Data Sheet

Tachometer IC 2917

RS stock number 302-047

The RS Tachometer IC is a monolithic frequency to Voltage converter; featuring a ground referenced, protected input stage with built in hysteresis making it ideally suited for use with magnetic pick ups (RS stock number 304-166) or it may simply be adapted for use with many other sensors with pulse rate outputs.

This tachometer IC uses a charge pump technique and offers frequency doubling for low ripple. Its output swings to ground for a zero frequency input and the integral regulator clamps the supply to provide stable frequency to voltage or current operation.

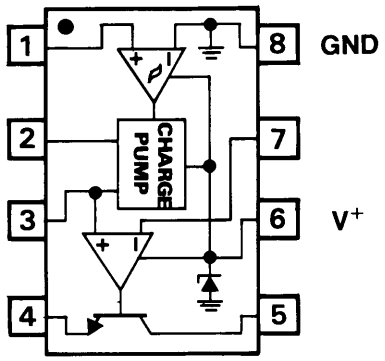
Additionally this device contains on op-amp/comparator together with a floating transistor that may be configured to provide either a proportional output or a speed switched output that will directly drive meters, relays, solenoids, lamps etc.

Absolute maximum ratings (Note 1)

Supply voltage ____ 28V
Supply current ____ 25mA
Collector voltage ____ 28V
Differential input voltage
  Tachometer ____ 28V
  Op-amp/Comparator ____ 28V
Input voltage range
  Tachometer ____ ±28V
  Op-amp/Comparator ____ 0.0V to +28V
Power dissipation ____ 500mW
Operating temperature range ____ -40˚C to +85˚C
Storage temperature range ____ -65˚C to +150˚C
Lead temperature (soldering, 10 seconds) ____ 300˚C

Features

- Built-in hysteresis with ground referenced fully protected input
- Interfaces directly with RS magnetic pick-up
- Built in zener
- Floating transistor output will source or sink 50mA to operate relays, solenoids, meters etc.
- Frequency doubling for low ripple
- 0.3% typical linearity.



Electrical characteristics $V_{CC} = 12V_{DC}$, $T_A = 25˚C$

Parameter	Conditions	Min	Typ	Max	Units
TACHOMETER					
Input thresholds	V_{IN} = 250mVp-p @ 1kHZ (Note 2)	±10	±15	±40	mV
Hysteresis	V_{IN} = 250mVp-p @ 1kHZ (Note 2)		30		mV
Offset voltage	V_{IN} = 250mVp-p @ 1kHZ (Note 2)		3.5	10	mV
Input bias current	V_{IN} = ±150mV$_{DC}$		0.1	1	μA
V_{OH} Pin 2	V_{IN} = +125mV$_{DC}$ (Note 3)		8.3		V
V_{OL} Pin 2	V_{IN} = -125mV$_{DC}$ (Note 3)		2.3		V
Output current: I_2, I_3	V2 = V3 = 6.0V (Note 4)	140	180	240	μA
Leakage current: I_3	I_2 = 0, V3 = 0			0.1	μA
Gain constant, K	(note 3)	0.9	1.0	1.1	
Linearity	f_{IN} = 1kHz, 5kHz, 10kHz, (Note 5)	-1.0	0.3	+1.0	%

Parameter	Conditions	Min	Typ	Max	Units
OP/AMP COMPARATOR					
V_{OS}	V_{IN} = 6.0V		3	10	mV
I_{BIAS}	V_{IN} = 6.0V		50	500	nA
Input common-mode voltage		0		V_{CC}-1.5V	V
Voltage gain			200		V/mV
Output sink current	V_C = 1.0	40	50		mA
Output source current	V_E= V_{CC}-2.0		10		mA
Saturation voltage	I_{SINK} = 5mA		0.1	0.5	V
	I_{SINK} = 20mA			1.0	V
	I_{SINK} = 50mA		1.0	1.5	V
ZENER REGULATOR					
Zener voltage (Pin 6)	R_{DROP} = 470Ω		7.56		V
Series resistance			10.5	15	Ω
Temperature stability			+1		mV/°C
TOTAL SUPPLY CURRENT			3.8	6	mA

Note 1: For operation in ambient temperatures above 25°C, the device must be derated based on a 150°C maximum junction temperature and a thermal resistance of 187°C/W junction to ambient.

Note 2: Hysteresis is the sum $+V_{TH}-(-V_{TH})$, offset voltage is their difference.

Note 3: V_{OH} is equal to 3/4 x V_{CC}-1 V_{BE}, V_{OL} is equal to 1/4 x V_{CC}-1 V_{BE} therefore V_{OH}-V_{OL} = $V_{CC}/2$. The difference, V_{OH}-V_{OL} and the mirror gain, I_2/I_3 are the two factors that cause the tachometer gain constant to vary from 1.0.

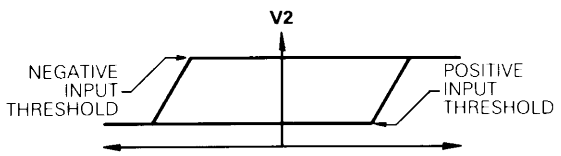
Note 4: Be sure when choosing the time constant R1 x C1 that R1 is such that the maximum anticipated output voltage at pin 3 can be reached with I_3 x R1. The maximum value for R1 is limited by the output resistance of pin 3 which is greater than 10MΩ typically.

Note 5: Nonlinearity is defined as the deviation of V_{OUT} (@ pin 3) for f_{IN} = 5kHz from a straight line defined by the V_{OUT} @ 1kHz and V_{OUT} @ 10kHz. C1 = 1000pF, R1 = 68k and C2 = 0.22µFd.

Design considerations

The first stage 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. One input is internally grounded so that an input signal must swing above and below ground and exceed the input thresholds to produce an output. This makes the device ideally suited for use with magnetic variable reluctance pickups which typically provide a single-ended output. This single ended input is fully protected against voltage swings to +28V, which may be attained with these types of pickups.

Tachometer Input Threshold Measurement



V_{IN} TACHOMETER

Following the input stage is the charge pump where the input frequency is converted to dc voltage. To do this requires one timing capacitor, one output resistor and one integrating or filter capacitor. When the input stage changes state, due to a zero crossing, the capacitor is either charged or discharged linearly between two voltages whose difference is half the regulator voltage (Vz). So in one half cycle of the input frequency the change in charge on the timing capacitor is equal to Vz/2 x C1. The average amount of current pumped into or out of the capacitor then is:

$$i_{C(AVG)} = \frac{\Delta Q}{T} = \frac{C1 \times V_2 \times (2 f_{IN})}{2}$$
$$= V_z \times f_{IN} \times C_1$$

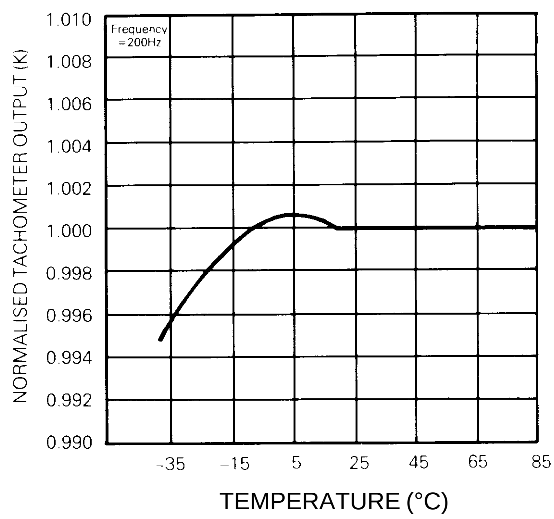
The output circuit mirrors this current very accurately into the load resistor R1, connected to ground, such that if the pulses of current are integrated with a filter capacitor then:

$$V_0 = i_C \times R1$$
$$= V_Z \times f_{IN} \times C1 \times R1 \times K$$

(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.

Normalised Tachometer Output
vs Temperature



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 Vo/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 R1, C2 combination is:

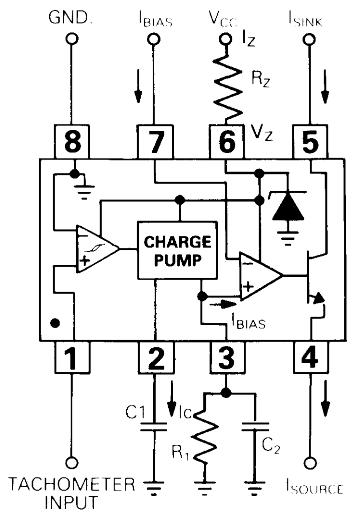
$$V_{RIPPLE} = \frac{V_Z}{2} \times \frac{C1}{C2} \times \left(1 - \frac{V_Z \times f_{IN} \times C1}{I_Z}\right) \text{ pk-pk}$$

It appears R1 can be chosen independent of ripple, however response time, or the time it takes V_{OUT} to stabilise 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_Z, C1 and I_Z:

$$f_{MAX} = \frac{I_Z}{C1 \times V_Z}$$

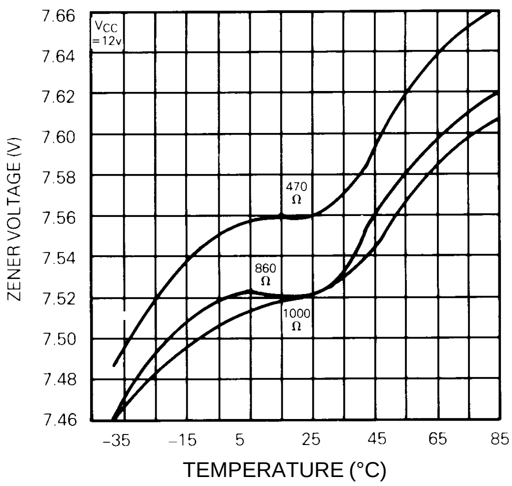
Figure 1



Choosing R_Z

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 3mA at the voltage level provided by the zener. At low supply voltages there must by some current flowing to operate the regulator. As an example, if the raw supply varies from 9 to 16V, a resistance of 470Ω will minimise the zener voltage variation to 160mV. If the resistance goes under 400Ω or over 600Ω the zener variation quickly rises above 200mV for the same input variation.

Zener Voltage vs Temperature



Typical applications

Figure 2 **Minimum component tachometer**

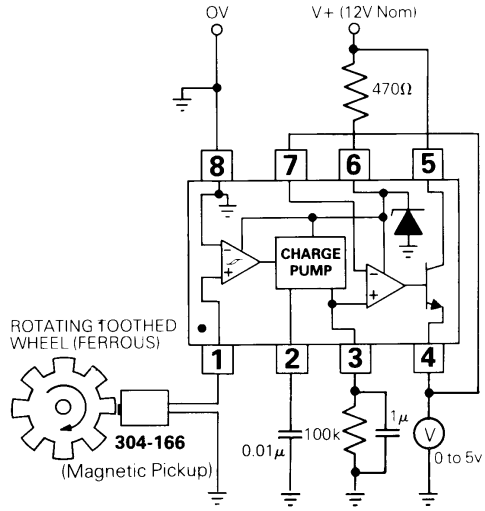
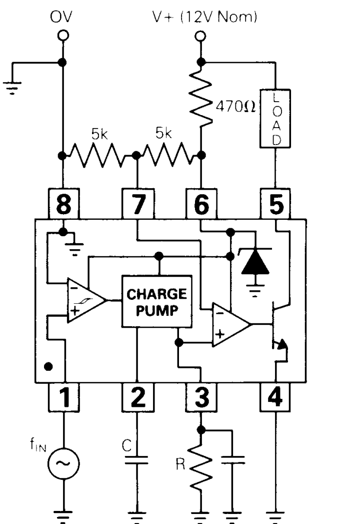


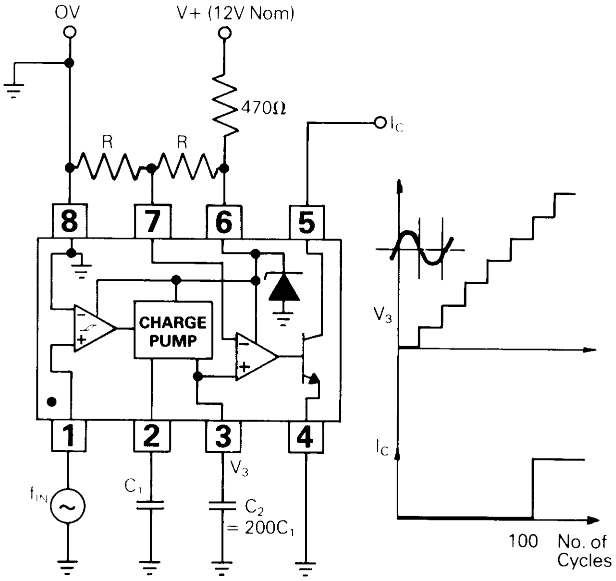
Figure 3 **Speed switch**



Load is energised when:

$$f_{IN} \geq \frac{1}{2RC}$$

Figure 4 **100 Cycle delay switch**



V_3 steps ups in voltage by the amount.

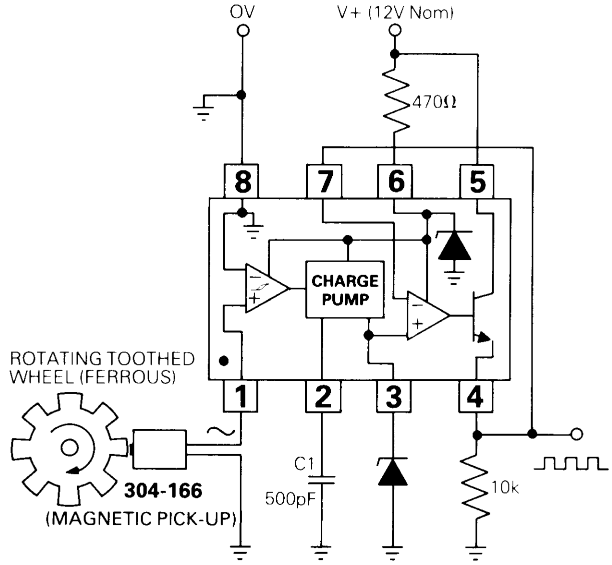
$\frac{V_{CC} \times C1}{C2}$ for each complete cycle

(2 zero crossings).

e.g. If C2 = 200 C1 after 100 consecutive input cycles.

$V3 = 1/2\, V_z$ (V_Z = zener volts)

Figure 6 **Frequency doubler**

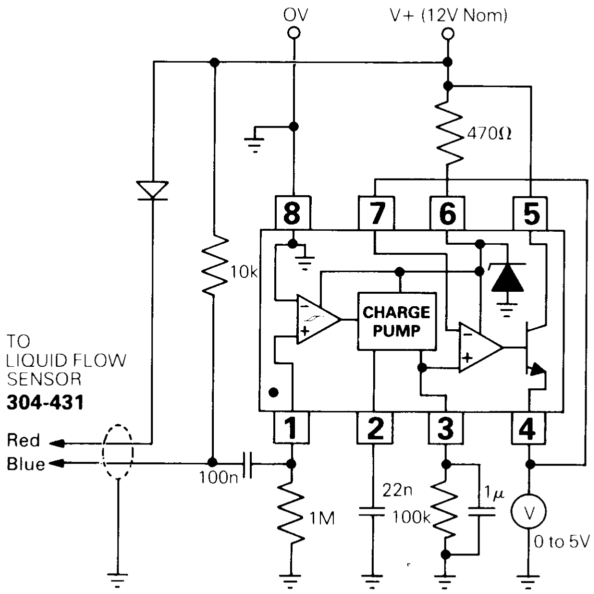


Precision two-shot output frequency equals twice input frequency.

Pulse width = $\frac{V_z}{2} \times \frac{C_1}{I_2}$

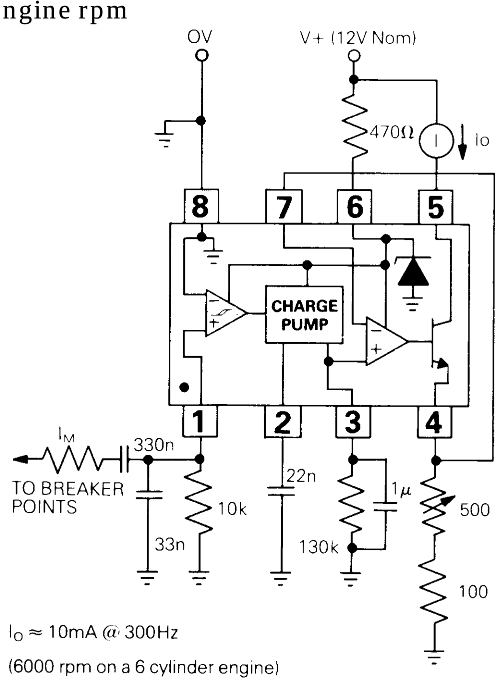
Pulse height = V_{ZENER} (external zener) pin 3

Figure 5 **Flow meter**



Note: Flow sensor output is decoupled to provide a signal that is symmetrical about 0V.

Figure 7 **Current driven meter indicating engine rpm**



$I_O \approx$ 10mA @ 300Hz

(6000 rpm on a 6 cylinder engine)

RS Components, PO Box 99, Corby, Northants, NN17 9RS
An Electrocomponents Company
Telephone: 01536 201234