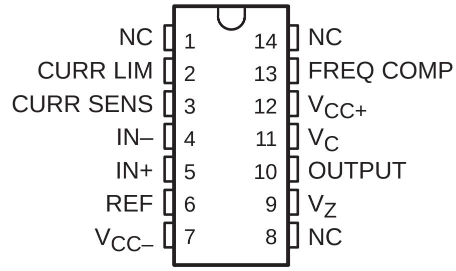
- **150-mA Load Current Without External Power Transistor**
- **Adjustable Current-Limiting Capability**
- **Input Voltages up to 40 V**
- **Output Adjustable From 2 V to 37 V**
- **Direct Replacement for Fairchild μA723C**

D OR N PACKAGE
(TOP VIEW)



description

The μA723 is a precision integrated-circuit voltage regulator, 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 μA723 is 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 can be connected as shown in Figures 4 and 5.

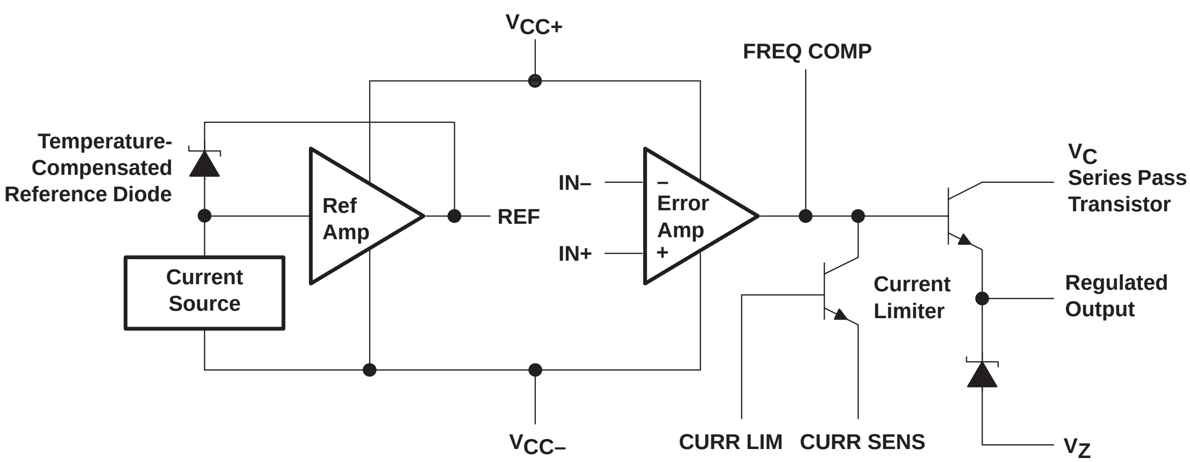
The μA723C is characterized for operation from 0°C to 70°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES		CHIP FORM (Y)
	PLASTIC DIP (N)	SMALL OUTLINE (D)	
0°C to 70°C	μA723CN	μA723CD	μA723Y

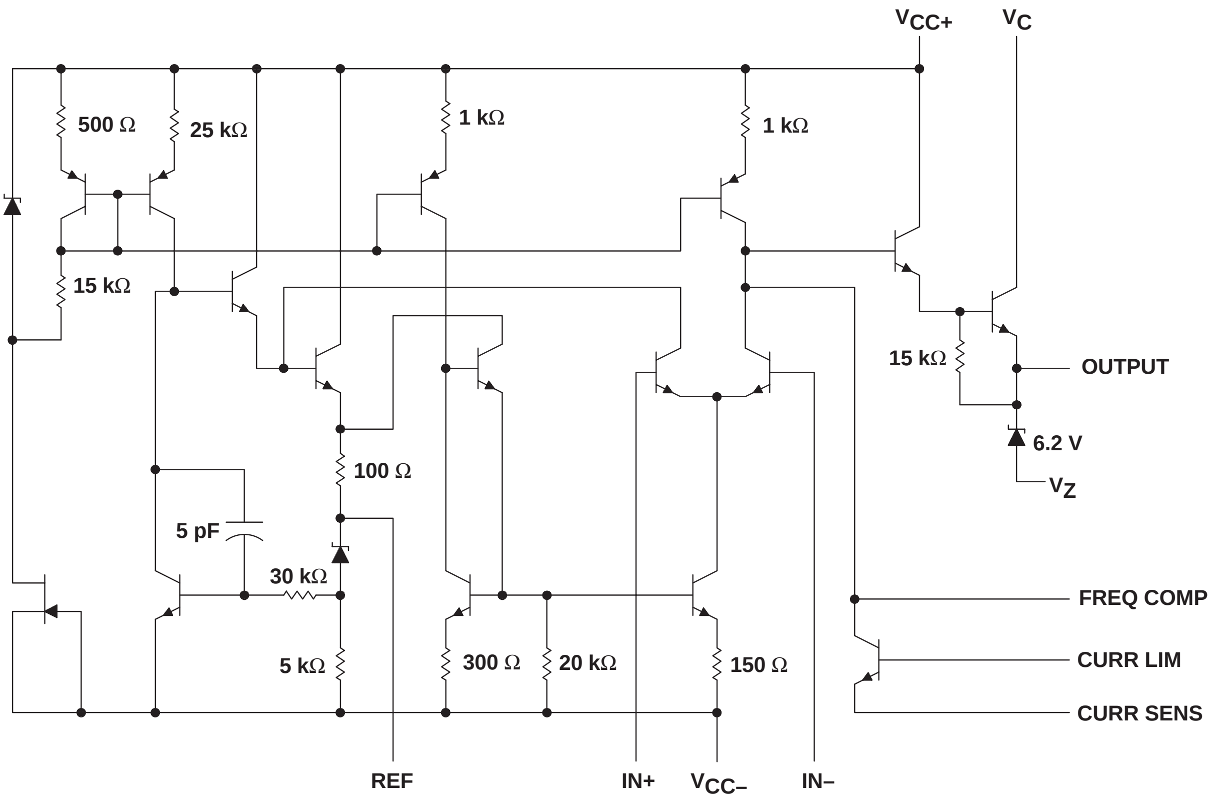
The D package is available taped and reeled. Add the suffix R to the device type (e.g., μA723CDR). Chip forms are tested at 25°C.

functional block diagram



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.

schematic



Resistor and capacitor values shown are nominal.

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
Package thermal impedance, θ_{JA} (see Notes 1 and 2): D package	86°C/W
N package	101°C/W
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or N package	260°C
Storage temperature range, T_{stg}	–65°C to 150°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.

NOTES: 1. Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can impact reliability.

2. The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace length of zero.

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
Operating free-air temperature range, T_A	μA723C	0	70	°C

electrical characteristics at specified free-air temperature (see Notes 3 and 4)

PARAMETER	TEST CONDITIONS		T_A	μA723C			UNIT
				MIN	TYP	MAX	
Input regulation	V_I = 12 V to V_I = 15 V		25°C		0.1	1	mV/V
	V_I = 12 V to V_I = 40 V		25°C		1	5	
	V_I = 12 V to V_I = 15 V		0°C to 70°C			3	
Ripple rejection	f = 50 Hz to 10 kHz,	C_{ref} = 0	25°C		74		dB
	f = 50 Hz to 10 kHz,	C_{ref} = 5 μF	25°C		86		
Output regulation			25°C		–0.3	–2	mV/V
			0°C to 70°C			–6	
Reference voltage, V_{ref}			25°C	6.8	7.15	7.5	V
Standby current	V_I = 30 V,	I_O = 0	25°C		2.3	4	mA
Temperature coefficient of output voltage			0°C to 70°C		0.003	0.015	%/°C
Short-circuit output current	R_{SC} = 10 Ω,	V_O = 0	25°C		65		mA
Output noise voltage	BW = 100 Hz to 10 kHz,	C_{ref} = 0	25°C		20		μV
	BW = 100 Hz to 10 kHz,	C_{ref} = 5 μF	25°C		2.5		

NOTES: 3. 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.
4. 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 3 and 4)

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

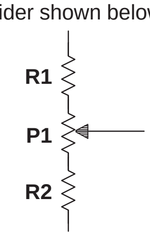
APPLICATION INFORMATION

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

OUTPUT VOLTAGE (V)	APPLICABLE FIGURES (SEE NOTE 5)	FIXED OUTPUT ±5%		OUTPUT ADJUSTABLE ±10% (SEE NOTE 6)		
		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 (see Note 7)	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: 5. The R1/R2 divider can 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.

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



Adjustable Output Circuit

7. 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.

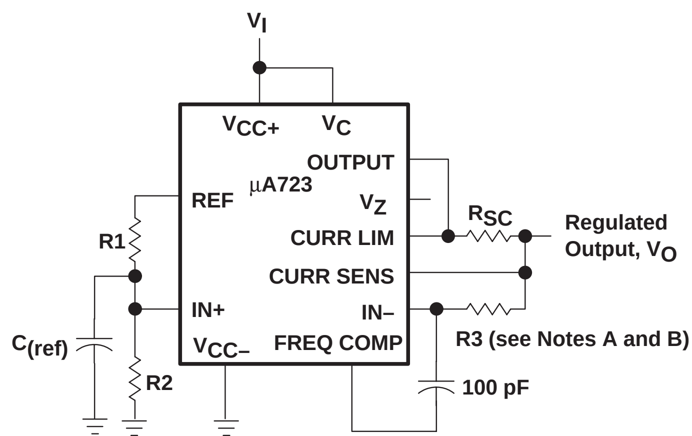
APPLICATION INFORMATION

Table 2. Formulas for Intermediate Output Voltages

OUTPUTS FROM 2 V TO 7 V SEE FIGURES 1, 5, 6, 9, 11, 12 (4) AND NOTE 5	OUTPUTS FROM 4 V TO 250 V SEE FIGURE 7 AND NOTE 5	CURRENT LIMITING
$V_O = V_{(ref)} \times \frac{R2}{R1 + R2}$	$V_O = \frac{V_{(ref)}}{2} \times \frac{R2 - R1}{R1}$ $R3 = R4$	$I_{(limit)} \approx \frac{0.65\ V}{R_{SC}}$
OUTPUTS FROM 7 V TO 37 V SEE FIGURES 2, 4, (5, 6, 9, 11, 12) AND NOTE 5	**OUTPUTS FROM –6 V TO –250 V SEE FIGURES 3, 8, 10 AND NOTES 5 AND 7**	**FOLDBACK CURRENT LIMITING SEE FIGURE 6**
$V_O = V_{(ref)} \times \frac{R1 + R2}{R2}$	$V_O = -\frac{V_{(ref)}}{2} \times \frac{R1 + R2}{R1}$ $R3 = R4$	$I_{(knee)} \approx \frac{V_O R3 + (R3 + R4)\ 0.65\ V}{R_{SC} R4}$ $I_{OS} \approx \frac{0.65\ V}{R_{SC}} \times \frac{R3 + R4}{R4}$

NOTES: 5. The R1/R2 divider can 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.

7. 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.

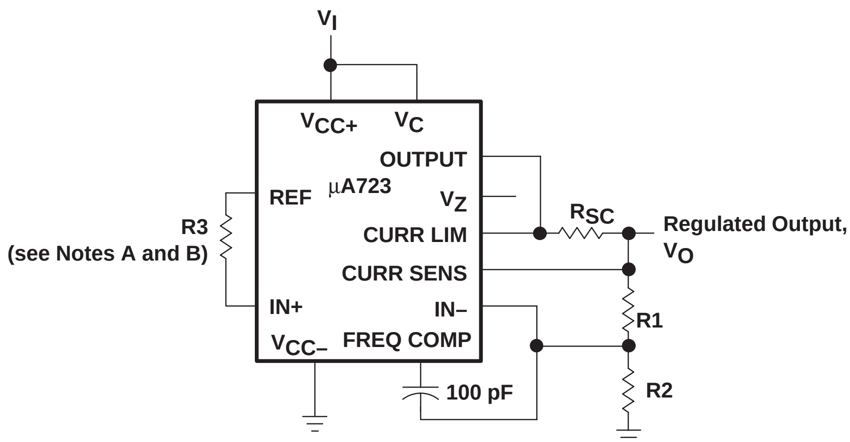


NOTES: A. $R3 = \frac{R1 \times R2}{R1 + R2}$ for a minimum α_{V_O}

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

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

APPLICATION INFORMATION



NOTES: A. $R3 = \frac{R1 \times R2}{R1 + R2}$ for a minimum α_{V_O}

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

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

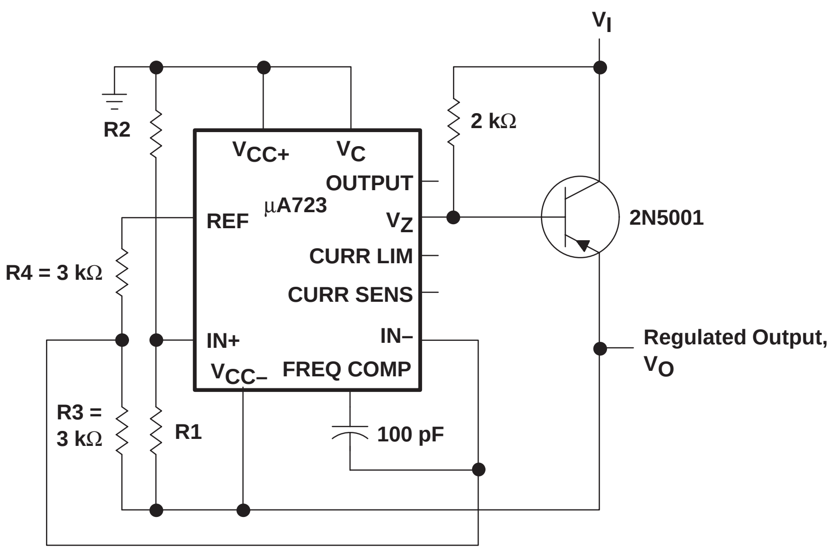


Figure 3. Negative-Voltage Regulator

APPLICATION INFORMATION

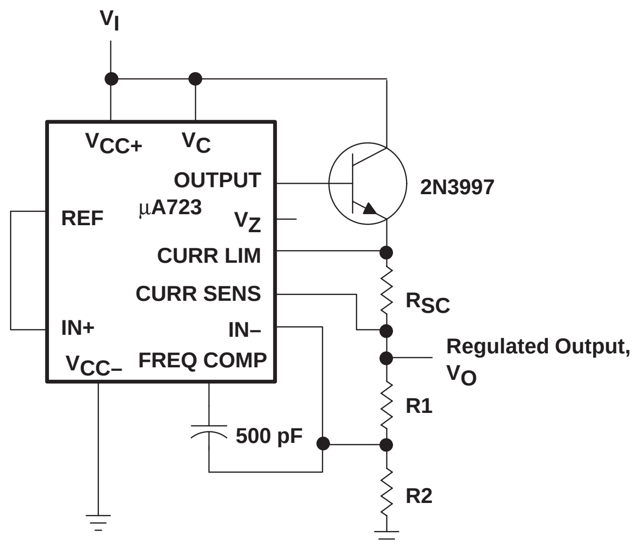


Figure 4. Positive-Voltage Regulator (External npn Pass Transistor)

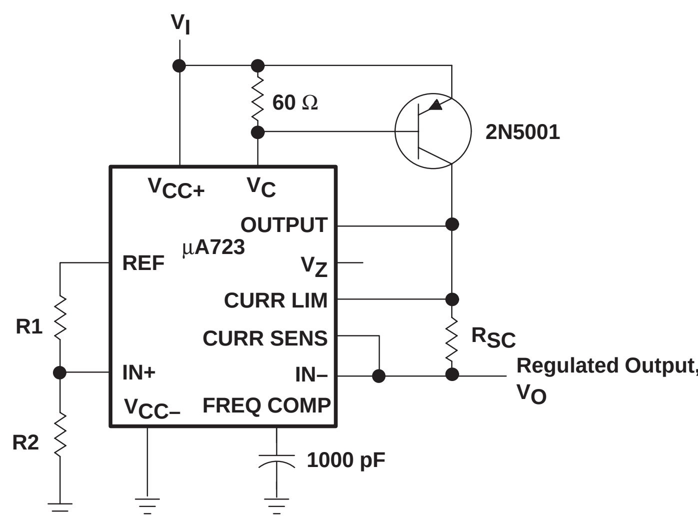


Figure 5. Positive-Voltage Regulator (External pnp Pass Transistor)

APPLICATION INFORMATION

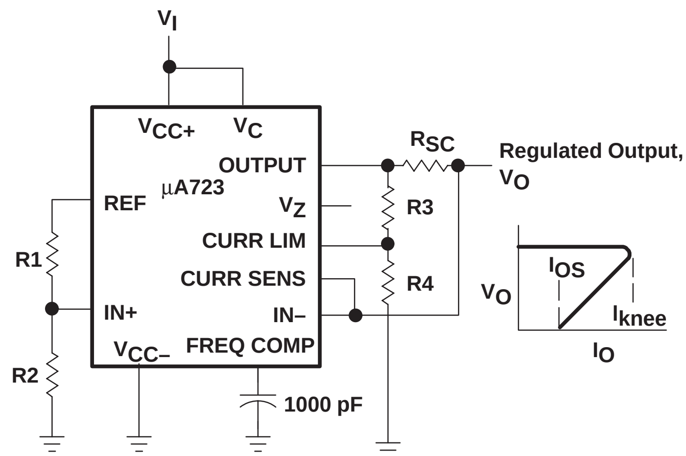


Figure 6. Foldback Current Limiting

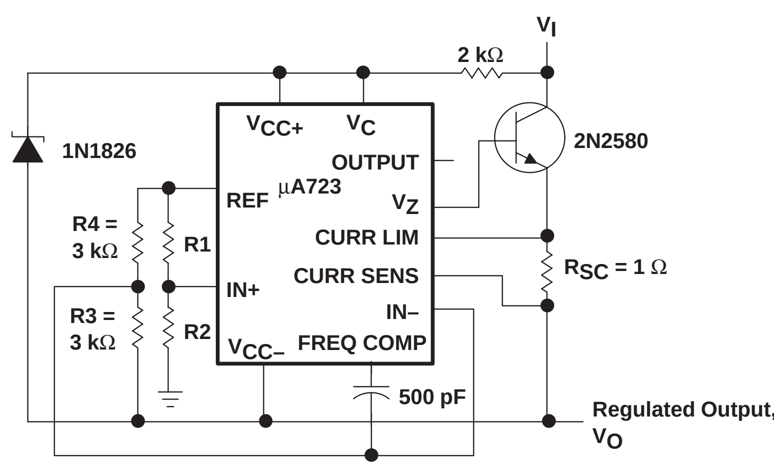


Figure 7. Positive Floating Regulator

APPLICATION INFORMATION

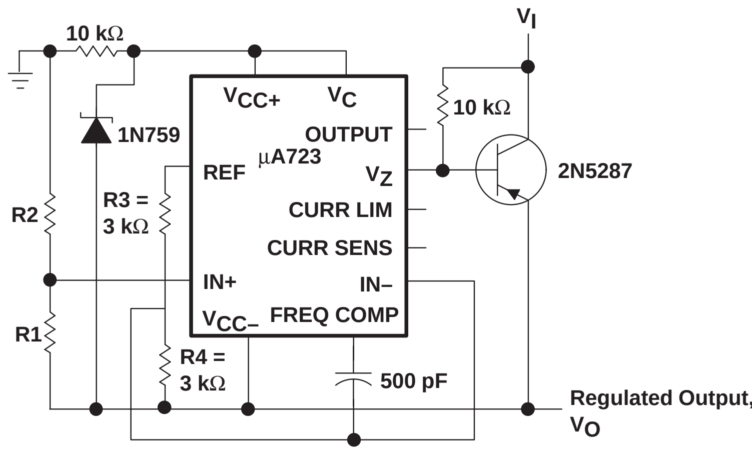
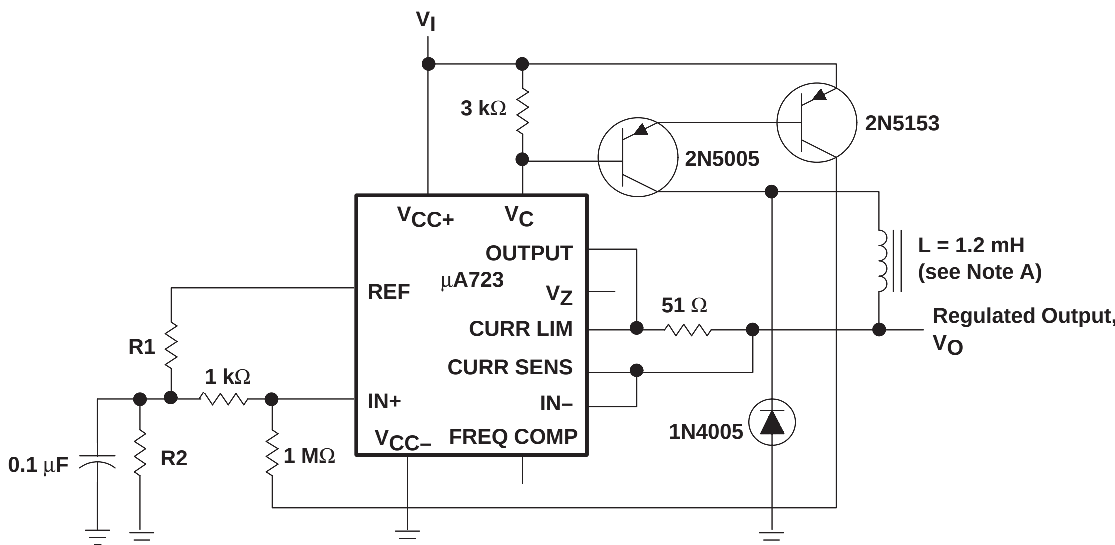


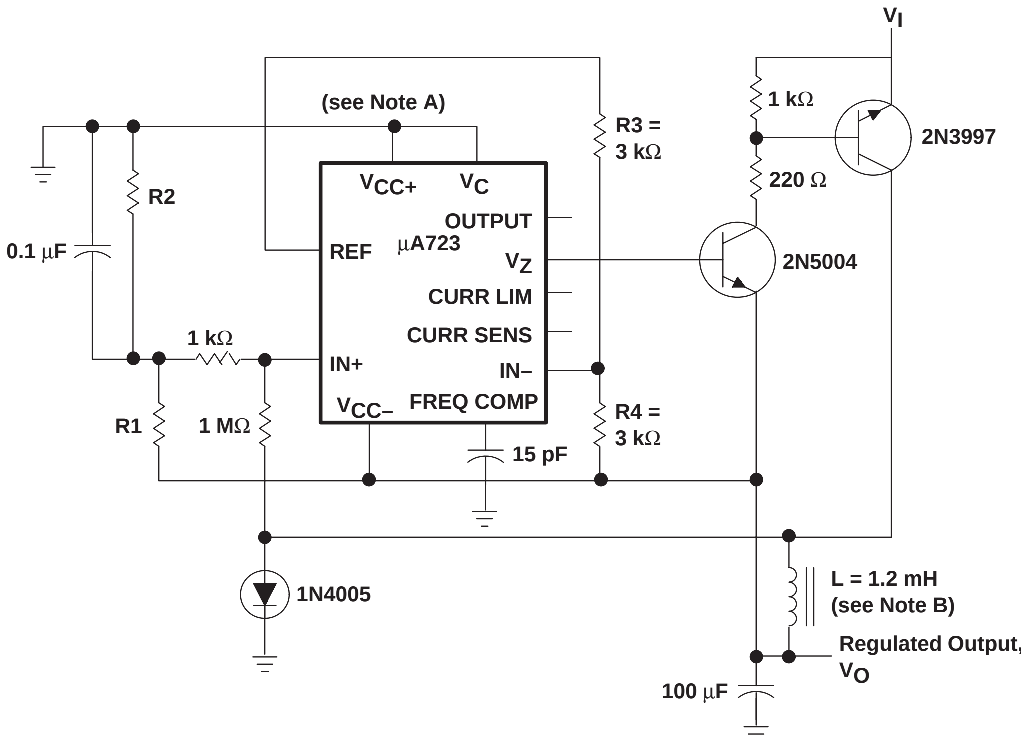
Figure 8. Negative Floating Regulator



NOTE A: 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.

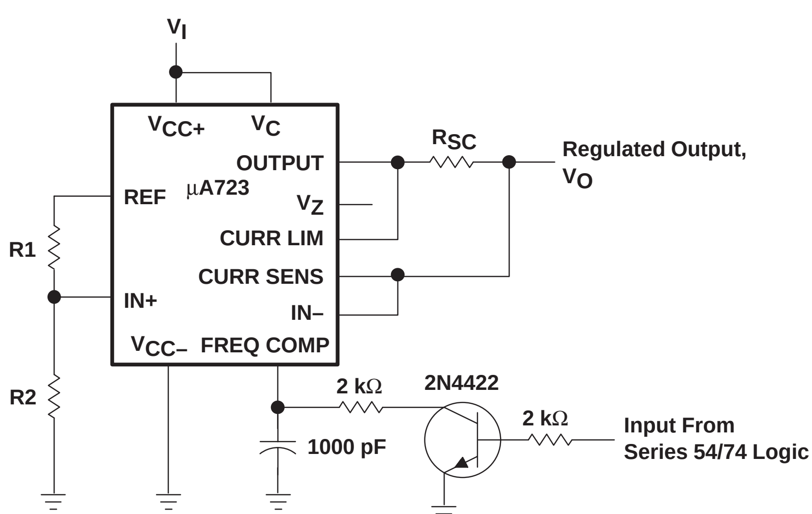
Figure 9. Positive Switching Regulator

APPLICATION INFORMATION



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. 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.

Figure 10. Negative Switching Regulator



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

Figure 11. Remote Shutdown Regulator With Current Limiting

APPLICATION INFORMATION

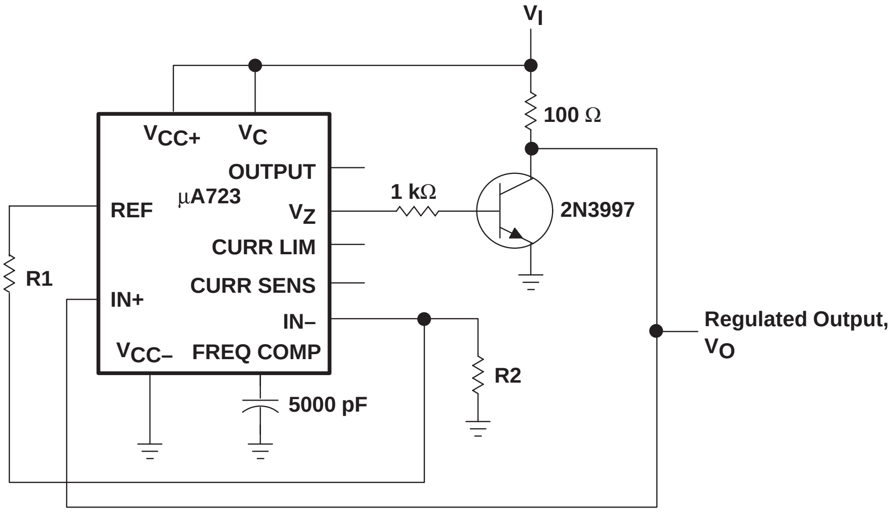


Figure 12. Shunt Regulator