



## LM4136

### Quad Operational Amplifier

#### General Description

The LM4136 monolithic quad operational amplifier consists of four independent high gain, internally frequency compensated operational amplifiers. The specifically designed low noise input transistors allow the LM4136 to be used in low noise signal processing applications such as audio preamplifiers and signal conditioners. The simplified output stage completely eliminates crossover distortion under any load conditions, has large source and sink capacity, and is short-circuit protected. A novel current source stabilizes output parameters over a wide power supply voltage range.

#### Features

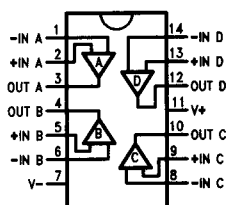
- Unity gain bandwidth—3.0 MHz
- Continuous short circuit protection
- No frequency compensation required
- No latch up
- Large common mode and differential voltage range
- LM741 operational amplifier type performance
- Parameter tracking over temperature range
- Gain and phase match between amplifiers

#### Applications

- Audio preamplifiers
- Signal conditioning

#### Connection Diagram

14-Lead DIP and SO-14 Package



Top View

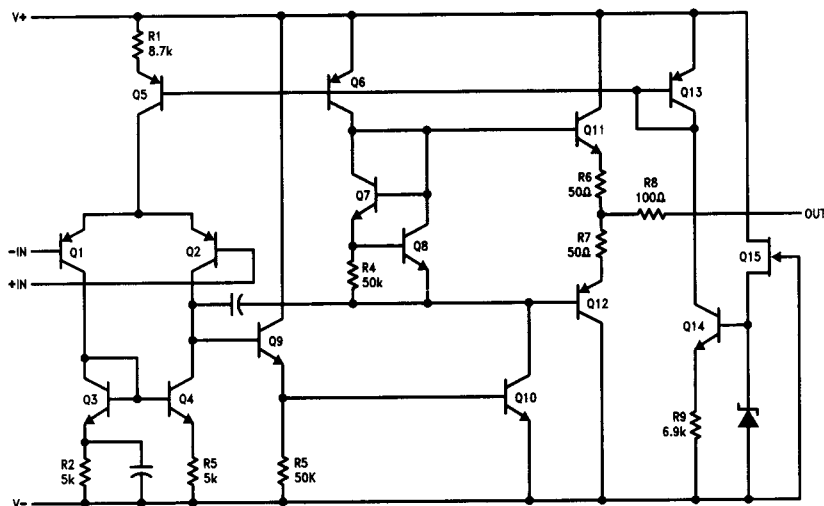
TL/H/10065-1

#### Ordering Information

| Device Code  | NS Package Number | Package Description  |
|--------------|-------------------|----------------------|
| LM4136CJ     | J14A              | Ceramic DIP          |
| LM4136J/883* | J14A              | Ceramic DIP          |
| LM4136CN     | N14A              | Molded DIP           |
| LM4136CM     | M14A              | Molded Surface Mount |

\*Available per JM38510/11004

#### Equivalent Circuit (1/4 of Circuit)



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## Absolute Maximum Ratings

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

|                                           |                 |
|-------------------------------------------|-----------------|
| Storage Temperature Range                 |                 |
| Ceramic DIP                               | −65°C to +175°C |
| Molded DIP and SO-14                      | −65°C to +150°C |
| Operating Temperature Range               |                 |
| 0°C to +70°C                              |                 |
| Lead Temperature                          |                 |
| Ceramic DIP (Soldering, 60 sec.)          | 300°C           |
| Molded DIP and SO-14 (Soldering, 10 sec.) | 265°C           |

Internal Power Dissipation (Notes 1, 2)

|                                        |       |
|----------------------------------------|-------|
| 14L-Ceramic DIP                        | 1.36W |
| 14L-Molded DIP                         | 1.04W |
| SO-14                                  | 0.93W |
| Supply Voltage                         |       |
| ±18V                                   |       |
| Differential Input Voltage (Note 3)    |       |
| ±30V                                   |       |
| Input Voltage (Note 1)                 |       |
| ±15V                                   |       |
| Output Short Circuit Duration (Note 4) |       |
| Indefinite                             |       |
| ESD Tolerance                          |       |
| 1000V                                  |       |

## LM4136

### Electrical Characteristics $T_A = 25^\circ\text{C}$ , $V_{CC} = \pm 15\text{V}$ unless otherwise specified

| Symbol   | Parameter                    |           | Conditions                                                                              | Min | Typ  | Max | Units            |
|----------|------------------------------|-----------|-----------------------------------------------------------------------------------------|-----|------|-----|------------------|
| $V_{IO}$ | Input Offset Voltage         |           | $R_S \leq 10\text{ k}\Omega$                                                            |     | 0.5  | 6.0 | mV               |
| $I_{IO}$ | Input Offset Current         |           |                                                                                         |     | 5.0  | 200 | nA               |
| $I_{IB}$ | Input Bias Current           |           |                                                                                         |     | 40   | 500 | nA               |
| $Z_i$    | Input Impedance              |           |                                                                                         | 0.3 | 5.0  |     | M $\Omega$       |
| $P_c$    | Power Consumption            |           |                                                                                         |     | 210  | 340 | mW               |
| CMR      | Common Mode Rejection        |           | $R_S \leq 10\text{ k}\Omega$                                                            | 70  | 90   |     | dB               |
| $V_{IR}$ | Input Voltage Range          |           |                                                                                         | ±12 | ±14  |     | V                |
| PSRR     | Power Supply Rejection Ratio |           | $R_S \leq 10\text{ k}\Omega$                                                            |     | 30   | 150 | $\mu\text{V/V}$  |
| $A_{VS}$ | Large Signal Voltage Gain    |           | $R_L \geq 2.0\text{ k}\Omega$ , $V_O = \pm 10\text{V}$                                  | 20  | 300  |     | V/mV             |
| $V_{OP}$ | Output Voltage Swing         |           | $R_L = 10\text{ k}\Omega$                                                               | ±12 | ±14  |     | V                |
|          |                              |           | $R_L = 2.0\text{ k}\Omega$                                                              | ±10 | ±13  |     |                  |
| TR       | Transient Response           | Rise Time | $V_I = 20\text{ mV}$ , $R_L = 2.0\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $A_V = 1.0$ |     | 0.13 |     | $\mu\text{s}$    |
|          |                              | Overshoot |                                                                                         |     | 5.0  |     | %                |
| BW       | Bandwidth                    |           | $A_V = 1.0$                                                                             |     | 3.0  |     | MHz              |
| SR       | Slew Rate                    |           | $R_L = 2.0\text{ k}\Omega$ , $A_V = 1.0$                                                |     | 1.0  |     | V/ $\mu\text{s}$ |
| CS       | Channel Separation           |           | $f = 10\text{ kHz}$ , $R_S = 1.0\text{ k}\Omega$<br>Open Loop                           |     | 105  |     | dB               |
|          |                              |           | $f = 10\text{ kHz}$ , $R_S = 1.0\text{ k}\Omega$<br>$A_V = 100$                         |     | 105  |     |                  |

The following specifications apply over the range of  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$

|          |                           |                                                        |     |     |     |      |
|----------|---------------------------|--------------------------------------------------------|-----|-----|-----|------|
| $V_{IO}$ | Input Offset Voltage      | $R_S \leq 10\text{ k}\Omega$                           |     |     | 7.5 | mV   |
| $I_{IO}$ | Input Offset Current      |                                                        |     |     | 300 | nA   |
| $I_{IB}$ | Input Bias Current        |                                                        |     |     | 800 | nA   |
| $P_c$    | Power Consumption         | $T_A = T_{A\text{ Max}}$                               |     | 180 | 300 | mW   |
|          |                           | $T_A = T_{A\text{ Min}}$                               |     | 240 | 400 |      |
| $A_{VS}$ | Large Signal Voltage Gain | $R_L \geq 2.0\text{ k}\Omega$ , $V_O = \pm 10\text{V}$ | 15  |     |     | V/mV |
| $V_{OP}$ | Output Voltage Swing      | $R_L = 2.0\text{ k}\Omega$ , $V_{CC} = \pm 15\text{V}$ | ±10 |     |     | V    |

**Note 1:**  $T_{J\text{ Max}} = 150^\circ\text{C}$  for the Molded DIP and SO-14, and  $175^\circ\text{C}$  for the Ceramic DIP.

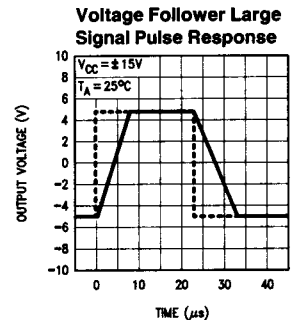
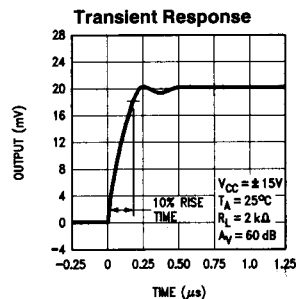
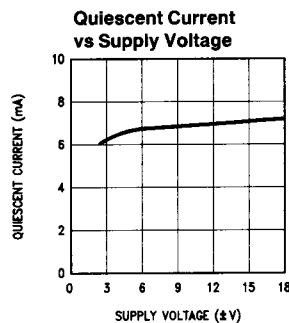
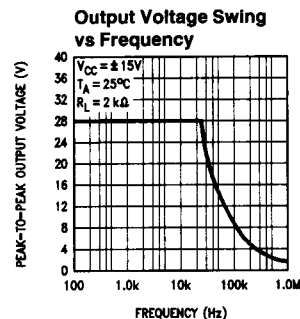
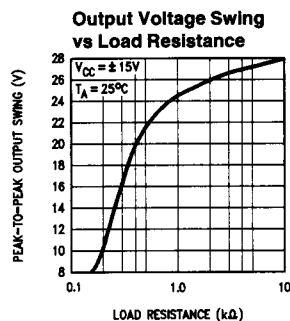
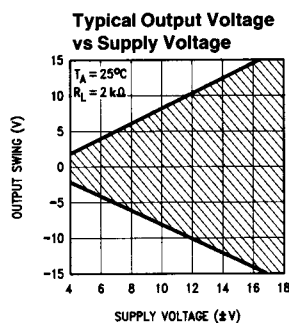
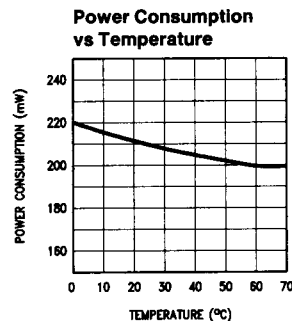
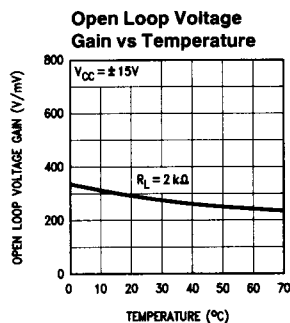
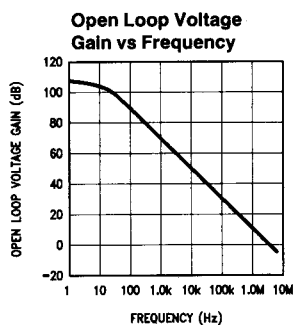
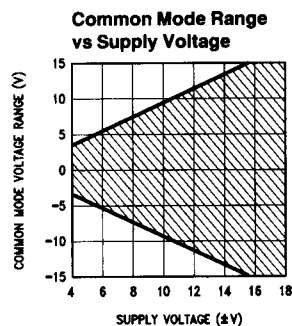
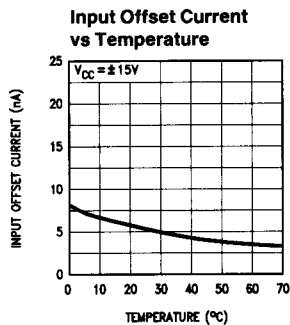
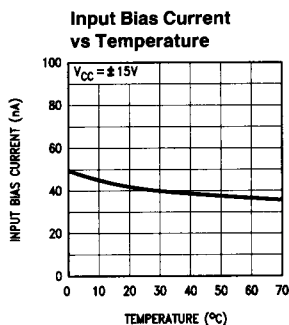
**Note 2:** Ratings apply to ambient temperature at  $25^\circ\text{C}$ . Above this temperature, derate the 14L-Ceramic DIP at  $9.1\text{ mW}/^\circ\text{C}$ , the 14L-Molded DIP at  $8.3\text{ mW}/^\circ\text{C}$ , and the SO-14 at  $7.5\text{ mW}/^\circ\text{C}$ .

**Note 3:** For supply voltage less than  $\pm 15\text{V}$ , the absolute maximum input voltage is equal to the supply voltage.

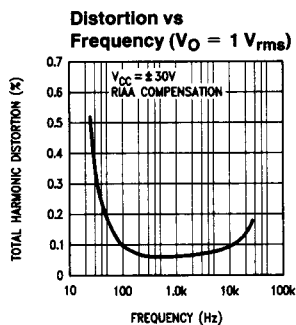
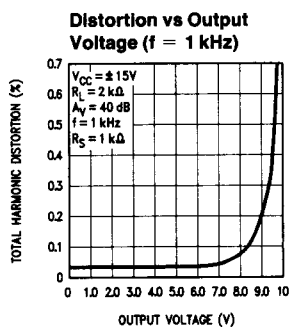
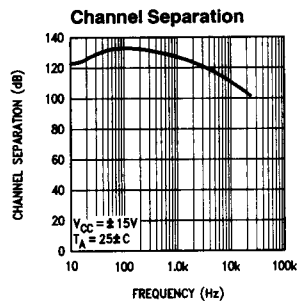
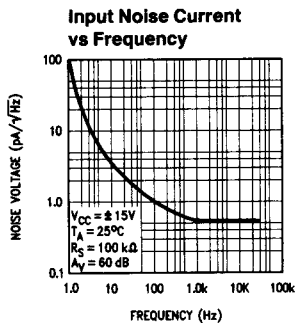
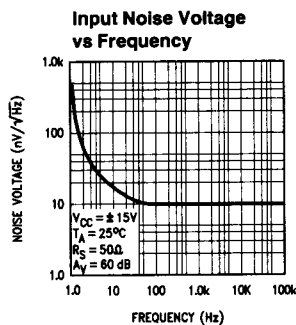
**Note 4:** Short circuit may be to ground, one amplifier only.

**Note 5:** For military specifications see RETS4136X for LM4136J.

# Typical Performance Characteristics



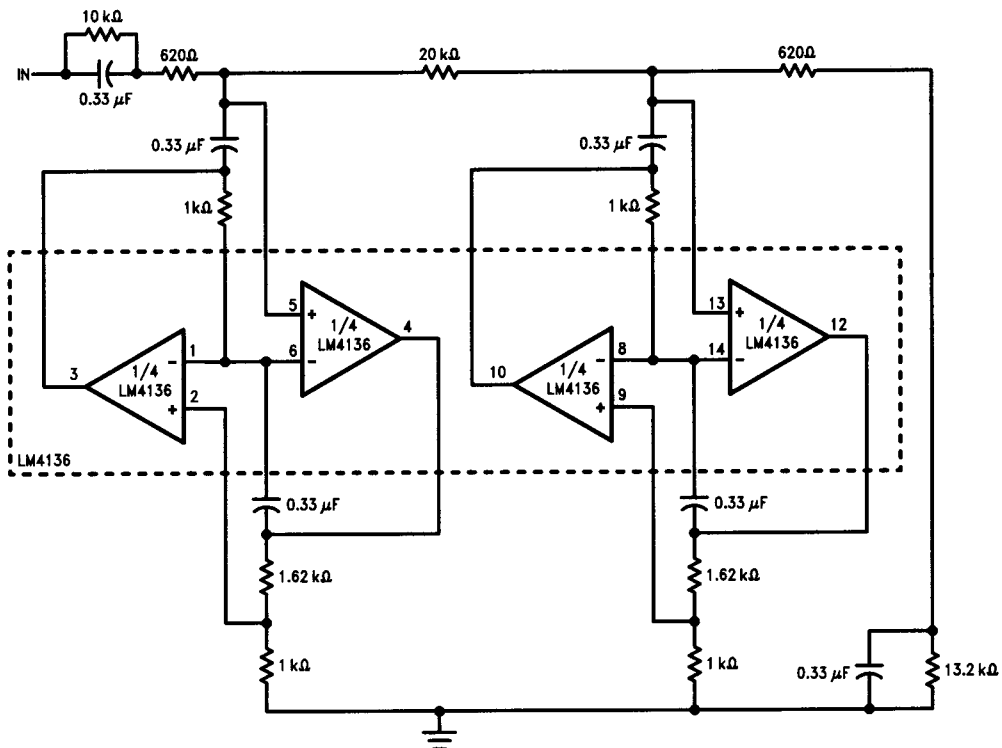
# Typical Performance Characteristics (Continued)



TL/H/10065-4

## Typical Applications

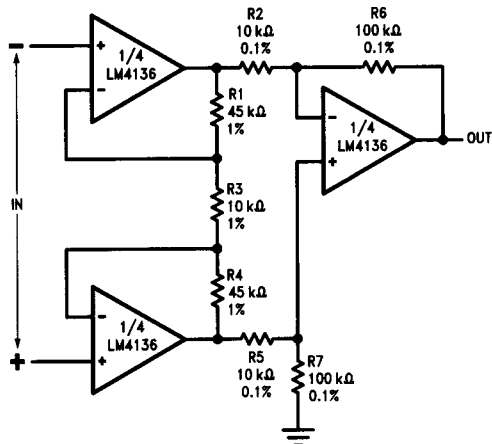
### 400 Hz Lowpass Butterworth Active Filter



TL/H/10065-5

# Typical Applications (Continued)

## Differential Input Instrumentation Amplifier with High Common Mode Rejection

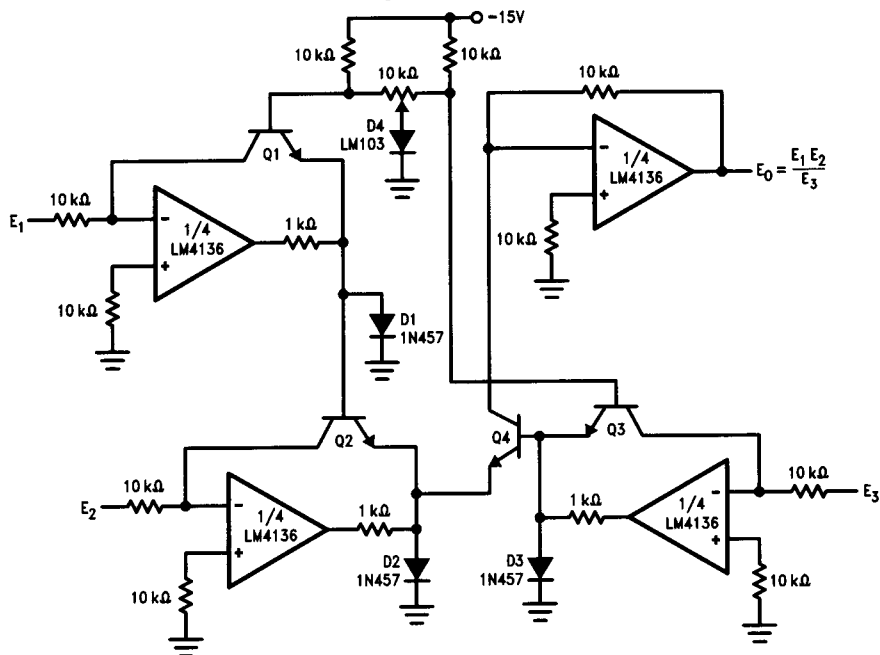


$$A_V = \frac{R_6}{R_2} \left( 1 + \frac{2R_1}{R_3} \right)$$

Matching determines CMRR:  
 $R_1 = R_4$   
 $R_2 = R_5$   
 $R_6 = R_7$

TL/H/10065-6

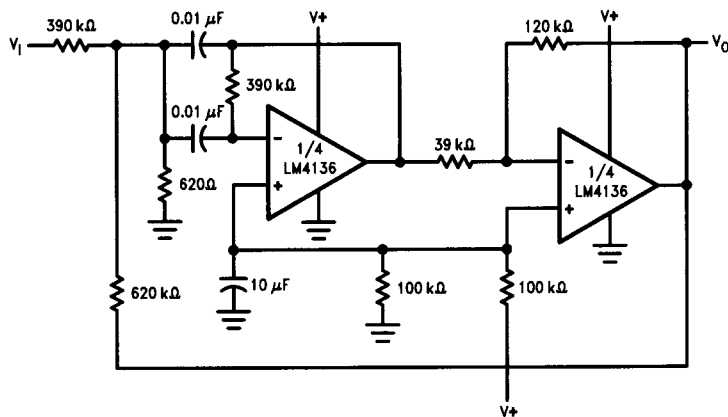
## Analog Multiplier/Divider



TL/H/10065-7

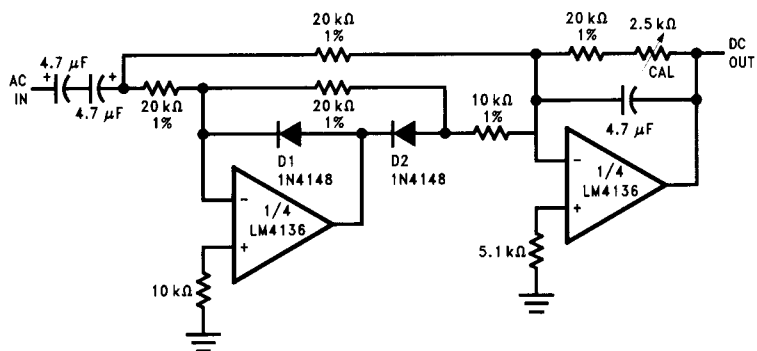
# Typical Applications (Continued)

## 1 kHz Bandpass Active Filter



TL/H/10065-8

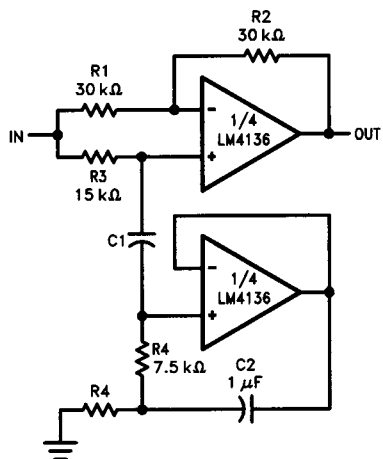
## Full-Wave Rectifier and Averaging Filter



TL/H/10065-9

## Typical Applications (Continued)

**Notch Filter Using the LM4136 as a Gyrator**

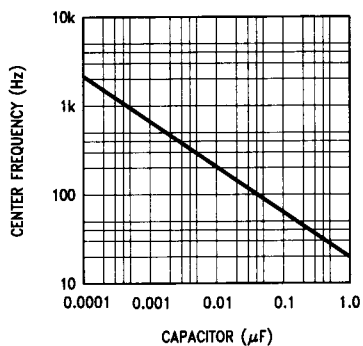


TL/H/10065-10

Trim R, Such That

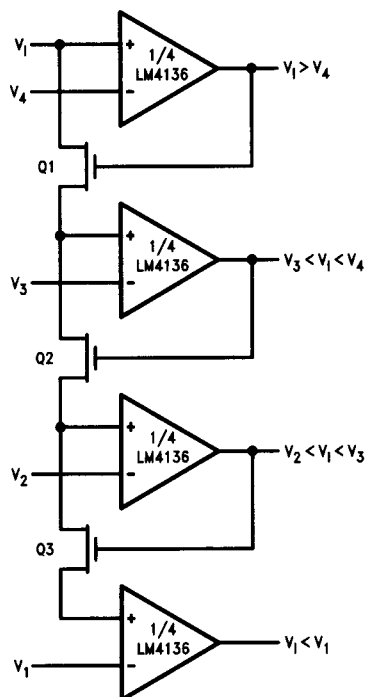
$$\frac{R1}{R2} = \frac{R3}{2 R4}$$

**Notch Frequency vs Capacitor**



TL/H/10065-12

**Multiple Aperture Window Discriminator**



TL/H/10065-11