



LM134 LM234 - LM334

THREE TERMINAL ADJUSTABLE CURRENT SOURCES

- OPERATES FROM 1V TO 40V
- 0.02%/V CURRENT REGULATION
- PROGRAMMABLE FROM 1 μ A TO 10mA
- $\pm$ 3% INITIAL ACCURACY

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 1V t 10V

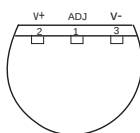
The current is determined by an external resistor without requiring other external components.

Reverse voltages of up to 20V 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.

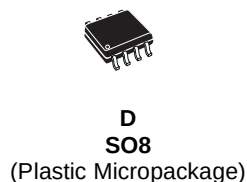
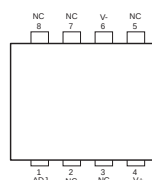
For the LM134/LM234/LM334, the voltage on the control pin is 64mV at +25°C and is directly proportional to the absolute temperature (°K). The simplest external resistor connection generates a current with $\approx$ 0.33%/°C temperature dependence. Zero drift can be obtained by adding an additional resistor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

PIN CONNECTIONS (top view)

TO92
(Top view)



SO8
(Top view)



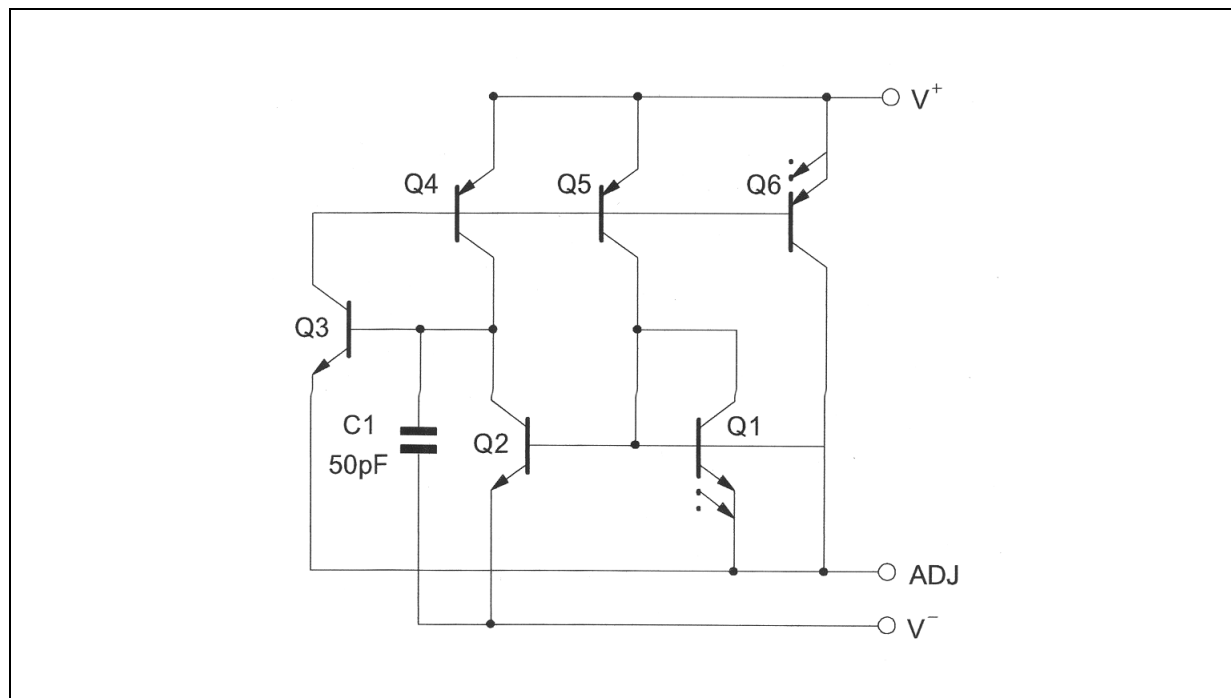
ORDER CODE

Part Number	Temperature Range	Package	
		Z	D
LM134	-55°C, +125°C	•	•
LM234	-25°C, +100°C	•	•
LM334	0°C, +70°C	•	•

Z = TO92 Plastic package - also available in Bulk (Z), Tape & Reel (ZT) and Ammo Pack (AP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)

LM134 - LM234 - LM334

SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

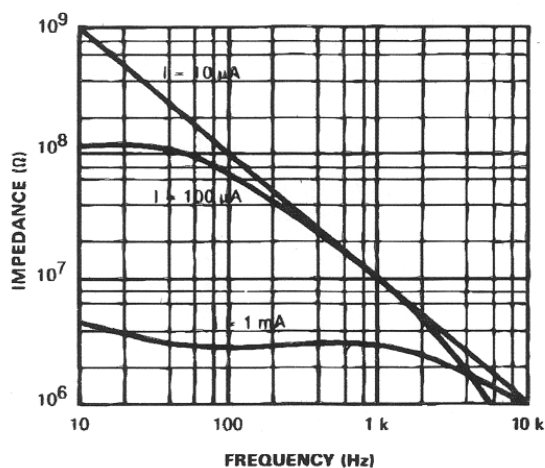
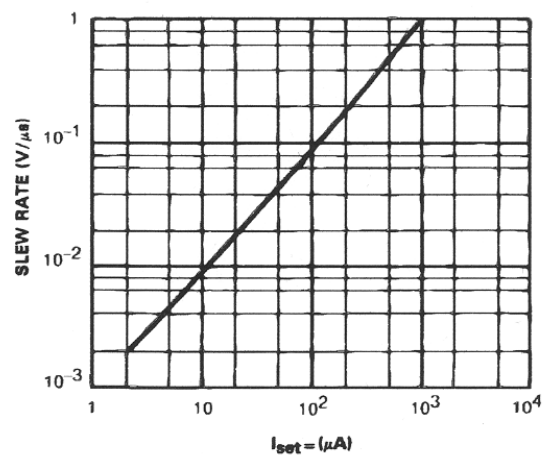
Symbol	Parameter	LM134	LM234	LM334	Unit
	Voltage V^+ to V^- Forward Reverse	40 20		30 20	V
V_{ADJ^-}	ADJ Pin to V^- Voltage	5			V
I_{SET}	Set Current	10			mA
P_{tot}	Power Dissipation	400			mW
T_{Stg}	Storage Temperature Range	-65 to +150			°C
T_{oper}	Operating Free-air Temperature Range	-55 to +125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

ELECTRICAL CHARACTERISTICS

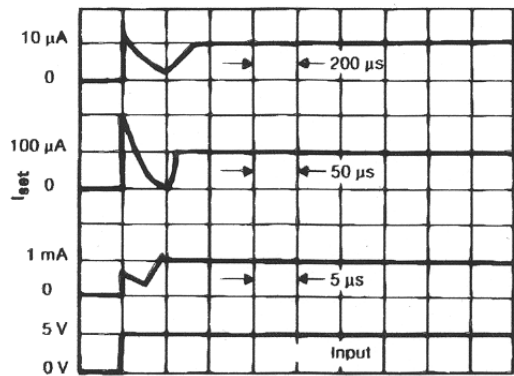
$T_j = +25^\circ\text{C}$ with pulse testing so that junction temperature does not change during testing (unless otherwise specified)

Parameter	LM134 - LM234			LM334			Unit
	Min.	Typ.	Max.	Min.	Typ.	Max.	
Set Current Error ($V^+ = +2.5\text{V}$) ⁻¹⁾ $10\mu\text{A} \leq I_{\text{SET}} \leq 1\text{mA}$ $1\text{mA} \leq I_{\text{SET}} \leq 5\text{mA}$ $2\mu\text{A} \leq I_{\text{SET}} \leq 10\mu\text{A}$			3 5 8			6 8 12	%
Ratio of Set Current to V_- Current $10\mu\text{A} \leq I_{\text{SET}} \leq 1\text{mA}$ $1\text{mA} \leq I_{\text{SET}} \leq 5\text{mA}$ $2\mu\text{A} \leq I_{\text{SET}} \leq 10\mu\text{A}$	14	18 14 14	23	14	18 14 14	26	
Minimum Operating Voltage $2\mu\text{A} \leq I_{\text{SET}} \leq 100\mu\text{A}$ $100\mu\text{A} \leq I_{\text{SET}} \leq 1\text{mA}$ $1\text{mA} \leq I_{\text{SET}} \leq 5\text{mA}$		0.8 0.9 1			0.8 0.9 1		V
Average Change in Set Current with Input Voltage $2\mu\text{A} \leq I_{\text{SET}} \leq 1\text{mA}$ $+1.5\text{V} \leq V_+ \leq +5\text{V}$ $+5\text{V} \leq V_+ \leq +40\text{V}$ $1\text{mA} \leq I_{\text{SET}} \leq 5\text{mA}$ $+1.5\text{V} \leq V_+ \leq +5\text{V}$ $+5\text{V} \leq V_+ \leq +40\text{V}$		0.02 0.01 0.03 0.02	0.05 0.03		0.02 0.01 0.03 0.02	0.1 0.05	% / V
Temperature Dependence of set current ⁻²⁾ $25\mu\text{A} \leq I_{\text{SET}} \leq 1\text{mA}$	0.96 T	T	1.04 T	0.96 T	T	1.04 T	
Effective Shunt Capacitance		15			15		pF

- Set current is the current flowing into the V_+ pin. It is determined by the following formula $I_{\text{set}} = 67.7\text{mV}/R_{\text{set}}$ ($T_j = +25^\circ\text{C}$)
Set current error is expressed as a percent deviation from this amount
- I_{set} is directly proportional to absolute temperature ($^\circ\text{K}$). I_{set} at any temperature can be calculated from $I_{\text{set}} = I_o (T/T_o)$ where I_o is I_{set} measured at T_o ($^\circ\text{K}$)

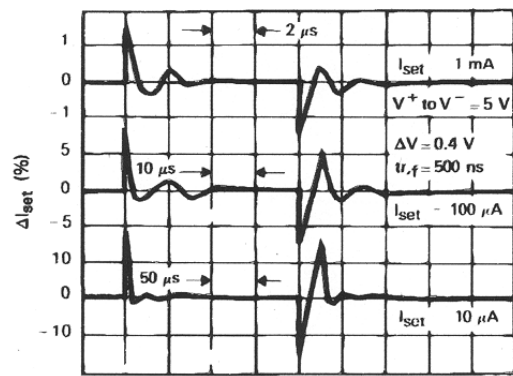
OUTPUT IMPEDANCE**MAXIMUM SLEW RATE FOR LINEAR OPERATION**

START UP



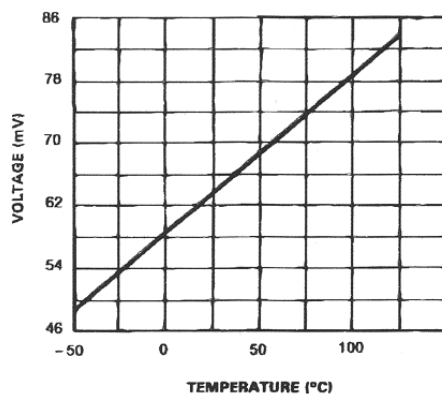
TIME (SCALE CHANGES AT EACH CURRENT LEVEL).

TRANSIENT RESPONSE

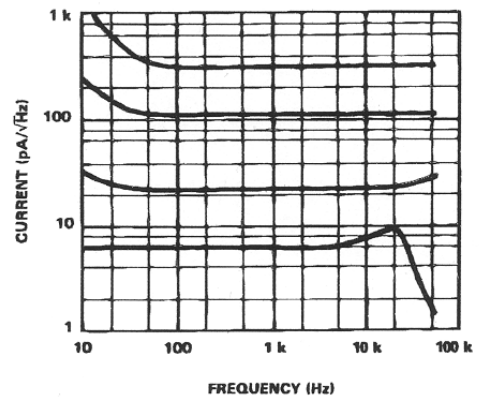


TIME (SCALE CHANGES AT EACH CURRENT LEVEL).

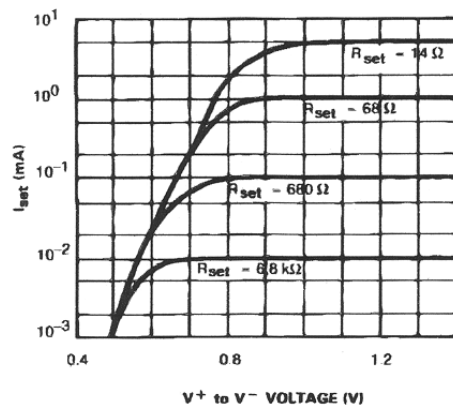
VOLTAGE ACROSS R_{set}



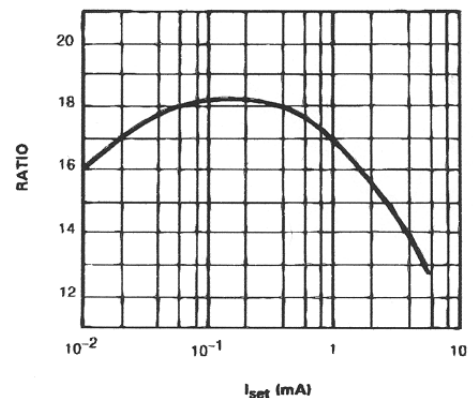
CURRENT NOISE



TURN-ON VOLTAGE



RATIO OF I_{set} to V^- CURRENT



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 $I_{set} = 10\mu A$, $dv/dt \text{ max.} = 0.01V/\mu s$; at $I_{set} = 1mA$, $dv/dt \text{ max.} = 1V/\mu s$. Slew rates of more than $1V/\mu s$ 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 $100\mu A$. For example, each increase of $1V$ in the voltage across the LM134 at $I_{set} = 1mA$ will increase the junction temperature by $\approx 0.4^\circ C$ (in still air). The output current (I_{set}) has a temperature coefficient of about $0.33\%/^\circ C$. Thus the change in current due to the increase in temperature will be $(0.4)(0.33) = 0.132\%$. This is 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 $100\mu A$.

SHUNT CAPACITANCE

In certain applications, the $15pF$ value for the shunt capacitance should be reduced :

- ☐ because of loading problems,
- ☐ because of limitation of output impedance of the current source in a.c. applications. This reduction of 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 $3pF$ and regulation can be improved by an order of magnitude without any modifications 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 used as an active load for a transistor amplifier, the noise at the input will increase by about $12dB$. In most cases this is acceptable, and a single amplifier can be built with a voltage gain higher than 2000.

LEAD RESISTANCE

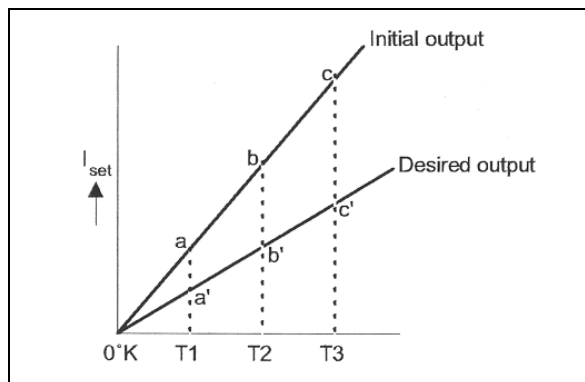
The sense voltage which determines the current of the LM134, LM234, LM334 is less than $100mV$. At this level, the thermocouple effects and the connection resistance should be reduced by locating the current setting resistor close to the device. Do not use sockets for the ICs. A contact resistance of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

SENSING TEMPERATURE

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

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

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 $0^\circ K$.



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. A gain adjustment provided at T_2 will move the output from b to b' and will correct the slope at the same time so that the output at T_1 and T_3 will be correct. This gain adjustment can be carried out by means of R_{set} or the load resistor used 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 $33ppm/^\circ C$ 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 $20ppm/^\circ C$ are now available. Wirewound resistors can be used when very high stability is required.

TYPICAL APPLICATIONS

Figure 1 : Basic 2-terminal Current Source

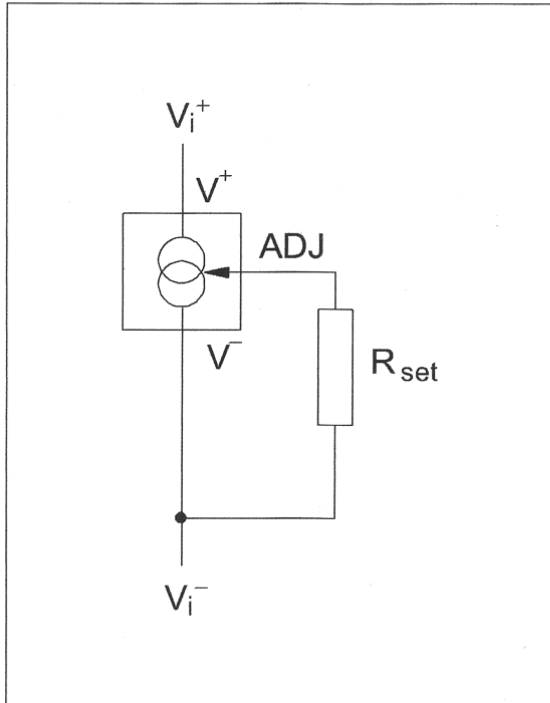


Figure 2 : Alternate Trimming Technique

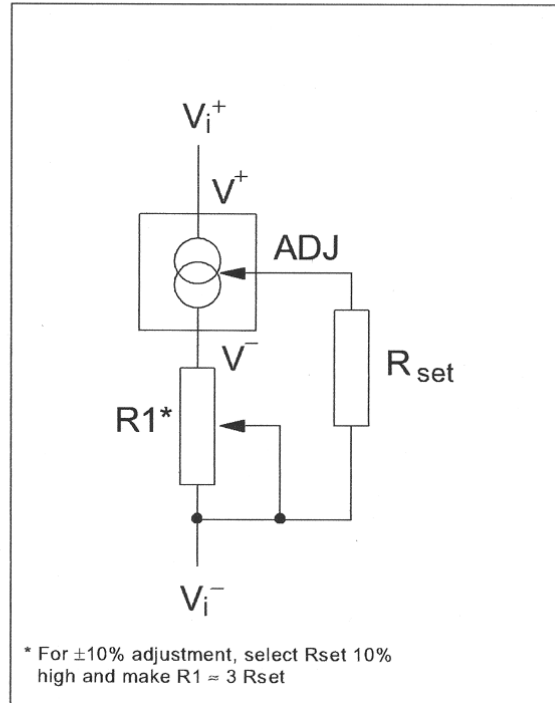


Figure 3 : Terminating Remote Sensor for Voltage Output

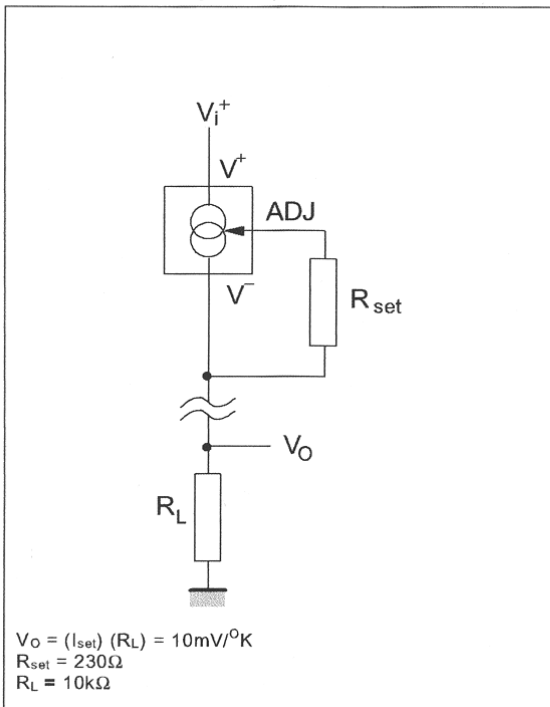


Figure 4 : Zero Temperature Coefficient Current Source

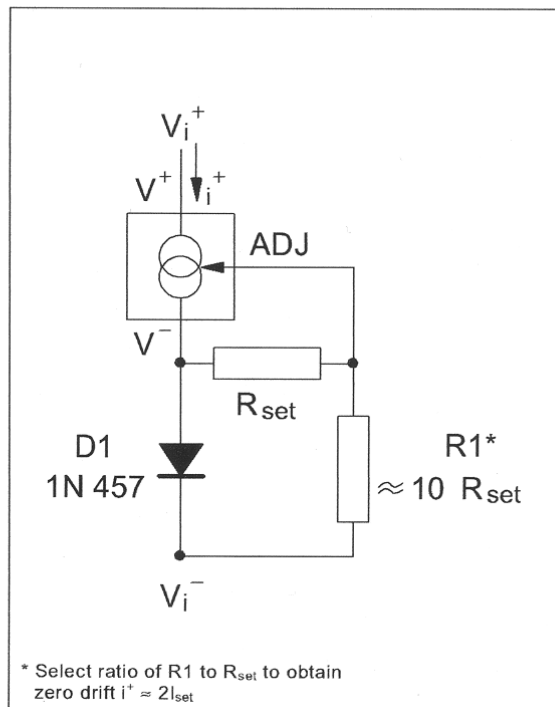


Figure 5 : Low Output Impedance Thermometer

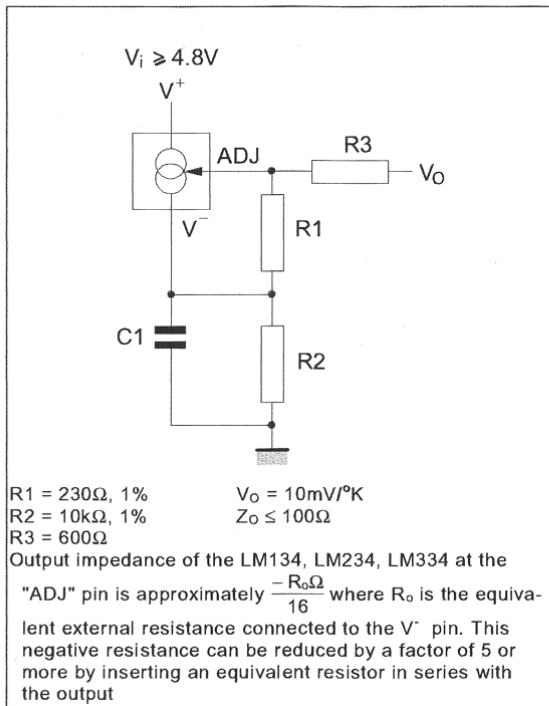


Figure 6 : Low Output Impedance Thermometer

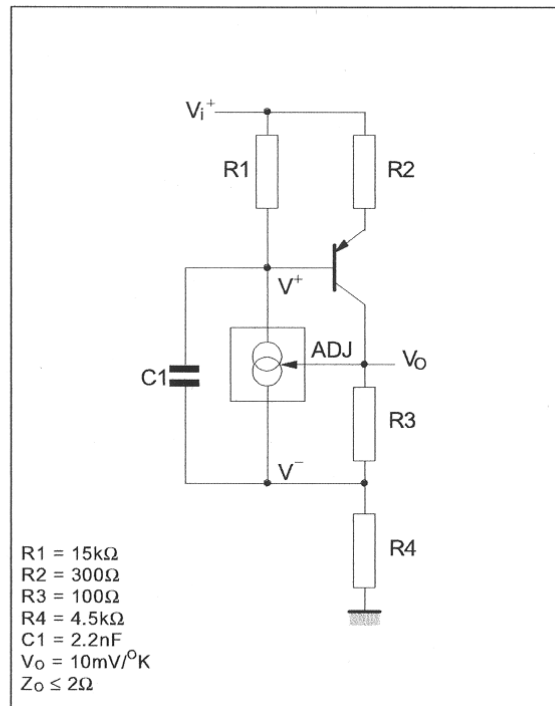


Figure 7 : Micropower Bias

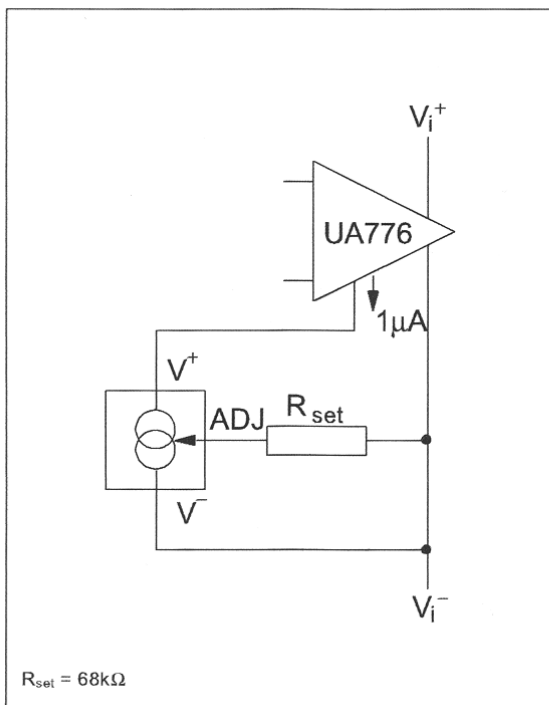


Figure 8 : Low Input Voltage Reference Driver

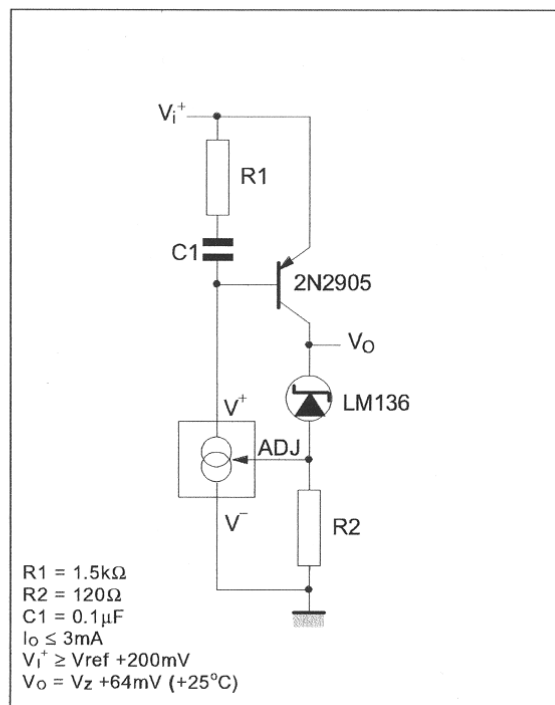
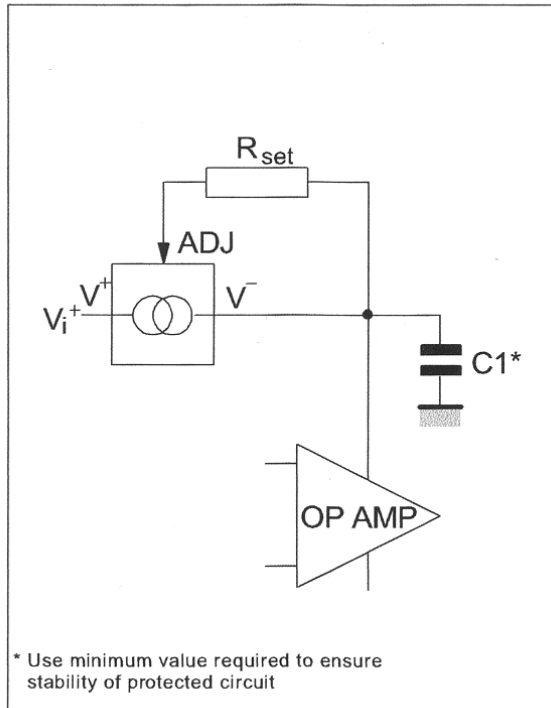
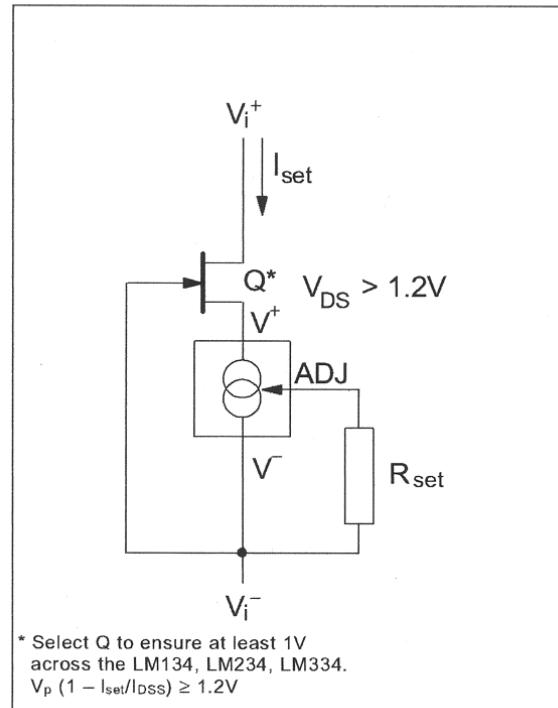
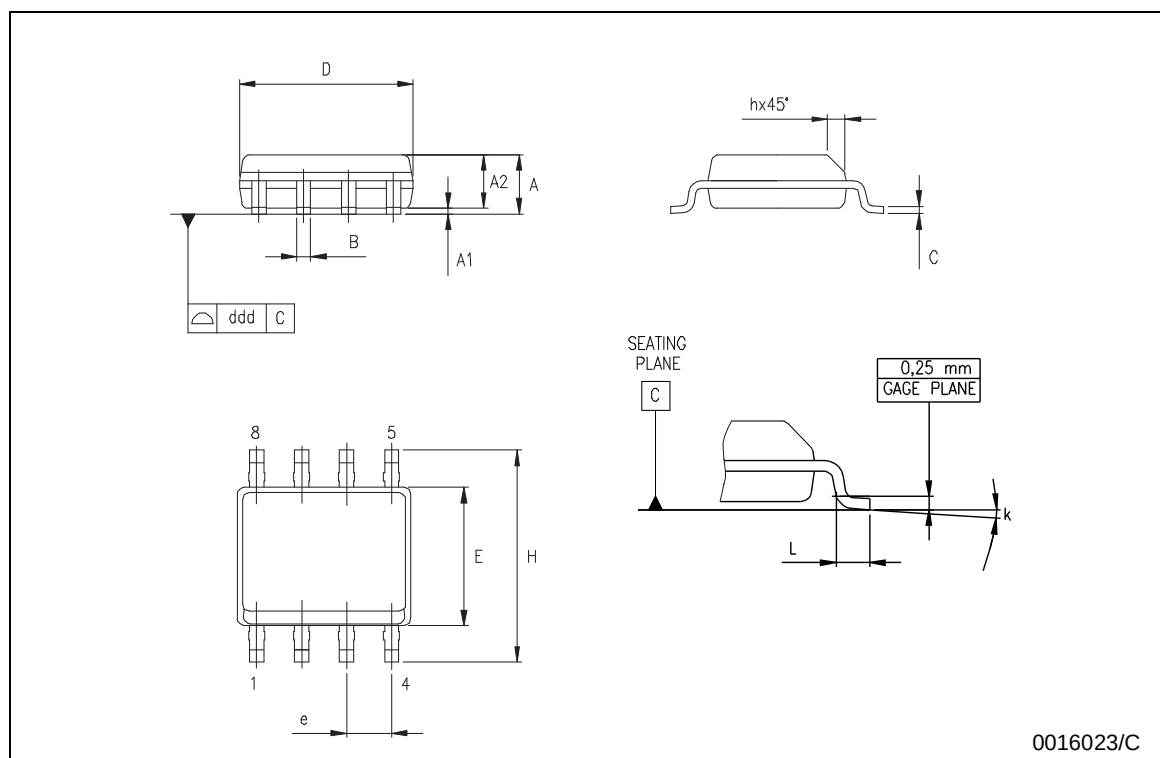


Figure 9 : In-line Current Limiter**Figure 10 : Fet Cascading for Low Capacitance**

PACKAGE MECHANICAL DATA

SO-8 MECHANICAL DATA

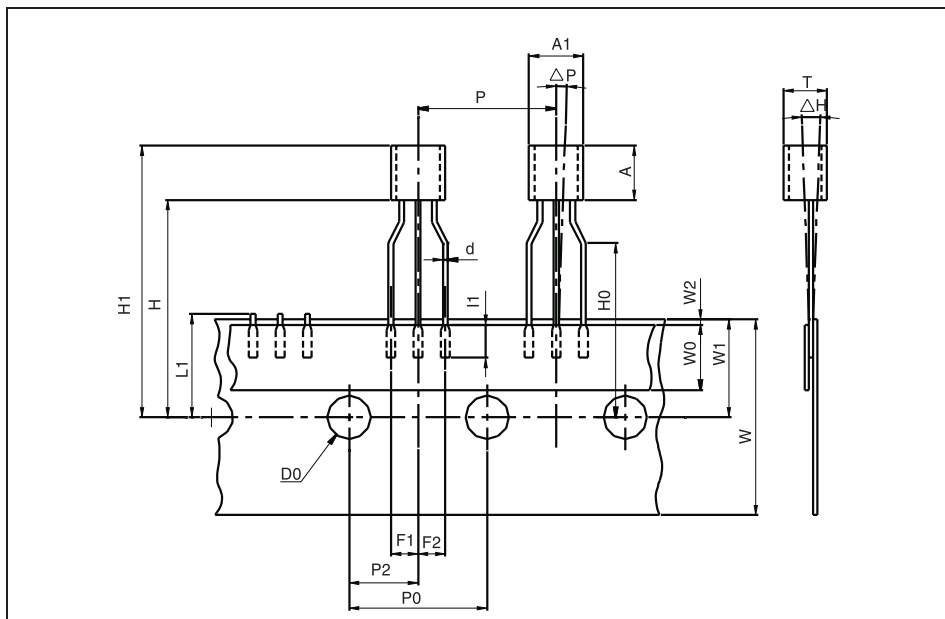
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



PACKAGE MECHANICAL DATA - TO92 TAPE AMMO PACK & TO92 TAPE & REEL

TO-92 MECHANICAL DATA

DIM.	mm.			inches		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
l1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
h	-1	0	1	-0.039	0	0.039
P	-1	0	1	-0.039	0	0.039
W	17.5	18.0	19.0	0.689	0.709	0.748
W0	5.7	6	6.3	0.224	0.236	0.248
W1	8.5	9	9.75	0.335	0.354	0.384
W2			0.5			0.020
H			20			0.787
H0	15.5	16	16.5	0.610	0.630	0.650
H1			25			0.984
DO	3.8	4.0	4.2	0.150	0.157	0.165
L1			11			0.433



Packing information are available at: <http://www.st.com/stonline/prodpres/packages/stdlin.htm>

PACKAGE MECHANICAL DATA - TO92 BULK

TO-92 MECHANICA DATA						
DIM.	mm.			mils		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.32		4.95	170.1		194.9
b	0.36		0.51	14.2		20.1
D	4.45		4.95	175.2		194.9
E	3.30		3.94	129.9		155.1
e	2.41		2.67	94.9		105.1
e1	1.14		1.40	44.9		55.1
L	12.7		15.49	500.0		609.8
R	2.16		2.41	85.0		94.9
S1	0.92		1.52	36.2		59.8
W	0.41		0.56	16.1		22.0

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Packing information are available at: <http://www.st.com/stonline/prodpres/packages/stdlin.htm>

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