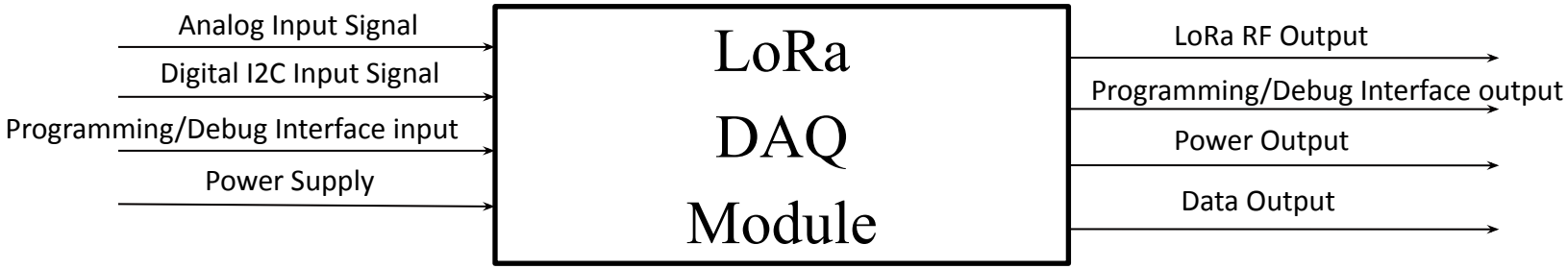
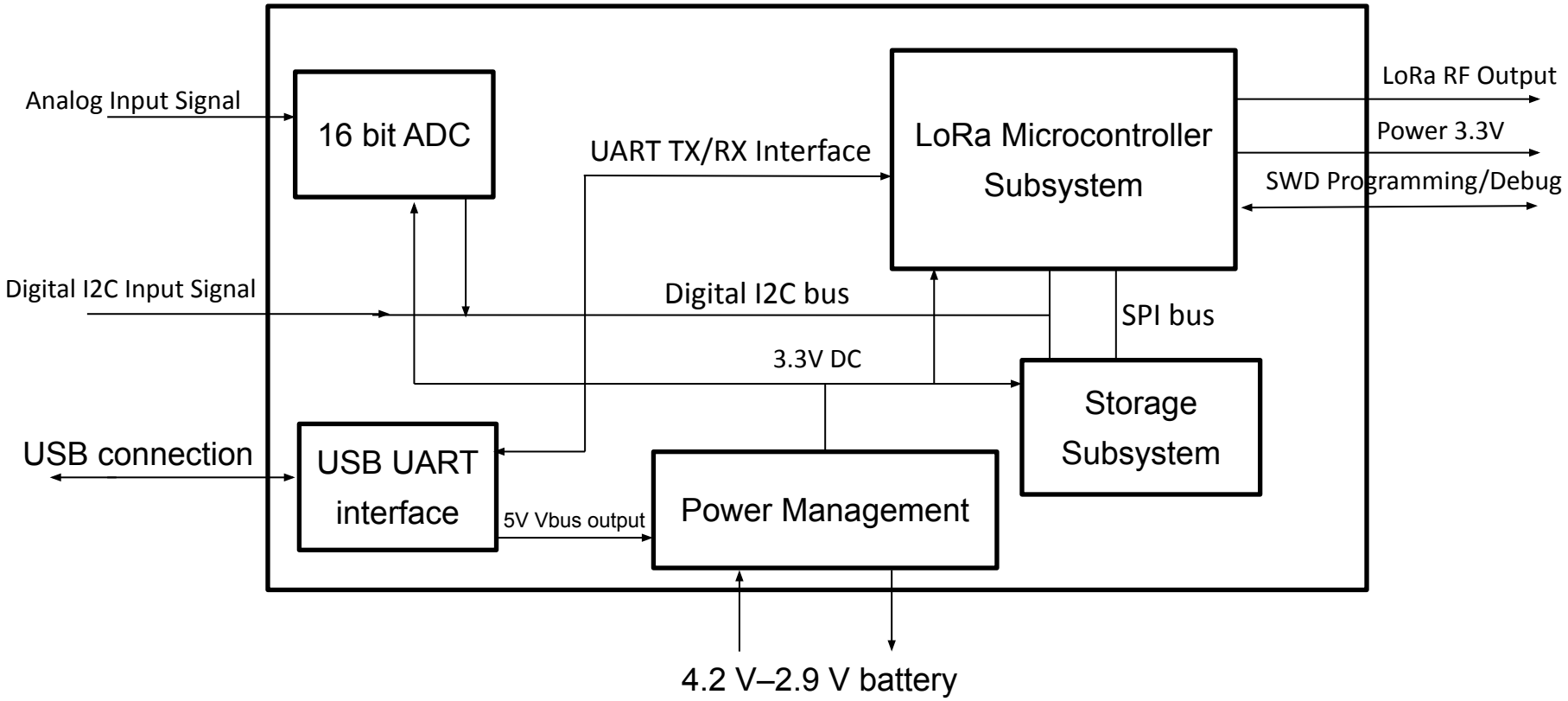
LoRa DAQ Module: Level 0

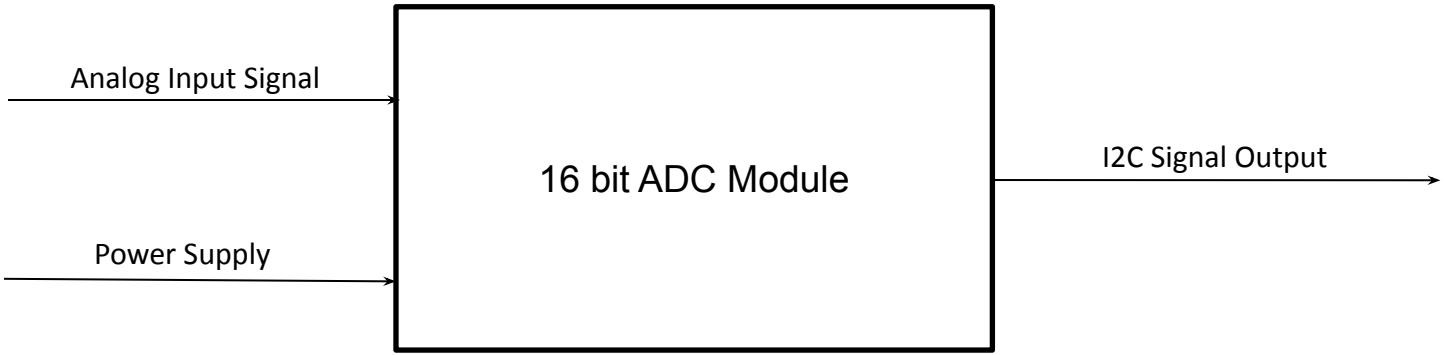


Module	**LoRa DAQ Module**
Inputs	**Analog Input Signal:** up to 0.33 V peak from analog sensors **Digital I²C Input Signal:** SDA, SCL from digital sensors **Programming/Debug Interface Input:** from ST-Link or UART interface **Power Supply:** 4.2 V–2.9 V battery or 5 V USB
Outputs	**LoRa RF Output:** 902–928 MHz **Programming/Debug Interface Output:** ST-Link or UART interface **Power Output:** 3.3 V for sensors **Data Output:** SD card interface
Functionality	The LoRa DAQ Module reads data from custom analog and digital sensors, stores measurements on a local SD card, and can transmit real-time data through the 902–928 MHz LoRaWAN radio. The system is designed for long-term, low-power operation, enabling continuous data collection and transmitting on a chargeable battery supply.

LoRa DAQ Module: Level 1

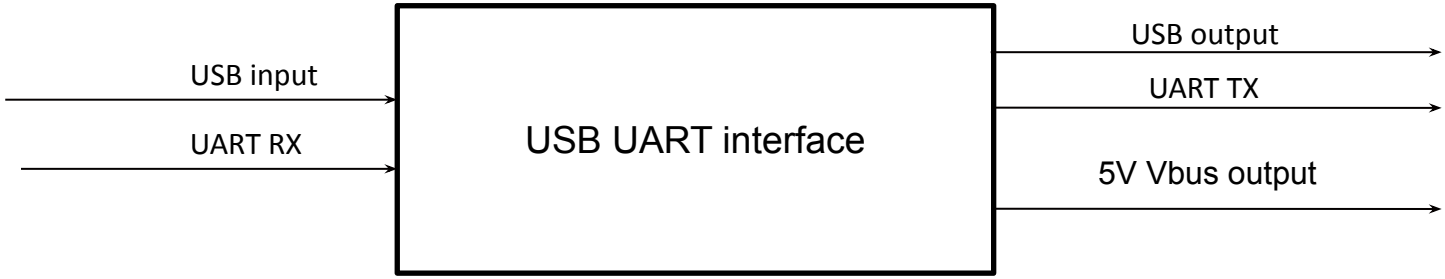


16 bit ADC Module: Level 1



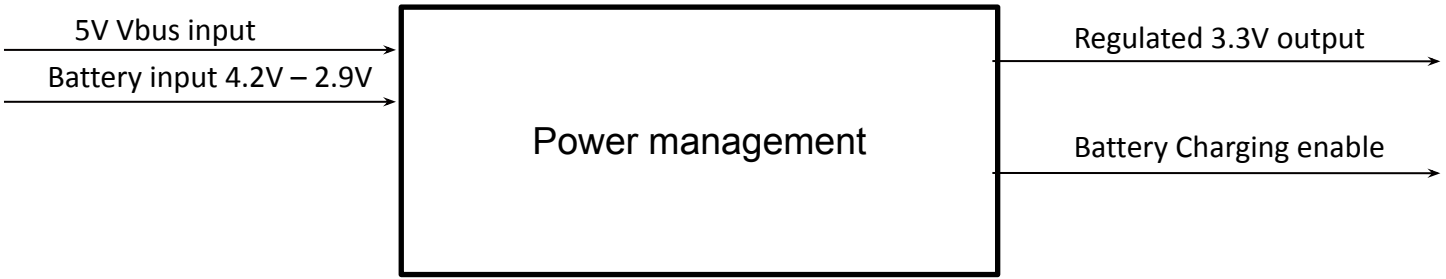
Module	**16 bit ADC Module**
Inputs	**Analog Input Signal:** up to 0.33 V peak from analog sensors **Power Supply:** 3.3V power supply from power management
Outputs	**I2C Signal Output:** The converted analog input signal is transmitted to the microcontroller through I2C interface (SDA/SCL).
Functionality	The 16-bit ADC module samples the external analog input from connected sensors, conditions the signal using an internal gain amplifier, and converts it into a high-resolution digital value. The resulting digital data is transmitted to the microcontroller through the I2C interface.

Module: Level 1



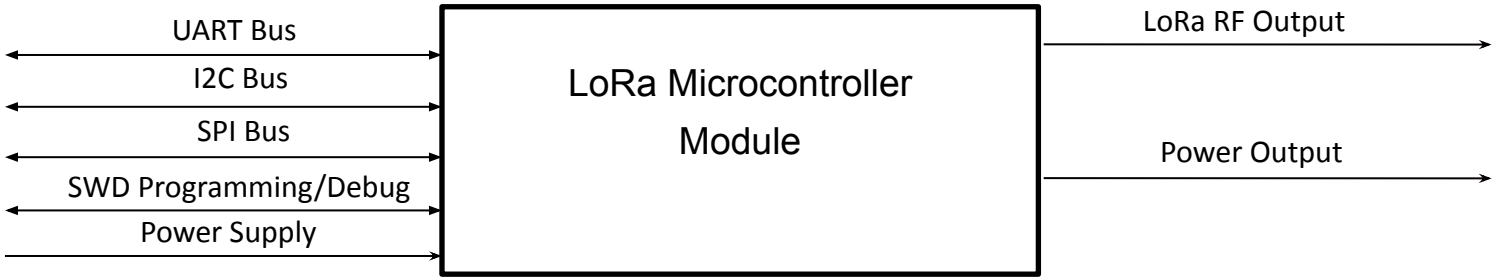
Module	**USB UART interface**
Inputs	**USB Input:** USB data and 5 V power supplied from a computer through the USB connector **UART RX:** Serial data received from the microcontroller.
Outputs	**USB Output:** Serial data transmitted back to the computer through the USB connection (converted from UART). **UART TX:** Serial data transmitted to the microcontroller **5 V VBUS Output:** Provides the 5 V USB power to the power-management subsystem.
Functionality	The USB UART interface converts USB data from the computer into UART signals that the our microcontroller can process and convert the MCU UART back into USB communication with the host computer. This module also forwards the USB 5V VBUS supply to our power management block, enabling our system to operate or charge our battery when connecting to a USB port

Power Management: Level 1



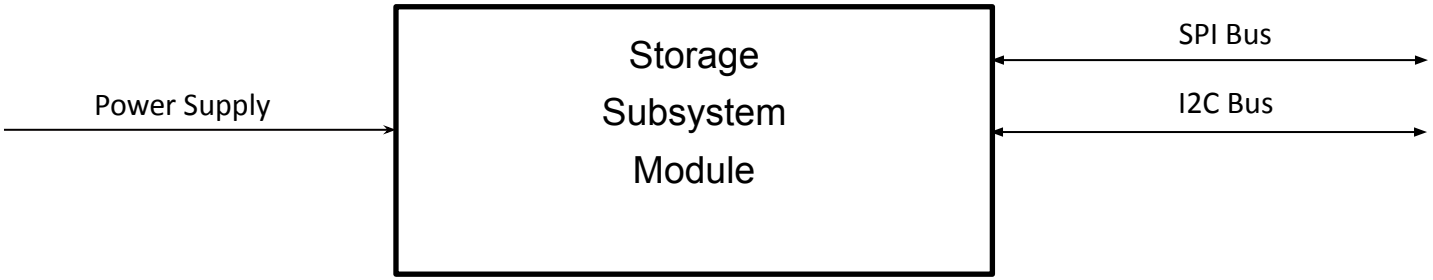
Module	**Power Management Module**
Inputs	**5 V VBUS Input:** USB-supplied 5 V provided through the USB-UART interface. This voltage is used to power the system and to charge the battery. **Battery Input (4.2 V – 2.9 V):** Li-ion battery voltage supplied, used when USB is not connected.
Outputs	**Regulated 3.3 V Output:** Primary logic-level power rail used by the microcontroller, ADC module, peripherals, and sensors. **Battery Charging Enable :** Managed charging of the Li-ion battery using the charger IC when USB power is available.
Functionality	The Power Management module automatically manages all system power sources. It selects between USB 5 V and the battery using a power-mux, charges the Li-ion battery when USB is connected, and provides a stable 3.3 V rail for all system components. An internal 5 V regulator is also used within the power circuitry if using battery to make continuous operation and seamless transitions between USB and battery power mode.

LoRa Microcontroller Module: Level 1



Module	**LoRa Microcontroller Module**
Data interface I/O and power	**UART Interface:** Bidirectional serial communication with the USB-UART interface (TX/RX). **I2C Bus:** Bidirectional digital interface used to communicate with the ADC, EEPROM, and external I2C sensors. **SPI Bus:** Bidirectional digital interface used for SD card storage and Read. **Programming/Debug Interface:** SWD bidirectional interface for firmware programming and debugging (ST-Link). **Power Supply:** 3.3 V regulated input from the Power Management Module.
External Outputs	**LoRa RF Output:** 902–928 MHz radio-frequency output for wireless transmission. **Power Output:** 3.3 V for sensors power supply
Functionality	The LoRa Microcontroller Module manages system control, communicates with digital sensors, and storage devices, and sends collected data through the 902–928 MHz LoRa radio. It interfaces with the ADC, EEPROM, SD card, and USB-UART bridge through UART, I2C, and SPI buses. The module runs on a 3.3 V supply and supports firmware programming and debugging via the SWD interface.

Storage Subsystem Module: Level 1



Module	**Storage Subsystem Module**
Data interface I/O	**SPI Bus:** Bidirectional SPI communication interface used to read from and write to the micro-SD card. **I2C Bus:** Bidirectional I²C interface used for accessing the onboard EEPROM for configuration and calibration data.
Input	**Power Supply:** 3.3 V regulated power from the Power Management Module
Functionality	The Storage Subsystem Module provides digital storage for the DAQ system. The micro-SD card stores large amounts of sensor data through the SPI bus, while the EEPROM stores small configuration values or calibration data over the I2C bus. Together, these support long-term data logging and persistent system settings for debugging and validation.