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Examen : Certificat d'Aptitude Professionnelle	Code : 5025005
Spécialité : MECANICIEN D'ENTRETIEN D'AVIONS option T3	Coef : 3
Epreuve : EP1.6 : METROLOGIE	Durée : 3h

CONVERTISSEUR FREQUENCE TENSION.

ROLE :

L'objectif de cette épreuve est l'étude et l'étalonnage d'un bloc fonctionnel réalisant une fonction secondaire isolée d'un dispositif plus complexe de mesure de débit de carburant.

La structure retenue permet de produire une différence de potentiel Uv proportionnelle à la fréquence f_D du signal d'entrée U_{fd}. Cette relation reste valable jusqu'à une fréquence de 950Hz. Au delà, Uv reste constant et égal à 12V.

Le schéma structurel, la face avant du coffret ainsi que de la documentation technique sur les principaux composants sont fournis.

Première partie: analyse de documentations techniques.

1) Rappelez la fonction du composant LM2907

2) Rappelez la fonction du composant LM136

3) Identifier dans la documentation du circuit LM2907 le schéma d'application utilisé.

4) Rechercher dans la documentation la relation liant Uv et fd en fonction de RA4, C1 et Vcc (12V)

5) Quelle est la valeur de Uv pour une fréquence fd = 0Hz

6) Compléter le tableau suivant:
C1 = 10nF RA4 = 50kΩ et Vcc = 12V

f en Hertz	0	200	400	600	800	900	1000
Uv en Volt							

7) Tracer sur la feuille de papier millimétré la courbe de Uv en fonction de la fréquence.

Deuxième partie: métrologie

8) Régler une alimentation régulée à 12V.

(A faire vérifier par l'examinateur)

9) A l'aide d'un générateur de fonctions basse fréquence et d'un oscilloscope, régler et visualiser un signal d'entrée variable sinusoïdal de fréquence 500Hz et d'amplitude 5V.

(A faire vérifier par l'examinateur)

10) Alimenter la carte en 12V puis appliquer le signal variable sur Ufr.

(A faire vérifier par l'examinateur)

11).Faire varier la fréquence du signal Ufr de 100Hz à 1000Hz. (pas de 100Hz). Mesurer Uv pour chaque valeur de la fréquence et pour deux positions de RA4.

RA4 en butée haute

f en Hertz	100	200	300	400	500	600	700	800	900	1000
Uv en Volt										

RA4 en butée basse

f en Hertz	100	200	300	400	500	600	700	800	900	1000
Uv en Volt										

12) Régler RA4 à mi course et compléter le tableau suivant:

RA4 à mi-course

f en Hertz	100	200	300	400	500	600	700	800	900	1000
Uv en Volt										

13) Tracer sur la feuille de papier millimétré les trois courbes de Uv en fonction de la fréquence.

14) Conclusion sur la plage de fréquence sur laquelle Uv est proportionnelle à fd.

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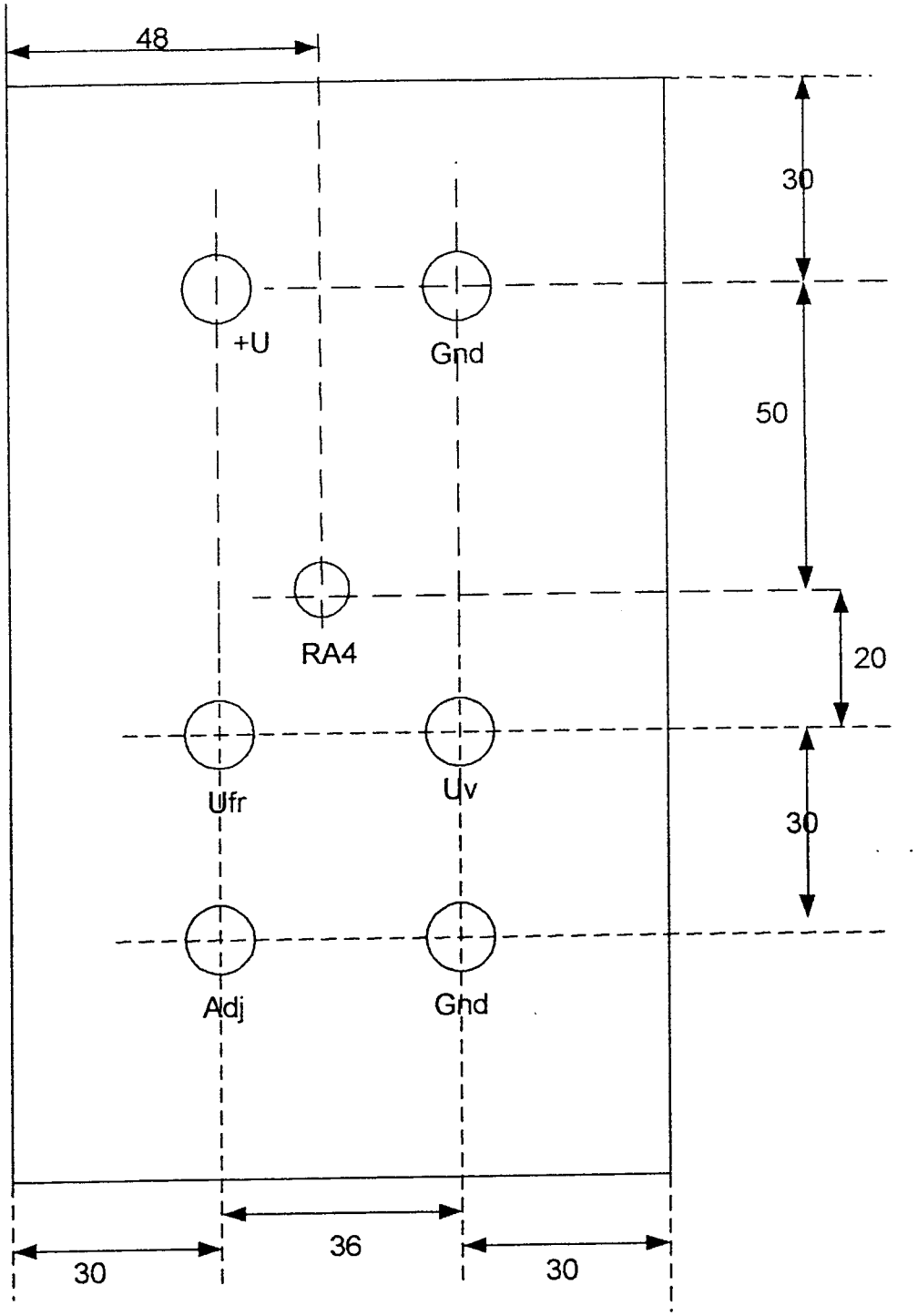
FACE AVANT DU COFFRET.



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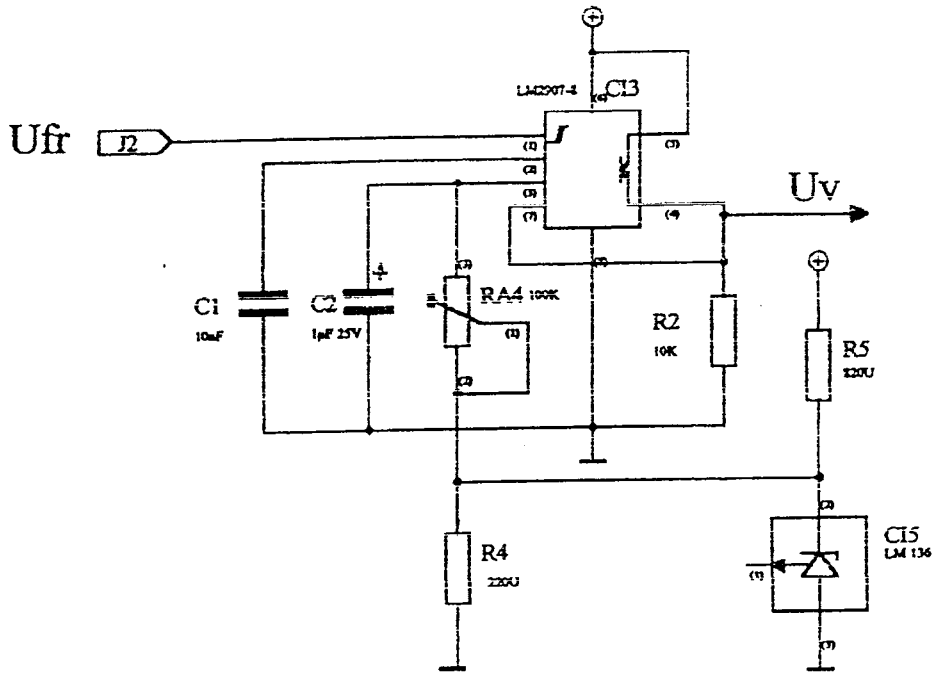
SCHEMA STRUCTUREL.



DOCUMENTATION CONSTRUCTEUR.

National Semiconductor

Industrial Blocks

LM2907, LM2917 Frequency to Voltage Converter

General Description

The LM2907, LM2917 series are monolithic frequency to voltage converters with a high gain op amp/comparator designed to operate a relay, lamp, or other load when the input frequency reaches or exceeds a selected rate. The tachometer uses a charge pump technique and offers frequency doubling for low ripple, full input protection in two versions (LM2907-8, LM2917-8) and its output swings to ground for a zero frequency input.

Advantages

- Output swings to ground for zero frequency input
- Easy to use: $V_{OUT} = f_{IN} \times V_{CC} \times R1 \times C1$
- Only one RC network provides frequency doubling
- Zener regulator on chip allows accurate and stable frequency to voltage or current conversion. (LM2917)

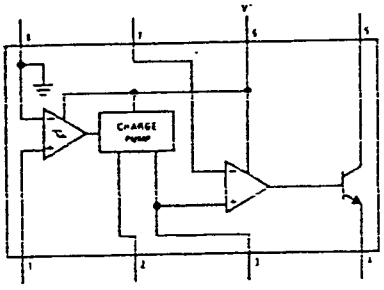
Features

- Ground referenced tachometer input interfaces directly with variable reluctance magnetic pickups
- Op amp/comparator has floating transistor output
- 50 mA sink or source to operate relays, solenoids, meters, or LEDs
- Frequency doubling for low ripple
- Tachometer has built-in hysteresis with either differential input or ground referenced input
- Built-in zener on LM2917
- ±0.3% linearity typical
- Ground referenced tachometer is fully protected from damage due to swings above V_{CC} and below ground

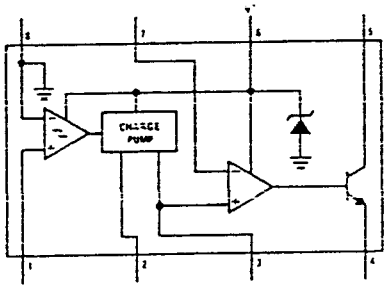
Applications

- Over/under speed sensing
- Frequency to voltage conversion (tachometer)
- Speedometers
- Breaker point dwell meters
- Hand-held tachometer
- Speed governors
- Cruise control
- Automotive door lock control
- Clutch control
- Horn control
- Touch or sound switches

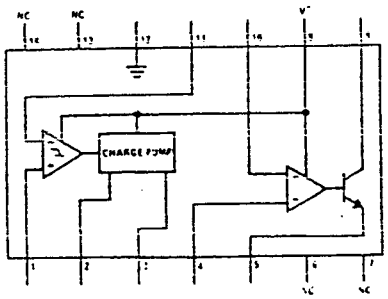
Block and Connection Diagrams Dual-In-Line Packages, Top Views



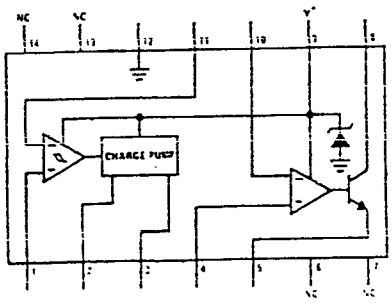
Order Number LM2907N-8
See NS Package N08B



Order Number LM2917N-8
See NS Package N08B



Order Number LM2907J
See NS Package J14A
Order Number LM2907N
See NS Package N14A



Order Number LM2917J
See NS Package J14A
Order Number LM2917N
See NS Package N14A

DOCUMENTATION CONSTRUCTEUR.

General Description (Continued)

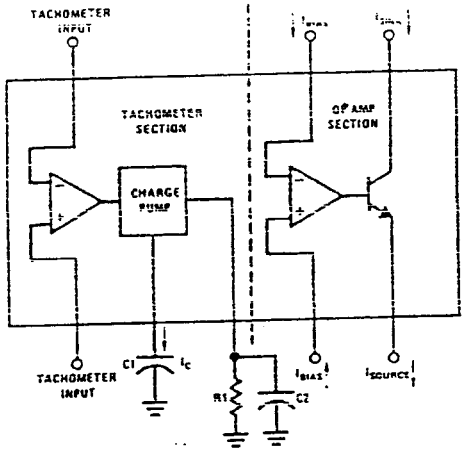
The op amp/comparator is fully compatible with the tachometer and has a floating transistor as its output. This feature allows either a ground or supply referred load of up to 50 mA. The collector may be taken above V_{CC} up to a maximum V_{CE} of 28V.

The two basic configurations offered include an 8-pin device with a *ground referenced tachometer* input and an internal connection between the tachometer output and the op amp non-inverting input. This version is well suited for single speed or frequency switching or fully buffered frequency to voltage conversion applications.

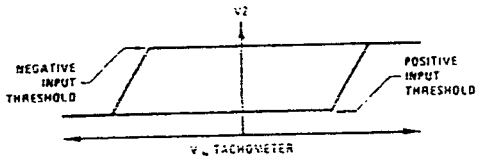
The more versatile configurations provide differential tachometer input and uncommitted op amp inputs. With this version the tachometer input may be floated and the op amp becomes suitable for active filter conditioning of the tachometer output.

Both of these configurations are available with an active shunt regulator connected across the power leads. The regulator clamps the supply such that stable frequency to voltage and frequency to current operations are possible with any supply voltage and a suitable resistor.

Test Circuit and Waveform



Tachometer Input Threshold Measurement



Applications Information

The LM2907 series of tachometer circuits is designed for minimum external part count applications and maximum versatility. In order to fully exploit its features and advantages let's examine its theory of operation. The first stage of operation is a differential amplifier driving a positive feedback flip-flop circuit. The input threshold voltage is the amount of differential input voltage at which the output of this stage changes state. Two options (LM2907-8, LM2917-8) have one input internally grounded so that an input signal must swing above and below ground and exceed the input thresholds to produce an output. This is offered specifically for magnetic variable reluctance pickups which typically provide a single-ended ac output. This single input is also fully protected against voltage swings to ±28V, which are easily attained with these types of pickups.

The differential input options (LM2907, LM2917) give the user the option of setting his own input switching level and still have the hysteresis around that level for excellent noise rejection in any application. Of course in order to allow the inputs to attain common-mode voltages above ground, input protection is removed and neither input should be taken outside the limits of the supply voltage being used. It is very important that an input not go below ground without some resistance in its lead to limit the current that will then flow in the epi-substrate diode.

Following the input stage is the charge pump where the input frequency is converted to a dc voltage. To do this requires one timing capacitor, one output resistor, and an integrating or filter capacitor. When the input stage changes state (due to a suitable zero crossing or differential voltage on the input) the timing capacitor is either charged or discharged linearily between two voltages whose difference is $V_{CC}/2$. Then in one half cycle of the input frequency or a time equal to 1/2 f_{IN} the change in charge on the timing capacitor is equal to $V_{CC}/2 \times C1$. The average amount of current pumped into or out of the capacitor then is:

$$\frac{\Delta Q}{T} = i_{(AVG)} = C1 \times \frac{V_{CC}}{2} \times (2f_{IN}) = V_{CC} \times f_{IN} \times C1$$

The output circuit mirrors this current very accurately into the load resistor R1, connected to ground, such that if the pulses of current are integrated with a filter

DOCUMENTATION CONSTRUCTEUR.

LM2907, LM2917

Applications Information (Continued)

capacitor, then, $V_o = i_c \times R1$, and the total conversion equation becomes:

$V_C = V_{CC} \times f_{IN} \times C1 \times R1 \times K$

Where K is the gain constant—typically 1.0.

The size of C2 is dependent only on the amount of ripple voltage allowable and the required response time.

CHOOSING R1 AND C1

There are some limitations on the choice of R1 and C1 which should be considered for optimum performance. The timing capacitor also provides internal compensation for the charge pump and should be kept larger than 100 pF for very accurate operation. Smaller values can cause an error current on R1, especially at low temperatures. Several considerations must be met when choosing R1. The output current at pin 3 is internally fixed and therefore $V_o/R1$ must be less than or equal to this value. If R1 is too large, it can become a significant fraction of the output impedance at pin 3 which degrades linearity. Also output ripple voltage must be considered and the size of C2 is affected by R1. An expression that describes the ripple content on pin 3 for a single R1C2 combination is:

$$V_{RIPPLE} = \frac{V_{CC}}{2} \times \frac{C1}{C2} \times \left(1 - \frac{V_{CC} \times f_{IN} \times C1}{I_2}\right) \text{ pk–pk}$$

It appears R1 can be chosen independent of ripple, however response time, or the time it takes V_{OUT} to stabilize at a new voltage increases as the size of C2 increases so a compromise between ripple, response time, and linearity must be chosen carefully.

As a final consideration, the maximum attainable input frequency is determined by V_{CC}, C1 and I_2:

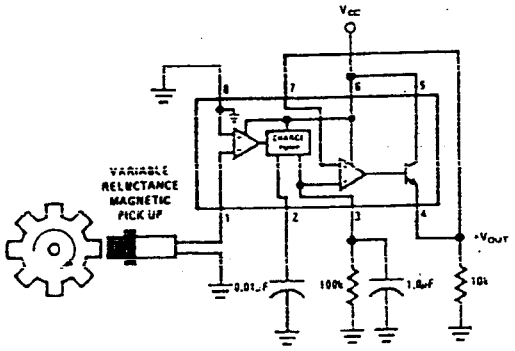
$$f_{MAX} = \frac{I_2}{C1 \times V_{CC}}$$

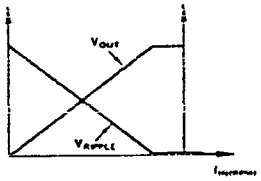
USING ZENER REGULATED OPTIONS (LM2917)

For those applications where an output voltage or current must be obtained independent of supply voltage variations, the LM2917 is offered. The most important consideration in choosing a dropping resistor from the unregulated supply to the device is that the tachometer and op amp circuitry alone require about 3 mA at the voltage level provided by the zener. At low supply voltages there must be some current flowing in the resistor above the 3 mA circuit current to operate the regulator. As an example, if the raw supply varies from 9 to 16V, a resistance of 470Ω will minimize the zener voltage variation to 160 mV. If the resistance goes under 400Ω or over 600Ω the zener variation quickly rises above 200 mV for the same input variation.

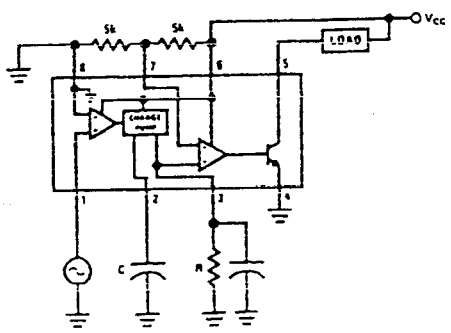
Typical Applications

Minimum Component Tachometer

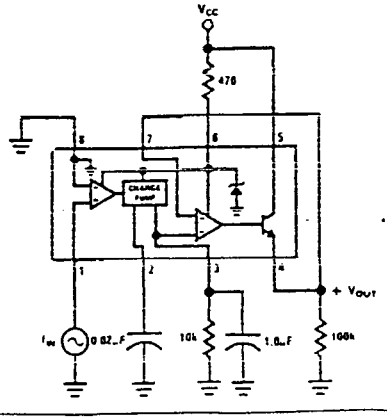




"Speed Switch" Load is Energized When $f_{IN} \geq \frac{1}{2RC}$



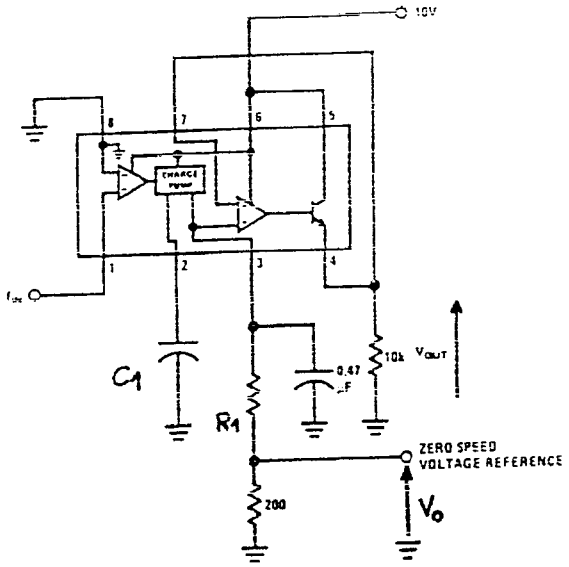
Zener Regulated Frequency to Voltage Converter

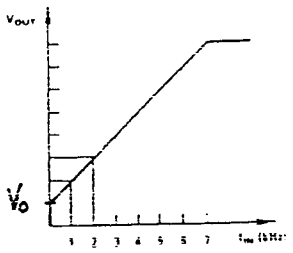


DOCUMENTATION CONSTRUCTEUR.

Typical Applications (Continued)

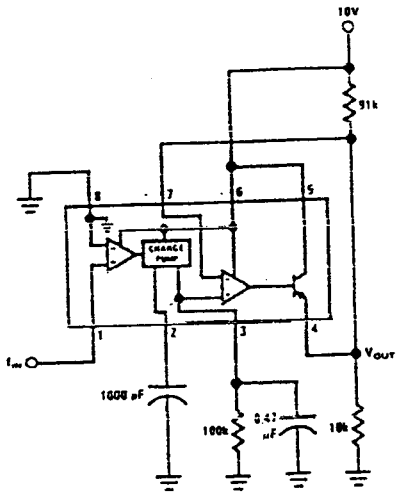
Changing the Output Voltage for an Input Frequency of Zero

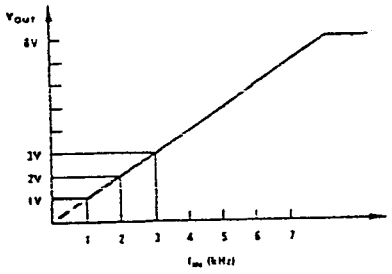




$$V_{out} = (f_{in} \times V_{cc} \times R_1 \times C_1) + V_o$$

Changing Tachometer Gain Curve
or Clamping the Minimum Output Voltage





DOCUMENTATION CONSTRUCTEUR.

LM136-5.0/ LM236-5.0/LM336-5.0

National Semiconductor

Voltage References

LM136-5.0/LM236-5.0/LM336-5.0 5.0V Reference Diode

General Description

The LM136-5.0/LM236-5.0/LM336-5.0 integrated circuits are precision 5.0V shunt regulator diodes. These monolithic IC voltage references operate as a low temperature coefficient 5.0V zener with 0.6Ω dynamic impedance. A third terminal on the LM136-5.0 allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136-5.0 series is useful as a precision 5.0V low voltage reference for digital voltmeters, power supplies or op amp circuitry. The 5.0V make it convenient to obtain a stable reference from low voltage supplies. Further, since the LM136-5.0 operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

The LM136-5.0 is rated for operation over −55°C to +125°C while the LM236-5.0 is rated over a −25°C to +85°C temperature range. Both are packaged in a TO-46 package. The LM336-5.0 is rated for operation over a 0°C to +70°C temperature range and is available in either a three lead TO-46 package or a TO-92 plastic package. For applications requiring 2.5V see LM136-2.5.

Features

- Adjustable 4V to 6V
- Low temperature coefficient
- Wide operating current of 400 μA to 10 mA
- 0.6Ω dynamic impedance
- ±1% initial tolerance available
- Guaranteed temperature stability
- Easily trimmed for minimum temperature drift
- Fast turn-on
- Three lead transistor package

LM136/LM236/LM336

National Semiconductor

Voltage References

LM136/LM236/LM336 2.5V Reference Diode

General Description

The LM136/LM236 and LM336 integrated circuits are precision 2.5V shunt regulator diodes. These monolithic IC voltage references operate as a low temperature coefficient 2.5V zener with 0.2Ω dynamic impedance. A third terminal on the LM136 allows the reference voltage and temperature coefficient to be trimmed easily.

The LM136 series is useful as a precision 2.5V low voltage reference for digital voltmeters, power supplies or op amp circuitry. The 2.5V make it convenient to obtain a stable reference from 5V logic supplies. Further, since the LM136 operates as a shunt regulator, it can be used as either a positive or negative voltage reference.

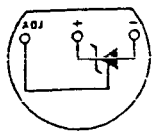
The LM136 is rated for operation over −55°C to +125°C while the LM236 is rated over a −25°C to +85°C temperature range. Both are packaged in a TO-46 package. The LM336 is rated for operation over a 0°C to +70°C temperature range and is available in either a three lead TO-46 package or a TO-92 plastic package.

Features

- Low temperature coefficient
- Wide operating current of 300 μA to 10 mA
- 0.2Ω dynamic impedance
- ±1% initial tolerance available
- Guaranteed temperature stability
- Easily trimmed for minimum temperature drift
- Fast turn-on
- Three lead transistor package

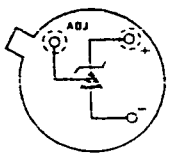
Connection Diagrams

TO-92
Plastic Package



BOTTOM VIEW

TO-46
Metal Can Package



BOTTOM VIEW

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COURBES.