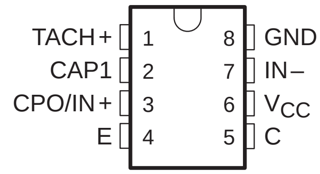
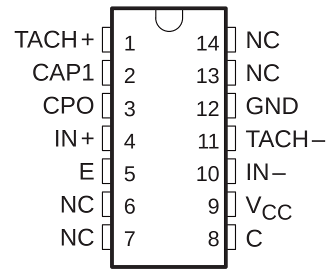
- **Output Swings to Ground for Zero-Frequency Input**
- **Only One RC Network Provides Frequency Doubling for Low Ripple**
- **8-Pin Versions Interface Directly to Variable-Reluctance Magnetic Pickups**
- **Uncommitted Collector and Emitter Outputs Provide 40-mA Sink or Source Current to Operate Relays, Solenoids, Meters, or LEDs**
- **Built-In Hysteresis for Noise Immunity**
- **Linearity Typically ±0.3%**
- **8-Pin Versions Are Fully Protected From Damage Due to TACH Input Swing Above V_{CC} and Below Ground**

LM2907, LM2917 . . . D OR P PACKAGE
(TOP VIEW)



LM2907, LM2917 . . . D OR N PACKAGE
(TOP VIEW)



NC – No internal connection

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES		
	SMALL OUTLINE (D)	PLASTIC DIP (N)	PLASTIC DIP (P)
–40°C to 85°C	L2907D8	—	LM2907P
	L2907D14	LM2907N	—
	L2917D8	—	LM2917P
	L2917D14	LM2917N	—

applications

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

description

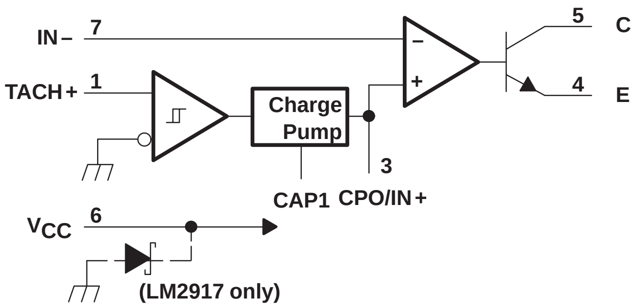
The LM2907 and LM2917 are monolithic frequency-to-voltage converters. Each device has an output circuit that activates loads such as relays and lamps when the input frequency reaches or exceeds a selected rate. The converter (tachometer) section consists of a comparator driving a charge pump and offers frequency doubling for low ripple, full input protection in 8-pin versions, and an output swing to ground for a zero-frequency input. The output section consists of an operational amplifier, normally operating as a comparator, that drives an output transistor with both the collector and emitter floating. The circuit can either sink or source 40 mA of load current.

Two basic configurations are offered: 8-pin devices and 14-pin devices. Each 8-pin version has a ground-referenced tachometer input and an internal connection between the tachometer output and the operational amplifier input. The 8-pin versions are suited to single-speed or single-frequency switching or fully buffered frequency-to-voltage conversion applications. The more versatile 14-pin versions provide differential tachometer inputs and uncommitted operational amplifier inputs. The tachometer input can be floated, and the operational amplifier becomes suitable for active filter conditioning of the tachometer output.

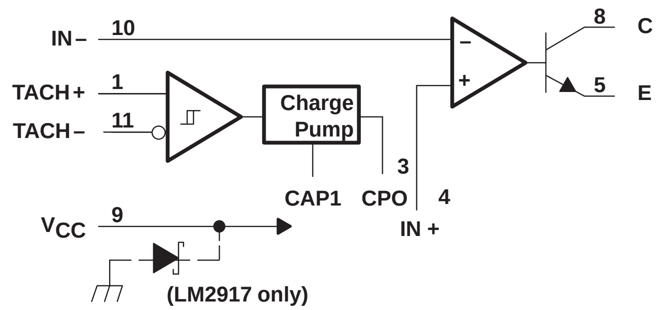
The LM2917 has an active shunt regulator connected across the power leads. The regulator clamps the supply voltage so that stable frequency-to-voltage and frequency-to-current conversions are possible with any supply voltage and a suitable resistor.

The LM2907 and LM2917 are designed for operation from –40°C to 85°C.

functional block diagrams



8-PIN VERSIONS



14-PIN VERSIONS

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC}: LM2907 . . . . 28 V
Supply current, I_{CC}: LM2917 . . . . 25 mA
Collector-to-emitter voltage . . . . 28 V
Operational amplifier input voltage range, IN+ and IN– . . . . 0 V to V_{CC}
Tachometer input voltage range: 8-pin version TACH+ . . . . 0 V to 28 V
14-pin version TACH+ and TACH– . . . . 0 V to V_{CC}
Continuous total dissipation . . . . See Dissipation Rating Table
Operating free-air temperature range . . . . –40°C to 85°C
Storage temperature range . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . 260°C

† Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the recommended operating conditions section of this specification is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING
D (8 pin)	725 mW	5.8 mW/°C	377 mW
D (14 pin)	950 mW	7.6 mW/°C	494 mW
N	1150 mW	9.2 mW/°C	598 mW
P	1000 mW	8.0 mW/°C	520 mW

electrical characteristics, V_{CC} = 12 V (LM2907), V+† = 12 V through 470 Ω (LM2917), T_A = 25°C

converter (tachometer) section

PARAMETER			TEST CONDITIONS	LM2907			LM2917			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IT}	Input threshold voltage		V_I = 250 mV, f = 1 kHz	±8.5	±15	±40	±8.5	±15	±40	mV
V_{hys}	Input hysteresis (see Note 1)		V_I = 250 mV, f = 1 kHz		30			30		mV
V_{IO}	Input offset voltage (see Note 1)	8-pin versions	V_I = 250 mV, f = 1 kHz		5	15		5	15	mV
		14-pin versions	V_{ID} = 250 mV, f = 1 kHz		3.5	10		3.5	10	
I_{IB}	Input bias current		V_I = ±50 mV		0.1	1		0.1	1	µA
V_{OH}	High-level output voltage	CAP1	V_I or V_{ID} = 125 mV		8.3			5		V
V_{OL}	Low-level output voltage	CAP1	V_I or V_{ID} = – 125 mV		2.3			1.2		V
I_O	Output current	CAP1, CPO	CAP1 and CPO at 6 V	140	200	240				µA
			CAP1 and CPO at 3.8 V				140	200	240	
	Leakage current	CPO	CAP1 open, CPO at 0 V, See Note 3			0.1			0.1	µA
	Gain constant			0.9	1	1.1	0.9	1	1.1	
	Nonlinearity (see Note 2)		f = 1 kHz, 5 kHz, or 10 kHz		0.3	±1		0.3	±1	%

output section

PARAMETER		TEST CONDITIONS	LM2907			LM2917			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_I = 6 V, See Note 3		3	10				mV
		V_I = 3.8 V, See Note 3					3	10	
I_{IB}	Input bias current	V_I = 6 V		50	500				nA
		V_I = 3.8 V					50	500	
A_V	Voltage amplification			200			200		V/mV
I_C	Collector output (sink) current	V_C = 1 V, V_E = 0	40	50		40	50		mA
I_E	Emitter output (source) current	$V_C = V_{CC}$, $V_E = V_{CC} - 2$		–10			–10		mA
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_C = 5 mA		0.1	0.5		0.1	0.5	V
		I_C = 20 mA			1			1	
		I_C = 50 mA		1	1.5		1	1.5	

† V+ is the symbol for voltage applied to a series resistor to create a current source.

NOTES: 1. Hysteresis is the algebraic difference $V_{IT+} - V_{IT-}$; offset voltage is the difference in magnitudes $|V_{IT+}| - |V_{IT-}|$. See parameter measurement information test circuit.

2. Nonlinearity is defined as the deviation of V_O at CPO for f = 5 kHz from a straight line defined by the V_O at 1 kHz and V_O at 10 kHz, with C1 = 1000 pF, R1 = 68 Ω, C2 = 0.22 µF.

3. CAP1 must be bypassed with a 0.001-µF capacitor to prevent oscillation for these tests.

zener regulator (LM2917 only), V+† = 12 V through 470 Ω, T_A = 25°C

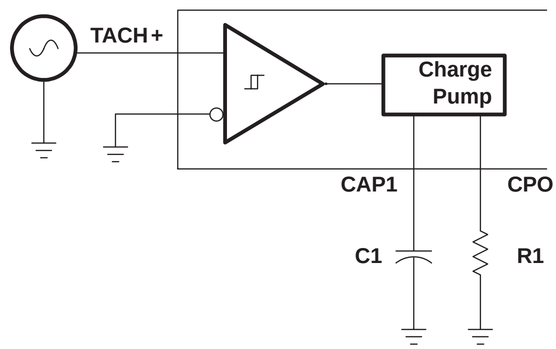
PARAMETER		MIN	TYP	MAX	UNIT
V_Z	Regulated supply voltage		7.56		V
α_{VZ}	Temperature coefficient of regulated supply voltage		1		mV/°C
r_s	Series resistance		10.5	15	Ω

† V+ is the symbol for voltage applied to a series resistor to create a current source.

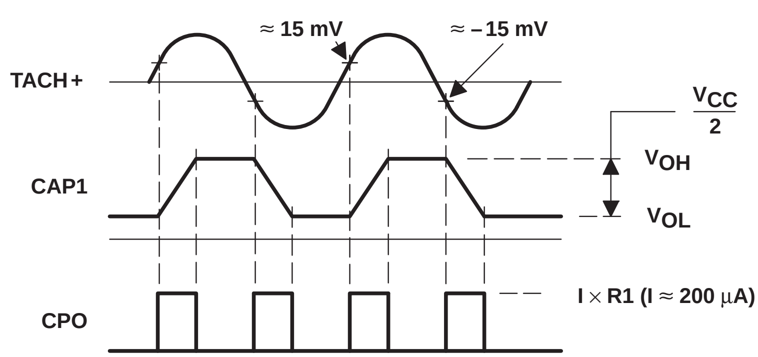
total device (LM2907 only), V_{CC} = 12 V, T_A = 25°C

PARAMETER		MIN	TYP	MAX	UNIT
I_{CC}	Supply current		3.8	6	mA

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



WAVEFORMS

Figure 1. Test Circuit and Waveforms

APPLICATION INFORMATION

The LM2907 and LM2917 frequency-to-voltage converter circuits provide maximum versatility with a minimum of external parts. The first stage of each device is a differential comparator. The single-input 8-pin versions have one input grounded so that an input signal must swing above and below GND and exceed the input thresholds to produce an output. This version is specifically for magnetic variable-reluctance pickups, which typically provide a single-ended ac output. These single-ended inputs are fully protected against voltage swings to ±28 V, which are easily attained by this type of pickup.

The differential-input 14-pin versions provide the option of setting the input reference level, maintaining hysteresis around that level to provide excellent noise rejection in any application. The input protection is removed in the 14-pin versions. Therefore, neither of the differential inputs should exceed the limits of the supply voltage. An input must not go below GND without a resistance in the lead to limit the current that flows in the episubstrate diode. The charge-pump circuit that follows the input state produces a dc output voltage proportional to the input frequency. The charge-pump circuit (see Figures 1 and 2) consists of a timing capacitor (C1), an output resistor (R1), and an integrating or filter capacitor (C2). When the input changes state (due to a suitable zero crossing or differential voltage on the input), the timing capacitor is either charged or discharged linearly with a constant current of 200 μA through CAP1 between two voltages whose difference is $V_{CC}/2$. Within one-half cycle of the input frequency or a time equal to 1/2f, the change in charge on C1 is equal to $(V_{CC}/2)C1$. The average amount of current pumped into or out of the capacitor is:

$$\text{CAP1 current (average)} = \frac{Q}{T} = C1 \bullet \frac{V_{CC}}{2} \bullet 2f = V_{CC} \bullet f \bullet C1$$

The output of the charge pump accurately mirrors the CAP1 current into the load resistor (R1) connected to CPO. If the pulses of current are integrated with a filter capacitor, the output voltage is the average CAP1 current times R1 and the total equation becomes:

$$V_O = V_{CC} \bullet f \bullet C1 \bullet R1 \bullet K$$

where K is the gain factor, which is typically one.

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

selection of R1, C1, and C2

To achieve optimum performance, there are some limitations to be considered in the selection of R1 and C1. The timing capacitor controls the RC time and provides internal compensation for the charge-pump circuit. For very accurate operation, it should be 100 pF or greater. Smaller values, especially at lower temperatures, can cause an error current through R1. $V_O/R1$ must be less than or equal to the output current at CPO, which is fixed typically at 200 μA. If R1 is too large, it becomes a significant fraction of the output impedance at CPO, which degrades the linearity. In addition, ripple voltage must be considered when selecting R1. The size of C2 is directly affected by the size of R1. An expression that describes the ripple content at CPO is:

$$V_{ripple} = \frac{V_{CC}}{2} \bullet \frac{C1}{C2} \bullet \left(1 - V_{CC} \bullet f \bullet \frac{C1}{200}\right) \text{ volts peak-to-peak}$$

where:

C1 and C2 are in farads,
V_{CC} is in volts, and
f is in hertz.

APPLICATION INFORMATION

R1 cannot be chosen independent of ripple because response time or the time it takes V_O to stabilize at a new level increases as the size of C2 increases. 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_{cap} (current through CAP1).

$$f_{max} = \frac{I_{cap}}{C1 \bullet V_{CC}} \text{ hertz}$$

where:

I_{cap} is typically 200 µA,
C1 is in farads, and
V_{CC} is in volts.

zener regulator options (LM2917)

For those applications in which an output voltage or current must be obtained independent of supply voltage variations, the LM2917 can be used. The most important factor in selecting a dropping resistor for the unregulated supply is that the frequency-to-voltage converter circuit and the operational amplifier alone require approximately 3 mA at the voltage level set by the zener diode. 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 supply voltage varies between 9 V and 16 V, a resistance of 470 Ω minimizes the zener voltage variation to typically 160 mV. If the resistance goes under 400 Ω or above 600 Ω, the zener variation quickly rises above 200 mV for the same input variation.

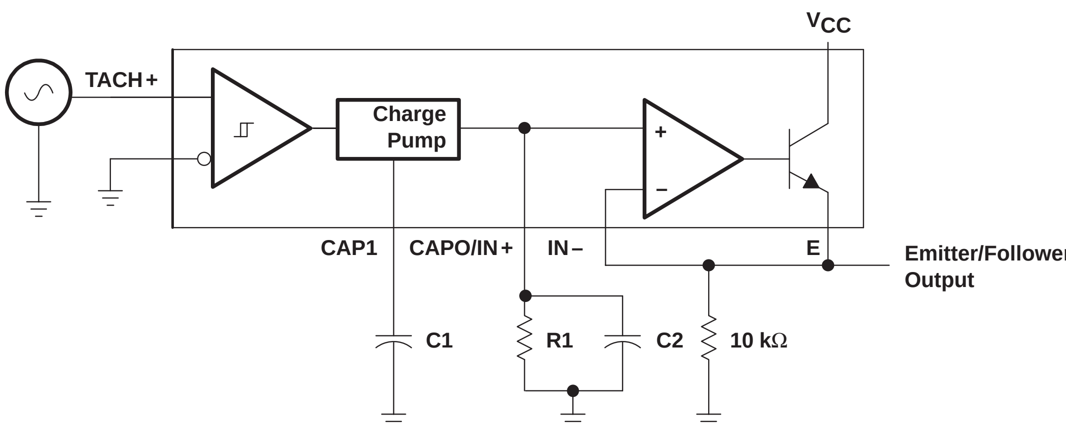


Figure 2. Minimum-Component Tachometer

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