User Manual

eco-DEVICE

Table of Contents

Version Control

Version	Date	Author	Comments
V1.1	11/12/2017	A Foster	Initial release
V1.11	12/12/2017	D Gomes	Remove temperature
V1.20			
V1.30	26/01/2018	D Gomes	Update eco-DIGITAL, added 4-20mA example
V1.31	29/01/2018	D Gomes	Update eco-ANALOG byte positions and added negative value examples as well as update eco-DIGITAL
V1.32	03/02/2018	D Gomes Z Richards	Device names consistency. Added more eco-DIGITAL examples
V1.33	10/03/2018	D Gomes	Updated commissioning for 2.4.3
V1.34	11/03/2018	D Gomes	Minor Update, commissioning for 2.4.3
V1.35	20/03/2018	D Gomes	Minor Update, commissioning for 2.4.3
V1.36	25/04/2018	D Gomes	Minor Update, add eco-ANALOG connection info

1.

1. Device General Information

The ***eco*-DEVICES** are ready-to-use in the field incorporating a radio transceiver allowing the transmission of data via a connection with equipment to be monitored such as utility meters, sensors and other devices. Housed in a durable enclosure and designed to withstand extreme environmental conditions, the ***eco*-DEVICES** are powered via a long-life Lithium-thionyl chloride cell (Li-SoCl2).

Once connected to the equipment, the ***eco*-DEVICE** will automatically transmit output messages via a low power wide area network (LPWAN) through to a cloud-based server. These messages can be accessed via an API call or callback setup to push data to a software platform to facilitate diagnostic analysis and reporting.

The ***eco*-DEVICES** can be supplied as a complete unit with the appropriate sensor connected (as specified with the order) tested and ready for installation. The devices are sealed to meet environmental requirements for moisture protection. There should be no need to dismantle the device or carry out any configuration changes on site. Once installed the unit is activated as described in section 4 Activation of the ***eco-D***

The ***eco*-DEVICES** are designed to simply transmit the data at frequent pre defined intervals and not necessarily in response to each on site data input. It is a "push" system that sends data at a preset timing interval (the standard default is every hour). The timing interval can be adjusted if details are supplied prior to supply of the items. There is no manipulation or storage of individual data readings within the device itself. Any factoring, large-scale storage, interval calculations and billing activities must be done at the receiving (back) end of the data capture. The "measured data" is simply accumulated in the device and transmitted via one-way communications to the LPWAN network.

In the event of a communications failure due to external circumstances, there may be a delay in receipt of accumulated data. The updated "current" data will be received at the back end once communications are reestablished. The EW device will not be aware of any communications failure and will continue to transmit data as normal during that time.

The communications is predominantly one way from the device to the network receiver with minimal downlink configuration capabilities.

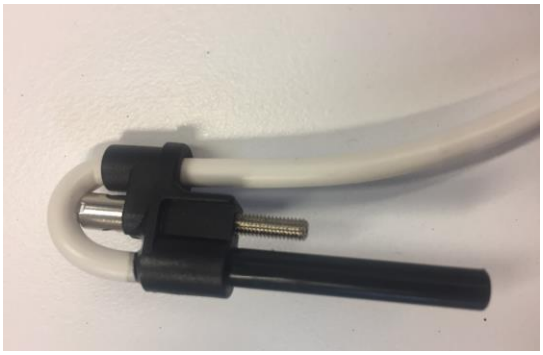
2. Main Features

The following list is a summary of the main features of the ***eco*-DEVICES**

- Durable Plastic Enclosure
- Simple Installation
- Pre-Delivery Configuration
- Battery Status Indication
- Variable Preset Reporting Rate
- Cumulative Data Maintained (no loss)
- Designed to AS/NZS 4268 Standards

3. On Site Installation

The ***eco*-DEVICE** can have a sensor fitted that suits the application. Typically, the sensor is supplied to EW by the manufacturer of the equipment to be monitored, permanently fitted to the device and tested before delivery to the customer. For the purposes of illustration, a sensor designed to operate with an Elster V100 water meter is used in the following examples.



The Elster V100 probe

Probe lead connected to the ***eco* - Device**

3.1 Connection to the Equipment

To insert the device probe into the meter the plastic plug that comes fitted to the meter as standard needs to be removed. The probe should be fully inserted, and the retaining screw then tightened. The probe cable length is one meter.

3.2 Device Mounting Options

As the device uses a radio frequency antenna to transmit signals it is preferred that the unit is not mounted directly onto a metal cabinet or wall plate.

The device has two mounting holes located at the top of the external housing.

Depending on the location of the meter it is recommended that the device be fixed securely using appropriate anchors or screws (not supplied).

If the water meter is free standing the device can be attached using cable ties.

An optional mounting bracket *will soon be available* (additional cost and lead times apply). The bracket will allow the device to be connected to the body of the water meter

4. Activation of the *eco*-DEVICE

Before executing the following, you should ideally have the device registered to the backend and setup a default downlink of 0xfa23000000.

The device must be activated as follows, holding a magnet for 6-10 seconds against the bottom side of the housing.

While the magnet is in position, the status LED will flash 3-4 times followed by a 1 Second ON, 1 Second OFF rate, 8-10 times after which It will then do a 2 Second ON followed by a burst of 7-10 successive flashes and one final flash indicating a transmission to the backend.

<u>If the LED does not go into the above sequence, you need to remove and then re-apply the magnet holding it in position until the above sequence has executed.</u>

The magnet activated switch is now in configuration mode which will allow the user 10 attempts to force a transmission to request a downlink configuration packet.

Each transmission request sends up a packet of how may attempts have been made as fc01 thru fc0a followed by a default packet containing voltage, rssi etc. If and only if the last download packet is an interval setting packet, the device will send up the payload as well.

The example here is for a downlink, setting an hourly transmission interval.

This means for an eco-DIGITAL device, first send down an eco-DIGITAL setup packet on the first *forced* transmission and then set up another downlink to set the transmission interval, such as 0xfa23000000 on a second *forced* transmission.

After 10 *forced* transmission attempts, the magnetic switch is disabled.

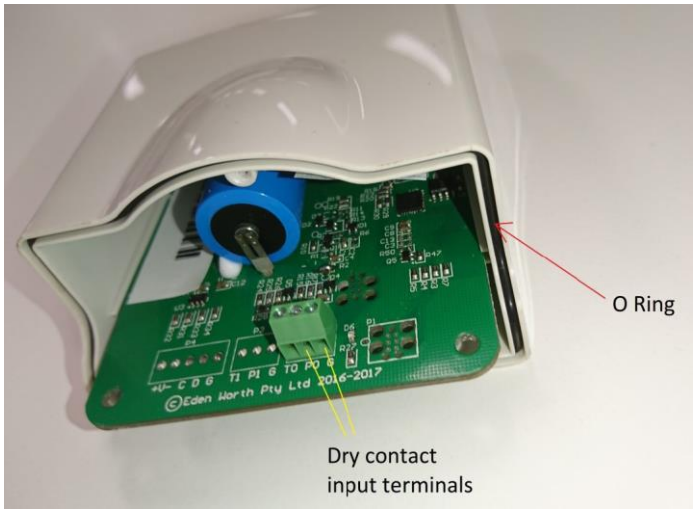
Time	Delay (s)	Header	Data / Decoding	Location	Base station	RSSI (dBm)	SNR (dB)
2018-03-10 10:03:37	2.6	0000	51000004d5beef0ded		3A5F	-50.00	93.05
2018-03-10 10:03:16	1.5	0010	09e30d490cf80042 Temp: 24.8 °C VDD idle: 3.555 V VDD tx: 3.145 V RSSI: -34.0		3A5F	-51.00	92.91
2018-03-10 10:02:41	2	0000 ack required	fc02		3A5F	-51.00	92.99

5. Device Characteristics

5.1 Device Inputs

The actual input used on the device depends on the sensor required for the application. The sensor characteristics can vary significantly. At present the EW devices can handle Pulse, Digital, or Analog inputs. The details relating to the various ***eco*-DEVICE** input specifications can be found in the appendices to this manual. To continue with the previous example of the device designed to monitor Elster V100 water meters, the Elster manufactured probe is a reed switch that provides an open / closed circuit (dry contact) input each time the meter registers a unit of water flow. The device counts contact closures from the probe. Any probes fitted to the device during manufacture should not be tampered with, as they have been factory tested prior to delivery.

Whilst the hardware circuit board is used for multiple applications the firmware is specific to the intended use hence no other probes or detectors can be connected to the pulse logger for alternative application unless it is accompanied with a change in firmware. As previously stated these devices are manufactured and delivered for specific applications and are not intended to be modified in the field.



5.2 Device Transmission

The device will continue to transmit the cumulative data commencing when first installed and activated.

5.3 Data Payload

The data from the device will be wrapped according to the LPWAN protocol requirements.

The details below are an example only for the ***eco*–PULSE** unit and show the actual data that is transmitted from the device for use by the customer. Please see the appendices for the other logger variants ***eco*–DIGITAL** and ***eco*–ANALOG.**

Note that in addition to the actual data read there is also information about the device, provided as standard. The device operating temperature and battery voltage information.

5.4 Battery Life

Battery life is highly dependent on the number of transmissions and receptions per day. Receptions are inherently highly restricted but if abused can significantly add to battery depletion rate.

If the configured settings for the device are to continuously transmit data every hour the single battery life is 3.5 years. If the transmission rate is reduced to 1 to 2 transmissions per day, the single battery life is extended to 10+ years.

The devices can be fitted with up to two 3500mAHr Lithium Thionyl Chloride large capacity cells as an optional extra (one cell is standard).

5.5 Environmental

The ***eco*–DEVICE** external casing cover is sealed with an "O ring" however to achieve the "International Protection Rating" of IP67 the screws holding the external casing together should have an appropriate non-corrosive sealant applied such as silicone by the installer.

6. Device Features and General Specifications

6.1 Features

- Durable Plastic Enclosure
- Simple Installation
- Pre-Delivery Configuration
- Battery Status Indication
- Variable Preset Reporting Rate
- Time and Date Stamp
- Cumulative Data Maintained (no loss)

6.2 Specifications

- Designed to AS/NZS 4268 and AS/NZS 60950 Standards
- Sigfox, RC4 (Australia, New Zealand, Hong Kong, Taiwan, Singapore, South America). Other zones (RC1, RC2, RC3) available on request. Contact Thinxtra for connecting your device to the nationally available Sigfox network in ANZ - sales@thinxtra.com. For coverage, please see - https://www.thinxtra.com/coverage/ and www.sigfox.com/coverage
- Lora Frequency Bands 915.2-927.8 MHz
- Component Operating Ambient Temperature -20 / +60 °C
- Operating Voltage 3.6V nominal
- Supports up to 2 Li-$SOCl_2$ Batteries
- Sigfox Output Power +22.5 dBm (Wisol)
- LoRA Output power +18.5dBm (RN2903 module)
- Dimensions: 80mm W x 150mm H x 55mm D (approx.)
- Weight: 165gm

7. Default downlink packet

All ***eco*–DEVICES** have the option to receive a default downlink packet that is used to sync the device to midnight UTC as well as define the transmission intervals. By default, this transmission interval is set to hourly but can be changed from 1min through to up to 60 days.

This packet is read only on successful contact with the back end for the first time (Note: if the device is unable to reach an LPWAN base station at commissioning time, the unit will not receive this packet on initial commissioning startup) otherwise it is re transmitted at approximately midnight every day. For Sigfox this assumes you have appropriate subscription for downlink support.

If you do not have the relevant downlink subscription level, the unit will still operate but with factory settings which by default is hourly transmission and no sync.

Bytes	0	1	2	3	4	5	6	7
	0xFA	Periodic transmission interval	Time of Day MSB	Time of Day LSB				

Byte 0 Packet ID
0xFA where indicates this the default time sync and transmission and interval setting downlink packet.

Byte 1 Periodic transmission interval
This byte is broken into 2 nibbles, where the most significant nibble is the multiplier from 0-14 and the least significant nibble is an enumerated unit of minutes of 1min, 10min, 30min, 60min, 120min, 1440min and 5760min.

We did it this way to save on data payload and hence can have a larger range of interval periods using only one byte.

e.g. to a set 90 minute interval
From the table you can see an interval of 90 mins can be set in 2 different ways either (Multiplier)3x (Unit column3)30mins or (Multiplier)9x (Unit column2)10mins

So the complete downlink packet would look like either: -
0xFA33000000000000 or…
0xFA92000000000000

Unit	1	2	3	4	5	6	7
minutes	1	10	30	60	120	1440	5760
Multiplier	mins	mins	mins	hrs	hrs	days	days
0	0 (1 $1)	0 (2 $2)	0 (3 $3)	0 (4 $4)	0 (5 $5)	0 (6 $6)	0 (7 $7)
1	1 (17 $11)	10 (18 $12)	30 (19 $13)	1 (20 $14)	2 (21 $15)	1 (22 $16)	4 (23 $17)
2	2 (33 $21)	20 (34 $22)	60 (35 $23)	2 (36 $24)	4 (37 $25)	2 (38 $26)	8 (39 $27)
3	3 (49 $31)	30 (50 $32)	90 (51 $33)	3 (52 $34)	6 (53 $35)	3 (54 $36)	12 (55 $37)
4	4 (65 $41)	40 (66 $42)	120 (67 $43)	4 (68 $44)	8 (69 $45)	4 (70 $46)	16 (71 $47)
5	5 (81 $51)	50 (82 $52)	150 (83 $53)	5 (84 $54)	10 (85 $55)	5 (86 $56)	20 (87 $57)
6	6 (97 $61)	60 (98 $62)	180 (99 $63)	6 (100 $64)	12 (101 $65)	6 (102 $66)	24 (103 $67)
7	7 (113 $71)	70 (114 $72)	210 (115 $73)	7 (116 $74)	14 (117 $75)	7 (118 $76)	28 (119 $77)
8	8 (129 $81)	80 (130 $82)	240 (131 $83)	8 (132 $84)	16 (133 $85)	8 (134 $86)	32 (135 $87)
9	9 (145 $91)	90 (146 $92)	270 (147 $93)	9 (148 $94)	18 (149 $95)	9 (150 $96)	36 (151 $97)
10	10 (161 $A1)	100 (162 $A2)	300 (163 $A3)	10 (164 $A4)	20 (165 $A5)	10 (166 $A6)	40 (167 $A7)
11	11 (177 $B1)	110 (178 $B2)	330 (179 $B3)	11 (180 $B4)	22 (181 $B5)	11 (182 $B6)	44 (183 $B7)
12	12 (193 $C1)	120 (194 $C2)	360 (195 $C3)	12 (196 $C4)	24 (197 $C5)	12 (198 $C6)	48 (199 $C7)
13	13 (209 $D1)	130 (210 $D2)	390 (211 $D3)	13 (212 $D4)	26 (213 $D5)	13 (214 $D6)	52 (215 $D7)
14	14 (225 $E1)	140 (226 $E2)	420 (227 $E3)	14 (228 $E4)	28 (229 $E5)	14 (230 $E6)	56 (231 $E7)
15	15 (241 $F1)	150 (242 $F2)	450 (243 $F3)	15 (244 $F4)	30 (245 $F5)	15 (246 $F6)	60 (247 $F7)

==========

Byte 2-3 Time of Day.
Bytes 2,3 define how many minutes since UTC midnight. This is used by the device to synchronise its interval relative to midnight. Where byte 2 is the LSB and byte 3 represents the MSB.

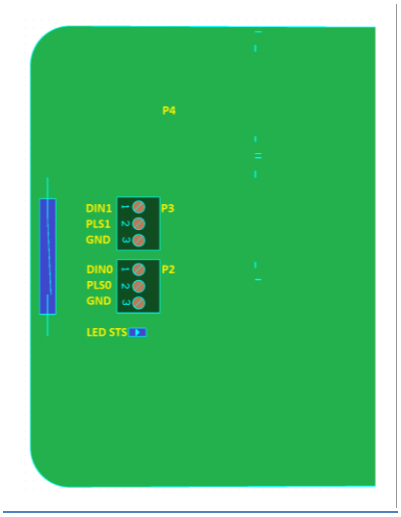
Time sync messages are requested on the transition past UTC, Sigfox Downlinks default to affixed length of eight (8) bytes, this restriction is applied to LoRA also.

The time sync messages are used to set the current UTC time in the device with a accuracy of the periodic time interval and precision is in minutes.
e.g. the following sets periodic interval to one minute and the time of day to 12:30 (750 minutes represented in hexadecimal by $02EE)
FA11EE0200000000
Comprising the following data:
FA Message ID
11 Time Interval (translates to one minute)
EE02 Time Of Day
00000000 Unused

8. Appendices: Specific *eco* variant device setup information.

The following details relate to the individual ***eco*–DEVICES** and are provided to assist in understanding the flexibility of the device applications. It must be remembered however that the appropriate firmware version must be loaded and tested for each sensor variant utilized in any given application.

8.1 Setup information for *eco*–PULSE



Pulse Input

The ***eco*–PULSE** supports pulse input on pin 2 on connectors P2 & P3 referenced to pin 3 (GND).

Each input has a pull-up resistor to the battery terminal voltage. The pull-up is approximately 100k ohms. Although the inputs can tolerate up to 30VDC, it is advisable to keep these inputs to within the devices operational range of up to 3.6V

eco-Pulse Logger Backend *DOWNlink packet definitions*

For the eco-Pulse, apart from the default downlink time sync and interval setting packet (0xFA) above, there are no user configurable parameters.

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eco-Pulse Logger Backend UPlink packet definitions

For the eco-Pulse, apart from the default downlink time

Pulse uplink packet definition: -

This is the normal operational mode packet that is sent up at the end of each pulse reporting interval.

Bytes	0	1	2	3	4	5	6	7	8	9	10	11
	0x01	NA	NA	NA	Pulse0 Byte2	Pulse0 Byte1	Pulse0 Byte0	Volts MSB	Volts LSB	Pulse1 Byte2	Pulse1 Byte1	Pulse1 Byte0

Byte 0 Packet ID

0x01 where indicates this is an input type application and *n* = 0-f i.e. up to 16 different input applications supported. The default is 0 i.e. 0x01

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Byte 1-3 NA

==========

Byte 4-6 Pulse0 Count

==========

Byte 7-8 Battery Voltage

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Byte 9-11 Pulse1 Count

Power Supply voltage Reading

Voltage is represented over 2 bytes in mV

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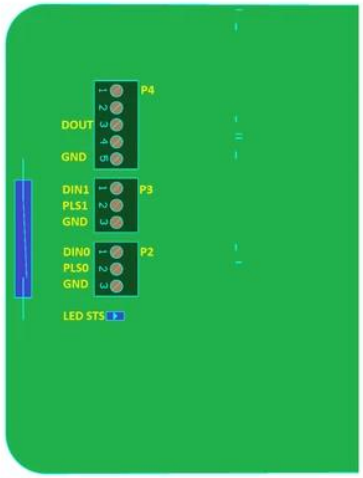
8.2 Setup information for *eco*–DIGITAL



Digital Operating Modes

There are two modes of operation for a digital device: event reporting; and sensor reading.

Event reporting involves the 2 inputs DIN0 and DIN1, only. Where periodic and immediate reports are configured the messages are transmitted when the conditions are met.

Sensor reading requires the activation of a device using DOUT prior to reading the configured inputs DIN0 or DIN1. ONLY where a change in state of the input is detected a message is transmitted.

Digital Inputs

The ***eco*-DIGITAL** supports 2 inputs DIN0 and DIN1

Each input has a pull-up resistor to the battery terminal voltage. The pull-up is approximately 100k ohms. It is advisable to keep these inputs to within the devices operational range of up to 3.6V. Ideally, these inputs operate best with a voltage free contact. Therefore, for higher voltage, perhaps use the higher voltage to switch a reed relay and use the reed relay contacts to activate the digital inputs

Digital inputs can be programmed to trigger a transmission of DIN status on immediate change of state or transmit DIN states *periodically* (note, only if either have changed since last interval).

i.e. if either input has changed since last interval period, this change will be transmitted on the following interval however, if the input changed state and then back again during the interval, this will not be transmitted.

Optionally if using the periodic transmission mode above, the digital output can be activated at each interval for a short period of time to enable an external device before taking a DIN state reading.

Digital Output.

Pin 3 of P4 is a digital output and can source battery voltage for small sensor loads or can sink up to 50mA for short periods. Currently the user must pre-specify either the source or sink configuration option when placing an order for these devices.

The output can only operate in interval mode i.e. you can specify if it is turned ON for a period of time every interval, where period and interval are set via a downlink. (Your LPWAN subscription level needs to allow downlinks). This mode facilitates the power control to an external sensor or to gate an event to an external device.

Default configuration.

The ***eco*-DIGITAL** is set by default as follows: -

- Output DOUT is enabled to activate periodically for 200mS by default and provides ~3.6 Battery Voltage <= 50mA.
- DIN0 configured as 60 min Periodic interval reading and operates in conjunction with DOUT which can optionally.
- DIN1 configured as Immediate

i.e. for periodic DIN0 above, a transmission will only occur if DIN0 has changed and is held in that changed state since the last interval transmission. DOUT will activate on the interval to allow power to an external device.

DIN1 on the other hand will transmit as soon as its input changes state (subject to network/modem restrictions)

eco-Digital Logger Backend DOWNlink packet definitions

Bytes	0	1	2	3	4	5	6	7
	0x21	DOUT Enable	DIN Enable	DIN0 Low Duration	DIN0 High Duration	DIN1 Low Duration	DIN1 High Duration	DOUT High Duration

Byte 0 Packet ID

0x2*n* where indicates this is an input type application and *n* = 0-f i.e. up to 16 different input applications supported. The default is 0 i.e. 0x21

==========

Byte 1 DOUT enable

This enables the digital output on periodical transmission function.

==========

Byte 2 DIN enable

Bit	0	1	2	3	4	5	6	7

Each bit enables either immediate or periodic detection of DINx going high or low where.

bit 0 Enable DIN0 low immediate detect
bit 1 Enable DIN0 low periodic detect
bit 2 Enable DIN0 high immediate detect
bit 3 Enable DIN0 high periodic detect
bit 4 Enable DIN1 low immediate detect
bit 5 Enable DIN1 low periodic detect
bit 6 Enable DIN1 high immediate detect
bit 7 Enable DIN1 high periodic detect
Note: Both the immediate and periodic functions can be selected at the same time for each input.
==========

The following settings determine how long an input needs to maintain the change of state for before asserting a logic change and how long the output is activated for if enabled.

Byte 3 DIN0 LOW state duration
Byte 4 DIN0 HIGH state duration

Byte 5 DIN1 LOW state duration
Byte 6 DIN1 HIGH state duration

Byte 7 DOUT duration

Bit	0	1	2	3	4	5	6	7
Nibble	LSN	LSN	LSN	LSN	MSN	MSN	MSN	MSN

bit 0-3 LSNibble Index
bit 4-7 MSNibble Multiplier

The duration byte is a packed number comprising the Multiplier and Index. The index is used to determine the units to use in the duration calculation. The unit used for de-bounce period is in the order of milliseconds, this is different to the units used in the periodic transmission calculation where the period range is from minutes to days.
To determine the units for the duration calculation, the index directly translates to 100ms intervals, index 2 translates to 200ms.

e.g. to a set 600 millisecond interval
60ms requires the (Multiplier)6x (Units)100ms, set the duration Multiplier to 6 and the Index to 1 (0x61)

eco-Digital Downlink – Event Config Example

Turn on all immediate and periodic event reporting:
0x2100FF1111111100

21 Message Id
00 DOUT Flag
FF Event Flag (DIN1/DIN0)
11 DIN0 LOW state duration (100ms)

11 DIN0 HIGH state duration (100ms)
11 DIN1 LOW state duration (100ms)
11 DIN1 HIGH state duration (100ms)
00 DOUT duration

Turn on all immediate event reporting:
0x2100551111111100

21 Message Id
00 DOUT Flag
55 Event Flag
11 DIN0 LOW state duration (100ms)
11 DIN0 HIGH state duration (100ms)
11 DIN1 LOW state duration (100ms)
11 DIN1 HIGH state duration (100ms)
00 DOUT duration

Turn on all periodic event reporting:
0x2100AA1111111100

21 Message Id
00 DOUT Flag
AA Event Flag
11 DIN0 LOW state duration (100ms)
11 DIN0 HIGH state duration (100ms)
11 DIN1 LOW state duration (100ms)
11 DIN1 HIGH state duration (100ms)
00 DOUT duration

Turn on all immediate on DIN0 and periodic on DIN1 event reporting:
0x2100A51111111100

21 Message Id
00 DOUT Flag
A5 Event Flag (DIN1 Periodic, DIN0 Immediate)
11 DIN0 LOW state duration (100ms)
11 DIN0 HIGH state duration (100ms)
11 DIN1 LOW state duration (100ms)
11 DIN1 HIGH state duration (100ms)
00 DOUT duration

eco-Digital Downlink – DOUT Config Example

To set the ecoDevice to operate DOUT it is necessary to configure the following parameters:

a. enable DOUT
b. set power up duration for DOUT
c. enable periodic reporting on the DIN
d. set the de-bounce durations.

The following example uses DIN0:
0x21010A1111000011

21 Message Id
01 DOUT

0A Event Flag (DIN0 Periodic reports for LOW and HIGH enabled)
11 DIN0 LOW state duration (100ms)
11 DIN0 HIGH state duration (100ms)
00 DIN1 LOW state duration
00 DIN1 HIGH state duration
21 DOUT duration (200ms)

The following example uses DIN1:
0x2101A00000111111

21 Message Id
01 DOUT Flag
A0 Event Flag (DIN1 Periodic reports for LOW and HIGH enabled)
00 DIN0 LOW state duration
00 DIN0 HIGH state duration
11 DIN1 LOW state duration (100ms)
11 DIN1 HIGH state duration (100ms)
21 DOUT duration (200ms)

eco-Digital Logger Backend UPlink packet definitions

Digital Uplink Messages communicate the state of the two Digital Inputs and are defined by type and reporting mode.
Digital uplink messages are classified by two types: Event and Periodical read messages.
The two modes for reporting state changes, either immediately on occurrence or periodically.
Each state type of change (Low/High) can be reported.
Event messages are generated when either the immediate or periodic conditions are met.
Periodical read messages are only generated on a change of state.
The Digital messages have the following structure.

Bytes	0	1
	0x2n	DIN State

Byte 0 Packet ID

0x2*n* where indicates this is either an Event (0x21) or Periodical read(0x22)
==========

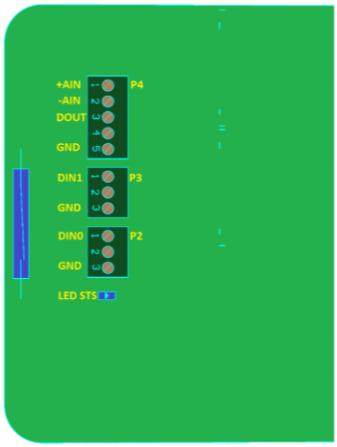
Byte 1 DIN State

DIN State indicates which state change has occurred.

DIN0 Immediate Transmission LOW detect	0x0D
DIN0 Periodic Transmission LOW detect	0x0E
DIN0 Immediate Transmission HIGH detect	0x0F
DIN0 Periodic Transmission HIGH detect	0x10
DIN1 Immediate Transmission LOW detect	0x11
DIN1 Periodic Transmission LOW detect	0x12
DIN1 Immediate Transmission HIGH detect	0x13
DIN1 Periodic Transmission HIGH detect	0x14

==========

8.3 Setup information for *eco*–ANALOG



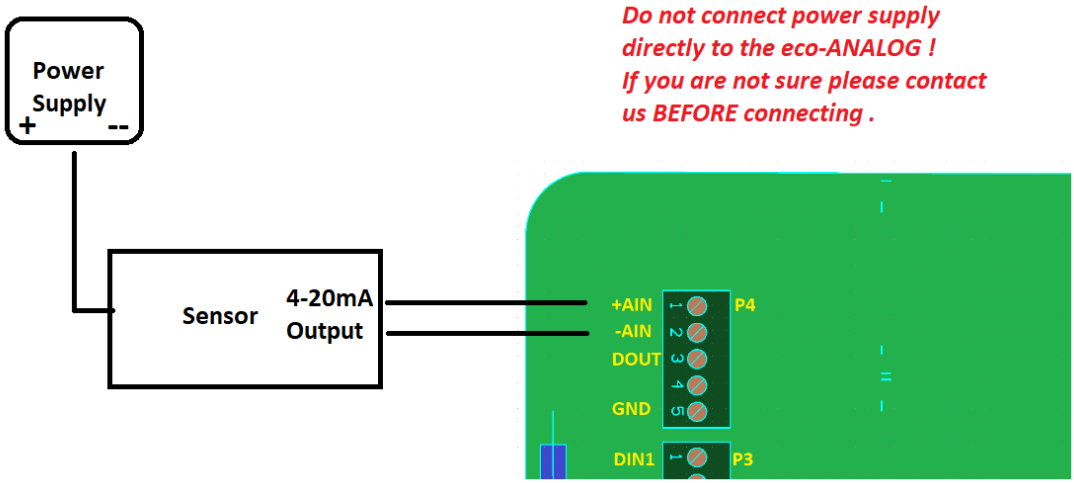
Analog Input

The ***eco*-ANALOG** supports a differential input across pins 1 & 2 of P4. Analog Input type can be either 4-20mA, 0-10VDC, +/- 2.5VDC type sensors.

Input type i.e. 4-20mA or 0-10V or other **must be specified** when placing an order.

Inputs can be programmed to be read on a specific interval cycle.

4-20mA Connection details



eco-*ANALOG* Logger Backend DOWNlink packet definitions

Apart from the default downlink time sync and interval setting packet (0xFA) above, there are no user configurable parameters.

==========

eco-ANALOG Logger Backend UPlink packet definitions

Analog uplink packet definition: -
This is the packet that is sent up..

Bytes	0	1	2	3	4	5	6	7	8
	0x5n	An3	An2	An1	An0	NA	NA	Volts MSB	Volts LSB

Byte 0 Packet ID

0x5*n* where indicates this is an input type application and *n* = 0-f i.e. up to 16 different input applications supported. The default is 0 i.e. 0x51

0x51 – 4-20mA mode
0x52 – 0-10VDC mode
0x53 – Differential mode 1
0x53 – Differential mode 2

Byte 1-4 AN3-AN0
Analog reading (Type dependent, see 4-20mA example below)
==========
Byte 5-6 NA
==========
Byte 7-8 Volts
Battery Voltage is represented over 2 bytes in mV
==========

Example for 4-20mA type eco-ANALOG

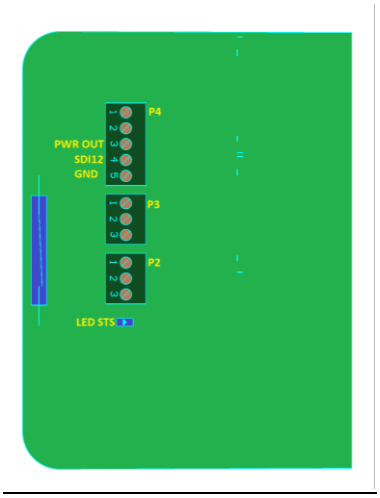
This is represented as a +/- percentage (x100) of the overall range of the analog type. E.g. For 4-20mA where 4mA Represents 0% and 20mA represents 100%, negative numbers are also supported and represented as twos complement.

mA Tot	**Bytes 1-4**	**DEC**	**/100 = %**
4	0x00000000	0	0
5	0x00000271	625	6.25
6	0x000004E2	1250	12.5
7	0x00000753	1875	18.75
8	0x000009C4	2500	25
9	0x00000C35	3125	31.25
10	0x00000EA6	3750	37.5
11	0x00001117	4375	43.75
12	0x00001388	5000	50
13	0x000015F9	5625	56.25
14	0x0000186A	6250	62.5
15	0x00001ADB	6875	68.75
16	0x00001D4C	7500	75
17	0x00001FBD	81025	81.25
18	0x0000222E	8750	87.5
19	0x0000249F	9375	93.75
20	0x00002710	10000	100

Sample uplink packets: -		
0x5100001**ac9**beef0e15	1ac9 = 6857/100 = **68.57%**	
0x51ffff**fffc**beef0e15	~fffc = 3 + 1 = 4/100 = **0.04%**	
0x51ffff**f63c**beef0e51	~f63c = 2499 + 1 = 2500/100 = **-25%**	

A value of *51ffffff63cbeef0e51* translates to 0xf63c = -25% which typically means the terminals are open circuit.

8.4 Setup information for *eco*–SMART (SDI12 Soil Moisture Probe type 1)



***eco*–SMART** (SDI12-Soil moisture probe)
The eco-SDI12-Soil moisture probe logger *specifically* connects to an Aquacheck Soil moisture probe.

Typically, connection is via a pigtail lead, where, red is power to the probe, black is ground and blue (SDI12 above) is the output from the probe. Ensure all leads are suitably insulated before commissioning unit.

Ensure you have the probe connected **BEFORE commissioning.**

The logger can be setup to read on interval only, which is configurable via a backend downlink packet.

Power to the probe is controlled by the application and is only provided when a read is required. This is internally limited to ~50mA. **Note: DO NOT USE EXTERNAL SUPPLY.**

The ***eco*–SMART** (SDI12-Soil moisture probe) variant logger can support either a 4 or 6 sensor probe but as far as the logger is concerned, the data reported by the probe is directly transmitted to the back end without interpretation of decoding.

eco-*SMART t(SDI-12)* Logger Backend DOWNlink packet definitions

Apart from the default downlink time sync and interval setting packet (0xFA) above, there are no user configurable parameters.

==========

eco-SMART t(SDI-12) Logger Backend UPlink packet definitions

This is the packet that is sent up..

Bytes	0	1	2	3	4	5	6	7	8	9	10	11
	0xNn											

Byte 0 **Data-Coding-ID**
0x30 or 0x60 See next page

Note: The following is applicable to both the Sigfox and LoRaWAN specific devices.

Sigfox allows max 12 bytes of data payload. Sending probe data requires compression to be able to fit the data sample into the required payload. (this method fits moisture and temperature data into one packed)
Sigfox SDI-12 unit will support a maximum of 6 sensors. Depending on the probe (or any other device) connected, will determine the data compression used.
6 sensor probes: 6 soil moisture values and the first 4 temperature values will be encoded as well as an optional counter with a resolution of 511 counts. Moisture will have a resolution of 0.1SF (in the range 0 to 102.3) and temperature will have a resolution of 0.5 degrees C (in the rage 0 to 31.5 degrees C)
4 sensor probes: 4 soil moisture values and first 3 temperature values, counter. Moisture will have full resolution of 0-32767 (in the range 0 to 120) and temperature will have a resolution of 0.25 degrees C (in the range -20 to 43.75 degrees C)
Note that a 6-sensor probe can be forced to read in 4 sensor mode, this setting is described in the downlink section.

The 3 high bits in the first byte of the Sigfox frame determine the data encoding method:
Data-Coding-ID = ((BYTE(1)&0xe0)>>5

Data-Coding-ID value	**Payload encoding**
0	spare
1	Standard 6-sensor (6 SM and 4 Temp)
2	SDI weather station data
3	Standard 4-sensor (6 SM and 3 Temp)
4	spare
5	spare
6	spare
7	Engineering data

Decoding the data (notation is based on "C" operator notation, e.g.: 0x2e represents HEX byte 2E or 46; and a<<b means a (bits) shift left by b counts)

Data-Coding-ID value 1 (6 sensor probe):

Parameter	Decoded data
Data-Coding-ID	((BYTE(1)&0xe0)>>5
D-COUNT	Delta count = (Byte(1)&0x1f)<<4+(Byte(10)&0xf0)>>4
SM (1 to 4)	SMx = ((Byte(x*2)&0x03)<<8 + Byte(x*2+1))/10 where x is 1 to 4
SM5	SM5 = ((Byte(10)&0x03)<<8 + Byte(11))/10
SM6	SM6 = ((Byte(10)&0x0c)<<6 + Byte(12))/10
Temp(1 to 4)	Tx = ((Byte(x*2)&fc)>>2)/2 where x is 1 to 4 (Or Tx = ((Byte(x*2)&fc))/8)

Data-Coding-ID value 3: (4 sensor probe, or 6 sensor probe forced to read as 4)

Parameter	Decoded data
Data-Coding-ID	((BYTE(1)&0xe0)>>5
D-COUNT	Delta count = (Byte(1)&0x1f)<<4 + (Byte(2)&0x80)>>4 + (Byte(3)&0x80)>>5 + (Byte(4)&0x80)>>6 + (Byte(5)&0x80)>>7
SM (1 to 4)	SMx = ((Byte(x+1)&0x7f)<<8 + Byte(x+2))/320 where x 1 to 4
Temp (1 to 3)	Tx =((Byte(x+9))/4)-20 where x is 1 to 3

For more information, please contact Aquacheck directly.

9. Backend downlink and server configurations

It is out of the scope of this document to detail how to setup callback and API support for LPWAN's.

Suffice to say here are some resources to reference:

https://semtech.force.com/lora/LC_Resources#
https://resources.sigfox.com/document/custom-callback-creation

End of Document