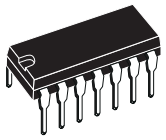
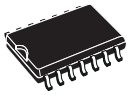
LM723

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



DIP-14

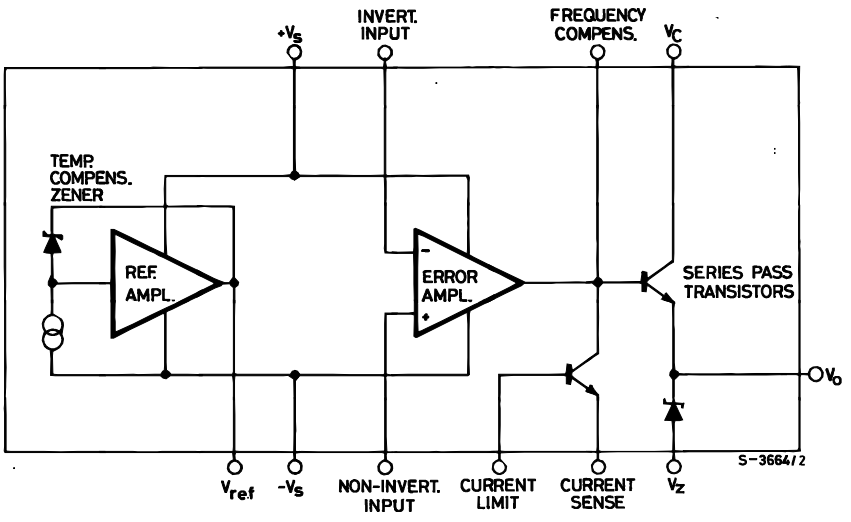


SO-14

DESCRIPTION

The LM723 is a monolithic integrated programmable voltage regulator, assembled in 14-lead dual in-line plastic and SO-14 micro package. 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.

SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

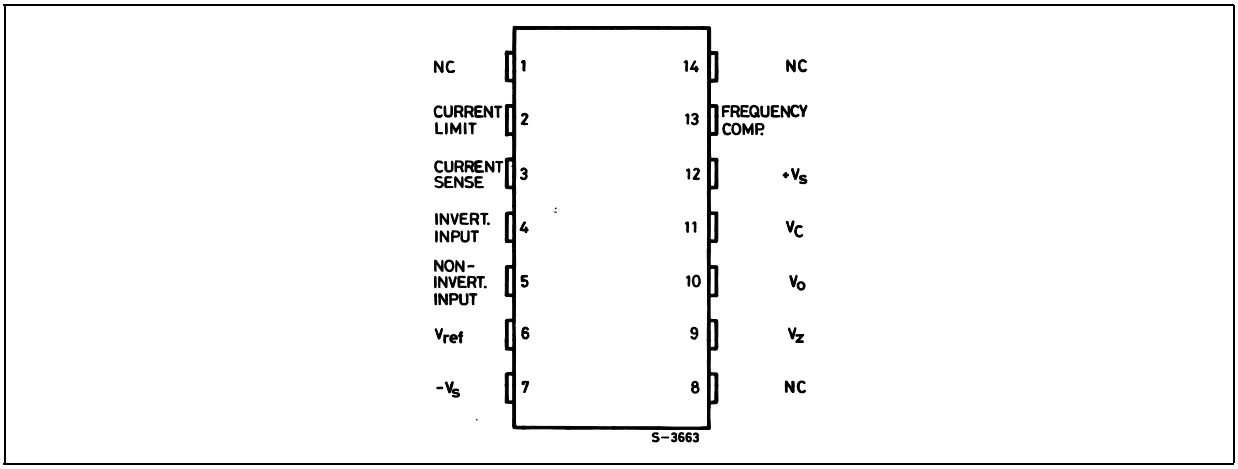
Symbol	Parameter	Value		Unit
		LM723	LM723C	
V_I	DC Input Voltage	40	40	V
ΔV_{I-O}	Dropout Voltage	40	40	V
I_O	Output Current	150	150	mA
I_{REF}	Current from V_{REF}	15	25	mA
T_{op}	Operating Temperature	-55 to 125	0 to 70	°C
T_{stg}	Storage Temperature	-65 to 150	-65 to 150	°C
T_J	Junction Temperature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

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

THERMAL DATA

Symbol	Parameter		DIP14	SO-14	Unit
$R_{thj-amb}$	Thermal Resistance Junction-Ambient	Max	200	160	°C/W

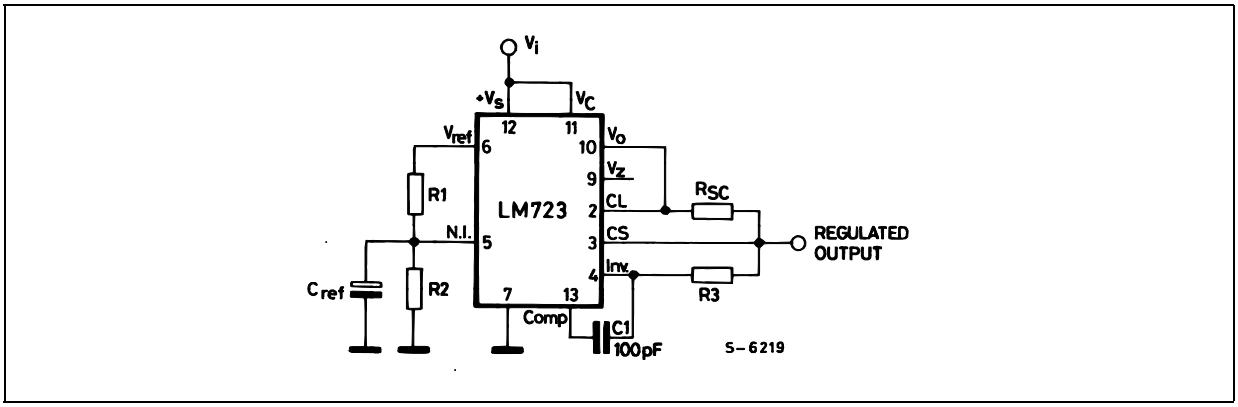
PIN CONNECTION (top view)



ORDERING CODES

TYPE	DIP-14	SO-14
LM723	LM723N	
LM723C	LM723CN	LM723CD

TEST CIRCUITS (pin configuration relative to the plastic package)



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

ELECTRICAL CHARACTERISTICS FOR LM723 (refer to the test circuits, T_{amb} = 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		

ELECTRICAL CHARACTERISTICS FOR LM723C (refer to the test circuits, T_{amb} = 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		

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

Figure 1 : Maximum Output Current vs Voltage Drop

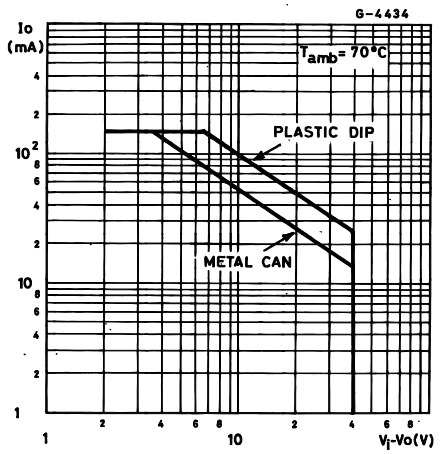


Figure 2 : Current Limiting Characteristics

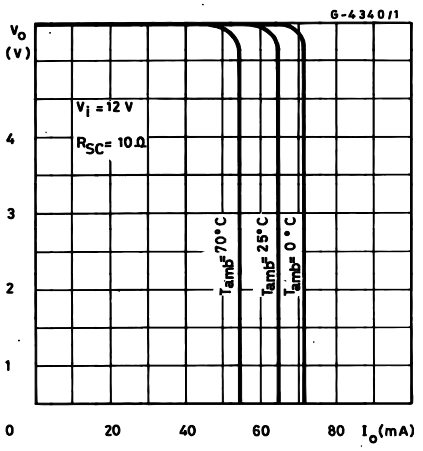


Figure 3 : Current Limiting Characteristics vs Junction Temperature

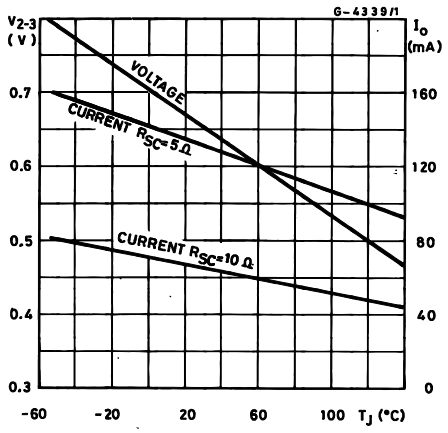


Figure 4 : Load Regulation Characteristics without Current Limiting

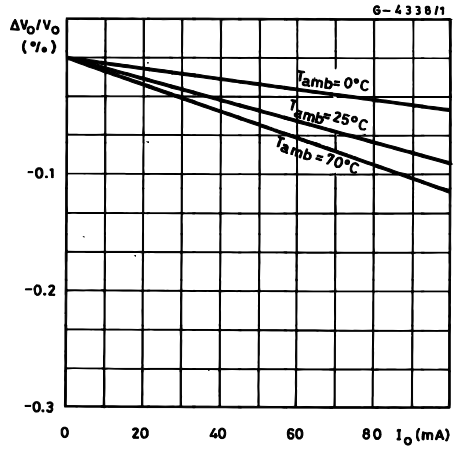


Figure 5 : Load Regulation Characteristics with Current Limiting

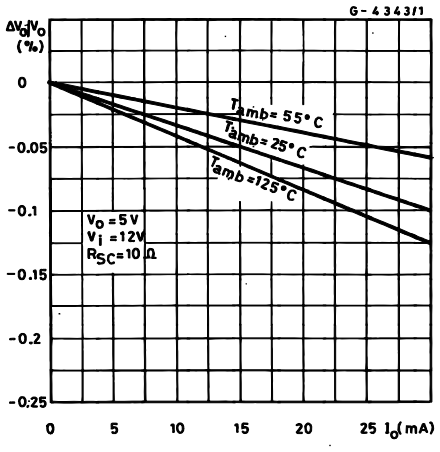


Figure 6 : Load Regulation Characteristics with Current Limiting

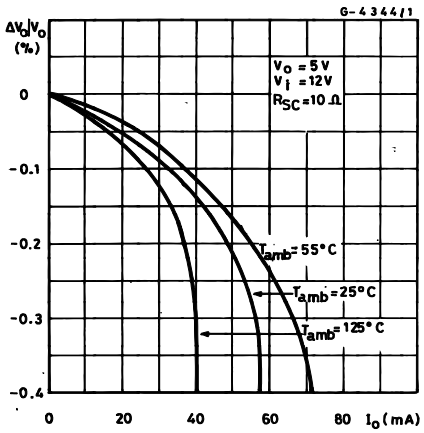


Figure 7 : Line Regulation vs Voltage Drop

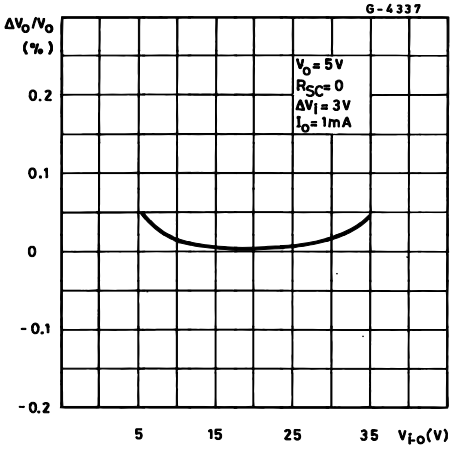


Figure 8 : Load Regulation vs Voltage Drop

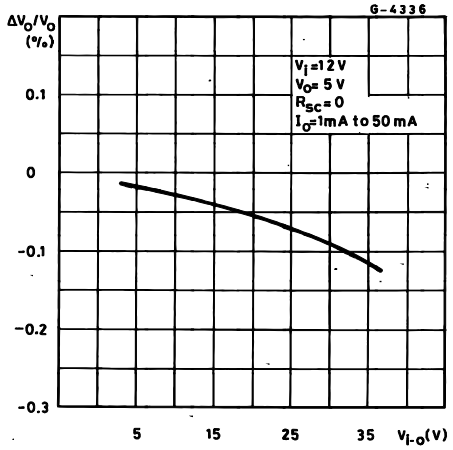


Figure 9 : Quiescent Drain Current vs Input Voltage

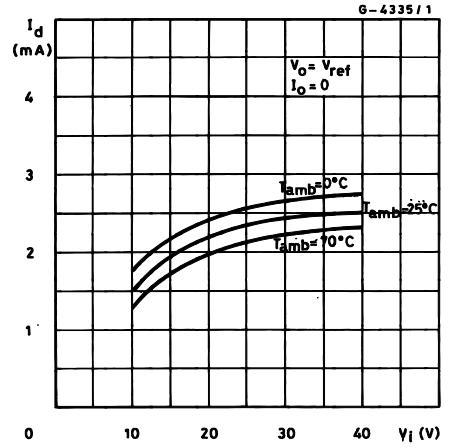


Figure 10 : Line Transient Response

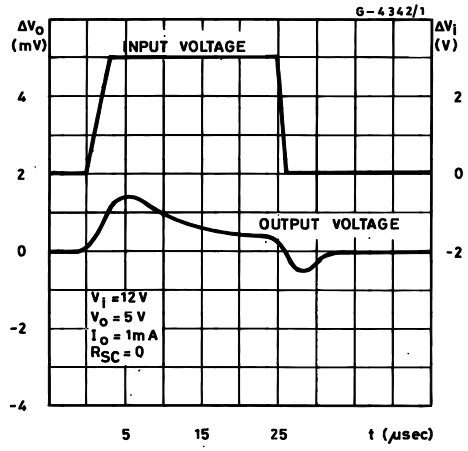


Figure 11 : Load Transient Response

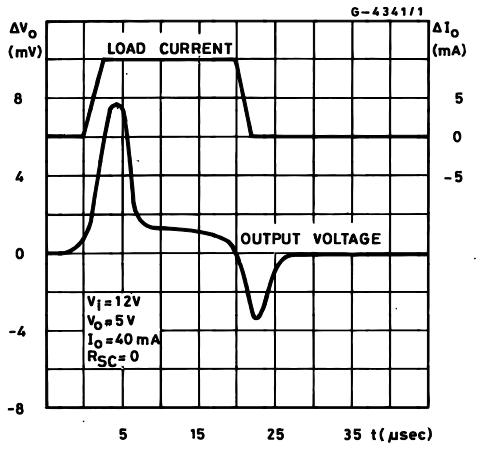


Figure 12 : Output Impedance vs Frequency

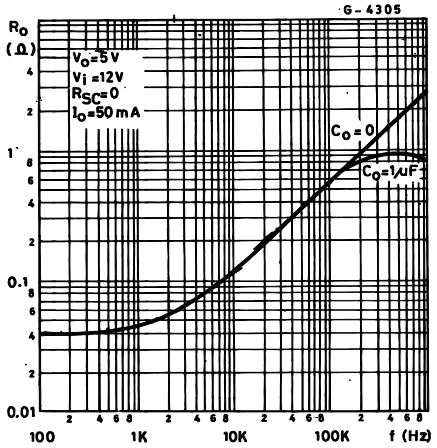


TABLE 1: Resistor Values (KΩ) for standard Output Voltages

Output Voltage	Applicable Figures	Fixed Output ± 5%		Output Adjustable ± 10% *		
		R1	R2	R1	P1	R2
+3	13, 16, 17, 18, 21, 23	4.12	3.01	1.8	0.5	1.2
+5	13, 16, 17, 18, 21, 23	2.15	4.99	0.75	0.5	2.2
+6	13, 16, 17, 18, 21, 23	1.15	6.04	0.5	0.5	2.7
+9	14, 16, 17, 18, 21, 23	1.87	7.15	0.75	1	2.7
+12	14, 16, 17, 18, 21, 23	4.87	7.15	2	1	3
+15	14, 16, 17, 18, 21, 23	7.87	7.15	3.3	1	3
+28	14, 16, 17, 18, 21, 23	21	7.15	5.6	1	2
+45	19	3.57	48.7	2.2	10	39
+75	19	3.57	78.7	2.2	10	68
+100	19	3.57	102	2.2	10	91
+250	19	3.57	255	2.2	10	240
-6**	15	3.57	2.43	1.2	0.5	0.75
-9	15	3.48	5.36	1.2	0.5	2
-12	15	3.57	8.45	1.2	0.5	3.3
-15	15	3.65	11.5	1.2	0.5	4.3
-28	15	3.57	24.3	1.2	0.5	10
-45	20	3.57	21.2	2.2	10	33
-100	20	3.57	97.6	2.2	10	91
-250	20	3.57	249	2.2	10	240

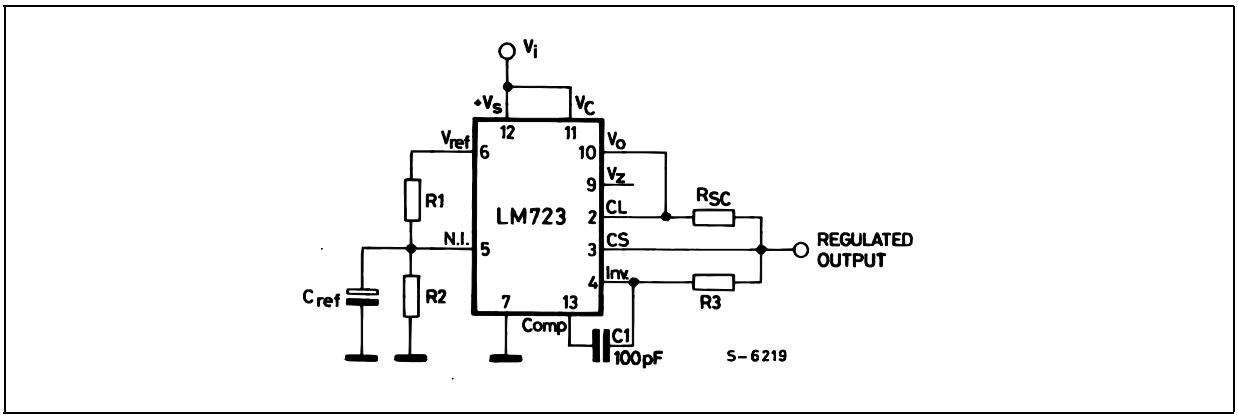
* Replace R1/R2 divider with the circuit of fig. 24.
** V+ must be connected to a +3V or greater supply.

TABLE 2: Formula for Intermediate Output Voltages

Outputs from 2 to 7V Fig. 13, 16, 17, 18, 21, 23 $V_O=(V_{REF}xR_2)/(R_1+R_2)$	Outputs from 4 to 250V Fig. 19 $V_O=(V_{REF}/2)x[(R_2-R_1)/R_1]$; $R_3=R_4$	Current Limit $I_{LIMIT}=V_{SENSE}/R_{SC}$
Outputs from 7 to 37V Fig. 14, 16, 17, 18, 21, 23 $V_O=V_{REF}x[(R_1+R_2)/R_2]$	Outputs from -6 to -250V Fig. 15, 20 $V_O=(V_{REF}/2)x[(R_1+R_2)/R_1]$; $R_3=R_4$	Foldback Current Limiting $I_{KNEE}=[(V_OxR_3)/(R_{SC}xR_4)]x[V_{SENSE}x(R_3+R_4)]/(R_{SC}xR_4)$ $I_{SHORTCKT}=(V_{SENSE}/R_{SC})x[(R_3+R_4)/R_4]$

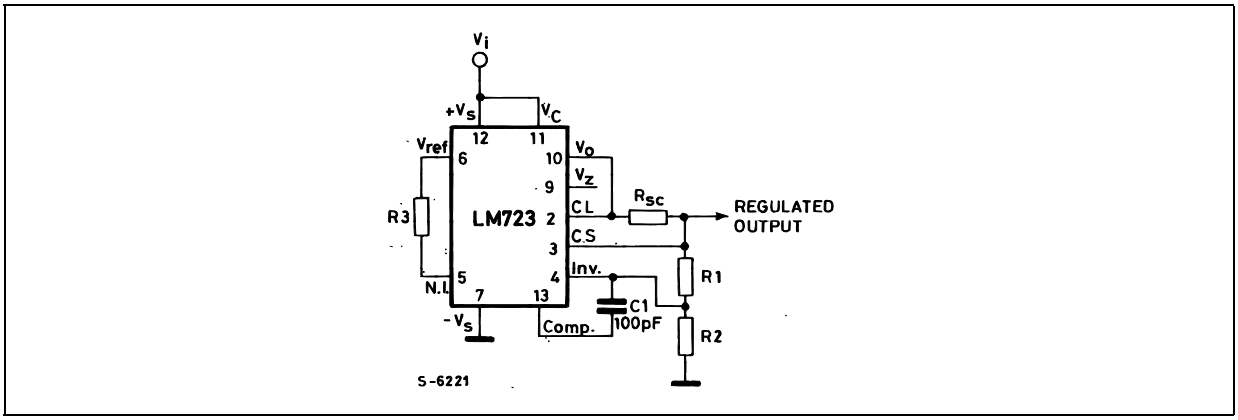
APPLICATIONS INFORMATION

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



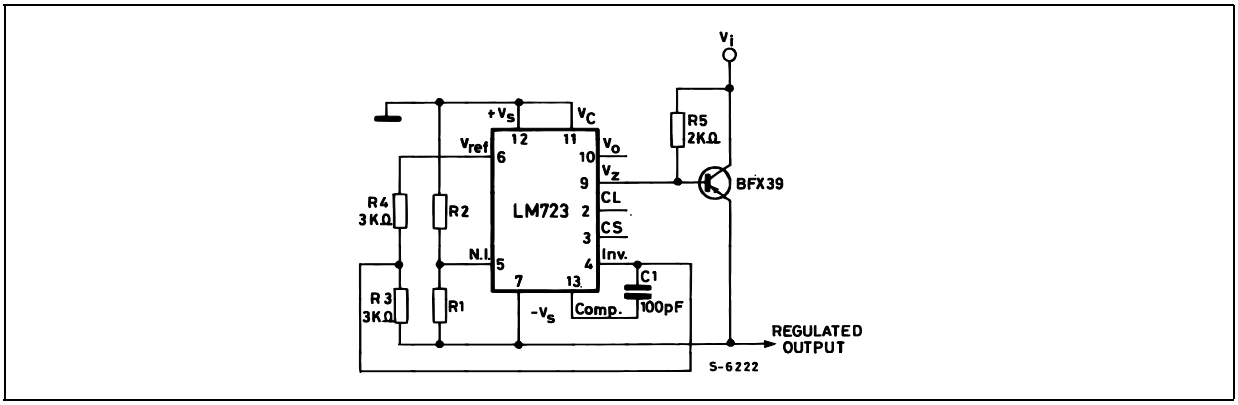
NOTE: $R_3 = (R_1 x R_2)/(R_1+R_2)$ for minimum temperature drift.
R_3 may be eliminated for minimum component count.
Typical performance
Regulated Output Voltage.....5V
Line Regulation (ΔV_I = 3V).....0.5mV
Load Regulation (ΔI_O = 50mA)...1.5mV

Figure 14 : Basic High Voltage Regulator (V_O = 7 to 37V)



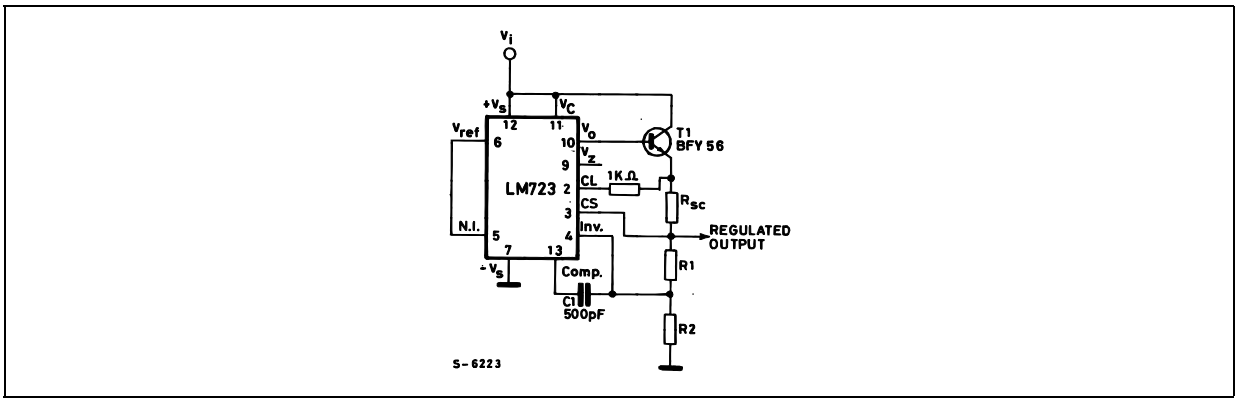
NOTE: $R_3 = (R_1 x R_2)/(R_1+R_2)$ for minimum temperature drift.
R_3 may be eliminated for minimum component count.
Typical performance
Regulated Output Voltage.....15V
Line Regulation (ΔV_I = 3V).....1.5mV
Load Regulation (ΔI_O = 50mA).....4.5mV

Figure 15 : Negative Voltage Regulator



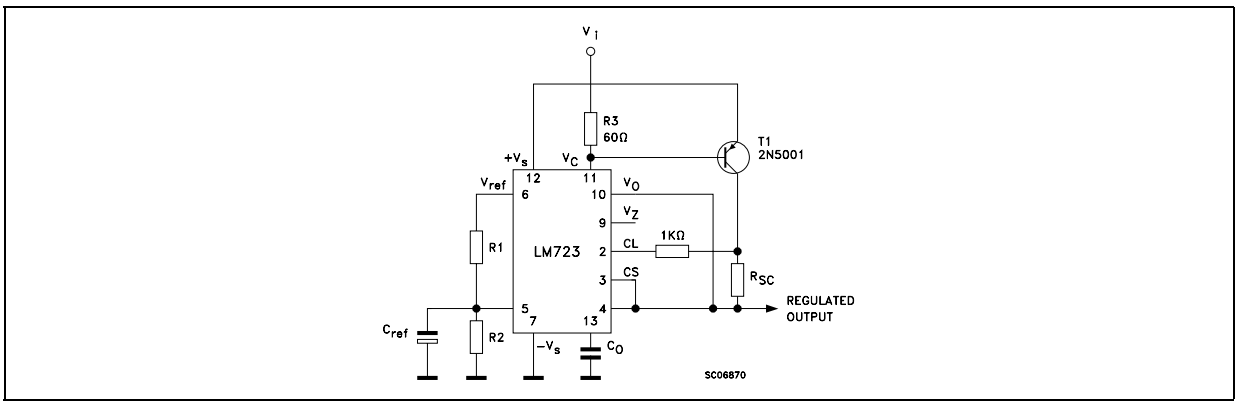
Typical performance
Regulated Output Voltage.....15V
Line Regulation (ΔV_I = 3V).....1mV
Load Regulation (ΔI_O = 100mA).....2mV

Figure 16 : Positive Voltage Regulator (External NPN Pass Transistor)



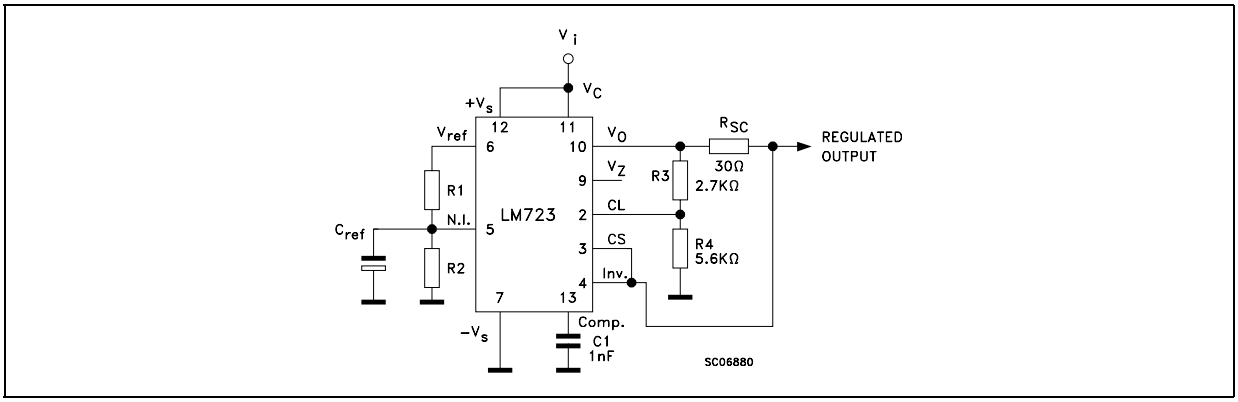
Typical performance
Regulated Output Voltage.....15V
Line Regulation (ΔV_I = 3V).....1.5mV
Load Regulation (ΔI_O = 1A).....15mV

Figure 17 : Positive Voltage Regulator (External PNP Pass Transistor)



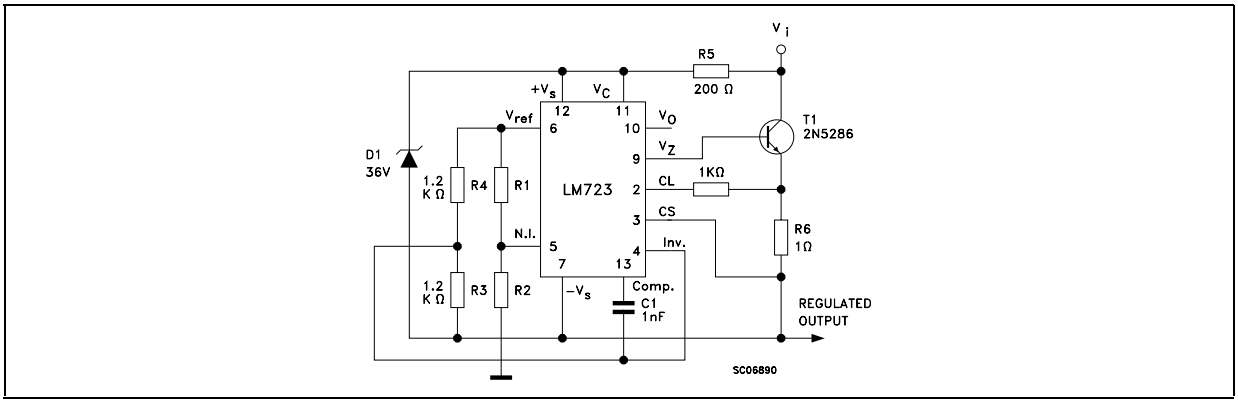
Typical performance
Regulated Output Voltage.....5V
Line Regulation (ΔV_I = 3V).....0.5mV
Load Regulation (ΔI_O = 1A).....1.5mV

Figure 18 : Foldback current limiting



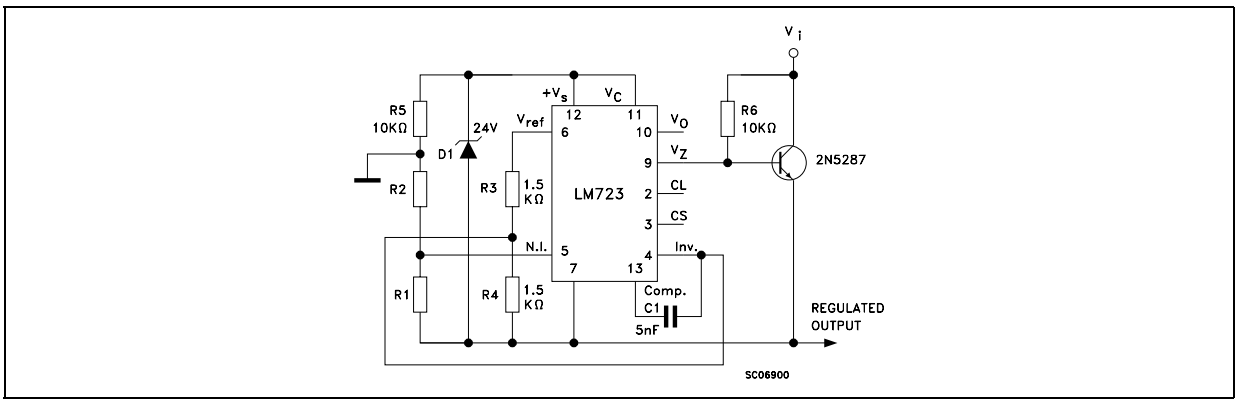
Typical performance
Regulated Output Voltage.....5V
Line Regulation (ΔV_I = 3V).....0.5mV
Load Regulation (ΔI_O = 10mA).....1mV
Current Limit Knee.....20mA

Figure 19 : Positive Floating Regulator



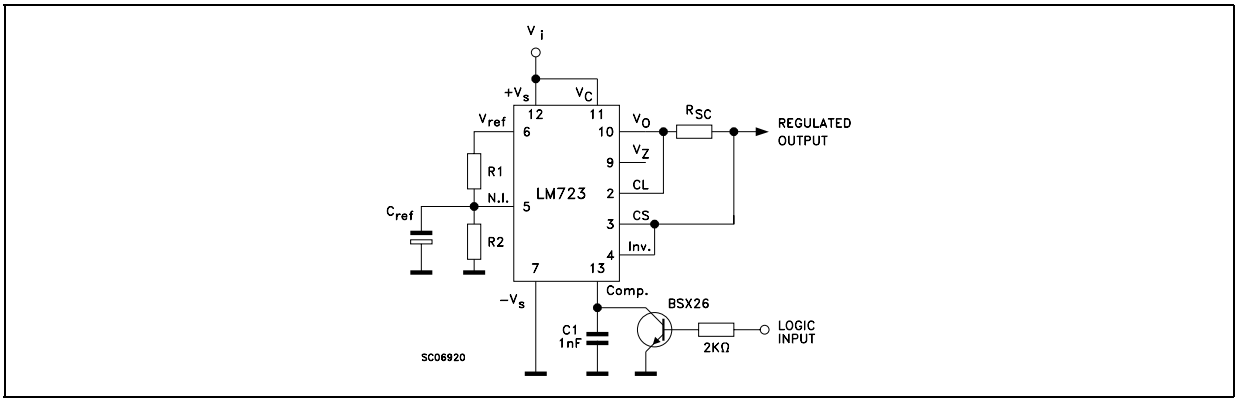
Typical performance
Regulated Output Voltage.....100V
Line Regulation (ΔV_I = 20V).....15mV
Load Regulation (ΔI_O = 50mA).....20mV

Figure 20 : Negative Floating Regulator



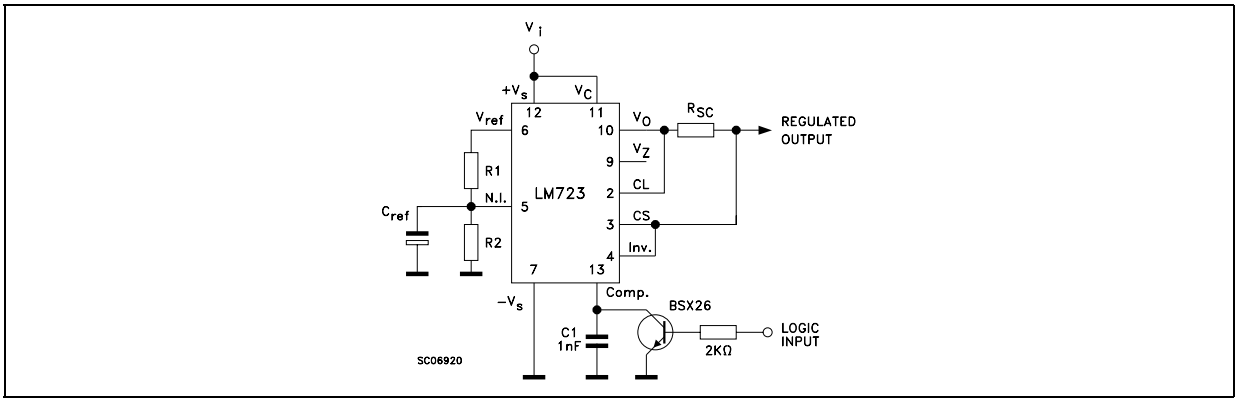
Typical performance
Regulated Output Voltage.....-100V
Line Regulation (ΔV_I = 20V).....30mV
Load Regulation (ΔI_O = 100mA).....20mV

Figure 21 : Positive Switching Regulator



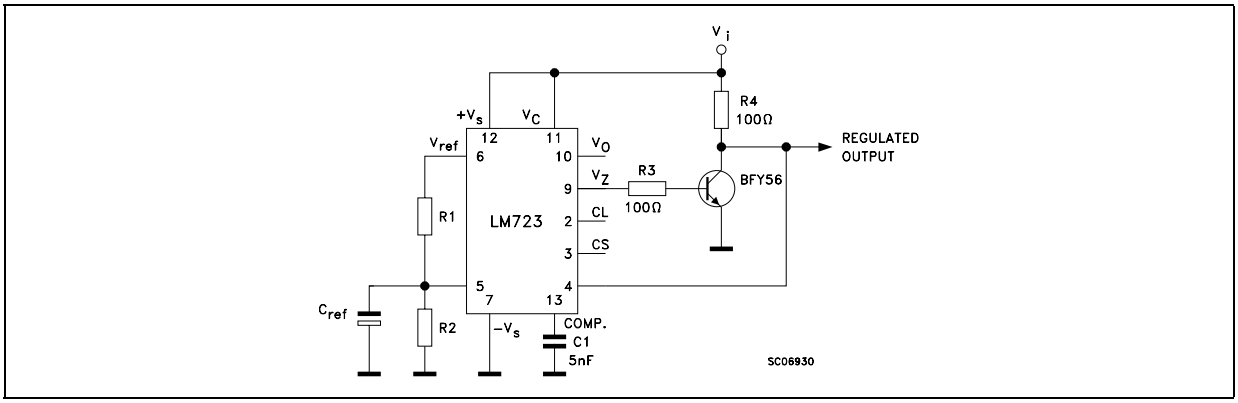
Typical performance
Regulated Output Voltage.....5V
Line Regulation (ΔV_I = 30V).....10mV
Load Regulation (ΔI_O = 2A).....80mV

Figure 22 : Remote Shutdown Regulator with Current Limiting



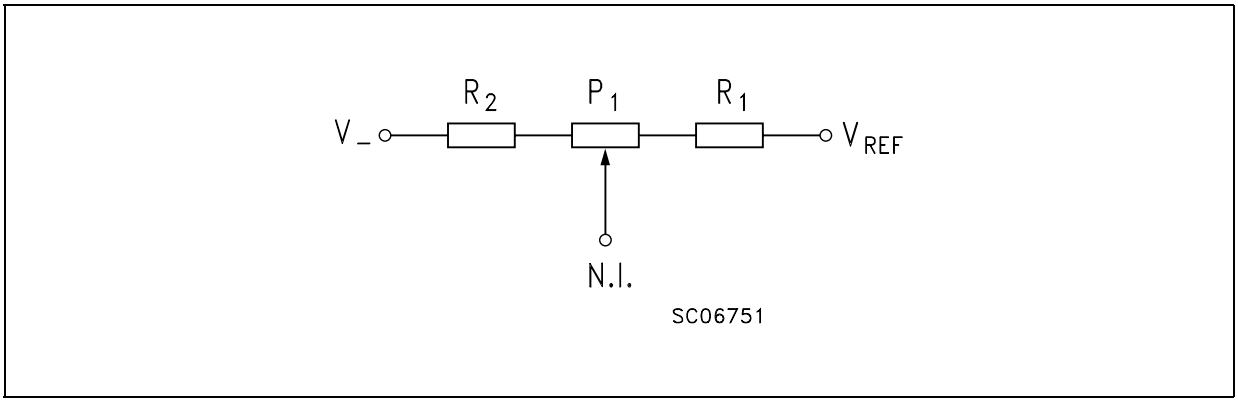
Note: current limit transistor may be used for shutdown if current limiting is not required.
Typical performance
Regulated Output Voltage.....5V
Line Regulation (ΔV_I = 3V).....0.5mV
Load Regulation (ΔI_O = 50mA).....1.5mV

Figure 23 : Shunt Regulator



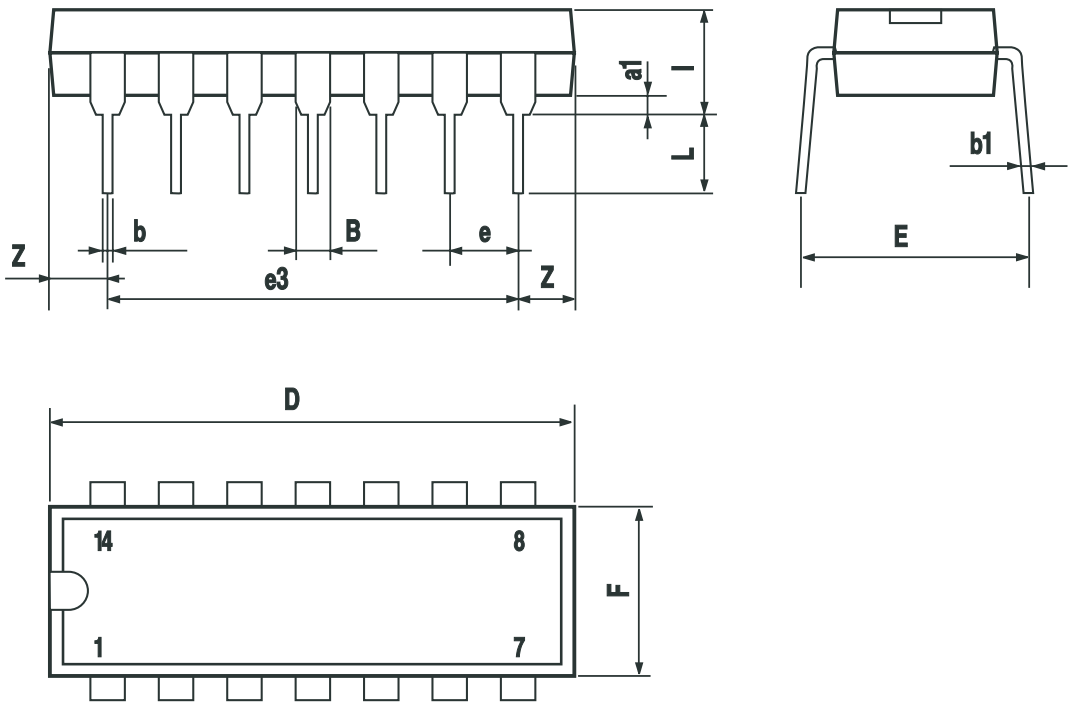
Typical performance
Regulated Output Voltage.....5V
Line Regulation (ΔV_I = 10V).....2mV
Load Regulation (ΔI_O = 100mA).....5mV

Figure 24 : Output Voltage Adjust



Plastic DIP-14 MECHANICAL DATA

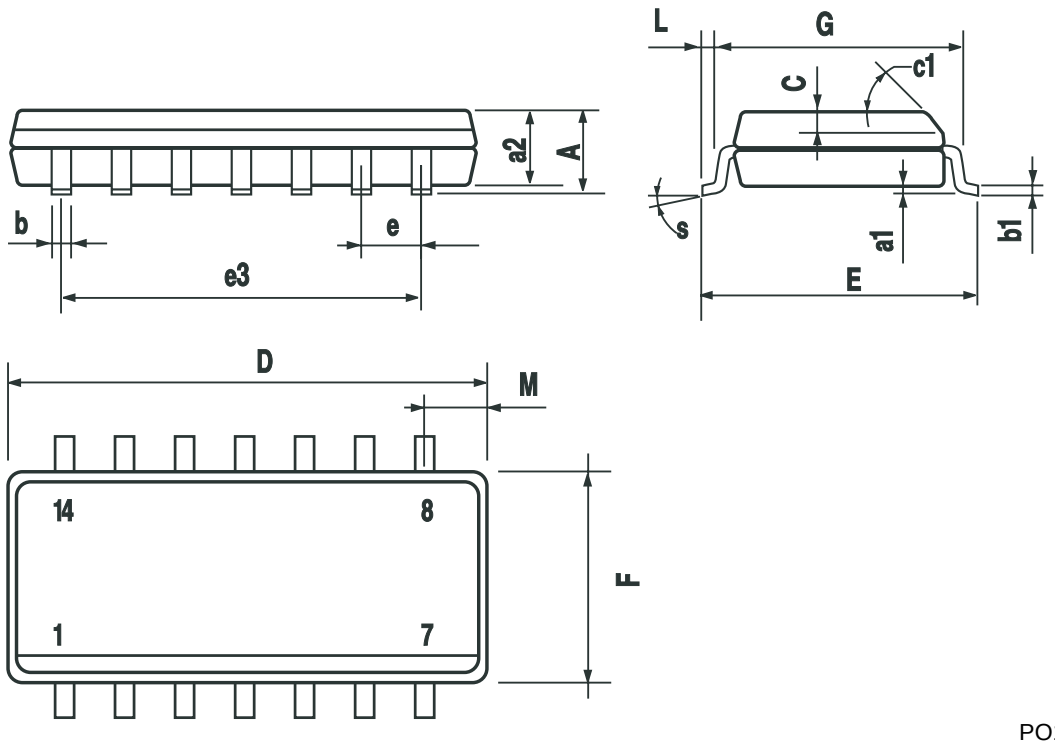
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100



P001A

SO-14 MECHANICAL DATA

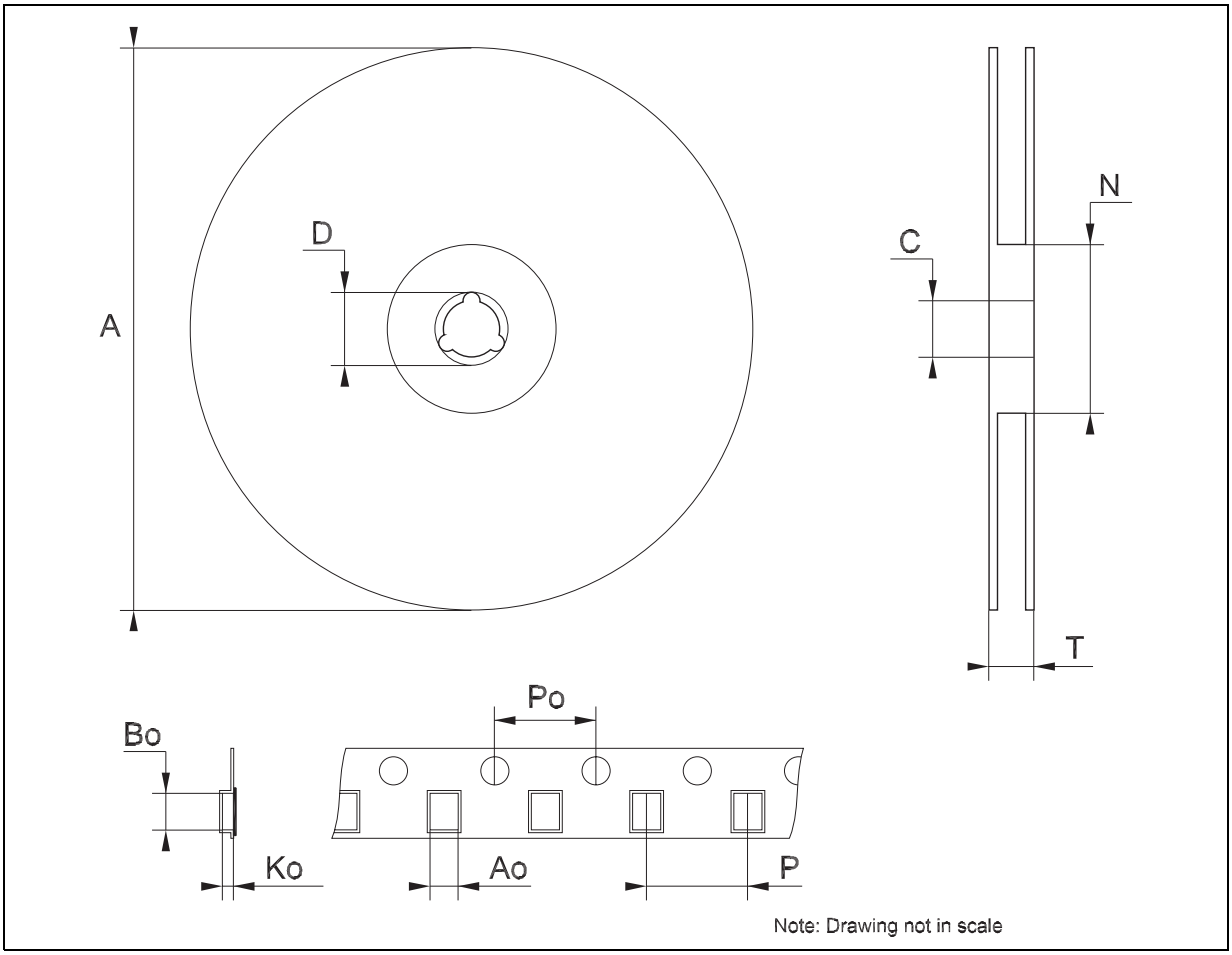
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



PO13G

Tape & Reel SO-14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.4		6.6	0.252		0.260
Bo	9		9.2	0.354		0.362
Ko	2.1		2.3	0.082		0.090
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319



Note: Drawing not in scale