

## LM6152/LM6154

# Dual and Quad 75 MHz GBW Rail-to-Rail I/O Operational Amplifiers

### General Description

Using patented circuit topologies, the LM6152/LM6154 provides new levels of speed vs. power performance in applications where low voltage supplies or power limitations previously made compromise necessary. With only 1.4 mA/amplifier supply current, the 75 MHz gain bandwidth of this device supports new portable applications where higher power devices unacceptably drain battery life. The slew rate of the devices increases with increasing input differential voltage, thus allowing the device to handle capacitive loads while maintaining large signal amplitude.

The LM6152/LM6154 can be driven by voltages that exceed both power supply rails, thus eliminating concerns about exceeding the common-mode voltage range. The rail-to-rail output swing capability provides the maximum possible dynamic range at the output. This is particularly important when operating on low supply voltages.

Operating on supplies from 2.7V to over 24V, the LM6152/LM6154 is excellent for a very wide range of applications, from battery operated systems with large bandwidth requirements to high speed instrumentation.

### Features

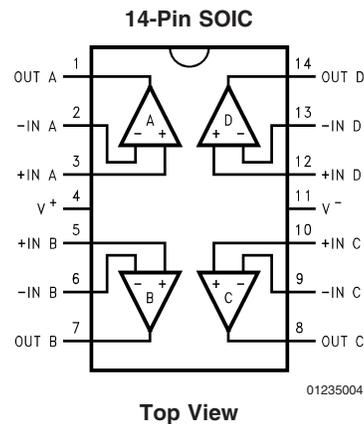
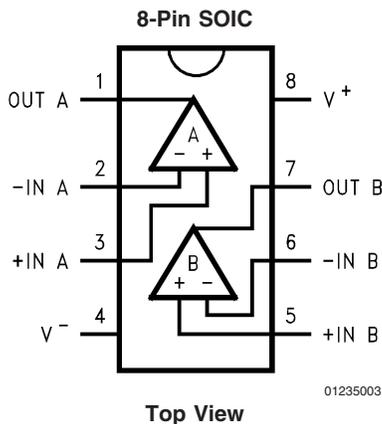
At  $V_S = 5V$ , typical unless noted.

- Greater than rail-to-rail input CMVR -0.25V to 5.25V
- Rail-to-rail output swing 0.01V to 4.99V
- Wide gain-bandwidth 75 MHz @ 100 kHz
- Slew rate
  - Small signal 5 V/ $\mu$ s
  - Large signal 45 V/ $\mu$ s
- Low supply current 1.4 mA/amplifier
- Wide supply range 2.7V to 24V
- Fast settling time of 1.1  $\mu$ s for 2V step (to 0.01%)
- PSRR 91 dB
- CMRR 84 dB

### Applications

- Portable high speed instrumentation
- Signal conditioning amplifier/ADC buffers
- Barcode scanners

### Connection Diagrams



### Ordering Information

| Package     | Part Number | Package Marking | Transport Media          | NSC Drawing |
|-------------|-------------|-----------------|--------------------------|-------------|
| 8-Pin SOIC  | LM6152ACM   | LM6152ACM       | 95 Units/Rails           | M08A        |
|             | LM6152ACMX  |                 | 2.5k Units Tape and Reel |             |
|             | LM6152BCM   | LM6152BCM       | 95 Units/Rails           |             |
|             | LM6152BCMX  |                 | 2.5k Units Tape and Reel |             |
| 14-Pin SOIC | LM6154BCM   | LM6154BCM       | 55 Units/Rails           | M14A        |
|             | LM6154BCMX  |                 | 2.5k Units Tape and Reel |             |

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|   |   |
|---|---|
| ESD Tolerance (Note 2)                            | 2500V   |
| Differential Input Voltage                        | 15V   |
| Voltage at Input/Output Pin                       | (V <sup>+</sup> ) + 0.3V, (V <sup>-</sup> ) -0.3V |
| Supply Voltage (V <sup>+</sup> - V <sup>-</sup> ) | 35V   |
| Current at Input Pin                              | ±10 mA  |
| Current at Output Pin (Note 3)                    | ±25 mA  |
| Current at Power Supply Pin                       | 50 mA   |
| Lead Temperature (soldering, 10 sec)              | 260°C   |

Storage Temperature Range -65°C to +150°C

Junction Temperature (Note 4) 150°C

**Operating Ratings** (Note 1)

|                                       |                              |
|---------------------------------------|------------------------------|
| Supply Voltage                        | 2.7V ≤ V <sup>+</sup> ≤ 24V  |
| Junction Temperature Range            | 0°C ≤ T <sub>J</sub> ≤ +70°C |
| LM6152, LM6154                        |                              |
| Thermal Resistance (θ <sub>JA</sub> ) |                              |
| 8-pin SOIC                            | 193°C/W                      |
| 14-pin SOIC                           | 126°C/W                      |

**5.0V DC Electrical Characteristics**

Unless otherwise specified, all limits are guaranteed for T<sub>J</sub> = 25°C, V<sup>+</sup> = 5.0V, V<sup>-</sup> = 0V, V<sub>CM</sub> = V<sub>O</sub> = V<sup>+</sup>/2 and R<sub>L</sub> > 1 MΩ to V<sup>+</sup>/2. **Boldface** limits apply at the temperature extremes.

| Symbol            | Parameter                          | Conditions                | Typ<br>(Note 5) | LM6154AC                      | LM6154BC                      | Units       |
|-------------------|------------------------------------|---------------------------|-----------------|-------------------------------|-------------------------------|-------------|
|                   |                                    |                           |                 | LM6152AC<br>Limit<br>(Note 6) | LM6152BC<br>Limit<br>(Note 6) |             |
| V <sub>OS</sub>   | Input Offset Voltage               |                           | 0.54            | 2<br>4                        | 5<br>7                        | mV<br>max   |
| TCV <sub>OS</sub> | Input Offset Voltage Average Drift |                           | 10              |                               |                               | μV/°C       |
| I <sub>B</sub>    | Input Bias Current                 | 0V ≤ V <sub>CM</sub> ≤ 5V | 500<br>750      | 980<br>1500                   | 980<br>1500                   | nA max      |
| I <sub>OS</sub>   | Input Offset Current               |                           | 32<br>40        | 100<br>160                    | 100<br>160                    | nA max      |
| R <sub>IN</sub>   | Input Resistance, CM               | 0V ≤ V <sub>CM</sub> ≤ 4V | 30              |                               |                               | MΩ          |
| CMRR              | Common Mode Rejection Ratio        | 0V ≤ V <sub>CM</sub> ≤ 4V | 94              | 70                            | 70                            | dB          |
|                   |                                    | 0V ≤ V <sub>CM</sub> ≤ 5V | 84              | 60                            | 60                            | min         |
| PSRR              | Power Supply Rejection Ratio       | 5V ≤ V <sup>+</sup> ≤ 24V | 91              | 80                            | 80                            | dB<br>min   |
| V <sub>CM</sub>   | Input Common-Mode Voltage Range    | Low                       | -0.25           | 0                             | 0                             | V           |
|                   |                                    | High                      | 5.25            | 5.0                           | 5.0                           | V           |
| A <sub>V</sub>    | Large Signal Voltage Gain          | R <sub>L</sub> = 10 kΩ    | 214             | 50                            | 50                            | V/mV<br>min |
| V <sub>O</sub>    | Output Swing                       | R <sub>L</sub> = 100 kΩ   | 0.006           | 0.02<br>0.03                  | 0.02<br>0.03                  | V<br>max    |
|                   |                                    |                           | 4.992           | 4.97<br>4.96                  | 4.97<br>4.96                  | V<br>min    |
|                   |                                    | R <sub>L</sub> = 2 kΩ     | 0.04            | 0.10<br>0.12                  | 0.10<br>0.12                  | V<br>max    |
|                   |                                    |                           | 4.89            | 4.80<br>4.70                  | 4.80<br>4.70                  | V<br>min    |
| I <sub>SC</sub>   | Output Short Circuit Current       | Sourcing                  | 6.2             | 3<br>2.5                      | 3<br>2.5                      | mA<br>min   |
|                   |                                    |                           |                 | 27<br>17                      | 27<br>17                      | mA<br>max   |
|                   |                                    | Sinking                   | 16.9            | 7<br>5                        | 7<br>5                        | mA<br>min   |
|                   |                                    |                           |                 | 40                            | 40                            | mA<br>max   |

## 5.0V DC Electrical Characteristics (Continued)

Unless otherwise specified, all limits are guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 5.0\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V_O = V^+/2$  and  $R_L > 1\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

| Symbol | Parameter      | Conditions    | Typ<br>(Note 5) | LM6154AC<br>LM6152AC<br>Limit<br>(Note 6) | LM6154BC<br>LM6152BC<br>Limit<br>(Note 6) | Units     |
|--------|----------------|---------------|-----------------|---|---|-----------|
| $I_S$  | Supply Current | Per Amplifier | 1.4             | 2<br><b>2.25</b>                          | 2<br><b>2.25</b>                          | mA<br>max |

## 5.0V AC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 5.0\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V_O = V^+/2$  and  $R_L > 1\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

| Symbol | Parameter                    | Conditions  | Typ<br>(Note 5) | LM6154AC<br>LM6152AC<br>Limit<br>(Note 6) | LM6154BC<br>LM6152BC<br>Limit<br>(Note 6) | Units                   |
|--------|------------------------------|---|-----------------|---|---|-------------------------|
| SR     | Slew Rate                    | $\pm 4\text{V Step @ } V_S = \pm 6\text{V}$ ,<br>$R_S < 1\text{ k}\Omega$                         | 30              | 24<br><b>15</b>                           | 24<br><b>15</b>                           | V/ $\mu\text{s}$<br>min |
| GBW    | Gain-Bandwidth Product       | $f = 100\text{ kHz}$  | 75              |   |   | MHz                     |
|        | Amp-to-Amp Isolation         | $R_L = 10\text{ k}\Omega$   | 125             |   |   | dB                      |
| $e_n$  | Input-Referred Voltage Noise | $f = 1\text{ kHz}$  | 9               |   |   | nV/ $\sqrt{\text{Hz}}$  |
| $i_n$  | Input-Referred Current Noise | $f = 1\text{ kHz}$  | 0.34            |   |   | pA/ $\sqrt{\text{Hz}}$  |
| T.H.D  | Total Harmonic Distortion    | $f = 100\text{ kHz}$ , $R_L = 10\text{ k}\Omega$<br>$A_V = -1$ , $V_O = 2.5\text{ V}_{\text{PP}}$ | -65             |   |   | dBc                     |
| $t_s$  | Settling Time                | 2V Step to 0.01%  | 1.1             |   |   | $\mu\text{s}$           |

## 2.7V DC Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V_O = V^+/2$  and  $R_L > 1\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

| Symbol                   | Parameter                          | Conditions                                      | Typ<br>(Note 5) | LM6154AC<br>LM6152AC<br>Limit<br>(Note 6) | LM6154BC<br>LM6152BC<br>Limit<br>(Note 6) | Units                        |
|--------------------------|------------------------------------|---|-----------------|---|---|------------------------------|
| $V_{\text{OS}}$          | Input Offset Voltage               |   | 0.8             | 2<br><b>5</b>                             | 5<br><b>8</b>                             | mV<br>max                    |
| $\text{TCV}_{\text{OS}}$ | Input Offset Voltage Average Drift |   | <b>10</b>       |   |   | $\mu\text{V}/^\circ\text{C}$ |
| $I_B$                    | Input Bias Current                 |   | 500             |   |   | nA                           |
| $I_{\text{OS}}$          | Input Offset Current               |   | 50              |   |   | nA                           |
| $R_{\text{IN}}$          | Input Resistance, CM               | $0\text{V} \leq V_{\text{CM}} \leq 1.8\text{V}$ | 30              |   |   | $\text{M}\Omega$             |
| CMRR                     | Common Mode Rejection Ratio        | $0\text{V} \leq V_{\text{CM}} \leq 1.8\text{V}$ | 88              |   |   | dB                           |
|                          |                                    | $0\text{V} \leq V_{\text{CM}} \leq 2.7\text{V}$ | 78              |   |   |                              |
| PSRR                     | Power Supply Rejection Ratio       | $3\text{V} \leq V^+ \leq 5\text{V}$             | 69              |   |   | dB                           |
| $V_{\text{CM}}$          | Input Common-Mode Voltage Range    | Low   | -0.25           | 0   | 0   | V                            |
|                          |                                    | High  | 2.95            | 2.7                                       | 2.7                                       | V                            |
| $A_V$                    | Large Signal Voltage Gain          | $R_L = 10\text{ k}\Omega$                       | 5.5             |   |   | V/mV                         |
| $V_O$                    | Output Swing                       | $R_L = 10\text{ k}\Omega$                       | 0.032           | 0.07<br><b>0.11</b>                       | 0.07<br><b>0.11</b>                       | V<br>max                     |
|                          |                                    |   | 2.68            | 2.64<br><b>2.62</b>                       | 2.64<br><b>2.62</b>                       | V<br>min                     |
|                          |                                    |   |                 |   |   |                              |
| $I_S$                    | Supply Current                     | Per Amplifier                                   | 1.35            |   |   | mA                           |

## 2.7V AC Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V_O = V^+/2$  and  $R_L > 1\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

| Symbol | Parameter              | Conditions           | Typ<br>(Note 5) | LM6154AC<br>LM6152AC<br>Limit<br>(Note 6) | LM6154BC<br>LM6152BC<br>Limit<br>(Note 6) | Units |
|--------|------------------------|----------------------|-----------------|---|---|-------|
| GBW    | Gain-Bandwidth Product | $f = 100\text{ kHz}$ | 80              |   |   | MHz   |

## 24V DC Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 24\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V_O = V^+/2$  and  $R_L > 1\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

| Symbol                   | Parameter                          | Conditions                                     | Typ<br>(Note 5) | LM6154AC<br>LM6152AC<br>Limit<br>(Note 6) | LM6154BC<br>LM6152BC<br>Limit<br>(Note 6) | Units                        |
|--------------------------|------------------------------------|--|-----------------|---|---|------------------------------|
| $V_{\text{OS}}$          | Input Offset Voltage               |  | 0.3             | 2<br><b>4</b>                             | 7<br><b>9</b>                             | mV<br>max                    |
| $\text{TCV}_{\text{OS}}$ | Input Offset Voltage Average Drift |  | <b>10</b>       |   |   | $\mu\text{V}/^\circ\text{C}$ |
| $I_{\text{B}}$           | Input Bias Current                 |  | 500             |   |   | nA                           |
| $I_{\text{OS}}$          | Input Offset Current               |  | 32              |   |   | nA                           |
| $R_{\text{IN}}$          | Input Resistance, CM               | $0\text{V} \leq V_{\text{CM}} \leq 23\text{V}$ | 60              |   |   | Meg $\Omega$                 |
| CMRR                     | Common Mode Rejection Ratio        | $0\text{V} \leq V_{\text{CM}} \leq 23\text{V}$ | 94              |   |   | dB                           |
|                          |                                    | $0\text{V} \leq V_{\text{CM}} \leq 24\text{V}$ | 84              |   |   |                              |
| PSRR                     | Power Supply Rejection Ratio       | $0\text{V} \leq V_{\text{CM}} \leq 24\text{V}$ | 95              |   |   | dB                           |
| $V_{\text{CM}}$          | Input Common-Mode Voltage Range    | Low  | -0.25           | 0   | 0   | V                            |
|                          |                                    | High   | 24.25           | 24  | 24  | V                            |
| $A_V$                    | Large Signal Voltage Gain          | $R_L = 10\text{ k}\Omega$                      | 55              |   |   | V/mV                         |
| $V_O$                    | Output Swing                       | $R_L = 10\text{ k}\Omega$                      | 0.044           | 0.075<br><b>0.090</b>                     | 0.075<br><b>0.090</b>                     | V<br>max                     |
|                          |                                    |  | 23.91           | 23.8<br><b>23.7</b>                       | 23.8<br><b>23.7</b>                       | V<br>min                     |
| $I_{\text{S}}$           | Supply Current                     | Per Amplifier                                  | 1.6             | 2.25<br><b>2.50</b>                       | 2.25<br><b>2.50</b>                       | mA<br>max                    |

## 24V AC Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 24\text{V}$ ,  $V^- = 0\text{V}$ ,  $V_{\text{CM}} = V_O = V^+/2$  and  $R_L > 1\text{M}\Omega$  to  $V^+/2$ . **Boldface** limits apply at the temperature extremes.

| Symbol | Parameter              | Conditions           | Typ<br>(Note 5) | LM6154AC<br>LM6152AC<br>Limit<br>(Note 6) | LM6154BC<br>LM6152BC<br>Limit<br>(Note 6) | Units |
|--------|------------------------|----------------------|-----------------|---|---|-------|
| GBW    | Gain-Bandwidth Product | $f = 100\text{ kHz}$ | 80              |   |   | MHz   |

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

**Note 2:** Human body model is 1.5 k $\Omega$  in series with 100 pF.

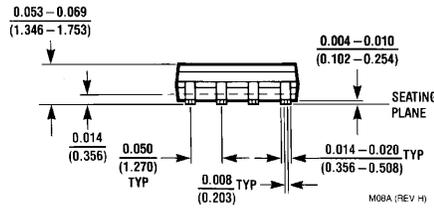
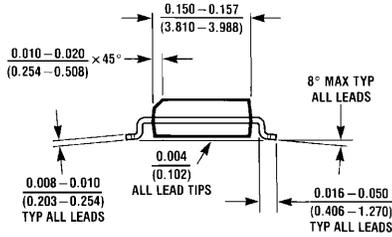
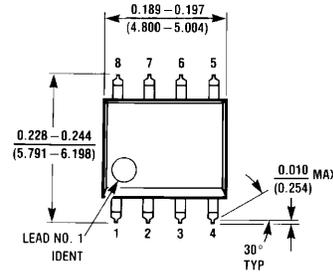
**Note 3:** Applies to both single-supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150 $^\circ\text{C}$ .

**Note 4:** The maximum power dissipation is a function of  $T_{\text{J(MAX)}}$ ,  $\theta_{\text{JA}}$ , and  $T_{\text{A}}$ . The maximum allowable power dissipation at any ambient temperature is  $P_{\text{D}} = (T_{\text{J(MAX)}} - T_{\text{A}}) / \theta_{\text{JA}}$ . All numbers apply for packages soldered directly into a PC board.

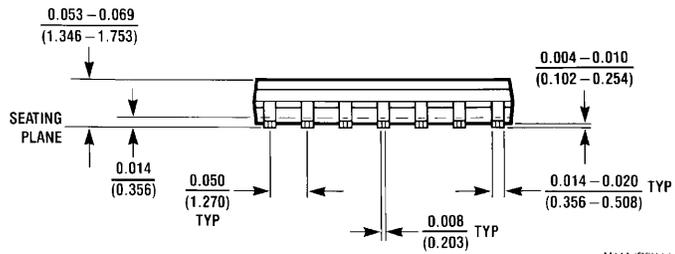
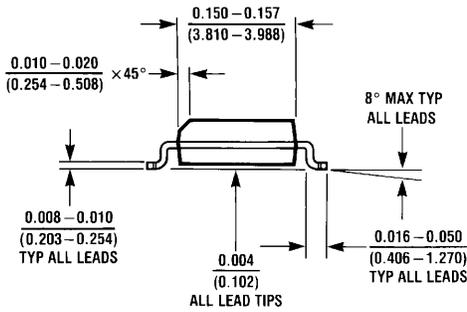
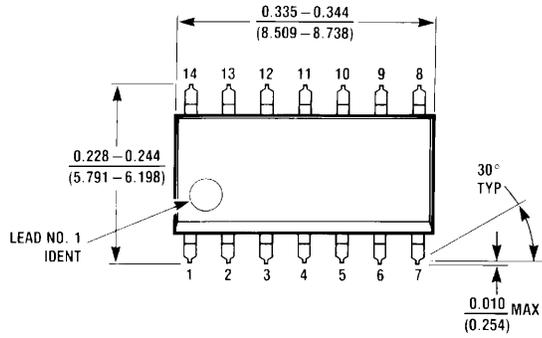
**Note 5:** Typical Values represent the most likely parametric norm.

**Note 6:** All limits are guaranteed by testing or statistical analysis.

**Physical Dimensions** inches (millimeters) unless otherwise noted



**8-Pin SOIC**  
NSC Package Number M08A



**14-Pin SOIC**  
NSC Package Number M14A