

# OPERATIONAL AMPLIFIERS

**MC1556G**  
**MC1456G**  
**MC1456CG**

## INTERNALLY COMPENSATED, HIGH PERFORMANCE MONOLITHIC OPERATIONAL AMPLIFIER

... designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components. For detailed information, see Application Note AN-522.

- Low Input Bias Current — 15 nA max
- Low Input Offset Current — 2.0 nA max
- Low Input Offset Voltage — 4.0 mV max
- Fast Slew Rate — 2.5 V/ $\mu$ s typ
- Large Power Bandwidth — 40 kHz typ
- Low Power Consumption — 45 mW max
- Offset Voltage Null Capability
- Output Short-Circuit Protection
- Input Over-Voltage Protection

## OPERATIONAL AMPLIFIER INTEGRATED CIRCUIT

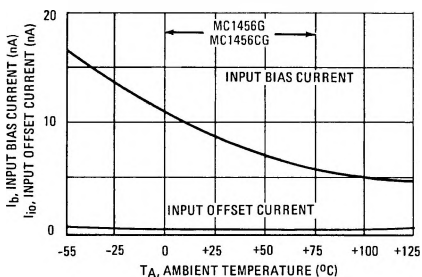
EPITAXIAL PASSIVATED

CASE 601  
 TO-99

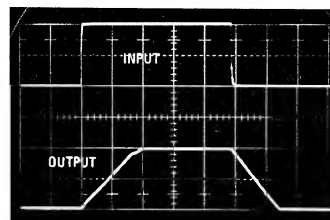


(bottom view)

TYPICAL INPUT BIAS CURRENT AND INPUT  
 OFFSET CURRENT versus TEMPERATURE for MC1556G

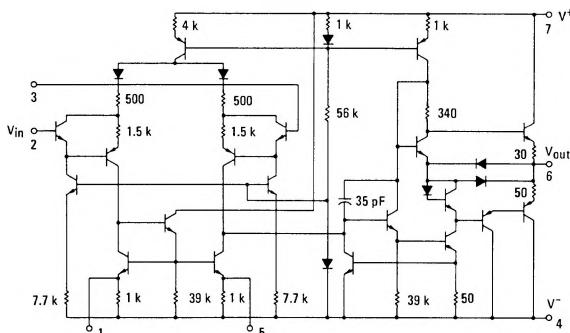


VOLTAGE-FOLLOWER PULSE RESPONSE

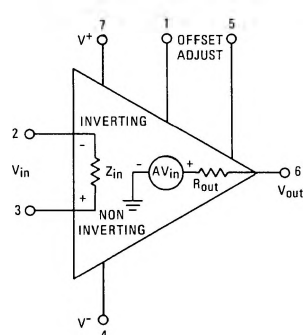


2  $\mu$ s/DIVISION

CIRCUIT SCHEMATIC



EQUIVALENT CIRCUIT



See Packaging Information Section for outline dimensions.

# MC1556G, MC1456G, MC1456CG (continued)

## MAXIMUM RATINGS (T<sub>A</sub> = +25°C unless otherwise noted)

| Rating                                                                        | Symbol                           | MC1556G         | MC1456G<br>MC1456CG | Unit        |
|-------------------------------------------------------------------------------|----------------------------------|-----------------|---------------------|-------------|
| Power Supply Voltage                                                          | V <sup>+</sup><br>V <sup>-</sup> | +22<br>-22      | +18<br>-18          | Vdc         |
| Differential Input Signal                                                     | V <sub>in</sub>                  | ±V <sup>+</sup> |                     | Volts       |
| Common-Mode Input Swing                                                       | CMV <sub>in</sub>                | ±V <sup>+</sup> |                     | Volts       |
| Load Current                                                                  | I <sub>L</sub>                   | 20              |                     | mA          |
| Output Short Circuit Duration                                                 | t <sub>S</sub>                   | Continuous      |                     |             |
| Power Dissipation (Package Limitation)<br>Derate above T <sub>A</sub> = +25°C | P <sub>D</sub>                   | 680<br>4.6      |                     | mW<br>mW/°C |
| Operating Temperature Range                                                   | T <sub>A</sub>                   | -55 to +125     | 0 to +75            | °C          |
| Storage Temperature Range                                                     | T <sub>stg</sub>                 | -65 to +150     | -65 to +150         | °C          |

## ELECTRICAL CHARACTERISTICS (V<sup>+</sup> = +15 Vdc, V<sup>-</sup> = -15 Vdc, T<sub>A</sub> = +25°C unless otherwise noted)

| Characteristic                                                                                                                                                      | Fig.  | Symbol                                                     | MC1556G           |              |            | MC1456G          |              |            | MC1456CG    |              |            | Unit                   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------|-------------------|--------------|------------|------------------|--------------|------------|-------------|--------------|------------|------------------------|
|                                                                                                                                                                     |       |                                                            | Min               | Typ          | Max        | Min              | Typ          | Max        | Min         | Typ          | Max        |                        |
| Input Bias Current<br>T <sub>A</sub> = +25°C<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> (See Note 1)                                                 |       | I <sub>b</sub>                                             | —                 | 8.0          | 15         | —                | 15           | 30         | —           | 15           | 90         | nAdc                   |
| Input Offset Current<br>T <sub>A</sub> = +25°C<br>T <sub>A</sub> = +25°C to T <sub>high</sub><br>T <sub>A</sub> = T <sub>low</sub> to +25°C                         |       | I <sub>io</sub>                                            | —                 | 1.0          | 2.0        | —                | 5.0          | 10         | —           | 5.0          | 30         | nAdc                   |
| Input Offset Voltage<br>T <sub>A</sub> = +25°C<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub>                                                            |       | V <sub>io</sub>                                            | —                 | 2.0          | 4.0        | —                | 5.0          | 10         | —           | 5.0          | 12         | mVdc                   |
| Differential Input Impedance (Open-Loop, f = 20 Hz)                                                                                                                 |       | R <sub>p</sub>                                             | —                 | 5.0          | —          | —                | 3.0          | —          | —           | 3.0          | —          | Megohms                |
| Parallel Input Resistance                                                                                                                                           |       | C <sub>p</sub>                                             | —                 | 6.0          | —          | —                | 6.0          | —          | —           | 6.0          | —          | pF                     |
| Common-Mode Input Impedance (f = 20 Hz)                                                                                                                             |       | Z <sub>in</sub>                                            | —                 | 250          | —          | —                | 250          | —          | —           | 250          | —          | Megohms                |
| Common-Mode Input Voltage Swing                                                                                                                                     | 1     | CMV <sub>in</sub>                                          | ±12               | ±13          | —          | ±11              | ±12          | —          | ±10.5       | ±12          | —          | V <sub>pk</sub>        |
| Equivalent Input Noise Voltage<br>(A <sub>V</sub> = 100, R <sub>s</sub> = 10 k ohms, f = 1.0 kHz, BW = 1.0 Hz)                                                      | 2     | e <sub>n</sub>                                             | —                 | 45           | —          | —                | 45           | —          | —           | 45           | —          | nV/(Hz) <sup>1/2</sup> |
| Common-Mode Rejection Ratio (f = 100 Hz)                                                                                                                            | 3     | CM <sub>rej</sub>                                          | 80                | 110          | —          | 70               | 110          | —          | —           | 110          | —          | dB                     |
| Open-Loop Voltage Gain, (V <sub>out</sub> = ±10 V, R <sub>L</sub> = 2.0 k ohms)<br>T <sub>A</sub> = +25°C<br>T <sub>A</sub> = T <sub>low</sub> to T <sub>high</sub> | 4,5,6 | A <sub>VOL</sub>                                           | 100,000<br>40,000 | 200,000<br>— | —<br>—     | 70,000<br>40,000 | 100,000<br>— | —<br>—     | 25,000<br>— | 100,000<br>— | —<br>—     | V/V                    |
| Power Bandwidth<br>(A <sub>V</sub> = 1, R <sub>L</sub> = 2.0 k ohms, THD ≤ 5%, V <sub>out</sub> = 20 Vp-p)                                                          | 9     | P <sub>BW</sub>                                            | —                 | 40           | —          | —                | 40           | —          | —           | 40           | —          | kHz                    |
| Unity Gain Crossover Frequency (open-loop)                                                                                                                          | 5     | f <sub>c</sub>                                             | —                 | 1.0          | —          | —                | 1.0          | —          | —           | 1.0          | —          | MHz                    |
| Phase Margin (open-loop, unity gain)                                                                                                                                | 5,7   |                                                            | —                 | 70           | —          | —                | 70           | —          | —           | 70           | —          | degrees                |
| Gain Margin                                                                                                                                                         | 5,7   |                                                            | —                 | 18           | —          | —                | 18           | —          | —           | 18           | —          | dB                     |
| Slew Rate (Unity Gain)                                                                                                                                              |       | dV <sub>out</sub> /dt                                      | —                 | 2.5          | —          | —                | 2.5          | —          | —           | 2.5          | —          | V/μs                   |
| Output Impedance (f = 20 Hz)                                                                                                                                        |       | Z <sub>out</sub>                                           | —                 | 1.0          | 2.0        | —                | 1.0          | 2.5        | —           | 1.0          | —          | kohms                  |
| Short-Circuit Output Current                                                                                                                                        | 8     | I <sub>SC</sub>                                            | —                 | -17, +9.0    | —          | —                | -17, +9.0    | —          | —           | -17, +9.0    | —          | mAdc                   |
| Output Voltage Swing (R <sub>L</sub> = 2.0 k ohms)                                                                                                                  | 10    | V <sub>out</sub>                                           | ±12               | ±13          | —          | ±11              | ±12          | —          | ±10         | ±12          | —          | V <sub>pk</sub>        |
| Power Supply Sensitivity<br>V <sup>-</sup> = constant, R <sub>s</sub> ≤ 10 k ohms<br>V <sup>+</sup> = constant, R <sub>s</sub> ≤ 10 k ohms                          |       | S <sup>+</sup><br>S <sup>-</sup>                           | —<br>—            | 50<br>50     | 100<br>100 | —<br>—           | 75<br>75     | 200<br>200 | —<br>—      | 75<br>75     | —<br>—     | μV/V                   |
| Power Supply Current                                                                                                                                                |       | I <sub>D</sub> <sup>+</sup><br>I <sub>D</sub> <sup>-</sup> | —<br>—            | 1.0<br>1.0   | 1.5<br>1.5 | —<br>—           | 1.3<br>1.3   | 3.0<br>3.0 | —<br>—      | 1.3<br>1.3   | 4.0<br>4.0 | mAdc                   |
| DC Quiescent Power Dissipation<br>(V <sub>out</sub> = 0)                                                                                                            | 11    | P <sub>D</sub>                                             | —                 | 30           | 45         | —                | 40           | 90         | —           | 40           | 120        | mW                     |

Note 1: T<sub>low</sub>: 0° for MC1456G and MC1456CG  
-55°C for MC1556G

T<sub>high</sub>: +75°C for MC1456G and MC1456CG  
+125°C for MC1556G

MC1556G, MC1456G, MC1456CG (continued)

TYPICAL CHARACTERISTICS

( $V^+ = +15\text{ Vdc}$ ,  $V^- = -15\text{ Vdc}$ ,  $T_A = +25^\circ\text{C}$  unless otherwise noted)

FIGURE 1 – INPUT COMMON-MODE SWING versus POWER SUPPLY VOLTAGE

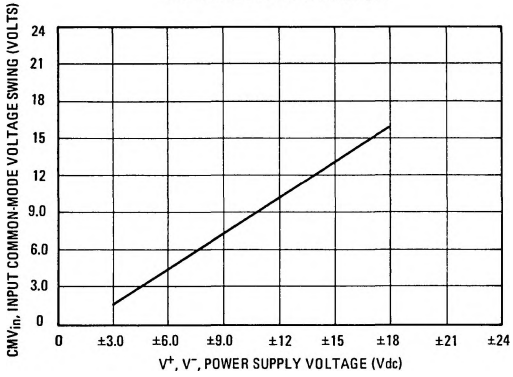


FIGURE 2 – SPECTRAL NOISE DENSITY

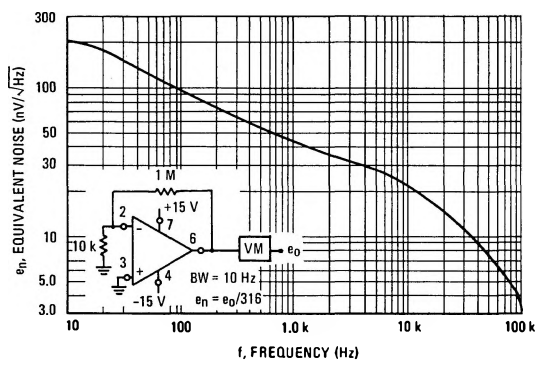


FIGURE 3 – COMMON-MODE REJECTION RATIO versus FREQUENCY

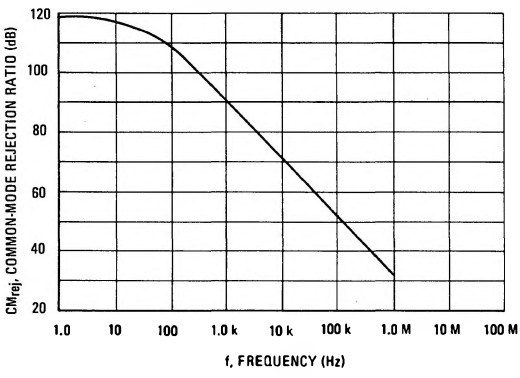


FIGURE 4 – OPEN-LOOP VOLTAGE GAIN versus TEMPERATURE

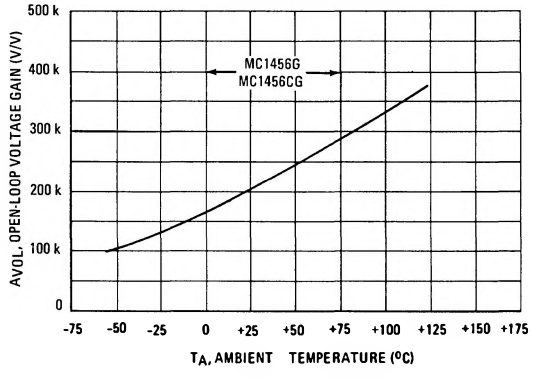


FIGURE 5 – OPEN-LOOP FREQUENCY RESPONSE

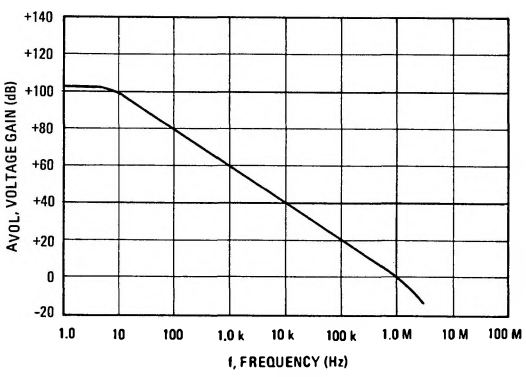
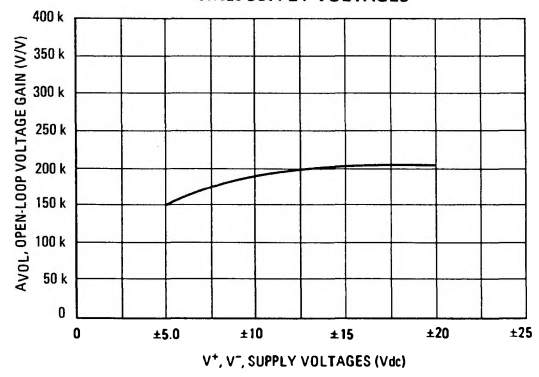


FIGURE 6 – OPEN-LOOP VOLTAGE GAIN versus SUPPLY VOLTAGES



TYPICAL CHARACTERISTICS (continued)

FIGURE 7 – OPEN-LOOP PHASE SHIFT

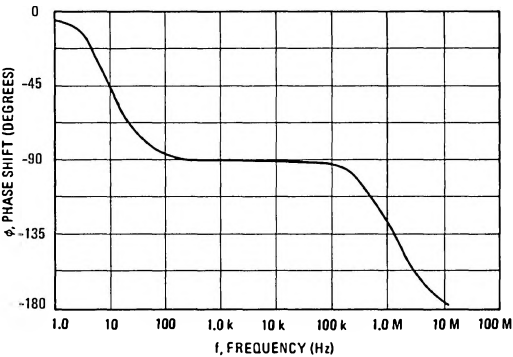


FIGURE 8 – OUTPUT SHORT-CIRCUIT CURRENT versus TEMPERATURE

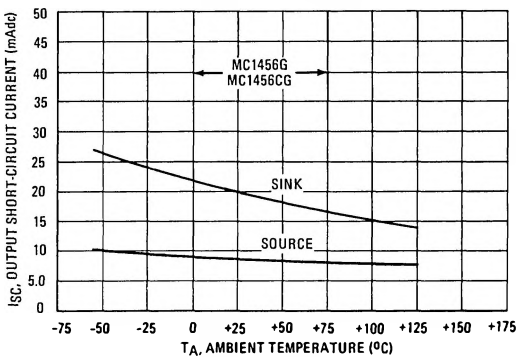


FIGURE 9 – POWER BANDWIDTH

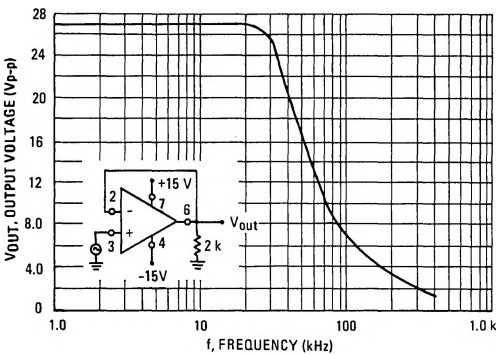


FIGURE 10 – OUTPUT VOLTAGE SWING versus LOAD RESISTANCE

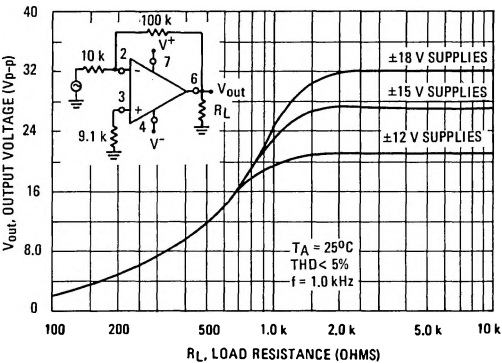
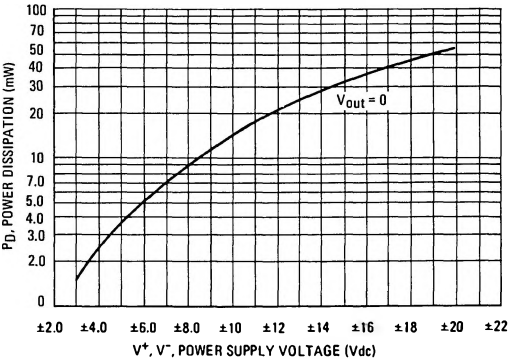


FIGURE 11 – POWER DISSIPATION versus POWER SUPPLY VOLTAGE



TYPICAL APPLICATIONS

Where values are not given for external components they must be selected by the designer to fit the requirements of the system.

FIGURE 12 – INVERTING FEEDBACK MODEL

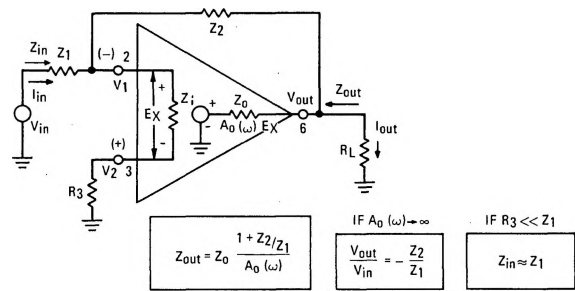


FIGURE 13 – NON-INVERTING FEEDBACK MODEL

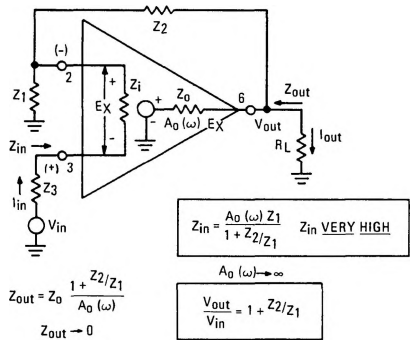


FIGURE 14 – LOW-DRIFT SAMPLE AND HOLD

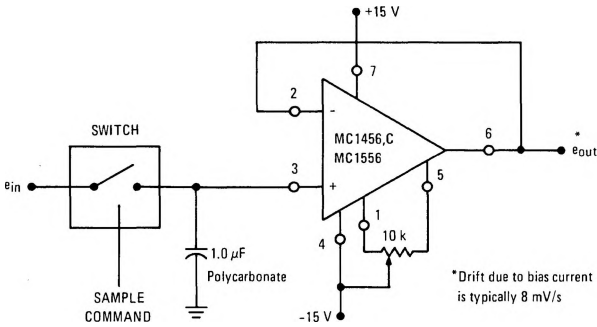
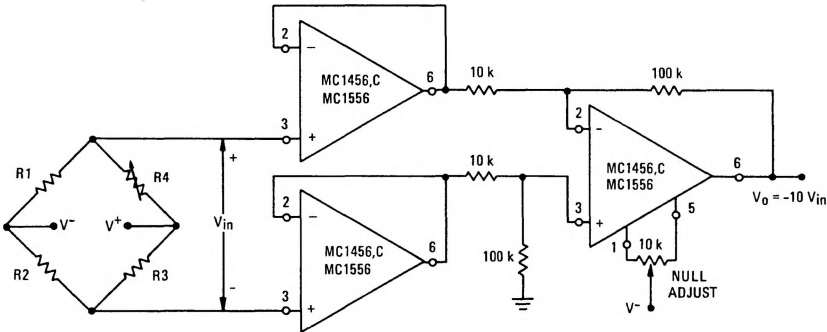
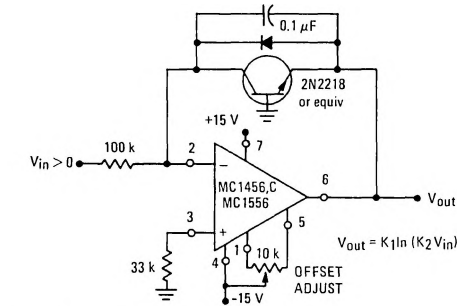


FIGURE 15 – HIGH IMPEDANCE BRIDGE AMPLIFIER



TYPICAL APPLICATIONS (continued)

FIGURE 16 – LOGARITHMIC AMPLIFIER



See Application Note AN-261 for further detail.

FIGURE 17 – VOLTAGE OFFSET NULL CIRCUIT

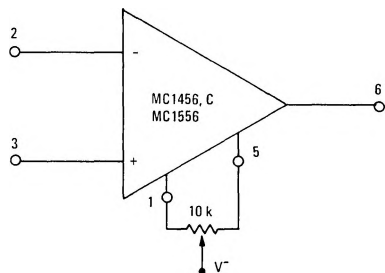


FIGURE 18 – HIGH INPUT IMPEDANCE, HIGH OUTPUT CURRENT VOLTAGE FOLLOWER

