

# HARDROCK-500

## Operating Instructions

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1 March 2021

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# 1. INTRODUCTION

This instruction manual covers the operation of the Hardrock-500 amplifier. It will cover basic operation, the automatic antenna tuner (ATU), if equipped, interfacing and operation with various transceivers, serial communications, updating the firmware and firmware revision notes.

The Hardrock-500 (HR500) is a 5W input 400-500W output linear amplifier designed for use on 160 to 10 meter Amateur Radio bands.

ITEM	SPECIFICATION
Frequency Range	160, 80, 60, 40, 30, 20, 17, 15, 12, 10 meter Amateur Radio Bands
Input Power	5W maximum, typically 3-4W for full output
Output Power	400 - 500W nominal
AC Power	80-260 Volts AC, 12 Amps @ 115V, 6 Amps @ 230V
Keying Modes	Stand-by, Push-to-Talk
Input/Output Jacks	UHF Connectors
Size	9" W by 7" H by 14.2" D (229mm W by 178mm by 361mm) (not including switches and connectors)
Weight	16.5 lbs/7.2 Kg under 18 lbs/8.2 Kg with ATU

The HR500 can also be equipped with an internal automatic antenna tuner.

# 1. Advisory and Warnings

There are several risks associated with assembling, testing and operating high power RF equipment. At HobbyPCB, LLC. safety is our highest priority and we have taken every reasonable precaution to ensure the safety of our builders when assembling and operating our products. Take a moment to read through the advisories and warnings and if you are not comfortable assuming the risks associated with this product you should return it unassembled in its original packaging for a complete refund.

## AC Voltage

The AC voltages inside the Hardrock-500 are potentially dangerous. We have taken precautions inside the case of the Hardrock-500 to prevent high voltages on exposed surfaces but the potential for electrical shock still exists in the bottom portion of the chassis around the AC wiring and the power supply boards. ***Under no circumstances should AC power be connected to the Hardrock-500 with the bottom cover removed. There are no adjustments, measurements or tests that require the builder/operator to open the bottom cover with power applied to the unit. Always connect the chassis to a suitable ground using the ground stud on the rear of the unit.***

## Water/Moisture

The Hardrock-500 is designed to be operated indoors in a dry location. The forced air cooling system used by the Hardrock-500 moves large quantities of air in through the front, top and bottom of the enclosure and forces it out through the rear of the enclosure. Any moisture, (rain, beverages, drips, leaks, etc), can be drawn inside the Hardrock-500 chassis creating a potentially dangerous conditions. ***Never operate the Hardrock-500 if there is the potential for water in or near the environment surrounding the Hardrock-500. If liquids are present or inadvertently enter the Hardrock-500's enclosure, immediately remove the AC power by disconnecting it at the source and do not operate the Hardrock-500 until completely dry conditions can be assured.***

## High Level RF

Even though an amplifier is not included with the Hardrock-500, we anticipate that the majority of builders will add a high power amplifier to the Hardrock-500 which can create high power RF which has some inherent dangers. In the top of the chassis, the RF deck, LPF board and rear panel board all carry high-level RF energy. ***Under no circumstances should the Hardrock-500 be operated at high RF power levels with the top cover removed. There are no adjustments, measurements or tests that require the builder/operator to open the top cover with RF applied to the unit.***

Once the Hardrock-500 is fitted with a RF amplifier, the operator should ensure that the RF power is being delivered to a suitable load or antenna. The Hardrock-500 has protection circuitry and algorithms for internal circuitry but not for external equipment like loads and/or antennas that could be damaged if not sufficiently rated for the applied RF power. Antennas should be installed in a manner that prevents excessive RF exposure.

## Physical Considerations

The Hardrock-500 weighs up to 18 lbs (8.2 Kg). Avoid dropping the unit. The fans on the rear of the unit pose a potential risk to fingers and other small objects. Do not block the opening in the top, bottom, front or rear of the chassis. Some of the internal parts may have sharp edges so use caution (and gloves) to prevent cuts.

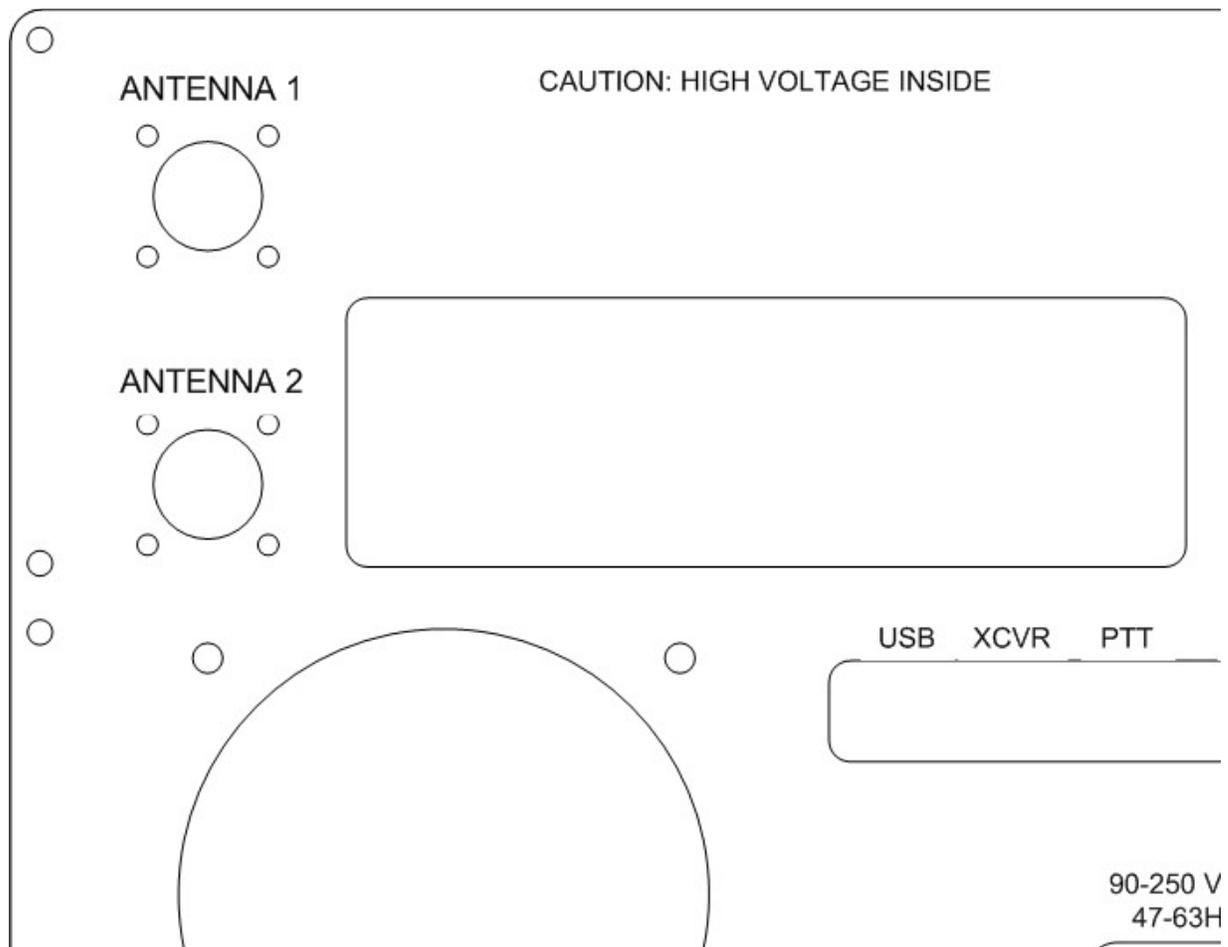
## 2. BASIC OPERATION

### Connecting the Hardrock-500 Amplifier

Before you can begin using the HR50, you'll have to connect it to other equipment in your station. Here are the basic items you'll need:

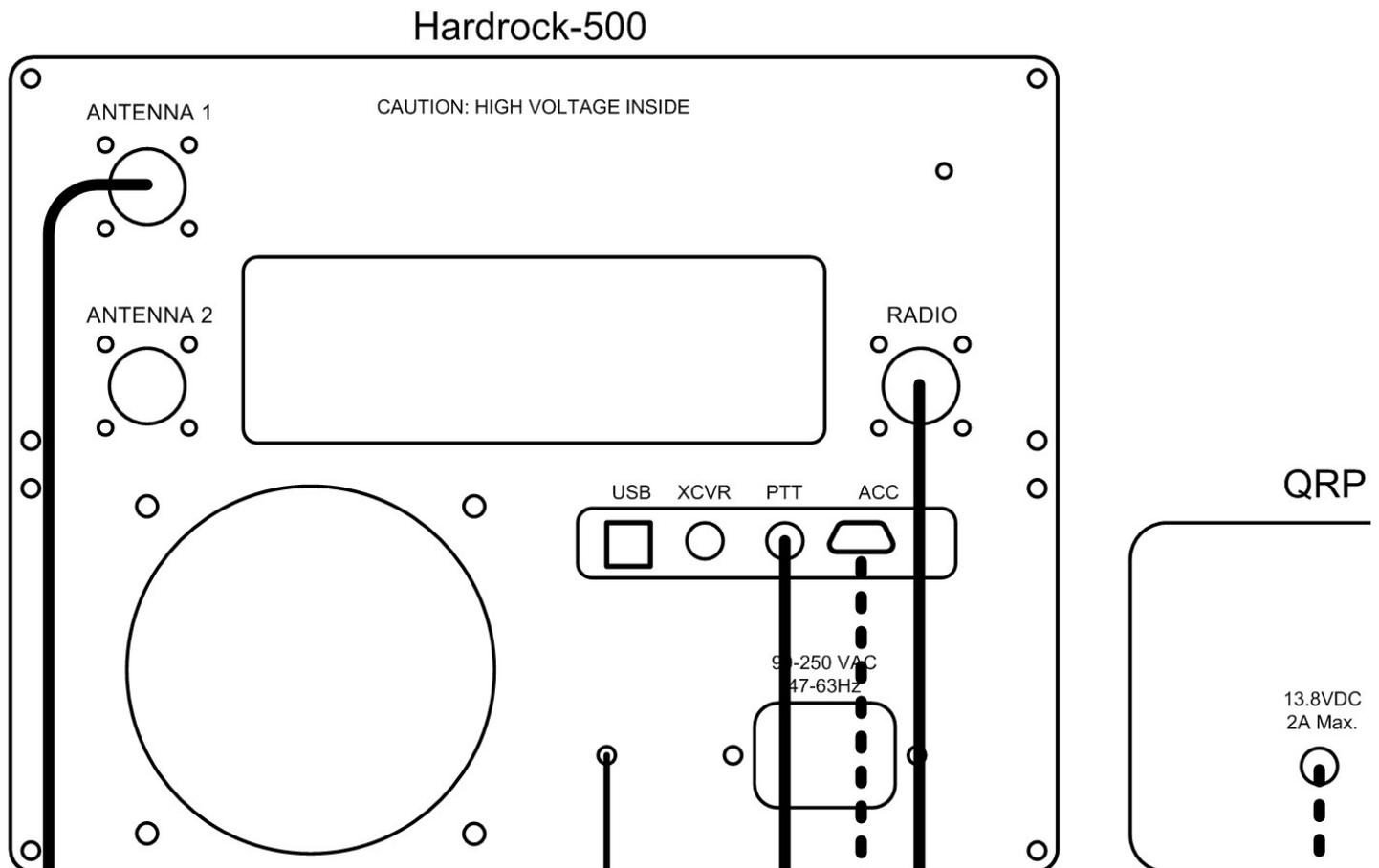
- AC power cable to connect to the AC supply in your area – **Must be at least #16 AWG preferable #14 AWG**
- A QRP radio. The HR500 is designed to work with QRP radios which produce 5W of drive. Drive levels vary per band but generally are between 3 and 5W for maximum output. The maximum continuous drive is 6W and no damage has been reported with short bursts of 15-20W. Putting 100W into the input of this amplifier will damage the amp. The radio connects to the amplifier using a 50 ohm coax jumper with a PL-259 on the amplifier end and the appropriate mating connector on the radio end.
- An antenna or two. The HR500 primarily delivers power into 50 ohm loads. The amp is tolerant to mismatches up to a maximum of 50W reflected power. The optional ATU can help match a wide range of load impedances for better power transfer. The antennas connect to the HR500 using a PL-259 connectors.

Let's look at the rear panel:



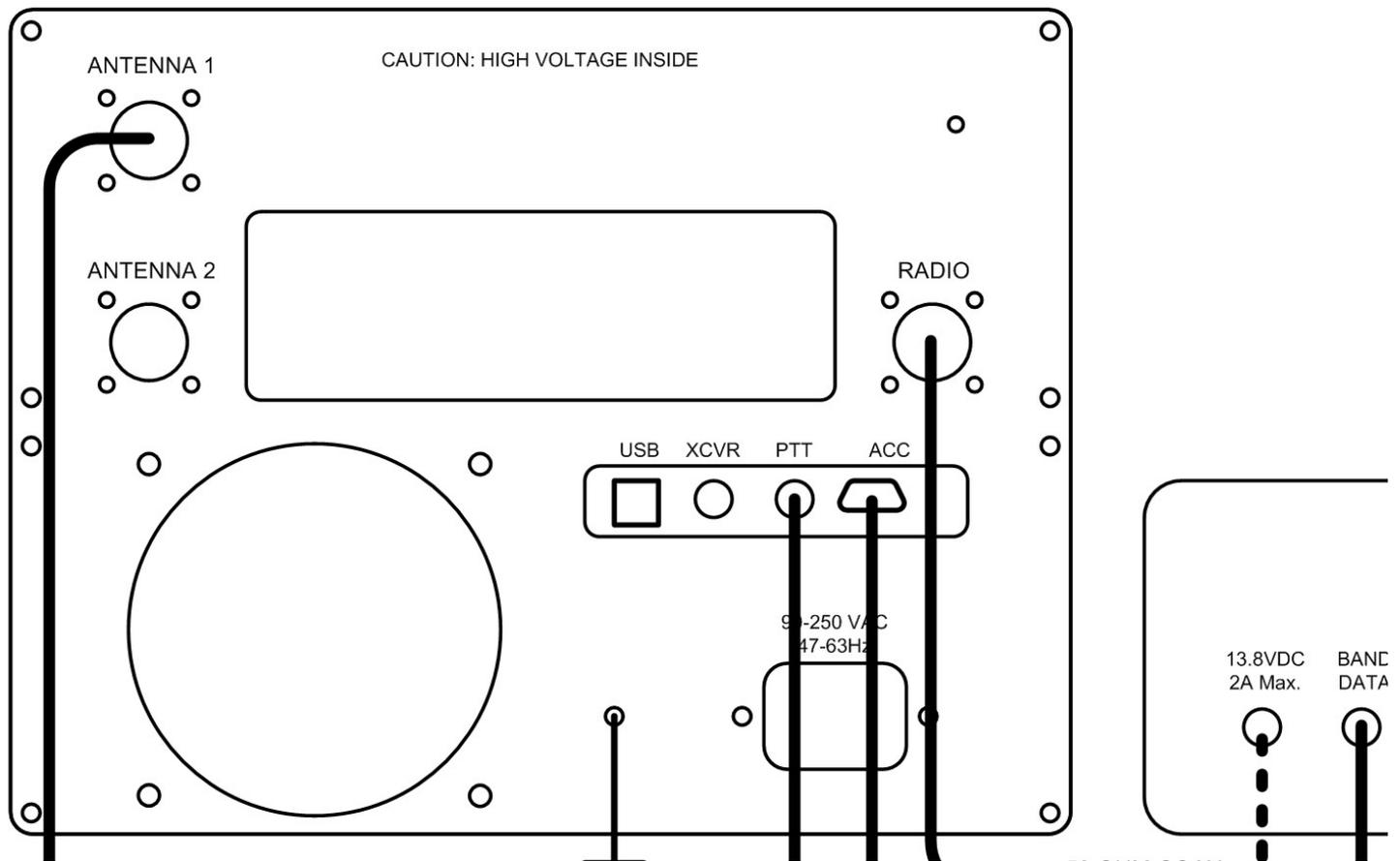
CONNECTOR	SIGNAL
RADIO	RF Input, 1.8-30 MHz, 1 – 5W from transceiver
ANTENNA 1	RF Output, 400-500W nominal, active when Antenna 1 is selected
ANTENNA 2	RF Output, 400-500W nominal, active when Antenna 2 is selected
90-250 VAC	AC Input IEC C14 connector, mates with a C13 plug
USB	Universal Serial Bus connection to PC
PTT	Amplifier keying signal, ground to key, RCA connector
ACC	Various interface signals for transceiver/amplifier communications
XCVR	Various interface signals for transceiver communications

## QRP Transceiver Setup: With PTT



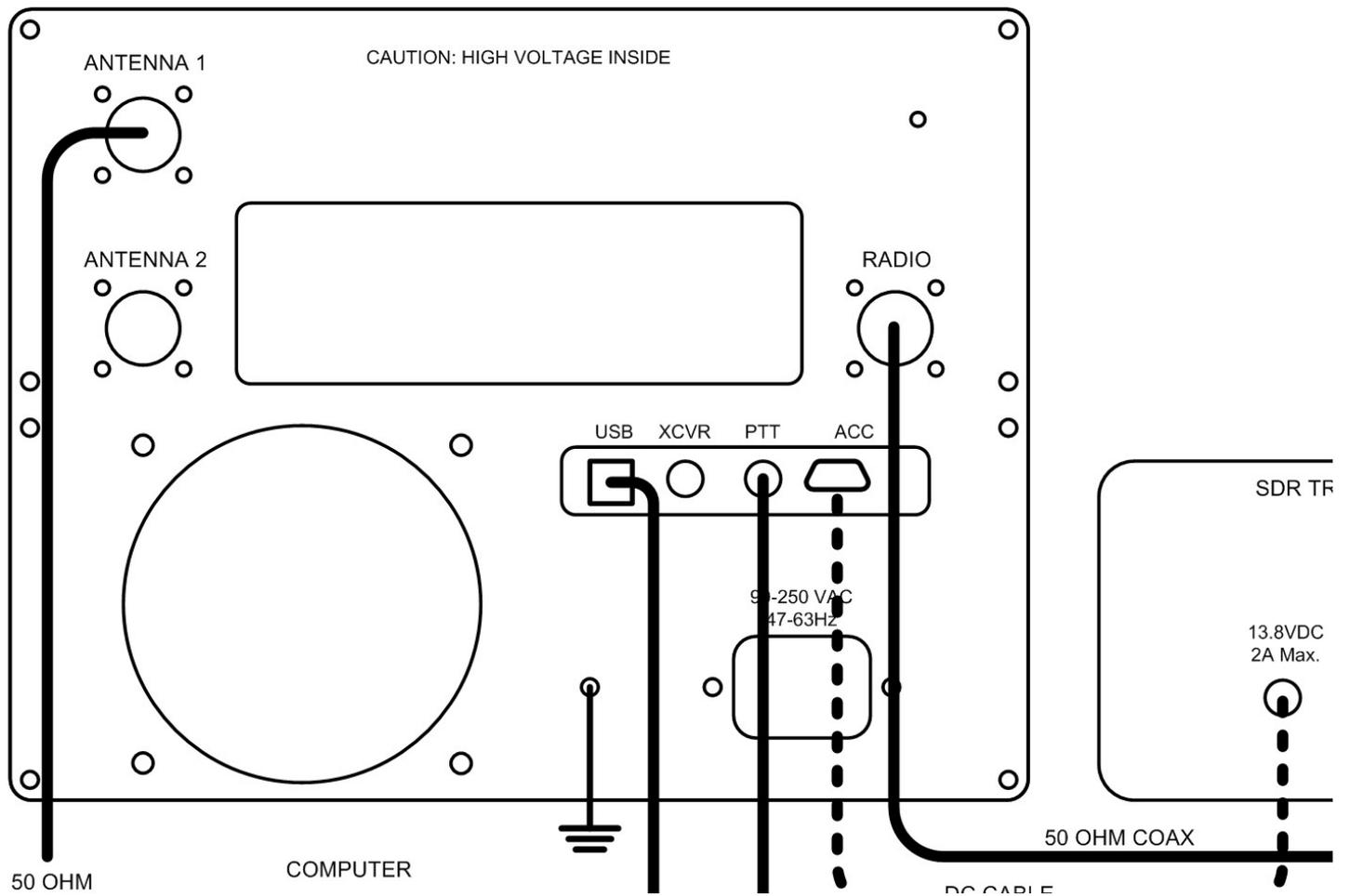
A shielded wire connects the PTT output from the transceiver to the PTT input on the amplifier. The PTT line keys the T/R relay. A suitable HF antenna is connected to ANTENNA 1 or ANTENNA 2 on the HR500. A maximum of 2 antennas can be connected to the amplifier. Connect the ground stud on the amplifier to a suitable RF ground. The Hardrock-500 has a 13.8V DC output which can supply up to 2 amps to power a QRP radio.

## QRP Transceiver Setup: With PTT and Band Data



In this setup the HR500 receives frequency information from the transceiver to automatically select the operating band and proper ATU channel. The specific detail of this connection is highly dependent on the type of transceiver. Complete details are provided in the transceiver interface section of this manual. In some cases the band data will be connected to the ACC jack as shown in other cases the band data will connect to the XCVR jack. A suitable HF antenna is connected to ANTENNA 1 or ANTENNA 2 on the HR500. A maximum of 2 antennas can be connected to the amplifier. Connect the ground stud on the amplifier to a suitable RF ground. The Hardrock-500 has a 13.8V DC output which can supply up to 2 amps to power a QRP radio.

## SDR Transceiver Setup: Band Data from Computer



SDR software running on a computer can provide band/frequency information to the HR500 amplifier via a USB port. Specific information about the software and SDR's currently supported is found in the transceiver interface section of this manual. . A suitable HF antenna is connected to ANTENNA 1 or ANTENNA 2 on the HR500. A maximum of 2 antennas can be connected to the amplifier. Connect the ground stud on the amplifier to a suitable RF ground. The Hardrock-500 has a 13.8V DC output which can supply up to 2 amps to power a QRP radio.

## Operating the Hardrock-500 Amplifier



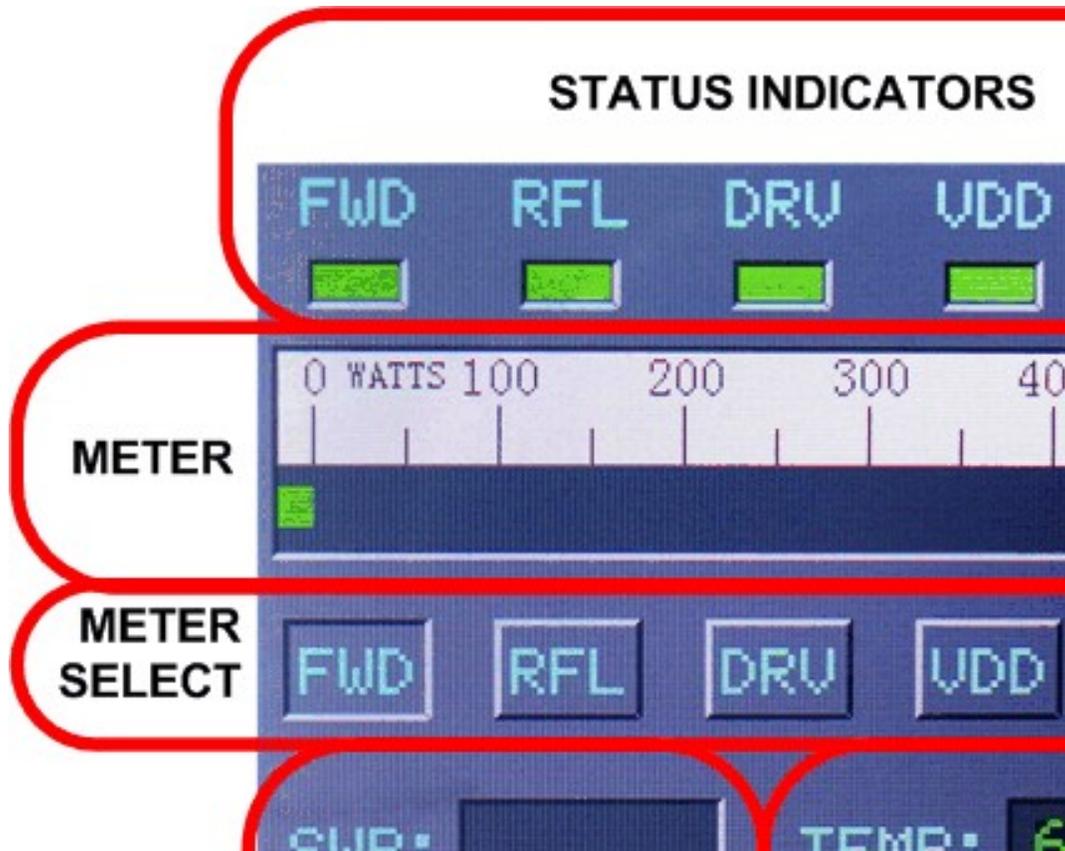
### Tuning on the HR500

The power switch in the lower left corner of the amplifier doubles as an AC circuit breaker. In addition to turning the power on and off to the unit the breaker will trip if AC currents in excess of 20A are detected. In addition to the circuit breaker each of the three power supplies in the amplifier are fused to prevent potentially dangerous AC currents. When powering the Hardrock-500 from a 120V AC source, it is extremely important to ensure that the line voltage does not drop below 115V AC.

A massive amount of energy is stored in the power supply section of the amplifier so the screens will stay active for several seconds after the power is turn off. Its best not to reapply power until the amp completely exhausted any stored energy and the displays are blank.

Many of the Hardrock-500's operating parameters are stored in non-volatile memory and are restored when the amplifier is powered. The operating mode, band, meter and temperature selection as well as ATU operating parameters will be restored to the previously set values when the amplifier is turned on.

## The Meter Screen



The Hardrock-500 uses a pair of color LCD touch screens for user input and to display operating parameters and conditions. The screen on the left side of the front panel is the meter screen and provides information about the operating conditions.

The following paragraphs describe the various sections of the meter screen.

**Status Indicators** – The five indicators at the top of the screen indicate the state of the protection circuitry in the amplifier. Green indicates normal operating conditions, yellow indicates that the parameter is close to the limit and red indicates that the amplifier was switched off to prevent damage due to unsafe operating conditions.

- FWD – forward power indicator
  - Green – Output power < 500 Watts
  - Yellow – Output power > 500 Watts
  - Red (trip) – Output power > 600 Watts
  - Remedy: Reduce input power
- RFL – reflected power indicator
  - Green – Reflected power < 30 Watts
  - Yellow – Reflected power > 30 Watts
  - Red (trip) – Reflected power > 50 Watts
  - Remedy: Adjust antenna matching; Reduce input power

- DRV – Drive (input) power indicator
  - Green – Input power < 8 Watts
  - Yellow – Input power > 8 Watts
  - Red (trip) – Input power > 12 Watts
  - Remedy: Reduce input power
- VDD – MOSFET drain voltage indicator
  - Green – Vdd > 45 Volts
  - Yellow – Vdd < 45 Volts
  - The voltage sensor will not trip the amplifier off
- IDD – MOSFET drain current indicator
  - Green – Idd < 18 Amperes
  - Yellow – Idd > 18 Amperes
  - Red (trip) – Idd > 20 Amperes
  - Remedy: Reduce input power ; Adjust antenna matching

*A trip can only occur while the Hardrock-500 is on-line and transmitting. If a warning (yellow) or trip (red) occurs during a transmission, the indicator will remain in the alert state even after the transmission so the operator will know that the condition occurred and can make the appropriate adjustments. Warning and trip conditions do not need to be manually reset, all conditions are set to normal, the next time the amplifier is keyed.*

**Meter** – The meter is a 300 segment digital bar graph capable of displaying forward power, reflected power, drive power, MOSFET drain voltage or the MOSFET drain current.

**Meter Select** – Selects which parameter is displayed on the meter.

**SWR Indicator** – This is the measured SWR as seen by the output of the amplifier, in between the amp and the ATU if the ATU is installed.

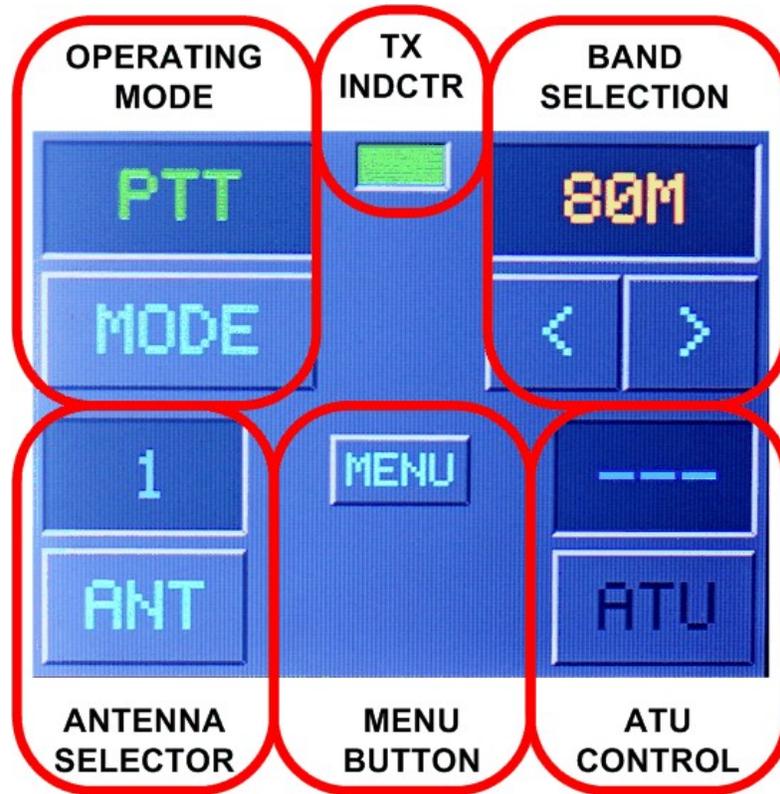
*The Hardrock-500 can only measure SWR when RF power is present. If there has been no SWR measurement the display area will remain blank. When RF is present and an accurate SWR measurement is being made, the SWR will be displayed in white numerals. If the RF is removed for more than 2 seconds, the numerals will turn grey indicating the measurement what the latest recorded value but not necessarily current.*

**Temperature Indicator** – Displays the temperature of a sensor located in between the MOSFETs thermally attached to the copper heat spreader. Tapping the screen where the temperature is displayed will toggle the value between Celsius and Fahrenheit temperature scales. If the temperature exceeds 50°C (122°F) the numerals will be yellow, if the temperature exceeds 65°C (150°C) then numerals will be red.

*If the heatsink temperature exceeds 70°C (160°F) the Hardrock-500 will trip off-line and keying will not be possible until the temperature decreases.*

*Higher capacity fans are available if your Hardrock-500 and your operating modes/style are causing high temperatures.*

## The Selection Screen



The screen on the right hand side allows the user to change various amplifier settings and access the menu.

**Operating Mode** – This selects whether the Hardrock-500 will key-up in response to a PTT signal.

- OFF mode - the amp will not key when PTT is pulled to ground, the antenna selector still functions and the ATU (if equipped) can be bypassed or in-line as selected.
- PTT mode – the amp will key when PTT is asserted

**TX Indicator** – Green indicates the Hardrock-500 is in receive mode, red indicates transmit mode.

**Band Selection** – Indicates the selected band either selected locally by the arrow keys below the band or remotely via transceiver interface. Analog transceiver modes for the Yaesu and Xiegu transceivers render the manual selection in-operative. If the Hardrock-500 receives a command to select a frequency that is not in one of its operating bands, the band display will read 'UNK' and the amplifier will not key.

**Antenna Selector** – Indicates which antenna the output of the amplifier is directed to. The button allows changing the selection between antenna 1 and antenna 2. The selections retained on a per band basis and the selected antenna is used even if the amp is off-line. When the Hardrock-500 is powered off, antenna 1 is connected to the input jack.

**Menu Button** – menu functions are explained in section 3 of this manual.

**ATU Control** – ATU functions are explained in section 4 of this manual.

### 3. MENU SETTINGS

The Hardrock-500 amplifier has a menu system for setting some of the operating parameters. This section covers the operation of that menu system.

#### Basic Menu Navigation

To access the menu the amp must be in RX or off-line mode. The menu system is unavailable during TX. Press menu button on the selection screen to activate the menu system.



To move around the menu items press the '<' and '>' keys.

When the parameter you want to adjust is displayed press the 'SELECT' button to select the item.

To change the selected item use the '<' and '>' keys to show the available settings and press the 'OK' button to store the new setting and remain in the menu or the 'EXIT' button to store the new setting and exit the menu.

The menu screen also displays the amplifier's firmware version and, if the ATU is installed, its firmware version as well.

#### Menu Items

All menu items are stored in non-volatile memory and restored when the power is turned on.



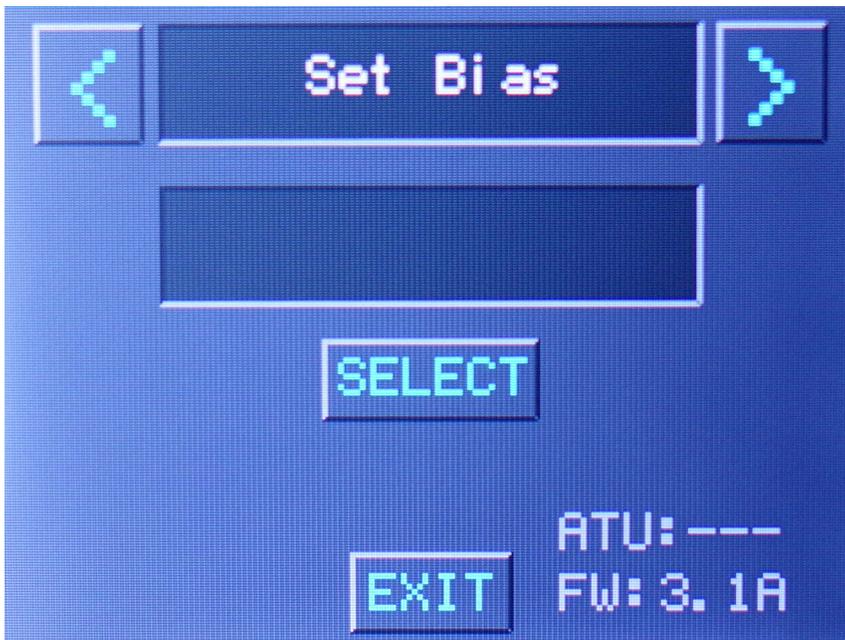
**ACC Baud Rate** – selects the speed at which the Hardrock-500 communicates with devices connected to its ACC jack. The ACC Baud Rate is the communication speed of the serial port on pins 2, 3 and 5 of the ACC jack. This setting is used in conjunction with the Transceiver selection to set up automatic band switching. This must be set to the same speed that the transceiver uses. Available settings are 4800, 9600, 19200 and 38400.



**Transceiver** – selects which type of transceiver is connected to the Hardrock-500 for automatic band switching. The USB and ACC port respond to CAT commands even if 'None' is selected so SDR transceivers (like the Flex-1500) that use PowerSDR, HSDR or other SDR software can select the band on the Hardrock-500 automatically. Transceivers that use serial communications must also have the corresponding USB or ACC baud rate set correctly to function properly.



**Meter Calibration** – This menu setting adjusts the forward, reflected and drive power meters power readings. The value is in percent so the default value is 100. Values above 100 will increase the power displayed on the meter and values less than 100 will decrease the meter reading. The scaling is applied to all firmware routines that are based on power readings including the indicators, trip points and serial command responses.



**Set Bias** - This menu setting aids in the setup of the amplifier by activating the bias voltage and displaying the measured bias current. A detailed procedure for setting the bias can be found in the Hardrock-500 Assembly manual.



**USB Baud Rate** – selects the speed at which the Hardrock-500 communicates with devices connected to its USB jack. The USB jack also used to update the firmware in the amplifier and the ATU.

## 4. ATU OPERATION

In the section covers operation of the ATU-500 with the Hardrock-500 amplifier.

When you turn the Hardrock-500 on, if the ATU-500 is installed and connected correctly, the right hand LCD will contain controls for the ATU.



The two controls for the ATU are TUNE and ATU.

The ATU control selects whether the ATU is bypassed (BYP) or actively applying a tuning solution (ON).

Tuning solutions are stored in EEPROM for each band and each antenna so if the ATU had been tuned on the selected band/antenna combination the previous tuning solution will be applied.

The ATU can be used with or without the 500W amplifier as can the antenna selection.

*You must apply RF to the input of the Hardrock-500 so the ATU can tune the antenna. If your radio does not have a TUNE mode you'll need to select a mode that causes the radio to create a RF signal like AM, FM, CW, RTTY. Keying the radio in SSB does not produce enough RF for the ATU to complete a tuning cycle.*

The TUNE control is used to initiate an auto-tune cycle. The ATU will only tune when the TUNE button is pressed, it does not tune based on high SWR or any other external factors. If you want it to tune, press the TUNE button and apply RF energy. Pressing the TUNE button again, while the ATU is tuning immediately stops the tuning cycle.

**Tuning the ATU** – When you press the TUNE button if the ATU is on BYP (bypass) it will switch to 'ON'. The status window will display 'Tuning' and the ATU will wait for RF to be applied.



The tuning action is different depending on the state of the amp:

Hardrock-500 Operating Conditions	ATU Action
<b>MODE = 'OFF'</b>	The ATU waits for RF and starts tuning when RF is present. If tuning is successful the tuning solution is applied and can be used with the amp on or off.
<b>MODE = 'PTT'</b> <b>Amp is not keyed</b>	The ATU waits for RF and starts tuning when RF is present, the amp is not brought on-line while the ATU is tuning. If tuning is successful the tuning solution is applied and next time the amp is keyed the amp is brought on-line with the ATU.
<b>PTT = 'ON'</b> <b>Amp is keyed</b>	The amp is taken off-line and the ATU tunes when RF is present. If tuning is successful the tuning solution is applied and next time the amp is keyed the amp is brought on-line with the ATU.
<b>PTT = 'ON'</b> <b>Amp has tripped the high SWR condition</b>	The amp is taken off-line and the ATU tunes when RF is present. If tuning is successful the tuning solution is applied and next time the amp is keyed the amp is brought on-line with the ATU and the error condition will be cleared.

When Tuning is initiated and RF is applied, the amp first checks the current tune state of the amplifier. If the VSWR is better than 1.2:1 a tuning is not performed and the ATU status is 'Tuned'.

The ATU then checks the bypass path and if the SWR is better than 1.3:1 a tuning is not performed and the ATU status is 'Tuned'. If the SWR is higher than 6:1 a tuning is not performed and the ATU status is 'Hi SWR', indicating that the current antenna cannot be used at this frequency without additional matching.

If the load SWR is higher than 1.3:1 and lower than 6:1 the ATU starts a tuning cycle. If the RF power drops below 00.5W for more than a second, the ATU discontinues tuning and the status is 'Lo Power'. If the ATU completed tuning and the final SWR is greater than 2:1 the ATU status is 'Failed' indicating that a suitable tuning solution could not be found.

If the tuning cycle completes and the final SWR is less than 2:1 the tuning solution is applied and the ATU status is 'Tuned'.

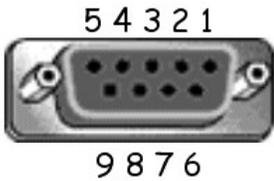


## 5. TRANSCEIVER INTERFACING

This section covers interfacing the Hardrock-500 amplifier with specific transceivers. In most cases this involves connecting the PTT line from the transceiver to the amplifier and establishing a communications path for frequency data.

The ACC jack is one means of interfacing transceivers to the Hardrock-500 amplifier. The jack is a standard DB9 female connector with the following pin assignments:

### DB9 Female



- Pin 1 – 5V 100mA max for external circuits
- Pin 2 – Serial data into the HR500 or analog band voltage input, 0-3.3/5V, 5V Max Analog
- Pin 3 – Serial Data out of the HR500 0/5V output
- Pin 4 – PTT input to the HR500 +/- 50V Max, pulled to 5V max current <1 mA to ground
- Pin 5 – Ground
- Pins 6, 7 – 13.8 VDC @ 2A max, transceiver power
- Pins 8, 9 – Ground, power return for transceiver power

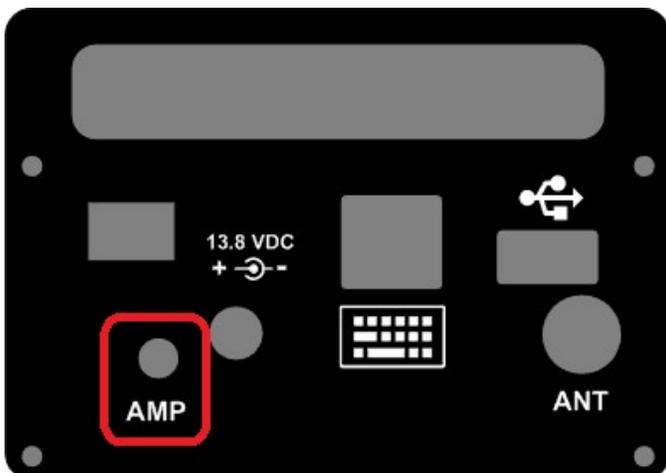


**DATA**  
**PTT**  
**GND**

The 3.5mm TRS jack labeled 'XCVR' on the back of the Hardrock-500 provides quick access ground, PTT and band data signals. The diagram to the left shows the location of the signals on the mating plug. The data (tip) contact is connected to the DB9 pin 2 inside the amplifier and the PTT (ring) is connected to pin 4.

### HobbyPCB RS-HFIQ and IQ32 Transceivers

The RS-HFIQ and IQ-32 transceivers have 3.5mm jacks for connecting an external amplifier. On the IQ32, the jack is labeled 'AMP':



On the RS-HFIQ the jack is labeled 'AUX':



Use an off-the-shelf 3.5mm jumper to connect the amp to the radio, set the transceiver type in the amps menu to RS-HFIQ/IQ-32, set the ACC baud rate to 19200 and everything is ready to go.

## Elecraft KX-2 KX-3

The Elecraft KX-2 and KX-3 transceivers work very well with the Hardrock-500 amplifier. If you use the PX3 pan adapter you must set the baud rate to 38400. To enable these features you must change the following settings in the KX3's menu:

**AUTO INF** – Set for ANT CTRL (causes the KX3 to send frequency data)

**RS232** – 19200 (could be set to other baud rates as long as the ACC Baud Rate in the HR50 is the same)

**ACCIO2** – ON (enables the PTT output)

On the KX2, the AUTO INF option is found under the TECH SUPPLEMENTAL MENU. To access it, you must set TECH MD prior to ON to be able to set AUTO INFO value to ANT CONTRL. In the spring of 2018, Elecraft released a FW update for the KX3 that put the AUTO INF menu under a TECH menu as well.

The HR500 menus also need to be setup:

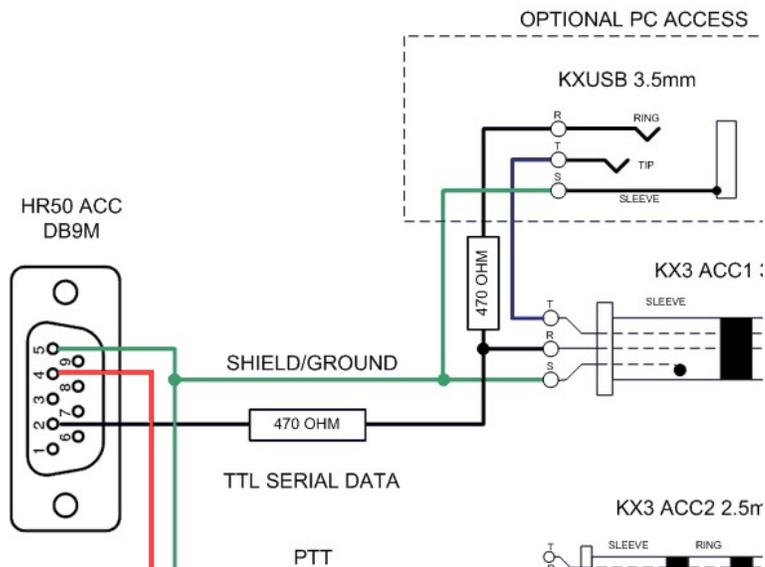
**ACC Baud Rate** – 19200 (must be the same as the KX3)

**Transceiver** - Set to KX3/KX2

The KX3 must be connected via the KX3's ACC1 and ACC2 port and the HR500's ACC port. The HR500 only listens to the data coming from the KX3 so it is possible to add a 3.5mm jack that duplicates the functions of the KX3's ACC1 jack allowing computer access to the KX3 via the KXUSB cable to run logging or rig control apps.

An interfacing kit is available on the HobbyPCB website that has a small dongle that converts the DB-9 to the jack required to interface with the KX3, KX2 and KXUSB cable using off-the-shelf cables (included in the kit).

You can make your own custom cable using the following diagram which shows the required connections:

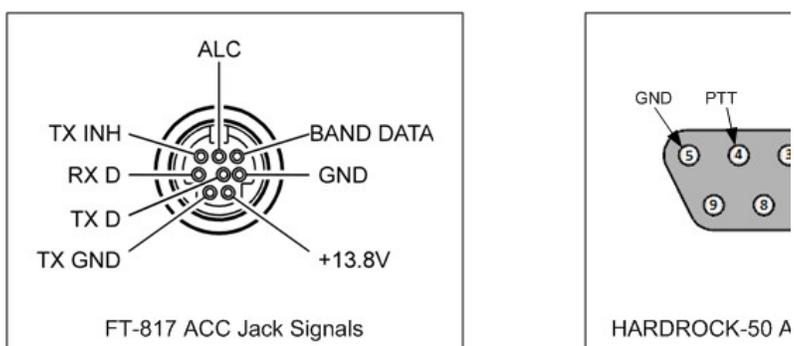


## Yaesu FT-817/818

The Yaesu FT-817/818 is a very popular QRP transceiver and interfaces with the HR505 amplifier for PTT keying and automatic band selection. The FT-817/818 provides an analog voltage output the level of which indicates the transceiver's band setting. The HR500 can read this voltage level and set the amplifier's band accordingly. If the FT-817 is operating on a band that is not supported but the HR505 (6m, 2m and 70cm) the amp will display UNK for the band and remain in bypass.

Select FT817 in the Hardrock-500's menu to enable automatic band switching.

The following drawing shows the required connection:



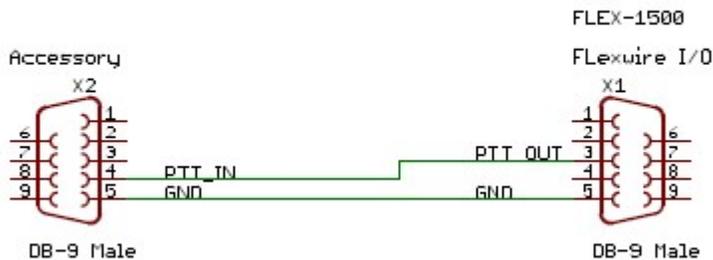
## Flexradio Flex-1500

The Flex-1500 QRP SDR can be connected to the HR500 amplifier for PTT and automatic band selection. PTT requires a cable that connects the Hardrock-500 ACC port to the Flex-1500's Flexwire I/O. Automatic band selection uses a USB connection between the computer running PowerSDR software controlling the Flex-1500 and the HR500. To configure PowerSDR to send frequency information to the HR500, follow these steps:

1. Start PowerSDR
2. Select SETUP
3. Click the CAT Control tab
4. On the CAT Control frame, select the port that the HR50 uses and if you haven't changed the HR50's USB Baud Rate in the menu, set the baud rate to 19200.
5. Check the Allow Kenwood AI Command box
6. Check the Enable CAT box
7. Click OK

The following drawing shows the required connection:

### Hardrock-50 - Flex 1500 PTT Cable



DO NOT REVERSE CABLES OR DAMAGE COULD OCCUR!

## ELAD FDM DUO Transceiver

An interface kit for the ELAD FDM DUO is available on the HobbyPCB website. The interface kit contains a small PCB that can be plugged directly into either the radio or the amp and uses a cable (supplied with the kit) to connect to the amp or radio. The kit also includes a 'Y' cable so you can still connect other ELAD peripherals.

Set the transceiver to 'FT-817' in the Hardrock-500's menu. No changes are needed to the ELAD's set up as long as you have the latest version of ELAD's firmware. Some older versions of ELAD's firmware do not send the I2C band data but I'm not sure exactly where the break is. If your radio supports ELAD's preselector, it will work with the Hardrock-50 interface.

## Xiegu X5105 and G90 Transceivers

The Xiegu transceivers are supported for PTT and automatic band changes with the Hardrock-500 amplifier. The Xiegu transceivers output a voltage that changes depending on the selected band. The HR500 can read this voltage level and set the amplifier's band accordingly.

Select transceiver 'Xiegu' in the HR500's menu to support automatic band selection.

You must have the Xiegu CE-19 interface kit to break out the PTT and band data signals from the transceiver. Use an off-the-shelf 3.5mm TRS cable to connect 'PTT CON' on the CE-19 to 'XCVR' on the Hardrock-500.

## ICOM IC705 Transceiver

The ICOM IC705 transceiver is supported for PTT and automatic band changes with the Hardrock-500 amplifier. You must have the Hardrock-IC705 interface kit available (3/2021) from HobbyPCB.com.

Connect the Hardrock-IC705 interface to the Hardrock-500 using the included DB9-DB9 cable. Connect the Hardrock-IC705 interface to the IC705 's SEND/ALC jack using the included 3.5mm cable.

Select transceiver 'ICOM IC705' in the HR500's menu to support automatic band selection.

Use the Bluetooth menu in the IC705 to connect to 'Hardrock Amp' and a data device. The passcode is '1234'

The correct baud rate in the Hardrock-500 will be selected automatically.

## 6. SERIAL COMMANDS

The following commands are recognized by the Hardrock-500 amplifier:

FA – VFO A Frequency  
HRAA – Acknowledge Message  
HRAN – Select which antenna is selected  
HRAP – Ask of the ATU is present  
HRBN – Set the HR500's frequency band  
HRFW – Forces a reset and activates the bootloader to accept new firmware  
HRMD – Set the HR500's keying mode  
HRPW – Read the HR500's FWD, RFL, Drive power or SWR  
HRST – Reports the complete operating status of the HR500  
HRTB – Bypass or activate the ATU  
HRTM – Pass data to ATU  
HRTP – Read the heatsink temperature  
HRTR – Report result of last tuning attempt  
HRTS – Set the temperature display to 'F' or 'C'  
HRTT – Ask if the ATU is tuning  
HRTU – Put the ATU in TUNE mode  
HRVT – Read HR500's MOSFET drain voltage, VDD  
IF – General information

### Command Format

Commands sent from the computer to the HR500 are considered either GETs or SETs. GET commands are used by the computer to get information from the HR500; the HR500 will then provide an appropriate response message (RSP). SET commands are sent by the computer to change the amplifier's configuration. A SET can be followed by a GET to verify the new settings.

SET commands use 2 or 4 characters, optional data fields, and a terminating semicolon (;). Examples:

HRMD0; Computer sets mode to 'OFF'  
HRBN7; Computer selects 40M band

Many SET commands have a corresponding GET command, which is just the command letters with no data. The data format of the response message from the HR500 (RSP) is usually identical to the format of the SET data. Exceptions are noted in the command descriptions.

Characters sent to the HR50 can use either upper or lower case. The HR50 will always respond with upper case.

### IF / FA (Frequency; SET)

SET format: FAxxxxxxxxxxx; where xxxxxxxxxxxx is the frequency in Hz.

Example:

FA00014060000; sets the HR50 to 14060 kHz.

The Hz, 10Hz and 100Hz digits are ignored by the HR50 for calculating the band and ATU frequency segment. If the specified frequency is in a different amateur band than the present one, the HR50 will change to the new band.

**HRAA (Acknowledge Message; GET)**

RSP format: HRAA; a simple response to indicate that the amp is present and listening on the port

Example: HRAA; the HR500 responds HRAA;

**HRAN (HR500 Antenna Select; SET/GET)**

SET/RSP format: HRANx; where x represents desired antenna:

1 = Antenna 1                      2 = Antenna 2

Example: HRAN2; selects antenna 2

**HRAP (ATU Present Query; GET)**

RSP format: HRAPx; responds with HRAP1; if the ATU is present or HRAPO; if it is not present.

**HRBN (HR500 frequency Band; SET/GET)**

SET/RSP format: HRBNxx; where xx represents desired band, leading 0 not required:

1 = 10M	6 = 30M
2 = 12M	7 = 40M
3 = 15M	8 = 60M
4 = 17M	9 = 80M
5 = 20M	10 = 160M
other = Unknown band (reports 99)	

Example: HRBN7; sets the band to 40M

If the HR500 is setup to use a transceiver that uses a band voltage like the FT-817 or Xiegu transceivers, the band will immediately change back to the band asserted by the transceiver since the HR500 is reading the band control voltage from the 3 or 4 times a second.

**HRFW (Commands the HR500 to reset and listen for the bootloader; SET)**

SET format: HRBFW;

*This command is automatically send by the firmware loading app on the PC and does not have an operational function.*

**HRMD (HR500 change keying mode; SET/GET)**

SET/RSP format: HRMDx; where x = 0 (OFF), 1 (PTT)

Example HRMD1; sets the HR500 keying mode to PTT

### **HRPWx (Get data current power/VSWR readings)**

SET/RSP format: HRPWx; where x = F, R, D, or V

Responds with the current forward power, reflected power, drive power or VSWR depending on 'x'.

Values of 'x' are:

- F – reads forward power
- R – reads reflected power
- D – reads drive power
- V – reads VSWR (if the power is not sufficient for and accurate reading 0.0 will be returned)

Example HRPWF; response: HRPWF350; – the amp is producing 350 watts of forward power

### **HRST (Get Hardrock-500 status)**

RSP format: HRST-fff-rrr-ddd-sss-vvv-iii-ttt-m-bb-a-

Responds with all current operating parameters.

- fff – forward power in watts
- rrr – reflected power in watts
- ddd – drive power in 1/10<sup>th</sup> watt
- sss – SWR in 1/10<sup>th</sup> ratio
- vvv – Drain voltage in volts
- iii – drain current in amps
- ttt – temperature in °C or °F depending on setting
- m - MODE 0 – Off, 1 – PTT
- bb - band
- a – Antenna Selection 1 or 2

### **HRTB (HR500 Tuner Mode; SET/GET)**

SET/RSP format: HRTBx; where x represents desired ATU mode:

0 = Bypass the ATU

1 = Activate ATU

Example: HRTB0; bypasses the ATU

### **HRTM; (HR50 ATU Message/Response)**

SET/RSP format HRTM<tuner message>;

Acts as pass through to communicate with the ATU.

Example HRTMC?; requests the current capacitor setting in the ATU.  
HR50 responds HRTM 8; the ATU capacitor is set to step 8 out of 127

Tuner Messages:

'A' command. Starts and autotune cycle. ? report final L, C, HL and RL values  
'B' command. Set BAND 1-10, ? reports current band  
'C' command. Sets the capacitance 0-127. ? reports current value  
'D' command. 1 = engage dir cplr, 0 = BYPASS dir cplr, ? reports current state  
'E' command. Stores 0xff in all memory locations, clearing the tuner  
'F' command. Reports the final return loss value after tuning  
'H' command. Sets the CAP to the input or output. ? reports current value  
'I' command. Responds with tuner info string  
'L' command. Sets the inductance 0-63. ? reports current value  
'N' command. Sets ANT to either 1 or 2. ? reports current value  
'P' command. Reports the tuning parameters  
'Q' command. Writes the current settings to Band/Freq eeprom locations  
'R' command. Reports the current return loss value  
'S' command. Reports the status of the most recent autotune attempt  
'U' command. Causes the tuner to wait for bootloader connection  
'V' command. Reports the current firmware version  
'Y' command. 1 = BYPASS tuner, 0 = normal operation, ? reports current state

#### **H RTP; (HR50 read temperature)**

RSP format H RTPn x; n = temperature value; x = F (Fahrenheit) or x = C (Celsius)

Reads the temperature of the heat spreader in °C or °F depending on setting

#### **H RTR (ATU Tuning Result Query; GET)**

RSP format: H R TTx; where x is the result of the last tuning attempt

A - Tuning cycle aborted by user  
E – Load SWR > 6:1 so the ATU cannot tune safely  
F – Load could not be tuned better than 2:1 SWR  
H – Input power is too high to tune safely  
L – Input power is too low to tune adequately  
T – Antenna was tuned successfully  
S - Antenna was tuned successfully

#### **H RTS; (HR50 read temperature/set temperature scale)**

SET format H RTSx; x = F (Fahrenheit) or x = C (Celsius)

RSP format H RTSx; x = F (Fahrenheit) or x = C (Celsius)

Example H RTSC; sets the temperature scale to Celsius

**HRTT (ATU Tuning Query; GET)**

RSP format: HRTTx; responds with HRTT1; if the ATU is tuning or HRTT0; if the ATU is not tuning.

**HRTU (Tune ATU; SET)**

HRTU; places the ATU in TUNE mode, same as pressing the tune button on the front panel. If the ATU is in the process of tuning when the command is received, the current tuning cycle is canceled.

**HRVT; (HR50 read DC input voltage)**

RSP format HRVTxx.xV; where xx.x is the DC input voltage.

## 7. FIRMWARE UPDATE

This section describes the steps required to install new firmware in the Hardrock-500. New firmware is required when we develop new feature, resolve issues or add support for new transceivers.

### Prerequisites

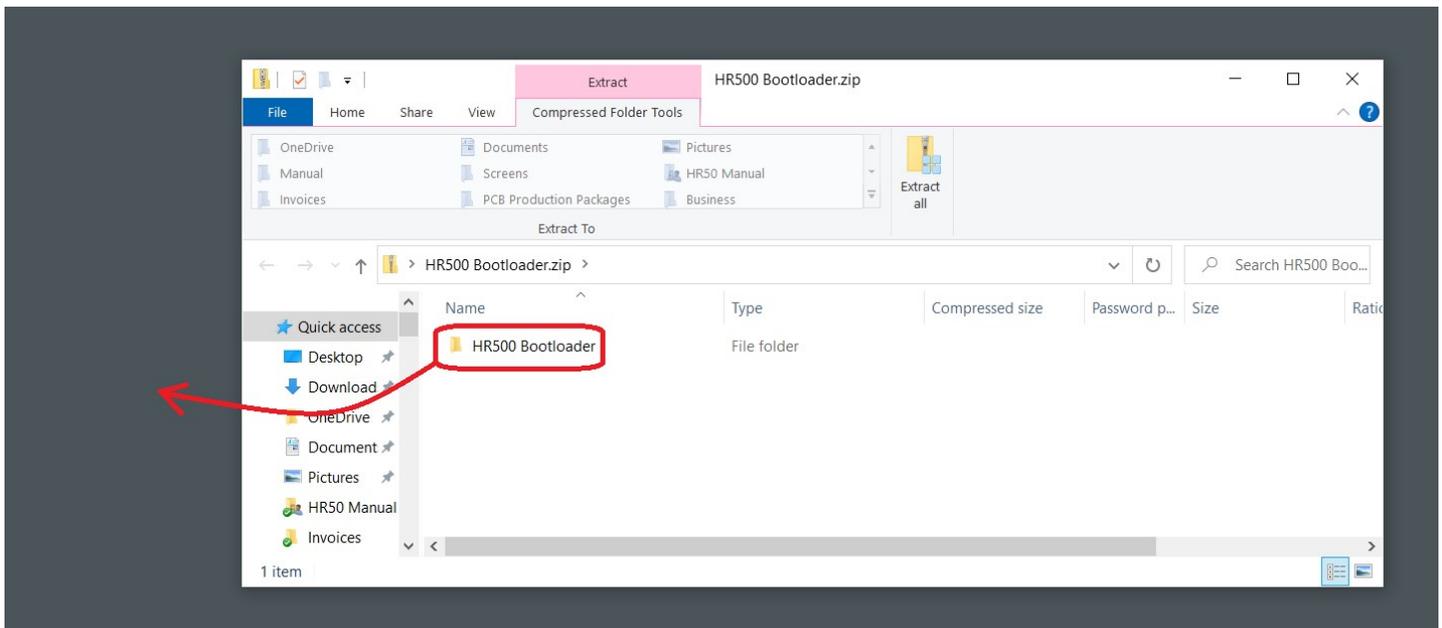
Before you can install new firmware you will need the following:

1. A Hardrock-500 amplifier connected to AC power
2. Windows PC connect to the Hardrock-500 via USB cable
3. Bootloader and new firmware downloaded from the website:

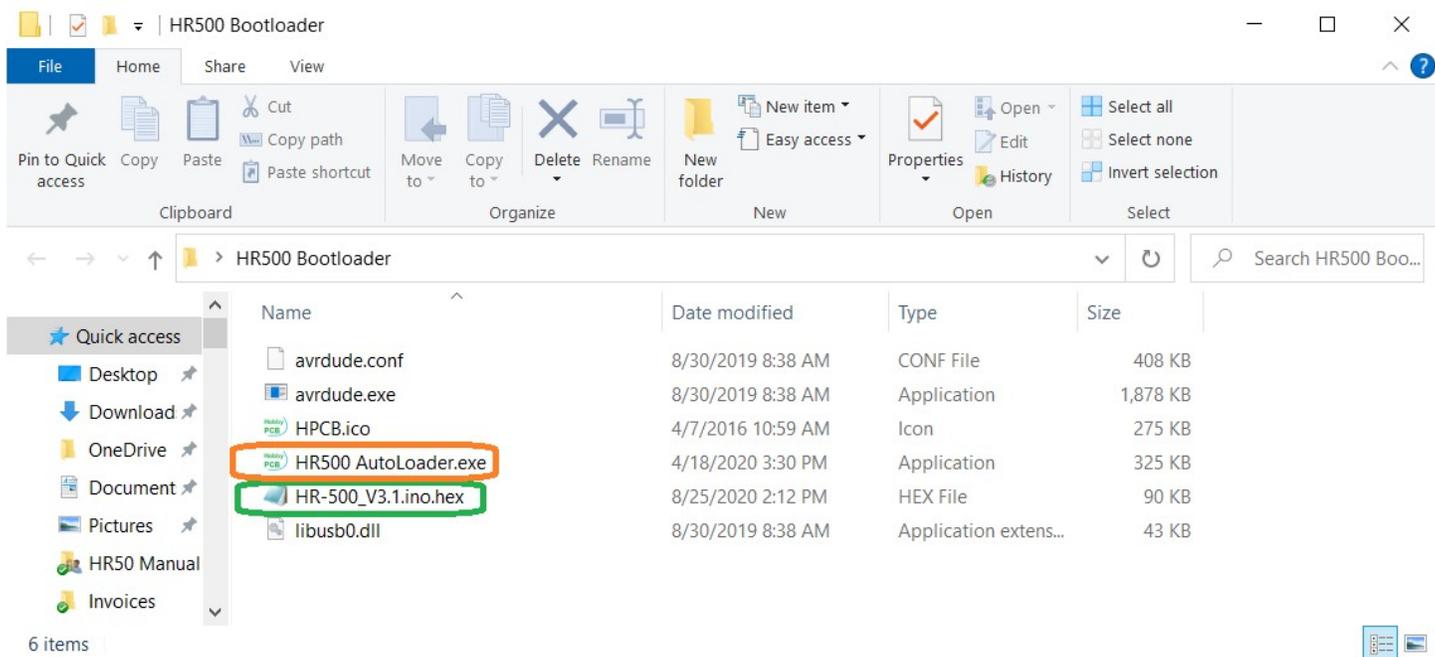
<https://sites.google.com/site/hobbypcbhardrock500/home/firmware-update>

### Procedure

Open the 'HR500 Bootloader.zip' file that you downloaded from the HR500 website and drag the folder inside it to the desktop.

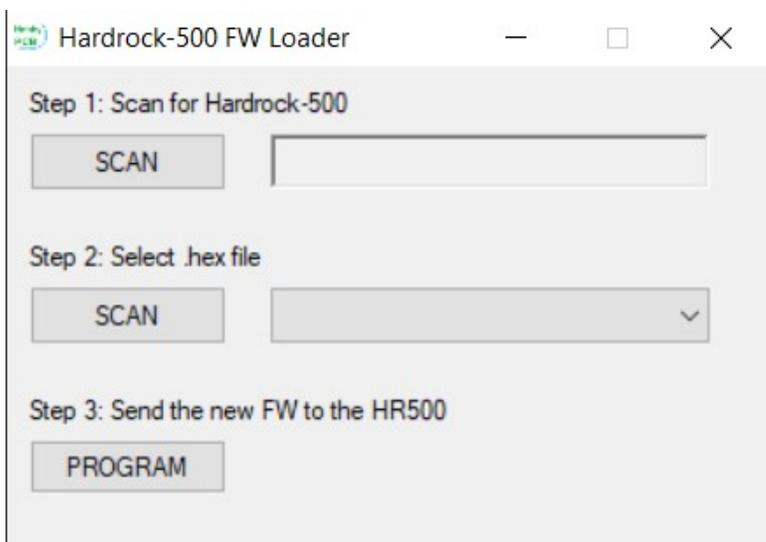


Then open the folder:



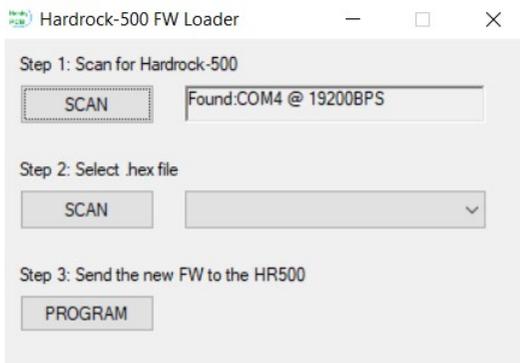
We will release the entire folder with a new .hex file every time there is an update to the firmware. If you choose to retain old versions of the firmware just drop the .hex file to your current bootloader folder.

Double-click on the HR500Autoloader to start the application:



The application is mostly self-explanatory. The first step is to find where the Hardrock-500 is connected to PC. Do this by clicking on the 'SCAN' button under Step 1. The application will then try all available COM ports and all possible baud rates until it finds a Hardrock-500. For fastest results, the HR500 should be connected and powered before pressing 'SCAN' but the HR500 will be found even if you start the amplifier after the application.

When the amp is found the COM port and baud rate will be shown:



If the scanning process discovers the Hardrock-500 on a port higher than COM9 you will need to unplug the Hardrock-500's USB cable and remove your unused COM ports and the port that the HR500 was on. Then the next time you plug it in, it will appear on a lower COM port.

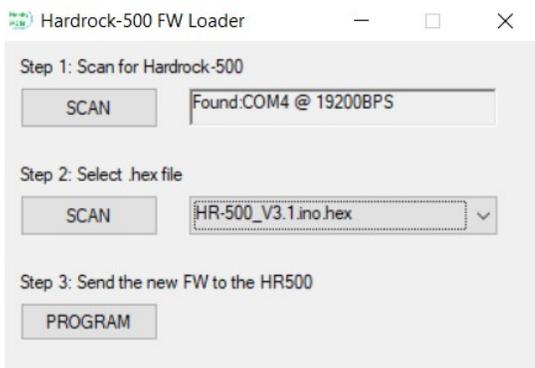
Here are instructions for removing unused COM ports:

Open the Command Prompt as administrator and start the Device Manager from the same command prompt.

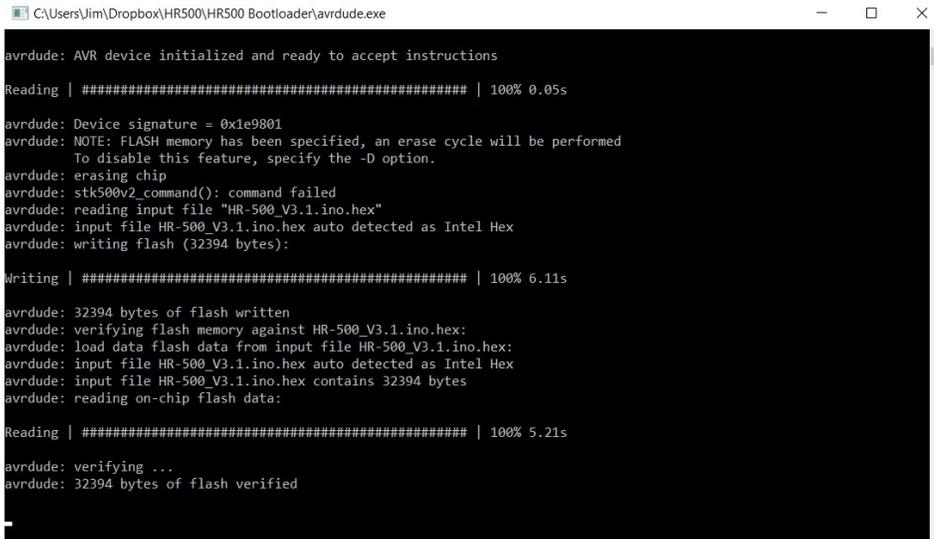
1. Click on the Windows Icon  and type "command prompt" – without the quotes
- 2.
3. Right click on  and select "Run as Administrator"
4. Enter "set devmgr\_show\_nonpresent\_devices=1" – without the quotes
5. Enter "start devmgmt.msc"
6. In the box that opens, select "Show hidden devices" in the "view" menu.

Now if you expand the section on COM ports, all the COM ports that have ever been created will be displayed, the non present ones being in grey. You can uninstall away anything that you don't want (right click, select uninstall). You must uninstall the port that the Hardrock-500 was using or it will reconnect on the same port.

Step 2 identifies the .hex file that you would like to send to the HR500. Press 'SCAN' under Step 2 to load the drop-down with all of the .hex files in the folder then select the file that you want to send to the HR500. Note that when we release the folder, there will only be one .hex file.



Then press 'PROGRAM' and the HR500 will reset and the AVRDUDE screen will appear and the FW will be updated:



```
C:\Users\Jim\Dropbox\HR500\HR500 Bootloader\avrdude.exe
avrdude: AVR device initialized and ready to accept instructions
Reading | ##### | 100% 0.05s
avrdude: Device signature = 0x1e9801
avrdude: NOTE: FLASH memory has been specified, an erase cycle will be performed
To disable this feature, specify the -D option.
avrdude: erasing chip
avrdude: stk500v2_command(): command failed
avrdude: reading input file "HR-500_V3.1.ino.hex"
avrdude: input file HR-500_V3.1.ino.hex auto detected as Intel Hex
avrdude: writing flash (32394 bytes):
Writing | ##### | 100% 6.11s
avrdude: 32394 bytes of flash written
avrdude: verifying flash memory against HR-500_V3.1.ino.hex:
avrdude: load data flash data from input file HR-500_V3.1.ino.hex:
avrdude: input file HR-500_V3.1.ino.hex auto detected as Intel Hex
avrdude: input file HR-500_V3.1.ino.hex contains 32394 bytes
avrdude: reading on-chip flash data:
Reading | ##### | 100% 5.21s
avrdude: verifying ...
avrdude: 32394 bytes of flash verified
```

The AVRDUDE window should close when programming is complete. Sometimes the AVRDUDE program fails to connect with the HR500 and shows a blank window. If this happens close the blank window, wait for the HR500 to finish resetting and try again.

## 8. ATU FIRMWARE UPDATE

This section describes the steps required to install new firmware in the ATU-500. New firmware is required when we develop new feature or resolve issues.

### Step 1 – Download the bootloader and new firmware

Go to the ATU-500 webpage:

<https://sites.google.com/site/hobbypcbhardrock500/home/atu-500-antenna-tuner>

and download MikroBootLoader app and the latest firmware. Place the files on your desktop or a folder of your choice. Rename MIKROBOOTLOADER.EXE.SAFE, removing the .SAFE from the file name.



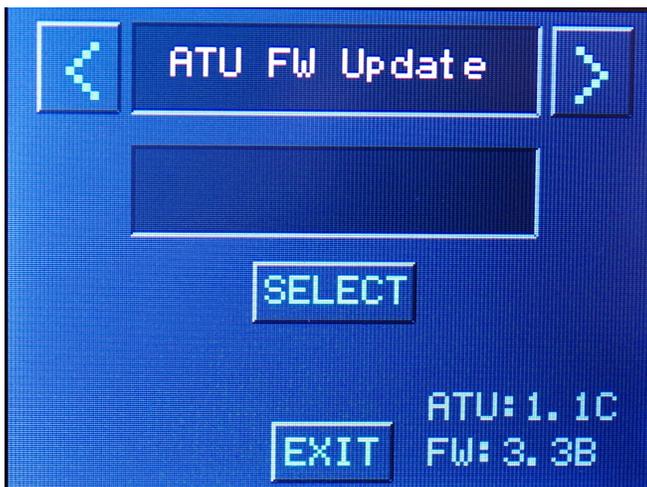
 ATU-500 ASSEMBLY MANUAL - RUN 1 - 2021.PDF (9532K)	WA2EUJ, JAN 12, 2021, 9:25 AM	V.1	 
 ATU500_V1_1.HEX (22K)	WA2EUJ, JAN 26, 2021, 9:22 AM	V.1	 
 MIKROBOOTLOADER.EXE.SAFE (1831K)	WA2EUJ, JAN 26, 2021, 9:22 AM	V.1	 

 ADD FILES

### Step 2 – Put the Hardrock-500 in ATU FW Update mode

Press the menu button on the Hardrock-500's right LCD screen. Navigate to the ATU FW update screen, press select, then press OK. At this point whether you update the ATU FW or not, you will have to power cycle the Hardrock-500.

*Make 100% certain that you are installing ATU-500 FW any other hex file loaded into the ATU will brick it!*



## Step 3 – Upload the FW

Connect the Hardrock-500 to your PC with a USB cable then start the MikroBootloader App:



Change the Port to whatever COM port your HR500 registered as. Leave the rest of the settings alone and click OK. If you don't know which port your HR500 is on, start the bootloader with the HR500's USB cable unplugged, note which ports are available. Shut down the bootloader, plug in the HR500's USB cable, restart the bootloader and the new port in the list will be the HR500's port.

*Make certain that **PIC18** is selected in the 'Select MCU' box in the upper left portion of the bootloader.*



Now press the 'Connect' button on the bootloader. If everything goes right, you will see the following screen:



Note the Green lights and the word "Connected" in the History Window. Now you can move to select "Choose a HEX file" and browse for the new ATU firmware file you downloaded from ATU files page.

Last, click "Begin uploading" to upload the new version of the firmware to your ATU-500. After successful upload, you will need to cycle power on the amp and should notice the version change on the menu screen.