Logger LTE
User Manual

Contents

9-5988-07

1. Product Description

The 4G NB-IoT/CAT-M1 logger is a flexible and configurable battery-operated, ATEX certified multipurpose data logger, suitable for monitoring fuel tanks levels and flow rates.
The logger contains an integrated cellular modem supporting (2G), LTE-CAT M1 & NB-IoT networks which communicates data in a binary message to a remote server via a TCP connection.
The logger contains an internal temperature logger which measures the temperature and a reed switch for activation and initiating manual measurements.

1.1 Abbreviations/Definitions

The following is a list of terms that may be found in this document.

RSSI	Received Signal Strength Indicator
CRC	Cyclic Redundancy Check
RTC	Real Time Clock
HW	Hardware
FW	Firmware
Ack	Acknowledgement from the network server
Message	The data packet / payload / datagram sent across the network
MSB	The Most Significant Bit is the left-most bit in the string
Payload	Data transmitted between logger and network
0x	Identifies the number as hexadecimal. Note: numbers are assumed decimal unless specified otherwise.
0b	Identifies the number as binary. Note: numbers are assumed decimal unless specified otherwise.
Unsigned byte	Will only allow you to represent numbers in the positive range
Signed byte	Will allow you to represent numbers both in the positive and negative ranges
IoT	Internet of Things
Dormant	Dormant units are inactivated to ensure the longest battery service life
POR	Power Out Reset
BOR	Brown Out Reset

2. Configuring Device

2.1 Network Server Response

Every time a logger makes an outgoing status connection to the gateway, the network server has the option to respond with configuration settings to alter the operation of the device.
Sending responses to the logger is very useful for tasks such as changing the connection schedule. Care must be taken, as sending the wrong settings could render the device incapable of correct operation.

2.2 Message Types

The logger transmits or receives several packet types.

The standard message is referred to as a message type 4 and is transmitted based on a schedule defined by S2 Schedule Configurator register.

For message type 4, the unit transmits only the updates to the 28-position log i.e., only those values that have changed since the last transmission.

In the event of an alarm condition, the unit transmits a message type 8 which transmits the contents of the faster buffer log as this is the data that will have triggered the alarm.

Message Type	Description
Message 4	**Standard results from logger.** (Most common Message type) The scheduled data upload is referred to as a message type 4 and will contain new logging buffer values since the last schedule upload, along with additional information.
Message 6	**Logger Settings.** A message type 6 can be requested from the logger with the command R1=02, R1 = 04 or R1 = 08. A message type sends the contents of the S registers (and may be truncated to 140 bytes if configured to send data via SMS). The response to R1=02 is the settings starting from S0, R1=04 is the settings starting from S12 and R1=08 is the settings starting from S19.
Message 8	**Similar to message 4 with alarms or logger waking up.** A message 8 is transmitted when an alarm is activated or when the logger is activated with a magnet. A message type 8 contains the measurement values contained in the sampling buffer (because these are the values used to trigger the alarm). The exception to this is a no change alarm in which case a message type 4 is transmitted (with the logger buffer values as those are the data points used for that particular alarm).
Message 9	**Similar to message 4 with alarms.** A message 9 is transmitted when a predefined offset time (S29) has passed after the dynamic alarm 1 (S7) was triggered. A message type 9 contains the ullage values from the sampling buffer. It can be useful for analysing filling and emptying events.
Message 16	**ICCID and modem information.** A message type 16 is sent to the server when the command R6=02 is received by the logger. This message type also contains additional status information.
Message 17	**GPS information.** A message type 17 is sent to the server when the command R7=FF is received by the logger. FF = timeout (Hex, seconds). This message type also contains additional status information. NOTE: From firmware v4.2 and succeeding versions, when message 17 is requested, the unit closes temporarily the TCP-IP connection. Once the GPS data is collected or the timeout occurs, a new connection is established delivering message type 17.

2.2.1 Header Message

The header of the message is always the same for all message types up to byte 16.
The following table contains the 16-byte header message.
**Please note that all Hexadecimal entries require CAPITAL lettering.*

2.2.1.1 Product ID reference

**See 9-5965 Product ID reference document*

Byte 15 highlights the message type and therefore how to interpret the rest of the message.

Sample Payload: (Payloads are Hexadecimal)
0801810486147508610750210045510 47B 0001970000008 2010F0A5B28770A5B28770A5B28760A5B28770A5B287
70A5B28770A5B28770A5B28760A5B28760A5B28760A5B28760A5B28760A5D28770A5D2877
0A5D28770A5D28770A5D28770A5D28770A5D28770A5D28770A5D28770A5D28770A5F287700000000000000000000
0000000EEBA

Byte#	Payload	Description	Notes	Result
0	08	Defines the product type	0x08 = TEK 822 *(See section 2.2.1.1)*	TEK 822
1	01	Defines the Hardware Revision Major 5 bits of Byte 1 = 0 (BG96) or 1 (BG95) Minor 3 bits of Byte 1 = 1 -> Pcb Rev1	Major 5 bits of 0x01 = 0b00000 = 0 Minor 3 bits of 0x01 = 0b001 = 1	BG96/pcb rev01
2	81	Defines the Firmware Revision Minor 5 bits of Byte 2 = FW Major Revision Major 3 bits of Byte 2 = FW Minor Revision	Minor 5 bits of 0xC1 = 0b00001 = 1 Major 3 bits of 0xC1 = 0b100 = 4	1.4
3	04	Defines the reason for contact *(See Section 2.2.1.2)*	0x04 = 0b00000100	Server Request
4	86	Defines the Status of Alarms *(See Section 2.2.1.3)*	0x86 = 0b10000110	Active Lim3 Lim2
5	14	Defines the RSSI value of the LTE module	0x14 = 20	20
6	75	Defines battery, RTC & LTE status and battery percentage *(See section 2.2.1.4)*	0x75 = 0b01110101 Batt = (21 x 100) / 31	LTE Act RTC Set Batt = 67.7%
7	08	Defines the IMEI number	Combination of bytes 7 to 14	IMEI = 0861075021004551
8	61			
9	07			
10	50			
11	21			
12	00			
13	45			
14	51			
15	04	Defines the Message Type Minor 6 bits = Message Type	Minor 6 bits of 0x04 = 0b000100 = 4	Message Type 4
16	7B	Defines the length of the following payload (Bit5&Bit4 of byte 15 x 256) + Byte 16	• 0x04 = 0b00000100 = 0 • 0x7B = 123 (0 x 2^8) + 123 = 123	123

2.2.1.2 Contact Reason

Binary breakdown for contact reason:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Dynamic Limit2 Status	Dynamic Limit Status	TSP Requested	Reboot	Manual	Server Request	Alarm	Scheduled

0 = Inactive
1 = Active

2.2.1.3 Alarm/Status

Binary breakdown for alarm status:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Active	*Reserved*	*Reserved*	*Reserved*	Bund Status	Limit 3	Limit 2	Limit 1

0 = Inactive
1 = Active

Bit3: (Bund closed if Set)
Flag will be set if Bund switch closed.

2.2.1.4 Battery/Status

Binary breakdown for battery status:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	LTE Act	RTC Set	Battery Percentage				

0 = Inactive
1 = Active

- Battery Percentage = (5 Minor bits x 100) / 31

2.2.2 Message Type 4, 8 & 9

The following table is for a standard Message type 4 payload. Message type 8 will also follow this format.
This is a continuation of the preceding header message format, section 2.2.1.

Sample Payload: (Payloads are Hexadecimal)
0801C2828E14750861075021004551047B00019700000082010F0A5B28770A5B28770A5B28760A5B28770A5B28770A5B28770A5B28770A5B28760A5B28760A5B28760A5B28760A5B28760A5B28760A5D28770A5D28770A5D28770A5D28770A5D28770A5D28770A5D28770A5D28770A5D28770A5F2877000000000000000000000000EEBA

Byte#	Payload	Description	Notes	Result
15	04	Defines the Message Type Minor 6 bits = Message Type	Minor 6 bits of 0x04 = 0b000100 = 4	Message Type 4
16	7B	Defines the length of the following payload (Bit5&Bit4 of byte 15 x 256) + Byte 16	• 0x04 = 0b00000100 = 0 • 0x7B = 123 (0 x 2^8) + 123 = 123	123
17	00	Defines the message count (Byte 17 x 2^8) + Byte 18	(0x00 x 2^8) + 0x01 (0 x 2^8) + 1 = 1	1
18	01			
19	97	Defines the Try Tickets remaining Major 3 bits of byte 19	Major 3 bits of 0x97 0b10010111 → 100 = 4	4
20	00	Defines the last error code (FW≤v3.0) Defines the energy used (FW>v3.0) Combine Byte 20 & Byte 21	0x0000 = 0	0
21	00			
22	00	N/A	N/A	N/A
23	82	Defines the logger speed *(See section 2.2.2.1)*	0x82 = 0b10000010 → 2 x 15 = 30 mins → 0 hours 30 mins = 00:30	00:30
24	01	Count of 10-second increments taken for logging in to network + seconds to connect to GPRS server	0x01 = 1	1
25	0F	Defines the Real Time Clock (hh:mm:ss) Minor 5 bits of Byte 19 : Byte 25 : 00	0x97 = 0b10010111 → 10111 = 23 hours 0x0F = 15 mins	23:15:00
26-29	0A5B2877	Data 0	*See section 2.2.2.2*	*See section 2.2.2.2*
30-33	0A5B2877	Data 1		
34-37	0A5B2876	Data 2		
38-41	0A5B2877	Data 3		
42-45	0A5B2877	Data 4		
4649	0A5B2877	Data 5		
50-53	0A5B2877	Data 6		
54-57	0A5B2876	Data 7		
58-62	0A5B2876	Data 8		
62-65	0A5B2876	Data 9		
66-69	0A5B2877	Data 10		
70-73	0A5B2876	Data 11		
74-77	0A5B2876	Data 12		
78-81	0A5B2876	Data 13		
82-85	0A5D2877	Data 14		
86-89	0A5D2877	Data 15		
90-93	0A5D2877	Data 16		
94-97	0A5D2877	Data 17		
98-101	0A5D2877	Data 18		
102-105	0A5D2877	Data 19		
106-109	0A5D2877	Data 20		
110-113	0A5D2877	Data 21		
114-117	0A5D2877	Data 22		
118-121	0A5D2877	Data 23		
122-125	0A5F2877	Data 24		
126-129	00000000	Data 25		
130-133	00000000	Data 26		
134-137	00000000	Data 27		
138-139	EEBA	N/A		

2.2.2.1 Logger Speed

- If byte 23 = 00 then the result = 1
- If byte 23 = 80 then the result = 15
- If byte 23 ≠ 00 & byte 23 ≠ 80 then use minor 7 bits of byte 23 and multiply the result by 15.
- Result in minutes, convert to hours and then to 24-hour format (hh:mm)

Example:

Byte 23 = 55

- 0x55 = 0b01010000 → 85
- 85 x 15 = 1275minutes = 21.25 hours = 21 hours 15 minutes = 21:15

2.2.2.2 Measurement

Example: Byte 26 – 29 = 0x0A5B2877

RTC	Data	Aux1	Aux2	ºC
RTC (Data 0): This is the measurement timestamp of the scheduled measurement sample taken immediately before the payload delivery. **RTC: (Data 1 – 27)** Subtract the logger speed from the RTC (Data 0) time to get this measurement timestamp.	This is the measurement taken by the logger. Combine nibble3&nibble2 with nibble1&nibble0" ADC or percentage result taken from the 10 minor bits of this combination. Example: Bytes 26-29 = 0x0A5B2877 (0x28 = 0b00101000) (0x77 = 0b01110111) Combo = 0b0010100001110111 → 0b0001110111 = 119	Should always be 10. 4 major bits starting at bit 5 of Byte 28. Example: Byte 28 = 0x28 → 0b1010 = 10	Should always be 10. Represented by Byte 26 Example: Byte26= 0x0A = 10	This is the temperature reported by the logger, measured in °C. Bit5&Bit4 divided by 2. Subtract 30 from the result. Example: Byte26-29=0x0A5B2877 0x5B = 91 91/2 = 45.5 45.5 - 30 = 15.5°C

Description	Byte#	Payload	RTC	%	AUX1	AUX2	ºC
Data 0	26	0A5B2877	23:15	119	10	10	15.5
Data 1	30	0A5B2877	22:45	119	10	10	15.5
Data 2	34	0A5B2876	22:15	118	10	10	15.5
Data 3	38	0A5B2877	21:45	119	10	10	15.5
Data 4	42	0A5B2877	21:15	119	10	10	15.5
Data 5	46	0A5B2877	20:45	119	10	10	15.5
Data 6	50	0A5B2877	20:15	119	10	10	15.5
Data 7	54	0A5B2876	19:45	118	10	10	15.5
Data 8	58	0A5B2876	19:15	118	10	10	15.5
Data 9	62	0A5B2876	18:45	118	10	10	15.5
Data 10	66	0A5B2877	18:15	119	10	10	15.5
Data 11	70	0A5B2876	17:45	118	10	10	15.5
Data 12	74	0A5B2876	17:15	118	10	10	15.5
Data 13	78	0A5B2876	16:45	118	10	10	15.5
Data 14	82	0A5D2877	16:15	119	10	10	16.5
Data 15	86	0A5D2877	15:45	119	10	10	16.5
Data 16	90	0A5D2877	15:15	119	10	10	16.5
Data 17	94	0A5D2877	14:45	119	10	10	16.5
Data 18	98	0A5D2877	14:15	119	10	10	16.5
Data 19	102	0A5D2877	13:45	119	10	10	16.5
Data 20	106	0A5D2877	13:15	119	10	10	16.5
Data 21	110	0A5D2877	12:45	119	10	10	16.5
Data 22	114	0A5D2877	12:15	119	10	10	16.5
Data 23	118	0A5D2877	11:45	119	10	10	16.5
Data 24	122	0A5F2877	11:15	119	10	10	17.5
Data 25	126	00000000	10:45	0	0	0	-30
Data 26	130	00000000	10:15	0	0	0	-30
Data 27	134	00000000	09:45	0	0	0	-30

2.2.3 Message Type 6

The Message type 6 will contain the header message, followed by the settings of the unit.
This is a continuation of the preceding header message format, section 2.2.1.

Sample Payload: (Payloads are Hexadecimal)

08018224E0146F0861075021004551 06EB 53303D38302C53313D30352C53323D3746303033382C53333D30312C53343D303831452C53353D383833322C53363D383834362C53373D30302C53383D30302C53393D2B333533383631373536333634 2C5331303D2C5331313D54454B3832322C5331323D73747265616D2E636F2E756B2C5331333D73747265616D69702C5331343D73747265616D69702C5331353D38342E35312E3235302E3130342C5331363D393030302C5331373D373230302C5331383D43382C5331393D30302C5332303D30302C5332313D2C5332323D2C5332333D31332C5332343D30302C5332353D30302C5332363D3130

08018224E0146F086107502100455 is the message header, as defined in section 2.2.1

06EB Message Type 6, 235 bytes to follow.

53303D38302C53313D30352C53323D3746303033382C53333D30312C53343D303831452C53353D383833322C53363D383834362C53373D30302C53383D30302C53393D2B333533383631373536333634 2C5331303D2C5331313D54454B3832322C5331323D73747265616D2E636F2E756B2C5331333D73747265616D69702C5331343D73747265616D69702C5331353D38342E35312E3235302E3130342C5331363D393030302C5331373D373230302C5331383D43382C5331393D30302C5332303D30302C5332313D2C5332323D2C5332333D31332C5332343D30302C5332353D30302C5332363D3130

Message Body

The Message Body is asci hex coded binary is simply converted to an ascii string.
Each 2-character pair converts to an asci character.
E.g., 0x53 converted to a decimal value = 83. Decimal 83 converts to character ‘S’ from asci tables.
hiip://www.asciitable.com/
Using online convertor such as hiips://www.rapidtables.com/convert/number/hex -to-ascii.html

Converted to ascii:
S0=80,S1=05,S2=7F0038,S3=01,S4=081E,S5=8832,S6=8846,S7=00,S8=00,S9=+353861756364,S10=,S11=TEK822,S12=stream.co.uk,S13=streamip,S14=streamip,S15=84.51.250.104,S16=9000,S17=7200,S18=C8,S19=00,S20=00,S21=,S22=,S23=13,S24=00,S25=00,S26=10

Which is the complete string of Settings for the unit, each setting parameter is delimited using a comma.

2.2.4 Message Type 16

The following table is for a standard Message type 16 payload.

Sample Payload: (Payloads are Hexadecimal)
0801C10480134008664250311713761048B2C383938383233393030303030323838393532333362C31393837352C33382C34302C31333631322C302C39313133312C31383030342C31322C3234303631392C31343336302C32382C60BB

0801C10480134008664250311713761 is the message header, as defined in section 2.2.1

104B Message Type 16, 75 bytes to follow.

2C383938383233393030303030323838393532333362C31393837352C33382C34302C31333631322C302C39313133312C31383030342C31322C3234303631392C31343336302C32382C60BB
Message Body

The Message Body is asci hex coded binary is simply converted to an ascii string.
Each 2-character pair converts to an asci character.
E.g., 0x53 converted to a decimal value = 83. Decimal 83 converts to character 'S' from asci tables.
hiip://www.asciitable.com/
Using online convertor such as hiips://www.rapidtables.com/convert/number/hex -to-ascii.html

Converted to ascii:
ICCID: 89882390000028895236
Energy Used to Date: 19875
Min Temp: 38
Max Temp: 40
Message Count: 13612
Count of Delivery Fail: 0
Total Send Time: 91131 *(Can be used in conjunction with message count to determine average send time)*
Max Send Time: 18004
Min Send Time: 12
RSSI Total: 240619 *(Can be used in conjunction with RSSI Valid Count to determine average RSSI)*
RSSI Valid Count: 14360
RSSI Fail Count: 28

2.2.1 Message Type 17

The following table is for a standard Message type 17 payload.

Sample Payload: (Payloads are Hexadecimal)
0801C1048013400866425031171376114924C39352C3133343434322E302C353235352E393935304E2C3030383332
2E34343137572C312E392C3132372E382C322C302E30302C302E302C302E302C3032313031352C30342C8843

0801C1048013400866425031171376 is the message header, as defined in section 2.2.1

1149 Message Type 17, 73 bytes to follow.

2C39352C3133343434322E302C353235352E393935304E2C30303833322E34343137572C312E392C3132372E382C
322C302E30302C302E302C302E302C3032313031352C30342C8843
Message Body

The Message Body is asci hex coded binary is simply converted to an ascii string.
Each 2-character pair converts to an asci character.
E.g., 0x53 converted to a decimal value = 83. Decimal 83 converts to character 'S' from asci tables.
hiip://www.asciitable.com/
Using online convertor such as hiips://www.rapidtables.com/convert/number/hex -to-ascii.html

Converted to ascii:
GPS Time to Fix: 95
UTC (Format: hh:mm:ss.s): 134442.0
Latitude (Forrmat: ddmm.mmmm N/S): 5255.9950N
Longitude (Format: dddmm.mmmm E/W): 00832.4417W
Horizontal precision (0.5-99.9): 1.9
Altitude: 127.8
GNSS positioning mode: 2
Ground heading based on true north (Format: ddd.mm): 0.00
Speed over ground (Format: xxxx.x, unit: Km/h): 0.0
Speed over ground (Format: xxxx.x, unit: knots): 0.0
Date (Format: ddmmyy): 021015
Number of satellites (From 00 to 12): 04

3. Description of Data Transmission

3.1 S-Parameters (Settings)

The logger is configured using the following S parameters. Blank values are undefined and can lead to inconsistent operation.

S-	Parameter	Description
S0	S-Logger Config	• How often a unit should store a reading. • How often a measurement is taken.
S1	Listen Config	• How long the unit remains active after powering up (Multiples of 5 minutes, Max of 155 minutes)
S2	Schedule Config	• Set schedule for when unit is to log data to server (Maximum activity = daily, every 2 hours)
S3	Control configurator	• Access Technology: (NBIOT/CATM1/2G) • CRC checking • Bund Alarm
S4 & S5 & S6	Static alarms	• Alarm if measurement is higher or lower than a selected height.
S7 & S8	Dynamic alarms	• Alarm if measurement is rising or falling at a rate greater than selected.
S9	Primary Server SMS Phone number	• SMS fall back phone number.
S10	Reserved	• N/A
S11	Unit Password	• Password required in order to update or change settings to unit.
S12	PDP APN	• Access Point Name. Name of the gateway to the server.
S13	PDP APN Username	• APN Username.
S14	PDP APN Password	• APN Password.
S15	Destination Server IP address or URL	• IP address or URL for server that unit is required to issue data to.
S16	Destination Server Port number	• Port number for server that the unit is required to issue data to.
S17	Battery Capacity (in mA Hrs)	• Determined by the battery capacity
S18	F-Stop	• For Ratiometric Gauges, to calibrate Max voltage reading Out to 100(Full) (or 1000)
S19	Control3 Configurator	• APN Auth Type: PAP or CHAP or None
S20	E-Stop	• For Ratiometric Gauges, to calibrate Min voltage reading Out to Zero (Empty)
S21	MCC MNC (Network Operator Short Code)	• Mobile Country Code / Mobile Operator Code
S22	Operating Band Code	• LTE only
S23	Message deliver try configurator	• How many attempts to make data drop before falling back to SMS. • Time between attempts.
S24	Schedule delay	• How many minutes of a delay from the schedule set as S2.
S26	Control2 configurator	• Reserved Functions
S29	Control4 Configurator	• Reserved Functions

3.2 Data recording – S0

The logger data is sampled and stored at various rates and stored in 2 different buffers, referred to as "Logging buffer" (Message type 4) and "Sampling buffer" (Message type 8).
The rate at which the sampling buffer is filled is the sampling period and can be set at once per minute or once every 15 minutes (set by the MSB of S0). The sampling buffer has 10 positions so will fill in either 10 minutes or in 2 hours and 30 minutes, depending on the setting of S0.
The rate at which the logger is filled is referred to as the logger speed and the rate at which it is filled can be set from once every 15 minutes up to once every 31 hours (in increments of 15 minutes) using the lower 7 bits of S0.
The log samples are synchronised to the real-time clock i.e., samples will be taken on the hour and multiples of 15 minutes after that. The log has 28 positions. Therefore, the logger will cover a minimum period of 28 x 15 minutes = 7 hours or a maximum of 31 x 28 hours = 868 hours. Each time a new sample is taken the oldest sample "drops off" the end of the log.

3.3 Listen time – S1

Once the unit has delivered its payload it can be configured to stay on the network in listen mode to pick up any commands that the user may wish to send to it. The duration that the unit will stay in listen mode after a scheduled upload is defined by the S1 setting. The listen time is set in increments of 5 minutes up to a maximum of 155 minutes (0 = 60 seconds). When the unit receives an SMS or TSP command the timer is reset, with the exception of an R1=80 command (see section 3.17) which will cause the module to shut down and enter sleep mode.
The duration that a unit remains connected to the network is critical for battery life which must be balanced with allowing sufficient time for commands to be received. (Maximum recommended of 10 minutes)
Unit will emit a beep once every 4 seconds when not sending or receiving data.
When the unit receives data, it will emit a high beep followed directly by a low beep.
When the unit has sent data, it will emit a low beep followed directly by a high beep.

3.4 Schedule configurator – S2

The system will upload the data from the logging buffer at regular intervals defined by settings in the S2 register (only values since the last scheduled upload will be transmitted). (See section 3.16.3)
The unit can be configured to send data once per day on particular days of the week or can be configured to send more regularly i.e., every 2 hours or 4 hours, between specific times. These settings can also be overwritten to have unit send data fortnightly or monthly.

3.5 Communication channels – S3 & S26

The unit can communicate over LTE or GPRS. The default communication is over LTE with the unit falling back to SMS in the event of the communications being unsuccessful. These settings can be changed using S3 and S26. Alternatively, S26 can be used to disable SMS fall back (bit 0) or S26 bit 1 can be set to allow SMS on alarm only (but not for scheduled uploads). Note that bit 1 overrides this setting i.e., bit 1 disables SMS in all instances. Bit 2 of S26 can be used to disable text back queries (see SMS text back section)

3.6 CRC checking – S3

CRC is a Cyclic Redundancy Check added to the end of any message sent to the unit and is used for basic message integrity. This feature can be enabled/disabled via bit 4 of S3.

3.7 Alarms – S4, S5, S6, S7 & S8

Static Alarm: Static alarms are based on the sampled values. There are three separate static alarms configured by S4, S5 and S6. These can be configured to alarm when the measured value is higher or lower than the defined threshold and a hysteresis value can also be defined. Note that the unit adds 3cm to the hysteresis value entered to compensate for any jitter in the measurement. When a static alarm is activated, an immediate message type 8 is sent to the server – see section on message types for further information.

Dynamic Alarm: Dynamic alarms are based on entries in the sample buffer. When a dynamic alarm is triggered an immediate message type 8 is sent to the server – see section on message types for further information. There are up to 2 dynamic alarms configured with S7 and S8.
S7 can initiate a countdown timer for the unit to transmit a message containing data from the sampling buffer. The rate-of-change (ROC) alarms are calculated using the current and previous readings. This can be useful to detect fill and empty events. For more details refer to S29.
S8 can also operate as No-Change alarm (NCA), depending on S26 configuration. The NCA is calculated using the current and 10th oldest reading. The polarity defined on S8 sets the direction which the content being monitored is expected to change, in order to avoid triggering an alarm. The alarm is triggered if the content is changing slower or equal than the expected change, the content is static or the content is changing in reversed direction.

Note that it is recommended that a minimum of 5% change is looked for over the full log which sets limitations on possible settings.

3.8 Standard communications – S9, S10, S12, S13, S14,S15 & S16

When communicating the unit connects to the network with settings defined in S12, S13 and S14 (PDP APN, username and password). The data will be sent to the IP address and port number stored in S15 and S16 respectively. The server at this IP address can then pick up communications coming on this port and parse as per detailed in section 3.16.7.

3.9 System password – S11

Any commands sent to the unit need to start with the password set in S11. The default password is TEK822.

3.10 Battery capacity in mA hrs – S17

This is a 5-character ASCII string which defines the capacity of the battery installed in the logger in mA hours.

Example Values	
"A" Size Capacity	3600
Double “A” Pack	7200
"C" Size Capacity	7700
"D" Size Capacity	17500

3.11 F-Stop (Force Stop) – S18

This is used to calibrate ratio-metric gauges maximum voltage reading.

3.12 Control3 Configurator – S19

Allows to set APN authentication type.

3.13 E-Stop (Empty output voltage) – S20

This is used to calibrate ratio-metric gauges minimum voltage reading to zero (empty).
Example:
An empty stop value representing 0.25V will have an empty stop value of 0x0A.
A value of 0.02 V represents a value of 0x01. The formula for e-stop value is the following:
(200 x voltage)/5 rounded to the nearest integer. This number is then converted to hexadecimal.
The minimum value is therefore 0.02V.

3.14 Retry configurator – S23

In the event of the unit not being able to deliver its payload successfully it can make a number of subsequent attempts to deliver the data. The total number of attempts that the unit will make can be configured using S23. Note that in the event of SMS being enabled (see section on Communication Channels), the last try attempt will be via SMS.

3.15 Schedule delay – S24

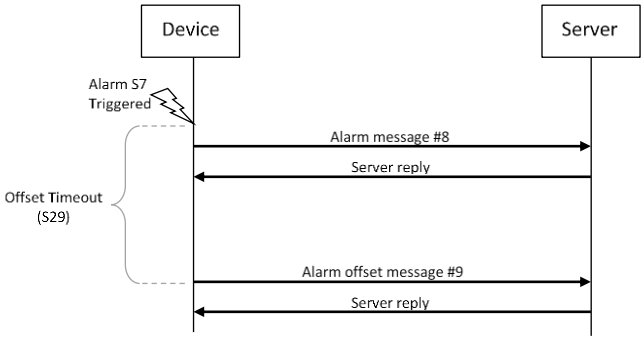
The S2 register can define the upload schedule in increments of 15 minutes. If a number of units are installed together this can lead to excessive network traffic at these times. A different schedule delay can be configured for each unit to overcome such a problem. S24 is used to configure the delay in minutes from the schedule upload time configured by S2.

3.16 Control2 configurator – S26

The S26 register defines the SMS control and formatting of ADC sensor data for the logger.

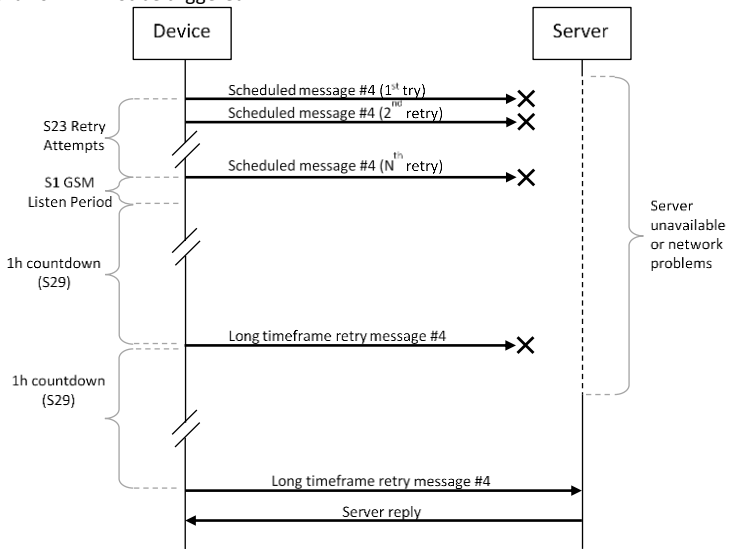
3.17 Dynamic Alarm 1 Offset Timer – S29

When the dynamic alarm 1 (S7) is triggered, a second message can be sent to the server, after a pre-selected period has passed. This can be useful to detect fill or empty events. The message will be reported as type #9 and it contains data from the sampling buffer, at a sample rate defined on S0. This option can be enabled via S29.



3.18 Long Timeframe Retry – S29

In the event of the unit not being able to deliver its scheduled payload, after all attempts (S23) and GSM listen period (S1), the unit will start successive single attempts, with 1-hour period. This will continue until the payload is delivered or a new scheduled message is triggered. Any off-schedule message, even if successfully delivered, doesn't override a pending long timeframe retry message. This retry mechanism is only available for scheduled messages and it is enabled by default. It can be disabled using S29.
NOTE: When the scheduled message is not delivered due to supercapacitor undervoltage, the 1-hour retry mechanism will not be triggered.



3.19 Manual wakeup

Holding a magnet to the hot spot will cause the unit to take 10 sample readings in quick succession, filling the sampling buffer, and will transmit this data in a message type 8 to the server. Therefore, the contents of the sampling buffer are effectively cleared when the unit is activated with a magnet.

3.20 Configuration Commands

3.20.1 S0: Logger Configuration

Logger Speed:

- Range of 0 - 31.75 Hours
- Multiples of 0.25 hours
- 0 = Locked to Sampling Rate

Configuration	Command	Formula	Description
Logger Speed	0.00	A	Desired logger Speed, hours, in 0.25-hour increments. Max 31 hours
Sampling Period	1	B	Desired sampling period: 0 if once per min, 1 if once every 15 mins
RESULT:	**S0=80**		***Data sample once every 15 mins, Logged ever 15 mins***

Formula:
S0=(128 x B) + (A x 4)

Example:

- S0=(128 x 1) + (0.00 x 4)
- S0=128 + 0
- S0=128
- S0=0x80

3.20.2 S1: Listen Configuration

- Max of 155 minutes (Recommended Max 10 minutes)
- Multiples of 5 minutes
- 0 = 60 seconds (Recommended)

Configuration	Command	Formula	Description
Listen Period	5	A	Desired listen Period
RESULT:	**S1=01**		***Listen period 5 minutes***

Formula:
S1=(A/5)

Example:

- S1= (5/5)
- S1=1
- S1=0x01

3.20.3 S2: Schedule Configuration

This parameter defines how the sensor is configured to regularly send logged measurement data in Data Message Type 4 to the server.

- If the End Time entered is before the Start time, no scheduled data will be transmitted

Configuration	Command							Formula	Description
	Sunday	Saturday	Friday	Thursday	Wednesday	Tuesday	Monday		
Day to upload	1	1	1	1	1	1	1	A	Enter '1' to select day(s) of week for data delivery
	8							B	Enter Time to Dial, Hours
	0							C	Enter Time to Dial, Minutes (Will be rounded to 15 min intervals)
Upload More than once per day	0							D	Enter '1' if Upload required more than once per day Enter '0' if once per day
	1							E	Enter '1' to dial every 4 hrs, '0' to dial every 2 hrs (Ignored if once per day)
	22							F	Enter End time (Hours) (> Start Time) (Ignored if once per day)
Weekly Override: > once per week	0							G	Override weekly schedule: Enter '1' if fortnightly or once per month delivery required.
	0							H	Enter '1' for once per month, on the 21st, ***or***, enter '0' for Fortnightly on the 1st & 14th each month
RESULT:	**S2=7F2056**								***Daily @ 08:00***

Formula:

A=(Sunday,Saturday,Friday,Thursday,Wednesday,Tuesday,Monday)

1. **XX**= (G,**A**)
2. **YY**= (H x 128) + (B x 4) + (C/15)
3. **ZZ**= (E x 64) + (D x 32) + F
4. S2=**XXYYZZ**

Example:

1. XX=(0b01111111)
   XX=0x7F

2. YY=(0 x 128) + (8 x 4) + (0/15)
   YY=(0 + 32 + 0)
   YY=32
   YY=0x20

3. ZZ=(1 x 64) + (0 x 32) + 22
   ZZ=64 + 0 + 22
   ZZ=86
   ZZ=0x56

4. S2=7F2056

3.20.4 S3: Control Configuration

Configuration	Command	Formula	Description
Network Comms Mode	01	A	0=LTE CatM1, 1=LTE NB-IOT, 2=2G
Reserved	0	B	Reserved
Message 16	0	C	0=Send Msg 16 by server request only 1=Send Msg 16 sent once per month preceding the 1st scheduled Msg 4 in that month
Reserved	0	D	Reserved
Dry contact Switch P1	0	E	1=Enable. Recommended not set.
CRC checking of incoming data	0	F	1=Enable Note! If set, will disable phone commands!
Reserved	0	G	Reserved
RESULT:	**S3=01**		

Formula:
S3=G,F,E,D,C,B,A

Example:
- S3=0b00000001
- S3=0x01

3.20.5 S4, S5, S6: Static Limit Configuration

Configuration	Command	Command	Command	Formula	Description
Limit Polarity	1	0	0	A	1= alarm when measured value is higher than the threshold, 0 = alarm when measured value is lower than the threshold
Alarm Enabled	1	0	0	B	1 = Enabled, 0 = Disable. N.B. Alarm Status flags in Message headers will be set, irrespectively.
Hysteresis	10	0	0	C	Reset level is 3 greater than value entered here
Threshold	150	0	0	D	The setting threshold for level alarm.
RESULT:	**S4=E896**	**S5=0000**	**S6=0000**		**S4 Example: Alarm set if measured units are >150, reset level = 137**

Formula:
$S4= D + C \times (2^{10}) + B \times (2^{14}) + A \times (2^{15})$

Example:
- $S4=150 + 10 \times (2^{10}) + 1 \times (2^{14}) + 1 \times (2^{15})$
- S4=150 + 10240 + 16384 + 32768
- S4=59542
- S4=0xE896

3.20.6 S7, S8: Dynamic Limit Configuration

- Range of 0 - 63, in increments of 1 units.

Configuration	Command	Command	Formula	Description
Polarity	1	0	A	1= Alarm if Rising Units (Tank Not Emptying) 0= Alarm if Falling Units (Tank Not Filling)
Alarm Enabled	1	0	B	1=Enabled, 0 = Disable (Alarm Status flags will be set, irrespectively)
Rate	27	0.0	C	Units per minute or units per 15 minutes, depending on S0 Range 0-63, in increments of 1 unit Alarm if change = C/15
RESULT:	**S7=BD**	**S8=00**		**S7 Example: Alarm if change >0.27 unit/min**

Formula:
S7= A x (2^7) + B x (2^6) + C x (2^0)

Example:
- S7=1 x (2^7) + 1 x (2^6) + 27 x (2^0)
- S7=128 x 64 + 27
- S7=219
- S7=0xBD

3.20.7 S9 – S17: SMS, APN, URL and Tank Details Configuration

- The following Parameters S9 to S16 are Ascii, with max length of 20 characters (A20)

S-	Description	Default
S9:	Primary Server SMS Phone Number (A18)	
S10:	Reserved	
S11:	Unit Password (A6)	TEK822
S12:	PDP APN (A29)	
S13:	PDP APN Username (A15)	
S14:	PDP APN Password (A15)	
S15:	Destination Server IP address or URL (A40)	
S16:	Destination Server Port Number (A5)	
S17:	Battery Capacity	7200

3.20.8 S18: F-Stop

- For Ratiometric Gauges.

Configuration	Command	Formula	Description
Max voltage reading Out to 100(Full) (or 1000)	5	A	Maximum Sensor Volt
RESULT:	**S18=C8**		

Formula:
S18=(200 x A)/5 *{rounded to the nearest integer}*

Example:
- A=5

- S18=(200 x 5)/5
- S18=1000/5
- S18=200
- S18=0xC8

3.20.9 S19: Control3 Configurator

- APN authentication type.

- S19=00 (PAP or CHAP)
- S19=01 (None)

3.20.10 S20: E-Stop

- For Ratiometric Gauges.

Configuration	Command	Formula	Description
Min voltage reading Out to Zero (Empty)	1	A	Minimum Sensor Volt
RESULT:	**S20=28**		

Formula:
S20=(200 x A)/5 *{rounded to the nearest integer}*

Example:
- A=1

- S20=(200 x 1)/5
- S20=200/5
- S20=40
- S20=0x28

3.20.11 S21 MCC_MNC Mobile Country Code / Operator Code

The setting parameter is the mobile operator's short code and should be set according to the sim card in use.
E.g., for Vodafone Ireland, the network operator short code is 27201
Leave blank if 2G.

3.20.12 S22 LTE Band

LTE Band lookup table:

LTE CAT-M1		LTE NB-IoT		2G	
Band	**S22 Code**	**Band**	**S22 Code**	**Band**	**S22 Code**
B1	1	B1	1	900MHz	1
B2	2	B2	2	1800MHz	2
B3	4	B3	4	850MHz	4
B4	8	B4	8	1900MHz	8
B5	10	B5	10		
B8	80	B8	80		
B12	800	B12	800		
B13	1000	B13	1000		
B18	20000	B18	20000		
B19	40000	B19	40000		
B20	80000	B20	80000		
B26	2000000	B26	2000000		
B28	8000000	B28	8000000		
B39	4000000000				

3.20.13 S23: Message Deliver Configuration

- Try Tickets max of 8
- Try Period max of 320 seconds

Configuration	Command	Formula	Description
Try Tickets	4	A	Number of delivery attempts
Try Period	30	B	Time between tries (seconds)
RESULT:	**S23=13**		

Formula:

1. X=A-1
2. Y=(B/10) -1 *{Note: Result of B/10 to be rounded down}*
3. S23= X + (Y x 8)

Example:

1. X=4-1
   X=3
2. Y=(30/10) -1
   Y=3-1
   Y=2
3. S23=3 + (2 x 8)
   S23=19
   S23=0x13

3.20.14 S24: Schedule Delay

- Max delay of 14 minutes
- Default = No delay (0 minutes)

Configuration	Command	Formula	Description
Delay	5	A	Data Drop Delay from Scheduled
RESULT:	**S24=05**		

Formula:

S24=A

Example:

- S24=5
- S24=0x05

3.20.15 S26: Control2 Configuration

- 1 = Enabled, 0 = Disabled

Configuration	Command	Formula	Description
Temperature Alarm (Static Alarm 0)	0	A	1=Enable
SMS Disable fall back (GPRS only)	0	B	If Enabled, last Try ticket will be GPRS only
SMS Alarm only fall back	0	C	If Enabled, last re-try attempt will be SMS if alarm only.
Reserved	0	D	Reserved
No change Alarm (Dynamic Alarm 2 – S8)	0	E	1=Enable
ADC Sensor Output1	0	F	0=Normal, 1=Inverted output reporting
ADC Sensor Output2	0	G	0=Low Resolution 0-100%, 1=High Res, 0-1000
ADC Sensor Output3	1	H	If 0, Bits # 5,6 above apply. If 1, output is Raw 10-bit ADC (0-1023)
RESULT:	**S26=80**		

Formula:
S26=H,G,F,E,D,C,B,A

Example:
- S26=0b10000000
- S26=0x80

3.20.16 S29: Control4 Configuration

- 1 = Enabled, 0 = Disabled

Configuration	Command	Formula	Description
Reserved	0	A	
Reserved	0	B	
Reserved	0	C	
Disable long timeframe retry	1	D	1h retry for scheduled messages, if all normal retry attempts fail 0=enabled, 1=disabled
Dymanic Limit 1 Offset Timer	3	E	Offset timer to report msg #9 after dynamic limit 1 (S7) triggers 0=disabled, 1=15min, 2=30min, 3=60min
Reserved	0	F	
Reserved	0	G	
RESULT:	**S29=38**		

Formula:
$S29=G \times (2^7) + F \times (2^6) + E \times (2^4) + D \times (2^3) + C \times (2^2) + B \times (2^1) + A \times (2^0)$

Example:
- $S29= 0 \times (2^7) + 0 \times (2^6) + 3 \times (2^4) + 1 \times (2^3) + 0 \times (2^2) + 0 \times (2^1) + 0 \times (2^0)$
- S29= 48
- S29=0x38

3.21 Request commands

Commands can be sent via SMS or via GPRS (converted to hex)

Request commands are available as follows:

<password>, R2= yy/mm/dd:hh/mm/ss	set RTC
<password>, R3=ACTIVE	sets units to active state
<password>, R4=DEACT	de-activates scheduled uploads
<password>, R6=03	close TCP connection
<password>, R1=80	shutdown modem and sleep

S parameters can be programmed using the following format:
<password>,Sx = yyyy
where x is the number of the S parameter that is to be set and yyyy is the value to which it will be set. Note that commands can be concatenated (separated by commas).

Note: The command R3=ACTIVE should be issued to the logger upon first activation.

3.22 SMS text back

Details of SMS text back queries are in the commands and config file. When a text back query is received, the reply is sent to the number from which the query came.

Default Password (S11) = TEK822			
Command	**Meaning**	**Response Example**	**Note**
Level=?	TextBack the Tank Fuel level reading	Level=63	The Level number returned is as formatted by S26. Level reading based on measuring pin ADC #1
TEK822, Info=?	(Password Protected) Status Information: IMEI, HW Version, SW Version, Battery, Rssi, Network Operator, RTC, Active/Deact.	IMEI=863835020373234 Hw=1 Fw=3.7 Bat=47 Rssi=23 Serv="O2 IRL",3G,R RTC 24/9/15 13:12:1 (0) Act Loc=52.905273,-8.546389	Loc (location) is optionally available If location is returned. For M!0/UC15, this will be approximate location based on Cell positioning. Format DD, Lat/Long. The position is refreshed after this message, or after manual activation. For UC20, if GPS location is requested, then this field will be GPS, in degrees.
TEK822, Set=?,n	(Password Protected) Dump of S parameters, starting at n. (If 'n' omitted, will start at S0)	S0=01,S1=02,S2=7F0036,S3=04,S4=8832,S5=0000,S6=0000,S7=CA,S8=9E,S9=+447624811142,S10=+447624811142,S11=TEK822,S13=streamip,S14=streamip,S15=84.51.244.10	The starting number n can be varied. In the example of using start number=0, not all of the S-parameters may fit into 160 characters. Therefore, more than 1 dump may be needed. In the example shown, the 1st 15 S=params occupies 152 chars. Another Texback command Set=?,16 would be needed to follow.

4. Technical Specification

4.1 Reed switch interface

A reed switch provides a user interface input for the LTE logger. The reed switch is triggered by a user held magnet.

4.2 Buzzer

The LTE logger status feedback will also be provided via a buzzer. Detailed further in document.

4.3 TSP Interface

Test interface (transponder) can be used for test and parameter programming purposes. The transponder does not form part of the product.

4.4 Connectivity

Communication is provided by an on-board Module. The LTE logger communicates using standard protocols / services available from a common-carrier.

5. On-site Maintenance Checks

For installations where the logger is operated in Hazardous areas, the connected sensor device must have the appropriate certifications, and installed according to the sensor device manufacturer installation instruction. Installation of this equipment must be carried out by suitable trained personnel.

5.1 Mounting

During on-site maintenance, the operator must ensure that the LTE logger is still securely tightened in a position that is not susceptible to physical damage.
The logger should ideally be located within 2 meters of the sensing device.

5.2 Environment

During on-site maintenance, the operator must check that external environment does not degrade the performance of the logger or the sensor, such as clay, dust, water, etc.

5.3 Cleaning

Electrostatic Hazard. Clean only with damp cloth.

6. Trouble Shooting

6.1 Beep Pattern

Beep Pattern	Definition
Low beep once per second	Network Registration
High beep once per second	GPRS Registration
Low beep once every 4 seconds	Network / TCP Listen
Low beep once every 2 seconds	Re-establish Network / TCP
High / Low combination beep	Incoming Data
Low / High combination beep	Outgoing Data
Low double-beep every 4 seconds	Network Listen (Data Received & Unit Active)
Low double-beep every 2 seconds	Re-establish Network
High double-beep every 4 seconds	TCP Listen (Data Received & Unit Active)
High double-beep every 2 seconds	Re-establish TCP

For further details please see additional documents:

- *DS-5048-XX TEK 822 LPG Logger 4G CAT-M1*
- *DS-5081-XX TEK 822 NB-IoT_CAT-M1 Logger Exi LPG sensor*
- *9-5940-XX TEK 822 LPG Logger 4G NB-IoT_CAT-M1 Installation Guide*
- *9-5923-XX TEK 822 Installation Instructions*
- *9-5965-XX Product ID reference document*
- *9-6083-XX TEK 822 Retry Mechanism with 2G fallback*
- *9-6084-XX TEK 822 Connection Sequence & Remote configuration*
- *M-I5268-XX TEK 643 - TEK 822 Battery Replacement*