

High precision voltage regulator

Features

- Input voltage up to 40 V
- Output voltage adjustable from 2 to 37 V
- Positive or negative supply operation
- Series, shunt, switching or floating operation
- Output current to 150 mA without external pass transistor
- Adjustable current limiting



The LM723 is a monolithic integrated programmable voltage regulator, assembled in 14-lead dual in-line plastic package. The circuit provides internal current limiting. When the output current exceeds 150 mA an external NPN or PNP pass element may be used. Provisions are made for adjustable current limiting and remote shutdown.

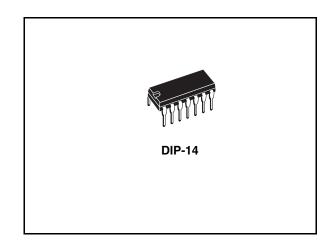


Table 1. Device summary

Order code	Package
LM723N	DIP-14
LM723CN	DIP-14

Contents LM723

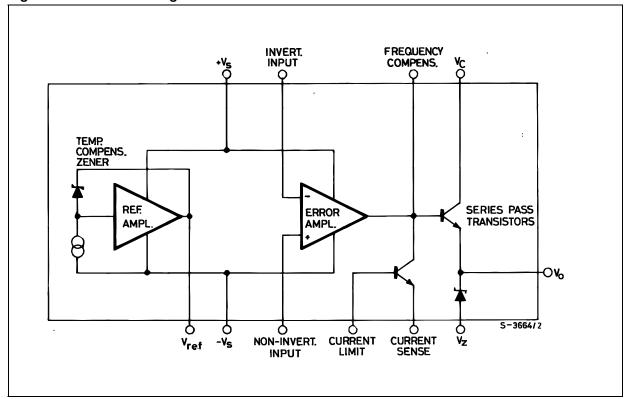
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LM723 Diagram

1 Diagram

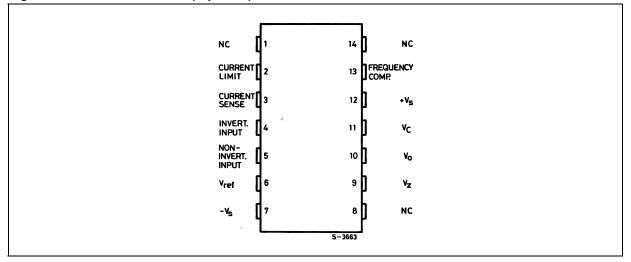
Figure 1. Schematic diagram



Pin configuration LM723

2 Pin configuration

Figure 2. Pin connections (top view)



LM723 Maximum ratings

3 Maximum ratings

Table 2. Absolute maximum ratings

Cumbal	Parameter	Value		
Symbol	Parameter	LM723	LM723C	- Unit
VI	DC input voltage	40	40	V
ΔV_{I-O}	Dropout voltage	40	40	V
I _O	Output current	150	150	mA
I _{REF}	Current from V _{REF}	15	25	mA
T _{OP}	Operating Temperature	-55 to 125	0 to 70	°C
T _{STG}	Storage Temperature	-65 to 150	-65 to 150	°C
T _J	Junction Temperature	150	125	°C

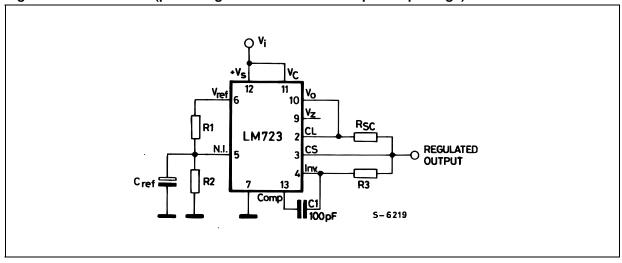
Table 3. Thermal data

Symbol	Parameter	DIP14	Unit
R _{thJA}	Thermal resistance junction-ambient Max	200	°C/W

Circuit LM723

4 Circuit

Figure 3. Test circuit (pin configuration relative to the plastic package)



Note: $V_{I} = 12 \ V; \ V_{O} = 5 \ V; \ I_{O} = 1 \ mA; \ R_{1}/R_{2} \le 10 \ k\Omega$

5 Electrical characteristics

Table 4. Electrical characteristics for LM723 (refer to the test circuits, $T_A = 25$ °C, unless otherwise specified.)

Symbol	Parameter	Test conditions		Min.	Тур.	Max.	Unit	
		V _I = 12 to 15 V	V _I = 12 to 15 V		0.01	0.1		
$\Delta V_O/\Delta V_I$	Line regulation	V _I = 12 to 40 V			0.02	0.2	%	
		$V_I = 12 \text{ to } 15 \text{ V}, T_A = -55 \text{ to}$	125°C			0.3		
A) / A /	l and requilation	I _O = 1 to 50 mA			0.03	0.15	0/	
$\Delta V_{O}/V_{O}$	Load regulation	$I_O = 1$ to 10 mA, $T_A = -55$ t	o 125°C			0.6	%	
V _{REF}	Reference voltage	I _{REF} = 160 μA		6.95	7.15	7.35	V	
OVE	Supply voltage rejection	0	C _{REF} = 0		74		- dB	
SVR		T = 100 HZ to TUKHZ	C _{REF} = 5µF		86			
$\Delta V_{O}/\Delta T$	Output voltage drift		-			150	ppm/°C	
I _{SC}	Output current limit	$R_{SC} = 10\Omega$, $V_O = 0 V$	$R_{SC} = 10\Omega, \ V_O = 0 \text{ V}$		65		mA	
VI	Input voltage range			9.5		40	V	
Vo	Output voltage range			2		37	V	
V_O-V_I				3		38	V	
I _d	Quiescent current	V _I = 30V, I _O = 0 mA			2.3	5	mA	
K _{VH}	Long term stability				0.1		%/1000 hrs	
oN	eN Output noise voltage BW = 100 Hz to 10 kHz	DW = 100 Hz to 10 kHz	C _{REF} = 0		20		\/	
eiv		$C_{REF} = 5$			2.5		μV	

Electrical characteristics LM723

Table 5. Electrical characteristics for LM723C (refer to the test circuits, $T_A = 25$ °C, unless otherwise specified.)

Symbol	Parameter	Test conditio	Min.	Тур.	Max.	Unit		
		V _I = 12 to 15 V	V _I = 12 to 15 V		0.01	0.1		
$\Delta V_{O}/\Delta V_{I}$	Line regulation	V _I = 12 to 40 V			0.1	0.5	%	
		$V_I = 12 \text{ to } 15 \text{ V}, T_A = 0 \text{ to } 7$	O°C			0.3		
A)/ //	Load regulation	I _O = 1 to 50 mA			0.03	0.2	%	
$\Delta V_{O}/V_{O}$	Load regulation	$I_O = 1$ to 10 mA, $T_A = 0$ to	70°C			0.6	%	
V _{REF}	Reference voltage	I _{REF} = 160 μA		6.8	7.15	7.5	V	
C) / D	SVR Supply voltage rejection	County welfare rejection f 100 Hz to 10 Hz	C _{REF} = 0		74		-ID	
SVH		C _{REF} = 5μI			86		dB	
$\Delta V_O/\Delta T$	Output voltage drift					150	ppm/°C	
I _{SC}	Output current limit	$R_{SC} = 10\Omega$, $V_O = 0$ V	$R_{SC} = 10\Omega, \ V_O = 0 \ V$		65		mA	
V _I	Input voltage range			9.5		40	V	
Vo	Output voltage range			2		37	V	
V _O -V _I				3		38	V	
I _d	Quiescent current	V _I = 30V, I _O = 0 mA			2.3	4	mA	
K _{VH}	Long term stability				0.1		%/1000 hrs	
eN	Output raise valters DW 400 Lists 40 ld is		C _{REF} = 0		20		\/	
en	Output noise voltage	BW = 100 Hz to 10 kHz $\frac{112}{C_{REF}} = 5\mu F$			2.5		μV	

80 I_o(mA)

Typical performance characteristics 6

(unless otherwise specified $V_{O(NOM)} = 3.3 \text{ V}$)

Maximum output current vs voltage Figure 5. Figure 4. **Current limiting characteristics** drop

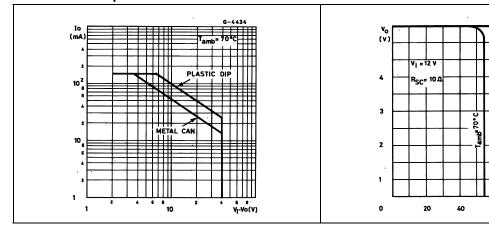


Figure 6. Current limiting characteristics vs Figure 7. Load regulation characteristics without current limiting junction temperature

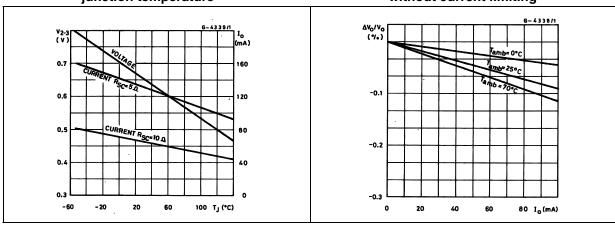
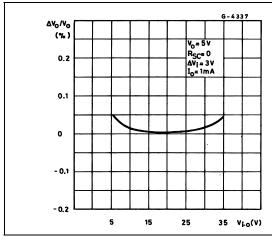


Figure 8. Load regulation characteristics

with current limiting with current limiting ΔV₀(%) 0 -0.0 -0.1 -0.1 -0.2 -0.2 -0.3 -0:25 25 l_o(mA) 20 40 60 80 lo(mA)

Figure 10. Line regulation vs voltage drop

Figure 11. Load regulation vs voltage drop



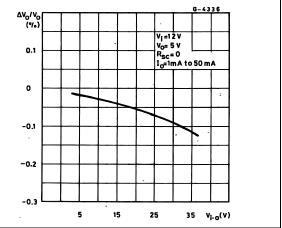
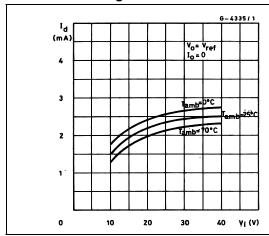


Figure 12. Quiescent drain current vs input voltage

Figure 13. Line transient response



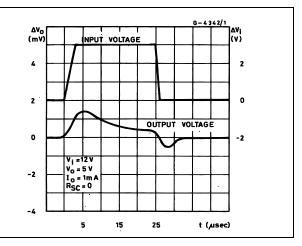
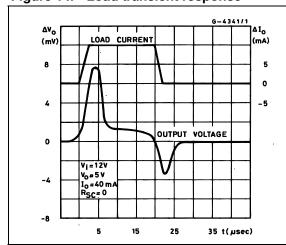


Figure 14. Load transient response

Figure 15. Output impedance vs frequency



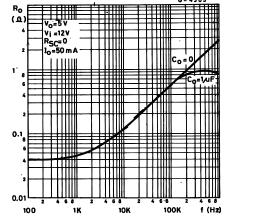


Table 6. Resistor values ($k\Omega$) for standard output voltages

Output	A	Fixed ou	ıtput ± 5%	Outpu	t adjustable ±	10% ⁽¹⁾
Voltage	Applicable figures	R1	R2	R1	P1	R2
+3	16, 18, 20, 21, 24, 26	4.12	3.01	1.8	0.5	1.2
+5	16, 18, 20, 21, 24, 26	2.15	4.99	0.75	0.5	2.2
+6	16, 18, 20, 21, 24, 26	1.15	6.04	0.5	0.5	2.7
+9	17, 18, 20, 21, 24, 26	1.87	7.15	0.75	1	2.7
+12	17, 18, 20, 21, 24, 26	4.87	7.15	2	1	3
+15	17, 18, 20, 21, 24, 26	7.87	7.15	3.3	1	3
+28	17, 18, 20, 21, 24, 26	21	7.15	5.6	1	2
+45	22	3.57	48.7	2.2	10	39
+75	22	3.57	78.7	2.2	10	68
+100	22	3.57	102	2.2	10	91
+250	22	3.57	255	2.2	10	240
-6 ⁽²⁾	18	3.57	2.43	1.2	0.5	0.75
-9	18	3.48	5.36	1.2	0.5	2
-12	18	3.57	8.45	1.2	0.5	3.3
-15	18	3.65	11.5	1.2	0.5	4.3
-28	18	3.57	24.3	1.2	0.5	10
-45	23	3.57	21.2	2.2	10	33
-100	23	3.57	97.6	2.2	10	91
-250	23	3.57	249	2.2	10	240

^{1.} Replace R1/R2 divider with the circuit of *Figure 27*.

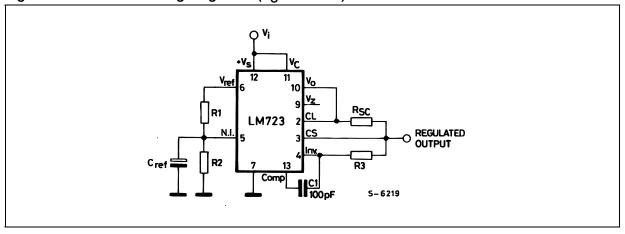
Table 7. Formula for intermediate output voltages

	Conditions	
Outputs from 2 to 7V Figure 16, 19, 20, 21, 24, 26 V _O =(V _{REF} xR ₂)/(R ₁ +R ₂)	Outputs from 4 to 250V	Current Limit I _{LIMIT} =V _{SENSE} /R _{SC}
Outputs from 7 to 37V Figure 17, 19, 20, 21, 24, 26 V _O =V _{REF} x[(R ₁ +R ₂)/R ₂]	Outputs from -6 to -250V Figure 18, Figure 23 $V_O=(V_{REF}/2)x[(R_1+R_2)/R_1] ;$ $R_3=R_4$	$\label{eq:loss_loss} \begin{split} & \text{Foldback Current Limiting} \\ I_{\text{KNEE}} &= [\ (V_{\text{O}} \text{xR}_3) / (R_{\text{SC}} \text{xR}_4)] \ \text{x}[\ V_{\text{SENSE}} \text{x}(R_3 + R_4)] \\ & \ / \ (R_{\text{SC}} \text{xR}_4) \\ I_{\text{SHORTCKT}} &= (V_{\text{SENSE}} / R_{\text{SC}}) \text{x}[\ (R_3 + R_4) / R_4] \end{split}$

^{2.} V+ must be connected to a +3 V or greater supply.

7 Applications information

Figure 16. Basic low voltage regulator $(V_0 = 2 \text{ to } 7 \text{ V})$



Note: $R_3 = (R_1 x R_2)/(R_1 + R_2)$ for minimum temperature drift.

R₃ may be eliminated for minimum component count.

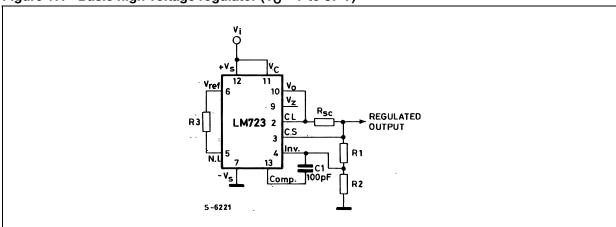
Typical performance

Regulated output voltage......5 V

Line regulation ($\Delta V_I = 3 V$)......0.5 mV

Load regulation ($\Delta I_O = 50 \text{ mA}$)...1.5 mV

Figure 17. Basic high voltage regulator ($V_0 = 7$ to 37 V)



Note: $R_3 = (R_1 x R_2)/(R_1 + R_2)$ for minimum temperature drift.

R₃ may be eliminated for minimum component count.

Typical performance

Regulated output voltage......15 V

Line regulation ($\Delta V_1 = 3 V$)...............1.5 mV

Load regulation ($\Delta I_O = 50 \text{ mA}$)....4.5 mV

Figure 18. Negative voltage regulator

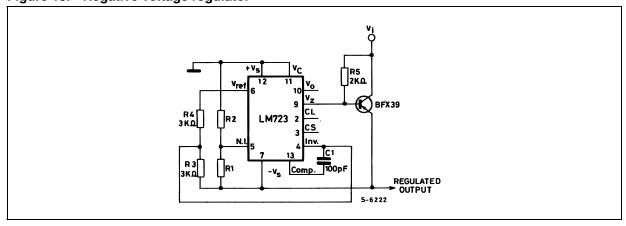
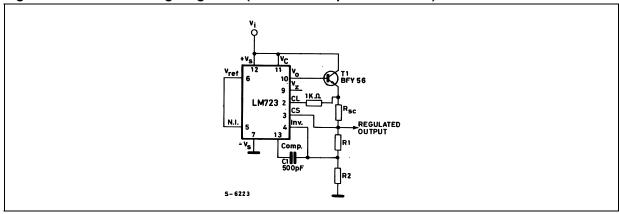


Figure 19. Positive voltage regulator (external NPN pass transistor)



Note: Typical performance

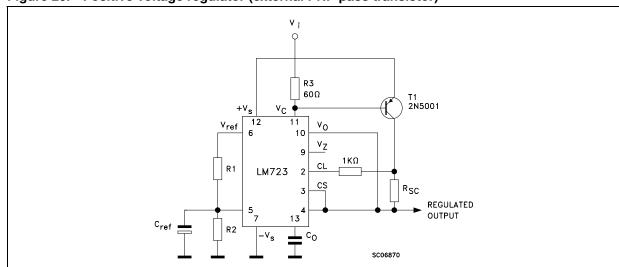
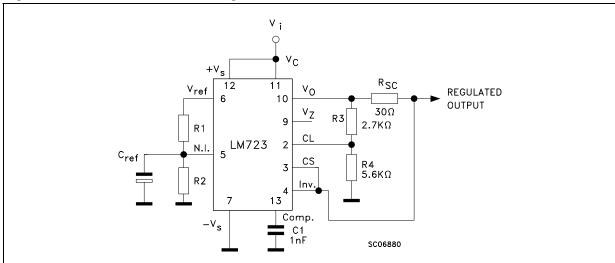


Figure 20. Positive voltage regulator (external PNP pass transistor)

Figure 21. Foldback current limiting



Note: Typical performance

Figure 22. Positive floating regulator

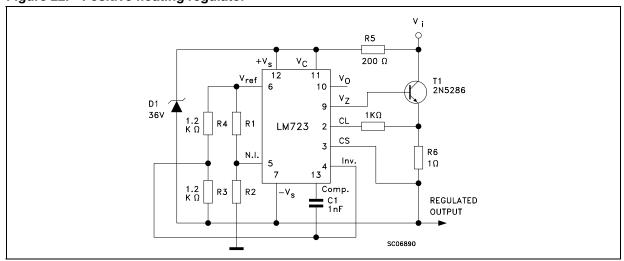
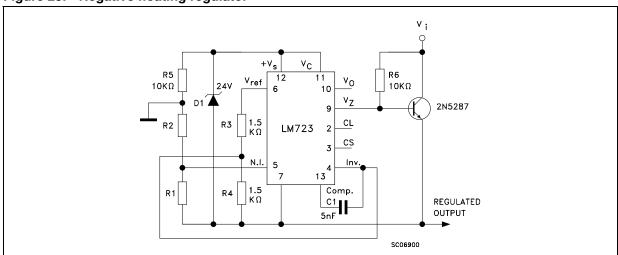


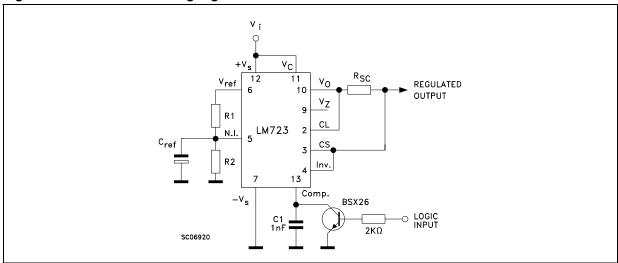
Figure 23. Negative floating regulator



Note: Typical performance

Regulated output voltage.....-100 V Line regulation (Δ V_I = 20 V).....30 mV Load regulation (Δ I_O = 100 mA)......20 mV

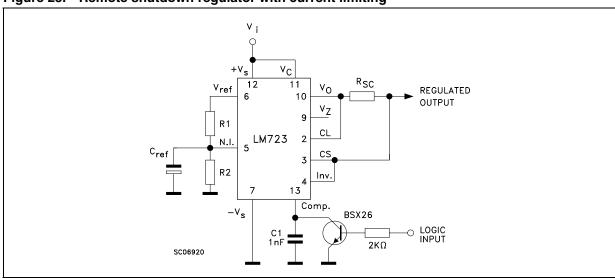
Figure 24. Positive switching regulator



Regulated output voltage......5 V Line regulation (Δ V_I = 30 V)......10 mV

Load regulation ($\Delta I_O = 2 A$).....80 mV

Figure 25. Remote shutdown regulator with current limiting



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

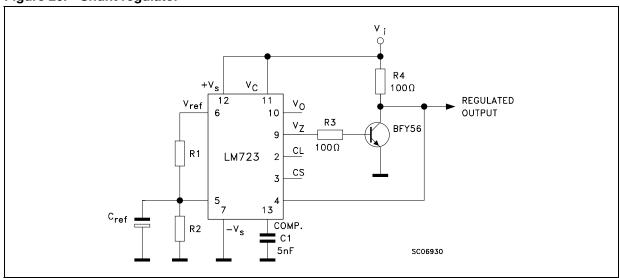
Typical performance

Regulated output voltage......5 V

Line regulation ($\Delta V_I = 3 V$)......0.5 mV

Load regulation ($\Delta I_O = 50 \text{ mA}$)......1.5 mV

Figure 26. Shunt regulator

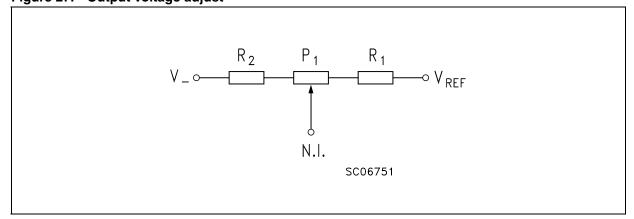


Regulated output voltage......5 V

Line regulation ($\Delta V_I = 10 V$)......2 mV

Load regulation ($\Delta I_O = 100 \text{ mA}$).....5 mV

Figure 27. Output voltage adjust

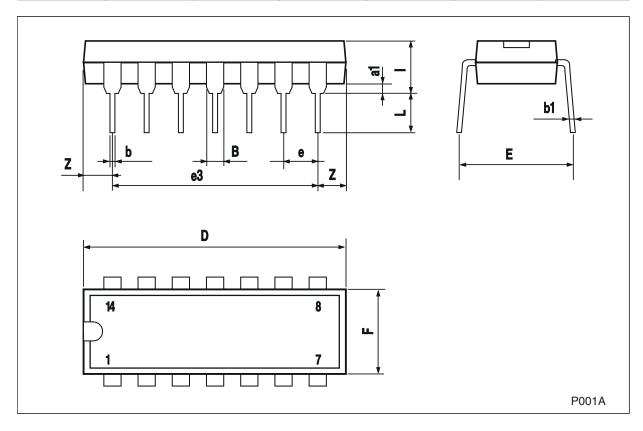


8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK[®] packages. These packages have a lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

Plastic DIP-14 mechanical data

Dim		mm.			inch.	
Dim.	Min.	Тур.	Max.	Min.	Тур.	Max.
a1	0.51			0.020		
В	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
е		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100



Revision history LM723

9 Revision history

Table 8. Document revision history

Date	Revision	Changes
21-Jun-2004	5	
22-Nov-2007	6	Added Table 1.

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