2 meter Narrow-banding

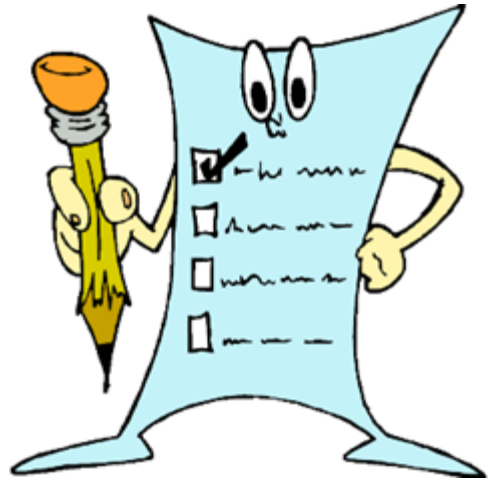
Survey and Test Results

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

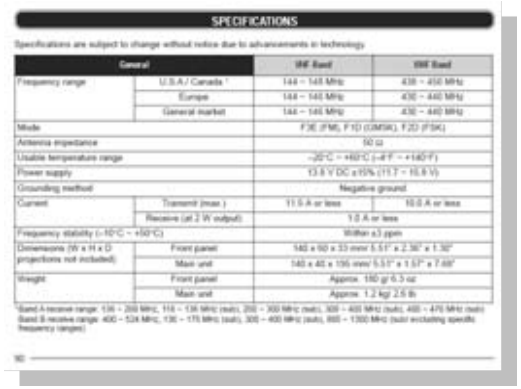
Research and Testing Statistics

- 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


SPECIFICATIONS

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

General		VHF Band	UHF Band
Frequency range	U.S.A. / Canada *	144 – 148 MHz	430 – 450 MHz
	Europe	144 – 146 MHz	430 – 440 MHz
	General market	144 – 146 MHz	430 – 440 MHz
Mode		F3E (FM), F1D (GMSK), F2D (FSK)	
Antenna impedance		50 Ω	
Usable temperature range		-20°C ~ +60°C (-4°F ~ +140°F)	
Power supply		13.8 V DC ±15% (11.7 ~ 15.8 V)	
Grounding method		Negative ground	
Current	Transmit (max.)	11.5 A or less	10.0 A or less
	Receive (at 2 W output)	1.0 A or less	
Frequency stability (-10°C ~ +50°C)		Within ±3 ppm	
Dimensions (W x H x D projections not included)	Front panel	140 x 60 x 33 mm/ 5.51" x 2.36" x 1.30"	
	Main unit	140 x 40 x 155 mm/ 5.51" x 1.57" x 7.68"	
Weight	Front panel	Approx. 190 g/ 6.3 oz	
	Main unit	Approx. 1.2 kg/ 2.6 lb	

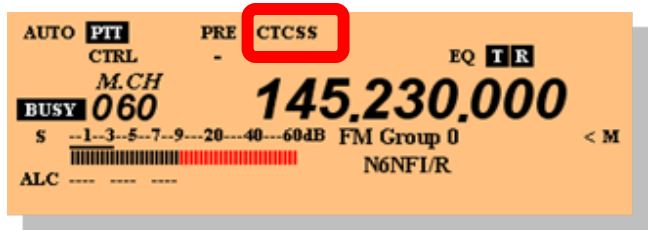
* Band A receive range: 136 – 200 MHz, 118 – 136 MHz (rx/x), 200 – 300 MHz (rx/x), 300 – 400 MHz (rx/x), 400 – 470 MHz (rx/x)
Band B receive range: 400 – 524 MHz, 136 – 175 MHz (rx/x), 300 – 400 MHz (rx/x), 800 – 1300 MHz (rx/x excluding specific frequency ranges)

- 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

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)

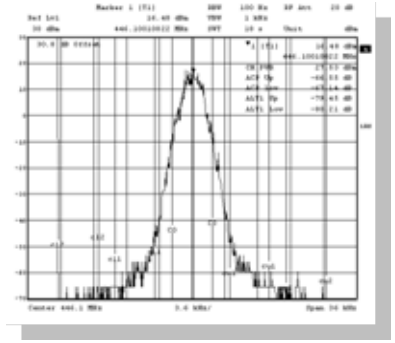


- Issue:
  - With repeater outputs closer together, many radios will receive enough RF energy in their receiver passband from adjacent channel to cause squelch to open
  - CTCSS tones on repeater output allows users to use CTCSS decode a.k.a Tone Squelch to prevent false triggering by adjacent channel
- 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 >= +/- 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

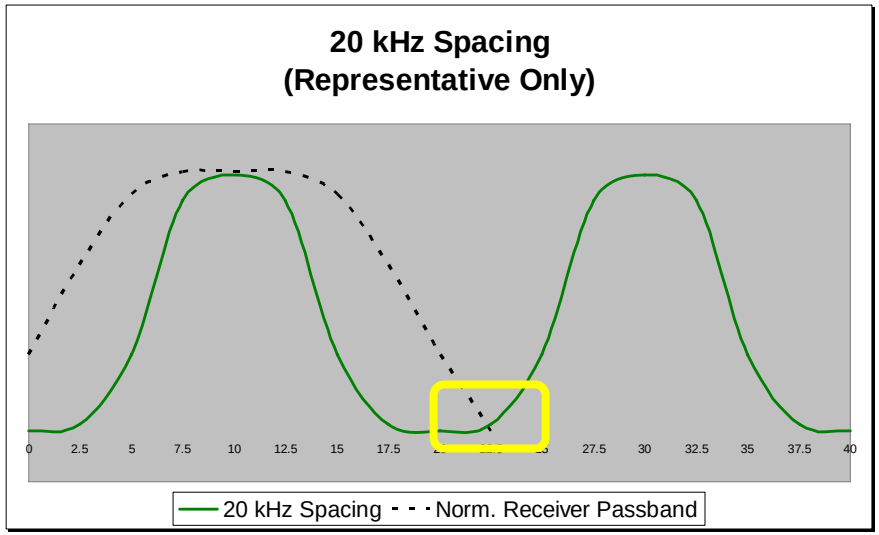
Narrow Transmit Deviation

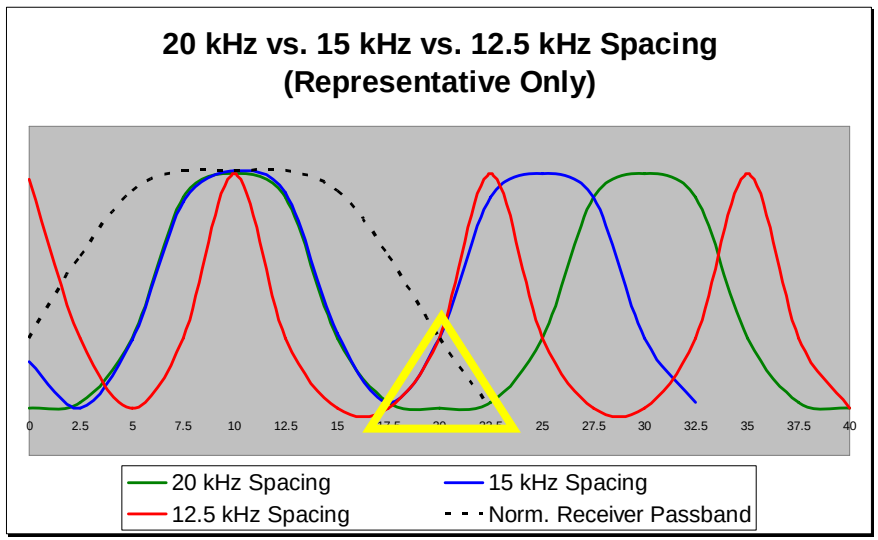


- Issue:
  - +/- 2.5 kHz deviation required for 12.5 kHz channel spacing
- Results:
  - Only 55% of radios currently in use can be set for 2.5 kHz deviation
  - Setting is usually global or per band; some support per-memory
  - Often listed as an obscure menu options, sometimes just a footnote
- Problem 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 ½ 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)



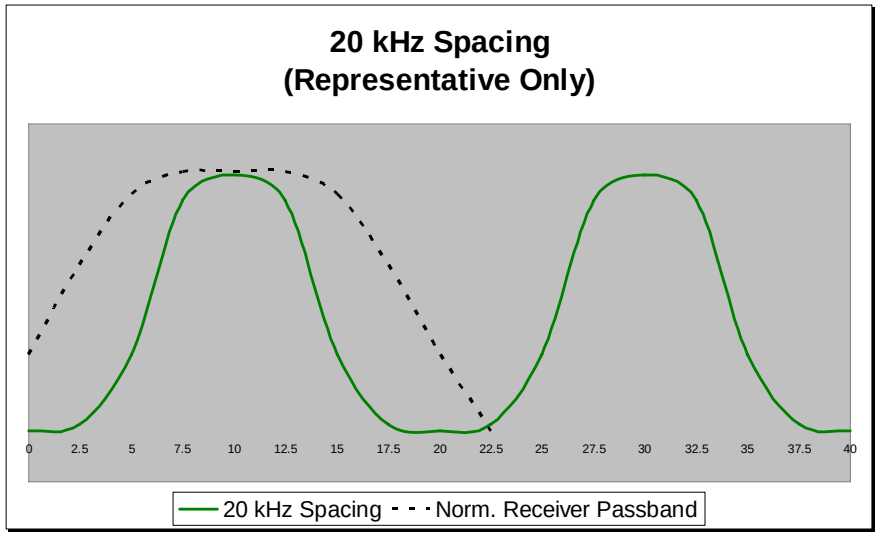


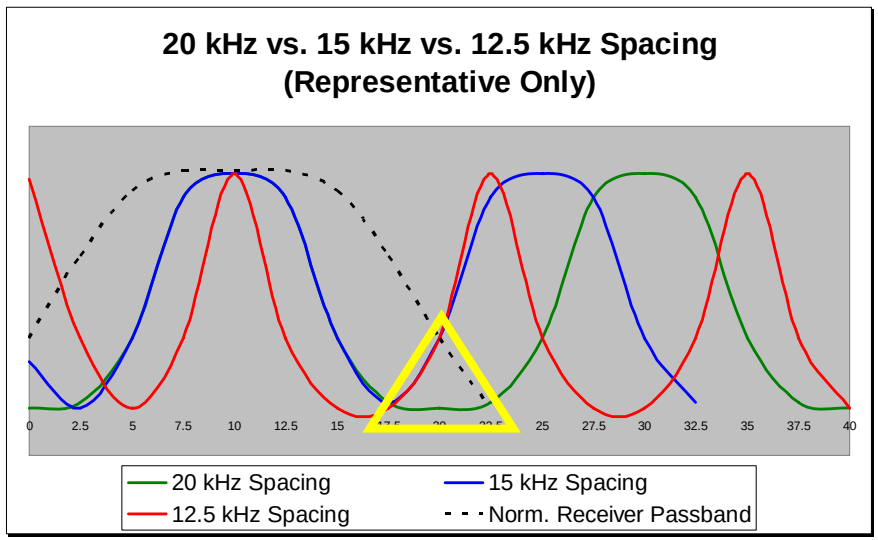
Radio Testing

- 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 < 10dB signal difference
  - Expected results confirmed
- Transmitter Testing
  - Most radios were well behaved
    - < 5 kHz deviation for normal FM
    - < 2.5 kHz deviation for NFM
  - Some radios were not
    - 5.5-6.0 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