PathTrax

User's Manual

The solution for making easy shielding effectiveness measurements.

PRAXSYM
DISTINCTIVE SOLUTIONS

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Warranty Statement

PRAXSYM warrants that all items will be free from defects in material and workmanship under use as specified in this guide for a period of one year from date of delivery. PRAXSYM further agrees to repair or replace, at its discretion, any failure which upon PRAXSYM's inspection appears to be a result of workmanship or material defect. In no case, shall PRAXSYM's liability for breach of warranty exceed the purchase price of the items in question. PRAXSYM's liability on any claim of any kind, for any loss connected with, or resulting from the use of, performance or breach thereof, installation, inspection, operation or use of any equipment furnished by PRAXSYM, shall in no case exceed the purchase price of the goods which give rise to the claim.

Praxsym, Inc.
120 S. Third Street
Fisher, IL 61843

P: 217-897-1744
Sales@praxsym.com
www.praxsym.com

Chapter 1 General Information

Introduction

PathTrax is a user-friendly microprocessor-based transmitter and receiver system that measures relative signal strength, path loss and shield level. The units are powered by rechargeable batteries for up to 4 hours of continuous operation (2 hours for the transmitter). The battery charging circuitry allows full recharge in 90 minutes or less.

The large backlit LCD screen provides numeric as well as graphic representation of signal levels. Operation is via top mounted controls or through the USB port provided. Complete control of the unit's operation can be accomplished via the serial port, with the exception of power ON/OFF and receiver volume. Measurement data can be transferred to a portable computer for later analysis.

Equipment List

- Transmitter
- Receiver
- Hard Shell Case
- USB Patch Cable
- User's Manual
- Driver CD
- Two Power Supplies
- Two Antennas
- 32 Stereo Ω Headphones

Safety/Handling

- The PathTrax system has been designed to survive in-field usage, however the following handling restrictions should be observed:
- Protect the units from electrostatic discharge.
- Do not connect high power (>10 mW) RF sources to the RF connectors.
- Do not connect DC sources to the RF connectors.

Specifications

All models of the PathTrax line share the same specifications except for the operating frequency. The frequency ranges for these models are listed below:

Pathtrax 915 covers 885 to 960 MHz

Pathtrax 860 covers 824 to 900 MHz

Pathtrax 838 covers 806 to 870 MHz

Pathtrax 500 covers 489 to 512 MHz

Receiver

Tuning Step Size:	1 MHz, 100 kHz and 10 kHz
Operating Modes:	Signal Strength, Spectrum Monitor, Path Loss, Shield Level
IF Bandwidth:	15 kHz nominal
1st IF:	90 MHz
2nd IF:	450 kHz
RF Input Connector:	TNC Female (BNC on Pathrax 500)
RF Input Impedance:	50 Ω nominal
Input Preselection:	4 pole Chebychev, 80 MHz 1 dB bandwidth
Measurement Accuracy:	+/- 1.0 dB (-110 dBm to 0 dBm) +/- 2.0 dB (-120 dBm to -110 dBm)
Maximum Safe Input Level:	+10 dBm (10 mW) minimum
Battery Operation:	4 hours minimum at full charge
AC/Charger Operation:	95-265 VAC, 48-65 Hz

Charge Time:	90 minutes typical
Remote Operation:	via USB interface
I/O Connectors:	5-pin, mini-USB, type B connector
Controllable Functions:	All functions except ON/OFF/Volume
Output Data:	All measurement data and instrument status
Reading Rate:	500 ms (step tuning frequency and read data)
Controls:	ON/OFF/VOLUME, FREQUENCY TUNE, COARSE/FINE, THOLD (sets threshold for go/no-go testing), LOCK (locks out control panel), MODE (SIGNAL STRENGTH, SPECTRUM MONITOR, PATH LOSS, and SHIELD LEVEL) and CAL (provides path loss or shielding reference level normaliza tion)
LED Indicators:	BATTERY OVERTEMP, BATTERY CHARGE, BATTERY FAULT
LCD Displayed Functions:	Frequency, Battery Level, Mode (Signal Strength, Spectrum Monitor Path Loss and Shield Level), CAL Status, LOCK Status, Frequency Adjust Status (Coarse or Fine)
Weight:	5.5 lb. Nominal
Case Size:	11.7″H x 5.1″D x 4.9″W

Transmitter

Tuning Step Size:	1 MHz, 100 kHz and 10 kHz
Maximum Output Power:	+30 dBm nominal (1 Watt)
Output Power Control:	1 dB steps from –30 to +30 dBm
Output Level Accuracy:	+/- 1.0 dB maximum over Temp and Frequency
Harmonics:	-50 dBc typical
Output Impedance:	50 Ω nominal
Load VSWR:	Safe operation into infinite VSWR
RF Output Connector:	TNC Female (BNC on Pathtrax 500)
Battery Operation:	2 hours minimum at full charge
Batteries:	Nickel Cadmium 9.6V @ 1800 mAh
AC/Charger Operation:	95-265 VAC, 48-65 Hz
Charge Time:	90 minutes typical
Remote Operation:	via USB interface
I/O Connectors:	5-pin, mini-USB, type B connector
Controllable Functions:	All functions except ON/OFF
Output Data:	Instrument Status
Reading Rate:	500 ms (step tuning frequency)
Weight:	5.5 lb. Nominal
Case Size:	11.7″H x 5.1″D x 4.9″W

Chapter 2 Controls and Connections

Receiver

FREQUENCY – F.DIGIT – The frequency select knob operates in conjunction with the F.DIGIT button. Pressing the F.DIGIT button toggles the step size between 10 kHz, 100 kHz, and 1 MHz. The current step size is displayed on the FRQ ADJ line of the display. Turning the knob clockwise increases the frequency by the selected step size. Counter-clockwise rotation decreases the frequency by the selected step size.

MODE – The Mode button toggles the receiver between Signal Strength, Spectrum Monitor, Path Loss and Shield Level. The current mode is always displayed on the LCD screen. Press the Mode button until the desired mode of operation is displayed.

CAL – When setting up the unit for Path Loss or Shield Level measurements, pressing this button initiates the internal System Calibration sequence. (See OPERATION section for details)

THOLD – These two buttons increment the threshold value up or down. The value is displayed on the LCD. This is the signal level at which the audible alarm is triggered.

LIGHT – This button activates the backlighting for the LCD display.

LOCK - The lock button toggles on and off to lock the control panel, in order to guard against accidental changes during a measurement. The status of the lock function is displayed on the LCD screen.

POWER ON/OFF/VOLUME – Turn the control clockwise to power ON the unit and counter-clockwise to turn it off. The volume control changes the audio level for the alarm output.

PHONES – This is the audio jack for the threshold tone output. The supplied headphones can be plugged into this output jack.

INPUT – RF Input connector (50 OHM)

REMOTE – This is the USB connection port. (See the section on remote operation for details on this connection.)

Transmitter

FREQUENCY – F.DIGIT – The frequency select knob operates in conjunction with the F.DIGIT button. Pressing the F.DIGIT button toggles the step size between 10 kHz, 100 kHz, and 1 MHz. The current step size is displayed on the FRQ ADJ line of the display. Turning the knob clockwise increases the frequency by the selected step size. Counter-clockwise rotation decreases the frequency by the selected step size.

MODE – The mode button toggles the unit between FREQ and ATTEN. The current mode is displayed on the MODE line of the display. When in the Frequency mode, the FREQUENCY select knob steps the frequency as set by the F.DIGIT button. When in the Attenuator mode, the FREQUENCY select knob steps the output level as set by the F.DIGIT button.

ATTEN – Pressing the ATTEN button changes the power output level in 10 dB steps, from -30 to +30 dBm. The current power level is displayed on the LCD screen. Press the ATTEN button until the desired output power is displayed. When the MODE is set to the ATTEN then the FREQUENCY select knob will change the output power in 1, 2, or 5 dB steps selected by the F.DIGIT button.

LIGHT – This button activates the backlighting for the LCD display.

LOCK – The lock button toggles on and off to lock the control panel in order to guard against accidental changes during a measurement. The status of the lock function is displayed on the LCD screen.

POWER – This is a rotary ON/OFF switch. Rotate clockwise to turn ON, rotate counter-clockwise to turn OFF.

OUTPUT – RF output connector (50 OHM)

REMOTE – This is the USB connection port. (See section on remote operation for details on this connection.)

Chapter 3 Operation

Receiver Modes

The receiver has four different modes. Pressing the MODE button will cycle through SIGNAL STRENGTH, SPECTRUM MONITOR, PATH LOSS, and SHIELD LEVEL modes. The selected mode of operation is shown on the LCD.

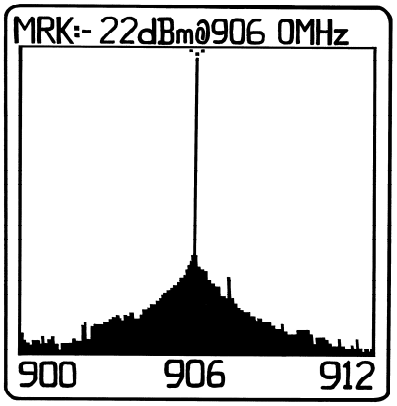
Signal Strength Mode

SIGNAL STRENGTH mode is used to measure the signal level of a continuous wave (CW) signal. The receiver has a narrow (+/-7.5 kHz) IF bandwidth enabling it to measure a test signal in the presence of interfering signals in the same band. Although the receiver has no demodulation capabilities, it can be used to measure the signal level of narrow band modulated signals. The signal strength is displayed on the LCD display in dBm (decibels relative to 1 mW). The receiver is calibrated at the time manufacture by applying signals of known levels to the RF connector. Antenna gain must be accounted for when making measurements using different antennas.

One should monitor the proposed test frequency in SIGNAL STRENGTH mode to ensure that no interfering signals are present, before making measurements in PATH LOSS or SHIELD LEVEL modes. To take full advantage of the dynamic range of the receiver, interfering signals measured at the test frequency should be below -120 dBm. If an interfering signal is present, the level will be displayed on the LCD. Choose a clear frequency before operating the transmitter.

Spectrum Monitor Mode

In SPECTRUM MONITOR mode the receiver can be used to view a 1.2 MHz span of the frequency spectrum. This mode is ideal for locating a clear frequency that you can use for conducting a test or for identifying large interfering signals that could cause errors in measurements. Use the receiver's left and right THOLD buttons to move between each 1.2 MHz span of spectrum. The Frequency control rotary knob adjusts the position of the marker.



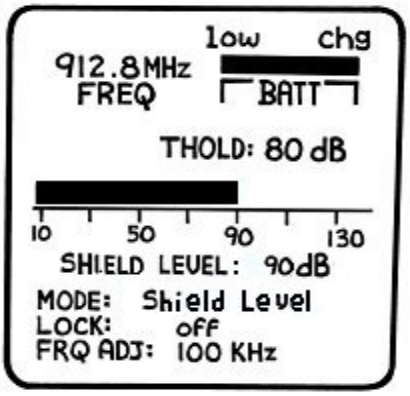
Spectrum Monitor Mode

Path Loss Mode

PATH LOSS mode can be used to measure the amount of attenuation/path loss between the transmitter and receiver. Before making path loss measurements, the receiver is initialized with the transmitter to obtain a baseline measurement of 0 dB. Once initialized, the receiver can be moved around the stationary transmitter while monitoring the change in path loss.

Shield Level Mode

SHIELD LEVEL mode can be used to measure the amount of attenuation/shield level that is provided by an enclosure or other obstacles between the transmitter and receiver. Before making shield level measurements, the receiver is initialized with the transmitter to obtain a baseline measurement of 0 dB.



Shield Level Mode

Receiver Initial Set-up and Power On

Attach one of the antennas to the RF connector located on the top of the receiver. Rotate the POWER switch to the ON position.

The receiver powers up in SIGNAL STRENGTH mode. In SIGNAL STRENGTH, the receiver displays the level of signals at the current frequency. Allow the receiver to warm up for 5 minutes before taking measurement data.

Setting the Receiver Frequency

The receiver powers up each time tuned to the default frequency. Rotate the FREQUENCY adjust knob to tune the receiver in 1 MHz steps.

Depress the F.DIGIT button to rotate the step size between 10 kHz, 100 kHz, and 1 MHz. The current step size is displayed on the FRQ ADJ line of the display. Rotate the FREQUENCY adjust knob to tune the receiver in the selected step size.

Setting the Receiver Tone Threshold

The receiver contains an audio tone generator that can be used to alert the operator if a shield level has dropped below a predetermined threshold level. This feature is especially useful when sweeping across seams or around openings in a shielded enclosure when the LCD is not easy to view. The tone alert feature may only be used in SHIELD LEVEL or PATH LOSS mode. The frequency of the output tone is determined by the signal level measured by the receiver.

Using the THOLD arrow keys on the top of the receiver, adjust the threshold level to the desired level that the tone will be turned on. The threshold level is displayed on the LCD on the THOLD line.

Connect the 32 Ω headphones to the PHONES jack on top of the receiver. The receiver's ON/OFF switch is also the volume control for the tone generator output.

Transmitter Initial Set-up and Power On

Attach one of the antennas to the RF connector located on the top of the transmitter.

Rotate the POWER switch to the ON position.

Allow the transmitter to warm up for 5 minutes before beginning a test.

Setting the Transmitter Output Level

The transmitter powers up with output level set to -30 dBm (60 dB attenuation). The output level of the transmitter is adjusted by changing the attenuation setting of the output attenuator. -30 dBm output level corresponds to 60 dB attenuation and +30 dBm (1 Watt) corresponds to 0 dB attenuation.

Depress the ATTN button on the top of the transmitter to step the output attenuator in 10 dB steps. The attenuation level always increases in 10 dB steps, and to the next even 10 dB amount. For example, if the attenuator has been set at 13 dB using the rotary control in ATTEN mode, pressing the ATTN button will move the attenuator to 20 dB, 30 dB and so on. When the attenuation level is set to 60 dB, depressing the ATTN button will move the attenuation level to 0 dB.

Depress the MODE button on the top of the transmitter to toggle the function of the FREQUENCY control knob between frequency adjust mode and power adjust mode. This allows adjustment of the output attenuator in smaller steps. The current setting of the MODE button is displayed on the LCD.

Depress the F.DIGIT button on the top of the transmitter to increment the FREQUENCY select knob between 1, 2, and 5 dB steps. The current attenuator step size is displayed on the "PWR ADJ" line of the display.

Setting the Transmitter Frequency

The transmitter powers up tuned to the default frequency of the transmitter model. Depress the MODE button on the top of the transmitter to select "FREQ" mode.

Rotate the FREQUENCY adjust knob to tune the transmitter in 1MHz steps.

Depress the F.DIGIT button to rotate the step size between 10 kHz, 100 kHz, and1 MHz. The step size is listed at the bottom of the display. Rotate the FREQUENCY adjust knob to tune the transmitter in the selected step size.

Making Path Loss Measurements

Before making path loss measurements, turn on the transmitter and receiver, tune both units to the test frequency, set the transmitter attenuator to 60 dB, and allow both units to warm up for 5 minutes.

With the receiver in SIGNAL STRENGTH mode, monitor the test frequency to insure no interfering signal is present on your test frequency.

Place the transmitter at the test location. Place the receiver at a location approximately 5 feet from the transmitter and at the same height. Set the receiver to PATH LOSS mode, the receiver will flash "INITIALIZE? PRESS CAL" on the display.

Ensure that there are no obstructions between the transmitter and receiver and then press the CAL button on the top of the receiver. The display should indicate a PATH LOSS of 60 dB.

Return to the transmitter and depress the ATTN button. The attenuation will change to 0 dB so that the transmitter output power is now +30 dBm.

Verify that the receiver displays a PATH LOSS between 0 and 3 dB. This reading may vary slightly as every environment is unique.

The receiver may now be moved about and will display the PATH LOSS to the test transmitter.

Depress the LOCK button to prevent accidental changes to the control settings, which may lead to measurement errors.

Making Shield Level Measurements

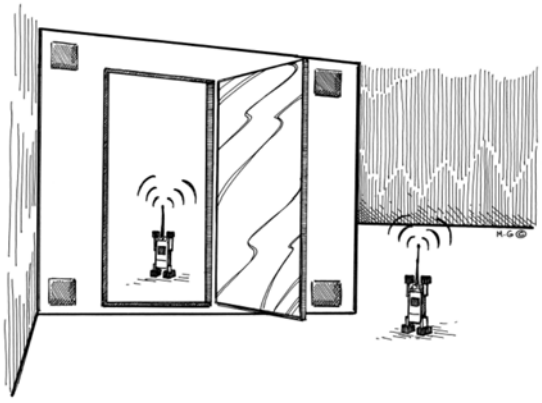
Before making shield level measurements, turn on the transmitter and receiver, tune both units to the test frequency, set the transmitter attenuator to 60 dB, and allow both units to warm up for 5 minutes.

With the receiver in SIGNAL STRENGTH mode, monitor the test frequency to insure no interfering signal is present on your test frequency.

Place the transmitter inside the enclosure on a marked reference position near the center of the enclosure.

Place the receiver outside the enclosure on a marked reference position at least four feet from the transmitter and at the same height. Ensure that the receiver reference position is within line of sight of the transmitter. Set the receiver to SHIELDING LEVEL mode, the receiver will flash "INITIALIZE? PRESS CAL" on the display.

Ensure that there are no obstructions between the transmitter and receiver and then press the CAL button on the top of the receiver. The display should indicate a SHIELDING LEVEL of 60 dB.



Return to the transmitter and depress the ATTN button. The attenuation will change to 0 dB so that the transmitter output power is now +30 dBm.

Verify that the receiver displays a SHIELDING LEVEL between 0 and 3 dB. This reading may vary slightly as every environment is unique.

Close the door to the enclosure and begin sniffing with the receiver. The receiver is now measuring and displaying the SHIELDING LEVEL of the enclosure.

Using the THOLD arrow keys on the top of the receiver, adjust the threshold level to the desired level that the tone will be turned on. The threshold level is displayed on the LCD on the THOLD line.

Depress the LOCK button to prevent accidental changes to the control settings, which may lead to measurement errors.

Recharging the PathTrax Units

The normal battery charge procedure consists of the following steps:

1. Insert the plug of the AC/DC 15 V adapter into the recharge receptacle on the right side of the PathTrax Transmitter or Receiver. Plug the charger line cord into an AC source (95-250 VAC, 47-63 Hz). The green CHARGE light on the front face of the PathTrax unit will illuminate during the entire fast charge cycle. The fast charge cycle of a discharged battery will normally take 1.5 to 2 hours. When the unit is fully charged, the CHARGE light will begin flashing indicating the trickle charge phase. If the battery voltage drops below the recharge threshold in trickle charge, the charger will reinitiate a fast charge cycle. The PathTrax unit may be left in trickle charge mode over night.

2. The OVERTEMP light indicates that the battery pack has exceeded its maximum temperature during the charge process. When the OVERTEMP light is illuminated, the CHARGE light will be turned off indicating that the charge process has been halted. Once the battery has cooled down to an acceptable temperature, the charge cycle will resume.

3. The FAULT light indicates that the charge process has been terminated. A FAULT will be indicated under the following conditions:
    a. The charge is not normally terminated before the end of the cycle timer.
    b. Excessive input voltage.
    c. Very low battery voltage (indicating shorted cells).
    d. Battery voltage low after 1/12 of charge timer.
    e. Excessive die temperature of the charge controller (This FAULT will resume charging once the temperature drops).
    f. A charge cycle is restarted while the battery is fully charged. When the AC/DC charger pack is turned on with a fully charged battery, the Fault light might illuminate, indicating the batteries are full and no charging will take place. This condition is dependent on many factors including, battery age, battery charge, time since last charge termination, and charger voltage and therefore might not occur in all cases. Should this condition occur, but you would like to begin a new charge cycle, turn the unit on for at least ½ hour (discharge battery) before initiating a new charge cycle.

4. If it becomes necessary to remove or replace the NiCad battery pack (A detailed description of this process can be found on the Praxsym website, www.praxsym.com):
    a. Locate the bottom face plate of the unit, which houses the battery compartment cover
    b. Remove 4 socket head screws from the battery cover bumper
    c. Remove 4 Phillips head screws from the battery cover
    d. Remove the battery cover and disconnect the 2 pin connector
    e. Slide the battery out of the compartment

Chapter 4 Remote Operation

Both the PathTrax receiver and transmitter contain a built-in USB to RS-232 converter allowing the user to connect the PathTrax unit directly to a PC with no external hardware or custom cables. All PathTrax functions can be controlled remotely with the exception of power ON/OFF and Receiver audio output volume. All other functions, including the calibration sequence, can be handled via the USB connection. The commands are in ASCII. All commands are terminated with a CR (carriage return, hex 0D.)

The USB interface uses a Min-USB 2.0 cable (5-pin, supplied). The connector on the unit is a Mini-USB Type B with the following pin-out:

USB Pin	Signal Name	Function
1	VBUS	Bus Voltage (from host)
2	D-	Data
3	D+	Data
4	ID	ID
5	GND	Signal Ground

Configuring the Control Software

The PathTrax units have an asynchronous serial communications interface. A USB to serial converter is built-in. This allows the user to connect the PathTrax units to a laptop computer without the use of external hardware. Because the units use asynchronous serial communications, no special application software is required. The remote interface may be driven by standard terminal emulator software. Versions of this software are available without cost from the internet. A typical version is Tera Term Pro. Before remote control of the PathTrax units can begin, a driver must be installed so that the terminal emulator software can communicate with the USB to serial converter inside of the PathTrax unit.

Install the supplied cable between a USB port on the PC/laptop and the USB port on the PathTrax unit. Start the terminal emulation software.

Open the Terminal setup window from the Setup Menu.

Select CR+LF for Receive
Select CR for Transmit
Enable Local Echo

Open the Serial Port setup window from the Setup Menu. Set the parameters as indicated:

Port:	USB may configure from COM1 to COM12
Baud rate:	9600
Data:	8 bit
Parity:	None
Stop:	1 bit
Flow Control:	None

The settings may be found in various places depending on the terminal emulation software used.

Data Link Layer Description

Transmission Packet

The transmission packet consists of a series of ASCII characters (capital letters) used to identify the packet, optional numerical data represented in ASCII, and a carriage return (0Dh) to indicate the end of the packet.

Transmission Flow

Every packet in each direction is terminated with a carriage return (ASCII 0Dh) to indicate that the packet has been completed. If the PathTrax unit receives 15 characters with no carriage return, it will abort the packet and send an error response to the host. There is no time-out for the transmission of a packet.

Errors

Either host or PathTrax unit will discard a packet if it contains an error. The PathTrax Transmitter and Receiver will respond differently to a packet with an error using a code to help identify the source of the error. If the host receives a packet that contains an error, it must re-issue a command to obtain the desired response. Error response codes are listed below:

Invalid commands sent to the PathTrax Receiver will be acknowledged with an error response. An error response will consist of 4 ASCII bytes followed by a carriage return. The error code consists of the two characters ER followed by a two-character error status code.

- ERIC<CR> Invalid command
  The command was not recognized. Verify the command you are sending is valid.
- ERIN<CR> Invalid number or range
  The data included in the previous command was invalid or out of range.
- ERIM<CR> Incompatible Mode for command
  The command was not recognized because it was entered in an incompatible mode.
- ERNI<CR> Not Initialized, Shield Level not available
  Response to the "SL?" query when the Receiver has not been initialized with the Transmitter.

User Commands

Note: The under score "_" indicates a space (hex 20) is sent in the command
Note: <CR> indicates that the user should press the "enter" key.

Receiver Commands

SS?<CR>	Returns the last measured signal strength in the form (-)XXX (dBm) for the current band. Example: -70
SL?<CR>	Returns the last measured shield level in the form XXX (dB) for the current frequency. Example: 103

PL?<CR>	Returns the last measured path loss in the form XXX (dB) for the current frequency.
	Example: 103
FR = XXX.yy<CR>	Sets receiver frequency (in MHz).
	Example: FR=507.30<CR>
FR?<CR>	Returns the current frequency setting in the form XXX.yy (MHz).
	Example: 500.00
BA?<CR>	Return battery voltage (note the BATT on the display begins to flash at 8.40 volts)
	Example: BA=08.60
VR?<CR>	Returns version
	Example: PATHTRAX TX Vx.xx

Transmitter Commands

FR = XXX.yy<CR>	Set the frequency to XXX.yy where XXX.yy is a frequency within the band covered by the unit. The frequency will be echoed back and rounded down to the nearest frequency that meets the current step size.
	Example: FR=507.00
FR?<CR>	Returns the current frequency of operation.
	Example: FR=505.00

SR?<CR>	Status Request. Returns LC if unit is in Local Mode and RM is unit is in Remote Mode. Next it returns OK if conditions are normal. If the unit has lost phase lock UNLCK is returned. Example: LC, RM, OK, UNLCK
BA?<CR>	Returns battery voltage. Example: BA=09.60
LC<CR>	Local mode, place the front panel in control. OK
RM<CR>	Remote mode, locks the front panel. OK
AT_XX<CR>	Sets attenuation. XX is decimal number between 0 and 60. OK
AT?<CR>	Returns the value of the attenuation. Example: AT=53
VR?<CR>	Returns version. Example Vx.xx
PO?<CR>	Returns value of output power in dBm. Example: PO=+30
PO=XX<CR>	Sets amount of output power in dBm. XX must be decimal number between -30 and 30. OK

OFF<CR>	On the PathTrax 838 TX, this turns the amplifier off.
	OK
ON<CR>	On the PathTrax 838 TX, this turns the amplifier on.
	OK

Installing the USB-Serial Driver

Both the PathTrax receiver and PathTrax transmitter have a USB V2.0 communications port. This enables the product to be controlled by any PC or laptop with a USB V1.1 or V2.0 interface. When used by the user in normal operation, the USB interface mimics RS-232 serial communications.

When connecting the transmitter to your PC for the first time, you may need to install the virtual USB-Serial Driver. This driver will be installed automatically on most PCs with Windows 7, Windows 8, or Windows 10 operating systems.

Notes

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