

# LT1999: High Voltage, Bidirectional Current Sense Amplifier

## DESCRIPTION

Demonstration circuit 1698A features the LT1999, a high voltage, bi-directional current sense amplifier.

The demo board amplifies the voltage drop across an on board current sense resistor. The output voltage is a bi-directional signal that is centered on the  $V_{REF}$  voltage and is proportional to the current through the sense resistor. The output is scaled by one of three fixed gain options. The gain options are: 10V/V (DC1698A-A), 20V/V (DC1698A-B)

and 50V/V (DC1698A-C). The input voltage range is from  $-5V$  to  $80V$  (independent of the device supply voltage) allowing the part to be used for high or low side current sensing. The LT1999 requires a separate 5V supply voltage.

**Design files for this circuit board are available at <http://www.linear.com/demo>**

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## PERFORMANCE SUMMARY

Table 1. Performance Summary ( $T_A = 25^\circ C$ )

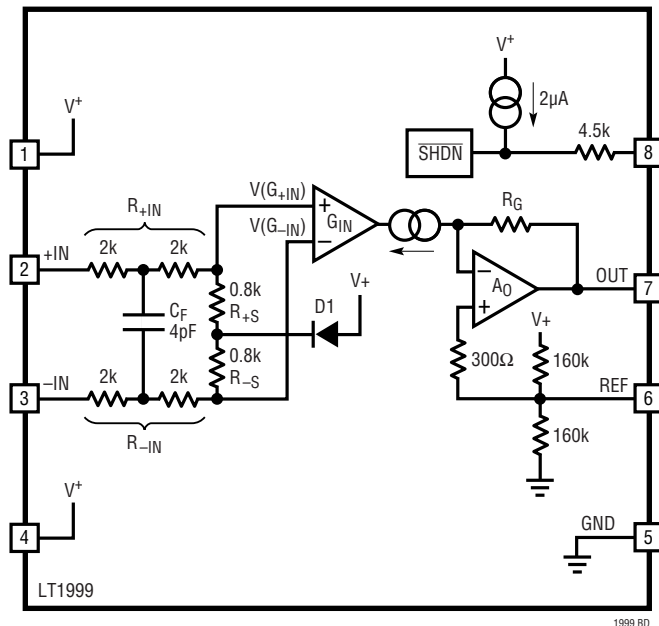
| SYMBOL      | PARAMETER   | CONDITIONS                                | MIN  | TYP      | MAX         | UNITS    |
|-------------|---|---|------|----------|-------------|----------|
| $V_S$       | Supply Range  |   | 4.5  |          | 5.5         | V        |
| $V_{CM}$    | CM Input Voltage Range  |   | -5   |          | 80          | V        |
| CMRR        | Common Mode Rejection Ratio   | $V_{CM} = 0V$ , $7V_{P-P}$ , $f = 100kHz$ | 80   | 100      |             | dB       |
| $V_{OUT}$   | Swing Output High (with Respect to $V^+$ )<br>Swing Output Low (with Respect to $V^-$ ) | $R_{LOAD} = Open$<br>$R_{LOAD} = Open$    |      | 5<br>150 | 125<br>225  | mV<br>mV |
| $V_{OSI}$   | Input Referred Offset Voltage   | $T_A = 25^\circ C$ , $V_{CM} > 5.5V$      |      | 550      |             | $\mu V$  |
| $I_Q$       | $V^+$ Quiescent Current   | $V_{CM} > 5.5V$                           |      | 1.55     |             | mA       |
| $V_{REF}$   | Open Circuit Voltage  | $V_S = 5V$                                | 2.44 | 2.5      | 2.55        | V        |
| $V_{REFIN}$ | REF Pin Input Range   |   | 1.25 |          | $V^+ - 1.5$ | V        |

## OPERATING PRINCIPLES

The LT1999 operates by amplifying the voltage drop across a user selected sense resistor. The voltage across the resistor is amplified by a fixed gain of 10V/V, 20V/V or 50V/V (LT1999-10, LT1999-20, LT1999-50) and is level

shifted to the OUT pin of the device. The voltage difference and polarity with respect to the  $V_{REF}$  pin voltage indicates the magnitude and direction of the current in the sense resistor.

## BLOCK DIAGRAM



## QUICK START PROCEDURE

Demonstration circuit 1698 is easy to set up and evaluate the performance of the LT1999. Refer to Figure 1 for proper measurement equipment setup and follow the procedure:

1. With power off, connect a power supply to  $V^+$  and the common to GND. This supply should be between 4.5V and 5.5V. Connect a second supply's positive terminal to the  $V_{SENSE}^+$  and connect its common to the circuit ground. The second supply's (load supply) output voltage can range from  $-5V$  to  $80V$ .
2. With power off, connect the load to the  $V_{SENSE}^-$ . If the load power source does not have accurate current readout a DMM may be connected in series with the load as shown in Figure 1.
3. Connect a voltmeter to the  $V_{OUT}$  terminal, with the common connected to the  $V_{REF}$  terminal. An oscilloscope can also be used to monitor  $V_{out}$  with respect to ground.
4. Turn on the power supply to the device and the load supply.
5. Measure the output voltage with respect to  $V_{REF}$ . The output voltage will be proportional to the load and with the factory set sense resistor will equal  $0.5V$  per  $1A$ .

**QUICK START PROCEDURE**

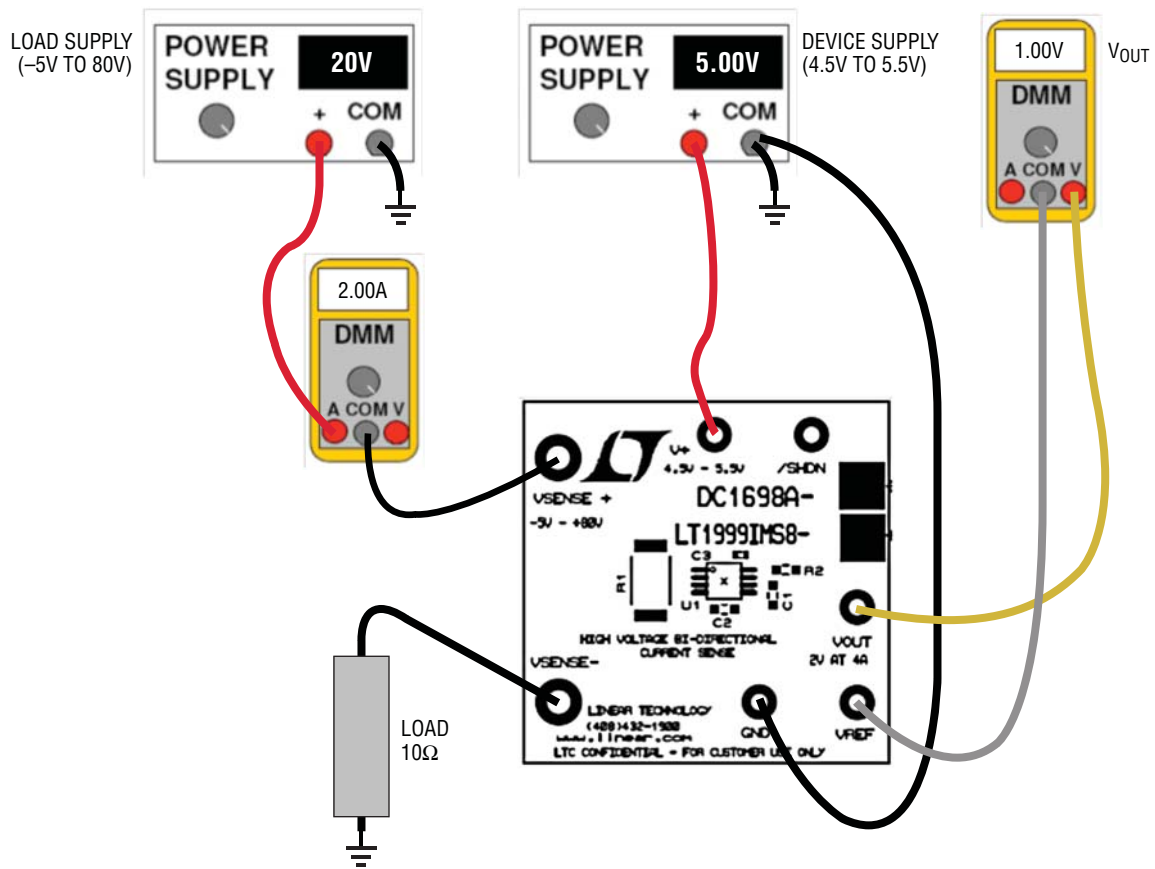


Figure 1. Proper Measurement Equipment Setup

# DEMO MANUAL DC1698A

## PARTS LIST

| ITEM               | QUANTITY | REFERENCE | DESCRIPTION                             | MANUFACTURER'S PART NUMBER           |
|--------------------|----------|-----------|---|--------------------------------------|
| <b>General BOM</b> |          |           |   |                                      |
| 1                  | 2        | C1, C2    | Capacitor, 0.1 $\mu$ F 10% 25V X7R 0603 | AVX, 06033C104KAT2A                  |
| 2                  | 1        | C3        | Capacitor, 100pF 10% 16V X7R 0402       | AVX, 0402YC101KAT2A                  |
| 3                  | 1        | R2        | Resistor, 0 $\Omega$ 0603 1% 1/16W      | YAGEO, RC0603FR-070RL                |
| <b>DC1698A-A</b>   |          |           |   |                                      |
| 1                  | 1        | DC1698A   | General BOM                             |                                      |
| 2                  | 1        | R1        | Resistor, 0.05 $\Omega$ 1% 2512 2W      | SEI, CSRN2512FT50L0                  |
| 3                  | 1        | U1        | IC, LT1999IMS8-10                       | Linear Technology, LT1999IMS8-10#PBF |
| <b>DC1698A-B</b>   |          |           |   |                                      |
| 1                  | 1        | DC1698A   | General BOM                             |                                      |
| 2                  | 1        | R1        | Resistor, 0.025 $\Omega$ 1% 2512 1W     | Vishay, WSL2512R0250FEA              |
| 3                  | 1        | U1        | IC, LT1999IMS8-20                       | Linear Technology, LT1999IMS8-20#PBF |
| <b>DC1698A-C</b>   |          |           |   |                                      |
| 1                  | 1        | DC1698A   | General BOM                             |                                      |
| 2                  | 1        | R1        | Resistor, 0.01 $\Omega$ 1W 1% 2512 SMD  | Vishay, WSL2512R0100FEA              |
| 3                  | 1        | U1        | IC, LT1999IMS8-50                       | Linear Technology, LT1999IMS8-50#PBF |

**SCHEMATIC DIAGRAM**

| REVISION HISTORY |     |             |            |
|------------------|-----|-------------|------------|
| ECO              | REV | DESCRIPTION | DATE       |
|                  | 1   | PRODUCTION  | 10/01/2010 |
|                  |     | APPR        | CUYLER L.  |

| ASSY | U1            | R1        |
|------|---------------|-----------|
| -A   | LT1999IMS8-10 | 0.05 ohm  |
| -B   | LT1999IMS8-20 | 0.025 ohm |
| -C   | LT1999IMS8-50 | 0.01 ohm  |

|   |                       |   |  |
|---|-----------------------|---|--|
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| TITLE: SCHEMATIC                          |                       |   |  |
| HIGH VOLTAGE BI-DIRECTIONAL CURRENT SENSE |                       |   |  |
| SIZE                                      | IC NO.                | REV   |  |
| N/A                                       | LT1999IMS8-10/-20/-50 | 1   |  |
| DATE: 10/2010                             |                       | SH 1 of 1   |  |

|  |                  |           |  |  |  |
|--|------------------|-----------|--|--|--|
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|  | PCB DES.         | CL        |  |  |  |
|  | APP. ENG.        | CUYLER L. |  |  |  |
| <b>SCALE = NONE</b>  |                  |           |  |  |  |

**NOTES: UNLESS OTHERWISE SPECIFIED**

- ALL RESISTORS ARE IN OHMS, 0603
- ALL CAPACTORS ARE IN MICROFARADS, 0603

THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

# DEMO MANUAL DC1698A

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