

Practical Guidelines for building a Magnetometer by Hobbyists

Part 4 : Double Magnetometer Project

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1. Overview

This is the [Block Diagram](#) of the Double Magnetometer system.

- The survey instrument is the mobile station. It is manually operated and transported from point to point on the survey field. Its current XY position can be manually defined by the operator according to a grid of wires sitting on the ground or its could optionally be defined by an automatic positioning system (GPS or Ultrasonic).
- The Survey Control & Storage station is fixed and located somewhere close but outside the survey field. Its purpose is to gather the survey results on a single point and to safely store them on a host PC. Here, an operator is useful but not mandatory for proper operation of the survey. If he is present, he can monitor the progress of the survey on a graphical XY map and warns the survey operator if he notices any disturbance or any remarkable fact. If he is not present, the fixed station just records the survey results on a log file and sound an alarm in case of detection of possible errors in the measured values.
- The survey instrument is normally equipped with a single channel board and sensor but these could be doubled to accelerate the speed of survey by capture two parallel survey lines at the same time.
 - o The main survey operator manually triggers a measurement cycle by pressing a button.
 - o This action triggers the transmission of a short RF message to the fixed station and both stations synchronously start a polarization/measurement cycle.
 - o When this is terminated, the mobile station sends the measurement data (XY coordinates and nT value(s)) to the fixed station through the RF link.
 - o The program at the fixed station executes some calculations and validations on the data and sounds an alarm (preferably heard by the survey operator as well) if necessary.
 - o If the measurement is accepted, the fixed station records the received survey data as well as its own nT value on a log file and displays the current gradient on an XY map on the host PC.

The Mobile Station will be built from 4 distinct boards:

- A **single channel board** with a single sensor for Polarization Control/Signal Amplification/Filtering. This board is self-contained with its own CPU for polarization control and Signal Analysis with an I2C Bus connection to the main board
- One **RF Transmitter board** to establish a simplex radio link with the fixed station.
- One **main Control Board** controlling the whole system and the human-interface for the mobile operator.
- One passive **back-panel** with its plug-in connectors for power supplies and I2C bus.
- A **5-button Keyboard and LCD** for human-interface.

The Fixed Station will be built with 4 distinct boards:

- A **single channel board** (same as on the mobile station)
- One **RF Receiver board** to establish a simplex radio link with the mobile station.
- One **main Control Board** (same as on the mobile station but without keyboard nor LCD)
- One passive **back-panel** with its plug-in connectors for power supplies and I2C bus.
- A **Laptop PC** connected to the main board through RS232 for survey results storage and display under control of a second operator.

This system configuration requires two operators, one controlling the fixed station and one operating the mobile station.

- The mobile station operator manually triggers a polarization/measurement cycle.
- The main control board of the mobile station sends a small synchronization message to the fixed station through the RF link.
- Both stations starts a polarization/measurement cycle at the same time.
- At the end of the cycle, the main board of the mobile station sends the measured nT value and its coordinates to the fixed station through the RF link and its I2C bus.
- The main board of the fixed station sends the two nT values and the current coordinates to the PC through the RS232 link.
- The PC calculates, validates, stores and displays the gradient. If any nT value or the gradient is erroneous, an alarm is sounded and the mobile operator is warned to redo the same measurement if necessary.

2. Polarization sub-system

This is the Circuit of the [Polarization Control](#) system. The polarization sub-system is controlled by three digital lines (POL_CTL, SQUELCH, SERIES) coming from its own local [PIC18F452 CPU](#).

3. Amplifier/Signal Analyser Channel

The [Signal Amplifier/Filter Circuit](#) and the Signal Analyzer Circuit (combined on the same slave board together with the Polarization circuit) of the Double PPM system are based on the traditional **PIC18F452** from Microchip.

The channel controlled by a distinct digital line PICKX coming from the Main Control Board. The PICKX line ON conditions the beginning of the signal frequency analysis coming from the TTL_OUT line and the PICKX line OFF conditions the sending of the frequency result to the main board through the I2C Bus (SCL, SDA lines).

4. RF Link Module

This is the [RF Link Control Circuit](#) of the Double PPM system. It establish a simplex radio link between the two stations. The mobile station has a plugged-in RF transmitter Module and the fixed station has a plugged-in RF Receiver Module. The control of the RF modules is made by a small 16F87 8-bit micro-controller from Microchip. It also controls the I2C link used to communicate with the main controller board.

5. Main Control Module

This is the [Main Control Circuit](#) of the Double PPM system. It controls the polarization and signal pick-up cycles through a single digital lines (PICKX) and controls the capture of the frequency calculation from the channel by setting OFF its PICKx line.

It is based on the traditional **PIC18F452** from Microchip with 32Kwords flash program.

The **LCD** is used to display the current field nT value and XY coordinate as well as menu display for parameter settings on the mobile station.

The **four-arrow keys + OK** is the keyboard of the mobile station.

An **RS-232 interface** to connect a PC for survey results up-loading and system parameter set-up.

A **Buzzer** is used for aural feed-back (key press, alarm...)

A special **trigger push-button** (connected in parallel with the **OK** button) is depressed by the operator to start each measurement cycle in manual mode.

6. Packaging

The Back-panel board holds the slave channel, the RF link and the main control boards which vertically plugs in through their male header connectors.

The Back-panel board has been dimensioned to be exactly inserted into the PCB slides of an electronic box made of aluminum extrusion with a size of 155x105x80mm.

The top of the box cover will hold the LCD, the Buzzer and the keyboard on the mobile station.

The first side of the cover will hold the BNC connector to the sensor.

The second side of the cover will hold the RS-232 connector and the 12V power supply connector to an external gel cell battery..

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