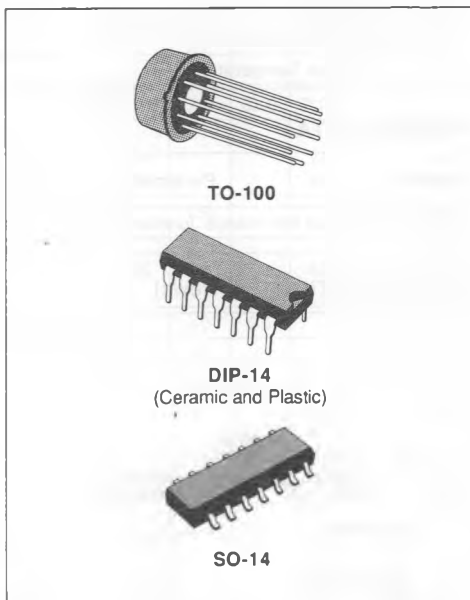


HIGH PRECISION VOLTAGE REGULATOR

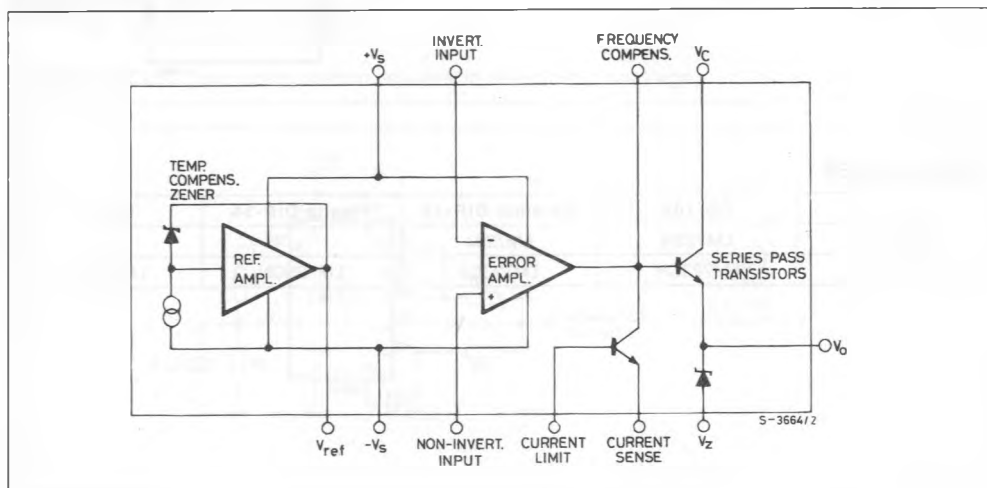
- INPUT VOLTAGE UP TO 40V
- OUTPUT VOLTAGE ADJUSTABLE FROM 2 TO 37V
- POSITIVE OR NEGATIVE SUPPLY OPERATION
- SERIES, SHUNT, SWITCHING OR FLOATING OPERATION
- OUTPUT CURRENT TO 150mA WITHOUT EXTERNAL PASS TRANSISTOR
- ADJUSTABLE CURRENT LIMITING

DESCRIPTION

The LM723 is a monolithic integrated programmable voltage regulator, assembled in 14-lead dual in-line plastic and ceramic package, 10-lead Metal Can (TO-100 type) and SO-14 micropackage. The circuit provides internal current limiting. When the output current exceeds 150mA an external NPN or PNP pass element may be used. Provisions are made for adjustable current limiting and remote shut-down.



BLOCK DIAGRAM



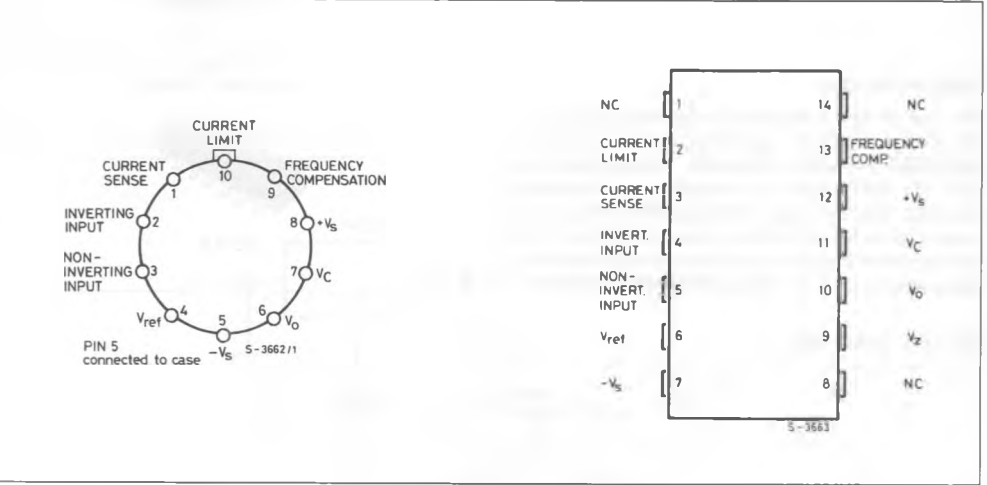
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM723	LM723C	Unit
V_i	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_{sig}	Storage Temperature	- 65 to 150	- 65 to 150	°C
T_j	Junction Temperature	150	125	°C

THERMAL DATA

Symbol	Parameter	Plastic DIP-14	Ceramic DIP-14	TO-100	SO-14	Unit
$R_{th j-amb}$	Thermal Resistance Junction-ambient Max	200	150	155	165	°C/W

PIN CONNECTION (top views)



ORDER CODES

Type	TO-100	Ceramic DIP-14	Plastic DIP-14	SO-14
LM723	LM723H	LM723J		
LM723C	LM723CH	LM723CJ	LM723CN	LM723CD

ELECTRICAL CHARACTERISTICS (refer to the test circuit, $T_{amb} = 25^{\circ}\text{C}$ unless otherwise specified)

Symbol	Parameter	Test Conditions	LM723C			LM723			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
$\frac{\Delta V_o}{\Delta V_i}$	Line Regulation	$V_i = 12 \text{ to } 15\text{V}$ $V_i = 12 \text{ to } 40\text{V}$ $V_i = 12 \text{ to } 15\text{V} ;$ $T_{\min} \leq T_{\text{amb}} \leq T_{\max}$		0.01 0.1	0.1 0.5		0.01 0.02	0.1 0.2	%
$\frac{\Delta V_o}{V_o}$	Load Regulation	$I_o = 1 \text{ to } 50\text{mA}$ $T_{\min} \leq T_{\text{amb}} \leq T_{\max}$ $I_o = 1 \text{ to } 10\text{mA}$		0.03	0.2 0.6		0.03	0.15 0.6	%
V_{REF}	Reference Voltage	$I_{\text{ref}} = 160\mu\text{A}$	6.8	7.15	7.5	6.95	7.15	7.35	V
SVR	Ripple Rejection	$f = 100\text{Hz to } 10\text{KHz}$ $C_{\text{ref}} = 0$ $C_{\text{ref}} = 5\mu\text{F}$		74 86			74 86		dB dB
$\frac{\Delta V_o}{\Delta T}$	Output Voltage Drift				150			150	ppm °C
I_{SC}	Short Circuit Current Limiting	$R_{\text{SC}} = 10\Omega \quad V_o = 0$		65			65		mA
V_i	Input Voltage Range		9.5		40	9.5		40	V
V_o	Output Voltage Range		2		37	2		37	V
$V_i - V_o$			3		38	3		38	V
I_d	Quiescent Drain Current	$I_o = 0$ $V_i = 30\text{V}$		2.3	4		2.3	5	mA
	Long Term Stability			0.1			0.1		% 1000 hrs
e_N	Output Noise Voltage	$\text{BW} = 100\text{Hz to } 10\text{KHz}$ $C_{\text{ref}} = 0$ $C_{\text{ref}} = 5\mu\text{F}$		20 2.5			20 2.5		μV μV
V_z	Output Zener Voltage (for plastic package only)	$I_z = 1\text{mA}$	6.9		7.7				V

Note : $T_{min} = 0^{\circ}C$ (LM723C) ; $125^{\circ}C$ (LM723)
 $T_{max} = 70^{\circ}C$ (LM723C) ; $-55^{\circ}C$ (LM723).

TEST CIRCUIT (pin configuration relative to the plastic package)

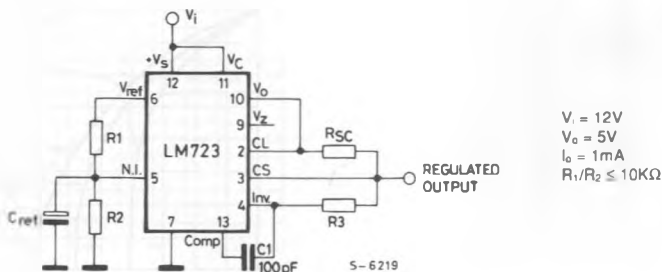


Figure 1 : Maximum Output Current vs. Voltage Drop.

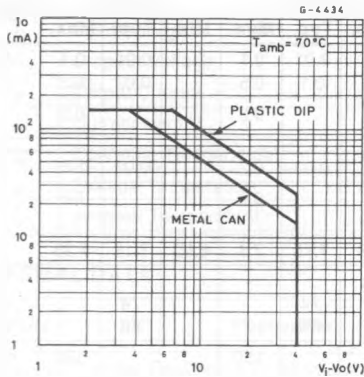


Figure 2 : Current Limiting Characteristics.

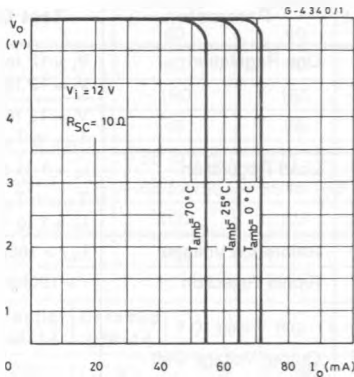


Figure 3 : Current Limiting Characteristics vs. Junction Temperature.

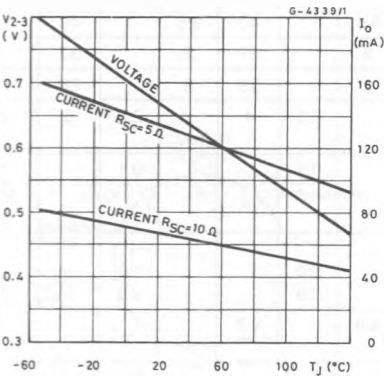


Figure 4 : Load Regulation Characteristics without Current Limiting.

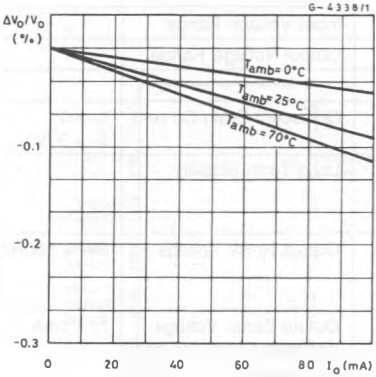


Figure 5 : Load Regulation Characteristics with Current Limiting.

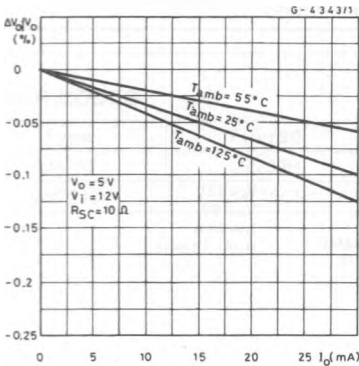


Figure 6 : Load Regulation Characteristics with Current Limiting.

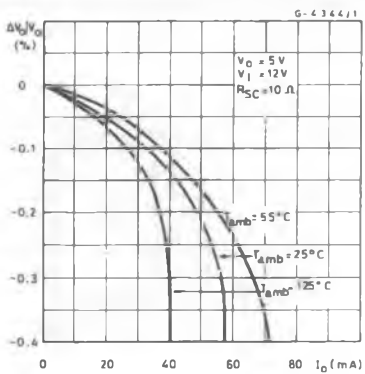


Figure 7 : Line Regulation vs. Voltage Drop.

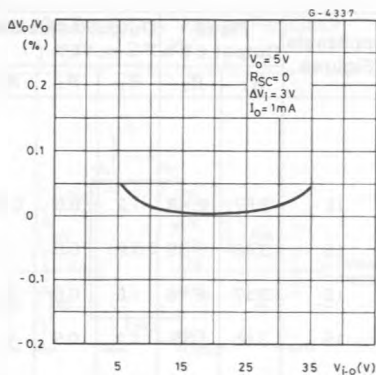


Figure 8 : Load Regulation vs. Voltage Drop.

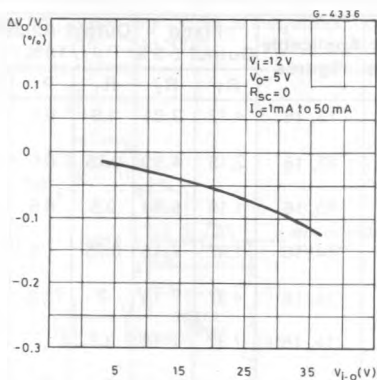


Figure 9 : Quiescent Drain Current vs. Input Voltage.

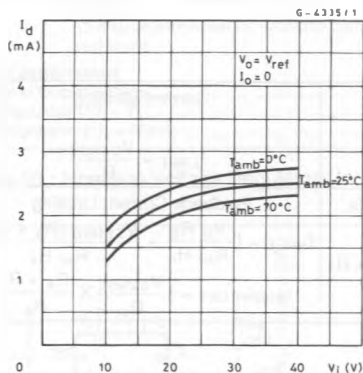


Figure 10 : Line Transient Response.

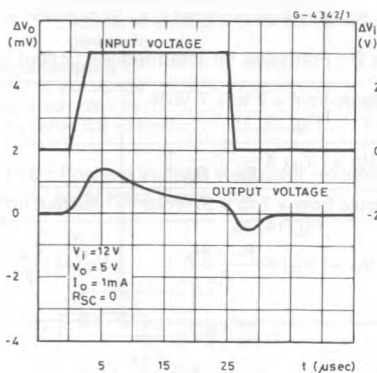


Figure 11 : Load Transient Response.

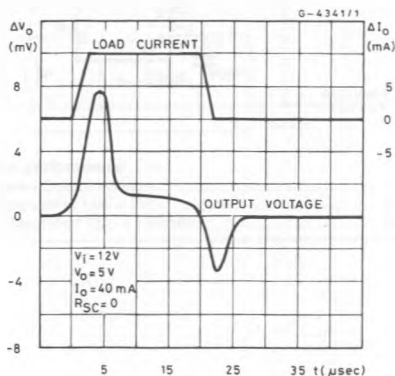


Figure 12 : Output Impedance vs. Frequency.

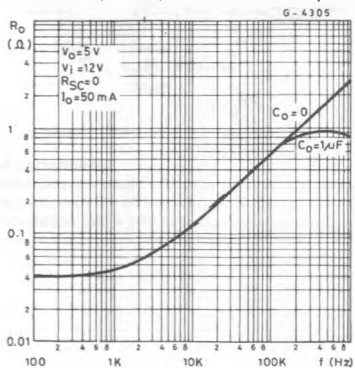


Table 1 : Resistor Values (KΩ) for Standard Output Voltages.

Output Voltage	Applicable Figures	Fixed Output ± 5%		Output Adjustable ± 10% (°)			Output Voltage	Applicable Figures	Fixed Output ± 5%		Output Adjustable ± 10% (°)		
		R ₁	R ₂	R ₁	P ₁	R ₂			R ₁	R ₂	R ₁	P ₁	R ₂
+ 3	13, 16	4.12	3.01	1.8	0.5	1.2	+ 100						
+ 5	13, 16	2.15	4.99	0.75	0.5	2.2	+ 250						
+ 6	13, 16	1.15	6.04	0.5	0.5	2.7	− 6(°°)	15	3.57	2.43	1.2	0.5	0.75
+ 9	14, 16	1.87	7.15	0.75	1	2.7	− 9	15	3.48	5.36	1.2	0.5	2
+ 12	14, 16	4.87	7.15	2	1	3	− 12	15	3.57	8.45	1.2	0.5	3.3
+ 15	14, 16	7.87	7.15	3.3	1	3	− 15	15	3.65	11.5	1.2	0.5	4.3
+ 28	14, 16	21	7.15	5.6	1	2	− 28	15	3.57	24.3	1.2	0.5	10

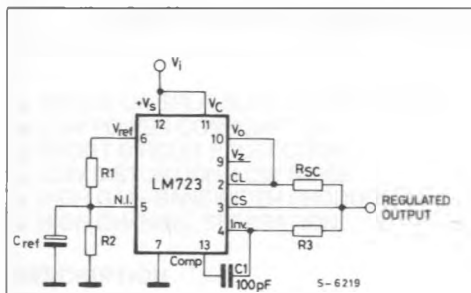
Note : (°) Replace R₁/R₂ divider with the circuit of fig. 24.
(°°) V⁺ must be connected to a + 3V or greater supply.

Table 2 : Formulae for Intermediate Output Voltages.

Outputs from + 2 to + 7 Volts Fig. 13, 16 $V_O = [V_{ref} \times \frac{R_2}{R_1 + R_2}]$		Current Limiting $I_{LIMIT} = \frac{V_{SENSE}}{R_{sc}}$
Outputs from + 7 to + 37 Volts Fig. 14, 16, $V_O = [V_{ref} \times \frac{R_1 + R_2}{R_2}]$	Output from − 6 to − 250 Volts Fig. 15, 20 $V_O = [\frac{V_{ref}}{2} \times \frac{R_1 + R_2}{R_1}] ; R_3 = R_4$	Foldback Current Limiting $I_{KNEE} = [\frac{V_O R_3}{R_{sc} R_4} + \frac{V_{SENSE} (R_3 + R_4)}{R_{sc} R_4}]$ $I_{SHORT\ CKT} = [\frac{V_{SENSE}}{R_{sc}} \times \frac{R_3 + R_4}{R_4}]$

APPLICATION INFORMATION (pin numbers relative to the plastic package).

Figure 13 : Basic Low Voltage Regulator ($V_o = 2$ to $7V$).



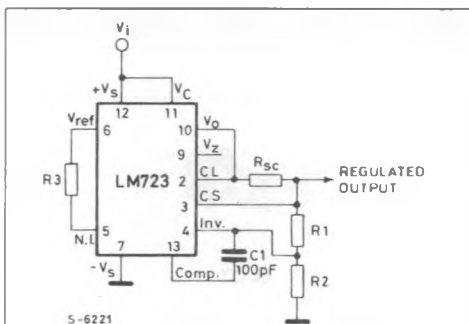
Note : $R_3 = \frac{R_1 \cdot R_2}{R_1 + R_2}$ for minimum temperature drift

R3 may be eliminated for minimum component count.

Typical performance

Regulated Output Voltage.....	5V
Line Regulation ($\Delta V_i = 3V$).....	0.5mV
Load Regulation ($\Delta I_o = 50mA$).....	1.5mV

Figure 14 : Basic High Voltage Regulator
($V_o = 7$ to $37V$).



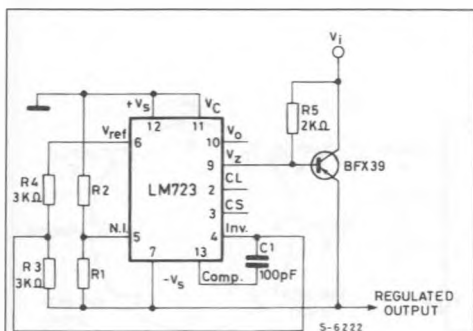
Note : $R_3 = \frac{R_1 \cdot R_2}{R_1 + R_2}$ for minimum temperature drift

R3 may be eliminated for minimum component count.

Typical performance

Regulated Output Voltage	15V
Line Regulation ($\Delta V_i = 3V$)	1.5mV
Load Regulation ($\Delta I_o = 50mA$)	4.5mV

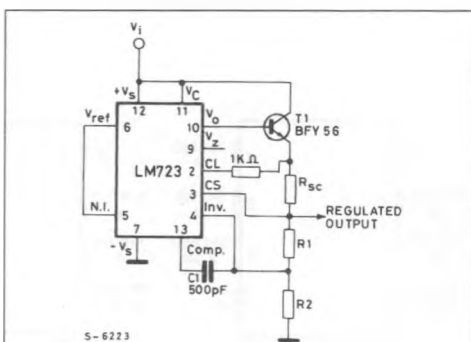
Figure 15 : Negative Voltage Regulator.



Typical performance

Regulated Output Voltage	15V
Line Regulation ($\Delta V_i = 3V$)	1mV
Load Regulation ($\Delta I_o = 100mA$)	2mV

Figure 16 : Positive Voltage Regulator (external NPN Pass Transistor).



Typical performance

Regulated Output Voltage	+ 15V
Line Regulation ($\Delta V_i = 3V$)	1.5mV
Load Regulation ($\Delta I_o = 1A$)	15mV