The Elmer Project Part V

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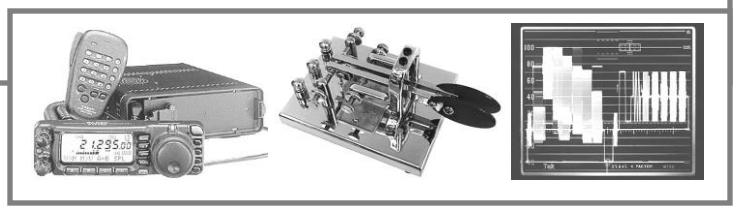
An Ode To The Mode



Edited by Nelson Derks, AC5UP

One of the advantages of being a Radio Amateur is the ability to experiment with modulation techniques and discover their strengths and weaknesses. There is no one perfect mode for every situation. In this installment we'll look at some of the more popular modes, and why we choose them.

PHONE: FM / SSB / AM

The voice modes are by far the most popular on the Amateur bands. No surprise here, if you can master the art of putting one word after another and knowing when to push the button on the mic, you're there. Phone has a fast learning curve and works well in conversational QSO's. The most popular of the voice modes is likely to be Narrow-Band FM due to the large number of Technician class licensees and the low cost of getting started. Two Meter FM rigs usually tune in 5 kHz steps with automatic repeater offsets that make setting up your station a snap. Like many of you, my first QSO was on Two Meters and the biggest challenge was a little mic fright… The rest was plug and play. FM is legal in many band segments above 29 MHz and offers good sound quality and non-critical tuning.

FM has several unique characteristics like the capture effect and noise floor limiting that make it better suited to stronger local signals than weak signal DX. FM detectors favor the stronger signal during a 'double' and those of you who travel have probably heard an FM car radio capture one of two stations between cities, then flip back & forth depending on the strongest signal at the moment. That's the capture effect, and on modern gear it takes less than a 1 dB differential for the strongest signal to cover all others. That makes for near-zero QRM and no heterodyne whistles, but it also makes it difficult to pull a weak signal out of the noise. As a signal reaches the detector threshold, the signal-to-noise ratio improves rapidly as the signal level improves. With a modest signal your FM rig will yield cleaner copy than AM or SSB, but may suffer from multi-path and phase distortion in difficult locations. The difference in how an AM or FM detector handles weak signals can be heard by disconnecting the antennas from any AM/FM broadcast receiver with the FM muting turned off. The AM section is quiet with no signal, but the FM side is solid noise. FM is easy on the ears with a good signal, but VHF'ers who live to stretch the last mile from a milliwatt prefer CW and SSB for their ability to work down to (and often below) the noise floor.

Single Side Band is an improvement over Double Sideband AM and is definitely the preferred mode for weak signal voice work. A standard AM signal is comprised of three components: An RF carrier plus the upper and lower side bands added by the modulating audio. The carrier conveys almost nothing to the listener, while the modulation side bands are mirror images of each other. Do we need both of them? An AM transmitter can deliver about the same signal strength with approximately 40% less input power by suppressing the carrier. Eliminate one of the side bands, and you save another 30% on your power bill with almost no loss of information. That's called efficiency, and when an OM can chew rags half way around the world on a barefoot rig you understand why SSB gained the popularity it enjoys on HF.

Have you ever wondered why so many 100 Watt (Peak Envelope Power) SSB rigs are rated at 40 Watts (or less) on AM? 100 Watts PEP works out to 30 + 30 Watts in the upper & lower side bands plus 40 Watts of carrier when you flip the switch to AM. You still have 100 Watts PEP going up the coax, but only 40 Watts of carrier. This also explains why the CW, FM and RTTY ratings are usually 100 Watts. These modes use a steady carrier at 100 Watts peak to peak with no amplitude modulation. We wiggle the VFO for FM and RTTY, or pulse the carrier on and off for CW, but it's always 100 Watts peak.

Returning to the differences between SSB and AM, seasoned OM's probably cringe when they see a phrase like "no loss of information with SSB". If you've heard the AM'ers on 75, 20 and 10 Meters you know why. There are Hams running AM boat anchors that sound so good I almost wish jingle ID's were legal. No loss of information? In terms of a QSO exchange, no, but the reduced audio fidelity of SSB is hard to ignore. An SSB signal uses less bandwidth than AM and the tradeoff (like FM) is between efficiency and fidelity. An SSB receiver has to replace the missing carrier with a signal from the local BFO (Beat Frequency Oscillator) in exactly the right ratio as the transmitter must remove a side band & carrier without compromising the desired signal. Circuit tolerances and frequency stability are significantly tighter and periodic tune-ups by the Radio Doctor are not unheard of if you hope to radiate a clean SSB signal. One way to tell if your rig needs a little TLC is to find a quiet spot and switch from LSB to USB. If there's a significant change in the tone of the white noise, the alignment could use a touch-up.

CW: More Than A Mode…

…it's a Tradition. Nothing warms up a conversation among Hams like the topic of CW as a license requirement. But, for the practical application of the mode, I'll defer to Clif, **N5UW** for his experience:

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CW! The most despised, discussed, cussed and maligned mode of operation on the bands. Why bother? You don't spell out every word with the mic, why do it with a key? Well, there comes a time in your DX pursuits when you start hearing the same countries over and over. A change of mode can open a whole new world of DX to the operator. CW is, and always has been, one of the most efficient ways to communicate on the air. It will get through when an SSB signal is gobbled up by noise and doesn't rely on nuance (like audio does) for good

intelligibility. The transmitter is either on or off and every character element is sent at full power. It's no coincidence the first Amateur mode is the most efficient. Radio parts were expensive in the early days when receiver sensitivity was measured in millivolts, not microvolts, and you're not the first Ham to want a signal that gets out.

Before Amateur Radio I spent 25 years doing living history re-enactments. I knew how to build a fire with flint and steel. To me, high tech was a Bic lighter! You may think I was attracted to CW because of the tradition, but nothing could be further from the truth. EVERYONE HATES CW when they are trying to learn it! No one is a natural-born CW operator and I thought I would never get past 5 wpm. Learning any language takes time, practice, and a desire to become fluent enough to be understood.

I made it through the upgrades all the way to 20 wpm and an Extra Class license then vowed I was finished with CW! I spent two years chasing DX on Phone and had a ball. Got the certificates and was really full of myself. Then the Solar Cycle hit rock bottom and the DX went Buh-Bye. Oh no! What now? My buddy George, **KG5HR** started calling on the phone every night, telling me to get on 40M CW and work the rare one with a huge signal. I would listen but couldn't copy squat. After about three months I decided enough was enough and got on the Novice part of 40 to copy code. George talked me into a hot DX pileup one night that totally frustrated me. He finally did the Elmer thing and said "just copy one letter at a time till you have his call. This is not a race, you know. Take all the time you need. When you get his call sign all you do is recognize your own call when he answers you, then send 5NN back at him." Dang… It worked!

Find a friend who is willing to get on the air with you and jump in the fray. Another good hint was to find a small cassette recorder capable of two speeds. On the really fast guys, record them at high speed then play it back at the slower speed. This makes deciphering a 35 wpm call sign a snap. Remember, this is not a race. With a good attitude you will have fun, and try to remember that no one is perfect. The best of CW ops make mistakes and my biggest hang up was the fear of making a mistake on the air. Don't worry, we all learned CW as a second language and everyone messes up a few characters in a QSO.

Now, for the reward: It took two years before I worked my first 100 countries on SSB. Plenty of those Q's were spent trying to get between the big boys with their big antennas and amps. Like many of you, I got a few bruises along the way but hung tough. After becoming active on CW I had 100 countries confirmed in one year with 100 watts into wire and vertical antennas. What a difference! As a bonus, I logged some new countries that I never heard on phone. There are ops who run CW only, just as there are those who do only phone. If you really get into the DX chase full bore, it pays to be fluent in both modes. CW is the one tool in your DX Bag of Tricks that everyone can afford! ***—N5UW***

DIGITAL: RTTY & The 'TOR' Modes

I'm going to offend a few digital purists by lumping RTTY and the other Frequency Shift Keying (FSK) data modes together, but will treat PSK-31 as a separate mode. Read on, and you'll understand why…

The granddaddy of all the text modes is TeleType (TTY) and, like any mode with a history, carries a lot of baggage. TTY gear can be traced back nearly 70 years in commercial and military applications and relies on the five bit Baudot alphabet of 96 characters. That's enough to get a message out, but without Forward Error Correction (FEC) Radio TeleType (RTTY) will drop characters and add garbage to the print on all but the cleanest signals. Until recently, frequency drift, QRN, QRM, and QSB were the persistent enemies of RTTY Ops. Modern transceivers have eliminated the VFO drift problem while Digital Signal Processing (DSP) is remarkably effective in dealing with everything but the heaviest QSB. My first experience with RTTY was copying the press feeds from Pravda and TASS on 14.990 MHz in the late 80's with a Collins R-390 and a Drake demodulator that translated Baudot to ASCII for the Diablo Hy-Type II. Pretty classy setup for an SWL, compared the more traditional Model V and tube demod approach, but like all boat anchors it ate paper, ribbons and the printer could be heard anywhere in the house. The R-390 wasn't drifty after it warmed up for an hour or two, but it was SOP to baby-sit the BFO with one eye on the tuning display. I'm glad those days are gone. Now I can park the IC-756 on an ARRL bulletin and the KAM+ will see 30 minutes of solid print from a cold start without touching anything, plus the DSP works FB. It took 60 years of technology to make RTTY a user-friendly mode and it will probably be with us for sixty more as RTTY's weakness against QRM and QRN is also a virtue. FEC modes like Amtor, Pactor and Packet will yield either perfect print or NO print. Under poor conditions, RTTY will squeeze out bits & pieces from a QSO right down to the noise floor. Just as N5UW has seen DX success with CW, I've seen the same with RTTY. If you're new to the digital modes, remember that your transmitter is running a 100% duty cycle when you're on the keys and many ops reduce output power to protect the finals and power supply from overheating. It's a good idea to 'finger test' the heat sinks to determine what your limits are.

Amtor, Pactor, G-Tor, Clover, Packet and other TOR modes are variations on the RTTY theme that add several refinements. It's still FSK keying, but they use the 8-Bit ASCII set of 256 characters with Forward Error Correction to ensure perfect copy at both ends of the circuit. The data stream is chopped into packets with a checksum value the receiver can use to test the data integrity of each packet. Whenever a bad packet fails this test a re-send is requested. The terminals will keep re-sending this packet until it's received correctly or one side drops the link for excessive re-tries. This is common practice in computer transfer protocols and you can download files over the radio using these modes. By Internet standards it's slower than a Yugo with a cracked distributor cap, but it can be done. There are Amtor, Packet and Pactor Bulletin Board Systems (BBS's) on VHF & HF that work much like a dial-up telephone BBS of the early 90's. You set the frequency and send a connect request to the BBS's call sign. If the request is received, the BBS takes over the link and sends the menus and such needed to navigate the system, check your mailbox, or send new mail. Twenty years ago this would have been unbelievable High-Tech for a Ham Radio application, but today the appeal is strictly hobbyist. Check the specs on a broadband Internet connection and you'll see there's no comparison in speed. We don't have the bandwidth to go much above 9600 baud on VHF (300 on HF) and for a simple keyboard-to-keyboard QSO that's adequate. The FEC modes demand a modern transceiver with diode switching as a relay won't survive the constant RX / TX turnovers for very long. Like RTTY, the transmitter duty cycle is greater than

CW or SSB, so reduce your power during extended QSO's. Also like RTTY, there are numerous software programs available to automate the QSO exchange and make the keyboard modes more conversational. Some logging programs (like Logger) also include a terminal emulator with call sign lookup and automated contest exchange.

PSK31: A Mode With A Future

What gives one mode more of a future than another? The traditional method of going digital involves a box that hangs off the back of your radio to convert signals between analog RF and digital data. That's conventional thinking and the processor and firmware in the digi-box determine its capabilities. The digi-box plugs in to your Pentium-something PC running as a dumb terminal. Sound like a good idea? Pull the top cover off most TNC's and you'll find a genuine Zilog Z-80 processor (copyright 1984) running at 4 or 8 MHz. The Z-80 is perfectly capable of handling this task, but your computer can do so much more than display characters. Like CW, PSK31 uses a variable size character code at 31 baud for an equivalent speed of 50 wpm. It's not an FEC mode, so it can work at the noise floor via Quadrature Phase Shift Keying and connects to the sound card and serial port of your computer. Let's see what Bob, **K5SIT** has to say about operating PSK31:

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The price of computers continues to drop as the speed and features of the machines continue to improve. This is a marvelous coincidence for Amateurs as it's now very affordable to put your computer on the air.

I have worked 43 DXCC countries, all 50 US States, 20 IOTA's, every call area in VK-Land, plus WAC since January 2001 using PSK31. That's a grand total of 443 contacts on all HF bands (except 160M) using nothing more than 50 Watts into a vertical. I've also found that PSK31 folks QSL well above the average and I have a 98% return rate on my QSL cards.

First, here's the brag file I use on PSK31: Yaesu FT-847 @ 50 Watts. Butternut Vert. or inverted vee's for 160m & 80m. Pent. III @ 650 mhz. DigiPan V1.6d w/RIGblaster. Logging-LOGic V5.3.127 Auto from DigiPan. QSL is 100% via eQSL and/or direct/or Buro.(DX).

Here's the exchange file I use: <CALL> <NAME> DE <MYCALL> HELLO <NAME> NICE TO MEET U. NAME IS BOB BOB. UR RST IS <RST> <RST>. QTH WOODWARD, OKLAHOMA. WOODWARD, COUNTY. GRID: EM06jg. SO HOW CPY? DigiPan uses macros that automatically replace the information in the brackets with the actual QSO exchange. Just double click on the receive screen and it is done. You will also notice the exchange is sent in uppercase as caps run slower on PSK31. When you're working DX, you want the call exchange to go out correctly. Use lowercase the rest of the time or someone will tell you about it! DigiPan has space for 24 macros you can customize to reduce the routine typing effort. Just click the macro tab and the text is inserted into the transmit buffer. I have worked complete QSO's using just a set of macros and this works especially well on shorter Q's like the DX contacts.

The first thing to do is download DigiPan 1.6d. Get it installed on your computer and run a patch cord from your "speaker out" connection to the "line in" connection on the sound card. Run a sample QSO sound file and you'll see what the signal should look like. Once you have the computer working, you'll need to build or buy an interface for your rig. *QST* carries plenty of ads for these and the links at the end of this section will point you in the right direction. You can find schematics on line and there's not much to the interface box. There are other programs you can try, but DigiPan is a good choice for the beginner.

One thing to remember is that PSK31 does not like high power or too much audio drive. If you push it too hard, someone will get on your case about it. The vertical antenna I use is tuned through a MFJ 989C tuner and DigiPan has a tune macro that will key the rig. Watch the output needle and turn your output down to Ø then bring it up slow until you just see power going out. Turn your mic gain down to Ø then back up just until you see output. Bring up the Windows audio control panel and turn the audio down to Ø then back until you just see the output come up. Don't use any compression. Remember, lower is better! Read the help files in the DigiPan package and here are some links I've found useful:
http://www.packetradio.com/psk31.htm
http://www.westmountainradio.com/
http://www.aintel.bi.ehu.es/psk31.html
http://www.qsl.net/wm2u/ ***—K5SIT***

IMAGE MODES: FAX, SSTV, ATV

People write big, fat books about this stuff, especially Fast-Scan ATV. If you've heard the signals that sound like they need a shot of WD-40 on 14.230 and 14.233 MHz, that's FAX. There is (almost) always some one sending a picture. Like other modes, it's best done through a computer. You can store and edit received picture files, resend them and put your mug on the air. Cheap. Visit: www.muenster.de/~welp/sb.htm and http://www.hffax.de/ for more.

I have very little exposure to Slow Scan TV (SSTV). It's essentially a variation of Facsimile where a string of frames are sent in a sequence that conveys a sense of time or motion. It's not fluid, but it does get the point across. The original application was for security cameras over a phone line and this was an easy adaptation to the limited bandwidth of HF. There is plenty of information and software on the Web at: www.btinternet.com/~g7pbb/sstv.htm and http://sstv.home.mindspring.com/

Fast Scan Amateur TV is real-deal NTSC Television. Due to the 5 MHz bandwidth of the signal it's restricted to 440 MHz and up. An ATV station can be as simple as a camcorder on a plug 'n play transceiver, or as sophisticated as a Ham Shack control room complete with a sync generator, cameras, VTR's, switcher and a keyer for the character generator. Much of the RF gear is salvaged from Cable TV systems while the video stuff comes from wherever you find it. Cable channels cover the 450 MHz range and old CATV modulators can be peaked, tweaked and amplified up to the legal limit. (!) RX is as simple as a cable-ready TV with a preamp (or down converter) at the antenna. ATV is probably the most tech-intensive mode in Amateur Radio and you can drop a bundle on the gear or master the art of scrounging. For those of you who remember the days of putting a signal on the air with surplus military gear, ATV is still like that. Tulsa is home to one of the finest ATV stations I've seen (on the air) at **WA5QDZ** and we have a few ATV repeaters in town. It's not for everyone, but ATV will keep a chronic tinker occupied. *Roll Credits…* ***—AC5UP***

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— 73 and Good DX!