MegaSat Development Board

What is the MegaSat?

- The MegaSat is a microprocessor developmental board designed to assist students in learning electronic instrumentation and programming using the Arduino Mega.

- It was developed by the Louisiana Space Grant Consortium as a replacement for the BalloonSat developmental board.

Development Background

- CanSat was a project conceived by Professor Bob Twiggs at Stanford University's Space Science Development Laboratory in the late 1990s.
- CanSat was designed to be accommodated within a soda can-sized satellite enclosure.
- BalloonSat was developed in the early 2000s at LSU by S.B. Ellison and Jim Giammanco as an adaptation of the CanSat.
- ACES needed a more convenient way to expand the payload with external devices and wanted the convenience of having on-board components not offered by CanSat. This led to the creation of BalloonSat.
- After many years of service, the hardware on the BalloonSat became outdated. The MegaSat was designed to update the hardware.

From CanSat to BalloonSat

- CanSat featured a BASIC Stamp microcontroller, an additional memory chip for data storage and a modem for connecting to an external radio transmitter/receiver.

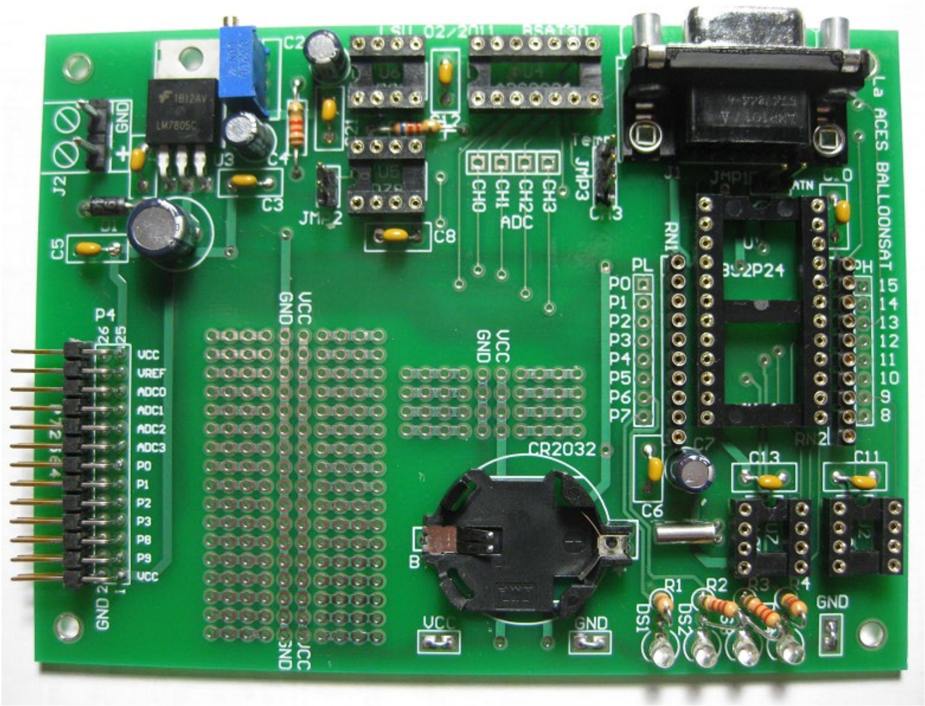
- ACES payloads did not need the modem of CanSat so this was eliminated, but a number of enhancements were added to better accommodate payloads and allow for easier external expansion for students who wanted to go beyond the baseline features.

CanSat

From BalloonSat to MegaSat

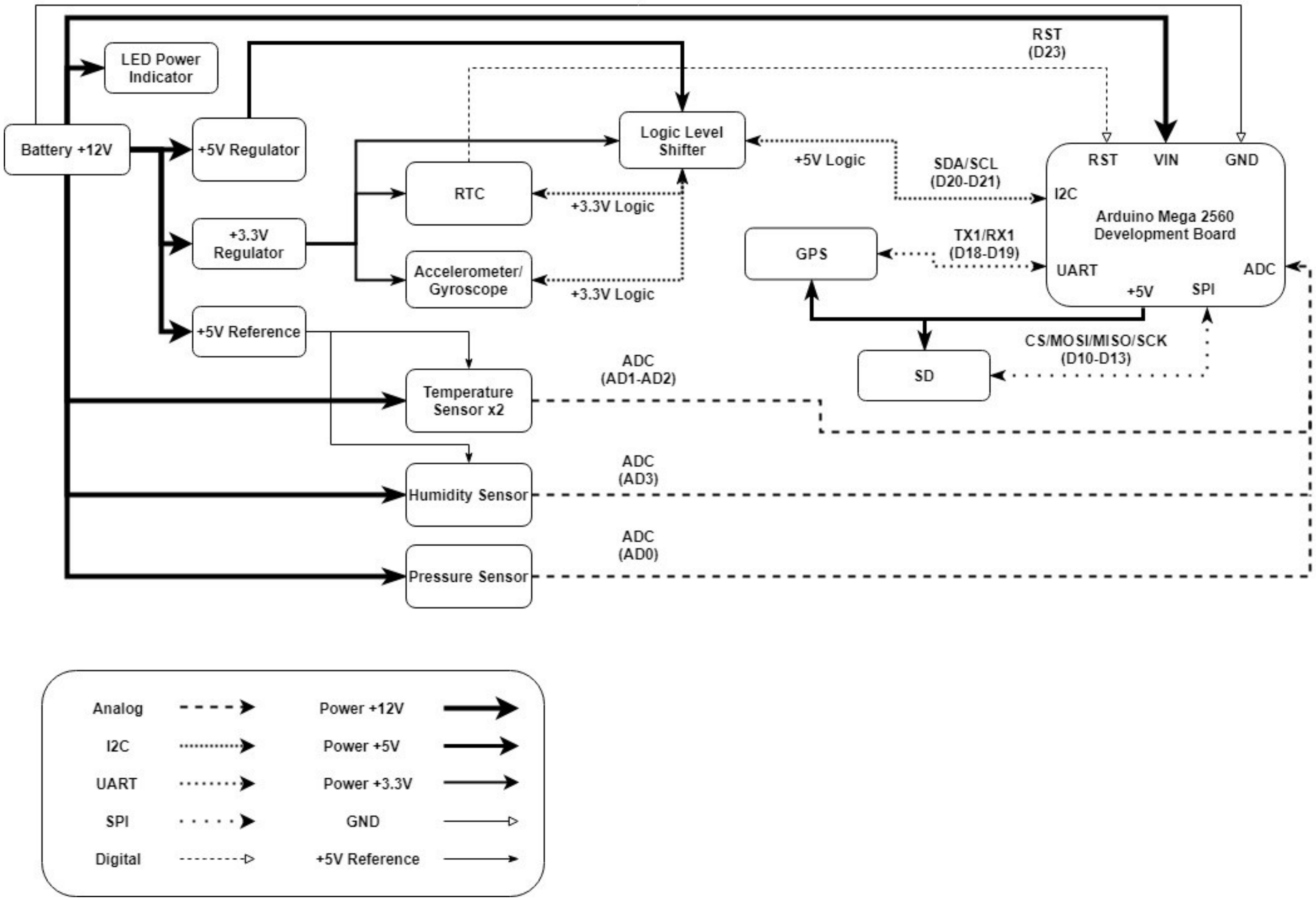
- The BalloonSat featured a Basic Stamp microcontroller, an external EEPROM, a 4-channel analog-to-digital converter, a voltage reference, a temperature sensor, a real time clock with a battery backup, and 4 on-board LEDs for use as visual indicators

- The BalloonSat was used by the ACES program for over ten years before the MegaSat was created to update the hardware.



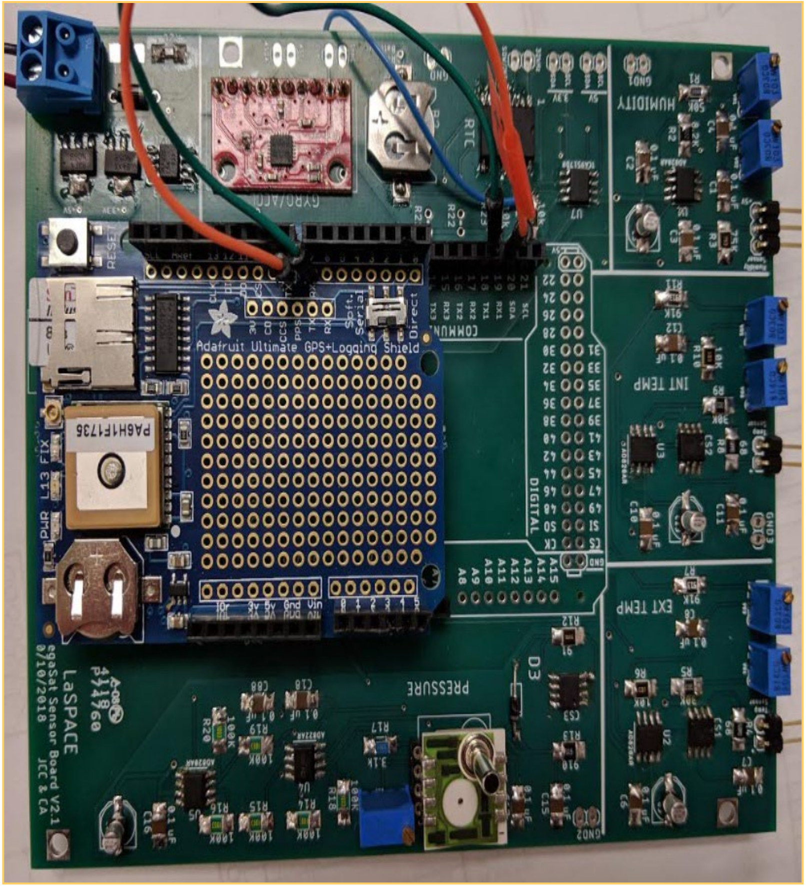
BalloonSat

MegaSat System Diagram



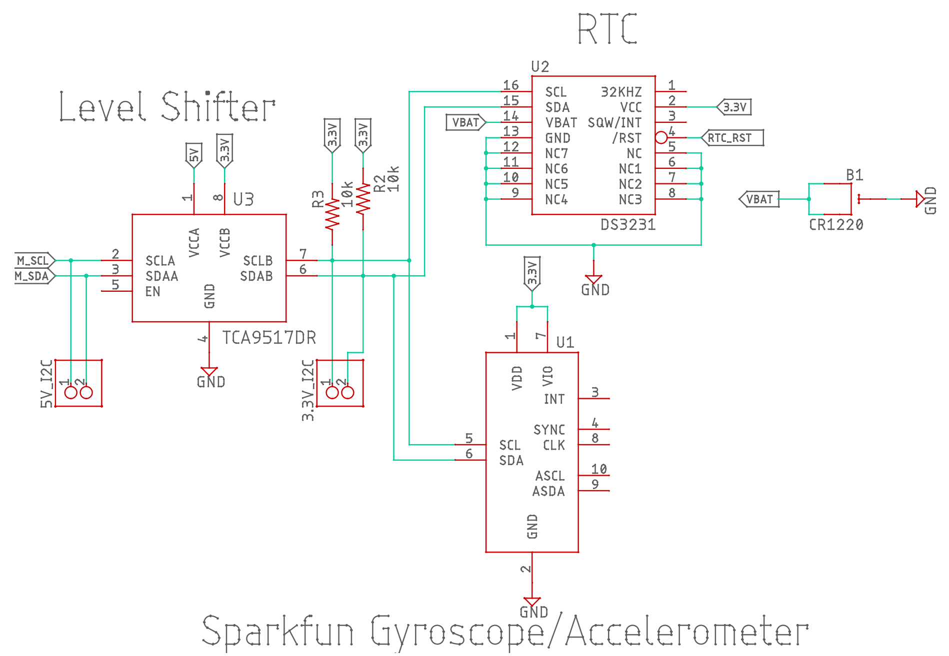
MegaSat Components

- The MegaSat included several components for students to utilize:
- Arduino Mega Interface
- Real Time Clock
- Gyroscope / Accelerometer
- Analog Sensors
  - Temperature x 2
  - Pressure in gain ranges
  - Humidity
- Additionally, the MegaSat powers all components on the board from an a +12V supplied externally to the board



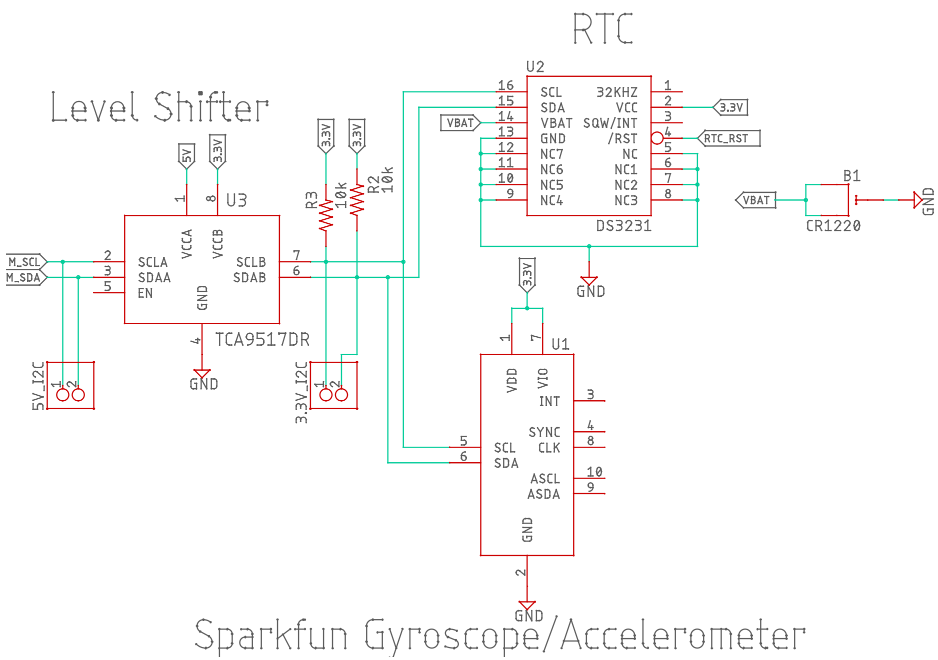
Real-Time Clock

- Maxim Integrated DS3231 RTC
- Fast (400kHz) serial I2C interface
- Precision temperature-compensated voltage reference to enhance accuracy and a comparator circuit that monitors for power failure
- Digital Temp Sensor Output: ±3°C Accuracy
- Backup battery
- Registers for year, month, day, hour, minute, second
- Time must be set by writing the correct values to the registers (Just like setting a clock/watch)
- Operating temperature from -40°C to +85°C
- I2C Address (0x68 default)



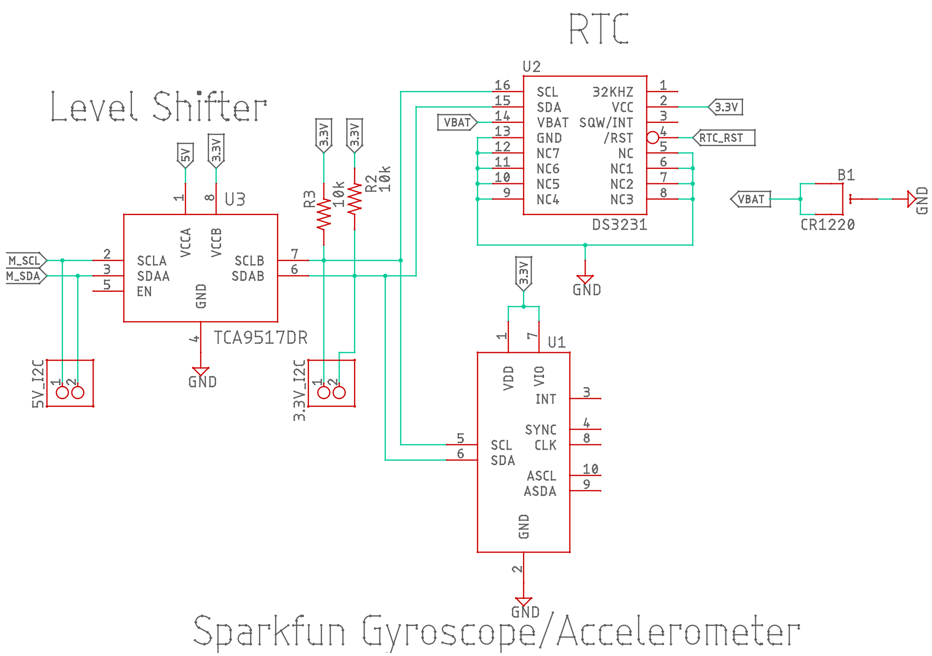
Gyroscope/Accelerometer

- InvenSense MPU-6050 gyroscope/accelerometer
- I2C digital-output of axis values for acceleration and rotation (x, y, z)
- Angular rate sensor (gyro) with a full-scale range of ±250, ±500, ±1000, and ±2000 degrees per second (dps)
- Accelerometer with a full-scale range of ±2g, ±4g, ±8g and ±16g
- I2C Address 0x68 or 0x69 set by external jumper, so must change the jumper on the breakout board to prevent RTC address conflict
- Acclerometer/Gyro reading for each axis broken up into upper and lower byte each stored in a separate register



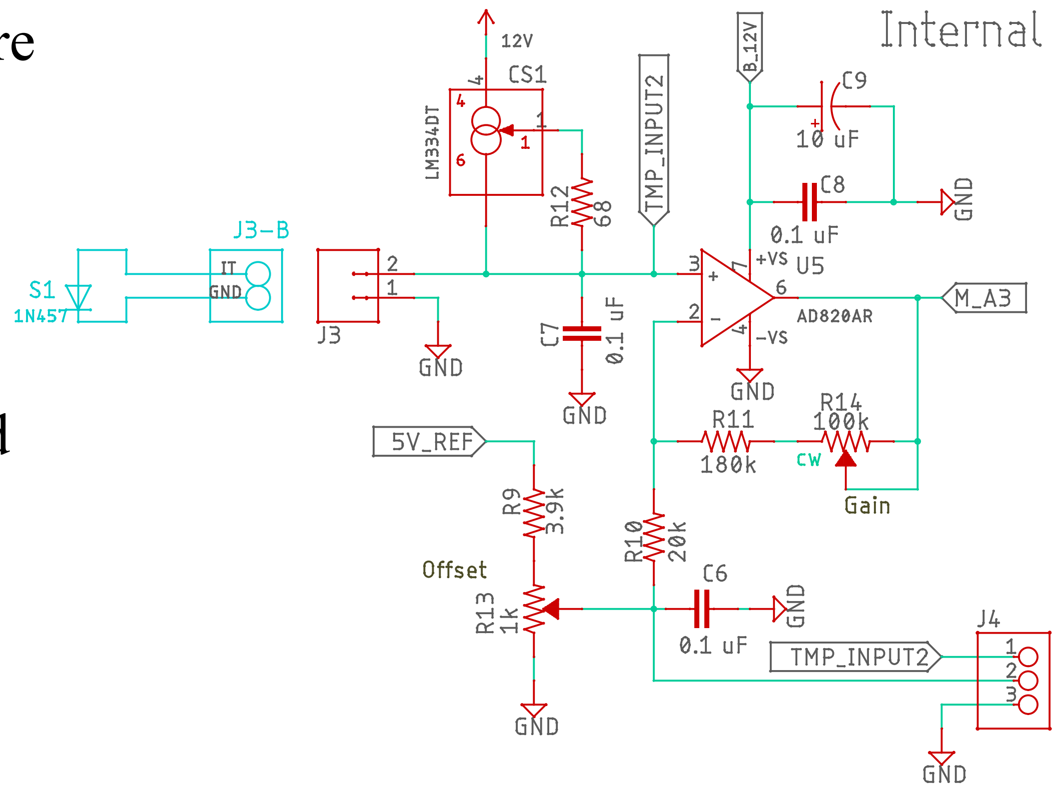
Logic-Level Shifter

- RTC and IMU operate at 3.3V logic while Arduino operates at 5V
- Texas Instrument TCA9517 Level-Shifting I2C Bus Repeater
- Two-channel bidirectional buffer with level shifting capabilities for I2C
- Shifts both serial data (SDA) and the serial clock (SCL) signals on the I2C bus
- Bidirectional voltage-level translation between low and high voltages
- Accommodates Standard Mode and Fast Mode I2C Devices



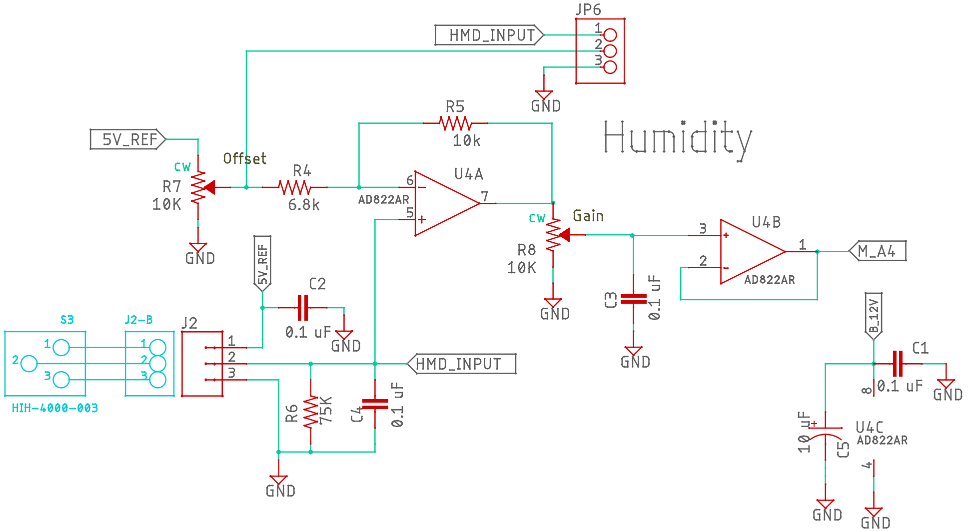
Temperature Sensors

- 1N457 diodes temperature acts as sensor
- Two identical sensors with amplifying circuits
- Idea is to set the gain and offset for differing expected ranges
  - For example, internal circuit of -10 to 50C and external -50 to 50C
  - Team should feel free to use their sensors as needed to meet requirements



Humidity Sensor

- Honeywell HIH-4000-003
- Near linear voltage output vs percentage of relative humidity
- Note each sensor should come with factory calibration data
- Calibration data can be used if teams are unable to perform their own calibration



Pressure

- Honeywell SSC series pressure sensor
- 0-15 psia range
- 0-5V output direct to analog pin (A0)
- Amplified output to give increased sensitivity at low pressure (A1)