OPERATING AND MAINTENANCE MANUAL

MODEL 8501/8502 PEAK POWER METERS

SERIAL NUMBER 1510476

WAVETEK MICROWAVE, INC.

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1499-19488
Code 13 (3-87)

WARRANTY

Wavetek warrants that all products manufactured by Wavetek conform to published Wavetek specifications and are free from defects in materials and workmanship for a period of one (1) year from the date of delivery when used under normal operating conditions and within the service conditions for which they were furnished.

The obligation of Wavetek arising from a Warranty claim shall be limited to repairing, or at its option, replacing without charge, any product which in Wavetek's sole opinion proves to be defective within the scope of the Warranty. In the event Wavetek is not able to modify, repair or replace non-conforming defective parts or components to a condition as warrantied within a reasonable time after receipt thereof, Buyers shall be credited for their value at the original purchase price.

Wavetek must be notified in writing of the defect or nonconformity within the Warranty period and the affected product returned to Wavetek's factory or to an authorized service center within (30) days after discovery of such defect or nonconformity.

For product warranties requiring return to Wavetek, products must be returned to a service facility designated by Wavetek. Buyer shall prepay shipping charges, taxes, duties and insurance for products returned to Wavetek for warranty service. Except for products returned to Buyer from another country, Wavetek shall pay for return of products to Buyer.

Wavetek shall have no responsibility hereunder for any defect or damage caused by improper storage, improper installation, unauthorized modification, misuse, neglect, inadequate maintenance, accident or for any product which has been repaired or altered by anyone other than Wavetek or its authorized representative and not in accordance with instructions furnished by Wavetek.

Exclusion of Other Warranties

The Warranty described above is Buyer's sole and exclusive remedy and no other warranty, whether written or oral, is expressed or implied. Wavetek specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. No statement, representation, agreement, or understanding, oral or written, made by an agent, distributor, representative, or employee of Wavetek, which is not contained in the foregoing Warranty will be binding upon Wavetek, unless made in writing and executed by an authorized Wavetek employee. **Under no circumstances shall Wavetek be liable for any direct, indirect, special, incidental, or consequential damages, expenses, losses or delays (including loss of profits) based on contract, tort, or any other legal theory.**

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ALPHABETICAL INDEX GIVING THE LOCATION OF KEY WORDS AND FUNCTIONS USED AND DESCRIBED IN THE "OPERATION" SECTION OF THIS MANUAL

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Remote Operation:

Complete setup and measurement capabilities accessible via GPIB (IEEE-488). Reporting of errors, malfunctions, operational status, and self-test diagnostics available through serial poll capability.

Direct Plot Output:

Outputs hardcopy pulse profile plots, including time, date and part identification, to a GPIB plotter.

GPIB Address:

Selectable from front panel

IEEE Interface Functions:

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, TE0, LE0

General:

Stored Setups:	Saves settings at power down, and has 10 additional setups in non-volatile memory.
Self-Test:	Self-test is optionally performed at any time. A diagnostic code indicates the cause and location of any errors.
Reset Control: (Rear Panel)	Returns instrument to present default condition.

Design and Construction:

To the intent of MIL-T-28800C, Type III, Class 5, Style E or F, Color R

Power Requirements:

100, 120, 220, or 240VAC ±10%
50, 60, or 400Hz ±5%

Power Consumption: Approx. 100VA

Environmental Characteristics:

Temperature:

Operating:	0° to $50^\circ C$ ($+32^\circ$ to $+122^\circ F$)
Non-operating:	-40° to $+65^\circ C$ (-40° to $+149^\circ F$)

Humidity:

Operating: (without precipitation)	95% ±5% to $30^\circ C$ 75% ±5% to $40^\circ C$ 45% ±5% to $50^\circ C$

Physical:

Dimensions: (H x W x D)

Bench Mount:

With Feet:

148.3 x 425.7 x 355.6 mm
(5.84 x 16.76 x 14.00 in.)

Without Feet: (Instrument Only)

132.6 x 425.7 x 355.6 mm
(5.22 x 16.76 x 14.00 in.)

Rack Mount:

132.6 x 482.6 x 355.6 mm
(5.22 x 19.00 x 14.00 in.)

Conforms to EIA RS-310 Standard for a 19" rack.

Weight:

Model 8501:	12 kg (26 lbs)
Model 8502:	13 kg (28 lbs)

1.2.2 Detector Specifications

Frequency Ranges:

High Speed:	750MHz to 18.5GHz 750MHz to 26.5GHz 750MHz to 40GHz

(High speed detectors can be used down to 500MHz.)

Low Speed:	30MHz to 18.5GHz 30MHz to 26.5GHz

Rise Time:

High Speed: Less than 15ns

(Typical = 10ns)

Low Speed: Less than 750ns

(Typical = 500ns)

Power Range:

Measurement:	-20 to +20dBm (Pulse) -40 to +20dBm (CW)
Absolute Maximum: (Damage Limit)	+23dBm (200mW)

Return Loss (SWR):

	Type N, APC7	Type K
Below 2GHz	23dB (1.12)	25dB (1.12)
2 to 12.4GHz	20dB (1.22)	20dB (1.22)
12.4 to 18GHz	16dB (1.37)	16dB (1.37)
18 to 26.5GHz		14dB (1.50)
26.5 to 40GHz		10dB (1.92)

Calibration Factor Uncertainty

Frequency	Sum of Uncertainties(%) [1]	Probable Uncertainty(%) [2]
Below 10GHz	2.6%	1.2%
10 to 18GHz	6.9%	3.7%
18 to 26.5GHz	10%	6.5%
26.5 to 40GHz	20%	10%

[1] Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NBS.

[2] Square root of the sum of the individual uncertainties squared. (RSS)

Measurement Uncertainty: (Root of the sum of the squares)

The total Measurement Uncertainty will consist of the Calibration Factor Uncertainty (see the preceding table) plus the Calibrator Uncertainty at 1GHz (= 1.5%) plus the Mismatch Uncertainty of the Calibrator and Detector at 1GHz (= 0.6%) plus the Linearity if not near 1mW (= 3%) plus the uncertainty due to noise if operating at low signal levels plus the Mismatch Uncertainty of the Detector and Source under test.

Typical Example:

Frequency = 6GHz, Source Return Loss = 10dB

Calibration Factor uncertainty at 6GHz:	2.6%
Calibration uncertainty at 1GHz:	1.5%
Mismatch uncertainty of Calibrator and Sensor at 1GHz:	0.6%
Linearity (if not near 1mW):	3.0%
Noise (see preceding section on Accuracy):	±3.5uW
Mismatch of sensor and source:	3.2%

Total mismatch uncertainty = 10.9% ±3.5uW

RSS Value = 5.34% ±3.5uW

Physical:

Dimensions:

37 mm (1.44 in.) Diameter
103 mm (4.05 in.) Length

Weight: 0.3 kg (0.7 lbs)

2. INITIAL INSTRUCTIONS

2.1 RECEIVING INSPECTION

Inspect the instrument for shipping damage. Be sure that all portions of the shipment are located before discarding any packing material or shipping containers. (See Section 6 if a Performance Verification test is required.)

2.2 POWER REQUIREMENT

WARNING: Before applying ac mains power to the instrument, be sure that the instrument is set for the correct line voltage.

The unit is set at the factory for operation at the normal supply voltage for the country in which it is sold. The input frequency must be 50, 60, or 400Hz $\pm 5\%$. The combination of the module and transformer design allows instrument operation of 100, 120, 220, or 240 volts. Conversion from one voltage to another can be made by changing the voltage selection PC board. (See Figure 2-1, below.)

2.3 CHASSIS GROUNDING

DANGER: FAILURE TO PROPERLY GROUND THE INSTRUMENT CAN ALLOW HIGH VOLTAGES TO BUILD UP ON THE CHASSIS. THE VOLTAGE LEVELS COULD BE DANGEROUS TO OPERATING PERSONNEL.

The instrument is supplied with a three-conductor NEMA type power cord. The current carrying conductor is white and its return is black.

The green wire of the power cord is for connection to earth ground. The instrument will be properly grounded if the plug is connected to a properly installed three-prong receptacle. If a three-prong to two-prong adapter is used, be sure that the pigtail lead of the adapter is earth-grounded.

2.4 DETECTOR PRECAUTIONS

The Model 8501/8502 detectors are configured in a metal housing to provide superior mechani-

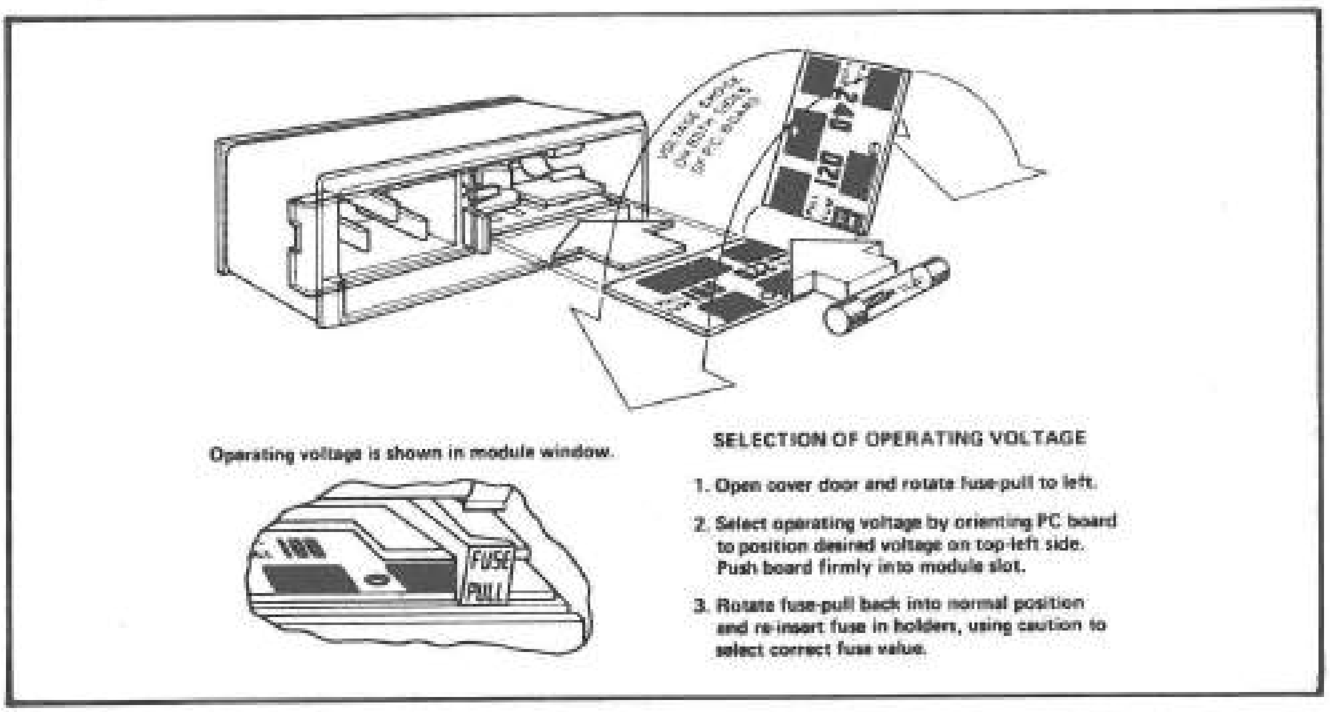

Figure 2-1. Voltage Selection

cal performance as well as excellent shielding. When connecting the detectors to other devices or components it must be remembered that **THE BODY OF THE DETECTOR SHOULD NEVER BE TURNED IN ORDER TO TIGHTEN THE RF CONNECTION.** Mechanical damage may result if improper handling is attempted when connecting the detectors.

WARNING: All Wavetek Model 8501/8502 detectors contain balanced, zero biased Schottky diodes for power sensing. If the detector is connected to CW or Peak power devices whose power output is in excess of +23dBm (200mW) degradation or total destruction of the diode can occur. Diodes degraded or destroyed in this manner will not be replaced under warranty.

2.5 RETURNING THE INSTRUMENT

If it is felt that the instrument should be returned to Wavetek Microwave for any reason, it is recommended that the Wavetek Microwave Customer Service Department be contacted before the unit is sent back. It is often the case that many problems can be resolved by telephone or Telex without the necessity of returning the instrument. The telephone number is (408) 734-5780, extension 260, or Telex 371-6460.

3. OPERATION

3.1 INTRODUCTION

The Model 8501/8502 meters are designed to be very simple to operate. The operator basically has only to follow the instructions given in the prompts and menus shown in the LCD display window to set up the necessary parameters for making a measurement. Ten levels of specific, operational menus are available that can be accessed with the MENU key. The type of measurement (Peak or CW) being made at any particular time will also be shown in the lower right corner of the LCD window to remind the operator which mode is in use.

Along with the menus and prompts given on the LCD display, the 8501/8502 meters use five different audible tones to indicate the occurence (or non-occurence) of certain events during setup and testing. These tones are called "clicks", "chirps", "chimes", "blats", and "warble", and are defined as follows:

Click: When a key is pressed and a "click" is heard, this means that the key is active and its function will be included in whatever parameters are being keyed in at the time. If no click is heard, the key is not active and not performing any function at that time.

Chirp: When a "chirp" is heard after pressing a key, this indicates that the key cannot be used as part of the particular setup sequence being keyed in at the time.

Chime: A "chime" is heard when a function that takes a specific amount of time to complete, such as self test or auto zero, has completed. Further commands can then be keyed in.

Blat: A "blat" indicates that an improper entry has been attempted. For example, the number of samples to be taken for pulse averaging can only be entered with up to three digits (1 to 999). If an attempt were made to enter, say, 1000, a blat would be heard when the last zero was pressed and the zero would not be added.

Warble: The "warble" tone is heard when a self test or calibration function does not pass due to an error of some type. An error message will be presented on the LCD display screen.

The actual sounds and usage of these tones will become apparent while the first operational sequence is being performed. There is a volume control on the rear panel of the instrument which can be used to adjust the audio tones to any desired level.

NOTE: In the remainder of this section, except where specified as Model 8501 or 8502, the instrument will be referred to as just "PPM" (Peak Power Meter).

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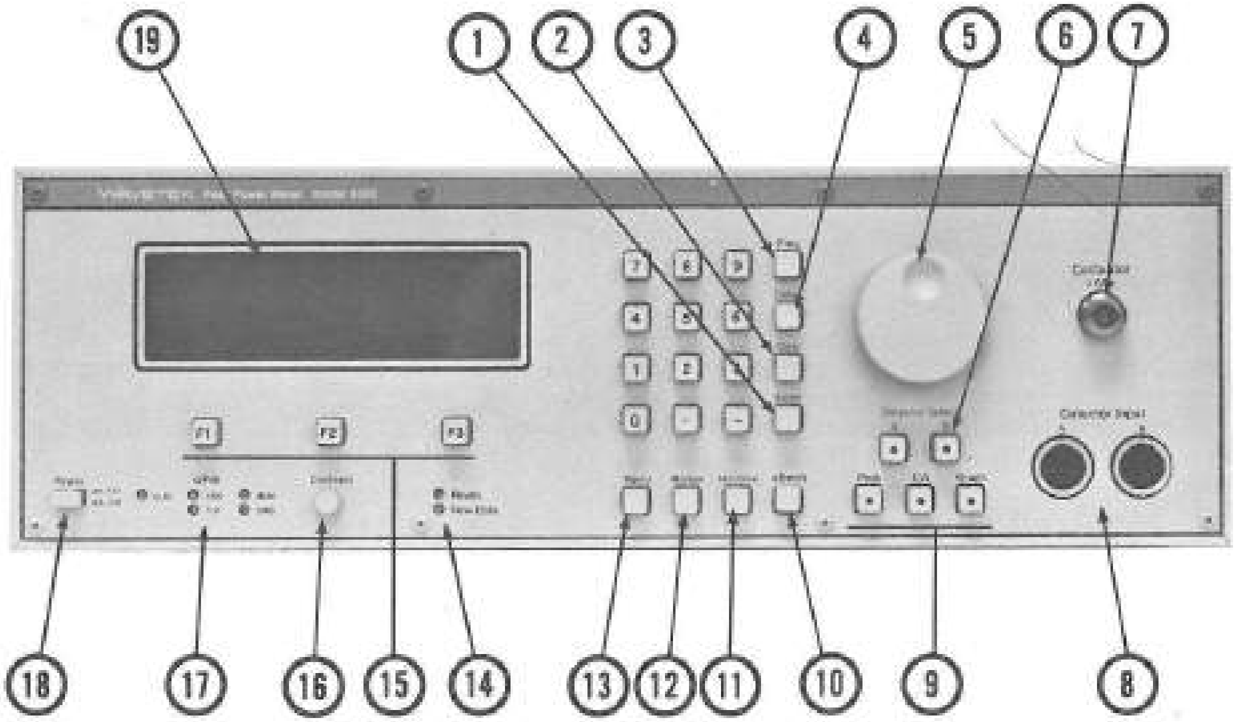
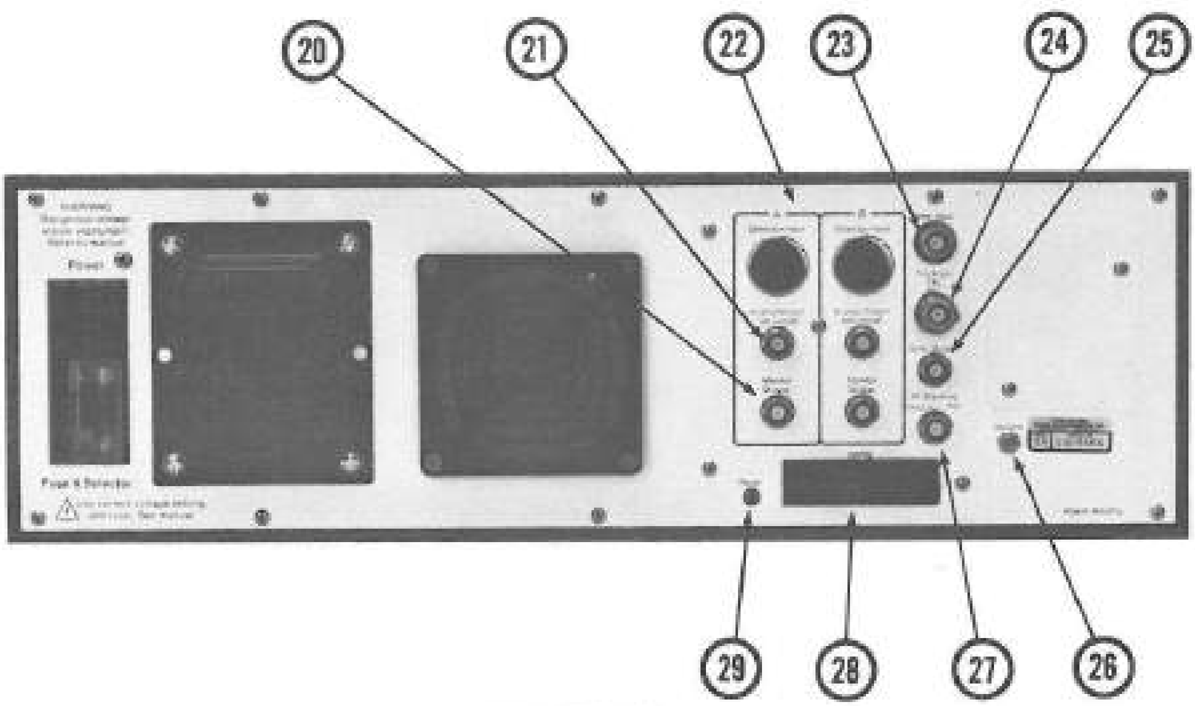


FRONT PANEL



REAR PANEL

Figure 3-1. Model 8501/8502 Controls, Connectors, and Indicators
(See corresponding numbers in Section 3.2 for descriptions.)

3. OPERATION

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5. **HAND WHEEL** (Large Knob)

The Hand Wheel is used to change the value of selected parameters. The ability to use the wheel will be indicated on the display by the appearance of a delta symbol (Δ) next to the name of the parameter of interest. For instance, when in the Peak Mode, pressing the DELAY key will cause the " Δ" to appear next to the "DLY" indication. This means that the Hand Wheel can be used to change the Cursor Delay setting. Pressing ENTER terminates the use of the Wheel and causes the " Δ" to disappear.

6. **DETECTOR SELECT A or B** (8502 only)

These keys are used to select which channel should display data on the Model 8502 display. They are also used at times to indicate to the 8502 for which channel a trigger level entry is intended.

In the CW and Peak Modes it is possible to display measurements for either channel A, channel B, or both at the same time. In the Graph Mode, only one channel at a time can be viewed.

When the 8502 Ratio Mode is in use, the A and B keys call up a menu so that the type of signal to be ratioed (CW or Peak) can be specified for the selected channel. This is useful for cases where it is desired to determine the ratio between a CW and a Peak signal. For example, a radar TWT might have a pulsed output, but its input could be CW. To measure its gain, the Peak output would have to be subracted from the CW input. The 8502 does this instantly and automatically.

7. **CALIBRATOR** Connection

The CALIBRATOR connection is used for the automatic calibration of the PPM's detectors. The detector's frequency response characteristics are read over its entire dynamic range from the factory-measured data stored in the PROM inside the detector housing, and then used for normalizing the power readings during test routines. (See Section 3.5.2 on page 3-12 for the Self-Calibration procedure.)

8. **DETECTOR INPUT** Connections

These receptacles provide the input from the A and B channel detectors in the Model 8502. The Model 8501 has a single input.

9. **PEAK, CW, GRAPH** Keys (Mode Keys)

These keys select whether the PPM will be used for CW or Peak power measurements. GRAPH is used when making Peak power measurements to allow the graphic display of the detected pulse and easy determination of pulse timing factors. In addition to the LCD readout display indications, the selected mode is also made obvious by noting which LED in the center of the PEAK, GRAPH, and CW keys is lit. If the Model 8502 is being used for Dual Channel operation and all of the power LED's are out, then it is in the Ratio Mode. (See Ratio Measurements, Section 3.6.6.5 on page 3-34.)

10. **dB/mW** Key

In all of the modes of operation, the dB/mW key is used to determine which units of power the PPM will display. For absolute power measurements, the units are dBm or mW. The PPM will autorange similar to most Digital Voltmeters when mW is selected. If the power is very low, then the PPM will display power in uW or nW to provide more measurement resolution. If the Offset function has been activated, the reading could be in W (Watts).

If the Marker Mode is in use (only accessible from the Graph Mode -- see Section 3.6.3.3.1 on page 3-19), the dB/mW key will call up a menu. This menu offers the choice to display power in dBm, mW, or in % Reference power. The % Reference power is useful for searching out specific points such as the 10% or 90% points on a pulse.

When using the dual channel Model 8502 in the Ratio Mode, the dB/mW key is used to select either dB (Ratio A/B) or linear numbers to some exponent to arrive at a percentage figure.

11. **MEMORY** Key

The MEMORY key can be used to activate three Memory Menus. Pressing the key once causes the display of Memory Menu #1. Pressing the key twice shows Memory Menu #2, and three times shows Memory Menu #3. Pressing CLEAR returns the routine to the Data Display Mode.

The Memory Menus control the usage of the PPM's non-volatile setup memories. The contents of the 10 available memory locations can be Stored, Recalled, Initialized, and Displayed. The menus also give the user the option to return to the current test setup (the one in use just before the MEMORY key was pressed), as well as the option to return to the initial power-on status. See Section 3.8 on page 3-40 for more information on the PPM's memory capabilities.

12. MARKER Key

The MARKER key functions only in the Graph Mode. When MARKER is pressed, the PPM will enter the Marker Mode. The Marker Mode is used to place markers on the pulse profile being displayed on the LCD screen during the use of the Graph Mode. These markers can be used to determine parameters such as risetime, falltime, and pulse width. The GRAPH key is pressed when it is desired to exit the Marker Mode. Note that the Marker Mode uses the Delay Window settings that were selected while in the Graph Mode. While in the Marker Mode, the routine will not allow the changing of the Start or Window Delays, or the selection of the Autoscale function.

13. MENU Key

The MENU key allows access to the ten Main Menus of the PPM. Depending on the mode of operation, other keys can cause the display of sub-menus that pertain to the particular function of that key. However, the MENU key will cause the routine to step through each of the Main Menus each time it is pressed. If it were pressed, say, three times, then Menu #3 (or simply MENU (3)) would be presented on the display.

A specific description of each menu that will be presented at each keystroke of the MENU key is given in Appendix B, starting on page 3-50 of this section. Wherever possible, commands or user selections that would normally be used more often are located at the "top" of the menu structure (i.e. MENU (1) through MENU (4)). Less commonly used menus are located toward the "bottom" of the menu structure (i.e MENU (5) through MENU (10)).

14. "Ready" and **"New Data"** Indicators

These LEDs flash whenever the system is receiving a trigger. If the "Ready" light is steadily on and the "New Data" light is off, it would indicate that a trigger was not being received.

15. F1, F2, F3 Function Keys

These keys activate functions as displayed on the LCD display screen. F3 is used in the Graph Mode to change the Internal Trigger Level or the Reference Power Level. Otherwise, these keys are only used while making selections from a menu. When the PPM is in the Marker Mode, the F3 key is used to display a list of markers that have been set and show their delay times (i.e. the amount of time between the reference delay and the occurence of the marker).

16. CONTRAST Control Knob

This control adjusts the intensity of the information being presented on the LCD display screen, and should be adjusted for the clearest display in relation to the angle from which the LCD display window will be viewed while testing is being performed.

17. GPIB Indicators

These LEDs indicate whether the PPM is under local or remote (REM light on) control, and the current GPIB status. (LSN = listen, TLK = talk, SRQ = service request, and LLO = local lockout.)

18. POWER Switch

This is a push-push type switch used to turn on and off the ac power to the PPM.

19. LCD Display

This is the PPM's alphanumeric and graphic display screen for presenting data and showing pulse waveform profiles.

3.2.2 Rear Panel Description

20. MONITOR Output

This connection can be used to interconnect a test instrument such as an oscilloscope to externally monitor the detected signals entering the PPM.

21. ANALOG Output

100mV/dB output for interfacing the PPM with the WMI Model 1038-NS20 or N10 Scalar Analyzers for making swept peak power measurements. (See Section 3.7.2 on page 3-39 for description.)

NOTE: When using the PPM in the 1018B Emulation Mode, it should be kept in mind that the 1018B instrument has a 10 mV/dB analog output while the PPM has 100mV/dB. If the 10mV/dB output of the 1018B is required, a 10:1 resistive divider network should be employed to reduce the PPM's 100mV/dB output.

22. DETECTOR Inputs

These channel A and B inputs (the single input of the 8501) will be just blank cover plates unless option 03 (Rear Panel Connection) has been specified. In that case, the Detector Input and Calibrator connections will not be present on the front panel and will, instead, be located here. The Calibrator connection would be above the Serial/Code number label on the right side of the rear panel.

23. FREQ Input

This is a voltage proportional to frequency input connection that can be used to receive the Frequency Reference or V/GHz output signal from an external signal generator. This signal can be used to provide frequency information to the PPM for detector frequency response correction when required.

24. TRIG Input - TTL

This connection is used to interface a signal source to provide an External Trigger when this mode of operation is desired.

25. SYNC Output

For synchronizing the PPM to an external counter.

26. VOLUME Control

This control can be used to adjust the level of the audio tones generated by the PPM.

27. RF BLANKING Output - TTL

A blanking signal is available here that can be used to turn off the RF power of the external signal source when it is desired to autozero or calibrate the detectors.

28. GPIB Connection

This is the interface connection for controlling the instrument through the GPIB (IEEE Bus).

29. RESET Switch

This control is available to return the PPM to an initial "power-on" condition without having to turn off the instrument.

3.3 INITIAL PROCEDURES

Basic operation of both the Model 8501 (single detector) and the Model 8502 (dual detector) meters is essentially the same for making standard peak power and CW measurements. The single channel 8501 does not, of course, have the ratio measurement capability of the dual channel 8502. The following instructions are generally written to define the operation of both instruments. If a Model 8501 is being used, please ignore references to "A" and "B" keys, distinctions between the "A" and "B" channels, and reference to two detectors. If the instructions require that a distinction be made between the two instruments, the specific model number will be given rather than "PPM".

3.3.1 Power On Procedures

1. Before turning on the power to the PPM, be sure that it is set for the correct input voltage. (Section 2.2 on page 2-1 of the Initial Instructions section describes the setting of the operating voltage.)

2. Connect a detector to the PPM's front panel DETECTOR INPUT connection (channel A) using the Wavetek detector cable (P/N 16956-XXX) supplied with the system. (See the next paragraph for connection instructions.) If a dual channel Model 8502 is to be used, detectors should be connected to both the channel A and channel B inputs for dual channel operation.

   To connect the cable to the detector housing pull back on the metal sleeve at the detector end of the cable, align the red dots, and make the connection. To connect the other end of the cable to the front panel DETECTOR INPUT receptacle, again pull back the metal sleeve, align the red dots on the cable and input receptacle, and make the connection.

3. Turn on the power by pressing the power switch at the lower left corner of the front panel.

3.3.2 Power-On Display

The following display will appear on the PPM LCD display at initial turn-on:

> *Be sure no RF is applied to detectors*
> *Press ENTER to start self-test*
> *Press CLEAR to skip self-test*

Selecting ENTER initiates the Self-Test. (See Self-Test, Section 3.7.3 on page 3-40) After self-test passes (or if CLEAR is pressed), the display will change to the Initial Mode Selection Menu which will be:

F1 for 'CW' display format	*F2 for Autoscaling and 'Graph' display*	*F3 for last setup at turn-off*

Pressing F1 selects the CW Mode (Channel A). (See CW Mode, Section 3.6.2 on page 3-15.)

Pressing F2 selects the Graph Mode. (See Graph Mode, Section 3.6.3.3 on page 3-19.) If a detected pulse is present, its profile will be "Autoscaled" (the complete pulse shown) on the LCD display.

NOTE: If there is no pulse or the pulse power is less than -3dBm at the channel A detector input, the instrument will not attempt to autoscale. Then, either the power must be increased until autoscaling begins or another mode of operation must be selected.

Pressing F3 selects the panel setup that was in use just prior to the last time the power was turned off. This is useful for starting in wherever testing was last discontinued without the necessity of having to go through a setup procedure again.

3.3.3 Warm Up Time & Temperature Indication

When initially operating the PPM, it is common to see a prompt in the upper left corner of the display stating "RECAL A: dT XXX DEGS-C." The number of degrees shown is the difference between the present temperature of the detector and the temperature at which it was last calibrated.

The prompt only occurs if the change in detector temperature is more than $\pm 5^oC$. When this prompt is displayed it means that sufficient time should be allowed for the instrument to warm up so that accurate readings can be taken. Variations of less than $\pm 5^oC$ from the calibration temperature do not result in a temperature prompt display because minor temperature changes in the detector are monitored and compensated by the 68000 microprocessor.

If the PPM continues to display the temperature prompt after 30 minutes warm up or if the room ambient temperature changes by more than 5 degrees Celsius, a Self Calibration will be required. (See Self Calibration, Section 3.5.2 on page 3-12.)

3.4 MODE SELECTION

3.4.1 Selecting CW Operation

In the initial Power-On display (see Section 3.3.2), pressing F1 will select the CW Mode. If the routine is at any other data display point (not Menu display), press the CW key. To enter the CW Mode directly from power-on press:

CLEAR + F1

If a menu is being displayed and it is desired to escape and go to the CW Mode press:

CLEAR → CW

If in the Peak or Graph mode, press CW to access the CW Mode.

NOTE: If the Model 8502 is being used in the Ratio mode, selecting CW will cancel RATIO and the 8502 will display the CW power of channel A.

In certain instances the option will be given to select the CW Mode if there is some reason that another mode is not operating properly. For example, if a trigger had not been provided as required in the Peak Mode. This is to allow an escape from erroneous modes of operation.

Very few adjustments or menu selections are required to set up the unit for CW measurements. The two major settings that must be specified are defined as follows:

A. Frequency

(See FREQ Key description, Section 3.2.1. Number 3 on page 3-4.)

Selects the operating frequency at which the power will be measured. Normally, the PPM will automatically adjust for detector frequency response variations by using the factory measured frequency response data stored in the ROM in the detector housing. Other options are available as detailed in Frequency Correction, Section 3.6.1 on page 3-13. Not compensating for the frequency response of the detector could result in an error in the power measurement reading.

B. CW Averaging

Selects how many samples of the signal being measured will be taken and averaged to reduce noise effects at low power levels. To adjust the averaging number, press MENU twice, then F1. A number between 1 and 999 averages must then be entered. Note that the number of averages presently in effect is not indicated until the averaging menu has been entered.

3.4.1.1 LOW POWER LEVEL MEASUREMENTS (below -30dBm)

When the PPM is used in the CW mode, its dynamic range is extended to below -40dBm. Under low power testing conditions, it is necessary to observe the correct auto-zeroing procedures in order to obtain the highest measurement accuracy. Periodic zeroing should be done more often in environments where the temperature changes drastically. (See Section 3.5.3 on page 3-12 for the auto-zeroing procedure.)

3.4.2 Selecting Peak Power Operation

If it is desired to enter the Peak Mode for the first time since the unit was turned on, first follow the instructions for entering the CW Mode. Then, press the PEAK key on the front panel. After this, follow the trigger setting guidelines given in Section 3.4.2.1 below. Lack of a trigger can cause a blank or frozen display. To exit either of these situations either the trigger can be set, or the CW Mode can be re-accessed by pressing the CW key. The Peak Mode can be accessed from the initial power on state by pressing:

CLEAR → F1 → PEAK

If a menu is being displayed and it is desired to escape to the Peak Mode press:

CLEAR → PEAK

If in the CW or Graph Mode, Peak is accessed by pressing PEAK

3.4.2.1 TRIGGERING

To be able to make measurements in the Peak (or Graph) Mode, the first thing that must be done is to ensure that the system receives a triggering signal that will drive its timebase and crystal based delay generator. After this is done, the delay generator functions to accurately place a sampling window at the desired time on the pulse to be measured. The different triggering methods are detailed below.

3.4.2.1.1 Internal Triggering

The PPM can generate its own Internal Trigger from the detected RF video envelope at the detector output. This triggering mode requires that the power of the RF pulse be greater than the Internal Trigger Level. The Trigger Level is an adjustable threshold at which the rising, leading edge of a pulse will cause the PPM to take a reading. The precise time at which a reading is taken following the trigger is determined by the delay generator. This function of the PPM is called Cursor Delay. (See the Cursor Delay description given in Section 3.6.3.3.2.B on page 3-20.)

Normally, the Trigger Level is set at -10dBm (default). The internal trigger level can be adjusted if desired by pressing MENU once, then selecting F1. A trigger level value between -10 and +16dBm can then be entered.

NOTE: If there is no RF pulse present at the detector input or if the pulse amplitude is too low, the PPM will not internally trigger. When this occurs the LCD display may be blank, the "New Data" light will not be lit, and the "Ready" light will not be on.

If a dual channel Model 8502 is being used, the routine will ask whether internal triggering is to be driven by inputs from channel A or channel B. Selection is made by pressing the appropriate DETECTOR SELECT A or B key. To select the Internal Trigger Mode and set the level press:

(8501) MENU (1) → F1 → nn.nn

or

(8502) MENU (1) → F1 → A (or B) → nn.nn

(nn.nn = selected trigger level numbers)

3.4.2.1.2 External Triggering

For some test routines it may be desirable to provide an external trigger to the system. This can be especially useful if the trigger pulse from the external source leads the RF pulse at the detector input by a small amount of time. Readings can then be taken just prior to the arrival of the RF pulse allowing close inspection and measurement of the pulse's leading edge.

To use the External Trigger Mode, connect a BNC cable from the TTL sync pulse output of the system under test (or pulse generator) to the External Trigger input on the rear panel of the PPM. To select the External Trigger Mode, press the MENU key once, then select F2. After this has been done, correct operation of the External Trigger Mode is verified by noting that the "Ready" and "New Data" lights on the front panel are flashing.

If an attempt is made to operate in the External Trigger Mode without supplying the required trigger as described above, the LCD display will freeze, the "Ready" light will be on, and the "New Data" light will be out.

To select External Trigger press:

MENU (1) → F2

3.4.2.2 SELECTING GRAPH MODE OPERATION

3.4.2.2.1 General Information

The Graph Mode of the PPM provides graphic capabilities for the display, plotting, and analyses of RF pulse profiles. The same triggering methods previously described for the Peak Mode of operation also apply to the Graph Mode. Features are available which allow measurement of commonly required pulse parameters such as risetime, pulse width, etc.

When the system is operating satisfactorily in the Peak or Graph Modes, it is possible to toggle back and forth between the two modes by pressing the PEAK or GRAPH keys whenever desired. The only exception to this is when an 8502 is being used in the dual channel mode of operation since the Graph Mode does not allow dual channel operation. If a dual channel function is being used and it is desired to switch to the Graph Mode, single channel operation must first be selected. (See Dual Channel Operation, Section 3.6.6.3 on page 3-32.)

The ability to toggle back and forth between Peak and Graph Modes is useful for a number of reasons. For example, in the single channel Peak Mode, the LCD display produces very large, distinct power readout characters that can be read from a distance. (See Figure 3-2 on page 3-17.) In addition, while in the Peak Mode, the current frequency being used for the test is directly visible on the display. In the Graph Mode, the display is primarily used for inspection of the pulse profile and the frequency is not displayed to allow room on the display for other important pulse profile parameters. (See Figure 3-3 on page 3-19 for a typical Graph Mode display.)

All operating parameters such as trigger mode, frequency, and cursor delay are maintained in both the Peak and Graph Modes. The Graph Mode can be used to place the cursor at a specific point on the pulse, and then the PEAK key can be pressed to see the power reading displayed using the large readout characters.

3.4.2.2.2 Entering the Graph Mode

To use the Graph Mode, the triggering selection guidelines discussed in Section 3.4.2.1 on page 3-9 must be followed.

The easiest way to enter the Graph Mode from the power-on state is to select "Autoscaling" (F2). If a pulse larger than -3dBm is present at the selected channel's detector input, the system will attempt to autoscale the pulse on the LCD display. Under some conditions, autoscaling cannot take place due to the complex shape of the pulse or other timing factors. The PPM will then display only a part of the pulse on the LCD display. The reference level will be correct for rectangular pulses. The PPM will not have been able to set an appropriate Delay Window for the pulse. It may be possible to subsequently autoscale by changing the initial delay value for autoscaling to be closer to twice the actual pulse width for the pulse in question. This is done by selecting:

MENU (8) + F2 + n.nnnn + ENTER

(n.nnnn = initial delay in us)

Another method to access the Graph Mode is to first select the CW Mode and then press the GRAPH key. This method allows entering the Graph Mode without regard to triggering parameters. In addition, entering the Graph Mode by this method sets all of the Graph Mode parameters such as Cursor Delay and Delay Window to their default values.

To enter the Graph Mode and Autoscale the pulse from the power-on state, press:

CLEAR + F2

To enter the Graph Mode and obtain the default settings from the power-on state, press:

CLEAR + F1 + GRAPH

If a menu is being displayed and it is desired to escape to the Graph Mode, press:

CLEAR + GRAPH

If in the Peak, CW Mode, or Ratio Modes (previous Graph or Peak Mode settings will apply), press GRAPH.

A sub-mode of the Graph Mode is available for the placing of markers on the pulse profile. The Marker Mode can only be accessed while in the Graph Mode by pressing the MARKER key. When the marker routine is in use, a different set of menus applicable to graphic and marker processing become available. (See Section 3.6.3.4 on page 3-24 for a complete discussion of the Marker Mode.)

3.5 SELF-CALIBRATION & AUTO-ZEROING

3.5.1 General Information

The purpose of the PPM's Self-Calibration (Self-Cal) function is to ensure that measurement accuracy will be maintained despite changes in detectors, changes in detector diode temperature, or other changes that might occur in the PPM's analog circuits.

During the time the instrument is performing its Self-Cal routine, the RF output of the 1GHz calibrator is accurately stepped from +20 to -30dBm. Each step is measured by an internal standard and, at each point, the calibrator output power as measured by the RF detector is compared to the standard. The power readings are then digitally adjusted by the PPM's microprocessor and stored in memory. For power levels below -30dBm, the system relies on the Auto-Zero function as well as the inherent repeatability of the detector's voltage output versus input power at these levels. (Refer to Section 5.9 on page 5-32 of the Electrical Description section for a complete description of the automatic calibration system.)

In order to make any type of power measurements with the PPM it will be necessary to use the appropriate calibration and zeroing procedures to ensure the highest accuracy.

After the instrument has warmed up for 30 minutes and the mode of operation has been selected, a detector self-calibration should be performed. In addition, if the ambient room temperature changes more than $\pm 5^{o}C$ from the temperature at which the system was last calibrated, self-calibration should also be done. If there has been a change in the temperature of the detector of more than $\pm 5^{o}C$ since it was last calibrated, the difference will be shown.

3.5.2 How to Self-Calibrate

1. Connect the channel A detector to the 1GHz CALIBRATOR output connection.

2. Press the MENU key once, then press F3 to call up the Cal or Zero Detectors menu.

3. The menu offers the following choices:

F1 to Calibrate the Detectors	*F2 to Auto Zero the Detectors*	*F3 to Return to Data Display*

   Select F1 for the detector self-calibration.

4. The display will then show the last date and time the detector was calibrated. To proceed with the calibration, press the ENTER key. The Self-Cal process takes about 50 seconds during which time the statement "A (or B) CALIBRATION IN PROGRESS" will be displayed.

   If a Model 8501 is in use, pressing the CLEAR key will return the routine to the data display (the last mode of operation). If the Model 8502 is being used, pressing the CLEAR key will bypass the channel A calibration and go to the channel B calibration.

   After successful completion of the Self-Cal function, the instrument will go back to displaying data in the last mode of operation. With the Model 8502, either bypassing or successfully completing the channel A calibration will take the routine to the channel B calibration.

5. Channel B calibration is done in the same manner as the channel A calibration. The date and time of the last B channel calibration will be presented, and the option will be given to either press ENTER to start the cal procedure or to press CLEAR to return to the data display.

3.5.2.1 SELF-CALIBRATION FAILURES

In the event of some type of malfunction such as a burned out detector diode or if the operator forgets to connect the detector to the calibrator, the Self-Cal function will fail. If this occurs, the following error menu will be displayed:

A Calibration Error Exists
Press CLEAR to Continue
Press ENTER to Repeat Cal

Selecting CLEAR returns the instrument to the last mode of operation.

Selecting ENTER gives the operator the opportunity to correct a simple error such as not connecting the detector to the calibrator. This can be accomplished, and then the Self-Cal procedure can be repeated.

(See Section 7.4.4 #6 on page 7-14 of the Maintenance Section of this manual for the procedure to follow if the PPM fails the Self-Cal.)

3.5.3 Auto-Zero Function

To initiate the Auto-Zero function, turn off the RF power to the detector to be zeroed and then press the MENU key once. Select F3 to get to the Self-Cal/Auto-Zero menu. Then select F2 to Auto-Zero and follow the displayed prompts. The keystrokes to Auto-Zero are:

MENU (1) → F3 → F2

If the Model 8502 is in use, channel A must be Auto-Zeroed before channel B, or channel A can be bypassed by pressing CLEAR and going directly to channel B.

3.6 MEASUREMENT PROCEDURES

3.6.1 Frequency Correction, Cal Factor, and dB Offset

The Frequency Correction and Offset functions are used to enhance measurement accuracy, and to compensate for detector amplitude and frequency response variations as well as devices residual to the test setup.

Frequency correction is selected in Menu #3. Three methods of frequency correction are available (and will be described in detail in this section). These are:

a) PROM Table -- User Supplied Frequency (default mode).

b) PROM Table -- External Frequency Input (uses the 1V/GHz output of the sweeper)

c) User Supplied Calibration Factor (allows direct entry in dB)

To select the desired mode, press:

MENU (3) → F3

Then select F1, F2, or F3 respectively, for items a, b, or c. This will determine the functioning of the FREQ key of the instrument.

Whenever a mode is selected that will use the PROM table in the detector assembly for frequency correction, the PPM will interpolate between the discrete amplitude correction points stored in the detector's PROM. This allows entry of frequencies other than those stored in the PROM, and reduces the need for operator interpretation and manual correction of power readings.

NOTE: All of the information stored in the PROM of the detector currently in use can be reviewed by accessing MENU (9) and pressing F2 for channel A, and/or F3 for channel B (for the 8502).

3.6.1.1 PROM FREQUENCY CORRECTION (User supplied frequency)

This is the default mode of the instrument. Factory measured frequency correction data is stored in a PROM inside the detector housing, thus eliminating the need for the operator to refer to a frequency correction chart and then make manual adjustments to the system for each discrete frequency point. The PROM data is used by the PPM to correct for all of the detector's amplitude variations across its entire frequency range. When the system is first turned on, the PROM data stored in the detector (or detectors) is transferred to the main memory of the PPM.

To select the "PROM Table - User Supplied Frequency" mode, press:

MENU (3) → F3 → F1

The display will then ask for the frequency of operation to be entered. The default frequency is 1GHz, the same as that of the Calibrator. Press ENTER to complete the entry.

After selecting the "PROM Table - User Supplied Frequency" mode, use of the FREQ key allows the entry of the Carrier Frequency and gives the microprocessor the ability to correct for any detector frequency response deviations.

3.6.1.2 PROM FREQUENCY CORRECTION (External Frequency Input)

The purpose of the PROM Frequency Correction function is to allow entry of the operating frequency by means of an externally applied voltage. The voltage level will be proportional to the frequency, and will be used by the PPM to correct power readings for detector frequency response.

When this function is active, the RF frequency of a sweep generator or signal source can be changed and the PPM will convert the analog voltage input (coming in through the rear panel FREQUENCY INPUT connection) to a digital representation of the frequency. The PPM's microprocessor then uses this information to correct power readings according to the frequency correction table stored in the detector's PROM.

If the sweep generator (sweeper) is equipped with a rear panel output providing frequency information, this information will usually consist of an analog voltage proportional to the RF frequency output of the sweeper at any given time. Some sweeper manufacturers refer to this voltage as "Frequency Reference", "Volts/GHz (V/GHz)", or "Voltage Proportional to Frequency" ($V \propto F$). The most common coefficients for this output are 1V/GHz and 0.5V/ GHz.

Once the $V \propto F$ frequency correction function has been activated, the FREQ key can be used to change the parameters for use by the $V \propto F$ function.

To activate the $V \propto F$ frequency correction function, perform the following:

1. Connect a BNC cable from the V/GHz output of the sweeper to the FREQUENCY INPUT connection on the rear of the PPM.

2. Make the following keypad entry:

   MENU (3) → F3 → F2

   The instrument will then ask for the sweeper V/GHz value (will normally be 1 or 0.5). Press n.n → ENTER (where n.n is volts).

   The Sweeper Start Voltage is required next. If the sweeper's frequency range is from 2 to 18GHz and the sweeper V/GHz coefficient is 0.5V/GHz, then this value would normally be 2 x 0.5 = 1. Press ENTER to complete this entry.

   The last entry required is the Sweeper Start Frequency. If the same sample shown above were used, then the value entered would be 2. Press ENTER to complete the entry.

The above steps set the frequency scaling factor for the PPM so that the analog voltage coming in from the FREQUENCY INPUT connection can be interpreted to the correct frequency by the PPM's microprocessor.

3.6.1.3 USER SUPPLIED CAL FACTOR

Where the user prefers to use their own detector frequency response correction factors, the PPM provides a means to correct for any detector frequency response variations manually (in dB). An example where this could be necessary is when the data stored in the detector's PROM might be out of date.

To activate the Cal Factor feature of the system, press:

MENU (3) → F3 → F3

If the dual channel 8502 is being used, you will be asked to select a channel. Select A or B as appropriate.

Next, the value of the desired Cal Factor must be entered in dB. Complete the entry by pressing ENTER.

When using the Cal Factor mode, the frequency of operation is unknown to the PPM. Therefore, the Cal Factor will be shown on the LCD display instead of Frequency. This also serves to notify the operator that this mode is in effect. The LCD readout will display the Cal Factor as "CF = nn.nn dB."

NOTE: In the Cal Factor mode of operation the FREQ key is used to alter the Cal Factor (dB), not the frequency.

3.6.1.4 OFFSET

(Offsets data readings by a user selectable dB figure)

The Offset feature of the instrument is capable of digitally offsetting the displayed power value within a range of -40 to +90dB. The offset will be in effect whether the measurement is in dBm or linear power in milliwatts.

The Offset function is mainly useful for two purposes. One is the ability to add or subtract minor correction factors to correct for possible errors that might be introduced by attenuators or other devices in the test setup. The other purpose is the ability to adjust the reading in high power measurement situations where it is desirable to read the correct power directly on the display despite the fact that the unattenuated power being tested is well above the measurement range of the detectors.

In the latter case, a high power coupler is normally used to attenuate the signal to a level that can be safely measured by the detectors (less than +20dBm). If the exact coupling factor of the coupler being used is known, the Offset feature can then be used to subtract it out. Then the display will accurately show the high power present at the device under test. (However, the detectors only see the coupled power which has been attenuated to avoid burning out the detector diode.)

To offset the displayed power reading, press:

(8501) MENU (3) → F1
or
(8502) MENU (3) → F1 or F2

(F1 is for the Model 8502 channel A offset and F2 is for the channel B offset.)

After the Offset function has been selected, enter the desired offset in dB and then press ENTER.

When the Offset function has been activated, an asterisk (*) will appear next to the "FREQ" indication on the LCD display to indicate to the operator that an offset is in use. (If the Cal Factor function is in use, the asterisk will be next to the "CF" indication.)

The display will appear as:

"*FREQ = nn.nGHz" or "*CF = n.nndB"

3.6.2 CW Power Measurement

To make a CW measurement be sure that the PPM has warmed up for at least 30 minutes, and then perform the following steps:

1. Select the CW Mode as described in Section 3.4.1 on page 3-8.
2. Self-Calibrate the PPM. (Section 3.5.2 on page 3-12.)
3. Determine that the power range to be measured will not exceed the maximum power capability of the instrument (**<u>must</u> be less than +23 dBm**). If it will, connect an attenuator or coupler to the output of the device under test to bring the power down into the range of the PPM, and use the attenuator or coupler's output as the measurement point for the detector attachment. If in doubt, use a 10dB attenuator. This should prevent a mild overload that might only result in detector degradation rather than burn out.
4. Be sure the RF power of the source is <u>completely</u> OFF.
5. Connect the detector to the power source being measured.
6. Auto-Zero the detector by pressing:

   MENU (1) → F3 → F2 → ENTER

   or, if channel B of a Model 8502 is to be zeroed:

   MENU (1) → F3 → F2 → CLEAR → ENTER

When a "chime" is heard, this indicates that a successful auto-zero has been accomplished. If a "warble" is heard, then either there was RF power present at the detector input or there could be a failure. (If a failure is suspected, then run the Self-Test procedure given in Section 3.7.3 on page 3-40.)

7. Upon successful completion of the auto-zero function, turn on the RF power of the source to be measured.
8. Take into account the detector's frequency response so that an accurate reading can be made at the frequency of operation. If the External Frequency mode (i.e. PROM Table and Sweeper Back Panel) is being used, this step is unnecessary. (See Section 3.6.1.2 on page 3-13 for more information.) The keystrokes are as follows:

   FREQ → nn.nn → ENTER

   If the PPM is in the "PROM Table - User Supplied Frequency" mode, nn.nn is the Carrier Frequency in GHz.

   If the PPM is in the "User Supplied Calibration Factor" mode, nn.nn is the Cal Factor in dB.
9. If a coupler or attenuator is being used at the detector input, enter the attenuation value as a positive offset. For example, if an attenuator with a value of 30.2dB at the frequency of operation were being used,

the required offset would be entered as follows:

(8501) MENU (3) → F1
or
(8502) MENU (3) → F1 or F2

(Select F1 for channel A, F2 for channel B)

Then enter the value of the offset in dB, followed by ENTER:

30.2 → ENTER

10. The PPM will now be reading CW power, and the display will look something like:

A: +35.26dBm

**FREQ=10.78GHz CW*

NOTE: +35.26dBm represents the power at the input of the attenuator which is connected to the detector input. The actual power at the detector input would be +35.26 - 30.2 = +5.06dBm.

11. Select the number of samples to be taken to arrive at an average reading (default is 4 readings):

MENU (2) → F1

Then enter the number desired followed by ENTER.

The number of samples that can be taken to arrive at an average can be between 1 and 999. For power levels below -30dBm, it is recommended that more than 100 samples be taken to reduce noise effects.

12. To change the displayed power reading from dBm to milliwatts or vice versa, press the dB/mW key.

3.6.3 Peak Power Measurement

3.6.3.1 METHOD 1: PEAK MODE via GRAPH AUTOSCALE

There are several methods that can be used to make Peak Power measurements with the system. The easiest method is to use the Autoscaling function in the Graph Mode. The Autoscaling function only operates on pulses greater than -3dBm. Complex pulse shapes such as double pulses cannot always be successfully autoscaled. Methods for these situations will be covered later.

After the pulse to be measured has been successfully autoscaled, it is only necessary to press the PEAK key and the system will read the power at the center point of the pulse. The readout will be displayed on the LCD screen in large alphanumeric characters. For the following procedure, assume that either a single channel Model 8501 is being used or just channel A or channel B of the dual channel 8502.

3.6.3.1.1 Autoscaling Procedure

1. Connect the detector(s) to the PPM and allow it to warm up for 30 minutes. Then conduct the Self-Cal procedure as described in Section 3.5.2 on page 3-12.

2. Connect the channel A (or B) detector input to a pulsed signal greater than -3dBm. When the Autoscaling function is initiated the system will attempt to automatically select the correct Start and Window delay times which will center the pulse on the display. If the signal at the detector RF input is less than -3dBm (or there is no pulse present at the input), then the system will not trigger and the following display will appear:

   Waiting for trigger on A (or B) Detector Signal

F1 for Trig Mode or Level Change	*F3 for CW Data Display*

   If it is still desired to "Autoscale" at this point, the easiest thing to do is to increase the RF power until the power at the detector input is greater than -3dBm. Then the system will start to trigger and the autoscaling process will begin.

NOTE #1: The Autoscaling function of the PPM does not allow automatic scaling when using an External Trigger signal input.

NOTE #2: The factory-set default pulse width is 75us (pulses wider than 75us cannot be Autoscaled when using the default setting), and the default pulse averaging is four samples for the Autoscaling function. This can be changed to allow the user to enter a different pulse width and averaging number by accessing Menu #8 (press the MENU key 8 times), and then following the prompts given in that menu. Once the pulse width and/or pulse averaging has been changed from the default setting, the values will remain at the new setting whenever the instrument is turned off and on again. The values are not affected by recalling setups, or are they reset at power-on. See Appendix D on page 3-59.

3. In order to Autoscale, the system must be in the Graph Mode as described in Section 3.4.2.2 on page 3-10.

4. Press CLEAR to initiate the Autoscale function. If the previously mentioned triggering requirements have been met, the PPM will display the statement, "AUTOSCALING IN PROGRESS." When the Autoscaling has successfully completed, the pulse profile will be centered in the graphics display area on the left side of the LCD readout window. The Cursor (displayed as a vertical line with spaces just above and below the point where it crosses the pulse) will be located at the center of the pulse profile. If all of the above has occured, go to Section 3.6.3.1.2.

Due to the many varieties of pulse widths, pulse shapes, and duty cycles that might be encountered, it is not always possible for the PPM to autoscale. If the failure to autoscale is the result of a pulse being present that is wider than the 75us default setting, the setting can be changed by accessing Menu #8, making the change, and then repeating the autoscaling procedure detailed in this section. It is best to keep the initial delay less than the pulse repetition period since the time to Autoscale is affected by both of these values. Alternatively, one of the other methods given in these instructions should be employed to use the Peak or Graph Modes.

3.6.3.1.2 Power Display

1. Press the PEAK key. The PPM will now display the power reading at the Cursor location in large alphanumeric characters, similar to the display shown in Figure 3-2, below. At the lower left of the display will be the statement "DLY = n.nnn us". This is the Cursor Delay which indicates the time difference between the pulse's initial triggering point and the point where the reading was taken. (If the triggering method is changed, a given Cursor Delay does not necessarily guarantee that the power reading will be taken at exactly the same point on the pulse as it was before.)

Figure 3-2. Typical Single Channel Peak Power Display

2. Press FREQ and enter either the RF operating frequency or the Cal Factor in dB.

   (This step is not required if the External Frequency input mode is being used.)

3. Enter any required offset as described in Section 3.6.1.4 on page 3-14.

4. If desired, the Peak Averaging can be changed by pressing:

   MENU (2) → F2 → nnn → ENTER

   (nnn = number of samples to be averaged - must be between 1 and 999. Default is 4)

5. The power will then appear on the display.

6. To change the time at which the power readings are taken, press the DELAY key. When this is done, a small delta symbol (Δ) will appear next to the DLY indication on the screen ("Δ DLY = N.NN ns" - see Figure 3-2). The delta symbol means that the

Hand Wheel on the front panel can now be used to alter the Cursor Delay time. As an alternative, Delay entries can also be made through the keypad.

After the selection has been made for the desired delay time, pressing ENTER will enter and then terminate the selection. This also prevents the Hand Wheel from being accidentally bumped and moving the cursor to some undesired delay time.

3.6.3.2 METHOD 2: PEAK MODE - DIRECT ACCESS

For the purposes of this procedure, assume that either the single channel 8501 or only channel A of the dual channel 8502 is being used. The procedures for channel B of the 8502 are almost the same as those for channel A. However, if it is desired to use the Internal Trigger function with channel B, this must be selected by using the MENU key as described in Section 3.4.2.1.1 on page 3-9.

1. Allow the PPM to warm up for 30 minutes, then conduct the Self Cal procedure as described in Section 3.5.2 on page 3-12.

2. Select the Peak Mode of operation (Section 3.4.2 on page 3-9), being sure to observe the triggering guidelines given in Section 3.4.2.1. If there is no external trigger available or if there is any uncertainty as to which method to use, use the Internal Trigger.

3. To verify that the PPM is in the desired mode and that it is receiving the proper triggering, check the following:

   a) The light in the center of the PEAK key should be lit. (If not, this means that the Peak Mode has not been entered.)

   b) The "Ready" and "New Data" lights should be flashing. (If not, then the system is not receiving a trigger. If external was selected and no triggering indication is observed, try the Internal Trigger function. The RF pulse power level must be greater than -10 dBm.)

4. Once Step 3 has been successfully accomplished, the PPM should be taking readings in the Peak Power Mode. However, the cursor might not be positioned on the specific pulse of interest at this time.

If the Peak Mode is being accessed for the first time since the instrument was turned on, then the Peak Mode settings will be at their default values. Otherwise, the settings will be those which were in use the last time the Peak Mode was exited. The easiest way to ensure that all of the Peak Mode settings are at their default values is to select Peak operation after turning the system off for a few seconds. Turn the instrument on again, and then press:

CLEAR → F1 → PEAK.

The LCD display of the PPM should look something like Figure 3-2.

An indication of "-------" instead of a number in the power readout portion of the display would indicate that the power being sampled is below the measurement range of the system. This means that either the overall power of the pulse is too low, or that the cursor has not been placed on a sufficiently high powered section of the pulse of interest. (Another possibility could be that there is no RF present at all. In that case, however, the PPM would not be triggering if Internal Triggering were being used and there was not enough RF at the detector input.)

NOTE: If the External Trigger mode is being used, the likelihood of obtaining a meaningful power reading at this point depends on the timing relationship between the RF pulse at the detector input and the external trigger pulse coming in through the rear panel input connection of the instrument.

If the trigger pulse and the RF pulse are coincident in time, then the default Cursor Delay time of 1us will probably result in the Cursor being located somewhere on the pulse. This depends, of course, on the pulse width exceeding 1us.

It is recommended that Internal Trigger is used before using the External Trigger mode so that certain pulse information such as pulse width can be obtained. This can save the effort of having to search for the pulse using the Cursor Delay function. (Using the Graph Mode makes searching much easier.)

5. As previously mentioned, the delta symbol (Δ) next to the DLY indication on the display means that the Hand Wheel is active and, if turned, will alter the value of the Cursor Delay (CSR DLY). To locate the highest power point on the pulse, it is best to start at the rising edge of the pulse and move the cursor gradually up in time until the power reading reaches its maximum point. This can be done as follows:

   a) Turn the Hand Wheel counter clockwise until the Cursor Delay is zero (i.e. "DLY = 0.000ns" on the display).

   b) Slowly rotate the Hand Wheel clockwise while monitoring the power readout display. Note that the increments that the Hand Wheel causes the DLY to step through will change faster as the wheel is turned faster. Rotate the wheel until the power readings begin increasing. This indicates that the leading edge of the pulse being measured is being monitored.

   c) Continue increasing the Cursor Delay until the power readings go through a peak or stay at a high level. If the maximum power point is passed, turn the wheel counter clockwise slowly, thus reducing the cursor delay until the maximum reading is once again reached.

   d) Press the FREQ key and enter either the desired RF operating frequency or the Cal Factor in dB as required. (This step is not necessary if the external frequency input mode is in use.)

   e) Enter any required dB Offset as described in Section 3.6.1.4 on page 3-14.

   f) The power will be displayed similar to Figure 3-2. The desired unit of power measurement can be selected by pressing the dB/mW key on the front panel.

6. If difficulties arise in locating the pulse to be measured, it is advisable to use the Graph Mode with Autoscale.

3.6.3.3 PEAK POWER MEASUREMENTS USING THE GRAPH MODE

3.6.3.3.1 <u>Graph Mode Selection</u>

It is recommended that the basic information pertaining to the Graph Mode given in Section 3.4.2.2. on page 3-10 be read for a better understanding of this function. The Graph Mode display looks something like that shown in Figure 3-3. Pulse profiles are shown graphically on the left side of the display while the right side displays the power and timing parameters pertinent to the pulse.

Figure 3-3. Typical Graph Mode Display

To use the Graph Mode for peak power measurements, follow the instructions given next for accessing the Graph Mode:

1. Connect the detector(s) to the detector connection(s) on the front panel, and allow the system to warm up for 30 minutes. Then conduct a Self Cal as described in Section 3.5.2 on page 3-12.

2. After ensuring that the pulse power of the RF source to be measured is not high enough to cause damage to the detectors (limit to less than +20dBm), connect the channel A detector to the source.

3. Select the Graph Mode of operation. If the instrument has just been turned on this would be CLEAR → F2. The PPM will attempt to autoscale the pulse on the display. If there is no pulse present at the de-

tector input or if the pulse power is below -3dBm, then the PPM will not trigger (the "New Data" light will be out).

While the PPM is Autoscaling, the display will indicate "Autoscaling in Progress". When autoscaling is complete, the pulse will be centered in the graphics area of the LCD display and the vertical cursor will be positioned at the center of the pulse profile. If this has been achieved, proceed to Section 3.6.3.3.2.

If the display does not indicate a pulse centered in the graphics area of the LCD display with the vertical cursor positioned at the center of the pulse profile, then the autoscaling process was not successful.

One possible reason that the PPM might not be able to autoscale is that the RF pulse might be too wide. The default setting of the PPM for the maximum pulse width that can be autoscaled is 75us. If desired, this maximum setting can be changed by accessing MENU (8) and then selecting F2.

3.6.3.3.2 Graphics Display Definitions

After entering the Graph Mode, the display should look something like Figure 3-3.

The delta symbol (Δ) next to any of the parameters means that the Hand Wheel can be used to change the value of that function. When ENTER is pressed, the delta symbol will disappear and the Hand Wheel will be disabled. (This prevents accidental movement of the Wheel.)

A. CSR PWR

Indicates the power level at the location of the cursor. By pressing the dB/mW key, this can be indicated in either dBm or in Watts.

B. CSR DLY

The Cursor Delay indication shows the amount of time after triggering has occured that the Cursor will sample the power of the pulse. The time at which the trigger occurs is dependent on either the Trigger Level or, if External Triggering has been activated, on the triggering signal provided by the external source. The delta symbol next to CSR DLY means that the Cursor Delay is adjustable by using the Hand Wheel.

C. STRT DLY

This is the Start Delay of the graphics display area on the LCD readout. It signifies the amount of time between the occurence of the trigger and when readings begin at the left side of the graphics display. If Autoscale was used to go to the Graph Mode, then the Start Delay would be set to 0.0000 nanoseconds. If the Graph Mode was accessed after power-on through the CW Mode, then the Start Delay would be at its default value of 0.0000 nanoseconds also. However, if the Graph Mode were entered by some other means, then the Start Delay would be set at whatever value was used the last time the Graph Mode was accessed. When the Start Delay is at 0.0000ns, it is coincident with the timing of the trigger.

D. DLY WIND

The Delay Window is the amount of time between the left and right sides of the graphics display area. The default value is 10.000us. When the Autoscale function is used, the PPM will adjust the Delay Window to display the pulse profile so that the trailing edge of the pulse can be seen. Autoscaling decreases the Delay Window in a 1, 2, 5 sequence of nanoseconds or microseconds as required until the trailing edge no longer disappears from view off of the right side of the graphics area.

Entering the Graph Mode with any previous settings still in effect can result in possibly unpredictable values being shown for Cursor, Start, and Window Delays. If there is any confusion, the default values can be obtained by selecting the CW Mode after power-on and then pressing the GRAPH key.

E. "A TRIG = -3dBm" or "EXTERNAL"

This display indicates the present triggering mode of the system. "A TRIG = -3dBm" is the setting automatically made and displayed by the PPM when Autoscale is activated while operating channel A in the Graph Mode. It means that the PPM will trigger when the leading edge of the RF pulse rises above -3dBm at the channel A detector input.

If the dual channel 8502 meter were operated using channel B and autoscale were activated, then the system would be set to trigger internally from the channel B detector at -3dBm. The LCD display would then indicate "B TRIG = -3 dBm".

"EXTERNAL" means that the routine is in the External Trigger mode regardless of which input channel is selected.

F. "F3: TRG LEV/REF PWR" or "RECAL: dT = -7.2C"

The "RECAL: dT = -7.2C" display is only indicated when the detector temperature has changed more than ±5°C, thus advising that measurements might not be accurate and to recalibrate the detector (i.e. conduct a Self-Calibration as described in Section 3.5.2 on page 3-12.) "-7.2C" is, of course, only an example. The actual change depends on the difference in the operating temperature at the moment, and the temperature at which the last Self-Cal was performed.

When using Internal Trigger, "F3: TRG LEV/ REF PWR" provides a means to alter the trigger level (TRG LEV). It also allows the Reference Power Level (REF PWR) to be changed.

1. TRG LEV

To alter the Trigger Level, press F3. A menu will then be displayed similar to:

Press F1 to Enter Trigger Level	*Press F2 to Enter Reference Power Level (For Detector A)*	*Press F3 to Return to Data Display*

To change the Trigger Level, select F1. When this is done, the display will show the delta symbol beside the TRG LEV indication. The Hand Wheel can then be used to alter the Trigger Level, or any desired number can be entered through the numeric keypad. Pressing the ENTER key will terminate the entry and lock in the new trigger level (the delta symbol will also disappear).

2. PWR REF

The PPM's Power Reference nomenclature refers to the manner in which the pulse profile is displayed. Referring to the left hand graphics area of Figure 3-3 on page 3-19, there are four horizontal "tic" (division) marks on the left vertical axis of the display. These tic marks correspond from top to bottom to the 100%, 90%, 50%, and 10% power points on the pulse profile with respect to the Reference Power. The default Reference Power is 1mW. However, once the Autoscale function has been used, the Reference Power is automatically adjusted to whatever the power level is at the cursor location. Therefore, the Autoscale feature not only serves to center the pulse on the time (or horizontal) axis, it also optimizes the display positioning on the power (or vertical) axis by setting the highest power level as the 100% Reference point.

The adjustable Reference Power level is provided to give the user a maximum degree of flexibility in measuring rise time, fall time, or other pulse timing parameters. This is important because it means that the PPM can be set up to accommodate the various types of test parameters that different users might need for their specific measurement requirements.

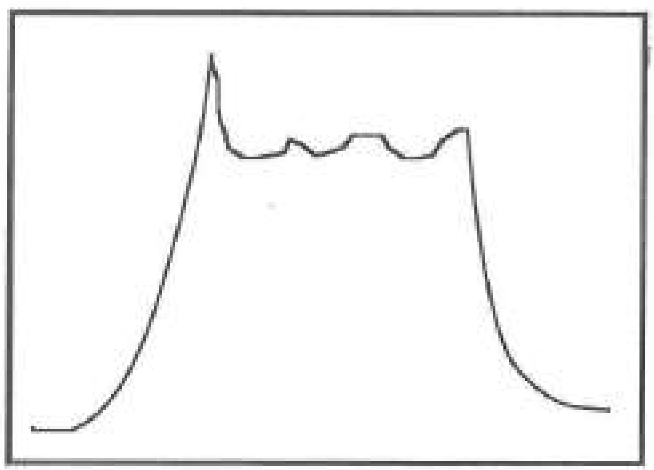


Figure 3-4. Pulse with Overshoot

The pulse shown in Figure 3-4 demonstrates the need for the PPM's flexibility in setting different Reference Power levels. As can be seen by the shape of the pulse, it would not be likely that a user would want to use the top of the pulse's overshoot as the reference level (100% point) for determining the risetime. There are certain conventions, such as risetime being the time between the 10% and 90% power points on a pulse, which are commonly agreed to in the RF/Microwave industry. Some other related definitions remain flexible according to the application. The PPM allows the user to determine what convention will be used in timing measurements.

There are two ways to set the Reference Power Level on the PPM. Select F3 when in the Graph Mode. Then select F2 from the menu shown in Section 3.6.3.3.2.F.1 (TRIG LEV - on page 3-21). When this is done, the choice will be given to either enter the desired Reference Power Level through the keypad or to use the Hand Wheel to move the cursor to the point on the displayed pulse profile that is desired to be the 100% Reference. After setting the cursor or keying in the desired Reference Power Level, the ENTER key is pressed to complete the adjustment. It may be noticed on the display that there is a vertical shift of the pulse resulting in the 100% tic mark lining up with the point on the pulse that is now the Power Reference.

3.6.3.3.3 Graphics Display Area

A. The graphics display area on the left side of the LCD readout window is the area where measured pulse profiles are "drawn" onto the readout. The PPM's crystal-based delay generator determines exactly when a reading is to be taken. The accuracy and stability of the generator makes it possible to use the Hand Wheel to alter the Cursor Delay and change the time at which a reading is sampled in 0.1ns increments. It is not possible to have such resolution graphically except when using the Window Delay in nanoseconds.

As the Window Delay increases, the resolution of power data being written on the display decreases. There are approximately 100 data points in the graphics area of the PPM display. Therefore, depending on the selected scaling, changes in Cursor position or minute changes in the pulse profile may not be noticeable. However, changes in Cursor Power or Delay in the digital readout section at the right side of the display will still be evident. X-Y plotting of the displayed graphic results can assist in evaluating the profile of the pulse being tested. (See Section 3.6.5 on page 3-29 for information regarding plotting functions.)

B. If it is desired to learn duty cycle information about the pulse train being tested, an oscilloscope can be connected to the MONITOR OUTPUT connection on the rear panel of the PPM. While it may be possible to view more than one pulse in a train on the PPM display, this method is not reliable for short pulse widths. This is primarily due to the fact that there is insufficient resolution on the horizontal axis to guarantee that all pulses in a given time frame would be impinged on display pixels in order to be seen.

However, if the approximate time between pulses is known, the Start Delay function can be used to "zero in" on another pulse in the train other than the first one. Another method would be to use an External Trigger pulse that can be delayed in varying amounts, thus allowing data to be taken further along the pulse train.

C. The Cursor is the vertical line that represents the time at which the power reading displayed as CSR PWR is being taken. If Cursor Delay is selected (DELAY + F3), then the Hand Wheel or keypad is used to change the position of the Cursor. The minimum delay of the Cursor is whatever value has been established for the Start Delay.

As previously described in Section 3.6.3.3.2.F.2 (PWR REF) on page 3-21, the tic marks on the left hand vertical axis of the graphics area (power axis) relate to percentage (%) of Reference Power. The tic marks on the horizontal axis of the graphics area (Delay time axis) are spaced 1/10th of the Window Delay apart. This provides a means to estimate certain timing factors of the displayed pulse. For example, if the Start Delay were 0.0000ns (i.e. the left edge of the graphics area was coincident with the trigger), and the Window Delay was 100us, then each of the tic marks along the horizontal axis would represent 10us of delay. If the Cursor were set to approximately 45us, then the Hand Wheel could be used to move the Cursor 4.5 "divisions" from the left side of the graphics area.

3.6.3.3.4 Adjusting Graph Settings

In addition to making automatic risetime, falltime, and pulse width measurements, the PPM is also capable of making time measurements between markers which can be set wherever desired on the pulse profile display. Use of the markers will be covered in the next section.

After Autoscaling, the following adjustments can be made to allow detailed inspection of the detected pulse. If the system will not Autoscale, refer to Section 3.6.3.1.1 on page 3-16.

A. Positioning the Cursor

The following procedure describes how to position the cursor on the displayed pulse and establish a cursor delay.

While in the Graph Mode, press DELAY. The delta sign should be present next to the CSR DLY indication. Turn the Hand Wheel slowly clockwise. Note that the cursor will begin to move, and that the CSR DLY reading will be increasing in time. If the Hand Wheel is moved too quickly, the rate at which the function changes alters dramatically. Therefore, care should be taken when using the wheel. If the cursor should disappear off the right edge of the display, it can be brought back by continuing to rotate the Hand Wheel in a clockwise direction until it reappears or wraps around to the left side of the display.

Another method to recover the cursor if it should disappear (or if it is not on the display to begin with), is to use the keypad. (This can be done as long as the delta symbol is next to the CSR DLY indication.) Divide the DLY WIND (Delay Window) reading by 2 (making allowance for the Start Delay), then use the keypad to enter the resulting time expressed in microseconds. Pressing ENTER terminates the entry, and the cursor will appear in the center of the display.

It is possible to make the position of the cursor the delay reference (cursor delay = 0). Then, delay measurements will be made on the pulse with respect to the reference delay. This means that delays will be negative (or in advance) if the cursor is moved to the left edge of the reference, and positive (or lagging) if the cursor is moved to the right edge. While in the Graph Mode, press:

DELAY + DELAY

Using the Hand Wheel, position the cursor to the point on the displayed waveform at which it is desired to establish the delay reference. Then, pressing the ENTER key will act as a command to set the delay reference to this point. The cursor delay will then read 0.0000 ns, and all timing measurements will be with respect to this point.

B. Changing the Size of the Window

If it is desired to expand the size of the displayed Window so that the leading edge of the pulse can be more closely inspected, press the following keys to adjust the Delay Window:

DELAY + F2

The delta symbol will appear next to the DLY WIND indication. Rotate the Hand Wheel counter-clockwise while observing the display. The value of the DLY WIND should be decreasing. Keep turning the wheel until the leading edge of the pulse is clearly visible for inspection.

If the Hand Wheel is turned far enough, the minimum limit of 12 nanoseconds will be reached. The resulting display will depend on the risetime characteristics of the pulse being sensed by the PPM detector. To reset the Delay Window, either enter the original value via the keypad or Autoscale once more by pressing the CLEAR key.

3.6.3.4 PEAK POWER MEASUREMENTS USING THE MARKER MODE

3.6.3.4.1 Basic Marker Information

The Marker Mode of the PPM is only accessible and usable after successful entry into the Graph Mode. The purpose of the Marker Mode is to provide a means to analyze timing information of the RF/Microwave pulses. The Marker Mode will allow the placement of markers manually, or have the PPM automatically set markers on the displayed pulse profile.

Up to four markers per channel are available. This means that the single channel Model 8501 has four markers available while the dual channel Model 8502 has four markers available for channel A and another four for channel B. However, the Graph and Marker Modes do not allow for the display of two channels at once so it may be desireable to switch back and forth between channel A and channel B graph displays with their independent sets of stored markers.

When the Marker Mode is in use, it is possible to set markers at predetermined points on the pulse profile. These points can be set manually using the Hand Wheel, or the PPM system's Autoplacement function can set them automatically. Autoplacement of markers is determined by Marker Menu selections which identify the manner in which the markers will be set by the PPM. (Markers can be set on the rising edge or falling edge of the pulse profile at specific percentages of the Reference Power.)

Once the markers have been activated and placed on the pulse profile, it is possible to display the time difference between two pairs of markers. For instance, the first Marker Pair Delay Difference displayed could be the rise-time measurement and the second Marker Pair Delay Difference could be the pulse width.

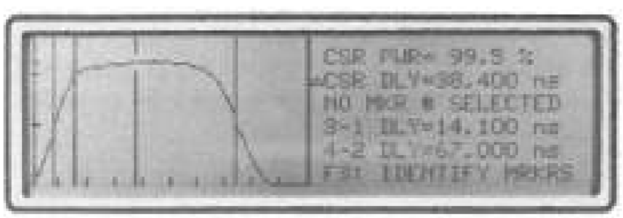


Figure 3-5. Typical Marker Mode Display

While the Marker Mode allows certain kinds of manipulation such as altering the Cursor Delay, other Window settings (Start Delay and Window Delay) cannot be changed unless the routine is returned to the Graph Mode.

3.6.3.4.2 Marker Mode Displays (See Figure 3-5)

The Marker Mode allows the display of CSR PWR (Cursor Power) in dBm, linear power (Watts), or as a percentage of the Reference Power. The % of Reference Power display is useful for placing the cursor at any desired power percentage, and then reading timing information from the display.

In order to be able to select in what form the CRS PWR reading will be displayed, the function of the dB/mW key is modified while operating in the Marker Mode. Pressing the dB/mW key will activate a sub-menu as shown below:

Press CLEAR to return to data display

F1 to Select Log Power Display Format	*F2 to Select Watt Power Display Format*	*F3 to Select % of Ref Pwr Display Format*

3.6.3.4.3 Marker Mode Selection

The procedure for entering the Marker Mode is as follows:

1. Select the Graph Mode by the usual means (see Section 3.6.3.3 on page 3-19).

2. Change the PPM Graph Mode settings by using the Autoscaling feature (press CLEAR), or by manually adjusting the Start and Window Delays so that the pulse to be examined is centered in the LCD readout window.

3. Select the desired Trigger Mode. If markers are to be set on the leading edge of the pulse, it may be desireable to use the External Trigger Mode. A trigger signal coincident with the leading edge of the RF pulse to be measured should ensure that markers can be set at or below 10% of the reference power. Different measurement

situations will call for different setup methods, but the main thing to remember is to set up the PPM so that the entire pulse profile can be seen on the PPM's display window.

4. Select the Marker Mode by pressing the MARKER key once. The first time the mode is entered, no markers will be displayed. The Cursor will be active as indicated by the delta symbol next to the CSR DLY indication on the display. The CSR DLY value will be at the delay time that was set while in the Graph Mode. In subsequent accessing of the Marker Mode, previous marker placements and settings will remain in effect until changed.

   When the Marker Mode is first accessed, the pulse profile will be erased, and then re-written on the display. Marker Menu functions such as Autoplacement will be executed after the first full "sweep" of the pulse profile has been re-written to the display. (During this process, the PPM's microprocessor stores the pulse profile information in a special area of memory dedicated to marker operations.)

5. The next consideration in placing markers on the display is to decide whether they will be set automatically with the Autoscale function, or whether they will be set manually. This will be covered in the following sections.

3.6.3.4.4 Default Values for Autoplacement

After the Graph Mode settings have been successfully adjusted so that the pulse profile is centered on the LCD readout as shown in Figure 3-3 on page 3-19, markers can then be Autoplaced by the PPM on the profile.

When the Autoplacement function is used, markers are set at predetermined percentages of the Reference Power. The default values are as follows:

Marker 1:	10%	rising slope (of profile)
Marker 2:	50%	rising slope
Marker 3:	90%	rising slope
Marker 4:	50%	falling slope

The preceding default marker placement values can be changed while operating in the Marker Mode by pressing the MARKER key once and then selecting F3. When this is done, the display lists the marker autoplacement values, and the opportunity is given to either keep the displayed values or to change them by pressing F1.

Note that any settings, default or otherwise, do not automatically guarantee that a marker will be activated by the Autoplacement process. If the % power of the default reference or the reference that was selected for a given marker is outside the limits of the data profile being displayed in the PPM's display window, then that marker will not be shown.

3.6.3.4.5 Changing Autoplacement Marker Values

To change the values that the PPM will use for the Autoplacement of markers, enter the Marker Mode and press MARKER → F3. The following display will then appear:

Marker 1:	*rising slope, 10.0% of reference*
Marker 2:	*rising slope, 50.0% of reference*
Marker 3:	*rising slope, 90.0% of reference*
Marker 4:	*falling slope, 50.0% of reference*

F1 to change values	*F2 to keep values*

Select F1 to change the % power levels. The next series of display readouts will allow the choice of whether a particular marker will be Autoplaced on the rising or falling slope of the profile, and at what percentage of Reference Power. Once the entry of these values is started, information must be entered for all four markers before returning to the Data Display Mode. It is also possible to leave the values as they are to speed up the entry of information.

3.6.3.4.6 Selecting the Autoplacement Function

To initiate the Autoplacement function, wait until the first "sweep" of the pulse profile has completed after entering the Marker Mode, and then press:

MARKER → F2.

NOTE: The PPM will complete the sweep first before responding to the F2 command if the first sweep of the pulse profile had not completed prior to pressing F2.

If all markers can be placed on the profile at their respective % of power levels, a display similar to Figure 3-5 on page 3-24 should result. The markers are solid vertical lines, whereas the Cursor line has a gap above and below the point where it crosses the trace on the displayed pulse profile. If all of the markers cannot be placed, the PPM will list any markers that were not able to be placed. Press CLEAR to return to the data display.

See Section 3.6.4.2.1 on page 3-28 for possible contributing causes that might make it impossible for the PPM to autoplace a marker. Also, it should be noted that any previously defined markers, including manually placed markers, will be redefined or erased and declared UNDEFINED if they cannot be placed in autoplacement, or are defined not to be placed.

3.6.3.4.7 <u>Autoplacement - Delay Between Markers</u>

After the markers have been successfully Autoplaced, the pulse profile parameter indications on the right hand side will look something like the following:

CSR PWR = +0.44dBm
Δ CSR DLY = 120.60ns
NO MKR # SELECTED
3-1 DLY = 15.500ns
4-2 DLY = 68.800ns
F3: IDENTIFY MRKRS

The fourth and fifth rows on the display indicate the time difference between marker numbers 3 & 1, and marker numbers 4 & 2 respectively. When the default % of power reference for Autoplacement are used, 3-1 indicates risetime (10% to 90% points on the rising slope), and 4-2 indicates the pulse width (50% rising slope to 50% falling slope).

The fourth and fifth rows can be used to display the difference between any two pairs of markers. The default pairs are shown here as 3-1 and 4-2. (See Section 3.6.3.4.9 for more information on manually adding and deleting marker pairs.)

3.6.3.4.8 <u>Marker Timing with Respect to the Reference Delay</u>

By pressing F3 (Identify Markers), a list can be displayed showing the times at which the different markers occur with respect to the reference delay. Pressing CLEAR returns the routine to the Data Display Mode.

3.6.3.4.9 <u>Manual Marker Placement</u>

Manual placement of markers is initiated by entering the Marker Mode, selecting a Marker To Be Defined, and then using the Hand Wheel to place it at the chosen delay. As stated previously, the fourth and fifth rows of the Marker Mode display can be used to show the time difference between two pairs of markers. The procedure for manual placement of markers is as follows:

1. Enter the Graph Mode of operation, and adjust the pulse profile so that it is centered on the display. The entire profile of the pulse should be visible on the LCD readout. This means that the Start Delay should be set to occur before the pulse, and the Window Delay should be long enough so that the pulse has ended before reaching the right hand side of the graphics area of the display.

2. Select the Marker Mode of operation and, to select the Marker To Be Defined, press:

   MARKER → F1 → n → ENTER.

   Where "n" is the marker number (between 1 and 4). If "n" is marker 1, then row 3 of the display will show "SET TO DEFINE MARKER 1". This indicates that the setting of the Cursor Delay (Δ CSR DLY) with the Hand Wheel will determine the placement of Marker 1 on the pulse profile.

3. Adjust the Hand Wheel until the Cursor is moved to the point where Marker 1 is to be located on the pulse profile. Press ENTER to complete the selection. Alternatively, enter the position of the marker, with respect to the delay reference, using the keypad.

Now, "NO MARKER # SELECTED" will be shown again in row 3 of the display. This means that the Cursor Delay function no longer affects the placement of a marker. If the Hand Wheel is moved slowly, it will be noted that there is a "permanent" marker at the old location of the Cursor. At this point Marker 1 has successfully been placed. (This can be verified by pressing F3 to display a listing of the marker timing locations.)

Use this procedure to set all four markers on the pulse profile. The display will show four vertical marker lines as well as the Cursor.

4. To add a Marker Pair for the purpose of displaying a Delay Difference, press:

   DELAY → F2 → n1 → n2 → ENTER

   Where "n1" is the marker number with the larger delay value of the marker pair to be defined, and "n2" is the marker number with the smaller delay value of the marker pair to be defined. The PPM lists the respective marker delays during this process to make the "n1" and "n2" selection easier to accomplish.

When ENTER is pressed, the PPM will return to the Data Display Mode with the defined marker pair delay difference displayed in row 4 or 5.

5. To delete a Marker Pair, press:

   DELAY → F1

If there are presently two pairs of markers activated, the PPM will then display the following:

Press CLEAR to Return To Data Display
Defined MRKR DLY DIFF PAIRS: 3-1, 4-2

F1 to	*F2 to*	*F3 to*
Delete 1st	*Delete 2nd*	*Delete*
MRKR DLY	*MRKR DLY*	*Both*
DIFF PAIR	*DIFF PAIR*	*Pairs*

Select F1, F2, or F3 as desired. The PPM will then return to the Marker Mode display with the appropriate marker pair difference row(s) deleted. This function does not serve to delete the markers themselves. Once markers have been defined, they can be deleted by intializing the PPM and re-selecting the Marker Mode, or they can be deleted by not defining (and therefore placing them) during the marker placement routine.

3.6.4 Typical Timing Measurements

The most commonly used timing measurements required when analyzing pulsed RF/microwave signals are:

- Pulse Width
- Risetime
- Falltime
- Repetition Rate

The first three of these parameters can be measured directly by the PPM and displayed on the LCD readout window. Auxiliary equipment would be required to measure repetition rate, as discussed in Section 3.6.4.4 on page 3-29.

The main problem in approaching these kinds of measurements is defining what power point will be used as the 100% power reference point, and what values consititute "risetime", "falltime", etc.

The 100% power point can be a somewhat arbitrary decision due to the possibility of unpredictable or unconventional pulse shapes. In addition, in some applications, the conventions for defining pulse timing characteristics can vary. The PPM handles these deviations with ease by allowing the operator to define where the 100% power reference occurs, as well as what percentage values will be used for the Autoplacement of markers.

3.6.4.1 POWER REFERENCE (100% Point)

Two methods of defining the 100% Power Reference are available with the PPM. Once the Graph Mode has been entered and the pulse profile is centered in the graphic display section of the readout window, F3 and then F2 are pressed to set the Power Reference. When this is done, the Graph display will return and the Power Reference can be entered in dBm through the keypad.

The second method is to repeat the above steps with the exception of using the keypad, and then to use the Hand Wheel to change the position of the Cursor to the point on the pulse profile which is desired to be the 100% Power Reference. Pressing ENTER then terminates the procedure.

Immediately following the Autoscaling function, the PPM sets the Reference Power level to that of the Cursor. (Autoscale places the Cursor at the center of the pulse.) For many measurement situations, this selection of the Power Reference is adequate for the timing measurements discussed in this section.

To verify the present setting of the Power Reference, the "DISPLAY CURRENT SETUP" function of the MEMORY key can be used. To display the current setting of the Power Reference (channel A), press:

MEMORY (2) → F1 (5)

(Press MEMORY twice, then F1 five times)

The PPM will then display the following:

Instrument Status Readout: 5

A Trigger Level = 501uW
A Ref Power = 1.047mW
A Start Delay = 0.0000ns
A DLY Window = 50.000ns
MORE *EXIT*

To return to the Data Display Mode, press F3.

If a Model 8502 is being used, and it is desired to see the status of the Reference Power for channel B, press the following keys from the Data Display:

MEMORY (2) → F1 (6)

To verify the present setting of the Power Reference in dBm when in the Graph Mode display, press:

F3 → F2 → any keypad number

The display will then change to indicate the present value of the Reference Power Level in dBm. It will be necessary to re-enter this power level if no change is desired.

3.6.4.2 PULSE RISETIME, FALLTIME AND PULSE WIDTH

In most applications, pulse risetime is defined as the time between the 10% and 90% power points on the leading edge of the pulse. The pulse width is defined as the time between the 50% power point on the leading edge of the pulse, and the 50% point on the trailing edge of the pulse. The PPM system's default settings for Autoplacement of marker numbers 1 & 3, and 2 & 4 correspond to the above values.

If it is desired to use values other than the power point percentages given above for risetime and pulse width, this can be done by entering the Marker Mode, and then pressing MARKER → F3 → F1 to enter user selected timing values for marker Autoplacement.

3.6.4.2.1 Risetime and Pulse Width Measurement via Autoplacement

Assuming that the RF pulse being measured is capable of being Autoscaled, use the following procedure:

1. Enter the Graph Mode, then initiate the Autoscale function by pressing CLEAR.

2. Adjust the settings of the Graph Mode so that the entire pulse profile of interest can be seen in the display window. It may be necessary to use the External Trigger mode to ensure that the entire leading edge of the pulse can be seen.

3. Enter the Marker Mode by pressing the MARKER key once. Wait for the pulse profile to be re-written to the display.

4. To Autoplace the markers, press:

   MARKER → F2

Provided all the markers can be placed on the screen at their predetermined % of power reference levels, the PPM display should look something like Figure 3-5 on page 3-24. If it is not possible for the system to place one or more particular marker(s), the PPM will display which one(s) could not be placed. Pressing CLEAR returns the routine to the Data Display Mode with the available markers displayed.

5. After successful marker Autoplacement, rows four and five on the right hand side of the display will be showing the Risetime and Pulse Width respectively. This assumes the default settings for each of the markers.

NOTE: Contributing causes for the PPM being unable to Autoplace a marker are as follows:

- Internal trigger level too high, resulting in the leading edge of the pulse not being visible.
- Change in the RF power level of the device under test.
- Reference Power level set at the wrong level.

3.6.4.3 PULSE FALLTIME

In most applications, falltime is the time difference between the 90% and 10% power points on the trailing edge of the pulse profile. The PPM does not provide default parameters for measuring falltime, however the internal markers can be used as described below.

Assuming that marker numbers 2 and 4 will be re-defined to display falltime, the procedure would be as follows:

1. Follow Steps 1, 2, and 3 of Section 3.6.4.2.1.
2. Press: MARKER → F3 → F1 → F3 → F2 → xx.x → ENTER → F3 → F2 → yy.y → ENTER → MARKER → F2
3. In the preceding command sequence, for the 10% point on the falling edge, xx.x = 10. For the 90% point, yy.y = 90.
4. The sequence in Step 2 uses the default marker difference capability of the PPM to select markers 4 - 2 to calculate the falltime.

3.6.4.4 REPETITION RATE

Due to the limited number of horizontal points available in the PPM's LCD readout, it is rather impractical to use it graphically for measuring repetition rate. It is possible to measure repetition rate, however, by attaching an oscilloscope to the PPM's rear panel MONITOR OUTPUT connection to view the detected video envelope of the pulse train being measured. This will allow the repetition rate to be calculated.

Once the timing between the first and second pulses monitored on the oscilloscope has been determined, the second pulse in the train can be analyzed by altering the Start Delay to coincide with the next pulse.

3.6.5 Digital Plotting of Graphic Data

3.6.5.1 PLOTTERS SUPPORTED

The PPM is configured to provide direct output of Graph Mode information for hardcopy recording on a digital plotter. This is done without the necessity of using a computor or GPIB controller. The following plotters (and any other 100% compatible plotters) are supported:

- Hewlett-Packard Model 7440A
- Hewlett-Packard Model 7470A
- Hewlett-Packard Model 7475A

All of the above plotters must be configured with the option for GPIB usage.

3.6.5.2 HOW TO MAKE PLOTS

The procedure for making plots with the PPM is quite simple. Plots can be made from the Graph and Marker Modes only. If a plot is made from the Graph Mode, it will not contain any marker information. The PPM plots are essentially duplications of the information shown on the PPM display at the time the plot function is activated.

Two different plotting speeds can be selected by the PPM. These are: a Fast Plot for use with normal plotting paper, and a Slow Plot for making plots using transparency paper (film).

To make a (fast) paper plot, press:

MENU (2) → F3 → F1

For (slow) transparency plots, press:

MENU (2) → F3 → F2

It should be noted that when the PPM has "drawn" a complete pulse profile on its display, it is ready to act as a GPIB controller. If the PPM is part of a GPIB system, **it is up to the user to be sure that no active controller is on the bus when the front panel plot function is initiated for correct operation of the system.**

The following steps are required to generate an X-Y hardcopy plot:

1. Connect a GPIB cable from the PPM's rear panel GPIB connection to the plotter's GPIB input connection.

2. Choose a GPIB address for the plotter, and set its address switches according to the instructions in its operating manual. (Address 6 is recommended; see Step 3.)

3. Select the plotter address for the PPM by pressing:

   MENU (5) → F2 → n → ENTER

   Where "n" is the plotter address. The default address to which the PPM sends data is 6. If the plotter address is changed from the default value of 6, it will remain at the new value until another value is entered. That is, it is not reset at power-on or any other time until intentionally changed again.

4. Check that the plotter pens are installed and operating properly. Following the manufacturer's instructions, insert paper into the plotter and prepare it to plot.

5. If it is required or desired, enter a Code number and Part number to be printed on the plot. If no Code and Part numbers are selected, numbers previously entered will be plotted. The default numbers are blank.

   a) Enter the Code number as follows:

      MENU (4) → F1 → nnnn.... → ENTER

      (Where nnnn.... is a number up to 12 digits.)

   b) Enter the Part number as follows:

      MENU (4) → F2 → nnnn.... → ENTER

      (Where nnnn.... is a number up to 12 digits.)

6. The date and time are always plotted. The date and time are obtained from the internal, real-time clock of the PPM which is kept alive by a battery when the instrument is turned off. If it is desired to check and/or change the date and time before plotting, press:

   MENU (4) → F3 → F3 (if clock is correct)

   or, to change the clock:

   MENU (4) → F3 → F1 → mmddyy → ENTER → hhmmss → ENTER → F3

   (mmddyy = month, day, year)
   (hhmmss = hours, minutes, seconds)

7. Enter the Graph or Marker Mode as desired. If the Marker Mode is used, marker pair delay difference timing will be plotted if activated on the LCD readout. See Figures 3-6 and 3-7 on the next page for examples of the types of plots available from the PPM.

8. Before the PPM can make a plot, it must first complete one "sweep" of the pulse profile. Assuming the profile is completed, press:

   MENU (2) → F3 → F1 for a paper plot

   or

   MENU (2) → F3 → F2 for a transparency plot

If there is any GPIB bus error, an alarm will sound. This indicates that when the PPM checked the IEEE Bus, it was unable to address the plotter. The possible causes for this might be an incorrect address setting, the plotter not set up correctly, or the plotter is turned off. If this situation occurs, press F2 to return the PPM to its previous mode of operation. (Note: This feature allows PPM operation to continue despite bus "hang-ups".)

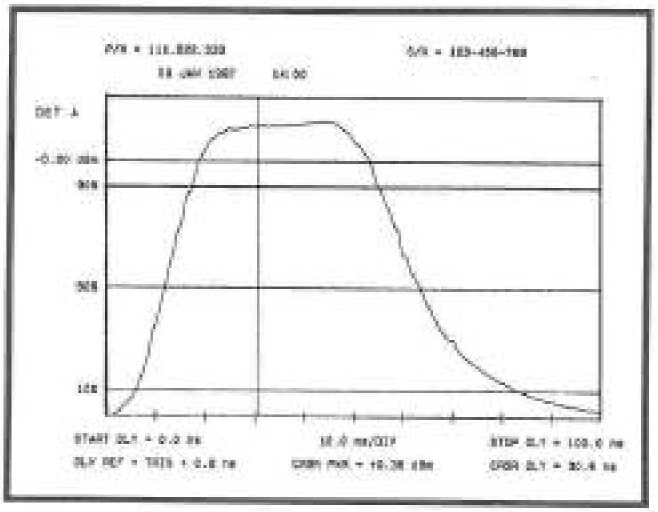


Figure 3-6. Example of Graph Mode Digital Plot

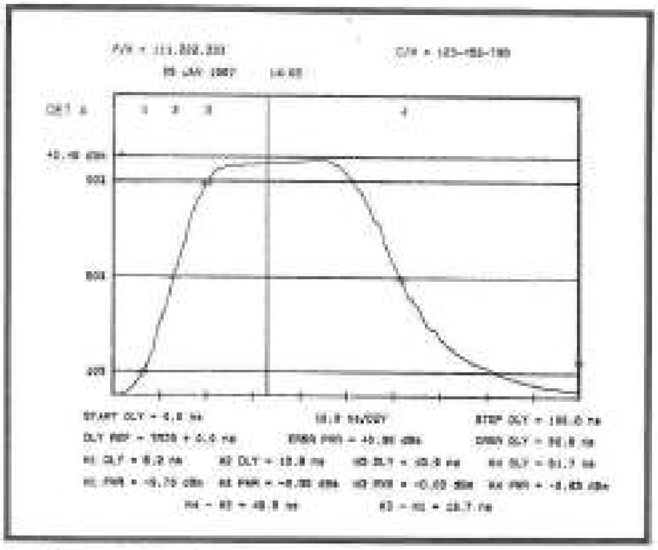


Figure 3-7. Example of Marker Mode Digital Plot

9. Once the plot has started, control of the PPM can be regained before the plot has finished. This gives the ability to proceed with further testing without having to wait for the plotter to complete its task.

10. If it is necessary to Abort the plot for some reason, press:

    MENU (5) → F1

The plot will be terminated as soon as possible.

3.6.6 Dual Channel Measurements (Model 8502 only)

The dual channel capability of the Model 8502 provides two very useful functions. These are:

- Display of Power Measured by Two Channels Simultaneously.
- Display of the Power Ratio between Two Channels.

Applications for these two functions are many and varied. Dual channel measurements allow two points in a system to be measured with one power meter. The PPM can simultaneously measure both channels in either the CW or Peak Power Modes (or it can measure and display one channel in CW Mode while the other channel is measuring Peak power).

The Ratio function allows relative measurements to be made in either CW or Peak. It is also possible to ratio Peak to CW or CW to Peak. These functions are useful for gain and loss measurements under CW or Peak conditions (or a combination of the two).

3.6.6.1 DUAL CHANNEL OPERATION - CW, CW MEASUREMENTS

The following procedure is used for making dual channel CW measurements:

1. After power-on, press CLEAR → F1 to access the CW Mode. Wait for approximately 30 minutes for the PPM to warm up.

2. Self-Calibrate both channels. Press:

   MENU (1) → F3 → F1

   Follow the instructions displayed by the PPM, connecting the appropriate detector to the Calibrator when prompted.

3. Connect the detectors to the device(s) or system to be tested.

4. The PPM will now be displaying CW power for channel A. To display CW power for both channels, press B.

5. Select the frequency of operation or cal factor as necessary for detector response correction by pressing the FREQ key. (For information on frequency correction, see Section 3.6.1 on page 3-13.)

6. Enter any required display offsets. (See Section 3.6.1.4 on page 3-14 for more information.)

7. To return to single channel operation, use the DETECTOR SELECT A and B keys as required.

3.6.6.2 DUAL CHANNEL OPERATION - PEAK, PEAK MEASUREMENTS: METHOD 1

1. The simplest way to begin displaying Peak power in both channel A and channel B simultaneously is to follow the procedure given in Section 3.6.6.1 for CW power, then press the PEAK key.

2. If the PPM is triggering, it will then display the Peak power in both channels. The following default settings are in effect if Dual Channel/Peak operation is entered by this means:

   - Internal Trigger from channel A (set at -10dBm) (i.e. pulse at channel A causes trigger if greater than -10 dBm)
   - Frequency = 1.00GHz
   - Chan A Cursor Delay = 1.0000us
   - Chan B Cursor Delay = 1.0000us
   - Hand Wheel active on channel A Cursor Delay as indicated by the delta symbol next to CSR DLY

3. If the PPM's "New Data" and "Ready" lights are flashing, this means that a trigger is occuring and measuring should be possible. Try adjusting the channel A Cursor Delay by turning the Hand Wheel until the CSR DLY reads 0.0000ns. The Delay can then be increased slowly until the reading is being taken on the desired part of the pulse.

4. To change the Cursor Delay for channel B, press the DELAY key followed by the B key. The Hand Wheel can then be used to alter the channel B Cursor Delay.

5. If there are any difficulties due to timing factors, it is recommended that External Triggering be used. The trigger signal should occur slightly before the RF pulses to be measured. The Cursor Delays can then be used to place the Cursors on the pulses to allow readings to be taken.

3.6.6.3 DUAL CHANNEL OPERATION - PEAK, PEAK MEASUREMENTS: METHOD 2

This method utilizes the PPM's Graph Mode capabilities to facilitate placing Cursors on the pulses of interest. Signal timing should be considered first of all. For purposes of discussion, assume the timing of the signals to be measured are similar to those shown in Figure 3-8.

As can be seen from Figure 3-8, the Measurement Port 1 pulse occurs before the Measurement Port 2 pulse. If Measurement Port 2 were used to generate an Internal Trigger, it would be impossible to set the Cursor on the leading edge of the displayed Measurement Port 1 pulse because the minimum Cursor Delay of 0ns would be the trigger point (leading edge of the Measurement Port 2 pulse).

Therefore, this situation would require that either Measurement Port 1 be used to generate an Internal Trigger, or that an External Trigger be used. Doing this would ensure that readings could be taken at any desired points on the pulses being measured.

In cases where the pulses at each detector input are essentially occuring at the same time, this problem could be ignored. However, it is generally the case that using the External Trigger results in more satisfactory performance.

The preceding information is provided mainly to emphasize the importance of knowing the timing relationships of the signals to be measured. If there is any doubt or confusion, the rear panel MONITOR OUTPUT of the PPM can be connected to an oscilloscope to quickly ascertain the timing relationships.

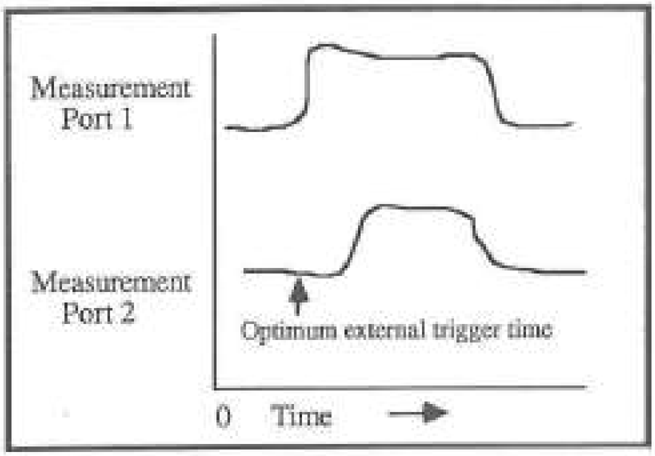


Figure 3-8. Typical Signal Timing

Assuming an Autoscalable pulse greater than -3 dBm is to be measured by channel A for this example, the procedure for Dual Channel operation in the Peak Mode via the Graph Mode would be:

1. Connect the channel A detector to the RF source (port) that is believed to be generating a pulse before the second source (port) to be measured (i.e Measurement Port 1). If the pulses of the two sources are coincident, use either port.

2. Connect the channel B detector to the second source (port).

3. Select the Graph Mode in channel A, and press CLEAR to Autoscale.

4. After the pulse has been successfully Autoscaled, set the Cursor to the desired measurement point.

5. Make a note of the Window and Cursor Delays. (The Start Delay will be 0.0000ns after Autoscaling.)

6. Press the DETECTOR SELECT B key to switch to the channel B Graph Mode.

7. Set the Window and Cursor Delays to the same values as were noted in Step 5. If the pulse is not visible on the LCD readout, gradually increase the Start Delay until the entire pulse is on the screen.

8. Set the Cursor Delay to the point on the pulse where it is desired to take a measurement. Channel A and B Cursors should now be placed wherever dual channel readings are to be taken. This can be verified by pressing DETECTOR SELECT A or B as necessary to check that the Cursors are properly positioned.

9. Select the Peak Mode of operation by pressing the PEAK key.

10. Select Dual Channel operation by pressing DETECTOR SELECT A. Make sure that the LEDs in the center of the DETECTOR SELECT A and B keys are lit. This signifies that the PPM is in the Dual Channel Mode. The display should look something like:

A: +0.65dBm *30.600ns*

B: -4.65dBm *39.700ns*

FREQ = 1.00GHz *PEAK*

3.6.6.4 DUAL CHANNEL OPERATION - PEAK, CW MEASUREMENTS

If it is desired to measure Peak power on one channel and CW on the other channel, the procedure is the same as when measuring Peak power on both channels with some minor differences. These differences are:

A. The channel used to make the Peak power measurement determines the triggering of the PPM. For low amplitude signals (below -10dBm in the Peak Mode), use external triggering.

B. It is not necessary to use the Graph Mode or any Delay settings on the channel that will be measuring CW as the power will be continuous, and it makes no difference at what time the CW is sampled.

C. Even though one channel is displaying CW power, the PPM will be operating as though both channels were in the Peak Mode. CW averaging will have no effect on the measurement. The rate at which the RF is sampled and averaged is determined by the characteristics of the Peak power channel.

3.6.6.5 HOW TO MAKE POWER RATIO MEASUREMENTS

To make Ratio measurements, the power measured by both channels must be within the specified power measurement range of the PPM system. When operating in CW, this power range is -40 to +20dBm. In the Peak Mode, this power range is -20 to +20dBm. Power readings taken in the Ratio Mode outside of these ranges will result in an error display.

The Ratio Mode only provides the ratio of A/B, not vice versa. The PPM can ratio two CW signals, two Peak signals, or a combination of both. The following procedures show how to perform each of these ratioing operations.

3.6.6.5.1 Ratioing Two CW Signals

This is the easiest Ratio function of the PPM. Proceed as follows:

1. Allow the PPM to warm up for at least 30 minutes. Then Self-Calibrate both channels. From power-on, press:

   CLEAR → F1 → MENU (1) → F3 → F1

   Then follow the displayed prompts to complete the Self-Cal. After Self-Cal has completed, the PPM will be measuring CW power in channel A.

2. Select the Ratio Display Mode by pressing:

   MENU (6) → F2

3. The default mode for power ratio measurements is for Peak power on both channels. To set both channels for CW operation, press:

   A → F2 → B → F2

The PPM will now be reading the ratio of A/B. Normally this is expressed in dB, however, it can also be expressed as a linear reading (such as 19654 EXP=-4) by pressing the dB/mW key. The LCD readout screen indicates that two CW signals are being ratioed by displaying "CW/CW" in the lower right hand corner of the readout.

Remember that the frequency of operation or Cal Factor must be entered using the FREQ key, and any desired Offsets should also be included. (These functions are described in Section 3.6.1 on page 3-13.)

Figure 3-9. Typical Ratio Display

3.6.6.5.2 Ratioing Two Peak Signals

The point in time at which readings of Peak power are taken in both channels for ratioing purposes is determined by the setting of the Cursor Delay. Although it is most desireable that both pulses being monitored occur at exactly the same time, in practice this would be a very rare event. Therefore, the signals to be measured must be carefully evaluated to ensure that accurate readings are taken.

The Cursor Delay must be set so that samples are being taken on both the channel A and B pulses. See Figure 3-10 for an example of good and bad Cursor Delay settings in this situation.

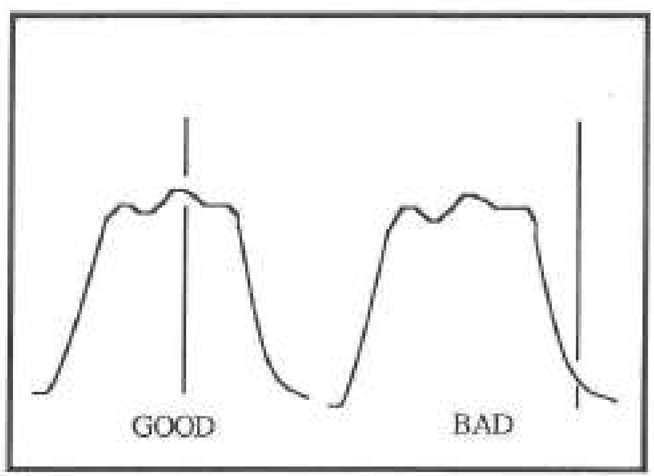


Figure 3-10. Typical Good & Bad Cursor Display Settings

The following are guidelines that can be used when ratioing two Peak signals:

1. Make a single channel Peak measurement using the Graph Mode (Autoscaling is recommended).

2. Set the Cursor Delay so that the power reading (CSR PWR) is being taken close to the center of the pulse.

3. Verify that the Cursor Delay setting is adequate for both channels by switching to the other channel. Use the same Start, Window, and Cursor Delays as in the first channel. If the pulses occured at the same time, the Cursor would be close to the center of the pulse sampled by the other channel.

4. Switch channels, checking to be sure that the Cursor is not placed close to the edge of either of the pulses being sampled.

5. Once the Cursor has been satisfactorily set, press the following keys to activate the Ratio Display Mode:

MENU (6) → F2

The default setting for the type of signal being used by both channels is Peak. This is verified by "PK/PK" being displayed in the lower right hand corner of the LCD readout. If this is not the case, select Peak operation by pressing:

A → F1 → B → F1

The PPM should now be displaying the Ratio of the two pulses. Be sure to use the FREQ key and Offset function if necessary.

3.6.6.5.3 <u>Ratioing Peak to CW Signals</u>

This function is very useful in many applications such as traveling wave tube (TWT) testing that require the measurement of gain under pulsed conditions. This could be a problem when the TWT has a CW input and a pulsed output. The PPM easily performs this type of measurement using the following procedure:

1. Make a single channel Peak power measurement at the port of the device under test that has the pulsed signal.

2. Set the Cursor at the desired point on the displayed pulse profile. Using the Graph Mode is the simplest way to do this.

3. Select the Ratio Mode by pressing:

MENU (6) → F2

4. Set which channel will be CW by pressing:

B → F2 (if channel B is to be CW)

or

A → F2 (if channel A is to be CW)

5. Set which channel is to be Peak by following the same procedure as above, only pressing <u>F1</u> instead of F2.

The lower right hand corner of the LCD readout will indicate which channel is CW and which is PEAK. Whichever indication is farthest to the right side will be channel B.

3.6.7 High Power Measurements

One of the most important things to remember when using the PPM is that it employs balanced, zero bias, Schottky diode detectors as power sensors. Due to this highly sensitive, highly accurate configuration, the maximum power that the detectors can handle before burning out is +23dBm (200mW). This limitation is regardless of duty cycle.

3.6.7.1 POWER WARNING - MAX/MIN POWER LIMITS

The PPM has a built-in warning system to advise the operator of mild overloads to the detectors. Large overloads which are usually the result of a failure in the device under test or the operator inadvertently leaving an attenuator out of the test setup, cannot be prevented because of the speed at which these failures happen. However, the operator will be advised by a prompt on the LCD display when the power level exceeds the preset power warning level.

The default value for the MAX Power warning point is +20.5dBm. This can be set to anywhere between -10 and +21dBm by the operator.

The PPM also has a lower level limit (MIN). This is mainly used to avoid displaying power readings outside the lower power range of the instrument. When the power level being measured by the PPM is below the lower level limit, the LCD readout will display dashes ("--------") to indicate that the power being measured is too low for the PPM to take an accurate measurement.

The default value for the MIN Power warning point is -45.0dBm. This can be set anywhere between -15 and -50dBm by the operator.

To change the MAX and MIN power limits, press the following keys:

MENU (6) → F1 → mm.mm → ENTER → nn.nn → ENTER

Where mm.mm is the Maximum power limit, and nn.nn is the Minimum power limit.

3.6.7.2 HOW TO MAKE HIGH POWER MEASUREMENTS

The procedure for making absolute CW or Peak power measurements under high power conditions is as follows:

1. Approximate the Peak power of the signal to be measured.

2. After 30 minutes warm-up, Self-Cal the PPM detectors.

3. Choose an appropriate attenuator or coupler to be used in the test setup to reduce the power being measured to a safe level for the detectors. The power at the detector input must be less than +20dBm.

   When making this approximation, be sure to use "worst case" power levels. If in doubt, a 10dB attenuator can be used directly on the detector input in addition to the selected high power coupler or attenuator.

4. Ensure that the RF power of the source to be measured is turned OFF.

5. Connect the high power coupler to the RF source to be measured as shown in Figure 3-11. If a high power attenuator is used, connect as shown in Figure 3-12.

6. Connect the PPM detector with its attenuator to the coupled output of the high power coupler (Figure 3-11), or to the output of the high power attenuator (Figure 3-12).

7. Auto Zero the PPM by pressing:

   MENU (1) → F3 → F2 → ENTER

If a dual channel Model 8502 is being used, follow the prompts given on the LCD display readout. Select ENTER or CLEAR as necessary to Zero the desired channel(s).

8. Turn ON the RF power of the source under test.

9. If measuring a pulsed signal, it is important that the Cursor be placed on the pulse. This can be done by using the PPM's Autoscale feature which is activated in the Graph Mode by pressing CLEAR. If this method is not possible, try using the Internal Trigger with the level set at -10dBm. Then set the Cursor at 0.0000ns and increase the Cursor Delay gradually until the CRS PWR is at its maximum.

   If the "New Data" light on the front panel of the PPM does not flash, then the instrument is not triggering. If the trigger level is at -10dBm and no trigger occurs, there might not be enough power at the detector input to be able to measure. If this is the case, recheck the calculations that were made to decide what attenuation levels were required to prevent detector burnout. If necessary, reduce the attenuation at the detector input by 10dB to increase the power so that the PPM will trigger.

NOTE: If a TTL Trigger signal is available from the source being measured, then using the External Trigger Mode is advisable. If an oscilloscope is available, the PPM's rear panel MONITOR OUTPUT(s) can be used to determine the proper timing settings for the instrument.

10. Once the PPM is reading power as desired, enter the frequency of operation (or Cal Factor) by pressing the FREQ key.

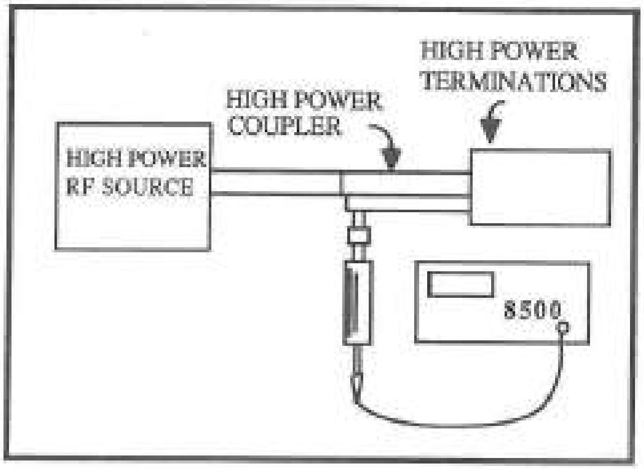


Figure 3-11. Detector Connection to a High Power Coupler

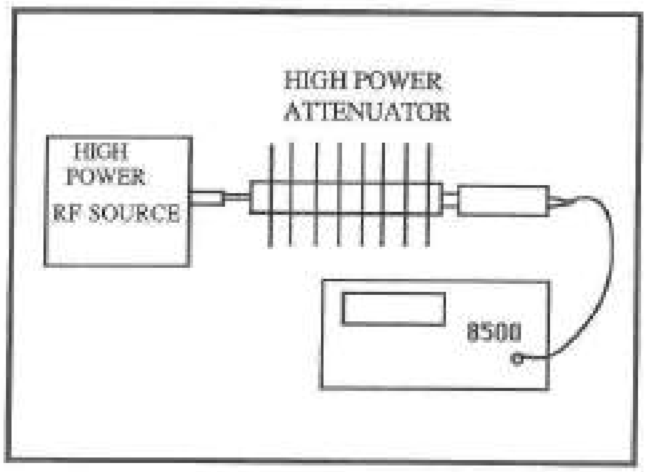


Figure 3-12. Detector Connection to a High Power Attenuator

11. To obtain the absolute power output of the RF source being measured, use the PPM's Offset feature to offset the displayed values by the combined attenuation values of the coupler and/or attenuators being used in series with the detectors. Most couplers and attenuators have attenuation versus frequency response curves supplied that can be used for exact entry of the required offset. To enter the Offset, press:

MENU (3) →F1 →nn.nn →ENTER

Where "nn.nn" is the Offset desired. For channel B offset on the 8502, use F2 instead of F1. When the Offset feature is in use, this will be shown on the LCD display by the presence of an asterisk (*) next to the FREQ or CF indication.

3.6.7.2.1 High Power Relative Measurements (8502 only)

The procedure for making a gain or loss measurement is the same as for absolute power, but requires activating the Ratio Display function of the 8502. The Offset feature is used to compensate for external devices before entering the Ratio Mode. (See Section 3.6.6.5 on page 3-34 for more information on Ratioing.)

3.7 SPECIAL CAPABILITIES OF THE PPM

3.7.1 Single Pulse Measurements

Measurement of a single pulse can be accomplished with the PPM by operating in the Peak Mode. (The Graph Mode cannot be used for single pulse measuring.)

Two methods are available for making single pulse power measurements. These are discussed in the next two sub-sections.

3.7.1.1 SINGLE PULSE MEASUREMENT USING INTERNAL TRIGGER

To make a single pulse measurement using the Internal Trigger, it must first be decided how long after the trigger has occured that the measurement should be taken. For example, in the single pulse shown in Figure 3-13, the PPM trigger level has been set to -10dBm. If the Cursor Delay were set to 0.0000ns, then the power measurement would be taken at the trigger point. In this case, this is not on the "top" of the pulse being measured.

In order to measure power at the top of the pulse as is required in most applications, the Cursor Delay needs to be set at around 5us. Therefore, to accurately make Peak power measurements using the Internal Trigger mode of operation, the operator must have some idea of the pulse width boundaries to be tested.

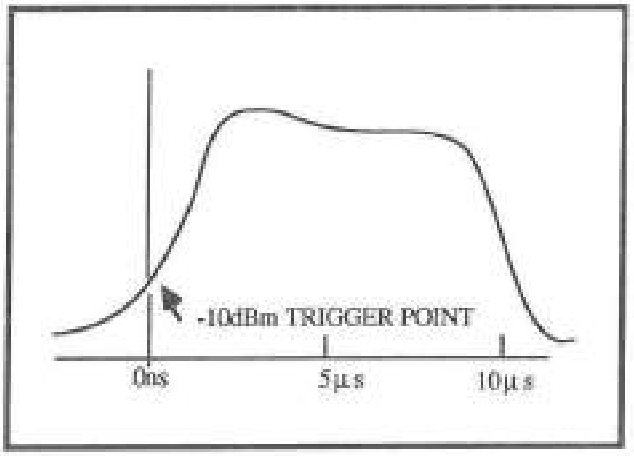


Figure 3-13. Single Pulse with -10dBm Trigger Level

In cases where the risetime of the pulse is known to be repeatable and the pulse width is known never to be below, say, 8us, it could be decided to set the Cursor Delay to 5us. This decision would allow measurement of all pulse widths greater than 5us without the necessity of altering the Cursor Delay.

Single pulse measurements cannot be made with the same accuracy as repeating pulse trains. This is primarily due to the fact that there is no way to eliminate noise that might be present in the test setup. For repetitive pulse trains, averaging can be used to eliminate errors due to noise.

The procedure for making a single pulse measurement is as follows:

1. Allow the PPM to warm up for 30 minutes, then conduct a Self-Cal.

2. Select the Peak Mode of operation. If there is no pulse at the detector input there will be no trigger. If this is the case, the LCD display will either be blank or frozen with the last data that was taken. The "Ready" light should be lit, the "New Data" light will be dark.

3. Set the Trigger Mode to Internal, and then set the trigger level as desired. If the expected power level to be measured is greater than 0dBm, it may be desireable to set the Trigger Level to about -5dBm. Setting the Trigger Level to -10dBm does allow the detection of pulses with a lower power level, but this also increases the risk of triggering on noise or a transient that might be present in the system under test.

4. Set the Cursor Delay to the desired time following the trigger that the measurement is to be taken. Press the DELAY key and use the Hand Wheel or enter the Delay in microseconds through the keypad. For this example, use 5us.

5. Set the Peak Pulse Averaging number to 1.

6. Connect the detector to the RF source to be measured.

7. When a pulse of sufficient amplitude to cause a trigger enters the detector input, the PPM (in this case) will take a reading 5us later. The Peak power being measured at the time of the Cursor Delay will then be "frozen" on the display until the next pulse or trigger occurs.

3.7.1.2 SINGLE PULSE MEASUREMENT WITH AN EXTERNAL TRIGGER

Making a single pulse measurement using an External Trigger is done with the same limitations as with the Internal Trigger. However, it is possible to control exactly when the power reading is taken by supplying a TTL trigger to the PPM's rear panel trigger input at the appropriate time.

The PPM is set to External Trigger by pressing:

MENU (1) → F2

The trigger signal must arrive coincident with or before the RF pulse to be measured when measuring with the External Trigger. If the power reading needs to be taken exactly at the time that the trigger occurs, then the Cursor Delay is set to 0.0000ns. If the pulse to be measured arrives after the trigger, then set the Cursor Delay so that the power reading will be taken at the desired point on the pulse.

3.7.2 Measuring Peak Power Under Swept Conditions
(See Figure 3-14 for typical setup)

The frequency response and power level characteristics of pulsed signals can be measured under swept frequency conditions by combining the capabilities of the Wavetek PPM with those of the Wavetek Model 1038-NS20 or Model 1038-N10 Scalar Network Analyzers.

The Analyzer's normalization memory can be used to subtract out "residual" test setup responses, thus allowing direct readout of the frequency response of the device under test. There are a variety of applications where this ability can be very useful such as:

- Pulsed TWT testing
- Microwave frequency performance of pulsed radar systems
- Return Loss
- VSWR Measurements under Pulsed Conditions

and others.

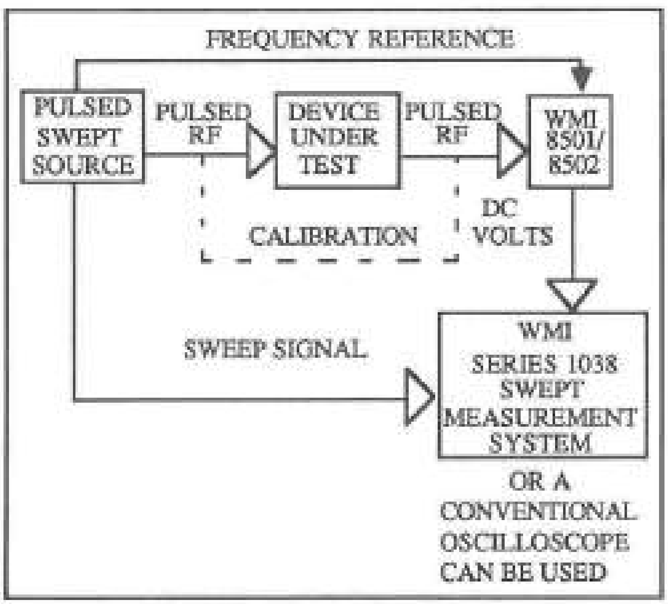


Figure 3-14. Typical Pulsed Swept Measurement System

If a Wavetek 1038 system is not available, a conventional oscilloscope can be used by first displaying the PPM's output, and then marking the system tracking errors on the CRT in grease pencil for visual correction.

The PPM is normally used in the Peak Mode for this type of testing. Most PPM settings would be the same as when measuring a single frequency pulsed signal. In order to use the Swept/Pulse system with any degree of accuracy, the pulse repetition rate must be considerably faster than the speed at which the RF sweep takes place. This is determined mostly by the setting of the sweep generator's sweep speed. The PPM is capable of reading better than 100pps, and the output level will be at 100mV/dB. Swept measurements can also be made simultaneously from channels A and B of the 8502, but the PPM's reading rate will be somewhat slower.

It is very convenient to use the sweep generator's Frequency Reference signal to continually inform the PPM as to what the RF frequency is at any given time. (Frequency Reference is synonymous with V/GHz, Voltage proportional to Frequency, etc.) Using this feature ensures that, as the sweep generator changes frequency, the PPM "knows" to alter its frequency correction accordingly. The PPM then uses the proper frequency correction for the detector(s) at each descrete frequency point without necessitating any operator input or any calculations. (Section 3.6.1.2 on page 3-13 covering the use of "PROM FREQUENCY CORRECTION - External Frequency Input" will give more information on the interfacing of external frequency signals.)

To make swept frequency measurements under pulsed conditions, equipment should be set up similar to Figure 3-14. The measurement routine is initiated by pressing:

MENU (9) → F1

During the time that the fast analog output mode is active, the PPM's LCD display window will indicate:

FAST ANALOG OUTPUT
MEASUREMENT MODE

Press MENU key to exit

3.7.3 Self-Testing the PPM

The Self-Testing feature of the PPM is provided as a quick "health check" of the instrument. There are three ways to initiate the Self-Test function:

A. Turn on the PPM Power Switch, and then press ENTER.

B. If a Self-Test is desired at some point while a testing routine is being conducted without interrupting the sequence of the routine, this can be done by accessing MENU (10) and pressing F2. After the Self-Test has successfully completed, the instrument will return to the same point it was at in the routine just prior to the Self-Test.

C. The third method of initiating the Self-Test without turning the instrument off is to press the RESET switch on the rear panel of the instrument and then press the ENTER key. When the Self-Test has successfully completed, the PPM will return to the "power-on" status.

While the Self-Test is in progress, the following will be displayed:

PERFORMING SELF TEST
CLOCK/CALENDER INDICATES
(day) (date) (time) (year)
System version # = n.nn

C. At the successful completion of the Self-Test, the PPM will display "Self Test Completed: Passed". A "chime" will then be sounded, and the Power-On menu will appear as described in Section 3.3.2 on page 3-8 or, if Self-Test was selected using MENU (10), the PPM will return to its previous display mode.

D. If some type of failure is detected by the PPM's microprocessor during the Self-Test, the display will indicate:

SELF TEST FAILED! - PRESS CLEAR
ERROR NUMBER(S): 11, 8, etc.

Pressing CLEAR will bring back the Power-On display as described in Section 3.3.2. However a failed Self-Test indicates a problem of some kind, and it is recommended that the PPM not be used for measuring until it is checked according to the procedures given in Section 7.4.3 on page 7-12 of the Maintenance Section of this manual. Table 3-A, below, gives a listing of the error numbers and their associated meanings.

Table 3-A. Self-Test Error Flags

Error	Cause
01	-5.2V Supply
02	Memory Bad
03	Excessive A Channel Offset
04	A Channel Gain Error
05	Excessive B Channel Offset
06	B Channel Gain Error
07	A Channel Analog Output DAC
08	B Channel Analog Output DAC
09	Delay 8255s (ICs)
10	Delay Time Error
11	Calibrator Bridge Voltage Error

3.7.4 Frequency Display Disable/Enable

If there is some reason (such as classified testing) why it might be desired not to have the frequency of operation displayed in the LCD display window while measurements are being taken, this can be done by using the F3 key of MENU (6) as a toggle for this function.

Pressing MENU (6) + F3 the first time will cause the frequency numbers shown at the bottom of the display window to be replaced by asterisks (****).

When it is desired to return to the normal frequency display mode, MENU (6) + F3 is again pressed and the numbers indicating the frequency will return.

3.8 NON-VOLATILE MEMORY

The PPM system's Non-Volatile Memory is intended primarily to provide a means to Store front panel settings for later Recall. This is particularly useful when complicated setups are in use. Usage of this feature can save many menu selections that might otherwise have to be entered every time the instrument is used.

The PPM stores all front panel information pertaining to the present setup in a memory location called "Current Setup". When the PPM is turned off, Stored setups and the Current setup in memory are kept alive by a rechargeable battery. (Exceptions are detailed in Appendix D on page 3-59.) The battery will ensure that the contents of the memory will be preserved for about 90 days without needing to be recharged. Recharging takes place whenever the PPM is turned on.

When the PPM has been turned on and Self-Test either completed or bypassed, the opportunity will be presented to select "Last Setup at Turn-Off". If it is desired to use the PPM in the same manner as when it was last used, this feature of the Non-Volatile Memory is very convenient. Other features of the Non-Volatile Memory will be discussed next.

3.8.1 Memory Features

To access the Memory features of the PPM, press the MEMORY key. There are three levels of menus accessible by sequentially pressing the MEMORY key. Appendix B, Section B.2 on page 3-53 shows the Memory Menus in detail. If the Memory Menu is accessed accidently, return to the Data Display Mode is accomplished by pressing CLEAR.

3.8.1.1 STORE SETUP

The PPM has 10 Non-Volatile Memories for storing front panel setups. These are numbered from 1 through 10. To store the present PPM front panel setup in one of these 10 memories, press:

MEMORY (1) → F2 → nn → ENTER

Where nn is the number of the memory where the setup is to be stored (between 1 and 10). If no number were entered, the operation would be aborted when ENTER was pressed and the PPM would return to data display.

3.8.1.2 RECALL SETUP

To Recall a previously stored setup, press:

MEMORY (1) → F1 → nn → ENTER

Where "nn" is the number of the memory to be recalled (from 1 to 10). If no number is pressed, the operation is aborted when ENTER is pressed and the PPM will return to data display.

3.8.1.3 GET POWER-ON SETUP

To retrieve from memory the front panel setup that was operative the last time the instrument was used before power-off or the rear panel RESET button was used, press:

MEMORY (1) → F3

CAUTION: This selection will erase the Current selection. If there should be any doubt as to whether the Current selection will be needed later, it is advisable to Store the setup in a numbered memory before executing the command.

3.8.1.4 DISPLAY SETUPS

When one of the Display Setup features of the PPM is activated, the panel settings of the selected setup are shown on the LCD display screen. This is useful if it is desired to determine the exact parameters that were used for a particular setup, and allows checking whether or not the various settings are correct before making any measurements.

A. To Display the contents of the Current setup, press:

   MEMORY (2) → F1

   The PPM will then display the current instrument status readout in a screen by screen display mode. To scroll to the next screen display, press the F1 key for "More". To exit and return to the Data Display Mode, press F3.

B. To Display the contents of the Power-On setup, press:

   MEMORY (2) → F2

   The PPM will then display the Power-On instrument status readout screen by screen. To scroll to the next screen display, press the F1 key for "More". To exit and return to data display, press F3.

C. To Display the contents of a numbered memory setup, press:

MEMORY (2) → F3 → nn → ENTER

Where nn is the number of the memory (between 1 and 10) that is to be displayed. If no number is entered, the operation is aborted when ENTER is pressed and the PPM returns to data display.

The PPM will display the instrument status readout of the Memory screen by screen. To scroll to the next screen display, press the F1 key for "More". To exit and return to data display, press F3.

3.8.1.5 INITIALIZING SETUPS

This feature of the PPM allows the initializing of the current setup, a numbered memory setup, or the power-on setup. "Initializing" resets the selected setup's parameters to the factory default settings. Certain parameters are not initialized. These are listed in Appendix D on page 3-59. The Initializing function can be useful if, for some reason, the operator gets lost or has difficulty interpreting readings due to the complexity of a particular setup. Initializing also allows parameter settings to be made from a "known" status.

A. To Initialize the Current setup, press:

MEMORY (3) → F1

CAUTION: This selection will erase the Current setup. If there is any doubt as to whether or not the Current setup will be used again, it is advisable to Store the setup in a numbered memory before executing the command.

B. To Initialize all memory setups except for the Current setup, press:

MEMORY (3) → F2

NOTE: It is a good idea to Display the contents of the numbered memory setups before executing this command to see if it is desired to retain any of the setups in question.

C. To Initialize a numbered Memory setup, press:

MEMORY (3) → F3 → nn → ENTER

Where nn is the number of the memory (between 1 and 10) to be initialized. If no number is entered, the operation is aborted when ENTER is pressed and the routine will return to data display.

3.9 EMULATION OF THE WMI MODEL 1018B PEAK POWER METER BY THE MODEL 8501/8502 METERS

3.9.1 General

The Model 1018, 1018A, and 1018B series of peak power meters were the predecessors to the Model 8501/8502 meters. This 1018 series was first produced in 1969, and has had several design upgrades as state-of-the-art technology has advanced. In 1978 Pacific Measurements, Inc. (now known as Wavetek Microwave, Inc.) added limited IEEE Bus capability to the 1018, but no provision was available for controlling front panel states. Only the cursor delay, trigger or reset, and the taking of data was remotely controllable.

The main purpose of the 1018B emulation mode is to provide a means for current users of the 1018B to quickly adapt to using the 8501/8502 meters in automatic systems. While "perfect" emulation is not possible, the PPM can mimic certain operations of the 1018B. This emulation only relates to GPIB (IEEE Bus) operations. That is, the ability to reset, trigger, alter the cursor delay, and take a power reading over the bus. For detailed information on GPIB operations with the PPM, see the IEEE Bus Interface section of this manual.

Although software written for the 1018B series would not take advantage of many of the new features of the PPM, the emulation capability might allow work to continue while new software is being written for the PPM.

NOTE: In order to use the 1018B software with the PPM in the 1018B Emulation Mode, the software must be written so that the talk and listen addresses of the PPM are both the same.

For further information, see Section 4.5 on page 4-27 of the IEEE Bus discussion in this manual.

3.9.2 Initiating the 1018B Emulation Mode

To initiate the 1018B Emulation Mode, press:

MENU (7) → F2

Thereafter, MENU (7) is used to select settings relating to the way in which the PPM will emulate the 1018B. See the MENU (7) listing in Section B.1 of Appendix B on page 3-51 for a listing of available settings. In order to know which selections to make, three questions must be answered regarding how the 1018B is presently being used on the IEEE Bus. These are:

1. Is SRQ Enabled or Disabled?

2. Is the instrument set up to output data upon being talk-addressed (automatic trigger reset), or does the instrument require a trigger reset (a GET or "?" command) to take a data point?

It should be noted that 1018B emulation is incompatible with the Ratio Mode, and once the routine is in the 1018B Emulation Mode the Fast Analog Output function cannot be accomplished. For further information, See Section 4.5 on page 4-27.

3. What is the Talk/Listen address? (They must be the same.)

Based on these questions, use MENU (7) to select the appropriate settings. Use MENU (5) → F3 to set the PPM addresses.

Once the above has been done, it should be possible to swap a Model 1018B with option 05 (GPIB) with a Model 8501 or 8502 meter and continue operations.

To terminate the 1018B Emulation Mode, press:

MENU (9) → F2

APPENDIX A

SUMMARY OF COMMANDS

A.1 GENERAL

This Appendix contains a summary of the commands required to activate all of the various functions of the PPM. The commands are listed for each of the different modes of operation (All, CW, Peak, Graph, Marker, Dual Channel, and 1018B Emulate) of the instrument.

Following page 3-59 (Appendix D), is located a reproduction of the laminated Quick Reference card that came with this manual. If the laminated card has been mislayed or is not available, this sheet can be referenced to determine how to go from one mode to the other. The reverse side of the sheet gives a Quick Reference to all of the major menus shown in Appendix B.

A.2 COMMANDS APPLICABLE TO ALL MODES

Auto Zero Detectors	MENU (1) → F3 → F2
Calibrate Detectors	MENU (1) → F3 → F1
Self-Test the Instrument (If desired during a test routine)	MENU (10) → F2
Detector Offset (Channel A)	MENU (3) → F1 → nn.nn → ENTER
Detector Offset (Channel B - 8502 only)	MENU (3) → F2 → nn.nn → ENTER
Fast Analog Output	MENU (9) → F1
Frequency Correction - User Freq/PROM	MENU (3) → F3 → F1 → nn.nn → ENTER
Frequency Correction - Sweeper/PROM	MENU (3) → F3 → F2 → vv.vv → ENTER → ss.ss → ENTER → ff.ff → ENTER
Frequency Correction - Cal Factor (dB)	MENU (3) → F3 → F3 → A or B → nn.nn → ENTER
Frequency Display Disable/Enable	MENU (6) → F3 (toggle)
Review Detector PROM Information	MENU (9) → F2 (for A) or F3 (for B)
Check Date and Time then Exit	MENU (4) → F3 → F3
Change Date and Time then Exit	MENU (4) → F3 → F1 → mmddyy → ENTER → hhmmss → ENTER → F3
Set Max and Min Power Limits	MENU (6) → F1 → nn.nn → ENTER → nn.nn → ENTER

Recall Setup in Memory (n)	MEMORY (1) → F1 → n → ENTER
Store Setup in Memory (n)	MEMORY (1) → F2 → n → ENTER
Recall Power-On Setup	MEMORY (1) → F3
Display Current Setup	MEMORY (2) → F1 → F1 or F3 (F3 = Exit; F1 = More)
Display Power-On Setup	MEMORY (2) → F2 → F1 or F3 (F3 = Exit; F1 = More)
Display Setup in Memory (n)	MEMORY (2) → F3 → n → ENTER → F1 or F3 (F3 = Exit; F1 = More)
Re-Initialize Current Setup	MEMORY (3) → F1
Re-Initialize All But Current Setup	MEMORY (3) → F2
Re-Initialize A Numbered (n) Setup	MEMORY (3) → F3 → n → ENTER
Initiate 1018B Emulation	MENU (7) → F2
* End 1018B Emulation	MENU (9) → F2

A.3 CW MODE COMMANDS

Select CW Mode	CW
CW Averaging	MENU (2) → F1 → nnn → ENTER

A.4 PEAK MODE COMMANDS

Select Peak Mode	PEAK
Select <u>8501</u> Internal Trigger and Level	MENU (1) → F1 → nn.nn → ENTER
Select <u>8502</u> Internal Trigger and Level	MENU (1) → F1 → A or B → nn.nn → ENTER
Select External Trigger	MENU (1) → F2
Peak Averaging	MENU (2) → F2 → nnn → ENTER
Change Cursor Delay (Δ = Hand Wheel can be used instead of keypad	DELAY → nn.nnnn or (Δ) → ENTER

* only valid after 1018B Emulation has been entered

A.5 GRAPH MODE COMMANDS

Select Graph Mode (from single channel operation only)	GRAPH
Select 8501 Internal Trigger and Level	MENU (1) → F1 → nn.nn → ENTER
Select 8502 Internal Trigger and Level	MENU (1) → F1 → A or B → nn.nn → ENTER
Select External Trigger	MENU (1) → F2
Peak Averaging	MENU (2) → F2 → nnn → ENTER
GPIB Plot (Paper)	MENU (2) → F3 → F1
GPIB Plot (Transparency)	MENU (2) → F3 → F2
Code Number Entry for Plot	MENU (4) → F1 → nnnn → ENTER (nnnn = up to 12 digits)
Part Number Entry for Plot	MENU (4) → F2 → nnnn → ENTER (nnnn = up to 12 digits)
Check Date & Time for Plot then Exit	MENU (4) → F3 . . . . F3
Change Date & Time for Plot	MENU (4) → F3 → F1 → mmddyy → ENTER → hhmmss → ENTER → ENTER
Abort (Stop) Plotting Activity	MENU (5) → F1
Enter Plotter GPIB Address	MENU (5) → F2 → nn → ENTER
Set Initial Delay for Autoscaling (Normal PPM operation)	MENU (8) → F2 → nn.nn → ENTER
Set Averaging Value for Autoscaling (Normal PPM operation)	MENU (8) → F3 → nnn → ENTER
* Set Initial Delay for Autoscaling (1018B emulation operation)	MENU (10) → F2 → nn.nn → ENTER
* Set Averaging Value for Autoscaling (1018B emulation operation)	MENU (10) → F3 → nnn → ENTER
Change Start Delay (us) (Δ = Hand Wheel can be used instead of keypad)	DELAY → F1 → nn.nn or (Δ) → ENTER
Change Window Delay (us) (Δ = Hand Wheel can be used instead of keypad)	DELAY → F2 → nn.nn or (Δ) → ENTER

* only valid after 1018B Emulation has been entered

Change Cursor Delay (us) (Δ = Hand Wheel can be used instead of keypad)	DELAY → F3 → nn.nn or (Δ) → ENTER
Enter Delay Reference (us) (Δ = Hand Wheel can be used instead of keypad)	DELAY → DELAY → nn.nn or (Δ) → ENTER
Clear Delay Reference	DELAY → DELAY → 0 → ENTER
Change Internal Trigger Level (Δ = Hand Wheel can be used instead of keypad)	F3 → F1 → nn.nn or (Δ) → ENTER
Change Power Reference (100% Point) (Δ = Hand Wheel can be used instead of keypad)	F3 → F2 → nn.nn or (Δ) → ENTER

A.6 MARKER MODE COMMANDS

Autoplace Markers at Predetermined Percentages of Reference Power. (Pulse profile should be completely visible before activating this command. Default marker placements are 10%, 50%, and 90% points on rising slope, and 50% on falling slope.)	MARKER → F2
Check Marker Autoplacement % and Slope Settings then Exit	MARKER → F3 . . . . F3
Change Marker Autoplacement % and Slope Setting. (Follow displayed instructions after pressing F1.)	MARKER → F3 → . . . .
Display (Identify) Marker Timing Values with Respect to Delay Reference - Default Reference is Trigger Point	F3 . . . . CLEAR
Select Log Power Display	dB/mW → F1
Select Watt Power Display	dB/mW → F2
Select % of Reference Power Display	dB/mW → F3

A.6.1 Marker Autoplacement (from power-on)

To enter the Marker Mode from Power-On using Autoscale and Autoplacement, the following procedure is recommended. (Assumes RF pulse power greater than -3dBm at the detector input.) Press:

CLEAR → F2 → MARKER (wait for profile to complete) → MARKER → F2

This method automatically places markers at their default relative power levels on the pulse profile. (See Section 3.6.3.4.4 on page 3-25 for a listing of default values.) If a marker's default relative power level cannot be found on the pulse profile it remains absent from the display, and the display will indicate UNDEFINED.

A.7 DUAL CHANNEL OPERATION

A.7.1 CW Mode Commands

From Power-On select: CLEAR → F1 → B

If the Dual Channel state is being entered from some other state, use the channel A and B keys. When both A and B keys are lit, the Dual Channel state has been activated.

A.7.2 Peak Mode Commands

Assuming that there is an "Autoscalable" pulsed signal greater than -3dBm at the channel A detector input, from Power-On select:

CLEAR → F2 . . . Peak → B

This method uses the Graph Mode to ensure that the cursor is placed on the pulse measured by channel A.

In other situations, Dual Channel operation can be achieved by entering the Dual Channel state in CW, and then pressing the PEAK key. From Power-On, press:

CLEAR → F1 → B → PEAK

Make sure that a trigger is occuring by monitoring the "New Data" and "Ready" lights. (See Section 3.4.2.1, Triggering, on page 3-9.)

This method does not guarantee that the cursor will be placed on the pulse. To find the pulse, use the procedures outlined in Section 3.6.6.2 on page 3-32.

A.7.3 Other Dual Channel Commands

Detector Offset (Channel B)	MENU (3) → F2 → nn.nn → ENTER
Display Ratio A/B Power Mode	MENU (6) → F2
dB/Linear Ratio Toggle	dB/mW (when using the Ratio Mode)
Select Peak Mode for Channel A	A → F1 (when using the Ratio Mode)

Select CW Mode for Channel A	A → F2 (when using the Ratio Mode)
Select Peak Mode for Channel B	B → F1 (when using the Ratio Mode)
Select CW Mode for Channel B	B → F2 (when using the Ratio Mode)
Exit Ratio Mode	CW or PEAK

A.8 IEEE & 1018B EMULATION COMMANDS

Select PPM Listen and Talk Address	MENU (5) → F3 → nn → ENTER
Initiate 1018B Emulation Mode	MENU (7) → F2
* Disable/Enable Service Request	MENU (7) → F1 (Toggle)
* Automatic/Bus Command Trigger Reset	MENU (7) → F2
* Get Data Fast (No LCD Display)	MENU (7) → F3
* Set Measurement Range	MENU (8) → F1 (for nnn.n uW) MENU (8) → F2 (for nn.nn mW) MENU (8) → F3 (for n.nnn mW)
* End 1018B Emulation Mode	MENU (9) → F2

* These commands only valid after initiating 1018B Emulation Mode.

APPENDIX B

MENU DISPLAYS

B.1 MENU KEY DISPLAYS

The following displays are activated by repeatedly pressing the MENU key. MENU (1) means the key is pressed once. MENU (2) indicates the key is pressed twice, etc.

Following page 3-59 (Appendix D) is a reproduction of the laminated Quick Reference card that came with this manual. The reverse side of this sheet shows, for Quick Reference, all of the menus given in this Appendix.

Keystrokes	Menu Displayed		
MENU (1):	*Press CLEAR to return to data display* *Press MENU for next lower level menu*		
	F1 for Int Trig and to Set Level	*F2 for Ext Triggering Detectors*	*F3 to Cal or Zero*
MENU (2):	*Press CLEAR to return to data display* *Press MENU for next lower level menu*		
	F1 to Enter CW Averaging Number	*F2 to Enter Peak Averaging Number*	*F3 for GPIB Plot*
MENU (3):	*Press CLEAR to return to data display* *Press MENU for next lower level menu*		
	F1 to Enter Detector A Offset	*F2 to Enter Detector B Offset*	*F3 to Enter Source of Frequency Correction*
	NOTE: F2 does not apply to the Model 8501		
MENU (4):	*Press CLEAR to return to data display* *Press MENU for next lower level menu*		
	F1 to Enter Code Number	*F2 to Enter Part Number*	*F3 for Read and Set Time*

MENU (5):

Press CLEAR to return to data display
Press MENU for next lower level menu

F1 to Abort Current Plotting Activity	*F2 to Enter Plotter Address*	*F3 to Enter 8500 Listen and Talk Address*

MENU (6):

Press CLEAR to return to data display
Press MENU for next lower level menu

F1 to Set Max and Min Power Limits	*F2 to Select Ratio Display Mode*	*F3: Hide (or Display) Frequency Information*

NOTE: F2 does not apply to the Model 8501

MENU (7):

(When in the normal 8500 mode)

Press CLEAR to return to data display
Press MENU for next lower level menu

	F2: Emulate 1018B	

MENU (7):

(1018B Emulate Mode, Bus Trigger Reset, SRQ Enabled)

Press CLEAR to return to data display
Press MENU for next lower level menu

F1 to Disable SRQ (Service Request)	*F2 for Automatic Trigger Reset*	*F3 to Get Data Fast; No LCD Data Display*

MENU (7):

(1018B Emulate Mode, Auto Trigger Reset, SRQ Disabled)

Press CLEAR to return to data display
Press MENU for next lower level menu

F1 to Enable Service Request	*F2 for Bus Command Trigger Reset*	*F3 to Get Data Fast; No LCD Data Display*

MENU (8): (When in 1018B Emulate Mode)

Press CLEAR to return to data display
Press MENU for next lower level menu
Current Range Value is 2

F1 for Range 1 (XXX.XuW)	*F2 for Range 2 (XX.XXmW)*	*F3 for Range 3 (X.XXXmW)*

MENU (8): (When in normal 8500 mode)

Press CLEAR to return to data display
Press MENU for next lower level menu

F1 to Program Detector PROM	*F2 to Set Initial Dly Value for Autoscaling*	*F3 to Set Averaging Value for Autoscaling*

NOTE: The MENU (8) → F1 key's function is designed to be used only in conjunction with the WMI PROM Programming Accessory Kit, P/N 16976. The instructions included with the Kit specify how to use the F1 key function.

If F1 were pressed without any requirement for using the PROM Programming device, a long series of sub-menus would normally have to be stepped through in order to escape from the routine. To circumvent this, press the RESET button on the rear of the instrument to escape back to the "power-on" condition.

MENU (9) (When in normal 8500 mode)

Press CLEAR to return to data display
Press MENU for next lower level menu

F1 for Fast Analog Output	*F2: Review 'A' Detector PROM*	*F3: Review 'B' Detector PROM* (8502 only)

MENU (9): (When in 1018B Emulate mode)

Press CLEAR to return to data display
Press MENU for next lower level menu

F2 to End 1018B Emulation

MENU (10): (When in normal 8500 mode)

Press CLEAR for return to data display
Be sure no RF is applied to detectors

F2 to
Start Self Test

MENU (10): (1018B Emulate mode only. Same as MENU (8) for the normal 8500 mode.)

MENU (11): (1018B Emulate mode only. Same as MENU (9) for the normal 8500 mode.)

MENU (12): (1018B Emulate mode only. Same as MENU (10) for the normal 8500 mode.)

B.2 MEMORY KEY DISPLAYS

The following menus are activated by repeatedly pressing the MEMORY key. MEMORY (1) indicates to press the key once. MEMORY (3) indicates to press the MEMORY key three times.

MEMORY (1): *Press CLEAR to return to data display*
Press MEMORY for additional selections

F1 to Recall Setups	*F2 to Store Setups*	*F3 to get Power-On Setup*

MEMORY (2): *Press CLEAR to return to data display*
Press MEMORY for additional selections

F1 to Display Current Setup	*F2 to Display Power-On Setup*	*F3 to Display a Numbered Setup*

MEMORY (3): *Press CLEAR to return to data display*

F1 to Re-Initialize the Current Setup	*F2 to Re-Initialize All but Current Setup*	*F3 to Re-Initialize a Numbered Setup*

B.3 DELAY KEY DISPLAYS (Graph Mode Only)

(Detector channel information pertains to the Model 8502 only)

Press DELAY to enter delay reference

Press F1 to Enter Start Delay	*Press F2 to Enter Delay Window (for Detector A)*	*Press F3 to Enter Cursor Delay*

NOTE: Pressing the DELAY key a second time will cause the ENTER key to act as a command to set the Delay Reference time to be that of the Cursor. To avoid accidental entry of Delay Reference, press F3, then ENTER.

B.3.1 DELAY Key Display (Marker Mode Only)

F1 to Delete One Mrkr Pair Dly Diff Display	*F2 to Add One Mrkr Pair Dly Diff Display*	*F3 to Return to Data Display*

B.4 MARKER KEY DISPLAY (Marker Mode Only)

This menu is only accessible after entry into the Marker Mode. The Marker Mode can only be entered from the Graph Mode. To enter the Marker Mode from the Graph Mode, press the MARKER key once. Pressing the MARKER key a second time will result in the following display:

Press CLEAR to return to data display

F1 for Selection of Marker to be Defined	*F2 for Automatic Placement of Markers*	*F3 to Set % Power Levels Before Auto Placement*

B.5 F3 KEY DISPLAY (Marker Mode Only)

This display is only accessible after entry into the Marker Mode. The Marker Mode can only be entered from the Graph Mode. To enter the Marker Mode from the Graph Mode, press the MARKER key once. This display is intended to show the operator a list of all of the markers that have been defined and their delay times. Therefore, if no markers have been defined, a prompt will appear stating, "No Markers Yet Defined".

If all four available markers have been defined (either manually by the operator, or through the PPM's Auto Placement routine), a display similar to the following will be shown:

Defined 'A' Markers are listed below

Marker 1: 84.100ns
Marker 2: 100.34ns
Marker 3: 215.51ns
Marker 4: 600.91ns

Press CLEAR to return to data display

B.6 dB/mW KEY DISPLAY (Marker Mode Only)

Press CLEAR to return to data display

F1 to Select dB Power Display Format	*F2 to Select Watt Power Display Format*	*F3 to Select % of Ref Pwr Display Format*

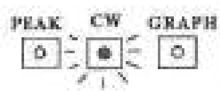
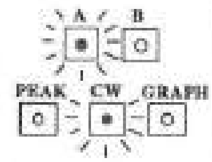
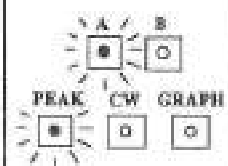
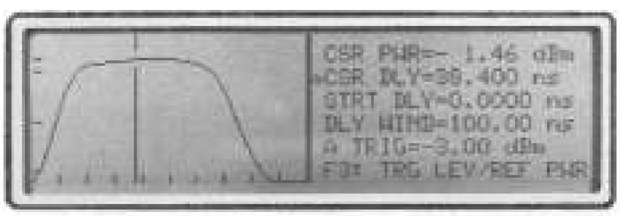
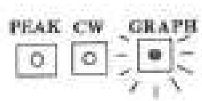
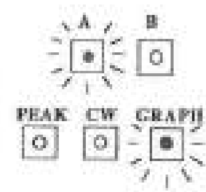
APPENDIX C

DATA DISPLAY FORMATS

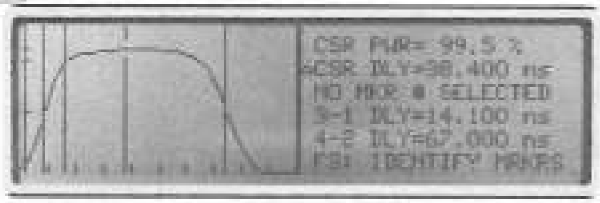
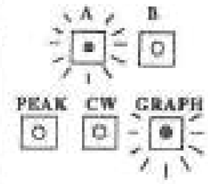
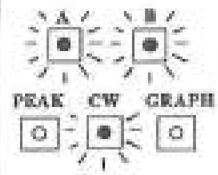
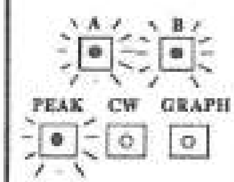
C.1 GENERAL

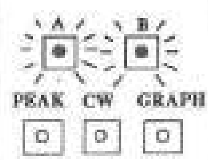
This Appendix shows photos of the major display formats that will be presented in each of the operating modes of the PPM. To the right of the photos are depicted the front panel keys that will be lighted to indicate what functions are in use to produce the particular display. The keys are shown for both the Model 8501 and Model 8502 since the 8502 is equipped with "A" and "B" channel keys that are not on the 8501, and keys lit during the dual channel operation of the 8502 would not be applicable for the Model 8501.

C.2 DATA DISPLAYS

<table>
<tr><th>MODE</th><th>DATA DISPLAYS</th><th>8501</th><th>8502</th></tr>
<tr><td>Channel A
CW Mode</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Channel A
PEAK Mode</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Channel A
GRAPH Mode</td><td>
</td><td>
</td><td>
</td></tr>
</table>

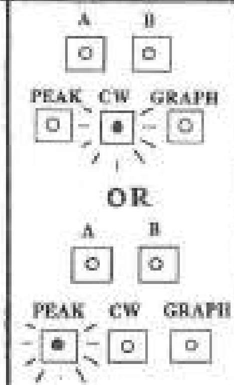
Channel B displays are same as above, only with the "B" key lit and "B:" shown on the LCD display.

<table>
<tr><th>MODE</th><th>DATA DISPLAYS</th><th>8501</th><th>8502</th></tr>
<tr><td>Channel A
MARKER Mode</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Channel B same as above, only with the "B" key lit instead of "A".</td></tr>
<tr><td>Dual Channel
CW Mode</td><td></td><td>N/A</td><td></td></tr>
<tr><td>Dual Channel
PEAK Mode</td><td></td><td>N/A</td><td></td></tr>
<tr><td>Dual Channel
RATIO Mode

(A = CW Signal)
(B = CW Signal)</td><td></td><td>N/A</td><td></td></tr>
</table>

For ratioing various types of signals to each other, the indication in the lower right corner would be:

A = Peak; B = CW = "PK/CW"
Both A & B = Peak = "PK/PK
A = CW; B = Peak = "CW/PK"

MODE	DATA DISPLAYS	8501	8502
Any Mode	Error Indicated Display Blank or Frozen No Trigger Occuring		
		N/A	

APPENDIX D

PPM DEFAULT SETTINGS

Factory-programmed settings of various user defineable functions have the following defaults whenever there have been no changes made in the settings by the operator during any testing routines.

Function	Default Setting
Averaging	CW: 4 samples; Peak: 4 samples
Internal Trigger Level	-10dBm
Frequency	1.00GHz
Offset	0dB
Cursor Delay	1.0000 microseconds
Start Delay	0.0000 nanoseconds
Window Delay	10.0000 microseconds
Reference Power Level	0dBm
Reference Delay	0.0000 microseconds
Cal Factor	0dB
Mode	Channel A, CW power, dBm
Trigger Mode	Channel A, Internal
Marker Difference	3-1, 4-2
Automatic Placement of Markers	10%, 50%, 90% Rising; 50% Falling

Also, the following settings are not affected by power-on, initialization, and setup store or recall:

Maximum Power	+20.5dBm
Minimum Power	-45.0dBm
Autoscale Average Number	10
Autoscale Initial Delay	Greater than 75us
Plotter Address	6
PPM Address	4
Source of Frequency Correction	a) User supplied (as input, default = 1GHz) b) V prop F, parameters not subject to store/recall or initialization c) Cal Factor, not subject to store/recall or initialization
Frequency Display	Displayed

MODEL 8301/8302 FUNCTIONAL COMMANDS – QUICK REFERENCE CARD

Shown below is a listing of all of the commands required to manually activate the various functions of the instruments. The listing gives the specific commands pertaining to each discrete mode of operation (All modes, CW, Peak, Graph, Marker, Dual Channel, and 10188 Emulation), and is formatted to show how to get from one mode to the other (e.g. large arrows between the mode sections contain the name of the key to press to go from one mode to the other in the direction the arrow is pointing). For a more complete discussion of the commands, see Appendix A at the end of the Operation section (Section 3) in the Model 8301/8302 Operating and Maintenance Manual.

ALL MODES

Auto Zero Detectors	MENU (1) + F3 + F2
Calibrate Detectors	MENU (1) + F3 + F1
Self-Test Instrument (While Measuring)	MENU (10) + F2
Detector Offset (Channel A)	MENU (3) + F1 + nn.nn + ENTER
Detector Offset (Channel B - 8302 only)	MENU (3) + F2 + nn.nn + ENTER
Fast Analog Output	MENU (9) + F1
Frequency Correction - User Freq/PROM	MENU (3) + F3 + F1 + nn.nn + ENTER
Frequency Correction - Sweeper/PROM	MENU (3) + F3 + F2 + nn.nn + ENTER + nn.nn + ENTER + nn.nn + ENTER
Frequency Correction - Cal Factor (dB)	MENU (3) + F3 + F3 + A or B + nn.nn + ENTER
Frequency Display Disable/Enable	MENU (6) + F3 (toggle)
Review Detector PROM Information	MENU (9) + F2 (for A) or F3 (for B)
Check Date and Time then Exit	MENU (6) + F3 + F3
Change Date and Time then Exit	MENU (6) + F3 + F1 + mmddyy + ENTER + hhmmss + ENTER + F3
	hhmmss + ENTER + F3
Set Max and Min Power Limits	MENU (4) + F1 + nn.nn + ENTER + nn.nn + ENTER
Recall Setup in Memory (n)	MEMORY (1) + F1 + n + ENTER
Store Setup in Memory (n)	MEMORY (1) + F2 + n + ENTER
Recall Power-On Setup	MEMORY (1) + F3
Display Current Setup	MEMORY (2) + F1 + F1 or F3 (F3 = Exit; F1 = More)
Display Power-On Setup	MEMORY (2) + F2 + F1 or F3 (F3 = Exit; F1 = More)
Display Setup in Memory (n)	MEMORY (2) + F3 + n + ENTER + F1 or F3 (F3 = Exit; F1 = More)
Re-Initialize Current Setup	MEMORY (3) + F1
Re-Initialize All But Current Setup	MEMORY (3) + F2
Re-Initialize A Numbered (n) Setup	MEMORY (3) + F3 + n + ENTER
Initiate 10188 Emulation	MENU (7) + F2
* End 10188 Emulation	MENU (9) + F2

GRAPH MODE

Select 8301 Internal Trigger and Level	MENU (1) + F1 + nn.nn + ENTER
Select 8302 Internal Trigger and Level	MENU (1) + F1 + A or B + nn.nn + ENTER
Select External Trigger	MENU (1) + F2
Peak Averaging	MENU (2) + F2 + nnn + ENTER
Set Initial Delay for Autoscaling (Normal PPM operation)	MENU (8) + F2 + nn.nn + ENTER
Set Averaging Value for Autoscaling (Normal PPM operation)	MENU (8) + F3 + nnn + ENTER
* Set Initial Delay for Autoscaling (10188 emulation operation)	MENU (9) + F2 + nn.nn + ENTER
* Set Averaging Value for Autoscaling (10188 emulation operation)	MENU (9) + F3 + nnn + ENTER

(For commands listed below: (Δ) = Hand Wheel can be used instead of the keypad)

Change Start Delay (ns)	DELAY + F1 + nn.nn or (Δ) + ENTER
Change Window Delay (ns)	DELAY + F2 + nn.nn or (Δ) + ENTER
Change Cursor Delay (ns)	DELAY + F3 + nn.nn or (Δ) + ENTER
Enter Delay Reference (ns)	DELAY + DELAY + nn.nn or (Δ) + ENTER
Clear Delay Reference	DELAY + DELAY + 0 + ENTER
Change Internal Trigger Level	F3 + F1 + nn.nn or (Δ) + ENTER
Change Power Reference (100% Point)	F3 + F2 + nn.nn or (Δ) + ENTER

GRAPH ← PEAK →

GRAPH ← CW →

GRAPH ← MARKER →

GPIB PLOTTING

GPIB PLOTTING	MENU (2) + F3
Code Number Entry for Plot	MENU (4) + F1 + nnnn + ENTER (nnnn = up to 12 digits)
Part Number Entry for Plot	MENU (4) + F2 + nnnn + ENTER (nnnn = up to 12 digits)
Check Date & Time for Plot then Exit	MENU (6) + F3 . . . . F3
Change Date & Time for Plot	MENU (6) + F3 + F1 + mmddyy + ENTER + hhmmss + ENTER + ENTER
Abort (Stop) Plotting Activity	MENU (3) + F1
Enter Plotter GPIB Address	MENU (5) + F2 + nn + ENTER

PEAK MODE

Select 8301 Internal Trigger and Level	MENU (1) + F1 + nn.nn + ENTER
Select 8302 Internal Trigger and Level	MENU (1) + F1 + A or B + nn.nn + ENTER
Select External Trigger	MENU (1) + F2
Peak Averaging	MENU (2) + F2 + nnn + ENTER
Change Cursor Delay ((Δ) : Hand Wheel can be used instead of keypad)	DELAY + nn.nnnn or (Δ) + ENTER

CW ↓ PEAK ↑

CW MODE

CW Averaging	MENU (2) + F1 + nn.nn + ENTER

CW ↑ PEAK ↑

MARKER MODE

Autoplace Markers at Predetermined Percentages of Reference Power. (Pulse profile should be completely visible before activating this command. Default marker placements are 10%, 50%, and 90% points on rising slope; and 50% on falling slope.)	MARKER + F2
Check Marker Autoplacement % and Slope Settings then Exit	MARKER + F3 . . . . F3
Change Marker Autoplacement % and Slope Setting. (Follow displayed instructions after pressing F2.)	MARKER + F3 + ...
Display (Identify) Marker Timing Values with Respect to Delay Reference – Default Reference is Trigger Point.	F3 . . . . CLEAR
Select Log Power Display	dB/mW + F1
Select Watt Power Display	dB/mW + F2
Select % of Reference Power Display	dB/mW + F3

IEEE & 10188 Emulation Commands

Select PPM Listen and Talk Address	MENU (5) + F3 + nn + ENTER
Initiate 10188 Emulation Mode	MENU (7) + F2
* Disable/Enable Service Request	MENU (7) + F1 (toggle)
* Automatic/Bus Command Trigger Reset	MENU (7) + F2
* Get Data Fast (No LCD Display)	MENU (7) + F3
* Select Measurement Range	MENU (8) + F1, F2, or F3 for nn.nn uW, nn.nn mW, or n.nnn mW respectively
* End 10188 Emulation Mode	MENU (9) + F2

MODEL 8302 SPECIFIC COMMANDS FOR DUAL CHANNEL & RATIOING OPERATION

Detector Offset (Channel B)	MENU (3) + F2 + nn.nn + ENTER
Display Ratio A/B Power Mode	MENU (4) + F3
dB/Linear Ratio Toggle	dB/mW (when using the Ratio Mode)
Select Peak Mode for Channel A	A + F1 (when using the Ratio Mode)
Select CW Mode for Channel A	A + F2 (when using the Ratio Mode)
Select Peak Mode for Channel B	B + F1 (when using the Ratio Mode)
Select CW Mode for Channel B	B + F2 (when using the Ratio Mode)
Exit Ratio Mode	CW or PEAK

* These commands only valid after initiating 10188 Emulation Mode.

(Turn over for Model

MODEL 8501/8502 MENU DISPLAYS – QUICK REFERENCE CARD

This side of this Quick Reference Card shows a listing of the menus that will be displayed when the MENU, MEMORY, DELAY, MARKER, F3, and dB/mW keys are pressed. The numbers in parenthesis after the key designation indicate the number of times the key must be pressed to access that menu (i.e. MENU (3) means press MENU three times). Some of the menus are displayed only when certain modes are in use. This will be indicated after the menu heading. For a more complete discussion of the menus, see Appendix B at the end of Section 3, "Operation", in the Model 8501/8502 Operating and Maintenance Manual.

MENU Key Displays

Keystrokes	Menu Displayed
MENU (1):	*Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 for Int Trig and to Set Level* / *F2 for Ext Triggering* / *F3 to Cal or Zero Detectors*
MENU (2):	*Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Enter CW Averaging Number* / *F2 to Enter Peak Averaging* / *F3 for GPIB Plot Number*
MENU (3):	*Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Enter Detector A Offset* / *F2 to Enter Detector B Offset* / *F3 to Enter Source of Frequency Correction* NOTE: F2 does not apply to the Model 8501.
MENU (4):	*Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Enter Code Number* / *F2 to Enter Port Number* / *F3 to Read and Set Time*
MENU (5):	*Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Abort Current Plotting Activity* / *F2 to Enter Plotter Address* / *F3 to Enter 8500 Listen and Talk Address*
MENU (6):	*Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Set Max and Min Power Limits* / *F2 to Select Ratio Display Mode* / *F3: Hide (or Display) Frequency Information* NOTE: F2 does not apply to the Model 8501.
MENU (7):	(When in the normal 8500 mode) *Press CLEAR to return to data display* *Press MENU for next lower level menu* *F3 to Emulate 1018B*
MENU (7):	(1018B Emulate Mode, Bus Trigger Reset, SRQ Enabled) *Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Disable Service Request* / *F2 for Automatic Trigger Reset* / *F3 to Get Data Fast; No LCD Data Display*
MENU (7):	(1018B Emulate Mode, Auto Trigger Reset, SRQ Disabled) *Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Enable Service Request* / *F2 for Bus Command Trigger Reset* / *F3 to Get Data Fast; No LCD Data Display*
MENU (8):	(When in 1018B Emulate Mode) *Press CLEAR to return to data display* *Press MENU for next lower level menu* Current Range Value is X *F1 for Range 1 (XXX.XuW)* / *F2 for Range 2 (XX.XXmW)* / *F3 for Range 3 (X.XXXmW)*
MENU (8):	(When in normal 8500 mode) *Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 to Program Detector PROM* / *F2 to Set Initial Dly Value for Autoscaling* / *F3 to Set Averaging Value for Autoscaling*
MENU (9):	(When in normal 8500 mode) *Press CLEAR to return to data display* *Press MENU for next lower level menu* *F1 for Fast Analog Output* / *F2: Review 'A' Detector PROM* / *F3: Review 'B' Detector PROM* (8502 only)

MENU Key Displays (con't.)

Keystrokes	Menu Display
MENU (9):	(When in 1018B Emulate mode) *Press CLEAR to return to data display* *Press MENU for next lower level menu* *F3 to End 1018B Emulation*
MENU (10):	(When in normal 8500 mode) *Press CLEAR to return to data display* *Be sure no RF is applied to detectors* *F2 to Start Self Test*
MENU (10):	(1018B Emulate mode only. Same as MENU (8) for the normal 8500 mode.)
MENU (11):	(1018B Emulate mode only. Same as MENU (9) for the normal 8500 mode.)
MENU (12):	(1018B Emulate mode only. Same as MENU (10) for the normal 8500 mode.)

MEMORY Key Displays

Keystrokes	Menu Display
MEMORY (1):	*Press CLEAR to return to data display* *Press MEMORY for additional selections* *F1 to Recall Setups* / *F2 to Store Setups* / *F3 to get Power-On Setup*
MEMORY (2):	*Press CLEAR to return to data display* *Press MEMORY for additional selections* *F1 to Display Current Setup* / *F2 to Display Power-On Setup* / *F3 to Display a Numbered Setup*
MEMORY (3):	*Press CLEAR to return to data display* *F1 to Re-Initialize the Current Setup* / *F2 to Re-Initialize All but Current Setup* / *F3 to Re-Initialize a Numbered Setup*

DELAY Key Display (Graph Mode Only)

(Detector channel information pertains to the Model 8502 only)

Press DELAY to enter delay reference

Press F1 to Enter Start Delay	*Press F2 to Enter Delay Window* (for Detector A)	*Press F3 to Enter Cursor Delay*

NOTE: Pressing the DELAY key a second time will cause the ENTER key to act as a command to set the Delay Reference time to be that of the Cursor. To avoid accidental entry of Delay Reference, press F3, then ENTER.

DELAY Key Display (Marker Mode Only)

F1 to Delete One Mrkr Pair Dly OUT Display	*F2 to Add One Mrkr Pair Dly OUT Display*	*F3 to Return to Data Display*

MARKER Key Display (Marker Mode Only)

Press CLEAR to return to data display

F1 for Selection of Marker to be Defined	*F2 for Automatic Placement of Markers*	*F3 to Set % Power Levels Before Auto Placement*

F3 Key Display (Marker Mode Only)

If all four available markers have been defined (either manually by the operator, or through the PPM's Auto Placement routine), a display similar to the following will be shown:

Defined 'A' Markers are listed below

Marker 1: 84.150ns
Marker 2: 200.5ns
Marker 3: 312.5ns
Marker 4: 800.5ns

Press CLEAR to return to data display

dB/mW Key Display (Marker Mode Only)

Press CLEAR to return to data display

F1 to Select dB Power Display Format	*F2 to Select Watt Power Display Format*	*F3 to Select % of Ref Pwr Display Format*

(Turn over for Commands)

4. GPIB (IEEE BUS) INTERFACE

4.1 INTRODUCTION

This section of the manual is divided into several sub-sections to assist the user in obtaining required information as easily as possible. Once familiarization with the Model 8501/8502 Peak Power Meter (PPM) commands and functions has been accomplished, controlling the instrument through the GPIB should be a fairly simple task. A first time user of the PPM should read Section 4.2 before attempting to control the instrument over the bus, as this section provides all of the basic information required to begin programming.

The different sub-sections of these GPIB instructions will contain the following information:

As previously mentioned, the user is advised to become conversant with the manual operation of the PPM before attempting to begin programming the instrument. Section 3 of this manual provides detailed information on controlling the instrument through the front panel.

The PPM allows several modes of GPIB operation. Power measurements can be taken in a variety of modes and formats. These range from simple CW measurements to complex graphic display capabilities of pulse profiles, complete with marker information.

The 1018B emulation feature allows the PPM to be installed in most test systems where the 1018B was previously used without the need for immediate re-programming. The emulation can facilitate the usage of the PPM with the old 1018B software while work to write new code is under way.

4.2 GENERAL INFORMATION

This section will describe the various methods and modes that can be used for remotely controlling the PPM through the GPIB. Typical sample programs illustrating the use of commands will be given.

4.2.1 PPM IEEE Bus Functions

Remote operation of the PPM is accomplished through the GPIB under the control of a remote controller/calculator. Bus functions are implemented using the notation of the IEEE-488 1978 specification. These are given in Section 4.7 on page 4-31.

4.2.1.1 BUS FUNCTION ORDER OF EVENTS

The following is the general order of events when operating through the GPIB:

1. Parsing of Command String
2. Actions taken:
   a) Autoscale, if requested
   b) Power measurement, marker placement, etc.
   c) Output of data upon TACS

It should be noted that it is necessary to wait for certain events to complete before sending new commands. Examples of such commands are AUTO and Marker Placement. If the PPM is placed in TACS and then untalked or if a new command string is sent, then the taking of data will be terminated as will the autoscale function if it is not yet complete. Failure of autoscale will result in a service request and the error condition of 60.

Completion will be signaled by the SRQ reporting either success or failure. If the command is AUTO and marker placement it is necessary to wait for AUTO success or failure, and then marker placement success or failure before expecting any time measurement output data from the PPM.

The controller should time out if the PPM does not complete the appropriate service requests in a reasonable amount of time; allowing for the autoscale average number, pulse repetition rate, etc.

It is recommended that commands be sent at power-on, or after Device Clear from the controller, that will guarantee the state of the instrument. See Appendix D on page 3-59 of the Operations Section for the default settings.

Any pulse profile related command (DUMG, Plot commands, and marker placement commands) will perform their operation on the collected data the moment they are received.

Throughout this IEEE Bus operation section of the manual, delays handled as arguments to commands sent to the PPM are listed as ddddd .dd us. The PPM will accept resolution down to 0.1us or 0.dddd us. Arguments should not be sent with excess digits to the right of the decimal point.

4.2.2 Front Panel Menus

(See Appendix B on page 3-50 of Section 3, Operation, for a complete listing of top level menus.)

Before attempting to remotely control the PPM over the bus, it should be kept in mind that there are various front panel menu selections that will affect bus activity. The front panel menu selections relating to the GPIB will include the following capabilities:

1. Enter the PPM address

   MENU (5) + F3 + nn + ENTER

2. Enter the plotter address

   MENU (5) + F2 + nn + ENTER

   The address entries are self-explanatory; valid values are 0 to 30. The addresses entered are stored in non-volatile memory and need not be re-entered when power is turned off and on again, only when they change.

3. Emulate 1018B (see Section 4.5 on page 4-27). The instrument will always power-on in the normal PPM mode, not the 1018B emulation mode.

4. Plot (see Section 4.2.5.3 on page 4-6).

5. Stop current plotting activity (see Section 4.2.5.6 on page 4-7 regarding the Stand Alone Plot function).

NOTE: Item 1 above, "Enter the PPM address" is most important as the PPM will not respond to bus commands unless this has been correctly accomplished.

4.2.3 Power-On Condition

When the PPM is first turned on, it will be in an idle condition with the LCD readout window showing the "Power-On" display (see Section 3.3.2 on page 3-8 of the Operation section of this manual).

Until it either receives instructions from the GPIB controller to go to the Remote state, or to bypass or start Self-Test by a front panel keystroke, the instrument will remain in the idle, power-on condition. To enter Remote, the PPM must be listen-addressed with the Remote line high. If the instrument is instructed to enter Remote with no front panel keys pressed, it will skip self-test and display CW power for channel A. Other settings such as Frequency will be at their default settings. The address to place the PPM in Remote at power-on will be the same address that was used before power-off. (The default address is 4.)

4.2.4 Remote and Local Lockout Functions

The PPM is designed to only accept commands or output data through the bus when it is in the Remote state. It is placed in the Remote state by listen-addressing the instrument with REN asserted, per the IEEE-488 1978 standard. The PPM will ignore talk-addressing when it is not in the Remote state. Any GET (Group Execute Trigger) command or any data sent to the instrument when it is addressed while not in Remote will result in an error condtion and a service request (if SRQ is enabled) will be generated.

When in Remote, the PPM's front panel keyboard will not be active except for an escape sequence to return to local control. The escape sequence is initiated by pressing the MENU key. At that time the PPM will suspend all operations, including IEEE Bus interaction. The measurement being displayed on the front panel will be replaced with a prompt to press the F1 key to return to local control, or to press the F2 key to abort the return to local escape sequence. The instrument will not respond to any other keystrokes. If F1 is pressed, the instrument will return to local control and resume normal manual operation. If F2 is pressed, the instrument will resume normal operations in the Remote state as though no action had occured. Once the unit has been returned to Local by using the front panel commands given above, it will return to remote the next time it is Listen-Addressed (LADS) with REN asserted.

Another method to return to Local is achieved by sending a GTL (Go To Local) command from the GPIB controller. The PPM will return to the Local control state when it receives this command, and can then be returned to the Remote state the next time it is listen-addressed with REN asserted.

Besides the return to local escape sequence and the GTL universal command, the PPM will also exit the Remote state when the REN line goes low.

4.2.4.1 LOCAL LOCKOUT

After the PPM has entered the Remote state, a Local Lockout command can be sent to it to disable the use of the front panel. This feature is intended to prevent accidental changes in front panel settings or interruption of the program.

When the instrument is in the Local Lockout mode, the Return to Local escape sequence activated by the MENU key is disabled. There is no way to regain control from the front panel once Local Lockout has been commanded.

To go to the Local Lockout mode, the Local Lockout (LLO) bus command must be sent to the PPM. The "LLO" light on the PPM's front panel will not be turned on at that time, but the instrument will be in the LLO state. At the next change in the state of the instrument, either a change in the addressed state of the PPM on the GPIB or any keystroke made on the front panel, the "LLO" light will turn on. If a front panel keystroke is made, it is ignored and will not affect the state of the instrument. Subsequent attempts to control the unit from the front panel will also be ignored.

4.2.5 Output Modes

The PPM is designed to output data over the GPIB in six different modes. In addition, the instrument has two speeds of data transmission: Data Normal and Data Fast. The default speed is Data Normal. The Data Fast mode allows high speed transfer of measurement data through the GPIB interface. While the Data Fast mode is in use, there will be no readings displayed on the PPM's front panel display. There are some functions that are not permitted in the Data Fast mode. These are detailed in Section 4.3.4.1, Data Fast Mode, on page 4-15.

The PPM can only be in one output mode when it is talk-addressed. For example, the unit cannot be programmed to plot and then immediately output the difference in temperature since the last calibration. If the PPM receives more than one output mode instruction, the most recent command will supercede all previous output commands.

The instrument must always be in an output mode. It sends output information when it receives a command to initiate another output mode, or when a current output mode is completed and terminates itself. The self terminating modes are Plot, Output Temperature Difference Since Calibration, Output Status Byte, and Stand Alone Plot. When these modes complete, the PPM will not send any more data until it is untalked (the Stand Alone Plot untalks itself). When untalked, the default output mode becomes either Update Data Trigger Reset or Update Data Continuously, depending on which mode was last initiated. When power is first applied to the instrument, the default output mode is Update Data Trigger Reset.

NOTE: Before selecting any of the PPM Output Modes described above, required parameters should be set so that the PPM data that is taken will be valid. For example, plotting commands will not work unless the PPM has been set to either the Graph or Marker Mode.

4.2.5.1 UPDATE TRIGGER RESET OUTPUT MODE

A. In order to access this mode of operation, a string of four characters must be sent over the bus to the PPM as follows:

"UPDT"

If BASIC is being used on an HP Series 200 computer, the command might look like:

```
OUTPUT 704;"UPDT"
```

where:

OUTPUT is the GPIB command to send the letters in quotation marks following the semicolon.

The 7 in the "704" is the HP instruction that the output is to go via the GPIB interface.

The 04 in the "704" is the Listen/Talk address of the PPM. The Listen/Talk address must be set by using the MENU key on the PPM's front panel. (See the Menu (5) description in Appendix B on page 3-51 of the Operation Section of this manual.)

B. In the Update Trigger Reset Mode, the PPM will not take any data until it receives a trigger reset. When the trigger reset is received through the GPIB, the instrument is set to record the next measurement. If the instrument is in the Peak, Graph, or Marker Mode, the measurement (power reading at the cursor location) will be taken the next time the instrument is triggered. Triggering can be either internal or external, depending on how the instrument has been configured by the user. The recorded measurement data will be output through the GPIB when the PPM next enters TACS (Talker Active State).

The trigger reset can take one of the following two forms:

1. The universal GPIB command, GET (Group Execute Trigger), can be sent over the bus when the PPM is listen-addressed.

   or

2. The controller can send the PPM's "UPDN" (Update Data Now) command to act as a trigger reset (e.g. OUTPUT 704;"UPDN")

When the PPM completes the measurement and has the data ready to output, it will request service if it not in TACS and has SRQ enabled. Entering TACS will clear the service request if the instrument has not already been serviced directly by the GPIB controller program.

The procedure to trigger reset the PPM with the GET command consists of the following steps:

1. Listen-address the PPM.

2. Send the GET universal command.

3. Talk-address the PPM.

4. Release ATN to set the PPM in TACS.

5. If in the Peak Mode, send the pulse to trigger the PPM.

   NOTE: As previously mentioned, if the pulse is sent before the PPM is in TACS, an SRQ will be generated if SRQ has been enabled. Entering TACS will clear the SRQ.

6. Read the power measurement string as it is sent by the PPM. The string will be terminated with a carriage return followed by a line feed character sent with EOI.

The procedure to trigger reset the PPM with the "UPDN" command is the same as using the universal GET command except that, after Step 1 when the PPM has been listen-addressed, the command string "UPDN" should be sent. Power measurement data output format is covered in Section 4.2.7 on page 4-9.

Sample Program:

```
10  PRINT CHR$(12);
20  !    THIS PROGRAM USES THE
30  !    UPDATE TRIGGER RESET MODE
40  !    OF THE PPM TO COLLECT
50  !    POWER MEASUREMENT DATA.
60  !    "UPDN" RESETS THE PPM. IT
65  !    IS THEN READY OR "ARMED".
70  !    THE PPM WILL SEND DATA
80  !    AFTER RECEIVING THE "UPDN"
90  !    COMMAND.
100 !
110 !    DATA ENTERED AS A STRING
120 !    D$ IS DISPLAYED, AND THEN
130 !    REPEATED CONTINUOUSLY.
140 !
150 OUTPUT 704;"UPDT"
160 OUTPUT 704;"UPDN"
170 ENTER 704;D$
180 DISP D$
190 GO TO 160
200 END
```

NOTE: In the Dual Channel Mode, it is necessary to read the IEEE Bus twice to get A and B channel data.

4.2.5.2 UPDATE DATA CONTINUOUSLY OUTPUT MODE

A. In order to access this mode of operation, a string of four characters must be sent over the bus to the PPM as follows:

   "UPDC"

   If BASIC is being used with an HP Series 200 computer, the command might look like:

   OUTPUT 704;"UPDC"

   where:

   OUTPUT is the GPIB command to send the letters in quotation marks following the semicolon.

   The 7 in the "704" is the HP instruction that the output is to go via the GPIB interface.

   The 04 in the "704" is the Listen/Talk address of the PPM. This address must be set from the front panel by using the MENU key. (See the MENU (5) description in Appendix B on page 3-51 of the Operation section of this manual.)

B. In the Update Data Continuously Mode, the PPM is ready to send a continuous stream of data points while it is in TACS. Upon entering TACS, the PPM will initiate a trigger reset and be ready to record the next measurement. If the instrument is in the Peak, Graph, or Marker Modes, the measurement (power reading at the cursor location) will be taken the next time the instrument is triggered. Triggering can be either internal or external, depending on how the user has configured the instrument.

   Upon continuous triggering, measurement data points separated by commas will be sent by the PPM. Measurement data will continue to be sent through the GPIB separated by commas (every time a trigger occurs) until the instrument has been untalked.

Sample Program:

```
10  !   THIS PROGRAM USES "UPDC"
20  !   - UPDATE DATA CONTINUOUSLY.
30  !   THE DATA IS SENT BY THE PPM
40  !   WHEN IT IS TALK ADDRESSED
50  !   WITH THE "ENTER" STATEMENT
60  !
70  OUTPUT 704;"UPDC"
80  !
90  !   TAKE 10 READINGS AND
100 !   DISPLAY THEM:
110 FOR I=1 TO 10
120 ENTER 704 USING "K,#";A$,A(I)
130 DISP A(I)
140 NEXT I
150 END
```

4.2.5.3 PLOT OUTPUT MODE

In this mode the PPM sends HPGL plotter commands to plot a pulse on a compatible plotter. The PPM command "PLOT" initiates the capturing of a pulse and relevant information that will be plotted when the PPM enters TACS. The procedure to plot a graph over the GPIB consists of the following steps:

1. Prepare the PPM by entering the Graph or Marker Mode and obtaining the desired pulse profile to be plotted as shown in the PPM's display window.

2. Send the PLOT command to the PPM.

3. Listen-address the plotter.

4. Talk-address the PPM.

5. Release ATN, putting the PPM in TACS.

The PPM will terminate the plot with a carriage return followed by a line feed sent with EOI. If necessary, the plot can be aborted by the untalking of the PPM during transmission of the plot.

Whenever the PLOT command is sent to the PPM while it is in the Graph Mode, the PPM will plot just the graph. If the PPM is in the Marker Mode, both the graph and the markers will be plotted with the markers labeled and delay times shown. (See Figure 3-6 and 3-7 on page 3-31 of the Operation Section of this manual for typical plots of Graph and Marker Mode pulse profiles.)

4.2.5.3.1 Adding Serial & Code Numbers Numbers to a Plot

The following commands are used when it is desired to have any serial or code numbers appear on a hardcopy plot.

PLPNxxxxxx.......

(x = string of 12 or less characters Plot part number, ASCII string)

PLCNxxxxxx......

(x = string of 12 or less characters Plot code number, ASCII string)

Any printable character is allowed including spaces, except that all leading spaces prior to the first non-space character are stripped off, and not included in the number of characters in the string. The string must be terminated by a semicolon which is not printed. Therefore, no semicolons can be contained within a label string.

Sample Program:

```
10  !   THIS PROGRAM DEMONSTRATES
20  !   HOW TO MAKE THE PPM OUTPUT
30  !   A PULSE PROFILE DISPLAYED
40  !   IN THE GRAPH MODE TO A
50  !   DIGITAL PLOTTER.
60  !
70  !   "C$" AND "P$" ARE STRINGS
80  !   THAT CAN BE SENT SO THAT A
90  !   CODE NUMBER & PART NUMBER
100 !   ARE PRINTED ON THE PLOT BY
110 !   THE PPM.
120 !
130 C$="ABCDEFGHIJKL"
140 P$="123456789012"
150 !
160 !   AFTER ENTRY INTO THE GRAPH
170 !   MODE, THE FOLLOWING
180 !   COMMANDS WILL INITIATE THE
190 !   PPM'S PLOT ROUTINE. THE
200 !   ADDRESS OF THE PLOTTER AND
210 !   PPM MUST BE SET CORRECTLY -
220 !   IN THIS CASE THE PPM IS AT 704,
230 !   AND THE PLOTTER IS AT 706.
```

```
240 OUTPUT 704;"PLCN"&C$
250 !     SEND CODE NUMBER TO PPM
260 OUTPUT 704;"PLPN"&P$
270 !     SEND PART NUMBER TO PPM
280 !
290 !     THESE ARE THE COMMANDS TO
300 !     INITIATE THE PLOT ROUTINE:
310 !
320 OUTPUT 704;"PLOT"
330 !     (PUTS PPM IN PLOT OUTPUT MODE)
340 !
350 SEND 7;UNL
360 SEND 7;LISTEN 6
370 !     (LISTEN ADDRESSES THE PLOTTER)
380 SEND 7;TALK 4
390 !     (TALK ADDRESSES THE PPM)
400 !
410 SEND 7;DATA
420 !     (RELEASES ATN LINE ALLOWING
430 !     PLOTTING TO BEGIN)
440 !
450 WAIT 180
460 !     WAIT UNTIL PLOTTING HAS
470 !     FINISHED BEFORE UNTALKING
480 !     THE PPM. PLOT TAKES ABOUT
490 !     3 MINUTES
500 !
510 !     UNTALK AND UNLISTEN ALL BUS
520 !     DEVICES
530 SEND 7;UNT UNL
540 END
```

4.2.5.4 TEMPERATURE DIFFERENCE OUTPUT MODE

This mode can be used to determine the difference in temperature for each detector since it was last calibrated. The mode provides a means to maintain measurement accuracy by allowing the software to determine when a detector Self-Cal is required. If detector temperature difference information is desired, the command DTMP is sent to the PPM. The instrument will then be ready to output a data string in the following format: (X and Y = temperature reading digits; S = polarity)

DTPASXX.S,DTPBSYY.Y(CR)(LF-EOI)

This will be true with both the Model 8501 and 8502 instruments. If no detector is present, the digit portion of the string will read +00.0. The zeros can either mean no change in temperature difference or no detector present. With the 8501, the "B" reading will always be zeros.

<u>Sample Program:</u>

```
10  !     THIS PROGRAM EXTRACTS
20  !     TEMPERATURE INFORMATION
30  !     FROM THE PPM SO THAT A
40  !     CONTROLLER CAN DETERMINE
50  !     IF A SELF-CAL IS REQUIRED.
60  !     IF THE TEMP SINCE LAST SELF-
70  !     CAL IS MORE THAN +/-5 DEG-C,
80  !     SELF-CAL IS RECOMMENDED
90  DIM A$ 19
100 !
110 !
120 OUTPUT 704;"DTMP"
130 ENTER 704;A$
140 DISP A$
150 END
```

4.2.5.5 STATUS BYTE OUTPUT MODE

The PPM uses this mode to send its status byte out through the GPIB as a character string. The value sent is the internal status value, thus it is not exactly the same as the byte sent during a serial poll in which bit 7 is high when service is being requested (see Section 4.4, Service Request, on page 4-26). The character string sent out to represent the status value will consist of a four digit character head, STAT, followed by three digits. This output mode can only be active when SRQ is disabled. Service request status bytes are not buffered when SRQ is disabled, so only the most recent status value will be output. The status value is followed by a carriage return, followed by a line feed sent with EOI.

4.2.5.6 STAND ALONE PLOT OUTPUT MODE

4.2.5.6.1 <u>Plotting Without Using a Controller</u>

The PPM uses this mode to send HPGL digital plotter commands to plot a pulse, much as it does in the Plot Mode. The difference is that stand alone plots are initiated by commands from the front panel of the PPM. This is to allow plotting without the use of a controller. (See Section 3.6.5 on page 3-29 of the Operation Section.)

4.2.5.6.2 Stand Alone Plot Output Mode: PPM Internal Procedures

This section describes what actions are performed by the PPM when the Stand Alone Plot is initiated from the front panel. Before the PPM can output plotter information, it is first necessary to enter either the Graph or Marker Mode of operation. The Operation Section of this manual contains the information required to prepare for and produce digital plots of Graph and Marker Mode data. The following paragraphs will describe the PPM's internal procedures for GPIB interaction when front panel plots are to be made.

When the PPM has "drawn" a complete pulse profile on its display, it is ready to act as a GPIB controller. When the plot routine is activated, the PPM checks to make sure that there is no other active controller on the bus. If the PPM is in the Remote state, it implies that a controller is present and registers as a GPIB bus error. Also, all PPM service requests are generated by action on the GPIB, and are cleared when REN is dis-asserted (see Section 4.2.4, Remote and Local Lockout, on page 4-3). Therefore, if the PPM internally detects any abnormal status condition in its status byte, it will assume that there was recent activity on the bus involving a controller and refuse to proceed further with the plot. It will also attempt a service request to see if there is any response from the controller.

If the PPM does not detect an indication of another controller, it will assume that it is the only controller-capable device on the bus, and act as system controller. Depending on the system configuration, these checks made by the instrument may not be perfect.

CAUTION: For proper system operation, it is up to the user to be sure that no active controller is on the bus when the front panel function is initiated.

While the PPM is checking the state of the bus, it will display the message "Checking GPIB Interface", and the keyboard will be inactive.

If the PPM does detect an indication of a controller on the bus or if the PPM takes control of the bus and attempts to address the plotter but does not get a handshake, a GPIB bus error message will be displayed and a prompt will require F2 to be pressed to continue. If the PPM does not detect a bus error, a chime will sound and normal operation will resume while the plot is being sent over the GPIB. Once plotting has begun, control of the front panel will be returned to local.

NOTE: If it is desired to add serial and code numbers to the plot, use the information given in Section 3.6.5.2 Step 5 on page 3-30 of the Operation Section.

4.2.6 Command String Format

Control of the PPM is accomplished by using four character mneumonic commands. Some of these require one or more numerical entries (arguments). The command structure is intended to be taken literally; there are no "optional" formats. Thus, if two arguments are specified for a command, both must be given for the command to be processed.

A character string is terminated with a line feed character and/or an EOI. Carriage returns are ignored. Therefore, a carriage return/line feed sequence will act as a string terminator and will be treated as a line feed. More than one command (and respective arguments) can be sent in a command string as long as the string does not exceed 128 characters, including the terminator. (If an EOI is sent and the last character is not a line feed, only 127 characters can be sent.) None of the commands will be able to be processed until the string is terminated, and then they will be processed in the order in which they were given (see Section 4.2.5, Output Modes, on page 4-3 regarding conflicting output commands).

When the command string is received, it is first checked for syntax and numerical values and commands are reviewed to make sure they are valid. If a syntax error or an invalid data error is detected, or the execution of the command string would lead to an operation error, then none of the commands will be executed and a service request will be generated if SRQ is enabled.

A very forgiving syntax is allowed since the PPM can distinguish between any command and any argument, with no separator character required between commands or a command and its argument. The only time a separator character is required is between arguments when the command has two or more arguments. A separator is defined to be a space, a comma, or a semicolon. Any number of separators are allowed before the first command, between a command and an argument, between arguments, between the last argument of a command and the next command, or at the end of the string, without effecting the PPM's interpretation of the command string. Commands can be sent in either upper or lower case format.

An argument consists of a digit string which can optionally be preceded by a " + " or " - " sign. If no sign is present, the number is assumed to be positive. The digit string can also contain a decimal point if desired. The dimension of each argument is fixed, therefore no dimensional identifier is needed or allowed, only a number. This will be described in the command description sections to follow. 1018B command arguments follow a different format as is discussed in Section 4.5, 1018B Emulation, on page 4-27.

4.2.7 Power Measurement Data Output Format

The measurement data output formats transmitted by the PPM over the GPIB depend on whether the PPM is in the "dBm" or "W" power mode of operation. These modes are entered by using GPIB commands as described in Section 4.3.4.2 on page 4-15 or, when the PPM is not in the Remote mode, by pressing the dB/mW key on the front panel.

Power measurements over the GPIB are taken only during the Update Trigger Reset or Update Data Continuously output modes (See Sections 4.2.5.1 and 4.2.5.2 on pages 4-4 and 4-5.)

To initiate the taking of a power measurement over the GPIB, a command is sent to the PPM from the controller and then talk-addressed. When the PPM has been triggered, it will transmit its data through the GPIB to the controller. See the command descriptions given in Section 4.3.1 on the next page for the commands required to take data. The measurement data strings are discussed in subsequent sections.

4.2.7.1 LOG (dBm) DATA FORMAT

When the PPM is in the dBm mode (as indicated in the LCD readout window), the first three letters of the data string are DBM. This indicates that the data represents a dBm value. The following letter indicates which detector (channel A or B) was taking the measurement. This is followed by a polarity sign, and then a string of five digits with a decimal point after the third digit.

Each measurement taken in the Update Trigger Reset Mode will be terminated by a carriage return followed by a line feed sent with EOI. Measurements taken in the Update Trigger Continuously Mode will be separated with commas. Examples are:

Update Trigger Reset Mode:

DBMA-012.73(CR)(LF-EOI)
DBMB+002.47(CR)(LF-EOI)

Update Data Continuously Mode:

DBMA+016.74
DBMA+018.23
DBMA+017.34
and so on

The actual measurement string (less terminating and delimiting characters for each data point) will always be 11 characters long.

4.2.7.2 LINEAR POWER (mW) DATA FORMAT

When the PPM is in the linear power mode (as indicated in the LCD readout window), the first three characters of the data string will be PWR. This indicates that the measurement is a linear value, with the units always in WATTS. As with DBM, the next character indicates which detector (channel A or B) was taking the measurement. This is always followed by a value in engineering notation. The value consists of four digits and a decimal point. These are followed by an "E", then a polarity sign and two more digits. The digits following the E are always multiples of three. This makes it easier to determine if the data is being given in terms of microwatts, milliwatts, nanowatts, etc.

Each measurement taken in the Update Data Trigger Reset mode will be terminated by a carriage return followed by a line feed sent with EOI. Measurements taken in the Update Data Continuously mode will be separated by commas. Examples are:

Update Data Trigger Reset mode:

PWRA31.61E-06(CR)(LF-EOI)
for 31.61 microwatts

PWRB634.7E-03(CR)(LF-EOI)
for 634.7 milliwatts

Update Data Continuously mode:

PWRA64.98E-06,
PWRA65.23E-06,
PWRA89.32E-06,
and so on

The actual measurement string (less terminating or delimiting characters for each data point) will always be 13 characters long.

4.3 GPIB COMMAND DESCRIPTIONS AND FUNCTIONS

4.3.1 General Information

There are approximately 100 different commands available to program the PPM for use on the GPIB. This section will provide functional information pertaining to the commands with the least complex material covered first.

For most applications the automatic features of the PPM provide easy methods of making pulsed measurements. However, a great deal of flexibility and control is available if the user prefers to work with "raw" data.

An alphabetical listing of all commands will be found in Section 4.8, Command Summary, on page 4-32.

The PPM has the following general capabilities:

A. The ability to measure and output CW or Peak power, or a Ratio of two signals in Linear (Watts) or Log (dBm) format.

B. In some applications, the PPM can output the microwave frequency at which the power measurement is being taken.

C. Graphically display pulse profiles automatically.

D. Markers can be placed on the display manually or automatically.

E. Risetime, falltime, and pulse width can be measured and output automatically.

F. Time differences between selected markers can be measured and output automatically.

G. Self-test capabilities are built in.

H. The PPM Calibration function automatically linearizes the detector over a 50dB power range for the most accurate power measurements.

I. The temperature of the detectors can be monitored to verify whether the detector should be recalibrated.

J. The PPM makes use of a PROM with stored frequency response data contained in the RF detector assembly. The instrument uses the stored data to automatically compensate for detector frequency response variations. A rear panel connector is available on the unit to connect a V/GHz signal to allow for automatic frequency selection and correction of measured power.

K. The use of balanced detectors enhances accuracy when used in situations where even harmonics are present.

L. Setups can be stored or recalled to and from the PPM's non-volatile memory by GPIB commands as well as manually through the front panel.

M. Graph displays can be plotted on digital plotters. In addition, data pertaining to a pulse profile can be output to the controller.

N. A "Data Fast" mode disables the front panel display, allowing faster bus operation.

O. Frequency information can be hidden when the PPM is used for classified testing.

NOTE: The Model 8501 instrument will respond to the same command sets as the Model 8502. The only exception is that the 8501 only responds to commands relating to channel A.

4.3.1.1 FUNCTION TIMING

Instrument functions that take a specific amount of time to complete will be noted with an asterisk (*) in the following discussion.

During the time the PPM is processing a function such as calibration, zeroing, or self test, the instrument will continue to be active on the bus. Any new commands will terminate previous activity if not already completed. No output will be given and, if any commands are sent by the controller, only the first byte will be accepted. The PPM will then send "Not Ready for Data" until the function is complete.

When the particular function completes, the PPM will request service and send SRQ if SRQ has been enabled. Successful completion of the task is verified by checking the value of the status byte. A listing of Status Codes is given in Section 4.6 on page 4-30. If SRQ has not been enabled, the controller can only learn the result of the operation by asking for the status byte with the STAT command (see the next section).

4.3.2 Functions Common to All Modes

4.3.2.1 CALIBRATION COMMANDS

* CALA Calibrate channel A detector

* CALB Calibrate channel B detector

Typical Program Line: OUTPUT 704;"CALA"

* It is advisable to use the PPM's SRQ capabilities to monitor whether the calibration has completed and is successful or not. A serial poll can be conducted, and the returned Status value interpreted. See Section 4.4 on page 4-26 for SRQ features, and Section 4.6 on page 4-30 for applicable Status Code values.

4.3.2.2 TEMPERATURE DIFFERENCE SINCE LAST CALIBRATION COMMANDS

DTMP Output the Difference in the temperature of each detector since calibration. This command causes the temperature to be read from each detector (or whatever detector is connected). It will be formatted as described in Section 4.2.5.4 on page 4-7, and is useful for determining whether recalibration of detectors should take place. Normally the PPM can maintain accuracy within $\pm5^{\circ}$C of the temperature of calibration.

4.3.2.3 AUTOZERO DETECTORS COMMANDS

* ZERA Zero channel A detector

* ZERB Zero channel B detector

4.3.2.4 STORE or RECALL SETUP COMMANDS

STORn Store current PPM settings in non-volatile setup memory number n.

(n = number between 1 and 10)

RECLn Recall PPM setting from non-volatile memory n, and make it the current setting.

(n = number between 0 and 10. Setup number 0 cannot be used for storage - it is the last setup before power was turned off or the PPM received a Device Clear from the GPIB controller)

4.3.2.5 HIDE and UNHIDE FRONT PANEL FREQUENCY INFORMATION COMMANDS

FQHD Hide the frequency information

FQDS Display the frequency information

4.3.2.6 OUTPUT STATUS BYTE INFORMATION COMMAND

STAT Output status byte. This command will only be effective when SRQ is disabled. If it is received while SRQ is enabled, a service request will be generated.

Typical Program Lines:

```
OUTPUT 704;"STAT"
ENTER 704;A$
PRINT A$
```

4.3.2.7 SRQ RELATED COMMANDS

SRQE Enable SRQ

SRQD Disable SRQ

UNDD Disable SRQ only for underrange conditions. (Permits continuing data output without undesired SRQ interference.)

UNDE Enable SRQ for underrange conditons.

4.3.2.8 POWER LIMITS

The purpose of setting power limits is to alert the controller of two possibilities having occured. These are:

1. Overrange: Warns that the detector (or other component) may have been damaged, and data taken may be invalid.
2. Underrange: Warns that the power level being measured is low and may be inaccurate.

The PPM can be enabled to generate an SRQ for underrange conditions. The point at which the PPM sends an SRQ is determined by the MINP command. Data output during an underrange condition is as follows:

Log Mode:	-99.99dBm
Linear Mode:	0.000E-99

Overrange conditions always generate an SRQ (if SRQ is enabled), but normal data is still output. **It should be kept in mind that if the detector is exposed to power level in excess of +23 dBm, not only will the PPM's measurement accuracy be degraded, but damage or complete destruction of the detector's diode can occur.**

The commands for setting power limits are:

MAXPsnn.nn

Set power level (in dBm) for overrange condition.

(s = polarity; n = dBm; +21.00 max, -10.00 min)

MINPsnn.nn

Set power level (in dBm) for underrange condition.

(s = polarity; n = dBm; -15.00 max, -50.00 min)

4.3.3 Measurement Data Correction

4.3.3.1 BASIC DATA CORRECTION INFORMATION

The manner in which the PPM is able to make very fast peak power measurements is dependent on the usage of zero bias schottky diode detectors as power sensing elements. These diodes have typical risetimes of less than 10 nanoseconds making them useful for pulsed RF applications. However, at microwave frequencies, it is necessary to compensate for the detector's non-linearity with frequency.

Each WMI detector used in the PPM has a built-in PROM which contains frequency correction data. Depending on the mode of operation, the PPM can be instructed to automatically subtract out the frequency non-linearity error from the power measurement being made.

In order for this automatic correction to take place, the PPM needs to know the frequency of operation. This can be done at the front panel, over the GPIB, or by the use of the Voltage Proportional to Frequency feature (V prop F). The V prop F is an analog voltage connected to the PPM's rear panel EXTERNAL FREQUENCY input connection. A voltage is usually available from most sweepers called V/GHz with a coefficient of 1V/GHz. This voltage can be converted to digital information by the PPM, and used as a "frequency input" instead of having to enter it by some other means.

In addition to automatic frequency correction, it may be desired in some applications to use manual corrections based on specific measurements rather than the factory-supplied data in the detector's PROM. This is known as "Cal Factor". (Some power meters on the market use the term "% efficiency", but it is basically the same thing.) Cal Factor is expressed in dB, and is the amount of power that must be added to or subtracted from the measurement so that the data will be correct.

Another "Data Modifier" called "Offset" can also be used. Complex microwave test setups sometimes include attenuators or couplers to reduce high power signals to safe levels that can be measured by delicate instruments such as the PPM. The Offset feature allows the "subtraction" of residual attenuator or coupler errors from the measurement.

The preceding Data Correction commands will be discussed in the following sections.

4.3.3.2 DETECTOR PROM CORRECTION: USER SUPPLIED FREQUENCY

FREQff.ff

(Where ff.ff is the frequency of the correction.)

Correction is determined by taking user supplied frequency (ff.ff) and referencing data in a PROM in the detector.

Min Value: 0.01GHz
Max Value: 110.00GHz

<u>Sample Program:</u>

```
10  !  THIS PROGRAM SETS THE
20  !  FREQUENCY FOR DETECTOR
30  !  RESPONSE CORRECTION FOR
40  !  THE PPM
50  !
60  F=5.25 ! PPM FREQUENCY SETTING
70  !
80  !  SEND COMMAND TO PPM
90  OUTPUT 704 USING 100;"FREQ",F
100 IMAGE 4A,DDD.DD
110 END
```

4.3.3.3 DETECTOR PROM CORRECTION: EXTERNAL FREQUENCY (V/GHz, Freq Ref)

FPRVvv.vv,ss.ss,mm.mm

(Where v, s, and m are the arguments required to scale the voltage input at the PPM's rear panel FREQUENCY INPUT connection.)

Correction to be applied for the frequency response of the detector will be determined from three user supplied values to properly reference data in the PROM in the detector. The three arguments are respectively:

(1) A coefficient representing the voltage proportional to frequency of the sweeper's V/GHz or Freq Ref output):

Min Value: 0.10V/GHz
Max Value: 10.00V/GHz

The most common values for this coefficient are 0.5 and 1.00V/GHz. Consult the manual for the sweeper being used to obtain the correct coefficient.

(2) The minimum coefficient voltage corresponding to the minimum frequency of the sweeper:

Min Value: 0.0V
Max Value: +19.000V

Example: If the sweeper's V/GHz is 0.5V and the minimum start frequency is 2.0GHz, then this value would be 2 x 0.5 = 1V.

(3) The minimum frequency of the sweeper:

Min Value: 0GHz
Max Value: 110.00GHz

Sample Program:

```
10  !    PPM EXTERNAL FREQUENCY MODE
20  G=5 !  VOLTS/GHZ
30  V=1 !  V/GHZ START FREQUENCY
40  F=2 !  SWEEPER START FREQUENCY
50  OUTPUT 704 USING 60;"FPRV",G,V,F
60  IMAGE 4A,3(DD.DD)
70  END
```

4.3.3.4 EXTERNAL FREQUENCY (V/GHz) AND OUTPUT FREQUENCY TO CONTROLLER COMMAND

FPVOvv.vv,ss.ss,mm.mm

(Where v, s, and m are the arguments required to scale the voltage input at the PPM's rear panel FREQUENCY INPUT connection.) These are the same as described previously for FPRV.

This command causes the same action as the FPRV command but in addition, asks the PPM to output to the controller the converted frequency information from the PPM's rear panel external frequency input.

NOTE: When using FPVO and operating in the UPDC mode, there will be a stack build up. Old frequency and power data will be output in applications such as swept power measurements.

Sample Program:

```
10  !  PPM EXTERNAL FREQUENCY PLUS
20  !  FREQUENCY OUTPUT MODE
30  OUTPUT 704;"UPDT"  !  SELECT OUTPUT
40  !  MODE.  SELECT EXTERNAL FREQ
50  !  MODE AND COLLECT A DATA
60  !  POINT AND ITS FREQUENCY
70  G=5 !  VOLTS/GHZ
80  V=1 !  V/GHZ START FREQUENCY
90  F=2 SWEEPER START FREQUENCY
100 IMAGE 4A,3(DD.DD)
110 OUTPUT 704 USING 100;"FPVO",G,V,F
120 TRIGGER 704
130 ENTER 704 USING "4A,7D,X,4A,6D";A$,B,
    C$,D
140 PRINT USING "K,";"POWER  ",A$," IS ",B
150 PRINT USING "K,";"FREQ  ",C$," IS ",
    D," GHZ"
160 END
```

4.3.3.5 USER DEFINED DETECTOR CALIBRATION FACTOR COMMANDS

DCFAcc.cc

Detector calibration factor for channel A in dB (cc.cc):

Min Value: -9.99dB
Max Value: +9.99dB

DCFBcc.cc

Detector calibration factor for channel B in dB (cc.cc):

Min Value: -9.99dB
Max Value: +9.99dB

Sample Program:

```
10  !  THIS PROGRAM SHOWS HOW TO USE
20  !  THE PPM CAL FACTOR FEATURE
30  !
40  !  CHANNEL A CAL FACTOR
50  !  COMMAND FOR 2.56dB:
60  OUTPUT 704;"DCFA";2.56
70  !
80  !  CHANNEL B CAL FACTOR
90  !  COMMAND FOR 2.56dB
100 OUTPUT 704;"DCFB";2.56
110 !
120 END
```

4.3.3.6 OFFSETTING MEASURED DATA: dB OFFSET COMMANDS

OFFAsnn.nn

Channel A offset

(s = polarity;
nn.nn = dB value)

Min Value: -40.00dB
Max Value: +90.00dB

OFFBsnn.nn

Channel B offset

(s = polarity;
nn.nn = dB value.

Min Value: -40.00dB
Max Value: +90.00dB

4.3.4 Mode Selection and Control

This section describes the various modes of operation available with the PPM, with the exception of the Graph and Marker Modes. The Graph and Marker Modes of operation are given in Section 4.3.6 on page 4-17.

Commands or functions that affect a specific mode of operation are either given or referred to in the following command listings. It should be kept in mind that it is sometimes possible to combine modes, therefore care must be taken to observe the rules and arguments set forth. An example would be the Ratio Mode (available only on the Model 8502). With the PPM it is possible to ratio a CW signal to a Pulsed signal. It would be wise, therefore, to be sure that the rules for triggering under pulsed conditions are followed.

4.3.4.1 DATA NORMAL MODE / DATA FAST MODE COMMANDS

DATF Enter the Data Fast Mode

DATN Enter the Data Normal Mode

All PPM commands and functions operate under the Data Normal Mode (DATN). The Data Fast (DATF) mode of operation is provided to speed up GPIB operations. However, if the Data Fast Mode is used, the front panel display will display only "Fast Measurement Mode". No measurements will be displayed until the Data Normal Mode is re-entered.

Some rules to remember when using the Data Fast Mode are:

- No Graph or Marker Mode capability.
- No Linear Mode capability.

It is not possible to enter the DATF mode while operating in the Graph, Marker, and/or Linear Modes. Conversely, it is not possible to enter one of these modes while in the DATF mode.

The PPM's default mode of operation is the Data Normal Mode.

4.3.4.2 SELECT LOG OR LINEAR POWER MEASUREMENT MODE COMMANDS

DBMW dBm measurement mode display and GPIB output.

WATT Linear measurement mode (mW) display and GPIB output.

Typical Program Line: OUTPUT 704;"WATT"

4.3.4.3 SELECT MEASUREMENT MODE COMMANDS
(Except Graph, Marker & Ratio Modes)

4.3.4.3.1 <u>CW Power Commands</u>

CWPA CW power, channel A

CWPB CW power, channel B

CWAB CW power, channels A & B

A CW related command is:

AVCWnnn

Select number of averages n for CW power measurements. Higher numbers reduce noise effects and stabilize readings at low power levels.

(n = number between 1 and 999)

4.3.4.3.2 <u>Peak Power Commands</u>

The Peak Power Mode must be used very carefully. Power measurements in this mode depend on the occurrence of a trigger, and the positioning of the cursor on the pulse to be measured. For more information, refer to Section 3.4.2 on page 3-9 of the Operation section of this manual.

PKPA Peak power, channel A

PKPB Peak power, channel B

PKAB Peak power, channels A & B

4.3.4.4 RELATED PEAK POWER COMMANDS

AVPK Select number of averages, n, for Peak power measurements. Higher numbers will reduce noise effects and provide more stability at low power levels.

(n = number from 1 to 999 - higher than 4 is recommended).

TRGAsnn.nn

Internal trigger level, channel A

TRGBsnn.nn

Internal trigger level, channel B

Min Value: -10.00dBm
Max Value: +16.00dBm

TRGE External triggering

NOTE: It is important to remember that no data can be taken in the Peak Mode unless a trigger is occuring. This is indicated by the flashing of the "New Data" light on the front panel. See Section 3.4.2 on page 3-9 of this manual for description.

RDLAnnnnnn.nn

Set channel A reference delay. (Arbitrary timing point to which other timing measurements are related.)

(n = microseconds)

RDLBnnnnnn.nn

Set channel B reference delay. (Arbitrary timing point to which other timing measurements are related.)

(n = microseconds)

Min Value: 0 us
Max Value: 213999.97us

CDLAsnnnnnn.nn

Set channel A cursor delay. Sets timing position of the Cursor on the graphic display. The Cursor is the vertical line located where the power reading (CSR PWR) is being taken. (Timing is related to the Reference Delay (REF DLY)).

(n = microseconds; s = polarity)

CDLBsnnnnnn.nn

Set cursor delay for channel B. Sets timing position of the Cursor on the graphic display. The Cursor is the vertical line located where the power reading (CSR PWR) is being taken. (Timing is relative to the Reference Delay (REF DLY)).

(n = microseconds; s = polarity)

Min Value: 0 - Reference Delay
Max Value: 213999.97us - Reference Delay

Sample Program:

```
10  D=1 ! CURSOR DELAY IN
20  !     MICROSECONDS
30  !
40  ! CHANGE CHANNEL A CURSOR
50  ! DELAY
60  OUTPUT 704;"CDLA";D
70  !
80  ! CHANGE CHANNEL B CURSOR
90  ! DELAY
100 OUTPUT 704;"CDLB";D
110 END
```

4.3.4.5 RATIO MODE COMMANDS (Model 8502 only)

The Ratio Mode can be used to measure the power ratio of two signals. These signals can be CW, pulsed, or a combination of both. Depending on whether the PPM is in the Linear (mW) or Log (dBm) mode, the instrument can output data in terms of dB or linear factor A/B expressed as "nnnnnEsnn". The format for ratioing is always Chan A/Chan B.

ACBC Select the ratio of channel A (CW) to channel B (CW)

ACBP Select the ratio of channel A (CW) to channel B (Peak)

APBC Select the ratio of channel A (Peak) to channel B (CW)

APBP Select the ratio of channel A (Peak) to channel B (Peak)

NOTE: Remember that if the internal trigger function is being used, the channel that will provide the trigger must be specified and its level set. See Section 4.3.4.4 on page 4-15.

4.3.5 Command for Retrieving Data from the PPM

UPDC Select Update Data Continuously Mode. The PPM will output a continuous "stream" of power measurement data points separated by commas. Every time the PPM receives a trigger a new data point is added to the "stream". The formats to be discussed in the following two NOTES can then occur:

NOTE 1:

When using the FREQ, CALA (A Cal Factor), CALB (B Cal Factor), or FPRV (Rear Panel Frequency Input) methods for detector frequency response correction (NOT "FPVO"), the PPM's Linear Mode data output string for Channel A will be:

PWRAnn.nnEsnn,PWRAnn.nnEsnn,PWRAnn.nnEsnn

(n = linear power in watts; Esnn = exponent)

This example shows a data string for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nnEsnn". If channel B is in use, the header before the data points would be "PWRB" instead of "PWRA".

The PPM's dBm mode data output string for channel A will be:

DBMAsnnn.nn,DBMAsnnn.nn,DBMAsnnn.nn

(s = polarity; n = dBm)

This example shows a data string for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "DBMAnn.nnEsnn". If channel B is in use, the header before the data points would be "DBMB" instead of "DBMA".

NOTE 2:

When using the FPVO (Rear Panel Frequency Input and Output Frequency) method for detector frequency reponse correction, the PPM's Linear Mode data output string for Channel A will be in the following form:

PWRAmm.mmEsee,FRQAfff.ffE+09,PWRAnn.nnEsee,FRQAggg.ggE+09

(m = first power data point; f = first frequency data point; n = second power data point; g = second frequency data point; Esee = exponent for power in watts; E+09 indicates frequency is in GHz.)

This example shows a data string for 2 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nnEsnn,FRQAfff.ffE+09". If Channel B is being used, the headers before the data points would be "PWRB" and "FRQB". See NOTE 1, preceding, for the description of dBm header and data formats.

UPDT Select Update Data Trigger Reset Output Mode. Prepares the PPM for power measurement data taking routines using UPDN or DET.

UPDN Update Data Now. Take a power reading when the next trigger occurs. This command is only operational if the PPM is in the Update Trigger Reset Mode. See UPDT.

The PPM will output a single data point each time "UPDN" is received. The output formats are the same as those described under UPDC. If FPVO is being used, the frequency at which the power measurement was taken is also output. See UPDC at the beginning of this section, and FPVO in NOTE 2.

4.3.6 Graph and Marker Mode GPIB Operation

The implementation of the Marker Mode for GPIB usage differs somewhat from front panel manual operation. For example, Autoscaling of pulse profiles is not allowed from the front panel in the Marker Mode. The Graph Mode must first be returned to for Autoscaling to be accomplished. However, when operating the PPM over the GPIB, the instrument can be programmed to Autoscale either from the Marker Mode or the Graph Mode.

Therefore, the Graph Mode will seldom be used while the instrument is under GPIB control. There is one exception:

> The Graph Mode allows plotting of pulse profiles without any marker information. This can speed up the plotting function. However, it is likely that in most situations the automatic marker functions of the PPM will be desired.

Given the preceding information, it is assumed that the Marker Mode is the preferred graphic mode of operation.

NOTE: Delay values used by the instrument (Cursor, Start, Window, and Marker) are all displayed and output relative to the Reference Delay at the time the delays are specified. When the Reference Delay is changed, it will effect all of the other indicated delay values.

> The real timing of the functions described above (relative to the trigger) remains the same, but the displayed and GPIB output times of these functions are all in relation to the Reference Delay. When the Reference Delay changes, the other delays change accordingly. For example, if the Cursor Delay was 5ns and the Reference Delay was increased by 2ns, the Cursor Delay would decrease to 3ns. Therefore, Reference Delay entries should always be made first. Most applications and measurements will not require changing the Reference Delay from its default setting of 0.000 nanosecond.

The information to be given next is in ascending order of complexity. All functions that provide results on an automatic basis will be covered first. This should reduce programming time by allowing the PPM's internal software to take care of various tasks such as risetime.

Obviously, there are some types of pulses that cannot easily be measured automatically. If it is required that algorithms be devised to extract pulse information, the PPM should serve this purpose well by using the manual commands and functions which will be covered later in this section.

4.3.6.1 GRAPH/MARKER MODE SELECTION COMMANDS

GRFA Select Graphic display mode, channel A.

GRFB Select Graphic display mode, channel B.

MRKA Select Marker display mode, channel A.

MRKB Select Marker display mode, channel B.

NOTE: The Data Fast Mode has no graphic capability.

4.3.6.2 AUTOMATIC FUNCTIONS OF GRAPH AND MARKER MODES

The following commands will instruct the PPM to automatically carry out a procedure of some kind. In most cases, only instrument settings are made. In some cases, settings are made and appropriate information is output to the controller.

When using the PPM's graphic capabilities, it should be kept in mind that any operations are only applicable to Pulse measurements. All pulse operations require a trigger of some kind. Therefore, before attempting GPIB operations it is advised to become familiar with the manual operation of the PPM. To ensure that the instrument will trigger properly, the Internal Channel A, Internal Channel B, or the External Trigger function must be selected.

Caution: Certain functions such as Autoscaling will only be operative in the Internal Trigger mode. (The channel being autoscaled must have an RF pulse at the detector input with peak power greater than -3dBm.) Failure to trigger for any pulse operation over the GPIB will result in placing the PPM in a "Waiting for Trigger" state.

4.3.6.2.1 Automatic Window Delay Selection Related Commands (Autoscaling)

AUTO Autoscale Current Pulse Profile. If SRQ is enabled, it will be sent at the completion of Autoscaling. Successful Autoscaling can be determined by checking the value of the Status byte.

AVASnnn

Select the Number of Averages, n, for Autoscaling (1 to 999). This command can be useful when attempting to Autoscale a pulse in a "noisy" environment. The more stable the pulse to be Autoscaled is, the less averages required. This setting is independent of other averaging settings such as AVCW or AVPK.

Caution: The number of averages set by this command is never reset to a default value (not even by a Device Clear command). Therefore, it is advisable to set the desired value prior to commencing the Autoscaling function, or to set it once at the beginning of the program and not change its value again.

ASDLnnnnnn.n

Select Maximum Expected Pulse Width for Autoscaling. The purpose of this command is to allow autoscaling of narrow pulses with high repetition rates.

(n = 0.5 to 200,000 microseconds.)

Caution: The maximum expected pulse width set by this command is never reset to a default value (not even by a Device Clear command). Therefore, it is advisable to set this to the desired value prior to activating the Autoscale function.

4.3.6.3 AUTOMATIC MARKER PLACEMENT/TIMING MEASUREMENTS

Using the PPM's automatic marker placement and timing measurement functions will erase any previous marker delay and difference settings. Depending on the pulse profile being observed, the automatic function might be unable to define a particular desired parameter. In this case, an SRQ would be generated. If this should happen, "back up" steps can be taken by the GPIB controller to rectify the situation. In many cases, the variety of manual commands available will make it fairly easy for a user to use his or her own methods to analyze the pulse being measured.

It must be kept in mind that a trigger must occur on a consistent basis in order to make repeatable pulse measurements for profiling operations. Erratic pulse trains or profiles can lead to errors or confusion. In situations where pulse widths or repetition rates are likely to continually vary, it would be better to make single pulse measurements in the Peak Mode. However, in order to make single pulse measurements, the user should have some idea of where the Cursor Delay should be set in order to make the measurement.

The commands given in Section 4.3.6.3.2 on page 4-20 allow for easy measurement of the most commonly desired pulse parameters. These include Risetime, Falltime, Pulse Width, and combinations thereof. The automatic measurements are determined by conventions commonly used in the microwave industry. For example, risetime would be from the 10% to 90% power points on the leading edge of the pulse. However, there are still some "gray" areas which the user must take into account when using these automatic timing functions.

These "gray" areas include deciding what point on the pulse should be considered as the 100% power reference point for the PPM to use when determining the risetime, falltime, and pulse width. This problem can be seen more clearly by magnifying the top of a pulse profile with an overshoot at its rising edge as shown in Figure 3-4 on page 3-21 of the Operation Section of this manual.

It is obvious that, in most situations, it is more desireable to use the center of the pulse as the reference point. Special situations can, of course, occur where the setting of the reference point would be somewhat arbitrary.

The PPM handles the above problems in two ways. The first method is when Autoscaling is used. The Reference Power level is automatically set to a point more or less centered in time between the 3dB points on the pulse. The power axis of the display is also adjusted so that the point selected as the reference point is set to the top of the display as 100%.

The second method is to allow the user to set the Reference Power at some desired level. Power measurements can be taken at different points along the top of the pulse to find the optimum point at which to set the Reference Power. These decisions are based on the types of pulses it is expected will be encountered.

4.3.6.3.1 Reference Power Related Commands

PRFAsnn.nn

Set Channel A Reference Power for graphic display. Sets 100% power reference point as a reference for automatic timing measurements. It also serves to center the pulse on the power axis so that displays and plots of pulses with low amplitudes are "expanded" to show more resolution.

(s = polarity; nn.nn = dBm value)

PRFBsnn.nn

Set Channel B Reference Power for graphic display. Sets the 100% power reference point as a reference for automatic timing measurements. It also serves to center the pulse on the power axis so that displays and plots of pulses with low amplitudes are "expanded" to show more resolution.

(s = polarity; nn.nn = dBm value)

Min Value: -20.00dBm
Max Value: +20.00dBm

Sample Program:

```
10  P=0 ! CHANNEL A REFERENCE
20  ! POWER IN DBM
30  !
40  ! CHANGE CHANNEL A REFERENCE
50  ! POWER
60  OUTPUT 704;"PRFA";P
70  !
80  ! CHANGE CHANNEL B REFERENCE
90  ! POWER
100 OUTPUT 704;"PRFB";P
110 END
```

RPOA Output Current Reference Power for Channel A. If the PPM is in the linear mode it will output:

RFALnn.nnEsnn

(nn.nn = Watts; Esnn = exponent)

If the PPM is in the dBm mode it will output:

RFADsnn.nn

(nn.nn = dBm; s = polarity)

RPOB Output Current Reference Power for Channel B. Linear mode output is:

RFBLnn.nnEsnn

(nn.nn = Watts; Esnn = exponent)

The dBm mode output is:

RFBDsnn.nn

(nn.nn = dBm; s = polarity)

4.3.6.3.2 Automatic Timing Measurement Commands

When making timing measurements, the delay window should be set so that the time to be measured corresponds to at least one third of the total delay. For example, do not use a delay window of 10us to measure risetimes faster than 3us; go to a shorter delay window.

RISE Measure and Output Risetime of Displayed Pulse Profile. Risetime is from the 10% power point to the 90% power point on the rising edge of the pulse. Output format for channel A is:

RISAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

RISBnn.nnnEsnn

FALL Measure and Output Falltime of Displayed Pulse Profile. Falltime is from the 90% power point to the 10% power point on the falling edge of the pulse. Output format for channel A is:

FALAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

FALBnn.nnnEsnn

PLWD Measure and Output Pulse Width of Displayed Pulse Profile. Pulse width is the time between the 50% power points on the rising and falling edges of the pulse. Output format for channel A is:

WIDAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

WIDBnn.nnnEsnn

RSFL Measure and Output Risetime and Falltime of Displayed Pulse Profile. For definitions, see RISE and FALL. Output format for channel A is:

RISAnn.nnnEsnn,FALAnn.nnnEsnn

(n = seconds; Esnn = exponent)
Output format for channel B is:

RISBnn.nnnEsnn,FALBnn.nnnEsnn

RSWD Measure and Output Risetime and Pulse Width of Displayed Pulse Profile. For definitions of risetime and pulse width, see RISE and FLWD descriptions. Output format for channel A is:

RISAnn.nnnEsnn,WIDAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

RISBnn.nnnEsnn,WIDBnn.nnnEsnn

WDFL Measure and Output Pulse Width and Falltime of Displayed Pulse Profile. For definition of falltime and pulse width, see FALL and PLWD descriptions. Output format for channel A is:

WIDAnn.nnnEsnn,FALAnn.nnnEsnn

(n = seconds; Esnn = exponent)

Output format for channel B is:

WIDBnn.nnnEsnn,FALBnn.nnnEsnn

4.3.6.4 MANUAL MARKER PLACEMENT/ TIMING MEASUREMENT COMMANDS

The PPM has a very forgiving command syntax which means that it is possible to send many commands in one string. For example, it is possible to use one string to place four different markers and then have the PPM output two pairs of delay differences.

MKPRn,xx.x

Place Marker n (1 to 4) on the Rising Edge of the Pulse at the % Reference Power Defined by xx.x, and Output the Delay. The specified % reference must be between 4.0% and 99.0%. If channel A is in use, the PPM will output:

MRKAm,snn.nnnEsnn

If channel B is in use, the PPM will output:

MRKBm,snn.nnnEsnn

(m = marker number; s = polarity;
nn.nnn = delay in seconds; Esnn = exponent)

MKPFm,xx.x

Place marker n (1 to 4) on the Falling Edge of the Pulse at the Reference Power Defined by xx.x, and Output the Delay. The specified reference power must be between 4.0% and 99.0%. If channel A is in use, the PPM will output:

MRKAm,snn.nnnEsnn

For channel B, the output is:

MRKBm,snn.nnnEsnn

(m = marker number; s = polarity; nn.nnn = delay in seconds; Esnn = exponent)

MKDFm,n

Place Marker Numbers m and n According to Their Previously Defined % Reference Powers and Positions on the Pulse Profile and Output the Difference between Their respective Delays. If channel A is in use, the PPM will output:

MDFA,m-n,nn.nnnEsnn

NOTE: If "-1" is used as the argument for MKDF, all Marker Difference indications are cleared. The markers themselves will remain intact. Note also that markers m and n must have been previously defined for automatic placement. Otherwise an error will be generated at the time the command is received, and no action will be taken. The status condition will be 37. (See Section 4.6 on page 4-30.)

If channel B is in use, the PPM will output:

MDFB,m-n,nn.nnnEsnn

(m = first marker number defined; n = second marker number defined; nn.nnn = the delay of m minus n in seconds; Esnn = exponent)

MKPA Place all Four Markers According to Their Previously Defined % Reference Powers and Positions on the Pulse Profile and Output Their Respective Delays. For channel A, the output is:

MRKA1,snnn.nnEsnn;2,snnn.nnEsnn;3,snnn.nnEsnn;4,snnn.nnEsnn

If channel B is in use, the output is:

MRKB1,snnn.nnEsnn;2,snnn.nnEsnn;3,snnn.nnEsnn;4,snnn.nnEsnn

The numbers 1, 2, 3, & 4 represent the marker numbers to be used. The "snn.nnEsnn" following each marker number is the delay time of that marker with respect to the reference delay.

(s = polarity; nnn.nn = delay in seconds; Esnn = exponent. The arguments between each set of marker information is separated by a semi-colon.)

NOTE: If a marker number cannot be used for some reason; if a marker was not defined in preparation for placement; or if the PPM could not place the marker, an SRQ will be generated and the marker will not be placed. Then the instrument will output a delay of 0.00 00E-99 seconds for that marker. If all markers are placed successfully, a service request will be generated and the status condition will be 31. If one or more markers are not placed for the reasons described above, then the status condition will be 37 after SRQ.

MKDAm,snnnnnn.nn

Set Marker Number m to Desired Delay, n, in Microseconds on Channel A. (200,000 microseconds maximum)

MKDBm,snnnnnn.nn

Set Marker Number m to Desired Delay, n, in Microseconds on Channel B. (200,000 microseconds maximum)

MKCAm Clear Marker Number m on Channel A.

MKCBm Clear Marker Number m on Channel B.

The above two commands clear both the current marker delay and any definition of automatic marker placement. In other words, they define the marker not to be placed.

4.3.6.5 WINDOW AND CURSOR CONTROL COMMANDS

Some commands can be used in the Graph and Marker Modes as well as the Peak Mode of operation. Peak power measurements are made by placing the Cursor at the desired time point on the pulse to be measured. As previously mentioned, the Cursor Delay is with respect to the Reference Delay. Therefore, in the Peak Mode of operation, it is possible to set the Reference Delay and the Cursor Delay. These two commands are repeated here for use in the Graph and Marker Modes of operation.

Reference Delay is primarily used only in situations where a user wishes to pick an arbitrary point on the pulse as the reference to which all other timing measurements are to be made. One example might consist of a gaussian shaped TACAN radar pulse that is slightly distorted. It could be desired to make timing measurements with respect to the highest point on the pulse. It might also be desired to know the timing of the 3dB point of the pulse with respect to its peak. When in doubt, the Reference Delay should be set to 0.0000 nanoseconds.

Besides the Reference Delay and Cursor Delay, the Start Delay and Window Delay can also be controlled. When the Reference Delay is 0, the Start Delay is the time between the occurence of a trigger and the beginning of the display of information on the PPM's graphic display. The Window Delay is the time "window" shown on the PPM display. By "expanding" or "contracting" the window, it is possible to view a wider or narrower pulse as desired. If Autoscaling is used, the PPM makes these settings automatically.

RDLAnnnnnn.nn

Set Channel A Reference Delay.
(This is the arbitrary timing reference point that the user desires to use for referencing other timing measurements.)

(n = microseconds)

Min. Value: 0us
Max. Value: 213999.97us

RDLBnnnnnn.nn

Set Channel B Reference Delay.
(This is the arbitrary reference point the user desires to use for referencing other timing measurements.)

(n = microseconds)

Min. Value: 0us
Max. Value: 213999.97us

CDLAsnnnnnn.nn

Set Cursor Delay for Channel A.
Sets the timing position of the Cursor on the graphic display, or for Peak measurements. The Cursor is the vertical line on the display where the power reading (CSR PWR) is taken. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value: 0 - Reference Delay
Max. Value: 213999.97us - Reference Delay

CDLBsnnnnnn.nn

Set Cursor Delay for Channel B.
Sets the timing position of the Cursor on the graphic display, or for Peak measurements. The Cursor is the vertical line on the display located where the power reading (CSR PWR) is taken. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value: 0 - Reference Delay
Max. Value: 213999.97us - Reference Delay

CDOA Output Current Channel A Cursor Delay. The PPM will output:

CDLAsnn.nnnEsnn

(s = polarity; nn.nnn = delay in seconds; Esnn = exponent)

CDOB Output Current Channel B Cursor Delay. The PPM will output:

CDLBsnn.nnnEsnn

(s = polarity; nn.nnn = delay in seconds; Esnn = exponent)

SDLAsnnnnnn.nn

Start Delay for Channel A. Sets timing position of left side of graphic display. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value: 0 - Reference Delay
Max. Value: 213999.97us - Window Delay - Reference Delay

SDLBsnnnnnn.nn

Start Delay for Channel B. Sets timing position of left hand side of graphic display. (Timing is relative to the Reference Delay.)

(n = microseconds; s = polarity)

Min. Value: 0 - Reference Delay
Max. Value: 213999.97us - Window Delay - Reference Delay

WDLAnnnnnn.nn

Delay Window for Channel A. Sets the amount of time from the left side to the right side of the graphic display.

WDLBnnnnnn.nn

Delay Window for Channel B. Sets the amount of time from the left to the right side of the graphic display.

(n = microseconds; s = exponent)

Min. Value: 12ns
Max. Value: 213999.97us - Start Delay - Reference Delay

4.3.6.6 COMMANDS TO OUTPUT GRAPHIC DATA TO A CONTROLLER

The PPM can be programmed to output data in several ways as described in Section 4.2.5 on page 4-3. When working with graphic displays it may be useful to enter the entire pulse profile into the controller. Once data has arrived at the controller, various operations programmed by the user can be conducted. For example, it could be desired to program the controller to calculate the peak to peak pulse flatness. The advantage of this method of data acquisition is that it is not necessary to go through the procedure of placing the cursor, taking a power reading, and then repeating the procedure until all points of interest are entered into the controller.

The PPM's graphic display (dump) capability allows the controller to use one command to fetch 118 data points along the pulse profile, as well as any pertinent timing settings relating to the profile being examined.

DUMG Output All 118 Power Measurement Points of the Displayed Pulse Profile. If channel A is in use, the PPM will output:

RDLAnn.nnnEsnn,
SDLAnn.nnnEsnn,
WDLAnn.nnnEsnn,
PWRAnnn.nnEsnn,nnn.nnEsnn, (repeats until all 118 data points have been output)

(Esnn = exponent)

The PPM outputs the Reference Delay (RDLA) in seconds (nn.nnn), then the Start Delay (SDLA), and then the Window Delay (WDLA). This information is followed by the 118 power readings representing the pulse profile. All fields and data points are separated by commas. The "header" for the power readings is PWRA. The power readings take the form of "nnn.nnEsnn"; where nnn.nn is always in Watts, and Esnn is the exponent.

When the PPM outputs using channel B, the headers change to indicate B channel:

RDLB
SDLB
WDLB
PWRB

4.3.6.7 COMMANDS USED FOR PLOTTING

As previously mentioned, there is very little reason to plot or conduct graphic operations in the Graph Mode. All of the operations conducted through the GPIB can be accomplished in the Marker Mode. (This is not completely true in the manual mode of operation.) Therefore, it is assumed that the PPM is in the Marker Mode of operation when executing any of the commands listed in this section for making hardcopy plots.

As described in Section 4.2.5.6 on page 4-7, the PPM has two different plotting modes available. The "Stand Alone Plot" mode should not be used when the instrument is under the control of a remote controller. Also, the "Stand Alone Plot" mode should not be initiated from the front panel of the PPM when the instrument is under GPIB control. (See CAUTION given in Section 4.2.5.6.2 on page 4-8.)

Before a plot is made, it might be desired to enter a part number or code number that can be used for reference. These commands are described in detail in Section 4.2.5.3.1 on page 4-6, and are included in summary in the following description.

PLCNaaaaaaaaaaaa

Set Code Number for plot to ASCII string represented by up to 12 characters (a).

PLPNbbbbbbbbbbbb

Set Part Number for plot to ASCII string represented by up to 12 characters (b).

PLOT — Plot Pulse Profile Currently Displayed. Marker information will not be plotted while the PPM is in the Graph Mode of operation. See Section 4.2.5.3 on page 4-6 for details on using the PLOT command.

There is also a sample progam following Section 4.2.5.3.1 on page 4-6 showing how to format the required "listen" and "talk" addressing procedures.

PLTT — This is the same as the PLOT command, but at a slower speed for transparency plots instead of paper plots.

PLTM — Autoplace Markers as Previously Defined (see Section 4.3.6.3 on page 4-19), and then Plot. This command ensures the most accurate placement of markers prior to plotting because the same data is used for the marker placement as is used for the plot.

PTTM — Same as PLTM, but at a slower speed for transparencies instead of paper plots.

NOTE: If it desired to save a plot on disk exactly as it would have been plotted by a digital plotter, the entire HPGL plot string can be entered into a variable in the GPIB controller using the following program:

```
10  DIM A$(CCCCC) ! NEED VARIABLE SIZE
20  ! HERE
30  OUTPUT 704;"PLOT"
40  ENTER 704;A$ ! ENTER PLOT HPGL
50  ! COMMANDS.
60  ! ADD PROGRAM LINES HERE TO
70  ! STORE A$
.
.
100 END
```

A$ can be recalled later from the disk file for plotting.

NOTE: When plots are output from the PPM, the pulse profile will always be in a linear format including when the reference power is labeled in dBm.

4.3.6.8 PROGRAMMING NOTES

The programming commands for the PPM can be strung together as long as the maximum length limitations specified in Section 4.2 are not exceeded.

This feature enables procedures to be formatted in a logical manner, and reduces the overall number of programming lines required. The following sample program shows how this can be done.

```
10  CLEAR 704 ! DEVICE CLEAR
20  OUTPUT 704;"ASDL200,AVAS25,AUTO"
30  OUTPUT 704;"PLCNabcdefg;PLPNqwerty;
40  RSFL,PLTM"
50  SEND 7;UNL
60  SEND 7;LISTEN 6
70  SEND 7;TALK 4
80  SEND 7;DATA
90  WAIT 180
100 SEND 7;UNT UNL
110 END
```

NOTES:

Line 20: Sets the maximum pulse width for autoscaling to 200 microseconds; sets the averaging for autoscaling to 25 averages; instructs the PPM to autoscale.

Lines 30 & 40: Sets the code numbers for the plot to "abcdefg"; sets the part number for the plot to "qwerty"; instructs the PPM to find the rise and fall times of the displayed pulse; instructs the PPM to place the markers as defined and to plot the displayed pulse profile.

The remaining lines in the sample program are used for bus handling.

Care should be exercised when grouping commands. If conflicting commands are sent in the same string, the last one to be received will be implemented. For example:

```
OUTPUT 704;"MRKA,CDLA5,PKPA"
```

This program line would result in the cursor delay being set at 5us, but the PPM would enter the channel A Peak Mode, not the Marker Mode as indicated by the MRKA portion. In other words, the PPM does not execute any of the commands until (CR)(LF) are received at the end of the program line.

4.4 SERVICE REQUESTS (& SERIAL POLL)

The ability of the PPM to request service over the GPIB can be enabled or disabled by a GPIB command. The PPM's power-on default status enables the SRQ function of the instrument. Usually a service request is generated to report a significant condition to the controller, and the status byte will not be cleared until it is read; REN is dis-asserted; or the instrument is reset. The exception to this is the output-ready condition which will also be cleared when the data is read. If SRQ is disabled the status bytes are not saved, but the current condition is available to be read using the STAT command (also see Sections 4.2.5 and 4.3, Output Modes and Command Descriptions on pages 4-3 and 4-10).

All SRQs are buffered in the PPM. If another error condition is detected after the first value has been read, then the SRQ will remain asserted with the second value in the status byte. Up to 16 status conditions can be buffered in this way. Once a non-zero condition is read from the PPM, the status byte should be read until it becomes zero by taking appropriate action. For example, if the error were overrange power, overrange SRQs will continue until the error is fixed.

When the controller reads the status byte through the GPIB via a serial poll, the 7th bit will always be high if the PPM was requesting service. Thus, the actual value of the PPM status will be the byte that is read minus the 7th bit. When the PPM's status is read by the STAT command (when SRQ is disabled), the byte that is sent out always has the 7th bit as zero (see Output Modes section on page 4-3).

Any status condition that has the sixth bit high will indicate abnormal device operation. In decimal form, this is the case for any status code of value greater than or equal to 32.

Sample Program:

```
10  !  THIS PROGRAM USES SERIAL POLL
20  !  AND SRQ TO DETERMINE IF THE
30  !  PPM SUCCESSFULLY AUTOSCALED
40  !  AS INSTRUCTED.
50  !
60  A=0
```

```
70  ! ENABLE GPIB INTERRUPT
80  ON INTR 7 GOSUB 180
90  ENABLE INTR 7;2
100 !
110 !  ENABLE PPM SRQ
120 OUTPUT 704;"SRQE"
130 !  INSTRUCT PPM TO AUTOSCALE
140 OUTPUT 704;"AUTO"
150
160 !  SRQ WAIT LOOP
170 GOTO 160
180 !  SRQ HANDLING ROUTINE:
190 !  CONDUCT SERIAL POLL, AND
200 !  PUT STATUS BYTE VALUE IN
210 !  VARIABLE 'A'
220 A=SPOLL(704)
230 !  SUBTRACT 64 FROM STATUS
240 !  BYTE TO GET STATUS CODE
250 !  NUMBER CORRECT.  AUTOSCALING
260 !  RETURNS A CODE OF 27.
270 !
280 A=A-64
290 IF A=27 THEN GOTO 330
300 DISP "AUTOSCALING PROBLEM"
310 GOTO 340
320 RETURN
330 DISP "AUTOSCALING OK"
340 BEEP
350 END
```

4.4.1 Error Conditions

When it is first activated, the PPM will check to see if there has been a change in its internal software. An SRQ will be sent over the bus if any change is detected. The PPM will attempt to capture the PROM data from the detector(s), and will also check the detector's serial number(s) to see if there has been a detector change. The instrument will also detect a change in detectors that occurs at any time during a test and measurement operation. When detectors are changed, the instrument will request service and calibration will be required. No data can be taken over the GPIB until recalibration has been completed, or the detector has been removed or changed for the detector that was last calibrated.

If the instrument detects a power over range condition, it will send an SRQ. If data is being collected to be output over the bus, the data will still be available in memory and can be read out. However, if the power level was outside the PPM's normal range the data may not be accurate. This data may still give some idea of what power was being measured. If a serious overrange condition occured, detector damage may have resulted.

If an underrange condition occurs when the PPM is operating under bus control and it is not collecting data to be sent over the bus in the Update Data Trigger Reset, or Update Data Continuously Modes, then the instrument will not signal the controller (with a service request) that the under range condition has occured. Instead, the data display will display the standard under range message of "------". However, if the instrument is collecting data to send over the bus and the data is under range, then the PPM will request service (if SRQ is enabled) to report the condition if the user has asked for it to be reported. If the instrument is in the Update Data Trigger Reset Mode, the under range condition will be reported (via a serial poll) before the output ready condition. The data that will be output over the bus, if the data is still requested, will be an impossible value to indicate to the controller that an under range condition has occured and that the data is not valid. If the log (dBm) mode were in use, the instrument would output a reading of -999.99 dBm. In the linear mode, the reading will be 000.00E-99.

4.5 1018B EMULATION

(Emulation of the 1018B instrument is accessed through the front panel. See Section 4.2.2, Front Panel Menus, on page 4-2.)

4.5.1 Differences in 1018B and 8501/8502 Operation

The differences in the 1018B emulation mode to standard 8501/8502 PPM operation are as follows:

4.5.1.1 COMMANDS

The command set is limited to the three following 1018B commands:

? Update data, behaves exactly as the UPDN PPM command

< NNN Sets cursor delay to a value between 0 and 9.99 us

> NNN Sets cursor delay to a value between 0 and 99.9 us

One to three digits are required, no sign or decimal point is allowed.

The instrument will only read the first 1018B command it receives and ignore the balance of any command string it receives. If the string does not start with a valid 1018B command, the instrument will ignore the entire string and take no action.

4.5.1.2 OUTPUT DATA MODES

There are two output data modes in the 1018B Emulation Mode. These are Update Data Trigger Reset and Update Data Continuously. The default state upon entering the 1018B Emulation Mode is Update Trigger Reset. After that, the output mode can be changed from the front panel (see the Front Panel Menus section on page 4-2). The two modes work in exactly the same way as with the PPM except that the data output format is different.

4.5.1.3 OUTPUT FORMAT

The data will always be output in a string consisting of a polarity sign, four digits, a comma, one last digit with a value of 0 - 3, a carriage return, and then a line feed character followed by a null character (all data lines low) sent with EOI. The first four digits represent the measurement, and the last digit after the comma indicates the range.

Range	Data Format
0	SNNN.N dBm
1	SNNN.N microwatts
2	SNN.NN milliwatts
3	SN.NNN milliwatts

NOTE: The sign will always be positive for linear values.

Examples:

-0147,0(CR)(LF)(NULL - EOI) = -14.7dBm

+1257,3(CR)(LF)(NULL - EOI) = +1.257mW

In the Update Continuously Mode, a continuous string of these measurements will be sent, including the terminating characters, until the PPM is untalked.

4.5.1.4 REMOTE

As in the regular PPM operation mode, the instrument must be in the REMOTE state to accept any commands over the GPIB or to output any data. However, unlike the standard PPM operation, the front panel is fully active while in the REMOTE state and more Menu options will become active in 1018B emulation (see the Front Panel Menus section). This imposes two requirements for the operator. One is the fact that a cursor delay will be accepted on either the front panel or over the GPIB. The most recent cursor delay will be used to determine the measurement. The other difficulty is that a measurement and not a menu prompt must be displayed on the screen for the instrument to be able to collect data. If the controller tries to collect data while the PPM has a front panel menu displayed, the PPM will take no action until it returns to displaying data on the front panel. Then it will collect and output the data. Also, there is no return to local escape sequence while in REMOTE since the front panel is not locked out. There is no local lockout feature either.

4.5.1.5 SERIAL POLL

The serial poll feature operates similar to the 1018B serial poll function. The only time SRQ is asserted is if an output is ready and the value of the status byte is zero.

4.5.1.6 FRONT PANEL MENUS

The front panel menu will include three options regarding GPIB control when in the 1018B emulation mode. These options represent capabilities which can be set on the 1018B front panel, but not on the PPM in general usage. This is because each of these options are directly controllable over the GPIB in normal PPM usage.

Disable/Enable SRQ:

This allows the SRQ capability to be enabled or disabled with the same effects as the SRQE and SRQD PPM GPIB commands. Whatever option is offered, enable or disable, will be the opposite of the current state.

Update on Trigger Reset/Continuous:

This sets the Output Mode. The choice offered will be the opposite of the current mode. Upon entering the 1018B emulation mode, the Output Mode will be set to Update on Trigger Reset.

End 1018B Emulation Mode:

This prompt will replace the menu prompt that initiated the 1018B Emulation Mode.

4.5.1.7 ANALOG OUTPUT

When using the PPM in the 1018B Emulation Mode, it should be kept in mind that the 1018B instrument has a 10mV/dB Analog Output while the PPM has 100mV/dB. If the 10mV/dB output of the 1018B is required, a 10:1 resistive "L" attenuator can be placed on the PPM's output.

4.5.2 Notes on Operation in the 1018B Emulation Mode

4.5.2.1 TWO DETECTORS

The Model 8502 has two detectors instead of only one as does the 1018B. When in the 1018B Emulation Mode, either detector can be used with the choice made through the front panel. It is up to the operator to know which detector is active when the command is given over the GPIB to change cursor delay or to take a measurement. If both detectors are active, the instrument will ignore any GPIB commands and not be able to output any data.

4.5.2.2 REFERENCE DELAY, CORRECTION OF CARRIER FREQUENCY, AND OFFSET VS 1018B DIRECT MODE

A correction will always be made on the carrier frequency. However, to simulate the 1018B direct mode if desired, the reference delay and offset features of the PPM can be negated by setting both to zero via the front panel.

4.5.2.3 OVER AND UNDER RANGE CONDITIONS

The maximum value that the 1018B can output is 19.99mW. Any power reading over that will just result in a reading of 19.99mW when in the linear mode. In the log mode, the reading could be displayed up to 099.99dBm. The minimum values are 000.0uW in the linear mode or a reading of -099.9dBm indicating an under range condition in the log mode.

4.5.3 1018B Features not Emulated by the PPM

Following is a list of the differences in GPIB operation when the Model 1018B Peak Power Meter is replaced on the bus with a Model 8501 or Model 8502 Peak Power Meter (PPM):

1. The PPM has no ability to be directly triggered with a GET command. It can only reset its trigger to capture the next pulse that will trigger the instrument.

2. The PPM has no talk only mode.

3. Whereas the 1018B allowed completely independent talk and listen addresses, the PPM must have the same talk and listen addresses. The addresses are set as one via the front panel.

4. The 1018B locks out the front panel delay setting capability while in the REMOTE state. The front panel delay setting ability remains active on the PPM when in the REMOTE state of the 1018B Emulation Mode.

5. The 1018B will take commands and output data even if it is not in the REMOTE state. This requires the instrument to be in REM.

4.6 STATUS CODE DECIMAL VALUES

The decimal values of the various status codes minus the 7th bit are as follows:

> NOTE: To determine the value with the 7th bit high, add 64 to the values listed below.

4.6.1 Status Code Values with Conditions

0 Operation normal, no condition to report.

1 Output ready to be sent over GPIB.

10 Self test passed.

20 Calibration passed.

25 Autozero passed.

27 Autoscaling completed and passed.

31 All markers specified to be placed were successfully placed. If RISE, PLWD, FALL, RSFL, RSWD, or WDFL, all measurements successfully made.

33 Command string syntax error, command(s) not processed.

34 Command string has invalid argument, command(s) not processed.

35 Command string(s) incomplete when unlistened, string(s) sent so far are lost, command(s) not processed.

36 PPM command buffer overflow. Limit of 128 character string exceeded. String lost, no commands processed.

37 Cannot execute MKDF, markers to be placed are undefined. No command(s) processed,

38 Command not executed, PPM not in REMOTE state.

39 Command not implemented, no commands processed.

40 GET sent when not in REMOTE.

41 GET or UPDN command sent when not in the Update Data Trigger Reset Output Mode. If UPDN command, no command(s) processed.

43 Not in graph or marker mode, must be in graph mode for AUTO (Autoscale Graph), or PLOT commands to function. No command(s) processed.

44 Autoscaling, PLOT, DUMG, or a marker placement command has been specified in the command string and a mode change requested later at some point in the same command string. No command(s) processed.

45 STAT command sent while SRQ enabled, STAT command not active.

46 SRQ buffer overflow, SRQ enabled and not being read quickly enough by the controller.

48 Cannot enter Fast Measurement Mode. Either in linear, graph, or marker mode. No command(s) processed.

49 Cannot execute RECL or WATT commands, or any graph or marker commands in the Fast Measurement Mode. No command(s) processed.

50 Error in reading PROM data from detector A.

51 Error in reading PROM data from detector B.

52 Calibration aborted for lack of a detector.

53 Calibration passed, but with PROM read error.

54 Calibration failed with PROM read error.

55 Calibration failed.

57 Autozero aborted for lack of detector.

58 Autozero fail.

59 Autoscaling aborted for lack of detector.

60 Autoscaling interrupted by GPIB bus command, no trigger received.

61 Unable to Autoscale.

63 Unable to place markers specified or required to make a pulse parameter measurement.

170 Self test failed.

(See Section 7.4.3 on page 7-12 of the Maintenance Section of this manual for description and possible causes pertaining to Error Numbers 01 through 11. These will be decimal values 170 through 180, respectively.)

184 New software detected. Must recalibrate both detectors.

185 Serial numbers don't match. Must recalibrate A and B detectors.

186 Serial number doesn't match. Must recalibrate detector A.

187 Serial number doesn't match. Must recalibrate detector B.

189 Instrument operation failure. PPM will probably need to be reset.

190 Under range. Measurement not accurate.

191 Over range. Damage to instrument may have occurred.

4.7 SUMMARY OF BUS FUNCTIONS

4.7.1 Normal PPM Operation (Under GPIB Control)

SH1 Complete source handshake capability.

AH1 Complete acceptor handshake capability.

T6 Basic talker and serial poll capability, unaddressed as a talker if listen addressed, no talk only mode.

TE0 No talk address extension capability.

L4 Basic listener capability, unaddressed as a listener if talk addressed, no listen only mode.

LE0 No listen address extension capability.

SR1 Complete service request capability (when SRQ enabled).

RL1 Complete remote local interface capability with local lockout capability.

PP0 No parallel poll capability.

DC1 Complete device clear capability (responds to device clear (DCL) and selective device clear (SDC)).

DT1 Complete device trigger capability (responds to group execute trigger, GET (see Section 4.2.5.1, Update Trigger Reset, on page 4-4)).

C0 No controller capability.

4.7.2 PPM Stand Alone Plot Operation

When the PPM is in the Stand Alone Plot mode, two functions will exhibit different capabilities. The Talker and Controller functions are redefined as follows:

T5 Same as T6 capability described in Section 4.7.1 except it has talk only capability used while plotting.

C1, C3, & C28

System controller capability with the ability to send REN and interface messages, but with no capability to send IFC, respond to SRQ, conduct parallel poll, or pass control.

4.8 COMMAND SUMMARY:
(Alphabetical Listing)

The command summary listings given in this section will be in the following format:

ASDLnnnnnn.nn

Description/PPM output strings where applicable.

(n = microseconds; 200,000 maximum)

NOTE: The position of the decimal point can vary in Delay commands.

When arguments are not required, the argument column is blank. If the command is not intended to make the PPM output a data string, the output string will say "none". Arguments are represented by lower case characters, while commands and output string "headers" are capitalized.

Commands that are <u>underlined</u> indicate that the command cannot be used while in the Data Fast (DATF) Mode.

ACBC Select Ratio Mode - Channel A (CW) to Channel B (CW) / none

ACBP Select Ratio Mode - Channel A (CW) to Channel B (Peak) / none

APBC Select Ratio Mode - Channel A (Peak) to Channel B (CW) / none

APBP Select Ratio Mode - Channel A (Peak) to Channel B (Peak) / none

ASDLnnnnnn.nn

Select Initial Delay Used for Autoscaling Pulse Profile / none

(n = microseconds; 200,000 maximum)

<u>AUTO</u> Autoscale Current Pulse Profile / none

AVASnnn

Select Averaging Value Used for Autoscaling Pulse Profile / none

(n = 1 to 999)

AVCWnnn

Select Number of Averages for CW Power Measurement / none

(n = 1 to 999)

AVPK Select Number of Averages for Peak Power Measurement / none

(n = 1 to 999)

CALA Calibrate Channel A Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

CALB Calibrate Channel B Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

CDLAnnnnnn.nn

Set Channel A Cursor Delay / none

(n = microseconds; 200,000 maximum) Cursor Delay is in respect to the Reference Delay - position of decimal point may vary. If Reference Delay = 0, then the Cursor Delay is with respect to the trigger.

CDLBnnnnnn.nn

Set Channel B Cursor Delay / none

(See CDLA)

CDOA Read Out Current Channel A Cursor Delay / PPM will output:

CDLAsnn.nnnEsnn

(s = polarity; n = Cursor Delay in seconds (decimal point may shift); Esnn is the exponent value in engineering notation.

CDOB Read Out Current Channel B Cursor Delay / PPM will output:

CDLBsnn.nnnEsnn

(See CDOA)

CWAB Select Dual Channel Mode: CW Both Channels / none

CWPA Select Channel A Only: CW Power / none

CWPB Select Channel B only: CW Power / none

DATF Select Data Fast Operation (No LCD Display) / none

NOTE: Graph, Marker, or Linear Power Modes cannot be used while operating in DATF. Conversely, DATF cannot be used while in the Graph, Marker, or Linear Power Modes. Do not use commands related to these modes when the DATF function is in use.

DATN Select Data Normal Operation (Exit Data Fast) / none

DBMW Select dBm Power Format / none

DCFAc.cc

Select Channel A Cal Factor / none

(c.cc = Cal Factor; -9.99dB min, +9.99 dB max)

DCFBc.cc

Select Channel B Cal Factor / none

(See DCFA)

DTMP Read Out Temperature Difference of Detectors Since Last Calibration / PPM will output:

DTPAsxx.x, DTPBsyy.y

DUMG Graphic Display - Read Out Reference Delay, Start Delay, Window Delay, and 118 Displayed Data Points of Current Pulse Profile / When PPM is displaying channel A, it will output:

RDLAnn.nnnEsnn,SDLAnn.nnnEsnn,WDLAnn.nnnEsnn,PWRApp.ppEspp,pp.ppEspp . . . . .

(Ref. Dly, Strt. Dly, Wind Dly, Power - 118 points separated by commas. Delays (n) are in seconds; Powers are always in Watts)

FALL Measure and Output Fall Time of Displayed Pulse Profile (90% to 10% on the falling edge of the pulse profile. This command erases previously set markers / The PPM will output the following string when operating in channel A:

FALAnn.nnnEsnn

For channel B:

FALBnn.nnnEsnn

(n = seconds; Esnn = exponent; s = polarity)

FPRVvv.vv,ss.ss,mm.mm

Select External Frequency Input Mode. Sweeper Connected to Rear Panel Input Determines Detector Frequency Response Correction / none

(v = volts/GHz; 0.1 to 10.00; s = Start Voltage; 0 to 19.00; m = Start Frequency; 0 to 110.00GHz)

FPVOvv.vv,ss.ss,mm.mm

Select "FPVO" mode. i.e. Selects the External Frequency input mode and causes output of current operating RF frequency with each power measurement taken while using UPDN or UPDC / none

(See FPRV)

FQDS Enable (Unhide) Frequency Information Display on PPM Front Panel / none

FQHD Disable (Hide) Frequency Information Display on PPM Front Panel / none

FREQff.ff

Select Frequency for Detector Frequency Correction / none

(f = frequency; 0.01 to 110.00GHz)

GRFA Select Graph Mode - Channel A / none

GRFB Select Graph Mode - Channel B / none

MAXPsnn.nn

Set Power for Overrange Condition / none

(s = polarity; n = power in dBm; +21.00 max, -10.00 min)

MINPsnn.nn

Set Power for Underrange Condition / none

(s = polarity; n = power in dBm; -15.00 max, -50.00 min)

MKCAn

Clear Marker Number Selected on Channel A / none

(n = marker number to clear; 1 to 4)

MKCBn

Clear Marker Number Selected on Channel B / none

(n = marker number to clear; 1 to 4)

MKDAn,dddddd.dd

Select Channel A Marker Delay number n, and set it's delay to d / none

(n = marker number to clear; 1 to 4; d = marker delay in microseconds; 200,000 max)

MKDBn,dddddd.dd

Select Channel B Marker Delay number n, and set it's delay to d / none

(See MKDA)

MKDFa,b

Place Markers (a and b) which were previously selected, and Output Their Delay Difference (a - b). Marker differences can also be deselected - See MKDF-1 / When the PPM is in channel A, it will output:

MDFA,a-b,nn.nnnEsnn

(a = first marker; b = second marker; result will be the marker "a" delay minus the marker "b" delay)

MKDF-1

Deselect all Marker Difference Pairs / none

MKPA Autoplace All Four Markers as previously selected and Output Their Delays / If the PPM is in channel A it will output:

MRKA1,nn.nnnEsnn;2,nn.nnnEsnn;3,nn.nnnEsnn;4,nn.nnnEsnn

If the PPM is in channel B, it will output the same as above only with MRKB header.

(1, 2, 3, and 4 = marker numbers; n = delay in seconds; Esnn = exponent)

MKPFa,xx.x

Place Given Marker on Falling Slope of Pulse Profile at the Selected % Power Reference, and Output Its Delay / When the PPM is in channel A, it will output:

MRKAa,nn.nnnEsnn

When the PPM is in channel B, it will output:

MRKBa,nn.nnnEsnn

(a = marker number; 1 to 4; x = percent of reference power to place marker; 4.0% min, 99.0% max; n = delay in seconds; Esnn = exponent)

MKPRa,xx.x

Place Given Marker on Rising Slope of Pulse Profile at the Selected % Power Reference, and Output Its Delay / When in channel A, the PPM will output:

MRKAa,nn.nnnEsnn

When in channel B, the PPM will output:

MRKBa,nn.nnnEsnn

(See MKPF)

MRKA Select Channel A Marker Mode / none

MRKB Select Channel B Marker Mode / none

OFFAsnn.nn

Set Channel A Offset / none

(s = polarity; n = dB offset; -40.00 min, +90.00 max)

OFFBsnn.nn

Set Channel B Offset / none

(See OFFA)

PKAB Select Dual Channel Mode: Peak Power Both Channels / none

PKPA Select Channel A Only: Peak Power Mode / none

PKPB Select Channel B Only: Peak Power Mode / none

PLCNx

Set Code Number to be Plotted / none

(x = ASCII string of 12 characters or less)

PLOT Plot Pulse Profile Currently Displayed GPIB interface must be managed correctly. PPM will output pulse profiles with relevent marker information (or without if desired) using HPGL graphics codes to a compatible digital plotter. See Section 4.2.5.3 on page 4-6 for plotting instructions.

PLPNx

Set Part Number to be Plotted / none

(x = ASCII string of 12 characters or less)

PLTM Autoplace the Markers as previously defined, and immediately begin plotting / See PLOT. (This command ensures that the placement of markers is based on the same power measurement data as is sent to the plotter for increased accuracy of marker placement(s) on the hardcopy plot.)

PLTT Plot Pulse Profile Currently Displayed at Slower Speed for Transparencies / Same as PLOT, but slower pen speed.

PLWD Measure and Output Pulse Width of Pulse Profile Currently Displayed (50% point on rising edge of pulse to 50% point on the falling edge of the pulse). This command erases previously set markers / The PPM will output the following string when operating in channel A:

WIDAnn.nnnEsnn

For channel B:

WIDBnn.nnnEsnn

PRFAsnn.nn

Set Channel A Reference Power for Graphic Display / none

(s = polarity; n = dBm value; +20.00 max, -20.00 min)

PRFB Set Channel B Reference Power for Graphic Display

(s = polarity; n = dBm value; +20.00 max, -20.00 min)

PTTM Plot With Autoplaced Markers at Slower Speed for Transparencies / Same as PLTT, but with slower pen speed.

RDLAnnnnnn.nn

Set Channel A Reference Delay / none

RDLBnnnnnn.nn

Set Channel B Reference Delay / none

(n = microseconds; 200,000 max)

RECLn

Recall Non-Volatile Set Memory Number n / none

(n = memory location; 0 to 10; 0 is the last setup before device clear or power off. The remainder are user memories in which setups can be stored from the front panel, or see STOR command)

RISE Measure and Output Risetime of Pulse Profile Currently Displayed (10% to 90% on the rising edge of the profile). This command erases previously set markers / The PPM will output the following string when operating in channel A:

RISAnn.nnnEsnn

For channel B:

RISBnn.nnnEsnn

(n = seconds; Esnn = exponent; s = polarity)

RPOA Read Out Current Channel A Reference Power / The PPM will output channel A reference power in the following format:

If operating in the Linear Power Mode:

RFALxx.xxEsnn

(x = power in Watts; Esnn = exponent)

If operating in the dBm power format:

RFADsnnn.nn

(s = polarity; n = reference power in dBm)

RPOB Read Out Current Channel B Reference Power. (Readout is the same as RPOA, substituting "B" for "A".)

RSFL Measure and Output Rise and Fall Times of Pulse Profile Currently Displayed. See FALL and RISE for definitions used for fall and risetimes / When operating in channel A, the PPM will output:

RISAnn.nnnEsnn,FALAnn.nnnEsnn

When operating in channel B:

RISBnn.nnnEsnn,FALBnn.nnnEsnn

(n = delay in seconds; Esnn = exponent)

RSWD Measure and Output Risetime and Pulse Width of Pulse Profile Currently Displayed. See RISE for definition of risetime. Pulse width is the time between the 50% power point on the pulse's rising edge, and the 50% point on it's falling edge / Channel A readout is:

RISAnn.nnnEsnn,WIDAnn.nnnEsnn

Channel B readout is:

RISBnn.nnnEsnn,WIDBnn.nnnEsnn

SDLAnnnnnn.nn

Set Channel A Start Delay / none

(n = microseconds; position of decimal may vary. Max = 200,000us - Window Delay - Reference Delay; Min = 0 - Reference Delay. Start Delay is with respect to the Reference Delay. If Reference Delay is 0, then Start Delay is coincident with the trigger.)

SDLBnnnnnn.nn

Set Channel B Start Delay / none

(See SDLA)

SELT Initiate Self Test. Can be used with SRQ for a health check. See Section 4.4 on page 4-26 for description.

SRQD SRQ Disable. See Section 4.4.

SRQE SRQ Enable. See Section 4.4.

STAT Output Status Byte. This command is only effective when SRQ is disabled. If sent while SRQ is enabled, an SRQ will be generated. The PPM will output:

STATnnn

(n = decimal number representing current Status Byte. See Section 4.2.5.5 on page 4-7 and Section 4.4 on page 4-26.

STORn Store Current PPM Settings in Non-Volatile Set-Up Memory Number n / none

(n = number between 1 and 10)

TRGAsnn.nn

Select Channel A Internal Trigger and Set Level in dBm / none

(s = polarity; n = trigger level - +16 dBm max, -10dBm min)

TRGBsnn.nn

Select Channel B Internal Trigger and Set Level in dBm / none

(See TRGA)

TRGE Select External Trigger Mode / none

UNDD Disable PPM SRQ for Underrange Conditions. See Section 4.4 for more information / none

UNDE Enable PPM SRQ for Underrange Conditions. An SRQ will be generated if the power level measurement data is below the level set by MINP / none

UPDC Select Update Data Continuously Output Mode. The PPM will output a continuous "stream" of power measurement data points separated by commas. Every time the PPM receives a trigger, a new data point is added to the stream. The formats described below can occur.

NOTE 1:

When using the FREQ, DCFA (A Cal Factor), DCFB (B Cal Factor), or FPRV (Rear Panel Frequency Input) methods for detector frequency response correction, the PPM's Linear Mode data output string for channel A will be:

PWRAnn.nnEsnn,PWRAnn.nnEsnn,PWRAnn.nnEs
nn

(n = linear power in Watts; Esnn = exponent)

This example shows a data string for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nnEsnn". For channel B, the header before the data points would be "PRWB" instead of "PWRA".

The PPM's dBm Mode output for channel A would be:

DBMAsnnn.nn,DBMAsnnn.nn,DBMAsnnn.nn

(s = polarity; n = dBm)

This example shows a data stream for 3 triggers. Subsequent triggers will produce more data points separated by commas in the form of "DBMAsnn.nn". For channel B, the header before the data points would be "DBMB" instead of "BDMA".

NOTE 2:

When using the FPVO (Rear Panel Frequency Input and Output) method for detector frequency response correction, the PPM's Linear Mode data output string for channel A will be in the form:

PWRAmm.mmEsee,FRQAfff.ffE+09,PWRAnn.nnEsee,FRQAggg.ggE+09

(m = first power data point; f = first frequency data point; n = second power data point; g = second frequency data point; Esee = exponent for power in Watts; E+09 indicates frequency is in GHz)

This example shows a data stream for 2 triggers. Subsequent triggers will produce more data points separated by commas in the form of "PWRAnn.nnEsnn,FRQAfff.ffE+09". If the PPM is in channel B, the headers before the data points would be "PWRB" and "FRQB". See NOTE 1, preceding, for description of dBm header and data formats.

UPDN Update Data Now. i.e Take a power reading when the next trigger occurs. This command is only operational if the PPM is in the Update Trigger Reset Mode. See UPDT. / The PPM will output a single data point each time "UPDN" is received. The output formats are the same as those described under UPDC except that each data point is not followed by a comma. Instead, each point is followed by a carriage return followed by a line feed sent with EOI. If FPVO is being used, the frequency at which a power measurement was taken is output also. See UPDC and FPVO.

UPDT Select Update Date Trigger Reset Output Mode. Prepares the PPM to take power readings using UPDN or GET / none

WATT Select Linear Power Format / none

WDFL Measure and Output Pulse Width and Falltimes of Pulse Profile Currently Displayed. See FALL for definition of falltime. Pulse width is the time between the 50% point on the pulse's rising edge and the 50% point on it's falling edge / When operating in channel A, the PPM will output:

WIDAnn.nnnEsnn,FALAnn.nnnEsnn

For channel B, the output is:

WIDBnn.nnnEsnn,FALBnn.nnnEsnn

(n = delay in seconds; Esnn = exponent)

WDLAnnnnnn.nn

Set Channel A Delay Window / none

(n = microseconds; position of decimal point may vary. 0.012us min; 200,000 - Start Delay - Reference Delay max)

WDLBnnnnnn.nn

Set Channel B Delay Window / none

(See WDLA)

ZERA Autozero Channel A Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

ZERB Autozero Channel B Detector. Takes time to complete - SRQ can be used to monitor successful (or unsuccessful) completion / none

*IDN? Identification Query - Output Model; Software Version. The PPM will output:

WMI,8501,0,VERnn.nn

(WMI = Wavetek Microwave, Inc.; 8501 = model number; 0 = N/A; VER = software version; n = number of the software version. If using a Model 8502, "8501" would be replaced by "8502")

4.8.1 1018B Emulation Commands

<NNN Set Delay 0 to 9.99 microseconds (1018B Emulation) / none

(nnn = delay in tenths of nanoseconds.)

NOTE: A decimal point cannot be sent in the argument string.

>NNN Set Delay 0 to 99.9 microseconds (1018B Emulation) / none

(nnn = delay in tenths of microseconds.)

NOTE: A decimal point cannot be sent in the argument string.

? Update Data (1018B Emulation). Causes a trigger reset when in the "update" or "trigger" modes. The PPM will output power measurement data the next time a trigger occurs.

4.8.1.1 DATA FORMATS

Data will be in the following formats:

dBm Mode:

snnnn,0(CR)(LF)(NULL EOI)

(Interpret snnnn,0 as nnn.n dBm)

Range 1: (microwatts)

snnnn,1(CR)(LF)(NULL EOI)

(Interpret snnnn,1 as nnn.n uW)

Range 2: (milliwatts)

snnnn,2(CR)(LF)(NULL EOI)

(Interpret snnnn,2 as nn.nn mW)

Range 3: (milliwatts)

snnnn,3(CR)(LF)(NULL EOI)

(Interpret snnnn,3 as n.nnn mW)

(s = polarity; linear always +; n = power value)

NOTE: When operating in the Linear Mode, the range is determined from the linear range that has been set from the front panel.

5. ELECTRICAL DESCRIPTIONS OF PC BOARD CIRCUITRY

5.1 INTRODUCTION

This section of the manual contains a functional description of the electrical circuits contained on the more complex PC boards and front panel assembly of the Model 8501/8502 Peak Power Meters (PPM). Table 5-A lists all of the various circuit assemblies by reference designation, and includes the Schematic Diagram (SD) and assembly number for each board.

There is one electrical characteristic that is common to all of the PC boards in the PPM. This is the method used to provide the proper grounding configuration throughout the instrument. Each PC board contains both input and output isolator stages. This is to transfer the ground reference from the Reference or Ratio Common Ground used when signals are passing between the PC boards, to an on-board Common Ground. When any signals leave the boards, they pass through another isolator stage which transfers them back to the between-the-boards reference ground.

Table 5-A. Model 8501/8502 Circuit Assemblies

Ref. Desig.	Nomenclature	Ass'y. No.	SD No.
A1	Interconnect PC Board	16932	16933
A2	Power Supply PC Board	16995	16996
A3	GPIB/Cal Control PC Board	16968	16969
A4	C.P.U. PC Board	16878	16879
A5	Digital Delay PC Board	16685	16686
A6/A7	Analog PC Board	16669	16670
A8	Front Panel Interface PC Board	16911	16912
A9	Front Panel PC Board	16903	16904
A10	LCD Display PC Board	16866	16944
A11	Delay Line	16869	16944
A12	Calibrator	19448	17097
A13	Delay Line	16869	16944

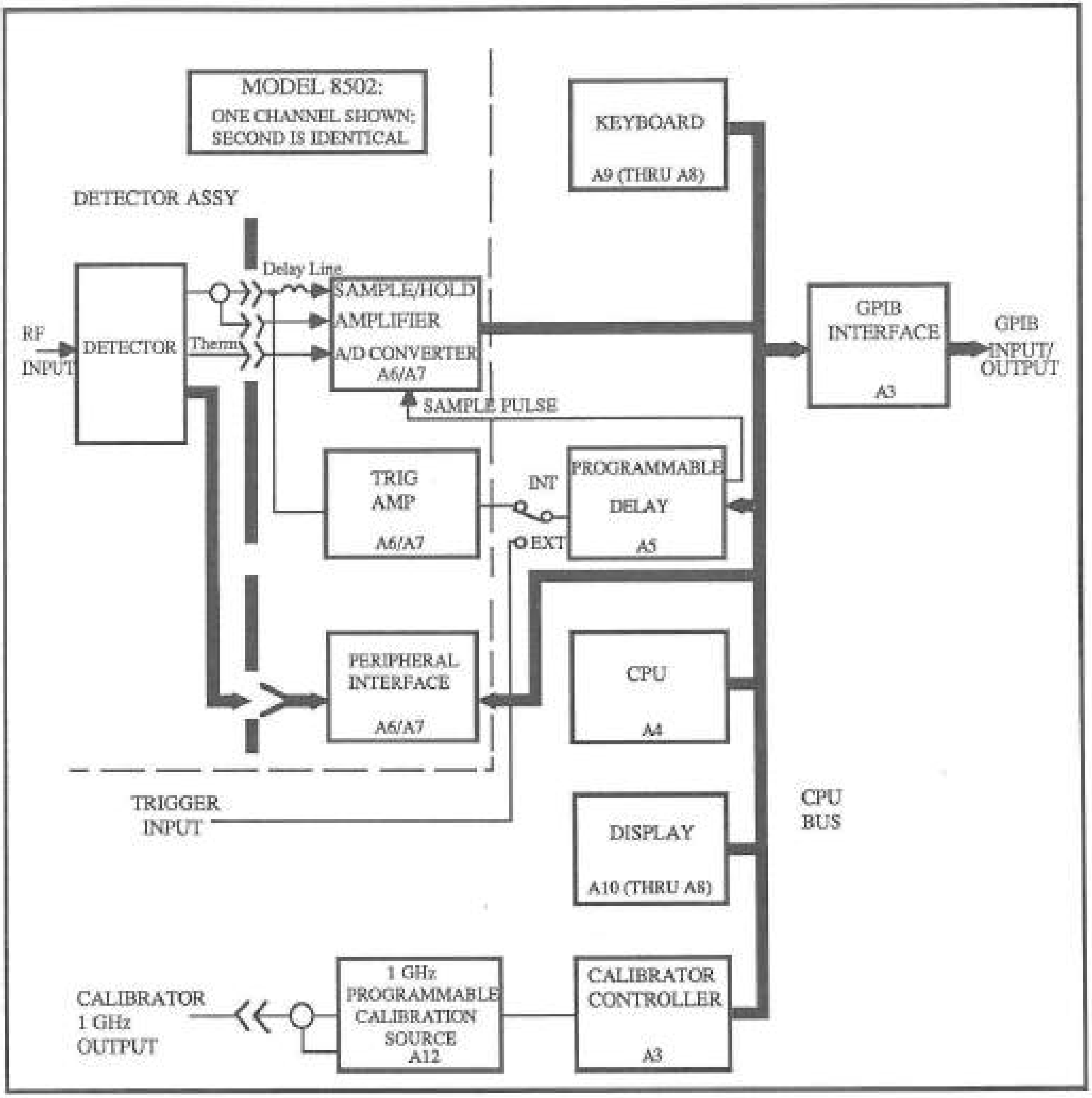


Figure 5-1. Model 8501/8502 PPM System Block Diagram

sitive to the voltage drop across R29 which is controlled in parallel through Q6. U2A is the current limiter for the +5V, and U3A is the current limiter for the -5V. U4 compares the unregulated +5V with the reference from U5. If its output is too low, the AC Fail signal will tell the CPU that the power is about to fail. R61, CR19, and C21 will keep the voltage supply at U4 up long enough for the +5V to drop to a logic zero threshold after the instrument goes to a power-OFF state.

5.3.1 Test Point Indications

TP1	Reads the current in the +15V drive circuitry
TP2	Reads the current in the -15V drive circuitry
TP3	+15V
TP4	15V Common Sense
TP5	-15V
TP6	15V Common
TP7	Reads the current in the +5V drive circuitry
TP8	Reads the current in the -5V drive circuitry
TP9	+5V Sense
TP10	-5V Sense
TP11	5V Common Sense

(discussion continued on page 5-8)

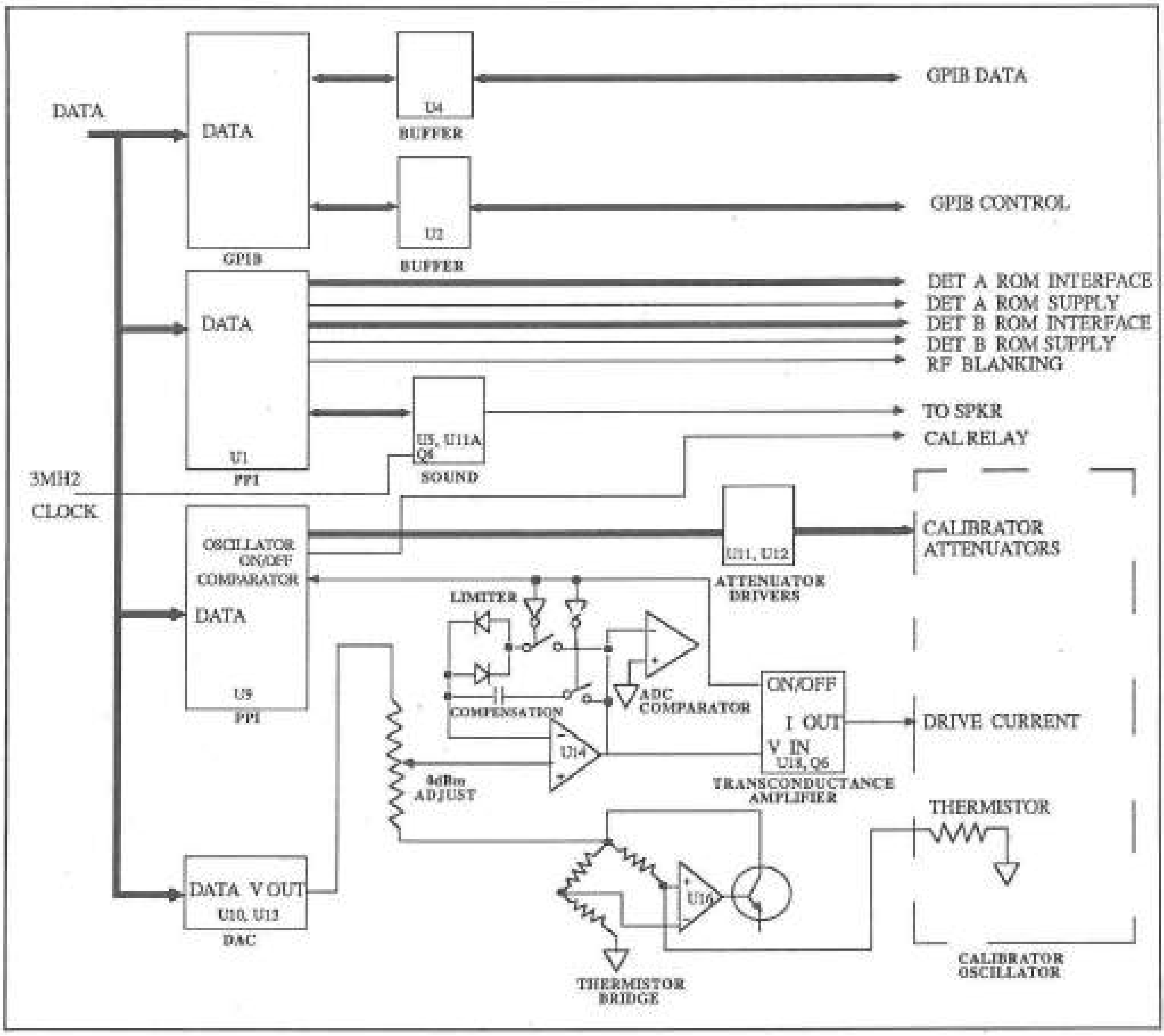


Figure 5-2. GPIB/CAL Control PC Board Block Diagram (Bd. #A3)

(CALIB SET) which is in parallel with R74. A second signal then comes from the thermistor bridge circuit of U16 and Q5. The bridge circuit uses the thermistor in the Calibrator as one leg of a bridge. The bridge is self-balancing, which means that it will always seek a voltage level that will keep it in balance. When the system is first turned on, the thermistor will have a high resistance because it is cold. This unbalanced condition will cause a maximum voltage level to be present at TP9. The voltage level will stay high until the thermistor warms up to a point where the bridge is balanced. Then the voltage level at TP9 will drop and, due to negative feedback, will seek a level which is just sufficient to maintain a balance in the bridge. The bridge voltage is fed back into the summing junction through R18.

The system has two modes of operation controlled by U17A&B which are, in turn, controlled by either a high or low output from the B7 connection of U9. In one mode, the circuit is used to measure the voltage of the bridge (initiated by a low output from B7); in the other mode of operation, the circuitry is used to control the bridge voltage (initiated by a high output from B7). When it is required to measure the bridge voltage, the Calibrator must be turned off so the voltage that selects the measuring mode also turns off the oscillator. The reason for this is that the ambient voltage of the bridge must be measured with no RF applied.

U17B has two parts, one of which serves to invert the logic signal through pin 14 which is the inverse of what comes in through pin 16. The other half of U17B switches the signal into the oscillator control circuit which causes the oscillator to turn off. This is done when the switch is closed by causing the signal to unbalance the oscillator control circuit in such a way that no current can flow to the oscillator. Under that condition, C9 is disconnected from the circuit during the measuring period and the diode pair, CR1 and CR2, act to clamp the circuit to prevent U14's output from going more than ±1V from ground independent of the applied signal. U15 is a comparator that detects whether the output of U14, pin 6, is either positive or negative. The output of U15 then goes to the C port of U9 as an input. This tells the CPU whether U14's output is either high or low as determined by the comparator. In the measurement mode, there is also a CPU driven successive approximation routine which puts a series of words out to the DAC, U10. Then, using standard successive approximation, the voltage level at TP9 is determined and placed in memory. On the basis of the voltage placed in memory and knowing the desired power out, the CPU can then calculate the voltage that must be written to U10 to control the oscillator for the desired output power. To briefly recap, the process is to measure the bridge voltage with no RF applied, determine the desired output power, and then write voltage corresponding to that power to the U10 DAC.

When it is required that the oscillator be controlled, the B7 output of U9 will supply a high voltage signal to close the switch at C9 and open the switch on CR1 and CR2. C9 then serves to stabilize the complete control loop while the thermistor bridge system controls the oscillator. The control system operates in the following way. The oscillator provides RF power to the thermistor and, the more RF applied, the less dc power is required in the self-balancing bridge. Consequently, as the RF power increases the voltage at TP9 will decrease. This voltage feeds into the summing junction at U14. Since diodes CR1 and CR2 are switched out of the loop, the feedback circuit then goes from pin 6 of U14 through R51 to the input of U18D. Pin 11 of U17B is open now, so there is no current fed to U18D from that point, and the voltage applied through R51 directly controls the current through Q6.

R47, R48, R49, R51, R52, U18D, and Q6 are used to form a voltage to current converter. The voltage over R49 will equal the input voltage present at R51, but will be shifted to be relative to -15V. (Can be read at TP7.) Referring to Figure 5-3 on the next page, the current through R49 will be Vin/R49. Assuming that Q6 has a current gain much greater than 1, the current driving the oscillator can be approximated to Vin/R49. As the voltage increases, the oscillator output power and the RF power dissipated in the thermistor will increase resulting in a decrease of the bridge voltage at TP9.

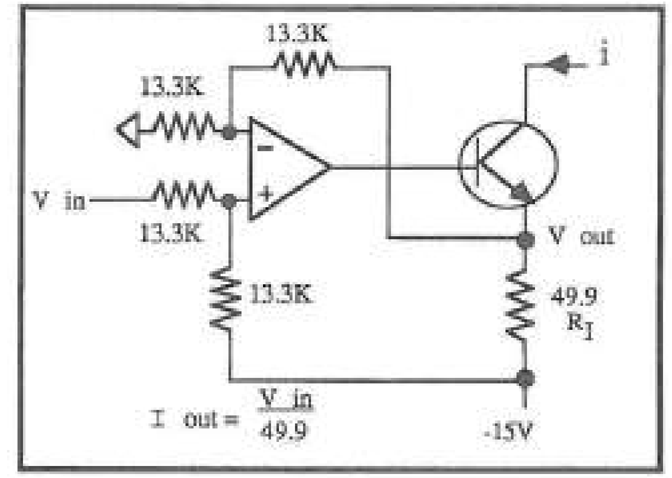


Figure 5-3. Voltage to Current Converter

Mathematically, the conversion function as shown in Figure 5-3 can be described as:

$V+ = (Vin - 15)/2$

$V- = Vout/2$

$Vout = Vin - 15$

$i = (Vout + 15)R_I$

$i = Vin/R_I$

The decrease of voltage will reflect as a decrease in the level of current and, finally, equilibrium will be obtained wherein there is just enough power being supplied to the oscillator to bring the summing junction to a balance at U14. The oscillator will then regulate at that level. The net result is that whatever is written into the U10 DAC will force the voltage at the thermistor bridge to the desired level to produce the required power level from the oscillator.

U18A is the buffer for the incoming +10V reference voltage. Q10 and Q11 are controlled by the B6 connection of U9 to provide a signal which can supply current to turn on a relay external to the PPM during calibration for special applications.

5.4.1 Test Point Indications

TP1	+5V
TP2	5V Common
TP3	-15V
TP4	15V Common
TP5	Output of the control amplifier for the Calibrator control. Its voltage (ranging from a few hundred mV to 10V) will be related to the power required by the Calibrator.
TP6	+15V
TP7	Measure from TP7 to TP3 to give an indication of the current through the oscillator. Will be between 1 and 30mA.
TP8	+10V
TP9	Output of the thermistor bridge. Typically will have a voltage of about 7V under ambient conditions.

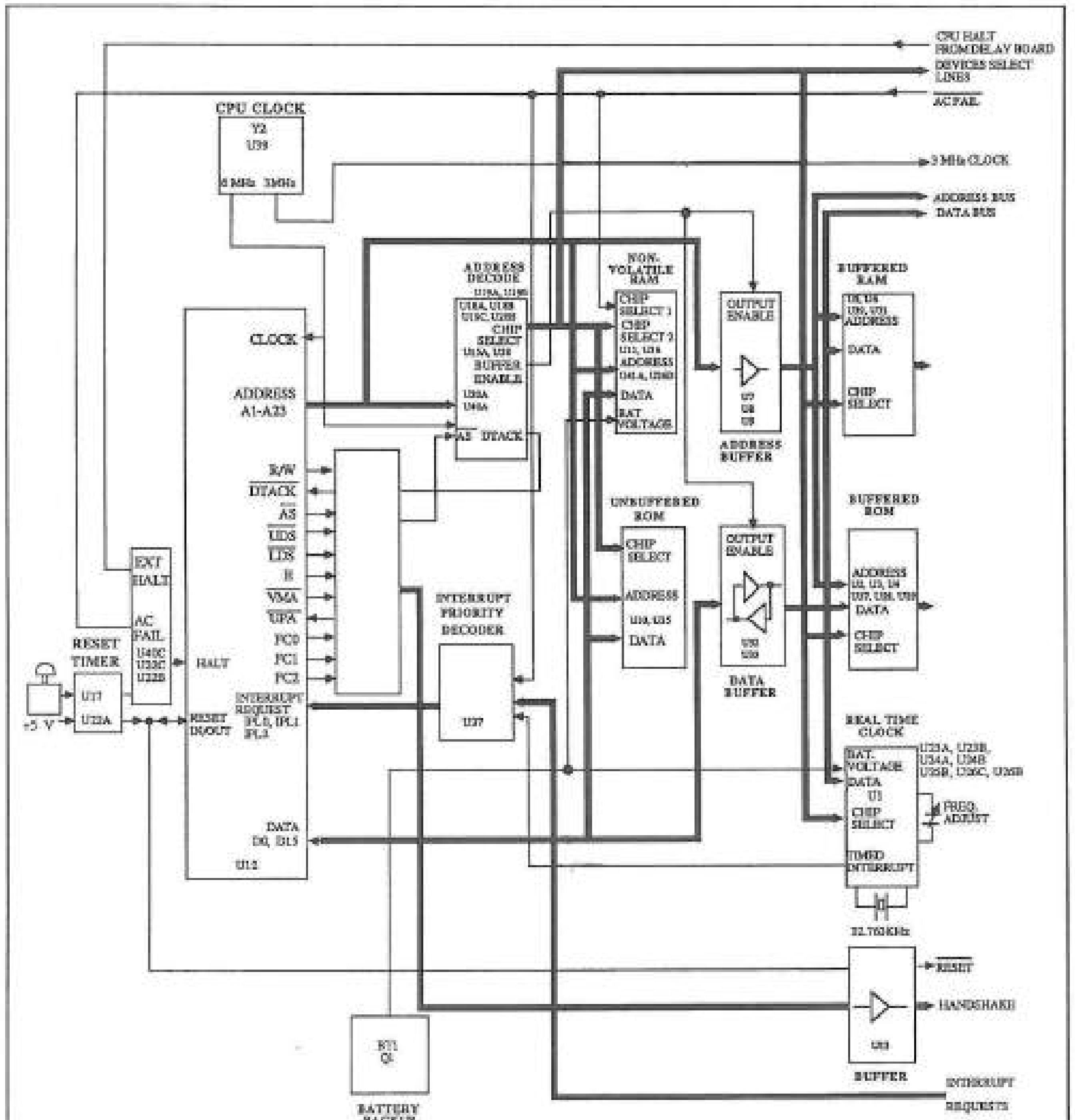


Figure 5-4. CPU PC Board Block Diagram (Bd. #A4)

5.5 CPU PC BOARD (#A4)

(See Figure 5-4 on page 5-11 and SD 16879 on page 8-17)

The CPU (Central Processing Unit) PC board is used to control all of the various functions of the instrument. The circuitry of the CPU is logically divided between those circuits shown on Sheet 1 of SD 16879 and those shown on Sheet 2 of SD 16879.

Sheet 1 of SD 16879 shows the following CPU functions:

A. The Microprocessor (MPU).

B. Address decoding and handshake signal generating circuits.

C. Unbuffered memory.

D. Reset timer.

E. Interrupt Priority Decoder.

F. Data Buffers.

Sheet 2 of SD 16879 shows the following CPU functions:

G. External Memory.

H. Real Time Clock.

I. Backup Battery circuit.

Starting with Sheet 1 of SD 16879 and going in the same sequence as shown above, the functional operation of each CPU sub-circuit is described as follows:

A. THE MICROPROCESSOR.

The Microprocessor is a Motorola 68000 MPU. It has a 16 bit databus, 32 bit internal registers, and runs on a 6MHz clock frequency. If it is desired to see the timing of the MPU in its various modes of operation, it is recommended that the user refer to the manufacturer's manual.

B. ADDRESS DECODING AND HANDSHAKE GENERATING CIRCUITS

This circuitry performs the address decoding for the memories and other devices included on the CPU board and elsewhere in the instrument. It generates the device select signals for the various components, creates the proper timing for each device, and performs the necessary handshaking for the transfer of data between the CPU and the different devices.

U18A&B, U20B, and U19C decode address lines 20 through 23 to select the multiplexer U34. The address strobe not-AS is active when the address lines hold a valid address.

(Note: The term "not-" preceding an address or signal line designation in this discussion indicates that the line is an active low. This is shown on the SD by a bar drawn over the line designation.)

Address lines 16, 17, 18, and 19 are used to select one of the 16 outputs of the multiplexer which will be used as the device select line (not-CS0 through not-CS15). Not-CS0 through not-CS7 are used to address the memories, not-CS8 through not-CS13 address different I/O devices, and not-CS14 and not-CS15 address devices that require a handshake according to the 6800 protocol.

U15A, U38, U19A,D&E, and U16 are used to create the proper timing and handshaking for each device category. When selecting one of the memories, U15A will produce a direct not-DTACK (Data Transfer ACKnowlege) signal to U12 through NAND gate U21C. The MPU will then execute the data transfer without introducing any additional wait states. When selecting one of the I/O devices (not-CS8 through not-CS13), the output of U38D goes high thus enabling the shift register, U16, which is clocked by the 6MHz system clock. After three clock pulses, output QC goes high creating an active CE signal that is used by the Analog PC Board circuitry. After another clock pulse QD goes high, is inverted in U19A, and creates a delayed not-DTACK through U21C. The MPU responds by inserting a corresponding number of wait states in the data transfer which allows the device to time the data transfer. Not-DTACK can also be received from any external device connected to the CPU bus that has its own address decoding circuits.

When not-CS14 or not-CS15 are selected, U19E will generate a not-VPA (Valid Peripheral Address) signal through NAND gate U21B. This will tell the MPU that a valid 6800 device has been addressed, and the MPU will respond by generating a data transfer according to the 6800 protocol. The E and not-VMA (Valid Memory Address) outputs are used in this protocol. There is an external input to the not-VPA, and the not-VPA is also used in the interrupt process.

NAND gate U20A and inverter U40A are used to provide an active low signal when a device outside the buffers is addressed.

C. UNBUFFERED MEMORY

The memory inside the buffers consists of 2 8K*8 bits of RAM and 2 32K*8bits of ROM with the RAMs kept alive by a battery (non-volatile) when the instrument is turned off. NAND gate U26D (also battery powered) is deselected by the not-AC FAIL signal when the instrument is off to protect the contents of the memory. Each pair of memories use the 16 bit wide data bus and are addressed with one device select signal. The upper and lower data bytes are selected in OR gate U14 by letting the Upper Data Strobe (not-UDS) and Lower Data Strobe (not-LDS) gate the R/not-W output from the MPU to produce the Lower data Write Enable (not-L.WE), Upper data Write Enable (not-U.WE), Lower data Output Enable (not-L.OE), and Upper data Output Enable (not-U.OE) signals.

D. RESET TIMER

The reset timer, U17, consists of a 555 timer used as a monostable pulse generator. When the instrument is turned on or when the reset button on the back panel is pressed it generates a 0.5 second pulse which is used to reset the MPU. U22A&B give separate open collector inputs to the not-RESET and not-HALT inputs. U22C provides the not-HALT signal which comes from the Delay board. The not-RESET pin of the MPU is a bidirectional line, and the MPU can generate its own resets. Diode CR1 enables the not-AC Fail to Halt the MPU. This is necessary to ensure that the MPU is not trying to make a data transfer to the non-volatile RAMs or Real Time Clock when they are being deselected by the AC Fail signal.

E. INTERRUPT PRIORITY DECODER

The Interrupt Priority Decoder, U37, interfaces the three interrupt priority lines (IPL0, IPL1, and IPL2) to the seven interrupt request lines (IRQ1 through IRQ7). The three output lines of U37 will have encoded the number of the highest priority input line that has been driven low. As can be seen on the SD, the not-AC Fail line is connected to the highest priority interrupt input. The lowest priority interrupt input is connected to the Real Time Clock for timed interrupts.

F. DATA BUFFERS

Data buffers U7, U8, U9, U13, U32, and U33 are used to give an increased drive capability to all of the signals on the CPU bus that require the increased capability. They are all enabled by U40A from the Address Decoder circuit. This will happen each time none of the Unbuffered Memories have been selected. The R/not-W signal is used to determine the direction of data flow in the bidirectional buffers used with the data bus lines.

G. EXTERNAL MEMORY

The External Memory interfaces the buffered CPU bus. It consists of two pairs of 8K*8 bits of RAM (U5, U6, U30, and U31), and three pairs of 32K*8 bits of ROM (U2, U3, U4, U27, U28, and U29).

H. REAL TIME CLOCK

The Real Time Clock, U1, interfaces the Buffered CPU bus. Data transfer follows the 6800 compatible protocol with the E and not-VMA signals used to produce the handshaking required for the transfer. U23A&B, U24A&B, U25B and U26B are used to control U1. To see the timing used in the data transfer it is recommended that the manufacturer's data sheet for U1 (Motorola Type MC146818P) be consulted. C47 is used to adjust the frequency of the internal clock of U1. The 32.768kHz frequency can be monitored at TP6. The Real Time Clock also provides a timed Interrupt Request signal (IRQ1) that is used by the CPU operating system. Its frequency is software programmable, and can be monitored at TP7. The Real Time Clock is deselected by the not-AC Fail line

through U26B.

I. BACKUP BATTERY CIRCUIT

The CPU board is supplied with backup power from the on-board battery, BT1, whenever the line voltage is off or too low to supply the instrument with the required input voltage. Transistor Q1 is turned on by the +15V supply to supply +5V to the circuits connected to the battery with a minimum drop in voltage. While the instrument is turned on, R1 regulates the trickle charge current going to the battery to be sure that it is charging at a proper rate.

5.5.1 Test Point Indications

TP1	System Clock. 12MHz
TP2	Read/Write signal from U13
TP3	5V Common
TP4	+5V
TP5	Reset Signal from U17
TP6	Real Time Clock (U1) Output. Used for Calibration
TP7	Interrupt Request Signal from U1
TP8	Battery Voltage
TP9	15V Common
TP10	+15V

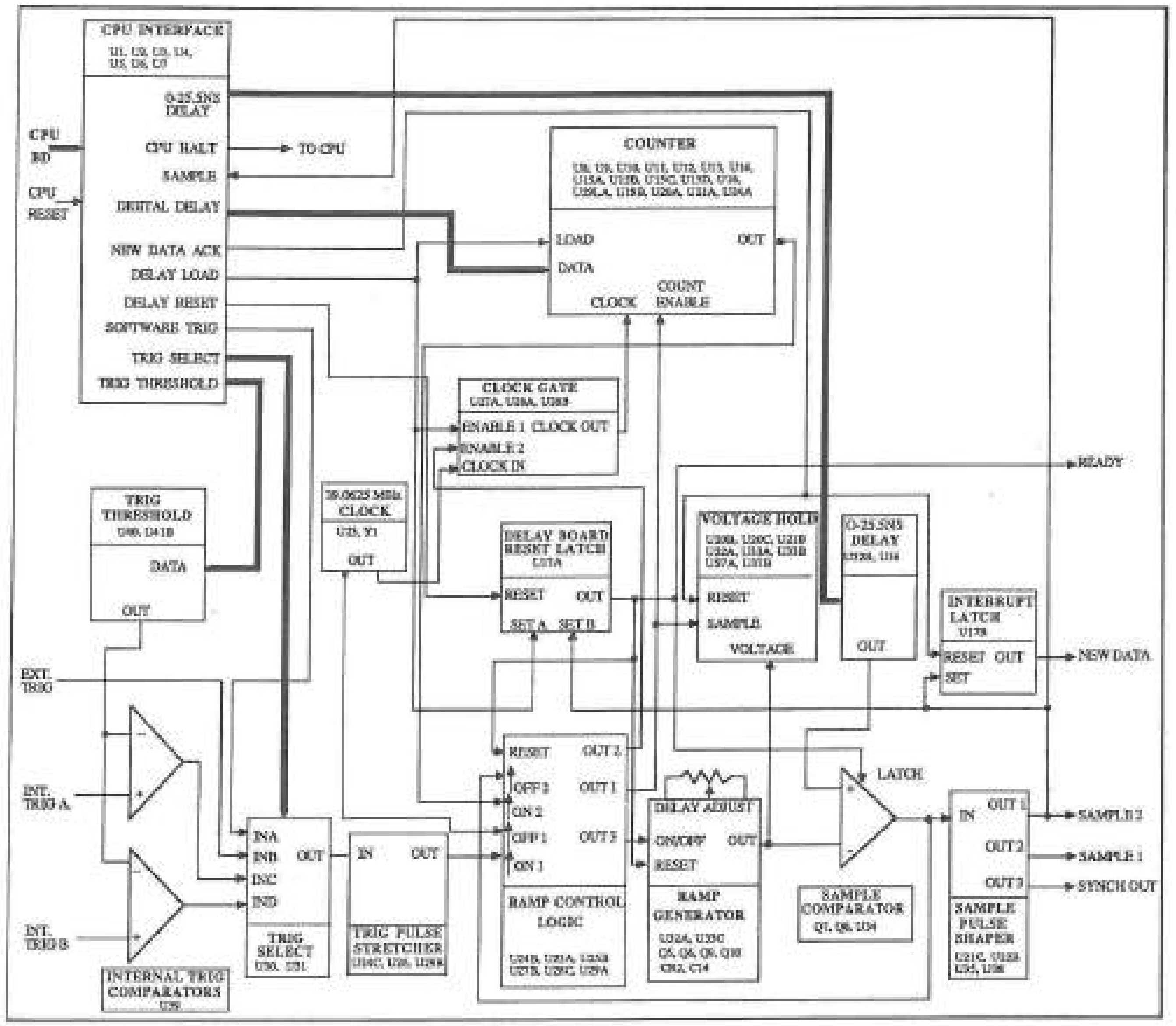


Figure 5-5. Digital Delay PC Board Block Diagram (Bd. #A5)

5.6 DIGITAL DELAY PC BOARD (#A5)

(See Figure 5-5 on page 5-15 and SD 16686 on page 8-21)

The Digital Delay PC Board circuitry is used to establish any time delays that may be desired when examining sample pulses. Delays can be set in increments of 0.1ns up to about 430ms.

As can be seen in the block diagram, Figure 5-5, there is a highly complex interaction between each of the sub-functions of the delay board circuitry. For this reason, this discussion will be presented in three sections to give the user a clearer understanding of this complex interaction. First, a brief description will be given for each of the blocks shown in Figure 5-5, then the overall functioning of the board will be described, and finally the sub-functions shown in each block will be described in detail.

A. CPU INTERFACE

The CPU Interface forms the link between the CPU bus and all of the sub-functions on the board that are controlled by the CPU. The Interface also controls the CPU Halt signal which is used to turn off all action by the CPU microprocessor from the time the delay board is triggered until a sample is taken. This serves to minimize the noise normally generated by the CPU when an analog signal sample is taken.

B. TRIG THRESHOLD

The Trig Threshold circuit sets the level for the Internal Trig Comparators. It accepts data from the Trig Level Bus, and produces a voltage between 0 and 2.5V which is sent to the comparators.

C. INTERNAL TRIG COMPARATORS

The Internal Trig Comparators consist of one fast comparator each for channel A and channel B's Internal Trigger Signals (only A is used in the Model 8501). The comparators also contain overvoltage protection at each of the inputs to protect them against voltages higher than a maximum of 3.0V.

D. TRIG SELECT

The Trig Select is a digital multiplexer that selects either the Internal trigger from channel A or B, a software trigger generated by the CPU, or an external trigger from a source attached to the instrument's rear panel connection, all controlled through the CPU interface.

E. TRIG PULSE STRETCHER

The purpose of the Trig Pulse Stretcher is to make sure that the delay board is triggered only by the first leading edge of each trigger pulse. It stretches the pulse to 200ns after the last trailing edge of the pulse. In this way, all glitches shorter than 200ns will be removed from the pulse. Its input comes from the Trig Select circuit, and its output goes to the Ramp Control Logic.

F. CLOCK

The Clock is a crystal controlled, very stable, square wave generator. It operates at a frequency of 39.0625MHz to give a 25.6ns period.

G. CLOCK GATE

The Clock Gate provides the timing to the Counter when either in the count mode or in the delay data mode. When counting, the clock is enabled with a clock enable signal from the Ramp Control Logic and, when loading, it is enabled by a load signal from the CPU Interface.

H. COUNTER

The Counter is used to establish a coarse delay time. It is controlled by the Digital Delay Bus and the load signal from the CPU Interface. The clock gives it a resolution from 25.6ns to a maximum delay of about 430ms. The output is the selected clock pulse with just one gate delay with respect to the clock.

I. DELAY BOARD RESET LATCH

The Delay Board Reset Latch resets the board to accept the first trigger pulse after the reset is accomplished. The reset signal comes from the CPU through the Interface. The Latch resets the Ramp Control Logic, the Ramp Generator, the Voltage Hold, the Sample Comparator latch, and the Ready output that controls the "Ready" and "New Data" lamps on the front panel of the instrument.

J. RAMP GENERATOR

The Ramp Generator produces an accurate ramp that is used for the 0 to 25.6ns delay. The Reset input presets the voltage at the output to a 3.0V bias. When turned on by the ON/OFF input, the voltage drops at a rate that can be adjusted with the Delay Adjust potentiometer. The output voltage can be held at a fixed value for a long period of time with the Voltage Hold circuit.

K. VOLTAGE HOLD

The purpose of the Voltage Hold circuit is to hold the output voltage of the Ramp Generator during the time it is waiting for the count output from the Counter. It consists of a double buffered sample and hold amplifier with input and output tied together. It is reset by the New Data Ack signal from the CPU Interface. The Sample input from the Ramp Control Logic samples the voltage for 33us and then holds the voltage. The hold mechanism only prevents the voltage from increasing, not from decreasing. A controlled current leakage ensures that the droop of the voltage is positive, and thus is taken care of by the Voltage Hold circuit.

L. SAMPLE COMPARATOR

The Sample Comparator compares the output from the Ramp Generator with the output voltage from the 0 to 25.6ns Delay circuit. It has a latch input from the Delay Board Reset Latch. The latch prevents any change in the output of the comparator from the time the sample is triggered to the time the delay board is reset so that no spurious samples will be taken.

M. RAMP CONTROL LOGIC

The Ramp Control Logic controls the sequence of events that are required to generate the selected time delay. The Reset input enables the circuit to accept the first positive edge from the trigger pulse. The ON 1 input accepts the trigger pulse to turn on the Ramp Generator, enable the Counter, and to initiate the Voltage Hold. The OFF 1 input, consisting of the first negative edge of the clock signal after the trigger, turns off the Ramp Generator and enables the Clock Gate. The ON 2 signal comes from the Counter's count output and turns on the Ramp Generator. The OFF 2 signal consists of the Sample Comparator output which turns off the Ramp Generator when the sample is taken.

N. 0 to 25.5ns DELAY

This circuit consists of a DAC controlled by the Delay DAC Bus through the CPU Interface circuitry. It sets the proper levels for a delay between 0 and 25.5ns with an accuracy of ± 0.1ns. Its output goes to the Sample Comparator.

O. PULSE SHAPER

The Pulse Shaper is triggered by the Sample Comparator and provides the sample signals to the samplers on the analog boards. It also provides a synch signal to the rear panel SYNCH OUTPUT connector of the instrument. The synch signal is simultaneous with the 15ns wide Sample 1 signal. The Sample 2 signal is also used in the CPU Interface to end the halt signal to the CPU. Sample 2 also goes to the Interrupt Latch and the Delay Board Reset Latch to prevent any triggering from occuring until after the delay board has been reset.

P. INTERRUPT LATCH

The Interrupt Latch output goes directly to the CPU interrupt request input to alert the CPU that a sample has been taken. It is reset by the New Data Ack signal coming from the CPU Interface when the analog board has finished with the sampled voltage.

5.6.1 Delay Board Operation Description
(Reference Figure 5-5, Figure 5-6 on page 5-19 and SD 16686 on page 8-21)

This section will describe the sequence of events that occur in the delay board starting with the reset of the circuits, and continuing through the generating of the pulse sample outputs.

The positive edge of the Delay Reset signal at U17A pin 11 will clock the Delay Reset Latch whose output will enable the Ramp Control Logic, the Ramp Generator, and the Sample Comparator. The reset input of the ramp control flip-flops (pin 13 of U29A and U29B) is released so that another trigger input can be accepted. The Ramp Generator switch, U33C, that is holding the output voltage at its initial value will open and the Sample Comparator latch, U34, will be released.

At the time the trigger pulse occurs, the Pulse Stretcher will ensure that only the first positive edge of the pulse will be able to trigger the Ramp Control Logic. The ON 1 input will clock flip-flop U29A and its output (monitored at TP1) will then activate the following events:

a) Turn on the Ramp Generator.

b) Trigger the Voltage Hold circuit to take a 3.3 microsecond duration sample of the Ramp Generator's output voltage and then to hold it.

c) Enable the Ramp Control Logic flip-flop, U25B so that it can accept the Clock signal for the required timing.

d) Enable the U14 counter.

The first positive edge of the pulse from the Clock-inverted output at U23B pin 14 will time flip-flop U25B to turn off the Ramp Generator and also to enable the Clock Gate. The Ramp Generator output voltage will then remain stable while the Voltage Hold function is taking a sample of it. The next clock pulse then starts the Counter counting down. When it has counted down to zero, it will cause an inverted clock pulse to be gated at its output, U24A pin 6, which will in turn clock flip-flop U25A to turn on the Ramp Generator.

As the output voltage reaches the level determined by the selected delay, the Sample Comparator U34 will flip and trigger the Pulse Shaper to produce the sample pulses. The output will also turn off the Ramp Generator by resetting U25A in the Ramp Control Logic circuit. The Sample 2 leading edge then sets the Delay Board Reset Latch and the Interrupt Latch, and resets the CPU Interface Halt signal. When the instrument is first powered on, the Delay Board Reset Latch is set by the Load signal because no Sample 2 signal is generated at that time.

Activation of the Delay Board Reset Latch will then cause the following events:

a) The Ramp Control Logic flip-flops, U25B and U29A, will be reset.

b) The Ramp Generator output voltage will be reset to +3V.

c) A ready signal will be sent to the front panel "Ready" lamp.

After the CPU has processed the requested interrupt, it will send a New Data Ack signal to reset the Interrupt Latch and the Voltage Hold circuits.

A very important function in the operation of the delay board is the ability to precisely set a delay using a very stable clock with a frequency lower than the resolution of the board, and still be able to accept trigger signals that are not in synch with the clock. As can be seen in Figure 5-6 on the Ramp Output Voltage timing line, the time A from the trigger to the negative clock edge plus the time B from the count out negative edge to the set threshold point is always the same. This is one clock period plus the fine delay set by the 0 to 25.5ns Delay DAC plus eventual gate and other delays. These delays are independent of the exact timing between the trigger signal and the clock.

5.6.2 Detailed Block Descriptions

The circuitry on the delay board uses both TTL and ECL circuits. Where very high speed of operation and/or low propagation delay is required, ECL circuits are used. The logic voltage levels for the ECL circuits are -0.81V to -0.98V for a logic '1', and -1.64V to -1.85V for a logic '0'. When an input is connected to ground it has a logic '1', and when it is connected to -5.2V it has a logic '0'. (ECL circuits use the -5.2V supply.) Special translators are required to translate between ECL and TTL signal levels. A high or low ECL output is always in reference to its non-inverted output.

(continued on page 5-20)

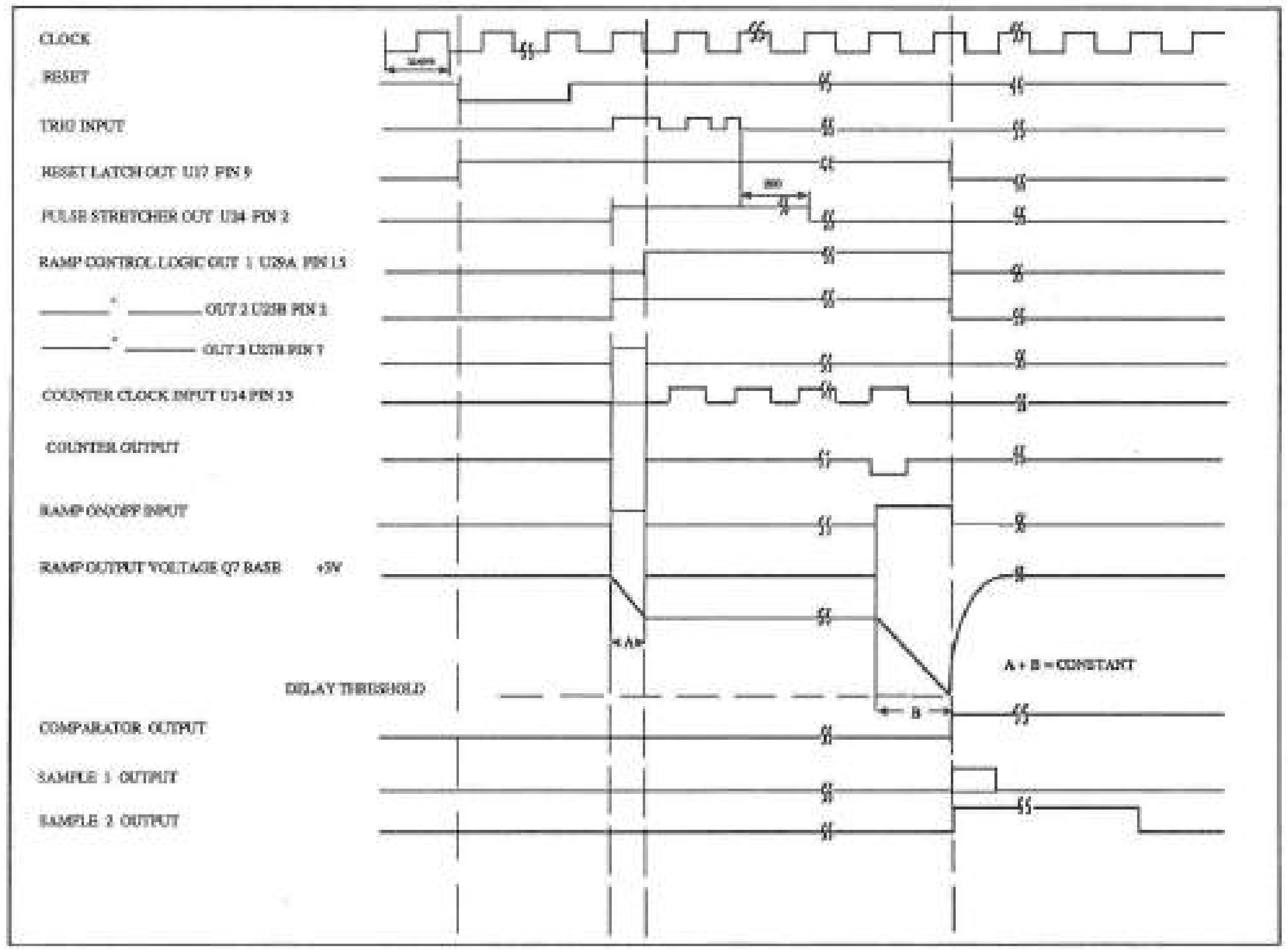


Figure 5-6. Timing Diagram - Delay Board Functions

A. CPU INTERFACE

All of the control of the delay board is accomplished through the two PPIs (Parallel Peripheral Interface), U6 and U7. They are configured so that all of their total of 48 ports are outputs. Both PPIs are selected through the CS10 line. Selection of U6 is done by having the write signal, WR, and the read signal, RD, gated by the lower data byte strobe, LDS, signal going to U4A. Selection of U7 is accomplished by the action of the upper data byte strobe, UDS, which goes to U4B. Address lines A1 and A2 are used to select one of the output ports, A, B, or C, or the PPI control register.

The delay is determined by the Delay DAC Bus from U6 port A, and by the Digital Delay Bus from U6 port B and U7 ports A and B. The delay can be set by one single long integer written to the board. The selected delay will be the inverted value of that integer. In other words, Delay = the maximum delay minus the set value. The trigger level is determined by the Trig Level Bus. It requires 10 bits of data which are sent from U6 port C and U7 ports C0 and C1. The trigger is selected by Trig Select 0 and Trig Select 1 from U7 ports C2 and C3. The delay board's interrupt acknowledgment, New Data Ack, comes from U7 port C7.

The Load, Reset, and CPU Halt signals are generated by U1, U2, and U3. If U2 multiplexes U7 ports C2 and C3 into the Y0 line, it tells the circuit to do nothing. Into the Y1 line means to reset, into the Y2 line tells it to load, and into the Y3 line indicates Halt Enable. To set the Halt signal, Halt Enable is used to set the latch U3A. Then, when Y1 is addressed, the following will happen:

1. The monostable pulse generator, U1, will generate a reset signal at the point where the negative edge of the signal at Y1 occurs.

2. After that, the positive edge of the signal at Y1 will clock U3B which will produce the Halt signal.

The Halt function will be reset by a signal through the Sample 2 line. If no sample has been triggered, it can be reset by the CPU Reset or the interrupt requests corresponding to data received from the keyboard or through the GPIB. This is done by resetting latches U3A and U3B. The Reset also activates the Software Trigger. This will be ignored by the delay circuits unless soft trigger has been selected.

B. TRIG THRESHOLD

The Trig Threshold circuitry consists of the 10 bit DAC, U40, amplifier U41B, and associated components. Its output is determined by the data present on the Trig Level Bus, and can be monitored at TP15. The amplitude range is 0 to 10.23V with 10mV resolution. Registers R16 and R17 form a voltage divider to give a level between 0 and 2.56V which is sent to the Trig Comparators.

C. INTERNAL TRIG COMPARATORS

The Internal Trig Comparators function is accomplished by using one dual, fast ECL output comparator. Its recommended maximum input voltage is 3V. Each input is protected against overvoltage by an identical circuit. On channel A, the input is connected to the emitter of Q13. The base of Q13 is connected to 2.1V which is derived from the +15V supply through R8 and R9. When the voltage is greater than 2.1V plus the VBE(ON) of Q13, Q13 will then have a low resistance to ground that will serve to limit the comparator input voltage. The non-inverted outputs of the channel A and channel B comparators can be monitored at TP14 and TP-15.

D. TRIG SELECT

The Trig Select circuitry consists of an ECL 4-wide 4-3-3-3 input, AND/OR gate U30, and a TTL-ECL translator, U31, for the trigger select lines. The trigger inputs are active lows, and are selected when the two remaining inputs of the OR gate are low. The output goes low when the selected trigger input goes low.

E. TRIG PULSE STRETCHER

The Pulse Stretcher function is initiated by the monostable multivibrator, U26, which is configured through its E+ and E- inputs by flip-flop U29B to accept only a negative sloping trigger, and by the 2-input OR gate U24C. All action takes place in the ECL format.

To better understand the operation of the Pulse Stretcher, assume to start with that the output of U29B has been clocked but not reset. The input would then be low. When the input goes high, the first thing that happens is that the output of the OR gate goes high. Then, the output of U29B will be reset causing the second input of the OR gate to go high. When the input goes low it will trigger U26 into generating a 200ns output pulse. U26 can be retriggered so that if the input signal contains more pulses that are less than 200ns apart, the output will stay low until 200ns after the last negative edge. When the output of U26 goes back to the high condition (the reset input of U29A is then low), U29A is clocked and the inverted output goes low. Since this means that both inputs of U24C are low, the output of the Pulse Stretcher will now go low.

After the PPM is first turned on, it is necessary to give the Pulse Stretcher one trigger input pulse (generated by the soft trigger function) to initialize it.

F. CLOCK

The Clock consists of U23A,B&C, and Y1. U23-A is used as a positive feedback amplifier with the Y1 crystal. U23C provides a dc bias to the input and U23B is an output buffer. The frequency is adjusted with C79. The clock frequency can be measured with a high impedance probe at TP5.

G. CLOCK GATE

The Clock Gate consists of AND gates U28A and U28B whose outputs are OR'd in U27C. The clock is connected to both U28A and U28B, and can be gated by either the load signal on U28A pin 4 or by the Ramp Control Logic Out 2 on U28B pin 7.

H. COUNTER

The Counter consists of high speed ECL binary counter U14, five TTL binary counters U8, U12, U11, U10, and U9 (with the first one being S-TTL), and the clock input. ECL delay data is translated from TTL by U13. It is clocked from the Clock circuitry. During the delay count, the multiplexer U16 selects the Terminal Count (TC connection) of U14 as the clock input to U8, and the Carry Out (CO connection) of U8 as the clock input to U12, U11, U10, and U9. U11, U10, and U9 operate in a look-ahead, carry mode. U19A, U20A, and U24A are using the U8 Terminal Count and the U8 and U9 Carry Out to select the first clock pulse after the counter has counted up to a full count.

When all of the counters are loaded, they have to be provided with one clock pulse while the Load input is low (Parallel Enable for U14) to execute the load. In U14, this is done by the Clock Gate circuit. For the other counters, the load signal will be executed by having the multiplexer U16 delay the negative edge of the signal and inverting the signal using U15A,B&C.

I. DELAY BOARD RESET LATCH

The Delay Board Reset Latch function is accomplished by flip-flop U17A. Inverter U15E and NAND gate U20D are used so that U17A can be reset by both the Sample 2 and Reset signals.

J. RAMP GENERATOR

The Ramp Generator is driven by a dc current sink consisting of U32A, Q9, and Q10. U32 compares the voltage at R32 with a voltage reference provided by CR2, R29, R30, and R31. The output of U32, boosted in darlington configuration, will regulate the current through R32 to I = Vref/R32. The current which forms the slope of the ramp is adjusted by R30 (DELAY ADJ). Q5 and Q6 are configured as a differential pair driven by the differential outputs of the ECL gate U27B. When the Ramp Generator is off, the current flows from ground. When it is on, it discharges C14 at a rate equal to dV/dT = I/C. The starting voltage is provided by the +10V reference through R44 and R45 when switch U33C is closed.

K. VOLTAGE HOLD

The Voltage Hold circuit consists of amplifiers U37A&B, analog switches U33A&B, monostable vibrator U22A, and NAND gates U20B&C. The output of U37B sinks all leakage current injected to the Ramp Generator output voltage mode. R46 provides a controlled leakage to ensure that the leakage is positive. Diode CR1 ensures that U37B will not prevent the voltage from decreasing when the Ramp Generator is turned on. U37's output voltage can be monitored at TP9. U37A serves as a buffer amplifier. Its output can be sampled and held by analog switches U33A&B. Before the sample is taken, U33B is closed to keep the voltage at 3.0V. When the sample is triggered, U22A produces a 3.3us pulse closing U33A. The leading edge of the pulse will also set the flip-flop formed by U22B&C whose output will open U33B. During the sampling period, C9 will be charged and will then hold the voltage.

L. SAMPLE COMPARATOR

The Sample Comparator consists of ECL comparator U34, Q7, and Q8. Q7 and Q8 are used to increase the input impedance of the comparator, and to stabilize the input bias current. U34 has a latch input that will keep the output of the comparator from changing when driven ECL low. U34's output can be monitored at TP-11.

M. RAMP CONTROL LOGIC

(Description covered in Section 5.6.1.M on page 5-17.) TP1 can be used as an oscilloscope trigger when testing the Delay Board.

N. 0 to 25.5ns DELAY

The 0 to 25.5ns Delay is set by the 8 bit DAC U35 and amplifier U32B. The output is biased by R37 from the +10V reference, and has a range of -0.5V to +0.994V full scale with 5.86-mV resolution. The output voltage can be measured at TP6.

O. PULSE SHAPER

The Pulse Shaper consists of an ECL monostable multivibrator, U38, which will provide a 15ns pulse. U35 provides buffered differential outputs to the Sample 1 line and the Synch Out signal. U22 provides a 4.3ms Sample 2 pulse.

P. INTERRUPT LATCH

The Interrupt Latch consists of a D-type flip-flop, U17B. It is clocked by the Sample 2 line to produce an interrupt request New Data signal to the CPU, and is reset through the New Data Acc. line

5.6.3 Test Point Indications

TP1	Output of U29A. Trigger signal that tells when the board has been triggered and reset. Can be used to trigger a scope when testing the board.
TP2	-5.2V
TP3	5V Common
TP4	+5V
TP5	Clock Frequency (C79 adjusts)
TP6	Output of U36, U37 DAC which determines the 0 to 25.5ns threshold.
TP7	U34 comparator input
TP8	U34 comparator input
TP9	U37B hold amplifier output
TP10	10V Reference
TP11	U34 comparator output
TP12	5V Common
TP13	U39 comparator output (trigger signal)
TP14	U39 comparator output (trigger signal)
TP15	U40. Trigger level DAC
TP16	+15V
TP17	15V Common
TP18	-15V

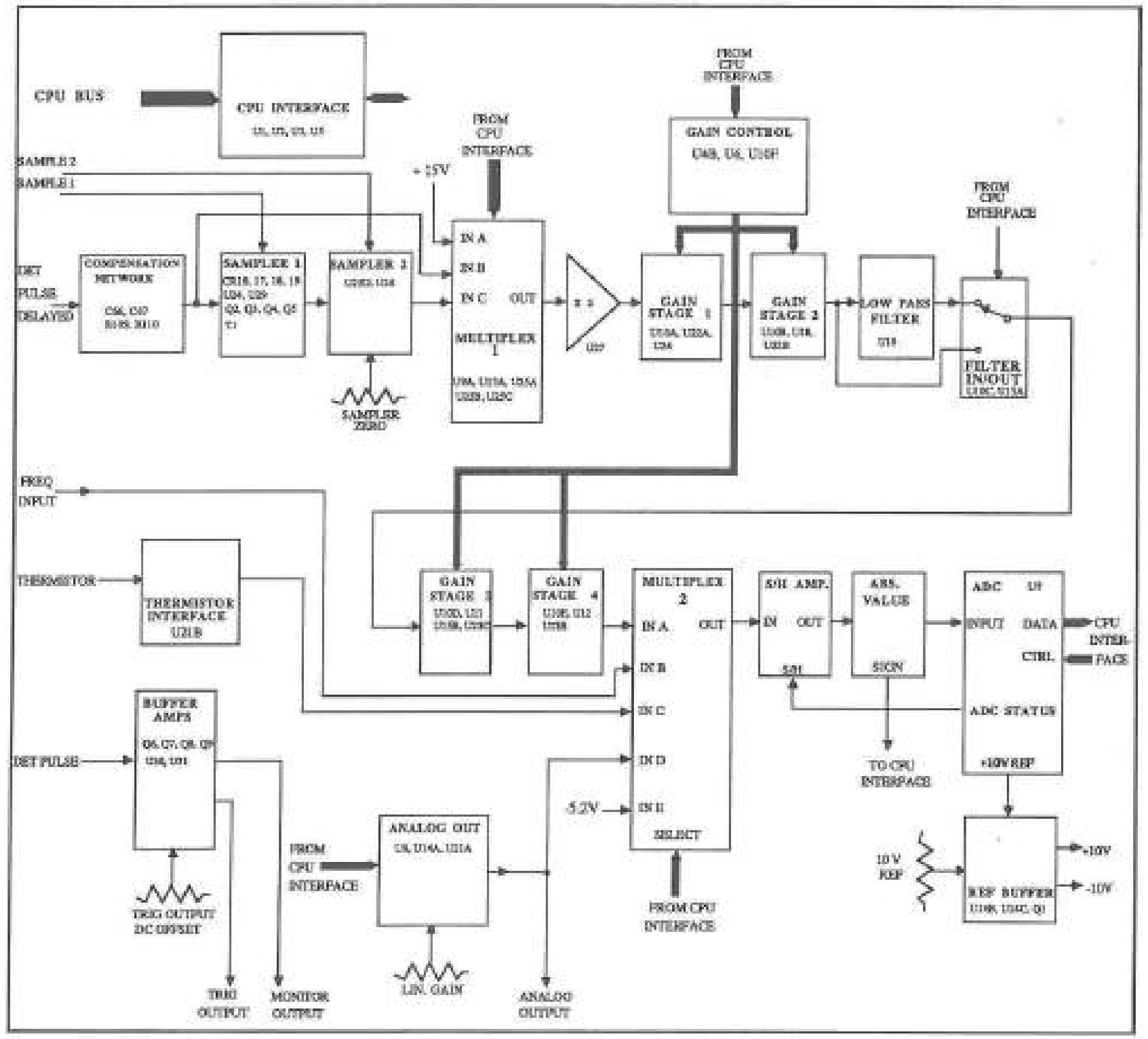


Figure 5-7. Analog PC Board Block Diagram (Bd. #A6/A7)

5.7 ANALOG PC BOARD (#A6/A7)

(See Figure 5-7 on page 5-23 and SD 16670 on page 8-27)

The Analog PC Board circuitry is used to accept, convert to digital, and condition the analog voltage coming from the channel A and B RF detectors. A6 is the reference designation for the channel A board, and A7 is the designation for the channel B board. Both boards are exactly the same. The Model 8501 meter uses only A6.

Referring to Sheet 1 of SD 16670, the board first has an RC network that compensates for the frequency dependent losses in the delay, to assure correct pulse response. This is followed by a fast sample and hold circuit (U29) with a sample pulse width of 15ns. Next is a second sample and hold circuit (U28) with a pulse width of approximately 4us. The second sample and hold circuit is to ensure that the sampled signal that is present will not change in amplitude while it is being held. The signal is held during the time from when the sample is taken to the completion of the data conversion cycle. U28 can either use the sampled signal, or take the signal directly from the input without using the sampling circuitry.

There are four stages of gain available after the signal reaches U28. The gain can be either 1 or 8 through each stage. The circuits involved are composed of U27 with a fixed gain of 2, amplifier U26, U18, low pass filter U19, U11 which is the third gain stage, and U12 which is the amplifier for the fourth gain stage. All four stages are used only in the CW mode, and give a total gain of just over 8,000. In the peak pulse mode, the last amplifier (U12) is not used, so the total gain will be 1,000.

After the four gain stages, there is a multiplexer circuit that allows the selection of either the measured signal from the detector or the voltage from the thermistor in the detector. U21B will generate a voltage proportional to the thermistor temperature, and this voltage goes to U20 which generates a voltage proportional to the frequency.

U16, U17A,B&C, and U9 comprise a circuit that will give the absolute value and determine the polarity sign of the signal. U16 ensures that the voltage is steady during the conversion time. It receives the status (when conversion is occurring) from A to D convertor U7. The D to A conversion circuit formed by U8, U14A, and U21A is used to give an analog output proportional to the power level being sensed by the detector.

The system's 10V reference voltage comes from the U7 A to D convertor. U14C gives the +10V reference, and U14B gives the -10V reference. During the automatic self test routine of the instrument, the signal from the DAC (U8, U14, and U21) is tested to assure that these components are operating properly.

As an example of signal flow through the analog circuitry, when the first signal sample is directed to the fast sample and hold circuit, it comes in through the Sample 1 line (on the left side of the SD) as a balanced ECL signal, and then goes to differential receiver U24. Q4 and Q5 are a differential transistor stage biased with Q3 and Q2. A fixed current is produced which is then switched between Q4 and Q5, and through the transformer, T1. T1 drives the sample bridge (CR16 through CR19) between being either backward or foreward biased to charge the sample capacitor, C72. The network formed by R122, R123, R124, and R125 is used to produce a backward bias. R120 is used to give a controlled discharge of C72 between the samples. This is done so that whenever a sample is to be taken, C72's voltage is close to zero to set it to the same condition for each of the samples. The reason for this is to assure repetitive accuracy for every sample of the specific signal being measured. U29 is a high impedance resolution amplifier, and R119 is a chosen value to give the best pulse response.

The second signal sample comes into the board through the line labeled Sample 2, and goes to a circuit which includes switch U25D, holding capacitor C70, and isolation amplifier U28. R136 serves the same purpose as R120 (to control C70's discharge). Setting the zero (or close to zero) dc offset level required while sampling is in progress is controlled at R112 (Sample Zero), and can be monitored at TP5.

Selecting between the CW or peak power mode signals is done through the U25A&B switches. U25A&B can also select to look at the +15V signal through U13A. This allows the gain of the various stages to be separately checked using a known input. U27 has a fixed gain of 2. U25C (on the negative input of U27) is permanently closed, and is used to improve the common mode reaction of the amplifier to give identical characteristics to the plus and minus inputs.

Each of the four selectable gain stages are identical. They consist of, first, a comparator (U23) where the input signal is compared with a fixed level. Then, the signal from each of the stages is sent to the U6 latch. U6 can operate in several different modes. When measurements are being taken, the latch is in the autoranging mode. This means that the inputs for the latch are the signals from the comparators. The outputs, which directly follow the inputs in the autoranging mode, are controlling the switch and the gain circuits. The first gain stage, U22A, determines whether the gain will be 1 or 8 by selecting different feedbacks. If the routine is in a mode where several samples are being averaged, the first sample will be in the autorange mode and be amplified by the selected gain.

When autoranging is inactive (latch output is high impedance), the latch interfaces with outputs from the CPU to allow the CPU to control the gain. This mode is used during calibration or self test to allow the gain to be manually selectable.

U19 is a filter that can be selected to be either in or out of the gain loop. In the CW mode it is in the loop, but in the pulse mode it is not used to allow for a faster settling time during the analog to digital conversion. U19 is switched in or out of the loop by U15A.

U16 is an integrated sample and hold amplifier directly controlled by the status signal from the U7 A to D convertor. When U7 is given the command to convert, the status signal goes active and stays active until the conversion has completed. Then, U17B,C&D rectifies the signal to give a positive output which is sent to one of the inputs of the U6 latch. Input 2D1 of U6 is used to determine the positive or negative status of the signal. U7 interfaces directly to the data bus, and has a built-in 10V voltage reference which is used throughout the system. R13 is used to adjust the value of the 10V reference.

The thermistor interface circuit, U21B, uses the resistance of the detector's thermistor in conjunction with the 10V reference to determine what the value of its output voltage (gain) will be. This output is then sent to the U20 multiplexer.

U8 is a 12 bit DAC. U21 gives a fixed offset so that there will be a resolution of exactly 2mV corresponding to 0.02dB when R47 is adjusted to the proper gain setting. The total range is from +30 to -50dBm.

Sheet 2 of SD 16670 shows the buffer amplifiers used with the trigger signals and monitor outputs. The input to these amplifiers comes from the detector output voltage before it reaches the delay line (at the point where the detector cable interfaces with the instrument). PPI U1 has all of the output control signals and status inputs as well as an interface to the CPU bus.

The buffer amplifier consists of Q6, Q7, Q8, Q9, U30, and U31. Q6 is a FET input and Q7 is used to keep the gain as close to one as possible. The output of Q7 (an emitter follower) is followed by Q8 and Q9 in parallel to give two emitter follower outputs. Q9 goes to the Monitor Output line. The Monitor Output line carries the shape of the pulse rather than the true dc level. The Trig Out line has ac coupling from Q8 (through C76), U30, and the diodes in the U31 circuitry to give a dc level restoration (pseudo dc). The purpose of this is to allow the output between the pulses to be clamped to 0V. R113 can be used to adjust this function.

U2A,B,C&D and U3A,B,C&D are the final address decoders. The chip select line, the Address line (A14), and data strobes are used to choose whether to activate the A to D or D to A convertor, or to activate PPI U1 which is controlled by the data bus and will interface read or write signals through the A1 and A2 lines.

Sheet 3 of SD 16670 shows the voltage input and grounding configurations for all of the IC's on the Analog PC board.

5.7.1 Test Point Indications

TP1	Reference Common
TP2	+10V Reference
TP3	Output of the analog DAC
TP4	Analog output as seen on the rear panel connection
TP5	Output of the 2nd sample and hold, U28
TP6	+5V
TP7	5V Common
TP8	-5V
TP9	+15V
TP10	-15V
TP11	15V Common
TP12	Can be used as scope trigger
TP13	0Vdc adjust readout point

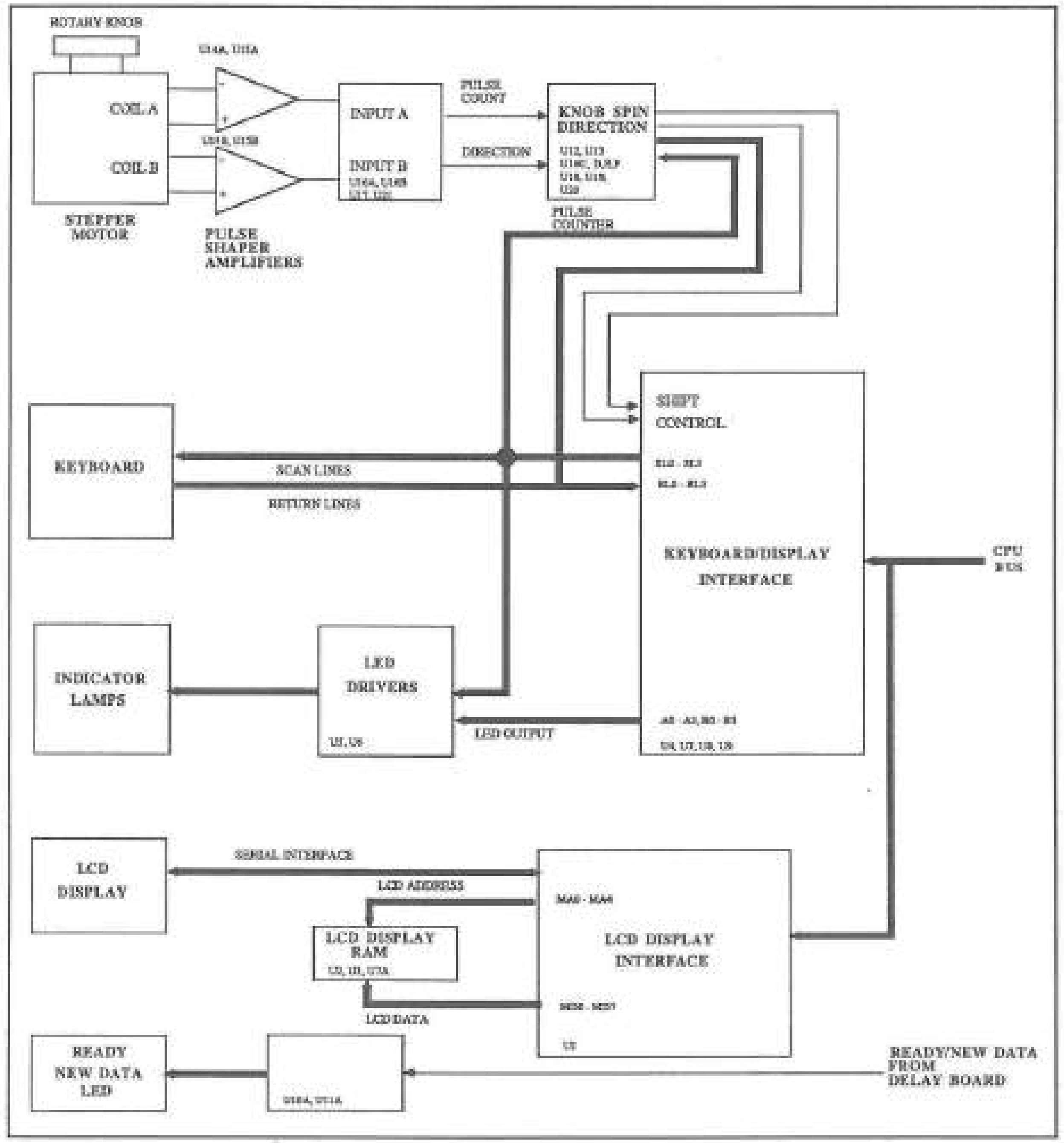


Figure 5-8. Front Panel Interface PC Board Block Diagram (Bd. #A8)

5.8 FRONT PANEL INTERFACE PC BOARD (#A8) (See Figure 5-8 on page 5-27 and SD 16912 on page 8-33)

The Front Panel Interface PC board contains circuitry to control the LCD display of the instrument (through U1, U2, U3, and U7), to provide the interface to the keyboard and front panel indicator lamps (through U4, U5, and U6), and to interface with the hand wheel (rotating knob) on the front panel.

Referring to Sheet 1 of SD 16912, U1 interfaces with the CPU, the data bus, chip select lines, read/write lines, the A1 address line, and the clock input line. The output of U1 goes directly to the LCD display. U2 and U3 are 16K RAMs used to store what is being shown on the display. This means that there is a separate data address and data bus between U1 and the U2 and U3 memories. U4 (the display and keyboard interface) has logic for the selection of the read and write functions. It has a number of scan lines (outputs) designated SL0, SL1, SL2, and SL3 that go to the keyboard. Connection is made between one of the lines and one of the return lines (RL) to tell the circuitry which key was pressed. The scan lines are also connected to the peripheral drive circuit so that, together with the output lines A0 through B3 (connected to U6), the control of which indicator lamp is to be turned on is accomplished.

Referring to Sheet 2 of SD 16912, the circuit receives its input from the stepper motor that interfaces with the hand wheel on the front panel. The output is a signal that corresponds to 16 different keys in the keyboard interface circuitry. Each one is equal to a speed at which the stepper motor is being turned. Also, there are two other lines on the interface IC (U13B) that sense that the hand wheel is in use and what direction it is being turned (U12B through RL0 through 7, and SL0 & 1). This signal is input to U14A&B.

The stepper motor creates two sinusoidal signals that are 90° out of phase with each other. The voltages of these signals are proportional to the speed of rotation of the hand wheel. That is, the higher the frequency (speed of rotation), the higher the voltage. U14A&B are low pass filters with the cut-off frequency determined by the slowest speed the hand wheel can be turned (a small fraction of a Hertz). As the frequency increases, the level builds until it reaches a constant amplitude. The amplitude is input to timers U14A&B and used so that if the input level is above 2/3 of the level of the supply voltage, then the output will be high. If the input goes below 1/3 of the supply voltage level, it will go to zero. The function is similar to a Schmitt trigger with levels of 1/3 and 2/3 of the supply voltage.

U15A&B output a train of square waves which are also 90° out of phase with each other. The square waves go through RC networks, and then give four inputs to U21A. Each one of the inputs represents an up or down-going edge of one of the U15A&B square waves. The output is a pulse train of short pulses that indicate when the hand wheel is being moved. U21A receives the pulse train, and U17A,B,C&D decode the direction of movement. If the wheel is turned in one direction, U21B will have the same pulse train. When the wheel is turned in the other direction, the pulse train will not be present.

Flip flop U12A is a gate controlled by the data input signal. From U12A the signal goes to monostable oscillator U13A so that when the wheel is first turned an approximate 100ms pulse is generated (read at TP3). This pulse does three things: (1) The U12B flip flop clocks out the direction the wheel is turned; (2) The pulse enables the U19 4-bit counter so that, during the 100ms time period, the number of pulses from the wheel are counted, and; (3) The count of the pulse goes into demultiplexer U18 so that the count from 1 to 7 corresponds to the 8 outputs. The cycle then repeats for counts 8 to 16 to give the same outputs. At the end of the 100ms time, U13 is triggered. U13 is a 20ms monostable oscillator and, during the 20-ms time period, the output from U18 is read. This is the shift signal that tells the circuit that the hand wheel is being manipulated. This signal, together with the scan lines and the highest order bit from U15, will determine if it is scan line 0, scan line 1, etc. that is enabling U18. SL0 gives the 1 to 7 count, and SL1 gives the 8 to 16 count. When the count reaches 15, the counter stops so that it doesn't go back to zero and start over. This gives the maximum possible speed to the function.

5.8.1 Test Point Indications

TP1 +5V

TP2 5V Common

TP3 100ms pulse from hand wheel movement

TP4 Shift signal

(continued on page 5-32)

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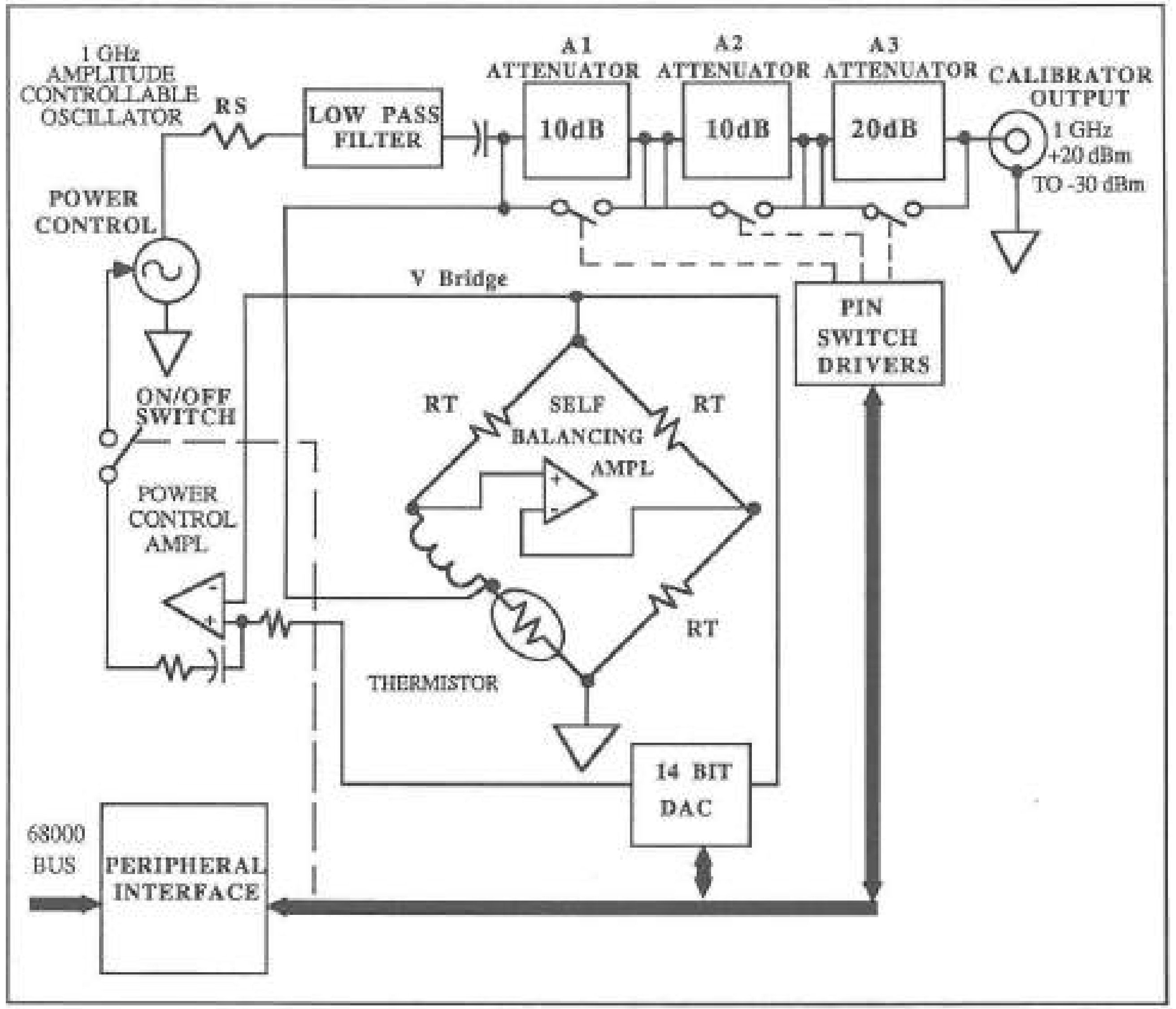


Figure 5-9. Automatic Detector Calibrator (Ass'y. #A12) Functional Diagram

5.9 CALIBRATOR (#A12)

(See Figure 5-9 on page 5-31 and SD 17097 on page 8-43)

The RF Diode Detector Automatic Calibrator uses a computer-controlled calibration circuit to generate precise calibration data using a simple power meter (thermistor) as a reference. This permits diode detectors to be used for absolute power measurements with the same accuracy usually associated with thermistor power meters.

Since the automatic calibration system is a completely new concept developed by Wavetek for calibrating diode detectors, the first portion of this discussion will be a general description of the overall theory involved in the system's operation. The last part of the discussion will cover the operation of the specific components contained in the calibrator assembly.

The system basically consists of an amplitude-controllable oscillator operating at a fixed frequency of 1GHz. A portion of the RF output is coupled into a thermistor leveling circuit which is physically mounted inside the metal housing of the calibrator assembly. Referring to Figure 5-9, the thermistor is maintained at a fixed resistance by applying a dc bias current through it. This is achieved by using a self-balancing Wheatstone bridge with the thermistor inserted in one leg of the bridge. The amount of power required to maintain the thermistor at the fixed resistance, Rt, is constant so that the RF power plus the dc power dissipated at the thermistor equals a constant. This constant can be determined by switching the RF power off and measuring the bridge voltage.

The oscillator output power can then be set by measuring this ambient bridge voltage and calculating the dc voltage which would balance the bridge when the oscillator has the required power output. When this required bridge voltage is written to the DAC on the GPIB/Cal Control PC board, the feedback causes the oscillator to settle to the selected RF power.

The above technique allows the calibrator output power to be precisely controlled over a dynamic range of approximately 15dB. The dynamic range is increased by passing the oscillator power through a set of switched attenuators. The attenuators are designed to allow attenuation values of 0, 10, 20, 30, and 40dB. The overall gain is adjusted so that the 20dB stage will provide a precise 0dBm reference with a specific power level out of the oscillator. Integrated control of the calibrator and detector permits errors in the other attenuator stages to be completely removed in the following manner.

With a particular attenuator switched in, the processor sets the oscillator output power to precisely 9mW and measures the detector voltage. The next level of attenuation is switched in, and a successive approximation algorithm is used to find the oscillator power (about 90mW) which will give precisely the same detector voltage. By dividing the two powers, the relative attenuation of the two ranges is obtained. Since the 20dB range is adjusted to give a 0dBm absolute reference, the absolute effective attenuation of each range can be calculated.

The automatic calibration system generates a table of detector voltages that are equivalent to known level of input power. This is done by applying many different input powers to the detector, measuring the amplified detector output, and storing the result. The calibration procedure is completely automatic, and the entire process including the range switching, attenuator measurements, and detector calibration takes less than one minute.

Since there is 15dB of dynamic range in the thermistor leveled oscillator and 40dB of attenuation available for insertion, the calibrator operates over a total 55dBm dynamic range. Below -33dBm, the diode detector itself is linear (square law), so the total dynamic range of the system will be 60dB (-40 to +20dBm).

The frequency response of each individual RF detector is measured over its entire specified range at the factory, and the information is stored in a ROM that is an integral part of the detector. Then, the frequency response information contained in the detector's ROM and the table generated by the calibration system are compared so that if a voltage equal to, say, -10-dBm is generated by the calibrator, the instrument looks at that voltage, compares it to its table, and by interpolating between data points knows that that specific voltage level equals -10dBm. In this way, offset and gain errors in the detector amplifiers are removed and the system has the capability of measuring power over the full dynamic range of the detector with just as much accuracy as the power can be produced from the calibrator.

Refer now to SD 17097. Q1, together with the Base and Emitter Resonators, is the 1GHz controllable oscillator. A portion of the signal from Q1 is coupled to a thermistor leveling circuit through the Low Pass Filter to remove harmonics, and through the ¼ wave Choke to allow connection to one end of the thermistor, RT1. The other end of the thermistor is connected to RF ground through an RF bypass line labeled FL5. RT1 samples the RF signal at the output of the low pass filter, and that sample is sent to the control circuitry on the GPIB/Cal Control PC board (see Section 5.4 on page 5-8 for description). The control circuit has a feedback system involving some amplifiers and associated circuitry as described in Section 5.4. The output from this feedback system controls the Q1 oscillator so that the voltage at the top end of RT1 is maintained at a constant level.

Following the thermistor leveling circuit is a series of pin diode attenuators comprising three stages of attenuation (10dB, 10dB, and 20dB) for a total capability of 40dB. These stages are switched in and out by control signals from the GPIB/Cal Control board. In the first 10dB stage, if the current through the attenuator is in the direction to turn on the series diode, CR2, then the attenuator is bypassed and minimum attenuation occurs. If the control current is in the other direction, CR2 is turned off and CR1 and CR4 will conduct so that 10dB of signal will be lost. The other stages are similarly switched in and out to allow attenuation from 0 to 40dB in 10dB stages. The output then goes to the CAL connector.

R3 supplies current from the -10 to -13V control voltage source to the emitter of Q1, and R1 and R2 are bias resistors to provide a -10V bias to the base of Q1.

6. PERFORMANCE VERIFICATION TESTS

6.1 INTRODUCTION

Information in this section is useful for periodic evaluation of the performance of the Model 8501/8502 Peak Power Meters (PPM). These tests can also be used for receiving inspection testing when the instrument is first received, if required.

Sections 2.2 and 2.3 of this manual's Initial Instructions section should be reviewed to ensure that the instructions given therein have been complied with before the instrument is turned on. Prior to starting these procedures, the instrument should be allowed to warm up for at least 30 minutes to assure maximum stability during the testing.

Information given in this section can be used to calibrate and/or confirm calibration of the PPM and its detector(s) using the built-in automatic detector calibration system.

The Performance Verification Checks given in this section are valid only if the detector has been automatically calibrated at an ambient temperature between +15°C and +30°C, and is operating within 5°C of the temperature at the time of calibration.

A Performance Verification Test Data recording sheet is located on page 6-7. This sheet should be removed, copied, and the copies used for recording test indications (as specified in the test procedure) each time a Performance Verification test is performed on this instrument.

6.2 EQUIPMENT REQUIRED

(All test equipment must be within calibration specifications as given in the instruction manual or calibration procedures pertaining to each instrument or device.)

Description	Representative Model	Key Characteristic
CW Thermistor Power Meter	H. P. Model 432B	Inst. Acc. of at least 0.5%
Thermistor Mount	H. P. Model 8478B	1.1 SWR @ 1GHz
Directional Coupler, 10dB	Narda Model 3002, 10dB	1.15 SWR @ 1GHz
Attenuators, 10 to 40dB in 10dB increments	Weinshel Model 1	1.15 SWR @ 1GHz
Precision Pulse Generator	Wavetek Model 178	10 ppm Freq. Accuracy
RF Source (Signal Generator)	Wavetek Model 904, 907	Trig. Modulator
Low Pass Filter	H.P. Model 360B	50dB Atten. @ 2GHz
Counter, to 1GHz	EIP Model 548A	1GHz Capability
Return Loss Bridge	Wiltron 63N50 or 97NF50	Directivity 36B. Freq. Range from 1GHz to max. freq. of sensor being used.
Scalar Network Analyzer	Wavetek 1038-NS20/NS206	Freq. Range as above.
Digital Voltmeter (DVM)	Fluke Model 8600A	0.05% Accuracy
Precision DC Source	Digitec Model 3110	0.1% Accuracy
Graphics Plotter	H.P. Colorpro, Model 7440A	GPIB Compatible

6.3 TEST PROCEDURES

6.3.1 Initial Procedures

The tests in this section are done to determine that the performance of the Model 8501 or 8502 Peak Power Meter (PPM) is within the parameters of the specifications given for the instrument. Assemble all of the required test equipment and the PPM to be tested. Connect all equipment to the ac power line, turn it on, and allow at least 30 minutes for it to warm up before starting the test.

6.3.2 Power Linearity Test

Connect the test setup as shown in Figure 6-1. The linearity will be tested in a series of 10dB steps over the range of the instrument. At low power levels, the linearity measurement will reflect the uncertainty due to the noise specification. Measurements will be made in both the CW and Peak Modes.

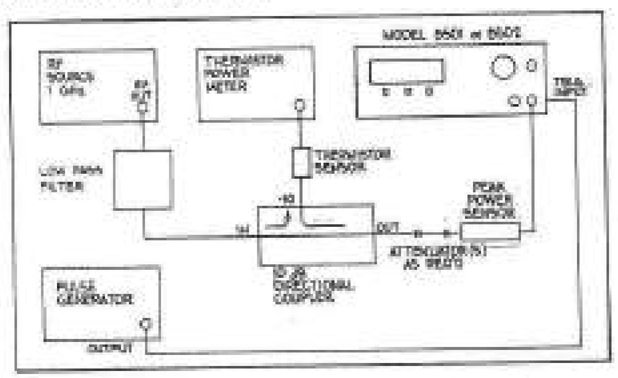


Figure 6-1. Power Linearity Test Setup

Refer to Tables 6-A and 6-B of the Performance Verification Data recording sheet on page 6-7. These tables facilitate the collection of data for the CW and Peak power linearity test. The tolerance is already entered in the table for each step; the tolerance includes an allowance for specified noise errors at low power levels. **In order to make accurate measurements using the Thermistor Power Meter it is absolutely essential that it be zeroed properly.** This should be checked frequently, keeping in mind that the instrument <u>must</u> be re-zeroed if any drift has occurred.

For each value of attenuation the following steps are to be performed:

1. After initial power-on and warm up, set the PPM to read CW power in mW, with the CW averaging number set to 500. This is done by pressing:

   F1 → MENU (2) → F1 → 500 → ENTER

   (MENU (2) means to press the MENU key two times to access Menu #2.)

   Check that the display indication is in mW. If not, press the dB/mW key.

   Then perform an automatic calibration on the detector (use channel A for an 8502). Use this detector for the rest of the test.

   Automatic calibration is performed by, first, attaching the detector to the 1GHz CALIBRATOR connection on the front panel of the PPM, and then pressing:

   MENU (1) → F3 → F1

2. Be sure that the Thermistor Power Meter is zeroed correctly. Adjust the RF Source for a reading of 0.500mW ±0.005mW.

3. Record the PPM reading in the "PPM Reading" column of Table 6-A, CW Linearity Data, of the Performance Verification Test Data sheet.

4. Adjust the source to read 50.0uW ±0.5uW.

5. Record the PPM reading in the "Lin. Error" column of Table 6-A.

6. Calculate the error percentage compared to a perfect 10:1 change using the formula:

   Percent Error = 10(P1/P2 - 10)

7. Note that the error should be less than the value specified in the "Error Limit" column.

8. Add an additional 10dB of attenuation between the coupler and the Peak Power Sensor, and repeat Steps 2 through 8. The next lower rows of Table 6-A will be used to record the readings taken for the 20, 30, and

40dB attenuations as Steps 2 through 8 are repeated for each level of attenuation.

9. Set the Pulse Generator to generate 5V pulses (TTL) with 10 microseconds duration and a repetition rate of 1kHz. Connect the Pulse Generator output to the TRIG INPUT connection on the rear panel of the PPM.

10. Set the PPM to use an external trigger in the Peak Mode, mW display. Peak averaging set to 500. This is done by pressing:

    PEAK → MENU (1) → F2 → MENU (2)
    F2 500 → ENTER

    If the display indication is not in mW, press the dB/mW key.

11. Remove all attenuators and repeat Steps 2 through 8 for the Peak Mode, recording the test indications in Table 6-B, Peak Linearity Data, of the data recording sheet.

6.3.3 Calibrator Output Level Test

The following test will check the absolute level of the Calibrator function of the PPM. Note that verifying the level is not the same as setting the level. When the calibrator was previously adjusted, it was done using equipment capable of setting it to a level within the specifications of the instrument. The equipment used to verify the value also has its own uncertainties. Due to the nature of the measurement, equipment does not exist to make it practical to require a 10 times (or even 3 times) accuracy difference between the specified performance and the specified accuracy of the measuring equipment. Therefore, the uncertainty allowed for this test reflects both the uncertainty of the calibrator, and the uncertainty of the PPM and the detector used to verify it.

Place the PPM in the CW Mode by pressing the CW key, then press the MENU key and select Calibration. When the Calibration/Zeroing menu appears, press F1 and then immediately press the number key "7". Be sure that the Thermistor Power Meter is zeroed, and then connect it to the CALIBRATOR output connection and set it to the 1mW range. The calibrator should read 1mW. To be sure that the measurement is correct, the following steps must be performed exactly as given. Under no circumstances should any other key be pressed than the ones specified.

CAUTION: Do not press the ENTER key when the Thermistor Sensor is connected to the Calibrator. This will cause the Calibrator to output 100mW, and will possibly destroy the Thermistor Sensor.

1. Press CLEAR, then zero the Thermistor Power Meter.

2. Press number key "7", and read the Thermistor Power Meter. Take note of the meter reading.

3. Repeat Steps 1 and 2. Average six readings if successive readings are different.

4. Disconnect the Thermistor Power Meter from the CALIBRATOR connection.

The average reading in Step 3 should be 1.000-mW ±4.5%. Note that a smaller uncertainty than 4.5% can be supported by this technique if the calibration factor of the sensor has been determined by a primary standards laboratory such as the National Bureau of Standards. This value merely reflects current commercial practice.

6.3.4 Calibrator Return Loss Test

Connect the Return Loss Bridge to the CALIBRATOR output and proceed as in the previous test (substituting the Return Loss Bridge for the Thermistor Mount until Step 1 is reached. Press CLEAR. Using the Network Analyzer, measure the return loss of the Calibrator over the band of frequencies from 0.95 to 1.05GHz. The measured loss should be greater than 25dB.

6.3.5 Delay Accuracy Test

Set the Pulse Generator to generate a 10us wide pulse with a repetition rate of exactly 1.250-kHz. Adjust the amplitude to 5V. Connect the Pulse Generator to the RF Source (Signal Generator) as shown in Figure 6-2. Set the Source to generate a 50us pulse when triggered by the by the Pulse Generator. Adjust the amplitude of the Source to 0dBm or greater. The frequency of the Source is not important. Any Source operating within the range of the PPM will be satisfactory, so long as it can be triggered with an external pulse signal and has a rise time less than about 30ns.

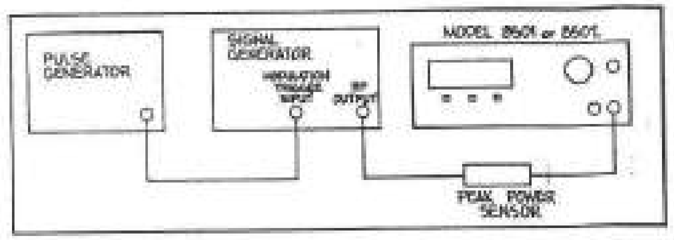


Figure 6-2. Delay Accuracy Test Setup

Set the PPM to read in the Graph Mode by pressing the GRAPH key. Press CLEAR to cause the autoscale function to be performed after the PPM has been connected to the Pulse Generator. A graph of the pulse profile should now be displayed. Then, proceed as follows:

1. Select a delay window of 0.2us, and set the cursor delay to place the cursor at the 50% point on the rising edge of the pulse.

2. Set the "Reference Delay" to be the value read at the 50% point. Now set the start delay to 799.05us. Set the cursor delay to place the cursor on the 50% point of the rising edge of the pulse. The cursor delay should read 800.00us ±0.08us.

6.3.6 Analog Output Accuracy Test

Set the RF Source to generate 0dBm CW, and connect the channel A detector to the output (the only detector with the 8501). Connect the DVM to the channel A analog output (the single analog output with the 8501) on the rear of the PPM and, using the procedure given in Section 6.3.2, Step 1 on page 6-2, set the PPM to read CW with an averaging factor of 900. Perform the following tests:

1. Adjust the RF Source so that the PPM reads exactly 0.00dBm. Record the reading of the DVM. It should be less than 10mV.

2. Adjust the RF Source so that the PPM reads exactly -10.00dBm. Subtract the DVM reading recorded in Step 1 from the current reading. The magnitude of the difference should be 1.000V ±5mV.

3. If a Model 8502 is in use, repeat Steps 1 and 2 after moving the DVM to the channel B analog output.

6.3.7 Voltage Proportional to Frequency Test

Press the MENU key three times (third menu) and select F3 to choose the source of frequency correction. Then press F2 to select the rear panel input. The input characteristics will then be specified as follows:

Voltage/GHz = 1.00
Sweeper Start Voltage = 0.00
Sweeper Start Frequency = 0.00

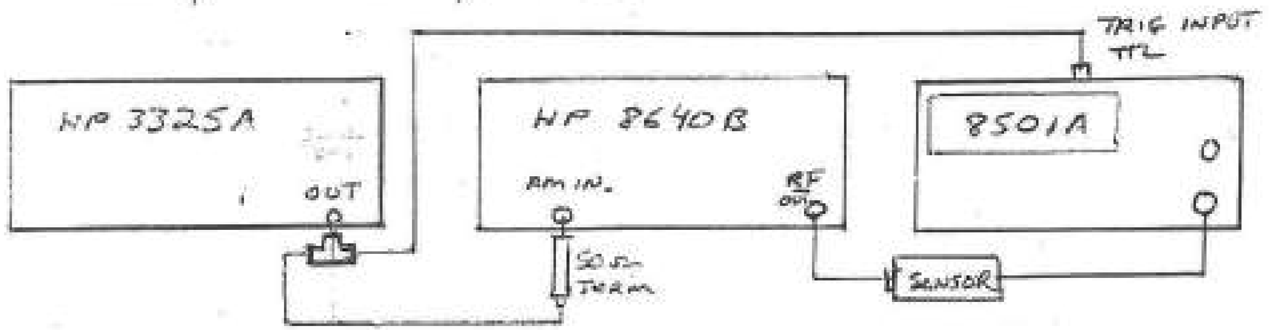
Adjust the Precision dc Source to 0.00V and connect it to the FREQUENCY input at the rear of the PPM. Select the CW Mode display. The FREQ readout at the bottom of the display should read 0.00GHz. Set the Precision dc Source to exactly 10.00V. The display should now read 10.00 GHz ±0.05GHz.

6.3.8 Detector Return Loss Test

Using the 1038-NS20/NS206 or another return loss test setup appropriate to the frequency range of the detectors to be used with the PPM, measure the return loss of the sensor(s) used with the PPM. Further information on the use of this type of equipment is available in Wavetek Microwave's Application Note AN20, "Swept Frequency Testing". Specifications depend on the type of sensor, its frequency range, and the type of connector being used. Refer to the specifications given in Section 1.2.3 on page 1-3 of the General Information section of this manual to determine the specifications for the particular sensor under test. When using this equipment, be sure to allow for the bridge directivity's contribution to measurement uncertainty (in dB); this must be subracted from the value of return loss specified for the detector.

WAVETEK 8501A

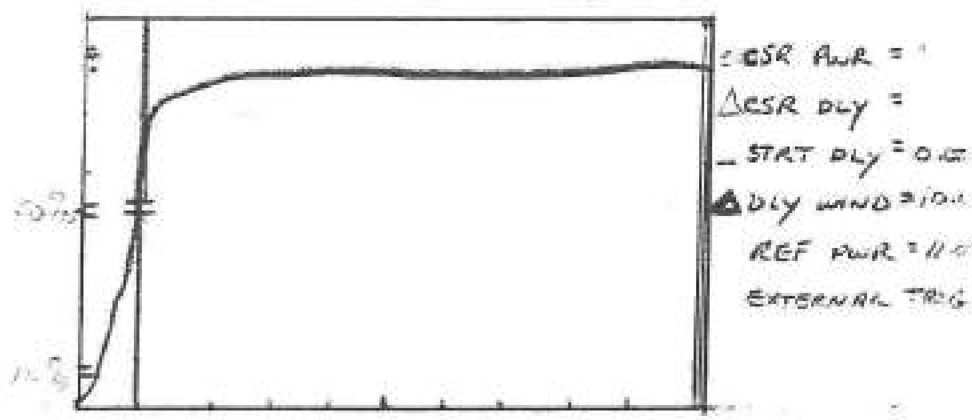
6.3.5 DELAY ACCURACY TEST.



HP 3325A SETUP
FREQ — 1.250 KHZ
FUNC. — ⊓⊔
AMPTD — 5V-P-P

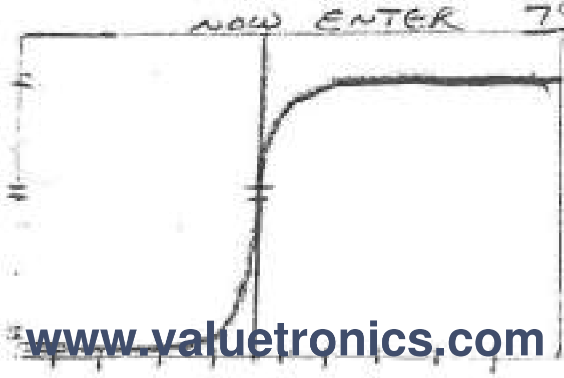
CONNECT SETUP ABOVE.

HP 8640B SET UP
FREQ — 1000 MHZ
RF OUT — ON
OUTPUT Level — 10dB
AM — PULSE



ON 8501A
PRESS [GRAPH / AUTO SCALE] THEN IF NEEDED [PULSE CURSOR MARKER] UNTIL The GRAPH ABOVE IS SHOWN.

PRESS [GRAPH AUTO SCALE] LET UUT MAKE A COUPLE OF SWEEPS.
PRESS F1 [⇧] TO PLACE The Δ (CURSOR AT THE RIGHT SIDE OF THE GRAPH,) AT Δ CSR DLY = NOW ROTATE THE FRONT PANEL KNOB TO BRING THE BAR CURSOR ON THE GRAPH TO THE RISETIME 50% POINT. AS SHOWN A THE CSR DLY = APPROX 550 ns.
NOW PRESS F2 [⇩] ONCE FOR Δ STRT DLY =.
NOW ENTER 799.05 [µS] LET THE UUT MAKE A COUPLE OF SW



NOW PRESS F1 [⇧] ONCE FOR Δ CSR DLY. AND ROTATE THE FRONT PANEL KNOB TO LINE UP The BAR CURSOR AT The RISE TIME 50% POINT READ THE CURSOR DELAY NUMBER. IT SHOULD BE ≈ 800.57 µs NOW SUBTRA THE ORIGINAL CSR DLY VALUE (550 ns) FROM The 800. µs the VALUE SHOULD BE 800.0 µS ± .05 µS

6.3.9 Plotter Output/IEEE 488 Interface

Connect the signal generator to the PPM and display a pulse waveform in the Graph Mode. The pulse parameters, frequency, etc., are arbitrary for the purposes of testing the GPIB plot output of the PPM.

1. Using an IEEE 488 cable, connect the graphics plotter to the GPIB output connection on the rear of the PPM. Note the plotter address as selected on the plotter.

2. Press the MENU key five times, and select F2 to enter the plotter address. If the current address is different from the desired address, enter the correct address number.

3. Press the MENU key twice, and select F3 to begin the plot.

This completes the Performance Verification Tests of the PPM. If the instrument performed as given in this procedure, it is correctly calibrated and within published specifications.

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PERFORMANCE VERIFICATION TEST
DATA SHEET

Note: Copies should be made of this sheet before it is used, and kept with the manual. These copies can be utilized when future Performance Verification Testing is performed on this instrument.

Date: ____________________

Operator: ________________________

Test Number: __________________ (if required)

Model 8501 or 8502 S/N: __________
(cross out N/A above)

Table 6-A. CW Linearity Data (Section 6.3.2)

Total Atten.	Pwr. Set.	PPM Reading	Lin. Error	Error Limit
0dB	0.500mW		N/A	N/A
	50.0uW			5%
10dB	0.500mW		N/A	N/A
	50.0uW			5%
20dB	0.500mW		N/A	N/A
	50.0uW			5%
30dB	0.500mW		N/A	N/A
	50.0uW			5%
40dB	0.500mW		N/A	N/A
	50.0uW			9.7%

(continued on next page)

Table 6-B. Peak Linearity Data (Section 6.3.2)

Total Atten.	Pwr. Set.	PPM Reading	Lin. Error	Error Limit
0dB	0.500mW	5.019 mW	N/A	N/A
	50.0uW			5%
10dB	0.500mW		N/A	N/A
	50.0uW			6.2%
20dB	0.500mW		N/A	N/A
	50.0uW			17%

Section 6.3.3 through Section 6.3.7 Readings

Section of Manual	Specification	Reading
6.3.3 Step 3	0.955 to 1.045mW	
6.3.5 Step 2	799.92 to 800.08us	
6.3.6 Step 2	0.995 to 1.005V	
6.3.7	9.95 to 10.05GHz	

7. MAINTENANCE

7.1 INTRODUCTION

This section of the manual defines maintenance practices and troubleshooting procedures required for fault isolation down to PC board level.

It should be remembered that problems can occur that might be produced by equipment or components peripheral to the 8501/8502 units. Preliminary checks should be made to be sure that external equipment or components are not causing what appears to be a malfunction within the instrument.

7.2 PERIODIC MAINTENANCE

The following maintenance procedures should be performed once each year (with exception as noted) unless the meter is operated in an extremely dirty or chemically contaminated environment, or is subject to severe abuse (such as being dropped). In such cases, more frequent maintenance (immediate if the unit is dropped or severely abused in some way) is required.

A. Blow out all accumulated dust and dirt with forced air under moderate pressure. Also, the cooling fan on the rear panel of the PPM should be checked every 3 months for accumulated dust. A dirty filter could restrict the air flow into the unit to the point where the instrument could overheat, causing the thermal sensor to shut the instrument off right in the middle of a test routine. If dirty, the filter should be removed, cleaned with a mild detergent and water solution, dried, and replaced. (If necessary, replacement filters can be ordered from the factory.)

   Removal of the filter from its holder is accomplished by snapping the retainer out of the holder. Do not remove the screws from the filter holder.

B. Inspect the unit for any loose wires or damaged components. Check to see that the unit's PC boards are properly seated in their receptacles, and that all wire lead connectors are properly attached to their PC board pins.

C. The front panel and housing of the unit can be cleaned using a cloth dampened in a mild detergent. Do not use abrasive cleaners, scouring powders, or any harsh chemicals. Wipe the soap residue off with a clean, damp cloth, then dry with a clean dry cloth.

D. Make a performance verification check in accordance with the procedures found in Section 6 of this manual. If the performance is within the required specifications, no further service is required.

7.3 CALIBRATION

Using all solid state components, the Model 8501/8502 meters are extremely rugged and reliable. Consequently, there is very little drift due to component aging, and adjustments to the units are rarely required. If measurements indicate that an adjustment is set within the indicated range, do not attempt to put it "right on". It is often the case that variations in the equipment being used to make the test account for small differences in measured values. Since some adjustments can be interactive, **be absolutely sure that an adjustment is really required before making it.**

Except where specified, the instrument will be referred to as just "PPM" (Peak Power Meter) in these procedures.

Calibration Data Sheets covering the readings taken in Sections 7.3.3.1 through 7.3.3.7 are included at the end of this section, starting on page 7-15. These sheets can be removed, copied, and the copies used for recording test and calibration data readings, if required.

NOTE: If it is desired to calibrate any of the RF detectors used with the PPM (such as after replacing the diode element), this can be accomplished in the field by using the Wavetek Microwave PROM Programming Accessory Kit, P/N 16976. This kit contains all of the necessary components and instructions required for proper detector calibration. If the kit is not available, the detector can be returned to the factory for calibration.

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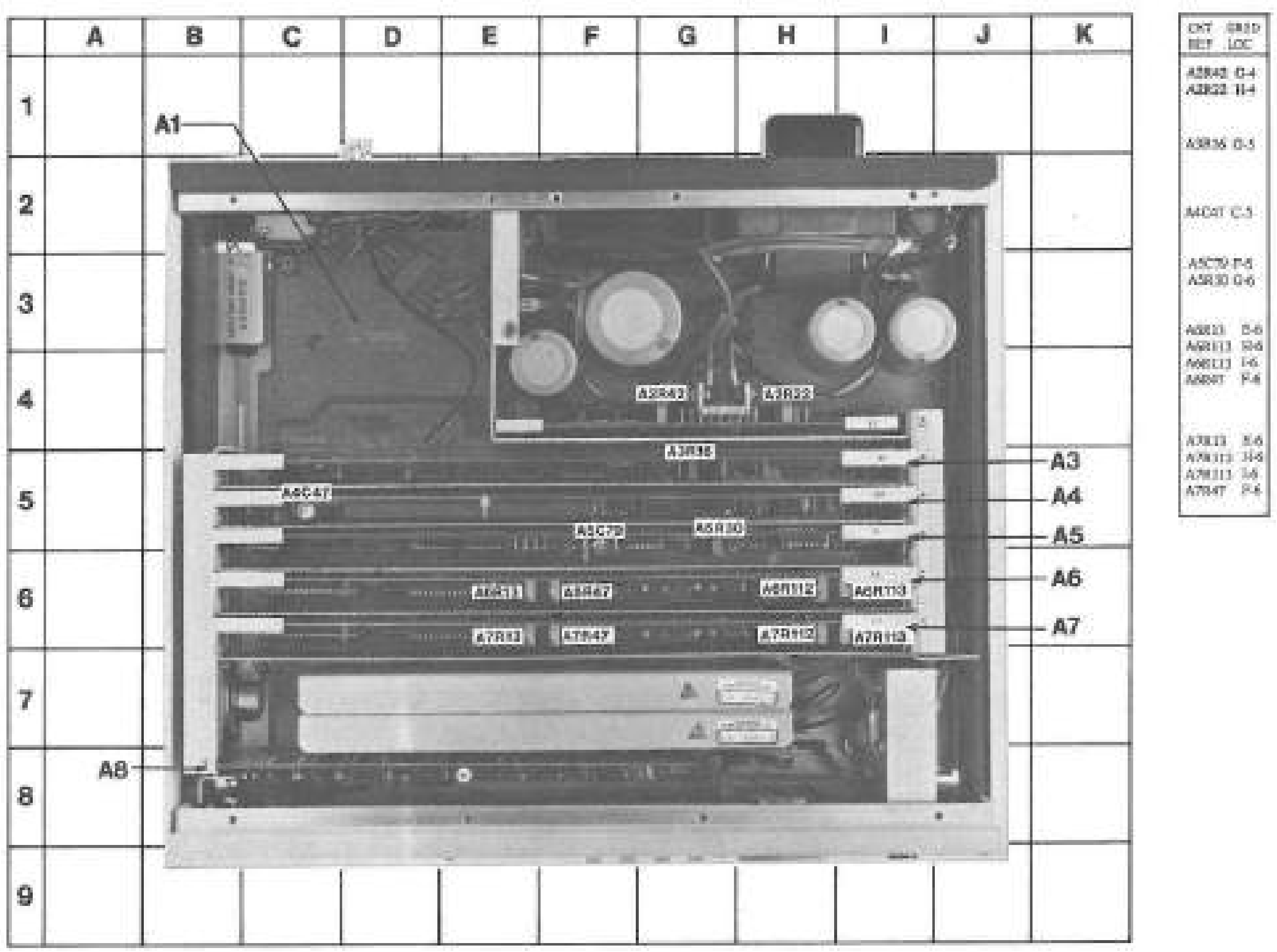

Figure 7-1. Location of 8501/8502 Calibration Components

7.3.1 Test Equipment Required

(All test equipment must be within calibration limits as specified in the instruction manual or calibration procedures pertaining to the particular piece of equipment.)

Description	Representative Model	Key Characteristics
Digital Voltmeter (DVM)	Fluke Model 8800	5½ dig. dis., 0.05% accuracy.
Frequency Counter	EIP Model 548	10 digit readout. At least 1GHz
Frequency Counter/Timer	Tektronix Model DC509	30us period ±1ppm
Oscilloscope (Scope)	Tektronix Model 465	5mV/DIV and 50MHz bandwidth
Power Meter	H. P. Model 432	0.95 to 05GHz at 0dBm ±1.3%
Precision Voltage Source	Digitec Model 3110	5.000V with 0.02% accuracy.
Pulsed RF Signal Generator	Wavetek Model 907	Trig. Modulator
Variac	General Radio Model W5MT3A	Metered
RF Detector	Wavetek P/N 16936	High Speed (15ns)

7.3.2 PPM Preset Conditions

A. Set the Frequency Counter/Timer as follows:

1. Set FUNCTION switch to "PERIOD A".
2. Set AVERAGES switch to "10 to the 6th power".
3. Set SLOPE switch to "+".
4. Set ATTEN switch to "X1".
5. Set SOURCE switch to "EXT".
6. Set COUPL switch to "DC".
7. Set TRIG LEVEL switch to "AUTO".

B. Set the Signal Generator as follows:

1. Select MODE - PM (Pulse Modulation).
2. Select PULSE MODE - INT -PULSE.
3. Select RATE (HZ) - 1K.
4. Select PULSE DELAY - X1.
5. Select PULSE WIDTH - X1.
6. Adjust RATE to mid-way between 'MIN' and 'MAX'.
7. Adjust DELAY to approx. 3usec (MINIMUM).
8. Adjust WIDTH to mid-way between 0.2usec and 10usec (approx. 5usec).

C. Connect a cable from the SYNC NORMAL OUTPUT of the Signal Generator to the TRIG INPUT on the back of the PPM.

D. Connect the PPM to the Variac, set the Variac to 115VAC, and turn power on.

7.3.3 Procedures

(Figure 7-1 on page 7-3 is provided as a fold-out sheet that can be used as reference to locate the various components required for adjusting purposes during the calibration procedure.)

The procedures of the following sub-sections should be performed whenever the instrument is due for routine calibration, or when it is felt that calibration is required. All test points and adjusting components are labeled, and are accessible at the top of the PC boards. It is not necessary to remove any individual PC boards from the unit to perform these calibration procedures.

7.3.3.1 REGULATOR BOARD (A2)

A. +5 Volt adjust.

1. Connect the DVM LO test lead to A2 TP11.
2. Connect the DVM HI test lead to A2 TP9.
3. Adjust A2R42 (+5V ADJ) for a DVM reading of +5.000V ±100mV.
4. Vary the Variac voltage from 100VAC to 130VAC.
5. The DVM reading must not change more than ±5mV.

B. -5.2V Check.

1. Connect the DVM HI test lead to A2 TP10.
2. The DVM must read -5.200V ±200mV.
3. Vary the Variac voltage from 100VAC to 130VAC.
4. The DVM reading must not change by more than ±5.2mV.
5. Set the Variac to 115VAC.

C. -15V Adjust.

1. Connect the DVM LO test lead to A2 TP6.
2. Connect the DVM HI test lead to A2 TP5.
3. Adjust A2R22 (-15V ADJ) for a DVM reading of 15.000V ±15mV.
4. Vary the Variac voltage from 100VAC to 130VAC.
5. The DVM reading must not change by more than ±15mV.

D. +15V Check.

1. Connect the DVM HI test lead to A2-TP3.
2. The DVM must read +15.000V ±45mV.
3. Vary the Variac voltage from 100VAC to 130VAC.
4. The DVM reading must not change by more than ±15mV.

E. Turn OFF the power.

F. Disconnect the Variac and plug the PPM into the bench ac mains connection.

7.3.3.2 INITIALIZATION

A. Turn ON the instrument and adjust the CONTRAST of the display for easy viewing.

B. Perform the SELF TEST by pressing ENTER.

1. At the completion of the Self Test press F1. If the Self Test failed, note the failure number and proceed by pressing CLEAR and then F1.

C. Calibrate the Detector.

NOTE: The following portion of the Calibration procedure only needs to be done if the Detector being used is different than the one that was last used with the PPM.

1. Press ENTER.

2. Connect the Detector (channel A detector if the unit is an 8502) to the CALIBRATOR output.

3. Press ENTER and wait for the calibration cycle to complete.

4. Disconnect the Detector from the CALIBRATOR output.

5. If the unit is an 8502 and a channel B detector is connected, perform the following. Otherwise press CLEAR.

   a. Connect the channel B detector to the CALIBRATOR output.

   b. Press ENTER → ENTER and wait for the calibration cycle to complete.

   c. Disconnect the detector from the CALIBRATOR output.

D. If needed or desired, the Internal Clock can be set as follows:

1. Press MENU → MENU → MENU → MENU → F3 → F1

2. Enter the correct date (MMDDYY → ENTER)

3. Enter the correct time (HHMMSS → ENTER → F3

7.3.3.3 ANALOG BOARD (A6/A7)

NOTE: Analog PC Board Nos. A6 and A7 are exactly the same. The Model 8501 uses just A6 whereas the Model 8502 uses both A6 and A7. When testing a Model 8502, all A6 reference designations listed in this section will become A7 when the A7 board is tested.

A. +10V Reference Adjust.

1. Connect the DVM LO lead to A6TP1 (REF COMMON).

2. Connect the DVM HI lead to A6TP2 (+10V).

3. Adjust A6R13 (10V REF ADJ) for 10.000V ±3mV.

4. If the unit is an 8502, repeat Steps 1 through 4 for PC board A7.

5. Disconnect the DVM.

B. Sampler Zero Adjust.

1. Set the PEAK AVERAGING NUMBER to 20 by pressing MENU → MENU → F2 → 20 → ENTER

2. Connect the Scope lead to A6TP5.

3. Adjust A6R112 (SAMPLER ZERO) for 0V ±2mV offset at the sample time.

C. Trigger Offset Adjust.

1. Connect the Scope lead to A6TP13 (TRIGGER OFFSET).

2. Adjust A6R113 (TRIG OUT DC OFFSET) for 0V ±1mV offset.

3. If the unit is an 8502, repeat Steps B and C for board A7.

4. Disconnect the Scope test leads.

D. Analog Output Adjust.

1. Press the RESET button on the back of the PPM.
   menu scroll for F1 for service functions

2. Press F1 → 1 → F2
   analog output PAC's   Press 1 then #5

3. Connect a cable from the DVM to the ANALOG OUTPUT on the back of the PPM (ANALOG A output if the unit is an 8502).

4. Adjust A6R47 (LIN GAIN) for 0.000V ±10mV reading on the DVM.

5. Press F3.
6. The DVM should read 3.000V ±25mV.
7. Press F1.
8. The DVM should read -5.000 ±35mV.
9. If the unit being tested is an 8502, press F2 and repeat Steps 3 through 8 after moving the rear cable to the ANALOG B output.

E. Thermistor Sense Circuit.

1. Press CLEAR → 4 → F1
2. The reading should be approximately 5000mV at a detector temperature of 30°C (82.4°F). The reading will vary about ±0.2V/°C with any increase or decrease in temperature from the 30°C level. (Press F1 for new readings.)
3. Press CLEAR → CLEAR → F3

7.3.3.4 GPIB/CAL CONTROL BOARD (A3)

CAUTION: The maximum output power of the Calibrator is over 100mW. Be sure it is working properly before connecting the Power Meter.

A. Calibrator Frequency Check.

1. Connect the Frequency Counter to the PPM CALIBRATOR output.
2. Select CALIBRATOR TEST MODE by pressing MENU → F3 → F1 → 7
3. The frequency must be 1GHz ±50MHz.
4. Disconnect the Frequency Counter from the CALIBRATOR output.
5. Press CLEAR.

B. Calibrator Output Adjust.

1. Zero the Power Meter.
2. Connect the Power Meter detector to the CALIBRATOR output on the PPM.
3. Adjust A3R16 (CALIB SET) for 0dBm.
   a. Press any numeric key. If the Power Meter indication is negative (e.g. -0.2dBm), adjust A3 R16 in the CW direction to approximately twice the error.
   b. Press any of the numeric keys to take another reading.
   c. Repeat Steps a and b until the Power Meter reads 0.00dBm.
4. Disconnect the Power Meter from the PPM.

C. PPM Calibrate.

1. Connect the Detector (channel A if the unit is an 8502) to the CALIBRATOR output.
2. Press ENTER.
3. Wait for the PPM to calibrate itself (about 1 minute).
4. Disconnect the Detector from the CALIBRATOR output.
5. If the unit is an 8502, repeat Steps 1 through 4 for channel B.

7.3.3.5 CPU BOARD (A4)

A. Time Oscillator Adjust.

1. Connect the Frequency Counter/Timer common lead to A4TP3 (COMMON).
2. Connect the Frequency Counter/Timer test lead to A4TP6.
3. Adjust A4C47 for 30.517578usec ±0.000040usec.
4. Disconnect the Frequency Counter/Timer test leads.

7.3.3.6 DIGITAL DELAY BOARD (A5)

A. Delay Oscillator Adjust.

1. Connect the Frequency Counter common lead to A5TP3 (5V Common).

2. Connect the Frequency Counter test lead to A5TP5.

3. Adjust A5C79 for 39.062500MHz ±100 Hz.

4. Disconnect the Frequency Counter test lead.

B. Vernier Delay Adjust.

NOTE: This adjustment requires the use of the High Speed (15nsec) Detector. Do not attempt it with a Low Speed (750nsec) detector.

1. Connect the Detector (channel A if the unit is an 8502) to the Signal Generator.

2. Place the PPM in the Graph Mode by pressing GRAPH → CLEAR

NOTE: The left half of the PPM display should look similar to Figure 7-2. The small vertical markers at the bottom of the display represent 1/10th of the total display window. The left edge of the display is 0usec (START DELAY), and the right edge is equal to the DELAY WINDOW plus the START DELAY. The small horizontal markers going up the left side of the display represent the 10%, 50%, 90% and Reference Power (100%) levels.

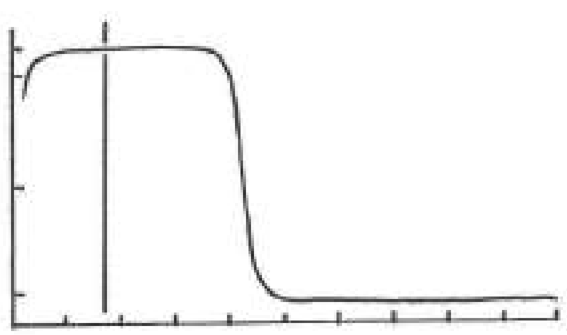

Figure 7-2. PPM Digital Delay Display

3. Select EXTERNAL TRIGGER by pressing MENU → F2

4. Adjust the Start Delay to move the start of the pulse near the beginning of the Graphics Display. This is done as follows:

   a. Press DELAY → F1

   b. Rotate the HAND WHEEL CW until the start of the pulse is within 1/4 of a division of the start of the Graphics Display.

   c. Press ENTER.

5. Adjust the Delay Window to 0.05 usec by pressing DELAY → F2 → .05 → ENTER

6. Set the Cursor Delay to the 25.6 nsec multiple (Table 7-A on the next page) that occurs after the start of the displayed pulse by pressing DELAY → F3 → nn (e.g. 0.0256 for 25.6nsec) → ENTER

7. Set the Start Delay for the Cursor Delay minus the figure shown in the 6 nsec column on Table 7-A by pressing DELAY → F1 → nn (e.g 0.0196 which is 0.0256 minus 0.006) → ENTER

8. Set the Pulse Delay on the Signal Generator so that the rising edge of the pulse on the PPM display crosses through the cursor at approximately the input pulse's 50% point.

9. Set the Delay Window for 12nsec by pressing DELAY → F2 → .012 → ENTER

10. Set the Reference Power to 1dB more than the Cursor Power indicated on the PPM display by pressing F3 → F2 → nn → ENTER

11. Adjust A5R30 (VERNIER DELAY) to its maximum CCW position.

(continued on page 7-10)

Table 7-A. Multiples of 25.6nsec (Use with Section 7.3.3.6)

n SEC	-6nsec	u SEC	-6nsec	u SEC	-6nsec	u SEC	-6nsec
25.60	19.60	1.0240	1.0180	2.0224	2.0164	3.0208	3.0148
51.20	45.20	1.0496	1.0436	2.0480	2.0420	3.0464	3.0404
76.80	70.80	1.0752	1.0692	2.0736	2.0676	3.0720	3.0660
102.40	96.40	1.1008	1.0948	2.0992	2.0932	3.0976	3.0916
128.00	122.00	1.1264	1.1204	2.1248	2.1188	3.1232	3.1172
153.60	147.60	1.1520	1.1460	2.1504	2.1444	3.1488	3.1428
179.20	173.20	1.1776	1.1716	2.1760	2.1700	3.1744	3.1684
204.80	198.80	1.2032	1.1972	2.2016	2.1956	3.2000	3.1940
230.40	224.40	1.2288	1.2228	2.2272	2.2212	3.2256	3.2196
256.00	250.00	1.2544	1.2484	2.2528	2.2468	3.2512	3.2452
281.60	275.60	1.2800	1.2740	2.2784	2.2724	3.2768	3.2708
307.20	301.20	1.3056	1.2996	2.3040	2.2980	3.3024	3.2964
332.80	326.80	1.3312	1.3252	2.3296	2.3236	3.3280	3.3220
358.40	352.40	1.3568	1.3508	2.3552	2.3492	3.3536	3.3476
384.00	378.00	1.3824	1.3764	2.3808	2.3748	3.3792	3.3732
409.60	403.60	1.4080	1.4020	2.4064	2.4004	3.4048	3.3988
435.20	429.20	1.4336	1.4276	2.4320	2.4260	3.4304	3.4244
460.80	454.80	1.4592	1.4532	2.4576	2.4516	3.4560	3.4500
486.40	480.40	1.4848	1.4788	2.4832	2.4772	3.4816	3.4756
512.00	506.00	1.5104	1.5044	2.5088	2.5028	3.5072	3.5012
537.60	531.60	1.5360	1.5300	2.5344	2.5284	3.5328	3.5268
563.20	557.20	1.5616	1.5556	2.5600	2.5540	3.5584	3.5524
588.80	582.80	1.5872	1.5812	2.5856	2.5796	3.5840	3.5780
614.40	608.40	1.6128	1.6068	2.6112	2.6052	3.6096	3.6036
640.00	634.00	1.6384	1.6324	2.6368	2.6308	3.6352	3.6292
665.60	659.60	1.6640	1.6580	2.6624	2.6564	3.6608	3.6548
691.20	685.20	1.6896	1.6836	2.6880	2.6820	3.6864	3.6804
716.80	710.80	1.7152	1.7092	2.7136	2.7076	3.7120	3.7060
742.40	736.40	1.7408	1.7348	2.7392	2.7332	3.7376	3.7316
768.00	762.00	1.7664	1.7604	2.7648	2.7588	3.7632	3.7572
793.60	787.60	1.7920	1.7860	2.7904	2.7844	3.7888	3.7828
819.20	813.20	1.8176	1.8116	2.8160	2.8100	3.8144	3.8084
844.80	838.80	1.8432	1.8372	2.8416	2.8356	3.8400	3.8340
870.40	864.40	1.8688	1.8628	2.8672	2.8612	3.8656	3.8596
896.00	890.00	1.8944	1.8884	2.8928	2.8868	3.8912	3.8852
921.60	915.60	1.9200	1.9140	2.9184	2.9124	3.9168	3.9108
947.20	941.20	1.9456	1.9396	2.9440	2.9380	3.9424	3.9364
972.80	966.80	1.9712	1.9652	2.9696	2.9636	3.9680	3.9620
998.40	992.40	1.9968	1.9908	2.9952	2.9892	3.9936	3.9876

12. The display should look similar to Figure 7-3, below.

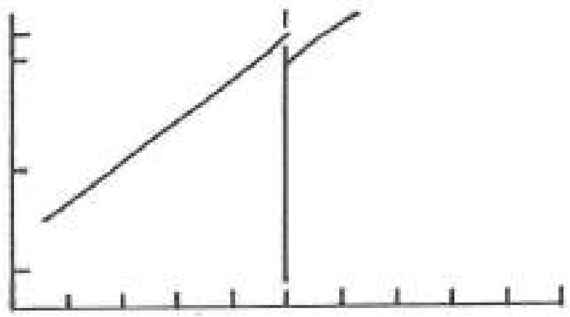

Figure 7-3. PPM Display w/A5R30 Max. CCW

13. Adjust A5R30 CW until the risetime of the displayed pulse is smooth (see Figure 7-4).

14. Set the PEAK AVERAGING NUMBER to 50 by pressing MENU → MENU → F2 → 50 → ENTER

15. The rising slope of the pulse must still look smooth. If not, readjust A5R30.

16. Press CLEAR.

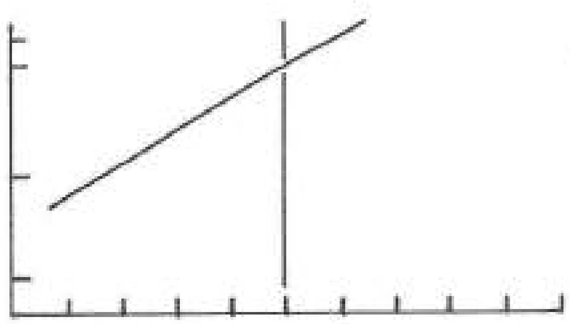

Figure 7-4. PPM Display w/Smooth Risetime

7.3.3.7 EXTERNAL INTERFACE

A. Monitor Outputs.

1. Connect a terminated coaxial cable from the MONITOR output on the back of the PPM (channel A if the unit is an 8502) to the Scope.

2. The Scope display should look like the pulse displayed on the PPM Graphics display with the baseline at approximately -0.4V and the amplitude representing the buffered detector signal.

3. If the unit being tested is an 8502:

   a. Disconnect the channel A detector from the Signal Generator.

   b. Connect the channel B detector to the Signal Generator.

   c. Select B channel AUTOSCALE by pressing B → CLEAR

   d. Move the coaxial cable from the A channel MONITOR output to the B channel MONITOR output on the 8502.

   e. The Scope display should be the same as Step 2.

4. Disconnect the terminated coaxial cable from both the 8502 and the Scope.

B. Sync Output.

1. Connect a coaxial cable (no termination) from the SYNC output on the back of the PPM to the Scope.

2. The Scope display should look similar to Figure 7-5, below.

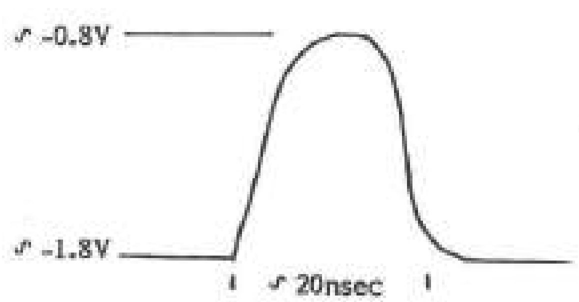

Figure 7-5. PPM Sync Output Scope Display

3. Disconnect the coaxial cable from both the PPM and the Scope.

C. Frequency Input.

1. Connect a coaxial cable from the Voltage Source to the FREQUENCY INPUT connection on the back of the PPM.

2. Set the Voltage Source to +5.000V.

3. Select the External Frequency input by pressing MENU → MENU → MENU → F3 → F2 → ENTER → ENTER → ENTER

4. Place the system into the Peak Mode by pressing PEAK.

5. The FREQ = XXXX portion of the PPM display must read 5.00GHz ±0.02GHz.

D. RF Blanking Output.

1. Connect a coaxial cable from the Scope to the RF BLANKING output on the PPM.

2. Disconnect the Detector from the Signal Generator.

3. The Scope should display a dc level of +5V.

4. Enter the Autozero function by pressing MENU → F3 → F2 → ENTER

5. During the Autozero cycle the Scope display must drop to near 0V.

7.3.3.8 MISCELLANEOUS

A. Volume Adjust.

1. Adjust the VOLUME ADJ on the back of the PPM fully CW.

2. Press several keys. Very little (if any) sound should be heard from the speaker.

3. Adjust the VOLUME ADJ fully CW.

4. Press several keys. The various tones should be very easy to hear.

7.4 TROUBLESHOOTING

Information provided in this section should enable a technician to locate a malfunction and determine specifically which PC board is causing the problem. The instructions given in this section are used to trace a problem to a specific board. Then, the electrical description of the board contained in Section 5 (located by referring to the Table of Contents at the front of the manual), and the pertinent schematic diagram (SD) of Section 8 (located by referring to the Index for the SD's on page 8-1) can be employed to assist the technician in circuit tracing the bad board. Ensure that devices or components external to the PPM are not the cause of the problem before starting the Troubleshooting procedure.

In general, troubleshooting of the PPM is divided into three parts. First, the display is observed for any error flags (numbers) that might pinpoint the specific faulty section of the circuitry (after performing the Self Test function --- see Section 3.7.3 on page 3-40). Second, a known and specific pulse or CW signal is applied and varied as required to allow a general determination of the severity and parameters of the problem. Third, suspect PC boards are placed on extenders, and waveforms and dc voltages indications are traced and checked. Following this initial philosophy, the subsequent steps given in this section can be used to isolate and locate the specific PC board responsible for a particular problem.

7.4.1 Equipment Required

The same equipment as listed on page 7-4 will be required for performing the Troubleshooting procedures given in this section. Additionally, the WMI P/N 17075 Extender Board is needed for troubleshooting the Power Supply PC Board (A2), and the WMI P/N 17076 Extender Board is required for troubleshooting the GPIB/Cal (A3), CPU (A4), Delay (A5), and Analog (A6) PC Boards to component level.

7.4.2 Initial (Power-On) Failure Indications & Possible Causes

1. No indication that the power is turned on when the "ON" button is pressed. (Fan not running and no lights lit on the front panel.)

a) Ensure that the power cord is plugged into an ac source with the correct voltage and frequency for the PPM. (See Section 2.2 on page 2-1 of the Initial Instructions section of this manual.)

b) Check the AC Input Fuse (F1) on the rear panel to be sure that it is in place and not blown.

c) Ensure that the AC Select Plate is installed in the rear of the instrument.

d) Ensure that the Power Supply Regulator PC Board (A2) is properly seated in its socket.

e) Check the Thermal Shut-Off switch located on board A2. (Also, see Section 7.2.A on page 7-1.)

f) Check the ±5V (CR1) and ±15V (A1 CR1) Bridge Rectifiers.

2. Front panel apparently works (LCD display turns on and lights flash when power is applied), but the fan is not running.

a) Check the ±15V supplies.

b) Check the fan motor.

c) Check the Fan Filter Circuit consisting of A1R1 through A1R4, A1 C13, and A1C14.

3. Fan is running, but nothing on the front panel is working.

a) Check the +5V and -5.2V power supplies.

b) Ensure that the Front Panel Interface PC Board (A8) is properly seated in its socket.

4. Front panel lights are flashing and LCD display is dark.

a) Ensure that the CPU PC Board (A4) is properly seated in its socket.

b) Press the RESET button on the rear panel. If this clears the problem, check the output of the Reset Timer (A4U17) for a pulse width of approximately 750ms when the RESET button is pressed.

c) Check the 6MHz CPU clock at A4 TP1.

d) Check the CPU Halt signal at A4 U12, pin 17 (low digital level indicates a "Halt" condition).

e) Check the Address and Data I/O on the CPU at A4U12.

f) Check the Address Buffers on the CPU at A4U7, A4U8, and A4U9.

g) Check the Data Buffers on the CPU at A4U32 and A4U33.

h) Check the Address Decoder on the CPU at A4U34.

i) Ensure that all of the PROMs on the CPU board are installed in their proper locations.

7.4.3 Self-Test Failure Indications & Possible Causes

Information given in this section assumes that the PPM was working properly when it was initially turned on, that Self-Test was selected, a failure occured, and an Error Number was shown in the instrument's display window. Note that during the Self-Test, all of the front panel LEDs are lit.

Each of the 11 Self-Test checks will be described briefly, and then possible causes of the problem (as indicated by the displayed Error Number pertaining to the specific test) will be listed.

7.4.3.1 SELF-TEST #1 **(Error Number 01):** -5.2V Out of Tolerance

This test applies -5.2V to the Analog A/D Converter (A6U7) through switch A6U13. The -5.2V must be between -4.94 and -5.46V.

a) Check the -5.2V regulator circuit on PC board A2.

b) Check the switches (A6U13C and A6 U20) on the Analog Board (A6).

c) Check the PPI chip (A6U1).

7.4.3.2 SELF-TEST #2 **(Error Number 02):** Memory Bad

Performs a "walking ones" test on the volatile RAM. (Clears the memory, then writes and reads a "1" to each memory location. Then writes and reads a "2", etc.)

a) Check the volatile RAM chips A4U5, A4U6, A4U30, and A4U31.

7.4.3.3 SELF-TEST #3 **(Error Number 03):** Excessive A Channel Offset

This test sets the A channel Analog PC Board (A6) to its maximum gain of 8192, and measures the total offset voltage present at the input to the Analog A/D Converter (A6U7). The allowable range for the voltage at the input to the Analog PC Board is ±0.5mV which would mean a range of ±4.096V at the input to the A/D Converter.

a) Swap the detector and re-run the Self-Test.

b) Check the amplifiers in the Analog PC Board.

c) Check the Analog Switches A6U25, A6U20, A6U15, and A6U13.

d) Check the PPI chip A6U1.

7.4.3.4 SELF-TEST #4 **(Error Number 04):** A Channel Gain Error

This Self-Test sets the first variable gain stage to a gain of 8 and measures the offset. Then, 0.5V is applied to the input of the x2 amplifier and the overall gain is measured. The first variable gain stage is then re-set to unity gain, and the second stage is tested, then the third, and then the fourth in the same way. The tolerance for each stage is ±2% of the gain.

a) Check the amplifiers in the Analog PC Board.

b) Check the Analog Switches A6U22, A6U15, and A6U13.

c) Check the PPI chip A6U1.

7.4.3.5 SELF-TEST #5 **(Error Number 05):** Excessive B Channel Offset

Use the same description and Troubleshooting procedures as given in Section 7.4.3.3. All reference designations are changed to A7. Applies only to the Model 8502.

7.4.3.6 SELF-TEST #6 **(Error Number 06):** B Channel Gain Error

Use the same description and Troubleshooting procedures as given in Section 7.4.3.4. All reference designations are changed to A7. Applies only to the Model 8502.

7.4.3.7 SELF-TEST #7 **(Error Number 07):** A Channel Analog Output DAC

This test routes the output of the Analog Output DAC circuit to the input of the Analog A/D Converter. The DAC is stepped through 81 steps from low to high (each step is 0.1V). The tolerance is ±0.5% ±10mV.

a) A6R47 (LIN GAIN) is not adjusted properly. See Section 7.3.3.3.D on page 7-6.

b) Check DAC circuit A6U8, A6U14A, and A6U21A.

c) Check analog switches A6U20 and A6U13C.

d) Check the PPI chip A6U1.

e) Check the decoder circuit consisting of A6U2C & D, A6U3C, and A6U5D.

7.4.3.8 SELF-TEST #8 **(Error Number 08):** B Channel Analog Output DAC

Use the same description and Troubleshooting procedures as given in Section 7.4.3.7. All reference designations are changed to A7. Applies only to the Model 8502.

7.4.3.9 SELF-TEST #9 **(Error Number 09):** Delay 8255s

This test writes a hex "AA" to the first port of A5U6 and reads back the data. It then writes a hex "55" to the same port and reads back the data. These tests are then performed on the remaining two ports of A5U6, and on all three ports of A5U7.

a) Check A5U6 and A5U7.

b) Check A5U4.

c) Check Address Decoder A4U34.

7.3.4.10 SELF-TEST #10 **(Error Number 10):** Delay Time Error

This test sets the PPM into the Peak Mode with a delay of 200ms. It then triggers the delay circuit and measures the time until the delay is complete. The tolerance is ±7ms.

a) Make a thorough check of all circuits on the Digital Delay PC Board (A5).

7.4.3.11 SELF-TEST #11 **(Error Number 11):** Calibrator Bridge Voltage Error

This test uses the same software as the Calibration cycle to check the Bridge Voltage.

a) Check A3TP9. Must be between +3 and +10Vdc.

b) Check PPI chip A3U9.

c) Check A3U14, A3U15, A3U10, A3 U13, and A3U18A.

d) Check the Calibrator (A12).

e) Check Address Decoder A4U34.

7.4.4 Input/Output & Calibration Failures

1. The External Trigger input is not functioning.

   a) External Trigger not selected. See Section 3.4.2.1.2 on page 3-10.

   b) Check A5Q1.

   c) Check A5U31 and A5U30.

   d) Check A5U7.

2. The External Frequency input is not functioning.

   a) The External Frequency input has not been selected. See Section 3.6.1.2 on page 3-13.

   b) Check A6U20 (or A7U20 if this is a B channel problem).

   c) Check A6R81, A6R140, and A6C94.

   d) Check A6U1.

3. The SYNC OUTPUT is not functioning.

   NOTE: This is an ECL level pulse that has a pulse width of approximately 20ns.

   a) Check A5U35C.

4. The RF BLANKING OUTPUT is not functioning properly.

   a) Check A3Q7.

   b) Check A3U8.

5. The MONITOR OUTPUT is not working.

   a) Check A6Q9 (or A7Q9 if it is a B channel problem).

6. The PPM passes Self-Test, but fails when attempting to calibrate the detector.

   a) Replace the detector.

   b) Replace the detector cable.

   c) Refer to Section 7.3.3.4 on page 7-7 to check the Calibrator output.

CALIBRATION DATA SHEET

NOTE 1: Copies should be made of this sheet before it is used, and kept with the manual. These copies can be utilized when future calibration routines are performed on this unit.

NOTE 2: While continuing step by step through the calibration procedures, if it should be found that any specifications cannot be met by performing the indicated adjustments, immediately go to Section 7.4, Troubleshooting, and follow the instructions given therein.

Date: ______________

Operator: ____________________

Test Number: ____________ (if required)

Model 8501 or 8502 PPM S/N: ____________
(cross out one)

Section of Manual	Specification	Reading	
7.3.3.1.A.3	+4.900V to +5.100V		
7.3.3.1.A.5	Within ±5mV of A.3 reading		
7.3.3.1.B.2	-5.000V to -5.400V		
7.3.3.1.B.4	Within ±5.2mV of B.2 reading		
7.3.3.1.C.3	-14.985V to -15.015V		
7.3.3.1.C.5	Within ±15mV of C.3 reading		
7.3.3.1.D.2	+14.955V to +15.045V		
7.3.3.1.D.4	Within ±15mV of D.2 reading		
		A6	A7
7.3.3.3.A.3	+9.997V to +10.003V		
7.3.3.3.B.3	-2mV to +2mV		
7.3.3.3.C.2	-1mV to +1mV		
7.3.3.3.D.4	-10mV to +10mV		
7.3.3.3.D.6	+2.975V to +3.025V		

(continued on next page)

Section of Manual	Specification	Reading	
		A6	A7
7.3.3.3.D.8	-4.965V to -5.035V		
7.3.3.3.E.2	Approx. 5000mV ($\pm$0.2V/^{o}C deviation from 30^{o}C)		
7.3.3.4.B.3	950MHz to 1050MHz		
7.3.3.5.A.3	30.517538 to 30.517618usec		
7.3.3.6.A.3	39.062400 to 39.062600MHz		
7.3.3.7.C.5	4.98 to 5.02GHz		
7.3.3.7.D.3	+5Vdc		
7.3.3.7.D.5	Approx. 0Vdc		