How To Connect the Kenwood TS-590S to the SDR-IQ Receiver

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Introduction

These brief notes explain how to connect the Kenwood TS-590S transceiver to an RFSPACE SDR-IQ software defined radio receiver. This lets you control receiver tuning from either the TS-590S or the SDR-IQ – the two units tune in step.

The SDR-IQ also provides an outstanding graphics interface that displays a wide spectrum of received signals, allowing "point-and-shoot" operation – you just click on a signal on the display, and both the SDR-IQ and the TS-590S will immediately jump to that frequency.

The control of the TS-590S and the SDR-IQ is implemented by Simon Brown's SDR-RADIO software [1].

To see how the SDR-IQ and TS-590S work together, take a look at the video at [2]. The software shown in the video is actually SpectraVue, but SDR-RADIO works in essentially the same way.

A good knowledge of how to operate both the TS-590S and the SDR-IQ individually is assumed in this HOWTO.

The procedures described here have been specifically tested with Windows XP Home + SP3. The procedures for other versions of Windows should be similar.

All interconnections between the TS-590S and the SDR-IQ are external to the units. There is no need to open either of the boxes.

This HOWTO is in five parts:

- Part 1: Connecting the Hardware
- Part 2: Setting up the Hardware and Software
- Part 3: Preparing to Transmit
- Part 4: Other Hardware Configurations
- Part 5: References

Disclaimer

Every effort has been made in this HOWTO to describe accurately how to connect the TS-590S to the SDR-IQ in a safe manner. However, no responsibility can be accepted if the units are damaged in any way – tread carefully!

PART 1: CONNECTING THE HARDWARE

Hardware Requirements

- Kenwood TS-590S transceiver [3]
- A Windows PC with two USB ports
- RFSPACE SDR-IQ receiver [4]
- ELAD Switch Box (or similar) for RF and AF switching [5]
- Dummy load
- Stereo headphones
- Interconnecting cables (listed later_
- BNC tee adapter

The Big Picture

Figure 1 on the next page shows a simplified picture of the hardware.

The SDR-IQ Receiver

The rear panel of the SDR-IQ has three connectors:

- **ANTENNA**: Receives the RF signal from the antenna, via the ELAD Switch Box. Also connected to **RX ANT** on the TS-590S.
- **USB**: Sends received signals to the PC, and receives control signals and power from the PC.
- **SERIAL**: Not used here.

The ELAD Switch Box

The ELAD Switch Box contains three relays:

- An antenna switchover relay, switching the antenna between the SDR-IQ/TS-590S receiver inputs (**ANTENNA/RX ANT**) and the TS-590S transmitter output (**ANT 1**).
- A grounding relay, to connect the receiver inputs to ground when transmitting.
- An audio switchover relay, to switch the headphones between the SDR-IQ audio output and the TS-590S transmit audio monitor.

The Switch Box draws about 50 mA from a 13.8 VDC power supply.

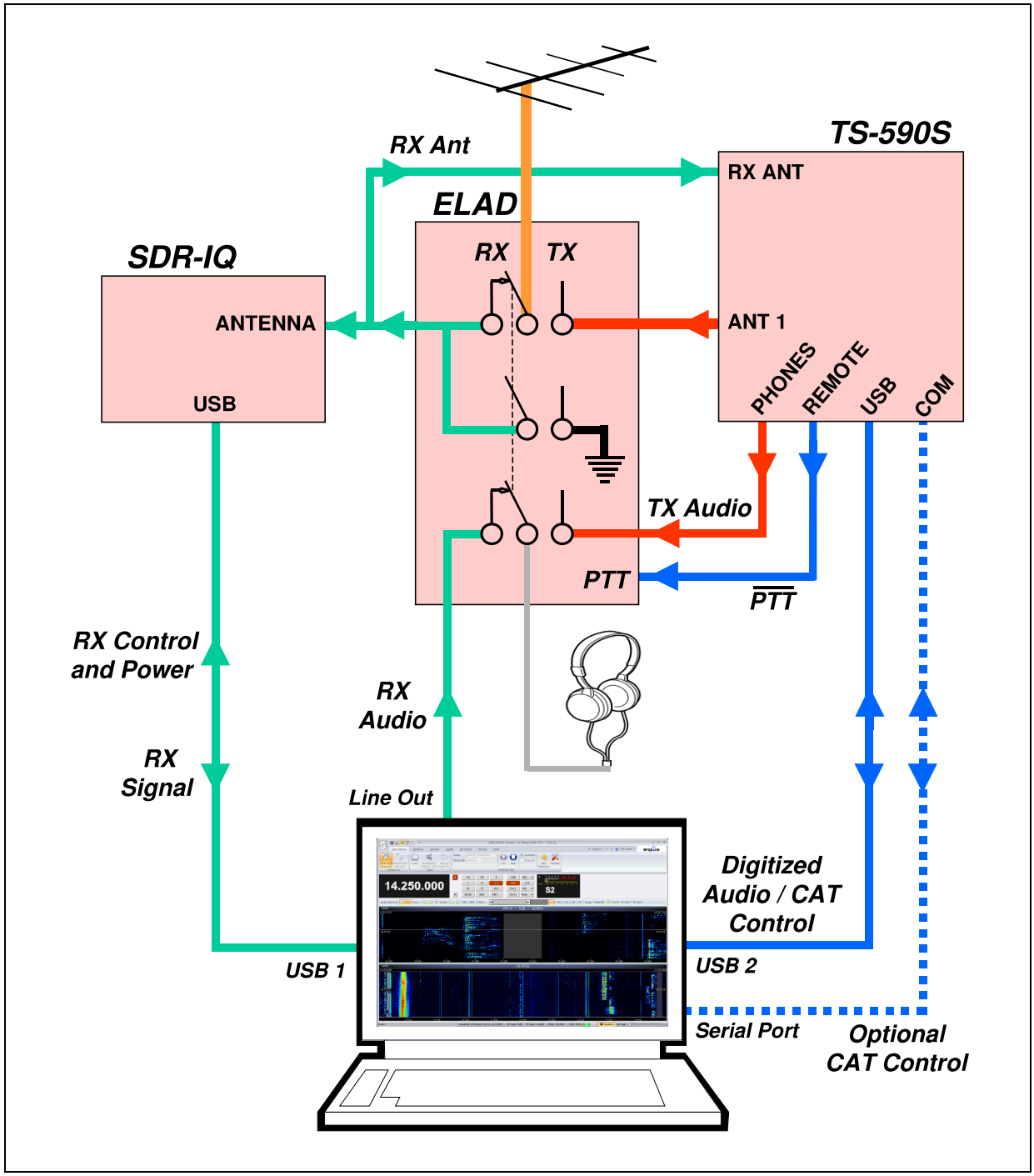


Figure 1: The big picture, showing the connections between the SDR-IQ, the ELAD Switch Box, the TS-590S and the PC

The ELAD relays switch to the transmit position when the **PTT** input of the Switch Box is grounded. The $\overline{PTT}$ signal originates from the **REMOTE** connector on the TS-590S. See Figure 2.

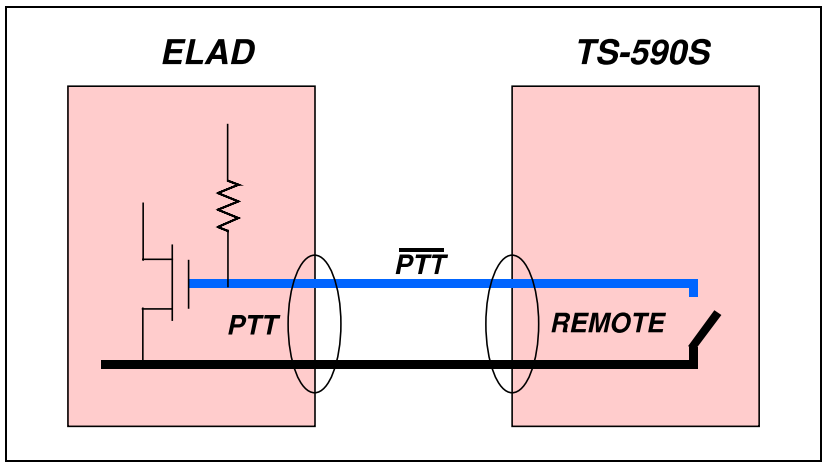


Figure 2: The PTT connection between the ELAD Switch Box and the TS-590S. When switching to transmit, the TS-590S closes the switch, thus grounding the $\overline{PTT}$ line

The TS-590S

Several connections are made to the TS-590S:

- **RX ANT**: Receives the RF signal from the antenna, via the ELAD Switch Box. This input is only used when listening directly on the TS-590S – that is, when the SDR-IQ is not being used.
- **ANT 1**: Transmitter output, connected to the antenna via the ELAD Switch Box.
- **PHONES**: Monitor output, connected to the headphones via the ELAD Switch Box when transmitting.
- **REMOTE**: The PTT connection to the ELAD Switch Box.
- **USB**: Connected to the PC. Normally used for digitized audio transfer between the TS-590S, and also for CAT control and firmware update. In this HOWTO, the connection transfers CAT commands between the TS-590S and the SDR-RADIO software to control frequency and mode setting.
- **COM**: The serial port, optionally connected to the PC. Can be used for CAT control where the USB connection is unsuitable (for example, because of application software port conflicts).

The PC

Three ports (and optionally a fourth) are used here:

- **USB 1**: Connects to the **USB** port of the SDR-IQ, for:
  - the transfer of signals from the receiver
  - the transfer of control commands and power to the receiver
- **Line Out**: The receiver audio output, connected to the headphones via the ELAD Switch Box when receiving.
- **USB 2**: Connected to the **USB** port on the TS-590S. Used in this HOWTO for frequency and mode setting.
- **Serial Port**: Connected to the **COM** port of the TS-590S.

Connecting Everything Together

Figures 3 and 4 on the next two pages show how to connect everything together. Altogether 11 cables are required:

Cable #	*Connecting*	*Connectors*
❶	SDR-IQ **ANTENNA** to one side of BNC tee connector on ELAD **RX** – see Figure 5	BNC male to BNC male
❷	TS-590S **COM** to PC **Serial** (or PC **USB** if using a USB-to-serial cable)	9-pin DIN female to PC serial connector (If using a USB-to-serial cable, a female-to-female 9-pin adapter will also be required)
❸	TS-590S **USB** to PC **USB 2**	USB-B to USB-A
❹	SDR-IQ **USB** to PC **USB 1**	USB-B to USB-A
❺	TS-590S **ANT 1** to ELAD **RTX**	PL-259 to PL-259
❻	TS-590S **REMOTE** to ELAD **PTT** (special cable – see Figure 6 for wiring details)	7-pin or 5-pin DIN to RCA phono
❼	ELAD **ANTENNA** to the antenna	PL-259 to antenna
❽	TS-590S **RX ANT** to other side of BNC tee connector on ELAD **RX** – see Figure 5	BNC male to BNC male
❾	Fused power cable to ELAD **13,8 VDC**	Power supply to 5.5mm DC plug, positive inner
❶❼	TS-590S **PHONES** to ELAD **TX AF IN**	6.35mm (¼-inch) mono male to 3.5mm (~⅛-inch) mono male
❶❶	PC **Line Out** to ELAD **RX AF IN**	3.5mm (~⅛-inch) stereo male to 3.5mm (~⅛-inch) stereo male

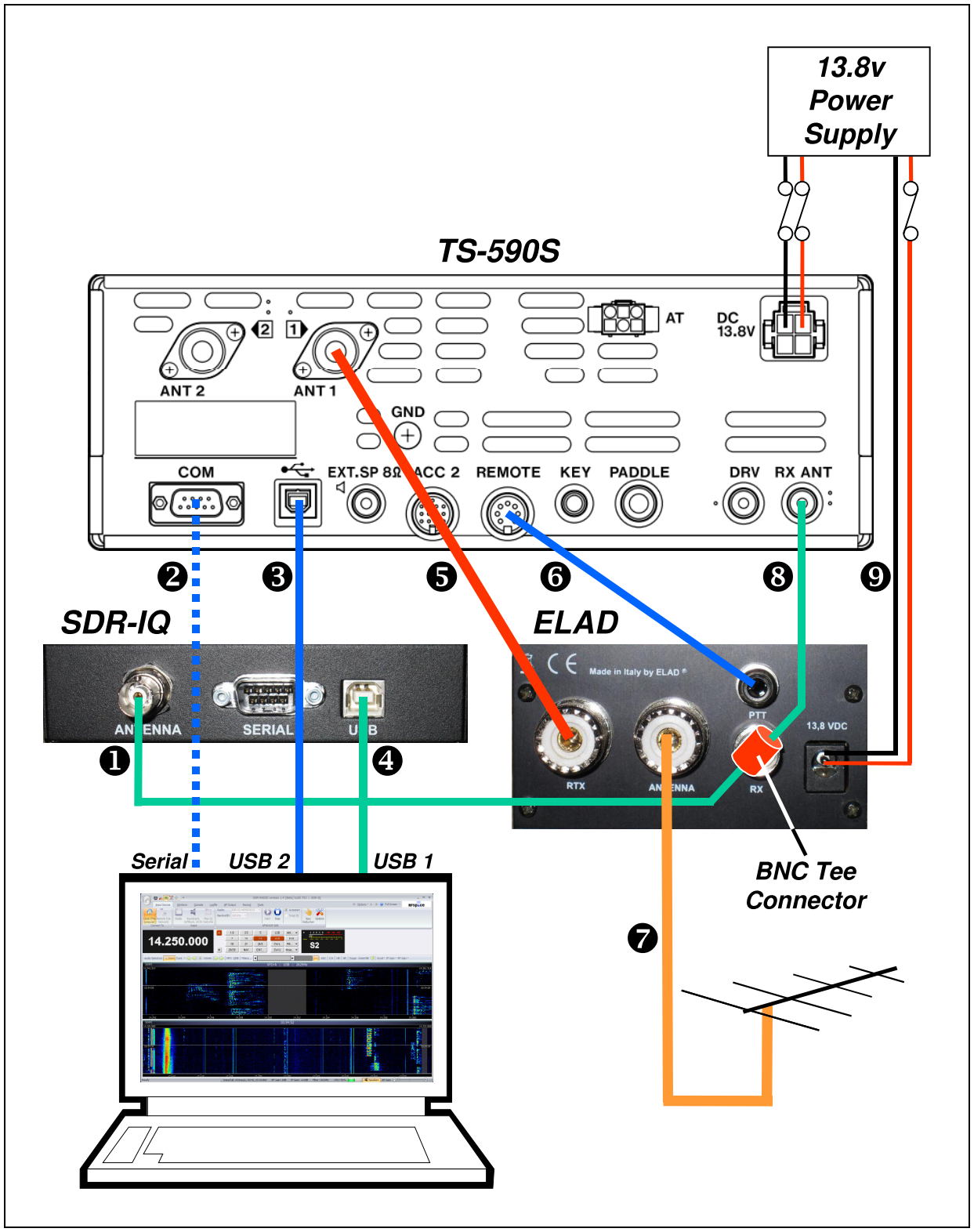


Figure 3: Connections on the rear side of the units. See Figure 5 for BNC tee connector detail

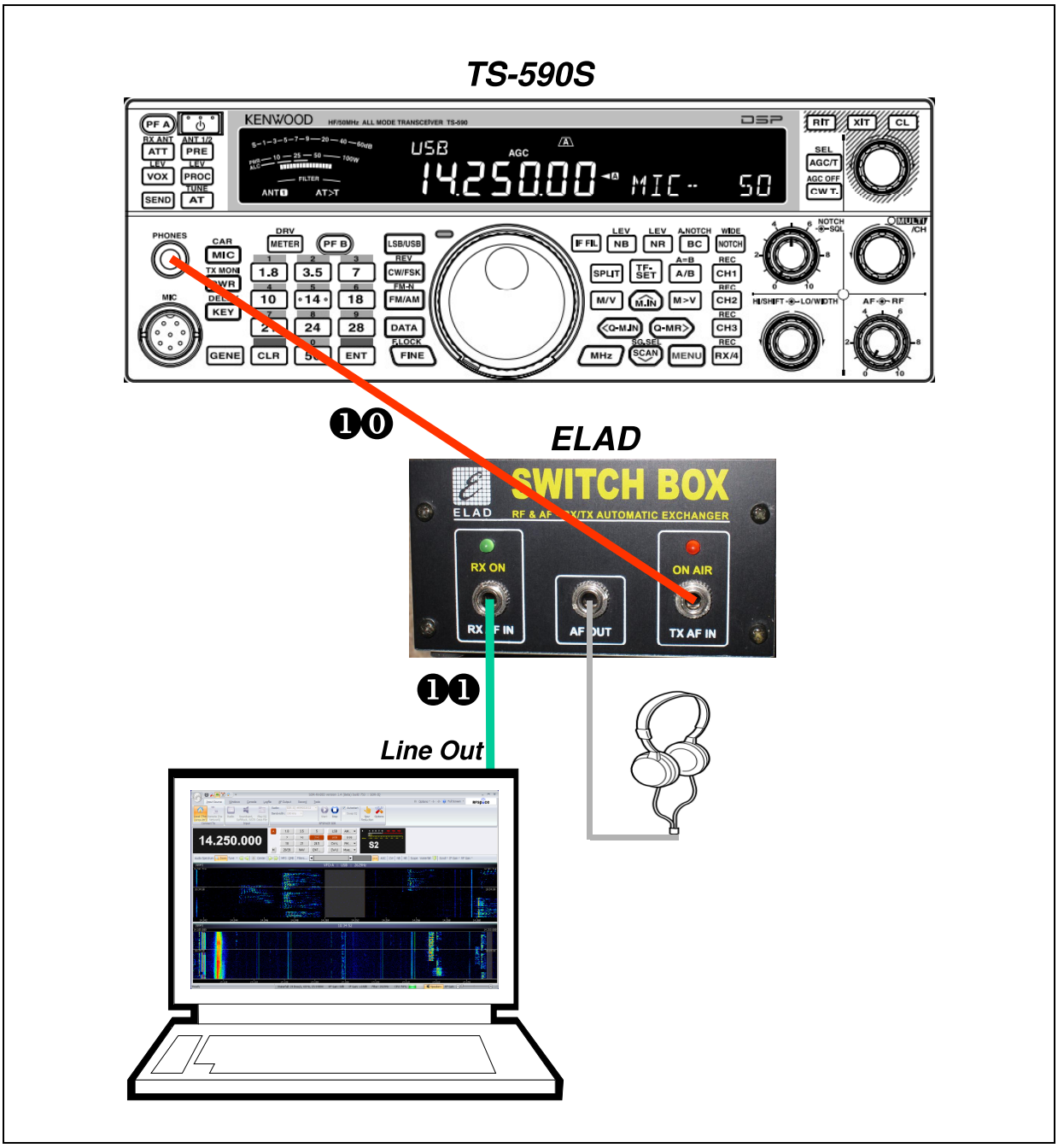


Figure 4: Connections on the front side of the units

Connecting the Antenna Cables to the ELAD Switch Box

The two Receive cables (cables ❶ and ❽) are connected to the ELAD Switch Box through a BNC tee connector. See Figure 5.

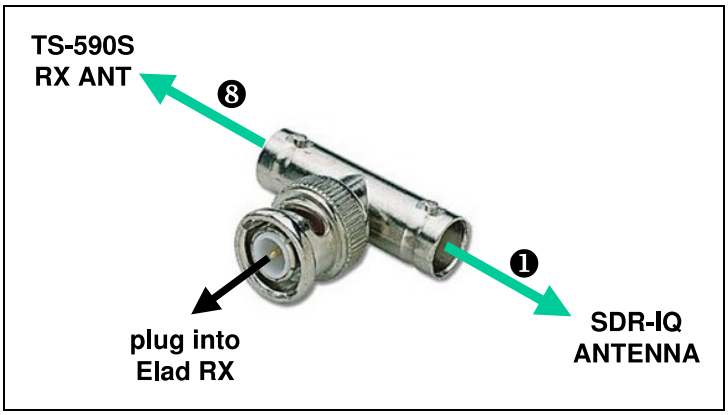


Figure 5: Using a BNC tee connector for the Receive cables

Wiring the PTT Cable

Figure 6 shows the wiring for the special PTT cable (cable ❻). Because only pins 2 and 4 are used on the TS-590S **REMOTE** connector, either a 7-pin or a 5-pin DIN plug may be used here.

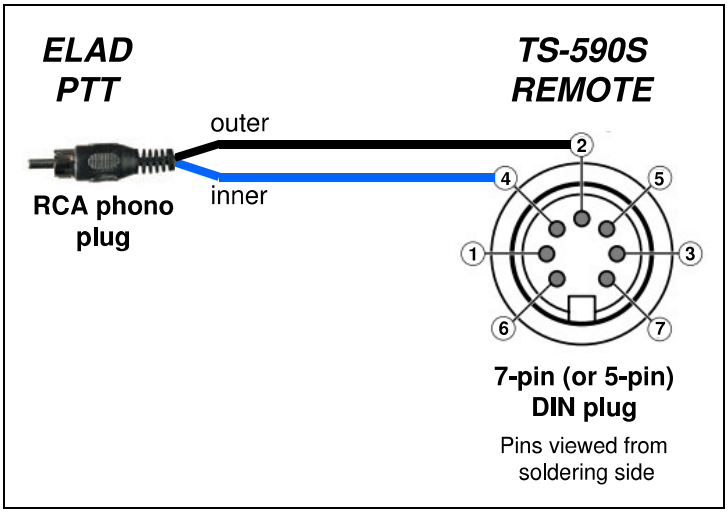


Figure 6: Wiring of the special PTT cable

PART 2: SETTING UP THE HARDWARE AND SOFTWARE

IMPORTANT: Do not attempt to transmit until you reach Part 3 of this HOWTO. Otherwise you may irreparably damage the SDR-IQ receiver.

PC Port Setup

You need to decide which TS-590S port you intend to use for communication with the SDR-RADIO software: either the serial COM port or the USB port. Either port will work, and the choice will usually come down to which of the ports is already used by other application software. In practice it is best to install the software for both ports, making it easy to switch from one port to the other if conflicts arise.

Serial COM Port: If your PC has a standard serial COM port, there is no need to install any special software. Most PCs today, however, do not have a hardware serial port, so it is necessary to use a USB-to-serial cable instead. In this case you will need to install the software driver that comes with the cable – for example, from Prolific or FTDI.

USB Port: Before the PC can communicate with the radio via the USB port, you need to install the virtual COM port driver, which sets up a USB-to-UART bridge. The driver software and full instructions for installation are at [6].

After installation, the drivers should appear in Windows Device Manager as serial ports, similar to Figure 7.

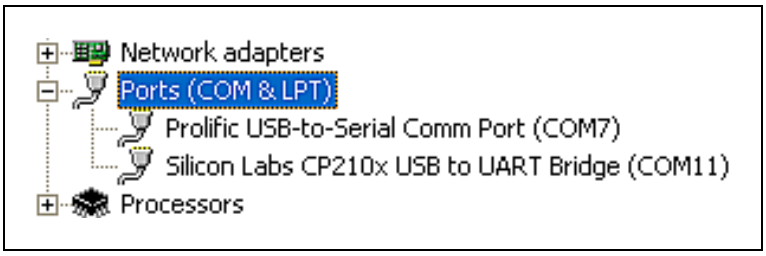


Figure 7: In this example, COM7 is assigned to the serial COM port, and COM11 to the USB port

TS-590S Firmware

Before progressing further, you should bring the TS-590S firmware up to date – the current release (September 2011) of the firmware is v1.05. This is to ensure that the **RX ANT** input to the transceiver is muted when transmitting. Early versions of the firmware did not mute the **RX ANT** input, with a consequent risk to the receiver.

Firmware update is a straightforward process, and is covered in detail in [7].

TS-590S Port Setup

To support communication between the PC and the TS-590S, you need to set up the speeds for the COM port and the USB port. The two speeds do not have to be the same – unless you have a slow PC, you can use a speed of 115200 baud.

To set up the speeds on the TS-590S, press the **MENU** button on the front panel, then turn the **MULTI/CH** knob to select Menu 61 (COMPORT BAUD RATE) and Menu 62 (USB PORT BAUDRATE) to set up the chosen speeds.

In the examples in the rest of this HOWTO, the TS-590S communicates with the PC via the COM11 USB port at 115200 baud.

TS-590S TX Delay Setup

To give the ELAD Switch Box sufficient time to switch from Receive to Transmit and clamp the SDR-IQ input to ground, you need to set up the TX delay in the TS-590S; that is, the delay between asserting PTT and TX RF appearing.

To do this, press the **MENU** button on the front panel, then turn the **MULTI/CH** knob to select Menu 53 (HF LINEAR AMPLIFIER CONTROL RELAY). Then select Option 3 (25 mS delay).

[*Note: The ELAD Switch Box contains automatic RF sense circuitry, which in theory makes the PTT input superfluous. However, there are two arguments for not using automatic RF switching:*

- *The RF sense circuitry does not work reliably on less than about 10 watts of RF. QRP operation below 10 watts results in continuous relay chatter.*
- *TX RF is present in the unit before the relays completely switch over. This means that a spike of potentially high power RF could find its way into the SDR-IQ before the SDR-IQ input is grounded.*

For these reasons the use of the PTT line is highly recommended].

SDR-RADIO Software – External Radio Setup

The next two pages describe in detail how to set up the definition for the TS-590S in the SDR-RADIO software.

Step 1: Select External Radios

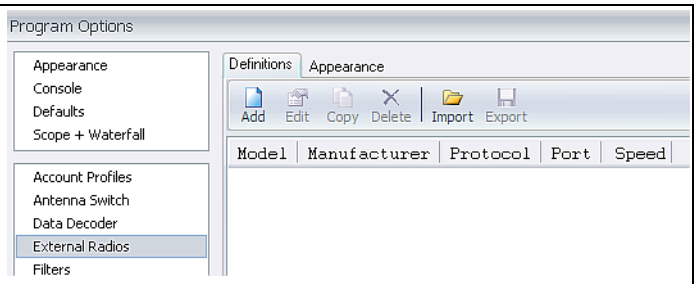
SDR-RADIO: Input Source > Options

Select **External Radios**

A blank Definitions Table appears (opposite, bottom right)

Click on the **Add** button

The General menu appears



Step 2: Set up General Options

Manufacturer: select `Kenwood`

Protocol: select `Kenwood New`

Model: enter `TS-590S`

Serial port: select chosen COM port

Speed: select chosen speed

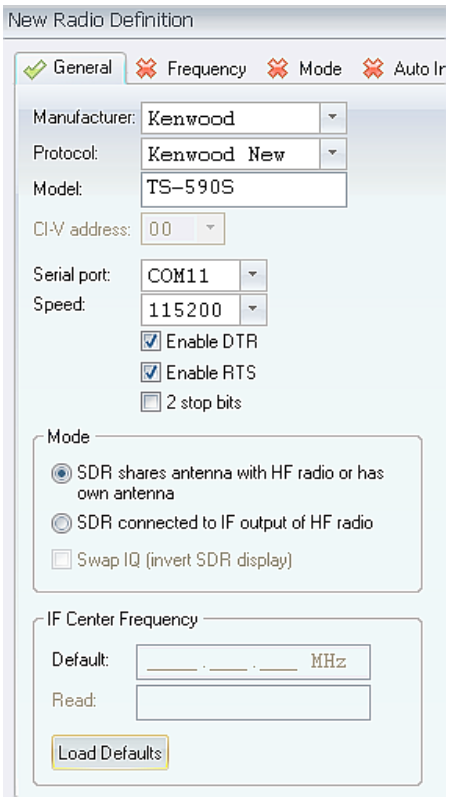
Enable DTR: check

Enable RTS: check

Mode: select SDR shares antenna with HF radio or has own antenna

Click on the **Frequency** tab

The Frequency menu appears



Step 3: Set up Frequency CAT Commands

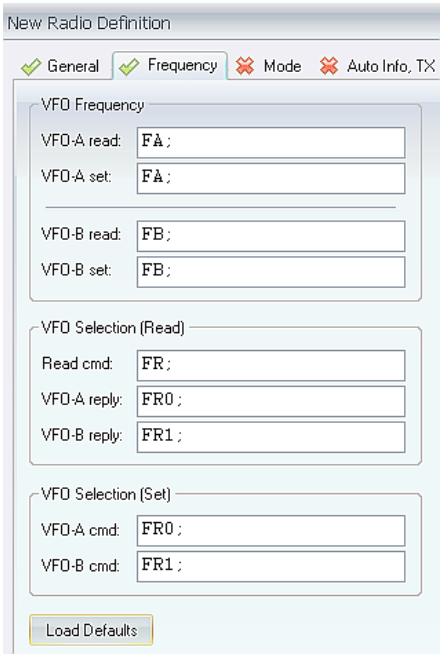
When the Frequency menu appears, all the boxes are blank

Click on **Load Defaults**

All the boxes will be automatically filled

Click on the **Mode** tab

The Mode menu appears



Step 4: Set up the Mode CAT Commands

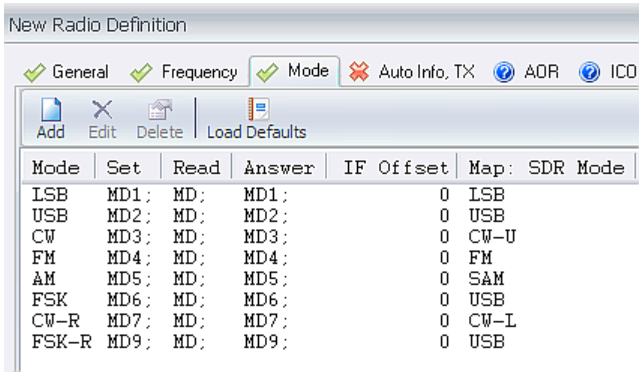
When the Mode menu appears, all the boxes are blank

Click on **Load Defaults**

All the boxes will be automatically filled

Click on the **Auto Info TX** tab

The Auto Info TX menu appears



Step 5: Set up the Auto Info TX CAT Commands

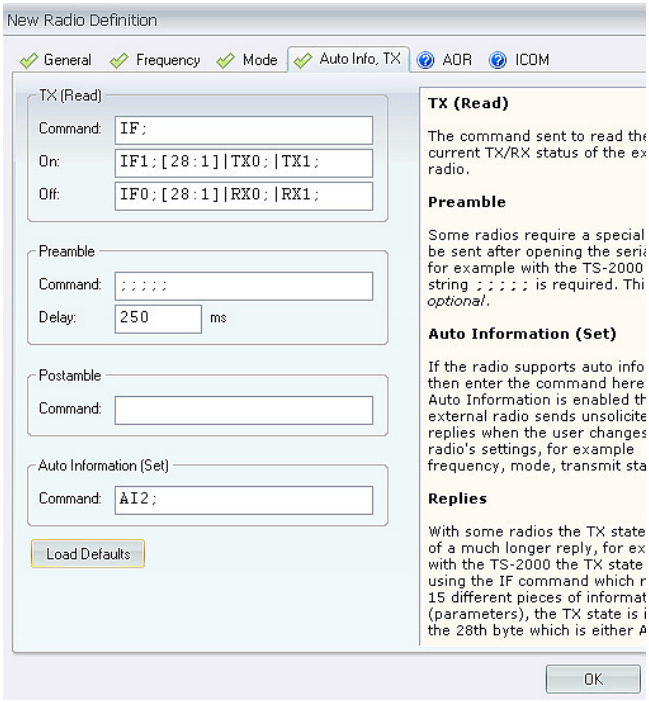
When the Auto Info TX menu appears, all the boxes are blank

Click on **Load Defaults**

All the boxes will be automatically filled

Click on **OK**

The Program Options menu reappears

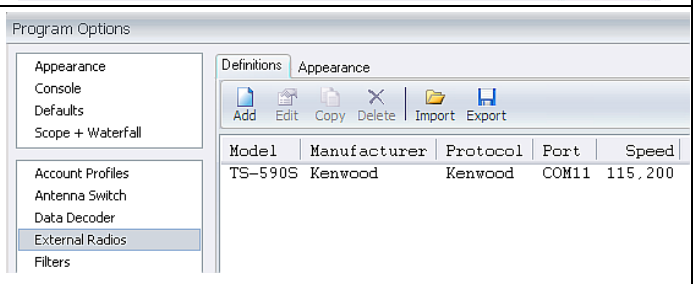


Step 6: Verify the new Radio Definitions Table entry

The TS-590S entry now appears in the Definitions Table

Select the table entry, then click on **Export** to save the definitions

The Save Radio Definitions menu appears



Step 7: Save the External Radio Definitions

When the Save Radio Definitions menu appears, the program automatically creates a suitable filename.

Edit this filename if required, then click on **Save**

SDR-RADIO Software – Initial Receiver Gain Setup

When setting up the SDR-IQ for the first time, it is advisable to reduce the IF and RF gain settings to their minimum values, to reduce the risk of overload when transmitting. Later, after checking that the receiver does not overload, you will change the settings to more appropriate values.

To change the receiver gain settings, first select a band (the gain settings are stored separately for each band), then click on **IF Gain** and **RF Gain** and select the minimum values. See Figure 8.

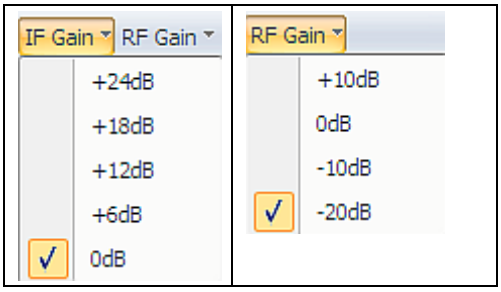


Figure 8: Choose the minimum SDR-IQ gain values at this stage

SDR-RADIO Software – Setting up TX Attenuation

The SDR-RADIO software lets you minimise the RF gain of the SDR-IQ when transmitting, to prevent overload during transmission. Click on Windows > External Radio, then click on the **Options** menu and select **Attenuation**. Check the Minimise box, and choose the greatest attenuation value (60 dB). See Figure 9.

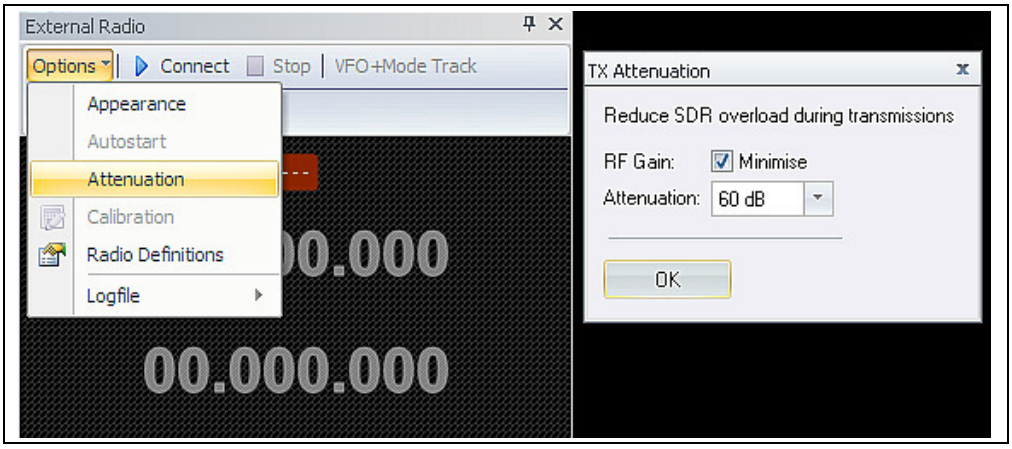


Figure 9: Choose the highest value of TX attenuation

Setting up the VFO+Mode Track and Mute on TX Options

You are now ready to connect to the TS-590S.

Click on **Connect** in the External Radio pane. A new Connect window appears – see Figure 10. Click on the **Connect** button in this window.

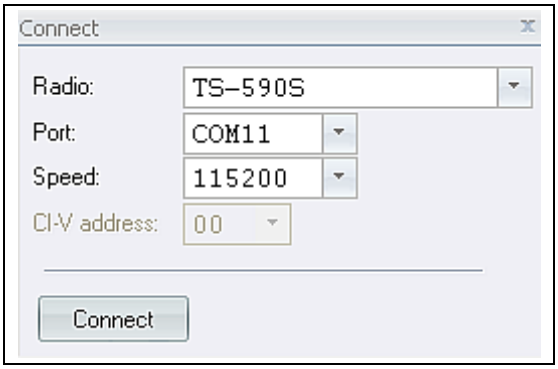


Figure 10: Connecting to the TS-590S

The frequency display should then change from all-zeros to the VFO-A and VFO-B frequencies that are already set up on the TS-590S, and the mode indicator (USB/LSB) should also be displayed in red.

Click on the **VFO+Mode Track** and **Mute on TX** buttons – see Figure 11.

Figure 11: Setting VFO+Mode Track and Mute on TX

To check that the TS-590S and SDR-RADIO are now operating in sync with each other:

- On the TS-590S turn the VFO knob and change from USB to LSB. The frequency display and mode indicator on the SDR-RADIO External Radio pane should follow suit.
- Change the frequency and sideband on the SDR-RADIO screen. The frequency display and mode indicator on the TS-590S should likewise follow suit.

PART 3: PREPARING TO TRANSMIT

Checking for SDR-IQ Overload

The SDR-IQ receiver has an overload indicator that flashes red when the input signal exceeds a safe value. See Figure 12.

Figure 12: The overload indicator on the front panel of the SDR-IQ

To check that overload does not occur:

1. Temporarily connect a dummy load to the ANTENNA port on the ELAD Switch Box.
2. Turn the Power setting on the TS-590S down to 5 watts.
3. Press the AT button on the TS-590S to ensure that the transmitter output is tuned.
4. Select FM Mode on the TS-590S. The mode indicator on SDR-RADIO should change to FM.
5. Press the microphone PTT switch briefly (not more than a second or so). The mode indicator on SDR-RADIO should change to TX ON, in yellow. See Figure 13.

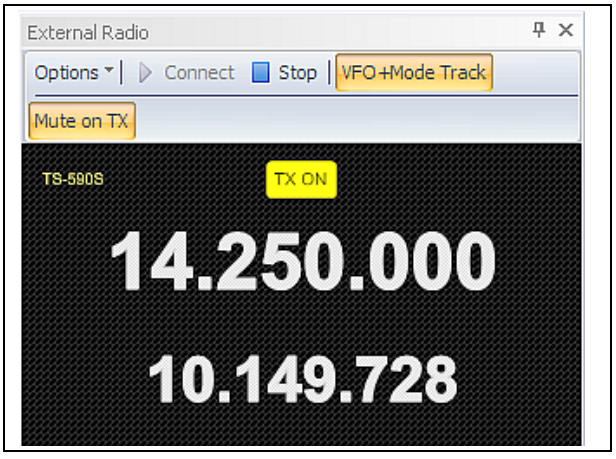


Figure 13: The mode indicator changes to TX ON when transmitting

6. While transmitting, check that the SDR-IQ overload indicator does not light.
7. Repeat steps 4 and 5, gradually increasing the power up to 100 watts. The SDR-IQ overload indicator should not light at any time.

8. Increase the SDR-IQ IF and RF gain settings to maximum, and repeat step 6. Again, the SDR-IQ overload indicator should not light. **Provided the hardware and software are configured as already described, the overload indicator should *never* light, even when the transmitter is running at full power. Occasional brief overloads will probably not do any damage, but any frequent or lengthy spells of overload should be thoroughly investigated.**

9. The overload check is now complete. Change the TS-590S mode from FM back to the usual preferred mode, remove the dummy load and reconnect the antenna. Everything is now ready for on-air operation.

Some Miscellaneous Points

- Because of processing delays in the SDR-RADIO software, it is possible the SDR-IQ is not suitable for certain digital modes that depend on a very short turnround time between Transmit and Receive. Experimentation with receiver settings such as AGC and Noise Reduction may be required to minimise the turnround time.

- When setting up the USB COM ports, Windows sometimes allocates port numbers that are outside the range of permissible ports used by application packages. The technique for changing COM port numbers to more suitable values is described at [8].

- The SDR-RADIO software is a rapidly moving target – fixes, updates and enhancements sometimes appear every few days! For this reason it is essential to subscribe to the SDR-RADIO Yahoo group [9] to keep up to date with latest developments.

- To keep up to date with TS-590S reviews, documentation, software and HOWTOs, the "TS-590S Resources Page" offers a convenient one-stop takeoff point [10].

PART 4: OTHER HARDWARE CONFIGURATIONS

To monitor own transmissions via the SDR-IQ

In the hardware configuration shown earlier, the headphones are switched through the ELAD Switch Box, such that when you are transmitting they are connected to the PHONES output on the TS-590S. This means that when transmitting you are listening to the audio from the transceiver.

In some circumstances, however, you may wish to monitor the quality of your on-air transmissions through the SDR-IQ. To do this, three simple steps are required (see Figure 14):

1. Turn the AF Gain control on the TS-590S down to minimum.
2. Unplug the Line Out cable (cable ❿❶) from the PC.
3. Unplug the headphones from the ELAD Switch Box, and plug them into the PC Line Out port.

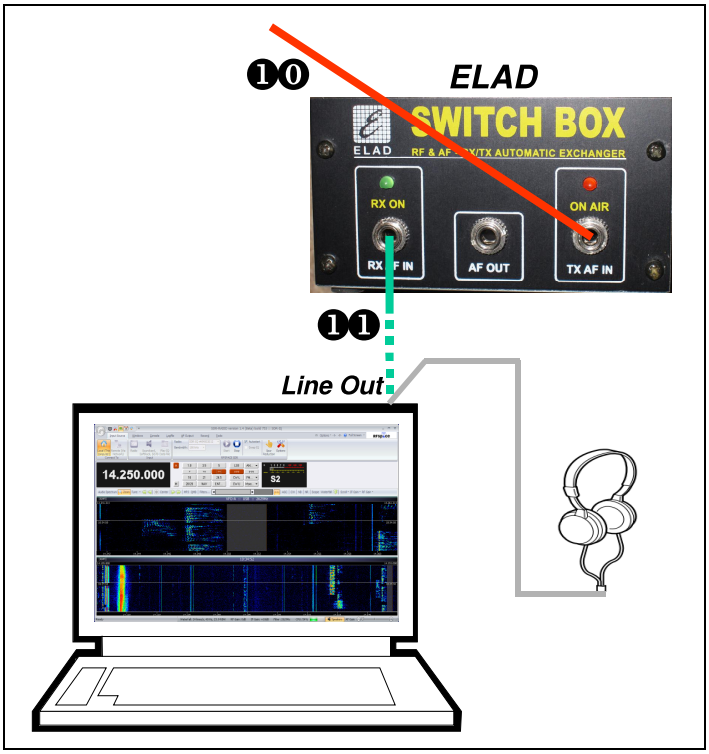


Figure 14: Connecting the headphones direct to the PC's Line Out port allows monitoring of both received and transmitted signals

With this configuration you can monitor both received and transmitted signals on the SDR-IQ. Be aware, though, that the transmitted audio will be delayed by several (perhaps many) tens of milliseconds, which can be quite disconcerting when monitoring your own voice!

To revert to TS-590S only operation

There may be times when you want to operate the TS-590S in "native" mode; that is, without the SDR-IQ. To do this, three simple steps are required (see Figure 15):

1. Unplug the TX Audio cable (cable ❿) from the PHONES jack on the TS-590S.
2. Unplug the headphones from the ELAD Switch Box, and plug them into the PHONES jack on the TS-590S.
3. Press the RX ANT button on the TS-590S, and check that the RX symbol appears on the display.

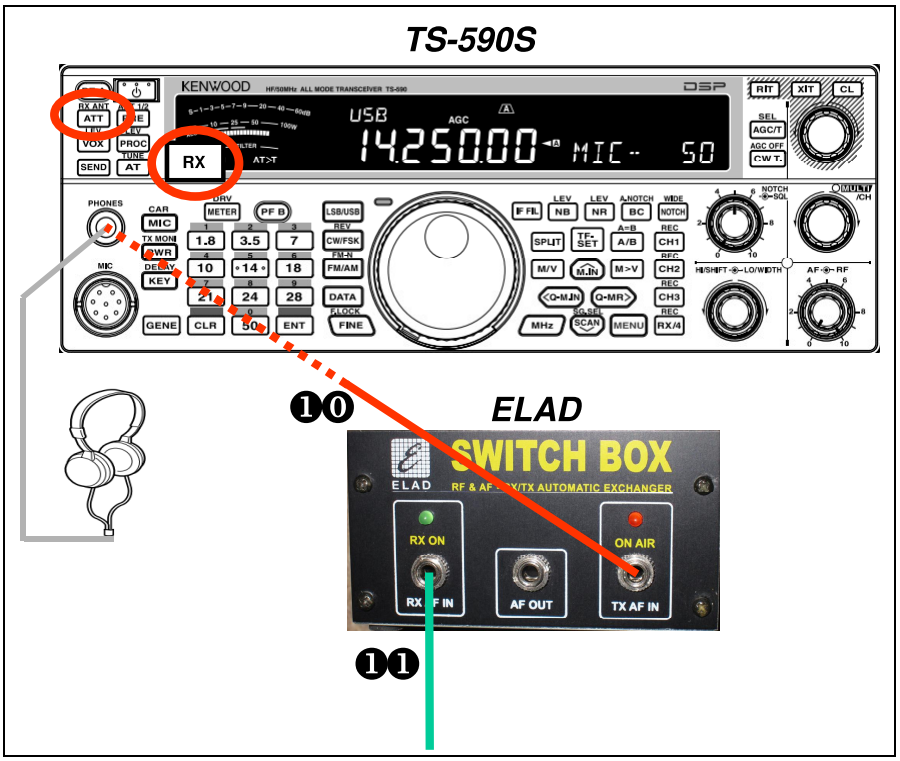


Figure 15: Using the TS-590S by itself. For this to work, the RX ANT button must be pressed to make the RX indicator appear on the display (ringed)

No other cabling changes are needed, making it very quick to switch to TS-590S only operation.

PART 5: REFERENCES

[1] SDR-RADIO software: http://sdr-radio.com/

[2] YouTube video of TS-590S and SDR-IQ: http://www.youtube.com/watch?v=JFAhhy4Wbsc

[3] Kenwood TS-590S transceiver: http://www.kenwoodusa.com/Communications/Amateur_Radio/HF_Base_Mobile/TS-590S

[4] RFSPACE SDR-IQ receiver: http://www.rfspace.com/RFSPACE/SDR-IQ.html

[5] ELAD Switch Box: http://www.woodboxradio.com/uk/Switchbox.html

[6] TS-590S Virtual COM Port Driver: http://www.kenwood.com/i/products/info/amateur/vcp_e.html

[7] Kenwood TS-590S firmware: http://www.kenwood.com/i/products/info/amateur/ts_590/ts590_update_e.html

[8] Changing USB COM ports: http://answers.sensorysoftware.com/answer101.htm

[9] SDR-RADIO Yahoo Group: http://groups.yahoo.com/group/sdr-radio-com/

[10] TS-590S Resources Page: http://homepage.ntlworld.com/wadei/ts-590s.htm

Document Version History

Version	*Date*	*History*
1.0	2 September 2011	First version