HDX Single Antenna PIT Tag Reader

User Guide

Oregon RFID

May 28, 2019
Firmware Version 1.40

Single Antenna Reader

The Oregon RFID HDX Single Antenna PIT Tag Reader detects PIT tags and timestamps each event before writing it to the log file. It is designed for unattended remote operation with an internal datalogger and power level monitor.

The front panel displays the reader status and has pushbutton controls to turn the reader on and off, enable the beeper and start tuning mode. The reader can also be remotely operated by typing commands to the serial port console using a USB-to-serial cable or Bluetooth with a laptop and a terminal program.

The reader can be powered from 10 to 20 volts DC. The amperage required will depend on the antenna characteristics but it is usually between 1 and 2 amps. Antennas with a higher current draw do not work well. The rated limit is 4 amps.

The reader will automatically shut down when the voltage falls below 10 volts. The MV command can be used to adjust the threshold and restart voltage.

GNSS Receiver

An integrated Telit SL869 Global Navigation Satellite System receiver maintains the time of day when a signal is available. A temperature compensated oscillator maintains the clock during signal dropouts.

The GNSS receiver detects signals from GPS (USA), GLONASS (RU), Galileo (EU) and QZSS (JP) satellites. It has a horizontal position accuracy of 1.5 meters. The vertical accuracy is not rated by the manufacturer.

When searching for a signal the blue GNSS LED will flash until one is found. The first search can take a few minutes. Once the device has obtained tracking information from a satellite it will usually re-acquire the signals much faster, often within a few seconds.

Time References

All time of day measurements are driven by a clock that is referenced to one of these sources:

- GNSS when the receiver has a signal
- From another PIT tag reader using CAT5 cable
- internally from a temperature compensated oscillator

The reader displays the letter G (GNSS), N (network) or U (uncalibrated) after the time to indicate the current reference.

When the reader has both GNSS and a cabled network signal, the network reference will be chosen. This can be overridden to select GNSS when cabled using the OVG/OVN commands.

Front Panel Indicators and Controls

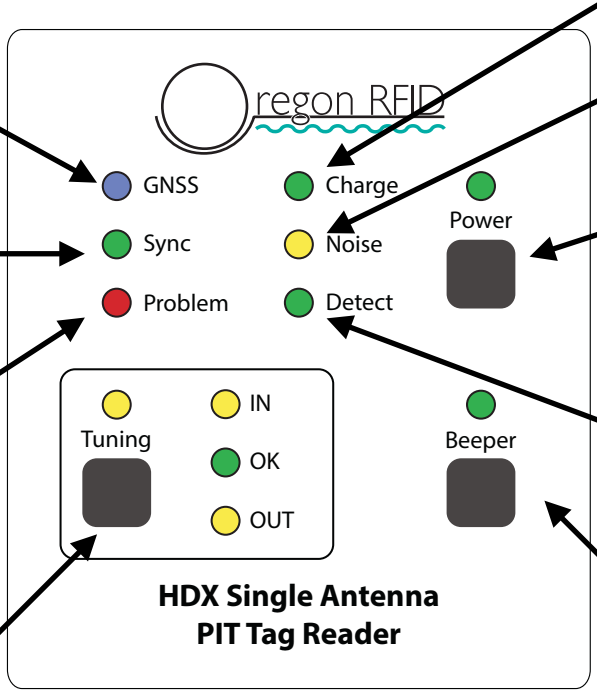
The reader can be operated with the button and LED indicators on the front. All functions can also be accessed remotely with the USB-to-Serial cable and a computer with a terminal emulator program.

GNSS LED flashes while searching for a satellite signal. LED is on solid after a valid link is established.

The Synch LED is on when the reader is synchronized using GNSS. The LED flashes when wired synchronization is used.

The Problem LED is on when something prevents saving detection data. The LED flashes when there is a problem with the time of day clock.

Press the Tuning button to enable the IN/OK/OUT tuning indication..



The Charge LED flashes with the HDX charge pulse.

Noise level indication.

The Power button switches between Standby (flashing LED) and Run (solid LED) modes. Hold the button down for 3 seconds to turn the reader off.

Flashes when a PIT tag is detected.

The Beeper button enables the beeper. Pressing it a second time enables proximity mode where the duration of the beeps is determined by the tag signal strength.

Hold Power+Beeper+Tuning buttons down at the same time for a few seconds to restart the reader.

Do not use run mode unless an antenna is attached.

Reader Operation

The reader has four operating modes:

RUN	Reader scans for tags and logs detections
STANDBY	Reader is off, settings can be changed and data can be downloaded without an antenna attached
OFF	Reader and datalogger are off, GNSS clock remains on, and a subset of commands can be sent
DEEP SLEEP	OFF with power removed, the internal clock runs

The reader mode is selected with the Power button. When the reader is off, pressing once starts Standby mode and the green Power LED will flash. Pressing the Power button a second time will start the reader and the Power LED will stop flashing.

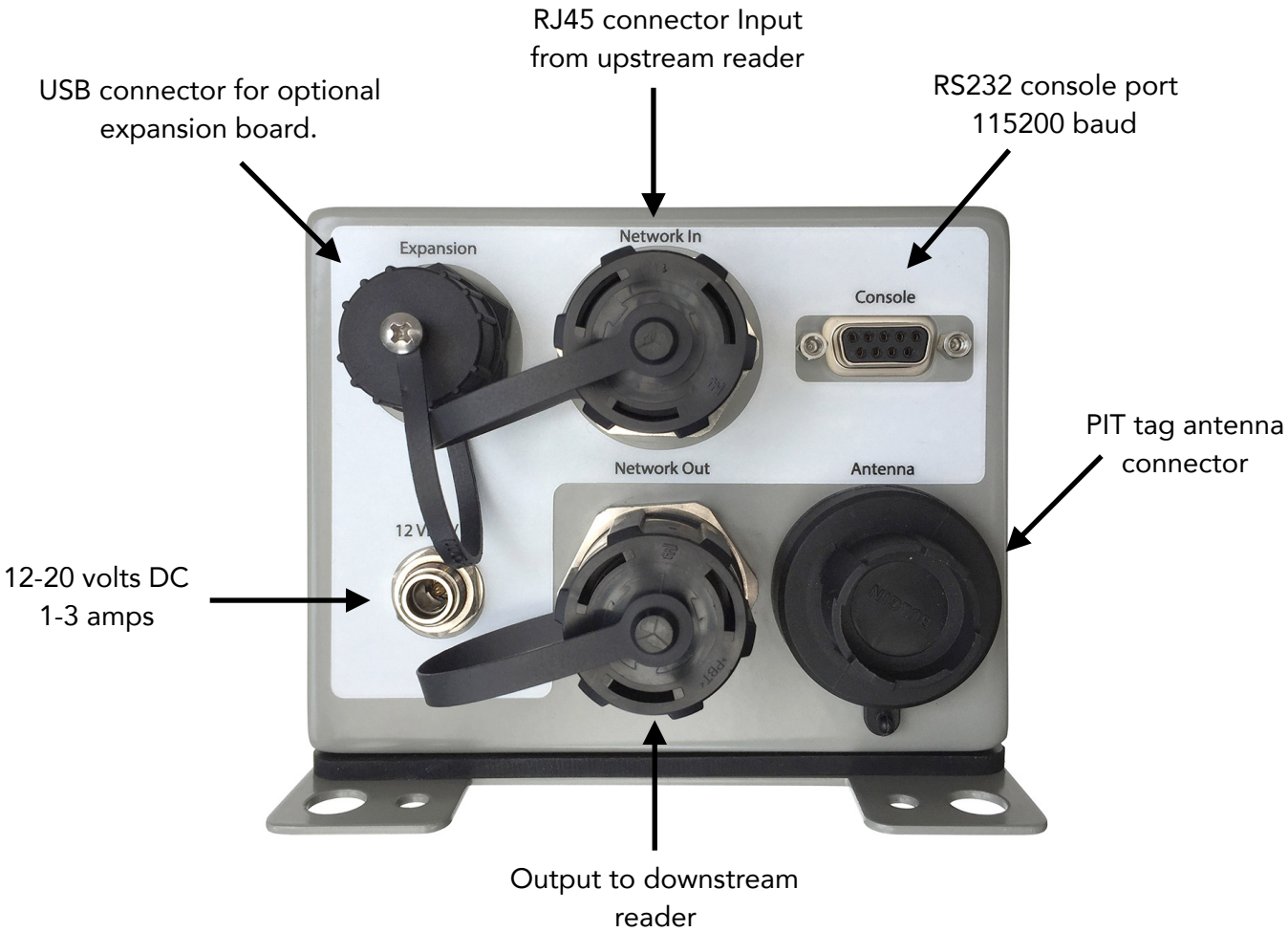
To turn the reader off, press and hold the Power button for three seconds.

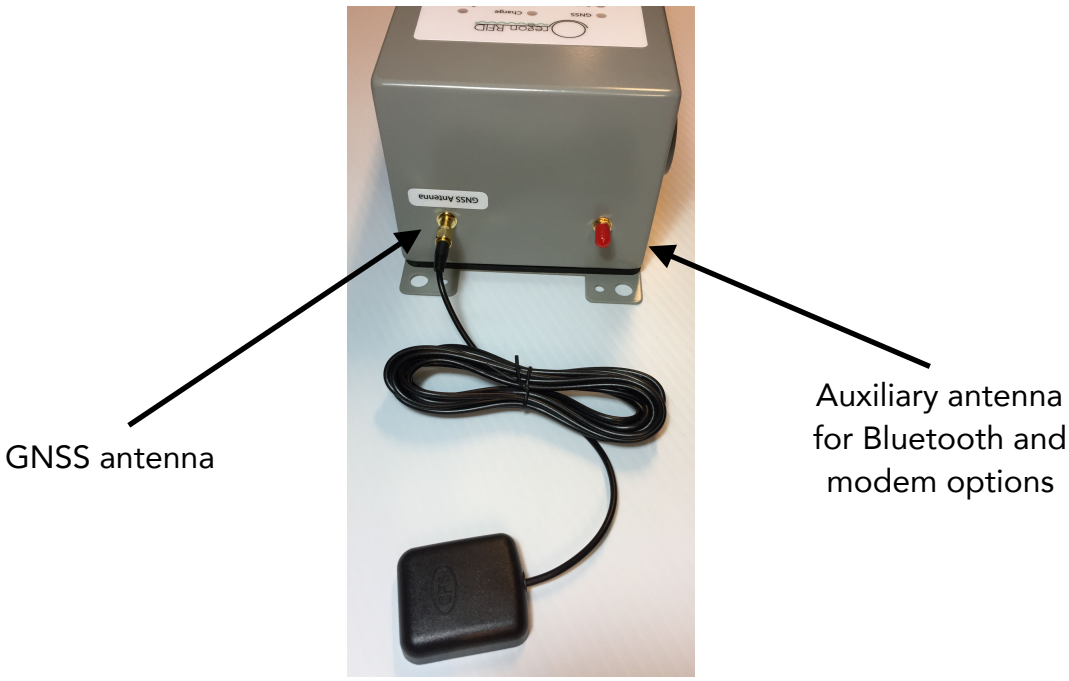
Beeper Modes

The beeper has two different operating modes. When the beeper is on solid, a short beep sound will be made every time a tag is detected.

When the button is pressed a second time, the Beeper LED will flash to indicate that proximity mode is enabled. The duration of the beep will be related to the strength of the tag signal. The closer the antenna is to a tag, the longer it will beep. This facilitates locating tag positions with a mobile antenna.

Reader Connections

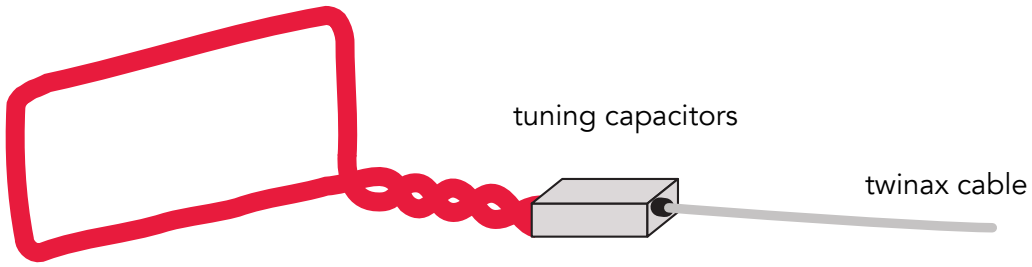




Antennas

A PIT Tag antenna needs to be a loop of wire to generate a magnetic field. The loop can be long in one axis but the other is limited to a few feet or there will be a hole in the center where the tag cannot be read because it is too far from the wire.

The wire between the loop and the tuning capacitors should be twisted to inhibit noise and to stabilize the tuning.



Tuning Capacitors

Capacitors are used to tune the antenna to 134.2 kHz, the international standard frequency for animal tracking.

The distance between the antenna loop and tuning capacitors (wire tail) should be as short as possible. The loop and capacitors create an electrical circuit that will oscillate at a high power level when a signal is applied. Any length of wire between the loop and capacitors will add resistance to lower the power level.

Oregon RFID offers both manual and automatic tuning capacitors.

Twinax Cable

Twinax cable efficiently passes power from the reader to the tuning capacitors and so can be quite long. It should be kept separate from power and other antenna cables to prevent interference passing between them.

Making an Antenna

Antennas are made from loops of wire. Any loop of wire has an electrical characteristic called inductance (magnetic capacity). The inductance of the loop must be within the tuning range of the capacitors.

Each of our tuning capacitor products have different ranges.

Model	Tuning range µH	
ATC Autotuner	25	102
Manual	18	95
Standard	8	80
Easy	22	100
Slim (mobile)	23	100

Inductance is easy to measure with an inductance meter by connecting to the ends of the antenna loop without any capacitors attached.

The simplest antenna to make is a single turn loop. The inductance of a loop about 30' to 190' wide will usually be one turn of wire.

Loops smaller than approximately 30' wide will have low inductance and so will need two or more turns to raise the value back into range.

Antenna Wire Size

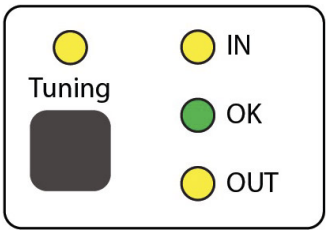
The size of the wire is related to the electrical resistance. Thinner wire has higher resistance to electrical flow than thicker wire. Large antennas are made from long lengths of wire which increase resistance and lower power levels. To compensate a larger diameter wire is used on large antennas to lower the resistance.

Small diameter antennas are made of many turns of thin diameter wire. If the wire is too thick then the antenna will consume an excessive amount of wire that shortens the run time from batteries and heats up the electronics.

Contact Oregon RFID Tech Support for suggestions of what wire size to use. It is a critical decision that determines how well the antenna will work.

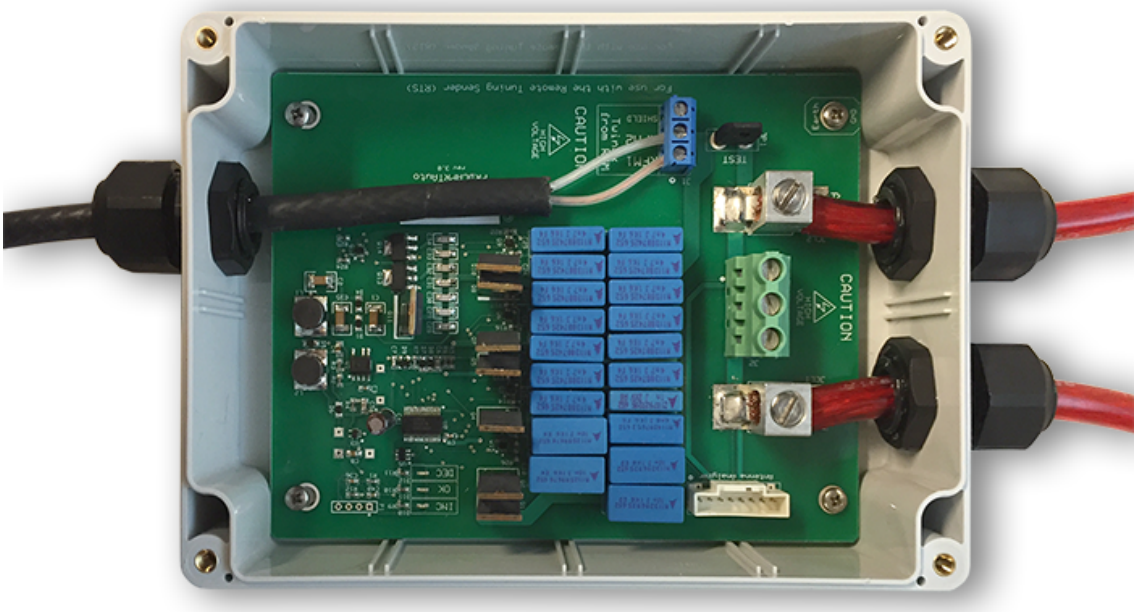
Auto Tuning

Using the Autotuner, the Tuning button is used to start the tuning process. The reader should not have any tags in the read zone when this is operating or it can affect the tuning.



When tuning, the IN and OUT LEDs will be on during the search and the green OK LED will be on when it is in tune. After a few seconds the autotuner will save the settings in memory and the reader will begin scanning again.

If the antenna is not within the tuning range then the IN or OUT LED will remain on and the reader will begin to scan to indicate the antenna is out of tune. Use an inductance meter to measure and make sure it is within the tuning range. Contact Oregon RFID Technical Support for assistance.

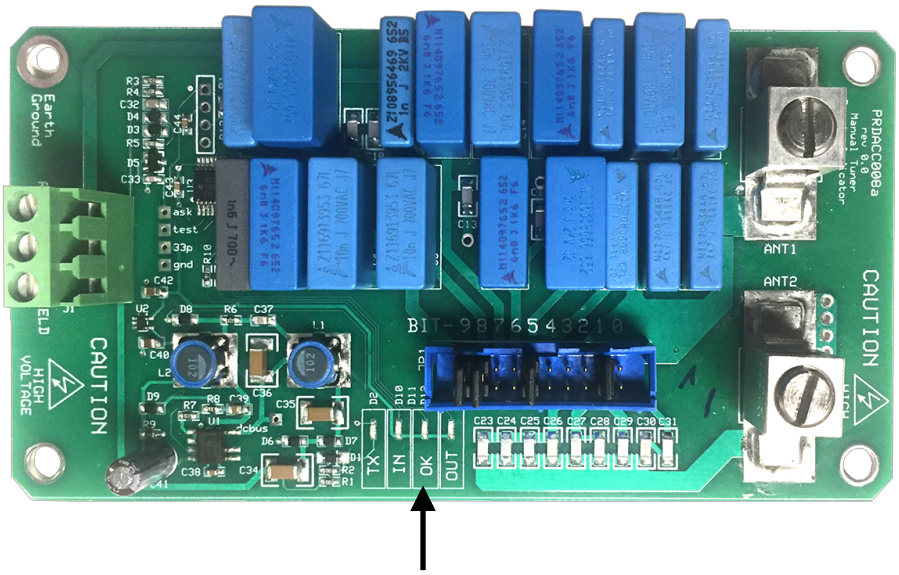


Manual Tuning

The Manual tuner has IN/OK/OUT indicators to assist in manually tuning the capacitors. Press the Tune button to start the tuning process.

Remove all of the jumpers and place one in Bit 9. If the OUT LED is on, remove it. Place a jumper at Bit 8 and if the OUT LED is on, remove it. If the LED is in, leave it in. Repeat until Bit 0 is tested. Stop when the green OK LED is on.

After the OK LED is on continuously for 5 seconds the reader will start scanning again.



IN/OK/OUT
LEDs

The Tuning button can also used with legacy manual tuning capacitors (Standard, Easy, Slim). Press the Tune button and then make the jumper adjustments by following the IN, OK and OUT LEDs on the front of the reader.

HDX Cycle Timing

Half Duplex sends a short magnetic pulse from the antenna to inductively charge a PIT tag and then listens for a response. The factory setting is 50 ms to charge and 50 ms to listen which results in 10 scans per second. The charge and listen times can be adjusted to control the speed and optimize the charge time for least power consumption.

The HD command displays the current setting. The speed can be changed with the HDR command or the charge and listen times can be adjusted separately. The minimum value for the listen time is 20 ms, the time that it takes for the tag to send a reply.

```
HDR    10   scan rate
HDC    50   charge ms
HDL    50   listen ms
```

Changing the charge or listen time will cause a corresponding change to the other value to maintain the same scan rate. Shortening the charge time, for example, will lengthen the listen time the same amount.

```
> HDR10                    > HDR5
HDR    10   scan rate       HDR     5   scan rate
HDC    50   charge ms       HDC    50   charge ms
HDL    50   listen ms       HDL   150   listen ms

> HDR20                    > HDR1
HDR    20   scan rate       HDR     1   scan rate
HDC    30   charge ms       HDC    50   charge ms
HDL    20   listen ms       HDL   950   listen ms
```

It is important to have sufficient speed to detect tags moving through the field. Decreasing the read speed will lower the overall power consumption and increase run time from batteries.

Fast Scan Mode

The FS1 command enables a special mode to scan as fast as possible. The minimum HDX listen cycle is 20 ms to hear the tag message but in Fast Scan mode, the reader listens for a few milliseconds and if no tag is responding another charge pulse will begin immediately. If there is tag in the field, the reader will listen for the full 20 ms period. Because the charge pulse is on most of the time the reader power consumption and temperature will increase.

Fast Scan mode cannot be synchronized with other readers.

Range Extender

The RE1 command enables shortcut when a tag is detected. If the tag number is the same as the previous detection, the read cycle is ended early without waiting to check the CRC. This can extend the read range somewhat.

Phantom Tags

Phantom tags are false detections caused by random noise that generates the correct pattern that matches a PIT tag with a valid checksum. The tag number will appear for only one scan and will not be repeated. They usually have tag numbers outside any known range (Animal tags with prefexes outside the range 900-999).

Phantom tags are identified with the type code P (instead of A, R or W). These records can be shown in reports along with real detections with the PH1 command. To block the tags from being displayed use the PH0 command.

Even if they are not displayed, phantom tags are still stored in the datalogger file and can be shown with the commands UPP (since last upload) and UDP (for date).

Phantom tags occur more often when there are higher noise levels. The PF1 command enables a check to block most phantom tags. The read range may be slightly shortened when this is enabled. Compare the read range after the commands PF0 and PF1 are entered to see the difference.

Reader Console

The reader can be controlled using the console that is accessed using the RS232 serial port or Bluetooth. A USB-to-serial cable is included to connect to a Windows, Mac or Linux computer. Many terminal emulator programs are available that can be used. See Oregon RFID's YouTube channel for instructions for setting up and using CoolTerm.

The commands are listed in Appendix 2.

Bluetooth Radio

The Bluetooth radio supports RCOMM serial ports to wirelessly connect with laptops and Android phones or tablets.

The Bluetooth interface can be used with terminal programs such as HyperTerminal, CoolTerm, BlueTerm and Putty.

The Bluetooth radio is turned on and off with the BT1 and BT0 commands.

Automatic Synchronization

The GNSS receiver is used to automatically synchronize the charge and listen times of the HDX read cycle. All readers will turn their charge pulses on and off simultaneously using the accurate time reference.

The charge and listen timings (HDC, HDL commands) must be the same on all readers in order to synchronize.

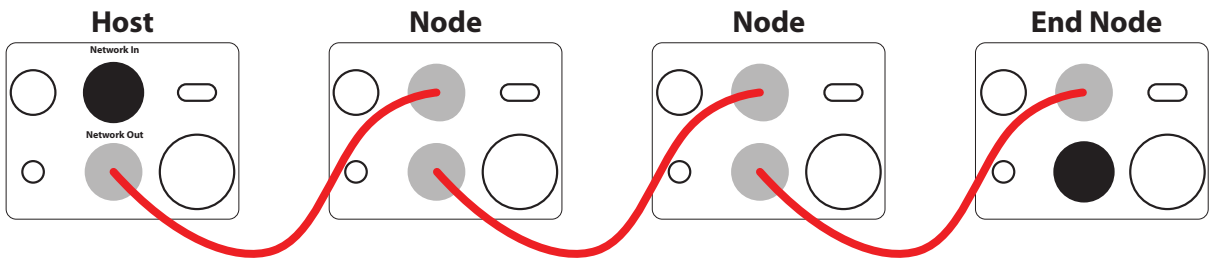
When searching for a GNSS signal, the blue GNSS LED will flash. When the LED stops flashing the SYNCH LED will go on to indicate the reader is in synchronization.

If no signal is available, CAT5 cable can connect the readers together to synchronize. The SYNCH LED will flash when wired synchronization is active.

Wired Synchronization

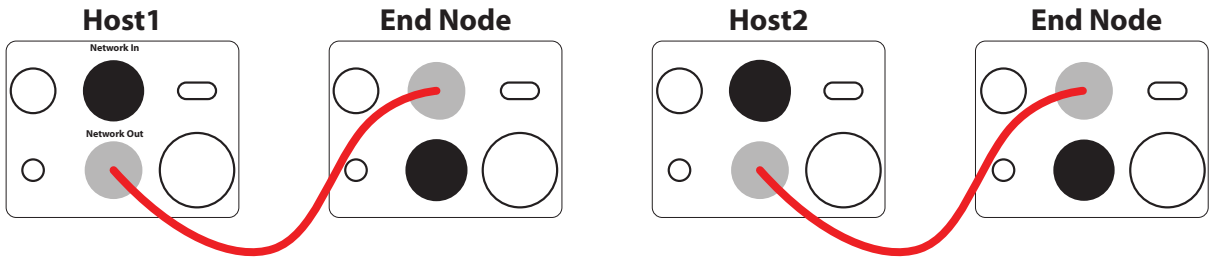
If GNSS signals cannot be received CAT5 (ethernet) cable can be used to interconnect readers to have a common signal to synchronize. Readers are connected with waterproof connectors using crimp-on RJ45 connectors. See cable assembly instructions on the next page.

Each reader has two connections, each is connected from one OUT to another's IN. The reader at the head of the chain that has nothing plugged to IN becomes the Host that generates timing signals for the rest of them. If the Host has a GNSS signal it will use that for the Nodes. Otherwise the internal time of day clock of the Host will be the reference for all Nodes so they are on the same base.



Disconnected Cables

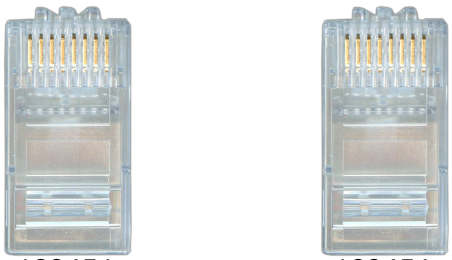
If a cable between readers is unplugged or broken, a Node at the break will change into a Host to synchronize the readers connected to it.



If both hosts have a GNSS reference they they will both use that for their sub-networks. However if any Host is without a signal, the internal time of day clock will be used and can eventually drift and interfere with other sub-networks.

Network Cable

CAT5 cable (three twisted pairs of wire) can be used to network multiple readers together. When connected, the head end reader will generate a synchronization signal to all of the other readers. The time of day is also sent once per second to synchronize all clocks.



The RJ45 connectors are wired the same on each end of the cable.

Update Firmware

Firmware update files are issued by Oregon RFID to add new features and fix bugs. Notifications of new versions are sent out on our mailing list.

To update the reader firmware, open update file with a text editor, select the entire file and copy it to the clipboard. Open the serial connection with the reader and start a terminal program.

Type RB to restart the reader controller:

```
>RB
Update? Y
Start
```

Paste the firmware after **`Start`** is shown. After the file is uploaded, the number of lines and bytes are shown and the file is evaluated. If the checksum is okay the reader firmware is updated.

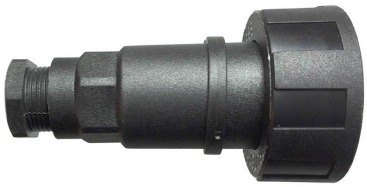
```
ORSR MCU4
Update(Y)?y
Start
.................................................................
.................................................................
.................................................................
.................................................................
...............................................
Received 7088/311749
Checksums OK
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------------------------------------------------------
-----------------------------------------------
```

Appendix 1

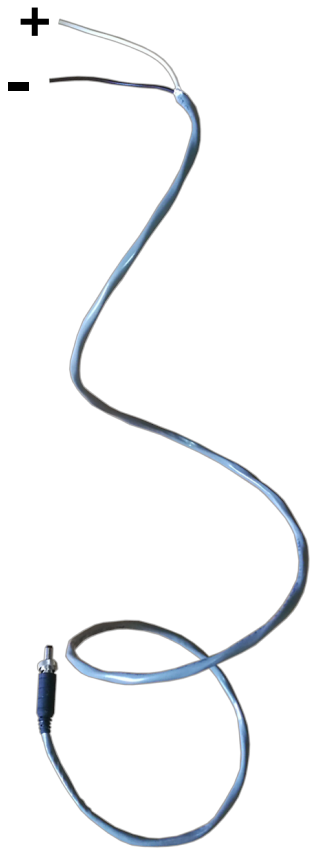
Reader Components

Included With Reader

USB to RS232 serial cable



Waterproof Twinax connector



Power cable with waterproof connector

The black wire is ground/earth

Waterproof RJ45 connector caps

GNSS antenna with SMA connector

Appendix 2

Commands

Console Commands

ON	Reader power on	Starts the reader scanning and detecting tags.
ST	Reader standby	Places the reader in standby mode with reader not scanning, database is open for uploads, and settings can be changed.
OF	Reader power off	Turns the reader off, closes the database.
BT	Turn Bluetooth radio on/off	BT1 to turn on, BT0 to turn off (Bluetooth reader only)
UH	Show upload history	Displays a list of datalogger file uploads. Each time the UP command is typed to upload data, a new entry is added to the list.
UP	Upload records since last	Uploads all new datalogger records since the last time UP was typed. Previous uploads can be listed by typing UP plus the number from the UH command. UP* will show all records in the database. UPS will only show summary records.
UD	Upload records by date	UD 2018-12-1, 14 (number of days)
UT	Upload records for tag number	UT 900_226000054842
TL	Show the accumulated tag list	All tags listed in tag order with time last seen
RD	Rebuild database	Repairs tables used by UD, UT and TL commands
TC	Show the tag classifications	Classification field is in tag detection record
OV	Override with GNSS or NET	When both GNSS and NET connections are valid, OVG selects GNSS and OVN selects the NET. With OVG the reader will stop when there is no GNSS signal and start when it returns.
FM	View or change record field names	Edit the record format for detection records. Type FM to see the current format. Type FM plus the field names to edit.
FN	Display database field names	Show all field names available for FM command. See next section for the list of field names
DM	Display mode in real time	DM I=Initial scan, C=consecutive, F=final, A=all
CS	Column separator	S=space, C=comma, T=tab
TF	Tag format	D=decimal, H=hex, B=bi hex
HD	HDX scan speed settings	HDR enter read speed in scans per second HDC enter charge pulse time HDL enter listen time
RE	Range extender	Increases read distance
MG	Max delay gap	Time in seconds to wait after a tag has been detected before deciding that is has left.

Console Commands (continued)

FS	Fast scan mode (1=on, 0=off)	After the charge pulse ends, if a tag is not detected within 4 ms, the charge pulse is started again. CANNOT BE SYNCHRONIZED WITH OTHER READERS.
NO	Display noise level	Show the minimum and maximum values every second. Standby mode only.
RN	Reader name	Up to 15 character name for the reader.
SC	3 letter site code	3 letter site code used for file names and can be displayed in the record with the SCD token.
MV	Minimum voltage before shutdown	When the supply voltage goes below this value, the reader will drop into standby mode. The reader will go to standby when the voltage drops below 10 volts.
RB	Reboot	Restart the reader firmware and enable firmware update.
TU	Tune antenna	Start autotuner if attached or display IN/OK/OUT if using a manual tuner. Displays '+' or '-' while tuning, '.' when in tune.
MT	Modify tuning	Adjust autotuner setting with + and - keys
DT	Show date	View or enter date in ISO form. YYYY-MM-DD HH:MM:SS.TTT The letter after the date is the reference used G GNSS signal N reader network time E elapsed since startup U unreferenced
TZ	Set time zone	Hours from UT (TZ-8 for Pacific)
LO	Show GNSS location	Show the current location from the GNSS receiver.
BP	Beeper (0=off, 1=on, 2=proximity)	Enable the piezoelectric beeper to make noise whenever a tag is detected. 0 = off 1 = on 2 = proximity mode
BR	LED brightness levels	BR1 for dim, BR2 for medium and BR3 for bright.
DK	Minutes before display goes dark	The LEDs consume power so they will turn off after there is no activity on the front panel or the console serial port. Pressing any button or sending any command will wake the LEDs. The default value is DK0 which means it will not turn off.
SY	Display system status	Shows short report with voltages, amperages, noise levels
BD	Baud rate of console	1=9600 baud 2=57600 baud 3=115200 baud (default)

Console Commands (continued)

AB	About memory, copyrights	Firmware V1.0 (c)2019 Oregon RFID, Inc. Serial number 0010-0003-0B37-3933-3155-37 FatFS R0.13a (c) 2017 ChaN, all rights reserved GCC (c) Free Software Foundation, Inc. All rights reserved by respective holder
WE	Write every scan record	In addition to summary record, the reader will store all individual detections (I records). WE1 to turn on. WE0 to turn off. This will generate many times more data than just a summary.
PH	Show/hide phantom detections	PH1 to enable, PH0 to disable them
PF	Phantom filter (1=on, 0=off)	Read and check tag postfix; can decrease read range a little.
FR	Factory reset	Initializes all settings to factory values. FRD Factory reset the database file FRR Factory reset the reader settings FRA Factory reset all FRD+FRR
CV	Convert tag number	Enter a tag number and the other forms will be displayed. Converts between decimal, hexadecimal and bi-hex formats.
QU	Explain prompt codes	Shows the current meaning of the four character prompt.

Console Commands (for readers with RFM-009)

MQ	Measure Q, ESR	Pause for 60-80 seconds to evaluate antenna
SM	Show antenna measurements	Show most recent results, SMA for Q table values

Appendix 3

Data Record Formatting

Detection Record format

A tag detection causes the datalogger to store a record with a few dozen fields in the database. All of this data is written for every detection.

When uploading the log file, the output record from the database displays selected fields that are determined by a format definition. The default format is:

DTY ARR SPC TRF DUR SPC TTY SPC TAG SCD NCD EFA

DTY	Detection type	S
ARR	Arrival time and date	2019-03-16 23:22:20.500
SPC	Output one space character	
TRF	Time reference	G
DUR	Duration	00:00:00.300
SPC	Output one space character	
TTY	Tag type	A
SPC	Output one space character	
TAG	Tag ID number	900_226000078747
SCD	Site code	AAA
NCD	Number of consecutive detections	4
EFA	Effective amps	0.5

This creates the record shown below.

```
S  2019–03–16 23:22:20.500 G      00:00:00.300  A      900_226000078747 AAA      4    0.5
```

Customizing the Record Format

The format can be customized according to your needs with the FM command. When using the reader as a mobile backpack it is useful to show the longitude and latitude of the detections. This can be done by adding LON and LAT to the default format.

FM DTY ARR SPC TRF DUR SPC TTY SPC TAG SCD NCD EFA LON LAT

Full list of field names

DTY	Detection type, S summary, I individual, E event
TCH	Tag technology HDX, FDX, HF
TTY	Tag type A=Animal, R=Read only, W=Writeable, P=Phantom
PFG	Phantom flag (P or N)
TAG	Tag ID number
ANT	Antenna number
ARR	Arrival date and time
TRF	Time reference G=GNSS, N=network, U=unreferenced
DEP	Departure date and time
SSN	Starting scan number (since midnight)
ESN	Ending scan number
NCD	Number of consecutive detections
EMP	Number of empty scans preceding detection
LAT	Latitude
LON	Longitude
ALT	Altitude meters
SIV	Satellites in view
HDP	Location horizontal accuracy (m)
TSS	Tag signal strength
CPA	Charge pulse amps
LSA	Listen amps
EFA	Effective amps
CPT	Charge pulse time
LST	Listen time
ANV	Antenna voltage
ANA	Antenna amperage
NOI	Noise
DUR	Duration
CLS	Tag class
SCD	Site code
SPC	Output one space character

Appendix 4

Command Line Prompt

Command prompt format

Each command line prompt displays the current system status. The characters used are listed below

0	Off with power connected
H	Host mode (generates system timing for network)
N	Node mode (synchronized to host)
R	Running, detections saved to file
S	Standby, not scanning, database accessible
Z	Off
G	Synch to GNSS signals
N	Synch to network signal
U	Unsynchronized
B	Beeper on
*****	Beeper not on

Time types

A character after the time indicates the reference.

14:44:57.876 U

G	Referenced to the GNSS signal
N	Referenced to network signal on cable between readers
U	Unreferenced time, using local clock

Tag classification code

The tag class is based on information from the tag identification number. The tag class is used by the proximity beeper function.

A	12mm HDX Oregon RFID
B	23mm HDX Oregon RFID
C	32mm HDX Oregon RFID
D	12mm TIRIS
E	Other TIRIS (0000)
F	Writeable
G	Allflex HDX
H	Other HDX

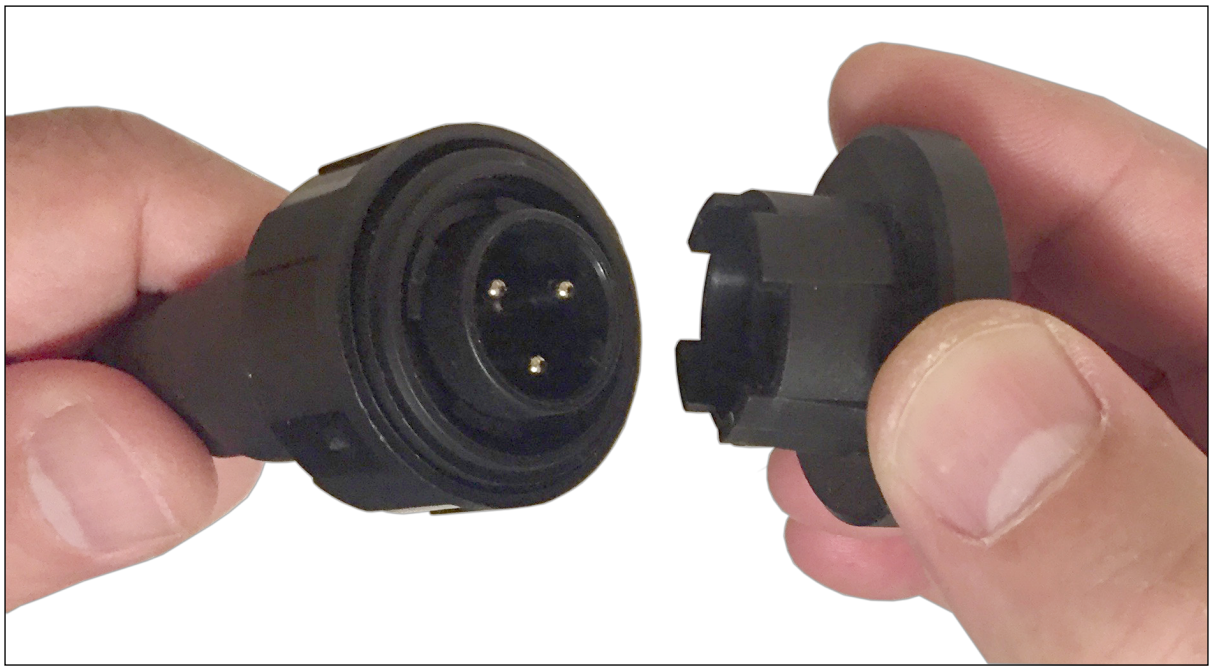
Appendix 5

Assembling Waterproof Twinax Connectors

Assembling Waterproof Twinax Connectors

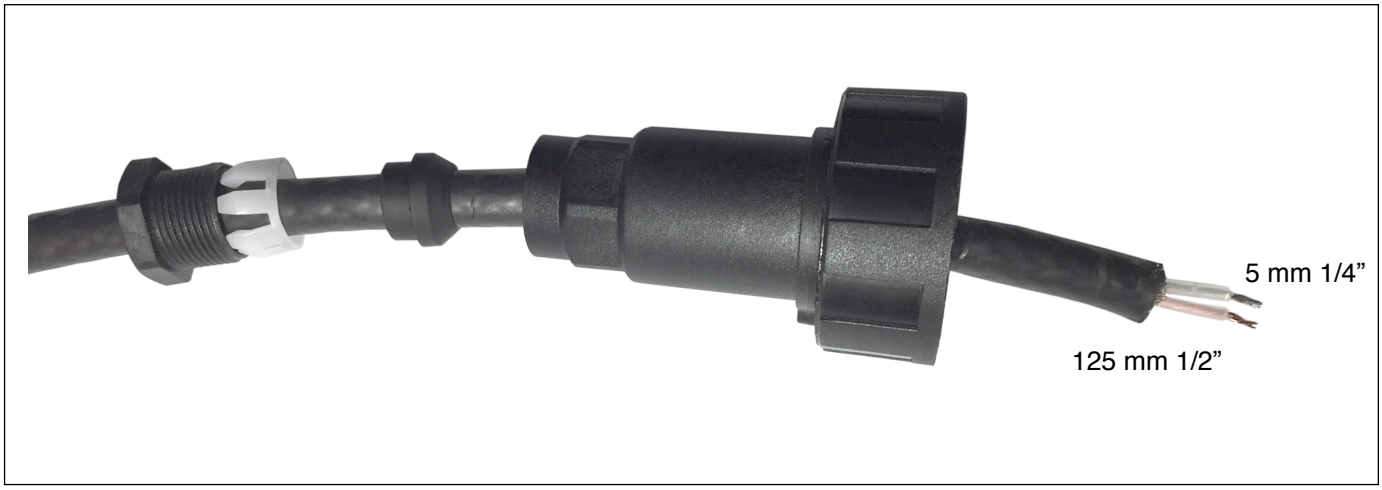
See the Oregon RFID channel for a video showing this process.

Disassemble the connector by unscrewing the lock ring using the protective cap from the reader as a tool.

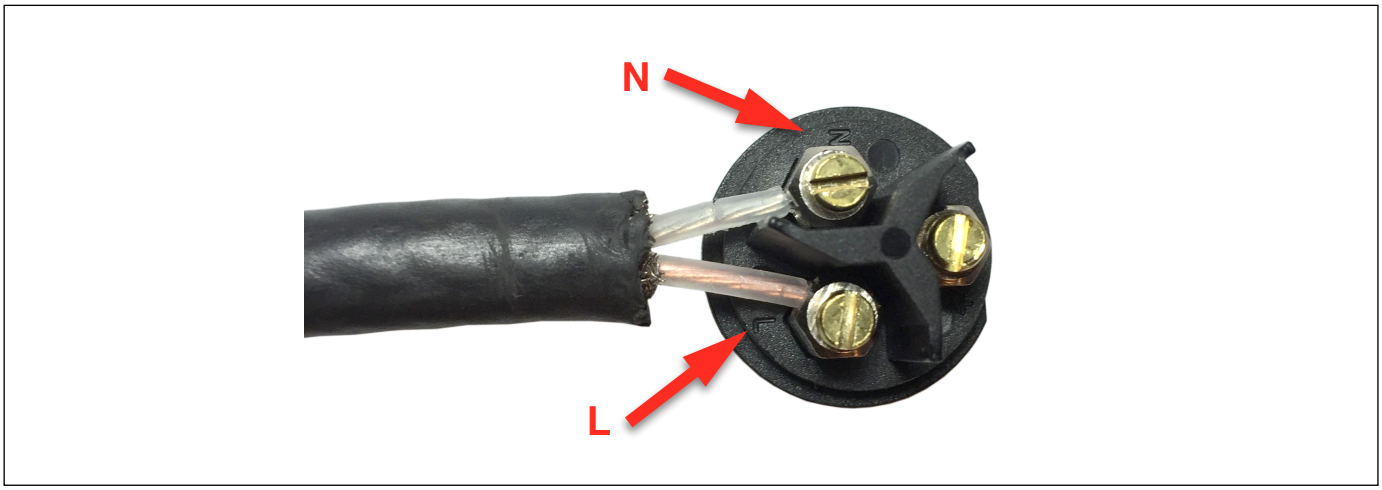


Remove the ring and inside assembly.

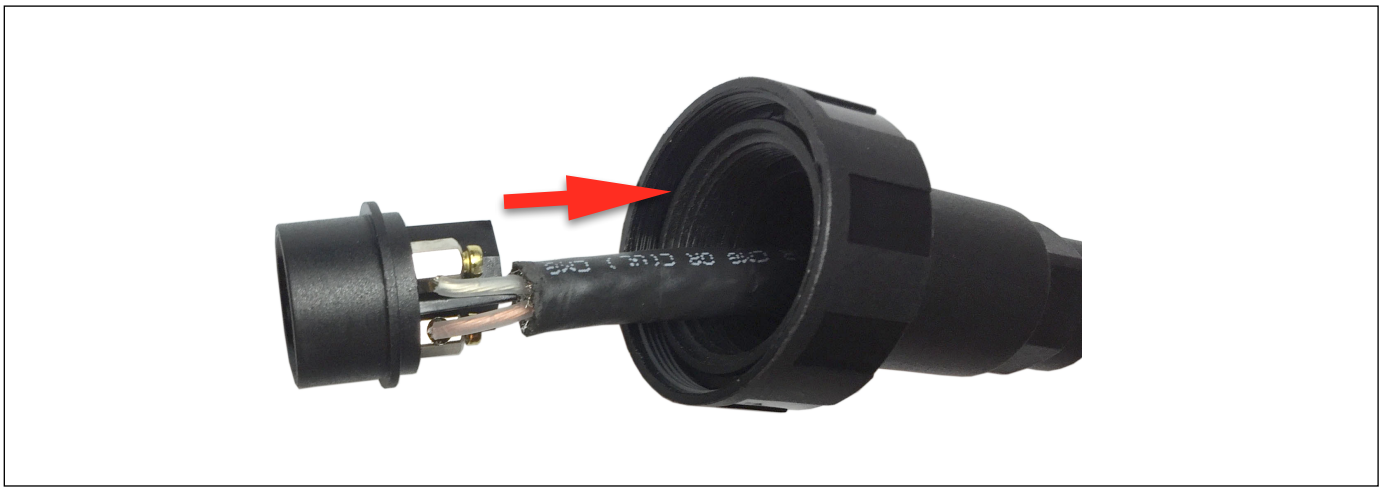
Place the parts on the twinax cable as shown. Strip off the ends of the wire.



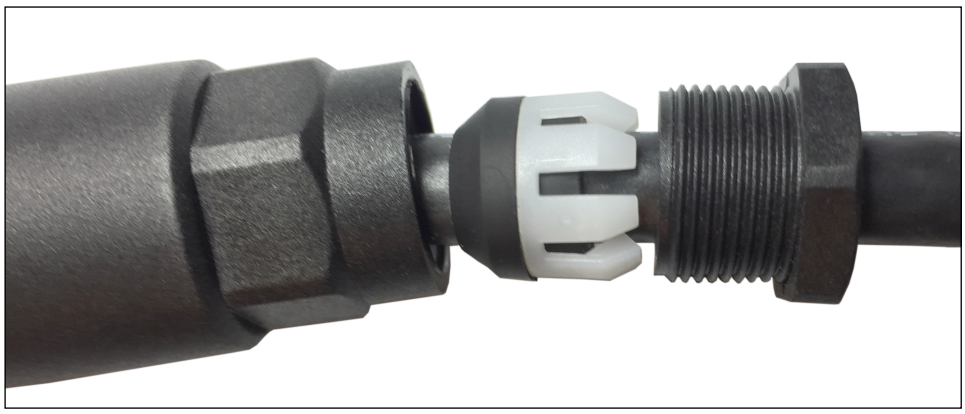
Connect the twinax cable ends to the terminals marked N and L.



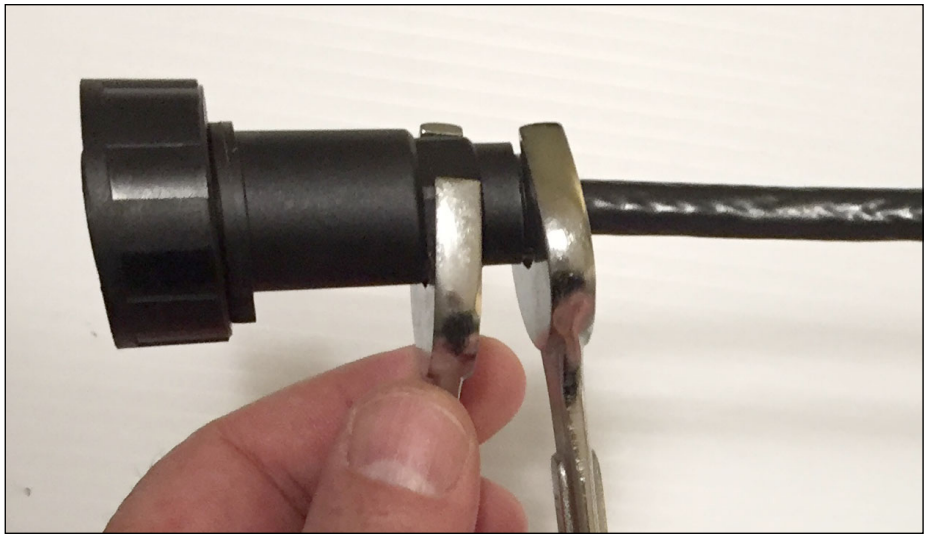
Pull the cable so the assembly goes back in the housing.



Push the seals into the connector and tighten the threaded nut.
Carefully push and hand tighten the nut until the plastic threads are inside the connector. This can require patience to get started.



After the nut is engaged, use two hand wrenches (3/4" and 11/16") to tighten the seal.



IMPORTANT: Twist the cable and connector in opposite directions make sure that the cable cannot twist inside the connector. There should be no movement or the wires will break inside the connector.

Replace the lock ring and tighten using the protective cap.

Completed assembly