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1.0 GENERAL INFORMATION

Listed below are the differences between the different meter styles.

P6000	P6000A/DPF6000	P5000/DPF5000
“Classic”front panel.	“Classic” front panel.	New “Designer” front panel.
NEMA-4 w/ cover.	NEMA-4 w/ cover.	NEMA-4 standard.
Meter slides out of case from front.	Meter slides out of case from front.	Meter slides out of case from rear.
Front panel to display board mounting: not compatible to P6000A & P5000.	Front panel to display board mounting: not compatible to P6000.	Front panel to display board mounting: not compatible to P6000.
Front panel is removable to adjust potentiometers on input options boards* and programming pins. Input & output option boards may not be compatible to P6000A & P5000. Reference for P6000 Manual - 10980ML-01	Front panel is removable to adjust potentiometers on input options boards* and programming pins. or A slot at top of case is provided for possilbe location of potentiometers access. Input Option boards may not be compatible to P6000.	Front panel is not removable. Potentiometers and programming pins may be adjusted by removing meter from case*. or A slot at top of case is provided for possible location of potentiometers access. Input option boards may not be compatible.

* Detailed information in the input options manual.

This meter is a fully programmable counter with six-digit resolution for totalizing input pulses or for measuring frequency, period, time interval and frequency ratio.

The meter is menu-driven for simple programming. Alphanumeric prompts on the display make it easy to program with front panel pushbuttons. Pushing the appropriate| button scrolls the display through the functions and settings, repeating (for corrections) as often as desired. Alternatively, a personal computer can be used to program the meter and to monitor the display data via the RS-232 port (standard feature). If desired, the program setup may be stored in nonvolatile memory for recall upon demand or at power-on.

The two setpoints and corresponding alarm outputs make it an ON-OFF Controller for either stand-alone or computer-controlled applications. The crystal time base may be electronically calibrated, either manually from the front panel or remotely with a personal computer.

2.0 GETTING STARTED

2.1 SAFETY CONSIDERATIONS

This instrument is protected according to Class II of IEC 348 and VDE 0411. To ensure safe operation, follow the guidelines below:

POWER VOLTAGE - Verify that the instrument is connected for the power voltage rating that will be used.

POWER WIRING - This instrument has no power-on switch; it will be in operation as soon as the power is connected.

RAIN OR MOISTURE - Do not expose the instrument to condensing moisture.

FUMES AND GASES - Do not operate the instrument in the presence of flammable gases or fumes.

EXERCISE CAUTION - As with any electronic instrument, high voltages may be exposed when attempting to install, calibrate, or remove parts of the meter.

2.2 ASSEMBLY & MOUNTING

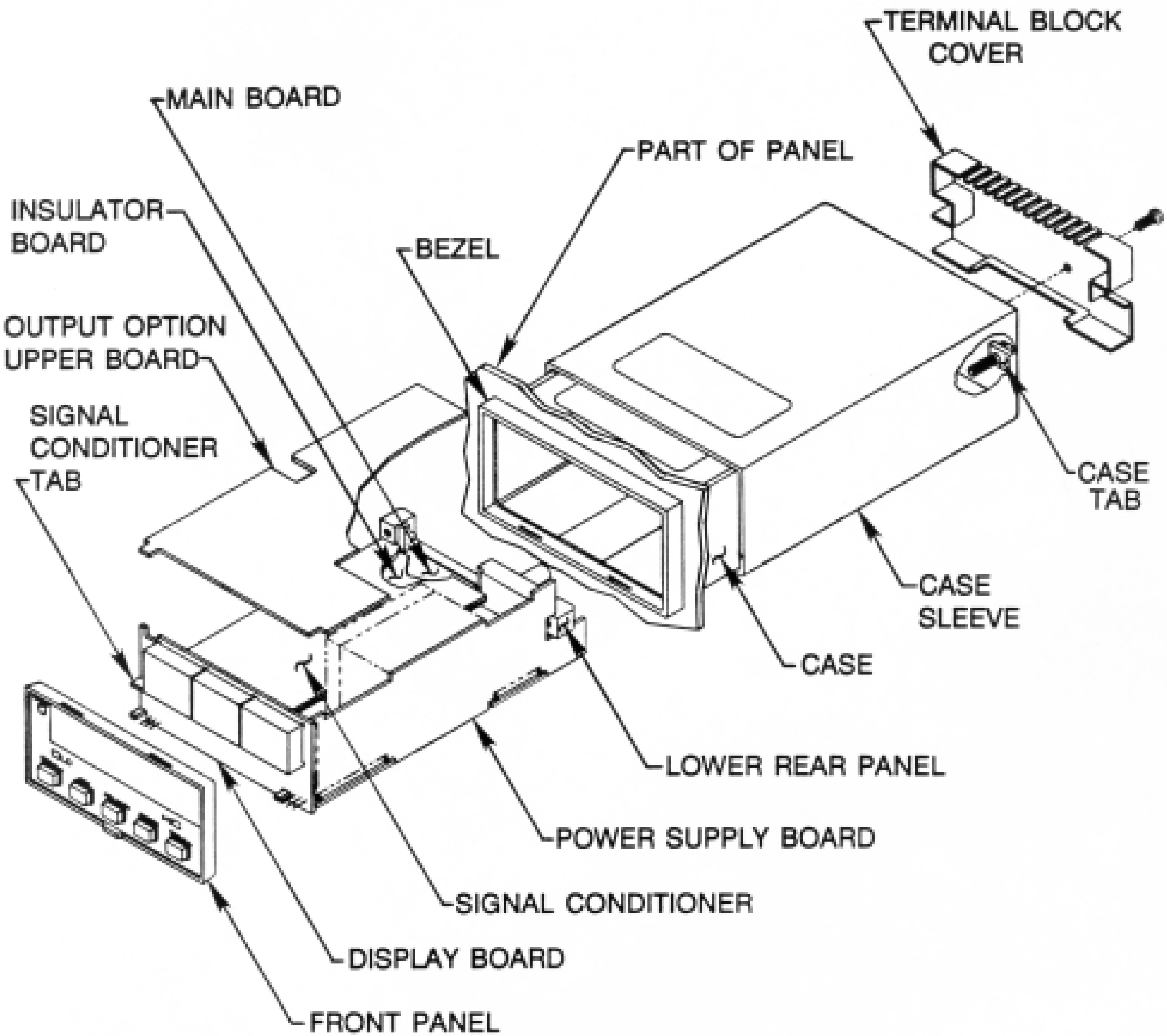


Figure 2-1 Exploded View - “Classic” Style

The “Classic” meter is housed in a 4896-150, 1/8 DIN case. The electronic circuitry can be installed or removed from the front and is attached to the case with two #8 screws through the rear panel.

To install a pre-configured meter:

NOTE:	Installation of input options (mezzanine board) and output options (upper board) is shown in the Input Options and the Output Options Manuals.

1. Use a Phillips-head screwdriver to remove the three screws on the rear of the case

2. Slide the sleeve off the case (see Figure 2-1 Exploded View).

3. Verify the panel cutout dimensions in Figure 2-2 Case Dimensions. Insert the case in the pane cutout from the front and slide the sleeve on from the rear. Install the two #8 screws to secure the sleeve to the case.

4. Connect all connectors and attach the terminal block cover with the #4 screw.

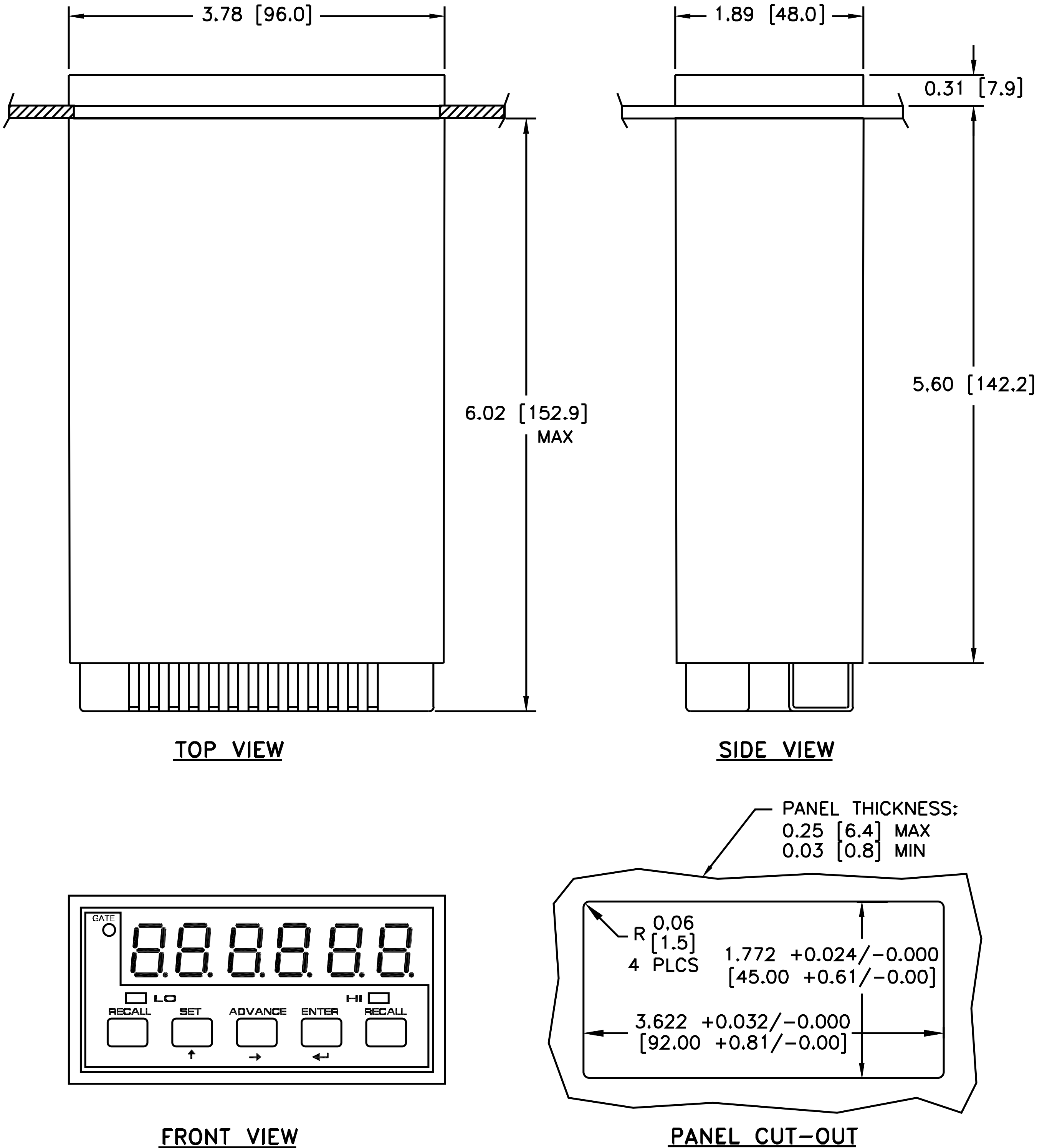


Figure 2-2 Case Dimension, Front View - “Classic Style”

2.3 ASSEMBLY AND MOUNTING

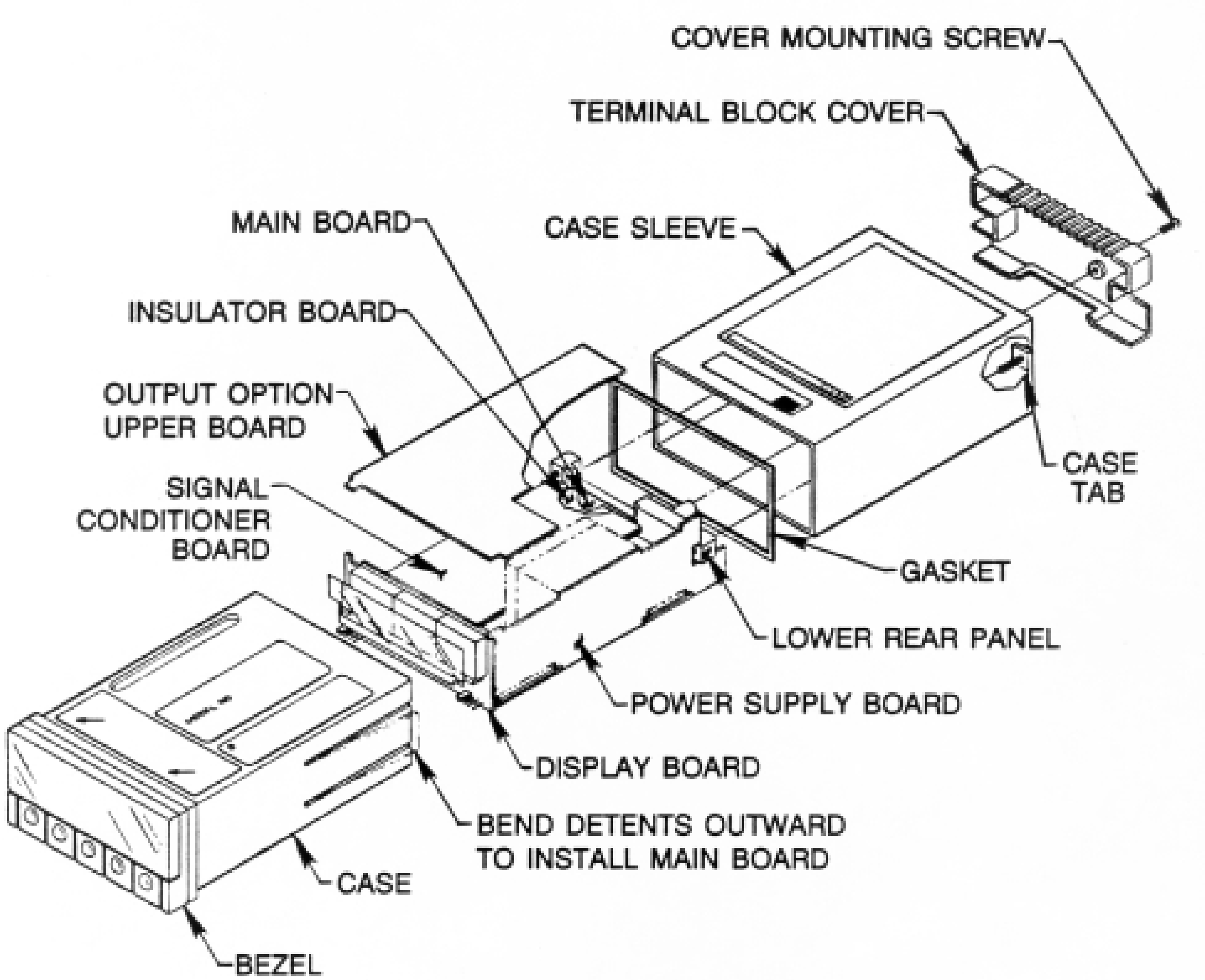


Figure 2-3 Exploded View - “Designer” Style

The “Designer” meter circuit boards are housed in a 4896 1/8-DIN plastic case and sleeve. The bezel, display lens and pushbuttons are NEMA-4 (waterproof) sealed to the case; the electronics assembly slides into the case from the rear when the flexible side panel detents are moved aside. Six front pins on the electronics assembly then mate with the connectors on the inside of the case.

To install a preconfigured meter:

NOTE: The main board, display board and power supply board are soldered together as a basic unit. Installation of input options (mezzazine board) and output options (upper board) is shown in the Input Options and the Output Options Manuals.

1. Use a phillips-head screwdriver to remove the three screws on the rear of the case.

2. Slide the case sleeve off the case.

3. Verify the panel cutout dimensions in Figure 2-4 Case Dimensions. For panel mounting, the entire edge of the panel cutout is sandwiched between the bezel (and gasket) in front and the sleeve in the rear. Install the two #8 screws to secure the sleeve to the case.

4. Connect all connectors and attach the terminal block cover with the #4 screw.

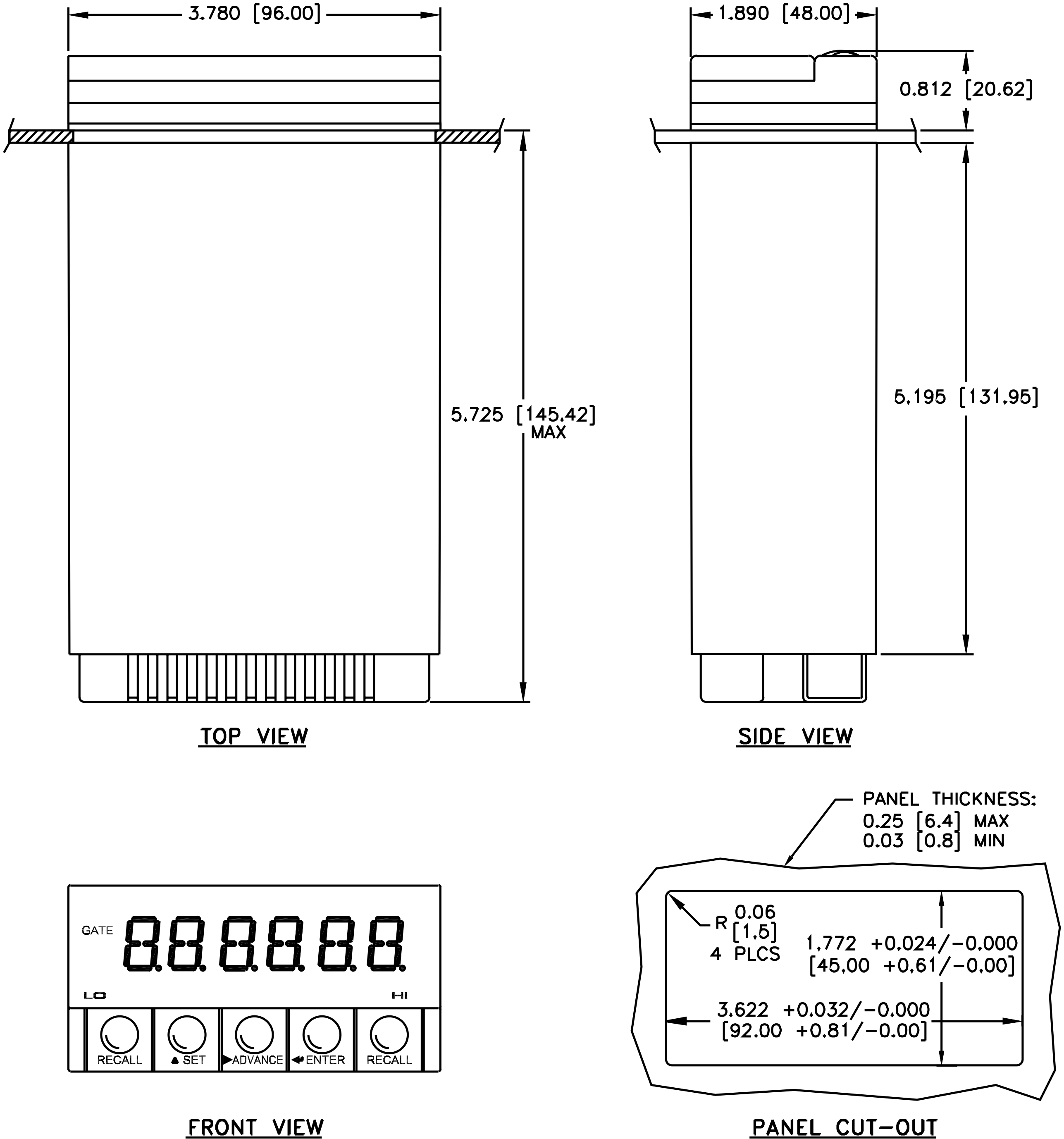


Figure 2-4 Case Dimensions, Front View - “Designer” Style

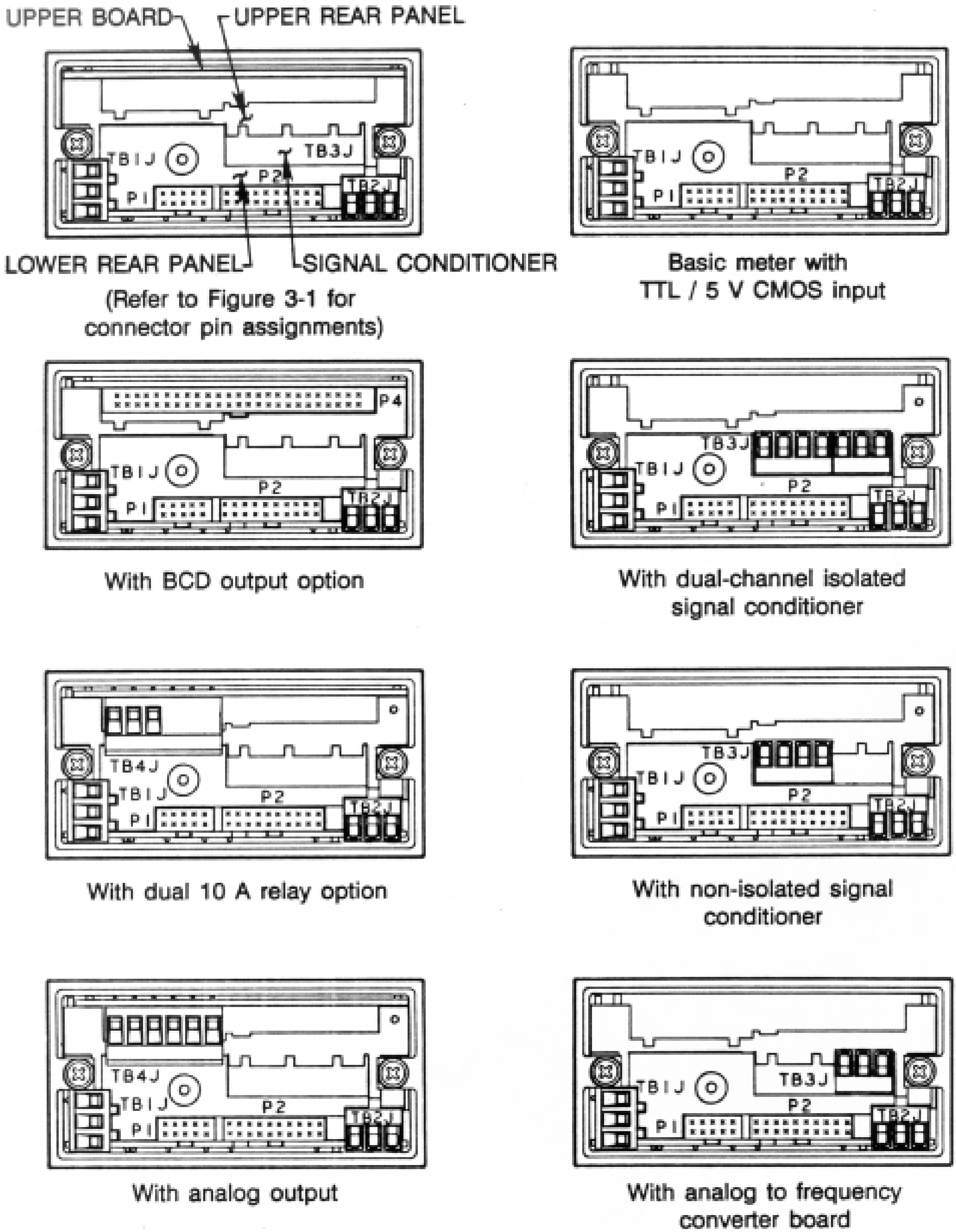


Figure 2-5 Rear Panel Views

3.0 POWER AND SIGNAL CONNECTIONS

3.1 TURNING IT ON

INCORRECT POWER INPUT CAN DAMAGE YOUR P6000A/P5000 COUNTER

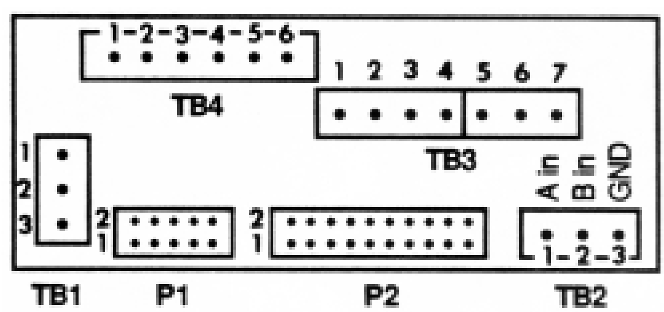
Connect the proper voltage to the power screw terminal (TB1). The meter will display the programmed function (default is FrEq) until it reads the input signal. Then that value will be shown.

<u>CONNECTOR DETAIL</u>

P2		P1	
1	SPARE FF D IN	1	N/C
2	SPARE FF RESET IN	2	N/C
3	SPARE FF Q OUT	3	RS-232 DATA OUT
4	SPARE FF Q OUT	4	RS-232 RTS IN
5	SPARE FF CLK IN	5	RS-232 DATA IN
6	GROUND	6	N/C
7	ALARM HI OUT	7	N/C
8	+5 V OUT	8	N/C
9	ALARM LO OUT	9	RS-232 GND
10	ALARM GO OUT	10	0-20mA ASCII OUT
11	V+ IN/OUT		
12	GROUND		
13	HOLD IN		N/C = No Internal Connection
14	BUFFER IN		
15	BUFFER OUT		
16	BLANK ENABLE IN*		
17	GROUND		
18	RESET IN		
19	EXT. GATE IN		
20	DIGIT 6 OUT (400 Hz)		

9.5 - 32 V DC POWERED	115 OR 230 V AC POWERED
NC	AC HI
+	AC LO
-	AC GND

With dual 10 A relays and dual-channel isolated pulse signal conditioner



*or LINE FREQ OUT
(USA=120 Hz, EURO=100 Hz

Figure 3-1 Rear Panel Pin Assignments

3.2 TESTING

To verify the default settings, connect a TTL-compatible signal source between pins 1 (SIG HI) and 3 (SIG GND) on the TB2 connector. For test purposes, the 400 Hz digit-drive output (connector P2-pin 20) can be connected to the signal input, TB2-pin 1. If digit output is connected to signal input, display reads 400.0 ± .1% Hz.

4.0 EASY PROGRAMMING WITH DISPLAY PROMPTS

Section 4 explains the front-panel programmable features (in bold), their display character, and how to modify the existing setup.

4.1 FEATURES

Frequency Measures the input frequency. Displays in Hz (Scale Factor = 1); can also display in kHz, RPM (for tachometer application), feet/sec, or other engineering units.

Period Measures the input period (inverse of frequency) and displays in milliseconds can also display in seconds, minutes, or other engineering units.

Time Interval Use for pulse width measurement, or for stopwatch applications where reset after each measurement is desired. Measures the time interval (or average time interval) between the rising or falling edges of two signals. Displays in milliseconds (Scale Factor = 1); can also display in seconds, minutes, or other engineering units.

Frequency Ratio b/A Used as an FB/FA frequency ratio meter with FB and FA up to 7 MHz. Ideal for monitoring the relative speed of shafts, conveyor belts and other moving machinery.

Totalize Use for cumulative totals, stopwatch applications, as an up-counting (positive scale factor) or down-counting (negative scale factor) totalizer.

Scale factor The input may be multiplied or divided by any desired scale factor from -9.9.9.9.9. to +9.9.9.9.9.9. with a decimal point selected in any position shown.

Offset After measuring the input(s), the meter multiplies or divides the result by the scale factor and then adds the offset. The offset value can range from -

99999

to 999999 *. Like SCALE, the decimal point is programmable.

Range The decimal point can be selected on any of the six positions F.F.F.F.F.F. or it can **(Display** be floating (Auto-range). It should be noted that when a fixed decimal point is **Decimal** selected, the meter maintains a meaningful unit of measurement in the **Point)** reading. For example, if input frequency is 10 Hz, function equals frequency, and fixed decimal point equals 3, the display reads 10.00, not .10.

* The offset is limited to +390000 in units manufactured prior to January 1988 if the scale facto is positive.

Slope Determines which edge of the input pulse begins the measurement. Frequency, Period and Totalize measure A Input; Time Interval and Frequency Ratio measure both A and B Inputs.

Setpoints -.9.9.9.9.9 to 9.9.9.9.9.9.

After applying the scale factor and offset, the displayed measurement is compared to the setpoint values.

A high or low alarm LED lights when the display falls outside of a setpoint. Three open-collector transistors with active-low alarm outputs correspond to the LO, GO and HI alarms.

LO ALARM: Displayed value < SETPOINT LO
HI ALARM: Displayed value > SETPOINT HI
GO ALARM: SETPOINT LO ≤ Displayed value ≤ SETPOINT HI

Example: Setpoint HI is 500.0 and Setpoint LO is -100.0

	LED Alarm Lights	
Reading	LO	HI
500.1	Off	On
500.0	Off	Off
10.5	Off	Off
-99.8	Off	Off
-100.2	On	Off

To convert Setpoint LO to a second high setpoint, set software switch 5 of Configuration 2 to a '1' (CnFG 2 = X1XXXX). LO ALARM becomes active when the reading is greater (more positive) than that setpoint. The GO alarm still becomes active when neither the LO nor the HI alarm is active.

Gate time Partially controls the reading rate; the Gate LED lights during gate time.

Configurations 1 and 2 These program internal software switches (SS# below) which specify display brightness, baud rate, zero blanking; activate external or interna gate inputs; modify alarm conditions.

Each display digit carries a software switch function in Configurations 1 and 2. The functions are modified using the front-panel pushbuttons.

Switch	CONFIGURATION 1	CONFIGURATION 2
SS1	1=Display leading zeros 0=Blank leading zeros	1=Display 50% brightness 0=Full brightness (if SS2 = 0)
SS2	1=1200 BAUD rate 0=9600 BAUD rate	1=Display 25% brightness 0=Full brightness (if SS1 = 0)
SS3	1=RTS handshake per character 0=RTS handshake per message	1=Transmit data to parallel BCD 0=Do not transmit data
SS4	1=Zero with No Input 0=Allow Low Frequency	1=Latch alarm outputs 0=Do not latch
SS5	1=Ext. gate input active low 0=Ext. gate input active high	1=Change low alarm to high alarm 0=Normal low alarm action
SS6	1=Disable internal gate time 0=Enable internal gate time	1=No units-of-measure displayed 0=Display units-of-measure

Calibration Factory standard locks out this feature. Recalibration requires simple jumper configuration and front panel pushbutton programming.

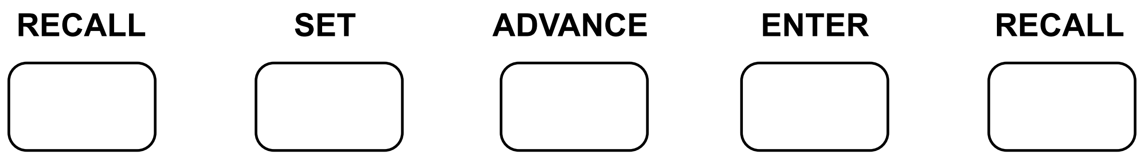
Store (save) The meter is microcomputer based and allows two memory modes:active and nonvolatile. Active memory consists of your latest programmed data. Once the data (and settings) is "stored", it becomes saved in nonvolatile memory and can be restored upon power up. At power loss or "recall", any data in active memory is lost (unless previously stored).

4.2 DISPLAY SYMBOLS AND DESCRIPTIONS

A .SC	Scale Factor is a MULTIPLIER. Display = (measurement · scale) + offset
A/SC	Scale Factor is a DIVIDER. Display = (measurement / scale) + offset
A nEG	A input trigger slope is NEGATIVE (counting negative edges)
A POS	A input trigger slope is POSITIVE (counting positive edges)
Auto	Auto-ranging is selected. The meter selects the decimal point.
b nEG	B input trigger slope is NEGATIVE (counting negative edges)
b POS	B input trigger slope is POSITIVE (counting positive edges)
CAL ib	CALIBRATION value, expressed in parts per million -99999 to 999999 ppm with six possible decimal point positions
CnFG 1	CONFIGURATION 1, set of six software switches, SS1 - SS6. Six digits on the display, each can be set to 0 or 1 to disable or enable a feature.
CnFG 2	CONFIGURATION 2, set of six software switches, SS1 - SS6. Six digits on the display, each can be set to 0 or 1 to disable or enable a feature.
F.FFFFF	FIXED RANGE, with selected decimal point flashing.
Fr b/A	Operating mode is Frequency Ratio B/A (B input is divided by the A input)
FrEq	Operating mode is Frequency (measures the A input frequency)
Func	Function. Used to select the operating mode.
GAtE t	Nominal GATE TIME, the averaging time that determines the display update rate. The value ranges from 00.00 to 99.99 seconds, with a fixed decimal point.
OFFSEt	OFFSET (Preset). Display = (Input x Scale) + Offset Ranges from -99999 to 999999 with a programmable decimal point.
PEr iod	Operating mode is Period.
rAnGE	Range can be set to autorange (with a floating decimal point) or have a fixed decimal point location.
SCALE	Scale factor. Ranges from -99999 to 999999 with a programmable decimal point. Multiply or divide.
SLOPE	Trigger SLOPE of the Input(s). Positive or negative slopes can be selected for A and B inputs, independently.
SP HI	High setpoint. Ranges from -99999 to 999999 with a programmable decimal point.
SP LO	Low setpoint. Ranges from -99999 to 999999 with a programmable decimal point.
ti Int	Operating mode is Time Interval, A to B.
totAL	Operating mode is Totalize.

4.3 PROGRAMMING PUSHBUTTONS

Your meter was programmed per the factory-default settings shown in Section 4.4 unless you ordered it factory-programmed for your requirements. To change this setup, programming from the front panel is made simple by use of pushbuttons.



Push in this order:

ENTER -	scrolls through the main menu selection
ADVANCE -	scrolls through the sub-menu selection and the digital position on the display
SET -	modifies functions or settings
ENTER -	enters the modification into active memory

<u>ENTER</u>

After entering a change, the meter automatically displays the next menu title. The main menu titles appear in this order: Func, SCALE, OFFSEt, rAnGE, SLOPE, SP LO, SP HI, GAtE t (not in Totalize), CnFG 1, CnFG 2, CALIb (may be locked out), noStor. One or more of the main menu titles may be skipped, if locked out (bypassed) by jumper installation on pin groups S7 and S8.

<u>ADVANCE</u>

After a menu title has been selected (using ENTER), push ADVANCE to take the program into the sub-menu for that item. For instance, push ADVANCE after SP HI is displayed to show the setpoint number. Push ADVANCE repeatedly to change a flashing location, which indicates the position or function that will change (a digit or decimal point in this example). The actual modification is made with the SET button, and the modification is entered into memory using ENTER . The display then shows the next main menu item (GAtE t in this example).

Push ADVANCE after Func is displayed to show the current active function: FrEq, PEriod, Ti Int, Fr b/A or totAl. This function will show up flashing, indicating that it can be modified with the SET button.

<u>SET</u>

Once a selection is made, push SET to modify the function or number which is flashing. Push ENTER to enter the modification into the active memory. (This is not stored.)

RECALL — Pushed simultaneously, the two RECALL buttons reset the meter. The last program stored (saved) is read into active memory and will be displayed. As in a power loss, data not stored is lost.

Push $\boxed{\text{SET}}$ $\boxed{\text{ADVANCE}}$ $\boxed{\text{ENTER}}$ simultaneously to reset the counter and start a measurement using the latest settings (in active memory).

4.4 FACTORY-DEFAULT SETTINGS

Programmable Features

Operating Mode (Function)	Frequency
Setpoints	Hi = 100000. Lo = 0.00000
Scale	Multiply by 1.00000
Offset	000000.
Range	Fixed decimal point, FFFFFF.
Trigger slope	A and B Positive
Nominal gate time	0.3 second (00.30)
Configuration 1	000000
Configuration 2	000001
Calibration	as appropriate (lock-out jumper installed)

Jumpers Installed

Display board: S7-B, S8-A	Locks out calibration feature
Main board: SA-M, SB-M	DC-100 kHz frequency response; -20 to +25 volts maximum input

4.5 PROGRAMMING AND APPLICATION EXAMPLES

The pushbuttons scroll through the menu items repeatedly, making corrections or changes simple. If a setting is correct, just press ENTER.

FREQUENCY MEASUREMENT

A sensor generates one pulse for every revolution of a shaft. To measure the input frequency and display in RPM (instead of Hz), set SCALE FACTOR to 60.

Features used:		
	Function -	set to Frequency mode
	Scale -	use "multiply by" and 60.0000
	Range -	autorange or fixed decimal point location, depends on application
	Store -	optional, stores in nonvolatile memory

Flashing indicates the position or function that will change.

PUSH	DISPLAY SHOWS	NOTES
ENTER	Func	
SET	FrEq	Press until flashing FrEq is displayed.
ENTER	SCALE	
SET	A.SC or A/SC	A.SC (multiply by), A/SC (divide by) A.SC <--- SET ---> A/SC
ADVANCE	1.00000 ---> 1.00000	Scrolls the position you can set. Applies to digits and decimal point.
SET	1.00000 ---> 6.00000 6.00000 ---> 60.0000	ADVANCE to the digit or decimal-point position you wish to change, then press SET until the desired value or decimal-point location is reached.
ENTER	OFFSEt	
ADVANCE	000000	Verify it is set to 000000. If the offset is other than 000000, change as previously done in Scaling, using SET and ADVANCE.
ENTER	rAnGE	Can be set to Auto-range (floating decimal point) or to use a fixed decimal point.
ADVANCE	FFFFFF	Auto <--- ADVANCE ---> F.FFFFF To change the decimal-point location, press SET to scroll to the desired location.

ENTER	SLOPE	Sub-menus are A pos or A neg. A POS <--- SET ---> A nEG Either one may be used with frequency applications.
ENTER	SP LO	Using ADVANCE and SET, you may enter a low setpoint.
ENTER	SP HI	Using ADVANCE and SET, you may enter a high setpoint.
ENTER	GAtE t	Select from 00.00 to 99.99 seconds using ADVANCE and SET.
ENTER	CnFG 1	Controls software switches for leading zeros, baud rate, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection. Use ADVANCE and SET buttons to change.
ENTER	CnFG 2	Controls software switches for display brightness, alarm outputs, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection.
ENTER	ndStor	CAUTION: The settings are in active (VOLATILE) memory for use until power is disconnected or new settings are entered. DO NOT PRESS ENTER IF YOU WISH TO SAVE THE NEW SETUP.
SET	StorE	Once the data is "Stored" in nonvolatile memory, these settings will restore at power-on or when both RECALL buttons are pushed simultaneously.
ENTER		

BEGIN MEASUREMENT - To reset the counter and start a measurement, simultaneously press SET ADVANCE ENTER. NOTE: If a signal is connected to the input, a frequency reading in RPM replaces this display.

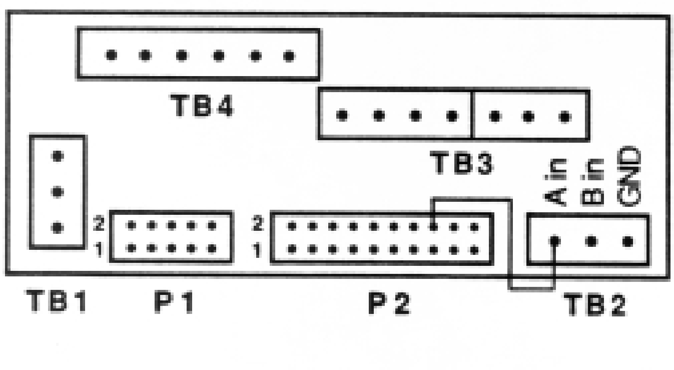
Scale Factor Formula: If more than one pulse per revolution, use this formula to determine scale factor.

$$\text{SCALE = Multiply by } \frac{60}{n}$$

Example: 10 pulses per revolution => SCALE = X 6

LINE FREQUENCY MEASUREMENT

To monitor line frequency with 4-digit resolution, such as 60.00, connect the line frequency output to the A input. (Connect P2-pin 16 to TB2-pin 1.)



P2

SPARE FF D IN	1	2	SPARE FF RESET IN
SPARE FF Q OUT	3	4	SPARE FF Q OUT
SPARE FF CLK IN	5	6	GND
ALARM HI OUT	7	8	+5 V OUT
ALARM LO OUT	9	10	ALARM GO OUT
V+ IN/OUT	11	12	GND
HOLD IN	13	14	BUF IN
BUF OUT	15	16	BLANK ENABLE IN *
GND	17	18	RESET IN
EXT. GATE IN	19	20	DIGIT 6 TEST OUT

* or LINE FREQUENCY OUT
(USA = 120 Hz, EUROPE = 100 Hz)

Features used:

- Function - set to Frequency mode
- Scale - use "divide by" and 2
- Offset - set to 000000
- Range - use FFFF.FF decimal-point setting
- Store - optional, stores in nonvolatile memory

Flashing indicates the position or function that will change.

PUSH	DISPLAY SHOWS	NOTES
ENTER	Func	
SET	FrEq	Press SET until flashing FrEq is displayed.
ENTER	SCALE	
SET	A.SC or A/SC	A.SC (multiply by), A/SC (divide by) A.SC <--- SET ---> A/SC
ADVANCE	1.00000 ----> 1.00000	Scrolls the position you can set. Applies to digits and decimal point.
SET		ADVANCE to the digit you wish to change, then press SET until the desired value or decimal-point location is reached.
ENTER	OFFSEt	

ADVANCE	000000	If the offset is other than 000000, change as previously done in Scaling, using SET and ADVANCE.
ENTER	rAnGE	Can be set to Auto-range (floating decimal point) or to use a fixed decimal point.
ADVANCE	FFFFFF	Press ADVANCE to change Auto-range to fixed decimal point, then press SET to scroll the decimal point to FFFF.FF.
ENTER	SLOPE	Sub-menus are A pos or A neg. A POS <--- SET ---> A nEG Either one may be used with frequency applications.
ENTER	SP LO	Using ADVANCE and SET, you may enter a low setpoint.
ENTER	SP HI	Using ADVANCE and SET, you may enter a high setpoint.
ENTER	GAtE t	Select from 00.00 to 99.99 seconds using ADVANCE and SET as in Scaling.
ENTER	CnFG 1	Controls software switches for leading zeros, baud rate, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection. Use ADVANCE and SET buttons to change.
ENTER	CnFG 2	Controls software switches for display brightness, alarm outputs, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection.
ENTER	ndStor	CAUTION: The settings are in active (VOLATILE) memory for use until power is disconnected or new settings are entered. DO NOT PRESS ENTER IF YOU WISH TO SAVE THE NEW SETUP.
SET	StorE	Once the data is "Stored" in nonvolatile memory, these settings will restore at power-on or when both RECALL buttons are pushed simultaneously.
ENTER		

BEGIN MEASUREMENT - To reset the counter and start a measurement, simultaneously press SET ADVANCE ENTER . NOTE: If a signal is connected to the input, a frequency reading in RPM replaces this display.

TOTALIZE

To use the meter as a totalizer permanently, the function should be set to totAL and his change should be stored in nonvolatile memory to restore at power-on. For down counting, use a negative scale factor and a positive offset. In case of power failure, the meter blanks the display and stores the latest reading in nonvolatile memory.

Example: Use Totalize to count parts per container.
Six parts per one container would be as follows.

Features used:		
	Function -	set to Totalize mode
	Scale -	use "divide by" and scale factor of "6"
	Store -	optional, saves setup in nonvolatile memory

Flashing indicates the position or function that will change.

PUSH	DISPLAY SHOWS	NOTES
ENTER	Func	
SET	totAL	Press until flashing totAL is displayed.
ENTER	SCALE	
SET	A.SC or A/SC	A.SC (multiply by), A/SC (divide by) A.SC <--- SET ---> A/SC
ADVANCE	1.00000 ---> 1.00000	Scrolls the position you can set. Applies to digits and decimal-point location.
SET		ADVANCE to the digit you wish to change, the left-most position for this example, then press SET until the desired value (6) or decimal- point location is reached.
ENTER	OFFSEt	Use SET and ADVANCE features to set the offset. Set it to any value that you want to start counting; 000000. in this case.
ENTER	rAnGE	
ADVANCE	FFFFFF	Auto <--- ADVANCE ---> F.FFFFF SET scrolls through the decimal- point locations.

SET	FFFFFF.x	Push SET until decimal point is at the desired fixed location.
ENTER	SLOPE	Sub-menus are A pos or A neg. A POS <--- SET ---> A nEG Either one may be used with frequency applications.
ENTER	SP LO	Using ADVANCE and SET, you may enter a low setpoint.
ENTER	SP HI	Using ADVANCE and SET, you may enter a high setpoint.
ENTER	CnFG 1	Controls software switches for leading zeros, baud rate, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection. Use ADVANCE and SET buttons to change.
ENTER	CnFG 2	Controls software switches for display brightness, alarm outputs, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection.
ENTER	noStor	CAUTION: The settings are in active (VOLATILE) memory for use until power is disconnected or new settings are entered. DO NOT PRESS ENTER IF YOU WISH TO SAVE THE NEW SETUP.
SET	StorE	Once the data is "Stored" in nonvolatile memory, these settings will restore at power-on or when both RECALL buttons are pushed simultaneously.
ENTER		

BEGIN MEASUREMENT - To reset the counter and start a measurement, simultaneously press SET ADVANCE ENTER.

STOPWATCH IN TOTALIZE

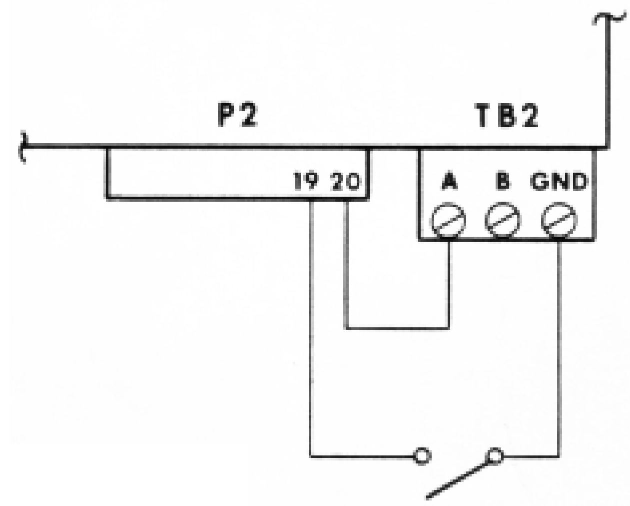
Stopwatch applications can be used in Totalize or Time-Interval mode. For cumulative time, use Totalize. (If the result should be reset after each measurement, use Time Interval.)

Connect as shown below. This shows use of the 400 Hz output at P2-pin 20 and the external gate pin 19.

P2

SPARE FF D IN	1	2	SPARE FF RESET IN
SPARE FF Q OUT	3	4	SPARE FF $\overline{Q}$ OUT
SPARE FF CLK IN	5	6	GND
ALARM HI OUT	7	8	+5 V OUT
ALARM LO OUT	9	10	ALARM GO OUT
V+ IN/OUT	11	12	GND
HOLD IN	13	14	BUF IN
BUF OUT	15	16	BLANK ENABLE IN *
GND	17	18	RESET IN
EXT. GATE IN	19	20	DIGIT 6 TEST OUT

* or LINE FREQUENCY OUT
(USA = 120 Hz, EUROPE = 100 Hz)



Features used:

Features used:	Function -	set to Totalize mode
	Scale -	use "divide by" and "400" to read in seconds
	Range -	use FFFFF.F for tenth of a second resolution
	Store -	optional, stores setup in nonvolatile memory. In case of AC power loss, the meter blanks the display and stores the latest reading in nonvolatile memory.

Flashing indicates the position or function that will change.

PUSH	DISPLAY SHOWS	NOTES
ENTER	Func	
SET	totAL	Press until flashing totAL is displayed.
ENTER	SCALE	
SET	A/SC	A.SC (multiply by), A/SC (divide by) A.SC <--- SET ---> A/SC
ADVANCE	1.00000 ---> 1.00000	Scrolls the position you can set. Applies to digits and decimal point.

SET	4.00000 ---> 400.000	ADVANCE to the digit you wish to change, then press SET until the desired value or decimal-point location is reached.
ENTER	OFFSEt	Use SET and ADVANCE features as above to verify offset is 000000.
ENTER	rAnGE	
ADVANCE	F.FFFFF	Auto <--- ADVANCE ---> F.FFFFF
SET	FFFFF.F	SET scrolls through the decimal- point locations. Press SET until the decimal point is here FFFFF.F
ENTER	SLOPE	Sub-menus are A pos or A neg.
	A POS <--- SET ---> A nEG	
ENTER	SP LO	Using ADVANCE and SET, you may enter a low setpoint.
ENTER	SP HI	Using ADVANCE and SET, you may enter a high setpoint.
ENTER	CnFG 1	Controls software switches for leading zeros, baud rate, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection. Use ADVANCE and SET buttons to change.
ENTER	CnFG 2	Controls software switches for display brightness, alarm outputs, etc. Refer to Configuration charts in Section 4.1 FEATURES for selection.
ENTER	noStor	CAUTION: The settings are in active (VOLATILE) memory for use until power is disconnected or new settings are entered. DO NOT PRESS ENTER IF YOU WISH TO SAVE THE NEW SETUP.
SET	StorE	Once the data is "Stored" in nonvolatile memory, these settings will restore at power-on or when both RECALL buttons are pushed simultaneously.
ENTER		

BEGIN MEASUREMENT - To reset the counter and start a measurement, simultaneously press SET ADVANCE ENTER.

A.1 LOCKOUT FEATURES

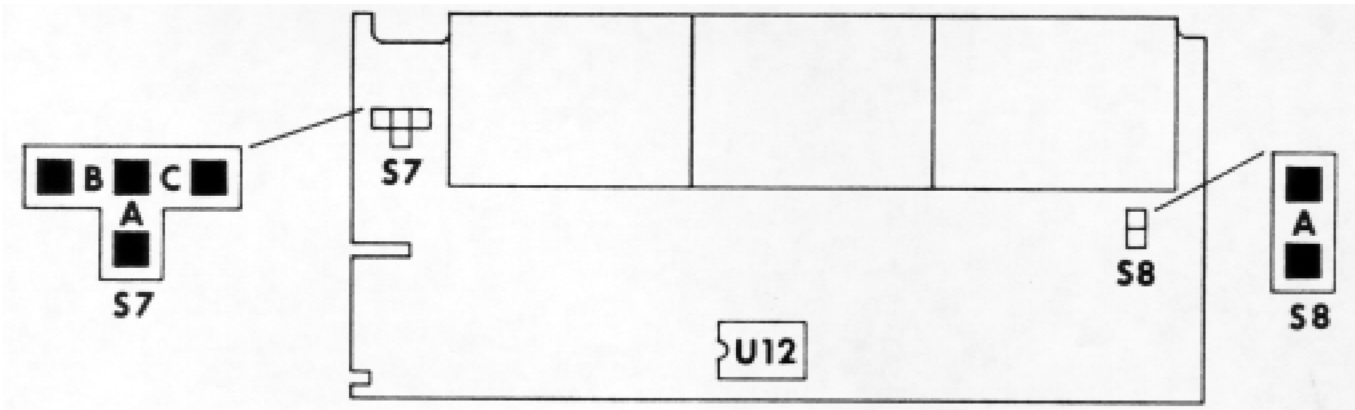


Figure A-1 Display Board Jumper Locations

Function Locked Out	Install Jumper	Remove Jumper	Notation
No Lock-out	S7-C, S8-A	-	
Calibration	S7-B, S8-A	-	Standard
Calibration	S7-A, S8-A	-	
All items except setpoints	S8-A	S7-A, B,C	
Disable front-panel buttons	-	S8-A	S7 not affected

* Save in nonvolatile memory

A.2 FREQUENCY RESPONSE

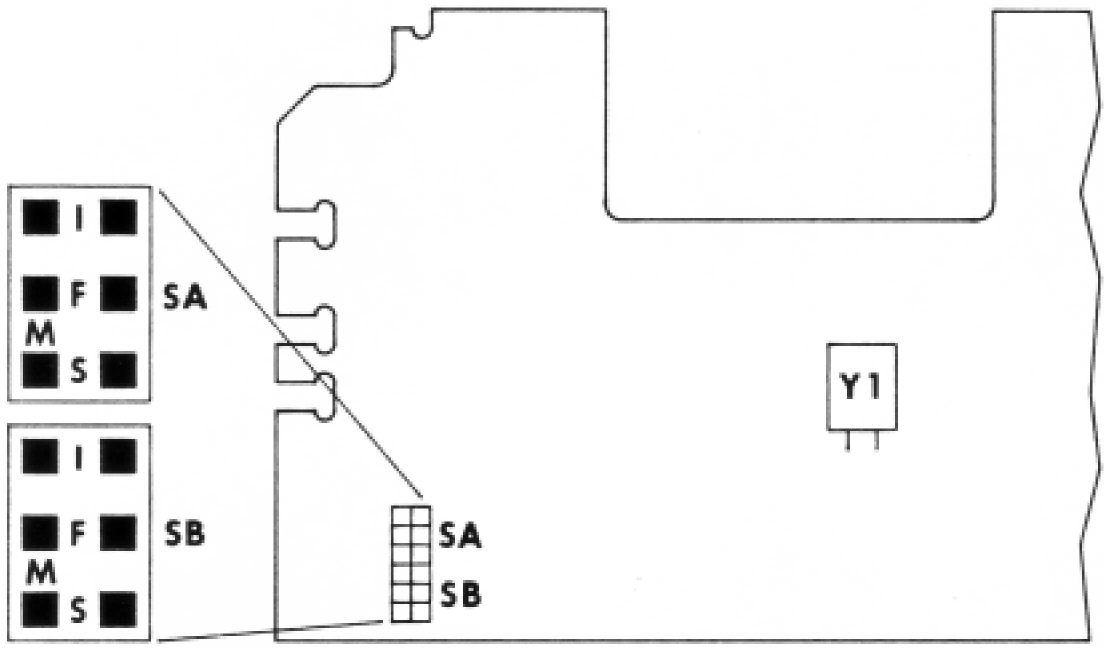


Figure A-2 Main Board Jumper Locations

Frequency	Maximum Input	Install Jumper
DC-7 MH (min)	-.5 to +5.5 V	SA-F, SB-F
DC-100 kHz (typ)	-20 to +25 V	SA-M, SB-M (standard)
DC-3 kHz (typ)	-20 to +25 V	SA-S, SB-S

For maximum noise rejection, select the lowest frequency response position that is compatible with your input frequency.

NOTE: Jumpers installed on SA-I and SB-I connect the signal conditioner output.

All of the control I/O lines are located on P2, a 20-pin dual row header at the rear of the counter. A 20-position mating mass-termination connector is an option (D20D). Alternatively, a 34-pin mass-termination connector (industry standard) can be used to access both the I/O and RS-232 lines.

RESET INPUT

This is a TTL/CMOS-compatible, low-true input with a 10 k Ohm pull-up resistor. A low level of 2.2 milliseconds or more on this input resets the counter. If the function is Totalize, the offset is displayed and the alarm outputs are updated according to the offset value. In other functions, zero is displayed and the alarm outputs are reset regardless of the setpoint values. All alarm outputs remain in the reset condition until the first measurement is completed. Table B-1 shows the effect of a reset pulse on the meter outputs. The meter can also be reset by pushing the three center front-panel buttons simultaneously.

OUTPUT	FREQUENCY, PERIOD TIME INTERVAL, FREQ B/A	TOTALIZE
Display	Zero	Offset
Hi, LO, and GO alarms	Reset (to high level)	Updated according to the offset value
RS-232	No data is transmitted	Offset is transmitted
Parallel BCD (Options)	Updated according to the display and alarm outputs	

Table B-1 Output Effect Immediately After $\overline{\text{RESET}}$

HOLD INPUT

Except in Totalize function, the P6000A does not start a measurement when the $\overline{\text{HOLD}}$ input is low ($\overline{\text{HOLD}}$ is true). A high level ($\overline{\text{HOLD}}$ false) of 0.1 millisecond minimum at this time starts and completes a measurement.

In Totalize, the display is frozen and no ASCII data is transmitted when $\overline{\text{HOLD}}$ remains low for a full reading cycle. If the $\overline{\text{HOLD}}$ input goes high for 0.5 millisecond anytime during the reading cycle, the display is updated and ASCII data is transmitted. The parallel BCD data is updated regardless of the $\overline{\text{HOLD}}$ input.

EXTERNAL GATE INPUT

This is a TTL/CMOS-compatible input with a 20 kOhm pull-up resistor. The polarity used is normally positive (high true), but negative polarity can be selected by setting SS5 of Configuration 1 (CnFG 1 = X1XXXX). When the meter function is Totalize, the A input pulses can be gated with a signal on the External Gate input. Unlike conventional counters, this gating does not introduce any error.

When the meter function is Frequency, Period, or Frequency Ratio, an external gate time signal can be connected to this input instead of using the internal gate time. In this case, SS6 of Configuration 1 should be set to disable the internal gate time (CnFG 1 = 1XXXXX). The maximum allowed Gate Time in Frequency Ratio is 80 seconds. There is no maximum limitation in Frequency or Period. Burst frequency measurement is possible, using an external gate signal without disabling the internal gate time.

BLANK ENABLE INPUT/LINE FREQUENCY OUTPUT

The output is normally at high level with a 7.5 kOhm pull-up resistor. When the 50/60 Hz AC power is present, two low-level pulses (about 3 milliseconds) appear on this output for each AC power cycle. The signal can be tied to the A input for line frequency measurement (scale factor = 0.5, multiplier).

This pin can also be used as an input. When tied to ground, it prevents display blanking in case of an interruption in AC power. Connection of this input to a TTL or high speed CMOS (HC Series) is not recommended since, in the presence of the AC power, it is pulled down with a 301-ohm resistor twice per cycle.

TEST OUTPUT - DIGIT 6

This is a TTL/CMOS compatible signal. The frequency of this signal is 400.0 Hz $\pm$.1% with 1/6 duty cycle. This output can drive 5 LSTTL loads.

NOTE: This is a display multiplex signal and must not be pulled down with a load of more than .2 mA.

SPARE INVERTOR AND FLIP-FLOP

A TTL/CMOS compatible Schmitt trigger and a spare 'D' type flip-flop are provided on P2.

The inputs (clock, clear, and D) are CMOS compatible (HI level > 3.5 V, LO level < .9 V). However, a 20 k pull-up resistor is provided on clear and D inputs to make them TTL at low frequencies. This flip-flop can be configured to divide the clock frequency by two (connect Q output to the D input), thus increasing the meter maximum operating frequency to 14 MHz.

ALARM LOW, HIGH, AND GO

These are open-collector outputs corresponding to LOW and HIGH setpoints (see Section 4.1, Setpoints). Each output, if the alarm condition is active, can sink 150 mA. When the alarm condition is inactive, an output can withstand 30 V.

5.0 PROGRAMMING

5.1 GENERAL INFORMATION

The meter may be programmed using the three center pushbuttons (SET, ADVANCE and ENTER) or by a personal computer through RS-232 port (connector A).

This instrument is designed to present a “serial menu” when “ENTER” pushbutton is pushed. Pushing the appropriate button rolls the display through the meter functions, parameter names and digits, repeating (for corrections) as often as desired.

This programming results in the active program by which the meter makes its measurements. At the end of the programming sequence, the choice of ‘StorE/noStor’ is provided to allow this active program to be preserved in the nonvolatile memory or to be used temporarily, keeping a different program for later use in the nonvolatile memory. The stored program can become the active program (discarding the one currently in operation) by simultaneously pushing both RECALL buttons.

For security purposes, programming with front panel pushbuttons can be partially or completely disabled by S7 and S8, the two lock-out jumpers on the display board, as described in Table 5-1 below.

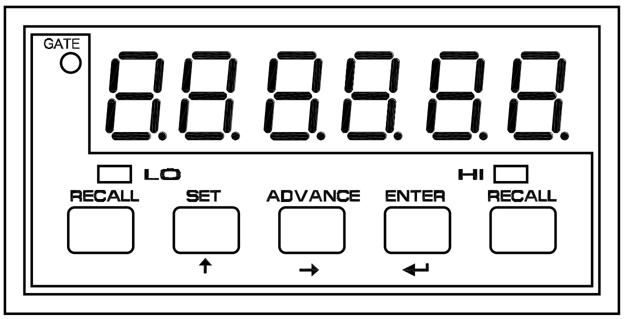
S7 POSITION	S8 POSITION	MENU ITEMS LOCKED-OUT
C	A	All menu items available, no lock-out.
B	A	CALIB (Calibration Value) locked-out.
A	A	CALIB and STORE (Storing the program in the non volatile memory) locked-out.
Removed	A	All menu items locked out except SP HI (Setpoint High) and SP LO (Setpoint Low). In these positions, and ENTER stores any new value in both active and nonvolatile memory.
Don’t Care	Removed	The programming pushbuttons are completely disabled.

Table 5-1 Lock-Out Jumpers

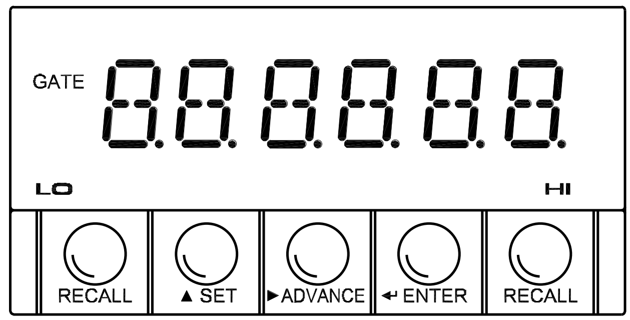
5.2 SELECTING THE FUNCTION TO BE PERFORMED

Apply power to the meter and the meter will briefly display the chosen function stored in the nonvolatile memory, which becomes the active program upon power-up.

The counter now switches to Measurement mode (in about one second) if there are signa pulses. To review or alter the programming, push ENTER. This will now display 'Func' instead of measurements. Repeated SET commands now roll the display through 'FrEq', 'PEriod', 'ti Int' (for time interval), 'Fr b/A' (Frequency Ratio B input divided by A input), and 'totAL' (for totalizing, e.g., counting). The desired one of these is selected by pushing ENTER when it is displayed, moving you to scale factor selection.



Front View - Classic



Front View - Designer

If the function was already correct, you can move directly to scale factor with an ENTER when 'Func' is displayed.

5.3 MULTIPLY OR DIVIDE BY A SCALE FACTOR

The input rate may be multiplied or divided by any desired scale factor from -.9.9.9.9.9. to +9.9.9.9.9.9. with a decimal point selected in any position shown.

When 'SCALE' is displayed, pushing ADVANCE moves the display to either 'A.SC' or 'A/SC', depending on which was in the program. To switch to the opposite, use SET, but do <u>not</u> yet push ENTER if you also wish to change the scale-factor numerical value or decimal location. (If pushed in error, the menu can be rolled around to SCALE again by 11 ENTERs).

Another ADVANCE moves the value of scale factor onto the display, with the Most-Significant-Digit flashing (#6, on the left). If you wish to keep the scale factor as is, push ENTER, and go to 'OFFSET'. To change the MSD, push SET repeatedly until the desired numeral is displayed. Push ADVANCE to move to the next-most-significant digit.

Having altered or accepted all six digits of the scale factor, one more ADVANCE allows you to reposition the decimal point, rolling it around with repeated SETs. When the decimal is correct, ENTER keeps the value and the multiply or divide operator.

5.4 SELECTING AN OFFSET

The meter allows the scaled measurement value to be offset by any number from -99999 to +999999 with the decimal point in any position. Pushing ADVANCE when OFFSEt is displayed moves the display to the offset value, which can be altered with the SET and ADVANCE pushbuttons just like the scale factor discussed above. When the offset value is correct, or to accept the value shown, push ENTER; this moves the display to rAnGE.

5.5 CHOOSING AUTO-RANGING OR FIXED DISPLAY DECIMAL-POINT LOCATION

When rAnGE is shown, ADVANCE displays the active-program choice, which will be either Auto or six F’s with a flashing decimal point. The flashing denotes the location of the fixed decimal point. The default position is FFFFFF. (d.p. = 1).

5.6 SELECTING RISING OR FALLING EDGE TRIGGERS FOR A AND B INPUTS

When SLOPE is displayed:

Push ADVANCE to display the current active program, which is A POS or A nEG. Another ADVANCE will display the B input, B POS or B nEG. Push SET to change from positive to negative or vice versa.

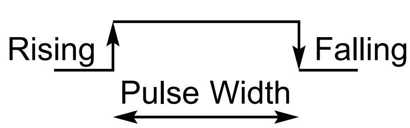
ADVANCE	SET
A POS ⟷ b POS	A POS ⟷ A nEG

> NOTE: B input is not used with Frequency, Period or Totalize functions; therefore, ADVANCE has no effect.

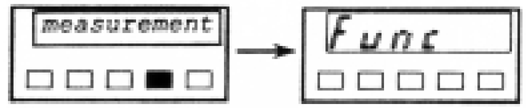
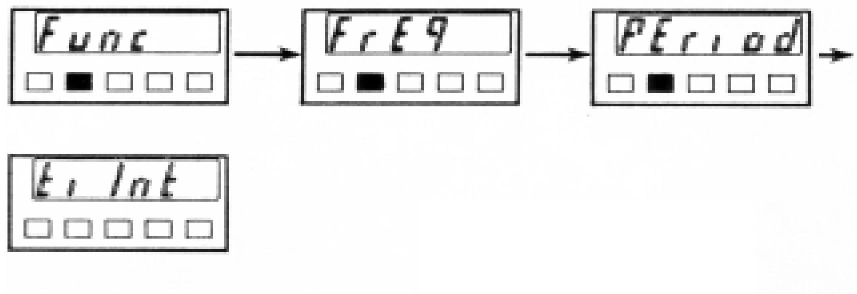
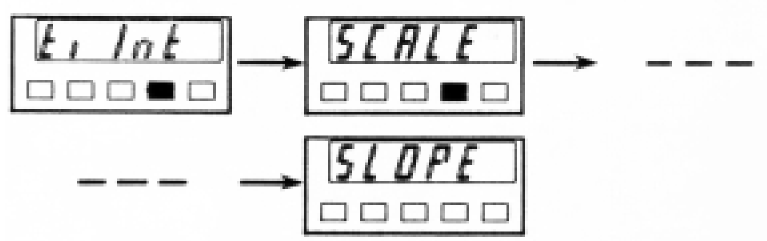
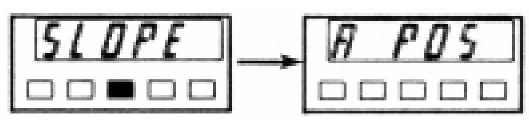
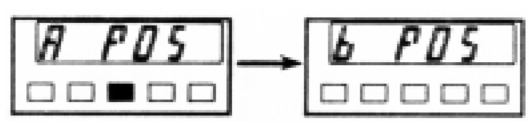
ENTER now displays setpoint selection.

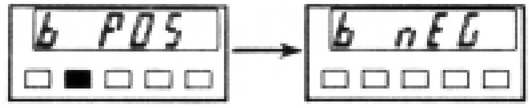
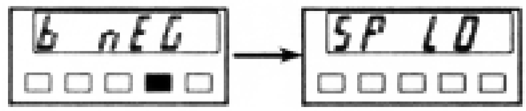
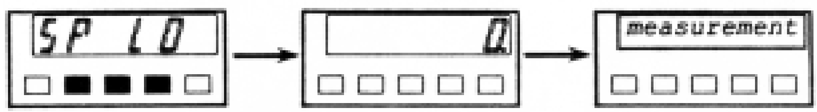
<u>Example 1</u>:

For a pulse width measurement, the time interval function (ti Int) should be chosen.



The positive and negative trigger slopes should be set for the A and B inputs, respectively.

DO THIS	DISPLAY SHOWS
Push ENTER once.	
Push SET three times to set the function to Time Interval.	
Push ENTER four times to select the slope.	
Push ADVANCE once to display the current setting of A input slope; can be changed with SET.	
Push ADVANCE again for B input slope.	

DO THIS	DISPLAY SHOWS
Push SET once for negative slope.	
Push ENTER once.	
Push the three center pushbuttons simultaneously. (Be careful <u>not</u> to push SET first).	

> NOTE: The changes are not stored in nonvolatile memory and will be lost when the power is turned off.

5.7 SETTING LOWER AND UPPER ALARM (or CONTROL) VALUES

SP LO is first displayed, and an ADVANCE will show its current value; this can be altered like the scale factor (or offset) by use of ADVANCE and SET.

When correct, ENTER displays SP HI , and the value-changing routine is repeated. Another ENTER moves you to gate-time selection.

High and low alarm outputs can be latched by setting the software switch SS4 of Configuration 2 (XX1XXX). In this case the alarm output remains activated until a reset.

> NOTE: Alarm outputs become active when display value exceeds the setpoint at least one count. For precise setting, use the full meter resolution (e.g., 399.000 rather than 000399).

5.8 SELECTING A GATE TIME

The measurement gate time is equal to this selection, from 00.00 to 99.99 seconds, plus a small time allowance for computation/communication. (There is no gate time for totalizing, so this choice is not displayed.)

When 'GAtE t' is displayed, ADVANCE shows the current value (00.30 is the default); it may be altered with ADVANCE and SET (in 0.01 second increments). ENTER places that chosen value in the active program.

5.9 CONFIGURATION #1 AND #2

The last ENTER moves 'CnFG 1' onto the display. Here, each digit represents a software switch (SSW) and any or all of them may be reset. Alternate '1' and '0' are displayed with SET, and ADVANCE selects the next right-hand digit, rolling around to the MSD after the LSD (right- most digit).

After setting the six software switches of the CnFG 1, an ENTER command moves the display onto CnFG 2. Again, any or all of the software switches of CnFG 2 may be set to '1' or '0' to enable or disable a feature.

The functions of these six software switches are described in Section 4.1 .

5.10 CALIBRATION OF THE CRYSTAL FREQUENCY (CALIb displayed)

This six-digit value is the ppm (parts-per-million) fine tuning of the crystal, and it is examined/altered by ADVANCE/SET just as the other values discussed above. The default setup locks out this item from the main menu (not displayed). To view or change the calibration value, install jumpers on S7-C and S8 of the display board. To calibrate the meter:

1. Set the function to Frequency, the Gate Time to 01.00 second and the calibration value to zero. Other setup parameters should be the same as the default setup (Section 4.4).

2. Connect a TTL-compatible calibration source frequency to the A input. SA jumper should be on the F position.

3. Note the displayed value and calculate the calibration value as follows:

$$\text{CALib} = 1{,}000{,}000 \times \left(\frac{\text{F input freq}}{\text{Display}} - 1\right)$$

4. Enter the calculated CALib and store it in the nonvolatile memory as described in the following Section.

Another ENTER command moves the display to the last step, 'noStor'.

5.11 REPLACING THE STORED PROGRAM WITH THE ACTIVE PROGRAM

At this point, a complete active program has been defined. To use it and begin measurements, push ENTER in response to noStor. This active program may be quite different from that stored in the nonvolatile memory. It will be discarded if power is interrupted or if RECALL is used.

This active program may also replace the stored program so that it is automatically restored upon power interruption. Push SET and ‘StorE’ will be displayed. Now an ENTER writes the active program into the storage and starts measurements. The previously stored program is discarded.

S7 on A position prevents storing the program in nonvolatile memory.

6.0 REMOTE PROGRAMMING

6.1 GENERAL INFORMATION

The meter contains a full-duplex RS-232 port for communications. It receives setup commands and data and sends measurement values and current setup data. It operates a either 1200 or 9600 baud, 7 data bits, even parity and 1 stop bit. It emulates DCE (data communication equipment) and uses a handshake line while sending data, but none while receiving data. A four-wire cable is the maximum required for communications:

Transmitted data
Received data
Request to send
Signal ground

When connected to a computer, such as an IBM PC, and one of four commands (Put, Get, Write or Read) is received, the meter interrupts its program, receives the message, takes appropriate action, and then starts over with a new measurement. No handshake is required because the meter devotes its full attention to receiving the command data from the computer.

In the other direction, the meter sends measurement and confirming setup data to the computer under handshake (RTS) control. When the computer RTS output is true, data is sent by the meter. When it is false, data is not sent. There are two modes of handshaking when sending measurement data, message and character. In the Message Handshake mode, the meter checks the RTS input from the computer when it is ready to send measurement data. If the RTS is true, it sends the complete message data; if it is false, it skips sending the data completely and continues with the next measurement. In the Character Handshake mode, the program checks the RTS input before sending each character and does not continue with the next measurement until the current measurement has been completely sent.

6.2 ASCII OUTPUT

The meter sends measurement data according to the following fixed formats of 12 characters (CnFG 2 SSW #6=0) or 9 characters (CnFG 2 SSW #6=1). Each character is sent as a 7-bit ASCII code character with even parity, and can be blank (ASCII 32) or as shown below:

12-Character message SSW #6=0 of CnFG 2

CHAR#	1	2	3	4	5	6	7	8	9	10	11	12
	H B or L	0 to 9, . (period), (space), or -M S								H	Z	(CR)

9-Character message SSW #6=1 of CnFG 2

CHAR#	1	2	3	4	5	6	7	8	9
	H B or L	0 to 9, . (period), (space), or -							(CR)

6.2.1 12-Character Format

In this format, the first character provides alarm information.

H	=	high alarm
L	=	low alarm
B	=	both high and low alarms
space	=	neither high nor low alarms

The next 7 characters represent the measurement value as displayed on the front panel. If positive, there are 6 digits and a decimal point; if negative, there is a minus sign with 5 digits and a decimal point. If leading zero suppression is selected, blanks are sent in place of leading zeros. If the value overflows the 6-digit limit, it is sent in exponential format up to a maximum of 9.99 E9 or -9.9 E9.

The next character is a space, followed by two units of measurement characters:

HZ	for frequency
MS	for period, time interval
2 spaces	for frequency ratio, totalize

The final character is a carriage return.

6.2.2 9-Character Format

The first 8 characters of this format are the same as in the 12-character format. The space and the units of measurement (or spaces) are omitted. The carriage return is the 9th character and indicates the end of the measurement. The 9-character format is used when a faster reading rate (and resulting shorter alarm response time) is more important than units of measurement.

6.3 SETUP DATA

When requested by the commands 'Get' or 'Read', setup data is sent to the computer for verification. Setup data is both sent and received as ASCII characters representing the sixteen hex characters 0-9, A-F. Each hex character represents four bits or 16 pieces of information. The 7-bit ASCII characters are shown with a leading even-parity bit.

Hex Character	Bit Pattern	Hex Character	Bit Pattern
0	0011 0000	8	1011 1000
1	1011 0001	9	0011 1001
2	1011 0010	A	0100 0001
3	0011 0011	B	0100 0010
4	1011 0100	C	1100 0011
5	0011 0101	D	0100 0100
6	0011 0110	E	1100 0101
7	1011 0111	F	1100 0110

The setup data consists of a total of 42 nibbles of information that is sent and received in the following order:

Meter Display	Parameter	# of Nibbles
CALib	Calibration	6
SP HI	Setpoint High	6
SP LO	Setpoint Low	6
OFFSEt	Offset	6
SCALE	Scale	6
GAtE t	Gate Time	4
CnFG2	Configuration 2	2
CnFG1	Configuration 1	2
SLOPE	Slope	1
rAnGE	Range	1
Func	Function	2

Each parameter is sent with the most-significant nibble first. Each bit may have stand-alone significance or may be part of a binary number according to the following formats.

<u>CALIB, SP HI, SP LO, OFFSET, SCALE (6 Nibbles Each)</u>

MS Nibble → X XXX XXXX XXXX XXXX XXXX XXXX ← LS Nibble

X: Polarity
0 = +
1 = -

XXX: Coded Decimal Point Location

XXXX XXXX XXXX XXXX XXXX: Binary value of magnitude

X.X.X.X.X.X.
6 5 4 3 2 1
DP 1 - 6

> NOTE: The decimal point value cannot be set 0 or 7; it must be 1 to 6.

Example: A01000 = -0409.6
DP=2, - Polarity

<u>GATE TIME</u>

MS Nibble → XXXX XXXX XXXX XXXX ← LS Nibble

Binary value of magnitude in hundredths of seconds

Example: 0100 = 2.56 sec

<u>CONF 2</u>

MS Nibble → 0 0 X X X X X X ← LS Nibble

1 = Display Dimming 50%
1 = Display Dimming 75%
1 = Parallel BCD Option
1 = Latching Alarms
1 = Make Low Alarm 2nd High Alarm
1 = Send no units of measurement

CONF 1

MS → X 0 X X 0 X X X ← LS
Nibble Nibble

- 1 = No leading zero suppression
- 1 = 1200 baud (0 = 9600 baud)
- 1 = Character Handshake
- Must be 0
- 1 = External Gate Negative Polarity
- 1 = Disable Internal Gate Time
- SCALE Operation, 1 = Divide (0=Multiply)

SLOPE

MS → 0 0 X X ← LS
Bit Bit

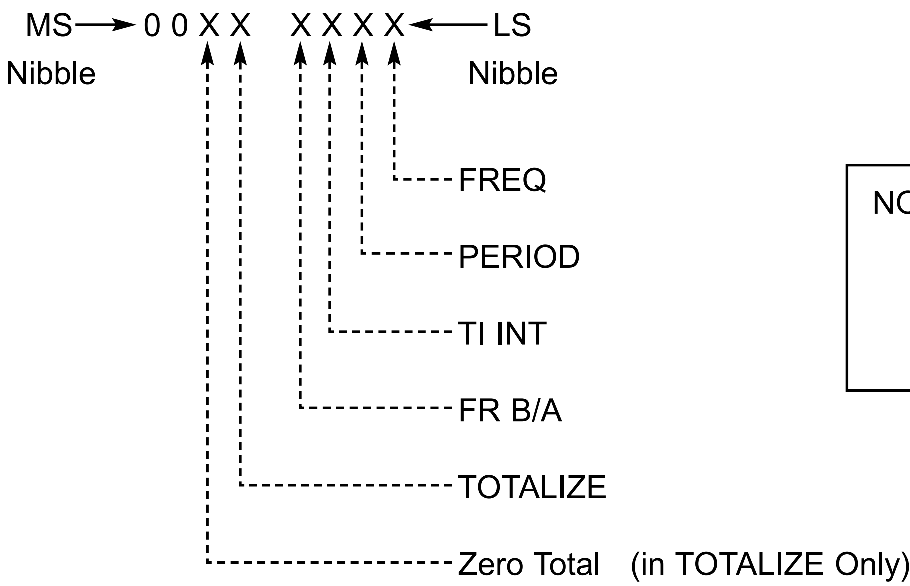
- 1 = A Negative Slope (0=Positive Slope)
- 1 = B Negative Slope (0=Positive Slope)

RANGE

MS → 0 X X X ← LS
Bit Bit

Value	Decimal Point Location	
0	Auto-range	
1	FFFFFF.	Right of digit 1 (LSD)
2	FFFFF.F	Right of digit 2
3	FFFF.FF	Right of digit 3
4	FFF.FFF	Right of digit 4
5	FF.FFFF	Right of digit 5
6	F.FFFFF	Right of digit 6 (MSD)

FUNC



NOTE: One and only one bit must be a 1, except for TOTALIZE, which may also have the Zero Total bit set to a 1.

When received by the meter with the TOTALIZE bit, the Zero Total bit causes the value to be reset to zero; otherwise, the TOTALIZE value is unaffected.

6.4 ASCII INPUT

The meter receives commands and setup data. Four commands may be received: Put, Get, Write and Read. Each is a single letter preceded by the preamble string of three characters @ U? . These characters have been selected to reduce the probability of noise patterns generating an acceptable command. The Put command is followed by 42 hex characters of desired setup data and all commands are terminated with a carriage return, indicated by (CR).

@ U?PXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX(CR)
@ U?G(CR)
@ U?W(CR)
@ U?R(CR)

The effect of the commands are described in the following paragraphs and in Figure 6-3.

6.4.1 'Put' Command @ U?P (setup data) (CR)

This command sends setup data to the meter, which receives it into its active memory and then starts making measurements using the new setup parameters. This setup data is replaced by that in nonvolatile memory if the power is cycled off and on or the Recall pushbuttons activated.

6.4.2 'Get' Command @ U?G (CR)

This command requests the meter to send the current setup parameters in the active memory to the computer. It is normally used after the Put command to verify correct reception of the setup parameters by the meter.

6.4.3 'Write' Command @ U?W (CR)

This command transfers the setup data in the meter's active memory (active program) to nonvolatile memory (stored program). If it is desired to have a different program active but not stored, this may be sent with a new 'Put' command or, if not locked out, entered from the keyboard. Setup data in nonvolatile memory is then transferred back to the active memory when power is cycled off and on or the Recall pushbuttons activated.

6.4.4 'Read' Command @ U?R (CR)

This command requests the meter to read (transfer) the setup data in nonvolatile memory into the active memory for use in the measurements that follow and to send this setup data to the computer.

6.5 INTERFACING EXAMPLES

The meter can interface to any device with RS-232C communications. The output levels are ±5 V and the inputs may accept up to ±25 V. The pin connections are labeled for the meter to emulate DCE (Data Communications Equipment). Examples are given for connections to an IBM PC with D-25 and D-9 connectors.

	IBM PC (DTE) D-25 Connector	Meter (DCE)		
Transmitted Data	2	P1-5	RS-232	IN
Received Data	3	P1-3	RS-232	OUT
Request to Send	4	P1-4	RS-232	RTS
Signal Ground	7	P1-9	GND	

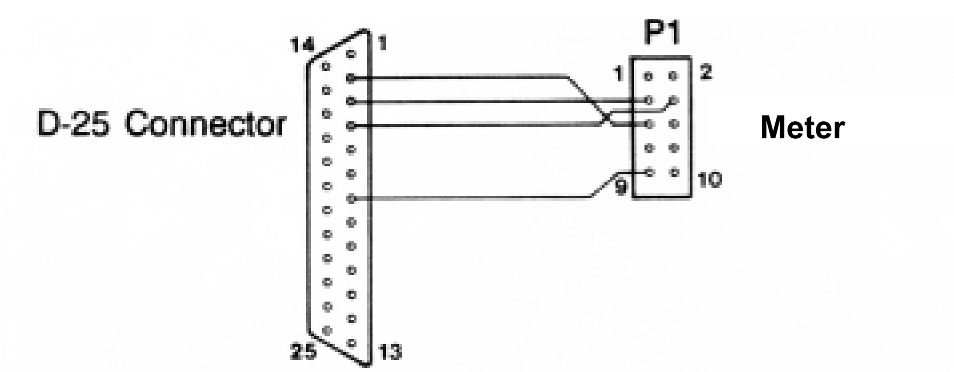


Figure 6-1 Connection of Serial Port to IBM Computer with D-25 Connector

	IBM PC (DTE) D-9 Connector	Meter (DCE)		
Transmitted Data	3	P1-5	RS-232	IN
Received Data	2	P1-3	RS-232	OUT
Request to Send	7	P1-4	RS-232	RTS
Signal Ground	5	P1-9	GND	
	Do Not Connect	P1-10	0-20 mA	

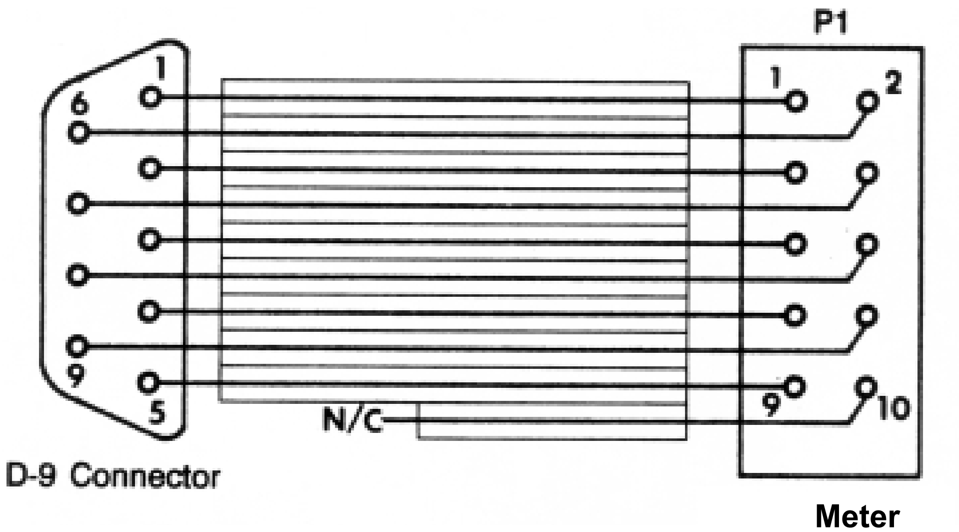


Figure 6-2 Ribbon Cable and Mass Termination to Connect Meter Serial Port to IBM Computer with D-9 Connector

See Programming Considerations, Section 6.6.2, for examples of IBM BASIC Program Statements for communications.

6.6 PROGRAMMING CONSIDERATIONS

6.6.1 Baud Rate

If possible, it is recommended that 9600 baud be used for communi-cations instead of 1200 since a faster reading rate is achieved when less time is spent communicating. The time required to send measurements and receive setup data is:

	9600 baud	1200 baud
Measurements (12 characters)	12.5 msec	50 msec
Setup data (43 characters)	45.8 msec	183 msec

If the application program is to initiate communications with the meter and the initia baud rate setting of the meter is unknown, it is possible to write the application program to perform a Get command at 9600 baud rate. If that fails, change baud rate of the external device to 1200 and try again. Once communication is established at the same baud rate, it may be changed by sending new setup data with the desired baud rate.

6.6.2 Communication Control Programming

The following statements written in IBM BASICA are suggested for inclusion in an application program written for the meter.

1. CLOSE 1: OPEN "COM1:9600,E,7,1,RS,CS,DS" AS #1

This opens the IBM communications file for 9600 baud, even parity, 7-bit word and 1 stop bit. RTS is made false to begin with and the CTS and DSR handshake lines are ignored. Two stop bits could also be used but would only lengthen the communications time. If the IBM communications port is COM2, change COM1 above to COM2 and 3FC to 2FC in 2 and 3 below.

2. 3000 OUT &H3FC,INP(&H3FC) AND &HFD:RETURN

This subroutine resets the RTS output of the IBM to low (false). RTS false prevents the meter from sending readings.

3. 3100 OUT &H3FC,INP(&H3FC) OR &H02:RETURN

This subroutine sets the RTS output of the IBM to high (true). RTS true allows the P6000A/P5000 to send readings.

4.
```
4000   IF LOC(1)=0 THEN 4030
4010   ON ERROR GOTO 4040
4020   A$=INPUT$(LOC(1),#1)
4030   ON ERROR GOTO 0:RETURN
4040   RESUME 4000
```

This subroutine empties the input buffer, and does it without a program-terminating error whenever the buffer is full. If the statement on line 4020 is executed by itself when the buffer is full, an error is generated.

5. PRINT #1, '@U?P' + SETUP$

This sends the setup data of 42 hex characters in SETUP$ to the meter.

6. PRINT #1, ‘@U?G’
   PRINT #1, ‘@U?R’

The first statement requests that the setup data be sent from the meter to the IBM computer. The second statement requests that the setup data be transferred from nonvolatile memory to active memory before being sent.

7. PRINT #1, ‘@U?W’

This writes (transfers) data from the meter’s active memory to the nonvolatile memory.

8.
```
1000   GOSUB 4000                  'EMPTY INPUT BUFFER
1010   B$=""                       'HOLDS CUMULATIVE INPUT DATA
1020   GOSUB 3100                  'MAKE RTS TRUE TO START P6000A
                                       SENDING DATA
1030   IF LOC(1)=0 THEN 1030       'WAIT FOR DATA
1040   A$=INPUT$(LOC(1),#1)        'GET DATA FROM INPUT BUFFER
1050   B$=B$+A$                    'CONCATENATE CHARACTERS
1060   CR=INSTR(B$,CHR$(13))       'FIND LOCATION OF CARRIAGE RETURN
1070   IF CR=0  THEN 1030          'IF NOT RECEIVED YET, REPEAT
1080   A$=LEFT$(B$,CR-1)           'THE VALUE IS ALL CHARS UP TO THE
                                       CARRIAGE RETURN
1090   GOSUB 3000                  'MAKE RTS FALSE TO STOP P6000A FROM
                                       SENDING DATA
```

This reads the data sent from the meter to the IBM PC.

9. To read data continuously, add the following:

```
1100   B$=MID$(B$,CR+1)            'STRIP THE READING FROM THE STRING
1110   GOSUB XXXX                  'DO SOMETHING WITH THE DATA IN A$
1120   GOTO 1020                   'READ MORE DATA
```

To read the meter output from the computer screen, use the following program which was written in IBM BASICA.

```
10 ‘   READ.BAS
100 SCREEN 0:CLS:KEY OFF:CLOSE
130 CR$=CHR$(13)
160 PRINT:PRINT “SET THE P6000A/P5000 TO 9600 BAUD.”
180 PRINT:INPUT “ENTER COM1 (1) OR COM2 (2) RS-232 PORT “;W
185 PRINT:INPUT “INCLUDE UNITS OF MEASUREMENT (Y/N) “;K$
186 IF (K$ = “Y” OR K$ = “y”) THEN LN = 11 ELSE LN = 8
190 IF W=1 THEN COMM$=”COM1” ELSE COMM$ = “COM2”
500 ‘ ====================== Open serial communications
530 CLOSE:OPEN COMM$+”:9600,E,7,1,CS,DS” AS #1
540 CLS
1000 ‘ ======================= Start main program
1010 GOSUB 5030                    ‘CLEAR INPUT BUFFER
1050 IF INKEY$=CHR$(27) THEN 2000
1060 IF LOC(1)=0 THEN 1050
1070 A$=INPUT$(LOC(1),#1)           ‘READ RECORD
1080 B$=B$+A$
1090 Q=INSTR(B$,CR$)
1100 IF Q=0 THEN 1050
1110 A$=LEFT$(B$,Q-1)
1120 B$=MID$(B$,Q+1)
1130  IF LEN(A$) < > LN THEN 1050
1150 PRINT A$
1160 GOTO 1050
2000 ‘ =======================
2010 PRINT “ESC=EXIT  CR=CONT   “;
2020 PRINT “?”;
        2030 KY$=INKEY$:IF KY$=CHR$(27) THEN 2080
2040 IF KY$=CHR$(13) THEN CLS : GOTO 1010
2070 IF KY$=”” THEN 2030
2080 CLOSE :SCREEN 0:END ‘ =========== Exit here
5000 ‘*******************************************
5010 ‘*          CLEAR INPUT BUFFER       *
5020 ‘*******************************************
5030 IF LOC(1)=0 THEN 5060
5040 ON ERROR GOTO 5070
5050 A$=INPUT$(LOC(1),#1)
5060 ON ERROR GOTO 0:RETURN
5070 RESUME 5030
```

To change the meter’s setup data or to monitor the readings, use the SB02 Option which provides a complete menu-driven program.

6.7 PARITY CHECKING

Although the meter includes an even parity bit with data sent out on the RS-232C interface, it does not check the data received for even parity.

6.8 TIMING

When a Put command is sent to the meter, it is accompanied by a string of 42 setup characters. The statement PRINT #1, @U?P + SETUP$ puts the string into an output buffer for transmission and the BASIC program continues while the data is being transmitted. If within a few lines, the statement PRINT #1, @U?G is executed, the @U?G is added to the end of the setup string in the buffer which is still being transmitted. This causes the @U?G characters to be missed because each transmission from the computer must be completely received by the meter and the next measurement started before another command is issued. A statement FOR J=1 TO 300:NEXT J introduces enough delay to allow separation between commands.

6.9 MODEM OPERATION

The meter can be connected to a freestanding modem, such as the Hayes Smartmodem 1200, so that data can be transmitted and received over phone lines. A typical controller would be an IBM PC with a Hayes Smartmodem 1200B plug-in modem.

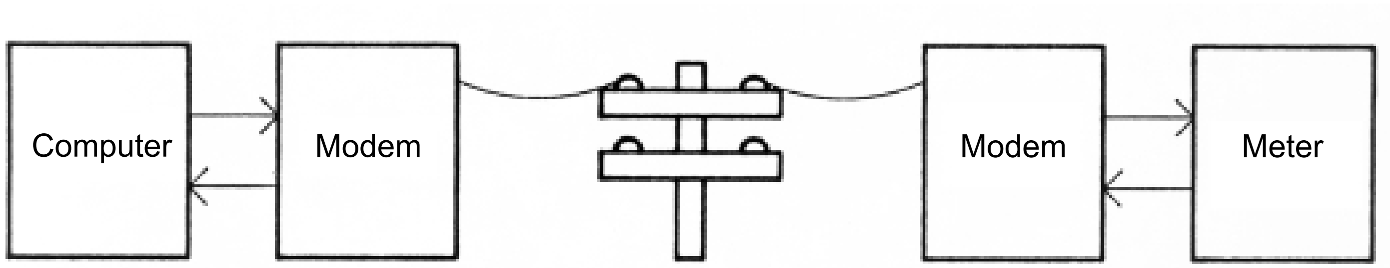


Figure 6-3 Modem Concept

Using a rate of 1200 baud, measurement data can be received by the computer from the meter and setup data can be sent to the meter from the computer. By using an auto-answering modem connected to the meter, data can be gathered from a remote location upon demand. If a command is sent to the meter at 1200 baud while the meter's active memory is programmed for 9600 baud, the meter will automatically switch to 1200 baud. This prevents the modem application from being disabled when a setup parameter of 9600 baud is accidentally sent to the meter.

6.10 0 - 20 mA, ASCII OUTPUT

When closed, solder switch J connects a 249 ohm pull-up resistor to this open collector output, providing a 20 mA current source for the 0 - 20 mA, ASCII output. This output can be used over longer distances than the RS-232 output.

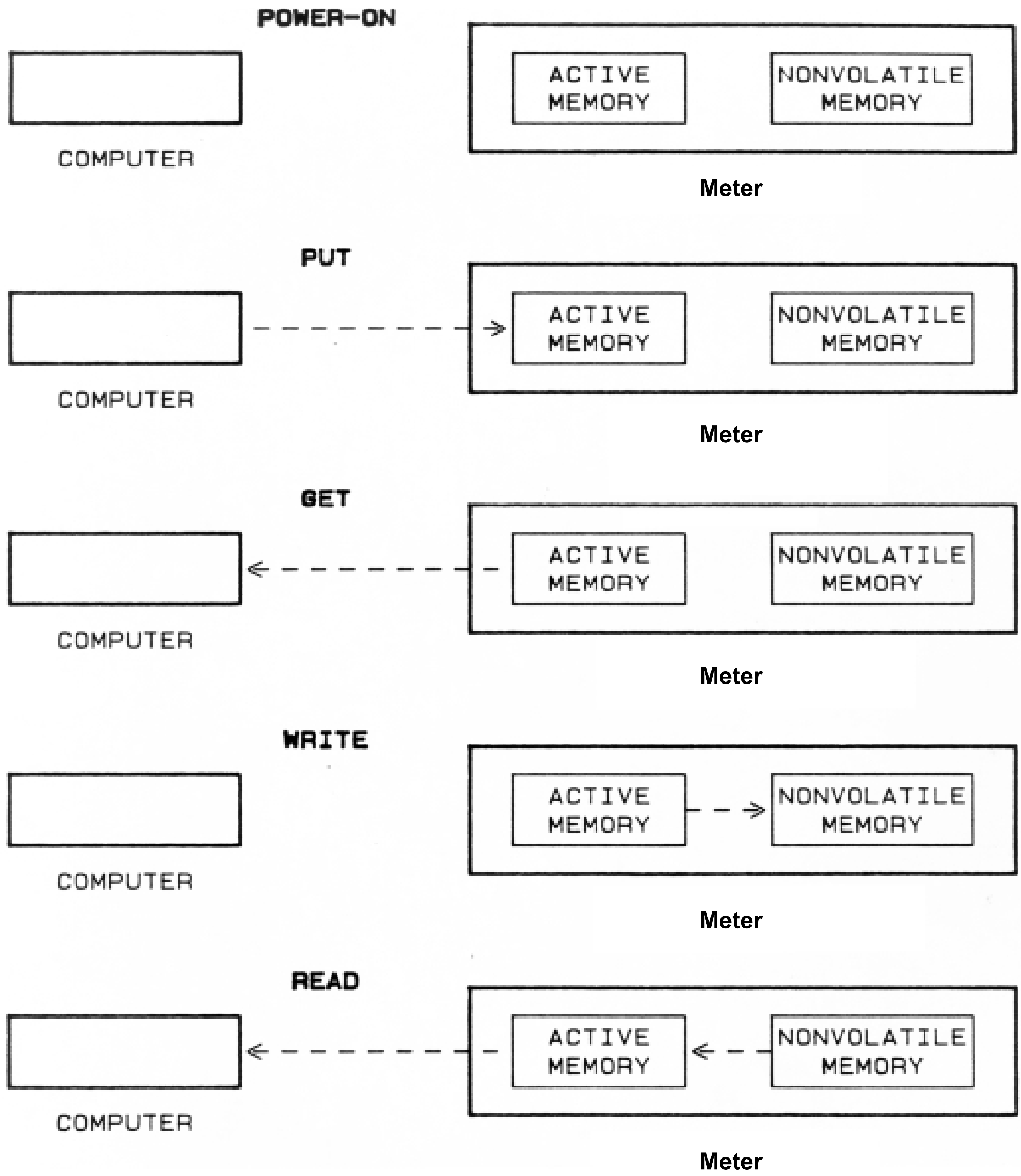


Figure 6-4 Programming Commands

7.0 TROUBLESHOOTING CHART

Your meter is a powerful, universal counter with a wide range of programming parameters. An error in the programmed parameters can cause the counter to provide unexpected results. Before requesting service, please read this troubleshooting chart.

SYMPTOMS	ACTION TO TAKE OR EXPLANATION
Display Blank (completely)	Check the power connections. For battery-powered units, connect the BLANK ENABLE input (pin 16 of P2) to the GND. Push the two RECALL buttons simultaneously or turn off the power for 20 seconds.
Display shows the functions, e.g., FrEq and does not advance to show a measurement.	Check the input connections, levels, and jumpers (SA and SB). The input signal(s) may be missing. The Gate Time may be too long. The Internal Gate Time may be disabled (SSW #6 of the Configuration Word 1 should be 0XXXXX). The External Gate Polarity may be reversed (SSW #5, Configuration Word 1). HOLD input (pin 13 of P2) might be held low.
Display reads zero	Push the two RECALL buttons simultaneously. If display still reads zero, use Auto-range. The scale factor may be a small multiplier (including zero) or a large divider. RESET input may be low.
Display shows an illegal character (not in glossary)	Push the two RECALL buttons simultaneously or turn off the power for 20 seconds.
Display in exponential format, e.g., 1.23 E6 (Overflow indication)	If the digital following the E is 5 or smaller, use the Auto-range. If it is 6 or greater, use a larger divide or smaller multiply scale factor and Auto-range.

SYMPTOMS	ACTION TO TAKE OR EXPLANATION
One or more digits are flashing.	The counter may be in the programming mode. Push the three center pushbuttons to reset the counter. If the display is still flashing, reset SSW #4 of Configuration 1 to zero (XX0XXX).
Leading zeroes are blank	Set the SSW #1 of Configuration 1 to zero (XXXXX1).
Leading zeroes are not blank	Reset the SSW #1 of Configuration 1 to zero (XXXXX0).
Reading is incorrect	Check the function, scale factor, offset, slope (in Time Interval only) and Calibration Factor.
Programming push-buttons don't work at all	Check the lock-out jumper on S8. $\overline{\text{RESET}}$ input might be held low.
Programming push-buttons don't work properly	Check the lock-out jumper on S7.
The least-significant digit(s) bouncing	The signal source may not be stable enough.
Display does not update	The $\overline{\text{HOLD}}$ input (pin 9 of P1) might be held low. Inputs may be disconnected. Gate Time may be too long.

NOTE: In setting the software switches (SSW) of Configuration 1 and 2, "X" represents "don't care" which means that either 0 or 1 may be selected to disable or enable other features.

8.0 SPECIFICATIONS

8.1 GENERAL INFORMATION

Programmable Functions:	Frequency, Period, Time Interval A to B, Frequency Ratio B/A, Totalize
Scale Factor:	-99999 to 999999 with a choice of six decimal point positions (9.9.9.9.9.9.), multiply or divide
Offset:	-99999 to 999999 with a choice of six decimal point positions (9.9.9.9.9.9.)

8.2 INPUT CHARACTERISTICS

Max Frequencies (A and B inputs square wave, 0 to +5 V):	SA and SB on F positions: 7 MHz (min) SA and SB on M positions: 200 kHz (typ) SA and SB on S positions: 3 kHz (typ)
Trigger Slopes (A and B):	Positive or Negative, programmable
Input Threshold:	All TTL and CMOS compatible except spare flip-flop inputs, which are: 5 V, CMOS compatible (Low = less than 0.9 V, High = more than 3.5 V)
Input Impedance:	A, B and External Gate inputs: 20 k pull-up $\overline{\text{HOLD}}$ input: 100 k pull-up (typ) $\overline{\text{RESET}}$ input: 10 k pull-up
Max Input Voltage : (A and B)	SA and SB on F positions: -0.5 and +5.5 V SA and SB on M or S positions: -20 and +25 V
Max Input Voltage : (all other inputs)	-0.5 and 5.5 V

8.3 DISPLAY

Type:	“Classic” Case: 7-segment, orange LED with red lens “Designer” Case: 7-segment, orange LED with gray lens
Digit Height:	14.2 mm (.56 in)
Symbols:	-.8.8.8.8.8. and 8.8.8.8.8.8.
Decimal Point:	Six positions; programmable Fixed or auto-ranging
Leading Zeros:	Blank or displayed; programmable
Overflow Indication:	Display in exponential format to 9.99 E9
Update Time:	Averaging time + (10-40 milliseconds) + communication time
Brightness:	100%, 50%, 25%; programmable
Displayed Value:	(Measurement · Scale Factor) + Offset
Indicator Lights:	GATE LED; Low and High alarm LEDs
Capacity: decimal format	-99999 or 999999
exponential format	-9.9×10^9 or 9.99×10^9

8.4 OUTPUT CHARACTERISTICS

Lo, Hi and Go Alarm Outputs:	Open-collectors, active low, 150 mA at 1 V
Digit 6:	High level = 3.5 V at 100 μA Low level = 0.4 V at 1.6 mA Frequency = 400 Hz ±.1%

8.5 TIME BASE

Internal Clock Reference:	11.059 MHz
Stability:	± 50 ppm over 0-60°C range
Fine-Calibration method:	Programmable calibration value
Calibration accuracy at 25°C:	± 2 ppm

8.6 COMMUNICATION

RS-232 OUT, IN and RTS:	RS-232 C compatible with transmit handshake line (RTS)
	Levels: ± 5 V
Transmitted data:	Alarm + 6 digits + decimal point + CR (9 characters)
or	Alarm + 6 digits + d.p. + space + units of measurement + CR (12 characters)
Baud rate:	1200 or 9600 baud, programmable
Received data:	Complete setup parameters, no handshake
0-20 mA ASCII out:	Open collector (data the same as RS-232 OUT)
Bit serial BCD (Internal connection to parallel BCD board):	32 bits; display and alarm data. When enabled, takes about 10 milliseconds to be transmitted.

8.7 FREQUENCY/PERIOD FUNCTION

Frequency range:	10^{-6} Hz to 7 MHz (140 nsec to 36 days)
Nominal Gate Time (NGT):	00.00 to 99.99 seconds
Averaging Time (Actual Gate Time):	(NGT + 2.7 ms) or Ext. Gate Time + time to complete the last period
Max Ext. Gate Time:	$\frac{6 \times 10^{10}}{F_A}$ or 36 days, whichever is less
Units-of-Measurement (Scale Factor = 1):	Frequency: hertz Period: milliseconds
Accuracy at 25°C: (Auto-range SA on F Position)	± 1 LSD ± 2 ppm of input

Calculation time:	Scale Factor is a multiplier; 20-35 ms Scale Factor is a divider; 30-45 ms
Max speed (gate time minimum) (Parallel BCD disabled, RTS false):	20-40 readings/second

8.8 TIME INTERVAL

Interval range, A to B:	400 ns to 36 days
Trigger error (A - B):	SA and SB on F positions: +30 ± 70 ns SA and SB on M positions: +30 ± 250 ns SA and SB on S positions: ± 9 μs
Accuracy, NGT = 00.00:	± 1 LSD ± trigger error ± TI (Time Base Error)
Accuracy, NGT ≠ 00.00:	± 1 LSD ± trigger error ± $\frac{\text{(T.B. Error) TI}}{\sqrt{N}}$ where N is number of averaged intervals
Number of averaged intervals:	$N = \frac{\text{(Averaging Time) X Frequency}}{2}$
Nominal Gate Time (NGT):	00.00 to 99.99 seconds, in .01 sec steps
Averaging time:	NGT = 00.00: .1 ms + time to complete the last interval NGT ≠ 00.00: NGT + 2.5 ms + time to complete the last interval
Averaging method:	Every other Time Interval
Unit of Measurement: (Scale Factor = 1)	milliseconds

8.9 FREQUENCY RATIO, $\frac{B}{A}$

B input frequency range:	0.007 Hz to 7 MHz
A input frequency range:	F_B > 5 kHz: 10^{-6} Hz to 7 MHz F_B < 5 kHz: $\frac{1}{F_A} + \frac{1}{F_B} < 160$ sec
Nominal Gate Time (NGT):	00.00 to 99.99 seconds, in .01 sec steps

Averaging time:	(NGT + 2.5 ms) or Ext. Gate Time + time to complete the last period of A and B
Resolution: (SA and SB on F positions)	FB > 5 kHz: $\dfrac{1}{(\text{Averaging Time}) \ X \ F_B}$
	FB < 5 kHz: $\dfrac{1}{5000 \ X \ (\text{Averaging Time})}$
Max External Gate Time:	$\dfrac{6 \ X \ 10^{10}}{F_A}$ or $\dfrac{3.5 \ X \ 10^{13}}{F_B}$, whichever is less

8.10 TOTALIZE

Count direction:	Up or Down (determined by sign of scale factor)
LSD: (Auto-range, Scale Factor=1)	1 count of the input
Internal count capacity:	(60,000,000,000) $6 \ X \ 10^{10}$ counts
AC power failure provisions:	Display value stored in nonvolatile memory and restored with power

8.11 POWER

+5 V output:	Regulated, 50 mA max in nontotalize modes (1) (reduced by upper-board option)
V+ output:	Unregulated, 6-9 V, 50 mA max in nontotalize modes (1) (reduced by upper-board option and current drawn from the +5 V output)
AC voltage (standard):	115 or 230 V ac ±10% 47 to 400 Hz
Power consumption:	7.5 W max.
Battery backup: (connected to V+ with a diode)	6-12 V, 50 mA (typ), without upper-board option

NOTE: In Totalize Mode, 10 mA can be drawn from +5 V or V+ when display brightness is normal or dim (CnFG 2 = XXXX1). Up to 50 mA can be drawn if the BLANK ENABLE input is tied to GND. This prevents a power failure detection.

FREQUENCY AND PERIOD

To display the input frequency in Hz, a conventional counter simply counts the input pulses (cycles) during a 1-second gate time and displays the result without any change. The meter counts both the input pulses and the internal clock pulses during a programmable gate time and calculates the frequency. As a result, the display resolution is not limited by the input frequency. One-tenth of a second of gate time is enough for 6-digit resolution. (Figure C-1 compares the resolution of a conventional counter with .1 second gate time with the meter resolution.)

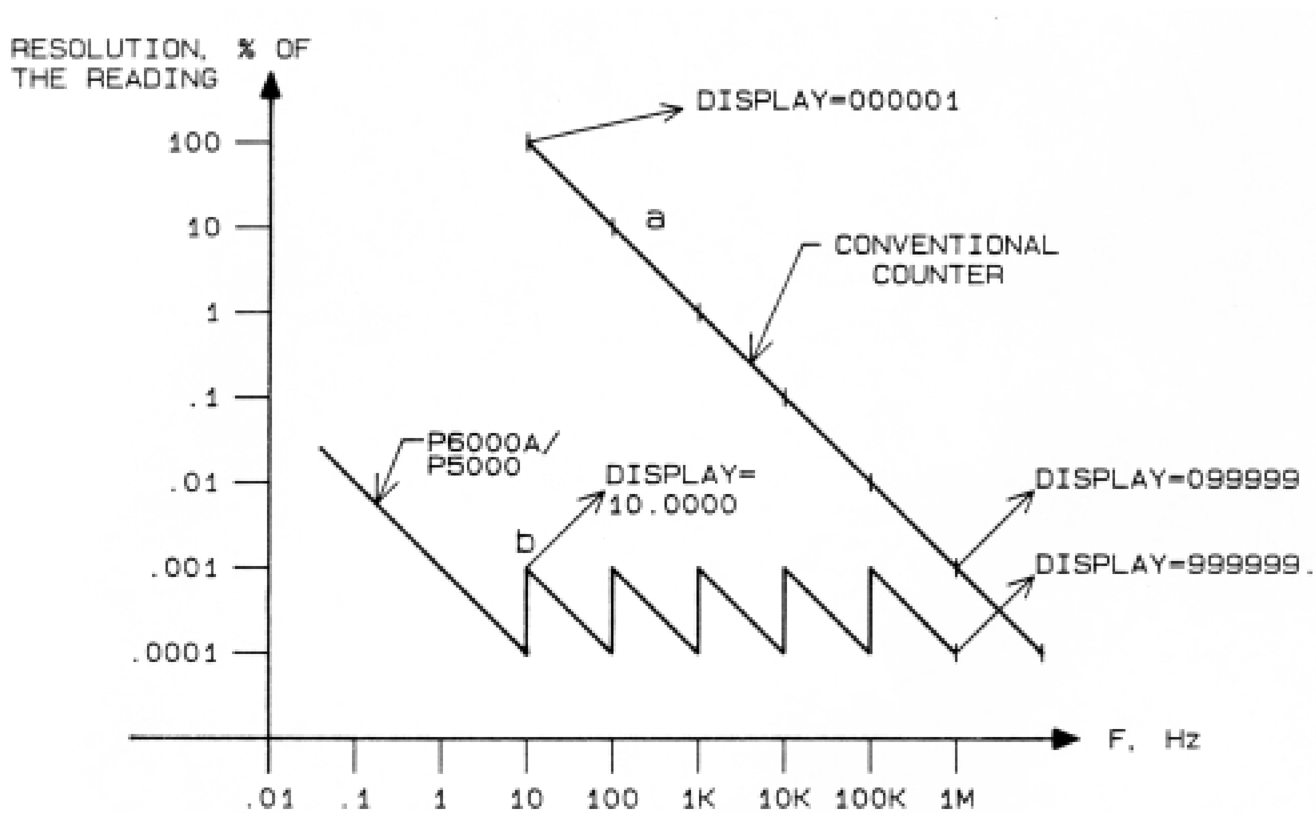


Figure C-1 Resolution Comparison of meter to Conventional Counters

Gate Timing:

The meter starts a frequency/period measurement by arming the A flip-flop. Then, the first trigger slope of the A input sets this flip-flop and opens the A and B gates, permitting the input pulses and the 11.059 MHz internal clock to be counted by the A and B counters, respectively. After the gate time is over, the meter disarms the A flip-flop; and the next trigger slope of the input resets the flip-flop and closes the A and B gates. At this time, the meter reads the A and B counters and calculates the frequency or period.

$$\text{Frequency} = \frac{\text{Number of Input Pulses}}{\text{Averaging Time}} = \frac{\text{Counter A}}{\text{Counter B/Clock Frequency}}$$

$$\text{Frequency, Hz} = \frac{\text{Counter A}}{\text{Counter B}} (11.059 \text{ X } 106) \left(\frac{\text{Calibration Value}}{1000000} +1 \right)$$

$$\text{Period, ms} = \frac{1000}{\text{Frequency, Hz}}$$

When using an external gate time, the timing is the same except that after arming the flip-flop, the meter waits until the external gate signal disarms the flip-flop and the next input pulse closes the A and B gates. Burst Frequency Measurement is possible using the external gate input without disabling the internal gate. The timings are shown below in Figure C-2.

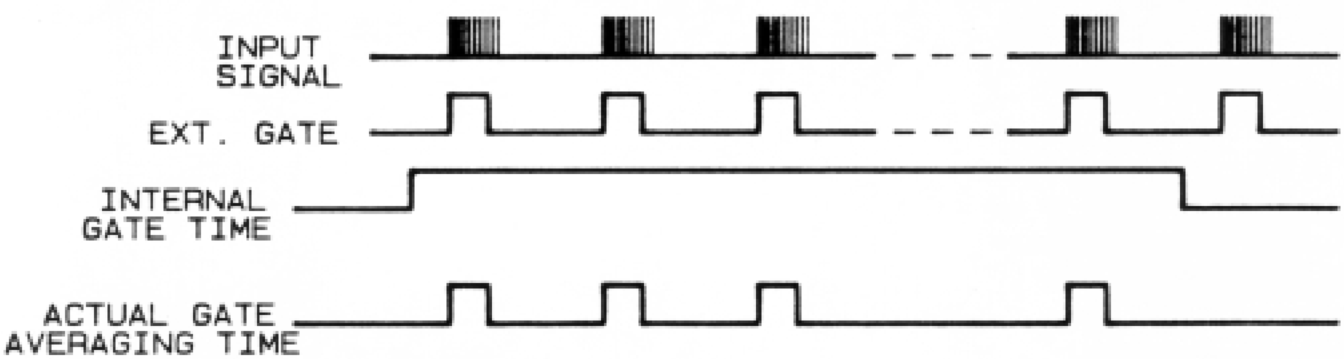


Figure C-2 Burst Frequency Measurement

The external gate signal must be active only when the input signal is valid.

TIME-INTERVAL MEASUREMENT (A TO B)

The meter measures the time interval from the trigger slope of the A input to the trigger slope of the B input and displays the result in milliseconds. If the Nominal Gate Time is long enough, the meter averages a number of time intervals. This helps to improve the accuracy by $\sqrt{N}$, where N is the number of measured intervals (every other interval is measured).

$$\text{Display Resolution} < \frac{1}{11059 \text{ (Time Interval in milliseconds)} \cdot \sqrt{N}}$$

Gate Timing:

The measurement is started by arming the A flip-flop. The trigger slope of the A input then sets the A flip-flop. This opens the A and B gates and arms the B flip-flop. The next trigger slope of the B input sets the B flip-flop and this resets the A flip-flop and closes the A and B gates. If the Nominal Gate Time is long enough, the second trigger slopes of the A and B inputs reestablish the original condition and the next pair of (third) trigger slopes opens and closes the gate again.

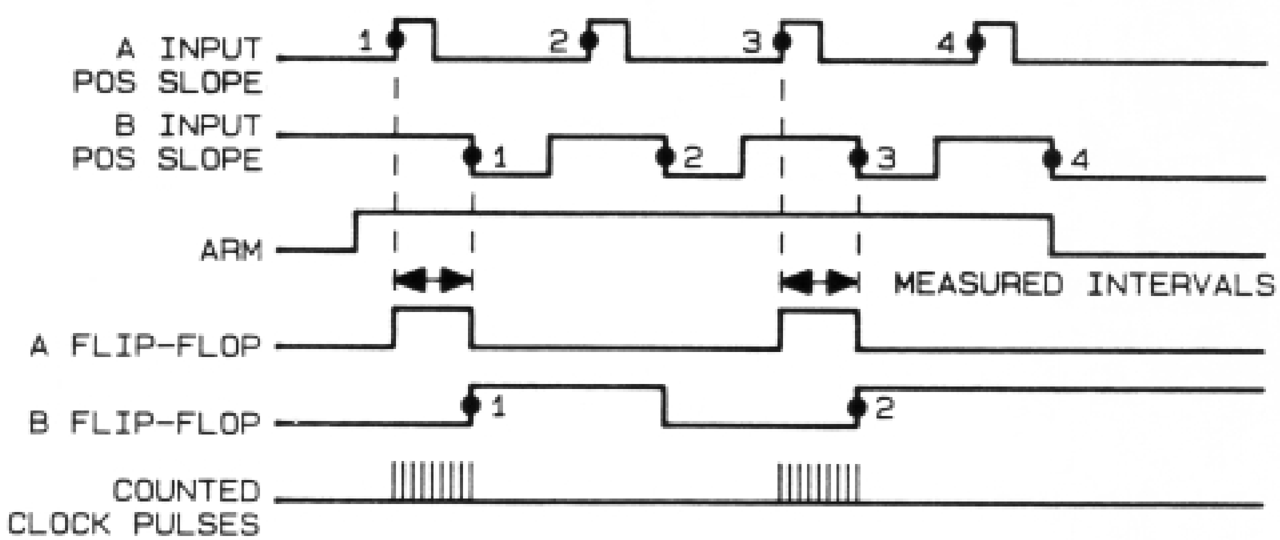


Figure C-3 Time-Interval Measurement Timing

The A counter counts the number of intervals averaged (B flip-flop output), and the B counter counts the internal clock pulses during the averaged intervals.

When the B input frequency is greater than 5 kHz, frequency ratio measurement is done similar to the frequency measurement, except that the B counter counts the B input pulses, instead of internal clock pulses. The display resolution is determined by the B input frequency and the averaging gate time (Auto-range, Scale = 1).

$$\text{Display Resolution} = \frac{1}{F_B \cdot (\text{Averaging Time})}$$

Where: Averaging Time = Nominal Gate Time + 2.5 ms + time to complete the last A and B cycles.

Gate Timing:

The measurement is started with the arming of the A flip-flop. The selected trigger slope of the A input then sets the A flip-flop. This arms the B flip-flop and opens the A gate. Now the selected trigger slope of the B input opens the B gate. At the conclusion of gate time, the meter disarms the A flip-flop. Then the next A pulse closes the A gate and the next B pulse closes the B gate. While the respective gates are open, the A and B input pulses are counted by the A and B counters. The meter then reads the A and B counters and calculates the frequency ratio.

$$\text{Display} = \left(\frac{\text{Counter B}}{\text{Counter A}}\right) (\text{Scale Factor}) + \text{OFFSET}$$

It should be noted that, because the scale factor and offset can be negative numbers, it is possible to display $K \cdot \frac{B-A}{A}$ (or $K \cdot \frac{A-B}{A}$) since

$$K \cdot \frac{B-A}{A} = K\left(\frac{B}{A} - 1\right) = \frac{B}{A} \cdot K - K \quad \begin{array}{ll} = \text{Scale Factor} & = K \\ \text{OFFSET} & = -K \end{array}$$

When the B input frequency is less than 5 kHz, the meter interpolation method achieves much greater accuracy than conventional counters. This feature makes the meter very useful in low frequency ratio measurements.

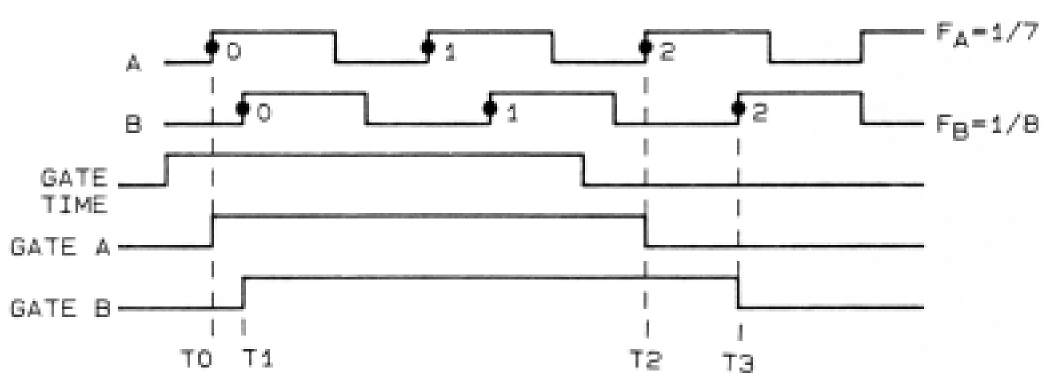


Figure C-4 Frequency Ratio Measurement Timing

$$\text{Display} = \left(\frac{\text{Counter B}}{\text{Counter A}} \cdot \frac{\text{T2-T0}}{\text{T3-T1}} \right) (\text{Scale Factor}) + \text{OFFSET}$$

For the above waveforms and scale factor = 1, OFFSET = 0 :

$$\text{Display} = \frac{2}{2} \cdot \frac{14}{16} = \frac{7}{8}$$

When the B input frequency is less than 5 kHz, the display resolution is determined by the Averaging Time only.

$$\text{Display Resolution} = \frac{1}{5000 \cdot (\text{Averaging Time})}$$

The timer that records the T0, T1, T2 and T3 times has 160 seconds capacity, so when measuring the ratio of very low frequencies, the total measurement time should not exceed 160 seconds.

TOTALIZE

Totalize is started by arming the A flip-flop. Then the first trigger slope of the A input sets the A flip-flop and opens the Gate. This allows the A input pulses to be counted by the A counter. The meter reads the A counter and adds one count to it if Gate A is open, so that the number of A input pulses is displayed. This method of gating allows the input pulses to be repeatedly gated by an external signal (on the external gate input) without any error.

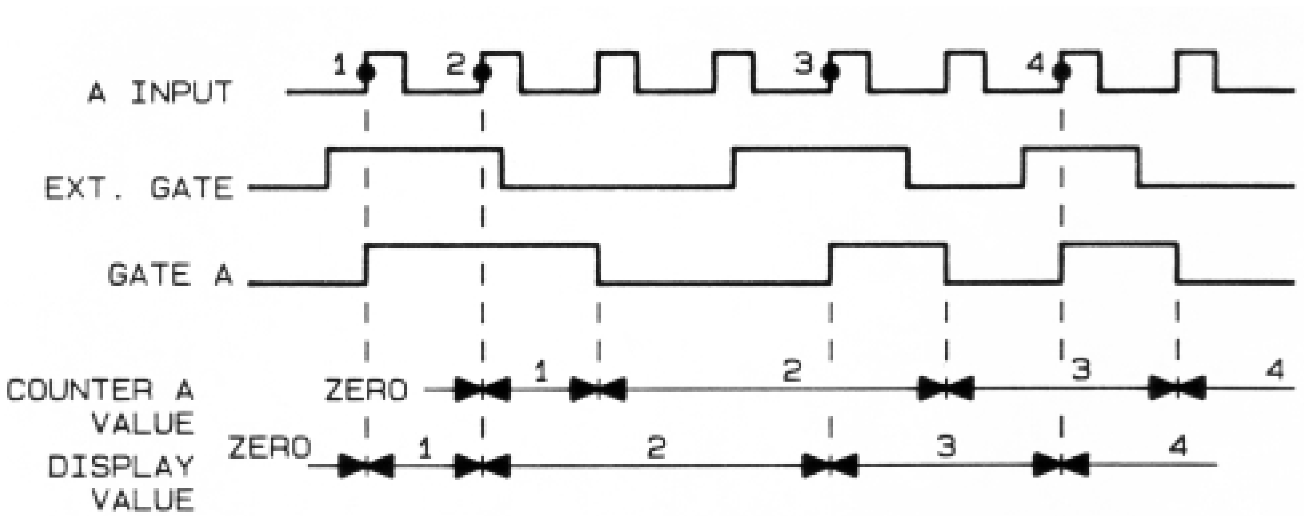


Figure C-5 Timing in Totalize Function

It should be noted that the display value and the alarm outputs status lag the input pulses by 0-25 milliseconds (calculation time) plus the communication time. This delay cannot be seen on the display but when using the alarm outputs for control purposes, it may be desired to reduce this delay as much as possible. This display update time is minimized by:

1. Disabling the parallel BCD data, if not used (sending data to the parallel BCD board takes about 10 milliseconds);

2. Disabling the RS-232 output by leaving RTS open or false. (The RS-232 output takes about 13 milliseconds at 9600 baud);

3. Using a multiplier scale factor (a divider scale factor lengthens the calculation time about 10 sec).

With these provisions, the display update time is reduced to 8-15 milliseconds in totalize and 20-30 milliseconds in other functions.

SYMBOL	DESCRIPTION	OTHER POSSIBLE SETTINGS
A .SC	Scale Factor is a MULTIPLIER Display = (measurement · scale) + offset	A/SC
A/SC	Scale Factor is a DIVIDER Display = (measurement/scale) + offset	A.SC
A nEG	A input trigger slope is NEGATIVE (counting negative edges)	A POS
A POS	A input trigger slope is POSITIVE (counting positive edges)	A nEG
Auto	Auto-ranging is selected. The meter selects the decimal point.	F.F.F.F.F.F., fixed range with one of the six available decimal points
b nEG	B input trigger slope is NEGATIVE (counting negative edges)	b POS
b POS	B input trigger is POSITIVE (counting positive edges)	b nEG
CAL Ib	CALIBRATION value, expressed in parts per million	-99999 to 999999 ppm with six possible decimal point positions

SYMBOL	DESCRIPTION	OTHER POSSIBLE SETTINGS
CnFG 1	CONFIGURATION 1, set of six software switches, SS1-SS6	6 digits, each can be 0 or 1 to disable or enable a feature
CnFG 2	CONFIGURATION 2, set of six software switches, SS1-SS6	6 digits, each can be 0 or 1 to disable or enable a feature
F.F.F.F.F.F.	FIXED RANGE, with selected decimal point flashing	Auto, Auto-ranging
Fr b/A	Meter function is FREQUENCY RATIO B/A (B input is divided by the A input)	FrEq, PEriod, ti Int, totAL
FrEq	Meter function is FREQUENCY (measures the A inputfrequency)	PEriod, ti Int, Fr b/A, totAL
Func	Operating FUNCTION	Available functions are: Frequency, Period, Time Interval, Frequency Ratio and Totalize
GAtE t	Nominal GATE TIME, the averaging time that determines the display update rate	The value ranges from 00.00 to 99.99 seconds, with a fixed decimal point.
OFFSEt	OFFSET (Preset) (Display = (Input X Scale) + Offset)	Ranges from -99999 to 390000 with a programmable decimal point
PEr iod	Meter function is PERIOD	FrEq, ti Int, Fr b/A, totAL

SYMBOL	DESCRIPTION	OTHER POSSIBLE SETTINGS
rAnGE	RANGE	Can be set to Auto-range (Auto) or a fixed decimal point can be selected (F.F.F.F.F.F.)
SCALE	SCALE Factor	Ranges from -99999 to 999999 with a programmable decimal point. Multiply or divide.
SLOPE	Trigger SLOPE of the Input(s)	Positive or negative slopes can be selected for A and B inputs, independently.
SP HI	SETPOINT HIGH	Ranges from -99999 to 999999 with a programmable decimal point
SP LO	SETPOINT LOW	Ranges from -99999 to 999999 with a programmable decimal point
ti Int	Meter function is TIME INTERVAL A to B	FrEq, PEriod, Fr b/A, totAL
totAL	Meter function is TOTALIZE	FrEq, PEriod, ti Int, Fr b/A

Time-Interval Measurement

The Time-Interval Measurement is used to measure the time between events A and B and display the measurement in seconds.

Features used:	Function -	set to time interval
	Scale -	use “divide by” 1000
	Slope -	negative A and B trigger slopes
	Gate Time -	set to 00.00 for single-event measurement (no averaging)

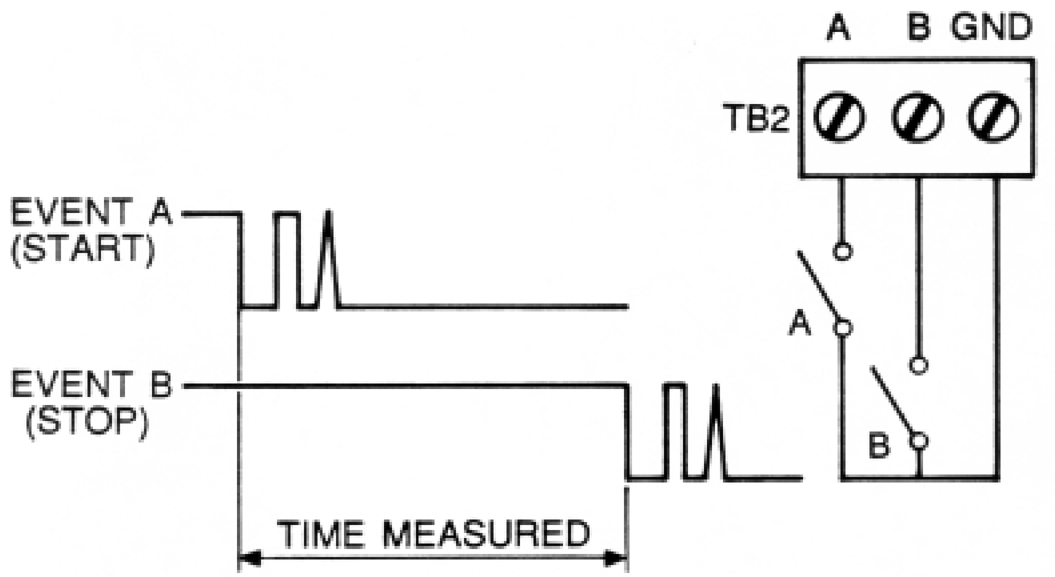


Figure E-1 Time-Interval Measurement

NOTE: No reset is required; a new reading replaces the old reading automatically.

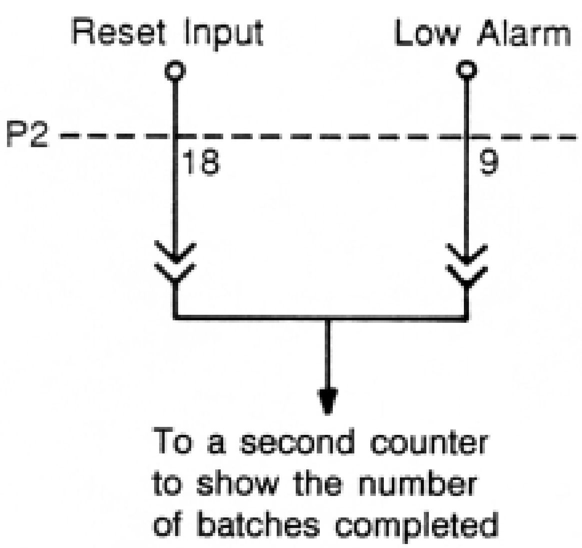
NOTE: Debouncing is not required; therefore, START and STOP pulses can be generated with mechanical switches.

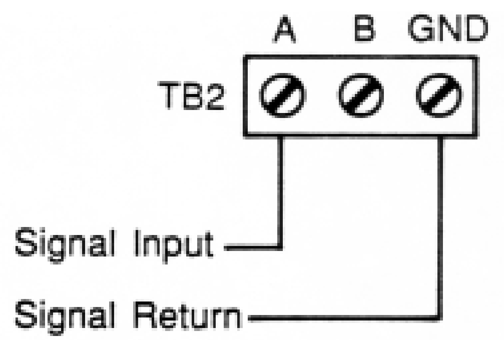
PUSH	DISPLAY SHOWS	NOTES
ENTER	Func	
SET	ti Int	Press until flashing ti Int is displayed.
ENTER	SCALE	
SET	A/Sc	If A.SC is displayed, press SET to change it to A/SC (divide by).
ADVANCE	1.00000 --> 1.00000	Press until the decimal point is flashing.
SET	--> 1000.00	Press until display reads 1000.00
ENTER	--> SLOPE	Press until SLOPE is displayed.
SET	--> A nEG	If A POS, press to toggle to A nEG.
ADVANCE	--> b nEG	If b POS, press SET to toggle to b nEG.
ENTER	GAtE t	Press until GAtE t is displayed.
ADVANCE	00.30 --> 00.30	Press until 3 is flashing. (00.30 sec. is the default Gate Time.)
SET	00.00	Press once.
ENTER	noStor	Press until no Stor is displayed.
SET	StorE	
ENTER	ti Int --> measurement	Display momentarily shows ti Int (new function). If A and B input signals are present, a time-interval measurement replaces the A display.

BATCH COUNTER

The Batch Counter is used to count repetitiously in descending order from 200 to 0. Each five input pulses are counted as one count.

Features used:	Function -	set to TOTALIZE
	Scale -	set to “divide by” -5 (negative to count down)
	Offset -	set to 200 (starting point)
	Setpoint Low -	set to .01 so a zero reading activates the Low Alarm



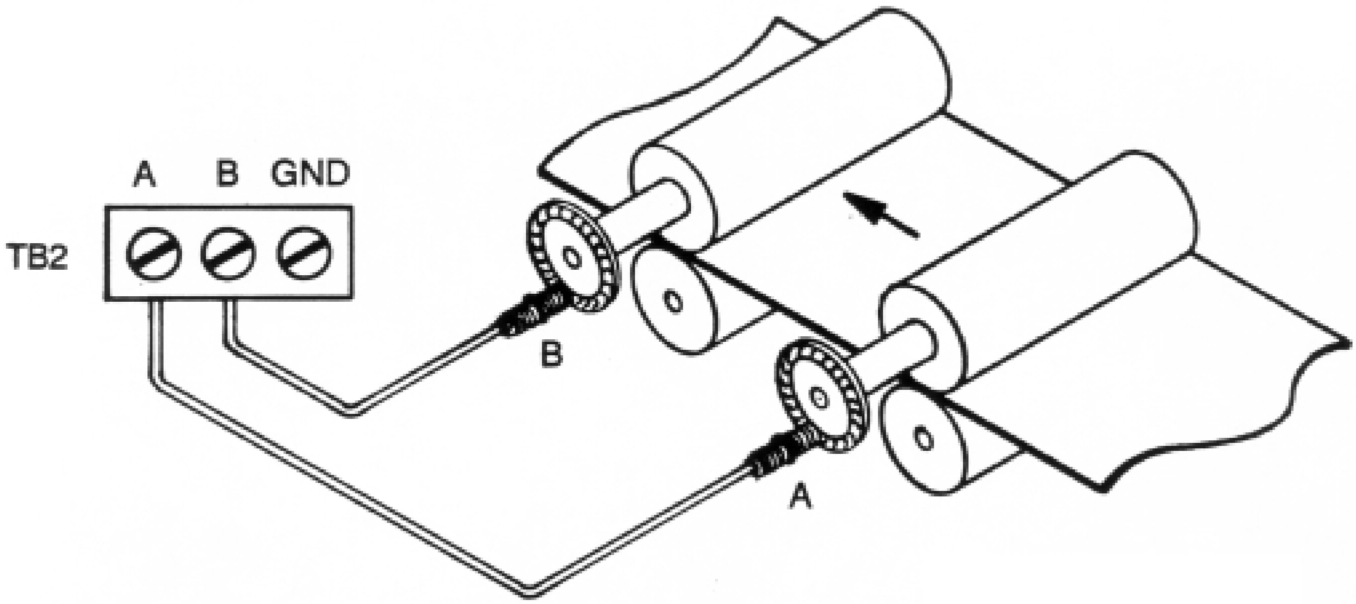


NOTE: Input pulses must be TTL compatible. If they are generated by a mechanical switch, a signal conditioner option should be used for debounding.

PUSH	DISPLAY SHOWS	NOTES
ENTER	Func	
SET	totAL	Press until totAL is flashing.
ENTER	SCALE	
SET	A .SC → A/SC	If A.SC, press again to get A/SC.
ADVANCE	1.00000	
SET	-.00000	Press until a negative sign is displayed. (Only the leftmost digit can be set to a negative sign.)
ADVANCE and SET	-5.0000	Use ADVANCE and SET to set the scale factor value to -5.0000.
ENTER	OFFSEt	
ADVANCE	→ 000000.	Press until digit #3 is flashing.
SET	000200.	Press to make digit #3 a 2.
ENTER	SP LO	Press until Setpoint Low is displayed.
ADVANCE	000000.	Press ADVANCE until digit #4 is flashing.
SET	00 1000.	Press once.
ADVANCE	00 1000.	Press until the decimal point is flashing.
SET	0.0 1000	Press once.
ENTER	noStor	Press until no Stor is displayed.

Use SET and ENTER to store the new program in nonvolatile memory.

FREQUENCY RATIO



In some applications it is necessary to measure the ratio or draw between two frequencies. For ratio measurement, just program the Function to Fr b/A (frequency ratio B input/A input).

NOTE: Display shows $\frac{\text{B input frequency}}{\text{A input frequency}}$

To measure the draw in a percentage, use the frequency ratio mode. Set the Scale Factor to “multiply by 100” and set the Offset to “ -100” .

$$\text{Draw \%} = \frac{B - A}{A} \times 100 = \frac{B}{A} \cdot 100 - 100$$

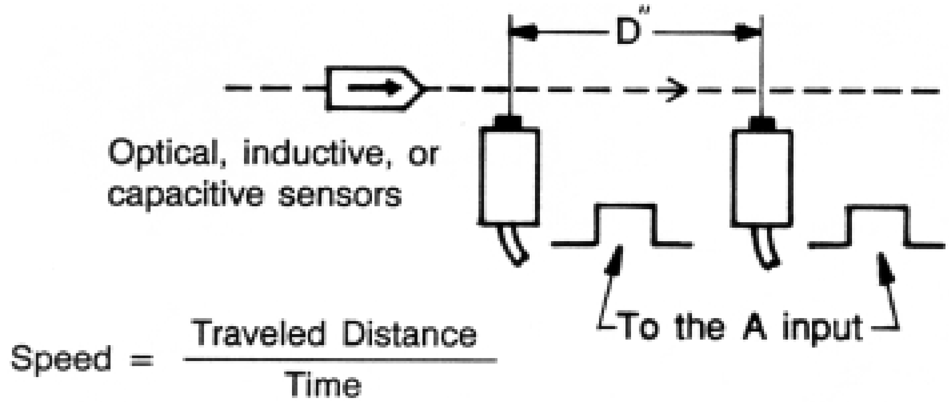
Features used:

Function - set to Fr b/A
Scale - set to “multiply by 100”
Offset - set to “ -100”

PUSH	DISPLAY SHOWS	NOTES
ENTER	Func	
SET	Fr b/A	Press until Fr b/A is flashing.
ENTER	SCALE	
SET	A .SC	If A/SC, press again to get A.SC.
ADVANCE	→ 1.00000	This is the default scale factor value. Press until the decimal point is flashing.
SET	→ 100.000	Set the decimal point in the position shown.
ENTER	OFFSEt	
SET	000000 → -00000.	This is the default value of OFFSET. Press until the minus sign is flashing.
ADVANCE	-00000.	Press until digit #3 is flashing.
SET	-00 100.	Press once.
ENTER	noStor	Press until no Stor is flashing.
SET	StorE	
ENTER	Fr b/A → measurement	Display shows the new function momentarily. A measurement replaces this display.

SINGLE-EVENT SPEED MEASUREMENT

In some applications it is necessary to measure the speed of a moving object and to display the speed in miles per hour (mi/hr).



Place two sensors or switches, D inches apart. Use Frequency mode and select zero Gate Time. (The meter will use 2.5 - 3.0 millisecond gate time.)

To find the speed in inches per second (in/sec):

$$\text{Display} = \text{Scale Factor} \times \text{Frequency (Hz)} = \frac{1}{\text{T (sec)}} \text{ X Scale Factor}$$

$$\text{Speed (in/sec)} = \frac{\text{D (inches)}}{\text{T (sec)}}$$

To display the speed:

$$\text{Display} = \text{Speed} \Rightarrow \frac{1}{T} \text{ X Scale Factor} = \frac{D}{T}$$

Scale Factor (for in/sec) = D (inches) ; "multiply"

To find the speed in mi/hr:

$$\text{Scale Factor} = \frac{\text{D (inches)}}{63360} \text{ X } 3600 = \frac{\text{D (inches)}}{17.6} \text{ ; "multiply by"}$$

$$\text{OR} \quad \frac{17.6}{\text{D (inches)}} \text{ ; "divide by"}$$

NOTE: The time between pulse A and B must be longer than 3 milliseconds.

If D = 4” :

Features used: Function - set to Frequency mode

Scale Factor - set to “multiply by” $\frac{D}{17.6}$ = .22727 or

“divide by” $\frac{17.6}{D}$ = 4.4

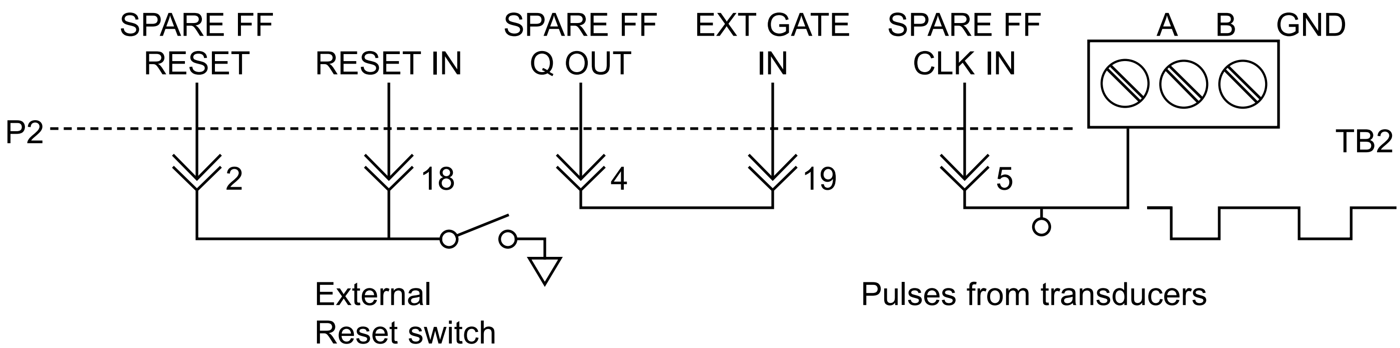
Gate Time - set to 00.00 (The meter will use 2.5 - 3.0 millisecond gate time.)

> NOTE: Reset the meter by pushing the three center pushbuttons prior to each measurement.

PUSH	DISPLAY SHOWS	NOTES
ENTER	SCALE	Press until SCALE is displayed.
SET	A/SC	Press until A/SC is selected.
ADVANCE and SET	1.00000 → 4.40000	Use ADVANCE and SET pushbuttons to program the scale value to 4.4.
ENTER	GAtE t	Push until GAtE t is displayed.
ADVANCE	00.30 → 00.30	This is the default Gate Time.
SET	00.00	Press once for zero.
ENTER	noStor	Press until no Stor is displayed.
SET	StorE	
ENTER	FrEq → measurement	Display shows FrEq until a measurement is done.

HIGH SPEED MEASUREMENTS

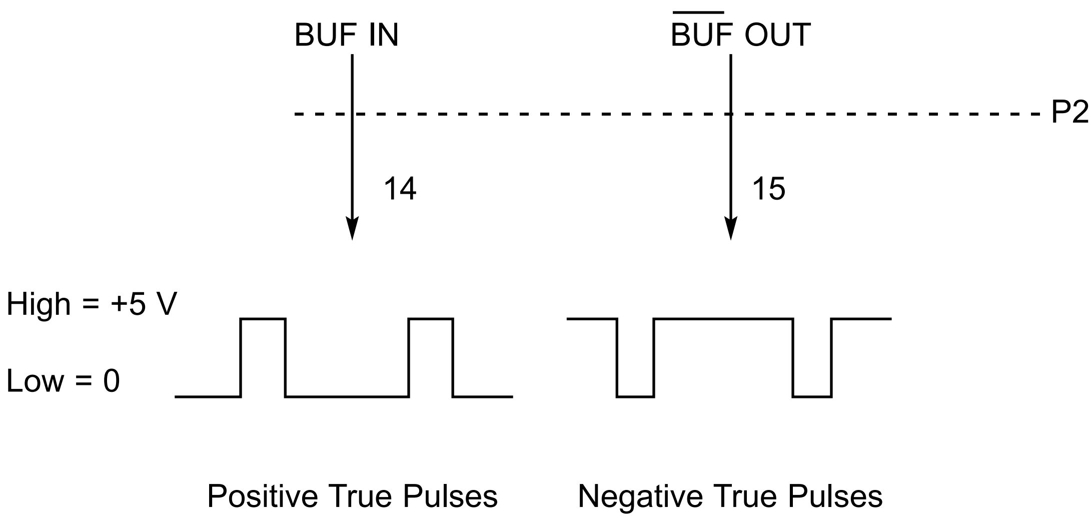
The previous example requires a time of more than 3 milliseconds between two pulses. This limits the maximum measureable speed to 18.9394 D or 75.7576 mi/hr when D = 4”. For faster speed measurements, use the following circuit:



1. Select the scale factor as described in the previous example.
2. Select the negative trigger slope for the A input.
3. Disable the internal gate by setting the software switch SSW #6 of Configuration 1.
4. Reset the meter prior to each measurement by an external switch or pulse connected to pin 2 and pin 18 of P2.

PUSH	DISPLAY SHOWS	NOTES
Select the scale factor as shown in the previous example.		
ENTER	SLOPE	Press until SLOPE is displayed.
SET	→ A nEG	Set the trigger slope to A negative.
ENTER	CnFG 1	Press until CnFG 1 (Configuration 1) is displayed.
SET	→ 100000	Set SSW #6 to 1 (leftmost digit).
ENTER	noStor	Press until no Stor is displayed. Use SET and ENTER to save the changes in the nonvolatile memory as shown in the previous example.

> NOTE: If your tranducers generate positive true pulses, use the spare inverter to convert them to negative true pulses.



With this circuit, very high speed measurements are possible. The only limitation is that the two pulses should not overlap.

To measure the speed of a bullet in mi/hr:

1. Place two optical sensors 10” apart.

2. Use the above circuit and install the SA-F push-on jumper on the main board for better accuracy.

3. Select the Scale Factor as described in the previous example. (Scale Factor “multiplier” = .56818 or Scale Factor “divider” = 1.76) The turn on and turn off delays of the optical sensors determine the maximum measureable speed. For example, if the sensor can generate a pulse as short as 5 μs and the bullet is 1” long, the maximum speed is 11363 mi/hr.

READING ZERO WHEN THERE IS NO INPUT

If the meter input is disconnected during a measurement, the last reading remains on the display permanently. Although this is a requirement in very low frequency measurements, it is undesireable in some applications.

To make the meter read zero in frequency mode when the input is disconnected, use a signal conditioner option (P6A1A/DPFX300, P6A2A/DPFX400, or P6A3/DPFX200) to reset the meter. The default setting of P6A1A/DPFX300 provides a low true signal on pin 2 of TB2 (B input) when the input frequency is less than 9 Hz. This signal can be used to reset the meter by connecting it to pin 18 of P2, the RESET input. On the P6A3/DPFX200, a similar signal is generated on pin 4 of TB3 when the input frequency is less than 0.7 Hz. The RS-232, however, is not updated; and alarm outputs will be in the no-alarm state (open collector).

A new feature is provided in the new version of the meter's microcomputer (part #49943-03 which is printed on the 40 pin chip) to read zero when input pulses are missing for more than about 2 seconds (1.92 to 2.56 seconds). To enable this feature, software switch SSW #4 of Configuration 1 must be set as follows: CnFG 1 = XX1XXX. If the Gate Time is more than 2.56 seconds, the meter will wait longer.

The alarm outputs, RS-232, parallel BCD, and analog outputs, are updated like a true zero measurement.

Gate Time (in seconds)	Time with no input to read zero (in seconds) (CnFG 1 = XX1XXX, U5 = 49943-03
0 TO 2.55	1.92 TO 2.56
2.56 TO 5.11	2.56 + (1.92 TO 2.56)
5.12 TO 7.67	5.12 + (1.92 TO 2.56)

Table E-1 Time with No Input to Read Zero

The meter comes with AC power as standard (115 V ac or 230 V ac). A DC power supply board is available as an option. Refer to Figure 3-1 for location of rear pins.

F.1 CHANGING VOLTAGE OPERATION

Operation	Install	Remove
115 V	W2, W3	W1*
230V	W1*	W2, W3

* Insulated wire recommended.

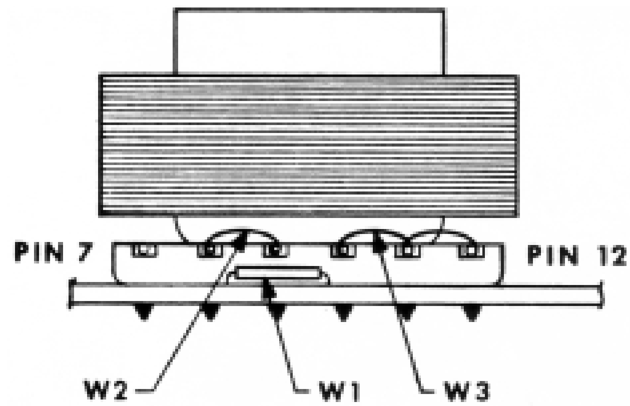


Figure F-1 Side View of Transformer

AC Power Supply

In the AC powered units, pin 11 of P2 is an unregulated voltage, 5.5 to 9 V and pin 8 of P2 is a +5 V regulated voltage. In nontotalize functions, a total of 50 mA can be drawn from these outputs to drive external circuitry. In totalize function, 20 mA can be drawn if normal or dim display brightness has been selected.

Alternatively, pin 11 can be used as a power input for backup battery connection. Connect the backup battery to this pin with a diode as shown in Figure F-1. The backup battery should be capable of supplying 60 mA at 6 to 12 V. When the AC power is disconnected, the display turns off. If the external battery can supply 400 mA, display blanking may be prevented by connecting the BLANK ENABLE, pin 16 of P2, to ground. In this case, if the battery voltage is higher than 9 V, the maximum display brightness must not be used.

The backup battery does not drive the isolated signal conditioner circuitry.

In the absence of AC power, the meter can be powered with a 5 V ±5% regulated voltage. Connect the external +5 V to pins 8 and 12 (+5 V and V+) of the P2 connector.

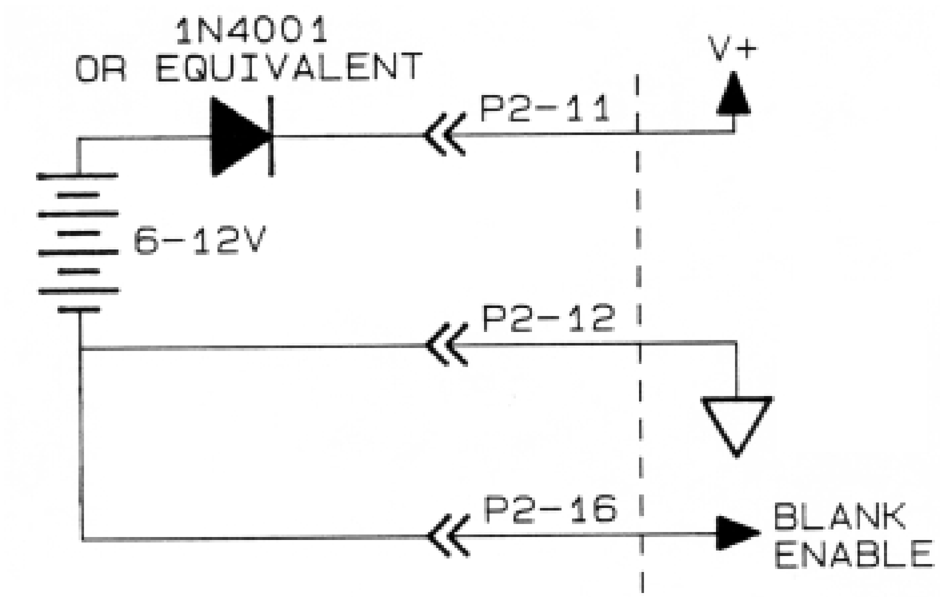


Figure F-2 Connection of an External Battery

DC Power Supply Option

The power transformer is replaced with a DC to DC converter, which allows operation with a single DC power source.

Refer to Figure 3-1 for rear pin assignments. Connect a 9.5 to 32 V dc power source capable of supplying 1 A current to TB1-pins 2 (positive) and 3 (negative). The outputs of the DC power supply board power the entire unit.

NOTE: The maximum display brightness must not be used (Configuration 2 must be XXXX1) with a signal conditioner or an upper-board option.

NOTES

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

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RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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