



## LM236-LM336

### 2.5V voltage references

#### Features

- Low temperature coefficient
- Wide operating current of 400 $\mu$ A to 10mA
- 0.2 $\Omega$  dynamic impedance
- Guaranteed temperature stability
- Fast turn-on

#### Description

The LM236 and LM336 are precision 2.5V regulator diodes. These voltage reference monolithic ICs operate like 2.5V Zener diodes with a low temperature coefficient and a dynamic impedance of 0.2 $\Omega$ . A third pin enables adjusting the reference voltage and the temperature coefficient.



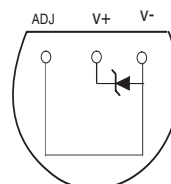
**TO92**  
(Plastic package)



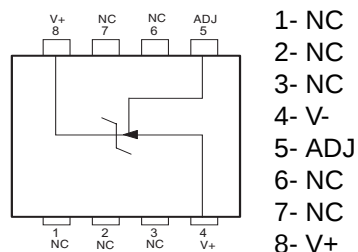
**SO8**  
(Plastic micropackage)

#### Pin connections

**TO92**  
(Bottom view)

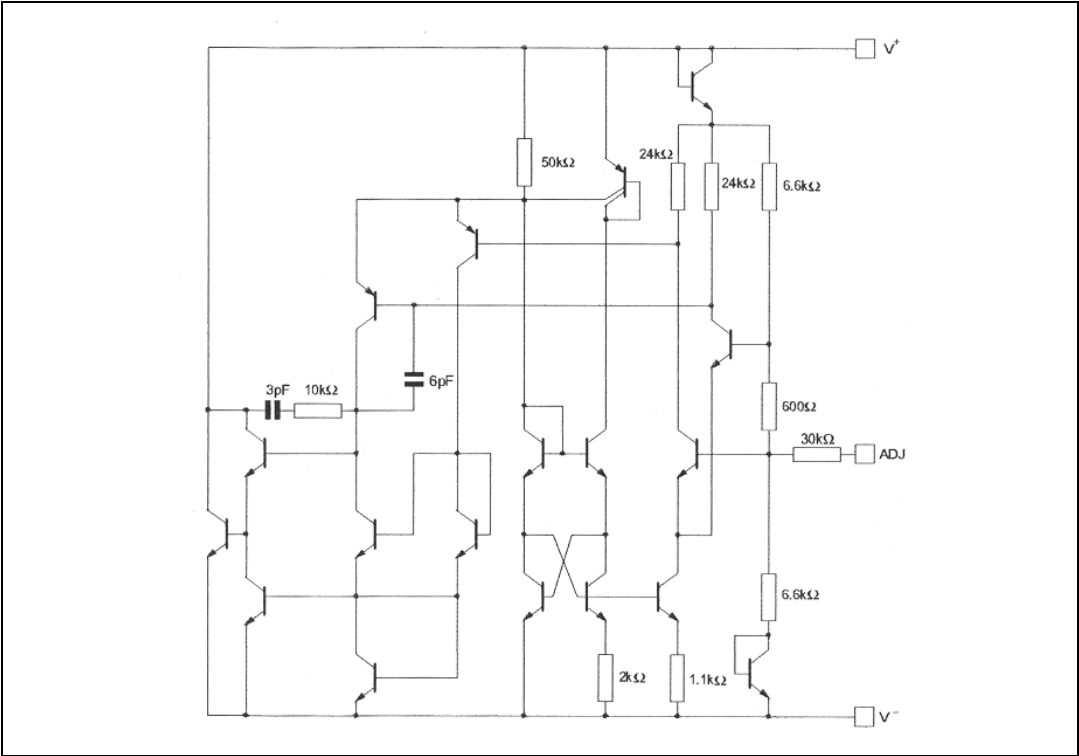


**SO8**  
(Top view)



1 Schematic diagram

Figure 1. Schematic diagram



2 Absolute maximum ratings

Table 1. Absolute maximum ratings (AMR)

| Symbol         | Parameter                            | LM236       | LM336,B  | Unit |
|----------------|--------------------------------------|-------------|----------|------|
| $I_R$<br>$I_F$ | Current<br>Reverse<br>Forward        | 15<br>10    |          | mA   |
| $T_{oper}$     | Operating free-air temperature range | -25 to +85  | 0 to +70 | °C   |
| $T_{stg}$      | Storage temperature range            | -65 to +150 |          | °C   |

### 3 Electrical characteristics

Table 2. Electrical characteristics

| Symbol       | Parameter                                                                                                                                                             | LM236 |            |          | LM336,B      |              |              | Unit     |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|----------|--------------|--------------|--------------|----------|
|              |                                                                                                                                                                       | Min.  | Typ.       | Max.     | Min.         | Typ.         | Max.         |          |
| $V_R$        | Reference breakdown voltage<br>$T_{amb} = +25^{\circ}\text{C}$ , $I_R = 1\text{mA}$<br>LM236, LM336<br>LM336B                                                         | 2.44  | 2.49       | 2.54     | 2.39<br>2.44 | 2.49<br>2.49 | 2.59<br>2.54 | V        |
| $\Delta V_R$ | Reverse breakdown voltage change with current<br>$400\mu\text{A} \leq I_R \leq 10\text{mA}$<br>$T_{amb} = +25^{\circ}\text{C}$<br>$T_{min} \leq T_{amb} \leq T_{max}$ |       | 2.6<br>3   | 6<br>10  |              | 2.6<br>3     | 10<br>12     | mV       |
| $Z_D$        | Reverse dynamic impedance ( $I_R = 1\text{mA}$ )<br>$T_{amb} = +25^{\circ}\text{C}$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                            |       | 0.2<br>0.4 | 0.6<br>1 |              | 0.2<br>0.4   | 1<br>1.4     | $\Omega$ |
| $K_{VT}$     | Temperature stability ( $V_R = 2.49\text{V}$ , $I_R = 1\text{mA}$ )                                                                                                   |       | 3.5        | 9        |              | 1.8          | 6            | mV       |
| $K_{VH}$     | Long term stability ( $T_{amb} = +25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ , $I_R = 1\text{mA}$ )                                                                  |       | 20         |          |              | 20           |              | ppm      |

Figure 2. Reverse voltage change

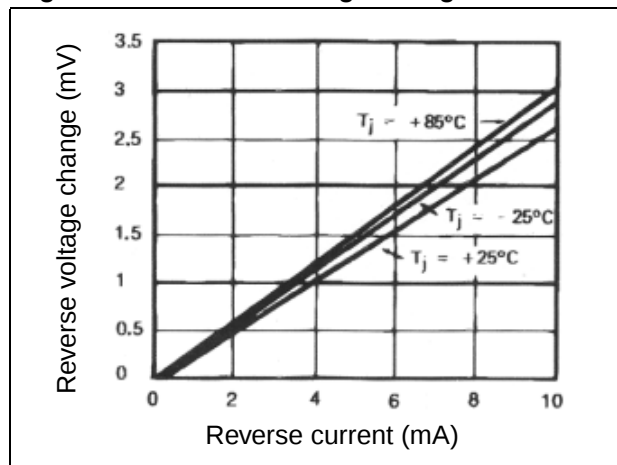


Figure 3. Zener noise voltage

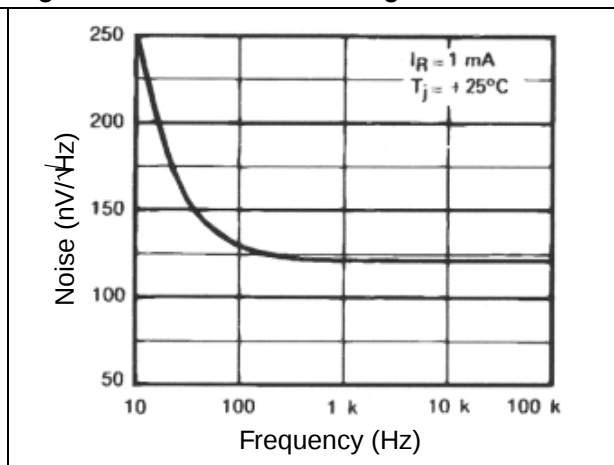


Figure 4. Dynamic impedance

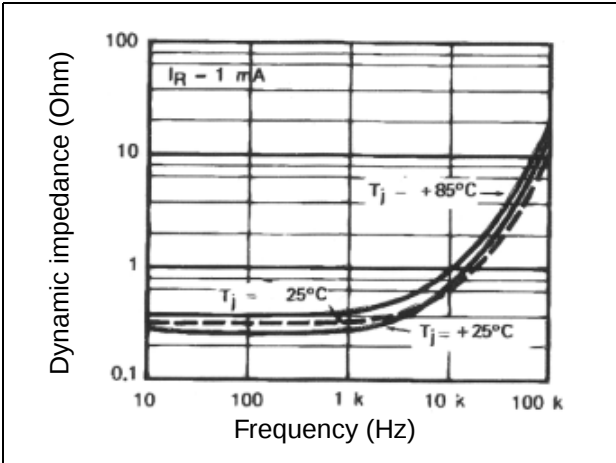


Figure 5. Response time

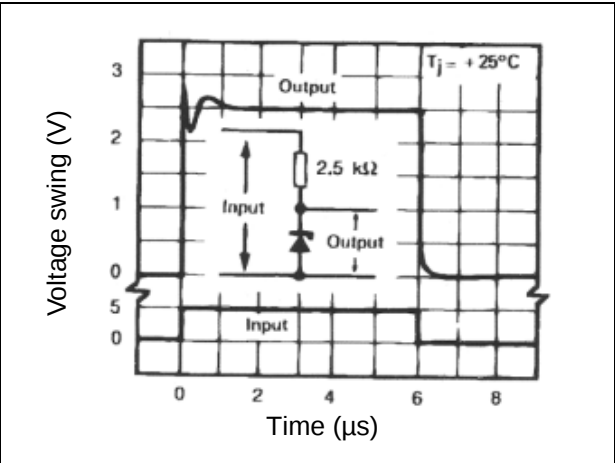


Figure 6. Reverse characteristics

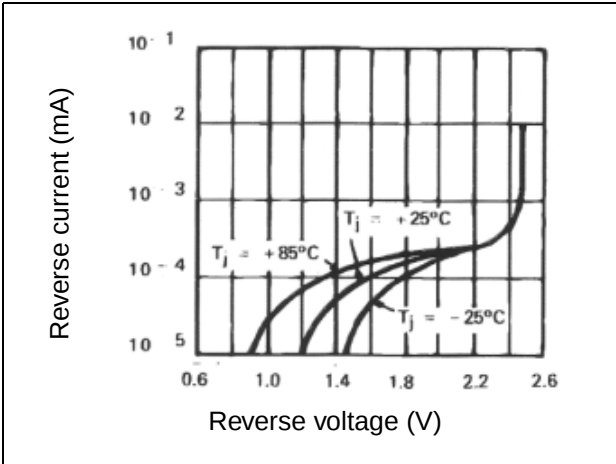


Figure 7. Forward characteristics

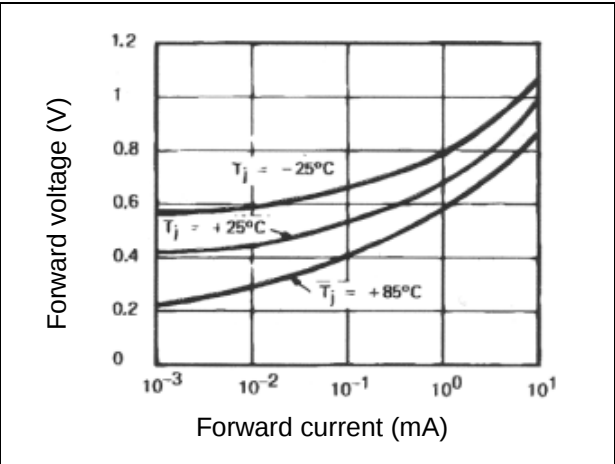
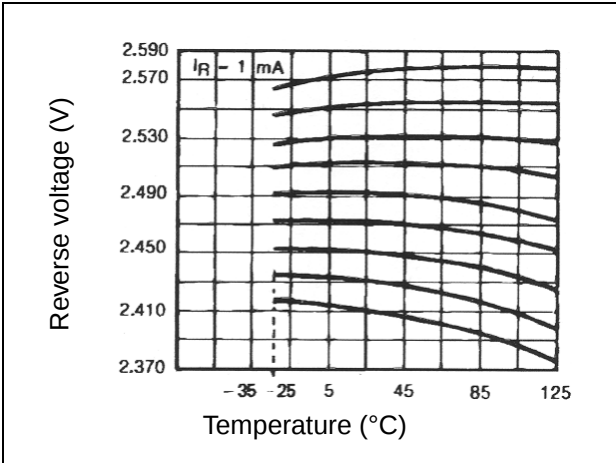


Figure 8. Temperature drift



## 4 Application information

The LM236, LM336 voltage references are easier to use than zener diodes. Their low impedance and wide current range facilitate biasing in any circuits. Besides, the breakdown voltage or the temperature coefficient can be adjusted so as to optimize the performance of the circuit.

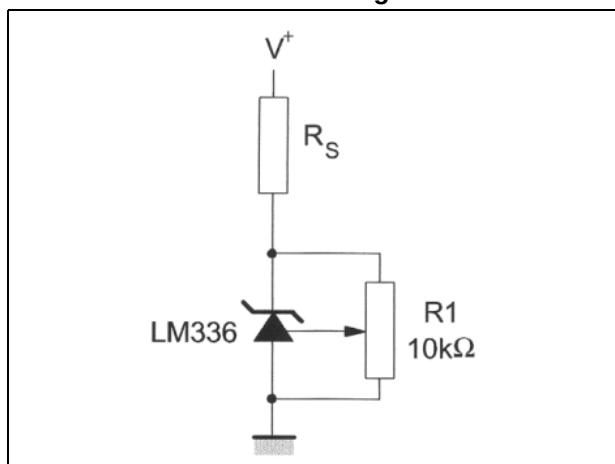
[Figure 9](#) represents a LM336 with a  $10\text{k}\Omega$  potentiometer to adjust the reverse breakdown voltage which can be adjusted without altering the temperature coefficient of the circuit. The adjustment range is generally sufficient to adjust the initial tolerance of the circuit and the inaccuracy of the amplifier circuit.

To obtain a lower temperature coefficient two diodes can be connected in series as indicated in [Figure 10](#).

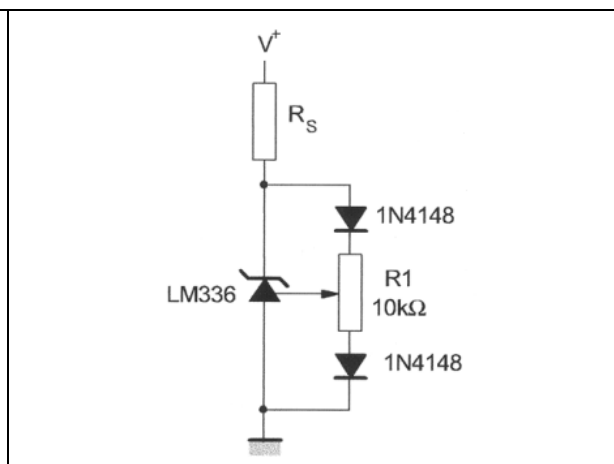
When the circuit is adjusted to  $2.49\text{V}$  the temperature coefficient is minimized.

For a correct temperature coefficient, the diodes should be at the same ambient temperature as the LM336. The value of  $R_1$  is not critical ( $2\text{-}20\text{k}\Omega$ ).

**Figure 9. LM336 with pot for adjustment of breakdown voltage**



**Figure 10. Temperature coefficient adjustment**



## Typical applications

Figure 11. 2.5V reference

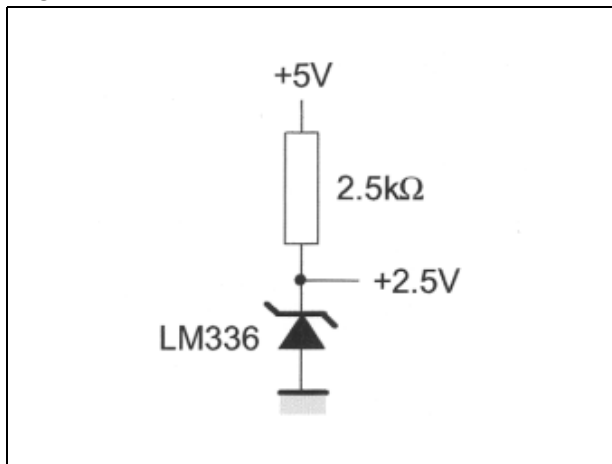


Figure 12. Wide input range reference

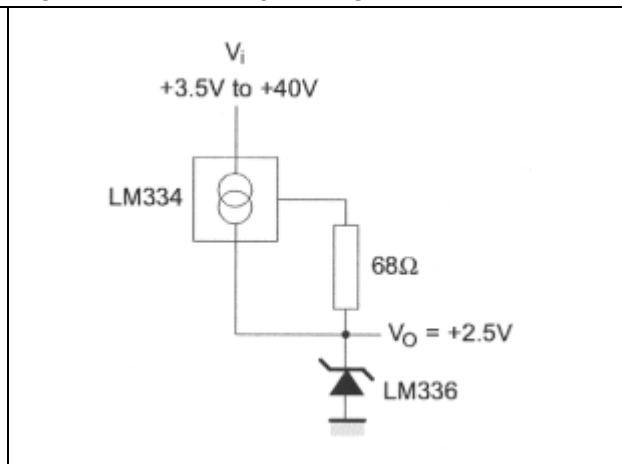
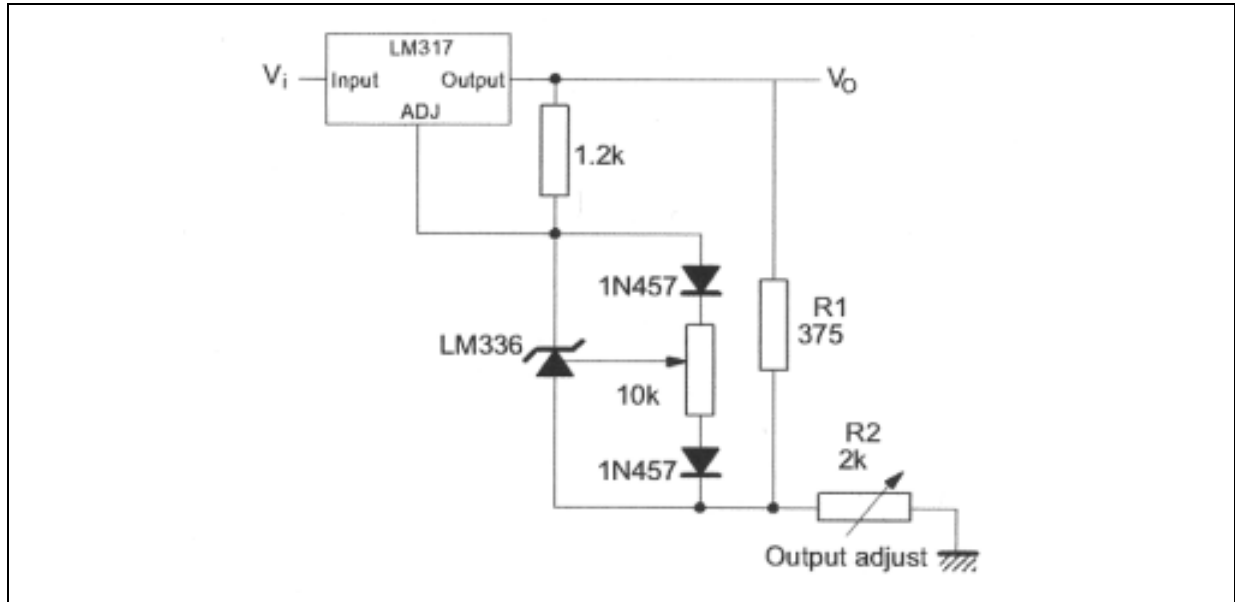


Figure 13. Precision power regulator with low temperature coefficient



The circuit diagram shows a precision rectifier configuration. An input voltage  $V_D$  (ranging from +5V to +40V) is applied to the non-inverting input (+) of the LM308A op-amp. The inverting input (-) is connected to ground through a 20kΩ resistor. The op-amp's output is connected to the anode of an LM336 diode. The cathode of the diode is connected to ground. A 100pF capacitor is connected between the output of the op-amp and its inverting input. The LM336 diode is also connected to the output of the op-amp. The output of the diode is connected to the output of the op-amp. The output voltage is labeled  $V_O$  (ranging from +5V to +40V). The input voltage  $V_D$  is also connected to the base of a 2N2905 transistor, which is connected to the output of the op-amp. The emitter of the transistor is connected to ground, and the collector is connected to the output of the op-amp. The output of the op-amp is also connected to the output of the transistor. The output voltage is labeled  $V_O$  (ranging from +5V to +40V).

The circuit diagram shows a precision current source. A positive supply voltage  $V^+$  is connected to the LM334, which is in series with a  $35\Omega$  resistor. The node between the LM334 and the  $35\Omega$  resistor is connected to a network of resistors: a  $2.5k\Omega$  (1%), a  $25k\Omega$  (1%), a  $250k\Omega$  (1%), and a  $2.5M\Omega$  (1%). These resistors are connected to a common node that also branches to the non-inverting input (pin 3) of the LM308A op-amp and to a  $10k\Omega$  "calibrate" resistor. The LM336 is connected between the  $35\Omega$  resistor and the  $10k\Omega$  resistor. The LM308A op-amp is configured with its non-inverting input (pin 3) connected to a resistor  $R_x$  to ground. The output (pin 6) is labeled  $V_O$ . A  $100pF$  capacitor is connected between pins 1 and 8 of the LM308A. The inverting input (pin 2) is connected to the same node as the  $10k\Omega$  resistor. The LM308A is also connected to  $V^+$  and ground.

Figure 16. Bipolar output reference

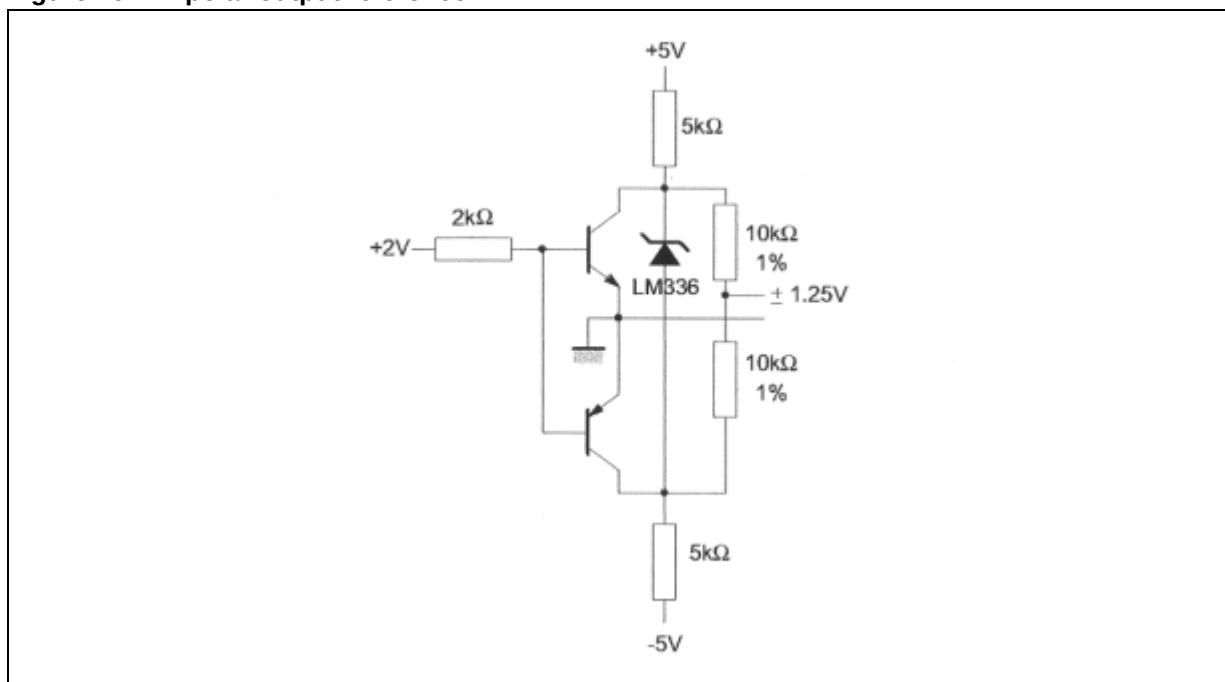


Figure 17. 5V buffered reference

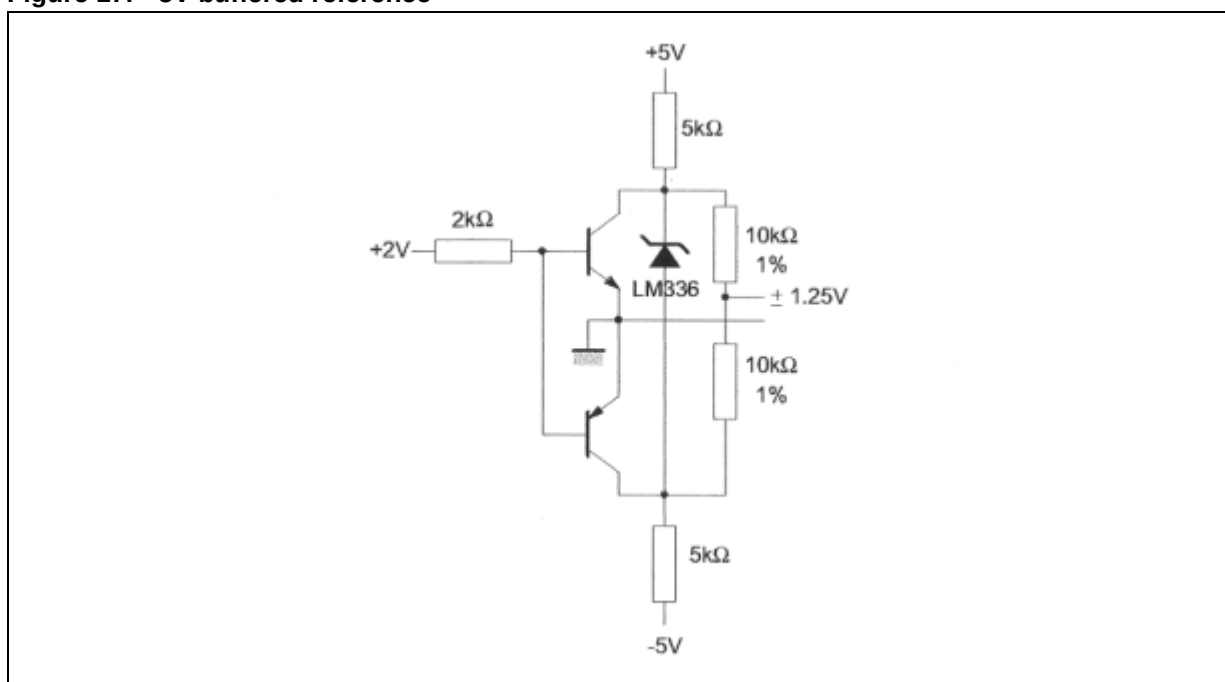
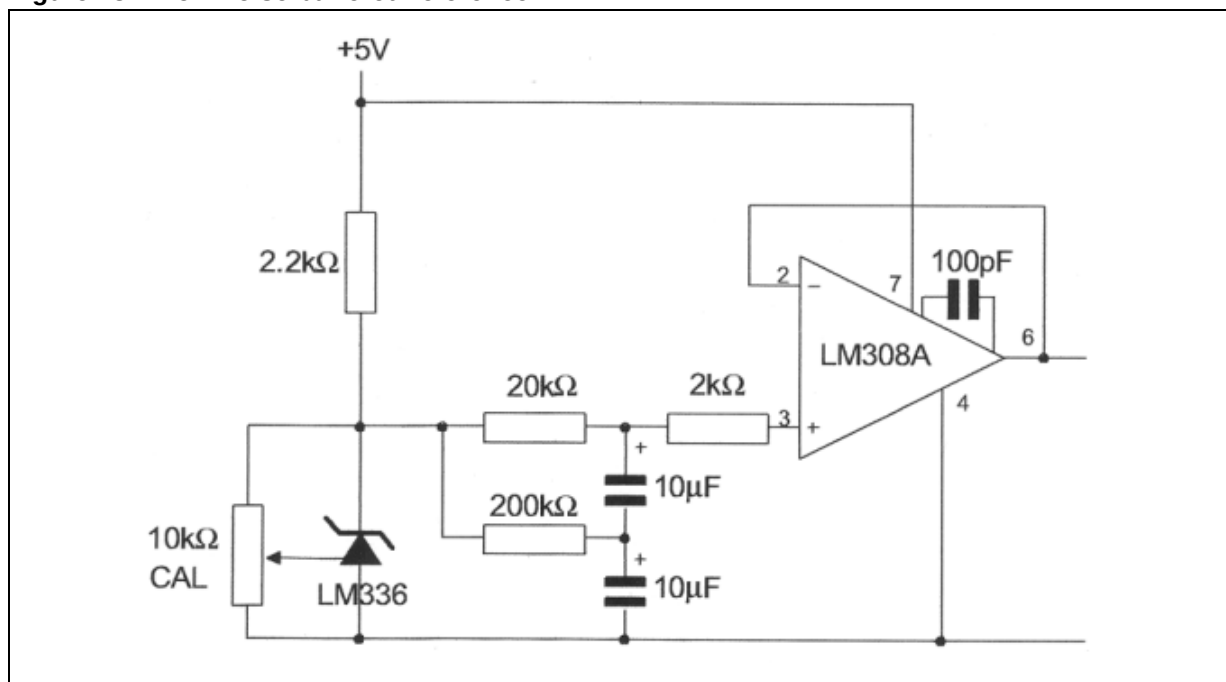


Figure 18. Low noise buffered reference



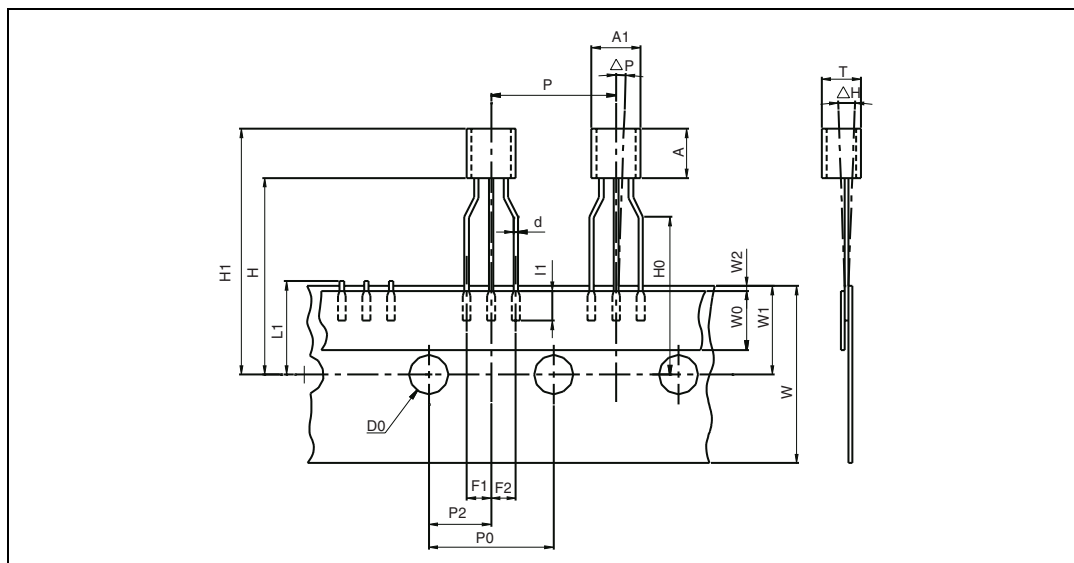
## 5 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK<sup>®</sup> packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

## 5.1 SO-8 package mechanical data

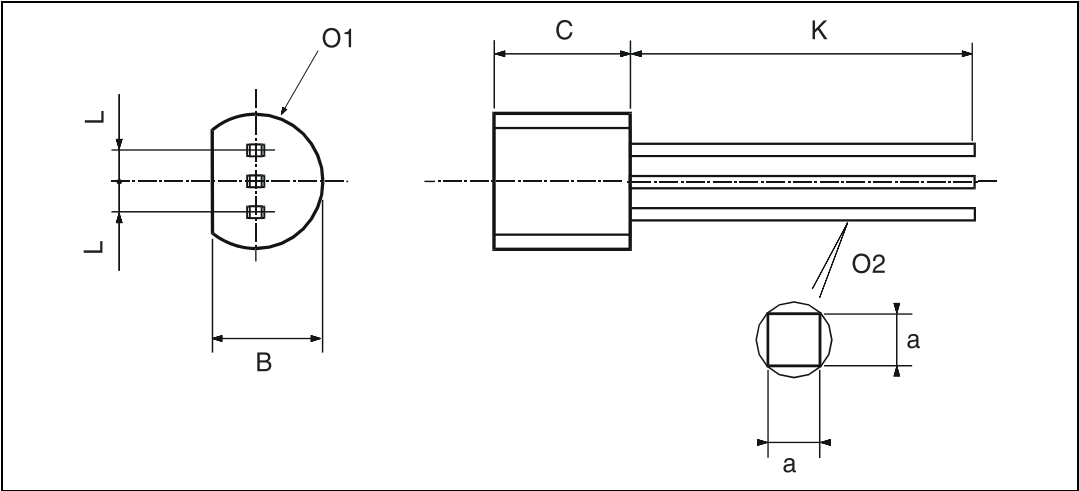
| Ref. | Dimensions  |      |      |        |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Millimeters |      |      | Inches |       |       |
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    |             |      | 1.75 |        |       | 0.069 |
| A1   | 0.10        |      | 0.25 | 0.004  |       | 0.010 |
| A2   | 1.25        |      |      | 0.049  |       |       |
| b    | 0.28        |      | 0.48 | 0.011  |       | 0.019 |
| c    | 0.17        |      | 0.23 | 0.007  |       | 0.010 |
| D    | 4.80        | 4.90 | 5.00 | 0.189  | 0.193 | 0.197 |
| H    | 5.80        | 6.00 | 6.20 | 0.228  | 0.236 | 0.244 |
| E1   | 3.80        | 3.90 | 4.00 | 0.150  | 0.154 | 0.157 |
| e    |             | 1.27 |      |        | 0.050 |       |
| h    | 0.25        |      | 0.50 | 0.010  |       | 0.020 |
| L    | 0.40        |      | 1.27 | 0.016  |       | 0.050 |
| k    | 1°          |      | 8°   | 1°     |       | 8°    |
| ccc  |             |      | 0.10 |        |       | 0.004 |

## 5.2 TO-92 ammpack and tape & reel package mechanical data



| Dim.  | Millimeters |      |      | 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 |
| Δh    | -1          | 0    | 1    | -0.039 | 0     | 0.039 |
| ΔP    | -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 |

### 5.3 TO-92 bulk package mechanical data



| Dim. | Millimeters |      |       | Inches |        |        |
|------|-------------|------|-------|--------|--------|--------|
|      | Min.        | Typ. | Max.  | Min.   | Typ.   | Max.   |
| L    |             | 1.27 |       |        | 0.05   |        |
| B    | 3.2         | 3.7  | 4.2   | 0.126  | 0.1457 | 0.1654 |
| O1   | 4.45        | 5.00 | 5.2   | 0.1752 | 0.1969 | 0.2047 |
| C    | 4.58        | 5.03 | 5.33  | 0.1803 | 0.198  | 0.2098 |
| K    | 12.7        |      |       | 0.5    |        |        |
| O2   | 0.407       | 0.5  | 0.508 | 0.016  | 0.0197 | 0.02   |
| a    | 0.35        |      |       | 0.0138 |        |        |

## 6 Ordering information

**Table 3. Order codes**

| Part number     | Temperature range | Package | Packing                         | Marking |
|-----------------|-------------------|---------|---------------------------------|---------|
| LM236D/DT       | -25°C to +85°C    | SO-8    | Tube or Tape & reel             | LM236   |
| LM236Z/ZT/AP    | -25°C to +85°C    | TO-92   | Bulk or Tape & reel or Ammopack | LM236   |
| LM336D/DT       | -25°C to +85°C    | SO-8    | Tube or Tape & reel             | LM336   |
| LM336Z/ZT/AP    | -25°C to +85°C    | TO-92   | Bulk or Tape & reel or Ammopack | LM336   |
| LM336BD/BDT     | 0°C to 70°C       | SO-8    | Tube or Tape & reel             | LM336B  |
| LM336BZ/BZT/BAP | 0°C to 70°C       | TO-92   | Bulk or Tape & reel or Ammopack | LM336B  |

## 7 Revision history

| Date        | Revision | Changes                                                                                                                                                                                                                      |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2-May-1997  | 1        | Initial release.                                                                                                                                                                                                             |
| 24-May-2003 | 2        | Caption of pinout diagram for TO-92 package changed to indicate top view.                                                                                                                                                    |
| 29-May-2007 | 3        | Corrected caption of pinout diagram for TO-92 package on cover page (previous version is wrong, should be bottom view).<br>Updated <a href="#">Section 5: Package information</a> and <a href="#">Table 3: Order codes</a> . |

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