

## FEATURES

- Direct Replacement for Present References
- Ultra Low Drift—3ppm/°C Typ.
- Curvature Corrected
- Series or Shunt Operation
- Ultra High Line Rejection  $\approx 1/2$  ppm/V
- Low Output Impedance  $\approx 0.02\Omega$
- Tight Initial Output Voltage
- 100% Noise Tested

## APPLICATIONS

- A to D and D to A Converters
- Precision Regulators
- Constant Current Sources
- V to F Converters
- Bridge Excitation

## DESCRIPTION

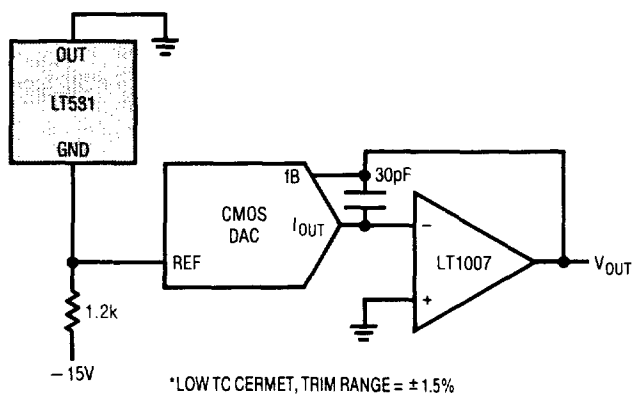
The LT580/LT581 are bandgap voltage references utilizing thin film technology and a greatly improved curvature correction technique. Wafer level trimming of both reference and output voltage combines to produce units with high yields to very low TC and tight initial tolerance of output voltage.

The LT580/LT581 can both sink and source up to 10mA and can be used in either the series or shunt mode. This allows the reference to be used for both positive and negative output voltages without external components. Minimum input-output voltage is less than 1V in the series mode, providing improved tolerance of low line conditions.

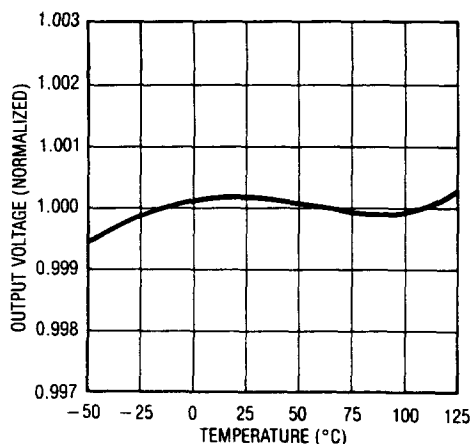
For voltage references with improved specifications, please see the LT1019, LT1021, and LT1031 data sheets.

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Negative 10V Reference for CMOS DAC



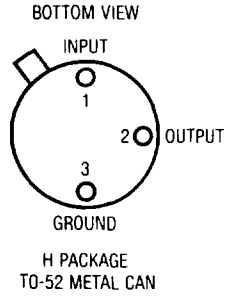
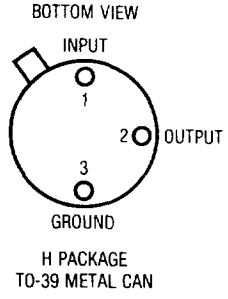
Output Voltage Drift



## ABSOLUTE MAXIMUM RATINGS

|                                             |                 |
|---------------------------------------------|-----------------|
| Input Voltage .....                         | 40V             |
| Storage Temperature Range .....             | – 65°C to 175°C |
| Lead Temperature (Soldering, 10 sec.) ..... | 300°C           |
| Operating Temperature Range                 |                 |
| J, K, L, M Grades .....                     | 0°C to 70°C     |
| S, T, U Grades .....                        | – 55°C to 125°C |

## PACKAGE/ORDER INFORMATION

|  | ORDER PART NUMBER                                                         |
|------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
|                                                                                    | LT580JH<br>LT580KH<br>LT580LH<br>LT580MH<br>LT580SH<br>LT580TH<br>LT580UH |
|  | LT581JH<br>LT581KH<br>LT581LH<br>LT581SH<br>LT581TH<br>LT581UH            |

## LT580 ELECTRICAL CHARACTERISTICS $V_{IN} = +15V$ , $T_A = 25^\circ C$ unless otherwise noted

| SYMBOL                                  | PARAMETER                                                       | CONDITIONS                     | MIN   | LT580<br>TYP | MAX       | UNITS       |
|-----------------------------------------|-----------------------------------------------------------------|--------------------------------|-------|--------------|-----------|-------------|
| $V_R$                                   | Output Voltage                                                  | LT580J                         | 2.425 | 2.500        | 2.575     | V           |
|                                         |                                                                 | LT580K, S                      | 2.475 | 2.500        | 2.525     | V           |
|                                         |                                                                 | LT580L, M, T, U                | 2.490 | 2.500        | 2.510     | V           |
| TC                                      | Output Voltage Change<br>Over Temperature in<br>mV and (ppm/°C) | LT580J (0°C to 70°C)           | •     |              | 15 (85)   | mV (ppm/°C) |
|                                         |                                                                 | LT580K (0°C to 70°C)           | •     |              | 7 (40)    | mV (ppm/°C) |
|                                         |                                                                 | LT580L (0°C to 70°C)           | •     |              | 4.3 (25)  | mV (ppm/°C) |
|                                         |                                                                 | LT580M (0°C to 70°C)           | •     |              | 1.75 (10) | mV (ppm/°C) |
|                                         |                                                                 | LT580S (– 55°C to + 125°C)     | •     |              | 25 (55)   | mV (ppm/°C) |
|                                         |                                                                 | LT580T (– 55°C to + 125°C)     | •     |              | 11 (25)   | mV (ppm/°C) |
|                                         |                                                                 | LT580U (– 55°C to + 125°C)     | •     |              | 4.5 (10)  | mV (ppm/°C) |
| $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$  | Line Regulation                                                 | 7V ≤ $V_{IN}$ ≤ 30V LT580J, S  |       | 0.5          | 6         | mV          |
|                                         |                                                                 | LT580K                         |       | 0.5          | 4         | mV          |
|                                         |                                                                 | LT580L, M, T, U                |       | 0.5          | 2         | mV          |
|                                         |                                                                 | 4.5V ≤ $V_{IN}$ ≤ 7V LT580J, S |       | 0.1          | 3         | mV          |
|                                         |                                                                 | LT580K                         |       | 0.1          | 2         | mV          |
|                                         |                                                                 | LT580L, M, T, U                |       | 0.1          | 1         | mV          |
| $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$ | Load Regulation (Sourcing)<br>Shunt Mode                        | 0 ≤ $I_{OUT}$ ≤ 10mA           |       | 1            | 10        | mV          |
|                                         |                                                                 | 1.5mA ≤ $I_{SHUNT}$ ≤ 10mA     |       | 2            | 10        | mV          |
| $I_Q$                                   | Quiescent Current                                               |                                |       | 0.75         | 1.5       | mA          |
| $e_n$                                   | Output Noise (Note 1)                                           | 0.1Hz to 10Hz                  |       | 10           |           | μVp-p       |
|                                         | Output Voltage<br>Stability with Time                           | Per Month                      |       | 25           |           | μV          |
|                                         |                                                                 | Long Term                      |       | 250          |           | μV          |

# LT581 ELECTRICAL CHARACTERISTICS $V_{IN} = +15V$ , $T_A = 25^\circ C$ unless otherwise noted

| SYMBOL                                  | PARAMETER                                                                                        | CONDITIONS                                 | MIN   | LT581<br>TYP | MAX       | UNITS                 |
|-----------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------|-------|--------------|-----------|-----------------------|
| $V_R$                                   | Output Voltage                                                                                   | LT581S, J                                  | 9.970 | 10.000       | 10.030    | V                     |
|                                         |                                                                                                  | LT581T, K                                  | 9.990 | 10.000       | 10.010    | V                     |
|                                         |                                                                                                  | LT581U, L                                  | 9.995 | 10.000       | 10.005    | V                     |
| TC                                      | Output Voltage<br>Change, Maximum<br>Deviation from $25^\circ C$<br>in mV and (ppm/ $^\circ C$ ) | LT581J ( $0^\circ C$ to $70^\circ C$ )     | •     |              | 13.5 (30) | mV (ppm/ $^\circ C$ ) |
|                                         |                                                                                                  | LT581K ( $0^\circ C$ to $70^\circ C$ )     | •     |              | 6.75 (15) | mV (ppm/ $^\circ C$ ) |
|                                         |                                                                                                  | LT581L ( $0^\circ C$ to $70^\circ C$ )     | •     |              | 2.25 (5)  | mV (ppm/ $^\circ C$ ) |
|                                         |                                                                                                  | LT581S ( $-55^\circ C$ to $+125^\circ C$ ) | •     |              | 30 (30)   | mV (ppm/ $^\circ C$ ) |
|                                         |                                                                                                  | LT581T ( $-55^\circ C$ to $+125^\circ C$ ) | •     |              | 15 (15)   | mV (ppm/ $^\circ C$ ) |
|                                         |                                                                                                  | LT581U ( $-55^\circ C$ to $+125^\circ C$ ) | •     |              | 10 (10)   | mV (ppm/ $^\circ C$ ) |
| $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$  | Line Regulation                                                                                  | $15V \leq V_{IN} \leq 30V$                 |       | 0.5          | 3         | mV                    |
|                                         |                                                                                                  | $13V \leq V_{IN} \leq 15V$                 |       | 0.1          | 1         | mV                    |
| $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$ | Load Regulation (Sourcing)                                                                       | $0 \leq I_{OUT} \leq 5mA$                  |       | 50           | 500       | $\mu V/mA$            |
|                                         | Shunt Mode                                                                                       | $1mA \leq I_{SHUNT} \leq 5mA$              |       | 100          | 500       | $\mu V/mA$            |
| $I_Q$                                   | Quiescent Current                                                                                |                                            |       | 0.75         | 1.0       | mA                    |
| $e_n$                                   | Output Noise (Note 1)                                                                            | 0.1Hz to 10Hz                              |       | 30           |           | $\mu Vp-p$            |
|                                         | Long Term Stability                                                                              | Non-Cumulative                             |       | 25           |           | ppm/kHr               |
| $I_{SC}$                                | Short Circuit<br>Current                                                                         |                                            |       | 30           |           | mA                    |
| $I_{OUT}$                               | Output Current                                                                                   | Sourcing                                   | 10    | 25           |           | mA                    |
|                                         |                                                                                                  | Sourcing                                   | 5     |              |           | mA                    |
|                                         |                                                                                                  | Sinking                                    | 5     |              |           | mA                    |

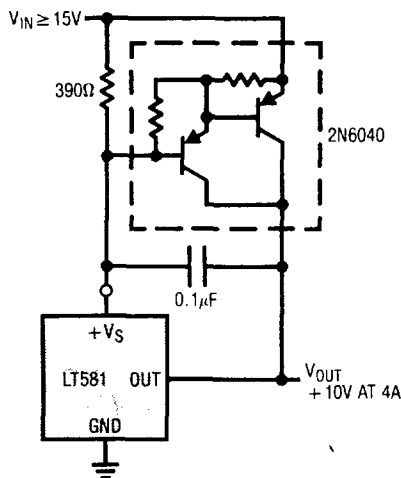
The • denotes the specifications which apply over the full operating temperature range.

**Note 1:** Although 0.1Hz to 10Hz noise is not a standard production test, Linear Technology does 100% test 10Hz to 1kHz noise. Consult factory for details.

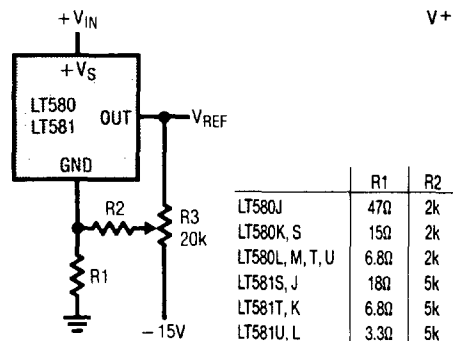
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## TYPICAL APPLICATIONS

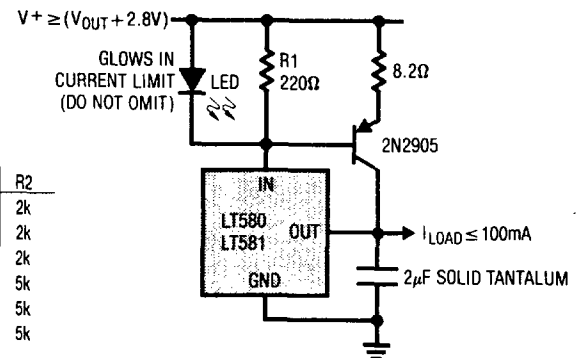
### High Current Precision Supply



### Suggested Output Trim

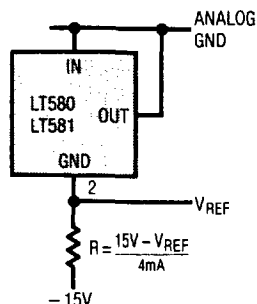


### Output Current Boost with Current Limit

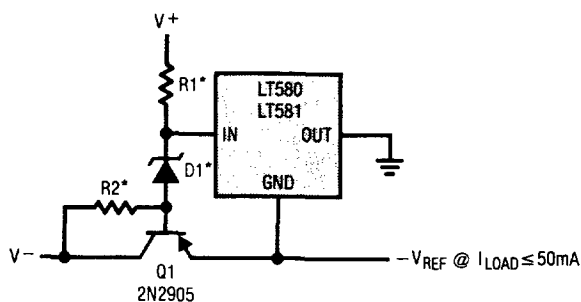


## TYPICAL APPLICATIONS

Two-Terminal Negative Reference

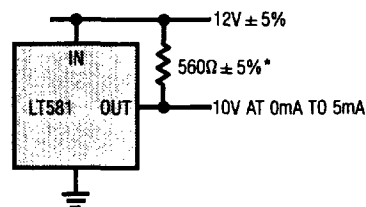


Negative Series Reference



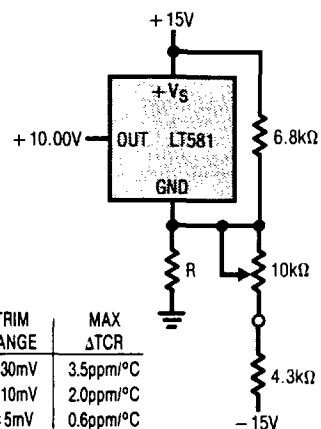
$$R1 = \frac{V+ - 5V}{2mA}, R2 = \frac{|V-| - VREF}{1mA}, D1 = VREF + 5V$$

12V Supply Connection



\*NOT REQUIRED ON LTC LT580 OR LT581

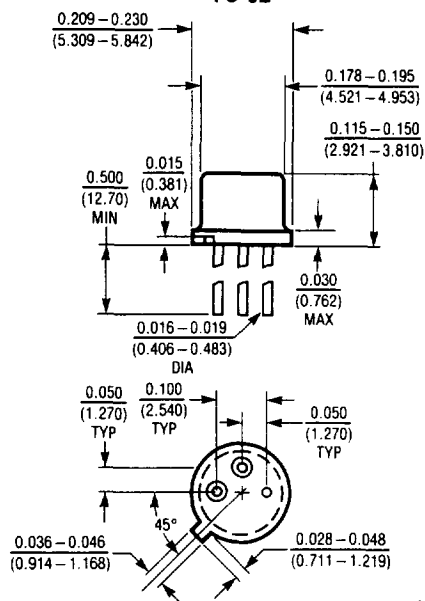
Optional Trim Configuration



| R    | TRIM RANGE | MAX ΔTCR  |
|------|------------|-----------|
| 22Ω  | ±30mV      | 3.5ppm/°C |
| 12Ω  | ±10mV      | 2.0ppm/°C |
| 3.9Ω | ±5mV       | 0.6ppm/°C |

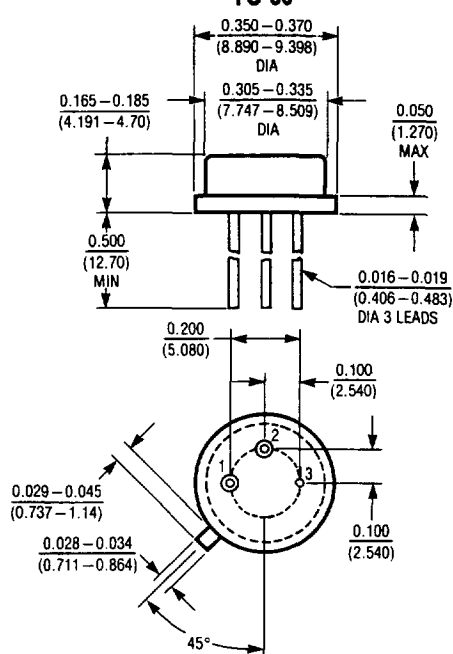
## PACKAGE DESCRIPTION

LT580  
TO-52



| $T_{jmax}$ | $\theta_{JA}$ |
|------------|---------------|
| 150°C      | 360°C/W       |

LT581  
TO-39



| $T_{jmax}$ | $\theta_{JA}$ |
|------------|---------------|
| 150°C      | 150°C/W       |