- **150-mA Load Current Without External Power Transistor**
- **Typically 0.02% Input Regulation and 0.03% Load Regulation (μA723M)**
- **Adjustable Current Limiting Capability**
- **Input Voltages to 40 V**
- **Output Adjustable From 2 V to 37 V**
- **Direct Replacement for Fairchild μA723C and μA723M**

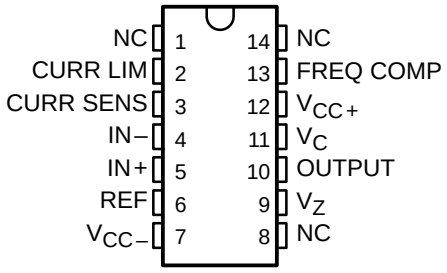
## description

The μA723C and μA723M are precision monolithic integrated circuit voltage regulators featuring high ripple rejection, excellent input and load regulation, excellent temperature stability, and low standby current. The circuit consists of a temperature-compensated reference voltage amplifier, an error amplifier, a 150-mA output transistor, and an adjustable output current limiter.

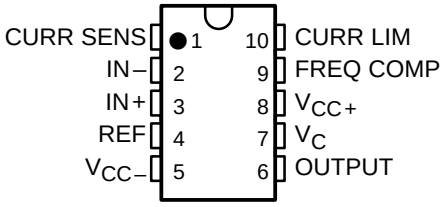
The μA723C and μA723M are designed for use in positive or negative power supplies as a series, shunt, switching, or floating regulator. For output currents exceeding 150 mA, additional pass elements may be connected as shown in Figures 4 and 5.

The μA723C is characterized for operation from 0°C to 70°C. The μA723M is characterized for operation over the full military temperature range of –55°C to 125°C.

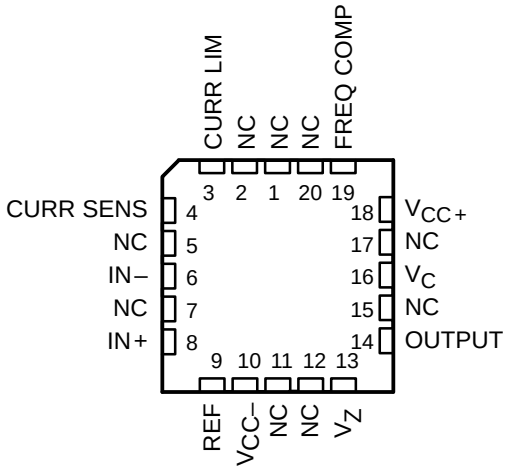
**μA723C . . . D OR N PACKAGE**
**μA723M . . . J PACKAGE**
**(TOP VIEW)**




**μA723M . . . U PACKAGE**
**(TOP VIEW)**

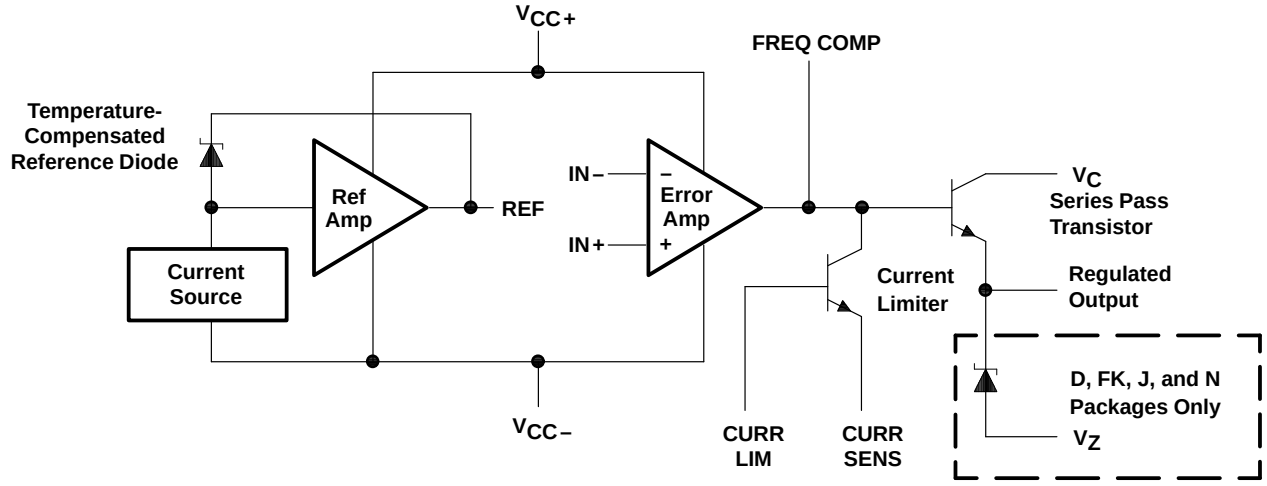



**μA723M . . . FK PACKAGE**
**(TOP VIEW)**

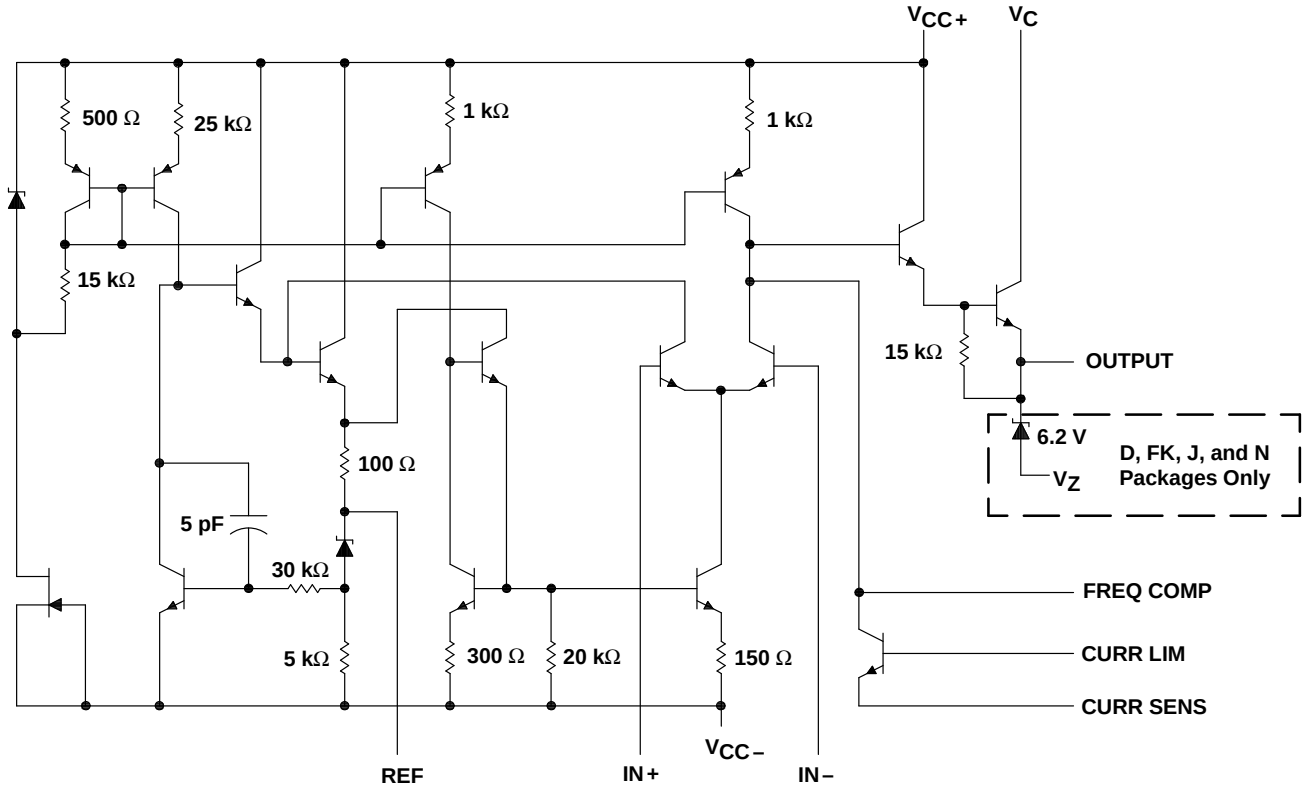



NC – No internal connection

## functional block diagram




## schematic

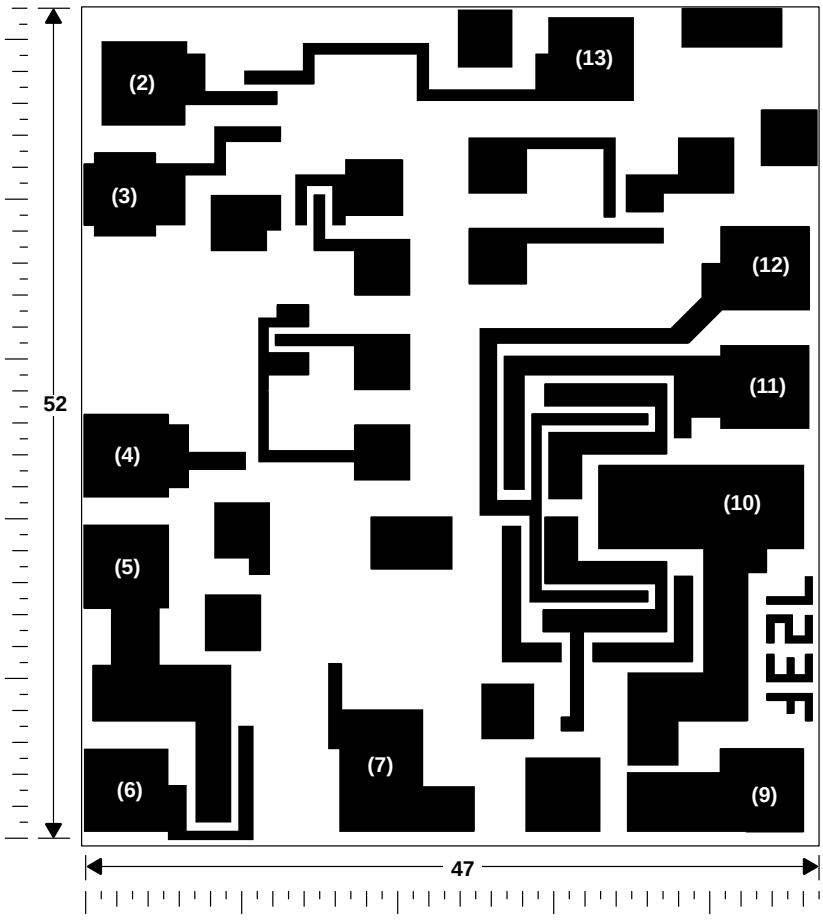


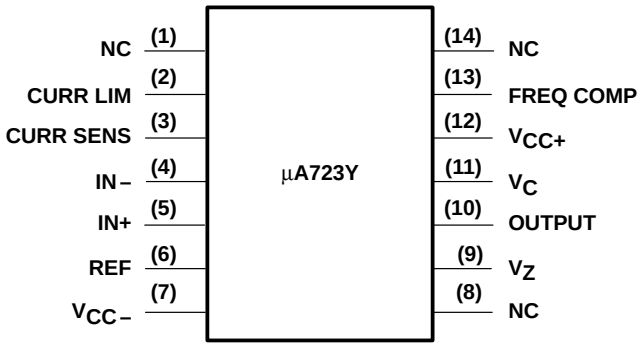

Resistor and capacitor values shown are nominal.

## μA723Y chip information

This chip, when properly assembled, displays characteristics similar to the μA723C. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. The chips may be mounted with conductive epoxy or a gold-silicon preform.

**BONDING PAD ASSIGNMENTS**




**CHIP THICKNESS: 15 MILS TYPICAL**

**BONDING PADS: 4 × 4 MILS MINIMUM**

**$T_J$max = 150°C**

**TOLERANCES ARE ±10%.**

**ALL DIMENSIONS ARE IN MILS.**

**TERMINALS 1, 8, AND 14 ARE NOT CONNECTED**

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

Peak voltage from $V_{CC+}$ to $V_{CC-}$ ($t_w \leq 50$ ms) . . . . . 50 V
Continuous voltage from $V_{CC+}$ to $V_{CC-}$ . . . . . 40 V
Input-to-output voltage differential . . . . . 40 V
Differential input voltage to error amplifier . . . . . ±5 V
Voltage between noninverting input and $V_{CC-}$ . . . . . 8 V
Current from $V_Z$ . . . . . 25 mA
Current from REF . . . . . 15 mA
Continuous total dissipation (see Note 1) . . . . . See Dissipation Rating Table
Operating free-air temperature range, $T_A$: μA723C . . . . . 0°C to 70°C
μA723M . . . . . –55°C to 125°C
Storage temperature range, $T_{stg}$ . . . . . –65°C to 150°C
Case temperature for 60 seconds, $T_C$: FK package . . . . . 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J or U package . . . . . 300°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or N package . . . . . 260°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: Power dissipation = $[I_{(standby)} + I_{(ref)}]\ V_{CC} + [V_C - V_O]\ I_O$.

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \leq 25°C$ POWER RATING | DERATING FACTOR | DERATE ABOVE $T_A$ | $T_A = 70°C$ POWER RATING | $T_A = 125°C$ POWER RATING |
|---|---|---|---|---|---|
| D | 950 mW | 7.6 mW/°C | 25°C | 608 mW | — |
| FK and J | 1000 mW | 11.0 mW/°C | 59°C | 879 mW | 274 mW |
| N | 1000 mW | 9.2 mW/°C | 41°C | 733 mW | — |
| U | 675 mW | 5.4 mW/°C | 25°C | 432 mW | 135 mW |

## recommended operating conditions

| | MIN | MAX | UNIT |
|---|---|---|---|
| Input voltage, $V_I$ | 9.5 | 40 | V |
| Output voltage, $V_O$ | 2 | 37 | V |
| Input-to-output voltage differential, $V_C - V_O$ | 3 | 38 | V |
| Output current, $I_O$ | | 150 | mA |

## electrical characteristics at specified free-air temperature (see Notes 2 and 3)

| PARAMETER | TEST CONDITIONS | $T_A$† | μA723C | | | μA723M | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input regulation | $V_I$ = 12 V to $V_I$ = 15 V | 25°C | | 0.1 | 1 | | 0.1 | 1 | mV/V |
| | $V_I$ = 12 V to $V_I$ = 40 V | 25°C | | 1 | 5 | | 0.2 | 2 | |
| | $V_I$ = 12 V to $V_I$ = 15 V | Full range | | | 3 | | | 3 | |
| Ripple rejection | f = 50 $H_z$ to 10 kHz, $C_{ref}$ = 0 | 25°C | | 74 | | | 74 | | dB |
| | f = 50 Hz to 10 kHz, $C_{ref}$ = 5 μF | 25°C | | 86 | | | 86 | | |
| Output regulation | | 25°C | | −0.3 | −2 | | −0.3 | −1.5 | mV/V |
| | | Full range | | | −6 | | | −6 | |
| Reference voltage, $V_{ref}$ | | 25°C | 6.8 | 7.15 | 7.5 | 6.95 | 7.15 | 7.35 | V |
| Standby current | $V_I$ = 30 V, $I_O$ = 0 | 25°C | | 2.3 | 4 | | 2.3 | 3.5 | mA |
| Temperature coefficient of output voltage | | Full range | | 0.003 | 0.015 | | 0.002 | 0.015* | %/°C |
| Short-circuit output current | $R_{SC}$ = 10 Ω, $V_O$ = 0 | 25°C | | 65 | | | 65 | | mA |
| Output noise voltage | BW = 100 Hz to 10 kHz, $C_{ref}$ = 0 | 25°C | | 20 | | | 20 | | μV |
| | BW = 100 Hz to 10 kHz, $C_{ref}$ = 5 μF | 25°C | | 2.5 | | | 2.5 | | |

*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

† Full range for μA723C is 0°C to 70°C and for μA723M is −55°C to 125°C.

NOTES: 2. For all values in this table, the device is connected as shown in Figure 1 with the divider resistance as seen by the error amplifier ≤ 10 kΩ. Unless otherwise specified, $V_I = V_{CC+} = V_C$ = 12 V, $V_{CC-}$ = 0, $V_O$ = 5 V, $I_O$ = 1 mA, $R_{SC}$ = 0, and $C_{ref}$ = 0.

3. Pulse-testing techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

## electrical characteristics, $T_A$ = 25°C (see Notes 2 and 3)

| PARAMETER | TEST CONDITIONS | μA723Y | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP | MAX | |
| Input regulation | $V_I$ = 12 V to $V_I$ = 15 V | | 0.1 | | mV/V |
| | $V_I$ = 12 V to $V_I$ = 40 V | | 1 | | |
| Ripple rejection | f = 50 $H_Z$ to 10 kHz, $C_{ref}$ = 0 | | 74 | | dB |
| | f = 50 Hz to 10 kHz, $C_{ref}$ = 5 μF | | 86 | | |
| Output regulation | | | –0.3 | | mV/V |
| Reference voltage, $V_{ref}$ | | | 7.15 | | V |
| Standby current | $V_I$ = 30 V, $I_O$ = 0 | | 2.3 | | mA |
| Short-circuit output current | $R_{SC}$ = 10 Ω, $V_O$ = 0 | | 65 | | mA |
| Output noise voltage | BW = 100 Hz to 10 kHz, $C_{ref}$ = 0 | | 20 | | μV |
| | BW = 100 Hz to 10 kHz, $C_{ref}$ = 5 μF | | 2.5 | | |

NOTES: 2. For all values in this table, the device is connected as shown in Figure 1 with the divider resistance as seen by the error amplifier ≤ 10 kΩ. Unless otherwise specified, $V_I = V_{CC+} = V_C$ = 12 V, $V_{CC-}$ = 0, $V_O$ = 5 V, $I_O$ = 1 mA, $R_{SC}$ = 0, and $C_{ref}$ = 0.

3. Pulse-testing techniques must be used that will maintain the junction temperature as close to the ambient temperature as possible.

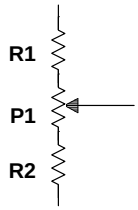
## APPLICATION INFORMATION

### Table 1. Resistor Values (kΩ) for Standard Output Voltages

| OUTPUT VOLTAGE (V) | APPLICABLE FIGURES (SEE NOTE 4) | FIXED OUTPUT ±5% | | OUTPUT ADJUSTABLE ±10% (SEE NOTE 5) | | |
|---|---|---|---|---|---|---|
| | | R1 (kΩ) | R2 (kΩ) | R1 (kΩ) | P1 (kΩ ) | P2 (kΩ ) |
| 3.0 | 1,5,6,9,11, 12 (4) | 4.12 | 3.01 | 1.8 | 0.5 | 1.2 |
| 3.6 | 1,5,6,9,11, 12 (4) | 3.57 | 3.65 | 1.5 | 0.5 | 1.5 |
| 5.0 | 1,5,6,9,11, 12 (4) | 2.15 | 4.99 | 0.75 | 0.5 | 2.2 |
| 6.0 | 1,5,6,9,11, 12 (4) | 1.15 | 6.04 | 0.5 | 0.5 | 2.7 |
| 9.0 | 2,4,(5,6, 9,12) | 1.87 | 7.15 | 0.75 | 1.0 | 2.7 |
| 12 | 2,4,(5,6, 9,12) | 4.87 | 7.15 | 2.0 | 1.0 | 3.0 |
| 15 | 2,4,(5,6, 9,12) | 7.87 | 7.15 | 3.3 | 1.0 | 3.0 |
| 28 | 2,4,(5,6, 9,12) | 21.0 | 7.15 | 5.6 | 1.0 | 2.0 |
| 45 | 7 | 3.57 | 48.7 | 2.2 | 10 | 39 |
| 75 | 7 | 3.57 | 78.7 | 2.2 | 10 | 68 |
| 100 | 7 | 3.57 | 105 | 2.2 | 10 | 91 |
| 250 | 7 | 3.57 | 255 | 2.2 | 10 | 240 |
| –6 (Note 6) | 3, 10 | 3.57 | 2.43 | 1.2 | 0.5 | 0.75 |
| –9 | 3, 10 | 3.48 | 5.36 | 1.2 | 0.5 | 2.0 |
| –12 | 3, 10 | 3.57 | 8.45 | 1.2 | 0.5 | 3.3 |
| –15 | 3, 10 | 3.57 | 11.5 | 1.2 | 0.5 | 4.3 |
| –28 | 3, 10 | 3.57 | 24.3 | 1.2 | 0.5 | 10 |
| –45 | 8 | 3.57 | 41.2 | 2.2 | 10 | 33 |
| –100 | 8 | 3.57 | 95.3 | 2.2 | 10 | 91 |
| –250 | 8 | 3.57 | 249 | 2.2 | 10 | 240 |

NOTES: 4. 4The R1/R2 divider may be across either $V_O$ or $V_{(ref)}$. If the divider is across $V_{(ref)}$, use the figure numbers without parentheses. If the divider is across $V_O$, use the figure numbers in parentheses.

5. To make the voltage adjustable, the R1/R2 divider shown in the figures must be replaced by the divider shown below.




**Adjustable Output Circuit**

6. For Figures 3, 8, and 10, the device requires a minimum of 9 V between $V_{CC+}$ and $V_{CC-}$ when $V_O$ is equal to or more positive than –9 V.

## APPLICATION INFORMATION

### Table 2. Formulas for Intermediate Output Voltages

| | | |
|---|---|---|
| Outputs from 2 V to 7 V<br>See Figures 1,5,6,9, 11, 12 (4)<br>and Note 4<br>$V_O = V_{(ref)} \times \frac{R2}{R1 + R2}$ | Outputs from 4 V to 250 V<br>See Figure 7<br>and Note 4<br>$V_O = \frac{V_{(ref)}}{2} \times \frac{R2 - R1}{R1}$<br>$R3 = R4$ | Current Limiting<br>$I_{(limit)} \approx \frac{0.65\ V}{R_{SC}}$ |
| Outputs from 7 V to 37 V<br>See Figures 2,4,(5,6,9, 11, 12)<br>and Note 4<br>$V_O = V_{(ref)} \times \frac{R1 + R2}{R2}$ | Outputs from –6 V to –250 V<br>See Figures 3, 8, 10 and<br>Notes 4 and 6<br>$V_O = -\frac{V_{(ref)}}{2} \times \frac{R1 + R2}{R1}$<br>$R3 = R4$ | Foldback Current Limiting<br>See Figure 6<br>$I_{(knee)} \approx \frac{V_O R3 + (R3 + R4)\ 0.65\ V}{R_{SC} R4}$<br>$I_{OS} \approx \frac{0.65\ V}{R_{SC}} \times \frac{R3 + R4}{R4}$ |

NOTES: 4. The R1/R2 divider may be across either $V_O$ or $V_{(ref)}$. If the divider is across $V_{(ref)}$, use figure numbers without parentheses. If the divider is across $V_O$, use the figure numbers in parentheses.

6. For Figures 3, 8, and 10, the device requires a minimum of 9 V between $V_{CC+}$ and $V_{CC-}$ when $V_O$ is equal to or more positive than –9 V.

## APPLICATION INFORMATION

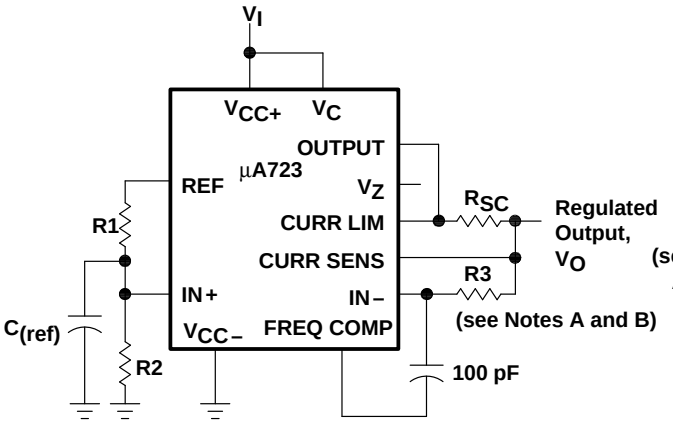



**Figure 1. Basic Low-Voltage Regulator ($V_O$ = 2 V to 7 V)**

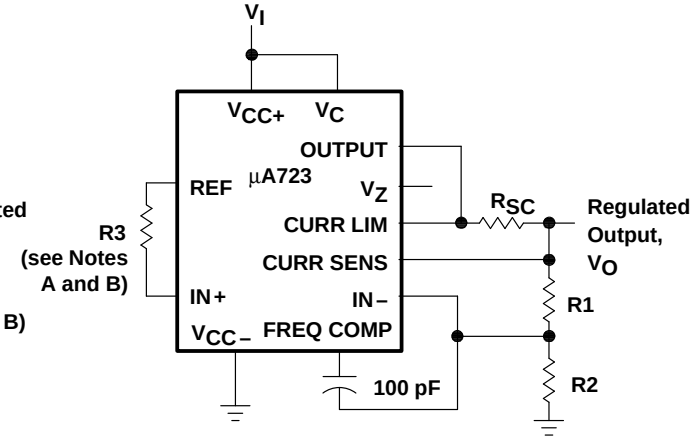



**Figure 2. Basic High-Voltage Regulator ($V_O$ = 7 V to 37 V)**

NOTES: A. $R3 = \frac{R1 \times R2}{R1 + R2}$ for minimum $\alpha_{VO}$

B. R3 may be eliminated for minimum component count. Use direct connection (i.e., $R_3 = 0$).

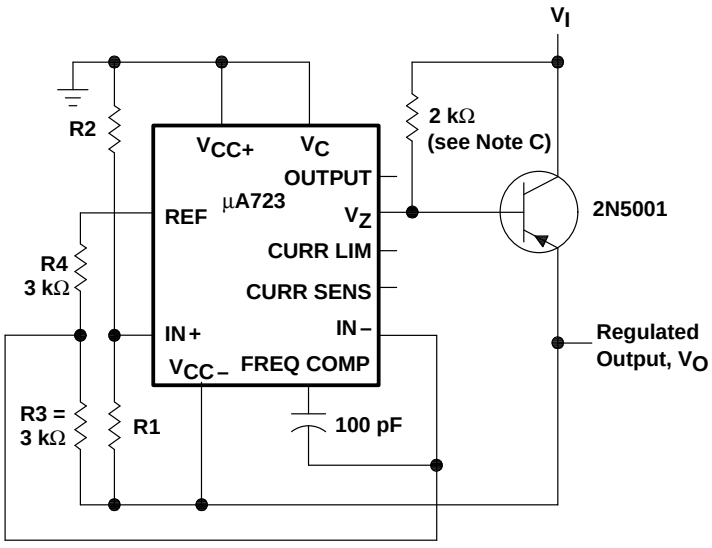



**Figure 3. Negative-Voltage Regulator**

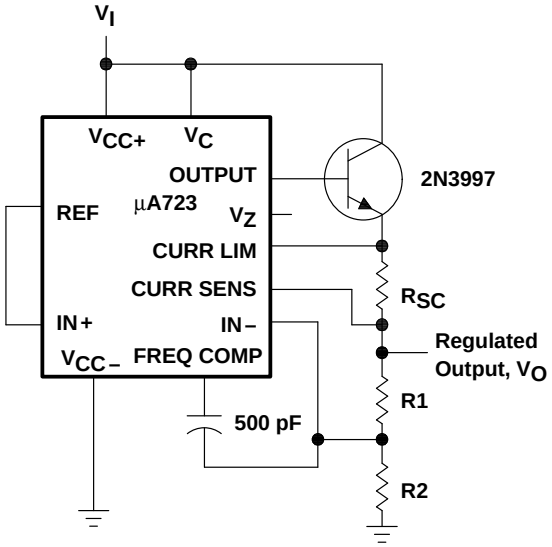



**Figure 4. Positive-Voltage Regulator (External N-P-N Pass Terminator)**

NOTE C: When 10-lead μA723U devices are used in applications requiring $V_Z$, an external 6.2-V regulator diode must be connected in series with OUTPUT.

## APPLICATION INFORMATION

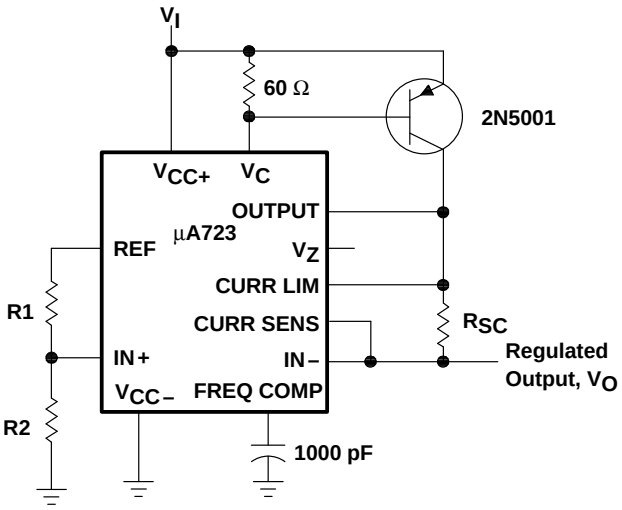



**Figure 5. Positive-Voltage Regulator (External P-N-P Pass Transistor)**

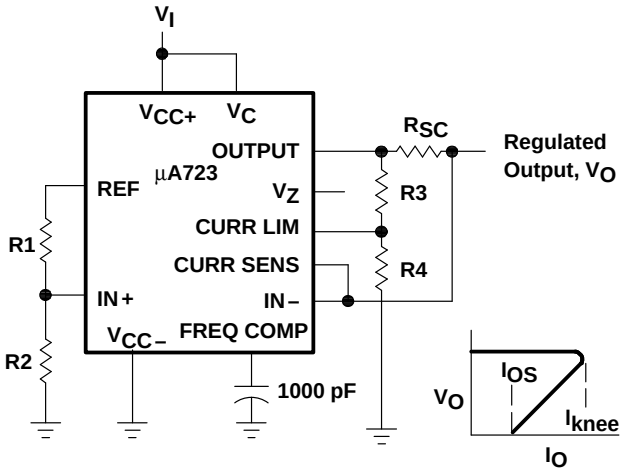



**Figure 6. Foldback Current Limiting**

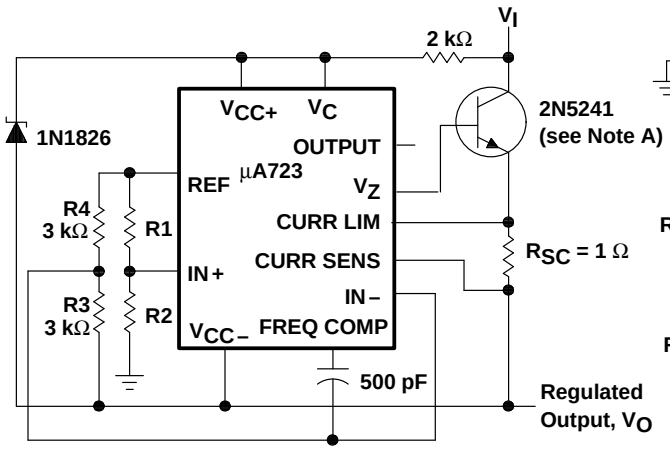



**Figure 7. Positive Floating Regulator**

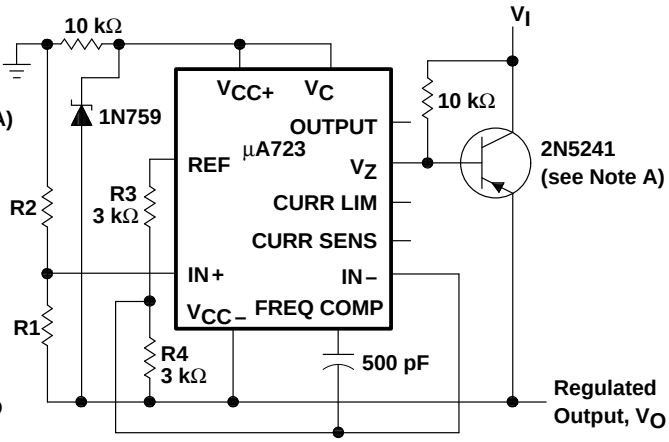



**Figure 8. Negative Floating Regulator**

NOTE A: When 10-lead μA723U devices are used in applications requiring $V_Z$, an external 6.2-V regulator diode must be connected in series with OUTPUT.

## APPLICATION INFORMATION

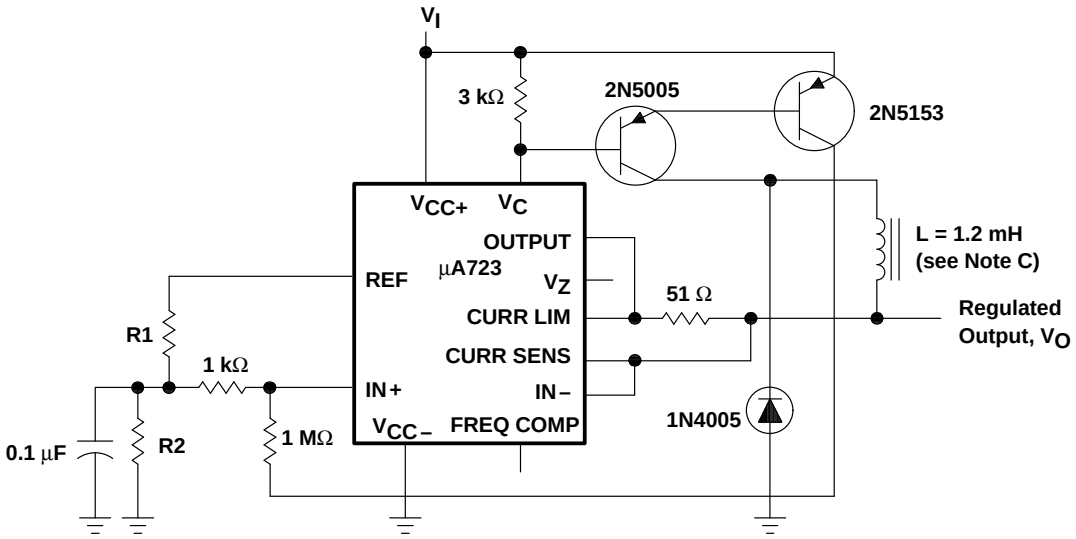



**Figure 9. Positive Switching Regulator**

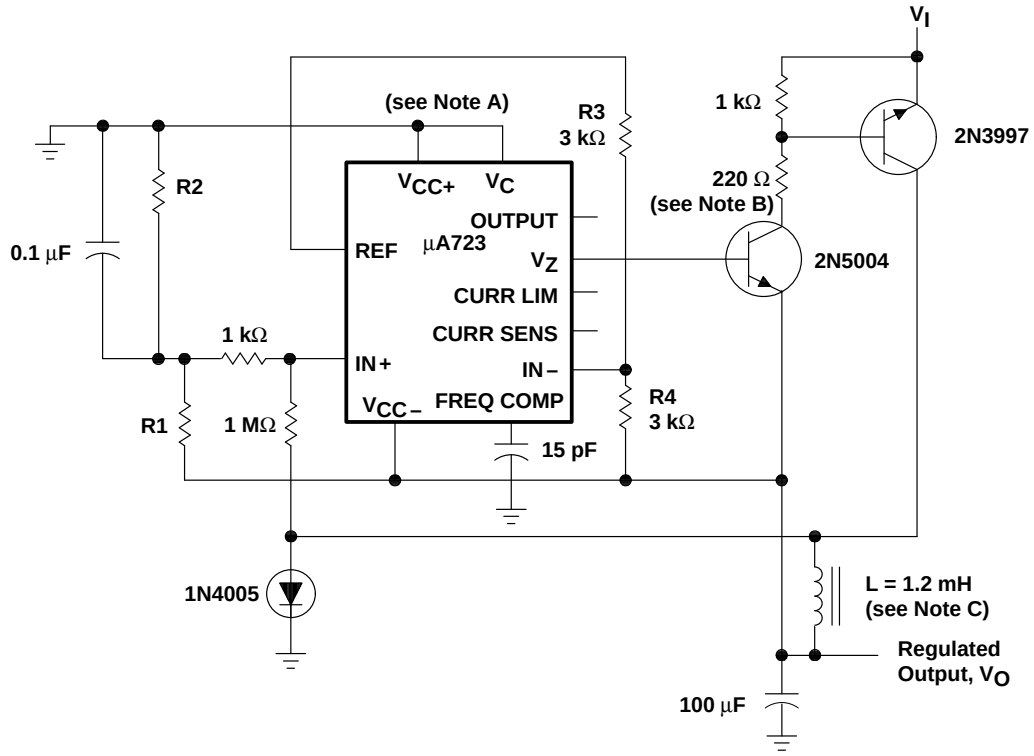
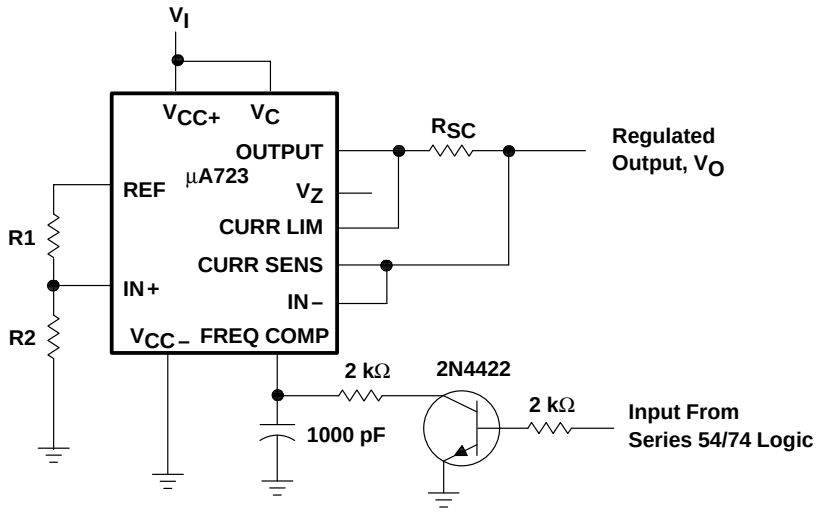



**Figure 10. Negative Switching Regulator**

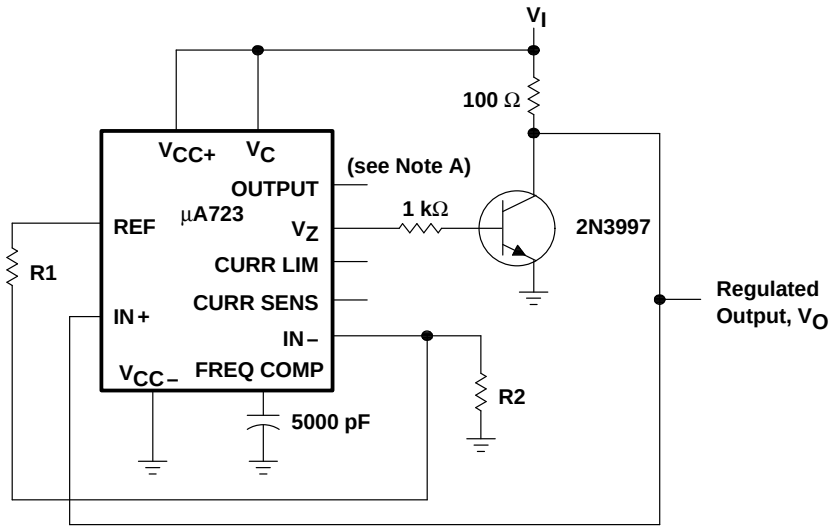
NOTES: A. The device requires a minimum of 9 V between $V_{CC+}$ and $V_{CC-}$ when $V_O$ is equal to or more positive than –9 V.
B. When 10-lead μA723U devices are used in applications requiring $V_Z$, an external 6.2-V regulator diode must be connected in series with OUTPUT.
C. L is 40 turns of No. 20 enameled copper wire wound on Ferroxcube P36/22-3B7 potted core or equivalent, with a 0.009-inch air gap.

## APPLICATION INFORMATION




NOTE A: A current-limit transistor may be used for shutdown if current limiting is not required.

**Figure 11. Remote Shutdown Regulator With Current Limiting**




NOTE A: When 10-lead μA723U devices are used in applications requiring $V_Z$, an external 6.2-V regulator diode must be connected in series with OUTPUT.

**Figure 12. Shunt Regulator**

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