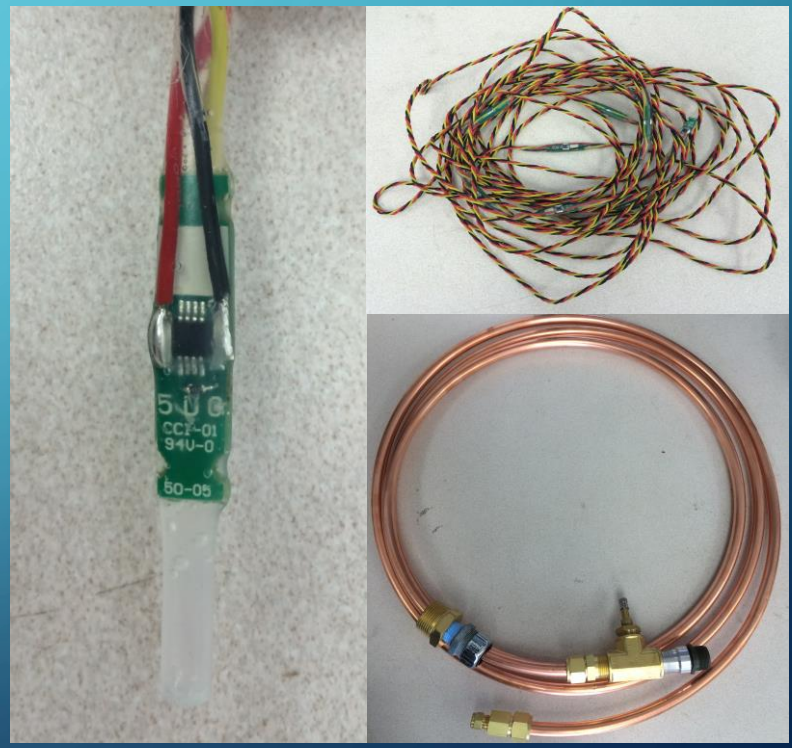
WIRELESS digiTAM™ SYSTEM

BASE STATION

REMOTE STATION

digiTAM™ ARRAY

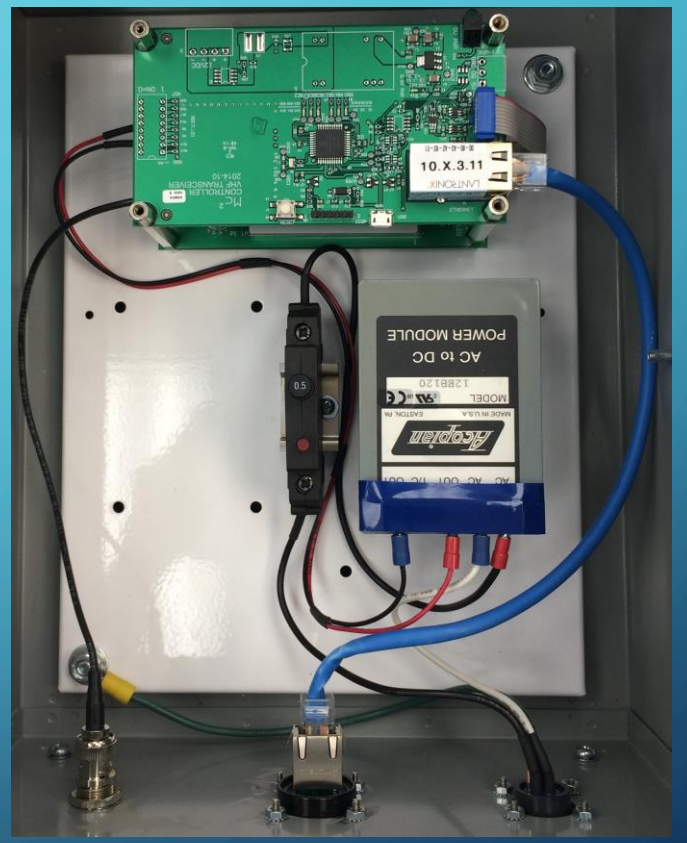


REMOTE

Unique address – polled

BASE STATION

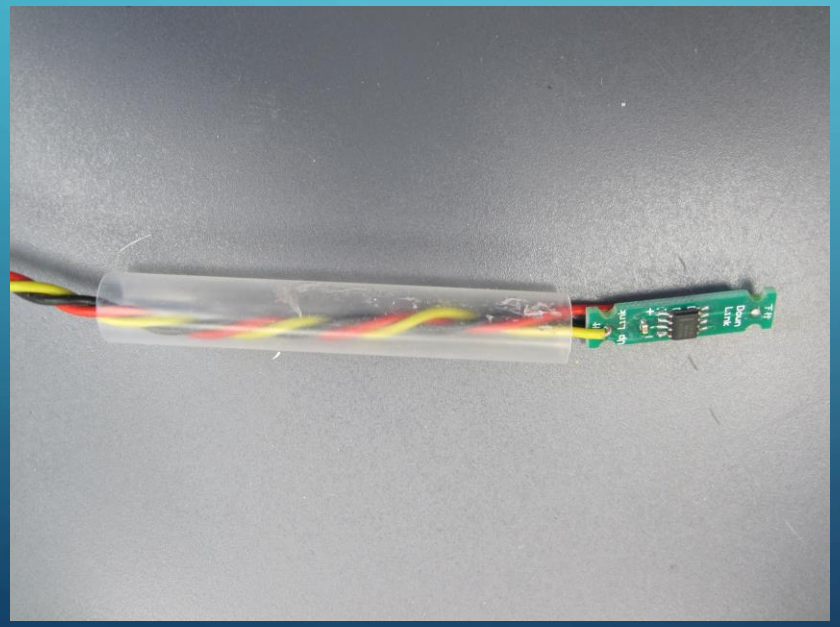
Capable of serving 254 remotes



- DATA RATE OF 1200 B/S, WHICH CAN READ 21 SENSORS IN 3 SECONDS
- INCLUDES REDUNDANCY ERROR DETECTION ALGORITHM
- BASE STATION CAPABLE OF SERVING 254 REMOTES

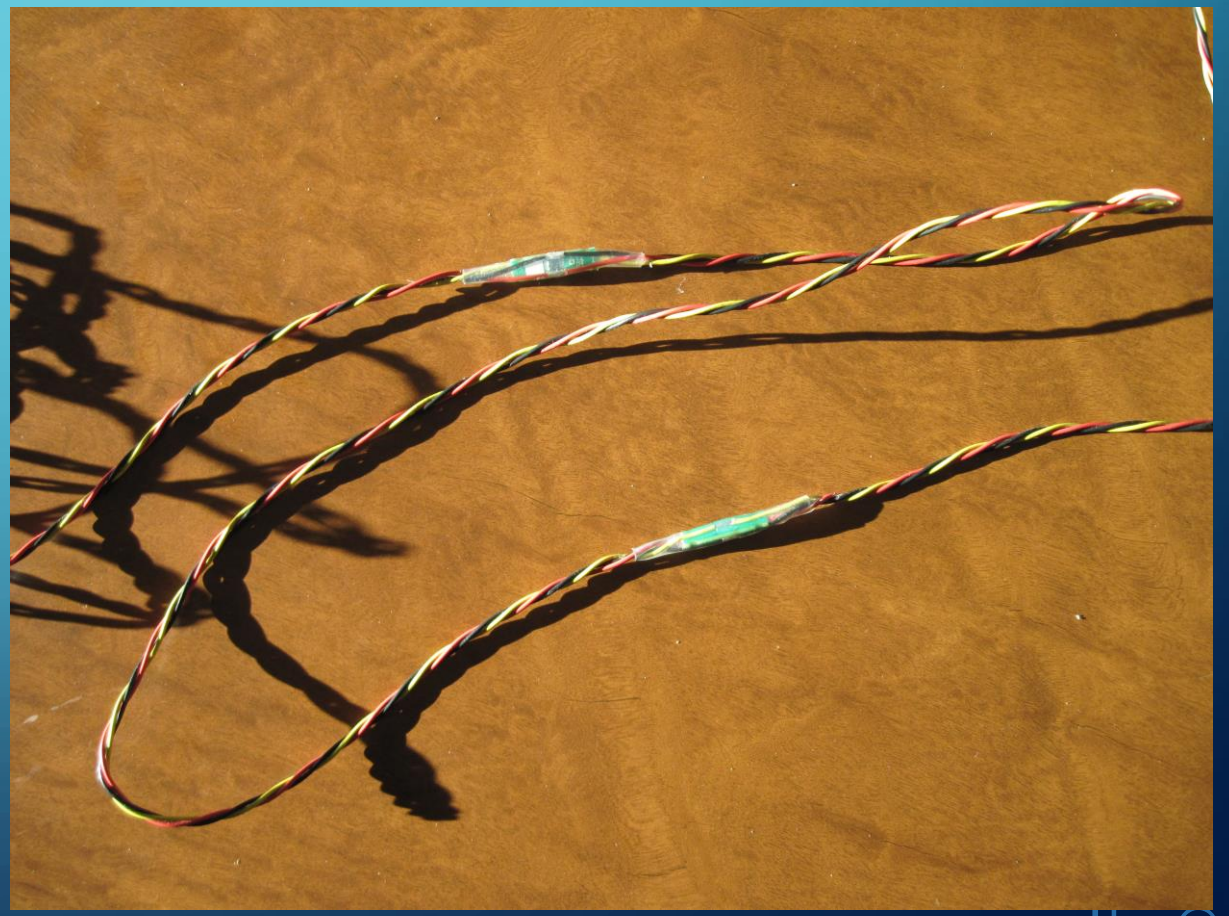
WIRELESS digiTAM™ PROJECT

- Uncertainties
- Work Undertaken
- Accomplishments



UNCERTAINTIES

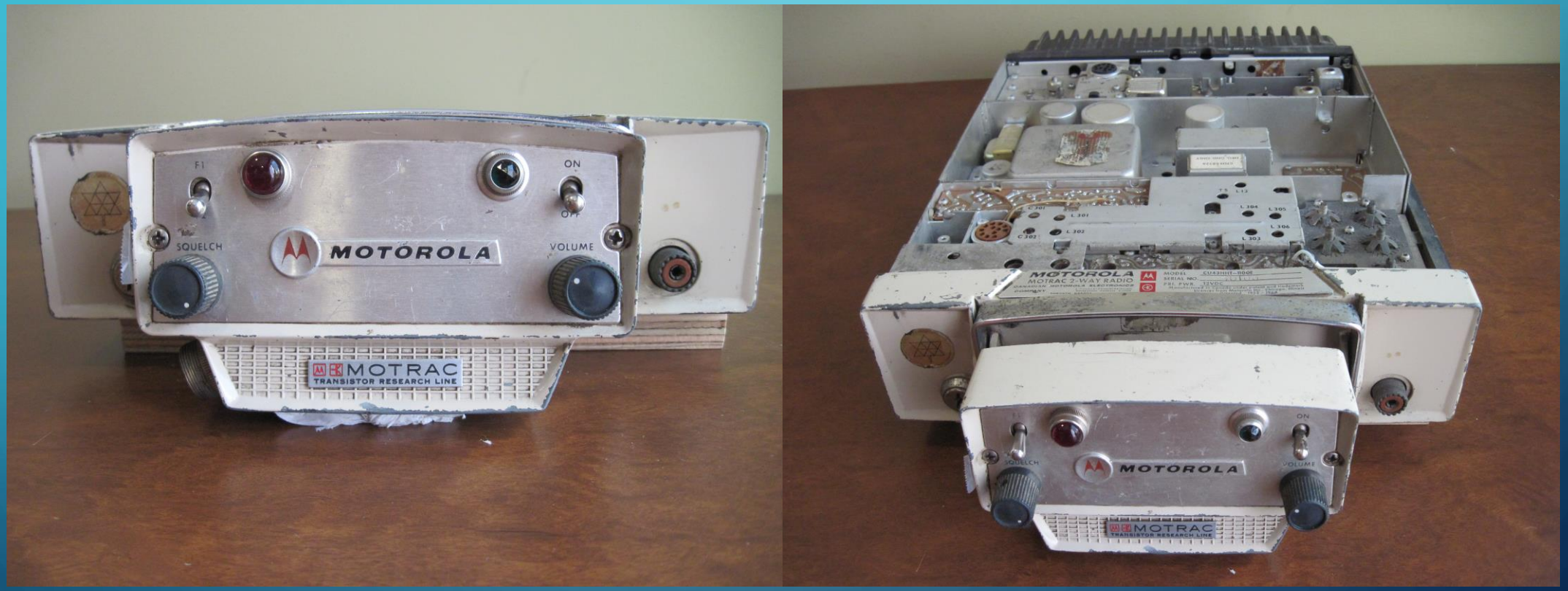
- Operational
- Hardware



OPERATIONAL UNCERTAINTIES

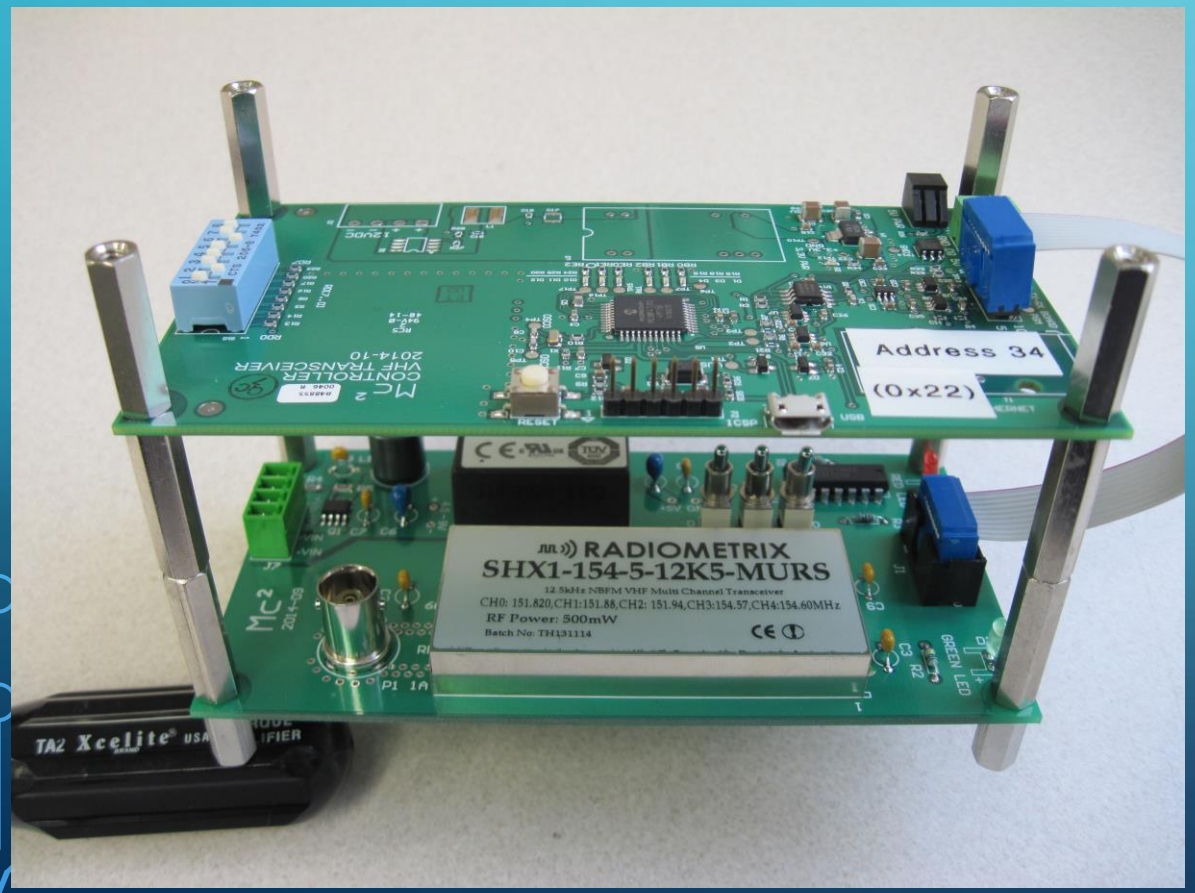
- Operability with Existing Data System in a Field Environment
- Radio Signal Quality due to Cluttered Sites
- Correctness of Data
- User Friendliness

EASY TO INTERPRET RESULTS



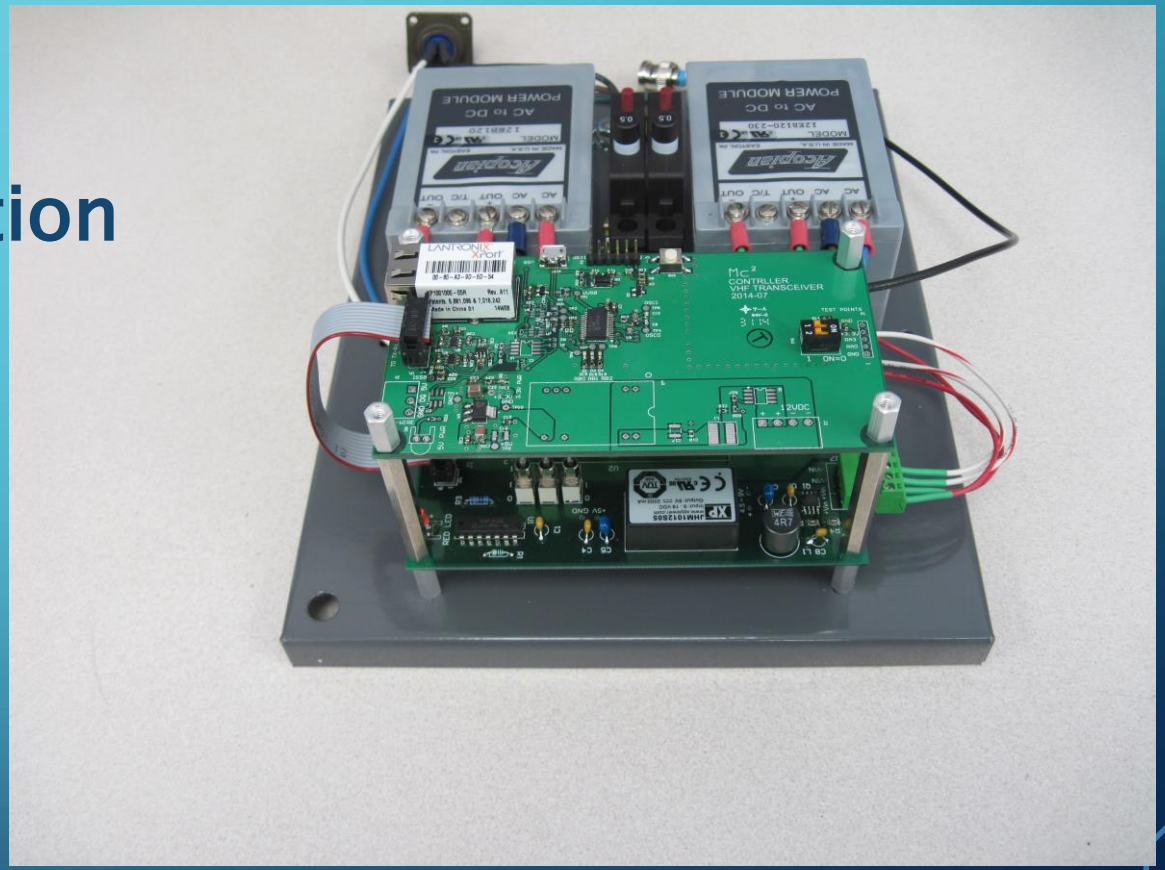
HARDWARE UNCERTAINTIES

- Electronics Reliability
- Mechanical Durability
- Material Compatibility with Stray Electric Fields and Solvents



HARDWARE UNCERTAINTIES (cont'd)

- Optimal Energy Harvesting Solution
- Managing Battery Charge
- Reliability of Sensors
- Managing Abnormal Conditions

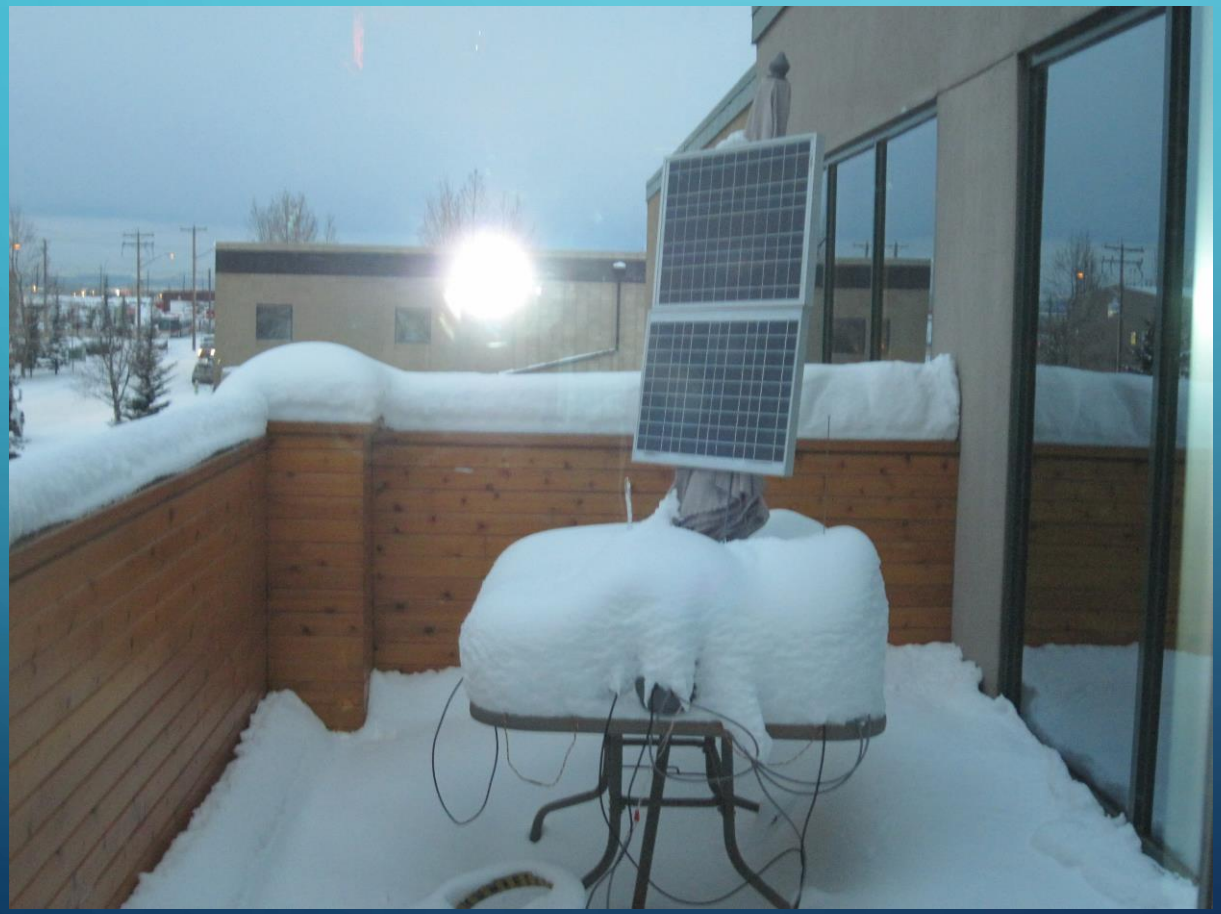


WORK UNDERTAKEN

- Field Testing
- Battery Watchdog
- Optimal Energy Harvesting Solution
- Diagnostics Software
- Improved Link Budget
- Electronics Design for Reliability
- Sensor Failure Issues
- Sensor Measurements in Well

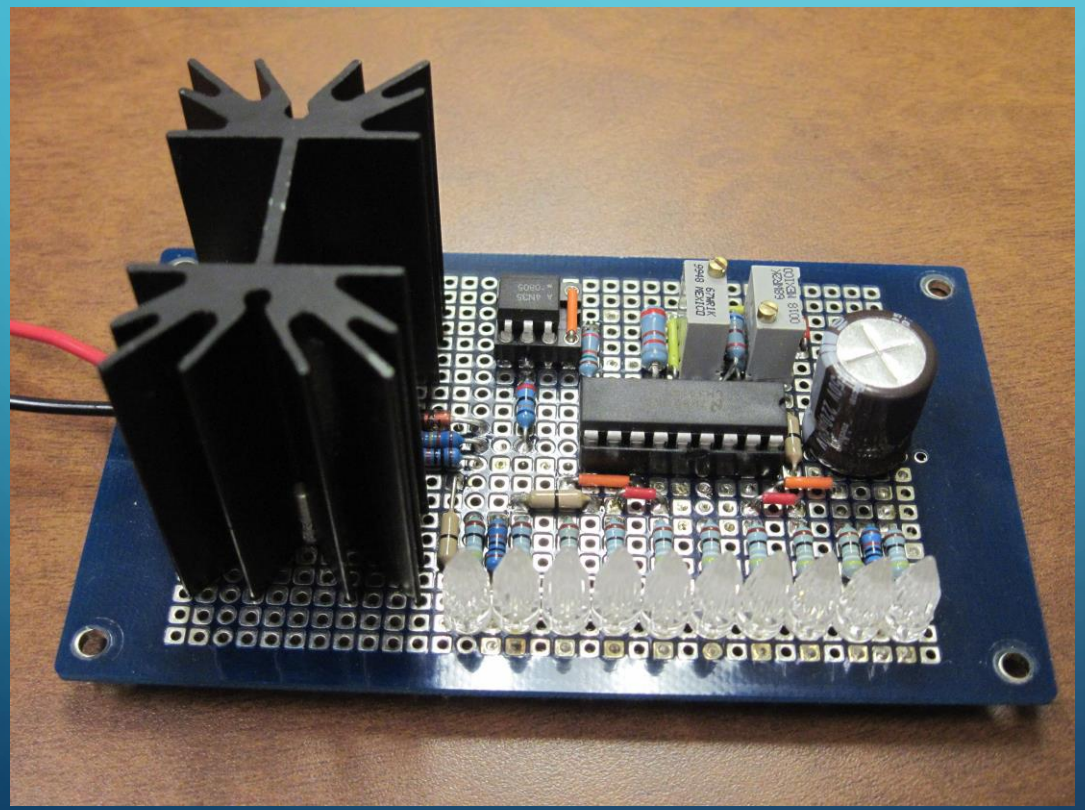
FIELD TESTING

- PROVING SYSTEM RELIABILITY
- IDENTIFICATION OF PERFORMANCE ISSUES



BATTERY WATCHDOG

TREATMENT OF BATTERY FAILURE FOR REMOTES



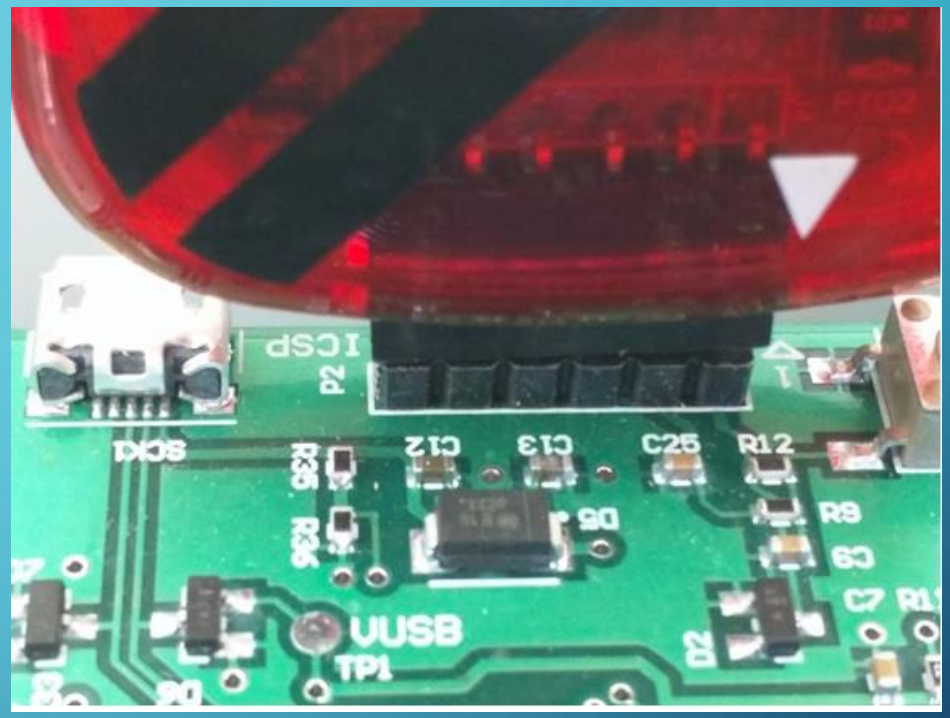
DIAGNOSTICS SOFTWARE -- ALLOWS REMOTE TROUBLESHOOTING

COMMUNICATION LINK VERIFICATION

SENSOR VERIFICATION

DATA EXPORT TO A SPREADSHEET

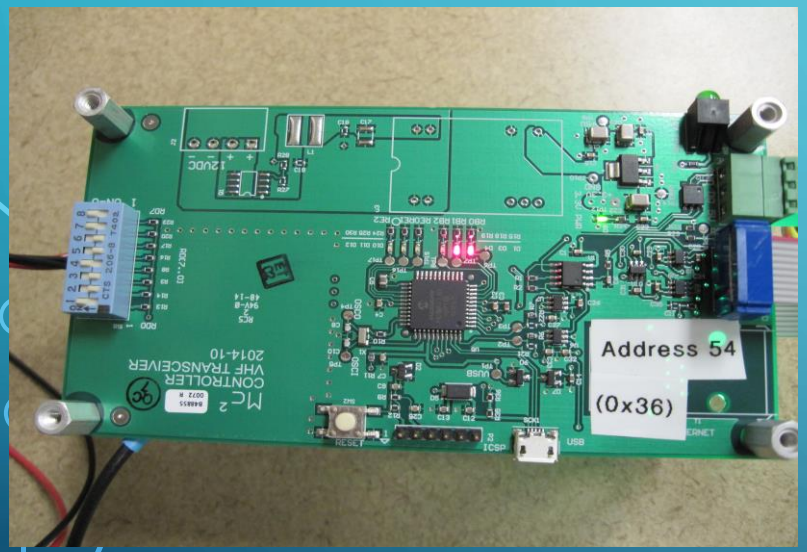
FIELD UPGRADEABLE SOFTWARE



Improved Link Budget

ELECTRONICS DESIGN for RELIABILITY

M-Controller



Transceiver

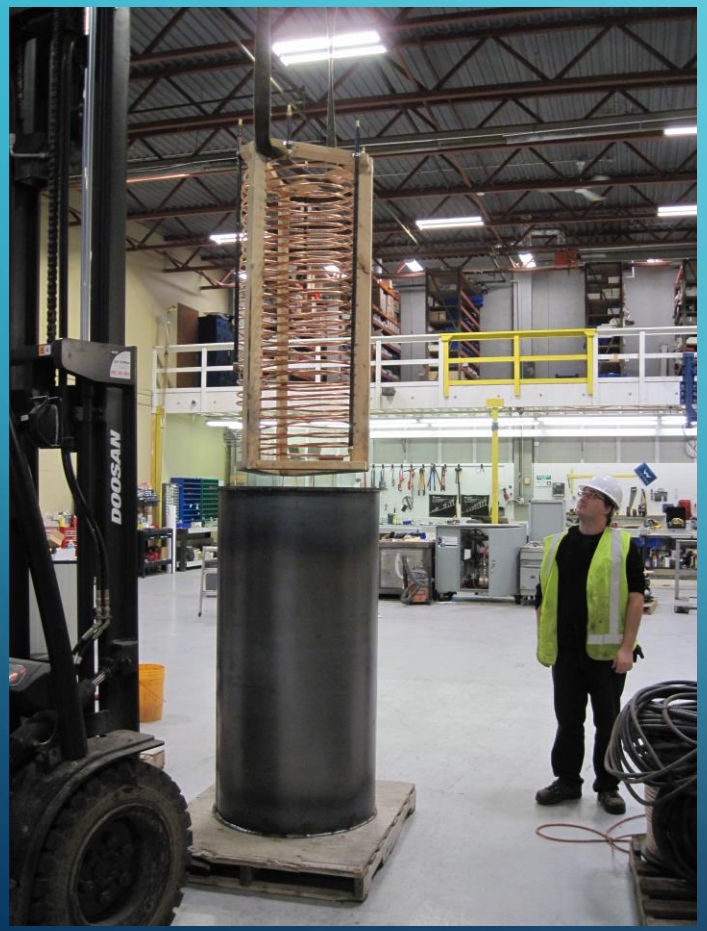
Transponder

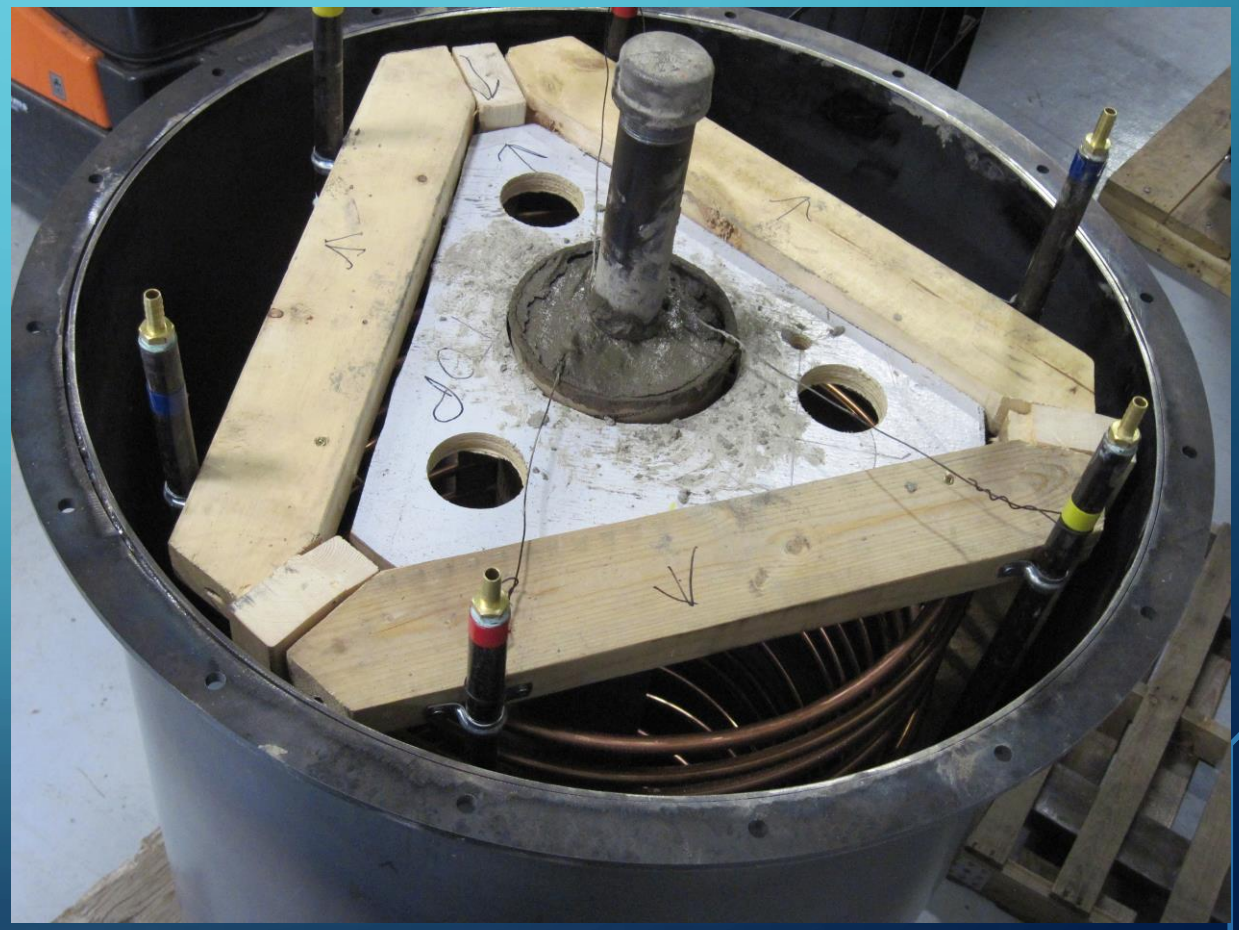
UNDERSTANDING SENSOR FAILURE

Hydraulic Hose

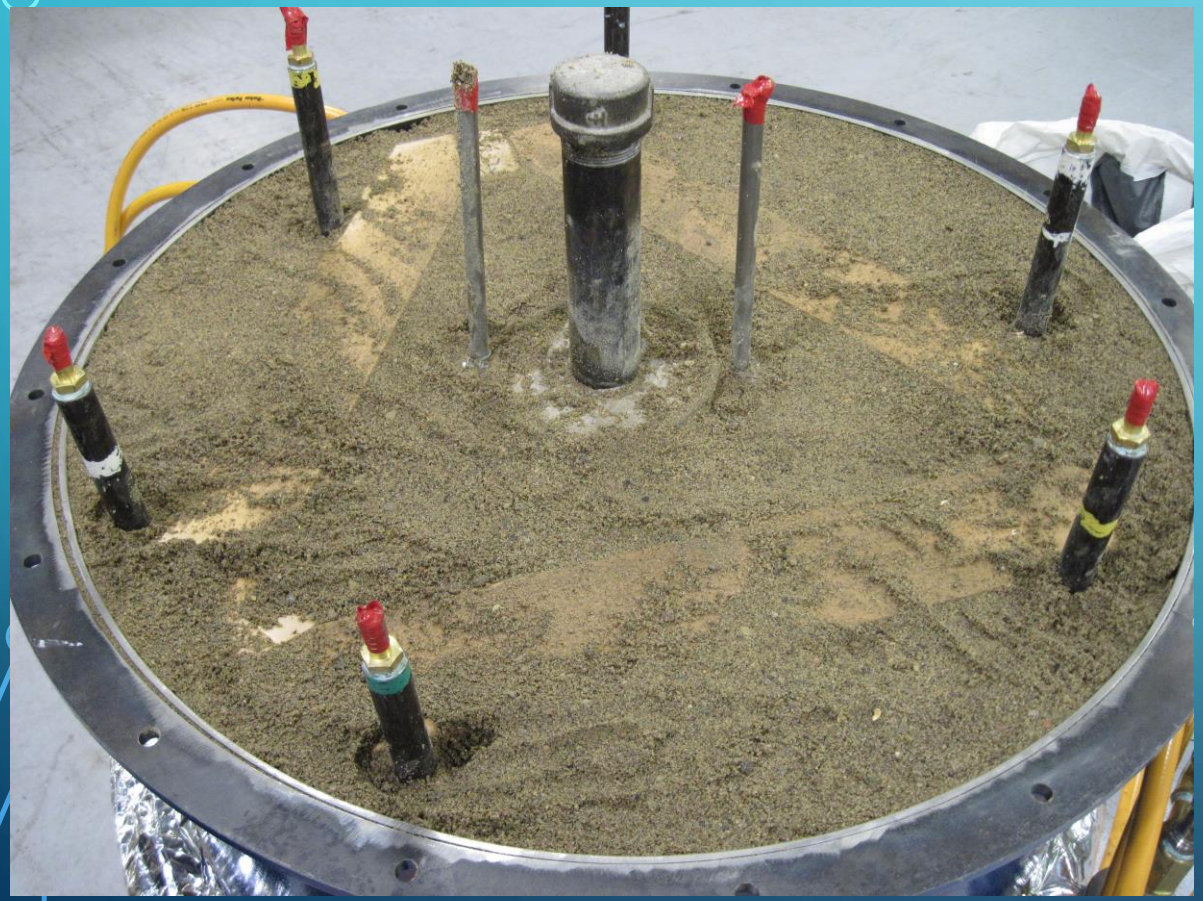
Metal Tubing

SENSOR MEASUREMENTS IN WELL



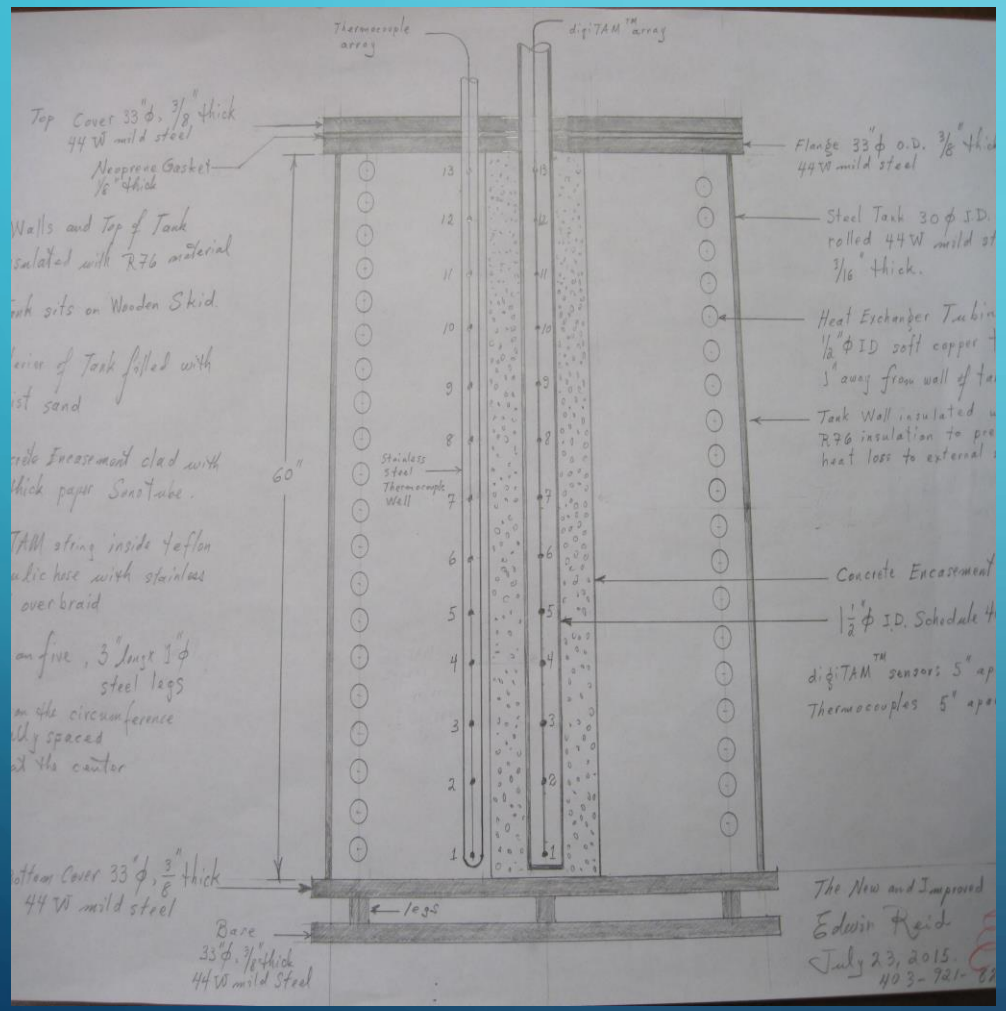


SENSOR WELL MEASUREMENTS (cont'd)

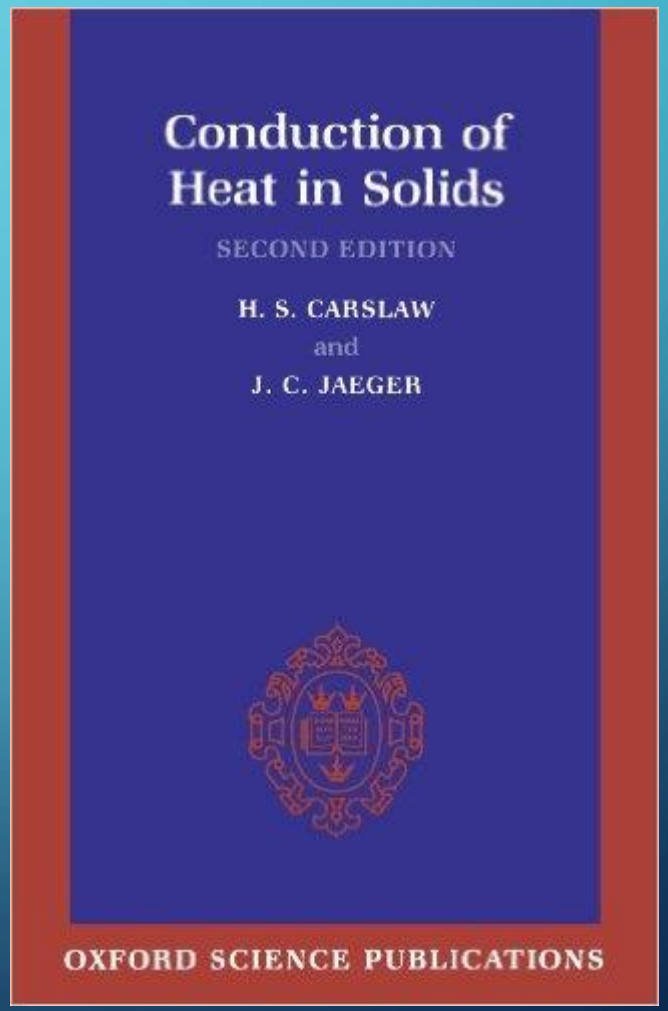


CORRECTNESS OF TEMPERATURE MEASUREMENTS

Experimental

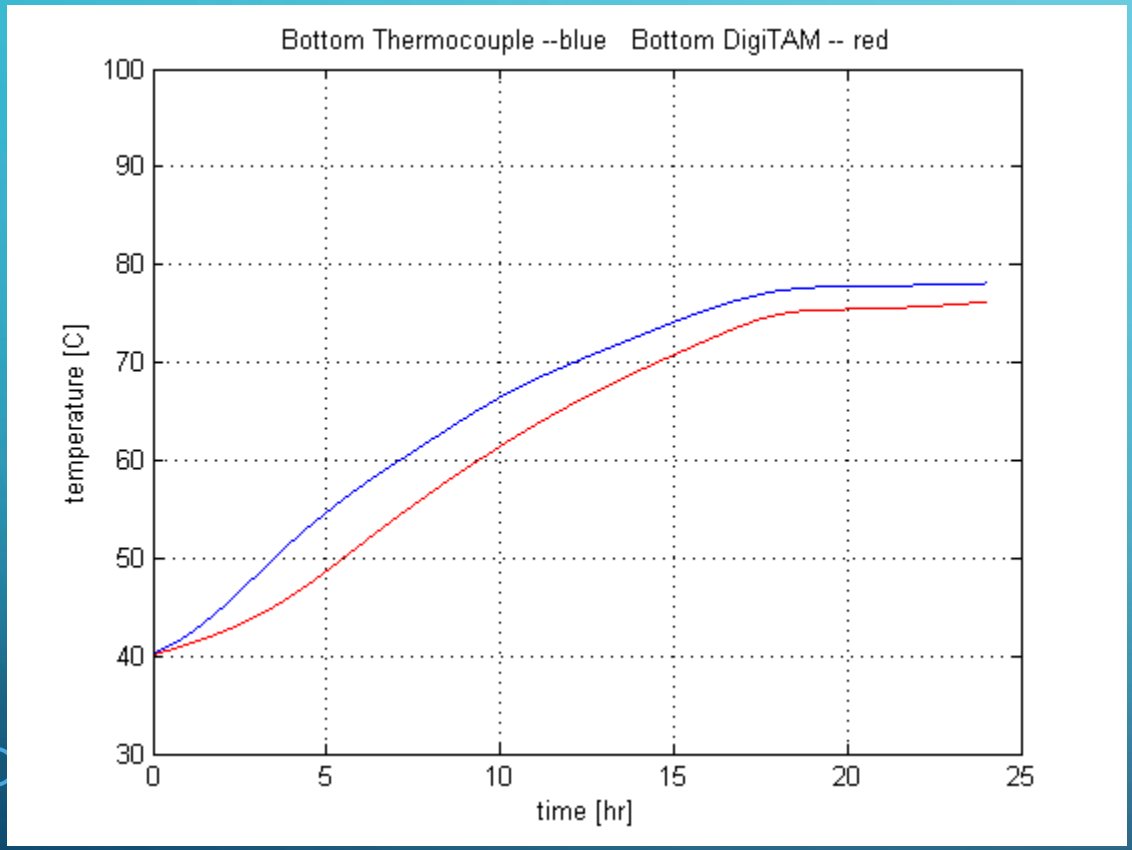


Analytical

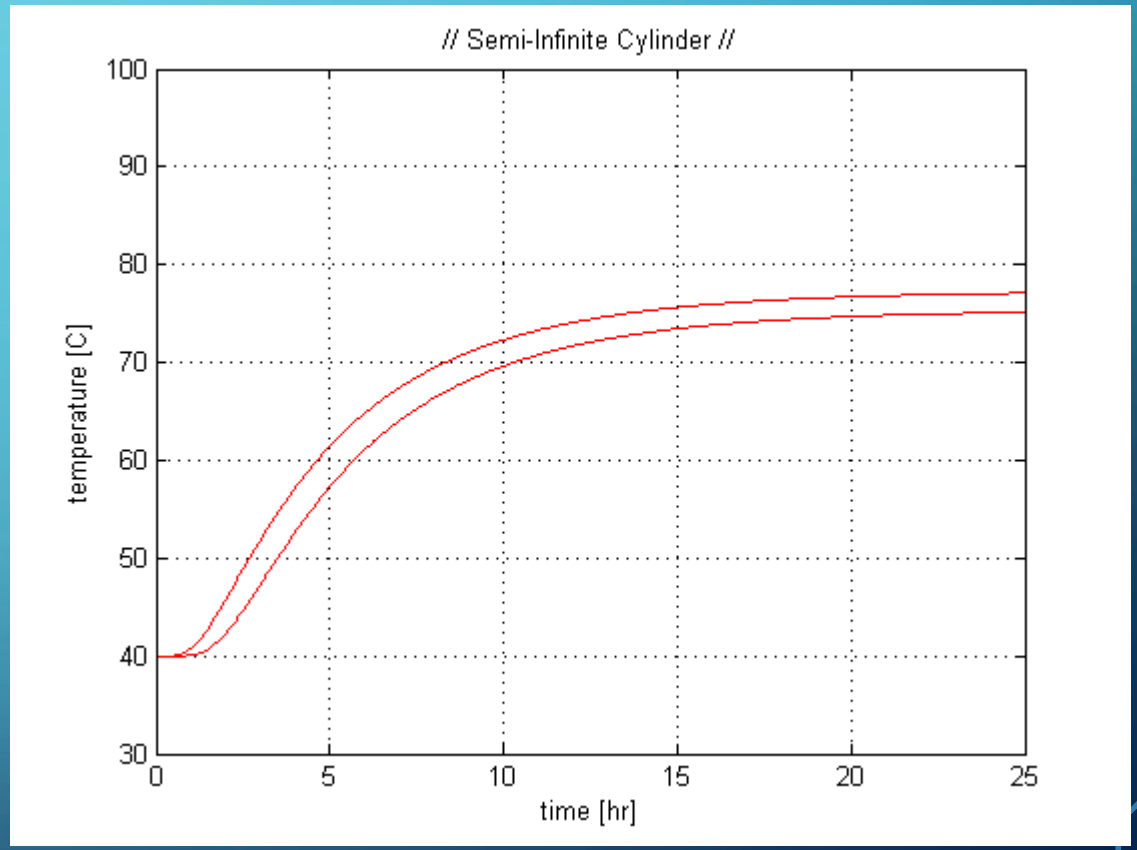


STEP RESPONSE OF TEMPERATURE VS. TIME FOR BOTTOM SENSOR

EXPERIMENTAL

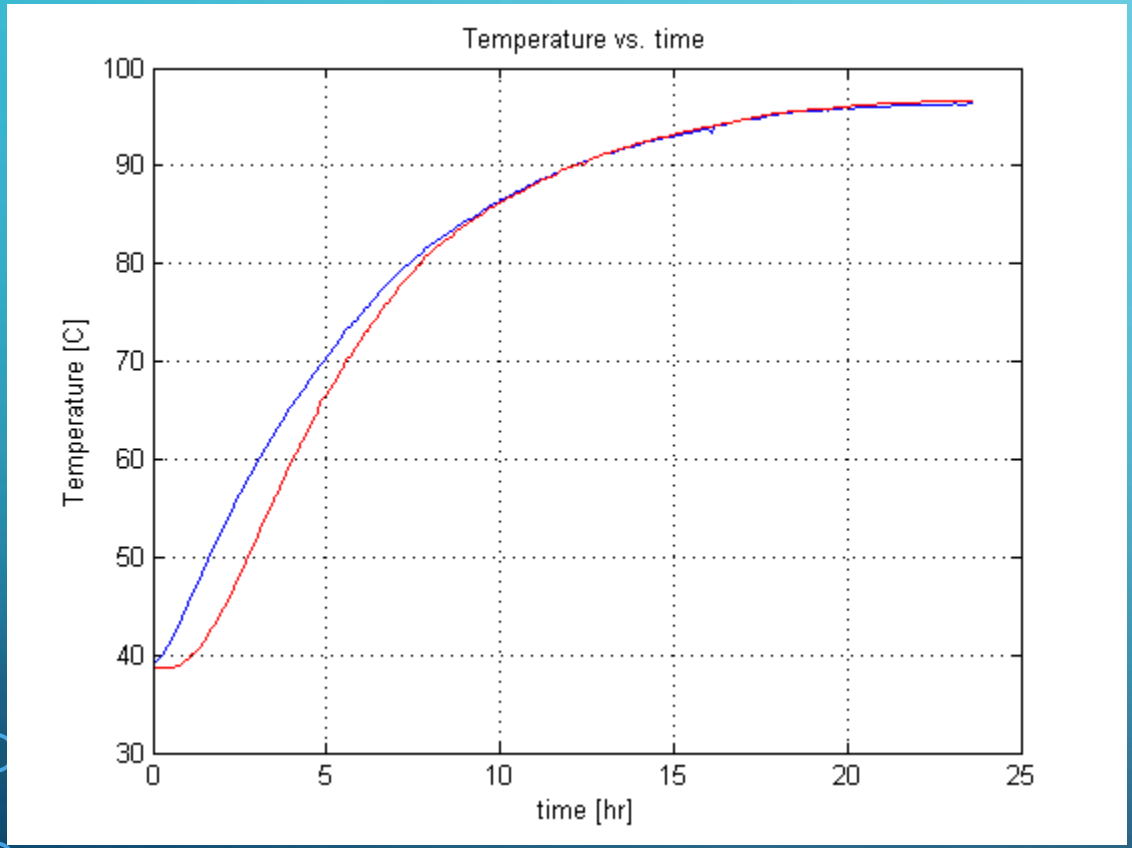


ANALYTICAL

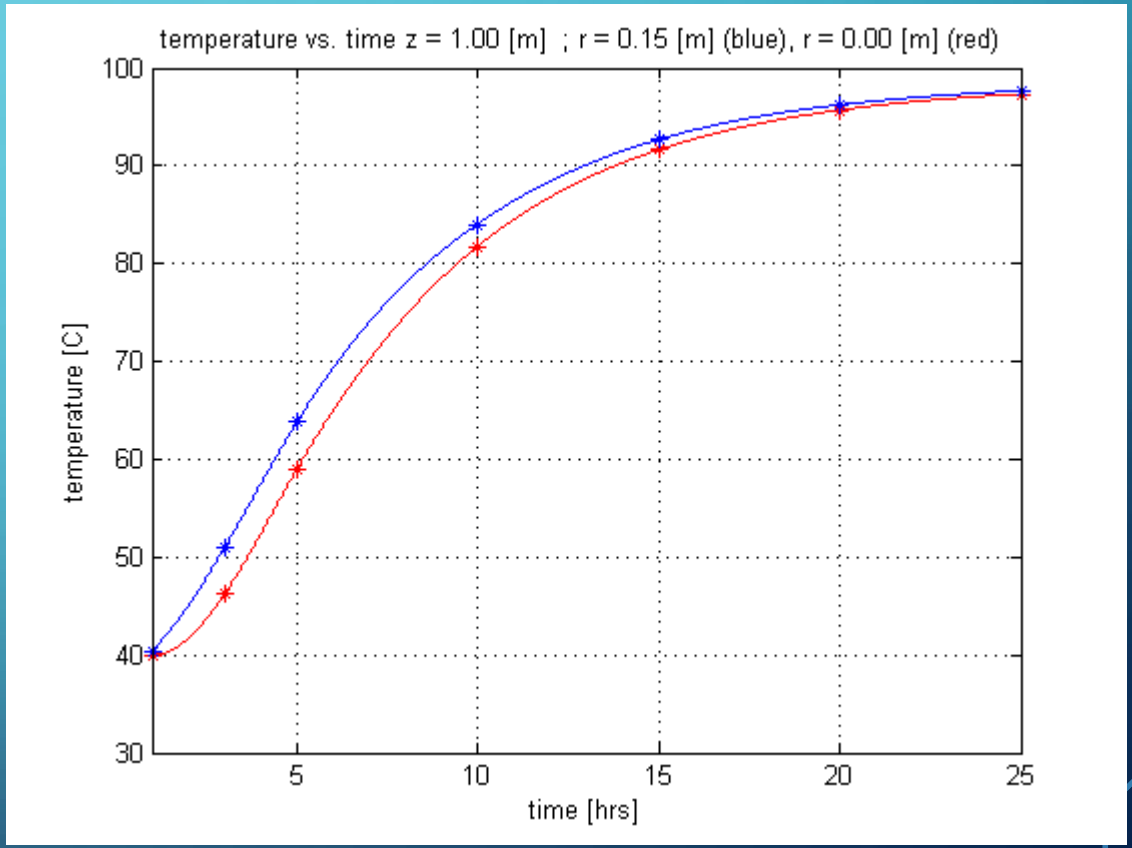


STEP RESPONSE OF TEMPERATURE VS. TIME FOR MIDDLE SENSOR

EXPERIMENTAL

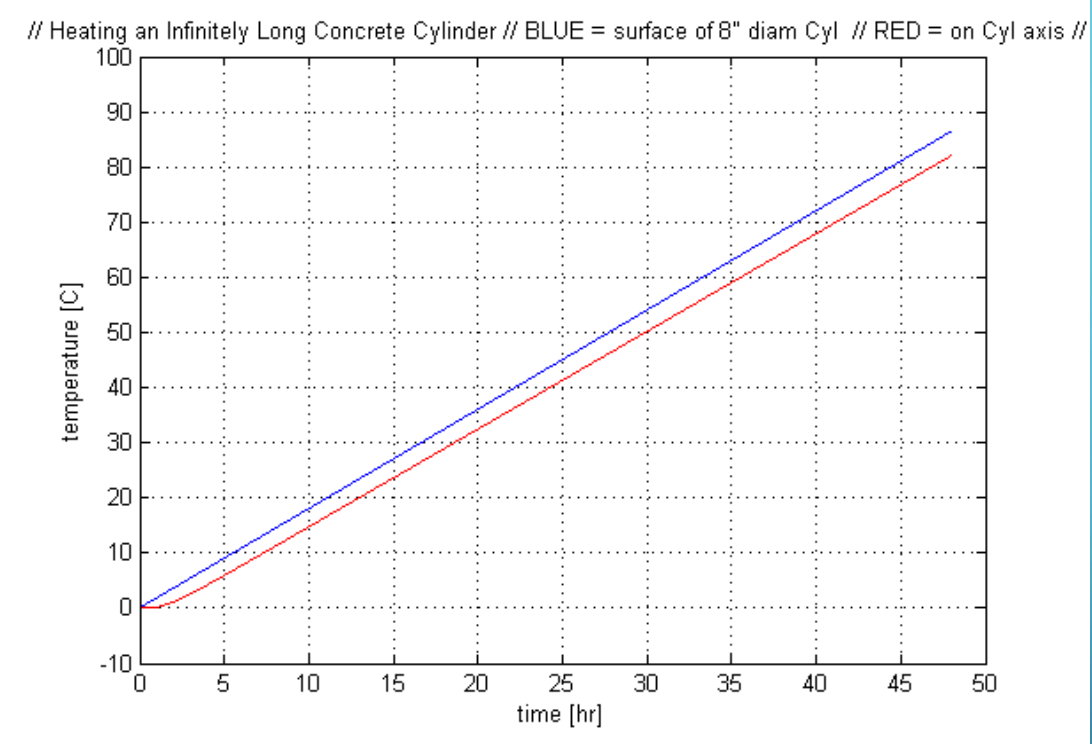


ANALYTICAL

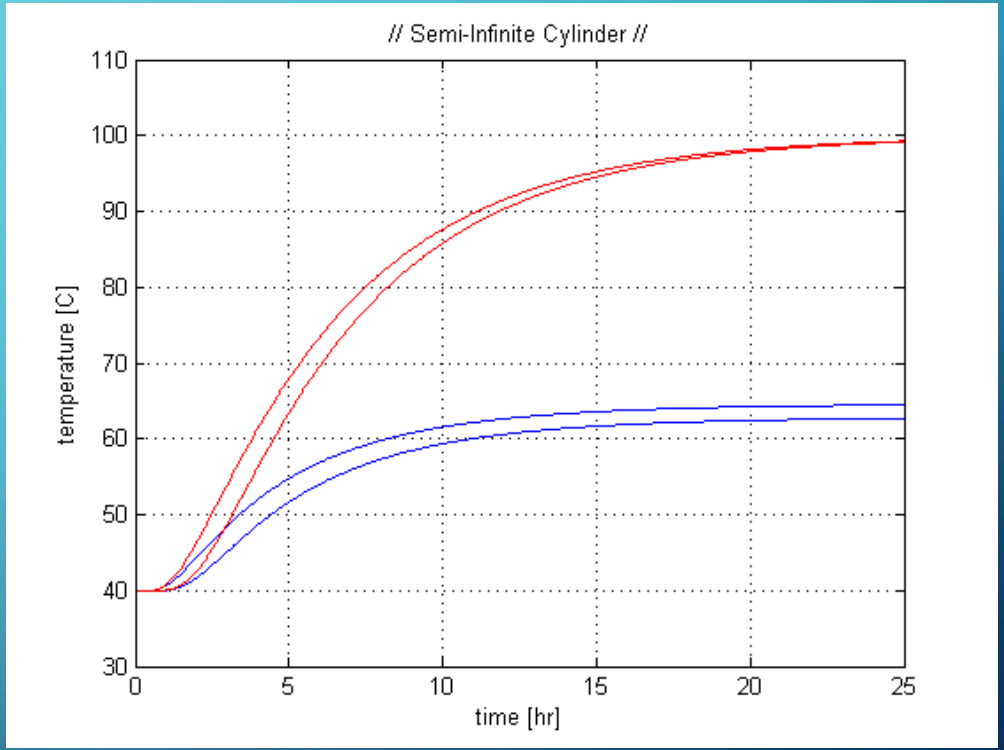


TEMPERATURE VS. TIME

RESPONSE TO A RAMP EXCITATION



RESPONSE TO STEP EXCITATION MIDDLE AND BOTTOM SENSORS



Volterra Integral Equation

$$f(t) = \int_0^t \mathfrak{K}(t-\xi)y(\xi)\,d\xi$$

Kernel

$$\mathfrak{K}(t-\xi) = \frac{2}{a}\sum_{n=1}^{\infty} \alpha\lambda_n \frac{e^{-\alpha\lambda_n^2(t-\xi)}}{J_1(\lambda_n a)}$$

Resolvent

$$\Re(t) = \mathfrak{L}^{-1}\left[\frac{1}{sK(s)} - 1\right]$$

Solution

$$y(t) = f'(t) + \int_0^t \Re(t-\xi)f'(\xi)\,d\xi$$