

	Design Requirement Specification Wi-Fi PDF logger	Document #	DRS-0404
		Revision:	Z

Product:	Wi-Fi PDF logger
Description:	Wi-Fi PDF in the enclosure of the Min-Max Thermometer

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1. Definitions

EEPROM	- Non-Volatile Data Memory
PDF	- Pact Document File
USB	- Universal Serial Bus
RAM	- Volatile Memory
IC	- Integrated Circuit
MCU	- Micro Controller Unit
T	- Internal Temperature Sensor
T1	- External Channel 1 Temperature Sensor
T2	- External Channel 2 Temperature Sensor
TRH	- Internal Temperature/Humidity Sensor
T0	- T or Temperature Sensor Part of Internal TRH
RH	- Humidity Sensor Part in TRH

2. References

#	Document Name or Description
1	
2	
3	

3. Introduction

This document specifies the design requirements for a Wi-Fi PDF data logger, capable of creating a PDF file, standalone, without any PC software and able to upload data to a Cloud Server at a configurable "push" interval. We shall refer to this device as the " Wi-Fi PDF Logger" or "the Logger".

This DRS is for a logger with 4 buttons, Wi-Fi module, buzzer, flat lithium rechargeable battery and an LCD with dual color backlight. This Device shall be built with the existing Min-Max Thermometer enclosure with new thicker bottom case to fit the flat battery and sensor cable connectors exiting form the bottom side of the Logger.

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4. Requirements

4.1 Enclosure

The requirements listed in this section are all related to the features of the enclosure, which shall be developed as a tooling option of the enclosure of the existing Min-Max Thermometer.

4.1.1 Top Case

The sensor port and the USB connector port of the top enclosure shall be closed by a tooling option and shall not be present in the enclosure of the Logger. The top case shall be combined with a thicker bottom case.

4.1.2 The USB Port

The USB port shall be located in the bottom half of the enclosure in the narrow bottom side

4.1.3 The Sensor Ports

The two sensor ports shall be relocated next to the USB port on the bottom, narrow side of the enclosure. These shall feature stereo jack connectors with gold-plated contacts.

4.1.3.1 The Second Sensor Port

The second sensor port shall be made available by a tooling option.

4.1.4 The Battery Compartment

The battery compartment is not required but the battery may be imbedded into the top case to free up PCB space for components. The battery of this Logger shall not be a serviceable item i.e., it shall not be replaceable by the User.

4.1.5 The Buttons

The buttons shall be the same in the Min-Max Thermometer – CLEAR, MODE, UP and DOWN

4.1.6 The Magnets

The magnets shall be required and shall be imbed in the bottom case. They shall not be exposed to the outside. Five magnets may be needed to support the thicker and heavier Logger.

4.1.7 The Back Labels

Indented space for labels must be located on the back side of the Logger.

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4.1.8 The Color

The enclosure shall be in a gray color with PENTON "Cool Gray" swatch. The sensor cables shall also be in gray color. The Overlay and key pad designs shall have artwork designed by Marketing.

4.1.9 The IP rating

The enclosure shall have at least IP56, which is for splash resistance.

4.1.10 The Packaging

The packaging shall contain one Logger with Probe(s) and buffers, insert cart with instructions.

4.2Power

This section describes the Power requirements:

4.2.1 Primary Power

The primary power shall be supplied from the USB port of the Logger, where USB type C cable connector shall provide 5V DC 0.5A power from a USB charger wall adapter.

The presence of the primary power shall be indicated by the Power icon:



4.2.2 Backup Power

The backup power shall be supplied from a rechargeable Lithium-Ion battery located inside the enclosure. The backup battery shall be able to sustain normal operation for up to 2 months after the primary power is lost. The backup operation time shall be guaranteed for specific operating conditions such as ambient temperatures from -20°C to 25°C with RH 50%.

To save the power of the battery the LCD backlight features shall also be disabled in this mode.

4.2.3 Backup Battery Charging

The backup battery shall be charged by the USB port and the charging status shall be indicated on the LCD of the Logger with a battery gauge icon.

4.2.4 Backup Life Indication

The battery life shall be displayed on the LCD as 4-segmented battery icon gauge. The gauge may be hidden when the Logger is operating on the primary power source and the battery is charged to

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full.



The battery level shall be read every 30 minutes or every time WiFi Radio start to run (push data to cloud server). There is no battery level read during WiFi Radio running. Memory Mapping [vBAT_LVL] shall record the battery level as following definition:

Battery Level:

4: >4V, that is (4V,4.2V], for 100% 4 bars in battery icon of the LCD display.

3: (3.8V,4V] for 75% 3 bars in battery icon of the LCD display.

2: (3.76V,3.8V] for 50% 2 bars in battery icon of the LCD display.

1: (3.3V,3.76V] for 25% 1 bar in battery icon of the LCD display.

0: <=3.3V for 0% 0 bar in the battery icon and low battery alert should be trigger.

The Wi-Fi functions shall be disable when the vBAT_LVL<=1 (battery capacity falls below 25%)

4.2.5 Power Failure Alert

The power status shall be send to Cloud by Reading Payload with the parameter "powerByAdaptor"

- "powerByAdaptor":1 for powered by Primary Power
- "powerByAdaptor":0 for powered by Backup Power

Cloud server shall automatic trigger alert when this parameter changed from 1 to 0.

4.2.6 Failsafe Mode

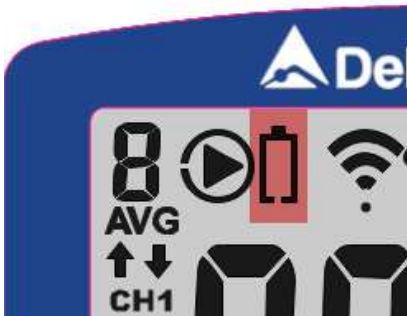
The Wi-Fi radio features shall be automatically disabled when the backup battery life falls below 25% and that condition shall be indicated on the LCD by the battery gauge as required by the WHO specification for vaccine temperature monitoring devices.

During Failsafe Mode the logger shall continue operation similar to a standard PDF Logger.

Failsafe mode shall be indicated by an empty battery life gauge:

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4.2.7 Exit Failsafe Mode

When battery is charged and battery voltage is larger than [WIFI_BAT_TH], default set to 3600mV(3.6V), it shall exit Failsafe Mode. This shall be indicated by at lease one bar empty battery life gauge.



4.3Sensors

Total 4 sensors shall be supported:

- T* Internal Temperature Sensor
- T1 External Channel 1 Temperature Sensor
- T2 External Channel 2 Temperature Sensor
- TRH* Internal Temperature/Humidity Sensor

* Only support one internal sensor: T or TRH.

Following two more symbols are used to define internal sensors by function:

- T0 T, or Temperature Sensor Part of Internal TRH
- RH Humidity Sensor Part of Internal TRH

Memory Mapping [CONTROL_WORD].SENSOR_T defines the sensor type & sensors implemented:

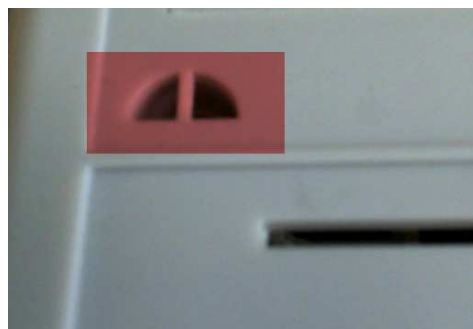
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[CONTROL_WORD].SENSOR_T			Sensors
0	0	0	T
0	0	1	T1
0	1	0	T/T1
0	1	1	T1/T2
1	0	0	T/T1/T2
1	0	1	TRH
1	1	0	TRH/T1
1	1	1	TRH/T1/T2

4.3.1 Internal Sensor

The internal sensor shall be a digital Temperature and Relative Humidity chip module, referenced as T and RH. The chip shall be located under the vent opening in the front enclosure of the Logger.



4.3.2 External Sensors

The external temperature sensors, referenced as T1 and T2, shall be detachable, digital and imbed into blunt probes where they shall be fully sealed from water ingress.

4.3.3 The Back Stand

The Logger shall be used only attached to the side wall of a refrigerator or other vertical, flat surface. The back stand shall not be required.

4.3.3.1 Cable wire

The cable wire isolation shall be Teflon. The cable shall have at least 4 wires to connect to the digital sensor.

4.3.3.2 Cable Length

The cable length shall be 3 m or other, as specified by the BOM

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4.3.3.3 The Buffer

The sensor response time delay buffer shall be either an Aluminum or a Glycol Bottle

4.3.3.4 The Connectors

The sensor connector shall be stereo jack/plug with gold-plated contacts. The connector's strain relief shall be straight, not right-angled. Pig-tail connectors cables shall not be used in this Logger.

4.3.3.5 Accuracy and Calibration

The sensors shall not require calibration or LUT. The general accuracy of the sensor readings shall be:

- 0.5°C (Maximum) From 0°C to +65°C
- 1.0°C (Maximum) From -95°C to +125°C

4.3.4 Sensor Lost

It is possible that external sensor channel#1/#2 be removed for a while during operation.

For sensor lost period"

- (1) A special value (0x8000=-32768), Sensor-Lost-Value, shall be logged to indicate sensor lost.
- (2) The part in PDF Char Report shall be blank
- (3) The data point reading part in PDF/CSV data report shall be blank.
- (4) Sensor Lost data points shall not be used for statistical calculation.

4.4Data Logging

The data logging shall be a continuous process in the Wi-Fi logger. It shall serve as a backup to the data already sent to the Cloud Server. The files related to sensors' data shall be the PDF chart, PDF data , the Daily Stats (DS) and the Way Point Record (WP).

4.4.1 The Data Log

Configuration option **[MAX_DATA_POINTS]** gives the max data points, it is 32,000 for a single sensor or proportionately less for more sensors as listed below:

Sensor#	Max Setting Value of [MAX_DATA_POINTS]
1	32000
2	16000
3	8000
4	8000

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Internal and External sensors shall be logged but either of the sensors can be excluded from the Log with a configuration option **[CONTROL_WORD].SENSOR_T**. For each enabled sensor the data shall be downloaded in two file formats – PDF (chart and data) and CSV (data)

4.4.2 The Daily Stats

If configuration option **[CONTROL].DAILY_STATS** is set to 1, the Logger shall keep a record of the daily statistics in file that can be downloaded or viewed on the LCD sequentially. The default size of the Daily Stats memory shall be for 30 days but the maximum number of days shall be adjustable by configuration option **[DAILYSTATS_MAX]**, up to 128. Configuration option **[vDAILY_STATS_CTR]**, Daily Stats Counter, gives the number of Daily Stats recorded. The records will be entered in the file at midnight. The file shall continue accumulation of new data in loop around fashion until cleared by a configuration process.

4.4.2.1 The Daily Stats Record

The Daily Stats record for one sensor shall contain information (total 16bytes):

- Date [3 bytes]: year/month/day
- Number of waypoint saved in the day [1 bytes]
- sensors' readings at midnight [2 bytes]
- Average [2 bytes]
- Max [2 bytes]
- Min [2 bytes]
- Minutes above High Alarm [2 bytes]
- Minutes below Low Alarm [2 bytes]

4.4.2.2 The Daily Stats Memory Allocation

Total 2Kbyte flash memory is assigned to Daily Stats record.

One day for one sensor is ~~16~~ 20-bytes.

Following table lists the max setting value for **[DAILYSTATS_MAX]**

Sensor#	The Max Setting Value of [DAILYSTATS_MAX]
1	128
2	64
3	32
4	32

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4.4.2.3 The Daily Stats File

This file shall be shown only when **[CONTROL].DAILY_STATS** is set to 1 and **[vDAILY_STATS_CTR]** is greater than zero. The file shall be in CSV format.

(1) Columns: Seven columns shall be shown.

- Date: Header shall show "Date".
 - ✧ Absolute Time: The value shall be shown in the format specified in [Date and Time](#).
 - ✧ Relative Time: The value shall be shown in the format 001(Days). Days shall always be shown.
- Min: Header shall show "Min" and either °C or °F.
- Max: Header shall show "Max" and either °C or °F.
- Average: Header shall show "Average" and either °C or °F.
- Minutes Above High Alarm: Header shall show "Minutes Above High Alarm".
- Minutes Below Low Alarm: Header shall show "Minutes Above Low Alarm".
- Sensors' readings at midnight: Header shall show "Sensor Reading at Midnight" and either °C or °F.
- Waypoint: Header shall show "Waypoint".

(2) Looped Data:

When Daily Stats data is looped, a maximum of **[DAILYSTATS_MAX]** days shall be shown, with the day one being the oldest day in memory.

4.4.3 The Waypoint

The waypoint feature shall be always enabled. The Logger shall keep a record of events which the User can enter by key press. The Waypoint record shall be downloaded as a file. The maximum size of the Waypoint file shall be at least 128 records. The file shall continue accumulation of new data in loop around fashion until cleared with the [Standby Mode](#). Memory Mapping **[vWAYPOINTS_CTR]** gives the number of Waypoint recorded.

4.4.3.1 The Waypoint Record

The waypoint shall be inserted by the Clear button ([see Clear button](#)) when the button is pushed and held, which may also clear current alarm indication.

The waypoint record shall contain information about:

- a) Date and Time in FAT format: [4 bytes]
- b) Data-points: [4 bytes] (to get Sensor reading value)
- c) Alarm Status: [1 byte]
- d) Reserve: [1 byte]

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- e) Average: [2 bytes]
- f) Max: [2 bytes]
- g) Min: [2 bytes]
- h) List of the Alarm trigger conditions: total [32 Bytes] for four alarm type
 - a. Setpoint: [0 Bytes] this can get from Static Configuration
 - b. First Event: [4 Bytes]
 - c. Events: [2 Bytes]
 - d. Total Time: [2 Bytes]

4.4.3.2 The Way Point Memory Allocation

Total 6Kbyte flash memory is assigned to Way Point record.

One waypoint for one sensor need 48bytes

Following table lists the max way point supported

Sensor#	Max Way-Points
1	128
2	64
3	32
4	32

4.4.3.3 The Waypoint File

The waypoint file shall be in CSV format and shall store waypoint data records in loop around for up to 128 records.

This file shall be shown only when **vWAYPOINTS_CTR** is greater than zero. The file shall be in CSV format.

(1) Columns: Following columns shall be shown

- Date/Time: Header shall show "Date/Time"; Date and time shall be shown in the [Date and Time](#) format.
- Value: Header shall show "Value" and either °C or °F; Value shall be shown with one digit of precision.
- Min: Header shall show "Min" and either °C or °F.
- Max: Header shall show "Max" and either °C or °F.
- Average: Header shall show "Average" and either °C or °F.
- Extreme High Alarm(Yes/No): Header shall show "Extreme High Alarm (Yes/No)

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- High Alarm(Yes/No): Header shall show "High Alarm (Yes/No)
- Low Alarm(Yes/No): Header shall show "Low Alarm (Yes/No)
- Extreme Low Alarm(Yes/No): Header shall show "Extreme Low Alarm (Yes/No)
- Extreme High Alarm Set Point: Header shall show "Extreme High Alarm Set Point" and either °C or °F.
- Extreme High Alarm First Event: Header shall show "Extreme High Alarm First Event".
- Extreme High Alarm Events: Header shall show "Extreme High Alarm Events"
- Extreme High Alarm Total Time: Header shall show "Extreme High Alarm Total Time"
- High Alarm Set Point: Header shall show "High Alarm Set Point" and either °C or °F.
- High Alarm First Event: Header shall show "High Alarm First Event".
- High Alarm Events: Header shall show "High Alarm Events"
- High Alarm Total Time: Header shall show "High Alarm Total Time"
- Low Alarm Set Point: Header shall show "Low Alarm Set Point" and either °C or °F.
- Low Alarm First Event: Header shall show "Low Alarm First Event".
- Low Alarm Events: Header shall show "Low Alarm Events"
- Low Alarm Total Time: Header shall show "Low Alarm Total Time"
- Extreme Low Alarm Set Point: Header shall show "Extreme Low Alarm Set Point" and either °C or °F.
- Extreme Low Alarm First Event: Header shall show "Extreme Low Alarm First Event".
- Extreme Low Alarm Events: Header shall show "Extreme Low Alarm Events"
- Extreme Low Alarm Total Time: Header shall show "Extreme Low Alarm Total Time"

(2) Looped Data

When waypoint data is looped. Max Way-Points shall be shown, with the point one being the oldest data point in memory.

4.4.4 The Logger's Drive

The Logger shall display as a removable drive in any OS.

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4.4.4.1 The Drive Name

The Logger drive shall be named "FlashLink"

4.4.4.2 The File System

The Logger drive shall display the typical files of the Vaccine PDF Logger: PDF for chart and table, CSV for Data, Daily Stats and Waypoint. CONFIG.TXT for configuration and BIN for PC processing.

The BIN file shall be Locked and the PDF chart report file shall be encrypted and protected from alterations. The Logger shall reject formatting or file deletions request from the OS.

4.4.4.3 Download Time

The time for downloading full memory shall be less than 15 sec

4.4.5 Logger's Files

All files listed below (except the CONFIG file) shall be present on the Drive when the Logger is connected to PC and they will have the following characteristics:

4.4.5.1 File Encryption

Chart PDF File shall be the encrypted single page file. Data PDF File shall not be encrypted. All files (the CSV and the Graph/Data PDF) shall be created dynamically without using external physical memory.

4.4.5.2 File Names

The file names shall contain device ID number based on Serial or Trip numbers. In addition, the Loggers shall provide local report files for each enabled sensor with the sensor's prefix (T0, T1, T2, TRH) or no prefix if only one sensor enabled in the file name for distinction.

- The Trip Number
- The Serial Number
- When none of the above ID numbers are available in memory then a place holder name: "_____ " will be used.

The file name shall be followed by:

- "-0000-CHART.PDF" for PDF Chart Report.
- "-0000-DATA.PDF" for PDF Data Report.
- "-0000-DATA.CSV" for CSV Data Report.
- "-0000-DS.CSV" for DAILY STATS Report.
- "-0000-CERT.PDF" for the calibration certificate file
- "-0000-WP.CSV" for the waypoint file

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Example (takes Sensor T1 as example):

- T1_30456001-0000-CHART.PDF
- T1_30456001-0000-DATA.PDF
- T1_30456001-0000-DATA.CSV
- T1_30456001-0000-DS.CSV
- T1_30456001-0000-WP.CSV

4.4.5.3 BIN File

This file shall have a special purpose for the Logger. ([BIN File section](#))

4.4.5.4 CONFIG File

This file shall be used to configure the logger by using commands and values as text.
([CONFIG File section](#))

4.4.5.5 PDF Graph File

Single page encrypted PDF report with summary and data graph. All temperature data shall be displayed in both scales C and F, with the primary scale on top (this applies to summary section) or on the left (this applies to the vertical axis of the graph).

The PDF file shall have the following properties:

4.4.5.6 Page Header

The top of all pages shall display over a straight line:

a) Company's Logo

The DeltaTrak's Logo shall be placed in the top left corner of the page as default. The Logo picture shall be a Logger configuration option which can change to the Logo of the User's Company. The size of the bit map shall be determined and constrained by the memory space allocated for the image.

Logo picture requirement:

- Format : JPG
- Resolution: 240W, 50H
- Size : 8192.

Logo can be configured by .BIN file (refer to "BIN File Memory Map").

b) Report Title

The report title shall read be "FlashLink PDF Report" by default

The Report Title shall be a configuration option that can be changed. Memory Mapping [PAGE_HEADER_NAME] is used to set Report Title, and the maximum character allowed is 28.

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4.4.5.7 Page Footer

The bottom of all pages shall display under straight line:

- a) Active hyperlink to www.deltatrak.com/technicalservices by default
This URL shall be a configuration option for this device. Memory Mapping [URL] is used to set hyperlink, and the maximum character allowed is 42.
- b) The version number of the firmware as suffix and a three-digit number - "FlashLink-0.0.00-A.0.0". The suffix "A" shall be used on loggers with LCD.

4.4.5.8 Trip Information

This section shall include the Data Tag fields:

- a) Order
- b) Shipper/Carrier
- c) Receiver
- d) Product
- e) Signature

Remark: these fields shall have no corresponding Memory Map and these fields are left for customer to input.

4.4.5.9 Logger Configuration

This shall contain information about:

- a) Trip#
- b) Model + Extension Model Number

The logger shall display in the PDF report the extra data appended to the 5-digit Model number. If the extension is empty then only the 5-digit number shall be displayed in the report. Empty will mean "not programmed" or filled with spaces, i.e. ASCII code (32).

The extension number shall be 10 bytes maximum and shall be able to represent alphanumeric data.

- c) Logging Interval
- d) Alarm Skip
- e) Alarm Delay
- f) Time Zone.

4.4.5.10 Alarm Results

The Alarm Results in PDF report shall be calculated by the data points of:

- (1) If no waypoint: from the start data point to current data point.

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- (2) If waypoint recorded: from the last waypoint to current data point.
- (3) If loop occurs: data points not in flash memory are not calculated.

Alarm Results in PDF report includes following items:

- a) Ideal Range
The format of that the shall be as the following example:
Ideal Range: $\geq 32^{\circ}\text{F}/0^{\circ}\text{C}$ to $\leq 41^{\circ}\text{F}/5^{\circ}\text{C}$
Where the numbers are the Low and High alarm limits settings
- b) High, Low and Extreme High and Extreme Low Limits
- c) Cumulative Limits
Time Limits: 1 Hr 0 Min
- d) First Event
- e) Events
- f) Total Time in Alarm Time
- g) Alarm Result
The title shall be called "Alarm Status".
For each of the set points the report shall display green ✓ for pass and red ✗ for fail. No words "pass" and "fail" shall be used.
No background colors shall be used.

4.4.5.11 Logged Data Summary

This shall contain information about:

- a) Start Time
- b) Stop Time
- c) Recorded Time
- d) Data Points

4.4.5.12 Statistical Summary

This shall contain information about:

- a) Maximum
- b) Minimum
- c) Average
- d) Degree Minutes
- e) Mean + Standard deviation
- f) MKT

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4.4.5.13 Graph

a) **Data Trace**

The Data shall be displayed in continuous trace line. The Trace color shall be Black and the thickness will be sufficient to be printed on paper very visibly. A sensor trace segment shall never overlap with any of the graph's outlines or cross the outline frame of the plot area.

When no data was recorded or out-range has occurred, broken line shall be visible if the Gap configuration option is selected. If this option is not selected, a solid line will represent all points with under and over range readings.

b) **Data Point Limits**

32K for single sensor, less for more

c) **Stretch To fit**

The data trace shall be displayed in the full horizontal and vertical size of the plot area. For small data size this shall have a stretch effect.

d) **Grid**

The graph shall contain a simple horizontal and vertical grid with 10x10 major divisions. The Grid lines shall be thinner than the data traces.

e) **Left Axis**

The sensor reading shall be displayed at each major division tick mark. The precious of the reading shall be 0.1 and the values shall be in the primary followed by the secondary temperature scale

f) **Time Axis**

The horizontal scale shall display date and time information in the form of "Month/Day/Year HH:MM:SS"

g) **Alarm Lines**

The graph shall display the extreme alarm thresholds as solid horizontal lines. Normal alarm thresholds shall be shown as dashed lines. The color of the high thresholds shall be red; the color of the low thresholds shall be blue.

The display of alarm lines shall be a configuration option for the device and it shall be enabled by default. Memory Map [CONTROL].HIDE_ALARM_BARS is used for this setting: 0 – display, 1 – not display.

h) **Waypoint**

Waypoint shall be displayed superimposed on to the graph as vertical dotted lines with proper thickness. The lines shall run from the bottom axis to the top axis of the grid frame.

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4.4.5.14 Statistical Exclusion of Over/Under range Data

The Over/Under range data shall be excluded from the Statistical calculations if the out-range Gap option [CONTROL].OUT_OF_RANGE_GAP is enabled, in which case the over/under range points are not plotted on the chart.

4.4.5.15 PDF Data File

This shall be a second PDF File with data in a table. This file shall vary in size and it shall not be encrypted. The name of this file shall have a suffix "-DATA" to differentiate it from the Graph report file, which shall be encrypted.

Each data page shall include three tables with columns for:

- 1) Data Point Number
- 2) Date and Time
- 3) Sensor Value

Each column shall have a title.

4.4.5.15.1 Indication of Waypoint

[Waypoints](#) , inserted into the data point shall be indicated in the table by showing the corresponding data point with an asterisk.

4.4.5.16 CSV File

This shall be a .CSV with log data, which can be open in MS Excel. It shall contain the sensor's readings in the format:

- a) Date
- b) Time
- c) Sensor

4.5LCD

This section specifies the requirements of the LCD.

4.5.1 LCD Type

The LCD shall be a standard Liquid Cristal gray segment type with transfective backing, so that backlight can be used. The LCD drive type and segments shall not be specified in this DRS and can be left to the discretion of the hardware designers.

4.5.2 LCD Backlight

The LCD shall have a backlight with two colors – ~~Blue~~ Green and Red.

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The blue color shall be used to illuminate the LCD when a button is pushed and keep it lit for a configurable timeout by memory mapping [BBL_TO] after no button is pushed. The default timeout shall be set to 30 sec. If [BBL_TO] is set to 0, there is no button press backlight. Blue backlight is only available when powered by adaptor. Also in Service Mode, there is no blue backlight.

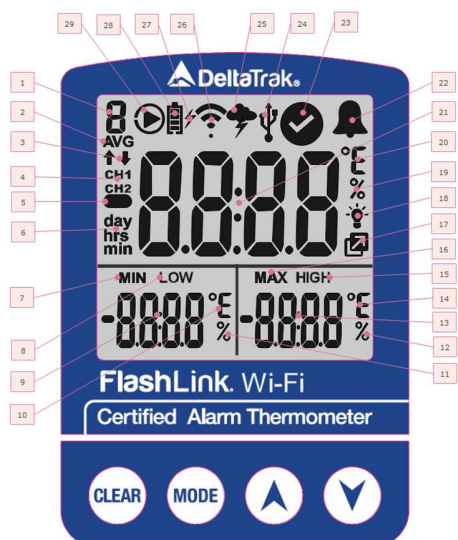
The Red backlight shall be used in conjunction with the [Alarm indication](#) if configuration option [CONTROL].ALARM_BACKLIGHT is set. It shall illuminate the LCD when the Logger is in alarming state. The Red light shall be steady when the Logger is on [Primary Power](#) and flashing once at the configurable intervals [RBL_ALM_FLG_INT] (5 sec default) when the logger runs on the [backup battery power](#).

The two back-lights are driven by two PWM respectively.

In normal mode, the brightness level is defined by Memory Mapping [RBL_BRTN] for red backlight, and [BBL_BRTN] for blue backlight. The range of brightness level is from 0 to 20, 0 for full-off, and 20 for full-on.

In USB mode, the brightness level is fixed to full-on.

4.5.3 LCD Layout



- 1) Level Icon – use in Service Mode
- 2) Average Icon – use in Daily Stats review
- 3) Arrow Icons – use in Alarm indication
- 4) Sensor Channel Icons – use with external sensors
- 5) Negative sign – use with negative readings
- 6) Time Icons – use with time values
- 7) Min Icon – use for minimum value
- 8) Low Icon – use for low Alarm value
- 9) Left Value – use for setting or reading values
- 10) Left scale – use for temperature readings

- 11) Left RH scale – use for RH readings
- 12) Right RH scale – use for RH readings
- 13) Right Value – use for setting or reading values
- 14) Right scale – use for temperature readings
- 15) High Icon – use for high Alarm value
- 16) Max Icon – use for maximum value
- 17) Sensor Disconnected Icon – no use at this moment
- 18) Light Icon – use when light sensor is in alert

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- 19)Center RH scale – use for center reading when it is RH
- 20)Center Scale Icon – use for center reading when it is Temperature
- 21)Center Reading – use for any sensor in display modes
- 22)Bell Icon – use to indicate alarm state
- 23)Check Icon – use to indicate no-Alarm state
- 24)USB Icon – use to indicate presence of USB connection
- 25)Cloud Icon – use to indicate presence of Cloud connection
- 26)Wi-Fi Icon – use to indicate presence of Wi-Fi connection and signal strength
- 27)Primary Power Icon – use to indicate that the primary power is present
- 28)Battery Icon – use to indicate operation on battery power and the current battery life
- 29)Run and Standby Icons - use to indicate the running or Standby state

4.5.4 LCD Mockup Examples

Note: The content of this section provides example mockups of the LCD in various states of the Logger. These may change during development and are provided here only for reference as of Nov 10,2022 (GK).

4.5.4.1 Default View

Showing sensor T1 (CH1) and Logger running on primary power with no alarms. The Wi-Fi signal is 100% and the last connection to the Cloud Server was good.

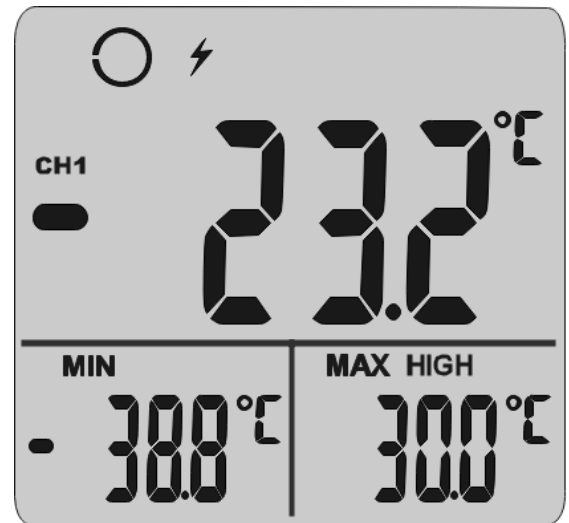


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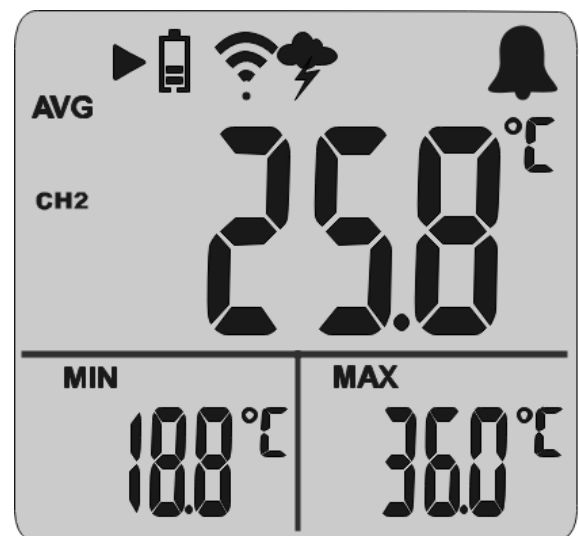
4.5.4.2 Standby View

Standby with no Logging, no Wi-Fi and no Cloud. The Logger is only showing the temperature of T1 as standard Min-Max thermometer



4.5.4.3 History Mode 1

First set of Daily Stats for T2 (CH2) showing AVG, MIN, MAX and for a day with Alarm point(s). The Logger is also running on backup battery with less than full life.

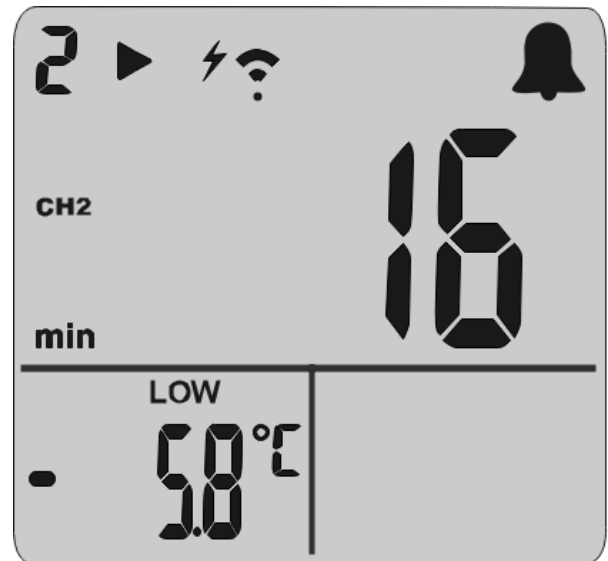


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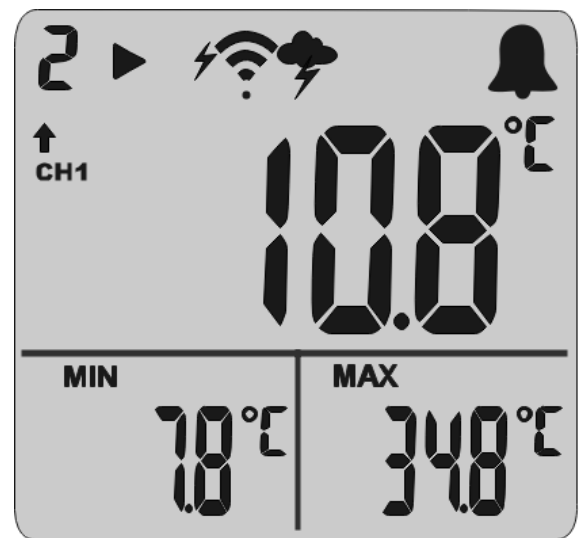
4.5.4.4 History Mode 2

This view shows Logger with imperfect Wi-Fi strength; no Cloud connection; with Primary Power and in History mode showing the 16 minutes of time in alarm spent below extreme low set point of -5.8C for sensor T2 (CH2).



4.5.4.5 x-Hi Alarm on T1

Extreme high alarm indication on T1 (CH1)



4.6Buttons

The Logger shall have four buttons on the front side of the enclosure. The buttons shall be imbed in a dome-switch graphics overlay and shall prove a nice tactile feel when operated.

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4.6.1 Holding Time

There will be two possible actions of the buttons - click (press and release) or click and hold. Button holding shall be considered when the button remains pressed for a given Holding Time. The Holding Time shall be a configuration option [BUTTON_HOLD_TIME], default 3 sec.

4.6.2 “Clear” Button

This button shall be used to cancel Alarm State or clear the statistical memory of the Logger.

4.6.2.1 Click: Clear Alarm State

Clicking the button during the alarming state of the Logger shall cancel the alarm indication until the occurrence of a new alarm condition.

IMPORTANT: The alarm clearing applies only to the audible and visual indications of the logger. The Statistical and Alarm State are not affected.

4.6.2.2 Click: Return to Default Display Mode

Clicking the button during the Daily Sates review mode of the Logger shall return the Logger to its default display state.

4.6.2.3 Click & Hold: Clear Stats

Clicking and holding the button shall clear the ~~Min-Max-Avg~~ stats of all sensors and at the same time it shall record an event in [The Waypoint File](#).

IMPORTANT: The time in-alarm recorded by the logger in the LCD will be preserved thus the LCD time in alarm will not match the time in-alarm displayed in the CHART PDFs for the sensors.

4.6.2.4 Enable/Disable

Each of the Clear button’s functions described above shall be disabled or enabled by configuration options [CONTROL].CLEAR_BUTTON_DISABLE. The default state shall be “Enabled”.

4.6.3 “Mode” Button

This button shall be used to change the display mode of the Logger.

4.6.3.1 Click: Change the default view

Clicking the Mode button shall cycle through several display modes of the Sensors’ readings. These modes shall display information about one of the available sensors or a combination of them:

1) T internal and T1, T2 external

The sensor channel icons CH1 or CH2 shall be displayed at the same time when both sensors are displayed in the lower half of the LCD with T1 on the left side.

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The internal sensor shall be displayed in the center of the LCD.

This mode shall not be available if the T2 or the T sensors are not available.

2) ~~**RH internal and T1, T2 external**~~

~~The sensor channel icons CH1 or CH2 shall be displayed at the same time when both sensors are displayed in the lower half of the LCD with T1 on the left side.~~

~~The internal %RH sensor shall be displayed in the center of the LCD.~~

~~This mode shall not be available if the T2 and RH sensors are not available~~

3) **T0 internal**

The CH1 & CH2 icons shall turn off. The reading of the internal temperature sensor shall be in the middle of the LCD. The bottom half of the LCD shall display Min and Max values of the sensor.

This mode shall be the default one after a power on reset.

4) **RH internal**

The CH1 & CH2 icons shall turn off. The reading of the internal humidity sensor shall be in the middle of the LCD. The bottom half of the LCD shall display Min and Max values of the sensor.

5) **T1 external**

The CH1 will display and the reading of the sensor shall be in the middle of the LCD. The bottom half of the LCD shall display Min and Max values of the sensor.

6) **T2 external**

If T2 is available the LCD will display just like T1 does. The displayed sensor channel icon shall be CH2.

This mode shall not be available if the T2 sensor is not available

4.6.3.2 Click & Hold: C/F Toggle

Clicking and holding the button shall change the temperature scale so that if it is C° it will become F° and vice versa.

4.6.3.3 Enable/Disable

Each of the button functions described above shall be disabled or enabled by configuration options [CONTROL].MODE_BUTTON_DISABLE. The default state shall be "Enabled".

4.6.4 "Up" and "Down" Buttons

These buttons shall be used to view the Daily Stats on the LCD as specified by WHO for "History Mode". The direction of the review shall depend on the button pressed - "Up" move to preset date and "Down" move to past dates.

4.6.4.1 Daily Stats Values Navigation

If the "Up" and "Down" buttons shall be used to navigate the Daily Stats Record which shall be displayed in five consecutive views on the LCD for each available sensor:

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1) **Min, Max and Avg**

The Avg value shall be displayed in the center of the LCD, the MIN in the left bottom section and the MAX in the right bottom section

2) **Thi, Tlo, TxHi and TxLo**

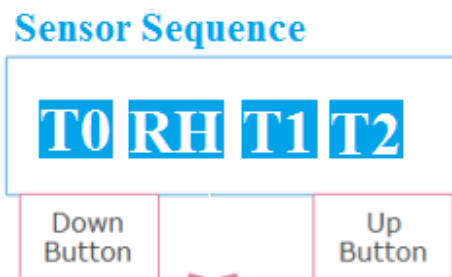
These shall be alarm time values with the Time displayed in the center of the LCD and the corresponding alarm in the left bottom section

The buttons shall navigate the stats display of the selected sensor from left to right as shown:



4.6.4.2 Sensor Navigation sequence

The buttons shall navigate the selected sensor from left to right as shown (if the sensor is available by memory mapping [CTRL].SENSOR_TYPE)

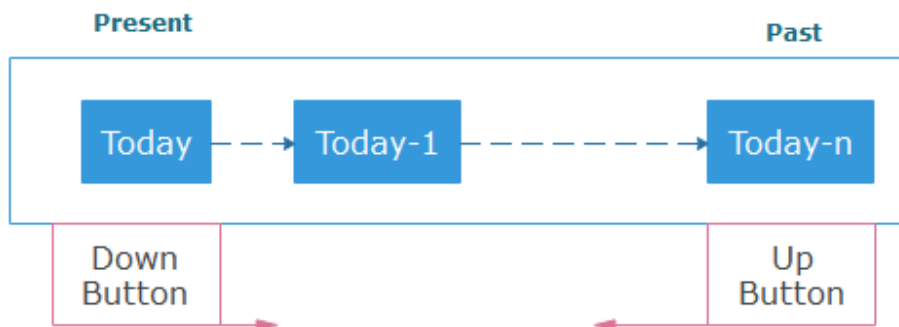


4.6.4.3 Day Navigation

After navigating through all 5 screens of the stats for the selected day the Up or Down button shall transition to the next day in the sequence as shown:

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Before starting to show the stats of the newly selected day the day number itself shall be displayed in the center of the LCD and the icon "day" shall be on. On the next click if the button the new stats shall be displayed as described in the previous section.

4.6.4.4 Fast Day Scrolling

The "Up" or "Down" buttons is pressed and held down the display shall advance the days in the Daily Stats record in the corresponding direction of the button - "Up" for next and "Down" for previous day. The Day sequence number (1 for yesterday, 2 for the day before and so on) shall be displayed in the center of the LCD for 50 msec before the next day is selected. When the button is released, the display shall show the stats of T1 of the selected day.

4.6.4.5 Looping During History Mode

If the "Down" button is used to navigate to the last day of the Daily Stats record the selected day shall loop back to the present day.

Pushing the "Up" button when the display is showing the first stat view (Min, Max and Avg) for T1 of the current day shall not go to the last day on record but instead it shall do nothing until the "Down" button is used.

4.6.4.6 Existing the History Mode

The mode shall have 30 sec time out with no button press after which it shall return to the current default display mode.

Pressing any of the two buttons "CLEAR" or "MODE" shall exit History Mode and return to the default display mode.

4.6.4.7 No Sensor Reading

There is no sensor reading during Daily Stats. Review.

4.6.5 "Mode" + "Up": Service Mode

The Service mode shall be used for special functions such as programming initial connection parameters, clearing the memory and loading it with factory defaults.

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The Service Mode shall be entered when the "Up" button is pressed while the "Mode" button is also pressed. The LCD's Level Icon shall be used to indicate the Service Mode level if more than one Service Mode levels are implemented.

During Service Mode the "Up" and "Down" buttons shall be used to navigate through the service levels.

The "Mode" button shall be used to **select** or **enter** , and "Clear" button shall be used to **exit** Service mode. The Service mode shall also have 60 sec automatic timeout.

The "CLEAR" / "DOWN" buttons shall also be used as confirmation or discard of selection when entering a Service Mode.

Following Service Mode functions are supported:

4.6.5.1 Service Mode # 1: Run / Standby / OFF Mode toggle

Refer to [5.6 Operational Modes](#) for detail about these operation mode.

In this service mode "rUn" or "Stb" or "OFF" shall be shown on upper part of LCD to indicate current Mode or to-be-set Mode is Run or Standby of OFF.

In OFF Mode, the Logger shall consume minimum power from the battery. The LCD shall be blank.

In Standby Mode the Logger shall not indicate alarm, no Daily Stats, no Waypoint, or use the Wi-Fi connection. It shall only display the sensor readings and log data like a normal PDF Logger. The mode can be useful when the vaccine refrigerator is in repair and the logger is not required to record data but only keep its settings and display the sensors' readings. The Standby Mode shall be indicated by the circle of the status icon. In contrast, the running mode shall be indicated with the right pointing arrow head.



After returning from Standby Mode to Run Mode the statistical history including the Daily Stats shall be cleared. The Data Logging shall restart from the beginning of the memory and the Start Time for data reports shall be initialized with the current RTC time.

The operation of this Service Mode is as following:

- **Phase 1: toggle setting**

Click "Mode" button shall change between Standby / OFF or Run / OFF if current Mode is Run or Standby, and "no"/"YE5" (means no/yes) shall show on bottom left/right of LCD.

- **Phase 2: Confirm setting**

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Click "Clear" button to select "no" or after 60 seconds, it recover to previous setting and return to Service menu.

Click "Down" button to select "YE5", it shall exit from Service Mode, then run on new setting.

4.6.5.2 Service Mode # 2: Master Reset

In this service mode "rSt" shall be shown on upper part of LCD to indicate it is in Master Reset Service Mode.

The operation of this Service Mode is as following:

- **Phase 1: Select**

Click "Mode" button, "no"/"YE5" (means no/yes) shall show on bottom left/right of LCD.

- **Phase 2: Confirm**

Click "Clear" button to select "no" or after 60 seconds, it return to Service menu.

Press "Down" button to select "YE5", it shall exit from Service Mode, then clear the data memory and reload the factory configuration which was in the device before it was first used. It shall clear [vDATA_CTR] data point counter to 0 if it is not. The logging shall be restart from data point 0.

4.6.5.3 Service Mode # 3: Button Sound On/Off Adjustment

"but5" shall be displayed on upper part LCD panel, that means "button Sound"

"5Et" shall show on bottom left of LCD.

"On" or "OFF" shall show on bottom right of CLD to indicate Button Sound On/Off status.

Press "Mode" button to toggle Button Sound On/Off.

4.6.5.4 Service Mode # 4: LCD Bias Adjustment

Memory Mapping [LCDBias] holds LCD Bias Level, the range is 0~9, default 7.

"LCD" shall be displayed on upper part LCD panel

"b1A5" shall show on bottom left of LCD, that means "bias"

Bias level ("00"~"09") shall show on bottom right of CLD.

(1) Press "Mode" button to adjust bias level.

4.6.5.5 Service Mode # 5: Red Backlight Brightness Adjustment

"rbtn" shall be displayed on upper part LCD panel

"SEt" shall show on bottom left of LCD", and red backlight brightness level ("00"~"20") shall show on bottom right of CLD.

(1) Press "Mode" button to adjust the brightness level.

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4.6.5.6 Service Mode # 6: Blue Backlight Brightness Adjustment

"bbtn" shall be displayed on upper part LCD panel

"SEt" shall show on bottom left of LCD", and blue backlight brightness level ("00"~"20") shall show on bottom right of CLD.

(1) Press "Mode" button to adjust the brightness level.

4.6.5.7 Service Mode # 7: External Sensor Offset Calculate

This service mode only effective where external sensor T1 or T1&T2 are presented. "CAL" shall be displayed on upper part LCD panel

Click and hold "Clear" button during this service mode shall clear all saved external sensor T1 & T2 adjustment offset to 0, corresponding to memory mapping [vT1_Offset] & [vT2_Offset] respectively. "SEt", "CLR" shall show on bottom left / right part of LCD respectively. Press "Clear" button again shall return to "CALC" Service mode

Press "Mode" button shall enter adjustment process. The device shall be able to perform a single point auto-adjustment at $T_{ref} = 0^{\circ}\text{C}$ with a deviation of $\pm 0.9^{\circ}\text{C}$.

During adjustment process, "C#P#" shall be displayed on bottom left part of LCD to indicate External Temperature Channel#1(T1) or Channel#2(T2), and Adjustment Process Phase#1 or Phase#2. Temperature reading or error number Err# shall be displayed on bottom right of LCD.

● Adjustment Phase 1: Measurement

- (1) It shall take one measurement. If this first time reading is $T > 2^{\circ}\text{C}$ or $T < -2^{\circ}\text{C}$, Err 1 shall be showed on LCD right away; otherwise continue next step.
- (2) If the first time reading is $T > 0.9^{\circ}\text{C}$ or $T < -0.9^{\circ}\text{C}$, system shall wait up to 64 seconds until the reading gets within $\pm 0.9^{\circ}\text{C}$ range. If after 64 seconds, the reading doesn't reach $\pm 0.9^{\circ}\text{C}$ range, Err 1 shall be showed on LCD; otherwise continue next step.
- (3) It shall take 3 consecutive readings (with 1s interval), and if these differ by no more than 0.3°C , the system shall calculate the average of these measurements readings (**T_a**), and calculate the error **$T_e = T_a - T_{ref}$** . **T_e** shall be used to new adjustment offset candidate.

● Adjustment Phase 2: Verification

- (1) After successful Adjustment Phase 1, system shall measure with the new adjustment offset **T_e** and blinking the reading three times with display readings 2 seconds and blank 1 second.
- (2) If the reading is outside $\pm 0.3^{\circ}\text{C}$ of **T_{ref}** , then Error 2 will be shown and the new adjustment offset **T_e** shall be canceled
- (3) If the reading is within $\pm 0.3^{\circ}\text{C}$ of **T_{ref}** , then the new adjustment offset **T_e** will be made final and save to memory mapping [vT1_Offset] or [vT2_Offset], then

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system shall go to next sensor adjustment phase or complete the adjustment process if no more sensor to adjust.

After successful adjustment calculation, "SEt", "5UCC" shall show on bottom left / right part of LCD respectively. Press "Clear" button again shall return to "CALC" Service mode.

4.6.6 "Mode" + "Down": Statistic Review

By press "Mode" then press "Down", it shall enter Statistic Review mode. The purpose is to show the current values of statistical calculations performed by the Logger and alarm configuration settings from logging start or that last waypoint(if have). The LCD shall display statistical data.

The statistical calculation are base on:

- 1) If no waypoint: from the start data point to current data point.
- 2) If waypoint recorded: from the last waypoint to current data point.
- 3) If loop occurs: data points not in flash memory are not calculated.

4.6.6.1 Entry

Pressing "Mode", then press "Down" shall enter Stats Review mode.

The Stats Review shall not be available during Standby Mode.

4.6.6.2 Exit

Stats review shall exit by one of three possible ways:

- 1) By clicking "Clear" button.
- 2) By letting the mode expire in 30 sec if no "Down" button press.

After exiting the mode shall return to the one before the Stats Review mode was entered. The LCD shall display the image before the mode was entered.

4.6.6.3 Indication

During Stats Review the Battery Gauge and the activity mode icons (Active or Stopped) shall be hidden. The "Down" buttons shall navigate Stats Record display in five consecutive views on the LCD for each available sensor:

- 1) **Min, Max and Avg**
The Avg value shall be displayed in the center of the LCD, the MIN in the left bottom section and the MAX in the right bottom section
- 2) **Thi, Tlo, TxHi and TxLo**
These shall be alarm time values with the Time displayed in the center of the LCD and the corresponding alarm in the left bottom section

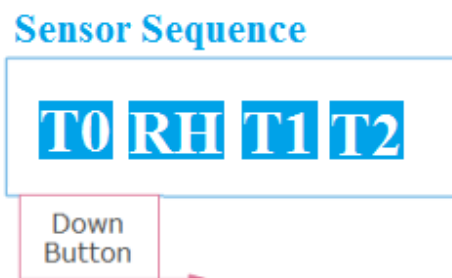
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The “Down” button shall navigate the Stats. Review display of the selected sensor from left to right as shown below:



The “Down” button shall navigate the selected sensor from left to right as shown (if the sensor is available by memory mapping [CTRL].SENSOR_TYPE), when the last sensor completes, it shall loop to the first sensor.



4.6.7 “Mode” + “Clear”: force push data

By press “Mode” then press “Clear”, it shall force connect to WiFi/Cloud then push data to Cloud. It shall give a beep tone to indicate force connect/push start. If WiFi/Cloud already connected and all data already pushed to Cloud, there is no force connect/push, and it shall give two beep tone to indicate such case.

This feature is only available when Logge is in Run Mode, and Configuration Option [CONTROL_WORD].WIFI_ENABLE is set to 1.

4.7 Wi-Fi Radio

This section specifies the features related to the Wi-Fi radio link.

4.7.1 Implementation

The Wi-Fi radio features shall be provided by an FCC-certified module. The module shall be installed on the main PCB of the Logger and shall not require external antenna but optional external antenna shall be fitted in the AA battery compartment when required. The power management of the module shall be controlled so that the operating time on backup battery is at least 2 months ([see Backup power](#))

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4.7.2 Data Security

The Wi-Fi radio shall be able to support standard encryption protocols such as WFA, WPA/WPA2 and WAPI and shall send data up to the Cloud Server by URL with SSL or by IP, which will be less secure. The option for SSL or IP for URL shall be in the configuration settings of the Logger.

4.7.3 Configuration by the PC

The Wi-Fi network connection settings of the module shall be also set by using the USB port of the Logger. In the root folder the Loggers shall make available a text file called [CONFIG.TXT](#), which shall be used to configure the Logger with keywords and values.

In addition, using the method of writing to the BIN file the User shall be able to configure the radio and the Logger's settings by using the FlashLink Program Manager software.

4.7.4 Push Interval

The push interval shall be the period of time between connection sessions with the Cloud Server. The push interval is calculated by following criteria:

4.7.4.1 Primary Power Mode

Memory Mapping [P_PUSH_INTERVAL] (resolution by seconds) is used to set push interval when powered by Primary Power.

4.7.4.2 Backup Power Mode

Memory Mapping [B_PUSH_INTERVAL] (resolution by seconds) is used to set push interval when powered by Backup Power.

4.7.5 Push Data to Cloud Criteria

When push interval coming, Logger shall push data to cloud by following criteria:

- (1) Configuration Payload (Option) - two consecutive Configuration Payloads shall push to Cloud once per day.
- (2) Reading Payload with all optional items (Required)
- (3) Reading Payloads with only required items (Optional) - how many such payloads push to cloud depends on data points still not push to Cloud.
- (4) One reading payload includes up to 60 data points (if have).
- (5) The total push time should be no more than [LOG_INT]/3, but at least 1 minute.

4.7.6 General Configuration Parameters

The Wi-Fi module shall accept several configuration parameters.

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4.7.6.1 Network Name

This shall be the name (SSID) of the local wi-fi network to which the Logger is to be connected. The corresponding memory mapping is [WIFI_NAME].

4.7.6.2 Network Password

This shall be the password of the local wi-fi network to which the Logger is to be connected. The corresponding memory mapping is [WIFI_PIN].

4.7.6.3 Push Interval

[P_PUSH_INTERVAL] for powered by Primary Power.

[B_PUSH_INTERVAL] for powered by Backup Power.

4.7.6.4 SERVER URL

This is the URL of Cloud Server.

4.7.6.5 SERVER PORT

This is the TCP/SSL Port of Cloud Server.

4.7.6.6 WIFI_ENABLE

Wi-Fi Radio can be enabled or disabled by setting Memory Mapping [CONTROL_WORD].WIFI_ENABLE to 1 or 0.

If Wi-Fi Radio is disabled, all Wi-Fi functions shall be disabled, and the logger becomes a standalone Min Max PDF logger.

4.7.7 Time Updates

When connected to the Cloud the Logger shall periodically obtain accurate atomic time from Internet Time Servers. A configuration setting shall define the Time Zone offset of the Local time. The offset shall then be automatically applied to the data log, so the data is reported in Local time when downloaded in all of the supported file report formats.

4.7.8 Indications

The Logger shall indicate the state of the connection to the Wi-Fi network by the icons on the LCD. The same icons shall also be used to give information about the signal strength (RSSI) in the four segments of the wave gauge.

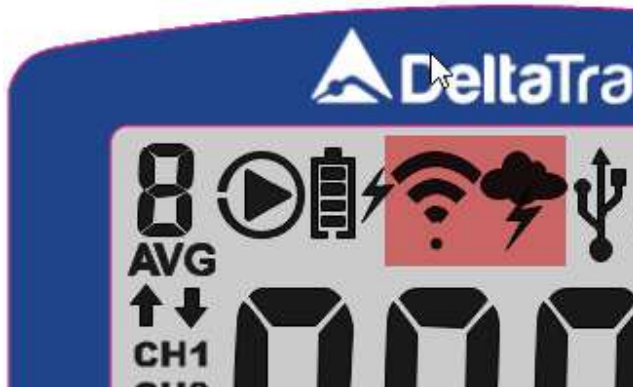
RSSI	WiFi-Icon
>=-60	

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>=-70	
>=-80	
>=-99	
=-100	blank

If the Logger has connected to the Cloud Server, then the cloud icon shall appear on the LCD as well. The Cloud server must be automatically available when the Internet service is present, so then the cloud icon will indicate also that the Internet is available.



4.7.9 Connect to Local Router

Memory Mapping [WIFI_NAME] and [WIFI_PIN] are ssid & password of local router used for router connect.

4.7.9.1 Primary Power Mode

In Primary Power Mode, Logger shall always connect to router.

During connecting, Wi-Fi icon shall flash. If connecting fail, Logger shall try to connect to router every 30 seconds. After 3 tries, buzzer shall beep once for each connection fail. Also press [MODE] then [CLEAR] button then hold for [BUTTON_HOLD_TIME] shall force router re-connection.

After connected, Wi-Fi icon shall display with number of bars corresponding to RSSI - the radio signal strength. RSSI shall be ready every 60 seconds.

4.7.9.2 Backup Power Mode

In Backup Battery mode, Logger shall connect to local router during push-data-to-cloud. If connecting fail, logger shall try to connect in next push data to cloud.

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4.7.10 Connect & Push-Data to Cloud Server

Before Connect to Cloud Server, it is must that Logger has already connect to Local Router. Memory Mapping [SERVER_URL] and [SERVER_PORT] are Cloud Server SSL/TCP URL&PORT used for cloud-connect.

During connecting, Cloud icon shall flash. When connected, Cloud icon shall display still on LCD and push-data-to-cloud starts. If push data success, Cloud icons shall flash three times, then turn off.

In Primary Power mode, if cloud-connect or push-data fail, Cloud icon shall flashing, and Logger shall try to cloud-connect and push-data every 30 seconds. After 3 tries, buzzer shall beep once for each fail. Also press [MODE] then [CLEAR] button then hold for [BUTTON_HOLD_TIME] shall force cloud-connect and push-data-to-cloud.

In Backup Power mode, if cloud-connect or push-data fail, Logger shall try to connect cloud and push data in next push-data-to-cloud.

5. PDF Logger Functions

5.1 Hardware and Software Resets

After a reset the Logger shall continue its normal operation according to its last configuration state with minimal loss of time.

The reset conditions for the Logger shall be due to:

- Battery Replacement
- ESD shock
- Loss of system clock due to condensation
- Disconnection from USB port after new configuration (Software Reset)

After resetting the PDF Logger shall check its hardware status and update its configuration. If some Error condition is detected it shall be reported according to the [Error handling specification](#).

5.2 Startup and Self Checks

After resetting, the Logger shall perform a sequence of self-checks. These shall result in displaying of an Error code or in the indication of a successful start.

5.2.1 Data Memory Check (optional)

This is not applicable for this project due to no non-volatile external data memory used.

5.2.2 Configuration Check

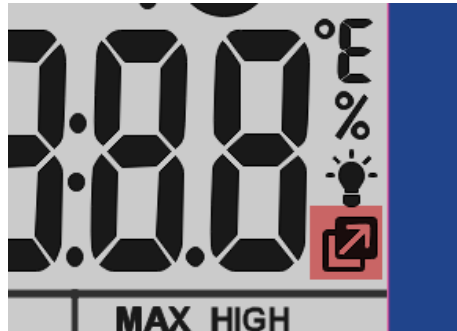
The Logger shall check for invalid configuration and enter self-configuration to load the default factory settings

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5.2.3 Sensors Check

The Logger shall read each sensor that is installed according to its sensor configuration settings. If a sensor is found to be disconnected the Logger shall indicate an Error and flash the sensor disconnected icon.



5.3 Error Handling

The Wi-Fi PDF logger shall have its own internal and autonomous Error handling algorithm. All firmware functions that are expecting errors shall have corresponding error handlers.

5.3.1 Error Exceptions

Sensor conditions, such as open sensor - sensor removed temporarily, shall not be indicated as Errors and the normal operation of the Logger shall continue without interruptions. However, the reading from disconnected sensor shall be identifiable in the data log. Some special value such as -0x8000=-32768 can be used for data recorded during the time sensor is disconnected.

5.3.2 Successful Start Indication

LCD shall flash all segments 3 times with RED and Blue LCD backlight toggle 3 times, and buzzer shall beep 3 times to indicate successful self-test after reset.

5.3.3 Error Mode

During Error Mode the Logger shall only indicate the Error number with red backlight of the LCD.

5.3.3.1 Accessibility

The Logger shall be accessible by PC software during Error mode. After disconnection from the USB port, the Logger shall self-reset and clear the Error Mode if the error condition is not present.

The Logger may also be accessible through the Wi-Fi radio in Error mode as long as the error is not related to the Wi-Fi Features.

5.3.3.2 Exiting

The Logger shall require hardware or software reset in order to exit from its Error Mode.

During Error Mode the system shall execute a self-reset every 5 minutes. This provides

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opportunity to recover from the error condition. More frequent Error recovery attempts may be set as a configuration option.

For Err 4~10 about sensor lost error, when sensor detected, it shall exit Error Mode at once.

5.3.4 Error Codes

The following conditions shall be indicated by Error and Sub-Error codes as follows:

a) **Err 1: Memory Error**

This is not applicable due to no non-volatile external data memory used (keep here for compatibility / future-use purpose).

b) **Err 2: Configuration Missing**

This error shall occur when no configuration found.

- Default configuration shall be loaded.

c) **Err 3: Invalid Configuration Error**

This error shall occur when:

- [CONFIG_TIME] is not valid
- [MAX_DATA_POINTS] is 0
- [UNDER_RANGE_TEMP] >= [OVER_RANGE_TEMP]
- [P_PUSH_INTERVAL]>864000
- [B_PUSH_INTERVAL]>864000

d) **Err 4: Sensor T0RH Error**

e) **Err 5: Sensor T1 Error**

f) **Err 6: Sensor T0RH & T1 Error**

g) **Err 7: Sensor T2 Error**

h) **Err 8: Sensor T0RH & T2 Error**

i) **Err 9: Sensor T1 & T2 Error**

j) **Err 10: Sensor T0RH & T1 & T2 Error**

k) **Err 11: WIFI module Error**

The Wi-Fi Module is not available but the device is configured to use it

l) **Err 12: Power by backup battery, and battery life falls below 25% (<=3.3V)**

5.3.5 LCD Indication

The Error Codes shall be indicated on the LCD as "Err #" until the resetting of the device or until pushing of any button, which shall also reset the device when it is in error mode.

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5.3.6 Saving the Last Error Code

The last Error code shall be saved to the non-volatile memory if the error is not related to the memory itself. The code shall be saved in **[vLAST_ERROR]** of the configuration memory.

5.4 Self-Configuration

The self-configuration shall occur when the internal configuration memory is not initialized, which may be a typical case during early production. Under such conditions the default configuration data stored in the flash memory shall be loaded. The configuration check procedure shall be a part of the setup execution sequence taking place after a reset.

5.5 Keeping Time

The Device shall maintain its internal RTC accurately throughout all operating modes. The RTC time shall be synchronized with the Atomic Time by the Internet Connection ([see Time Updates](#)). It shall be used in operation events, such as:

1. Alarm Triggering
2. Data Logging

5.5.1 Time Keeping Requirements

- a) The Logger shall keep time with accuracy better than 1 minute per month.
- b) Connecting to PC for downloading shall not interfere with the time keeping process
- c) Features, such as startup delay shall not affect the time keeping in the device
- d) Time loss, due to hardware reset shall be minimized to one logging interval or less
- e) The Logger's local Date and time shall sync with Cloud per day(if WiFi/Cloud available).

5.6 Operational Modes

The PDF data logger shall have the following operational modes:

5.6.1 Running Mode

During Running mode, the logger shall take sensor reading at the configured logging interval [LOG INT]. Each reading shall be compared to the alarm set points, so that the indication of Alarm can be triggered if needed. The Logger shall start this mode by assigning the internal RTC time value to the Logging Start Time [START TIME] register.

5.6.1.1 Entering

The mode shall be entered when memory mapping [vMODE] is set to 0 (RUN) upon Logger power-up, or by Service Mode #1.

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5.6.1.2 Looping

The logger shall continue recording after reaching the end of the data memory. New data shall overwrite old data without stopping.

5.6.1.3 Exiting

The mode shall exit only when the Logger is put into standby or OFF mode by Service Mode #1. After returning from Standby the logger shall start logging data from the beginning of the data memory again. The Start Time value shall be refreshed with the current time.

5.6.1.4 Indication

The Logging mode shall be indicated by displaying run icon (right pointing arrow) on the LCD.

5.6.2 Standby Mode

Logger shall act as a Min/Max PDF Logger in this mode, and following features are not supported: WIFI, Daily Stats., Waypoint & Alarm.

This mode shall be entered when MEMORY MAPPING [vMODE] is set to 1 (STANDBY) upon Logger power-up, or by Service Mode #1, or from OFF mode.

The Logging mode shall be indicated by displaying standby icon (circle) on the LCD.

5.6.3 OFF Mode

This mode shall be entered when MEMORY MAPPING [vMODE] is set to 2 (OFF) upon Logger power-up, or by Service Mode #1.

During this mode, Logger shall consume minimum power from the battery. The LCD shall be blank. This mode shall respond only to the [CLEAR] Button push.

- a) After each [CLEAR] button press the logger shall show "OFF 1"->"OFF 2"->"OFF 3"->"OFF 4" on the LCD with "OFF" at upper part, and digital at bottom right part. The first press may need hold a while till "OFF 1" appears.
- b) After four consecutive clicks, the Logger shall exit the OFF mode and it shall automatically enter Standby mode (see next). There shall be a 2 sec timeout on the expected 4 clicks of the button.

5.7 Alarm Features

5.7.1 Enable Alarms

All alarm functions and indications shall be enabled/disabled by a single bit flag in the control register [ALARM=1] = ENABLED. The Alarm features shall be disabled by default.

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5.7.2 Alarm Levels

The Logger shall support four alarm thresholds. All of these shall be expressed in temperature (degree °C) / Humidity(%) values. Validation of alarm thresholds shall be done by comparing the level temperature / humidity to the actual temperature. Each of the temperature / humidity level shall be represented by 2-byte register (2's compliment format) in the configuration block of the logger - [T0_EXT_HI_ALARM], [T0_HI_ALARM], [T0_LO_ALARM], [T0_EXT_LO_ALARM] for Sensor-T0; [T1_EXT_HI_ALARM], [T1_HI_ALARM], [T1_LO_ALARM], [T1_EXT_LO_ALARM] for Sensor-T1; [T2_EXT_HI_ALARM], [T2_HI_ALARM], [T2_LO_ALARM], [T2_EXT_LO_ALARM] for Sensor-T2; [RH_EXT_HI_ALARM], [RH_HI_ALARM], [RH_LO_ALARM], [RH_EXT_LO_ALARM] for Sensor-RH (see [Memory Mapping](#)).

If [_EXT_HI_ALARM]=[_HI_ALARM], Extreme High Alarm detection is canceled.

If [_EXT_LO_ALARM]=[_LO_ALARM], Extreme Low Alarm detection is canceled.

5.7.3 Alarm Indication

The Bell Icon, the Up or Down alarm icons together with the Level Icon - 1 for Normal or 2 for Extreme - shall display on the LCD.

If configuration option [CONTROL].ALARM_BUZZER is set, Normal level alarms shall be indicated by one Buzzer beep with 250 msec duration, and Extreme level alarms shall be indicated by three Buzzer beeps of 200 msec per beep with 50 msec pause between. The buzzer alarm interval is 5s.

If configuration option [CONTROL].ALARM_BACKLIGHT is set, LCD Red Backlight shall be used as [Alarm Light](#) (refer to [LCD Backlight](#)).

5.7.4 Clear Alert

[See definition for Clear button](#)

5.7.5 Skip Alarm

This shall be a configuration option represented by a register [SKIP_ALARM] (see memory map). This register shall indicate the number of data points from the beginning of the data block that shall not trigger alarms. The maximum settings shall be 255 points.

5.7.6 Delay alarm

The purpose of delay alarm function is to create a time buffer in the alarm response of the logger. This feature shall remove false alarm when known conditions such as door opening occur. Internally the delay alarm function shall be implemented as a countdown timer that is activated on the first point of alarm. If the alarm condition persists for a period longer than the specified Delay Alarm Setting, the alarm indication shall be triggered. Otherwise, if the temperature reading is restored to normal during the Delay period the Delay Alarm Timer shall also be reset and the process shall repeat with the next point in alarm.

The Delay Alarm shall be represented by 2-byte register in the configuration block. Each sensor has its Delay Alarm configuration option, [T_ALARM_DELAY]/[T1_ALARM_DELAY]/[T2_ALARM_DELAY]/

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[TRH_ALARM_DELAY] (see [memory map](#)). These registers shall be used to set countdown time in minutes.

5.7.7 Cumulative Alarm

The cumulative future shall be useful when the alarm indication should be triggered not by a single event but by duration of time, accumulated in alarm. Each of the alarm thresholds shall have a corresponding 2-byte counter register which shall be used to count down the number of points in alarm. The alarm indication for the corresponding threshold shall only be triggered when the corresponding cumulative time counter is zero. The cumulative counters shall be [T0_EXT_HI_ALARM_CTR], [T0_HI_ALARM_CTR], [T0_LO_ALARM_CTR], [T0_EXT_LO_ALARM_CTR] for Sensor-T0; [T1_EXT_HI_ALARM_CTR], [T1_HI_ALARM_CTR], [T1_LO_ALARM_CTR], [T1_EXT_LO_ALARM_CTR] for Sensor-T1; [T2_EXT_HI_ALARM_CTR], [T2_HI_ALARM_CTR], [T2_LO_ALARM_CTR], [T2_EXT_LO_ALARM_CTR] for Sensor-T2; [RH_EXT_HI_ALARM_CTR], [RH_HI_ALARM_CTR], [RH_LO_ALARM_CTR], [RH_EXT_LO_ALARM_CTR] for Sensor-RH (see [memory map](#)). These shall be reset during re-configuration.

5.7.8 Alarm Event and Total Time

Alarm Event shall be triggered under following condition:

Step1: no alarm condition detection for [SKIP_ALARM] data points after data logging start.

Step2: if there is alarm condition, [ALARM_DELAY] shall count down till 0; otherwise, [ALARM_DELAY] shall be reset to original count down value. Remark: zero point is excluded in alarm condition detection.

Step3: If [ALARM_DELAY] (in minutes) counts down to 0, Cumulative Alarm counter [ALARM_CTR] starts count down till 0. Remark: [ALARM_CTR] doesn't reset to original value even when alarm condition canceled.

Step4: if [ALARM_CTR] reaches 0, Alarm Event is triggered.

Total Time is the counter that includes all data points (except zero point) in alarm condition.

5.7.9 Alarm Set-point Exclusivity

All alarm set points shall be excluded from alarm triggering, which means that the sensor reading must violate the alarm set point in order to produce Alarm triggering.

5.7.10 Pushing Data to the Cloud Server

The alarm status shall be send to Cloud by Reading Payload with the parameter "alarms", details refer to [10. Server and Logger Protocol](#).

Cloud server shall automatic trigger alert if alarm occurs.

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5.8 General Options

5.8.1 WHO mode

WHO Mode shall be enabled by set configuration Option [CONTROL].WHO_MODE.

- If WHO mode is enabled, the daily stats memory shall be restricted to 30 days.
- If WHO mode is enabled, the total number of temperature reading per loop is restricted to 4,320, that is [LOG_INT] is fixed to 10min(600sec).

5.8.2 Alarm Light

The Red alarm LCD backlight functions shall be controlled by a Configuration option [CONTROL].ALARM_BACKLIGHT, refer to [LCD Backlight](#).

5.8.3 Beep on Click

Every button press shall produce a single beep when this configuration option [CONTROL].BUTTON_SOUND is enabled.

5.8.4 Primary Scale

This configuration option [CONTROL].SCALE shall determine the temperature scale of the logger. This can be either C ([CONTROL].SCALE=0) or F ([CONTROL].SCALE=1). The scale shall be able to be changed by user with the Mode button any time in normal default view if that button function is enabled by a configuration option.

The data reports produced by the Logger shall be done only in the specified scale. No dual scale temperature representation is required, so this shall keep the reports clear and easier to read.

5.8.5 Date Format

The date shall be represented in three formats based on a configuration option:

DATE_FORMAT= 0 for (mm/dd/yyyy) (default)

DATE_FORMAT= 1 for (dd/mm/yyyy)

DATE_FORMAT= 2 for (yyyy/mm/dd)

5.8.6 Out-range Gap

Set to display broken line (gap) for out-of-range point in PDF Chart Report by configuration option [CONTROL].OUT_OF_RANGE_GAP: 0 - solid line (default) or 1 - broken line.

5.8.7 Time Zone & Date/Time Setting

Internal RTC time and time values such as [CONFIG_TIME] shall be in UTC (aka GMT+0).

The time on report files created by the Logger shall include a configuration setting for Time Zone offset [TIME_ZONE], which shall be a floating point number with a range from -12.00 to 14.00, the

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resolution is quarter, such as 12:15 is for 12-hour-1-Quarter. The value of the time zone setting shall be available in the CONFIG.TXT file as a publicly accessible field

5.8.8 Alarm Buzzer

Set to enable the buzzer to sound when alarm event is triggered.

5.8.9 Wi-Fi

Set to enable use of the Wi-Fi module, see [4.7 Wi-Fi Radio](#). Successful data push requires valid access points credentials and web endpoint information. The configuration parameters HTTPS and v1wifi must also be set according to the web endpoint.

5.9 Statistical Features

The Logger shall keep track if statistical information for all of the available and enabled sensors. The Stats shall be saved at the

5.9.1 History Mode

The WHO specification calls for an operating mode that can allow the review of historical data for the past 30 days, one day at a time and on the LCD of the logger.

5.9.1.1 Entering

The mode shall be entered when "Up" or the "Down" arrow are pressed ([see Buttons](#)). It shall depend on the configuration option [CONTROL].DAILY_STATS = 1.

It shall also depend on the availability of Daily Stats data: vDAILY_STATS_CTR > 0.

When the configuration conditions above are present the Stats Review shall take place when the Stats Review mode is entered and the Stats from the day before the current day shall be displayed after the last Stats values of the current day, unless the fast-forward feature is used (see next).

See [exiting history mode](#) in the Button section.

5.9.1.2 Indication

The Daily Stats shall be viewed in sequence, one value at time in the order of the closest to the earliest day, i.e., in the order from 1 day ago to 128 days ago and back. The sequence shall start first with the "day" number displayed on the LCD together with the "day" icon and with the corresponding Alarm Sate icon. The QC Failure icon shall be visible if any of the exposure counters in the record i.e., minutes above or minutes below is greater than zero, which indicates alarm condition.

The corresponding channel icon shall be displayed as follows: CH1 for T1 sensor, CH2 for T2 sensor and none of them for the internal sensors.

The extreme alarm values shall display the Level icon with the number 2.

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5.9.2 Statistical Value

The following statistical data shall be available for view for each available sensor:

- Maximum reading: [vT0_MAX]/[vT1_MAX]/[vT2_MAX]/[vTRH_MAX]
- Minimum reading: [vT0_MIN]/[vT1_MIN]/[vT2_MIN]/[vTRH_MIN]
- Average reading: [vT0_TEMP_ACC]/[vT0_DATA_CTR]/...
- Time above extreme high alarm level: [vT0_EXT_HI_CTR]*[INT]/...
- Time above high alarm level: [vT0_HI_CTR]*[INT]/...
- Time below low alarm level: [vT0_LO_CTR]*[INT]/...
- Time below extreme low alarm level: [vT0_EXT_LO_CTR]*[INT]/...

Refer to 4.6.6 "Mode" + "Down" : Statistic Review for detail operation.

5.9.3 Daily Stats File

The daily stats file shall be in CSV format and it shall store the statistical record of up to **[DAILYSTATS_MAX]** days and after continue storing in loop around. The File name shall follow the common file naming convention with inserted "DS" in the file's name.

Refer to 4.4.2.3 The Daily Stats File for detail.

5.9.4 Waypoint File

Refere to 4.4.3.3 The Waypoint File for detail.

5.10 Battery Features (rechargeable battery)

5.10.1 Battery Life

The battery life shall be displayed by the corresponding gauge icon on the LCD. The following shall be applied to the logic of the gauge bars:

4.2V – 4V for 100% 4 bars in battery icon of the LCD display.

4V – 3.8V for 75% 3 bars in battery icon of the LCD display.

3.8 – 3.76V for 50% 2 bars in battery icon of the LCD display.

3.76V – 3.3V for 25% 1 bar in battery icon of the LCD display.

3.3V or lower for 0% 0 bar in the battery icon and low battery alert should be trigger.

The Wi-Fi functions shall be disable when the battery capacity falls below 25%.

The battery voltage shall be checked every 30 minutes.

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5.10.2 Battery Icons Display

The battery gauge shall be displayed when the Logger operates without the [Primary Power](#) or when the battery life is less than 100%. In other cases, the display shall be hidden from view.

5.11 USB Connection

The USB icon shall be displayed when the Logger is ready with the report files and the PC can recognize it as a removable drive.



5.11.1 Exit USB Mode

There are two ways to leave USB Mode:

- (1) Remove Logger from PC USB port, it shall exit USB Mode, and enter Backup Battery Mode.
- (2) If the Logger insert to PC USB port for more than 60 minutes, it shall exit USB Mode, and enter Primary Power Mode.

5.12 Calibration Certificate

The logger shall support internal calibration certificate in PDF format. The calibration certificate PDF will be programmed into the device by the MUX Manager production software.

At the time that the PDF data is programmed into the device the calibration date for the certificate will also be programmed into the device. Refer to [4.8 Sensor Calibration](#).

5.12.1 Enable Display of Calibration Certificate

The calibration certificate shall be displayed in the logger on a per sensor basis.

- {T0|T1|T2|RH} CAL_CERT bit is enabled in the control doubleword.

5.12.2 Calibration Certificate Check

The device shall not be required to validate the integrity or validity of the calibration certificate; instead, the device shall perform a check to determine the presence of calibration certificate data. While the corresponding calibration certificate bits are set then the *CERT.PDF will be displayed in the file folder of the device only when:

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- (1) (xx_CAL_CERT) setting is enabled
- (2) (xx_CAL_DATE_TIME) setting is a valid date/time
- (3) First 4 bytes of PDF data is "%PDF"

6. Electrical Requirements

6.1ESD

The circuit shall be able to withstand ESD occurrence of 4kV at the USB connector. Besides a normal reset there shall be no permanent damage to the circuit or change in its function.

6.2Backup Battery

The circuit shall use power from the USB connection when the connection is present otherwise the circuit shall be powered by Flat lithium rechargeable battery at 3.7V with 1800mAHr total capacity at 25C.

7. General Specification

- a) Max Data Points: 32K in loop around
- b) Temperature Range: -40°F to 183.6°F (-40°C to 87°C)
- c) Accuracy: 1°C from -40°C to -20°C
- d) Accuracy: 0.5°C from -20°C to 25°C
- e) Accuracy: 1°C from 25°C to 87°C
- f) Body ABS plastic
- g) Main unit thickness: XX±1 mm
- h) Total length: XX±1 mm
- i) Calibration: Factory calibrated
- j) Resolution: 0.2°F (.1°C)
- k) Water resistant: IP54

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FCC Warning:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Caution: Any changes or modifications to this device not explicitly approved by manufacturer could void your authority to operate this equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 0cm between the radiator and your body.