1. DESCRIPTION

The XD2907/XD2917 family of products are integrated frequency-voltage converters with high-gain operational amplifiers/comparators designed to operate relays, lights, or other loads when the input frequency meets or exceeds a selected rate. The included tachometer uses charging pump technology to multiply the frequency of low ripple; The comparator has a lag voltage of 30mV, which can be used to suppress external interference.

The op amp/comparator is fully compatible with the tachometer and has a floating transistor as its output, a feature that allows for grounding or powering loads up to 50mA. The collector can be above VCC, with a maximum VCE of 28V.

The universal configuration offers differential tachometer input and unrestricted op amp input. With this version, the tachometer input may float and the op amp is suitable for active filter regulation of the tachometer output.

This configuration can be used with an active shunt regulator connected via a power line, which clamps the power supply so that any supply voltage and suitable resistance can achieve stable frequency to voltage and current operation.

The XD2907/XD2917 uses DIP-14 and DIP-8 seals Pretend.

2. FEATURES

- The XD2907/XD2917 uses only one RC network for frequency doubling
- The ground based tachometer (frequency) input can be accessed directly from the input pin
- The operational amplifier/comparator uses a floating triode output
- Up to 50mA output current can drive switch tubes, leds, etc
- The included tachometer uses charging pump technology and has a frequency multiplier function for low ripple
- The lag voltage of the comparator is 30mV, which can be used to suppress external interference
- The output voltage is proportional to the input frequency, and the typical linearity is ±0.3%
- It has a protective circuit that is not damaged by input signals above the Vcc value or below the ground reference point
- At zero frequency input, the output voltage of the XD2907 can be adjusted according to the peripheral circuit
- When the input frequency reaches or exceeds a given value, the output can be used to drive relays, indicators, and other loads

3. TYPICAL APPLICATION

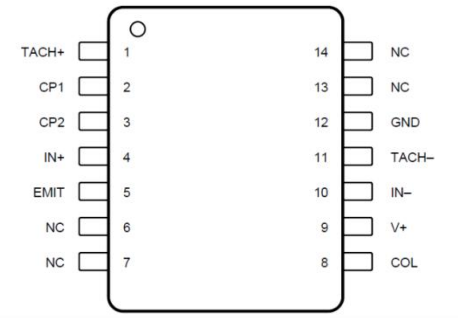
- Velocity measurement
- Frequency to Voltage conversion (tachometer)
- speedometer
- Hand tachometer
- governor
- Cruise control
- Car door lock control
- Clutch control
- Horn control
- Touch or sound switch

4. ADVANTAGE

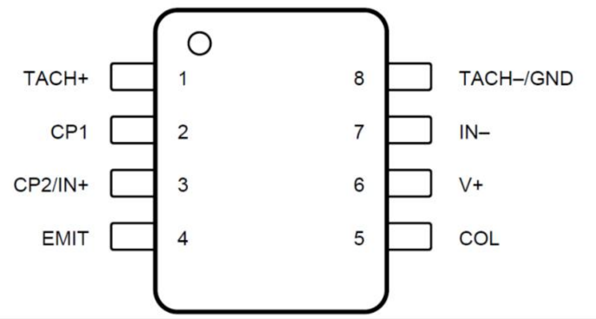
- The zero frequency input determines the output swing to the ground
- Easy to use: VOUT = fIN×VCC×R1×C1
- Only one RC network provides frequency doubling
- On-chip Zener regulator allows accurate and stable frequency to voltage or current conversion (XD2917)

5. PIN CONFIGURATIONS

The XD2907/XD2917 is available in DIP14 and SOP8/DIP8 package formats.



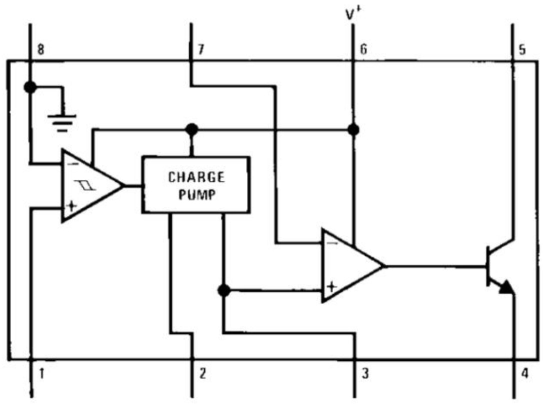
DIP14



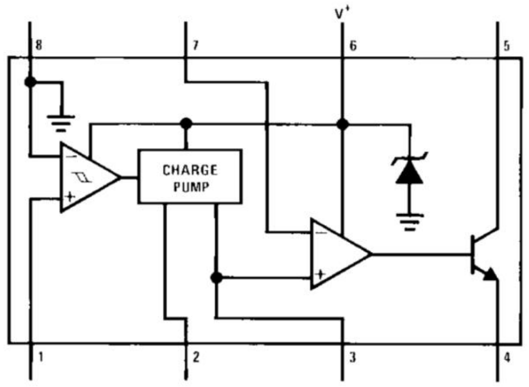
SOP8/DIP8

14-Pin Pin number	8-Pin Pin number	Pin name	I/O	Description
1	1	TACH+	I	The positive terminal of the input signal leads to the in-phase terminal of the internal Schmidt flip-flop comparator.
2	2	CP1	O	At the beginning of each positive half cycle, the capacitor placed on this pin will be charged to VCC / 2 through a constant current source with a typical value of 180μA. At the beginning of the negative half cycle, this capacitor emits the same amount of charge at the same rate.
3	3	CP2	O	The current output by the charge pump from this pin is equal to the absolute value of the capacitor current on CP1. Resistors and capacitors in parallel with this pin filter the current pulse into the output voltage.
4		IN+	I	In-phase input of a high-gain operational amplifier.
5	4	EMIT	O	The emitter of a bipolar junction transistor
6，7，13，14	—	NC	—	Bare foot
8	5	COL	I	The collector of a bipolar junction transistor
9	6	V+	P	Supply voltage
10	7	IN-	I	Inverting input to a high gain operational amplifier
11	8	TACH-	I	The negative terminal of the input signal leads to the in-phase terminal of the internal Schmitt flip-flop comparator.
12		GND	P	END

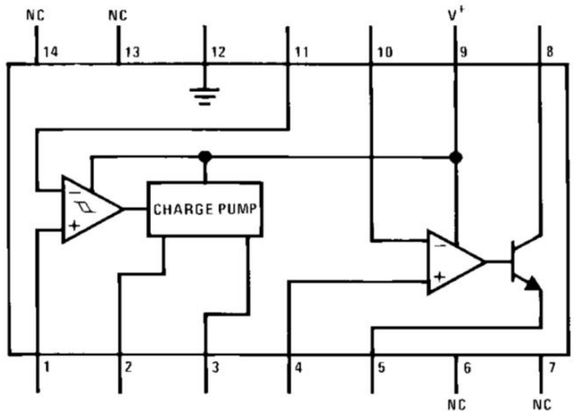
6. BLOCK DIAGRAM



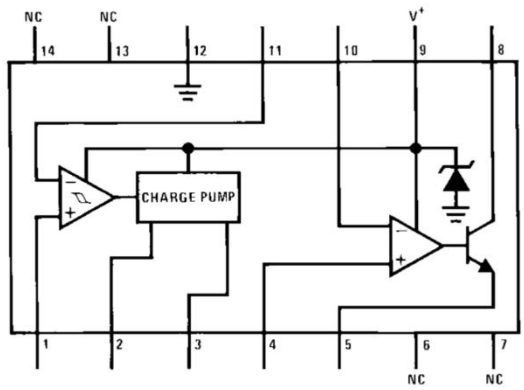
XD2907-8



XD2917-8



XD2907-14



XD2917-14

7. LIMITING PARAMETER

Parameter	Identification	Value
Supply voltage		28V
Current (Zener option)		25mV
Collector voltage		28V
Input voltage		28V
Operating temperature range, civil grade	Tj_Min/Max	-25~85℃
Storage temperature range	Ta_Min/Max	-40~140℃
Lead temperature (welding, 10s)	T_lead	260℃

8. ELECTRICAL PARAMETER

VCC = 12 VDC, TA = 25℃, refer to the test circuit diagram

Identification	Argument	Test condition	Min	Typ	Max	Unit
Tachometer						
	Input threshold	V_{IN} =250mVpp@1KHZ（Note 2）	±10	±25	±40	mV
	Retardation	V_{IN} =250mVpp@1KHZ（Note 2）		50		mV
	Offset voltage	V_{IN} =250mVpp@1KHZ（Note 2）		3.5	10	mV
	Input bias current	V_{IN} =±50mV_{DC}		0.1	1	uA
V_{OH}	Pin2	V_{IN} =+125mV_{DC}（Note 3）		8.3		V
V_{OL}	Pin2	V_{IN} =+125mV_{DC}（Note 3）		2.3		
I2、I3	Output current	V2=V3=6V（Note 4）	140	200	240	uA
I3	Output leakage	I2=0，V3=0			0.1	uA
K	Gain parameter	（Note 3）	0.9	1.0	1.1	
	linearity	f_{IN}=1kHz，5kHz，10kHz（Note 5）	-1	0.3	1	%
Comparator						
V_{OS}		V_{IN}=6V		3	10	mV
I_{BIAS}		V_{IN}=6V		50	500	nA
	Input common-mode voltage		0		VCC-1.5V	V
	Voltage gain			200		V/mV
Isink	Output filling current	VC=1V	40	80		mA
Isource	Output source current	VE=VCC-2		20		mA
VCES	Saturation voltage	Isink=5mA		0.1	0.5	V
		Isink=20mA		0.5	1.0	
		Isink=50mA		1.0	1.5	
Zener pressure regulator						
	Stabilized voltage	R_{DROP}=470Ω		7.56		V
	Series resistance			10.5	15	Ω
	Temperature stability			+1		mV/℃
	Total supply			3.8	6	mA

	current					

Note 1: TA = 25 ° C.

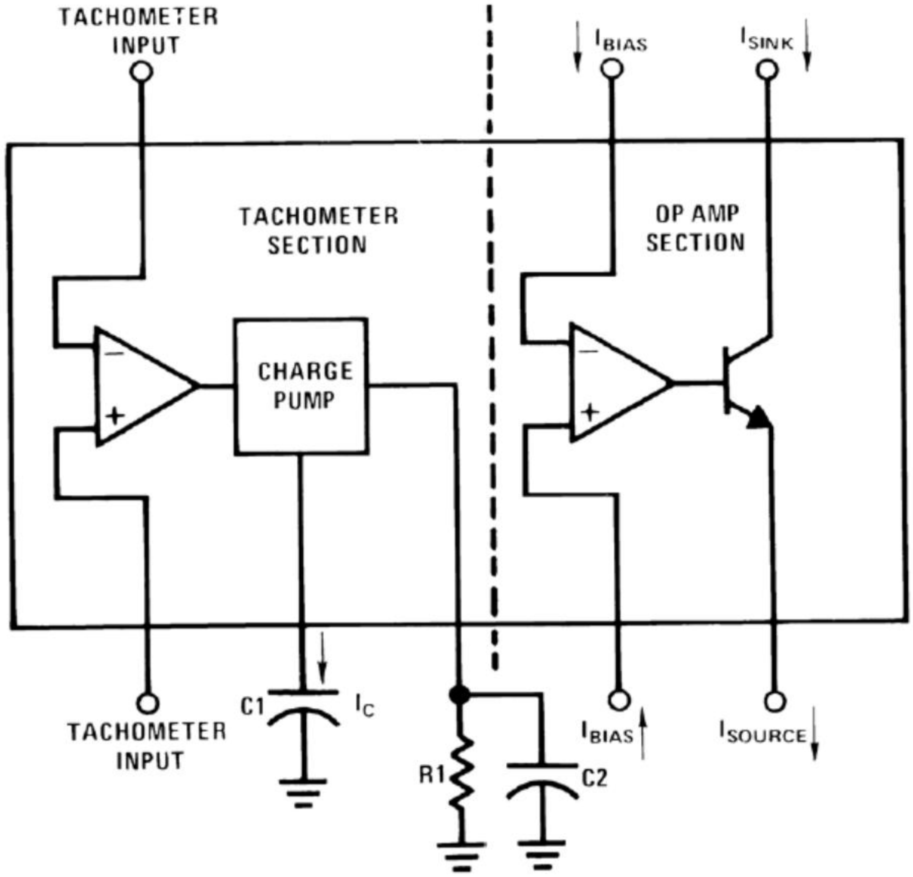
Note 2: Hysteresis is the sum of |+VTH|+|-VTH|, and imbalance is the difference between the two.

Note 3: VOH=3/4*VCC-VBE, VOL=1/4*VCC-VBE, VOh-vol =VCC/2. The difference between VOH and VOL is its mirror gain, and the I2/I3 ratio determines that the tachometer gain constant is different from 1.

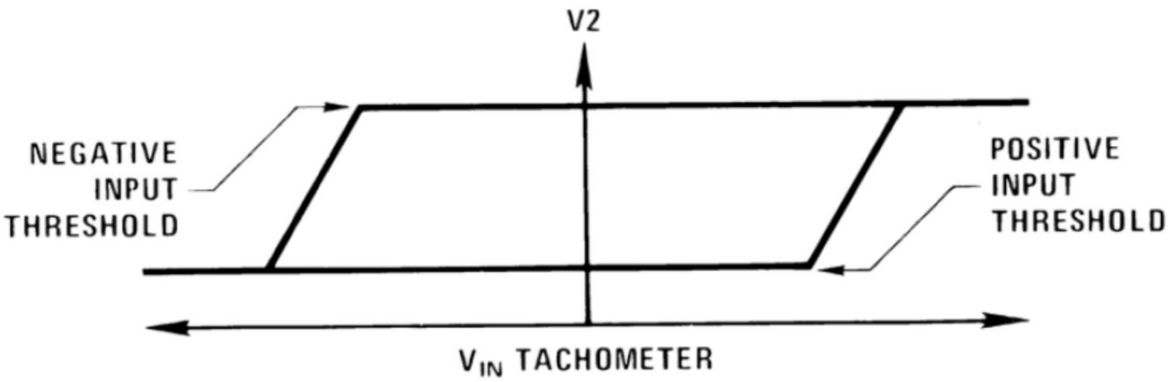
Note 4: To determine the time constant R1*C1, I3 * R1 can be used to achieve the maximum expected output voltage of pin3.

Note 5: The linearity deviation is determined by the pin3 output VOUT corresponding to the input 1khz, 5khz, and 10khz. (C1=100pF, R1=68K, C2=0.22mF)

9. TEST CIRCUIT DIAGRAM



10. TACHOMETER INPUT THRESHOLD MEASUREMENT



11. APPLICATION INFORMATION

The XD2907 series tachometer circuit is designed for minimal external parts and maximum versatility. In order to give full play to its characteristics and advantages, let's take a look at its operational theory. The first level of operation is the differential amplifier that drives the positive feedback flip-flop circuit, and the input threshold voltage is the amount of the differential input voltage of the output change state of the stage. Both models (XD2907-8,XD2917-8) have an input internally grounded so that the input signal must swing above the ground and above an input threshold to produce an output. This is a magnetically variable reluctance picker specifically designed to provide a single-ended AC output. The single input is also fully protected against voltage swing to ±28V, which can be easily achieved with these types of pickups.

Differential input options (XD2907, XD2917) give users the option to set their own input switching level and still have a lag above that level in any application for excellent noise suppression. Of course, in order for the input to be able to reach a common-mode voltage above ground voltage, input protection is removed, and neither should be outside the range of the supply voltage used.

After the input stage is the charge pump, where the input frequency is converted to a DC voltage. For this, a timing capacitor, an output resistor and an integrating or filtering capacitor are required. When the input stage changes state (due to an appropriate zero-crossing or differential voltage on the input), the timing capacitor charges or discharges linearly when the two voltage differences are VCC / 2. Then over one and a half cycles of the input frequency or a time equal to 1/2 fIN, the charge change on the timing capacitor is equal to VCC /2 ×C1. Therefore, the average current of the pump flowing into or out of the capacitor is:

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

The output circuit reflects this current very precisely to the load resistor R1 connected to the ground, such that if the current pulse is integrated with the filter capacitor, then VO = iC×R1, the total conversion equation is:

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

Where K is the gain constant, K is generally 1.0, and the size of C2 depends only on the amount of ripple voltage allowed and the required response time.

R1 and C1 choices

There are some limitations to the choice of R1 and C1, and these limitations should take into account optimal performance. The timing capacitor also provides internal compensation for the charge pump and should be kept greater than 500 pF for very precise operation. Smaller values can cause error currents on R1, especially at low temperatures. Several factors must be considered when selecting R1, the output current of pin 3 is fixed internally, so VO/R1 must be less than or equal to that value. If R1 is too large, it may be a large portion of the output impedance at pin 3, which reduces linearity. The output ripple voltage must also be considered, and the magnitude of C2 is affected by R1. The expression describing the ripple content on pin 3 of 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 seems that R1 can be selected independently of the ripple, but the response time or the time it takes for VOUT to stabilize at the new voltage increases as C2 gets larger, so the trade-off between ripple, response time, and linearity must be chosen carefully.

As a final consideration, the maximum attainable input frequency is determined by VCC, C1 and I2:

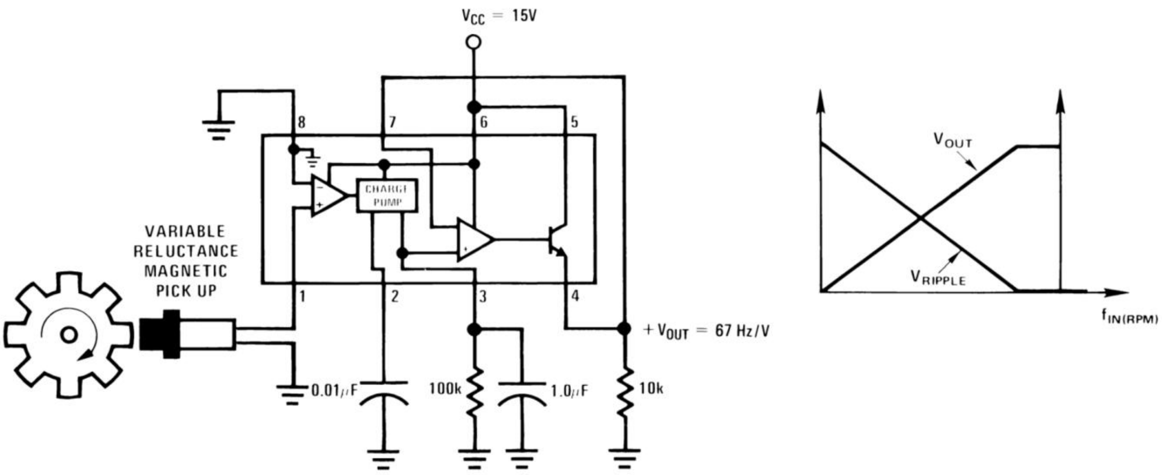
$$f_{MAX} = \frac{I_2}{C1 \times V_{CC}}$$

Use the ZENER adjustment option (XD2917)

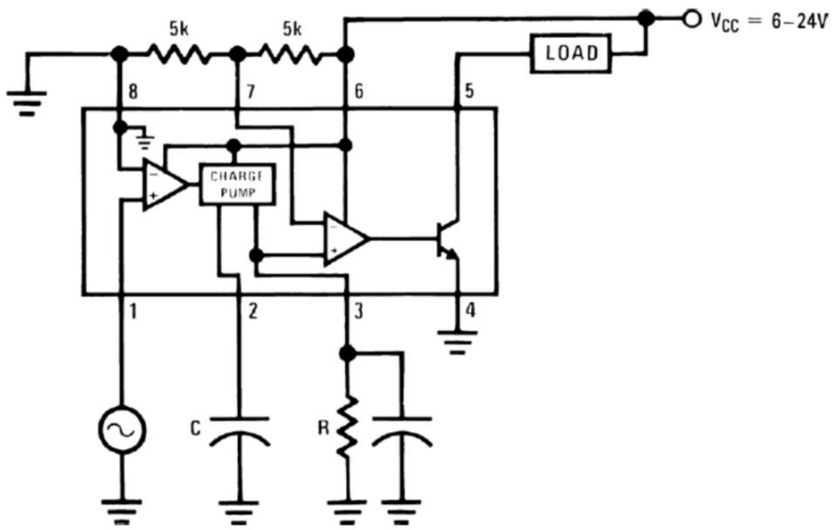
For applications where the output voltage or current must be obtained independently of changes in the supply voltage, choose the XD2917. At the voltage level provided by the regulator, both the individual tachometer and the op amp circuit require about 3 mA of current. At low supply voltages, some current must flow above the 3 mA circuit current to make the regulator work. For example, if the original power supply changes from 9V to 16V, a resistance of 470 Ω will minimize the Zener voltage change to 160mV. If the resistance value is less than 400 Ω or more than 600 Ω, the Zener strain will quickly rise above 200 mV for the same input change.

12. TYPICAL APPLICATION

This section shows an example of an application circuit using the XD2907 and XD2917 devices. Customers must first fully validate and test these circuits before implementing design development based on these examples.

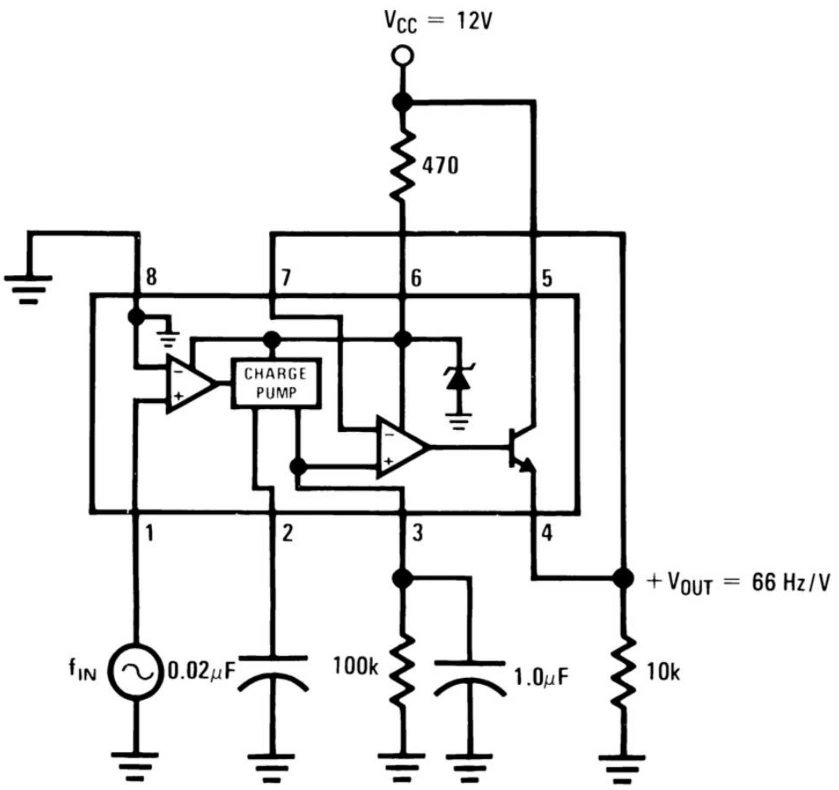


Minimum component tachometer

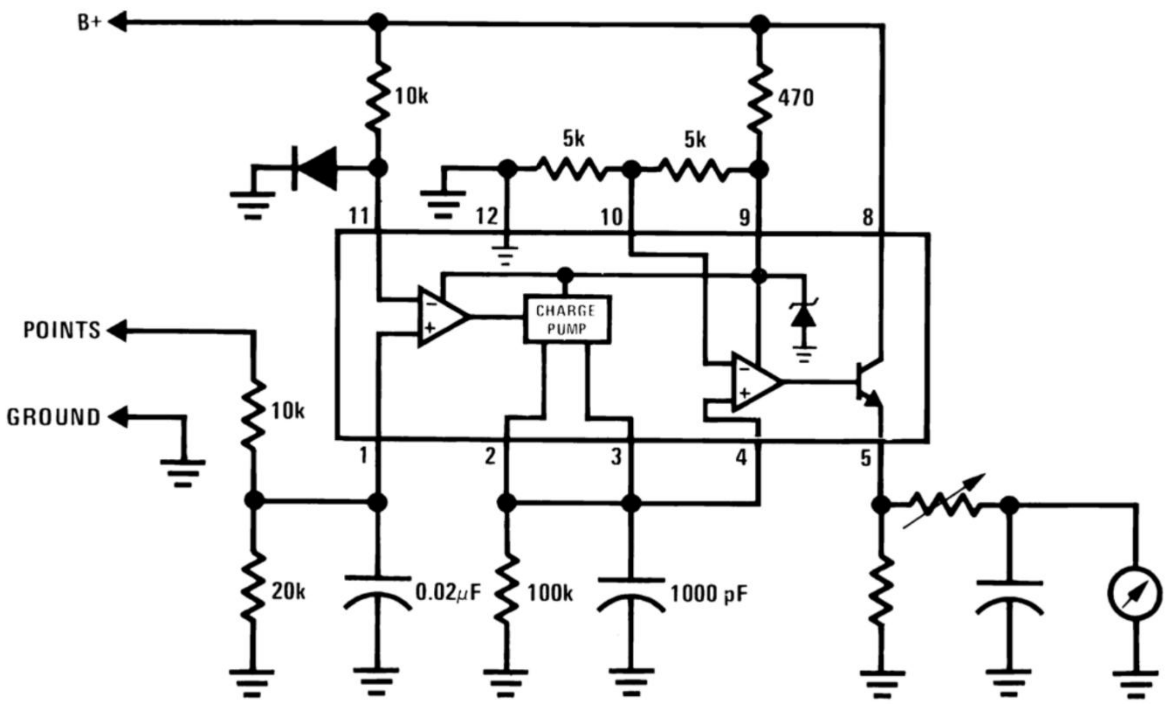


Load is energized when $f_{IN} \geq (1 / (2 \times R_C))$

Speed control switch

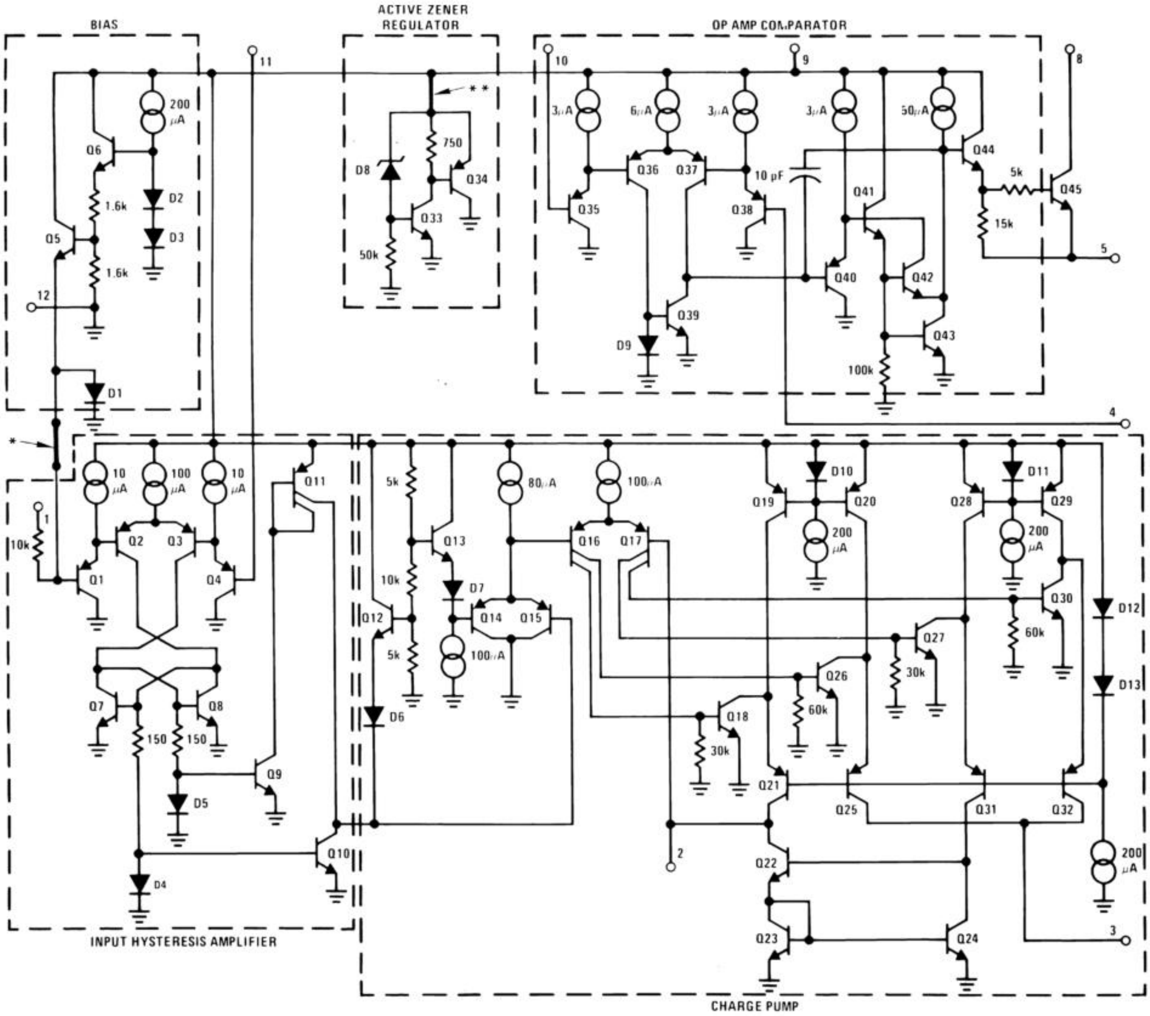


Zener regulated frequency voltage converter



Breakpoint stayometer

13. EQUIVALENT CIRCUIT DIAGRAM



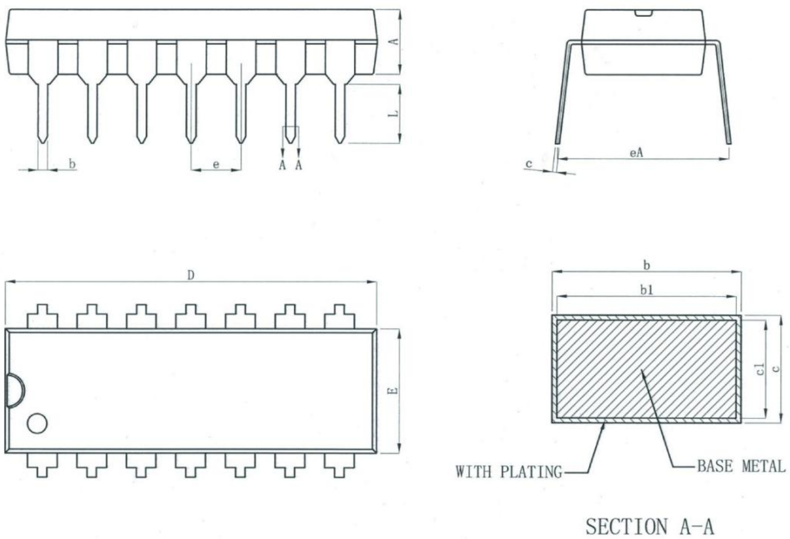
14. ORDERING INFORMATION

Ordering Information

Part Number	Device Marking	Package Type	Body size (mm)	Temperature (°C)	MSL	Transport Media	Package Quantity
XD2907-14	XD2907-14	DIP14	19.05 * 6.35	- 25 to +85	MSL3	Tube 25	1000
XD2907-8	XD2907-8	DIP8	9.25 * 6.38	- 25 to +85	MSL3	Tube 50	2000
XL2907-8	XL2907-8	SOP8	4.90 * 3.90	- 25 to +85	MSL3	T&R	2500
XD2917-14	XD2917-14	DIP14	19.05 * 6.35	- 25 to +85	MSL3	Tube 25	1000
XD2917-8	XD2917-8	DIP8	9.25 * 6.38	- 25 to +85	MSL3	Tube 50	2000
XL2917-8	XL2917-8	SOP8	4.90 * 3.90	- 25 to +85	MSL3	T&R	2500

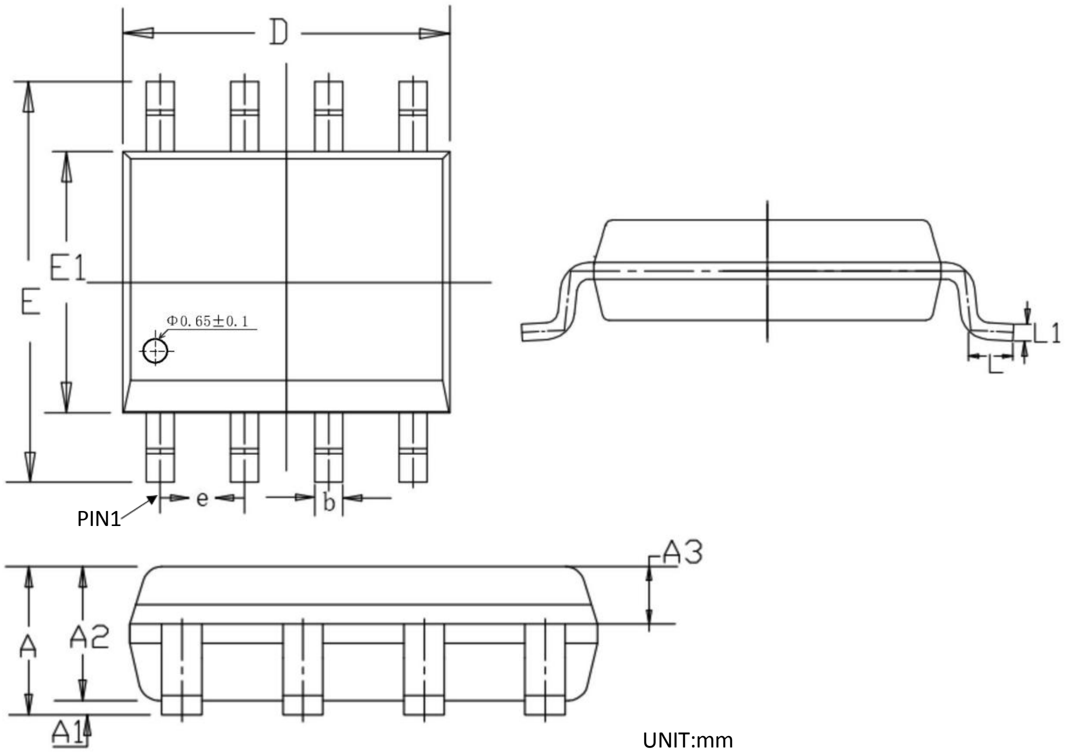
15. DIMENSIONAL DRAWINGS

DIP14



symbol	millimeter		
	Min	Nom	Max
A	3.20	3.30	3.40
b	0.44	----	0.53
b1	0.43	0.46	0.49
c	0.25	----	0.30
c1	0.24	0.25	0.26
D	18.95	19.05	19.15
E	6.25	6.35	6.45
e	2.54BSC		
eA	8.30	8.80	9.30
L	3.00	----	----

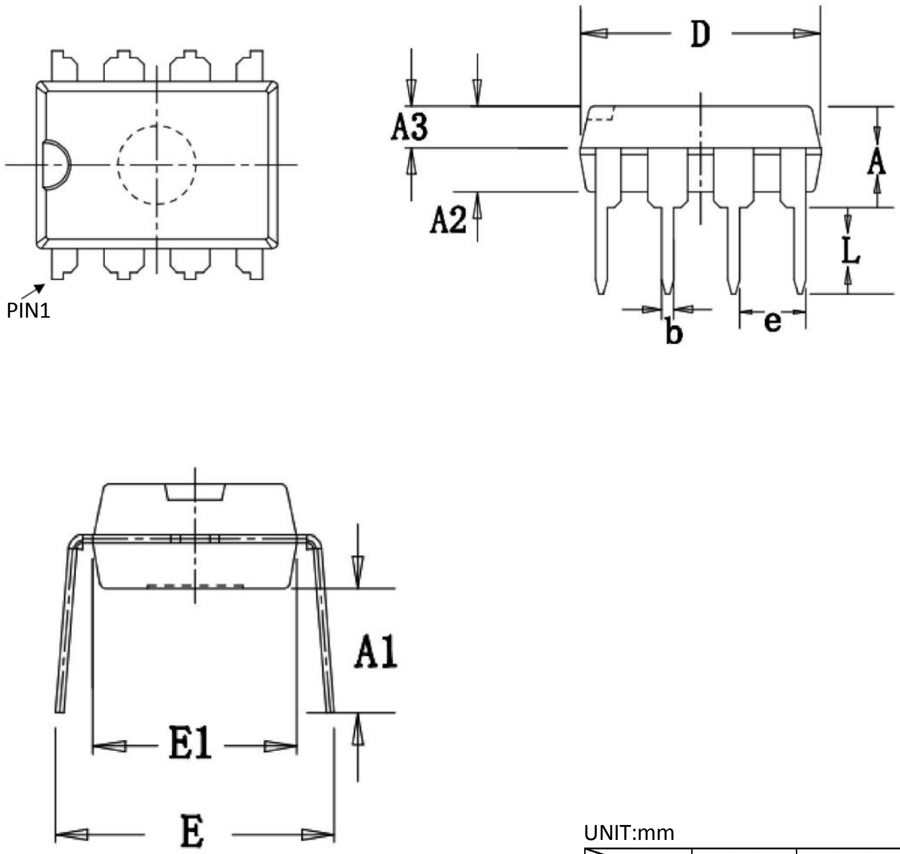
SOP8



UNIT:mm

	MIN	NOM	MAX
A	1.450	1.550	1.650
A1	0.100	0.150	0.200
A2	1.300	1.400	1.500
A3	0.600	0.650	0.700
b	0.380	–	0.510
e	1.240	1.270	1.300
D	4.800	4.900	5.000
E	5.800	6.000	6.200
E1	3.800	3.900	4.000
L	0.450	0.600	0.750
L1	—	0.25BSC	—

DIP8



UNIT:mm

	MIN	NOM	MAX
A	3.600	3.800	4.000
A1	3.786	3.886	3.986
A2	3.200	3.300	3.400
A3	1.550	1.600	1.650
b	0.440	–	0.490
e	2.510	2.540	2.570
D	9.150	9.250	9.350
E	7.800	8.500	9.200
E1	6.280	6.380	6.480
L	3.000	–	–