MegaSat Hardware Kit

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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.
From BalloonSat to MegaSat

- BalloonSat was developed in the early 2000s at LSU by S.B. Ellison and Jim Giammanco
- The BalloonSat featured a Basic Stamp microcontroller
  - 20 MHz
  - 38 Bytes RAM!
  - 61 PBASIC commands
- 64 Kb EEPROM (2LC64) on I2C
- RTC (DS1302)
- 4 Channel 8 Bit ADC0384
- The BalloonSat was used by the ACES program for over ten years before the MegaSat was created to update the hardware.
Major Components
MegaSat Kit

Battery
+12V

MegaSat Sensor Board
+12V
ADC
I2C

Arduino Mega 2560 Developmental Board
+5V
SPI
UART

Adafruit Ultimate GPS Logger Shield
Arduino Mega2560

- 16 MHz ATmega2560 Microcontroller
- 256 KB Flash Memory (Program Space)
- 8 KB SRAM (Variable Space)
- 4 KB EEPROM

Arduino Mega Development Board
Arduino I/O

• Communication with the Mega is achieved using stackable header pins that connect to the internal circuitry of the board.

• Header Pins provide easy access to:
  – Power Inputs/Outputs
  – Analog-to-Digital (ADC) Channels
  – Digital I/O Pins
  – Serial Channels

• Standard footprint with commercially available expansion boards (Shields)
ADC Channels

• The Mega provides sixteen 5V ADC channels for collecting information from external devices
• 10 bit (1024) resolution
Digital Input/Output

- The Mega provides 54 digital input/output (I/O) channels
- Four hardware serial (UART) TX/RX pairs
- SPI is available for MISO, MOSI, SCK and CS using the SPI library
- 5V I²C up to 400 KHz
- 15 PWM pins which provide an 8-bit “Analog” output (Not true analog)
Programming Changes

• Change from BASIC based programming language to C++ based
• Enables use of libraries, functions, user defined data structures
• Use Arduino IDE with built in library manager
Adafruit Ultimate GPS Logger Shield

- This is the Arduino Ultimate GPS Logger Shield. It comes with
  - microSD socket
  - Internal antenna and connector for external antenna
  - GPS unit
  - Prototyping Area
GPS Software Serial

- Adafruit shield “Hardware” connect to same UART as programming port
- Mega has additional 3 Additional hardware UARTs
- Use Jumper to connect to Serial1 to Software Serial Pins of the GPS unit
MegaSat Shield

- The MegaSat includes several components for students to utilize:
  - Arduino Mega Interface
  - Real Time Clock
  - Gyroscope / Accelerometer
  - Pressure, Temperature and humidity sensor
- MegaSat powers all components on the board and the Arduino a +12V supplied externally to the board (Does include bias protection)
- 4.5 x 5.5 inches
MegaSat Assembly

- Large number of surface mount components
- Still Capable of being soldered with standard soldering iron
- SMD Solder practice kit early in the second semester

Real-Time Clock

- Maxim Integrated DS3231 RTC
- Fast (400kHz) serial I2C interface
- Provide stable timestamp in event of no GPS fix
- Arduino clock based timing has observable drift and can be affect by interrupts.
Gyroscope/Accelerometer

- InvenSense MPU-6050 gyroscope/accelerometer
- Programmable tri-axis angular rate sensor (gyro) with full-scale range of ±250, ±500, ±1000, and ±2000 degrees per second
- Programmable tri-axis accelerometer with a full scale range of ±2g, ±4g, ±8g and ±16g
- Readout via I²C
- Has address conflict with RTC corrected by AD0 jumper
Environmental Sensors

- 2x 1N457 diodes temperature sensors
- Honeywell HIH-4000-003 Humidity Sensor
- ICS-1230 Pressure Sensor
- MegaSat has adjustable amplifying circuit to allow full 0-5V range of ADC
- Kit includes the connectors for remote mounting the temperature and humidity sensors
Expansion Capabilities

- Existing commercial Arduino shields can be added to the MegaSat including Protoshields for custom circuits
- Be careful of pin conflict

<table>
<thead>
<tr>
<th>Used Pins</th>
<th>Usage</th>
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<tbody>
<tr>
<td>D 18,19</td>
<td>Serial1 GPS UART</td>
</tr>
<tr>
<td>A 0,1,2,3</td>
<td>Temperature, Pressure Humidity Analog In</td>
</tr>
<tr>
<td>D 10,11,12,13</td>
<td>SD Card SPI</td>
</tr>
<tr>
<td>D 20, 21</td>
<td>I²C (IMU and RTC)</td>
</tr>
<tr>
<td>D 7, 8</td>
<td>GPS software Serial Pins</td>
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