TEST PLAN

SOFTWARE DEFINED RADIO

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11/30/2018

The rising STAR of Texas

Version	Revision Date	Description	Author
0.1	11/19/18	Parts assigned	James Bell
0.2	11/29/19	Sections 2,3,4,5 added	Samuel Hussey
1.0	11/30/18	All sections compiled	Samuel Hussey

Contents

1 Overview

In this Project the end goal is an operational software defined radio for educational purposes. It will be a half-duplex device operating in the North American High Frequency Range as allocated by the North American International Telecommunications Union.

2 Features to be tested/not to be tested

2.1 Features to be tested

The following are the major functionalities of the application that need to be tested in the testing process:

2.1.1 Components will receive either 12V or 5V from power adapter/voltage regulator

2.1.2 RF amplifier will have gain of 15-20 on 80m band and 12-15 on 20m band

2.1.3 Radio will only operate at 3.5-4.0MHz and 14.00-14.35MHz

2.1.4 Transmit power of 18-25mW

2.1.5 Latency under 100ms

2.1.6 On/off switch and indicating led

2.1.7 Clear way to tune frequency via rotary encoder

2.1.8 Volume control

2.2 Features not to be tested

2.2.1 NE612 mixers will receive RF frequencies of 3.50MHz-14.35MHz

- It is guaranteed by design because of the 80m and 20m bandpass filters.

2.2.2 Lineout gain from Teensy of 13-20dB

- Off-the-shelf component, 13-20dB gain is a Teensy specification.

2.2.3 Gain of Audio amplifier

- It is an off-the-shelf component.

3. Testing Approach

5V/12V Supplied to Components 2.1.1	
Approach	12V is guaranteed as it will be supplied by a 12V power adapter but can be tested the same as the 5V supply. The 5V supply will be tested with a digital multimeter by probing the output from the 5V voltage regulator and ground.
Pass/Fail Criteria	From the 5V voltage regulator, 4.65-5.35V is acceptable. From the 12V adapter, 11.65-12.35V is acceptable. Any values outside of these ranges is unacceptable.
Verification Method	If the measured values are within the acceptable ranges, then the test will be successful. The digital multimeters being used are accurate to a far greater degree than our pass/fail criteria so that is not a limitation.

RF Amplifier Gain 2.1.2	
Approach	The amplifier will be powered by a DC power source supplying 12V while an input signal of frequency varying from 3.5MHz to 4.0MHz and 14.00MHz to 14.35Mhz and a set amplitude will be supplied by a function generator. The output of the amplifier will be fed into an oscilloscope where the gain can be observed in the amplitude of the output sine wave.
Pass/Fail Criteria	A minimum gain of 15 will be considered acceptable at 3.5-4.0MHz while a gain of 12 will be acceptable at 14.00-14.35MHz.
Verification Method	The gain will be observed at the output of the amplifier. It will be verified by dividing the output amplitude of the signal by the original input amplitude. The resulting number will be our gain.

Radio will only operate at 3.5-4.0MHz and 14.00-14.35MHz 2.1.3	

Approach	The receiving portion of the radio will have 80m and 20m bandpass filters to filter out noise from the rest of the spectrum, these will be tested by doing a frequency sweep will an oscilloscope to insure that no frequencies outside of those bands are received. The transmit portion of the radio will be tested by transmitting to an off-the-shelf HF receiver that can verify the correct transmission.
Pass/Fail Criteria	It will be considered unacceptable if the radio transmits or receives frequencies outside of the 80m and 20m bands. Reception and transmission limited to only these frequency ranges is acceptable.
Verification Method	When doing the frequency sweep on the bandpass filters, we will expect the amplitude of the output signal to drop off outside of the desired frequency ranges. For the transmit portion, the HF receiver should not receive any transmissions outside of the desired frequency ranges. Since this will be controlled by software, we expect the cutoff to be at exactly the limits of the 80m and 20m bands.

Transmit Power of 18-25mW 2.1.4	
Approach	A transmission will be produced by the radio while a digital multimeter probes the output to observe if the power is 18mW at a minimum, but more will be acceptable and welcomed.
Pass/Fail Criteria	The anticipated power is 18-25mW, less than this is unacceptable. More is acceptable but not more than 31mW as this may indicate that something is not right within the device.
Verification Method	The current and voltage will be measured at the output of the radio and multiplied together in order to determine the power being transmitted.

Latency Under 100ms 2.1.5	
Approach	The radio will be probed at the input (microphone) and output (antenna) by an oscilloscope displaying both signals. A time stamp will be taken when an input signal is produced and then taken again when an output is seen.
Pass/Fail Criteria	Latency under 100ms will be considered acceptable, more than this is considered failing.
Verification Method	The difference in the two time stamps will be the recorded latency. The oscilloscope is able to measure much smaller time frames so the test equipment should not be a limiting factor.

On/Off Switch and Indicating LED 2.1.6	

Approach	A digital multimeter will be used to probe the power supply node after the switch while a DC power supply is connected and on.
Pass/Fail Criteria	If the switch is on, either 12V or 5V will be seen on the miltimeter and the LED should be illuminated in order to pass. If the switch is off, no voltage should be able to be measured and the LED should be off. Anything other than these results is considered unacceptable.
Verification Method	If the switch is off, then 0V should be measured and the LED should be observed in an off state. If the switch is on, then some voltage (12V or 5V) should be measured and the LED should be observed in an on state.

Clear way to alter frequency 2.1.7	
Approach	We will introduce 5 people that have not seen or used our device before and time how long it takes them to identify the method to alter the frequency.
Pass/Fail Criteria	If it takes 3 or less seconds, the tuning method is clear. If it takes more, then it will be considered unclear.
Verification Method	The test subjects will be timed from the moment that the device is unveiled. Because this measurement is being taken by hand, it is not expected to be extremely accurate, therefore, up to 3.5s will be acceptable with 3s being the ideal goal. The purpose is to show that the UI is simple and understandable.

Volume Control 2.1.8	
Approach	The speaker will output a signal while the volume control knob is adjusted from the minimum to maximum volume. A decibel meter application on a smart phone will be used to observe the change in output from the speaker.
Pass/Fail Criteria	At the minimum volume, 0dB should be measured. At the maximum volume, no more than 45dB should be measured.
Verification Method	As the volume control is turned up, the decibel meter app should show a steady increase from 0dB to the maximum volume our speaker can output without exceeding 45dB.

4. Test Cases

4.1 Test Case #1: 5V/12V Supplied to Components

Tested By:	Samuel Hussey	
Test Case Number	1	
Test Case Name	Power supply network	
Test Case Description	**12V is guaranteed as it will be supplied by a 12V power adapter but can be tested the same as the 5V supply. The 5V supply will be tested with a digital multimeter by probing the output from the 5V voltage regulator and ground.**	
Item(s) to be tested		
1	12V power adapter	
2	5V voltage regulator	
Specifications		
Input		**Expected Output/Result**
120V @ 60Hz		5V/12V DC
Resources Required		
1	Digital multimeter	
2	Electrical outlet	
3	DMM probes	
Procedural Steps		
1	Plug the 12V power adapter into an outlet and into the transceiver	
2	Turn the transceiver on	
3	Probe from the output of the 12V adapter to ground and observe the reading	
4	Probe from the output of the 5V regulator to ground and observe the reading	

4.2 Test Case #2: Amplifier Gain

Tested By:	Zachary Schneiderman
Test Case Number	2
Test Case Name	RF Amplifier Gain
Test Case Description	**The amplifier will be powered by a DC power source supplying 12V while an input signal of frequency varying from 3.5MHz to 4.0MHz and 14.00MHz to 14.35Mhz and a set amplitude will be supplied by a function generator. The output of the amplifier will be fed into an oscilloscope where the gain can be observed in the amplitude of the output sine wave.**

Item(s) to be tested	
1	RF amplifier

Specifications	
Input	**Expected Output/Result**
10mV peak @ 3.5MHz-4.0MHz 10mV peak @ 14.00MHz-14.35MHz	Gain of 15-20 Gain of 12-15

Resources Required	
1	12V DC power source
2	Function generator
3	Mixed signal oscilloscope

Procedural Steps	
1	Connect 12V source to power input of amplifier and turn on
2	Connect function generator to signal input of amplifier and set to 10mV peak at 3.5MHz
3	Connect oscilloscope to amplifier output and turn on
4	Take reading from oscilloscope while sweeping frequency up to 14.35MHz
5	Observe peak voltage readings on oscilloscope within 80m and 20m band regions
6	Divide output amplitudes by input amplitude to observe gain

4.3 Test Case #3: Radio will only operate at 3.5-4.0MHz and 14.00-14.35MHz 2.1.3

Tested By:	James Bell
Test Case Number	3
Test Case Name	Operating Frequency Regions
Test Case Description	**The receiving portion of the radio will have 80m and 20m bandpass filters to filter out noise from the rest of the spectrum, these will be tested by doing a frequency sweep will an oscilloscope to insure that no frequencies outside of those bands are received. The transmit portion of the radio will be tested by transmitting to an off-the-shelf HF receiver that can verify the correct transmission.**

Item(s) to be tested	
1	80 meter bandpass filter
2	20 meter bandpass filter
3	Teensy 3.6

Specifications	
Input	**Expected Output/Result**
Signals ranging from 3.0MHz to 30.0MHz	Reception/transmission of 3.5-4.0MHz and 14.00-14.35MHz only

Resources Required	
1	HF receiver
2	Function generator
3	Mixed signal oscilloscope

Procedural Steps	
1	Connect function generator to input and oscilloscope to output of 80m bandpass filter
2	Do a frequency sweep from 3.0MHz to 30.0MHz, observe if any undesired frequencies appear at the output
3	Repeat with 20m bandpass filter
4	With entire transceiver assembled, attempt to transmit at varying frequencies within and outside of the 80m and 20m band plans
5	Observe on off-the-shelf HF receiver if any undesired transmissions are received

4.4 Test Case #4: Transmit power of 18-25mW

Tested By:	Samuel Hussey	
Test Case Number	4	
Test Case Name	Transmission Power	
Test Case Description	**A transmission will be produced by the radio while a digital multimeter probes the output to observe if the power is 18mW at a minimum, but more will be acceptable and welcomed.**	
Item(s) to be tested		
1	Teensy 3.6	
Specifications		
Input		**Expected Output/Result**
Audio input through microphone		An output signal of 18mW minimum but no more than 31mW
Resources Required		
1	Digital multimeter	
2	12V DC power supply	
Procedural Steps		
1	Turn radio on and send an audio transmission through the microphone	
2	While transmitting, use DMM to measure current at output	
3	Repeat step 2 while measuring voltage	
4	Use observed values to calculate output power	
5	Repeat test over entire range of 80m and 20m bands to insure power output is consistent	

4.5 Test Case #5: Latency under 100ms

Tested By:	Zachary Schneiderman	
Test Case Number	5	
Test Case Name	Total Latency	
Test Case Description	**The radio will be probed at the input (microphone) and output (antenna) by an oscilloscope displaying both signals. A time stamp will be taken when an input signal is produced and then taken again when an output is seen.**	
Item(s) to be tested		
1	All components within transceiver	
Specifications		
Input		**Expected Output/Result**
Audio input through microphone		Signal transmission in under 100ms from start of input
Resources Required		
1	Mixed signal oscilloscope	
2	12V DC power supply	
Procedural Steps		
1	Connect oscilloscope to base of microphone input and output of the radio	
2	Change oscilloscope settings to display both signals simultaneously	
3	Input an audio signal and take a time stamp of the reading	
4	Take a time stamp of instance that output signal appears on display	
5	Record the difference between the two to acquire total latency and insure it is under 100ms	

4.6 Test Case #6: On/Off switch and indicating LED

Tested By:	James Bell	
Test Case Number	6	
Test Case Name	Power On/Off	
Test Case Description	**A digital multimeter will be used to probe the power supply node after the switch while a DC power supply is connected and on.**	
	Item(s) to be tested	
1	Power switch	
2	Indicating LED	
3	12V power adapter	
	Specifications	
Input		**Expected Output/Result**
12V DC		5V/12V if switch is on, 0V if switch is off
	Resources Required	
1	120V @ 60Hz	
2	Digital multimeter	
	Procedural Steps	
1	With the switch in the off position, plug the power adapter into outlet	
2	Using DMM, probe power supply network at 12V source and 5V regulator to insure no power is being supplied	
3	Turn the switch to the on position and repeat step 2 to insure that 12V is being supplied by the adapter while only 5V is leaving the regulator	

4.7 Test Case #7: Clear way to tune frequency

Tested By:	James Bell	
Test Case Number	7	
Test Case Name	Simplicity of UI	
Test Case Description	**We will introduce 5 people that have not seen or used our device before and time how long it takes them to identify the method to alter the frequency.**	
Item(s) to be tested		
1	Rotary encoder	
2	LCD display	
3	User interface	
Specifications		
Input		**Expected Output/Result**
5 participants who have not seen the device before		Ability to locate rotary encoder and understand its function within 3 seconds
Resources Required		
1	5 willing participants	
2	Timer	
Procedural Steps		
1	Introduce each participant to the radio whilst it is hidden from view	
2	Uncover the radio and have the participant locate the rotary encoder while understanding that this is the means to tune frequency	
3	Begin timing	
4	Stop timing when participant locates rotary encoder and LCD display	

4.8 Test Case #8: Volume Control

Tested By:	Zachary Schneiderman
Test Case Number	8
Test Case Name	Volume Control
Test Case Description	**The speaker will output a signal while the volume control knob is adjusted from the minimum to maximum volume. A decibel meter application on a smart phone will be used to observe the change in output from the speaker.**

Item(s) to be tested	
1	Audio Shield
2	Speaker
3	Audio amplifier

Specifications	
Input	**Expected Output/Result**
Audio signal through microphone	0-45dB from speaker

Resources Required	
1	Decibel meter

Procedural Steps	
1	Turn radio on and input an audio signal through the microphone
2	Fix speaker near decibel meter and insure that no sound is being measured when volume is off
3	Turn volume control up gradually to maximum and observe if decibel meter registers change in sound from speaker.

5. Testing Schedule

Test Dates	Test Case Number	Test Name	Responsible Engineers
1/23/18	#1	Power supply network	Samuel Hussey
1/30/18	#2	RF Amplifier Gain	Zachary Schneiderman
2/6/18	#3	Operating Frequency Regions	James Bell
2/20/18	#4	Transmission Power	Samuel Hussey
3/6/18	#5	Total Latency	Zachary Schneiderman
3/20/18	#6	Power On/Off	James Bell
4/3/18	#7	Simplicity of UI	James Bell
4/17/18	#8	Volume Control	Zachary Schneiderman