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On the Cover: Station on the coast of Maine, operators in New York (inset)...part of the winning strategy of WW2DX/1 in the 2017 CQ WPX SSB Contest. Details on page 12; contest results begin on page 14.

Does your mic cable keep you tied to your shack desk? Would you like to be able to do other things around the house while taking part in a net or working your way through a DX pileup? If so, WB2REM and K5PA might be able to help…

Go Untethered!

Operate Your Station with a Wireless Headset

BY JIM MILLNER,* WB2REM AND GENE HINKLE,# K5PA

here is nothing better than sitting in the ham shack with your headset on, working rare DX or just talking with your friends. Yet there are times when it would be even more convenient to communicate through the radio from other areas of the house. If this piques your interest, then let's go wireless by unshackling yourself from the radio!

The search for moderately-priced wireless headset solutions for the ham shack led us to the Plantronics CS520 binaural solution (Photo A). In the recent past, the Plantronics CS520 headset was widely used by telemarketers. As a result, an abundance of these headsets can be found online. The CS520 is a digital binaural 1.9-GHz headset using secure audio technology with a range of up to 350 feet. It is appealing because it is lightweight and comfortable with clear headset audio characteristics. The CS520 can be easily modified to work with most radios. The accompanying headset cradle doubles as a lithium battery charger. Another important feature of this headset is the mute button, which can be activated as needed when leaving the shack. The CS520 headset packages range in price online from $50 to $199+, depending on their condition. They can be found on eBay and other auction sites as well as in the Plantronics Outlet store. The CS520 usually comes with a headset, charging/mating base, 9-VDC power supply and a telephone system patch cable (not used in this application). Note: When buying the CS520 from eBay, make sure the unit purchased is DECT 6.0 for U.S. domestic

use and not the other version (unless you live outside U.S./FCC jurisdiction). Also, be aware that there is a CS520-XD version that is not compatible since it uses 900 MHz and is not DECT 6.0 compliant.

Wireless Headset Architecture

The hardware concept is rather straightforward as shown in Figure 1.

The CS520 base unit connects to the transceiver using a custom-made cable with audio and, if desired, a push-to-talk (PTT) connector jack interface. The CS520 headset communicates with the base unit using 1.9-GHz radio frequencies. An optional wireless handheld PTT button transmitter can be used to activate the transmit function on the transceiver. Alternately, manual PTT

Photo A. The Plantronics wireless headset that the authors modified to let them operate "untethered" from their radios. (All illustrations courtesy of the authors)
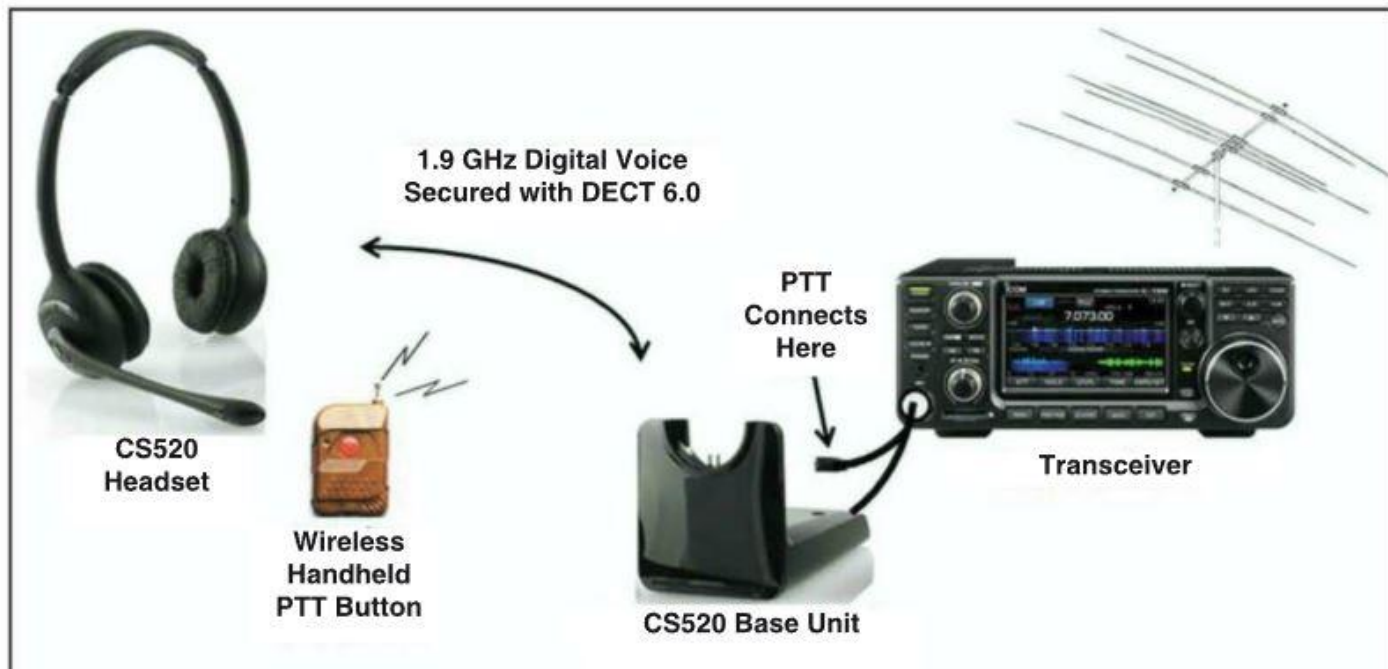
* <wb2rem@verizon.net>
# <k5pa@arrl.net>

Figure 1. Wireless headset/PTT architecture (see text for details).

buttons, switches, or footswitches can be interfaced to the PTT connector port.

Setting Up the CS520 Wireless Headset

There are a few methods for setting up the CS520 to work with your radio. The easiest one uses the radio's VOX function. This requires modifying a CAT 5/6 (RJ45) cable, leaving one of the RJ45 connectors intact. This side will be plugged into the headset base. The other RJ45 connector will be cut off and the wires prepared for soldering to the radio's microphone/speaker connector(s). If a push-to-talk (PTT) function is needed, then a short 1/8-inch stereo phone jack could be added to the radio's PTT connection. Details on how to make the microphone cable and add a PTT jack are described later.

On the back of the CS520's base there are the 9-volt power jack and the RJ45 female jack, as shown in Photo B. In addition, there is a narrowband (black)/wideband (yellow) audio switch. In field testing, the narrowband setting seemed to work better. This is probably due to less bandwidth on the narrowband setting, which makes it commensurate with HF SSB operation. The narrowband setting also uses less power, giving better battery life. The auto-connect switch on the right side allows the headset to connect automatically to the base unit when the headset is lifted off the base.

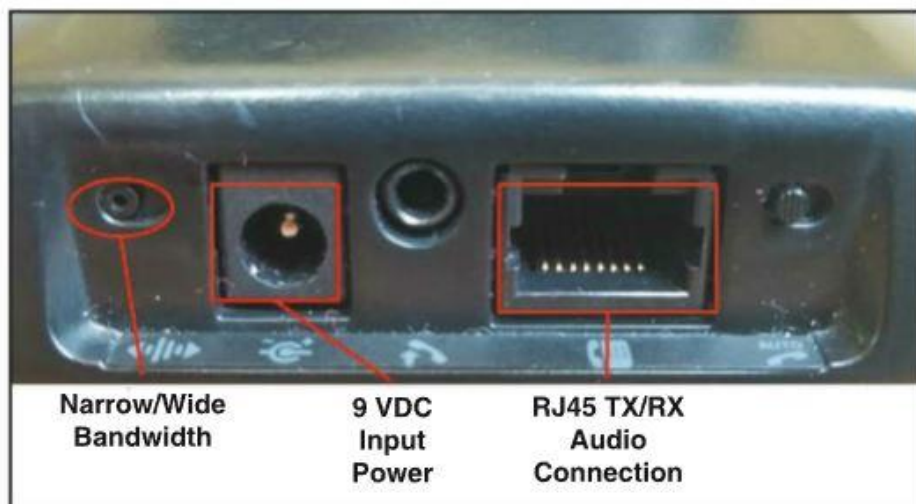Microphone and speaker audio adjustments are located on the bottom of the

Photo B. Controls on the back of the base unit.

headset base, as seen in Photo C. These seemed to work best in the lower limit settings (set to 2 in the photo). There is also an A-G configuration slide switch. Generally speaking, the headset comes from the factory with the switch set to letter A. This switch should be left alone. However, if the headset doesn't work well, try toggling through the other letters until you find one that works better. The Plantronics User Guide or the company's internet site can be referenced for more detailed information.

On the side of the headset (Photo D), there is a call button which, when pushed and released, allows audio to pass from the radio to the headset. Pushing and releasing this button again

breaks the connection. On the bottom of the headset there is a mute button (semi-circle push button) which, when triggered, mutes the transmitted audio and provides an audible tone to confirm the action. On the top of the headset is an up and down volume control.

A really nice feature is the ability to conference up to three other headsets to the same base unit. This is great for Field Day activities or general demonstrations to future ham operators. The conferencing procedure is easy and described in the CS520 User Manual.

Headset Cable Construction

A cable (Photo E) is needed to interface between the CS520 and the radio.

Table 1 Wire Connections from the CAT5/6 RJ45 Cable to an 8 Pin Round ICOM Transceiver Connector (IC746, 756, 7300, 7600)

FUNCTION	CONNECTOR & PIN #	RJ45 WIRE COLOR (T-568B Wire Color Convention)	RADIO CONNECTIONS	ICOM MIC CONNECTOR
RCVR-	RJ45 Pin 2	ORANGE	SPEAKER Common	PIN-6
RCVR+	RJ45 Pin 3	GREEN/WHITE-STRIPE	SPEAKER Out	PIN-8
MIC-	RJ45 Pin 4	BLUE	MIC Common	PIN-7
MIC+	RJ45 Pin 1	ORANGE/WHITE-STRIPE	MIC Input For Radios with DC Bias Add 0.47 µF Capacitor in Series	PIN-1
SHIELD	RJ45 BARE WIRE	SILVER		PIN-6
PTT	1/8" Plug TIP	Add Wire to MIC Conn., RED	PTT	Pin 5
PTT	1/8" Plug RING	Add Wire to MIC Conn., BLK	PTT Common	Pin 6

Figure 2 shows a wiring diagram of our concept. A common radio connector is called a Foster round 8-pin microphone plug and is shown on the left side of the diagram. Some radios use RJ45 connectors, Foster 4 or 6-pin connectors, or 1/8-inch phone jacks. We will describe how we built our cable using the Foster round 8-pin that is found specifically on some ICOM transceivers. If yours is different, you will need to adapt the audio and push-to-talk wires to your specific radio connector. (See References for link to resource page with wiring diagrams for additional transceivers and other information.)

The opposite end of the cable is the RJ45 plug that connects to the CS520 base unit. We suggest using an RJ45 shielded cable. We also show an option of controlling the PTT transmit via a 1/8-inch stereo phone jack. The other end of this jack connects to whatever device will be providing a switch closure for transmit control.

Each radio manufacturer has different microphone connectors and pin connections and will require modifications accordingly. To begin with, purchase a shielded CAT5 or CAT6 cable with RJ45 connectors on each end. The cable color codes should follow the T-568B standard for pin connections, shown in Figure 3, in order for the following color sequences to be correct. We have found that some prefabricated cables have the wires twisted in pairs but the stripe color listed is actually a solid white wire. We recommend that you perform a continuity check of all wiring prior to final soldering and assembly.

Make sure the cable is long enough to go between your radio and the headset base stand. Cut off one end of the cable. Where the cable was cut, strip back approximately 3/4 of an inch of the plastic outer layer, exposing the eight color-coded wires. Carefully peel back and cut off the foil shield but do not cut the stranded silver wire. This is the ground wire for the shield. Identify and isolate the orange, orange/white stripe, blue, and green/white stripe wires. Cut off the other four wires. Table 1 shows each colored coded wire and its function.

Each of the final wires will need to be stripped by about 1/8 of an inch, then tinned and soldered to your microphone connector. Many modern radios now also include the receiver audio output line on the microphone connector. If yours does not, then wire the two receiver audio lines to your speaker output jack.
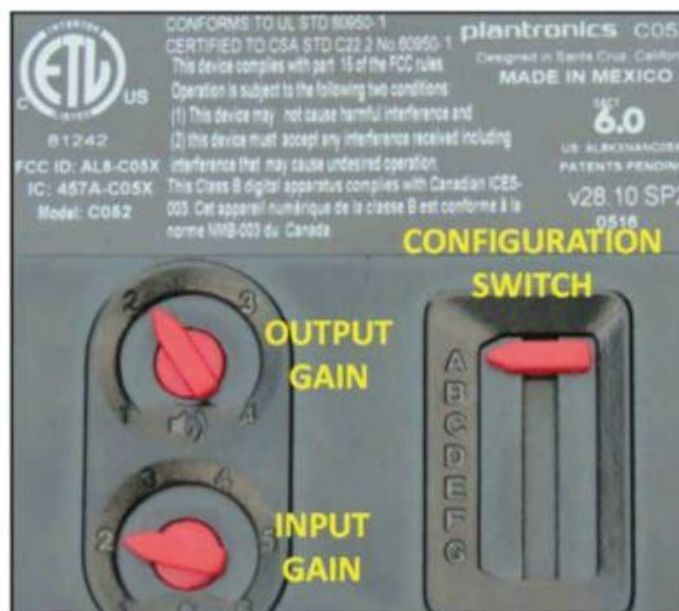

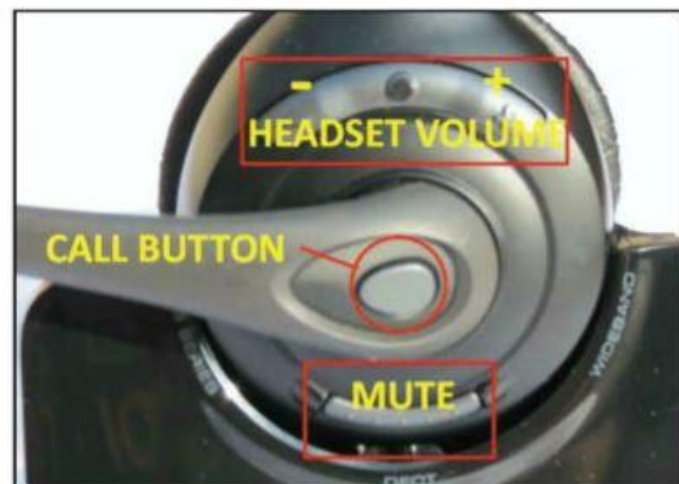Photo C. Controls on the bottom of the base unit.

Photo D. Controls on the side of the headset.

Add **Pushbutton**, Toggle **Switch** or **Roaming PTT Wireless Module** Across Wires To Transmit

1/8" PTT Stereo Plug
TIP & RING Switch or Relay Contact

1/8" PTT Stereo Jack
Switch Closure, n.o.

Foster 8-pin MIC Plug
Or Appropriate
Transceiver Plug

RJ45 Shielded Plug for
CS520 Base Unit
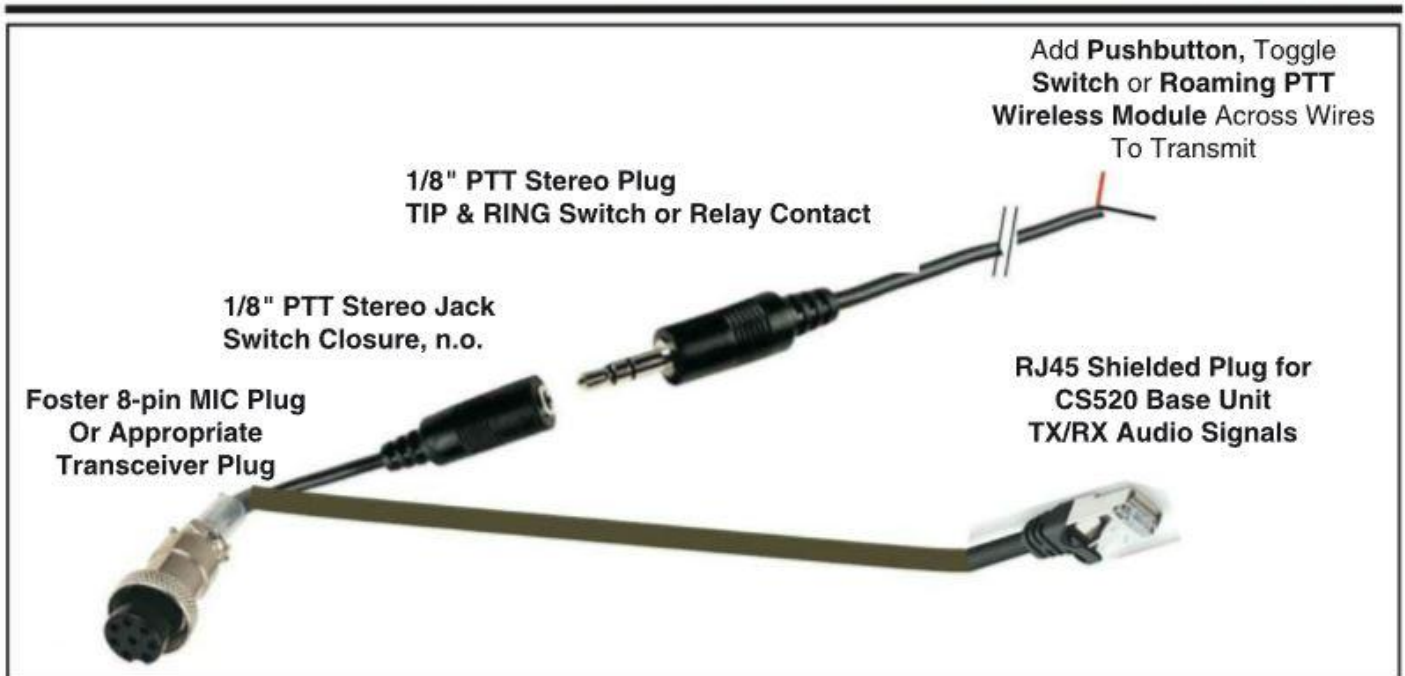**TX/RX Audio Signals**

Photo E. Cable for connecting base unit to radio. (Our example uses an 8-pin mic plug)

For radios that provide a bias voltage to the microphone, a DC blocking capacitor (value of 0.47 µF at 50 VDC) can be inserted in the wire connecting to pin-1 of the mic connector. We have found it easiest to insert the capacitor in the cable prior to entering the mic connector and cover it with heat-shrink tubing. Some radios have menu options that allow you to turn off the DC bias voltage when a dynamic microphone element is used. In that case, the DC blocking capacitor can be omitted and just select the radio's menu option to turn off the DC bias.

If you ever plan to have a PTT capability in addition to VOX, then you will also need to add a short 1/8-inch stereo phone
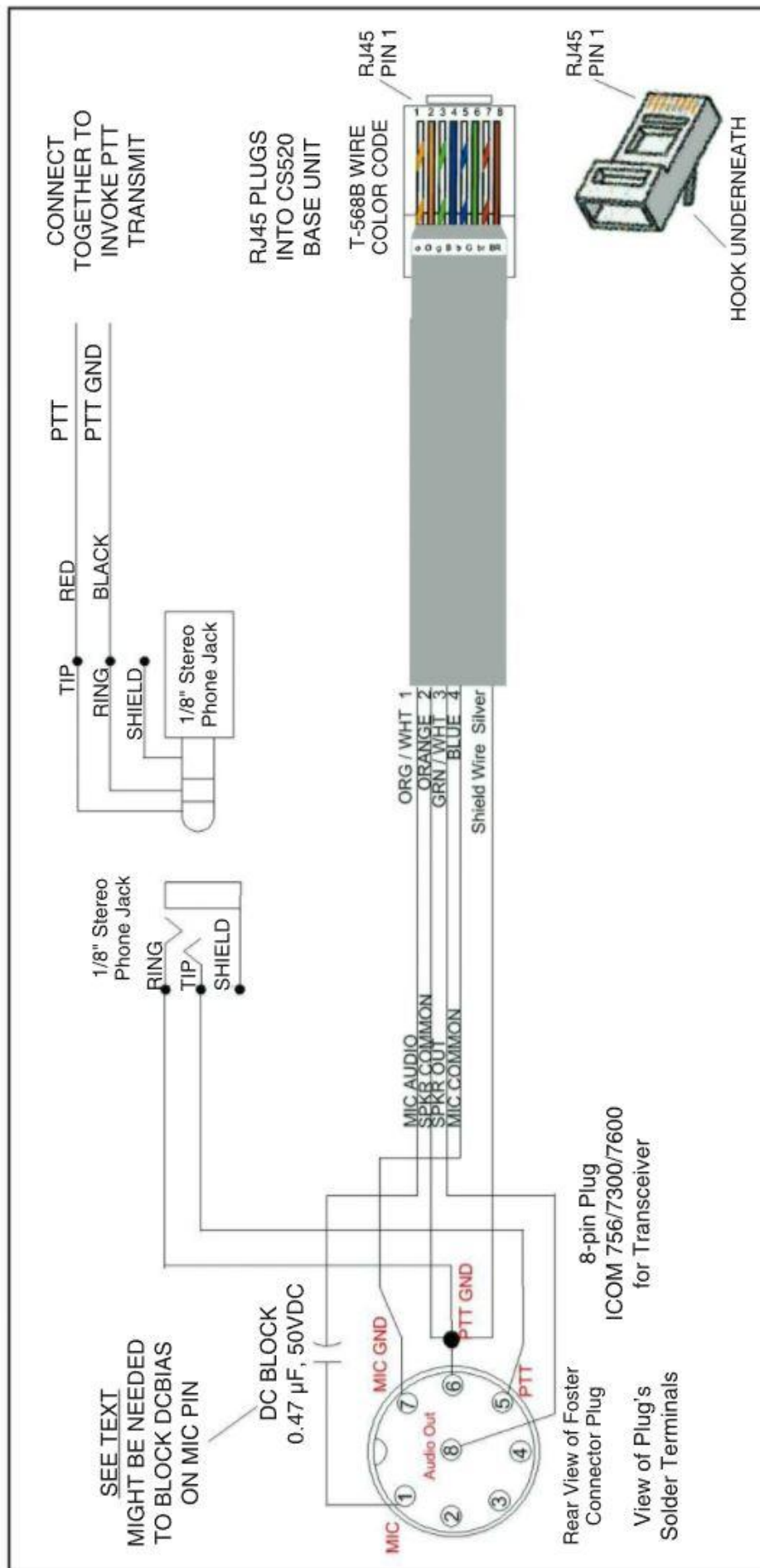
Figure 2. Schematic diagram for the CS520-to-radio interface.

jack wired to the PTT pins on the microphone connector. We suggest the phone jack be wired with the two PTT wires connected to the tip and ring positions on the jack and not the sleeve. That way, the PTT wires will be isolated from the sleeve. Having the PTT lines available provides a lot of future flexibility, as we will discuss later.

When the cable is completed, attach it to the radio in place of your regular microphone. Next, click the call button on the side of the headset if it is not already activated. You will hear a relay click and receiver audio should be present in the earphones. Put your radio in VOX while speaking, carefully adjust the VOX level to trigger the transmitter and then adjust the microphone and audio levels. You can do this with the controls on the top of the headset or underneath the base unit.

In our testing of the transmit audio, we found it had too much bass for effective communications. This is one reason we choose the 0.47-µF capacitor value, to limit the low frequency response. We adjusted the radio's transmit audio frequency control (or equalization in our transmit audio path) to increase the treble response and reduce the bass response. This is best performed while monitoring your own transmit audio and adjusting these controls. You should then verify the settings with other stations.

The headset's batteries last for approximately 5 hours of use and can be quickly recharged in less than an hour. One nice feature is the headset is always automatically being charged when it sits in the cradle of the base unit.

PTT Flexibility

The PTT jack, if added to the cable initially, provides for many flexible operating modes. The PTT modes include a simple push-button switch to initiate transmit, toggle switch to maintain transmit (not spring return), foot switches, and a wireless relay switch. The wireless approach provides the greatest flexibility. The ability to be remote makes net operations convenient and fun. Whichever PTT approach you choose, you will have the flexibility to add the wiring to the 1/8-inch stereo jack and connect your switch closure device. Table 2 shows the materials list for most wireless headset components and several vendors and part numbers that implement these common PTT switch closures.

Figure labels:

CONNECT TOGETHER TO INVOKE PTT TRANSMIT

RJ45 PLUGS INTO CS520 BASE UNIT

T-568B WIRE COLOR CODE

RJ45 PIN 1

HOOK UNDERNEATH

PTT — PTT GND

RED — BLACK

TIP — RING — SHIELD

1/8" Stereo Phone Jack

1/8" Stereo Phone Jack

RING — TIP — SHIELD

ORG / WHT 1
ORANGE 2
GRN / WHT 3
BLUE 4
Shield Wire Silver

MIC AUDIO
SPKR COMMON
SPKR OUT
MIC COMMON

8-pin Plug ICOM 756/7300/7600 for Transceiver

MIC GND
PTT GND
PTT
Audio Out
MIC

Rear View of Foster Connector Plug
View of Plug's Solder Terminals

DC BLOCK 0.47 µF, 50VDC

SEE TEXT MIGHT BE NEEDED TO BLOCK DCBIAS ON MIC PIN

One interesting PTT feature we incorporated is the ability to roam with the headset and use a push button for invoking PTT transmit instead of VOX. We chose the inexpensive Quicksilver Radio single channel wireless relay module, part number wr-sin. The wireless receiver operates at 315 MHz and fits within its own 1.5- x 1.5- x 1-inch plastic package. It was very easy to add the 12-VDC power wires (Anderson Powerpoles were chosen as shown in Photo F) and the switch contact wires using the 1/8-inch stereo phone plug. The operating range is about 200 feet, and the PTT button transmitter is a small module that has an extendable whip to reach maximum range. We have found the roaming PTT feature works well within our homes, patio, and pool areas, commensurate with the range of the wireless headsets.

RFI Mitigation

Depending on where you operate the CS520 headset, there always exists the possibility that high power HF or V/UHF

Table 2 Materials List

Manufacturer	Model Part Number	Description	Notes
Plantronics	CS520 / WH350 / #86920-01	Binaural Headset	eBay Source (Note that a CS520-XD is not compatible because it is works at 900 MHz only and not DECT 6.0)
Plantronics	CS520 / CO52	Base Unit	eBay Source
Plantronics	CS520 / Power Supply	9 VDC Power Supply	eBay Source
Plantronics	CS520 / Cable	Telephone Interface Cable	Not used
eBoot / Amazon	ASIN No. B01EJ0NFS	Lapel Mic Windscreen	Mini-size, Size 1.06"x0.87" x 0.31" Hole Size, 5-Pack
HOSA	MHE125	Headphone Extension Cable, 25 Feet or equivalent	Cut in half to make PTT Jack and PTT Device Plug
Cable Matters	160012-BLK-10x5	Ethernet Patch Cable in Black 10 Feet	Cat6a Snagless Shielded (SSTP/SFTP). Cut to make audio cables.
Jameco / JVP	#544948 / SR305C474KAA	0.47 μF 50V, X7R, 10%	Monolithic Radial Ceramic Capacitor, DC Blocking Capacitor for Radios with a DC Mic Bias Voltage
Foster 8-pin	LP MIC-J-8	8 Pin Female Microphone Plug	Ham Radio Outlet, <http://bit.ly/2t4H9v3>
Switchcraft	ED903	Push Button Switch	http://bit.ly/2t4H9v3
radiodan-w7rf eBay Store	PUSH TO TALK PTT SWITCH	Toggle Switch (also momentary)	Headset Microphone PUSH TO TALK PTT SWITCH momentary latched http://ebay.to/2uaioNK
MFJ	MFJ-1709	Foot Switch	http://bit.ly/2ua9e3H FOOT SWITCH, OPEN TYPE, 1/4~ PHONE JACK, RED (need to change the plug to 1/8" stereo plug)
Quicksilver Radio	wr-sin	Wireless Remote Relay, Single Channel	http://bit.ly/2uahHnE

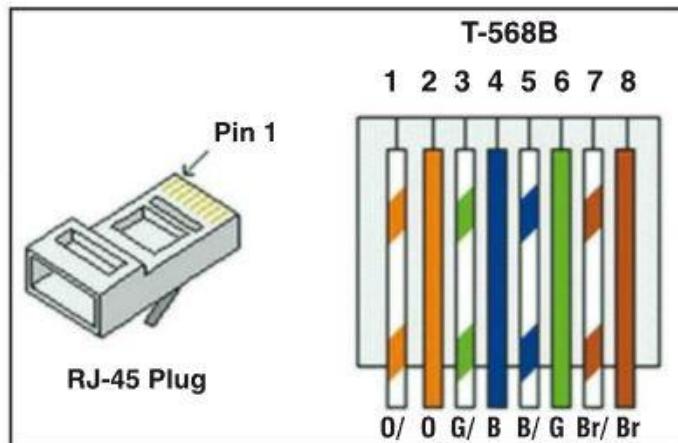Figure 3. T-568-B wire colors and RJ-45 pin connections.

Photo F. Roaming PTT wireless relay module assembly.

radio transmissions near the headset, base unit, or cabling could introduce interference to its operation.

We took the first step in RFI mitigation by specifying CAT5 or 6 shielded cables and connectors. This will help in most cases. If needed, adding small snap-on ferrite materials around the cables should further reduce RF interference.

The CS520 wireless headsets themselves are very robust since they operate on frequencies outside of common Wi-Fi and Bluetooth networks and use digital encoding techniques with encryption over the headset-to-base unit link. It is unlikely to be interfered with or create interference with other devices.

Summary

Cutting the cord and untethering oneself from the radio is both liberating and advantageous. The use of the Plantronics CS520, with modifications, has transformed radio operating from a sedentary activity to one that provides flexibility in movement and space. Its relatively wide area of coverage allows the user to work inside or outside the house, cook, or even exercise while speaking on the radio. The level of headset comfort, weight, audio clarity, and security meets and exceeds other wired headsets. So, break the shackles that chain you to the shack and enjoy more flexibility in how you operate and enjoy ham radio.

References

The authors have created a web page that provides a catalog of wiring interfaces for different transceivers as well as references to user manuals and other pertinent information of interest. See: <www.cs520hams.k5pa.com>

CS510/CS520 Wireless Headset System, User Guide, Plantronics: <http://bit.ly/2sRBT9W> Digital Enhanced Cordless Telecommunications: <http://bit.ly/2uEklia>

References

The authors have created a web page that provides a catalog of wiring interfaces for different transceivers as well as references to user manuals and other pertinent information of interest. See: <www.cs520hams.k5pa.com>

CS510/CS520 Wireless Headset System, User Guide, Plantronics: <http://bit.ly/2sRBT9W> Digital Enhanced Cordless Telecommunications: <http://bit.ly/2uEklia>

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http://www.cs520hams.k5pa.com

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