MCP6141/2/3/4

600 nA, Non-Unity Gain Rail-to-Rail Input/Output Op Amps

Features:

- Low Quiescent Current: 600 nA/amplifier (typical)
- Gain Bandwidth Product: 100 kHz (typical)
- Stable for gains of 10 V/V or higher
- Rail-to-Rail Input/Output
- Wide Supply Voltage Range: 1.4V to 6.0V
- Available in Single, Dual, and Quad
- Chip Select ($\overline{CS}$) with MCP6143
- Available in 5-lead and 6-lead SOT-23 Packages
- Temperature Ranges:
  - Industrial: -40°C to +85°C
  - Extended: -40°C to +125°C

Applications:

- Toll Booth Tags
- Wearable Products
- Temperature Measurement
- Battery Powered

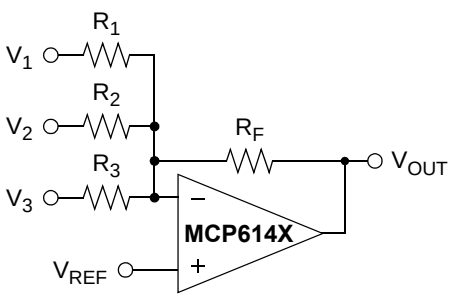
Design Aids:

- SPICE Macro Models
- FilterLab® Software
- Mindi™ Simulation Tool
- MAPS (Microchip Advanced Part Selector)
- Analog Demonstration and Evaluation Boards
- Application Notes

Related Devices:

- MCP6041/2/3/4: Unity Gain Stable Op Amps

Typical Application



Inverting, Summing Amplifier

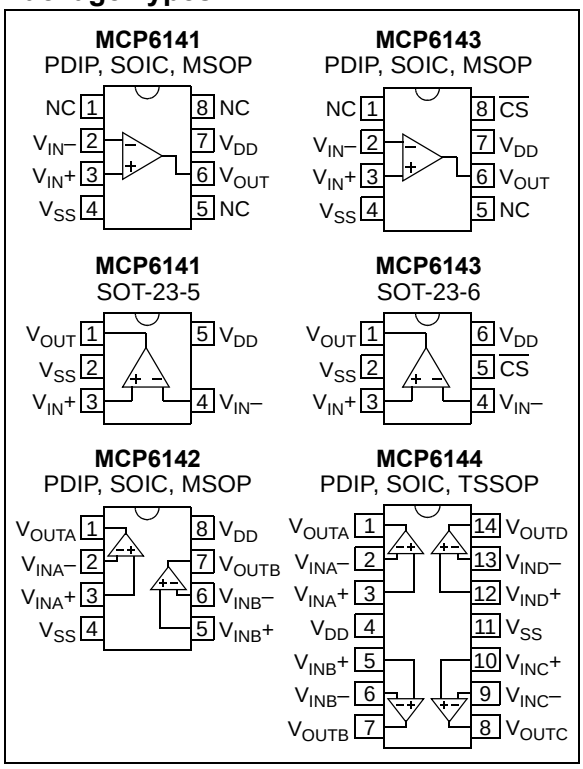
Description:

The MCP6141/2/3/4 family of non-unity gain stable operational amplifiers (op amps) from Microchip Technology Inc. operate with a single supply voltage as low as 1.4V, while drawing less than 1 µA (maximum) of quiescent current per amplifier. These devices are also designed to support rail-to-rail input and output operation. This combination of features supports battery-powered and portable applications.

The MCP6141/2/3/4 amplifiers have a gain bandwidth product of 100 kHz (typical) and are stable for gains of 10 V/V or higher. These specifications make these op amps appropriate for battery powered applications where a higher frequency response from the amplifier is required.

The MCP6141/2/3/4 family operational amplifiers are offered in single (MCP6141), single with Chip Select ($\overline{CS}$) (MCP6143), dual (MCP6142) and quad (MCP6144) configurations. The MCP6141 device is available in the 5-lead SOT-23 package, and the MCP6143 device is available in the 6-lead SOT-23 package.

Package Types



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

$V_{DD} - V_{SS}$ 7.0V
Current at Analog Input Pins.....±2 mA
Analog Inputs (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 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 ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = +1.4V to +5.5V, V_{SS} = GND, T_A = +25°C, V_{CM} = V_{DD}/2, $V_{OUT} \approx V_{DD}/2$, $V_L = V_{DD}/2$, R_L = 1 MΩ to V_L and $\overline{CS}$ is tied low (refer to Figure 1-2 and Figure 1-3).

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input Offset						
Input Offset Voltage	V_{OS}	-3	—	+3	mV	$V_{CM} = V_{SS}$
Drift with Temperature	$\Delta V_{OS}/\Delta T_A$	—	±1.8	—	µV/°C	$V_{CM} = V_{SS}$, T_A= -40°C to +85°C
	$\Delta V_{OS}/\Delta T_A$	—	±10	—	µV/°C	$V_{CM} = V_{SS}$, T_A = +85°C to +125°C
Power Supply Rejection	PSRR	70	85	—	dB	$V_{CM} = V_{SS}$
Input Bias Current and Impedance						
Input Bias Current	I_B	—	1	—	pA	
Industrial Temperature	I_B	—	20	100	pA	T_A = +85°
Extended Temperature	I_B	—	1200	5000	pA	T_A = +125°
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}||6	—	Ω||pF	
Common Mode						
Common-Mode Input Range	V_{CMR}	V_{SS}–0.3	—	V_{DD}+0.3	V	
Common-Mode Rejection Ratio	CMRR	62	80	—	dB	V_{DD} = 5V, V_{CM} = -0.3V to 5.3V
	CMRR	60	75	—	dB	V_{DD} = 5V, V_{CM} = 2.5V to 5.3V
	CMRR	60	80	—	dB	V_{DD} = 5V, V_{CM} = -0.3V to 2.5V
Open-Loop Gain						
DC Open-Loop Gain (large signal)	A_{OL}	95	115	—	dB	R_L = 50 kΩ to V_L, V_{OUT} = 0.1V to V_{DD}–0.1V
Output						
Maximum Output Voltage Swing	V_{OL}, V_{OH}	V_{SS} + 10	—	V_{DD} – 10	mV	R_L = 50 kΩ to V_L, 0.5V output overdrive
Linear Region Output Voltage Swing	V_{OVR}	V_{SS} + 100	—	V_{DD} – 100	mV	R_L = 50 kΩ to V_L, A_{OL} ≥ 95 dB
Output Short Circuit Current	I_{SC}	—	2	—	mA	V_{DD} = 1.4V
	I_{SC}	—	20	—	mA	V_{DD} = 5.5V
Power Supply						
Supply Voltage	V_{DD}	1.4	—	6.0	V	**Note 1**
Quiescent Current per Amplifier	I_Q	0.3	0.6	1.0	µA	I_O = 0

Note 1: All parts with date codes February 2008 and later have been screened to ensure operation at V_{DD} = 6.0V. However, the other minimum and maximum specifications are measured at 1.8V and 5.5V

AC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = +1.4V to +5.5V, V_{SS} = GND, T_A = +25°C, V_{CM} = V_{DD}/2, $V_{OUT} \approx V_{DD}/2$, $V_L = V_{DD}/2$, R_L = 1 MΩ to V_L, C_L = 60 pF and $\overline{CS}$ is tied low (refer to Figure 1-2 and Figure 1-3).

Parameters	Sym	Min	Typ	Max	Units	Conditions
AC Response						
Gain Bandwidth Product	GBWP	—	100	—	kHz	
Slew Rate	SR	—	3.0	—	V/ms	
Phase Margin	PM	—	65	—	°	G = +1
Noise						
Input Voltage Noise	E_{ni}	—	5.0	—	μV_{P-P}	f = 0.1 Hz to 10 Hz
Input Voltage Noise Density	e_{ni}	—	170	—	nV/√Hz	f = 1 kHz
Input Current Noise Density	i_{ni}	—	0.6	—	fA/√Hz	f = 1 kHz

MCP6143 CHIP SELECT ($\overline{CS}$) ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = +1.4V to +5.5V, V_{SS} = GND, T_A = +25°C, V_{CM} = V_{DD}/2, $V_{OUT} \approx V_{DD}/2$, $V_L = V_{DD}/2$, R_L = 1 MΩ to V_L, and C_L = 60 pF (refer to Figure 1-2 and Figure 1-3).

Parameters	Sym	Min	Typ	Max	Units	Conditions
$\overline{CS}$ Low Specifications						
$\overline{CS}$ Logic Threshold, Low	V_{IL}	V_{SS}	—	V_{SS}+0.3	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}	V_{DD}–0.3	—	V_{DD}	V	
$\overline{CS}$ Input Current, High	I_{CSH}	—	5	—	pA	$\overline{CS}$ = V_{DD}
$\overline{CS}$ Input High, GND Current	I_{SS}	—	-20	—	pA	$\overline{CS}$ = V_{DD}
Amplifier Output Leakage, $\overline{CS}$ High	I_{OLEAK}	—	20	—	pA	$\overline{CS}$ = V_{DD}
Dynamic Specifications						
$\overline{CS}$ Low to Amplifier Output Turn-on Time	t_{ON}	—	2	50	ms	G = +1V/V, $\overline{CS}$ = 0.3V to $V_{OUT} = 0.9V_{DD}/2$
$\overline{CS}$ High to Amplifier Output High-Z	t_{OFF}	—	10	—	µs	G = +1V/V, $\overline{CS}$ = V_{DD}–0.3V to $V_{OUT} = 0.1V_{DD}/2$
Hysteresis	V_{HYST}	—	0.6	—	V	V_{DD} = 5.0V

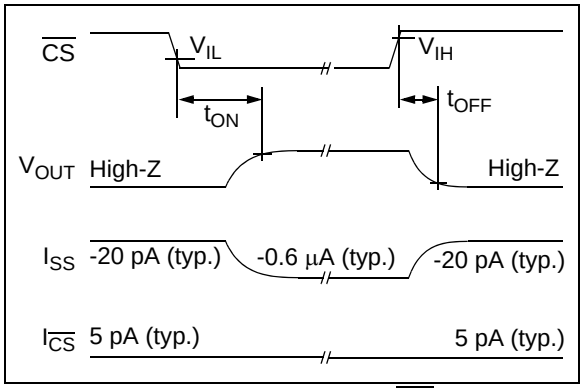


FIGURE 1-1: *Chip Select ($\overline{CS}$) Timing Diagram (MCP6143 only).*

TEMPERATURE CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = +1.4V to +5.5V, V_{SS} = GND.						
Parameters	**Sym.**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Temperature Ranges						
Specified Temperature Range	T_A	-40	—	+85	°C	Industrial Temperature parts
	T_A	-40	—	+125	°C	Extended Temperature parts
Operating Temperature Range	T_A	-40	—	+125	°C	**(Note 1)**
Storage Temperature Range	T_A	-65	—	+150	°C	
Thermal Package Resistances						
Thermal Resistance, 5L-SOT-23	θ_{JA}	—	256	—	°C/W	
Thermal Resistance, 6L-SOT-23	θ_{JA}	—	230	—	°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 1: The MCP6141/2/3/4 family of Industrial Temperature op amps operates over this extended range, but with reduced performance. In any case, the internal Junction Temperature (T_J) must not exceed the Absolute Maximum specification of +150°C.

1.1 Test Circuits

The test circuits used for the DC and AC tests are shown in Figure 1-2 and Figure 1-2. The bypass capacitors are laid out according to the rules discussed in **Section 4.6 "Supply Bypass"**.

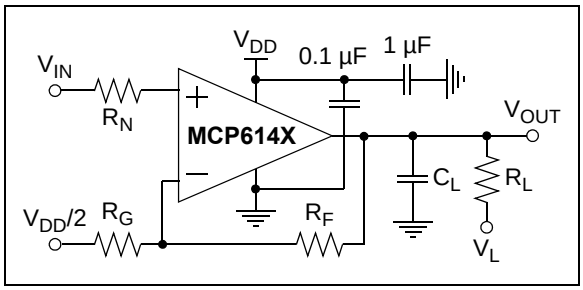


FIGURE 1-2: *AC and DC Test Circuit for Most Non-Inverting Gain Conditions.*

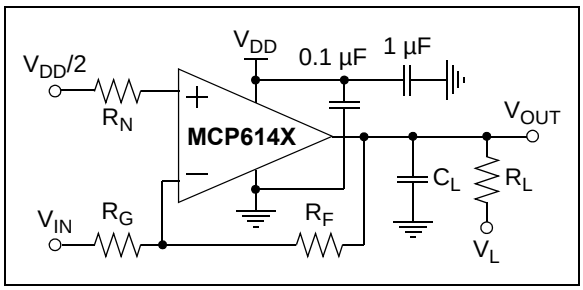
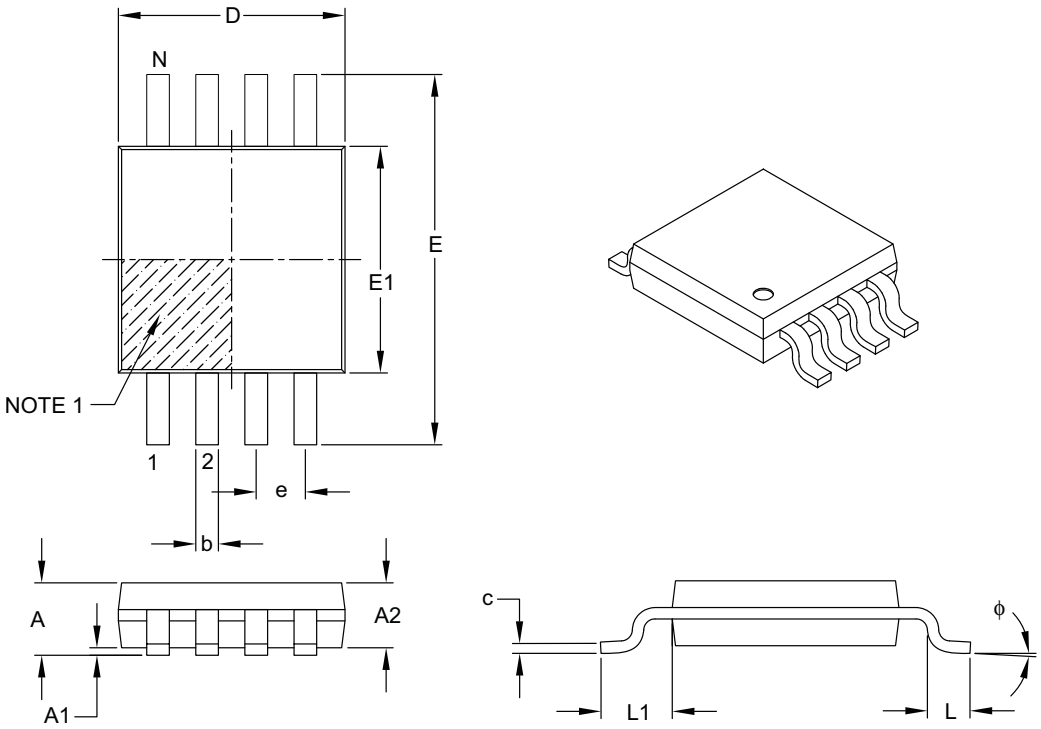


FIGURE 1-3: *AC and DC Test Circuit for Most Inverting Gain Conditions.*

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



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 0.15 mm 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 C04-111B

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:	MCP6141:	Single Op Amp
	MCP6141T:	Single Op Amp (Tape and Reel for SOT-23, SOIC, MSOP)
	MCP6142:	Dual Op Amp
	MCP6142T:	Dual Op Amp (Tape and Reel for SOIC and MSOP)
	MCP6143:	Single Op Amp w/ $\overline{CS}$
	MCP6143T:	Single Op Amp w/ $\overline{CS}$ (Tape and Reel for SOT-23, SOIC, MSOP)
	MCP6144:	Quad Op Amp
	MCP6144T:	Quad Op Amp (Tape and Reel for SOIC and TSSOP)
Temperature Range:	I =	-40°C to +85°C (industrial)
	E =	-40°C to +125°C (extended)
Package:	CH =	Plastic Small Outline Transistor (SOT-23), 6-lead (Tape and Reel - MCP6143 only)
	MS =	Plastic Micro Small Outline (MSOP), 8-lead
	OT =	Plastic Small Outline Transistor (SOT-23), 5-lead (Tape and Reel - MCP6141 only)
	P =	Plastic DIP (300 mil body), 8-lead, 14-lead
	SL =	Plastic SOIC (3.9 mm body), 14-lead
	SN =	Plastic SOIC (3.9 mm body), 8-lead
	ST =	Plastic TSSOP (4.4 mm body), 14-lead

Examples:

a)	MCP6141-I/P:	Industrial Temperature 8 lead PDIP package.
b)	MCP6141T-E/OT:	Tape and Reel, Extended Temperature 5 lead SOT-23 package.
a)	MCP6142-I/SN:	Industrial Temperature 8 lead SOIC package.
b)	MCP6142T-E/MS:	Tape and Reel, Extended Temperature 8 lead MSOP package.
a)	MCP6143-I/P:	Industrial Temperature, 8 lead PDIP package.
b)	MCP6143T-E/CH:	Tape and Reel, Extended Temperature 6 lead SOT-23 package.
a)	MCP6144-I/SL:	Industrial Temperature 14 lead PDIP package.
b)	MCP6144T-E/ST:	Tape and Reel, Extended Temperature 14 lead TSSOP package.