

**KAM**  
**KPC-4**  
**KPC-2400**  
**KPC-2**  
**KPC-1**

# Operations Manual

Version 3.0 – Aug. 13, 1990



RF Data Communications Specialists

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9 am - noon, 2 pm - 5 pm Central Time, Monday-Friday

The KAM, KPC-4, KPC-2400, KPC-2 and KPC-1 are Kantronics hardware and software designs incorporating the AX.25 Version 2 Level 2 Packet protocol as adopted by the American Radio Relay League. This manual contains information from earlier KPC-1, KPC-2, KPC-2400, KPC-4 and KAM manuals and addendums, modified as appropriate. In addition, Kantronics acknowledges the use of material from the original Tucson Amateur Packet Radio Corporation (TAPR) TNC-1 manual granted by OEM agreement.

We have attempted to make this manual technically and typographically correct as of the date of the current printing. Production changes to the TNC may add errata or addendum sheets. We solicit your comments and/or suggested corrections. Please send to Kantronics Inc., 1202 E 23rd Street, Lawrence, KS 66046.

Printed in the U. S. A.

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# Operations Manual

## Table of Contents

	Page
<b>Preface</b> .....	1
Some Abbreviations .....	1
<b>Intro/Getting Started</b> .....	2
Asynchronous Commands .....	3
Dual-Port Set-Up Commands .....	4
<b>Front Panels</b>	
KAM .....	6
KPC-4 .....	7
KPC-2 .....	8
KPC-2400 .....	9
KPC-1 .....	9
<b>Packet Mode</b> .....	10
Command Mode .....	10
Connected vs. Unproto .....	10
Monitoring and Calling CQ .....	11
A Simple Connect .....	11
Digipeating .....	12
Gateway .....	13
Multi-Connects .....	13
Round Table Discussions .....	13
Timing .....	14
Dwait vs. Persistence and Slottime .....	14
Txdelay .....	14
Frack .....	15
Retries AX.15 Level 2, Version 1 vs. Version 2 .....	15
Flow Control .....	16
Software Flow Control .....	16
Hardware Flow Control .....	17
Converse Mode vs. Transparent Mode .....	17
Getting Out of Transparent .....	18
HF Packet Operation .....	18
<b>PBBS</b>	
General .....	19
Configuring your PBBS .....	19
Using the PBBS .....	19
Reverse forwarding messages from your mailbox .....	21
<b>KA-NODE</b>	
General .....	22
Configuring Your KA-NODE .....	22
Using a KA-NODE .....	23
Local Acknowledgments, Higher Throughput .....	24
Automatic Disconnect .....	24
Using the XCONNECT Command (KAM and KPC-4 only) .....	25
Determining Which Port You Have Connected To .....	25
KA-NODE Commands for Remote Use .....	26

<b>Kantronics Host Mode Operation</b> .....	28
Communication Format .....	
Host computer to TNC .....	28
KAM HF Modes .....	29
TNC to Host Computer .....	29
HF Mode operation .....	30
<b>WEFAX Mode</b> .....	
General .....	31
Background: HF WEFAX Transmission and Resolution .....	31
Finding WEFAX Broadcasts .....	31
Tuning WEFAX Signals on HF .....	32
Receiving WEFAX Transmissions .....	32
The WEFAX Command .....	33
Suggestions for Writing a WEFAX Terminal Program .....	33
WEFAX Program Functions .....	33
<b>KISS Mode</b> .....	35
<b>RTTY and ASCII Modes</b> (KAM only) .....	
RTTY Theory .....	38
RTTY and ASCII Operation .....	39
Miscellaneous Information .....	42
Summary of RTTY/ASCII Directives .....	43
<b>AMTOR Mode</b> (KAM only) .....	
AMTOR Theory .....	44
AMTOR Operation .....	45
Tuning AMTOR .....	46
Summary of AMTOR Directives .....	47
<b>NAVTEX/AMTEX Mode</b> (KAM only) .....	
NAVTEX/AMTEX Theory .....	48
NAVTEX/AMTEX Operation .....	49
<b>CW Mode</b> (KAM only) .....	
Summary of CW Directives .....	50

## Preface

This manual will introduce you to the various modes of operation available with your new Kantronics TNC. It assumes that you have read the Installation Manual and have successfully completed connecting your TNC to your computer and radios.

First, we start with the modes common to all Kantronics TNCs, including Packet, the Personal Mailbox, KA-NODE, WEFAX and KISS Mode. From here, we move into the modes that are only available on the Kantronics All Mode (KAM) communicator. These include RTTY, ASCII, AMTOR and CW.

As you start, we must assume that you have your computer turned on and that you have started your terminal or communication software on your computer. Since there are many different types of computers and hundreds of terminal programs available, we will not attempt to tell you how to accomplish these steps. If you have problems starting either your computer or your terminal program, refer to the manuals that came with them.

### Some Abbreviations

Ctrl-x = Ctrl is the control key and x represents any alpha character. This is a two key combination. Press the Ctrl key while holding it down type the letter x (this can be capital or lower case, but will shown as capital). Release both. If your computer keyboard has no key labeled Ctrl, consult your computer manual to determine which key performs the control key function.

\$ preceding a number denotes a hex number (base 16)

<CR> = carriage return, \$0D, decimal 13, Ctrl-M, [↵]

<LF> = line feed, \$0A, decimal 10, Ctrl-J

I/O = Input/Output

Computer and terminal are used interchangeably to describe whatever device is attached to talk to the TNC.

## Intro / Getting Started

Now that you have your new Kantronics unit connected to your radio and computer, let's take a moment to see what it is and how to make it understand what you want to do. A Terminal Node Controller (TNC) is very similar to a telephone modem because it receives digital signals from the computer (Terminal) and converts them to tones suitable for transmission to distant location. The TNC also receives tones from your radio and converts them into the digital signals understood by your computer. A TNC, however, does much more, because it controls the push-to-talk line of your transmitter, keying the radio whenever it needs to send data. It also converts the data into a "packet", adding the required addressing, error checking and control information to insure the data gets from one Node to the next. The error checking implemented in your TNC must be the same as the error checking used by any other station you want to talk to and this standard method is called a protocol. The protocol used in Amateur Radio Packet TNCs is called AX.25. Different protocols are used for other modes of operation, such as AMTOR.

In order for your TNC to do something, you must issue instructions to it, letting it know exactly what you want done. In order to accomplish this, the TNC must be in the Command Mode (expecting you to give it instructions) and any time you want to change the way your TNC operates, you must be in this mode. The TNC tells you that it is ready for your commands by sending you the prompt `cmd:`.

When you first turn on your TNC out of the box (or after a hard reset) you may see some garbage characters on your screen. The TNC is performing an autobaud routine. It is sending the same message over and over again at different baud rates. When the TNC baud rate matches the baud rate set in your terminal (communications) program, the display will read:

**PRESS (\*) TO SET BAUD RATE**

When these words are readable press the asterisk, **\***, on your keyboard. This will set the baud rate until the TNC is turned off; keep reading for how to avoid having to do this all the time. Then the TNC will display the following:

**ENTER YOUR CALLSIGN =>**

At this point enter your amateur callsign. This callsign will be used by the TNC for many different things, including being in every packet you send and deciding if a packet it receives is specifically for you. Now you should see the sign-on message and command prompt on your screen, as:

**KANTRONICS sign-on-message**  
`cmd:`

In some cases (notably Commodore-64 users with the Kanterm program and some dumb terminals) the `cmd:` prompt may not appear. This is due to the TNC sending lower case characters and the terminal doesn't recognize them. In these cases, you will probably see only the colon (`:`). This can usually be resolved by turning the LCOK command OFF.

The `cmd:` prompt means the TNC is ready to listen to you. Anything you type will be interpreted as a command. If the TNC doesn't understand, it will display:

**EH?**

To change a command setting you type the command, a space, the argument (a number or whatever is appropriate) and then the RETURN or ENTER [↵] key. If you turn the TNC off and back on

again, the changes will not be remembered unless you have used the PERM command, or using a Battery Backup or SmartWatch.

All commands are listed alphabetically in the Commands Manual and many are discussed by mode in this Operations Manual. The Command Manual also has an introduction that goes into more detail on the structure of commands.

## Asynchronous Commands

Asynchronous commands are commands that allow your TNC and computer to talk the same language. These commands in the TNC will have their counterparts in your computer program, although some programs may limit what you can set. Following is a list of TNC defaults and their corresponding computer setting. then we will explain the commands using both the computer and the TNC terminology.

TNC	Computer
ABAUD 0	The TNC runs an autobaud routine to allow it to match the speed set in your computer when the TNC receives an asterisk
8BITCONV ON	Data Bits or Word Length 8
PARITY 4	Parity no or none
ECHO ON	Full Duplex
XFLOW ON	Software Flow Control

**Baud Rate** is how fast the computer and TNC will talk to each other. This is set in the TNC with the ABAUD command. The settings allowed by the TNC are 0, 300, 600, 1200, 1800, 2400, 4800 and 9600. (KPC-1 only allows 0, 300, 1200 and 9600.) When set to 0, the autobaud routine will run at power-up – requiring you to press the asterisk whenever you turn on the TNC.

**Word Length** and **Data Bits** are often used interchangeably to refer to how many bits are used to recognize a character. Each character is made up of smaller parts called bits (analogous to a dit or dah in Morse code). These bits are seen as high or low voltages on the cable between the TNC and computer to make the desired combination for a character. A standard by the name of ASCII allows 8 bits for each character, although all the standard alphanumeric characters and punctuation can be recognized with only 7 bits. The TNC will talk to the computer using either 7 or 8 bits depending on setting of the command 8BITCONV. As default 8BITCONV ON means 8 bits. Set 8BITCONV OFF to strip the 8th bit and use only 7 bits.

**Parity** determines what the 8th bit will be and is an old form of error detection which few modern-day programs check. PARITY 4 is the default in the TNC which means the 8th bit will be seen as part of the character. Odd or Even Parity will change the 8th bit depending on whether there is an odd or even number of high voltages in the 7-bit character. Mark and Space Parity will hold the 8th bit either high or low. In the TNC, setting PARITY 0 is odd parity; Parity 1 is even parity; PARITY 2 is mark parity; PARITY 3 is space parity and PARITY 4 is no parity. 8BITCONV must be ON before the TNC will look at the 8th bit (the TNC always sends the 8th bit in TRANSPARENT Mode).

**Stop Bits.** The TNC always uses 1 stop bit.

**Full Duplex** or **Half Duplex.** (Some programs use the term Echo for Half Duplex.) When using Full Duplex the computer expects the attached device to send back (echo) what was sent to it. A setting of Half Duplex will tell the program that it must do the displaying to the screen for what you type. The TNCs default is ECHO ON, which tells the TNC to send back what it receives. This

corresponds to a setting of Full Duplex for the computer. If you set your computer for Half Duplex, you will need to turn ECHO OFF or you will see two of everything you type. When using a split screen program, you may want to set ECHO OFF in the TNC because the program will be handling what you type in the buffered keyboard screen.

**Flow Control.** Often times one device may talk to another device faster than it can handle the information. When this happens, the excess information is stored in a buffer until it can be processed. This buffer is only so large. If the data were to over-flow the buffer, it would be lost. Flow Control is the terminology used for how the devices inform each other to stop or start sending data. There are two ways to accomplish this: software and hardware. The TNCs default XFLOW ON allows the TNC to implement software flow control (hardware flow control is always recognized by the TNC).

Software Flow Control is implemented by the program or TNC looking at the data and watching for two certain characters. One of these characters (normally Ctrl-S) tells the device to stop sending data and the other (normally Ctrl-Q) tells the device to re-start sending data. The TNC commands XOFF and XON tells the TNC which characters to send to the computer to stop and start data flow. The commands STOP and START define which characters the TNC expects from the computer. These commands all come defaulted for normal software flow control.

Hardware Flow Control is implemented by the device watching the voltages on the RTS and CTS pins of the RS-232 port. The TNC will always monitor these pins, so only connect them if you are going to use them. If you use hardware flow control, you should turn XFLOW OFF. See the Connecting your Computer section of the Installation Manual for how to wire your RS-232 cable for hardware flow control.

**Perm.** If you would like to customize the defaults in the TNC for your situation, all you have to do is type **PERM** at the **cmd:** prompt (followed by a RETURN or ENTER key). This command will write your customized defaults to the EEPROM. Now, if you turn the TNC off and back on again, your defaults will be used. This command can be used at least 1000 times, so as you experiment with your parameters and find ones you would like to have different than factory default, just use this command. If for any reason you ever want to go back to the factory default, a Hard Reset can be performed (see the Hard Reset section of the Installation Manual), or use the **RESTORE D** command as described in the Commands Manual.

## Dual-Port Set-Up Commands

**PORT.** The **KAM** and **KPC-4** both have two radio ports. When turned on, the **KAM** will be addressing the VHF port and the **KPC-4** will address Port 1. If you wish, this may be changed so that the other port will be addressed when the unit is turned on. For the **KAM**, you could type **PORT HF** at the **cmd:** prompt, and for the **KPC-4** you would type **PORT 2**. This command would then need to be PERMed (if not using Battery Backup or SmartWatch). This only affects what port the TNC will address when it is turned on after the next soft reset. In order to change ports during Packet operations see Multi-Connects in the Packet section or the STREAMSW command in the Commands Manual. When using non-packet modes on the **KAM** the HF port is automatically selected. In order to enter a non-packet mode, the MAXUSERS command must be set to allow HF operation.

**MAXUSERS.** This command causes the TNC to allocate the memory required for the maximum number of simultaneous connections you wish to allow. The **KAM** and **KPC-4** will allow a setting of 0. If MAXUSERS is set to 0/0, these TNCs will accept only one connect at a time from either port of the TNC. This special condition will be highlighted by being displayed simply as MAXUSERS 0. This makes it feasible to use the **KAM/KPC-4** with MBL or RLI BBS programs on two frequencies. Setting MAXUSERS to 0/n or n/0 will disable the port designated for 0.

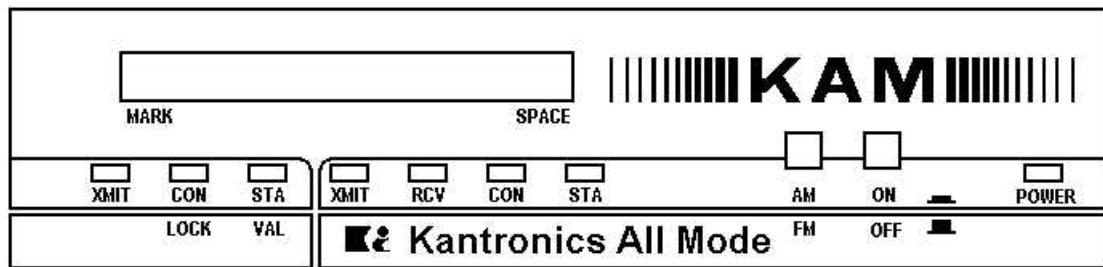


## INTRO

**PMODE** (KAM only). When set to NONE as default, the KAM will be in the Packet Mode. This command allows you to have your KAM come on in the mode you select. Optional parameters are: ASCII, AMTOR, CW, FEC, RTTY, NAVTEX and NONE (Packet). Starting the KAM in the Kiss or Host Mode is accomplished with the INTFACE command (INTFACE will override PMODE). As with all commands this must be PERMed for the KAM to remember it after being turned off (if not using the Battery Backup or SmartWatch).

## Front Panels

### KAM



The front panel has two switches, eight LEDs and a ten segment LED bargraph. There are seven LEDs used as operating status indicators. The front panel is divided into two sections. The left three LEDs are the indicators associated with HF operation, and the four right LEDs are the indicators associated with VHF operation. The two segments are divided by a white color bar. Each LED has the functions indicated below:

#### HF Section:

**XMIT** – This LED will illuminate when the **KAM** is keying the PTT line on your HF radio OR when HF packets are being received.

**CON/LOCK** – This LED will illuminate when you have an HF Packet connection OR an AMTOR lock condition.

**STA/VAL** – This LED will illuminate when you have unacknowledged HF packets OR valid AMTOR data.

#### VHF Section:

**XMIT** – This LED will illuminate when the **KAM** is keying the PTT line on your VHF radio.

**RCV** – This LED will illuminate when you are receiving a VHF packet.

**CON** – This LED will illuminate when you have a VHF Packet connection. In addition, when operating non-Packet HF modes, this LED will blink ON/OFF for approximately 10 seconds if **KAM** receives a VHF Packet connect request.

**STA** – This LED will illuminate when you have unacknowledged VHF packets. Also, if the CON light is OFF, the STA light is used to indicate PBBS status – ON steady indicates someone is connected to the PBBS and blinking indicates mail in the Kantronics TNC for you.

#### POWER INDICATOR

**POWER** - The single LED on the right end of the front panel illuminates when power is applied.

#### Switches

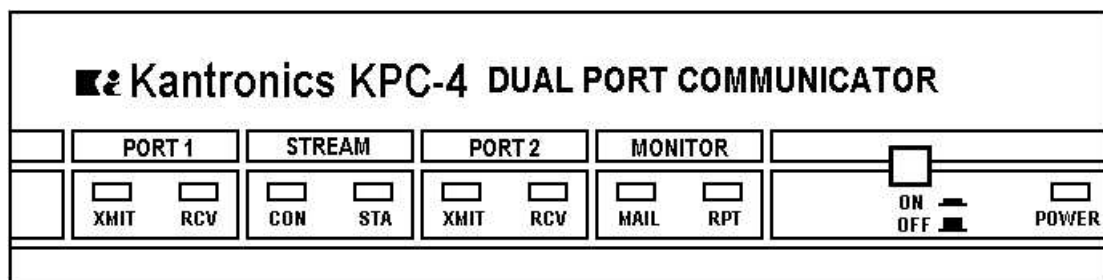
**ON/OFF** – Provides power control of the **KAM**.

**AM/FM** – Switches the limiters in or out of the demodulator circuits. This switch should be set to AM for CW operation and FM for RTTY/ASCII/AMTOR. For Packet operation, either AM or FM can be selected. Use the setting you prefer.

## Ten Segment LED Bargraph

The bargraph provides a visual indication of the received HF signal. The end segments, labeled MARK and SPACE, blink alternately on a properly tuned RTTY/ASCII/AMTOR or Packet signal. In CW Mode the left end (MARK) of the bargraph illuminates when no signal is present and the right end (SPACE) lights when a signal is detected. In addition, when your PTT line is being keyed to transmit on the HF port, the LED bargraph will be blanked out. The bargraph may be used to tune WEFAX if the audio from the WEFAX signal is connected to the HF radio port as well as the VHF port. Between picture transmissions, most WEFAX stations transmit a SPACE signal.

## KPC-4



The front panel has a power switch and nine LEDs. There are eight LEDs used as operating status indicators and one for power. The front panel is divided into four sections, each section containing two operating status LEDs. Each section is separated by a white color bar. Each LED has the function indicated below:

### PORT 1

**XMIT** – This LED will illuminate when the KPC-4 is keying the PTT line of your radio attached to radio Port 1.

**RCV** – This LED will illuminate when you are receiving data from your radio attached to radio Port 1.

### STREAM

**CON** – This LED will illuminate when you have a Packet connection on the current stream. The current stream is the stream to which the I/O is directed. (See STREAMSW in the Commands Manual.)

**STA** – This LED will illuminate when you have unacknowledged packets on the current stream.

### PORT 2

**XMIT** – This LED will illuminate when the KPC-4 is keying the PTT line of your radio attached to radio Port 2.

**RCV** – This LED will illuminate when you are receiving data from your radio attached to radio Port 2.

## MONITOR

**MAIL** – This LED will illuminate when there is a station connected to your PBBS. In addition, whenever the PBBS is holding mail addressed to you and no connection to the PBBS exists, this LED will blink continuously.

**RPT** – This LED will illuminate whenever the **KPC-4** gateway or digipeat functions are actively in use and will stay on for several seconds after each use.

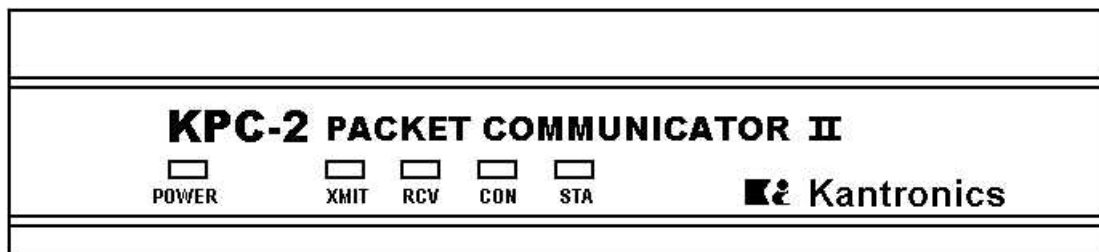
## Power Indicator

**POWER** – The single LED on the right end of the front panel will illuminate when power is applied.

## Switch

**ON/OFF** – Provides power control for the **KPC-4**.

## KPC-2



The front panel has five LED indicators which provide information as follows:

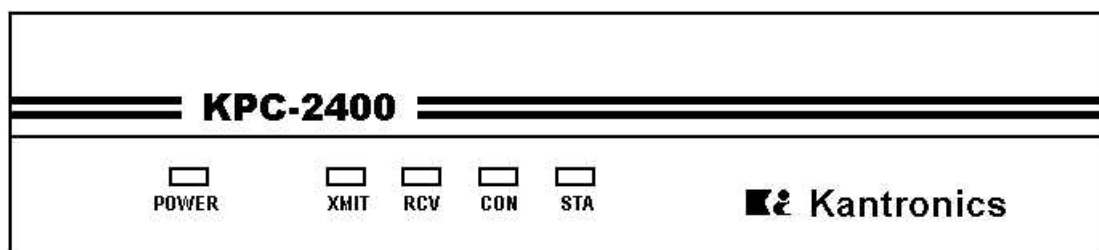
**POWER** – This LED illuminates when power is applied. The power ON/OFF switch is located on the rear panel.

**XMIT** – This LED illuminates when the TNC keys the PTT line of your radio to send data.

**RCV** – This LED illuminates when the TNC detects a signal on the radio frequency.

**CON** – This LED illuminates when you have a Packet connection on the current stream. The current stream is the stream to which the I/O is directed. (See STREAMSW in the Commands Manual.)

**STA** – This LED illuminates when the TNC has outgoing packets which have not been acknowledged on the current stream. Also, if the CON light is OFF, the STA light is used to indicate PBBS status – ON steady indicates someone is connected to the PBBS and blinking indicates mail in the Kantronics TNC for you.

**KPC-2400**

The front panel has five LED indicators which provide information as follows:

**POWER** – This LED illuminates when power is applied. The power ON/OFF switch is located on the rear panel.

**XMIT** – This LED illuminates when the TNC keys the PTT line of your radio to send data.

**RCV** – This LED illuminates when the TNC detects a signal on the radio frequency.

**CON** – This LED illuminates when you have a Packet connection on the current stream. The current stream is the stream to which the I/O is directed. (See STREAMSW in the Commands Manual.)

**STA** – This LED illuminates when the TNC has outgoing packets which have not been acknowledged on the current stream. Also, if the CON light is OFF, the STA light is used to indicate PBBS status – ON steady indicates someone is connected to the PBBS and blinking indicates mail in the Kantronics TNC for you.

**KPC-1**

The front panel has three LEDs which provide information as follows:

**POWER** – This LED illuminates when power is applied. The power ON/OFF switch is located on the rear panel.

**XMIT** – This LED illuminates when the TNC keys the PTT line of your radio to send data.

**RCV** – This LED illuminates when the TNC detects a signal on the radio frequency.

## Packet Mode

Packet-Radio is the communication of digital data via radio. A packet is a group of characters with a flag and header at the beginning and a checksum and flag at the end. A flag is a specific character used to signify the beginning and ending of a packet. The header is information concerning who the packet is from, who it is to, any relay stations needed to get to the destination and some control information. A checksum is a complicated mathematical formula that produces a number that is unique to the combination of characters that are in the packet. This unique number is figured by every station that handles the packet and if it does not match the number that is in the packet, the packet is thrown away, thus error-free communications. A packet is also called a frame. The Terminal Node Controller (TNC) is the workhorse of Packet-Radio. As a listening device it hears an audio signal from the radio, changes the data to digital form, determines if it is a good packet and sends it to whatever device is attached, usually a computer. As a relay device it also checks the packets it receives and determines if the packets need to be resent, then does so if appropriate. As a sending device it receives digital data from the computer, packetizes it and changes it into audio tones which are sent out to the radio. The rules the TNC uses to do all of this is called a protocol.

The most used protocol in amateur Packet-Radio is AX.25 Level 2 and the nitty gritty details of the inner workings can be found in a book named *AX.25 Amateur Packet-Radio Link-Layer Protocol* available from the ARRL. Most of you are not going to want to go that deep, the TNC takes care of the nitty gritty for you, although there are parameters you can set that determine how efficiently some of that work is done. In this section of the book we will discuss the fundamentals of how to get on the air and how parameters interrelate. The default parameters will get most everyone on the air, but by using this information, you can change your parameters to be most efficient in whatever situation you find yourself.

### Command Mode

In order to change parameters, or give any other instructions to the TNC, you must be in Command Mode. This is the mode you will be in when you turn on the TNC (unless you have changed the PMODE parameter in the **KAM**). Once you have left Command Mode for any reason, there is a parameter called COMMAND that determines what special character you will use to return to Command Mode. This comes defaulted as a **Ctrl-C**. (While holding down the **control key** press **c**, then release both.) All parameters are described in alphabetical order in the Commands Manual. Whenever you enter Command Mode, the TNC will send a prompt to your screen that looks like this:

**cmd:**

### Connected vs. Unproto

There are two ways to send data in Packet-Radio, connected or unproto (unconnected). In the Command Mode you first establish a connection. Then your TNC will send packets to that specific station and expects acknowledgments in return. If an acknowledgment is not received, the TNC will resend the data (depending on the setting of AX25L2V2 it may send a poll first). The RETRY parameter will determine how many times this is done before the connection is lost due to bad conditions. If the acknowledgment is received, the TNC is happy and will send more data, when available. Therefore the Connected Mode, barring impossible conditions, assures that the station you are connected to, will receive everything you say and in the order you say it.

In the Unproto Mode your TNC sends a packet. As far as the TNC is concerned, the packet is not directed to a specific station, therefore no acknowledgment is expected and no retries are attempted. This mode is often used for calling CQ and informal round table chit chats.

## Monitoring and Calling CQ

If you turn the MONITOR command ON, you will begin to see other people's packets on your screen. You will notice two callsigns at the beginning of each packet separated by a >. The first callsign is the station the packet is from. And the second callsign is the station the packet is to. An Unproto packet may have a name or CQ for the second callsign.

To set what will be seen as the "to" callsign of an Unproto packet, you use the UNPROTO command. This comes default as CQ, but if you wanted to put in your name instead, you would be sure you are in Command Mode and issue a command similar to this:

```
u name<CR>
```

where **u** is short for unproto, *name* is your name and <CR> is the return or enter key on your computer keyboard. In order to call CQ you must get into the Convers Mode, so that what you are typing to the TNC will be interpreted as data to be sent out on the air and not as commands. To do this, type:

```
k<CR>
```

or, if you have a version earlier than 2.84, this shortcut is not available and you must type:

```
conv<CR>
```

Now anything you will be packetized and sent out on the air. Remember to get back to Command Mode you enter a **Ctrl-C** (default) by holding down the **control key** while pressing **c**. You will be going between Command and Convers Mode depending on if you want to talk to the TNC or have the TNC packetize what you type to go out on the air.

## A Simple Connect

Once you see a station you would like to connect to, be sure you are in Command Mode, and issue a connect request, example:

```
c callsign<CR>
```

where **c** is short for connect and *callsign* is the callsign of the station you wish to connect to. If for any reason the connection fails, the TNC will send the following message to your screen:

```
*** RETRY COUNT EXCEEDED
*** DISCONNECTED
```

When your TNC does receive an acknowledgment for a connect packet it will display a message on your screen like:

```
*** CONNECTED TO callsign
```

and your TNC will change to the Converse Mode (dependent on setting of NOMODE and CONMODE). Now what you type will be interpreted by the TNC as data to be sent to the other station and not commands to the TNC. The MCON parameter comes defaulted to OFF. Therefore once you are connected all you will see is what you type and what the other person sends you. Any packets sent by other people will not be monitored.

Two things determine when the data will be packetized. One is the parameter SENDPAC. This is defaulted as the return or enter key you are telling the TNC to make a new packet. A second parameter, PACLEN, determines the maximum length of any packet. If you enter data longer than this length, a packet will be made even though you have not pressed the return or enter key.

When you have finished your conversation you need to end the connection. To do this, you go into the Command Mode and type a **d** for Disconnect. Remember to press the return or enter key after any command to the TNC. Once your station has received the acknowledgment for the disconnect packet the TNC will send this message to your screen:

**\*\*\* DISCONNECTED**

Either station can issue the disconnect command, no matter which station originated the connect.

## Digipeating

Everything we have done so far will only be heard by those within range to hear your signal. With Packet-Radio it is possible to get further than that. The DIGIPEAT parameter in the TNC comes defaulted ON. This makes you a possible relay station, or digital repeater – digipeater, or just digi for short. In many VHF communities one, or more, of these is put up in a good, high location and referred to as a dedicated digi. The TNC and radio is all that is needed for the digital repeater to do its job. A computer would be needed if you wanted to change a parameter, but it would not need to stay there for the digi to work. The higher the antenna, the more effective a digi will be, but remember, every TNC has the capability of being a digipeater.

If we turn the MRPT command ON, we will begin to see more than just the "from" and "to" stations of the monitored packets. We will also see the callsigns of those stations that have been used as digipeaters. (If you turn HEADERLN ON the headers will end with a return and be on a separate line from the packet data.) This list of stations is often called a path. Here is an example of what you might see:

**WK5M>KA5ZTX,IAH\*,LAG,AUS:**  
**Hi there**

In this example WK5M is talking to KA5ZTX using the digipeaters IAH, LAG and AUS. The asterisk beside IAH tells you that you are hearing that digipeater. You will notice that IAH, LAG and AUS are not real callsigns. The TNC provides parameters (MYALIAS and ALIAS) to set up an alias, which is often easier to remember than a callsign. To make this connection WK5M would have typed the following command to his TNC:

**c ka5ztx v iah,lag,aus**

**v** is short for via and up to 8 digis may be used. You must specify digis in the order they will be encountered along the path from your station to the station you wish to connect to. A space must be typed after the **c** and on both sides of the **v**, but digis are separated by commas and no spaces. A path can also be used with the Unproto command:

**u cq v nom,lch,slr,bix**

Unproto sets up the path for anything that is subsequently typed in the Convers Mode where no connect exists. Connect issues a connect request to the specified station, via the specified path. Then an error-free conversation can take place between them.

When digipeating the packet goes all the way from the first station, through all relay stations, then to the destination station. Then the response also has to take this same path in reverse. Chances for collisions, therefore retries, are multiplied with every digi used. This is often called end-to-end acknowledgment. Another way to get from one place to another is to connect a "node". A node will take care of the acknowledgment between it and the next node or end user. See the KA-NODE section for more information. Ask your local packeteers about other kind of nodes which may be in your area, such as TheNet and NET/ROM.



## Gateway

In the **KAM** and **KPC-4** a Gateway is also available. This is similar to digipeating except that the retransmission of the packets takes place on the other radio port of the TNC from where it was received. In other words, if you are on VHF and send a packet via a Gateway callsign of a **KAM** your packet would be retransmitted on HF, on whatever frequency the radio connected to the **KAM** is set for. When you use one of these gateways remember that on HF the baud rate is slower so you may want to lengthen some of your timing parameters. See the KA-NODE section for another way to accomplish this with a more reliable connection.

The TNC has some parameters that need to be set before this feature can be used. The MYGATE parameter needs a callsign that is different than any other callsign parameter and GATEWAY needs to be turned ON. Also keep in mind that gateway operation is not permitted by FCC rules and regulations in an unattended station.

## Multi-Connects

The TNC makes it possible for you to talk to more than one person at the same time, if you want to. A stream (or channel) is used for each conversation. The command MAXUSERS determines how many streams may be used at one time. And the command USERS determines how many people can connect to you. An incoming connect uses the next available stream. If the number of streams set by USERS is full, then that station will get a busy message instead of a connect. However, if MAXUSERS is set larger than USERS, you can still issue outgoing connects on the additional streams.

The character specified in the STREAMSW parameter is used to change from one stream to another. The streams are lettered A – Z. So in order to change streams you type the STREAMSW character and then the letter designator for the stream you want (no return or enter in this case). This can be done in Command or Convers Modes and the CON and STA lights on the front panel of the TNC will change appropriately for the stream you choose.

For an example, let's assume I'm using a **KAM** and have my HF streamswitch set to the " \ " and the VHF streamswitch set to " | ". Now if I want to transmit on HF packet, I simply enter **\a** to cause my current I/O stream to be the A stream on the HF port. To change back to VHF, I would enter **|a** to go to the A stream of VHF. The current I/O stream when the TNC is first turned on will be the A stream of the port specified by the PORT command for dual-port units.

The STATUS command allows you to see who is on which stream, or the status of the stream, i.e. waiting acknowledgment, connect in progress, disconnected. Turning STATSHORT ON will cause the STATUS command to list only the current Input/Output stream and any connected streams.

If you are connected and have MONITOR and/or MCON OFF, the normal headers containing the "to" and "from" callsigns will not be shown. The setting of STREAMEV will then determine how often you see the stream designator. This parameter comes defaulted OFF, so the stream designators are only shown when a change in streams occurs. Turning this command ON will make the stream designators show on every packet. Turning STREAMCA ON will also add the callsign of the "from" station beside the stream designator.

## Round Table Discussions

Several people talking together present a difficult situation for Packet-Radio since the protocol requires two stations to connect in order to make sure they receive each others packets. If you wanted to be absolutely sure that everyone got everything you said, you would have to connect to each person and retype everything to each person. That could get a bit cumbersome, so most

people use the Unproto Mode and are aware that a collision may occur once in a while. You can usually tell by the conversation if something was missed; if you don't get an answer to a question it's probably not that he is ignoring you, but either the question or the answer got collided with.

With MONITOR ON, the BUDLIST and BUDCALLS commands can help in setting up your monitoring to see only those you want to see. List up to 10 calls in BUDCALLS and set BUDLIST to BOTH. Now you will only see packets "to" and "from" those calls. If you like, you may each want to connect to one person, then you know at least that one got what was said, but be sure MCON and MALL are ON.

## Timing

### Dwait vs. Persistence and Slottime

When the TNC acts as a digipeater, packets that need to be relayed are retransmitted as soon as the frequency is clear. Because of the end-to-end acknowledgment of these kinds of packets it is best for an originating station to avoid colliding with digipeated packets. The TNC provides two ways to accomplish this delay. These two methods are the standard DWAIT method or the newer PERSISTENCE/SLOTTIME algorithm. During a connect using no digis, this delay also gives the receiving station time to switch from transmit to receive.

Using the DWAIT method, once the TNC detects a clear frequency, it will wait DWAIT (times 10 milliseconds) time before beginning to keyup the radio to transmit a packet. This is a packet originated by you not a digipeated packet.

The algorithm used with the PERSIST and SLOTTIME parameters helps avoid collisions by randomizing the wait time before transmitting. The more random the timing the less chance of two TNCs transmitting at the same time and colliding. Once the TNC detects a clear frequency it will wait SLOTTIME (times 10 milliseconds). Then it will generate a random number. If this number is smaller than the setting of PERSIST the TNC will transmit. If it is larger, it will wait another SLOTTIME and generate another random number and again decide whether to transmit or not. When using PERSIST and SLOTTIME you should set DWAIT to 0, since both will be used if specified.

As an example, let's assume that PERSIST is set to 63 and SLOTTIME is set to 10. This value of SLOTTIME results in a random number being generated every 100 milliseconds. When the TNC sees that the channel is clear, it waits 100 ms, then generates a random number between 0 and 255 (inclusive). In our example, the number was 83, then the TNC would not start the keyup of the transmitter since 83 is greater than the 63 PERSIST value. Instead, it would wait an additional 100 ms, and if the channel is still clear, generate a new random number. This time, let's say it comes up with the number 27. Since this is less than the PERSIST value, we now start the keyup of the transmitter to send the packet.

### Txdelay

TXDELAY should be adjusted to allow your radio sufficient time to switch from the receive mode to transmit and develop full power output. If the TNC sends the packet before the radio is at full power, the beginning of the packet will be lost and no one will be able to decode it. It is a good idea to allow a little extra time for this parameter to allow the station you are talking to sufficient time to switch from his transmit mode back to receive. This is not usually necessary if you are connected through a digipeater, but if you are connected direct, this could make the difference between successful communications and no communications. The TNC sends flags during this period, so if someone has this set extra long you will hear a repetitive sound at the beginning of the packet.

## Frack

Frame acknowledgment time. If the TNC expects an acknowledgment of a packet it has sent, it will wait FRACK seconds for the acknowledgment. If the acknowledgment is not received it will either send a poll or retransmit the packet, depending on the setting of AX25L2V2. When digis are used, extra time is allowed for each transmission using the following equation:

$$\text{FRACK} \times ((2 \times n) + 1) \text{ seconds}$$

where  $n$  is the number of digipeaters. The lower the baud rate (HBAUD) the longer this parameter should be set, because everything is slower. The length of the transmission (determined by PACLEN and MAXFRAME) also needs to be taken into account when deciding how to set FRACK. Longer packets (and more of them) require more time to be transmitted, more time to be repeated by the digipeater and so on down the line. The FRACK timer begins when PTT is released (the packet has been sent) and is suspended when data carrier from the radio is present or when your station is transmitting.

## Retries AX.25 Level 2, Version 1 vs. Version 2

The way retries are accomplished depends on AX25L2V2 being OFF or ON. To explain this we will follow a conversation through its path. First let's assume station "A" is connected to station "B" with Version 1 protocol (AX25L2V2 OFF). When station A sends a packet to station B, he expects to receive an acknowledge back indicating that station B has received the information. In order to verify that the proper packet (or frame) has been acknowledged, each frame has a number. This number is sent as a part of the frame so the receiving station knows where this packet belongs in the conversation. The frame numbers range from 0 – 7 and because of this, we are limited to a MAXFRAME of 7 (we do not want the same frame number reused in the same transmission). This is also true for Version 2. If the first acknowledge is received, there is really no difference between the two versions, practically speaking. The difference shows up with retries, so let's assume that the packet did not get through on the first attempt.

Let's now assume that station A sends frame number 3 to station B. Station B does not receive the frame and therefore no acknowledge is received by station A. With version 1, the entire packet is retransmitted (with the same frame number) again to station B and this continues until station A receives an acknowledge from station B. This acknowledge can take two basic forms. The first time station B receives frame 3, he will send an acknowledge of the form "ready to receive frame 4" `<rr4>`. If this acknowledge is sent and station A did not receive it, station A will again send frame 3. Since station B already received frame 3, he would acknowledge it with the form "I've already got frame number 3" `<rej4>`. This is also known as Reject Frame sent. This process would continue until the retry count is exceeded when, under version 1, the sending TNC will initiate a disconnect and dump the packet into the air UNPROTO. (The monitoring of the commands in `< >` depends on the settings of MRESP and MCON.)

Now let's look at the same conditions under version 2 (AX25L2C2 ON). Station B does not receive the frame and therefore no acknowledge is received by station A. This time, station A sends a POLL or question to station B saying, in effect, "did you receive my frame number 3?" `<<RR3>>`. Since station B did not receive the frame, he would respond with "no I did not" `<<rr3>>`. This really says "I am ready to receive frame 3". At this point, station A, upon receiving the rr3 would immediately resend the entire frame. If station B had already received frame 3 once but the acknowledge never got to station A, the question from station A for the retry would be the same. Station B's response however, would be different. He would respond with "ready to receive frame 4" `<<rr4>>`. If station A does not receive station B's reply this POL/REPLY sequence would continue for the number of retries set in the sending TNC and if no response was received, the TNC at station A would then begin to issue connect requests to station B since there is still an outstanding

packet of information. This is the major difference between version 1 and version 2. The connect attempts would then continue for the number of retries set in the TNC and if no response was received from station B after all of the above, station A would disconnect and dump the packet UNPROTO. The parameter RELINK can be turned OFF to avoid the reconnect attempt.

In either version 1 or version 2 another interesting feature of packet is the ability to automatically reestablish a connection. For instance, station A is connected to station B and has one frame outstanding. Station B disconnects without station A knowing it (perhaps a power failure, double disconnect or even a timeout (retry count exceeded)). The first time station B receives the outstanding packet from station A he will send a disconnect message to station A. When station A receives this, station A automatically issues a connect request to station B and the connection is re-established to pass the outstanding traffic.

## Flow Control

The flow control commands insure that the TNC gets everything that is sent to it by the computer and that the computer gets everything the TNC sends it. When the computer sends the TNC data, the TNC stores this data in a buffer until it can packetize it, send it and get acknowledgment. When the TNC sends the computer data, it also stores in a buffer until it can be processed, stored to disk, sent to printer, or whatever. This buffer area is only so big, if more data is sent than will fit in the buffer, it is lost. To avoid this, the two devices can tell each other to start and stop sending data. This is called Flow Control and can be accomplished in two ways: software and hardware. Which way you implement, this depends on the capabilities of your computer communications program and personal preference. The cable between your computer and TNC must also be wired appropriately.

### Software Flow Control

Software flow control sends special characters on the TXD and RXD lines of the RS-232 cable. These are the same lines used for sending regular data between the TNC and computer – Software flow control normally send a Ctrl-S to stop data and a Ctrl-Q to restart data. When a buffer gets close to full the device will send a Ctrl-S and expect the other device to stop. When the buffer gets emptier, it will send a Ctrl-Q to tell the other device to send more data. How full or empty a buffer is when the special characters are sent, is determined by the program. But, since the regular data lines are being used a Ctrl-S sent from the keyboard will also stop data. And likewise, if there is a Ctrl-S in a file being sent, data flow will stop until a Ctrl-Q is received.

XFLOW needs to be turned ON for the TNC to use software flow control. XOFF determines the character sent by the TNC to stop the flow of data from the computer, and the XON character restarts the flow. The TNC expects the computer to send the STOP character to stop data and the START character to restart data. To use software flow control these commands would be set as follows: XFLOW ON, XOFF \$13, START \$11.

In the Transparent Mode two more commands are provided that make it possible to send or receive these special characters and still use software flow control. TXFLOW controls flow control sent by the TNC to the computer and TRFLOW controls what the TNC expects from the computer. In both these commands are ON (and the above commands are set as stated), then software flow control will take place in both directions to and from the TNC and computer. But if you are in Transparent Mode sending a file, the computer is not going to be telling the TNC to stop and start since you are sending the file. But if there is a Ctrl-S in the file, the TNC will think the computer is telling the TNC to stop and will not send any data to your computer until it receives a Ctrl-Q (even if you have completed sending the file). To solve this problem, you can turn TRFLOW OFF and send all characters and turn TXFLOW ON, so the TNC will still tell the computer when to stop and restart. On the other hand, if receiving a file, set TRFLOW ON and TXFLOW OFF.

## Hardware Flow Control

Hardware flow control monitors the voltages on the RTS and CTS pins of the RS-232 cable. Therefore these two wires must be in the cable between your TNC and computer. The TNC holds CTS high as long as it can receive data. Once its buffer gets full, it pulls this line low. The computer program monitors this line and when it is pulled low, knows to stop sending data. When the line is again pulled high by the TNC, the computer program will restart sending data. On the other hand, the computer holds RTS high as long as it can receive data and pulls it low to tell the TNC to stop sending data. The TNC always uses hardware flow control, so only wire the RTS and CTS pins if your computer program is also using hardware flow control.

## Convers Mode vs. Transparent Mode

In the Convers Mode there are many special characters. To list a few:

Command	Default	Description
SENDPAC	Ctrl-M	Causes a packet to be packetized
DELETE	Ctrl-H	Backspace character
REDISPLAY	Ctrl-R	Redisplays the keyboard buffer
CANLINE	Ctrl-X	Cancels a line
STOP	Ctrl-S	Stops output from TNC to computer
PASS	Ctrl-V	Pass a special character

These characters are all very useful when having a Packet conversation with someone. If you want to send a packet, you hit the return. If you make a mistake, you can backup with the delete or backspace key or kill the whole line with Ctrl-X. And if you really want to send one of these characters, you can always proceed it with the PASS character.

Transparent Mode is made for the sending of files, whether they be ASCII data files or program files. The special characters do not mean anything to the TNC, they are just characters to be put in a packet and sent to the radio. (XOFF, XON, STOP, START may be used depending on the settings of XFLOW, TXFLOW and TRFLOW, see the flow control section.) A SENDPAC character will not cause a packet to be packetized, instead this is controlled by a timer (PACTIME). This way short lines do not make short packets, therefore less overhead and more efficient use of the frequency. How congested the frequency is should be kept in mind when setting the PACLEN and MAXFRAME parameters.

Besides ignoring special characters, Transparent Mode also ignores the settings of 8BITCONV and PARITY. The TNC acts as though 8BITCONV is ON and PARITY is 4 (none), so be sure the computers on both ends of the connection are set the same. All monitor commands are treated as OFF in Transparent Mode. All you will see, is what is being sent to you. You would probably want to set USERS to 1, so no one interferes with the transfer. The setting of ECHO is also ignored. Even if ECHO is ON, Transparent Mode will not echo to the attached terminal. Some programs allow for local echoing to the screen while uploading.

## Getting Out of Transparent

Getting into Transparent Mode is easy, just type a **t** in Command Mode. But since Transparent Mode allows the sending of all characters you can not get out of Transparent Mode by just typing a **Ctrl-C** (COMANND character) as in Convers Mode. In order to get out of Transparent Mode you must follow a special sequence or use a modem break if your program supports one. The special sequence must be followed precisely. This example assumes the COMMAND character is Ctrl-C and CMDTIME is 1 second:

- Wait at least 1 second since the last character was sent from the computer to the TNC
- Type a **Ctrl-C**
- Within 1 second type a second **Ctrl-C**
- Within 1 second type a third **Ctrl-C**
- Wait 1 second and the **cmd:** prompt should appear

If the guard time of one second before and after the three Ctrl-Cs is not there, the TNC assumes that they are data and sends them to the radio. Don't get impatient, one second can seem longer than you think it should.

## HF Packet Operation

All of the information previously presented applies to HF Packet as well as VHF Packet, but the major differences all center around the timing parameters.

The reason for this is the band conditions on HF generally cause more of what is called the hidden station concept. A simple example will demonstrate:

If I'm located in Lawrence, Kansas, and I'm talking to a station in Boston, Massachusetts, all goes very well as long as we are the only two stations on frequency. In the real world, there are many other stations on at the same time. Now, I send a packet of data to my friend in Boston and a station in San Diego has data to send also. He doesn't transmit because he hears my signal. The Boston station receives my packet and I quit transmitting. Now the Boston station keys up to send his acknowledgment back to me but the San Diego station also keys up to send his data because he can't hear the Boston station. Here we have a collision. I hear both of them, so the acknowledge doesn't arrive.

On the other side of the coin, if the Boston station sends me a packet, I may receive it fine, then the San Diego station keys up to send a packet of data. Perhaps this is several long packets which cause him to transmit for 5 seconds. I didn't transmit because I heard the San Diego station. Now, the San Diego station stops sending, I start my DWAIT or SLOTTIME wait, and a station in Seattle keys up to answer the San Diego station. Again I don't transmit because I hear the Seattle station. By this time, perhaps 8 seconds or so have gone by. The Boston station didn't receive my ack – of course not! I haven't sent it yet because the channel isn't clear! But, his FRACK time is expired and he thinks I missed it. Even if I acknowledge right now, he will still have to go through the POLL/RESONSE sequence since his FRACK time expired.

What we see here, is the need on HF, with more hidden stations and slower baud rates, to increase our FRACK time to give the receiving station a reasonable opportunity to ack our packets before we retry. Otherwise, we have lots of retries and very little data.

## PBBS

### General

Your TNC contains the Kantronics Personal Mailbox system which will allow you to leave messages for others which may be retrieved later. The personal mailbox is compatible with the large community bulletin board systems (RLI, MBL, etc.) and will allow them to forward mail for you directly into your TNC. You may also place Personal or NTS type messages into your mailbox, and if the local Community BBS system allows, your TNC mailbox will forward these messages from your personal mailbox into the community system on request.

### Configuring your PBBS

In order to enable your PBBS, you must set the MYPBBS callsign to be a unique callsign – that is, it cannot be the same as any other callsign in your TNC. You must also set the PBBS size, to allocate some RAM memory to the mailbox. This is accomplished with the PBBS command. The maximum setting allowed will depend on the amount of memory available. NUMNODES, MAXUSER and NAVSTA (**KAM**) will affect the amount of memory available.

If you change the size of the mailbox, the TNC will not renumber any exiting messages. If the new size is large enough for all existing messages, no messages will be lost. To renumber the messages, specify PBBS *n* with *n* being the current size. All messages will be renumbered starting with the number 1.

At times, you may be away from your computer and would like to switch a user into your mailbox automatically if he connects to your MYCALL. This can be accomplished by setting the CMSG command to PBBS. In order for this to operate, you must also have some message in the CTEXT. When this is done, a user who connects to your MYCALL will be sent your CTEXT first. Then, when the TNC receives the acknowledgment for the CTEXT, the user will be automatically connected to the PBBS. The TNC will then send the normal PBBS sign on message, the PTEXT (if any) and the PBBS prompt. The sign-on message is enclosed in square brackets and consists of the unit name, firmware version and H for support of hierarchical forwarding. Example: **[KAM-3.0-H]**

If it becomes necessary to disconnect a station from your PBBS, you can use the local terminal connected to your TNC to accomplish this (see DISCONNECT MYPBBS). If a station connects to your PBBS and no activity occurs on that connection for 15 minutes, the PBBS will automatically disconnect the user, in order to make your PBBS available to other users.

### Using the PBBS

In order to use any TNC PBBS (even your own) first, get the **cmd:** prompt on your TNC and then connect to the callsign of the PBBS. For instance, if MYPBBS is DC7XJ-1 I would simply type **C DC7XJ-1**. Since the PBBS is in my own TNC, no packets would be transmitted, but I would connect to the PBBS and receive the same prompt as if I had connected to someone else's PBBS.

When you connect to a TNC PBBS, you will first see the message from your TNC indicating that you are connected – **\*\*\* CONNECTED TO DC7XJ-1**. The PBBS will then send you its initial sign on message. If you have defined a PTEXT, the TNC will send it as the next line and then it sends the PBBS command prompt. Example:

```
*** CONNECTED TO DC7XJ-1
[KAM-3.0-H]
PTEXT would be here (if any)
ENTER COMMAND: B,J,K #, KM,L,LM,R #,RM,S, or Help >
```

Using the PBBS is therefore the same, whether you are using your own PBBS or another persons PBBS. At this point, you are ready to send a message to another user, or issue any other mailbox command.

Let's assume I want to send a message to KA5ZTX. I would now use the send command:

**S KA5ZTK**

and the TNC responds with:

**SUBJECT :**

I now enter a short subject line:

**Just a quick question**

The PBBS now prompts you to enter your message:

**ENTER MESSAGE - END WITH CTRL-Z OR /EX ON A SINGLE LINE**

Now you enter the text of your message. To end the message and have it saved, type a **Ctrl-Z** (hold down the **control key** and press **Z**) or type **/EX**. The Ctrl-Z or /EX must be on a line by itself – do not type anything else on this line. When the message has been ended properly, the PBBS responds with:

**MESSAGE SAVED**

**ENTER COMMAND: B,J,K #,KM,L,LM,R #,RM,S, or Help >**

You may now enter more mailbox commands. The commands available in the TNC PBBS are:

B	Causes the TNC PBBS to disconnect you from the mailbox
J	Sends a list of stations heard lately by the TNC. (If MHEARD is set to 0 this command will not be available.)
K #	Kill message number #
KM	Kill Mine
L	List all messages in the mailbox (If connected remotely, only lists those addressed to you, from you or addressed to ALL)
LM	List all messages addressed to you
R #	Read message number #
RM	Read Mine
S	Send a message
H	Help – displays a short help menu

One additional command available from your own PBBS is REROUTE. This command lets you change the TO field of any message in your PBBS. The format of the REROUTE command is:

**REROUTE *n* *callsign***

where *n* = message number and *callsign* = new TO field.



## Reverse forwarding messages from your mailbox

The Kantronics TNC mailbox will allow you to enter messages which will be forwarded by full-service BBSs (RLI, MBL, etc.). These messages have a special format and can only be entered in your OWN personal mailbox. Let's suppose I want to send a message to WA4EMV who lives in Texas. I know his home BBS is WB5BBW, so I can put this message in my PBBS with the command:

**S WA4EMV @ WB5BBW.#STX.TX.USA.NA**

Complete information on Hierarchical forwarding can be obtained from your local BBS system operator, but basically the first field after the @ symbol is the HOME BBS of the station you are trying to send a message. The next several fields (separated by periods) are the state (two letter postal abbreviation), country and continent. In this case, since Texas is so large, it is sub-divided into smaller areas. These are indicated with the # symbol (in this case #STX – South Texas).

Messages entered into your mailbox in this format will be reverse forwarded to the full service BBS when requested and the following rules apply:

If the first item after the @ symbol begins with "NTS", the message will be sent as TRAFFIC using the ST command. All other messages will be sent as PRIVATE with the SP command when they are sent to the full-service BBS. The TNC does not incorporate any means to initiate a BULLETIN from its PBBS.

If you attempt to send a message to ALL @ AMSAT, for instance, the local full-service BBS would receive it as a PRIVATE message and not as a bulletin. As a result, it would not be accessible by anyone other than the SYSOPs of the BBSs. Although this may seem to be an inconvenience, it is necessary to help avoid over-congesting the Packet network with duplicate copies of the same bulletin.

The TNC acts like a "smart BBS" when forwarding to or from a full-service BBS. This means, that it will no longer send the SUBJECT: prompt, nor will it send the ENTER MESSAGE prompt. You will also notice that when a full-service BBS connects to your PBBS, the TNC does not send the usual ENTER COMMAND prompt, but only the > is sent. This is designed to reduce the amount of data on the Packet network, since "smart" BBSs know what is expected of them.

Once a message has been successfully forwarded out of your mailbox, it will be deleted from the PBBS.

## KA-NODE

### General

The Kantronics KA-NODE is part of your TNC, which provides users with local acknowledgments of packets, rather than the "old" style end-to-end acknowledgment previously required when connecting to distant stations. This feature is useful when connecting to distant stations and generally results in a significant increase in data throughput. If you connect to a dual-port Kantronics KA-NODE (the **KAM** or **KPC-4**) you may also "gateway from one port to the other using the commands described under "Using a KA-NODE". This would allow a VHF user to access HF Packet frequencies by using such a KA-NODE. Each packet you send to a KA-NODE is acknowledged by that KA-NODE and also passed to the next station in the path. Since the data has been acknowledged from your station, any retries which are required due to collisions or other conditions will be automatically performed by the KA-NODE.

Frequently when connecting to a distant city, you may wish to talk to more than one station. Perhaps when you connected, you got a message saying "I'm not here right now, please leave a message in my PBBS". By using the "S(tay)" option when telling a KA-NODE to connect to another station; the KA-NODE will not disconnect from you if it receives a disconnect from the distant station, instead, you will receive a message from the KA-NODE saying **###DISCONNECTED BY (call) AT NODE (MYNODE)**. In other words, if I connected from Lawrence, Kansas to a KA-Node in Lincoln, Nebraska, and then told that KA-NODE to connect to someone using the command **C call Stay**, and then that station sent me the above message and disconnected, I would remain connected to the KA-NODE in Lincoln! This allows me to issue a connect directly to his BBS, without having to re-establish the entire path. In multiple KA-NODE paths, each time you say B(ye) to the distant KA-NODE, this would return you to the next previous KA-NODE which had been told to "Stay" in the chain of KA-NODES. From that point, you could build a path in a different direction. One point to note here, is that if you use the KA-NODE to connect to a BBS (W0RLI or WA7MBL for instance), and use the STAY option, than say B(ye) to the BBS, you would remain connected to the KA-NODE closest to the BBS. If you issue the connect without the STAY option, any disconnect from either end will cause the entire link to disconnect.

The KA-NODE checks the passage of data through the node and if no activity occurs for some pre-selected time (see KNTIMER) then the KA-NODE will disconnect both sides of the node.

### Configuring Your KA-NODE

In order to set your Kantronics TNC for use as a KA-NODE, several conditions must be met. First, you must allocate the number of circuits you wish to allow through the KA-NODE (see NUMNODES). Each circuit consists of an "IN" and an "OUT" side. Secondly, the callsign assigned to the KA-NODE (see MYNODE) must be different from the callsign used for either you (see MYCALL and MYALIAS) or the PBBS (see MYPBBS) and gateway (see MYGATE). If desired, you may set the NDWILD command ON. This will cause your KA-NODE to accept a connect request to any SSID of the MYNODE callsign, except those mentioned above. Packets passing through your KA-NODE are monitored unless your MYNODE callsign is included in the SUPCALLS list and SUPLIST is turned ON. If it becomes necessary to disconnect a station from your KA-NODE, you can issue the command DISCONNECT MYNODE from the local terminal connected to your TNC.

Each KA-NODE circuit allowed will require approximately 4.3 k of memory, with a maximum of 13 circuits in a **KPC-4** with 64 k RAM. If you attempt to set NUMNODES to a value requiring more memory than available, you will receive a message indicating that the value is out of range or not enough RAM. The total number of circuits which may be allocated will also be affected by the amount of memory allocated to the Personal Mailbox.

## Using a KA-NODE

To use the KA-NODE as a means of connecting to some other node or end-user, you must first connect to the KA-NODE. At the **cmd:** prompt on your TNC, issue a connect request to the callsign of the KA-NODE, let's say LAW. When you make connection, you will see the following messages on your display:

```
*** CONNECTED TO LAW
### CONNECTED TO WILD NODE LAW (WDOEMR) CHANNEL A
ENTER COMMAND B,C,J,N,X, or Help
?
```

The **\*\*\* CONNECTED** message is sent by your local TNC to the terminal and the **### CONNECTED TO NODE** message is coming from the distant KA-NODE. **WDOEMR** is the MYCALL of the station containing the KA-NODE in this example, **WILD** indicates that he is running a "wildcard" node and **CHANNEL A** indicates that you have connected to its channel A. If A is in use, you may obtain channel B. The channels, or circuits, are assigned by the KA-NODE as needed.

After connecting to the KA-NODE, you are in CONVERS mode at your own station, but the KA-NODE is waiting for a command. You issue a command to the node by STAYING IN CONVERS MODE. The KA-NODE will interpret the data you send as its commands. It can receive only commands; it doesn't know what data is. At this point, let's assume that you wish to know what other KA-NODES are nearby. You would issue the NODES command by typing **N** or **NODES**, in response to the KA-NODE "enter command" prompt. You will receive a list of KA-NODES which have recently been heard. For example, let's suppose that KC was heard by LAW. Your list received from the Nodes command would be:

```
KC (N0APJ-2) 12/23/87 02:38:45
ENTER COMMAND B,C,J,N,X, or Help
?
```

KC denotes the KA-NODE callsign, the MYCALL of the KA-NODE station is in parentheses, followed by date and time heard. If LAW had heard nothing, it would respond with:

```
NO KNOWN NODES
```

You may, instead, wish to know what other stations the KA-NODE has heard lately. This would accomplished by sending the JHEARD command. The node will respond by listing its own MHEARD log. The list will contain end user and node callsigns and in the same type of list you get by using your own MHEARD command at the **cmd:** prompt.

At this point, let's suppose that you would like to connect to the node called KC through your current connection with LAW. Just issue a connect request to KC as follows in response to the "enter command" from LAW:

```
CONNECT KC
```

The response will be:

```
###LINK MADE
###CONNECTED TO NODE KC (MYCYLLSIGN OF KC) CHANNEL A
ENTER COMMAND B,C,J,N,X, or Help
?
```

At this point you are "patched" through the KA-NODE LAW to the node KC. When LAW issued the connect request to KC, it used your own call but subtracted a count of one from your SSID. For ex-

ample, if you connected to LAW with W0XI, LAW connected (via your request) to KC with WX0XI-15. This is automatic. At this point, you could connect to another KA-NODE, some other network node using AX.25 as an uplink or downlink protocol, or to an end-user. Let's assume that you desire to connect to N0APJ. So, just enter in response to the node "enter command" above:

**C N0APJ Stay**

and you'll get the response:

**###LINK MADE**

You are now connected to N0APJ. If you have issued a connect command to a KA-NODE and realize that you have made a mistake with the call or for any other reason wish to cancel the connection, you may do so by using the ABORT command. In order for the abort to work, it MUST be the first word entered following the connect command and must be spelled out entirely. For instance, if you tell the KA-NODE:

**XC KB5EEG**

and then decide to abort the connect, your next entry must be:

**ABORT**

Any other entry will cancel any possible abort of the connection and you must wait for the KA-NODE to retry out.

## Local Acknowledgments, Higher Throughput

Now that you are connected to N0APJ, you can carry on a normal Packet QSO. While everything appears "normal" and AX.25 compatible, acknowledgments to your packets are generated by the KA-NODE directly connected to you. Each channel in the link takes care of its own errors. In other words, the link between KC and LAW handles its own error checking. In this way, one weak line will not cause end-to-end packets and acknowledgments to be repeated as they would with digipeating. The result is substantial improvement in throughput for connections using nodes.

When it comes time to disconnect, you do so in the standard AX.25 manner. To disconnect the link described above, type **Ctrl-C**, obtain the **cmd:** prompt on your TNC and issue the disconnect command:

**cmd: D**  
**\*\*\*DISCONNECTED**

You'll get the usual disconnect message from your TNC as noted. If however, your distant partner, in this case N0APJ, disconnects the link, you'll see the following:

**###DISCONNECTED BY N0APJ AT NODE KC**  
**ENTER COMMAND B,C,J,N,X, or Help**  
**?**

## Automatic Disconnect

If a user abandons a connection to a KA-NODE, or a link between two KA-NODES without disconnecting and there is no activity through the link for a specified period of time (see KNTIMER), the node will initiate a disconnect.

## Using the XCONNECT Command (**KAM** and **KPC-4** only)

The cross-connect (XCONNECT) command is a unique feature of the KA-NODE. This command allows cross linking between two frequencies through the node in much the same manner as the Kantronics unique GATEWAY command, but with local acknowledgment of packets.

For example, suppose you just connected to node LAWKAN and wish to cross-connect to WD0EMR whose station is tuned to the frequency of the other port of the node. Just issue **XC WD0EMR** following the node prompt:

```
ENTER COMMAND B,C,J,N,X, or help
?XC WD0EMR<CR>
```

The response you receive will be:

```
### LINK MADE
### CONNECTED TO WD0EMR
```

You can also determine from the response to the NODE command, which port a node is on. Below is an illustration of a KA-NODE response to a NODE command:

```
LAWKAN*    12/02/87 15:45:00
N66046/X   12/02/87 15:49:15
OLAKAN/X   12/02/87 16:15:21
```

In this typical display the callsign of the node is given, followed by the date and time it was last heard. The slant bar X (**/x**) indicates that the node was heard on the opposite port from the one you are connected on. the asterisk (**\***) means that the node was heard via a digipeater.

## Determining Which Port You Have Connected To

When you are connected to a **KPC-4** or **KAM** node, you can determine which port you are on at the node, by using the JHEARD command. A typical node response to the JHEARD command may appear on your display as shown (the **KAM** uses **/H** and **/V** instead of **/1** and **/2**):

```
N66046/2*   12/01/87 14:32:59
WK5M-1/1    12/01/87 16:25:01
W0XI/2      12/02/87 16:28:05
WD0EMR/1    12/02/87 16:32:09
```

In this illustration the number following the slant bar (**/**) indicates the port the station was heard on. Your callsign will usually be the last one in this list.

You can now see, that by comparing the port on which your call appears in the JHEARD list to the port indicated for other stations, you can determine whether to **CONNECT** or **XCONNECT** to the station of your choice.

## KA-NODE Commands for Remote Use

When accessed by radio, the KA-NODE has several commands which may be given to it. These commands are listed here for reference, with a description of each command. In these descriptions, the UPPER case characters of the command are required. LOWER case characters are optional. Those items listed within [ ] are optional and if used the UPPER/LOWER case convention listed above applies.

- **ABORT**

This command will abort a KA-NODE Connect or XCONNECT request if it is the first data sent after the request. It must be spelled out entirely.

- **Bye**

This command will cause the KA-NODE to initiate a disconnect.

- **Connect *callsign***

This command will cause the node to issue a connect request to *callsign* in the usual AX.25 mode. If the connect is successful, a link will be made to the next node or end-user station.

- **Help**

This command causes the KA-NODE to send a brief help list, showing all commands available, with the options and a short description of each command.

- **Jheard [Short | Long]**

This command will cause the KA-NODE to transmit its TNC MHEARD log. The returned list (without the short or long option) will look like this:

(KAM)	(KPC-4)
LAWKAN/H* 01/09/88 08:25:15	LAWKAN/1* 01/09/88 08:25:15
N66046/V 01/10/88 00:03:10	N66046/2 01/10/88 00:03:10
WK5M-3/H 01/10/88 00:03:19	WK5M-3/1 01/10/88 00:03:19
WD0EMR/V 01/10/88 00:04:15	WD0EMR/V 01/10/88 00:04:15
(KPC-1, 2 or 2400)	
LAWKAN* 01/09/88 08:25:15	
N66046 01/10/88 00:03:10	
WK5M-3 01/10/88 00:03:19	
WD0EMR 01/10/88 00:04:15	

The left column indicates the callsign (and SSID if appropriate) of a station heard. The number following the slant bar (/) shows the port on which the station was heard, if both ports are active. The asterisk indicates the station was heard via a digipeater. The center and right columns indicate date and time the station was last heard. In both cases, the last call on the list will probably be your call. The above JHEARD lists show WD0EMR connecting to the KA-NODE and requesting the nodes JHEARD log.

The short (JHEARD S) version of this command would produce the following list:

(KAM)	(KPC-4)	(KPC-1, 2 or 2400)
LAWKAN/H*	LAWKAN/1*	LAWKAN*
N66046/V	N66046/2	N66046
WK5M-3/H	WK5M-3/1	WK5M-3
WD0EMR/V	WD0EMR/2	WD0EMR

The long (JHEARD L) version of this command will also show the destination field and digipeaters used. This list would look like:

(KAM)

```
LAWKAN/H*      >W0XI      01/09/88 08:25:15
  VIA KSKU, TOP*, KSKU
N66046/V       >BEACON    01/10/88 00:03:10
WK5M-3/H*     >WD0EMR    01/10/88 00:03:19
  VIA W0XI, TOP*
WD0EMR/V       >KC        01/10/88 00:04:15
  VIA KSTOP, KCMO
```

(KPC-4)

```
LAWKAN/1*      >W0XI      01/09/88 08:25:15
  VIA KSKU, TOP*, KSKU
N66046/2       >BEACON    01/10/88 00:03:10
WK5M-3/1*     >WD0EMR    01/10/88 00:03:19
  VIA W0XI, TOP*
WD0EMR/2       >KC        01/10/88 00:04:15
  VIA KSTOP, KCMO
```

(KPC-1, 2 or 2400)

```
LAWKAN         >W0XI      01/09/88 08:25:15
  VIA KSKU, TOP*, KSKU
N66046         >BEACON    01/10/88 00:03:10
WK5M-3/        >WD0EMR    01/10/88 00:03:19
  VIA W0XI, TOP*
WD0EMR         >KC        01/10/88 00:04:15
  VIA KSTOP, KCMO
```

- **Nodes** [Short | Long]

This command will cause the node to return a list of KA-NODES it has heard, as well as NET/ROM or TheNet nodes. The format of the list is similar to that of the JHEARD list above.

- **XConnect** *callsign* (KAM and KPC-4 only)

This command will cause the node to issue a connect request to callsign in the usual AX.25 format from the node but uses the other port of the KA-NODE. Cross-connecting enables you to gain access via the node to another frequency.



## Kantronics Host Mode Operation

To operate in the Host Mode with a Kantronics TNC you must first set the INTFACE command to HOST. After this is set, it will be necessary to perform a soft reset to enter the Host Mode. This may be accomplished by typing **RESET** at the **cmd:** prompt. If you want the TNC to always operate in the Host Mode, be sure to give the command PERM. You will also need to set the ABAUD command to the appropriate baud rate for your terminal. If the ABAUD command is not set, the TNC will run its normal autobaud routine, looking for an asterisk (\*) from the keyboard. When the asterisk is entered, the TNC will then immediately enter Host Mode. While operating Host Mode, your program must use hardware flow control (RTS/CTS). Software flow control is not possible in Host Mode.

### Communication Format

#### Host computer to TNC

Communication from the host to the TNC must occur in blocks. The block of data is delimited with a FEND character (\$C0) at the beginning and end. If the FEND character appears within the block of valid data, the host must replace this character with a special sequence, consisting of a FESC (\$DB) followed by a TFEND (\$DC). One other special sequence may be required in the event a FESC (\$DB) character is required in the data field. This is accomplished by the special sequence of a FESC (\$DB) followed by a TFESC (\$DD). These special sequences are the same used in the KISS code, as implemented by Phil Karn, KA9Q.

After the opening FEND, the next character is the command byte and will indicate the type of command being given to the TNC. The permissible characters in the command byte are C, D or Q. For the **KAM** only, there are some other combinations used for non-packet HF Mode operation. These will be covered later.

A 'C' command byte indicates a command that the TNC will interpret as if it were in the Command Mode. If the command byte is a 'D', the TNC will consider the data as data to be transmitted on the specific port and stream. The letter 'Q' in the command byte will cause the TNC to exit the Host Mode and return to Terminal Mode.

The next byte is the port byte. This must be used with every block of type 'D' to signify which port (1 or 2) is to be used for transmission of the data. Type 'C' blocks must always specify this byte as either a 1 or 2, but this is only used on those commands that are specific to a port. This would include the CONNECT and DISCONNECT commands. When using the **KAM**, the VHF port is selected by a port byte of '1' and the HF port is '2'. Single port units use port byte '1'.

The fourth byte is a stream byte. This byte determines which stream (A – Z) the TNC will use for the data. If the stream byte is 0 for a data packet (command byte D), the data will be sent out UNPROTO. (See the section on the **KAM** HF modes for more information.) For commands that do not involve a specified port or stream, the port and stream bytes are ignored, but must be specified. In these cases, you should address port 1 stream A.

After these four header bytes, the structure of the block for a command is exactly the same as if you were entering the command from the Terminal Mode of the TNC. If entering data to be transmitted, simply place the data in the following bytes. Note that commands do not need a carriage return included in the data portion of the packet.

After the data or command, terminate the information from the host with a FEND (\$C0) character.



## KAM HF Modes

When operating non-packet modes (i.e. RTTY, ASCII, AMTOR or CW) with the **KAM**, a few additional host to TNC frames are required. First, select the mode with standard command structures as described above (e.g. FEND C2ARTTY 75 FEND). Data that you wish to transmit to the other station should have command by 'D', port byte '2' and stream by '0'. Special host frames for these modes are:

FEND T FEND	Enter transmit mode
FEND E FEND	Enter receive mode when buffer empty
FEND R FEND	Enter receive mode immediately
FEND X FEND	Return HF port to Packet mode
FEND Ctrl-X FEND	Clear the transmit buffer in KAM HF

## TNC to Host Computer

Communication from the TNC to the host also occurs in blocks which are delimited at beginning and end with FEND characters (\$C0).

After the beginning FEND, the next character is the status byte. A status byte 'C' is a response to a command from the host with the command byte 'C'. A status byte of 'D' indicates, that the data was received on a connected stream (see the section below on the **KAM** HF operation). 'M' in the status byte means that the data in this block is the result of the monitor commands.

A status byte of 'S' is a status message caused by a change in the link state. Such messages include the \*\*\* CONNECTED TO, \*\*\* DISCONNECTED and FMR sent. A special 'S' block of data consists of two FEND characters, the characters S00 and another FEND character. This indicates that the TNC has performed a soft reset and all existing connections (if any) are not longer valid. This is equivalent to the TNC having just been turned on. A data block with the status byte 'R' is a \*\*\* CONNECT REQUEST. A block with status byte 'T' is the result of the TRACE command. Port and stream bytes (defined below) are valid for 'D' and 'S' blocks, but only the port byte is valid for 'T', 'M' and 'R' blocks.

The port byte follows the status byte and will contain the port number the specific information is from. This will be a '1' if the TNC is in single port operation or a '1' or '2' if in dual port operation. When using the **KAM**, the VHF port is indicated by a port byte of '1' and the HF port is '2'. Single port units use port byte '1'.

The stream byte follows the port byte. The stream byte will be 'A' – 'Z' for data on the connected streams. Data being sent to the host which is not connected data will have the stream by set to '0'.

If the TNC returns a 'C' status block with no data, this indicates that the command was accepted. This will occur on connect and disconnect commands.

A 'T' block from the host (TRACE information) is raw data and not a hex dump of the received packet.

The KISS transparency (FESC, FEND, TFEND and TFESC) described above is always applied to all blocks.

## HF Mode operation

When using a non-packet mode on the HF port of the KAM, received HF data will be sent to the host with status byte 'D', port byte '2' and stream byte '0'. Each received character is sent from the KAM to the host in a separate block.

When operating AMTOR mode A, another KAM to host block is possible, indicating the current status of your station (IRS or ISS). This block has a status byte of 'I', port byte '2' and the stream byte indicates IRS ('0') or ISS ('1'). This block will be sent whenever there is a change.

When operating in the AMTOR mode A (ARQ) the KAM will send an 'S' block containing information pertinent to the link. For instance, when the link is established, the KAM sends an 'S' with the message <LINKED> or <LINKED to xxxxxxx>. 'S' frames are also sent indicating a link failure, or anytime the KAM returns to AMTOR STANDBY. This can occur when the other station breaks the link, or if the link fails due to poor propagation.

When receiving NAVTEX, the KAM does not send any information to the host until it received a proper NAVTEX header for a message that is eligible to be printed (see the NAVTEX section of the operating manual). When the header is received (ZCZC XXNN) this header will be sent to the host in a single block. After the closing NNNN of the message, if the number of errors received exceeds the NAVERR setting, an error message will be sent from the KAM to the host indicating "\*\*\* TOO MANY ERRORS" and the message number. This will be sent as a 'D20' frame and not as a status frame. This allows this message to be stored in the file if you are capturing the HF channel to disk. This message will also be sent if the link fails before the closing of the current message.

## WEFAX Mode

### General

Facsimile reception (WEFAX) is available with your TNC since the weather facsimile broadcast are using an 800 Hz FSK shift which is compatible with the Kantronics 1200 baud modem. In order to receive WEFAX, you must have a program for your computer which will receive 8 bit data from the TNC and format it properly for display on your computer screen or your printer. Kantronics has available three terminal programs which meet these requirements – MAXFAX for the Commodore 64 and 128 computers, SuperFax II for the PC and WeFaxWorks for the Apple Macintosh computer.

### Background: HF WEFAX Transmissions and Resolution

Many of the weather charts broadcast on HF as WEFAX are hand drawn synoptic maps. i.e. a summary of weather conditions, showing such things as atmospheric pressure and surface temperature over wide areas. many of these maps show whole continents or oceans. These maps and charts are often produced by a particular weather service at their own HF radio station site. Two predominant stations are NAM, the Norfolk US Navy Fleet Weather Service station, and CFH, the Canadian Forces Halifax station.

Full size charts are eighteen (18) inches wide and vary in length from 10 to 18 inches. In past years, many charts were generated on a rotating drum at 60 scan lines per minute, but modern day charts are digitized (placed in computer storage) at the rate of 120 scan lines per minute on a flat-bed scanner. The scanner digitizes with a resolution of 96 lines or pixel per inch. So, the maximum resolution of a hand-drawn synoptic chart, when digitized, is nearly 1800 by 1800 pixels!

In addition to the temperature and pressure charts, redigitized satellite photos are sometimes transmitted over HF. The sources of most of these satellite weather photos are the National Oceanic and Atmospheric Administration (NOAA) operated weather satellites.

All WEFAX charts and pictures received on HF come from an HF ground station, not from any of the satellites. As mentioned above, many stations generate their own weather charts. Weather photos coming from the satellites are received first by a ground station, reformatted and then relayed by telephone line to the HF transmission site for dissemination.

When the WEFAX maps and charts are transmitted on HF, some of the resolution is lost. This occurs because the FSK modulation scheme used by all manufacturers of HF WEFAX transmission equipment will not support the baud rate needed for full horizontal resolution. The FSK has been kept, however, to make today's equipment compatible with that produced earlier and received-map resolution is acceptable.

### Finding WEFAX Broadcasts

There are approximately 50 commercial and governmental WEFAX transmitters located in over 20 countries around the world. Most broadcast on HF (between 3 and 30 MHz). Many broadcast continually while others are on a sporadic schedule. You will nearly always find the following if ionospheric conditions permit:

## WEFAX

LOCATION	FREQUENCIES (MHz)
Halifax, NS	4.275, 6.630, 9.890, 13.510
Norfolk, VA	8.080, 10.865, 16.410
San Diego, CA	8.646, 17.410
Mobile, AL	9.158
San Fran, CA	4.346, 8.682, 12.730, 17.151
Washington, DC	4.795, 10.185, 12.205, 14.672

In addition, many of the frequency guides for sale by various radio equipment suppliers list WFAF station frequencies.

### Tuning WEFAX Signals on HF

As mentioned earlier, WEFAX broadcasters use an 800 Hertz shift FSK format, using mark and space frequencies of 1500 and 2300 Hertz respectively. These tones, like voice broadcasts, are used to modulate the station RF carrier. You can tune these signals with your standard 1200 baud Packet modem by tuning 1.7 kHz below the published frequency in upper-sideband (USB). For example, with your HF transceiver or receiver set to USB, turn the dial until the frequency readout shows 8078.3 to receive NAM (the Norfolk US Navy Fleet Weather Service transmitting on 8080 kHz.)

### Receiving WEFAX Transmissions

To receive WEFAX you need to connect an audio cable from your HF receiver to the audio input of your TNC. The **KPC-4** uses Port 2 and the **KAM** uses the VHF port for receiving WEFAX. You should connect an audio cable from the audio output jack of your HF receiver to the correct audio input pin of the **KPC-4/KAM** to receive the WEFAX signal. With the **KAM** you can connect the audio from your HF receiver to the VHF and HF ports at the same time and use the bargraph tuning indicator to tune your WEFAX station.

For the dual port communicators, you will need to set the MAXUSERS to 0/1 and for the single port units, set MAXUSERS 1 before starting WEFAX reception. Be sure to read the documentation that comes with your WEFAX program to determine how to use it.

All of the programs available from Kantronics will require, that you set MAXUSERS as listed above and each of them will issue the proper WEFAX command to start the reception of the image. The programs will work best at higher ABAUD rates and we suggest 9600 for the PC and Macintosh based programs, and 1200 for the Commodore 64.

## The WEFAX Command

To cause your TNC to enter the WEFAX Mode, you use the WEFAX command. **KPC-4** and **KAM** owners must remember to set MAXUSERS 0/1 before issuing the WEFAX command.

- WEFAX *n*

This command will cause the TNC to sample the audio input at *n* samples per second. The value of *n* is determined by the number of pixels (dots) which can be displayed across one line of your terminal screen in the graphics mode. For instance, if the PC computer you use has 640 dots across the screen and the WEFAX station is transmitting 2 lines per second (120 per minute) you should use an *n* value of 1280. These values keep your TNC in sync with the HF WEFAX transmitting station. If your WEFAX picture skews, adjust the TNC clock by using the command DAYTWEAK. The ABAUD rate of the TNC must be set and PERMed to a value at least 5/4 the WEFAX *n* rate. This gives the terminal program time to display or store each pixel byte and to handle the extra start and stop bits added to the 8 pixel bits/byte (coming at xxxx baud rate). XFLOW may be used with WEFAX. To stop the sampling of WEFAX data and return to Command Mode, simply send a **Ctrl-C** to the TNC.

If you are using the Kantronics MAXFAX or PACFILE program with a PC compatible, you should set the ABUD to 9600 in the TNC and PERM it at that value.

## Suggestions for Writing a WEFAX Terminal Program

Preferences will vary for each WEFAX terminal program writer or user, but the following functions seem appropriate, at a minimum, for enjoyable operation.

### WEFAX Program Functions:

1. Be able to display maps and charts on your computer screen as they are being received (real time).
2. Be able to store them on a disk as they are being received or after you have taken a look.
3. Be able to print the displayed or stored maps or charts.
4. Be able to clear the screen or map storage areas at any time.

What about hardware requirements? First of all, you'll have to have enough computer storage to handle the resolution you want. To save every pixel the HF station sends, you'll need up to 1800 lines, each line being your screen width in pixels (PC 640 pixels or 80 bytes) or 135 kBytes! However, your screen will not show this much. A PC or compatible in graphics mode can display 200 by 640 pixels, so we suggest that you write your program to save, for instance, 600 of 1800 lines at 640 pixels, or 48 kBytes. Then, you'd be saving every third line received and sampling at an incoming bit rate of 1280 (640 by 2, hence the reason for WEFAX 1280). This will also improve the aspect ratio of the saved image, since the pixels on your PC screen are not square and the picture is scanned at a resolution of 96 lines per inch. For the standard Macintosh, the normal screen is 512 pixel wide by 342 pixels high. The screen can therefore display more of a single picture at one time, but the horizontal resolution is slightly less than the PC.

Speed of program execution is important! Generally, interpretive BASIC will be too slow unless you want to limit reception to say one picture at a time. Most advanced BASICs will allow the allocation of up to 32 k of storage in the I/O buffer. Then, as you are displaying incoming WEFAX lines, new data will slowly be accumulating in the buffer. If you don't have your program to do too much, interpretive BASIC can just make it. Compiled BASIC, C or assembly language programs, of course, are faster and more preferable.

## WEFAX

Some considerations for the RS-232 port. When the TNC is set in WEFAX Mode, it will send pixel by pixel bytes to your computer continually until you send it a **Ctrl-C** or turn it off! When in WEFAX Mode, the TNC will do nothing else; it is simply too busy handling all that data. The bytes sent to your computer on the RS-232 receive data line include one start bit, eight pixel bits and one stop bit. The most significant bit is the left-hand bit for your display. In effect then, if you specify WEFAX 1280, the TNC will send you bytes every  $8/1280$  of a second or 160 bytes per second.

Now for printing. We recommend that you use a printer that is Epson graphics compatible with the PC or Commodore. If you write the program and your printer can handle 600+ pixel per line (this is about 60 dots per inch or dpi) and at least 32 lines per inch vertically, then it should be capable of printing WEFAX maps and charts. Note, that six lines per inch of standard text is roughly equivalent to 72 lines per inch of graphics.

What about the structure of your program? We recommend that you include a simple terminal program that would be used to set the basic parameters of your TNC (ABAUD, MAXUSERS etc.). In addition, we recommend that you have a software loop that is interruptible by the arrival of pixel bytes. These bytes would then be stored and/or displayed in the interrupt routine. Once the bytes are processed, the interrupt routine would return to the main loop to await more pixel bytes from the TNC. If you use BASIC, BASICA or compiled BASIC, then ON COM statement is useful. Look in the manual under trapping.

## KISS Mode

The KISS Mode allows the TNC to act as a modem and packet assembler/disassembler (PAD). The heart of the work to be done concerning what happens to data, must reside in your computer in order to use this mode of operation. The KISS code, as designed by Phil Karn, is implemented to support higher level protocols for sharing computer resources in a network fashion.

The most popular program using the KISS Mode of operation is TCP/IP or Transport Control Protocol/Internet Protocol. This program will allow simultaneous file transfers using FTP (File Transfer Protocol), user conversations using TELNET and a Simple Mail Transfer Protocol (SMTP). In addition, multi-connect capability is built into the package, with the data being displayed only for the current "session". You can relate a session to an I/O stream in the normal TNC operating mode.

In the KISS Mode, the TNC simply passes all received data to your computer and the computer program is responsible for all processing of that data, including decisions concerning routing, digitizing and other control decisions. The TNC converts the synchronous data being received from the radio link into asynchronous data to be passed to the computer over the serial port and converts the synchronous data from your computer into the synchronous format suitable for radio transmission. The TNC retains the responsibility for these functions, as well as determining proper timing for channel access.

In the KISS Mode, channel access is determined by two settings in your TNC – namely PERSIST and SLOTTIME. The algorithm used to determine whether or not to transmit using this method has been shown to be considerably more sophisticated than the DWAIT method used by most standard AX.25 Packet stations. The result of using the persistence algorithm is increased throughput under most channel conditions. For our explanation of this algorithm, let's assume a PERSIST setting of 63 and a SLOTTIME setting of 10. This slottime setting corresponds to 100 milliseconds.

When the TNC detects, that the channel is clear and available (no carrier is detected), it starts a timer (SLOTTIME). When the timer expires (100 ms in our case) the TNC generates a random number between 0 and 155. If the generated number is equal to or less than the PERSIST value, the TNC keys up the transmitter and sends the data packet. With our setting of 63 the odds of this occurring after the first slottime are about 1 in 4. (Actually the odds are PERSIST plus 1 divides by 256.) If the TNC generated random number is greater than PERSIST, the TNC restarts the timer and waits for the timer to expire again before generating a new random number. This is repeated until the TNC gains channel access and sends its packet of information.

By carefully examining what happens, we can see that making SLOTTIME smaller will cause the TNC to generate the random number more frequently, whereas raising the PERSIST value will give a better chance (improve the odds) of transmitting the data. Through careful choice of these values, it is possible to improve data throughput while at the same time permitting shared channel usage by other packet users.

Data received from the radio is converted into asynchronous format by the TNC and sent to your computer. The data actually sent over the serial port is formatted with special control information, allowing the TNC to determine the type of data being received from the TNC.

Let's look at data from the TNC to the computer. First, all information flowing in this direction is data. No special messages are sent from the TNC to the computer in KISS Mode. The only data flowing in this direction is that received through the radio link. Every "frame" of data sent from the TNC will begin and end with a special FEND character. This character is the ASCII code \$C0 (hex) or 192 decimal. The second byte of the data will be the data type and will always be at \$00. This means that the following information is data. If the data actually contains the FEND character (\$C0) it will be necessary to tell the computer that the \$C0 it receives is not the end of the frame, but simply is more data. This is accomplished by replacing the \$C0 character with a special sequence consisting of a FESC (\$DB) followed by a TFEND character (\$DC). One final special sequence which could be sent from the TNC to the computer is a FESC (\$DB) followed by TFESC (\$DD). This is translated into \$DB by the computer program.

Now, looking at data flowing in the other direction, that is from the computer to the TNC. There are five possible commands that you may need to issue to the TNC from the computer and they basically concern setup parameters. These are commands needed to set TXDELAY, PERSISTENCE, SLOTTIME, FULLDUP and finally, a command to exit the KISS Mode of operation. The only other data which the computer may send to the TNC in KISS Mode is data which is to be transmitted over the radio (HDLC) channel. The data coming from the computer must also begin and end with the same FEND character as is used for data coming from the TNC. All special character sequences must also be used to send the FEND and FESC characters as data.

Each of the commands is assigned a command type number as follows:

TYPE	FUNCTION
0	Data to be transmitted
1	TXDELAY – second byte contains txdelay in 10 ms increments
2	PERSISTENCE – second byte contains persistence value
3	SLOTTIME – second byte contains slot interval
255	Causes exit from KISS Mode

For example, if I want to set the TXDELAY in my KISS Mode TNC to 100 milliseconds, the computer would send the following bytes to the TNC:

C0 01 0A C0

and to send a data packet saying hello would be:

C0 00 68 65 65 6C6F C0

It is important to note, that this data packet does not contain any addressing information, and therefore cannot be sent via AX.25 protocol. All of the addressing and formatting of the addresses must be done in the computer and sent as a data packet to the TNC.



One final sequence of value (particularly for PC compatible users) is the "Leave KISS Mode" sequence:

C0 FF C0

If for some reason, you have INTERFACE KISS and PERMed, when you turn the unit off and then on again, you will be in KISS Mode. The only way to leave this, would be to perform a hard reset or use the TCP/IP command to leave KISS Mode, or to send the C0 FF C0 sequence from your keyboard. The PC compatibles offer this last opportunity by following this sequence:

Press and HOLD the ALT key. Type the numbers 192 from the numeric KEYPAD – Not the keyboard. Release the ALT key.

Press and HOLD the ALT key. Type the numbers 255 from the numeric KEYPAD – Not the keyboard. Release the ALT key.

Press and HOLD the ALT key. Type the numbers 192 from the numeric KEYPAD – Not the keyboard. Release the ALT key.

Now, if the terminal program you are using, sent all those characters, you will be out of the KISS-Mode. Remember to PERM the INTERFACE command to something besides KISS if you do not want your TNC to be in KISS Mode when you turn the unit off and then back on.

Although not currently implemented in the TCP/IP software, the KAM and KPC-4 are capable of supporting dual-port KISS Mode operation. This is accomplished by using the high nibble (4 bits) of the command byte to indicate, which port to use. A non-zero high nibble, with the low nibble being the previously defined TYPE, will address the KAM HF port or the KPC-4 radio Port 2, while a zero high nibble will address the KAM VHF port or the KPC-4 radio Port 1.

## RTTY and ASCII Modes

**KAM only**

# RTTY Theory

RTTY is a 5 level (5 bit) BAUDOT code, which limits the number of possible characters to 32. This obviously does not provide enough combinations for all 26 letters of the alphabet and the numerals and punctuation. Therefore, in order to allow more combinations, two special characters have been reserved as a FIGURES shift and LETTERS shift. When you first enter the RTTY Mode, the system is in the LETTERS shift, thus allowing normal alphabetic characters to be typed. When you type any numbers or punctuation, the **KAM** automatically inserts a FIGURES shift prior to sending the character. One FIGURES shift is sent prior to the beginning of a string of numbers, but if a space is typed, a new figures shift will be required. You may manually insert a FIGURES shift by typing a **Ctrl-N** or a LETTERS shift by typing a **Ctrl-L**. If this is done, the **KAM** will not insert the FIGURES shift for you, for that sequence of numbers.

The standard mechanical teletype machine always "un-shifted" when it received a space character, thus any numerals or punctuation immediately following a space will require a FIGURES shift to insure, that the receiving machine is in the FIGURES mode. The KAM simulates this un-shifting based on the setting of the USOS command.

When operating in RTTY, standard procedure is to transmit approximately one line of RYs prior to actually typing your message. This allows the receiving station time to properly tune his station and adjust his receiving equipment. This was particularly true with the older mechanical units, but has carried over into today's computer terminal RTTY operation. A typical sequence, then, for calling CQ might look like this:

R Y  
CQ CQ CQ DE WK5M WK5M WK5M  
CQ CQ CQ DE WK5M WK5M WK5M  
CQ CQ CQ DE WK5M WK5M WK5M K K K

The RY has been used for the synchronizing and testing purpose because in the 5 level Baudot code, this represents a complete reversal of the bit pattern, therefore the receiving mechanical machine had to completely reverse all levers all levers and gears within the time frame of one character. It was felt that if the machine could do a complete reversal like this, it could copy any other combination without problem.

RTTY is transmitted using FSK (Frequency Shift Keying) in which two possible conditions for each bit of data are sent as two distinct frequencies. These are called MARK and SPACE, and the difference between these two frequencies is called the SHIFT. Most amateur RTTY is transmitted with a 170 Hz shift, but other common shifts used are 425 Hz and 850 Hz. With FSK, the frequencies are generated by changing the actual carrier frequency of the transmitter. Another method of transmitting RTTY is to generate the tones within a piece of equipment and then modulate the carrier with the tones. This is called AFSK (Audio Frequency Shift Keying). The KAM supports both methods of transmitting RTTY and ASCII signals as well as all three of the standard shifts. In addition, the KAM can use non-standard shifts by selecting MODEM SHIFT and setting your own choice of MARK and SPACE tones.

ASCII is an 8 bit code, allowing 256 possible combinations and thus overcomes the shortcomings of RTTY concerning numbers and punctuation. Because all possible numbers, letters and punctuation can be defined within this set of combinations, no LETTERS or FIGURES shift is required. Transmission of ASCII is accomplished using FSK or AFSK as is done in Baudot RTTY and many of the operational practices have been carried forward from RTTY to ASCII.

## RTTY and ASCII Operation

RTTY and ASCII operation with the **KAM** is accomplished through the HF radio port. Several commands and special directives are used to control the operation of the **KAM** in RTTY or ASCII operation. The following commands (from the **cmd:** prompt) will set the defaults for RTTY and ASCII operation:

ASCBaud	INvert
AUtocr	LCRtty
AUTOStrt	LOWtones
CCitt	MYAUtost
CRAdd	RBaud
DIDdle	USOs
Echo	XMitecho
FSKinv	

Entering the RTTY Mode from the Command Mode is accomplished by typing **RTTY** in response to the **cmd:** prompt. This will place the **KAM** in RTTY operation at the baud rate specified by RBAUD (default 45) and the display would show the message:

**-RTTY 45-**

To enter RTTY at another baud rate, you would use the command **RTTY *n***, where *n* is the desired baud rate.

To enter the ASCII Mode, the same procedure is followed as for RTTY operation, except that the baud rate is specified by the ASCBAUD setting and you type **ASCII** at the **cmd:** prompt setting. The display shows:

**-ASCII 110-**

Once you have entered the RTTY or ASCII Mode of operation, several directives are activated, allowing operation in the selected mode. These directives and their use are:

<b>Ctrl-L</b>	Send LETTERS shift character in RTTY Mode
<b>Ctrl-N</b>	Send FIGURES shift character in RTTY Mode
<b>Ctrl-C S</b>	Change shift (170, 425, 850 or MODEM)
<b>Ctrl-C I</b>	Invert mark and space signals received from radio
<b>Ctrl-C T</b>	Enter transmit mode
<b>Ctrl-C E</b>	Enter receive mode when transmit buffer is empty
<b>Ctrl-C R</b>	Enter receive mode immediately
<b>Ctrl-C X</b>	Leave current mode and return to <b>cmd:</b> prompt (packet)
<b>Ctrl-C <i>n</i></b>	where <i>n</i> is a number (0–9) Changes current baud rate according to the following chart:

<i>n</i>	BAUD RATE	WPM
1	45	60
2	50	67
3	57	75
4	75	100
5	100	132
6	110	147
7	150	200
8	200	267
9	300	400
Ø	rbaud/ascbaud	

Now that you've entered the desired mode (let's assume RTTY), we'll walk through a sample of RTTY operation. The same procedures will apply to ASCII operation. First, let's see how we can call CQ in RTTY. Since we entered the RTTY Mode without any other parameters, we are operating at 45 baud (default and most commonly used) with a 170 Hz shift (again default and most common).

Next, we must place our transmitter into the transmit mode and enter the CQ message. To do this, we first enter a **Ctrl-C T** directive, which places the transmitter in transmit. Then we would type:

RYYRYRYYRYRYYRYRYYRYRYYRYRYYRYRYYRRYRYYRYRYYRYRYYRYRYYRYRYYRYRYY  
CQ CQ CQ DE WK5M WK5M WK5M  
CQ CQ CQ DE WK5M WK5M WK5M  
CQ CQ CQ DE WK5M WK5M WK5M K K K

---

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After we've typed this, we need to return to receive mode, but we want to be sure that the entire message is transmitted (the transmit buffer is empty) so we'll use the **Ctrl-C E** directive.

When the transmitter turns off, we now tune the receiver, looking for a station answering our CQ. Tuning RTTY and ASCII signals is simplified by use of the LED bargraph. While observing this indicator system, tune for an alternate blinking of the end segments of the bargraph. Once the station is tuned in, the terminal will begin to display the characters being received.

When the other station indicates, that it is our turn to transmit, we would again enter the **Ctrl-C T** directive to again begin transmitting. The data we type will now be sent over the air to the receiving station.

At the point we are ready to end the QSO, we simply shut down the transmitter using the **Ctrl-C E** directive and the QSO is ended. We can return to the command prompt (**cmd:**) and thus the Packet Mode of operation by entering the directive **Ctrl-C X**.

Perhaps you would prefer to just monitor RTTY transmissions, looking for someone else who may be calling CQ. After you have entered the RTTY Mode, simply start tuning (you're already in receiving mode). Again tune the receiver slowly until you receive the alternate blinking ends of the bargraph tuning indicator. If you fail to obtain this indication, try selecting a different shift. If you still fail to obtain this indication using the standard shifts, the station may be using non-standard tones which could be decoded by selecting MODEM SHIFT and using the MARK and SPACE commands to set various tones until the tuning indicator gives the proper indication, it is still possible that the signal may be at the wrong baud rate or the signal may be inverted. If the signal is at the incorrect speed (baud rate) you may change your receive speed while receiving by using the **Ctrl-C n** directive. If you think the signal may be inverted, you can invert the received signal by using the **Ctrl-C I** directive. This directive is a toggle type of operation – that is, the first time will invert the signal and a second entry will return the signal to normal.

Now lets examine each of the commands relating to RTTY and ASCII operation to see the effect each will have on these modes.

The ASCBAUD command sets the baud rate to be used when entering the ASCII Mode from the **cmd:** prompt with no speed specified. This setting is also used to set the baud rate when the **Ctrl-C Ø** directive is issued.

AUTOOCR will cause the **KAM** to insert a carriage return sequence after you have entered  $n$  characters without pressing the return key on your keyboard. The **KAM** will count all characters, including FIGURES and LETTERS shift characters. The default setting is 72.

AUTOLF ON causes the **KAM** to insert a line feed after every carriage return which is received from the distance station. If received RTTY or ASCII signal appear double-spaced on your screen, you want to turn this command OFF.

The AUTOSTRT command is useful if you wish to leave your station in the automatic mode, in which you can receive messages from other stations, even when you are not present. With AUTOSTRT ON, a station can cause you to start receiving data by sending the callsign in your MYAUTOST parameter (will accept up to 7 characters allowing for MARS callsigns) prior to sending his message to you. The **KAM** will stop receiving when it receives **NNNN** from the other station, or when there is no signal present for approximately 30 seconds.

The CCITT command controls which RTTY character code will be used in the RTTY Mode. When this command is OFF (the default) the US RTTY code will be used, and when ON, the European code (ITA2) will be used. These two codes differ only on four characters and the differences are shown here:

ITA2	US TTY's
BELL	'
'	BELL
+	"
=	;

A standard operation practice in RTTY is to send a CR CR LF at the end of each line to allow the receiving station time to return the carriage of the mechanical RTTY machine to the far left edge of the paper before sending the next character. This can be accomplished by setting the CRADD command to ON. This causes the **KAM** to send an extra CR after every CR transmitted. This command applies to ASCII and RTTY Modes of operation, as well as AMTOR.

The DIDDLE command will cause the **KAM** to send a special diddle character whenever you are in the transmit mode and no data is being sent. The default for the DIDDLE command is OFF. This is used to allow the receiving station to tune your signal prior to you sending data since it causes both mark and space signals to be transmitted. The standard diddle character in the RTTY Mode is the LTRS shift, and in ASCII a NULL is sent as the diddle character.

The ECHO command allows the TNC to send any character you enter from the keyboard back to your terminal. If you are using a split-screen terminal program, your terminal program may provide this local echo for you and you will then want to turn ECHO OFF. This would then allow what you send to appear in your transmit window and the data you receive, would appear in the receive windows of your terminal. (See XMITECHO for more information.)

The FSKINV command (default OFF) will determine the polarity of the signals sent from the **KAM** to the FSK input of your transceiver. In the OFF state, a MARK is open collector (open circuit) and a SPACE is ground (closed circuit). Since transceiver manufacturers have not implemented a standard for FSK operation, it may be necessary to invert your transmitted signal using this command. You cannot invert the transmitted signal once you are in the RTTY or ASCII Mode, but only by the use of this command prior to entering either of these modes. In order to invert your transmitted signal using AFSK, you will need to use modem shift (see SHIFT command or **Ctrl-C S** directive) and set your MARK and SPACE tones using the MARK and SPACE command.

If INVERT is OFF, the **KAM** will decode RTTY, ASCII and AMTOR signal as sent (i.e. mark is decoded as mark and space is decoded as space). Most RTTY on the HF bands is sent in lower sideband, but if your radio is upper sideband only, you may want to set the INVERT command ON. The decoding of the mark and space signals may be inverted after you've entered the RTTY, ASCII or

AMTOR Mode by using the invert directive (**Ctrl-C I**). (See FSKINV for inverting for inverting signals that you are transmitting.)

The LCRTTY command can be used to send and receive lower case RTTY. When ON, lower case characters may be sent and receive in RTTY and AMTOR Modes of operation. This is accomplished by using the RTTY NULL character as a special shift character. This method is also used in RTTY to send the Russian Cyrillic alphabet. If USOS is ON, a received space will shift to lower case. The distant station will only receive lower case case characters if he also has LCRTTY ON.

The LOWTONES command controls the MARK and SPACE frequencies when using the standard shifts of 170, 425 and 850 Hz. When ON, the European low tones are used, with MARK being 1275 Hz and Space being the MARK frequency plus the selected shift. When this commands is OFF, the standard RTTY tones are used: MARK is 2125 Hz and SPACE is the 2125 plus the selected shift.

The RBAUD command sets the baud rate to be used when entering the RTTY Mode from the **cmd:** prompt with no speed specified. This setting is also used to set the baud rate when the **Ctrl-C Ø** directive is issued.

The USOS command (Un-shift on Space) when ON will cause the **KAM** to switch from figures to letters upon receiving a space character from the other end. If LCRTTY is also on, a received space will switch to lower case characters.

When XMITECHO is turned on, the **KAM** will echo the transmitted characters to your terminal at the time they are actually being transmitted. This can be useful for determining when your transmit buffer is empty and therefore you may return to receive mode. With split screen programs, the echoed data will show up in the receive window as it is echoed from the **KAM**.

## Miscellaneous Information

Typically, in RTTY and ASCII operation, speed of transmission is specified in BAUD rather than words-per-minute. A chart of comparison between these two is provided below:

BAUD	WPM
45	60
50	67
57	75
75	100
100	132
110	147
150	200
200	267
300	400

You may set any desire baud rate, in 1 baud increments, from 20 baud up to a maximum of 500 baud. However, HF operation below 28 MHz is limited to 300 baud.

RTTY and ASCII signals are sent by transmitting two different tones, called MARK and SPACE. The difference between these two signal frequencies is referred to as the SHIFT. Standard shifts employed in amateur RTTY communication are 170 Hz, 425 Hz and 850 Hz. The **KAM** supports all of these shifts as pre-programmed shifts, but also support the selection of any desired shift through the use of the SHIFT command. If this is set to MODEM, the **KAM** will generate the MARK and SPACE tones which are specified by MARK and SPACE commands. This would allow the use of non-standard shifts or non-standard frequency pairs if desired.

Once you have entered either the RTTY or ASCII Mode, the shift may be changed by using the **Ctrl-C S** directive. This will sequentially step through the available shifts – 170, 425, 850 and MODEM. Initially, the **KAM** will enter the RTTY or ASCII Mode using the shift set in the SHIFT command. Pressing the **Ctrl-C S** directive would change the shift and display a message showing the new shift:

**-425 SHIFT-**

## Summary of RTTY/ASCII Directives

<b>Ctrl-L</b>	Send LETTERS shift character
<b>Ctrl-N</b>	Send FIGURES shift character
<b>Ctrl-C S</b>	Change shift (170, 425, 850 or MODEM)
<b>Ctrl-C I</b>	Toggle invert mark and space signals received from radio
<b>Ctrl-C T</b>	Enter transmit mode
<b>Ctrl-C E</b>	Enter receive mode when transmit buffer is empty
<b>Ctrl-C R</b>	Enter receive mode immediately
<b>Ctrl-C X</b>	Leave current mode and return to <b>cmd:</b> prompt (packet)
<b>Ctrl-C <i>n</i></b>	where <i>n</i> is a number (0–9) Changes current baud rate according to the following chart:

<i>n</i>	BAUD RATE	WPM
1	45	60
2	50	67
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4	75	100
5	100	132
6	110	147
7	150	200
8	200	267
9	300	400
Ø	rbaud/ascbaud	



## AMTOR Mode

### KAM only

### AMTOR Theory

Information transmitted by AMTOR is specially encoded to provide a scheme of error detection. This coding takes the form of each character containing 4 SPACE signals and 3 MARK signals. The receiving station can use this 4/3 ratio to determine if the character received is "probably" correct. If the received signal were to arrive with 4 MARK and 3 SPACE signals, the signal is obviously in error and the receiving station could take the appropriate action. The information is transmitted in blocks of 3 characters, that is, the sending station will transmit 3 characters and then pause for an answer from the receiving station. The answer will consist of a single character, indicating that the block just sent was either received OK or that the block should be retransmitted.

AMTOR operation is possible in two basic modes. Mode A operation is a one-on-one mode, enabling the receiving station to request retransmission of any characters received which contain errors. This mode provides a high degree of error immunity due to the handshaking between the two stations involved in the communication. This mode is commonly referred to as ARQ. Mode B operation is similar to RTTY operation, in that the signals are not error-checked by a specific station and no handshaking is performed. Mode B is the mode for calling CQ or other operations where more than one station is intended to receive the communication. Mode B operation is called FEC – Forward Error Correction. In this mode, each character is sent twice, and the receiving stations will check each character for the proper 4/3 ratio. If the first character received is correct, it is printed and the next one ignored. Otherwise, the second character is checked and if it is correct, then it is printed. If neither character was received correctly, then a special character will be displayed on the terminal to replace the invalid character. On the KAM, the default character is a space, but you may choose any character you wish with the MISSCHAR command.

A variation of the Mode B operation is called SELFEC – Selective FEC. In this mode, the sending station would cause a specific receiving station to automatically enter the receive mode and copy the signal – thus is selectively starts the receiver.

AMTOR stations are each identified with a SELCAL – the selective callsign used to identify this station from all others. In most amateur communication, we think of the callsign being used for this purpose, but in AMTOR, the SELCAL is normally composed of the first letter of your call and the last three letters of your call. Thus the SELCAL for KA5ZTX would be KZTX. If your callsign does not contain four letters, the standard practice is to duplicate the first letter of the SELCAL. Thus WK5M would have a SELCAL of WWKM. The SELCAL is used in both the SELFEC and ARQ modes of operation.

With the implementation of the CCIR 625 recommendation for AMTOR operation, the SELCAL may now contain 7 characters. This SELCAL cannot include the characters G, H, J, L, N and W. The reasons for this are contained in the 'Comité Consultatif International des Radiocommunications' "CCIR Recommendation 491-1" which describes a TOR station identity.

The KAM allows you to enter this 7 character SELCAL in two ways. First, you may enter the actual 7 characters you wish to use. Currently, there is no defined standard for selecting your 7 characters. The second option in the KAM is to enter a 9 digit number. The KAM will then calculate the corresponding SELCAL in accordance with 625.

Once you have entered your MYSEL7 and MYSEL4, the KAM will automatically respond to either SELCAL for a mode A (ARQ) QSO, or (if AUTOSTRT is ON) for a SELFEC mode B (FEC) transmission.



If you want to initiate a call to another station using the 625 form of AMTOR, simply use the AMTOR command with appropriate SELCAL:

AMTOR XDBUXAS  
or  
AMTOR 123456789

AMTOR ARQ (Mode A) operation requires that both station transmit alternately. First the information sending station (the station actually sending data) sends three characters. This requires 210 milliseconds. This station then enters the receive mode and listens for the acknowledgment from the information receiving station. The sending station will wait 240 milliseconds for the acknowledge. After this 240 milliseconds delay, the sending station will again enter transmit and send the next (or the same) three characters.

Since both stations are constantly switching from receive to transmit and back again, fast switching times are required for AMTOR ARQ operation. You can adjust TXDAMTOR to allow for the time required for your station to change from receive to transmit, but you should allow a small extra time for the other station to switch from transmit to receive. Regardless of the setting of this parameter, the total turn around time for one AMTOR data/ack cycle remains 450 milliseconds.

## AMTOR Operation

There are three methods of entering AMTOR Mode of operation from the `cmd:` prompt, depending on which mode AMTOR operation you wish to use.

Entering LAMTOR at the `cmd:` prompt will allow you to receive Mode A (ARQ) and Mode B (FEC) AMTOR signals, but this mode does not support transmitting. If you are receiving Mode A AMTOR, you may see repeated characters or miss characters completely, since you are not part of the link. The two stations which are linked may be requesting retransmission (thus you see repeated characters) or they may have received the character and you didn't due to band conditions. In this listen only mode, you may receive characters which do not meet the 4/3 space/mark ratio, or characters which do not properly decode in the AMTOR character set. These will be displayed on your screen as the MISSCHAR which is defined in your `KAM`.

The second method to enter AMTOR operation is to use the FEC command, which places you in the Mode B receive. In this mode you may receive FEC transmissions, and you can enter the transmit mode by issuing the `Ctrl-C T` directive. You can then enter any text you wish sent from the keyboard and return to receive mode with the `Ctrl-C E` directive.

The FEC command is also used to initiate a SELFEC transmission. Entering FEC with a SELCAL (`Fec xxxx[xxx]`) will automatically enter the transmit mode of FEC and send the `xxxx[xxx]` SELCAL to start the designated stations receive system. You would then send your message, returning to receive with the `Ctrl-C E` directive. In order to enable your unit to receive only SELFEC signals, you must turn AUTOSTRT ON. Once you have started receiving, you will stop upon the end of the transmission or upon losing lock with the FEC signal.

To enter the Mode A AMTOR operation you use the AMTOR command. Using the command `AMTOR xxxx[xxx]` (where `xxxx[xxx]` is a selcal) will cause your `KAM` to attempt to establish an ARQ link to the station with SELCAL `xxxx[xxx]`. If you simply enter `AMTOR` you will enter a standby receive mode, in which you will be able to receive FEC transmissions or your unit will respond to an ARQ call. You can enter the FEC transmit mode from this standby condition, enabling you to call CQ by using the `Ctrl-C T` directive. This puts your `KAM` in FEC transmit and any characters you type will now be sent in FEC Mode. After you've entered your CQ message, you can use the `Ctrl-C E` directive, which will return you to the AMTOR standby mode after the transmit buffer is

empty, allowing you to respond to an ARQ call answering your CQ. For instance, to enter AMTOR and call CQ, the sequence would be:

```
cmd: AMTOR
Ctrl-C T
CQ CQ CQ de WK5, WK5M WK5M SELCAL WWKM WWKM WWKM
CQ CQ CQ de WK5, WK5M WK5M SELCAL WWKM WWKM WWKM
CQ CQ CQ de WK5, WK5M WK5M SELCAL WWKM WWKM WWKM
Ctrl-C E
```

If you then receive a call, your transmitter would begin responding automatically to the call and you would be the Slave station (since you did not initiate the link). If the station linked to you using the CCIR 625 format, you will receive a message indicating his selcal. The station that called you is called the Master and is automatically the Information Sending Station (ISS). Any data he types will appear on your screen, and the TNCs handle request for transmission of incorrectly received data automatically. When he is ready to have you transmit data to him, he would enter the changeover sequence, which consists of a **FIGURES shift, +?**. You then become the ISS and the other station is the Information Receiving Station (IRS). You now type your message to the other station and when you are finished and want him to respond, you send the changeover sequence. Since the **KAM** automatically inserts the FIGURES shift for you, all you need to type is the **+?** to perform the changeover.

While you are the IRS, it may at times be necessary to "seize" the link from the other station and become the ISS. In order to do this, while receiving, use the **Ctrl-C T** directive. This will send a special sequence to the other station and cause a changeover to occur.

The **KAM** also supports the WRU (Who aRe yoU) function. This function causes the other station to send a pre-defined string indicating information about his station. In the **KAM**, this information is entered with the WTEXT command. To initiate the WRU function, use the **Ctrl-W** directive while you are the ISS and then the remote station will send his information to you if his TNC also supports this function.

After you've finished your conversation with the other station, you may return to the Command Mode (**cmd:**) by issuing the **Ctrl-C X** directive. This will terminate the link and return you to Packet Mode operation.

## Tuning AMTOR

AMTOR signals are very similar to RTTY signals, in that they are transmitted with MARK and SPACE tones and therefore the bargraph indicator will light both ends of the bargraph when properly tuned in. If the station you are tuning is in Mode A, the bargraph will seem to flash on and off as the station alternately transmits and then receives. Once a station is properly tuned, the LOCK and VAL lights on the **KAM** will light. Once you have this LOCK conditions, the **KAM** will start sending data to your terminal. The VAL light may go out at times, indicating that invalid characters have been received. If you have the station tuned properly, but nothing prints on your screen, you should try the invert function by using the **Ctrl-C I** directive. You can change the shift being used by using the **Ctrl-C S** directive, which will cycle through the available shifts. Most AMTOR is sent with a standard 170 Hertz shift.

## Summary of AMTOR Directives

Ctrl-C E	Return to receive mode when transmit buffer is empty
Ctrl-C I	Invert received MARK/SPACE signals
Ctrl-C R	Return to receive mode immediately
Ctrl-C S	Select next MARK/SPACE shift
Ctrl-C T	Enter transmit mode – seize ISS status
Ctrl-C X	Exit AMTOR Mode back to Command Mode (Packet)
Ctrl-W	Send "who are you" sequence

## NAVTEX / AMTEX Mode

### KAM only

### NAVTEX / AMTEX Theory

NAVTEX transmissions are, in reality, Mode B AMTOR (FEC). What makes NAVTEX unique however, is the actual message format. NAVTEX stations always transmit on 518 kHz LSB and are typically located on the coast lines. The same format is now being used by the American Radio Relay League (ARRL) to transmit their bulletins on a daily basis. These are transmitted during their scheduled teleprinter bulletins.

At the beginning of a NAVTEX (or AMTEX) transmission, the sending station will send a preamble, identifying the station that is transmitting, the type of message and the message sequence number. The preamble would look like this:

**ZCZC AG25**

The ZCZC is always present and the receiving unit sees this as the identification that the identifier is coming next. The components of the identifier, as defined in the NAVTEX documentation are:

B1 B2 B3 B4

B1 is used to identify the station that is transmitting and consists of the letters A through Z. B2 indicates the message class (A through Z). Note that class A, B and D messages must always be printed once. B3 and B4 are the sequence number for the message and will have values from 00 through 99. Messages with sequence number 00 are always printed. When the message number reach 99, they wrap to 01 as the next number.

Currently operating NAVTEX stations are:

Halifax, Nova Scotia	Guam
Boston, MA	Honolulu, HI
New Orleans, LA	Kodiak, AK
Miami, FL	Astoria, OR
San Juan, P.R.	Long Beach, CA
Chesapeake, VA	San Francisco, CA

For NAVTEX messages, the currently assigned message classes are:

A	Navigational warnings
B	Meteorological warnings (storm warnings)
C	Ice reports
D	Search and Rescue Information
E	Meteorological forecasts
F	Pilot message
G	Decca message (Decca is offline since March 2000)
H	LORAN-C message (LORAN-C is offline since September 2010)
I	Omega message (Omega is offline since September 1997)
J	differential Omega message
Z	QRU – no message on hand
K–Y	Reserved

NOTE: K has been proposed for "other electronic navigational aid system message".

Once a message has been received from a particular station with less than a specified amount of errors, it will not be printed again, as the receiving system keeps track of the message numbers it has received. If it then sees the same message class and number from the same transmitting station, it will not output the message to the terminal.

For ARRL AMTEX bulletins, the defined B1 codes are:

A	ARRL issued bulletins
C	CRRL issued bulletins (Canadian)
I	IARU issued bulletins
J	JARL issued bulletins
S	AMSAT issued bulletins
X	Miscellaneous

and the currently assigned message classes are:

A	Emergency bulletins
B	Priority bulletins
D	Reserved
E	DX bulletins
G	General bulletins
K	Keplarian bulletins
P	Propagation forecasts
S	Satellite bulletins
X	Miscellaneous bulletins

## NAVTEX / AMTEX Operation

To enter the NAVTEX/AMTEX mode, you simply type **NAVTEX** from the **cmd:** prompt and press return. At this point you will see nothing on the terminal until a valid NAVTEX message is received.

To exit the NAVTEX mode and return to the **cmd:** prompt, type a **Ctrl-C** followed by the letter **X**. (Do not hold the control key when you type the X.)

Before entering the NAVTEX Mode (while you still have the **cmd:** prompt) you may specify which stations you wish to receive using the NAVSTA command. For instance, if I wish to copy AMTEX bulletins issued by ARRL, but do not want those from other stations (CRRL for example), I would type **NAVSTA A** at the **cmd:** prompt. To monitor all stations, simply type **NAVSTA ALL**.

You may also specify which message classes you wish to receive by using the NAVMSG command. If you want the Satellite bulletins and DX bulletins, you would type **NAVMSG ES** and press return. Note, that if you eliminate message classes A, B, or D from the list of valid message classes, you will receive a WARNING message from the **KAM** since the NAVTEX specification requires that these classes must be printed at least once. To set your system to copy all message classes, type **NAVMSG ALL**.

The NAVERR command is used to specify the percent of errors allowed in a received message before **KAM** considers the message as not being received properly.

In the event you wish to clear the message sequence numbers, allowing all messages to be received again, use the NAVCLR command. If the NAVTEX Mode is used infrequently, it is advisable to clear the numbers, since the transmitting station may have already wrapped sequence numbers back around to those you have stored.

## CW Mode

### KAM only

Several parameters can be set for the default values you would like to use when entering the CW Mode operation. These parameters and their factory default are listed here for your reference:

CWBand 200

CWSpeed 25

CWTone 750

PROsign \$5C

If you want to change any of these, simply type the command name followed by the new value you wish to use for your default (e.g. **CWS 30**). Then you should PERM these changes to save them so the **KAM** will remember them the next time you turn the power on. The **CWBAND** command will set the audio bandwidth (in Hertz) for the CW filtering. The **CWTONE** command sets the center frequency in the **CWBAND** for the audio tone. **CWSPEED** controls the default receive speed used if you enter the CW Mode with no optional speed specified. The **PROSIGN** command defines the character used as a "lead in", to indicate that the next two characters are to be combined as a **PROSIGN**.

To enter the CW operating mode of the **KAM**, type **CW** at the **cmd:** prompt. This will place the **KAM** into receive mode at the default speed. If you desire to enter CW Mode at a different speed, just use the command **CW nn** – where **nn** is the speed (5–99) that you desire. The **KAM** will attempt to lock to the speed of the incoming CW signal, but in order for this to operate quickly, the **KAM** must be set to within 20 WPM of the received signal speed.

After you enter the CW command, your screen will display the current transmit and receive speed:

**-25-25-**

This indicates, that you are set to send and receive at 25 words per minute. Now tune in the station you wish to receive. You should tune SLOWLY and watch the bargraph tuning indicator on the **KAM**. When the station is properly tuned, the bargraph should deflect fully to the right. Tuning will depend on several factors, including receiver stability, internal filtering in your receiver, the **CWBAND** setting of your **KAM** (audio bandwidth) and the speed with which you turn the receiver tuning dial. The most common problem encountered in tuning CW with the **KAM**, is moving the tuning dial too quickly for the **KAM** to indicate full deflection. Once you have tuned to a station, the **KAM** will track the receive speed. You can lock your transmit speed to that of the received signal by entering a **Ctrl-C L** directive (hold the **control key** and press **C**, then release both keys, then type the letter **L**). To unlock the **KAM** transmit speed and allow the **KAM** to further track the incoming signal speed, type a **Ctrl-C U** directive. You may use the **Ctrl-C U** directive at any time to see the current transmit and receive speed.

While in the CW Mode, you may wish to change the speed setting for transmit and receive. This can be accomplished by using the **Ctrl-C n** directive. The chart below shows the **n** selected and the speed which will be used:

<b>n</b>	<b>Speed</b>	<b>n</b>	<b>Speed</b>
1	5 wpm	6	30 wpm
2	10 wpm	7	35 wpm
3	15 wpm	8	40 wpm
4	20 wpm	9	45 wpm
5	25 wpm	0	50 wpm

Once you have selected your desired transmit speed, either by the above **Ctrl-C n** directive, the **CW nn** command, or by locking to a received station with the **Ctrl-C L** command, you can enter the transmit mode by using the **Ctrl-C T** directive. At this point, the transmitter turns on and characters you type from the keyboard are sent over the air at the specified speed. Some split screen terminal programs do not send any data to the **KAM** until you press the return key. Therefore you may have long periods of no data periods of no data actually being transmitted. This has the advantage, however, of allowing you to go back and correct any typing errors you may have made. Many other split screen programs will send your keyboard input directly to the **KAM** and thus, you lose the ability to backspace and correct errors you have made. Still other programs will allow you to change whether the keyboard input is sent immediately or delayed until you press the return or enter key.

A very useful command for non-packet mode operation with the **KAM** is the **XMITECHO** command. When this command is on, the characters you have typed on the keyboard will be echoed to the terminal AS THEY ARE TRANSMITTED. This will allow you to determine if your terminal program is sending your keystrokes immediately to the **KAM** or if it waits until you press the return key. In most cases when operating non-packet modes, you will want to turn ECHO OFF in the **KAM** since split screen programs will display typed characters in the transmit window.

Often in CW operation, you may want to send special PROSIGNS. Several common combinations are available as single keystrokes from the keyboard and are listed below for your reference. For instance, if I wish to transmit the BT symbol, I would simply type an **=** on the keyboard and the **KAM** will send the **BT** for me.

Symbol	Abbreviation	Meaning
+	AR	End of Message
=	BT	Break or Pause
%	AS	Wait
&	KA	Attention
#	SK	End of Transmission
(	KN	Invitation to Transmit
*	AA	All After
!	SN	Attention

In addition to these pre-defined combination, the **KAM** has several user-definable characters which may be programmed to be sent with a single keystroke. Also, the same combination that's sent, can be displayed with a user defined one- or two-character sequence when your **KAM** receives that code combination.

The redefinable codes and default characters used for transmit and receive display are listed here and in the Commands Manual.

MORSE CODE	TX	RX	MORSE CODE	TX	RX
**_--	\$00	\$00	*_*-	\$2A(*)	\$4141(AA)
--*	\$00	\$00	----	\$00	\$00
***_*	\$21(!)	\$534E(SN)	**_**	\$00	\$00
**_*-	\$00	\$00	**_--*	\$00	\$00
*_***	\$25(%)	\$4153(AS)	*_***_	\$00	\$00
*_--*	\$2B(+)	\$4152(AR)	*_--*	\$00	\$00
*_--**	\$00	\$00	*_--*	\$00	\$00
*_---*	\$00	\$00	_**_*	\$2F(/)	\$2F(/)
--**--	\$00	\$00	_**_**	\$00	\$00
--*_--	\$26(&)	\$4B41(KA)	_**_--*	\$28()	\$28()
--*---	\$00	\$00	--**_*	\$00	\$00
--*_-*	\$00	\$00	--*_--	\$00	\$00
---*_*	\$00	\$00	---*_*	\$23(#)	\$534B(SK)
*_***_*	\$00	\$00			

For instance, the code character \*\_\*- in the above chart can be transmitted by typing the \* key on the keyboard and when the KAM receives the code combination \*\_\*- it will display AA. If you want to define any special combination from the above list, you would use the MORSE command. For example, let's say I want to send the code combination ---\*\_\* whenever I press the @ key on my keyboard and when I receive the same combination, I want to display KM. To make this definition, I would use the command:

**MORSE ---\*\_\* 64 7577**

In this example, 64 is the decimal code for the "@" character and 75 is the code for "K" while 77 is the ASCII for "M". The definition could also be entered in hex if desired. An entry may be deleted from the special definition by using the command **Morse (code) 00 0000**.

When you are ready to return to receive mode, you use the directive **Ctrl-C R** or **Ctrl-C E**. These two directives both will return you to receive mode, but they operate slightly differently. The **Ctrl-C R** directive will return you to the receive mode IMMEDIATELY – even if you have data in the transmit buffer which has not yet been sent. On the other hand, the **Ctrl-C E** directive will return you to receive mode after ALL data currently in the transmit buffer has been transmitted.

The final step you need to know about CW operation with the KAM is how to leave the CW Mode and return your TNC to the command prompt. This is accomplished with the **Ctrl-C X** directive.

You can use your KAM to practice CW with most HF transceivers on the market today. Set up your key, keyer or bug connected to your key input of your HF transceiver, and connect the external speaker jack of your transceiver to the KAM. Next, set your transceiver so that when you press the key, it will generate a sidetone signal, allowing you to hear what you are sending. You will want to be sure you are not actually transmitting at this time. Many of the transceivers will allow this by tuning outside the normal amateur bands since they will not allow transmitting out of band. You can turn the RF gain on your receiver down, so you will not hear other stations that may be on the frequency you've chosen. By adjusting the KAM CWTONE command to the frequency of your sidetone, your KAM will copy what you send and display it on your terminal screen, just by entering the CW Mode. After a little practice, you'll find your CW sending skills improving.



You can also use the **KAM** to send CW to you by storing a file on the disk and then connecting the KAM green wire (CW KEY) to your key input of your HF transceiver. Again, set the transceiver so that it will generate sidetone, but will not transmit. Place the **KAM** in the CW Mode, out it in transmit (**Ctrl-C T**) and then upload the file from your disk to the **KAM**.

### Summary of CW Directives

<b>Ctrl-C E</b>	Return to receive when transmit buffer empty
<b>Ctrl-C L</b>	Lock transmit and receive speed to current receive speed
<b>Ctrl-C R</b>	Return to receive mode immediately
<b>Ctrl-C T</b>	Change to transmit mode
<b>Ctrl-C U</b>	Unlock receive speed to allow tracking of incoming signal. Transmit speed stays at current setting
<b>Ctrl-C n</b>	Set transmit and receive speed to setting from chart (above)

The above description is specified to CW operation of the **KAM**. In addition, you should be aware of other settings within your TNC which will affect the overall operation of your computer or terminal and the **KAM**. In particular, review the Asynchronous Commands described in the first section of this manual. For instance, if you have XFLOW ON, then you may use the flow control characters (START and STOP) to control whether or not the **KAM** will send data to your terminal, or simply store the information in its internal RAM memory.