INTERSIL

ICM7226A/B 10 MHz Universal Counter System

ICM7226A Drives Common Anode LED's
ICM7226B Drives Common Cathode LED's

FEATURES

- Functions as a frequency counter, period counter, unit counter, frequency ratio counter or time interval counter
- Output drivers directly drive both digits and segments of large 8 digit LED displays. Both common anode and common cathode versions are available
- Measures frequencies from DC to 10 MHz
- Measures period from 0.5μ sec to 10 sec
- Stable high frequency oscillator, uses either 1MHz or 10MHz crystal
- Control signals available for gating of prescalers and prescaler display logic
- Multiplexed BCD outputs
- All terminals protected against static discharge; no special handling precautions required

GENERAL DESCRIPTION

The ICM7226 is a fully integrated Universal Counter and LED display driver. It combines a high frequency oscillator, a decade timebase counter, an 8 decade data counter and latches, a 7 segment decoder, digit multiplexer and 8 segment and 8 digit drivers which can directly drive large LED displays. The counter inputs accept a maximum frequency of 10MHz in frequency and unit counter modes and 2MHz in the other modes. Both inputs are digital inputs. In many applications, amplification and level shifting will be required to obtain proper digital signals for these inputs.

The ICM7226 can function as a frequency counter, period counter, frequency ratio (f_A/f_B) counter, time interval counter or as a totalizing counter. The counter uses either a 10MHz or 1MHz crystal timebase. An external timebase input is also provided. For period and time interval, the 10MHz timebase gives a 0.1μsec resolution. In period average and time interval average, the resolution can be in the nanosecond range. In the frequency mode, the user can select accumulation time of .01 sec, .1 sec, 1 sec and 10 sec. With a 10 sec accumulation time, the frequency can be displayed to a resolution of .1 Hz in the least significant digit. There is 0.2 second interval between measurements in all ranges. Control signals are provided to enable gating and storing of prescaler data.

Leading zero blanking has been incorporated with frequency displayed in KHz and time in usec. The display is multiplexed at a 500Hz rate with a 12.5% duty cycle for each digit. The ICM7226A is designed for common anode display with typical peak segment currents of 25mA. The ICM7226B is designed for common cathode displays with typical segment currents of 12mA. In the display off mode both digit drivers & segment drivers are turned off allowing the display to be used for other functions.

ORDERING INFORMATION

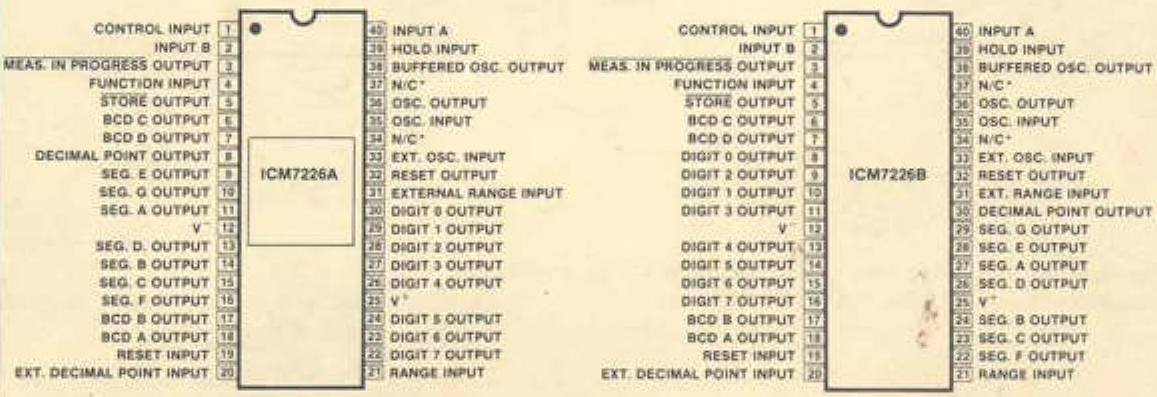
Component:

- ICM7226A IDL (Common anode driver, −20°C to +70°C Operating temperature range, 40 pin ceramic DIP)
- ICM7226B IPL (Common cathode driver, −20°C to +70°C Operating temperature range, 40 pin plastic DIP)

Evaluation Kit:

- ICM7226 EV/KIT - See page 3 (available Nov. 1978)

PIN CONFIGURATION



*FOR MAXIMUM FREQUENCY STABILITY, CONNECT TO V+ OR V−

ABSOLUTE MAXIMUM RATINGS

Maximum Supply Voltage (V^+-V^-)	6.5 volts
Maximum Digit Output Current	400mA
Maximum Segment Output Current	60mA
Voltage on any Input or Output Terminal (Note 2)	Not to exceed V^+-V^- by more than ±0.3 volts
Maximum Power Dissipation at	1.0 watts (ICM7226A)
70° C (Note 1)	0.5 watts (ICM7226B)
Maximum Operating Temperature Range	-20° C to +70° C
Maximum Storage Temperature Range	-55° C to +125° C

Absolute maximum ratings refer to values that if exceeded may destroy or permanently change the device. The device is guaranteed for continous operation only under the conditions defined under the section TYPICAL OPERATING CHARACTERISTICS.

Note 1: The ICM7226 may be triggered into a destructive latchup mode if either input signals are applied before the power supply is applied or if input or outputs are forced to voltages exceeding V^+-V^- by more than 0.3 volts.

ELECTRICAL CHARACTERISTICS V^+-V^- = 5.0V, Test Circuit, T_A = 25° C, unless otherwise specified.

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS
Operating Supply Current	I_{DD}	Display Off Unused inputs to V^-		2	5	mA
Supply Voltage Range		-20° C < T_A < 70° C Input A, Input B Frequency at F_{MAX}	4.75		6.0	volts
Maximum Guaranteed Frequency Input A, Pin 40	F_{AMAX}	-20° C < T_A < 70° C 4.75V < V^+-V^- < 6.0V Figure 1 Function = Frequency, Ratio, Unit Counter Function = Period, Time Interval	 10 2.5	 14		 MHz MHz
Maximum Frequency Input B, Pin 2	F_{BMAX}	-20° C < T_A < 70° C 4.75V < V^+ -V^- < 6.0V Figure 2	2.5			MHz
Minimum Separation Input A to Input B Time Interval Function		-20° C < T_A < 70° C 4.75V < V^+ -V^- < 6.0V Figure 3	250			nsec
Maximum osc. freq. and ext. osc. freq. Minimum ext. osc. freq.		-20° C < T_A < 70° C 4.75V < V^+ -V^- < 6.0V	10		 100	MHz kHz
Oscillator Transconductance	gm	V^+ -V^- = 4.75V T_A = +70°C	2000			µS
Multiplex Frequency Time Between Measurements	F_{MAX}	f_{osc} = 10 MHz f_{osc} = 10 MHz		500 200		Hz msec

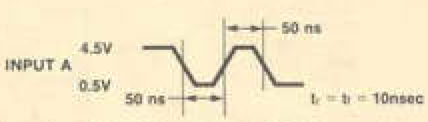


Figure 1: Waveform for Guaranteed Minimum F_{AMAX} Function = Frequency, Frequency Ratio, Unit Counter.

Figure 2: Waveform for Guaranteed Minimum F_{BMAX} and F_{AMAX} for Function = Period and Time Interval.

Figure 3: Waveform for Minimum Time Between Transitions of Input A and Input B.

Channel A going negative starts the time interval counter. Channel B stops the counter. Channel A must then go negative after B goes negative to complete the measurement cycle. On repetitious signals this occurs automatically. On "one-shot" time interval measurements, external provisions must be made to accomodate the above described procedure.

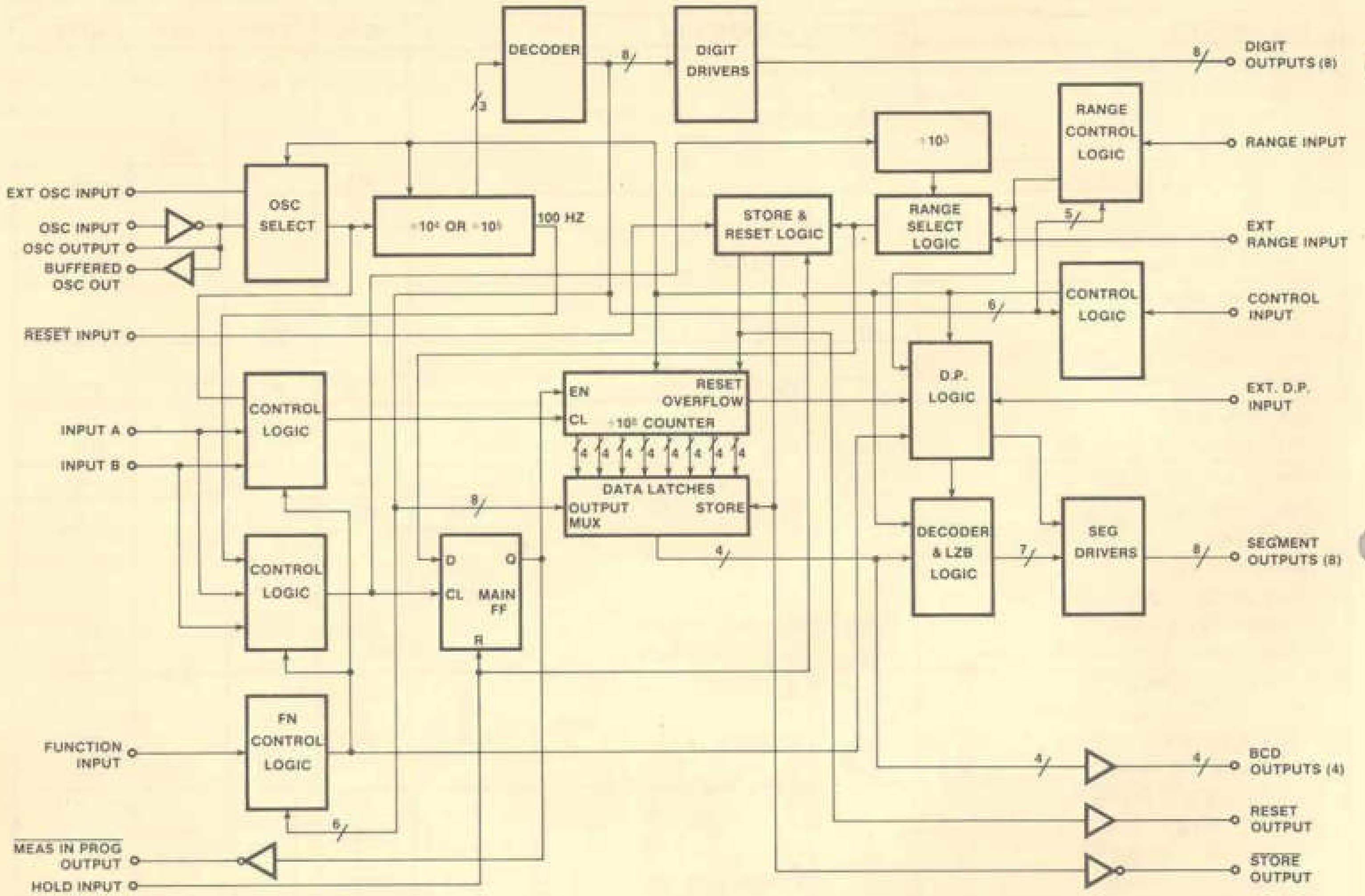
ELECTRICAL CHARACTERISTICS = $V^+ - V^- = 5.0V$, test circuit, $T_A = 25°C$, unless otherwise specified.

PARAMETER	SYMBOL	CONDITION	MIN	TYP	MAX	UNITS
INPUT VOLTAGES PINS 2,19,33,39,40 input low voltage input high voltage	 V_{IL} V_{IH}	 $-20°C < T_A < +70°C$ Referred to V^-	 1.0 		 3.5	 V V
PIN 39 INPUT LEAKAGE	I_L		10			μA
PIN 33 input low voltage input high voltage	 V_{IL} V_{IH}	 $-20°C < T_A < 70°C$ Referred to V^-	 .8 		 2.0	 V V
Input resistance to V^+ PINS 19,33	 R	 $V_{IN} = V^+ -1.0V$	 100	 400		 kΩ
Input resistance to V^- PIN 31	 R	 $V_{IN} = V^- +1.0V$	 100	 400		 kΩ
Output Current PINS 3,5,6,7,17,18,32,38	 I_{OL}	 $V_{OL} = V^- +0.4V$	 .36			 mA
PINS 5,6,7,17,18,32	I_{OH}	$V_{OH} = V^- +0.4V$	100			μA
PINS 3,38	I_{OH}	$V_{OH} = V^+ -.8V$	265			μA
ICM7226A DIGIT DRIVER PINS 22,23,24,26,27,28,29,30 high output current low output current	 I_{OH} I_{OL}	 $V_{out} = V^+ -2.0V$ $V_{out} = V^- +1.0V$	 170 	 200 -.3		 mA mA
SEGMENT DRIVER PINS 8,9,10,11,13,14,15,16 low output current high output current	 I_{OL} I_{OH}	 $V_{out} = V^- +1.5$ $V_{out} = V^+ -1.0V$	 25 	 35 100		 mA μA
MULTIPLEX INPUTS PINS 1,4,20,21 input low voltage input high voltage	 V_{IL} V_{IH}	 Referred to V^-	 2.0		 .8 	 V V
Input Resistance to V−	R	$V_{IN} = V^- +1.0V$	100	200		kΩ
ICM7226B DIGIT DRIVER PINS 8,9,10,11,13,14,15,16 low output current high output current	 I_{OL} I_{OH}	 $V_{out} = V^- +1.0V$ $V_{out} = V^+ -2.5V$	 50 	 75 100		 mA μA
SEGMENT DRIVER PINS 22,23,24,26,27,28,29,30 high output current leakage current	 I_{OH} I_L	 $V_{out} = V^+ -2.0V$ $V_{out} = V^-$	 10 	 15 	 10	 mA μA
MULTIPLEX INPUTS PINS 1,4,20,21 input low voltage input high voltage	 V_{IL} V_{IH}		 $V^+ -.8$		 $V^+ -2.0$ 	 V V
input resistance to V^+	R	$V_{IN} = V^+ -1.0V$	200	360		kΩ

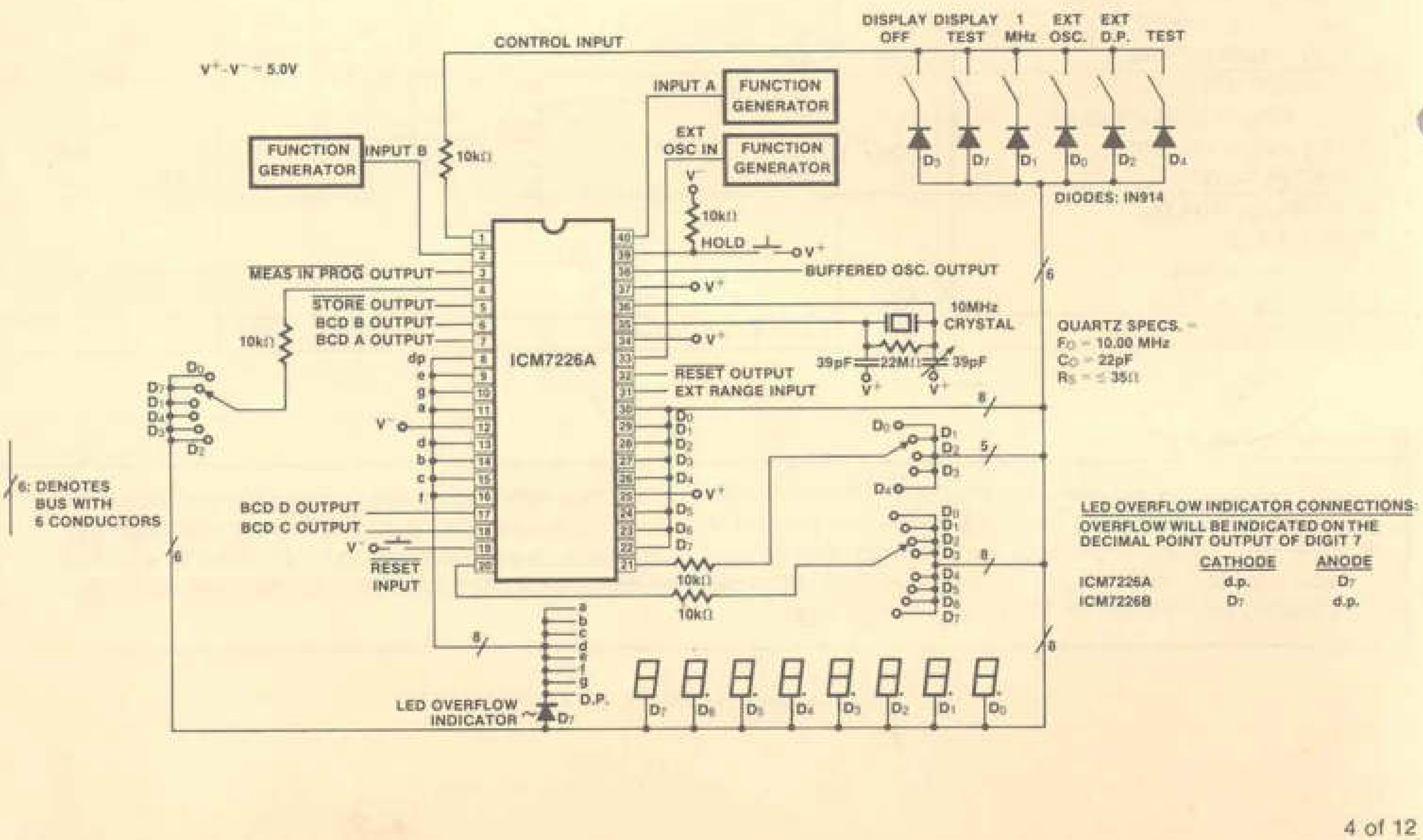
EVALUATION KIT

An evaluation kit is available for the ICM7226. It includes all the components necessary to assemble and evaluate a universal frequency/period counter based on the ICM7226. With the help of this kit, an engineer or technician can have the ICM7226 "up-and-running" in less than an hour. Specifically, the kit contains an ICM7226AIDL, a 10MHz quartz crystal, eight each 7-segment .3" leds, PC board, resistors, capacitors, diodes, switches and IC socket. Ordering information for the kit is given on page 1.

BLOCK DIAGRAM



TEST CIRCUIT



APPLICATION NOTES

GENERAL

Inputs A & B

The signal to be measured is input at Input A in Frequency, Period, Unit Counter, Frequency Ratio and Time Interval modes. The other input signal to be measured is input at Input B in Frequency Ratio and Time Interval. In Frequency Ratio F_A should be larger than F_B.

Both inputs are digital inputs with a typical switching threshold of 2.0V at $V^+ = 5.0V$. For optimum performance the peak to peak input signal should be at least 50% of the supply voltage and centered about the switching voltage. When these inputs are being driven from TTL logic, it is desirable to use a pullup resistor. The circuit counts high to low transitions at both inputs.

Note: The amplitude of the input should not exceed the supply by more than .3 volt otherwise, the circuit may be damaged.

Multiplexed Inputs

The function, range, control and external decimal point inputs are time multiplexed to select the input function desired. This is achieved by connecting the appropriate digit driver output to the inputs. The input function, range and control inputs must be stable during the last half of each digit output, (typically 125 μsec). The multiplex inputs are active high for the common anode ICM7226A and active low for the common cathode ICM7226B.

Noise on the multiplex inputs can cause improper operation. This is particularly true when the unit counter mode of operation is selected, since changes in voltage on the digit drivers can be capacitively coupled through the LED diodes to the multiplex inputs. For maximum noise immunity, a 10K resistor should be placed in series with the multiplex inputs as shown in the application notes.

Table 1 shows the functions selected by each digit for these inputs.

TABLE 1

	FUNCTION	DIGIT
FUNCTION INPUT PIN 4	Frequency	D_0
	Period	D_7
	Frequency Ratio	D_1
	Time Interval	D_4
	Unit Counter	D_3
	Oscillator Frequency	D_2
RANGE INPUT PIN 21	.01 Sec/1 Cycle	D_0
	.1 Sec/10 Cycles	D_1
	1 Sec/100 Cycles	D_2
	10 Sec/1k Cycles	D_3
External Range Input PIN 31	Enabled	D_4
CONTROL INPUT PIN 1	Blank Display	D_3&Hold
	Display Test	D_7
	1MHz Select	D_1
	External Oscillator Enable	D_0
	External Decimal Point Enable	D_2
	Test	D_4
EXTERNAL DECIMAL POINT INPUT, PIN 20	Decimal Point is Output for Same Digit That is Connected to This Input	

Control Input Functions

Display Test - All segments are enabled continuously, giving a display of all 8's with decimal points. The display will be blanked if Display Off is selected at the same time.

Display Off - To enable the Display Off mode it is necessary to input D_3 to the control input and have the HOLD input at V^+. The chip will remain in the Display Off mode until HOLD is switched back to V^-. While in the Display Off mode, the segment and digit driver outputs are open. During Display Off the oscillator continues to run with a typical supply current of 1.5mA with a 10MHz crystal and no measurements are made. In addition, inputs to the multiplexed inputs will have no effect. A new measurement is initiated when the HOLD input is switched to V^-.

1MHz Select - The 1MHz select mode allows use of a 1MHz crystal with the same digit multiplex rate and time between measurements as with a 10MHz crystal. The decimal point is also shifted one digit to the right in Period and Time Interval, since the least significant digit will be in μsecond increments rather than 0.1 μsec increments.

External Oscillator Enable - In this mode the external oscillator input is used instead of the on chip oscillator for the Timebase input and Main Counter input in Period and Time interval modes. The on chip oscillator will continue to function when the external oscillator is selected, but will have no effect on circuit operation. The external oscillator input frequency must be greater than 100KHz or the chip will reset itself to enable the on chip oscillator.

External Decimal Point Enable - When external decimal point is enabled a decimal point will be displayed whenever the digit driver connected to the external decimal point is active. Leading Zero Blanking will be disabled for all digits following the decimal point.

Test Mode - In the test mode the main counter is split into groups of two digits each and the groups are clocked in parallel. The reference counter is split such that the clock into the reference count goes directly to the clock of the third decade counter (10 sec/1k cycle range). Store is also enabled so the count in the main counter is continuously output.

Range Input - The range input selects whether the measurement is made for 1, 10, 100, 1000 counts of the reference counter or if the external range input determines the measurement time. In all functional modes except Unit Counter a change in the range input will stop the measurement in progress without updating the display and then initiate a new measurement. This prevents an erroneous first reading after the Range Input is changed.

Function Input - The six functions that can be selected are: Frequency, Period, Time Interval, Unit Counter, Frequency Ratio and Oscillator Frequency.

These functions select which signal is counted into the main counter and which signal is counted by the reference counter as shown in Table 2. In Time Interval a flip flop is toggled first by a 1 → 0 transition at Input A and then by a 1 → 0 transition at Input B. The oscillator is gated into the Main Counter from the time Input A toggles the flip flop until Input B gates the flip flop. A change in the function input will stop the measurement in progress without updating the display and then initiate a new measurement. This prevents an erroneous first reading after the Function Input is changed. If main counter overflows, an overflow indication is output on the decimal point output during D7.

TABLE 2

DESCRIPTION	MAIN COUNTER	REFERENCE COUNTER
Frequency (F_A)	Input A	100Hz (Oscillator ÷ 10^5 or 10^4)
Period (T_A)	Oscillator	Input A
Ratio (F_A/F_B)	Input A	Input B
Time Interval (A→B)	Osc•Time Interval FF	Time Interval FF
Unit Counter(Count A)	Input A	Not Applicable
Osc. Freq. (Fosc)	Oscillator	100Hz (Osc ÷ 10^5 or 10^4)

External Decimal Point Input - when the external decimal point is selected this input is active. Any of the digits, except D_7, can be connected to this point. D_7 should not be used since it will overide the overflow output and leading zeros will remain unblanked after the decimal point.

Hold Input - Except in the Unit counter mode when the Hold Input is at V^+, any measurement in progress is stopped, the main counter is reset and the chip is held ready to initiate a new measurement. The latches which hold the main counter data are not updated so the last complete measurement is displayed. In Unit counter mode when Hold Input is at V^+ the counter is stopped but not reset. When Hold is changed to V^- the count continues from where the counter stopped.

$\overline{\text{Reset}}$ Input - The $\overline{\text{Reset}}$ Input is the same as a Hold Input, except the latches for the main counter are enabled, resulting in an output of all zeros.

External Range Input - The External Range Input is used to select different ranges than those provided on the chip. Figure 4 shows the relationship between Measurement In Progress and External Range Input.

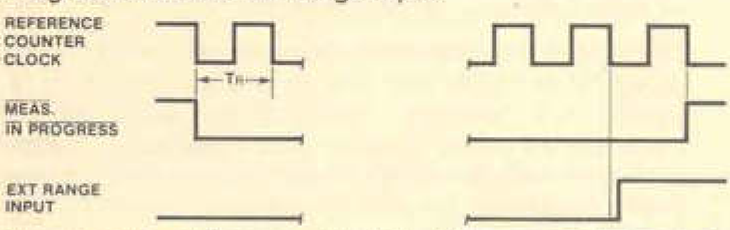


Figure 4: External Range Input to End of $\overline{\text{Measurement}}$ in Progress.

$\overline{\text{Measurement In Progress}}$, $\overline{\text{Store}}$ and $\overline{\text{Reset}}$ Outputs - These outputs are provided to enable display of prescaler digits. Figure 5 shows the relationship between these signals during the time between measurements. All three outputs can drive a low power Schottky TTL load. The $\overline{\text{Measurement In Progress}}$ Output can directly drive an ECL load, if the ECL device is powered from the same power supply as the ICM7226.

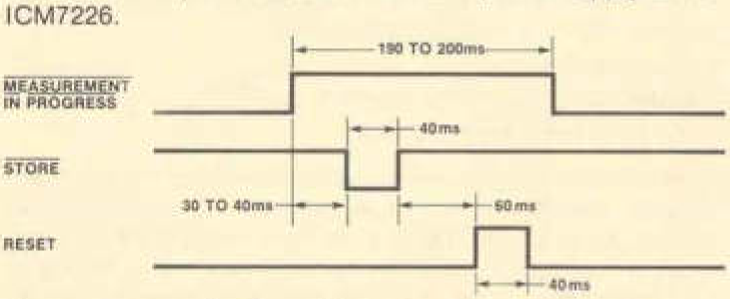


Figure 5: Reset, $\overline{\text{Store}}$, and $\overline{\text{Measurement in Progress}}$ Outputs Between Measurements.

BCD Outputs - The BCD representation of each digit output is output on the BCD outputs. Leading zero blanking of the display has no effect on the BCD output. Each BCD output will drive one low power Schottky TTL load. Table 3 shows the truth table for the BCD outputs.

TABLE 3 Truth Table BCD Outputs

NUMBER	D PIN 7	C PIN 6	B PIN 17	A PIN 18
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

Buffered Oscillator Output - The Buffered Oscillator Output has been provided to enable use of the on chip oscillator signal without loading the oscillator itself. This output will drive one low power Schottky TTL load. Care should be taken to minimize capacitive loading on this pin.

DISPLAY CONSIDERATIONS

The display is multiplexed at a 500Hz rate with a digit time of 244 μsec. An interdigit blanking time of 6 μsec is used to prevent ghosting between digits. The decimal point and leading zero blanking have been implemented for right hand decimal point displays. Any zeros following the decimal point will not be blanked. Also, the leading zero blanking will be disabled if the Main Counter overflows. The decimal point has been implemented to display frequency in KHz and time in μsec.

The ICM7226A is designed to drive common anode LED displays at peak current of 25mA/segment, using displays with V_F = 1.8V at 25mA. The average DC current will be over 3mA under these conditions. The ICM7226B is designed to drive common cathode displays at peak current of 15mA/segment using displays with V_F = 1.8V at 15mA. Resistors can be added in series with the segment drivers to limit the display current in very efficient displays, if required. Figures 6, 7, 8 and 9 show the digit and segment currents as a function of output voltage for common anode and common cathode drivers.

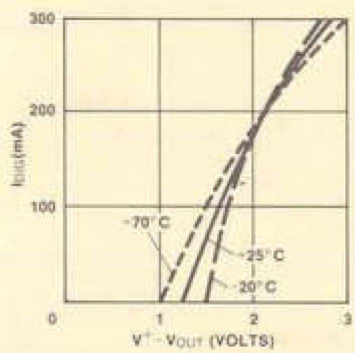


Figure 6: ICM7226A Typical I_{DIG} Vs. V^+-V_{out}
$4.5 \le V^+ - V^- \le 6.0V$

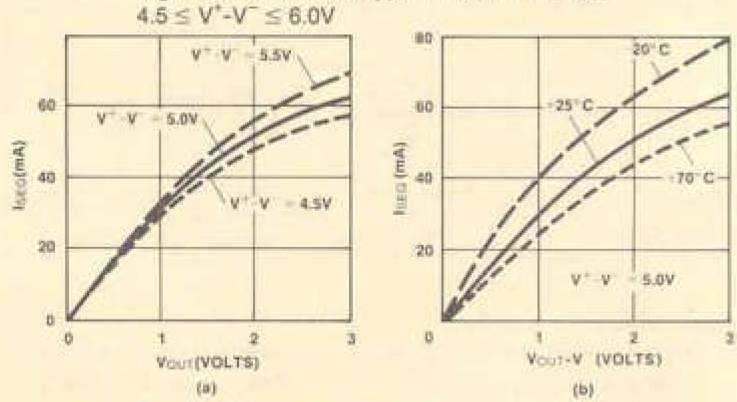


Figure 7: ICM7226A Typical I_{SEG} Vs. V_{out}-V^-

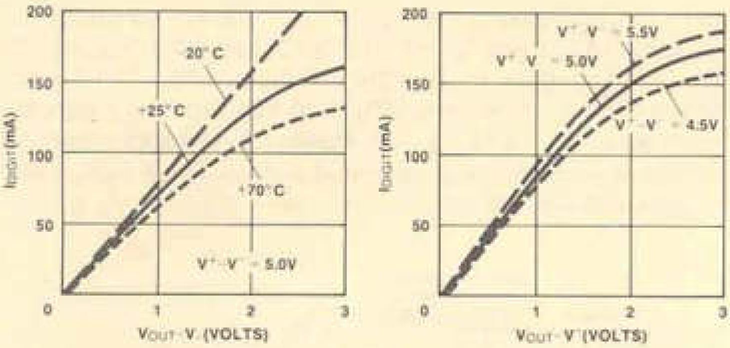


Figure 8: ICM7226B Typical I_{DIGIT} Vs. $V_{OUT}-V^-$

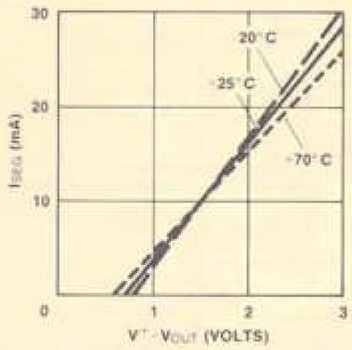
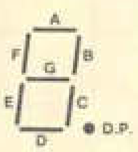


Figure 9: ICM7226B Typical I_{SEG} Vs. V^+-V_{out}
$4.5V \le V^+-V^- \le 6.0V$

To increase the light output from the displays, V+ may be increased up to 6.0V, however, care should be taken to see that maximum power and current ratings are not exceeded.

The segment and digit outputs in both the 7226A and B are not directly compatible with either TTL or CMOS logic. Therefore, level shifting with discrete transistors may be required to use these outputs as logic signals.

Segment Identification



ACCURACY

In a Universal Counter crystal drift and quantization errors cause errors. In Frequency, Period and Time Interval Modes, a signal derived from the oscillator is used in either the Reference Counter or Main Counter. Therefore, in these modes an error in the oscillator frequency will cause an identical error in the measurement. For instance, an oscillator temperature coefficient of 20ppm/°C will cause a measurement error of 20ppm/°C.

In addition, there is a quantization error inherent in any digital measurement of ±1 count. Clearly this error is reduced by displaying more digits. In the Frequency Mode the maximum accuracy is obtained with high frequency inputs and in Period Mode maximum accuracy is obtained with low frequency inputs. As can be seen in Figure 10, the least accuracy will be obtained at 10 KHz. In Time Interval measurements there is a maximum error of 1 count per interval. As a result there is the same inherent accuracy in all ranges as shown in Figure 11. In Frequency Ratio measurement more accuracy can be obtained by averaging over more cycles of Input B as shown in Figure 12.

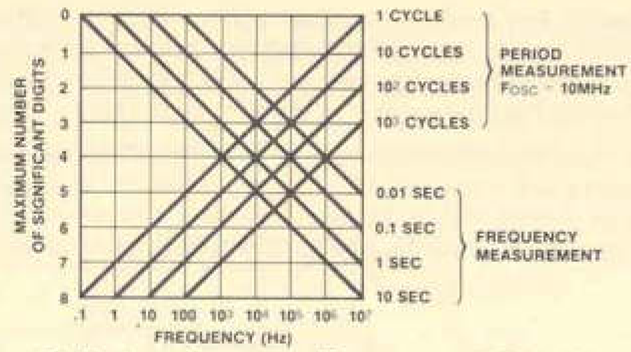


Figure 10: Maximum Accuracy of Frequency and Period Measurements Due to Limitations of Quantization Errors.

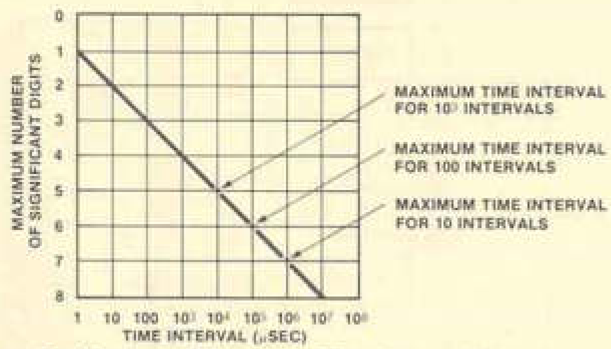


Figure 11: Maximum Accuracy of Time Interval Measurement Due to Limitations of Quantization Errors.

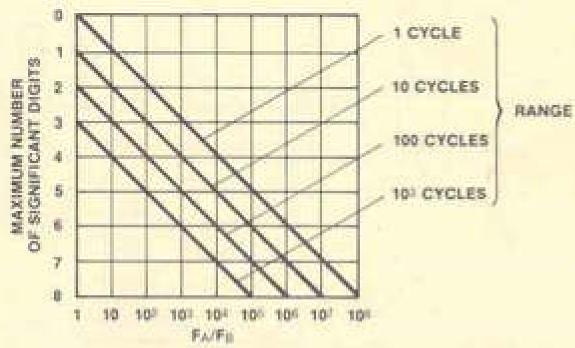


Figure 12: Maximum Accuracy for Frequency Ratio Measurement Due to Limitations of Quantization Errors.

CIRCUIT APPLICATIONS

The ICM7226 has been designed to be used as a complete Universal Counter or with prescalers and other circuitry in a variety of applications. Since Input A and Input B are digital inputs additional circuitry will be required in many applications for input buffering, amplification, hysteresis, and level shifting to obtain the required digital voltages. For many applications an FET source follower can be used for input buffering and an ECL 10116 line driver can be used for amplification and hysteresis to obtain a high impedance input, sensitivity and bandwidth. However, cost and complexity of this circuitry can vary widely depending upon the sensitivity and bandwidth required. When TTL prescalers or input buffers are used, pull up resistors to V+ should be used to obtain optimal voltage swing at Inputs A and B.

If prescalers aren't required the ICM7226 can be used to implement a minimum component Universal counter as shown in figure 13. This circuit can be for input frequencies up to 10MHz at Input A and 2MHz at Input B.

For input frequencies up to 40 MHz the circuit shown in figure 14 can be used to implement a Frequency and Period Counter. To obtain the correct value when measuring frequency and period it is necessary to divide the 10MHz oscillator frequency down to 2.5MHz. In doing this the time between measurements is also lengthened to 800 msec. and the display multiplex rate is decreased to 125 Hz.

If the input frequency is prescaled by ten then the oscillator frequency can remain at 10 or 1MHz, but the decimal point must be moved. Figure 15 shows use of a ÷10 prescaler in frequency counter mode. Additional logic has been added to have the 7226 count the input directly in Period mode for maximum accuracy. Note that Input A comes from Q_C rather than Q_D to obtain an input duty cycle of 40%. If an output without a duty cycle near 50% must be used then it may be necessary to use a 74121 monostable multivibrator or similar circuit to stretch the input pulse to guarantee a 50 nsec minimum pulse width.

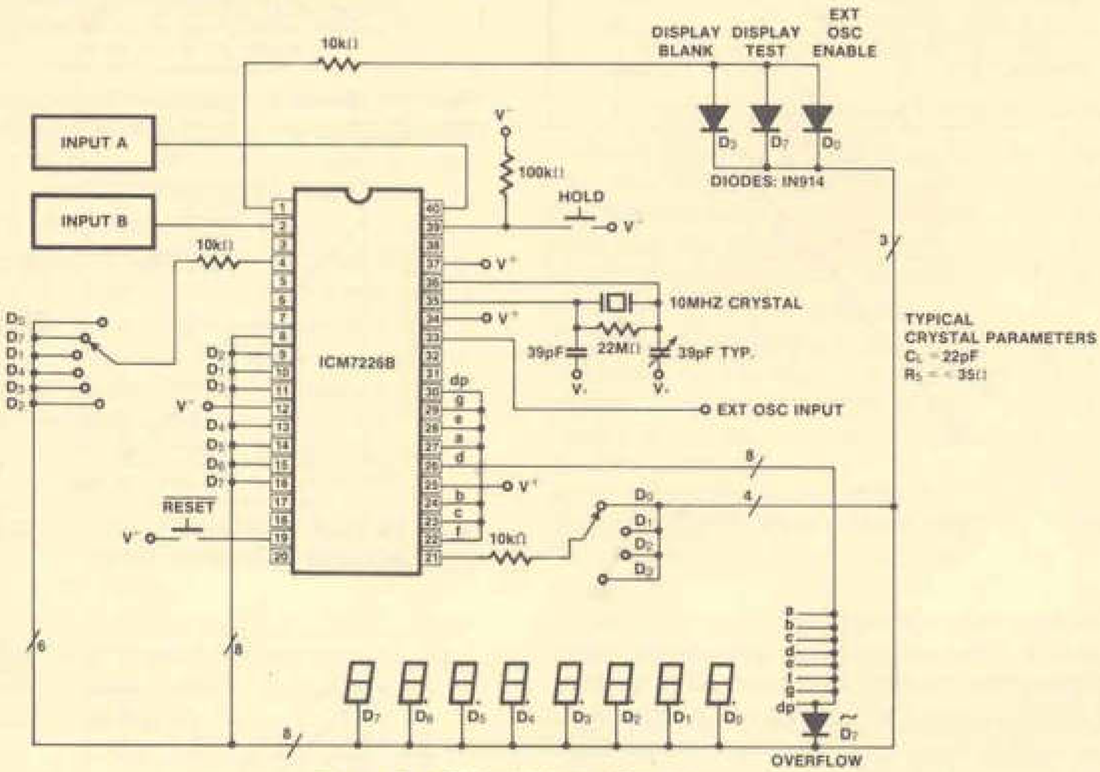
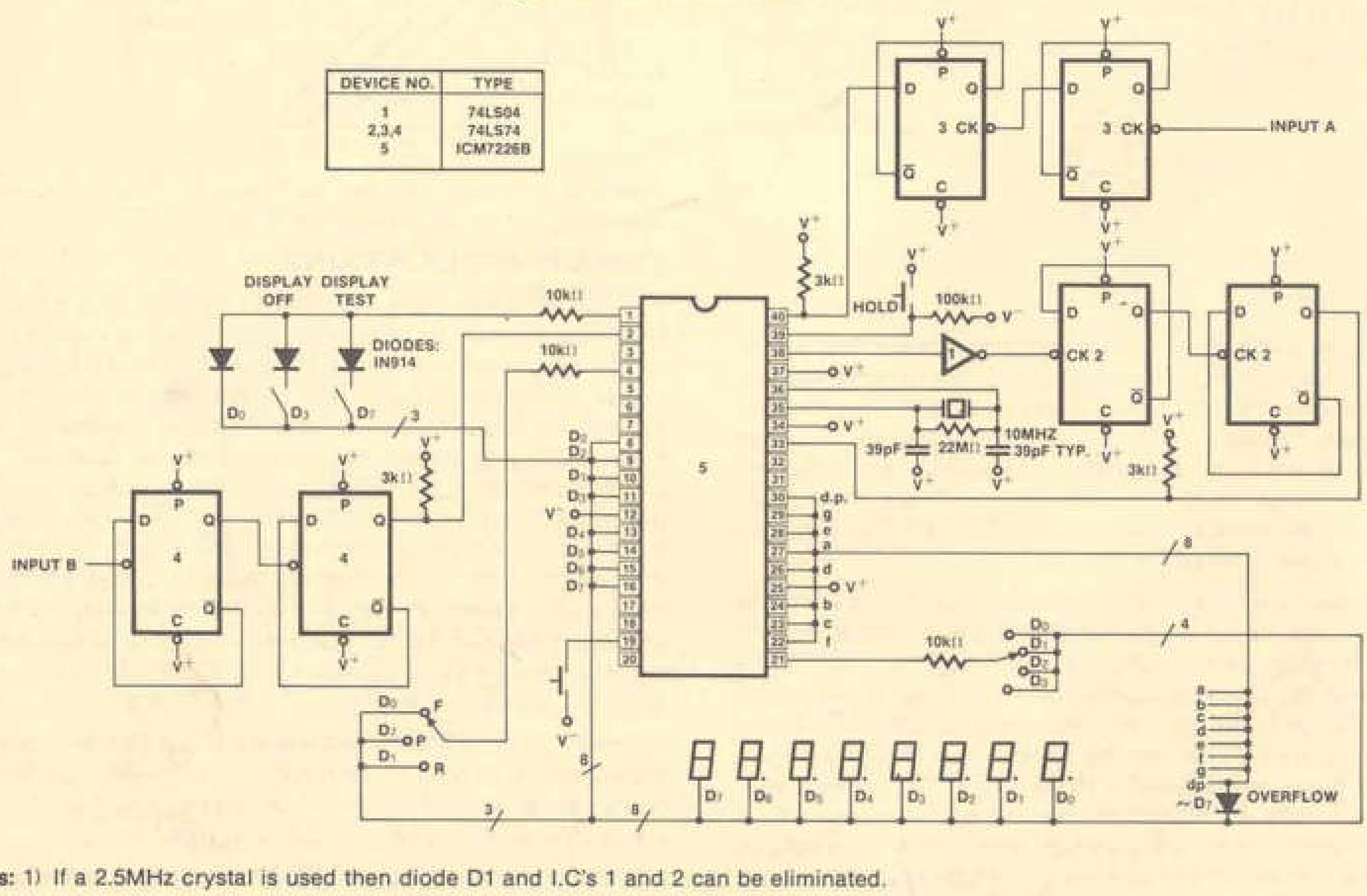


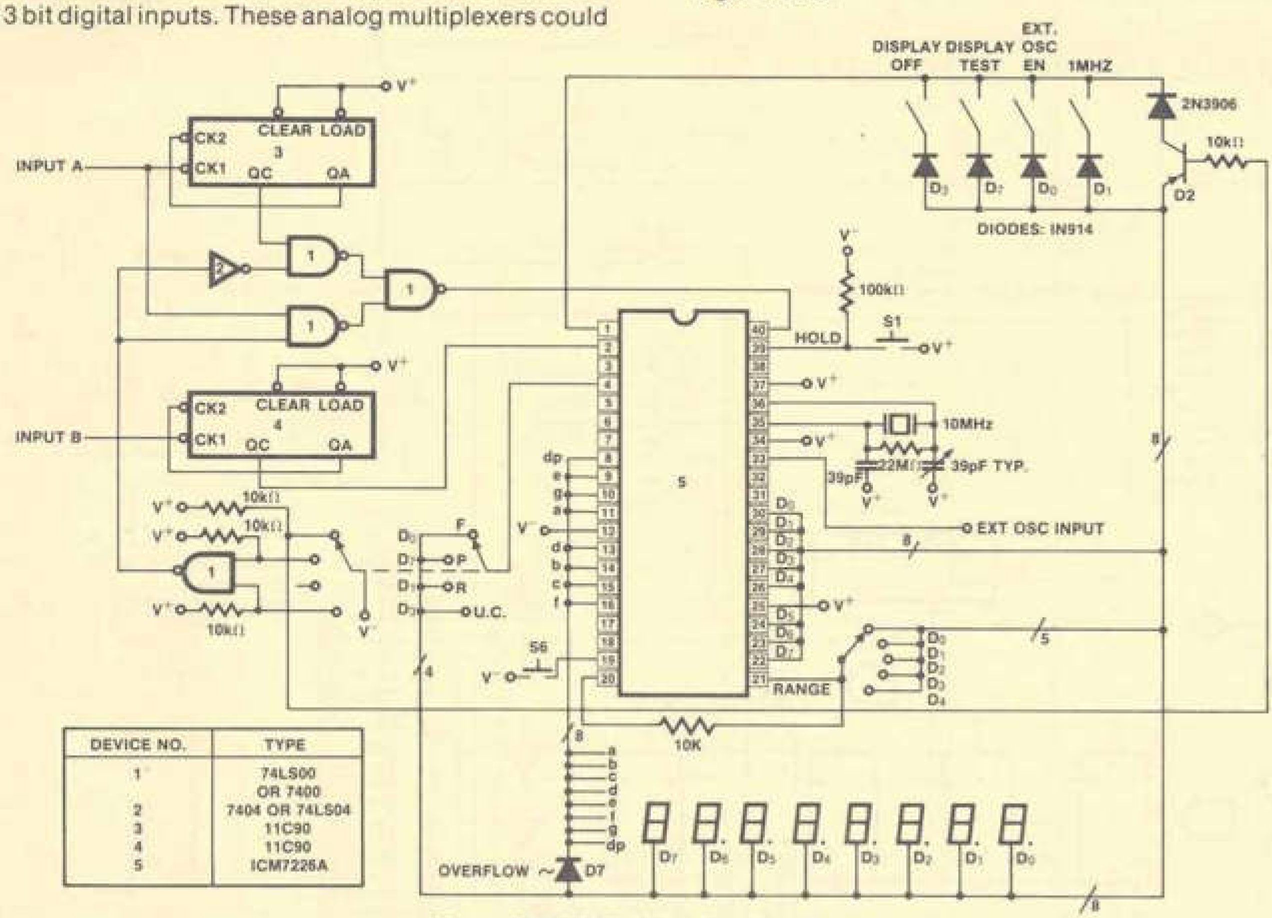
Figure 13: 10MHz Universal Counter



Notes: 1) If a 2.5MHz crystal is used then diode D1 and I.C's 1 and 2 can be eliminated.

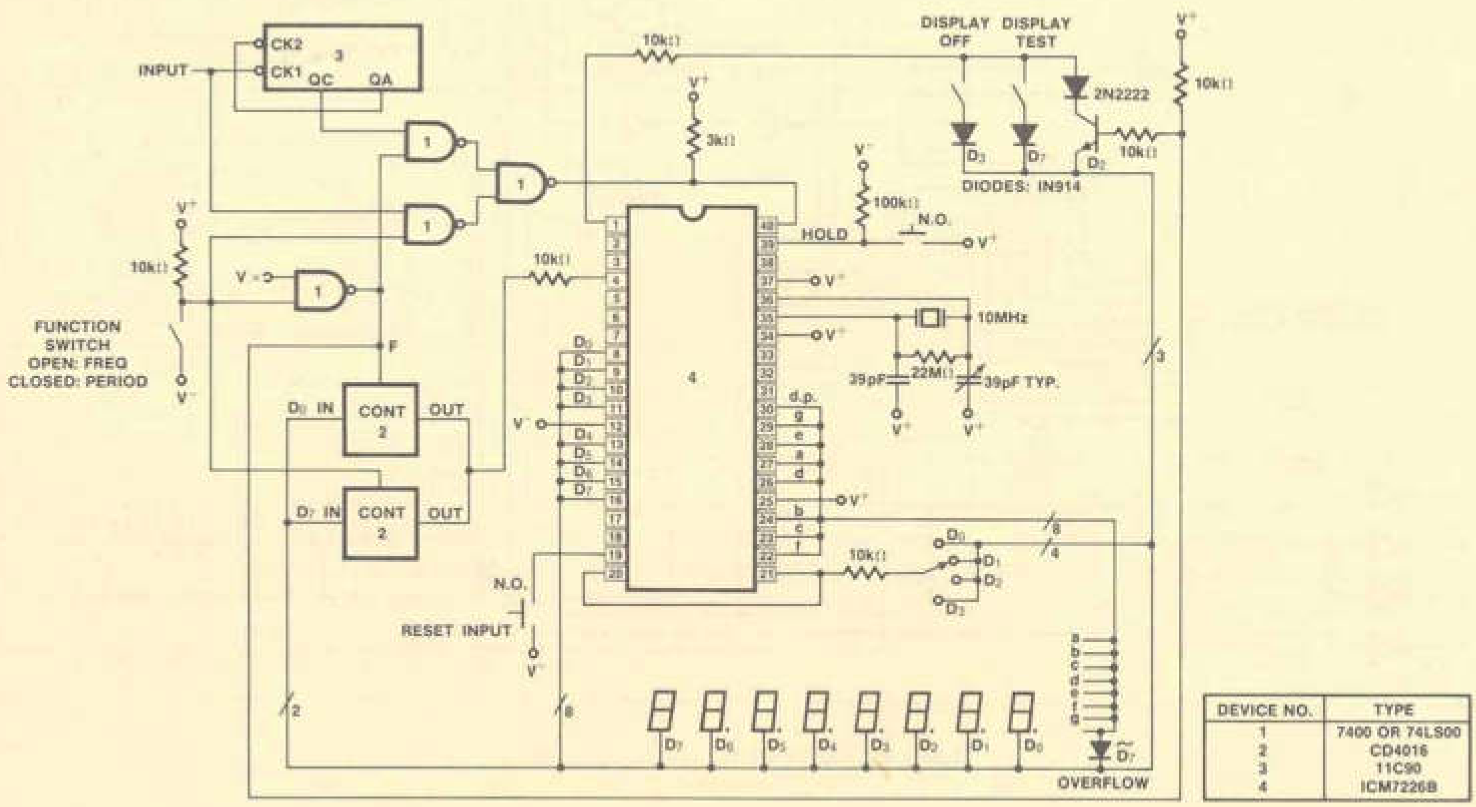
Figure 14: 40MHz Frequency, Period Counter

Figure 16 shows the use of a CD4016 analog multiplexer to multiplex the digital outputs back to the Function Input. Since the CD4016 is a digitally controlled analog transmission gate no level shifting of the digit output is required. CD4051's or CD4052's could also be used to select the proper inputs for the multiplexed input on the ICM7226 from 2 or 3 bit digital inputs. These analog multiplexers could also be used in systems in which the mode of operation is controlled by a microprocessor rather than directly from front panel switches. TTL multiplexers such as the 74153 or 74251 could also be used, but some additional circuitry will be required to convert the digit output to TTL compatible logic levels.



DEVICE NO.	TYPE
1	74LS00 OR 7400
2	7404 OR 74LS04
3	11C90
4	11C90
5	ICM7226A

Figure 15: 100MHz Multi Function Counter



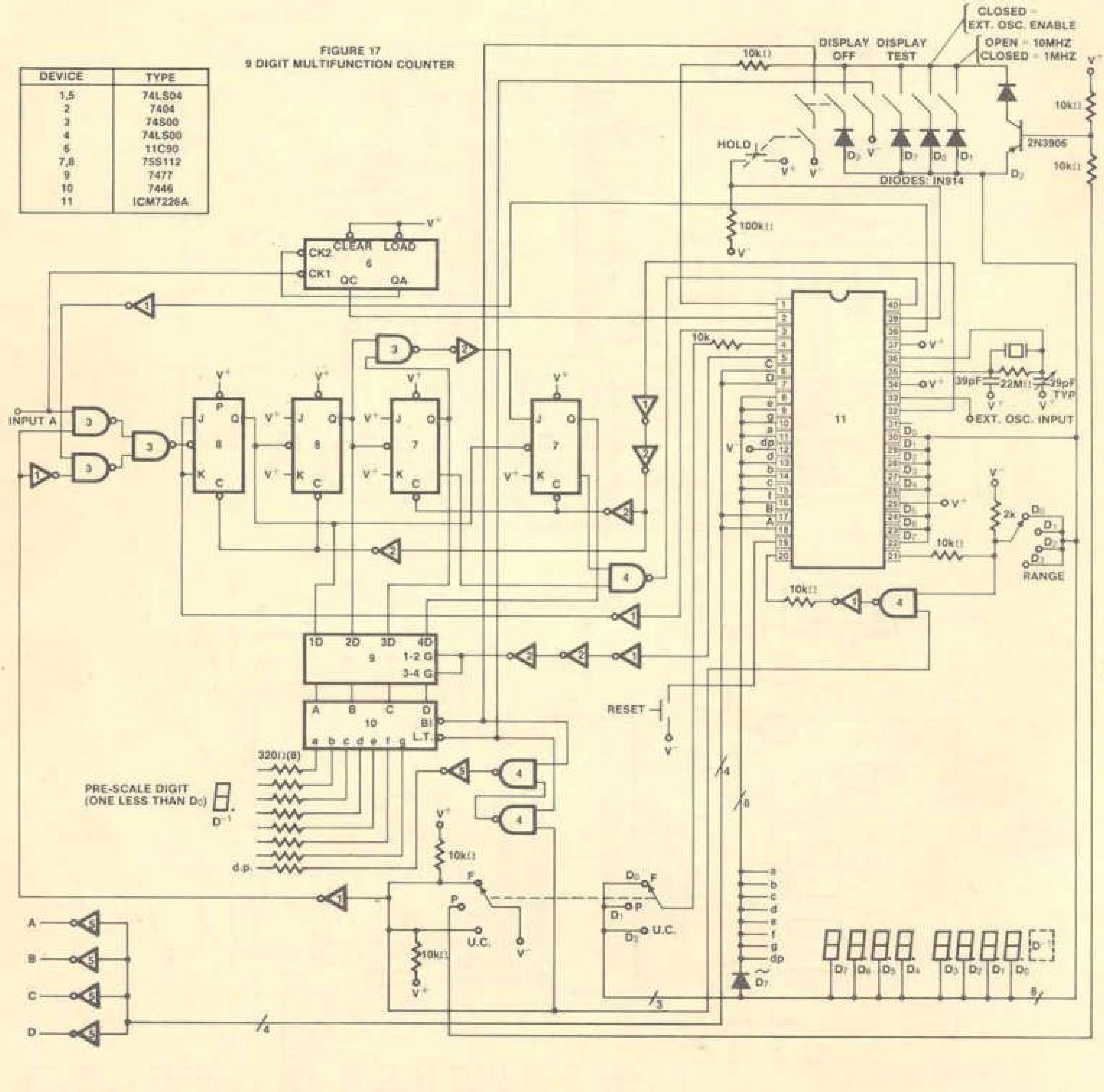
DEVICE NO.	TYPE
1	7400 OR 74LS00
2	CD4016
3	11C90
4	ICM7226B

Figure 16: 100MHz Frequency Period Counter

If the prescaler information needs to be displayed, then the Measurement in Progress, Store and Reset outputs from the ICM7226 can be used to control the prescaler and data latch as shown in figure 17. Note that the output of IC 7 has been decoded with a NAND to obtain a 40% duty cycle for the signal into input A.

To obtain a full Universal Counter with prescalers with the count displayed, it is necessary to add significantly more circuitry to implement the Time External Mode as shown in figure 18.

All of the circuits shown directly drive a multiplexed LED display, however, the BCD outputs can be used with external BCD to 7 segment decoders and appropriate level shifting to drive other types of displays.



DEVICE	TYPE
1,5	74LS04
2	7404
3	74S00
4	74LS00
6	11C90
7,8	75S112
9	7477
10	7446
11	ICM7226A

Figure 17: 9 Digit Multi Function Counter

DEV. #	TYPE
1,2,5	74LS04 OR CD4049
3,9	74S04
4	74LS10
6,7,10	74S00
8	74S10
11	74LS90
12,13,14	74S112 OR 74S114
15	7477
16	7446
17	ICM7226A

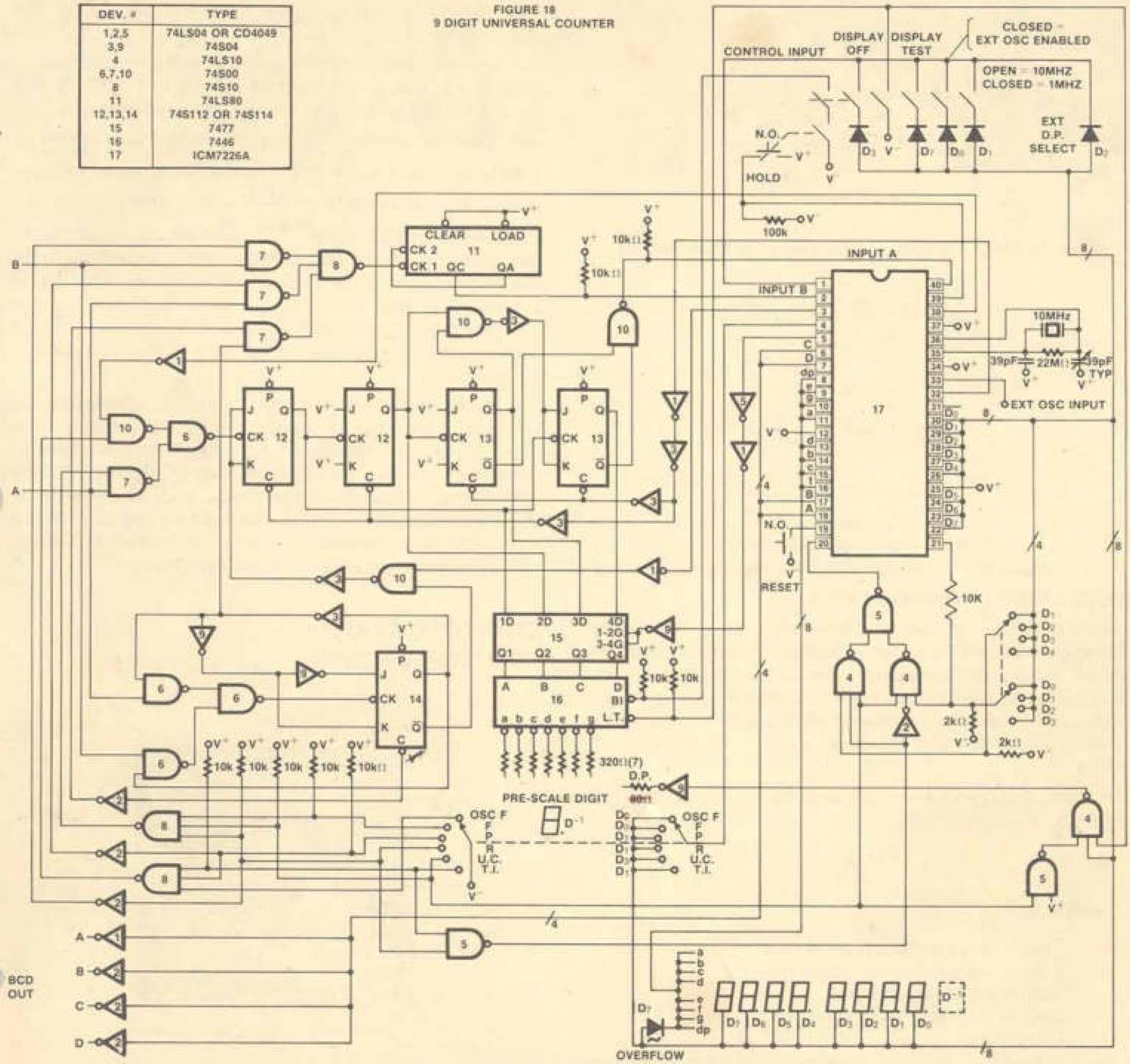
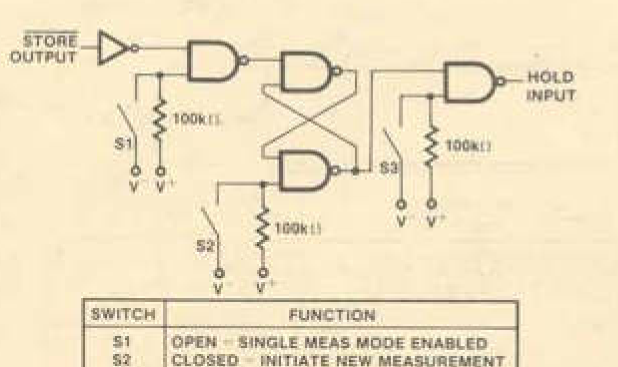


Figure 18: 9 Digit Universal Counter

The circuit shown in figure 19 can be used in any of the circuit applications shown to implement a single measurement mode of operation. This circuit uses the Store output to put the ICM7226 into a hold mode. The Hold input can also be used to reduce the time between measurements. The circuit shown in figure 20 puts a short pulse into the Hold input a short time after Store goes low. A new measurement will be initiated at the end of the pulse on the Hold Input. This circuit reduces the time between measurements to less than 40 msec from 200 msec. Use of the circuit shown in Figure 20 on the circuit shown in Figure 14 will reduce the time between measurements from 800 msec. to 1600 msec.



SWITCH	FUNCTION
S1	OPEN = SINGLE MEAS MODE ENABLED
S2	CLOSED = INITIATE NEW MEASUREMENT
S3	CLOSED = HOLD INPUT

Figure 19: Single Measurement Circuit for Use With ICM7226

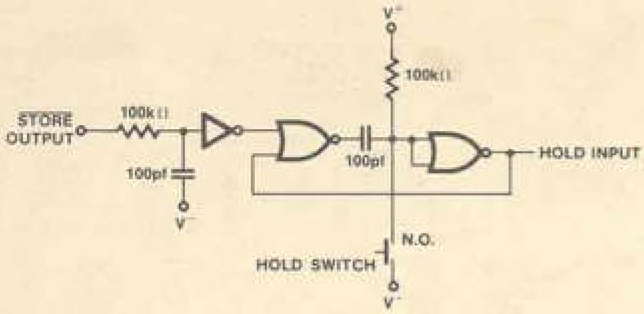


Figure 20: Circuit for Reducing Time Between Measurements

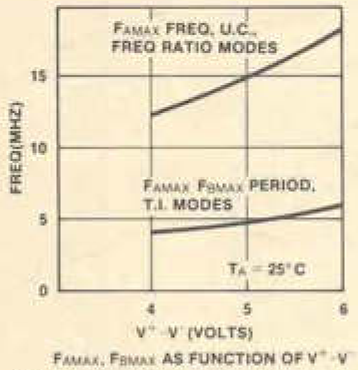


Figure 21: Typical Operating Characteristics

OSCILLATOR CONSIDERATIONS

The oscillator has been implemented as a high gain complementary FET inverter. An external resistor of 10MΩ or 22MΩ should be connected between the oscillator input and output to provide biasing. The oscillator is designed to work with a parallel of resonance 10 MHz quartz crystal with a static capacitance of 22pF and a series of less than 35 ohms.

For a specific crystal and load capacitance, the required g_m can be calculated as follows:

$$g_m = \omega^2 \ \text{Cin Cout Rs} \left(1+\frac{C_O}{C_L}\right)^2$$

$$\text{where } C_L = \left(\frac{\text{CinCout}}{\text{Cin+Cout}}\right)$$

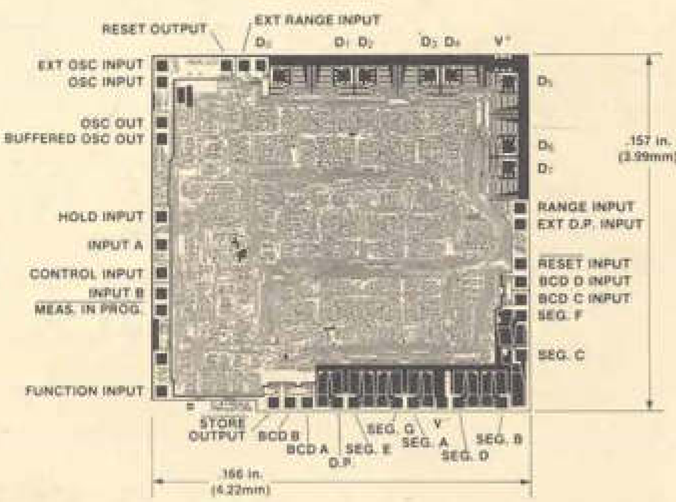
C_O = Crystal static capacitance
R_S = Crystal Series Resistance
Cin = Input Capacitance
Cout = Output Capacitance
$\omega = 2\pi f$

The required g_m should exceed the g_m specified for the ICM7226 by at least 50% to insure reliable startup. The oscillator input and output pins each contribute about 5pf to Cin and Cout. For maximum frequency stability, Cin and Cout should be approximately twice the specified crystal static capacitance.

In cases where non decade prescalers are used it may be desirable to use a crystal which is neither 10MHz. In that case, both the multiplex rate and time between measurements will be different. The multiplex rate is $f_{max} = \frac{f_{osc}}{2x10^4}$ for 10MHz mode and $f_{max} = \frac{f_{osc}}{2x10^3}$ for the 1MHz mode. The time between measurements is $\frac{2x10^6}{f_{osc}}$ in the 10MHz mode and $2x10^5$ in the 1MHz mode. The buffered oscillator output should be used for an oscillator test point or to drive additional logic. This output will drive one low power Schottky TTL load. When the buffered oscillator output is used to drive CMOS or to drive the external oscillator input, a 10kΩ resistor should be added from buffered oscillator output to V^+.

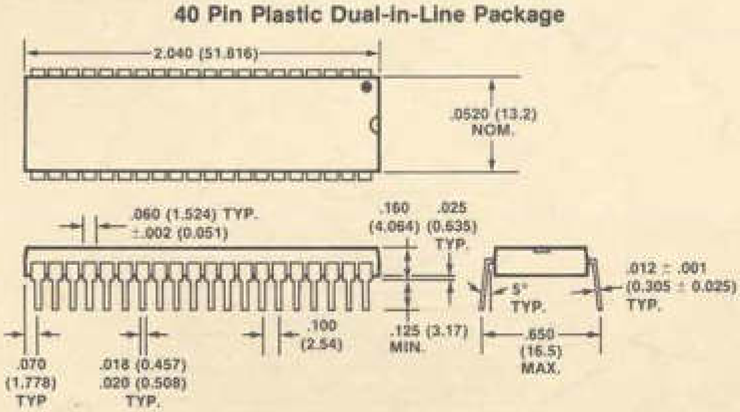
The crystal and oscillator components should be located as close to to the chip as practical to minimize pickup from other signals. In particular, coupling from the Buffered Oscillator Output and External Oscillator Input to the oscillator output or input can cause undesirable shifts in oscillator frequency. To minimize this coupling, pins 34 and 37 should be connected to V^+ or V^- and these two signals should be kept away from the oscillator circuit.

CHIP TOPOGRAPHY (ICM7226A SHOWN)



PACKAGE DIMENSIONS

40 Pin Plastic Dual-in-Line Package



40 Pin Ceramic Dual-in-Line Package