The Amateur Packet Radio Handbook Chapter 2
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There are three basic pieces of equipment which are needed to operate packet. These pieces are (broadly): (1) a radio and the support stuff needed to make it work, (2) a modem, and (3) a terminal.

2.A TERMINALS

A terminal is a device you type on to send messages. It also displays messages which come to you. Terminals come in many forms (and prices).

2.A.1 DUMB TERMINALS: In principle, almost any terminal can be used with a packet modem. Many who do not already have a computer look at dumb terminals or glass teletypes because they can be very inexpensive. So long as they are RS232 ASCII devices, they will work. But using one puts you at a real disadvantage. Once the text has left the screen, it is lost, forever. These devices very rarely have the ability to save incoming text. On the other hand, if your goal is to do packet at an absolute minimum cost, you might find this attractive. If this is the case, do not overlook some of the alternatives mentioned below.

2.A.2 OLDER COMPUTERS: Many older computers can be quite inexpensive and attractive so long as suitable software is available. A few still use Apple IIs (though software is scarce). Commodores, (especially C64s) are quite often used; several modem manufacturers provide software for C64s. You must be careful about using C64s because the serial input/output is "TTL" rather than RS232; either a special adaptor or a modem which accepts TTL is needed. Potential C64 buyers are well advised to avoid "C64+4" machines. These are not compatible with standard C64s and software in nearly nonexistent. TI-99, Commodor VIC-20 & PET, and Apple Lisa computers are also to be avoided.

Older 8086-based IBM-style PCs are available for a few hundred dollars or less. This will not get you a hard-disk or color monitor but you really do not need either of these. You do need at least one RS232 serial port. The '186 and '286 computers are also good but may cost a little more.

2.A.3 MODERN COMPUTERS: Newer computers of all kinds are acceptable. These include '386 & '486 PCs, Macintoshs, and UNIX workstations. There is a variety of software available although seldom written specifically for packet operation. Many people (including the author) have never used packet-specific software and are able to make the packet system do everything for them which anybody else can do. Laptops work well for mobile and portable packet. Palmtops can often work although the key size can make typing difficult. Some data organizers will also work but check very carefully before purchasing one.

See Chapter 18 in Volume 2 for discussion of packet terminal software.

2.B MODEMS

There are several types of modems in common use. But before discussing modems, lets look at what they need to do. Usually, in packet radio, the modem is responsible for managing the message construction, connection, error correction, and mailboxes, to name just a few functions. The modem must also carry out the conventional modem tasks of converting logic signals into a form suitable for radio transmission. To do this, the modem has two parts. One is the classic modem (which, at lower baud rates, uses audio tones). The second part is really a specialized computer which carries out the packet-specific functions.

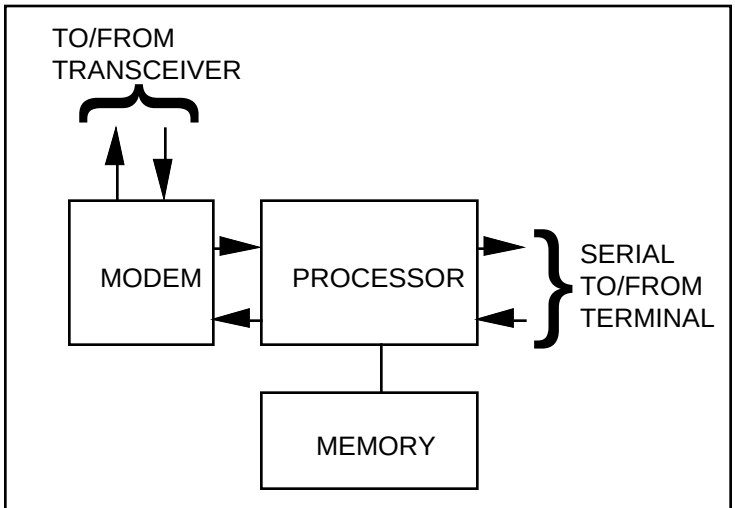

FIGURE 2-1, TNC BLOCK DIAGRAM

To be fair, it should be noted that there are situations in which a computer carries out the packet-specific functions and a true (and simple) modem is used. Several of these are actually quite popular because of very low cost (see DigiCom and BayCom, below).

2.B.1 TNC2's: Of the conventional packet modems, a very common type is the TNC2 clone which is made by several manufacturers. The term TNC stands for terminal node controller. These include the MFJ-1270 and MFJ-1274. There are several made by other manufacturers which are functionally quite similar to the TNC2 types but have different (but similar) commands and capabilities. These include the AEA PK-232s & PK-232MBXs, and Kantronics KPC3s.

2.B.2: MULTIMODE CONTROLLERS: These handle modes such as AMTOR and RTTY in addition to packet. These are of little use unless you plan to operate on HF.

2.B.3: BayCom MODEMS: The BayCom modem is a true modem which relies on an IBM-style computer to carry out the packet related functions. It requires special software to make it operate.

2.B.4: DigiCom MODEMS: Similar to BayCom but specifically for Commodore C64 computers.

2.B.5: THE DATA ENGINE is a relatively new device which is targeted specifically at high speed operation. It can operate with two radios and is particularly well suited for use with bulletin boards and nodes.

2.B.6: CROSS-BAND TNC's: Kantronics makes some specialized TNCs which are particularly designed to operate simultaneously on one HF frequency and one VHF frequency. The form of operation is often referred to as a KaNode. They are frequently available for use by others.

2.B.7: EXPANSION-SLOT PACKET MODEM: These are cards which plug directly into expansion slots in computers (usually PC/clone). Some may act, as far as computer software is concerned, as a serial card.

2.B.8: MODEM-COMPUTER CONNECTION: Along with the modem, you need a cable to connect the modem to your terminal. Most TNCs appear to provide a DB-25 female connector. The other end must match

your terminal, whether it is DB-25, DB-9, DIN, or other. Many TNC manufacturers make available cables for specific computers (usually at extra cost).

A list of packet modems and their manufacturers is included in Chapter 19 of Volume 2.

2.C A NOTE ABOUT MODEM COMMANDS

Not all TNCs use exactly the same commands. The commands which are used in this book are generally the TNC2-clone commands. Where alternative commands are known, they are indicated. In general, a name or description is used with the command. If you look up in your instruction manual using the the descriptive words used here, you should come close. If you do have problems, feel free to contact the author.

2.D RADIOS

Most hams come to packet radio with a radio they use for other purposes. It is a very rare situation where we have the luxury of selecting something specifically for packet. As a result, the most commonly used radios are hand-talkies or mobile radios. But if we know a little about what makes a radio good for packet, better choices can be made when the time comes to get that new(er) radio.

2.D.1: RADIO CHARACTERISTICS: Transmit/ Receive (T/R) switching is a significant factor. Many older radios use mechanical relays for switching. These relays are both slow and rapid to wear out. One of the aspects of packet as compared to voice is the much more frequent change from receive to transmit. Thus, relays tend to fail more quickly. The slow switching time adds to transmitter keyup time. The consequences of this are discussed in section 2.F.

Many of the older synthesized radios take some time to settle in frequency (even in simplex operation) when changing between receive and transmit. This may cause the start of the packet of other stations to be missed, for example. Here, the best advice is experience of other packet operators.

2.D.2: MODEM-RADIO CONNECTION: One of the long standing problems in assembling a packet radio station is connecting the modem to a radio. There is usually some information in the instructions with the

TNC. If the radio is fairly new, there may also be information in its instructions.

Many TNCs, perhaps most, come with a radio cable. When it is supplied, it almost always comes without connectors on the radio end. It is your problem to make that final link. To make the connection, you must determine one crucial piece of information about the radio: how does the transmitter key? To determine this, you need to look at the audio connector(s). If the connector is a multi-pin circular connector (commonly used for speaker-microphones or microphones with telephone keypads or microphones with radio control buttons) determine whether one of the pins is a PTT (push-to-talk) function. If so, the transmitter keying is separate from audio. If the only connector(s) are miniature audio jacks (common on handi-talkies), inspect the microphone jack. If the jack takes a 2-circuit plug (like a stereo plug), then transmitter keying might be separate from audio. If the transmitter keying is not separate from audio, then it is combined with audio (and almost always with transmit audio).

With many TNC's an internal jumper must be added for combined PTT and transmit audio. With others, the PTT and transmit signals must be combined as part of the wiring between the TNC and the radio; in this case it may be necessary to connect transmit audio throught a capacitor and PTT through a resistor to a single terminal of the radio. Check your both radio and TNC instructions for the information about how to do this. If you have purchased your TNC used, verify that this jumper is appropriate for your transmitter.

2.D.3 ANTENNAS: It is not always obvious what antenna arrangement is "best" for packet radio. One general rule is that operation will be much better if you can locate an antenna away from your TNC and terminal. 10-20 feet (3-6 meters) will generally be sufficient unless your computer is particularly noisy.

One of the big arguments concerns non-directional vs directional antennas. Most of if this discussion will be postponed until section 2.E because you may not be able to tell until your station is in actual operation. At this point, it is worth mentioning that part of the choice is determined by the geographical pattern of stations (and nodes) in your area. If you will likely connect directly with stations in a variety of directions, then an non-directional antenna may be best. But if most of your work is likely to be in one direction, a beam may be better. You should not offend anybody if you start with an non-directional antenna.

2.E ASSEMBLING YOUR PACKET STATION

After gathering the basic pieces, there comes a time when you need to go ahead and "do it". This section will suggest a step-by-step process you may be able to use. This assumes that you are not using a TNC in KISS mode; if you want to do so, please try it simpler first! In the following, text you type is *ITALICIZED* .

2.E.1 SETTING UP A TNC & COMPUTER: Now, lets get specific about TNCs and computers.

SETTING UP THE MODEM

Step 1: Connect your terminal to the modem. Few cases require more than a 3-wire RS232 link. Again, see Chapter 20 (Volume 2) for suggestions.

Step 2: Connect the power source to the TNC. Most TNC's require 12V DC. This may come from a wall adaptor provided with the TNC or it may come from the transceiver power. Be VERY CAREFUL that power is connected in the correct polarity or you may destroy the TNC! Leave the power OFF at this point.

Step 3: Turn on the terminal. If it is a computer, start the terminal program. If the program is a conventional terminal emulator, then proceed. If it is a more elaborate program (such as LanLink, TCP/IP, etc) follow the program's instructions. Many of these require configuration files to begin. You may find it easier with a simple "terminal emulator" at the start (see Chapter 18, Volume 2).

Step 4: Configure the terminal serial parameters (except for BayCom or DigiCom). You need to read the TNC's instructions to determine the TNC's default serial parameters. It appears that TNC2 clones default to 1200 baud, even parity, and 7 bit data; you need to set your terminal to the same. You should also try "full duplex". Later, you will be able to find out if the latter choice is correct.

Step 5: Apply power to the TNC. (Ignore for BayCom) The power light, if there is one, should turn on. You should see on the terminal screen a "log-on message". This often gives the manufacturer's name,

the software version, and perhaps some memory information.

Step 6: (Ignore for BayCom or DigiCom) If no message is seen, try pressing the "enter key" several times. A few TNCs require some characters from the terminal to determine the baud rate. If you still do not see anything, retry the power several times. If you still do not see anything, try other combinations of parity and data bits. If you still do not see anything, make certain that the terminal serial output is connected to the modem serial input and that the terminal serial input is connected to the modem serial output.

Step 7: Send a "command mode character" to the TNC from the terminal. For default TNC2 clones, this is "control-C". Check in your TNC instructions for information if control-C (which will be abbreviated "^C" from now on) does not work. With a command mode character, you should see the command mode prompt on the screen. Again for TNC2 clones, this prompt is "cmd:". Once you get this, you are "half-way there".

Step 8: Program the TNC operating parameters. First and foremost is you callsign. For TNC2 clones, you type *MYCALL callsign* where "callsign" is your call. Nodes and other stations will not permit you to connect with the default call which is often "NOCALL" Some TNCs may require you to specify different callsigns for the mailbox and digipeating; see comments about "SSID" later on and check in your area for the standard practice concerning these assignments.

I do not change many of the defaults. What is particularly important at this point is TXDELAY (TNC2 term). To start with, until you know how your radio works, set TXDELAY fairly long. This sets the interval between when the transmitter is told to start and when signal is actually applied. I use TXDELAY 60 which sets 600mS (0.6 seconds). This amount should be fairly good for most medium to slow radios.

You should now have a working computer-TNC combination!

Step 9: (Ignore for BayCom) Set RF baud rate on TNC if it is a HF/VHF unit like TNC2s. Many of these TNCs have a switch which controls the baud rate (and tone combinations) used over the air. This need not be the same as the computer-TNC baud rate. In general, 1200 baud is used on frequencies higher than 10 Meters and 300 baud is used on frequencies below 10 Meters; both are used on 10 Meters.

Step 10: Connect your radio to the TNC. See Chapter 21 (Volume 2) for suggestions.

2.E.2 RADIO SETUP: Once the terminal and TNC are operating, the radio is the next item.

RADIO SETUP

Step 1: Connect a dummy load to your radio. If you don't have a dummy load, set it to lowest output power and use the worst antenna you have. For most of us, this is probably a "rubber duckie".

Step 2: Turn on the radio. It should not immediately transmit. There should be some kind of transmit indicator which tells you whether or not it is being keyed. This may be a light or some other indicator.

Step 3: Set your radio to simplex and tune to one of the packet frequencies. In the U.S., these are generally 144.900 MHz to 145.100 MHz. You will first want to choose a frequency not in general use. It is pretty safe to use an "even" frequency such as 144.92 or 144.94 because the commonly used frequencies are 144.91, 144.93, etc.

Step 4: With the TNC in command mode (from Step 7 of "Modem Setup"), enter a connect command. Since you will not really be connecting to anything, use any call or alphabetic name with 6 or fewer characters. An example might be: *C W7ABC*.

Step 5: You should see the PTT (push-to-talk) indicator on your TNC flash at regular intervals of a few seconds. Likewise, the transmitter must key every time the PTT indicator flashes. If so, you have the transmitter keying line properly connected.

Step 6: After a number of tries, the TNC should stop and you should see a message on the screen which says something like "*** retry count exceeded".

Step 7: Connect your radio to the antenna you expect to use. Select a frequency with packet activity. You can find this by disconnecting the TNC from your radio and listening as you tune from 144.90 to 145.10. On a packet frequency in use, you will hear rather irritating buzzes. Plug

the TNC back into the radio when you find a frequency.

Step 8: The DCD (data carrier detect) indicator on your TNC should flash regularly as packets are received. If not, adjust the volume control on the receiver. If there is still no DCD, you may not have received audio connected properly. Also, make certain that the RF baud rate setting on the TNC fits the situation you are operating.

Step 9: Assuming that the DCD indicator does flash, now try to monitor activity. For TNC2s, the command is *MON ON* ; for AEA TNCs, try "M 9". You should now start to see lines of strange characters appearing on your screen. In the font which will be used from now on to show text which the TNC sends to your terminal, it might look like:

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KA7ZIN-15>N7ICS <RR R F R4>
SALEM>KA7ZIN <RR R F R4>
SALEM>KA7ZIN <RR R F R5>
KA7ZIN-15>N7ICS <I C P S3 R4>:Yeah, tell me about
it.  Well I will let u continue.  73, cul, KA7ZIN
K
```

You may need to adjust the transceiver audio level to get consistent copy by your TNC.

Step 10: You now need to set the deviation for your TNC and transceiver. In a sense, this is the loudness of your signal. Most TNC's have a transmit audio level adjustment. Remove the cover of your TNC and locate this adjustment with the aid of the instruction manual. You will need a small screwdriver (about 1/8" or 3mm blade). To initially make this adjustment, it is very desirable to have the use of another VHF radio. Tune it to the same frequency as you are using. Listen to other signals. Some of them may be weak with "hiss" in the back-ground while others will be fairly clear. Concentrate on the loudness of the clear signals.

Now, in command mode, type *CAL* or the equivalent for your TNC for calibrate. Press *K* to key the transmitter and note the loudness in your other radio. Don't leave your transmitter on any longer than absolutely necessary; press *K* again to turn it off. If your loudness is not similar to the others which you heard, adjust the transmit audio level in the TNC and try it again. When it is adjusted, type *Q* to return to normal operation.

This is a preliminary adjustment. See Chapter 22 (Volume 2) for detailed information about adjustment of deviation. You should now be ready for some on-the-air communication!