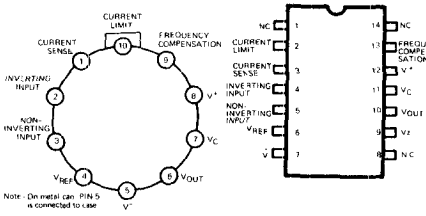
L 123 B1/T1

precision voltage regulator

STANDARD TEMPERATURE RANGE, 0°C ÷ 70°C

- **Positive or negative supply operation**
- **Series, shunt, switching or floating operation**
- **.01 % line and load regulation**
- **Output voltage adjustable from 2 to 37 volts**
- **Output current to 150 mA without external pass transistor**

CONNECTION DIAGRAM
TOP VIEW



The L 123 is a monolithic voltage regulator constructed on a single silicon chip using the Planar epitaxial process. The device consists of a temperature compensated reference amplifier, error amplifier, power series pass transistor and current limit circuitry. Additional NPN or PNP pass elements may be used when output currents exceeding 150 mA are required. Provisions are made for adjustable current limiting and remote shutdown. In addition to the above, the device features low standby current drain, low temperature drift and high ripple rejection. The L 123 is intended for use with positive or negative supplies as a series, shunt, switching or floating regulator. Applications include laboratory power supplies, isolation regulators for low level data amplifiers, logic card regulators, small instrument power supplies, airborne systems and in other power supplies for digital and linear circuits.

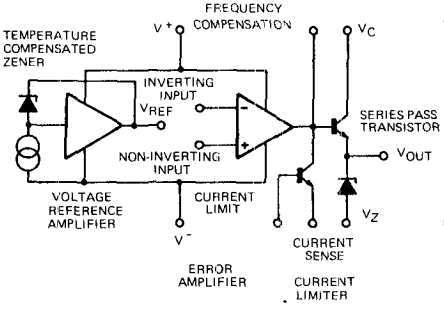
ABSOLUTE MAXIMUM RATINGS (1)

(T_A = 25° C unless otherwise noted)

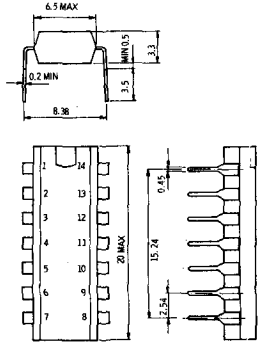
Voltage from V+ to V−	40 V
Input-Output Voltage Differential	40 V
Maximum Output Current	150 mA
Current from V_{REF}	25 mA
Internal Power Dissipation (1)	800 mW
Operating Temperature Range	0°C to + 70° C
Storage Temperature Range (Metal Can)	- 65° C to + 150° C
Storage Temperature Range (DIP)	- 55°C to + 125° C
Lead Temperature (Soldering, 60 sec.)	300° C

NOTE ON PAGE 2

EQUIVALENT CIRCUIT

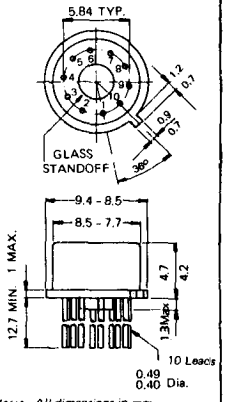


PHYSICAL DIMENSIONS
14-pin plastic DIP



Note : all dimensions in mm.

PHYSICAL DIMENSIONS
similar to
Jedec TO 100 outline



Notes All dimensions in mm.
Leads are gold-plated Kovar.

ORDERING NUMBER

L123 B1 (for TO 116 package)
L123 T1 (for TO 5 package)

ELECTRICAL CHARACTERISTICS (note 2)

PARAMETER (see definitions)	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Line Regulation	$V = 12$ V to $V = 15$ V		0.01	0.1	% V_{OUT}
	V_{IN}=12 V to $V_{IN} = 40$ V		0.1	0.5	% V_{OUT}
	$0°C \leq T_A \leq 70°C$, V_{IN}= 12V to V_{IN}= 15V			0.3	% V_{OUT}
Load Regulation	$I_L = 1$ mA to $I_L = 50$ mA		0.03	0.2	% V_{OUT}
	$0°C \leq T_A \leq 70°C$, $I_L = 1$ mA to $I_L = 50$ mA			0.6	% V_{OUT}
Ripple Rejection	f = 50 Hz to 10 kHz, $C_{REF} = 0$		74		dB
	f = 50 Hz to 10 kHz, $C_{REF} = 5\,\mu F$		86		dB
Average Temperature Coefficient of Output Voltage	$0°C \leq T_A \leq 70°C$		0.003	0.015	%/°C
Short Circuit Current Limit	$R_{SC} = 10\,\Omega$, $V_{OUT} = 0$		65		mA
Reference Voltage		6.80	7.15	7.50	V
Output Noise Voltage	BW = 100 Hz to 10 kHz, $C_{REF} = 0$		20		μV_{rms}
	BW = 100 Hz to 10 kHz, $C_{REF} = 5\,\mu F$		2.5		μV_{rms}
Long Term Stability			0.1		%/1000 hrs
Standby Current Drain	$I_L = 0$, $V_{IN} = 30$ V		2.3	4	mA
Input Voltage Range		9.5		40	V
Output Voltage Range		2		37	V
Input-Output Voltage Differential		3		38	V

DEFINITION OF TERMS

LINE REGULATION - The percentage change in output voltage for a specified change in input voltage.
LOAD REGULATION - The percentage change in output voltage for a specified change in load current.
RIPPLE REJECTION - The ratio of the peak to peak input ripple voltage to the peak to peak output ripple voltage.
AVERAGE TEMPERATURE COEFFICIENT OF OUTPUT VOLTAGE - The percentage change in output voltage for a specified change in ambient temperature.
SHORT CIRCUIT CURRENT LIMIT - The output current of the regulator with the output shorted to the negative supply.
REFERENCE VOLTAGE - The output of the reference amplifier measured with respect to the negative supply.
OUTPUT NOISE VOLTAGE - The rms output noise voltage with constant load and no input ripple.
STANDBY CURRENT DRAIN - The supply current drawn by the regulator with no output load and no reference voltage load.
INPUT VOLTAGE RANGE - The range of supply voltage over which the regulator will operate.
OUTPUT VOLTAGE RANGE - The range of output voltage over which the regulator will operate.
INPUT-OUTPUT VOLTAGE DIFFERENTIAL - The range of voltage difference between the supply voltage and the regulated output voltage over which the regulator will operate.
SENSE VOLTAGE - The voltage between current sense and current limit terminals necessary to cause current limiting.
TRANSIENT RESPONSE - The closed-loop step function response of the regulator under small-signal conditions.

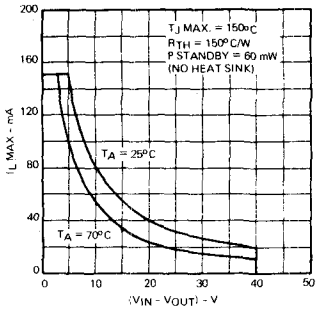
NOTES:

(1) Derate metal can package at 6.4 mW/°C and dual in-line package at 8 mW/°C for operation at ambient temperatures above 25°C.
(2) Unless otherwise specified, $T_A = 25°C$, $V_{IN} = V+ = V_C = 12$ V, $V- = 0$, $V_{OUT} = 5$ V, $I_L = 1$ mA, $R_{SC} = 0$, $C_I = 100$ pF and divider impedance as seen by the error amplifier ≤ 10 KΩ.
(3) For metal can applications where V_Z is required, an external 6,2 zener should be connected in series with V_{OUT}.
(4) Figures in parentheses may be used if R_1/R_2 divider is placed on opposite of error amp.
(5) Replace R_1/R_2 in figures with divider shown in figure 13.
(6) V+ and V_C must be connected to a + 3 V or greater supply.
(7) L_1 is 40 turns of # 20 enameled copper wire wound on Ferroxcube P36/22-3B7 pot core or equivalent with 0,23 mm. air gap.

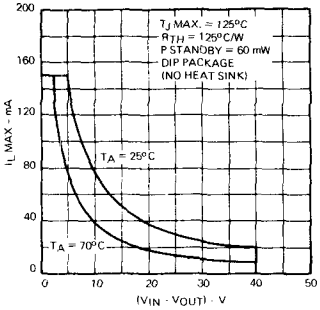
STANDARD TEMPERATURE RANGE

TYPICAL ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

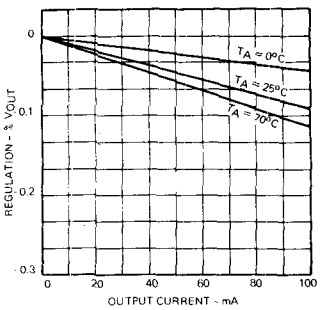
MAXIMUM LOAD CURRENT AS A FUNCTION OF INPUT-OUTPUT VOLTAGE DIFFERENTIAL



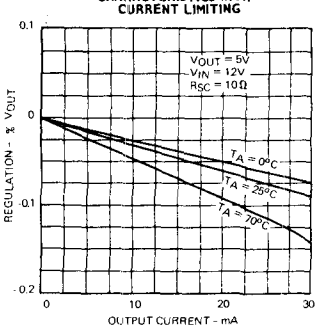
MAXIMUM LOAD CURRENT AS A FUNCTION OF INPUT - OUTPUT VOLTAGE DIFFERENTIAL



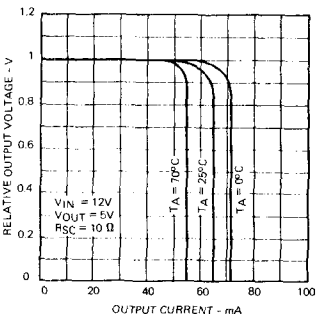
LOAD REGULATION CHARACTERISTICS WITHOUT CURRENT LIMITING



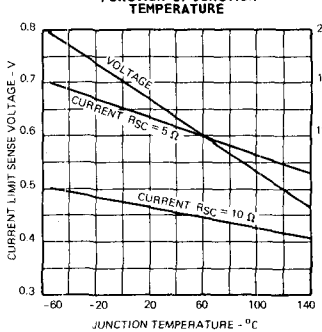
LOAD REGULATION CHARACTERISTICS WITH CURRENT LIMITING



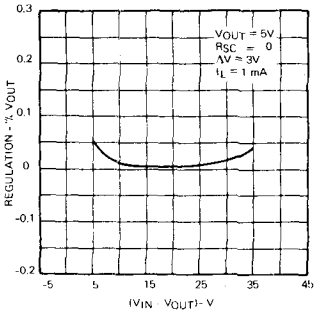
CURRENT LIMITING CHARACTERISTICS



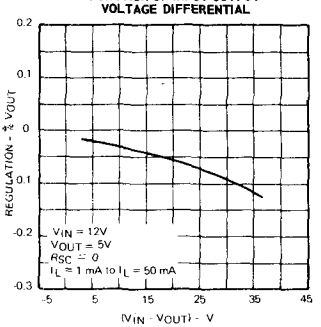
CURRENT LIMITING CHARACTERISTICS AS A FUNCTION OF JUNCTION TEMPERATURE



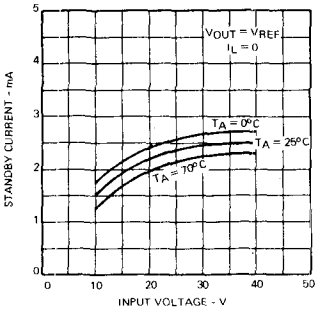
LINE REGULATION AS A FUNCTION OF INPUT - OUTPUT VOLTAGE DIFFERENTIAL



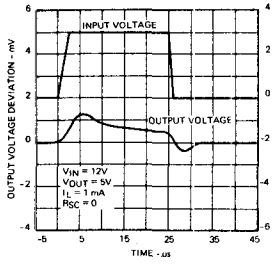
LOAD REGULATION AS A FUNCTION OF INPUT-OUTPUT VOLTAGE DIFFERENTIAL



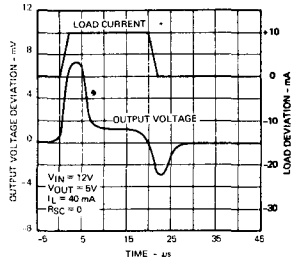
STANDBY CURRENT DRAIN AS A FUNCTION OF INPUT VOLTAGE



LINE TRANSIENT RESPONSE



LOAD TRANSIENT RESPONSE



OUTPUT IMPEDANCE AS A FUNCTION OF FREQUENCY

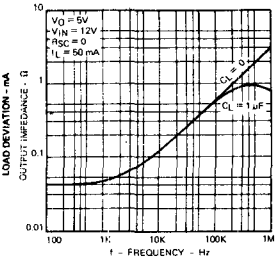


TABLE I
RESISTOR VALUES (KΩ) FOR STANDARD OUTPUT VOLTAGES

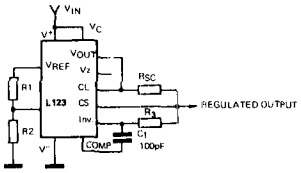
POSITIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		OUTPUT ADJUSTABLE ± 10%(Note 5)			NEGATIVE OUTPUT VOLTAGE	APPLICABLE FIGURES	FIXED OUTPUT ±5%		5% OUTPUT ADJUSTABLE ± 10%		
	(Note 4)	R_1	R_2	R_1	P_1	R_2			R_1	R_2	R_1	P_1	R_2
+ 3	1, 5, 6, 9 12 (4)	4.12	3.01	1.8	0.5	1.2	+ 100	7	3.57	102	2.2	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	1, 5, 6, 9, 12 (4)	2.55	4.99	0.75	0.5	2.2	- 6 (note 6)	3, (10)	3.57	2.43	1.2	0.5	0.75
+ 6	1, 5, 6, 9, 12 (4)	1.55	6.04	0.5	0.5	2.7	- 9	3, 10	3.48	5.36	1.2	0.5	2
+ 9	2, 4, (5,6, 12, 9)	1.87	7.15	0.75	1	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	1	3	- 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	3	- 28	3, 10	3.57	24.3	1.2	0.5	10
+28	2, 4, (5, 6, 9, 12)	21	7.15	5.6	1	2	- 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)] $V_{OUT} = [V_{REF} \times \frac{R_2}{R_1 + R_2}]$	**Outputs from +4 to +250 volts [Figure 7]** $V_{OUT} = [\frac{V_{REF}}{2} \times \frac{R_2 - R_1}{R_1}]$; $R_3 = R_4$	**Current Limiting** $I_{LIMIT} = \frac{V_{SENSE}}{R_{SC}}$
Outputs from +7 to +37 volts [Figures 2, 4, (5, 6, 9, 12)] $V_{OUT} = [V_{REF} \times \frac{R_1 + R_2}{R_2}]$	**Outputs from −6 to −250 volts [Figures 3, 8, 10]** $V_{OUT} = [\frac{V_{REF}}{2} \times \frac{R_1 + R_2}{R_1}]$; $R_3 = R_4$	**Foldback Current Limiting** $I_{KNEE} = [\frac{V_{OUT} R_3}{R_{SC} R_4} + \frac{V_{SENSE}(R_3 + R_4)}{R_{SC} R_4}]$ $I_{SHORT\ CKT} = [\frac{V_{SENSE}}{R_{SC}} \times \frac{R_3 + R_4}{R_4}]$

BASIC LOW VOLTAGE REGULATOR FIG. 1

(V_{OUT} = 2 to 7 V)



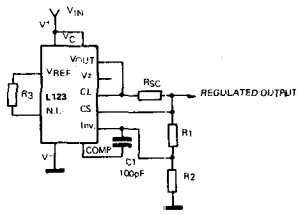
NOTE: $R3 = \frac{R1 \cdot R2}{R1+R2}$ for minimum temperature drift.
R3 may be eliminated for minimum component count.

TYPICAL PERFORMANCE

Regulated output Voltage	5 V
Line Regulation (ΔV_{IN} = 3 V)	0.5mV
Load Regulation (ΔI_L = 50mA)	1.5mV

BASIC HIGH VOLTAGE REGULATOR FIG. 2

(V_{OUT} = 7 to 37 V)

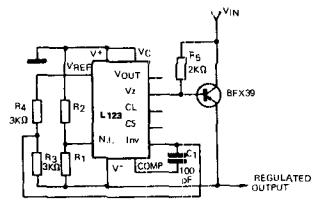


NOTE: $R3 = \frac{R1 \cdot R2}{R1+R2}$ for minimum temperature drift.
R3 may be eliminated for minimum component count.

TYPICAL PERFORMANCE

Regulated Output Voltage	15 V
Line Regulation (ΔV_{IN} = 3 V)	1.5mV
Load Regulation (ΔI_L = 50mA)	4.5mV

NEGATIVE VOLTAGE REGULATOR FIG. 3



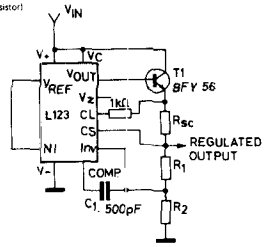
NOTE 3

TYPICAL PERFORMANCE

Regulated Output Voltage	*15 V*
Line Regulation (ΔV_{IN} = 3 V)	1mV
Load Regulation (ΔI_L = 100mA)	2mV

POSITIVE VOLTAGE REGULATOR FIG. 4

(External NPN Pass Transistor)

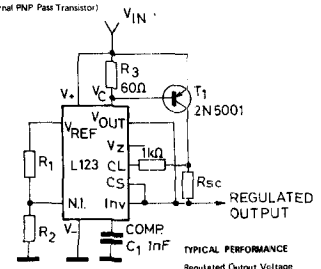


TYPICAL PERFORMANCE

Regulated Output Voltage	*+ 15 V*
Line Regulation (ΔV_{IN} = 3 V)	1.5mV
Load Regulation (ΔI_L = 1 A)	15mV

POSITIVE VOLTAGE REGULATOR FIG. 5

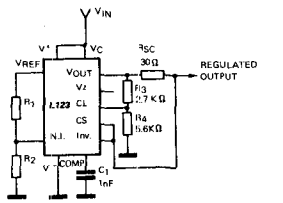
(External PNP Pass Transistor)



TYPICAL PERFORMANCE

Regulated Output Voltage	+ 5 V
Line Regulation (ΔV_{IN} = 3 V)	0.5mV
Load Regulation (ΔI_L = 1 A)	5mV

FOLDBACK CURRENT LIMITING FIG. 6

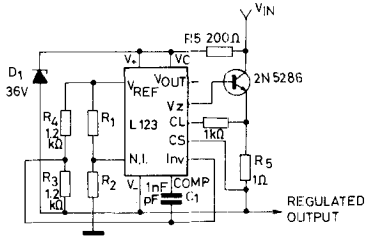


TYPICAL PERFORMANCE

Regulated Output Voltage	+ 5 V
Line Regulation (ΔV_{IN} = 3 V)	0,5mV
Load Regulation (ΔI_L = 10mA)	1mV
Current Limit Knee	20mA

POSITIVE FLOATING REGULATOR

FIG. 7



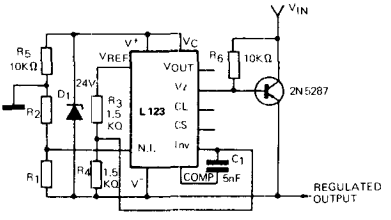
TYPICAL PERFORMANCE

Regulated Output Voltage	+ 100 V
Line Regulation (ΔV_{IN} = 20V)	15 mV
Load Regulation (ΔI_L = 50 mA)	20 mV

NOTE 3

NEGATIVE FLOATING REGULATOR

FIG. 8



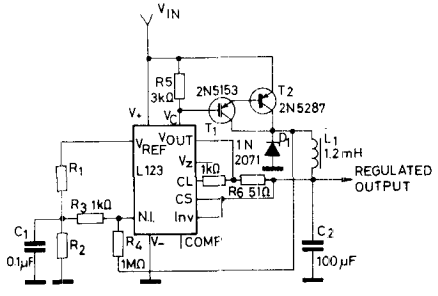
TYPICAL PERFORMANCE

Regulated Output Voltage	- 100 V
Line Regulation (ΔV_{IN} = 20 V)	30 mV
Load Regulation (ΔI_L = 100 mA)	20 mV

NOTE 3

POSITIVE SWITCHING REGULATOR

FIG. 9



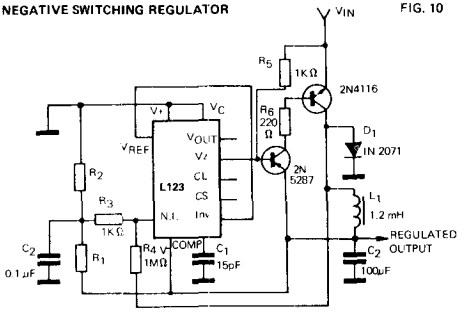
TYPICAL PERFORMANCE

Regulated Output Voltage	+ 5 V
Line Regulation (ΔV_{IN} = 30V)	10 mV
Load Regulation (ΔI_L = 2A)	80 mV

NOTE 7

NEGATIVE SWITCHING REGULATOR

FIG. 10



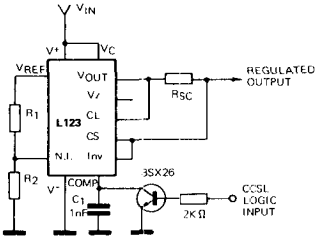
TYPICAL PERFORMANCE

Regulated Output Voltage	- 15 V
Line Regulation (ΔV_{IN} = 20 V)	8 mV
Load Regulation (ΔI_L = 2 A)	6 mV

NOTE 3
NOTE 7

REMOTE SHUTDOWN REGULATOR WITH CURRENT LIMITING

FIG. 11



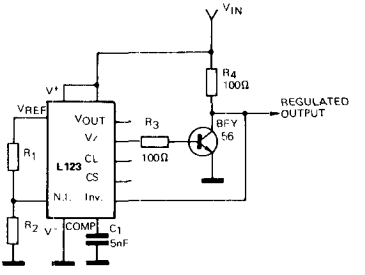
NOTE: Current limit transistor may be used for shutdown if current limiting is not required.

TYPICAL PERFORMANCE

Regulated Output Voltage	5 V
Line Regulation (ΔV_{IN} = 3 V)	0.5 mV
Load Regulation (ΔI_L = 50 mA)	1.5 mV

SHUNT REGULATOR

FIG. 12



TYPICAL PERFORMANCE

Regulated Output Voltage	+ 5 V
Line Regulation (ΔV_{IN} = 10V)	2 mV
Load Regulation (ΔI_L = 100 mA)	5 mV

NOTE 3

OUTPUT VOLTAGE ADJUST

FIG. 13