}$
Quiescent Current (per comparator)	$I_Q$	0.3	0.6	1	$\mu A$	$I_{OUT} = 0$
<b>Input</b>						
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	$\pm 1.5$	+7.0	mV	$V_{CM} = V_{SS}$ ( <b>Note 1</b> )
Drift with Temperature	$\Delta V_{OS}/\Delta T_A$	—	$\pm 3$	—	$\mu V/^{\circ}C$	$T_A = -40^{\circ}C$ to $+125^{\circ}C$ , $V_{CM} = V_{SS}$
Input Hysteresis Voltage	$V_{HYST}$	1.5	3.3	6.5	mV	$V_{CM} = V_{SS}$ ( <b>Note 1</b> )
Linear Temp. Co.	$TC_1$	—	6.7	—	$\mu V/^{\circ}C$	$T_A = -40^{\circ}C$ to $+125^{\circ}C$ , $V_{CM} = V_{SS}$ ( <b>Note 2</b> )
Quadratic Temp. Co.	$TC_2$	—	-0.035	—	$\mu V/^{\circ}C^2$	$T_A = -40^{\circ}C$ to $+125^{\circ}C$ , $V_{CM} = V_{SS}$ ( <b>Note 2</b> )
Input Bias Current	$I_B$	—	1	—	pA	$V_{CM} = V_{SS}$
At Temperature (I-Temp parts)	$I_B$	—	25	100	pA	$T_A = +85^{\circ}C$ , $V_{CM} = V_{SS}$ ( <b>Note 3</b> )
At Temperature (E-Temp parts)	$I_B$	—	1200	5000	pA	$T_A = +125^{\circ}C$ , $V_{CM} = V_{SS}$ ( <b>Note 3</b> )
Input Offset Current	$I_{OS}$	—	$\pm 1$	—	pA	$V_{CM} = V_{SS}$
Common Mode Input Impedance	$Z_{CM}$	—	$10^{13}  4$	—	$\Omega  pF$	
Differential Input Impedance	$Z_{DIFF}$	—	$10^{13}  2$	—	$\Omega  pF$	

**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:**  $V_{HYST}$  at differential temperatures is estimated using:  $V_{HYST}(T_A) = V_{HYST} + (T_A - 25^{\circ}C) TC_1 + (T_A - 25^{\circ}C)^2 TC_2$ .

**3:** Input bias current at temperature is not tested for the SC-70-5 package

**4:** Do not short the output above  $V_{SS} + 10V$ . Limit the output current to Absolute Maximum Rating of 30 mA. The minimum  $V_{PU}$  test limit was  $V_{DD}$  before Dec. 2004 (week code 52).

# MCP6546/6R/6U/7/8/9

## DC CHARACTERISTICS (CONTINUED)

**Electrical Specifications:** Unless otherwise indicated,  $V_{DD} = +1.6V$  to  $+5.5V$ ,  $V_{SS} = GND$ ,  $T_A = 25^\circ C$ ,  $V_{IN+} = V_{DD}/2$ ,  $V_{IN-} = V_{SS}$ ,  $R_{PU} = 2.74 k\Omega$  to  $V_{PU} = V_{DD}$  (Refer to [Figure 1-3](#)).

Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Open-Drain Output</b>						
Output Pull-Up Voltage	$V_{PU}$	1.6	—	10	V	(Note 4)
High-Level Output Current	$I_{OH}$	-100	—	—	nA	$V_{DD} = 1.6V$ to $5.5V$ , $V_{PU} = 10V$ (Note 4)
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	$I_{SC}$	—	$\pm 1.5$	—	mA	$V_{PU} = V_{DD} = 1.6V$ (Note 4)
	$I_{SC}$	—	30	—	mA	$V_{PU} = V_{DD} = 5.5V$ (Note 4)
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:**  $V_{HYST}$  at differential temperatures is estimated using:  $V_{HYST}(T_A) = V_{HYST} + (T_A - 25^\circ C) TC_1 + (T_A - 25^\circ C)^2 TC_2$ .
- 3:** Input bias current at temperature is not tested for the SC-70-5 package
- 4:** Do not short the output above  $V_{SS} + 10V$ . Limit the output current to Absolute Maximum Rating of 30 mA. The minimum  $V_{PU}$  test limit was  $V_{DD}$  before Dec. 2004 (week code 52).

## AC CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated,  $V_{DD} = +1.6V$  to  $+5.5V$ ,  $V_{SS} = GND$ ,  $T_A = 25^\circ C$ ,  $V_{IN+} = V_{DD}/2$ , Step = 200 mV, Overdrive = 100 mV,  $R_{PU} = 2.74 k\Omega$  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	—	$\mu s$	(Note 1)
Propagation Delay (High-to-Low)	$t_{PHL}$	—	4.0	8.0	$\mu s$	
Propagation Delay (Low-to-High)	$t_{PLH}$	—	3.0	8.0	$\mu s$	(Note 1)
Propagation Delay Skew	$t_{PDS}$	—	-1.0	—	$\mu s$	(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	$E_{ni}$	—	200	—	$\mu V_{P-P}$	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:  $t_{PDS} = t_{PLH} - t_{PHL}$ .

## TEMPERATURE CHARACTERISTICS

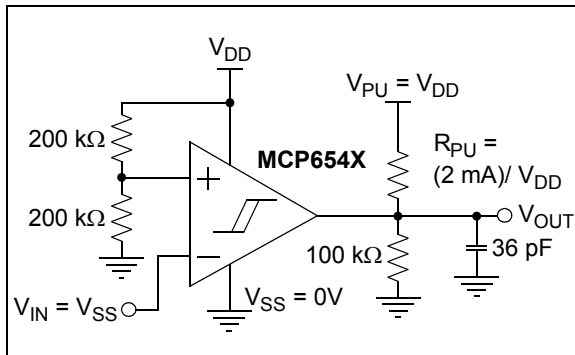
**Electrical Specifications:** Unless otherwise indicated,  $V_{DD} = +1.6V$  to  $+5.5V$  and  $V_{SS} = GND$ .

Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Temperature Ranges</b>						
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	
<b>Thermal Package Resistances</b>						
Thermal Resistance, 5L-SC-70	$\theta_{JA}$	—	331	—	°C/W	
Thermal Resistance, 5L-SOT-23	$\theta_{JA}$	—	256	—	°C/W	
Thermal Resistance, 8L-PDIP	$\theta_{JA}$	—	85	—	°C/W	
Thermal Resistance, 8L-SOIC	$\theta_{JA}$	—	163	—	°C/W	
Thermal Resistance, 8L-MSOP	$\theta_{JA}$	—	206	—	°C/W	
Thermal Resistance, 14L-PDIP	$\theta_{JA}$	—	70	—	°C/W	
Thermal Resistance, 14L-SOIC	$\theta_{JA}$	—	120	—	°C/W	
Thermal Resistance, 14L-TSSOP	$\theta_{JA}$	—	100	—	°C/W	

**Note:** The MCP6546/6R/6U/7/8/9 I-temp family 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  $+150^\circ\text{C}$ .

### 1.1 Test Circuit Configuration

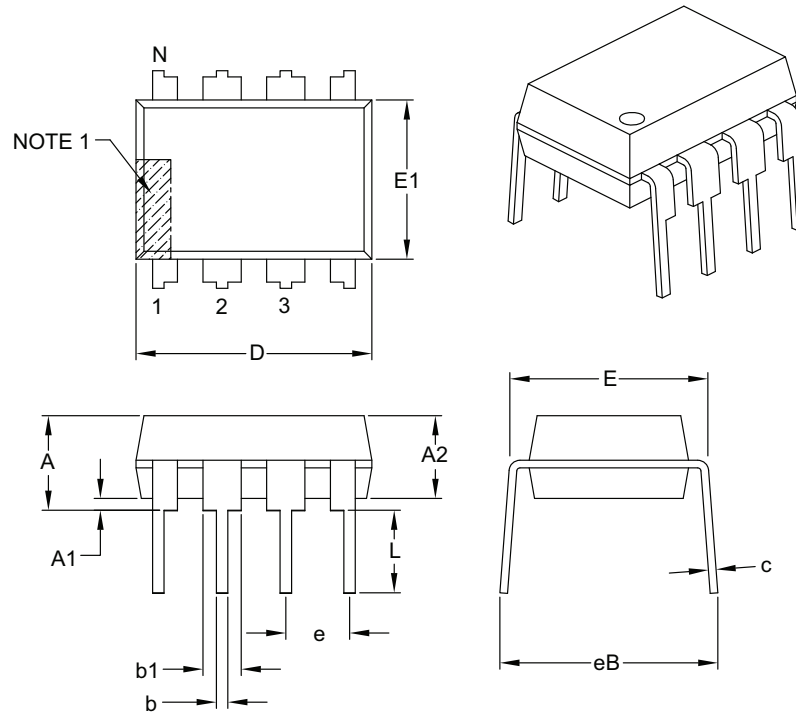
This test circuit configuration is used to determine the AC and DC specifications.



**FIGURE 1-3:** AC and DC Test Circuit for the Open-Drain Output Comparators.

# MCP6546/6R/6U/7/8/9

## 8-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]



		Units	INCHES		
Dimension Limits			MIN	NOM	MAX
Number of Pins	N		8		
Pitch	e		.100 BSC		
Top to Seating Plane	A	–	–	–	.210
Molded Package Thickness	A2	.115	.130	.195	
Base to Seating Plane	A1	.015	–	–	
Shoulder to Shoulder Width	E	.290	.310	.325	
Molded Package Width	E1	.240	.250	.280	
Overall Length	D	.348	.365	.400	
Tip to Seating Plane	L	.115	.130	.150	
Lead Thickness	c	.008	.010	.015	
Upper Lead Width	b1	.040	.060	.070	
Lower Lead Width	b	.014	.018	.022	
Overall Row Spacing §	eB	–	–	–	.430

### Notes:

- Pin 1 visual index feature may vary, but must be located with the hatched area.
- § Significant Characteristic.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
- Dimensioning and tolerancing per ASME Y14.5M.

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

Microchip Technology Drawing C04-018B

# MCP6546/6R/6U/7/8/9

## PRODUCT IDENTIFICATION SYSTEM

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

<u>PART NO.</u>	<u>-X</u>	<u>/XX</u>	<b>Examples:</b>
Device	Temperature Range	Package	
Device:	MCP6546: Single Comparator MCP6546T: Single Comparator (Tape and Reel) (SC-70, SOT-23, SOIC, MSOP)		a) MCP6546T-I/LT: Tape and Reel, Industrial Temperature, 5LD SC-70.
	MCP6546RT: Single Comparator (Rotated - Tape and Reel) (SOT-23 only)		b) MCP6546T-I/OT: Tape and Reel, Industrial Temperature, 5LD SOT-23.
	MCP6546UT: Single Comparator (Tape and Reel) ( <b>SOT-23-5 is E-Temp only</b> )		c) MCP6546-E/P: Extended Temperature, 8LD PDIP.
	MCP6547: Dual Comparator		d) MCP6546RT-I/OT: Tape and Reel, Industrial Temperature, 5LD SOT23.
	MCP6547T: Dual Comparator (Tape and Reel for SOIC and MSOP)		e) MCP6546-E/SN: Extended Temperature, 8LD SOIC.
	MCP6548: Single Comparator with $\overline{CS}$		f) MCP6546UT-E/OT: Tape and Reel, Extended Temperature, 5LD SOT23.
	MCP6548T: Single Comparator with $\overline{CS}$ (Tape and Reel for SOIC and MSOP)		a) MCP6547-I/MS: Industrial Temperature, 8LD MSOP.
	MCP6549: Quad Comparator		b) MCP6547T-I/MS: Tape and Reel, Industrial Temperature, 8LD MSOP.
	MCP6549T: Quad Comparator (Tape and Reel for SOIC and TSSOP)		c) MCP6547-I/P: Industrial Temperature, 8LD PDIP.
Temperature Range:	I = -40°C to +85°C E* = -40°C to +125°C		d) MCP6547-E/SN: Extended Temperature, 8LD SOIC.
	* SC-70-5 E-Temp parts not available at this release of the data sheet.		a) MCP6548-I/SN: Industrial Temperature, 8LD SOIC.
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)		b) MCP6548T-I/SN: Tape and Reel, Industrial Temperature, 8LD SOIC.
			c) MCP6548-I/P: Industrial Temperature, 8LD PDIP.
			d) MCP6548-E/SN: Extended Temperature, 8LD SOIC.
			a) MCP6549T-I/SL: Tape and Reel, Industrial Temperature, 14LD SOIC.
			b) MCP6549T-E/SL: Tape and Reel, Extended Temperature, 14LD SOIC.
			c) MCP6549-I/P: Industrial Temperature, 14LD PDIP.
			d) MCP6549-E/ST: Extended Temperature, 14LD TSSOP.