CSC™ CHERRY SEMICONDUCTOR

CS-189

TACHOMETER DRIVE CIRCUIT

DESCRIPTION

The CS-189 is specifically designed for use with air-core meter movements. The IC (see Block Diagram, Figure 1) comprises charge pump circuitry for frequency-to-voltage conversion, a shunt regulator for stable operation, a function generator, and sine and cosine amplifiers. The buffered sine and cosine outputs will typically sink or source 20mA.

CHARGE PUMP

The input frequency is buffered though a transistor, then applied to the charge pump for frequency-to-voltage conversion (see Functional Diagram, Figure 2). The charge pump output voltage, EØ, will range from 2.1V with no input (Ø=0°) to 7.1V at Ø=270°. The charge that appears on C_T is reflected to C_{OUT} through a Norton amplifier. The frequency applied at Pin 10 charges and discharges C_T through R_1 and R_2. C_{OUT} reflects the charge as a voltage across resistor R_T.

FUNCTION GENERATOR/SINE AND COSINE AMPLIFIERS

The output waveforms of the sine and cosine amplifiers are derived by On-Chip Amplifier/Comparator circuitry. The various trip points for the circuit (i.e. 90°, 180°, 270°) are determined by an internal resistor divider connected to the voltage regulator. The voltage EØ is compared to the divider network by the function generator circuitry. Use of an external zener reference at Pin 1 allows both sine and cosine amplifiers to swing positive and negative with respect to this reference. The output magnitudes and directions have the relationship as shown in Figures 3A, 3B and 3C.

NOTE: Pin connections referenced are for the 14L DIP

BLOCK DIAGRAM

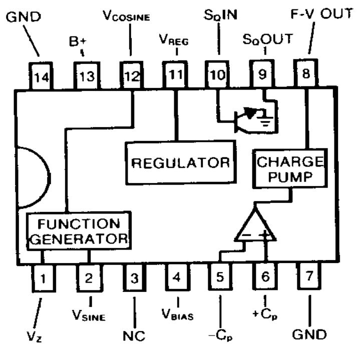
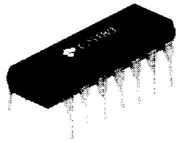


FIGURE 1

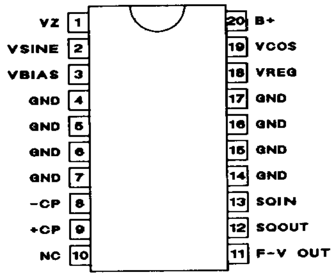


FEATURES:
- Single supply operation
- On-Chip regulation
- 20mA output drive capability
- Wide temperature range
- Accuracy = .05%/°C

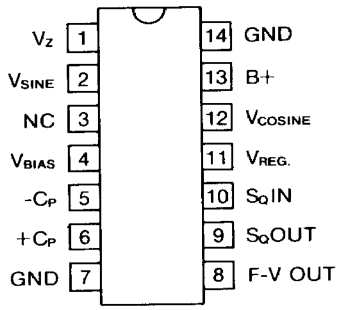
APPLICATIONS:
- Tachometers
- Speedometer
- F/V conversion
- Windspeed & direction
- Flowmeter control

PIN CONNECTIONS

20L SOIC WIDE



14L DIP



(TOP VIEW)

Cherry Semiconductor Corporation, 2000 South County Trail, East Greenwich, Rhode Island 02818
(401) 885-3600 Telex WUI 6817157

ABSOLUTE MAXIMUM RATINGS

Operating Temperature .... -30° C to +100° C
Storage Temperature .... -65° C to +150° C
Supply Voltage 20V
Power Dissipation .... 2W@ 25° C
(Derate 16mW/° C above 25° C)

ELECTRICAL CHARACTERISTICS (V_{CC}=13.1V, T_A=25° C)

PARAMETER	SYMBOL	PIN NO.	TEST CONDITIONS (SEE TEST CIRCUIT FIG. 1)	MIN.	TYP.	MAX.	UNITS
Supply Current (note 2)	I_{CC}	13	V_{CC}=15V		54	72	mA
			V_{CC}=13.1V		45	60	
			V_{CC}=11.3V		38	60	
Regulated Voltage	V_{REG}	11	I_{REG}=4.3mA	7.8	8.5	9.2	V
Regulation	ΔV_{REG}		I_{REG}=0 to 5mA		0.10	0.20	
Signal Input Current	I_{IN}	10		0.1	2.0	4.0	mA
Saturation Voltage	V_9SAT	9	I_9=5mA, I_{10}=0.5mA		0.20	0.40	V
Leakage Current	I_9		V_9=16V, V_{10}=0V			10	μA
Input Current	I_5	5	Zero input to pin 6		1	15	nA
Input Current	I_6	6					
F to V Output	E MIN	8	V_{10}=0 (zero input), ∅=0°	1.9	2.1	2.3	V
	E MAX		V_{COS}=0 (note 1), ∅=270°	6.6	7.1	7.6	
Linearity	%	8	E_O vs. Frequency V_{COS}=0 (note 1), ∅=270°			±1.5	%
V_{SINE} at ∅=0°	V_{SINE}	2	V_{10}=0 (zero input), ∅=0°	-0.35	0	+0.35	V
MAX V_{SINE} +			V_{COS}=0 (note 1), ∅=90°	4.0	4.5	5.0	
MAX V_{SINE} −			V_{COS}=0 (note 1), ∅=270°	-4.0	-4.5	-5.0	
Coil Drive Current	I_{SINE} +	2	V_{COS}=0 (note 1), ∅=90°		20	25	mA
	I_{SINE}−		V_{COS}=0 (note), ∅=270°		20	25	
MAX V_{COS}+	V_{COS}	12	V_{10}=0 (zero input), ∅=0°	4.0	4.5	5.0	V
MAX V_{COS}−			V_{SINE}=0 (note 1), ∅=180°	-4.0	-4.5	-5.0	
Coil Drive Current	I_{COS}+	12	V_{10}=0 (zero input), ∅=0°		20	25	mA
	I_{COS}−		V_{SINE}=0 (note 1), ∅=180°		20	25	
External Voltage Ref.	V_Z	1		5.13	5.40	5.67	V

Note 1: V_{SINE} measured Pin 2 to Pin 1. V_{COS} measured Pin 12 to Pin 1. All other voltages specified are measured to ground.
Note 2: Max PWR dissipation ≤ V_{CC} x I_{CC} -(V_2 I_{SINE} + V_{12} I_{COS}).

FUNCTION GENERATOR OUTPUT (∅): V_{CC}=13.1V, T_A=25° C

$\varnothing = \text{ArcTan}\left(\frac{V_{sine}}{V_{co}}\right)$ (Measured angle after calibration at 180° C)

For $\varnothing_A$=45°, 90°, 135°, 180°, 225°, 270°, (Desired angle)
$(\varnothing_A - \varnothing_M) \leq 4.0°$

TEMPERATURE SENSITIVITY: V_{CC}=13.1V
$\Delta\varnothing_{MT} = \varnothing_M$ (T=25°C) $-\varnothing_M$ (-20°C≤T≤+85°C)
$(\Delta\varnothing_{MT}) \leq 3.5°C$, -20°C≤T≤+85°C

VOLTAGE SENSITIVITY: T_A=25° C
$\Delta\varnothing_{MV} = \varnothing_M$ (V_{CC}=13.1V) $-\varnothing_M$ (11.3V≤V_{CC}≤15V)
$(\Delta\varnothing_{MV}) \leq 2°$, 11.3V≤$V_{CC}$≤15V

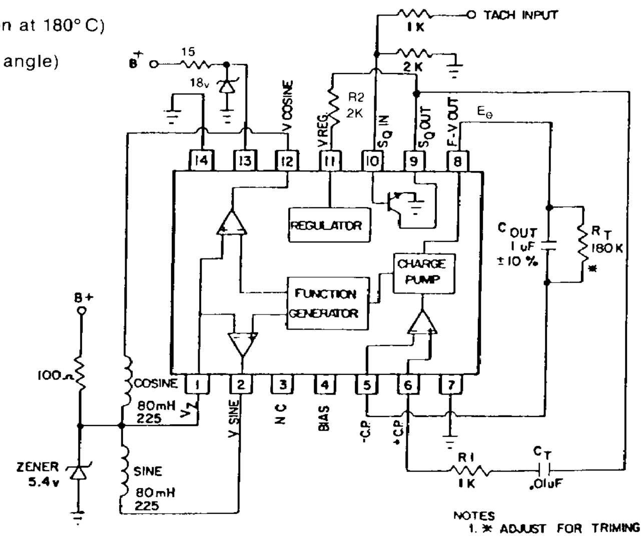


FIGURE 2
FUNCTIONAL DIAGRAM
(TEST CIRCUIT)

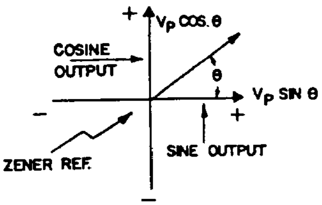


FIGURE 3A

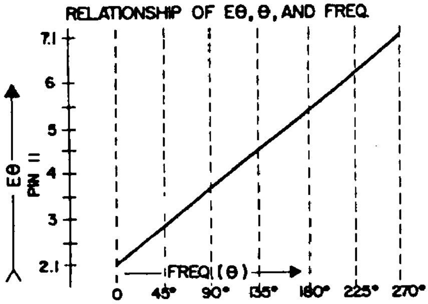


FIGURE 3B

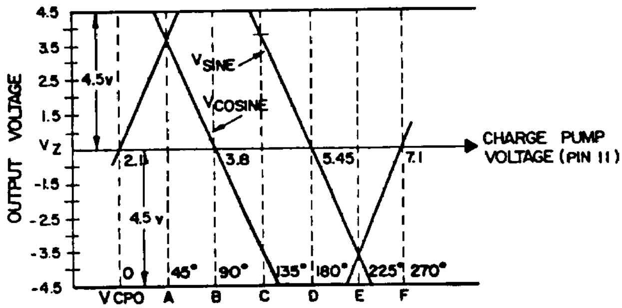


FIGURE 3C

TACHOMETER APPLICATION

$$\frac{RPM}{60} \times \frac{\#\ OF\ CYL.}{2} = \text{Frequency}$$

E (Pin 8)=2.1 + Frequency x C_T x R_T (V_{REG}-.7)

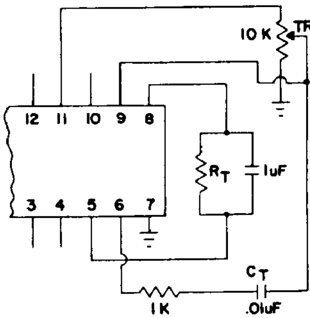
The above equations were used in calculating the following values, where E=7.1V at =270° and C_T=.01 F.

4 cylinder: Freq=200Hz, R_T=320K
6 cylinder: Freq=300Hz, R_T=220K
8 cylinder: Freq=400Hz, R_T=150K

Typical values shown above apply to a nominal value of V_{REG} of 8.5 volts. It must be realized that trimming of R_T will be necessary to compensate for variations in regulator voltage from one unit to another.

An alternative to this adjustment is to replace R_2 with a potentiometer, as shown in Figure 4.

Partial schematic shown in Figure 5 represents one method for use with DC applications instead of frequency.



ALTERNATE TRIMMING METHOD

FIGURE 4

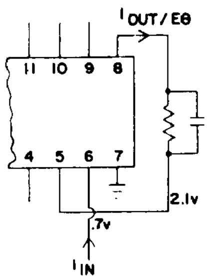


FIGURE 5

ORDERING INFORMATION

PART NUMBER	DESCRIPTION
CS-189DW	20 Lead SO Wide
CS-189N	14 Lead PDIP