

Remote Environmental Monitors (REM)

Arizona Department of Environmental
Quality (AZDEQ)

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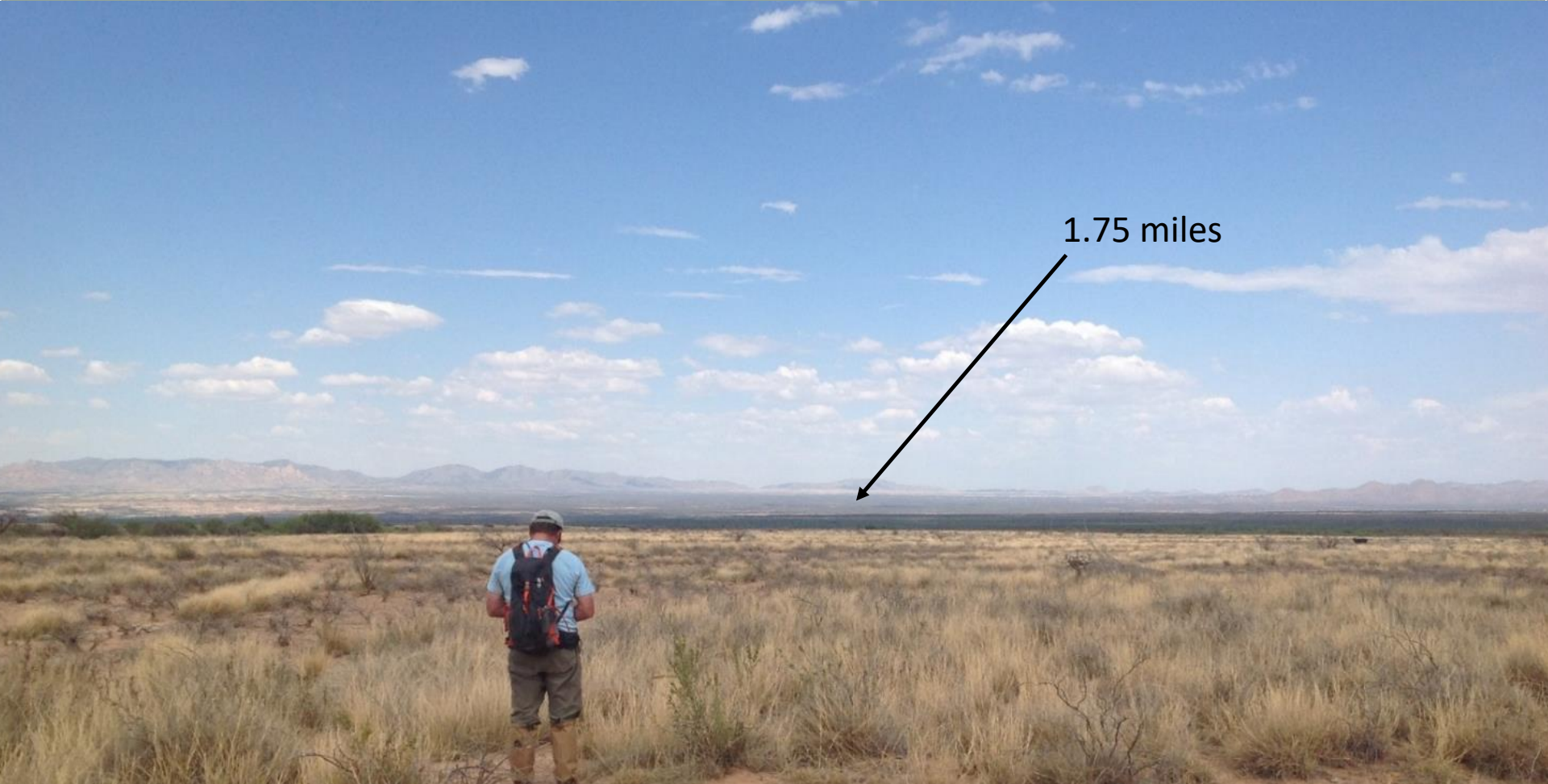
*Hans Huth (hjh@azdeq.gov)
Office of Border Environmental Protection*

*Ron Tiller (rlt@azdeq.gov)
Water Quality Division*

February 5th, 2019



Current State, or “How did we do it yesterday?”



1.75 miles

Current State, or “Where was the waste?”

Average retrieval run requires 1.2 hours/site/employee.

Ratio of hit/miss = 48% (n = 32/67)

Conservative Estimate of Waste: $\sim 1.2 * 2 * 35 = 84$ hours

Unnecessary Risks and wear/tear (snakes, heat, equipment)



Exploring Open Source Alternatives for Doing More with Less

Arduino Prototype for Remote Environmental Monitoring



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March 28, 2016

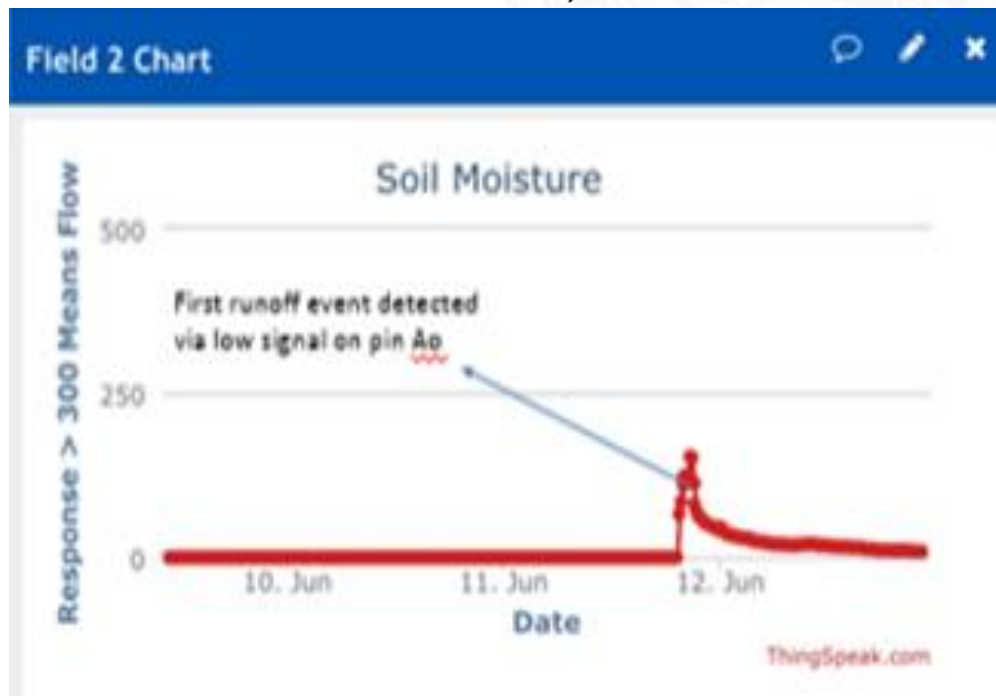


Arduino community logo used with permission

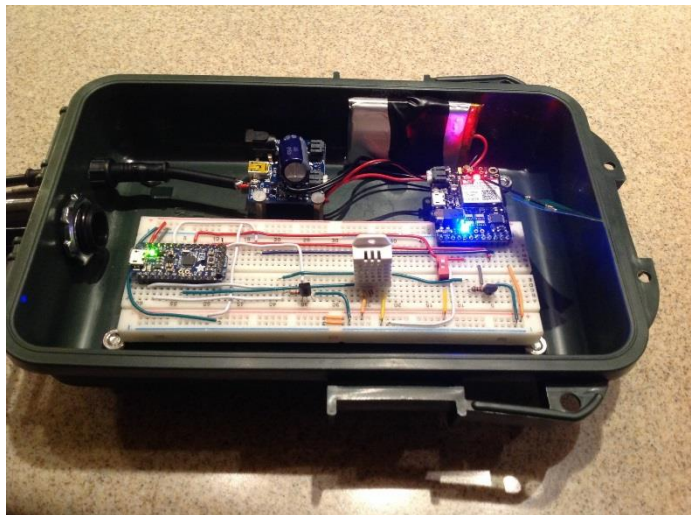
Field Installation May 8, 2016



Success!
First Detect
June 11, 2016



Adafruit FONA Breakout (2G)



Parameter	Result
Time Period	May 3, 2016 – February 12, 2017
Days in Service	285
Records Collected	30,506
Frequency	1 record / 12.5 minutes
Max Down Time (DT)	59 minutes
Events > 50 min. DT	51 (2 days total; < 1% of 285)
Bat. Charge/Discharge	~285 cycles

- Employed non-strategic high frequency reporting
- Tolerated one season of temperature extremes w/ no maintenance
- Successful Beta
- *Revisit design and improve*

T-Mobile 2G Problem

Most of state is unserved by T-Mobile's 2G network.

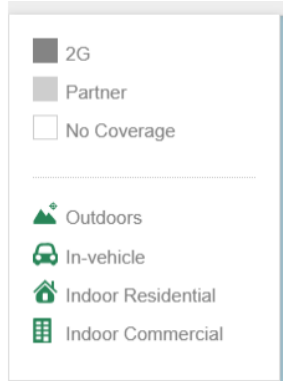
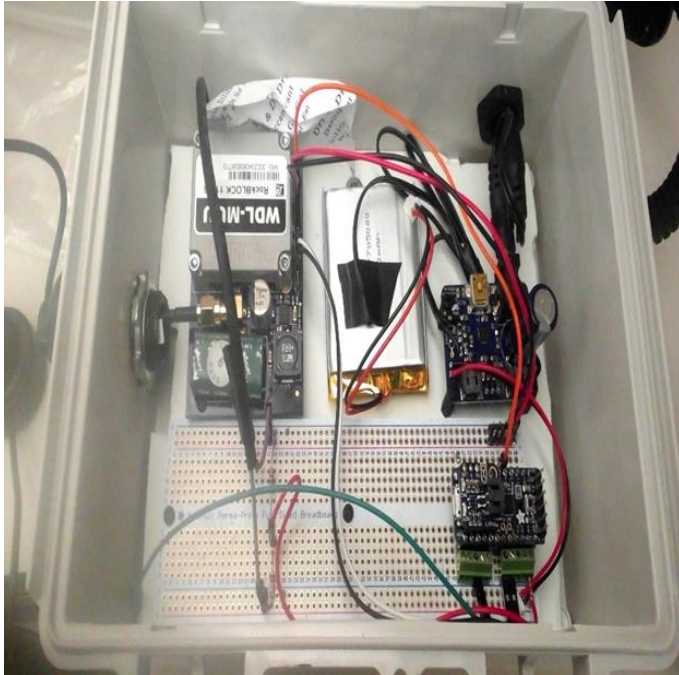


Figure 1: T-Mobile 2g Coverage. <https://orion.freeus.com/coverage-map.aspx>

Updated REM Design

Upgraded to Rockblock (Iridium) Satellite Modem
Service everywhere the sky is visible

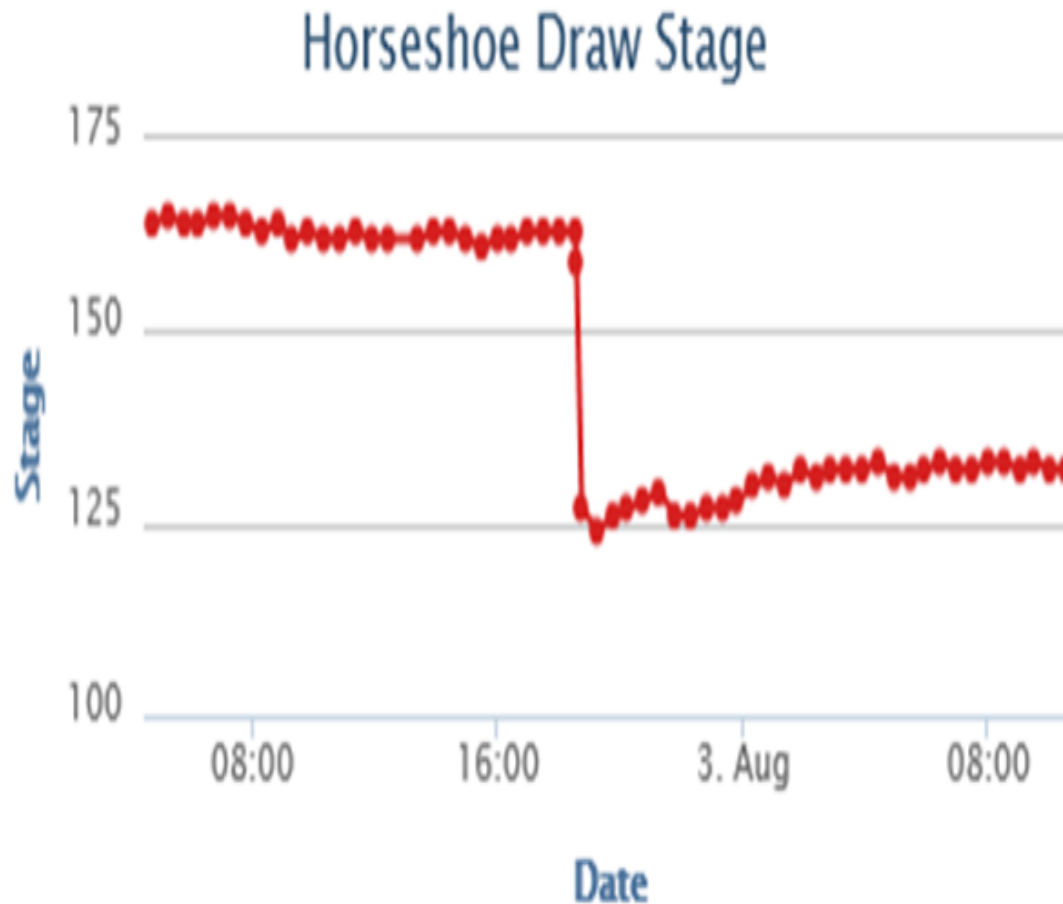


Updated Box Design, Added Satellite Modem

Detect Flow at Horseshoe Draw August 2, 2018



Between 6:33 – 6:44pm on
8/2/2018 the updated REM
captured the 1st flow event.



Integration with Hach AS950 Auto Sampler

Integrated with Auto
Sampler at Big Bug Creek
near Prescott.



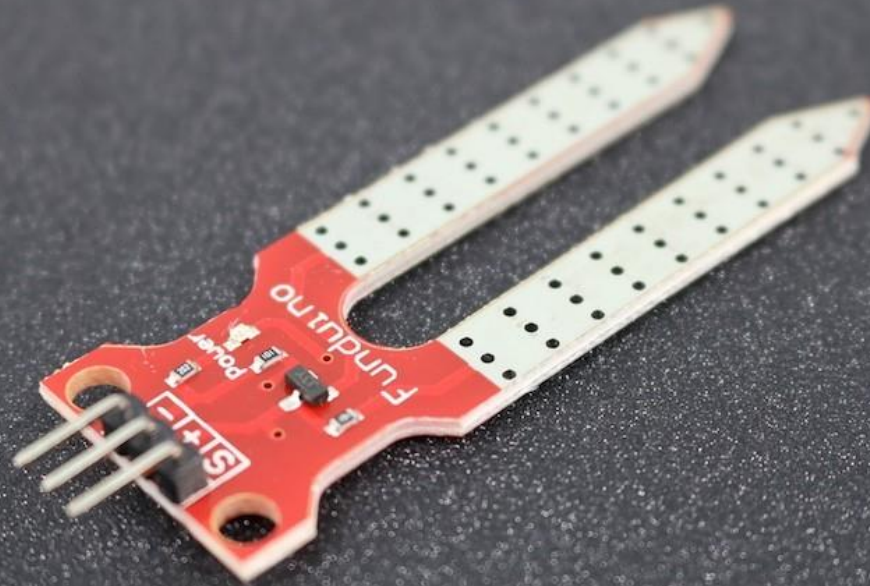
Integrated with Auto Sampler
at Green Bush Draw near
Naco.



Flow Switch
For Auto
Sampler



Low Cost Switch



West Naco Installation

Detect Cross Border
Flow in Naco



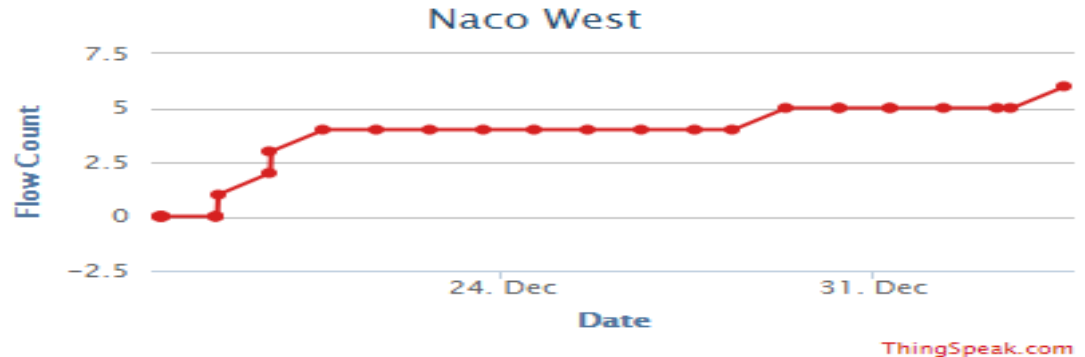
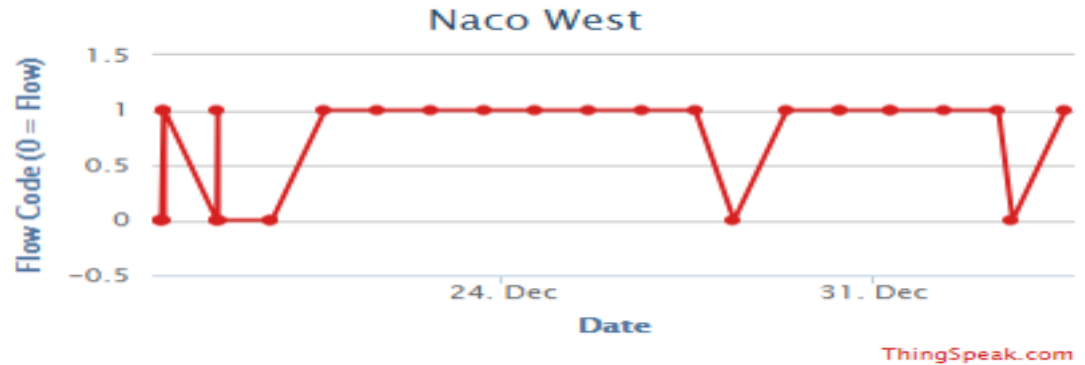
Similar Flow Switch
to Auto Sampler



East Naco Installation

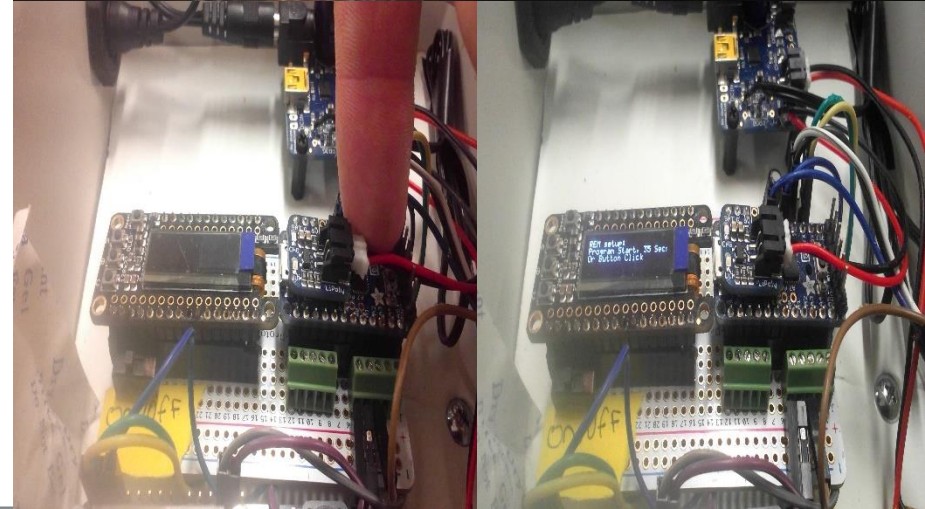


Example of Thingspeak Channel For Naco



Stock Tank Installation

Help a Grantee Install a satellite REM at their remote Stock Tank.



Their Thingspeak Page

Thingspeak™

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Created: [2 months ago](#)

Entry: [about an hour ago](#)

Views: 332

Field 1 Chart



Jones Tank



Thingspeak.com

Field 2 Chart



Jones Tank



Thingspeak.com

Field 3 Chart



Jones Tank

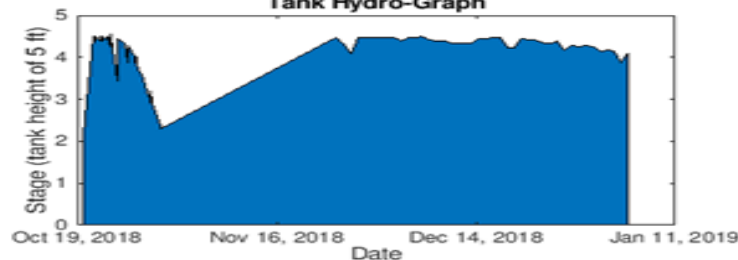


Thingspeak.com

Stock Tank HydroGraph



Tank Hydro-Graph



Cost

REM Type:	Equipment Cost	Modem Cost	Total Equipment Cost	Monthly Cost	Cost per Message
2G- Fona	150	44.95	\$194.95	\$6	100Mb \$3
Satellite-RockBlock Modem	150	253.00	\$403.00	\$13	\$0.13 (<270 bytes)



Benefits

- Flexibility
- Relatively low cost
- Low maintenance
- Open source
- Low power, durable



- Learning curve
- Knowledge of hardware
- Programming
- Open source libraries
- Testing (trial and error)

```
ROCKBLOCK_REV3_AUTOSAMPLER_COMMENTED

unsigned long INTERVAL = 6400000; // reporting interval to detect change (30 minutes where 1000 = 1 second) **Can be modified remotely
unsigned long Reading_Rate = 30000; // (30 secs) interval that voltRead takes readings **Can be modified remotely

// AUTOSAMPLER: Program complete code is only active for 90 seconds after the program
// to ensure the code is not missed Reading_Rate should not exceed 90 seconds.

SoftwareSerial ssIridium(ROCKBLOCK_RX_PIN, ROCKBLOCK_TX_PIN); // type Arduino Stream
IridiumSMD isbd(ssIridium, ROCKBLOCK_SLEEP_PIN); // this is my ROCKBLOCK

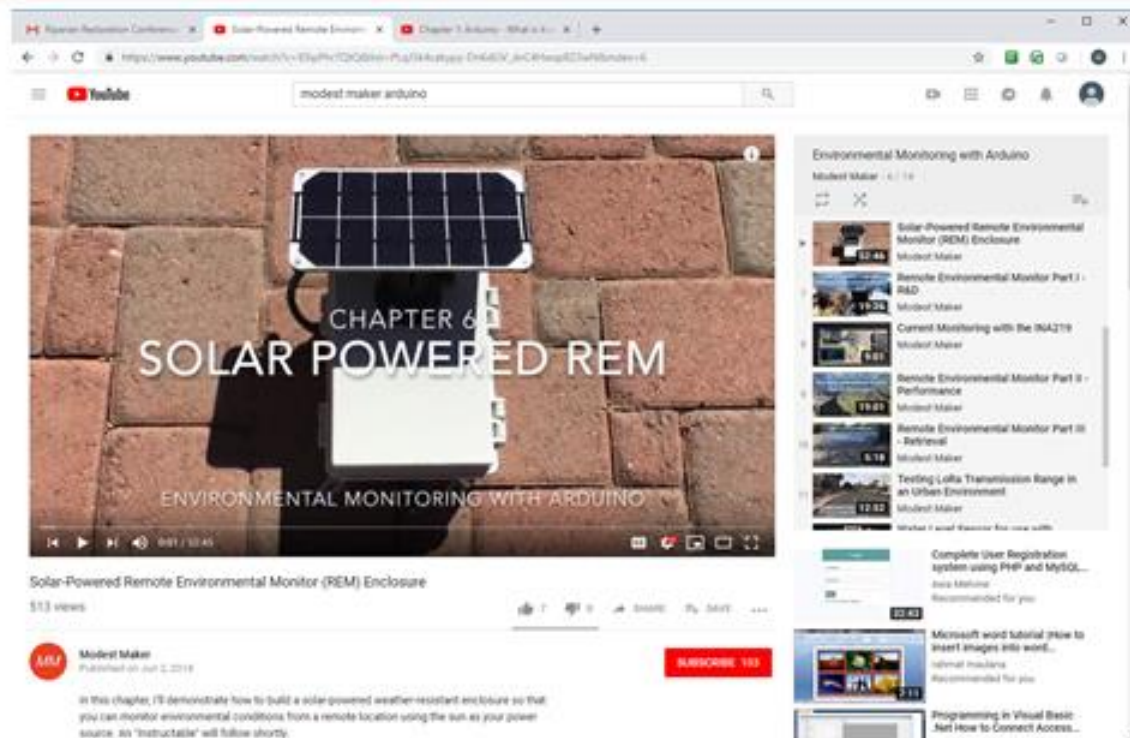
// Rangefinder/AutoSampler pins/variables
// Vin----> R1 ----> Vout(to analog pin) ----> R2 ----> GND || Voltage Divider

#define ProgComp 11 // Attach to green on Sampler. Connect blue wire to arduino GND.
// #define RangeTrig 6 // Attach to pin 4 on range sensor;
// #define RangePin A5 // Attach to pin 3 on range sensor
#define Volt_Read_Pin A5 // Attach to voltage divider for Autosampler

int t_arraysize = 9; // quantity of values for median (odd numbers)
uint16_t rangevalue[] = { 0, 0, 0, 0, 0, 0, 0, 0, 0 }; // group array for 9 ultrasonic values to calculate median/mode
float modeE; // calculated mode distance (value that occurs most often) (cm or volts)
float modFold; // used to store old voltRead values if needed (i.e. if there is a change) (cm or volts)
float change = 10; // used to measure change. INITIALLY SET TO 10 SO THE LOOP WILL RUN WHEN INITIALLY SET UP
// GETS SET TO ACTUAL CHANGE IN mode AND modFold DURING FIRST LOOP.
float changeCond = 1.0; // Conditional value to start loop, can be changed through message retrieval. **Can be modified remotely

byte complete; // determine if autosampler is completed
byte completedWhileWorking = 1; // determine if AutoSampler completed the program while the RockBlock was busy
// set to 0 when program is complete.
float Min_Bat_Volt = 11.8; // Conditional for minimum battery voltage **Can be changed remotely

String compCode; // string for adding complete code to my URL
String myHgt; // string for adding stage field to myUrl
String myChange; // string for adding change field to myURL
```



CHAPTER 6
SOLAR POWERED REM
ENVIRONMENTAL MONITORING WITH ARDUINO

Solar-Powered Remote Environmental Monitor (REM) Enclosure

513 views

Modest Maker
Published on Jun 2, 2019

Subscribe 101

In this chapter, I'll demonstrate how to build a solar-powered weather-resistant enclosure so that you can monitor environmental conditions from a remote location using the sun as your power source. An "Instructable" will follow shortly.

Environmental Monitoring with Arduino

Modest Maker · 4:14

- 1 Solar Powered Remote Environmental Monitor (REM) Enclosure Modest Maker 5:46
- 2 Remote Environmental Monitor Part I - R&D Modest Maker 15:25
- 3 Current Monitoring with the INA219 Modest Maker 9:01
- 4 Remote Environmental Monitor Part II - Performance Modest Maker 18:01
- 5 Remote Environmental Monitor Part III - Refinement Modest Maker 6:16
- 6 Testing LoRa Transmission Range in an Urban Environment Modest Maker 10:50

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Net How to Connect Access...

https://www.youtube.com/playlist?list=PLqJ5k4cakypv-Dn6dGV_dvC4Hwxp8Z3wN

<https://www.youtube.com/playlist?list=PLqJ5k4cakypwMUFxZ1ckiiUfp1Ngf6o29>

<http://www.biod101.com>

... or search
"modest maker arduino"
on YouTube



*Thank
You!*

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Water Quality Division*

*"Everything around you that you call life was made up
by people that were no smarter than you."
- Steve Jobs*

February 5th, 2019