MCP6541/1R/1U/2/3/4

Push-Pull 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
- CMOS/TTL-Compatible Output
- Propagation Delay: 4 µs (typ., 100 mV Overdrive)
- Wide Supply Voltage Range: 1.6V to 5.5V
- Available in Single, Dual and Quad
- Single available in SOT-23-5, SC-70-5 * packages
- Chip Select ($\overline{CS}$) with MCP6543
- Low Switching Current
- Internal Hysteresis: 3.3 mV (typ.)
- Temperature Ranges:
  - Industrial: -40°C to +85°C
  - Extended: -40°C to +125°C

Typical Applications

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

Related Devices

- Open-Drain Output: MCP6546/7/8/9

Description

The Microchip Technology Inc. MCP6541/1R/1U/2/3/4 family of comparators is offered in single (MCP6541, MCP6541R, MCP6541U), single with Chip Select ($\overline{CS}$) (MCP6543), dual (MCP6542) and quad (MCP6544) configurations. The outputs are push-pull (CMOS/TTL-compatible) and are capable of driving heavy DC or capacitive loads.

These comparators are optimized for low power, single-supply operation with greater than rail-to-rail input operation. The push-pull output of the MCP6541/1R/1U/2/3/4 family supports rail-to-rail output swing and interfaces with TTL/CMOS logic. The internal input hysteresis eliminates output switching due to internal input noise voltage, reducing current draw. The output limits supply current surges and dynamic power consumption while switching. This product family operates with a single-supply voltage as low as 1.6V and draws less than 1 µA/comparator of quiescent current.

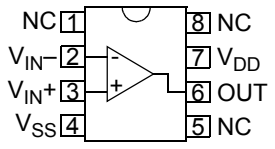
The related MCP6546/7/8/9 family of comparators from Microchip has an open-drain output. Used with a pull-up resistor, these devices can be used as level-shifters for any desired voltage up to 10V and in wired-OR logic.

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

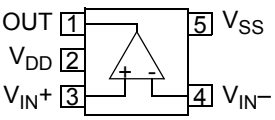
MCP6541U SOT-23-5 is E-Temp only.

Package Types

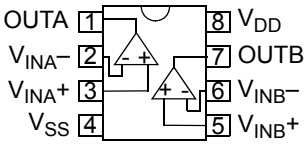
MCP6541
PDIP, SOIC, MSOP



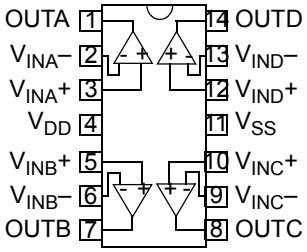
MCP6541R
SOT-23-5



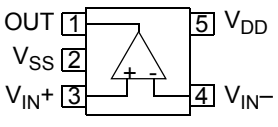
MCP6542
PDIP, SOIC, MSOP



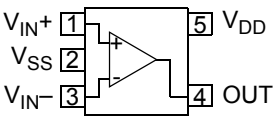
MCP6544
PDIP, SOIC, TSSOP



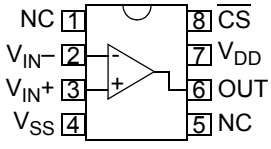
MCP6541
SOT-23-5, SC-70-5



MCP6541U
SOT-23-5



MCP6543
PDIP, SOIC, MSOP



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V_{DD} - V_{SS} 7.0V
Current at Analog Input Pin (V_{IN}+, V_{IN}-.....±2 mA
Analog Input (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 .....±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; 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"**

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}, and R_L = 100 kΩ to V_{DD}/2 (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	1.0	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 +125°C, V_{CM} = V_{SS}
Input Hysteresis Voltage	V_{HYST}	1.5	3.3	6.5	mV	V_{CM} = V_{SS} **(Note 1)**
Linear Temp. Co. **(Note 2)**	TC_1	—	6.7	—	µV/°C	T_A = -40°C to +125°C, V_{CM} = V_{SS}
Quadratic Temp. Co. **(Note 2)**	TC_2	—	-0.035	—	µV/°C^2	T_A = -40°C to +125°C, V_{CM} = V_{SS}
Input Bias Current	I_B	—	1	—	pA	V_{CM} = V_{SS}
At Temperature (I-Temp parts)	I_B	—	25	100	pA	T_A = +85°C, V_{CM} = V_{SS} **(Note 3)**
At Temperature (E-Temp parts)	I_B	—	1200	5000	pA	T_A = +125°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	

Note 1: The input offset voltage is the center (average) of the input-referred trip points. The input hysteresis is the difference between the input-referred trip points.
2: V_{HYST} at different temperatures is estimated using V_{HYST} (T_A) = V_{HYST} + (T_A - 25°C) TC_1 + (T_A - 25°C)^2 TC_2.
3: Input bias current at temperature is not tested for SC-70-5 package.
4: Limit the output current to Absolute Maximum Rating of 30 mA.

DC CHARACTERISTICS (CONTINUED)

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}, and R_L = 100 kΩ to V_{DD}/2 (Refer to Figure 1-3).

Parameters	Sym	Min	Typ	Max	Units	Conditions
Push-Pull Output						
High-Level Output Voltage	V_{OH}	V_{DD}–0.2	—	—	V	I_{OUT} = -2 mA, V_{DD} = 5V
Low-Level Output Voltage	V_{OL}	—	—	V_{SS}+0.2	V	I_{OUT} = 2 mA, V_{DD} = 5V
Short-Circuit Current	I_{SC}	—	-2.5, +1.5	—	mA	V_{DD} = 1.6V (**Note 4**)
	I_{SC}	—	±30	—	mA	V_{DD} = 5.5V (**Note 4**)

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

2: V_{HYST} at different temperatures is estimated using V_{HYST} (T_A) = V_{HYST} + (T_A - 25°C) TC_1 + (T_A - 25°C)^2 TC_2.

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

4: Limit the output current to Absolute Maximum Rating of 30 mA.

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, and C_L = 36 pF (Refer to Figure 1-2 and Figure 1-3).

Parameters	Sym	Min	Typ	Max	Units	Conditions
Rise Time	t_R	—	0.85	—	µs	
Fall Time	t_F	—	0.85	—	µs	
Propagation Delay (High-to-Low)	t_{PHL}	—	4	8	µs	
Propagation Delay (Low-to-High)	t_{PLH}	—	4	8	µs	
Propagation Delay Skew	t_{PDS}	—	±0.2	—	µs	**(Note 1)**
Maximum Toggle Frequency	f_{MAX}	—	160	—	kHz	V_{DD} = 1.6V
	f_{MAX}	—	120	—	kHz	V_{DD} = 5.5V
Input Noise Voltage	E_{ni}	—	200	—	μV_{P-P}	10 Hz to 100 kHz

Note 1: 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**
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 MCP6541/1R/1U/2/3/4 I-Temp parts operate 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.

1.1 Test Circuit Configuration

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

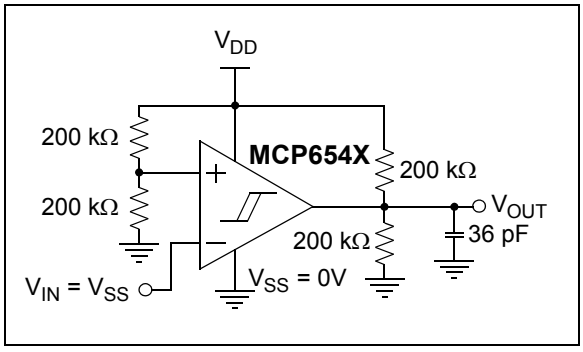
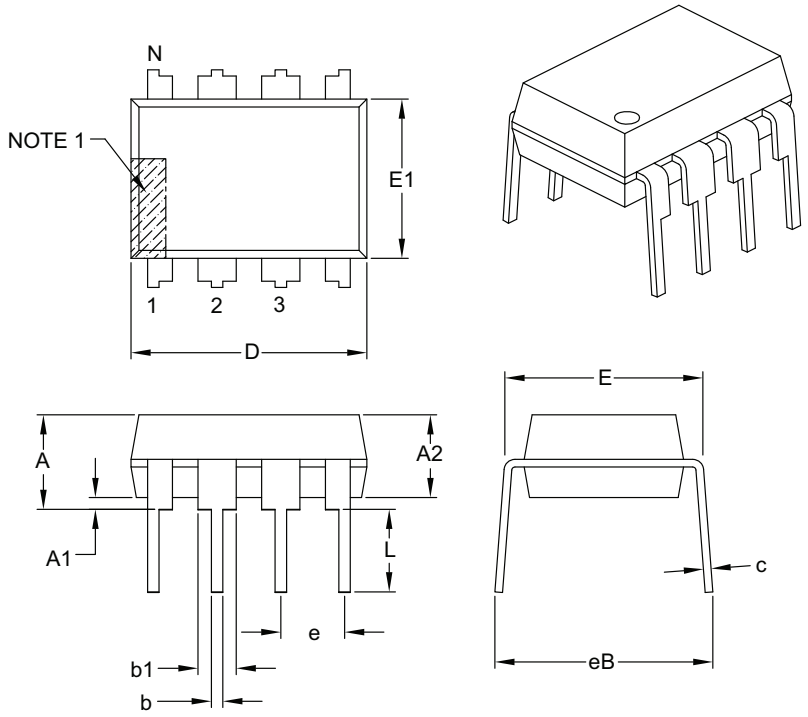


FIGURE 1-3: *AC and DC Test Circuit for the Push-Pull Output Comparators.*

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:

1. Pin 1 visual index feature may vary, but must be located with 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 .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

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

Microchip Technology Drawing C04-018B

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:	MCP6541:	Single Comparator
	MCP6541T:	Single Comparator (Tape and Reel) (SC-70, SOT-23, SOIC, MSOP)
	MCP6541RT:	Single Comparator (Rotated - Tape and Reel) (SOT-23 only)
	MCP6541UT:	Single Comparator (Tape and Reel) **(SOT-23-5 is E-Temp only)**
	MCP6542:	Dual Comparator
	MCP6542T:	Dual Comparator (Tape and Reel for SOIC and MSOP)
	MCP6543:	Single Comparator with $\overline{CS}$
	MCP6543T:	Single Comparator with $\overline{CS}$ (Tape and Reel for SOIC and MSOP)
	MCP6544:	Quad Comparator
	MCP6544T:	Quad Comparator (Tape and Reel for SOIC and TSSOP)
Temperature Range:	I =	-40°C to +85°C
	E * =	-40°C to +125°C
	* SC-70-5 E-Temp parts not available at this release of the data sheet.	
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 (MCP6544)
	ST =	Plastic TSSOP (4.4mm Body), 14-lead (MCP6544)

Examples:

a)	MCP6541T-I/LT:	Tape and Reel, Industrial Temperature, 5LD SC-70.
b)	MCP6541T-I/OT:	Tape and Reel, Industrial Temperature, 5LD SOT-23.
c)	MCP6541-E/P:	Extended Temperature, 8LD PDIP.
d)	MCP6541RT-I/OT:	Tape and Reel, Industrial Temperature, 5LD SOT23.
e)	MCP6541-E/SN:	Extended Temperature, 8LD SOIC.
f)	MCP6541UT-E/OT:	Tape and Reel, Extended Temperature, 5LD SOT23.
a)	MCP6542-I/MS:	Industrial Temperature, 8LD MSOP.
b)	MCP6542T-I/MS:	Tape and Reel, Industrial Temperature, 8LD MSOP.
c)	MCP6542-I/P:	Industrial Temperature, 8LD PDIP.
d)	MCP6542-E/SN:	Extended Temperature, 8LD SOIC.
a)	MCP6543-I/SN:	Industrial Temperature, 8LD SOIC.
b)	MCP6543T-I/SN:	Tape and Reel, Industrial Temperature, 8LD SOIC.
c)	MCP6543-I/P:	Industrial Temperature, 8LD PDIP.
d)	MCP6543-E/SN:	Extended Temperature, 8LD SOIC.
a)	MCP6544T-I/SL:	Tape and Reel, Industrial Temperature, 14LD SOIC.
b)	MCP6544T-E/SL:	Tape and Reel, Extended Temperature, 14LD SOIC.
c)	MCP6544-I/P:	Industrial Temperature, 14LD PDIP.
d)	MCP6544T-E/ST:	Tape and Reel, Extended Temperature, 14LD TSSOP.