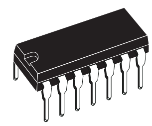
LM723

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



DIP-14

Description

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 shut-down.

Table 1. Device summary

Order code	Package
LM723N	DIP-14
LM723CN	DIP-14

Contents

1 Diagram 3

2 Pin configuration 4

3 Maximum ratings 5

4 Circuit 6

5 Electrical characteristics 7

6 Typical performance characteristics 9

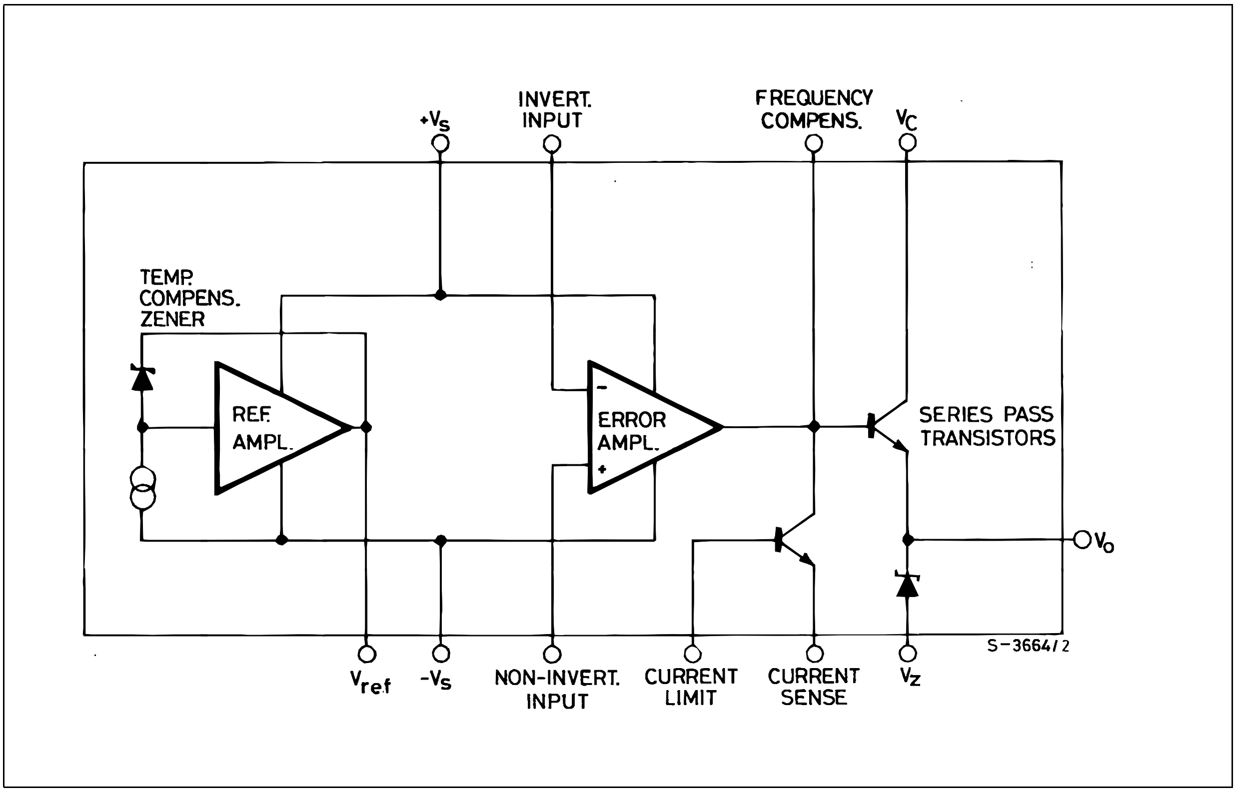
7 Applications information 12

8 Package mechanical data 18

9 Revision history 20

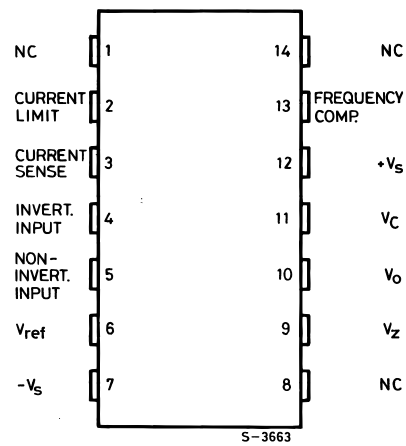
1 Diagram

Figure 1. Schematic diagram



2 Pin configuration

Figure 2. Pin connections (top view)



3 Maximum ratings

Table 2. Absolute maximum ratings

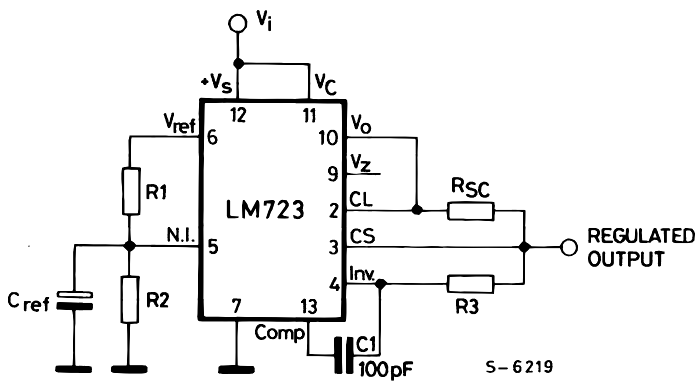
Symbol	Parameter	Value		Unit
		LM723	LM723C	
V_I	DC input voltage	40	40	V
ΔV_{I-O}	Dropout voltage	40	40	V
I_O	Output current	150	150	mA
I_{REF}	Current from V_{REF}	15	25	mA
T_{OP}	Operating Temperature	-55 to 125	0 to 70	°C
T_{STG}	Storage Temperature	-65 to 150	-65 to 150	°C
T_J	Junction Temperature	150	125	°C

Table 3. Thermal data

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

4 Circuit

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



Note: $V_I = 12\ V; V_O = 5\ V; I_O = 1\ mA; R_1/R_2 \leq 10\ k\Omega$

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.	Typ.	Max.	Unit
$\Delta V_O/\Delta V_I$	Line regulation	V_I = 12 to 15 V			0.01	0.1	%
		V_I = 12 to 40 V			0.02	0.2	
		V_I = 12 to 15 V, T_A = -55 to 125°C				0.3	
$\Delta V_O/V_O$	Load regulation	I_O = 1 to 50 mA			0.03	0.15	%
		I_O = 1 to 10 mA, T_A = -55 to 125°C				0.6	
V_{REF}	Reference voltage	I_{REF} = 160 µA		6.95	7.15	7.35	V
SVR	Supply voltage rejection	f = 100 Hz to 10kHz	C_{REF} = 0		74		dB
			C_{REF} = 5µF		86		
$\Delta V_O/\Delta T$	Output voltage drift					150	ppm/°C
I_{SC}	Output current limit	R_{SC} = 10Ω, V_O = 0 V			65		mA
V_I	Input voltage range			9.5		40	V
V_O	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
eN	Output noise voltage	BW = 100 Hz to 10 kHz	C_{REF} = 0		20		µV
			C_{REF} = 5µF		2.5		

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

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
$\Delta V_O/\Delta V_I$	Line regulation	V_I = 12 to 15 V			0.01	0.1	%
		V_I = 12 to 40 V			0.1	0.5	
		V_I = 12 to 15 V, T_A = 0 to 70°C				0.3	
$\Delta V_O/V_O$	Load regulation	I_O = 1 to 50 mA			0.03	0.2	%
		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
SVR	Supply voltage rejection	f = 100 Hz to 10kHz	C_{REF} = 0		74		dB
			C_{REF} = 5µF		86		
$\Delta V_O/\Delta T$	Output voltage drift					150	ppm/°C
I_{SC}	Output current limit	R_{SC} = 10Ω, V_O = 0 V			65		mA
V_I	Input voltage range			9.5		40	V
V_O	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 noise voltage	BW = 100 Hz to 10 kHz	C_{REF} = 0		20		µV
			C_{REF} = 5µF		2.5		

6 Typical performance characteristics

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

Figure 4. Maximum output current vs voltage drop

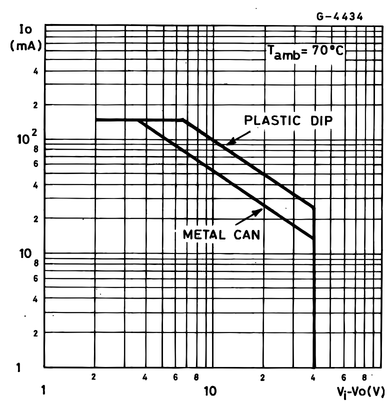


Figure 5. Current limiting characteristics

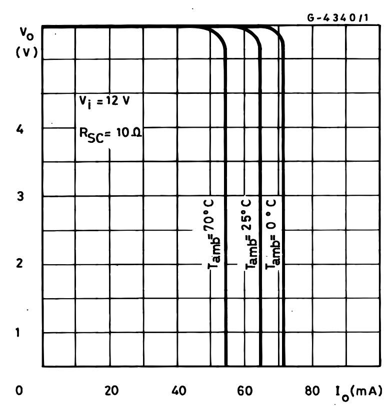


Figure 6. Current limiting characteristics vs junction temperature

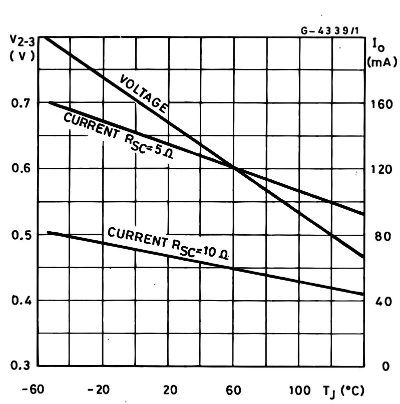


Figure 7. Load regulation characteristics without current limiting

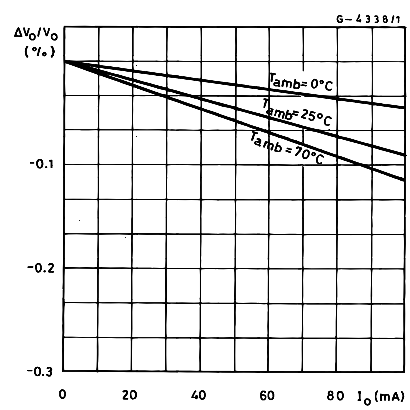


Figure 8. Load regulation characteristics with current limiting

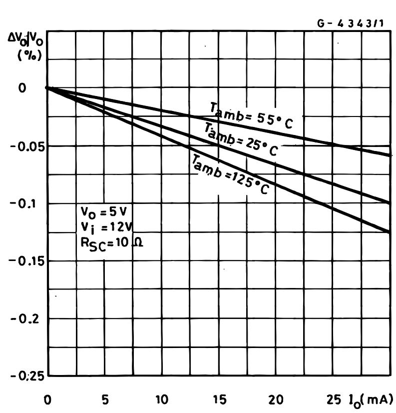


Figure 9. Load regulation characteristics with current limiting

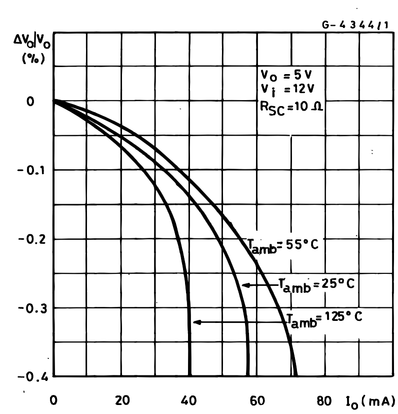


Figure 10. Line regulation vs voltage drop

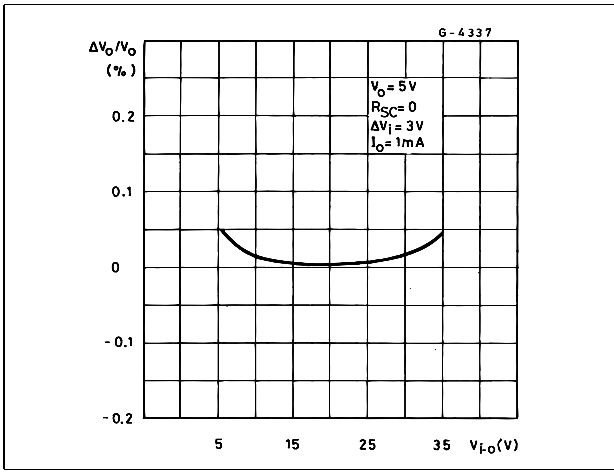


Figure 11. Load regulation vs voltage drop

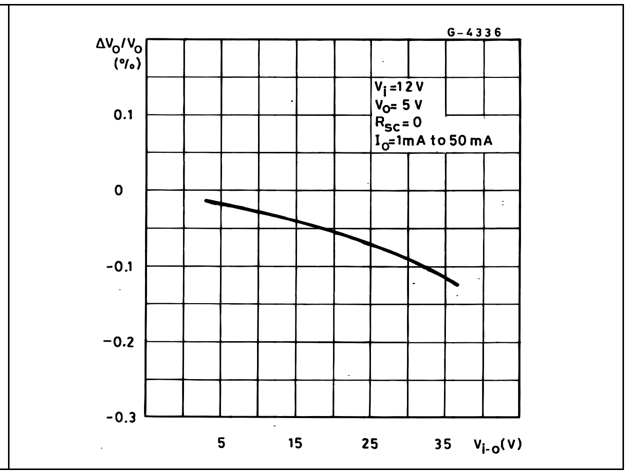


Figure 12. Quiescent drain current vs input voltage

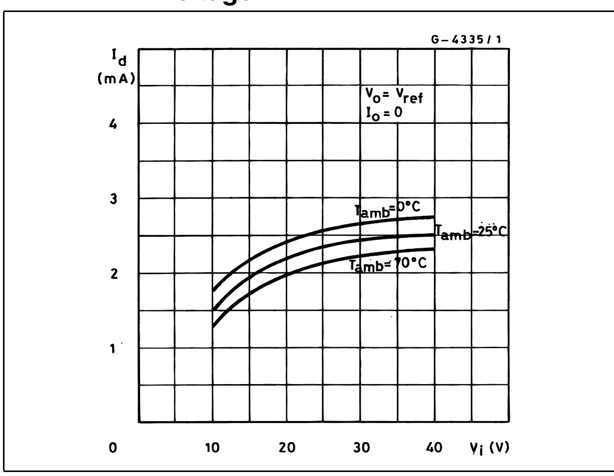


Figure 13. Line transient response

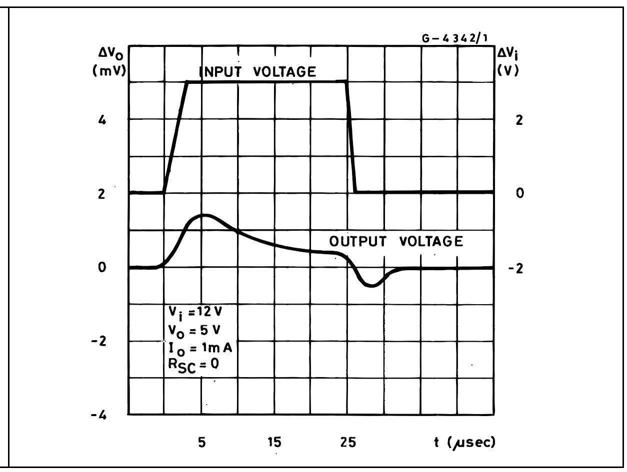


Figure 14. Load transient response

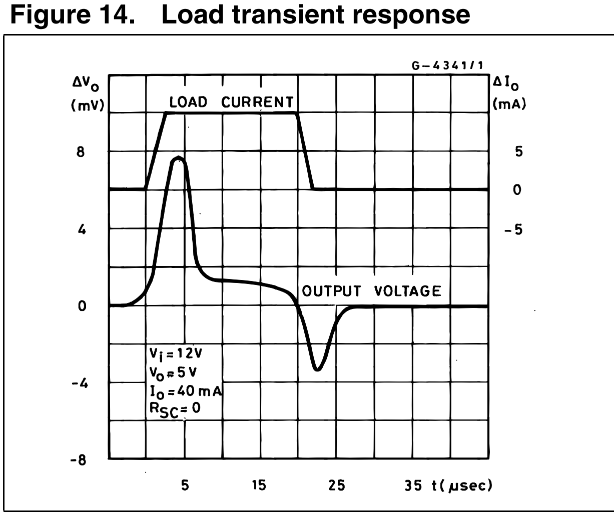


Figure 15. Output impedance vs frequency

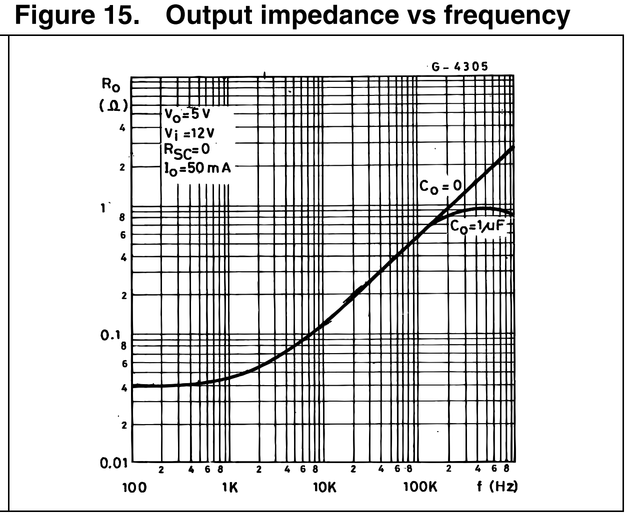


Table 6. Resistor values (kΩ) for standard output voltages

Output Voltage	Applicable figures	Fixed output ± 5%		Output adjustable ± 10% [(1)]		
		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

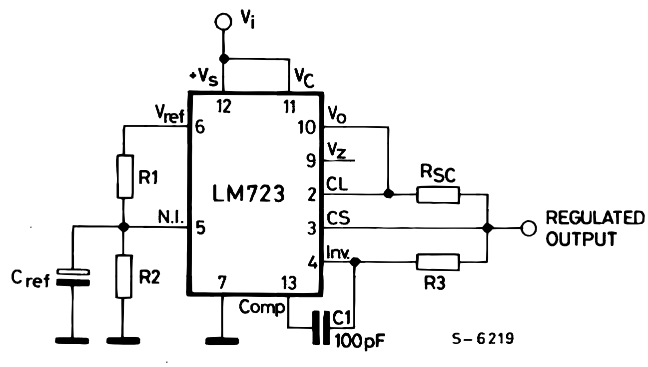
1. Replace R1/R2 divider with the circuit of *Figure 27*.
2. V+ must be connected to a +3 V or greater supply.

Table 7. Formula for intermediate output voltages

Conditions		
Outputs from 2 to 7V *Figure 16, 19, 20, 21, 24, 26* $V_O=(V_{REF} \times R_2)/(R_1+R_2)$	Outputs from 4 to 250V *Figure 22* $V_O=(V_{REF}/2) \times [(R_2-R_1)/R_1]$; $R_3=R_4$	Current Limit $I_{LIMIT}=V_{SENSE}/R_{SC}$
Outputs from 7 to 37V *Figure 17, 19, 20, 21, 24, 26* $V_O=V_{REF} \times [(R_1+R_2)/R_2]$	Outputs from -6 to -250V *Figure 18, Figure 23* $V_O=(V_{REF}/2) \times [(R_1+R_2)/R_1]$; $R_3=R_4$	Foldback Current Limiting $I_{KNEE}=[(V_O \times R_3)/(R_{SC} \times R_4)] \times [V_{SENSE} \times (R_3+R_4)] / (R_{SC} \times R_4)$ $I_{SHORTCKT}=(V_{SENSE}/R_{SC}) \times [(R_3+R_4)/R_4]$

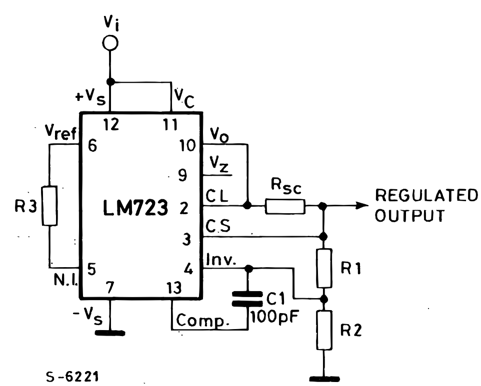
7 Applications information

Figure 16. Basic low voltage regulator (V_O = 2 to 7 V)



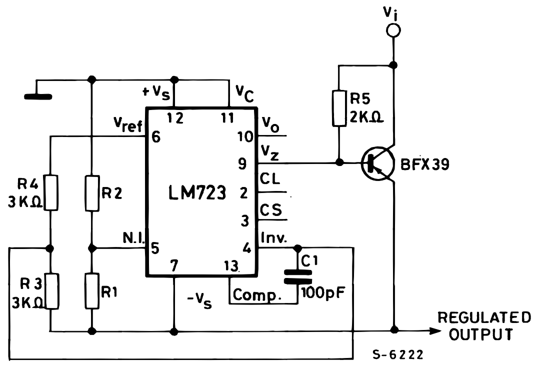
Note: *$R_3 = (R_1xR_2)/(R_1+R_2)$ for minimum temperature drift.*
R_3 may be eliminated for minimum component count.
Typical performance
Regulated output voltage..................5 V
Line regulation (Δ V_I = 3 V)..........0.5 mV
Load regulation (Δ I_O = 50 mA)...1.5 mV

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



Note: *$R_3 = (R_1xR_2)/(R_1+R_2)$ for minimum temperature drift.*
R_3 may be eliminated for minimum component count.
Typical performance
Regulated output voltage..................15 V
Line regulation (Δ V_I = 3 V)............1.5 mV
Load regulation (Δ I_O = 50 mA).....4.5 mV

Figure 18. Negative voltage regulator



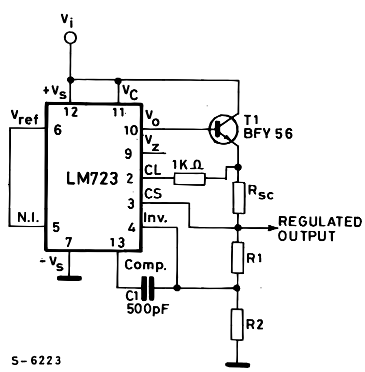
Note: *Typical performance*

Regulated output voltage.................15 V

Line regulation (Δ V_I = 3 V)...............1 mV

Load regulation (Δ I_O = 100 mA)......2 mV

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



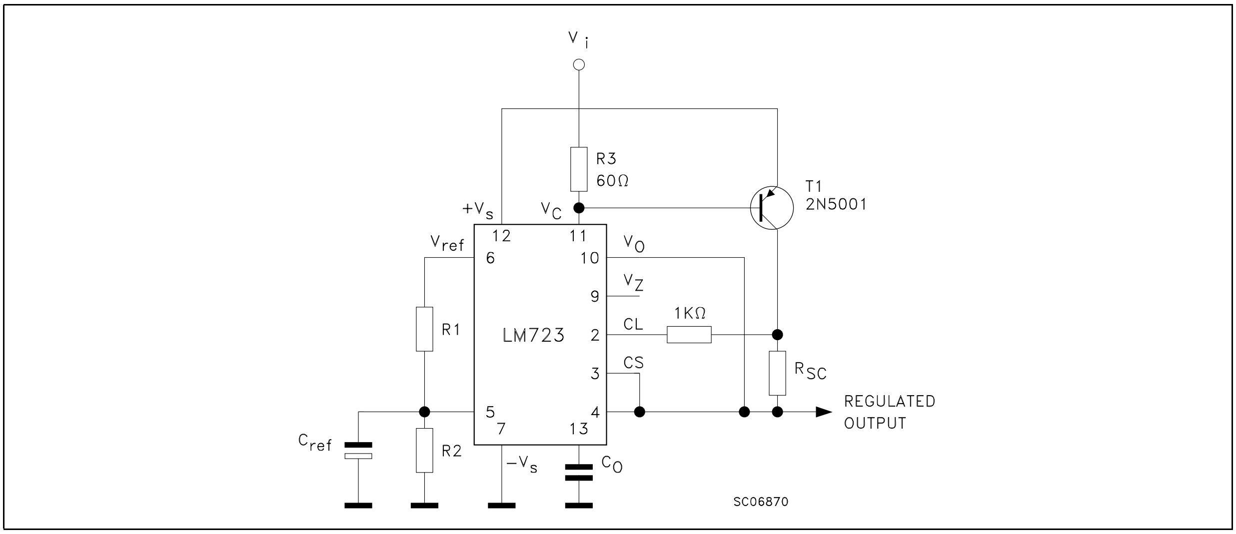
Note: *Typical performance*

Regulated output voltage................15 V

Line regulation (Δ V_I = 3 V)...........1.5 mV

Load regulation (Δ I_O = 1 A)...........15 mV

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



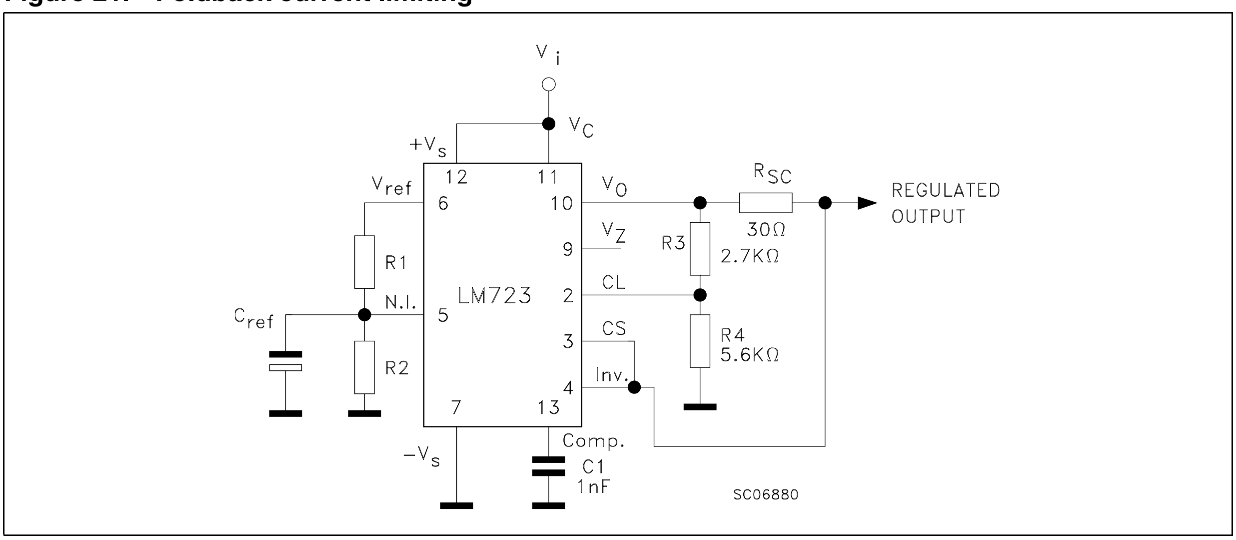
Note: Typical performance

Regulated output voltage...................5 V

Line regulation (Δ V_I = 3 V)...........0.5 mV

Load regulation (Δ I_O = 1 A)..........1.5 mV

Figure 21. Foldback current limiting



Note: Typical performance

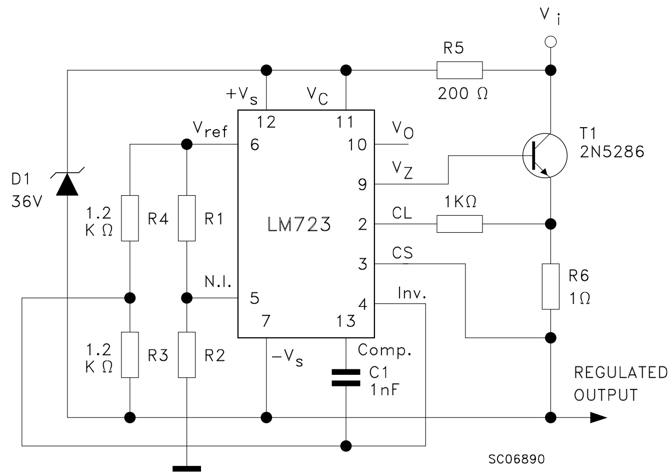
Regulated output voltage....................5 V

Line regulation (Δ V_I = 3 V)............0.5 mV

Load regulation (Δ I_O = 10 mA)........1 mV

Current limit knee...........................20 mA

Figure 22. Positive floating regulator



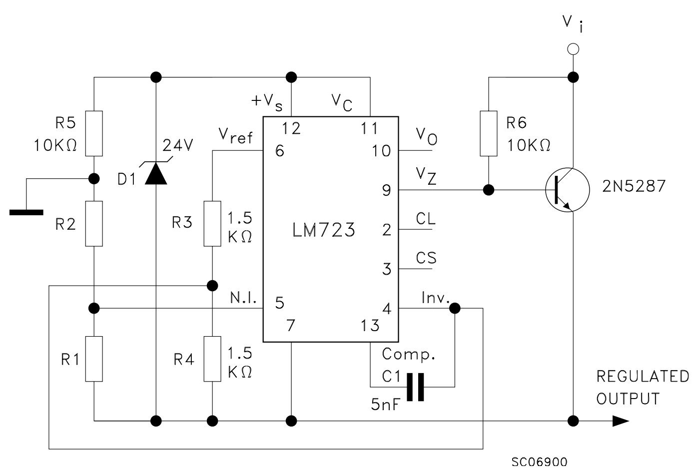
Note: *Typical performance*

Regulated output voltage....................100 V

Line regulation (Δ V_I = 20 V)...............15 mV

Load regulation (Δ I_O = 50 mA)..........20 mV

Figure 23. Negative floating regulator



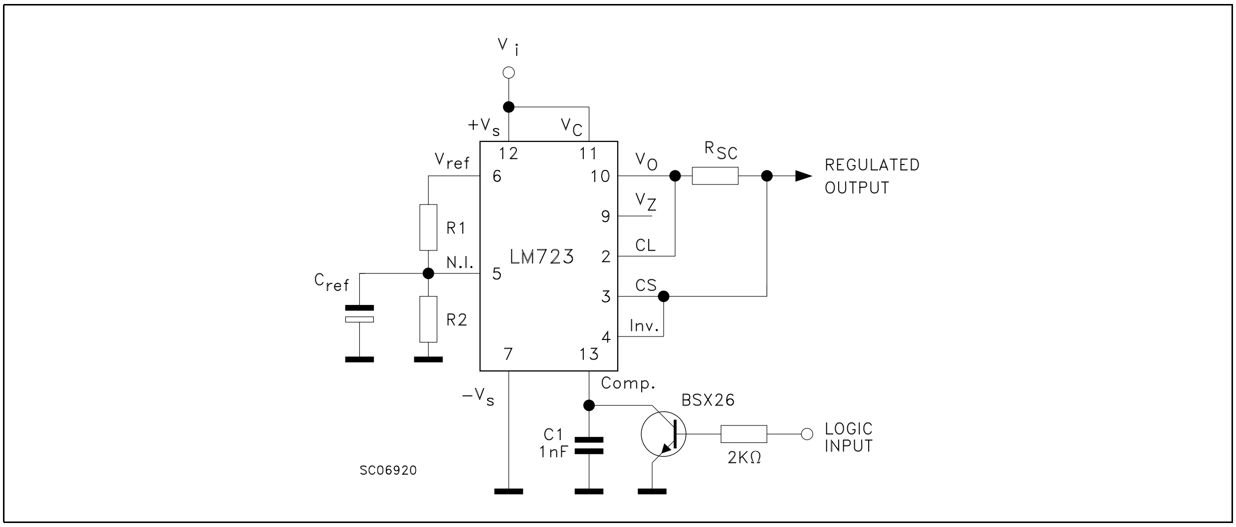
Note: *Typical performance*

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



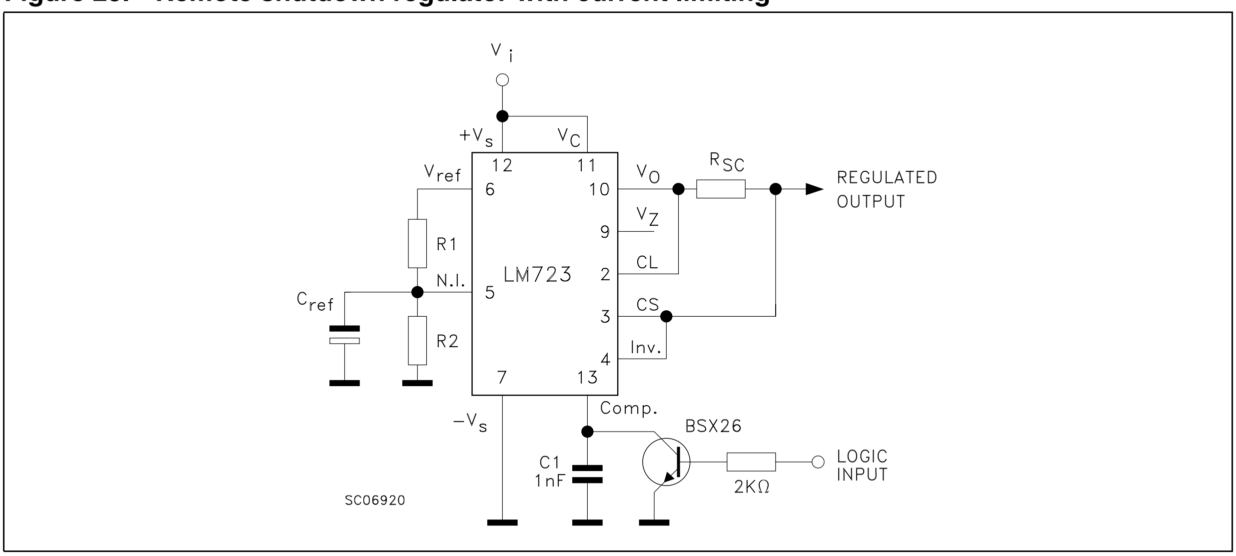
Note: *Typical performance*

Regulated output voltage....................5 V

Line regulation (Δ V_I = 30 V)...........10 mV

Load regulation (Δ 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.*

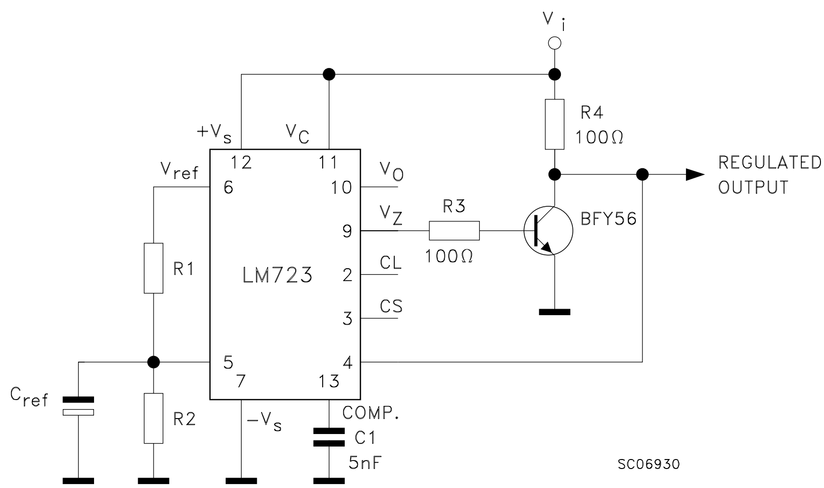
Typical performance

Regulated output voltage...........................5 V

Line regulation (Δ V_I = 3 V)...................0.5 mV

Load regulation (Δ I_O = 50 mA)............1.5 mV

Figure 26. Shunt regulator



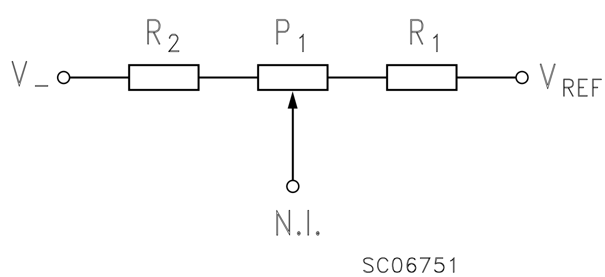
Note: *Typical performance*

Regulated output voltage............................5 V

Line regulation (Δ V_I = 10 V)....................2 mV

Load regulation (Δ I_O = 100 mA)..............5 mV

Figure 27. Output voltage adjust

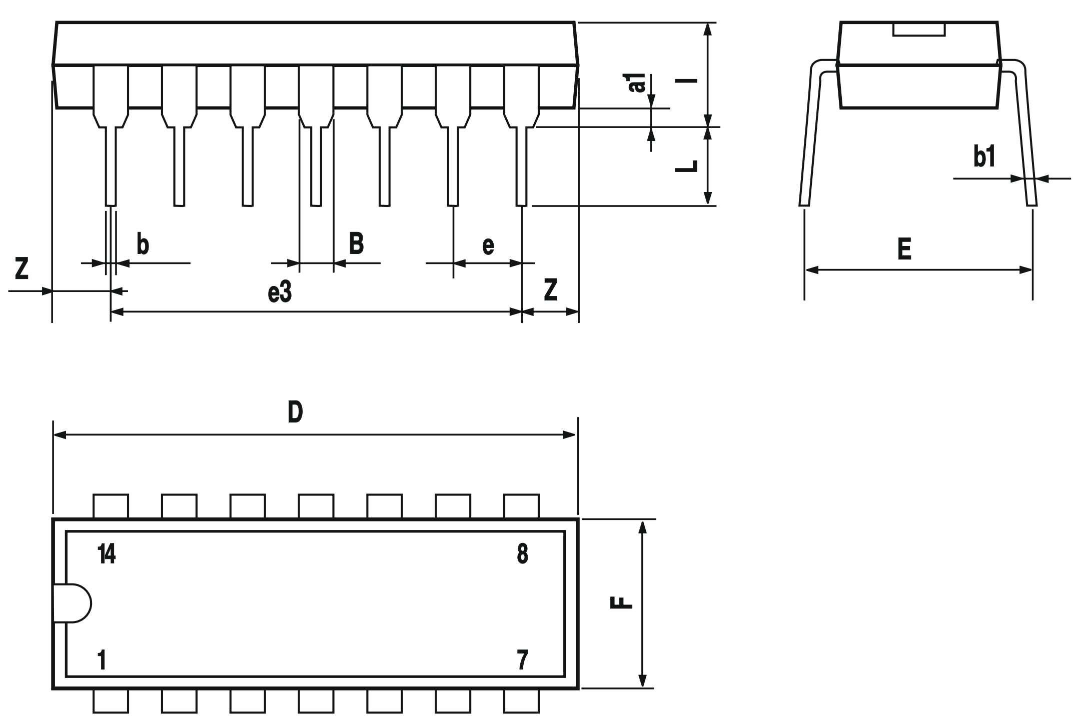


8 Package mechanical data

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.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	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	
e		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



P001A

9 Revision history

Table 8. Document revision history

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