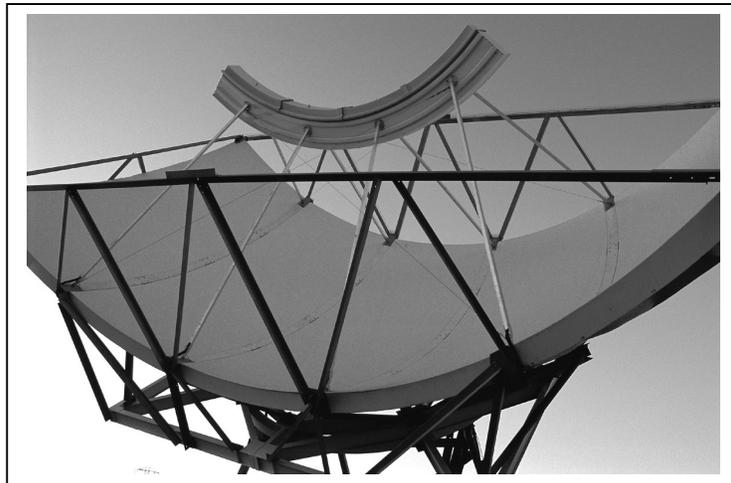


Amateur Radio Emergency Communications Guidebook Part 2 - Technical

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Amateur Radio Emergency Communications Guidebook

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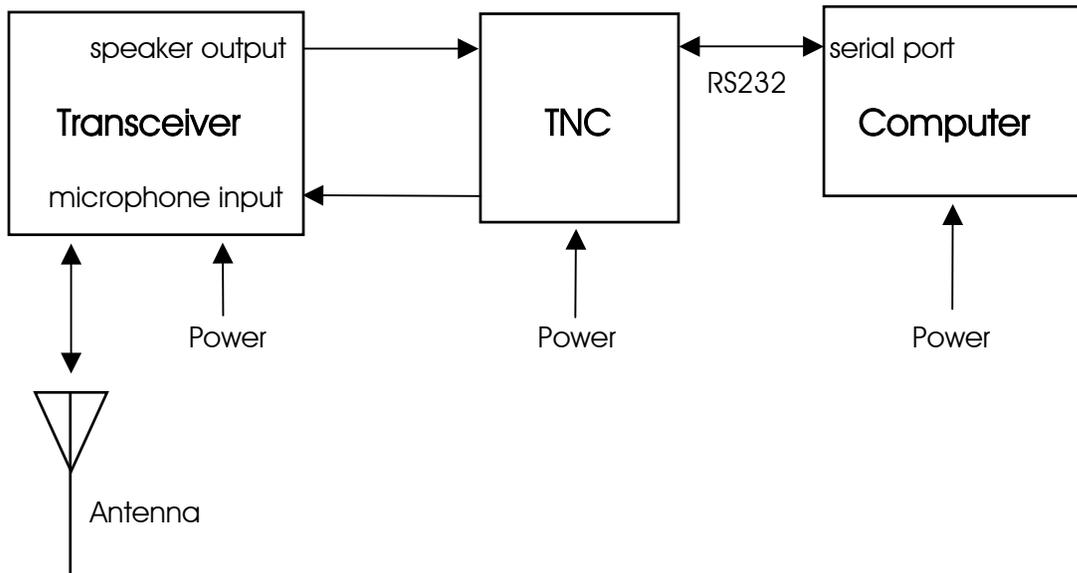
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Packet Radio



Introduction

The equipment needed to get on the air is:

- Radio transceiver (without the microphone).
- Computer or terminal (probably none of the latter exist any longer).
- Terminal node controller (TNC).
- Appropriate interconnection cables.

There is packet activity on HF, but VHF is the best place to begin operating Packet Radio. The Terminal Node Controller (TNC). The TNC contains special firmware especially designed for Packet Radio. This "firmware" converts computer data into "packets" of digital information that can be sent (error free, via Packet Radio nodes) across the Packet Radio network. Some radios, such as the Kenwood TMD700A have a built-in TNC.

Keyboarding with friends over long distances is easy when using a Packet Radio Network. Very little power is needed, as the nodes along the network perform as "Automatic Routing" devices. The nodes do the " Automatic Routing " function automatically. The Packet Radio user only has to establish the connection. The rest is handled by the nodes.

The TNC

A "Terminal Node Controller" (TNC) is similar to the modem used in computers. The TNC is used to interface the terminal or computer into the "RF" or radio (wireless) medium. Inside the TNC most manufacturers have added some internal firmware called a "PAD." The pad or "Packet

assembler/disassembler" captures incoming and out-going data and assembles it into "packets" of data that can be sent to and from a data radio or transceiver.

The PAD also enables the Push-To-Talk (PTT) circuits of the radio transceiver. When the enter key of the computer keyboard is pressed, the typed in data is sent out over the air to the target station or a nearby "store-and-forward" device known as a "node."

Incoming (received) data from the transceiver is also converted within the PAD, from Packets of data into a stream of usable data and sent to the TNC/modem. The data stream is then sent to the serial comport of the computer for display on the screen, or manipulated by a resident terminal program into on-screen text, pictures, or save-to-disk processing.

Usually an RS232 DB25 male to DB9 female cable is used to connect the TNC to the computer. The RS232 cable can be purchased. The TNC can connect to the radio either via the microphone connector or a separate data connector, which is usually a DIN connector. The microphone or data connector usually must be wired according to the manufacturers specifications.

There are TNC's and there are TNC's. A low cost TNC will work fine. However, you will need to put many control codes into it or use a software program that can add these codes. The more expensive TNC's have many control codes built-in. With built-in control codes, you can use simple software programs like "hyper Terminal," which is free with windows. In my station, I'm using the Kantronics KPC3 Plus and Hyper Terminal.

Transmit Level Adjustment

The transceiver drive should be about 3 to 3.5 kHz. of deviation. This can be measured using a deviation meter if available. If not, check the manual of the transceiver for the packet audio input voltage (for the ICOM 207H it is 400 mV). Next, check the manual of the TNC for the procedure to adjust the output audio voltage of the TNC. If the appropriate equipment is not available, some trial and error may work.

Antenna Height

If your attempting to work direct over long distances, without the use of a FlexNet Digi (Node) or a BBS, no antenna can be big enough nor high enough !

Using a well located Node or BBS is similar to voice operation through a repeater, wherein a handi talkie and rubber duck antenna is often sufficient.

Software

A terminal program is needed to control the data going to and from the TNC and radio. Software can range from a simple DOS or Windows program to more sophisticated software that has logging and other functions. Some manufacturers include software with their TNC's.

There are two communication speeds that are used in Packet Radio 1200 Baud or 9600 Baud. Set the computer serial port to the speed of the computer serial port, usually 9600 Baud. Set the packet

system speed to 1200 or 9600 Baud. ABAUD refers to the computer to TNC (serial port), and HBAUD refers to the RADIO or ON-AIR Baud rate (data speed).

There are a number of packet software packages available costing close to \$100. Personally, I don't like any of the ones I have tried. I like and use the "Hyper Terminal" program that is supplied with Microsoft Windows. Set Hyper Terminal for the com port you are using, which is usually COM1, the speed at which the com port works, which is usually 9600 bps, Data bits = 8, Parity = none, Stop bits = 1. After you complete the settings, save them as "Packet."

For those that prefer a more "user friendly" packet terminal for older PC's, DOS based "paKet" is excellent. Windows based WinPack (know in Europe as TPK) is also good. Any of these "shell" programs do greatly simplify the TNC commands that are detailed in the following paragraphs. They also enable you to multistream, such as remain connected to a DX Cluster while you check your mail and hold a keyboard to keyboard conversation with a friend!

Packet Operation

Switch the transceiver ON and turn the volume up a quarter turn or just above the "9:00 o'clock position." Make sure the squelch is not set too tight. The squelch should be set to a position where the transceiver is quiet. The squelch is set in a similar manner that you would use for voice operation. When first turned on, the TNC you may display garbled text on the screen. This is usually because the terminal to TNC baud rate is not set to the same parameters. Some TNC's will do a "search" mode to find the proper settings.

Perform a "control C" [**Ctrl C**] (press Ctrl and the letter C at the same time) to place the TNC into the command (cmd:) mode. This is where all commands are made to and from the TNC. Any command that is typed while in the "cmd: mode is received by the TNC as a direct order. These codes can vary with TNC's.

Once in the command mode, press the [Enter] key. Each time the [Enter] key is pressed a "cmd:" prompt should appear on the screen. This is an indication that the computer has control (command) of the TNC.

All commands must be followed by the [Enter] key.

The next step will be to set the station call sign into the TNC. At the cmd: prompt, type:

MY (*your call sign*)

Test the TNC to see if the station call sign is set into the TNC. To do so, type:

MY

The screen should display a response from the TNC with:

MYCALL (*your call sign*)

MYCALL NOCALL indicates that a call sign has never been set, or the internal memory battery has been disconnected or is dead.

To enter your call sign type:

MY (*your call sign*)

The TNC should respond with:
MYCALL (*your call sign*)

This indicates that the computer and TNC are communicating properly. If there is no response after typing MY, then try typing:

ECHO ON

The :cmd: should appear on the screen again, with a message similar to the following:
ECHO was OFF

If the computer is displaying double letters, (for example; MMY CCAALLL), this indicates that the ECHO command should be turned OFF. Type the following:

ECHO OFF

The TNC should respond with:
ECHO was ON

Below are some commands that should be made active:

ECHO ON (normal) or ECHO OFF (if double letters are displayed)

MONITOR ON

MCOM ON

MCON OFF (to display only packets addressed to you) or MCON ON (to display all packets)

MRPT ON

If the RS-232 interface cable is wired using the RTS, CTS, Txd, Rxd, and Signal Ground leads, then set the XFLO command OFF. If the RTS, and CTS signals were not used, then make sure the XFLO command is ON.

Note: TNC's have 3 modes of operation: Command, Converse and Transparent. You must remain aware of which mode the TNC is in at any current moment!

Command Mode

In the COMMAND mode, the TNC will interpret data received from the keyboard as a command to process data, not as data to transmit.

When you are in the command mode, the screen will display:
cmd:

Brief list of NEWUSER commands:

CONMODE CONVERS (TNC will automatically be placed into CONVERS mode after connection is established)

CONMODE TRANS (TNC will automatically be placed into TRANS mode)

CONNECT or **C** (connects to another station)

CONVERS (to enter convers mode)

DAYTIME (to read the time and date)

DAYTIME yymmddhhmm[ss] (to enter the time and date)

DIGIPEAT ON (turns digipeat on)

DIGIPEAT OFF (turns digipeat off)

DISCONNECT or **D** (disconnect from another station)

DWAIT n (n=0-255) (10 times n in milliseconds) (delay used to avoid collisions between digipeated packets)

ECHO ON (character received from the keyboard are echoed back to the screen)
ECHO OFF
HELP (for most TNC's will generate a list of commands)
INTERFACE NEWUSER (for most TNC's will enter standard terminal mode with a limited command set)
INTERFACE TERMINAL (for most TNC's will enter terminal mode with full command set)
MCOM ON (monitors all packets being transmitted)
MCOM OFF
MCON ON (will display all packets received)
MCON OFF (will display only packets addressed to you)
MHEARD SHORT (short list of stations heard * indicates digipeating)
MHEARD LONG (long list of stations heard)
MHEARD CLEAR (clear the list of stations heard)
MONITOR ON (unconnected packets will be seen. Also acts as a master control for MALL, MCOM, MCON, MRESP, MRPT)
MONITOR OFF
MRESP ON (monitors packets including AX.25)
MRESP OFF
MRPT ON (entire digipeat list is displayed)
MRPT OFF
MYALIAS xxxxxx-n (n= 0-15) (sets TNC to an alias call sign for digipeating)
MYCALL xxxxxx-n (n=0-15) (sets TNC for you call with the optional supplementation Station Identifier (SSID))
NOMODE ON (TNC does not change modes after a connection is established)
NOMODE OFF (TNC will change to whatever mode is established in CONMODE after a connection is established)
TXDELAY n (n=0-255) (delays transmit to give your radio enough time to reach full power, set delay to 10 times n in milliseconds) (300 ms is commonly used)
UNPROTO CALL VIA W2ABC,W2CDF,W2EFG (max 8 call signs)

Convers (Conversation) Mode

In the CONVERS mode, the TNC will interpret data received from the keyboard as data to be transmitted. Most TNC's will automatically switch to the CONVERS mode after a connection has been established. When you are in the COMMAND mode, you can switch to the CONVERS mode by giving the command:

CONVERS or **K**

If you are in CONVERS mode and want to switch to COMMAND mode, type:

[Ctrl] C

Trans (Transparent) Mode

A second method for transmitting data, called TRANS mode, is to instruct the TNC to ignore "control characters," such as "backspace," and transmit every character as data. For many TNC's TRANS mode is a TERMINAL mode not a NEWUSER mode.

If you are in TRANS mode and want to switch to COMMAND mode, type:

[Ctrl] C three times with a pause of less than second between entries

Monitoring or Calling CQ

If you turn the MONITOR command on, you will see other packet stations on your screen. You will see two call signs at the beginning of each packet separated by a ">" The first station is the station that is sending the packet. The second is the station receiving the packet.

To call CQ, you must be in the CONVERS mode, so that the data received from the keyboard will be interpreted as data to be transmitted.

To enter the CONVERS mode, type:
CONVERS or **K**

Anything you type at this point, will be transmitted.

Example:
W2XYZ CQ CQ CQ

If a station wants to connect to you, they will type the **CONNECT W2XYZ** command

To return to the COMMAND mode, type:
[Ctrl] C

Packet Direct

The most common frequency for packet communications is 145.010 mhz at 1200 Baud.

Begin in the command mode:
[Ctrl] C

Enter your call sign into the TNC
MY (*your call sign*)

Test that the TNC has received your call sign:
MY

The screen should display a response from the TNC with:
MYCALL (*your call sign*)

To connect directly to W2XYZ, assuming you both have a direct path:
CONNECT W2XYZ or **C W2XYZ**

If the TNC receives an acknowledgement of connection it will display:
***** CONNECTED TO W2XYZ**

Once connected, the TNC should automatically switch to conversation mode (CONVERS). You can type in text, then press enter to send. You should automatically receive text from the station you are connected to.

When you have completed your conversation, you need to get back to COMMAND mode to sign off.

To get back to COMMAND mode, type:
[Ctrl] C

To disconnect, type:
DISCONNECT or **D**

The TNC should respond with:
***** DISCONNECTED**

Digipeating

The original implementation of Amateur Packet Radio 20 years ago was through the use of Digipeaters. The concept being that each and every station would enable their "Digi" as a shared resource, and users could step their way employing intermediate Digi's to reach a friend beyond the range of either of their own stations.

While this method has been surpassed by intelligent network "nodes", it still has merit for emergency communications purposes. Amateurs should still learn how to use the "digi" function within their TNC's.

Every Amateur Packet Radio station can be a Digipeater by simply turning on the Digipeat command, which is:
DIGIPEAT ON

A station that turns on digipeating will retransmit any packet that is received that contains the MYCALL or MYALIAS in the digipeat list of address.

Example:
Sending station is KB2SEN and receiving station is KB2REC.
Stations KB2A, KB2B, and KB2C all have digipeat turned on.

The geographical layout of the stations is KB2A, KB2B, and KB2C. In order for KB2SEN to be able to reach KB2REC, KB2SEN has to transmit to KB2A, then KB2A has to transmit to KB2B, then KB2B has to transmit to KB2C.

The connect command for KB2SEN to connect to KB2REC would be as follows.
C KB2REC VIA KB2A,KB2B,KB2C or **C KB2REC V KB2A,KB2B,KB2C**

The return path for KB2REC to KB2SEN is automatic. Once the connection is made, KB2REC only has to type the reply and press enter to send a packet back to KB2SEN. KB2REC's TNC will reverse the path back to KB2SEN.

Note: Due to Packet Radios structure no more than 8 digits can be used.

When you have completed your conversation, you need to get back to COMMAND mode to sign off.

To get back to COMMAND mode, type:
[Ctrl] C

To disconnect, type:
DISCONNECT or **D**

The TNC should respond with:
*** DISCONNECTED

Network NODES

"Nodes" are a vast improvement to the original "digi" scheme. They have gone through many evolutions, starting with the original NETROM, to it's clones TheNET, G8BPQ and MSYS, and finally onto a newer networking protocol called FlexNet. All nodes on Long Island, and most in the surrounding area, now employ the newer faster intelligent FlexNet protocol. Other networking protocols such as ROSE and FPAC never existed in our local area, while use of TCP/IP has faded greatly.

Note, while NETROM and it's clones called a Network Node simply a "NODE" FlexNet, which was developed in Germany called them "DIGI's" based upon the German name for a "Digital Repeater". A "FlexNet DIGI" is what we call a "NODE", not the "digi" described in the digipeating section.

Many packet radio "NODES" connected to the worldwide network exist Long Island:

WA2PNU (144.990 MHz, at 1200 Baud, Huntington)
(M or C WA2PNU-4 for BBS)

WB2CIK (145.07 MHz, at 1200 Baud, West Hills)
(M or C WA2PNU-4 for BBS)
(C WB2CIK-14 for DX Cluster)

NY2LI-8 (145.03 MHz, at 1200 Baud, Hauppauge)

NY2LI (145.05 MHz, at 1200 Baud, Yaphank)

N2NEI (145.07 MHz, at 1200 Baud, Southampton)
(M or C N2NEI-4 for BBS)

K1IMD-2 (144.99 MHz, at 1200 baud, Jamesport)
(M or C N2NEI-4 for BBS)

KC2COJ (145.05 MHz, at 1200 baud, Far Rockaway)
(M OR C KC2COJ-4 for BBS)
(C KC2COJ-1 for TCP/IP Router)

NY2S (145.09 MHz, at 1200 baud, Lynbrook)
(M or C NY2S-4 for BBS)

Frequencies from 144.91 to 145.09 MHz on 2 M, and 441.00 to 441.10 MHz on 70 CM bands are set aside for packet use. There is some additional activity in the 145.59 to 145.69 MHz segment too.

Long Island FlexNet Site Information

This 10 Port FlexNet 3.3g Digi is located in West Hills, LI, NY, USA

The FlexNet runs on a 66 MHz 486DX with 9 RS-232 Ports. Each port in turn interfaces with a TNC running 6PACK firmware, thus off-loading some of the AX-25 protocol burden from the main computer.

The following Servers are immediately available:

Bulletin Board: WA2PNU-4 DX Cluster: WB2CIK-14

SysOp is John C Papson, WB2CIK @ WA2PNU.#NLI.NY.USA.NA

Updated Northeastern USA FlexNet info can be found at www.northeastflexnet.org

Port	Baud	Frequency	Function
0	1200	145.07	User access at 1200 baud
1	9600	145.59	User access at 9600 baud
2	19200	434.95	Link to Valhalla NY & Alpine NJ
3	9600	420.85/421.175	Link to Far Rockaway NY
4	9600	428.875	Link to Putnam NY
5	9600	421.95	Link to Orange CT
7	1200	50.73	Link to Jamesport NY & Yaphank NY
8	1200	223.54	Link to Huntington NY & Hauppauge NY
9	1200	441.075	User access at 1200 baud & BBS forwarding
10	9600	null-modem	Link to DX Cluster computer

This site has long-term emergency power.

Connecting through a Node

1) To connect to W2XYZ thru node WA2PNU, assuming both stations are listening to WA2PNU node:

C W2XYZ V WA2PNU

2) To connect to W2XYZ thru node NY2LI, assuming your listening to WA2PNU node and W2XYZ is listening to NY2LI node:

C W2XYZ V WA2PNU NY2LI

3) To connect to W2XYZ thru distant node K2JFK (Clay NY), assuming your listening to WA2PNU and W2XYZ is in Clay NY listening to node K2JFK:

C W2XYZ V WA2PNU K2JFK

4) Above examples are from a disconnected state. You can connect first to your local node, C WA2PNU, and then the WA2PNU call can be deleted from the previous examples, such as:

1) **C W2XYZ**

2) **C W2XYZ V NY2LI**

3) **C W2XYZ V K2JFK**

5) To find out what node W2XYZ is monitoring, on an ARRL section by section basis, you connect to any node within that section, and then do a "find".

Example:

F W2XYZ

6) "A" command on any FlexNet will give a manually built list of nodes with geographic locations. Some sites have newer updates than others. "D" gives the machine made <D>estination

list, showing callsigns, SSID range, and "round trip times" of other nodes. The D list will always be up to date! Nodes with RTT's under 1000 should be easily connected to, over about 1000 means the path may be dropping out due to propagation conditions.

Example (with your radio set to 145.07 MHz):

C WB2CIK

*** CONNECTED to WB2CIK

PC/FlexNet V3.3g West Hills, LI, NY, USA

1200 baud 145.07 9600 baud 145.59

SysOp John C Papson WB2CIK @ WA2PNU

"C WB2CIK-15" to reach me at home keyboard

<C>onnect <D>estinations <F>ind <H>elp <I>nfo <MH>eard <P>orts <Q>uit <U>ers

<A> for Callsign vs Location Table <M>ail will connect to the nearest BBS

Disconnecting from a node

Q for <Q>uit on FlexNet nodes, remember command is **B** for ye on FBB BBS's!

Bulletin Board Servers

Bulletin Boards are a "Store and Forward" device. Once you post your message or bulletin, the server stores it and then passes it on to the neighboring BBS's.

Typically, Personal messages and NTS traffic are forwarded instantly, wherein Bulletins may be delayed until off peak hours as not the tie up the network.

Connecting to a BBS

BBS's usually are co-located with a Node. But not all Nodes have a BBS.

The nodes usually have the path to a BBS programmed in. The **M** command will connect you to the BBS (<M>ailbox).

Users can either connect to their nearest Node, and then connect onward to the BBS, or just connect directly to the BBS itself.

Example:

Starting on 144.99 MHz, **C WA2PNU**, then **M**.

Or starting on 144.99 MHz, just **C WA2PNU-4**

Starting on 145.07 MHz, **C WB2CIK**, and then **M**, will also connect you to WA2PNU-4 BBS!

Example:

C WB2CIK

*** CONNECTED to WB2CIK

PC/FlexNet V3.3g West Hills, LI, NY, USA

1200 baud 145.07 9600 baud 145.59

SysOp John C Papson WB2CIK @ WA2PNU

"C WB2CIK-15" to reach me at home keyboard

<C>onnect <D>estinations <F>ind <H>elp <I>nfo <MH>eard <P>orts <Q>uit <U>ers

<A> for Callsign vs Location Table <M>ail will connect to the nearest BBS

M (command is short for <M>ailbox)

link setup...

*** connected to WA2PNU-4

[FBB-7.00g-AB1FHMRX\$]

WA2PNU BBS, QTH FN30HU.

Hello John, you are now on channel 1.

Here are 864 active messages, 229214 is last message and 228445 is the last you have listed.

Assigned channels:

Ch. 1 (FLEX) : WB2LUA-0 - MSP WB2CIK

on 01/04/02 10:43

via : WA2PNU-0 WB2CIK-2

Ch. 2 (FLEX) : KB2VLX-4 - Mon 01/04/02 10:42

via : WA2PNU-0

(2) WA2PNU BBS (H for help) >

Abbreviated list of available FBB BBS commands:

A Abort - Abort listing.

B Bye - Log off the BBS.

H Help - Help.

K Kill - Kill messages.

L List - List messages.

M Make - Copy a message to a file.

N Name - Change your name.

NQ Your Home QTH, "City, ST"

NZ Zip - State your zip-code.

NH homeBBS - Type your home-BBS.

O Option - Select options (paging, language, list/read personal etc).

ON 123 will set the three most significant digits to 123, so you can read messages by only using the last 3 digits.

R Read - Read messages.

S Send - Send messages.

X Expert - Shortens the command prompt line

Supplemental Identifier (SSID)

By adding -0 to -15 after your call sign, the operator can use their call sign 16 times.

Types of messages

There are three basic types of messages, Personal (P), Bulletin (B), and NTS Traffic (T).

Personal messages are from one user to a second user, while Bulletins are from one user to a group of users in a designated area.

The difference being that (P) messages route only to the intended recipients home BBS while (B) bulletins flood every BBS in the designated area.

Example:

A bulletin may be sent to TRIBBS, NEBBS, NYBBS, CTBBS, USBBS or WW, meaning respectively the Tri-State Metro area, New England BBS's, New York BBS's, Connecticut BBS's, BBS's throughout the USA, or BBS's throughout the entire World.

NTS traffic is third party mail, forwarded via Postal ZIP codes. It is routed to the nearest BBS's to the third parties street address.

Listing messages

The following commands are used to list messages

L lists every message on the BBS, back to the marker of the previous last message you listed. Beware that this command will list the last couple weeks or more of messages (think in terms of several thousand) the first time you long on to a BBS as a new first time user.

LL ## lists the last ## number of messages. Again this command will list (P), (B) and (T) messages.

LM Will list (P) messages only addressed to you

LB will list only (B) bulletins

LT will list only (T) NTS traffic

LS (subject) will list messages containing the subject in message title

Example:

LS DX will list very message with "DX" in the title.

Receiving a Message

R ### where ### is the message number will give you the text of that message, be it (P) (B) or (T).

With (P) mail, it is polite to kill any message you have received and read with either the **K ###** or **KM** commands.

K ### will kill one message, as specified by the number ###

KM will kill all messages addressed to you.

In the case of NTS traffic, once you have delivered the message, it is proper to log back onto the BBS and kill that message.

Receiving Private Mail

RP (Receive Private) or **R ###**, where ### is the message number

KM (Kill Message) to delete the current message

To Send a Reply:

SR (Send Reply) or **SR ###**, where ### is the message number

Sending Private Mail

SP K2HAM (Send Private)

Routing (from WP) to K2JFK.#CNY.NY.USA.NOAM.

{White Paper (WP) server transparently learns users home BBS address's from traffic passing through each BBS, and in turn automatically shares this information between BBS's}

Enter the title for this message to K2HAM

Text Message

Enter the text for the message, end with Ctrl-Z or /EX on a blank line)

Hello test, 1 2 3 4 5 6 7 8 9 10

73 de Jose

/ex {Always end with /EX on a new line}

Mid: 32607_WA2PNU Size: 85 bytes

WA2PNU BBS (H for help) >

An (P) mail address must follow this format:

K2HAM@K2JFK.#CNY.NY.USA.NOAM

^ addresses call sign

^ addresses home BBS

^ supplemental geographic info (often ARRL Section)

^ State

^ Country

^ Continent

Sending a Bulletin

SB RACES @ TRIBBS (Send Bulletin)

(this bulletin will flood all the BBS's in the Tri State area)

Enter the title for this bulletin:

Monday Nights Test Message

Enter the text for the message, end with Ctrl-Z or /EX on a blank line)

Hello test, 1 2 3 4 5 6 7 8 9 10 from the EOC in Huntington, LI, NY.

73 de Jose, RACES Officer, Huntington

/ex {Always end with /EX on a new line}

Mid: 32607_WA2PNU Size: 185 bytes

WA2PNU BBS (H for help) >

Sending NTS TRAFFIC

When the message is ready to be entered into your local BBS, you must use the **ST** command, which means "Send Traffic", followed by the zip code of the destination city, then @ NTS followed by the two letter state abbreviation. The form used is:

ST ZIPCODE @ NTSxx (send NTS traffic)

Example:

A message being sent to Boston, MA 02109 would be entered as follows:

ST 02109 @ NTSMA

Enter the title for this bulletin:

Test Message

Enter the text for the message, end with Ctrl-Z or /EX on a blank line)

Hello test, 1 2 3 4 5 6 7 8 9 10 from the EOC in Huntington, LI, NY.

73 de Jose, RACES Officer, Huntington

/ex {Always end with /EX on a new line}

Mid: 32607_WA2PNU Size: 185 bytes

WA2PNU BBS (H for help) >

To Send a Reply:

SR (Send Reply) or **SR ###**, where ### is the message number

Disconnecting from the BBS

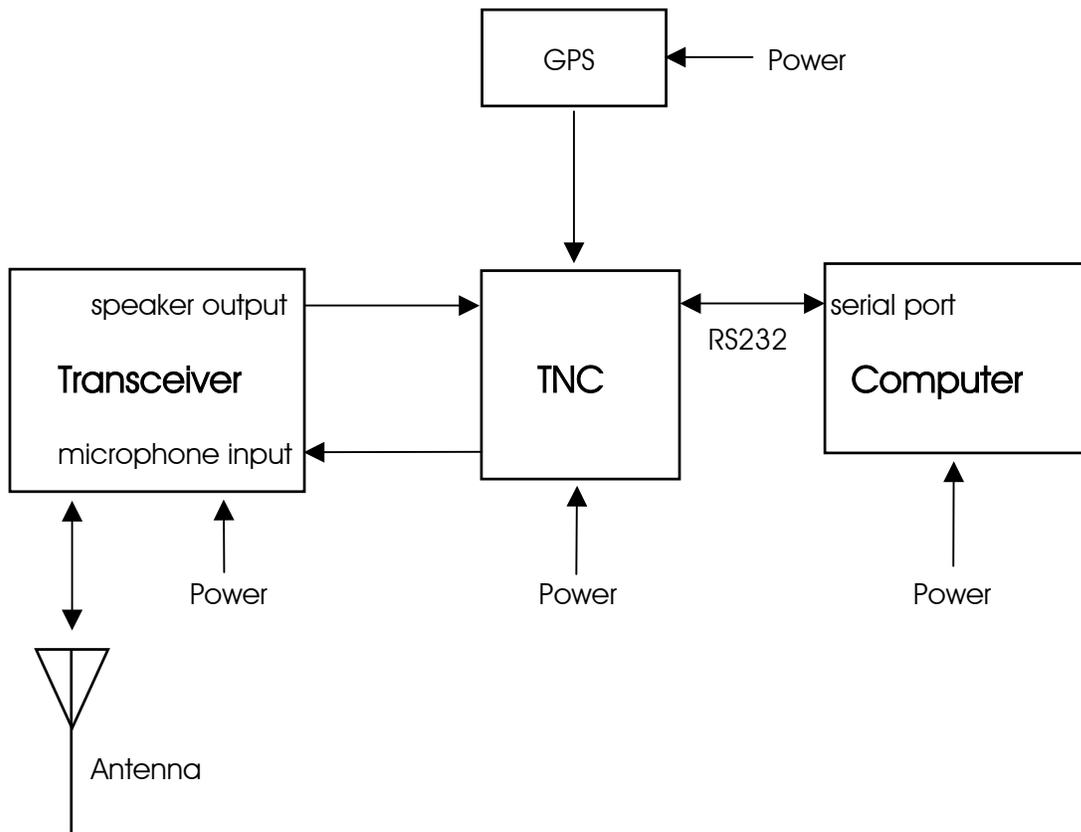
B for ye on FBB BBS's, remember command is **Q** for <Q>uit on FlexNet Nodes!

You have been connected 5mn 14s - Computer-time: 9s

Bye, John, and welcome back.

*** reconnected to WB2CIK

APRS: Automatic Position Reporting System



Automatic Position Reporting System (APRS) is a packet radio system used for tracking objects, people, vehicles, boats, aircraft, manned/unmanned balloons, weather systems, etc. APRS uses an Amateur Radio mode called unconnected (U) packets.

APRS was developed by Bob Bruninga WB4APR, and was first introduced to the Amateur Radio Community at the ARRL Computer Networking Conference in New Jersey in 1992. Over the past 10 years APRS usage has grown and expanded across the globe. Many new features and capabilities have been added since its inception. Worldwide, there are over 4000 stations on the map at any one time. There are a number of software programs that can be used to identify and track APRS stations (beacons). I like IU-View32, which works with Street Atlas maps and is very inexpensive. APRS beacons can also be tracked via the internet at www.findu.com.

Basically, APRS is a packet system with the addition of a GPS (global positioning system) receiver. Many TNC's have GPS receiver inputs. There are stand alone GPS devices, which have map displays and tracker GPS units, which do not have map displays and are less expensive. GPS coordinates can also be manually entered into an APRS system. This is often done with fixed station operation. Weather stations can be interfaced with APRS to report live and up to date weather information over an APRS network.

There are several vhf radios and handi talkies that have built in TNC's and GPS receiver inputs. These type of radios allow you to automatically transmit an APRS beacon and use voice mode without changing any settings.

The universal frequency used for APRS is 144.390 MHz.

During emergencies, APRS can be very valuable. APRS can be monitored at an emergency operations center to track emergency response teams, mobiles, etc. Responders in the field can also see their own location.

QRM is a major concern in packet and APRS. It is important to use the minimum number of hops to get your message through. If you are a home station and know the digipeaters in your area, then program a specific path. For example: K2ABC, K2ABCD. Home stations should not usually use more than RELAY,WIDE. Mobile packet stations have about half the range than voice mode.

If you are a mobile, you should not need more than 2 to 3 hops. Mobiles usually use the path RELAY,WIDE because they may be out of range of a WIDE digipeater, but be near someone's home station acting as a RELAY. Wider ranges can be achieved by using the RELAY,WIDE,WIDE path.

In 1994, the WIDEn-n capability was incorporated in the Kantronics TNC's. The WIDE-n-n digipeater repeats any packet with the address of WIDEn-n, but only once. It keeps a copy of the last 30 seconds of packets, and compares each new packet that hears these last ones to avoid duplication. This method eliminates the multiple looping of packets caused by multiple generic paths such as WIDE,WIDE,WIDE, which can be as many as 21 copies. In a WIDEn-n network, there would only be three packets outward bound 3 hops.

The "n" in the WIDEn-n path indicates the number of hops. Each digipeater that repeats the packet, decrements the WIDE-SSID by one. So the -n decrements to zero, but the WIDEn portion indicates the original number of hops so that recipients know how far it traveled. A long distance traveler or special event of wide interest may use up to WIDE5-5 but a local commuter may only want to use WIDE2-2 to limit QRM. The advantage of the WIDEn-n routing is that every packet still only has one digipeater call.

It is important to know the first digipeater that a packet hit, not the last. Users should begin all packets with WIDE,WIDEn-n so that the first digipeater does a call sign substitution and the packet arrives as FIRST,WIDEn-n.

The Global Positioning System is maintained by the U.S. Department of Defense and consists of 25 satellites in orbit around the earth. Positioning information is determined by a small receiver which measures the time in micro-seconds that it takes to receive the broadcast from between 1-12 satellites. By receiving the signal from at least four satellites, position information down to about 10 meters can be determined. Altitude information can also be obtained from the system. In mobile situations you can determine speed and direction.

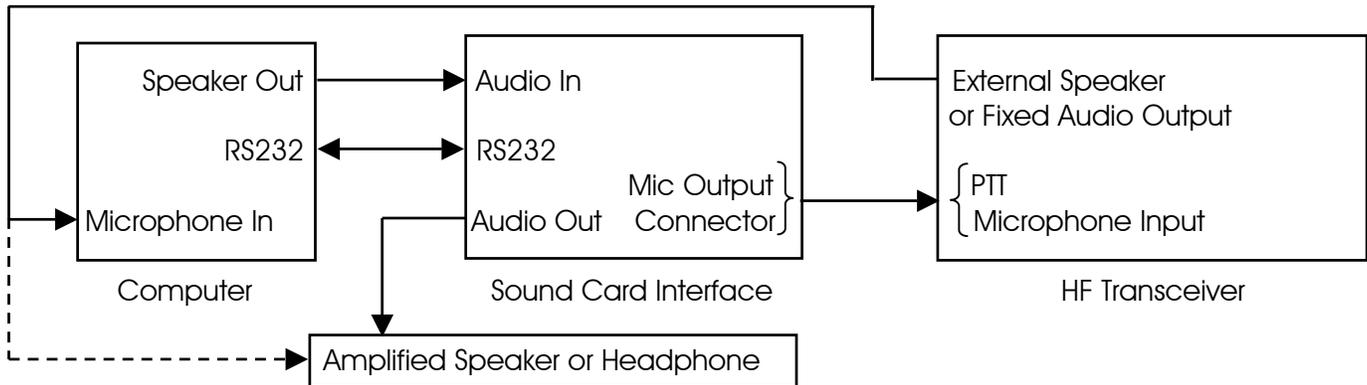
Below are some commands that should be made active:

ECHO ON (normal) or ECHO OFF (if double letters are displayed)
BEACON EVERY 0 (to manually enter beacons at base station)
MONITOR ON
MCOM ON
MCON OFF (to display only packets addressed to you) or MCON ON (to display all packets)
MRPT ON

APRS Symbols and SSID Extensions

<u>SSID</u>	<u>Symbol</u>	<u>NWAPRS Station Type</u>
-0	Dot	Home Station
-1	Ambulance	Home PBBS
-2	Bus	
-3	Fire Truck	
-4	Bicycle	
-5	Yacht	
-6	Helicopter	
-7	Aircraft	TH-D7 Station
-8	Ship	Secondary Automobile
-9	Car	Primary Automobile
-10	Motorcycle	Primary WIDE
-11	Balloons	Secondary WIDE
-12	Jeep	
-13	RV	
-14	Truck	
-15	Van	TCPIP Only

Phase Shift Keying (PSK) Radio



PSK31 (Phase Shift Keying) is a data mode that uses a personal computer and sound card to communicate. Packet is primarily designed for communications between two people or bulletin board. PSK31 is designed for multiple users like the voice nets. Anyone listening can see what everyone else is sending. PSK31 had many advantages over other modalities, such as requiring lower transmit power and more immunity from noise and interference (QRM). It uses an alphabet that has a text speed of 50 wpm. It does not require any handshaking with a second station. Roundtable communications are common in PSK31 mode. PSK31 was developed by Peter Martinez G3PLX.

The information in PSK31 is transmitted in patterns of reversed-polarities or 180-degree phase shifts. Phase modulation has several advantages over CW, which uses on-off keying. In a noisy or distorted propagation environment, the amplitude of CW will shift and vary much more than the phase of a signal.

The baud rate is 31.25 and the bandwidth is 31 Hz using narrow CW filters. The normal bandwidth of other modes is approximately 300-500 Hz. PSK31 can be used with lower signal levels in a crowded digital band. PSK31 operates in a much narrower bandwidth than FSK (Frequency Shift Keying).

PSK63 is a variation of PSK31. It has a bandwidth of 63 Hz. and a speed of 100 wpm. RTTY has a speed of 60 wpm. PSK63 has improved polar path performance over PSK31.

The difference between a CW filter of 500 Hz and the bandwidth of PSK31 of 31 Hz ($10 \cdot \log(500/31)$ db = 12 db) is 12 db, which demonstrates that a CW transmitter must transmit 16 times more power than a PSK31 transmitter to achieve the same signal to noise ratio. Therefore, a PSK31 station can operate at 16 times less power than a CW station.

PSK creates a problem of key-clicks. The solution for eliminating key-clicks is to filter the output or to shape the envelope amplitude of each bit. The same problem of key-clicks may appear at the receiving end. PSK31 can eliminate this problem by filtering the receive signal or by shaping the envelope of the received bit. If a simple cosine wave is used at the receiver, a signal from one receive bit may be spread into the next bit. At the receive end, 4 bits are shaped at a time. The transmit and receive filters must be matched to each other. Over-driving the audio can create intermodulation products if it is not linear. So, it is important to not over-drive the audio.

BPSK (Binary PSK) mode that does not have forward error correction but is probably the most common mode on the bands. It can be identified by its two vertical lines in the "Vector" signal view window.

QPSK (Quadrature PSK) is another mode whereby instead of phase reversals (180 degree phase shifts), and additional pair of 90 and 270 degree phase-shifts are possible. It is like having two PSK (BPSK) transmitter on the same frequency, but, 90 degrees out of phase with each other. The result is twice the bit rate and 3 db less signal-to-noise ratio. QPSK mode has forward error correction but is a little harder to tune. It can be identified by its two vertical lines and two horizontal lines in the "Vector" signal view window. It is also sideband sensitive. Sometimes lower sideband is used.

PSK uses a personal computer and a 16 bit computer sound card. The audio output from the sound card is connected to the audio input of the transceiver with a 100:1 voltage divider to reduce the voltage from the sound card audio output to the transceiver audio input. Some interfaces use transformer isolation and some use opto-isolation. There a number of radio sound card interfaces available commercially. Most include a microphone connector, wire with microphone plug, bypass switches, a computer RS232 connector, and audio inputs and outputs.

Software

There are a number of software programs that can be used for PSK. This author used the highly recommended WinPSKse. It is freeware available at <http://www.psk31.com> along with various article and technical information on PSK31. WinPSKse is an adaptation of AE4JY's fine WinPSK program expertly crafted by Dave Knight, KA1DT. WinPSKse has the ability to display and read two PSK31 signals at the same time, in an easy to read and interpret presentation. This has a much improved user interface. For example, it has an amazing new simultaneous spectrum/waterfall display.

Some PSK31 calling frequencies

BPSK primarily uses upper side band mode.

1,838.150 kHz

3,580.150 kHz to 3.620 kHz

7,035.150 kHz for region 1 and region 3, and 7080.15 for region 2 (the Americas)

10,142.150 kHz

14,070.150 kHz (Primary calling frequency)

18,100.150 kHz

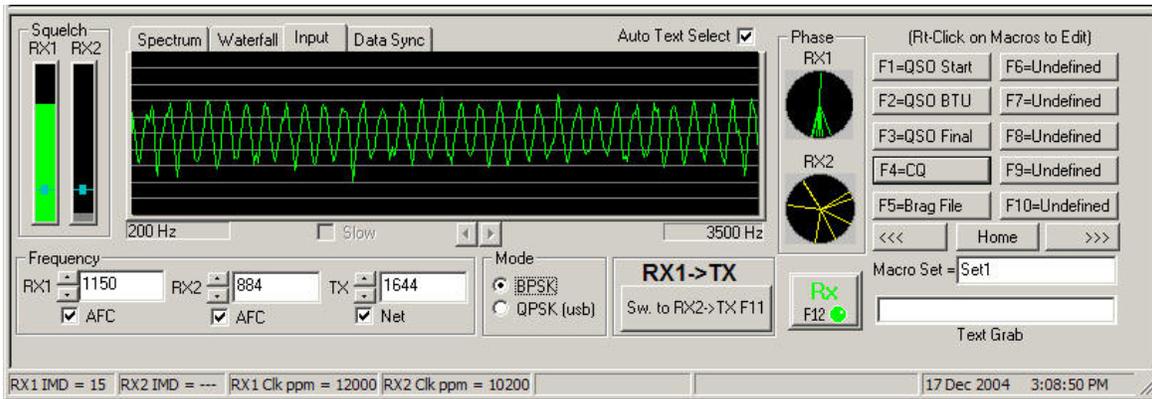
21,080.150 kHz 150 (although most activity can be found 10 kHz lower)

24,920.150 kHz

28,120.150 kHz

145,550 kHz

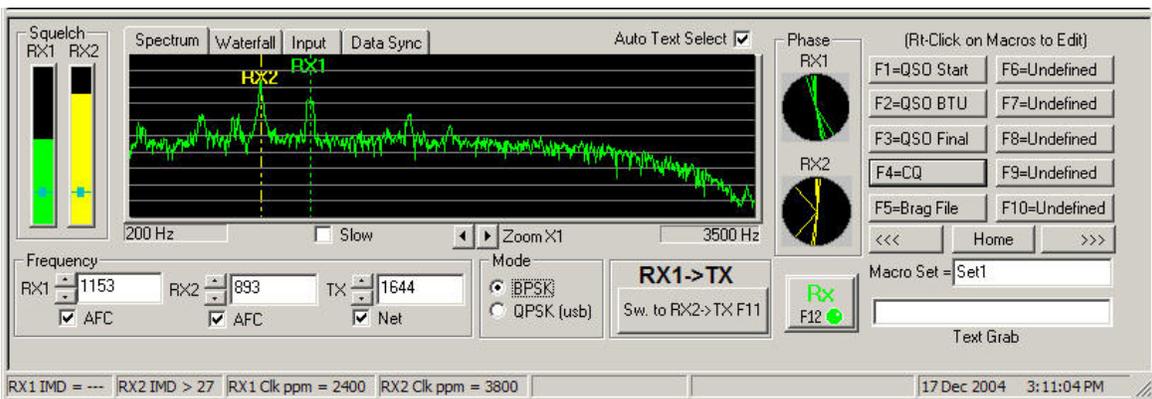
Receive Audio Input Level



Tune the radio to a loud signal or carrier at 14,070.150 kHz. Display the soundcard's mixer program (or use the one that comes with Windows). Set the mixer's LINE IN setting to mid way. Adjust the volume control on the radio while viewing the INPUT signal display in the software program. The volume should be adjusted for a good signal level that is not too high and not too low.

Tuning in a PSK31 Signal

In the spectrum display view, look for peaks. Click the mouse on a peak to change the receive frequency marker position. If the display is not showing anything, adjust the soundcard Recorder mixer volume control or the volume control of the radio. Below is a typical PSK31 signal (RX1).



Transmit Audio Level Adjustment

Transmit level is more complicated to adjust than the receive level because the actual signal spectrum coming out of the transmitter cannot be seen at the transmitter. Adjust the mixer's VOLUME setting to adjust the transmit audio level. The best method is to guess at a good level (mid way), then get a critical signal report over the air. The correct setting will vary from radio to radio. It is better to under-drive the radio until a clean signal is clean is obtained. In general never drive the transmitter anywhere near its rated power at first.

Operation Hints and Tips

The actual Transmit/Receive frequency is the USB radio dial frequency plus the audio frequency displayed in software. If using LSB, subtract the audio frequency from the radio dial setting. For example if the transceiver is in the USB mode and reads 14070.00 KHz and the audio frequency is 1500 Hz, then the actual transmit/receive frequency is 14071.50 KHz.

The TX and RX frequencies are limited between 200 and 3500 Hz. It is best to avoid the edges because transmitters may have some frequency limitations as well as some soundcards.

Don't send all text as UPPER CASE letters. PSK31 was designed to send the most commonly used letters such as 'e' and 't' much faster than letters such as 'z' that are used less frequently. Uppercase letters take much longer to send and slow down the transmission. Capitalize letters as needed. A common practice is to send callsigns in upper case.

Make sure the PC time and date are set correctly.

Try using the QPSK mode when conditions get rough. In many circumstances, using QPSK will greatly improve reception due to its error correcting capability.

Winlink 2000

Normal Internet Connection



Radio Communications During a Local Interrupted Internet Connection

Interrupted Area



Short Distance (75 miles)

Non-Interrupted Area



Radio Communications During a Regionally Interrupted Internet Connection

Interrupted Area



Long Distance (hundreds to thousands of miles)

Non-interrupted Area



Winlink 2000 is a worldwide digital amateur radio message transfer system. It provides E-mail transfer with attachments, map & text-based position reporting, graphic & text-based weather bulletin services, and emergency communications by linking radios to the Internet.

The Winlink 2000 system is currently being utilized for emergency communications where local or regional communications are disrupted, including the loss of the Internet, and where accuracy of information is important.

Winlink 2000 can be used by any licensed Amateur radio operator. The operator logs into one of the participating network stations using the "AirMail" software. Currently, Winlink 2000 has a flow of over 150,000 messages monthly into 41 participating stations from 5100 + users. The Winlink 2000 user must have a General Class or higher license to use HF radio.

Winlink 2000 may be very useful for emergency communications using the Telpac with Paclink email-based VHF/UHF radio Packet for "last mile" communications coverage. Airmail is used for greater distances using the HF radio link to Winlink 2000 and the internet.

"Telpac" stands for TELnet-PACket Bridge and it allows the Winlink 2000 operator to use the VHF/UHF Packet mode with the B2F protocol. Telpac is used by the Packet nodes to interface with the end-user, who is using Paclink or Airmail. Paclink utilizes Outlook or Outlook Express to provide the end-user with a connection to the Winlink 2000 system by way of Telpac.

PACTOR is an HF (3 to 30 MHz.) radio teletype mode developed in Germany by Ulrich Strate (DF4KV) and Hans-Peter Helfert (DL6MAA) to improve on inefficient modes such as AMTOR/SITOR and Packet-Radio (AX.25) in weak short wave conditions. PACTOR offers a much better error correction system, and a considerably higher data transfer rate, than AMTOR/SITOR and result in a protocol much more resistant to interference than Packet-Radio under poor propagation conditions. For the first time in amateur radio, online data compression is used to increase the effective transmission speed. Pactor I is capable of 200 bps. PACTOR II is capable of 800 bps. PACTOR III is capable of 3600 bps. To use PACTOR, a PACTOR TNC/Modem is used in place of a packet TNC and HF frequencies are used.

The dial (transmit) frequency is 1,500 KHz lower than the center frequency.

Current PACTOR nodes in the United States:

AB7AA - Bill in Waikiki Beach, Oahu, Hawaii, Scan Center Frequencies
3641.9, 7103.7(P3), 10142.7(P3), 14064.4, 14109.2(P3), 18104.9, 18106.2(P3)

AH6QK - Richard in Kaneohe, Oahu, Hawaii, Scan Center Frequencies:
7070.9, 10126.9, 14069.0, 14110(P3), 18101.9

KA6IQA - Tom in Rancho Santa Fe, California, Scan Center Frequencies:
7066.9, 7101.2(P3), 14112.4, 14104.2(P3)
18102.9, 18106.7(P3), (13:00 to 03:00 UTC)

KB6YNO, Hamilton, Massachusetts, Scan Center Frequencies:
7069.9, 10125.9, 14067.9, 14094.9 (P3), 18098.9

KF6NPC - Mike in Riverside County, CA., Scan Center Frequencies:
3621.2, 7067.9, 7103.7, (P3), 10146.2 (P3), 14096.0 (P3)
VHF 1200 baud packet frequency for KF6NPC: 145.07

KN6KB - Rick in Rockledge, Florida, Scan Center Frequencies:
7068.9, 7103.7(P3), 10146.2(P3), 14066.4

KQ4ET – Joel, Virginia Beach, VA, Scan Center Frequencies:
3628.7, 7067.9, 10146.5(P3), 14110.0(P3)

K4CJX - Steve in Nashville, Tennessee, K4CJX Center Scan Frequencies:
Station # 1: 7076.9 (P2), 7101.2 (P3), 14076.9 (P2), 14106.7(P3)
Station # 2: 10123.9 (P2), 10141.2(P3)
Station # 3: 18103.9 (P2), 18108.7(P3)

K4SET - Scott in Murray, Kentucky, Scan Center Frequencies:
7074.9, 7103.7(P3), 10,136.9, 10143.4(P3), 21073.9, 21095.2 (P3)

K6CYC - Scott in Los Angeles, California, Scan Center Frequencies:
7069.9, 10123.9, 10143.7# - Omni-directional
21068.9, 21096.2(P3), 14068.9, 14102.7(P3) - Beaming South Pacific

W7IJ - Bill in Spanway, WA, Scan Center Frequencies:
Station 1: 3631.9(P3), 7068.9(P2), 7103.7 (P3), 10139.5 (P2)
Station 2: 14069.4(P2), 14110.0 (P3), 21077.9 (P2), 21091.2 (P2)

K6IXA - Grady in Atwater, California, Scan Center Frequencies:
Station # 1: 10122.9, 10143.7(P3)
Station # 2: 14064.9, 14102.7(P3)

K7AAE - Ronald in Woodinville, Washington, Scan Center Frequencies:
Station # 1: 3629.9, 7076.9, 10133.9, 10145.7(P3)
Station # 2: 14067.9, 14109.2(P3)

N8PGR, North Royalton, Ohio (20 miles south of downtown Cleveland and lake Erie)
Scan Center Frequencies: 3621.9, 7071.9, 10140.4, 14117.9

NOIA - bud in Deltona, Florida, Scan Center Frequencies:
3626.9, 7072.9, 10133.9, 14072.9, 14098.7(P3), 18106.2(P3)

WA2DXQ - Dave in Ft. Lauderdale, Florida

WB5KSD - Jon in Farmersville, Texas, Scan Center Frequencies:
7075.9, 10132.9, 14078.9, 14109.2 (P3)

WB0TAX - Deni in Elm Grove, Louisiana, Scan Center Frequencies:
7103.7 (P3), 10133.9, 10143.7 (P3), 14066.9 (P2), 14096.2 (P3), 18106.2 (P3)

WD8DHF - Gary in Harker Heights, Texas, Scan Center Frequencies:
Station #1: 3590.9, 7075.4, 70103.7(P3), 10,127.9
Station #2: 14075.4, 14098.7(P3), 18075.4, 18107.9(P3)
Station # 3: 21075.4, 21091.2 (P3)

WU3V - Jim in Great Falls, MT, Scan Center Frequencies:
3631.2 (ALL), 7074.9, 7103.7(P3), 10126.9, 10143.4(P3), 14069, 14102.7(P3)

WX4J - Earl in Switzerland, Florida, Scan Center Frequencies:
3622.4, 3620.9(P3), 7066.9, 7065.4(P3), 10143.4, 10141.9(P3) 14066.9, 14065.4(P3)

W1ON, Bedford, Massachusetts (near Boston), Scan Center Frequencies:
3620.9, 7070.9, 14075.9, 14104.2 (P3), 18100.9

W6IM - Rod in San Diego, California, Scan Center frequencies:
Dipole - 7073.9, 10141.2(P3)
Beam (135 deg) - 14073.9, 14098.7(P3)

W7BO - John in Woodland, Washington, Scan Center Frequencies:
7.067.9, 7101.2(P3)

W9GSS, East Peoria, Illinois, Scan Center Frequencies:
7072.9, 14073.9, 14109.9 (P3), 21098.0 (P3)

W9MR, Keensburg, Illinois, Scan Center Frequencies:
7065.9, 10145.2 (P3), 14069.9, 14101.7 (P3)

Current PACTOR nodes in Canada:

VE6KBS - Karl in Calgary, Alberta, Center Scan Frequencies:
7096.0, 7096.5(P3), 14078.9, 14104.2(P3), 18100.9, 18106.2(P3), 21079.9, 21098.7(P3)

VE2AFQ - Andre in Montreal, VE2AFQ Scan Center Frequencies:
7073.9, 7101.4 #, 14068.9, 14109.9 #, Telpac: 145.070 MHz

VE1YZ - Neil near Halifax, Scan Center Frequencies:
7067.9, 10129.9, 10148.2(P3), 14111(P3), 14112.9

Airmail Software Protocols

Software: Download and install "Airmail" version 3.1.936 or later.

Address Book Setup

Main page
Click on the black book icon (second from left)
Click New
Name: person's name
To: Their email address
Email gate: Email
Post Via: WL2K
Click OK

Formatting a New Message

Main page
Click on white page icon (third from left)
Click on a name from your address book
Click OK
Type a message
Click on the small floppy disk icon (6th from the left to save it)
Click on the mailbox icon to post it (7th from the left to say it is ready to send)
Now, click on the Outbox (on the left, you should see a mailbox with a blue arrow and the message) The message will be sent by whatever modality is used to make a connection.

Telnet Client Setup

Internet connection to this computer is required
Main page
Click on Modules
Click on Telnet Client
Click on the yellow shaking hands
Click on New
Place in the boxes
Remote Callsign: K4CJX
Remote Host: k4cjsx.no-ip.com
Port: 12001
Timeout: 30
Local Callsign: your call
Password: WL2KTELNETCLIENT
Check B2
Click OK
You should see K4CJX in the window at the top of the Telnet Client now.
Click the green button/icon and if you are connected to the Internet it should make a connection with Steve and sign off automatically.

Sending a Message Through Telnet

Main page
Click on modules
Click on Telnet Client
Click on the green button and the message should go. Watch closely, it does not take long.

VHF Packet Client Setup

Main page

Tools

Options

Modules

VHF Packet Client - check the block and click on the Setup button

From the Connections column:

TNC Type: select the TNC you are using - KPC-3 is at the bottom of the list

Com Port: Select your computers serial com port (usually Com1)

Baud Rate: Select the serial port baud rate (usually 9600)

Do not make changes in the Port Settings column

Check Show Hints

Check Terminal Window and Telnet Client

Check Show in Taskbar for Terminal Window and for VHF Packet Client and Telnet Client

Click Apply at the bottom

Click OK

Close Airmail and restart it.

Note: you cannot program multiple connections. You need to connect directly with a Telpac node.

Sending a Message Through VHF/UHF Packet

Main page

Click on modules

Click on Packet Client

Connect To: callsign of the Telpac Station

Connect As: your callsign

Click on the green button and the message should go. Watch closely, it does not take long.

Sending a Message Through VHF/UHF Packet via Multiple Nodes

Main page

Click on modules

Click on Packet Client

Connect To: callsign of the first packet station

Connect As: your callsign

Click on the Handshaking icon (third from the left)

Click on the green button

Once connected to the first packet station, Click on the Keyboard Icon (fourth icon from the left)

Using the connect command (c) in the lower window (C callsign) to connect to the next node

If you need the connect to more nodes, use the above step repeatedly until you come to the Telpac node

Once connected to the telpac node, click on the Handshaking icon (third from the left)

The message should go. It may take a long time depending upon the number of nodes used

HF Client Setup

Main page

Tools

Options

Connections

From the Modem (TNC) Connection column:

Modem type: select the modem you are using (PTC-Illex)

Com Port: select the com port you are using (usually Com1)

Baud Rate: Select the serial port baud rate (57600)

Center Frequency: 1500

Check USB

From the Modem (TNC) Connection column:

Select none if you do not have a remote control for your radio

Check Show Hints

Click Apply at the bottom

Click OK

Close Airmail and restart it.

Sending a Message Through HF

Main page

Click on modules

Click on HF Client

Connect To: callsign of the PMBO Station

Connect As: your callsign

Click on the green button and the message should go. Watch closely, it does not take long.

Note: the first you log onto an HF station, your callsign and license may need to be verified.

Satellite Radio



Amateur Satellite Radio (AMSAT) is basically a repeater or transponder in orbit around the earth. There are several satellites in Low Earth Orbit and several satellites in High Earth Orbit.

There are four basic categories of satellites:

1. Low Earth Orbit – Analog (CW and Voice)
2. Low Earth Orbit - Digital
3. High Earth Orbit
4. Occupied Spacecraft

Most of the amateur satellites and occupied spacecraft are in Low Earth Orbit (LEO). Low Earth Orbit satellites orbit the earth many times a day. Because Low Earth Orbit satellites have low orbits, and sensitive receivers, omni directional antennas can be used without substantial amounts of power. However, their passes are short and communications must consequently be short. Low Earth Orbit satellites typically have an approximate 90 to 100 minute period of evolution (time to make one orbit around the earth). Your communications window is approximately 8-20 minutes. Low Earth Orbit satellites typically have orbits of approximately 250 km to 1,000 km. The orbits of occupied spacecraft are typically below 500 km.

High Earth Orbit (HEO) satellites require beam antennas, azimuth/elevation rotators, computer tracking, and higher power radios. High Earth Orbit satellites will have longer passes and consequently longer communications capabilities. High Earth Orbit satellites typically have orbits of approximately 11 hours. High Earth Orbit satellites typically have orbits of 35,000 km at apogee and 4,000 km at perigee.

There are currently several analog satellites including RS-12, UO-14, RS-15, FO-20, AO-27, FO-29, SO-41, and the occupied spacecraft in orbit. The equipment required to communicate with these satellites are: an HF radio and/or a 2m / 70 cm radio. Packet equipment is required for digital work. Receiver preamps may also be needed.

Sending a transmission to a satellite is called an "uplink." Receiving a transmission from a satellite is called a "downlink." Uplink and downlink frequencies are different. Oscar is an acronym for "Orbiting Satellite Carrying Amateur Radio."

Working a satellite is very similar to working "split" on HF or "cross-band" repeat on repeaters, where you transmit on one band and listen on another. For example, if you chose RS-12, it will accept a signal anywhere from 145.910 MHz to 145.950 MHz and retransmit between 29.410 MHz and 29.450 MHz. These are known as the uplink and downlink passbands, and there is a direct relationship between them. A signal you transmit at 145.920 MHz will be retransmitted by the satellite at about 29.420 MHz and 145.930 MHz comes down as about 29.430 MHz, etc. This is because RS-12 (as well as RS-15) uses what is known as a "non-inverting linear transponder". The international space station uses uplink and downlink in the same (2 meter) band.

The following is a list of common satellite modes:

Dual Band Modes

A	2 meters uplink	10 meters downlink
B (UV)	70 cm uplink	2 meters downlink
J (VU)	2 meters uplink	70 cm downlink
K	15 meters uplink	10 meters downlink
LU	23 cm (1.2 GHz) uplink	70 cm downlink
LV	23 cm (1.2 GHz) uplink	2 meters downlink
US	70 cm uplink	13 cm (2.4 GHz) downlink
LS	23 cm uplink	13 cm downlink
T	15 meters uplink	2 meters downlink

Single Band Modes

V	2 meters	2 meters
U	70 cm	70 cm
L	23 cm	23 cm
S	13 cm	13 cm
X	3 cm	3 cm

Uplink indicates the earth station transmit frequency. Downlink indicates the earth station received frequency.

Some satellites have dual modes that operate simultaneously. Satellites have 3 basic types of retransmissions: beacon, transponder, and repeater. Most satellites have a fixed Morse code beacon at the lower end of the satellites band-pass transponder. This is useful to detect when the satellite has crossed the horizon and is in range for operation. It can also be used to determine doppler shifts.

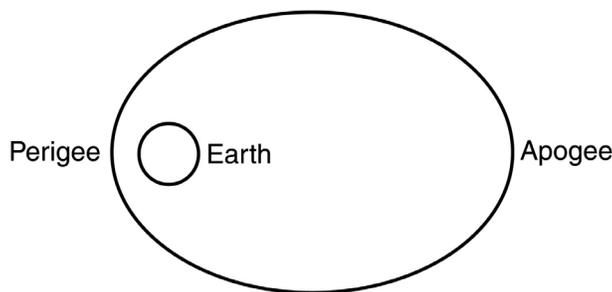
A transponder is similar to a repeater, but has a range of frequencies that are converted from one band to another. This range of frequencies is known as the pass band of the transponder. There are two types of transponders: Non-inverting and inverting. A non-inverting transponder will receive an upper side band signal at the high end of the uplink pass band and it will transmit it as an upper side band signal at the high end of the downlink pass band. An inverting transponder will receive an upper side band signal at the high end of the uplink pass band and it will transmit it as a lower side band signal at the lower end of the downlink pass band.

A repeater closely resembles an earthbound repeater. It listens for signals on one frequency and transmits on another frequency. All satellite repeaters (and transponders) are full duplex, meaning one

can listen to the signal on the downlink while transmitting. Headphones are often used to avoid audio feedback.

Unlike earthbound communications where it is possible to pick a frequency and stay there, there is a phenomenon known as Doppler Shift that satellite that must considered. An example of Doppler shift is hearing a train blowing its whistle as it passed by? The tone changes as the train comes close and moves away. The sound inside the train remains the same. The change in tone is a result of the Doppler Shift. Signals coming from space experience the same phenomena as the satellite moves at a speed of about 17,000 miles per hour. The operator has to constantly tune the receiver and transmitter to make up the difference. The frequency shift varies by band. On RS-12 with its 2 meters uplink and 10 meters downlink, the change is about +/- 2.5 kHz. On FO-20 and FO-29, where the uplink is 2 meters and the downlink is 70 cm, the shift is about +/- 10 kHz.

Satellites travel in an elliptical orbit. Apogee is the point in a satellite's orbit where it is farthest from the earth. Perigee is the point in a satellite's orbit where it is closest to the earth. Inclination is the angle of the orbital plane with respect to the earth's equator. A node is the point where the orbital path crosses the equator. The ascending and descending pass is the south to north or north to south communications opportunity. These are also the points of Acquisition of Signal (AOS) and Loss of Signal (LOS). A footprint is the area of the earth's surface, which is visible to the satellite at one time. The lower the satellite's orbit, the smaller the footprint. Keplerian Elements (KEPS) are a set of numerical data that represents a satellite's orbital characteristics. The use of this information allows tracking programs to determine where that satellite is at any one time, to predict passes, and plot ground tracks. Keplerian elements should be updated every few weeks for stable orbits and more frequently if the object's orbit is altered. The AMSAT format is the most user-friendly format of Keplerian elements. However, the NORAD Two-Line Element (TLE) is the indigenous format available from NASA.



The AMSAT format looks like this:

```
Satellite: AO-27
Catalog number: 22825
Epoch time: 03177.89093483
Element set: 590
Inclination: 98.2597 deg
RA of node: 200.9638 deg
Eccentricity: 0.0007455
Arg of perigee: 236.0777 deg
Mean anomaly: 123.9698 deg
Mean motion: 14.28984247 rev/day
Decay rate: 4.2e-07 rev/day ^ 2
Epoch rev: 50820
Checksum: 344
```

Some communication satellites stay stationary with respect to the earth so that TV signals can be received with small antennas. To achieve this stationary position, a satellite must have a one-day orbital period like earth. The satellite to earth distance is calculated as 35,768 km. The satellite orbit must be circular with near zero inclination to stay stationary. If the orbit is closer to an inclined ellipse, the satellite projection to the earth surface will follow a skewed figure 8 pattern. This pattern is good for amateur radio because it can cover additional surface area of the earth and the satellite is closer to the earth at perigee.

Most of the time satellites are no higher than 35 degrees or so above the horizon. The closer the satellite is to the horizon, the greater the distance it is from the observer and the higher the path loss and the greater the transmit and receive gain that is needed. Vertical antennas will work well, especially ones with some gain, although some of the really high gain verticals are optimized for low angles of radiation and the signal strength falls off rapidly as the elevation angle increases. Another problem with verticals is that noise tends to be vertically polarized. This is not a problem with FM signals, but a big problem with SSB and CW. Dipole antennas also work well, but they often suffer a loss of gain off the ends. Beam antennas can be tilted up about 30 degrees to provide more gain toward the horizon. However, many satellite operators report excellent results in the standard flat horizontal orientation. When using beam antennas, the operator will need to continuously correct their direction as the satellite moves by. This becomes difficult to manage manually with the low earth orbit satellites because they have relatively fast velocities. Computer controlled antennas with azimuth/elevation rotators can track the satellites with ease. Azimuth/elevation rotators and computer controllers tend to be expensive.

A radio signal passing through the ionosphere changes polarization. A horizontally polarized signal transmitted from a satellite would change polarization when reaching earth. This phenomenon is called the Faraday Rotation. Circularly polarizing antennas are often used to deal with Faraday Rotation. Circularly polarized antennas will also minimize the spin modulation effect, which is caused by a satellites rotation of approximately 1 revolution per second.

Most satellites have an automatic transmitter at the satellite called the beacon. The beacon is usually located at the high or low end of the pass-band and will send out satellite identification and telemetry. Most beacons use CW.

When beginning satellite operation, try to get on one of the FM satellites, such as UO-14, AO-27, or ISS. These satellites are probably the easiest to work with a minimum amount of equipment. This can be done with an HT and a directional antenna. The antenna does not need to have much gain. It can be a 3-element beam that is held pointing at the satellite. Arrow antenna makes the 146/437-10 handheld antenna with a foam grip for about \$75. Satellites like FO-20 and FO-29 are easy to work, but require two beams with an azimuth/elevation rotator and a computer controller. More sophisticated equipment will allow you to transmit and receive simultaneously on 2 bands and make frequency shifting for Doppler correction easier. At the time of this writing, AO-27 is only available on weekends. UO-14 is probably the best satellite to start with. ISS is easy to reach since it is so low. However, the ISS crew are not always available. Check the NASA website site for "Crew Scheduling" to see what times are allocated for amateur radio.

There are a number of tracking software programs on the market. After much trial and error by this author, the NOVA software program appears to be the best. It works well with Windows XP and the operator can update the Keplerian elements with the click of the mouse, provided there is with an internet connection. Some programs were actually inaccurate as compared to the online tracking by NASA of the international space station.

Online resources include:

<http://www.amsat.org>

<http://www.amsat.org/amsat/news/wsr.html> (weekly satellite status report)

<http://www.amsat.org/amsat/ftp/keps/current/amsat.all> (Keplerian elements)

<http://www.arrl.org>

<http://ariss.gsfc.nasa.gov>

<http://spaceflight.nasa.gov/realdata/tracking/index.html> (tracking international space station)

<http://www.nlsa.com/index.html> (Nova satellite tracking software)

<http://www.orbitessera.com/> (N2WWD webpage)

Kilometer = Miles x 1.621388

Miles = Kilometers x 0.621388

Region 1: Africa, Europe, Russia, Middle East (excluding Iran), and Mongolia

Region 2: The Americas, including Hawaii, Johnston Island, and Midway Island

Region 3: The rest of Asia and Oceania

Low Earth Orbit – Analog Satellites (partial list)

<u>Satellite</u>	<u>Frequencies (MHz)</u>	<u>Transponder /Beacon</u>	<u>Mode</u>	<u>Notes</u>
<u>RS-15 (NORAD 23439)</u>				
Launched: December 26, 1994 from the Baikonur Cosmodrome				
Approximate height (varies) 2,160 km – 1,885 km				
Downlinks	29.352	B		CW
	29.354 - 29.394	T	A	CW / USB
Uplinks	145.858 -145.898	T	A	CW / USB
Semi-operational as of June 8, 2003				
<u>FO-20 (Fuji-OSCAR 20, NORAD 20480) (2)</u>				
Launched: February 07, 1990 by an H1 launcher from the Tanegashima Space Center in Japan.				
Approximate height (varies) 1,745 km – 912 km				
Downlinks	435.795	B		CW
	435.800 - 435.900	T	J	CW / USB
Uplinks	145.900 - 146.000	T	J	CW / LSB
Operational as of June 8, 2003				
<u>AO-27 (OSCAR 27, AMRAD, NORAD 22825) (3)</u>				
Launched: September 26, 1993 by an Ariane launcher from Kourou,				
Approximate height (varies) 804 km – 790 km				
Downlink	436.795		J	FM Voice
Uplink	145.850		J	FM Voice
Semi-operational as of June 8, 2003				
<u>FO-29 (Fuji-OSCAR 29, NORAD 24278) (also see 1200 and 9600 Baud)</u>				
Launched: August 17, 1996, by an H-2 launcher from the Tanegashima Space Center in Japan.				
Approximate height (varies) 1,333 km – 801 km				
Downlinks	435.795	B		CW
	435.800 - 435.900	T	J	CW / USB
Uplinks	145.900 - 146.000	T	J	CW / LSB
Downlink	435.910	B		FM Voice digitalker
Downlink	435.795	B		12 WPM CW telemetry
Operational as of June 8, 2003				
<u>SO-41 (SAUDISAT 1A, NORAD 26545)</u>				
Launched: September 26, 2000 aboard Soviet ballistic missile from the Baikonur Cosmodrome.				
Approximate height (varies) 672 km – 614 km				
Downlink	436.775		J	FM Voice
Uplink	145.850		J	FM Voice
Operational, but, intermittent as of June 8, 2003				

SO-50 SAUDISAT-1C

Launched: December 20, 2002 aboard a Soviet ballistic missile from the Baikonur Cosmodrome.

Approximate height (varies) 650 km

Uplink	145.850 MHz (67.0 Hz PL tone) T	J	FM Voice
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Downlink	436.800 MHz T	J	FM Voice
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Operational as of June 8, 2003

AO-51 (ECHO)

Launched: July 30, 2004

Approximate height (varies) 718 km

Analog Uplink	145.920 MHz FM (PL - 67Hz), 1268.700 MHz FM (PL - 67Hz)
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Analog Downlink	435.300 MHz FM, 2401.200 MHz FM
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PSK-31 Uplink	28.140 MHz USB
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Digital Uplink	145.860 MHz 9600 bps, AX.25, 1268.700 MHz 9600 bps AX.25
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Digital Downlink	435.150 MHz 9600 bps, AX.25, 2401.200 MHz 38,400 bps, AX.25
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Broadcast Callsign: PACB-11

BBS Callsign: PACB-12

Operational as of November 10, 2004

Low Earth Digital Satellites (partial list)

<u>Satellite</u>	<u>Frequencies (MHz)</u>	<u>Transponder</u> <u>/Beacon</u>	<u>Mode</u>	<u>Notes</u>
<u>AO-16 (OSCAR 16, Pacsat, Microsat-A, NORAD 20439)</u>				
Approximate height (varies) 797 km – 780 km				
Downlinks	437.025	T/B	J	1200 bps PSK SSB
	437.051	T	J	1200 bps PSK SSB
	2401.14280	B		1200 bps PSK SSB - (usually off)
Uplinks	145.900	T	J	1200 bps AFSK FM
	145.920	T	J	1200 bps AFSK FM
	145.940	T	J	1200 bps AFSK FM
	145.960	T	J	1200 bps AFSK FM
Semi-operational as of June 8, 2003				
<u>NO-44 (PC-SAT, NORAD 26931)</u>				
Approximate height (varies) 800 km – 790 km				
Downlink	144.390		V	APRS
Uplink	145.827		V	1200 bps AX.25 AFSK
Operational as of June 8, 2003				
<u>FO-29 (Fuji-OSCAR 29, NORAD 24278) (see also Analog and 1200 Baud)</u>				
Approximate height (varies) 1,333 km – 801 km				
Downlink	435.910	T	J	9600 bps FM BPSK
Uplink	145.850	T	J	9600 bps FM
	145.870	T	J	9600 bps FM
	145.910	T	J	9600 bps FM
Callsign 8J1JCS, Operational as of June 8, 2003				

AO-51 (ECHO)

Approximate height (varies) 718 km
PSK-31 Uplink 28.140 MHz USB
Digital Uplink 145.860 MHz 9600 bps, AX.25, 1268.700 MHz 9600 bps AX.25
Digital Downlink 435.150 MHz 9600 bps, AX.25, 2401.200 MHz 38,400 bps, AX.25
Broadcast Callsign: PACB-11
BBS Callsign: PACB-12
Operational as of November 10, 2004

High Earth Orbit Satellites (partial list)

<u>Satellite</u>	<u>Frequencies (MHz)</u>	<u>Transponder</u> <u>/Beacon</u>	<u>Mode</u>	<u>Notes</u>
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AO-10 (OSCAR 10, Phase 3B, NORAD 14129)

Launched: June 16, 1983 by an Ariane launcher from Kourou, French Guiana.
Approximate height (varies) 35,421 km – 4,026 km

Downlinks	145.810	B		CW
	145.825 - 145.975	T	B	CW / USB
Uplinks	435.030 - 435.180	T	B	CW / LSB

Semi-operational as of June 8, 2003

Occupied Spacecraft (partial list)

<u>Satellite</u>	<u>Frequencies (MHz)</u>	<u>Transponder</u> <u>/Beacon</u>	<u>Mode</u>	<u>Notes</u>
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ISS (International Space Station)(NORAD 25544)(6)

ARISS (Amateur Radio on the International Space Station)(NORAD 25544)(6)

The ARISS initial station was launched September 2000 aboard shuttle Atlantis.

Approximate height (varies) 402 km – 391 km

Downlink	145.800	T	V	Worldwide voice/packet
Uplink	144.490	T	V	Region 2 & 3 voice
Uplink	145.200	T	V	Region 1 voice
Uplink	145.490	T	V	Worldwide packet

TNC callsign: RSOISS-1
U.S. callsign: NA1SS
Russian callsigns: RSOISS,
RZ3DZR

Operational as of June 8, 2003

Antennas and Propagation

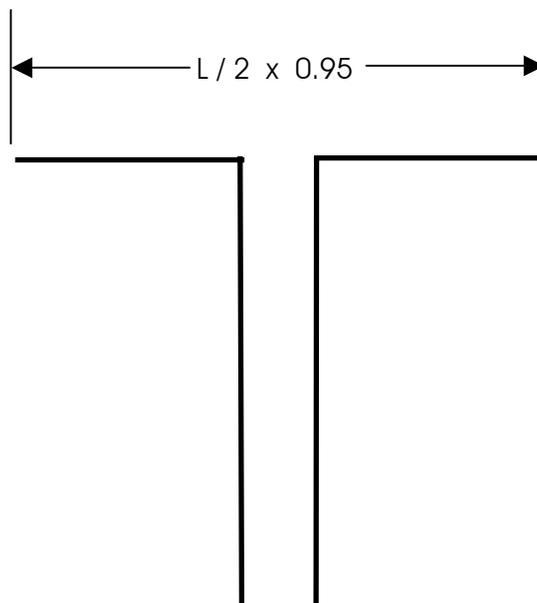
Any conducting material can act as an antenna. Designers go to “great lengths” to design antennas in order to control their radiation pattern and gain. The two main factors in antenna design and operation are the geometry of the antenna and the proximity of the antenna to nearby objects.

The Half Wave Dipole

Each half of the half wave dipole is 1/4 wavelength. Together they make up 1/2 wavelength.

The free space wavelength of an electromagnetic wave is: $L = c / f$ (Hz), where $c = 300,000,000$ meters/second (velocity of light) or L (meters) = $300 / f$ (MHz).

The velocity of a wave along an antenna or transmission is slower than it is in free space, usually about 95 % of c . Therefore, a half wave dipole is 5 % shorter than it's free space wavelength.

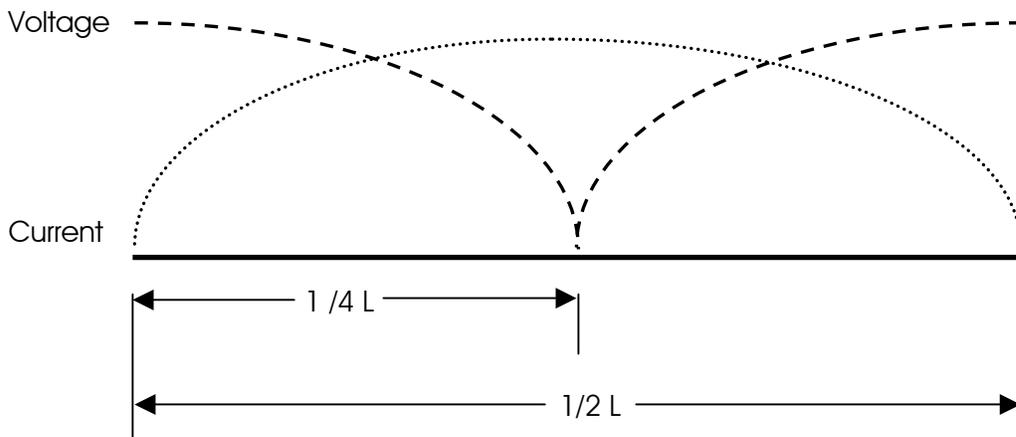


$$\text{A 7 MHz. half wave dipole length} = (c / f) \times 0.95 \times 0.5 \text{ meters}$$

$$\text{A 7 MHz. half wave dipole length} = (300 / 7) \times 0.95 \times 0.5 = 20.36 \text{ meters}$$

$$\text{A 7 MHz. half wave dipole length} = ((c / f) \times 0.95 \times 0.5) \times 3.2808 \text{ feet}$$

$$\text{A 7 MHz. half wave dipole length} = ((300 / 7) \times 0.95 \times 0.5) \times 3.2808 = 66.79 \text{ feet}$$



The voltage and current waves of an antenna are 90 degrees out of phase with each other.

If the current is high and the voltage is low, the impedance will be low ($R = E/I$). The impedance is the lowest at the center of a half wave dipole (72 ohms). At the ends, the impedance is the highest (2,000-3,000 ohms).

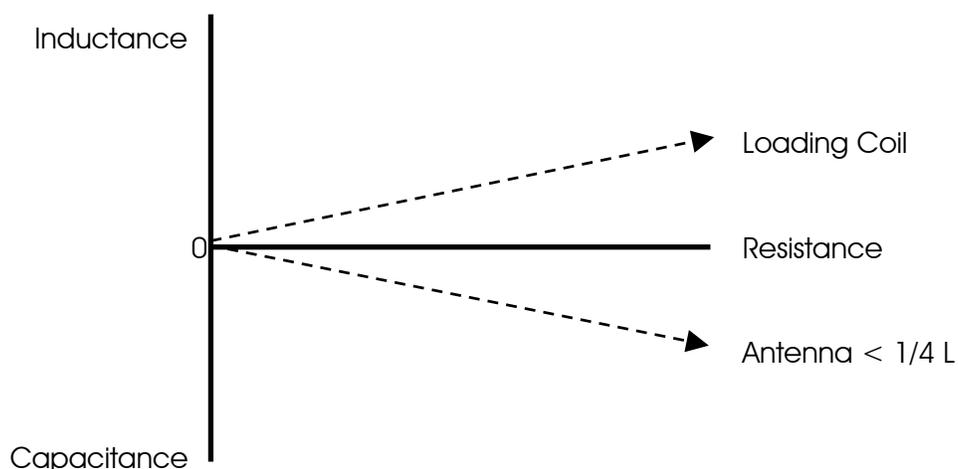
The half wave dipole is resonant when the length is made such that the mid point yields the lowest voltage and highest current.

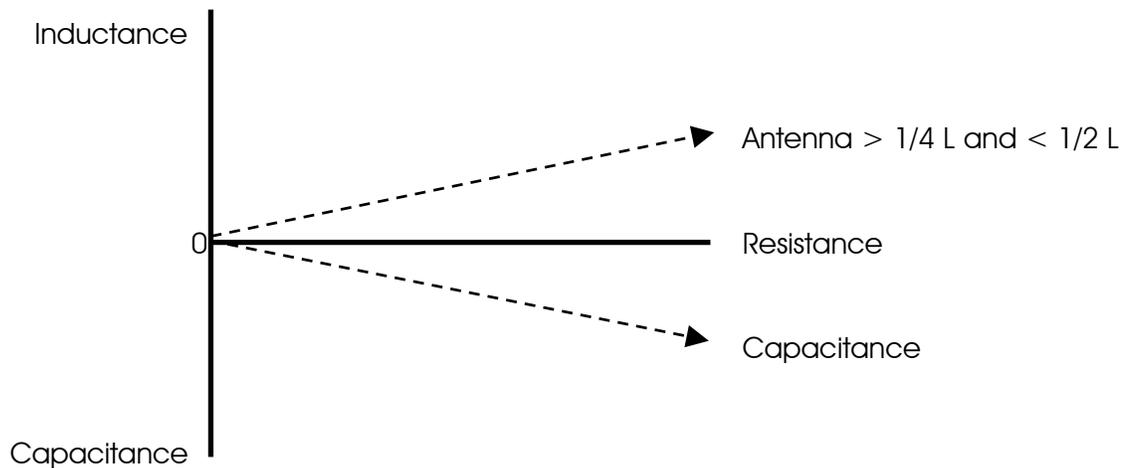
A $1/4$ wavelength antenna or an antenna of multiple $1/4$ wavelengths is a resonant antenna.

Any circuit is resonant when the inductive reactance and capacitive reactance are equal. At resonance, inductive reactance and capacitive reactance are 180 degrees apart and when equal, cancel each other, leaving only the resistance component. The shortest length of wire that can be resonant is a quarter wavelength.

If the antenna is shorter than a quarter wavelength, it will have a capacitive reactance. It will require the addition of an inductive reactance (loading coil) to cancel the capacitive reactance and become resonant.

If the antenna is longer than a quarter wavelength and shorter than a half wavelength, it will have an inductive reactance. It will require the addition of a capacitive reactance (capacitor) to cancel the inductive reactance and become resonant.





The Five-Eighth Wave Ground Plane Antenna

Normally, a $5/8 L$ antenna cannot be resonant because it is not a multiple of a $1/4 L$. However they are commonly found as vertical antennas. The vertical section is $5/8 L$, which has a capacitive reactance because it is longer than two $1/4 L$'s. An inductive loading coil is added somewhere along the length of the vertical to cancel the capacitive reactance. The $5/8$ wave antenna is actually tuned to $3/4 L$ by the addition of the loading coil making it effectively a $3/4$ wavelength antenna. The four horizontal radials are $1/4$ wavelength each.

The Quarter Wave Ground Plane Antenna

The quarter wave ground plane antenna is often used with radials or installed on a flat conducting surface, such as the roof of a car. It is simply a reflector whereby some of the radiation will be reflected by the ground plan and interact with the incident wave from the antenna. This kind of antenna provides an omni directional pattern.

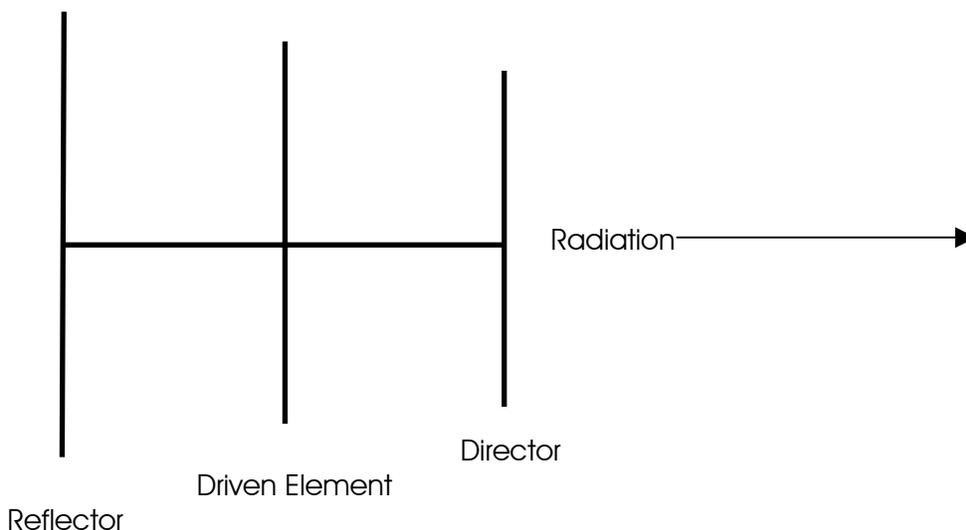
The Yagi Antenna

A Yagi antenna has one driven element, a dipole, and at least one other parasitic element. The parasitic dipoles receive radiation from the main dipole and re-radiate it. The energy is radiated from the main driven element and after a short delay, energy is picked up and re-radiated by the parasitic elements. The antenna can be made to radiate in one direction by controlling the spacing and length of the parasitic elements to yield a greater gain.

The three element Yagi has: a driven element, a reflector element, and a director element. The primary direction of radiation is in the direction of the driven element to director element. The driven element length is determined by equations used to calculate the dipole antenna. The reflector is 5% longer than the driven element and the director is 5% shorter than the driven element. The spacing between the elements are usually between 0.15 to 0.2 wavelengths (0.18 for maximum forward gain).

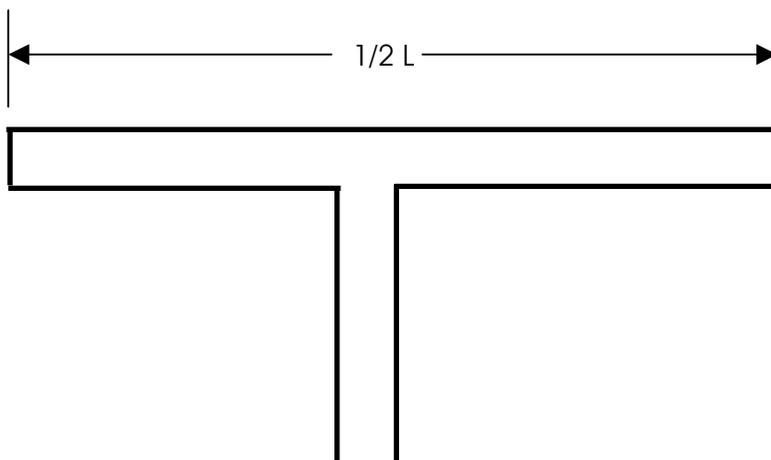
Propagation delays caused by the spacing of the elements, causes wave cancellation towards the rear of the antenna and wave reinforcement towards the front of the antenna. The gain is usually about 6-8.5 dB over a dipole.

Additional elements can be added to a Yagi to increase the power gain. Additional elements are always directors placed in front of the driven element. Doubling the number of directors, will increase the gain by about 3 dB. Adding parasitic elements to a Yagi decreases the antenna bandwidth.



The Folded Dipole Antenna

The folded dipole antenna is an antenna that consists of two dipoles connected in parallel. Folding the dipole increases the feed point impedance. Two dipoles folded, the feed point resistance increases by 2 squared (4), which is equal to 300 ohms. Three parallel dipoles increases by 2 cubed (8). The dipole forming the driven element of a Yagi antenna is often folded to increase the feed point impedance by 4.



Trapped Antennas

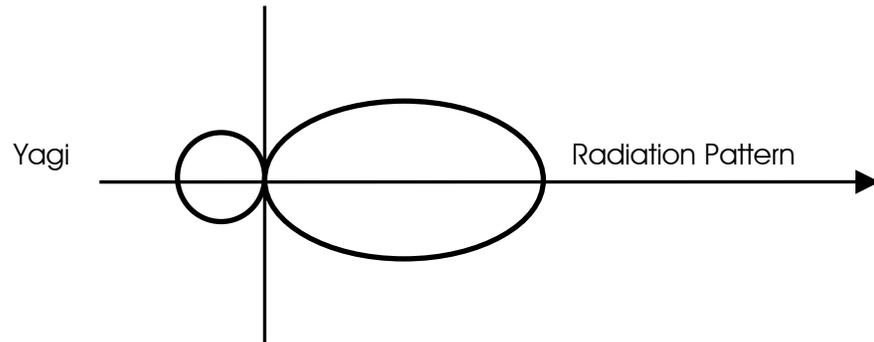
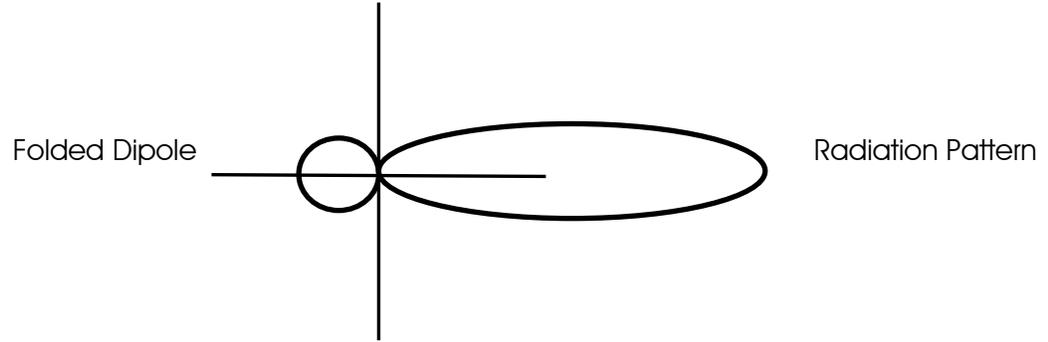
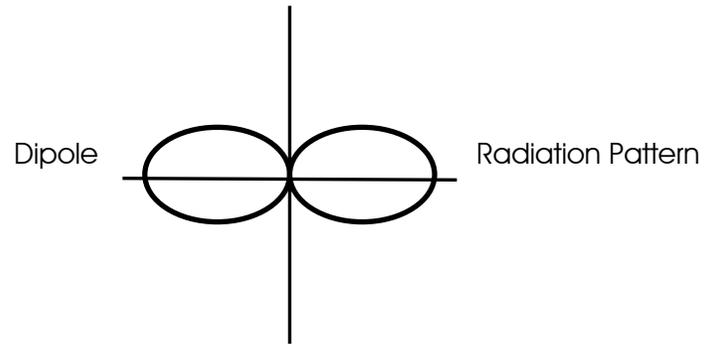
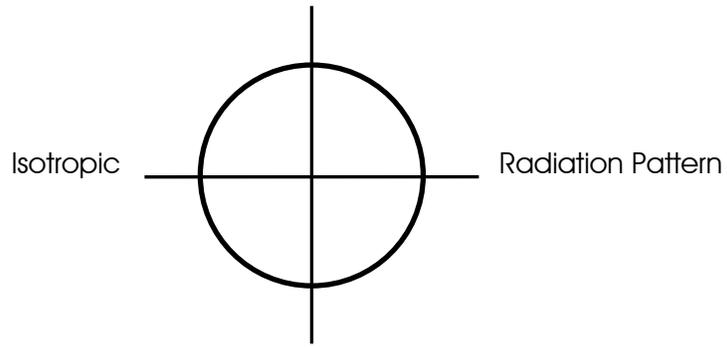
Traps are parallel tuned circuits used on HF antennas that have high impedances used to switch different sections of the antenna in and out of resonance. When the traps are not used at their resonant frequencies, they become loading coils and shorten the effective length of the antenna wire needed.

Isotropic and Practical Antennas

The isotropic antenna is a theoretical antenna that radiates equally in all directions and serves as a reference. A half wave dipole antenna has a gain of 2.14 dB above an isotropic antenna. Rubber duck antennas have a loss of several dB below an isotropic antenna.

An antenna that directs most of the electromagnetic radiation in one direction has a power advantage over an omni directional antenna. The power gain of an antenna is the ratio of the power radiated in its primary direction as compared to the isotropic antenna. A gain of 6 dB is a factor of 4 and 1 "S" point on the S-meter.

The area of a dipole's radiation pattern (A1) is 1.64 times that of the isotropic's pattern (A2). Therefore, the gain can be calculated as $\text{Gain} = 10 \text{ Log } (A1/A2) = 10 \text{ Log } (1.64/1) = 2.15 \text{ dB}$



Voltage Standing Wave Ratio (VSWR)

The Voltage Standing Wave Ratio (VSWR) is the ratio between the impedances of the feed line and the load. If we connect a 50 Ohm resistor at one end of a piece of 50 Ohm coaxial cable, and connect a transmitter and SWR meter at the other end, the VSWR will be 1:1. The resistor is not resonant. However, if we connect a resonant antenna that has an impedance of 144 Ohms to the end of that piece of cable, the VSWR will be 2.88:1 (VSWR = Antenna Impedance / Feed Line Impedance).

If a feed line is cut to a length that creates a VSWR measurement of 1:1 at the transmitter end of that feed line, the actual VSWR on this line is (infinity):1. Using VSWR is not the best method for tuning an antenna. The best method to measure the resonant frequency of an antenna is to use an antenna bridge at the antenna.

High VSWR does not cause feed line radiation. Most of the radiation from a coaxial cable is caused by terminating an unbalanced feed line with a balanced load. The remainder of the radiation is due to other problems such as, braid corrosion, improperly installed connectors, and signal pickup caused by routing the feed line too close to, and parallel to the antenna.

A properly terminated and installed open wire line does not radiate. Even with infinite SWR, the fields surrounding each wire cancel each other out. Terminating the line in an unbalanced load, or causing anything to come within the "field space" will cause unbalance in the line, thus allowing the line to radiate.

Propagation

The ionosphere is a layer in the Earth's atmosphere that lies in a range of 80 to 300 miles above the Earth's surface that reflects radio waves. As the sun shines on the ionosphere it changes composition and height, which affects the propagation characteristics. In general signals below 30 MHz bounce off this layer and return to Earth while signals above 30 MHz go through the layer into outer space. Radio signals that are bounced or refracted off the ionosphere are also affected by the time of day and season of the year.

During the 24-hour cycle the ionosphere changes in height above the Earth and bounces some signals while absorbing others. During the day the higher frequencies (above 10 MHz) tend to propagate while lower frequencies are absorbed. At night the reverse happens. There are many exceptions to this but it is a good general guideline.

Seasons also affect propagation. Summertime in the northern hemisphere means that higher frequencies have better propagation while in the winter the lower frequencies improve. An interesting time of the year for propagation is when the seasons change from fall to winter and from winter to spring. This is often when the best DX can be found. Because the seasonal change is occurring in both hemispheres but in the opposite direction DX from North American to Australia or southern Africa can be at its best.

Another phenomenon that affects radio propagation is the 11-year sunspot cycle. A peak occurred during the year 2000 and the next peak will occur around 2011. A sunspot low occurs at the midpoint of this cycle. When the sunspots are at their maximum propagation is at its best. At this time the higher shortwave frequencies exhibit the best propagation extending to 6 meters, which becomes quite popular during this time of the cycle. 10 meters can easily work stations worldwide with low power (even qrp) and a modest antenna.

<u>Band (meters)</u>	<u>Frequency (MHz)</u>	<u>Use (band conditions vary for many reasons)</u>
160	1.8 – 2.0	Night
80	3.5 – 4.0	Night and Local Day
40	7.0 – 7.3	Night and Local Day
30	10.1 – 10.15	CW and Digital
20	14.0 – 14.350	World-wide Day and Night
17	18.068 – 18.168	World-wide Day and Night
15	21.0 – 21.450	Primarily Daytime
12	24.890 24.990	Daytime During Sunspot Highs
10	28.0 – 29.7	Daytime During Sunspot Highs
6	50 – 54	Local to World-wide
2	144 – 148	Local and Medium Distance
70 cm	430 – 440	Local

Near Vertical Incidence Sky wave Antennas

NVIS propagation is a propagation pattern that uses antennas with high-angle radiation (almost 90 degrees, vertical) and low operating frequencies for a range of about 0-300 miles.

Long distance propagation uses radio waves that are reflected from the ionosphere and return to earth at some distance away. Radio waves that are radiated at a very low angle, travel a long distance to reach the ionosphere at a very shallow angle and return to earth far away. When the angle of radiation increases, the radio waves reach the ionosphere at a greater angle, and return to earth closer to their point of origin. Signals that reach the ionosphere at a higher angle of incidence will not be reflected at all, but will continue out into space. The area of reflection that would have occurred is the "skip zone". Depending on operating frequencies, antennas, and propagation conditions, this skip zone can start at roughly 12 to 18 miles and extend out to several hundred miles, preventing communications.

NVIS antennas are designed to minimize the ground wave (low takeoff angle) radiation and maximize the sky wave (very high takeoff angle, 60-90 degrees). Essentially, the NVIS antenna radiates a wave almost straight up, then bounces from the ionosphere and returns to the Earth in a circular pattern around the transmitter. Because of the near-vertical radiation angle, there is no skip zone. Communications are continuous out to several hundred miles from the transmitter. The nearly vertical angle of radiation requires the use of lower frequencies, usually 2-10 MHz. This type of propagation is excellent when communicating over hills and mountains. These frequencies are the same frequencies that contain a lot of atmospheric noise, such as distant thunderstorms. The NVIS antenna is optimized for listening to signals from nearby areas, and minimizes the reception of signals from distant sources.

One of the most effective antennas for NVIS is a dipole that is mounted from 0.1 to 0.25 wavelengths above ground. When a dipole is brought very close to ground, the angle of radiation increases. In the range of 0.1 to 0.25 wavelengths above ground, vertical and nearly vertical radiation reaches a maximum.

Skip Zones

A skip zone is the area that is not covered by sky wave radiation. In other words, the sky wave angle is such that the sky wave travels a long distance before reaching earth. The distance between the transmitting antenna and the point where the sky wave reaches the earth is the skip zone.

The "take-off angle" is the angle at which a wave leaves the transmitting antenna.

Nomograph for determining primary skip zone (one hop) as a function of radiation angle.

For a 2 or 3 element yagi at HF (7 to 14 Mhz) approx heights are:
(assuming average soil conductivity = 5 mS / meter dielectric constant = 13)

<u>TO Angle (degrees)</u>	<u>Height (feet)</u>	<u>Distance F2 Layer (miles)</u>
45	20	400-800
40	27	450-900
30	32	650-1,300
20	37	950-1,700
15	45	1,200-2,000
12	50	1,300-2,300
10	60	1,400-2,400

For a 2 or 3 element yagi at HF (21 to 28 Mhz) approx heights are:
(assuming average soil conductivity = 5 mS / meter dielectric constant = 13)

<u>TO Angle (degrees)</u>	<u>Height (feet)</u>	<u>Distance F2 Layer (miles)</u>
45	20	200-400
40	27	225-450
30	32	325-650
20	37	475-850
15	45	600-1,000
12	50	675-1,150
10	60	700-1,200

Emergency Power

Emergency Power Requirement Estimate

<u>Appliance</u>	<u>Rated Watts</u>	<u>x Hours/day</u>	<u>Surge Watts</u>	<u>Surge Watts</u>
Light Bulbs (75 watt each)	75 x number	_____	75 x number	_____
Compact fluorescent (25/100 watt)	25 x number	_____	25 x number	_____
Refrigerator/Freezer	500	_____	2000	_____
Sump Pump	800	_____	2000	_____
Water Pump (1/3 HP)	1000	_____	3000	_____
Furnace Fan (1/2 HP)	875	_____	2300	_____
Electric Blanket	400	_____	400	_____
Space Heater	1800	_____	1800	_____
Heat Pump	4700	_____	12000	_____
Dehumidifier	650	_____	800	_____
Attic Fan	300	_____	900	_____
Table Fan	800	_____	2000	_____
Window Air Conditioner	1200	_____	4800	_____
Central Air (10k BTU)	1500	_____	6000	_____
Central Air (24k BTU)	3800	_____	15000	_____
Central Air (40k BTU)	6000	_____	24000	_____
Computer	300	_____	300	_____
CD Player	100	_____	100	_____
VCR	100	_____	100	_____
Radio	100	_____	100	_____
Television	300	_____	300	_____
Receiver	420	_____	420	_____

Microwave	800	_____	800	_____
Blender	300	_____	900	_____
Coffee Maker	1500	_____	1500	_____
Electric Range (1 element)	1500	_____	1500	_____
Toaster (2-slice)	1000	_____	1600	_____
Dishwasher (Hot Dry)	1500	_____	3000	_____
Electric Oven	3410	_____	3410	_____
Steam Iron	1200	_____	1200	_____
Washing Machine	1150	_____	3400	_____
Gas Clothes Dryer	700	_____	2500	_____
Electric Clothes Dryer	5400	_____	6750	_____
Security System	500	_____	500	_____
Deep Freezer	500	_____	1000	_____
Hair Dryer	1200	_____	1200	_____
Garage Door Opener (1/3 HP)	750	_____	750	_____
Electric Water Heater	4000	_____	4000	_____

Total Per Day		_____		_____

Note: the generator must be able to handle the total surge power.

Note: Compact fluorescent (25/100 watt) bulbs provide an equivalent of 100 watts of light and use 25 watts of power.

Generators

Generators are basically gasoline, natural gas, or propane powered. They usually generate substantial amounts of power. Portable generators commonly generate 1,000 to 5,000 watts continuously with a surge of about 1,300 to 6,500 watts. There are several disadvantages of gasoline powered generators. They require a constant refilling of gasoline and gasoline cannot be stored for long periods of time. Gasoline stations require electric pumps to supply gasoline and they may not have emergency generators. Natural gas is often available in many homes. Propane can be stored. Propane tanks are usually refilled by gas pressure, which eliminates the need for electric pumps.

Solar Power

Solar power is far more expensive than generator power. There are several advantages of using solar power. Sunshine is the source of power, which eliminates dependency on vendors for fuel. Solar power is clean and requires little maintenance. The disadvantage is initial cost. Typically, solar power is used to charge batteries, which are connected to an inverter.

A solar cell or photovoltaic cell (PV) is made of semiconductors, usually silicon. Ordinarily pure silicon is a poor conductor of electricity so impurities such as phosphorus and boron are added to create the semi-conductor. The addition of these impurities allows the silicon to conduct electricity. The semiconductor absorbs part of the light. The absorbed light energy knocks electrons loose, allowing them to flow freely. Metal contacts are placed on the top and bottom of the solar cell so that current can be drawn from it.

A solar electric panel consists of an aluminum framed sheet of highly durable low reflective, tempered glass that has had individual solar cells adhered to the inner glass surface. These individual solar cells are wired together in a series parallel configuration to obtain the necessary voltage and current. The back of the panel is protected by another sheet of tempered glass or a long lasting material such as Tedlar. The series parallel connections are passed through the protective backing and then wired to a weather proof junction box which is permanently mounted to the back of the panel where the panel's output connections are made. There are also flexible cells and panels, roof tile cells, etc.

Solar panels are rated as watts per hour. For example, in direct sunlight, a 50 watt solar panel will produce 50 watts per hour. It will produce 350 watts in 7 hours, and so on.

Batteries

When designing a marine deep cycle battery, manufacturers must keep in mind that the battery may be used for starting a boats engine. In order to start an engine, the battery must contain a lot of plates and plate area, which give the battery its high cranking capacity. In order to squeeze enough plates into a standard battery case, the plates must be made thin. The thinner the plates the shorter the life span of the battery when it is used in a deep cycle application. If cost is a major factor and the batteries will only be used occasionally during an emergency, a marine deep cycle battery may be adequate.

A much better choice for long-term continuous use is the golf cart battery. The plates are much thicker and designed to be deep cycled below 50% depth of discharge day in and day out, year after year. A properly maintained golf cart battery should last 3 two 5 years in a typical renewable energy

application. A typical golf cart battery is available in a 6 volt 220 amp hour ratings. Two batteries will be required and they will need to be wired in series to produce 12 volts @ 220 amp hours. Golf cart batteries are considered the minimum type of battery that is used in renewable energy application. There are larger batteries available in 6, 4 and even 2 volt configurations which have even larger plates and thus longer life expectancies.

When there is power available from the utility company, batteries can be charged from the power line. During emergencies, when there is no power from the utility company, batteries will have to be charged from the solar panel.

Calculating Battery Usage:

$$\frac{\text{Amp Hour x Volts (Watts)}}{\text{Hours of Use}} = \text{Watts per Hour}$$

$$\frac{\text{Amp Hour x Volts (Watts)}}{\text{Watts per Hour}} = \text{Hours of Use}$$

Example:

A 12 volt, 100 ah battery will provide:

100 amps in 1 hour (1200 watts in 1 hour)

14.3 amps for 7 hours (171 watts in 7 hours)

5 amps for 20 hours (60 watts in 20 hours)

Calculating the Load:

Watt Hours = Load Watts x Hours of Use
Add 10 percent for battery losses.

Example: If a television draws 200 watts and runs for three hours (200 x 3 = 600) it will use 600 watt hours

Inverters

An inverter is an electronic device, which inverts DC energy AC energy. Most household appliances such as refrigerators, TVs, lighting, stereos, computer etc., all run off of AC electricity.

Modern DC to AC inverters are very reliable, quiet, and require virtually no maintenance. There are two different types of DC to AC inverters in common use today. The first type of inverter is known as a modified sine wave inverter. This type of inverter is very high in efficiency and produces a waveform, which is an approximation of the pure sine wave waveform.

High frequency units take the incoming 12 Volts DC and will step up that voltage to approximately 200 volts DC through a high frequency DC to DC converter circuit and then will take the 200 Volts and will wave shape it into a modified sine wave using a using a device called a high voltage H-bridge. The high voltage H-bridge is basically a group of field effect transistors that are arranged in such a way as to form the necessary half cycles that create the modified sine wave at the 60 Hz frequency required for US appliances. By utilizing high frequency, the need for a large iron core output

transformer is eliminated and much smaller transformers can be used. As a result of this, high frequency inverters tend to be much lighter but do have a lower surge capacity because they lack the fly wheel effect found in heavy iron core output transformer based inverters.

Low frequency units take the incoming 12 Volts DC and converts it into AC, using a multivibrator or microprocessor based circuit. The AC is kept at a low voltage and is converted into a 60 Hz signal before it is fed to the iron core transformer. Wave shaping and the increased current that is needed to drive the transformer is performed again by an H-bridge which is a group of field effect transistors that are arranged in such a way as to feed high current pulses to the primary windings of the transformer at precise moments of each wave form half cycle. The transformer converts the lower voltage which was fed to its primary windings into 120 Volts AC at its secondary windings using simple transformer step up principles involving a 10 to 1 ratio, converting 12 Volts AC to 120 AC. This type of inverter is more durable than the high frequency inverters, and has a much higher surge capacity. Low frequency units tend to cost two to five times more than do high frequency units and often weigh four times more.

The second type of inverter is known as a pure sine wave inverter. This type of inverter produces pure sine waves, but at the cost of some efficiency loss and at a much higher price. Most pure sine wave inverters are typically priced at least 75% higher than the modified sine wave counterparts and in some cases do not have as high of a surge capability as do modified sine wave units.

A 3,000 Watt, 120 VAC, Output Solar System

The Batteries will need to supply 3,600 watts of electricity per hour, 86,400 watts per day. The inverter efficiency is about 71 percent. Therefore 3,600 watts DC will be needed to convert to 3,000 watts AC. The solar panels will need to charge the batteries with 86,400 watts during sunlight (about 7 hours per day) at the rate of 12,342.9 watts per hour. The system will require a space of about 30 feet x 30 feet, weigh more than 7,000 pounds, and cost over \$60,000.

Calculate Time of Battery Use:

$$\frac{\text{Amp Hour x Volts (Watts)}}{\text{Watts per Hour}} = \text{Hours of Use} = \frac{400 \text{ ah} \times 6 \text{ volts} \times 36 \text{ batteries}}{3600 \text{ watts per hour (150 a} \times 24 \text{ v)}} = 24 \text{ hours}$$

Calculate Time of Battery Recharge from Solar Panels:

$$\frac{\text{Amp Hours x Volts (Watts)}}{\text{Solar Panel Watts}} = \frac{400 \text{ ah} \times 6 \text{ volts} \times 36 \text{ batteries}}{66 \times 185 \text{ watts per hour}} = 7.1 \text{ hours}$$

The system consists of:

- Sixty Six 185 watt, 24 v solar panels, 62" x 32.5" x 1.8", 38 pounds, (about \$50,000)
Connected in parallel (923.6 square feet [30' x 30'], 2,508 pounds)
- 3,600 watt output, 24 volt - 210 amp input (150 amp input at 3000 watt output), modified sine wave inverter (about \$1,800)
- Three 60 amp charge controllers (about \$600)
- Thirty six 400 ah, 6 volt, 127 pound batteries connected in series and parallel for 24 v (about \$7,700 and 4,572 pounds)
- Miscellaneous cables, etc.

U.S. Amateur Bands

December 2004

Extra (E), Advanced (A), General (G), Technician (T), Technician Plus (T+), Novice (N)

160 Meters

E, A, G 1.8 – 2.0 MHz CW, RTTY, Data, Phone, Image

80 Meters

E	3.5 - 3.75 MHz CW, RTTY, Data	3.75 - 4.0 MHz CW, Phone, Image
A	3.525 – 3.750 CW, RTTY, Data	3.775 – 4.0 MHz CW, Phone, Image
G	3.525 – 3.750 CW, RTTY, Data	3.775 – 4.0 MHz CW, Phone, Image
N, T+	3.675 – 3.725 CW	

60 Meters

E, A, G 5.332, 5.348, 5.368, 5.373, 5.405 MHz. USB phone, 50 W ERP max. power
5.1675 MHz, Alaska emergency use only

40 Meters

E	7.0 – 7.15 MHz CW, RTTY, Data	7.15 – 7.3 MHz CW, Phone, Image
A	7.025 – 7.15 CW, RTTY, Data	7.15 – 7.3 MHz CW, Phone, Image
G	7.025 – 7.15 CW, RTTY, Data	7.225 – 7.3 MHz CW, Phone, Image
N, T+	7.1 – 7.15 CW	

30 Meters

E, A, G 10.1 – 10.15 MHz CW, Phone, Image, 200 watt maximum.

20 Meters

E	14.0 – 14.15 MHz CW, RTTY, Data	14.15 – 14.35 MHz CW, Phone, Image
A	14.025 – 14.15 CW, RTTY, Data	14.175 – 14.35 MHz CW, Phone, Image
G	14.025 – 14.15 CW, RTTY, Data	14.225 – 14.35 MHz CW, Phone, Image

17 Meters

E, A, G 18.068 – 18.11 MHz CW, RTTY, Data 18.11 – 18.168 MHz CW, Phone, Image

15 Meters

E	21.0 – 21.2 MHz CW, RTTY, Data	21.2 – 21.45 MHz CW, Phone, Image
A	21.025 – 21.2 CW, RTTY, Data	21.225 – 21.45 MHz CW, Phone, Image
G	21.025 – 21.2 CW, RTTY, Data	21.3 – 21.45 MHz CW, Phone, Image
N, T+	21.1 – 21.2 CW, 200 Watts maximum.	

12 Meters

E, A, G 24.89 – 24.93 MHz CW, RTTY, Data 24.93 – 24.990 MHz CW, Phone, Image

10 Meters

E, A, G	28.0 – 28.3 MHz CW, RTTY, Data	28.3 – 29.7 MHz CW, Phone, Image
N, T+	28.1 – 28.3 MHz CW, RTTY, Data	28.3 – 28.5 MHz Phone, CW,

6 Meters

E, A, G, T, T+ 50.0 – 50.1 MHz CW 50.1 – 54.0 MHz Phone, CW, RTTY, Data, MCW, Image,
Test

2 Meters

E, A, G, T, T+ 144.0 – 144.1 MHz CW 144.1 – 148.0 MHz Phone, CW, RTTY, Data, MCW, Image,
Test

1.25 Meters

E, A, G, T, T+, Novice limited to 25 Watts

222 – 225 MHz Phone, CW, RTTY, Data, MCW, Image, Test

70 Centimeters

E, A, G, T, T+

420 – 450 MHz Phone, CW, RTTY, Data, MCW, Image, Test

23 Centimeters

E, A, G, T, T+

Test

1240 – 1300 MHz Phone, CW, RTTY, Data, MCW, Image,

Novice limited to 5 watts

1270 – 1295 MHz Phone, CW, RTTY, Data, MCW, Image,

Test

Anderson Powerpoles[®]



Figure 1

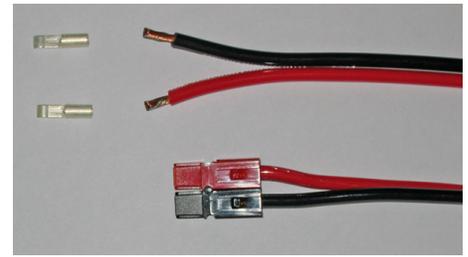


Figure 2

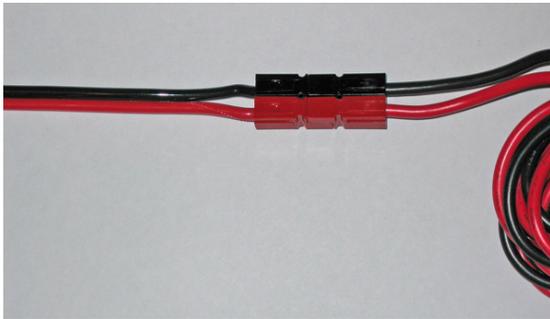
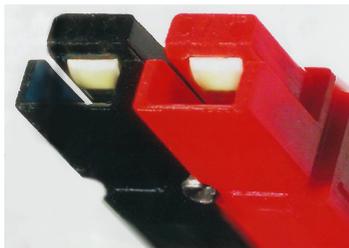


Figure 3



Figure 4



Connectors should be aligned in this direction
(Red on the Right with the conductor on the top)

One of the nicest features of Anderson Powerpoles[®] is that there are no male or female connectors. To connect them together, simply turn one or one set of connectors upside down. This makes them universal and can be used to connect various pieces of equipment easily, even to someone else's power supply.

Start with a set of black and red connectors. Several other colors are available. Slide them together and insert the pin between them as seen in Figure 1.

Next, strip off 1/4" of insulation and slightly tin the wires. Solder the metal connectors to the wires. I find crimping makes it very difficult if not impossible to insert the metal pieces into the plastic shell. After soldering the wires to the metal connectors, allow them to cool. Then insert them into the plastic shells as seen in Figure 2.

To connect to sets of cable together, simply turn one pair upside down and push together as seen in Figure 3.

You can come off the power supply with a double cable as seen in Figure 4. Adapter and junction cables are available commercially. There are also fuse blocks (Rig Runners) and more available commercially.

ITU Phonetic Alphabet

A - Alpha

B - Bravo

C - Charlie

D - Delta

E - Echo

F - Foxtrot

G - Golf

H - Hotel

I - India

J - Juliet

K - Kilo (pronounced keelo)

L - Lima (pronounced leema)

M - Mike

N - November

O - Oscar

P - Papa

Q - Quebec (pronounced kaybek)

R - Romeo

S - Sierra

T - Tango

U - Uniform

V - Victor

W - Whiskey

X - X-ray

Y - Yankee

Z - Zulu

International Q Signals

QRA - What is your call sign?

QRG - Will you tell me my exact frequency (or the frequency of...)?

QRH - Does my frequency vary?

QRI - What is the tonal quality of my transmission?

QRJ - Are you receiving my transmissions poorly?

QRK - What is the intelligibility of my signals?

QRL - Are you/is the frequency busy? More!

QRM - Is there man-made interference to my transmissions? More!

QRN - Are you troubled by static or some other natural source of noise? (ok, cut the jokes :-) More!

QRO - Shall I increase power? More!

QRP - Shall I decrease power? More!

QRQ - Shall I send faster? More!

QRS - Shall I send more slowly?

QRT - Shall I stop sending? More!

QRU - Do you have anything for me?

QRV - Are you ready? More!

QRX - When will you call me again?

QRY - What is my turn?

QRZ - Who is calling me?

QSA - What is the strength of my signals?

QSB - Are my signals getting weaker? More!

QSD - Is my keying defective?

QSG - Shall I send (number) messages at a time?

QSK - Can you hear me in between your signals and may I break in? More!

QSL - Can you acknowledge receipt? More!

QSLL - I will QSL on receipt of your QSL card. More!

QSM - Shall I repeat the last message I sent to you?

QSN - Did you hear my transmissions on (frequency)?

QSO - Can you communicate with me? More!

QSP - Will you relay to (station)?

QST - General call preceding a message addressed to all Amateurs. More!

QSU - Shall I send or reply on this frequency?

QSW - Will you send on this frequency?

QSX - Will you listen on (frequency)?

QSY - Shall I change transmission to another frequency?

QSZ - Shall I send each word or group more than once?

QTA - Shall I cancel message (number)?

QTB - Do you agree with my word count?

QTC - How many messages do you have to send?

QTH - What is your location?

QTR - What is the correct time?

Signal Reporting

<u>Characteristics</u>	<u>Readability</u>	<u>Signal Strength</u>
1	Unreadable	Faint signals, barely perceptible
2	Barely readable, occasional words distinguishable	Very weak signal
3	Readable with considerable difficulty	Weak signal
4	Readable with practically no difficulty	Fair signal
5	Perfectly readable	Fairly good signal
6		Good signal
7		Moderately strong signal
8		Strong signal
9		Extremely strong signal

A signal report "5 by 9" would indicate that the readability is "5" (perfectly readable) and the signal strength is "9" (strong signal)

CTCSS (PL) Tone Frequencies

The purpose of CTCSS is to reduce co-channel interference during band openings. CTCSS repeaters would respond only to signals having the CTCSS tone required for that repeater. These repeaters would not respond to distant weak signals on their inputs and would not repeat those signals. Listed are the standard Electronic Industries Association (EIA) frequency codes, in hertz, along with their Motorola alphanumeric designators.

67.0 – XZ	146.2 - 4B
69.3 – WZ	151.4 - 5Z
71.9 – XA	156.7 - 5A
74.4 – WA	162.2 - 5B
77.0 – XB	167.9 - 6Z
79.7 – WB	173.8 - 6A
82.5 – YZ	179.9 - 6B
85.4 – YA	186.2 - 7Z
88.5 – YB	192.8 - 7A
91.5 – ZZ	203.5 - M1
94.8 – ZA	203.5 - M1
97.4 – ZB	206.5 - 8Z
100.0 - 1Z	206.5 - 8Z
103.5 - 1A	210.7 - M2
107.2 - 1B	218.1 - M3
110.9 - 2Z	225.7 - M4
114.8 - 2A	229.1 - 9Z
118.8 - 2B	233.6 - M5
123.0 - 3Z	241.8 - M6
127.3 - 3A	250.3 - M7
131.8 - 3B	254.1 - OZ
136.5 - 4Z	
141.3 - 4A	