SGS-THOMSON MICROELECTRONICS

LM134
LM234-LM334

THREE TERMINAL ADJUSTABLE CURRENT SOURCES

- OPERATES from 1 V to 40 V
- 0.02 % V CURRENT REGULATION
- PROGRAMMABLE from 1 µA to 10 mA
- ± 3 % INITIAL ACCURATY

Z
TO92
(Plastic Package)

(order code at the end of the Datasheet)

DESCRIPTION

The LM134/LM234/LM334 are 3-terminal adjustable current sources characterized by :

- an operating current range of 10000 : 1
- an excellent current regulation
- a wide dynamic voltage range of 1 V to 40 V

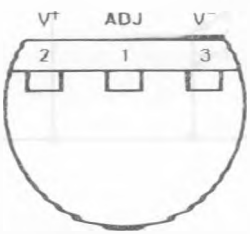
The current is determined by an external resistor without requiring other external components.

Reverse voltages of up to 20 V will only draw a current of several microamperes. This enables the circuit to operate as a rectifier and as a source of current in a.c. applications.

For the LM134/LM234/LM334, the voltage on the control pin is 64 mV at + 25 °C and is directly proportional to the absolute temperature (°K). The simplest external resistor connection generates a current with ≈ 0.33 %/°C temperature dependence. Zero drift can be obtained by adding an additional resistor and a diode to the external circuit.

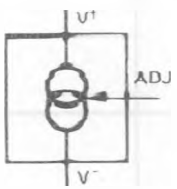
PIN CONNECTION

(bottom view)



E88LM134-01

BLOCK DIAGRAM



E88LM134-02

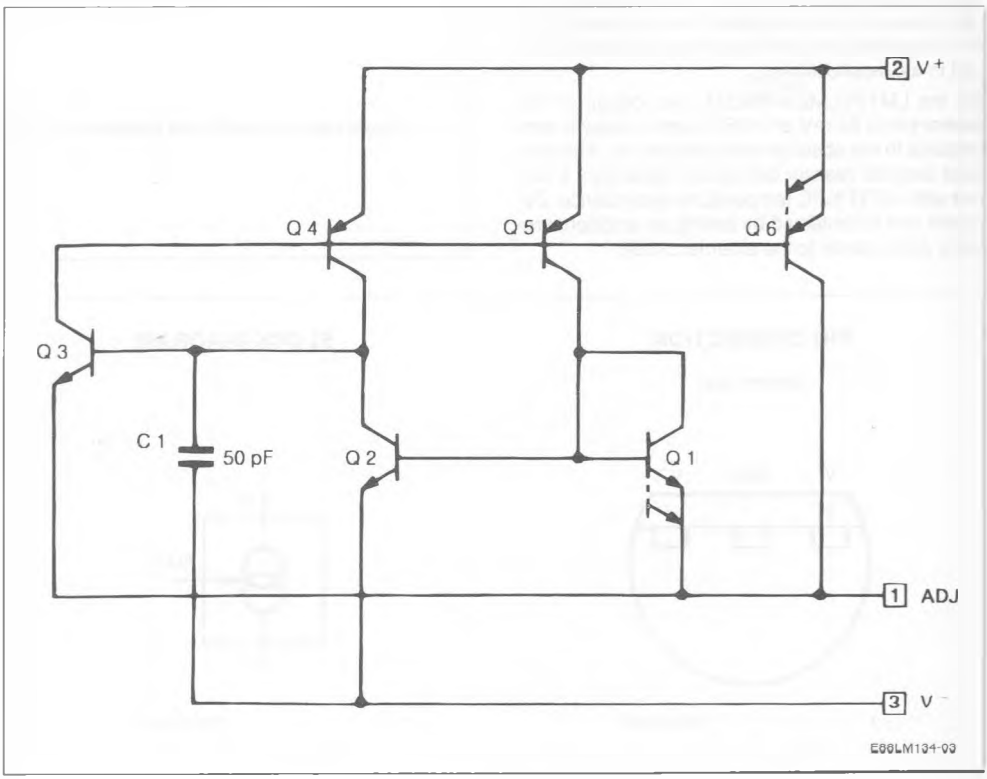
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	LM134, LM234	LM334	Unit
	Voltage V^+ to V^- Forward Reverse	 40 20	 30 20	V
V^-_{ADJ}	ADJ Pin to V^- Voltage	5	5	V
I_{SET}	Set Current	10	10	mA
P_{tot}	Power Dissipation	400	400	mW
T_{stg}	Storage Temperature Range	− 65 to + 150		°C
T_{oper}	Operating Free-air Temperature Range LM134 LM234 LM334	 − 55 to + 125 − 25 to + 100 0 to + 70		°C

THERMAL DATA

$R_{th(j-c)}$	Maximum Junction-case Thermal Resistance	60	°C/W
$R_{th(j-a)}$	Maximum Junction-ambient Thermal Resistance	200	°C/W

SCHEMATIC DIAGAM



ELECTRICAL CHARACTERISTICS

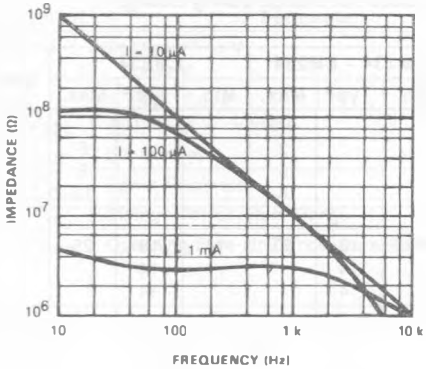
T_j = + 25 °C with pulse testing so that junction temperature does not change during testing. (unless otherwise specified)

Parameter	LM134 - LM234			LM334			Unit
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Set Current Error (V^+ = + 25 V) - Note 1							%
10 µA ≤ I_{SET} ≤ 1 mA			3			6	
1 mA ≤ I_{SET} ≤ 5 mA			5			8	
2 µA ≤ I_{SET} ≤ 10 µA			8			12	
Ratio of Set Current to V^- Current							
10 µA ≤ I_{SET} ≤ 1 mA	14	16	23	14	16	26	
1 mA ≤ I_{SET} ≤ 5 mA		14			14		
2 µA ≤ I_{SET} ≤ 10 µA		14			14		
Minimum Operating Voltage							V
2 µA ≤ I_{SET} ≤ 100 µA		0.8			0.8		
100 µA ≤ I_{SET} ≤ 1 mA		0.9			0.9		
1 mA ≤ I_{SET} ≤ 5 mA		1			1		
Average change in set current with input voltage							% / V
2 µA ≤ I_{SET} ≤ 1 mA							
+ 1.5 V ≤ V^+ ≤ + 5 V		0.02	0.05		0.02	0.1	
+ 5 V ≤ V^+ ≤ + 40 V		0.01	0.03		0.01	0.05	
1 mA ≤ I_{SET} ≤ 5 mA							
+ 1.5 V ≤ V^+ ≤ + 5 V		0.03			0.03		
+ 5 V ≤ V^+ ≤ + 40 V		0.02			0.02		
Temperature Dependence of set current - (note 2) (25 µA ≤ I_{SET} ≤ 1 mA)	0.96 T	T	1.04 T	0.96 T	T	1.04 T	
Effective Shunt Capacitance		15			15		pF

Notes : 1. Set current is the current flowing into the V^+ pin. It is determined by the following formula I_{set} = 67.7 mV/R_{set} (T_j = + 25 °C).
Set current error is expressed as a percent deviation from this amount.

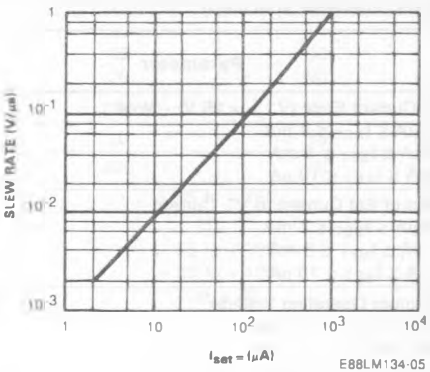
2. I_{set} is directly proportional to absolute temperature (°K). I_{set} at any temperature can be calculated from I_{set} = I_O (T/T_O) where I_O is Iset measured at T_O (°K).

OUTPUT IMPEDANCE



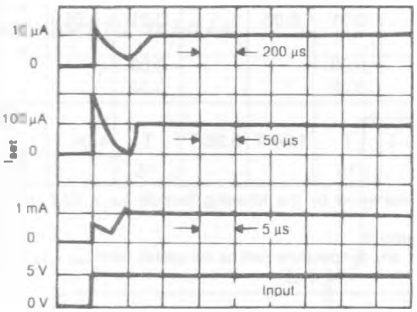
E88LM134-04

MAXIMUM SLEW RATE FOR LINEAR OPERATION



E88LM134-05

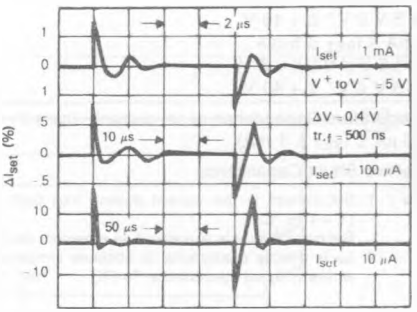
START UP



TIME (SCALE CHANGES AT EACH CURRENT LEVEL).

E88LM134-06

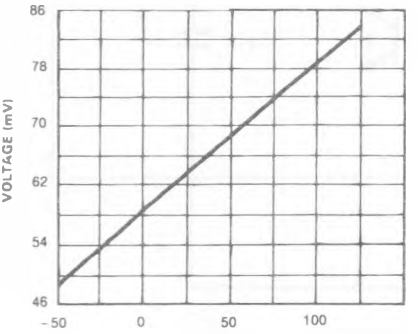
TRANSIENT RESPONSE



TIME (SCALE CHANGES AT EACH CURRENT LEVEL).

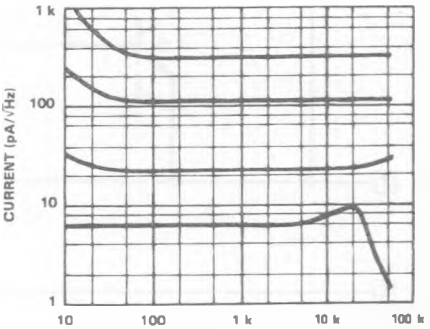
E88LM134-07

VOLTAGE ACROSS R_{set}



E88LM134-08

CURRENT NOISE



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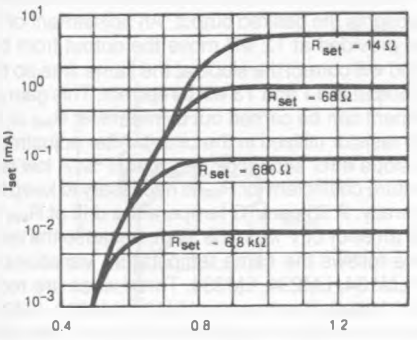
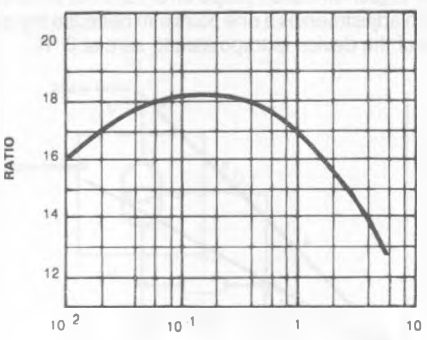
TURN ON VOLTAGE



E88LM134-10

RATIO OF I_{set} to V⁻ CURRENT



E88LM134-11

APPLICATION HINTS

SLEW RATE

At slew rates above a threshold (see curve) the LM134, LM234, LM334 can have a non-linear current characteristic. The slew rate at which this takes place is directly proportional to I_{set}. At I_{set} = 10 µA, dv/dt max. = 0.01 V/µS ; at I_{set} = 1 mA, dv/dt max. = 1 V/µS. Slew rates of more than 1 V/µS do not damage the circuit nor do they produce high currents.

THERMAL EFFECTS

Internal heating can have a significant effect on current regulation for an I_{set} above 100 µA. For example, each increase of 1 V in the voltage across the LM134 at I_{set} = 1 mA will increase the junction temperature by ≈ 0.4 °C (in still air). The output current (I_{set}) has a temperature coefficient of about 0.33 %/°C. Thus the change in current due to the increase in temperature will be (0.4) (0.33) = 0.132 %. This is a degradation of 10 : 1 in regulation versus the true electrical effects. Thermal effects should be taken into account when d.c. regulation is critical and I_{set} is higher than 100 µA. The dissipation of the connections of CB-97 package can reduce this thermal effect by a coefficient of more than 3.

SHUNT CAPACITANCE

In certain applications, the 15 pF value for the shunt capacitance should be reduced :
- because of loading problems,
- because of limitation of the output impedance of the current source in a.c. applications. This reduction of the capacitance can be easily carried out by adding a FET as indicated in the typical applications. The value of this capacitance can be reduced by at least 3 pF and regulation can be improved by an order of magnitude without any modification of the d.c. characteristics (except for the minimum input voltage).

NOISE

The current noise produced by LM134, LM234, LM334 is about 4 times that of a transistor. If the LM134, LM234, LM334 is utilized as an active load for a transistor amplifier, the noise at the input will increase by about 12 dB. In most cases this is acceptable, and a single amplifier can be built with a voltage gain higher than 2 000.

LEAD RESISTANCE

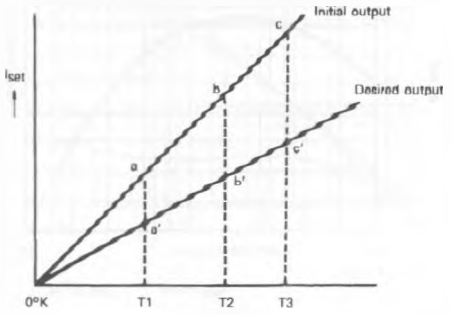
The sense voltage which determines the current of the LM134, LM234, LM334, is less than 100 mV. At this level, the effects of the thermocouple and the connection resistance should be reduced by locating the current setting resistor close to the device. Do not use sockets for the ICs. A contact resistance of 0.7 Ω is sufficient to decrease the output current by 1 % at the 1 mA level.

SENSING TEMPERATURE

The LM134, LM234, LM334 are excellent remote controlled temperature sensors because their operation as sources of current preserves their accuracy even in the case of long connecting wires. The output current is directly proportional to the absolute temperature in degrees Kelvin according to the following equation.

$$I_{set} = \frac{(227\ \mu V/°K)\ (T)}{R_{set}}$$

The calibration of the LM134, LM234, LM334 is simplified by the fact that most of the initial accuracy is due to gain limitation (slope error) and not an offset. Gain adjustment is a one point trim because the output of the device extrapolates to zero at 0 °K.



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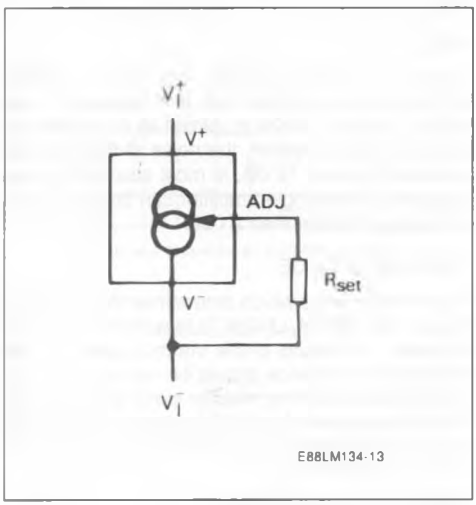
This particularity of the LM134, LM234, LM334 is illustrated in the above diagram. Line abc represents the sensor current before adjustment and line a'b'c' represents the desired output. An adjustment of the gain provided at T2 will move the output from b to b' and will correct the slope at the same time so that the output at T1 and T3 will be correct. This gain adjustment can be carried out by means of R_{set} or the load resistor utilized in the circuit. After adjustment, the slope error should be less than 1 %. A low temperature coefficient for R_{set} is necessary to keep this accuracy. A 33 ppm/°C temperature drift of R_{set} will give an error of 1 % on the slope because the resistance follows the same temperature variations as the LM134, LM234, LM334. Three wires are required to isolate R_{set} from the LM134, LM234, LM334. Since this solution is not recommended. Metal-film resistors with a drift less than 20 ppm/°C are now available. Wirewound resistors can be utilized when very high stability is required.

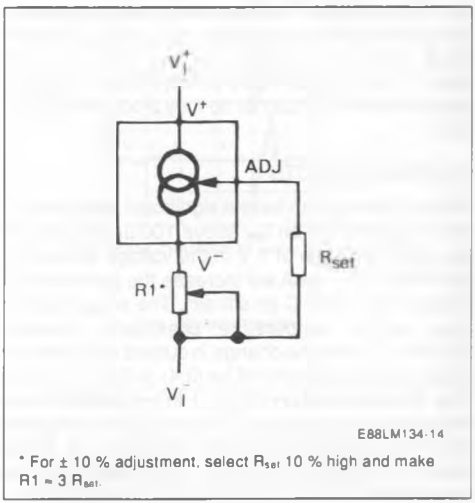
TYPICAL APPLICATIONS

Figure 1 : Basic 2-terminal Current Source.



E88LM134-13

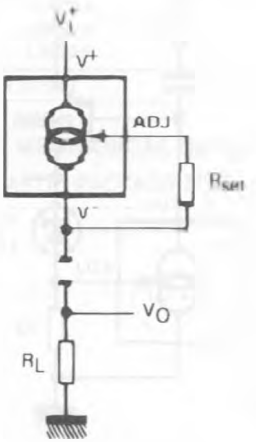
Figure 2 : Alternate Triming Technique.



E88LM134-14

* For ± 10 % adjustment, select R_{set} 10 % high and make $R1 \approx 3\ R_{set}$.

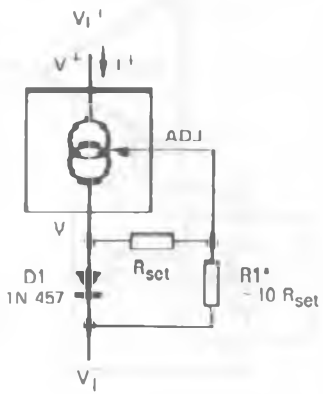
Figure 3 : Terminating Remote Sensor for Voltage Output.



$V_O = (I_{set})(R_L) = 10$ mV/°K
$R_{set} = 230\ \Omega$
$R_L = 10$ kΩ

E88LM134-15

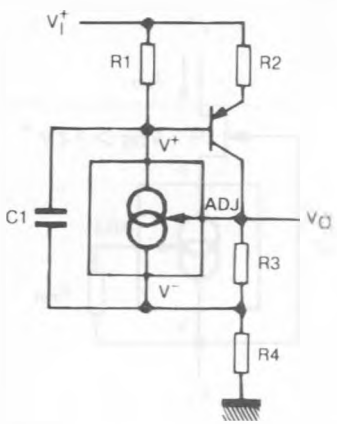
Figure 4 : Zero Temperature Coefficient Current Source.



E88LM134-16

* For ± 10 % adjustment, select R_{set} 10 % high and make $R1 \approx 3\ R_{set}$.

Figure 5 : Low Output Impedance Thermometer.



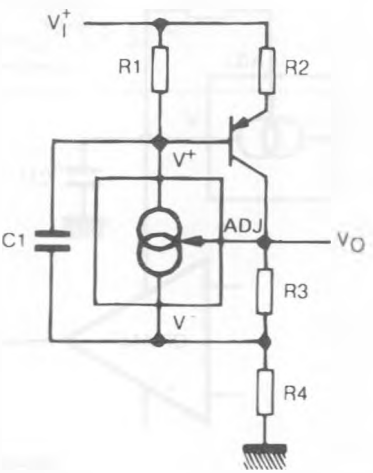
R1 = 230 Ω, 1 %
R2 = 10 kΩ, 1%
R3 = 600 Ω

$V_O = 10$ mV/°C
$Z_O \leq 100\ \Omega$

E88LM134-17

* Output impedance of the LM134, LM234, LM334 at the "ADJ" pin is approximately $\frac{-R_O\ \Omega}{16}$ where R_O is the equivalent external resistance connected to the V⁻ pin. This negative resistance can be reduced by a factor of 5 or more by inserting an equivalent resistor in series with the output.

Figure 6 : Low Output Impedance Thermometer.



R1 = 15 kΩ
R2 = 300 Ω
R3 = 100 Ω
R4 = 4.5 kΩ
C1 = 2.2 nF
$V_O = 10$ mV/°C
$Z_O \leq 2\ \Omega$

E88LM134-18

Figure 7 : Micropower Bias.

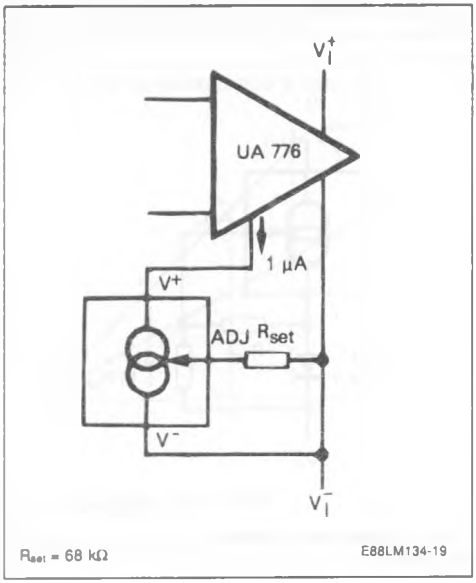


Figure 8 : Low Input Voltage Reference Driver.

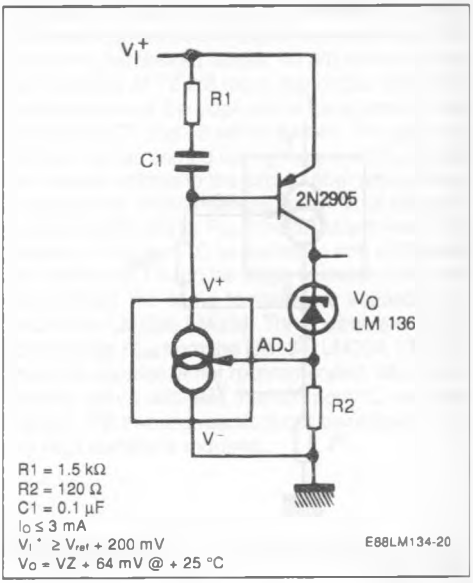
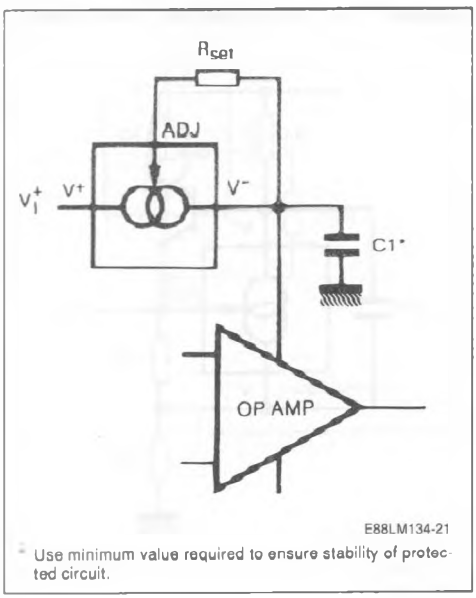
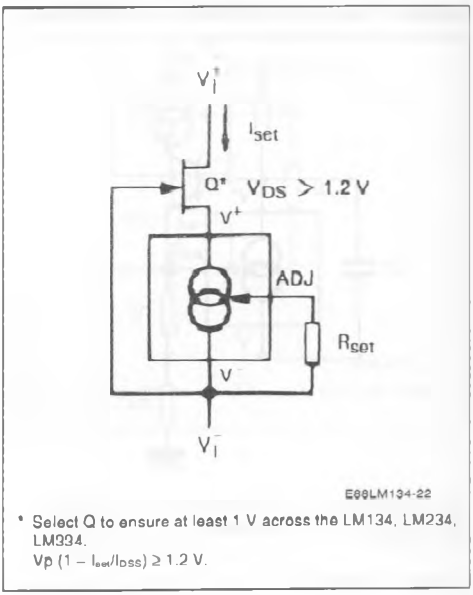


Figure 9 : In-line Current Limiter.



* Use minimum value required to ensure stability of protected circuit.

Figure 10 : Fet cascading for low capacitance.



* Select Q to ensure at least 1 V across the LM134, LM234, LM334.
$V_P (1 - I_{set}/I_{DSS}) \geq 1.2$ V.

ORDER CODES

Part Number	Temperature Range	Package
		Z
LM134	– 55 °C to + 125 °C	•
LM234	– 25 °C to + 100 °C	•
LM334	0 °C to + 70 °C	•

Example : LM134Z

PACKAGE MECHANICAL DATA

3 PINS - PLASTIC PACKAGE TO92