LEGALLY COMPLIANT RADIO OPPORTUNITIES FOR FLORIDA BAPTIST DISASTER RELIEF

v 2.0 12/3/2020 G. Gibby

The existing VHF and/or UHF repeaters and handheld radios of Florida Baptist Disaster Relief (FBDR) have now been researched and experimentally measured, yielding the following table of existing and future possibilities:

No.	Radio	Current FCC Compliant?	Next Step
1	Motorola CDR700	YES	We do not yet have
	repeater, programmed for	This radio is FCC tested	licensure for these radios.
	single freq. 469.975 MHz	for narrowband operation	
	(in)/454.975 MHz (out);	and has FCC ID	Licensure being applied
	approx 40 watts output	compatible with Part 90	for.
		operation.	
			Have radio & duplexer
			RE-TUNED for operation
			on two closely spaced
			ITINERANT LEGAL
			repeater pairs.
			This will give us our choice of either of TWO repeater frequencies at any location nationwide.
2	Kenwood handitalkies (2	YES	We do not yet have
	Watts) currently used by	This radio is FCC tested	licensure for these radios.
	ERT personnel.	for narrowband (12.5kHz	
		spacing) and has FCC ID	Licensure being applied
		compatible with Part 90	for.
		operation.	
			Have these radios retuned

			 if possible to newly chosen UHF frequencies. This likely requires a Kenwood authorized dealer and may involve a cost. This will give us 2 UHF Channels that can be used locally without a repeater or with a repeater, either at a location or mobile.
3	Baofeng UV-82C that may be purchased for \$54 each.	YES – these radios are FCC tested for narrowband (12.5 kHz spacing) compatible with Part 90 operation – and they operate on TWO bands, both VHF and UHF.	Licensure being applied for. We are able to program these radios OURSELVES and can program them for 3 VHF channels – local usage without a repeater, either at a location or in vehicles. 2 UHF channels – local usage without a repeater or With A Repeater either at a location or in vehicles.
4	Kenwood TKR-820-1 repeater.	NO – unfortunately this repeater appears to be of older 16kHz bandwidth and not suitable for compliant current operation.	The DUPLEXER out of this repeater can potentially be used for the construction of a backup- repeater.
5	Inexpensive Baofeng UHF-only radios (BF- 888S)	NO – these radios are wideband transmission and not legal for current Part 90 operation.	

6	DTECU MUDE VI	VEC for MUDC for	This is another solution
0	BIECH MURS-VI	1 ES - 10T MUKS five	This is another solution
	radios	fixed channels only, 2	for single campus
		watts, NO REPEATER	communications, 2 watts,
			no repeater, likely
			covering a megachurch or
			super walmart adequately.

Remainder of this document provides technical information

Appendix 1	Technical explanation of measuring emission bandwidth and collated results from all tests
Appendix 2	Baofeng UV-82C spectrum
Appendix 3	Baofeng UV-82C intentionally on wide settings
Appendix 4	UV-5R comparison
Appendix 5	Motorola CDR700 repeater transmitter
Appendix 6	Kenwood Repeater
Appendix 7	Kenwood Handhelds TK-3400K
Appendix 8Information on current duplexer in Motorola CI repeater.	

APPENDIX ONE: Technical explanation of measuring emission bandwidth.

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MODULATION applied to transceiver under test: FCC PART 2:

§ 2.1049 Measurements required: Occupied bandwidth.

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:

(a) Radiotelegraph transmitters for manual operation when keyed at 16 dots per second.

(b) Other keyed transmitters - when keyed at the maximum machine speed.

(c) Radiotelephone transmitters equipped with a device to limit modulation or peak envelope <u>power</u> shall be modulated as follows. For single sideband and independent sideband transmitters, the input level of the modulating signal shall be 10 dB greater than that necessary to produce rated peak envelope <u>power</u>.

(1) Other than single sideband or independent sideband transmitters - when modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. The input level shall be established at the frequency of maximum response of the audio modulating circuit.

So I can do this by using our digital interface systems and FLDGI to send a 2500 Hz tone into the mic input from the Transceiver; or else use speaker output.

Output of transceiver is then connected to a suitable VHF dummy load with a tap – I have one with a - 50 dB tap that will reduce 30dBm (1 watt) to -20dBm (safe for the spectrum analyzer)

Narrowband requirement:

Applicable Standard

FCC §2.1049, §90.209 and §90.210

Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

1) For any frequency removed from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0 , 0dB.

2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.626 kHz but no more than 12.5 kHz, at least 7.27 (f_d –2.88 kHz) dB.

3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz at least: 50+10logP

Putting that in English:

- All full strength (0 db) up to 5.625 on each side

- Must be 20 db down at 5.625 from center
- then linearly down to 70 dB below at 12.5 kHz from center.

Important spectrum analyzer settings:

RBW 300 Hz

VBW 1 kHz [I don't understand this one, but I copied it]

"Emission Bandwidth" is the smallest bandwidth for which the signal fits into the mask as per diagram below – but in FCC tests they just print the narrowband mask and see if it is inside it.



MY TEST RESULTS

Date/ Time	Device under Test	Modulation Signal	Center dBm with chosen attenuation	kHz from center where signal drops below -20 dB skirt	kHz from center where signal drops below -70 dB from center	Apparent emission bandwidth (= 2 x kHz from center @ -20 dB if remains under skirt)
Sun 11/29 0830	UV82C NARROW Appendix 1 Comment: 2 nd harmonic down -47 dB	2500 Hz	Approx -9	< 5 kHz (easily meets spec)	Around 11 Khz or so from center	Difficult to measure in one test but clearly < 12 kHz PASSES NARROW
Sun 11/29 0840	UV82C WIDE Appendix 2	2500 Hz	Approx -13	> 6 kHz	Around 14 kHz or so from center	Not certain but clearly > 12 kHz FAILS NARROW TEST
Sun 11/29 1300	UV-5R Narrow setting 451.800 MHz Comment: 2 nd harmonic down approx -40 dB	2500 Hz	Approx -8	Clearly <5kHz	Around 12 kHz or less	PASSES NARROW
Wed 12/2	Motorola CDR700	2500 Hz into microphone connections		Clearly < 5 kHz		PASSES NARROW
Wed 12/2	Kenwood TKR-820-1	2500 Hz into microphone connection	Not certain that I was able to overdrive sufficiently	Appeared to pass		Appeared to pass – but certification doesn't exist unless this radio shows proof of

Date/ Time	Device under Test	Modulation Signal	Center dBm with chosen attenuation	kHz from center where signal drops below -20 dB skirt	kHz from center where signal drops below -70 dB from center	Apparent emission bandwidth (= 2 x kHz from center @ -20 dB if remains under skirt)
						modification (missing sticker)
Thursday 12/3/2020	Kenwood	2.5 kHz overdrive into external mic insertion		< 5 Khz		Appears to easily pass the narrowband requirement

REPEATER STATED FREQUENCY: Transmit 464.9750 PL 203.5

ITINERANT FREQUENCIES:

REF: https://forums.radioreference.com/threads/fcc-itinerant-licensing.242354/

Full power itinerent Frequencies: - you would need to choose an area of operation : ie citywide, countywide, statewide, or nationwide.

 451.8000
 456.8000

 451.80625
 456.8125

 451.8125
 456.8125

 451.81875
 456.8125

464.5000	469.5000	(footnotes 10, 34)
464.5500	469.5500	(footnotes 10, 34)

(10) This frequency will be assigned only to <u>stations</u> used in itinerant <u>operations</u>, except within 56 km (35 miles) of Detroit, Mich., where it may be assigned for either itinerant or permanent area <u>operations</u> (*i.e.*, general use).

(34) Operation on this frequency is limited to a maximum output power of 35 watts.

Easiest frequencies would be to go to

464.5000 / 469.5000 464.5500 and 469.5500

APPENDIX TWO: UV-82C NARROW

Notes: General fits well inside the required narrowband mask.

The spectrum out beyond 12.5 kHz has some signals that appear to breach the -70dB limit but this could be due to my test setup. That is a LOT of signal reduction.





NOTE: This touches the red line mask in several places and does not pass the narrow band limit.

APPENDIX 4: UV-5R For comparison on Narrow Band settings

NOTE: This is just as good as the UV-82C as far as narrowband measurement....probably because they use same modulation techniques (mathematical inside an SDR transceiver) – but as noted elsewhere the 2nd harmonic isn't as well suppressed. (The duplexer cans would likley take this out)



APPENDIX 5: Motorola CDR 700 Repeater Direct Signal

Strongest signal I could manage, 80 mV into the mic connections. Carrier alone is about -4 dBm with 12 dB attenuation on my tapped dummy load (approx 36 db itself)

The signal appears to easily fit inside the 12.5 kHz limits – and harmonics of this 60 watt output repeater were not even visible on my scope down to -60 dB



APPENDIX 6: Kenwood Repeater

This repeater appeared to be about 1.5-2kHz below stated frequency and had an output of approx 20 watts.

No carrier signal was approx -12 dBm on my spectrum analyzer after all the external attenuation. The dynamic mic proved difficult to drive and I can't be absolutely certain I overdrove by much but the loudest I could get a signal in wasnt' much different so I think it was adequate.



APPENDIX SEVEN: KENWOOD HANDITALKIE ModelTK-3400-K FCC ID ALH 435002 Emissions 11K0F3E and 16K0F3E



Likely the responses around -60 and blow are harmed by my measurement setup. The setup is same as previous with Siglent spectrum analyzer, but a paper cutout was used to avoid having to redraw each limit.

NOTE: I verified the frequencies programmed into the current Kenwoods:

Channel	Transmit	Receive	Example Usage
1	469.9750	464.9750	For repeater use
2	464.9750	464.9750	For simplex "talk around" usage

Emission Bandwidth

All other channels do not		
transmit.		

APPENDIX EIGHT: Information on Motorola CDR700 Repeater DUPLEXER

As of Thursday Dec 3 2020

Rear view of Duplexer (N Connectors!!)



Front view (removed front cover of repater to show the adjustment screws)



Spectrum analyzer analysis #1:

Note: Pair 2 & 4 are current programmed frequencies;

Pair 1 and 3 are a nearby ITINERANT frequency pair;



Spectrum Analyzer #2:

