



2 meter Narrow-banding Survey and Test Results

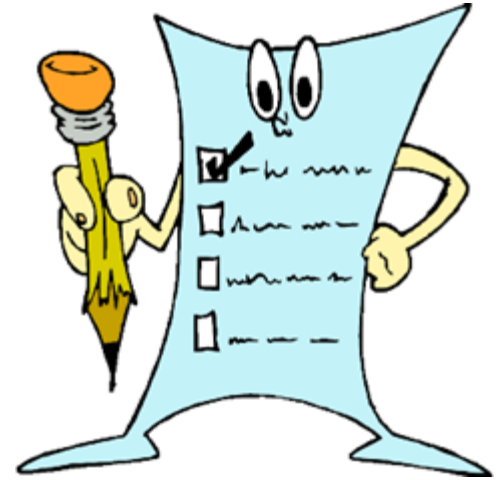
Santa Clara County ARES/RACES

Overview

- Santa Clara County ARES/RACES is heavily dependent on many repeaters in the 2m band segment
- There was a great deal of concern that the proposal was being rushed through without adequate understanding of the impact to users
- We decided to conduct an investigation of the impact of narrow-banding on ARES/RACES operations
- ARES/RACES members were polled to determine which radios were being used for ARES/RACES activities
- Radios specifications were reviewed and several representative radios were tested
- Results were reported to the NARCC public e-mail reflector and at the NARCC meeting

Survey Methodology

- E-mail to all Santa Clara County ECs
 - Asked for in-use radios; no collectors' items
- ECs sent e-mail to all ARES/RACES members
- ECs consolidated responses
 - Call sign, manufacturer, model, quantity
- County consolidated city results; de-duped, error checked
- Most popular radios determined
- Research and testing was performed



Research and Testing Statistics



- Totals
 - Total number of radios reported = **966**
 - Total number of models reported = 251
- Research
 - Researched all models that were reported at least twice
 - Total number of models researched = **115**
 - Total number of radios represented by models researched = 830
 - Percentage of radios reported that were researched = **86%** (830/966)
 - In other words, the research covered the majority of radios in use
- Testing
 - We also tested 15 radios, including **6 of the top 7** radio models

Research

- Radios stack ranked by popularity
 - All radios that were reported at least twice were reviewed
- Both specification sheet and user instructions were examined
 - 115 user manuals were read, because ...
 - Sometimes the needed info was in the text; not in the specifications
 - Important for understanding actual user procedures for setting options
- Parameters reviewed / issues discovered
 - Ability to tune to 12.5 step size
 - CTCSS Decode (Tone Squelch)
 - Frequency stability
 - 2.5 kHz Transmit Deviation
 - Narrow Receive Bandwidth

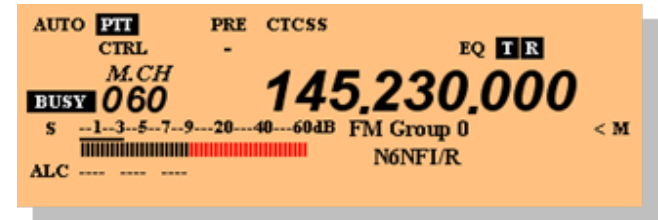
SPECIFICATIONS

Specifications are subject to change without notice due to advancements in technology.

General		IME Band	IME Band
Frequency range	U.S.A./Canada	144 - 148 MHz	430 - 450 MHz
	Europe	144 - 148 MHz	430 - 440 MHz
	General market	144 - 148 MHz	430 - 440 MHz
Mode	F3E (FM), F3D (DMR), F2D (FSK)		
Antenna impedance	50 Ω		
Usable temperature range	-20°C to +60°C (-4°F to +140°F)		
Power supply	13.8 V DC ±15% (11.7 - 15.8 V)		
Grounding method	Negative ground		
Current	Transmit (max.)	11.0 A or less	10.0 A or less
	Receive (at 2 W output)	1.0 A or less	
Frequency stability (-50°C to +50°C)	Within ±3 ppm		
Dimensions (W x H x D) <small>(protrusions not included)</small>	Front panel	140 x 50 x 23 mm (5.5" x 2.30" x 1.30")	
	Main unit	140 x 40 x 105 mm (5.5" x 1.5" x 7.00")	
Weight	Front panel	Approx. 140 g (5.3 oz)	
	Main unit	Approx. 1.2 kg (2.6 lb)	

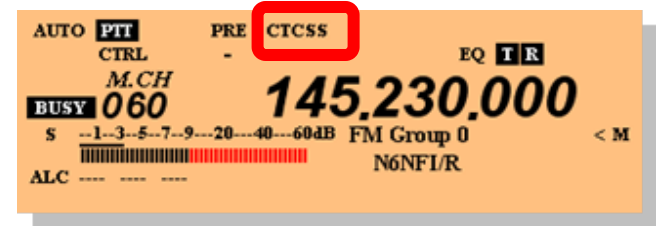
*Band A receive range: 136 - 200 MHz; 114 - 136 MHz (excl. 200 - 300 MHz); 300 - 400 MHz (excl. 400 - 475 MHz)
 Band B receive range: 400 - 520 MHz; 130 - 175 MHz (excl. 300 - 400 MHz); 900 - 1300 MHz (excl. excluding specialty frequencies (excl.))

Tune to 12.5



- Issue:
 - Narrow-banding makes use of 12.5 kHz spacing between channels
 - Radios must be able to tune to 12.5 kHz channel spacing
- Results:
 - Almost all radios investigated can tune to 12.5 kHz step size (93%)
 - Generally, set on a per-mode basis; some per band; some per memory
 - Current mixed 15/20 spacing is handled by 5 kHz step size
 - 2.5 kHz step size not available on any radio for mixed 12.5/15 spacing
- Problem Identified
 - Bands with mixed step-sizes will usually require menu option change
 - Tuning between repeaters in different parts of the band will be confusing
 - Tuning between repeaters and simplex will be confusing
- Conclusion:
 - 12.5 kHz tuning is definitely possible; problematic with mixed step size

CTCSS Decode (Tone Squelch)

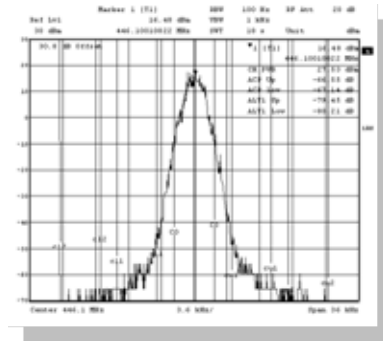


- Issue:
 - With repeater outputs closer together, many radios will receive enough RF energy in their receiver passband from adjacent channel to cause squelch to open
 - CTCSS tones on repeater output allows users to use CTCSS decode a.k.a Tone Squelch to prevent false triggering by adjacent channel
- Results:
 - Most radios investigated can decode CTCSS (93% = 82% standard, 11% option)
- Problem Identified:
 - Many radios picked up adjacent channel at small signal levels when spaced at 15 or 12.5 kHz
 - In 3 of top 4 radios, if adjacent signal is only 3.5 to 9.5 dB strong, it will bleed thru
- Conclusion:
 - CTCSS tones on repeater output strongly recommended for 15 kHz spacing or less
 - Adjacent channels should alternate tones so adjacent channels don't use same tone

Frequency Stability

- Issue:
 - Narrow-band channel size requires more accuracy and stability in the transmitter in order for it to be on and stay on frequency
- Results
 - 18% had transmit frequency stability \geq ± 10 ppm = ± 1.45 kHz
 - A few models had ± 20 ppm stability.
- Problem Identified
 - Almost 1/5 of the radios may have problems due to instability of transmit frequency
- Conclusion
 - ± 1.45 kHz is a lot of drift when considering the channel size and the expectation of ± 2.5 kHz deviation

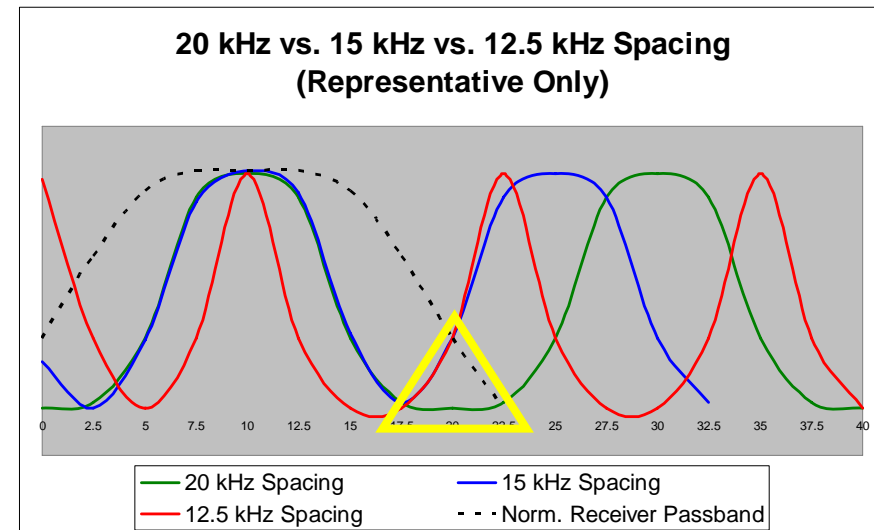
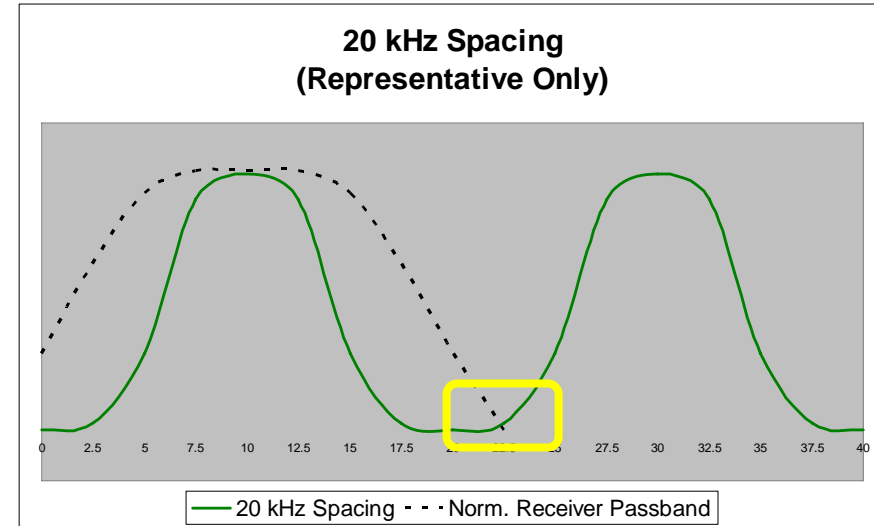
Narrow Transmit Deviation



- Issue:
 - +/- 2.5 kHz deviation required for 12.5 kHz channel spacing
- Results:
 - Only 55% of radios currently in use can be set for 2.5 kHz deviation
 - Setting is usually global or per band; some support per-memory
 - Often listed as an obscure menu options, sometimes just a footnote
- Problem Identified:
 - Setting to narrow deviation requires adjusting menu settings when tuning to different parts of the band
 - People will forget to set it to narrow for repeater sub-band or forget to set it back for the rest of the band
- Conclusions:
 - Not possible for 45% of users
 - For 55%, it is possible, but about 1/2 require menu-level changes

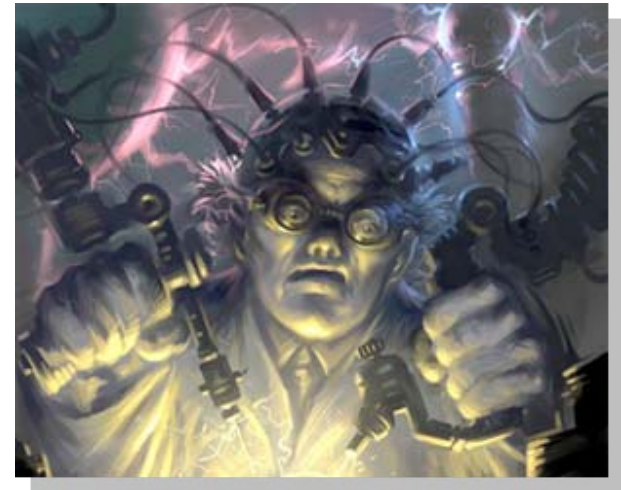
Narrow Receiver IF Passband

- Issue:
 - With narrower channel spacing, the receiver will need to be more selective
- Results:
 - 90% of radios do NOT narrow their receiver passband, even when set in narrow mode
- Problem Identified:
 - 90% of radios will likely experience more interference if channels are spaced closer together
- Conclusions:
 - Need to verify expected interference through testing (done and verified)



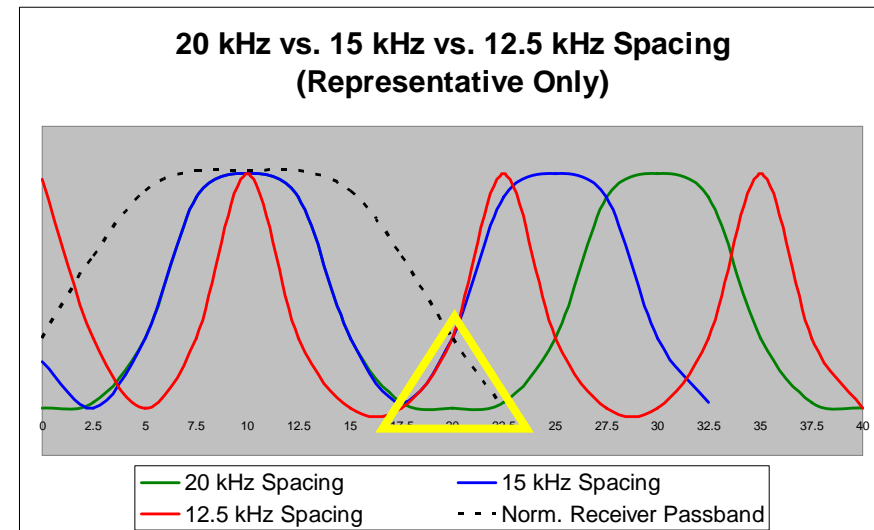
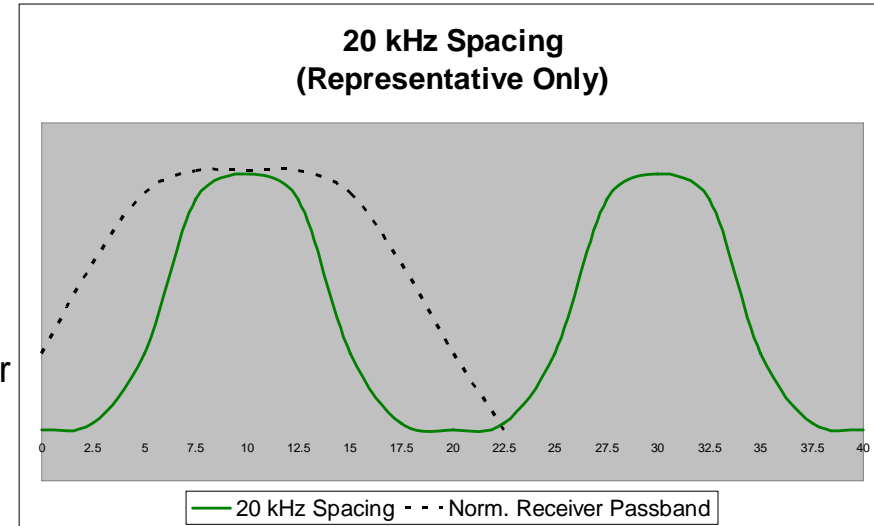
Radio Testing

- Tested 15 models
 - Mix of HT and mobile
 - Kenwood, Icom, Yaesu, Alinco
 - 6 of the top 7 radios reported
 - Represents 256 of the 966 radios reported or **26% of radios reported**
- Transmitter testing
 - Deviation in standard and “narrow” mode (if available)
- Receiver testing
 - Spacing
 - 20 kHz spacing @ 5 kHz deviation
 - 15 kHz spacing @ 5 kHz deviation
 - 12.5 kHz spacing @ 2.5 kHz deviation
 - 12.5 kHz spacing @ 2.5 kHz deviation w/ receiver’s “narrow” mode enabled
 - Looking for signal level for each of three conditions:
 - Adjacent channel is audibly bleeding through
 - Adjacent channel is significantly interfering
 - Receiver capture



Testing Results

- Receiver Testing
 - At 20 kHz spacing
 - Interference extremely difficult to create
 - At 15 kHz and 12.5 kHz spacing
 - Interference occurs in some radios if adjacent channel is even slightly stronger
 - For 3 of top 4 popular radios, that value is $< 10\text{dB}$ signal difference
 - Expected results confirmed
- Transmitter Testing
 - Most radios were well behaved
 - $< 5\text{ kHz}$ deviation for normal FM
 - $< 2.5\text{ kHz}$ deviation for NFM
 - Some radios were not
 - $5.5\text{--}6.0\text{ kHz}$ deviation for normal FM
 - Need to do more than just narrow the repeater deviation; strong user signals will be an issue, too



Testing Results (cont.)

- Conclusion
 - Spacing less than 20 kHz creates opportunities for interference
- Recommendations for mitigating interference
 - Recommend/require repeaters limit to 4 kHz deviation
 - Repeaters are likely to be the strongest signal
 - However, won't help strong user signals, so ...
 - Minimize/eliminate coverage overlap between repeaters on adjacent channels
 - Minimize/eliminate bleed-through from strong repeater or user signals
 - Recommend/require repeaters to output tone; alternate for adjacent channels
 - Allows users to use tone squelch to eliminate false squelch breaks

Overall Conclusions and Observations

- 12.5 kHz spacing is NOT usable at this time, period
 - 45% of radios can not narrow transmit deviation
 - 90% of radios can not narrow receiver IF bandwidth
 - 12.5 kHz tuning step size is not always a per channel setting
- 15 kHz spacing would create more interference; can mitigate by
 - Limit repeater deviation to 4 kHz
 - Re-coordinate repeaters so adjacent channels do not have overlapping coverage
 - Strong user signals can have the same impact as strong repeater signals on an adjacent channel
 - Repeaters should output tone; adjacent channels use different tones
 - users enable CTCSS decode (tone squelch) to avoid false squelch breaks
- Results and Conclusions summarized and submitted to NARCC

NARCC Meeting - Voting Results

- Decided to not vote on the proposals now
- Allow 2 weeks to submit alternative proposals
- Give people time to review & discuss all proposals
- Call a Special Meeting in 3 months (July 11) to vote

Next Steps

- Deadline for proposals is Monday, April 20
- Will be posted to NARCC website: <http://www.narcc.org>
- Review and discuss options
- LOTS of education to accomplish before July 11

End