IoT Over Satellite Agriculture Use Case

How to use Sensoterra sensors over the Inmarsat IDP satellite network with the MinFarm MF-400 IoT Satellite Bridge

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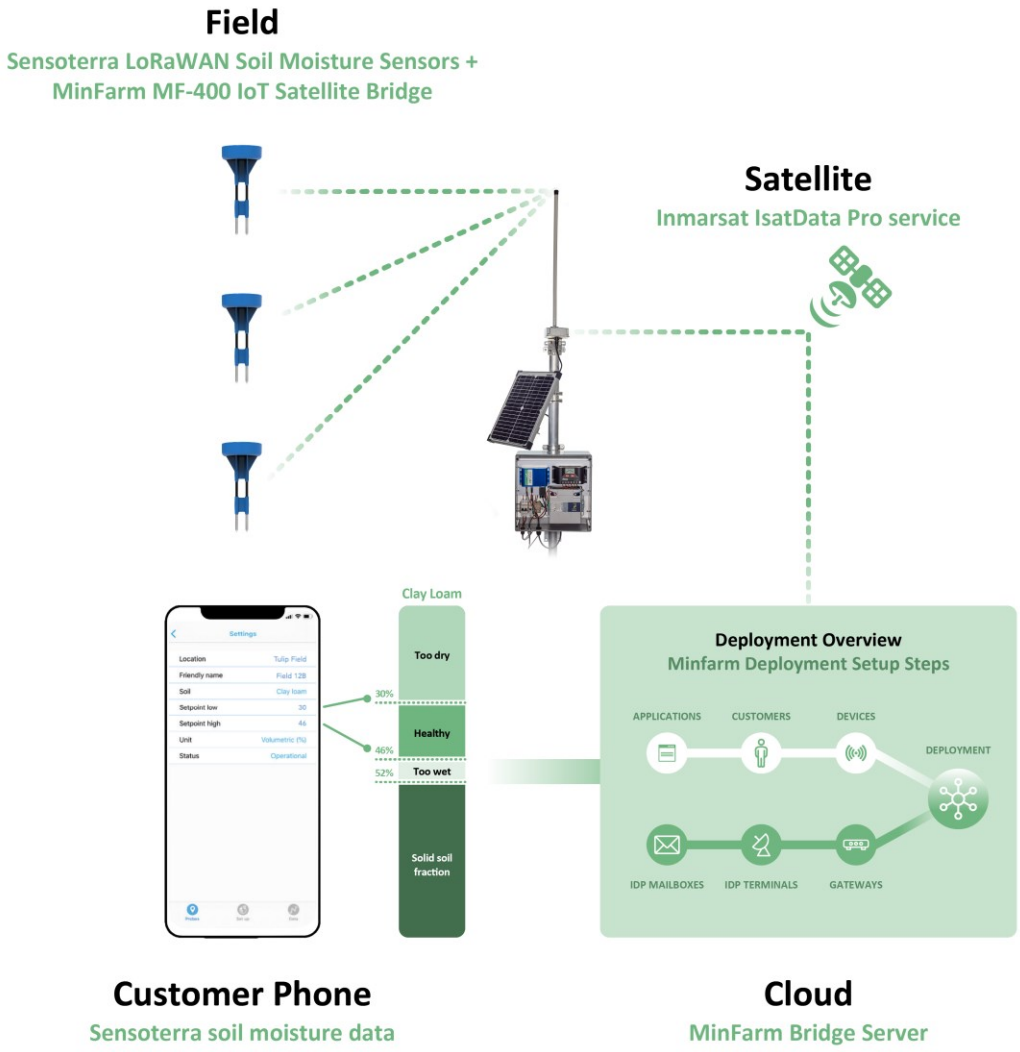
1.0 Introduction

Measuring the water content of soil is a vital tool to aid farmers with management of their crop. If plants receive too little, or too much water this results in penalties on crop yield and quality - which translates to lost revenue at harvest. In many agricultural areas of the world, farmers invest in irrigation systems to apply water to crops, however the system is only as good as the operator, and knowing how much water to apply to the crop is vital. Soil moisture sensors are a well-established technology that farmers use to calculate the volumetric water content (%) of the soil. If the volumetric content is too low, then farmers can choose to irrigate and make a decision on how long to irrigate for. Traditionally soil moisture sensors have an in-built data logger which must be manually read in the field. This means more field visits for the farmer, and less ability to react to quickly changing conditions. New age, wireless soil moisture technology overcomes this problem by sending the data to the cloud and enabling alerts if certain thresholds are met (e.g. soil is too dry). However, a lack of access to mains power and terrestrial connectivity prevents deployment of such systems in rural agricultural environments. This use case focuses on the use of soil moisture sensors, enabled by a private LoRaWAN™ network and backhauled by Inmarsat IsatDataPro.

2.0 Solution Overview

This document describes the equipment and installation process required for installing Sensoterra soil moisture sensors and a MinFarm MF-400 IoT over Satellite Bridge in a location with no power or cellular coverage with a sensor update frequency of once per hour. This solution will provide continuous real time monitoring of soil moisture from a field located anywhere in the world via the Sensoterra app available on Apple's App store and GooglePlay.



2.1 Components

- Sensoterra Single Depth soil moisture sensor
- MF-400 Gateway
- Inmarsat IsatDataPro (IDP) satellite terminal
- Sensoterra application software on your mobile phone or laptop

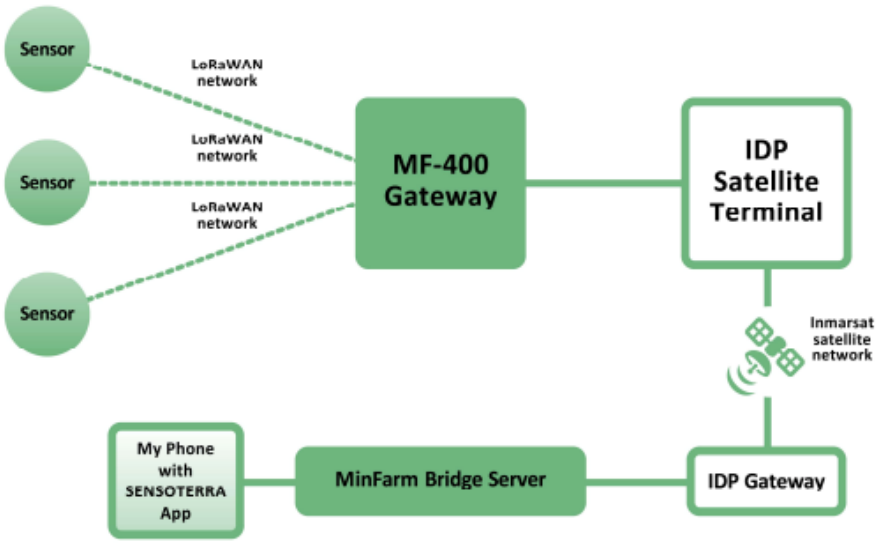
2.2 How It Works

The technical part in simple terms. How does it all work? There are two main networks involved. One is called LoRaWAN™, and the other is the Inmarsat satellite network.

The LoRaWAN™ (‘long range wide area network’) is a low power wireless network that allows you to connect wireless battery operated devices to a gateway that can be several kilometres away. Through this gateway, the devices can then connect to the Internet. It is low power, has a good range, and is wireless.

The Inmarsat satellite network provides a global, reliable and trusted method of accessing the Internet using low-powered, portable satellite terminals.

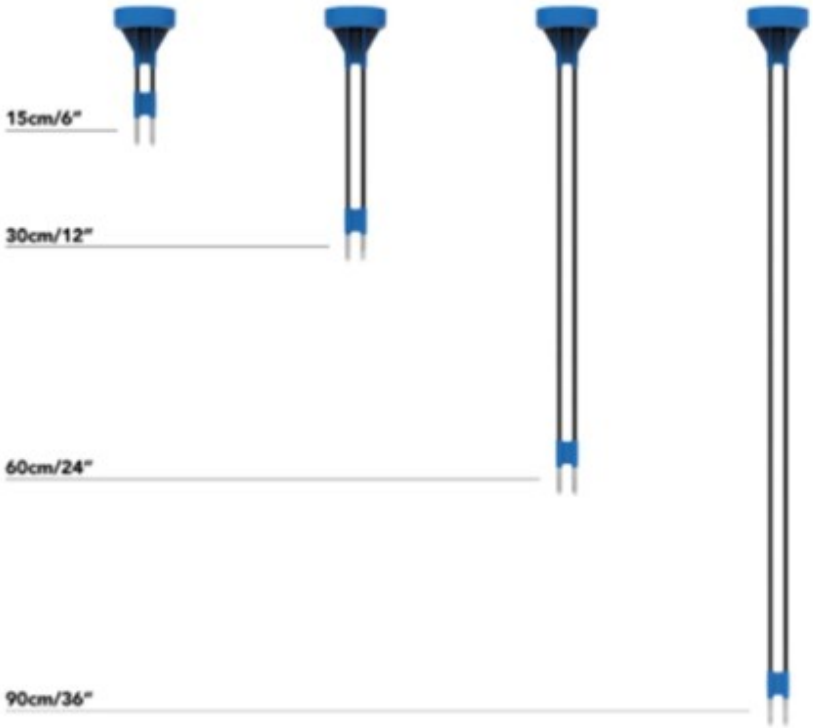
The Sensoterra single depth sensor sits out in a remote area of your land. Every hour the sensor sends information to the MF-400 Gateway. This is sent over the LoRaWAN™ network. It passes the information to the IDP satellite terminal, over satellite, back down to a satellite receiving station, called the IDP gateway, which then passes it on to the MinFarm Bridge Server, and then on to your mobile phone where it can be viewed using the Sensoterra application software.



3.0 Hardware Component Setup

3.1 Sensoterra Sensor

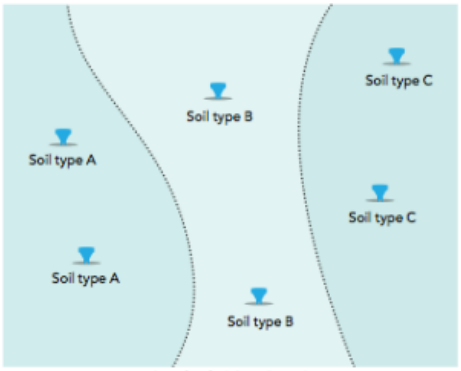
The picture below shows a Sensoterra single depth sensor which measures soil moisture levels. Sensoterra also produce a multi depth device which has 6 different sensors attached, but for the purpose of this paper we will talk about the single depth sensor. The MF-400 IoT Satellite solution will work with both sensors in a similar way. You should contact Sensoterra to discuss what sensor best suits your requirements.



Device Installation

Refer to the Sensoterra Installation Guide for particular installation and setup instructions for your single depth sensor. Schematics shown below are taken from this guide.

Choosing your location



Example of a field with soil variety

The field you like to monitor can consist of geographic features like slopes, valleys and changing soil types. These features might influence the soil moisture levels throughout the field. Consider placing sensors in different places to get a broad overview of the field you monitor.

1 Preparation

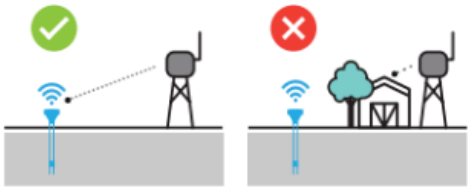
1 Preparation

Ensuring good connectivity

Sensoterra sensors communicate over the LoRa network. This means the data is first sent from the sensor to a gateway, which then forwards the data to the cloud via an internet connection. In some countries and areas, telecom providers have gateways available for your sensor to connect to.

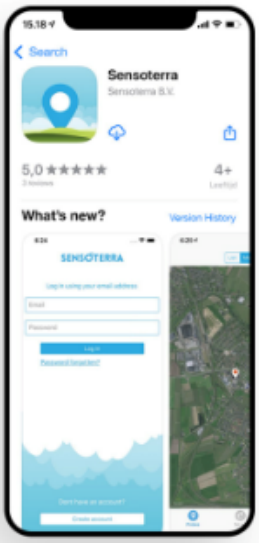
If you are installing your own gateway, the basic rule is to **find free line of sight** from the sensor antenna to the gateway antenna.

Objects like houses, barns, big trees, big vehicles in the line between sensor and gateway could obstruct the signal. Try to get the gateway antenna up as high as possible to get a look over the fields and think about the location of the objects when choosing the locations of the sensors.



1 Preparation

Download the app



Download the Sensoterra app

Download and install the Sensoterra app from the App Store or Google Play on your smartphone. Create an account or log-in. You will need the app for registering sensors when you install them in the field.

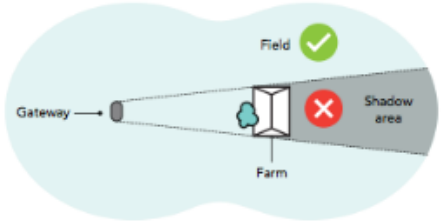
Available on the App Store

GET IT ON Google Play

1 Preparation

Terrain

Terrain that is hilly creates signal shadows over the field. Placing the gateway at the highest point of the hills could reduce the signal shadows. The sensors should be placed on the side of the hill that is facing the gateway. Buildings and large structures can also obstruct the signal. Avoid placing them in the signal shadow or place your gateway elsewhere.



3.2 MF-400 Gateway

The MF-400 Gateway can be seen in the picture below.

3.2.1 MF-400 Technical Overview

The MF-400 Gateway provides network server connectivity for 100 remote LoRaWAN™ sensors via Inmarsat IsatDataPro (IDP) satellite terminals and can operate continuously from a single 80W solar panel.

The MF-400 runs an optimized protocol to ensure that airtime satellite costs per sensor are kept to a minimum. This makes the MF-400 a standalone, low power, low-cost solution for adding satellite connectivity to your existing COTS LoRaWAN™ sensor devices.

The MF-400 Gateway supports LoRaWAN™ version 1.0.2, and is compatible with a very wide range of commercial off the shelf (COTS) LoRaWAN™ sensors. Both the communication device and the solar charger are installed in IP67 rated CPN enclosures for harsh environments.

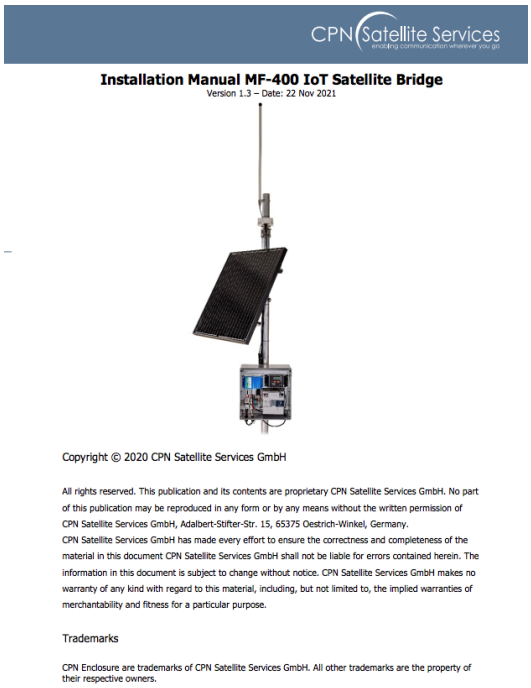
MinFarm provides a platform with a range of IoT management tools for setting up, integrating and maintaining IoT sensors in the field. These tools are fully compatible with existing IoT management platforms, sensor network services, and customer applications via an API. MinFarm IoT over Satellite management tools provide a stable and low cost solution for adding remote connectivity via satellites to existing IoT service infrastructure. Below is a list of these tools.

MinFarm IoT over Satellite Management Tools

Optimized Bridge Protocol	**Remote Gateway Reboot**
Message Encryption	**Remote Gateway Metrics Retrieval**
API Access	**Remote Sensor Metrics Retrieval**
Remote Sensor List Update	**Remote Heartbeat and Ping Command**
Remote Firmware Update	**Endpoint Integration**
Remote Sensor Configuration	**Third-party IOT Platform Integration**

3.2.2 MF-400 Installation

Refer to the MF-400 Installation Guide for installation, full safety instructions, and tools required. Images shown below are taken from this guide.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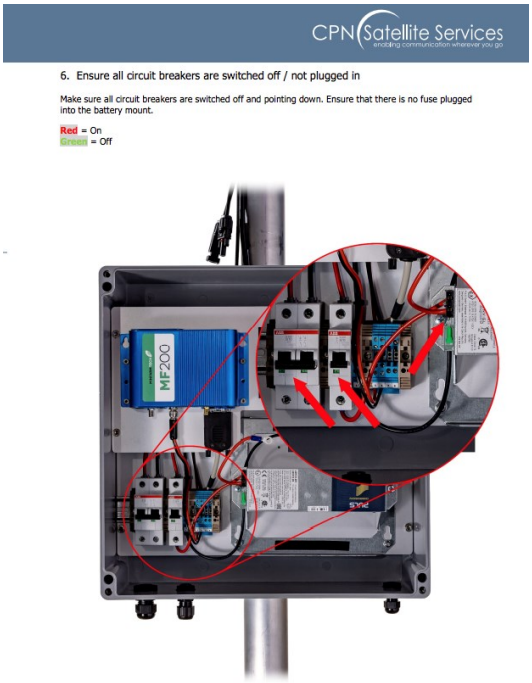
Version 1.3 – Date: 22 Nov 2021


CPN Satellite Services

6. Ensure all circuit breakers are switched off / not plugged in

Make sure all circuit breakers are switched off and pointing down. Ensure that there is no fuse plugged into the battery mount.

Red = On
Green = Off

3.3 Inmarsat IsatDataPro Satellite Terminal

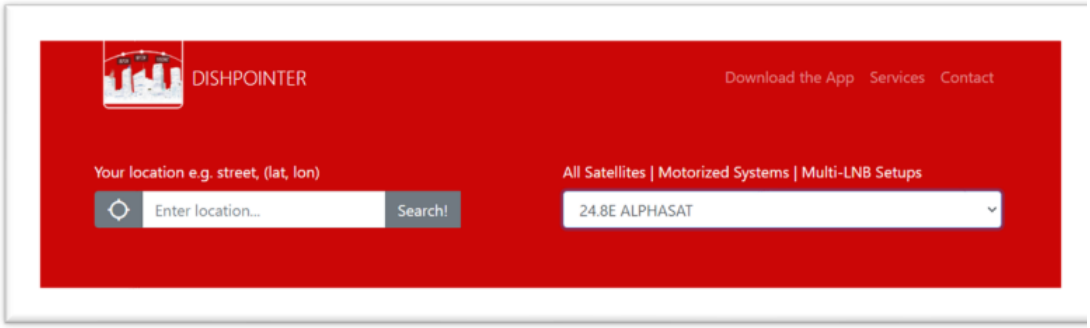
The IDP satellite terminal is shown in the picture below.

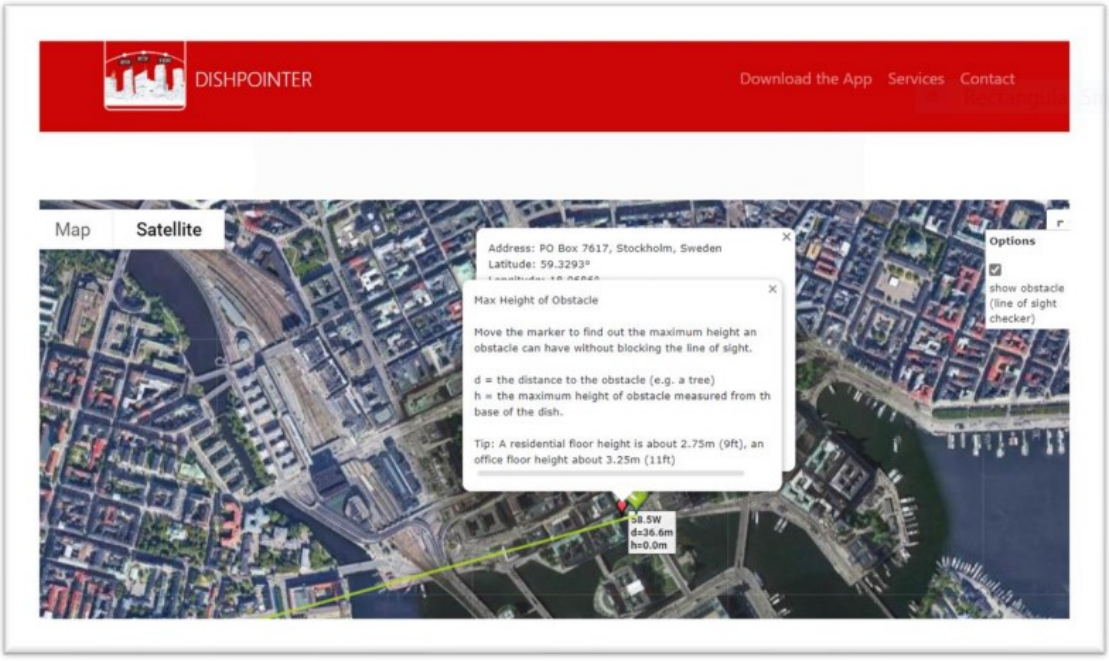
IDP Satellite Terminal Contents

1 x IDP ST 2100 Satellite Terminal

1 x IDP Pole Mount

The IDP terminal is one of the simplest to position as it doesn't need pointing towards the satellite. So long as it is laid flat on the mounting position then the terminal antenna (which is inside the ST2100 or similar terminal) will automatically find the satellite signal. However do ensure that the satellite terminal is positioned in such a way so that line-of-site (LOS) to the satellite is not blocked. See the MinFarm guide Positioning of the IDP Satellite Terminal for more information on this. The images below are taken from this guide.

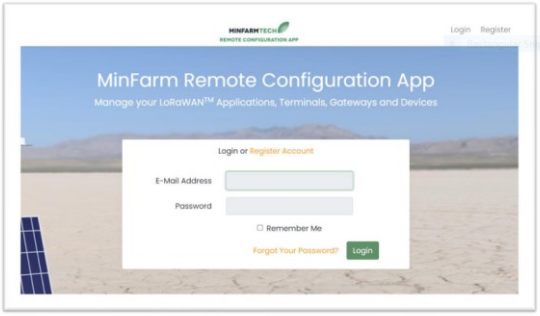


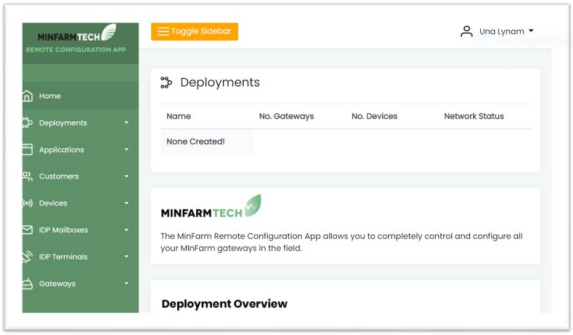


4.0 Software Configuration - The MinFarm API

All software configuration and setup is performed using the MinFarm API. Tools such as Gateway metrics, Sensor metrics, firmware update, ping commands, heartbeat commands *etc.* are performed using the MinFarm API. The MinFarm API uses OAuth 2.0 authentication. OAuth 2.0 does not share password information, but gives the user a token, known as a Personal Access Token.

The user interface of the MinFarm API is called the MinFarm Dashboard. The MinFarm API can be accessed using this user interface, and also using an application called Postman. For more detail on using the MinFarm API, refer to the guide An Introduction to the MinFarm API. The images below are taken from this guide.





5.0 Total System Test Before Field Installation

Each component of the setup first needs to be activated, and then everything added together to create the network. This is best done at a facility that has good internet access, and any troubleshooting can be easily carried out.

- Build out the entire MF-400 Gateway (with solar panel and IDP satellite terminal) and attach to a pole outside. Select a location that has line of site to the Inmarsat satellite. For help on location, refer to the MinFarm guide Positioning of IDP Satellite Terminal.
- Verify that the solar panel is charging the battery. Refer to the Solar Charger User Guide.

- Verify that the MF-200 (blue box) is powered on and ready. Look at the status LEDs at the front. It is in the ready state when - PWR should be solid green and STATUS should blink twice every second. Note that it takes about 5 minutes from power-on for the MF-200 to enter the ready state.
- Place the sensor(s) close by (but at least 5 metres from the MF-400 Gateway).
- Confirm that uplinks are appearing on the Sensoterra application on your phone or laptop.
- If problems occur, contact MinFarm Tech.

6.0 Field Installation

Ensure everything is working properly before you visit the site. You will need some standard tools for installing a pole-mounted device (refer to the MF-400 Installation Guide), and also a BGAN satellite terminal for Internet access.

- Install the MF-400 Gateway and solar panel on a pole. Set up the IDP satellite terminal.
- Install the sensor(s) according to the Sensoterra Installation Guide.
- Verify that the solar panel is charging the battery. Refer to the Solar Charger User Guide.
- Verify that the MF-200 (blue box) is powered on and ready. Look at the status LEDs at the front. It is in the ready state when - PWR should be solid green and STATUS should blink twice every second. Note that it takes about 5 minutes from power-on for the MF-200 to enter the ready state.
- Verify that uplinks are appearing on the Sensoterra application. If problems occur, contact MinFarm Tech.

7.0 Contact Details

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