



## LM324

## LINEAR INTEGRATED CIRCUIT

# QUAD OPERATIONAL AMPLIFIERS

### DESCRIPTION

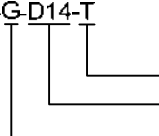
The UTC **LM324** consists of four independent, high gain internally frequency compensated operational amplifiers which are designed specifically to operate from a single power supply over a wide voltage range. Operation from split power supplies is also possible. Application areas include transducer amplifier, DC gain blocks and all the conventional OP amp circuits which now can be easily implemented in single power supply system.

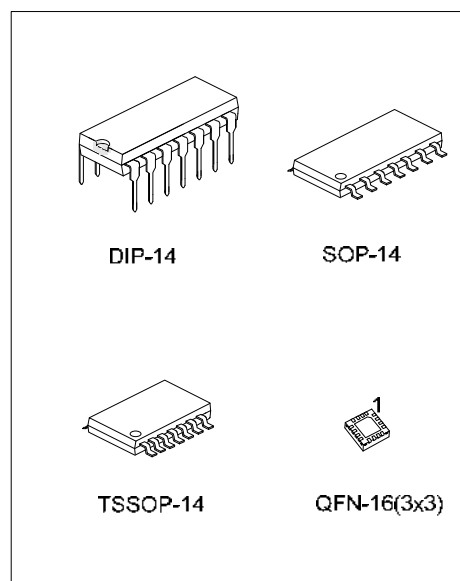
### FEATURES

- \*Internally frequency compensated for unity gain
- \*Large DC voltage gain :100dB
- \*Wide operating supply range ( $V_{CC}=3V\sim 32V$ )
- \*Input common-mode voltage includes ground
- \*Large output voltage swing: From 0V to  $V_{CC}-1.5V$
- \*Power drain suitable for battery operation

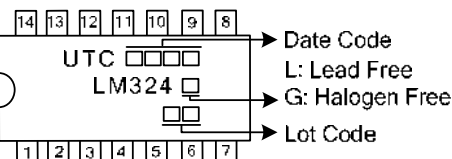
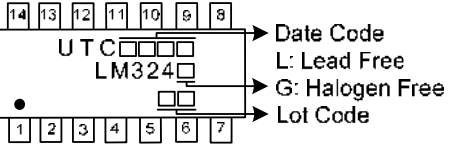
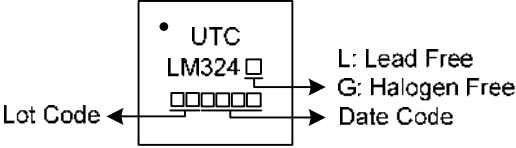
### ORDERING INFORMATION

| Ordering Number   |                   | Package     | Packing   |
|-------------------|-------------------|-------------|-----------|
| Lead Free         | Halogen-Free      |             |           |
| LM324L-D14-T      | LM324G-D14-T      | DIP-14      | Tube      |
| LM324L-S14-R      | LM324G-S14-R      | SOP-14      | Tape Reel |
| LM324L-P14-R      | LM324G-P14-R      | TSSOP-14    | Tape Reel |
| LM324L-Q16-3030-R | LM324G-Q16-3030-R | QFN-16(3×3) | Tape Reel |

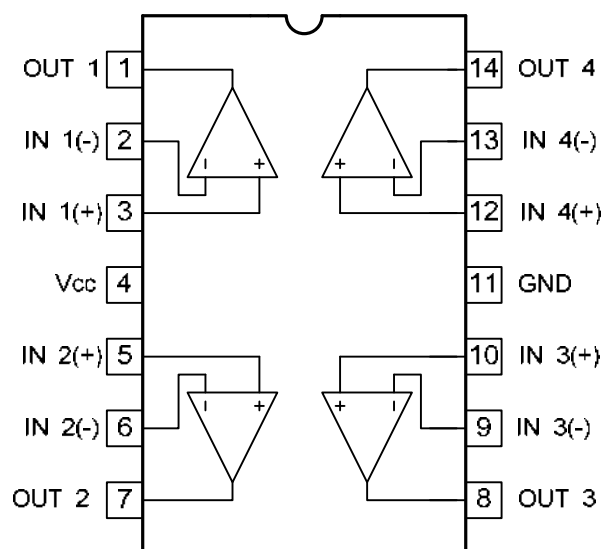
|                                                                                                                                                                                               |  |                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <div>LM324G-D14-T</div> <div></div> <div>(1) Packing Type<br/>(2) Package Type<br/>(3) Green Package</div> |  | (1) T: Tube, R: Tape Reel<br>(2) DIP: DIP-14, S14: SOP-14, P14: TSSOP-14<br>Q16-3030: QFN-16(3×3)<br>(3) G: Halogen Free and Lead Free, L: Lead Free |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------|



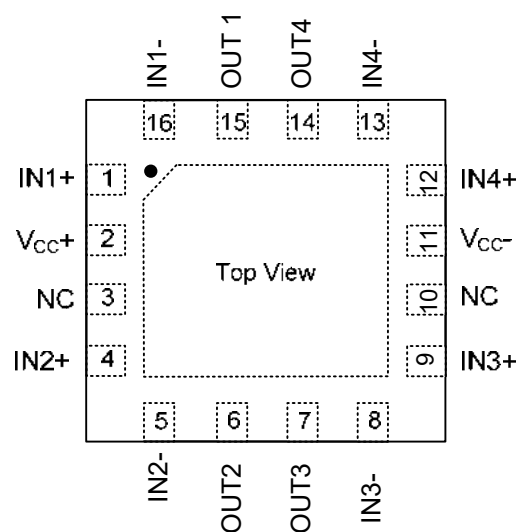
### MARKING

| PACKAGE            | MARKING                                                                            |
|--------------------|------------------------------------------------------------------------------------|
| DIP-14             |  |
| SOP-14<br>TSSOP-14 |  |
| QFN-16(3×3)        |  |

### PIN DESCRIPTION

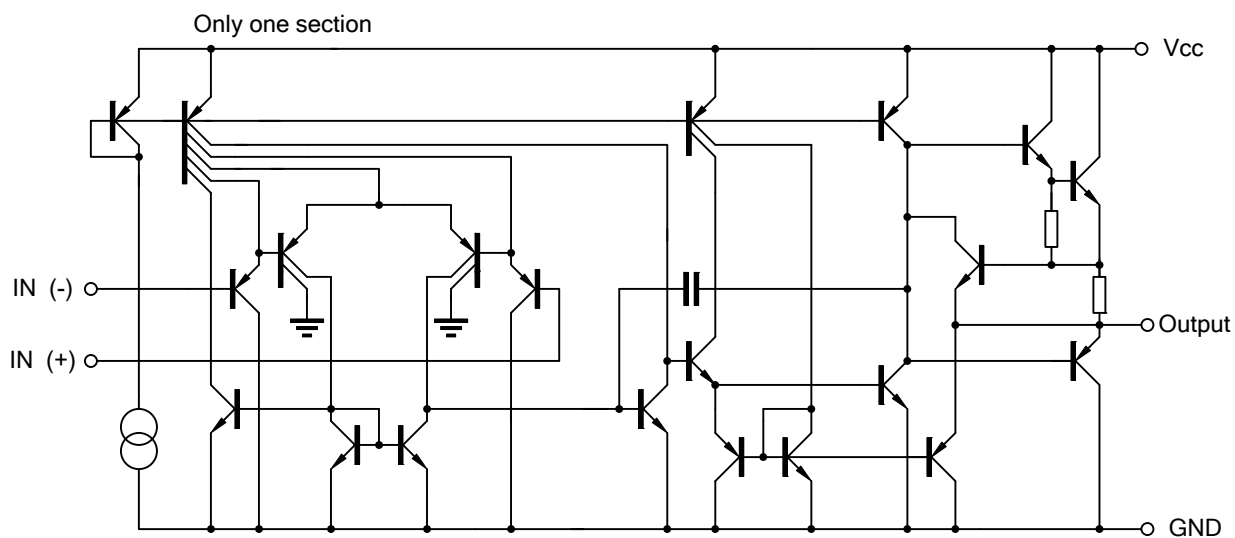


DIP-14/SOP-14/TSSOP-14



QFN-16(3×3)

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATINGS

| PARAMETER                  |             | SYMBOL        | RATINGS        | UNIT |
|----------------------------|-------------|---------------|----------------|------|
| Supply Voltage             |             | $V_{CC}$      | $\pm 16$ or 32 | V    |
| Differential Input Voltage |             | $V_{I(DIFF)}$ | $\pm 32$       | V    |
| Input Voltage              |             | $V_{IN}$      | -0.3 ~ +32     | V    |
| Power Dissipation          | DIP-14      | $P_D$         | 800            | mW   |
|                            | SOP-14      |               | 580            | mW   |
|                            | TSSOP-14    |               | 460            | mW   |
|                            | QFN-16(3×3) |               | 1300           | mW   |
| Operating Temperature      |             | $T_{OPR}$     | -20 ~ +85      | °C   |
| Storage Temperature        |             | $T_{STG}$     | -65 ~ +150     | °C   |

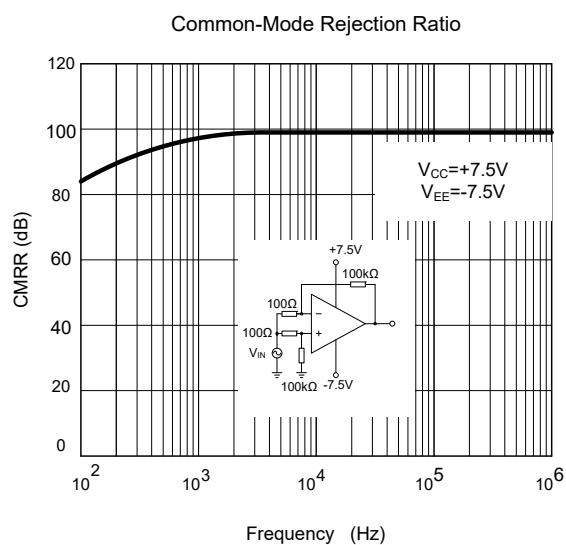
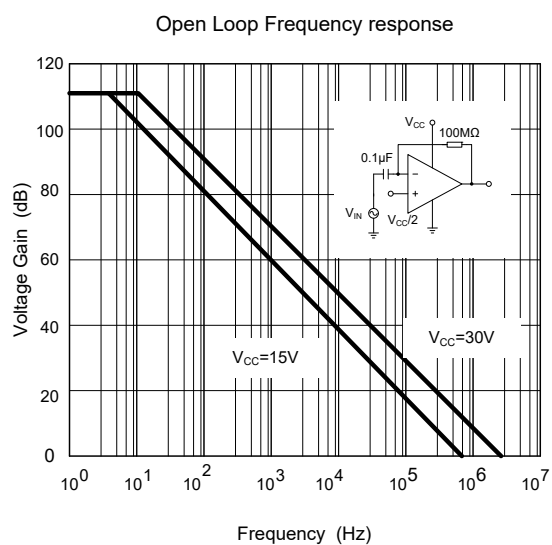
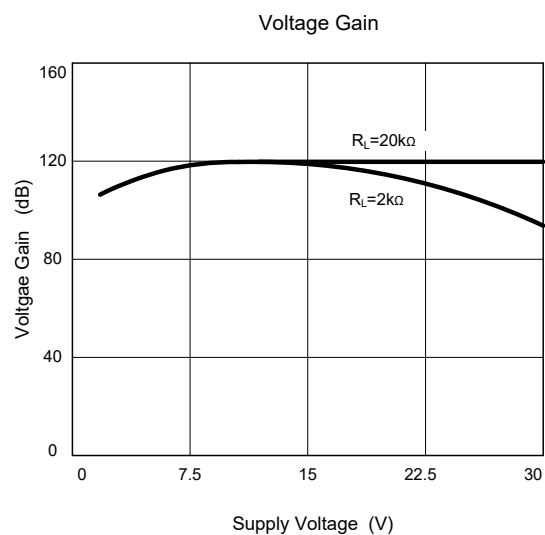
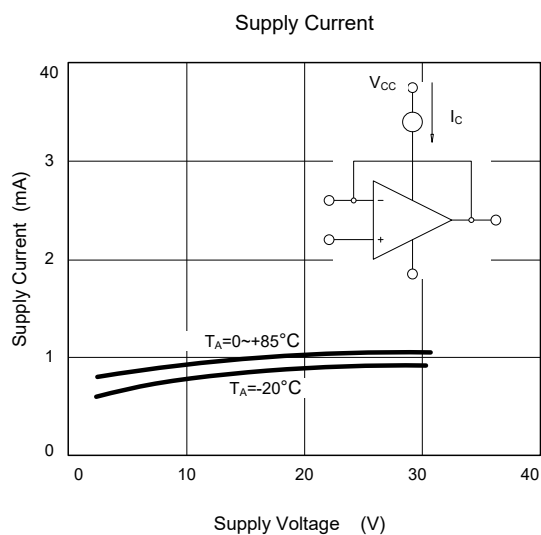
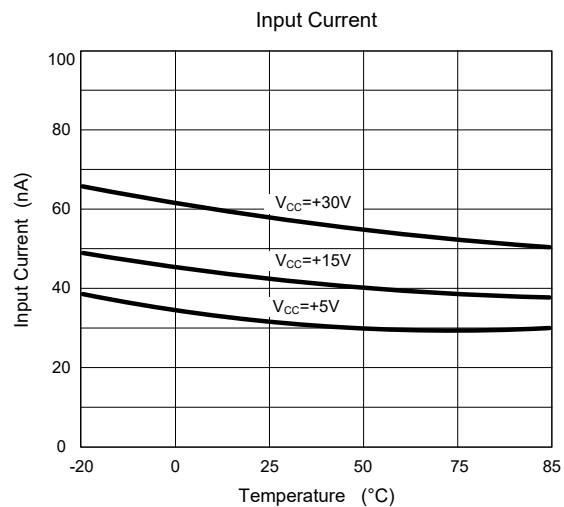
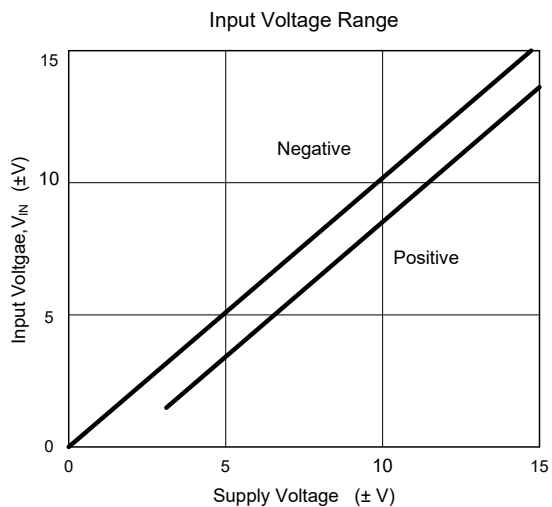
Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

## ■ ELECTRICAL CHARACTERISTICS

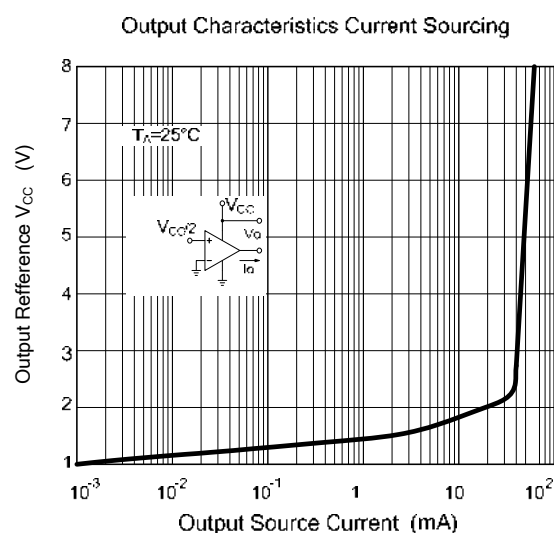
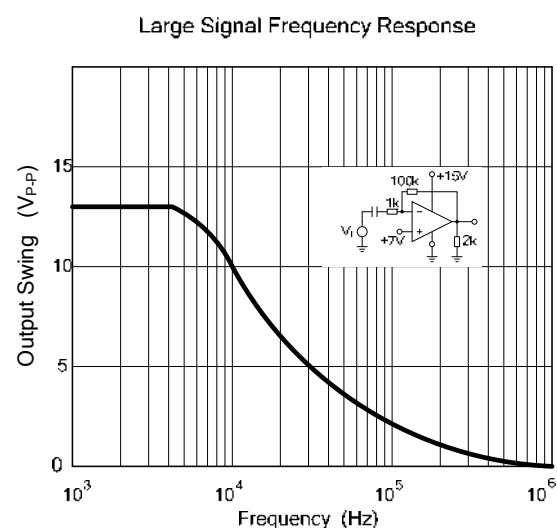
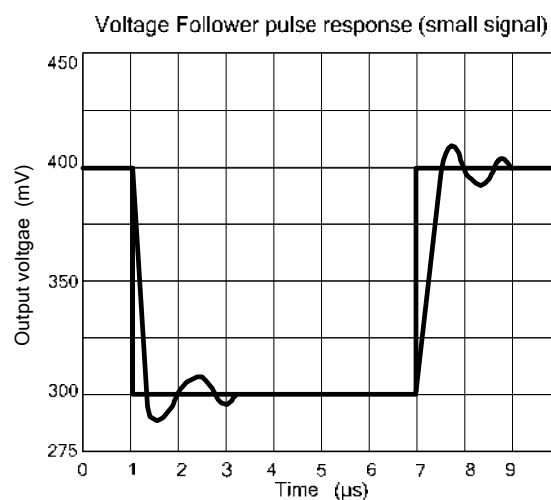
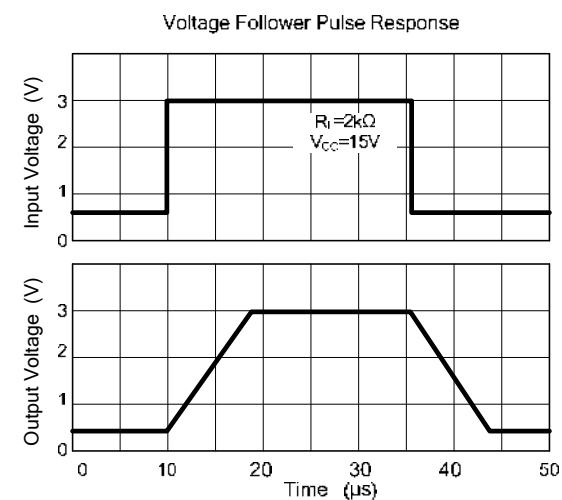
( $V_{CC}=5.0V$ , All voltage referenced to GND unless otherwise specified.)

| PARAMETER                       | SYMBOL        | TEST CONDITIONS                                                 | MIN | TYP | MAX          | UNIT    |
|---------------------------------|---------------|-----------------------------------------------------------------|-----|-----|--------------|---------|
| Input Offset Voltage            | $V_{I(OFF)}$  | $V_{CM}=0V$ to $V_{CC}-1.5V$<br>$V_{O(P)}=1.4V$ , $R_S=0\Omega$ |     |     | 5.0          | mV      |
| Input Offset Current            | $I_{I(OFF)}$  |                                                                 |     |     | 50           | nA      |
| Input Bias Current              | $I_{I(BIAS)}$ |                                                                 |     |     | 250          | nA      |
| Input Common Mode Voltage       | $V_{I(CM)}$   | $V_{CC}=30V$                                                    | 0   |     | $V_{CC}-1.5$ | V       |
| Power Supply Current            | $I_{CC}$      | $R_L=\infty$ , $V_{CC}=30V$                                     |     | 1.0 | 3.0          | mA      |
|                                 |               | $V_{CC}=5V$                                                     |     | 0.7 | 1.2          | mA      |
| Large Signal Voltage Gain       | $G_V$         | $V_{CC}=15V$ , $R_L \geq 2K\Omega$<br>$V_{O(P)}=1V \sim 11V$    | 25  | 100 |              | V/mV    |
| Output Voltage Swing            | $V_{OH}$      | $V_{CC}=30V$ , $R_L=2K\Omega$                                   | 26  |     |              | V       |
|                                 |               | $V_{CC}=30V$ , $R_L=10K\Omega$                                  | 27  | 28  |              | V       |
|                                 | $V_{OL}$      | $V_{CC}=5V$ , $R_L>10K\Omega$                                   |     | 5   | 20           | mV      |
| Common Mode Rejection Ratio     | CMRR          |                                                                 | 65  | 75  |              | dB      |
| Power Supply Rejection Ratio    | PSRR          |                                                                 | 65  | 100 |              | dB      |
| Channel Separation              | CS            | $f=1KHZ \sim 20KHZ$                                             |     | 120 |              | dB      |
| Short Circuit Current to Ground | $I_{SC}$      |                                                                 |     | 40  | 60           | mA      |
| Output Current                  | $I_{SOURCE}$  | $V_I(+)=1V$ , $V_I(-)=0V$<br>$V_{CC}=15V$ , $V_{O(P)}=2V$       | 20  | 40  |              | mA      |
|                                 | $I_{SINK}$    | $V_I(+)=0V$ , $V_I(-)=1V$<br>$V_{CC}=15V$ , $V_{O(P)}=2V$       | 10  | 13  |              | mA      |
|                                 |               | $V_I(+)=0V$ , $V_I(-)=1V$<br>$V_{CC}=15V$ , $V_{O(P)}=200mV$    | 12  | 45  |              | $\mu A$ |
| Differential Input Voltage      | $V_{I(DIFF)}$ |                                                                 |     |     | $V_{CC}$     | V       |

## ■ TYPICAL CHARACTERISTICS



# TYPICAL CHARACTERISTICS (Cont.)



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