

PWRLink™ II 4100S Series Optical Transmitter Product Manual

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1

Overview

1.1 About This Manual

This instruction manual is a complete guide to installation, configuration and operation of the PWRLink™ II 4100S Series Optical Transmitter (PWL 4100S). The models that are covered by this manual are listed in Appendix A, Section A.8.

- Chapter 1 provides a description of the PWL 4100S.
- Chapter 2 describes the installation procedure.
- Chapter 3 introduces the user interfaces.
- Chapter 4 describes how to set up and configure the transmitter.
- Chapter 5 outlines maintenance procedures.
- Chapter 6 provides instructions on what to do in the event of problems.
- Appendix A provides complete technical specifications.
- Appendix B shows additional user interface details.
- Appendix C provides additional details about using modulated carriers.
- Appendix D provides a list of Harmonic's offices.

1.2 Description

The PWL 4100S transmitter is a compact plug-in module designed for use in the Harmonic HLP 4200 equipment platform. An HMC 4001 module carrier is needed to mount the transmitter in the platform. Harmonic has optimized the PWRLink II family of transmitter modules for high-performance transmission of RF broadband information over optical fiber networks.

The PWL 4100S has the following key features:

- Transmission bandwidth from 45 to 1003 MHz
- Optical performance with 80 NTSC (System M) analog channels plus additional digital loading
- Internal monitoring and control using 32-bit microprocessor
- Local control of operating parameters—provided by the HLP 4200 platform
- Remote control and monitoring—provided by NETWatch Site Controller

- Autosetup feature that adjusts RF pad for optimum modulation performance
- Automatic gain control and manual gain control modes of operation

Figure 1-1 shows front and rear panel features of the PWL 4100S transmitter module.

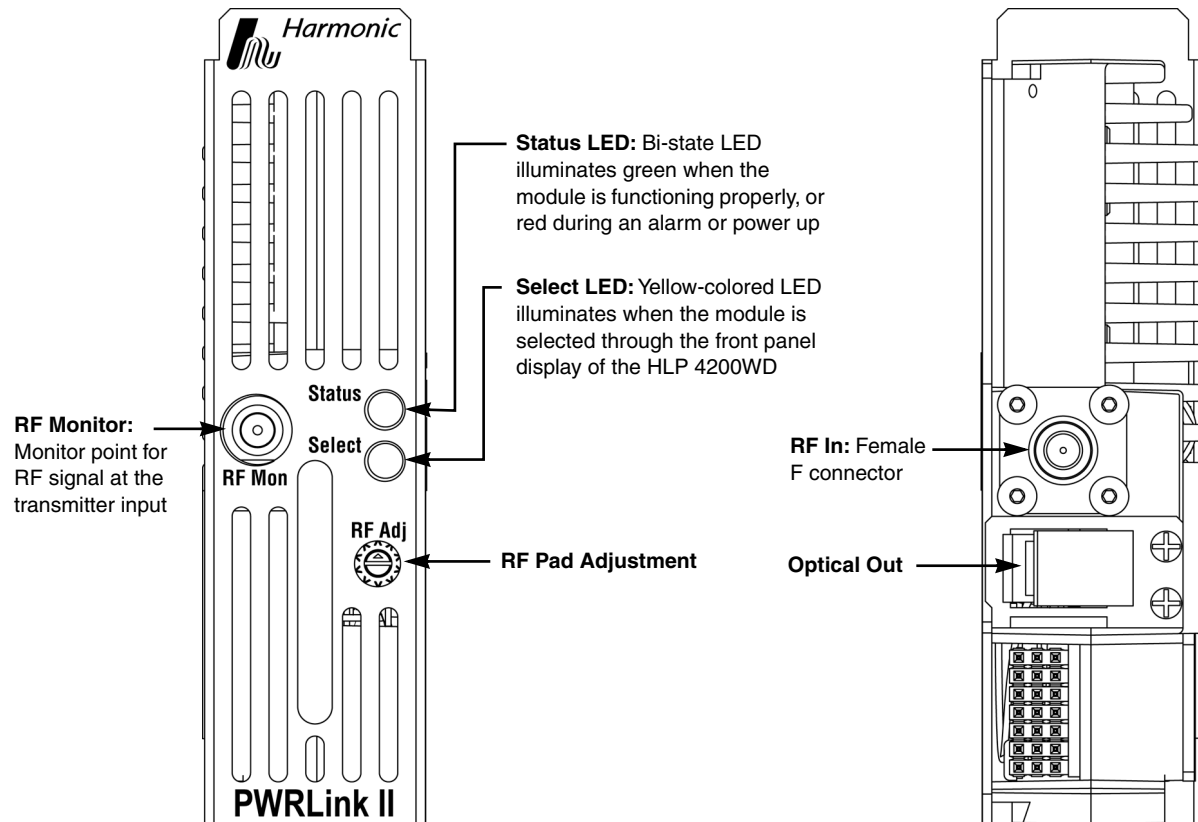
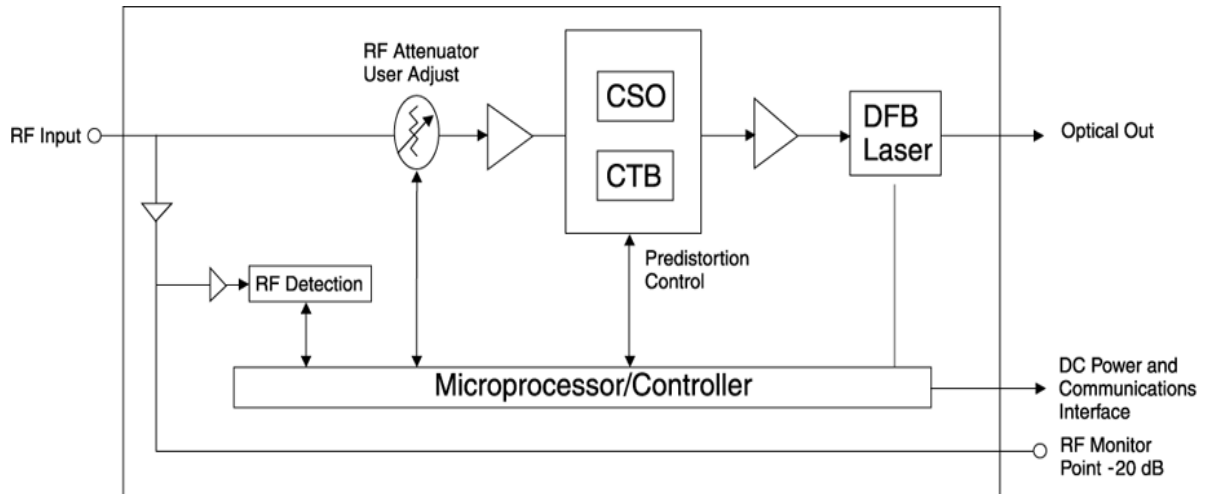


Figure 1-1. PWL 4100S front and rear panel features

Transmitter performance is optimized by combining state-of-the-art 1310 nm distributed feedback (DFB) laser technology and patented pre-distortion linearization circuitry. Harmonic has designed the PWRLink II family for integration into networks with advanced element management systems; each transmitter module employs a microprocessor-based communication and monitoring architecture. Figure 1-2 is a block diagram of the PWL 4100S transmitter.

The transmitter's microprocessor continuously monitors and controls all critical transmitter parameters in order to optimize performance over both time and temperature changes. The microprocessor-controlled parameters include:

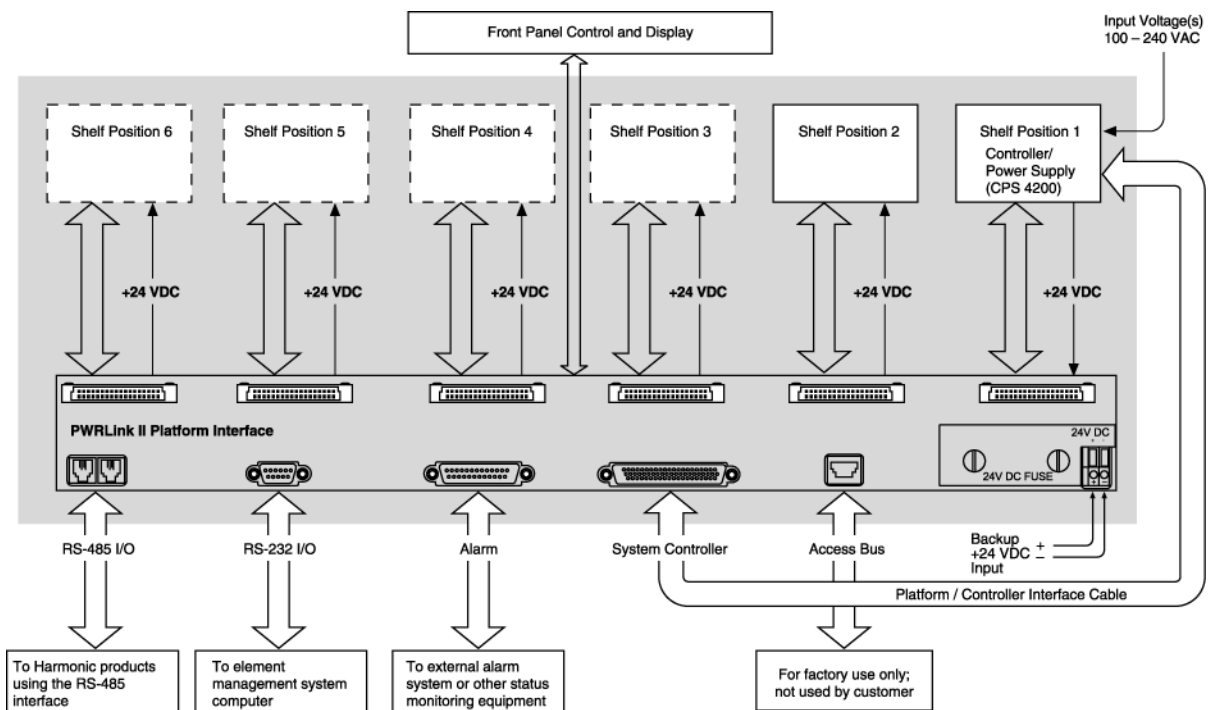
- Input signal attenuation pad
- Laser power, temperature, and bias
- Electrical circuit temperature and setpoints



PWL48BLD

Figure 1-2. PWL 4100S block diagram

The PWL 4100S transmitter is a compact plug-in module that mounts easily in Harmonic's HLP 4200 platform via the HMC 4001 module carrier. See Figure 1-3 for a functional diagram of the HLP 4200 platform. The transmitter module draws power from the platform's 24 VDC power bus, and communicates with the platform controller via the platform communication bus.



HL42FD

Figure 1-3. HLP 4200 functional diagram

For additional information on the HLP 4200 platform and its associated communication and power buses, see the *HLP 4200 Platform Product Manual*. For further information on the platform controller and power supply options, see the CPS 4200 or CPS 4248 manual.

1.3 Applications

The PWL 4100S transmitter is designed to operate alone or with other systems, depending on the application:

- Alone, in local distribution and narrowcasting applications
- In combination with Harmonic's MAXLink™ 1550 nm transmission system, for complete broadband network solutions

The PWL 4100S provides an ultra-linear RF input-to-optical output (1310 nm) response for the simultaneous transmission of analog video and digital signals in the 45 to 1003 MHz frequency band.

The 1310 nm optical signal transmitted by a PWRLink II module can be received by optical receivers and nodes manufactured by Harmonic or other major broadband equipment manufacturers. To learn more about equipment compatibility and broadband network design and optimization, contact customer service. See Appendix D, *Harmonic Inc. – Offices*.

Installing the PWL 4100S Transmitter

This chapter describes how to:

- Receive and inspect the PWRLink™ II 4100S Series Optical Transmitter
- Install the transmitter module in the HLP 4200 platform
- Connect the fiber cable
- Connect the RF broadband input
- Test RF signal input

2.1 Receiving and Inspecting

As you unpack your unit, inspect the shipping container and equipment for damage. Save the shipping material for future use.

If the container or the equipment is damaged, notify both the freight carrier and Harmonic. See Appendix D, *Harmonic Inc. – Offices* for contact information.

CAUTION: Before removing equipment from its antistatic bag, touch a ground point for several seconds. A suitable ground point is an unpainted part of the chassis of a grounded piece of equipment.

2.2 Installing the Transmitter Module

CAUTION: To protect yourself from potential injury and to protect the equipment from further damage, do not perform any operational tests if the equipment appears to be damaged.

The PWL 4100S transmitter module plugs into the HMC 4001 module carrier, shown in Figure 2-1 on page 2-2. The transmitter module is held in the carrier by a spring-loaded tab on the front handle of the carrier. You can place the HMC 4001 carrier into any desired position in the HLP 4200 platform.

The PWL 4100S module can be plugged into the carrier either with the carrier already mounted in the HLP 4200 platform, or prior to mounting the carrier into the platform. The HLP 4200 platform can be powered and operational during the plug-in process.

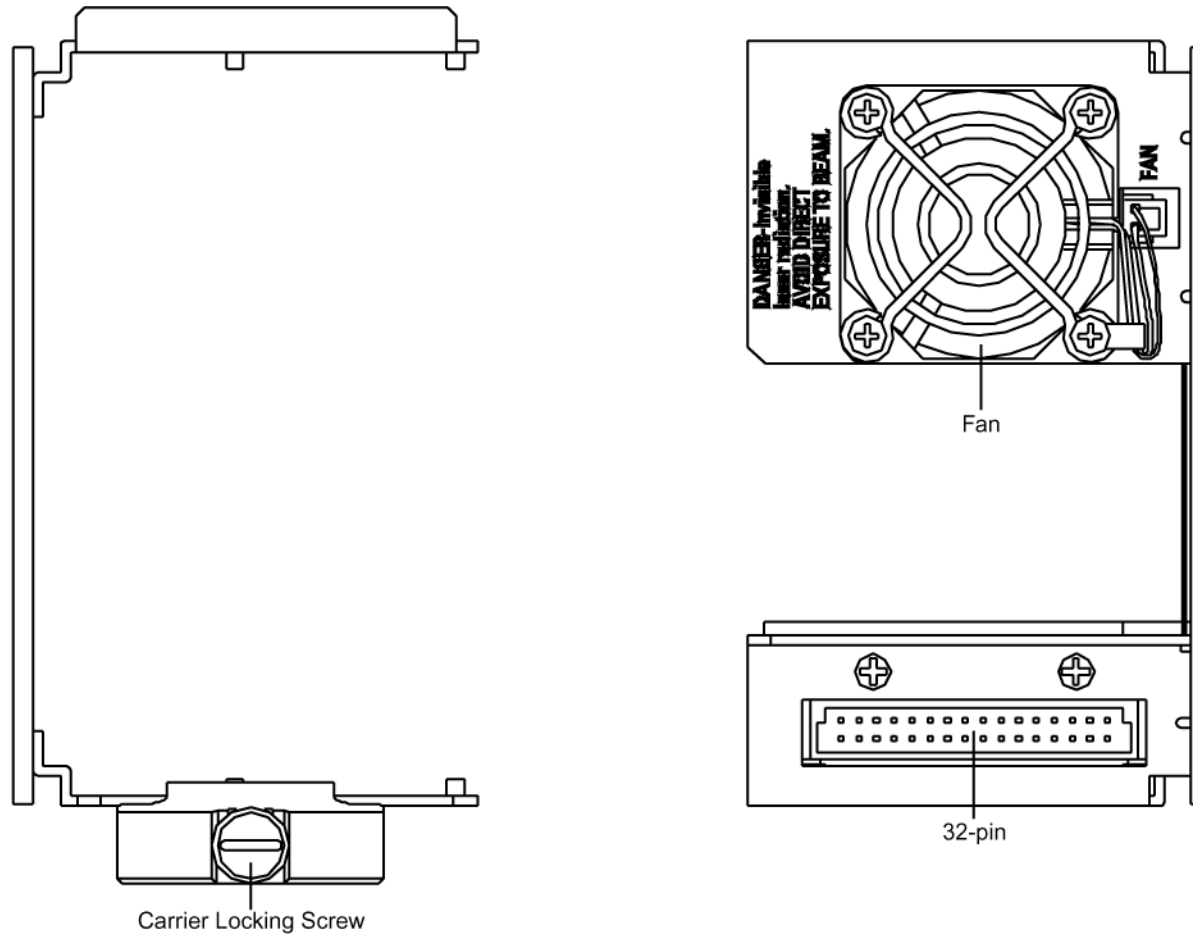


Figure 2-1. HMC 4001 module carrier front and rear panel features

To install the transmitter module in the HMC 4001 carrier:

- Insert the transmitter into the carrier until it locks into position.

To remove the transmitter module from the HMC 4001 carrier:

- Press down the spring-loaded tab on the carrier, then pull out the module.

To install the HMC 4001 carrier in the HLP 4200 platform:

1. Lower the HLP 4200 platform's control/display panel.
2. Slide the HMC 4001 carrier into any available slot in the platform until it is properly seated.
3. Lock the carrier into position with the carrier locking screw, shown in Figure 2-1.

The PWL 4100S receives power from the HMC 4001 carrier. The carrier is powered by the +24 VDC bus of the HLP 4200.

For additional information on the HLP 4200 platform, see the *HLP 4200 Platform Product Manual*. For additional information on platform controllers and/or power supply options, see the respective Harmonic manual for each component.

2.3 Connecting the Fiber Cable

To proceed with installation, connect the fiber optic cable to the transmitter output. The optical output connector of the PWL 4100S is located on the rear of the module, as shown in Figure 1-1 on page 1-2.

DANGER: Invisible Laser Radiation. **AVOID EXPOSURE TO BEAM.**

Never operate unit with a broken fiber or with a fiber connector disconnected.

To connect fiber optic cable to the transmitter output:

1. Verify that the transmitter module has been mounted into the HLP 4200 platform, as described in Section 2.2.
2. Determine the connector type on the PWL 4100S. The standard optical connector recommended by Harmonic is SC/APC. Other connector types can be special ordered.
3. Verify that the type of connector on the fiber cable is the same as what is on the PWL 4100S, for example, SC/APC.
4. Verify that the fiber cable connector has been cleaned properly. If the fiber cable connector needs to be cleaned, follow the cleaning procedure outlined in Section 5.1.1 *Cleaning Patch Cord or Pigtail Fiber Optical Connectors* on page 5-2.
5. Verify that the PWRLink II optical connector has not been exposed to any contamination. If you suspect that the connector may have been exposed to contamination (for example, by a dirty fiber cable connector), follow the cleaning procedure outlined in Section 5.1.2 *Cleaning Transmitter Module Optical Connectors* on page 5-2.

NOTE: Any contamination of either the fiber cable or PWL 4100S connector can significantly degrade optical link performance. This degradation will most likely manifest itself as poor carrier-to-noise (CNR) performance.

6. For SC-type optical connectors, note the key characteristics of the mating connectors and align them accordingly. Gently insert the fiber cable connector into that of the PWL 4100S until the connector clicks into place. For FC-type optical connectors, note the key characteristics of the mating connectors and align them accordingly. Gently insert the fiber cable connector into that of the PWL 4100S and tighten the rotating sleeve of the connector. *Do not overtighten!*

2.4 Connecting the RF Broadband Input

The PWL 4100S broadband RF connector is located on the rear panel of the module, as shown in Figure 1-1 on page 1-2.

The PWL 4100S female F connector accepts a 75 ohm impedance coaxial cable terminated with a male F-type connector. The male F connector on the cable should have a center pin diameter in the range of 0.64 mm to 0.8 mm.

NOTE: To ensure performance integrity, use RG-59 coaxial cable. Use of a connector with a center pin diameter greater than 0.8 mm can damage the input RF connector.

Insert the signal source connector into the PWL 4100S module RF input connector and tighten securely. The input video signal level must be between 15 and 22 dBmV per analog video channel based on 80 NTSC channels.

2.5 Testing RF Signal Input

Once you have connected the RF signal source, you can use the RF monitor to verify the presence of the RF signal input to the transmitter. The RF monitor is a test connector (female F-type) located on the front panel of the transmitter module, as shown in Figure 1-1 on page 1-2. The monitor level is 20 dB below the input level to the transmitter ± 1 dB.

User Interface Options

This chapter describes:

- HLP 4200WD display
- NETWatch Site Controller
- Front panel RF adjustment
- Front panel LED indicators

Each PWRLink™ II 4100S Series Optical Transmitter module employs a microprocessor, which makes it easy for you to communicate with and control the transmitter. This chapter describes three options for such communication and control. The options are:

- **HLP 4200WD push buttons and display**

The HLP 4200WD interface provides the most comprehensive means of monitoring and controlling PWL 4100S performance.

The Autoseup and Reset to Factory Settings commands are available only through this interface. For initial setup of the transmitter, Harmonic recommends using the HLP 4200WD display, if available.

- **NETWatch Site Controller Element Management System**

Once installed and configured, NETWatch Site Controller provides a straightforward way to monitor and control a network of multiple PWL 4100Ss, either locally or remotely.

- **PWL 4100S front panel RF adjustment**

The RF adjustment potentiometer on the front panel of each PWL 4100S module (shown in Figure 1-1 on page 1-2 as RF Pad Adjustment) can be used to set the internal RF pad level. Use this interface only if the first two interface options are not available.

3.1 HLP 4200WD Display

The PWL 4100S can be configured and monitored conveniently via the push buttons and LCD display of the HLP 4200WD equipment platform.

Figure 3-1 provides a flowchart of the commands and messages in the Main menu, which is at the top of the HLP 4200 WD platform interface hierarchy. In this figure, push-button commands are framed in ovals, and resultant display messages are framed in rectangular boxes.

Use the Main menu to scan through platform positions and select a specific transmitter module to monitor and control. The Main menu also allows you to set the platform address for communication with NETWatch Site Controller. Instructions for navigating the Main menu are provided in Section 4.4.1 *Step-by-Step Setup Instructions* on page 4-7.

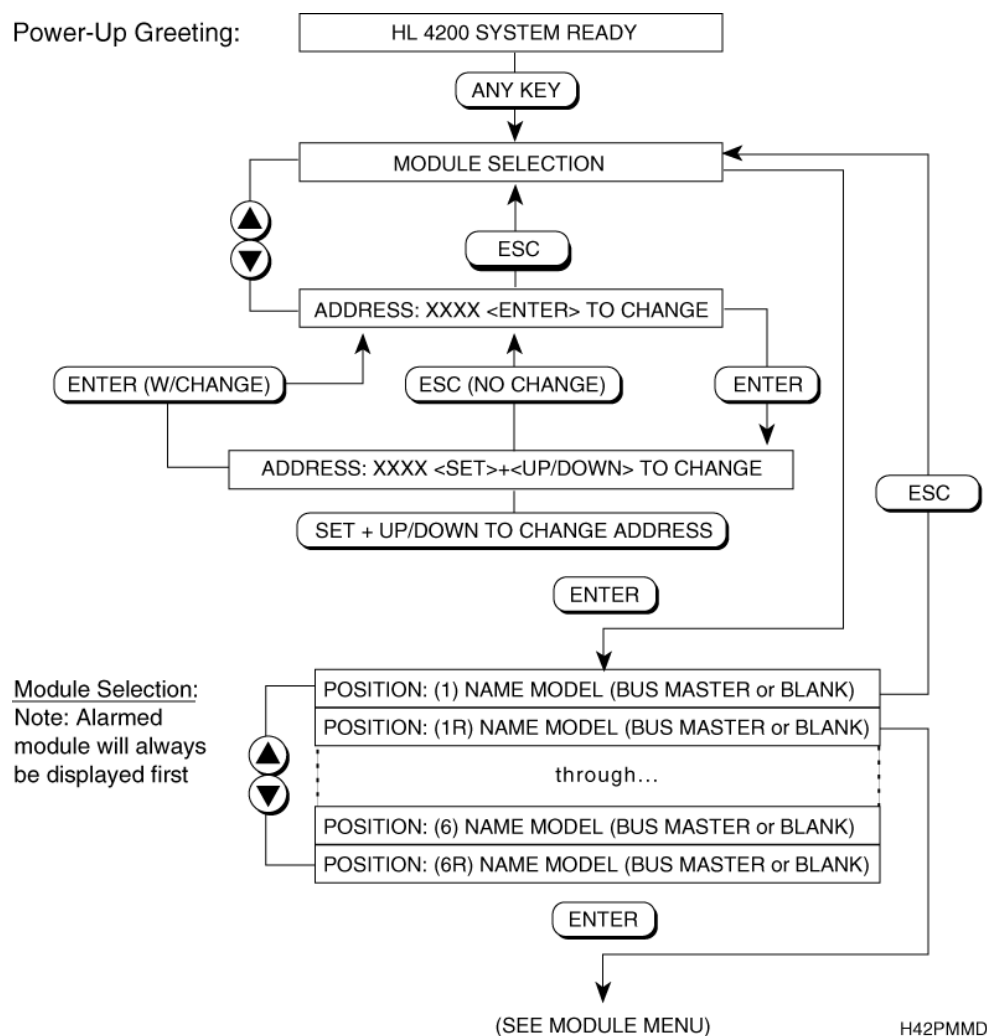


Figure 3-1. HLP 4200WD platform Main menu display

After you navigate the HLP 4200WD's Main menu and select a specific PWL 4100S module, the Transmitter menu appears. The Transmitter menu is organized into five sub-menus:

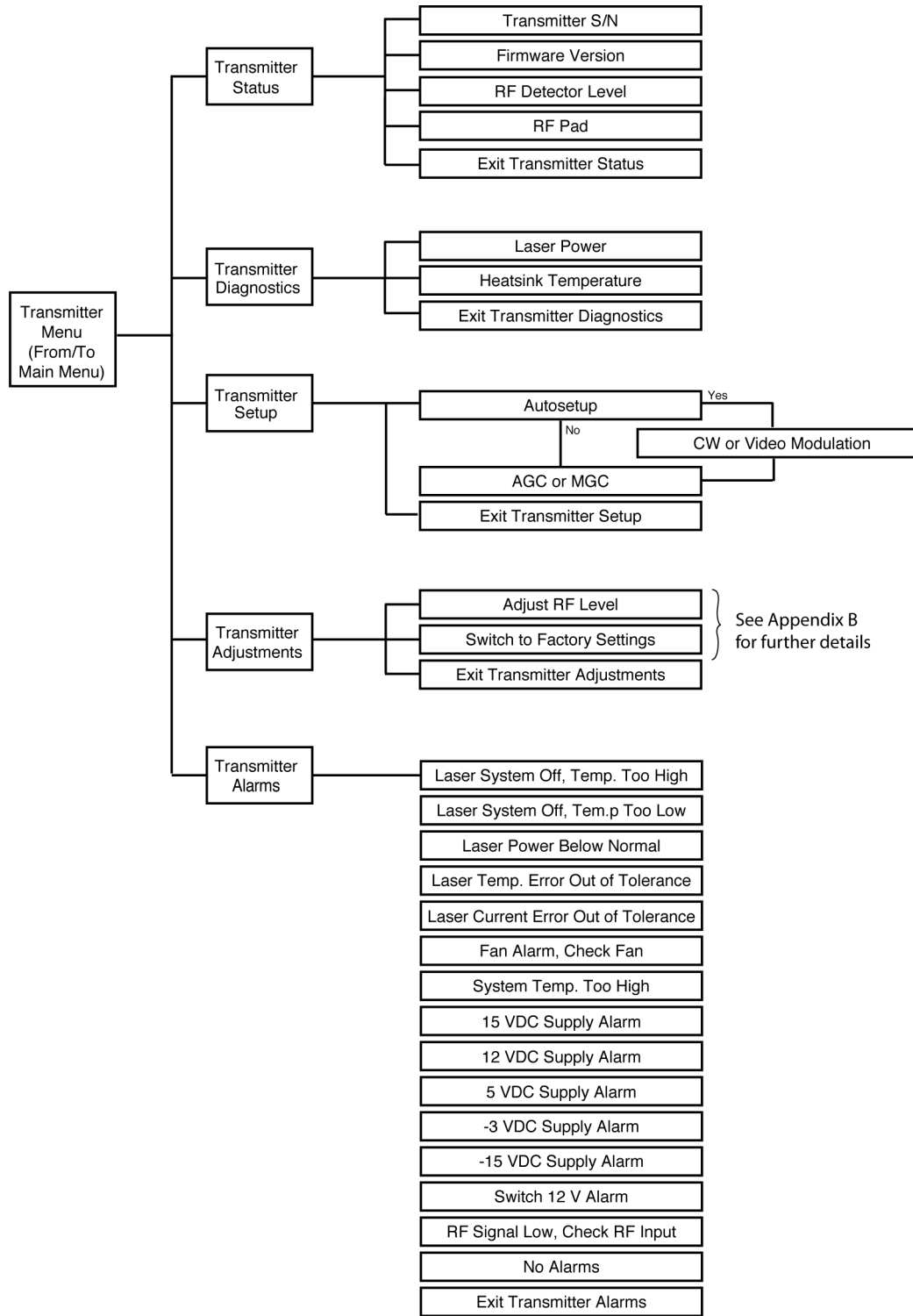
- Transmitter Status
- Transmitter Diagnostics
- Transmitter Setup
- Transmitter Adjustments
- Transmitter Alarms

These sub-menus are described below in Section 3.1.1 through Section 3.1.5.

Figure 3-2 on page 3-4 shows the information and controls available in the Transmitter menu. For further details, see Appendix B, *HLP 4200WD Menu Display*, which contains a fully detailed chart of the menu display.

The status and control parameters in the Transmitter menu apply only to the specific transmitter module that is selected. Use the HLP 4200WD's ▲ and ▼ buttons to scroll through the menus. Use the Enter button to make a selection. Use the Esc button to escape any menu.

For further information on using the HLP 4200WD display interface, see the *HLP 4200 Platform Product Manual*.



PWL49UI1

Figure 3-2. HLP 4200WD platform Transmitter menu display chart

3.1.1 Transmitter Status

The Transmitter Status menu lets you obtain the transmitter serial number, firmware version, and basic operating mode parameters.

3.1.2 Transmitter Diagnostics

The Transmitter Diagnostics menu allows you to:

- Determine the laser power
- Determine the heat sink temperature

3.1.3 Transmitter Setup

The Transmitter Setup menu allows you to:

- Run the Autosetup routine
- Select Manual Gain Control (MGC) or Automatic Gain Control (AGC) mode of operation
- Configure the transmitter in either CW or Video mode

3.1.4 Transmitter Adjustments

The Transmitter Adjustments menu allows you to:

- Adjust and optimize the RF pad settings
- Restore all transmitter parameters to the original factory settings

3.1.5 Transmitter Alarms

The Transmitter Alarms menu displays the active alarms in the transmitter.

NOTE: If an alarm condition is triggered in a specific transmitter module, when that transmitter is selected through the HLP 4200WD interface, the display automatically jumps to the alarm message within the Transmitter Alarms menu.

3.2 NETWatch Site Controller

Harmonic's NETWatch Site Controller provides a complete element management system, including a Windows™-based GUI and communications package for monitoring and controlling a network of multiple PWL 4100S transmitters either remotely or locally. For information on installing and using this system, consult the *NETWatch Site Controller Instruction Manual*.

3.3 Front Panel RF Adjustment

NOTE: Harmonic recommends that you use the front panel RF Adjustment control only if the interface options described in Section 3.1 and Section 3.2 are not available.

The PWL 4100S front panel includes an RF adjustment control, labeled *RF Adj*, as shown in Figure 1-1 on page 1-2. The RF adjustment potentiometer provides screwdriver-adjustable control of the input signal RF pad.

The RF pad adjustment potentiometer provides the following options:

- Each clockwise turning step of the RF adjustment switch increases the RF attenuation by 0.1 dB.
- Each counterclockwise step of the switch decreases the RF attenuation by 0.1 dB.
- Each full turn has 10 steps, equal to 1.0 dB.

Note that the RF adjustment switch works by communicating with the microprocessor, which in turn adjusts the pad value.

3.4 Front Panel LED Indicators

The PWL 4100S front panel includes two LEDs, as shown in Figure 1-1 on page 1-2.

- The *Status* LED illuminates red if an alarm condition exists within the transmitter, and for a short period during power up. The *Status* LED illuminates green if no alarm condition exists and the transmitter is operating normally.
One type of alarm condition is the *RF signal low* alarm. The *Status* LED indicates an alarm (red) whenever the RF composite power level at the input of the transmitter falls below 28 dBmV. If the level rises above the 28 dBmV threshold, the *Status* LED illuminates green.
- The *Select* LED illuminates yellow when the transmitter module is selected via the front panel controls of the HLP 4200WD.

4

Transmitter Setup

This chapter describes how to set up a PWRLink™ II 4100S Series Optical Transmitter for optimum performance. Any of the three user interface options described in Chapter 3, *User Interface Options*, can be used for transmitter setup. The first half of this chapter describes transmitter features and setup options. The second half of the chapter details the setup procedure for each of the three user interface options.

This chapter describes:

- Factory-optimized settings of the PWL 4100S
- Fine-tuning the transmitter
- Autoseup, Automatic Gain Control, and Manual Gain Control
- How to set up via the HLP 4200WD display
- How to set up via NETWatch Site Controller
- How to set up via the transmitter's front panel controls

NOTE: For initial setup of the transmitter, Harmonic recommends using the HLP 4200WD platform's push buttons and display, if available. If you are using another platform (such as HLP 4200ND) that does not have a display, the NETWatch Site Controller can be used for transmitter setup. In the event that neither of those interface options is available, you can adjust the RF level via the front panel of the PWL 4100S.

Before proceeding with the instructions outlined in this chapter, ensure that you have installed the transmitter properly into the HLP 4200 platform, as described in Chapter 2, *Installing the PWL 4100S Transmitter*.

4.1 Factory-Optimized Settings

The Harmonic factory optimizes the performance of each model in the PWL 4100S series prior to shipment. The factory setup is listed in Table 4-1.

Table 4-1: Factory Setup

Loading	80 unmodulated System M (NTSC) channels from 45 to 550 MHz; 450 MHz digital information above 550 MHz -6 dBc down from analog channels
RF input level	+15 dBmV per video channel
Link loss	100% fiber link (example: PWL 4115S is tested over 15 dB of fiber)
Harmonic receiver	HRM 3811

The Harmonic factory-optimized setup procedure balances:

- CNR (carrier-to-noise) performance
- CSO (composite second order) distortion performance
- CTB (composite triple beat) distortion performance

Once the Harmonic factory optimizes a PWL 4100S transmitter, the factory settings are written into the transmitter's memory. These settings allow the transmitter to achieve the performance given in Appendix A at factory setup for any model in the PWL 4100S series of transmitters.

These factory settings include:

- Internal RF pad value (user adjustable)
- Laser bias (not user adjustable)
- Laser current (not user adjustable)
- Laser temperature (not user adjustable)
- Others

4.1.1 Returning to Factory Settings

If at any time the transmitter's settings are changed, you can always return the transmitter to the original factory settings through the HLP 4200WD display interface. In the Transmitter Adjustments menu, select the Return to Factory Settings option. Follow the procedure in Section 4.4.3 *Resetting the Transmitter to Factory Defaults*.

When the transmitter reverts to the factory-optimized settings:

- If the transmitter is in AGC mode, the internal RF pad level automatically adjusts to get the adequate drive level to the laser for optimized performance.
- If the transmitter is in MGC mode, the transmitter reverts to factory settings based on Table 4-1, regardless of the actual RF input level. For the best performance, you must adjust the input level to 15 dBmV per channel. For instructions, see Section 4.4.2 *Fine-Tuning the Transmitter* on page 4-8.

Example

In the case of a transmitter with the following setup:

- Loading: 80 unmodulated NTSC channels from 45 to 550 MHz and 450 MHz from 550 to 1000 MHz -6 dBc down
- NTSC carriers RF input level: +18 dBmV per channel
- Factory optimized pad value at 15 dBmV per channel: 5.5 dB

In this example, the input level at 18 dB per channel is higher than the factory setting of 15 dBmV per channel.

There are two options for resetting the factory settings:

- If you use MGC ⊕ Reset to Factory Settings ⇒ Pad value will be 5.5 dB.
- If you use AGC ⊕ Reset to Factory Settings ⇒ Pad value will be $5.5 + (18-15) = 8.5$ dB.

If you use MGC ⊕ Reset to Factory Settings, the pad value will be 5.5 dB. The laser is overdriven. To optimize the transmitter's performance, you need to adjust the RF input level to the factory setting, 15 dBmV per channel.

Using AGC ⊕ Reset to Factory Settings provides the adequate drive level to the laser with a pad value of 8.5 dB.

4.2 Fine-Tuning Each Transmitter

Harmonic recommends fine-tuning each transmitter to fit your specific requirements and preferences precisely. You can modify the transmitter configuration to trade off CNR performance for improved CSO and CTB distortion performance.

If you increase the RF pad by 1 dB, the following results occur:

- Transmitter CNR decreases by 1 dB
- CSO decreases by approximately 1 dB
- CTB decreases by approximately 2 dB

You can adjust the RF level by using any of the three interface options. For the RF adjustment procedure using each of the interface options, see:

- *4.4.2 Fine-Tuning the Transmitter*
- *4.5 Setup via NETWatch Site Controller*
- *4.6 Setup via the Transmitter's Front Panel Controls*

4.3 Autsetup, Automatic Gain Control, and Manual Gain Control

The *Autosetup* feature enables you to quickly set the internal drive level to the laser as close as possible to the optimal value determined at the Harmonic factory. The transmitter operates in either the Automatic Gain Control (AGC) mode or the Manual Gain Control (MGC) mode.

4.3.1 Autosetup

What does Autosetup achieve?

The Autosetup feature calibrates and automatically adjusts the internal RF pad for very close-to-optimum modulation performance.

How does Autosetup operate?

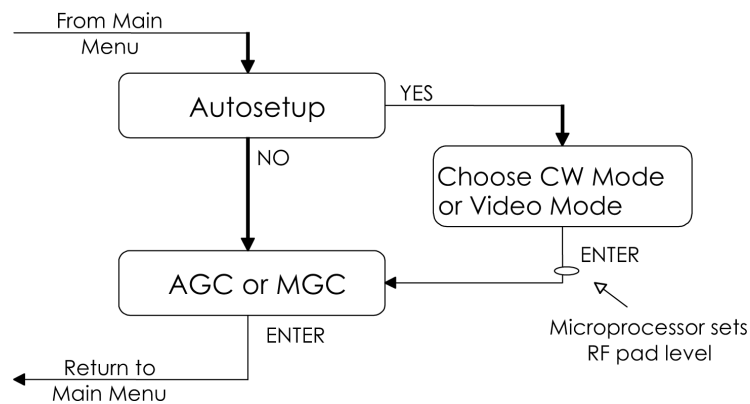


Figure 4-1. Autosetup via the HLP 4200 front panel

The Autosetup procedure works in three steps:

1. When you enter the Autosetup command via the HLP 4200WD front panel, the transmitter's internal microprocessor measures the input drive level to the transmitter. Then, it sets the attenuator pad so that the average RF drive level to the laser is at the same optimal value determined at the Harmonic factory using CW carriers.
2. Once this is done, the menu asks you to choose between CW Mode and Video Mode.
 - By entering CW Mode, you leave the current internal RF pad value as it stands.
 - By entering Video Mode, you add 3 dB to the current internal RF pad value.
3. Finally, you need to select AGC or MGC mode of operation. See Section 4.3.2 *Automatic Gain Control and Manual Gain Control*.

What if the video loading is less than 80 NTSC (System M) carriers?

When the number of video channels is less than 80 and you require better CNR, you can increase the input level as shown in Figure 4-2 on page 4-5. The Autosetup procedure will measure the RF input level and adjust the pad value for operation as close as possible to optimum performance.

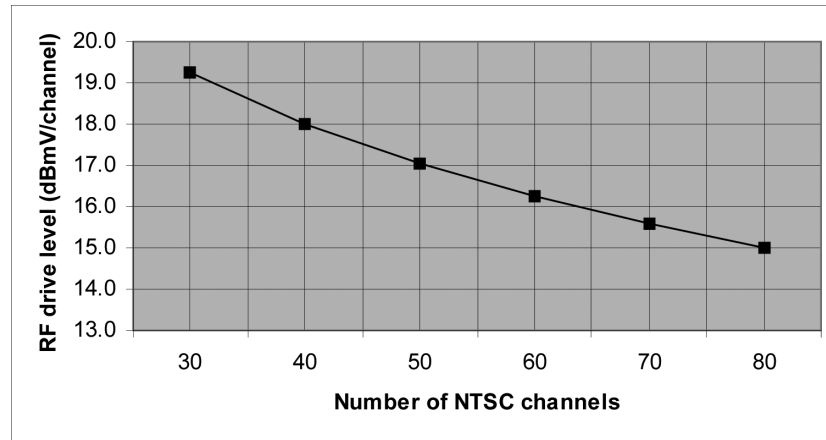


Figure 4-2. RF drive level as a function of channel loading

Even if you plan to add more video channels in the future, Harmonic recommends that you use 15 dBmV per channel to ensure that the system is easy to upgrade.

When should CW Mode or Video Mode be used?

The choice of mode depends on the loading.

Example

In the case of a transmitter with the following setup:

- Loading: 80 unmodulated NTSC (System M) channels from 50 to 550 MHz and 200 MHz digital loading from 600 to 800 MHz -10 dBc down
- RF input level: $+18$ dBmV per channel
- Factory optimized pad value at 15 dBmV per channel: 5.5 dB

In the case of CW unmodulated carriers: Harmonic recommends running Autosetup in CW Mode. In the factory, the transmitter is optimized using unmodulated carriers. Therefore, running Autosetup in CW Mode with the same channel load as the factory returns the pad level to close to the optimal value. In this case, if you use Autosetup \oplus CW Mode \Rightarrow Pad value will be $5.5 + (18-15) = 8.5$ dB.

In the case of modulated carriers: There are typically two different targets when setting up the transmitter with modulated carriers:

Target 1:

- Achieve the maximum possible modulation for the transmitter with better CNR, typically 2 dB higher than for unmodulated carriers
- The average CSO and CTB will be the same as the unmodulated case
- Preferably no digital loading on top of the video carriers

This target can be achieved by setting up the transmitter with modulated carriers in the CW Mode. In this case, if you use Autoseup ⊕ CW Mode ⇒ Pad value will be $5.5 + (18-15) = 8.5$ dB.

Target 2:

- Achieve the same CNR as you would with unmodulated carriers
- The average CSO and CTB will be better than they would be with unmodulated carriers
- Digital loading

This target can be achieved by setting up the transmitter with modulated carriers in Video Mode. In this case, if you use Autoseup ⊕ Video Mode ⇒ Pad value will be $5.5 + (18-15) + 2 = 10.5$ dB.

For further information about using modulated carriers and how this changes the RF level, see Appendix C, *Using Modulated Carriers*.

4.3.2 Automatic Gain Control and Manual Gain Control

The AGC function operates by measuring the input RF level to the transmitter and continuously adjusting the RF pad to maintain constant drive level to the laser. When you select AGC, the input level to the transmitter laser remains at its previously established value.

When you use AGC mode with the PWL 4100S, Harmonic recommends that you drive the transmitters 3 dB harder so that they can better compensate for the increased variation in the RF input signal. For example, for 80 NTSC (System M) channels, use an RF input level of 18 dBmV/channel.

In MGC mode, the internal RF pad value of the transmitter is kept at a fixed value regardless of the input RF level variation.

NOTE: You can adjust the drive level of the laser in either AGC or MGC mode by changing the RF pad. For instructions, see Section 4.2 *Fine-Tuning Each Transmitter* on page 4-3. After you have adjusted the pad, the transmitter will continue to operate in the same mode (AGC or MGC).

4.4 Setup via HLP 4200WD Display

This section provides instructions for setting up the PWL 4100S via the push buttons and LCD display of the HLP 4200WD equipment platform. To quickly and easily set up and review the PWL 4100S monitoring and control parameters, use the HLP 4200WD front panel. For a detailed description of this interface, see Section 3.1 *HLP 4200WD Display* on page 3-2.

4.4.1 Step-by-Step Setup Instructions

1. Verify that the PWL 4100S module is properly installed in the HLP 4200 platform. Instructions are provided in Section 2.2 *Installing the Transmitter Module* on page 2-1.
2. Verify that the HLP 4200WD is powered on and that no alarm conditions exist within the transmitter module; make sure that the Status LED on the front panel is green.
3. Verify that the RF input level per analog carrier is within the range of 15 to 22 dBmV/channel based on 80 NTSC channels.
4. Verify that the RF input signal has been properly connected to the transmitter. See Section 2.4 *Connecting the RF Broadband Input* on page 2-4.
5. On the HLP 4200WD, press the Esc button until the display reads `MODULE SELECTION`, then press Enter.
6. Press the ▲ or ▼ button until the display indicates the transmitter module you wish to set up, then press Enter.
7. Press ▲ or ▼ until the display reads `TRANSMITTER SETUP`, then press Enter. The message appears, `RUN AUTOSETUP? YES <SET+UP/DN> TO CHOOSE`.
8. Hold down the Set button and press ▲ or ▼ until the value you want is displayed—`YES` to run Autoseup or `NO` to skip Autoseup—then press Enter. For details of the Autoseup feature, see Section 4.3.1. If you choose `NO` to Autoseup, skip to Step 10.
9. The message appears, `VIDEO MODULATION <SET+UP/DN> FOR CW`. Hold down the Set button and press ▲ or ▼ until the value you want is displayed—`CW MODULATION` or `VIDEO MODULATION`—then press Enter. The transmitter's microprocessor adjusts the RF pad level.
10. The message appears, `AGC CONTROL <SET+UP/DN> FOR AGC`. Hold down the Set button and press ▲ or ▼ until the value you want is displayed—`AGC` or `MGC`— then press Enter. For details of the AGC feature, see Section 4.3.2 *Automatic Gain Control and Manual Gain Control*.
11. To exit the Transmitter Setup menu, press Enter.

4.4.2 Fine-Tuning the Transmitter

The setup instructions described in Section 4.4.1 will normally bring the transmitter to optimal operating conditions. Harmonic recommends fine-tuning each transmitter to your specific requirements and preferences.

If the factory-optimized RF level is not suitable for your particular application, you can use the following procedure to adjust the internal RF pad.

You can adjust the RF level while in either AGC or MGC mode. See the appropriate section. Pad adjustment does not alter the current mode of operation (AGC or MGC).

For details of the results of the RF adjustment, see Section 4.2 *Fine-Tuning Each Transmitter* on page 4-3.

To adjust the RF level via the HLP 4200WD push buttons and display:

1. Press the ▲ or ▼ button until the display reads `MODULE SELECTION`, then press Enter.
2. Press ▲ or ▼ until the display indicates the transmitter module you wish to adjust, then press Enter.
3. Press ▲ or ▼ until the display reads `TRANSMITTER ADJUSTMENTS`, then press Enter.
4. Press ▲ or ▼ until the display reads `ADJUST RF LEVEL`, then press Enter. The current RF pad setting is displayed with the instruction `<SET+UP/DN> TO CHANGE`.
5. Hold down the Set button and press ▲ or ▼ until the RF pad value you want is displayed, then press Enter.
6. To exit RF adjustment, press Enter.

4.4.3 Resetting the Transmitter to Factory Defaults

The factory-optimized settings are described in Section 4.1 *Factory-Optimized Settings* on page 4-2.

To return the transmitter to factory settings:

1. On the HLP 4200WD, press the ▲ or ▼ button until the display reads `MODULE SELECTION`, then press Enter.
2. Press ▲ or ▼ until the display indicates the transmitter module you wish to reset, then press Enter.
3. Press ▲ or ▼ until the display reads `TRANSMITTER ADJUSTMENTS`, then press Enter.
4. Press ▲ or ▼ until the display reads `SWITCH TO FACTORY SETTINGS`, then press Enter.
5. A message appears, telling you that all settings will be changed. Press Enter.
6. A message appears, `<ESC> TO ABORT OR <SET+UP/DN> TO SWITCH`. Hold down the Set button and press ▲ or ▼, then press Enter.
7. A confirmation message appears. Press Enter.

The transmitter reverts to the factory-optimized settings:

- If the transmitter is in AGC mode, the internal RF pad level adjusts to get the adequate drive level to the laser for optimized performance.
- If the transmitter is in MGC mode, the transmitter reverts to factory settings based on Table 4-1, *Factory Setup*, on page 4-2, regardless of the actual RF input level. For the best performance, you must adjust the input level to 15 dBmV per channel. For instructions, see Section 4.4.2 *Fine-Tuning the Transmitter* on page 4-8.

4.5 Setup via NETWatch Site Controller

If you are using a platform that does not have a display (such as the HLP 4200ND), you can use NETWatch Site Controller for transmitter setup. For details on communication with the PWL 4100S through the NETWatch Site Controller element management system, consult the *NETWatch Site Controller Instruction Manual*.

To use NETWatch Site Controller to set up the PWL 4100S:

1. Verify that the PWL 4100S module is properly installed in the HLP 4200 platform. Instructions are provided in Section 2.2 *Installing the Transmitter Module* on page 2-1.
2. Verify that the platform is powered on and that no alarm conditions exist within the transmitter module; make sure that the module icon in the NETWatch display is green.
3. Select automatic gain control (AGC) mode of operation.
4. Set the RF input level to the value given in Table 4-1, *Factory Setup*, on page 4-2.
5. Select manual gain control (MGC) mode of operation.

4.6 Setup via the Transmitter's Front Panel Controls

This section provides instructions for setting up the PWL 4100S via the RF adjustment control on the front panel of the transmitter module. Use this interface only when the first two setup options, described in Section 4.4 and Section 4.5, are not available.

NOTE: For initial setup of the transmitter, Harmonic recommends that you use the HLP 4200WD platform display interface, if available, and that you follow the setup procedure in Section 4.4.

If you are using an equipment platform that has been configured without a display (such as HLP 4200ND) and NETWatch Site Controller is not available, follow the procedure below to set up the PWL 4100S module:

1. Verify that the transmitter module is properly installed in the platform. See Section 2.2 *Installing the Transmitter Module* on page 2-1.
2. Verify that the RF input level to the transmitter is in the 15 to 22 dBmV range.

3. Verify that the RF input signal is properly connected to the transmitter. See Section 2.3 *Connecting the Fiber Cable* on page 2-3.
4. Using the *RF Adj* control on the front panel, adjust the RF input level to the value given in Table 4-1, *Factory Setup*, on page 4-2. For further details on how to use the RF adjustment switch, see Section 3.3 *Front Panel RF Adjustment* on page 3-6.

5

Maintenance

This chapter describes how to:

- Clean fiber optic connectors
- Replace the fan in the PWRLink™ II 4100S Series Optical Transmitter

5.1 Cleaning Fiber Optic Connectors

DANGER: The fiber cable carries invisible laser radiation. **AVOID EXPOSURE TO THE BEAM.** Never operate a unit that has a broken fiber or a disconnected fiber connector. For further information, see *A.9 Laser Radiation Warning* on page A-5.

Dirty optical connectors are the leading source of poor performance in an optical fiber network. Dirty optical connectors lead to optical signal loss and reflections, which in turn can seriously degrade carrier-to-noise (CNR) performance and, in some cases, distortion performance.

Therefore, Harmonic recommends that you clean all mating fiber connectors, before connecting them to an optical device.

In addition, if you suspect that the optical connector of a PWL 4100S may have been exposed to contamination (by a dirty fiber cable connector, for example), you should properly clean the PWL 4100S optical connector before connecting optical fiber.

CAUTION: Improper cleaning of an optical connector can do more harm than good. Never spray a clean-air product onto the surface of an optical connector. Spraying air onto an optical connector can cause condensation on the connector surface, leaving water spots and trapping dust. Failing to wipe a connector on dry lens paper immediately after wiping on paper wet with isopropyl alcohol can also lead to condensation on the connector. Using low-grade cleaning paper or other cloth to wipe an optical connector can leave microscopic fibers on the optical connector surface.

5.1.1 Cleaning Patch Cord or Pigtail Fiber Optical Connectors

To clean optical connectors, Harmonic recommends using a fiber optic connector cleaning cartridge (such as NTT Cletop). If a cleaning cartridge is not available, follow these steps.

1. Fold a piece of unused dry lens cleaning paper twice, for a four-ply thickness.
2. Use a drop of high-grade isopropyl alcohol to wet part of the paper.
3. Lay the connector on the lens cleaning paper with the tip touching the paper.
4. In one continuous motion, pull the connector from the wet part of the paper to the dry part.

5.1.2 Cleaning Transmitter Module Optical Connectors

To clean the optical connector of a PWL 4100S:

1. Remove the transmitter module from the HLP 4200 platform.
2. Inspect the bulkhead adapter for cleanliness with a video inspection scope, if available.
3. Clean the bulkhead adapter and internal connector with either a 2.5 mm optical connector swab or bulkhead adapter cleaning tools such as the Seikoh-Giken FerruleMate.
4. If alcohol is used in above step, finish with a dry swab or bulkhead adapter cleaning tools.
5. Inspect the bulkhead adapter for cleanliness with a video inspection scope, if available. Repeat steps 3 and 4 until the adapter and internal connector meet applicable cleanliness requirements.

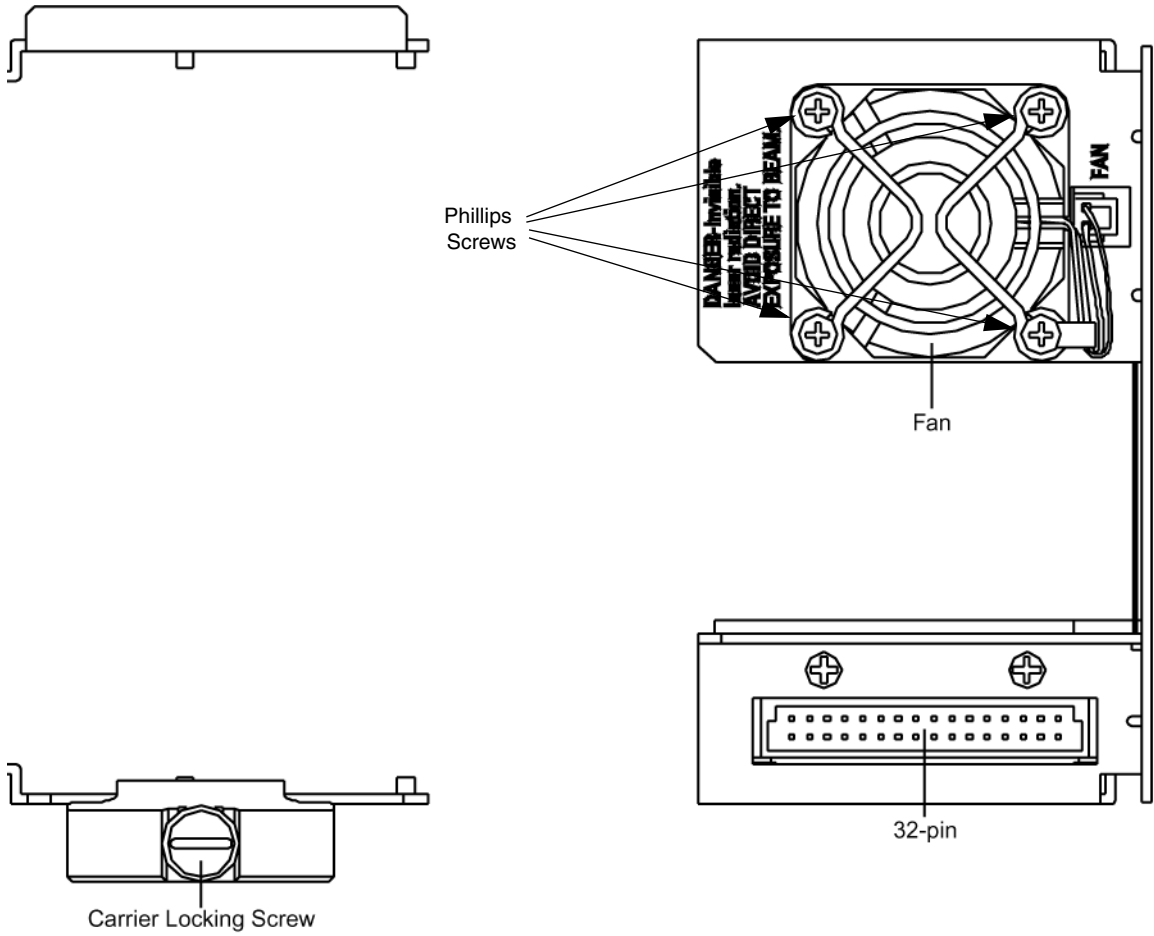
5.2 Fan Replacement

NOTE: The fan assembly mounted on the HMC 4001 carrier may be replaced without removing or disabling the PWL 4100S module. Under normal headend and central office environmental conditions, the transmitter can operate without fan cooling for a limited time.

Should a fan failure occur, contact Harmonic's technical service (see 6.2 *Case of Problems* on page 6-1).

To replace the fan:

1. Disconnect the fan's power cable.
2. Remove the four Phillips head screws, shown in Figure 5-1 on page 5-3, that secure the fan to the module housing.
3. Replace the failed fan unit with a new fan unit.
4. Secure the new fan unit with the four Phillips head screws.
5. Reconnect the power cable.



PL49CRR

Figure 5-1. HMC 4001 fan replacement

6

Troubleshooting

This chapter describes:

- How to troubleshoot the PWRLink™ II 4100S Series Optical Transmitter
- How to return the unit for service
- Manufacturer disclaimer

6.1 Troubleshooting

Should a problem occur, check the following:

1. View the Status LED on the transmitter's front panel to determine if an alarm condition is indicated. See *Front Panel LED Indicators* on page 3-6.
2. View the HLP 4200WD front panel display to determine if an alarm condition is indicated.
3. Confirm that the PWL 4100S is receiving power.
4. Confirm that the controller cable is connected to the transmitter module and the HLP 4200.

6.2 In Case of Problems

If you continue to have a problem, contact the Harmonic Customer Service department (see Appendix D, *Harmonic Inc. – Offices*). A service technician will assist you in determining whether a fault exists with the unit.

If the service technician determines that you need to return the unit, she or he will issue you a Return Material Authorization (RMA) Number. You must include this RMA number on the shipping container when returning the unit, and with all correspondence regarding the unit.

To return the unit, send it to one of the Harmonic Headquarters addresses listed in Appendix D, *Harmonic Inc. – Offices*. Please add the note:

Attn.: Customer Service
RMA no. _____

6.3 Disclaimer

Harmonic Inc. reserves the right to change any products described herein at any time, and without prior notice. Harmonic assumes no responsibility or liability arising from the use of the products described herein, except as expressly agreed to in writing by Harmonic. The use and purchase of this product does not convey a license under any patent rights, copyrights, trademark rights, or any intellectual property rights of Harmonic. Nothing hereunder constitutes a representation or warranty that using any products in the manner described herein will not infringe any patents of third parties.

Appendix A

Technical Specifications

A.1 Link Performance

Carrier-to-Noise (CNR): See Figure A-1

Carrier-to-CSO: >64 dB^{1,2}

Carrier-to-CTB: >69 dB^{1,2}

In Figure A-1, CNR and optical fiber loss are plotted against each other for PWL 4100S series transmitters with 80 NTSC (System M) channels^{1,3,4} running.

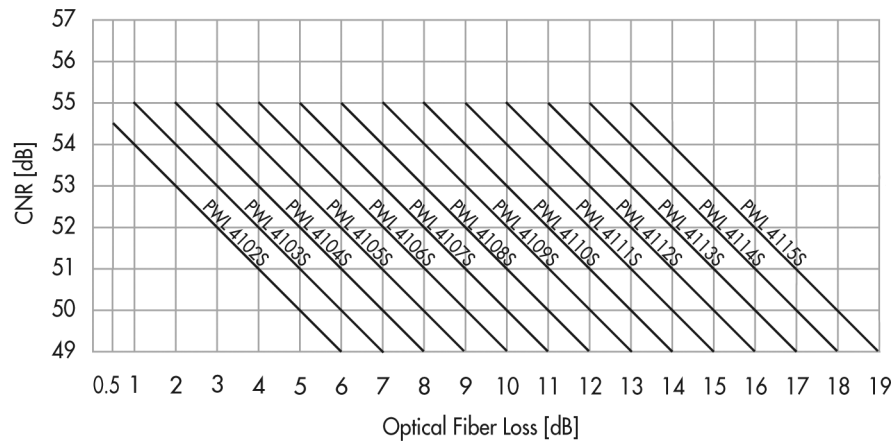


Figure A-1. CNR vs. optical fiber loss

1. Channel loading: 80 unmodulated System M (NTSC) channels up to 550 MHz and 450 MHz digital at -6 dBc.
2. Performance expected at +25° C. For operation over entire temperature range, subtract 3 dB from CSO and 2 dB from CTB.
3. Optical link defined as PWRLink II transmitter + 100% fiber link + HRM 3811 receiver.
4. When the link includes optical splitter loss, add 0.15 dB to CNR for every 1 dB of splitter loss.

A.2 Optical Output

Wavelength: 1300 to 1320 nm

Flatness: <1 dB peak-to-valley

Eye protection: Safety shutter

Optical return loss:

For SC/APC connectors: < -65 dB

For other connectors: < -55 dB

Table A-1: Optical Power

Transmitter Model	Optical Power (dBm)
PWL 4102S	2.5 ±0.5
PWL 4103S	3.5 ±0.5
PWL 4104S	4.5 ±0.5
PWL 4105S	5.5 ±0.5
PWL 4106S	6.5 ±0.5
PWL 4107S	7.5 ±0.5
PWL 4108S	8.5 ±0.5
PWL 4109S	9.5 ±0.5
PWL 4110S	10.5 ±0.5
PWL 4111S	11.5 ±0.5
PWL 4112S	12.5 ±0.5
PWL 4113S	13.5 ±0.5
PWL 4114S	14.25 ±0.75
PWL 4115S	15.25 ±0.75

A.3 RF Input

Input level range per unmodulated analog channel: 15 to 22 dBmV

Operational bandwidth: 45 to 1003 MHz

Frequency response: <1 dB peak-to-valley

RF attenuator adjustment range: 10 dB

Impedance: 75 ohm

Return loss: >16 dB

Level control: manual (MGC)/automatic (AGC); auto setup feature

A.4 User Interface

Front panel

Bi-state status LED: Normal = Green, Alarm = Red

Module selection indicator: Yellow LED

RF attenuation adjustment

Monitor point:

Flatness: ± 0.5 dB

Return loss: > 16 dB

Connector type: Female F

Level: -20 ± 1.5 dB below input

Rear panel

RF input connector type: Female F

Optical output (for connector types available, see Section A.8)

Element Management System—NETWatch Site Controller

HEM interface: RS-485, RS-232C connectors (in HLP 4200)

Carrier: Externally generated

A.5 Power Requirements

Nominal: +24 VDC, supplied by HLP 4200 bus

Maximum: +28 VDC

Consumption: 22 Watts maximum

A.6 Environmental

Operating temperature¹: 0° to +50° C / +32° to +122° F

Storage temperature: -40° to +70° C / -40° to +158° F

Automatic fan adjustment at: 40° & 50° C / 104° & 122° F

Relative humidity: Maximum 85% non-condensing

Software over temperature laser protection

1. For operation over entire temperature range, subtract 3 dB from CSO and 2 dB from CTB.

A.7 Physical

Dimensions (W x H x D): 1.3" x 4.4" x 12.7" / 3.3 cm x 11.2 cm x 32.2 cm

Weight: 0.95 kg / 2.1 lbs

Mounting: HLP 4200 platform, one half-module slot; via HMC module carrier

Optical connector type: SC/APC¹, FC/APC, SC/UPC, FC/UPC, E2000

RF connector type: Standard F, RG-59 cable type (accepts 0.64 to 0.8 mm center conductor diameter)

A.8 Models Available

PWL 4102S through PWL 4115S

PWL 41xxS-zz

xx = Model Number: 02 to 15

zz = Connector Type: AS, AF, US, UF or AE

AS = SC/APC

AF = FC/APC

US = SC/UPC

UF = FC/UPC

AE = E2000

1. SC/APC is the connector type recommended by Harmonic. Other connector types available upon request.

A.9 Laser Radiation Warning

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated (July 26, 2001) as applicable to Class 1M Laser Products.



This light emission device is classified to IEC 60825-1:1993 + A1 + A2

CAUTION: INVISIBLE LASER RADIATION. DO NOT VIEW DIRECTLY WITH MAGNIFIERS. CLASS 1M LASER PRODUCT.

Viewing the laser output with optical instruments (e.g. magnifier, microscopes) within a distance of 100mm may pose an eye hazard.

WARNUNG: UNSICHTBARE LASERSTRAHLUNG. NICHT DIREKT MIT LUPE BETRACHTEN. KLASSE 1M LASER PRODUKT.

Das betrachten des Laser Ausgangs mit optischen Instrumenten (z.B. Vergrößerungsglas, Mikroskope) innerhalb eines Abstandes von 100mm kann eine Augenverletzungs-Gefahr darstellen.

ATTENTION: RADIATION LASER INVISIBLE. NE PAS OBSERVER À LA LOUPE DIRECTEMENT. PRODUIT LASER CLASSE 1M.

L'observation des effets lasers à l'aide d'un appareil optique (comme loupe, microscope...) à une distance jusqu'à 100 mm peut poser un danger à l'oeil.

A.10 Agency Certifications

UL60950, CSA60950 (cTUVus)

FCC Part 15 Class A, VCCI, CDRH

EN60950, EN60825-1 (TUV GS-mark)

EN55022 Class A, EN55024 (TUV EMC-mark, CE)

A.11 Compliance with WEEE

Harmonic will ensure that all products that cannot be re-used will be recycled in compliance with the WEEE Directive. To that end, users are advised that (1) Harmonic equipment is not to be discarded in household or office garbage, (2) customers may consult the Harmonic web site (www.harmonicinc.com) for additional and updated information on this process.





Appendix B

HLP 4200WD Menu Display

Figure B-1 and Figure B-2 provide a flowchart of the commands and messages in the Transmitter Menu of the HLP 4200WD platform display.

In these figures, push-button commands are framed in ovals, and resultant display messages are framed in rectangular boxes. Use the HLP 4200WD's ▲ and ▼ buttons to scroll through the menus. Use the Enter button to make a selection. Use the Esc button to escape any menu.

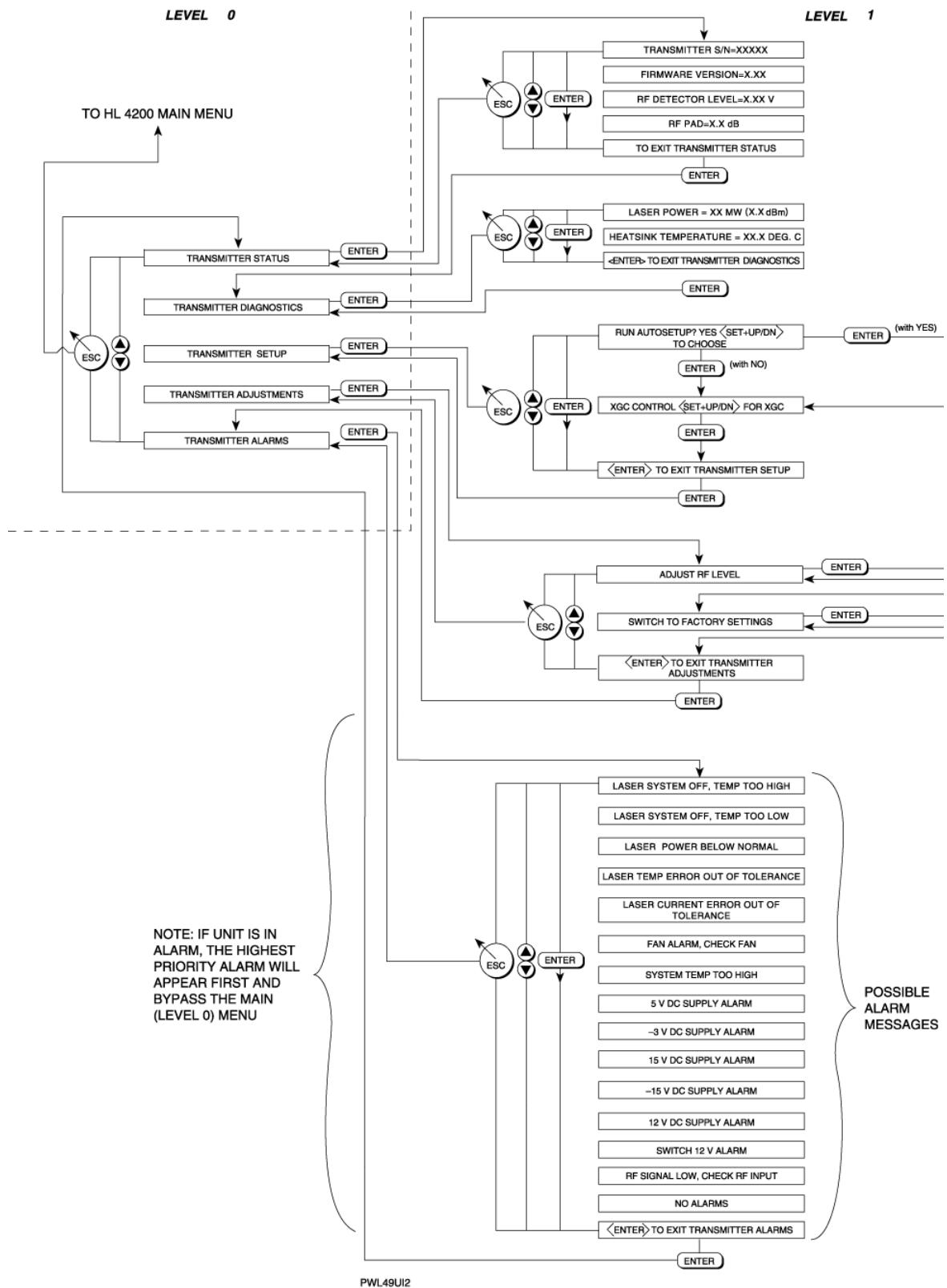


Figure B-1. HLP 4200WD platform Transmitter menu display, levels 0 and 1

LEVEL 2

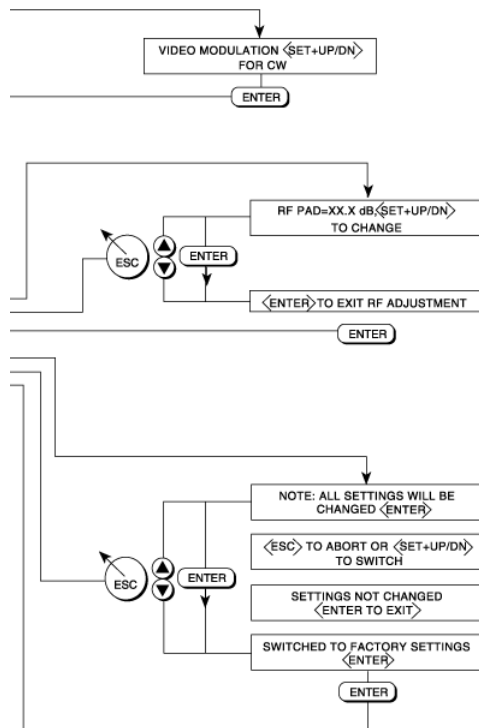


Figure B-2. HLP 4200 WD platform Transmitter menu display, level 2

Appendix C

Using Modulated Carriers

This appendix provides information about setting up PWRLink™ II 4100S Series Optical Transmitters for use with modulated carriers.

PWL 4100S transmitters are adjusted at the Harmonic factory for specified CNR, CSO and CTB using NTSC unmodulated carriers.

When the carriers are modulated:

- The average power of the modulated carrier is about 2 dB lower than the unmodulated carrier.
- Sideband signals are generated and the carrier level is reduced. The average carrier level is about 3 dB lower than the unmodulated carrier.
- There will be a period when the carrier is not being modulated, so that the peak value of the modulated carrier is the same as that of the unmodulated carrier.

When setting up the transmitter with modulated carriers, there are typically two different objectives, as described in the two sections below. You need to choose the objective that best fits your system requirements.

Objective 1

When following Objective 1:

- The goal is to achieve the maximum possible modulation, with better CNR by about 2 dB compared to unmodulated carriers.
- Average CSO and CTB will be the same as the unmodulated case. Higher CSO and CTB occur occasionally, for brief instants.

This objective can be achieved by setting up the transmitter with modulated carriers in CW mode when running Autosetup. See Figure C-1 on page C-3.

Remember that the modulated carriers are about 2 dB lower in average RF power. This is what the transmitter's built-in detector will determine. The transmitter responds to this drop at the detector by setting the pad 2 dB lower than the factory optimized setting.

In this case, the average input RF power is adjusted to be the same as in the unmodulated carrier. However, the carrier peak level is about 2 dB higher. Thus, the CNR is typically 2 dB better in this scenario than in the case of unmodulated carriers.

The transmitter has a higher chance of being clipped since modulated carriers reach peak value occasionally, and there is a possibility that the modulated carriers will line up in time and cause clipping. Clipping is not preferred for transmitters with high digital loading.

Objective 2

When following Objective 2:

- The goal is to achieve the same peak carrier RF value, so that the CNR remains unchanged compared to unmodulated carriers.
- Average CSO and CTB will be better than for unmodulated carriers, because the average channel's peak RF level is 3 dB lower for the modulated carriers.

This objective can be achieved by setting up the transmitter with modulated carriers in video mode when running Autosetup. See Figure C-1 on page C-3.

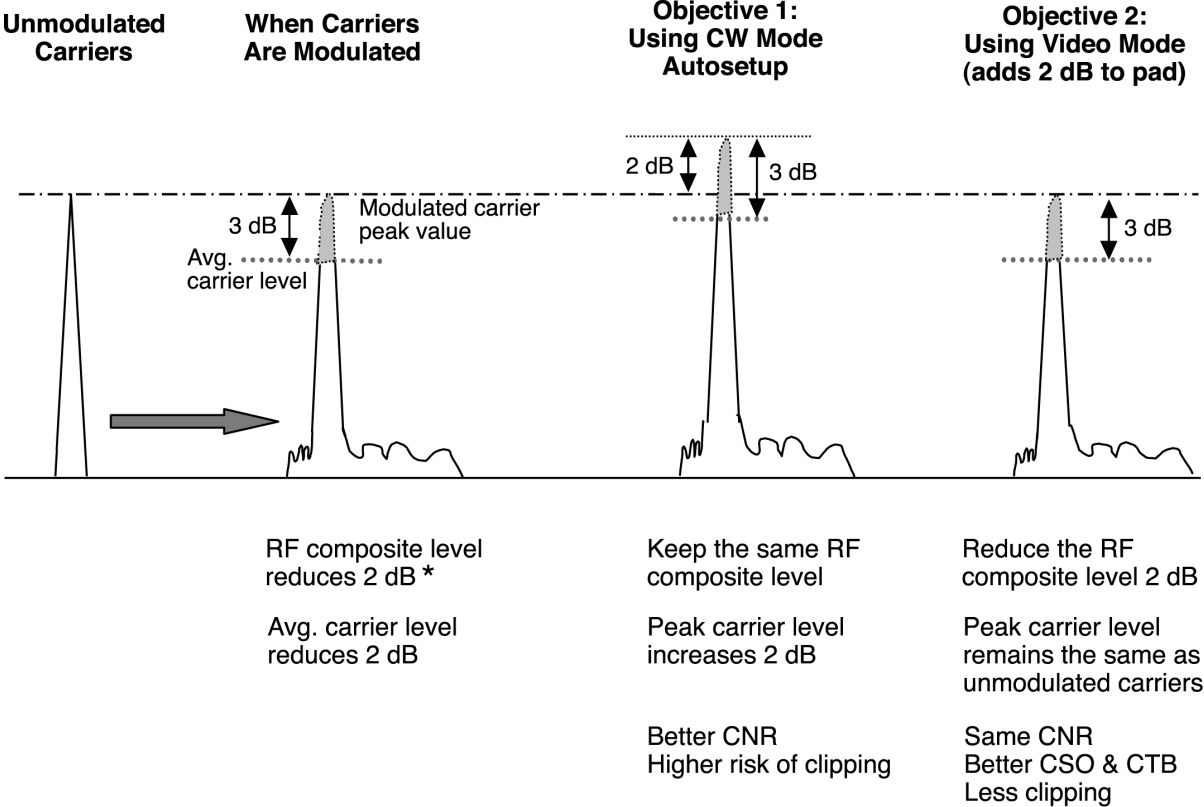
Remember that the modulated carriers are about 2 dB lower in average RF power. This is what the transmitter's built-in detector will determine. The transmitter responds to this drop at the detector by setting the pad 2 dB lower than the factory optimized setting. However, in this case, we know that the peak value of the carrier will be 2 dB higher. To cope with this, Video Mode adds 2 dB of pad and returns the peak carrier back to its original level. Thus, the pad value returns to its original value, and the CNR returns to the same value as in the unmodulated carrier case.

With a PWL 4100S transmitter set up this way with modulated carriers, the average power is 2 dB below the setup for carriers without modulation. The probability of clipping the laser is reduced. This provides better capability to add digital loading, above the 550 MHz video band.

Conclusion

Figure C-1 on page C-3 is a diagram of the Autosetup results. Using Autosetup to achieve one of the two objectives described above will satisfy most applications.

However, Autosetup will not satisfy all applications. You also need to fine-tune the transmitter to fit your specific requirements and preferences precisely. You can accomplish this by adjusting the pad manually after following the Autosetup procedure. See Chapter 4, *Transmitter Setup*.



* The composite level drop depends on the modulator. Harmonic assumes a 2 dB reduction in RF composite. Fine tuning can be achieved by adjusting the RF pad.

Figure C-1. RF spectrum with modulated carriers



Appendix D

Harmonic Inc. – Offices

Assistance

For technical support and customer service, call toll free: 800.730.4099.

Harmonic's web address is www.harmonicinc.com.

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