Xethru serial protocol

This document describes the serial protocol used by the Xethru module.

Notation

The following notation is used in this document:

```
<X> = Single byte
[X] = Multiple bytes
["abc"] = [0x61,0x62,0x63] = Ascii text
[X(i)] = 32 bit Integer, 4 bytes
[X(f)] = 32 bit Float, 4 bytes
```

Protocol format

Binary protocol using flag bytes and escaping.

Example: `<Start> + [Data] + <CRC> + <End>`

Flag	bytes
`<Start>`	0x7D
`<End>`	0x7E
`<Esc>`	0x7F

Data escaping

Escaping means that if the escape byte occurs in data, the next byte is not `<Start>`, `<End>` or `<Esc>`, but intended byte with same value as flags.

Example: `0x7D + 0x10 + 0x7F + 0x7E + 0x04 + 0xFF + 0x7E`

Here the byte 0x7E in the middle is intended, and should not be read as a flag. Therefore, there is added a byte. After parsing for escape bytes, the data becomes:

```
0x7D + 0x10 + 0x7E + 0x04 + 0xFF + 0x7E
```

Checksum

Calculated by XOR'ing all bytes, including `<Start>`. Note that the CRC is done after escape bytes is removed. This means that CRC is also calculated before adding escape bytes.

How it works

When powering up the sensor, it enters an idle mode. In this mode, the user can choose sensor behaviour by loading the desired sensor application. After loading the application, the user can

configure the application by sending application level commands. Finally, after configuring the application, the user can send a command to start the application.

```
Module reset --> Idle mode --> Load application --> Load parameters --> Run application
```

If you want to change sensor behaviour, rest the module and start again. Once the application is running, it is not possible to change parameters or application without performing a reset first.

Module level

Commands that control the module at a top level.

Load application

Loads the desired sensor application.

Example: `<Start> + <XTS_SPC_MOD_LOADAPP> + [AppID] + <CRC> + <End>`

Response: `<Start> + <XTS_SPR_ACK> + <CRC> + <End>`

Protocol codes:

Name	Value
XTS_SPC_MOD_LOADAPP	0x21
XTS_SPR_ACK	0x10

Execute application

After the application is loaded, it can be configured using 'Application level' commands (see below). Then the application is executed by setting the module mode.

Name	Value	Description
XTS_SM_NORMAL	0x10	Normal sensor operating mode
XTS_SM_IDLE	0x11	Idle mode. Sensor ready but not active.

Example: `<Start> + <XTS_SPC_MOD_SETMODE> + <XTS_SM_IDLE> + <CRC> + <End>`

Response: `<Start> + <XTS_SPR_ACK> + <CRC> + <End>`

Protocol codes:

Name	Value
XTS_SPC_MOD_SETMODE	0x20
XTS_SPR_ACK	0x10

Reset module

Use this command to completely reset the sensor module.

Example: `<Start> + <XTS_SPC_MOD_RESET> + <CRC> + <End>`

Response: `<Start> + <XTS_SPR_SYSTEM> + [XTS_SPRS_BOOTING(i)] + <CRC> + <End>`

Protocol codes:

Name	Value
XTS_SPC_MOD_RESET	0x22
XTS_SPR_SYSTEM	0x30
XTS_SPRS_BOOTING	0x10

LED control

Use this command to choose the behaviour of the sensor LED. There are three levels of LED operations, Off, Simple and Full. Different applications may use the LED differently, but in general the three levels will behave like this: - Off: Very simple LED indicator during startup and initialization. LED is always off in operating mode. - Simple: More indication during startup and initialization. Simple indication during operation, e.g. fixed indication or subtle blinking. - Full: Full indication during startup and initialization. Extensive use of blinking and colors to indicate sensor state and if possible values.

Example: `<Start> + <XTS_SPC_MOD_SETLEDCONTROL> + <Mode> + <Reserved> + <CRC> + <End>`

Response: `<Start> + <XTS_SPR_ACK> + <CRC> + <End>`

Protocol codes:

Mode	Value
XT_UI_LED_MODE_OFF	0
XT_UI_LED_MODE_SIMPLE	1
XT_UI_LED_MODE_FULL	2

Name	Value
XTS_SPC_MOD_SETLEDCONTROL	0x24
XTS_SPR_ACK	0x10

Application level

Generic application commands

Set Detection Zone

Set the desired detection zone.

Example: `<Start> + <XTS_SPC_APPCOMMAND> + <XTS_SPCA_SET> + [XTS_ID_DETECTION_ZONE] + [Start(f)] + [End(f)] + <CRC> + <End>`

Response: `<Start> + <XTS_SPR_ACK> + <CRC> + <End>`

Protocol codes:

Name	Value
XTS_SPC_APPCOMMAND	0x10
XTS_SPCA_SET	XTS_SPCA_SET
XTS_ID_DETECTION_ZONE	0x96a10a1c
XTS_SPR_ACK	XTS_SPR_ACK

Respiration application (RESP)

RESP Sensor status

Outputs the status of the RESP application, with data when available.

Example: `<Start> + <XTS_SPR_APPDATA> + [XTS_ID_RESP_STATUS] + [Counter(i)] + <StateCode> + [StateData(i)] + [Distance(f)] + [Movement(f)] + [SignalQuality(i)] + <CRC> + <End>`

StateCode values:

StateCode	Value	Description	StateData
XTS_VAL_RESP_STATE_BREATHING	0	Valid RPM sensing	Current RPM value
XTS_VAL_RESP_STATE_MOVEMENT	1	Detects motion, but can not identify breath	0
XTS_VAL_RESP_STATE_MOVEMENT_TRACKING	2	Detects motion, possible breathing soon	0
XTS_VAL_RESP_STATE_NO_MOVEMENT	3	No movement detected	0
XTS_VAL_RESP_STATE_INITIALIZING	4	No movement detected	0
XTS_VAL_RESP_STATE_ERROR	5	Sensor has detected some problem. StatusValue indicates problem.	0
XTS_VAL_RESP_STATE_UNKNOWN	6	Undefined state.	0

Output: - StateData: RPM, respirations per minute (Breathing state only). - Distance: Distance to where respiration is detected (Breathing state only). - Movement: Relative movement of the respiration, in mm (Breathing state only). - SignalQuality: A measure of the signal quality giving respiration. Typically used to identify if the sensor is positioned correctly (Breathing state only).

Protocol codes:

Name	Value
XTS_ID_APP_RESP	0x1423a2d6
XTS_SPR_APPDATA	0x50
XTS_ID_RESP_STATUS	0x2375fe26

Presence application (PRES)

PRES Sensor status

Outputs the status of the PRES application, with data when available.

Example: `<Start> + <XTS_SPR_APPDATA> + [XTS_ID_PRESENCE_STATUS] + <Presence> + [Reserved(f)] + [Reserved(f)] + [SignalQuality(i)] + <CRC> + <End>`

Output: - Presence: Indicating presence or no presence. - SignalQuality: A measure of the signal quality giving presence. Typically used to identify if the sensor is positioned correctly.

Protocol codes:

Name	Value
XTS_ID_APP_PRESENCE	0x00288912
XTS_SPR_APPDATA	0x50
XTS_ID_PRESENCE_STATUS	0x991a52be