SGS L123

LINEAR INTEGRATED CIRCUIT

HIGH PRECISION VOLTAGE REGULATOR

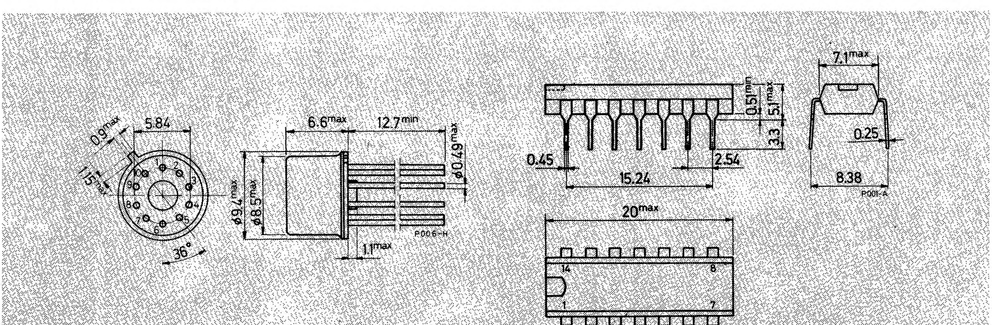
- INPUT VOLTAGE UP TO 40V
- OUTPUT VOLTAGE ADJUSTABLE FROM 2 TO 37V
- POSITIVE OR NEGATIVE SUPPLY OPERATION
- SERIES, SHUNT, SWITCHING OR FLOATING OPERATION
- OUTPUT CURRENT TO 150 mA WITHOUT EXTERNAL PASS TRANSISTOR
- ADJUSTABLE CURRENT LIMITING

The L123 is a monolithic integrated programmable voltage regulator, assembled in 14-lead dual in-line plastic package and 10-lead Metal Can (TO-100 type). The circuit provides internal current limiting. When the output current excedes 150 mA an external NPN or PNP pass element may be used. Provisions are made for adjustable current limiting and remote shut-down.

ABSOLUTE MAXIMUM RATINGS		L123	L123 C
V_i	Input voltage	40 V	40 V
ΔV_{i-o}	Dropout voltage	40 V	40 V
I_o	Output current	150 mA	150 mA
I_{ref}	Current from V_{ref}	15 mA	25 mA
P_{tot}	Power dissipation (at T_{amb} = 70°C) Plastic DIP	–	1 W
	TO-100	520 mW	520 mW
T_{op}	Operating junction temperature	-25 to 150 °C	0 to 70 °C
T_{stg}	Storage temperature	-65 to 150 °C	-65 to 150 °C

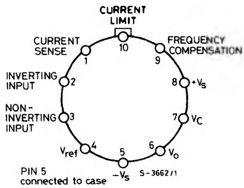
MECHANICAL DATA

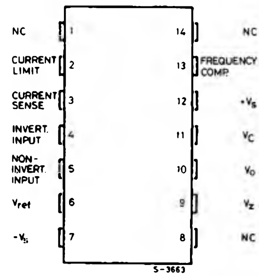
Dimensions in mm



TO-100 DIP

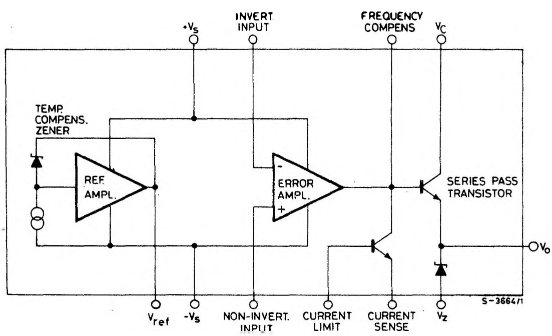
CONNECTION DIAGRAM AND ORDERING NUMBERS
(top views)



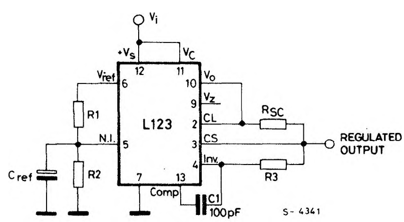


Type	TO-100	Plastic DIP
L123	L123T	–
L123C	L123CT	L123CB

BLOCK DIAGRAM



TEST CIRCUIT
(Pin configuration relative to the Plastic package)



$V_i = 12V$
$V_o = 5V$
$I_o = 1$ mA
$R_1//R_2 \leqslant 10$ KΩ

THERMAL DATA

			TO-100	Plastic DIP
$R_{th\ j\text{-}amb}$	Thermal resistance junction-ambient	max	155 °C/W	80 °C/W

ELECTRICAL CHARACTERISTICS (Refer to the test circuit, T_{amb} = 25°C unless otherwise specified)

Symbol	Parameter	Test conditions	L123C Min.	L123C Typ.	L123C Max.	L123 Min.	L123 Typ.	L123 Max.	Unit
$\frac{\Delta V_o}{\Delta V_i}$	Line regulation	V_i = 12 to 15V		0.01	0.1		0.01	0.1	%
		V_i = 12 to 40V		0.1	0.5		0.02	0.2	%
		V_i = 12 to 15V; $T_{min} \leq T_{amb} \leq T_{max}$			0.3			0.3	%
$\frac{\Delta V_o}{V_o}$	Load regulation	I_o = 1 to 50 mA		0.03	0.2		0.03	0.15	%
		$T_{min} \leq T_{amb} \leq T_{max}$ I_o = 1 to 10 mA			0.6			0.6	%
V_{ref}	Reference voltage	I_{ref} = 160 µA	6.8	7.15	7.5	6.95	7.15	7.35	V
SVR	Ripple rejection	f = 100 Hz to 10 KHz, C_{ref} = 0		74			74		dB
		f = 100 Hz to 10 KHz, C_{ref} = 5 µF		86			86		dB
$\frac{\Delta V_o}{\Delta T}$	Output voltage drift				150			150	ppm/°C
I_{sc}	Short circuit current limiting	R_{sc} = 10Ω 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 = 30V		2.3	4		2.3	5	mA
	Long term stability			0.1			0.1		%/1000 hrs
e_N	Output noise voltage	BW = 100 Hz to 10 KHz, C_{ref} = 0		20			20		µV
		BW = 100 Hz to 10 KHz, C_{ref} = 5 µF		2.5			2.5		µV
V_z	Output zener voltage (for plastic package only)	I_z = 1 mA	6.9		7.7				V

Note: T_{min} = 0°C (L123C); -25°C (L123).
T_{max} = 70°C (L123C); 150°C (L123).

Fig. 1 - Maximum output current vs. voltage drop

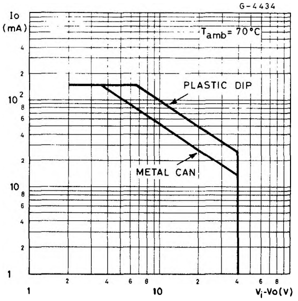


Fig. 2 - Current limiting characteristics

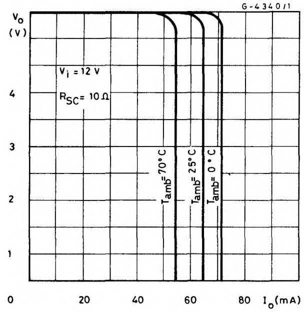


Fig. 3 - Current limiting characteristics vs. junction temperature

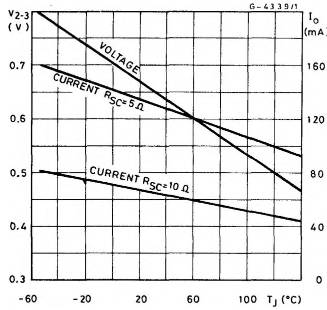


Fig. 4 - Load regulation characteristics without current limiting

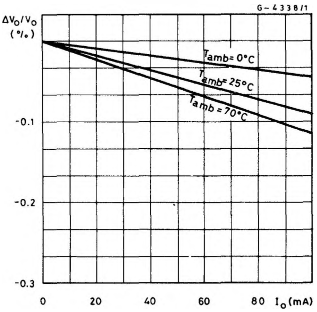


Fig. 5 - Load regulation characteristics with current limiting

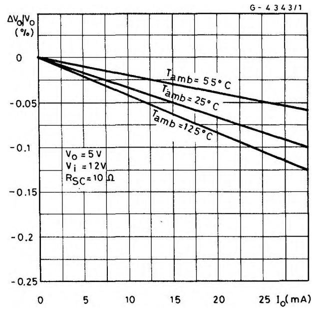


Fig. 6 - Load regulation characteristics with current limiting

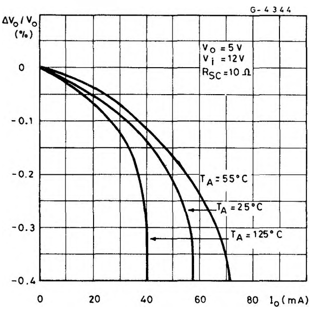


Fig. 7 - Line regulation vs. voltage drop

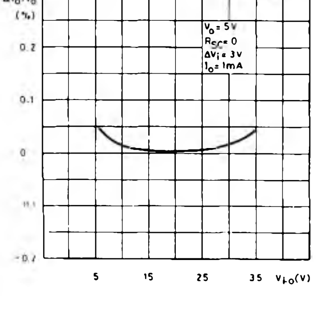


Fig. 8 - Load regulation vs. voltage drop

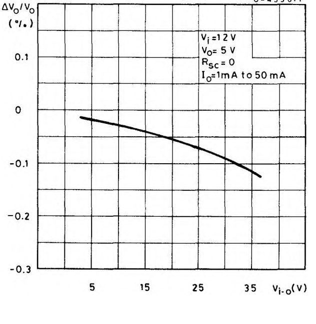


Fig. 9 - Quiescent drain current vs. input voltage

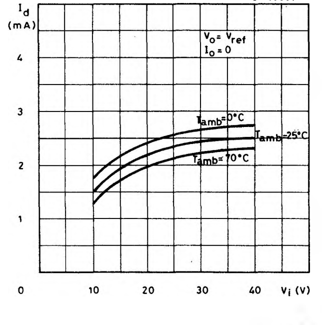


Fig. 10 - Line transient response

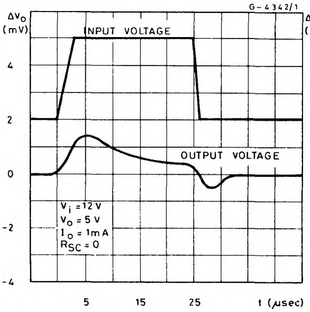


Fig. 11 - Load transient response

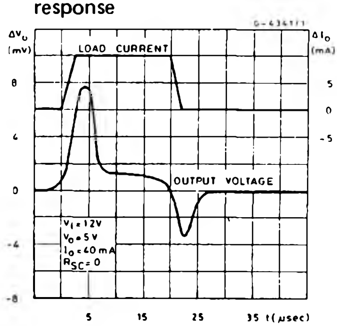


Fig. 12 - Output impedance vs. frequency

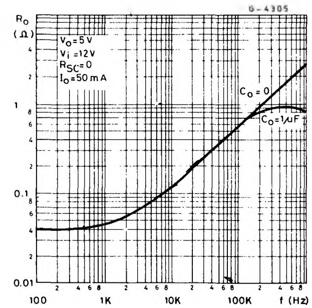


Table I — Resistor values (KΩ) for standard output voltages

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, 17 18, 21, 23	4.12	3.01	1.8	0.5	1.2	+100	19	3.57	102	2.2	10	91
+ 5	13, 16, 17 18, 21, 23	2.15	4.99	0.75	0.5	2.2	+250	19	3.57	255	2.2	10	240
+ 6	13, 16, 17 18, 21, 23	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, 17 18, 21, 23	1.87	7.15	0.75	1	2.7	- 9	15	3.48	5.36	1.2	0.5	2
+12	14, 16, 17 18, 21, 23	4.87	7.15	2	1	3	- 12	15	3.57	8.45	1.2	0.5	3.3
+15	14, 16, 17 18, 21, 23	7.87	7.15	3.3	1	3	- 15	15	3.65	11.5	1.2	0.5	4.3
+28	14, 16, 17 18, 21, 23	21	7.15	5.6	1	2	- 28	15	3.57	24.3	1.2	0.5	10
+45	19	3.57	48.7	2.2	10	39	- 45	20	3.57	41.2	2.2	10	33
+75	19	3.57	78.7	2.2	10	68	-100	20	3.57	97.6	2.2	10	91
							-250	20	3.57	249	2.2	10	240

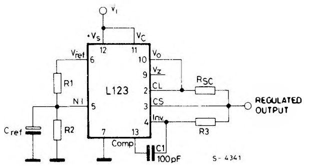
Note: (°) Replace R_1/R_2 divider with the circuit of fig. 24.
(°°) V^+ must be connected to a +3V or greater supply.

Table II — Formulae for intermediate output voltages

Outputs from +2 to +7 volts Fig. 13, 17, 18, 21, 23, 16	Outputs from +4 to +250 volts Fig. 19	Current Limiting
$V_O = [V_{ref} \times \frac{R_2}{R_1 + R_2}]$	$V_O = [\frac{V_{ref}}{2} \times \frac{R_2 - R_1}{R_1}]$; $R_3 = R_4$	$I_{LIMIT} = \frac{V_{SENSE}}{R_{sc}}$
Outputs from +7 to +37 volts Fig. 14, 16, 17, 18, 21, 23	**Output from -6 to -250 volts Fig. 15, 20**	**Foldback Current Limiting**
$V_O = [V_{ref} \times \frac{R_1 + R_2}{R_2}]$	$V_O = [\frac{V_{ref}}{2} \times \frac{R_1 + R_2}{R_1}]$; $R_3 = R_4$	$I_{KNEE} = [\frac{V_O}{R_{sc}} \frac{R_3}{R_4} + \frac{V_{SENSE}(R_3 + R_4)}{R_{sc} R_4}]$ $I_{SHORT\,CKT} = [\frac{V_{SENSE}}{R_{sc}} \times \frac{R_3 + R_4}{R_4}]$

APPLICATION INFORMATION (Pin numbers relative to the plastic package)

Fig. 13 - Basic low voltage regulator
(V_o = 2 to 7V)

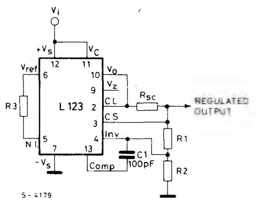


NOTE: $R3 = \frac{R1 \cdot R2}{R1 + R2}$ for minimum temperature drift.

R3 may be eliminated for minimum component count.

Typical performance
Regulated Output Voltage 5V
Line Regulation (ΔV_i = 3V) . . . . . . .0.5 mV
Load Regulation (ΔI_O = 50 mA) . . . .1.5 mV

Fig. 14 - Basic high voltage regulator
(V_o = 7 to 37V)

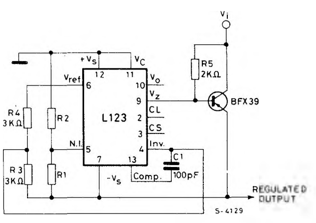


NOTE: $\frac{R1 \cdot R2}{R1 + R2}$ for minimum temperature drift.

R3 may be eliminated for minimum component count.

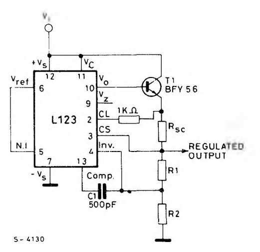
Typical performance
Regulated Output Voltage 15V
Line Regulation (ΔV_i = 3V) . . . . . . .1.5 mV
Load Regulation (ΔI_O = 50 mA) . . . .4.5 mV

Fig. 15 - Negative voltage regulator



Typical performance
Regulated Output Voltage . . . . -15V
Line Regulation (ΔV_i = 3V) . . . . 1 mV
Load Regulation (ΔI_O = 100 mA) . . . . 2 mV

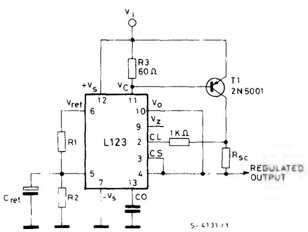
Fig. 16 - Positive voltage regulator (External NPN Pass Transistor)



Typical performance
Regulated Output Voltage . . . . +15V
Line Regulation (ΔV_i = 3V) . . . . . . .1.5 mV
Load Regulation (ΔI_O = 1A) . . . . . . 15 mV

APPLICATION INFORMATION (continued)

Fig. 17 - Positive voltage regulator (External PNP Pass Transistor)



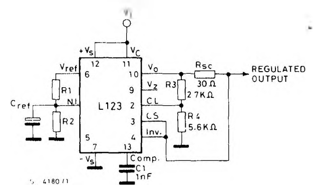
Typical performance

Regulated Output Voltage . . . . +5V

Line Regulation (ΔV_i = 3V) . . . . 0.5 mV

Load Regulation (ΔI_O = 1A) . . . . 5 mV

Fig. 18 - Foldback current limiting



Typical performance

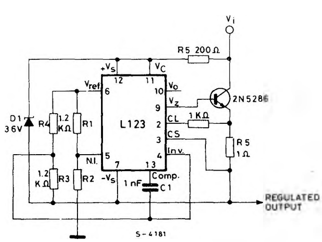
Regulated Output Voltage . . . . +5V

Line Regulation (ΔV_i = 3V) . . . . 0.5 mV

Load Regulation (ΔI_O = 10 mA) . . . . . 1 mV

Current Limit Knee . . . . 20 mA

Fig. 19 - Positive floating regulator



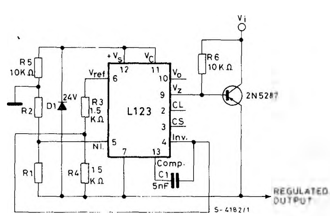
Typical performance

Regulated Output Voltage . . . . +100V

Line Regulation (ΔV_i = 20V) . . . . . . 15 mV

Load Regulation (ΔI_O = 50 mA) . . . . 20 mV

Fig. 20 - Negative floating regulator



Typical performance

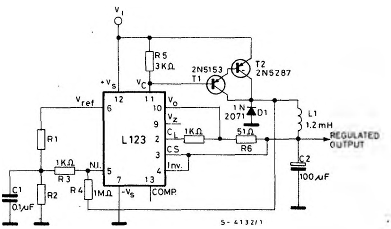
Regulated Output Voltage . . . . -100V

Line Regulation (ΔV_i = 20V) . . . . . . 30 mV

Load Regulation (ΔI_O = 100 mA) . . . 20 mV

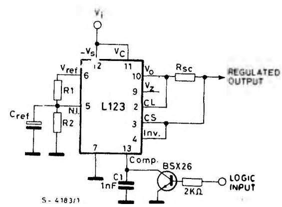
APPLICATION INFORMATION (continued)

Fig. 21 - Positive switching regulator



Typical performance
Regulated Output voltage . . . .+5V
Line Regulation ($\Delta V_i = 30V$) . . . . . . 10 mV
Load Regulation ($\Delta I_O = 2A$) . . . . . . 80 mV

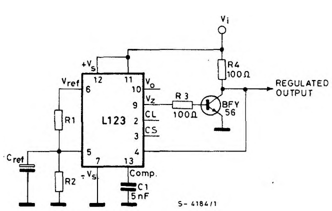
Fig. 22 - Remote shutdown regulator with current limiting



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

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

Fig. 23 - Shunt regulator



Typical performance
Regulated Output Voltage . . . .+5V
Line Regulation ($\Delta V_i = 10V$) . . . . . . .2 mV
Load Regulation ($\Delta I_O = 100$ mA) . . . .5 mV

Fig. 24 - Output voltage adjust