OPERATION MANUAL - RAAS-8a Remote Automatic Antenna Switch

WA4MCMkits

Don Friend – WA4MCM

Revision History

Revision Number	Date	Description	Notes
1.1	2/21/2022	• Modified instructions for installing optional USB virtual ComPort drivers from FTDI.	
1.2	3/4/2022	• Modified the **Windows Computer Interface (optional)** section to accommodate a design change which replaced the FTDI chip with the Silicon Labs chip as the USB to UART bridge.	
1.3	3/10/2023	• Added new communications protocol for controlling the switch's mode via the USB interface. • Added instructions for obtaining band data as well as the transmit signal from Flex radios	**Mode Switch**: Thanks to Kyle – AA0Z for his idea and support during the development of this new feature. **Flex Band Data:** Thanks goes to W4WU (Richard Cash) for his research and providing his results.
1.4	5/16/2023	• Fixed a broken reference in the Flex Radio Interface section	
1.5	7/2/2023	• Refined the Flex Radio 6000 Series band data section to reflect input from the field. Added a pinout table to clarify how to connect the switch-end DB-9 connector to the C232HM cable.	Thanks goes to M0MDS (Mike Field) for his invaluable research and input.
1.6	8/28/2023	• Added band data pin-out diagram for the Yaesu FTdx-101 series of radios.	

CONTENTS

INTRODUCTION

Thank you for purchasing this remote antenna switch kit. Every effort has been taken to design a product that will provide years of service and will enhance your ability to select the antenna you need for any situation.

I made this a kit in an effort to bring back some of the kit building nostalgia that was prevalent in the early days of Amateur Radio as well as add to the growing Maker Movement. A decision was made to use all through-hole components on the circuit boards to make the kit attractive to beginners. To keep the cost down, inexpensive off-the-shelf enclosures are used which also allows for the builder to acquire new metalworking skills.

73's,

Don – WA4MCM

FEATURES

- **Easy to Operate** – This antenna switch can be as easy to operate as simply pressing a button to select an antenna.

- **Automatic Antenna Selection** - If your transceiver provides band data, it can easily be programmed by the operator to automatically select an antenna when a new band is selected. The same antenna can be assigned to multiple bands.

- **Compatibility** – The automatic antenna selection feature relies on band data being supplied by the transceiver. It can utilize one of two types of band data: 4-line BCD (Yaesu and Elecraft), and voltage level (Icom). Unfortunately, Kenwood radios don't specifically output band data, but instead rely on the user to query the CAT port. However, there are commercially available band data decoders that will interface with Kenwood rigs and provide the necessary inputs to this antenna switch.

- **Transmitter Protection** – The switch will accept a transmit signal from the transceiver and lock out the ability to change antennas while transmitting.

- **Handles Up To 1500 Watts** – The switch will handle up to 1500 watts into a 50Ω load.

- **Low SWR** – the SWR is less than 1.2:1 for the 160 through 6 meter bands; less than 1.5:1 for the 2 meter band.

SPECIFICATIONS

- Input Voltage: 12V – 30V DC @ 400mA (a 12VDC 1A wall adapter is provided)

- Relay Output Voltage: 12V DC

- Relay Output Format: 3-line BCD

- Number of Antennas: up to 8 antennas (antenna #1 is selected by default when no power applied)

- Band Data Input: 4-line BCD (binary "0": 0V DC; binary "1": +5V DC), or voltage (0V to +8V DC)

- Transmit Signal Input: input line should be sent to ground by the radio when transmitting

- Controller Dimensions: 7 ¼" W x 6 ⅛" D x 1 ½" H

- Switch Box Dimensions: 6 ¾" W x 4 ¾" D x 2 ¼" H

OVERVIEW

BAND DATA INFORMATION

This switch can operate in one of two modes: Manual and Automatic.

In Manual Mode, an antenna is selected by simply pressing one of the 8 antenna buttons. The antenna will remain selected until the operator pushes a different button or changes the mode to Automatic.

In Automatic mode, depending on the transceiver manufacturer, the switch will read either the 4-line BCD pattern (e.g., Yaesu, Elecraft) or the band data voltage (e.g., Icom) presented at back panel connector. The operator can easily program which antenna should be selected for the BCD pattern or voltage level associated with the currently selected band. It doesn't matter what the pattern or voltage level is because the operator is free to assign ANY of the 8 available antennas to any pattern or voltage – even to multiple patterns.

The following list provides details about how the different manufacturers provide band data:

- **Icom** – Icom transceivers provide band data from an accessory jack on the back of the transceiver. On some rigs, this is a 13-pin DIN connector. On others, it may be a 7-pin DIN connector. In either case, a voltage between 0V and 8V DC is provided to represent the currently selected operating band.

  A note about Icom Band Data: Icom has chosen to use the same voltage level for the 10- and 12-meter bands (2V – 2.5V) and the same voltage level for the 15- and 17-meter bands (3V – 3.5V). You will not be able to assign a different antenna to either of these two band pairs.

- **Yaesu, Elecraft, and some others** – These manufacturers provide band data in the form of a 4-bit BCD word that corresponds to each operating band supported by the radio. Each bit can be either a "1" (+5VDC) or a "0" (0VDC).

If your transceiver is not listed above, check your radio's instruction manual to see if it provides band data using one of these two methods.

FRONT PANEL
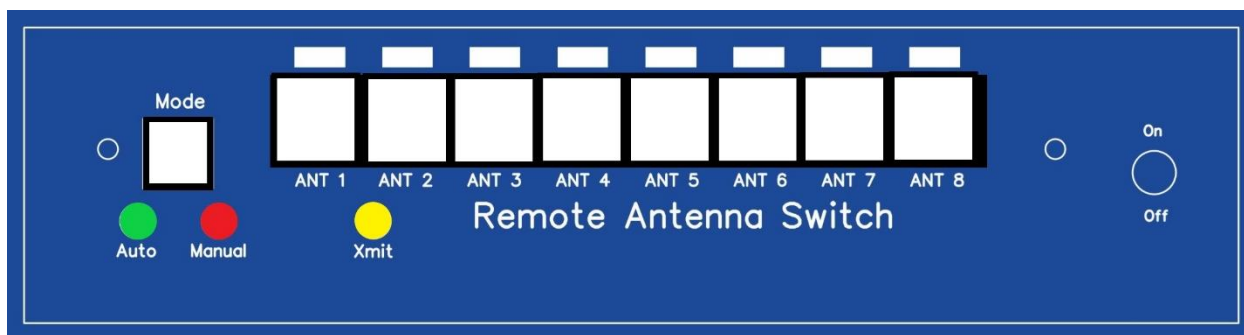
- **On / Off Switch:**   When switched to the "On" position, provides power to the Remote Antenna Switch controller.

- **Mode Pushbutton:**   Toggles between Manual and Automatic Mode.

- **Auto LED:**   Indicates that the controller is in automatic mode and will select the antenna based on the band data received from the transceiver.

- **Manual LED:**   Indicates that the controller is in manual mode and will select the antenna based on the operator's button selection.

- **Xmit LED:**   When lit, the radio is transmitting, and all antenna selection functions as well as the Mode switch are locked out.

- **Antenna 1 – 8 Pushbuttons**   Provide the means for either selecting an antenna while in manual mode or assigning an antenna to a particular band data pattern or voltage while in automatic mode. The buttons will also illuminate to indicate the currently selected antenna.

REAR PANEL
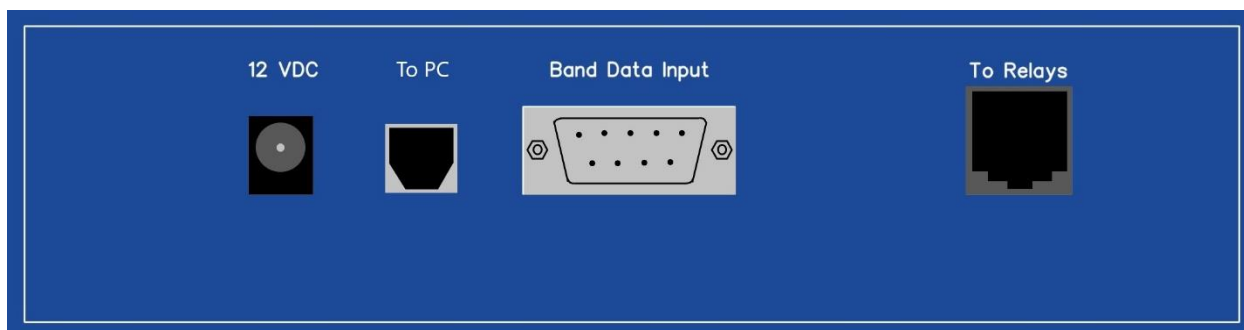
- **12 VDC Jack:**   Accepts the power plug from the 12 VDC wall adapter. Will accept any standard 5.5mm x 2.1mm 12 VDC power plug.

- **Band Data Input:**   Male DB-9 receptacle for plugging in an interface cable containing the band data and transmit signal lines.

- **To Relays:**   This is a standard RJ-11 6P4C receptacle for plugging in the cable going to and from the remote switch box.

- **To PC:**   Optional – This is a standard USB-B jack used for interfacing the antenna switch with your PC for remote control.

INSTALLATION

POWER CONNECTION

The remote antenna switch kit comes with a 12 VDC wall adapter whose plug will fit the power socket. However, the unit will accept any standard 12 VDC wall adapter with a 5.5mm x 2.1mm plug. The user may also use their station's 12 VDC supply bus and create their own power cable as long as the mating plug adheres to the previously mentioned dimensions.

CONNECTING TO THE RELAY BOX

The controller uses a 4-wire cable to convey the relay voltages to the remote switch box – 3 wires for the BCD word associated with antennas 1-8 and 1 wire for the ground. **This cable is not supplied with the kit.** However, inexpensive flat telephone cable is perfect for this use and is available at many retail outlets as well as online.

If you can find cable that already has RJ-11 (6-position, 4-connector) connectors installed, it would be a plus. If you can't, the kit is supplied with a plug that can be fitted to standard 4-conductor flat telephone cable and crimped using a standard crimping tool. In either case, be sure to write down the wire colors associated with each of the 4 functions as shown in Figure 1 below.
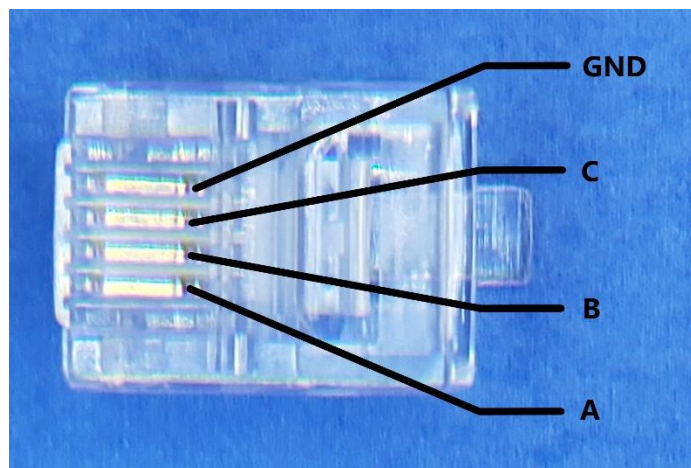

Figure 1 - Band Data RJ-11 Pinout

If you are installing the RJ-11 plug yourself, please take care to ensure a well-made plug and test for shorts with a multimeter.

The other end of the cable will be connected to the 4-pole terminal block mounted on the switch box circuit board. The cable must first be passed through the top plate of the box via the hole provided, then through the bottom side of the circuit board via the mating hole. Pull enough of the cable through so that it will reach the terminal block, then strip about 2 inches of the outer jacket to expose the 4 individual wires. Using the color reference you recorded earlier, strip about 3/8" of insulation from each wire, then insert the exposed end into the correspondingly labeled connection port on the terminal block. Finally tighten the set screw using a small straight slot screwdriver until the wire is held tightly. Repeat for each of the 4 wires.
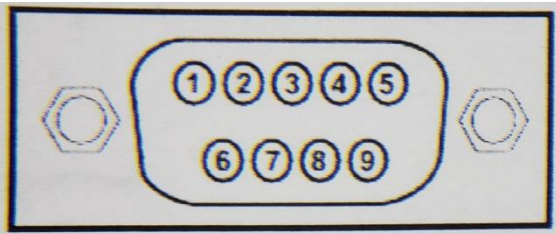
TRANSCEIVER BAND DATA INTERFACE

As noted earlier in this manual, the antenna switch uses two types of data from the transceiver:

- Band Data – either via a 4-line BCD word, or a "stepped" voltage level between 0V and 8V DC

- Transmit Signal – a single line that is sent to ground by the radio when the transmitter is keyed. This line will carry about 1mA of current when the transmitter is keyed.

Depending on the specific radio manufacturer and model, the data may be provided on a back-panel jack used for connecting a linear amplifier, or some other accessory jack. These will usually be some form of a multi-pin DIN connector. Please refer to your radio's user manual for details. The antenna switch accepts the data via the Band Data Input connector on the back of the controller unit. This is a standard male DB-9 connector. Table 1 lists each pin's function for this connector.

Table 1 - Band Data Pinout

Band Data Input Connector **As Viewed from the Rear of the Unit**	**Pin1:** Ground **Pin2:** Band Data A (Yaesu, Elecraft, etc.) **Pin3:** Band Data B (Yaesu, Elecraft, etc.) **Pin4:** Band Data C (Yaesu, Elecraft, etc.) **Pin5:** Band Data D (Yaesu, Elecraft, etc.) **Pin6:** Band Data Voltage (Icom) **Pin7:** Transmit Signal **Pin8:** Not Used **Pin9:** Not Used

 The mating female connector, along with a matching backshell, is included as part of the kit. However, the multi-conductor cable as well as the radio end connector have not been included. You will need to acquire them before making the interface cable. The following sections will provide as much guidance as possible regarding the creation of this cable for different radios. If your radio does not match with any of the following figures, please refer to your radio's operating manual for guidance on obtaining band data and the transmit signal.

INTERFACING WITH ICOM RADIOS

Most Icom transceivers provide Band Data and the Transmit Signal on a rear panel 13-pin DIN accessory jack. Figure 2 shows the pinouts for the 3 wires needed for the interface.

Important Note: Unfortunately, the 13-pin Accessory jack is also used for other functions such as inputs from a sound card and RTTY Keying input. If you are using any of these functions, this jack will already have a connector in place. You will need to evaluate the possibility of splitting out a second 3-wire cable from the connector to obtain the necessary interface lines.
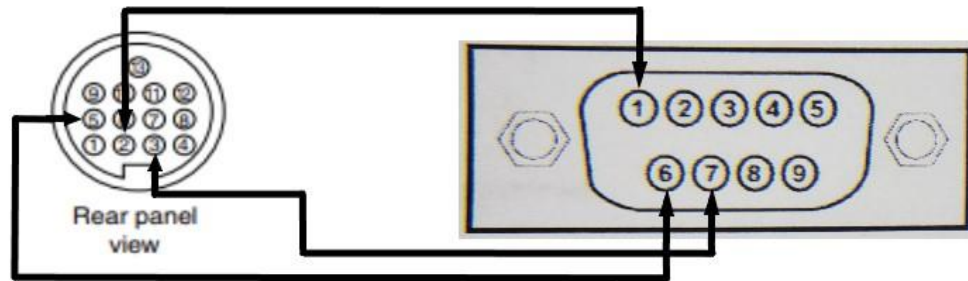
Figure 2 - Typical Icom 13-pin Accessory Jack Interface

The Icom IC-746 and IC-735 (and perhaps others) provide the needed data lines via a separate 7-pin DIN connector labeled ACC-2. Figure 3 shows the details.
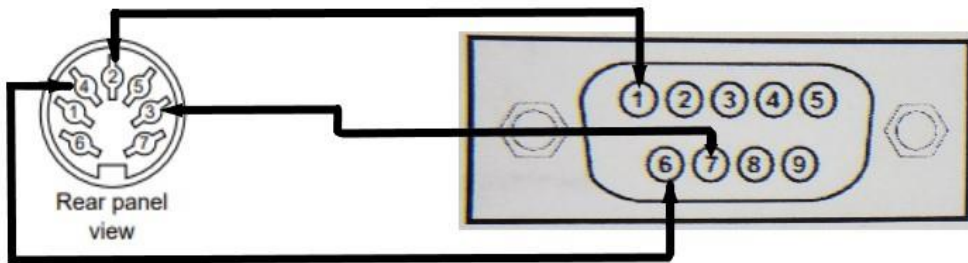

Figure 3 - Icom IC-746 / IC-735 ACC2 Jack Interface

INTERFACING WITH YAESU RADIOS

Most of the newer Yaesu radios provide both band data and the transmit signal from a 10-pin linear jack on their rear panel. Refer to Figure 4 for the pinout of this interface.
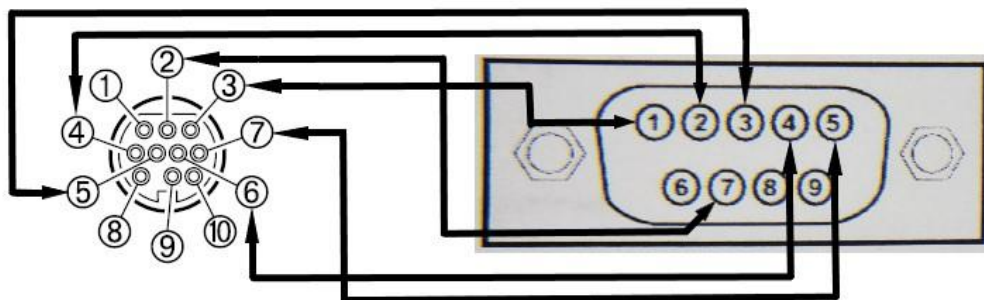

Figure 4 – Typical Yaesu 10 pin Linear Jack Interface – as viewed from the rear panel.

The Yaesu FTdx-101 line of transceivers use a DB-15 connector for their linear port. Refer to Figure 5 for the pin-out of this interface.
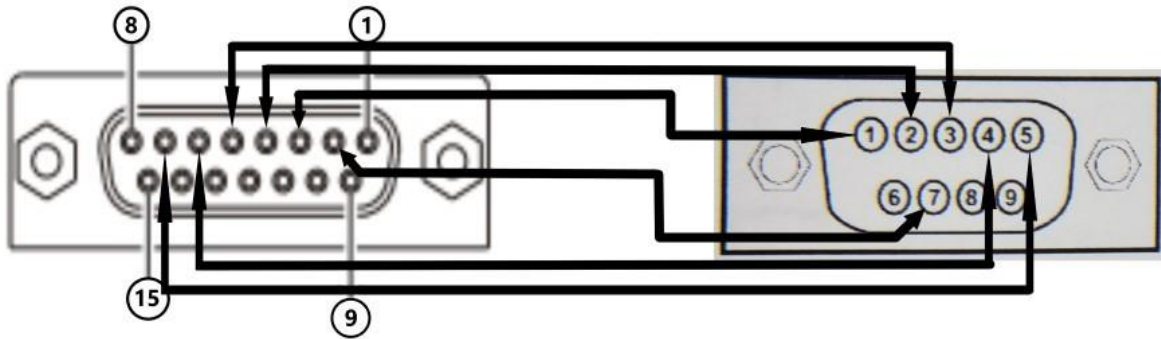

Figure 5 - Yaesu FTdx-101 Linear Jack Interface – as viewed from the rear panel.

The Yaesu FT-991A uses an 8-pin mini-DIN for the linear/tuner multi-function connector on the back of the radio. Refer to Figure 6 for the pinout of this interface.
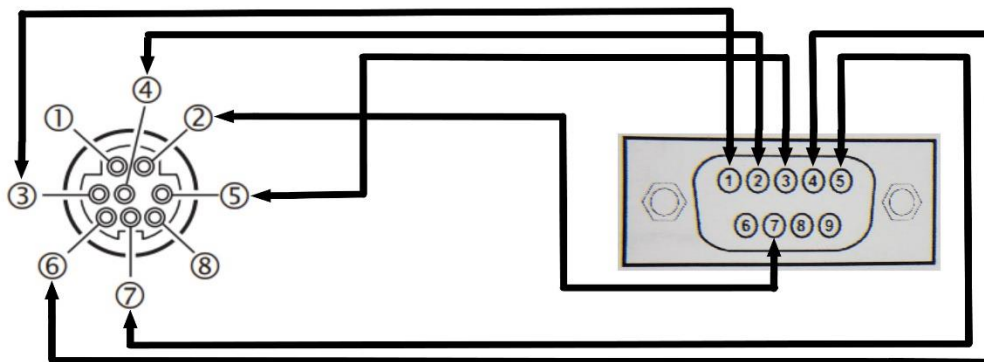

Figure 6 - Yaesu FT-991A Linear/Tuner Jack Interface – as viewed from the rear panel.

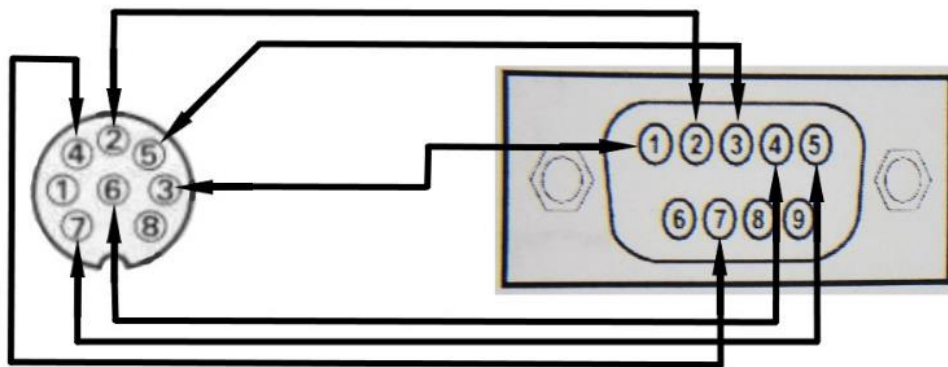Some older Yaesu radios have an 8-pin DIN Band Data jack. Figure 7 illustrates that interface.

Figure 7 – Typical Yaesu 8-pin DIN Band Data Jack Interface - as viewed from the rear panel.

INTERFACING WITH ELECRAFT RADIOS

Elecraft transceivers provide 4-line BCD band data as well as the transmit signal via a rear panel, 15-pin sub-D connector. Figure 8 below shows this interface.
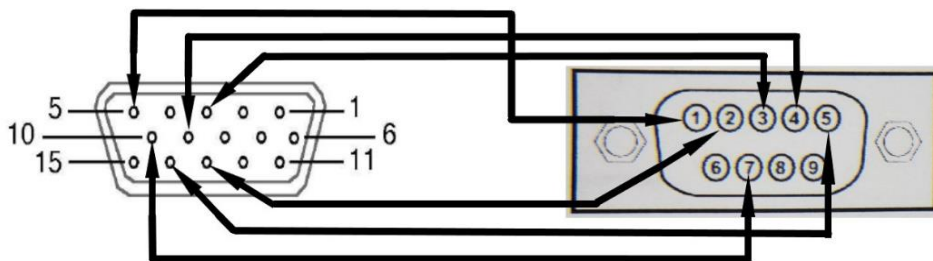

Figure 8 - Elecraft K3 Accessory Jack Interface - as viewed from the rear panel

INTERFACING WITH FLEX RADIOS

FLEX 5000 SERIES AND EARLIER

The ability to obtain band data from Flex radios prior to the newer 6000 series is spotty, at best. The Flex 5000 provides a FlexWire™ Peripheral Interface Bus which use I^{2}C to interface with external devices. According to the Flex 5000 User Manual, PowerSDR is configured to communicate to the external devices via this interface. Of course, an external interface board that can receive and interpret the FlexWire™ signals is required as well as cabling from this external board to the DB-9 band data input connector on the back RAAS-4a Remote Antenna Switch.

A search of the Internet found the following third-party product from K3TUF:

- http://www.k3tuf.com/FW.html

Note: The above referenced product has not been tested by WA4MCMkits and is only offered as an example. The kit builder is responsible for determining its actual usability for obtaining band data.
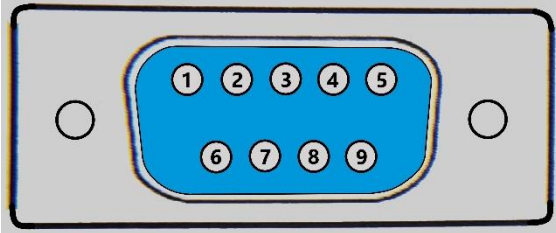
FLEX 6000 SERIES

BAND DATA

Flex 6000 series radios require an FTDI CH232HM USB cable (Digi-key PN 768-1105-ND) as well as SmartSDR configuration in order to obtain the required 4-bit BCD band data codes. Please refer to the following document from Flex Radio for guidance:

SmartSDR USB Cable Interface Guide

Follow the instructions for configuring the output for the **BCD** cable type, and the BCD type to **HF_BCD**. The document's section about the *Array Solutions BandMaster III* provides similar instructions to those needed for the RAAS-4a and RAAS-8a Remote Antenna Switches. Refer to the Table 2 below for details of the cable pin-out:

Table 2 - Flex Radio 6000 Series Cable Pin-out

DB-9 Female Connector ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ **As viewed from the solder cup side**	**Pin1:** CH232HM black wire **Pin2:** CH232HM orange wire **Pin3:** CH232HM yellow wire **Pin4:** CH232HM green wire **Pin5:** CH232HM brown wire **Pin6:** Not Used (Icom band data only) **Pin7:** Transmit Lockout Signal (see next section) **Pin8:** Not Used **Pin9:** Not Used

## TRANSMIT LOCKOUT SIGNAL

The transmit lockout signal can be obtained from the rear panel 15-pin accessory port – pin 11. This pin must first be programmed using the SmartSDR application. Go to the Radio menu and select the Tx Band settings. Place a check box in all boxes that correspond with the bands you are using under the ACC TX heading. See the SmartSDR User's Guide for further details.

WINDOWS COMPUTER INTERFACE (OPTIONAL)

With the optional USB interface board, the operator may remotely control the front panel push buttons using a Windows PC. The following sections provide the necessary information needed to use the interface.

VIRTUAL SERIAL PORT DRIVER INSTALLATION

The USB interface module is based on the Silicon Labs CP2102N USB to UART Bridge IC. On MS Windows PCs with Internet Access, the drivers should be installed automatically when you plug in the module for the first time. Once this is complete, you can identify the ComPort assigned to the module by reviewing the Windows Device Manager as shown below:
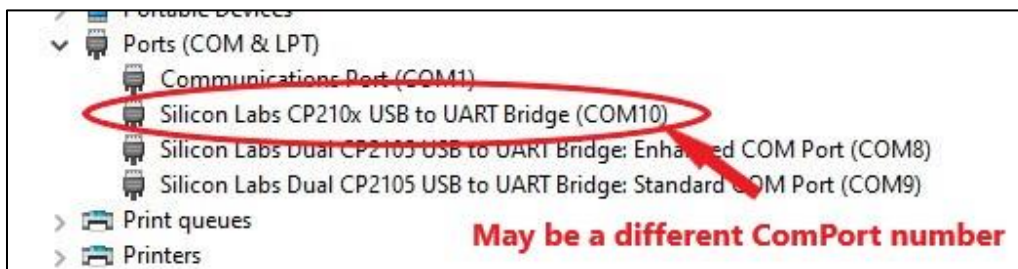
If there are more than one *Silicon Labs CP210x USB to UART Bridge* entry, you can easily identify the one associated with the Switch's USB module by unplugging it and observing which entry disappears from the Device Manager listing.

If the operating system was not able to automatically load the drivers, or if you are using something other than MS Windows, drivers may be obtained from the Silicon Labs web site at: https://www.silabs.com/developers/usb-to-uart-bridge-vcp-drivers.

ANTENNA SWITCH CONFIGURATION

Important! In order to use the USB interface, the antenna switch must be in **manual mode**.

The reason for this is that the interface translates the request protocol bytes into virtual "button pushes" inside the antenna switch. If the antenna switch is in Auto Mode, the front panel buttons are disabled for selecting antennas – in this mode, they are only used to program (assign) antennas to the different band data patterns obtained from the transceiver.

PC TO/FROM SWITCH COMMUNICATION PROTOCOL

The USB interface uses a very simple two-way communication protocol.

To change antennas, the sending program should send a two-byte word in the following format:

"A<x>" where <x> is the desired antenna number. For example, if the user wishes to select antenna number 3, send the following 2 bytes:

A3 (0x41, 0x33)

Likewise, to determine which antenna is currently selected, send a two-byte query in the following format:

A? (0x41, 0x3F)

And read the switch's response which will be in the same format as the antenna selection word. For instance, if the currently selected antenna is number 2, the following 2 bytes will be returned:

A2 (0x41, 0x32)

> **Important!** The ability to be able to remotely change the switch's mode requires the following minimum hardware versions:
> - Main controller circuit board version 6.2. or later.
> - USB Interface Module version 4.1, or later

To toggle the mode (Auto or Manual), the sending program should send a two-byte word in the following format:

MT (0x4D, 0x54)

Similar to querying for the current antenna, to determine the switch's current mode, send a two-byte query in the following format:

M? (0x4D, 0x3F)

And read the switch's response which will be in one of the following two formats:

MM (0x4D, 0x4D) for Manual Mode; MA (0x4D, 0x41) for Auto Mode

SUPPLIED WINDOWS REMOTE CONTROL APPLICATION

The USB interface module comes with a companion Windows application that can be used to remotely control the antenna switch. This application is only supported on the Microsoft Windows at this time.

The application is a stand-alone executable that can be copied anywhere on your hard drive you desire. It can be found on the flash drive that came with your switch kit: ***AntennaSwitchController.exe***.
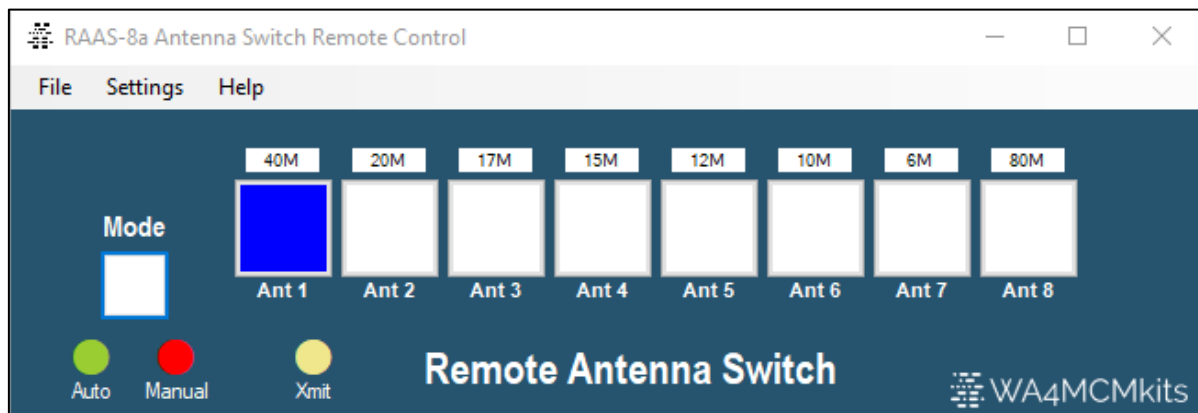
Application Settings:

Antenna Button Labels – Enter descriptive labels for each front panel antenna button. Note that only the first four labels will be used for the RAAS-4a model switch.

Antenna Switch Model – Click on the radio button that matches your particular switch's model. This will automatically change the number of antenna buttons on the front panel.

ComPort – Select the ComPort that corresponds to the switch's USB interface.
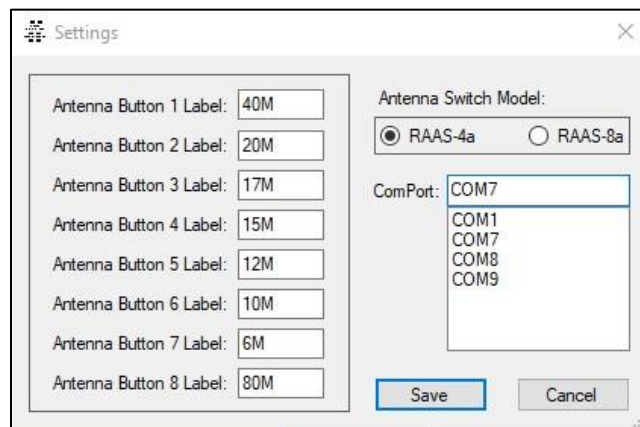
To identify which ComPort belongs to the switch, follow the steps listed below:

- While the switch's USB interface is plugged in, note the Comports displayed in the **Settings** dialog box.

- Close the **Settings** dialog box and unplug the USB interface cable.

- Reopen the **Settings** dialog box and note which ComPort disappeared – this is the switch's ComPort.

- Plug the USB interface cable back in and reopen the **Settings** dialog box. Select the switch's ComPort and Save the settings.

- You may need to restart the application for the change to take effect.

INTEGRATING WITH REMOTEHAMS SERVER

We worked with the folks at RemoteHams.com to add support for both switch models to their **RCForb** server software. Information regarding RemoteHams can be found at the following URL: https://www.remotehams.com/.

The RemoteHams web site has all the information needed to set up and use their software, so this document will not cover that. We will only highlight the steps needed to integrate the RAAS-4/8 switches with the **RCForb** server. Please follow the steps below for details on how to integrate with the RCForb server:

- Install the RCForb server software – These steps assume that the **RCForb** server has already been installed on your PC.

- Open the **Options** menu and select **Other Device Configuration** as shown below. This will display the **Radio Configuration Wizard** with the Other Devices tab selected. The applicable settings are in the center column – **Switch Support (Relay Boards)**.
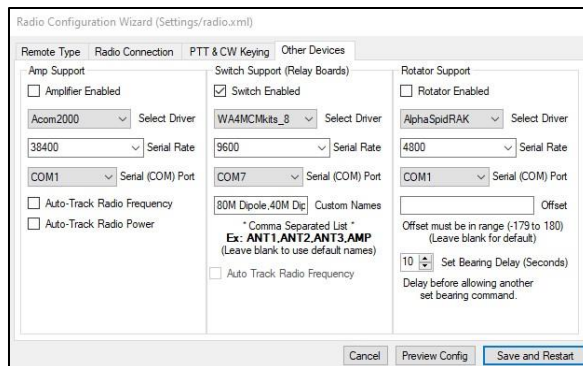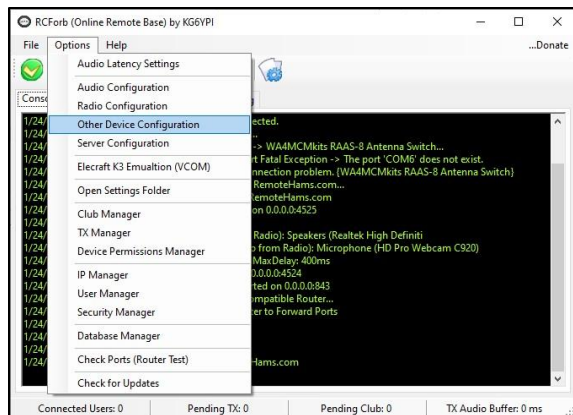
- **Select Driver –** Open the **Select Driver** drop-down box and select the appropriate switch model from the options provided – either WA4MCMkits_4 (RAAS-4a) or WA4MCMkits_8 (RAAS-8a).

- **Serial Rate –** Leave the baud rate at 9600

- **Serial (COM) Port –** Open the **Serial (COM) Port** drop-down box and select the ComPort associated with the switch's USB interface.

- **Custom Names –** If you wish to your remote clients see real-world names describing the antennas connected to the different buttons, enter a comma-delimited string in the Custom Names text box. Enter the number of names that match the number of buttons on your switch model. You may also enter the word "**disabled**" (without the quotes) to designate any open switch positions – this will remove that button from the remote client's display. If the number of labels entered is less than the number of buttons available, the remaining buttons will contain the default label (SW1, SW2, etc.).

- Click the **Save and Restart** button.

ANTENNA SWITCH OPERATION

This antenna switch operates by sending a 3-line (bit) binary word (0-7) to the remote relay box (plus a ground). Each wire will provide 12V DC (if its corresponding bit is high) to a series of relays which will, in turn, select the desired antenna.

Antenna selection is governed by one of two modes of operation:

- Manual Mode – The operator must manually select the desired antenna by pressing a front panel button.

- Automatic Mode – Changing the operating band on the connected radio will automatically select the antenna that has been assigned to that band.

The operating mode is toggled between Manual and Automatic by pressing and releasing the front panel Mode pushbutton.

MANUAL MODE

The antenna switch is in manual mode when the RED front panel LED is illuminated.

To select the desired antenna, simply push the corresponding antenna pushbutton. The button's LED will illuminate indicating that the antenna has been selected.

AUTOMATIC MODE

The antenna switch is in Automatic Mode when the GREEN front panel LED is illuminated.

While in this mode, antennas will be automatically selected based on the band currently set by the connected transceiver. For this to work, the operator must first assign a desired antenna for each band supported by the radio.

Note – Automatic mode is only available if band data information has been obtained from the transceiver via the Band Data Input connector on the back of the controller unit. If the antenna switch doesn't see any band data, it will rapidly flash all 8 antenna buttons.

The following sections describe how to assign an antenna to a particular band as well as how to unassign an antenna.

ASSIGNING ANTENNAS

To assign an antenna to a particular band, please follow the step-by-step instructions below:

1. Select the operating band on the connected radio. If the band hasn't already had an antenna assigned, the 8 front panel antenna buttons will be flashing sequentially. If a single antenna button is illuminated, and it is not the desired antenna, you must first skip to the next section to unassign this antenna.

2. Press and hold the button for the desired antenna until it illuminates.

3. Repeat steps 1 and 2 for the remaining bands that are supported by the connected radio.

UNASSIGNING ANTENNAS

To unassign an antenna from a particular band, please follow the step-by-step instructions below:

1. Select the operating band on the connected radio.

2. Press and hold the button associated with the antenna being unassigned until the 8 front panel antenna buttons start flashing sequentially.

3. If you need to unassign an antenna from another band, set the radio to that band and repeat steps 1 and 2.

APPENDICES

TROUBLESHOOTING

Please refer to Table 3

Table 3 - Troubleshooting Matrix

Symptom	Possible Solution
All the antenna LEDs are flashing rapidly.	The antenna switch is in automatic mode and there is no band data information coming from a connected radio.
	Check the Band Data Input connector to make sure it is tight.
The antenna LEDs are flashing sequentially.	The antenna switch is in automatic mode, but no antenna has been assigned for the currently selected operating band.
	Assign an antenna by following the steps in the Assigning Antennas section.
The yellow XMIT LED is not illuminated while transmitting.	The antenna switch is not receiving a transmit signal from the connected radio.
	Ensure pin 7 on the Band Data Input connector is being pulled to ground by the connected radio.
The remote Switch box is not selecting the correct antenna.	There is a problem with the 3-line BCD relay selection signal being sent to the relay box.
	Check to make sure that the cable is undamaged, and that the RJ-11 plug is made correctly.
	Check the 4-position terminal block in the remote switch box to ensure the 4 wires are undamaged and connected properly.
	Remove the controller's case top and observe the 3 LEDs located on the back left of the circuit board. They will form a 3-bit word corresponding to the selected antenna minus one - e.g., antenna 4 would be off-on-on (binary 3). If not, then there is a faulty transistor in the relay driver section of the controller. The following table may help identifying the offending transistor:
	Bit_0 LED wrong: Q1 or Q9
	Bit_1 LED wrong: Q2 or Q10
	Bit_1 LED wrong: Q3 or Q11