



# MICROCHIP MCP6241/1R/1U/2/4

## 50 $\mu$ A, 550 kHz Rail-to-Rail Op Amp

### Features

- Gain Bandwidth Product: 550 kHz (typical)
- Supply Current:  $I_Q = 50 \mu\text{A}$  (typical)
- Supply Voltage: 1.8V to 5.5V
- 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

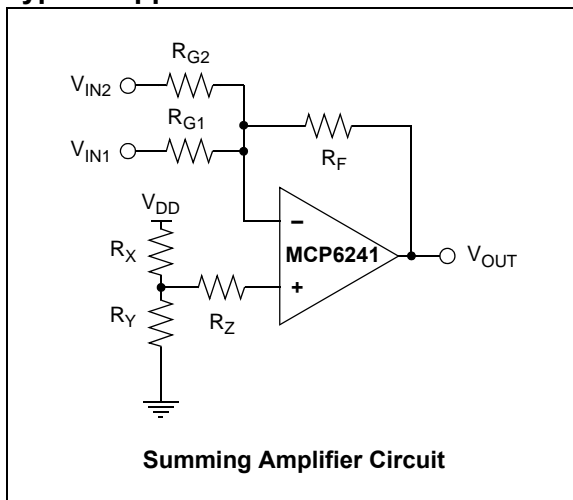
### Applications

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

### Design Aids

- SPICE Macro Models
- Mindi™ Circuit Designer & Simulator
- Microchip Advanced Part Selector (MAPS)
- Analog Demonstration and Evaluation Boards
- Application Notes

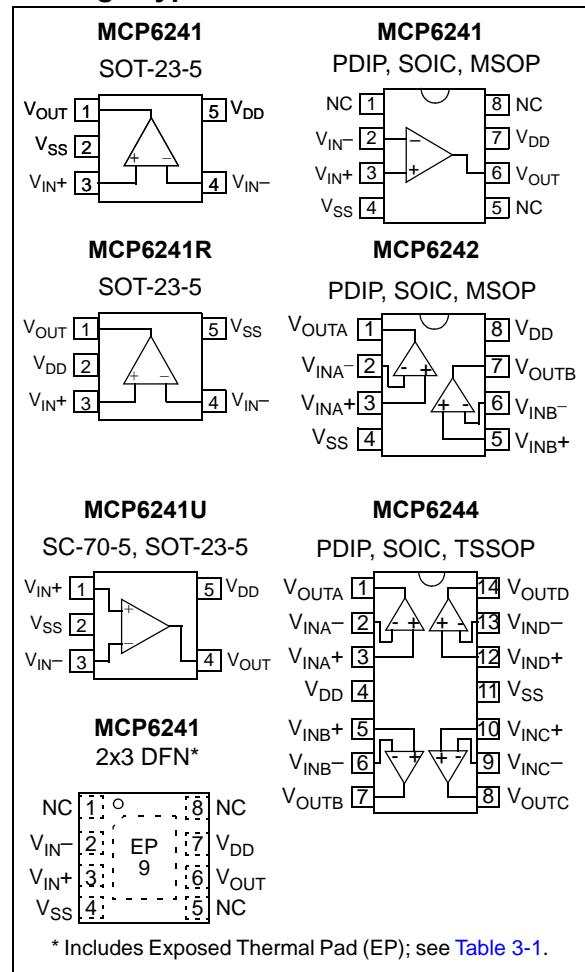
### Typical Application



### Description

The Microchip Technology Inc. MCP6241/1R/1U/2/4 operational amplifiers (op amps) provide wide bandwidth for the quiescent current. The MCP6241/1R/1U/2/4 has a 550 kHz gain bandwidth product and  $68^\circ$  (typical) phase margin. This family operates from a single supply voltage as low as 1.8V, while drawing 50  $\mu\text{A}$  (typical) quiescent current. In addition, the MCP6241/1R/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



## 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 $+125^{\circ}C$ ,<br>$V_{CM} = V_{SS}$ ( <b>Note 1</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 $+125^{\circ}C$ ,<br>$V_{CM} = V_{SS}$                   |
| Power Supply Rejection                  | 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                       | 60             | 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 $V_{DD} - 0.3V$ ,<br>$V_{CM} = V_{SS}$                       |
| <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            | —            | 5.5            | V                 |  |
| Quiescent Current per Amplifier         | $I_Q$                      | 30             | 50           | 70             | $\mu A$           | $I_O = 0$ , $V_{CM} = V_{DD} - 0.5V$   |

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

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## AC ELECTRICAL CHARACTERISTICS

**Electrical Characteristics:** Unless otherwise indicated,  $T_A = +25^\circ\text{C}$ ,  $V_{DD} = +1.8$  to  $5.5\text{V}$ ,  $V_{SS} = \text{GND}$ ,  $V_{CM} = V_{DD}/2$ ,  $V_{OUT} \approx V_{DD}/2$ ,  $R_L = 10\text{ k}\Omega$  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     | —   | 550  | —   | kHz                          |                                     |
| Phase Margin                | PM       | —   | 68   | —   | °                            | $G = +1\text{ V/V}$                 |
| Slew Rate                   | SR       | —   | 0.30 | —   | $\text{V}/\mu\text{s}$       |                                     |
| <b>Noise</b>                |          |     |      |     |                              |                                     |
| Input Noise Voltage         | $E_{ni}$ | —   | 10   | —   | $\mu\text{V}_{\text{P-P}}$   | $f = 0.1\text{ Hz to }10\text{ Hz}$ |
| Input Noise Voltage Density | $e_{ni}$ | —   | 45   | —   | $\text{nV}/\sqrt{\text{Hz}}$ | $f = 1\text{ kHz}$                  |
| Input Noise Current Density | $i_{ni}$ | —   | 0.6  | —   | $\text{fA}/\sqrt{\text{Hz}}$ | $f = 1\text{ kHz}$                  |

## TEMPERATURE CHARACTERISTICS

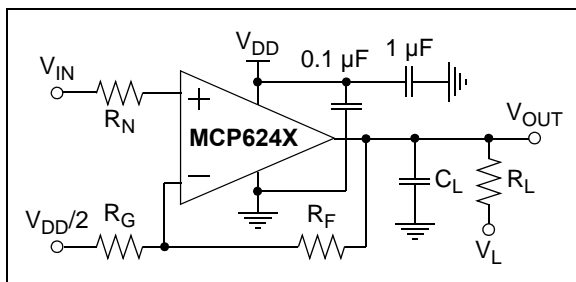
**Electrical Characteristics:** Unless otherwise indicated,  $V_{DD} = +1.8\text{V to }+5.5\text{V}$  and  $V_{SS} = \text{GND}$ .

| 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 (2x3)   | $\theta_{JA}$ | —   | 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  |               |

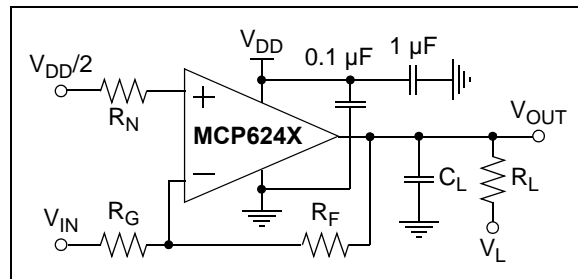
**Note:** The internal Junction Temperature ( $T_J$ ) must not exceed the Absolute Maximum specification of  $+150^\circ\text{C}$ .

### 1.1 Test Circuits

The test circuits used for the DC and AC tests are shown in [Figure 1-1](#) and [Figure 1-2](#). The bypass capacitors are laid out according to the rules discussed in [Section 4.6 “PCB Surface Leakage”](#).



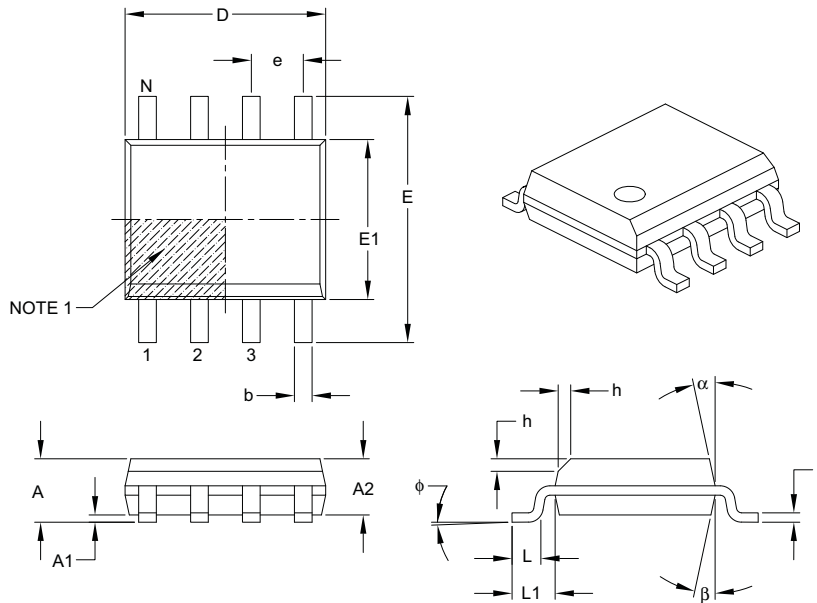
**FIGURE 1-1:** AC and DC Test Circuit for Most Non-Inverting Gain Conditions.



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

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



| Dimension Limits         | Units    | MILLIMETERS |     |      |
|--------------------------|----------|-------------|-----|------|
|                          |          | 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               | $\phi$   | 0°          | –   | 8°   |
| Lead Thickness           | c        | 0.17        | –   | 0.25 |
| Lead Width               | b        | 0.31        | –   | 0.51 |
| Mold Draft Angle Top     | $\alpha$ | 5°          | –   | 15°  |
| Mold Draft Angle Bottom  | $\beta$  | 5°          | –   | 15°  |

### Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- § Significant Characteristic.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
- 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

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## 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>  |
|--------------------|--|--|----------------|---|
| <b>Device</b>      | <b>Tape and Reel and/or Alternate Pinout</b>   | <b>Temperature Range</b>   | <b>Package</b> |   |
| Device:            | MCP6241: Single Op Amp (MSOP, PDIP, SOIC)<br>MCP6241T: Single Op Amp (Tape and Reel) (MSOP, SOIC, SOT-23)  | Single Op Amp (MSOP, PDIP, SOIC)<br>Single Op Amp (Tape and Reel) (MSOP, SOIC, SOT-23) |                | a) MCP6241-E/SN: Extended Temp., 8LD SOIC package.                    |
|                    | MCP6241RT: Single Op Amp (Tape and Reel) (SOT-23)  | Single Op Amp (Tape and Reel) (SOT-23)   |                | b) MCP6241-E/MS: Extended Temp., 8LD MSOP package.                    |
|                    | MCP6241UT: Single Op Amp (Tape and Reel) (SC-70, SOT-23)   | Single Op Amp (Tape and Reel) (SC-70, SOT-23)  |                | c) MCP6241-E/P: Extended Temp., 8LD PDIP package.                     |
|                    | MCP6242: Dual Op Amp<br>MCP6242T: Dual Op Amp (Tape and Reel) (MSOP, SOIC)   | Dual Op Amp<br>Dual Op Amp (Tape and Reel) (MSOP, SOIC)                                |                | d) MCP6241-E/MC: Extended Temp., 8LD DFN package.                     |
|                    | MCP6244: Quad Op Amp<br>MCP6244T: Quad Op Amp (Tape and Reel) (SOIC, TSSOP)  | Quad Op Amp (Tape and Reel) (SOIC, TSSOP)  |                | e) MCP6241RT-E/OT: Tape and Reel, Extended Temp., 5LD SOT-23 package  |
| Temperature Range: | E = -40° C to +125° C  |  |                | f) MCP6241UT-E/OT: Tape and Reel, Extended Temp., 5LD SOT-23 package. |
| Package:           | LT = Plastic Package (SC-70), 5-lead (MCP6241U only)<br>MC = Plastic Dual Flat, No Lead (DFN), 8-lead, (MCP6241 only)<br>MS = Plastic Micro Small Outline (MSOP), 8-lead<br>P = Plastic DIP (300 mil Body), 8-lead, 14-lead<br>OT = Plastic Small Outline Transistor (SOT-23), 5-lead (MCP6241, MCP6241R, MCP6241U)<br>SN = Plastic SOIC (150 mil Body), 8-lead<br>SL = Plastic SOIC (150 mil Body), 14-lead<br>ST = Plastic TSSOP (4.4 mil Body), 14-lead |  |                | g) MCP6241UT-E/LT: Tape and Reel, Extended Temp., 5LD SC-70 package.  |
|                    |  |  |                | a) MCP6242-E/SN: Extended Temp., 8LD SOIC package.                    |
|                    |  |  |                | b) MCP6242-E/MS: Extended Temp., 8LD MSOP package.                    |
|                    |  |  |                | c) MCP6242-E/P: Extended Temp., 8LD PDIP package.                     |
|                    |  |  |                | d) MCP6242T-E/SN: Tape and Reel, Extended Temp., 8LD SOIC package.    |
|                    |  |  |                | a) MCP6244-E/P: Extended Temp., 14LD PDIP package.                    |
|                    |  |  |                | b) MCP6244-E/SL: Extended Temp., 14LD SOIC package.                   |
|                    |  |  |                | c) MCP6244-E/ST: Extended Temp., 14LD TSSOP package.                  |
|                    |  |  |                | d) MCP6244T-E/SL: Tape and Reel, Extended Temp., 14LD SOIC package.   |
|                    |  |  |                | e) MCP6244T-E/ST: Tape and Reel, Extended Temp., 14LD TSSOP package.  |