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FULL FEATURED FAST RESPONSE FREQUENCY TO DIGITAL CONVERTER

CMS1010, CMS1010I

PRODUCT DESCRIPTION

The CMS1010 is a single chip solution to the problem of making instantaneous, high accuracy frequency measurements. The CMS1010 measures the frequency of an input signal based on its period. The result is a 10 bit binary output that is updated with every input pulse. Inputs are provided for user selection of frequency averaging and input range. The device provides OVER and UNDER frequency outputs, as well as a DATA VALID strobe. All outputs are TTL compatible. Linear over a 1000 to 1 range, the measurement accuracy is ± 0.5% of reading ± 1 LSB.

Packaged in a 28 pin DIP, the 5 volt, NMOS part requires a 400 KHz to 4.2 MHz crystal or external oscillator. Using crystal or oscillator frequencies of different values results in a variety of full scale ranges to tailor the part to a particular application. Using the range selection pins, R0 and R1, and different clock frequencies, pulse to pulse measurements of frequencies from 0.006 to 1125 Hz may be made.

The CMS1010 is a full featured version of the CMS1000. It is especially suited to digital applications where accuracy and fast response are necessary. The addition of a digital to analog converter yields a fast response, high accuracy frequency to voltage converter for analog applications.

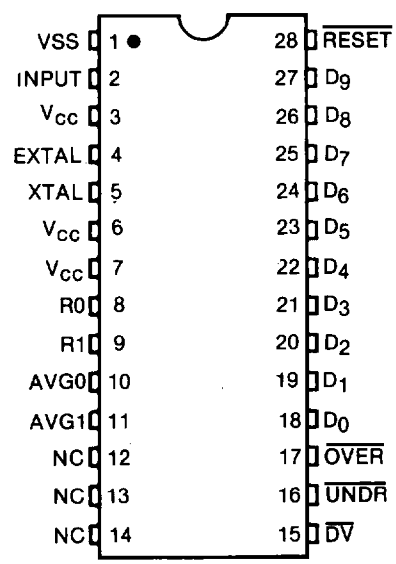
FEATURES

- SELECTABLE EXPONENTIAL AVERAGING
- PULSE TO PULSE RESPONSE
- 10 BIT BINARY OUTPUT
- ALL OUTPUTS TTL COMPATIBLE
- SELECTABLE INPUT RANGES UP TO 1125 HZ
- 1000 TO 1 DYNAMIC RANGE
- SINGLE CHIP SIMPLICITY
- SMALL SIZE - 28 PIN PACKAGE

APPLICATIONS

- BIOMEDICAL RATE MONITORS
- PRECISION TACHOMETERS
- SPEED MEASUREMENT
- OVER/UNDER SPEED SENSORS
- NO LAG MOTOR SPEED CONTROL FEEDBACK
- FREQUENCY TO VOLTAGE CONVERTERS
- MICROPROCESSOR DATA ACQUISITION SYSTEMS

FIGURE 1 — PIN ASSIGNMENTS



CMSIS002

SIGNAL DESCRIPTIONS (Refer to Pin Assignment Drawing)

V_{SS}	— Ground.
INPUT	— Signal input. Frequency calculation is made based on the time from falling edge to falling edge of this input.
V_{CC}	— Positive power connections.
NC	— No connection. These pins must be left unconnected.
EXTAL, XTAL	— Connections for crystal or external oscillator. Crystal should be standard microprocessor type - fundamental, parallel resonant.
RO, R1	— Frequency input range selection (see figure 2).
AVG0, AVG1	— Averaging option selection (see figure 3).
$\overline{\textbf{DV}}$	— Data valid output. All outputs are valid while this signal is low. Falling edge may be used as a "new data" signal.
$\overline{\textbf{UNDR}}$	— This output pin is logic low whenever a frequency calculation yields a result less than one LSB.
$\overline{\textbf{OVER}}$	— This output pin is logic low whenever a frequency calculation yields a result greater than the selected full scale.
D0-D9	— Binary frequency output pins.
$\overline{\textbf{RESET}}$	— Power on reset pin. Provide 1uf capacitor to Vss or an external 100mS $\overline{\text{RESET}}$ pulse to this pin.

RANGE SELECTION

R1	R0	RANGE[1] (HZ) For F_{osc} = 0.4 to 4.2 MHz	Example for F_{OSC} = 4 MHz
0	0	0 to F_{OSC} ÷ 3910	0 to 1023
0	1	0[2] to F_{OSC} ÷ 391000	0[2] to 10.23
1	0	0 to F_{OSC} ÷ 39100	0 to 102.3
1	1	Not Used	Not Used

[1]Input frequencies above selected full scale yield full scale output.
[2]Input frequencies below $F_{OSC}/2^{26}$ yield zero output.

FIGURE 2
RANGE SELECTION

AVERAGING SELECTION

AVG1	AVG0	WEIGHT (N)
0	0	1 (No Averaging)
0	1	4
1	0	8
1	1	16

$F_{out} = F_{present}/N + F_{out}$ previous * (N-1)/N
(See "Using the CMS1010")

FIGURE 3
AVERAGING SELECTION

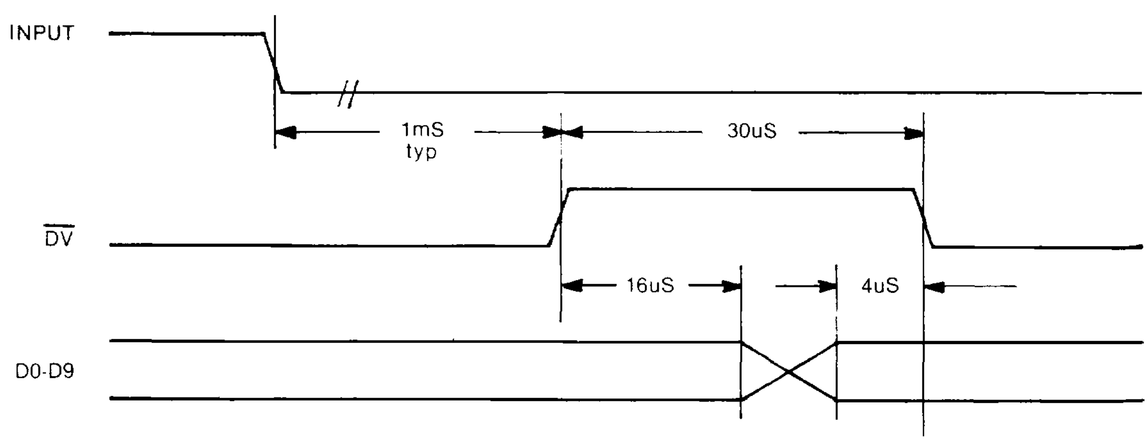


FIGURE 4
DATA VALID TIMING

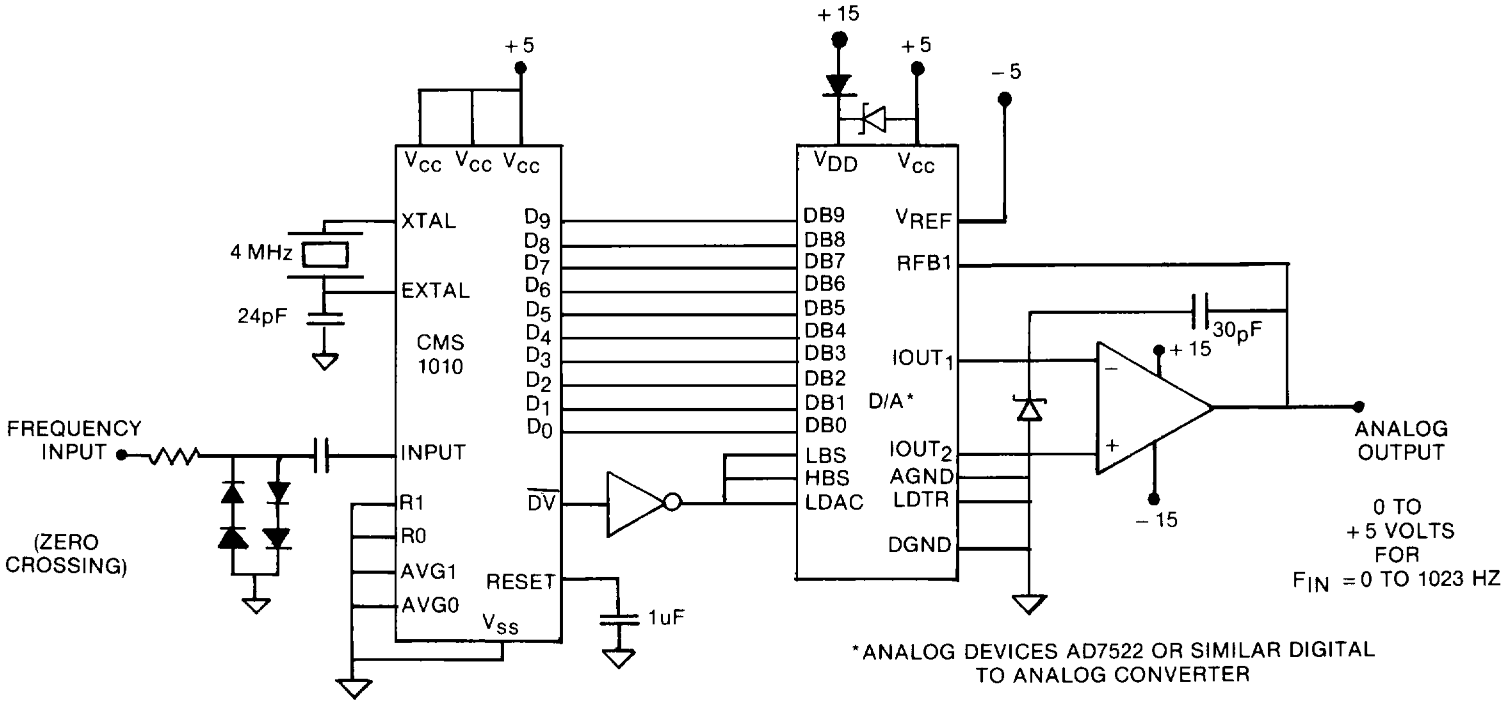


FIGURE 5 — ANALOG APPLICATION
FAST RESPONDING FREQUENCY TO VOLTAGE CONVERTER

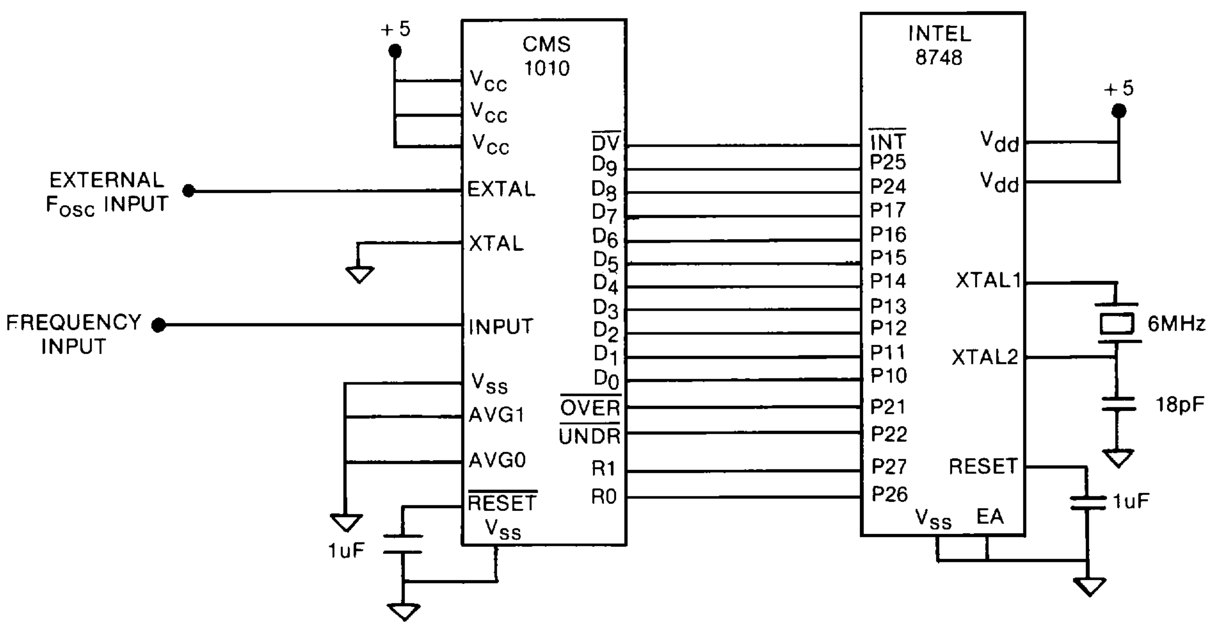


FIGURE 6 — MICROPROCESSOR APPLICATION

USING THE CMS1010

The CMS1010 is a precision frequency measurement integrated circuit designed for use in fast response, high accuracy frequency to voltage and other frequency measurement applications. The CMS1010 measures the frequency of a signal and updates its outputs with every cycle of the input. The CMS1010 is similar to the CMS1000 Frequency to Digital converter with two additional features — selectable exponential averaging and selectable frequency range. The CMS1010 has been designed for ease of use in frequency measurement applications.

RESET.

On power up and for zero input frequency, the binary outputs, D0-D9, will be logic zero. On the second input pulse, the CMS1010 updates all outputs.

AVERAGING.

The CMS1010 is extremely well suited for applications requiring a binary output proportional to the most recent input pulse period. In some situations, such as those where the input signal has significant pulse to pulse period variation, it is desirable to apply a low pass filter function to the frequency calculation. Using AVG1 and AVG0, the CMS1010 may be configured to calculate and output an exponential average of the frequency value rather than a new output with every input pulse. This is shown in Figure 3. With AVG1 and AVG0 tied to ground, no averaging is done. With AVG1 tied to ground and AVG0 tied to Vcc, the CMS1010 adds one-fourth of the frequency based on the most recent period of the input to three-fourths of the previously calculated frequency average. It then saves this value for the next calculation cycle and updates the outputs based on this value. The weighting of the most recent frequency can also be chosen as 1/8th or 1/16th.

In typical charge pump frequency to voltage converters, averaging is accomplished using a single pole, RC filter. Choosing the value of this RC requires a compromise between good response to changing inputs and consequent output ripple at low frequencies. Exponential averaging as implemented in the CMS1010 provides an average based on a certain number of input pulses, not on time. This combines excellent response with good noise rejection.

RANGE.

The frequency input range is determined by input pins R1 and R0 and the frequency of the crystal or external oscillator used. This is shown in Figure 2. For instance using a 4 MHz clock and with R1 and R0 tied to logic low, full scale output (D0-D9 = 3FFH) will occur for F_{in} = 1023 Hz. With R1 tied to logic high, full scale output will occur for F_{in} = 102.3 Hz. With R1 tied low and R0 tied high, full scale output will occur for F_{in} = 10.23 Hz. Using other crystal or external oscillator frequencies yields other ranges. For instance, a 1 MHz clock would allow full scale to be 255, 25.5 or 2.55 Hz. Due to internal counting limitations, zero input frequency is the larger of F_{OSC} divided by 67,110,000 or the selected full scale frequency divided by 1023.

Using a 4.4 MHz clock frequency, the CMS1010 can directly measure frequencies up to 1125 Hz. To measure frequencies above the selected full scale frequency, a divider may be used as an input prescaler. For instance, using an IC such as a CD40103 frequency divider in series with the frequency input, frequencies up to 288 KHz could be measured over a 1023 to 1 range.

INPUT COUPLING.

Signals may be direct coupled to the CMS1010 as shown in figure 6 or AC coupled as in figure 5. AC coupling of this type is useful in cases where the input frequency is not a TTL compatible signal. Frequency measurements are based on the time from falling edge to falling edge of the INPUT.

OVER AND UNDR.

The OVER and UNDR outputs may be used to drive LEDs in a current sink mode. The LEDs could be used in applications such as for "motor overspeed" and "motor stalled" indicators.

FREQUENCY TO VOLTAGE APPLICATIONS.

The CMS1010 offers unprecedented accuracy and response when used in frequency to voltage (F to V) applications since it outputs a new 10 bit binary value with every input pulse. Figure 5 shows a CMS1010 wired as a three chip frequency to voltage converter. Worst case error is less than 40 millivolts (0.7% of full scale) over the entire temperature range (0 to 70 C for the CMS1010, −40 to ±85 C for the CMS1010I). The main advantage of this type of F to V converter over an analog part such as a National LM331, is that the output will follow any change in the input frequency and does not have any ripple error. Conventional F to V converters, because of the nature of the pulsating charge pump that is used to provide their output, exhibit a ripple error that corresponds to the value of the timing elements they use. For more information on F to V conversion see CMS application note AN-001.

ABSOLUTE MAXIMUM RATINGS

Supply voltage (V_{CC})	−0.3 to +7.0 Vdc
Input voltage	−0.3 to V_{CC} Vdc
Operating Temperature Range	0 to +70° C (−40 to +85° C for CMS1010I)
Storage Temperature Range	−55 to +150° C
Junction Temperature	+150° C

ELECTRICAL CHARACTERISTICS

(V_{CC} = 5.25 Vdc, ± 0.5 Vdc, Vo tied to V_{sens}, $T_{amb.}$ = $T_{oper.}$ unless otherwise noted)

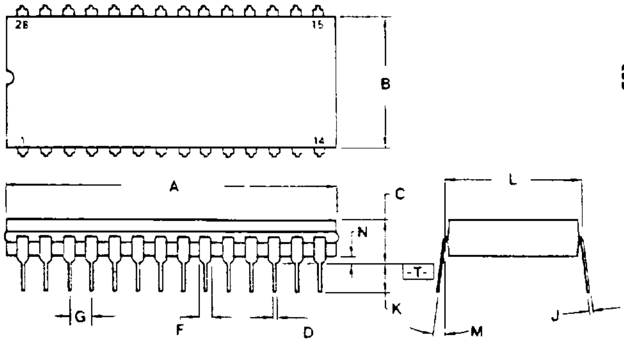
Operating Temperature Range	
CMS1010	0 to +70 C.
CMS1010I	−40 to +85 C.
Input High Voltage	
INPUT	4.0 Vdc Minimum, V_{CC} Maximum
EXTAL	2.0 Vdc Minimum, V_{CC} Maximum
R0, R1, AVG0, AVG1	2.0 Vdc Minimum, V_{CC} Maximum
Input Low Voltage	
INPUT	−0.3 Vdc Minimum, 1.5 Vdc Maximum
EXTAL	−0.3 Vdc Minimum, 0.8 Vdc Maximum
R0, R1, AVG0, AVG1	−0.3 Vdc Minimum, 0.8 Vdc Maximum
INPUT Zero Crossing Voltage (Through A Capacitor)	2.0 Vac p-p Minimum, 4.0 Vac p-p Maximum*
Input Capacitance	
INPUT, R0, R1, AVG0, AVG1	10 pf Typical
Input Current	
INPUT	20 uA Typical, 50 uA Maximum
R0, R1, AVG0, AVG1	2 uA Typical, 20 uA Maximum
EXTAL	
(V_{EXTAL} = 2.4 Vdc to V_{CC} & Crystal Option)	10 uA Maximum
(V_{EXTAL} = 0.4 Vdc & Crystal Option)	−1600 uA Maximum
Output Low Voltage	
(I_{Load} = 1.6 mA, D0-D9; I_{Load} = 3.2 mA, DV, UNDR, OVER)	0.4 Vdc Maximum
(I_{Load} = 10 mA, DV, UNDR, OVER)	1.0 Vdc Maximum
Output High Voltage (D0-D9, DV, UNDR, OVER)	
(I_{Load} = −100 uA)	2.4 Vdc Minimum
(I_{Load} = −10 uA)	3.5 Vdc Minimum
Vo Output Current	
Source	5 mA Minimum
Sink	Internal 2 k-ohm to ground
Power Supply Current, I_{CC}	100 mA Typical, 150 mA Maximum

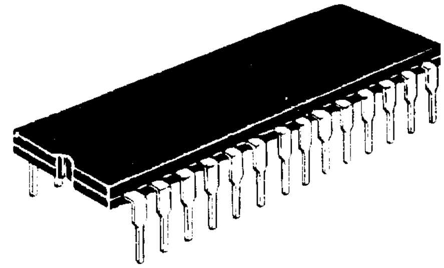
*This input floats to approximately 2.0 Vdc due to internal biasing when used with an AC coupled input

FREQUENCY CALCULATION CHARACTERISTICS

Reference Oscillator or Crystal Frequency (F_{OSC})	0.4 MHz. Minimum 4.2 MHz. Maximum
Input Range (Input frequencies above full scale yield all "1's" output)	0 to F_{OSC}/3910*
Output Range	0 to 1023 (000 to 3FF hex.)
Accuracy	±0.5% of Reading ±1 LSB

*See Figure 2 for complete range information.





DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	36.45	37.85	1.435	1.490
B	12.70	15.37	0.500	0.605
C	4.06	5.84	0.160	0.230
D	0.38	0.56	0.015	0.022
F	1.27	1.65	0.050	0.065
G	2.54 BSC		0.100 BSC	
J	0.20	0.30	0.008	0.012
K	2.54	4.06	0.100	0.160
L	15.24 BSC		0.600 BSC	
M	5°	15°	5°	15°
N	0.51	1.27	0.020	0.050

CMS1010, CMS1010I
28 PIN CERDIP PACKAGE

PRICING

	1-9	10-24	25-99	100-499
CMS1010 (0 to +70°C)	$80.00	$72.00	$64.00	$48.00
CMS1010I (−40 to +85°C)	$107.00	$96.00	$86.00	$65.00

CMS

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