MCP6291/1R/2/3/4/5

1.0 mA, 10 MHz Rail-to-Rail Op Amp

Features

- Gain Bandwidth Product: 10 MHz (typical)
- Supply Current: I_Q = 1.0 mA
- Supply Voltage: 2.4V to 6.0V
- Rail-to-Rail Input/Output
- Extended Temperature Range: -40°C to +125°C
- Available in Single, Dual and Quad Packages
- Single with $\overline{CS}$ (**MCP6293**)
- Dual with $\overline{CS}$ (**MCP6295**)

Applications

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

Design Aids

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

Description

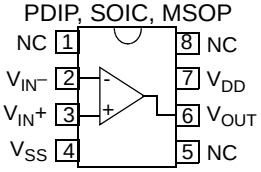
The Microchip Technology Inc. MCP6291/1R/2/3/4/5 family of operational amplifiers (op amps) provide wide bandwidth for the current. This family has a 10 MHz Gain Bandwidth Product (GBWP) and a 65° phase margin. This family also operates from a single supply voltage as low as 2.4V, while drawing 1 mA (typical) quiescent current. In addition, the MCP6291/1R/2/3/4/5 supports rail-to-rail input and output swing, with a common mode input voltage range of V_{DD} + 300 mV to V_{SS} – 300 mV. This family of operational amplifiers is designed with Microchip's advanced CMOS process.

The MCP6295 has a Chip Select ($\overline{CS}$) input for dual op amps in an 8-pin package. This device is manufactured by cascading the two op amps, with the output of op amp A being connected to the non-inverting input of op amp B. The $\overline{CS}$ input puts the device in a Low-power mode.

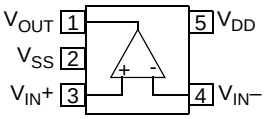
The MCP6291/1R/2/3/4/5 family operates over the Extended Temperature Range of -40°C to +125°C. It also has a power supply range of 2.4V to 6.0V.

Package Types

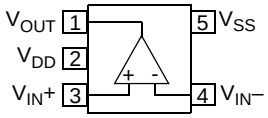
MCP6291
PDIP, SOIC, MSOP



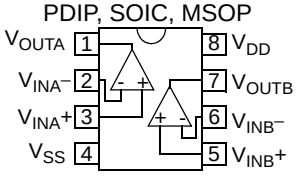
MCP6291
SOT-23-5



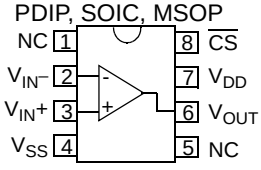
MCP6291R
SOT-23-5



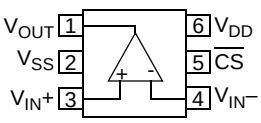
MCP6292
PDIP, SOIC, MSOP



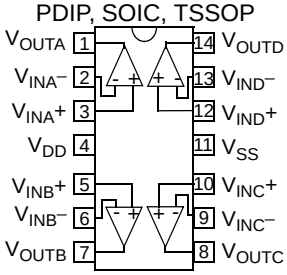
MCP6293
PDIP, SOIC, MSOP



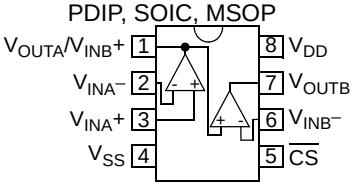
MCP6293
SOT-23-6



MCP6294
PDIP, SOIC, TSSOP



MCP6295
PDIP, SOIC, MSOP



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

$V_{DD} - V_{SS}$ 7.0V
Current at 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 SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = +2.4V to +5.5V, V_{SS} = GND, $V_{OUT} \approx V_{DD}/2$, $V_{CM} = V_{DD}/2$, $V_L = V_{DD}/2$, R_L = 10 kΩ 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}	-3.0	—	+3.0	mV	$V_{CM} = V_{SS}$ **(Note 1)**
Input Offset Voltage (Extended Temperature)	V_{OS}	-5.0	—	+5.0	mV	T_A = -40°C to +125°C, $V_{CM} = V_{SS}$ **(Note 1)**
Input Offset Temperature Drift	$\Delta V_{OS}/\Delta T_A$	—	±1.7	—	µV/°C	T_A = -40°C to +125°C, $V_{CM} = V_{SS}$ **(Note 1)**
Power Supply Rejection Ratio	PSRR	70	90	—	dB	$V_{CM} = V_{SS}$ **(Note 1)**
Input Bias, Input Offset Current and Impedance						
Input Bias Current	I_B	—	±1.0	—	pA	**Note 2**
At Temperature	I_B	—	50	200	pA	T_A = +85°C **(Note 2)**
At Temperature	I_B	—	2	5	nA	T_A = +125°C **(Note 2)**
Input Offset Current	I_{OS}	—	±1.0	—	pA	**Note 3**
Common Mode Input Impedance	Z_{CM}	—	10^{13}||6	—	Ω||pF	**Note 3**
Differential Input Impedance	Z_{DIFF}	—	10^{13}||3	—	Ω||pF	**Note 3**
Common Mode (Note 4)						
Common Mode Input Range	V_{CMR}	V_{SS} – 0.3	—	V_{DD} + 0.3	V	
Common Mode Rejection Ratio	CMRR	70	85	—	dB	V_{CM} = -0.3V to 2.5V, V_{DD} = 5V
Common Mode Rejection Ratio	CMRR	65	80	—	dB	V_{CM} = -0.3V to 5.3V, V_{DD} = 5V
Open-Loop Gain						
DC Open-Loop Gain (Large Signal)	A_{OL}	90	110	—	dB	V_{OUT} = 0.2V to V_{DD} – 0.2V, $V_{CM} = V_{SS}$ **(Note 1)**
Output						
Maximum Output Voltage Swing	V_{OL}, V_{OH}	V_{SS} + 15	—	V_{DD} – 15	mV	0.5V Input Overdrive
Output Short Circuit Current	I_{SC}	—	±25	—	mA	
Power Supply						
Supply Voltage	V_{DD}	2.4	—	6.0	V	T_A = -40°C to +125°C **(Note 5)**
Quiescent Current per Amplifier	I_Q	0.7	1.0	1.3	mA	I_O = 0

Note 1: The MCP6295's V_{CM} for op amp B (pins V_{OUTA}/V_{INB}+ and V_{INB}–) is V_{SS} + 100 mV.
2: The current at the MCP6295's V_{INB}– pin is specified by I_B only.
3: This specification does not apply to the MCP6295's V_{OUTA}/V_{INB}+ pin.
4: The MCP6295's V_{INB}– pin (op amp B) has a common mode range (V_{CMR}) of V_{SS} + 100 mV to V_{DD} – 100 mV. The MCP6295's V_{OUTA}/V_{INB}+ pin (op amp B) has a voltage range specified by V_{OH} and V_{OL}.
5: All parts with date codes November 2007 and later have been screened to ensure operation at V_{DD} = 6.0V. However, the other minimum and maximum specifications are measured at 2.4V and or 5.5V.

AC ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = +2.4V to +5.5V, 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, 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	—	10.0	—	MHz	
Phase Margin at Unity-Gain	PM	—	65	—	°	G = +1 V/V
Slew Rate	SR	—	7	—	V/µs	
Noise						
Input Noise Voltage	E_{ni}	—	4.2	—	μV_{P-P}	f = 0.1 Hz to 10 Hz
Input Noise Voltage Density	e_{ni}	—	8.7	—	nV/√Hz	f = 10 kHz
Input Noise Current Density	i_{ni}	—	3	—	fA/√Hz	f = 1 kHz

MCP6293/MCP6295 CHIP SELECT ($\overline{CS}$) SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, T_A = +25°C, V_{DD} = +2.4V to +5.5V, 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, 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
$\overline{CS}$ Low Specifications						
$\overline{CS}$ Logic Threshold, Low	V_{IL}	V_{SS}	—	0.2 V_{DD}	V	
$\overline{CS}$ Input Current, Low	I_{CSL}	—	0.01	—	µA	$\overline{CS}$ = V_{SS}
$\overline{CS}$ High Specifications						
$\overline{CS}$ Logic Threshold, High	V_{IH}	0.8 V_{DD}	—	V_{DD}	V	
$\overline{CS}$ Input Current, High	I_{CSH}	—	0.7	2	µA	$\overline{CS}$ = V_{DD}
GND Current per Amplifier	I_{SS}	—	-0.7	—	µA	$\overline{CS}$ = V_{DD}
Amplifier Output Leakage	—	—	0.01	—	µA	$\overline{CS}$ = V_{DD}
Dynamic Specifications (Note 1)						
$\overline{CS}$ Low to Valid Amplifier Output, Turn-on Time	t_{ON}	—	4	10	µs	$\overline{CS}$ Low ≤ 0.2 V_{DD}, G = +1 V/V, V_{IN} = $V_{DD}/2$, V_{OUT} = 0.9 $V_{DD}/2$, V_{DD} = 5.0V
$\overline{CS}$ High to Amplifier Output High-Z	t_{OFF}	—	0.01	—	µs	$\overline{CS}$ High ≥ 0.8 V_{DD}, G = +1 V/V, V_{IN} = $V_{DD}/2$, V_{OUT} = 0.1 $V_{DD}/2$
Hysteresis	V_{HYST}	—	0.6	—	V	V_{DD} = 5V

Note 1: The input condition (V_{IN}) specified applies to both op amp A and B of the MCP6295. The dynamic specification is tested at the output of op amp B (V_{OUTB}).

TEMPERATURE SPECIFICATIONS

Electrical Characteristics: Unless otherwise indicated, V_{DD} = +2.4V to +5.5V and V_{SS} = GND.						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Temperature Ranges						
Operating Temperature Range	T_A	-40	—	+125	°C	**Note**
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: The Junction Temperature (T_J) must not exceed the Absolute Maximum specification of +150°C.

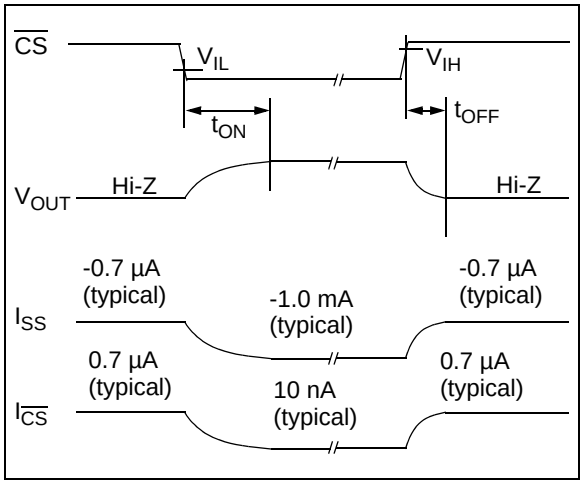


FIGURE 1-1: *Timing Diagram for the Chip Select ($\overline{CS}$) pin on the MCP6293 and MCP6295.*

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"**.

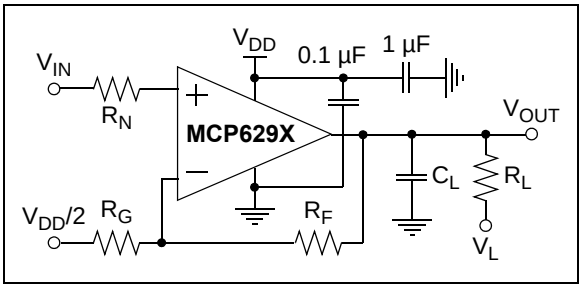


FIGURE 1-2: *AC and DC Test Circuit for Most Non-Inverting Gain Conditions.*

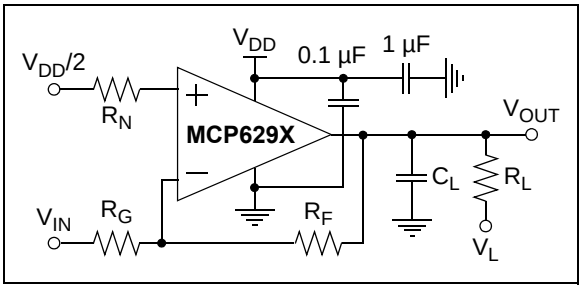
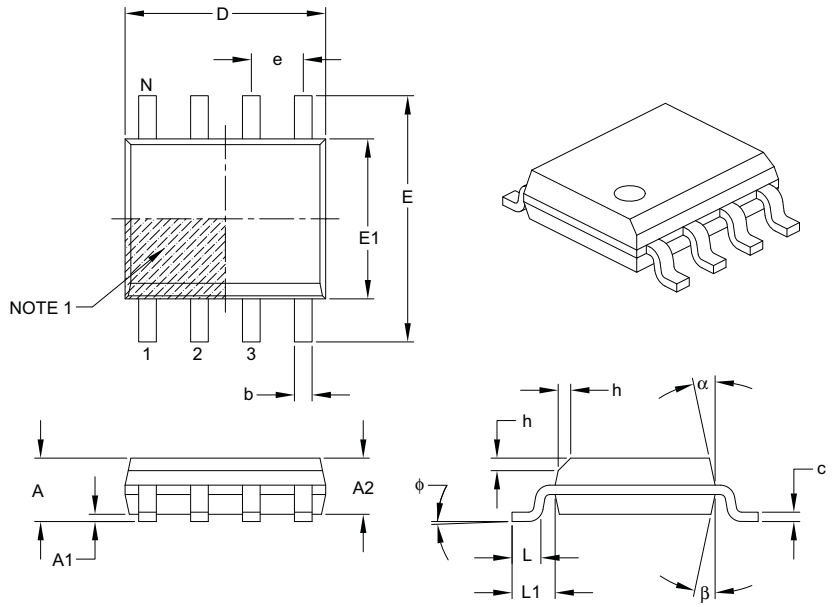


FIGURE 1-3: *AC and DC Test Circuit for Most Inverting Gain Conditions.*

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



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 0.15 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.

Microchip Technology Drawing C04-057B

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:	MCP6291:	Single Op Amp
	MCP6291T:	Single Op Amp (Tape and Reel) (SOIC, MSOP, SOT-23-5)
	MCP6291RT:	Single Op Amp (Tape and Reel) (SOT-23-5)
	MCP6292:	Dual Op Amp
	MCP6292T:	Dual Op Amp (Tape and Reel) (SOIC, MSOP)
	MCP6293:	Single Op Amp with Chip Select
	MCP6293T:	Single Op Amp with Chip Select (Tape and Reel) (SOIC, MSOP, SOT-23-6)
	MCP6294:	Quad Op Amp
	MCP6294T:	Quad Op Amp (Tape and Reel) (SOIC, TSSOP)
	MCP6295:	Dual Op Amp with Chip Select
	MCP6295T:	Dual Op Amp with Chip Select (Tape and Reel) (SOIC, MSOP)
Temperature Range:	E =	-40° C to +125° C
Package:	OT =	Plastic Small Outline Transistor (SOT-23), 5-lead (MCP6291, MCP6291R)
	CH =	Plastic Small Outline Transistor (SOT-23), 6-lead (MCP6293)
	MS =	Plastic MSOP, 8-lead
	P =	Plastic DIP (300 mil body), 8-lead, 14-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)	MCP6291-E/SN:	Extended Temperature, 8 lead SOIC package.
b)	MCP6291-E/MS:	Extended Temperature, 8 lead MSOP package.
c)	MCP6291-E/P:	Extended Temperature, 8 lead PDIP package.
d)	MCP6291T-E/OT:	Tape and Reel, Extended Temperature, 5 lead SOT-23 package.
e)	MCP6291RT-E/OT:	Tape and Reel, Extended Temperature, 5 lead SOT-23 package.
a)	MCP6292-E/SN:	Extended Temperature, 8 lead SOIC package.
b)	MCP6292-E/MS:	Extended Temperature, 8 lead MSOP package.
c)	MCP6292-E/P:	Extended Temperature, 8 lead PDIP package.
d)	MCP6292T-E/SN:	Tape and Reel, Extended Temperature, 8 lead SOIC package.
a)	MCP6293-E/SN:	Extended Temperature, 8 lead SOIC package.
b)	MCP6293-E/MS:	Extended Temperature, 8 lead MSOP package.
c)	MCP6293-E/P:	Extended Temperature, 8 lead PDIP package.
d)	MCP6293T-E/CH:	Tape and Reel, Extended Temperature, 6 lead SOT-23 package.
a)	MCP6294-E/P:	Extended Temperature, 14 lead PDIP package.
b)	MCP6294T-E/SL:	Tape and Reel, Extended Temperature, 14 lead SOIC package.
c)	MCP6294-E/SL:	Extended Temperature, 14 lead SOIC package.
d)	MCP6294-E/ST:	Extended Temperature, 14 lead TSSOP package.
a)	MCP6295-E/SN:	Extended Temperature, 8 lead SOIC package.
b)	MCP6295-E/MS:	Extended Temperature, 8 lead MSOP package.
c)	MCP6295-E/P:	Extended Temperature, 8 lead PDIP package.
d)	MCP6295T-E/SN:	Tape and Reel, Extended Temperature, 8 lead SOIC package.