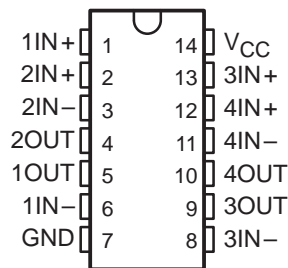


LM2900, LM3900 QUADRUPLE NORTON OPERATIONAL AMPLIFIERS

SLOS059 – JULY 1979 – REVISED SEPTEMBER 1990

- Wide Range of Supply Voltages, Single or Dual Supplies
- Wide Bandwidth
- Large Output Voltage Swing
- Output Short-Circuit Protection
- Internal Frequency Compensation
- Low Input Bias Current
- Designed to Be Interchangeable With National Semiconductor LM2900 and LM3900, Respectively

N PACKAGE
(TOP VIEW)

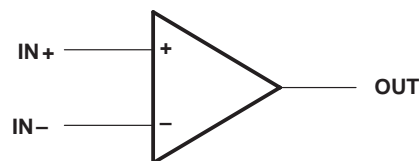


description

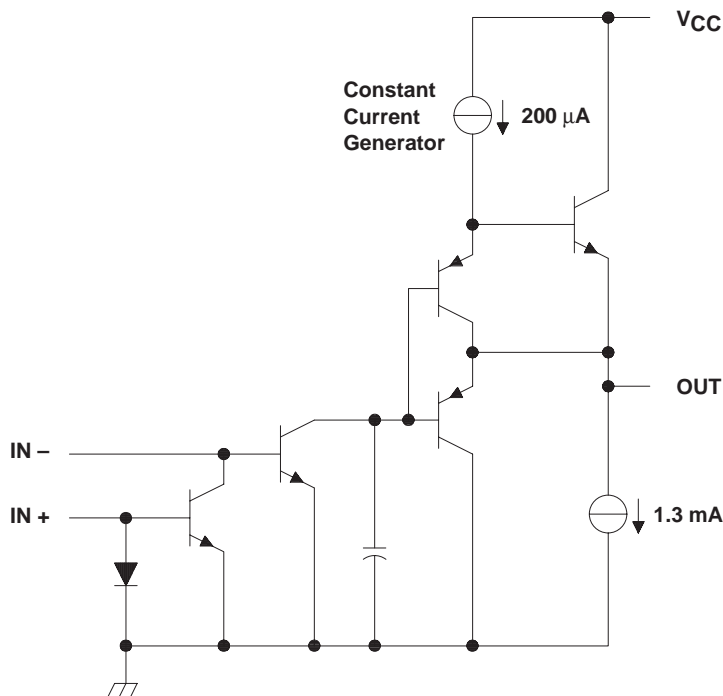
These devices consist of four independent, high-gain frequency-compensated Norton operational amplifiers that were designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is also possible. The low supply current drain is essentially independent of the magnitude of the supply voltage. These devices provide wide bandwidth and large output voltage swing.

The LM2900 is characterized for operation from -40°C to 85°C , and the LM3900 is characterized for operation from 0°C to 70°C .

symbol (each amplifier)



schematic (each amplifier)



PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

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LM2900, LM3900 QUADRUPLE NORTON OPERATIONAL AMPLIFIERS

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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

| | LM2900 | LM3900 | UNIT |
|---|------------------------------|------------|------|
| Supply voltage, V_{CC} (see Note 1) | 36 | 36 | V |
| Input current | 20 | 20 | mA |
| Duration of output short circuit (one amplifier) to ground at (or below) 25°C free-air temperature (see Note 2) | unlimited | unlimited | |
| Continuous total dissipation | See Dissipation Rating Table | | |
| Operating free-air temperature range | -40 to 85 | 0 to 70 | °C |
| Storage temperature range | -65 to 150 | -65 to 150 | °C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260 | 260 | °C |

NOTES: 1. All voltage values, except differential voltages, are with respect to the network ground terminal.
2. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$ POWER RATING | $T_A = 85^\circ\text{C}$ POWER RATING |
|---------|---|---|--|--|
| N | 1150 mW | 9.2 mW/°C | 736 mW | 598 mW |

recommended operating conditions

| | LM2900 | | LM3900 | | UNIT |
|--|--------|-----|--------|-----|------|
| | MIN | MAX | MIN | MAX | |
| Supply voltage, V_{CC} (single supply) | 4.5 | 32 | 4.5 | 32 | V |
| Supply voltage, V_{CC+} (dual supply) | 2.2 | 16 | 2.2 | 16 | V |
| Supply voltage, V_{CC-} (dual supply) | -2.2 | -16 | -2.2 | -16 | V |
| Input current (see Note 3) | | -1 | | -1 | mA |
| Operating free-air temperature, T_A | -40 | 85 | 0 | 70 | °C |

NOTE 3: Clamp transistors are included that prevent the input voltages from swinging below ground more than approximately -0.3 V. The negative input currents that may result from large signal overdrive with capacitive input coupling must be limited externally to values of approximately -1 mA. Negative input currents in excess of -4 mA causes the output voltage to drop to a low voltage. These values apply for any one of the input terminals. If more than one of the input terminals are simultaneously driven negative, maximum currents are reduced. Common-mode current biasing can be used to prevent negative input voltages.



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electrical characteristics, $V_{CC} = 15\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | | LM2900 | | | LM3900 | | | UNIT |
|--|---|-------------------------------------|------------------|------|-----|--------|------|-----|---------------------------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| I_{IB} Input bias current (inverting input) | $I_{I+} = 0$ | $T_A = 25^\circ\text{C}$ | 30 | 200 | | 30 | 200 | nA | |
| | | $T_A = \text{Full range}$ | | 300 | | 300 | | | |
| Mirror gain | $I_{I+} = 20\ \mu\text{A}$ to $200\ \mu\text{A}$ $T_A = \text{Full range}$, See Note 4 | | 0.9 | | 1.1 | 0.9 | | 1.1 | $\mu\text{A}/\mu\text{A}$ |
| Change in mirror gain | | | 2% | | 5% | 2% | | 5% | |
| Mirror current | $V_{I+} = V_{I-}$, See Note 4 | $T_A = \text{Full range}$, | 10 | | 500 | 10 | | 500 | μA |
| A_{VD} Large-signal differential voltage amplification | $V_O = 10\text{ V}$, $f = 100\text{ Hz}$ | $R_L = 10\text{ k}\Omega$, | 1.2 | | 2.8 | 1.2 | | 2.8 | V/mV |
| r_i Input resistance (inverting input) | | | | 1 | | | 1 | | M Ω |
| r_o Output resistance | | | | 8 | | | 8 | | k Ω |
| B_1 Unity-gain bandwidth (inverting input) | | | | 2.5 | | | 2.5 | | MHz |
| k_{SVR} Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) | | | | 70 | | | 70 | | dB |
| V_{OH} High-level output voltage | $I_{I+} = 0$, $I_{I-} = 0$ | $R_L = 2\text{ k}\Omega$ | | 13.5 | | | 13.5 | | V |
| | | $V_{CC} = 30\text{ V}$, No load | | 29.5 | | | 29.5 | | |
| V_{OL} Low-level output voltage | $I_{I+} = 0$, $R_L = 2\text{ k}\Omega$ | $I_{I-} = 10\ \mu\text{A}$, | | 0.09 | 0.2 | | 0.09 | 0.2 | V |
| I_{OS} Short-circuit output current (output internally high) | $I_{I+} = 0$, $V_O = 0$ | $I_{I-} = 0$, | | -6 | -18 | | -6 | -10 | mA |
| | | | Pulldown current | 0.5 | 1.3 | | 0.5 | 1.3 | |
| I_{OL} Low-level output current‡ | $I_{I-} = 5\ \mu\text{A}$ | $V_{OL} = 1\text{ V}$ | | 5 | | | 5 | | mA |
| I_{CC} Supply current (four amplifiers) | No load | | | 6.2 | 10 | | 6.2 | 10 | mA |

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified. Full range for T_A is -40°C to 85°C for LM2900 and 0°C to 70°C for LM3900.

‡ The output current-sink capability can be increased for large-signal conditions by overdriving the inverting input.

NOTE 4: These parameters are measured with the output balanced midway between V_{CC} and GND.

operating characteristics, $V_{CC\pm} = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$

| PARAMETER | TEST CONDITIONS | | | MIN | TYP | MAX | UNIT |
|----------------------------|--------------------|--|--|-----|-----|-----|------------------|
| SR Slew rate at unity gain | Low-to-high output | $V_O = 10\text{ V}$, $C_L = 100\text{ pF}$, $R_L = 2\text{ k}\Omega$ | | | 0.5 | | V/ μs |
| | High-to-low output | | | 20 | | | |



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TYPICAL CHARACTERISTICS†

INPUT BIAS CURRENT (INVERTING INPUT)
vs
FREE-AIR TEMPERATURE

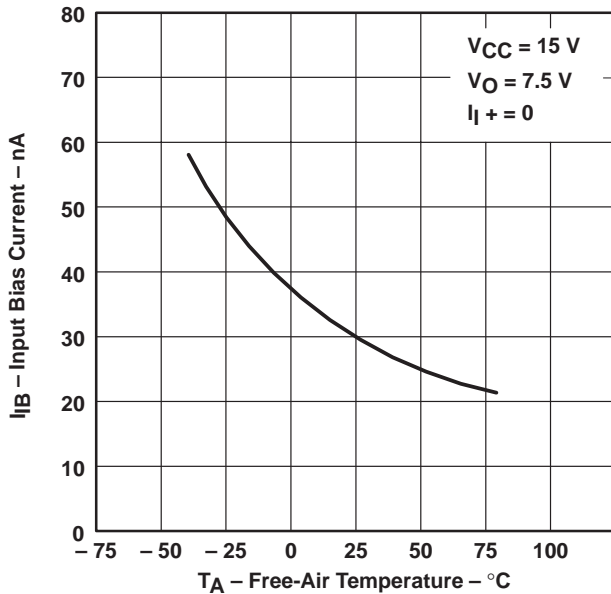


Figure 1

MIRROR GAIN
vs
FREE-AIR TEMPERATURE

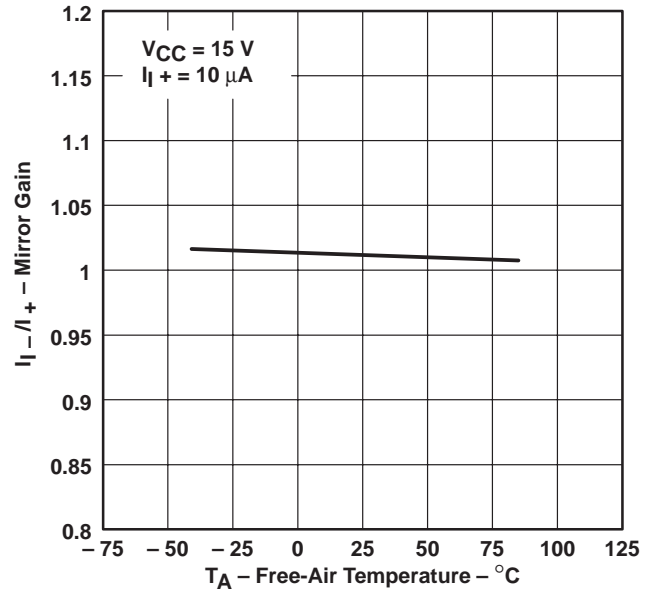


Figure 2

LARGE SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
FREQUENCY

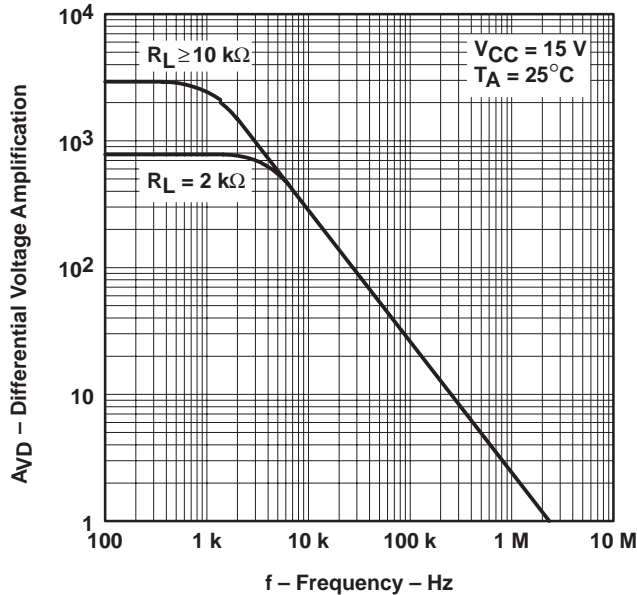


Figure 3

LARGE SIGNAL
DIFFERENTIAL VOLTAGE AMPLIFICATION
vs
SUPPLY VOLTAGE

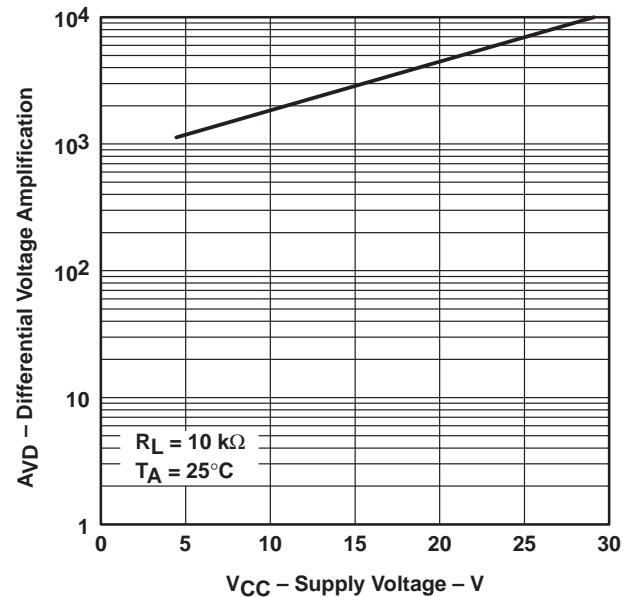
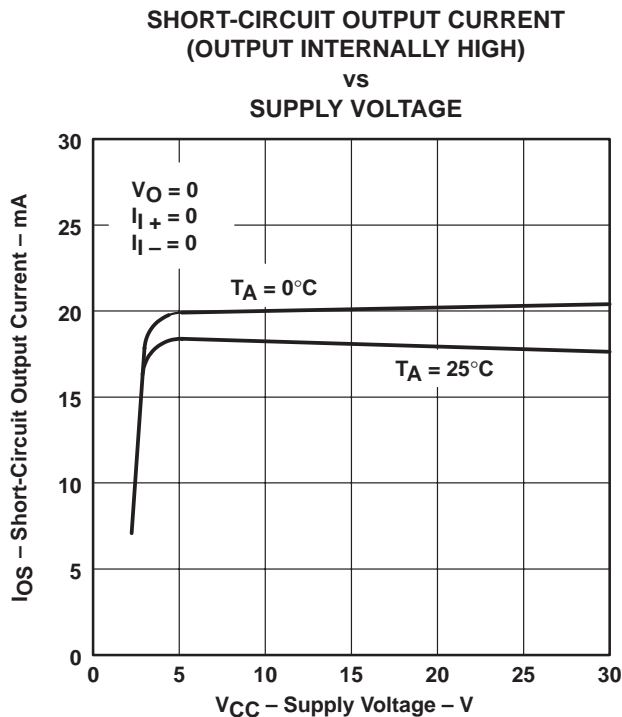
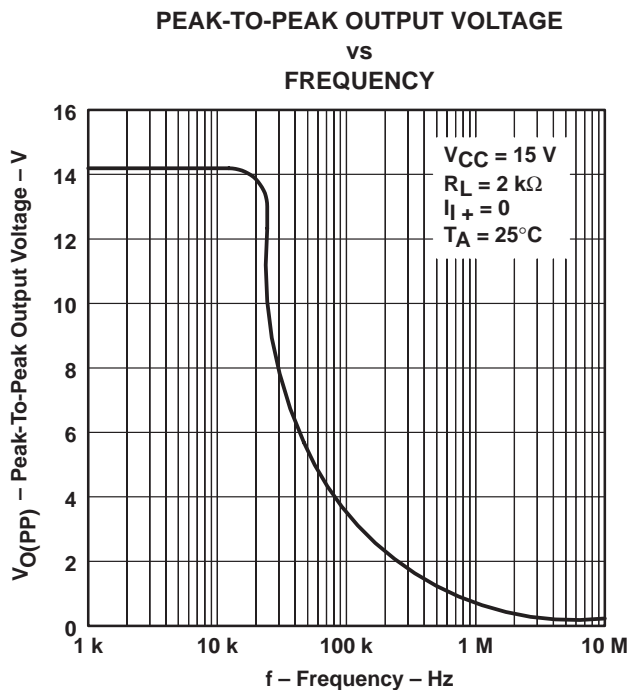
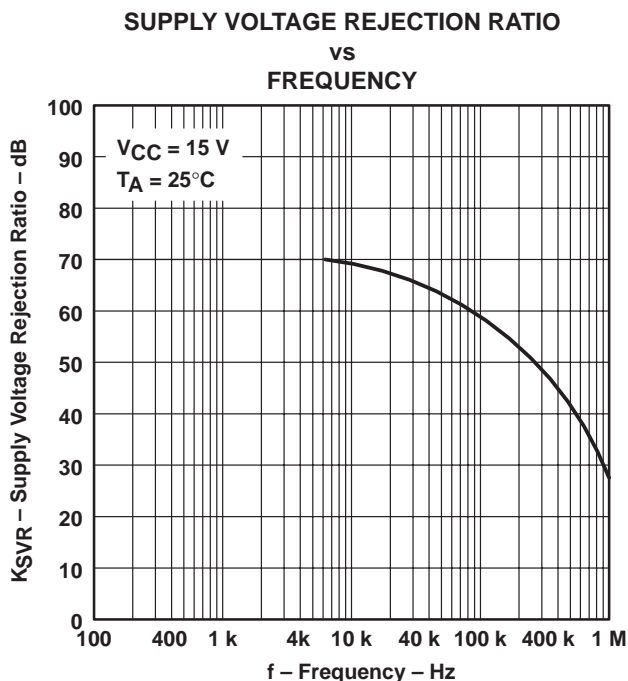
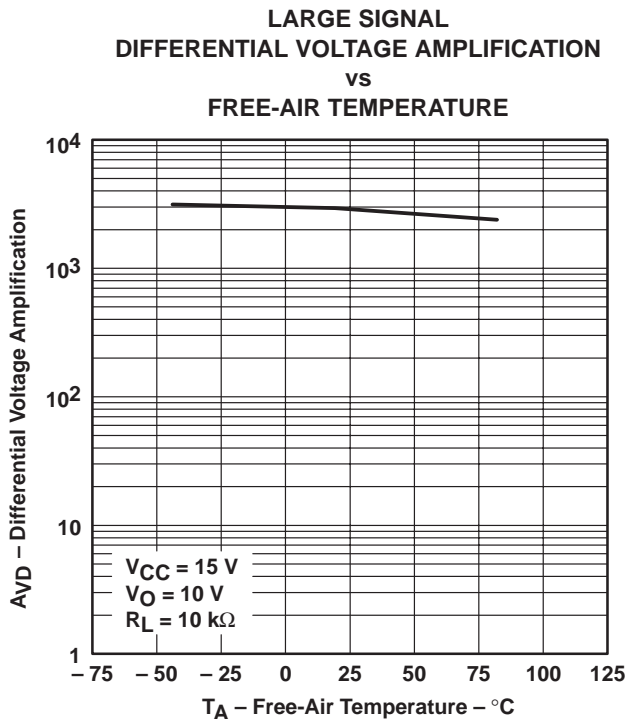


Figure 4

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS†



† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

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TYPICAL CHARACTERISTICS†

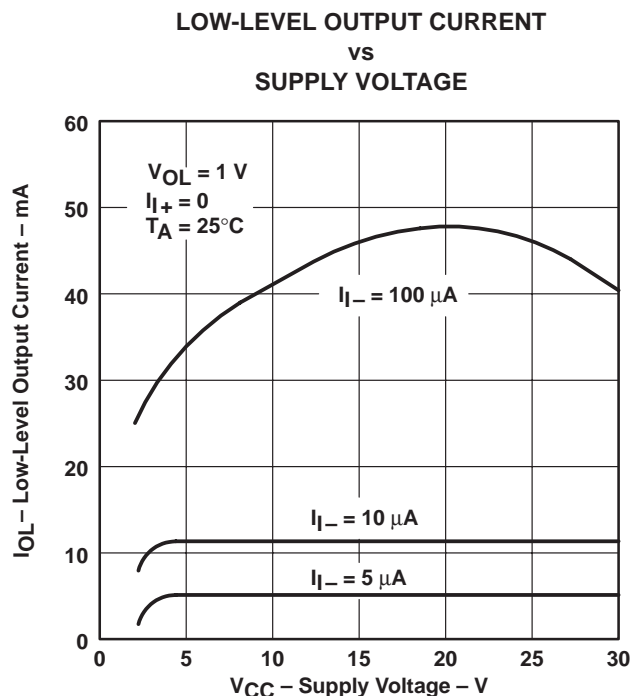


Figure 9

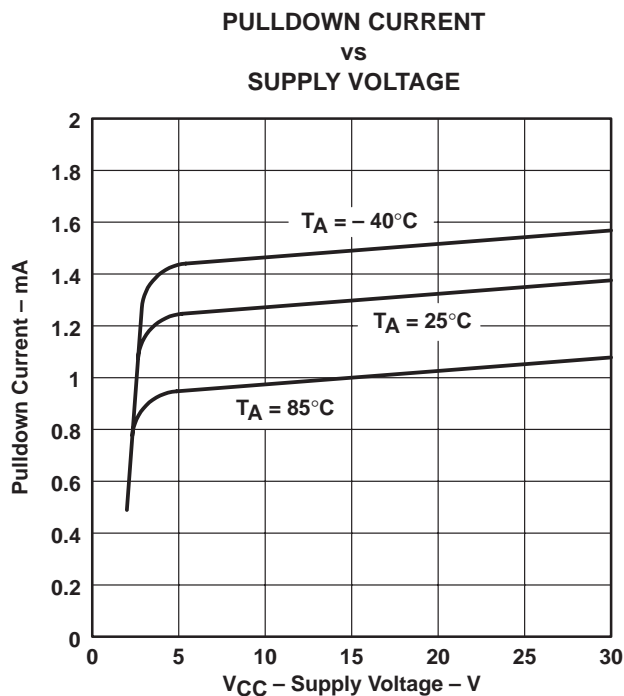


Figure 10

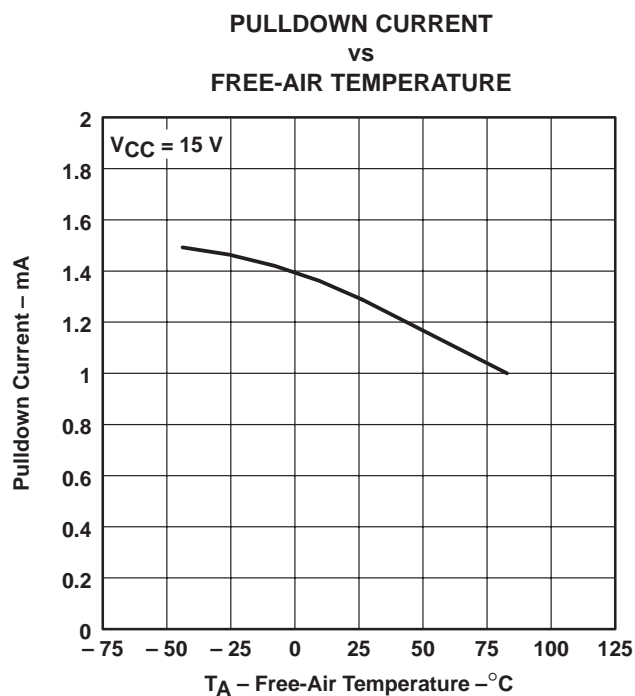


Figure 11

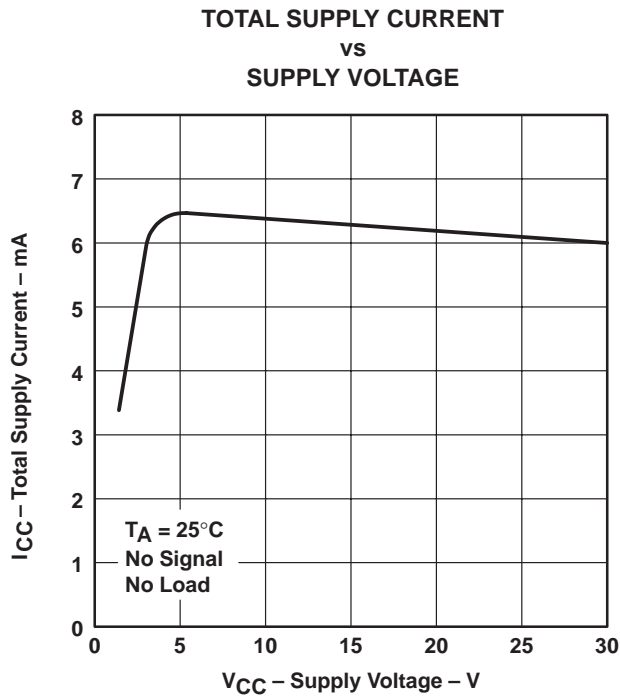


Figure 12

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

APPLICATION INFORMATION

Norton (or current-differencing) amplifiers can be used in most standard general-purpose operational amplifier applications. Performance as a dc amplifier in a single-power-supply mode is not as precise as a standard integrated-circuit operational amplifier operating from dual supplies. Operation of the amplifier can best be understood by noting that input currents are differenced at the inverting input terminal and this current then flows through the external feedback resistor to produce the output voltage. Common-mode current biasing is generally useful to allow operating with signal levels near (or even below) ground.

Internal transistors clamp negative input voltages at approximately -0.3 V but the magnitude of current flow has to be limited by the external input network. For operation at high temperature, this limit should be approximately $-100\ \mu\text{A}$.

Noise immunity of a Norton amplifier is less than that of standard bipolar amplifiers. Circuit layout is more critical since coupling from the output to the noninverting input can cause oscillations. Care must also be exercised when driving either input from a low-impedance source. A limiting resistor should be placed in series with the input lead to limit the peak input current. Current up to $20\ \text{mA}$ will not damage the device, but the current mirror on the noninverting input will saturate and cause a loss of mirror gain at higher current levels, especially at high operating temperatures.

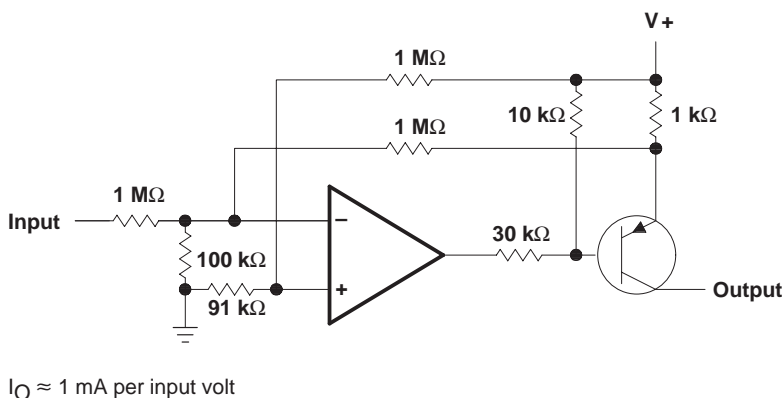


Figure 13. Voltage-Controlled Current Source

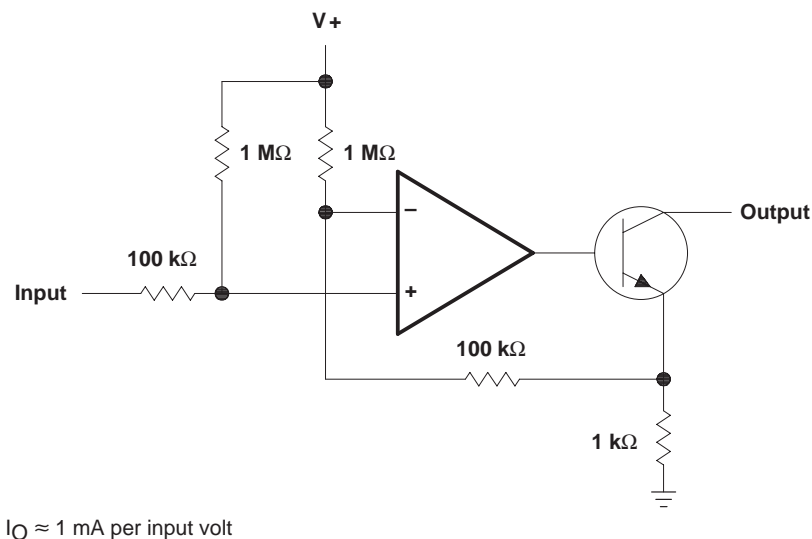


Figure 14. Voltage-Controlled Current Sink

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