NRI Electronics – Lora User Manual

Contents

Overview

This document describes the use of the NRIE Lora communication devices. There are three different devices

- loraLink – a transmitter capable of reading and transmitting SDI-12 sensors to a receiver
- loraServe – a Lora receiver which receives transmissions from the field and serves the data over a hard wired interface to the NRIE cloudGate device
- loraBridge – similar to loraServe but it operates as a stand alone bridge between the field device transmissions and the internet via a WiFi interface

General Description.

The Lora TX/RX units provided by NRIE run on the 915 MHZ band, the band allocated for Australia in particular. Other models will be added in the future for overseas use.

Antennas.

NRIE currently supply the Lora radios with one of three omni directional antennas. They have increasing gain which allows greater transmission distances to be achieved. Typical transmission distances nominated here are indicative only. Actual distances can only be determined with an on site survey.

When mounting any of the antennas, ensure that it is not shaded by mounting masts. The antenna should always be mounted at the top of the mast and have clear LOS to the receiver.

Other electronic and electrical interference sources should be avoided. Mount well away from electric fences and other radio antennas.

Because Lora radios have incredibly high receive sensitivity and good signal to noise ratios, they are capable of high distance transmission. Obviously this is very antenna dependent and other directional antennas could be used to extend the range, NRIE does not supply directional antennas.

1. This is a small antenna with 2dBi gain. It is provided with 1 metre of coax cable with a RSMA male connector which matches the connector on the Lora enclosure.

This antenna is suitable for line of sight (LOS) communication up to about 2000 metres.

The antenna is normally secured to a mounting pole using a right angle bracket which is supplied with it.

2. This antenna has a 6.5 dBi gain and is suitable for transmission distances up to 4000 metres LOS.

   It is approximately 600 mm in length and is fitted with an N-Female connector on the base. Various length coax cables are available, the standard being 1.5 m long

   The antenna mounts with a right angle bracket to the top of the mast as shown in the picture. After connecting the coax, the connection should be covered with self amalgamating tape similar to https://au.rs-online.com/web/p/self-amalgamating-tapes/1469000/

3. The highest gain antenna supplied by NRIE is the 10.5 dBi gain unit and should be suitable for very long distance transmission, LOS. The only way to determine range is to do range testing in the particular location where the radios are being used.

   The unit is 2500 mm long and is mounted with supplied U clamps to the top of the mast.

   It is fitted with an N-Female connector in the base and appropriate coax cables are supplied by NRIE to connect to the Lora radios. Self amalgamating tape should be used to seal the connection.

Transmission Distances.

The selection of antennas shown above is a starting point for determining the possible distances that can be achieved using the Lora transceivers.

The other aspect is the capability of the Lora transceivers to have a trade-off between sensitivity and speed of transmission. There are four variations that are allowed in the NRIE transceivers, only one variation is allowed in a network, all transmitters and receivers must be set to the same parameter.

The parameter is set in the radio using a terminal program as described in Setup Procedure. It cannot be set via the network as obviously the network is broken as soon as a radio has a different setting to the rest of the network.

While most of the transmissions to and from the radios are small, of the order of 100 characters, speed of transmission is a relevant factor. Because the transmissions are acknowledged in the network, meaning there is two-way transmission and the radios work from small battery power supplies, then the longer the transmission times, the greater the power use and drain on the battery.

The following RF parameters are available during the setup;

- 0: Default medium range. This is the default setting in the transceivers and should be suitable for most applications. It is a good balance between speed of transmission and range.
- 1: Fast but short range. Use this setting for short hops where very limited battery supply is available.
- 2: Slow and long range. Extend the receive sensitivity of the devices but slows the network down. Use where distance is an issue and only a few transceivers are in use.
- 3: Slow secure and long range. Similar to the last setting but more noise rejection.

It is important that all radios in a network have the same RF setting. They will not be able to communicate if different, so it is useless to set one transmitter which is farther away to slow and long range while keeping the rest of the network as default medium range. All radios need to be the same setting.

By the same reasoning, it would be possible to isolate two networks which were in the vicinity to each other by using different RF settings for each network.

loraLink.

The loraLink device is the transmitter end of the network. It will normally be supplied with a bracket which mounts a 2.5W 12VDC solar panel and the enclosure contains a 3AH 12VDC lithium battery. This power arrangement should be suitable for transmission of soil probe information where the sensor is powered down between scans. The solar panel provided is an epoxy coated one, these do show surface deterioration over time due to UV radiation. This does not seem to impact adversely on the output power of the panel. However it is good practice to keep panels clean and these epoxy panels can be brought back to full performance by cleaning them with a mild cutting compound as used in polishing car duco. The panel has also been designed to slip easily into place and connect via a waterproof connector to the enclosure so that, if needed, it can be quickly and cheaply replaced.

The unit can also be used to host a sensor which should be permanently powered up, such as an automatic weather station (AWS). Providing the constant current drawn to support the battery is less than 20mA the solar panel and battery are suitable.

If larger power supplies are required then it is possible to provide that, feed in to the enclosure is via the environmental connector used to charge the internal battery, any external charge voltage should be limited to 21VDC.

The layout of the loraLink transmitter is shown in Figure 1 below.

The connector at the top of the device is used to wire in an SDI-12 compatible sensor. From the left terminal through to the right the connections are

- 12VDC supply to the sensor, this can be switched or unswitched depending on the position of the Configuration Pins described below
- Data, this is the data line to the SDI-12 sensor
- This terminal is actually used as a transmit signal for other applications
- Ground terminal for the supply to the SDI-12 sensor.
  The cable from the SDI-12 sensor enters through the gland in the lid of the box. Cut the conduit of the cable back so that it only just enters the enclosure and is secured by the gland. This allows the more flexible wires to be routed to the screw connector without pushing adversely on the circuit card.
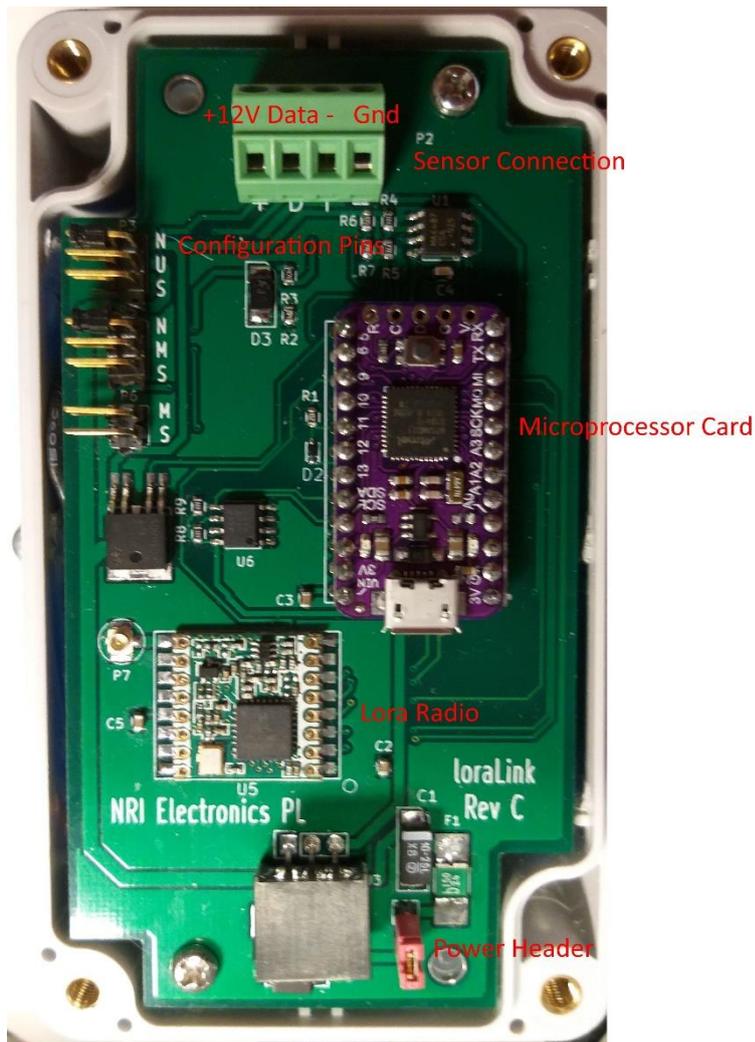
+12V Data - Gnd
Sensor Connection

Configuration Pins

Microprocessor Card

Lora Radio

Power Header

Figure 1 loraLink Transmitter

The Configuration Pins are arranged to allow the card to be used in other situations. For the normal use of the loraLink only the two top sets of 3 pins are relevant. The first header determines if the power is switched or unswitched to the SDI-12 sensor. Use the N position for switched, the U position for unswitched.

For a normal loraLink transmitter connected to an SDI-12 sensor, the second of the 3 way headers should have a link in the N position, this determines which signal is used for the data line on the sensor connector.

The bottom 2 way header is not used.

The Lora radio chip is not hardware configurable. The antenna cable connects internally to the uFl connector to the left of the chip. Care should be taken not to dislodge this connector when wiring in the sensor.

The Power Header at the bottom of the card connects power from the battery/solar panel to the rest of the circuitry. It should be removed when the unit is not in use or during shipping to avoid discharging the battery.

The microprocessor card drives the logic for the loraLInk. It has a small USB connector on the bottom edge which is used to program the microprocessor and also to set up its operation through the use of a terminal program as described in Setup Procedure. Use a standard USB cable such as provided with most Android smart phones to connect between a computer and the loraLink.

loraServe.

The loraServe device is used in conjunction with a cloudGate internet interface to receive transmissions from loraLink transmitters and to serve out setup and other information to them.

The loraServe circuit card is shown in Figure 2 – loraServe

Figure 2 loraServe

The microprocessor used is different to the loraLink device and there are no configuration pins. Otherwise the same Lora Transceiver is used and the antenna connector attaches at the uFl connector to the left of the radio chip.

The Power Header at the bottom right is used to power up the device once it has been wired up to the cloudGate.

The loraServe unit is connected by a 4 way cable to the cloudGate device which currently must be equipped with a Type 3 Expansion Card.

The loraServe must be wired to the Expansion #3 card using the coloured wires in the connecting cable as shown in Figure 3 if it is to operate correctly and not be damaged.

The loraServe device does not normally contain a battery and derives its power from the host cloudGate unit.

The loraServe device is programmed and setup through the Programming connector, the white, shrouded connector shown on the left of Figure 2. This is the same connector as used on the cloudGate device and the same programming cable is used.

Figure 3 Expansion #3 Connection

loraBridge.

The loraBridge device is similar to the loraServe unit but it connects directly to the internet via WiFi rather than through the cloudGate unit. A fuller description will be provided later

Firmware Changes.

Firmware changes are achieved by connecting an appropriate cable to the programming software running on a PC. A fuller description will be provided in a later revision of this document.

Setup Procedure.

The setup procedure for all devices is similar, most of the setup, indeed some of it must be done with a terminal program connected to the device programming socket/header. After a minimal setup is done this way, the rest can be achieved remotely by issuing commands to the server the Lora devices are connected to.

The terminal setup is always done at 115200 baud using no parity and 8 data bits. The User is free to work with any terminal program they prefer, NRIE generally use the RealTerm program https://sourceforge.net/projects/realterm/ but any similar one which will use the comms ports associated with the Lora devices will be satisfactory.

Each device to be programmed will generally create a new communications port on the computer. To ensure that the correct drivers for the device are loaded, the computer (assuming Windows PC) should be connected to the internet. Setup and check the devices before heading out to the field.

While there are similarities in the setup between the transmitter and the receiver they are handled separately here.

loraLink Transmitter Setup.

Connect the computer to the microprocessor card in the loraLink using the micro USB connector. Open the terminal program and setup the communication to 115200 baud, no parity and 8 data bits. Don't open the connection at this stage as generally Windows works by doing a reset on the device and then opening the communications channel. If your terminal program does not automatically update its list of available comms ports when you connect up a new device you will need to find how

to force it to do so. With Real Term you need to double click in the box showing the communication port number. After determining the correct communication port the computer assigns to the loraLink, close the connection, press Reset on the microprocessor card (the only button at the top of the card) and open the comms port after a couple of seconds. Press the ESC key on the computer several times. The loraLink will respond with the following;

```
You are setting up a field transmitter for this local LORA network

Enter a Device ID which is unique to this project

Enter the Device ID  :
```

This Device ID should be unique in the network you are setting up, it is used as the primary key to address the transmitter in the field. It can be any integer number up to 997. Generally simple numbers like 1, 2, 3 are used but this is at the discretion of the user. If there is any possibility of this Lora network interacting with an adjacent one then consideration should be given to making device id's unique in both networks. **This setting must be done by terminal and cannot be done by the network.** If a device id is already in the unit, this will be displayed as a default option, just hit ENTER to select it. Most of the other entries are handled in a similar fashion except for requests for the user to answer Y or N, in which case a default is not provided.

Next the device requests;

```
Enter the base server address:
```

This setting must be done by terminal and cannot be done by the network. The number entered must be the device id assigned to the network receiver and must be the same for all transmitters in the network. Beware of adjoining networks and their settings.

Next the device requests;

```
Enter the transmit power as 0 to 23 :
```

This sets the transmit power of the device roughly from 0 to 100 mWatts. Higher power is required for longer distances but also results in higher battery drain. The default is 20 which is a bit short of the maximum.

Next the device requests;

```
Enter the system wide RF parameter -

This must be the same for all radios in this network  Value 0 to 3
Default 0:

0: Default medium range

1: Fast but short range

2: Slow and long range

3: Slow secure and long range
```

This setting must be done by terminal and cannot be done by the network. An explanation of these settings was given above. The default is 0.

Next;

```
Enter the wait time to transmit if channel is busy (mSecs) :
```

The default is 2000 (2 seconds) and this is a good compromise for simple networks.

Next;

```
Enter the time to wait for a reply from the server (mSecs) :
```

Again the default is 2000 and is suitable for most networks

Next;

```
Enter the number of times to repeat transmission if no reply :
```

The default is 2 and unless the network is very noisy and congested that should be suitable.

Next;

```
Enter the battery read calibration factor :
```

The default is 1.0, generally this can only be determined after reading the battery with a voltmeter and checking the value the transmitter sends out. It can be adjusted over the network so just use the default or configured value that is there.

Next;

```
Are we enabling debug printout? Y/N
```

Normally when first setting up a network answer Y and this allows the user to observe what the device is doing. The device cancels this after about 5 minutes anyway in order to speed up the program.

Next;

```
Thank you, do you want to repeat connection setup? Y/N
```

Unless you have made a mistake or wish to change something already entered press N and the device will go on to the next stage of setup.

The next stage is setting up any SDI-12 sensors which are to be used on this transmitter. All these settings can be done over the network so they don't have to be done here but it is good practice to set the sensor up here and check it is connected and working before closing up the box.

```
Enter the SDI-12 scan interval (seconds) :
```

The default is 60 seconds which allows the user to check that the sensor is working but this is too fast for most agricultural sensors, the transmission period should be more like 15 minutes (900 seconds) and this reduces power consumption and lowers congestion on the network.

```
Enter time to wait after power up and before read (seconds) :
```

If the sensors are being powered up each time to read, they need some settling time, this value is entered here, default is 2 seconds.

Next the unit will allow the user to set up the SDI-12 sensor scan parameters. These are entered in one of six available 'slots' numbered 1 to 6. Each slot contains the parameters necessary to read a set of sensors in an SDI-12 probe. Essentially most probes can be read by knowing the following parameters;

- The overall probe address, many manufacturers send out probes with address 0 as the default.
- The command to read the sensor, this is normally M (measure) or C (continuous measure). C has to be used where there are more than 9 sensors on a probe, ie on an Enviropro 1200 mm soil probe with 12 sensors.
- The index used with the command, this is either 0, 1 or 2 for most situations. As an example the Enviropro soil probe uses 0 for moisture, 1 for salinity and 2 for temperature. Consult the probe information to determine the correct setting.
- The number of readings to obtain from the probe
- The decimal places to record the probe readings to

The network requires a unique tag to be provided for this set of sensor readings, the tag is alphanumeric and can be up to 15 characters long.

The appropriate values for each set of readings is entered in the following order, using the terminal program;

```
----------------------------------------------------------------

Enter the slot number for this sensor 1 -> 6 (ESC to exit) :

Enter a tag for the set of readings -

Tag must be alphanumeric and less than 15 characters

The tag must be unique in this LORA network

Do you want currently enable this sensor? Y/N

Enter the address for this sensor 0 -> 9  :

Enter the command to read the sensor M or C  :

Enter the index to the command 0 -> 3  :

This is used to make up the measure command, ie M2

Enter the number of values to read 0 -> 12  :

Enter the number of decimal places to use in result 0 -> 3  :
```

After setting up each sensor group the terminal program goes back and asks for another slot to fill in. Once the device has been fully setup press ESC and the device will then ask if you want to go back and edit the settings. If everything is OK press N and the unit will save the information and start working.

Since the default or saved settings are shown as you step through the terminal setup, you can restart the setup and just verify that everything is as required by hitting ENTER at most of the steps.

loraServe Receiver Setup

The setup for the receiver is similar to the transmitter, except that the receiver does not have local sensors, so the user only has to set up the radio parameters. These must match the parameters used in the transmitter.

Using the terminal program at 115200,N,8,1 setting, identify the communication port which has been assigned to the cable plugged into the receiver, noting that this communication port will be allocated to the cable you are using and not to the receiver itself, as in the case of the transmitter. Also because the cable does not go through a reset when the reset button on the receiver is pressed, the terminal connection can be left open during the reset phase.

Press the Reset button on the receiver and then type ESC a couple of times on the keyboard. The receiver identifies that a user is wanting to setup the device and responds with the following;

```
Entering the setup for the Lora Receive device

You are setting up the base receiver for this local LORA network

Enter a Device ID which is unique to this network - numeric 1 to 997

It should be an address which the transmitters in the network

will not be able to contact in any neighbouring network

Enter the Device ID  :
```

This address has to be unique for this network, it cannot be used by a transmitter and all transmitters must be set up with this as the base address. Be aware that Lora networks can cover substantial areas and the address cannot be a base address in a network which is in radio range of this one. The default setting is 10.

After this the receiver asks for the various radio settings which, in general should match those in the transmitters. The exception is that the transmit power has to be large enough to reach the farthest transmitter, some of the closer transmitters may have lower output power settings.

So, as for the transmitter, the receiver asks for the following information;

```
Enter the system wide RF parameter -

This must be the same for all radios in this network  Value 0 to 3
Default 0:
```

```
0: Default medium range

1: Fast but short range

2: Slow and long range

3: Slow secure and long range

Enter the wait time to transmit if channel is busy (mSecs) :

Enter the time to wait for a reply from the server (mSecs) :

Enter the number of times to repeat transmission if no reply :

Are we enabling debugComm printout? Y/N

Thank you, do you want to repeat? Y/N
```

The debug printout is normally enabled to allow a report on incoming transmissions which gives a good idea of what is working in the network. The printout is cancelled after 15 minutes to allow the receiver to process the transmissions quicker. It can be re-established by pressing the Reset button.

Setting Parameters Through the Network.

It is possible to set and change some of the network parameters via the server that the information is being sent to. This includes the setup of transmitter sensors, the battery calibration factor and the timing of transmissions. Most of the RF parameters cannot be changed as this would break the network.

In the future there will be a web based facility for doing this, currently it has to be done by sending the appropriate commands in a more manual fashion. In the case of the loraLink and loraServe networks, the changes are sent to the base cloudGate unit. So this can happen via WiFi or Cellular, depending on how the cloudGate connects to the server. The cloudGate unit resends the setup to the loraServe receiver which then relays it on to the appropriate loraLink transmitter. The whole process of changing a setting in the transmitters can take several minutes so it is best to ensure that the bulk of the setup is done via the terminal method as the installation is done.

Checking.

Documents
1. SDI12 AWS User Manual

Revision.

Revision 1.0 Initial writing December 2019