Magnetometer Support for the Personal Space Weather Station and Related Projects

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Project Goals:
HamSCI Magnetometer Network

- To establish a densely-spaced magnetic field sensor network to observe Earth's magnetic field variations in three vector components.
- Target performance level: ~10 nT field resolution at 1-sec sample rate (note: Earth's magnetic field ranges from 25,000 to 65,000 nT).
- Time-varying field measurement is sufficient: absolute measurement is not necessary.

Magnetometer Support and Extender

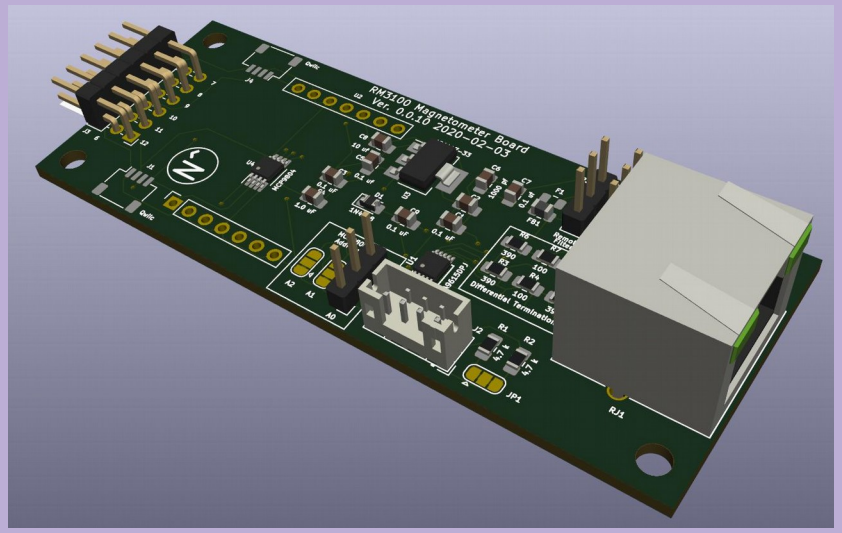
- Purpose:
  - To provide magnetometer support to the Personal Space Weather Station (PSWS) and similar projects.

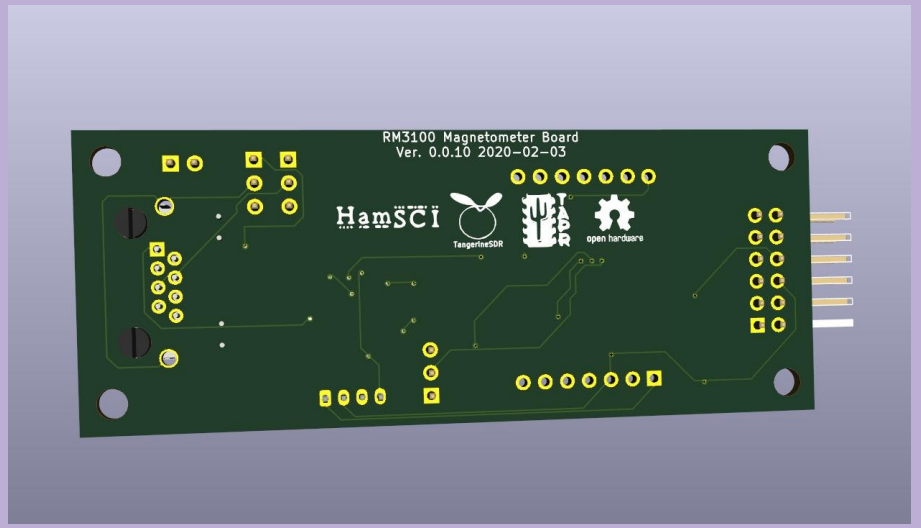
- Sensors:
  - PNI RM3100 magnetometer module.
  - MCP9808 temperature sensor.

- Interfaces:
  - Polled I2C communications through various common connectors.
  - Remote extension via differential I2C (PCA9615) up to 30 m using shielded RJ45 connectors and shielded twisted pair (Cat-6a type) cable.

For the PSWS, two boards are used with one PNI module and a shielded cable to create an extension link.

Board 3D Mock-Up

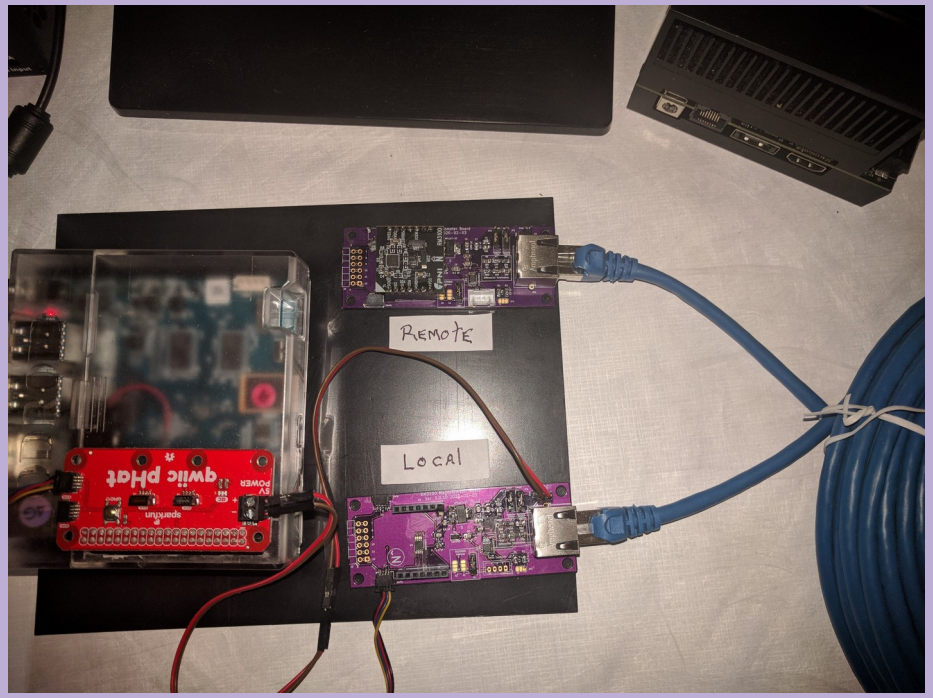




PNI RM3100 Magnetometer Module

- 3 axis magneto-inductive measurement module.
- Low cost (≤ $20) allows widespread deployment.
- Very small (25.4 mm x 25.4 mm x 8 mm) compared to other sensor types.
  Smaller footprint possible with custom layout.
- High sensitivity alternative to other magnetometer types.
  Manufacturer claims 13 nT with default settings.
- Native I2C and SPI interfaces for connection to common microcontrollers.
- All pins 3.3 V_{DC} only.

Setup for Electrical Testing



I2C Extender Function

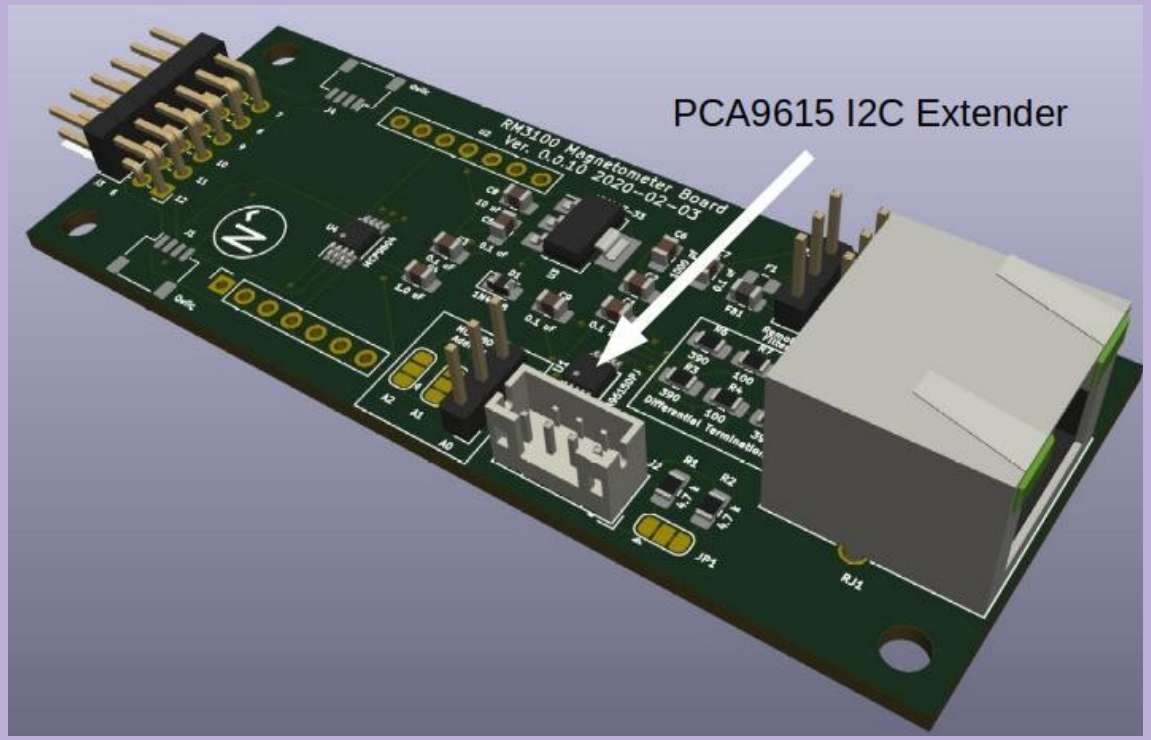
- The I2C bus was created to provide very short range (less than 0.5 m) serial communication between components or boards within a chassis. Single-ended signaling provides very limited noise immunity.

- PSWS and similar projects at quiet sites require significant separation between sensors and support electronics to achieve maximum sensitivity.

- NXP PCA9615 converts I2C single-ended to differential signaling at voltages independent of the original input. These factors allow increasing the separation of the remote sensor from the data collection apparatus to over 30 m (~100 ft) in testing.

- The design of the I2C/dI2C bus allows attachment of additional sensors at either the local or the remote end of the bus, within the limits of available power.

PCA9615 Location



Temperature Sensor

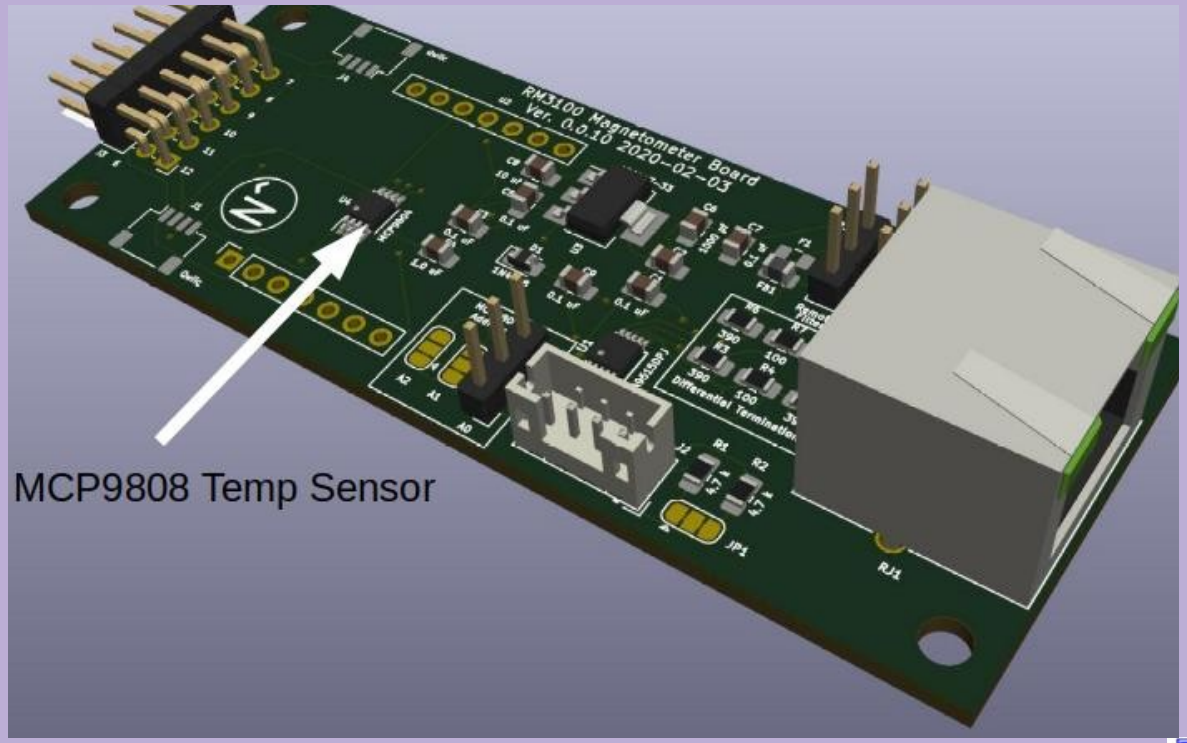
- For characterization, calibration, and normalization it was decided that having a temperature sensor in close proximity to the magnetometer sensor is desirable.

- The Microchip MCP9808 is very small, inexpensive, and uses very little current.

- This sensor measures temperatures between -20°C and +100°C with ±0.25°C / ±0.5°C (typical / maximum) accuracy.

- The sensor appears on the same I2C bus and requires no additional circuitry. A jumper is provided to select different bus addresses for the remote and the local ends of the link. This allows monitoring both the magnetometer and the data collection environment.

MCP9808 Location



Next Steps

- Software driver development
  - Current low level software is rudimentary.
  - Both low level and user facing software must be created to support further characterization and optimization of the sensors.

- Rigorous evaluation under realistic conditions
  - Testing at established quiet sites.
  - Comparison with calibrated sensors of established quality.

References

PNI Sensor RM-3100 User manual – downloadable from:
https://www.pnicorp.com/download/rm3100-user-manual/

PNI Sensor RM3100 Sales Sheet (datasheet) – downloadable from:
https://www.pnicorp.com/rm3100/

NXP I2C PCA9615 Range Extender IC:
https://cdn.sparkfun.com/assets/a/5/1/3/6/PCA9615.pdf

Microchip MCP9808 Temperature Sensor:
http://ww1.microchip.com/downloads/en/DeviceDoc/25095A.pdf