THE ELECRAFT KX2

By

Fred Cady – KE7X

ULTRA-PORTABLE, HANDHELD, HF RIG

The Elecraft KX2

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Fred has been licensed since 1959, holding an amateur extra class license. His calls over the years have been WA2GHN, KC4USM, ZL3ADY, KE7X/YV5, KE7X/YV7, KE7X/6Y5, 6Y9A, 3D2XA, and C6AKX. He is an avid CW contester and a member of the world-record holding contest group Team Vertical.

http://www.ke7x.com

Revision 1.1

Table of Contents

Preface

This book will expand on the KX2 Owner's Manual and provide insight into the workings of the KX2. There are many schematics and diagrams for those who, like me, are visual learners, plus there are greatly expanded text explanations for those who learn best by reading. Hands-on learners will enjoy working through exercises designed to illustrate the KX2's many features.

Chapter 1 will guide you through the basic ordering and configuration of your KX2. The available KX2 options are briefly described; each of these options is covered in more detail in later chapters. Chapter 1 helps us to initially configure and calibrate the KX2. Succeeding chapters describe how to operate the KX2 with separate chapters dedicated to CW, SSB, and DATA. An FM mode is not available in the KX2. The menu items needed for each operational mode are included with the text describing that mode. Chapter 7 contains a variety of hints and kinks on how to effectively use filtering and noise reduction techniques and describes other KX2 features. It includes an "Oops, why is it doing that?" section.

As you become familiar with the basic operation of your KX2, you may want to learn more about how it operates. Chapter 8 gives a brief overview of the hardware in this novel radio. Chapter 9 shows briefly how to add the KXPA100 and KXAT100 amplifier and tuner to your station. Chapter 10 describes strategies for your ongoing use of the often-overlooked but very useful KX2 Utility program that helps you to configure and maintain your KX2 and update its firmware.

For newcomers to the hobby, Chapter 11 describes the basics of radio propagation, antennas, standing wave ratio, antenna matching, and baluns to help understand that one can't just hook up any piece of wire and expect to make contacts. A troubleshooting flow chart is included.

A wealth of information is included in appendices. Appendix A is a glossary of terms expanding on the glossary in the *KX2 Owner's Manual*. Appendix B describes various microphone connections and their related audio set up. Appendix A summarizes all configuration menus included elsewhere in the text in one place for easy reference. Finally, Appendix D gives you a page to record your firmware update history.

Thanks go to many for support, reading, and suggesting improvements for this project. These include VE3YT Vic, VA7KH Steve, VA7DZ Eric, Elecraft folks (David, Dick, Lyle, Wayne) and members of the University of Waterloo Amateur Radio Club VE3TUX Murphy, VA3ZTS Zach, VA3PRX Jordan, and VA3XTZ Rob.

Note: You may find that some of the KX2 features and operations described do not seem to work or display ***N/A*** when you attempt to make an adjustment. This is because these features have not been implemented in the KX2 firmware as yet. They are expected to be available in the future.

All sections are up-to-date for the following firmware versions:

KX2: 2.68	KX2 Utility: 1.16.4.2
KXPA100: 1.35	KXPA Utility: 1.14.3.4

Updates and Errata

This edition of *The Elecraft KX2* has been published knowing that all features planned for the KX2 by Elecraft have not been implemented. We have attempted to cover those situations where features are known to be coming. As new information about new features becomes available, and as the inevitable errors are discovered, updates and corrections will be posted on the http://www.ke7x.com website. These will be freely available as pdf files on the website.

Chapter 1. Before You Start

1.1 Ordering Your New KX2

Before ordering your new Elecraft KX2, you must decide on the options you initially need or want. Fortunately, you can start with a very basic, inexpensive KX2 and easily add options later.

The options include:

- An internal automatic antenna tuner (KXAT2).
- An internal 11 volt, Li-ion battery (KXBT2) and external charger (KXBC2).
- A precision iambic keyer paddle (KXPD2 or KXPD3).
- A real-time clock with auxiliary outputs (KXIO2).
- Other options such as the MH3 hand microphone, USB and serial computer cables, padded carrying cases, and accessory cables with the Elecraft-recommended right-angle plugs to reduce strain on the KX2's input jacks.

If you would like a 100-watt station, Elecraft offers an external 100 watt power amplifier (KXPA100) with an optional external 100 watt automatic antenna tuner (KXAT100).

If you're on a tight budget, or not sure what you need, consider buying a radio with fewer options and then adding more later, as your needs become clearer.

Unlike the KX3 and K3S, the KX2 is available only factory assembled. To achieve the level of miniaturization needed in this ultra compact radio, high-density, state-of-the-art packaging is needed. Nevertheless, you can easily install the available options following the clearly written installation instructions. This allows you to purchase a bare-bones KX2 to start and then to add options as you need them.

1.2 KX2 Options

MH3 Microphone

The MH3 microphone includes a high-quality element, a space-saving right-angle plug, PTT switch and VFO UP/DN buttons.

KXAT2 Antenna Tuner

The KXAT2 antenna tuner compensates for a wide range of antenna mismatches, as much as 10:1. Very similar in function to the KX3's KXAT3 automatic tuner, the KXAT2 can be trained to remember its settings and will return to memorized settings after the operator QSY's away and then returns to that frequency. Like the KXAT3 and its bigger brother, the KXAT100, memories are held in 'bins', or band segments, to accomplish this memory tuning feature. See *The KXAT2 20 W Antenna Tuner*, page 134, for in-depth coverage of the KXAT2.

Adding the KXAT2 is highly recommended unless you are going to always be using low SWR antennas. If you use the KX2 for portable operation, you will find that the KXAT2 is a worthwhile investment.

If you add the optional KXPA100 amplifier and KXAT100 tuner to your system, the KXAT2 tuner should be bypassed or not used. In this case you might consider not installing it the first place.

KXIO2 Real-Time Clock and Auxiliary Output

The KXIO2 option provides a real-time clock and two user-programmable outputs (AUX jack). The time can be displayed in the KX2's VFO B area and in the ***TIME*** menu. Time accuracy can be fined-tuned to about +/- 2 seconds per day using the ***RTC ADJ*** menu. The two AUX outputs can be used for controlling per-band external equipment such as an antenna switch or transverter (see the ***AUX 1*** and ***AUX 2*** menus).

KXBC2 Li-ion Battery Pack and External Battery Charger

The KXBT2 internal Li-ion, 11 volt battery pack and KXBC2 external battery charger are manufactured by Tenergy.[1] If you choose to use the Li-ion battery pack, you *must* use the KXBC2 to charge it. Note that the Li-ion battery pack must be removed from the KX2 for charging. The battery can be safely charged in one to three hours. See *The KXBT2 Li-ion Battery Pack and KXBC2 External Charger*, page 128, for in-depth coverage of the KXBC2.

KXPD2 Keyer Paddle

The KXPD2 keyer paddle is a further development of the KXPD3 paddle available for the KX3. It solves the intermittent keying problems some users found with the KXPD3. The KXPD3 paddle can be used with the KX2 but Elecraft requires you to replace the left-hand thumb screw with one that is shorter so that it won't touch a part located directly behind the screw. You should order part E70045. (Newer KXPD3s, sold after approximately May 2016, have this shorter screw already.)

KXPA100 100-W Power Amplifier

The basic KX2 includes a 10-watt final output stage. The optional KXPA100 is an external 100 watt amplifier. It can be integrated with an optional, internal automatic antenna tuner. The amplifier's specifications include the following:

- The amp is convection cooled so no fans are required for normal use.
- The case uses Anderson Powerpole® connectors.

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[1] www.tenergy.com. You may purchase the battery pack and charger either from Elecraft or directly from Tenergy.

- There are provisions for two switchable antennas when the optional KXAT100 auto tuner is installed. You can select either of these from the KXPA100 front panel or from the KX2.
- It fully integrates with the KX2 via the ACC port. The KX2ACBL cable is required to split out the KEY OUT and serial I/O functions.
- There are LEDs for monitoring various operating parameters including SWR.
- Firmware updates and other good housekeeping facilities are available from the KXPA Utility using the same user interface as other Elecraft products.

See Chapter 9, page 143 for more information on how to use the KXPA100 with the KX2.

KE7X's *The KX2 Companion's Guide to the KXPA100 and KXAT100* provides complete operating information for the KXPA100 and KXAT100.[2]

KXAT100 100-W Antenna Tuner

The KXAT100 tuner is designed to be mated with the KXPA100 power amplifier. The tuner is optional and fits into the same cabinet as the amplifier. It has the same 'automatic' features as the KXAT2 tuner. See Chapter 9, page 143 for more information.

Cables

An RS232 port is needed to update firmware from the Elecraft web site to your KX2. This is done via your computer, which must be connected to both your KX2 ACC connector and the Internet. If you are going to use one of your computer's USB ports to connect to your KX2, a USB-to-serial adapter (KXUSB) can be used – it comes standard with the KX2. If your computer has a native RS232 port, you may exchange the KXUSB for the KXSER cable when your order your KX2. It adapts a native RS232 serial port's DE9 connector to the KX2's 3.5 mm tip-ring-sleeve (TRS) connector. (The KUSB USB-to-serial adapter used with the K3 and KPA500 will not work with the KX2 unless you use the KXSER cable with it). See *Connecting Your Computer to the KX2*, page 153 for a further explanation of USB and serial cables.

Another cable, the KX2ACBL, is used to break out the ACC KEY OUT signal to key an external amplifier, such as the KXPA100, and the serial I/O RS232 signals for the computer connection.

The KX2GNDPLUG is a mini-banana plug that allows you to plug in a ground connection for the KX2.

The power cable supplied with the KX2 uses a female 5.5 mm x 2.1 mm coaxial connector with the white striped lead connected to positive.

If you plan to use the KX2 in digital modes connected to a computer (*Data Mode Computer Connections and Set Up*, page 83), you should purchase the right-angle transmit and receive audio cables (E980229 and E980230).

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[2] Available in spiral-bound hard copy from www.lulu.com or in pdf form from www.ke7x.com.

1.3 What You get When You Order

Table 1-1. Ordering the KX2.

	Standard	Options
KX2	KX2 KXUSB USB-Serial Adapter or KXSER Serial Cable	MH3 Microphone KX2ACBL ACC break-out cable KXAT2 Automatic Antenna Tuner KXPD2 Keyer Paddle KXBT2 Internal Li-ion battery pack KXBC2 External Battery Charger BNC-RA Male-Female Right angle BNC adapter KX2GNDPLUG Quick Release Ground Plug BNC-BP BNC male to Stackable Binding Post adapter Transmit and Receive Audio Cables (E980229 and E980230) (Best for digital modes. Thumbscrew E70045 to use a KXPD3 paddle.
KXPA100	KXPA100 Amplifier KXUSB USB-Serial Adapter or KXSER Serial Cable	KX3-to-KXPA100 Adapter Cable KXAT100 Internal Automatic Antenna Tuner KXFT817CBL FT817-to-KXPA100 Adapter Cable SS30DV 14.1 V, 25 A switching power supply *The KX2 Companion's Guide to the KXPA100 and KXAT100*

1.4 Key to Symbols and Text Style

The following symbols and text styles denote various functions and controls.

RX ANT *Tap* the switch to control the function lettered on the switch.

MENU Holding this switch controls the function lettered in yellow underneath the switch. *Hold* the switch for ½ second to activate. Think of holding as a long press. You do not need to continue to hold the switch while adjusting the function.

MAIN A text or alphanumeric display using the VFO A or VFO B LCD display area.

ANT1 A display icon in the LCD display area.

OFS/B/CLR ∅ Front Panel knob that you rotate to set the value. The CLR function is selected by holding the knob for ½ second.

LOCK Indicates a menu item that must be *unlocked* by holding the FREQ button for more than 3 seconds.

1.5 More Information

Elecraft Website: The Elecraft website (http://www.elecraft.com) contains a wide variety of information about all Elecraft products, including all manuals, firmware updates, schematics, builders' resources, tech notes, and magazine reviews.

A particularly useful site to visit periodically is the *Mods & Notes* link on the Elecraft home page. Modifications and application notes for the K3S, KX3, and KX2 families will be found there.

Email List or Reflector: Browse to the Elecraft home page and then click on *email List (Reflector)*. Click on *Elecraft email List Guidelines* and take them to heart if you subscribe to the reflector. A great deal of information (along with some noise) flows to subscribers.

Searchable Web Archives: Frequently, your questions may have been answered already. If you browse to the *email List (Reflector)* on the Elecraft website, you will have several choices of archive search engines.

KE7X Books: Check www.ke7x.com for a complete list of books by KE7X for the K3, K3S, K-Line, KX-Line, and KX2.

Chapter 2. KX2 Configuration and Calibration

2.1 Introduction

This chapter describes the basic configuration and calibration settings needed to start operating the KX2. There is very little to configure and calibrate before you are up and running. Virtually everything you would normally set, switch, or adjust while operating is done with front panel buttons and knobs. You won't need to access the configuration menu while operating, which is a great feature. You should only need to access it to change the settings for various functions.

The settings you choose in the configuration menus tell the KX2 which options are installed and how they should function, allow fine adjustment of functions like AGC, and configure the RS232 port. You access the menu with a "Hold" (holding it longer than about ½ second) of the MENU button.

Certain menu functions are locked to prevent change and a lock symbol is displayed on the KX2's LCD display. These allow access to some of the inner workings of the KX2. To change these you must hold the FREQ button for at least three seconds.

2.2 Power On and Off

Holding for about two seconds and then releasing both the RATE and A/B buttons turns the KX2 on and off. This multiple switch choice was made so the KX2 would not accidently turn on while being carried in a backpack. If you operate the KX2 only from a power supply, Elecraft recommends that you DO NOT turn your KX2 off by turning off the external power supply. Using the switch combination allows the KX2 to store variables such as the current VFO frequencies in EEPROM before shutting down. This may not happen if you turn the power off at the power supply. The KX2 can also be turned off by software control. This is useful for remotely controlled operations.

2.3 Configuration Menus

2.3.1 Menu

Hold MENU to access the configuration menus and then rotate the OFS/B ∅ knob (often called the VFO B knob) to select the menu you want. The menu items are arranged alphabetically. Rotate VFO A to change a menu setting and then tap MENU to exit or rotate the OFS/B ∅ knob to another menu choice. When adjusting parameters in the menu, holding MENU for about 3 seconds displays information about the current menu item. The default value of the parameter is shown in parentheses at the beginning of the display. Tap any key to exit the help display. Appendix B shows all menu items.

Some menu items are mode-specific. For example, if you try to change ***MIC BIAS*** while in CW mode, the VFO B area will show ***N/A*** indicating that ***MIC BIAS*** can only be changed when in a voice mode. Some other menu items may show ***N/A*** when you try to activate or change them. This indicates a function or feature that is not implemented in the KX2's firmware yet. They are expected in the future.

> **Hint:** You may wish to save the KX2's configuration as shown in *Saving the KX2 Configuration*, page 157 before making substantial changes to configuration items. This will allow you to go back easily to a working configuration if needed.

2.3.2 Tech Mode

There is a sub-menu of the configuration menu called Tech Mode. (Hold MENU, then rotate OFS/B ∅ to ***TECH MD,*** and then rotate VFO A to ***On***.) When Tech Mode is enabled (***TECH MD*** = ***On***) a variety of advanced configuration and troubleshooting options are displayed. Elecraft recommends that you leave this turned off until needed for some configuration or troubleshooting purpose, but there is no harm in leaving it on. The word LOCK in the configuration menu tables below and in Appendix B indicates an item that needs ***TECH MD*** = ***On***. Tech Mode menu items are locked to prevent accidental changes. For these items, a small padlock symbol (🔒) appears on the KX2 display. To change a LOCKed the item, you must first unlock it by holding the FREQ switch for more than three seconds. A text reminder scrolls on the VFO B display prompting you to do this.

2.3.3 Per-Mode, Per-Band, etc. Configuration

Many configuration menu items are saved on per-mode, per-band, or on some other handy and logical basis. For example, you might like to have the ***VFO CRS*** tuning rate be different in sideband than in CW. In these cases, set up the KX2 to the intended mode, band, etc. Then access the menu item and set it as desired. This feature makes the KX2 much easier to operate on a day-to-day basis, as a change of band or mode will automatically change the menu items to the settings you like for the new band or mode.

2.4 Configuring and Updating the KX2

The Elecraft KX2 Utility program is used to configure hardware features and to update the KX2's firmware. Chapter 10, page 152 has complete details on how to install and use the KX2 Utility program.

2.4.1 Problems with KX2 Firmware Updating

Occasionally KX2 owners will experience problems updating new firmware. This may be caused by a corrupted firmware file or by not updating all files properly. The firmware files include a checksum for detecting errors that may occur during updating. If an error is detected in the checksum, the TX LED will flash and ***MCU LD*** will be displayed. If this

occurs, reload the firmware by following the steps in Section 10.2.3, 10.2.4, or 10.2.5 (page 159). You may also wish to erase all files in the firmware directory and update them again from the Elecraft website.

If you accidently load an old or incompatible firmware version and the KX2 is totally unresponsive, follow these steps.

- Check to make sure you are using the latest version of the KX2 Utility.
- Unplug the KX2 from the power supply. If the internal battery pack is installed, disconnect or remove it. Wait at least five seconds.
- Plug the power supply back in or reinstall the battery.
- Hold the KX2's [RATE] and [A/B] buttons for about 10 seconds or until you see the TX LED flash and ***MCU LD*** displayed on the LCD.
- Now load the correct firmware version using the KX2 utility.
- If this procedure fails, see *Reset – When All Else* Fails, below, for a full reset procedure.

For more detailed troubleshooting information, click on *Help* in the KX2 Utility program and read the *Troubleshooting* section.

2.4.2 Keeping Firmware Update Records

You should keep a record of your firmware update history in case you ever want to back track to an earlier version. Appendix D has a convenient form for this.

2.5 Reset – When All Else Fails

The KX2's menu parameters are stored in non-volatile (EEPROM or Flash) memory. These parameters are retained when the power is turned off – hence the name non-volatile memory. Although rare, it is possible for the non-volatile memory to become corrupted, resulting in the KX2's firmware running incorrectly. If this happens, you should reinitialize all parameters to the factory default values and then reload your configuration. Here is a procedure for doing this.

2.5.1 But Wait . . What to do before a Memory Failure Occurs and you Need a Reset

If you have a computer with the KX2 Utility program, save the current configuration as described in *Saving the KX2 Configuration*, page 157. This should be done *before* any memory error problems have occurred. Saving the configuration just before doing the ***EE INIT*** may just save corrupted information. The KX2 Utility program does not (at time this is written) have the ability to print out a hard copy of the configuration.

If you do not have a computer, write down important menu parameters such as AGC settings. In addition, record the KX2 option module enables such as ***ATU MD,*** etc. You may find it useful to go through Appendix A and write down each menu setting.

2.5.2 The Worst Case Scenario

Sometimes, when you are having a really bad day, both the EEPROM and your configuration file may be corrupted. If this is the case, you will have to perform the EEINIT and then manually enter the configuration. After manually entering the configuration, save it. *Do not* use any previously saved configurations.

2.5.3 Initializing Parameters to the Default Setting – EE INIT

> **Parameter initialization should not be done without first consulting Elecraft customer support. They can help you solve most problems without taking this step.**
>
> **Hopefully you will have saved a configuration file as shown in *Saving the KX2 Configuration*, page 157, long before you experience problems requiring and EEINIT.**

You should try this step only if you have lost total control of the KX2, because doing so restores all parameters to their default values. Therefore, any and all changes you have made, for example enabling options, will be lost. You will have to restore these configurations from a known good configuration file or enter them manually. Here's how you do it:

- Turn the KX2 off using the on/off switch combination (leave the power supply connected and turned on.)
- Hold the AF/MON/NB/Ø knob and turn the KX2 on by holding RATE and A/B. Hold for about three seconds until the LEDs turn on. After a few more seconds release the AF/MON/NB/Ø knob. You should now see ***EE INIT*** on the LCD.
- ***EE INIT*** should complete in a few seconds. If you see ***ERR nnn*** or other error messages, tap DISP to clear each.

If you have a computer, reload a configuration file that was saved **before** the problems occurred using the KX2 Utility program, unless, as Section 2.5.2, describes, the configuration file has become corrupted. Then, you should not reload the file. Instead, manually re-enter configuration menu items.

If you do not have a computer, manually restore the configuration items you wrote down and then redo the calibration items shown in Section 2.6.

2.6 Configuring the KX2

There is a variety of setup and calibration procedures that you should do before putting your KX2 on the air. When calibration procedures use Tech Mode menu entries, enable them by setting ***TECH MD On***. When finished, Elecraft recommends that you turn Tech Mode off to avoid accidently changing less frequently used menu items.

Before making configuration changes, save the KX2's configuration setting using the *KX2 Utility*. The configuration can be restored later if required.

2.6.1 Configuring Options

If you have installed options – such as the KXAT2 antenna tuner – you must enable them before they will operate properly. After setting these, exit the menu and turn the KX2 off and then back on. Any time a KX2 optional module is disabled or enabled, the module will not be recognized until power has been cycled on the rig. By cycling power after making module enable changes, the module status is sure to be saved in the KX2's firmware tables. They will then operate as documented in their respective owner's manuals.

To configure options you have installed, hold MENU and rotate the OFS/B ∅ (VFO B) knob to the appropriate menu. Rotate VFO A to change a menu setting and then tap MENU to exit or rotate OFS/B ∅ to another menu choice.

Here is how to enable your installed options:

- **KXAT2 Antenna Tuner:** Set ***ATU MD*** to ***Auto***.
- **KXPD2 or KXPD3:** Set ***CW KEY2*** to ***LFt = dot*** (normal) or ***LFt = dASH*** (reverse). If you set it to ***HAnd***, either paddle can be used as a hand key. (The KEY jack on the left side panel is configured using the ***CW KEY1*** menu and is configured the same way. The keying device plugged into the KEY jack is independent of the KXPD2 or KXPD3.)
- **KXIO2 Extended I/O Option (with RTC):** Set ***KXIO2*** menu to ***nor***. Set time using the ***TIME*** menu. See the ***AUX 1*** and ***AUX 2*** menu entries (see *Auxiliary Outputs*, page 133) to configure the AUX outputs.
- **KXPA100 External 100-W amplifier:** See the ***PA MODE*** menu and the KXPA100 manual.

Exit the menu and turn the KX2 off, then back on.

2.6.2 Configuring Menu Settings

There are a variety of menu settings you can just set and forget. They will remain constant through much of your operating.

- **Auto Power-Off:** The KX2 can turn itself off after a specified period of inactivity (i.e., no use of the controls). Use the ***AUTOOFF*** menu to select the time period in minutes. The default is ***InFinitE***.
- **Low-Battery Warning:** You can set ***BAT MIN*** to warn you when an internal or external battery is approaching end of charge. ***BAT LOW*** is displayed periodically when this level is reached. The default voltage (***10.0*** V) is appropriate for many 12 V batteries, as well as the specified internal 11 V battery. After the ***BAT LOW*** warning is displayed, if your power was set greater than 5 watts, the

KX2 will automatically reduce it to 5 watts. If the battery voltage drops to 7.5 volts, the KX2 will automatically shut off.

- **CW Iambic Mode:** CW users can specify Iambic mode ***A*** or ***B*** using the ***CW IAMB*** menu. The default is mode ***A***, which is a little more forgiving. Mode ***B*** may be preferred by operators who do "squeeze" keying. Both modes provide dot- and dash-memories—enabling fast code speeds—but with slightly different timing. See *Setting the CW Mode*, page 43.
- Microphone Settings: If you plan to use voice modes, set up ***MIC BIAS*** and ***MIC BTN*** to match your microphone. See *KX2 Microphone Set Up*, page 60.
- **Setting the Time:** The ***TIME*** menu sets the 24-hour real-time-clock (RTC) if a KXIO2 module is installed and the ***KXIO2*** menu is set to ***nor***. If no KXIO2 is installed, time will start at ***00:00:00*** at power-up.
    - While in the menu, tap 1 / 2 / 3 to select ***HH/MM/SS*** (hours/minutes/seconds), respectively. Then use VFO A to adjust the value. The *KX2 Utility* can also be used to accurately set the time. To display the present time, tap DISP and rotate OFS/B ∅ to locate the time display.
    - If the clock appears to be off by more than +/- 2 seconds per day, use the ***RTC ADJ*** menu to apply a correction. The clock circuitry must be powered by either the KX2's internal battery or an external supply. Refer to the KXIO2 menu for details.
- **VFO Coarse Tuning Steps:** ***VFO CRS*** can be used to set up a coarse tuning increment for each mode. Tap RATE to select normal or coarse tuning. See *VFO Tuning Rate*, page 26.
- **Tune Power Level:** If you're using an external antenna tuner or amplifier with the KX2, you may want to limit the power level used during TUNE. The ***TUN PWR*** menu can be used to set the desired power level.
    - If you have the KXAT2 internal ATU installed, power is automatically set to 3.0 watts during antenna tuning. There's no need to configure ***TUN PWR*** in this case.
- **VOX:** If you plan to use VOX in SSB or data modes, you'll need to set up the ***VOX GN*** and ***VOX INH*** (anti-VOX) menu entries. See *Microphone Gain and Compression*, page 65.

> After making configuration changes, save the KX2's configuration setting using the *KX2 Utility*. The configuration can be restored later if required.

2.7 Calibrating the KX2

All calibration steps are done at the factory. If you wish to re-do any calibration steps, but be sure you have the test equipment specified. If you wish to do this yourself, turn to your

Elecraft KX2 Owner's Manual. **Remember** to save the KX2's configuration information using the KX2 Utility both *before* and *after* making changes.

Reference Frequency. This calibration requires a stable signal generator and can be done with an on-air signal such as WWV. When done, it gives you an accurate frequency display to within ± 1 part-per-million (ppm).

Receive Sideband (*RXSBNUL*). This nulls the opposite sideband image of a received signal and will have been done at the factory. Customer service can supply instructions on request.

Transmit bias. This sets the transmitter bias current of the 10-watt amplifier stage to ensure low distortion. This needs to be done prior to the Transmit Gain Calibration procedure.

Transmit Gain. This compensates for transmit gain variations on each band. It is most easily done using the KX2 Utility program.

Transmit Carrier. Transmit carrier suppression is done at the factory. Must be performed in CW mode.

Transmit Sideband. This is the suppression of the transmit sideband and is normally done only at the factory. It requires a calibrated signal generator and a spectrum analyzer. The factory uses automated systems to complete this step.

2.8 Other KX2 Set Ups

2.8.1 Switch Feedback Tones

You can configure the KX2 to provide audible feedback tones when you tap or hold most switches by setting the ***SW TONE*** menu ***On***. A low-to-high tone (boop-beep) is generated when a switch function is turned on and high-to-low (beep-boop) when turned off. After tuning the ATU, SWR <= 2:1 gives a low tone, 2.1 to 3:1 a medium pitch tone, and SWR over 3:1 a high pitch tone.

Setting the ***SW TONE*** menu ***On*** is useful if you are having problems with switch taps and holds. If a function doesn't seem to be activated when you tap or hold a switch, the boop-beep you hear, or don't hear, can help you troubleshoot the problem.

If you choose ***SW TONE CODE nn***, the KX2 can send a two letter CW Morse code signal at ***nn*** WPM indicating which switch has been pressed. The *KX3 Guide for Blind Operators* manual[3] describes the CW signals used for the various switches as an aid for sight-impaired operators. See Table 2-1.

Holding the APF/AN switch on power-up turns on the CW Morse feedback and sets the speed to 20 WPM. Other speeds can be selected in the ***SW TONE*** menu.

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[3] This document (*KX2 CW UI, rev A3.pdf*) was produced mid-summer of 2016.

2.8.2 Setting the Time

Enter the ***TIME*** menu, as shown in Table 2-1 to set the clock or use the KX2 Utility program.

Tapping DISP and rotating OFS/B ∅ will display the time if you have set it in the menu.

The KX2 Utility program *Configuration* tab has a function that will set the KX2's time from your computer's time.

Although the KXIO2 will hold a voltage on the real-time clock for up to two hours to allow the battery pack to be removed for charging, batteries must be installed to maintain the clock when the external power supply is disconnected or turned off.

See *The KXIO2*, page 132 for more information on the KXIO2.

Table 2-1. Switch tones, time, and alarm menus.

Menu	Default	Description
SW TONE	***On***	When set to ***On***, a switch press generates an audible tone. When a switch function is turned on, a low-to-high tone (boop-beep) is generated; a high-to-low (beep-boop) tone is used to denote when the function is turned off. The switch tone volume is the same as the CW sidetone volume. After tuning the ATU, SWR <= 2:1 gives a low tone, 2.1 to 3:1 a medium pitch tone, and over 3:1 a high pitch tone. Some switches may not generate tones when they might interfere with received or transmitted audio. If set to ***CODE nn***, Morse code characters are generated on any applicable control activation at ***nn*** words-per-minute. A high tone indicates the activation of a function and a low tone deactivation. The *KX2 Guide for Blind Operators* manual describes what characters are sent and provides a text-only description of the KX2's front, left, and right side panels for blind operators. When ***CODE nn*** is set, tapping DISP sends a letter for the current mode and the 100 kHz, 10 kHz, and 1 kHz digits for the VFO A frequency. Digits to the right of the decimal point are not sent. You cannot access the secondary VFO B display when ***CODE nn*** is set because this is mainly an aid for blind operators. Holding the APF/AN switch on power-up turns on the CW Morse feedback and sets the speed to 20 WPM. Other speeds can be selected in the ***SW TONE*** menu.

TIME		Real-time clock. Tap [1], [2], and [3] and rotate VFO A to set the hours, minutes, and seconds. Tap [DISP] to exit the menu. Tapping [DISP] and rotating VFO B will display the time. A battery pack must be in the KX2 to maintain the time if the external power supply is disconnected or turned off and the KXIO2 option module must be installed. The ***RTC ADJ*** menu may be used to improve the long-term accuracy of the real-time clock. See *Setting the Real-Time Clock*, page 132.

Exercise

Set the ***SW TONE*** menu to ***CODE nn***. What do you hear when you tap [DISP]?

The CW code message is a character for the mode (C for CW, U for USB, L for LSB and D for Data) and then the 100 kHz, 10 kHz and 1 kHz digit of VFO A are sent.

What happens when you tap [BAND]?

A letter for the mode (C, U, L, or D) and then the band is sent. Example: C 7 R 0 indicating CW mode and the 7.0 band.

2.8.3 Power and Battery Control

The KX2 is designed to be a very efficient portable and backpacking radio. There are a variety of controls and menu items that can be configured to help you to optimize the power and battery consumption. The optional Li-ion KXBT2 battery pack will typically give you 8 hours of operating time and up to 10 watts power output.

Table 2-2. Power and battery control.

Menu	Default	Description
AUTO OFF	***OFF***	This allows you to set a time to automatically turn off the KX2 if 3 to 20 minutes have elapsed without any control operation or transmission. Set it to ***InFinitE*** to never turn it off. The timer is reset whenever the KX2 transmits or when switches or knobs are used. A setting of ***5*** or ***10*** minutes is recommended when running from batteries
BAT MIN	***10.0***	***BAT LOW*** warning threshold when the internal or external supply reaches this value. ***10.0*** — 12 volt batteries such as some 12 V gel cells and the optional 11 V Li-ion battery pack. The KX2 will turn itself off if the supply voltage drops below 7.5 volts.

Other battery life extending techniques include the following.

- Use headphones instead of the internal speaker.
- Turn off the preamp (tap PRE).
- Turn off the display backlight if ambient light permits.

2.8.4 Visual Effects

These menu items adjust the KX2 display.

Table 2-3. LCD settings.

Menu	Default	Description
BKLIGHT	***On***	Turns the LCD backlight on and off. Turning the backlight off will extend battery life and can be done in ambient lighting because the display is transflective.
LCDTEST	***OFF***	Rotate VFO A to turn on all LCD segments.
LED BRT	***4***	Allows setting of LED brightness for the backlight-off case only. During adjustment of this menu parameter, the backlight will automatically be turned off if it was on, and then turned back on when the menu is exited. The LEDs are dimmed only when ***BKLIGHT*** is ***OFF***, which can help you save power if operating on batteries.

2.8.5 Power-On Banner

The KX2 will display a power-on banner that scrolls across the VFO B display area when you turn the power on. Up to 22 characters can be displayed. The power-on banner is edited by the KX2 Utility program. Click on the *Configuration* tab and then on *Edit Power On Banner* . . . You may wish to set the banner to your callsign or a reminder to check something you often forget.

Chapter 3. KX2 Operations

> **Note:** You may find that some of the KX2 features and operations described in this chapter do not seem to work or display ***N/A*** when you attempt to make an adjustment. This is because these features have not been implemented in the KX2 firmware as yet. They are expected to be available in the future.

In this chapter we cover the basics of operating the KX2. Details for CW, voice, and the digital operating modes are covered in succeeding chapters. Here you will see configuration menu items, front panel controls, and operating hints that affect these modes. Chapter 7 will describe more fully how to use DSP filtering, noise blanking, and noise reduction to reduce interference and noise. Chapter 8 gives an overview of the KX2's receiver and transmitter hardware.

3.1 Band and Mode Selection

You begin by choosing your operating band by tapping BAND and rotating VFO A to change to a new band up or down and then tapping any switch to exit. You choose your operating mode by tapping the MODE and/or DATA front panel switches. Successively tapping the MODE switch toggles between CW, and USB or LSB (depending on the band selected). Tapping DATA selects the last used data mode. Tapping DATA again and then rotating the VFO B knob allows you to choose DATA A, AFSK A, FSK D, and PSK D data modes. The ***ALT MD*** menu selects the opposite sideband.

3.2 Tunable Functions

Several functions are activated by buttons along the bottom of the panel and are tuned by the knobs directly above them. See Figure 3-1.

Audio Peaking Filter: Hold APF-AN. You must be in CW mode. Hold APF-AN again to exit.

Notch Filter: Hold APF-AN in SSB mode. In SSB the notch frequency is automatically tuned.

CW Sidetone Pitch: Enter the ***PITCH*** menu and rotate VFO A to set the sidetone pitch. You must be in CW mode.

VOX and CW Keying Delay: Enter the ***VOX DLY*** menu and rotate VFO A to set the delay.

Noise Rejection – NR: Hold NR and rotate AF/MON/NB ∅ to set the noise rejection level.

Noise Blanking – NB: Hold and rotate AF/MON/NB ∅ to set the noise blanking level.

See *KX2 Operating Hints and Kinks*, page 97 for suggested settings for NR and NB.

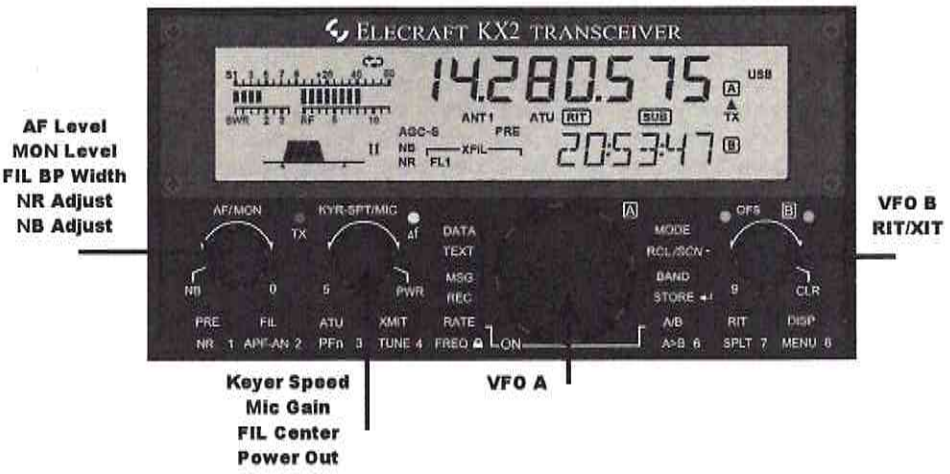

Figure 3-1. KX2 tunable functions.

3.2.1 AF and RF Gain

Audio Frequency (AF) Gain

Figure 3-1 shows the AF/MON ∅ control. Tapping the control toggles it between setting the audio frequency gain (AF) and the monitor (MON) volume level. In CW mode, this turns on the sidetone monitor (see *CW Front Panel Controls*, page 49) and in SSB mode you will hear your microphone audio (see *Voice Monitoring*, page 65).

When the knob is tapped or rotated, the VFO B display shows which function is being controlled (***AF*** or ***MON***) and shows the present gain. AF gain ranges from 0 to 60. Because of the small speaker in the KX2, most operators suggest keeping this value below about 20.

The KX2 is designed to be very battery-friendly and can detect when the AF gain is high enough to increase power consumption and possibly cause damage to the speaker output amplifier. When this condition is detected, a ***HI CUR*** warning is displayed and the AF gain is reduced. This is an automatic limiter operating in receive mode.

Tapping AF/MON ∅ activates the monitor function which controls the loudness of the signal you hear when transmitting (in voice and data modes) and the side tone level in CW mode. Turn the knob to set the monitor level. These MON settings are kept separately based on the mode selected (per-mode).

Radio Frequency (RF) Gain

Many radios have a separate control for the RF gain and users sometimes vary this control to suit their listening conditions. In many radios (with the exception of the Elecraft KX2 and KX3) this controls signal levels in the RF or IF (Intermediate Frequency) electronics. The KX2 (and KX3) designers have chosen a different approach. Mostly, an RF gain control is set at the maximum to be able to receive the weakest signals and only reduced when many strong signals are present (such as in a contest) to reduce the signal that succeeding amplification stages have to deal with. Taking this into account, and wishing to reduce the size and complexity of the KX2, the RF gain control is set in a configuration menu and is not controlled by a front panel knob.

Another separate limiter, ***AF LIM***, is available to protect your ears and is operational when the AGC is off.

RF gain is not per-band.

The RF gain in dB ranges from -0 to -60 where -0 is the maximum RF gain. You may wish to reduce it in strong signal conditions. It is useful, too, in noisy conditions to reduce the RF gain until the noise level is below the minimum signal indicator. An S-meter segment will be solidly illuminated to remind you when the RF gain is reduced.

RX Icon

The KX2 will automatically reduce receiver gain in the presence of very strong signals. When that happens, the RX icon will turn on. You might see this when a nearby station fires up its KW amplifier. You can set the level at which this occurs with the ***COR LVL*** menu.

Table 3-1. RF gain menu.

Menu	*Default*	
RF GAIN	*-0 dB*	Normally, RF GAIN is set to ***-0 dB*** (no gain reduction). As RF GAIN is advanced past ***-5 dB***, a single bar on the S-meter starts at S-2 and moves upward as a reminder of how far gain has been reduced (-5 dB/unit). If desired, ***MENU:RF GAIN*** can be assigned to PFn (see *Programmable Function Key*, page 41) for quick access. **Note 1:** RF gain is reset to ***-0 dB*** on power-up. Otherwise the operator might not be aware of a previous gain reduction used under different band conditions. **Note 2:** As is the case with many software-defined transceivers, the KX2's RF GAIN control is actually an input scaling factor applied within the DSP itself. Reducing RF gain doesn't impact the strength of signals seen by the A-to-D converter. Gain ahead of the ADC can only be reduced by turning the preamp off, and (if necessary) turning the attenuator on. **Note 3.** Some operators prefer to turn automatic gain control off

		(using the ***AGC MD*** menu) and adjust RF gain manually, maximizing dynamic variability of received signals. While this strategy works in a radio with an RF gain control knob, it is less effective in the KX2. If you plan to turn AGC off you should set up the ***AF LIM*** menu parameter to avoid painful audio volume on strong signals.
AF LIM	***nor 30***	This adjusts the audio output limiter. It can protect your ears if you operate **with AGC Off**. The range is from 0 to 30 where 30 is the highest level. Signals that exceed this will sound very distorted, reminding you to turn down the RF or AF gain controls. The AF limiter works only when the AGC is off (AGC-). Typical settings used by those who turn their AGC off are 17 to 23.
COR LVL LOCK	***Nor 0.1***	Sets the carrier-operated-relay (COR) threshold. The COR is used to protect the KX2's receiver from a transmitter being used nearby. The default ***0.1*** watt is the recommended level.

3.2.2 Preamplifier and Attenuator

Tapping the PRE switch turns the preamplifier and attenuator on and off as shown in Table 3-2. See also *Preamplifier and Attenuator*, page 102.

Table 3-2. Preamp and attenuator settings.

PRE Icon	ATT Icon	Resultant Gain	Signal Increase/ Decrease	Uses
Off	Off	0 dB[4]	none	Normal operations on bands where signals are good and noise is low.
On	Off	+20 dB	x 10	Operations on bands where signals are weaker, such as 12- and 10-meters.
Off	On	-20 dB	÷ 10	Operations on bands where noise is higher, such as 80-, 40- and 30-meters.

[4] What's a dB? A dB (decibel) is a logarithmic ratio of powers. $dB = 10 \log(P_2/P_1) = 20 \log (V_2/V_1)$. Solving for $V_2 = V_1 * 10^{(dB/20)}$.

3.2.3 Filter and Digital Signal Processing (DSP) Settings

After the receiver's RF signals are converted to audio, they are converted to digital form by an analog-to-digital converter. Then the Digital Signal Processing (DSP) circuitry takes over to process the signals to which you are listening. Bandwidth control, Noise Reduction (NR), Noise Blanking (NB), Audio Peaking Filter (APF), and Notch Filter, etc., are all provided by software in the DSP. There are no crystal filters like there are in the Ye Olde Receiver Design shown in Figure 8-1, page 124.

Figure 3-1 shows the AF/MON ∅, KYR-SPT/MIC ∅ knobs and the FIL switch that allow you to change DSP filter settings. Tapping FIL puts you into the filter adjust mode (***FIL ADJ*** displayed). The passband graphic display on the LCD (Figure 3-1 and Figure 3-2) shows the width and centering of the current filter. All filter settings are store per-band – for example, filter bandwidth settings on 20 and 80 meters can be different and will be remembered.

Figure 3-2. Bandwidth display on the KX2 LCD.

Dialing in the DSP bandwidth

Change the width of the bandpass filter

Tapping the FIL switch enters the ***FIL ADJ*** mode. Rotate the AF/MON ∅ knob to set the bandwidth. In general a narrow passband reduces interference but the bandwidth should be wide enough to copy the signal. While you rotate the knob, the bandwidth in kHz is displayed numerically on the VFO B area.

Tapping AF/MON ∅ normalizes the filter width to a standard based on your operating mode. See Figure 3-3 and Table 3-3.

Tap any switch, key the transmitter, or rotate VFO A to exit ***FIL ADJ*** mode.

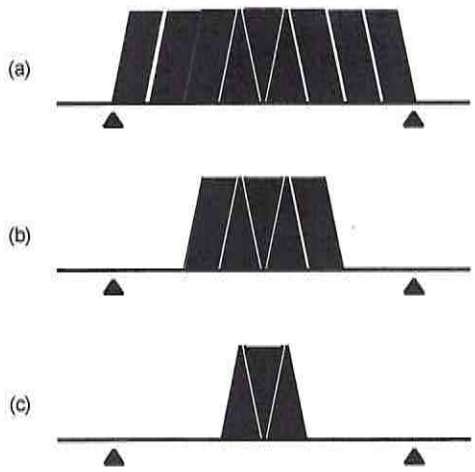

Figure 3-3. Bandwidth control. (a) 2000 Hz; (b) 400 Hz; (c) 250 Hz.

Figure 3-4 and Figure 3-5 show the effect of making the bandwidth narrower to eliminate an interfering signal. In Figure 3-4 the USB signal lower in frequency is being heard through the 2.7 kHz filter. In Figure 3-5 the bandwidth has been narrowed from 2.7 kHz to 2.2 kHz. Part of the signal we are listening to is lost but often it still remains totally copyable.

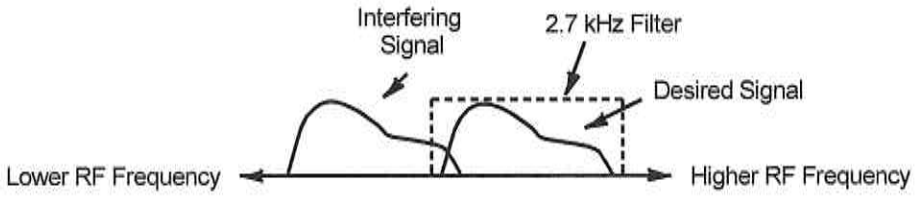

Figure 3-4. USB interfering signal.

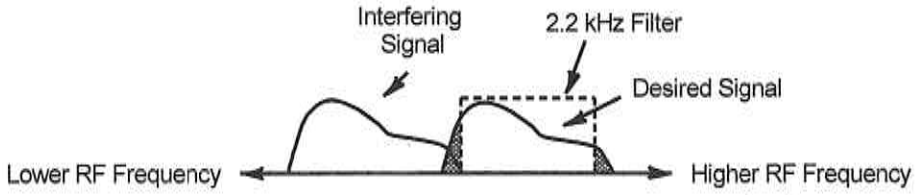

Figure 3-5. Narrowed bandpass reducing the interfering signal.

Shift the bandpass center frequency

While in ***FIL ADJ*** mode (or tap FIL) rotate the KYR-SPT/MIC ∅ knob to shift the passband left or right. Watch the bandwidth display and the VFO B display area. It will change as shown in Figure 3-6. This is sometimes helpful when there is QRM; the interfering signal can be moved out of the passband.[5] In Figure 3-6 the center frequency is displayed in the VFO B display area. A "*" on the frequency display shows when the bandpass is centered on your CW offset or pitch frequency. See Figure 3-6 (b).

Tap KYR-SPT/MIC ∅ to center the filter.

Tap any switch, key the transmitter or rotate VFO A to exit ***FIL ADJ*** mode.

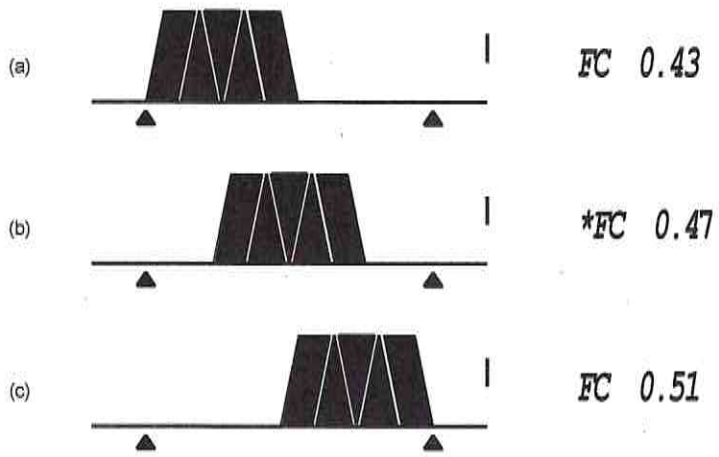

Figure 3-6. Bandpass center frequency shift. (a) Shift left 40 Hz; (b) Centered (note the *); (c) Shift right 40 Hz

Figure 3-7 shows the effect of shifting the filter's center frequency on the interfering signal of Figure 3-4. Often a combination of narrowing the filter and shifting its center frequency is very effective in reducing interference.

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[5] So to speak. Actually, the interfering signal doesn't move; the passband moves.

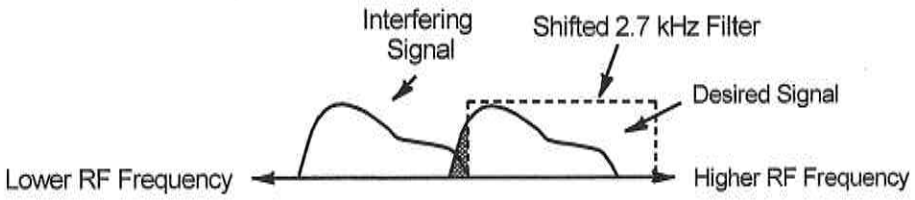

Figure 3-7. Reducing interference by shifting the center frequency.

DSP Normalization

Tapping FIL and then the AF/MON ∅ knob quickly normalizes all DSP settings, namely, the CW bandwidth is set to 400 Hz and the filter is centered on your CW pitch. Tapping the KYR-SPT/MIC ∅ knob normalizes only the center frequency.

The SSB passband is set to 2.70 kHz with a center frequency of 1.5 kHz in ***nor*** mode.

Table 3-3. Bandpass width and center setting.

Mode	Normalized		Typical Setting
	Width	Center	
CW	400 Hz	CW Sidetone Pitch (***PITCH*** menu)	300-400 Hz
SSB	2.7 kHz	1.5 kHz	2.0 – 2.2 kHz
AFSK A	400 Hz	1.0 kHz	300-400 Hz
FSK D	400 Hz	1.0 kHz	300-400 Hz
PSK D	400 Hz	1.0 kHz	50 – 100 Hz
DATA A	400 Hz	1.5 kHz	300-400 Hz

3.3 VFOs

The KX2 has two VFOs. VFO A controls the transmit and receive frequencies, except when operating Split. In Split mode VFO B controls the transmit frequency (see *Operating Split*, page 32). VFO B is controlled by the OFS/B ∅ knob. Tap the knob until the B LED is lit. The KX2 has a *dual-watch* receiver. This means you can listen on two frequencies (VFO A and VFO B) at the same time (on the same band, and at no wider

difference in frequencies than 15 kHz[6]). When dual-watch is enabled (menu ***DUAL RX*** is ***Auto***) and when operating Split mode, VFO B controls both the Split receive frequency of the dual-watch receiver and the transmit frequency. You must use stereo headphones or external stereo speakers to hear both signals. The right ear hears the dual-watch receiver and the left ear the main receiver. See Figure 3-8 and *Dual-Watch Receiver Mode*, page 31.

3.3.1 VFO A – Normal Operation

Normally, VFO A controls both transmit and receive frequencies. You can set the tuning rate (how fast the VFO tunes across the band) and you can enter a frequency directly into VFO A using the "keypad" number keys. There are a variety of controls and switches for tuning, as shown in Table 3-4.

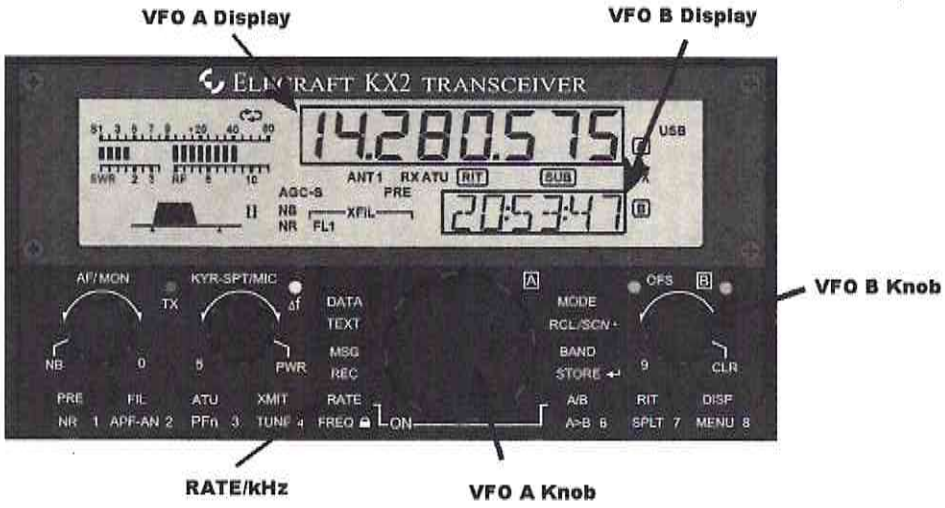

Figure 3-8. VFO A.

Table 3-4. VFO control switches.

Switch	Function
FREQ	Hold to enter a frequency into VFO A using the 0 – 9 switches and knobs. The KX2 does not have a key pad like the K3, so the digits 0 – 9 are entered by tapping the switches shown in Figure 3-9. After entering the frequency, tap the BAND key to finish.

[6] SUB flashes slowly if you exceed this.

RCL/*SCN*	Hold to recall a stored memory location (*Memories, page* 35). Long hold to scan between the frequencies stored in VFO A and VFO B. See *Band Scanning*, page 37.
RATE	Tap to toggle between 10 Hz tuning and the coarse tuning steps set by the ***VFO CRS*** menu. The default coarse step size for CW is 0.1 kHz, and for SSB, 0.5 kHz. In DATA modes, or when the audio peaking filter is in use in CW mode (*CW Audio Peaking Filter – APF*, page 99), RATE alternates between 1 Hz and 10 Hz steps. OFS/B is used to tune VFO A in coarse steps. For this purpose, the OFS LED must be lit (if not, tap the knob), and RIT must be turned off.
A/B	Exchanges the contents of VFO A and VFO B.
SPLIT	Holding SPLIT sets Split mode operation for listening on one frequency and transmitting on another. When in Split, VFO B controls the transmit frequency. *Operating Split, page* 32 describes Split operations in detail.
A>B	Copies the frequency in VFO A to VFO B.
CLR	Hold the OFS/B/CLR ∅ to zero the present RIT/XIT offset and other settings.

Direct Frequency Entry

You can enter a frequency into VFO A using the front panel number keys. The KX2 does not have a key pad like the K3 so the digits 0 – 9 are entered by tapping the switches shown in Figure 3-9.

Hold FREQ and then tap the MHz and kHz digits. Do not try to enter the 100 or 10 Hz digits. Entering the decimal point is optional. After entering the frequency, tap the BAND key to finish.

To enter a frequency in VFO B, first put it in VFO A and then hold A/B.

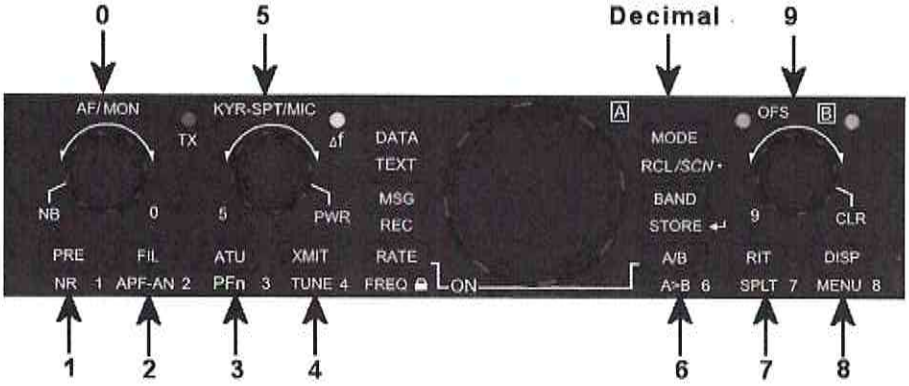

Figure 3-9. KX2 number key pad.

Exercise
Use the direct entry method to set VFO B to 14.059 and VFO A to 14.000

HOLD FREQ, and then tap PRE/1, XMIT/4, MODE/DECIMAL, AF/MON/0 ∅, KYR-SPT/MIC/5, and OFS/B/CLR/9

Enter (tap BAND)

Hold A>B

Hold FREQ, and then tap PRE/1, SPOT/4

Enter (tap BAND)

Exercise
Use the direct entry method to set VFO A to 3.545 MHz.

HOLD FREQ, and then tap ATU/3, KYR-SPT/MIC/5, XMIT/4, KYR-SPT/MIC/5

Enter (tap BAND)

Locking VFOs

You can lock VFO A by holding FREQ for about three seconds. Tap RATE to unlock. To lock VFO B, tap A/B to swap it with VFO A, lock VFO A, and then swap it back.

VFO Tuning Rate

The rate at which VFO A tunes across the band can be changed by tapping the RATE switch. You may choose fine tuning to tune in narrow band signals, such as PSK, and fast tuning to quickly move from one portion of the band to another. The menu items setting these VFO rates are shown in Table 3-5.

Table 3-5. VFO configuration menu items.[7]

Menu	Default	Description
VFO CRS	*Per Mode*	Sets the tuning rate for each VFO and each mode. Activated when RATE is tapped and the 100 Hz digit is displayed (Figure 3-11). See Table 3-6. This rate is also applied to offset tuning of VFO A (via OFS/B ∅ knob) when both RIT and XIT are turned off.

Table 3-6. Tuning rate.

Mode	*VFO CRS kHz*	Hz/VFO A revolution		
		Tuning Digit		
		100 Hz	10 Hz	1 Hz
CW	0.1	4.8 kHz (APF Off)	960 Hz	96 Hz (APF On)
	0.2	9.6 kHz (APF Off)	960 Hz	96 Hz (APF On)
	0.5	24 kHz (APF Off)	960 Hz	96 Hz (APF On)
	1.0	48 kHz (APF Off)	960 Hz	96 Hz (APF On)
SSB	0.1	4.8 kHz	960 Hz	
	0.5	24 kHz	960 Hz	
	1.0	48 kHz	960 Hz	
	2.5	120 kHz	960 Hz	
AM	1.0	48 kHz	960 Hz	
	5.0	240 kHz	960 Hz	
	9.0	432 kHz	960 Hz	
	10.0	480 kHz	960 Hz	
Data	0.1		960 Hz	96 Hz
	1.0		960 Hz	96 Hz

[7] When you are in the menus, holding MENU for about 3 seconds will show a short help message and the default value for the menu item in parentheses.

Rate Tuning

By tapping RATE and displaying the 10 Hz digit (Figure 3-10) you tune in 10 Hz steps. When only the 100 Hz digit is displayed (Figure 3-11) you tune in 100 Hz steps. When in CW mode and the APF filter (*CW Audio Peaking Filter – APF*, page 99) is engaged, you tune in 1 Hz steps (Figure 3-12). Data modes also tune at 1 Hz and 10 Hz.

The distance across the band tuned in one revolution of the VFO knob for each mode is shown in Table 3-6. .

Successively tapping RATE toggles between tuning the 10 Hz digit (see Figure 3-10) and 100 Hz allowing tuning at a coarser (faster) rate set by the ***VFO CRS*** menu. The faster tuning rate is useful when going from one end of a band to the other.

In CW mode when the Audio Peaking Filter (APF) is on and in Data modes, tapping RATE toggles between the 10 Hz and the 1 Hz digit.

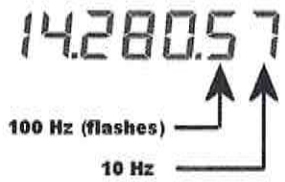

Figure 3-10. VFO A with rate 10 Hz tuning resolution.

Figure 3-11. VFO A with rate 100 Hz tuning resolution.

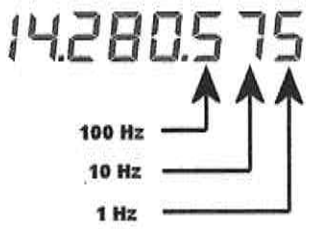

Figure 3-12. VFO A in APF fine tune mode (1 Hz resolution).

Exercise
Set the 100 Hz VFO tuning rate to 24 kHz/revolution for CW and 48 KHz/revolution for SSB.

Set CW mode.
Set ***VFO CRS*** to ***0.5***.
Set SSB mode.
Set ***VFO CRS*** to ***1.0***.

VFO A Tuning with VFO B Knob

When the OFS LED is lit (tap OFS/B ∅), the RIT control (the OFS/B ∅ knob), can tune VFO A in frequency steps given by ***VFO CRS***. Both RIT and XIT must be turned off (neither RIT nor XIT are active); the OFS/B ∅ knob will tune VFO A in large steps given by ***VFO CRS*** even though fine tuning for the VFO A knob is selected. This allows you to have the VFO A knob set up for fine tuning and use the VFO B knob (OFS/B ∅) to do a rapid frequency change.

Exercise
I would like to be able to tune VFO A at a fast rate using the OFS/B ∅ knob and at a fine rate using the VFO A knob without having to remember what switches to tap.

Set ***VFO CRS*** to a fast rate as shown in Table 3-6, tap RATE to display the 10 Hz digit, and then tap OFS/B ∅ until the OFS green LED is on. Now, when RIT and XIT are both off, the OFS/B ∅ knob tunes VFO A at a fast rate and the VFO A knob at a fine rate. Tap OFS/B ∅ again to be able to tune VFO B. If RIT or XIT are on, OFS/B ∅ tunes them at the same rate as VFO A.

3.3.2 VFO B

Figure 3-13 shows the KX2 VFO B. Its display area is below the main VFO A display (here showing the clock). Tap DISP to change to the frequency display.

Tap the OFS/B ∅ knob so that the VFO B LED is lit. The VFO B knob will now tune VFO B.

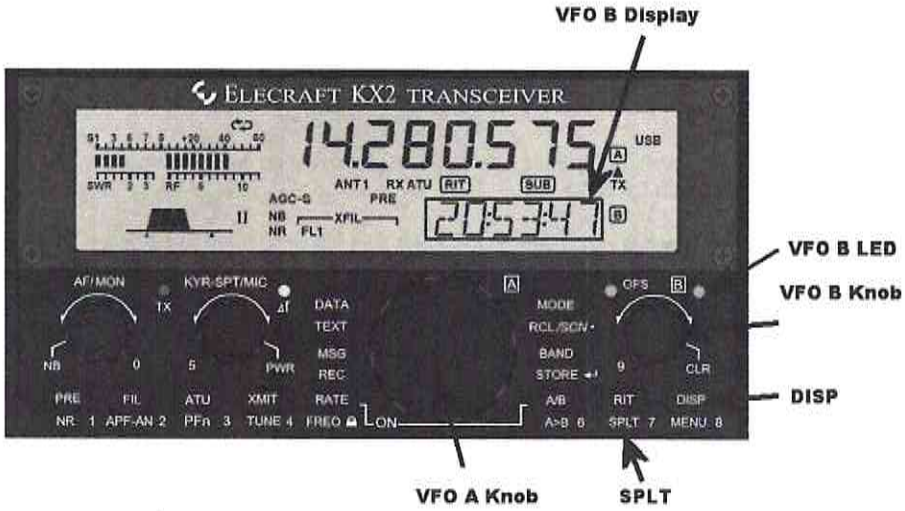

Figure 3-13. VFO B.

Alternate VFO B Displays

In Figure 3-13 the VFO B area is showing a twenty-four hour time display. This can be from the optional KXIO2 module if it is installed or the time since the KX2 was last turned on. The following displays are available by tapping DISP and rotating the OFS/B ∅ knob. See *VFO B Alternate Display*, page 116.

- Twenty-four hour time from the KXIO2 or since the KX2 was last turned on.
- Power supply voltage.
- Supply current.
- Power amplifier temperature.
- Audio signal level (AFV).
- Relative audio signal (dBV).
- Amp hours.

3.4 Dual-Watch Receiver Mode

The architecture of the KX2's receiver is shown in Figure 3-14. Although the KX2 has only one down-conversion receiver, the DSP can accept signals from both VFOs, mix them separately with the received signal, and thus allow you to listen to two frequencies simultaneously one in each ear. When both VFOs are used in this manner, the receiver is said to be in *dual-watch mode*, and the additional signal tuned by the B VFO is called the *dual-watch signal*. We also speak of a second, or dual-watch, (sub) receiver but most of it doesn't really exist. This is different from the K3, whose second receiver, the optional KRX3, is a complete and identical copy of the main receiver, from antenna terminal to audio output. The Software Defined Radio (SDR) architecture of the KX2's receiver makes it possible to get two receivers for the price of one.

There is only one set of components processing received signals up to and including the A-to-D converter. Then, the signal path is split into two paths, in the DSP stage, to implement both the main and dual-watch receivers. This means that all RF signal processing (low and bandpass filtering, preamplification and attenuation) is applied equally to both "receivers". It also means that the dual-watch receiver must be "watching" the same band of frequencies that the main receiver is receiving. You cannot, for example, listen on a second band like you can with a complete second receiver like the K3's.

The total frequency split distance is limited. VFO B can range from about 7 kHz above VFO A to 23 kHz below. This is constrained by the bandpass filtering stage. If you go outside that range, you will hear the dual-watch receiver turn off and see the SUB icon slowly flash. Finally, to hear both "receivers", you must use a stereo audio plug and stereo speakers or headphones (the left ear is the main "receiver's" output; the right ear is the dual-watch output). The SUB icon slowly flashes if you do not have stereo headphones or speakers plugged in.

To turn the dual-watch receiver on, set the ***DUAL RX*** menu to ***Auto***. The AF and RF volume controls apply identically to both receivers. Future firmware versions may allow the main and dual-watch receiver audio levels to be independently controlled.

After turning the dual-watch receiver on, tap [OFS/B ∅] to light the green [B] LED and to use the VFO B knob to tune the receiver.

Table 3-7. Dual-watch receiver menu.

Menu	Default	Description
DUAL RX	***OFF***	Set to ***Auto*** to turn on the dual-watch receiver. The SUB icon will turn on. If SUB is slowly flashing the VFO A and VFO B frequencies are too far apart for the dual-watch receiver to work (> ~ 15 kHz). You must be using stereo headphones to use this feature.

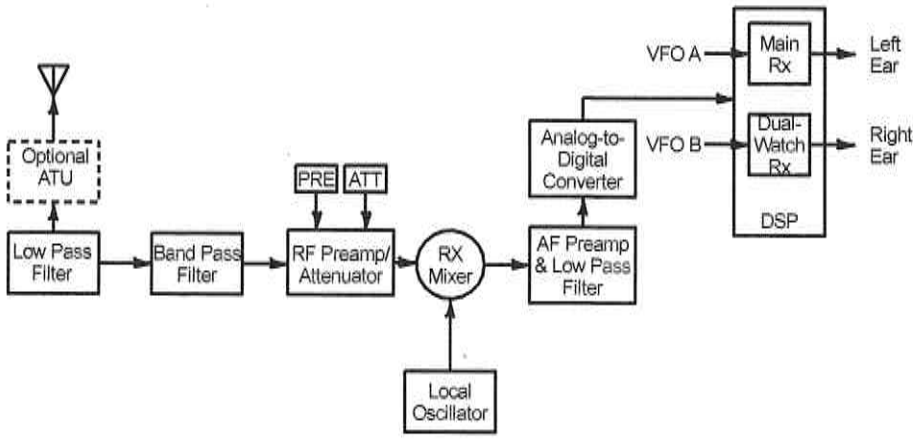

Figure 3-14. KX2 dual-watch receiver.

> **Remember:** The KX2's speaker is monaural. You have to use stereo headphones or two speakers plugged into the PHONES jack to hear the dual-watch receiver (and the audio effects described in *Audio Effects*, page 40).

3.5 Operating Split

Many DXpeditions control their pileups by transmitting on one frequency and listening on another. This allows them to be heard without interference from the pileup; it is called Split mode. Also, in many parts of the world, amateurs are not allowed to operate on frequencies that US amateurs use. Thus, these operators must transmit in their allowed band of frequencies and listen for US callers in theirs. A good operator should know how to operate Split and how to quickly find the place where the DX station is listening.

With your KX2 you can operate Split if both VFOs are on the same band. Cross-band Split is not possible. You can operate *cross-mode* Split between CW and SSB but only on the same band. (See the ***CW WGHT*** menu.)

You may be familiar with operating Split with another radio, such as the Elecraft K3. In these radios VFO A is normally used for both transmit and receive. When Split is activated VFO B comes into play. Now one VFO (in the K3 it is VFO B) is used to control the transmit frequency and the other the receive frequency. You leave VFO A on the DX station's frequency and tune VFO B to the station in the pileup who is working the DX. You have to be careful to avoid transmitting on the DX station's frequency by remembering to activate Split. The KX2's dual-watch receiver makes operating Split when chasing DX far easier than this.

3.5.1 Operating Split with a KX2 with the Dual-watch Receiver

After you have found the DX station's transmitting frequency, your task is to find the DX station's listening frequency. You will be listening to the DX station on one VFO and searching for the station that has successfully broken through the pile-up with the other. There are two ways to do this.

The first way is to use the Split mode. When in Split, you can listen to the DX on the main receiver (VFO A) in your left ear while you are tuning VFO B and listening to the dual-watch receiver with your right ear for the frequency on which to dump your call.[8] Enter Split mode by holding SPLIT. Don't forget to do this, or you will transmit on the DX frequency! (Someone will send UP! UP! and maybe even LID!, which is embarrassing.) When you are operating Split mode, the VFO B controls the transmit frequency.

To activate the dual-watch receiver in Split mode:

- Hold A>B to transfer VFO A to VFO B.
- Tap OFS/B ∅ to light the green B LED.
- Hold MENU and rotate OFS/B ∅ to the ***DUAL RX*** menu and rotate VFO A to ***Auto***.
- Enter Split mode by holding SPLIT.
- Tune through the pile-up using OFS/B ∅ to find the station being worked (in your right ear) while listening to the DX station on VFO A (in your left ear).

A disadvantage of this method is that if you are calling the DX, you are using the smaller VFO B knob to tune through the pileup. If you are the DX, however, transmitting on VFO B and tuning for callers in the pileup with VFO A will be easier.

The second way is to not use split but to reverse the roles of VFO A and VFO B. Hold A>B to equalize the VFOs and then turn on the dual-watch receiver (menu ***DUAL RX Auto***). Now use VFO A to tune through the pileup to find the station the DX is working. You will be listening to the DX station in your right ear (VFO B) and the pileup in your left ear (VFO A). **Do not** hold SPLIT because you **do** want to transmit on VFO A after you have found the frequency the DX station is listening on. The advantage of this method is that you will be tuning through the pileup using the larger, more easily tuned, VFO A knob.

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[8] Listening to the main receiver (the DX) with your left ear and the dual-watch receiver (the pileup) with your right ear mimics our visualization of the spectrum. You can, of course, change you headphones around to reverse this. However, the main/left, dual-watch/right combination makes sense because most DX stations operate Split with their listening frequency "up" or higher in frequency. This would be to the right on a spectrum display and thus listening to the pileup in the right ear and the DX in the left seems natural. The K3S and KX3 use the same organization for the same reason.

- Hold A>B to transfer VFO A to VFO B.
- Tap OFS/B ∅ to light the green B LED.
- Hold MENU and rotate OFS/B ∅ to the ***DUAL RX*** menu and rotate VFO A to ***Auto***.
- Tune through the pile-up using VFO A to find the station being worked while listening to the DX station on VFO B.

Exercise
Program PFn to toggle the Dual-Watch Receiver on and off.

Hold MENU and tune VFO B to ***DUAL RX***. Hold PFn and then tap DISP.

Hint: To avoid bumping the VFO A knob and moving off the DX's frequency, hold FREQ for ~ 3 seconds to lock the VFO. Tap RATE to unlock it.

3.5.2 Operating Split with a KX2 without Using the Dual-watch Receiver

Normally, VFO A is used for both transmit and receive. When SPLIT is held, VFO B becomes the transmit VFO, the SPLT icon turns on, the TX arrow points to B, and the yellow Δf LED is turned on if the receive and transmit frequencies or modes are different.

You will be listening to the DX station on VFO A and searching for the station that has successfully broken through the pile-up with VFO B. There are two ways to do this.

- Hold SPLIT to enter split mode.
- When you hear the DX station call a station in the pile-up, hold A>B to set both VFOs on the same frequency (the DX station's frequency). Quickly search through the pile-up using VFO A to find the station responding to the DX.
- When you find it, tap A/B to reverse the VFOs so that VFO A is now listening to the DX and VFO B (i.e. your transmit frequency) is on the station in the pile up. Get ready to call the DX on the next over.

If you forget to reverse the VFOs by tapping A/B when you call, you will be calling on the DX frequency, which usually earns approbation (UP! UP! and even LID!) from the pile-up.

A second option makes use of the RIT and XIT and does not use Split.

- When you hear the DX call a station in the pile-up, set the transmit XIT ***On*** in the ***XIT*** menu, tap the RIT button, and tap OFS/B ∅ to light the green OFS LED.

- Now search through the pile-up to find the station responding to the DX using the OFS/B ∅ RIT/XIT control knob.
- When you find it, tap RIT to return to listening on the DX station's frequency and call on the **XIT** offset frequency.
- Don't forget to set the ***XIT*** menu off when you are done.

These techniques are used with radios that do not have a second or a dual-watch receiver. You should use your KX2's dual-watch capability.

3.6 Memories

There are 100 general purpose memories (00 – 99) that can store VFO A and B frequencies, operating mode, and other information. You can label each memory with up to five characters to easily remember what the memory is for. In addition, there are four quick memories on each band accessed by tapping the 1 – 4 keys shown in Figure 3-9, page 26.

3.6.1 General Purpose Memories

General purpose memories save the present VFO A and B frequencies and the operating mode (CW, SSB, etc.).

Storing a General Purpose Memory (00 – 99)

- Set VFO A and VFO B frequencies and other information to be stored (CW, SSB, pre-amp, attenuator settings, etc.).
- Hold STORE and then rotate VFO A until the desired memory identifier (***00 – 99***) and any label defined for the memory shows in the VFO B display area. Any frequency that has been stored in the memory (for VFO A) is displayed as you rotate VFO A selecting different memories.
- Hold STORE again to save the data or tap any other key to cancel the operation.

Recalling a General Purpose Memory (00 – 99)

- Hold RCL/SCN and then rotate VFO A to select memory ***00 – 99***.
- Tap any key to exit.

Erasing a General Purpose Memory (00 – 99)

- Hold RCL/SCN (or STORE) and rotate VFO A to select memory ***00 – 99***.
- Hold OFS/B/CLR.
- Tap any key to exit.

You cannot clear the per-band 1 – 4 quick memories this way. These can only be reprogrammed.

Editing a General Purpose Memory

You cannot edit the contents of a general purpose memory from the KX2 keyboard. You can only store a new set of frequency data into the memory. However, a Frequency Memory Editor utility is available on the Elecraft website that allows you to edit the KX2's memories. See *Elecraft Frequency Memory Editor* below.

Adding a Text Label to a General Purpose Memory (00 – 99)

- Hold RCL/SCN (or STORE) and rotate VFO A to select the memory ***00 – 99***.
- Rotate VFO B to select the label position as indicated by the flashing cursor (–) and, using VFO A, select the letter for that position.
- You may select up to 5 characters from ***A-Z***, ***0-9***, and *, +, /, @, and _.
- Rotate VFO B to select the next position and then rotate VFO A to select the next character.
- If you set an "*" for the first character in a label, you designate a channel hopping memory. See *Memory Scanning or Channel Hopping*, page 38.
- Hold STORE to save the data.

The Elecraft Frequency Memory Editor program can be used to simplify setup and labeling of memories from your computer.

3.6.2 Quick Memories

Quick memories are available on each band; they are accessed by tapping the 1 – 4 keys. They are called quick memories because you do not have to tune VFO A to select the memory. You just hold RCL/SCN and tap 1 – 4. The frequencies you put in these memories are stored per-band. This allows each band to have four of its own quickly accessible frequencies. Therefore, you cannot change to a new band with a quick memory.

Storing a Quick Memory (1 – 4)

- Set VFO A and VFO B frequencies and other information to be stored (CW, SSB, etc.).
- Hold STORE and then tap the target memory key 1 – 4.

Recalling a Quick Memory (1 – 4)

- Hold RCL/SCN and then tap 1 – 4.

3.6.3 Elecraft Frequency Memory Editor

The Elecraft Frequency Memory editor is PC software that enables you to maintain the KX2's memories using a spreadsheet-like editor. It is available at the Elecraft website at http://www.elecraft.com/K3/FreqMemEdit/K3_Freq_Mem_Editor.htm.

3.6.4 Band Scanning

The KX2 can scan any band segment where the lower and upper limits of the band to be scanned are stored in a memory. It can also scan over a range of memories, called channel hopping. While scanning, the receiver can be muted, only opening up when a signal is detected. It can also be unmuted, or open, during the scan. When the band you are scanning is noisy, the scan may stop frequently. Try using a narrower filter, turning down the RF gain, or turning the preamp off.

You must set up a memory with VFO A holding the starting frequency, VFO B the ending frequency, and the desired operating mode, bandwidth, etc. You can use a general purpose memory or a quick memory as described above.

- Set VFO A to the start frequency and mode and VFO B to the end frequency and store these in a general purpose or quick memory.
- Recall the memory that stores the scan frequency limits using RCL/SCN and tap any key to exit.
- Tap RATE to select 10 Hz tuning.
- To start scanning hold RCL/SCN until ***SCAN*** appears in the VFO B area (~3 seconds).
- To stop scanning, rotate VFO A, or tap any switch, key, keyer paddle, or microphone PTT switch.
- To restart scanning, hold RCL/SCN.

The receiver is scanned at the VFO tuning rate described in the sections above. You may wish to set the finest VFO tuning rate before scanning.

Exercise
Set up memory ***01*** to scan from 14.000.000 to 14.060.000 in CW mode. Set the memory label to ***SCAN***.

Select CW mode.
Enter or tune to ***14.000.000*** in VFO A and ***14.060.000*** in VFO B.
Hold STORE and then rotate VFO A to select ***01*** (general purpose memory 01).
With the *01* flashing, rotate VFO B to the text positions and rotate VFO A to select the letter for the label.
Successively rotate VFO B and VFO A to enter ***S C A N*** for the memory label.
Hold STORE again to exit.

Exercise
Use the ***01*** memory as programmed above to start scanning.

Tap RATE until the fine tuning mode is entered.
Hold RCL/SCN and rotate VFO A to select the memory ***01***.
Hold RCL/SCN again to recall the memory into the VFOs and then hold RCL/SCN to start scanning.

3.6.5 Memory Scanning or Channel Hopping

You can set up the KX2 to scan through a sequence of discrete memory channels instead of scanning over a band of frequencies. This is useful when you want to monitor activity on calling channels, for example on the 60 meter band. The frequencies to be scanned must all be on the same band and the channels to be scanned must be in sequential memories.

Set up a sequence of general purpose memory channels as described above. While you are doing this, add a text label to the memory where the first character in the label is "*". Be sure to have VFO B contain a frequency in the same band because scanning is not allowed if VFO B is on a different band.

You scan through the channels by recalling into VFO A (RCL/SCN, tune VFO A, tap any key) one of the channels programmed with the "*" as the first character of the label and then holding RCL/SCN for about 3 seconds. The scan now channel hops through the sequence of channels with the "*" as the first character in their names.

Tap any switch to ***STOP*** channel scanning. Tap RATE to disable channel hopping to be able to use VFO A normally.

To manually hop through your stored memories, recall one of the channels programmed with the "*" as the first character of the label. Now as you turn VFO A, the KX2 hops through the channels. Tap RATE to disable channel hopping to be able to use VFO A normally.

3.7 Noise blanking and Noise Reduction

The KX2's DSP includes noise blanking (NB) and noise reduction (NR). In addition to reducing noise with these, a Notch filter can remove an interfering carrier.

> Noise blankers and noise reduction should be used sparingly because they can introduce other effects, such as intermodulation distortion (IMD), which can affect copy.

In general, a noise blanker works by detecting and suppressing fast rise-time pulses such as ignition noise. A noise reduction filter works to reduce random background noise using clever digital signal processing algorithms. The KX2's notch filter can remove a fixed frequency carrier.

Allow two to three seconds after changing a noise reduction or blanking level for the digital signal processing to become active.

Use the minimum level of noise reduction and/or noise blanking to achieve a clear signal. More extreme settings may result in a reduction of copyability.

Chapter 7, page 97 has a full description of the noise blankers and noise reduction signal processing; it's for you to read after you have started using your KX2.

Setting Noise Reduction Level

- Hold NR.
- VFO B display shows the current noise reduction setting for about three seconds.
- While the current level is displayed, rotate AF/MON ∅ to set one of ten noise reduction levels.
- VFO A is locked while doing this so tap any switch to return to the normal display and operation.
- Hold NR again to turn it off.
- See *Noise Rejection*, page 100 for a more complete description of the noise reduction filter.

Activating Noise Reduction

- Hold NR.
- VFO B display shows the current noise reduction setting for about 3 seconds.
- Hold NR again to turn it off.

Setting Noise Blanking Level

- Hold NB (push and hold the AF/MON/NB ∅ knob).
- VFO B shows the current noise blanker setting for about 3 seconds.
- Rotate AF/MON/NB ∅ to set one of fifteen noise blanking levels. Tap any switch to exit.
- VFO A is locked while doing this so tap any switch to return to the normal display and operation.
- Hold AF/MON/NB ∅ again to turn it off.

Activating Noise Blanking

- Hold NB (push and hold the AF/MON/NB ∅ knob).
- VFO B display shows the current noise reduction setting for about 3 seconds.
- Hold AF/MON/NB ∅ again to turn it off.

Activating the Notch Filter

The notch filter is automatic in SSB mode and is not used in the CW or DATA modes.[9]

- Hold APF-AN.
- If you are in SSB mode, the notch filter will automatically find the carrier and notch it out.
- If you are in CW or DATA mode, the audio peaking filter is activated, not the notch filter. See *CW Audio Peaking Filter* – APF, page 99.
- Hold APF-AN again to turn the notch off.
- See *Notch Filter*, page 100 for a more complete description of the notch filter.

3.8 Audio Effects

Setting ***AFX MD*** to ***dELAY*** switches in the audio effects feature if you are listening with stereo headphones or have stereo external speakers. The ***AFX MD*** menu allows ***dELAy***, which introduces a quasi-stereo delay between the two channels. Some operators like the AFX feature; some don't.[10]

Menu	Default	Description
AFX MD	***dELAY***	This sets up stereo audio effects (you must be using stereo headphones). Some users find this improves the copyability of signals. Choose ***dELAY*** or ***nor.*** Audio effects are disabled in ***DATA-A*** and ***AFSK-A*** modes. See *Audio Effects – AFX*, page 115.

3.9 Using an External Speaker

The KX2's internal speaker cannot produce a very loud audio signal without distortion and so many operators use external amplified speakers. A monaural speaker with a mono (T-S) plug may be used with the PHONES jack, but a 3.5 mm (1/8") stereo (TRS, tip-ring-sleeve) jack for two speakers will give you the stereo output that is required for the audio effects (AFX) and the dual-watch receiver.

3.10 Clock

The KX2's alternate VFO B display can display a clock that keeps time as long as the KX2 is turned on. It displays the elapsed time since turn-on although you can set the clock as described in *Setting the Real-Time Clock*, page 132, using the ***TIME*** menu.

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[9] At least at this stage of KX2 firmware development.

[10] Other AFX effects maybe available in future firmware developments.

The clock is set to 00:00:00 (after about two hours) when the KX2 power is turned off unless the KXIO2 Real-Time Clock and Auxiliary I/O module and Li-ion battery pack are installed.

3.11 Programmable Function Key

The KX2's PFn key is programmable and you can assign it as a shortcut to activate a menu item. At the time this is written, only PFn can be programmed in this way. A future firmware release is planned to allow more keys to be used for these useful functions.

Here is how you program a function key:

- Hold MENU and tune VFO B to the menu item of interest.
- Next, hold PFn to program that key to the selected menu item. The VFO B display area will show ***PFn SET***, indicating the function key has been set.
- Tap DISP to exit the menu setting function.

To use the shortcut to the menu item, hold ***PFn***.

You cannot erase a programmable function key but you can write over it with a new function.

Exercise
Program PFn to be a shortcut to the ***BKLIGHT*** menu item.
Hold MENU and tune VFO B to ***BKLIGHT.*** Hold PFn to store the shortcut and then tap DISP.

Exercise
What happens when you hold PFn after programming it as a shortcut to the ***BKLIGHT*** menu?
Each time you hold PFn ***BKLIGHT*** toggles between ***OFF*** and ***On.***

Exercise
Program PFn to toggle the Dual-Watch Receiver on and off.
Hold MENU and tune VFO B to ***DUAL RX.*** Hold PFn and then tap DISP.

3.12 Setting Keyer Speed and Output Power

Rotating the KYR-SPT/MIC/PWR ⊘ knob in CW mode sets the internal keyer's speed from 8 to 50 WPM and in voice modes, the microphone gain (see *KX2 Microphone Set Up*, page 67). Holding and rotating the knob sets the output power. The maximum power output varies with supply voltage and other parameters. The output power is displayed in the VFO B area while you are setting it and on the RF bar graph when you are transmitting.

- Full power output is specified as 10+ watts for 80 – 15 meters. Your power supply must be regulated well enough to supply 13.6 to 13.8 volts while

delivering 2.2 amps to the 10-watt KX2 or 22.0 to 24.0 amps to a KX2/KXPA100[11].

- The KX2 will still deliver up to 10 watts if the power supply voltage sags to about 10 volts. This results in a less spectrally pure signal, however. Elecraft urges you to use a well-regulated power supply.
- On 12 – 10 meters, full power output is specified as 8 watts.
- When operating with the internal Li-ion battery pack, the output power is still 10 watts but will drop to 5.0 watts if the supply voltage sags below 10 volts. (Chapter 8.4, page 128.)
- When tuning an antenna by tapping ATU, the transmitter delivers 2 – 3 watts when tuning the internal KXAT2 ATU or 5 watts when tuning an external KXAT100 tuner. This is set internally and cannot be changed.
- Elecraft recommends running 5 watts or less when operating any of the data modes to maintain a safe operating temperature. (*Data Modes*, page 77.)
- The KX2 will fold output power back to 5 watts at ~ 60 C. After it cools you must manually change to a higher power if desired.
- You can set the tuning power output when the TUNE button is held by setting the ***TUN PWR*** menu to a value other than ***nor***.

[11] These specifications assume you are transmitting into a fully resonant antenna, an antenna tuned by the ATU, or dummy load while in CW mode.

Chapter 4. CW

> **Note:** You may find that some of the KX2 features and operations described in this chapter do not seem to work or display ***N/A*** when you attempt to make an adjustment. This is because these features have not been implemented in the KX2 firmware as yet. They are expected to be available in the future.

4.1 Getting Started

Setting the CW Mode

Tap the MODE button until the CW icon is displayed. You must be in CW mode for many of the menu items discussed below to be adjusted.

To send CW, you must be in VOX mode (set the ***VOX MD*** menu ***ON***), or in PTT mode (***VOX MD OFF***). The KX2 will transmit when you key the radio in VOX mode and in PTT mode when you tap XMIT or activate PTT (in the MIC jack). (See *PTT*, page 55.)

Code Practice

You can get a feel for the KX2's keying characteristics (see *CW Weight*, page 47) without transmitting by setting the ***VOX MD*** menu ***OFF*** so that you are in PTT mode. If you are in VOX mode you will be transmitting when you key unless you set the power to ***0.0***.

You can practice sending code by using the CW decoder built into the KX2. If you send pretty-good CW, with no serious spacing errors, the decoder will decode the CW correctly, and the text display (in the VFO B window of the display) will agree with the text you send. This practice mode will help you learn how to send properly spaced CW code.

- Tap MODE until the CW icon is displayed.
- Set ***VOX MD*** menu ***OFF***.
- Hold the TEXT button to enter the text decode dialog. VFO B will show ***DEC OFF***, ***TX ONLY***, ***RX THRn,*** etc., when you are in the correct dialog. (If holding TEXT isn't done long enough, you may find yourself in the DATA mode dialog. If this occurs, tap MODE again until the CW icon is displayed.)
- Rotate the VFO B knob to select ***TX ONLY***. This will decode only the CW characters you send with the internal keyer. A small T icon will show when text decoding is activated.
- Tap DATA to exit the text decode dialog.
- Set the CW keyer for the desired speed by rotating KYR-SPT/MIC.

- Begin using the CW key (see *Keying*, page 54). (Don't forget to set transmit power to 0.0 or make sure you are not in VOX mode!) Monitor the decode window (VFO B window of the display) for the decoded letters of your text.
- Optionally, you can use the KX2 Utility to monitor an extended display of characters sent from the KX2's keyer. See *The KX2 CW Decoder*, page 58.

Menu for CW

Before starting to make CW contacts with your new KX2 transceiver, set up the menu items and make some front panel adjustments as shown in Table 4-1.

Table 4-1. Menu items for CW keying.

Menu	Default	Description
CW IAMB	***A***	This sets the iambic keying mode, ***A*** or ***B***. In mode ***A***, alternate dits and dahs are produced as long as both paddles are depressed. When the paddles are released, the keying completes the current character and stops. In mode ***B***, when the paddles are released, an extra dit is sent if the paddles were released during a dah, or vice-versa. Mode B is for operators used to squeeze keying, which inserts that extra dit or dah when the paddles are released. Once you are used to one mode it is hard to use another. If you sit down at someone else's rig that uses one mode and you normally use another, you can change the mode to your keying style with this menu item.
CW KEY1	***tiP=dot***	If you operate at someone else's station, you might bring your own paddle to operate CW. A "normal" (right-handed) paddle connection produces dits when the left paddle (dit-switch) is pressed and dahs when the right (dah-switch) is pressed. (Left-handers may prefer the other possibility, although that will make it difficult for you to operate somebody else's station if it does not have the capability to switch the dits and dahs.) You may have your dit-switch connected to the tip or the ring connection on the stereo paddle plug. This menu item allows you to specify if the tip connection should produce dits (***tiP = dot***) or dahs (***tiP = dASH***). If ***HAnd*** is selected, either of the two levers can be used as a hand key or as an external keyer or computer keying input.
CW KEY2	***LFt=dot***	Specifies whether the left lever of the KXPD2 is used for the dit connection (***LFt = dot***) or the dah (***LFt = dASH***). If ***HAnd*** is selected, either of the two levers can be used as a hand key, an external keyer, or for computer keying input.

CW WGHT	***1.25***	The ***CW WGHT*** parameter changes the element-to-space ratio for the internal keyer. The range for the KX2 is ***1.0*** to ***1.25***. See *CW Weight*, page 47.
	SSB –CW	Tapping the [1] key toggles between ***SSB +CW***, which allows CW to be sent when in SSB mode, and ***SSB –CW***, which doesn't. When ***SSB +CW*** the other station (operating SSB) will hear your signal at the tone set by your sidetone pitch. See *CW in SSB Mode*, page 73.
	NOR QSK	Tapping the [3] key toggles between ***NOR QSK*** and ***FST QSK***. The ***NOR*** mode reduces audio artifacts heard in the receiver during CW keying on a noisy band. ***FST*** provides somewhat faster receiver recovery time. See *CW Break-In Operation*, page 48.
	VOX	Tapping the [4] key selects ***VOX nor*** or ***AUTOOFF***, which turns CW VOX off when the KX2 is powered-up. This will allow you to avoid accidental keying with a PC, but means you have to switch VOX back on by setting the ***VOX MD*** menu ***ON*** every time you turn the KX2 on.
	VFO OFS	Tapping the [5] key selects automatic VFO offset when switching to CW from any other mode. The offset is the sidetone frequency that can be adjusted by holding the PITCH and tuning VFO A. ***VFO NOR*** (the default) provides no offset. ***VFO OFS*** is useful if you are carrying on a conversation in SSB and both stations wish to switch to CW.
PITCH	***0.60***	Set the ***PITCH*** menu to set the sidetone pitch. This is the tone you would like your ears to recognize easily to be able to zero beat a CW station you are calling. See *Zero Beating the Station*, page 52. In PSK-D mode (PSK31/63), the center pitch is 1000 Hz (fixed). In FSK-D mode (RTTY), the mark tone is 915 Hz (fixed).
VOX DLY	***0.0*** (CW) ***0.50*** (SSB/Data)	If ***VOX MD*** is set to ***On*** in the current mode, this menu sets the VOX delay time (recovery time from transmit to receive) in seconds. In CW mode, full break-in is achieved by setting the ***VOX DLY*** menu to ***0.0***, which turns on the QSK icon (See the ***CW WGHT*** menu for additional QSK settings.) Anything larger is semi-break-in, which sets the time for the KX2 to return to receive after transmitting. If you are using a non-QSK outboard linear amplifier, this time should be long enough that the amplifier does not try to switch between CW characters. Independent VOX delay times are saved in CW, SSB and audio data modes.

VOX MD	***On*** (CW) ***OFF*** (SSB, Data)	If ***VOX MD*** is ***OFF***, transmit must be started by tapping XMIT (otherwise known as PTT, or push-to-talk operation). In CW mode, setting ***VOX MD*** to ***On*** allows "hit-the-key" transmit. In SSB mode, ***VOX MD On*** allows transmit to start when you start speaking. In audio data modes, VOX starts transmit when a computer connected to the mic jack outputs an audio signal. In Data modes VOX is always ***On*** in PSK-D and FSK-D modes; PTT is not available. VOX may be on or off for DATA A and AFSK A. If ***CW WGT*** 4 is set to ***AUTOOFF*** you will have to activate VOX each time you power the radio up. This is useful to avoid having your computer key the rig through a serial interface when the computer is turned on after the KX2. VOX cannot be used with the built-in microphone.
ALT MD	***nor***	The ***ALT MD*** menu switches the CW, SSB, or DATA mode between normal and reverse (REV). CW normal uses the lower sideband (your carrier frequency minus the sidetone offset frequency), while CW reverse uses the upper sideband. This change is for receive only and is sometimes used to shift interfering signals around in the filter pass bands so that the received signal is easier to copy. If you have correctly tuned in the desired station (zero beat) using the CW tuning indicator or the auto-spot mode, the tone of the desired received signal will stay the nearly same for normal and reverse CW modes. The sideband you select for a band is saved for that band. When ***ALT MD*** is assigned to the programmable function switch ***PFn***, holding the switch toggles between ***nor*** and ***ALT*** on successive presses without remaining in the menu.

Exercise

Examine what happens when switching between CW and SSB with ***CW WGHT VFO OFS*** set to ***OFS*** and when it is set to ***NOR***.

Select CW mode and tune VFO A to some even CW frequency, such as 14.050.00.

Enter the ***CW WGHT*** menu and tap the 5 key to select ***VFO NOR***.

Exit the menu and switch between SSB and CW modes. With ***VFO NOR***, the VFO A display remains constant.

Change to ***VFO OFS*** and repeat the experiment.

With ***VFO OFS*** activated, the display shows 14.050.00 minus your CW PITCH.

Exercise
What happens if two stations are using SSB and decide to switch to CW with ***VFO NOR***.

With ***VFO NOR***, each station will have to re-tune the other to hear the CW tone. With ***VFO OFS*** activated, neither station will have to re-tune. Each station's VFO will be automatically offset by the pitch amount.

Exercise
You are operating at the scene of a disaster using a low antenna and low power while passing health-and-welfare traffic. You can hear the SSB station on the other end but it can't hear you very well. So, you would like to be able to listen on SSB and send on CW. What configuration menu item do you use to activate this cross-mode transmission?

Open the ***CW WGHT*** menu and tap the 1 key to set ***SSB +CW***.

4.2 CW Weight

The term "CW weight" can refer to the ratio of the dit-to-intersymbol-space time or the dah-to-dit ratio. Altering these ratios changes the sound of the keying. A "normal" weight is 1:1, where the time for the dit is the same as the intersymbol time and which gives a "normal" dah-to-dit ratio of 3:1. See Figure 4-1(a). When the dah-dit ratio is less than 3:1, the dits are emphasized and the keying is said to have a heavier weight, as in Figure 4-1(b). The ***CW WGHT*** menu adjusts both of these ratios. For example, if ***CW WGHT*** is ***1.2***, the dit time is increased by 20% and the intersymbol-space time is reduced by 20%. The dah time is increased by the same amount of time (i.e. 20% of the dit-time, in effect, increasing the dah-time by only 20/3 = 6.67%). See Table 4-2 and Figure 4-1.

Table 4-2. CW Weights.

	Normal Weight	More Weight	Less Weight
CW WGHT	1.0	1.2	0.9
Dit (ms)	60	72	54
Dah (ms)	180	192	174
Space (ms)	60	48	66
Dit:Space	1:1	1.5:1	0.82:1
Dah:Dit	3:1	2.67:1	3.22:1
Paris WPM	20	18.2	21

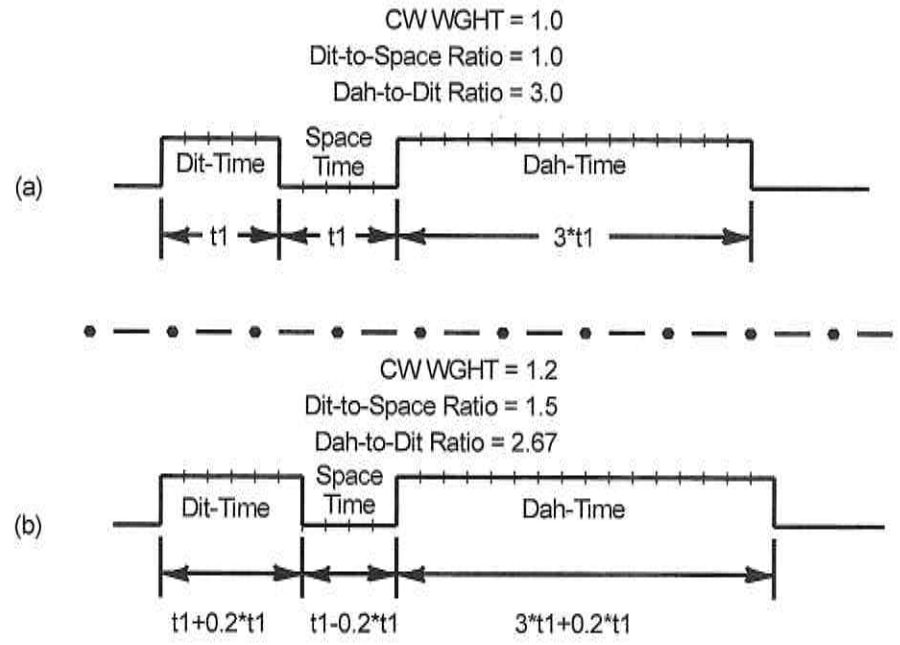

Figure 4-1. The KX2 CW weight controls the time between dits and dahs; (a) Normal 1:1 and 3:1 ratio; (b) "Heavier" keying with 1:1.5 and 2.67:1 ratios.

4.3 CW Break-In Operation

CW operators normally use "break-in" to key their radios. This means that they do not have to activate a PTT or tap the XMIT button to transmit. They simply just start to send CQ and the radio keys automatically. There are two styles of break-in – semi-break-in and full break-in. Break-in uses the VOX circuitry to activate the transmitter. The KX2 starts to transmit a few milliseconds, given by the ***TX DLY*** menu, after keying starts to allow downstream equipment, such as an amplifier, to switch to transmit mode. ***TX DLY nor*** is 5 milliseconds and is appropriate for most operations. (For comparison, a blink is roughly 10 milliseconds). If you are driving an amplifier that switches more slowly than the KXPA100 amplifier, you can increase the delay to as much as 20 milliseconds.

After the transmission ceases, the radio does not switch back to receive until the VOX delay times out. This is controlled by the ***VOX DLY*** menu. This delay can range from 0 to 2.0 seconds and can be set separately for CW, SSB and Data modes.

Break-in is called full break-in when the VOX delay is zero seconds. A longer delay is called semi-break-in. Many operators use full break-in so they can hear the receiver between characters that they are sending. Old time CW net operators used this technique so they could hear other stations breaking in while they were sending. Full break-in is also called QSK. The QSK icon will be displayed when ***VOX DLY*** is ***0.00***.

Tapping [3] in the ***CW WGHT*** menu selects either ***NOR QSK*** (original) or ***FST QSK***. The ***FST*** setting provides somewhat faster receive recover times while ***NOR*** is less susceptible to audio artifacts heard in the receiver during CW keying on a noisy band.

4.4 CW Front Panel Controls

Table 4-3 shows the front panel controls you should set up before making your first CW contact. You must be in CW mode for these controls to be effective.

Table 4-3. Front panel controls for CW.

Front Panel Control	Description
Sidetone Volume	Tapping and then turning the [AF/MON ∅] knob sets the volume of the sidetone you use to monitor your sending. It can range from 0 to 40. Set it to a comfortable level, which will depend on your listening environment. Lower is better to save your ears if you are using headphones. Tap the knob again to exit.
Internal Keyer Speed	When in CW mode, the [KYR-SPT/MIC ∅] knob varies the internal keyer speed from 8 to 50 WPM. You may also adjust the dit-to-space ratio with the ***CW WGHT*** menu. See Table 4-1, page 44. In voice modes, this knob adjusts the microphone level.

4.5 Connecting a Key

To send CW you must connect a straight key, paddle, bug, or computer keying line to the KEY jack, or you can use the KXPD2 paddle. You cannot program CW memories with a straight key in the KEY jack; you must use an external paddle or the KXPD2. The easy way to program CW memories is to use the KX2 Utility Program. See Table 4-4, Figure 4-2, and *The KX2 CW Decoder*, page 58.

Table 4-4. Panel jacks used for CW.

Left Side Panel Connections	Description
KEY	Connect your CW paddle to this 3.5 mm TRS (stereo) jack. As shown in Table 4-1, the ***CW KEY1*** menu can tell the KX2 which connection, the tip or ring, is the dit-switch connection. You may use a straight key, bug, or computer keying circuit, also. Set ***CW KEY1*** to ***HAnd*** and use the tip (plus the shield for ground) for the keying input. See *Computer Operated CW,* page 54 for computer keying information. To go back to using the internal keyer, set ***CW KEY1*** to ***tiP=dot.***
MIC	The MIC 3.5 mm jack's ring 1 may be used for PTT. See Figure 5-2, page 62.

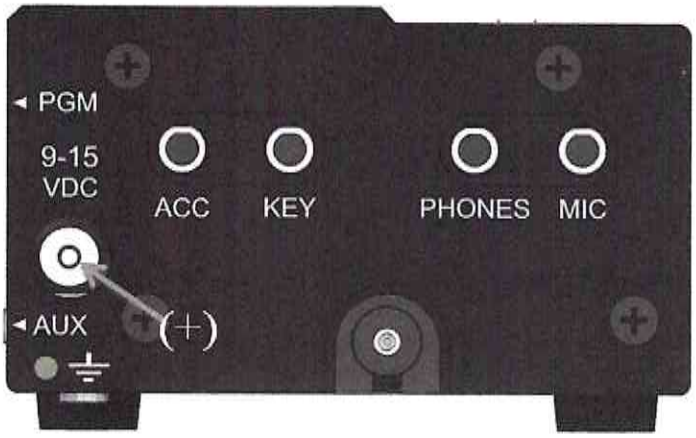

Figure 4-2. Left side panel keying jack.

Connecting a Paddle or a Straight key

Figure 4-3 shows the connections for a paddle. If the Dash Switch is connected to the tip and the Dot Switch to the ring, the ***CW KEY 1*** menu should be set to ***tiP=dASH***.

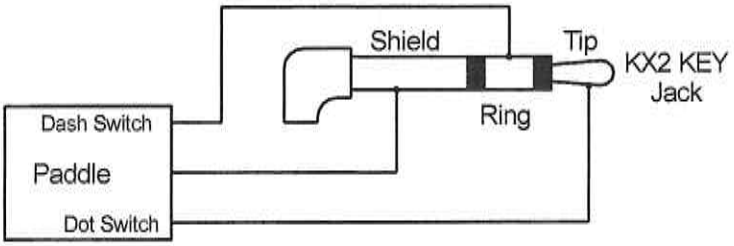

Figure 4-3. Connecting a paddle.

Figure 4-4 shows how to connect a straight key or a bug. The ***CW KEY 1*** menu should be set to ***HAnd***. Either the tip or the ring connection can be used. You must use a TRS (stereo) 3.5 mm plug.

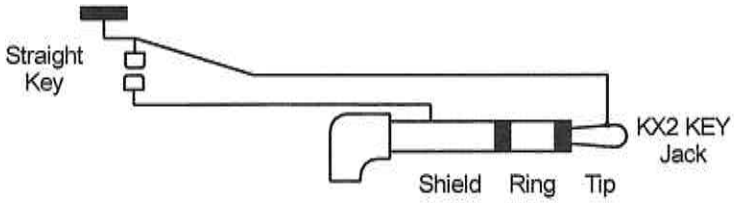

Figure 4-4. Connecting a straight key.

The Elecraft KXPD2 Paddle

Figure 4-5 shows the KXPD2 paddle. This plugs into the KX2 to provide a compact integrated CW rig. You may also use a KXPD3 paddle but Elecraft recommends replacing the left hand thumb screw for one that is shorter to avoid touching a closely spaced component behind the paddle. You can order this from Elecraft (part number E700425).

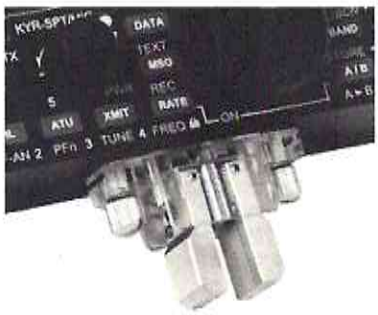

Figure 4-5. KXPD2 paddle.

4.6 Setting Your Sidetone Pitch

Many people have a "sweet spot" in their hearing that makes it easier to hear certain tones. Usually as we grow older, that tone or pitch may go down in frequency. You should adjust your sidetone pitch in the ***PITCH*** menu to make it easier to zero beat a station you are calling. When you "zero beat" a station it should have the same pitch). You can tap AF/MON once in a while, just to remind yourself of the pitch that you must tune CW stations to in order to zero beat them.

4.7 Zero Beating the Station

You should try to match your transmit frequency with that of the station you are going to call. This is called *zero beating*, and when done properly the operator of the station you are calling will hear your signal at his or her sidetone pitch. Being able to zero beat another station rapidly is an important skill for the serious CW operator. For example, you might be chasing a DX station that is operating Split and rapidly working stations in a pile-up. Finding the last station worked and zero beating that frequency will greatly enhance your chances of working the DX.

The term zero beating comes from the beat tone we hear when we listen to two, closely spaced, audio tones simultaneously. The two tones "mix" in our hearing so that we can hear both tones and the difference between them, call a "beat tone". As the two tones come closer in frequency, the beat tone becomes very low and then disappears. To zero beat a station, you must match the tone of the station to which you are listening to your sidetone. When they are matched, the beat note that you hear will go to zero. When this happens, you are right on the sending station's frequency.

> Zero beating a station you want to call is a vital skill to be mastered. The KX2 has three ways to help you zero beat.

CW Tuning - CWT

The CWT tuning display is shown in Figure 4-6. You must be in CW mode and the ***CWT*** menu must be set ***On***. As you tune across the CW signal you will see the black tuning indicator move from too low, to zero beat, to too high. If no bar appears in the tuning area, you may have to fine tune the VFO, or the signal may be too low to decode.

Auto Spot – SPT

If you find zero beating by audible pitch matching difficult, try the auto-spot mode. Turn ***CWT On*** and then tune in a station using a narrow receive bandwidth (200 to 500 Hz). Tapping KYR-SPT/MIC ∅ will then automatically set your VFO to the zero beat frequency. The black tuning indicator would appear centered as in Figure 4-6. When the RIT is on, the auto spot feature of the CW tuning (CWT) will tune RIT instead of VFO A.

Manual Zero Beat

If ***CWT*** is turned ***OFF***, (i.e., no CWT indicator is visible) you may use a manual method to zero beat. Tap the KYR-SPT/MIC ⌀ knob. This turns on your sidetone generator, which you will hear superimposed on the signal you want to zero beat. Tune the VFO and when the beat note goes to zero, you will be zero beat.

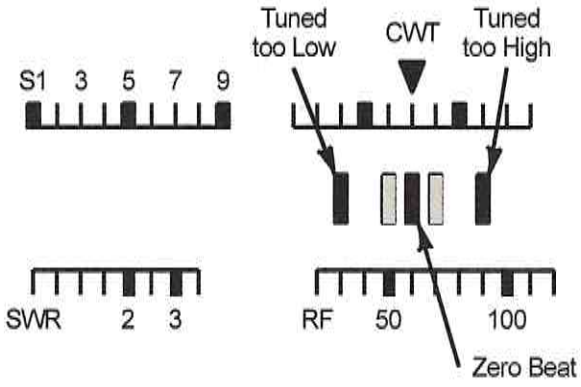

Figure 4-6. CWT display.

Exercise – Manual Zero Beat
Tune in a strong CW signal or a carrier with ***CWT*** turned ***OFF*** and tune the VFO so that the received signal is as close to your sidetone as you can. Now tap the KYR-SPT/MIC ⌀ knob and listen for the beat note. Fine tune the VFO so that your VFO zero beats the received signal. Are you able to hear the beat note go to zero as you get close to the zero beat frequency? (WWV on 10.000 MHz is a good choice to try this.)

Exercise – Auto Spot
Tune in a strong CW signal or a carrier with ***CWT*** turned ***On*** and tune the VFO so that the received signal bar is close to the CWT indicator. Now tap the KYR-SPT/MIC ⌀ knob. Your VFO should automatically adjust frequency to put you on zero beat.

Exercise
Here is how you can train your ear to be better at zero beating. First tune in a strong CW station and manually try to get as close to your zero beat frequency as you can – without using the spot tuning aids. Note the VFO frequency, then turn ***CWT On*** and tap the KYR-SPT/MIC ⌀ knob. If your VFO frequency doesn't change very much, you are doing a good job.

4.8 Computer Operated CW

4.8.1 Keying

The KX2 does not have level conversion circuits that would allow you to use the RTS and DTR RS232 serial I/O signals for CW keying and PTT as the K3 does.

The KX2 accepts only a switch-to-ground signal for CW keying and PTT. Unlike the K3, neither the KX2 nor the KX3 allow direct connection of RS232 RTS and DTR signals. Many contesting and logging software programs use RTS and DTR for keying and PTT. These signals must be converted to switch closures using a circuit like that shown in Figure 4-7 to simulate a hand key.

There are two ways to key the KX2 with computer-generated RS232 keying using a circuit like that in Figure 4-7. The first is to set ***CW KEY1*** to ***HAnd*** and then key either the tip or the ring connection of the KEY 3.5 mm jack. The second method is to set ***CW KEY2*** to ***HAnd*** and then provide a keying input on either the left or right KXPD2 paddle plug as shown in Figure 4-8.[12]

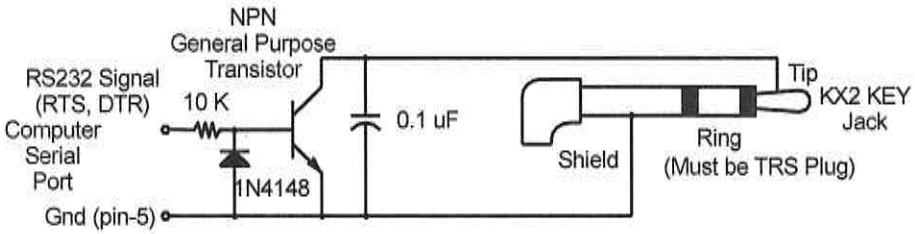

Figure 4-7. RS232 serial port keying circuit

Table 4-5. Typical NPN general purpose transistors used in Figure 4-7.

2N2222, 2N4124, 2N3904, bC337, NTE123, ECG123

[12] A mating plug for the KXPD3 paddle input connector is http://www.digikey.com/product-detail/en/PPPC022LJBN-RC/S5555-ND/776013.

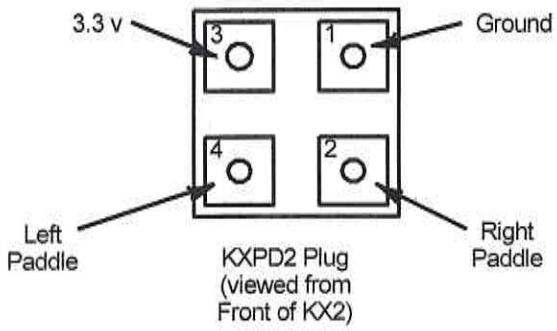

Figure 4-8. KXPD2 paddle plug.

You may use both the internal keyer, using the KXPD2 paddle or another paddle connected to the KXPD2 socket, and a computer keying the KEY line together. This is useful, for example, if you are using a contest logging program to send computer generated CW, but you would like to use the paddle to say hello to a friend. The sending speeds can be different with the internal keyer speed set by the front panel KYR- SPT/MIC ∅ control and the computer speed set by the logging program.

Another way to send CW from a computer is by using a keyer that uses the WinKey[13] or similar compatible chip. Most logging programs aren't very good at sending CW – they use routines that make poor use of computer central processing unit (CPU) processing cycles and can result in choppy CW. The WinKey is a popular solution. The logging program sends text to the WinKey via a serial or USB port and the WinKey converts it to CW, which then goes to the KEY input of the radio. The WinKey also accepts a paddle, so the operator can send CW from both the computer and the paddle. The WinKey has both CW and PTT outputs for two radios, which the logging program can select, so the WinKey is quite popular with contest operators. You can also use your KXPD2 paddle and send CW at a different speed than the WinKey's speed.

Finally, you can send and receive decoded CW with the KX2 Utility program's terminal module. Click the *Terminal* tab and click the CW button. Hold TEXT to turn on text decoding (see *The KX2 CW Decoder*, page 58). Decoded CW will be in the upper window. Type text to be transmitted in the lower window and click *Transmit*.

4.8.2 PTT

The MIC jack Ring 1 can be used for PTT. A logic low (0 volts) activates PTT by grounding Ring 1. The MIC jack accepts a four-pole TRRS plug, which supports microphone with up and down buttons (Figure 5-2, page 62). In this case, though, a three-pole TRS plug may be used, as shown in Figure 4-9.

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[13] http://www.k1el.com/

Figure 4-9 shows how to make a transistor interface to use a computer RS-232 DTR or RTS signal to generate a PTT signal.

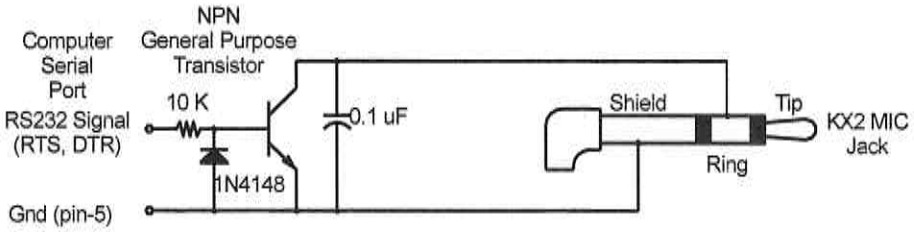

Figure 4-9. RS232 computer PTT.

4.9 CW Message Memories

There are three CW message memories in locations accessed by the switches 1 – 3 shown in Figure 3-9, page 26. Tapping one of these switches after tapping MSG will send the message in that memory. Each memory location holds 250 characters maximum. You may record a message as described below with the internal keyer (an external keyer driving the KEY input cannot be used, nor can a straight key or a bug) or you may use the KX2 Utility program to enter and save messages. If CW text decoding is active, the VFO B display area will show what is being recorded.

Recording a Message with the Internal Keyer

- Select CW by tapping MODE.
- Enter PTT mode by setting ***VOX MD OFF*** so you won't be transmitting while recording.
- Hold REC and then tap the key (1 – 3) for the memory where you want to store your message.
- Send the message to be recorded using either your paddle connected to the KEY jack, or the KXPD2, *and the internal keyer.*

> You cannot use an external keyer or a computer to send a CW message to be recorded.

- While you are recording your message, the remaining character buffer space will be displayed.
- When recording CW messages you may add "**. . _ _**" (IM) at the end of the message to cut the idle time when playing back a message while operating RTTY or PSKX21. See *CW-to-Data*, page 81.
- Tap MSG to stop and then set ***VOX MD*** to ***ON***. (However, it is a good idea to stay in transmit test mode until you have checked your message by playing it back.)

Editing CW Memories with the KX2 Utility Program

You can easily enter and edit the CW memories with the KX2 Utility program. Click on the *Configuration* tab and then *Edit CW Memories*. Click *Save* when through.

Playing Back a Message

- Tap MSG and then tap the message key (1 – 3).
- Sit back, relax, and listen to your message being sent.
- To cancel a message after it starts, either tap the keyer paddle, straight key or the XMIT switch.

Message Erase

Hold REC and then tap the message buffer key (1 – 3) that you want erased and then hold OFS/B/CLR Ø.

Auto-Repeat a Message

Tap MSG and then hold, rather than tap the message buffer key you want to repeat. The message repeat interval may be set to 1 to 255 seconds by the ***MSG RPT*** menu. Tapping the keyer paddle, straight key or the XMIT switch cancels the message.

Table 4-6. Message repeat time.

Menu	Default	Description
MSG RPT	***6***	Set this for the message repeat interval in seconds (***0*** to ***255***). Also used for *The Digital Voice Recorder (DVR)*, page 74.

Chaining Messages

While one message is playing back, tapping another message key chains another message to the one being played. It will be played after the first message has been completely sent.

Beaconing

You can use the Auto-Repeat feature to set up a CW beacon.

4.10 The KX2 CW Decoder

The KX2 can decode received CW (and other digital modes) and display the text in the VFO B display area as a scrolling display and in the KX2 Utility *Terminal* window. It can decode your transmitted CW also. You will get better decoding results if you carefully tune to the zero beat frequency and use a narrow bandpass filter. To enable or disable CW text decoding:

- Set MODE to CW.
- Cancel any alternate VFO B display by tapping DISP. (You should be displaying the VFO B frequency. You cannot display alternate VFO B data while CW text decode is active.)
- Turn CWT on, if it is not on all ready on (***CWT*** menu ON), and carefully tune the station you want to decode to zero beat. (See *Zero Beating the Station*, page 52.)
- With ***CWT On*** you can tap the KYR-SPT/MIC ∅ knob to automatically tune to the zero beat frequency.
- Hold TEXT and tune VFO B to one of these choices:

OFF	CW text decoding is off.
TX ONLY	Decodes only your transmitted CW.
RX THnn	Sets the receive threshold (***nn = 1 – 9***) for copying CW. Higher settings are used for stronger signals and faster CW speeds. With ***CWT*** turned ***On***, adjust the threshold so that the CWT bar flashes in synchronism with the CW signal.

- Hold TEXT to turn on decoding. A small **T** icon is displayed in the lower right corner of the display showing text decode mode is on.
- Fine tune the CW signal until decoding is achieved.
- CW decoding may be improved if you use a narrow filter bandwidth, such as 300 Hz.

4.11 Using the KX2 Utility Program for CW

Connect the computer running the KX2 Utility program as shown in Figure 4-10, and then navigate to the *Terminal* tab, shown in Figure 4-11. From here you can operate CW, RTTY (FSK D) and PSK (PSK D). Set the ***VOX MD*** menu ***ON*** to be able to key the KX2 when you tap the *Transmit* button.

You can define 16 message memories for each of the modes. Note: These are **not** the CW message memories described in *CW Message Memories*, page 56. These are messages stored in the Utility program and may be used for CW, RTTY, or PSK. A "|" character at the end of the message will reduce the "diddle" time when sending a RTTY message.

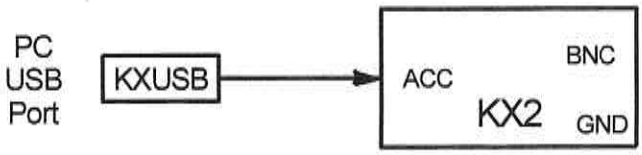

Figure 4-10. KX2 - PC connection.

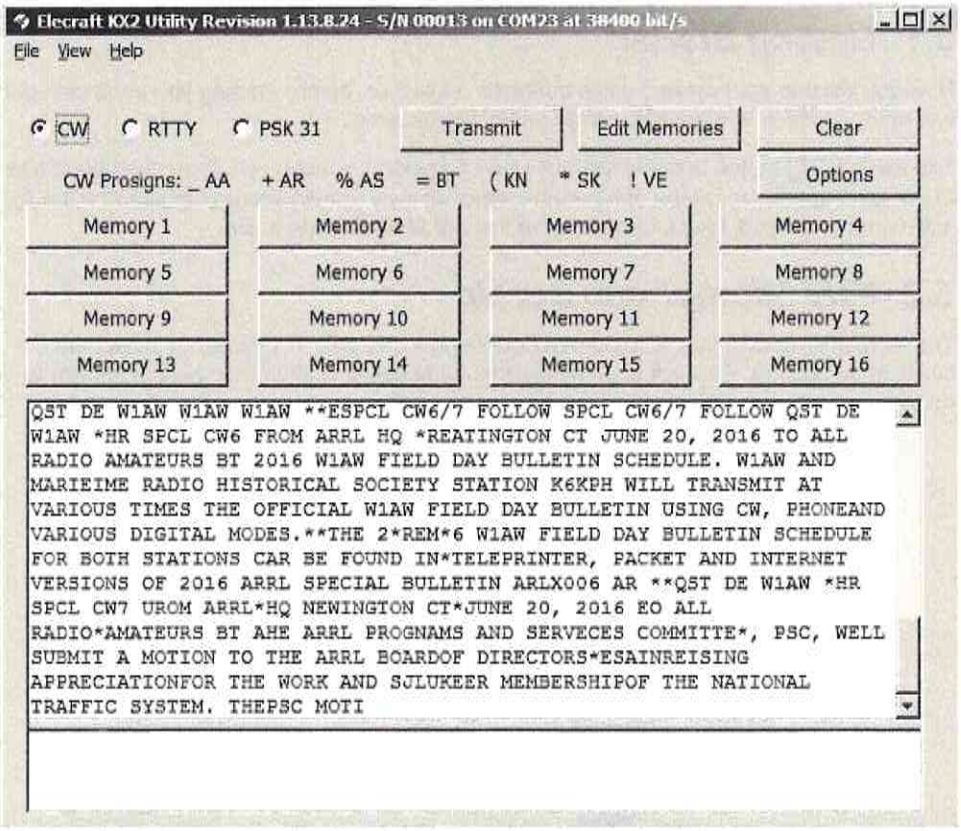

Figure 4-11. KX2 Utility Program CW Terminal Window.

Chapter 5. SSB and AM

> **Note:** You may find that some of the KX2 features and operations described in this chapter do not seem to work or display ***N/A*** when you attempt to make an adjustment. This is because these features have not been implemented in the KX2 firmware as yet. They are expected to be available in the future.

5.1 Getting Started

Now you want to start making voice contacts. However, before starting you must set up a few menu items and make some front panel adjustments.

Tap the MODE button until the USB or LSB or AM icon is displayed. You must be in one of the voice modes for many of the menu items discussed below to be adjusted. If the AM icon is not displayed, check to make sure the ***AM MODE*** menu is ***On***.

5.2 KX2 Microphone Set Up

The MH3 microphone jack is a 3.5 mm, four connection jack.[14] Figure 5-1 shows the corresponding plug. Elecraft strongly recommends using a right angle plug as shown to reduce strain on the KX2's jack.

Figure 5-1. MH3 microphone plug.

[14] This is called a Tip-Ring1-Ring2-Sleeve or TRRS connection.

Table 5-1. MH3 microphone connections.

Connection	Function	Details
Sleeve	Shield	Ground for the microphone audio.
Ring 2	Logic Ground	Ground for logic circuits that detect PTT as well as the UP and DN switches.
Ring 1	PTT/UP/DN	When the PTT switch is closed, Ring 1 is shorted to Ring 2. When UP is closed, a 10 K ohm is connected between Ring 1 and Ring 2; DN connects a 4.7 K ohm resistor. See Figure 5-2.
Tip	Mic Audio	Low impedance, unbalanced input; works with balanced or unbalanced dynamic mics, but only an unbalanced electret condenser mic. +3.3 V supplied when ***MICBIAS*** is ***On***.

Table 5-2 shows configuration menu items for setting up your microphone.

Table 5-2. Microphone menu items.

Menu	Default	Description
MIC BIAS	***On***	This provides +3.3 volts bias on the tip of the microphone jack. Electret microphones need this bias. Set it ***On*** for the Elecraft MH3 microphone. Not applicable for the internal KX2 microphone. For other microphones, see Appendix B, page 191
MIC BTN	***Ptt UP.dn***	If your mic has both a PTT switch and UP/DN buttons, set this to ***Ptt UP.dn***. Ring 1 is used for the push-to-talk circuit as well as Up and Down functions. ***Ptt UP.dn*** enables these functions in the KX2 and is the setting needed for the MH3 microphone. When the MH3 Up button is pressed, a 10 K ohm resistor is connected between Ring 1 and Ring 2. A 4.7 K ohm resistor tells the KX2 that the Down button is pressed. The Up and Down buttons change the KX2's frequency by the tuning rate set for VFO A. See *VFO Tuning Rate*, page 26. You must be in a voice mode (USB/LSB) to change this menu setting. Other microphones can be used. If they have a PTT circuit, set ***MIC BTN*** to ***Ptt***, otherwise use ***OFF***.

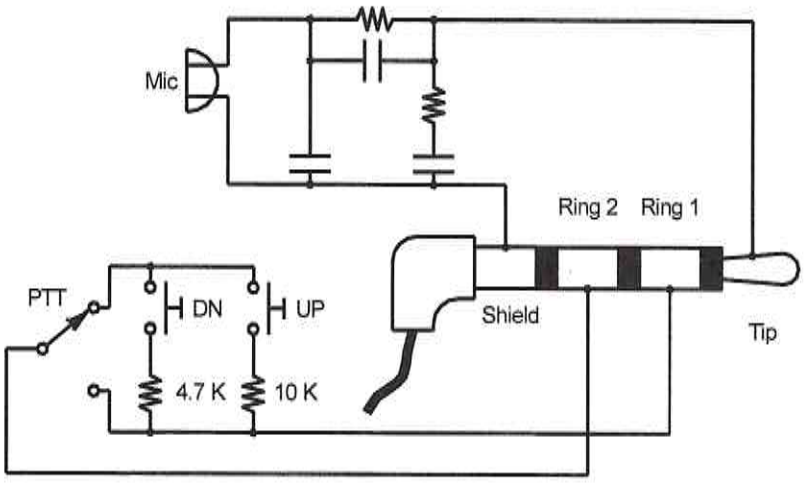

Figure 5-2. MH3 microphone.

What Happens if I use a TRS or TS plug in the TRRS MIC Jack?[15]

It is perfectly safe to use a microphone with a TRS (stereo), or even TS (mono), plug with the KX2's TRRS MIC jack. If your mic has a TRS plug with the mic element on the tip and the PTT switch on the ring, set ***MIC BTN*** to ***Ptt***. For a mic with a TS plug and no PTT, such as a computer microphone, set ***MIC BTN*** to ***OFF***.

Exercise

Configure the menu to use the Elecraft MH3 electret microphone needing bias.

Tap MODE to select USB/LSB.
Hold MENU and tune VFO B to ***MIC BIAS***. Select ***On*** with VFO A.
Set ***MIC BTN*** to ***Ptt UP.dn***.

---

[15] TRRS – four-pole, tip-ring1-ring2-sleeve; TRS – stereo, tip-ring-sleeve; TS – mono, tip-sleeve.

Exercise
Configure the menu to use a Heil HC-4 dynamic microphone not needing bias and which has a monaural tip-sleeve 3.5 mm plug.

Tap MODE to select USB/LSB.
Hold MENU and tune VFO B to ***MIC BIAS***. Select ***OFF*** with VFO A.
Tune VFO B to ***MIC BTN***. Select ***OFF*** with VFO A.

Exercise
I have a PTT switch with my Heil HC-4 dynamic microphone. How would I connect that to the KX2?

The MIC jack can be used as a PTT input. See Figure 5-3, page 55.

Push-to-Talk (PTT) or Voice Operated Transmission (VOX)

You can choose either PTT or VOX to key the KX2 when you transmit. The MH3 microphone has a PTT switch but when VOX MD is On, simply speaking into the mic will transmit.

Many SSB operators like to use a footswitch to activate PTT. Figure 5-4 shows a y-cable adapter that can be used with a microphone and a footswitch.

Using a Boom Mic Headset

Many operators like to use a boom microphone headset like many of the Heil models and the Yamaha CM500. Figure 5-3 shows the connections to be made. The headphone left and right audio are connected to the tip and ring of a 3.5 mm TRS (stereo) plug and a 3.5 mm TRRS plug is used for the microphone audio and PTT. Mic audio is on the tip and the PTT switch can be connected either to Ring 1 and Ring 2 or Ring 1 and Shield. Figure 5-2 shows that a four-connection TRRS jack is used for the KX2 microphone. It is perfectly OK to use a TRS plug so long as you set the ***MIC BTN*** menu to ***Ptt*** or TS plug for mic audio if ***MIC BTN*** is ***Ptt OFF.***

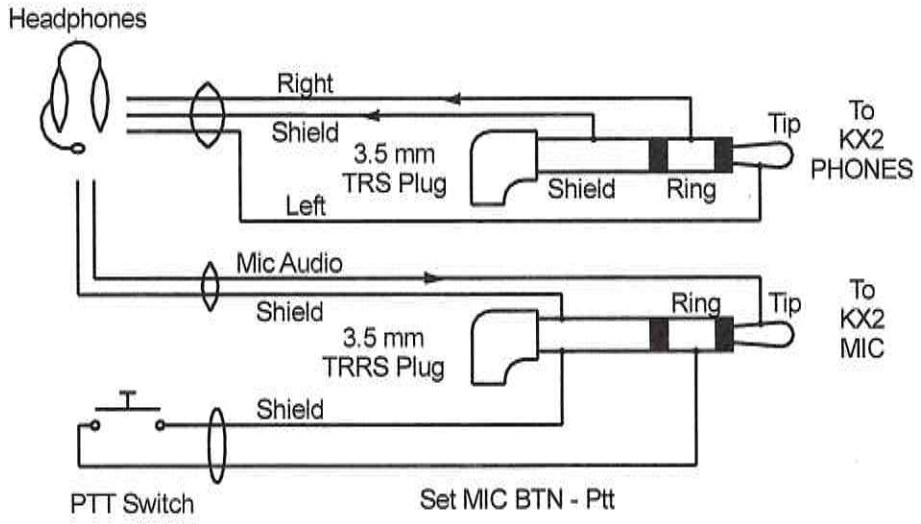

Figure 5-3. Headphone connections.

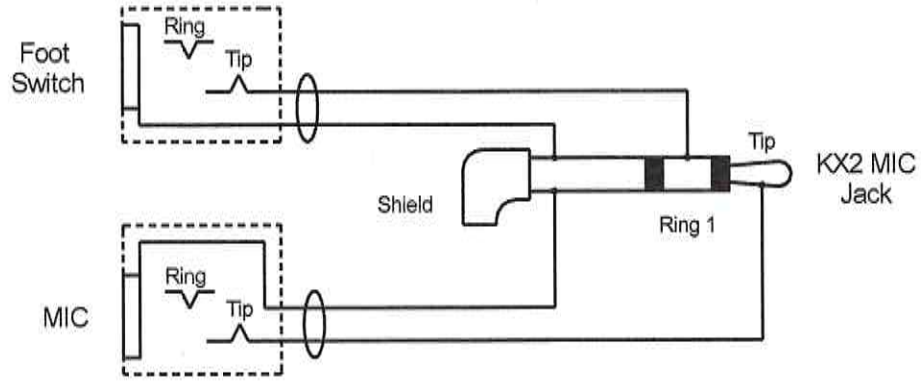

Figure 5-4. Microphone and PTT Y-cable adapter.

Voice Monitoring

You will want to monitor the sound of your KX2 while setting your microphone gain, compression, and other SSB settings. There are two ways to do this:[16]

Use the KX2 internal monitor: This works best if you use headphones to listen to the audio while you are talking.

- Hold KYR-SPT/MIC/PWR ∅ and then rotate it to set the power to ***0.0 W*** or use a dummy load to avoid transmitting on the air while you are setting up the audio levels.[17]
- Tap MODE to select LSB or USB.
- Press your microphone's PTT or tap XMIT.
- Tap the AF/MON ∅ knob and then adjust the monitor level to a comfortable level while speaking in your normal voice. Tap any key to exit the monitor level adjust mode.
- Release your PTT or tap XMIT to stop transmitting.
- Reset the power output to your desired operating level.
- *The Digital Voice Recorder (DVR)*, page 73 shows how to record and playback a message. The microphone gain and compression used when recording is the same use for transmitting.
- Record a test transmission using message memory #1.
- If you wish, make changes to the gain and compression and record again using memory #2.
- You can then easily compare the two to see which you like best.

5.2.1 Microphone Gain and Compression

You can set up your microphone gain and compression level settings after setting your voice monitoring level. Once you have done this, you should not have to change them unless you change microphones. There are two bar graph displays. Normally, you will show the ***SWR/RF*** display as shown in Figure 5-5. When setting the microphone gain and compression, you will use ***CMP/ALC*** display in Figure 5-6.

Microphone gain and compression levels are adjusted with the KYR-SPT/MIC ∅ knob.

---

[16] Three if you use another receiver. Turn down your output power and transmit into a dummy load. Be sure that you do not overload your monitoring receiver. If your second receiver is a K3 or KX3, turn off the receiver equalization so it doesn't influence what you hear.

[17] You don't actually have to set the power to zero but as a considerate operator you should.

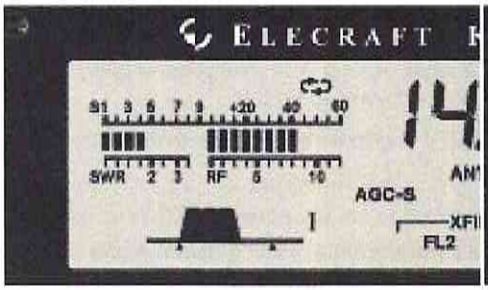

Figure 5-5. SWR/RF display.

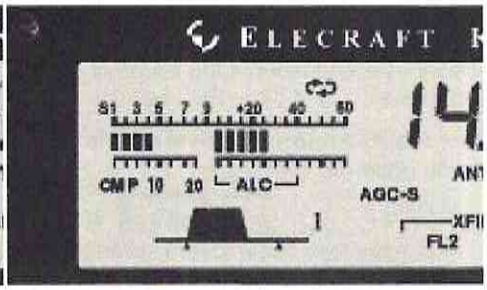

Figure 5-6. CMP/ALC display.

The ***CMP/ALC*** bar graph display and the action of the KYR-SPT/MIC ∅ knob depend on the setting of the ***CW WGHT*** CW-in-SSB menu (tap 1) as shown in Table 5-3. Basically, when CW-in-SSB is enabled, tapping KYR-SPT/MIC ∅ toggles between keyer speed and mic gain, rather than toggling between the two transmit metering scales (CMP/ALC and SWR/RF). The CMP/ALC scale is shown temporarily whenever the mic gain is adjusted.

Table 5-3. Switching bar graph display.

SSB Mode	To switch bar graph to *CMP/ALC*	To switch bar graph to *SWR/RF*
CW not allowed ***SSB -CW***	Tap KYR-SPT/MIC ∅.	Tap KYR-SPT/MIC ∅.
	Rotate KYR-SPT/MIC ∅. Bar graph changes back after a few seconds delay.	Bar graph changes back after a few seconds delay.
CW allowed ***SSB +CW***	Tap KYR-SPT/MIC ∅ to display ***MIC*** and then rotate KYR-SPT/MIC ∅. Bar graph changes back after a few seconds delay.	Bar graph changes back after a few seconds delay.

Setting Microphone Gain and Compression

- Set up voice monitoring as above and use your headphones to listen.
- Enter the ***CW WGHT*** menu and tap [1] so that ***SSB –CW*** is displayed.
- Hold [KYR-SPT/MIC/PWR ∅] and set the power to ***0.0 W,*** or use a dummy load to avoid transmitting on the air while you are setting up the audio levels.
- Set the ***TX CMP*** menu to ***0.0***. You will set compression to a proper level later.
- Tap [KYR-SPT/MIC ∅] to display the ***CMP/ALC*** display shown in Figure 5-6.
- While speaking into your microphone in a normal voice (use the mic PTT or tap [XMIT]), adjust [KYR-SPT/MIC ∅] for a peak ALC reading of about 5 bars, with the 6th just flickering. (If you are in SSB +CW mode, you may have to tap [KYR-SPT/MIC ∅] to display ***MIC***.) While you are adjusting the mic gain, the SWR/RF display changes to the compression and ALC display shown in Figure 5-7. The ALC meter is actually acting like a VU (volume unit) meter. The onset of ALC is about the 5th bar so you should stay below that level. DO NOT turn up the microphone gain any higher – higher settings may cause splatter!

  Note: The MH3 microphone may require the mic gain to be 20 – 25 and the internal mic 30 – 40. Low sensitivity microphone elements, such as the Heil HC-6, may require a gain of 50 or more.

- To adjust the compression[18], set the ***TX CMP*** menu to 10 – 20. VFO B area shows the compression level. About 10 dB or less is a good place to start. Exit the ***TX CMP*** menu, key your radio again and check the compression level by observing the CMP/ALC meter. You will want to do some on-the-air tests to confirm that your signal sounds OK. See Figure 5-7.
- Enter the ***CW WGHT*** menu and tap [1] so that ***SSB +CW*** is displayed if you wish to use this feature. (See *CW in SSB Mode*, page 73.)
- If you turned the power to zero, restore it to the power you would like to output.
- Tap [KYR-SPT/MIC ∅] to restore the ***SWR/RF*** display shown in Figure 5-5.
- As a final check, use the KX2's DVR to record and then playback a message to see how you will sound.

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[18] The use of speech compression is optional but many people do use it. It tends to give your signal more "punch" but does reduce the natural sound of your voice. In general, speech compression should be turned off when transmitting in AM mode.

Lyle Johnson, Elecraft's DSP guru offers the following advice for the KX3, which is also valuable for the KX2:

"The KX3 and the MH3 system are designed for close talking. I hold the MH3 near the right edge of my mouth, speaking across it rather than directly into it. ... This amounts to a little less than 1 cm (3/8 of an inch) of distance from corner of mouth to corner of mic. I then speak in a slightly louder than normal voice. With this configuration, medium settings of mic gain are enough for proper ALC indication (5 bars with 6th bar flickering). Once ALC is correct, the CMP settings work as expected.

Why is the system designed this way? Portable operation often has fairly high ambient noise. Close talking the microphone reduces the amplitude of that noise. And since many inexperienced operators tend to set "all knobs to the right", limiting the maximum gain encourages close talking the microphone, resulting in good signal-to-noise on the transmit audio. Finally, if ambient noise is an issue, careful use of the Tx Gate can help mask low-level noise. For example, I normally have ***TX GATE*** set to ***On*** and level of ***02***. This gets rid of mild background noise when I pause in speech while still allowing good VOX action. Dial in a little CMP and I'm good to go!"

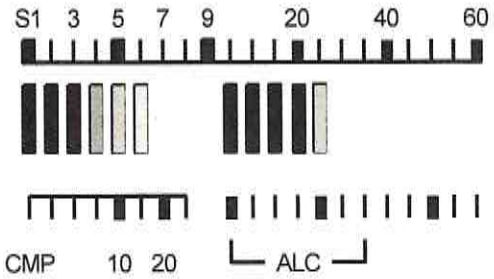


Figure 5-7. Compression and ALC meter display.

Transmit Audio Equalization

The KX2 provides eight bands of transmit (and receive, see *Receiver Audio Equalizing*, page 115) audio equalization. You can use this feature to compensate for variations in microphones and your voice. For example, if the microphone you are using has too much bass response for your liking, you can compensate for that by reducing the gain in the lower frequency bands.

- Set up voice monitoring as above and use your headphones to listen to your signal.
- Hold KYR-SPT/MIC/PWR Ø and set the power to ***0.0 W*** or use a dummy load to avoid transmitting on the air while you are setting up the audio levels.
- Access the ***TX EQ*** menu. The VFO A display area will show eight bands, whose center frequencies are shown in Figure 5-8. Tapping keys 1 – 8 and tuning VFO A adjusts the microphone gain to a maximum of plus or minus 16 dB for any band. As you rotate VFO A, the gain or attenuation in dB is shown in the VFO B area.
- You can hold OFS/B/CLR Ø to set all bands to 0 dB.
- As a final check, use the KX2's DVR to record and then playback a message to see how you will sound. Note that as shown in Figure 5-9, page 75, the transmit equalization is applied after the DVR recorded message on playback.

Thanks to K9YC for the following comments on equalizing your transmitter:

- Typical settings for SSB with most mics would have bands 1 and 2 set to -16 dB, band 3 to some moderate level of gain reduction (-6 to-10 dB), and the remaining bands set flat (0 dB). Mics that are excessively bright (most Heils, for example), may also need some reduction for bands 7 and/or 8.
- Professional mics will need full gain reduction (-16dB) on bands 1, 2, and 3, 6 dB reduction on band 4, 6 dB increase on band 7, and 10 dB increase on band 8.
- In general, increased gain should be avoided because it makes it more likely that the audio part of the DSP chain will run out of headroom and hit a digital clip.
- The only use for which bands 1 and 2 should not have deep reductions is the ESSB mode. Any power transmitted in these bands is wasted power from a communications point of view – virtually all speech intelligibility is carried between 400 Hz and 5 kHz, and that low frequency energy can use considerable transmit power that is far better used to carry mid-range audio where the intelligibility is.
- Where possible, avoid settings where all controls are run at their extremes. This includes bands of equalization settings added to extreme settings of compression. Taken together, these may produce poor audio and comprehension reports from the receiving station.

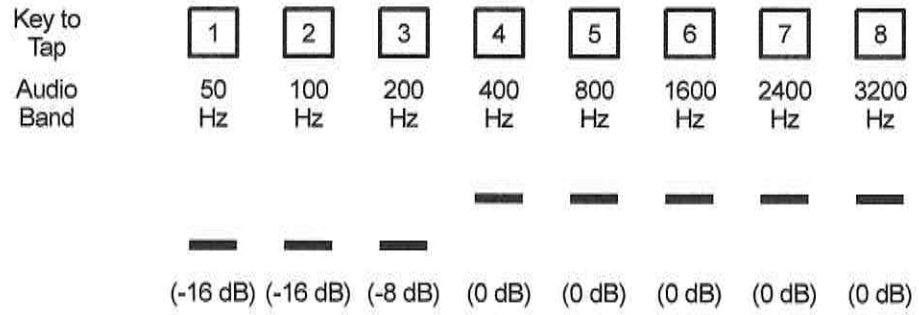


Figure 5-8. Transmit audio equalization.

A Neat Trick for Microphone Gain, Compression and Equalization Adjustment

The KX2's DVR is a great tool for adjusting the microphone gain, compression and transmitter equalization. Record your voice as shown in *The Digital Voice Recorder (DVR)*, page 74, and then play it back and you will hear it like other stations. Be sure to turn the KYR-SPT/MIC/PWR ∅ to zero or connect a dummy load so your testing will not be going out over the air. You can use two of the DVR buffers to be easily able to compare different settings.

Transmit Noise Gate

If your operating location is noisy, say from fans or other operating equipment, or while operating mobile, you may set the transmit noise gate to keep from transmitting audio below the noise gate level. The ***TX GATE*** menu item does this. This is an advanced feature and should be changed carefully. You should use the voice monitor with headphones when adjusting the noise gate. Set the threshold high enough to stop the noise but not too high to cause your voice modulation to drop out. Remember to set your output power to zero or use a dummy load.

Table 5-4. Transmit noise gate configuration menu.

Menu	Default	Description
TX GATE	*OFF 0*	Tap 1 to turn the noise gate on and off. Use VFO A to set the threshold so that the noise, such as fan noise from an amplifier, is not transmitted but your normal voice is. Since there's no visual indication that transmit audio is below the threshold, you should adjust it using the transmit voice monitor (MON), ideally while using headphones. Set the threshold high enough to cut off transmit audio due to local noise, but not so high that it causes your voice to drop out too frequently.

5.2.2 Controls for SSB

Table 5-5. Controls for SSB.

SSB Controls and Menus	Default	Description
VOX MD	***On*** (CW) ***OFF*** (SSB, Data)	If ***VOX MD*** is ***OFF***, transmit must be started by tapping XMIT (otherwise known as PTT, or push-to-talk operation). In CW mode, setting ***VOX MD*** to ***On*** allows "hit-the-key" transmit. In SSB mode, ***VOX MD On*** allows transmit to start when you start speaking. In audio data modes, VOX starts transmit when a computer connected to the mic jack outputs an audio signal. In Data modes VOX is always ***On*** in PSK-D and FSK-D modes; PTT is not available. VOX may be on or off for DATA A and AFSK A. VOX cannot be used with the built-in microphone. If ***CW WGT*** 4 is set to ***AUTOOFF*** you will have to activate VOX each time you power the radio up. This is useful to avoid having your computer key the rig through a serial interface when the computer is turned on after the KX2.
VOX GN	***030***	Adjusts the sensitivity of the VOX to match your microphone and voice. While speaking into your microphone in a normal voice, increase the ***VOX GN*** until the KX2 transmits reliably.
VOX DLY	***0.00*** (CW) ***0.50*** (SSB, Data)	If ***VOX MD*** is set to ***On*** in the current mode, this menu sets the VOX delay time (recovery time from transmit to receive) in seconds. In CW mode, full break-in is achieved by setting the ***VOX DLY*** menu to ***0.0***, which turns on the QSK icon (See the ***CW WGHT*** menu for additional QSK settings.) Anything larger is semi-break-in, which sets the time for the KX2 to return to receive after transmitting. If you are using a non-QSK outboard linear amplifier, this time should be long enough that the amplifier does not try to switch between CW characters. Independent VOX delay times are saved in CW, SSB and audio data modes.
VOX INH	***000***	Adjusts immunity of the VOX circuit to avoid false triggering because of audio from the speaker or headphones. If you find that audio from the speaker or from your headphones are triggering the VOX, increase ***VOX INH*** to reduce the problem.

Monitor Volume	Holding (and turning) the AF/MON ∅ knob sets the volume of the monitor you use to monitor your SSB transmissions. After setting up your mic gain and compression as shown above, you may wish to turn this level down so you do not hear your voice when transmitting.
VOX Transmit	Set the ***VOX MD*** menu ***On***. The VOX icon is displayed on the front panel. If the icon is not displayed, you must use the PTT input in the MIC jack or tap the XMIT switch to transmit. ***VOX MD*** toggles between ***PTT*** and ***VOX*** operation.
Alternate Sidebands	The ***ALT MD*** menu switches the SSB mode between upper (USB) and lower (LSB). USB is normal for 20 meters and above and LSB is normal for bands below 20 meters. The sideband you select for a band is saved for that band. When ***ALT MD*** is assigned to the programmable function switch ***PFn***, holding the switch toggles between ***nor*** and ***ALT*** on successive presses without remaining in the menu.

5.2.3 Setting up the VOX

VOX (voice operated transmission) is a convenient way to change to transmit when you speak into the microphone without activating push-to-talk.

- Set the ***VOX MD*** menu ***On***.
- Hold and turn KYR-SPT/MIC/PWR ∅ and set the power to ***0.0 W*** or use a dummy load to avoid transmitting on the air while you are setting up the VOX controls.
- Use headphones and adjust the monitor volume with the AF/MON ∅ knob to be able to hear yourself speak.
- Hold MENU and rotate OFS/B ∅ to the ***VOX GN*** menu.
- While speaking in a normal voice, increase the VOX gain until the KX2 transmits reliably. It should be set a few increments above where it first activates.
- Enter the ***VOX DLY*** menu and turn the KYR-SPT/MIC ∅ knob to set the time for the KX2 to return to receive after transmitting. You would like this to be long enough that you do not drop out of transmit between words.
- Keep the headphones on if you normally use them, or unplug them if you normally listen on a speaker.
- Now set up the VOX inhibit, or anti-VOX. Tune in a station with your normal audio gain level. If the speaker audio causes the VOX to trigger, access the ***VOX INH*** menu and increase it to limit the false triggering.
- If you operate in a noisy environment you may have to adjust Transmit Noise Gate (***TX GATE***) as described above.

Exercise
Set up PFn to toggle ***VOX MD On*** and ***OFF***.

Access the ***VOX MD*** menu. Hold PFn until ***PF1 SET*** is displayed. Exit the ***VOX MD*** menu.

5.2.4 CW in SSB Mode

This feature allows you to send CW while in SSB mode, which can be useful when your SSB signal cannot be copied due to poor conditions. The other station will hear a tone at your CW pitch. To enable CW-in-SSB locate the ***CW WGHT*** menu, then tap the 1 key to alternate between ***SSW +CW*** (enabled) and ***SSB –CW*** (disabled). When CW-in-SSB is enabled, tapping the KYR-SPT/MIC ∅ knob toggles between keyer speed and mic gain rather than between the two transmit metering scales (***CMP/ALC*** and ***SWR/RF***). The ***CMP/ALC*** scale is still shown temporarily whenever mic gain is adjusted.

Exercise:
You are operating at the scene of a disaster using a low antenna and low power while passing health-and-welfare traffic. You can hear the SSB station on the other end but it can't hear you very well. You would like to be able to listen on SSB and send on CW. What configuration menu item do you use to activate this cross-mode transmission?

Go to the ***CW WGHT*** menu and tap the 1 key to set ***SSB +CW***.

Cross Mode CW/SSB Split Operating

You can also receive an SSB signal and transmit CW by setting up VFO A for SSB and VFO B for CW and then entering split.

- Tune to your SSB receive frequency with VFO A.
- Tap MODE to select CW.
- Hold A>B to transfer the frequency, mode and filter setting to VFO B.
- Hold SPLIT to enter split mode. The TX icon will point to VFO B and the SPLT icon will turn on.
- Tap MODE to select USB or LSB for VFO A.

When you transmit the SSB station will hear your CW at your sidetone pitch.

Cross-mode SSB/CW operation can only be done on the same band. You cannot operate cross-band, cross-mode.

5.3 The Digital Voice Recorder (DVR)

The DVR uses spare room in the KX2's EEPROM program memory. You do not have to purchase an additional option like you do for the K3. There is a total of 30 seconds recording space that can be partitioned into two 15-second recordings.[19] Unlike the K3, which allows received audio to be recorded also, the KX2's DVR can record only voice input from the microphone.

Figure 5-9 shows the audio processing used in the DVR. In Figure 5-9(b) we see that any microphone gain and compression are applied to the recorded message. Any transmit equalization is applied when the message is transmitted. See Figure 5-9(c).

Recording a Message

- Tap [MODE] to select a voice mode.
- Set the voice monitor level (hold and turn [AF/MON ⊘]) to be able to hear your voice while recording.
- Set the ALC and compression for normal voice operation. (See *Microphone Gain and Compression*, page 65.)
- Hold [REC] and tap [1] or [2] on the numeric keyboard to select one of the two memory message buffers.
- The current message will be erased.
- After tapping [XMIT] speak your message. You do not have to press the PTT. The amount of record time left is displayed.
- Tap [XMIT] to end.
- Transmitting is disabled while recording a message.

Playback a Message

- Tap [MSG] followed by [1] or [2] to select the message buffer you want to playback.

Tapping [XMIT] or the paddle or hand key during playback will terminate the message.

Auto-Repeating a Message

- Set the repeat interval with the ***MSG RPT*** menu.
- Tap [MSG] and then hold the [1] or [2] key to select the message buffer you want to playback and repeat.

---

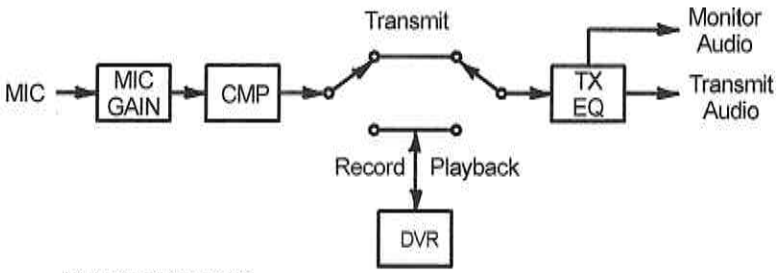
[19] A future firmware revision may allow other recording options.

Beaconing

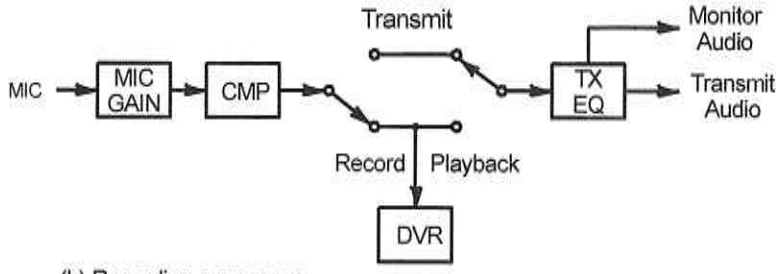
You can use the Auto-Repeat feature to set up a voice beacon.

Chaining

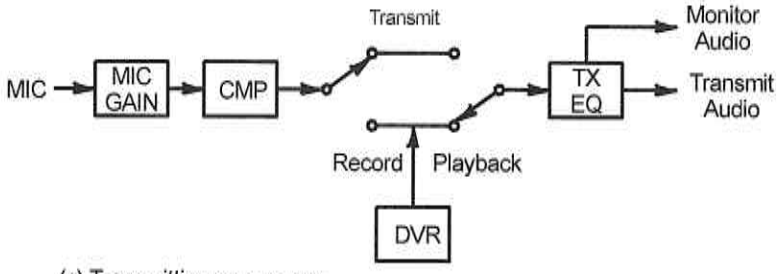
Chaining DVR messages cannot be done like they can with stored CW messages.



(a) Normal transmit.



(b) Recording a message.



(c) Transmitting a message.

Figure 5-9. Digital voice recorder; (a) Normal transmit; (b) Recording a message; (c) Transmitting a message.

5.4 AM Mode

AM reception on the KX3 uses traditional envelope detection. You can also listen to AM stations, such as WWV, in sideband mode. A menu item, ***AM MODE,*** can be set to ***OFF*** if you do not wish to use or allow this mode. This removes the AM selection from the ***MODE*** menu.

The KX2's receiver sensitivity falls off pretty quickly below 2 MHz due to high-pass filtering in the T/R switch, so AM will be of use mostly in the SWL bands above 2 MHz. NR (noise reduction) and NB (noise blanking) work in AM mode. On very strong signals you may have better results with the preamp turned off. On a really noisy band, a combination of NR and NB is best. Receive bandwidth can be set as high as 5 kHz in AM mode. This is the demodulated voice bandwidth, not the IF bandwidth (i.e., *not* the full signal, with both sidebands).

When transmitting, the RF bar graph will show the full power output in AM mode, including the carrier and both sidebands. For example, if you set PWR to 10 W, on voice peaks in AM mode you'll see about 10 bars, assuming MIC gain is set adequately. However, AM is far less efficient than SSB.

Chapter 6. Digital Modes

> **Note:** You may find that some of the KX2 features and operations described in this chapter do not seem to work or display ***N/A*** when you attempt to make an adjustment. This is because these features have not been implemented in the KX2 firmware as yet. They are expected to be available in the future.

The KX2 can send and receive radio teletype (RTTY) and PSK. You can get started using RTTY and PSK without a computer by using the internal keyer in data modes. See *CW-to-Data*, page 81. An even easier way to try out digital modes and CW is to use the KX2 Utility program's *Terminal* mode. Also, with a computer and sound card, the KX2 can send and receive other digital modes, such as AMTOR, PacTOR and WSJT, for which software to generate and detect signals is available.

> **Elecraft recommends using 5 watts or less when running any of these modes to maintain a safe operating temperature. The KX2 will automatically reduce power, if the temperature exceeds a safe value.**

6.1 Data Modes

The KX2's digital data mode is selected by tapping DATA until the DATA icon appears and the current data mode is shown in the VFO B display area. Then, you can choose one of the four data modes by tuning the OFS/B ⊘ knob.

In the following sections, a "D" data mode (***FSK D***, ***PSK D***) means that *direct* modulation is used to generate the digital transmitted data. With direct modulation, your KX2 generates the digital signals – no computer sound card is needed and no audio levels need to be adjusted. The internal keyer, or an ASCII data stream input on the RS232 serial port (ACC)[20], generates FSK or PSK directly. (Unlike the K3, there is no direct FSK keying input.)

In "A" modes (***DATA A***, ***AFSK A***), your computer's sound card generates the signal as an audio tone, which is then sent to the KX2 and transmitted as a SSB signal. Careful setting of audio levels are needed for these modes.

> **Note**: The data mode chosen is saved on a "per-band" basis. That means the radio could be in ***AFSK A*** mode on one band and ***FSK D*** on another. So, when you have chosen a data mode, say for a contest, it is best to step through all the bands, setting each band's data mode the same.

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[20] From a program running on a PC such as the KX2 Utility.

Note: When the KX2 transmits in the ***DATA A*** and ***AFSK A*** modes, all transmitter compression and transmitter and receiver equalization are turned off automatically but will be restored when leaving the data mode. If left on, these features could distort data signals.

DATA A

DATA A can be used for all audio frequency-shift or phase-shift transmission modes, including AFSK and PSK. The selection of VFO A and USB are normal for ***DATA A***. Compression is automatically set to zero and transmit and receive equalization are turned off to reduce transmitted signal distortion. The built-in text decoder is not used. VOX is set by the ***VOX MD*** menu.

AFSK A

AFSK A is also an audio frequency-shift transmission mode, but is optimized for RTTY. VFO A displays the transmit suppressed-carrier frequency and LSB is normal. The built-in text decoder can be used (see *Data Text Decode*, page 80) and a dual-passband RTTY filter is automatically selected (See Figure 6-2). If a computer is used to generate and decode ***AFSK A***, two stereo cables are needed between the KX2 and the computer. See Figure 6-4, page 86. VOX is set by the ***VOX MD*** menu.

FSK D

FSK D refers to the way RTTY signals are transmitted. Reception is the same as AFSK but direct modulation is used for transmission, not computer-generated audio tones like AFSK. The internal keyer (see *CW-to-Data*, page 81), or an ASCII data stream input on the RS232 serial port generate direct FSK. The built-in text decoder and the dual-passband RTTY filter works in this mode. Decoded received data are output to the RS232 serial port and also to the VFO B display area when text decode is enabled. The RTTY mark tone is 915 Hz and the shift is 170 Hz.[21] VOX mode is automatically chosen; PTT cannot be used.

[21] A future firmware upgrade may offer other RTTY mark/tone choices.

PSK D

PSK D is a direct modulation mode for PSK-31 and PSK-63. It decodes and displays received PSK signals on the built-in text decoder and transfers text to an external computer (if used) on the RS232 serial port. You can transmit using the internal keyer or an ASCII data stream input on the RS232 serial port. You can use auto-SPOT when CWT is enabled to help you with the critical tuning needed for PSK signals. To use an external program that generates and decodes PSK signals, you must set the KX2's mode to ***DATA A*** and not ***PSK D***. VOX mode is automatically chosen; PTT cannot be used.

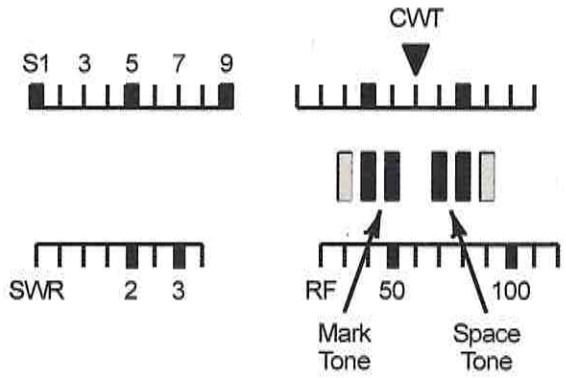

Figure 6-1. CWT display for RTTY.

Table 6-1. Data mode sidebands (use the *ALT MD* menu for Reverse).

Mode	Normal	Reverse
DATA A	USB	LSB
PSK D	USB	LSB
AFSK A	LSB	USB
FSK D	LSB	USB

RTTY Dual-Tone Filter

When the AFSK or FSK D modes are selected, the dual-tone RTTY filter shown in Figure 6-2 is automatically chosen by the DSP. The bandwidth of each passband can be

adjusted from 150 Hz to 500 Hz by tapping the FIL switch and turning the AF/MON ∅ knob. This filter is not activated for DATA A and PSK D modes.

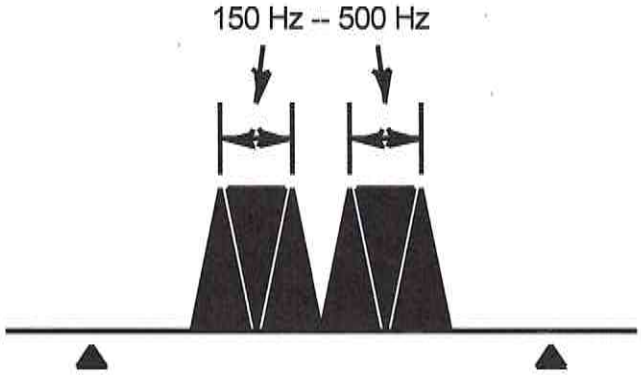

Figure 6-2. RTTY dual-tone filter.

6.2 Data Text Decode

Your KX2 can decode RTTY and PSK signals without an external computer. The decoded text is displayed in the VFO B display area. In addition, as shown in the next section, you may send either of these modes using the KX2's internal keyer or the KX2 Utility program.

- Cancel any alternate VFO B display by tapping DISP. You should see the VFO B frequency displayed. You cannot display alternate VFO B data (*Alternate VFO B Displays*, page 30) while data text decode is active.
- Tap DATA until the current data mode is shown and then rotate OFS/B ∅ to one of these choices:

AFSK	Decodes RTTY signals.
FSK D	
PSK D	Decodes PSK signals.
DATA A	The text decoder is not active for this mode.
The text decoder will decode RTTY signals when AFSK mode is selected but the KX2 will need an external computer and sound card to send RTTY.	

- Tap DATA to exit the data mode select display.
- Hold TEXT to turn on decoding. A small T icon is displayed below **DATA** showing text decode mode is on.

- The CWT display is turned on automatically when you enter the AFSK A, FSK D and PSK D modes. As shown in Figure 6-1, page 79, the mark tone appears to the left and the space tone to the right of the CWT center marker. Adjust your tuning to center the mark and space tone display as shown.
- In PSK D mode the automatic spotting feature (*Auto Spot*, page 52) is activated. Tap KYR-SPT/MIC ∅ to activate the automatic zero beat tuning
- Fine tune the RTTY or PSK signal until decoding is achieved.

6.3 CW-to-Data

You don't need a computer to send FSK D RTTY or PSK D PSK; this can be done by sending CW with the KX2's internal keyer. Here's how:

- Set up for text decode as shown in Section 6.2. Select either ***FSK D*** (for RTTY) or ***PSK D*** (for PSK) mode.
- Use the KXPD2 paddle or plug a paddle into the KEY jack on the left side panel.
- VOX mode ***On*** is automatically selected.
- Any CW you send will be translated to a FSK or PSK transmission and displayed in the VFO B display area. When you are first getting the hang of using this mode it is best to transmit into a dummy load or set the output power to zero.
- When you stop sending, the transmitter will continue sending the idle tones for about four seconds. To extend the timeout, send BT ("_ . . . _") which is *not* sent as data.
- To cut the idle transmit period, send ". . _ _" (**IM**mediately exit). This character is not sent as data.
- When recording CW messages you may add ". . _ _" at the end of the message to cut the idle time when the message is playing back.

6.4 Using the KX2 Utility Program for Digital Modes

Connect the computer as shown in Figure 4-10, page 59, and then start the KX2 Utility program. Navigate to the *Terminal* tab, shown in Figure 6-3. From here you can operate CW, RTTY (FSK D) and PSK (PSK D). You can define 16 memories for each of the modes by clicking *Edit Memories*. A "|" character at the end of the message will reduce the "diddle" time (the idle time at the end of the message) when sending a RTTY message (but not PSK D).

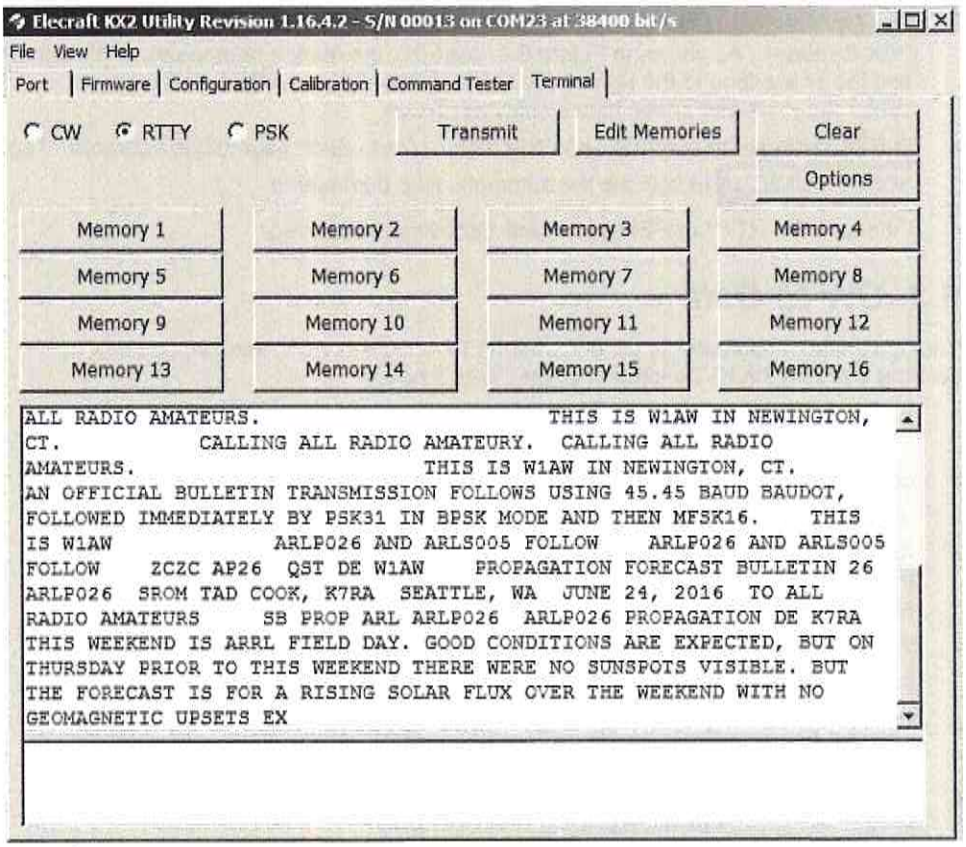

Figure 6-3. KX2 utility program RTTY terminal window.

FSK D and PSK D

- Cancel any alternate VFO B display by tapping DISP. You will see the VFO frequency displayed.
- Tap DATA until the current data mode is shown in VFO B and then rotate OFS/B to ***FSK D*** or ***PSK D***.
- The data rate for ***FSK D*** is set at ***45 bPS***. For ***PSK D***, rotate VFO A to select ***31*** or ***63 bPS***.
- Tap DATA to exit the data mode select display.
- Hold TEXT to turn on decoding. A small T icon is displayed below DATA, showing that text decode mode is on. Decoding toggles ***On*** and ***OFF*** each time you hold TEXT.

For *FSK D* RTTY:

- The CWT tuning aid will be turned on when you activate AFSK, FSK D, or PSK D. As shown in Figure 6-1, the mark tone appears to the left and the space tone to the right of the CWT center marker. Adjust your tuning to center the mark and space tone display as shown.
- Click the RTTY button in the *Terminal* window.
- Tune in a strong RTTY signal that you can decode. (See Table 6-5, page 91.)
- When signals are being decoded they will appear in both the KX2's data display area and in the KX2 Utility display.

For *PSK D*:

- Tune the KX2 to an area of the band where PSK signals are found (see Table 6-6, page 94). You will find that setting the VFO tuning to its 1 Hz step-size (tap RATE) and setting a narrow filter will help you to find the right spot to decode the RTTY or PSK signals.
- Click the PSK button in the *Terminal* window. PSK31 or PSK63 is chosen when you select the ***PSK D*** mode.
- Carefully tune VFO A until decoded text is displayed.
- Tap KYR-SPT/MIC ∅ to activate the automatic zero beat tuning.
- When signals are being decoded, they will appear in both the KX2's data display area and in the KX2 Utility display.

Transmitting FSK D or PSK D:

- VOX mode ***On*** is automatically selected.
- Click on a message memory button and then click on *Transmit*. The message will be transmitted and the KX2 returned to receive at the end.

  or
- Click in the bottom panel, type your message, and then click on *Transmit*.

6.5 Data Mode Computer Connections and Set Up

In addition to using the KX2 Utility for ***FSK D*** and ***PSK D***, there are two other ways to connect your KX2 to a computer for the ***AFSK A*** and ***DATA A*** digital modes.

The first is to use the internal sound card in your PC or laptop. This approach has the advantage of using simple stereo cables but does not provide signal isolation unless you use external isolation transformers. A way to connect these is shown in Figure 6-6, page 88.

A second way is to use an external interface, such as the various models of Rigblaster, SignaLink, RigExpert, etc. These can provide isolation for noise suppression (see *Noise Reduction*, page 87). Some offer an external sound card and USB or serial links to the PC. These interfaces can free up your PC's internal sound card and may also provide a PTT signal to key the KX2. However, they do add extra cost and set-up complexity.

6.5.1 Data Mode Signal Levels

It is very important to match signal levels between the KX2 and your computer when you use your computer to operate the digital modes. Most desktop computers have Line In and Line Out jacks, plus Mic In and Headphones Out. They may also have a Speaker output. Laptop computers often have only Mic In and Headphones Out. Also, laptops may have only monaural Mic In connections. You can use a monaural Mic input for the data modes described below.

Table 6-2. Computer sound card nominal voltages.

Computer Sound Card Signals	Nominal Voltage		Nominal Impedance - Ohms
	Peak-Peak	RMS	
Line In	894 mV	316 mV	10 K or more
Line Out	894 mV	316 mV	100 - 600
Mic In	10 – 100 mV	3 – 35 mV	1 K – 20 K
Headphones Out	100 mV	35 mV	A few ohms

Table 6-3. KX2 nominal voltages.

KX2 Signal	Nominal Voltage		Nominal Impedance - Ohms	Test Conditions THR=6, SLP=15	Best Computer Connection
	Peak-Peak	RMS			
PHONES	125 mV	44 mV	10	-73 dBm, S9, 14.010 MHz signal with preamp on; RF = -0, AF = 18	Mic In
PHONES	400 mV	140 mV	10	-73 dBm, S9, 14.010 MHz signal with preamp on; RF = -0, AF = 44	Mic In or Line In
Mic	100 mV	35 mV		With MH3 mic, 4 bars ALC, Mic Gain = 20	Headphones Out

Initial Sound Card Settings

Bring up your computer's sound card control panel and set initial levels as shown in Table 6-4. As you carry out your receive and transmit set-ups for AFSK A and DATA A as shown below, you may have to adjust these levels.

Table 6-4. Sound card and KX2 initial settings.

Sound Card Connection	Sound Card Level	KX2 Connection	KX2 Level
Line In	50%	PHONES	AF ~ 20-30
Line Out	10%	MIC	Mic Gain initially 0
Headphones Out	50%	MIC	Mic Gain initially 0
Mic In	10%	PHONES	AF ~ 5 - 10

6.5.2 KX2-to-Sound Card for AFSK A and DATA A

When operating ***AFSK A*** and ***DATA A*** modes, the computer sound card's Line In or Mic receives an audio signal from the KX2's PHONES jack. Figure 6-4 show the PHONES jack of the KX2 connected to the Line In or Mic In of the computer. You may find that using a stereo splitter, as in Figure 6-5, will help you listen to the sound of the RTTY or PSK signals when you are tuning around. This is particularly handy when you are getting started.

The KX2 transmits audio signals it receives from the computer sound card. To support this, the computer's Line Out/Headphones Out jack is connected with a stereo cable to the KX2 MIC In.[22] With this set up you will enable VOX so the audio tones arriving on the MIC jack will key the transmitter.

[22] Even though the MIC jack is for a four-pole TRRS plug, a three-pole TRS plug may also be used.

The audio cables between the KX2 and your computer should be *stereo* cables. The Elecraft transmit and receive audio cables (part numbers E980229 and E980230) are cables with the recommended right-angle plugs to be used at the KX2.

The up/down microphone functions are disabled in ***AFSK A*** and ***DATA A*** modes and so you do not have to change the ***MIC BTN*** menu settings when changing from voice to data modes. However, a stereo cable from the computer's Line Out or Headphones Out may have low enough impedance between the ring and the shield to activate PTT. If this occurs, you should use either a stereo plug with no ring connection or a monaural isolation transformer with no connections to the ring terminals as shown in Figure 6-6. You may also set ***MIC BTN OFF*** when you're in a data mode. You have to be in a voice mode (USB/LSB) to change this menu setting.

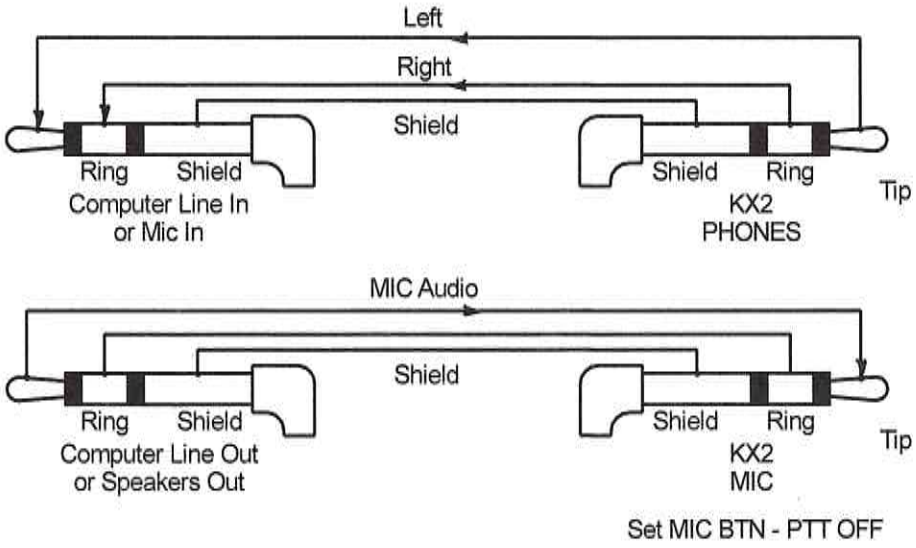

Figure 6-4. KX2-to-sound card for AFSK A and DATA A modes.

Figure 6-5. Stereo (TRS) 3.5 mm splitter.

6.5.3 Noise Reduction

Occasionally, when the KX2's PHONES output and its MIC input are connected directly to the computer as shown in Figure 6-4, a difference in the ground potentials of the KX2 and the computer can inject noise into the audio signals. When receiving, this noise can degrade the computer's ability to decode the digital signals. When transmitting, the noise can make VOX control unusable by causing VOX to be continuously activated. An important connection that helps reduce noise is the use of heavy ground braid between the computer and the KX2. A good source of copper braid for grounding is the shield from RG-8 or RG-11 coax. For more information, see K9YC's excellent presentation on the use of grounding and other techniques to reduce noise in your system.[23]

If you cannot locate a ground point on a laptop, or if bonding the cases of the KX2 and the computer together does not sufficiently reduce the noise, you may have to resort to isolating the audio signals. An audio isolation circuit is shown in Figure 6-6. This is also called *galvanic isolation*. A single transformer is used for the monaural MIC signal. Two transformers form a stereo isolation circuit for the PHONES output. If you are going to use the computer only for digital modes, a single audio transformer is suitable for the PHONES isolation.

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[23] http://audiosystemsgroup.com/HamInterfacing.pdf

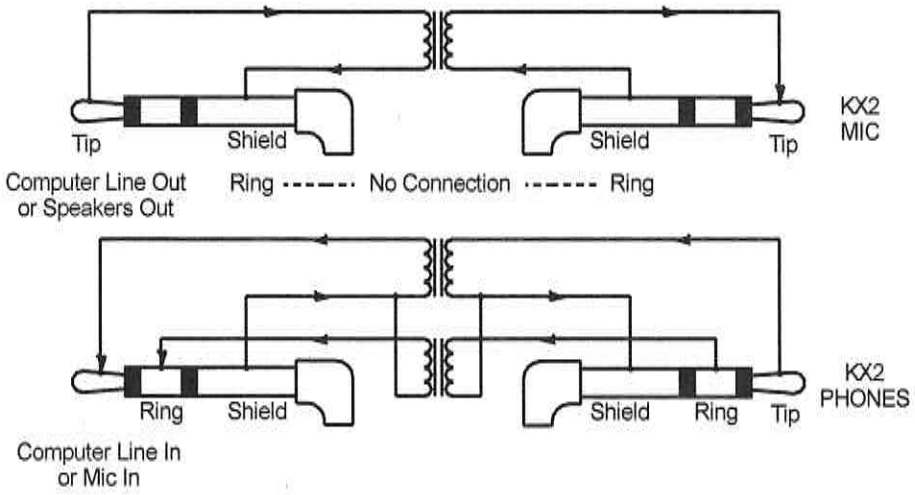

Figure 6-6. Audio or galvanic isolation transformers.[24]

6.6 Radio Teletype (RTTY)

You can use two modes for RTTY – AFSK A and FSK D. Audio Frequency Shift Keying (***AFSK A***) uses a computer sound card to generate tones at the mark and the space frequencies. A stereo cable connects the computer's Line Out or Headphones jack to the KX2's MIC In. The computer sound card's Line In or Mic receives audio tones from the KX2's PHONES jack to decode them for your display (Figure 6-4). You may set the KX2 to transmit using VOX or, if your RTTY software supports it, you may use a PTT signal using a serial port and a level converter input to the MIC connector (see *Computer Operated CW*, page 54). Most people simply use VOX. AFSK uses lower sideband, which is more-or-less the standard used for RTTY.

AFSK A is frequently chosen for RTTY, because once you are set up to use your computer's sound card it is easy to use other sound card modes such as PSK or other digital modes as described in *Other Digital Modes*, page 94.

Frequency Shift Keying (***FSK D***) uses the computer to send ASCII data and KX2 control commands via the serial port. Decoded RTTY data are returned to the computer. The KX2 Utility is a program with a simple and easy-to-use interface for CW, FSK D RTTY, and PSK and works easily for this mode.

In addition, there are many other programs for your computer that will run RTTY, such as MMTTY, Ham Radio Deluxe, and DXLab, as an Internet search will show.

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[24] Pulse Electronics Corporation T6075, Digikey part number 553-197-5-ND.

Setting Up for FSK D RTTY

An excellent way to get started with RTTY is to use the ***FSK D*** mode. The KX2 does not have a direct FSK input like the K3. Instead, it generates FSK D RTTY from a stream of ASCII characters sent from a computer to the KX2's RS232 serial port (ACC), or from the internal CW keyer. When Text Decoding is enabled (hold TEXT), decoded RTTY text is sent to the serial port and the VFO B display area. An external RTTY program can also decode received RTTY signals. Return to *Using the KX2 Utility Program for Digital Modes*, page 81 to see how to use the KX2 Utility for FSK-D.

Setting Up for AFSK A RTTY

Receiver Set Up

- Set up your computer's sound card levels as described in *Data Mode Computer Connections and Set Up*, page 83.
- Connect the audio cables as shown in Figure 6-4 or Figure 6-6. When using the computer's Mic input, set the Mic gain in the sound card's control menu for the lowest gain that gets the sound card's level display (when one is available) to full scale for the received RTTY signal.
- Use an audio splitter cable (Figure 6-5) and headphones so you can hear the RTTY signals while you are tuning.
- Cancel any alternate VFO B display by tapping DISP. You should see the VFO B frequency.
- Tap DATA until the current data mode is displayed and then rotate OFS/B ∅ to select ***AFSK A***.
- Tap DATA to exit the data mode select display.
- Set up the KX2 for data text decode as shown in *Data Text Decode*, page 80.
- Tune in a strong RTTY signal that you can decode using the KX2's internal data text decoder. (See Table 6-5, page 91.)
- Start your RTTY program on your computer.
- Set the RTTY program's mark frequency to 915 Hz and shift to 170 Hz.
- Check that the RTTY program is using Lower Sideband (LSB).
- When the KX2 is decoding the RTTY signal properly, as shown in the KX2's text decode area, adjust the computer's Line In or Mic level and/or the KX2's audio level AF/MON ∅ so your RTTY program will reliably decode the RTTY signal.

Transmitter Set Up

- Set the ***VOX MD*** menu ***On*** to enter VOX mode.
- Set the KYR-SPT/MIC/PWR ∅ to zero to not transmit on the air.
- Start your RTTY program sending RYRY characters.
- If the RYRY tones are not keying the KX2, tap XMIT.

- Adjust KYR-SPT/MIC ∅ to set the Mic gain for a peak ALC reading of about 4 bars. The ALC meter is actually acting like a VU (volume unit) meter. The onset of ALC is about the 5th bar so you should stay below that level. You may have to adjust the sound card's Line Out or Headphones Out (avoid going higher than about 50%) to achieve the peak ALC reading of about 4 bars without the Line Out or Headphones Out clipping. You would like to have the Mic Gain setting about the same as that used for SSB transmissions.
- If you tapped XMIT to transmit, tap it again.
- Hold MENU and rotate the VFO B knob to the ***VOX GN*** menu and adjust the ***VOX GN*** until the KX2 is keyed.
- Start and stop transmitting several times to ensure the VOX activates properly.
- If you turned the KYR-SPT/MIC/PWR ∅ to zero, restore it to the power you would like to output, but stay at 5 watts or below.

Troubleshooting

Here are some of the problems you might see when setting up AFSK A RTTY.

- You may find that the VOX keying stays on continuously. This may be an indication that noise is keying the VOX and that audio isolation as shown in Figure 6-6 may be needed.
- If you find the PTT is continuously activated and a stereo cable is used for the MIC input, there may be a low impedance on the ring terminal. You may need to change the ***MIC BTN*** menu to ***OFF***, or an audio isolation transformer, as shown in Figure 6-6, may be needed. A stereo TRS cable with no ring connection can be used too.
- The mark and shift frequencies in the KX2 and your RTTY software should be the same. Set your RTTY software to use 915 Hz with 170 Hz offset.
- Ensure that the external program is using the correct sideband. RTTY is normally LSB.
- Distorted tone transmission can be caused by overdriving the KX2 transmitter. Make sure your ALC is set correctly as described above.
- Distorted tone transmission can be caused if your PC's microphone is set to "Listen to this Device" in the computer, so that the microphone plays through the computer speakers.
- If you overdrive the computers' sound card by setting the KX2's audio level too high, you may distort the audio and the sound card may not be able to decode the signal. If you are using a Mic input on a laptop, you may have to reduce the KX2's audio (AF) level. Levels appropriate for a Mic input are usually much lower than the levels required for the computer's Line Input.
- A simple voltage divider at the computer's mic input can solve level problems. Figure 6-7 shows a 20 dB (10:1) attenuator that can be built into a full-size 3.5 mm (1/8") plug at the computer mic input.
- Noisy audio signals may require you to use audio isolation.
- You may wish to set ***AGC*THR*** low and ***AGC*SLP*** high to make strong and weak signals produce about the same audio levels. See *Automatic Gain Control – AGC*, page 104.

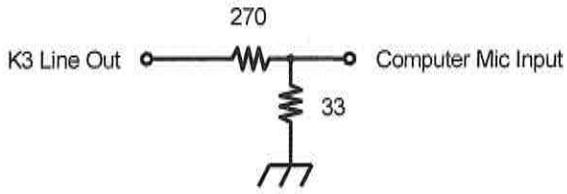

Figure 6-7. 20 dB attenuator.

Typical RTTY Frequencies

Table 6-5 shows frequencies that are commonly used for RTTY in the high frequency bands. Finding a RTTY transmission will help you set up your receiver and begin to use the RTTY mode. Make sure you stay within the frequencies permitted by your license.

Table 6-5. Typical HF RTTY frequencies (MHz).[25]

	RTTY			
Band	**USA**	**DX**	**EU/AF**	**JA**
10	28.080-28.100		28.050-28.150	
12	24.910-24.930		24.920-24.930	
15	21.080-21.100		21.080-21.120	
17	18.100-18.110		18.100-18.110	
20	14.080-14.100		14.080-14.100	
30	10.120-10.150		10.140-10.150	
40	7.025-7.050 7.080-7.100	7.040	7.035-7.045	7.025-7.040
80	3.580-3.600	3.590	3.580-3.620	3.520-3.530
160	1.800-1.810	1.838-1.843	1.838-1.843	

6.7 PSK

The direct keying ***PSK D*** mode may be used when sending PSK with the internal keyer, the KX2 Utility program, or with PSK computer software that can send ASCII text to the KX2 using the serial port. If you use an external program to generate and decode PSK signals, you must use the ***DATA A*** mode for Audio Frequency Shift Keying, which is normal for most computer PSK programs.

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[25] http://n1mm.hamdocs.com

Setting Up for PSK D

You can send and receive ***PSK D*** with a RS232 serial port connection between your computer and the KX2. Sound card connections are not needed, and you must have enabled the internal text decoder. Return to *Using the KX2 Utility Program for Digital Modes*, page 81 to see how to use the KX2 Utility for PSK-D.

Setting Up for DATA A PSK

Receiver Set Up

- Set up your computer's sound card levels as described in *Data Mode Computer Connections and Set Up*, page 83.
- Connect the audio cables as shown in Figure 6-4 or Figure 6-6, page 86 – 88. When using the computer's Mic input, set the Mic gain in the sound card's control menu for the lowest gain that gets the sound card's level display to full scale for the received PSK signal.
- Use an audio splitter cable (Figure 6-5, page 87) and headphones so you can hear the PSK signals while you are tuning.
- Cancel any alternate VFO B display by tapping DISP. You should see the VFO B frequency display.
- Tap DATA until the current data mode is displayed and then rotate OFS/B ∅ to select ***DATA A***.
- Tap DATA to exit the data mode select display.
- Start your PSK program on your computer.
- Tune the KX2 to an area of the band (see Table 6-6, page 94) where PSK signals are found and adjust the computer's Line In or Mic level and/or the KX2's AF gain to allow your PSK program to reliably decode the PSK signal.
- If your PSK program has a waterfall display and uses its own PSK detection filters, try setting the KX2 DSP bandwidth to its maximum.

Transmitter Set Up

- Set the ***VOX MD*** menu ***On*** to enter VOX mode.
- Set the KYR-SPT/MIC/PWR ∅ to zero to not transmit on the air.
- Start your PSK program sending characters.
- Adjust KYR-SPT/MIC ∅ to set the Mic gain for a peak ALC reading of about 4 bars. The ALC meter is actually acting like a VU (volume unit) meter. The onset of ALC is about the 5th bar so you should stay below that level. You may have to adjust the sound card's Line Out or Headphones Out to achieve the peak ALC reading of about 4 bars. Avoid going higher than about 50% so that Line Out or Headphones Out do not clip. You would like to have the Mic Gain setting about the same as that used for SSB transmissions.

- Hold MENU and rotate the VFO B knob to the ***VOX GN*** menu and adjust the ***VOX GN*** until the KX2 is keyed.
- Start and stop transmitting several times to ensure the VOX activates properly.
- If you turned the KYR-SPT/MIC/PWR Ø to zero, restore it to the power you would like to output.

Troubleshooting

Here are some of the problems you might see in setting up for DATA A PSK.

- You may find that the VOX keying stays on continuously. This may be an indication that noise is keying the VOX and that audio isolation, as shown in Figure 6-6, page 88, may be needed.
- If you find the PTT is continuously activated and a stereo cable is in use for the MIC input, there may be a low impedance on the ring terminal. You may need to change the ***MIC BTN*** menu to ***OFF*** or an audio isolation transformer as shown in Figure 6-6 may be needed. A stereo TRS cable with no ring connection can be used too.
- Distorted tone transmission can be caused by overdriving the KX2 transmitter. Make sure your ALC is set correctly as described above.
- If you overdrive the computers' sound card with a too high level from the KX2's audio out, you may distort the audio and the sound card will not be able to decode the signal. If using a Mic input on a laptop, you may have to reduce the KX2's audio (AF) level.
- Noisy audio signals may require you to use audio isolation.
- Loud signals in the receiver's passband may activate the AGC and make weaker signals difficult to decode. In this case it would be helpful make the DSP bandwidth narrower.
- You may wish to set ***AGC*THR*** low and ***AGC*SLP*** high to make strong and weak signals produce about the same audio levels. See *Automatic Gain Control – AGC*, page 104.

Typical PSK-31 Frequencies

Table 6-6 shows frequencies that are commonly used for PSK-31 in the high frequency bands. Finding a PSK transmission will help you set up your receiver and begin to use the PSK mode. Make sure you stay within the frequencies permitted by your license.

Table 6-6. Typical PSK-31 HF frequencies.

Band	PSK31
10	28.120
12	24.920
15	21.080
17	18.100
20	14.070
30	10.140
40	7.035/7.080
80	3.580
160	1.828

6.8 Other Digital Modes

There are a variety of other weak signal digital modes that are interesting and fun to try with the KX2. Some of the more popular ones are the following, with new innovative signal processing modes cropping up regularly.

WSJT: Weak Signal – Joe Taylor. The WSJT program provides several modes optimized for meteor scatter, troposcatter, or EME (Earth - Moon - Earth, moonbounce) communication. You can find the JT65, FSK441, and ISCAT modes in the WSJT package. http://www.physics.princeton.edu/pulsar/K1JT/

WSPR: Weak Signal Propagation Reporter. This program is designed for sending and receiving low-power transmissions to test propagation paths on the MF and HF bands. Users with Internet access can watch results in real time at WSPRnet. http://www.physics.princeton.edu/pulsar/K1JT/

JT65-HF: This is software for reception and transmission of the JT65A protocol with an emphasis upon its use in the high frequency bands instead of VHF/UHF. http://jt65-hf.com. The JT65A mode in the WSJT program will work on HF.

Olivia: Olivia is a weak signal mode that allows keyboard-to-keyboard conversations, unlike other weak signal modes that have rigidly set communication protocols. It is similar to PSK-31 but is remarkably effective for weak signals. http://hflink.com/olivia/

PSK2K: PSK2K is a high-speed meteor scatter software that can be operated in fully automatic mode if required. This enables QSOs to be completed fully automatically without user intervention. http://www.dk5ew.de/2012/01/13/psk2k-a-new-meteorscatter-mode-by-dj5hg/

Each of these digital modes requires a software package running on your personal computer. Popular programs offering a variety of these digital modes include Fldigi, WSJT, Ham Radio Deluxe (HRD), DXLab, Digipan and others. An Internet search is a first step to get you going using these modes.

Some of these modes have fairly long continuous transmit durations, for example 50 seconds in JT65A. Elecraft recommends that you keep the KX2's output power to 5 watts or less to ovoid overheating and causing the KX2 to shut down. Also, some modes require accurately timed transmissions so your computer must be synchronized to Universal Time (UTC). A variety of programs are available to synchronize your computer's clock to NIST time standards.

Modes such as JT65 also require very stable frequency transmissions. At the time of writing, Elecraft has not published a VFO temperature compensation procedure. It may become available in the future.

Typical JT65-HF Frequencies

Table 6-5 show frequencies that are commonly used for JT65A in the high frequency bands. Finding a JT65A transmission will help you set up your receiver and begin to use the JT65A mode. Make sure you stay within the frequencies permitted by your license.

Table 6-7. Typical JT65A HF frequencies.

Band	JT65	Band	JT65
10	28.076	20	14.076
12	24.917	30	10.139
15	21.076	40	7.076
17	18.102	80	3.576
		160	1.838

6.9 *Riding the Thermals*

In general, Elecraft recommends keeping the output power levels to 5 watts or less to avoid overheating the final amplifier transistors. The KX2 will typically fold back (reduce output power) when the case temp around the two output devices reaches ~60C. One way to maximize the amount of power used is to 'ride the thermals'.[26]

Set up the KX2 to monitor the Power Amp temperature. Tap DISP to show the secondary VFO B display and rotate VFO B to the ***PA*** position.

- Knowing that the KX2 will fold output power back to 5 watts at ~60 C, adjust the power output so that the KX2's PA temperatures run about 55 C while you are transmitting.
- In this way, the KX2 can be made to produce the maximum amount of power while ensuring that it will not fold back to 5 W.
- Typically, when the KX2 is operated into a dummy load or fully resonant antenna, power output will be ~7-8 watts using this technique.

6.9.1 Temperature Compensation

Operators that use high duty cycle modes, such as the digital modes may find that the KX2 tends to drift as it heats up during transmission, although lessons learned in the design of the KX3 have reduced this problem in the KX2. This is fairly normal and is not a problem for CW and voice modes but for modes such as JT65 and PSK, this drift is problematic.

An enhanced temperature compensation procedure can greatly increase the temperature stability of the KX2. At the time of writing, Elecraft has not published this procedure.

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[26] Thanks to Elecraft Customer Support engineer David Shoaf for the mental image of the KX2 soaring to new heights!

Chapter 7. KX2 Operating Hints and Kinks

Note: You may find that some of the KX2 features and operations described in this chapter do not seem to work or display ***N/A*** when you attempt to make an adjustment. This is because these features have not been implemented in the KX2 firmware as yet. They are expected to be available in the future.

7.1 Reducing Interference with Filtering

Filter and Digital Signal Processing (DSP) Settings, page 20 described the controls you have for using the digital signal processing filtering, and Figure 7-1 shows again how to change the DSP bandwidth and center frequency.

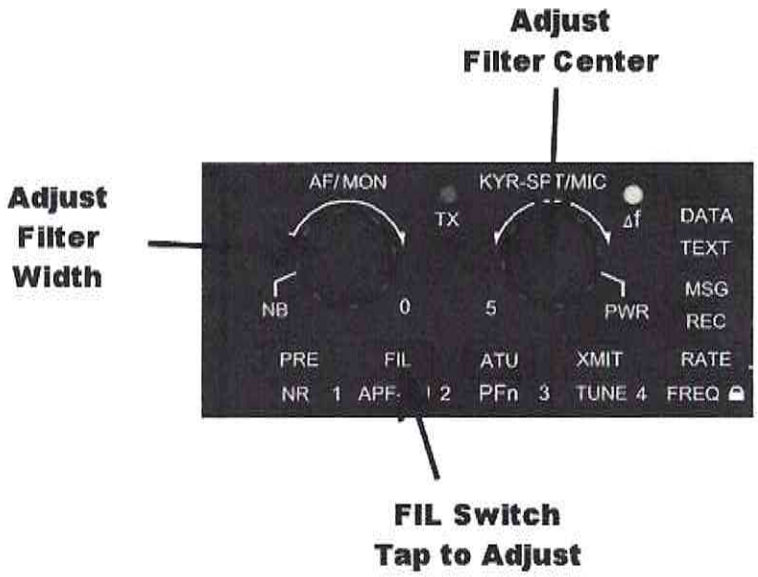

Figure 7-1. DSP filter adjustments.

Passband Width

After tapping the FIL switch, the AF/MON ⌀ knob controls the bandwidth of the DSP filter and the KYR-SPT/MIC ⌀ knob controls the center frequency of the filter. Making the filter more narrow reduces interference from the sides of your receive frequency. A very narrow width, say 50 or 100 Hz, may increase the amount of ringing you hear. After adjusting the bandwidth or center frequency, tap any other switch, key the transmitter, or

rotate VFO A. See Figure 3-5 and Figure 3-7, page 23 to see the effect of adjusting these controls.

DSP Normalization

Tapping FIL and then the AF/MON ∅ knob quickly normalizes all DSP settings, namely, the CW bandwidth is set to 400 Hz and the filter is centered on your CW pitch. Tapping the KYR-SPT/MIC ∅ knob normalizes only the center frequency.

The SSB passband is set to 2.70 kHz with a center frequency of 1.5 kHz in ***nor*** mode.

Reverse CW

The ***ALT MD*** menu switches between CW (***nor***), which uses lower sideband, and CW REV (***ALT***), which uses upper sideband. Changing the receive sideband in CW does not change the transmitted side band. In CW this can be useful to flip an interfering signal from the low side to the high side or vice versa. If you are accurately tuned to the zero beat, changing to the alternate CW sideband will not change the received station's tone but the interfering station will change pitch and thus may be less objectionable.

When ***ALT MD*** is assigned to the programmable function switch ***PFn***, holding the switch toggles between ***nor*** and ***ALT*** on successive presses without remaining in the menu.

Reverse SSB Sidebands

In SSB, the ***ALT MD*** menu switches to the other sideband, which you might do if somebody is transmitting on the wrong sideband. Both received and transmitted sidebands are changed.

Table 7-1. Alternate sideband changes.

Mode	Alternate Action
CW	Changes received sideband, does not change transmit sideband; CW, CW REV.
DATA	Changes received and transmitted sideband; DATA, DATA REV.
SSB	Changes received and transmitted sideband; USB, LSB.

CW Audio Peaking Filter – APF

The audio peaking filter (APF) provides a very sharp audio filter that is effective in pulling weak CW signals out of the noise. When CW signals are properly – carefully – tuned, they seem to "pop" out of the noise. The audio peaking filter is only operational in CW mode.

The APF is a very narrow DSP filter, about 30 Hz at the -3 dB points, with broad skirts. The narrow peak brings up the signal amplitude slightly, while the broad APF passband skirts prevent noise from being amplified and delayed so as to dominate the signal. The sharp point on the APF display in Figure 7-2 is illustrative only. You won't see this on the KX2's filter display.

Hold APF-AN to enter APF mode. Tap it again to return to normal filtering.

When in APF mode, a display similar to Figure 7-2 is shown. APF works at the CW sidetone frequency so you should *carefully* tune to zero beat the signal you are trying to copy. Use the fine VFO tuning (tap RATE until the Hz digit is displayed[27]) and use the CWT tuning feature. Set the ***CWT*** menu ***On*** to turn CWT on and tap KYR-SPT/MIC to automatically zero beat when there is sufficient signal.

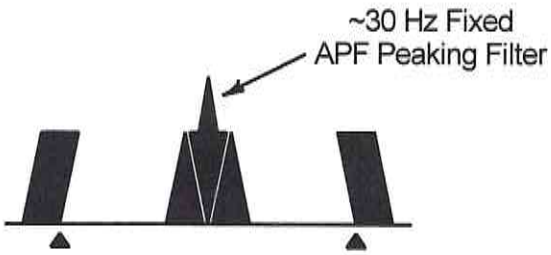

Figure 7-2. APF display.

Hints from Elecraft Users for Using the APF

- Use 1 Hz VFO tuning to carefully tune the station to the peak of the filter.
- Reducing the AF gain may help the signal pop out of the noise after you have accurately tuned to the signal.

Dual-tone Filter for AFSK A and FSK D RTTY

In DATA mode, the RTTY dual-tone filter, with pass bands set for the RTTY mark and space tones, is automatically turned on for AFSK and FSK RTTY (Figure 6-2, page 80).

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[27] 1 Hz tuning is automatically invoked when the APF is engaged.

When you use the KX2's internal PSK decoder, you may find a narrow passband width to be an advantage. If you are using an external "waterfall" display program you should set the passband width to the maximum width.

The ***ALT MD*** menu switches between DATA (upper sideband) and DATA REV (lower sideband). It can be useful in DATA modes to flip an interfering signal from the low side to the high side or vice versa. However, use this with caution. Some data modes [e.g. WSJT modes] specify USB; you will not be able to send or receive them if you have selected the wrong sideband.

7.2 Notch Filter

Most of us have experienced the annoyance of a steady carrier on or near the signal to which we are listening. Because a carrier (or even an interfering CW signal) is very narrowband, a notch filter can virtually eliminate that type of interference.

Automatic Notch

The auto notch will operate only in SSB mode. Holding APF-AN in SSB mode turns on the auto notch and the DSP will find the interfering carrier, or sometimes more than one carrier, and notch them out. The NTCH icon is turned on. Hold APF-AN again to turn the auto notch off. Auto notch is not available if AGC is off.

Exercise

Practice using the notch control.

Tune to an AM station in the broadcast band (or WWV) using SSB instead of AM. Tune slightly off the zero beat frequency until you hear the carrier and then hold APF-AN. The carrier should magically disappear.

7.3 Noise Rejection

You can use two noise rejection filters in the KX2. The DSP *noise blanker* algorithms are effective on complex waveform noise sources, such as fast rise-time pulses and high duty cycle, complex waveform noise often generated by computers, power supplies, and light dimmers. The DSP *noise reduction filter* reduces random noise such as background noise.

Noise blankers and noise reduction should be used sparingly because they can introduce other effects, such as intermodulation distortion (IMD), which can affect copy.

In general, a noise blanker (NB on the front panel) works by detecting and suppressing fast rise-time pulses, for example ignition noise. A noise reduction filter (NR on the front panel) works to reduce random background noise using clever digital signal processing algorithms. Use these noise reduction techniques only when necessary, as they can introduce side effects such as intermodulation distortion.

7.3.1 Noise Blanker

The noise blanker is activated by holding the AF/MON/NB ∅ knob. The NB icon is displayed and the current noise blanking level is displayed for three seconds in the VFO B display area. Rotating AF/MON ∅ while the present level is displayed allows you to choose different noise blanking levels ranging from ***NB 1*** to ***NB15***. After adjusting the level, tap any switch to exit.

Noise blankers will cause a certain amount of intermodulation or shaping of signals when set too aggressively. ***NB 1*** will do the least blanking and create essentially no artifacts. Settings up through ***NB 7*** or so will still minimize side effects. If the noise consists of really strong pulses, like from your neighbor's old jalopy, you can go all the way up to ***NB 15***. These higher settings are great for digging out weak signals, but they will modify the sound of strong signals somewhat and cause some pumping on a busy band.

After selecting a new NB level, VFO B continues to show that level and VFO A is locked. Tap any key to return to the normal VFO A and VFO B display.

The noise blanker setting is saved per-band because you may need different settings for different noise on each band. Hold the AF/MON/NB ∅ knob again to turn the noise blanker off.

7.3.2 Noise Reduction

DSP noise reduction reduces random noise such as background noise. It does not operate in ***DATA*** modes, or when the AGC is off. Noise Reduction is activated by holding NR and rotating the AF/MON ∅ knob to select a noise reduction parameter in the range of 0 to 10. When NR is turned on, the current parameter is shown for about three seconds during which you may select a new value. The NR setting is independent for SSB and CW modes and is saved for each mode.

After selecting a new NR level, the VFO B display continues to show that level and VFO A is locked. Tap any key to return to the normal VFO A and VFO B display.

When noise reduction is active the NR icon is displayed. Hold NR again to turn it off.

Caution: NR is *very* effective, so much so that your receiver may be silent – and you may think that it has died – if NR is on and it's not tuned to a signal. Just hold NR again to get reassuring random noise back!

Considerations for Noise Blanking and Noise Reduction

- The noise blanker (NB) and noise reduction (NR) features can be used together, with the noise blanker operating on one type of noise and the noise reduction on another. It is best, however, to try them one at a time.
- The noise blanker "chops a hole" in the received signal when it detects a noise impulse. While it doesn't activate on the weak signals you are trying to hear, it may affect their readability.
- Chopping a hole in the received signal can produce sum and difference frequencies, just like a mixer. These may increase your overall noise level or create artifacts such as clicks and pops. Because of this, you should use the noise blanker only when necessary.
- When adjusting a noise blanker parameter, do so slowly.
- Noise reduction parameters are separate for CW and SSB.
- A hollow sound is normal for the more aggressive NR settings.
- NB doesn't necessarily help with static crashes or broad band noise. This is to be expected; the NB is a pulse-type noise blanker, and both static crashes and atmospheric noise are usually too broad to trigger the pulse detection algorithm. NR may help with these, however.
- Adjusting the NB and NR is a trial-and-error process. When you're trying to reduce a particular noise, try the noise blanker first if it's a fast rise-time pulse such as ignition noise or static crashes. Other kinds of noise – such as computer hash and light dimmer noise – also may be more effectively dealt with by the noise blanker. Noise reduction filtering is effective on the random background noise, such as the atmospherics you might hear on 80 or 40 meters.
- When you are adjusting any of these noise reduction mechanisms, choose the least aggressive setting that is effective to reduce other unwanted non-linear effects that can occur with the more aggressive settings. Allow from one to three seconds for the DSP to adapt to the new setting.
- Lyle Johnson, Elecraft's DSP guru notes that noise reduction is in the audio path, after filtering and before the AF Gain control. It is influenced by Rx EQ settings, AGC settings (particularly ***SLP*** and ***THR***) – and of course, the level and type of noise. In general, NR is more effective for weaker signals with a lower AGC threshold and flatter slope. See *Automatic Gain Control – AGC*, page 104. Interestingly, the algorithm works best with wide selectivity. When the selectively is narrow, the band-limited noise resembles a signal and NR becomes less effective.

7.4 Preamplifier and Attenuator

A technique used by experienced operators of older radios is to control signal levels in the RF stages. This can greatly help reduce the effects of noise by reducing signal levels so that succeeding stages do not operate in a non-linear region.

The techniques used in the older radios have a place in improving the performance of the KX2 and similar radios. The goal is to reduce noise and strong signals in the RF stages before they overload the digital signal processing stages. Many experienced KX2 owners use the preamplifier and attenuator as shown in Table 7-2. On the lower frequency,

noisier bands, the attenuator is almost always turned on and the preamplifier off. On the higher frequency bands, the preamplifier is used. The on/off state of the attenuator and preamplifier are saved per-band.

A 20 dB preamplifier or a 20 dB attenuator may be set for each band:

- Tap PRE to cycle through three preamplifier/attenuator settings successively:
  - Preamp and attenuator both off.
  - Preamp on, attenuator off. PRE icon is on, ATT icon is off.
  - Preamp off and attenuator on. ATT icon is on, PRE icon is off.
- The setting is saved on a per-band basis and the PRE and ATT icons display the preamp/attenuation state.
- The 20 dB preamp must be on for the S-meter to indicate an S-9 with a 50 uV (-73 dBm) signal.

The preamplifier will automatically be turned off and attenuator automatically turned on when the KX2 detects a very strong signal. The RX receiver overload icon will alert you when this has happened. Tap PRE to turn the attenuator off when your kilowatt neighbor goes off the air.

By using the attenuator, preamplifier, and RF gain control, you can adjust the KX2 receiver's audio noise level. You will want to do this on each of your operating bands and you may have to make adjustments as band conditions change. The goal is to set the attenuator and preamplifier and adjust the RF gain control so that the noise on the band is only just audible and just flickers the S-meter. Here is a procedure to do this.

- Choose the operating band and tune to a frequency with just noise, no signal.
- Set the ***RF GAIN*** menu to ***-0***. (***RF GAIN*** is for all bands; it is not per-band.)
- Choose preamplifier and/or attenuator settings so the noise level is just flickering the S-meter at about S-1 (or as low as you can go, depending on how noisy the band is). The preamplifier and attenuator settings shown in Table 7-2 should be fairly close.
- If the band conditions are very noisy, reduce the ***RF GAIN*** until the S-meter noise just stops flickering. An S-meter segment will remain on to remind you that the RF gain is reduced.
- You can leave your RF gain settings like this and use the AF gain control to set a comfortable listening level.

A good technique to remember if you are operating in a contest with many signals on the band is to turn the attenuator on in addition to reducing the RF gain and reducing the preamplifier gain.

Table 7-2. Using the preamplifier and attenuator.

Band and Conditions	Preamplifier	Attenuator
160 meters	Off	On
80 meters	Off	On
40 meters	Off	Sometimes On
30 meters	Off	Sometimes On
20 meters	Off	Off
17 meters	Off	Off
15 meters	Sometimes On, 10 – 20 dB	Off
12 meters	On, 20 dB	Off
10 meters	On, 20 – 30 dB	Off
6 meters	30 dB	Off
Very noisy band conditions	Off	On
Very busy band, e.g. in contests	Off	On

7.5 RF Gain Control

Unlike the Ye Olde Receiver design shown in Figure 8-1, page 124, and many modern receivers, the only circuitry in the KX2 that controls the RF signal levels are the preamplifier and the attenuator.

As is the case with many software-defined transceivers, the KX2's RF GAIN control is actually an input scaling factor applied within the DSP itself. Reducing RF gain doesn't impact the strength of signals seen by the A-to-D converter. Gain ahead of the ADC can only be reduced by turning the preamp off, and (if necessary) turning the attenuator on. See *The KX2 Receiver*, page 124.

7.6 Automatic Gain Control – AGC

An AGC circuit detects a received signal's strength and then changes the overall system gain to make different signal levels sound much the same. During casual operation, say in a round table of friends, this is easier to listen to because the stronger signals sound like the weaker signals. It can also limit strong signals so they don't hurt our ears or exceed hardware limitations.

Overwhelming the receiver with too-strong signals can cause noise, thumps, pops and distortion - all very bad. In another scenario, say when you are trying to pull a signal out of a pileup, a good operator may not want AGC to make the strong signals sound about as loud as the weaker ones. To help you deal with these very different scenarios, the KX2's

well-designed AGC system will allow you to choose how the AGC works in various operating situations.

> The KX2's AGC is programmable. You can choose how it operates with respect to signal strength and how quickly or slowly it takes effect.

The KX2 has a variety of user configurable AGC controls, but before learning about these, let us first consider how the AGC operates (1) as a function of time – that is, how fast or slowly it activates and deactivates, and (2) as a function of signal strength – that is, how different signal levels are converted to audio levels.

7.6.1 AGC Time Behavior

The behavior of the AGC circuit as a function of time includes *attack rate*, *hold time*, and *decay rate*.

AGC Attack Rate: This is the rate at which the circuit changes its gain (in dB/ms) and settles on its new value when responding to a rapid change from a *weaker* to a *stronger* signal. A too-fast attack rate will result in the receiver responding to noise or static bursts and then be unable to hear weak signals. A too-slow attack rate may allow a strong signal to pass through and overwhelm succeeding electronics or digital signal processing stages. Conventional wisdom states that the AGC should respond to an increased signal in 1 – 2 milliseconds. The KX2 attack rate can be adjusted in the ***AGC*ATK*** menu.

AGC Hold Time: This is the time in seconds the AGC circuit maintains the receiver's gain value after a strong signal drops. You can adjust the hold time for the KX2's slow AGC with the ***AGC*HLD*** menu. AGC Hold time is only active in voice modes, not CW.

AGC Decay Rate: This is the rate (dB/ms) at which the AGC reduces the receiver's gain following a change from a *stronger* to a *weaker* signal. You can adjust the KX2's decay rate for AGC fast and slow with ***AGC*DCY***.

AGC-SPD: *FAST* (*AGC-F*) and *SLO* (*AGC-S*): The KX2 provides fast and slow decay rate AGC responses. The decay rate is programmable for each and the hold time is programmable for voice modes. Slow AGC with AGC hold is normally used for voice and data modes and fast AGC for CW. The attack rate is the same for both AGC-F and AGC-S.

Figure 7-3 represents an input signal changing rapidly from a weaker signal (S7) to a stronger one (S9) and then back to the weaker. The S7 signal produces a 2 Vp-p audio signal and the S9 signal 6 Vp-p when there is no AGC action. In Figure 7-4 the receiver first sets AGC gain at a suitable level for the weaker S7 signal. When the signal strength increases to S9, the receiver reduces its gain at the attack rate. The reduced gain for the S9 signal makes the stronger signal sound about as loud as the weaker one, and vice-versa.

When the signal changes back to S7, the gain returns to the S7 level at the decay rate.

Figure 7-5 shows the audio levels that occur when the AGC is active. Instead of an abrupt change from 2 Vp-p to 6 Vp-p as in Figure 7-3, the audio changes from about 1.9 Vp-p to about 5.5 Vp-p and then ramps down to the 3.3 Vp-p S9 level at the attack rate. When the signal changes from S9 to S7, the audio drops to about 1.1 Vp-p before ramping up to

1.9Vp-p at the decay rate. Thus, now the S9 signal is 3.3 Vp-p and the S7 signal 1.9 Vp-p, making them sound much more alike. This is the main goal of all AGC systems.

Figure 7-6 illustrates that the AGC hold time applies when a voice signal changes from a *stronger* to a *weaker* level. The gain is maintained at the stronger signal level for the hold time. This helps eliminate gain changes during voice modulation peaks.

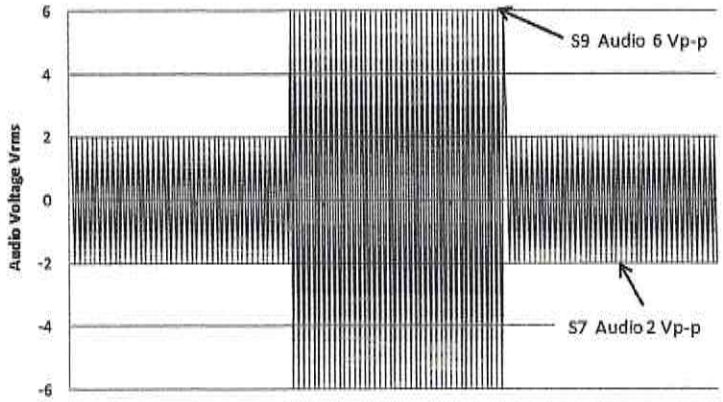

Figure 7-3. S7 - S9 - S7 audio with no AGC.

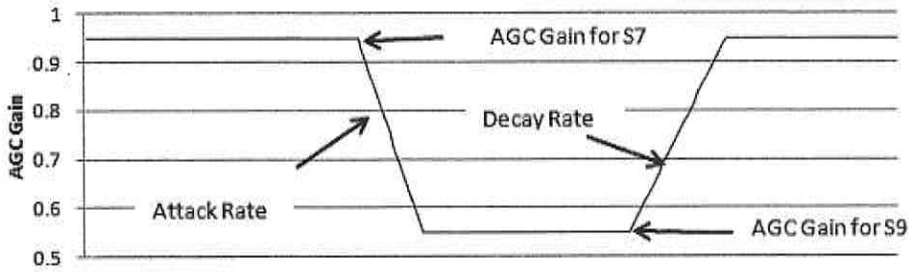

Figure 7-4. AGC gain changes.

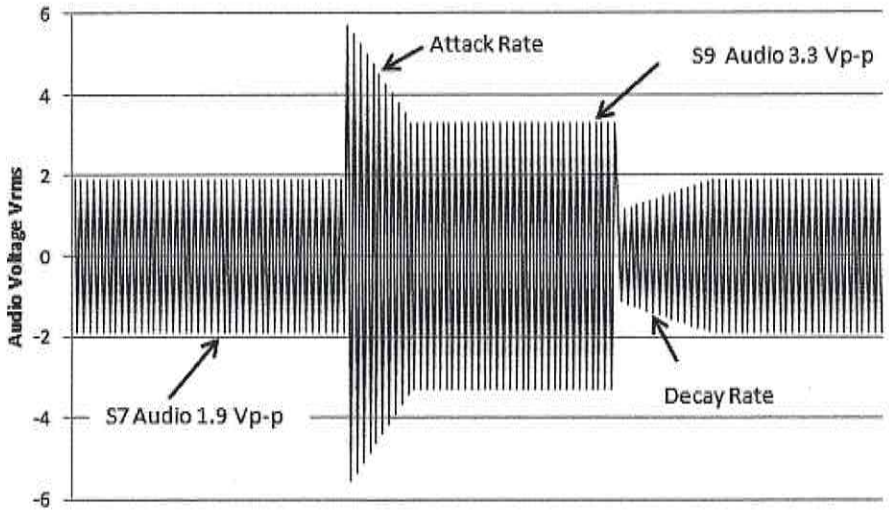

Figure 7-5. S7 - S9 - S7 audio with AGC.

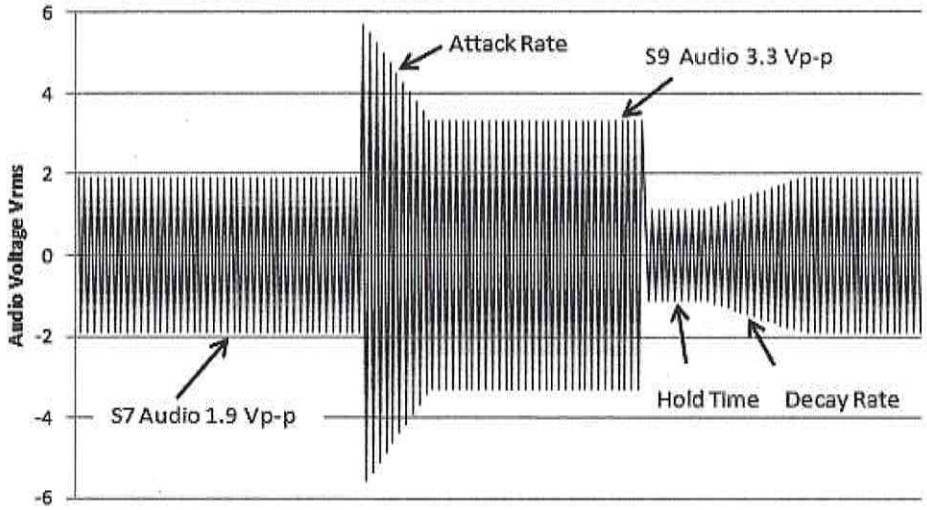

Figure 7-6. Audio with AGC hold for voice modes.

7.6.2 AGC as a Function of Signal Strength

Figure 7-7 shows how an AGC controls your receiver's audio output level as a function of input signal strength. For AGC off (the solid curve), the output audio level increases linearly with the input signal level until point C is reached where saturation of some component (for example, your ears) or some other non-linear effect takes place. When the AGC is on (the dotted curve), the output audio increases linearly until point B, called the threshold, is reached. From that point the output increases much more slowly, following the dotted line. That rate is called the *slope* of the AGC. When the input signals are in this range, stronger signals are reduced to be closer in strength, or audio level, to weaker signals.

Threshold: The threshold is the point at which the AGC starts to take effect. See point B in Figure 7-7.

Slope: The AGC slope is slope the dotted line (B – E) in Figure 7-7. It defines how much the output audio changes for changes in input signal when AGC is active.

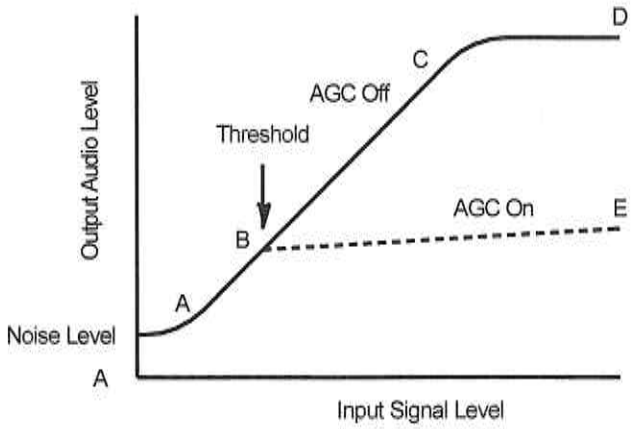

Figure 7-7. AGC as a function of signal strength.

7.6.3 Intermodulation Distortion and AGC Pumping

Two signal distortion effects are present in AGC circuits. These are Intermodulation Distortion (IMD) and AGC pumping.

IMD: IMD is the unhappy result of the combining two signals in a non-linear circuit. If we have two signals, say

$s_1 = a_1 \sin 2\pi f_1 t$ and

$s_2 = a_2 \sin 2\pi f_2 t$,

then these combine in a *linear* circuit to produce

$s_3 = s_1 + s_2$.

A linear circuit is one in which a graph of the output signal may be stronger, or louder, but otherwise looks just like the input, with exactly the same shape. Mathematically, we say

Output = K * Input

where K is a constant called the *gain* of the circuit.

Put another way, a change in the input produces exactly the same change in the output, no matter what the level of the input signal is. The line segment A-C in Figure 7-7 shows a linear response. It is called *linear* because the graph of the output plotted against input is a straight line.

On the other hand, in a non-linear circuit, A-B-E in Figure 7-7, the result of the combination of s_1 and $s_{2\,is}$ not only the original frequencies,

f_1 and f_2,

but also the sum and difference frequencies

(f_2+f_1) and $(f_2 - f_1)$.

If these sum and difference frequencies occur within the receiver passband, the result is a distortion or "muddling" of our two original signals by the sums and/or differences.

For example, consider operating CW with a filter bandwidth of 500 Hz centered on a sidetone frequency of 500 Hz. With this we should hear CW tones from 250 Hz to 750 Hz. If we have two signals of, say, 350 Hz and 650 Hz, the unwanted intermodulation difference frequency (650 – 350 = 300 Hz) also appears in our listening bandwidth.

Unfortunately, all active devices, such as amplifiers etc, are non-linear, some worse than others, but all exhibit some intermodulation. Some passive devices – diodes for example – are non-linear too. Elecraft has gone to great length to minimize IMD in the KX2 with careful circuit design and filtering. Its specifications show this effort.

AGC Pumping: AGC pumping is an effect that occurs when an unwanted strong signal is within the bandpass filter but is outside the digital signal processing passband. In this case, we would not hear that signal itself (because of the DSP filter), but we would hear its effect on signals in the DSP passband. Their amplitudes will be affected, or *modulated*, by the AGC changing the receiver's gain due to the unwanted strong signal.

Figure 7-8 shows this effect. Assume we are listening to an S7 signal that produces an audio level of -20 dBV. Now an unwanted S9 signal, which is outside our DSP bandwidth but unfortunately within the bandpass filter's bandwidth, appears. It's a string of CW dots, keyed on and off as shown by the dotted line. Because the AGC responds to this signal, even though we cannot hear it, the receiver's gain will be rapidly changed up and down and we will hear our S7 audio being modulated, or *pumped*.

To reduce the effect of AGC pumping, reducing the RF gain and changing the slope of the B-E line in Figure 7-7 will help. The ***AGC*SLP*** menu controls this slope.

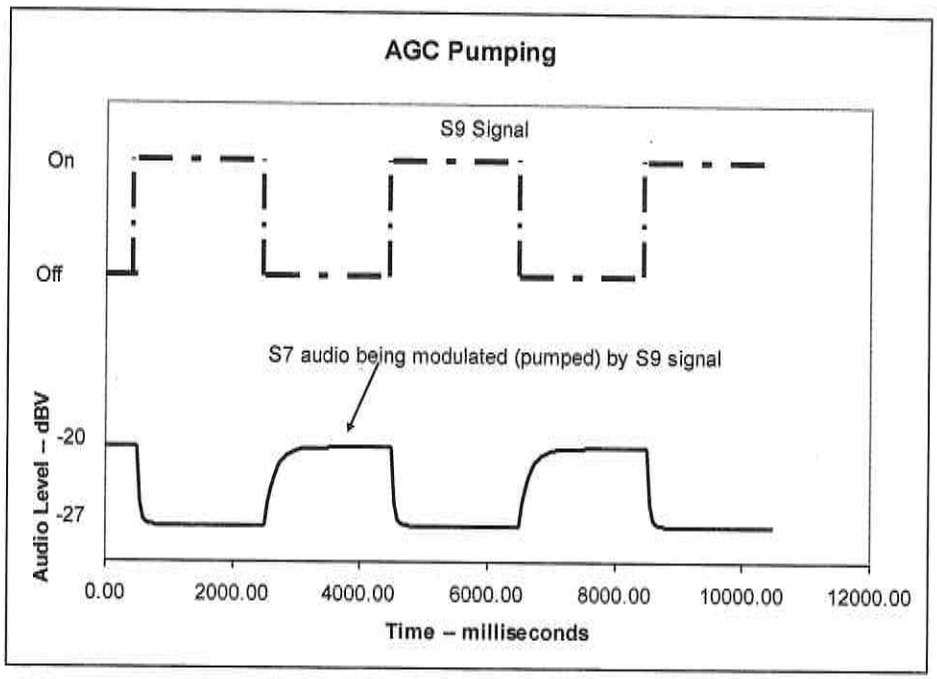

Figure 7-8. AGC pumping.

7.6.4 KX2 AGC Controls

The KX2's AGC is implemented in the digital signal processing. This takes place at audio frequencies. The AGC signal processing function occurs before any further bandwidth narrowing in the DSP. Table 7-3 and Table 7-4 show the menu items that can be adjusted in the KX2.

Table 7-3. Menus for the AGC time response.[28]

Menu	Default	Description
AGC MD	***On***	This turns AGC mode ***On*** and ***OFF***. When on, the AGC-F or AGC-S icons are visible. When ***AGC MD*** is ***OFF***, just the "AGC-" icon is visible. Be sure to set the ***AF LIM*** to avoid hurting your ears when you operate with the AGC off. (See *AF Limiter*, page 113.)

[28] When you are in the configuration menu, holding MENU for 3 seconds will show a short help message and the default value for the menu item in parenthesis.

AGC SPD		***SLO***	The AGC speed, Fast or Slow, is stored per-mode. The default is ***SLO*** for voice and data modes, and ***FASt*** for CW.
AGC*	***THR***	***005***	Tap 1.This sets the threshold signal level, or strength, at which AGC becomes effective as shown in Figure 7-10. ***THR*** may range from ***004*** to ***008***. See *Hints for Setting your AGC*, page 113.
	ATK	***215***	Tap 2.This sets the attack rate for the AGC as it responds to a drop in received signal level as shown in Figure 7-4 and Figure 7-5, page 107. A lower number than the default provides a softer (slower) attack but may result in overshoot. The range is 200 to 255.
	HLD	***000***	Tap 3. This sets the Slow AGC hold time. It specifies the number of seconds the AGC level is held after the signal level drops. Holding AGC slightly can reduce IMD and is useful in pileups. It can range from 0.00 to 2.00 seconds.
	DCY	***Fast 140*** ***Slow 040***	Tap 4. This sets the AGC decay characteristic for Slow and Fast AGC. A larger number is a faster decay. See Figure 7-4 and Figure 7-5, page 107. To set the fast or slow decay, first set ***AGC SPD*** to ***SLO*** or ***FASt***. The range for Fast AGC is 120 – 150; for Slow AGC 10 – 50.
	SLP	***015***	Tap 5.This allows you to control the slope of the AGC as shown in Figure 7-9, page 112. ***SLP 010*** gives the best signal discrimination in pileup situations; ***SLP 015*** gives a flat response. ***SLP*** may range from ***010*** to ***015.***
	PLS	***nor***	Tap 6. When set to ***nor,*** this allows the AGC to reject noise pulses and pass short signals like a CW dit. When it detects a noise pulse, the AGC attacks and then decays rapidly back to its previous level. ***OFF*** disables this feature.

Exercise

Demonstrate the effect of AGC decay when a receive signal changes from strong to weak.

Set ***AGC*SPD*** to ***SLO*** and ***AGC*DCY*** to the slowest decay rate. Set your XG1, XG2, or XG3 signal generator first to -33 dBm. Tune in the signal and then switch to -73 dBm. You should hear the audio level slowly ramp up as the AGC gain changes at the decay rate. This can also be heard easily if you listen on a band plagued by static crashes.

7.6.5 AGC SLP

Figure 7-9 shows the effect of changing the ***AGC*SLP*** parameter from ***SLP=10*** (steepest slope) to ***SLP=15*** (flat) with ***THR=8***.

If ***SLP=10***, we get the largest change in audio level for an input signal change when signals are above the threshold. You may wish to choose this for contest operating so you can pick out the signal you're trying to copy through the QRM by its strength. When ***SLP=15***, the curve is virtually flat – all signals above the threshold will give about the same audio loudness. You may wish to do this for casual operating and rag chewing or when static crashes are annoying you.[29] It is also useful for digital modes.

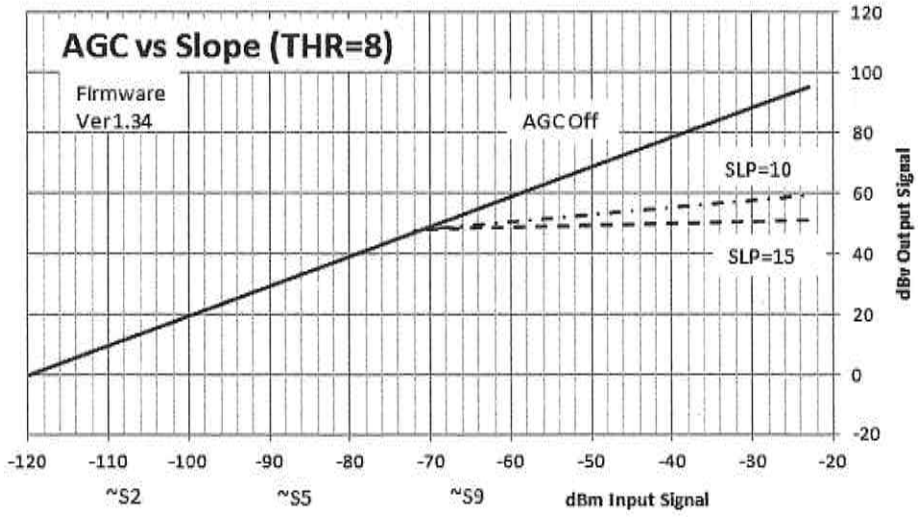

Figure 7-9. KX2 AGC and SLP.

Exercise
Set ***AGC*THR = 4*** and ***AGC*SLP = 10***. Inject a 50 uV (-73 dBm) signal using a signal generator. Compare how loud the signal sounds with the preamp on and off. Now change ***AGC*SLP*** to ***15***. How much does the audio change when switching the preamp on and off now?

7.6.6 AGC THR

Figure 7-10 shows how the threshold or onset of AGC changes as we change ***THR*** from 4 to 8. You may wish to choose a higher ***THR*** value if, for example, you are trying to pull weak signals out of the noise on 160 meters so the weak signal is not attenuated by the AGC's well-intentioned attempt to be helpful.[29] A higher ***THR*** is helpful in a pileup when trying to distinguish weak signals from stronger ones. A lower ***THR*** combined with a higher ***SLP*** will tend to make all signals sound about the same.

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[29] Future firmware versions may give us more choices for the AGC SLP and THR.

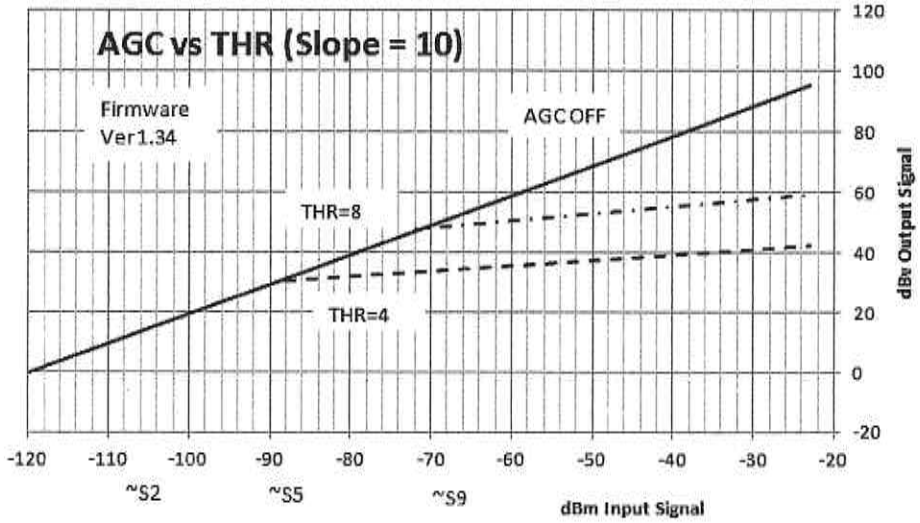

Figure 7-10. KX2 AGC and THR.

7.6.7 AF Limiter

Table 7-4 shows the AF limiter menu. If you **ever** operate with the AGC turned off, you should set the audio level limiter with the ***AF LIM*** menu to avoid hearing damage due to loud signals. A value of 20 seems to produce good results.

Table 7-4. Menu for the Audio Frequency Limiter.

Menu	Default	Description
AF LIM	***nor 30***	This adjusts the audio output limiter. It can protect your ears if you operate with AGC Off. The range is from 0 to 30 where 30 is the highest level. Signals that exceed this will sound very distorted, reminding you to turn down the RF or AF gain controls. The AF limiter works only when the AGC is off (AGC-). Typical settings used by those who turn their AGC off are 17 to 23.

7.6.8 Hints for Setting your AGC

The discussion and figures above should help you set the AGC for the type of operating you enjoy. Although Elecraft has given us tremendous flexibility and the tools to set up the AGC characteristics to your liking, it does mean that you must invest some time and effort in order to set the AGC parameters to best suit your operating styles. How you

would like the KX2 to react depends on the kind of operating you do – ragchewing, DXing, or pile up busting in phone or CW.

Most KX2 operators find that adjusting the ***SLP*** and ***THR*** produce the most discernible changes in the sound they hear. For most other settings the defaults seem to be adequate.

Your choice of a value for ***THR*** will depend somewhat on how noisy your band conditions are. If the threshold is set below the ambient noise, then noise will activate the AGC and the resultant audio signal-to-noise ratio will be reduced. Because the AGC settings are not saved on a per-band basis, you may wish to change the settings, particularly ***THR,*** for different bands. For example, on a noisy band, such as 80 meters on summertime afternoons, you could set ***THR*** higher so that the noise does not activate the AGC.

Another consideration for adjusting ***THR*** and ***SLP*** is how you would like the KX2 to treat different strength signals. While participating in a round-table ragchew with Big Signal Bob and Wimpy Signal Willy, your QSO will be more enjoyable if Bob and Willy can sound about the same (audio level). In this case, setting ***THR*** low (say 4) and ***SLP*** high (say 15, or flat) will accomplish that objective.

If you use the ***DATA A*** and ***AFSK A*** modes with computer software such as MMTTY decoding audio tones, you may wish to set ***THR*** low and ***SLP*** high so that the audio levels remain fairly constant over a range of signal strengths.

A serious contester, trying to pull call signs out of a pileup, would like ***SLP=10*** and ***THR=8*** or higher to achieve the best dynamic range for signal discrimination based on signal strength. This allows the strong signals to sound louder than the weaker ones, making it easier to pick them out of the pile up. This combination of settings is especially valuable when the pileup consists of stations of all about the same signal strength. Any enhancement you can give to the slightly stronger signals will make it much easier copy them in a messy pileup.

AGC decay (***AGC*DCY***) allows you to select the rate at which the AGC gain adjusts itself to the current signal after a change from a stronger to a weaker signal (Figure 7-4, Figure 7-5). Soft (longer) decay ramps the gain change in such a way to create less in-band IMD in pileups. However, a soft decay means that your receiver will take longer to bring weak signals up to the desired higher gain setting.

AGC*ATK controls how fast the gain settles on the stronger signal after a weak-to-strong signal change. Similarly, ***AGC*PLS = nor*** gives good attack rate performance in the presence of pulse noise by preventing the AGC from cranking up the gain on one-shot events.

AGC*HLD applies to voice modes.[30] It can reduce IMD caused by normal AGC-S decay times.

Many operators prefer AGC- F for CW and AGC-S for SSB. Contesters, though, sometimes choose AGC off. If you do, you should set ***AF LIM*** to a value that limits or clips the audio level so that you do not hurt your ears when a strong signal appears.

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[30] Future firmware revisions may include other modes.

Lyle Johnson, Elecraft's digital signal processing guru, notes that there is some interaction between the operation of the DSP noise reduction and the AGC settings. By choosing a flatter slope and lower threshold, the noise reduction will be more effective on weaker signals.

When you experiment with setting the AGC parameters, make changes slowly. Elecraft recommends that you change one setting by one unit, plus or minus, at a time. Then use the rig for a few days before making the next adjustment. You should keep a log of the changes you have made and of your reactions based on the way you use your KX2.

Another hint involves using the 20 dB attenuator. When many strong signals are present in the receiver's front end, the attenuator can help to keep the AGC from limiting.

Finally, remember that these AGC configurations are not saved on a per-band, per-mode basis as many other configuration menu items are. They apply across all bands and modes.

Exercise
Tune to a band that is fairly noisy at your location, say 40 meters. Select the ***AGC*THR*** menu (tap the [1] key if ****THR*** is not showing). Start with ***THR*** at a high value (8), and slowly change it to a lower value. At some point you will hear the speaker noise start to reduce as the AGC kicks in. Set ***THR*** to just above this value to avoid having AGC operate on band noise. As they say, "Your Mileage May Vary."

7.7 Audio Effects – AFX

Some interesting psychoacoustic effects can be created by slightly delaying or providing a small phase shift between what we hear in one ear compared to the other. The sense of spaciousness or separation of the signals produced can help us to improve our copy. Setting the ***AFX MD*** menu to ***dELAY*** turns this feature on. The amount of delay is not adjustable, at least with the firmware as this is written. You must be using stereo headphones or two external speakers to hear this effect; some operators love it, some don't.

The audio effects are disabled in the ***DATA A*** and ***AFSK A*** modes.

7.8 Receiver Audio Equalizing

The KX2 provides eight bands of receiver audio equalization to compensate for acoustic deficits in your station, headphones, or even your hearing. An important reason for ***RX EQ*** is to reduce the effects of extraneous signals and noise. For example, audio below about 400 Hz and above 3 kHz contributes little to the intelligibility of SSB or FM, so limiting the response to that range can reduce QRM and noise. Likewise, if we're copying a CW signal in the 400-600 Hz range, the only value of wider response is to be able to hear weak off-frequency signals calling you.

There are two receiver equalization setups available – one for CW and one for SSB. Receiver equalization does not apply in DATA modes – equalization would distort the signal and cause errors in the decoders.

Choose CW or SSB mode

Access the ***RX EQ*** menu. The VFO A display area will show eight audio bands, whose center frequencies are shown in Figure 7-11. Tapping keys [1] – [8] and tuning VFO A adjusts the receiver's audio gain plus or minus 16 dB in one dB steps. As you rotate VFO A, the amount of gain or attenuation in dB is shown in the VFO B area.

Elecraft recommends that you do not change the gain as much as +16 dB because high gain in these narrow audio bands can cause artifacts and other distortions.

You can hold [OFS/B/CLR Ø] to set all bands to 0 dB.

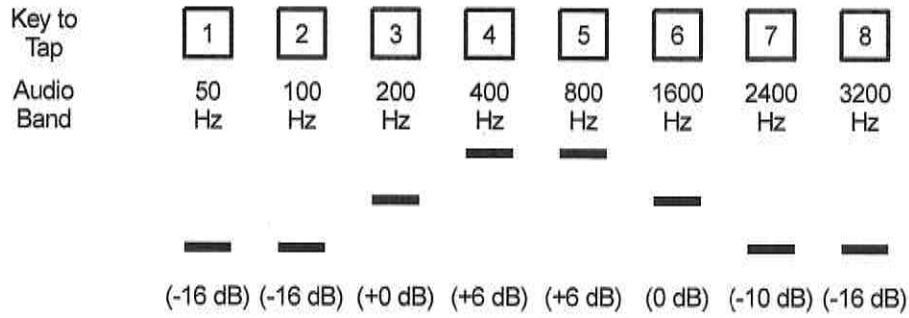

Figure 7-11. Receiver CW audio equalization.

7.9 VFO B Alternate Displays

We have seen how the VFO B display is used when you are entering memory labels, displaying decoded CW and RTTY text, and accessing the configuration menu. The VFO B display can show a wide variety of other information in addition to frequency by tapping [DISP] and rotating the VFO B knob. However, you cannot display alternate VFO B data while data or CW text decode is active.

Table 7-5. VFO B alternate display.

Item Displayed	Example
Time	***04:52:17*** The KXIO2 option module must be installed for time to be kept. If not, the time since the last power-on will be displayed. Use the ***TIME*** menu to set the time.

Power Supply Voltage	***PS 13.6 V*** This stays visible so the voltage can be checked during transmit. If you have both the internal battery pack and an external power supply connected, the display will show the higher of the two.
Supply Current	***1.06 A*** Typical receive current will be 0.15 – 0.20 A and transmit current 1 to 3 A.
Power Amplifier Temperature	***PA.I 29C*** or ***PA.X 29C*** One of two power amplifier temperatures will be displayed. If a KXPA100 is connected via the KX2ACBL and the KX3-to-KXPA100 adapter cable and the ***PA MODE*** menu is ***On***, ***PA.X nnC*** shows the e***X***ternal amplifier's temperature. Otherwise the internal KX2 temperature is shown.
True RMS Audio Voltage in mV	***AFV 2166***
Relative Audio Voltage in dB	***0.0 dBV***
Amp hours	This shows the total ampere-hours used since the value was last reset. It can be used to test batteries or estimate the remaining battery charge. Holding OFS/B/CLR ∅ when in the ***AMP HRS*** menu resets the amp-hours to 0.

7.9.1 AFV and dBV Measurements

Elecraft added the ***AFV*** (AF voltage) and ***dBV*** (AF voltage in decibels relative to the last ***AFV*** measurement) capability to help them make quick measurements at the factory before shipping K3 transceivers.[31] It proved very useful in the field as well and has been included in the KX2. It is designed to make measurements with a constant signal source such as the XG1, XG2, or XG3, but real-signal measurements can be made as well.

> AFV and dBV measurements are a great resource to see if changes you make are effective.

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[31] The actual definition of dBV is the voltage expressed as decibels relative to 1 V_{RMS}. By international standards, 0 dBV is 1V_{RMS}. That is NOT what this readout gives us. Rather, the KX2 establishes an arbitrary reference voltage equal to whatever ***AFV*** voltage was measured in the last 15 seconds or so. This is very useful, because it can be used to compare changes in the strength of a signal, or to compare one with another, or even to measure the response of filters, but it is NOT dBV. ***dBV*** (as defined for this KX2 measurement) = 20 $\log_{10}$ (New Voltage/Reference ***AFV*** Voltage).

Tapping DISP and rotating VFO B to ***AFV*** sets up a reference audio signal that serves as the ***0.0 dBV*** value. This is NOT dB relative to 1.0 volt. It is relative to whatever the reading was on ***AFV*** when you rotate VFO B to the ***dBV*** display. After the ***AFV*** display settles and you rotate to ***dBV***, the display will converge to ***0.0 dBV***. Now, further changes in the audio output voltage, say if you change an antenna, or a filter, or the preamp, or RF gain (but not AF gain) will show as a dB change relative to the original audio voltage level.

- Set up the reference conditions for the measurement you wish to make.
- Tap DISP and rotate VFO B to ***AFV***. Wait until the voltage reading (mV_{RMS}) stabilizes.
- Rotate VFO B to ***dBV*** and wait for the display to stabilize to ***0.0 dBV.***
- Now make your changes and observe the changes in ***dBV***.
- You do not, and should not, change back to display ***AFV*** because that will reset the reference voltage.
- To return to the normal frequency display for VFO B, tap DISP again.

Exercise

Measure the gain and attenuation given by the preamp and attenuator.

Set the transmitter output power to 0.0 (to make sure you do not accidently transmit into the signal generator) and attach an XG1, XG2, XG3 or other signal generator. Set the generator on the 1 μV output. Tap DISP and turn VFO B to the ***AFV*** display and wait for it to settle. Rotate VFO B to the ***dBV*** display and wait for it to settle on ***0.0dBV***. Tap PRE to turn the preamp on and you see its gain (about ***+20 dBV***). Tap PRE again to switch in the attenuator and you should see a reading about 20 dB less.

Exercise

Repeat the exercise above, but this time use the 50 μV output of your signal generator. What causes the difference in the readings for the gain and attenuation?

50 uV is enough signal to operate the KX2's AGC. Therefore, you should now see less increase in audio signal with the preamp on and less decrease with the attenuator switched in due to the slope of line B-E in Figure 7-7, page 108. Turn AGC off and you will see changes similar to those made in the previous exercise. (These measurements were made with ***SLP=0*** and ***THR=8***. If you have different settings you may see slightly different results.)

Exercise

Measure the width of a DSP filter.

Set the transmitter output power to 0.0 and attach an XG1, XG2, XG3 or other signal generator. Set the generator on the 50 μV output. Turn AGC off, set up the filter width you wish to measure, and zero beat the signal generator in CW mode. Turn down the RF gain, tap DISP and turn VFO B to the ***AFV*** display and wait for it to settle. Rotate VFO B to

the ***dBV*** display and wait for it to settle on ***0.0dBV***. Now rotate VFO A to higher frequency until the display shows ***-6 dBV*** and record this frequency. Rotate to the lower band edge to the ***-6 dBV*** point and the difference in the two frequencies is the filter bandwidth. (Note: You may see a "lopsided" filter bandpass depending on your CW sidetone frequency and the filter width selected. This is because the gain is rolled off on the low side starting at around 200 Hz. This is a necessary AF stability precaution in a miniature SDR with tons of gain at baseband. (Thanks, N6KR.)

7.10 Oops, Why is it doing That?

A feature, and a problem, with radios such as the KX2, which implement so much of their functionality in software, is that many functions are programmable and it is difficult to keep track of the radio's current configuration. This can be a problem because we can find ourselves with the radio not operating as we hoped and expected.

In addition to the *Troubleshooting* section in the *Owner's Manual*, which shows error messages that you might see and other troubleshooting tips, here are some "gotcha's" that have been posted to the Elecraft email list server.[32] If you can't solve your problem with hints from the *Owner's Manual* or this list, try searching the email reflector archive. If no luck, then post your question to the reflector, where plenty of expert advice is available. But do try the archive first, its faster and you won't be the gazillionth owner to ask the same question.

Audio

When I turn on NB **or** NR**, I hear lots of garbage:** You probably have the NB and NR settings too high. Try reducing the settings.

When I turn on NB **or** NR**, VFO does not change the frequency:** VFO A is locked when the NR or NB level is displayed on VFO B. Tap any key to return to normal operation.

My receiver sounds like it is dead: The noise reduction algorithms are so good that they can reduce all receiver noise to nearly zero. Check to see if NR is turned on.

I am getting a *HI CUR* warning: The KX2 is designed to be very battery-friendly and can detect when the AF gain is high enough to increase power consumption. When this condition is detected, a ***HI CUR*** warning is displayed and the AF gain is automatically reduced.

CW

After I turn on the rig, the VOX control is turned off: For CW, a selection in ***CW WGHT*** (tap 4) can turn VOX off when the rig is turned off. You would do this to avoid

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[32] Mainly for the K3S and KX3, but are applicable to the KX2 also.

keying the radio when turning on a PC whose serial port is connected to a KEY input. You can remind yourself about this by programming a power-on banner message such as ***VOX OFF*** using the KX2 Utility program. To restore VOX operation set the ***VOX MD*** menu to ***On***.

When I connect an external keyer to the KEY input, the decoder does not work for my transmitted CW: The CW decoder only works when you are using the internal keyer using the KXPD2 or an external paddle in the KEY input.

I can't program a CW message using an external keyer: This can be done only with the internal keyer or the KX2 Utility program.

When I switch to CW mode from a data mode, the PTT activates and the KX2 goes into transmit: When you are in DATA A or AFSK A mode, ***MIC BTN*** is set to ***OFF*** so that a low impedance, or a short, between Ring 1 and shield of the MIC connector will NOT key the rig. When you switch back to CW from a data mode, and if you have ***MIC BTN PTT***, then a low impedance between Ring 1 and shield, if it exists, will key the KX2. The solution is to set ***MIC BTN*** to ***OFF*** (you must be in CW or SSB/LSB mode) and then use VOX to key the rig. Alternatively ensure there is high impedance or open circuit between Ring 1 and the shield of the data cable plugged into MIC. For more information, see Figure 5-2, page 62 and *KX2-to-Sound Card for AFSK A and DATA A*, page 85.

When I plug my paddle in the dits and dahs are reversed: Enter the ***CW KEY1*** menu and select the ***tiP*** connection to conform to your paddle's wiring.

Miscellaneous

I've done something wrong, and now the KX2 will not respond to anything I do: First try disconnecting the power supply and removing the batteries. Wait a bit and then reconnect the power supply. If you still can't power it up at this point, connect the KX2 to a computer and hold down the RATE and A/B switches simultaneously for about 10 seconds. After this you will see the TX LED flash and ***MCU LD*** on the display. Connect to a computer and start the KX2 Utility to load new firmware.

A hint for miscellaneous weird things happening: RF in the shack can cause the KX2 to act strangely. If a bit gets changed in the KX2's control software, you can often reset things to normal by turning the power off and then back on. You may also want to consider reloading all firmware and/or restoring an earlier configuration. Then try to track down and eliminate the reason for the RF in the shack – it is never a good thing!

My KX2 has experienced a MCU load failure. I have followed the procedure in the help file in the KX2 Utility program but it still fails to load: The help file procedure should work properly. You must make sure to follow the procedure *exactly*. It may help to leave the KX2's power off for more than the suggested 30 seconds and it may help to re-boot the computer, reload the KX2 Utility (first make sure you have the latest version of the Utility) and close the port before reconnecting the power to the KX2. Also, make sure you do not have any other devices between the computer and the KX2 except for the USB-Serial adapter if you are using a USB port. Operators have reported problems updating software when using a microHAM interface. If you have a computer with an actual RS232 serial port, you may want to try that.

I can't get the scan function to work: Make sure you have the lower and upper band limits in a memory and that you recall that memory channel before holding RCL/SCN. Also, scan will not work if VFO A and VFO B are on different bands.

When I try to connect to the KX2 with the Utility program, I get the status message "KX2 waiting for firmware load. RS-232 speed 38400 bit/s." but the Utility will not update any firmware: This can happen if you have a serial port that looks like it is active to the Utility but is not actually connected to the KX2. Try selecting another serial port in the Utility Port page.

When I plug my Heil microphone in the radio, PTT is activated immediately: The Heil microphone plug may be a monaural (T-S) plug that will short the Ring 2 to shield connection in the MIC jack. This will activate PTT. You will have to go into the menu and set ***MIC BTN*** to ***OFF***.

After installing an optional module, the KX2 doesn't seem to recognize it: Any time a KX2 optional module is disabled or enabled, the module will not be recognized until power has been cycled on the rig. By cycling power after making module enable changes, the module is sure to be written into the KX2's firmware tables. They will operate as documented in their respective owner's manuals.

I get N/A when I try to change a menu item: Many menu items are mode-specific. For example, if you try to change ***MIC BIAS*** while in CW mode, the VFO B area will show ***N/A*** indicating that ***MIC BIAS*** can only be changed when in a voice mode. Another reason you may get this display is that the feature may not be enabled in your version of the firmware. It either hasn't been implemented by Elecraft yet or you need to update your firmware.

My S-meter has a segment that stays on and doesn't seem to indicate signal strength: This is an indication that your RF gain has been turned down. Check the ***RF GAIN*** menu.

The DC power connector on my KX2 seems to be flakey: Check to make sure you have the correct coaxial power connector. It should be 5.5 mm OD x 2.1 mm ID. A very common size with 2.5 mm ID will not make a good connection.

My KX2 seems to shut down by itself: Check the ***AUTO OFF*** menu. You can set that to turn the KX2 off if 3 to 20 minutes have elapsed without a control operation or transmission. Set it to ***InFinitE*** to leave it on.

Noise Reduction

When I tap NR, it does not work. All I get is <*N/A*>: Noise reduction does not work with AGC off or in Data modes. Check to see the AGC- icon is showing. If it is, AGC is off; go to the ***AGC MD*** menu and set it ***On***.

Power

When I hold TUNE I get 10 watts out and I'd like less to tune my amplifier: Access the ***TUN PWR*** menu item. By changing it from ***nor*** you can set it to any output power level you like when you hold TUNE.

When I hold TUNE, I don't get the output power I set using the KYR-SPT/MIC/PWR knob: Set the ***TUN PWR*** to ***nor***.

When I tap ATU I see 2 or 3 W displayed instead of the 10 watts I have the set for the power out: This is normal. The ATU uses 2 or 3 watts output to tune the antenna and cannot be changed.

When I tune an antenna with the ATU I can get 1.1:1 but when I run higher power it shows higher SWR: This often indicates that you have a loose connection or some bad coax in your system.

When I transmit full power on 12 meters I get a HI CUR warning: If you see a high-current warning, just reduce power a bit. The KX2 is rated at 10 W on 80-17 meters and 8 W on 15 – 10 meters.

When I transmit the output power always drops back to 5 watts: One of these things may be causing this: power supply not capable of 3 amps at 100% duty cycle; power supply voltage low; high VSWR; it is overheating.

RTTY

When I operate RTTY, changing bands changes from FSK D to AFSK A: The data mode is saved on a per-band basis. Tap DATA and select the data mode you want for each band.

When I try to change *VOX MD*, the display shows *n-A*: This happens in ***FSK D*** or ***PSK D*** mode. You cannot use PTT, only VOX, in these modes.

SSB

When I am in sideband, I do not get any power out: Check to see if you need to turn bias on for your microphone.

When I try to adjust *MIC BIAS* all I get on the display is *N/A*: Check to see if you are in CW mode. You must be in a voice mode to be able to adjust ***MIC BIAS***

I have been getting very poor audio reports: Avoid settings where all controls are run at their extremes. This includes bands of equalization settings added to extreme settings of compression. Taken together, these may produce poor audio and comprehension reports from the receiving station.

In USB or LSB mode the KX2 displays the CMP and ALC meter rather than SWR and RF: See Table 5-3, page 66.

VFO

Holding SPLIT gives *SPL N/A*: You cannot operate Split across different bands (cross-band Split) or cross-mode Split, except for CW/SSB on the same band. If you see this message, VFO B is on a different band or different mode, or the split is too wide. It's a good practice to tap A>B at least once to transfer the band information before holding SPLIT.

When I switch between CW and SSB my VFO A frequency changes: See ***CW WGHT*** and tap 5 to set ***VFO OFS*** to ***VFO NOR***.

Chapter 8. KX2 Hardware

8.1 The KX2 Receiver

A predecessor of the KX2 receiver is illustrated by "Ye Olde Receiver" design in Figure 8-1. This is a *double conversion*, superheterodyne receiver, with two mixers translating the RF signals down in frequency to audio, in two steps. A bank of crystal filters in the first IF provides the filtering and bandwidth selection for the received signal. The Elecraft K2 is a good example of this kind of receiver, which has been the standard design for more than eighty years.

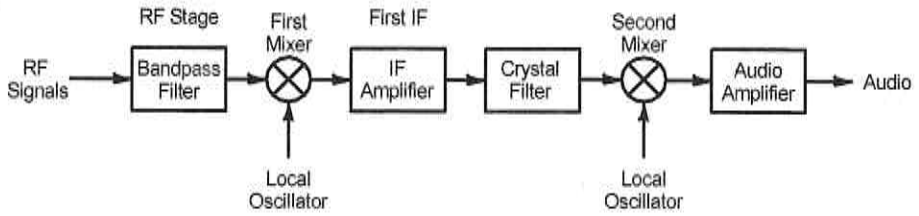

Figure 8-1. Ye olde receiver design.

The next step in receiver design is represented by the K3; its receiver is shown in Figure 8-2. This, too, is a double conversion receiver but now with a *roofing filter* in the first IF. The roofing filter is a crystal filter like that in Ye Olde Receiver, but its function is not to provide the receiver bandwidth selection like the crystal filter in Figure 8-1. Instead, it is designed to limit the RF energy to which succeeding stages are exposed. Following the second mixer, an analog-to-digital converter converts all signals from analog to digital, and the digital signal processing stage applies further filtering, signal processing, and detection to all signals. The digital signal processing filter establishes the final bandwidth of the signal.

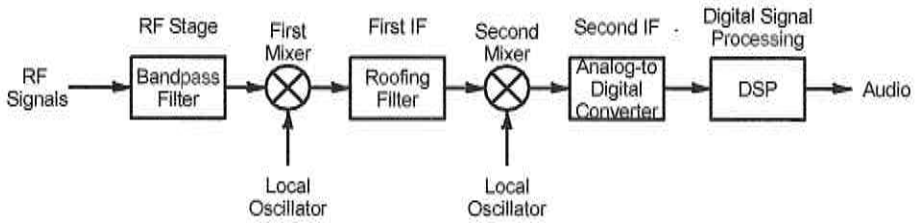

Figure 8-2. K3 receiver design.

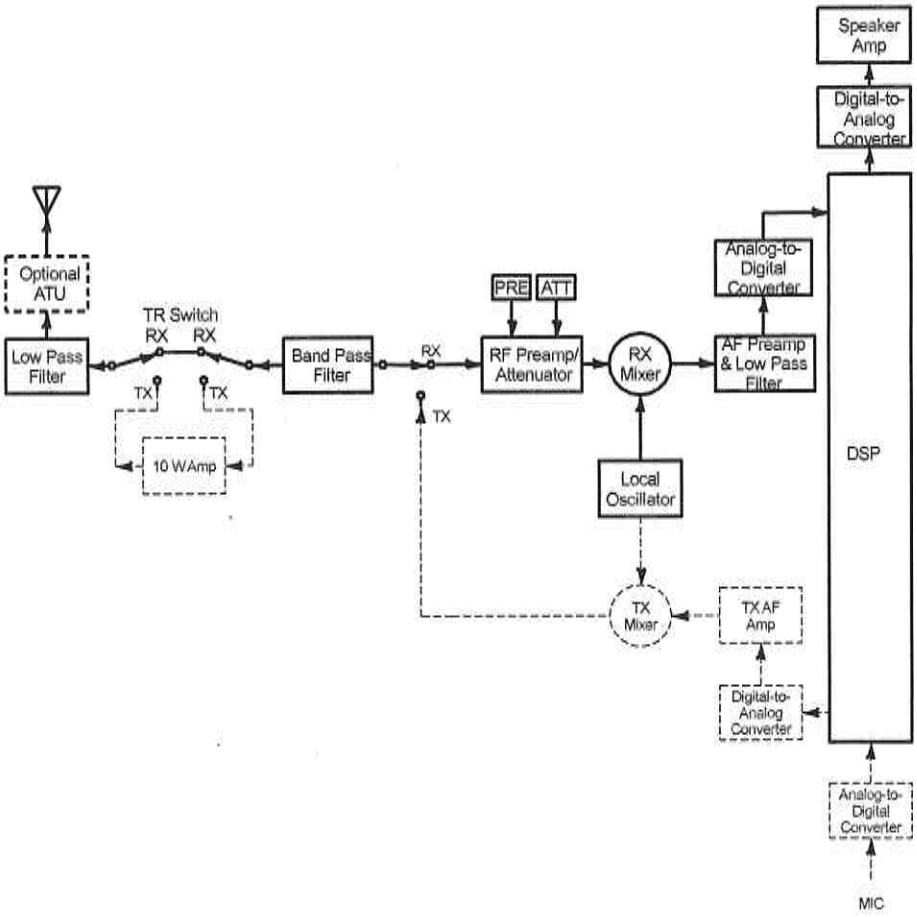

Figure 8-3. KX2 receiver block diagram.

Figure 8-3 shows the KX2 receiver block diagram. Because the KX2 is a transceiver, the transmitter uses some of these blocks also. The KX2 receiver is a *single conversion* design (sometimes called a *direct conversion*). The mixer converts the RF directly, in a single step, all the way down to audio frequencies. (Look Ma, no IF!). The KX2 does not have a roofing filter like the KX3 and K3S. Instead, extra care has been taken with the electronic design to avoid overload conditions.

The RF Stages

These are the blocks from antenna through the KXAT2 (optional) ATU to the RX Mixer. As we can see in this diagram, the low pass and band pass filters are in the output of the transmitter final amplifier, too; they eliminate higher order harmonics that might be generated when you are transmitting. The band pass filters are used also by the receiver

and are designed to provide rejection of images, harmonics, and intermodulation distortion products (IMD) on each Amateur band.

There are two controls over the signal levels in the RF stages. First, you can switch in a -20 dB attenuator by successively tapping PRE until the ATT icon is showing. When the PRE icon is showing, you have activated a +20 dB preamp. The attenuator and preamplifier settings are saved for each band (per-band). The 20 dB preamp must be on for a 50 uV (-73 dBm) signal to indicate S-9 on the S-meter. The RX mixer converts the RF signal directly to the baseband audio.

Audio Signal Processing

The output of the RX Mixer is digitized by the analog-to-digital converter and used in the DSP for modulation detection and digital signal processing. Following the DSP, a digital-to-analog converter produces the final audio output signal.

8.1.1 Receiver Filtering Overview

Figure 8-4 illustrates the organization of the receiver's analog and digital signal processing. The bandpass filter selected for each band filters the wide spectrum entering the receiver's front end, limiting it to 15 kHz (Figure 8-4(a)). Following the analog-to-digital conversion (b), the digital signal processing (DSP) sets the final bandwidth (c) of the receiver; you control this by tapping FIL and using the AF/MON ∅ and KYR-SPT/MIC ∅ knobs. The final audio output is produced by a final digital-to-analog converter.

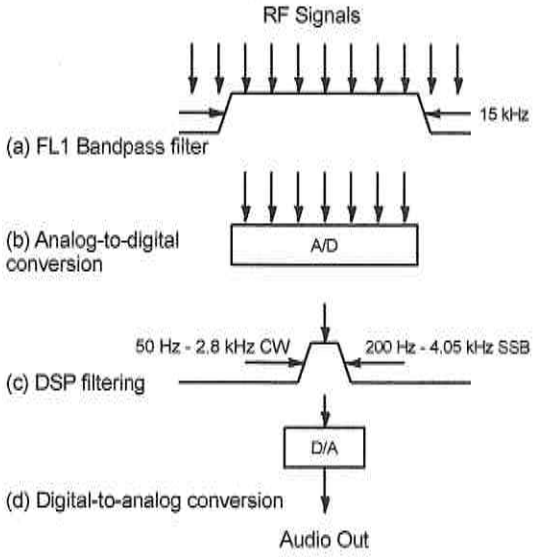

Figure 8-4. Receiver signal processing; (a) FL1; (b) A/D; (c) DSP; (d) D/A.

8.2 The KX2 Transmitter

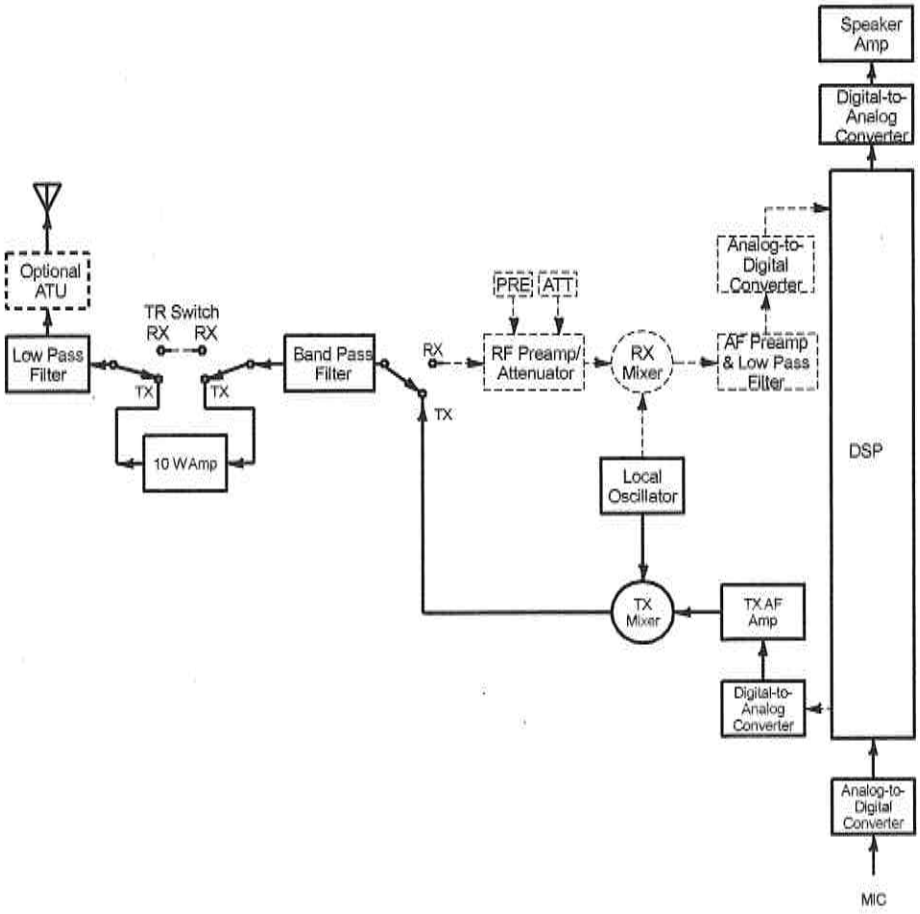

Figure 8-5. KX2 transmitter.

Figure 8-5 shows the KX2's transmitter. Audio from the MIC input, or keying from the CW paddle or the KEY inputs, is processed by the DSP to produce the appropriate waveform for transmission. The digital audio signal is converted to an analog signal and then mixed with the Local Oscillator in the TX mixer, filtered by the bandpass filters, amplified, filtered again by the output low pass filter and then transmitted through the optional ATU.

8.3 Software Defined Radios – SDRs

The KX2 is a member of a class of radios called *software defined radios*, or SDRs. While there is no defined or agreed upon standard definition for an SDR, the operating characteristics and personality of the KX2 clearly are defined by its software. The beauty of this type of design is obvious and is exploited very effectively by Elecraft engineers. We all look forward to software (firmware) updates as we know that these provide us with a continuing stream of advancement and improvements for our KX2s.

The KX2 contains the hardware to convert RF directly to baseband (AF) signals that are then converted by an analog-to-digital (A/D) converter to a stream of digital values. These are processed by the KX2's digital signal processing (DSP) stage. The DSP is implemented by software running in a special microprocessor designed especially to perform digital signal processing procedures. This is the software defined part (even though it is called firmware when we update our KX2s).

There are also software defined "radios" whose software is implemented in a personal computer and which use some external hardware to do the RF to baseband signal conversion. Examples include HDSDR[33], SpectraVue[34], NaP3[35], PowerSDR[36], and others. These programs accept in-phase (I) and quadrature phase (Q) signals produced by the radio part of the SDR. They can decode modulation, provide bandpass filtering, and most interestingly, provide us with a spectrum, or panadapter, display like the Elecraft PX3 used with the KX3 and the P3 with the K3.

Note: The KX2 does not produce I and Q signals to be used by an external panadapter program.

8.4 The KXBT2 Li-ion Battery Pack and KXBC2 External Charger

8.4.1 Batteries

- Use only the optional 11 V, 2.6 aH Li-ion KXBT2 battery pack and external KXBC2 charger available from Elecraft or from http://www.tenergy.com/.
- You cannot change the Li-ion batteries with an external power supply connected.
- The Li-ion battery pack must be removed from the KX2 for charging.
- Elecraft recommends that you remove your batteries whenever you choose to operate in a fixed mode with an external power supply for an extended time. This removes any chance that they may leak corrosive substances into your KX2.

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[33] High Definition Software Defined Radio. http://www.hdsdr.de/

[34] http://www.moetronix.com/spectravue.htm

[35] https://www.box.com/s/f9c0e1267092579715ae/1/280382327

[36] http://www.flex-radio.com/

- A ***BAT LOW*** warning will be displayed when the battery voltage reaches the threshold set by the ***BAT MIN*** menu. ***BAT MIN*** may be set at ***10.0*** for Li-ion battery packs as well as for many 12 volt batteries.
- The KX2 will automatically shut off if the battery voltage sags to 7.5 volts.
- The KXBC2 has an LED that will be red during charging and which changes to green when the charge is complete.
- A full charge cycle typically takes 1 to 2 hours depending on the charge state of the battery.
- The KX2 includes an amp-hour meter function that allows you to monitor the charge state of the battery.
- When the battery is removed for charging, a super capacitor will keep the optional KXIO2 real-time clock running for about 2 two hours.
- The smaller the discharge, the longer the battery will last. If at all possible, avoid full discharges and charge the battery more often between uses. Partial discharge of Li-ion is fine. There is no memory and the battery does not need periodic full discharge cycles to prolong life.

Table 8-1. Li-ion Battery menu.

Menu	Default	Description
BAT MIN	***10.0***	***BAT LOW*** warning threshold when the internal or external supply reaches this value. ***10.0*** — 12 volt batteries such as some 12 V gel cells and the optional 11 V Li-ion battery pack. The KX2 will turn itself off if the supply voltage drops below 7.5 volts.
AMP HRS		Shows total amp hours used by the KX2. This is useful for testing battery packs, estimating remaining battery charge, or tracking the amp hours needed to complete one or more objectives (e.g., a certain number of QSOs at a given power level). The value is preserved on power-off, so it can show amp hours used over any number of operating sessions. Holding OFS/B/CLR ∅ resets the value to 0.000; this is typically done after swapping in a fresh battery. (Amp hours is also one of the special VFO B displays; tap DISP, then rotate VFO B until you see ***n.nnnAH***. This display persists during transmit so you can monitor the rate of increase. In receive mode, the amp hour value will go up by .001 every 20-25 seconds. In transmit mode, the value will go up by .001 every 2 to 10 seconds, depending on operating mode, power setting, and antenna load impedance (all three can affect current drain).

Replacing Batteries

The optional KXIO2 real-time clock will continue to maintain correct time for at least two hours if you remove batteries to charge them. . Be sure to not install or change batteries with an external power supply connected.

Handling and Usage[37]

- Operating temperature range is -10 to 55 °C (14 to 130 °F).
- Do not place the battery on or near fire, stoves, or other high-temperature locations. Do not use or store the battery inside a hot vehicle. Do not leave the battery on surfaces that would help spread fire, such as wood or carpeting.
- Do not expose the battery to direct sunshine except for brief periods, such as when swapping battery packs.
- Do not short the positive and negative terminals of the battery together.
- Do not carry or store the battery together with metal objects that could cause a short, such as bare wire.
- Do not pierce the battery with nails, strike the battery with a hammer, step on the battery, or otherwise subject it to strong impact or shock.
- Do not allow the battery to get wet.
- Do not disassemble or modify the battery, or tamper with the battery's built-in safety and protection devices.
- Immediately discontinue use of the battery if, while using, charging, or storing the battery, the battery emits an unusual smell, feels hot, changes color, changes shape, or appears abnormal in any other way.
- In the event that the battery leaks and the fluid gets into one's eye, do not rub the eye. Rinse well with water and immediately seek medical care. If left untreated the battery fluid could cause damage to the eye.

Charging

- Charging temperature range is 0 to 40 °C (32 to 105 °F).
- The battery pack must be charged externally, using only the recommended or supplied smart-charger.
- Do not leave the battery unattended during charging. Charge only on a nonflammable surface.
- Do not attach the battery to a power supply, to another battery, or to a car's cigarette lighter/accessory jack.

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[37] From E740288 KXBC2 and KXBT2 Instructions, rev A5.pdf available on the Elecraft website.

- While charging, do not place the battery in or near fire or into direct sunlight. When the battery becomes hot, the built-in safety equipment is activated. This prevents the battery from charging further. Further heating of the battery can destroy the safety equipment and can cause additional heating, breaking, or ignition of the battery.
- Do not continue charging the battery if it does not recharge within the specified charging time. Doing so may cause the battery to become hot, rupture, or ignite.

STORAGE

- Storage temperature range is -20 to 45 °C (-4 to 113 °F). However, storing the batteries between 0 and 30 C (32 to 86 °F) will greatly increase battery life.
- For maximum life, batteries should be stored charged at about 30 to 50% of capacity.
- Batteries not in active use should be fully charged at least once per year to prevent over-discharge.

Shipping

- Shipping restrictions vary according to the company handling the cargo. The following are general requirements. Check with your shipper for details.
- When shipping 1 or 2 packs, place them in a rigid box with the warning below on the outside.

LITHIUM ION BATTERY: DO NOT LOAD OR TRANSPORT PACKAGE IF DAMAGED

CONTACT (include your telephone number).

8.4.2 KXBC2 FAQs

The care and feeding of the KXBT2's Li-ion batteries is perhaps the most challenging aspect of the KX2 Experience. Take these few simple precautions – they will help you to do battery management without tears.

But what if my batteries are not fully discharged? You may reduce the charging time proportionally if you feel your batteries are not fully discharged. The KXBC2 is a 2000 mA, constant-current charger. You should not overcharge the battery.

Can the Li-ion batteries overheat? Like all batteries, some of the electrical energy you put into them when charging gets turned into heat, so Li-ion batteries do heat up while charging.

What is polarity reversal? A battery pack, consisting of a series of cells, may have one cell that has slightly lower capacity than the others. When the battery pack becomes completely discharged, or nearly so, the good cells can drive the lower capacity cell into a

reverse polarity condition, which permanently damages it. To avoid this, do not completely discharge the battery pack.

How do I measure the battery voltage? Remove any external power supply. Tap DISP to switch to the alternate VFO B display and then rotate OFS/B ∅ to the ***PS*** display.

See *VFO B Alternate Displays*, page 116 for other VFO B displays.

8.5 The KXIO2

8.5.1 Real-Time Clock

The KX2's alternate VFO B display can display a real-time clock. The optional KXBC2 battery pack must be installed for the clock to keep time when an external power supply is disconnected or off. If you do not have the battery pack installed, the clock will continue to keep time as long as your external supply is on, but will stop keeping time after about two hours when you turn it off.

Setting the Real-Time Clock

The real-time clock operates in a 24-hour format.

- Turn the KX2 on.
- Hold MENU and select ***TIME***.
- Tap 1 and turn VFO A to set the hour.
- Tap 2 and turn VFO A to set the minutes.
- Tap 3 and turn VFO A to set the seconds.
- Tap DISP to exit the menu.
- The KX2 Utility program *Configuration* tab has a function that will set the KX2's time from your computer's time.

If your clock does not keep accurate time, you can adjust it with the ***RTC ADJ*** menu.

Menu	Description
RTC ADJ	This parameter can be adjusted to improve the long-term accuracy of the real-time clock on the KXIO2 option. (the ***KXIO2*** menu must be set to ***nor*** to use the RTC.) Monitor your clock's accuracy over 24 hours, preferably at your typical ambient operating temperature. (The KX2 can be turned off during any portion of this monitor period, as long as an internal battery or external supply is attached.) If it's off by more than +/- 2 seconds per day, use RTC ADJ to compensate. For example, if it's slow by 5 seconds per day, set ***RTC ADJ*** to "-5 SEC". Allow a few hours, minimum, before making a further correction.

8.5.2 Auxiliary Outputs

There are two open-drain outputs; AUX 1 is on the tip and AUX 2 is on the ring of the AUX jack. These can switch to ground a maximum of 28 volts at 150 mA. See Figure 8-6.

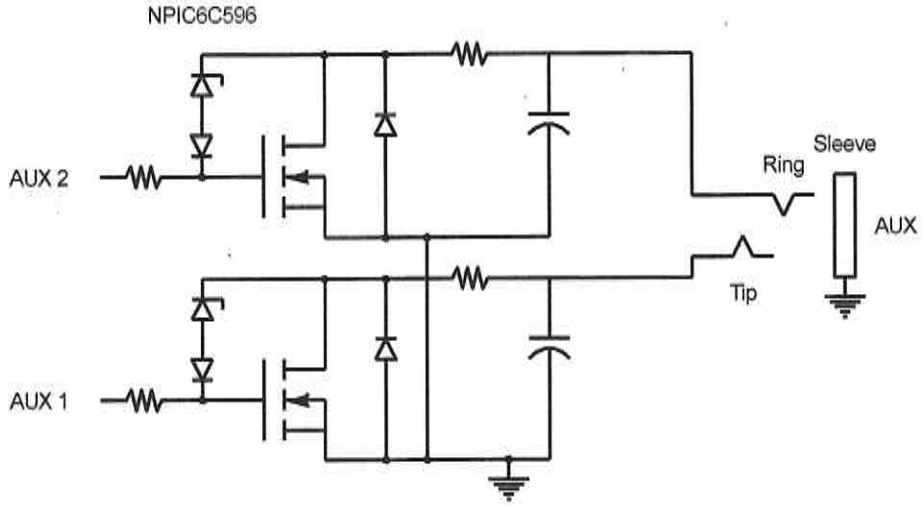

Figure 8-6. KXIO2 auxiliary outputs.

Menu	Default	Description
AUX 1 and ***AUX 2***	***OFF***	Used to set the KXIO2 option module's AUX outputs ***AUX 1*** or ***AUX 2*** to ***On*** or ***OFF*** on a per-band basis. The AUX jack provides a ground (0 V) and two *open-drain* output signals, AUX 1 and AUX 2. Open-drain outputs simulate a contact closure to ground when in the ***On*** condition, and are floating (high-impedance) when ***OFF***. Typically, the ***On*** state would be used to turn on a relay connected to a DC supply voltage (28 V max, 150 mA max). The two outputs could be used singly or in combination to switch an external device such as an antenna switch, select taps on a loading coil, etc. This could be especially useful during mobile operation. (Elecraft does not yet offer any products that make use of the AUX outputs, but may in the future.)

Exercise
An antenna switch switches ANT 1 to the KX2 when a control input is high and ANT 2 when the control is low (ground). How would you program AUX 1 to connect to ANT 1 for 20 – 10 meters and ANT 2 for 80 – 30 meters?

Tap BAND and use VFO A to select the 20 meter band (***14.0***).
Hold MENU and rotate VFO B to ***AUX 1***.
Rotate VFO A to ***OFF***.
Tap BAND to step to ***18.0***, rotate VFO A to ***OFF***.
Repeat for ***21.0***, ***24.9***, and ***28.0***.
When tapping BAND brings up ***1.8***, rotate VFO A to ***On***.
Repeat for ***3.5***, ***5.0***, ***7.0***, and ***10.0***.

8.6 Antennas and Antenna Tuning

The KX2 has one BNC antenna jack for 80 – 10meters. If you have an external antenna tuner, you can provide an RF carrier to it by holding TUNE. The power delivered for tuning is the value that you selected with the KYR-SPT/MIC/PWR Ø knob. This can be changed to a fixed value with the ***TUN PWR*** menu. The VFO A display area will show the SWR seen at your antenna connector when holding TUNE.

8.6.1 The KXAT2 20 W Antenna Tuner

The KXAT2 antenna tuner[38] is shown in Figure 8-7. It does a remarkable job of matching antennas from 80 meters to 10 meters over a range of at least a 10:1 SWR range.

The ATU is in the circuit on all HF bands 80 – 10 meters when the ***ATU MD*** menu is ***Auto***. It may be bypassed by setting ***bYP***. Tapping ATU will match the tuner to the impedance at the BNC antenna jack and tapping it a second time within five seconds will match it even more closely – to 1:1 if possible. The KXAT2 settings are kept for each band (per-band). Each band has multiple segments and the tuner will pick the tuning setting for that segment as you tune across the band. Once tuned at any frequency within these bands, it will automatically select the correct values to match the antenna.

In addition to the LCD SWR bar graph, tapping ATU will display the numerical SWR in the VFO A display area. When the ATU is tuning, the transmitter delivers 2 – 3 watts, not the power level set by the ***TUN PWR*** menu or the KYR-SPT/MIC/PWR Ø knob. This value is set internally and cannot be changed.

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[38] Although these devices are commonly called *antenna tuners* they do not "tune" the antenna. They provide a transformation so that the impedance at the end of the coaxial transmission line is transformed to nearly the same as the output impedance of the transmitter. This is called "matching" and allows the transmitter to transfer the maximum power to the antenna load. See Chapter 11, page 116.

When the 100 watt, KXAT100 antenna tuner is in use, the internal ATU is automatically bypassed.

The antenna "tuning" is done by an L – C or C – L network. An SWR bridge on the main RF board measures the SWR and the microcontroller unit closes or opens relays K1 – K7 and K9 – K15 to switch inductance and capacitance in or out (Figure 8-7). Relay K8 can place the capacitors on the antenna side or the transmitter side. When the ATU is bypassed (***ATU MD*** is ***bYP***), relays K1 – K7 are closed and K9 – K15 are open as shown.

When ***ATU MD*** is ***Auto***, the ATU is engaged for all bands. You cannot have it engaged for some bands and bypassed for others. This is not a problem because if your antenna presents a low SWR on a particular band, the ATU settings will be bypassed, or nearly bypassed, and will present very little loss.

The ATU settings are kept for each band. Each band has multiple segments with widths shown in Table 8-3. You can tap ATU in each segment the first time you use a new antenna to force the ATU to find the best tuning settings and to store them. Then the ATU will recall the ATU setting for each segment as you tune across the band. This keeps narrowband antennas in tune as you move around. Each time you move the VFO to another band segment the microcontroller will automatically choose that setting for the L and C in the ATU. If the LC data is the same as the previous segment, nothing will happen. If it is different, the stored LC data will be sent to the ATU's relays and the ATU icon will flash. This will *not* happen until you go into transmit mode and pause for one-half second so as not to mess up any CW timing. The ATU will not adjust its tuning when receiving to eliminate annoying relay clicking when tuning across the band.

If you switch to a different antenna, such as when taking the KX2 into the field, you may want to clear old ATU L – C settings for one or more bands prior to doing new auto-tunes. To do this, locate the ***ATU MD*** menu, and then hold OFS/B/CLR ∅ (hold function of the OFS/B/CLR ∅ knob). You can change bands from within this menu by tapping the BAND button and rotating VFO A to change the ***ATU MD***.

You can erase the stored L and C values for any band by holding OFS/B/CLR ∅ when in the ***ATU MD*** menu.

The ATU uses only about 3 watts output to tune the antenna, not the full power output that you have set.

Table 8-2. ATU menu.

Menu	Default	Description
ATU MD	***not inSt***	This may be set to ***Auto*** (active for all bands) or ***bYP*** (bypassed for all bands). There are ***L1 – L7*** and ***C1 – C7*** and ***Ct*** settings that test that the relays for each of the Ls and Cs are switching properly. Holding OFS/B/CLR Ø clears the stored LC data for the present band. When ***PA MODE*** is ***On***, this menu changes automatically to ***ATU.X MD***.
ATU.X MD		The ***ATU MD*** menu item is automatically changed to ***ATU.X MD*** when a KXPA100 amplifier with ATU is installed and operating (***PA MODE On***). You may select ***bYP*** or ***Auto***. Setting ***PA MODE OFF*** changes the menu back to the KX2's internal ***ATU MD*** menu and restores tuning operation to the KXAT2. Holding OFS/B/CLR Ø clears the stored LC data for the present band.

Exercise
Program the PFn function key to be able to toggle the ATU on and off.
Hold MENU and rotate VFO B to ***ATU MD***. Hold PFn until ***PF SET*** appears.

Setting Up Band Tuning Segments

- Set the KX2 at a frequency 5, 10, 50 or 100 kHz (depending on the band as shown in Table 8-3 up from the bottom of the band you wish to use.
- Set the ***ATU MD*** menu to ***Auto***.
- Tap ATU.
- Move up the band in 10, 20, 100 or 200 kHz steps tapping ATU at each step until you reach the top of the band.

Table 8-3. ATU tuning segments.

Band	Tuning Segment
80 – 12 m	20 kHz
10 m	100 kHz

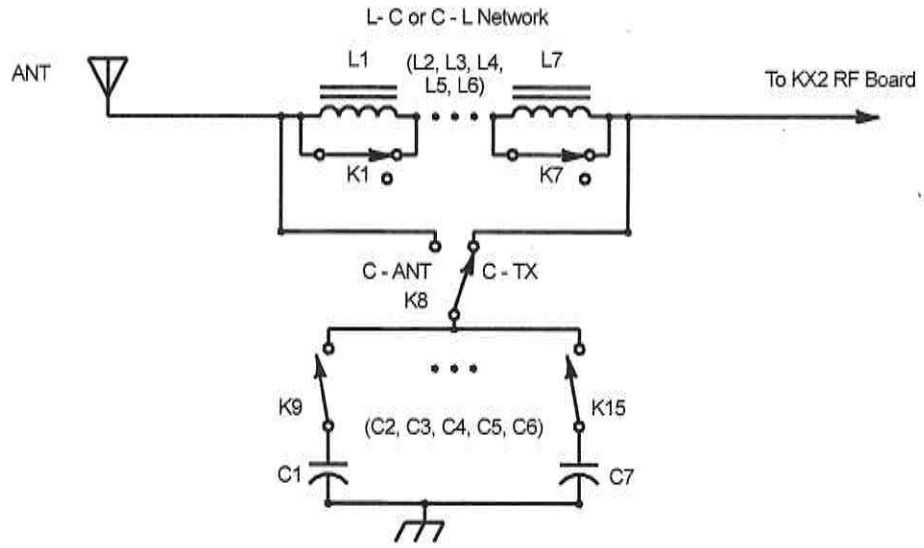

Figure 8-7. KXAT2 antenna tuner.

A helpful hint from Wayne, N6KR: When I use the KXAT2 in the field, with a slightly different antenna system each time, I like to clear all of the ATU memories on a given band before doing that first ATU. To do this, go into the ***ATU MD*** menu and hold the OFS/B/CLR Ø knob. Exit the menu. Now do the tune. If the antenna is not extremely narrow-banded, you may get by with one ATU per band.

8.7 KX2 Interface Circuits

8.7.1 ACC – The RS232 Serial Port and Amp Keying

Figure 8-8 shows the ACC RS232 serial and key out port. This basic circuit design is used also in other Elecraft products such as the XG3 signal generator and the KAT500 antenna tuner. It uses a 3.5 mm jack instead of the more familiar DE9 connector and as such can implement only the TxD and RxD serial signals. Therefore, the KX2 does not have the useful RTS and DTR signals that can be used for CW keying and PTT with the K3.

The ACC port on the KX2 is fully compatible with the RS232 interface standard, although it uses zero volts rather than a negative voltage when transmitting a low unit. The input

can accept the full RS232 range, +/- 25 V as input, but 0-5 volts and 0-3 volts will work too.

Figure 8-8 shows an open-drain, Key Out signal on Ring 2 of the Tip-Ring1-Ring2-Sleeve (TRRS) jack. A four-connection TRRS jack (Figure 8-9) is used when the Key Out signal is needed to key an amplifier. Figure 8-10 shows an optional KX2ACBL break-out cable and Chapter 9, page 143 shows how to use this when using the KXPA100 amplifier. If the Key Out signal is not needed, you may use a standard TRS cable for the serial. The KXUSB cable provides a USB-to-Serial adapter with the correct TRS plug to connect the KX2 to a computer.

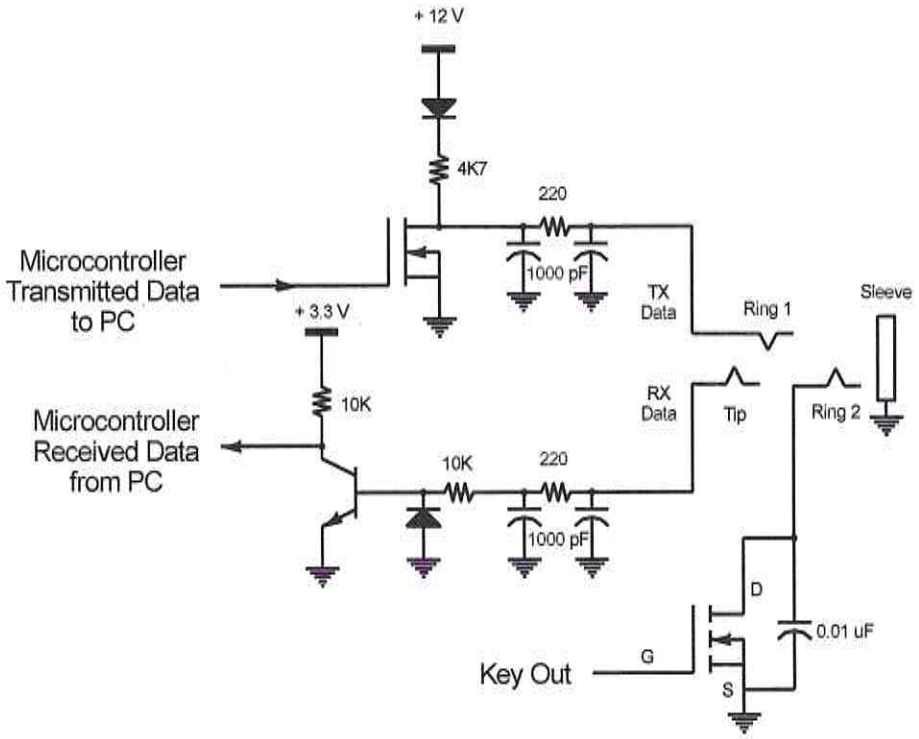

Figure 8-8. ACC serial and key out port.

Figure 8-9. ACC 3.5 mm 4-contact TRRS plug (use for serial and key out)

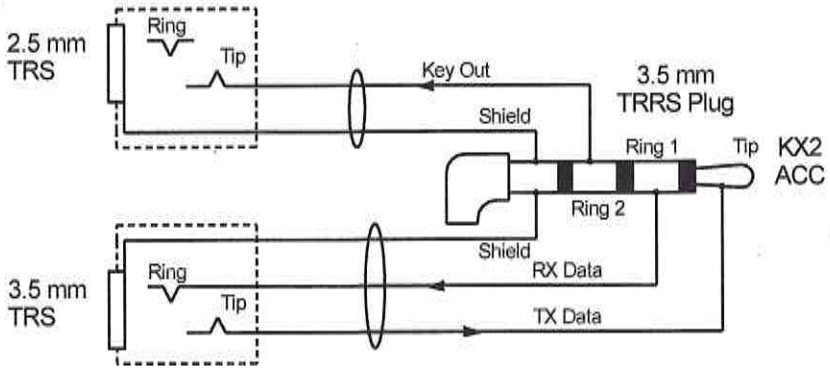

Figure 8-10. KX2ACBL Module.

8.7.2 Headphones and Speaker Output

The headphones output circuit is shown in Figure 8-11. It is designed for low impedance headphones; the right and left audio channels are generated by the digital signal processing through a digital-to-analog converter.

Figure 8-12 shows the speaker circuit. Speaker audio is generated in the digital signal processing and output by a digital-to-analog converter.

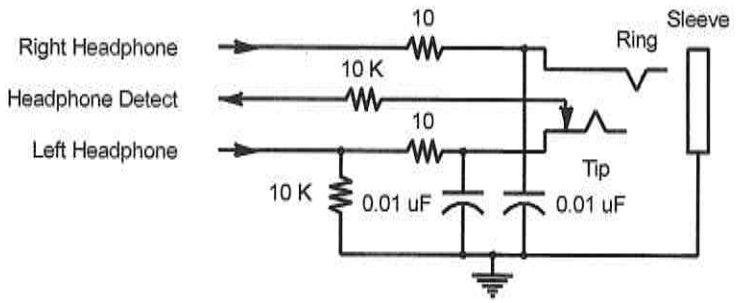

Figure 8-11. Headphones circuit.

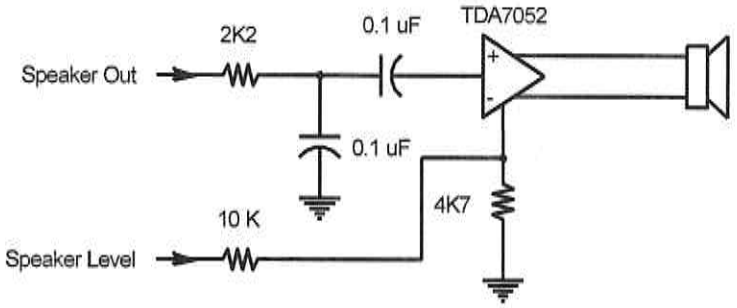

Figure 8-12. Speaker circuit.

8.7.3 KXPD2 and Key Paddle Input

Figure 8-13 (a) and (b) show the KXPD2 and paddle input circuits. Although in each case the tip connection generates dits, these can be configured in the ***CW KEY1*** and ***CW KEY2*** menus to be dahs, or used for a hand key or computer keying input.

You can use the KXPD2 paddle input plug for another paddle, hand key or for computer-generated keying. A 0.1" spaced socket can be manufactured from a standard header socket[39]. The KX3's KXPD3 is fully compatible and can be used, although the longer of

[39] A mating socket for the KXPD3 paddle input connector is http://www.digikey.com/product-detail/en/PPPC022LJBN-RC/S5555-ND/776013.

the two thumb screws should be replaced with a shorter one. Order Elecraft part number E700425.

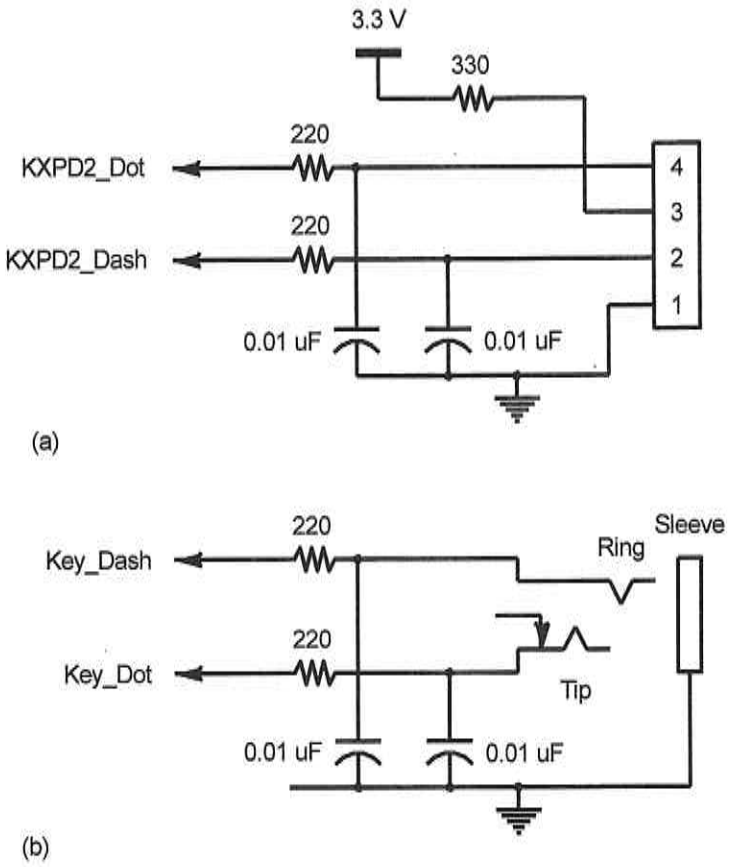

Figure 8-13. (a) KXPD2 input; (b) Key paddle input.

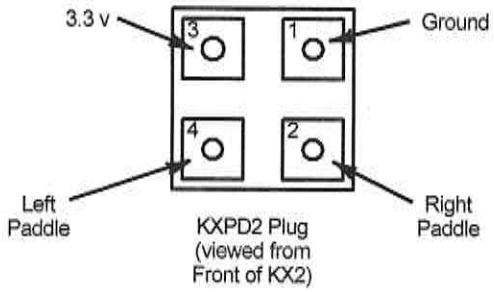

Figure 8-14. KXPD2 plug.

Table 8-4. CW tip and ring menus.

Menu	Default	Description
CW KEY1	***tiP=dot***	If you operate at someone else's station, you may want to bring your own paddle to operate CW. A "normal" (right-handed) paddle connection produces dits when the left paddle (dit-switch) is pressed and dahs when the right (dah-switch) is pressed. (Left-handers may prefer the other possibility, although that will make it difficult for you to operate somebody else's station if it does not have the capability to switch the dits and dahs.) You may have your dit-switch connected to the tip or the ring connection on the stereo paddle plug. This menu item allows you to specify whether the tip connection should produce dits (***tiP = dot***) or dahs (***tiP = dASH***). If ***HAnd*** is selected, either of the two levers or either the tip or ring connection can be used as a hand key or as an external keyer or computer keying input.
CW KEY2	***LFt=dot***	Specifies whether the left lever of the KXPD2 is used for the dit connection (***LFt = dot***) or the dah (***LFt = dASH***). If ***HAnd*** is selected, either of the two levers can be used as a hand key, an external keyer, or for computer keying input.

Exercise
You have an external keyer that grounds its output to key your radio. You plug it into the KEY jack to send CW. What connection on the TRS plug do you use and how do you set ***CW KEY1***?

You can use either the tip or ring connection and you set ***CW KEY1*** menu to ***HAnd***.

Exercise
When you have an external keyer plugged in the KEY jack, can you still use the KXPD2 to send CW?

Yes.

Chapter 9. Using the KXPA100 Amplifier and KAT100 Tuner

9.1 The KXPA100 Amplifier

The KX2 and the KXPA100 amplifier operate seamlessly together as a 100 watt transceiver. The amplifier is designed to be air-cooled with an extensive heat sink. You should leave a clear space of 1.5" (3.8 cm.) on each side and 3" (7.6 cm) on top for proper cooling.

There are two operating strategies from which to choose – basic, which offers simpler connections and cabling but with less closely coupled operation, and KX2-controlled, which has slightly more complex cabling but has much better communications with the KX2 transceiver for highly integrated operations.

There are two versions of the KXPA100, one with an optional, internal automatic antenna tuner (KXAT100) and one without.

The KXPA100 is designed to be closely integrated with the KX3 and it works just as well with the KX2. An optional KX3-to-KXPA100 Adapter is required for the best integration of the system. With it you can fully control the amplifier and tuner from the KX2. This is called the *KX3/KX2-Controlled Operation* mode.

You can also use the KX2 (or any other transceiver if you so wish) to operate without the tight integration offered by the KX3-to-KXPA100 Adapter. This configuration is described in the *Basic Operation* section below.

KXPA100 Cables

The KXPA100 is supplied with a KXUSB or KXSER serial cable to connect the amplifier to the PC for software control and updating firmware, and a fused DC power cable.

Many operators will choose to order the optional cable set (KXPACBL), which is used for the *KX3/KX2-Controlled Operation* mode to provide seamless operation of the KX2 and KXPA100. This option is highly recommended and includes the following:

KX3-to-KXPA100 Adapter: This cable adapter is designed to connect the KX3 ACC1 serial port and ACC2 keying line to the KXPA100. It is used in a KX2 system with a KX2ACBL. See Figure 9-3.

Right Angle BNC-to-PL259 RF Cable: You will need a BNC-to-PL259 cable to connect the KX2 to the KXPA100. This cable has a convenient right angle BNC for the KX2 end.

6" CAT6[40] Control Cable: The CAT6 control cable transfers control and RS232 serial data between the KX3-to-KXPA100 adapter and KXPA100.

KXPA100-to-KX2 Power Cable: This power cable has an Anderson Powerpole® connector on one end and a female 5.5 mm x 2.1 mm coaxial connector on the other. The red lead and center pin are positive.

9.2 Basic Operation

Figure 9-1 shows a KX2 without the optional KX3-to-KXPA100 Adapter. You must manually control the KXPA100 from its front panel but it will automatically switch bands when it detects RF from the transceiver. The transceiver must assert (pull low) the PA Key line to enable amplification. If you have the optional KXAT100 tuner, it will operate in the modes as discussed in *The KXAT100 Autotuner*, page 149.

You must not apply more than 10 watts of RF drive to the KXPA100 from any transceiver.

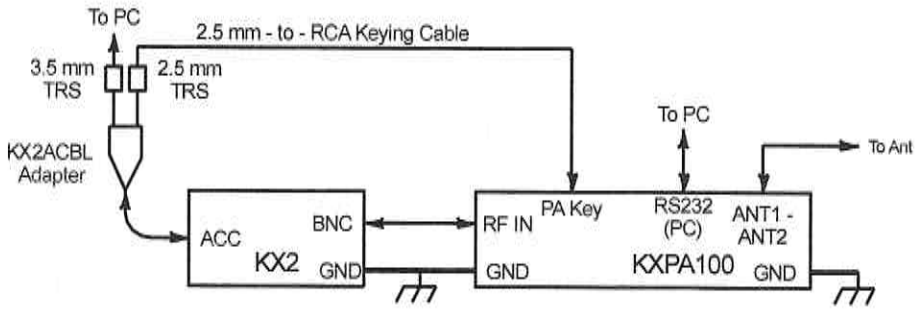

Figure 9-1. KX2 – KXPA100 basic operation.

- Connect your KX2 as shown in Figure 9-1.
- Switch the KXPA100 OFF/ON switch to ON. The ON LED should be lit.
- If you do not have an antenna and/or dummy load on each of the two antenna ports, you should disable the one not in use to avoid transmitting into an open circuit. This is done using the KXPA100 Utility.
- Connect a 50 ohm dummy load or low VSWR antenna to the active antenna (as shown by the ANT 1 and 2 LEDs. If you do not have the optional KXAT100 tuner

[40] The main difference between CAT6 and CAT5 cables is that the CAT6 is shielded and can be used for longer distances. The normal 6" cable does not need to be shielded but if you locate the KXPA100 remotely from the KX3, say for a mobile installation, you should use shielded CAT6 cable

installed you will have only one antenna connector. If you have two connectors, hold the ANT switch to select the active antenna.

- If your transceiver is not capable of more than 5 watts output, set the KXPA100 3 dB ATTEN switch to OUT/AUTO.
- If your transceiver is capable of more than 5 watts output, set the KXPA100 3 dB ATTEN switch to IN. The ATT LED should be lit.
- Apply about 2 watts to the KXPA100. You should see the KXPA100 TX LED illuminate and the power out LEDs showing 50 watts or so. If the amplifier doesn't key, check to see that your transceiver is pulling the PA Key line low.
- Please read *The KXAT100 Autotuner*, page 149 to learn how to use the KXAT100 autotuner.
- NEVER apply more than 10 watts of RF drive to the KXPA100 from any transceiver.

9.3 KX3/KX2-Controlled Operation

The smoothest, most highly integrated operation can be achieved if you purchase the optional KX3-to-KXPA100 Adapter Cable set (KXPACBL) for the KXPA100 and the KX2ACBL adapter cable for the KX2. This mode allows you to completely control the KXPA100 from the KX2 and enables you to locate the KXPA100 remotely from your KX2. Figure 9-2 shows the KX2ACBL and the KX3-to-KXPA100 adapter. Figure 9-3 shows the connections to be made for KX3/KX2 Controlled Operation. Note that instead of separate serial ports needed to update the KX2 and KXPA100, one PC COM port is daisy-chain connected to all.

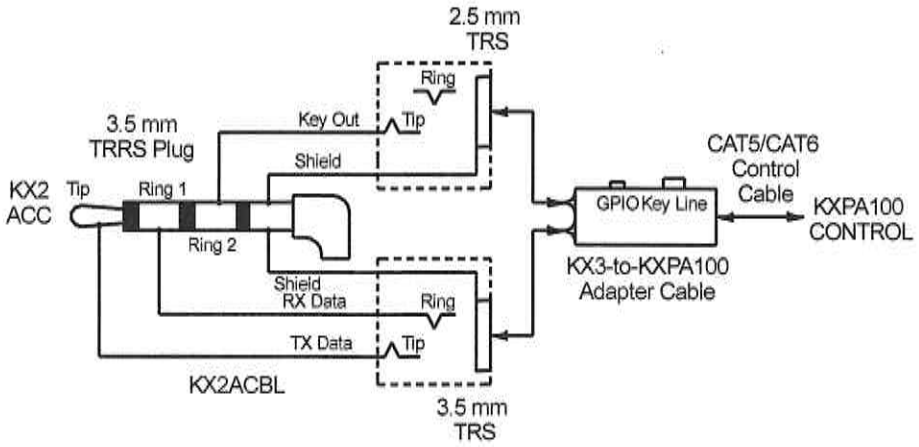

Figure 9-2. KX2ACBL and KX3-to-KXPA100 Adapter.

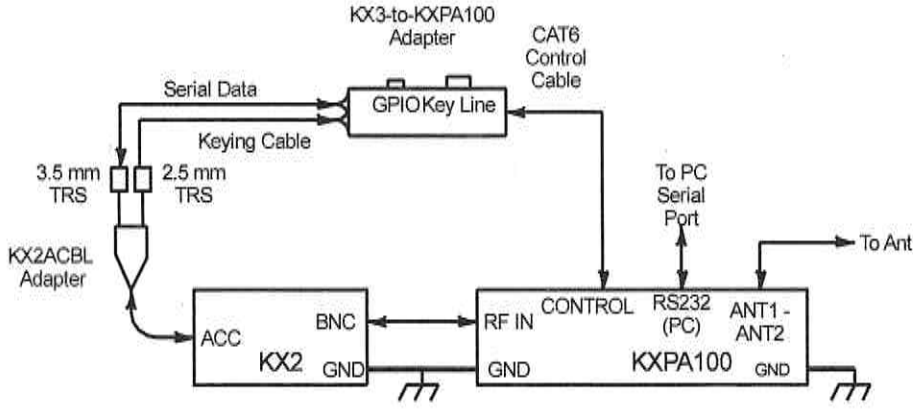

Figure 9-3. KX2 controlled operation.

KX2 PA MODE Menu

The KX2-Controlled Operation is enabled in the ***PA MODE*** menu by the following steps:

- Connect the KX2 to the KXPA100 using the optional KX2ACBL and KX3-to-KXPA100 Adapter cable set (KXPACBL). Use Figure 9-3.
- Make sure all cable plugs are inserted fully.
- Set the amplifier ON/OFF switch in the OFF position.
- Set the amplifier rear panel 3 dB ATTEN switch to OUT/AUTO.
- Apply power to both the KX2 and KXPA100 and turn on the KX2. The KXPA100 will not come on until you set the ***PA MODE*** menu to ***On*** as described below.
- Hold the KX2 MENU to enter the menu programming mode.
- Rotate OFS/VFO B ∅ to ***PA MODE*** and turn VFO A knob to ***On***. The KXPA amplifier On LED will come on and if the KXAT100 tuner is installed, the ANT selection LED and ATU MODE LED will be lit.
- Tap MENU to exit the KX2 menu.
- Attach an antenna or dummy load to the antenna indicated as the currently active antenna by the ANT LEDs.

Table 9-1. PA MODE menu.

Menu	Default	Description
PA MODE	***OFF***	Sets the operating mode for the Elecraft KXPA100 amplifier and its internal ATU. Set it to ***On*** only if the KX2 is connected to the KXPA100 via the KX2 Accessory cable (KX2ACBL) and KX3-to-KXPA100 adapter. This allows the KX2 to control the amplifier's output power, ATU tuning, and antenna switch as described in the KXPA100 Owner's Manual and *The KX2 Companion's Guide to the KXPA100 and KXAT100* by KE7X. Set to ***OFF*** otherwise. The KX2 can still be used with the KXPA100 without the KX3-to-KXPA100 adapter but an amplifier keying line is still required from ACC on the KX2 to KEY IN on the amplifier. See Figure 9-1. Tap [1] to turn ***PA ALC*** on/off (the default is on, or ***PA ALC+***). When ***PA ALC*** is ***On***, and KXPA100 power is set to 70 W or less (at the KX2), the operator can use the KX2's TUNE switch function to more accurately set the amplifier's output level. Refer to the KXPA100 manual for details. Transient KX2-to-KXPA100 communication errors are normally corrected without alerting the operator. For diagnostic purposes, they can be displayed as "FAULT nnn" where nnn is a 3-digit number originating from the KXPA100. To enable this, tap [6] until you see ***XFAULT+***.
	Pout CAL	This enables 75-W power calibration in TUNE mode. When [KYR-SPT/MIC/PWR Ø] is adjusted, and ***Pout CAL*** mode is in effect, setting power to 75 watts shows ***CAL 75W*** on VFO B. The KX3-to-KXPA100 adapter cable must be used. See the ***TX GAIN*** menu. See also the KXPA100 Owner's Manual.

Many KXPA100 functions may be controlled or set by the KX2's menu system. When you are adjusting something in the KXPA100, the KX2's VFO B area shows the parameter with an ***.X*** extension. For example, the KX2's ***ATU MD*** menu shows ***bYP*** or ***Auto*** when using the KX2 alone without the KXPA100 enabled. When the amplifier with a tuner is enabled, that same menu is ***ATU.X MD*** and the choices are ***bYP***, ***MAn*** or ***Auto***.

9.3.1 KXPA100 Operation

Turning the KXPA100 On and Off

When the KXPA100 [ON/OFF] switch is OFF, and ***PA MODE*** is ***On***, the KXPA100 is turned on and off with the KX2. When the KX2 is controlling the KXPA100 through the

KX2ACBL/KX3-to-KXPA100 cables, leave the KXPA100 ON/OFF switch in the OFF position. When the ON/OFF switch is ON, the amplifier remains on.

Antenna Selection

When the optional KXAT100 is installed, you have a choice of two antennas – ANT 1 and ANT 2. You can select either in one of two ways:

- Hold the ANT button on the front panel of the KXPA100. You will see the ANT selected LED change and the ANT1 or ANT2 icons on the KX2 will also show the antenna selected.
- Access the KX2 ***ANT.X SW*** menu. Rotate VFO A to select ***ANT.X 1*** or ***ANT.X 2*** indicating which antenna is selected and the KX2's ANT icon will change.

If you do not have an antenna and/or dummy load on each of the two antenna ports, you should disable the one not in use to avoid transmitting into an open circuit using the KXPA100 Utility.

ANT.X SW	*1*	This menu (e**X**ternal Antenna switch) can be used to remotely select antenna 1 or 2 on the KXPA100.

Power Control

The KXPA100 power output is pretty sensitive to its supply voltage. It must have a solid 13.8 V_{DC} to achieve 100 watts output. When connecting the power supply to the KXPA100, use as short a cable as possible and use heavy gage wire. It is best to plug the power supply into the bottom Powerpole connector. When ***PA MODE*** is ***On***, the KX2's KYR-SPT/MIC/PWR ∅ control has a range of 0 to 100 watts.

- Hold the KX2's KYR-SPT/MIC/PWR ∅ knob and rotate it to select a power level greater than 10 watts.

At power settings below 10 watts, the amplifier is bypassed and the KX2 is directly connected to the antenna. Also, even when operating with less than 10 watts, the KXAT100 tuner (if installed) will continue to be used. You will not be switched back to the KX2's tuner until ***PA MODE*** is ***OFF***.

The KXPA100 can automatically reduce the input power by 50%. It does this by switching in a 3 dB attenuator when it detects a situation such as high input power or high VSWR that could cause damage.

Band Switching

Automatic Band Switching: The KXPA100 automatically measures the frequency of the RF drive signal and switches to the proper band. This happens in a very short time (a few ms) and occurs when the KXPA100 is keyed and RF is present. This allows the very

basic and simple operational mode for a KX2 (or another manufacturer's radio) and a KXPA100 as shown in Figure 9-1.

Automatic band switching is always active, even when using the KX2-Controlled band switching shown in Figure 9-3. This is a safety measure to ensure that the KXPA100 always operates on the same band as the exciter transceiver.

KX2-Controlled Band Switching: When the KX2 and KXPA100 are connected as in Figure 9-3, the KXPA automatically follows band changes made on the KX2 without having to measure RF. The band information is communicated over the serial data line.

9.4 The KXAT100 Autotuner

The KX2's internal tuner is automatically bypassed and the KXAT100 tuner is used whenever ***PA MODE*** is ***On***, even if the amplifier is bypassed, as it is when the output power is set to 10 watts or less. When ***PA MODE*** is ***OFF***, the KXAT100 tuner is bypassed and the KX2's internal tuner is used.

Table 9-2 shows the KX2 ***ATU.X*** menu active when the output power is set to more than 10 watts.

Table 9-2. KXAT100 menu.

ATU.X MD	***bYP***	The ***ATU MD*** menu item is automatically changed to ***ATU.X MD*** when a KXPA100 amplifier with ATU is installed and operating (***PA MODE On***). You may select ***bYP***, ***Man***, or ***Auto***. Setting ***PA MODE OFF*** changes the menu back to the KX2's internal ***ATU MD*** menu and restores tuning operation to the KXAT2. Holding OFS/VFO B/CLR clears the stored LC data for the present band.

9.4.1 KXAT100 Tuning Strategies

The KXAT100 can achieve a very low VSWR over a wide range of tuning requirements by using two tuning strategies – *Memory Recall Tuning* and *Full Search Tuning*. The tuner's auto and manual operating modes use these strategies in different ways to provide tuning.

Memory Recall Tuning

When the tuner has achieved an acceptable match at an operating frequency, it stores the L and C values and the antenna being used in a memory segment to be recalled the next time that frequency is encountered. This allows the tuner to very quickly retune itself without going through a lengthy tuning cycle when you change bands or change frequencies within a band. *Setting Up Band Tuning Segments*, page 136 describes a process you can use to "train" your KXAT2 tuner for all your favorite operating frequencies. You can do the same for the KXAT100. A *Memory Recall Tune* is very fast.

Full Search Tuning

When RF is present, the frequency and VSWR are measured at intervals using RF sensing (this takes a few milliseconds). A *Full Search Tuning* cycle can be started by the tuner when it is operating in AUTO mode, RF is present, and the VSWR exceeds a dangerous threshold. It can be instigated also by tapping the KXAT100's TUNE switch and applying RF.

9.4.2 Manually Activating the Tuner

You can instigate a *Full Search Tune* to find the L–C combination needed for your present frequency and antenna either from the KX2 in KX2-Controlled operation or from the KXPA100's front panel for a basic configuration. When the tuner is tuning, the amplifier is not keyed and is bypassed.

KX2-Controlled Tuning

- Select the antenna to be tuned by either holding the ANT switch on the KXPA100 or using the ***ANT.X SW*** menu.
- Tap the ATU switch on the KX2 and the KX2 will supply 5 watts to the tuner. The tuner then steps through its tuning sequence and KX2 stops when it is done.
- Tap the ATU switch on the KX2 or the KXPA100 TUNE switch a second time within 5 seconds after it finds a solution to use finer tuning steps to achieve a better VSWR.

Note: The KX2's ***TUN PWR*** can be ***nor***, where the power out when the holding TUNE is set by the power knob, or to a specific value ranging from 0.0 to 10.0 watts. Regardless of this setting, when tapping ATU, the KX2 always outputs 5 watts when tuning the KXAT100 tuner (***PA MODE*** is ***On***) or 3 watts when tuning the KX2's internal tuner.

Basic Tuning

- Select the antenna to be tuned by holding the ANT switch on the KXPA100.
- Tap the KXPA100 TUNE switch. The 25 watt POWER OUT LED will flash indicating the tuner is ready to receive RF and to tune.
- Apply at least 2 watts and preferably 5 watts from the driving transceiver.
- Tap the KXPA100 TUNE switch a second time within 5 seconds to use finer tuning steps to achieve a better VSWR.

When 5 watts is applied to the tuner you will hear relays clicking and the left-hand POWER OUT LED will flash during tuning. If an acceptable VSWR is found, the final value is displayed briefly on the KX2's VFO A display (when using KX2-Controlled tuning) and on the KXPA100 SWR LEDs. If the KXAT100's mode was **Byp**, it will be switched to **Man**.

9.4.3 Auto Tuner Operation Modes

The KXAT100 has three operating modes – bypass (***bYP***), automatic tuning (***Auto***), and manual tuning (***MAn***). You choose any of these modes by tapping the MODE switch on the front panel of the KXAT100 or by entering the KX2 ***ATU.X MD*** menu. The selected mode is displayed by the **Byp**, **Man**, and **Auto** LEDs on the KXPA100 front panel or in the KX2 menu. Although the ***Auto*** mode seems like it would be the best mode to use, the ***MAn*** mode is better, as we shall describe below.

In each of the tuner operating modes there are two tuning strategies. These are (1) *Memory Recall Tuning*, where the tuner briefly opens the keying line and retrieves from memory previously stored L—C values appropriate for the current antenna and frequency, and (2) *Full Search Tuning* where the tuner opens the keying line for a time long enough to try different L—C combinations to correct the VSWR.

Which Mode Should I Choose?

Even though the *Full Search Tuning* feature of the automatic mode sounds ideal, for normal operation you should chose the manual mode. Here is why.

The tuner continuously measures the RF and calculates the VSWR. Because of hardware limitations, instantaneous VSWR calculations may not be correct, either because there is a slight delay between the measurement of the forward and reverse voltages used to calculate VSWR, or, giving a rapidly changing waveform, such as SSB, measurements taken at low power and high power points in the waveform may be different.

Therefore, in automatic mode, the tuner could proceed to do an unnecessary *Full Search Tune*, which is disturbing to the operator, to say the least.

In manual mode, if the incorrect VSWR is calculated, the tuner does not proceed to the *Full Search Tune* if subsequent VSWR measurement is low. To effectively use the manual mode, do the following:

- Initialize your tuner's memory segments for all frequencies in all bands.
- Choose the manual mode for normal operation.

This strategy is a good idea. If a momentary – and apparently "bad" – VSWR is calculated, the tuner takes no action because tuner settings are changed only if the frequency changes in **Man** mode, not because there is high VSWR as in **Auto** mode. If a serious antenna problem occurs with sustained high VSWR, for example if the wrong antenna is selected on a remote switch or your antenna falls down, subsequent VSWR measurements will remain high and the tuner holds the keying line open and illuminates the SWR fault LED. You can then take corrective action manually, after first determining if the wrong antenna is selected or if there has been an antenna failure.

9.4.4 More KXPA100 and KXAT100 Information

Check out *The KX2 Companion's Guide to the KXPA100 and KXAT100* by KE7X. See www.ke7x.com.

Chapter 10. KX2 Utility Program

10.1 Configuring and Updating the KX2

Almost every item in the Elecraft product line has firmware that is updated from time-to-time to add new features or to fix occasional programming errors. To take advantage of these improvements (at no charge), you need to first install a utility program (also free). You can then run the program to update the latest software.

Figure 10-1. Updating KX2 software.

The Elecraft web page (http://www.elecraft.com/) contains a link, *Firmware & S/W* as shown in Figure 10-1, that leads you to software and firmware that can be updated for your KX2. You will need to navigate to the unit's *Firmware Updates and Download/Config Utility* page by clicking on the blue colored link. It's good to keep all your firmware up-to-date; if you do so you can enjoy all of the improvements and new features available for your KX2.

The KX2 Utility program is a must-have program used to update new firmware versions. It also does many other useful chores such as saving and restoring configuration files and performing computer-controlled calibrations and configurations. It contains a command tester and other features shown in Table 10-1.

Table 10-1. Utility program features.

Tab	Feature
Port	Choose serial port connected to the KX2.
Firmware	Check firmware revisions and update to new versions.
Configuration	Save and restore KX2 configuration. Edit CW memories. Edit Power On Banner. Set KX2 time.
Calibration	Calibrate transmitter gain.

Command Tester	Test Programmer's Interface commands[41]
Terminal	A terminal programming for running CW, RTTY and PSK.

To use the utility program, first transfer the utility setup executable file to your computer by clicking on the appropriate blue link on the Elecraft website and save it. Execute the setup file and install the utility following the installation directions. The utility programs have useful and extensive help files if you encounter problems when updating firmware on the KX2. Note that there are versions of each utility program for Windows, Mac OSX, and Linux operating systems.

From time-to-time new versions of the utilities may become available. You should always use the latest version because older versions may not work with new firmware versions. Run your utility occasionally; it will inform you if new versions of the utility or the firmware are available.

10.1.1 Connecting Your Computer to the KX2

The utility program uses a computer's RS232 serial port[42] (or a USB connection that mimics an RS232 port) to control the KX2 and to update firmware. Your computer must have either an RS232 serial port or a USB port with a USB-to-Serial converter. The KX2 serial port implements only the TXD and RXD (and ground) signals. This means you cannot send CW keying or PTT signals on the same Com port from the computer to the KX2 without splitting these signals out and using level-translation hardware. Chapter 4.8 shows you how.

The KX2 serial port connector is not a "standard" DE9 connector; rather, it is a 3.5 mm (~1/8") tip-ring 1–ring 2-sleeve (TRRS) jack with data from the PC on the Tip, data to the PC on the Ring 1, a Key Out signal on Ring 2, and ground on the Sleeve. See Figure 8-8, page 138 Elecraft recommends that the 3.5 mm plug should have a molded right-angle plug to reduce strain on the ACC jacks. Elecraft offers two serial cables with a 3.5 mm TRS plug. The KXUSB is a USB-to-3.5 mm cable that requires the installation of a USB driver to allow it to mimic an RS232 port (Figure 10-2). The KXSER cable is a DE9-to-3.5 mm cable that can be used directly with a native RS232 port or a USB-to-serial converter. See Table 10-2 and Figure 10-3. You can make your own KXSER cable if your computer has a native RS232 port or a USB port plus a USB-to-serial converter.

For applications that require the serial port and a Key Out signal, for example an external amplifier, the KX2ACBL adapter shown in Figure 10-5 must be used.

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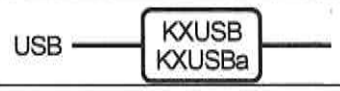
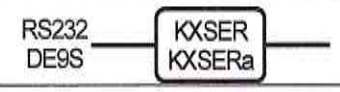
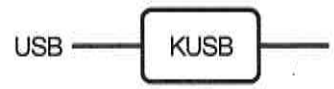
41 See *Elecraft K3 and KX2 Programmer's Reference.*

42 See www.ke7x.com/rs232-interfaces-1 for more information on RS232 serial ports.

Table 10-2. Serial cables.[43]

Serial Cable	Elecraft Name	Used For
	KXUSB, KXUSBa	KX2, KX3, PX3, KXPA100, KAT500, XG3, W1, W2
	KXSER, KXSERa	KX2, KX3, PX3, KXPA100, KAT500, XG3, W1, W2
	KUSB	K3, KPA500. The KUSB cable is a USB-to-DE9P cable and cannot be used with the KX2 or KX3 unless you also have the KXSER.

The KXUSB USB-to-Serial adapter uses the FTDI chipset that works with most computer operating systems. FTDI drivers can often be found easily by just using Microsoft Windows Update. Depending on your Windows operating system version, you may be able to just plug in your KXUSB and wait for drivers to be installed via the web from Microsoft Update. You have to be web connected when you plug the USB device in for the first time for this to work nicely. Drivers for this adapter can be found also on the Elecraft website.

The utility program can automatically find the com ports that are active in your PC. Sometimes, when setting up a logging or other program, a question arises about whether or not the program is communicating properly with the KX2. By using a utility program you can quickly check to make sure the computer and KX2 connection is working properly. If it passes this test, you will have to investigate the serial communications options that you set up in your logging program. This is very useful for configuring and troubleshooting other programs that do not have this feature.

- Connect the RS232 cable between the computer and the KX2.
- Run the utility program and open the *Port* tab.
- Click on *Refresh Port List* so that the utility program knows what com ports are available.
- Choose a serial port (COM1, COM2, . . .) to connect to the KX2. The utility will then attempt to make contact with the unit. You can see this process happening by observing the top banner section of the utility. Here, the utility will report progressively stepping through the baud rates. It is also reported in the Activity Log window. If it fails, choose another COM port.

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[43] The "a" designation in the Elecraft part number indicates a serial cable that may be ordered in addition to the "non-a" part number cable that is included with the basic KX2. The KXSER and the KXSERa cables are identical.

When a connection is made, a status message window will pop up showing you the MCU firmware version, the COM port in use, and the RS-232 speed. The KX2 baud rate will be set to 38,400 bps when the utility updates firmware, but will be restored to original rate, which you can set with the ***RS232*** menu.

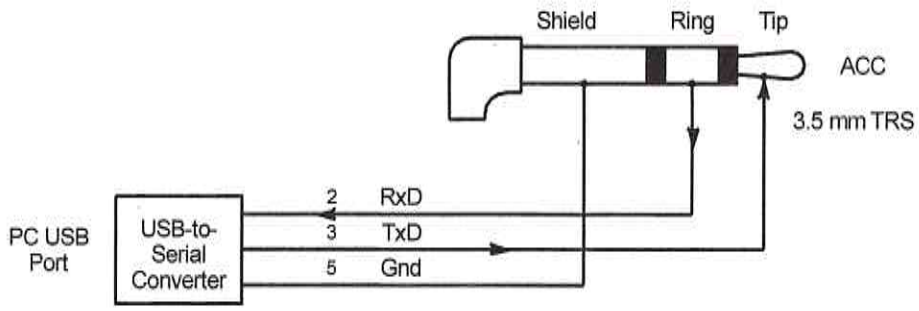

Figure 10-2. KXUSB USB-to-Serial adapter cable.

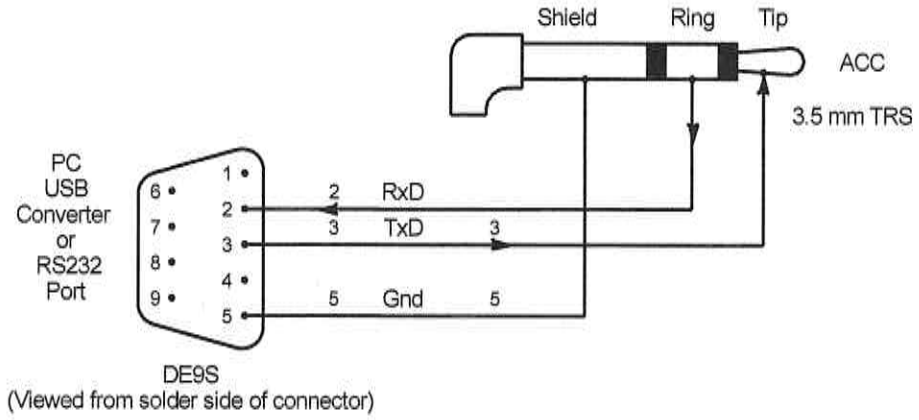

Figure 10-3. KXSER RS232 serial to KX2 adapter cable.[44]

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[44] A 3.5 mm right-angle connector with 6' cable is available from www.digikey.com, part number CP-2208-ND. The DE9S socket is Radio Shack 276-1358 with 276-1359 hood.

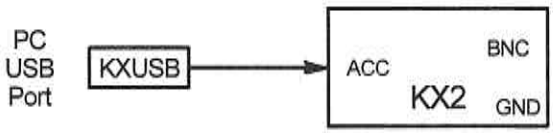

Figure 10-4. KX2 computer connection.

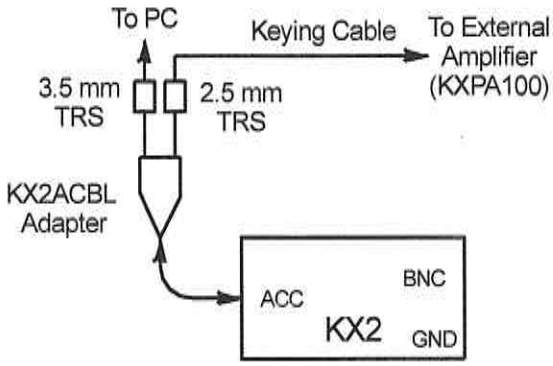

Figure 10-5. KX2 computer connection with an external amplifier.

10.2 Firmware

You should set up a folder or directory structure to organize the firmware versions you update. An example is shown in Table 10-3. Each time you update newly released firmware, make a directory or folder in the Firmware folder and save the new firmware files to that directory. This will allow you to go back to an earlier version of the firmware if needed.

There are two versions of firmware available. The *released* version contains code that has been rigorously tested in the field by many users. In addition, *beta* (not fully tested) versions of the firmware intended for early adopters and field testing are sometimes made available. If you choose to install a beta version, you should save each version in a separate folder or directory so that you can return to an earlier version if there is something you do not like or that does not work in a newer version.

You can find the current versions of firmware installed in your KX2 by holding the KX2 MENU button and tuning VFO B to ***FW REVS***. Rotate VFO A to see the MCU (***uC***) and the ***dSP*** firmware revisions.

You can then find out if you have the latest versions by going to the Elecraft website software page where you can find the current beta and production firmware revisions.

In Table 10-3, the Configuration folder contains files that hold configuration information that you enter in the menus. These files are saved by the utility program, and the default name is the serial number of your KX2, the date, and a time stamp. You may name them anything else you like. They are text files with a checksum, but do not try to read and edit the files with a text editor. If the checksum test fails, the utility will not use the file to restore your configuration. There is some human-readable information such as the MCU version, date and time of the save, utility version used, etc. You can make a similar directory structure for each of your Elecraft products.

Table 10-3. Directory structure for saving firmware files.

Root Directory	Elecraft
KX2 Files	KX2
KX2 Beta Files	KX2 Beta KX2fw2r33
KX2 Released Files	KX2 Released KX2fw2r30
KX2 Configuration Files	KX2 Configuration SN02310.20150202T162627.KX2Config

10.2.1 Saving the KX2 Configuration

You should save the KX2 configuration from time-to-time, especially when making drastic changes. In this way you can recover an earlier configuration if the new one gets damaged or doesn't behave as you would like.

The utility program allows the configuration information to be saved and later restored if necessary. For the KX2, the information saved are the parameters that are replaced by ***EE INIT*** (see *Reset – When All Else Fails*, page 8) so you should always save the configurations before taking the next drastic step of using the ***EE INIT***.

Saving the configuration is similar for all elecraft products.

- Start the utility program and open the *Configuration* tab.
- Click on *Save ... Configuration*.
- In the *Save As* option browse to the directory where you would like to save your configuration files.
- Click on *Save*.

The default configuration name shows the serial number of your unit (SNxxxx) following by the date (yyyymmdd), following by T and then the time (Thhmmss). The filename extension indicates the device type (KX2). You can overtype the filename with any name you choose. This file is a text file with a checksum to check for errors, and although you can open it to read with a text editor you should not save it. The text editor may make checksum errors and then the file will be unusable.

The configuration file contains a lot more than the menu items that operators can actually see. For the KX2, it also saves a block of memory from both the MCU and the DSP systems that are unique to the set of boards in each KX2. For example, when Elecraft calibrates an RF board, there are a number of operating parameters that are adjusted and saved for use during normal operation of the KX2. In addition to the menu items, then, all of these 'system' parameters are contained within the information held in a configuration file.

Since each configuration file is unique to each KX2, the serial number of the unit becomes important. Configuration files are saved with information about the unique serial number from which it was drawn. In the KX2 the matched sets of KX2 boards are able to be quickly restored to their factory settings upon a restore of the configuration file.

When you add a new option, it is important to create a new configuration file in order to be able to have a new 'image' of the configuration options available at that time. Configuration files, then, are very important to the good housekeeping functions of the KX2.

> Because configuration files contain information that is unique for a particular K2 you cannot load a config file saved from one KX2 into another.

So, how can do you protect from loading a configuration file from one KX2 to another KX2? Answer: The KX2 Utility checks the serial number of the target KX2 during a *Restore KX2 Configuration* and checks for a match with the configuration file selected. It will report the mismatch to the operator and ask for a confirmation that the operator does, indeed, wish to overwrite the existing KX2 configuration.

10.2.2 Restoring the KX2 Configuration

- Start the utility program and open the *Configuration* tab.
- Click on *Restore ... Configuration*.
- Browse to the directory with the saved configuration files and choose the one to be restored.

10.2.3 Updating Firmware to the Latest Released Version

> Elecraft recommends that you perform any firmware updates on your KX2 while connected to a known, good power supply. **DO NOT** depend on internal or external batteries to operate the radio while doing a firmware update.

Updating your KX2 firmware should be done regularly to keep abreast of operation improvements and bug fixes. You can choose to update to the latest released version or to a beta version that may not be completely debugged. Some operators choose to update only to a released version. Usually, though, the beta version is perfectly OK and subsequently becomes the released version.

The firmware updates go into one kind of memory and configuration data into another. Firmware load doesn't overwrite configuration data. That said, it's always a good idea to have a reasonably current configuration backup.

Here is a procedure to update to the latest firmware release:

- Connect the KX2 to a known, good power supply.
- Browse to the Elecraft website and find the current firmware releases.
- Add a directory or folder under the Firmware directory shown in Table 10-3. It is useful to name this directory to indicate the firmware version. (Example: KX2fw2r61 for KX2 firmware revision 2.61.)
- Start the utility program and save the current configuration.
- Open the *Firmware* tab.
- *Browse . . .* to the new folder you just created. You won't have anything in that folder until you complete the next step.
- In the *Check for New Files* section of the *Firmware* tab, you will see two buttons. The *Check Versions Now* button checks what you have currently in the KX2 and what is currently in the folder you have browsed to. Clicking on *Check Versions Now* should show that the *Available versions are Missing*.
- Click *Copy New Files from Elecraft*. The utility program will automatically connect to the Elecraft website to update the currently released firmware. You must have an active Internet connection when you do this. The files will be stored in your new folder.
- When the Activity Log shows that all the files have been copied, click on *Send All New Firmware to ....* Be sure to wait until all firmware, including the DSP module in the case of the KX2, has been loaded before operating. Be patient; this may take a few minutes. There is a tab labeled *Send All Firmware to ....* You should use this if you are going back to an earlier firmware version. The KX2 display shows which firmware is being loaded.
- Turn the KX2 power off and then back on.

10.2.4 Updating Firmware to a Beta Version

Updating to a beta version of the firmware is slightly different than updating to a released version.

- Save the current configuration.
- Add a directory or folder with the name of the new beta version under the beta Firmware directory shown in Table 10-3.
- Connect to the Internet.
- In your web browser browse to the Elecraft *Firmware & S/W* page and then click on the blue link to the KX2 firmware you want to update.
- If a beta version exists you'll see information about it and a blue link *...Beta Firmware Instructions*. This will take you to a page where you can click on the link *ftp://ftp.elecraft.com/.../firmware/beta*. (This is case sensitive.)
- Click on the zip file version ...fwXrYZ.zip for revision MCU X.YZ... and download to your beta folder and unzip all files.
- Start the utility program and open the *Firmware* tab.
- Browse to the folder you created above.
- **Do not click on** *Copy New Files from Elecraft*.
- Click on *Send All New Firmware to ....* Be sure to wait until all firmware has been loaded before operating. This may take several minutes. The KX2 display shows which firmware is being loaded.
- Turn the KX2 power off and then back on. [45]

10.2.5 Restoring an Older Version of the Firmware

You may decide to go back to an earlier version of the firmware, for example, if you try a beta version and it does not work well.

- Start the utility program and open the *Firmware* tab. *Browse . . .* to the folder with the version of the firmware you wish to restore.
- Click on *Send All Firmware to ....* Be sure to wait until all firmware has been loaded before operating. This may take several minutes.
- Turn the KX2 power off and then back on.

10.2.6 Forcing a KX2 Firmware Load

If you accidently load an old or incompatible firmware version and find the KX2 unresponsive, do the following:

- Unplug the KX2 from the power supply and remove the internal battery supply.

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[45] Although the utility programs reset the KX2 when the firmware is updated, Elecraft recommends that you turn the power off and then back on to save some parameters – for example the current KX2 VFO frequencies – to be used when you turn the power back on.

- Let the KX2 sit for at least 30 seconds.
- Plug a power supply back in or reinstall the battery.
- Hold the KX2's RATE and A/B switches together for about 10 seconds.
- After this you should see the TX LED flash and you will see ***MCU LD*** on the LCD.
- Connect the KX2 to a computer and run the KX2 Utility to load new firmware.

Chapter 11. Why Can't I make QSOs with my KX2?

The KX2 is an amazingly high performance radio and its small size is unprecedented for a multiple-mode, fully featured HF station. It is well suited, indeed designed for, portable operations including pedestrian mobile. It is priced to appeal to the first-time radio buyer. However, inexperienced HF operators may become frustrated if they cannot make contacts because they do not understand that one needs more than just a fine radio and an antenna. To be able to make contacts with your KX2 radio, not only do you need a good, low loss, effective antenna, but radio wave propagation must be in your favor. All hams need to understand how antennas and propagation combine to make successful QSOs easy, or difficult, to make.

11.1 Radio Wave Propagation – Part I

When a current flows in a conductor, Figure 11-1, it produces an Electro-Magnetic (EM) field around the wire. The field is represented by a magnetic field vector (H) and an electric field vector (E), both at 90 degrees to the direction of the current, and each other. The EM field is coupled into the space surrounding the wire and then propagates away from the wire. When an EM field travelling through space encounters another wire, it produces (induces) a current in that wire (Figure 11-2). This is how a signal transmitted into an antenna is radiated through space to be picked up by a receiving antenna.

The current induced in a conductor by the propagating EM field is a good thing for our receiving antenna. It can also be a bad thing if the propagating field induces current in a conductor being used for something else, for example, the surround-sound system in your neighbor's home theater.

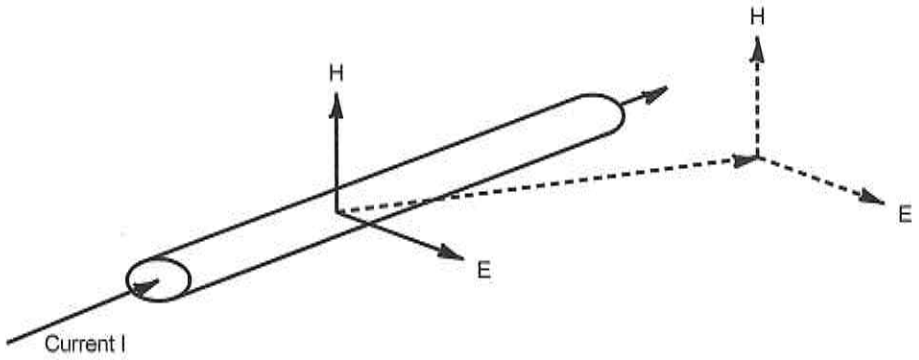

Figure 11-1. Transmitted electromagnetic (EMF) field.

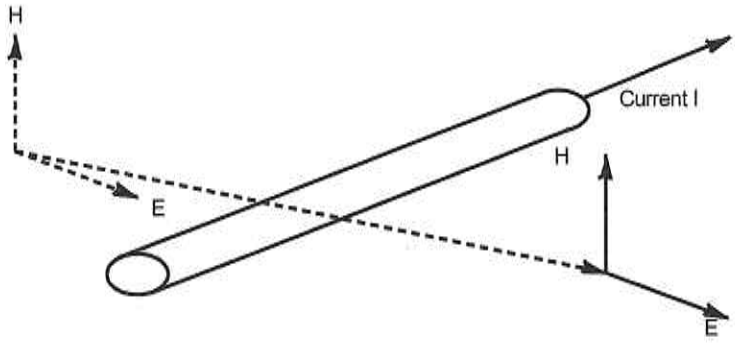

Figure 11-2. Received EMF field.

11.2 The Transmitter and Antenna

Figure 11-3 shows an equivalent circuit model of a transmitter and an antenna (connected directly to the transmitter – we will add a transmission line shortly). The transmitter consists of a voltage source, V_T, in series with a transmitter impedance, Z_T. The antenna is represented by the impedance Z_L. In modern, solid-state transmitters Z_T is 50 ohms (purely resistive). There are two important concepts of transmitters and antennas that can be described by studying Figure 11-3.

Maximum Power Transfer: A problem that beginning electrical engineering students are often asked to solve is "What should Z_L be so that the transmitter delivers the maximum power through Z_T to Z_L?" Although not intuitively obvious, the answer is that they should be equal, $Z_L = Z_T$.[46] We will see what this means when we add a transmission line to the equivalent transmitter circuit of Figure 11-3.

Antenna Current: Because Figure 11-3 is a *complete circuit,* the current *sourced* by the transmitter flows through the antenna (and generates a propagated EM field) and then *returns* to the transmitter. If there isn't a path for the antenna current to return to the transmitter as shown in Figure 11-4, zero current (or very little in a real antenna case) flows and therefore very little EM field is propagated. This is the situation that occurs when an operator merely connects an antenna to the center conductor or the transmitter's antenna jack and doesn't connect a conductor to the "ground" side of the jack. This can happen if you use a random length of wire or a telescoping whip antenna. The performance of these antennas will be very poor, and you will be disappointed with how

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[46] This is strictly true only if Z_T is resistive. If Z_T is reactive (inductive or capacitive) Z_L should be the complex conjugate of Z_T (capacitive or inductive). It is also not the value that achieves the highest transmitter efficiency P_L/P_T. When $Z_L = Z_T$, efficiency is 50%.

they work. To greatly improve these antennas, a simple wire, called a counterpoise, is connected to the ground side of the transmitter antenna jack. Figure 11-5 shows the resultant circuit model. Even though the counterpoise wire is not connected to the radiating part of the antenna, the radiated EM field induces a current in it to complete the circuit.

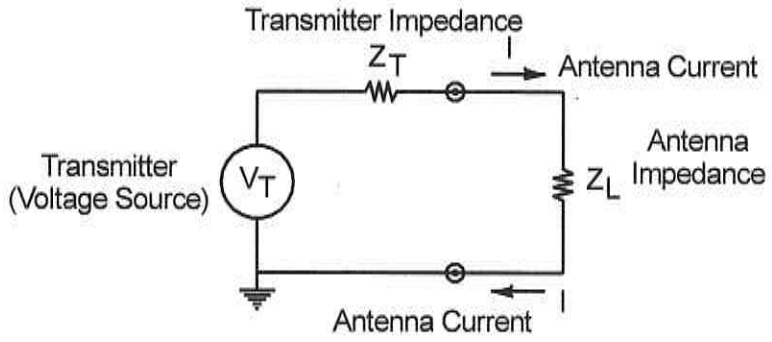

Figure 11-3. Transmitter and antenna equivalent circuit.

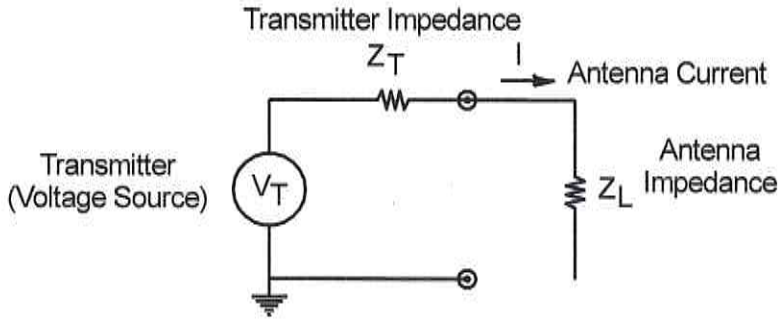

Figure 11-4. No antenna current, no propagated EM field!

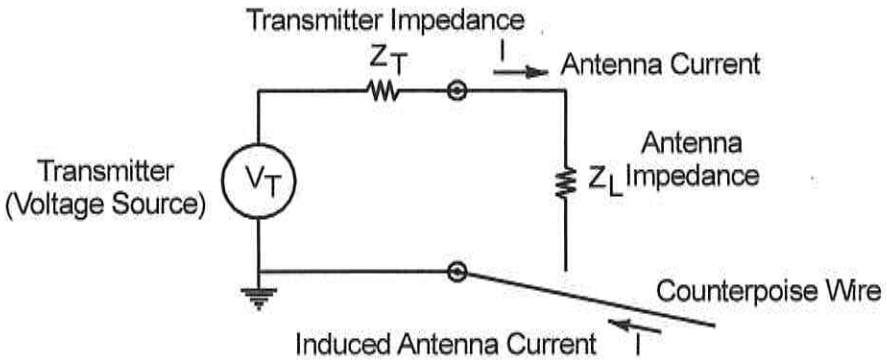

Figure 11-5. Random wire antenna with counterpoise.

The KX2 has a mini-banana jack that can be used to connect a counterpoise wire using the KX2GNPLUG Quick Release ground plug. Figure 11-6 shows a BNC – Binding Post adapter[47] to connect a random wire and counterpoise to the KX2 antenna jack.

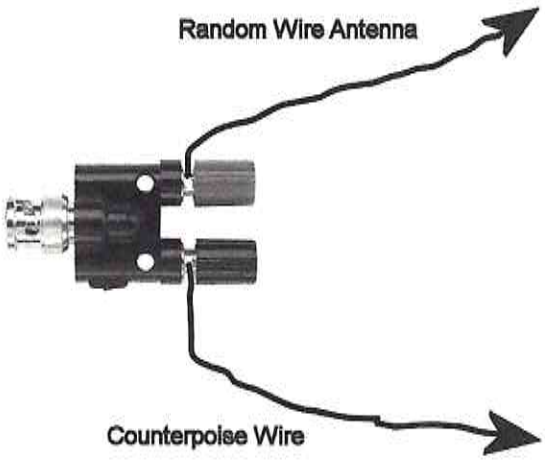

Figure 11-6. BNC – binding post adapter.

[47] Elecraft part number BNC-BP.

11.2.1 Antenna Impedance

Z_L in Figure 11-3 – Figure 11-5 represents the impedance of the antenna. Different antennas have different impedances, depending on the type of antenna, its height above ground, and whether or not the antenna is resonant at the operating frequency. Electrical engineers use Z to represent an impedance, which may consist of resistance, capacitance, and/or inductance. For now, we'll think about the overall magnitude of this impedance as a single number and focus on whether it is roughly the same as the transmitter impedance and the transmission line impedance.

Table 11-1. Typical Antenna impedance.

Antenna	Impedance – Ohms
½ λ Dipole	72
¼ λ Vertical	36 (but depends on radials)
Off-Center Fed Dipole (OCF)	10's – 1000's
Random Wire	10's – 1000's
End Fed Half Wave	1000 – 5000

The half-wave dipole and the quarter-wave vertical are known as resonant antennas when their length is cut for a specific operating frequency or band. In this case, their impedance is pretty close to that given in Table 11-1 and is resistive (at resonance).

Off-center fed dipoles (OCF), G5RVs, and random wire antennas, claimed to work on multiple bands, are non-resonant antennas. They are not cut to some specific length for a specific frequency.[48] The impedance of these antennas can range from 10's to 1000's of ohms. An antenna tuner (ATU) and balun often must be used with these antennas.

11.2.2 The Antenna and the Transmission Line

The circuit model of Figure 11-5 is only appropriate for an antenna connected directly to the transmitter. You might have this when you are using a random wire antenna or telescoping whip and are using a counterpoise. Other antennas such as dipoles and yagis, modeled by Figure 11-3, are usually located away from the transmitter and must be connected using a transmission line.

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[48] Nevertheless, providers of OCF and random wire antennas specify magic lengths that seem to work reasonably well for multiple ham bands. This is usually based on choosing a length that provides an impedance less than several hundred Ohms for each band. The G5RV antenna is cut for operation on the 20 meter band.

Transmission Lines

A transmission line is two parallel wires of sufficient length. What is a sufficient length? As a rough rule-of-thumb, wires that are longer than about one-tenth of a wavelength can be considered to be transmission lines. When they are this long or longer, it takes time for the signal to propagate from beginning to end.[49] Common transmission lines used to feed antennas include ladder line and coaxial cable.

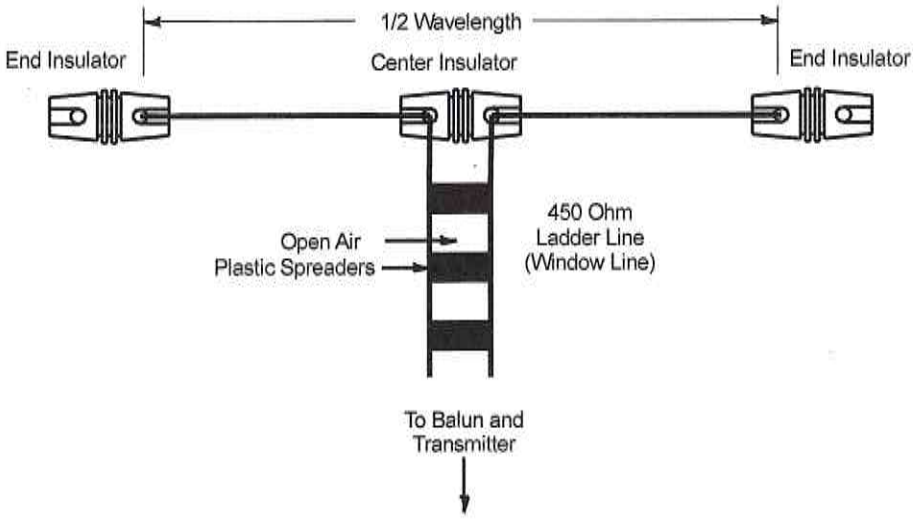

Figure 11-7. Dipole antenna fed with ladder line.

Figure 11-7 shows a 450 ohm ladder line feeding a dipole antenna. The antenna and the ladder line make a *balanced* transmission system and so at the transmitter, or more likely where the feed line enters the house, a transition is made to an *unbalanced* transmission line to connect to the unbalanced transmitter antenna connector, i.e. the coax connector on the back of your rig. See *Balanced and Unbalanced Systems, Baluns*, page 179.

Ladder line was used universally before the development of coax during WW II and is still used for some non-resonant, multiband antennas. It offers lower loss than coax but it is difficult to run from your antenna to your operating position. Its transmission characteristics are affected if it lies on the ground or is near metal objects.

Figure 11-8 shows a coaxial cable, such as RG-58, RG-8, or RG-213 feeding a dipole antenna. Coax is the most popular feedline used today. Because current flows *inside* the

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[49] Strictly speaking, signals always take time to propagate in any circuit. However, the propagation delay in a transmission line is significant enough that we must take it into account when we analyze such a system.

coax (more on this later), the feedline is easily brought to your operating position with worrying about nearby metal objects as you might with ladder line feeders.

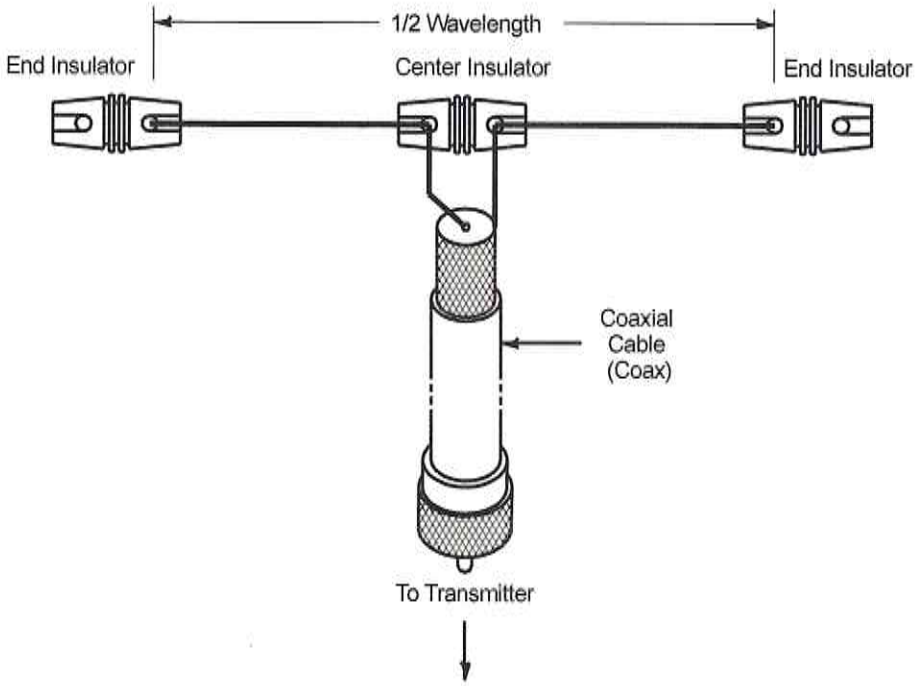

Figure 11-8. Coaxial fed dipole antenna.

11.2.3 Feedline Characteristic Impedance

The characteristic impedance of a feedline, Z_O, is a function of the size of the conductors, their spacing, and the material (air, plastic, Teflon, etc.) between them. Typical feedlines used in amateur radio are shown in Table 11-2. The actual impedance at any point along a transmission line is Z_{TL}, which changes when the antenna impedance is not equal to Z_O.

(If you are concerned that many of our antennas are balanced and not a perfect match to unbalanced coax, we'll discuss this starting in *Balanced and Unbalanced Systems, Baluns*, page 179. Just assume that Z_L is a lump of pure resistance for now.)

Table 11-2 Feedline impedances.

Feedline	Characteristic Impedance – Ohms
RG-58, RG-8X, RG-8,RG-213	50
RG-59, RG-11	72
TV Twinlead	300
Window Line	450
Open Wire Line	600

11.2.4 A Matched System

Figure 11-9 shows a system where the Transmitter Impedance, Z_T, equals the Transmission Line Impedance, Z_O, and the Antenna Impedance, Z_L. The is the very best we can do because Z_T equals Z_O, which gives us the maximum power transfer from the transmitter to the feedline, and Z_O equals Z_L, which gives us the maximum power transfer from the feedline to the antenna.

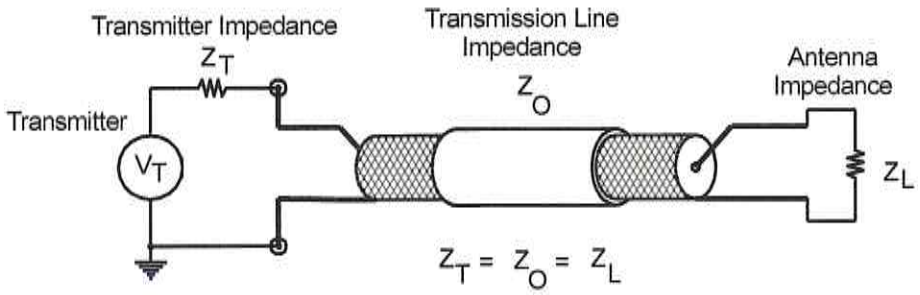

Figure 11-9. Matched system.

11.3 Standing Wave Ratio – SWR

A measure of the "goodness" of an antenna system is called the Standing Wave Ratio (SWR). A less than ideal SWR (above 1:1) is produced whenever the antenna impedance, Z_L, is not equal to the transmission line characteristic impedance Z_O. SWR is calculated by

$$SWR = Z_L/Z_O$$

when Z_L is > Z_O and

$$SWR = Z_O/Z_L$$

when Z_O is > Z_L.

The ideal occurs when $Z_L = Z_O$; SWR = 1:1.

When the SWR is greater than 1:1, standing voltage and current waves exist along the transmission line as shown in Figure 11-10. The voltage and current waves can be thought of as sine waves from the transmitter travelling forward and combining with voltage and current sine waves reflected back down the transmission line from the mismatch at the antenna.

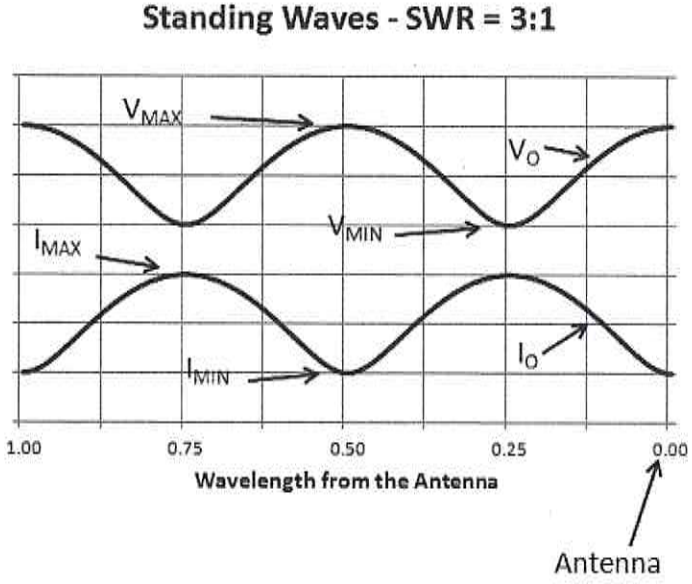

Figure 11-10. Standing Waves.

The standing waves exist only on the transmission line and are only a concern when Z_L does not equal Z_O. *The Problems with High SWR*, below, describes how SWR can affect our transmissions.

Exercise
The antenna is a ½ wavelength dipole and the feedline is RG-58. What is the SWR on the feedline?

SWR = 72/50 = 1.44:1.

11.3.1 SWR Impedance Transformation

Figure 11-10 shows the standing wave voltage and current along a transmission line with SWR = 3:1. At any point along the transmission line the impedance is given by $Z_{TL} = V_O/I_O$. Z_{TL}, in general, is not equal to the characteristic impedance of the line, Z_O, and it varies as a function of the distance from the antenna back toward the transmitter. The only time Z_{TL} is equal to the characteristic impedance Z_O is at specific points along the transmission line where the impedance transformation makes $Z_{TL} = V_O/I_O = Z_O$. Also, Z_{TL} can equal Z_L at multiples of one-half wavelength (0.5, 1.0 1.5 λ etc.) from the antenna. Figure 11-11 shows Z_{TL} starting at 150 ohms at the antenna and moving back toward the transmitter.

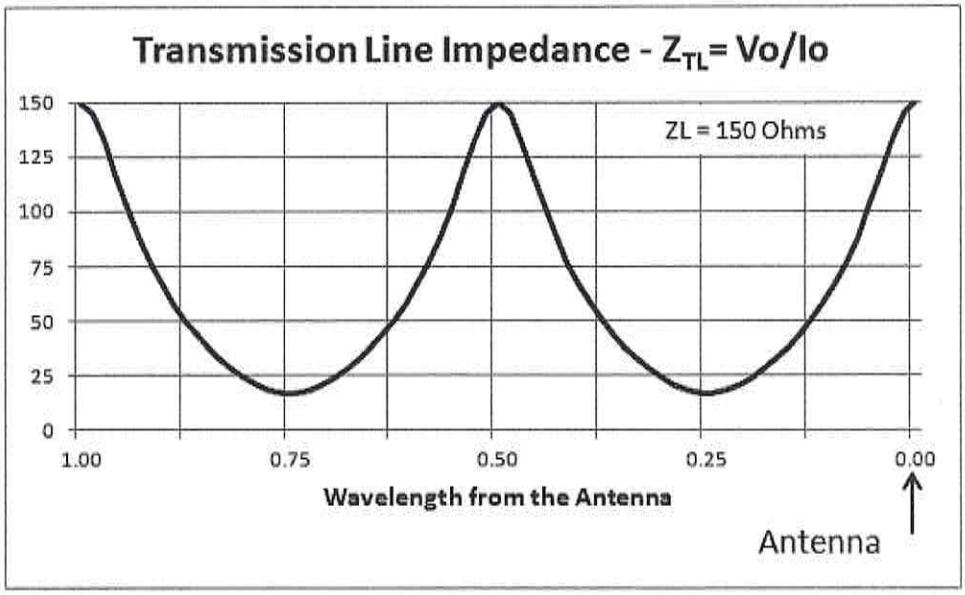

Figure 11-11. Transmission line impedance -- Z_{TL}

A conundrum of SWR measurements is that while the SWR in a transmission line is a constant given by Z_L/Z_O, when we make SWR measurements with a meter we find the measurements are not constant. It depends on where in the transmission line we make the measurement. Here is the reason why.

Most SWR meters, often called SWR bridges, simply measure V_O and I_O at the measurement point and then calculate SWR = Z_{TL}/Z_O assuming Z_O = 50 ohms. Thus, because Z_{TL} is changing, the calculated SWR changes as well. This is shown in Figure 11-12 where the measured SWR ranges from 1:1 to 3:1 depending on where the measurement is taken.

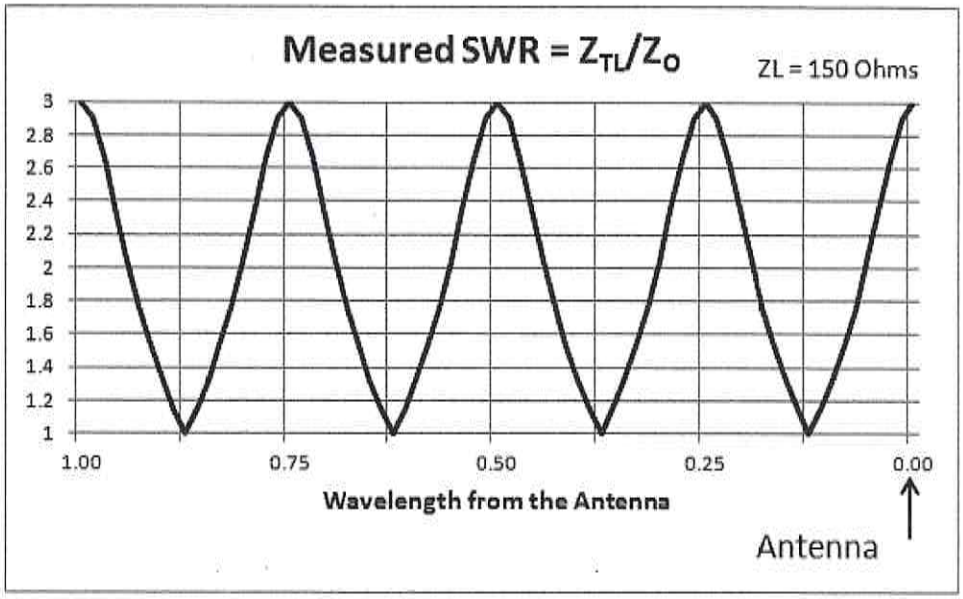

Figure 11-12. Measured SWR.

Figure 11-13 shows the impedance at any point along a feedline with characteristic impedance (Z_O) of 50 ohms, feeding a 75 meter antenna whose impedance is 150 ohms. At the antenna, the SWR is 3:1, and V_O/I_O = 150 ohms. As we move from the antenna back toward the transmitter and V_O drops and I_O rises (Figure 11-10), the transmission line impedance Z_{TL} drops to a minimum at about 40' and then rises and falls again until we reach the transmitter 125' from the antenna. At this point the transmitter "sees" Z_{TL} = 17 ohms and an SWR = 2.6:1. We will see if this is a problem or not in the next section.

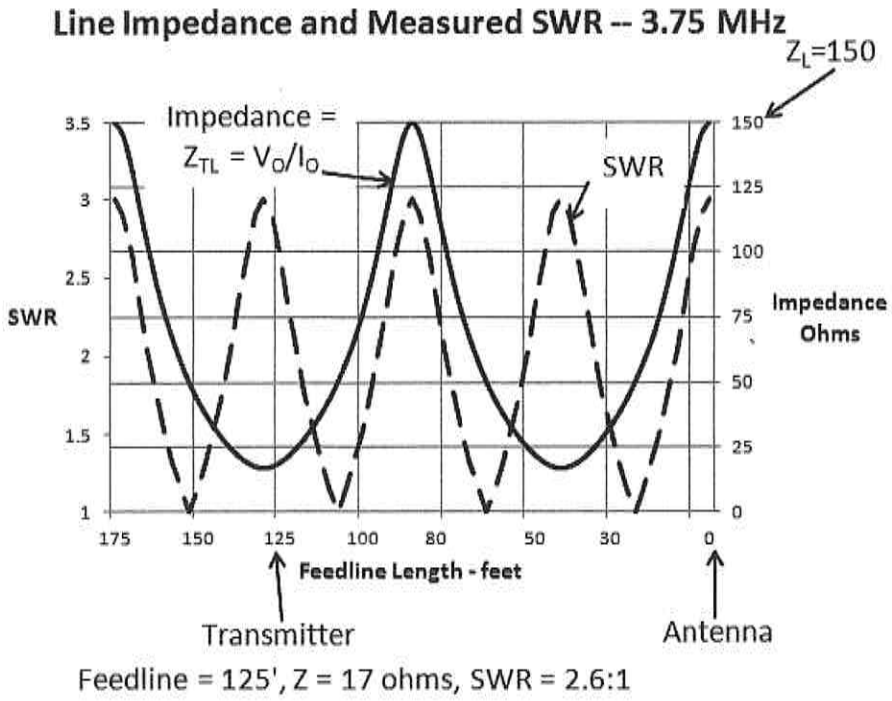

Figure 11-13. Line Impedance and measured SWR.

There are several important "take aways" from this example where the antenna impedance Z_L does not equal the characteristic impedance of the transmission line Z_O and standing waves exist on the transmission line.

- The measured SWR changes depending on where you make the measurement.
- If you measure SWR and then either move the meter or change the system by adding a length of feedline, the measured SWR changes.
- Adding a length of coax can change the measured SWR for better or worse. For example, in Figure 11-13, adding approximately 25' to the 125' feedline brings the impedance to 50 ohms and the SWR to 1:1.
- Depending on the SWR presented to the transmitter, you may have to take measures to protect your transmitter from damage and to be able to transfer the maximum power. In Figure 11-13 if you were unfortunate to have chosen a feedline approximately 175', the radio would see an impedance of 150 ohms and SWR of 3:1.
- The transmission line acts as an impedance transformer and therefore acts to change the impedance seen at the transmitter end of the feedline.

- The ladder line shown in Figure 11-7 also acts as an impedance transformer when SWR exists.
- Having a 1:1 SWR at your transceiver does not mean you have a good antenna. It only means that you have an impedance match between your transceiver and your feedline. It says nothing about how well your antenna is working or about losses in the system.
- The Z_L impedance is repeated at ½ wavelength intervals.
- A wavelength in the coax is the wavelength in free space times the velocity factor of the cable.

11.3.2 The Problems with High SWR

Many hams view SWR in an antenna/feedline system as an evil that must be overcome at all costs. The prevailing view is that SWR on a feedline causes losses. While true, the losses actually incurred in a feedline are generally small and comparable to the inherent cable loss (called matched cable loss) for SWR less than about 5:1.

Table 11-3 shows the signal lost in the cable itself (matched cable loss) and the additional loss in the cable due to SWR at various frequencies.[50] This total loss varies with the length and type of cable. (Remember, 1 dB of loss is approximately 20% of transmitter power, and 3 dB of loss is 50% of transmitter power.)

Table 11-4 shows the total loss in watts for various SWR values and 100 feet of RG-8X cable. Table 11-5 shows total cable loss for different cables and 5:1 SWR.

Table 11-3. Additional loss (in dB) due to SWR – 100' Belden RG-8X.

Frequency MHz	Matched Cable Loss dB (or Watts)[51]	Loss Due to SWR – dB			Total Loss dB		
		3:1	5:1	10:1	3:1	5:1	10:1
3.5	0.52 (1.1W)	0.30	0.68	1.56	0.82	1.2	2.08
7	0.75 (1.6W)	0.40	0.91	2.02	1.15	1.66	2.77
14	1.09 (2.2W)	0.54	1.19	2.55	1.63	2.28	3.64
21	1.35 (2.7W)	0.624	1.37	2.87	1.97	2.73	4.23
28	1.58 (3.1W)	0.69	1.51	3.11	2.27	3.09	4.69

[50] http://www.qsl.net/co8tw/Coax_Calculator.htm

[51] For a 10-watt transmitter.

Table 11-4. Total loss (matched loss + SWR loss) – 100' Belden RG-8X for a 10 watt transmitter.

Frequency MHz	Total Loss – Watts		
	3:1	5:1	10:1
3.5	1.7	2.4	3.8
7	2.3	3.2	4.7
14	3.1	4.1	5.7
21	3.6	4.6	6.2
28	4.1	5.1	6.6

Table 11-5. Total loss (matched loss + SWR loss) – 100' of cable, 10 watt transmitter, 5:1 SWR.

Frequency MHz	RG-174	RG-58	RG-8X	RG-213
	Total Watts Loss	Total Watts Loss	Total Watts Loss	Total Watts Loss
3.5	4.9	2.9	2.5	1.8
7	5.9	3.7	3.2	2.4
14	6.9	4.6	4.1	3.1
21	7.5	5.2	4.7	3.6
28	7.8	5.6	5.1	4.2

Exercise
A 100' RG-8X feedline is connected to a 50 ohm antenna. For 10 Watts going into the feedline on 40 meters, how much power reaches the antenna?

This is a matched antenna so there is no SWR loss. From Table 11-3 the matched cable loss is 1.6 Watts. The power at the antenna is 10 – 1.6 = 8.4 Watts.

Exercise
A 100' RG-8X feedline is connected to a 250 ohm antenna (SWR = 5:1). For 10 Watts going into the feedline on 40 meters, how much power reaches the antenna?

From Table 11-4 the total loss for 5:1 SWR is 3.2 Watts. The antenna power is 10 – 3.2 = 6.8 Watts.

Exercise

How can I calculate the losses if my transmitter is 100 Watts instead of 10 Watts?

Multiply the loss (in Watts) from Table 11-3 to Table 11-5 by 10. Do not change the dB loss values.

11.3.3 Matching to Achieve Maximum Power Transfer

There are four effects of SWR to which we should pay attention. These are:

1. Power losses in the transmission line.
2. Antenna impedance transformation due to the standing voltage and current waves.
3. Potential danger to our modern solid-state transmitter.
4. Reduction in power transfer due to the mismatch.

We discussed power losses due to SWR above and find that for SWR of 5:1 or less, the power loss is roughly equal to the losses in the cable itself.

The impedance transformation effect of SWR can affect our SWR measurement, but more importantly, it can present a danger to our modern solid-state transmitters and also reduce the amount of power transferred from the transmitter into the coax.

Modern transistor amplifiers are quite intolerant of over-voltages that may be produced by a high SWR load. For example, in the 3:1 SWR case shown in Figure 11-10, if your transmitter is located at a voltage maximum it can see 1.5 times the voltage as it would see for SWR = 1:1. For the case of SWR = 10:1, the voltage can be almost double. Most transmitters are quite happy with SWR of 2:1 or less.

The second reason to match the feedline impedance to the transmitter is to be able to transfer the maximum power from the transmitter to the feedline. Recall that the maximum power transfer occurs when the feedline impedance Z_{TL} (V_O/I_O) at the transmitter is equal to the transmitter output impedance Z_T. Figure 11-14.

Table 11-6 shows the losses occurring when the feedline impedance Z_{TL} is not equal to Z_T.

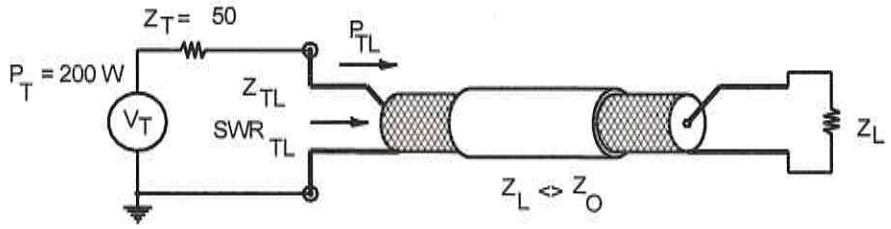

Figure 11-14. Maximum power transfer.

Table 11-6. Power delivered to transmission line (P_{TL}) from 10 watt transmitter.

Z_{TL}	SWR_{TL}	P_{TL} watts	Watts Loss	Loss - dB	
25	2:1	8.9	1.1	0.51	
50	1:1	10.0	0	0	
72	1.44	9.7	0.3	0.14	Feeding a dipole with 50 ohm coax
100	2:1	8.9	1.1	0.51	
150	3:1	7.5	2.5	1.25	
250	5:1	5.6	4.4	2.55	
500	10:1	3.3	6.7	4.81	

Exercise
My 10 watt, 40 meter rig drives 100' of RG-8X feedline. The measured SWR at the transmitter is 3:1. What is the total loss?

Table 11-6 shows that the power loss due to 3:1 SWR is 1.25 dB. Table 11-3 shows the total cable loss is 1.15 dB. The total loss is 1.25 + 1.15 = 2.4 dB.
dB = 10 Log (P2/P1) where P1 is 10 watts.
$P2 = P1 * 10^{(-0.24)}$ = 5.8 watts at the antenna. The total loss is 4.2 watts.

11.3.4 The ATU – Antenna Tuner Unit

Figure 11-15 shows an antenna tuner unit (ATU)[52] interposed between the transmitter and the feedline. Recall that when Z_L does not equal Z_O, standing waves exist on the transmission line and the antenna impedance is transformed along the transmission line to become $Z_{TL} = V_O/I_O$ at the transmitter end of the coax. An ATU consists of inductors (L) and capacitors (C) arranged in a circuit to provide another impedance transformation so that the impedance seen by the transmitter, Z_{ATU}, is equal to Z_T. This allows the maximum power to be transferred to the transmission line, eliminating the losses seen in Table 11-6. It also eliminates an SWR caused overvoltage that can damage the transmitter.

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[52] It is unfortunate that this device is called an "antenna tuning unit" because it DOES NOT tune the antenna. A more accurate name would be "antenna matching unit".

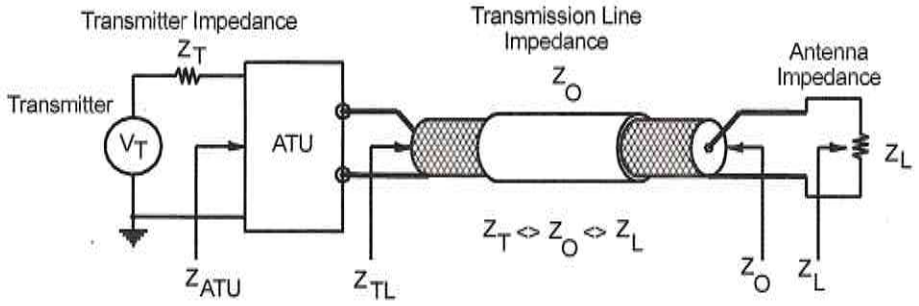

Figure 11-15. Using an ATU to match the feedline impedance to the transmitter impedance.

Here are some things to know about an antenna tuner:

- It transforms the impedance at the end of the line, Z_{TL}, to be equal to (or be the complex conjugate of) Z_T.
- It allows the maximum power transfer into the feedline when Z_{TL} does not equal Z_T.
- It keeps the voltage seen by the final amplifier transistors below damaging levels by making $Z_{ATU} = Z_T$.
- It does not tune or match the antenna (unless it is located at the antenna).
- It does not change the SWR on the transmission line (unless it is located at the antenna).
- The ATU may be external to the radio.
- An optional internal ATU is available for the KX2.

ATUs – The Bottom Line

Unless you are going to be using resonant antennas with low SWR, you should include an ATU, either internal or external, in your system.

11.3.5 SWR – The Bottom Line

- Standing voltage and current waves (and an SWR above 1:1) exist on a transmission line when Z_L does not equal Z_O.
- SWR signal loss is comparable to the matched cable loss when SWR is less than about 5:1.
- The larger coax varieties have less loss than smaller diameter cable.
- Shorter lengths of coax have less total loss than longer lengths.

- While the transmission line characteristic impedance, Z_O, is constant, the transmission line impedance, Z_{TL}, changes along the transmission line when standing waves exist.
- The SWR you measure depends on where along the transmission line you measure it.
- A high measured SWR at the transmitter can cause miss-match losses and can generate voltages high enough to damage a transmitter.
- An antenna tuner unit at the transmitter can match the transmission line impedance Z_{TL} to the internal transmitter impedance Z_T.

11.4 Balanced and Unbalanced Systems, Baluns and Un-Uns

The most common resonant antenna, the dipole, is a balanced antenna. A balanced antenna and feedline system is shown in Figure 11-16. In a balanced antenna, both halves of the dipole have the same, or nearly the same, current. Figure 11-16 also shows a balanced feedline and a balanced transmitter. In the early days of radio, these were common because balanced feedlines were also common.

Today, unbalanced transmitters as shown in Figure 11-17 are the norm and are fed with an unbalanced feedline -- coax. When a balanced antenna meets an unbalanced feedline and transmitter, a *balanced-to-unbalanced* transformation should be done. This device is called a Balun.

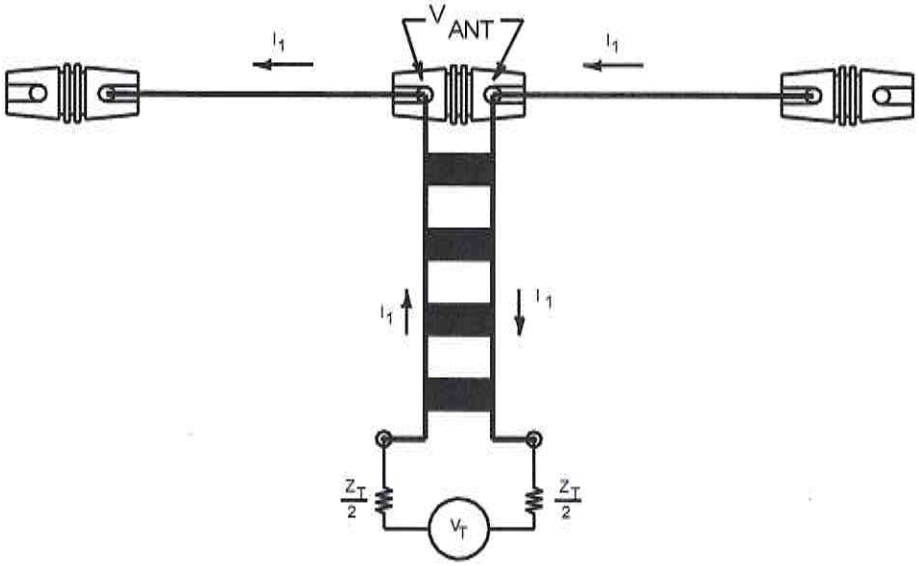

Figure 11-16. Balanced dipole antenna, balanced ladder line feeder.

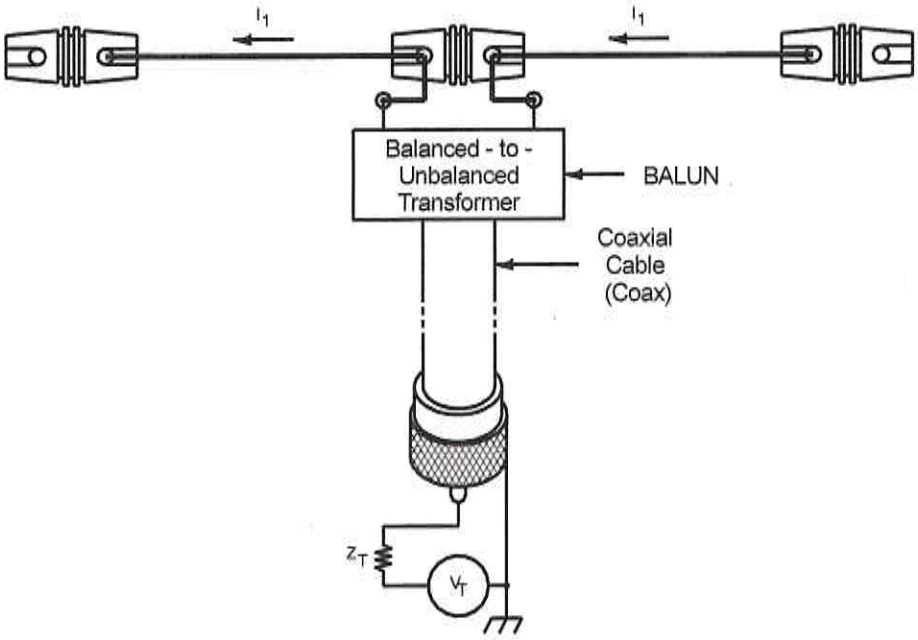

Figure 11-17. Balanced antenna, unbalanced feedline, and unbalanced transmitter.

There are two types of baluns – impedance transforming (or voltage) and choke (or current) baluns. The first is shown in Figure 11-17. Transformer windings can transform a high antenna impedance to a lower one. For example, a 9:1 balun is popular with users of off-center fed dipoles and random wire antennas. These often have an impedance on the order of 450 ohms and the 9:1 balun transforms it to 50 ohms to match a 50 ohm feedline. A second function of the impedance transforming balun is to provide equal voltage to both sides of the balanced antenna and to eliminate or reduce current flowing on the outside of the coaxial feedline. This is important to reduce feedline radiation, which can cause RF interference in the shack and to other nearby electrical components.

The second type of balun is a choke balun. The choke balun is also called a current balun because it acts to provide equal currents to each side of the balanced antenna and to reduce the current flowing on the outside of the coax shield. Figure 11-18 shows an example. Choke baluns do not perform any impedance transformation – they are 1:1. They are designed to eliminate or reduce feedline radiation. Choke baluns are most commonly built by sliding ferrite cores on the outside of the coax. A choke balun can also be made by winding the coax in a coil with several turns through a large ferrite core.[53]

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[53] A good place to learn more about baluns and other antenna topics is K9YC's audiosystemsgroup.com web page.

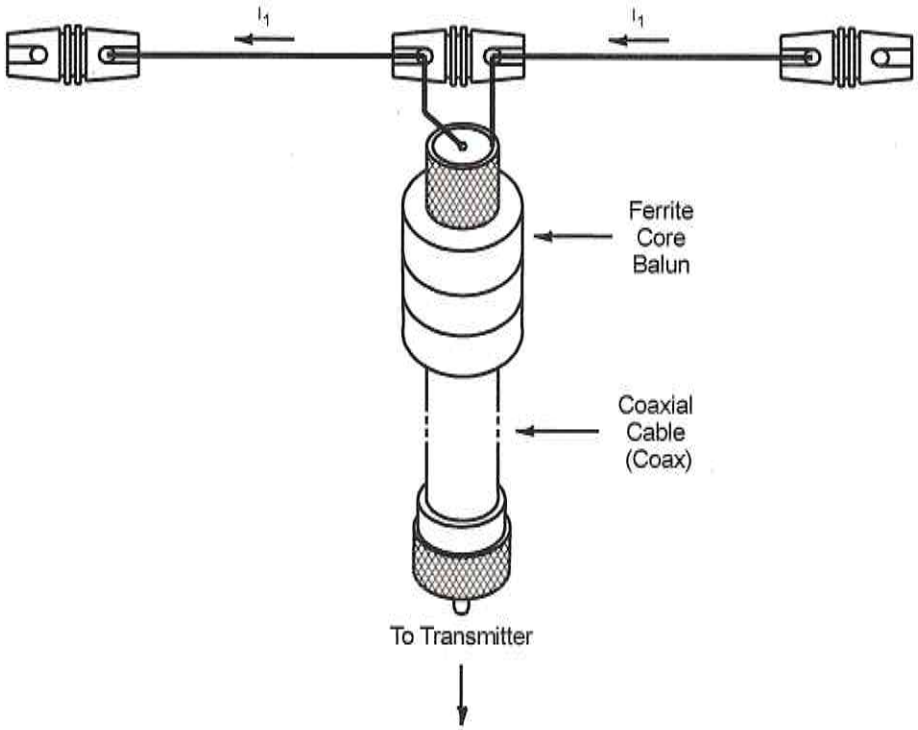

Figure 11-18. Ferrite cores used as a 1:1 choke or current balun.

Un-Uns

Another device, similar the impedance transforming balun because it is wound on a ferrite core, is the *Unbalanced-to-Unbalanced* impedance transformer, or *Un-Un*. These are used where an unbalanced antenna, such as End Fed Half Wave (EFHW) or random length wire, is used that has a very high input impedance. The impedance transformation is made to match the antenna's high impedance to the feedline to reduce SWR. A commonly used un-un provides a 9:1 impedance transformation making it useful for some high impedance antennas.

Baluns – The Bottom Line

You should always use a balun at the transition from a balanced antenna or feedline to an unbalanced feedline to prevent feedline radiation. With a balun, the outside of your coax is not part of the radiating antenna.

Un-Uns are commonly used with unbalanced, high impedance antennas to match the antenna to the feedline. There are other coupling methods that can be used as well.

Baluns and un-uns can introduce losses into your system, particularly when a high impedance transformation is needed. An article in June 2015 QST, *Don't Blow Up Your Balun*, by Dean Straw, N6BV, illustrates how these losses can "eat your lunch".

11.5 Cut Your Losses

We often think that when we key our 10 watt transmitter we are radiating 10 watts from the antenna. The previous sections have shown that there are losses all along the way that reduce that signal. If we want to successfully make contacts we should reduce these losses. Table 11-7 summarizes these losses and suggests strategies to reduce them.

Table 11-7. Antenna system losses.

Loss Type	Strategy to Reduce
No antenna return current.	Add counterpoise wire.
Losses in ground system of a vertical antenna.	Add radials and improve the ground conductivity in the area of the antenna (chicken wire screen under the antenna).
Antenna ohmic losses.	Use larger diameter conductors.
Transmission line matched losses.	Use larger and lower loss coax.
Transmission line SWR losses.	Use resonant antennas where Z_L is near Z_O. Use an ATU at the antenna. Use open wire feedline.
Miss-match losses.	Adjust transmission line length so that the transmitter "sees" 50 ohms. Use an ATU at the transmitter. Use an ATU at the antenna.
Balun and un-un losses.	Avoid the need for large ratio impedance transforming baluns and un-uns. Use large conductors in impedance transforming baluns and un-uns. Use enough ferrite material in choke baluns so that the choke impedance is high.
Low efficiency antennas.	Avoid multi-band antennas. Use resonant antennas like dipoles when possible.
$$$	Build your own! Wire antennas are easy and inexpensive to make.

11.6 Some Antennas

Antenna	Comments[54]
½ wave dipole	Easily the best of simple antennas. Inexpensive and easy to construct. Can be supported on two ends (flattop) or in the middle (inverted Vee if the ends are lower than the middle). Feed with 50 or 72 ohm coax with a 1:1 or choke balun at the feed point. For resonant operation, an ATU is probably not needed.
Vertical	Again, a good simple antenna, although it requires a ground (radials in/on the ground or elevated – my preference). If shorter than ¼ wavelength, it requires matching at the antenna. Feed with 50 ohm coax with 1:1 balun at the feed point. An ATU can be helpful.
G5RV	This is an antenna that can perform reasonably well on multiple bands. It is a 102' dipole fed with 34.8 feet of 450 ohm ladder line, which then can change to 50 ohm coax. A choke or current balun should be used at the junction of the ladder line and the coax. An ATU is needed for bands other than 20 meters.
Buddi-Pole	A compromise antenna when compared to a dipole or ¼ wave vertical. Popular for portable operation (compact, self-contained, easy to set up, etc.). Although a resonant match can be achieved, many simply tune the antenna with an ATU.
Alex Loop	This is example of a magnetic loop antenna. Also popular for portable operations. Very narrow bandwidth – requires retuning the antenna whenever the operating frequency is changed more than a few kilohertz. An ATU can be helpful.
Off-Center Fed Dipole	This antenna is an attempt to create a single antenna useful on multiple bands. Its feed point impedance varies widely; a 9:1 balun is recommended at the feed point. Losses (miss-match and SWR) can be substantial compared to a resonant antenna like a dipole. An ATU is a necessity.
End Fed Half Wave (EFHW)	This is a resonant antenna at its design frequency but due to being fed at the end, it is very high impedance (1,000 – 5,000 ohms). Impedance matching or antenna coupling is needed at the feed point as is a counterpoise. A transmitter ATU is also necessary in most cases. For more information, search for EFHW.
Random wire	A random wire antenna is simply a length of wire connected to the radio and carried out and up as far as possible. Some lengths work better than others. A counterpoise wire connected to the radio ground is required. Like the Off-center fed dipole, feed point impedance varies widely. The transmitter should have an ATU and an impedance matching Un-Un might be helpful to transform high impedances to the range the ATU can handle.

[54] KE7X opinions and biases.

Single band or multi-band whip	It is tempting to connect one of these mobile-type antennas directly to the radio and start transmitting. A counterpoise wire is required for effective propagation. A downside of these antennas is the mechanical strain on the radio's antenna connector. It is better to use one of these antennas on a mag mount on a cookie sheet and fed with 50 ohm coax. Connect the counterpoise wire to the cookie sheet.

11.7 The Gods of Propagation—Part II

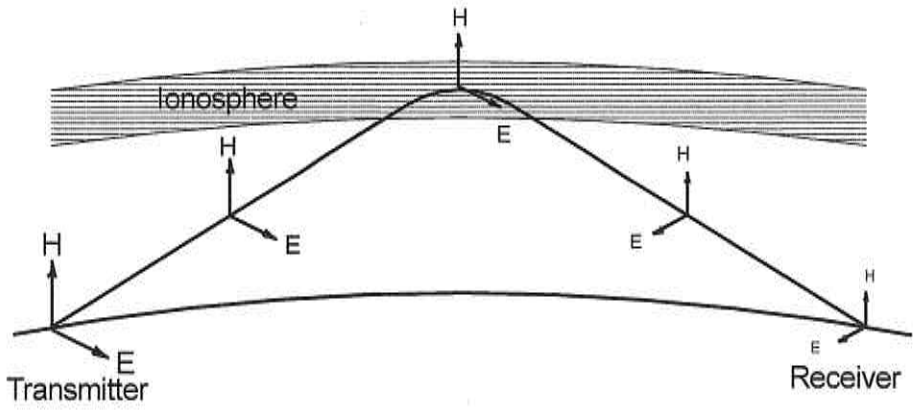

Figure 11-19. EMF field ionospheric skip propagation.

Figure 11-19 shows the general idea of high frequency radio propagation that "skips" or "reflects" from the ionosphere to propagate around the world. To be able to make contacts with your KX2 radio, not only do you need a good, low loss, effective antenna, but radio wave propagation must be in your favor too.

Here are some things we know about the ionosphere and radio propagation:

The Ionosphere

- The amount (density) of the ionization depends on solar radiation – solar flux.
- There is more ionization during daylight than at night. Therefore daytime propagation is different than nighttime propagation.
- The solar flux varies over an 11-year cycle called the sun spot cycle.[55]
- In high sun spot years, the solar flux is high.

[55] The sun spot cycle is actually more complex than a simple 11-year cycle.

- In low sun spot years, during the minimum of the sun spot cycle, bands like 10-, 12- and 15-meters may never open to skip propagation. However, 40- and 80-meters may provide more hours of skip propagation.
- A measurement of the solar radiation is called the solar flux index (SFI).
- When the SFI is low (<80), you might not have propagation on higher frequency bands like 12- and 10-meters.
- The distance into the ionosphere a radio wave penetrates before being reflected depends on the amount of ionization, the frequency of the wave, and the angle of incidence.
- For a given ion density, higher frequencies penetrate more than lower frequencies and can even penetrate the ionosphere completely and not be reflected.
- Low frequencies (160-, 80-meters) may be completely absorbed during daytime high ionization but can be reflected during the lower ionization at night.
- The Maximum Useable Frequency (MUF) is the maximum frequency that can be used to communicate between two points using skip propagation for a given ionosphere density.

The Geomagnetic Field

- The ionosphere is affected by the earth's magnetic field.
- Magnetic field activity is caused by the flow of charged particles from the sun interacting with the field.
- When the magnetic field is quiet, skip propagation is enhanced (think skipping a rock off a calm pond).
- When the magnetic field is active, it is moving around and consequently creating disturbances in the ionosphere. Skip propagation is less effective (think skipping a rock off a pond in a hurricane).
- Two measures of magnetic field activity are the A Index and K Index. The A Index is an average activity value over the past three hours and K represents activity over the past 24 hours.
- Low A and K indices are better for skip propagation.
- An A index > 5 is an indicator of strong magnetic field conditions and contacts may be difficult to make.

Propagation Conditions to Watch Out For

Solar Flux Index (SFI): SFI greater than about 100 means the higher bands (20 – 10 meters) may support propagation. In years of high solar activity SFI can approach 200 and world-wide propagation on 50 MHz can be found. When the flux dips below 80 or so, the lower bands offer the best, and maybe only, propagation.

K Index and A Index: These measure the geomagnetic field activity and we would like them to be low numbers. A K of 4 or more and rising indicates the field is currently active and propagation conditions will be degraded. The A index is a measure of yesterday's

field activity and when watched over several days can tell us if conditions are likely to improve or degrade. Again, a low number is more favorable to good propagation.

11.7.1 How to Find the Propagation Conditions

Propagation depends on the solar flux (higher is better) and quiet magnetic field conditions (A and K low are better). There are several web sites that are worth checking on a daily basis to see what the conditions are.

www.spaceweather.com: Current solar and field conditions and other interesting space weather conditions.

www.solarham.com: Current solar and field conditions in multiple formats in addition to SFI and A and K indices. Includes interesting solar imagery and aurora information.

www.dxmaps.com: Actual contact reports between stations all over the world. Updated every few minutes, you can watch activity on all bands 2200 meters through 450 MHz.

www.voacap.com: This site allows you to enter current solar conditions and then to see propagation forecasts for point-to-point contacts or for which areas of the world propagation exists for a given band and time of day.

11.8 Why Can't I Make a Contact Troubleshooting Flow Chart

1. Choose a band to operate.
2. Choose an operating mode.
3. Is it daylight? If yes, go to 5. If no, go to 4.
4. Are you trying a nighttime band such as 30, 40, 60 or 80 meters? If yes, go to 6. If no, switch to 30, 40, 60 or 80 meters; go to 6.
5. Are you trying a daytime band such as 20, 17, 15, 12, or 10 meters? If yes, go to 6. If no, switch to one of these bands; go to 6.
6. Does the www.dxmaps.com web site show propagation is being reported on the band you are on? If yes, go to 7. If no, switch to another band; go to 6.
7. Are magnetic field conditions stormy (A > 5)? If yes; if running low power and low/ineffective antenna consider changing to another band or trying on another day; go to 1. If no, go to 8.
8. Is the solar flux high enough to support good propagation on this band? (E.G. SFI > 50?). If yes, go to 9. If no, change to a lower frequency band; go to 3.
9. Do you hear band noise? If yes, go to 14. If no, go to 10.
10. Is NB turned on? If yes, turn it off (hold AF/MON/NB Ø); go to 11. If no, go to 11.
11. Is NR turned on? If yes, turn it off (hold NR); go to 12. If no, go to 12.
12. Is ***RF GAIN = -0***? If yes, go to 13. If no, set the ***RF GAIN*** menu ***-0***; go to 13.

13. Are the DSP filters normalized for the operation mode? If yes, go to 14. If no, normalize the width and center frequency (tap FIL, tap AF/MON ∅, tap KYR-SPT/MIC ∅, tap FIL). Go to 14.
14. Are you operating SSB? If yes, go to 15. If no, go to 17.
15. Is ***MICBIAS*** is set properly for your microphone? If yes, go to 16. If no, set the ***MICBIAS*** menu; go to 16.
16. Is ***ALT MD nor***? If yes, go to 22. If no, set the ***ALT MD*** menu ***nor***; go to 22.
17. Are you operating CW? If yes, go to 22. If no, go to 18.
18. Are you operating FSK D or PSK D? If yes, go to 19. If no, go to 20.
19. Do you have the KX2 Utility operating? If yes, go to 24. If no, load the KX2 Utility program; go to 24.
20. Are you operating AFSK A or DATA A? If yes, go to 21. If no, go to 2.
21. Do you have a RTTY or PSK programming running on your PC? If yes, go to 22. If no, start the program on your PC; go to 22.
22. Are you operating VOX? If yes, go to 23. If no, go to 24.
23. Is ***VOX MD On***? If yes, go to 24. If no, set the ***VOX MD*** menu ***On***; go to 24.
24. Are you using the correct antenna for the band? If yes, go to 25. If no, switch to the correct antenna; go to 25.
25. Is the SWR with the ATU bypassed < 2:1? If yes, go to 28. If no, go to 26.
26. Will the ATU bring the SWR < 2:1? If yes, go to 28. If no, go to 27.
27. Check all antenna connections. Go to 25.
28. Is the output power set > 0.0? If yes, go to 29. If no, increase the output power setting; go to 29.
29. Do you hear signals on the band? If yes, go to 30. If no, go to 1.
30. Call CQ or find a loud station and call it. Go to 31.
31. Are you able to make a contact? If yes, yea!. If no, go to 1.

11.9 More Information

In these days of miniature surface mount components and software designed radios we have lost many of the opportunities for building our radio equipment that were enjoyed by earlier hams. However, experimenting with and building and installing antennas remain a creative activity area that many of us still enjoy. Here are some resources to help you get started:

- *The ARRL Antenna Book*, The ARRL, Inc.
- *The ARRL Handbook,* The ARRL, Inc.
- *The ARRL Operating Manual*, The ARRL, Inc.

Appendix A. Glossary and Definitions

Active low signals: An active low signal is one that activates the action for which it is designed by going to a low (near ground) level.

AFSK: Audio Frequency Shift Keying. A digital DATA mode where the transmitter is operating in sideband and the modulation produces a frequency shift by applying an audio tone. An external audio source (computer sound card) must be used for this mode. See FSK.

ASCII: American Standard for Communication Information Interchange. A seven-bit code used for characters and text.

dBm: dBm is dB relative to a milliwatt. dBm = 10 $\log_{10}$(Output Power/1 mW).

DSP: Digital signal processing. Audio frequency analog signals in the KX2 are converted to digital form by an analog-to-digital converter and then processed by the DSP microprocessor.

Firmware: The programs running on the microcontrollers and digital signal processors are kept in a programmable read-only-memory called an EEPROM (Electrically Erasable Programmable Read Only Memory). The programs are more "firm", i.e. less frequently changed or removed, than those running in RAM on your PC. Thus, they are called firmware instead of software.[56]

Floating: A logic output that is neither high nor low. It usually presents a high impedance to any device "looking" in. See Open collector/open drain.

Fold-back: A reduction in power output due to an error condition, high VSWR, or high temperature. Initiated automatically by the KX2 to protect itself.

FSK: Frequency shift keying. A digital DATA mode where the modulation directly changes or shifts the transmit frequency. An external computer can generate these signals or the KX2 can generate them directly. See AFSK.

IF: Intermediate Frequency. A fixed frequency, either below (down converted) or above (up converted) the radio frequency band on which you are operating.

IMD: Intermodulation Distortion. These are sum and difference frequencies produced in non-linear signal processing stages.

MCU: Microcontroller unit. The microcontrollers in the KX2 control almost all operations.

MDS: Minimum Discernible Signal.

Mode: Mode refers to SSB, CW, or DATA.

Normally Open (NO)/Normally Closed (NC): Relay contacts are labeled normally open or normally closed based on their un-energized (normal) state.

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[56] In the early days of microprocessors, an unknown author, critical of the quality of some of the firmware and software, called it "mushware." The Elecraft KX2 programmers have advanced far beyond this primitive state of affairs.

Open collector, open drain: Logic devices whose outputs are tied together must use a transistor whose collector or drain is open, or not connected to any logic level.

Per-Band: A number of the KX2's controls and settings can be managed on a per-band basis. Each band can have its own setting.

Pull-up, pull-down: A pull-up is a passive device such as a resistor, or sometimes an active device like a transistor, that "pulls" a logic signal to a logic high level. The pull-down does the opposite, pulling the logic signal low.

RF: Radio frequency. The frequency of the band upon which you are operating. Often higher than the IF, but can be lower too.

Sink current: Current that flows into the output of a logic device. Logic devices sink current when their output is logic low.

Source current: Current that comes from, or is output from, a logic device. Logic devices source current when their output is logic high.

TRS, tip-ring-sleeve: Also called a stereo jack or plug. It has three connections – the tip and ring for signals and the sleeve, which is commonly a signal ground.

TRRS, tip-ring1-ring2-sleeve: These jacks and plugs have four connections. There are two ring connections. One must be careful plugging a TRS plug into a TRRS jack to ensure that the circuit inside can handle shorting the two rings together without damaging any circuitry.

TS, tip-sleeve: Also called a monaural or mono jack or plug. It has two connections – one for signal and one for signal ground.

Appendix B. Microphones

Microphones used with the K3 and KX2			
Microphone	**Element Type**	**Bias Needed?**	**Low or High Gain (K3 Only)**
Astatic D-104 with Radio Shack electret element	Electret	Yes	H
Audiotechnica ATR-30	Dynamic	No	L
Elecraft MD2	Electret	Yes	
Elecraft MH2	Electret	Yes	L
Elecraft MH3	Electret	Yes	L
Electrovoice 27	Dynamic	No	
Heil HC4 Element	Dynamic	No	H
Heil HC5 element	Dynamic	No	H, L
Heil HMM	Dynamic	No	H
Heil iC Element	Electret	Yes	H
Heil ProSet (not K2) (Uses HC4, HC5 or iC)	Dynamic or Electret	No-Dynamic Yes-Electret	
Heil ProSet K2	Electret	Yes	
Note: The Heil headsets from Elecraft use an electret element that requires ***MICBIAS*** to be turned on. Non-Elecraft sold Heil headsets, specifically with HC elements, should not enable ***MICBIAS*** because the HC elements are dynamic. Also, HC elements are low on signal in comparison to others, so the MIC Gain value has to be set pretty high.			
Icom HM-36 (handmic)	Electret	Yes	L
Icom SM-8 (desk mic, must be rewired for power)	Electret	Yes	L
Kenwood MC-43S	Dynamic	No	L
Kenwood MC-60	Dynamic	No	L
Kenwood MC-80	Electret	Yes	L
Radio Shack Optimus Nova 79	Electret	Yes	L
Sennheiser PC350	Electret	Yes	L
Shure 444D	Dynamic	No	L

Telex Boom Mic	Electret	Yes	L
W2ENY	Electret	Yes	L
WGA TR-2000 (not stereo)	Electret	Yes	
Yaesu MD-100A8X	Dynamic	No	H
Yamaha CM500	Electret	Yes[57]	L

For more information on a wide variety of microphones, http://homepage.ntlworld.com/rg4wpw/date.html by G4WPW is a very good reference.

[57] The CM-500 is an electret element and needs bias but unfortunately it gets its bias from both the tip and ring of the gray mic connector. The KX2's ***MICBIAS*** menu controls the bias on the tip but the ring is always biased by the PTT UP/DN logic. Try turning the ***MICBIAS OFF***. This will let you run a much lower microphone gain level. (Thanks Lyle KK7P for this tip.)

Appendix C. KX2 Configuration Menu

Menu Help: When in the menu, scroll to any menu item of interest and hold the MENU button for about 3 seconds to bring up the help display. The default value (if any) will be shown in parenthesis at the start of the help text.

Menu	Default		Description
2 TONE LOCK	*OFF*		Enables a 2-tone generator for LSB or USB transmit tests. Exit the menu and tap XMIT to transmit.
AF LIM	*nor 30*		This adjusts the audio output limiter. It can protect your ears if you operate **with AGC Off**. The range is from 0 to 30 where 30 is the highest level. Signals that exceed this will sound very distorted, reminding you to turn down the RF or AF gain controls. The AF limiter works only when the AGC is off (AGC-). Typical settings used by those who turn their AGC are 17 to 23.
AFX MD	*dELAY*		This sets up stereo audio effects (you must be using stereo headphones). Some users find this improves the copyability of signals. Choose ***dELAY*** or ***nor***. Audio effects are disabled in ***DATA-A*** and ***AFSK-A*** modes. See *Audio Effects*, page 40 and *Audio Effects – AFX*, page 115.
AGC MD	*On*		This turns AGC mode ***On*** and ***OFF***. When on, the AGC-F or AGC-S icon is visible. When ***AGC MD*** is ***OFF***, just the "AGC-" icon is visible. Be sure to set the ***AF LIM*** menu to avoid hurting your ears when you operate with the AGC off. (See *AF Limiter*, page 113).
AGC SPD	*SLO*		The AGC speed, Fast or Slow, is stored per-mode. The default is ***SLO*** for voice and data modes, and ***FASt*** for CW.
*AGC**	*THR*	*005*	Tap 1.This sets the threshold signal level, or strength, at which AGC becomes effective as shown in Figure 7-10, page 113. ***THR*** may range from ***004*** to ***008***. See *Hints for Setting your AGC*, page 113.
	ATK	*215*	Tap 2.This sets the attack rate for the AGC as it responds to a drop in received signal level as shown in Figure 7-4 and Figure 7-5, page 107. A lower number than the default provides a softer (slower) attack but may result in overshoot. The range is 200 to 255.
	HLD	*000*	Tap 3. This sets the Slow AGC hold time for voice modes. It specifies the number of seconds the AGC level is held after the signal level drops. Holding AGC slightly can reduce IMD and is useful in pileups. It can range from 0.00 to 2.00 seconds.

	DCY	***Fast 140*** ***Slow 040***	Tap 4. This sets the AGC decay characteristic for Slow and Fast AGC. A larger number is a faster decay. See Figure 7-4 and Figure 7-5, page 107. To set the fast or slow decay, first set ***AGC SPD*** to ***SLO*** or ***FASt***. The range for Fast AGC is 120 – 150; for Slow AGC 10 – 50.
	SLP	***015***	Tap 5.This allows you to control the slope of the AGC as shown in Figure 7-9, page 112. ***SLP 010*** gives the best signal discrimination in pileup situations; ***SLP 015*** gives a flat response. ***SLP*** may range from ***010*** to ***015.***
	PLS	***nor***	Tap 6. When set to ***nor,*** this allows the AGC to reject noise pulses and pass short signals like a CW dit. When it detects a noise pulse, the AGC attacks and then decays rapidly back to its previous level. ***OFF*** disables this feature.
ALT MD	***nor***	***CW***	If set to ***nor***, CW normal will be in effect on the present band. Set to ***ALT*** to use CW reverse mode instead (REV icon turns on). CW normal uses lower sideband (LSB) while CW reverse uses upper sideband (USB). This does not change your transmit frequency but can sometimes help reducing interfering signals. See *Reverse CW*, page 98.
		SSB	If set to ***nor*** the sideband normally used on the present band will be in effect. Lower sideband (LSB) is used on 160, 80, and 40 meters; USB is used on 60, 30, 20, 17,12, and 10 meters. Setting to ***ALT*** switches to the other sideband for that band. See Table 7-1, page 98.
		DATA	DATA A and PSK D normally use USB while AFSK A and FSK D use LSB. ***ALT MD*** selects the other sideband for the current data submode and turns on the REV icon.
		ALT MD is set for each band. When ***ALT MD*** is assigned to the programmable function switch ***PFn***, holding the switch toggles between ***nor*** and ***ALT*** on successive presses without remaining in the menu.	
AM MODE	***On***	If you are not planning to use AM, you can turn this ***OFF***. You can still copy AM stations, such as WWV, in sideband mode.	
AMP HRS		Shows total amp hours used by the KX2. This is useful for testing battery packs, estimating remaining battery charge, or tracking the amp hours needed to complete one or more objectives (e.g., a certain number of QSOs at a given power level). The value is preserved on power-off, so it can show amp hours used over any number of operating sessions. Holding	

		OFS/B/CLR ∅ resets the value to 0.000; this is typically done after swapping in a fresh battery. (Amp hours is also one of the special VFO B displays; tap DISP, then rotate VFO B until you see ***n.nnnAH***. This display persists during transmit so you can monitor the rate of increase. In receive mode, the amp hour value will go up by .001 every 20-25 seconds. In transmit mode, the value will go up by .001 every 2 to 10 seconds, depending on operating mode, power setting, and antenna load impedance (all three can affect current drain). See *The KXBT2 Li-ion Battery Pack and KXBC2 External Charger*, page 128.
ANT.X SW	***1***	This menu (e**X**ternal Antenna switch) can be used to remotely select antenna 1 or 2 on the KXPA100. See *Antenna Selection*, page 148.
ATU MD	***Not inSt***	This may be set to ***Auto*** (active for all bands) or ***bYP*** (bypassed for all bands). There are ***L1 – L7*** and ***C1 – C7*** and ***Ct*** settings that test that the relays for each of the Ls and Cs are switching. Holding OFS/B/CLR ∅ clears the stored LC data for the present band. See *The KXAT2 20 W Antenna Tuner*, page 134.
ATU.X MD		The ***ATU MD*** menu item is automatically changed to ***ATU.X MD*** when a KXPA100 amplifier with ATU is installed and operating (***PA MODE On***). You may select ***bYP*** or ***Auto***. Setting ***PA MODE OFF*** changes the menu back to the KX2's internal ***ATU MD*** menu and restores tuning operation to the KXAT2. Holding OFS/B/CLR ∅ clears the stored LC data for the present band.
AUTO INF LOCK	***nor***	If set to ***ANT CTRL***, the KX2 sends band data on the serial port (ACC) to be used by PC software applications and other hardware such as the SteppIR™ antennas.
AUTO OFF	***InFinitE***	This allows you to set a time to automatically turn off the KX2 if 3 to 20 minutes have elapsed without any control operation or transmission. Set it to ***InFinitE*** to never turn it off. The timer is retriggered (reset) anytime the KX2 transmits or when switches or knobs are used. A setting of 5 or 10 minutes is recommended when running from batteries.
AUX 1 and AUX 2	***OFF***	Used to set the KXIO2 option module's AUX outputs to ON or OFF on a per-band basis. The AUX jack provides a ground (0 V) and two *open-drain* output signals, AUX 1 and AUX 2. Open-drain outputs simulate a contact closure to ground when in the ON condition, and are floating (high-impedance) when OFF. Typically, the ***On*** state would be used to turn on a relay connected to a DC supply

<table>
<tr><td></td><td></td><td>voltage (28 V max, 150 mA max).

The two outputs could be used singly or in combination to switch an external device such as an antenna switch, select taps on a loading coil, etc. This could be especially useful during mobile operation. Elecraft does not yet offer any products that make use of the AUX outputs, but may in the future. See Figure 8-6, page 133.</td></tr>
<tr><td>BAT MIN</td><td>10.0</td><td>BAT LOW warning threshold when the internal or external supply reaches this value. Useful values are:
<table><tr><td>10.0</td><td>12 volt batteries such as some 12 V gel cells and the optional 11 V Li-ion battery pack.</td></tr></table>The KX2 will turn itself off if the supply voltage drops below 7.5 V.</td></tr>
<tr><td>BKLIGHT</td><td>On</td><td>Turns the LCD backlight on and off. Turning the backlight off will extend battery life and can be done in ambient lighting because the display is transflective.</td></tr>
<tr><td>COR LVL
LOCK</td><td>Nor 0.1</td><td>Sets the carrier-operated-relay (COR) threshold. The COR is used to protect the KX2's receiver from a transmitter being used nearby. The default 0.1 watt is the recommended level.</td></tr>
<tr><td>CW IAMB</td><td>A</td><td>This sets the iambic keying mode, A or B. In mode A, alternate dits and dahs are produced as long as both paddles are depressed. When the paddles are released, the keying completes the current character and stops. In mode B, when the paddles are released, an extra dit is sent if the paddles were released during a dah, or vice-versa. Mode B is for operators used to squeeze keying, which inserts that extra dit or dah when the paddles are released. Once you are used to one mode it is hard to use another. If you sit down at someone else's rig that uses one mode and you normally use another, you can change the mode to your keying style with this menu item.</td></tr>
<tr><td>CW KEY1</td><td>tiP=dot</td><td>If you operate at someone else's station, you may bring your own paddle to operate CW. A "normal" (right-handed) paddle connection produces dits when the left paddle (dit-switch) is pressed and dahs when the right (dah-switch) is pressed. (Left-handers may prefer the other possibility, although that will make it difficult for you to operate somebody else's station if it does not have the capability to switch the dits and dahs.) You may have your dit-switch connected to the tip or the ring connection on the stereo paddle plug.

This menu item allows you to specify whether the tip connection should produce dits (tiP = dot) or dahs (tiP = dASH).

If HAnd is selected, either of the two levers can be used as a hand key or as an external keyer or computer keying input.</td></tr>
</table>

CW KEY2	***LFt=dot***	Specifies whether the left lever of the KXPD2 is used for the dit connection (***tiP = dot***) or the dah (***tiP = dASH***). If ***HAnd*** is selected, either of the two levers can be used as a hand key, an external keyer, or for computer keying input.
CWT	***OFF***	When set to ***On***, the upper half of the S-meter becomes a tuning aid for CW, PSK31/63 (PSK D mode), or RTTY (FSK-D mode) signals. Also, when ***CWT*** is on in CW or PSK D modes, the manual signal spotting function of the KYR-SPT/MIC ∅ knob changes to *auto-spot* (see page 52). In this case the KX2 will attempt to tune in CW or PSK31/63 signals automatically.
CW WGHT	***1.25***	The ***CW WGHT*** parameter changes the element-to-space ratio for the internal keyer. The range for the KX2 is ***1.0*** to ***1.25***. *CW Weight*, page 47.
	SSB – CW	Tapping the 1 key toggles between ***SSB +CW***, which allows CW to be sent when in SSB mode, and ***SSB –CW***, which doesn't. When ***SSB +CW*** the other station (operating SSB) will hear your signal at the tone set by your sidetone pitch. See *CW in SSB Mode*, page 73.
	NOR QSK	Tapping the 3 key toggles between ***NOR QSK*** and ***FST QSK***. The ***NOR*** mode reduces audio artifacts heard in the receiver during CW keying on a noisy band. ***FST*** provides somewhat faster receiver recovery time. See *CW Break-In Operation*, page 48.
	VOX AUTOOFF	Tapping the 4 key selects ***VOX nor*** or ***AUTOOFF***, which turns CW VOX off when the KX2 is powered-up. This will allow you to avoid accidental keying with a PC but means you have to switch VOX back on by holding VOX every time you turn the KX2 on.
	VFO OFS	Tapping the 5 key selects automatic VFO offset when switching to CW from any other mode. The offset is the sidetone frequency that can be adjusted by holding the PITCH and tuning VFO A. ***VFO nor*** (the default) provides zero offset. ***VFO OFS*** is useful if you are carrying on a conversation in SSB and both stations wish to switch to CW.
DUAL RX	***OFF***	Set to ***Auto*** to turn on the dual-watch receiver. The SUB icon will turn on. If SUB is slowly flashing the VFO A and VFO B frequencies are too far apart for the dual-watch receiver to work (> ~ 15 kHz). You must be using stereo headphones to use this feature. See *Dual-Watch Receiver Mode*, page 31.

FW REVS		Display the installed firmware versions. Rotate VFO A to display the MCU (***uC***) and the DSP firmware. The ***FW REVS*** menu also shows the KXPA100 firmware revision when a KXPA100 is connected to the KX2 with the control cable. Tap [1] to see the RF PC board revision.
KXIO2	***Not Inst***	If a KXIO2 module is installed, set the parameter to ***nor***, then exit the menu and turn the KX2 off/on. To set the time, use the ***TIME*** menu. Use the ***RTC ADJ*** menu to improve the clock's long-term accuracy if desired. **Note:** The real-time clock circuitry must normally be powered by either the KX2's internal battery or an external power source. As a convenience for recharging the battery, which must be done externally to the KX2, the clock will keep time for up to about 2 hours with no power supply or battery connected. This capability is provided by a supercapacitor on the KXIO2 module (see *Replacing Batteries*, page 130). The KXIO2 also provides two open-drain signals on its AUX jack. These could be used for antenna switching or other applications. See the ***AUX 1*** and ***AUX 2*** menu entries. See *Auxiliary Outputs*, page 133.
LCDTEST	***OFF***	Rotate VFO A to turn on all LCD elements.
LED BRT	***4***	Allows setting of LED brightness for the backlight-off case only. During adjustment of this menu parameter, the backlight will automatically be turned off if it was on, and then turned back on when the menu is exited. The LEDs are dimmed only when ***BKLIGHT*** is ***OFF***, which can help you save power if operating on batteries.
MIC BIAS	***On***	This provides +3.3 volts bias on the tip of the microphone jack. Electret microphones need this bias. Set it ***On*** for the Elecraft MH3 microphone. Not applicable for the internal KX2 microphone. See Appendix B, page 191.
MIC BTN	***Ptt UP.dn***	If your mic has both a PTT switch and UP/DN buttons, set this to ***Ptt UP.dn***. Ring 1 is used for the push-to-talk circuit as well as Up and Down functions. ***Ptt UP.dn*** enables these functions in the KX2 and is the setting needed for the MH3 microphone. When the MH3 Up button is pressed, a 10 K ohm resistor is connected between Ring 1 and Ring 2. A 4.7 K ohm resistor tells the KX2 that the Down button is pressed. The Up and Down buttons change the KX2's frequency by the tuning rate set for VFO A. See *VFOs*, page 23. You must be in a voice mode (USB/LSB or FM) to change this menu setting. Other microphones can be used. If they have a PTT circuit, set ***MIC BTN*** to ***Ptt***, otherwise use ***OFF***. See also *KX2 Microphone Set Up*, page 60.

MSG RPT	***6***	Set this for the message repeat interval in seconds (***0*** to ***255***). See *CW Message Memories*, page 56 and *The Digital Voice Recorder (DVR)*, page 74.
PA MODE	***OFF***	Sets the operating mode for the Elecraft KXPA100 amplifier and its internal ATU. Set it to ***On*** only if the KX2 is connected to the KXPA100 via the KX2 Accessory cable (KX2ACBL) and KX3-to-KXPA100 adapter. This allows the KX2 to control the amplifier's output power, ATU tuning, and antenna switch as described in the KXPA100 Owner's Manual and *The KX2 Companion's Guide to the KXPA100 and KXAT100* by KE7X. Set to ***OFF*** otherwise. The KX2 can still be used with the KXPA100 without the KX3-to-KXPA100 adapter but an amplifier keying line is still required from ACC on the KX2 to KEY IN on the amplifier. See *Using the KXPA100 Amplifier and KAT100 Tuner* Figure 9-1. Tap [1] to turn ***PA ALC*** on/off (the default is on, or ***PA ALC+***). When ***PA ALC*** is ***On***, and KXPA100 power is set to 70 W or less (at the KX2), the operator can use the KX2's TUNE switch function to more accurately set the amplifier's output level. Refer to the KXPA100 manual for details. Transient KX2-to-KXPA100 communication errors are normally corrected without alerting the operator. For diagnostic purposes, they can be displayed as "FAULT nnn" where nnn is a 3-digit number originating from the KXPA100. To enable this, tap [6] until you see ***XFAULT+***.
	Pout CAL	This enables 75-W power calibration in TUNE mode. When KYR-SPT/MIC/PWR ∅ is adjusted, and ***Pout CAL*** mode is in effect, setting power to 75 watts shows ***CAL 75W*** on VFO B. The KX3-to-KXPA100 adapter cable must be used. See the ***TX GAIN*** menu. See also the KXPA100 Owner's Manual.
PITCH	***0.60***	Set the ***PITCH*** menu to set the sidetone pitch. This is the tone you would like your ears to recognize easily to be able to zero beat a CW station you are calling. See *Zero Beating the Station*, page 52. In PSK-D mode (PSK31/63), the center pitch is 1000 Hz (fixed). In FSK-D mode (RTTY), the mark tone is 915 Hz (fixed).
RF CAL LOCK	***114.nnn. nn***	Used to calibrate the KX2's synthesizer. See the *KX2 Owner's Manual* for details.

RF GAIN	***-0 dB***	Normally, RF GAIN is set to ***-0 dB*** (no gain reduction). As RF GAIN is advanced past ***-5 dB***, a single bar on the S-meter starts at S-2 and moves upward as a reminder of how far gain has been reduced (-5 dB/unit). If desired, ***MENU:RF GAIN*** can be assigned to PFn (see *Programmable Function Key*, page 41) for quick access. **Note 1:** RF gain is reset to ***-0 dB*** on power-up. Otherwise the operator might not be aware of a previous gain reduction used under different band conditions. **Note 2:** As is the case with many software-defined transceivers, the KX2's RF GAIN control is actually an input scaling factor applied within the DSP itself. Reducing RF gain doesn't impact the strength of signals seen by the A-to-D converter. Gain ahead of the ADC can only be reduced by turning the preamp off, and (if necessary) turning the attenuator on. **Note 3.** Some operators prefer to turn automatic gain control off (using ***MENU:AGC MD***) and adjust RF gain manually, maximizing dynamic variability of received signals. While this strategy works in a radio with an RF gain control knob, it is less effective in the KX2. If you plan to turn AGC off you should set up the ***MENU:AF LIM*** parameter to avoid painful audio volume on strong signals.
RS232	***4800 b***	Sets the serial communication rate in bits/sec. You may choose any of the standard rates when your serial device is connected directly to the KX2. If you are communicating with the KX2 through a KXPA100 amplifier, and the ***PA MODE*** is ***On***, the rate is set to 38400. During firmware download (via *KX2 Utility*), the baud rate is set automatically to 38400 baud. It is then restored to the value selected in this menu.
RTC ADJ		This parameter can be adjusted to improve the long-term accuracy of the real-time clock on the KXIO2 option. (***MENU:KXIO2*** must be set to ***nor*** to use the RTC.) Monitor your clock's accuracy over 24 hours, preferably at your typical ambient operating temperature. (The KX2 can be turned off during any portion of this monitor period, as long as an internal battery or external supply is attached.) If it's off by more than +/- 2 seconds per day, use RTC ADJ to compensate. For example, if it's slow by 5 seconds per day, set ***RTC ADJ*** to "-5 SEC". Allow a few hours, minimum, before making a further correction. See *Real-Time Clock*, page 132.

RX EQ	***0 dB***	This is an 8-band audio equalizer. VFO A is used to set the boost or cut (+16 dB to -16 dB) in eight AF bands (50, 100, 200, 400 and 800 Hz and 1.6, 2.4 and 3.2 kHz). Tap 1 – 8 to select a band and rotate VFO A to set the gain. Hold OFS/B/CLR ∅ to reset all bands to 0 dB. CW and SSB have separate equalizers. Any received equalization is turned off in DATA modes.
RXSBNUL LOCK	***GAIN nnn***	This is used to null the opposite sideband signal of each of the analog filters. See the *KX2 Owner's Manual* or the Elecraft website for details of this procedure.
SER NUM		Your KX2's serial number. Cannot be changed.
SW TEST LOCK	***OFF***	To turn on switch test, rotate VFO A to ***SCN ADC***. When holding any switch, the scan row and column is displayed. Rotating any of the potentiometers shows their analog-to-digital converter readings.
SW TONE	***OFF***	When set to ***On***, a switch press generates an audible tone. When a switch function is turned on, a low-to-high tone (boop-beep) is generated; a high-to-low (beep-boop) tone is used to denote when the function is turned off. The switch tone volume is the same as the CW sidetone volume. After tuning the ATU, SWR <= 2:1 gives a low tone, 2.1 to 3:1 a medium pitch tone, and over 3:1 a high pitch tone. Some switches may not generate tones when they might interfere with received or transmitted audio. If set to ***CODE nn***, Morse code characters are generated on any applicable control activation at ***nn*** words-per-minute. A high tone indicates the activation of a function and a low tone deactivation. The *KX2 Guide for Blind Operators* manual describes what characters are sent and provides a text-only description of the KX2's front, left, and right side panels for blind operators. When ***CODE nn*** is set, tapping DISP sends a letter for the current mode and the 100 kHz, 10 kHz, and 1 kHz digits for the VFO A frequency. Digits to the right of the decimal point are not sent. You cannot access the secondary VFO B display when ***CODE nn*** is set because this is mainly an aid for blind operators. Holding the APF/AN switch on power-up turns on the CW Morse feedback and sets the speed to 20 WPM. Other speeds can be selected in the ***SW TONE*** menu.
TECH MD	***OFF***	This must be ***On*** to enable ***TECH MODE*** menu items. These are marked LOCK in this list and in the text.

TIME		Real-time clock. Tap 1, 2, and 3 and rotate VFO A to set the hours, minutes, and seconds. Tap DISP to exit the menu. Tapping DISP and rotating VFO B will display the time. A battery pack must be in the KX2 to maintain the time if the external power supply is disconnected or turned off and the KXIO2 option module must be installed. The ***RTC ADJ*** menu may be used to improve the long-term accuracy of the real-time clock. See *Setting the Real-Time Clock*, page 132.
TUN PWR	***nor***	If set to ***nor***, when TUNE is held the power output follows the KYR-SPT/MIC/PWR ∅ knob. By turning VFO A you can set a fixed power level that overrides the current output power set by the KYR-SPT/MIC/PWR ∅ knob when holding TUNE. This is useful if you have an external amplifier or antenna tuner. It allows you to tune these at a lower output power level. This power level is not the power used by the KXAT2 tuner when tapping AT TUNE. That is set by the ATU and is either two or three watts. If ***TUN PWR*** is set to less than 10 watts, and if a KXPA100 is attached, it is bypassed when TUNE is held. See Chapter 9, page 143.
TX BIAS LOCK		This starts an automatic procedure to set the transmit bias of the 10-W transmitter to ensure low distortion. See the *KX2 Owner's Manual* for more information.
TX CMP	***0***	Transmit speech compression (SSB mode). A setting of ***20*** (dB) is a good compromise between SSB signal talk power ("punch") and good fidelity. Set to ***0*** (default) when doing 2-tone IMD testing. **Note:** TX CMP is automatically set to ***0*** in audio data modes (***DATA A*** and ***AFSK A***).
TXCRNUL LOCK		Used by the factory to null the transmit carrier on each band. See the *KX2 Owner's Manual* for more information.
TX DLY LOCK	***nor 005***	This sets the delay in milliseconds between key-down and RF output. This is useful with external power amplifiers having slow T/R relays. There are actually two TX DLY settings, one for HF-6 meters and the other for transverter bands. The ***nor*** setting, 5 ms; is recommended when using the KX2 (and KXPA100, if applicable) without a following high-power amp. A delay of up to 20 ms can be set for slower amps. Use the smallest delay possible. Longer delays can add some timing variation in CW mode at higher code speeds.

TX EQ	***0 dB***	This is an 8-band audio equalizer. VFO A is used to set the boost or cut (+16 dB to -16 dB) in eight AF bands (50, 100, 200, 400 and 800 Hz and 1.6. 2.4 and 3.2 kHz). Tap 1 – 8 to select a band and rotate VFO A to set the gain. Hold OFS/B/CLR ∅ to reset all bands to 0 dB. Any equalization is turned off in DATA modes. See *Transmit Audio Equalization* page 68.
TX GAIN LOCK	***ALC nn***	This shows the transmit gain for the present band and power settings. The gain constants are calibrated whenever TUNE is exactly ***6.0*** watts and SWR is 2.0:1 or lower. See the *KX2 Owner's Manual* for more information. If the ***PA MODE*** menu is set to ***On*** or ***Pout CAL*** and power is set above 10 W, the ***TX GAIN*** menu will show drive power in watts needed to hit 75 W at the KXPA100 amplifier . A letter '***A***' or '***t***' prefixes the drive power value shown. ***A*** signifies that the drive value is the factory calibration for the KXPA100. ***t*** signifies the drive obtained doing the P out CAL at 75 watts using your KX2. See ***MENU:PA MODE***. Holding OFS/B/CLR ∅ erases the KX2's calibration value on the present band, restoring the ***A*** value from the KXPA100. This menu is also used to turn transmit ALC on and off. It can be turned off for transmit testing purposes by tapping ATU while in this menu. (This is NOT necessary for any operational purpose. In all modes, ALC is optimized for low distortion.) When ALC is turned off, a (-) sign is added to the parameter, e.g. ***-ALC nn***. Also, an asterisk is added to the KYR-SPT/MIC/PWR ∅ control value when it is being adjusted (e.g. ***5.0 W****). With ALC off, the displayed power level will not change; the control functions as a fine power adjustment, and its effect must be observed with an external instrument
TX GATE	***OFF 0***	Tap 1 to turn the noise gate on and off. Use VFO A to set the threshold so that the noise, such as fan noise from an amplifier, is not transmitted but your normal voice is. Since there's no visual indication that transmit audio is below the threshold, you should adjust it using the transmit voice monitor (MON), ideally while using headphones. Set the threshold high enough to cut off transmit audio due to local noise, but not so high that it causes your voice to drop out too frequently.
TXSBNUL LOCK	***GAIN nn***	This is used at the factory to null the opposite transmit sideband. See the *KX2 Owner's Manual* for more information.

VFO CRS	***Per Mode***	Sets the coarse tuning rate (1 kHz, 500 Hz, or 100 Hz) for each mode. Activated when RATE is held. See *VFO Tuning Rate*, page 26. This rate is also applied to offset tuning of VFO A (via OFS/B ∅ knob) when both RIT and XIT are turned off.
VOX DLY	***0.00*** (CW) ***0.50*** (SSB, Data)	If ***VOX MD*** is set to ***On*** in the current mode, this menu sets the VOX delay time (recovery time from transmit to receive) in seconds. In CW mode, full break-in is achieved by setting the ***VOX DLY*** menu to ***0.0***, which turns on the QSK icon (See the ***CW WGHT*** menu for additional QSK settings.) Anything larger is semi-break-in, which sets the time for the KX2 to return to receive after transmitting. If you are using a non-QSK outboard linear amplifier, this time should be long enough that the amplifier does not try to switch between CW characters. Independent VOX delay times are saved in CW, SSB and audio data modes.
VOX GN	***030***	Adjusts the sensitivity of the VOX to match your microphone and voice. While speaking into your microphone in a normal voice, increase the ***VOX GN*** until the KX2 transmits reliably.
VOX INH	***000***	Adjusts immunity of the VOX circuit to avoid false triggering because of audio from the speaker or headphones. If you find that audio from the speaker or from your headphones are triggering the VOX, increase ***VOX INH*** to reduce the problem.
VOX MD	***On*** (CW) ***OFF*** (SSB, Data)	If ***VOX MD*** is ***OFF***, transmit must be started by tapping XMIT (otherwise known as PTT, or push-to-talk operation). In CW mode, setting ***VOX MD*** to ***On*** allows "hit-the-key" transmit. In SSB mode, ***VOX MD On*** allows transmit to start when you start speaking. In audio data modes, VOX starts transmit when a computer connected to the mic jack outputs an audio signal. In Data modes VOX is always ***On*** in PSK-D and FSK-D modes; PTT is not available. VOX may be on or off for DATA A and AFSK A. VOX cannot be used with the built-in microphone. If ***CW WGT*** 4 is set to ***AUTOOFF*** you will have to activate VOX each time you power the radio up. This is useful to avoid having your computer key the rig through a serial interface when the computer is turned on after the KX2.

WATTMTR LOCK	***1.00***	Wattmeter calibration parameter. The default setting is recommended. If an external, known-accurate wattmeter reads lower/higher than the KX2's wattmeter, decrease/increase the parameter. The internal wattmeter accuracy may vary up to +/- dB per band. On transverter bands, the menu name changes to ***WMTR XV***.
XIT	***OFF***	XIT is short for *Xmit Incremental Tuning*. Set to ***On*** to offset the transmit frequency without affecting the receive frequency. The XIT icon will turn on. Use [OFS/B ∅] to set the offset (+/- 9.999 kHz). This is also the offset that will be used with [RIT]. If you use XIT frequently, you may wish to assign it to [PFn]. XIT can be useful for applying a small offset to your transmit signal to improve copy by other stations, especially in PSK-D mode (such an offset must be determined experimentally). It can also be used as an alternative to SPLIT, leaving VFO B free for other purposes.
XVn IF LOCK	***28***	Select the IF (***7, 14, 21,*** and ***28***) for the transverter band (1 – 7).
XVn On LOCK	***no***	Tap the [1] – [7] keys to select the transverter band. Set the parameter to ***yES*** to turn the selected transverter on or ***NO*** to disable.
XVn OFS LOCK	***0.00***	An offset (-9.99 to +9.99 kHz) can be added to each of the seven transverter bands to compensate for errors in how the transverter is converting the VHF frequency to the IF. This allows you to have a KX2 frequency display that is compensated for offsets in the transverter and thus shows the true transverter frequency.
XVn PWR LOCK	***L .01***	Set the upper output power limit from the KX2 to the external transverter. Tap the [1] – [7] keys to select the transverter band. ***H x.x*** set the power in watts delivered to the transverter from the main antenna jack. The KX2 does not have a low-level transverter port, so transverters must have their own T/R switching and be able to handle the specified power level.
XVn RF LOCK	***144***	Tap the [1] – [7] keys to select the transverter band. Set VFO A to the lower edge of the band for that transverter. You may, though, be using it as the IF for a transverter on a still higher band – a transverter transverting for another transverter! In this case, you can set the parameter to the lower edge of the higher band. For example, a 1296 MHz transverter may have as its input and output 144 MHz. For this you can set ***XVn RF*** to ***1296.*** When ***XVn RF*** is set to the bottom of the transverter's band, the KX2's VFO will correctly display your operating frequency on that band. You can set XVn RF to ***0 – 24999*** MHZ,

Appendix D. KX2 Firmware Update Records

Released Firmware Directory				
Beta Firmware Directory				
Date	**Beta or Released**	**MCU Version**	**DSP Version**	**Comment**

Index