



# MICROCHIP MCP6231/1R/1U/2/4

## 20 $\mu$ A, 300 kHz Rail-to-Rail Op Amp

### Features

- Gain Bandwidth Product: 300 kHz (typical)
- Supply Current:  $I_Q = 20 \mu\text{A}$  (typical)
- Supply Voltage: 1.8V to 6.0V
- Rail-to-Rail Input/Output
- Extended Temperature Range:  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$
- Available in 5-Pin SC-70 and SOT-23 packages

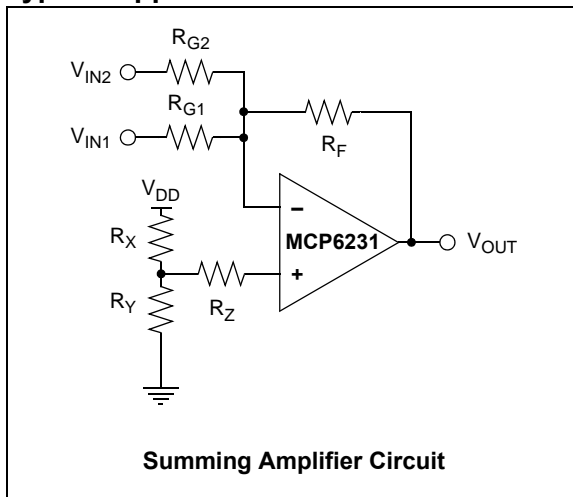
### Applications

- Automotive
- Portable Equipment
- Transimpedance amplifiers
- Analog Filters
- Notebooks and PDAs
- Battery-Powered Systems

### Design Aids

- SPICE Macro Models
- FilterLab<sup>®</sup> Software
- Mindi<sup>™</sup> Circuit Designer & Simulator
- Microchip Advanced Part Selector (MAPS)
- Analog Demonstration and Evaluation Boards
- Application Notes

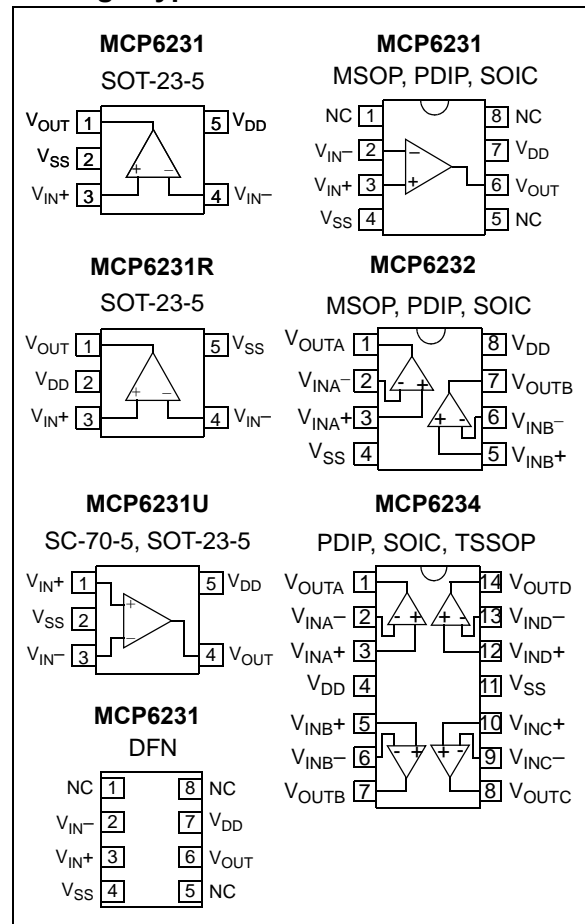
### Typical Application



### Description

The Microchip Technology Inc. MCP6231/1R/1U/2/4 operational amplifiers (op amps) provide wide bandwidth for the quiescent current. The MCP6231/1R/1U/2/4 family has a 300 kHz gain bandwidth product and  $65^\circ\text{C}$  (typical) phase margin. This family operates from a single supply voltage as low as 1.8V, while drawing 20  $\mu\text{A}$  (typical) quiescent current. In addition, the MCP6231/1R/1U/2/4 family supports rail-to-rail input and output swing, with a common mode input voltage range of  $V_{DD} + 300 \text{ mV}$  to  $V_{SS} - 300 \text{ mV}$ . These op amps are designed in one of Microchip's advanced CMOS processes.

### Package Types



# MCP6231/1R/1U/2/4

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

$V_{DD} - V_{SS}$ .....	7.0V
Current at Analog Input Pins ( $V_{IN+}$ , $V_{IN-}$ ) .....	$\pm 2$ 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 .....	$\pm 30$ 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) .....	$\geq 4$ kV; 300V

† **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, $T_A = +25^{\circ}C$ , $V_{DD} = +1.8V$ to $+5.5V$ , $V_{SS} = GND$ , $V_{CM} = V_{DD}/2$ , $R_L = 100$ k $\Omega$ to $V_{DD}/2$ and $V_{OUT} \approx V_{DD}/2$ .						
Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Input Offset</b>						
Input Offset Voltage	$V_{OS}$	-5.0	—	+5.0	mV	$V_{CM} = V_{SS}$
Extended Temperature	$V_{OS}$	-7.0	—	+7.0	mV	$T_A = -40^{\circ}C$ to $+125^{\circ}C$ , $V_{CM} = V_{SS}$ ( <b>Note</b> )
Input Offset Drift with Temperature	$\Delta V_{OS}/\Delta T_A$	—	$\pm 3.0$	—	$\mu V/^{\circ}C$	$T_A = -40^{\circ}C$ to $+125^{\circ}C$ , $V_{CM} = V_{SS}$
Power Supply Rejection Ratio	PSRR	—	83	—	dB	$V_{CM} = V_{SS}$
<b>Input Bias Current and Impedance</b>						
Input Bias Current:	$I_B$	—	$\pm 1.0$	—	pA	
At Temperature	$I_B$	—	20	—	pA	$T_A = +85^{\circ}C$
At Temperature	$I_B$	—	1100	—	pA	$T_A = +125^{\circ}C$
Input Offset Current	$I_{OS}$	—	$\pm 1.0$	—	pA	
Common Mode Input Impedance	$Z_{CM}$	—	$10^{13}  6$	—	$\Omega  pF$	
Differential Input Impedance	$Z_{DIFF}$	—	$10^{13}  3$	—	$\Omega  pF$	
<b>Common Mode</b>						
Common Mode Input Range	$V_{CMR}$	$V_{SS} - 0.3$	—	$V_{DD} + 0.3$	V	
Common Mode Rejection Ratio	CMRR	61	75	—	dB	$V_{CM} = -0.3V$ to $5.3V$ , $V_{DD} = 5V$
<b>Open-Loop Gain</b>						
DC Open-Loop Gain (large signal)	$A_{OL}$	90	110	—	dB	$V_{OUT} = 0.3V$ to $V_{DD} - 0.3V$ , $V_{CM} = V_{SS}$
<b>Output</b>						
Maximum Output Voltage Swing	$V_{OL}$ , $V_{OH}$	$V_{SS} + 35$	—	$V_{DD} - 35$	mV	$R_L = 10$ k $\Omega$ , 0.5V Input Overdrive
Output Short-Circuit Current	$I_{SC}$	—	$\pm 6$	—	mA	$V_{DD} = 1.8V$
	$I_{SC}$	—	$\pm 23$	—	mA	$V_{DD} = 5.5V$
<b>Power Supply</b>						
Supply Voltage	$V_{DD}$	1.8	—	6.0	V	
Quiescent Current per Amplifier	$I_Q$	10	20	30	$\mu A$	$I_O = 0$ , $V_{CM} = V_{DD} - 0.5V$

**Note 1:** The SC-70 package is only tested at  $+25^{\circ}C$ .

**Note 2:** All parts with date codes February 2007 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,  $T_A = +25^\circ\text{C}$ ,  $V_{DD} = +1.8$  to  $5.5\text{V}$ ,  $V_{SS} = \text{GND}$ ,  $V_{CM} = V_{DD}/2$ ,  $V_{OUT} \approx V_{DD}/2$ ,  $R_L = 100\text{ k}\Omega$  to  $V_{DD}/2$  and  $C_L = 60\text{ pF}$ .

Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>AC Response</b>						
Gain Bandwidth Product	GBWP	—	300	—	kHz	
Phase Margin	PM	—	65	—	°	$G = +1\text{ V/V}$
Slew Rate	SR	—	0.15	—	$\text{V}/\mu\text{s}$	
<b>Noise</b>						
Input Noise Voltage	$E_{ni}$	—	6.0	—	$\mu\text{V}_{\text{P-P}}$	$f = 0.1\text{ Hz to }10\text{ Hz}$
Input Noise Voltage Density	$e_{ni}$	—	52	—	$\text{nV}/\sqrt{\text{Hz}}$	$f = 1\text{ kHz}$
Input Noise Current Density	$i_{ni}$	—	0.6	—	$\text{fA}/\sqrt{\text{Hz}}$	$f = 1\text{ kHz}$

## TEMPERATURE CHARACTERISTICS

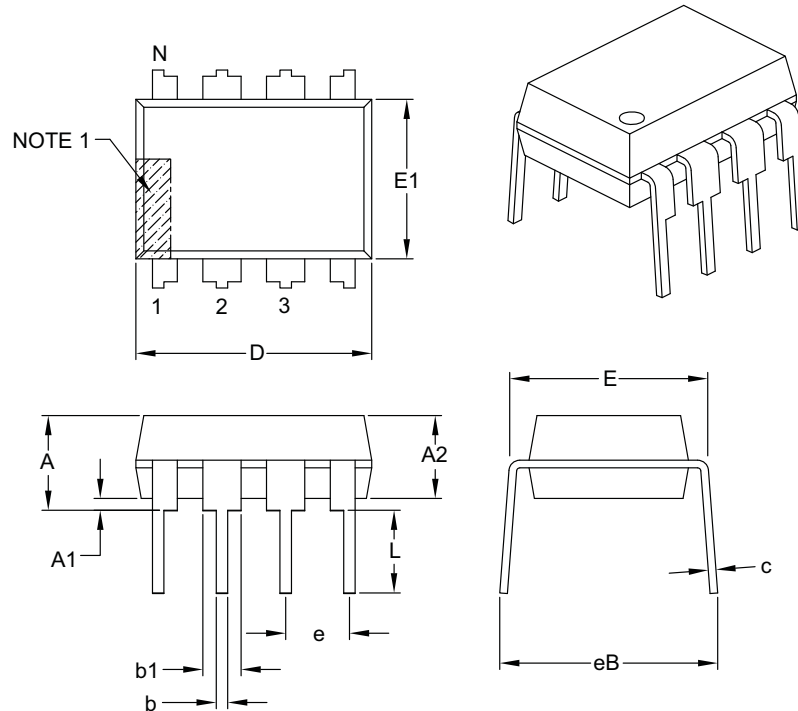
**Electrical Characteristics:** Unless otherwise indicated,  $V_{DD} = +1.8\text{V}$  to  $+5.5\text{V}$  and  $V_{SS} = \text{GND}$ .

Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Temperature Ranges</b>						
Extended Temperature Range	$T_A$	-40	—	+125	°C	
Operating Temperature Range	$T_A$	-40	—	+125	°C	<b>Note</b>
Storage Temperature Range	$T_A$	-65	—	+150	°C	
<b>Thermal Package Resistances</b>						
Thermal Resistance, 5L-SC70	$\theta_{JA}$	—	331	—	°C/W	
Thermal Resistance, 5L-SOT-23	$\theta_{JA}$	—	256	—	°C/W	
Thermal Resistance, 8L-DFN	$\theta_{JA}$	—	84.5	—	°C/W	
Thermal Resistance, 8L-MSOP	$\theta_{JA}$	—	206	—	°C/W	
Thermal Resistance, 8L-PDIP	$\theta_{JA}$	—	85	—	°C/W	
Thermal Resistance, 8L-SOIC	$\theta_{JA}$	—	163	—	°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 internal Junction Temperature ( $T_J$ ) must not exceed the Absolute Maximum specification of  $+150^\circ\text{C}$ .

# MCP6231/1R/1U/2/4

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



Dimension Limits	Units	INCHES		
		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

## 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>-X</u>	<u>/XX</u>	<b>Examples:</b>
Device	Tape and Reel and/or Alternate Pinout	Temperature Range	Package	
Device:	MCP6231: MCP6231T:	Single Op Amp (MSOP, PDIP, SOIC) Single Op Amp (Tape and Reel) (MSOP, SOIC, SOT-23)		a) MCP6231-E/MC: Extended Temperature 8LD DFN package.
	MCP6231RT:	Single Op Amp (Tape and Reel) (SOT-23)		b) MCP6231-E/MS: Extended Temperature 8LD MSOP package.
	MCP6231UT:	Single Op Amp (Tape and Reel) (SC-70, SOT-23)		c) MCP6231UT-E/LT: Tape and Reel, Extended Temperature 5LD SC-70 package
	MCP6232: MCP6232T:	Dual Op Amp Dual Op Amp (Tape and Reel) (MSOP, SOIC)		d) MCP6231-E/P: Extended Temperature 8LD PDIP package.
	MCP6234: MCP6234T:	Quad Op Amp Quad Op Amp (Tape and Reel) (TSSOP, SOIC)		e) MCP6231RT-E/OT: Tape and Reel, Extended Temperature 5LD SOT-23 package
Temperature Range:	E	= -40° C to +125° C		f) MCP6231UT-E/OT: Tape and Reel, Extended Temperature 5LD SOT-23.
Package:	LT	= Plastic Package (SC-70), 5-lead (MCP6231U only)		g) MCP6231-E/SN: Extended Temperature 8LD SOIC package.
	MC	= Plastic Dual Flat No-Lead (DFN) 2x3, 8-lead (MCP6231 only)		a) MCP6232-E/SN: Extended Temperature 8LD SOIC package.
	MS	= Plastic Micro Small Outline (MSOP), 8-lead		b) MCP6232-E/MS: Extended Temperature 8LD MSOP package.
	P	= Plastic DIP (300 mil Body), 8-lead, 14-lead		c) MCP6232-E/P: Extended Temperature 8LD PDIP package
	OT	= Plastic Small Outline Transistor (SOT-23), 5-lead (MCP6231, MCP6231R, MCP6231U)		d) MCP6232T-E/SN: Tape and Reel, Extended Temperature 8LD SOIC package
	SN	= Plastic SOIC (150 mil Body), 8-lead		a) MCP6234-E/P: Extended Temperature 14LD PDIP package
	SL	= Plastic SOIC (150 mil Body), 14-lead		b) MCP6234-E/SL: Extended Temperature 14LD SOIC package
	ST	= Plastic TSSOP (4.4 mil Body), 14-lead		c) MCP6234-E/ST: Extended Temperature, 14LD TSSOP package
				d) MCP6234T-E/SL: Tape and Reel, Extended Temperature 14LD SOIC package
				e) MCP6234T-E/ST: Tape and Reel, Extended Temperature 14LD TSSOP package