Clemson Senior Design

LoRa Radio Evaluation Design Requirements

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Table of Contents

[1. SCOPE 1](#_Toc192758074)

[2. Design Specifications 1](#_Toc192758075)

[2.1. Power Subsystem (Primary) 1](#_Toc192758076)

[2.1.1. Power Input 1](#_Toc192758077)

[2.1.2. Power Monitoring 1](#_Toc192758078)

[2.1.3. Power Analysis Report 2](#_Toc192758079)

[2.2. Local Processor Subsystem (Primary) 2](#_Toc192758080)

[2.2.1. Base Station Processor 2](#_Toc192758081)

[2.2.2. Base Station Memory 2](#_Toc192758082)

[2.2.3. Car Radio Processor 2](#_Toc192758083)

[2.2.4. Car Radio Memory 2](#_Toc192758084)

[2.3. LoRa Radio Subsystem (Primary) 2](#_Toc192758085)

[2.3.1. Chipset 2](#_Toc192758086)

[2.3.2. Precision Timing (Base Station Only) 3](#_Toc192758087)

[2.3.3. RF Input 3](#_Toc192758088)

[2.4. Ethernet Subsystem (Primary) (Base Station Only) 3](#_Toc192758089)

[2.4.1. RJ45 Connection 3](#_Toc192758090)

[2.4.2. Ethernet Speed 3](#_Toc192758091)

[2.5. USB Debug Port (Primary) 3](#_Toc192758092)

[2.5.1. Debug Terminal 3](#_Toc192758093)

[2.5.2. Programming Terminal 3](#_Toc192758094)

[2.6. External IO (Primary) 3](#_Toc192758095)

[2.6.1. External Header 4](#_Toc192758096)

[2.6.2. Common Pinout 4](#_Toc192758097)

[2.6.3. Signal Levels 4](#_Toc192758098)

[2.7. GPS Subsystem (Secondary) 4](#_Toc192758099)

[2.7.1. Chipset 4](#_Toc192758100)

[2.7.2. Common Selection 4](#_Toc192758101)

[2.7.3. RF Input 4](#_Toc192758102)

[2.8. IMU Subsystem (Secondary) 5](#_Toc192758103)

[2.8.1. Sensing 5](#_Toc192758104)

[2.8.2. Common Selection 5](#_Toc192758105)

[2.9. Battery Power Subsystem (Secondary) (Car Radio Only) 5](#_Toc192758106)

[2.9.1. Hot Swapping 5](#_Toc192758107)

[2.9.2. Charging 5](#_Toc192758108)

[2.9.3. Power Monitoring 5](#_Toc192758109)

Table of Figures

# SCOPE

This documentation outlines the hardware specifications and priorities for the design work done by the Clemson Senior design team in creating the LoRa Base Station Evaluation Board and the LoRa Car Radio Evaluation Board.

The purpose of these designs is to facilitate research into how LoRa radios can be used to create mesh networks for utilization on trains for various signaling and data monitoring applications.

# Design Specifications

The evaluation boards have been broken down into a set of subsystems. Each subsystem will have its own requirements and priority for completion.

Diagram

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Priorities are separated into primary and secondary. The goal should be to complete all the primary subsystems before work starts on secondary subsystems.

## Power Subsystem (Primary)

(AER-LORA-HW) These requirements refer to how the evaluation board receives power as a whole and not how each subsystem is powered. The design team may use their own skills and judgment to power each of the other subsystems from the input power described.

### Power Input

(AER-LORA-HW) The evaluation board shall be supplied by a single power input. This input shall be at +5VDC and shall utilize a barrel-type connector.

### Power Monitoring

(AER-LORA-HW) The evaluation board shall be capable of monitoring its own power draw from the primary power input source.

### Power Analysis Report

(AER-LORA-HW) The Clemson Design Team will create a report that shows the max power draw of each part on the evaluation board and how it is being supplied with the appropriate power. For switching regulator parts, the report shall also detail the calculations or simulations done to define the output voltage on the regulator, the power dissipation of the regulator and the stability of the regulator. For LDO regulator parts, the report shall also detail the calculations or simulations done to define the output voltage on the regulator and the power dissipation of the regulator.

## Local Processor Subsystem (Primary)

### Base Station Processor

(AER-LORA-HW) The local processor for the base station design will be the ATSAMA5D27-D1G. This unit is a System-in-Package that incorporates some of the more complex layout issues, like DDR memory routing, onto a single chip. This gets us the performance we need without overcomplicating the eval design.

### Base Station Memory

(AER-LORA-HW) The local processor shall have a total of at least 1GByte of external Flash memory. SPI or QSPI interface preferred, but not required.

### Car Radio Processor

(AER-LORA-HW) The local processor for the Car Radio design shall be from the STM32L4 series of chips. These allow drastically reduced power needs in exchange for much lighter performance.

### Car Radio Memory

(AER-LORA-HW) The local processor shall have a total of at least 64MBytes of external Flash memory. SPI or QSPI interface preferred, but not required.

## LoRa Radio Subsystem (Primary)

(AER-LORA-HW) The LoRa radio is the primary means of intercommunication between the nodes on the mesh.

### Chipset

#### Base Station Design

(AER-LORA-HW) The Base Station Design shall use the SX1276 chipset. The SX1250 front end module is not required but is recommended.

#### Car Radio Design

(AER-LORA-HW) The Car Radio Design shall use the SX1276 chipset. The SX1250 front end module is not required, but is recommended.

### Precision Timing (Base Station Only)

(AER-LORA-HW) The LoRa radio chip has a 1PPS (1 pulse per second) feature to improve timing accuracy. If the GPS subsystem is used, the 1PPS signal it provides shall be used to improve timing accuracy. (See Section 2.7)

### RF Input

(AER-LORA-HW) The LoRa antenna shall be input through an SMA interface.

## Ethernet Subsystem (Primary) (Base Station Only)

(AER-LORA-HW) This subsystem will be used on the Base Station Unit to backhaul collected data to another point on the network for storage and later analysis.

### RJ45 Connection

(AER-LORA-HW) The ethernet subsystem shall implement as a standard ethernet port for communication.

Note: This means a RJ45 connector, the standard transformer, a PHY chip, and the local processor MAC.

### Ethernet Speed

(AER-LORA-HW) The ethernet subsystem shall support at least 10/100Mbps communication rates.

## USB Debug Port (Primary)

(AER-LORA-HW) This subsystem will allow seamless connection and communication between the SW team’s computers and the eval board.

### Debug Terminal

(AER-LORA-HW) The USB port shall allow serial communication with the evaluation board for debugging purposes.

### Programming Terminal

(AER-LORA-HW) The USB port shall allow programming updates to the local processor.

## External IO (Primary)

(AER-LORA-HW) The evaluation board will be implementing a set of external IO for use in testing signaling across the mesh network. Separate breakout board will be made to utilize this header.

### External Header

(AER-LORA-HW) The evaluation board shall implement a 2-row, 100-mil header for external IO use.

One row will be for signals, and the other row will be GND. This way, each signal shall have its own dedicated GND pin.

The header shall have the following signal types and quantities implemented on it.

* 8x GPIO signals
* 2x DAC signals
* 2x ADC signals
* 1x UART Serial Interface (serial interfaces may use the same pins and be swappable)
* 1x I2C Serial Interface (serial interfaces may use the same pins and be swappable)
* 1x SPI Serial Interface (serial interfaces may use the same pins and be swappable)
* 2x +3.3V Power pins

### Common Pinout

(AER-LORA-HW) The external IO header shall have the same pinout on both the Base Station and Car Radio Designs.

### Signal Levels

(AER-LORA-HW) All pins on the external IO header shall be tolerant to voltage levels from 0V to +3.3VDC.

## GPS Subsystem (Secondary)

(AER-LORA-HW) GPS locationing may be necessary for several of the locationing features we would like to implement in the future.

### Chipset

(AER-LORA-HW) The eval board shall use a Ublox M8 or M10 series chip or module.

Additionally, the module shall have a 1PPS output for the LoRa radio module.

### Common Selection

(AER-LORA-HW) The Base Station and Car Radio Designs shall use the same chip or module.

### RF Input

(AER-LORA-HW) The GPS antenna shall be input through a SMA interface.

## IMU Subsystem (Secondary)

(AER-LORA-HW) The IMU system will primarily be used for “Wake on Motion” functionality.

### Sensing

(AER-LORA-HW) The IMU shall be 6 or 9 axis sensing.

### Common Selection

(AER-LORA-HW) The Base Station and Car Radio Designs shall use the same chip.

## Battery Power Subsystem (Secondary) (Car Radio Only)

(AER-LORA-HW) The Car Radio design is expected to be low power and battery operated.

### Hot Swapping

(AER-LORA-HW) The unit must swap back and forth between battery power and primary power during operation, without interruption. When primary power is applied, swap to it. When primary power is removed, swap to battery.

### Charging

(AER-LORA-HW) When the unit is plugged into primary power it shall charge the battery.

When the battery is full, the unit shall swap to trickle charge to protect the battery from overcharge degradation.

### Power Monitoring

(AER-LORA-HW) The unit shall be able to monitor and report battery levels.