Voltage Regulators

LM723/LM723C voltage regulator

general description

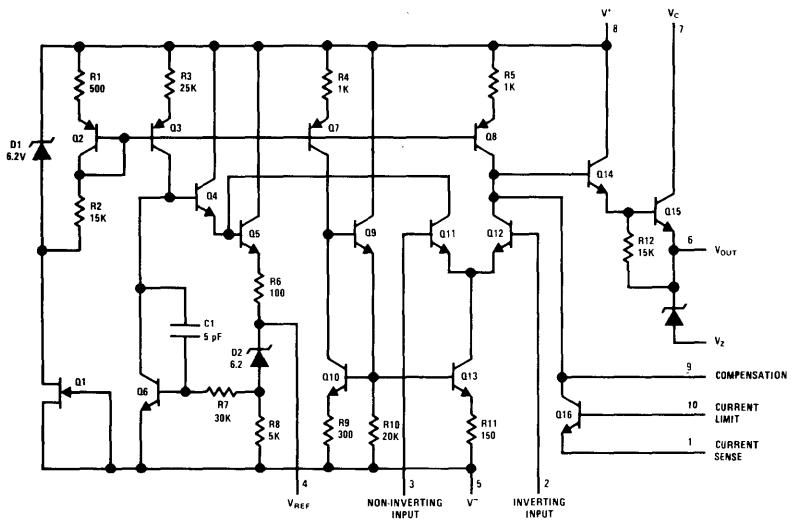
The LM723/LM723C is a voltage regulator designed primarily for series regulator applications. By itself, it will supply output currents up to 150 mA; but external transistors can be added to provide any desired load current. The circuit features extremely low standby current drain, and provision is made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

- 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.

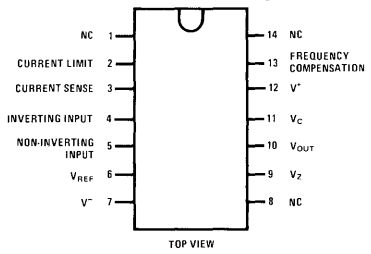
The LM723/LM723C is also useful in a wide range of other applications such as a shunt regulator, a current regulator or a temperature controller.

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

schematic and connection diagrams *



Dual-In-Line Package

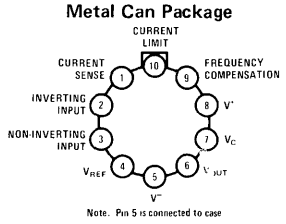


TOP VIEW

Order Number LM723D or LM723CD
See Package 1

Order Number LM723N or LM723CN
See Package 22

Metal Can Package

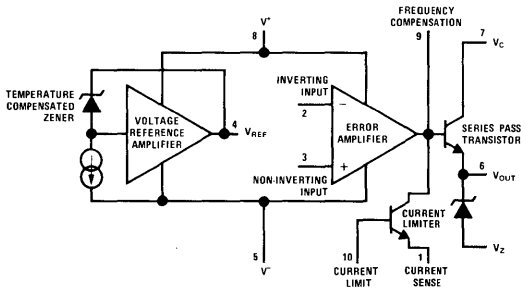


Note. Pin 5 is connected to case

TOP VIEW

Order Number LM723H or LM723CH
See Package 13

equivalent circuit *



* Pin numbers for metal can package only.
Note 7

absolute maximum ratings

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)	7.5V
Maximum Amplifier Input Voltage (Differential)	5V
Current from V_Z	25 mA
Current from V_{REF}	15 mA
Internal Power Dissipation Metal Can (Note 1)	800 mW
Cavity DIP (Note 1)	900 mW
Molded DIP (Note 1)	660 mW
Operating Temperature Range LM723	$-55^\circ C$ to $+125^\circ C$
LM723C	$0^\circ C$ to $+70^\circ C$
Storage Temperature Range Metal Can	$-65^\circ C$ to $+150^\circ C$
DIP	$-55^\circ C$ to $+125^\circ C$
Lead Temperature (Soldering, 10 sec)	$300^\circ C$

electrical characteristics (Note 2)

PARAMETER	CONDITIONS	LM723			LM723C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Line Regulation	V_{IN} = 12V to V_{IN} = 15V		.01	0.1		.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		.02	0.2		0.1	0.5	% V_{OUT}
Load Regulation	I_L = 1 mA to I_L = 50 mA		.03	0.15		.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
Average Temperature Coefficient of Output Voltage	$-55^\circ C \leq T_A \leq +125^\circ C$		.002	.015				%/°C
	$0^\circ C \leq T_A \leq +70^\circ C$					.003	.015	%/°C
Short Circuit Current Limit	R_{SC} = 10Ω, 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		20			20		μVrms
	BW = 100 Hz to 10 kHz, C_{REF} = 5 μF		2.5			2.5		μVrms
Long Term Stability			0.1			0.1		%/1000 hrs
Standby Current Drain	I_L = 0, V_{IN} = 30V		1.3	3.5		1.3	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

Note 1: See derating curves for maximum power rating above 25°C.

Note 2: Unless otherwise specified, T_A = 25°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 1. 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.

Note 3: 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.

Note 4: Figures in parentheses may be used if R1/R2 divider is placed on opposite input of error amp.

Note 5: Replace R1/R2 in figures with divider shown in Figure 13.

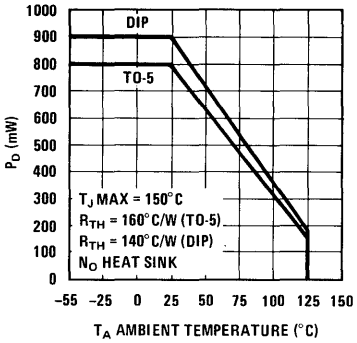
Note 6: V^+ must be connected to a +3V or greater supply.

Note 7: For metal can applications where V_Z is required, an external 6.2 volt zener diode should be connected in series with V_{OUT}.

maximum power ratings

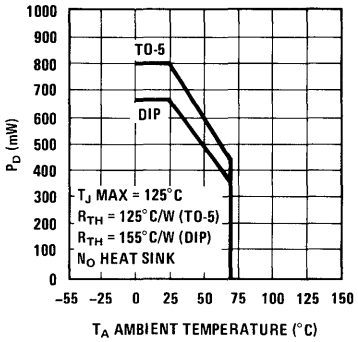
LM723

Power Dissipation vs Ambient Temperature



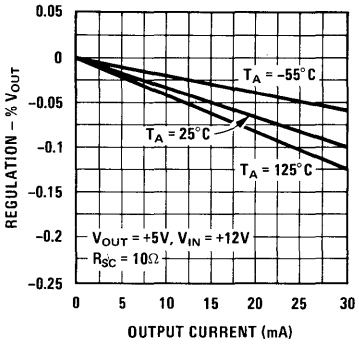
LM723C

Power Dissipation vs Ambient Temperature

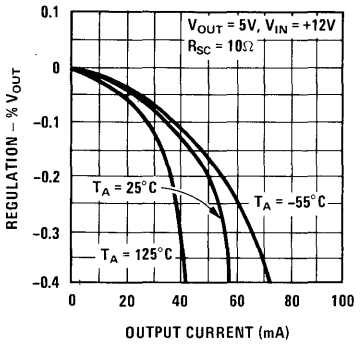


typical performance characteristics

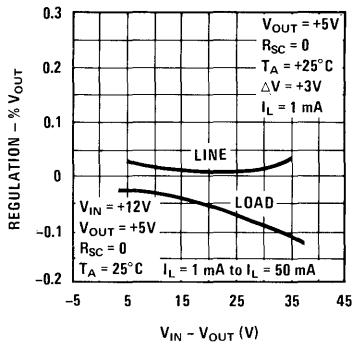
Load Regulation Characteristics with Current Limiting



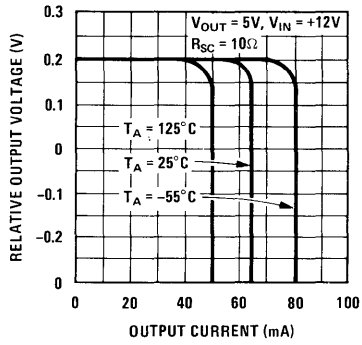
Load Regulation Characteristics with Current Limiting



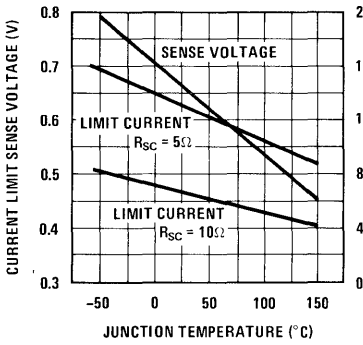
Load & Line Regulation vs Input-Output Voltage Differential



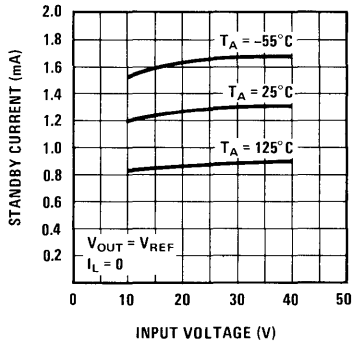
Current Limiting Characteristics



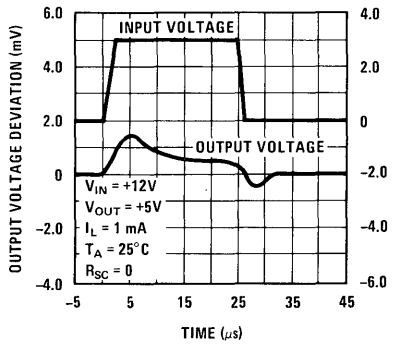
Current Limiting Characteristics vs Junction Temperature



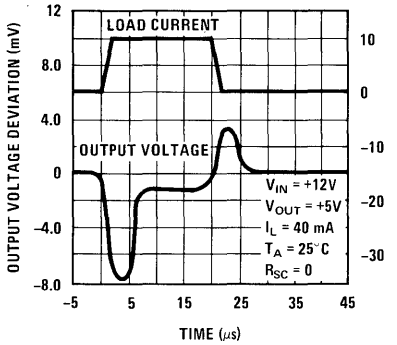
Standby Current Drain vs Input Voltage



Line Transient Response



Load Transient Response



Output Impedance vs Frequency

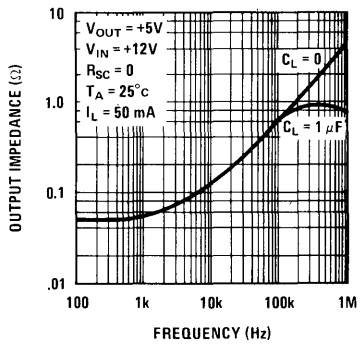


TABLE I RESISTOR VALUES (kΩ) FOR STANDARD OUTPUT VOLTAGE

POSITIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		OUTPUT ADJUSTABLE ±10% (Note 5)			NEGATIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		5% OUTPUT ADJUSTABLE ±10%		
	(Note 4)	R1	R2	R1	P1	R2			R1	R2	R1	P1	R2
+3.0	1, 5, 6, 9, 12 (4)	4.12	3.01	1.8	0.5	1.2	+100	7	3.57	102	2.2	10	91
+3.6	1, 5, 6, 9, 12 (4)	3.57	3.65	1.5	0.5	1.5	+250	7	3.57	255	2.2	10	240
+5.0	1, 5, 6, 9, 12 (4)	2.15	4.99	.75	0.5	2.2	-6 (Note 6)	3, (10)	3.57	2.43	1.2	0.5	.75
+6.0	1, 5, 6, 9, 12 (4)	1.15	6.04	0.5	0.5	2.7	-9	3, 10	3.48	5.36	1.2	0.5	2.0
+9.0	2, 4, (5, 6, 12, 9)	1.87	7.15	.75	1.0	2.7	-12	3, 10	3.57	8.45	1.2	0.5	3.3
+12	2, 4, (5, 6, 9, 12)	4.87	7.15	2.0	1.0	3.0	-15	3, 10	3.65	11.5	1.2	0.5	4.3
+15	2, 4, (5, 6, 9, 12)	7.87	7.15	3.3	1.0	3.0	-28	3, 10	3.57	24.3	1.2	0.5	10
+28	2, 4, (5, 6, 9, 12)	21.0	7.15	5.6	1.0	2.0	-45	8	3.57	41.2	2.2	10	33
+45	7	3.57	48.7	2.2	10	39	-100	8	3.57	97.6	2.2	10	91
+75	7	3.57	78.7	2.2	10	68	-250	8	3.57	249	2.2	10	240

TABLE II FORMULAE FOR INTERMEDIATE OUTPUT VOLTAGES

Outputs from +2 to +7 volts
[Figures 1, 5, 6, 9, 12, (4)]

$$V_{OUT} = [V_{REF} \times \frac{R2}{R1 + R2}]$$

Outputs from +4 to +250 volts
[Figure 7]

$$V_{OUT} = [\frac{V_{REF}}{2} \times \frac{R2 - R1}{R1}]\ ;\ R3 = R4$$

Current Limiting

$$I_{LIMIT} = \frac{V_{SENSE}}{R_{SC}}$$

Outputs from +7 to +37 volts
[Figures 2, 4, (5, 6, 9, 12)]

$$V_{OUT} = [V_{REF} \times \frac{R1 + R2}{R2}]$$

Outputs from -6 to -250 volts
[Figures 3, 8, 10]

$$V_{OUT} = [\frac{V_{REF}}{2} \times \frac{R1 + R2}{R1}]\ ;\ R3 = R4$$

Foldback Current Limiting

$$I_{KNEE} = [\frac{V_{OUT}\ R3}{R_{SC}\ R4} + \frac{V_{SENSE}\ (R3 + R4)}{R_{SC}\ R4}]$$

$$I_{SHORT\ CKT} = [\frac{V_{SENSE}}{R_{SC}} \times \frac{R3 + R4}{R4}]$$

typical applications

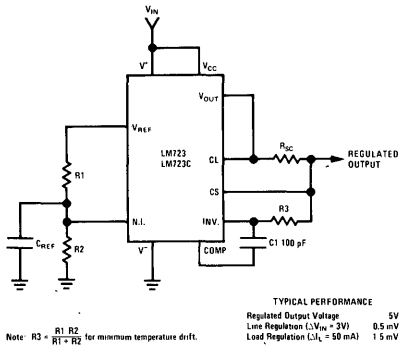


FIGURE 1. Basic Low Voltage Regulator (V_{OUT} = 2 to 7 Volts)

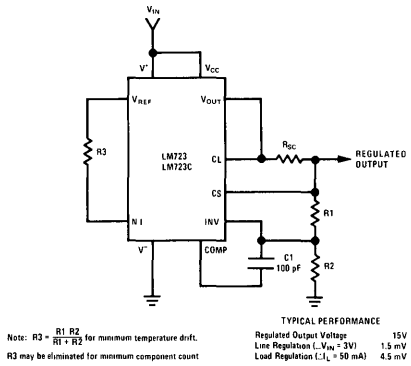


FIGURE 2. Basic High Voltage Regulator (V_{OUT} = 7 to 37 Volts)

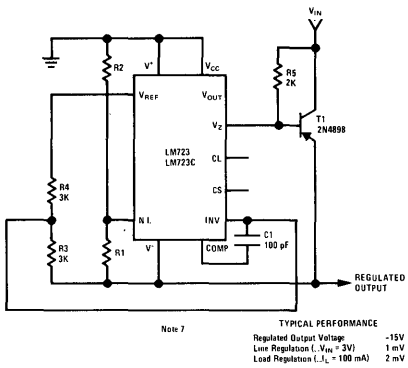


FIGURE 3. Negative Voltage Regulator

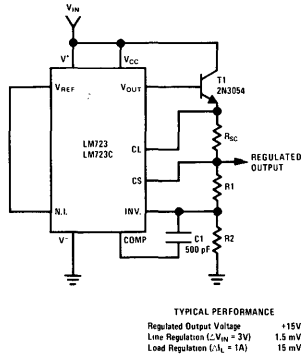


FIGURE 4. Positive Voltage Regulator (External NPN Pass Transistor)

typical applications (con't.)

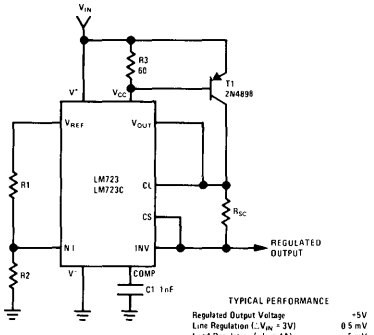


FIGURE 5. Positive Voltage Regulator (External PNP Pass Transistor)

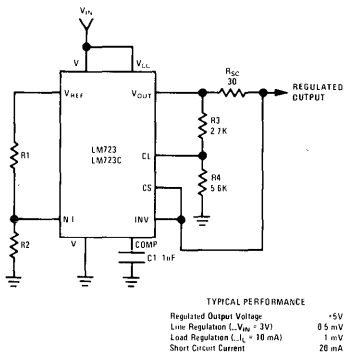


FIGURE 6. Foldback Current Limiting

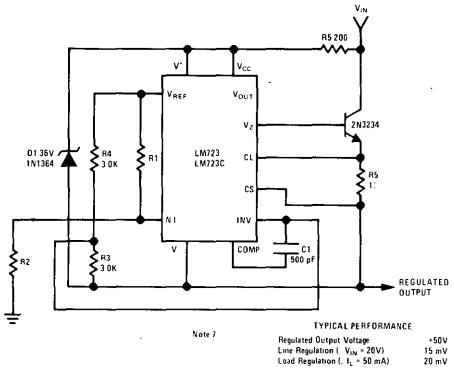


FIGURE 7. Positive Floating Regulator

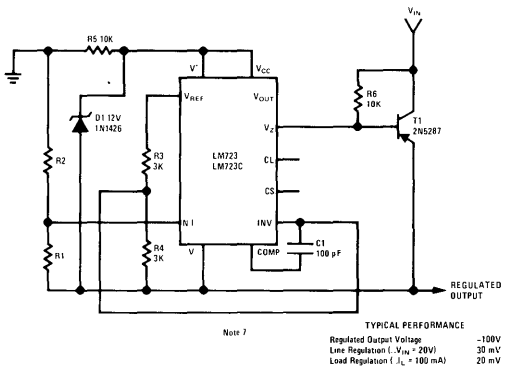


FIGURE 8. Negative Floating Regulator

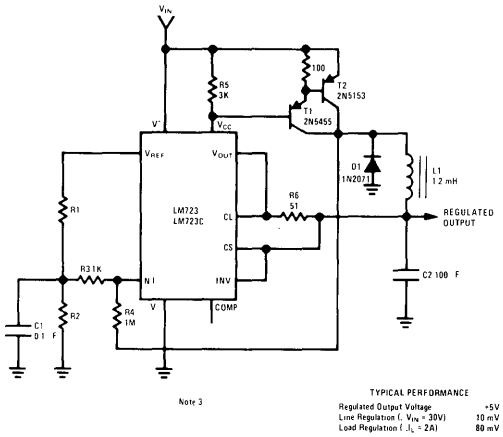


FIGURE 9. Positive Switching Regulator

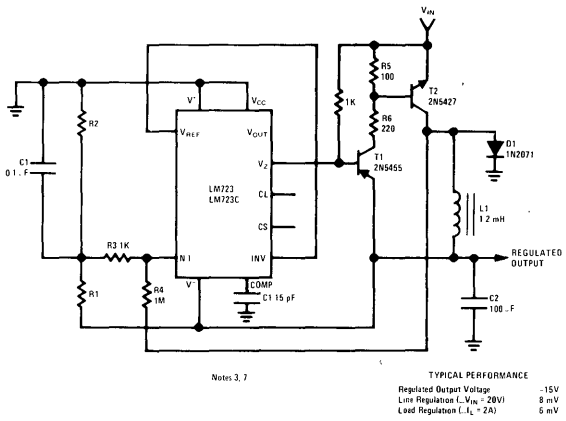


FIGURE 10. Negative Switching Regulator

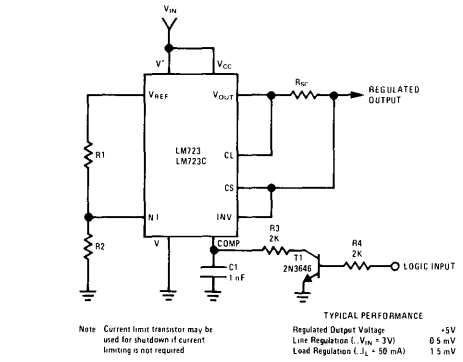


FIGURE 11. Remote Shutdown Regulator with Current Limiting

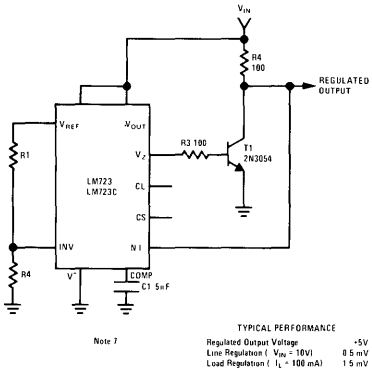


FIGURE 12. Shunt Regulator