# *iNode Serial Transceiver UART*

***Instruction manual***

# 1. About iNode

We would like to introduce a family of iNode devices working in the Bluetooth Low Energy ®. We will show you that it's not just tags to find lost keys, whether location tags, but still something more.

Our devices are capable of:
- these are mainly battery device.
- work without battery replacement for up to 12 months, depending on the type of application and usage.
- have memory for logging events, readings of measurements, etc.
- contain precise temperature, humidity sensors, accelerometer or magnetometer which allow home automation control, care of older persons or vehicle detection.
- as a remote control device, although a small power consumption, have a large range and features unavailable to other competitive facilities - password protection, AES encryption, control directly from the smartphone with BT 4.0.
- a unique encryption technology ensures the safety of the JPEG images recorded by our cameras.
- BT4.0 - LAN or BT4.0 - GSM gateways connect iNode sensors with the Internet.

iNode can also help to control the movement of people or goods, saving the time of appearance and disappearance (active RFID ® long range). New features related to the development of the product is also not a problem – this allows to remote firmware update with PC or smartphone with Bluetooth 4.0 ® and Low Energy Bluetooth enabled ® (Smart Bluetooth ®).

**iNode Serial Transceiver UART** is a Bluetooth Low Energy transceiver with 2x4 pin 2.54 mm connector with low voltage RS232 input and output. You can easy use it in your own controller or other device, to communicate in a simple way with the BLE type devices e.g. iNode. To control BLE devices it uses a basic set of HCI commands HEX-encoded transmitted character strings. To turn the scan on is enough to send to the 010C20020100 string. The same way of communication is used in the **iNode LAN** over TCP/IP or WebSocket or **iNode Serial Transceiver USB**.

Additional functionality of the **iNode Serial Transceiver UART** is a special characteristic, which allows you a bidirectional data transfer BLE <-> RS232.

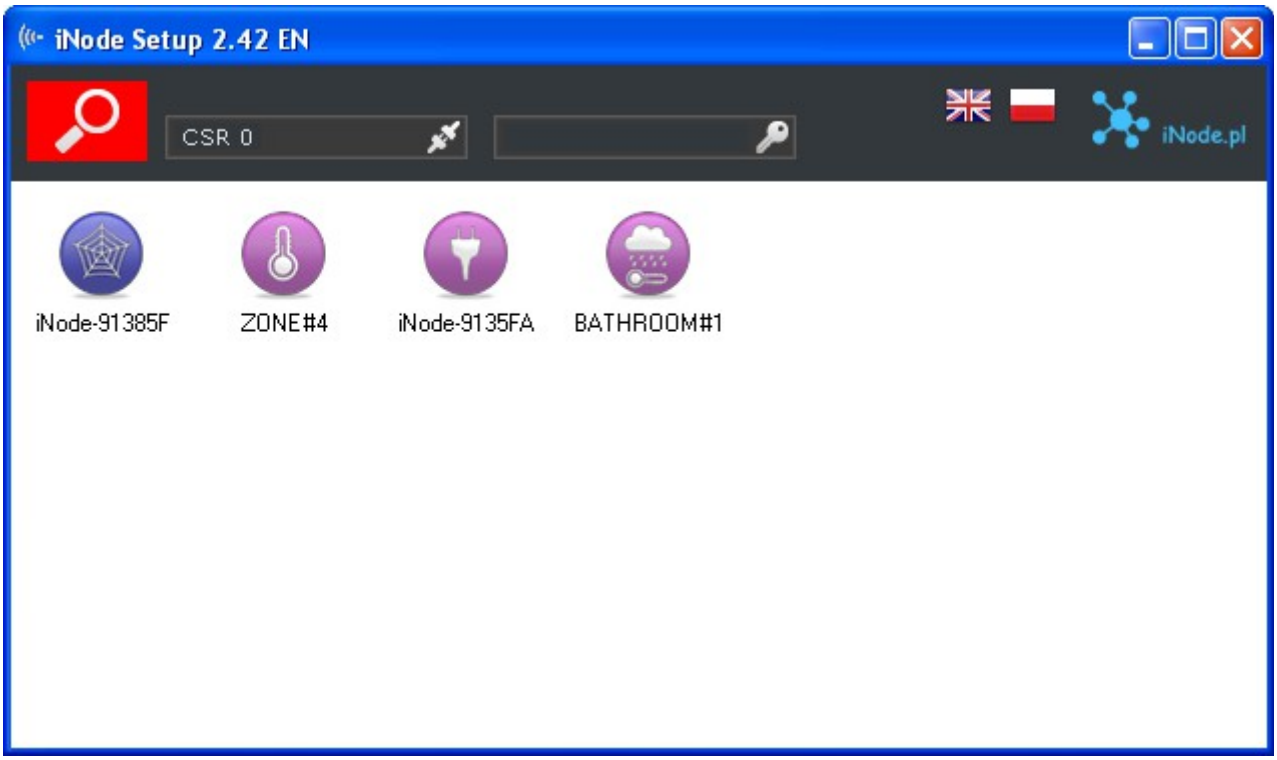
In standby mode (advertising in BLE is on all the time) consumes around 55µA (average current) only.

## 2. iNode Serial Transceiver UART

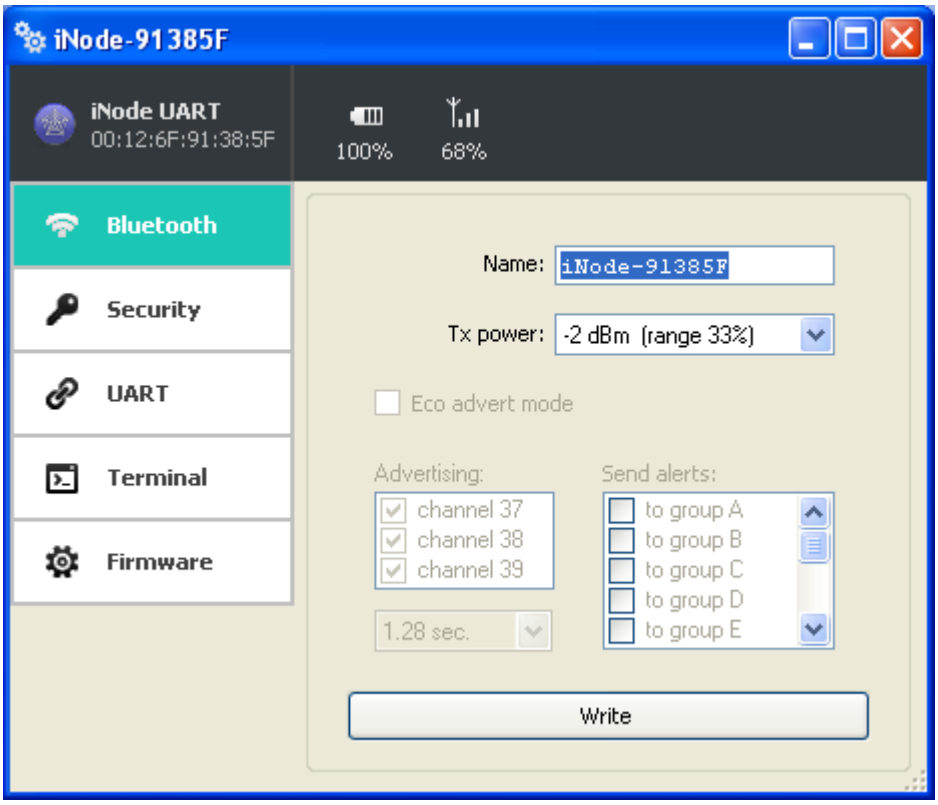
Install application **iNode Setup** and BT4.0 drivers on PC. Next run **iNode Setup** application (on Windows 7 to 10 with administrative rights), and press the red button with magnifying glass picture. If a BLE device you want connect to is password protected you should type the password in the text box with a key If you press the button you can change the type of adapter which will be used to communication – standard BT4.0 adapter (signed CSR …), **iNode Serial Transceiver** (signed COM ...) or **iNode LAN** (signed the name of the device).

In case the application cannot start or system error you should try to install **Microsoft Visual C++ 2005 Service Pack 1 Redistributable Package MFC Security Update** from that page: http://www.microsoft.com/en-us/download/confirmation.aspx?id=26347.

**iNode Setup** will find all nearby iNode devices and sort them regarding receiving signal strength. Each type of iNode device has a different icon. For **iNode Serial Transceiver UART** it is the first picture in the first row in the window below.




To configure **iNode Serial Transceiver UART** device you should double click on its icon. Application connects with this device and reads its settings:

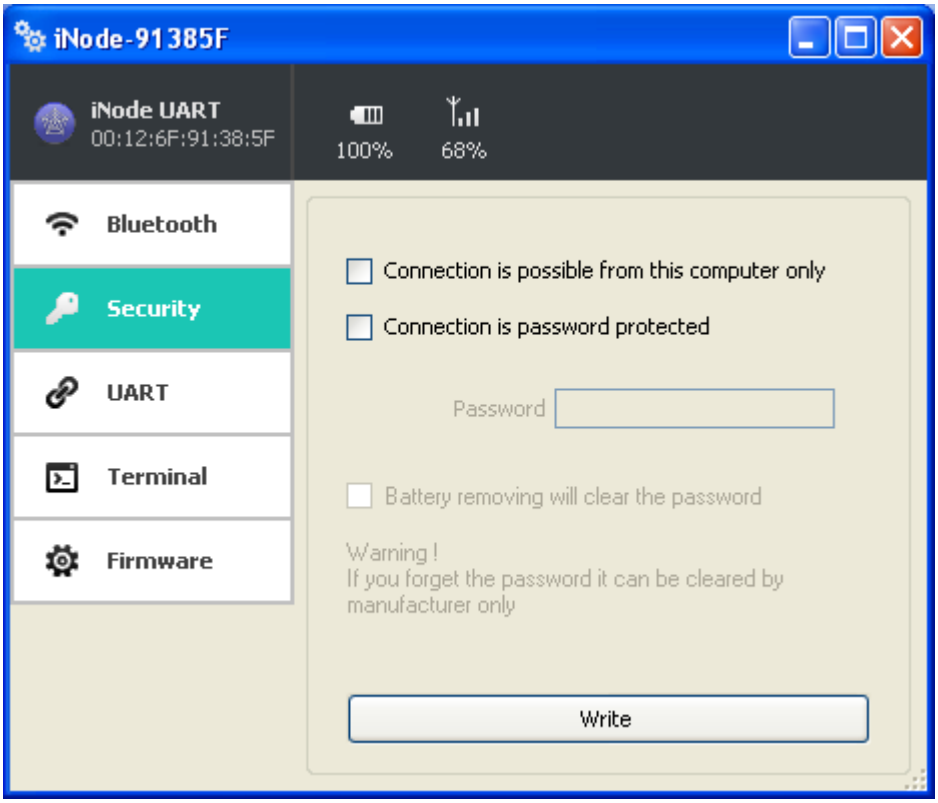



At the top of the window there is displayed following information:
- the name of the **iNode** family – in this case **iNode Serial Transceiver UART;**
- the unique device identifier;
- battery level: 100% means 3V or greater, while 0% it is 1,8V;
- signal strength received by this device from the BT4.0 adapter or iNode LAN;
- temperature;

At the **Bluetooth** tab there are following items:
- **Name**: you can change default device name typing a new one in this text box. Its length is 16 characters maximum.
- **Tx power**: determine the power the device broadcasts and simultaneously the range the device can be scanned.

You can save modified settings by pressing the **Write** button.

The picture below shows the **Security** tab:

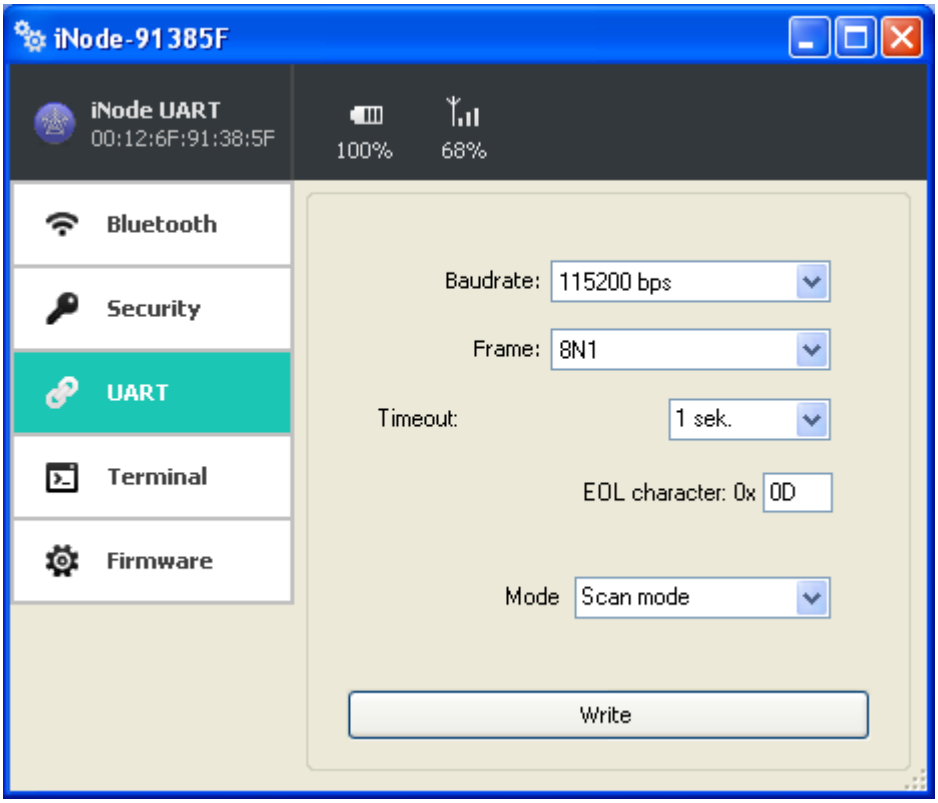



The following items can be set:

- **Connection is possible from this computer only**: this option enable you to protect the **iNode Serial Transceiver UART** access from others PCs or phones.
- **Connection is password protected**: access to the **iNode Serial Transceiver UART** is password protected. Password length is 16 characters maximum.
- **Battery removing will clear the password**: if you unchecked this option than please remember that if you forget the password it can be cleared by manufacturer only.

You can save modified settings by pressing the **Write** button.

The picture below shows the **UART** tab:



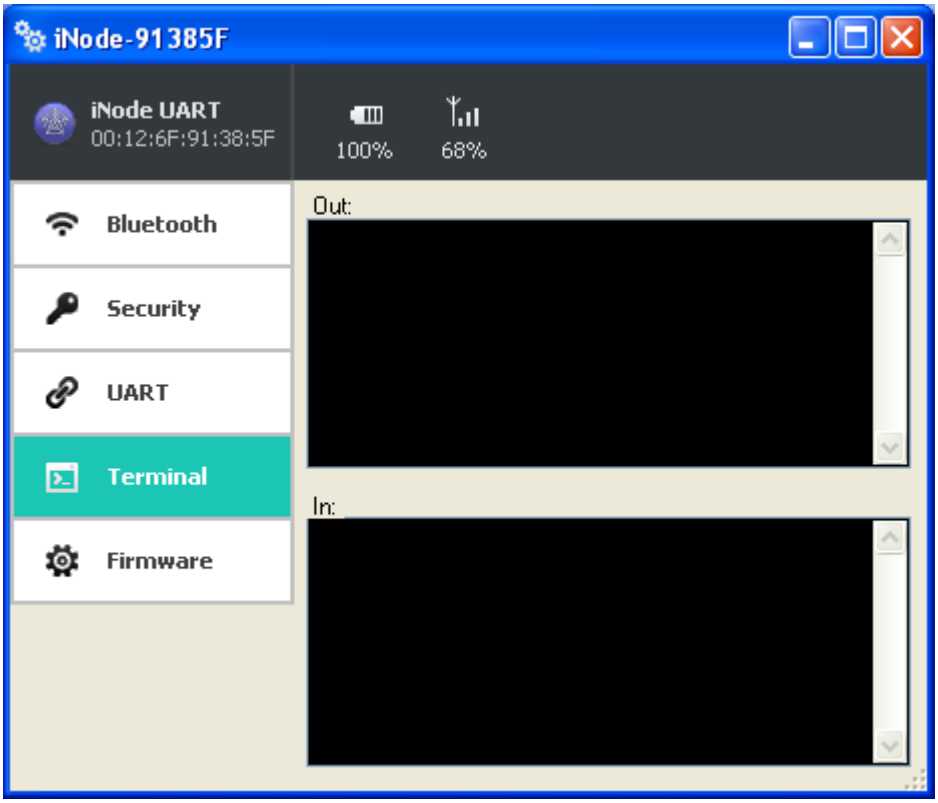

The following items can be set:

- **Baud rate**: select the speed of the physical UART connectors on the module. The default speed for the **iNode Serial Transceiver UART** is 115,200 bps. It can be set in the range from 2400 bps to 3,686,400 bps.
- **Frame**: specifies the parameters of the frame data byte-the number of bits, parity and number of stop bits. Possible values: 8N1, 8N2, 8E1, 8E2, 8O1, 8O2.
- **Timeout**: if UART doesn't receive a new character in this time the BLE frame will be sent with all characters received earlier.
- **EOL character**: the character that causes the sending data: Specifies what character received by the UART will send the data via BLE.
- **Mode**: allows you to select the operating mode of the device:
  - *Scan mode*: in this mode, the device does not broadcast advertisement frames but is ready to receive commands by UART.
  - *Standby mode*: in this mode, the device broadcasts advertisement BLE frames and wait for the connection. You can connect to it and send the data over the UART.

Notwithstanding the above settings, the data are sent by BLE when the UART buffer is full, or in packs of 20 bytes. This is the Bluetooth Low Energy standard.

You can save modified settings by pressing the **Write** button.

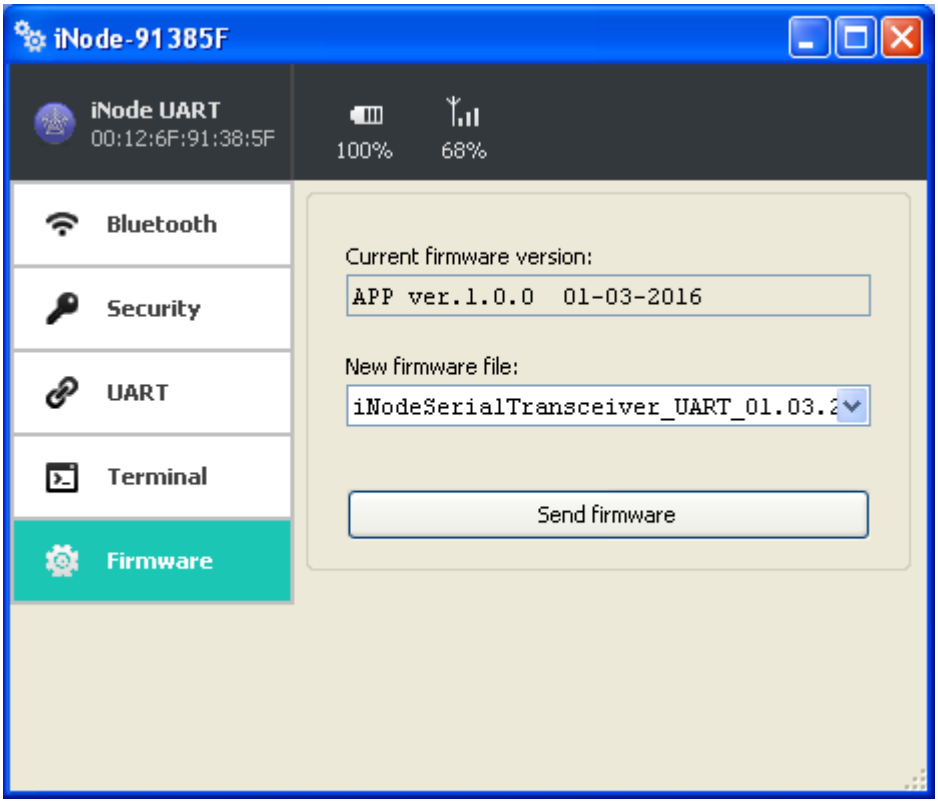
The picture below shows the **Terminal** tab:




If you are connected, you can send and receive data from UART:

- **Out**: characters typed here are sent to UART.
- **In**: characters received from UART via BLE are displayed here..

The picture below shows the **Firmware** tab:




**Current firmware version** field shows the version and creation date of the firmware in the device.

To change the firmware in the device first select **New firmware file**.

Firmware is uploaded to the device after clicking **Send firmware** button. Application checks if this firmware is correct for this type of device to avoid situation that we want to upload the firmware which needs the button to be pressed for broadcasting in the device but this device doesn't have it.

The ***fep*** files with the firmware, manuals or other information you can find at our technical support: http://support.inode.pl/ user: ***inode*** no password.

All **iNode** devices use to communication the Bluetooth 4.0/4.1 standard. More information about it you can find at https://www.bluetooth.org/en-us/specification/adopted-specifications

The data structure is described in Core_V4.0.pdf: Volume 2 Part E, Section 5.4.

When connection with remote BLE device is established, communication with them is performed using the Attribute Protocol encapsulated in HCI ACL DATA packets. The followings PDUs (Core_V4.0.pdf: Volume 3 Part F) can be used – see table below. Asterisk in Imp column means that that attribute is implemented in **iNode Serial Transceiver UART**.

| Attribute PDU Name | Attribute Opcode | Imp | Parameters |
|---|---|---|---|
| Exchange MTU Request | 0x02 | | Client Rx MTU |
| Exchange MTU Response | 0x03 | | Server Rx MTU |
| Find Information Request | 0x04 | | Starting Handle,<br>Ending Handle,<br>UUID |
| Find Information Response | 0x05 | | Format,<br>Information Data |
| Find By Type Value Request | 0x06 | | Starting Handle,<br>Ending Handle,<br>Attribute Type,<br>Attribute Value |
| Find By Type Value Response | 0x07 | | Handles Information List |
| Read By Type Request Section 3.4.4.1 | 0x08 | * | Starting Handle,<br>Ending Handle,<br>UUID |
| Read By Type Response Section 3.4.4.2 | 0x09 | * | Length,<br>Attribute Data List |
| Read Request Section 3.4.4.3 | 0x0A | * | Attribute Handle |
| Read Response Section 3.4.4.4 | 0x0B | * | Attribute Value |
| Read Blob Request Section 3.4.4.5 | 0x0C | * | Attribute Handle,<br>Value Offset |
| Read Blob Response Section 3.4.4.6 | 0x0D | | Part Attribute Value |
| Read Multiple Request | 0x0E | | Handle Set |
| Read Multiple Response | 0x0F | | Value Set |
| Read by Group Type Request | 0x10 | | Start Handle,<br>Ending Handle,<br>UUID |
| Read by Group Type Response | 0x11 | | Length,<br>Attribute Data List |
| Write Request Section 3.4.5.1 | 0x12 | * | Attribute Handle,<br>Attribute Value |
| Write Response Section 3.4.5.2 | 0x13 | * | - |
| Write Command Section 3.4.5.3 | 0x52 | * | Attribute Handle,<br>Attribute Value |
| Prepare Write Request | 0x16 | | Attribute Handle,<br>Value Offset,<br>Part Attribute Value |
| Prepare Write Response | 0x17 | | Attribute Handle,<br>Value Offset<br>Part Attribute Value |
| Execute Write Request | 0x18 | | Flags |
| Execute Write Response | 0x19 | | - |
| Handle Value Notification Section 3.4.7.1 | 0x1B | * | Attribute Handle,<br>Attribute Value |
| Handle Value Indication Section 3.4.7.2 | 0x1D | * | Attribute Handle,<br>Attribute Value |
| Handle Value Confirmation Section 3.4.7.3 | 0x1E | * | |
| Signed Write Command | 0xD2 | | Attribute Handle,<br>Attribute Value,<br>Authentication Signature |

Data sent over the UART is HCI frames HEX-encoded (for one byte there are two ASCII characters). At the end of the data being transmitted is always 0x0d, 0x0a. In the case of loss of synchronization on the HCI frame level, you can retrieve it by sending 0x0d, 0x0a. They can be added to each frame sent to the HCI module.

**Data coding scheme in advertisement frame and response for active scan.**

Information about **AD Type** codes can be found in a Core_V4.0.pdf: Volume 3 Part C, Section 8. and at the page https://www.bluetooth.org/en-us/specification/assigned-numbers/generic-access-profile

HCI frame with BLE scan result (advertisement frame):
***043E2802010000A35F356F12001C0201061107694E6F6465204E6176000000000000000003FF0080020AFEAD***

***043E28***

***04*** - HCI packet indicator: 0x04 EVENT (Core_V4.0.pdf: Volume 2 Part E, Section 5.4)
***3E*** - event_code = 0x3e -> LE EVENTS
***28*** - HCI parameter total length -> 0x28 = 40

***02010000A35F356F12001C0201061107694E6F6465204E6176000000000000000003FF0080020AFEAD*** - event_parameters:

***02*** - Subevent_Code = 0x02 -> LE Advertising Report event
***01*** - Num_Reports = 0x01 -> number of responses in event (always 1)
***00*** - Event_Type[i] = 0x00 -> connectable undirected advertising (ADV_IND)
***00*** - Address_Type[i] = 0x00 -> public device address
***A35F356F1200*** - Address[i] = 0x00126F355FA3 (Public Device Address)
***1C*** - Length_Data[i] = 0x1C = 28 (length of the Data[i] field)
***0201061107694E6F6465204E6176000000000000000003FF0080020AFE*** - Data[i] -> Length_Data[i] octets of advertising or scan response data formatted as defined in Core_V4.0.pdf: Volume 3 Part C, Section 8. https://www.bluetooth.org/en-us/specification/assigned-numbers/generic-access-profile

***02*** - 0x02 -> Length = 0x02
***0106*** -> Data
***01*** - 0x01 -> EIR Data Type = 0x01 -> «Flags»
***06*** - 0x06 -> EIR Data = 0x06 -> LE General Discoverable Mode (bit 1), BR/EDR Not Supported (bit 2)
***11*** - 0x11 -> Length = 0x11 = 17
***07694E6F6465204E617600000000000000*** -> Data
***07*** - 0x07 -> EIR Data Type = 0x07 -> «Complete List of 128-bit Service Class UUIDs»
***694E6F6465204E617600000000000000*** -> EIR Data = "iNode Nav" (UUID128 w postaci 16 znaków ASCII)
***03*** - 0x03 -> Length = 0x03 = 3
***FF0080*** -> Data
***FF*** -> EIR Data Type = 0xff -> «Manufacturer Specific Data»
***0080*** -> 0x8000 iNodeNav identifier
***02*** - 0x02 -> Length = 0x02 = 2
***0AFE*** -> Data
***0A*** -> EIR Data Type = 0x0a -> «Tx Power Level»
***FE*** -> 0xfe = -2 dBm

***AD*** - RSSI[i] = 0xAD -> RSSI = -83dBm (signed integer); Range: -127 < N < +20 dBm; 127 RSSI is not available

HCI frame with BLE scan result (response for an active scan):
***043E1A02010400A35F356F12000E0D09694E6F64652D333535464133AF***

***043E1A***

***04*** - HCI packet indicator: 0x04 EVENT (Core_V4.0.pdf: Volume 2 Part E, Section 5.4)
***3E*** - event_code = 0x3e -> LE EVENTS
***1A*** - HCI parameter total length -> 0x1A = 26

***02010400A35F356F12000E0D09694E6F64652D333535464133AF*** - event_parameters:
***02*** - Subevent_Code = 0x02 -> LE Advertising Report event
***01*** - Num_Reports = 0x01 -> number of responses in event (always 1)
***04*** - Event_Type[i] = 0x04 -> scan response (SCAN_RSP)
***00*** - Address_Type[i] = 0x00 -> public device address
***A35F356F1200*** - Address[i] = 0x00126F355FA3 (Public Device Address)
***0E*** - Length_Data[i] = 0x0E = 14 (length of the Data[i] field)
***0D09694E6F64652D333535464133*** - Data[i] -> Length_Data[i] octets of advertising or scan response data formatted as defined in Core_V4.0.pdf: Volume 3 Part C, Section 8. https://www.bluetooth.org/en-us/specification/assigned-numbers/generic-access-profile
***0D*** - 0x0D -> Length = 0x0D
***09694E6F64652D333535464133*** -> Data
***09*** - EIR Data Type = 0x09 -> «Complete Local Name»
***694E6F64652D333535464133*** – iNode-355FA3
***AF*** - RSSI[i] = 0xAF -> RSSI = -81dBm (signed integer); Range: -127 < N < +20 dBm; 127 RSSI is not available

BLE advertisement frame:
***02010619FF12930110000001700AB18951F485435BE5B809D6F571E40E8***

***020106***
***02*** -> data length: 2 bytes
***0106*** -> data
***01*** -> 0x01 -> EIR Data Type = 0x01 -> «Flags»
***06*** -> 0x06 -> EIR Data = 0x06 -> LE General Discoverable Mode (bit 1), BR/EDR Not Supported (bit 2)
***19FF12930110000001700AB18951F485435BE5B809D6F571E40E8***
***19*** -> data length: 25 bytes
***FF12930110000001700AB18951F485435BE5B809D6F571E40E8*** -> data (25 bytes)
***FF*** -> 0xFF -> EIR Data Type = 0xFF «Manufacturer Specific Data»
***12930110000001700AB18951F485435BE5B809D6F571E40E8***->
***1293*** -> 0x9312 -> 0x93XX identifier of iNodeCareSensor #3; 0xXX1X version 1; 0xXXX2 24 h elapsed from the last readout;

***0110*** -> 0x1001 type -> bit 15 to bit 12 -> reserved, bit 11 to bit 0 -> group
***0000*** -> 0x0000 flags ->
SENSOR_ALARM_MOVE_ACCELEROMETER=1,
SENSOR_ALARM_LEVEL_ACCELEROMETER=2,
SENSOR_ALARM_LEVEL_TEMPERATURE=4,
SENSOR_ALARM_LEVEL_HUMIDITY=8,

SENSOR_ALARM_CONTACT_CHANGE=16,
SENSOR_ALARM_MOVE_STOPPED=32,
SENSOR_ALARM_MOVE_GTIMER=64,
SENSOR_ALARM_LEVEL_ACCELEROMETER_CHANGED=128,
SENSOR_ALARM_LEVEL_MAGNET_CHANGE=256,
SENSOR_ALARM_LEVEL_MAGNET_TIMER=512

***1700*** -> 0x0017 value1
/* motion sensor */
0x8000 sensor in move (bit 15 =1)
bity 14 do 10:
X-axis (5 bits signed) -> 0x00= 0
bity 9 do 5:
Y-axis (5 bits signed) -> 0x00= 0
bity 4 do 0:
Z-axis (5 bits signed) -> 0x17= -9

***AB18*** -> 0x18AB value2
/* temperature sensor */
Temperature= ((175.72 * Temp_Code)/65536)-46.85 [°C]
Temp_Code = 0x18AB *4 = 0x62AC = 25260
Temperature = 20,879 °C

***951F*** -> 0x1F95 value3
/* humidity sensor */
%RH= ((125*RH_Code)/65536)-6 [%]
RH_Code = 0x1f95 *4 = 0x7e54 = 32340
%RH= 55,68 %

***485435BE*** -> 0x5448BE35 time (time-stamp; seconds elapsed since 01.01.1970)

***5B80 9D6F 571E 40E8*** -> AES128 digital signature for above data

BLE response for an active scan:

***0D09694E6F64652D333536313441020A02***

***0D09694E6F64652D333536313441***

***0D*** -> data length: 13 bytes

***09694E6F64652D333536313441*** -> dane

***09*** -> 0x09 -> EIR Data Type = 0x09 -> «Complete Local Name»

***694E6F64652D333536313441*** -> iNode-35614A

***020A02***

***02*** -> data length: 2 bytes

***0A02*** -> data

***0A***-> 0x0A -> EIR Data Type = 0x0A -> «Tx Power Level»

***02*** -> 0x02 -> Tx Power Level = +2dBm

# 3. The UART GATT service and characteristics

**UART_SERVICE** (this service contains characteristics for UART control, configuration and data transfer):
uuid: 0xc47f18cc8f71452ebce5893097437909

**UART_DATA** (characteristic intended to data transfer through the UART – only write function; data received from UART is sent using notification or indications if enabled earlier in UART_DATA_TRANSFER_CLIENT_CONFIG):
uuid: 0xc47f18cd8f71452ebce5893097437909

**UART_DATA_TRANSFER_CLIENT_CONFIG** (client config characteristic intended to enable and disable notifications or indications; always 2 bytes are written or read-out):
uuid: 0x2902

This two bytes make 16 bit word, which has following mean:
gatt_client_config_none = 0x0000 -> no notification & indication
gatt_client_config_notification = 0x0001 - > only notifications
gatt_client_config_indication = 0x0002 -> only indications

**UART_CONTROL** (characteristic intended to UART configuration; always 9 bytes are written or read-out):
uuid: 0xc47f18ce8f71452ebce5893097437909

uint16 uart_baudrate -> the UART baud rate; default value 115200bps
#define UART_RATE_2K4 (0x000a)
#define UART_RATE_9K6 (0x0028)
#define UART_RATE_19K2 (0x004e)
#define UART_RATE_38K4 (0x009e)
#define UART_RATE_57K6 (0x00eb)
#define UART_RATE_115K2 (0x01d9)
#define UART_RATE_230K4 (0x03af)
#define UART_RATE_460K8 (0x0760)
#define UART_RATE_921K6 (0x0ebf)
#define UART_RATE_1382K4 (0x161f)
#define UART_RATE_1843K2 (0x1d7e)
#define UART_RATE_2764K8 (0x2c3d)
#define UART_RATE_3686K4 (0x3afc)

uint16 uart_flags -> UART frame; default 0 – do not change;

uint8 uart_eol -> the character that causes the sending data: Specifies what character received by the UART will send the data via BLE.; default value: 0x0d;

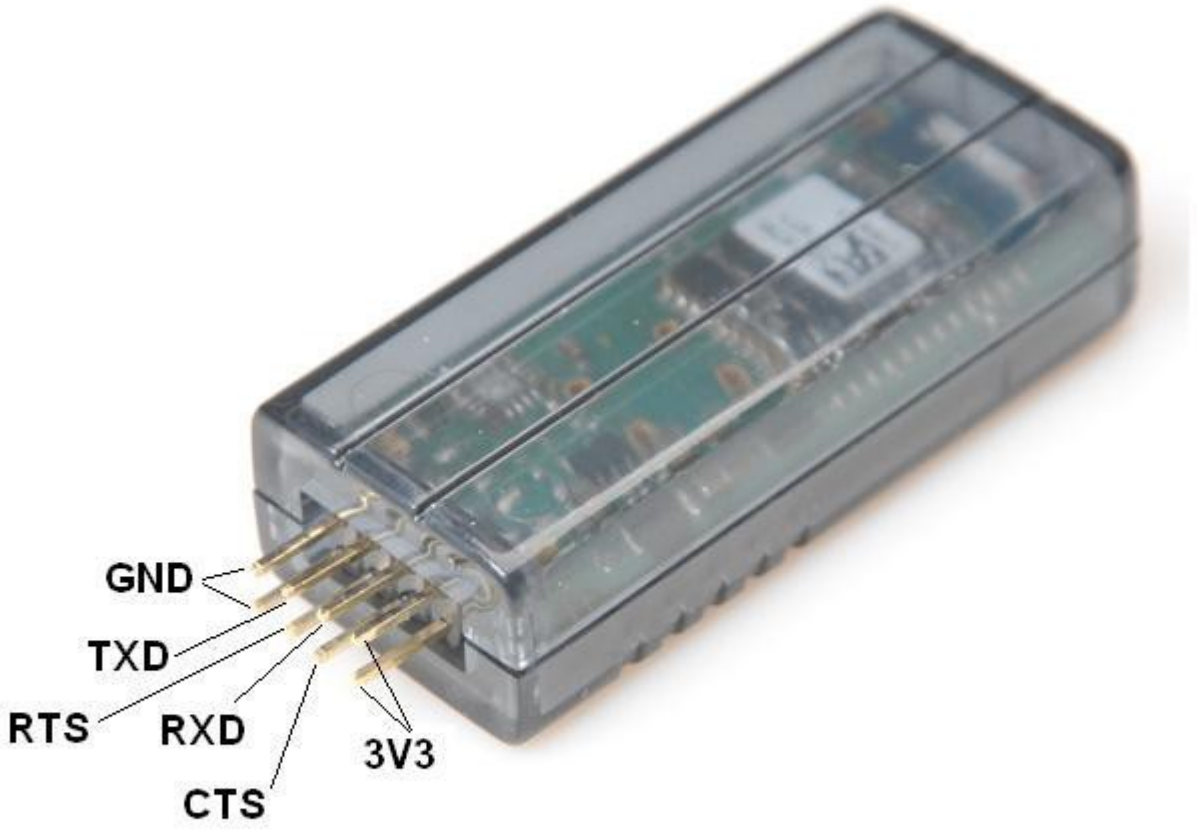
uint16 uart_tout -> if UART doesn't receive a new character in this time the BLE frame will be sent with all characters received earlier.

uint16 uart_mode -> default mode:UART_SERVICE_MODE_IDLE the module waits for the HCI frame on UART. It only broadcasts BLE advertisement frames for 60 seconds after pressing the button twice. In UART_SERVICE_MODE_SLOW_ADVERTISING, which in iNode Setup.exe is called as *standby mode* the module broadcasts BLE advertisement frames all the time. In this mode may not be possible to send BLE scan HCI command, but the module consumes only 50µA.

#define UART_SERVICE_MODE_IDLE (0)
#define UART_SERVICE_MODE_SLOW_ADVERTISING (1)

## 4. Connector pin out

Unlike other devices, iNode Serial Transceiver UART is powered not with the battery but with additional power supply source (DC): 3.3 V maximum. The current consumption depends on the module state and is ~5, 5mA (broadcast) to 25mA (scan-mode). The device is protected against the possibility of reverse power connection and should not then be damaged. Signal levels on the lines of UART: RXD, TXD, RTS and CTS are in the range 0 to 2, 8V. 2x4 pins connector is in pitch 2, 54 mm.



# 5. Technical information

### Bluetooth Low Energy:

- configurable from your PC:
  - the power with which the device operates in the range of-18 dBm + 8 dBm (maximum range up to 200 m in open space);
  - the name of the device;
  - the password of the user;
  - the password to access the device; independent of the user's password, the password for the authorization application on the smartphone or PC (protects against its copying and use by another client);
  - UART parameters;

### Power supply:

- 1,8-3,3 V DC;
- average current consumption (power supply 3,3V):
  - ~55µA in standby mode (BLE advertisement);
  - ~3 mA during connection (Tx power -2dBm);
  - up to 25 mA during BLE scan;

### Housing:

- plastic;
- dimensions: 55 mm x 20 mm x 15 mm;

### Other:

- ratio *scan window/scan interval* = 1 -> receiving from BLE all the time;
- signaling by LED:
  - broadcast mode
  - connection
- remote firmware update;
- connector: 2x4 pin, 2.54mm pitch;
- one control button;
- operating temperature: from -20 to 45 °C;
- humidity: 20-80% RHG.
- weight: 15 g;

### Software:

- Windows XP/Vista/7.0/8.0/8.1/10.0;
- Linux;

### Chipset:

- CSR 101x

# 6. Disposal

All the packaging materials are recyclable and are labeled as such. Dispose of the packaging in accordance with local regulations. Keep the materials out of children reach, as the materials can pose a hazard.

**Proper disposal:**

- According to WEEE Directive (2012/19/UE) the crossed-out wheelie bin symbol (shown on the left) is used to label all electric and electronic devices requiring segregation.
- Do not dispose of the spent product with domestic waste: hand it over to an electric and electronic device collection and recycling point. The crossed-out wheelie bin symbol placed on the product, instruction manual or package communicates this requirement.
- Plastics contained in the device can be recycled in accordance with their specific marking. By recycling materials and spent equipment you will help to protect the environment.
- Information on electric and electronic devices collection locations is available from local government agencies or from the dealer.
- Spent or fully discharged single-use and rechargeable batteries must be discarded in dedicated labeled bins, handed over to hazardous waste collectors or returned to electric equipment dealers.

# DECLARATION OF CONFORMITY 2/2/2015

(according to ISO/IEC Guide 22)

*Producer:* **ELSAT s.c.**
*Address:* Warszawska 32E/1, 05-500 Piaseczno k/Warszawy POLAND

Declares that the product:
*Product:* ***iNode Serial Transceiver UART***
*Model:* **iNode:0x0b10**

Conforms to the following Product Specifications and Regulations:

PN-EN 60950-1:2007/AC:2012
PN-ETSI EN 301 489-1 V1.9.2:2012
PN-ETSI EN 301 489-3 V1.6.1:2014-03
PN-ETSI EN 301 489-17 V2.2.1:2013-05
PN-ETSI EN 300 328 V1.8.1:2013-03
PN-EN 62479:2011/Ap1:2013-07

The product herewith complies with the requirements of the Low Voltage Directive 73/023/EEC, the EMC Directive 89/336/EEC, the RoHS Directive 2011/65/EU and carries the CE - marking accordingly.

Place of issue:
Piaseczno k/Warszawy

Date of issue:
17.02.2015

Signed on behalf of producer: Paweł Rzepecki
Function: Co-owner

Signature: 

**ELSAT s.c.** ul.Warszawska 32E/1 *05-500 Piaseczno k/Warszawy POLAND*
phone: +48 22 716 43 06
*http://iNode.pl/*