

## LM4140 High Precision Low Noise Low Dropout Voltage Reference

Check for Samples: [LM4140](#)

### FEATURES

- **High Initial Accuracy: 0.1%**
- **Ultra Low Noise**
- **Low Temperature Coefficient: 3 ppm/°C (A grade)**
- **Low Voltage Operation: 1.8V**
- **Low Dropout Voltage: 20 mV (typ) @ 1mA**
- **Supply Current: 230  $\mu$ A (typ),  $\leq$  1  $\mu$ A Disable Mode**
- **Enable Pin**
- **Output Voltage Options: 1.024V, 1.250V, 2.048V, 2.500V, and 4.096V**
- **Custom Voltages from 0.5V to 4.5V**
- **Temperature Range (0°C to 70°C)**

### APPLICATIONS SUMMARY

- **Portable, Battery Powered Equipment**
- **Instrumentation and Test Equipment**
- **Automotive**
- **Industrial Process Control**
- **Data Acquisition Systems**
- **Medical Equipment**
- **Precision Scales**
- **Servo Systems**
- **Battery Charging**

### DESCRIPTION

The LM4140 series of precision references are designed to combine high accuracy, low drift and noise with low power dissipation in a small package.

The LM4140 is the industry's first reference with output voltage options lower than the bandgap voltage.

The key to the advance performance of the LM4140 is the use of EEPROM registers and CMOS DACs for temperature coefficient curvature correction and trimming of the output voltage accuracy of the device during the final production testing.

The major advantage of this method is the much higher resolution available with DACs than is available economically with most methods utilized by other bandgap references.

The low input and dropout voltage, low supply current and output drive capability of the LM4140 makes this product an ideal choice for battery powered and portable applications.

The LM4140 is available in three grades (A, B, C) with 0.1% initial accuracy and 3, 6 and 10 ppm/°C temperature coefficients. For even lower Tempco, contact Texas Instruments.

The device performance is specified over the temperature range (0°C to +70°C) and is available in compact 8-pin package.

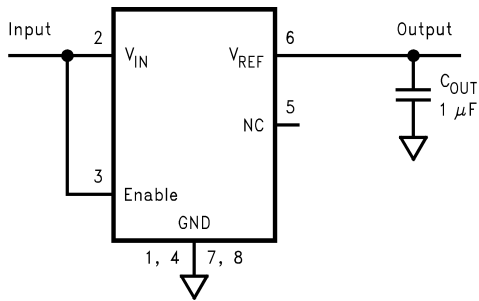
**For other output voltage options from 0.5V to 4.5V, contact Texas Instruments.**



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

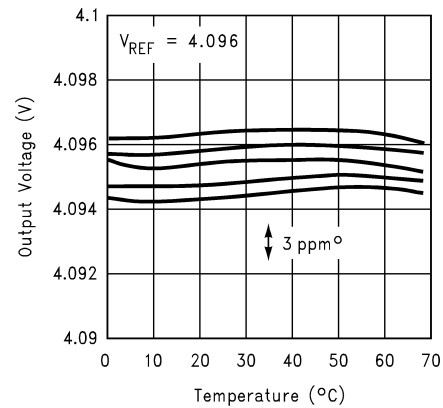
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**Typical Application**



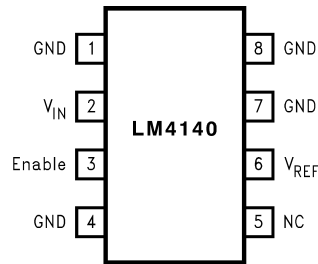
C<sub>OUT</sub>, Output bypass capacitor. See text for selection detail.

**Figure 1.**



**Figure 2. Typical Temperature Coefficient (Sample of 5 Parts)**

**Connection Diagram**



**Figure 3. 8-Lead Surface Mount Package Number D0008A Top View**

**PIN DESCRIPTIONS**

|                                  |  |
|----------------------------------|--|
| <b>V<sub>ref</sub> (Pin 6):</b>  | Reference Output. Capable of sourcing up to 8mA.   |
| <b>Input (Pin 2):</b>            | Positive Supply.   |
| <b>Ground (Pins 1, 4, 7, 8):</b> | Negative Supply or Ground Connection. These pins must be connected to ground.              |
| <b>Enable (Pin 3):</b>           | Pulled to input for normal operation. Forcing this pin to ground will turn-off the output. |
| <b>NC (Pin 5):</b>               | This pin must be left open.  |



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings <sup>(1)(2)</sup>

|   |               |
|---|---------------|
| Maximum Voltage on any Input pin                              | -0.3V to 5.6V |
| Output Short-Circuit Duration                                 | Indefinite    |
| Power Dissipation ( $T_A = 25^\circ\text{C}$ ) <sup>(3)</sup> | 345mW         |
| ESD Susceptibility <sup>(4)</sup>                             |               |
| Human Body Model  | 2 kV          |
| Machine Model   | 200V          |
| Lead Temperature:<br>Soldering, (10 sec.)                     | +260°C        |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (3) Without PCB copper enhancements. The maximum power dissipation must be de-rated at elevated temperatures and is limited by  $T_{JMAX}$  (maximum junction temperature),  $\theta_{J-A}$  (junction to ambient thermal resistance) and  $T_A$  (ambient temperature). The maximum power dissipation at any temperature is:  $P_{DISSMAX} = (T_{JMAX} - T_A)/\theta_{J-A}$  up to the value listed in the Absolute Maximum Ratings. The  $\theta_{J-A}$  for the SO-8 package is  $160^\circ\text{C/W}$ .
- (4) The human body model is a 100 pF capacitor discharged through a 1.5 k $\Omega$  resistor into each pin. The machine model is a 200 pF capacitor discharged directly into each pin.

### Operating Range <sup>(1)</sup>

|                            |                 |
|----------------------------|-----------------|
| Storage Temperature Range  | -65°C to +150°C |
| Ambient Temperature Range  | 0°C to 70°C     |
| Junction Temperature Range | 0°C to 80°C     |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

## LM4140 Electrical Characteristics

Unless otherwise specified,  $V_{IN} = 3.0\text{V}$  for the LM4140-1.024 and LM4140-1.250,  $V_{IN} = 5.0\text{V}$  for all other voltage options,  $V_{EN} = V_{IN}$ ,  $C_{OUT} = 1\mu\text{F}$  <sup>(1)</sup>,  $I_{LOAD} = 1\text{mA}$ ,  $T_A = T_J = 25^\circ\text{C}$ . Limits with standard typeface are for  $T_A = 25^\circ\text{C}$ , and limits in **boldface type** apply over  $0^\circ\text{C}$  to  $70^\circ\text{C}$  temperature range.

| Symbol    | Parameter   | Conditions | Min <sup>(2)</sup> | Typ <sup>(3)</sup> | Max <sup>(2)</sup> | Units |
|-----------|---|------------|--------------------|--------------------|--------------------|-------|
| $V_{REF}$ | Output Voltage Initial Accuracy <sup>(4)</sup>                                    |            |                    |                    |                    | %     |
|           | LM4140B-1.024<br>LM4140B-1.250<br>LM4140B-2.048<br>LM4140B-2.500<br>LM4140B-4.096 |            |                    |                    | $\pm 0.1$          |       |
|           | LM4140C-1.024<br>LM4140C-1.250<br>LM4140C-2.048<br>LM4140C-2.500<br>LM4140C-4.096 |            |                    |                    | $\pm 0.1$          |       |

- (1) For proper operation, a 1 $\mu\text{F}$  capacitor is required between the output pin and the GND pin of the device. (See [Application Hints](#) for details)
- (2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlation using Statistical Quality Control (SQC) methods. The limits are used to calculate TI's Average Outgoing Quality Level (AOQL).
- (3) Typical numbers are at 25°C and represent the most likely parametric norm.
- (4) High temperature and mechanical stress associated with PCB assembly can have significant impact on the initial accuracy of the LM4140 and may create significant shifts in  $V_{REF}$ . See [Application Hints](#) section regarding accuracy and PCB layout consideration.

## LM4140 Electrical Characteristics (continued)

Unless otherwise specified,  $V_{IN} = 3.0V$  for the LM4140-1.024 and LM4140-1.250,  $V_{IN} = 5.0V$  for all other voltage options,  $V_{EN} = V_{IN}$ ,  $C_{OUT} = 1\mu F$  <sup>(1)</sup>,  $I_{LOAD} = 1mA$ ,  $T_A = T_J = 25^\circ C$ . Limits with standard typeface are for  $T_A = 25^\circ C$ , and limits in **boldface type** apply over  $0^\circ C$  to  $70^\circ C$  temperature range.

| Symbol                           | Parameter  | Conditions                              | Min<br>(2)                    | Typ<br>(3) | Max<br>(2)                        | Units           |
|----------------------------------|--|---|-------------------------------|------------|-----------------------------------|-----------------|
| $TCV_{REF}/^\circ C$             | Temperature Coefficient:<br>A Grade<br>B Grade<br>C Grade    | $0^\circ C \leq T_A \leq +70^\circ C$   |                               |            | <b>3</b><br><b>6</b><br><b>10</b> | ppm/ $^\circ C$ |
| $\Delta V_{REF}/\Delta V_{IN}$   | Line Regulation  |   |                               |            |                                   | ppm/V           |
|                                  | 1.024V and 1.250V options                                    | $1.8V \leq V_{IN} \leq 5.5V$            |                               | 50         | 300                               |                 |
|                                  | All other voltage options                                    | $V_{ref} + 200mV \leq V_{IN} \leq 5.5V$ |                               | 20         | <b>200</b><br><b>250</b>          |                 |
| $\Delta V_{REF}/\Delta I_{LOAD}$ | Load Regulation  | $1mA \leq I_{LOAD} \leq 8mA$            |                               |            |                                   | ppm/mA          |
|                                  | All other voltage options                                    |   |                               | 1          | 20                                |                 |
|                                  | 4.096V Option  |   |                               | 5          | 35                                |                 |
|                                  |  |   |                               |            | <b>150</b>                        |                 |
| $\Delta V_{REF}$                 | Long-Term Stability  | 1000 Hrs                                |                               | 60         |                                   | ppm             |
| $\Delta V_{REF}$                 | Thermal Hysteresis <sup>(5)</sup>                            | $0^\circ C \leq T_A \leq +70^\circ C$   |                               | 20         |                                   | ppm             |
| Operating Voltage                | LM4140-1.024, LM4140-1.250                                   | $I_L = 1mA$ to $8mA$                    | <b>1.8</b>                    |            | <b>5.5</b>                        | V               |
| $V_{IN}-V_{REF}$                 | Dropout Voltage <sup>(6)</sup><br>LM4140-2.048, LM4140-2.500 | $I_L = 1mA$                             |                               | 20         | 40<br><b>45</b>                   | mV              |
|                                  |  | $I_L = 8mA$                             |                               | 160        | 235<br><b>400</b>                 |                 |
|                                  | LM4140-4.096   | $I_L = 1mA$                             |                               | 20         | 40<br><b>45</b>                   |                 |
|                                  |  | $I_L = 8mA$                             |                               | 195        | 270<br><b>490</b>                 |                 |
| $V_N$                            | Output Noise Voltage <sup>(7)</sup>                          | 0.1 Hz to 10 Hz                         |                               | 2.2        |                                   | $\mu V_{PP}$    |
| $I_{S(ON)}$                      | Supply Current   | $I_{LOAD} = 0mA$                        |                               |            |                                   | $\mu A$         |
|                                  | All other voltage options                                    |   |                               | 230        | 320                               |                 |
|                                  | 4.096V Option  |   |                               | 265        | 350                               |                 |
|                                  |  |   |                               |            | <b>400</b>                        |                 |
| $I_{S(OFF)}$                     | Supply Current   | $V_{Enable} < 0.4V$                     |                               | .01        | <b>1</b>                          | $\mu A$         |
| $V_H$                            | Logic High Input Voltage                                     |   | <b><math>0.8V_{IN}</math></b> |            |                                   | V               |
| $I_H$                            | Logic High Input Current                                     |   |                               | 2          |                                   | nA              |
| $V_L$                            | Logic Low Input Voltage                                      |   |                               |            | <b>0.4</b>                        | V               |
| $I_L$                            | Logic Low Input Current                                      |   |                               | 1          |                                   | nA              |
| $I_{SC}$                         | Short Circuit Current  |   | <b>8.5</b>                    | 20         | 35                                | mA              |
|                                  |  |   |                               |            | <b>40</b>                         |                 |

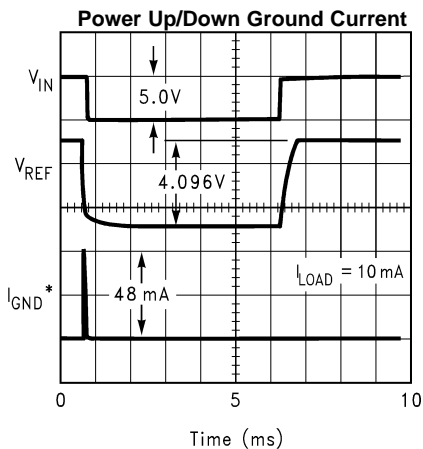
(5) Thermal hysteresis is defined as the changes in  $+25^\circ C$  output voltage before and after the cycling of the device from  $0^\circ C$  to  $70^\circ C$ .

(6) Dropout voltage is defined as the minimum input to output differential voltage at which the output voltage drops by 0.5% below the value measured with  $V_{IN} = 3.0V$  for the LM4140-1.024 and LM4140-1.250,  $V_{IN} = 5.0V$  for all other voltage options.

(7) The output noise is based on 1.024V option. Output noise is linearly proportional to  $V_{REF}$ .

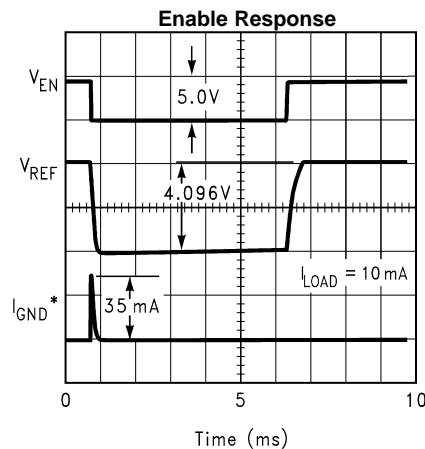
### LM4140 Typical Performance Characteristics

Unless otherwise specified,  $T_A = 25^\circ\text{C}$ , No Load,  $C_{OUT} = 1\mu\text{F}$ ,  $V_{IN} = 3.0\text{V}$  for LM4140-1.024 and LM4140-1.250, and 5V for all other voltage options.  $V_{IN} = V_{EN}$ .



Time (ms)

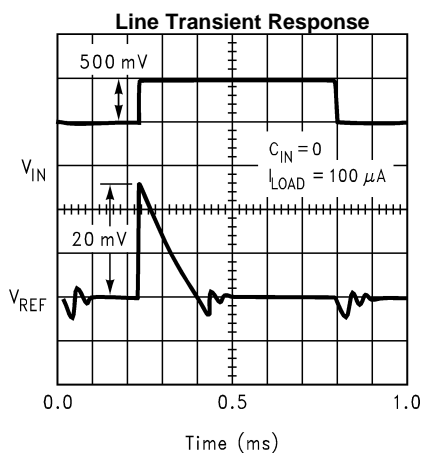
Figure 4.



Time (ms)

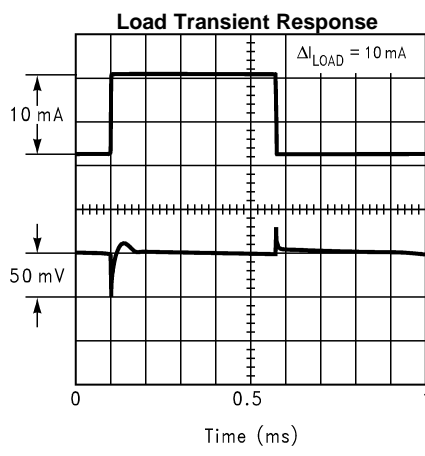
Figure 5.

\* The 1 $\mu\text{F}$  output capacitor is actively discharged to ground. See [ON/OFF OPERATION](#) section for more details.



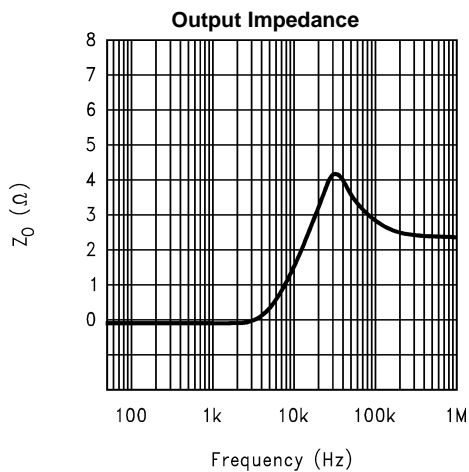
Time (ms)

Figure 6.



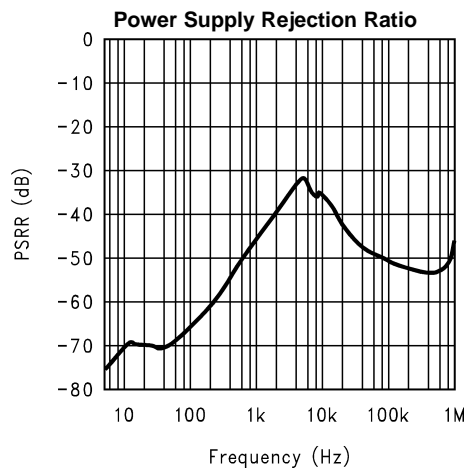
Time (ms)

Figure 7.



Frequency (Hz)

Figure 8.

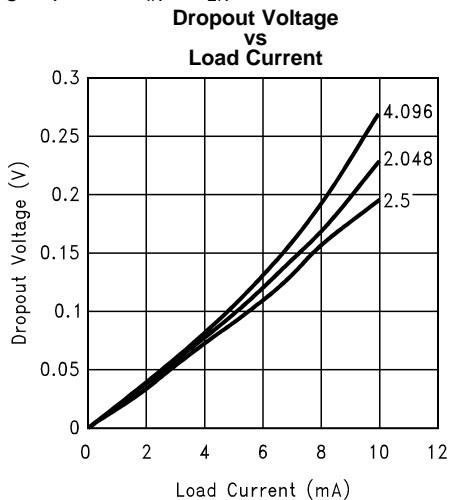


Frequency (Hz)

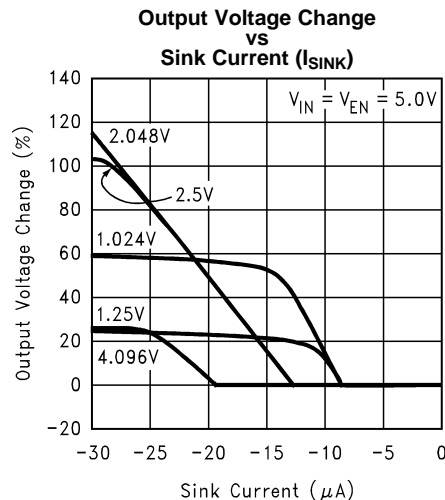
Figure 9.

**LM4140 Typical Performance Characteristics (continued)**

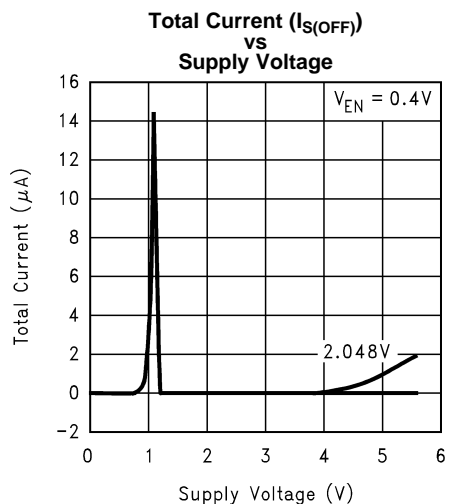
Unless otherwise specified,  $T_A = 25^\circ\text{C}$ , No Load,  $C_{OUT} = 1\mu\text{F}$ ,  $V_{IN} = 3.0\text{V}$  for LM4140-1.024 and LM4140-1.250, and 5V for all other voltage options.  $V_{IN} = V_{EN}$ .



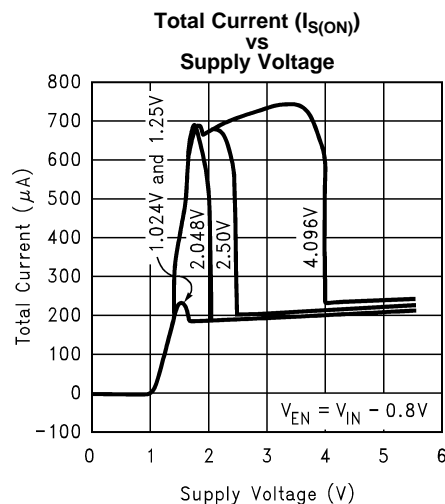
Note: 1.024V and 1.250V options require 1.8V supply.  
**Figure 10.**



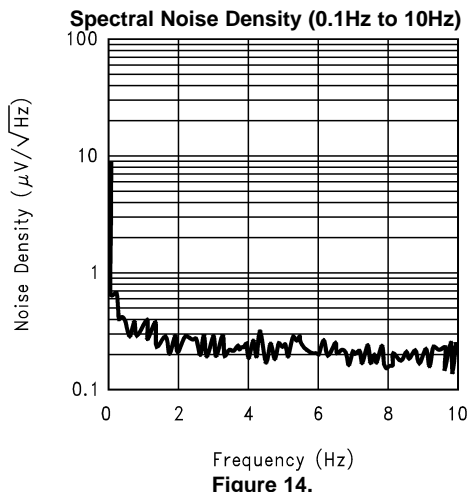
**Figure 11.**



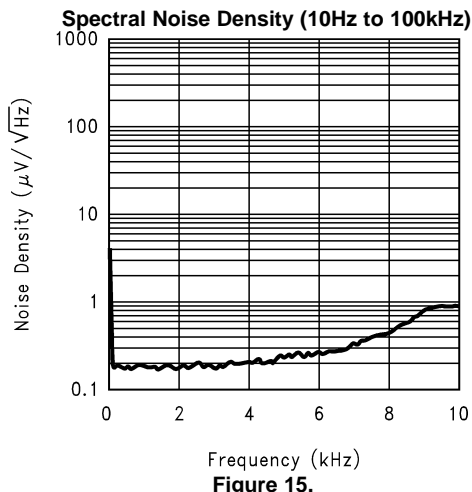
**Figure 12.**



**Figure 13.**



**Figure 14.**



**Figure 15.**

### LM4140 Typical Performance Characteristics (continued)

Unless otherwise specified,  $T_A = 25^\circ\text{C}$ , No Load,  $C_{OUT} = 1\mu\text{F}$ ,  $V_{IN} = 3.0\text{V}$  for LM4140-1.024 and LM4140-1.250, and 5V for all other voltage options.  $V_{IN} = V_{EN}$ .

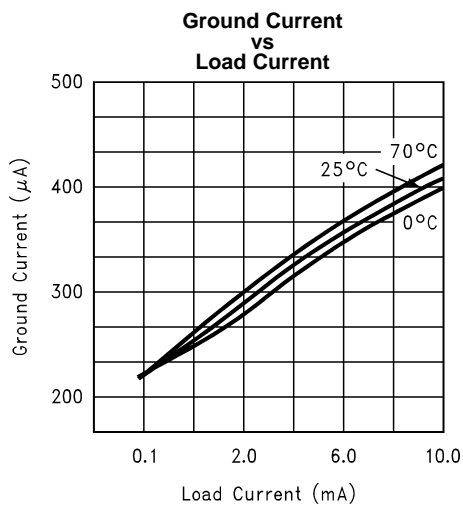


Figure 16.

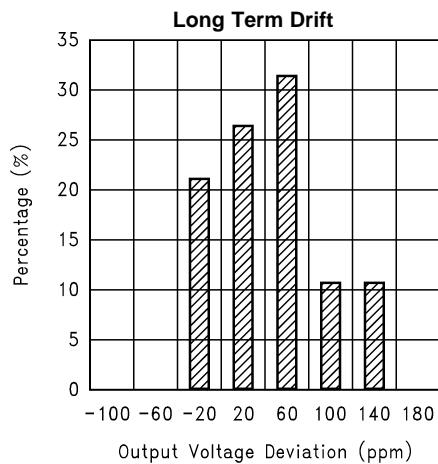


Figure 17.

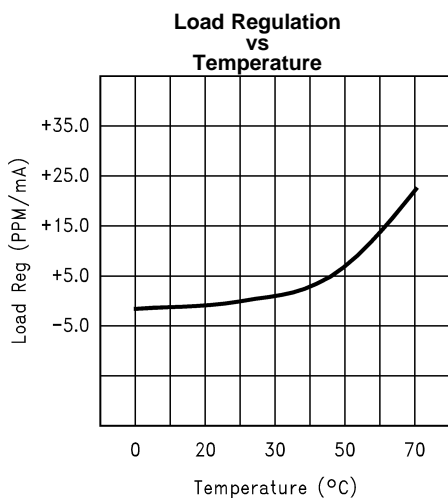


Figure 18.

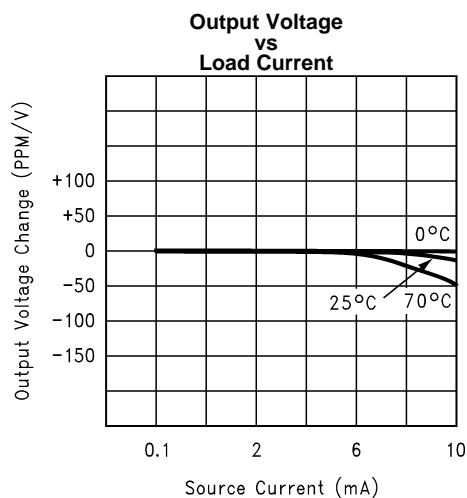


Figure 19.

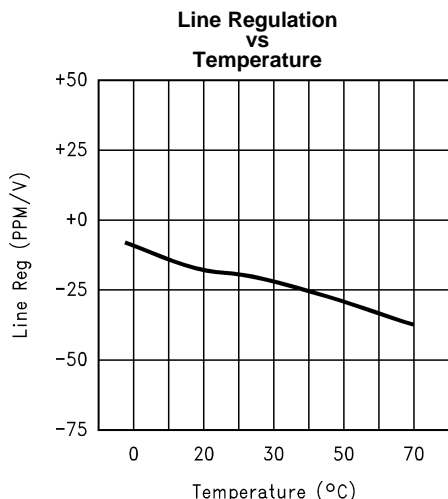


Figure 20.

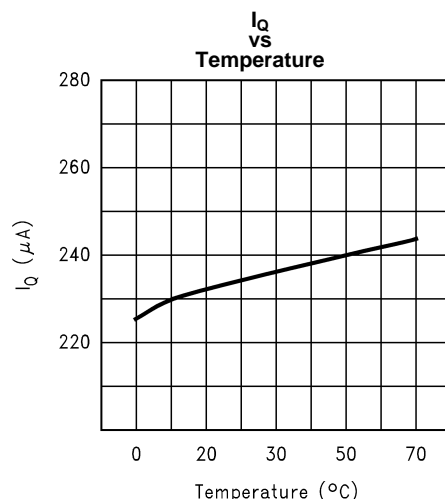


Figure 21.

**LM4140 Typical Performance Characteristics (continued)**

Unless otherwise specified,  $T_A = 25^\circ\text{C}$ , No Load,  $C_{OUT} = 1\mu\text{F}$ ,  $V_{IN} = 3.0\text{V}$  for LM4140-1.024 and LM4140-1.250, and 5V for all other voltage options.  $V_{IN} = V_{EN}$ .

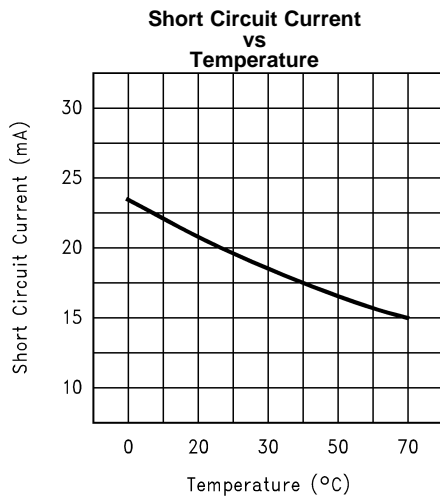


Figure 22.

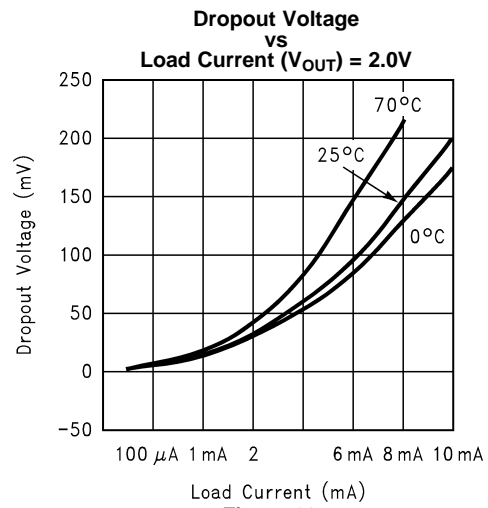


Figure 23.



## APPLICATION HINTS

### INPUT CAPACITORS

Although not always required, an input capacitor is recommended. A supply bypass capacitor on the input assures that the reference is working from a source with low impedance, which improves stability. A bypass capacitor can also improve transient response by providing a reservoir of stored energy that the reference can utilize in case where the load current demand suddenly increases. The value used for  $C_{IN}$  may be used without limit. Refer to the [Typical Application](#) section for examples of input capacitors.

### OUTPUT CAPACITORS

The LM4140 requires a  $1\mu\text{F}$  (nominally) output capacitor for loop stability (compensation) as well as transient response. During the sudden changes in load current demand, the output capacitor must source or sink current during the time it takes the control loop of the LM4140 to respond.

This capacitor must be selected to meet the requirements of minimum capacitance and equivalent series resistance (ESR) range.

In general, the capacitor value must be at least  $0.2\mu\text{F}$  (over the actual ambient operating temperature), and the ESR must be within the range indicated in [Figure 24](#), [Figure 25](#) and [Figure 26](#).

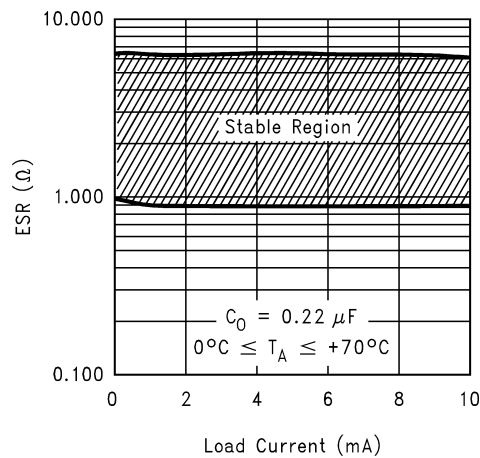


Figure 24.  $0.22\ \mu\text{F}$  ESR Range

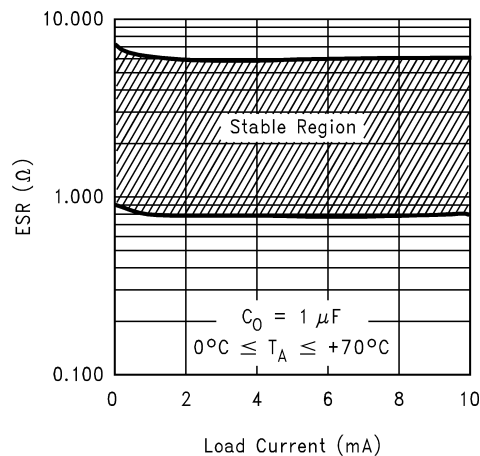
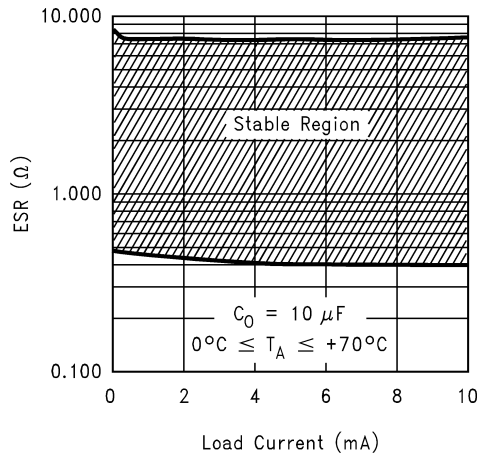


Figure 25.  $1\ \mu\text{F}$  ESR Range



**Figure 26. 10  $\mu\text{F}$  ESR Range**

## TANTALUM CAPACITORS

Surface-mountable solid tantalum capacitors offer a good combination of small physical size for the capacitance value, and ESR in the range needed for by the LM4140. The results of testing the LM4140 stability with surface mount solid tantalum capacitors show good stability with values in the range of 0.1 $\mu\text{F}$ . However, optimum performance is achieved with a 1 $\mu\text{F}$  capacitor.

Tantalum capacitors that have been verified as suitable for use with the LM4140 are shown in [Table 1](#).

**Table 1. Surface-Mount Tantalum Capacitor Selection Guide**

| 1 $\mu\text{F}$ Surface-Mount Tantalums   |                  |
|---|------------------|
| Manufacturer                              | Part Number      |
| Kemet                                     | T491A105M010AS   |
| NEC                                       | NRU105N10        |
| Siemens                                   | B45196-E3105-K   |
| Nichicon                                  | F931C105MA       |
| Sprague                                   | 293D105X0016A2T  |
| 2.2 $\mu\text{F}$ Surface-Mount Tantalums |                  |
| Kemet                                     | T491A225M010AS   |
| NEC                                       | NRU225M06        |
| Siemens                                   | B45196/2.2/10/10 |
| Nichicon                                  | F930J225MA       |
| Sprague                                   | 293D225X0010A2T  |

## ALUMINIUM ELECTROLYTIC CAPACITORS

Although probably not a good choice for a production design, because of relatively large physical size, an aluminium electrolytic capacitor can be used in the design prototype for an LM4140 reference. A 1 $\mu\text{F}$  capacitor meeting the ESR conditions can be used. If the operating temperature drops below 0°C, the reference may not remain stable, as the ESR of the aluminium electrolytic capacitor will increase, and may exceed the limits indicated in the figures.

## MULTILAYER CERAMIC CAPACITORS

Surface-mountable multilayer ceramic capacitors may be an attractive choice because of their relatively small physical size and excellent RF characteristics.

However, they sometimes have an ESR values lower than the minimum required by the LM4140, and relatively large capacitance change with temperature. The manufacturer's datasheet for the capacitor should be consulted before selecting a value. Test results of LM4140 stability using multilayer ceramic capacitors show that a minimum of 0.2 $\mu$ F is usually needed.

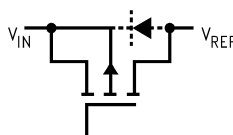
Multilayer ceramic capacitors that have been verified as suitable for use with the LM4140 are shown in [Table 2](#).

**Table 2. Surface-Mount Ceramic Capacitors Selection Guide**

| 2.2 $\mu$ F Surface-Mount Ceramic |                  |
|-----------------------------------|------------------|
| Manufacturer                      | Part Number      |
| Token                             | 1E225ZY5U-C203   |
| Murata                            | GRM42-6Y5V225Z16 |
| 4.7 $\mu$ F Surface-Mount Ceramic |                  |
| Token                             | 1E475ZY5U-C304   |

## REVERSE CURRENT PATH

The P-channel Pass transistor used in the LM4140 has an inherent diode connected between the  $V_{IN}$  and  $V_{REF}$  pins (see diagram below).



Forcing the output to voltages higher than the input, or pulling  $V_{IN}$  below voltage stored on the output capacitor by more than a  $V_{be}$ , will forward bias this diode and current will flow from the  $V_{REF}$  terminal to  $V_{IN}$ . No damage to the LM4140 will occur under these conditions as long as the current flowing into the output pin does not exceed 50mA.

## ON/OFF OPERATION

The LM4140 is designed to quickly reduce both  $V_{REF}$  and  $I_Q$  to zero when turned-off.  $V_{REF}$  is restored in less than 200 $\mu$ s when turned-on. During the turn-off, the charge across the output capacitor is discharged to ground through internal circuitry.

The LM4140 is turned-off by pulling the enable input low, and turned-on by driving the input high. If this feature is not to be used, the enable pin should be tied to the  $V_{IN}$  to keep the reference on at all times (the enable pin must not be left floating).

To ensure proper operation, the signal source used to drive the enable pin must be able to swing above and below the specified high and low voltage thresholds which ensure an ON or OFF state (see [LM4140 Electrical Characteristics](#)).

The ON/OFF signal may come from either a totem-pole output, or an open-collector output with pull-up resistor to the LM4140 input voltage. This high-level voltage may exceed the LM4140 input voltage, but must remain within the Absolute Maximum Rating for the enable pin.

## OUTPUT ACCURACY

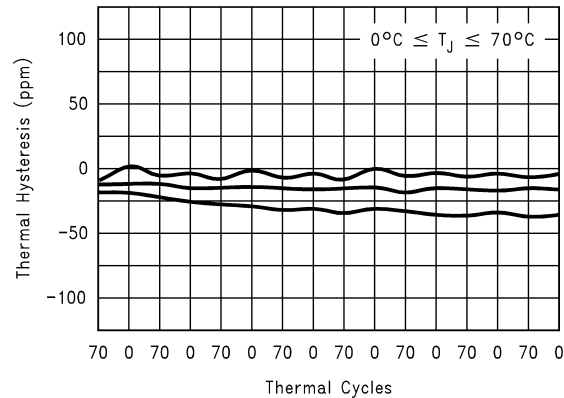
Like all references, either series or shunt, the after assembly accuracy is made up of primarily three components: initial accuracy itself, thermal hysteresis and effects of the PCB assembly stress.

LM4140 provides an excellent output initial accuracy of 0.1% and temperature coefficient of 6ppm/ $^{\circ}$ C (B Grade).

For best accuracy and precision, the LM4140 junction temperature should not exceed 70 $^{\circ}$ C.

The thermal hysteresis curve on this datasheet are performance characteristics of three typical parts selected at random from a sample of 40 parts.

Parts are mounted in a socket to minimize the effect of PCB's mechanical expansion and contraction. Readings are taken at 25 $^{\circ}$ C following multiple temperature cycles to 0 $^{\circ}$ C and 70 $^{\circ}$ C. The labels on the X axis of the graph indicates the device temperature cycle prior to measurement at 25 $^{\circ}$ C.



**Figure 27. Typical Thermal Hysteresis**

The mechanical stress due to the PCB's mechanical and thermal stress can cause an output voltage shift more than the true thermal coefficient of the device. References in surface mount packages are more susceptible to these stresses because of the small amount of plastic molding which support the leads.

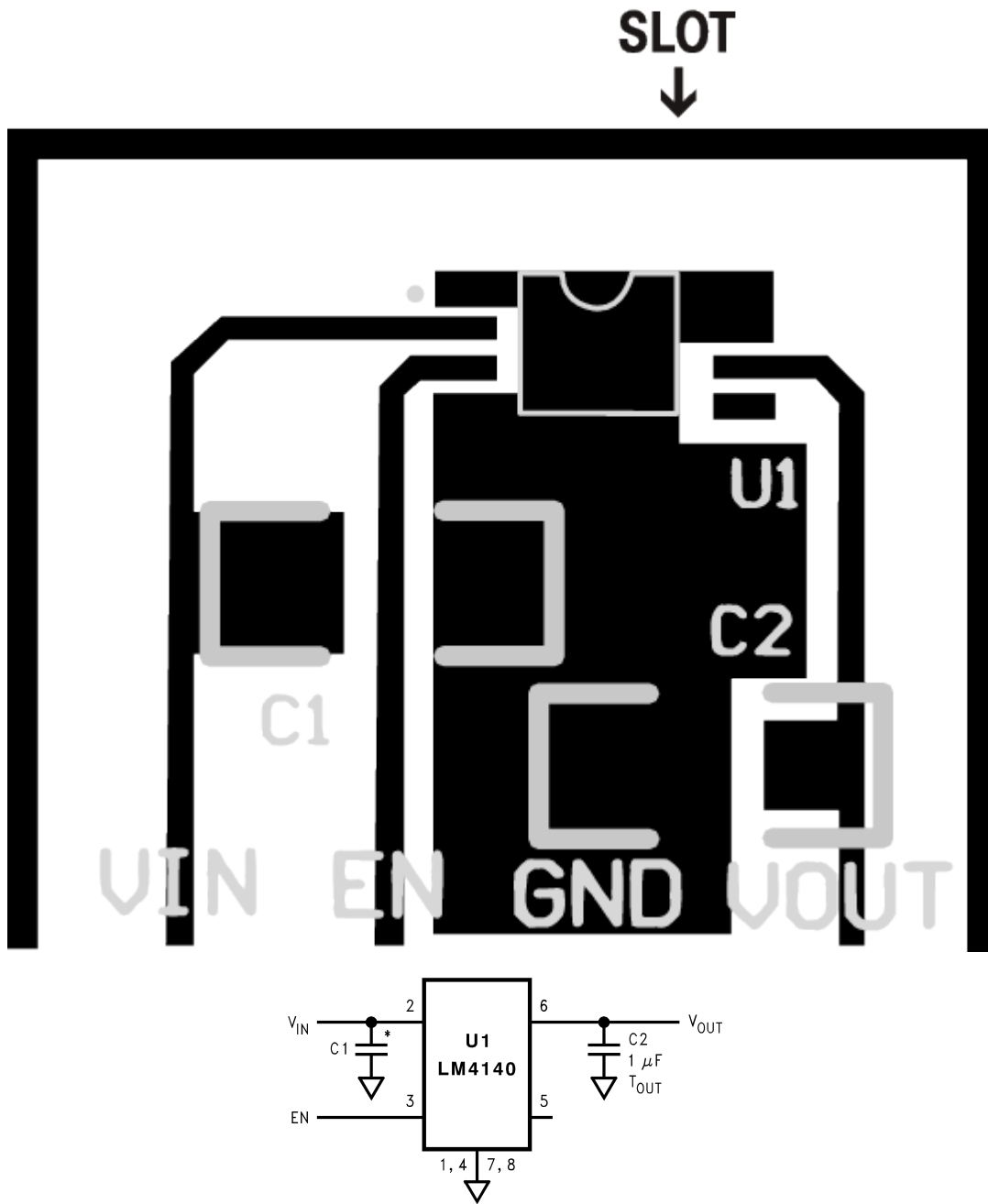
Following the recommendations on [PCB LAYOUT CONSIDERATION](#) section can minimize the mechanical stress on the device.

### PCB LAYOUT CONSIDERATION

The simplest ways to reduce the stress related shifts are:

1. Mounting the device near the edges or the corners of the board where mechanical stress is at its minimum. The center of the board generally has the highest mechanical and thermal expansion stress.
2. Mechanical isolation of the device by creating an island by cutting a U shape slot on the PCB for mounting the device. This approach would also provide some thermal isolation from the rest of the circuit.

[Figure 28](#) is a recommended printed board layout with a slot cut on three sides of the circuit layout to serve as a strain relief.



\* Optional input Capacitor (0.1 μF or higher).

**Figure 28. Suggested PCB Layout with Slot**

Typical Application Circuits

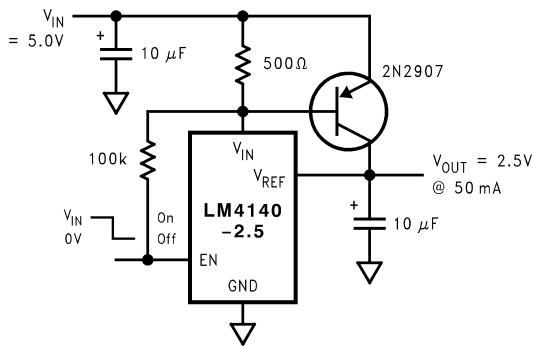


Figure 29. Boosted Output Current

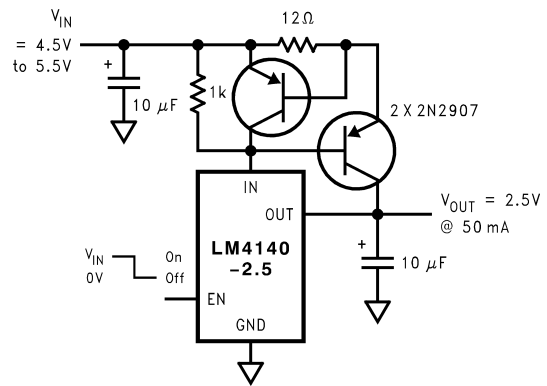


Figure 30. Boosted Output Current with Current Limiter

\* Low Noise Op Amp such as OP-27

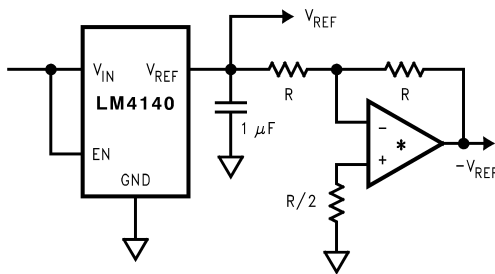


Figure 31. Complimentary Outputs

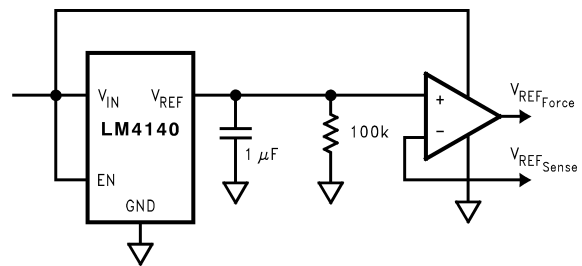
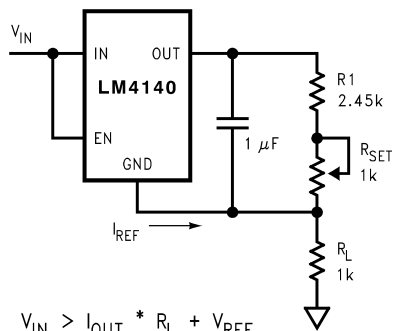


Figure 32. Voltage Reference with Force and Sense Output

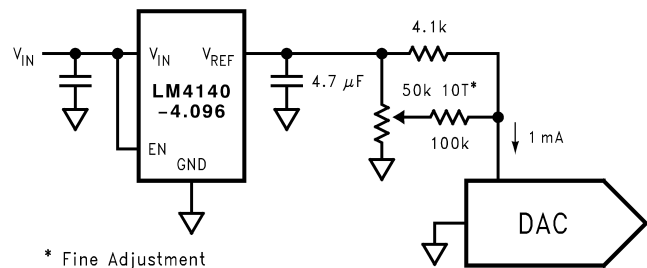


$$V_{IN} > I_{OUT} * R_L + V_{REF}$$

$$I_{OUT} = (V_{REF} / (R_1 + R_{SET})) + I_{REF}$$

R1 = 2.45k for  
 $I_L = 1 \text{ mA}$  using LM4120-2.5

Figure 33. Precision Programmable Current Source



\* Fine Adjustment

Figure 34. Precision DAC Reference

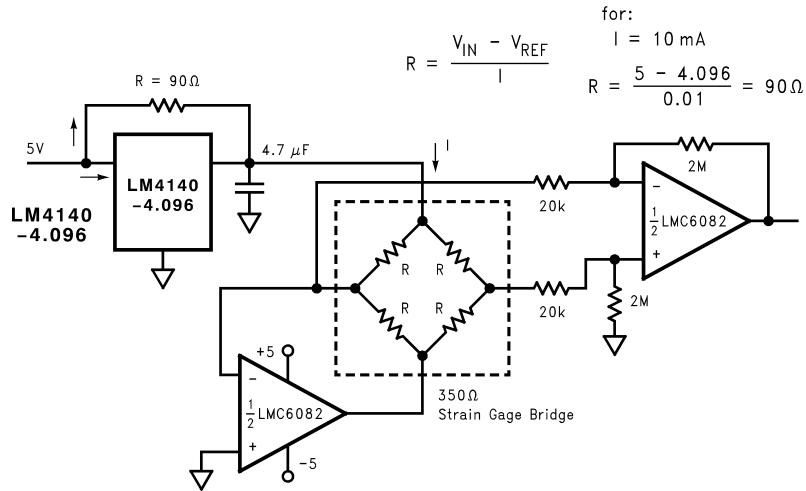


Figure 35. Strain Gauge Conditioner for 350Ω Bridge

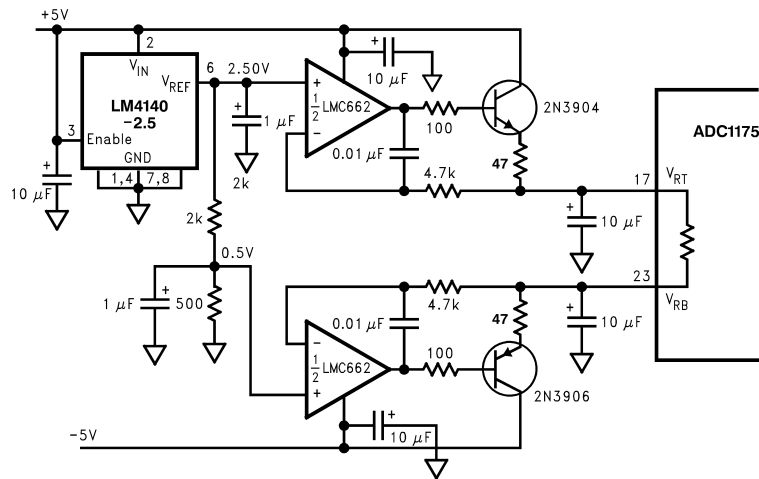


Figure 36.

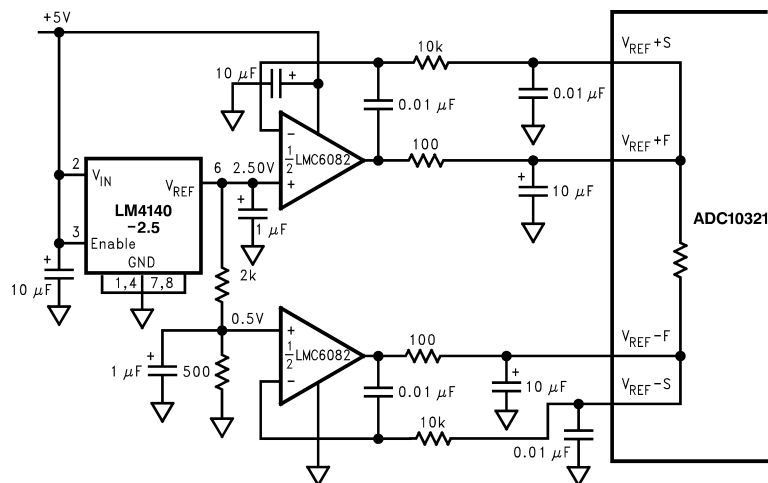


Figure 37.

### REVISION HISTORY

| Changes from Revision D (April 2013) to Revision E         | Page               |
|--|--------------------|
| • Changed layout of National Data Sheet to TI format ..... | <a href="#">15</a> |



**PACKAGING INFORMATION**

| Orderable Device    | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|---------------------|---------------|--------------|-----------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| LM4140ACM-1.0       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140A<br>CM1.0           | <a href="#">Samples</a> |
| LM4140ACM-1.0/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140A<br>CM1.0           | <a href="#">Samples</a> |
| LM4140ACM-1.2       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140A<br>CM1.2           | <a href="#">Samples</a> |
| LM4140ACM-1.2/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140A<br>CM1.2           | <a href="#">Samples</a> |
| LM4140ACM-2.0       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140A<br>CM2.0           | <a href="#">Samples</a> |
| LM4140ACM-2.0/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140A<br>CM2.0           | <a href="#">Samples</a> |
| LM4140ACM-2.5       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140A<br>CM2.5           | <a href="#">Samples</a> |
| LM4140ACM-2.5/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140A<br>CM2.5           | <a href="#">Samples</a> |
| LM4140ACM-4.1       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140A<br>CM4.1           | <a href="#">Samples</a> |
| LM4140ACM-4.1/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140A<br>CM4.1           | <a href="#">Samples</a> |
| LM4140ACMX-2.5      | ACTIVE        | SOIC         | D               | 8    | 2500        | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140A<br>CM2.5           | <a href="#">Samples</a> |
| LM4140ACMX-2.5/NOPB | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140A<br>CM2.5           | <a href="#">Samples</a> |
| LM4140ACMX-4.1      | ACTIVE        | SOIC         | D               | 8    | 2500        | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140A<br>CM4.1           | <a href="#">Samples</a> |
| LM4140ACMX-4.1/NOPB | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140A<br>CM4.1           | <a href="#">Samples</a> |
| LM4140BCM-1.0       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM1.0           | <a href="#">Samples</a> |
| LM4140BCM-1.0/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM1.0           | <a href="#">Samples</a> |
| LM4140BCM-1.2       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM1.2           | <a href="#">Samples</a> |

| Orderable Device    | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|---------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| LM4140BCM-1.2/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM1.2           | <a href="#">Samples</a> |
| LM4140BCM-2.0       | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM2.0           | <a href="#">Samples</a> |
| LM4140BCM-2.0/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM2.0           | <a href="#">Samples</a> |
| LM4140BCM-2.5       | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM2.5           | <a href="#">Samples</a> |
| LM4140BCM-2.5/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM2.5           | <a href="#">Samples</a> |
| LM4140BCM-4.1       | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM4.1           | <a href="#">Samples</a> |
| LM4140BCM-4.1/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM4.1           | <a href="#">Samples</a> |
| LM4140BCMX-1.0      | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM1.0           | <a href="#">Samples</a> |
| LM4140BCMX-1.0/NOPB | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM1.0           | <a href="#">Samples</a> |
| LM4140BCMX-2.5      | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM2.5           | <a href="#">Samples</a> |
| LM4140BCMX-2.5/NOPB | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM2.5           | <a href="#">Samples</a> |
| LM4140BCMX-4.1      | ACTIVE        | SOIC         | D                  | 8    | 2500           | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140B<br>CM4.1           | <a href="#">Samples</a> |
| LM4140BCMX-4.1/NOPB | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140B<br>CM4.1           | <a href="#">Samples</a> |
| LM4140CCM-1.0       | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM1.0           | <a href="#">Samples</a> |
| LM4140CCM-1.0/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM1.0           | <a href="#">Samples</a> |
| LM4140CCM-1.2       | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM1.2           | <a href="#">Samples</a> |
| LM4140CCM-1.2/NOPB  | ACTIVE        | SOIC         | D                  | 8    | 95             | Green (RoHS<br>& no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM1.2           | <a href="#">Samples</a> |
| LM4140CCM-2.0       | ACTIVE        | SOIC         | D                  | 8    | 95             | TBD                        | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM2.0           | <a href="#">Samples</a> |

| Orderable Device    | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|---------------------|---------------|--------------|-----------------|------|-------------|-------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| LM4140CCM-2.0/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM2.0           | <a href="#">Samples</a> |
| LM4140CCM-2.5       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                     | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM2.5           | <a href="#">Samples</a> |
| LM4140CCM-2.5/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM2.5           | <a href="#">Samples</a> |
| LM4140CCM-4.1       | ACTIVE        | SOIC         | D               | 8    | 95          | TBD                     | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM4.1           | <a href="#">Samples</a> |
| LM4140CCM-4.1/NOPB  | ACTIVE        | SOIC         | D               | 8    | 95          | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM4.1           | <a href="#">Samples</a> |
| LM4140CCMX-1.0      | ACTIVE        | SOIC         | D               | 8    | 2500        | TBD                     | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM1.0           | <a href="#">Samples</a> |
| LM4140CCMX-1.0/NOPB | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM1.0           | <a href="#">Samples</a> |
| LM4140CCMX-1.2      | ACTIVE        | SOIC         | D               | 8    | 2500        | TBD                     | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM1.2           | <a href="#">Samples</a> |
| LM4140CCMX-1.2/NOPB | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM1.2           | <a href="#">Samples</a> |
| LM4140CCMX-2.5      | ACTIVE        | SOIC         | D               | 8    | 2500        | TBD                     | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM2.5           | <a href="#">Samples</a> |
| LM4140CCMX-2.5/NOPB | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM2.5           | <a href="#">Samples</a> |
| LM4140CCMX-4.1      | ACTIVE        | SOIC         | D               | 8    | 2500        | TBD                     | Call TI          | Call TI              | 0 to 70      | 4140C<br>CM4.1           | <a href="#">Samples</a> |
| LM4140CCMX-4.1/NOPB | ACTIVE        | SOIC         | D               | 8    | 2500        | Green (RoHS & no Sb/Br) | CU SN            | Level-1-260C-UNLIM   | 0 to 70      | 4140C<br>CM4.1           | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

---

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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## TAPE AND REEL INFORMATION

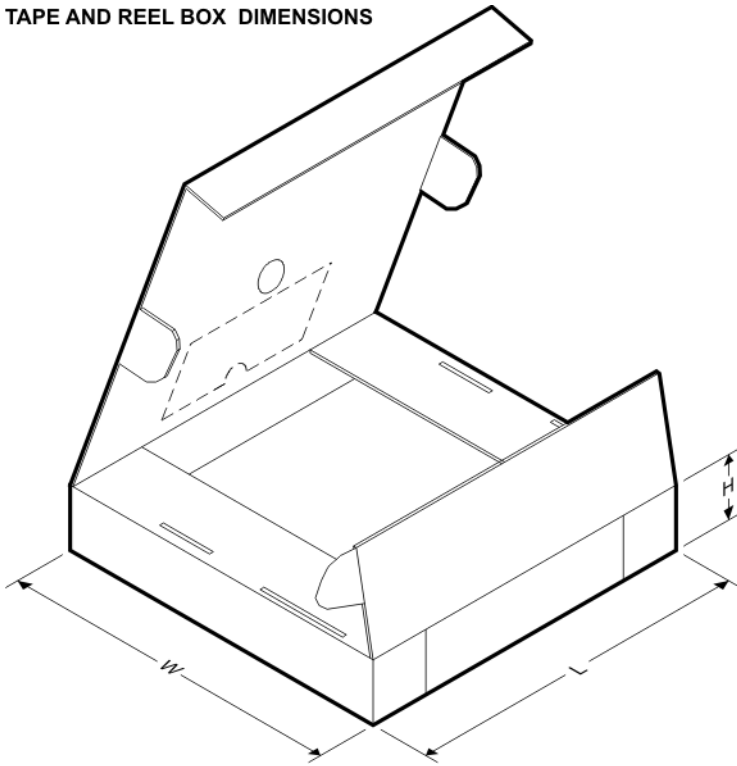


### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

| Device              | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM4140ACMX-2.5      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140ACMX-2.5/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140ACMX-4.1      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140ACMX-4.1/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140BCMX-1.0      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140BCMX-1.0/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140BCMX-2.5      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140BCMX-2.5/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140BCMX-4.1      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140BCMX-4.1/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-1.0      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-1.0/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-1.2      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-1.2/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-2.5      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-2.5/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-4.1      | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |
| LM4140CCMX-4.1/NOPB | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.5     | 5.4     | 2.0     | 8.0     | 12.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

| Device              | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM4140ACMX-2.5      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140ACMX-2.5/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140ACMX-4.1      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140ACMX-4.1/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140BCMX-1.0      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140BCMX-1.0/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140BCMX-2.5      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140BCMX-2.5/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140BCMX-4.1      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140BCMX-4.1/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-1.0      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-1.0/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-1.2      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-1.2/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-2.5      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-2.5/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-4.1      | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| LM4140CCMX-4.1/NOPB | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |

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|                               |  |
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