

APPLICATION NOTE

EN12830 DATA LOGGER

Bluetooth[®] LOW ENERGY



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1. About this document

This document describes how to configure and use the new ELA Innovation data logger, as well as new features implemented in the Blue EN12830 product line.

2. Applicable product



Blue PUCK T EN12830
IDF30241

3. General




Firmware in the EN12830 tag includes several new features:

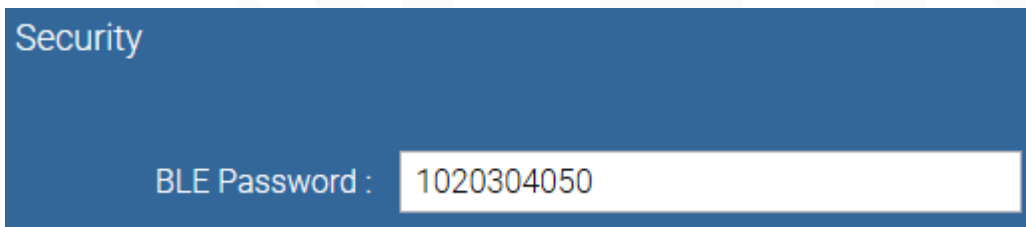
- EN12830 data logger functions
- Calibration of temperature values
- Storage of tag calibration values


Designed for the EN12830 standard (temperature recorders for the transport, storage, and distribution of temperature sensitive goods), these features are protected by a Bluetooth Low Energy (BLE) access password. The password is added during tag configuration using NFC.

BLE password configuration

The BLE password must be 10 characters long. It may contain special characters (Space, !, ", #, \$, %, &, ', (,), *, +, -, /, :, ;, <, =, >, ?, @) Here is an example of BLE password configuration in an EN12830 tag using the Device Manager PC application.

1. Open Device Manager and go into "Programmers" to select the reader "ACS ACR122".
2. Open the Configuration panel. 
3. Place the tag on the NFC reader and click on "Refresh". 
4. Click on the "Security options" icon. 
5. The "Security" window is displayed:



6. Enter the BLE password in this window and then click on "Write". 
7. When the write pop-up window is displayed, you may remove the tag from the NFC reader. The BLE password is now operational.

ATTENTION:

- A password cannot be read from the device.
- You can replace a password with a new password.
- Temperature data stored on the tag is erased if the password is changed.

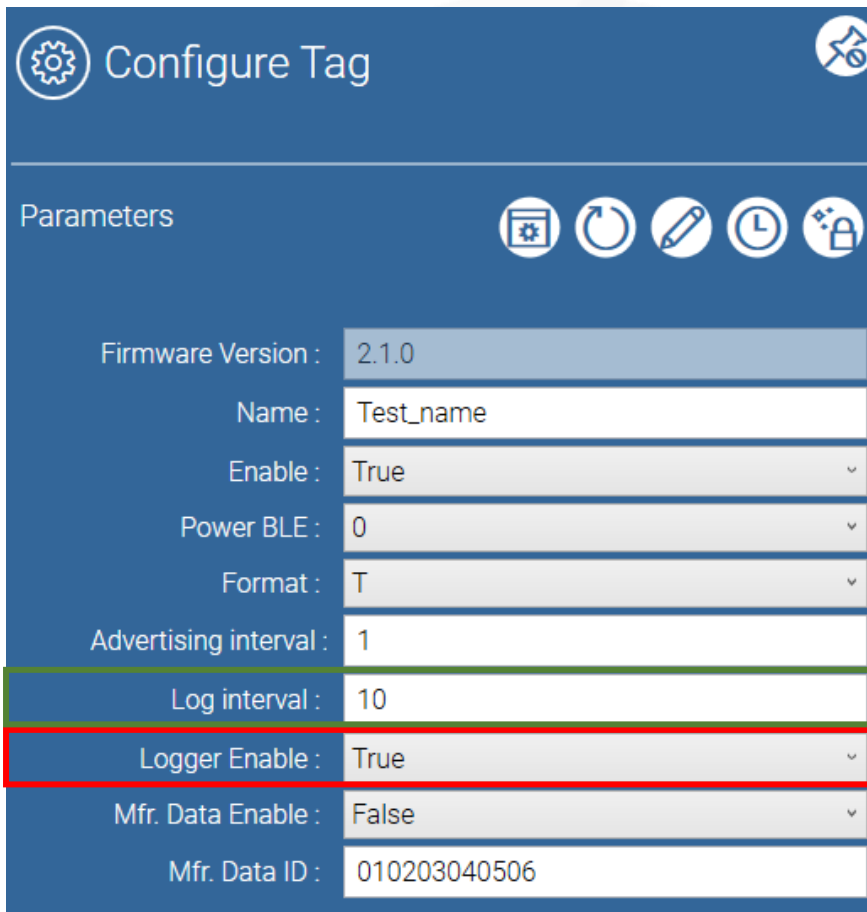
4. EN12830 data logger

1. General information

Firmware version 2.1.0 of ELA Innovation's Blue tags implements a data logger that is fully compatible with the *EN12830 Data Recorder v2018 standard*. The data logger contains timestamp and identification information for stored values, and implements a data control mechanism to ensure integrity.

2. NFC configuration

Datalogger fields are configured using the Device Manager application:



Parameters	
Firmware Version :	2.1.0
Name :	Test_name
Enable :	True
Power BLE :	0
Format :	T
Advertising interval :	1
Log interval :	10
Logger Enable :	True
Mfr. Data Enable :	False
Mfr. Data ID :	010203040506

To use the data logger, you must set the **Logger Activated** field to **True**. (1)

The storage interval for temperature values is configured using the **Log interval** field. The value expressed in this field is in **seconds**. (2)

In this example, the data logger is **activated** with an interval of **10 seconds** between readings.



NOTE: To be able to connect to the tag and download the datalogger, it is recommended to configure an **Advertising Interval less than or equal to 3 seconds**. If the advertising period is greater than this value, it will be impossible to establish *Connected Mode*.

3. Configuration of BLE connected mode

Starting datalogging

To start storing temperature readings in tag memory, you must send the start date/time to the tag. That start date/time will be used as the basis for time-stamping data. After the command is sent, the data logger will start monitoring and storing values for the period defined in NFC configuration.

The command to start the data logger and send the date is as follows: **DATALOGGER_START**. You must then provide the BLE password for the command to be taken into account by the tag. Lastly, you must provide the date in the following format: **DD/MM/YYYY HH:mm:SS +hh:gg**, where:

- **DD**: day on which logging starts, written with 2 digits (ex. 01, 08, 15...)
- **MM**: month in which logging starts, written with 2 digits (ex. 01, 05, 11...)
- **YYYY**: year in which logging starts, written with 4 digits (ex. 2019...)
- **HH**: hour at which logging starts, in 24-hour format, written with 2 digits (ex. 02, 16, 23...)
- **mm**: minute at which logging starts, written with 2 digits (ex. 01, 26, 54...)
- **SS**: seconds at which logging starts, written with 2 digits (ex. 05, 18, 56...)
- **hh**: UTC time zone hour used to start the logging, written with 2 digits (ex. 00, 03...).
- **gg**: UTC time zone minutes used to start the logging, written with 2 digits (ex. 00, 30...)

If the command syntax is valid, the tag returns **DATALOGGER_START: Success**. The date is then stored in the tag.

Command example:

DATALOGGER_START PASSWORD_1 05/06/2019 11:20:00 +01:00

Tag response if password is valid: **DATALOGGER_START: Success**

Tag response if password is invalid: **DATALOGGER_START: ACCESS DENIED**

Tag response if date is invalid: **DATALOGGER_START: WRONG PARAMETERS**

When this command is sent to the tag, the first sensor measure will be performed after the Logging period entered in the NFC configuration.

For example, if the Log interval is 30 seconds, the first data logger data will be measured and stored 30 seconds after sending the **DATALOGGER_START** command.

IMPORTANT: When this command is sent to the tag, all previous content stored on the data logger is deleted and datalogging restarts from zero.

Stopping datalogging

You may stop datalogging on the tag. This is done using the **DATALOGGER_STOP** command. You must provide the BLE password the command to be taken into account by the tag.

Command example:

DATALOGGER_STOP PASSWORD_1

Tag response:

- If the password is valid and datalogging is running: *DATALOGGER_STOP: Success*
- If the password is valid but datalogging is not running: *DATALOGGER_STOP: LOG not started!*
- If the password is invalid: *DATALOGGER_STOP: ACCESS DENIED*

The data stored in data logger memory may be retrieved (**READ_DATA** command) until you start another datalogging session or restart the tag.

4. Retrieving and verifying data

Command for retrieving data

IMPORTANT: You may read stored data at any time, without having to stop datalogging.

Retrieve stored data from the data logger using the **READ_DATA** command. You must provide the BLE password for the tag to return data.

If the command syntax is valid, the tag returns **READ_DATA: Success**. The tag then begins to transmit its data.

Command example:

READ_DATA PASSWORD_1

Tag response:

- If password is valid: *READ_DATA: Success*
- If password is invalid: *READ_DATA: ACCESS DENIED*
- If the password is valid but datalogging is not running: *READ_DATA: LOG not started!*

Reading all data logger values

Once the command is received, the tag transmits all the data stored in data logger memory. Data is in the following format:

---DOWNLOAD_START---
Firmware version: 2.1.0\n
MacAddress: 01:02:03:04:05:FE\n
Name: TAG_LOCAL_NAME\n
Unit: Celsius degrees\n
Start date: 01/04/2019 11:26:33 +01:00\n
<DATA_START>\n
01/04/2019 11:26:33+01:00: 23.34\n

01/04/2019 11:26:43+01:00: 23.44\n
[...]
<DATA_END>\n
CRC16: 0x0D06\n
---DOWNLOAD_END---

The newline characters (\n) are not visible, but they must be taken into account for CRC calculation.

Field explanation:

- --- *DOWNLOAD_START* --- : marker indicating the start of transmission by data logger
- *Firmware version*: data logger (tag) firmware version
- *MacAddress*: tag's unique ID number
- *Name*: tag's name as configured in NFC memory
- *Unit*: unit used for temperature values (°C in this example)
- *Start date*: datalogging start as sent by the **DATALOGGER_START** command
- <DATA_START>: marker indicating the start of temperature data transmission
- 01/04/2019 11:26:33+01:00: 23.34: Complete example of temperature data with timestamp
- <DATA_END>: marker indicating the end of temperature data transmission
- *CRC16*: circular redundancy check calculated from transmitted data
- --- *DOWNLOAD_END* --- : marker indicating the end of transmission by data logger

Reading temperature data

In the previous example, temperature readings are formalized as follows:

01/04/2019 11:26:33+01:00: 23.34

- **01/04/2019** corresponds to the date on which the temperature was read: 1 April 2019 in this example.
- **11:26:33** corresponds to the time at which the temperature was read.
- **+01:00** corresponds to the UTC time zone, provided with the DATALOGGER_START command.
- **23.34** corresponds to the temperature value expressed in the unit transmitted by the data logger, 23.34°C in this example.

Checking data logger CRC

Datalogger data is controlled by a CRC16 calculation (*Cyclic Redundancy Check*). CRC details are as follows:

- CRC-16-CCITT algorithm
- 0x1021 polynomial
- Initialization value: 0xFFFF

Calculation example: Input data (ASCII type input) 0123456789ABCDEF

- o Result: 0x2C1F

The data logger CRC calculation is performed on all the data contained between the markers: --- **DOWNLOAD_START** --- (not included) and the character string **CRC16: 0x**.(included).

Complete data logger example:

---DOWNLOAD_START---
Firmware version: 2.1.0\n
MacAddress: FA:FD:50:39:A1:2C\n
Name: BE_TEST_T3\n
Unit: Celsius degrees\n
Start date: 14/06/2019 12:00:00 +01:00\n
<DATA_START>\n
14/06/2019 12:00:10 +01:00: 26.62\n
14/06/2019 12:00:20 +01:00: 26.62\n
<DATA_END>\n
CRC16: 0xDF91\n
---DOWNLOAD_END---

The CRC value is calculated on all the data shown above in red. For this example, the value is thus 0xDF91. A CRC calculator is available online at this website address: <http://www.tahapaksu.com/crc/>. Use the result contained in the CRC-CCITT field (0xFFFF).

IMPORTANT:

- Using the READ_DATA function does not erase the recorded and transmitted data.
- Datalogging is not stopped when you read data. It continues automatically as soon as data transmission is finished.

Reading the datalogging start date

The command to read the datalogging start date that was sent to the tag is **READ_START_DATE**. You must provide the BLE password for the command to be taken into account by the tag.

Command example:

READ_START_DATE PASSWORD_1

Tag response:

- If the password is valid but datalogging is not running:
READ_START_DATE: LOG not started!
- If the password is valid and datalogging is running:
READ_START_DATE: DD/MM/YYYY HH:MM:SS +UU:UU
- If the password is invalid: *READ_START_DATE: ACCESS DENIED*

5. Calibration and calibration report

1. General information

Calibration

You may calibrate the temperature readings measured by the tag. Calibration uses the format aT^2+bT+c , where **a**, **b** and **c** are configurable coefficients. These coefficients may only be written with tag configuration via NFC. The coefficients may be read in *connected mode*.

They are transmitted in the format **XeY**, where **X** is an integer between -32768 and 32767, followed by a superscript **Y** from -128 to 127. **XeY** is equivalent to $X \cdot 10^Y$. Examples:

- 125e-5 = 0.00125
- 1e-2 = 0.01
- 12e-1 = 1.2

Examples of complete calibration:

- Sensor reading before calibration = 25.00°C. Calibration polynomial [c, b, a]: [5e-1, 1e0, 0e0]. The calculated value is therefore: $T_{cal} = 25.5^\circ\text{C}$
- Sensor reading before calibration = 25.00°C. Calibration polynomial [c, b, a]: [0e0, 101e-2, 0e0]. The calculated value is therefore: $T_{cal} = 25.25^\circ\text{C}$

You may not change the calibration state (activated/deactivated) in connected mode when datalogging is running.

You may only define a first-degree polynomial ($bT + c$), or a 0 degree polynomial (only **c**, which can be used for testing). Coefficients are always sent in the following order: [c, b, a].


Calibration

You may save a report containing calibration values (with the pair: setpoint value + measured value and calibration result) in tag memory. The report can be read in *connected mode*. Report example:

- Setpoint value 1: 25.00°C
- Measured value 1: 25.21°C
- Setpoint value 2: 75.00°C
- Measured value 2: 75.56°C
- Report result: 1 (OK)

2. NFC configuration

The fields for calibration and the calibration report are configured using the Device Manager application.

The window for configuring the fields is accessible via the "Data Logger" icon. 

Data Logger Configuration

Report Date : 01072019

Target Temp. Values

Measurement Temp

Calibration Result : 0

Calibration Enable : 0

Polynomial (ax^2+bx+c)


Polynomial Exponer


Date Report Cal. : 23072019




Hour Report Cal. : 10:29:42

Time Zone Rep. Cal. +00:00

Configuring calibration coefficients

To activate calibration (use of the temperature correction polynomial), you must enter 1 in the field **Calibration Enable**. Enter the polynomial coefficients as follows: click on the icon  next the **Polynomial. coef.** and add the coefficients in the order c, b, a:

 Define polynomial ax^2+bx+c

	Decimal Value	Exponent Value	Value	Validity	
Coefficient c	<input type="text" value="30"/>	<input type="text" value="-5"/>	30e-5	✓	
Coefficient b	<input type="text" value="1001"/>	<input type="text" value="-3"/>	1001e-3	✓	
Coefficient a	<input type="text" value="2"/>	<input type="text" value="-2"/>	2e-2	✓	

Click on OK. The coefficients are displayed like this:

Calibration Enable :


Polynomial (ax^2+bx+c)

Polynomial Exponer

You must then enter the current data, which is used to know when the calibration coefficients were modified. By default, Device Manager automatically fills in the three date fields with the current date.


Date Report Cal. :	23072019
Hour Report Cal. :	10:29:42
Time Zone Rep. Cal.	+00:00

The date is in the format DDMMYYYY for the day; hh:mm:ss for the time; and +HH:MM for the time zone.





When all fields are filled in, click on “Write”. 

When the write pop-up window is displayed, you may remove the tag from the NFC reader. Calibration parameters will now be taken into account.



Writing the calibration value report


To save a report with calibration values, enter the date in the format **DDMMYYYY** in the **Report date** field. Fill in the target/measured values by clicking on the icon  next to the **Target temp. Values** field.

Calibration Items Entries

	Target Value	Measurement Value	
Temperature Value 1	<input type="text" value="15.00"/>	<input type="text" value="15.1"/>	 
Temperature Value 2	<input type="text" value="55.00"/>	<input type="text" value="55.5"/>	 

When you click on OK, the coefficients are displayed like this:

Report Date :	01072019
Target Temp. Values	[15.00,55.00] 
Measurement Temp	[15.10,55.50] 
Calibration Result :	1

Lastly, enter calibration results (1 = OK, 0 = NOK) and click on “Write”. 

When the write pop-up window is displayed, you may remove the tag from the NFC reader. The calibration report is stored in tag memory and accessible in connected mode.

3. Configuration of BLE connected mode

Activating / deactivating calibration

The command to activate temperature calibration is **SET_CALIB_EN**. You must provide the BLE password for the command to be taken into account by the tag. Then you must provide a Boolean 1 (calibration activated) or 0 (calibration deactivated).

Command example:

SET_CALIB_EN PASSWORD_1 1

Tag response:

- If the password is valid and the command contains "1": *SET_CALIB_EN: 1*
- If the password is valid and the command contains "0": *SET_CALIB_EN: 0*
- If the password is invalid: *SET_CALIB_EN: ACCESS DENIED*
- If the data logger is already running: *SET_CALIB_EN: LOG already started*

4. Viewing data

Reading coefficients

The command to read the tag's calibration coefficients is **READ_CALIB_COEF**. You must provide the BLE password for the command to be taken into account by the tag.

Command example:

READ_CALIB_COEF PASSWORD_1

Tag response:

- If the password is valid and no coefficients are used:
READ_CALIB_COEF: No polynomial values used
- If password is valid: *READ_CALIB_COEF: Success*
- If the password is invalid: *READ_CALIB_COEF: ACCESS DENIED*

The READ_CALIB_COEF command starts a download of the information contained in the stored calibration coefficient report. The format is as follows:

Calibration coefficient date: 05072019 14:43:18 +01:00\n
Calibration coefficients: c=1e0 b=3e-2 a=125e-5

Reading calibration status

The command to read the tag's calibration status is **READ_CALIB_EN**. You must provide the BLE password for the command to be taken into account by the tag.

Command example:

READ_CALIB_EN PASSWORD_1

Tag response:

- If the password is valid and calibration is deactivated: *READ_CALIB_EN: 0*
- If the password is valid and calibration is activated:
READ_CALIB_EN : 1 c=1e0 b=3e-2 a=125e-5
- If the password is invalid: *READ_CALIB_EN: ACCESS DENIED*

Retrieving the calibration value report

Retrieving report values

The command to read the values in the tag's calibration report is **READ_REPORT_VAL**. You must provide the BLE password for the command to be taken into account by the tag.

If the command syntax is valid, the tag returns **READ_REPORT_VAL: Success**. The tag then begins to transmit its data.

Command example:

READ_REPORT_VAL PASSWORD_1

Tag response:

- If password is valid: *READ_REPORT_VAL: Success*
- If the password is invalid: *READ_REPORT_VAL: ACCESS DENIED*
- If the password is valid but no report is stored on the tag: *READ_REPORT_VAL: No values entered!*

The **READ_REPORT_VAL** command starts a download of the information contained in the stored calibration report. The format is as follows:

Calibration report date: 01012019\n
Nb of measures: 3\n
TargetVal1: 25.00\n
MeasVal1: 24.95\n
TargetVal2: 5.00\n
MeasVal2: 4.79\n
TargetVal3: 50.00\n
MeasVal3: 49.90\n

A newline character (\n) is placed at the end of each line.

Retrieving report results

The command to read the tag's calibration results state is **READ_REPORT_RES**. You must provide the BLE password for the command to be taken into account by the tag.

Command example:

READ_REPORT_RES PASSWORD_1

Tag response:

- If the password is valid and the result is "1": **READ_REPORT_RES: 1**
- If the password is valid and the result is "0": **READ_REPORT_RES: 0**
- If the password is invalid: **READ_REPORT_RES: ACCESS DENIED**

6. Summary of BLE commands in connected mode

Order	Information	
	Description	
DATALOGGER_START	Description	Starts data logger and records start date/time
	Example	DATALOGGER_START PASSWORD_1 05/06/2019 11:20:00 +01:00
DATALOGGER_STOP	Description	Stops datalogging on the tag
	Example	DATALOGGER_STOP PASSWORD_1
READ_DATA	Description	Retrieves all data logger values
	Example	READ_DATA PASSWORD_1
READ_START_DATE	Description	Reads data from the start date/time defined in the tag
	Example	READ_START_DATE PASSWORD_1
READ_CALIB_COEF	Description	Reads calibration polynomial coefficients
	Example	READ_CALIB_COEF PASSWORD_1
SET_CALIB_EN	Description	Activates / deactivates calibration
	Example	SET_CALIB_EN PASSWORD_1 1
READ_CALIB_EN	Description	Returns calibration status (activated / deactivated)
	Example	READ_CALIB_EN PASSWORD_1
READ_REPORT_VAL	Description	Reads values contained in calibration report
	Example	READ_REPORT_VAL PASSWORD_1
READ_REPORT_RES	Description	Reads calibration report results
	Example	READ_REPORT_RES PASSWORD_1

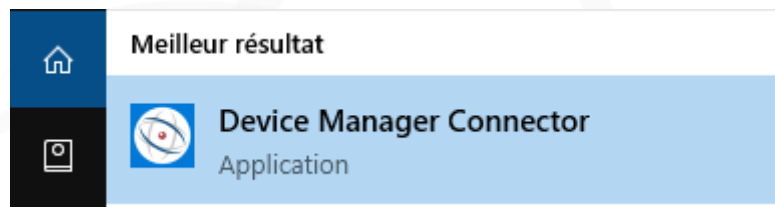
7. Example using Device Manager Connector

The **Device Manager Connector** application executes the commands for ELA Innovation Bluetooth® tags. This software offers a user interface that enables you to test features in a tag's BLE connected mode. You can use Device Manager Connector to send basic commands to control tags in ELA Innovation's Blue product line.

The application is available for free download from the Microsoft Store. Version 1.2.0 (and higher) enables you to manage data logger functions.

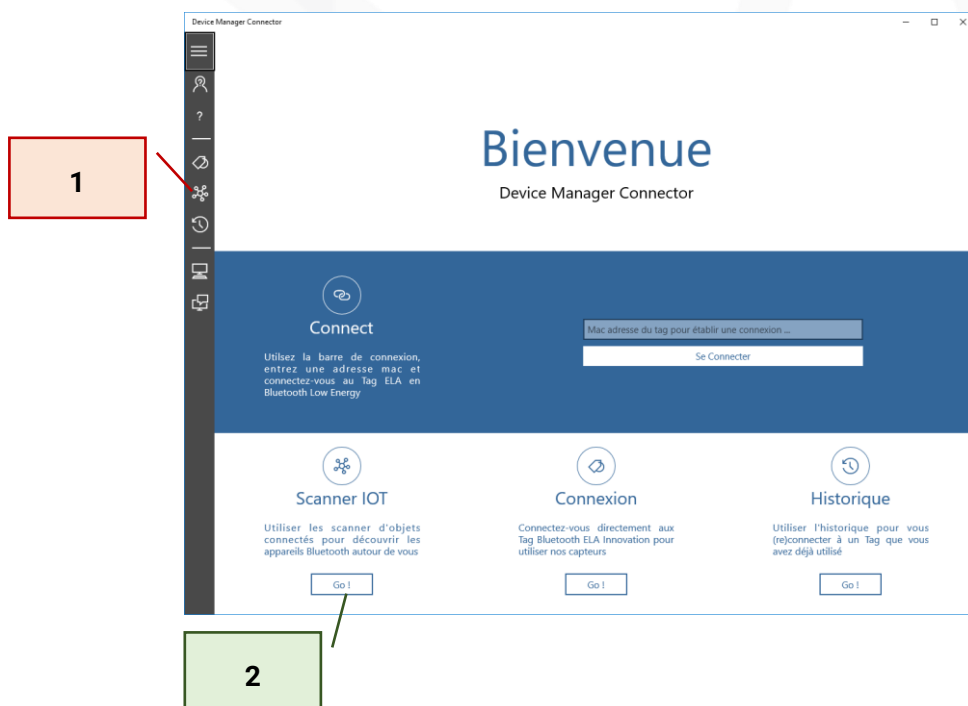
Launching the application

Open Device Manager Connector by clicking on the associated icon or by entering the application name in the Windows search bar: **Device Manager Connector**.



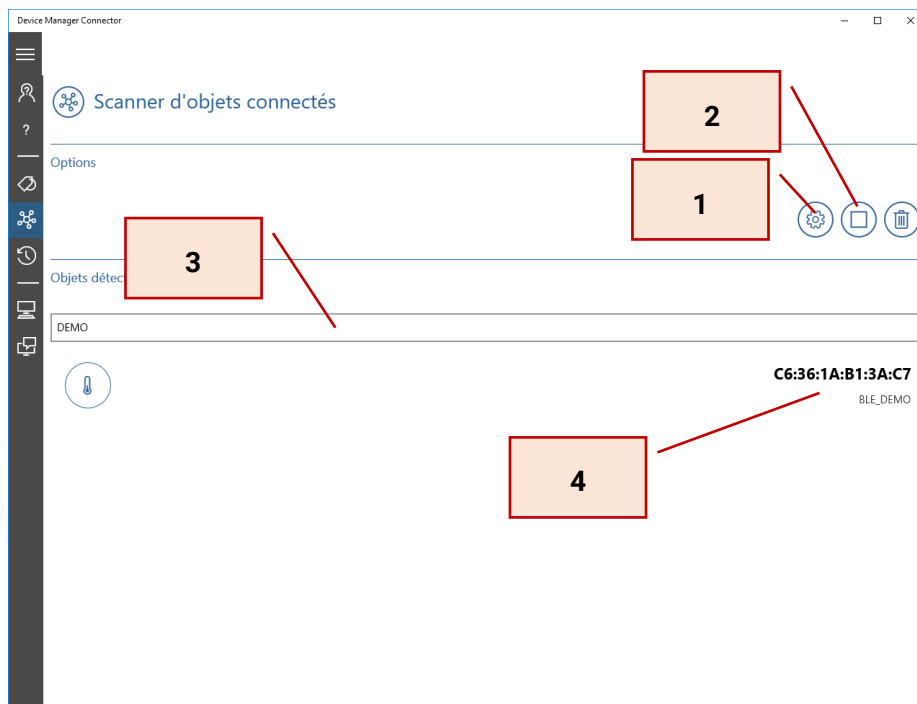
Once the application is running, we recommend that you use the **"IOT Scanner"** function to discover tags within wireless range and select the tag that you want to use. There are two ways to access this function:

- The IoT icon (1) in the left-hand menu bar
- The **IOT Scanner** button on the application's home page, then click on **Go!** (2)

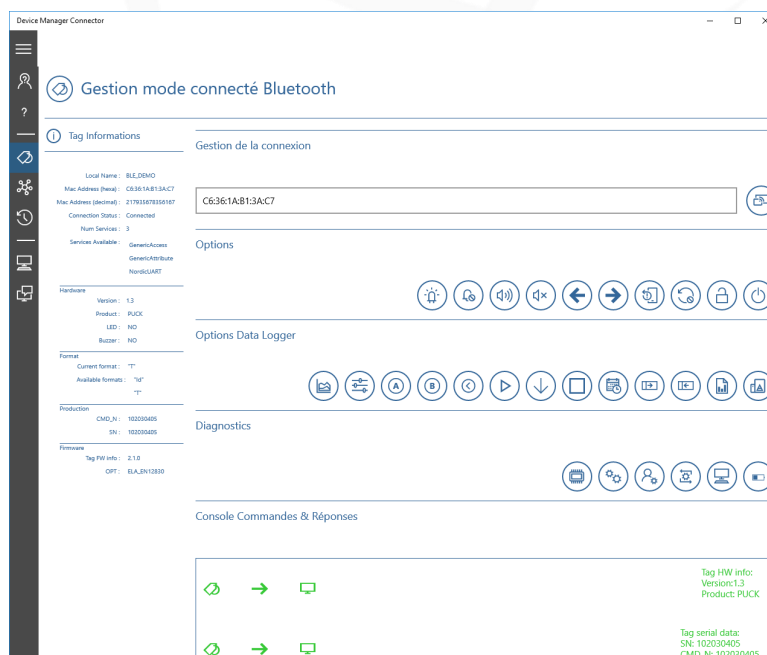


With the IOT Scanner function, you can start “listening” for Bluetooth communications by clicking on the Bluetooth Scan button. At any time, you may define a filter to more precisely target the tag that you want to access. The search bar enables you to browse through all the detected tags and refine your selection based on MAC address, tag name, etc.

- (1): scan preferences (show only tags with a default name)
- (2): start / stop scan
- (3): search bar
- (4): list of detected tags



Simply click on a tag in the list to connect to that tag. The application then switches to the connection screen, which displays all the information and available commands for the selected tag.



The tag connection screen is divided into three main sections:

- (1): general information
- (2): all available commands
- (3): command console (queries & responses)

1 Tag Informations

Local Name : BLE_DEMO
 Mac Address (hexa) : C6:36:1A:B1:3A:C7
 Mac Address (decimal) : 217935678356167
 Connection Status : Connected
 Num Services : 3
 Services Available : GenericAccess, GenericAttribute, NordicUART

Hardware
 Version : 1.3
 Product : PUCK
 LED : NO
 Buzzer : NO

Format
 Current format : "T"
 Available formats : "Id", "T"

Production
 CMD_N : 102030405
 SN : 102030405

Firmware
 Tag FW info : 2.1.0
 OPT : ELA_EN12830

2 Options

Options Data Logger

Diagnostics

3 Console Commandes & Réponses

Tag HW info:
 Version:1.3
 Product: PUCK










Tag serial data:
 SN: 102030405
 CMD_N: 102030405

General information

The information section displays all tag-related data. Each part is updated based on the data present (or not present) on the tag. The firmware version for **EN 12830** tags is **2.1.0**, with an OPT option: **ELA_EN12830**.

Commands

All the commands available for the data logger are available in the **Data Logger Options** section. The list below describes the buttons and their functions.

Order	Information	
DATALOGGER_START		Starts data logger and records start date/time
DATALOGGER_STOP		Stops datalogging on the tag
READ_DATA		Retrieves all data logger values
READ_START_DATE		Reads data from the start date/time defined in the tag
READ_CALIB_COEF		Reads calibration polynomial coefficients
SET_CALIB_EN		Activates / deactivates calibration
READ_CALIB_EN		Returns calibration status (activated / deactivated)
READ_REPORT_VAL		Reads values contained in calibration report
READ_REPORT_RES		Reads calibration report results

Console

The console section shows the transmission/reception actions for Bluetooth® commands. This display is for informational purposes, enabling you to follow:

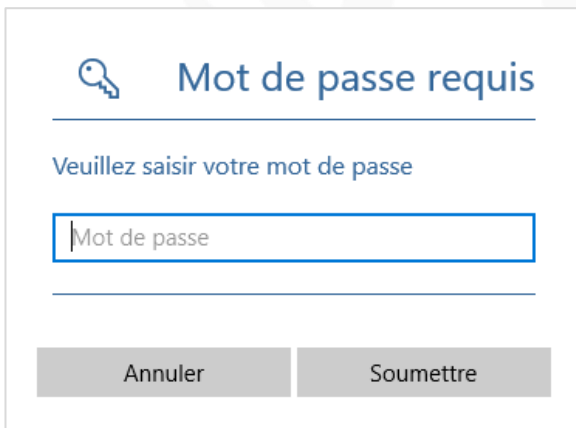
- Commands sent to the tag (in the image below, the pictograms represent the sending action; the command being sent is indicated on the right).




- Commands received by the tag (in the image below, the pictograms represent the receiving action; the information received is indicated on the right).



For each command sent to the data logger, you must enter the password to confirm whether the command should be sent. A pop-up window opens in which you can enter the password. The password to use here is the one that was defined during tag configuration. For more information, see Chapter 3 - General (Security).



Starting the data logger

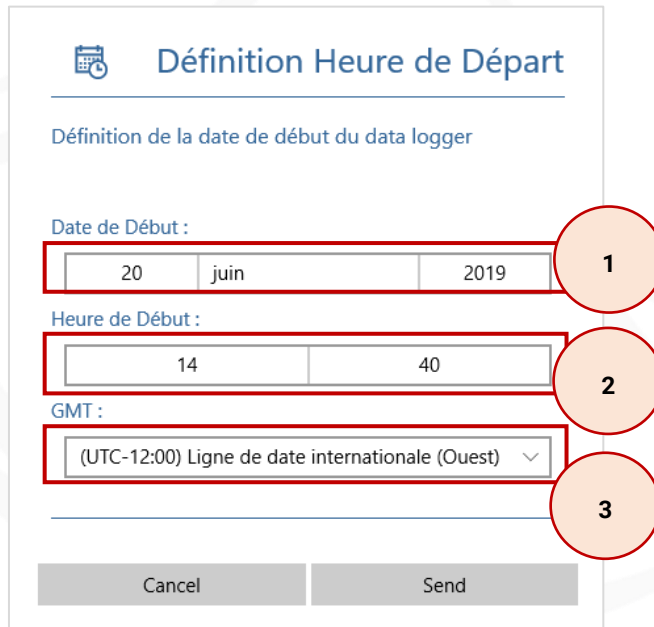
To use the application to retrieve data from a data logger, the data logger must first have been started (with the DATALOGGER_START command). To do this from the tag connection screen, click on the PLAY button  to start the data logger.

The application prompts you to enter the password, which is required to execute commands.

A pop-up window enables you to define the start time. Fill in the following fields:

- (1): Data logger start date
- (2): Data logger start time
- (3): Time zone in which the data logger is started

Then click on **Send** to transmit the settings, or **Cancel** to return to the previous screen without taking any action.



Définition Heure de Départ

Définition de la date de début du data logger

Date de Début :

20 juin 2019

Heure de Début :

14 40

GMT :


(UTC-12:00) Ligne de date internationale (Ouest)

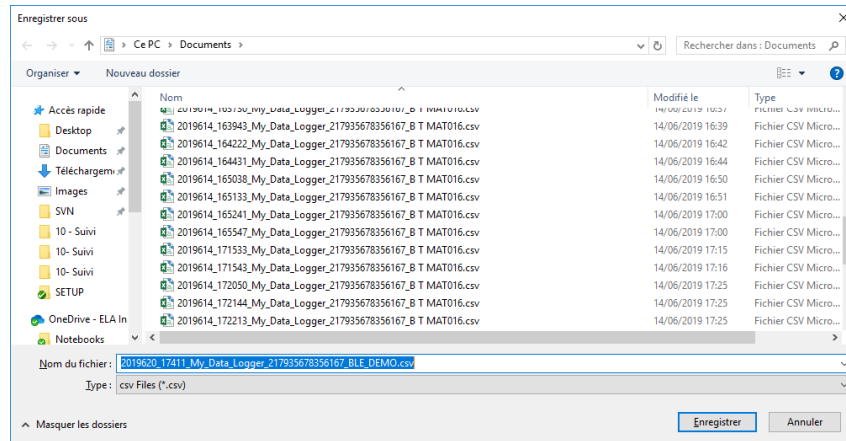
Cancel Send

Stopping the data logger

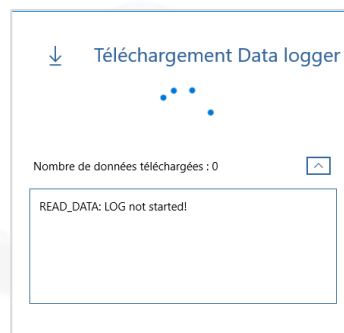
To stop data logger recording, click on the Stop button . When you click on the button, the password pop-up window opens. Enter the password to continue.

Reading the data logger

To read the data stored on the data logger, click on the READ_DATA button or on Download . When you click on the button, the password pop-up window opens. Enter the password to continue. The “Save as” window opens so you can save the data locally in a .CSV format file. The file name field contains a proposed default name for the file.



A download progress window shows the status of the file download.



If the data logger is not currently running, the above message is displayed.

Otherwise, data is retrieved progressively, as shown below.

