Synetica - enLink LoRaWAN decoders

Online decoder can be found here: Live Decoder

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Preamble

Synetica is a UK based company that designs and develops energy and environmental sensors. We specialise in highly accurate and reliable air quality monitoring using LoRaWAN long range wireless.

The **enLink** range of LoRaWAN devices are categorised into the following:

- Air Quality Monitors (Indoor and Outdoor, mains and battery powered)
- Indoor Environmental Sensors
- Modbus Reader - Serial RS485 RTU
- Pulse Counter
- Leak Sensor
- Differential Pressure / Air Flow
- Temperature Probes
- Voltage/Current Sensor

This repository contains various decoders for the LoRaWAN data packets. The uplink data is telemetry data containing values like temperature, particulates and gas concentrations.

This enLink firmware implements LoRa Mac 4.4.0 release from Semtech/StackForce LoRaMac-Node.

We implement EU863-870 and US902-928 (Hybrid mode) as defined in LoRaWAN Regional Parameters v1.0.2rB document. Class A endpoint implementation is fully compatible with "LoRaWAN specification 1.0.2".

Payload Contents of each enLink Model

Each model of enLink device has specific sensors. Each sensor exposes one or more data values. The **firmware code** is used to determine the sensors in the device. Note: the product code is similar to, but not the same as the firmware code. The following table can be used to determine the expected values in a uplink message. The KPI values are optional.

The firmware code is a concatenation of the base model plus the options.

> For example: `FW-ZN-LVCM` is the firmware code for an enLink Zone(**ZN**) with **L**ight, **V**OCs, **C**O_2 and **M**otion.

enLink AIR/AIR-X - Indoor/Outdoor Air Quality Monitor

Firmware Code	Options	Data Type(s)	Description
FW-AQM	(default)	0x01, 0x02	Temperature, Humidity
	L	0x03	Light Level (Indoor only)
	V	0x04, 0x05, 0x12, 0x3F	Pressure, VOC IAQ, bVOC, CO_2e
	C	0x08	CO_2 ppm
	X	0x06	Oxygen
	K	0x07, 0x09, 0x0A, 0x0D, 0x53, 0x54, 0x55, 0x56	Optional Gas Socket Sensors
	S	0x50, 0x51, 0x52	Sound
	P+	0x57, 0x58, 0x59, 0x5A, 0x5B, 0x5C, 0x5D, 0x5E, 0x5F, 0x60	Particles
	O	0x61	Ozone
	G	0x61, 0x66	Single Gas Sensor
	G+	0x61, 0x66	Up to 4 x Gas Sensors

enLink IAQ/OAQ - Indoor/Outdoor Air Quality

Firmware Code	Options	Data Type(s)	Description
FW-AQ	(default)	0x01, 0x02	Temperature, Humidity
	V	0x04, 0x05, 0x12, 0x3F	Pressure, VOC IAQ, bVOC, CO_2e
	C	0x08	CO_2 ppm
	D	0x67, 0x68	Outdoor EPA Sensor
	O	0x61	Ozone
	G	0x61, 0x66	Single Gas Sensor
	S	0x50, 0x51, 0x52	Sound
	P+	0x57, 0x58, 0x59, 0x5A, 0x5B, 0x5C, 0x5D, 0x5E, 0x5F, 0x60	Particles

Firmware Code	Options	Data Type(s)	Description
	PP	0x69, 0x6A, 0x6B, 0x57, 0x58, 0x6C, 0x5A, 0x6D, 0x6E, 0x5B, 0x5C, 0x5D, 0x6F, 0x5F	Particles

enLink ZonePlus

Firmware Code	Options	Data Type(s)	Description
FW-ZNP	(default)	0x01, 0x02	Temperature, Humidity
	L	0x03	Light Level
	V	0x04, 0x05, 0x12, 0x3F	Pressure, VOC IAQ, bVOC, CO_2e
	C	0x08	CO_2 ppm
	M	0x13, 0x14	Motion (PIR). Includes ATI feature
	S	0x50, 0x51, 0x52	Sound
	P+	0x57, 0x58, 0x59, 0x5A, 0x5B, 0x5C, 0x5D, 0x5E, 0x5F, 0x60	Particles

enLink Zone

Firmware Code	Options	Data Type(s)	Description
FW-ZNP	(default)	0x01, 0x02	Temperature, Humidity
	L	0x03	Light Level
	V	0x04, 0x05, 0x12, 0x3F	Pressure, VOC IAQ, bVOC, CO_2e
	C	0x08	CO_2 ppm
	M	0x13, 0x14	Motion (PIR). Includes ATI feature

enLink Modbus

Firmware Code	Options	Data Type(s)	Description
FW-MB-32	(None)	0x0F, 0x10, 0x11	Exception, Interval, Cumulative readings

enLink Status - Pulse Counter

Firmware Code	Options	Data Type(s)	Description
FW-STS-P/PX	(None)	0x0E, 0x15	Count (0 to 2^32), Change of State - Includes ATI feature

enLink Status - Leak Sensor

Firmware Code	Options	Data Type(s)	Description
FW-STS-L	(None)	0x30, 0x31	Resistance, Leak Event. Includes ATI feature on the leak event

enLink Status - Differential Pressure / Air Flow (Velocity)

Firmware Code	Options	Data Type(s)	Description
FW-STS-DP/AF	(None)	0x2C, 0x2D	Pressure, Air flow. Either one or both can be selected

enLink Status - Temperature Probes

Firmware Code	Options	Data Type(s)	Description
FW-STS	1T	0x17, 0x1A, 0x1D, 0x20, 0x23, 0x26, 0x29	Temperature, alarm status (if set) Includes ATI feature
	2T	As above, plus 0x18, 0x1B, 0x1E, 0x21, 0x24, 0x27, 0x2A	Temperature, alarm status (if set) Includes ATI feature

enLink Status - Voltage/Current Sensor

Firmware Code	Options	Data Type(s)	Description
FW-STS-VC	(None)	0x2E	Mode: Voltage
		0x2F	Mode: Current
		0x30	Mode: Resistance

enLink Status - Pura Sanitiser Liquid Level

Firmware Code	Options	Data Type(s)	Description
FW-STS-PURA	(None)	0x16	Status Changed

ATI - Adaptive Transmission Interval

This is included on enLink devices where an alarm or status feature requires immediate transfer of a radio message. The Adaptive feature means the unit will transmit a message at a long interval. This *heart-beat* is a normal radio message. If an alarm/status condition is detected, a message will be sent immediately. If the condition continues, the message will continue to send at a shorter interval, but not any more frequently.

Uplink Payload

The enLink payload structure is designed to be as efficient as possible. Data for multiple sensor values can be concatenated into a single payload which can be easily decoded. If the payload length is restricted due to channel time limits, the whole message will be split into multiple payloads. Each payload will always be split on a **Sensor Data** boundary. This is done so each payload can be easily decoded. A payload will always have the first byte as a **Data Type Identifier**.

Uplink Transmission Port

The enLink device design uses a single port byte value to transmit uplink messages. This is by default set to 1. This can be changed to allow the user to easily decode packets from different manufacturers, if needed. This can be changed either via the serial port menu, accessed by a USB cable or with a downlink message.

Uplink Payload Structure

The payload is an array of **Sensor Data** messages.

Sensor data consists of a **Data Type Identifier** byte followed by the **Data Value** as one or more bytes. The number of bytes in the data value is determined by the Data Type Identifier and is fixed. Details are here: Sensor Details.

Example Payload (hexadecimal): `01 01 23 02 56 03 01 A4`

These bytes can be split up as follows:

Finally, decoding the data:

Data Type Identifier	Data Value Calculation	Result
`0x01` - Temperature	((`0x01` * 256) + `0x23`) / 10 = (256 + 35) / 10	29.1 °C
`0x02` - Humidity	`0x56`	86 %rH
`0x03` - Ambient Light	(`0x01` * 256) + `0xA4` = 256 + 164	420 Lux

Each **Data Type** can use 1 or more bytes to send the value according to the following table:

Sensor Details

Type Hex Dec	Sensor	Sensor Range	Units	Num Bytes	Format	Scaling
0x01 001	Temperature	-40 to 85	°C	2	S16	/ 10
0x02 002	Humidity	0 to 100	%	1	U8	
0x03 003	Ambient Light	0.01 to 83k	lux	2	U16	
0x04 004	Pressure	300 to 1100	mbar	2	U16	
0x05 005	Volatile Organic Compounds (VOC) See: BOSCH Datasheet	0 to 500	IAQ	2	U16	
0x06 006	Oxygen	0 to 25	%	1	U8	/ 10
0x07 007	Carbon Monoxide	0 to 100	ppm	2	U16	/ 100
0x08 008	Carbon Dioxide (2 sensor ranges)	0 to 5000 or 0 to 50,000	ppm	2	U16	
0x09 009	Ozone (O3)	0 to 1 0 to 1000	ppm ppb	2	U16	/ 10000 / 10
0x0A 010	Air Pollutants: CO, Ammonia, Ethanol, H2, Methane / Propane / Iso-Butane.	100 to 1500 (Typ)	kΩ	2	U16	/ 10
0x0B 011	Particulate Matter 2.5	0 to 1000	µg/m3	2	U16	
0x0C 012	Particulate Matter 10	0 to 1000	µg/m3	2	U16	
0x0D 013	Hydrogen Sulphide (H_2S)	0 to 100	ppm	2	U16	/ 100
0x0E 014	Pulse ID + Pulse Counter	ID: 0 to 3 Value: 0 to 2^32	count	1 + 4	U32	
0x0F 015	MB ID + Modbus Exception	ID: 0 to 31 Error Num		1 + 1	U8	

Type Hex Dec	Sensor	Sensor Range	Units	Num Bytes	Format	Scaling
0x10 016	MB ID + Modbus Interval value	ID: 0 to 31 Interval Value		1 + 4	F32	
0x11 017	MB ID + Modbus Cumulative value	ID: 0 to 31 Cumulative Value		1 + 4	F32	
0x12 018	bVOC – VOC concentration		ppm	4	F32	
0x13 019	Detection count (PIR etc.)		count	4	U32	
0x14 020	Total occupied time		seconds	4	U32	
0x15 021	Change of State information	Change of State		3	U16	
0x16 022	Liquid Level Status	0 = No Liquid 1 = Detected	status	1	U8	
0x17 023	Probe 1 Temperature	-55 to 125	°C	2	S16	/ 10
0x18 024	Probe 2 Temperature	-55 to 125	°C	2	S16	/ 10
0x19 025	Probe 3 Temperature	-55 to 125	°C	2	S16	/ 10
0x1A 026	Time temperature probe 1 has spent in 'in band' zone		seconds	4	U32	
0x1B 027	Time temperature probe 2 has spent in 'in band' zone		seconds	4	U32	
0x1C 028	Time temperature probe 3 has spent in 'in band' zone		seconds	4	U32	
0x1D 029	Number of times in band alarm has been activated for temperature probe 1		count	2	U16	
0x1E 030	Number of times in band alarm has been activated for temperature probe 2		count	2	U16	
0x1F 031	Number of times in band alarm has been activated for temperature probe 3		count	2	U16	

Type Hex Dec	Sensor	Sensor Range	Units	Num Bytes	Format	Scaling
0x20 032	Time temperature probe 1 has spent below low threshold		seconds	4	U32	
0x21 033	Time temperature probe 2 has spent below low threshold		seconds	4	U32	
0x22 034	Time temperature probe 3 has spent below low threshold		seconds	4	U32	
0x23 035	Number of times low threshold alarm has been activated for temperature probe 1		count	2	U16	
0x24 036	Number of times low threshold alarm has been activated for temperature probe 2		count	2	U16	
0x25 037	Number of times low threshold alarm has been activated for temperature probe 3		count	2	U16	
0x26 038	Time temperature probe 1 has spent above high threshold		seconds	4	U32	
0x27 039	Time temperature probe 2 has spent above high threshold		seconds	4	U32	
0x28 040	Time temperature probe 3 has spent above high threshold		seconds	4	U32	
0x29 041	Number of times high threshold alarm has been activated for temperature probe 1		count	2	U16	
0x2A 042	Number of times high threshold alarm has been activated for temperature probe 2		count	2	U16	
0x2B 043	Number of times high threshold alarm has been activated for temperature probe 3		count	2	U16	
0x2C 044	Differential Pressure	+/- 5000	Pa	4	F32	
0x2D 045	Airflow	0 to 100	m/s	4	F32	

Type Hex Dec	Sensor	Sensor Range	Units	Num Bytes	Format	Scaling
0x2E 046	Voltage	0 to 10	Volts	2	U16	/ 1000
0x2F 047	Current	0 to 20	mA	2	U16	/ 1000
0x30 048	Resistance	0 to 10	kΩ	2	U16	/ 1000
0x31 049	Leak Detection (resistance rope)	0 = No Leak 1 = Detected	status	1	U8	
0x3F 063	CO_2e estimate equivalent		ppm	4	F32	
0x50 080	Sound Level Minimum		dB(A)	4	F32	
0x51 081	Sound Level Average		dB(A)	4	F32	
0x52 082	Sound Level Maximum		dB(A)	4	F32	
0x53 083	Nitric Oxide	0 - 100	ppm	2	U16	/ 100
0x54 084	Nitrogen Dioxide	0 – 5	ppm	2	U16	/ 10000
0x55 085	Nitrogen Dioxide	0 – 20	ppm	2	U16	/ 1000
0x56 086	Sulphur Dioxide	0 – 20	ppm	2	U16	/ 1000
0x57 087	Particulate matter mass concentration at PM1.0		$\mu g/m^3$	4	F32	
0x58 088	As above, PM2.5		$\mu g/m^3$	4	F32	
0x59 089	As above, PM4.0		$\mu g/m^3$	4	F32	
0x5A 090	As above, PM10.0		$\mu g/m^3$	4	F32	
0x5B 091	Particulate matter number concentration at PM0.5		$\#/cm^3$	4	F32	

Type Hex Dec	Sensor	Sensor Range	Units	Num Bytes	Format	Scaling
0x5C 092	As above, PM1.0		#/cm³	4	F32	
0x5D 093	As above, PM2.5		#/cm³	4	F32	
0x5E 094	As above, PM4.0		#/cm³	4	F32	
0x5F 095	As above, PM10.0		#/cm³	4	F32	
0x60 096	Particulate matter typical particle size		µm	4	F32	
0x61 097	Gas ID + Gas Concentration		ppb	1 + 4	F32	
0x62 098	Corrosion: Metal ID + Metal Thickness	~ 1000nm	nm	1 + 4	F32	
0x63 099	Corrosion: Metal ID + Minimum thickness		nm	1 + 2	U16	
0x64 100	Corrosion: Metal ID + Original thickness		nm	1 + 2	U16	
0x65 101	Corrosion: percentage of thickness between original thickness (100%) and minimum (0%)		%	1 + 4	F32	
0x66 102	Gas ID + Gas Concentration		µg/m³	1 + 4	F32	
0x67 103	Outdoor EPA Index Sensor Fast AQI (reading taken over 1 minute)	0 to 500	AQI	2	U16	
0x68 104	Outdoor EPA Index Sensor EPA AQI See: AirNow Technical Doc	0 to 500	AQI	2	U16	
0x69 105	Particulate matter mass concentration at PM0.1		µg/m³	4	F32	
0x6A 106	As above, PM0.3		µg/m³	4	F32	
0x6B 107	As above, PM0.5		µg/m³	4	F32	

Type Hex Dec	Sensor	Sensor Range	Units	Num Bytes	Format	Scaling
0x6C 108	As above, PM5.0		µg/m³	4	F32	
0x6D 109	Particulate matter number concentration at PM0.1		#/cm³	4	F32	
0x6E 110	As above, PM0.3		#/cm³	4	F32	
0x6F 111	As above, PM5.0		#/cm³	4	F32	

Decoding Complex Messages

Most sensor data values are self-explanatory, additional information for decoding more complex sensor data is given in the sections below.

Modbus

Types: `0x0F`, `0x10`, `0x11`

The enLink Modbus data types for Interval and Cumulative values use 5 bytes to encode the item index and value.

- Modbus Exception – standard Modbus exception codes, e.g. Code 2 – Illegal Data Address.
- Modbus Interval Value – for Modbus data types which do not accumulate, e.g. Voltage, Current, Temperature etc.
- Modbus Cumulative Value – for Modbus data types which are linked to a value which accumulates, e.g. kWh, Volume etc.

The first byte indicates which of the 32 available Modbus items is being accessed (0 to 31), followed by the Modbus Value represented as a 32 bit floating point value (IEEE754 format). Interval Value types are used for instantaneous values, such as Voltage, Current, Temperature, Pressure etc. Cumulative Values are used for items such as energy consumption and total volume.

Example Modbus Payload (hexadecimal): `10 04 41 BC 7A E1`

Payload Data:	10	04	41 BC 7A E1

This is an interval data value, from configured item number 5. The value is 23.56.

For an online converter, see Hex to Float Converter

Pulse Counters - Change of State

Type: `0x15`

The full message is sent as 3 bytes. The second byte indicates the reason for the radio transmission (Trigger Status), the third byte gives the open/close state of the inputs (Input State).

> Note: To enable the Change-of-State feature to transmit when a change is detected, the device configuration requires that **ATI** is enabled, and the **Transmit on Change of State** option is enabled.

The two data value bytes are bit-encoded as follows:

Trigger Status

- Bit 0 - Set to 1 when Input 1 Changed from *Closed* to *Open*
- Bit 1 - Set to 1 when Input 2 Changed from *Closed* to *Open*
- Bit 2 - Set to 1 when Input 3 Changed from *Closed* to *Open*
- Bit 3 - Not used
- Bit 4 - Set to 1 when Input 1 Changed from *Open* to *Closed*
- Bit 5 - Set to 1 when Input 2 Changed from *Open* to *Closed*
- Bit 6 - Set to 1 when Input 3 Changed from *Open* to *Closed*
- Bit 7 - Not used

If a message is received and the *trigger status* byte value is zero, then the message was either sent after a config button press, or because a regular transmission was scheduled. I.e. the ATI maximum interval has expired. In the NodeRed example decoder, this event is marked as a *heartbeat*.

You may receive a *trigger status* byte value where multiple bits are set. This could be that these events occurred before the radio packet could be sent. For example, a fast transition from *open -> closed -> open*. This may also be caused by a duty cycle restriction delaying the transmission, or the message sending was paused because a previous message was sent within the minimum ATI interval.

Input State

- Bit 0 - Input 1 state. Set to 1 when *Closed*
- Bit 1 - Input 2 state. Set to 1 when *Closed*
- Bit 2 - Input 3 state. Set to 1 when *Closed*
- Bit 3 - Not used
- Bit 4 - Not used
- Bit 5 - Not used
- Bit 6 - Not used
- Bit 7 - Not used

Example Payload (hexadecimal): `15 01 05`

Payload Data: 15 01 05

The example shows the transmission was triggered when Input #1 changed from *Closed* to *Open*, and the state of the inputs are:

- Input 1: Closed
- Input 2: Open
- Input 3: Closed

Gas Readings

Types: `0x61`, `0x66`

The full message is sent as 6 bytes. For example:

Payload (hexadecimal): `61 19 41 BC 7A E1`

Payload Data: 61 | 19 | 41 BC 7A E1

Ths translates to Gas Type `0x19` or 25 which is **Carbon Monoxide**. The value is 23.56ppb.

The Gas types are listed here:

`0x17` - Formaldehyde - HCHO / CH_2O	`0x1E` - Hydrogen Cyanide - HCN
`0x18` - Volatile Organic Compounds	`0x1F` - Hydrogen Fluoride - HF
`0x19` - Carbon Monoxide - CO	`0x20` - Ammonia - NH_3
`0x1A` - Chlorine - Cl_2	`0x21` - Nitrogen Dioxide - NO_2
`0x1B` - Hydrogen - H_2	`0x22` - Oxygen - O_2
`0x1C` - Hydrogen Sulphide - H_2S	`0x23` - Ozone - O_3
`0x1D` - Hydrogen Chloride - HCl	`0x24` - Sulphur Dioxide / Sulfur Dioxide (IUPAC) - SO_2

Corrosion

Types: `0x62`, `0x63`, `0x64`, `0x65`

The full message is sent as 6 bytes. The second byte indicates the coupon and sacrificial metal of the sensor.

Payload (hexadecimal): `62 01 44 58 D0 27`

Payload Data: 62 | 01 | 44 58 D0 27

The example shows Coupon #1 is Copper and the thickness is 867.252 nanometres (equivalent to 8672.52 Ångströms).

Other Coupon/Metal types are:

Coupon #1	**Coupon #2**
`0x00` - Unknown Metal / Error	`0x80` - Unknown Metal / Error
`0x01` - Copper	`0x81` - Copper
`0x02` - Silver	`0x82` - Silver

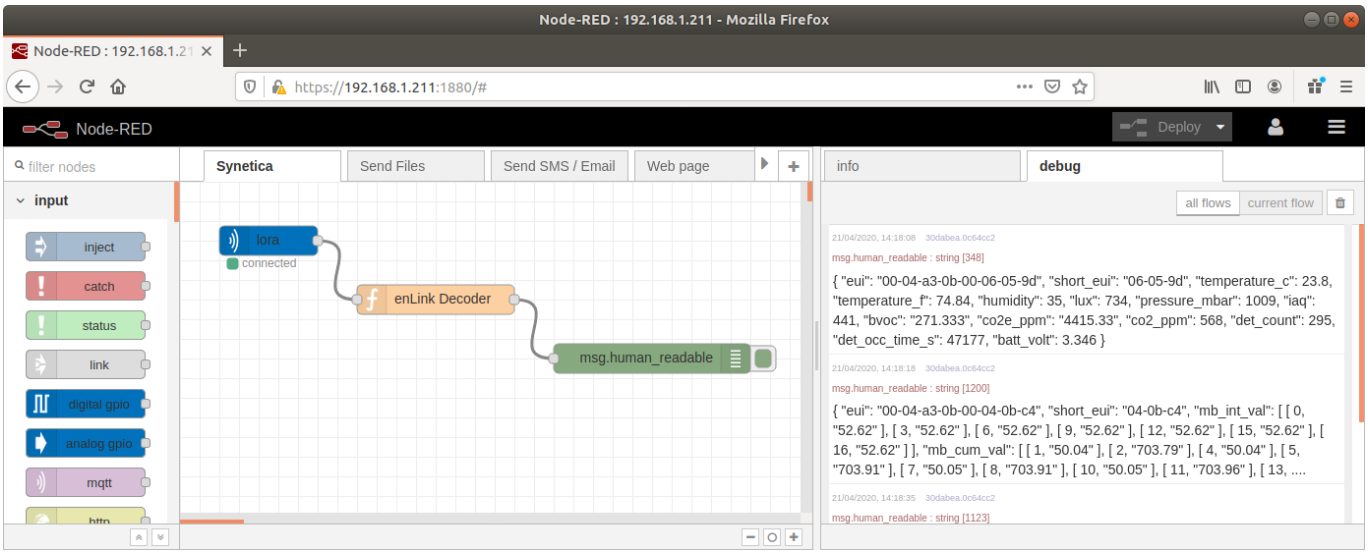
Coupon #1	Coupon #2
0x03 - Chromium	0x83 - Chromium

enLink KPI Payload Data

Each enLink end-node device can have optional Key Performance Indicators (KPI) added to the payload message. Each KPI can use 1 or more bytes to send the value according to the following table.

Type Hex Dec	KPI	Comments	Units	Num Bytes	Format
0x40 064	CPU Temperature	Packed Byte. See JS Code	°C	2	S16
0x41 065	Battery Status	0=Charging; 1 - 254 (1.8 - 3.3V); 255=Ext Power	status	1	U8
0x42 066	Battery Voltage	0 -> 3600 mV (3600=Ext Power)	mV	2	U16
0x43 067	RX RSSI	Received Signal Strength	dBm	2	S16
0x44 068	RX SNR	Received Signal-Noise Ratio	dB	1	S8
0x45 069	RX Count	Downlink message count	count	2	U16
0x46 070	TX Time	Time to send message	ms	2	U16
0x47 071	TX Power	Transmit power	dBm	1	S8
0x48 072	TX Count	Uplink message count	count	2	U16
0x49 073	Power up count	Number of times unit powered up	count	2	U16
0x4A 074	USB insertions count	Number of times USB activated	count	2	U16
0x4B 075	Login OK count	Successful logon count	count	2	U16
0x4C 076	Login fail count	Failed logon count	count	2	U16
0x4D 077	Fan runtime	Total time the air intake fan has run (AIR models only)	seconds	4	U32
0x4E 078	CPU Temperature	New from Ver: 4.9	°C	2	S16 /10

Example code for different LoRaWAN Network Servers (LNS) is included in the folders on this site.



Screenshot of example using NodeRED

Downlink Payload

Downlink payloads are sent to re-configure the device. When the device processes the payload, it acknowledges the message by transmitting an ACK/NACK and the identifier code. This is to notify the user that the message has been received. An example to decode the ACK/NACK messages that are sent from the end-node to the LNS is included in the NodeRED source.

Downlink Payload Structure

Header	Msg Len	Command	Value
1 byte	1 byte	1 byte	*n* bytes

The header byte is is always `0xA5`.

Msg Len is the number of bytes in the settings data. The settings data starts with a **Command** byte and then the command **Value**. The Value can be blank.

Downlink Receive Port

When the enLink device receives a downlink message, it first checks the port byte value. If this value matches the expected value, it then attempts to decode the message and process the result. By default the expected value is set to **All**, so it will, in effect, ignore the port value and simple decode and process the message. Only valid port values are allowed, as per the LoRaWAN Specification. These values are 1 to 223.

Settings Data Details

Name	Msg Len	Command	Value	Reboot Required?
Reboot	1	`0xFF`		
Public Network	2	`0x02`	`0`/`1` (Disable/Enable)	Yes
AppEUI	9	`0x05`	8 Bytes for the **EUI**	Yes
AppKey	17	`0x06`	16 bytes for the **Key**	Yes
Auto Data Rate (ADR)	2	`0x07`	`0`/`1` (Disable/Enable)	
Duty Cycle	2	`0x08`	`0`/`1` (Disable/Enable)	
Message Confirmation	2	`0x09`	`0`/`1` (Disable/Enable)	
Transmit Port	2	`0x0A`	`1` to `223` (Default is 1)	
Default Data Rate Index	2	`0x0B`	`1` to `6` (Requires ADR disabled)	
Transmit Interval Index	2	`0x0C`	`1` to `10`	

Name	Msg Len	Command	Value	Reboot Required?
Transmit Power Index	2	0x0D	1 to 6	
Receive Port	2	0x0E	0 to 223 (0 indicates **All** Ports. Default is **All**)	

The following are used in the AQM/Air, Zone and ZonePlus (with Light Sensor)

Name	Msg Len	Command	Value	Scaling
Lux Scale Parameter	3	0x20	0 to 65535	/1000 (0xFFFF represents 65.535)
Lux Offset Parameter	3	0x21	0 to 65535	None (0xFFFF represents 65535)

The following are used in the AQM/Air

Name	Msg Len	Command	Value
Case Fan Run Time	3	0x22	10 to 600 Seconds
HPM Particulate Fan Run Time (Discontinued)	3	0x23	10 to 60 Seconds

The following are used in devices with CO_2 sensor

Name	Msg Len	Command	Value
Enable/Disable Auto-Calibration	2	0x24	0/1 (Disable/Enable)
Set Target CO_2 Level	3	0x25	100 to 1000 ppm
Set to Known CO_2 Level	3	0x26	10 to 2000 ppm
Reset to factory Calibration **Only Sunrise model**	1	0x27	
Set Regular Auto-Cal Interval	3	0x28	24 to 8760 hours
Set the Out-of-Bounds limits **Only GSS model**	3	0x29	10 to 5000 ppm
Set initial auto-cal interval **Only GSS model**	3	0x2A	1 to 8760 hours

The following are used in devices with particulate sensors (SPS30 or IPS7100)

Name	Msg Len	Command	Value
Set fan run period (Sample time)	2	0x2B	3 to 180 Seconds
Set cleaning interval	3	0x2C	6 to 1440 hours

Downlink Message Examples

Reboot

Payload Data: A5 01 FF

Enable Message Confirmation

Payload Data: A5 02 09 01

Downlink Message Index Tables

The Indexes for some settings depend on the region the unit is programmed for.

`0x0B` - Data Rate Index

Index	EU868	Index	US915 Hybrid
0	DR0 SF12 BW125	0	DR0 SF10 BW125
1	DR1 SF11 BW125	1	DR1 SF9 BW125
2	DR2 SF10 BW125	2	DR2 SF8 BW125
3	DR3 SF9 BW125	3	DR3 SF7 BW125
4	DR4 SF8 BW125	4	DR4 SF8 BW500
5	DR5 SF7 BW125		

`0x0C` - Transmit Interval Index

Index	Transmit Interval	Message
1	30 s	`A5 02 0C 01`
2	1 min	`A5 02 0C 02`
3	2 min	`A5 02 0C 03`
4	5 min	`A5 02 0C 04`
5	10 min	`A5 02 0C 05`
6	15 min	`A5 02 0C 06`
7	20 min	`A5 02 0C 07`
8	30 min	`A5 02 0C 08`
9	1 hour	`A5 02 0C 09`
10	2 hours	`A5 02 0C 0A`
11	3 hours	`A5 02 0C 0B`

`0x0D` - Transmit Power Index

Index	EU868	Index	US195 Hybrid
1	16 dBm	6	20 dBm
2	14 dBm	7	18 dBm
3	11 dBm	8	16 dBm
4	9 dBm	9	14 dBm
5	8 dBm	10	12 dBm
6	6 dBm	11	10 dBm
7	4 dBm		
8	2 dBm		

Settings for Lux Sensor

To scale the lux reading to compensate for the enclosure light pipe, a scaling factor is applied to the sensor value:

> Adjusted_Reading = (Sensor_Value x Scale) + Offset

Defaults are:

- Scale = **2.0** (AQM/AIR), **1.678** (Zone and ZonePlus)
- Offset = **0** (All devices)

For example, set Scale to **12.345** (12345 in hexadecimal is `0x3039`)

> Message is: `A5 03 20 30 39`

Settings for CO_2 Sensors

To Enable Auto-Calibration:

> Message is: `A5 02 24 01`

To set the auto-calibration target to 450ppm

> Message is: `A5 03 25 01 C2`

To set the sensor to known CO_2 concentration of 780ppm (`0x030C`)

> Message is: `A5 03 26 03 0C`

To reset the sensor back to factory calibration (Sunrise Only)

> Message is: `A5 01 27`

To set the auto-calibration interval to 10 days (240 hours, 0x00F0)

> Message is: `A5 03 28 00 F0`

Settings for Particulate Sensors

To set the fan run period to 35 seconds:

> Message is: `A5 02 2B 23`

To set the cleaning interval to 8 days (192 hours, 0x00C0)

> Message is: `A5 03 2C 00 C0`

Example Uplink Replies to Downlink Messages

ACK (`0x06`) - Successfully changed the Message Confirmation Option (`0x09`)

> Return code: `A5 06 09`

NACK (`0x15`) - failed to change the Transmit Port (`0x0A`)

> Return code: `A5 15 0A`

Sample Code

A NodeRED example for decoding these messages is included in the folders on this site. It is so visual feedback can be seen during evaluation and commissioning. If you require these messages in your system, please modify the code to suit your platform.