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WA-7100/7600 Multi-line Wavemeter®

OPERATING MANUAL

Operating Manual (Rev. B)
08948-M-00

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burleigh

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Assumptions

This Operating Manual provides information for individuals who use the Burleigh Instruments WA-7100/7600 Multi-line Wavemeter.

This manual assumes familiarity with communication software and hardware interfaces with an IBM, or compatible, Personal Computer.

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Section 1. Introduction and Setup

This section provides general information on the WA-7100/7600 Multi-line Wavemeter and information on unpacking and setting up the Wavemeter.

Overview

Burleigh's Wavemeters are instruments designed for simple, automatic and accurate wavelength measurement of single or multiple wavelength laser sources. The interference fringes produced by the input laser radiation in a scanning Michelson interferometer are sampled in the interferometer scan at equally spaced intervals calibrated by a built-in reference laser. A high-speed digital signal processor computes a Fourier Transform of the interferogram to obtain a spectrum of the input laser that is displayed on the Wavemeter screen.

Discrete wavelengths included in the input laser source appear as peaks in the spectrum. The wavelength of each peak is accurately determined based on the knowledge of the reference laser wavelength. The WA-7100 Multi-line Wavemeter uses a HeNe reference laser that provides an absolute wavelength accuracy better than ±1 part per million. The WA-7600 uses a stabilized HeNe reference laser that allows the WA-7600 to have a wavelength accuracy of better than ±0.2 parts per million. Refer to Appendix A for complete specifications.

The WA-7100/7600 Multi-line Wavemeter contains a rigid monolithic interferometer built inside a single block that makes it robust and reliable. Inside the instrument, both the reference laser and the input laser beams are coupled into the interferometer by fiber optic cables that ensure good optical alignment. An embedded processor generates the spectral display and derives the wavelength and power of each spectral peak.

All measurement data and spectral information is displayed on a full color 6.5" VGA display, with operations controlled though a convenient front panel configuration. A floppy disk drive can be used for data storage or for in-field software upgrades. Instrument communication interface is accomplished via a GPIB (IEEE-488.2) instrument interface using a SCPI protocol. The front panel display, and other input and output functions are also controlled by the processor. The Wavemeter front panel has buttons to select different display screens, change parameters or display attributes, and manipulate the collection of data.

- Refer to **Section 2, Operation** for a step-by-step procedure on how to use the WA-7100/7600.
- Refer to **Section 3, Front Panel** , for detailed descriptions on the controls, display, and mode screens.
- Refer to **Section 5, Theory of Operation & Calibration**, for additional information on the Wavemeter's theory of operation.

The Wavemeter has a built-in bi-directional RS-232 interface and a GPIB interface for transmitting data and remotely controlling the Wavemeter. Data can be output to the floppy disk drive accessible through the front panel or output to the printer connected to the rear panel printer port.

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Refer to **Section 4, Remote Communications**, for information on these interfaces and the SCPI communication scheme.

The Monitor port on the back of the Wavemeter provides access to the interferometer fringe signals and timing signals that govern the wavelength measurement. Refer to **Appendix D, Rear Panel Controls**, for further information.

Safety Considerations

This product has been designed, manufactured and tested in accordance with EC Standard EN61010-1, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. Make sure that you follow the recommendations in this section to ensure safe operation of your wavemeter and to maintain the product in a safe condition.

Laser Classification: This product is classified FDA Laser Class I (IEC Laser Class 1) laser.

WARNING: THIS EQUIPMENT MUST BE USED AS SPECIFIED OR THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE COMPROMISED. YOU MUST USE THIS PRODUCT IN A NORMAL MODE AND SHOULD NOT DEVIATE FROM THE WRITTEN INSTRUCTIONS PROVIDED.

WARNING: THERE ARE NO OPERATOR SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL. TO PREVENT ELECTRICAL SHOCK, DO NOT OPEN OR REMOVE COVERS.

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WARNING: TO PREVENT ELECTRICAL SHOCK, TURN OFF THE POWER TO THE WAVEMETER BEFORE CLEANING. USE A DRY OR SLIGHTLY DAMPENED (WITH WATER) CLOTH TO CLEAN THE EXTERNAL PARTS. DO NOT ATTEMPT TO CLEAN ANYTHING INSIDE THE MACHINE.

WARNING: THIS IS A SAFETY CLASS 1 PRODUCT . PLUG THE MAIN POWER CORD INTO A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. ALWAYS USE A THREE-PRONG AC POWER CORD WITH THIS EQUIPMENT. FAILURE TO ENSURE ADEQUATE GROUNDING MAY CAUSE INSTRUMENT DAMAGE.

Unpacking & Inspection

The Burleigh WA-7100/7600 Multi-line Wavemeter is packed in a carton designed to give maximum protection during shipment. If the outside of the shipping carton is damaged, notify your shipping department immediately. Your shipping department may want to notify the carrier.

If the external shipping carton is not damaged, carefully remove and identify all of the components listed below. Contact Burleigh Instruments or your local representative if any of the components are missing. We recommend you save the shipping carton for future storage or transportation.

The Burleigh Wavemeter Systems include the following components:

- Wavemeter
- Power cord
- Operating Manual

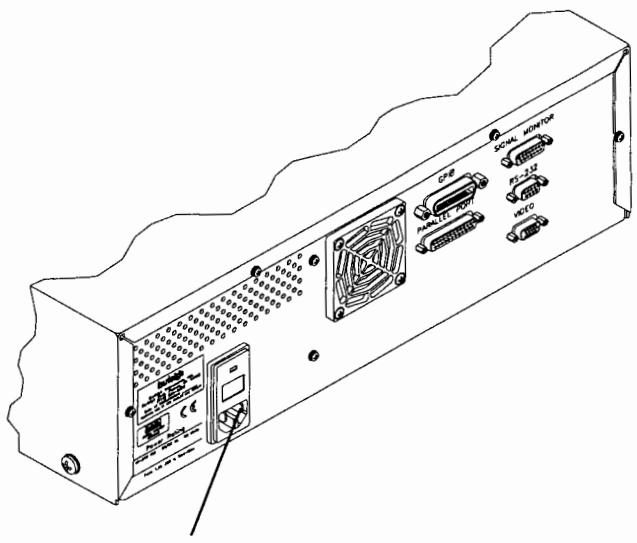
Setup

Setting up the Wavemeter is a very simple operation as described in the procedure below.

A color VGA screen is built into the front panel, but a computer monitor can also be attached to the rear panel connector for a larger display. A 3.5" floppy drive accessible from the front panel is used for transferring data or loading software upgrades.

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The standard fiber optic input connector is FC/UPC, but other fiber optic connectors are available.



AC power supply

To set up the Wavemeter,

1. Place your Wavemeter on a firm horizontal surface.
2. Attach the AC line cord. The Wavemeter uses a universal power supply that works with any line voltage 90-260 VAC, 50/60 Hz.
3. Turn on the Power Switch on the front panel of the Wavemeter. The system's self-test takes approximately 30 seconds.
4. Ensure all fiber optic connectors are clean and dry (see below). Then connect your fiber optic cable to the fiber optic connector on the Wavemeter front panel. Make sure the fiber end does not rub against any surface and do not overtighten.

CAUTION: Use care in handling fiber optic connectors. Always clean the fiber end prior to insertion into the connector for optimum performance and to avoid power measurement errors.

Fiber End Cleaning

To make good optical measurements, it is extremely important to clean the fiber optic connector before each connection. Dirt on the connector can degrade the reliability of the measurement and cause permanent damage to the connector resulting in an expensive repair.

Modern fiber optic connectors rely on a glass-to-glass contact to reduce Fresnel reflections at the connector interface. A dirty or damaged connector on the cable can damage the input connector on the Wavemeter front panel. Always use a good quality cable connector. If there is any question of the surface quality on the tip of the cable connector, inspect it under a microscope for scratches or debris. Follow the cleaning procedures below to ensure a trouble-free connection .

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Some general recommendations:

- Never use a metal or other hard object for cleaning that would scrape the connector.
- Do not apply index matching gel or oils.
- Always keep connectors covered for protection when not in use.

Cleaning a Fiber Optic Connector

To clean the end of the connector on the fiber optic cable,

1. Gently wipe the tip with a lint-free swab or lens paper dipped in isopropyl alcohol.
2. Dry it by wiping gently with a clean dry lint-free lens paper.
3. As soon as the connector is dry, insert it in the Wavemeter panel or cover it for later use.

Cleaning a Universal Connector

Note: Refer to the illustration below.

To clean the end of the Universal Connector,

1. Unscrew the fiber from the Wavemeter and put a protective cap on it.
2. Close the Universal protective fiber cap.

Note: Make sure the connector goes straight in and straight out. Do not tilt the connector or damage will occur. Take care not to damage the plastic cover.

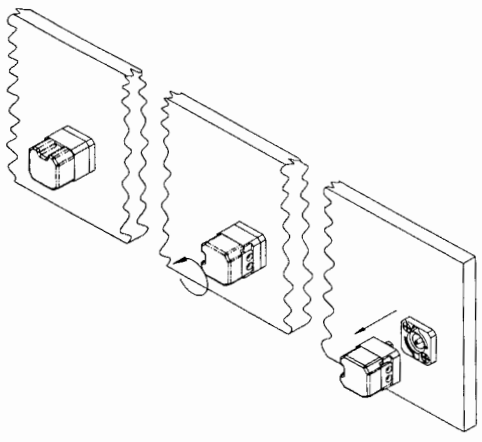
3. Grip the steel section and gently push in the universal connector and rotate it counter-clockwise ¼ turn.

Note: Gripping the plastic section may rip the cover off the connector.

4. Pull out the fiber optic connector.
5. Gently wipe the tip with a lint-free swab or lens paper dipped in isopropyl alcohol.
6. Dry it by wiping gently with a clean dry lint-free lens paper.
7. As soon as the connector is dry, insert it in the WA-7100/7600 panel or cover it for later use.

Note: The fiber optic adapter is keyed. Insert the adapter in the same position that you removed it.

8. Rotate the universal connector ¼ turn to lock it in.



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Fan Filter Cleaning

The fan on the rear panel of the WA-7100/7600 provides important ventilation to components inside the chassis. A filter covers the fan opening to keep out dust. This filter should be cleaned periodically, especially if it becomes noticeably dirty.

To clean the dust filter,

1. Pry off the plastic grill covering the filter with a small screwdriver.
2. Use a small brush, plus soap and water if necessary to clean the filter.
3. When the filter is dry, reposition it and snap the grill back in place.

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Section 2. Operation

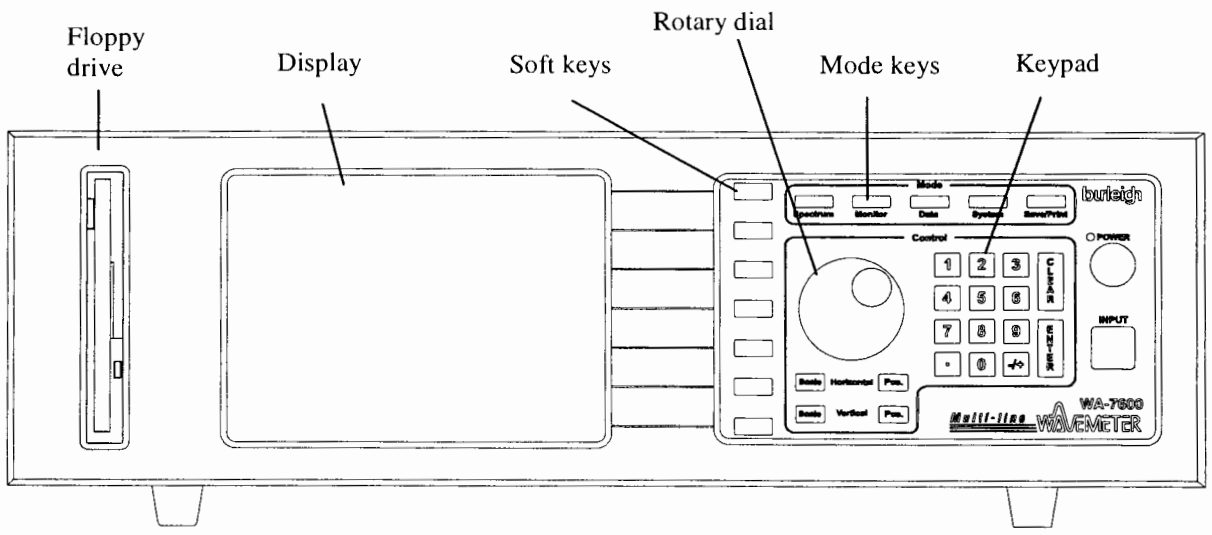
Using the WA-7100/7600

The WA-7100/7600 Multi-line Wavemeter uses Fast Fourier Transform (FFT) analysis of a signal from a scanning Michelson interferometer to obtain the spectrum of multi-wavelength laser sources within a fiber, such as found in WDM telecommunication systems. The Wavemeter is capable of displaying a spectrum of up to 256 channels with a resolution of approximately 30 pm and optical signal-to-noise ratio (OSNR) greater than 35 dB for a single line spectrum. The wavelength and power of each spectral line can be reported as a table of values or plotted graphically in real time. The measurement rate of the instrument is 0.8 Hz.

Front Panel Keys

The WA-7100/7600 operates in five modes of operation. These are the Spectrum, Monitor, Data, System and Save/Print modes.

Note: If you wish to change your settings, press the **SYSTEM** Mode key to move to the System screen. For more information on the System screen, refer to **Setting Up the System** at the end of this section.



When entering numbers using the numerical keypad, you must press the **Enter** key to execute the change. If you press any other non-numeric key, the number being entered will revert to its previous value.

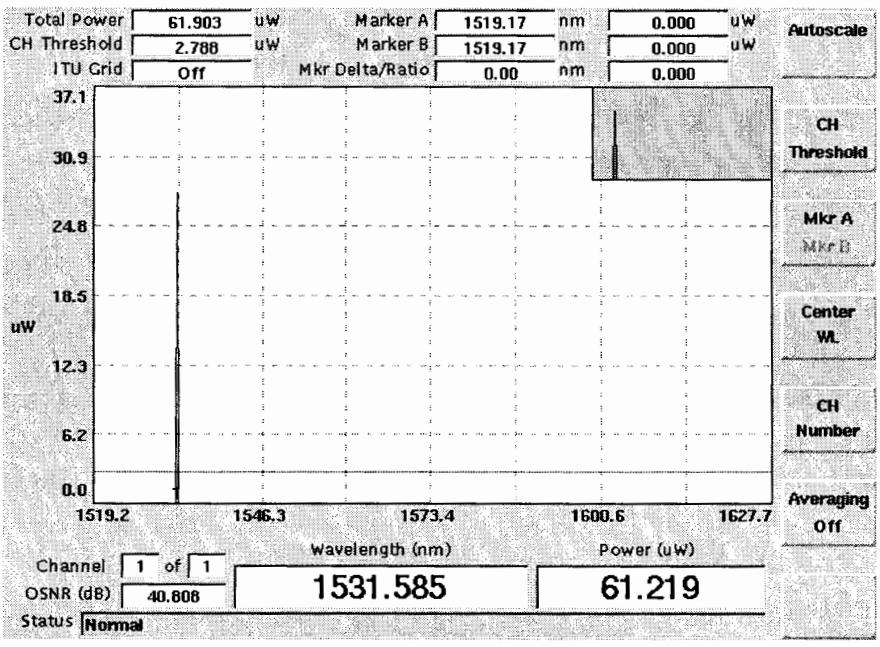
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Operating the WA-7100/7600

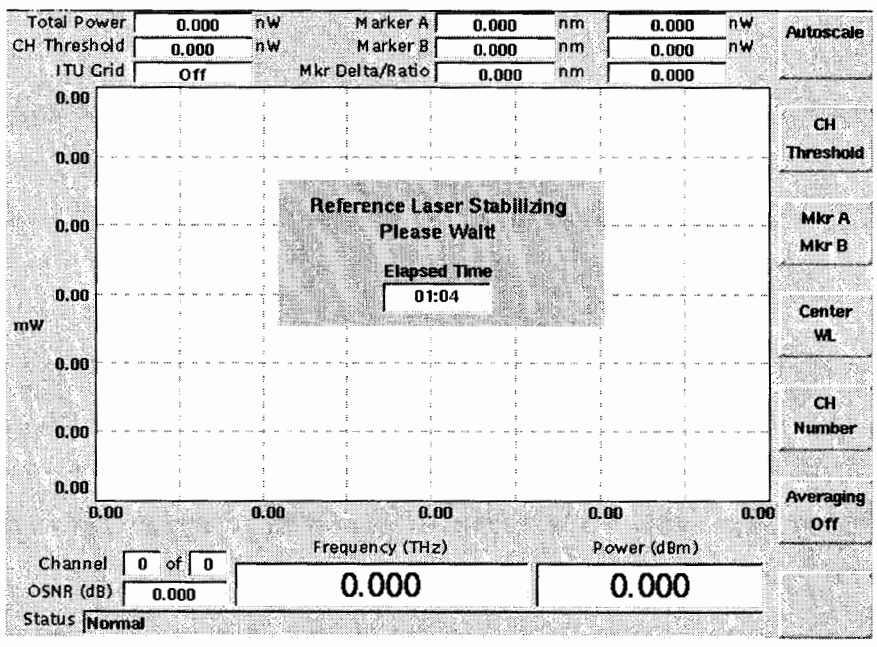
Follow the procedure below to operate the WA-7100/7600. Detailed descriptions of functions on each screen are provided in **Section 3, Front Panel Interface**.

1. Turn on the WA-7100/7600 Power button on the front panel of the machine.

   The Spectrum screen appears on the WA-7100/7600 display. This screen allows you to view the optical spectrum of the input signal.



Note: The following message appears on the WA-7600 display only:



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2. Press the **Autoscale** soft key. This automatically rescales the display for easy viewing and sets an appropriate threshold.

   Spectral peaks above the threshold indicate a separate channel. In general, you want to set the threshold to a place ABOVE any peaks or noise that you wish to ignore.

3. To adjust the threshold, press the **CH Threshold** soft key and use the Rotary dial or enter a number using the numerical keypad to adjust the threshold line (red horizontal line) to a level of your choice. If you enter a number, press the **Enter** key to accept the change.

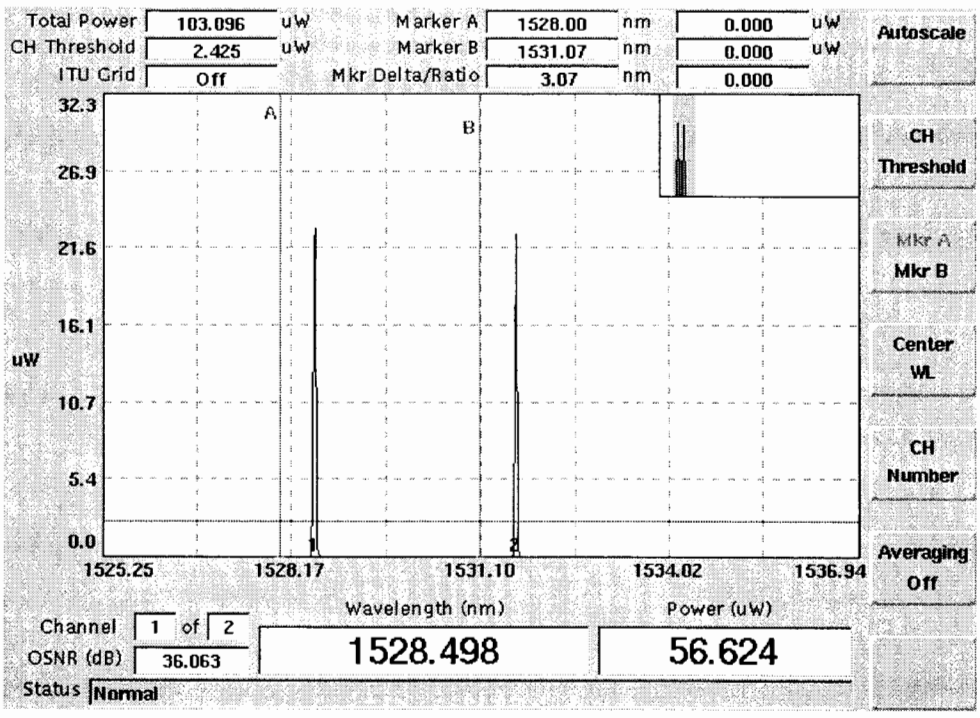
4. To adjust the horizontal scale and narrow in on an area of interest, press the **Horizontal Scale** key and use the Rotary dial. The thumbnail screen in the upper right corner shows which region of the spectrum is being viewed.

5. To view other portions of the spectrum, press the **Horizontal POS** key and use the Rotary dial to move the cyan band toward the new region of interest. Another alternative is to press the Center WL button and enter a wavelength number within the region of interest using the keypad. Press the Enter key. The number appears in the large wavelength text box at the bottom of the screen.

6. Similar functions apply to the **Vertical Scale** key as the **Horizontal Scale** key. To adjust the vertical scale and magnify an area of interest, press the **Vertical Scale** key and use the Rotary dial. Use the **Vertical POS** key with the Rotary dial to focus on a new region of interest.

7. To move from one channel to another, press the **CH Number** soft key and use the Rotary dial to change the number or enter a number using the numerical keypad. Press the **Enter** key to accept the change.

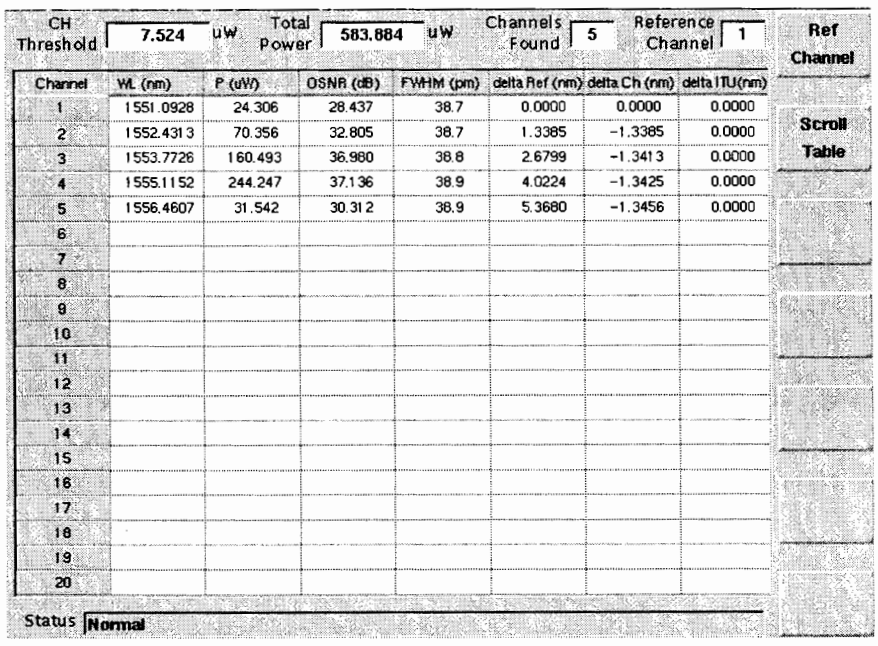
8. To move the markers to a desired location on the display, press the **Mkr A/Mkr B** soft key with the Rotary dial or enter a number using the numerical keypad to move the markers (denoted by red vertical lines) to a desired location on the display. (Toggle the key to move from one marker to another.) A red hash mark appears at the intersection point of the spectrum. If you set both markers, the wavelength difference and power ratio are displayed in the **Mkr Delta/Ratio** box at the top of the screen.



9. The **Total Power** box displays the total input power from the source.

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10. The **Ch Threshold** box displays the channel threshold level.
11. The **ITU Grid** box indicates the status of the ITU Grid setting on the System screen. It is either Off, 25 GHz, 50 GHz, 100GHz, or Hidden (if the wavelength range displayed is too wide).
12. To average the Spectrum, press the **Averaging/Off** soft key until **On** is displayed.
13. To move to the **Data** screen, press the **DATA** Mode soft key. The Data screen displays measurements for all channels detected above the threshold in a tabular form.



Channel	WL (nm)	P (uW)	OSNR (dB)	FWHM (pm)	delta Ref (nm)	delta Ch (nm)	delta ITU(nm)
1	1551.0928	24.306	28.437	38.7	0.0000	0.0000	0.0000
2	1552.4313	70.356	32.805	38.7	1.3385	-1.3385	0.0000
3	1553.7726	160.493	36.980	38.8	2.6799	-1.3413	0.0000
4	1555.1152	244.247	37.136	38.9	4.0224	-1.3425	0.0000
5	1556.4607	31.542	30.312	38.9	5.3680	-1.3456	0.0000
6							
7							
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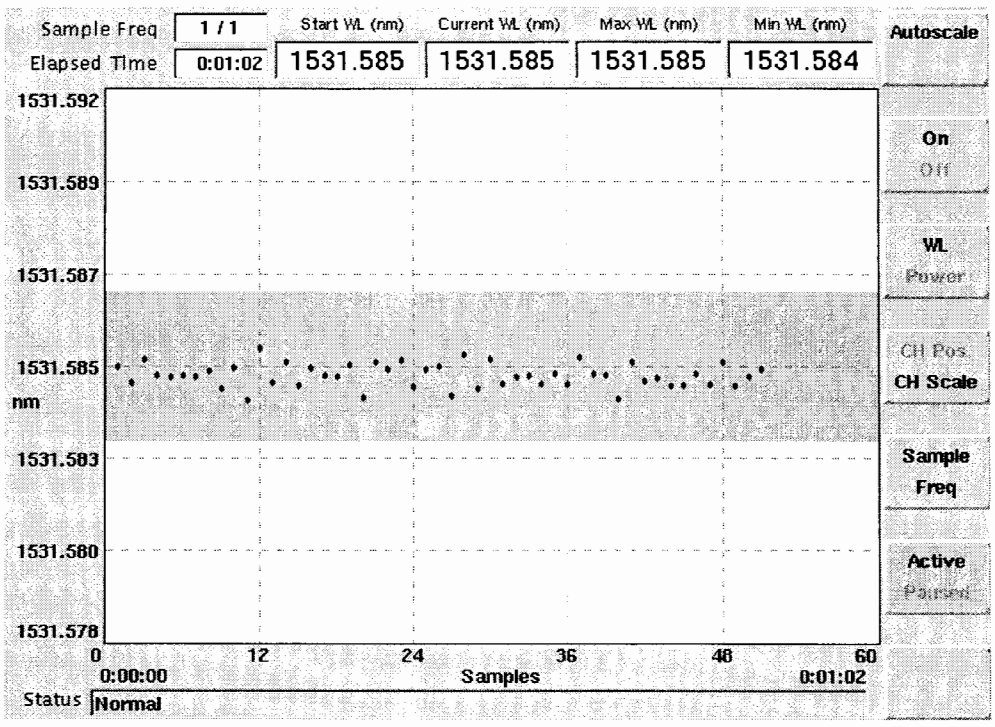
14. To change the reference channel, press the **Ref Channel** soft key and use the Rotary dial or numeric keypad. The Reference Channel box is highlighted. Note that this also changes the channel number on the **Spectrum** screen.
15. To save any display, press the **SAVE/PRINT** Mode key while viewing the screen of interest. (The Print function will be available in the next release of the software.)
16. To save a copy of the data table, place a floppy disk in the drive, be sure that the Source soft key indicates "Source Data," and then select the **Save Data** function.

    Note: For more detailed information on these functions, refer to **Section 3, Front Panel Interface**.

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17. Press the **MONITOR** Mode soft key to access the Monitor display. The Monitor screen provides a graphical display of wavelength drift over time or power change over time for an individual channel. While collecting data, the horizontal axis expands automatically to accommodate the length of the measurement period.

    A cyan band across the wavelength versus time display defines the position and width of the channel being measured. Measurement data for that channel is shown at the top of the screen, once the data collection is started.



18. Press the **On/Off** soft key to initiate the display. **On** indicates that data collection has started; **Off** indicates that data collection is not occurring.

    Press the **Autoscale** soft key to quickly adjust the wavelength scale to bring the data within range. The cyan band will be centered around the first channel.

19. Press the **On/Off** soft key again until Off is highlighted and data collection stops. Use the **Active/Paused** function to halt the display updating while data is continually being collected. To clear the screen of all data, press the On/Off soft key until Off is highlighted and press the Clear key on the numeric keypad.

20. Press the **Sample Frequency** soft key to change the frequency with which the system records/saves sample data. For example, if the sample frequency is ½, then only every other reading is recorded/saved.

21. To select another channel,

    —Press the **On/Off** soft key until it reads **Off**.

    —Press the **Clear** key on the numeric keypad.

    —Press the **Vertical Scale** key.

    —Turn the Rotary dial counterclockwise until the other channels appear on the screen.

    —Press the **Ch POS** soft key to move the cyan band to a new channel.

    —Use the **Ch SCALE** soft key to change the wavelength or frequency width of the channel being measured.

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—Use the WL/Power soft key to display the Wavelength or the Power of the selected channel.

22. To copy the monitor data to a floppy disk, press the **SAVE/PRINT** mode key (be sure the Source soft key indicates "Source Monitor," and then press the **Save Data** soft key.
23. To scale the power variation to within 10% of the top and bottom of the screen, press the **Autoscale** soft key.
24. Toggle the **WL/Power** soft key to go from the Wavelength versus samples graph to the Power versus samples graph.

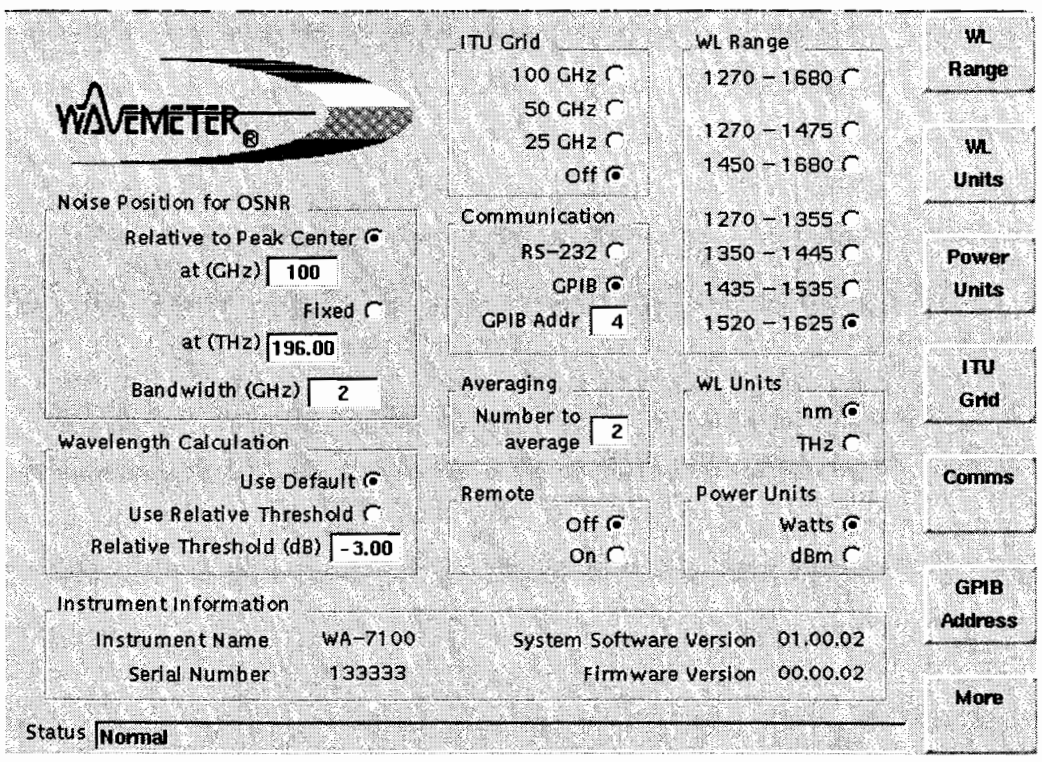
    Note: Continue with the next section if you want to set up the system parameters.
25. To turn off the WA-7100/7600, press the **Power** button on the front panel.

Setting Up the System

Follow the steps below to change the system parameters:

1. Press the **SYSTEM** Mode key. There are three System screens.

   The first System screen appears.

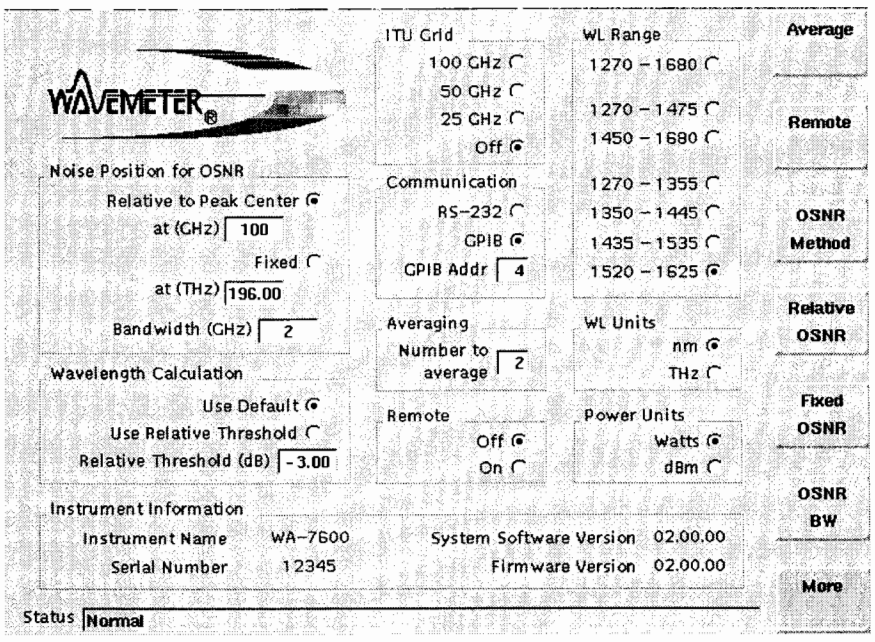


2. To change the **Wavelength range**, press the **WL Range** soft key. Press the button repeatedly to move to the wavelength range that meets your requirements.

   The full operating range is 1270-1680 nm. To be properly identified, all wavelengths existing in the source must fall within the wavelength range selected. When all wavelengths are within a narrow spectral band, choosing a smaller wavelength range will result in a higher resolution spectral display.

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3. To change **Wavelength Units**, press the **WL Units** soft key. Toggle the key to select either nm or THz.
4. To change **Power Units**, press the **Power Units** soft key. Toggle the key to select either linear scale (Watts) or decibel/log scale (dBm).
5. To make the **ITU Grid** appear on the Spectrum display, press the **ITU Grid** soft key. Press again to choose the 100 GHz, 50 GHz, or 25 GHz grid. If you do not want a grid displayed, select Off.
6. To change the **Communications** interface, press the **Comms** soft key; toggle the key to select either GPIB or RS-232.
7. To add or change the **GPIB** address, press the **GPIB Address** soft key. Enter a GPIB address using the numerical keypad. Press the **Enter** key to activate the change.
8. Press the **More** soft key to access additional functions on the System screen. The second System screen appears.



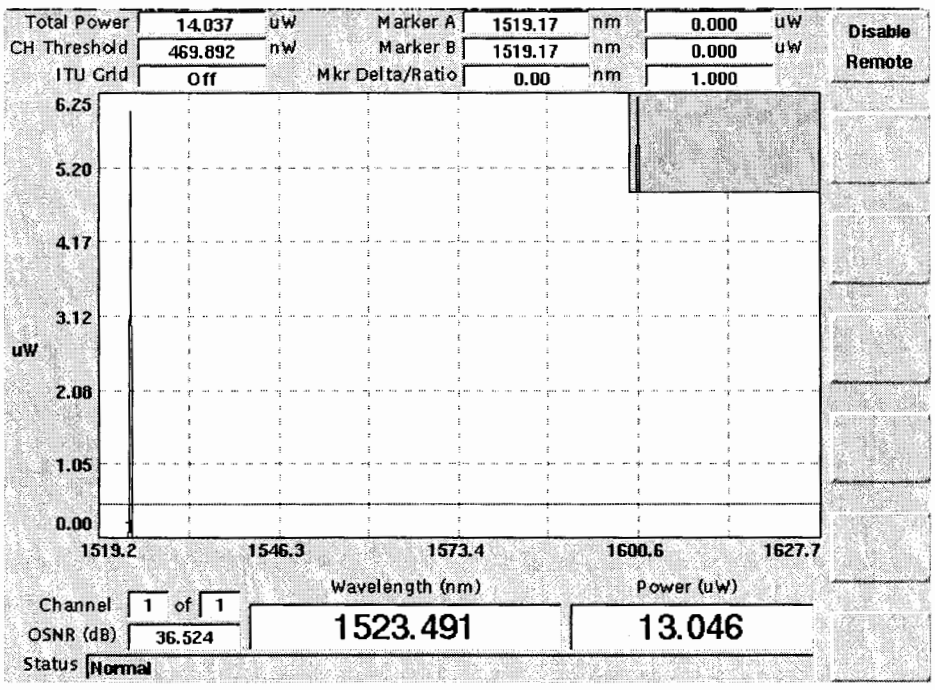
9. To change the number of spectra to **Average**, press the **Average** soft key. Using the numeric keypad, enter a value corresponding to the number of spectra you want to average.

   The Average function is provided to measure the average performance of the source. The WA-7100/7600 updates the spectrum every second. If the source wavelength or power is fluctuating, you may prefer to get an average measurement.

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10. Press the **Remote** soft key to turn the remote function on.

    Note: Once pressed, all other screens will display the **Disable Remote** soft key. Press this key on any other screen to turn **off** the remote function. An example of the Spectrum screen (with the remote option selected on the System screen) is shown below.

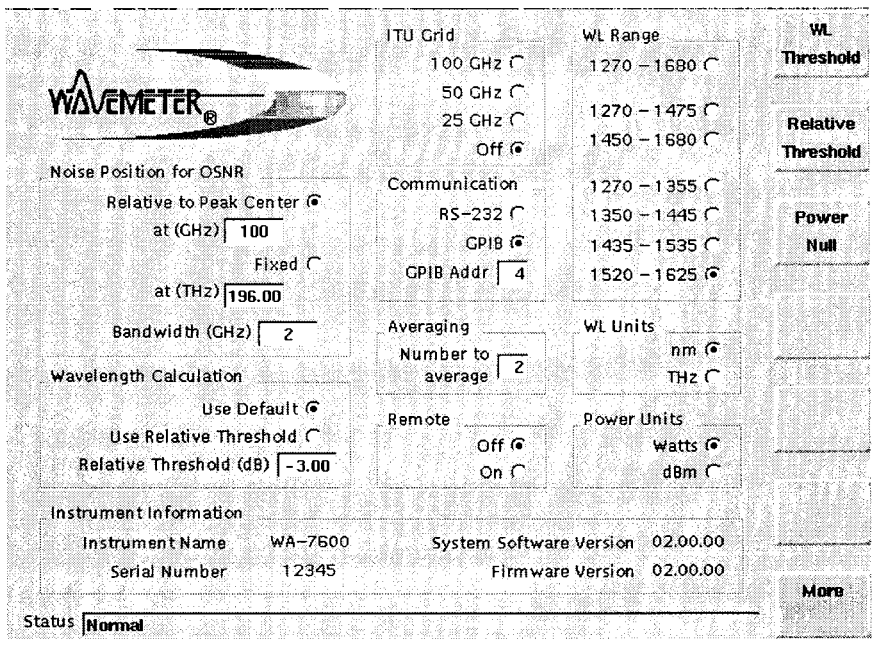


11. Press the **OSNR Method** soft key to select either a calculation made relative to peak center or made at a fixed frequency location.
12. Press the **Relative OSNR** soft key to select the frequency separation between the peak center and the noise center.
13. Press the **Fixed OSNR** soft key to select the fixed frequency location of the noise center.
14. Press the **OSNR BW** soft key to select the noise bandwidth for the OSNR calculation.

    Note: Refer to Noise Position for OSNR on page 5-2 for a complete description of OSNR calculations.

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15. Press the **More** soft key to access additional functions on the System screen. The third System screen appears.



16. Press the **Wavelength Threshold** soft key to determine which method is used for the wavelength calculation.
17. Press the **Relative Threshold** soft key to determine channel centers relative to the highest value in each channel. You can set the relative threshold value using the Rotary dial or the keypad.
18. To perform a **Power Null** calibration, press the **Power Null** soft key. The Power Null calibration is provided to zero the background offset for the power detector (Refer to Section 3, **Front Panel Interface** for more information.
19. Press the **More** soft key to return to the first System screen.

    Now you have identified the system settings that you want to use.

    Refer to the next section for detailed descriptions of each WA-7100/7600 function.

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Section 3. Front Panel Interface

To use the WA-7100/7600, follow the step-by-step procedure in Section 2, Operation.

To learn more details about the Wavemeter controls, screen displays and parameter values, refer to the information below. This section is meant to be used as a reference for the WA-7100/7600.

Front Panel Controls

The Wavemeter front panel is shown in Figure 2.1. The controls are described below.

The color VGA display reports all measurement data in a variety of formats. There are several different screens, each with different information and buttons for selecting parameters that affect how the data is collected and how the information is displayed.

The standard 3.5" floppy disk drive allows the operator to save data to a floppy disk and to install any future software upgrades.

Control	Description
Power	The POWER key turns the Wavemeter on and off. The green LED indicator shows the power status. When lit , the unit is turned on; when not lit, the unit is off.
Mode Keys	The MODE keys select the following mode screens: Spectrum, Monitor, Data, System and Save/Print.
Numbered Key Pad	The numbered keypad consists of Keys for the numerals 0-9, +/-, decimal point, Clear and Enter. These keys are used for various functions throughout the modes of operation.
Soft Keys	These keys are located vertically along the right side of the VGA display. The soft keys control different functions depending on which mode of operation you are using.
Rotary Dial	The rotary dial allows for scrolling both horizontally and vertically to change system parameters such as scaling, numeric entries, etc.
Scale Keys	The scale keys are used to optimize the Spectrum and Monitor mode displays. They allow you to zoom in and zoom out when used in combination with the rotary dial
Pos Keys	The position keys allow you to select which portion of the spectrum you are viewing.

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Using the Front Panel Controls

Use the front panel controls to review information and make changes to the available parameters.

Changing Modes of Operation

The WA-7100/7600 has five modes of operation: Spectrum, Monitor, Data, System and Save/Print. Press the appropriate key to view a particular Mode display.

Changing Parameter Values

Use the row of vertical gray keys located to the right of specific functions to highlight those functions. The selected function will be highlighted in cyan. Toggle the key to adjust the value of the selected function (where appropriate).

System Mode

The System mode allows for the setting of all the measurement and display parameters via the front panel soft keys. These parameters include:

- Wavelength Range
- Wavelength Units
- Power Units
- ITU Grid Setting
- Communications Setting (and GPIB address)
- Averaging On/Off (and number)
- Wavelength Calculation method (and Relative and Channel Threshold levels)
- OSNR Calculation method (and Relative frequency and Fixed frequency and Bandwidth)
- Channel Number (Spectrum and Data screen)
- Marker A and B position

Note: Press the More button at the bottom right of the first System screen to access the WL Threshold, Relative Threshold, Power Null, and OSNR parameters.

Note that the instrument information is included on the System mode display. Here you can check the instrument name, serial number, system software version and the firmware version. Make sure you have this information if you call the factory with a question.

A status bar at the bottom of each mode display indicates the status of the instrument during the various operations.

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Resolution/Wavelength Range

This sets the operational wavelength range to be used for measurements. The complete wavelength range of the WA-7100/7600 is 1270 to 1680 nm. When this entire range is selected, the spectral resolution of the measurements is limited to 40 pm (~5 GHz). In order to increase the spectral resolution of the measurements, a more limited wavelength range can be used. Therefore, seven wavelength range choices are available. These choices include complete wavelength coverage with 40 pm spectral resolution (~5 GHz), moderate wavelength coverage with 35 pm spectral resolution (~4.5 GHz), and limited wavelength coverage with 30 pm spectral resolution (~4 GHz).

Wavelength Units

This sets the units of wavelength (nm) or frequency (THz) displayed in the Spectrum, Data, and Monitor modes of operation.

Power Units

This sets the units of optical power that are displayed in the Spectrum, Data, and Monitor modes of operation. The choices are Watts and dBm.

ITU Grid

This activates or deactivates the use of the International Telecommunications Union (ITU) grid in the Spectrum or Data modes of operation. When operating in the Spectrum Mode, grid lines are displayed that partition the horizontal axis with either the 100 GHz , 50 GHz or 25 GHz ITU grid, whichever is chosen. When operating in the Data Mode, the difference between measured values and the closest value from the chosen ITU grid is automatically calculated.

Comms

This sets the method of instrument interface to either a GPIB or an RS-232. The default setting is GPIB.

GPIB address

This allows you to enter a new GPIB address. Press the soft key, then use the Rotary dial or the numerical keypad to enter a number.

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Average

This sets the averaging feature of the WA-7100/7600. To set the number of scans to average, press the **Average** soft key then use the Rotary dial or the numerical keypad to enter a number.

Remote

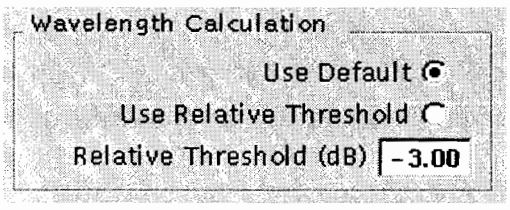
This removes all softkey functions from each screen so that all functionality is controlled via the communications interface.

Wavelength Calculation

A single *channel* is defined by a contiguous group of bins (an intensity distribution), where one or more of the bins is above the user selectable *channel threshold* level. The wavelength of a channel is calculated as the first moment (or centroid) of the intensity distribution that falls between the left and right limits of the channel. The user can choose between two methods of calculating the wavelength on the Wavelength Calculation panel of the System screen. The two choices are:

Default: The Default calculation defines the left and right limits of the channel to be the wavelengths at which the channel intensity drops to the level of the local noise floor. The WA-7100/7600 is shipped with the Wavelength Calculation set to Default.

Relative Threshold: When the Relative Threshold mode is selected, the calculation finds the centroid of only the subset of a channel's intensity distribution that exceeds the user-selected Relative Threshold. The Relative Threshold level is specified in dB, and defines a level measured downward relative to the highest point of each channel. This Relative Threshold level can be adjusted by pressing the Relative Threshold button, then entering a new number with the numeric keypad, or by rotating the rotary dial. Press the Enter key to activate the change.



Power Null

This function allows you to perform a power null calibration.

To do the calibration,

1. Select the Power Null soft key.
2. Press the ENTER button. The status bar reminds the user to place the cap on the Input connector.
3. Place the cap on the Input connector.
4. Press Enter. When the power null calibration is complete, the system status dialog returns to Normal.
5. Reconnect the fiber optic cable to the INPUT connector.

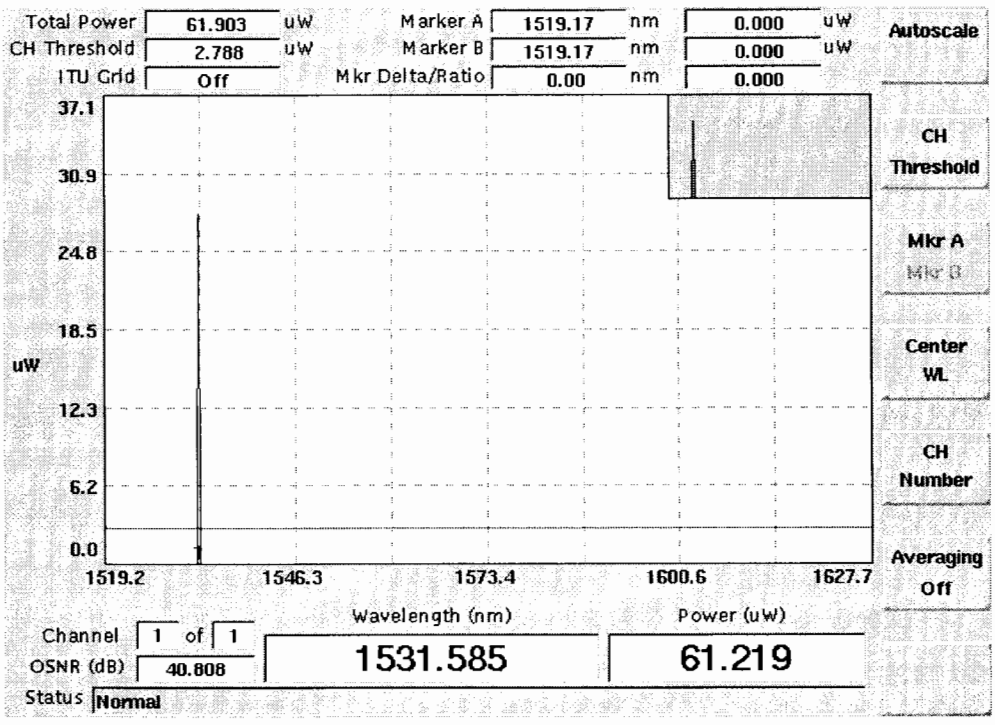
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Spectrum Mode

The **SPECTRUM** Mode displays the optical spectrum of the input signal using the units chosen in the **SYSTEM** Mode. The units on the horizontal axis are wavelength (nm) or frequency (THz), both increasing in value to the right. The vertical axis of power is displayed in units of mW/µW/nW or dBm. When you first select **SPECTRUM** Mode, the entire wavelength range chosen from the seven options in System Mode is displayed.

For convenient reference, the grid lines on the spectrum are plotted and labeled. The X axis always has seven grid lines and the Y axis always has five. It is also possible to display grid lines that partition the horizontal axis with either the 100 GHz, the 50 GHz or the 25 GHz ITU grid. When the ITU grid lines are selected in the **SYSTEM** Mode, they appear in a different color (blue) than the standard grid lines (gray). It may be necessary to zoom in so that the ITU grid lines are visible using the **Horizontal Scale** key.

Channels are identified as any spectral peak with an intensity greater than the threshold level. All channels are labeled with a number that increases toward longer wavelength. When frequency units are used, the numerical order of the peak labels is reversed to maintain a consistent label for each channel. Detailed information for any one of the channels can be listed in the table below the spectrum.



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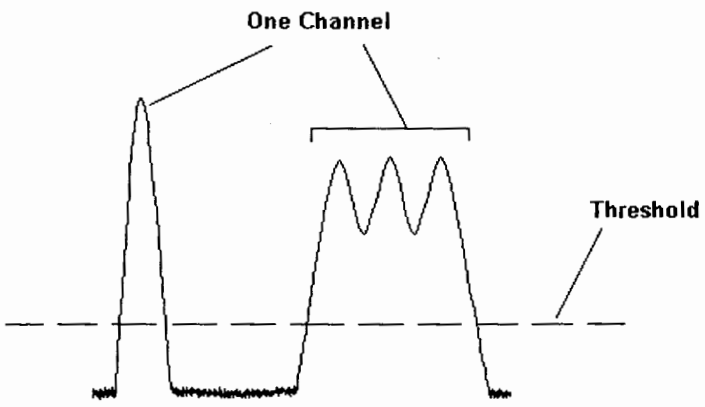
Total Power

Indicates the total power of the optical input signal.

CH Threshold

This function sets and labels the threshold level of measurement. Only peaks with an intensity level greater than the threshold are identified and measured. To adjust the threshold, select the CH Threshold key, then rotate the rotary dial, or enter a value using the numeric keypad. Press the Enter key to accept the change.

One channel includes any peaks that fall within the area from the point where the intensity goes above the threshold to the point where the intensity goes below the threshold, as shown below. When discussing the spectrum , we use the word *peak*. Once the peak has been identified and numbered, we refer to it as a channel.



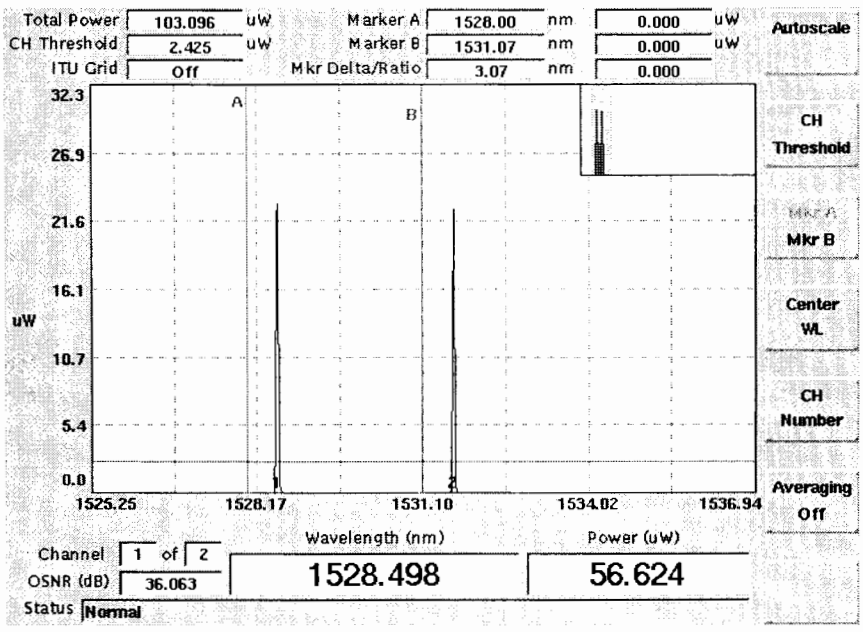
ITU Grid

Displays the status of the ITU Grid setting on the System screen: 100 GHz, 50 GHz, 25GHz or Off. If the Grids are on and there is not enough resolution on the Spectrum display, then the Grids do not display.

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Marker A and Marker B

These functions activate and display two markers that can be set to determine the wavelength and the power of two selected points of the displayed spectrum. The wavelength and Power values for each marker are listed next to the Marker A and Marker B boxes.



There are two ways to move the markers. Press the **Marker A/Marker B** soft key. Note that the selected marker's text box is highlighted. Enter the new number using the Rotary dial or the numeric keypad.

Mkr Delta/Ratio

Displays the difference between the wavelength of the peak under Marker A and the peak under Marker B, as well as the difference between the respective powers.

Auto Scale

The Auto Scale key resets the vertical scale of the displayed spectrum. The peak with greatest intensity is set to approximately two thirds of the full scale display. In addition, the threshold level is set to approximately 1/10 of the peak with greatest intensity within the viewing area. To activate this function, press the **Autoscale** soft key.

In the upper right corner of the graph there is a thumbnail image of the full wavelength range with a cyan band that indicates the region that you are viewing.

CH Number

This function allows you to view information about individual channels, including the channel number with the total number of channels, the wavelength or frequency of the peak, the intensity of the channel in the chosen units, and the signal-to-noise ratio. To view data on a channel, press the CH Number button, then use the keypad to enter the channel number of the peak of interest (followed by pressing the **Enter** key), or use the Rotary dial to increment the channel number.

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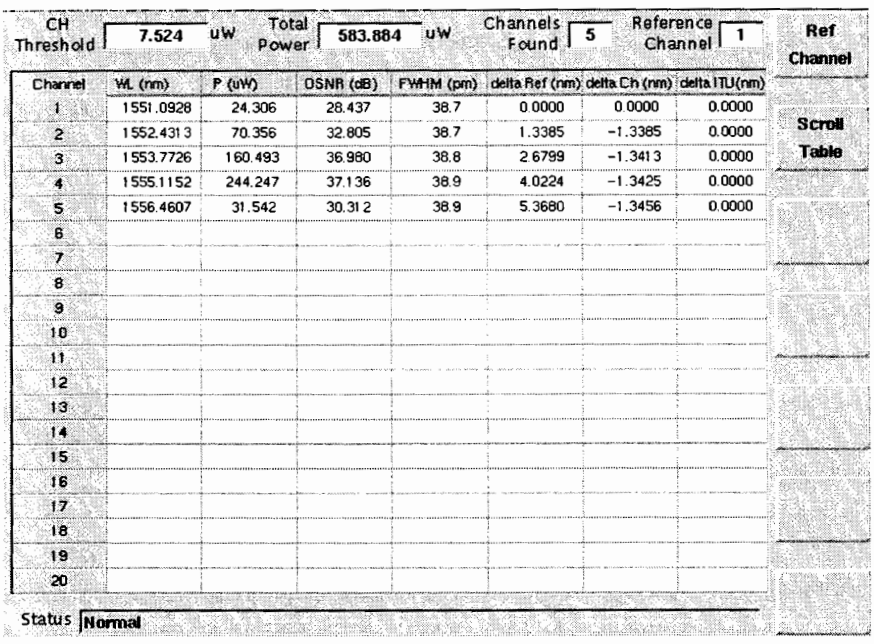
Note: When changing channel numbers, the peak represented by that channel will be centered on the graph if you zoom in on the viewing area.

Average

This allows you to toggle the Average feature On and Off. The number of spectra to average is selected on the System screen.

Data Mode

The data mode displays all of the measurement data in a tabular spreadsheet format, with additional measurement parameters included. This data table can be saved via a floppy disk drive on the front panel. (The print option will be available with the next release.)



Channel	WL (nm)	P (uW)	OSNR (dB)	FWHM (pm)	delta Ref (nm)	delta Ch (nm)	delta ITU(nm)
1	1551.0928	24.306	28.437	38.7	0.0000	0.0000	0.0000
2	1552.4313	70.356	32.805	38.7	1.3385	-1.3385	0.0000
3	1553.7726	160.493	36.980	38.8	2.6799	-1.3413	0.0000
4	1555.1152	244.247	37.136	38.9	4.0224	-1.3425	0.0000
5	1556.4607	31.542	30.312	38.9	5.3680	-1.3456	0.0000
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

The Data mode table lists various numerical measurement data for all peaks that are identified as channels. Any peak with intensity greater than that of the threshold value will be classified as a channel.

The information reported on the table includes:

- Total optical power measured for all combined channels by the system's calibrated photodetector.
- The number of channels identified with an intensity greater than the threshold level.
- The vacuum wavelength (nm) or the frequency (THz) of each of the channels.
- The optical power (W or dBm) of each of the channels.
- The optical signal-to-noise ratio of each of the channels.
- The full width at half intensity (FWHM) of each channel.
- The difference between the wavelength or the frequency of each channel and the reference channel.
- The difference between the wavelength or the frequency of each consecutive channel.

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- The difference between the wavelength or the frequency of each channel and the nearest ITU grid wavelength or frequency.

To use Data Mode,

1. If the number of channels is greater than the number of rows that can be shown on the screen, use the Rotary dial to scroll up and scroll down.
2. Use Ref Channel to select the channel used as a reference to calculate various wavelength differences listed in the table.

Parameter	Description
Channel	Numbers each of the channels
WL (nm)	Lists the wavelength (nm) or the frequency (THz) of each of the channels. The units used are chosen in the System Mode.
P (mW)	Lists the power in the units chosen in the System Mode of each of the channels.
OSNR (dB)	Lists the optical signal-to-noise ratio of each of the channels.
FWHM (nm)	Lists the full width at half intensity of each of the channels.
delta Ref (nm)	Lists the difference between the wavelength or the frequency of each channel and the reference channel.
delta Ch (nm)	Lists the absolute value of the difference between the wavelength or the frequency of each channel and its adjacent lower numbered channel.
delta ITU (nm)	Lists the difference between the wavelength or the frequency of each channel and the nearest ITU grid.

CH Threshold

The Threshold box lists the power level of the threshold in the units selected in the System Mode.

Total Power

Indicates the total power of the optical input signal.

Channels Found

Lists the number of peaks identified with an intensity greater than the threshold level.

Ref Channel

Identifies the channel that is used as a reference to calculate various wavelength differences listed in the table. To change the reference channel, press the Ref Channel key. Press the button repeatedly to move to a higher Channel number. Alternatively, enter the new Channel number using the numeric keypad.

Scroll Table

Use the Rotary dial to scroll through all the channels.

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Monitor Mode

The **MONITOR** Mode allows you to graphically monitor either channel wavelength or channel power over time. While in the wavelength monitor option, the graphical display plots all measured channels as a function of time. For a user selected channel, the starting wavelength, current wavelength, and maximum and minimum wavelengths are listed along the top of the screen for the entire measurement period. Choosing the Power Monitor option displays graphically the power over time for the selected channel. Similar to the Wavelength Monitor option, while monitoring the power, the screen displays the starting power, current power, minimum and maximum power values.

In **MONITOR** Mode, a graph of vacuum wavelength or frequency over time is displayed to monitor the drift characteristics of all the peaks identified with an intensity greater than the threshold level. The displayed graph can be optimized using the soft key functions located vertically along the right of the screen. The *Autoscale* function will automatically place the first channel in the center of the screen, and set a 200 pm (25GHz) tolerance window for that channel. The channel window, shown as a cyan band identifies the optical channel of interest.

The **MONITOR** mode display can be easily optimized for more detailed analysis of a specific optical signal. While in the wavelength monitor option, the width of the tolerance window can be modified by pressing the **CH Scale** soft key and making adjustments using the Rotary dial. To view a different optical channel, simply press the **Vertical POS** soft key and turn the Rotary dial until the new channel comes into view. The view of the new channel can then be optimized as above.

The **Wavelength/Power** soft key allows you to toggle between the wavelength and power monitor options. Choosing the power monitor option displays the power over time of the channel that was selected while in the wavelength monitor option. The cyan channel window doesn't appear when power is monitored.

The time axis scales automatically during the graphing period to a maximum of 500 data points. After the initial 500 data points, the Monitor mode continues to plot new data, but with a sliding window. 3600 data point are saved in memory and can be accessed via the **SAVE** Mode.

Auto Scale

This button is visible only in the Wavelength graph. When the system is collecting wavelength data, the Auto Scale button selects the first channel and expands the vertical scale to show 200 pm (or 25 GHz). When the system is not collecting data, Auto Scale resets the vertical scale of the displayed graph to the entire wavelength range chosen from the seven options on the System screen.

On/Off

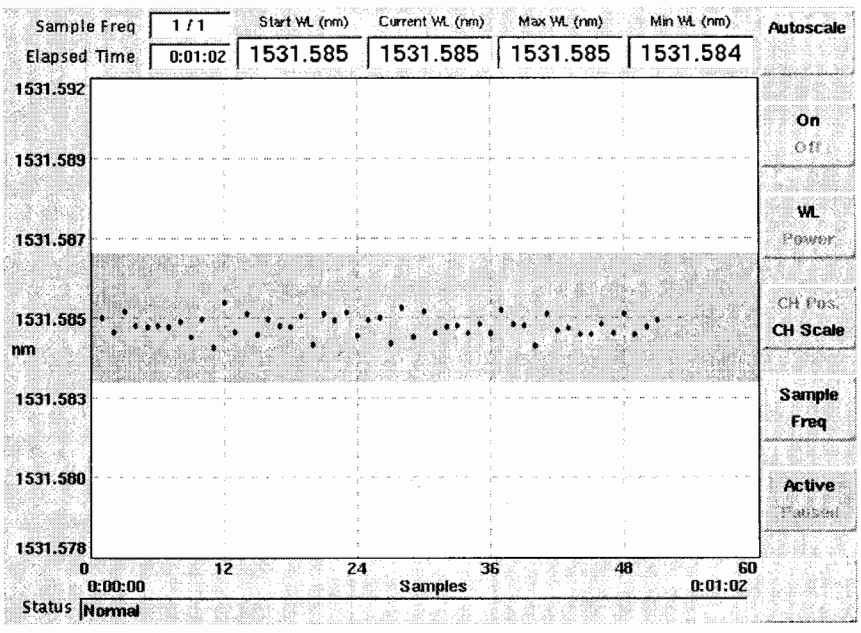
The On soft key allows you to start collecting data. The Off soft key stops the collection of data. To clear the screen, use the Clear key on the numerical keypad.

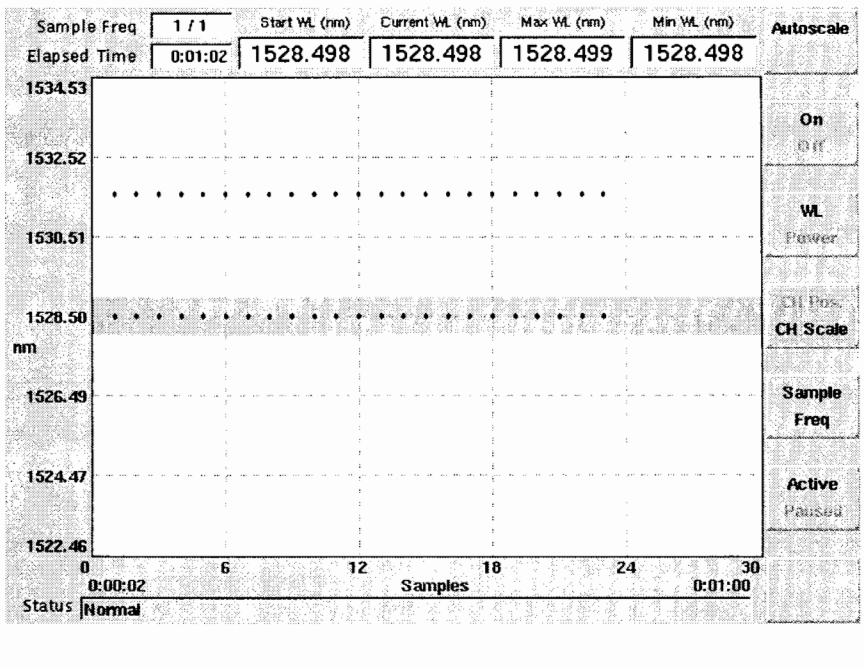
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WL Power

The WL/Power button toggles the display between graphs of wavelength versus samples and power versus samples, over the same time interval. Note that the Power graph will be blank if no wavelength values are within the channel window.

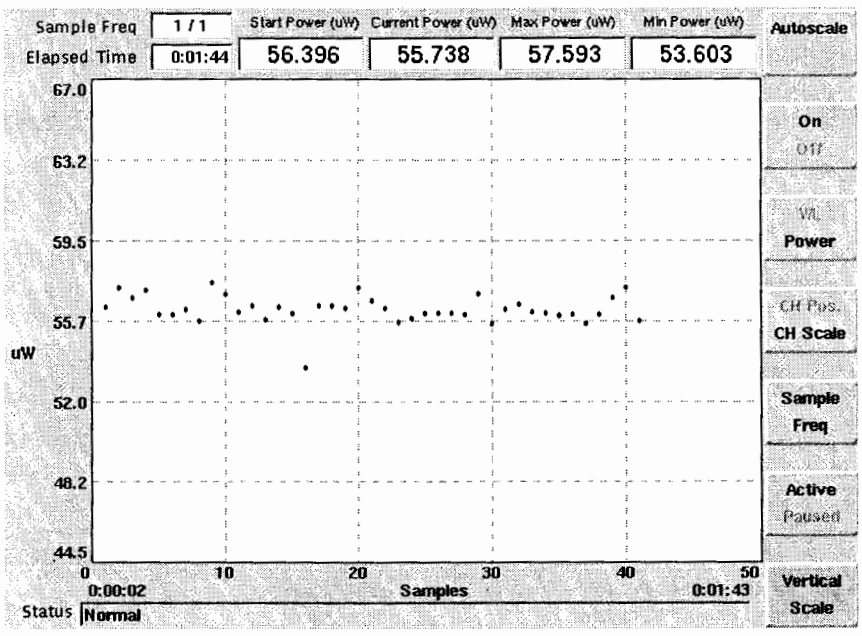
Wavelength Graph





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Power Graph



CH Pos/CH Scale

This soft key adjusts the scale and position of the channel window (cyan band), which defines a channel for the monitor. Data points located within the channel window are used to calculate the values shown at the top of the screen.

Sample Frequency

Represents the frequency at which a sample is displayed. For example, pressing 10 followed by pressing the Enter key results in every 10^{th} measurement being displayed. The Default is 1. Press the Sample Frequency soft key and then enter the sample frequency using the numeric keypad.

The maximum number of data points is 3600. After you reach that number, the oldest data points are deleted as the new data points come in. For long periods of data collection, use a sample time sufficient to collect the required number of data points.

Active/Paused

The Paused function stops the display update but does not stop data collection. To pause the display, press the Active/Paused soft key until Paused is highlighted. The display stops updating. All other functions can be used when Pause is activated. To deactivate the Pause function and update the display with new information, press the Active/Paused soft key again until Active is highlighted.

Elapsed Time

Indicates the elapsed time since data collection started (in hours, minutes, seconds). The elapsed time updates each time the system samples the data.

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CH Position/CH Scale

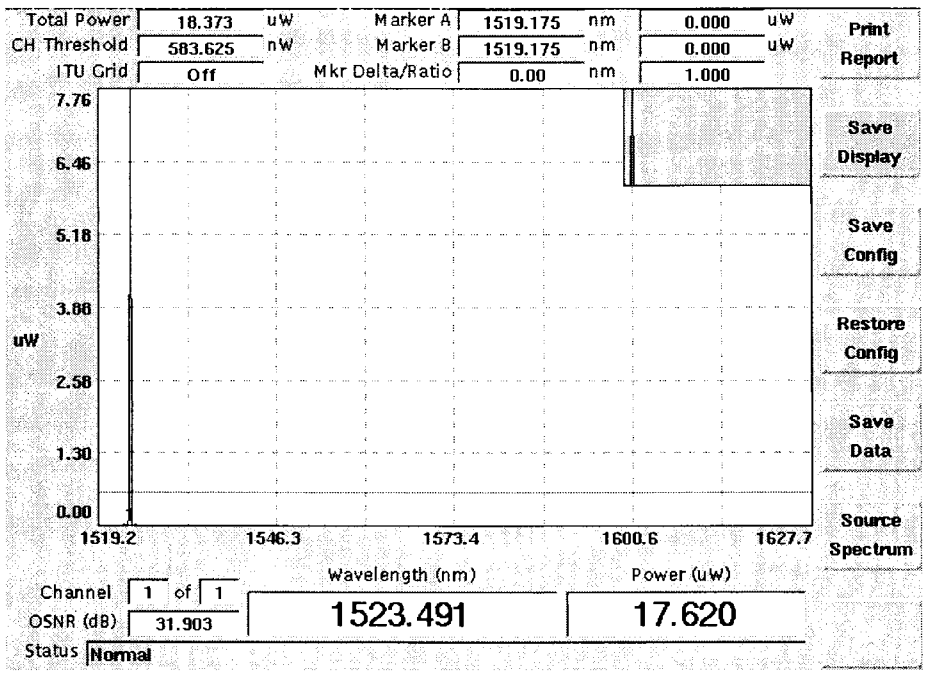
The Ch Position function allows you to move the channel window (cyan band) up and down to identify the data for any channel. To view data on a specific channel, press the **CH Pos/CH Scale** soft key until CH Position is highlighted, then use the Rotary dial to move the channel window up or down. The text boxes at the top of the screen show the starting wavelength (Start WL), current wavelength (Current WL), maximum wavelength (Max WL) and minimum wavelength (Min WL) of the selected channel.

The Ch Scale function allows the width of the channel window to be adjusted. Toggle to highlight CH Scale, then use the rotary dial the change the window width.

Save/Print Mode

This mode allows you to save and print data. You have several save choices, including:

- Saving a bitmap of the display in a standard .bmp format
- Saving the system configuration
- Saving the data from **Source** to a file in ASCII format



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Print Report

Press the **Print Report** soft key to output the currently selected screen to the printer as a text report.

Note: Make sure that the printer supports simple ASCII character input and that it is correctly connected to the parallel port on the Wavemeter. You can print three different reports, based on which screen was selected prior to changing the Save/Print screen. In the case of the screen above, the screen displayed prior to selecting the Save/Print screen was the Spectrum screen. Therefore, pressing the Save/Print soft key prints the Spectrum report.

Save Display

Press the Save Display soft key to save the currently selected screen as a bitmap file to the floppy disk. The filename will follow the naming convention MONIxxxx.BMP, SPECxxxx.BMP, or DATAxxxx.BMP (depending on the source screen), where xxxx is a number that is automatically incremented as files are saved.

Save Config

Press the Save Config soft key to save the system configuration to the system storage device. The saved configuration can then be restored, if necessary, using the Restore Config command. The following items are saved:

- Wavelength Range
- Wavelength Units
- Power Units
- ITU Grid Setting
- Communications Setting (and GPIB address)
- Averaging On/Off (and number)
- Wavelength Calculation method (and Relative and Channel Threshold levels)
- OSNR Calculation method (and Relative frequency and Fixed frequency and Bandwidth)
- Channel Number (Spectrum and Data screen)
- Marker A and B position

Restore Config

Press the Restore Config soft key to return the Wavemeter to the previously stored configuration.

Save Data

Saves data values from the selected source screen (Monitor, Spectrum, or Data Screen) to an ASCII file on the floppy disk. The file will be named MOxxxxyy.CSV, SPxxxxyy.CSV, or DAxxxxyy.CSV (depending on the source screen), where xxxx is a number that is automatically incremented as files are saved. The Monitor screen data consists of three columns—time, wavelength (or frequency), and power. The Spectrum data consists of a first line that shows the start wavelength and the wavelength increment (or frequency and frequency increment), followed by intensity values. The Data screen data is simply a text-only copy of the labels and columns from the Data screen.

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Source Monitor/Spectrum/Data

Selects the Screen to be used as the source for data to be saved. Each press of the key toggles the selected source from among the Monitor, Spectrum, and Data screens.

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Section 4. Remote Communications

This section discusses the use of remote communications to review and control the Wavemeter.

Overview

You can control the Wavemeter remotely using either an RS-232 or a GPIB interface using the SCPI communications protocol. Connections for both interfaces are provided on the rear panel of the Wavemeter as shown later in this section.

You must use the Wavemeter front panel controls to enable remote communications for the specific type of interface. Refer to the description of System Mode in Section 2 of this manual for information.

RS-232 Interface

The RS-232 port is a full duplex serial communications port. The connector is a 9-pin, female, D-Sub style connector configured to complement the standard Personal Computer (PC) RS-232 Serial port (COM1, COM2...). Use a serial extension cable with a 1:1 pin correlation for direct connection to a PC. Do not use a null-modem style.

Baud:	19200
Data Bits:	8
Parity:	None
Stop Bits:	1
Handshaking:	None

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GPIB Interface

The GPIB (General Purpose Interface Bus) interface port uses electrically compliant IEEE 488.1 transceivers, and meets with exception of controller function, the IEEE 488.2 requirements. The port used on the back of the WA-7100, is a standard IEEE 488 style connector, defined as a 24-pin, female, "champ" style connector with screw locks. This interface port is designed to connect to other IEEE 488 devices for remote operation and monitoring. Connection of this interface port to any interface other than a standard IEEE 488-compatible device may damage the interface. Please refer to the Remote Communication section (Appendix D) of this manual for interface commands and protocols.

GPIB System Controller Settings

This section describes how to set up your GPIB system controller for proper message termination and bus timing to communicate with the WA-7100/7600 Wavemeter. Other settings may also work, but these are the settings that usually work the best.

Set EOI at End of Write = Yes

This causes the system controller to assert the EOI signal during the last byte of a message written to the Wavemeter.

Set EOI With EOS on Write = No

The system controller should not assert the EOI signal when it writes an EOS character. The system controller should instead assert the EOI signal when sending the last byte of the message (which will be an EOS character anyway).

EOS Byte = 10

The Wavemeter uses a linefeed character (10, 0x0a, or \n) to identify the end of a message.

8-Bit EOS Compare = Yes

This causes the system controller to examine all eight bits of a received character to determine if it is an EOS character.

Terminate Read on EOS = Yes

The Wavemeter terminates all of its messages with an EOS character. It never uses the EOS character within a message. Therefore, when the system controller receives an EOS character from the Wavemeter, it can assume that it has received the last character of the message.

GPIB Bus Timing = 2000ns or 2µs

This sets the minimum time that the system controller will assert the DAV signal after driving a byte onto the bus.

Use Board's FIFOs = Never

It is unnecessary to use the FIFOs on the controller board for this application.

I/O Timeout = 10sec

This option sets the timeout value for all GPIB I/O operations. This is the recommended timeout value for the approximate length of time that GPIB functions wait for data to be transferred or commands to be sent. This setting must never be set to "disabled.

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GPIB Device Settings from the Host System

Be sure to configure the device settings identically to the System controller settings described above. However, the timeout value for the device must be set to 10secs.

SCPI Communications Scheme

This topic provides information on the communication scheme that follows the Standard Commands for Programmable Instruments (SCPI) Syntax and Style Guidelines.

The following table provides a summary of commands by subsystem and the information after the table describes each command in detail.

Note: [...] indicates an optional argument. {...|...|...} indicates a choice from a set of arguments. When a set of arguments consists of a consecutive range of integers such as 1 through 10, the range is shown as {1 – 10}.

For commands that take parameters, only 1 space can separate the command from the first parameter.

Responses that take the form of true or false, on or off, yes or no will always be 1 or 0 respectively.

SCPI Command Summary

Group & Command	Description
Common Commands	These commands are defined by IEEE 488.2 and control some functions that are common to all IEEE 488.2 instruments.
*CLS	Clears all event registers and the error queue.
*IDN?	Queries Wavemeter model number, serial number and firmware version.
*SAV	Saves Wavemeter settings.
*RST	Sets Wavemeter settings to a known state.
*RCL	Restores Wavemeter settings, (Recall).
Measurement Instructions	These commands configure and obtain measurements from the Wavemeter.
:CONFigure:{POWer | WAVelength | WPO | FWHM}	Configure the measurement sub-system for subsequent queries of power, wavelength, WPO, and FWHM.
:CONFigure?	Queries the current configuration of the measurement subsystem.
:{FETCh | MEASure | READ}:TPOW?	Returns the total power of the last scan. The units of the value returned are specified by :UNIT:POW or DISP:UNIT:POW.
: {FETCh | MEASure | READ}:SCALar[:POWer]? [{MIN | MAX | <expected value>}]	Returns a single channel's power measured during the last scan. MIN returns the minimum power, MAX (default if no parameter entered) returns the maximum power, or <expected value> returns the power closest to <expected value>. The units of the power returned and the units of the <expected value> parameter are specified by :UNIT:POW or DISP:UNIT:POW.

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Group & Command	Description
:{FETCh | MEASure | READ}:SCALar[:{ WAVelength | WPO | FWHM }]? [{MIN | MAX | <expected value>}]	Returns a single channel's wavelength, WPO (wavelength, power, and optical signal to noise ratio), or FWHM (full width, half max) measured during the last scan. MIN returns the minimum wavelength, MAX (default if no parameter entered) returns the maximum wavelength, or <expected value> returns the wavelength closest to <expected value>. The units of the wavelength returned and the units of the <expected value> parameter are specified by :UNIT:WAV or DISP:UNIT:WAV. For WPO the power reading is in the units specified by :UNIT:POW or DISP:UNIT:POW.
: {FETCh | MEASure | READ} :SCALar:FREQuency? [MIN | MAX]	**This query is only included for compatibility with older Wavemeters.** Returns a single channel's frequency measured during the last scan. MIN returns the minimum frequency, MAX (default if no parameter entered) returns the maximum frequency. The unit for this query is always in THz.
:{FETCh | MEASure | READ}:ARRay[:{POWer | WAVelength | WPO | FWHM}]?	Returns an array of power, wavelength, WPO, or FWHM readings for each channel that was captured during the last scan. The array is preceded by the number of channels in the array. The units of the values returned is specified by the :UNIT:POW and :UNIT:WAV or DISP:UNIT:POW and DISP:UNIT:WAV commands.
: {FETCh | MEASure | READ} :ARRay:FREQuency? [{ MIN | MAX]	**This query is only included for compatibility with older Wavemeters.** Returns an array of frequency measured during the last scan. The array is preceded by the number of channels in the array. The unit for this query is always in THz.
CALC1 Subsystem	These commands obtain calculated values from the Wavemeter. In general, calculated values are values derived from actual measurements.
:CALC1:MARKer:METHod {AMRK | BMRK | DELT | RAT}	Sets the mode used to calculate MARKer values. One parameter must be given.
:CALC1:MARKer:METHod?	Queries the mode used to calculate MARKer values.
:CALC1:{AMRK | BMRK} <wavelength>	Sets either of the marker locations.
:CALC1:{AMRK | BMRK}?	Queries either of the marker locations.
:CALC1:DATA? [SPEC | MARK]	Queries either the spectral or marker data.
CALC2 Subsystem	These commands obtain calculated values from the Wavemeter. In general, calculated values are values derived from actual measurements.
:CALC2:PTHReshold[:LEVel] <power>	Sets the value of the threshold, used to determine the presence of a channel in the spectrum data. The units used to define the threshold are specified by the :UNIT:POW or DISP:UNIT:POW command.
:CALC2:PTHReshold[:LEVel]?	Queries the value of the threshold used to determine the presence of a channel in the spectrum data.
:CALC2:RTHReshold:LEVel <power>	Sets the value of the threshold, in dB, used to determine the wavelength of a channel when wavelength calculation is in relative mode.

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Group & Command	Description
:CALC2:RTHReshold:LEVel?	Queries the value of the threshold, in dB, used to determine the wavelength of a channel when wavelength calculation is in relative mode.
:CALC2:RTHReshold[:STATe] {ON | OFF}	Sets the mode used to calculate the wavelength of a channel. When ON, wavelength is calculated based on the relative threshold, RTHR. When OFF, wavelength is calculated based on the channel threshold, PTHR.
:CALC2:RTHReshold[:STATe]?	Queries the mode used to calculate the wavelength of a channel.
:CALC2:DELTa:METHod [REF | CHAN | GRID]	Sets the mode used to calculate DELTa values. If no parameter given then defaults to REF.
:CALC2:DELTa:METHod?	Queries the mode used to calculate DELTa values.
:CALC2:REFerence {1-256}	Sets the current channel for the Spectrum and Data screen. For the Data screen it is used to calculate DELTa values when in the REFerence mode. For example to set the reference channel:
:CALC2:REFerence?	Queries the reference channel used to calculate DELTa values.
:CALC2:DATA? {TPOW | DELT}	Queries either the total power or a delta value from the CALC2 subsystem. The values returned are in units specified by the :UNIT commands.
:CALC2:GRID[:STATe] {ON | OFF}	Sets the state of the ITU grid used for calculations on the DATA screen and displayed on the Spectrum screen.
:CALC2:GRID[:STATe]?	Queries the state of the ITU grid used for calculations on the DATA screen and displayed on the Spectrum screen.
:CALC2:GRID:VALue {25 | 50 | 100}	Sets the value of the ITU grid used for calculations on the DATA screen and displayed on the Spectrum screen. The grid value may be set to 25, 50, or 100GHz.
:CALC2:GRID:VALue?	Queries the value of the ITU grid.
CALC3 Subsystem	These commands obtain calculated values from the Wavemeter. In general, calculated values are values derived from actual measurements.
:CALC3:SAMPle[:STATe] {STAR | STOP | PAUS | RES | CLE}	Controls the state of data collection for the CALC3 subsystem. Monitor data collection may be stopped, started, paused, resumed or cleared.
:CALC3:SAMPle[:STATe]?	Queries the state of data collection for the CALC3 subsystem.
:CALC3:SAMPle:FREQuency {1-99}	Controls the sampling rate of data collection for the CALC3 subsystem.
:CALC3:SAMPle:FREQuency?	Queries the sample rate of data collection for the CALC3 subsystem.
:CALC3:CHANnel <wavelength>	Sets the channel being monitored by the CALC3 subsystem.
:CALC3:CHANnel?	Queries the channel being monitored by the CALC3 subsystem.

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Group & Command	Description
:CALC3:TOLerance <wavelength>	Sets the +/- tolerance around the channel (in :CALC3:CHAN above) which defines the range in which collected data is treated as a channel for monitoring purposes. That is, samples, whose wavelengths fall outside of the tolerance, do not contribute to the power in that channel. The units used to define the tolerance are specified in by the :UNIT:WAV and :DISP:UNIT:WAV command.
:CALC3:TOLerance?	Queries the tolerance for acquiring data for the selected channel.
:CALC3:POWer:DATA? {STAR | CURR | MAX | MIN}	Queries power values for the currently selected channel from the CALC3 subsystem. The units for these values are specified by the :UNIT:POW command.
:CALC3:WAVelength:DATA? {STAR | CURR | MAX | MIN}	Queries wavelength values for the currently selected channel from the CALC3 subsystem. The units for these values are specified by the :UNIT:WAV command.
:CALC3:TIME?	Queries the elapsed time during with the CALC3 subsystem has been in either the STAR or PAUS state.
CALCulate Subsystem	These commands obtain calculated values from the Wavemeter. In general, calculated values are values derived from actual measurements. **They are duplicates of the CALC1 and CALC2 system and are only included here for compatibility with older Wavemeters.**
:CALCulate:DATA?	Queries the spectral data.
:CALCulate:PTHReshold {<power>}	Selects the value of the peak threshold.
:CALCulate:RTHReshold[:STATe]?	Queries the relative threshold state.
:CALCulate:RTHReshold[:STATe] {ON | OFF}	Selects use of relative threshold or not.
:CALCulate:RTHReshold:LEVel]?	Queries the value of the relative threshold.
:CALCulate:RTHReshold:LEVel] {<power>}	Selects the value of the relative threshold.
DISPlay Subsystem	
:DISPlay:DIALog {SPEC, SYST, DATA, MON, PRINt}	Selects which screen is shown on the Wavemeter's front panel.
:DISPlay:DIALog?	Queries which screen is being shown on the Wavemeter's front panel. NOTE: when the monitor screen is displayed, the return values are WMON an PMON.
:DISPlay:DIALog:MONitor {PMON | WMON}	Sets the display of either power or wavelength on the Monitor screen.
:DISPlay:DIALog:MONitor?	Queries which display is shown on the Monitor screen.
:DISPlay:UNIT:POWer {W | DBM}	Sets the units used to display power on the Wavemeter's screens.
:DISPlay:UNIT:POWer?	Queries the units used to display power on the Wavemeter's screens.
:DISPlay:UNIT:WAVelength {NAN | THZ}	Sets the units used to display wavelengths on the Wavemeter's screens.
:DISPlay:UNIT:WAVelength?	Queries the units used to display wavelengths on the Wavemeter's screens.
:DISPlay:X:{LEFT | RIGHt | CENTer | PDIVision} <wavelength>	Sets the left, right, center, or per division attributes of the Spectral graph's X axis on the Spectrum screen.

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Group & Command	Description
:DISPlay:X:{LEFT | RIGHt | CENTer | PDIVision}?	Queries the left, right, center, or per division attributes of the Spectral graph's X axis on the Spectrum screen.
:DISPlay:Y:{SPECtrum | MONitor}:{TOP | BOTTom | PDIVision} <numeric value>	Sets the top, bottom, or per division attributes of the Y axis on the Spectrum or Monitor screen.
:DISPlay:Y:{SPECtrum | MONitor}:{TOP | BOTTom | PDIVision}?	Queries the top, bottom, or per division attributes of the Y axis on the Spectrum or Monitor screen.
:DISPlay:Y:{SPECtrum | MONitor}:AUTO	Performs autoscale function on either the Spectrum or Monitor screen.
:DISPlay:CHANnel {1-256}	Sets the current channel for the Spectrum screen.
:DISPlay:CHANnel?	Queries the current channel of the Spectrum screen.
SENSe Subsystem	These commands are used to control factors which affect the way in which the measurements are taken.
:SENSe:AVERage[:STATe] {ON | OFF}	Sets the state of spectral averaging.
:SENSe:AVERage[:STATe]?	Queries the state of spectral averaging.
:SENSe:AVERage:COUNt {2 – 63}	Sets the number of spectra to be averaged together.
:SENSe:AVERage:COUNt?	Queries the number of spectra being averaged.
:SENSe:RANGe {0 – 6}	Sets the spectral range to be measured by the Wavemeter.
:SENSe:RANGe?	Queries the spectral range being measured by the Wavemeter.
STATus Subsystem	These commands are used to retrieve SCPI or Wavemeter status.
:STATus:QUEStionable:CONDition?	This command queries the SCPI Questionable register which contains bits that indicate that one or more measurement types are of questionable accuracy.
:STATus:QUEStionable:ENABle?	This command queries the Questionable Enable register.
:STATus:QUEStionable:ENABle <integer>	Used to set and clear the bits in the SCPI Questionable Enable register.
:STATus:HARDware:CONDition?	This command queries the hardware to provide information on the status of some of the hardware components that may contribute to invalid or erred measurements.
SYSTem Subsystem	These commands control system-wide parameters.
:SYSTem:REMote {ON | OFF}	Enables Remote control of the instrument.
:SYSTem:REMote?	Queries the state of remote control.
:SYSTem:ERRor?	Reads error strings from the Error Queue. If the Error Queue has any entries, the Error Queue bit is set in the Status Byte.
:SYSTem:HELP:HEADers?	This query returns a list of all commands/queries supported by the Wavemeter.
:SYSTem:VERSion?	Returns the year and revision of the SCPI standard that the Wavemeter follows.
TRIGger Subsystem	These commands control the triggering of the Wavemeter. Since the Wavemeter is fundamentally not a triggered instrument, these commands have little effect on the Wavemeter's operation.
:ABORt	Aborts a current measurement.
:INITiate[:IMMediate]	Initiates a new reading.

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expected value – returns the wavelength, WPO, or FWHM reading closest to this expected value. For example, a system is set in THz and the instrument is monitoring 2 channels with frequencies of 196.83211 and 187.01223, then the query ":READ:SCAL:WAV? 180.0" will result in the return string "187.01223".

If no peaks are above threshold (i.e. no channels), then the response will be 0.0.

:MEASure:SCALar:FREQuency? [<parameter>] or
:READ:SCALar:FREQuency? [<parameter>] or
:FETCh:SCALar:FREQuency? [<parameter>]

This query is only included for compatibility with older Wavemeters. Returns a single channel's frequency measured during the last scan. MIN returns the minimum frequency, MAX (default if no parameter entered) returns the maximum frequency. The unit for this query is always in THz.

none – if no parameter is given then it assumes MAX

MAX – MAXimum, returns the wavelength of the highest wavelength signal.

MIN – MINimum, returns the wavelength of the lowest wavelength signal.

If no peaks are above threshold (i.e. no channels), then the response will be 0.0.

:MEASure:ARRay:{POWer | WAVelength | WPO | FWHM}? [<parameter>] or
:READ:ARRay:{POWer | WAVelength | WPO | FWHM}? [<parameter>] or
:FETCh:ARRay:{POWer | WAVelength | WPO | FWHM}? [<parameter>]

Returns the wavelength, WPO, or FWHM reading of all channels with a Peak Power signal greater than the current threshold value. The list of readings is preceded by the number of channels in the list. The units of the values returned is specified by the :UNIT:POW and :UNIT:WAV or DISP:UNIT:POW and DISP:UNIT:WAV commands.

The return string is n (the number of channels) followed by each of the channels power reading <channel 1> through <channel n> all separated by commas. For example, a response may be for an instrument currently measuring 7 channels:

:DISP:UNITS:POW DBM

:READ:ARR:POW?

7,-14.73,-14.41,-16.69,-13.92,-10.33,-15.40,-14.98

If no peaks are above threshold (i.e. no channels), then the response will be 0.

:MEASure:ARRay:FREQuency? or
:READ:ARRay:FREQuency? or
:FETCh:ARRay:FREQuency?

This query is only included for compatibility with older Wavemeters. Returns the frequencies of all channels with a Peak Power signal greater than the current threshold value. The array is preceded by the number of channels in the array. The unit for this query is always in THz.

The return string is n (the number of channels) followed by each of the channels frequency <channel 1> through <channel n> all separated by commas. For example, a response may be for an instrument currently measuring 4 channels:

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:READ:ARR:FREQ?

4,193.8246,193.6231,193.4190,193.2144

If no peaks are above threshold (i.e. no channels), then the response will be 0.

Calculate Subsystem

Describes the SCPI commands and queries CALC1, CALC2, CALC3 and CALCulate. The CALCulate portion of these commands/queries is only **included for compatibility with older Wavemeters.**

Use the CALCulate subsystem to read and control the Wavemeter's calculated values.

:CALC1:MARKer:METHod {AMRK | BMRK | DELT | RAT}

Sets the mode used to calculate MARKer values. AMRK or BMRK is the frequency or wavelength of Marker A or B respectively. DELT is the difference in frequency or wavelength of Marker A and MarkerB. RAT is the power ratio of Marker A and Marker B. For example, to set it to Delta marker data:

:CALC1:MARK:METH DELT

:CALC1:MARKer:METHod?

Queries the mode used to calculate MARKer values.

For example:

:CALC1:MARK:METH?

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The response is:

DELT

:CALC1:{AMRK | BMRK} <wavelength>

Sets either of the marker locations. **Note,** the instrument must be set to the Spectrum screen prior to this command, possibly via the Display command. For example, to set Marker B to wavelength 1550.5 nm:

:CALC1:BMRK 1550.5

:CALC1:{AMRK | BMRK}?

Queries either of the marker locations.

For example:

:CALC1: BMRK?

The response is:

1550.5

:CALC1:DATA? [SPEC | MARK]

Queries either the spectral or marker data. If no parameter is given, then it defaults to SPEC.

For Spectral data queries, the response is several large strings made up of pairs of data. Each pair of data is made up of the frequency or wavelength and the power at that position in the spectrum. The number of data points depends on the spectral mode selected (as shown on the System screen, Low Res, Med Res and Hi Res). Each line of the response is terminated by a linefeed. The first line indicates the number of bytes of data that follow. This response is a <DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA> element, see IEEE 488.2 section 8. Each line of data contains 30100 characters or less. All lines of data must be read before continuing normal operations.

Returns #<integer>
<string>
<string>
<string>
...
<string>

The Wavelength value is in either THz or nm depending on the current system settings. The Spectral data is in milliwatts.

For example, a system set for nm and in mode 6 or (1520 – 1625 nm range):

:CALC1:DATA? SPEC

The response is:

#6188432

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1519.175, 2.39352e-06; 1519.187, 9.00641e-07; ...

Note: The string "#6188432" assumes a certain size FFT. The FFT is part of the embedded software and can change from version to version of the software. At the time this manual was published though this is valid for the current version of software.

Again the data is paired, the first float is the wavelength in nm and the second float is the power at that wavelength. Each wavelength / power pair is separated by a comma and the pairs are separated by semi-colons.

For Serial interfaces, Spectral data query is not supported.

For Marker data queries, the data returned is based on the Marker method selected. For example, if the marker method selected is DELT then the response would be the value of MarkerA – MarkerB.

:CALC2:PTHReshold[:LEVel] <power>

Sets the value of the peak threshold, which determines the presence of a channel in the spectrum data. The units used to define the threshold are specified by the :UNIT:POW or DISP:UNIT:POW command. **Note,** the instrument must be set to the Spectrum screen prior to this command, possibly via the Display command. For example to set the peak threshold to –3dBm:

:DISP:DIAL SPEC

:UNIT:POW DBM

:CALC2:PTHR –3.0

:CALC2:PTHReshold[:LEVel]?

Queries the value of the threshold used to determine the presence of a channel in the spectrum data. For example:

:UNIT:POW DBM

:CALC2:PTHR?

The response is:

–3.0

:CALC2:RTHReshold:LEVel <power>

Sets the value of the threshold, in dB, used to determine the wavelength of a channel when wavelength calculation is in relative mode. For example to set the relative threshold to –3dB from the maximum of the peak:

:CALC:RTHR:LEV –3.0

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:CALC2:RTHReshold:LEVel?

Queries the value of the threshold, in dB, used to determine the wavelength of a channel when wavelength calculation is in relative mode. For example:

:CALC2:RTHR?

The response is:

–3.0

:CALC2:RTHReshold[:STATe] {ON | OFF}

Sets the mode used to calculate the wavelength of a channel. When ON, wavelength is calculated based on the relative threshold, RTHR. When OFF, wavelength is calculated based on the entire peak, as defined by the local noise floor. For example, to set the state to on:

:CALC2:RTHR ON

:CALC2:RTHReshold[:STATe]?

Queries the mode used to calculate the wavelength of a channel. For example:

:CALC2:RTHR?

The response is:

1

:CALC2:DELTa:METHod [REF | CHAN | GRID]

Sets the mode used to calculate DELTa values from a reference channel, channel to next channel or ITU Grid. If no parameter given, then it defaults to REF. For example:

:CALC2:DELTa:METHod CHAN

Causes all data read via :CALC2:DATA DELT to be based on delta from one channel to the next channel.

:CALC2:DELTa:METHod?

Queries the mode used to calculate DELTa values. For example:

:CALC2:DELTa:METHod?

The response is:

CHAN

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:CALC2:REFerence {1-256}

Sets the current channel for the Spectrum and Data screen. For the Data screen it is used to calculate DELTa values when in the REFerence mode. **Note,** even though, this command affects the Spectrum screen, the instrument must be set to the Data screen prior to this command, possibly via the Display command. For example to set the reference channel:

:DISP:DIAL DATA

:CALC2:REFerence 2

:CALC2:REFerence?

Queries the reference channel used to calculate DELTa values. For example:

:CALC2:REFerence?

The response is:

2

:CALC2:DATA? {TPOW | DELT}

Queries either the total power or a delta value from the CALC2 subsystem. The values returned are in units specified by the :UNIT commands. For example, the system is measuring 5 channels, is set to THz unit, and method is delta:

:CALC2:DATA? DELT

The response is:

5,0.000000E+00,8.296401E-01,2.276000E-01,2.541850E-01,7.975304E-01

:CALC2:GRID[:STATe] {ON | OFF}

Sets the state of the ITU grid used for calculations on the DATA screen and displayed on the SPECtrum screen. For example:

:CALC2:GRID:STATe ON

:CALC2:GRID[:STATe]?

Queries the state of the ITU grid used for calculations on the DATA screen and displayed on the SPECtrum screen. For example, with the Grid on:

:CALC2:GRID:STAT?

The response is:

1

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:CALC2:GRID:VALue {25 | 50 | 100}

Sets the value of the ITU grid used for calculations on the DATA screen and displayed on the SPECtrum screen. The grid value may be set to 25, 50, or 100GHz. For example, to set the Grid to 50GHz spacing:

:CALC2:GRID:VAL 50

:CALC2:GRID:VALue?

Queries the value of the ITU grid. For example:

:CALC2:GRID:VAL?

The response is:

50

:CALC3:SAMPle[:STATe] {STAR | STOP | PAUS | RES | CLE}

Controls the state of data collection for the CALC3 subsystem. Monitor data collection may be started, stopped, paused, resumed or cleared. When paused, data collection continues, but the data is not updated on the display. Resuming data collection takes the CALC3 subsystem back to the RES state. CLE clears all data collected and is only functional if the Monitor state is STOP. **Note,** the instrument must be set to the Monitor screen prior to this command, possibly via the Display command. For example:

:DISPlay:DIAL MON

:CALC3:SAMPle:STATe STAR

:CALC3:SAMPle[:STATe]?

Queries the state of data collection for the CALC3 subsystem. For example:

:CALC3:SAMPle:STATe?

The response is:

RES

Note The instrument will not return the STAR state if it is operating normally; it will always return either PAUS, STOP, RES or CLE. Only CLE is returned if no data has been collected.

:CALC3:SAMPle:FREQuency {1-99}

Controls the sample rate of data collection for the CALC3 subsystem. The sample rate is rate at which a measured sample is recorded.

Note: The instrument must be set to the Monitor screen prior to this command, possibly via the Display command. For example, if the rate is 3 then only every 3rd sample is recorded.

:DISPlay:DIAL MON

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:CALC3:SAMPle:FREQuency 3

:CALC3:SAMPle:FREQuency?

Queries the sample rate of data collection for the CALC3 subsystem. For example,

:CALC3:SAMPle:FREQuency?

The response is:

3

:CALC3:CHANnel <wavelength>

Sets the channel being monitored by the CALC3 subsystem. **Note,** the instrument must be set to the Monitor screen prior to this command, possibly via the Display command. For example to set the channel to 196.777THz:

:DISPlay:DIAL MON

:CALC3:CHANnel 196.777

:CALC3:CHANnel?

Queries the channel being monitored by the CALC3 subsystem. For example:

:CALC3:CHANnel?

The response is:

196.7770

:CALC3:TOLerance <wavelength>

Sets the +/- tolerance around the channel (in :CALC3:CHAN above) which defines the range in which collected data is treated as a channel for monitoring purposes. That is, samples whose wavelengths fall outside of the tolerance do not contribute to the power in that channel. The units used to define the tolerance are specified in by the :UNIT:WAV and :DISP:UNIT:WAV command. **Note,** the instrument must be set to the Monitor screen prior to this command, possibly via the Display command. For example, to set the tolerance to 40 picometers:

:DISPlay:DIAL MON

:CALC3:TOL .040

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:CALC3:TOLerance?

Queries the tolerance for acquiring data for the selected channel. For example:

:CALC3:TOL?

The response is:

4.0000E-02

:CALC3:POWer:DATA? {STAR | CURR | MAX | MIN}

Queries start, current, maximum and minimum power values for the currently selected channel from the CALC3 subsystem. The units for these values are specified by the :UNIT:POW command. For example to get the start power in dBm:

:CALC3:POWer:DATA? STAR

The response is:

-1.396132E+01

:CALC3:WAVelength:DATA? {STAR | CURR | MAX | MIN}

Queries wavelength values for the currently selected channel from the CALC3 subsystem. The units for these values are specified by the :UNIT:WAV command.

:CALC3:WAVelength:DATA? CURR

The response is:

196.78004

:CALC3:TIME?

Queries the elapsed time (in seconds) since the system received the :CALC3:SAMPle:STAR command.

:CALC3:TIME?

The response is:

126

:CALCulate:DATA?

Same as :CALC1:DATA?

:CALCulate:PTHReshold {<power>}

Same as :CALC2:PTHReshold {<power>}

:CALCulate:RTHReshold[:STATe]?

Same as :CALC2:RTHReshold[:STATe]?

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:CALCulate:RTHReshold[:STATe] {ON | OFF}

Same as :CALC2:RTHReshold[:STATe] {ON | OFF}

:CALCulate:RTHReshold:LEVel?

Same as :CALC2:RTHReshold:LEVel?

:CALCulate:RTHReshold:LEVel {<power>}

Same as :CALC2:RTHReshold:LEVel {<power>}

DISPlay Subsystem

The DISPlay subsystem is used to manipulate the Wavemeter's front panel through the serial or GPIB SCPI interface. These commands do not affect the readings from the SCPI interface.

:DISPlay:DIALog {SPEC | SYST | DATA | MON | PRIN}

Selects which screen (Spectrum, System, Data, Monitor, or Save/Print) is shown on the Wavemeter's front panel. For example to set it to the Monitor screen:

:DISP:DIAL MON

:DISPlay:DIALog?

Queries which screen is being shown on the Wavemeter's front panel. The return values are {SPEC|SYST|DATA|WMON|PMON|PRIN} for the screens Spectrum, System, Data, Monitor (Wavelength), Monitor (Power), and Print/Save respectively. [For example:

:DISP:DIAL?

The response is:

WMON

:DISPlay:DIALog:MONitor {PMON | WMON}

Sets the Monitor screen to either a power or wavelength display. **Note**, requires that the Monitor screen is already displayed and the Monitor function started. For example, to set it to the Power screen:

:DISP:DIAL:MON PMON

:DISPlay:DIALog:MONitor?

Queries the display that is shown on the Monitor screen, Power or Wavelength. For example:

:DISP:DIAL:MON?

The response is:

PMON

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:DISPlay:UNIT:POWer {W | DBM}

Sets the units used to display power on the Wavemeter's screens. For example to set the power units to DBM:

:DISPlay:UNIT:POWer DBM

:DISPlay:UNIT:POWer?

Queries the units used to display power on the Wavemeter's screens. For example:

:DISPlay:UNIT:POWer?

The response is:

DBM

:DISPlay:UNIT:WAVelength {NAN | THZ}

Sets the units used to display wavelengths on the Wavemeter's screens. For example to set the wavelength units to THZ:

:DISPlay:UNIT:WAV THZ:DISPlay:UNIT:WAVelength?

Queries the units used to display wavelengths on the Wavemeter's screens. For example:

:DISPlay:UNIT:WAV?

The response is:

THZ

:DISPlay:X:{LEFT | RIGHt | CENTer | PDIVision} <wavelength>

Sets the left, right, center, or per division attributes of the Spectral graph's X axis on the Spectrum screen. **Note,** the instrument must be set to the Spectrum screen prior to this command, possibly via the Display command. For example to set the wavelength of the right side of the Spectral graph to 1570 nm:

:DISP:X:RIGH 1570

:DISPlay:X:{LEFT | RIGHt | CENTer | PDIVision}?

Queries the left, right, center, or per division attributes of the Spectral graph's X axis on the Spectrum screen. For example:

:DISP:X:RIGH?

The response is:

1.570000E+03

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:DISPlay:Y:{SPECtrum | MONitor}:{TOP | BOTTom | PDIVision} <numeric value>

Sets the top, bottom, or per division attributes of the Y axis on the Spectrum or Monitor screen. **Note,** the instrument must be set to the Spectrum or Monitor screen prior to this command, possibly via the Display command.

<numeric value> can be a floating point value.

For example, to set the bottom of the Monitor screen graph to 1530 nm:

:DISP:Y:MON:BOTT 1530.5

:DISPlay:Y:{SPECtrum | MONitor}:{TOP | BOTTom | PDIVision}?

Queries the top, bottom, or per division attributes of the Y axis on the Spectrum or Monitor screen. For example:

:DISP:Y:MON:BOTT?

The response is:

1.530500E+03

:DISPlay:Y:{SPECtrum | MONitor}:AUTO

Performs the autoscale function on either the Spectrum or Monitor screen. **Note,** the instrument must be set to the Spectrum or Monitor screen prior to this command, possibly via the Display command. For example, to autoscale the Monitor graph:

:DISP:Y:MON:AUTO

:DISPlay:CHANnel {1-256}

Sets the current channel for the Spectrum and Data screen. **Note,** even though, this command affects the Data screen, the instrument must be set to the Spectrum screen prior to this command, possibly via the Display command. For example to set the Spectrum channel number to 2:

:DISP:DIAL SPEC

:DISP:CHAN 2

:DISPlay:CHANnel?

Queries the current channel for the Spectrum and Data screen. For example:

:DISP:CHAN?

The response is:

2

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SENSe Subsystem

These commands are used to control factors that affect the way in which the measurements are taken.

:SENSe:AVERage[:STATe] {ON | OFF}

Sets the state of spectral averaging. For example, to turn averaging on:

:SENS:AVER:STAT ON

:SENSe:AVERage[:STATe]?

Queries the state of spectral averaging. For example:

:SENS:AVER:STAT?

The response will be

0

:SENSe:AVERage:COUNt {2 – 63}

Sets the number of spectra to be averaged together. For example, to set the average to 4:

:SENS:AVER:COUN 4

:SENSe:AVERage:COUNt?

Queries the number of spectra being averaged. Note, if averaging is off this query returns 1. For example:

:SENS:AVER:COUN?

The response will be:

4

:SENSe:RANGe {0 – 6}

Sets the spectral range (as shown by WL Range on the System screen) to be measured by the Wavemeter.

0 – 1270 to 1680
1 – 1270 to 1475
2 – 1450 to 1680
3 – 1270 to 1355
4 – 1350 to 1445
5 – 1435 to 1535
6 – 1520 to 1625

For example to change to 1450 to 1680:

:SENS:RANG 2

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:SENSe:RANGe?

Queries the spectral range being measured by the Wavemeter. For example:

:SENS:RANG?

The response is:

2

STATus Subsystem

These commands are used to retrieve SCPI or Wavemeter status.

Questionable Register

Bit	Bit Value	Description
0	1	The wavelength has already been read for the current scan.
1	2	Internal Communications
2	4	Power Null Calibration
3	8	The power value is outside the valid range of the Wavemeter.
4	16	The temperature value is outside the valid range of the Wavemeter.
5	32	(not used)
6	64	(not used)
7	128	(not used)
8	256	(not used)
9	512	The pressure value is outside the valid range of the Wavemeter.
10	1024	Indicates that at least one bit is set in the Questionable Hardware Condition register.

Questionable Hardware Condition Register

Bit	Bit Value	Description
0	1	Reference laser has not stabilized. (WA-7600 only)
1	2	Reference laser is over temperature. (WA-7600 only)
2	4	No reference laser fringes detected during scan.
3	8	(not used)
4	16	Analog to digital converter error.
5	32	Failed to read the EEPROM.
6	64	Failed to read or write to the SRAM.

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7	128	The scan assembly has stopped moving.
8	256	(not used)
9	512	(not used)
10	1024	(not used)
11	2048	(not used)
12	4096	The input laser fringe strength is too high.
13	8192	The reference laser % of peak power is out of range. (WA-7600 only)

:STATus:QUEStionable:CONDition?

This command queries the SCPI Questionable register which contains bits that indicate that one or more measurement types are of questionable accuracy. For example:

:STAT:QUES:COND?

A good response would be:

0

:STATus:QUEStionable:ENABle <integer>

Used to set and clear the bits in the SCPI Questionable Enable register. For example, to set all used bits in the Questionable register:

:STAT:QUES:ENAB 1567

:STATus:QUEStionable:ENABle?

This command queries the Questionable Enable register. The value returned is a hexadecimal integer. For example:

:STAT:QUES:ENAB?

The response is:

61F

:STATus:HARDware:CONDition?

This command queries the hardware to provide information on the status of some of the hardware components which may contribute to invalid or erred measurements. For example:

:STAT:HARD:COND?

A good response would be:

0

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SYSTem Subsystem

This subsystem monitors the status of the system.

:SYSTem:REMote {ON | OFF}

Enables Remote control of the instrument. This SCPI command is the same function as setting "Remote – On" on the System screen. For example to enable remote control:

:SYST:REM ON

:SYSTem:REMote?

Queries the state of remote control. For example:

:SYST:REM?

The response is:

1

:SYSTem:ERRor?

Reads error strings from the SCPI Error Queue. If the Error Queue has any entries, the Error Queue bit is set in the Status Byte. The Wavemeter has a 30 entry, first-in, first-out queue. Repeatedly sending the query :SYST:ERR? returns the error numbers and descriptions in the order in which they occurred until the queue is empty. Any further queries return 0, "No error" until another error occurs. A table of possible errors is shown below.

Returns <integer>, <string> (ex. –104, "Data type error")

For example: SYST:ERR?

SCPI Errors

Error Number	Description
0	No error
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-220	Parameter error
-221	Settings conflict
-222	Data out of range
-230	Data corrupt or stale

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:SYSTem:HELP:HEADers?

Reads a list of all commands and queries supported by the Wavemeter. Each line of the response is terminated by a linefeed. The first line indicates the number of bytes of help data that follow. The remaining lines are strings of help data. All lines of data must be read before continuing normal operations.

Returns:

#<integer>
<string>
<string>
<string>
...
<string>

:SYSTem:VERSion?

Returns the version of the SCPI specification that the Wavemeter's SCPI interface is based on. The first integer is the year and the second integer is the approved revision number for that year.

Returns: <integer>.<integer>

For example

:SYST:VERS?

The response is:

1995.0

Trigger Subsystem

The Wavemeter is unlike most SCPI instruments in that as it takes continuous readings, the scan engine controls the reading, not the user. As a result, the user should not attempt to control the Wavemeter through the Trigger subsystem. The commands below are listed only for the sake of completeness.

:ABORt

Halts acquisition of the current reading and returns the Wavemeter to a normal state.

Example: :ABOR

:INITiate[:IMMediate]

Starts the acquisition of a new reading and waits for the next. At this time the Wavemeter returns to a normal state.

Examples:
:INIT
:INIT:IMM

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UNIT Subsystem

These commands control the wavelength and power units. **They are duplicates of the :DISP:UNIT system and are only included here for compatibility with older Wavemeters.**

:UNIT:POWer {W | DBM}

Sets the power units.

:UNIT:POWer?

Queries the power units.

:UNIT:WAVelength {NAN | FREQ}

Sets the wavelength units.

:UNIT:WAVelength?

Queries the wavelength units.

Hardcopy Subsystem

: HCOPy:IMMediate

This command is only valid when the Save/Print screen is displayed. Starts a report to be printed. This is the same as pressing the "Print Report" softkey on the Save/Print screen.

Mass Memory Subsystem

:MMEMory:STORe

This command is only valid when the Save/Print screen is displayed. Saves the data selected by :MMEM:FEED to the floppy disk.

:MMEMory:FEED {SPEC | DATA | MON}

This command is only valid when the Save/Print screen is displayed. Select the screen that data will be saved from when the :MMEM:STOR command is sent.

:MMEMory:FEED?

Query the screen that data will be saved from when the :MMEM:STOR command is sent.

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Section 5. Theory of Operation & Calibration

This section reviews the theory behind the operation of the WA-7100/7600 Multi-line Wavemeter. It also discusses the factors that influence the accuracy of the measurement.

Operating Principles

The WA-7100/7600 Multi-line Wavemeter uses a Michelson interferometer to generate interference fringes from the input radiation. The input laser beam enters the Wavemeter through a fiber optic connector on the front panel. After collimation, the beam is directed into the Michelson interferometer. At the beamsplitter, the input beam is divided into two beams that follow separate optical paths. One beam reflects off the moving retro-reflector assembly and returns to the beamsplitter. The other beam reflects off of a fixed retroreflector and returns to the beamsplitter where it interferes with the first beam. The intensity reaching the input photodetector depends on the relative lengths of the two paths, which govern whether constructive or destructive interference occurs at the beamsplitter. As the retro-reflector moves back and forth, the detected intensity for each wavelength of the input beam varies sinusoidally. If multiple wavelengths exist in the input beam, the fringe pattern is the superposition of sinusoidal contributions from all the wavelengths.

In order to extract all the spectral components in the input beam from the Michelson interferometer fringe pattern, it is necessary to sample the detected intensity at precisely calibrated intervals in the scan of the interferometer. This is accomplished by introducing a second "reference" laser into the interferometer with an accurately known wavelength. This laser measures the displacement of the moving arm of the interferometer and provides a signal for accurately sampling the input laser fringe pattern.

After a large number of intensity values have been recorded from one scan of the interferometer, a Fast Fourier Transform is performed on the data to produce the spectrum of the input laser source. Both the wavelength and the relative power of each spectral component is obtained from the Fourier Transform.

A small portion of the input beam entering the Wavemeter is split off into a power meter. This measurement of the total input power, together with the spectral distribution from the Fourier Transform, is used to calculate the absolute power in each spectral component of the input laser source.

Wavelength Accuracy

The wavelength accuracy of the peaks in the Wavemeter spectrum is dependent on the knowledge of the reference laser wavelength and appropriate corrections for the dispersion in the refractive index of air. The WA-7100/7600 Wavemeters use a HeNe reference laser with refractive index correction based on temperature and pressure measurements inside the interferometer. The absolute accuracy of the reference laser wavelength is better than 0.5 parts per million for the WA-7100 and 0.1 parts per million for the WA-7600.

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Wavelength accuracy also depends on the alignment of the reference laser beam and the input laser beam in the Michelson interferometer. Fiber optic input coupling and stable opto-mechanical design ensure that the interferometer alignment does not change significantly with time and environmental conditions.

At the time of manufacturing, the wavelength accuracy of each WA-7100/7600 Multi-line Wavemeter is verified with an accurately known laser source, such as a Distributed Feedback (DFB) diode laser locked to an absorption band of acetylene ($^{12}C_2H_2$). The center of these absorption lines has been characterized to ± 150 KHz by K. Nakagawa et al. in "Accurate optical frequency atlas of the 1.5m bands of Acetylene", JOSA, B, 13, 2708 (1996) using an absorption line of Rubidium as the reference standard.

Power Accuracy

The WA-7100/7600 internal power meter is designed with excellent linearity over the full specified power range. Correction for the power detector responsivity also ensures that good power measurement flatness is achieved over the operating wavelength range.

With the complete spectrum normalized to the total power measurement, the power in each spectral peak is computed from the integrated intensity under that peak relative to the average local baseline.

The internal power meter in every WA-7100/7600 Multi-line Wavemeter is calibrated at the time of manufacturing using a high precision power meter that is regularly certified accurate traceable to NIST.

Noise Position for OSNR

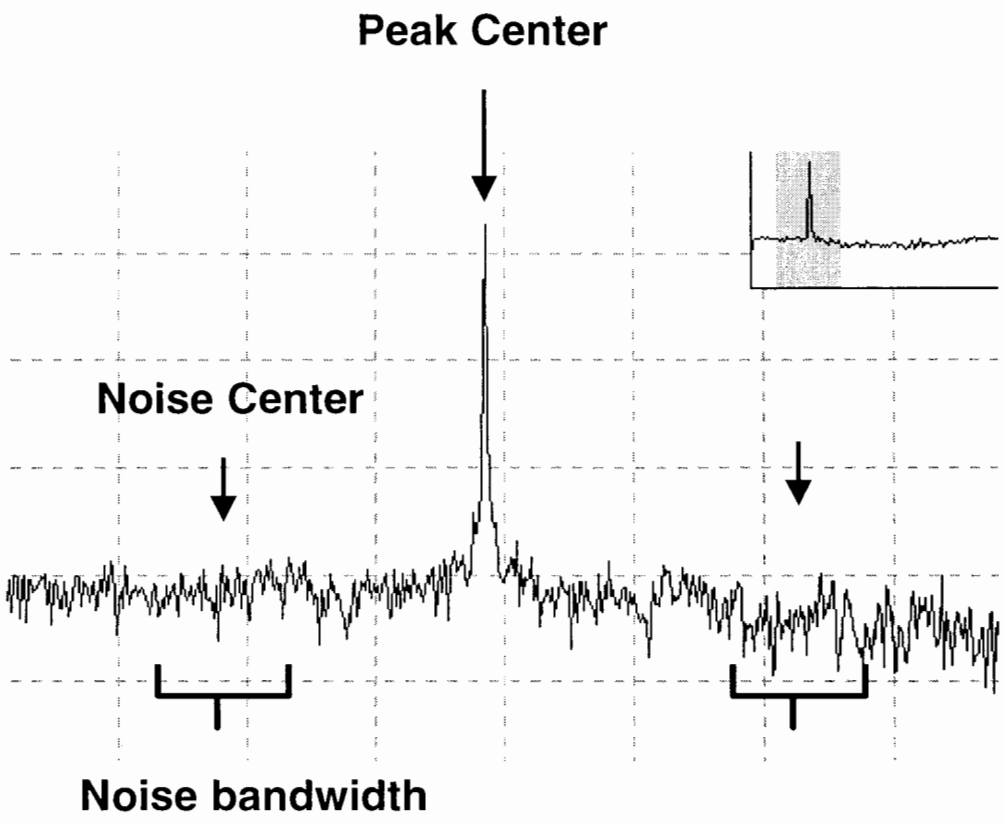
The user may choose how the noise power used in the WA-7100/7600 Optical Signal to Noise Ratio (OSNR) computation is defined. The OSNR is defined as follows:

$$OSNR = 10log\ (Peak\ Power/Noise\ Power)$$

The noise power may be centered at a specific user defined point in the spectrum by selecting the *Fixed* box in the *Noise Position for OSNR* panel of the *System* screen. Alternatively, the user may select spectral regions at a defined spectral separation from the peak center as illustrated below. The relative separation between the peak center and the noise centers may range from 5-200 GHz. The default value is 100 GHz. When *Relative to Peak center* calculation is chosen, the noise power is calculated as the average over the regions on the high and low wavelength sides of the peak.

In addition, user may select the bandwidth over which the optical noise is integrated. This is selected in the *Bandwidth* box of the *Noise Position for OSNR* panel. The user specified noise bandwidth may be between 2-125 GHz. The default value is 2 GHz. The noise bandwidth is illustrated below.

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Noise Bandwidth and Position Selection

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Appendix A. Specifications & Labeling

This Appendix provides specifications, dimensional drawings and labeling information.

Wavelength Measurement		**WA-7100**	**WA-7600**
Range		1270 to 1680 nm (178 to 236 THz)	
Absolute Accuracy		± 1.0 ppm ± 0.0015 nm at 1500 nm ± 0.0013 nm at 1300 nm	± 0.2 ppm ± 0.00030 nm at 1500 nm ± 0.00026 nm at 1300 nm
Repeatability		± 1.0 ppm	±0.2 ppm
Minimum Resolvable Separation	1270 to 1680 nm 1270 to 1475 nm 1450 to 1680 nm 1270 to 1355 nm 1350 to 1445 nm 1435 to 1535 nm 1520 to 1625 nm	*40 pm* *35 pm* *35 pm* *30 pm* *30 pm* *30 pm* *30 pm*	
Display Resolution		0.001 nm	0.0001nm
Units		nm (vacuum), THz	
Power Measurement			
Absolute Accuracy		± 0.5 dB (at ± 30 nm from 1310 and 1550 nm)	
Repeatability		0.1 dB	
Linearity		*± 0.3 dB*	
Display Resolution		0.01 dB	
Units		dBm, mW	
Sensitivity			
1270–1680 nm, single line input		-40 dB (0.10 μW)	

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Selectivity	
2 lines input separated by ≥ 50 GHz	*25 dB*
2 lines input separated by ≥ 15 GHz	*10 dB*
Optical Dynamic Range	
Signal-to-Noise Ratio (lines above –25 dBm)	*>35 dB, channel spacing ≥ 100GHz*
Input Power	
Maximum Displayed Level (sum of all lines input)	+10 dBm (10 mW)
Maximum Safe Level (sum of all lines input)	*+18 dBm (63 mW)*
Number of Laser Lines Input	
Maximum	*256*
Input Return Loss	
With FC/PC connector	35 dB
With FC/APC connector	40 dB
Measurement Cycle Time	
Time (Rate)	1.25 sec
Inputs/Outputs	
Optical Input	9/125 µm fiber FC/PC universal connector standard FC/APC universal connector optional
Instrument Interfaces	GPIB (IEEE-488.2), RS-232
Parallel Port	Printer
Video Port	VGA Monitor
Signal Monitor	± 7 V Analog, TTL Digital
Environmental	
Temperature Range	*10 to +40°C Operating, -10 to 70 °C Storage*
Pressure Range	*500 – 900 mm Hg*
Relative Humidity	≤ 90% (no condensation)
Laser	
Laser Classification	FDA Laser Class I according to 21 CFR 1040.10 IEC Laser Class 1 according to IEC 60825
Dimensions and Weight	
Dimensions (LxWxH)	16.71" x 16.95" x 5.23"
Weight	10.5 kg
Power Requirements	
Voltage and Frequency	90 to 260 VAC, 50/60 Hz
Current	*1.3 A*
Fuse	1.5 A slow-blow, .25" x 1.25" or 5 x 20 mm

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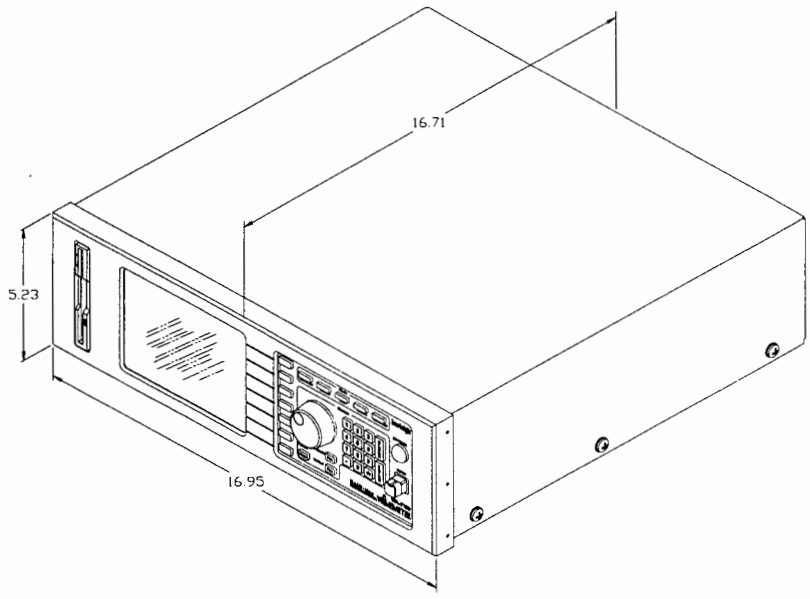
* Sensitivity defines the optical input power required over most of the wavelength range. More power may be necessary at either end of the range, depending on the photodetector.

Non-Italics = Guaranteed Specifications

Italics = Typical Specifications

Dimensional Drawing

WA-7100/7600



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Rack Mounting Option

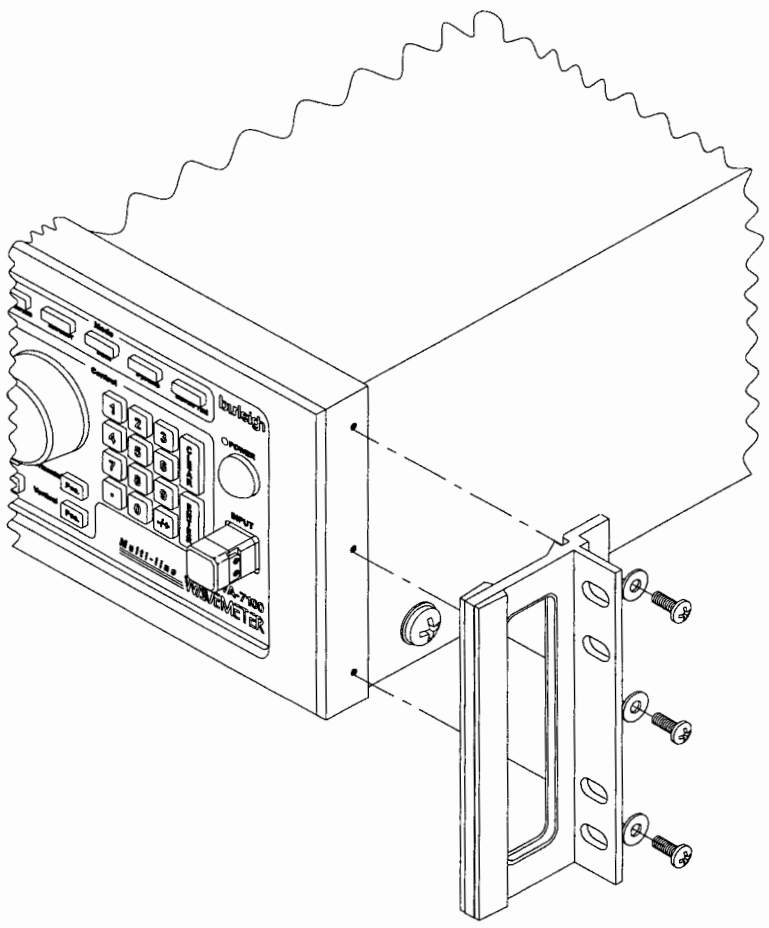
The WA-7100/7600 Wavemeter can be mounted in a standard 19" electronics rack by attaching the rack mounting brackets as shown below.

When the WA-7100/7600 is mounted in an enclosed rack, be careful not to block the fan on the rear panel and provide adequate ventilation inside the rack to prevent overheating.

For proper fit, you may want to remove the feet under the chassis.

CAUTION: **If you remove the feet, DO NOT reinsert the screws or damage to the internal components of the wavemeter can occur.**

Attaching Rack Mounting Brackets



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Appendix B. Changes from Version 1.x to 2.0 (WA-7100 Only)

Changes from Version 1.x to 2.0 (WA-7100 Only)

The following changes were made to the 2.0 Version of the WA-7100:

- Maximum number to average has changed from 99 to 63. Since this number is saved to a configuration file, a value of 64 to 99 saved from a previous version will be set to 63.
- The table on the Data Screen has blank entries for unused channels.
- System Display: The function Remote lockout was added to the system.
- Save/Print Display: The function Print Report was added to the system.
- SCPI Protocol: There is an additional parameter, CLE, to the :CALC3:SAMP command. For example: :CALC3:SAMP CLE. This clears the Monitor data from the display but only if the current sampling state is stopped.
- A response was added to the query :CALC3:SAMP?. If the Monitor display is currently stopped and hasn't recorded any data, then the response is CLE. If the Monitor display has stopped and recorded some data, then the response is STOP.
- A parameter was added to the query :CALC1:DATA?. The current SCPI supports :CALC1:DATA? [SPEC}, the additional parameter is MARK. So the new query is: :CALC1:DATA? [SPEC | MARK].
- New Commands/Queries:

  Common Commands:

  *RCL

  *RST

  *SAV

  Measurement Subsystem:

  :CONFigure:OSNR[:STATe] {REL | FIX}

  :CONFigure:OSNR:[STATe]?

  :CONFigure:ORELative:LEVel <frequency>

  :CONFigure:ORELative:LEVel?

  :CONFigure:OFIXed:LEVel <frequency>

  :CONFigure:OFIXed:LEVel?

  :CONFigure:OSNR:BANDwidth <bandwidth>

  :CONFigure:OSNR:BANDwidth?

  Calculate Subsystem:

  :CALC1:MARKer:METHod {AMRK | BMRK | DELT | RAT}

  :CALC1:MARKer:METHod?

  :CALC1:{AMRK | BMRK} <wavelength>

  :CALC1:{AMRK | BMRK}?

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Display Subsystem:

:DISPlay:DIALog:MONitor {POW | WAV}

:DISPlay:DIALog:MONitor?

:DISPlay:X:{LEFT | RIGHt | CENTer | PDIVision} <wavelength>

:DISPlay:X:{LEFT | RIGHt | CENTer | PDIVision}?

:DISPlay:Y:{SPECtrum | MONitor}:{TOP | BOTTom | PDIVision} <numeric value>

:DISPlay:Y:{SPECtrum | MONitor}:{TOP | BOTTom | PDIVision}?

:DISPlay:Y:{SPECtrum | MONitor}:AUTO

System Subsystem:

:SYSTem:REMote {ON | OFF}

:SYSTem:REMote?

Hardcopy Subsystem:

: HCOPy:IMMediate

Mass Memory Subsystem:

:MMEMory:STORe

:MMEMory:FEED {SPEC | DATA | MON}

:MMEMory:FEED?

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Appendix C. Status Messages

The WA-7100/7600 Wavemeter may occasionally display a message in a "pop-up" box on the screen. The table below lists the messages that may appear and explains their meaning.

Message	Meaning and Instructions
Place the cap on the Input connector and press ENTER.	During the Power Null operation, the cap must be on the fiber optic INPUT connector on the front panel to eliminate any input signal.
Input power is too high ... place the cap on the input connector and press ENTER.	Power Null operation failed. Input power is too high for zero level calibration of power meter. Place the cap on the fiber optic INPUT connector and press ENTER to perform the Power Null.
Power Null calibration successful.	Power Null operation succeeded.
System error ... service required.	A system error has been detected. Turn off the power switch, wait a few seconds and turn on the instrument again. If the same message appears, contact Burleigh's Service Department for instructions.
"Put cover on laser input, press \"Enter\" to continue or any other key to abort."	While performing a Power Null this message will appear.
"Please wait, system initialization in progress!"	On startup and when changing Wavelength ranges this message will appear.
"System error, service required! [xxxx]"	A general error message requiring service.
"Input Power is too Low!"	The wavemeter must detect input intensity greater than the minimum. Check the fiber connection.
"Input Power is too High!"	The wavemeter must detect input intensity less than the maximum.
"Gain stabilizing... Please Wait."	The autogain circuit is operating. This message should disappear in 1-2 seconds.
"Fringe Strength is too High!"	Use a fixed attenuator or other means to reduce the total input power.
"Power Null calibration failed!"	Check to be sure that any input has been removed.
"Normal"	General message indicating system is operating normally.
"Power Null failed!"	Check to be sure that any input has been removed.
ERROR MESSAGES FOUND ON THE SAVE/PRINT DISPLAY ONLY	
"Cannot save display to file, disk full or not found! [xxxx]"	Delete some files on the floppy disk or insert a new, blank floppy disk.
"Cannot save configuration to file! [%04d]"	System information cannot be written to the configuration file. Call Service.
"Cannot restore configuration from file! [%04d]"	System information cannot be read from the configuration file. Call Service.
"Cannot save data to file, disk full or not found! [xxxx]"	Cannot save the selected data to the floppy disk. Delete some files on the floppy disk or insert a new, blank floppy disk.

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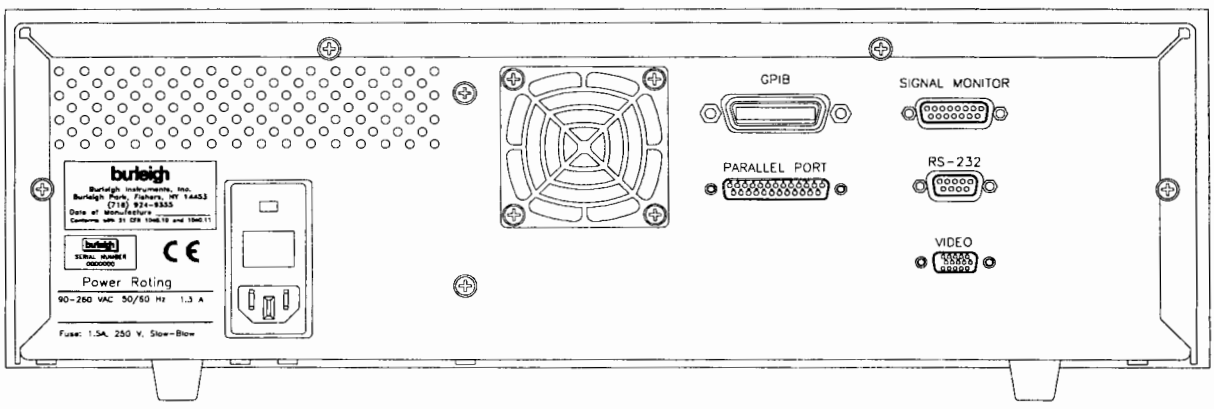
"Version numbers do not match! [xxxx]"	This error message will come up if you press the "Restore Config" button and it cannot read the configuration last stored when pressing the "Save Config" button. Try and resave the configuration files by pressing the "Save Config" button again
"Cannot print report! [xxxx]"	Cannot print a report, check that the printer is on and cables are connected.
"Printing report..."	A report is in process of being printed.

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Appendix D. Rear Panel Controls

The WA-7100/7600 rear panel contains an AC power connector and six interface connectors. This Appendix describes the function of the SIGNAL MONITOR, PARALLEL PORT, and VIDEO connectors on the WA-7100/7600 rear panel. For information on the function of the RS-232 and GPIB connectors, refer to Section 3, Remote Communications.

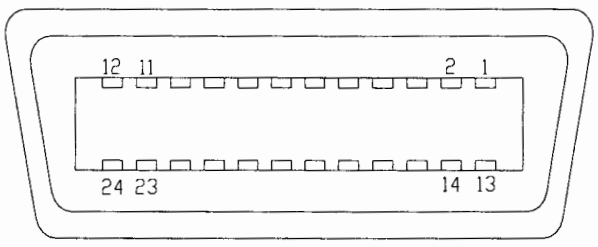
Wavemeter Rear Panel



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GPIB Port

GPIB Interface Connector



Standard IEEE-488 Connector Pinout

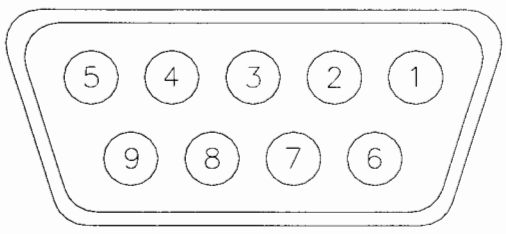
Pin Number	Signal Name
1	DIO1
2	DIO2
3	DIO3
4	DIO4
5	EOI
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD

Pin Number	Signal Name
13	DIO5
14	DIO6
15	DIO7
16	DIO8
17	REN
18	GND (TW W/ DAV)
19	GND (TW W/ NRFD)
20	GND (TW W/ NDAC)
21	GND (TW W/ FC)
22	GND (TW W/ SRQ)
23	GND (TW W/ ATN)
24	SIGNAL GROUND

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RS-232 Serial Interface Connector

The RS-232 port is a full duplex serial communications port. The connector is a 9-pin, female, D-Sub style connector



RS-232 Serial Port Pinout

Pin Number	Signal Name	Signal Source	Description
1	-	-	N/C
2	TxD	WA-7100/7600	Transmit Data. Data from the Wavemeter is output on this signal pin.
3	RxD	User	Receive Data. Data from the user is received on this signal pin.
4	DSR	User	Data Set Ready. This input signal must be held active by the user for the Wavemeter to consider the serial port connected to an external device.
5	GND	-	Signal Ground. Required for proper RS-232 operation.
6	DTR	WA-7100/7600	Data Terminal Ready. This output signal is active whenever the Wavemeter is powered and is not in internal reset.
7	CTS	User	Clear To Send. An input signal indicates to the Wavemeter when the user device is able to accept additional data.
8	RTS	WA-7100/7600	Request To Send. The Wavemeter makes this signal active as long as its internal command buffer has room in it. When the internal command buffer is full, the Wavemeter sets RTS inactive.
9	-	-	N/C

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Signal Monitor Connector

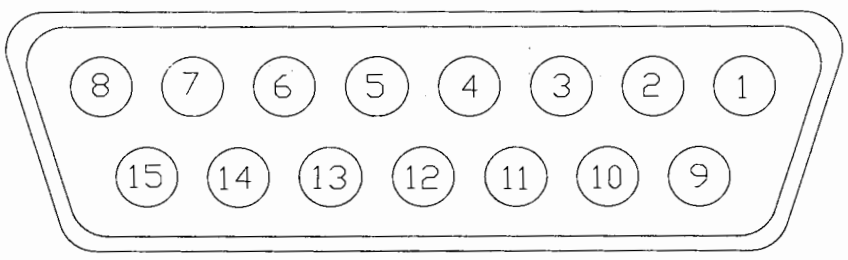
The Signal Monitor connector on the back panel of the Wavemeter provides a combination of analog and digital signals for observing the fringe signals and measuring timing signals using an oscilloscope. The signals have the characteristics described in Table D-2.

The Signal Monitor output is a 15-pin, female, D-sub style connector shown in Figure D-1 and with the pinout described below.

Signal Monitor Characteristics

	Analog Signals	Digital (TTL) Signals
Output Voltage	± 7 V maximum	V_{OL} = 0.4V max, V_{OH} = 2.4V min
Output Current	100 mA maximum	I_{OL} = 16 mA max, I_{OH} = -0.4 mA
Output Timing	NA	$t_r \leq 7$ nsec, $t_f \leq 7$ nsec

Signal Monitor Output Connector



Monitor Pinout

Pin Number	Signal Name	Signal Type	Description
1	INPUT	Analog	Input laser sinusoidal fringe signal.
2	REFERENCE	Analog	Reference laser sinusoidal fringe signal.
3	VREF	TTL	Valid reference laser fringe amplitude.
4	ZOP 1	TTL	Not used
5	TRIGGER	TTL	Scanning Window Trigger is a digital pulse with a duration that defines the maximum measurement interval for the interferometer scan. It goes active (H = active) during the allowed measurement interval.
6	DGND	-	Digital Ground
7	1 TRIG	TTL	Not used
8	ZOP	TTL	Zero Optical Path (ZOP) is a digital pulse derived from the interferometer scanner that produces a low to high transition at the point in the scan where the difference between the two optical paths in the interferometer is zero.
9	AGND	-	Analog Ground

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10	AGND	-	Analog Ground
11			N/C
12			N/C
13			N/C
14	DGND	-	Digital Ground
15	WINDOW	TTL	Not used

Parallel Port

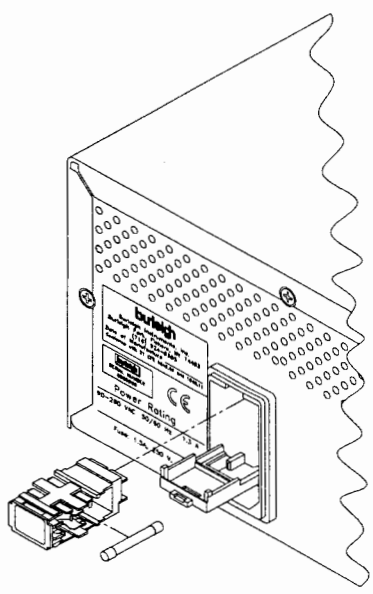
This port is used to connect to a standard Parallel Printer. The connector is a 25-pin, female, D-Sub style connector. The output is configured in Standard Parallel Port (SSP) mode, with IBM XT/AT and PS/2 compatibility.

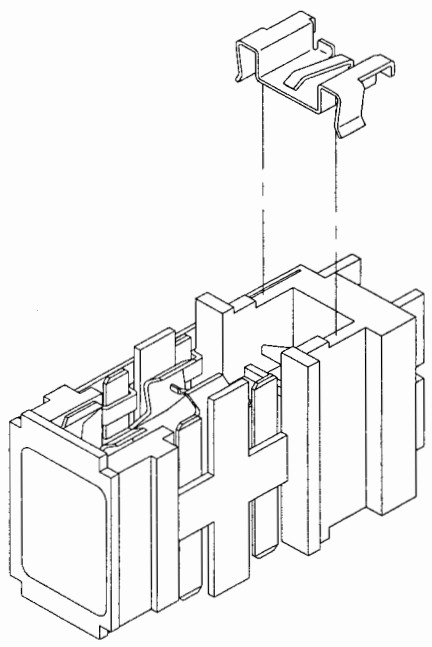
Video Connector

This port allows you to connect the WA-7100/7600 to a standard VGA compatible CRT monitor. The port uses a standard 15-pin, female, high-density D-Sub style connector. This port allows you to attach a larger or remote monitor that has the same display as the front panel.

Changing Fuses

The WA-7100/7600 Wavemeter can accept either single or dual line fuses as required by local regulations. The fuses are accessible at the rear panel of the instrument. The method for changing fuses is shown below.





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The fuse holder can be used for either single line or dual line fusing. The WA-7100/7600 comes from the factory with only one line fused. Removing the adapter clip (Figure D-2) allows dual fuses.

The fuse holder can hold 1.5 Amp, slow-blow, ¼" x 1¼" or 5 x 20mm style fuses.

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Warranty

Warranty

The Burleigh WA-7100/7600 Multi-line Wavemeter is warranted against defects in material and workmanship for a period of one year after date of delivery. Optical components are warranted for 90 days. During the warranty period, Burleigh will repair, or at its option, replace parts that prove to be defective when the instrument is returned prepaid to Burleigh Instruments, Inc. **Before returning an instrument, always call Burleigh for return authorization.** The warranty will not apply if the instrument has been damaged by accident, misuse, or as a result of modification by persons other than Burleigh personnel.

It is important to call Burleigh Instruments or your local sales representative in advance of returning a unit, for a Return Authorization Number (RA#). This will ensure the prompt handling of the repair, as well as provide important tracking information.

The liability of Burleigh Instruments, (except as to title) arising out of supplying of said product, or its use, whether under the foregoing warranty, a claim of negligence, or otherwise, shall not in any case exceed the cost of correcting defects in the products as herein provided. Upon expiration of the warranty period specified herein, all liability shall terminate. The foregoing shall constitute the sole remedy of the buyer. In no event shall the seller be liable for consequential or special damages.

Service

There are no user serviceable parts inside the WA-7100/7600 Multi-line Wavemeter. Removing the cover of the Wavemeter will void the warranty.

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Declaration of Conformity

Manufacturer's Name: Burleigh Instruments, Inc.

Manufacturer's Address: Burleigh Park
Fishers, NY 14453-0755
USA

declares this product:

Product Name: Multi-line Wavemeter

Model Number(s): WA-7100/7600

conforms to the following standards:

Safety: EN-61010-1: IEC 1010-1

EMC: EN-50081-1: EN-55011; Group 1, Class A : Emissions
EN-50082-1: IEC 1000-4-2: ESD Immunity; 4kV CD, 8kV AD
IEC 1000-4-3: RFI Immunity; 3V/m, 80-1000 MHz, 80% AM
IEC 1000-4-4: Electrical Fast Transient Immunity; 1 kV (peak)

Supplementary Information: "The product complies with the requirements of the **Low Voltage Directive 73/23/EEC** and the **EMC Directive 89/336/EEC**."

European Sales Office: Burleigh Instruments (UK) Ltd.
9 Allied Business Center, Coldharbour Lane
Harpenden, Herts, AL5 4UT, UK

Date of Issue: August, 1999

CE

signed: David J. Farrell, President

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