

## LM723/LM723C Voltage Regulator

Check for Samples: [LM723](#), [LM723C](#)

### FEATURES

- 150 mA Output Current Without External Pass Transistor
- Output Currents in Excess of 10A Possible by Adding External Transistors
- Input Voltage 40V Max
- Output Voltage Adjustable from 2V to 37V
- Can be Used as Either a Linear or a Switching Regulator

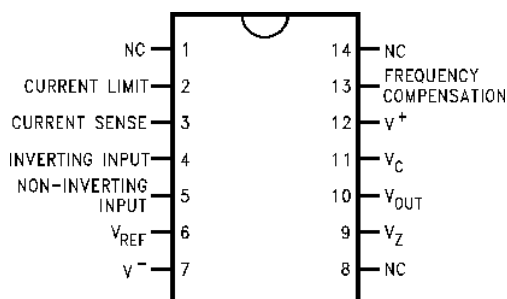
### DESCRIPTION

The LM723/LM723C is a voltage regulator designed primarily for series regulator applications. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current. The circuit features extremely low standby current drain, and provision is made for either linear or foldback current limiting.

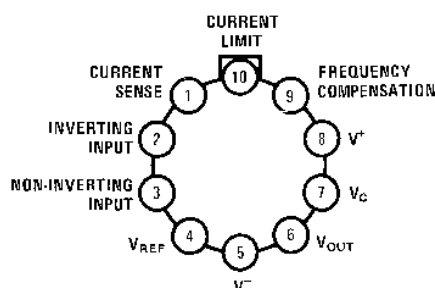
The LM723/LM723C is also useful in a wide range of other applications such as a shunt regulator, a current regulator or a temperature controller.

The LM723C is identical to the LM723 except that the LM723C has its performance ensured over a 0°C to +70°C temperature range, instead of –55°C to +125°C.

### Connection Diagram

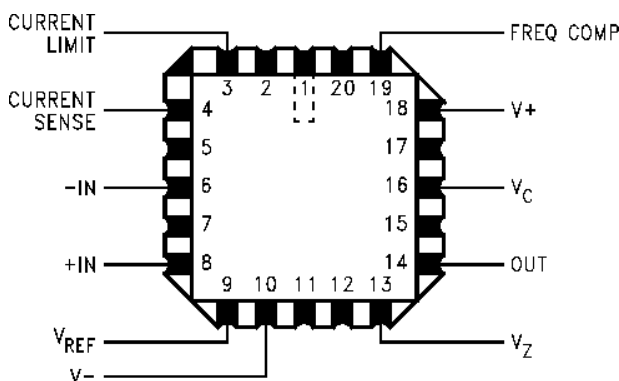


**Figure 1. Top View**  
CDIP Package or PDIP Package  
See Package J or NFF0014A



Note: Pin 5 connected to case.

**Figure 2. Top View**  
TO-100  
See Package LME



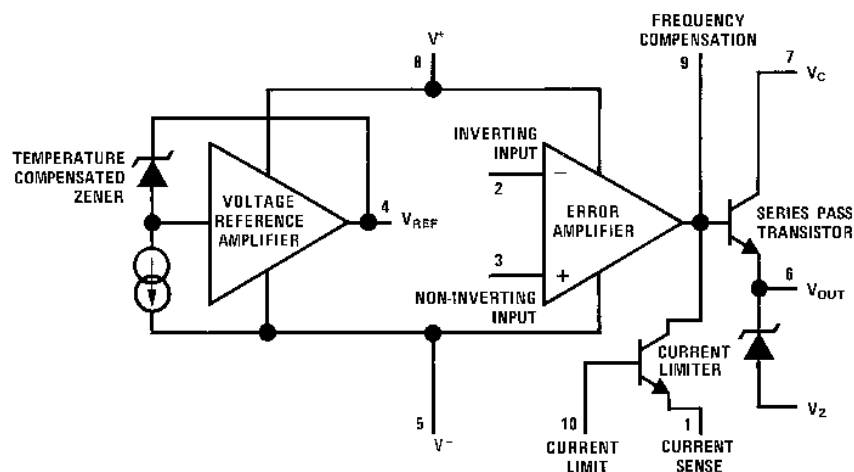
**Figure 3. Top View**  
See Package NAJ0020A



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.

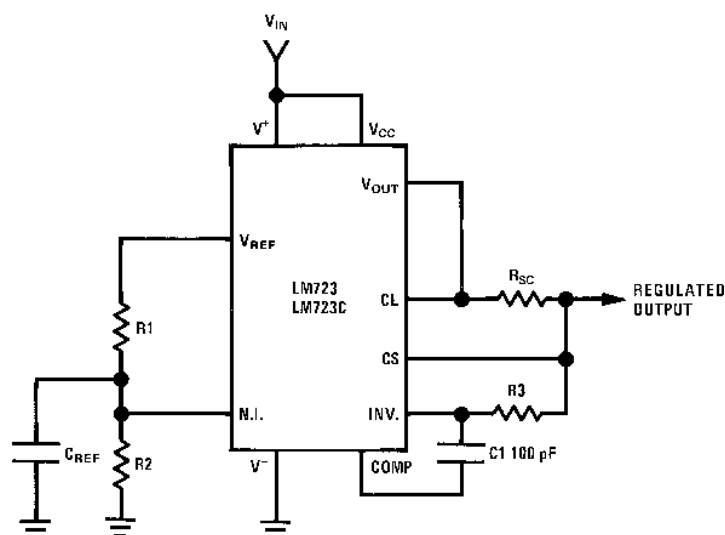
All trademarks are the property of their respective owners.

## Equivalent Circuit\*



\*Pin numbers refer to metal can package.

## Typical Application



$$\text{Note: } R3 = \frac{R1 R2}{R1 - R2}$$

for minimum temperature drift.

## Typical Performance

|                                                  |       |
|--------------------------------------------------|-------|
| Regulated Output Voltage                         | 5V    |
| Line Regulation ( $\Delta V_{IN} = 3V$ )         | 0.5mV |
| Load Regulation ( $\Delta I_L = 50 \text{ mA}$ ) | 1.5mV |

Figure 4. Basic Low Voltage Regulator ( $V_{OUT} = 2$  to 7 Volts)



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>

|                                                     |                 |
|-----------------------------------------------------|-----------------|
| Pulse Voltage from $V^+$ to $V^-$ (50 ms)           | 50V             |
| Continuous Voltage from $V^+$ to $V^-$              | 40V             |
| Input-Output Voltage Differential                   | 40V             |
| Maximum Amplifier Input Voltage (Either Input)      | 8.5V            |
| Maximum Amplifier Input Voltage (Differential)      | 5V              |
| Current from $V_Z$                                  | 25 mA           |
| Current from $V_{REF}$                              | 15 mA           |
| Internal Power Dissipation Metal Can <sup>(3)</sup> | 800 mW          |
| CDIP <sup>(3)</sup>                                 | 900 mW          |
| PDIP <sup>(3)</sup>                                 | 660 mW          |
| Operating Temperature Range                         |                 |
| LM723                                               | –55°C to +150°C |
| LM723C                                              | 0°C to +70°C    |
| Storage Temperature Range Metal Can                 |                 |
|                                                     | –65°C to +150°C |
| PDIP                                                | –55°C to +150°C |
| Lead Temperature (Soldering, 4 sec. max.)           |                 |
| Hermetic Package                                    | 300°C           |
| Plastic Package                                     | 260°C           |
| ESD Tolerance                                       | 1200V           |
| (Human body model, 1.5 kΩ in series with 100 pF)    |                 |

- (1) "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits.
- (2) A military RETS specification is available on request. At the time of printing, the LM723 RETS specification complied with the Min and Max limits in this table. The LM723E, H, and J may also be procured as a Standard Military Drawing.
- (3) See derating curves for maximum power rating above 25°C.

## ELECTRICAL CHARACTERISTICS<sup>(1)(2)(3)(4)</sup>

| Parameter        | Conditions                               | LM723 |      |      | LM723C |      |     | Units       |
|------------------|------------------------------------------|-------|------|------|--------|------|-----|-------------|
|                  |                                          | Min   | Typ  | Max  | Min    | Typ  | Max |             |
| Line Regulation  | $V_{IN} = 12V$ to $V_{IN} = 15V$         |       | 0.01 | 0.1  |        | 0.01 | 0.1 | % $V_{OUT}$ |
|                  | $-55^\circ C \leq T_A \leq +125^\circ C$ |       |      | 0.3  |        |      |     | % $V_{OUT}$ |
|                  | $0^\circ C \leq T_A \leq +70^\circ C$    |       |      |      |        |      | 0.3 | % $V_{OUT}$ |
|                  | $V_{IN} = 12V$ to $V_{IN} = 40V$         |       | 0.02 | 0.2  |        | 0.1  | 0.5 | % $V_{OUT}$ |
| Load Regulation  | $I_L = 1$ mA to $I_L = 50$ mA            |       | 0.03 | 0.15 |        | 0.03 | 0.2 | % $V_{OUT}$ |
|                  | $-55^\circ C \leq T_A \leq +125^\circ C$ |       |      | 0.6  |        |      |     | % $V_{OUT}$ |
|                  | $0^\circ C \leq T_A \leq +70^\circ C$    |       |      |      |        |      | 0.6 | % $V_{OUT}$ |
| Ripple Rejection | $f = 50$ Hz to 10 kHz, $C_{REF} = 0$     |       | 74   |      |        | 74   |     | dB          |
|                  | $f = 50$ Hz to 10 kHz, $C_{REF} = 5$ μF  |       | 86   |      |        | 86   |     | dB          |

- (1) Unless otherwise specified,  $T_A = 25^\circ C$ ,  $V_{IN} = V^+ = V_C = 12V$ ,  $V^- = 0$ ,  $V_{OUT} = 5V$ ,  $I_L = 1$  mA,  $R_{SC} = 0$ ,  $C_1 = 100$  pF,  $C_{REF} = 0$  and divider impedance as seen by error amplifier  $\leq 10$  kΩ connected as shown in Figure 4. Line and load regulation specifications are given for the condition of constant chip temperature. Temperature drifts must be taken into account separately for high dissipation conditions.
- (2) A military RETS specification is available on request. At the time of printing, the LM723 RETS specification complied with the Min and Max limits in this table. The LM723E, H, and J may also be procured as a Standard Military Drawing.
- (3) Specified by correlation to other tests.
- (4)  $L_1$  is 40 turns of No. 20 enameled copper wire wound on Ferroxcube P36/22-3B7 pot core or equivalent with 0.009 in. air gap.

**ELECTRICAL CHARACTERISTICS<sup>(1)(2)(3)(4)</sup> (continued)**

| Parameter                                                        | Conditions                                               | LM723 |       |       | LM723C |       |       | Units                 |
|------------------------------------------------------------------|----------------------------------------------------------|-------|-------|-------|--------|-------|-------|-----------------------|
|                                                                  |                                                          | Min   | Typ   | Max   | Min    | Typ   | Max   |                       |
| Average Temperature Coefficient of Output Voltage <sup>(5)</sup> | $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ |       | 0.002 | 0.015 |        |       |       | %/ $^{\circ}\text{C}$ |
|                                                                  | $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$    |       |       |       |        | 0.003 | 0.015 | %/ $^{\circ}\text{C}$ |
| Short Circuit Current Limit                                      | $R_{SC} = 10\Omega$ , $V_{OUT} = 0$                      |       | 65    |       |        | 65    |       | mA                    |
| Reference Voltage                                                |                                                          | 6.95  | 7.15  | 7.35  | 6.80   | 7.15  | 7.50  | V                     |
| Output Noise Voltage                                             | BW = 100 Hz to 10 kHz, $C_{REF} = 0$                     |       | 86    |       |        | 86    |       | $\mu\text{Vrms}$      |
|                                                                  | BW = 100 Hz to 10 kHz, $C_{REF} = 5 \mu\text{F}$         |       | 2.5   |       |        | 2.5   |       | $\mu\text{Vrms}$      |
| Long Term Stability                                              |                                                          |       | 0.05  |       |        | 0.05  |       | %/1000 hrs            |
| Standby Current Drain                                            | $I_L = 0$ , $V_{IN} = 30\text{V}$                        |       | 1.7   | 3.5   |        | 1.7   | 4.0   | mA                    |
| Input Voltage Range                                              |                                                          | 9.5   |       | 40    | 9.5    |       | 40    | V                     |
| Output Voltage Range                                             |                                                          | 2.0   |       | 37    | 2.0    |       | 37    | V                     |
| Input-Output Voltage Differential                                |                                                          | 3.0   |       | 38    | 3.0    |       | 38    | V                     |
| $\theta_{JA}$                                                    | PDIP                                                     |       |       |       |        | 105   |       | $^{\circ}\text{C/W}$  |
| $\theta_{JA}$                                                    | CDIP                                                     |       | 150   |       |        |       |       | $^{\circ}\text{C/W}$  |
| $\theta_{JA}$                                                    | H10C Board Mount in Still Air                            |       | 165   |       |        | 165   |       | $^{\circ}\text{C/W}$  |
| $\theta_{JA}$                                                    | H10C Board Mount in 400 LF/Min Air Flow                  |       | 66    |       |        | 66    |       | $^{\circ}\text{C/W}$  |
| $\theta_{JC}$                                                    |                                                          |       | 22    |       |        | 22    |       | $^{\circ}\text{C/W}$  |

(5) For metal can applications where  $V_Z$  is required, an external 6.2V zener diode should be connected in series with  $V_{OUT}$ .

## TYPICAL PERFORMANCE CHARACTERISTICS

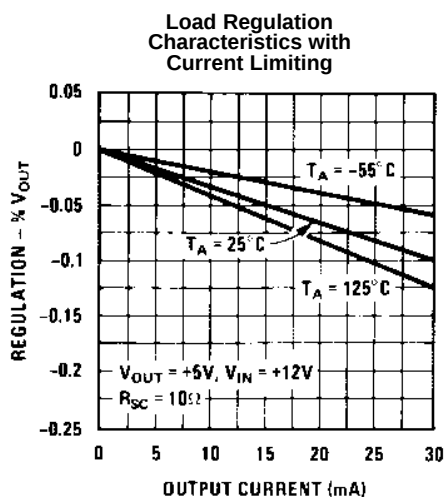


Figure 5.

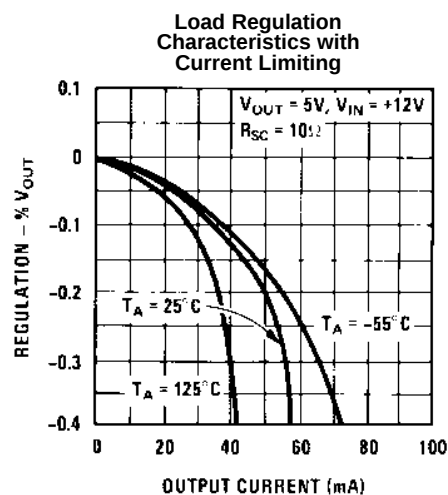


Figure 6.

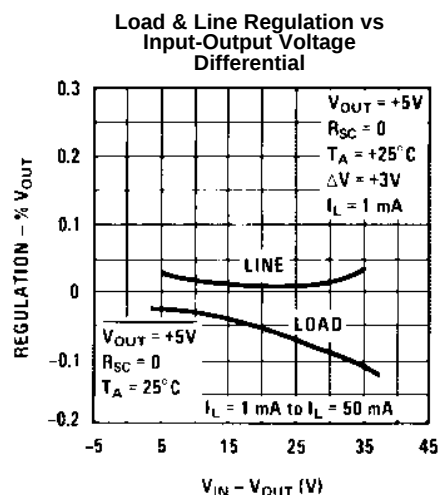


Figure 7.

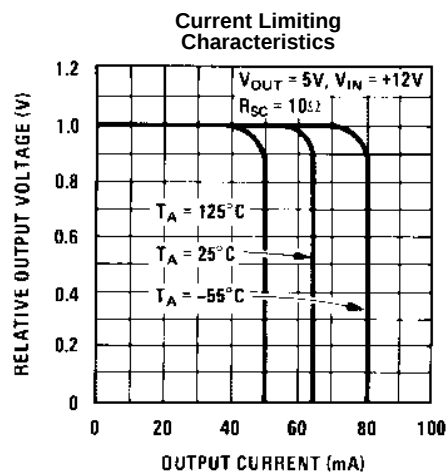


Figure 8.

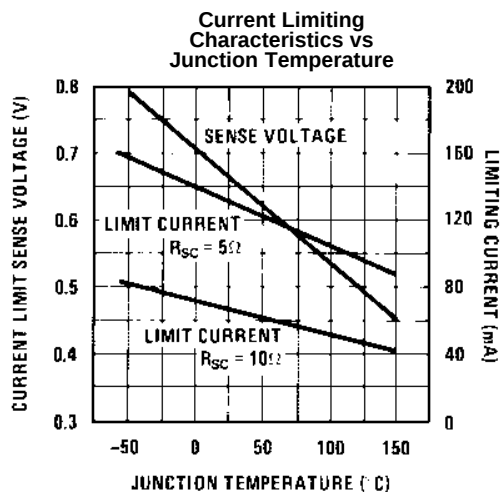


Figure 9.

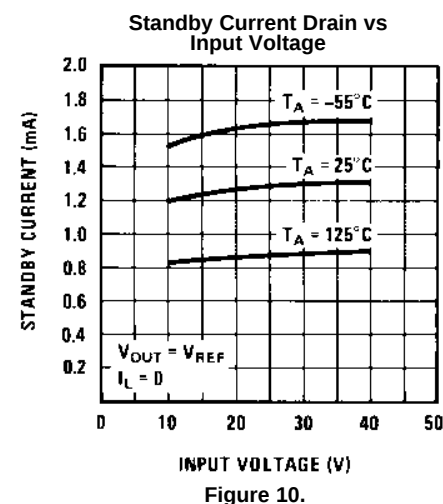


Figure 10.

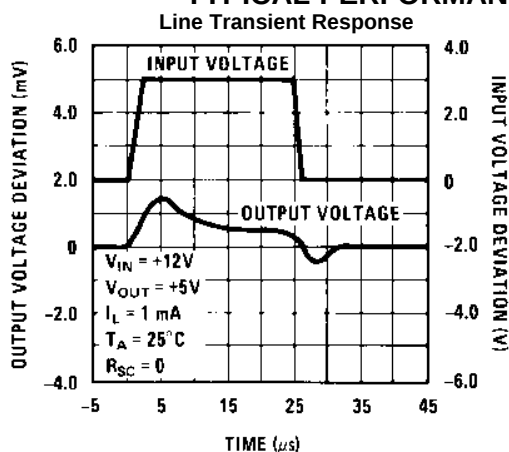
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

Figure 11.

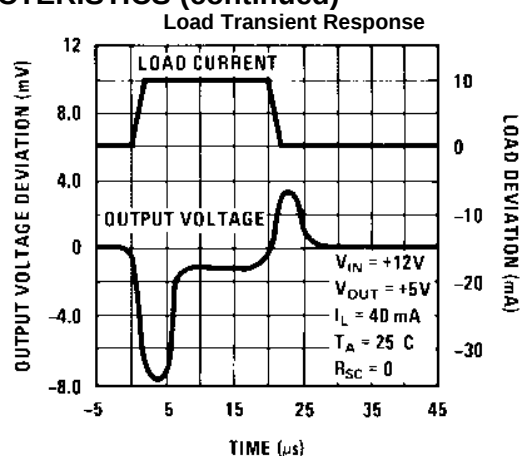


Figure 12.

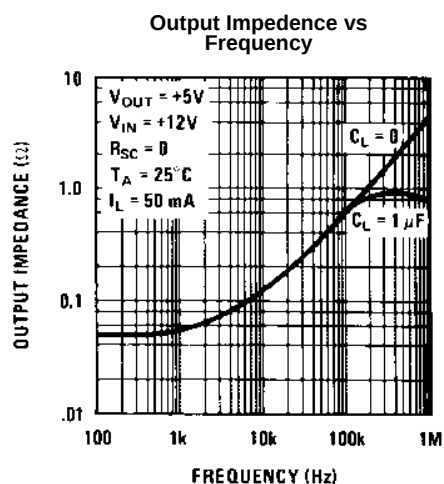
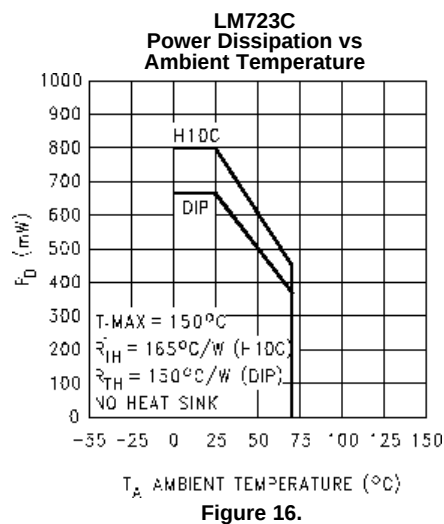
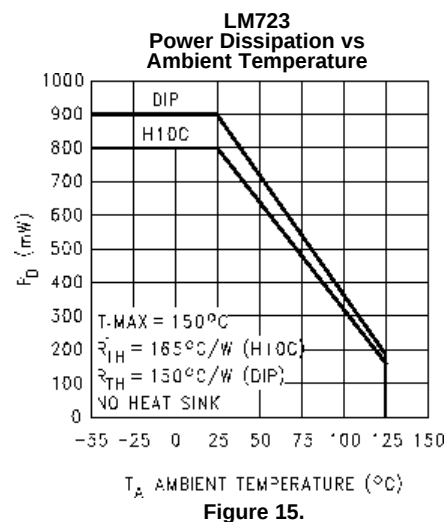
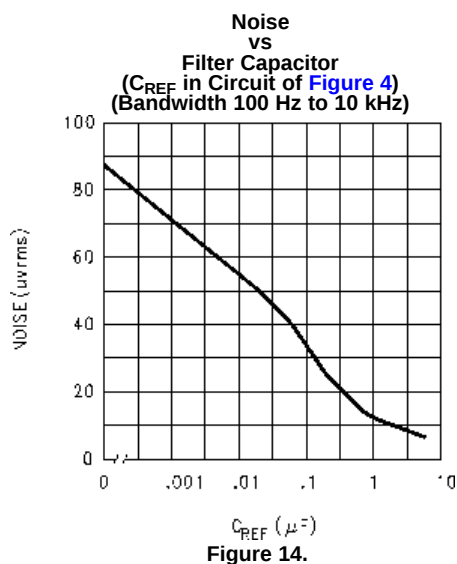


Figure 13.

## MAXIMUM POWER RATINGS



**Table 1. Resistor Values (kΩ) for Standard Output Voltage**

| Positive Output Voltage | Applicable Figures                                                 | Fixed Output ±5% |      | Output Adjustable ±10% <sup>(1)</sup> |     |     | Negative Output Voltage | Applicable Figures     | Fixed Output ±5% |      | 5% Output Adjustable ±10% |     |      |
|-------------------------|--------------------------------------------------------------------|------------------|------|---------------------------------------|-----|-----|-------------------------|------------------------|------------------|------|---------------------------|-----|------|
|                         |                                                                    | R1               | R2   | R1                                    | P1  | R2  |                         |                        | R1               | R2   | R1                        | P1  | R2   |
| +3.0                    | Figure 4, Figure 19, Figure 21, Figure 24, Figure 27 (Figure 19)   | 4.12             | 3.01 | 1.8                                   | 0.5 | 1.2 | +100                    | Figure 22              | 3.57             | 102  | 2.2                       | 10  | 91   |
| +3.6                    | Figure 4, Figure 19, Figure 21, Figure 24, Figure 27 (Figure 19)   | 3.57             | 3.65 | 1.5                                   | 0.5 | 1.5 | +250                    | Figure 22              | 3.57             | 255  | 2.2                       | 10  | 240  |
| +5.0                    | Figure 4, Figure 19, Figure 21, Figure 24, Figure 27 (Figure 19)   | 2.15             | 4.99 | 0.75                                  | 0.5 | 2.2 | −6 <sup>(3)</sup>       | Figure 18, (Figure 25) | 3.57             | 2.43 | 1.2                       | 0.5 | 0.75 |
| +6.0                    | Figure 4, Figure 19, Figure 21, Figure 24, Figure 27 (Figure 19)   | 1.15             | 6.04 | 0.5                                   | 0.5 | 2.7 | −9                      | Figure 18, Figure 25   | 3.48             | 5.36 | 1.2                       | 0.5 | 2.0  |
| +9.0                    | Figure 17, Figure 19, (Figure 19, Figure 21, Figure 24, Figure 27) | 1.87             | 7.15 | 0.75                                  | 1.0 | 2.7 | −12                     | Figure 18, Figure 25   | 3.57             | 8.45 | 1.2                       | 0.5 | 3.3  |
| +12                     | Figure 17, Figure 19, (Figure 19, Figure 21, Figure 24, Figure 27) | 4.87             | 7.15 | 2.0                                   | 1.0 | 3.0 | −15                     | Figure 18, Figure 25   | 3.65             | 11.5 | 1.2                       | 0.5 | 4.3  |
| +15                     | Figure 17, Figure 19, (Figure 19, Figure 21, Figure 24, Figure 27) | 7.87             | 7.15 | 3.3                                   | 1.0 | 3.0 | −28                     | Figure 18, Figure 25   | 3.57             | 24.3 | 1.2                       | 0.5 | 10   |
| +28                     | Figure 17, Figure 19, (Figure 19, Figure 21, Figure 24, Figure 27) | 21.0             | 7.15 | 5.6                                   | 1.0 | 2.0 | −45                     | Figure 23              | 3.57             | 41.2 | 2.2                       | 10  | 33   |
| +45                     | Figure 22                                                          | 3.57             | 48.7 | 2.2                                   | 10  | 39  | −100                    | Figure 23              | 3.57             | 97.6 | 2.2                       | 10  | 91   |
| +75                     | Figure 22                                                          | 3.57             | 78.7 | 2.2                                   | 10  | 68  | −250                    | Figure 23              | 3.57             | 249  | 2.2                       | 10  | 240  |

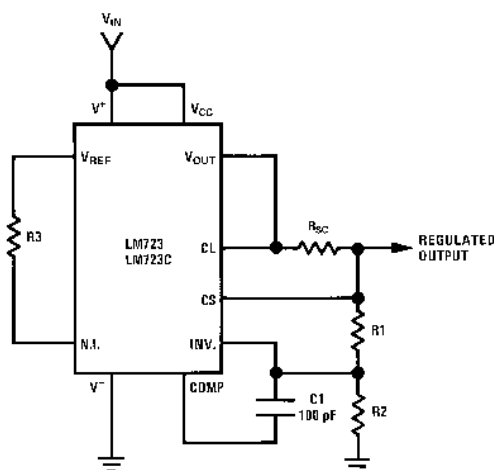
(1) Replace R1/R2 in figures with divider shown in Figure 28.

(2) Figures in parentheses may be used if R1/R2 divider is placed on opposite input of error amp.

(3) V<sup>+</sup> and V<sub>CC</sub> must be connected to a +3V or greater supply.**Table 2. Formulae for Intermediate Output Voltages**

|                                                                                                                                                                          |                                                                                                                                                                |                                                                                                                                                                                                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Outputs from +2 to +7 volts</b><br>(Figure 4 Figure 19 Figure 20 Figure 21 Figure 24 Figure 27)<br><br>$V_{OUT} = \left( V_{REF} \times \frac{R2}{R1 + R2} \right)$   | <b>Outputs from +4 to +250 volts</b><br>(Figure 22)<br><br>$V_{OUT} = \left( \frac{V_{REF}}{2} \times \frac{R2 - R1}{R1} \right); R3 = R4$                     | <b>Current Limiting</b><br><br>$I_{LIMIT} = \frac{V_{SENSE}}{R_{SC}}$                                                                                                                                                         |
| <b>Outputs from +7 to +37 volts</b><br>(Figure 17 Figure 19 Figure 20 Figure 21 Figure 24 Figure 27)<br><br>$V_{OUT} = \left( V_{REF} \times \frac{R1 + R2}{R2} \right)$ | <b>Outputs from −6 to −250 volts</b><br>(Figure 18 Figure 23 Figure 25)<br><br>$V_{OUT} = \left( \frac{V_{REF}}{2} \times \frac{R1 + R2}{R1} \right); R3 = R4$ | <b>Foldback Current Limiting</b><br><br>$I_{KNEE} = \left( \frac{V_{OUT} R3}{R_{SC} R4} + \frac{V_{SENSE} (R3 + R4)}{R_{SC} R4} \right)$ $I_{SHORT\ CKT} = \left( \frac{V_{SENSE}}{R_{SC}} \times \frac{R3 + R4}{R4} \right)$ |

## TYPICAL APPLICATIONS



Note:  $R3 = \frac{R1 R2}{R1 - R2}$

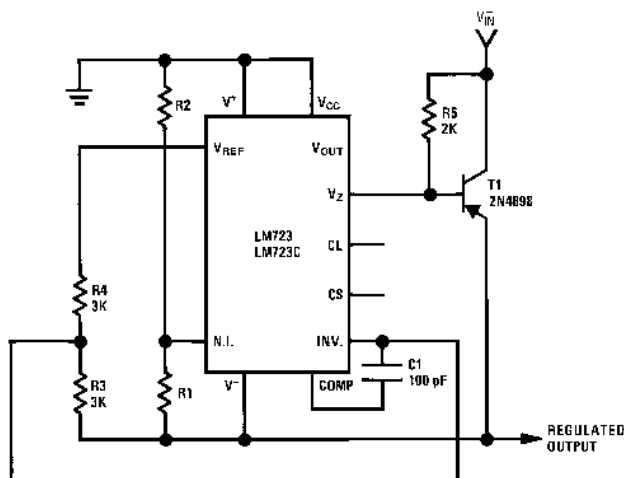
for minimum temperature drift.

R3 may be eliminated for minimum component count.

### Typical Performance

|                                                  |        |
|--------------------------------------------------|--------|
| Regulated Output Voltage                         | 15V    |
| Line Regulation ( $\Delta V_{IN} = 3V$ )         | 1.5 mV |
| Load Regulation ( $\Delta I_L = 50 \text{ mA}$ ) | 4.5 mV |

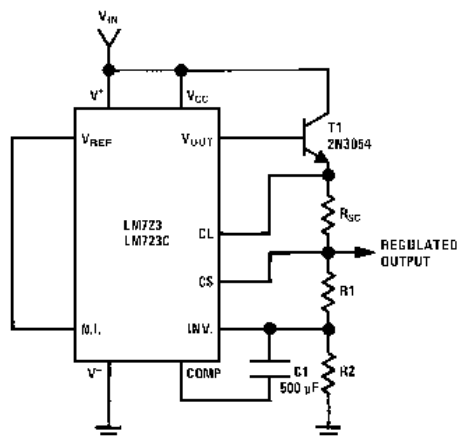
Figure 17. Basic High Voltage Regulator ( $V_{OUT} = 7$  to 37 Volts)



### Typical Performance

|                                                   |      |
|---------------------------------------------------|------|
| Regulated Output Voltage                          | -15V |
| Line Regulation ( $\Delta V_{IN} = 3V$ )          | 1 mV |
| Load Regulation ( $\Delta I_L = 100 \text{ mA}$ ) | 2 mV |

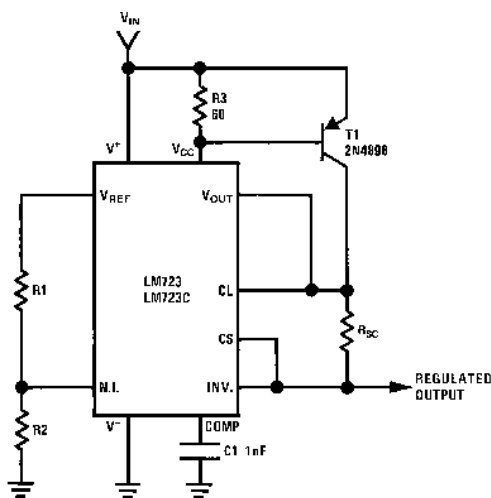
Figure 18. Negative Voltage Regulator



### Typical Performance

|                                          |        |
|------------------------------------------|--------|
| Regulated Output Voltage                 | +15V   |
| Line Regulation ( $\Delta V_{IN} = 3V$ ) | 1.5 mV |
| Load Regulation ( $\Delta I_L = 1A$ )    | 15 mV  |

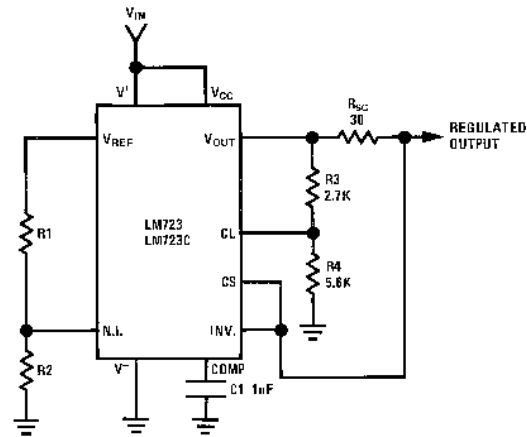
**Figure 19. Positive Voltage Regulator (External NPN Pass Transistor)**



### Typical Performance

|                                          |        |
|------------------------------------------|--------|
| Regulated Output Voltage                 | +5V    |
| Line Regulation ( $\Delta V_{IN} = 3V$ ) | 0.5 mV |
| Load Regulation ( $\Delta I_L = 1A$ )    | 5 mV   |

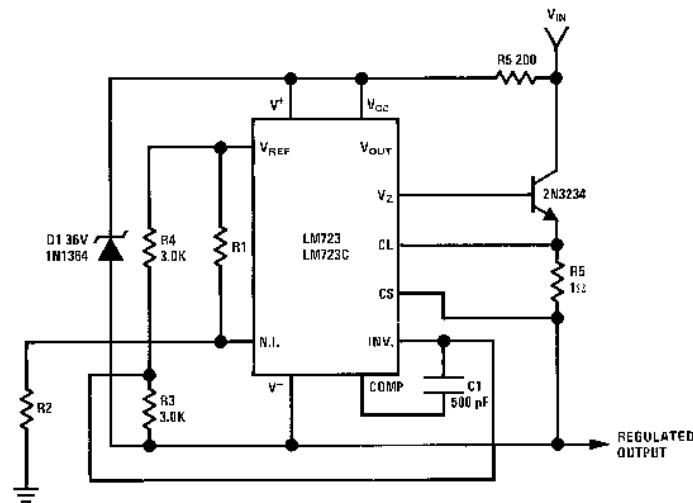
**Figure 20. Positive Voltage Regulator (External PNP Pass Transistor)**



## Typical Performance

|                                                  |        |
|--------------------------------------------------|--------|
| Regulated Output Voltage                         | +5V    |
| Line Regulation ( $\Delta V_{IN} = 3V$ )         | 0.5 mV |
| Load Regulation ( $\Delta I_L = 10 \text{ mA}$ ) | 1 mV   |
| Short Circuit Current                            | 20 mA  |

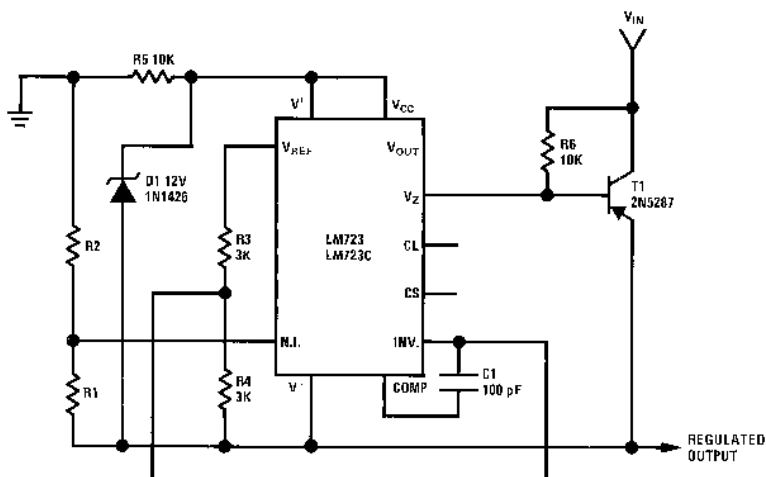
### Figure 21. Foldback Current Limiting



## Typical Performance

|                                                  |       |
|--------------------------------------------------|-------|
| Regulated Output Voltage                         | +50V  |
| Line Regulation ( $\Delta V_{IN} = 20V$ )        | 15 mV |
| Load Regulation ( $\Delta I_L = 50 \text{ mA}$ ) | 20 mV |

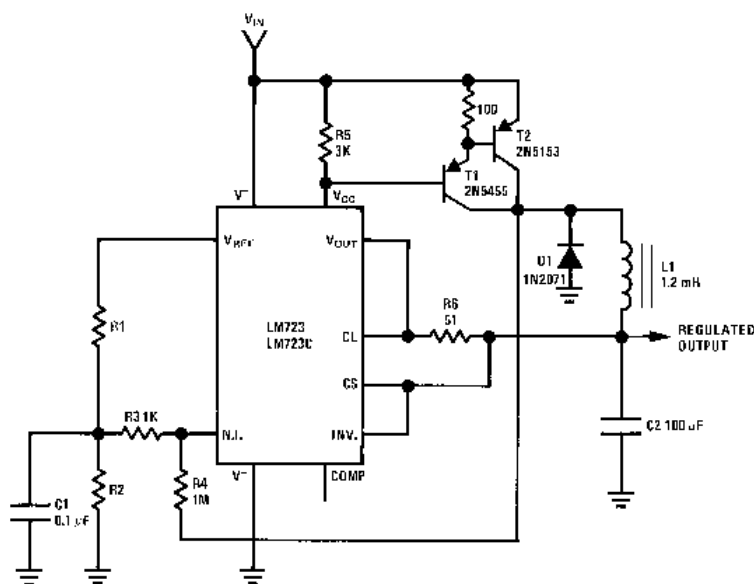
### Figure 22. Positive Floating Regulator



### Typical Performance

|                                                   |       |
|---------------------------------------------------|-------|
| Regulated Output Voltage                          | -100V |
| Line Regulation ( $\Delta V_{IN} = 20V$ )         | 30 mV |
| Load Regulation ( $\Delta I_L = 100 \text{ mA}$ ) | 20 mV |

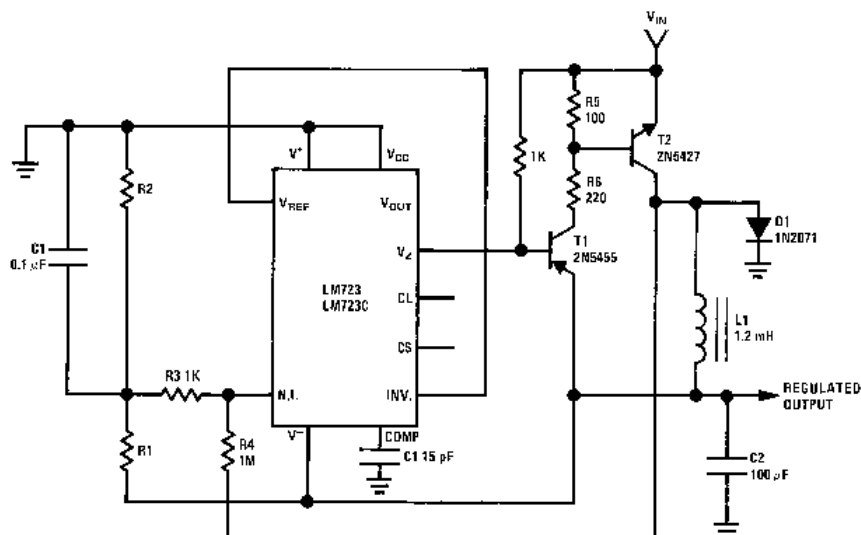
Figure 23. Negative Floating Regulator



### Typical Performance

|                                           |       |
|-------------------------------------------|-------|
| Regulated Output Voltage                  | +5V   |
| Line Regulation ( $\Delta V_{IN} = 30V$ ) | 10 mV |
| Load Regulation ( $\Delta I_L = 2A$ )     | 80 mV |

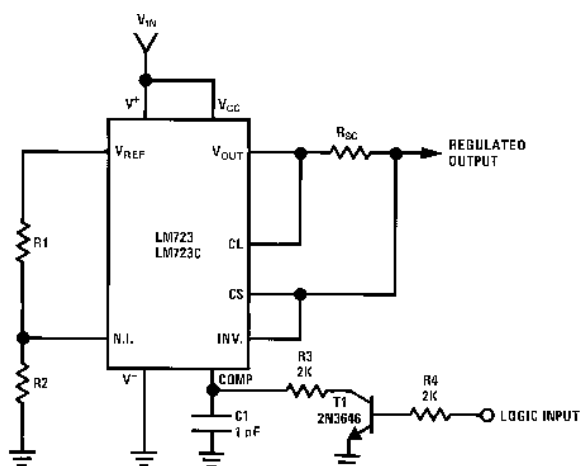
Figure 24. Positive Switching Regulator



### Typical Performance

|                                           |      |
|-------------------------------------------|------|
| Regulated Output Voltage                  | -15V |
| Line Regulation ( $\Delta V_{IN} = 20V$ ) | 8 mV |
| Load Regulation ( $\Delta I_L = 2A$ )     | 6 mV |

Figure 25. Negative Switching Regulator

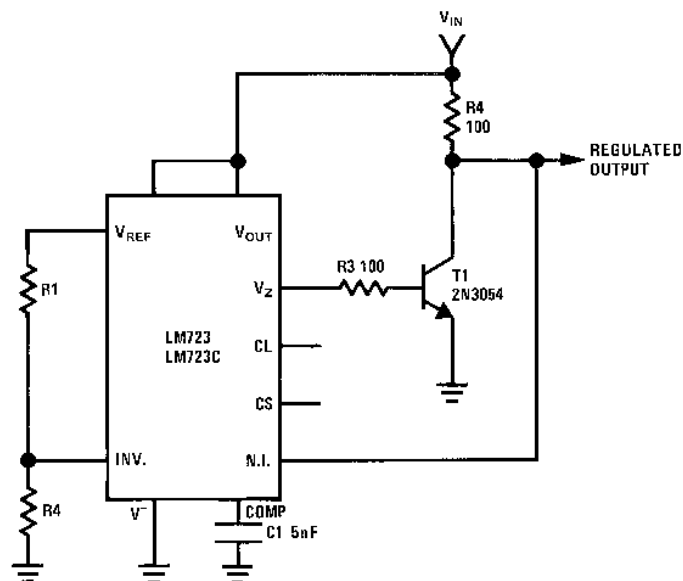


**Note:** Current limit transistor may be used for shutdown if current limiting is not required.

### Typical Performance

|                                                  |        |
|--------------------------------------------------|--------|
| Regulated Output Voltage                         | +5V    |
| Line Regulation ( $\Delta V_{IN} = 3V$ )         | 0.5 mV |
| Load Regulation ( $\Delta I_L = 50 \text{ mA}$ ) | 1.5 mV |

Figure 26. Remote Shutdown Regulator with Current Limiting



Regulated Output Voltage

+5V

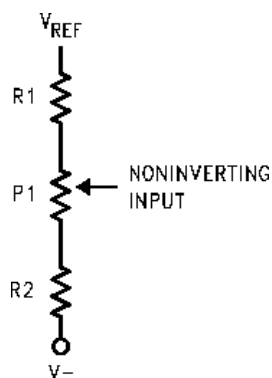
Line Regulation ( $\Delta V_{IN} = 10V$ )

0.5 mV

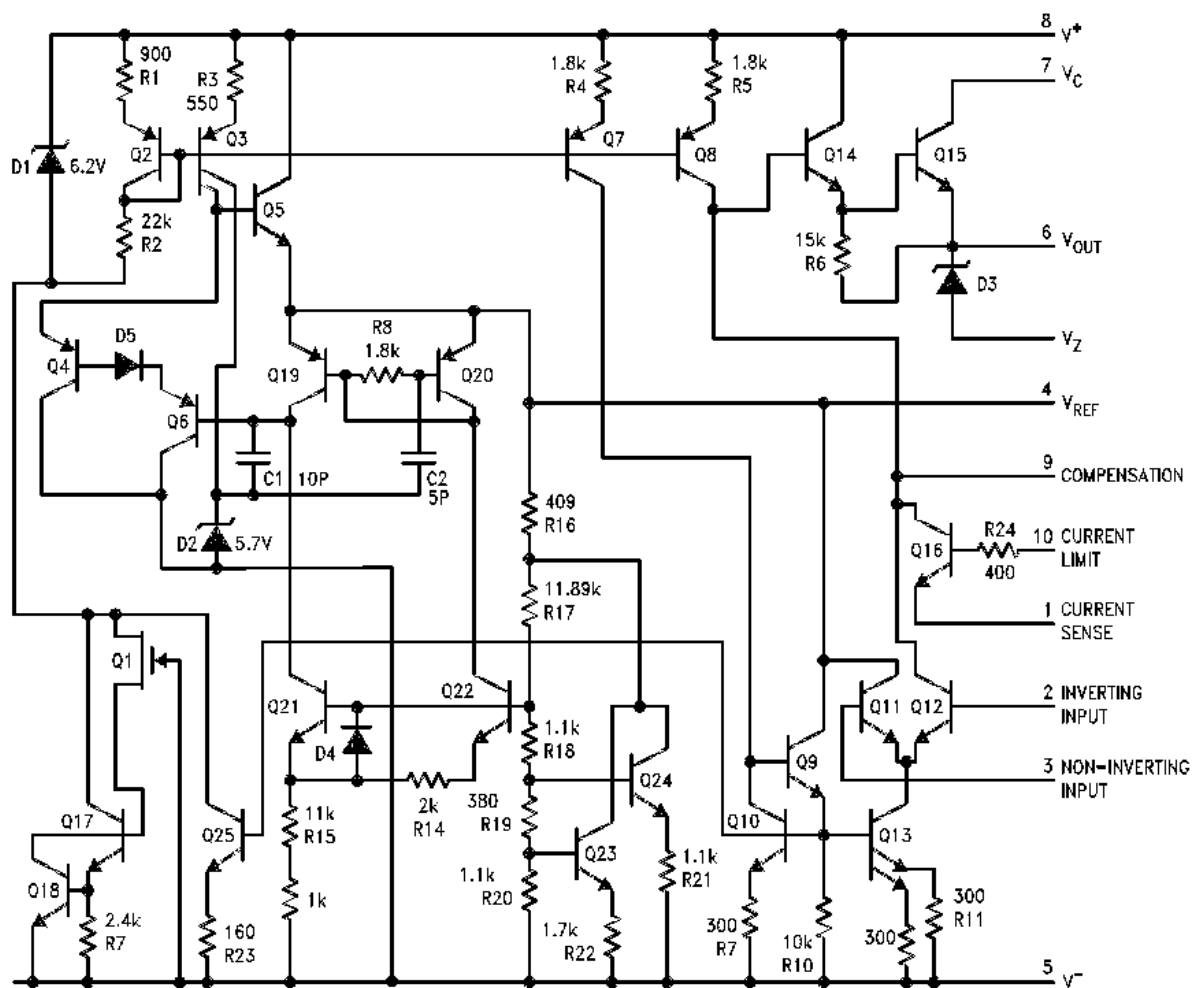
Load Regulation ( $\Delta I_L = 100 \text{ mA}$ )

1.5 mV

Figure 27. Shunt Regulator

Figure 28. Output Voltage Adjust <sup>(1)</sup>(1) Replace R1/R2 in figures with divider shown in [Figure 28](#).

## Schematic Diagram



## REVISION HISTORY

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

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM723CH          | ACTIVE        | TO-100       | LME                | 10   | 500            | TBD                        | Call TI                 | Call TI              | 0 to 70      | ( LM723CH ~<br>LM723CH) | <a href="#">Samples</a> |
| LM723CH/NOPB     | ACTIVE        | TO-100       | LME                | 10   | 500            | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     | 0 to 70      | ( LM723CH ~<br>LM723CH) | <a href="#">Samples</a> |
| LM723CN/NOPB     | ACTIVE        | PDIP         | NFF                | 14   | 25             | Green (RoHS<br>& no Sb/Br) | CU SN                   | Level-1-NA-UNLIM     | 0 to 70      | LM723CN                 | <a href="#">Samples</a> |
| LM723H           | ACTIVE        | TO-100       | LME                | 10   | 500            | TBD                        | Call TI                 | Call TI              | -55 to 150   | ( LM723H ~ LM723H)      | <a href="#">Samples</a> |
| LM723H/NOPB      | ACTIVE        | TO-100       | LME                | 10   | 500            | Green (RoHS<br>& no Sb/Br) | Call TI                 | Level-1-NA-UNLIM     | -55 to 150   | ( LM723H ~ LM723H)      | <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)

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.

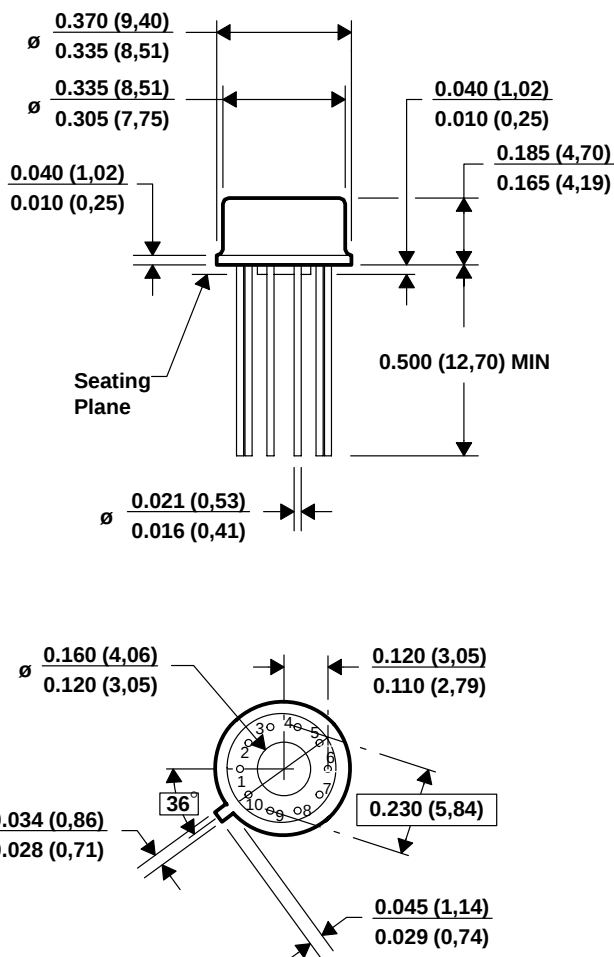
<sup>(6)</sup> Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## LME (O-MBCY-W10)

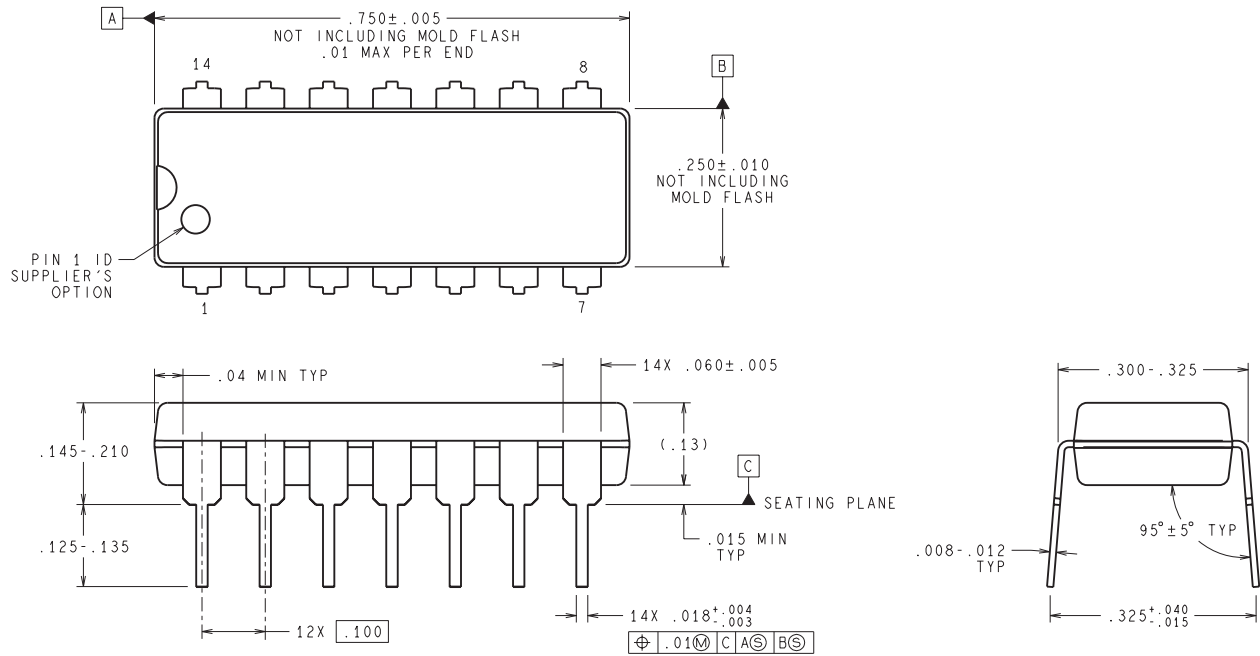
## METAL CYLINDRICAL PACKAGE



4202488/A 03/01

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - Leads in true position within 0.010 (0,25) R @ MMC at seating plane.
  - Pin numbers shown for reference only. Numbers may not be marked on package.
  - Falls within JEDEC MO-006/TO-100.

NFF0014A



**DIMENSIONS ARE IN INCHES**  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

N14A (Rev G)

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |                                                                                      |
|------------------------------|--------------------------------------------------------------------------------------|
| Audio                        | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>                                         |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>                                           |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |                                                                                          |
|-------------------------------|------------------------------------------------------------------------------------------|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)