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HF Update

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Today's Topics

- Transceiver overview
- Spectrum Scopes
- Portable Operating Update
- Keys/keying...anatomy of a key
- Appendix
 - Dynamic Range Review
- HF Q&A

Transceiver Needs

- Rob Sherwood has long advocated that the average ham only needs 85-90dB Third Order Dynamic Range (DR3)
- There is a DR3 contest going on among the major manufacturers right now. They are on a “more is better” campaign....Don't fall for it.
- There are plenty of really good radios with >85dB DR3 available today. Pick one that has the features you want and ergonomics you feel comfortable with.
- Beginners should not buy a high end radio. The learning curve is steep, even for experienced Hams. You may get discouraged by the complexity. Operating should be fun, not frustrating.

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Receiver Performance Summary

****Res. QRN**
↓

40M

20M

10M

Ref. Sig. Level

Table 1: Dynamic Range by Radio

2 kHz Spacing DR3	Signal Level Causing 3rd Order IMD = Noise Floor*	Radios in This Class		
55 dB	S9	FT-757		
60	S9+5 dB	FT-101E		
65	S9+10 dB	KWM-380	FT-2000	FT-1000D
70	S9+15 dB	TS-830	FTdx1200	IC-761
75	S9+20 dB	IC-756 Pro II/III TS-850	IC-7410/7600 /7700	FT-950 FT-450D IC-781
80	S9+25 dB	Ten-Tec Omni VI+/VII	IC-7800 IC-765	FTdx3000
85	S9+30 dB	R9500	TS-990/590S	FTdx9000
90	S9+35 dB	Ten Tec Eagle Ten Tec Orion I	FLEX 6400	TS-590SG
95	S9+40 dB	Ten-Tec Orion II	IC-7300 IC-7610	Flex 6600 /6700
100 dB	S9+45 dB	Elecraft K3, KX3, TS-890	FTdx5000 IC-7851	Apache ANAN 7000DLE

CW needs
↓

Vertical or Dipole

Yagi up >50'

Big East Coast Contest Station

*Receiver Noise = -128dBm in a 500Hz BW. Chart Format copied from Rob Sherwood, NC0B

**Dynamic Range requirements are reduced by atmospheric noise at your location.

Transceiver Trends

- Looking at this chart as it evolved over the past few years shows Direct Sampling SDRs filling in the high end boxes
- The new Kenwood TS-890 is a single receiver radio to fill in the middle of their product line (\$4K). I don't think the TS-990 has been selling well, it was overpriced for its market niche. The price is coming down.
 - TS-890 price seems high for a single receiver radio
 - Rob Sherwood thinks highly of it for a contest radio
 - TS-590sg is still a bargain
- Yaesu has announced a FTdx101MP/D. It appears to be an analog design based on the FT-5000 (9MHz 1st IF) with a built in SDR for the display. It is reported to have a better synthesizer which helps both RMDR and transmit noise.
 - MP version is 200W with power supply, ~\$5K
 - D version is 100W, ~\$4K
 - This is on my watch list, expect in stores 2Q 2019

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New Transceivers



Transceiver Trends – SDRs

- ICOM is still the big seller with the 7300 & 7610
- My IC-7610 quickly displaced the K3 as my radio of choice, both have great performance. The ICOM wins on ergonomics and audio quality. Both are more than I need.
- FLEX appears to be in the lead of the traditional SDRs but Apache has the cleanest SSB signal on the market and the best Noise Reduction performance as well.
 - FLEX and Apache seem to be having problems getting traction without a dealer network
- Elecraft has been surprisingly quiet. I expected a new transceiver announcement or teaser by now.
- ARRL test reports are putting a bigger emphasis on signal purity these days, probably due to prodding by Rob Sherwood
 - We are getting better RMDR, improved LO noise
 - Transmit audio is being measured, reduced SSB splatter

Spectrum Scopes or Panadapters

- I can't imagine using a radio without a spectrum scope. When I turn on my radio in the morning I flip through the bands 160, 80 and 40M quickly to check band activity.
- You can use a spectrum scope in either of two modes:
 - Fixed: where the scope band display stays the same as you tune
 - Center: where the selected frequency always appears in the center of the display, the display slides as you tune
- Since I'm a rag chewer I prefer the fixed mode. I want to see who is on the band so I can either call them or select a clear frequency to call CQ
- Most radios today have a waterfall display as well. This displays band activity vs time (band history). Very weak signals will often show on the waterfall, but be difficult to pick out of the noise on the spectrum display
- Both DXers and contesters benefit from spectrum displays
 - DXers can watch a pile-up and see what frequency the last station called was on
 - Contesters can find open frequencies to call CQ or simply work their way up a band calling every station they see on the waterfall or scope display

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Spectrum Displays



Spectrum Scopes – cont'd

- I'm going to talk about different radio manufacturer's scopes. I will only talk about radios I've owned
- Icom has always had good scopes. They were the first to market a radio with one, the venerable IC-781.
 - My IC-756 ProII had a nice scope
 - A waterfall display was added to the IC-7800 & 7600 and continues to be a feature of the new radios
- Yaesu scopes are pretty crude, but do show band activity
 - I added an LP Pan to my FT-5000 to have a very good scope, but it is limited to the center mode that I don't like
- The Kenwood TS-990 has a good scope. The TS-890 has a better scope, especially for contesters
- FLEX and Apache computer spectrum displays show a lot of detail
- The Elecraft P3 is my choice for the best scope available

Spectrum Scope Differences

- Different operators and activities need different tools. The following is some recent experience by myself and Rob Sherwood, NC0B
- The Elecraft P3 has adjustable display bandwidth, the resolution automatically increases as the BW is reduced. The SVGA option greatly increases the resolution
 - In the fixed mode the band chunks in fixed steps as you tune beyond the display bandwidth. I use a 50kHz BW, initially it will display 7.000-7.050mHz. As I tune past 7.050 it switches to 7.050-7.100mHz
 - The display is calibrated in either dBm or S-units
 - Waterfall Display tracks spectrum display
- The IC-7610 has a dual frequency display. If you want to watch another band while operating you can. I often monitor 6M for Es openings while operating HF in June/July. Contesters can see when another band opens
 - Fixed mode BW is programmable, it does not move as you tune out of its BW
 - Display is not calibrated
 - Waterfall display tracks spectrum display

Spectrum Scope Differences – cont'd

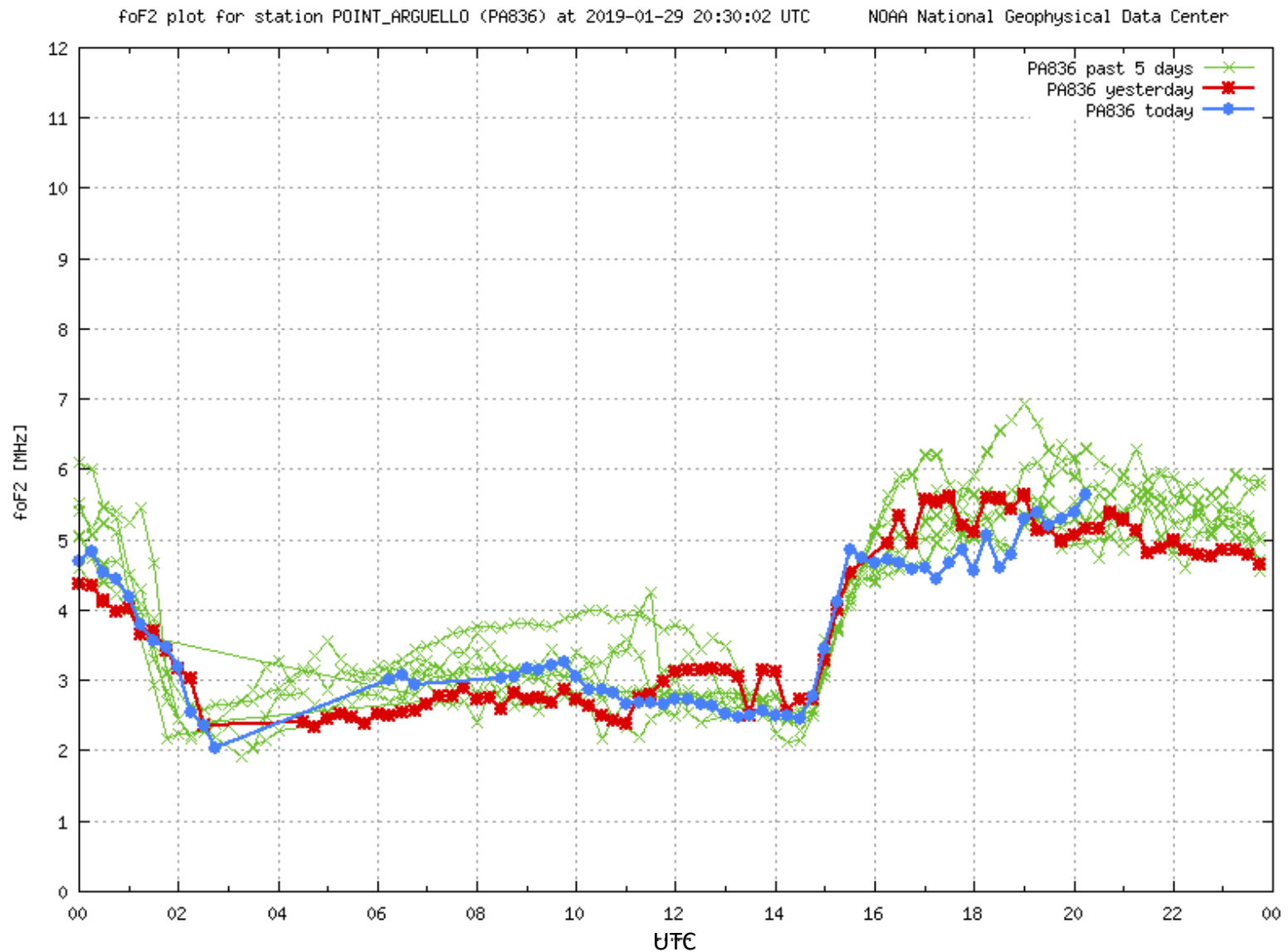
- The new TS-890 has a very nice spectrum scope/waterfall display. I've never used it, these comments were published by Rob Sherwood.
- Rob is a contester. He has what would be categorized as a good contest station in rural Colorado. Much of his hobby is comparing radios in a contest environment.
 - Rob used the IC-7610 (he owns two of them) and the new TS-890 in a recent 160M contest
 - He does not have receive antennas for 160 so he simply starts at the low end of the band and calls every station he can hear on his tall vertical. This is called Search and Pounce operation (S&P for short).
 - When operating S&P a narrow spectrum display is desirable (5-10kHz). Having a fixed display that switched every 5-10kHz could be annoying. You need to wait for the waterfall to refresh each time you switch. The waterfall shows more signals on a noisy band like 160M than the spectrum display plus it has history.
 - The IC-7610 does not switch automatically in fixed mode. Using the center mode, each time you change frequency the waterfall display smears.
 - Rob does not like the Elecraft K3, it sounds too harsh for him (that's true). I think there's more to it but he doesn't talk about it
 - The TS-890 waterfall display does not smear when the frequency is changed, you just lose some data at the displayed band edges. Rob says this is a game changer for S&P contesting
- The TS-890 is a single band radio, some DXers may not like that

Solar Minimum Propagation

- Many of you may have noticed poor propagation for local signals early in the mornings and evenings
- This is due to a low critical frequency (f_oF_2). The critical frequency is the highest frequency that will be reflected by the ionosphere for a vertical incidence signal (90 degrees elevation angle)
- The critical frequency is low due to less ionization in the ionosphere at this point in the solar cycle
- Higher frequency reflections do take place at lower elevation angles. The maximum usable frequency at a given elevation angle is given by $f_oF_2/\sin(\text{elevation angle})$

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Critical Frequency measured at Vandenberg



Skip Distances

Radiation Angle (degrees)	Single Hop Distance (miles)		Antenna Gain (dB)	
	f1 layer	f2 layer	Vertical on Gnd	Dipole @ $\lambda/4$
5	1200	2300	-2	-8
10	800	2000	1	-3
20	500	1200	2	2
30	300	800	2	5
40	240	650	0	6
50	200	500	-2	7
60	200	400	-4	7

Example: For me to chat with my friend WB6BEE in Pagosa Springs, CO, 650 miles from here, on 7MHz I need a critical frequency of $7 \times \sin(40^\circ) = 4.5\text{MHz}$ (~1500UTC). We both use dipoles and have strong signals for this path.

Portable Operation Update

- I still enjoy getting out in the field with my KX2. I have different antennas that I have found work best for me.
- Local Parks
 - End Fed Half Wave up 20' in a tree or using a SOTA Beams Compact Heavy Duty Mast
 - BuddiStick vertical on a tripod with two wire radials



SOTA Beams Compact Heavy Duty Mast

- Condos or other space limited places
 - LNR W4OP 46" loop



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Portable Operation Update – cont'd

- Ocean paths (Pt Vicente)
 - BuddiStick vertical
- Quick set-ups
 - Elecraft AX1, needs a tuner
 - MFJ 1820, no tuner req'd
 - Performance 2-3dB down from the BuddiStick



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Portable Operation Update – cont'd

- I've added a 30W HF Packer Amplifier for times when conditions are poor
 - Some antennas are not spec'd above 10 or 15w



5W Input

6x6x1.3"

1# 10oz

<https://hfprojects2.com/>

CW Operating

- I enjoy CW most of all. I've noticed that there is not much information available to help new CW Ops select keys and keyers
- If you will only be contesting you can sleep through this part, because you can use a keyboard for everything
- If you will be rag chewing or DXing the choice of a key and perhaps a keyer will be more important.
- Most modern radios have built-in keyers. They are generally good but have limitations. I never use the internal keyer at my home station.
 - Difficult to access memories
 - Lack of self-correct features
 - Slight differences in timing from radio to radio, not significant below 20wpm but can be at higher speeds

Keyers

- I use a Logikey K5. I'm used to it after >20 years of Logikey use.
 - It feels the same every time I use it with every radio
 - Push button memories provide quick message selection and programming
 - One set of menu items, each rig is different
- The K1EL series of keyers are also excellent, plus they have a computer interface for more flexibility

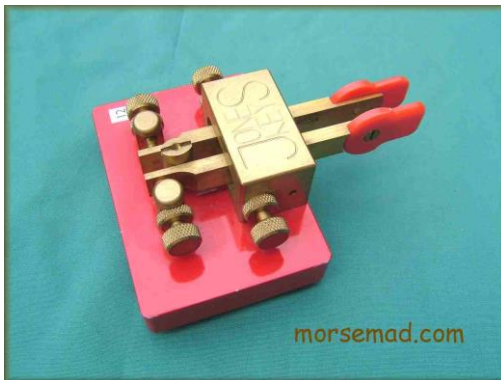


Keyers – cont'd

- I suggest new CW Ops use an electronic keyer
 - Bugs are difficult to master, much harder to send clean code characters. Difficult to adjust as well.
 - Hand keys are less difficult but are very tiring to use for long contacts
 - Some modern radios do not key well with bugs which have a higher contact resistance than a paddle
- Iambic vs Non-iambic keying
 - Some well meaning folks invented some “short cuts” for character generation. There are two flavors, Iambic A and B. You can read about them if you want
 - The idea was it would help send faster code
 - The truth is, it is an unnecessary complication. None of the High Speed CW champs use Iambic techniques
 - I don't send Iambic, but pick your poison

Iambic Paddles

- I started out as a Bug user. When I decided to get active again 30 years ago I chose to go the electronic keyer route
- I went to HRO and bought a Bencher Paddle, it was cheap and I didn't know any better. It worked fine up to about 20wpm
 - Above 20 the finger pieces flexed which threw off my timing. I have a fairly heavy fist
 - I went on a search for a stiffer key and bought a Jones key at a local Hamvention
- The Jones key was stiff enough but the lever arm was long making it necessary to move the arm more to close the contacts
- I found an English key by G4ZPY that had a short lever arm, but was difficult to adjust due to a complex design and coarse screw threads



Iambic Paddles – cont'd

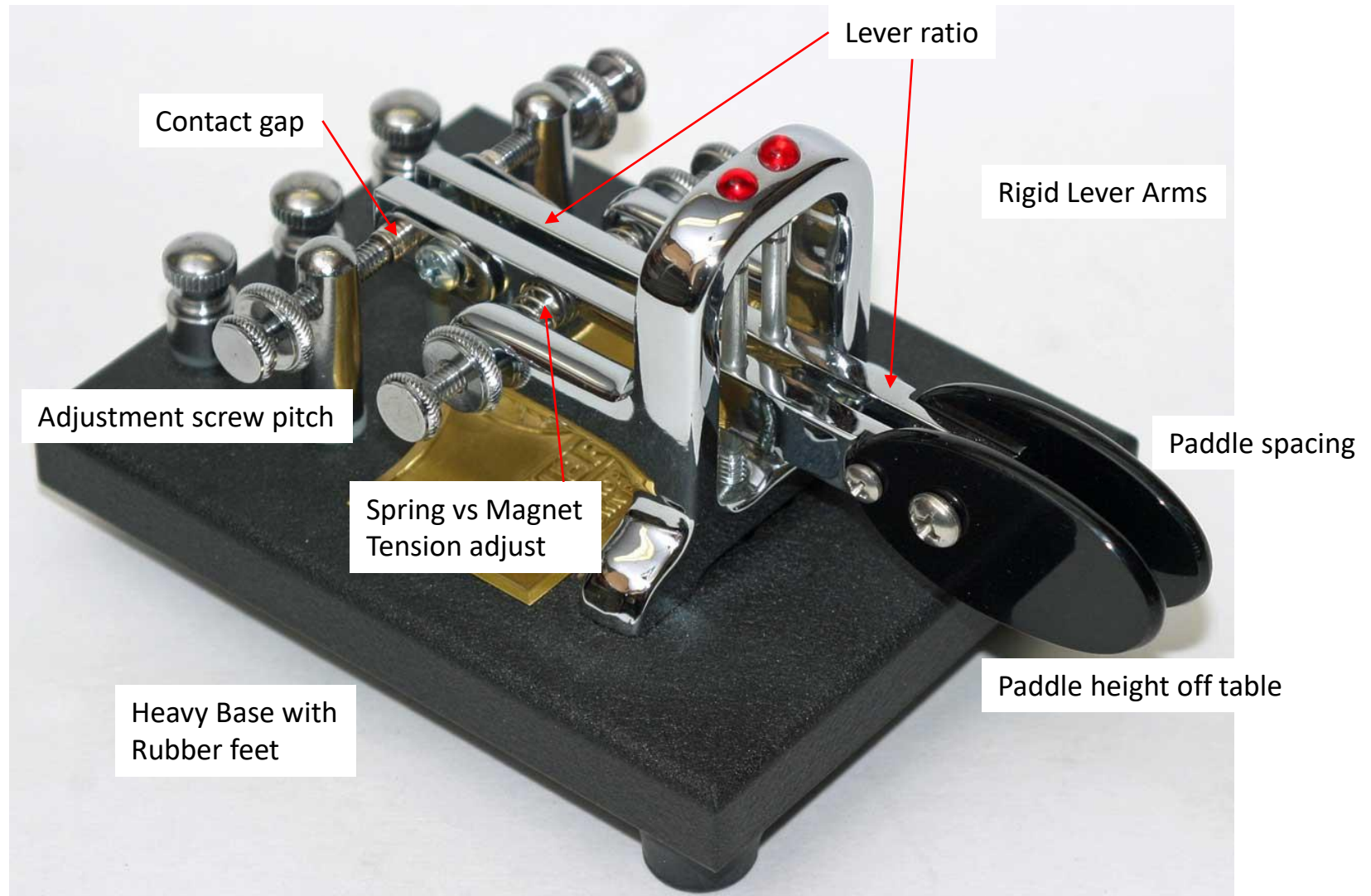
- As time went on new key designs became available
 - WBL, vertical lever, my 1st mono key
 - March, my 1st magnetic key
 - Mercury, very expensive, difficult to adjust, very nice to send with
 - Schurr (now Scheunemann), easy to adjust, the best spring return keys
- They all had different personalities. My goal was to send very well spaced code at higher speeds.
- I started analyzing the traits of each key I owned and looked at others. I also talked to other CW operators about their experiences.
- There is also some anatomy involved. Some of us have large hands and like to hit the paddle hard (ex bug users). Some have a lighter touch.
- You should try a key before you buy it. Make sure it does what you want
 - Unless you are a collector like me

lambic Paddle Characteristics

- The following are considerations in choosing a paddle key. They all don't necessarily apply to every operator
 - Finger piece spacing, I like mine $\sim 1/2$ " apart
 - Finger Piece height off the table, I like them close to the table
 - Lever ratio, 1:1 feels best to me
 - Magnetic vs spring tension, I prefer magnetic
 - Adjustment screw thread pitch, fine threads are easier to adjust and stay adjusted
 - lambic vs single lever (mono), I make fewer errors with a mono paddle
 - Weight, I find $\sim 3\#$ stays put on the table
- The high end keys I prefer have zero flex
- I modify keys to suit my preferences
- I never did get very fast at sending, but that's due to my fist and my focus on sending near perfect code

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Anatomy of a Key



Iambic Key Adjustments

- There are two basic adjustments
 - Contact Gap
 - Contact tension
 - Magnetic
 - Spring
- I started off using a small gap. I reasoned that would let me send faster. This requires more tension to prevent accidental key closure
- I gave one of my fine adjusted keys to a friend who sends better than I do at high speeds and the first thing he did was open the gaps and reduce the magnetic tension. I tried it and like it better.
- You have to play with the settings. Try one for a week or two and then change it a little.
- I have a tension gauge to keep track of my settings

My Key Preferences

- More recently I have been using N3ZN and Begali keys
 - Both are magnetic, have an excellent feel and fine adjustments
 - Pierro Begali, I2RTF, runs a large machine shop with many products. He uses more exotic materials
 - Tony, N3ZN, has a small one man shop and uses less expensive, but quality materials
 - Both have QRP/Portable products

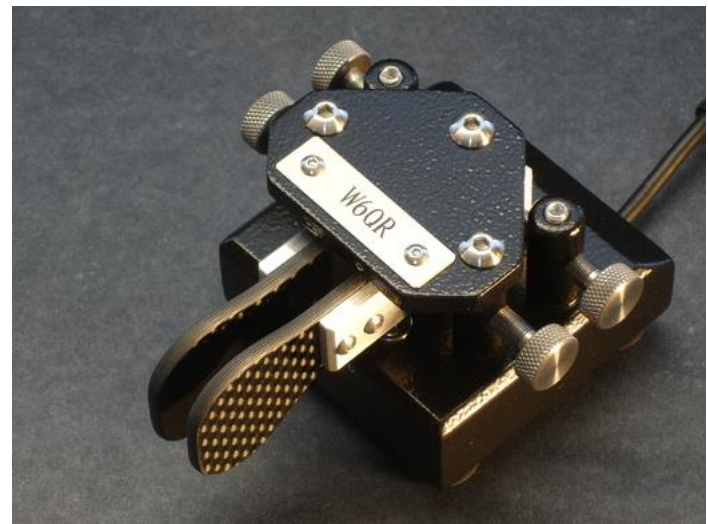
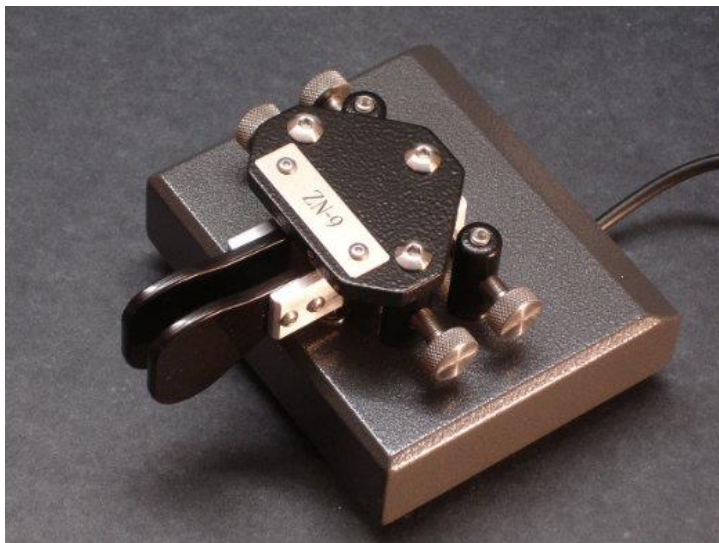
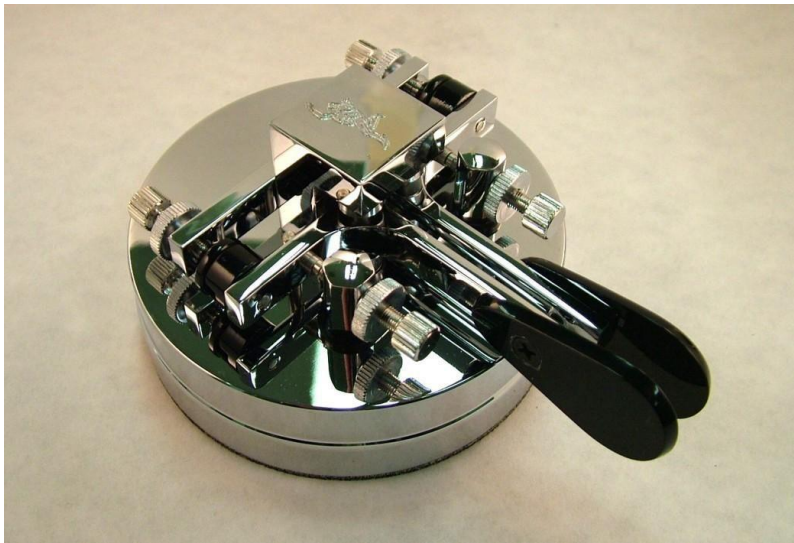


Begali Stradivarius



Begali HST

High End Keys



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American Morse Equipment



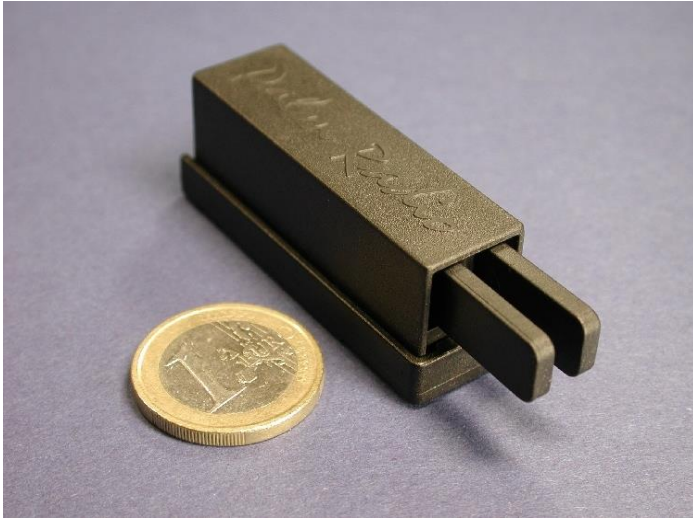
Porta Paddle with my KX2. This low cost kit works very well. It is held down with heavy duty Scotch fastener. A leg strap is available for mobile operation

Bush Wacker Mono Paddle. This is another low cost kit. It has a very nice feel to it for speeds <25 wpm



Keys for Portable Use

- Palm Radio (no longer in business)



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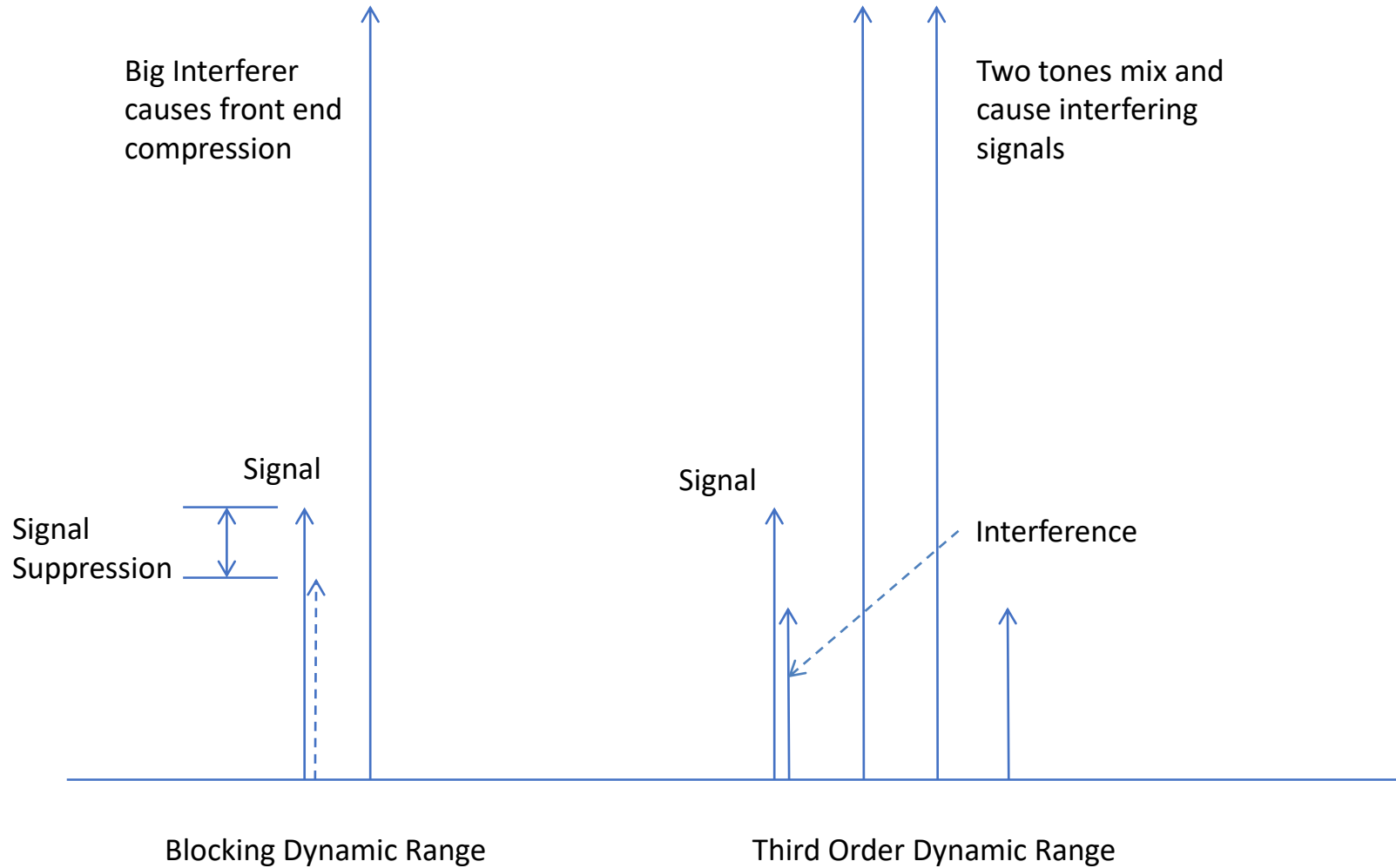
Appendix

- Dynamic Range Overview

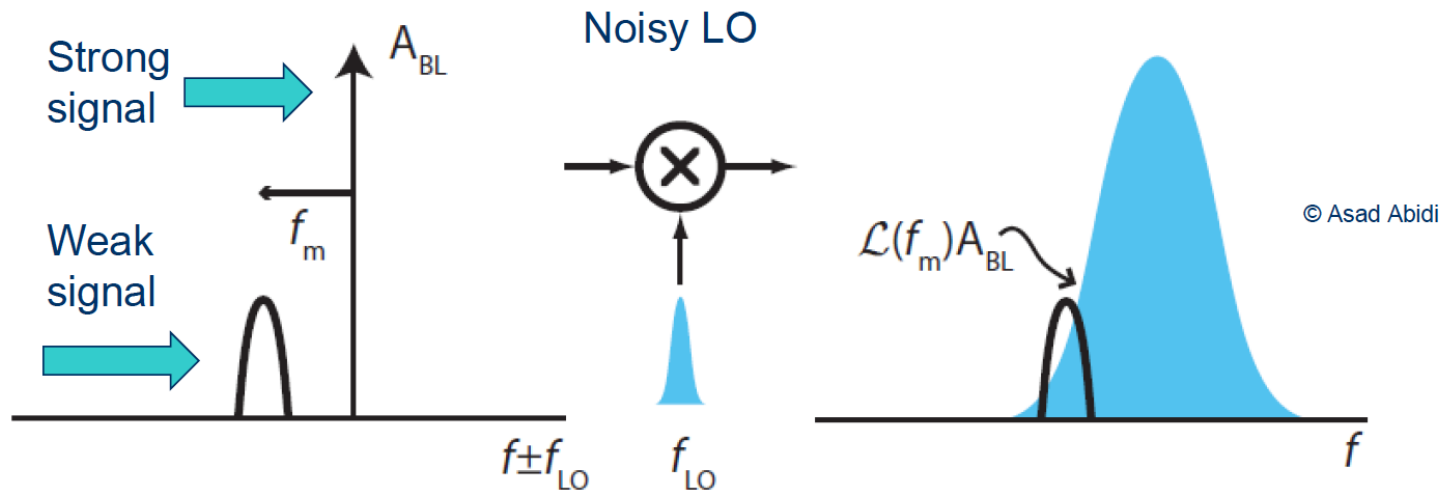
The Importance of Dynamic Range: A Brief Review

- Blocking Dynamic Range (BDR) prevents strong local signals from overloading your receiver
 - Most analog radios have >125dB BDR which prevents overload from S9+70dB signals
 - SDRs are limited by the maximum input allowed by the A/D converter, typically S9+60dB. Use the attenuator to reduce big guns
- Third Order Dynamic Range (DR3) limits spurious signal generation due to big nearby signals
 - 85-90dB DR3 is plenty for most stations, this is a 30MHz number
 - More is not better
 - Less is required on the lower HF bands where atmospheric noise is dominant
- Receive Mixing Dynamic Range (RMDR) limits spurious signal generation due to a large close in signal mixing with the receiver LO noise
 - Same requirement as DR3

Receiver Dynamic Range Limitations



Receive Mixing Dynamic Range



Noisy local oscillator (LO) transfers its noise to the strong out-of-passband signal and on top of the weak signal we are trying to copy.

Atmospheric Noise Limits Receive Sensitivity

From: CCIR Report 322

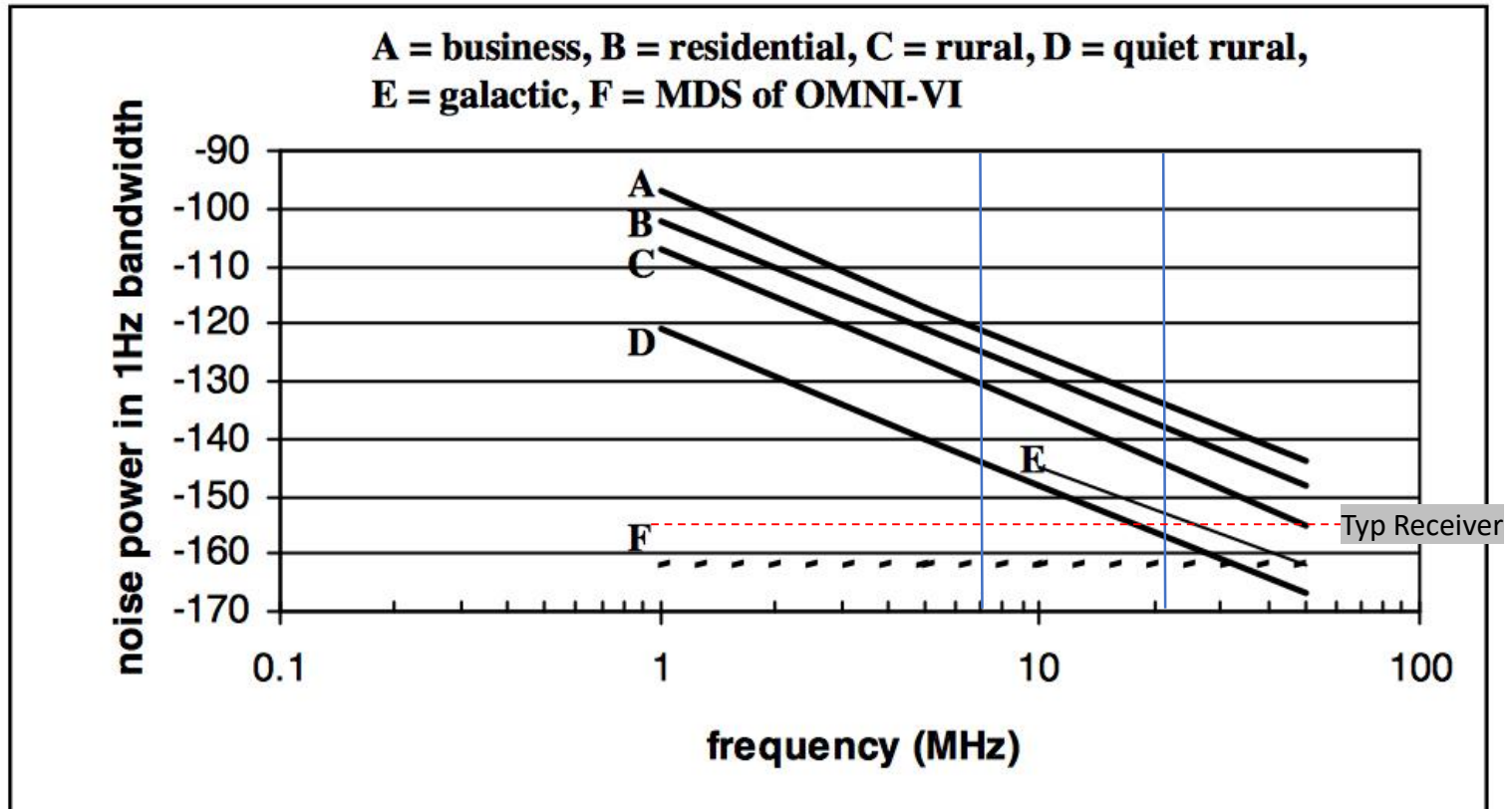


Figure 1 – Man-made noise and galactic noise versus frequency

Dynamic Range is Reduced by Atmospheric Noise

- Specified Dynamic Range is relative to a -128dBm receiver noise floor in a 500Hz bandwidth
 - Equivalent to -155dBm in a 1Hz bandwidth on the noise chart (Red dashed line)
 - You can experience this level in a rural environment on 10M (30mHz)
- On the lower frequency bands atmospheric noise is higher than receiver noise, especially in a residential location
- Example 20M:
 - In a residential environment the noise is 22dB higher than the receiver noise
 - This means you need 22dB less DR3 or RMDR, so 68dB would be adequate...*That's a big difference*
- On 40M a DR3 of 60dB would be adequate

Dynamic Range Summary

- Don't be hooked in by the manufacturers who tell you more is better
 - 90dB DR3 is plenty
 - There are 19 radios on Rob Sherwood's chart that have >90dB DR3
 - Pick one of those you like for ergonomics or other reasons
- If you have a ham neighbor or need to use your radio in a multi-transmitter environment like Field Day you need the best BDR you can get, otherwise don't worry about it
- If you are a casual low band operator an 80dB DR3 radio is probably fine for you
 - Many contesters still use their 70dB radios and simply avoid huge pileups
 - Go back later to work a weak station when the pile-up is gone