Water Moisture Sensor Ver 4

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This is a work in progress!, but most everything works.

Version 4 and 4a, Rev-6a Specifications:

Version 4 uses a ATSAMD51J19A, M4F processor

- Used an ATSAMD51J19A processor, with floating point, 120MHz CPU
- Choice of two LoRa radios.RFM95CW or CubeCell AM01
- Board pinout is define as an AdaFruit Feather M4 Express.

Version 4a uses a ATSAMD21G18A, M0 processor

- Used an ATSAMD21G18A processor, 48MHz CPU
- Choice of two LoRa radios.RFM95CW or EBYTE, E78-900M22S
- Board pinout is define as an AdaFruit Feather M0 Express.

- Li-ion, LiPo battery charger
- EUI64 ID chip
- Low Power operation,
- It can measures soil moisture with up to 8 sensors,
- External DS18B20 for soil and/or air temperature.
- MCP9800 and/or Si7021 (+ humidity) temperature.
- BME-280 and/or BME-680 environmental sensors.
- Support for a water pressure sensor via an analog port
- Support for a flow/water meter with pulse debouncing circuits.
- Flow meter can be Pulse per Unit or K-Offset.
- Solar-battery Powered or via external 7 to 28v AC or DC.
- Two place's for FRAM, EEPROM, security chip or other I2C devices.
- Connection for external I2C devices.
- Fits in a Bud PN-1323-CMB or PN-1328-CMB case.
- Software controlled power switch for external devices.
- Socket for an RCR123A rechargeable 650ma Li-Ion battery.

Connector P2, break out serial-2 to an FTDI 6-pin connector.
Connector P3 breakout I2C signals for external use. (.9 or 1.2in OLED Display)
Connector P4 allow for a daughter card.

The details:

Power supply:

External power is fuse by F1, a PTC device, limiting the total current to about 500ma, the input power is converted to +5V by a TI TPS560430Y/YF, 600ma switched regulator. Input power can come from external connection via J1, USB or via solar-battery.

If battery-solar power is used, a 6V solar panel can be connected to J2. U2, is a Microchip MCP-73831-2, that provide proper charging from the solar panel to an Li-Ion or LiPo 3.7V, RCR123A, 16340 rechargeable battery mounted on the main board. Charging is for Li-Ion or Li-Po ONLY, this chip will not support charging of LiFePO4 battery's. Voltage monitoring of the battery can be made via an analog channel with a 2 to 1, resistor divider connected to A5 of the processor.

Output from the battery and solar charger is monitored by a Microchip MIC2779L that will disable power to the board via D14, if battery voltage falls below a pre-set point. (Its currently set at 3.1V off, and back on at 3.6v). This make sure we do not kill the battery by discharging it completely.

The board has an optional power switch U10, a Microchip MIC2019 that is use to power external sensors, this can be control via software to reduce power when the CPU is sleeping. It also can limit output current via proper selection of R30 . JP1 or JP2, can be used to select 5V or 3.3V as source of power for U10.

We can also supply the VIN voltage via diode D12 and F2, to external device like a K-offset flow sensors that may require a higher voltage for operation.

Power to the board can also be supplied via a USB type "C" connector. This is also use for programing.

The board has a 10pin, .05in JTAG connector for programming the ATSAMD CPU.

Pulse Circuit:

A pulse output from a flow or water meter can be connected to J2. This connected can be condition by two optional circuits. U4, a MAX6816, digital signal debounced chip that can be used to about 15Hz. (good for most gallon per pulse meters), or a circuit using D16, an Op-Amp used to detect the pulses from a K-Offset type flow sensor. R17 is used to bias the sensor and is voltage dependent based on sensor used. Removing U16 or U4 and connecting JP3 you can use the pulse-in signal direct to U8.

External temperature:

An DS18B20 temperature sensor, can be connected to J2, AIN-0 pin with R18 providing bias voltage, and scaled by R1, R2 and C1 as needed.

AIN-0 can also be uses as a general purpose analog input (A4), for used with a pressure sensor or other device, or as a digital in/out pin.

Sensor's:

The board provision for a number of optional sensor's mounter on the board: U5, is a Microchip MCP9800 temperature sensor, U7, a Silicon Labs SI7021 temperature and humidity sensor, U11, a Bosch BME-680 environmental sensor with VOC gas, humidity, pressure and temperature, and U12, a Bosch BME-280, for temperature, barometric pressure and humidity.

I2C devices:

U13 and U14 can accommodate a number of standard I2C device's in SOIC-8 packages from FRAM's, Ram, EE-PROM, Crypto chips, etc. For general use, U13, is fitted with a FM24CL64 FRAM and U14, a 24AA025E64 EUI64 chip that can provide a unique 64bit serial number.

Analog Mux:

An 8 channel analog mux is install at U6, it can be used to route signals to the ATD converter channels A0-A3 or as digital inputs. Note: In normal configuration, it is set up in software to provide a special AC volt meter bridge circuit for sensing water moisture on 4 channels, or it can be configure as an 8 Channel Analog Mux or an 8 Channel digital input Mux.

Radio:

Both board have a place for an Hope RFM95CW, LoRa radio, DIO-0 and DIO-1 pins are connected to the CPU. The WS4 board with the M4F processor has a CubeCell AM01, LoRaWan radio that contains the full LoRa 1.0.1 stack.. The WS4A board with the M0 processor has a EBYTE E78-900M22S self contains LoRaWan radio. Both are programed via AT commands via a serial port.

Notes:

This board has been used with LMiC LoRaWAN and MCCI stack on the TTN network and with the MySensor software stack to a MySensor gateway.

The ATSAMD51 pins are as defined in the Arduino environment as a Adafruit Feather M4 Express. The ATSAMD21 pins are as defined in the Arduino environment as a Adafruit Feather M0 Express. This make it very easy to program these devices.

https://www.budind.com/pdf/hbpn1323mb.pdf

https://store.mcci.com/products/catena-4612-integrated-lorawan-node

Moisture Sensor's

This device can be use with a number of different types of moisture sensor's…

- Irrometer 200SS-15 Watermark Soil Moisture Sensor.
- RF based sensor's like the Vegetronix VH400 and Soilwatch-10
- Low cost Capacitive Soil Moisture Sensor, like the Dfrobot SEN0193 (and many more on eBay/Amazon)
- Home-Made Gypsum sensors.

Watermark 200SS:

The WATERMARK Soil Moisture Sensor measures electrical resistance inside of a granular matrix similar to gypsum to determine soil water tension.

To measure resistance inside the sensor, a voltage divider circuit is used. The circuit uses a known input voltage, output voltage, and series resistor value to calculate the value of the sensor resistor in a bridge configuration. Once the resistance is known, the value is calibrated to soil water tension value. Measurements are made with an AC style voltmeter with an alternating polarity to prevents building of a charge that both offsets the reading and degrades the electrodes over time.

In this controller we have 2 section of a 4-channel analog mux's, an 74HC4052 (U6) that is connected to 2 ATD ports and 2 digital ports on the CPU with its bias resistors R11 and R12. By manipulating these signals we can build an AC bridge to read resistance of the 4 sensors.

Home-Made Gypsum sensors:
Delmhorst GB-1 Gypsum Sensor Blocks:

The operate very much the same as the Watermark sensor, but may require some calibration prior to use: See these reference on how to build them:

https://www.youtube.com/watch?v=DP38vGFx6Ns
https://hackaday.io/project/6444/logs?sort=oldest
https://hackaday.com/2010/03/15/soil-moisture-sensing/

RF based sensor's or Capacitive Soil Moisture Sensor:

These sensors product a voltage that is proportional to the soil moisture. Up to 8 of them can be connect to the same mux's as use for the gypsum sensors, but they just provide

a direct path to the ATD converters. Power for them can be sourced from the board via the U10 power switch. Note: these devices can consume upto 30ma each, so one needs to be concern about total power that is available.

Other Sensor's:

The circuits on the board can also be used to connect almost any type of sensor, if they have a voltage output, I2C or simple digital interface. PH, temperature, humidity, IR, light, sound, ORP, air quality PM2.5, gas, CO, Co2, wind etc.…

This board has many option and configuration that can be selected by adding or removing components on the board as needed. Not all parts need to be installed, but selected as needed for your project.

Some reference on moisture sensors:

https://github.com/empierre/arduino/blob/master/SoilMoistSensor.ino

https://www.irrometer.com/pdf/sensors/403%20WATERMARK%20Sensor-WEB.pdf

https://www.irrometer.com/200ss.html

https://vegetronix.com/Products/VH400/

https://www.dfrobot.com/product-1385.html

https://pino-tech.eu/soilwatch10/

Delmhorst GB-1 Gypsum Sensor Blocks

https://hackaday.io/project/6444-vinduino-a-wine-growers-water-saving-project

Software

Depending on the processor board used, one can select from a number of software and networks options.

- LoRaWAN via TTN using MCCI, Semtech or IBM LoRa stack
- MySensor network via a gateway
- And many others…

https://stackforce.github.io/LoRaMac-doc/index.html

https://github.com/mcci-catena

https://github.com/matthijskooijman/arduino-lmic

http://mqtt.org/