

**EE SENIOR DESIGN
PROJECT STATEMENT OF WORK
SOFTWARE DEFINED RADIO**

**TEXAS STATE UNIVERSITY
INGRAM SCHOOL OF ENGINEERING**

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**SPONSOR TEXAS STATE UNIVERSITY
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10/17/2018



Revision History			
Version	Date	Description	Author
0.1	9/12/18	Rough Draft	James Bell
0.2	9/17/18	Fixed spelling and grammar errors	James Bell
0.3	9/19/18	Fixed problems brought up from feedback	James Bell
0.4	9/24/18	Fixed grammar, spelling, and inconsistencies	James Bell
1.0	9/24/18	Final Document accepted by Sponsor and Instructor	James Bell
1.1	9/30/18	Added LED indicator requirement for Power Switch	James Bell
1.2	10/17/18	Changed “build kit” to “educational tool” due to a miscommunication	James Bell
1.3	10/17/18	Updated the Project Scope Description	James Bell

TABLE OF CONTENTS

1.	EXECUTIVE SUMMARY	2
2.	BUSINESS NEED	2
3.	PRODUCT SCOPE DESCRIPTION	2
4.	PROJECT SCOPE DESCRIPTION	4
5.	SPONSOR SUPPORT ELEMENTS.....	6
6.	APPROVALS.....	6

1. EXECUTIVE SUMMARY (SAMUEL HUSSEY)

The product is a half-duplex Software-Defined Transceiver that will allow the transmission of signals in both directions, but not simultaneously, within the North American high frequency bands, 3.500MHz - 29.700MHz. The incoming and outgoing signals will be processed on a microprocessor using digital signal processing techniques, rather than hardware, to tune the antennae and apply filtering. The primary goals of the project are efficiency, clarity, and repeatability. A secondary goal will be to create a build kit to facilitate learning and ease of entry to the amateur radio community. This means affordable components and refinements where possible for the sake of simplicity, cost and efficiency.

The first prototype of the finished product will be finished by December 7th, 2018. Moving forward after this date, refinements to the designs will be addressed as well as stretch goals such as a casing and Raspberry Pi compatibility. The Software Defined Radio Transceiver team will be conducting all aspects of the project on the Texas State University campus including research, assembly, testing and troubleshooting. After all necessary research has been done on picking components, designing schematics, and developing the software portion of the design, an acceptable price list will be produced with approvals from Dr. Stapleton and Dr. Aslan. Lastly, construction and testing will commence with each group member working in conjunction with the others to meet deadline requirements and stay within the scope of the project that is further detailed below.

2. BUSINESS NEED (ZACHARY SCHNEIDERMAN)

Texas State University's Electrical Engineering department is sponsoring this project to have a functioning software-defined radio that will be used as a learning tool for students. Students will be able to use the radio to test various digital signal processing techniques such as bandpass filtering, transforms, and windows. Organizations such as the Bobcat Amateur Radio Club and the Institute of Electrical and Electronic Engineers student chapter on campus will also be able to use this radio for educational purposes.

3. PRODUCT SCOPE DESCRIPTION (JAMES BELL)

In this project the team will build and test a high frequency software defined radio. The key features of this radio are as follows:

- It will be able to turn on and off.
- It will be capable of receiving desired frequencies on the North American high frequency band.
- It will take the received transmissions and convert them to an audio signal.
- It will have real time audio.
- It will be capable of transmitting on the north American high frequency band.
- It will be capable of taking in audio and converting it for transmission.
- It will transmit the converted audio.

- A clear and simple to access way to alter the frequency transmitting and receiving on in the high frequency band.
- It will show the frequency currently tuned in to in a visual way.
- It will be able to run on standard US power.
- Its estimated unit cost should be less than \$300.
- The prototype device should resemble the specifications posted as closely as possible.
- The signal received will be understandable and clear.
- The device will have a volume control for the speaker.
- The device will have the option to select license class.
- The device will have an enclosure for safety.
- Optional: Higher power amplifier.
- Optional: Have the ability to run on an alternate power source.
- Optional: Be able to run with a Teensy or a Raspberry Pi.
- Optional: Should have a headphone jack.

Product Performance:

Features	Performance Targets
Turn on and off	Turns on and off, the on state will be indicated by an LED
Receiving and transmitting on a desired frequency	We will tune to a desired frequency on the North American high frequency band with this device
Take a radio signal and convert it to an audio signal	Using the Teensy microcontroller, the device will take in Single Sideband Radio signals and convert them to audio signals
Output and input audio in real time	Latency of less than 100 milliseconds
Transmitting receiving on North American high frequency 20- and 80-meter band	20-meter band: 3.500MHz – 4.000MHz 80-meter band 14.000MHz – 14.350MHz
Take audio from the user to transmit	It will be able to take in audio from a microphone and convert that signal in the Teensy to a Single Sideband radio signal
Transmit and receive audio with limited latency	It will do the audio to Single Side band conversion in less than 100 milliseconds
Clear way to alter frequency	Have a dial to select the frequency wanted
Make the desired frequency visible to the user	Have a display showing the current frequency
Run on standard US power	The device can be powered by 110V and 60Hz AC power from any US power outlet
Its estimated unit cost should be less than \$300	The unit will cost less than \$300 to produce
The signal received will be understandable and clear	The signal-to-noise ratio of the final device should be 25dB or more

The device will have volume control	The device will have a dial knob to control gain for the audio speaker.
The device will have an enclosure for safety reasons	The User will only be able to access the control components such as the volume control, mode control, signal selection, and the on and off switch
Optional: Have the ability to run on an alternate power source	Run on a 12V battery for at least 4 hours of constant transmission
Optional: Be able to run with a Teensy or a Raspberry Pi	Be able to run with a Teensy or a Raspberry Pi
Optional: Should have a headphone jack	Will have a 3.5mm standard headphone jack for audio reception

The intent for this project is to create an educational tool for a software defined radio operating on the North American high frequency band. This will facilitate education in radio communications and digital signal processing.

4. PROJECT SCOPE DESCRIPTION (ZACHARY SCHNEIDERMAN)

Project Schedule				
Task	DRI	Duration, Weeks	Start	End
Statement of Work (Executive Summary)	Samuel Hussey	3	8/31/2018	9/24/2018
Statement of Work (Business Need)	Zachary Schneiderman	3	8/31/2018	9/24/2018
Statement of Work (Product Scope Description)	James Bell	3	8/31/2018	9/24/2018
Statement of Work (Project Scope Description)	Zachary Schneiderman	3	8/31/2018	9/24/2018
Statement of Work (Sponsor Support Elements)	Samuel Hussey	3	8/31/2018	9/24/2018
Statement of Work (Approvals Signature)	James Bell	3	8/31/2018	9/24/2018
Watch and take notes on Videos of SDR	All	4	8/31/18	9/24/18

Complete Parts List	Zachary Schneiderman	2.5	9/24/18	10/18/18
Setup Arduino Environment and establish understanding the prototype code	James Bell	2.5	9/24/18	10/18/18
Complete Functional Specs	Samuel Hussey	2.5	9/24/18	10/1/18
Signed Spec Sheet	James Bell	3.5	10/10/18	11/5/18
Begin RF Amplifier		3	10/10/18	11/5/18
Begin Power Amp		3	10/10/18	11/5/18
Begin Bandpass Filter		3	10/10/18	11/5/18
Labor Cost Schedule	James Bell	2	11/5/18	11/19/18
Poster Draft	James Bell	3	11/5/18	11/26/18
Test/Benchmark Circuits		2	11/5/18	11/19/18
Develop Passthrough Tests		2	11/5/18	11/19/18
Create Quadrature Converter		3	11/5/18	11/26/18
Test Plan	James Bell		11/19/18	11/30/18
Configure LCD/Tuner Knob		2	11/19/18	12/2/18
Implement RF Receive Code		1	11/19/18	11/26/18
Receive/Tune tests		1.5	11/26/18	12/5/18
Transmitting/Tune tests		1.5	11/26/18	12/5/18
Final Preparations for Senior design day		1	12/5/18	12/7/18
Add licensing selection to radio		4	1/22/19	2/19/19
Raspberry Pi implementation		6	1/22/19	3/4/19
Custom PCB		6	1/22/19	3/4/19
Higher Power Amplifier		4	2/19/19	3/12/19
Alternate Power Sources		4	2/19/19	3/12/19
Custom Cases		4	3/12/19	4/9/19
Head phone output jack		4	4/9/19	5/6/19

5. SPONSOR SUPPORT ELEMENTS (SAMUEL HUSSEY)

Sponsor Support Elements		
Element	First Needed	Needed Until
Sponsor Meeting, at least 1 hour/week	9/17/18	5/6/19
SWR Meter and Dummy Load for testing transmissions	11/26/18	5/6/19
Spectrum Analyzer	11/26/18	5/6/19
Reference Books	9/17/18	5/6/19

6. APPROVALS (JAMES BELL)

The signatures of the people below indicate an understanding in the purpose and content of this document by those signing it. By signing this document, you indicate that you approve of the proposed project outlined in this Statement of Work and that the next steps may be taken to create a Functional Specification and proceed with the project.

Approver Name	Title	Signature	Date
	Project Manager		
	D2 Project Manager		
	Faculty Sponsor		
	Sponsor		
	Instructor		