TLV FORMAT

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Type | Data Mark | Data Type | Length (Bytes) | Read Write | Fixed Unit |  |
| T | 0x09 | Acc Ax | 4 | R | G | Acceleration reading on the x axis |
| 0x0A | Acc Ay | 4 | R | G | Acceleration reading on the y axis |
| 0x0B | Acc Az | 4 | R | G | Acceleration reading on the z axis |
| 0x0C | Tmp102: Temp | 4 | R | °C | tmp102 temperature reading |
| 0x0D | Bme280: Temp | 4 | R | °C | bme280 temperature reading |
| 0x0E | Bme280: Hum | 4 | R | % | bme280 humidity reading |
| 0x0F | Bme280: hPa | 4 | R | hPa | pressure reading bme280 |
| 0x16 | Meter N. | 4 | RW | None | meter id |
| 0x19 | Packet Sentence | 1 | R | None | packet of data |
| 0x1B | Meter Type | 1 | R | None | placeholder, variable that is consulted and is the reading of the gpio |
| 0x1C | Module Time | 6 | R | None | Year/mounth/day/hour/min/sec UTC |
| 0x1D | Positive/ negative | 1 | R | None | 00: Positive, east longitude  FF: Negative, west longitude |
| Longitude | 4 | R | Deg | Corresponds to degrees, minutes, and seconds in Hex |
| Positive/ negative | 1 | R | None | 00: Positive, North latitude  FF: Negative, South latitude |
| Latitude | 4 | R | Deg | Corresponds to degrees, minutes, and seconds in Hex |
| 0x1F | LEDs | 1 | RW | None | 00: LED1 OFF  00: LED1 ON  00: LED2 TOGGLE |
| 0x22 | Error Status Word | 1 | R | None | error message header |

Error Status Word

|  |  |
| --- | --- |
| BIT3~BIT2 | BIT1~BIT0 |
| Sensor ID | Error Type |

|  |  |
| --- | --- |
| ID | sensor type |
| 0x30 | No sensor Error |
| 0x31 | Mpu6050 |
| 0x32 | Tmp102 |
| 0x33 | Bme280 |
| 0x34 | GPS |

|  |  |
| --- | --- |
| ID | error identifier |
| 0x40 | No error |
| 0x41 | No Device |
| 0x42 | No Data |
| 0x43 | Invalid Gps Data |

This section shows the ID of the associated sensor and the ID that identifies what type of error it is. At the moment, only errors have been established for the connection of the sensors and the failure to obtain data. More error codes will be added in future work. referring to other parts of the system

1. **QUERY STRUCTURE FOR READING REGISTERS**

The node query has the following structure

* data format: header+length +Command code+ CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x03 | All bytes |
| Command code | 1 | 0xXX | See TLV format |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

The node's response will have the following structure

* data format: header + packet data + length + register of meter n. + Command code +CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0xXX | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| Command code | 1 | 0xXX | See TLV format |
| Data of Command code | n | 0xXXXXXXXX | data of the consulted command |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

* 1. **query of sensor measurements**

data format: header+length +module time+ CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x03 | All bytes |
| Command code | 1 | 0xXX | See TLV format |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

End device response (return) data format

data format: header + packet data + length + meter n. + sensor ID + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0xXX | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| Sensor register | 1 | 0xXX | See TLV format |
| sensor measurement | 4 | 0xXXXXXXXX | measured value in HEX |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

* 1. **meter number query**

data format: header+length + Command code + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x03 | All bytes |
| Command code | 1 | 0x16 | Meter number register |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

End device response (return) data format

data format: header + packet data + length + meter n. + sensor ID + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0xXX | All bytes |
| Meter n. | 1 | 0x16 | Meter number register |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

* 1. **date time query**

data format: header+length + Command code + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x03 | All bytes |
| Command code | 1 | 0x1C | Current time register |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

End device response (return) data format

data format: header + packet data + length + meter n. + Curret time register + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0xXX | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| Date time | 1 | 0x1C | Current time rister |
| Date time data | 6 | 0xXXXXXXXXXXXX | Year/Month/Date/Hour/Minute/Second in HEX |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

* 1. **GNSS query**

data format: header+length + Command code + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x03 | All bytes |
| Command code | 1 | 0x1D | GNSS register |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

End device response (return) data format

data format: header + packet data + length + meter n. GNSS refister + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0xXX | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| GNSS data register | 1 | 0x1C | GNSS register |
| East/west | 1 | 0xXX | 00: Positive, east longitude  FF: Negative, west longitude |
| longitude | 4 | 0xXXXXXXXX | Deg/min/sec |
| North/south | 1 | 0xXX | 00: Positive, North latitude  FF: Negative, South latitude |
| latitude | 4 | 0xXXXXXXXX | Deg/min/sec |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

* 1. **LEDs query**

data format: header+length + Command code + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x03 | All bytes |
| Command code | 1 | 0x1F | GNSS register |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

End device response (return) data format

data format: header + packet data + length + meter n. GNSS refister + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0xXX | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| LEDs register | 1 | 0x1F | LEDs register |
| Data LEDs | 1 | 0xXX | 00: LED1 OFF  00: LED1 ON  00: LED2 TOGGLE |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

1. **QUERY STRUCTURE FOR WRITING REGISTERS**

The node query has the following structure

* data format: header+length +Command code+ data to write + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x0X | All bytes |
| Command code | 1 | 0xXX | See TLV format |
| Data to write | n | 0xXX | See TLV format |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

The node's response will have the following structure

* data format: header + packet data + length + register of meter n. + number meter + Command code + data writing +CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0xXX | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| Command code | 1 | 0xXX | See TLV format |
| written data | n | 0xXXXXXXXX | written data |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

* 1. **LEDs status change**

data format: header+length +Command code+ data to write + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x0X | All bytes |
| Command code | 1 | 0x1F | See TLV format |
| Data to write | 1 | 0xXX | See TLV format |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

The node's response will have the following structure

data format: header + packet data + length + register of meter n. + Command code +CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0x08 | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| LEDs registers | 1 | 0x1F | See TLV format |
| LEDs status | 1 | 0xXX | 0X00: LED1 off  0x01：LED1 on  0x02：LED2 toggle |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

* 1. **Meter no. change**

data format: header+length +Command code+ data to write + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 | header indicating that it is a message sent to the node |
| length | 1 | 0x07 | All bytes |
| Command code | 1 | 0x16 | See TLV format |
| Data to write | 4 | 0xXXXXXXXX | See TLV format |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

The node's response will have the following structure

data format: header + packet data + length + register of meter n. + number meter +CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | packet of data |
| length | 1 | 0x07 | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

1. **QUERY STRUCTURE FOR STATUS ERROR**
   1. query of error

data format: header+length+command code+ CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x24 |  |
| length | 1 | 0x03 | All bytes |
| Command code | 1 | 0x22 | See Error Status |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

End device response (return) data format

data format: header + packet data + length + meter n. + erros status + CRC16

|  |  |  |  |
| --- | --- | --- | --- |
| name | byte | Data | Description |
| Frame header | 1 | 0x26 | header indicating that it is a message sent by the node |
| Packet data | 1 | 0x19 | Packet data |
| length | 1 | 0x1A | All bytes |
| Meter n. | 1 | 0x16 | Header number meter |
| Meter n. data | 4 | 0xXXXXXXXX | number meter in HEX |
| Error status | 1 | 0x22 | Erros status code |
| Error device id | 1 | 0xXX | See Error Status Word |
| Error type | 1 | 0xXX |
| CRC16 | 2 | 0xXXXX | Low bytes at the front,  high bytes at the back |

1. **EXAMPLE:**
   1. 260966DA – acceleration query on the x axis

Answer:

2419101612345678094AC2223443XXXX

* 24: Header
* 1910: packet sentence + length 10 (decimal 16)
* 1612345678: meter no. Dec 12345678 - hex, 305419896
* 094AC2: lectura aceleración eje x
* 223443: error status – 34 GPS – 43 invalid gps data.
* XXXX: CRC16
  1. 2622799A- error query

Answer:

24190F161612345678223141B8XXXX

* 24: Header
* 190F: packet sentence + length 0F (decimal 15)
* 1612345678: meter no. Dec 12345678 - hex, 305419896
* 223141: error status – 31 MPU6050 – 41 no device
* XXXX: CRC16
  1. 261CA91B – date time query

Answer:

2419121612345678121C170B150E0B00XXXX

* 24: Header
* 1912: packet sentence + length 12 (18 decimal)
* 1612345678: meter no. Dec 12345678 - hex, 305419896
* 1C170B150E0B00 which is 14:11:00 on Nov 21, 2023
  + 17: year: which is correspond to decimal 23, which is 2023
  + 0B month: which is correspond to decimal 11
  + 15:day: which is correspond to decimal 21
* XXXX: CRC16
  1. 261D69DA – GNSS query

Answer:

2419121612345678121C170B150E0B00XXXX

* 24: Header
* 1912: packet sentence + length 12 (18 decimal)
* 1612345678: meter no. Dec 12345678 - hex, 305419896
* 1DFF143209060063330258
  + FF: Negative, west longitude
  + 14320906: decimal 20° 50’ 09.06’’
  + 00: Positive, North latitude
  + 63330258: decimal 99° 51’ 02.88’’
* XXXX: CRC16
  1. 261F0169DA – LEDs status change

Answer:

24191216123456781F01XXXX

* 24: Header
* 190C: packet sentence + length 0C (12 decimal)
* 1612345678: meter no. Dec 12345678 - hex, 305419896
* 1F01
  + 01: LED 1 - ON
* XXXX: CRC16