915 MHz Transceiver for Digital Communication

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Presentation Outline

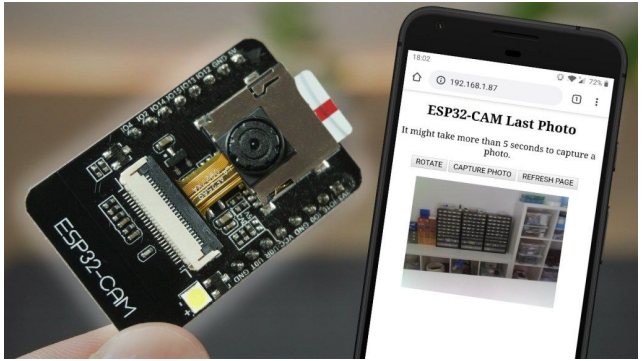
- Why this project exists
- Device Specifications
- System Modularity
- Project Timeline
- Additional Considerations
- Conclusion

Why this project exists

Project overview

- Lack of available 915MHz open-source and open-hardware modules
- As an example use case and practical implementation of the 915MHz module
- Enable extensible and easy communication tailored to more specific use cases
- Low Cost and ubiquitous hardware to facilitate inexpensive modules.

Potential Applications



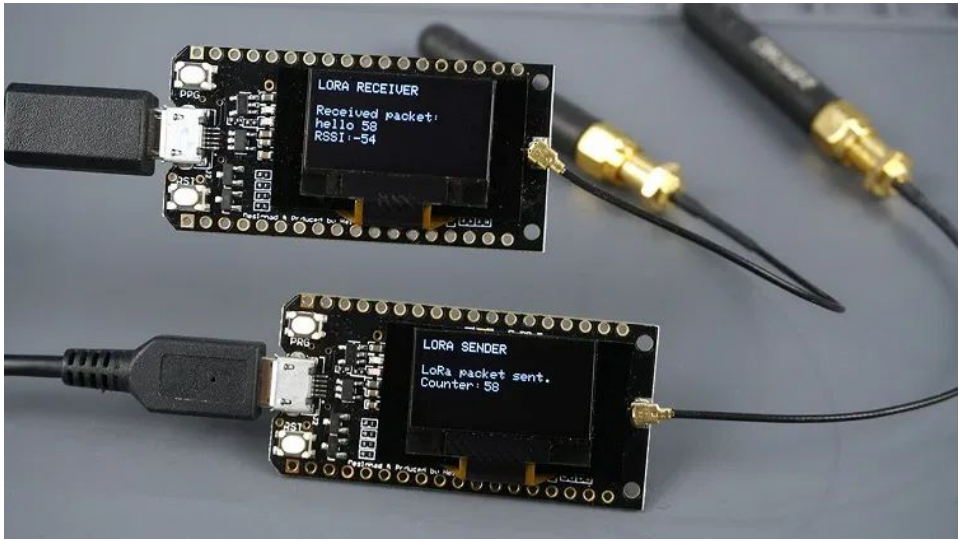


Table of LoRa WAN vs our Product

	LoRa	Our Product
Frequency	902-928 MHz	902-928 MHz
Data Rate	300 bit/s - 27 kbit/s	512 bit/s - 9.6 kbit/s
Duty Cycle	Very Low	Up to 100%
Hand-Shake	Required Handshake	Optional Handshake
Broadcasting	Does not Support	Support
License	$6000 Yearly	Free for use

Device Specifications

Preliminary Specifications of Transceiver module

Transceiver	MAX 7037
Modulation	FSK ASK
Antenna	SMA male 50 Ω
Power Max	10 dBm - 10mW
Frequencies	915 ISM band (902-928 MHz)

- Theoretical Range
  - 2dbi Antenna ideal range is 2.9km (1.80 Miles)
  - 5dbi Antenna ideal range is 15km (9.3 Miles)
- Baseline Current draw at 3.3V
  - Sleep draw is .8mA
  - Full TX draw is 120mA
  - RX draw is 20mA

Preliminary Specifications of Control module

Microcontroller	ESP 32
Communication I/O Protocols	SPI, I2C, WiFi, BT UART
Power Supply	12V → 5V → 3.3V
Supported Modules	Camera, Display, GPS, Battery, and Environment Sensor

- Baseline Current draw 3.3V
  - Sleep draw is .8mA
  - RF Tx off draw is 40mA
  - RF Tx on draw is 160mA
  - RF Tx off, Wifi/BT on draw 240mA
- External power budget 12V
  - 1A peak draw to peripheral devices

Function testing

- Component level testing
  - Software stability
  - Proper hardware installation
- Digital Radio
  - Successful Tx/Rx modulation
  - Compliance with regulations
- Module Testing
  - Operates as intended
  - Communication between systems

Quantitative Testing

- Max Range Testing for 2dbi Antenna
- Max Range Testing for 5dbi Antenna
- Power Draw on Maximum RF Tx Power
- Power Draw on Minimum RF Tx Power
- Power Draw for different RF Protocols

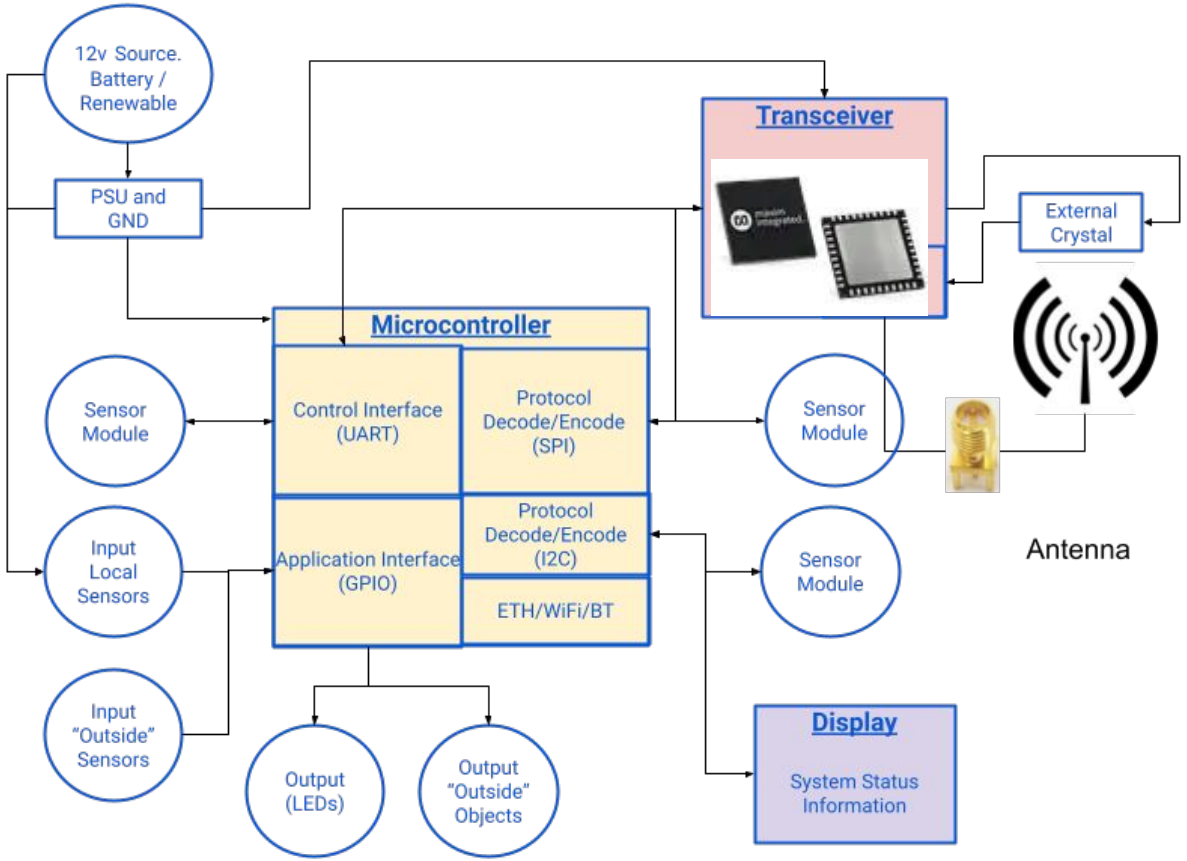
B.O.M.

QTY	Vendor	Vendor Part	ITEM DESCRIPTION	UNIT PRICE	TOTAL
1	Digikey	MAX7037EVKIT915#-ND	Eval Board Max7037	$254.99	$254.99
10	Digikey	MAX7037EGL+-ND	MAX7037 Chips	$5.96	$59.62
2	Digikey	343-ANT-916-CW-RCL-SMA-ND	SMA 900Mhz Hi Gain (Small) Antenna	$8.68	$17.36
2	Digikey	2151-RST-W1B6-10808-22M-FY-001-ND	SMA 900Mhz Low Gain (Small) Antenna	$4.64	$9.28
2	Digikey	1597-104020250-ND	OLED Display 1.12 (SH1107) v3.0 128x128 resolution	$12.50	$25.00
1	Digikey	1597-103020272-ND	I2C HUB (6 PORT)	$1.70	$1.70
1	Digikey	1597-1092-ND	4PIN MALE JUMPERS 5PACK	$3.20	$3.20
1	Digikey	1597-109020022-ND	GPS module for GPS / Beidou / Glonass / Galileo / QZSS / SBAS	$13.10	$13.10
2	Digikey	1597-1674-ND	Switch Human Interface 5WAY	$4.90	$9.80
2	Digikey	1597-104020169-ND	RGB LED	$4.40	$8.80
2	Digikey	1597-111020103-ND	Switch Human Interface Large Dual Button	$2.40	$4.80
1	Digikey	223-1785-ND	MS8607 SENSOR FOR GROVE SYSTEM	$16.09	$16.09
2	Digikey	1597-1687-ND	ESP32-CAM 2MP WIFI+BT AI-THINKER	$10.00	$20.00
2	Digikey	1965-ESP32-DEVKITC-32E-ND	ESP32-WROOM-32E series Transceiver Evaluation Board	$10.00	$20.00
1	Amazon	SMA Female Base	SMA Female Jack Connector 10-Count	$7.89	$7.89
1	Amazon	B07BBPX8B8	UART Cable	$10.99	$10.99

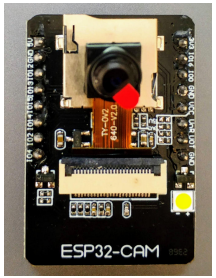
SUBTOTAL	$482.62
SHIPPING	$12.00
TOTAL	**$494.62**

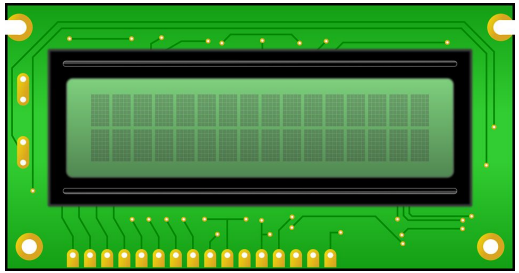
System Modularity

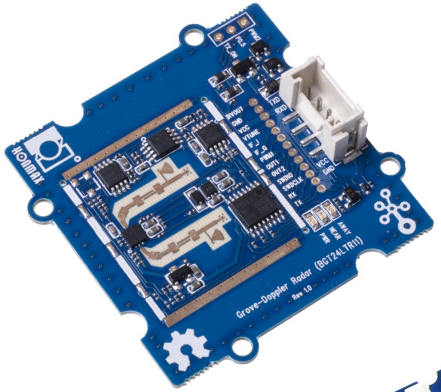
Block Diagram

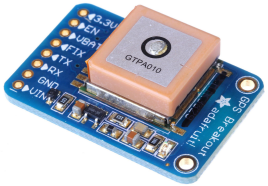


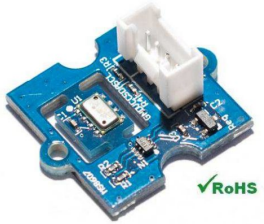
Potential Modular Accessory

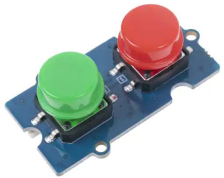


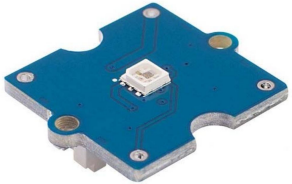


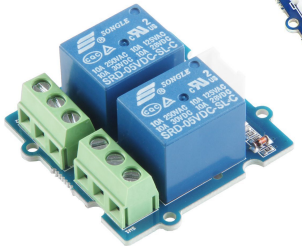






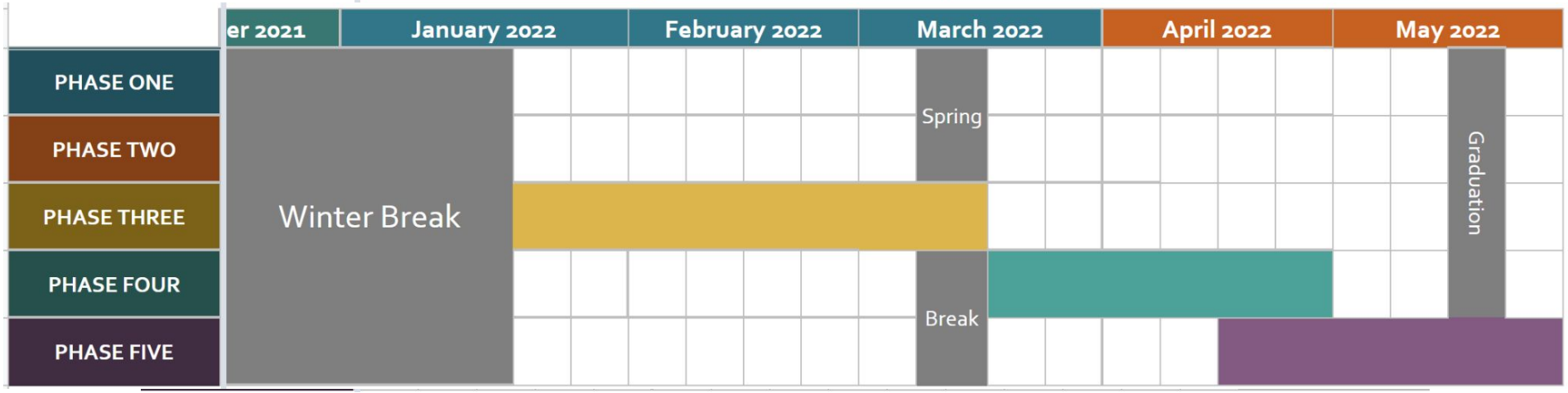




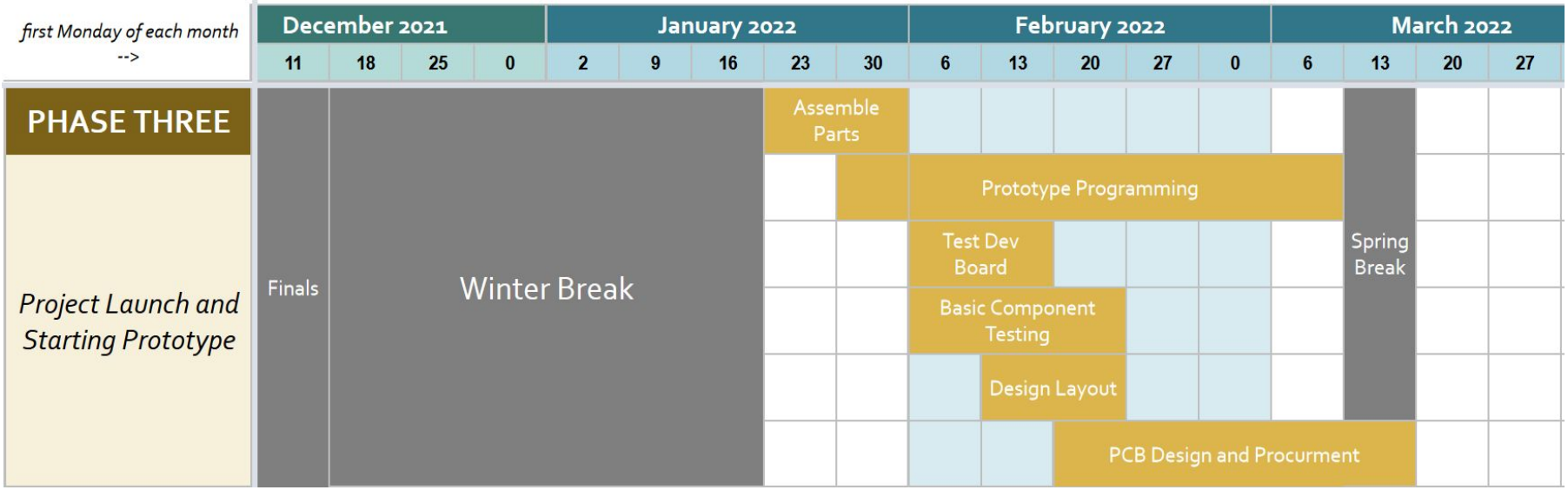


Project Timeline

High Level Timeline Overview



Senior Project Progress


first Monday of each month
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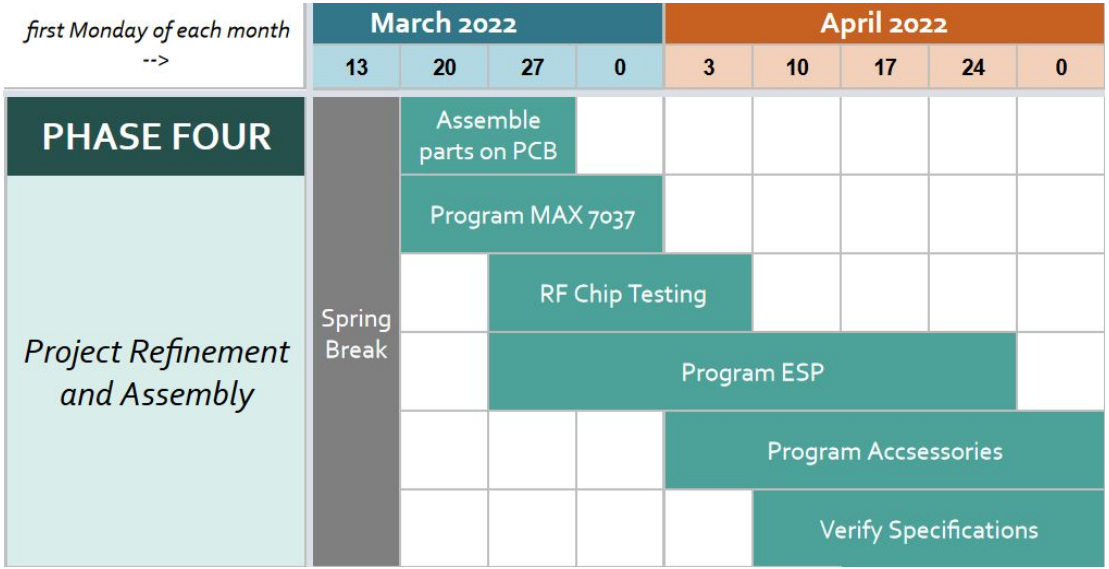
December 2021
January 2022
February 2022
March 2022
11
18
25
0
2
9
16
23
30
6
13
20
27
0
6
13
20
27
PHASE THREE
Project Launch and Starting Prototype
Finals
Winter Break
Assemble Parts
Prototype Programming
Test Dev Board
Basic Component Testing
Design Layout
PCB Design and Procurment
Spring Break


first Monday of each month
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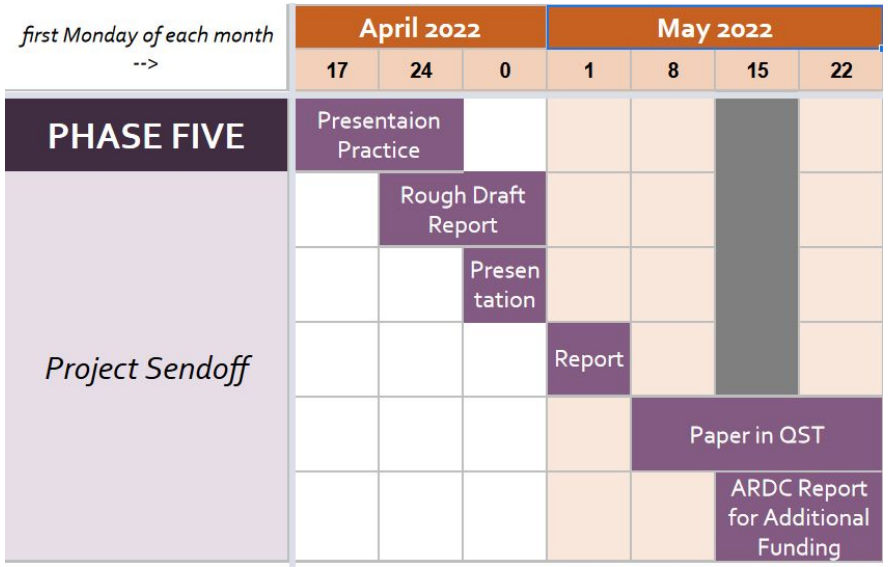
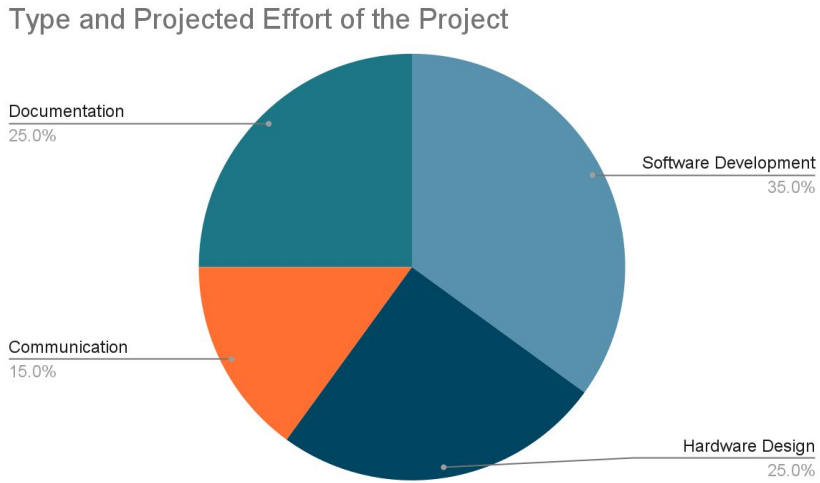
March 2022
April 2022
13
20
27
0
3
10
17
24
0
PHASE FOUR
Project Refinement and Assembly
Spring Break
Assemble parts on PCB
Program MAX 7037
RF Chip Testing
Program ESP
Program Accsessories
Verify Specifications


first Monday of each month
-->
April 2022
May 2022
17
24
0
1
8
15
22
PHASE FIVE
Presentaion Practice
Rough Draft Report
Presen tation
Report
Paper in QST
ARDC Report for Additional Funding
Project Sendoff

Division of Work

- Software Development
- Hardware Design
- Communication Schemes
- Documentation
- All have general knowledge in topics



Parts

Three rounds of funding

1. ECE Department
2. ARDC R&D
3. ARDC Production

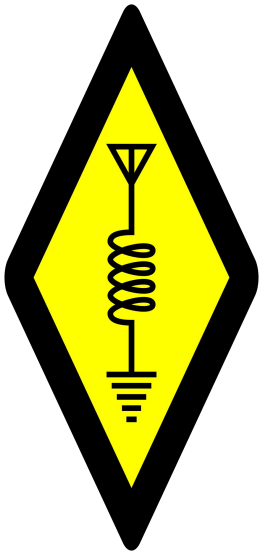
Additional Considerations

Software and Tools

- PCB Designer / CAD
  - -Keysight PathWave ADS
  - -KiCAD
- Embedded Systems Development
  - VS Code + ESP-IDF ESP32
  - Github
- RF Lab
  - Network Analyzer
  - Spectrum Analyzer
  - Oscilloscope
  - Logic Analyzer

Project Future

- Endless Applications
- Driven by Community Engagement
- Additional Communication Protocols



Conclusion

In Summary

- Microcontroller powered RF transceiver board for digital radio modes in the 915 MHz ISM band.
- Will be entirely Open source and Open hardware to make a positive impact in open initiatives and receive contributions from others.
- Use a higher duty cycle and be designed with extensibility in mind compared to the popular and proprietary alternative LoRa.
- Use ubiquitous and inexpensive hardware to build the board and interface with a variety of external modules.

Any Questions?

References

- https://www.espressif.com/sites/default/files/documentation/esp32_datasheet_en.pdf
- https://datasheets.maximintegrated.com/en/ds/MAX7037.pdf
- https://lora-alliance.org/resource_hub/lorawan-104-specification-package/