Teltonika AVL Protocols

Introduction

A codec is a device or computer program for encoding or decoding a digital data stream or signal. Codec is a portmanteau of coder – decoder. A codec encodes a data stream or a signal for transmission and storage, possibly in encrypted form, and the decoder function reverses the encoding for playback or editing.

Below you will see a table of all Codec types with ID's:

Codec 8	Codec 8 Extended	Codec 16	Codec 12	Codec 13	Codec 14
0x08	0x8E	0x10	0x0C	0x0D	0x0E

Also, there are using two data transport protocols: TCP and UDP. But it is not important which one will be use in Codec.

Codec for device data sending

In this chapter you will find information about every Codec protocol which are using for device data sending and differences between them.

Codec 8

- **Protocol Overview**

Codec8 – a main FM device protocol that is used for sending data to server.

- **Codec 8 protocol sending over TCP**

TCP is a connection-oriented protocol that is used for communication between devices. The workings of this type of protocol is described below in the **communication with server** section.

- **AVL Data Packet**

Below table represents AVL Data Packet structure:

0x00000000 (Preamble)	Data Field Length	Codec ID	Number of Data 1	AVL Data	Number of Data 2	CRC-16
4 bytes	4 bytes	1 byte	1 byte	X bytes	1 byte	4 bytes

Preamble – the packet starts with four zero bytes.
Data Field Length – size is calculated starting from Codec ID to Number of Data 2.
Codec ID – in Codec8 it is always `0x08`.
Number of Data 1 – a number which defines how many records is in the packet.
AVL Data – actual data in the packet (more information below).
Number of Data 2 – a number which defines how many records is in the packet. This number must be the same as "Number of Data 1".
CRC-16 – calculated from Codec ID to the Second Number of Data. CRC (Cyclic Redundancy Check) is an error-detecting code using for detect accidental changes to RAW data. For calculation we are using CRC-16/IBM.

Note: for FMB630, FMB640 and FM63XY, minimum AVL packet size is 45 bytes (all IO elements disabled). Maximum AVL packet size is 255 bytes. For other devices, minimum AVL packet size is 45 bytes (all IO elements disabled). Maximum AVL packet size is 1280 bytes.

- AVL Data

Below table represents AVL Data structure.

Timestamp	Priority	GPS Element	IO Element
8 bytes	1 byte	15 bytes	X bytes

Timestamp – a difference, in milliseconds, between the current time and midnight, January, 1970 UTC (UNIX time).
Priority – field which define AVL data priority (more information below).
GPS Element – location information of the AVL data (more information below).
IO Element – additional configurable information from device (more information below).

- Priority

Below table represents Priority values. Packet priority depends on device configuration and records sent.

Priority	
0	Low
1	High
2	Panic

- GPS element

Below table represents GPS Element structure:

Longitude	Latitude	Altitude	Angle	Satellites	Speed
4 bytes	4 bytes	2 bytes	2 bytes	1 byte	2 bytes

Longitude – east – west position.
Latitude – north – south position.
Altitude – meters above sea level.
Angle – degrees from north pole.
Satellites – number of visible satellites.
Speed – speed calculated from satellites.

Note: Speed will be `0x0000` if GPS data is invalid.

Longitude and latitude are integer values built from degrees, minutes, seconds and milliseconds by formula:

$$\left(d + \frac{m}{60} + \frac{s}{3600} + \frac{ms}{3600000}\right) * p$$

Where:
d – Degrees; m – Minutes; s – Seconds; ms – Milliseconds; p – Precision (10000000)
If longitude is in west or latitude in south, multiply result by –1.

Note:
To determine if the coordinate is negative, convert it to binary format and check the very first bit. If it is 0, coordinate is positive, if it is 1, coordinate is negative.

Example:
Received value: `20 9C CA 80` converted to BIN: `00100000 10011100 11001010 10000000` first bit is 0, which means coordinate is positive converted to DEC: `547146368`. For more information see two's complement arithmetic.

- IO Element

Event IO ID	1 byte
N of Total IO	1 byte
N1 of One Byte IO	1 byte
1'st IO ID	1 byte
1'st IO Value	1 byte
...	
N1'th IO ID	1 byte
N1'th IO Value	1 byte
N2 of Two Bytes	1 byte
1'st IO ID	1 byte
1'st IO Value	2 bytes
...	
N2'th IO ID	1 byte
N2'th IO Value	2 bytes
N4 of Four Bytes	1 byte
1'st IO ID	1 byte
1'st IO Value	4 bytes
...	
N4'th IO ID	1 byte
N4'th IO Value	4 byte
N8 of Eight Bytes	1 byte
1'st IO ID	1 byte
1'st IO Value	8 byte
...	
N8'IO ID	1 byte
N8'IO Value	8 bytes

Event IO ID – if data is acquired on event – this field defines which IO property has changed and generated an event. For example, when if Ignition state changed and it generate event, Event IO ID will be `0xEF` (AVL ID: 239). If it's not eventual record – the value is 0.

N – a total number of properties coming with record (N = N1 + N2 + N4 + N8).
N1 – number of properties, which length is 1 byte.
N2 – number of properties, which length is 2 bytes.
N4 – number of properties, which length is 4 bytes.
N8 – number of properties, which length is 8 bytes.
N'th IO ID - AVL ID.
N'th IO Value - AVL ID value.

- **Communication with server**

First, when module connects to server, module sends its IMEI. First comes short identifying number of bytes written and then goes IMEI as text (bytes).
For example, IMEI `356307042441013` would be sent as `000F333536333037303432343431303133`.
First two bytes denote IMEI length. In this case `0x000F` means, that IMEI is 15 bytes long.
After receiving IMEI, server should determine if it would accept data from this module. If yes, server will reply to module `01`, if not - `00`. Note that confirmation should be sent as binary packet. I.e. 1 byte `0x01` or `0x00`.
Then module starts to send first AVL data packet. After server receives packet and parses it, server must report to module number of data received as integer (four bytes).
If sent data number and reported by server doesn't match module resends sent data.

- Example:

Module connects to server and sends IMEI:
`000F333536333037303432343431303133`
Server accepts the module:
01
Module sends data packet:

AVL Data Packet Header	AVL Data Array	CRC-16
Four Zero Bytes – 0x00000000, “AVL Data Array” length – 0x000000FE	Codec ID – 0x08, Number of Data – **0x02** (Encoded using continuous bit stream. Last byte padded to align to byte boundary)	CRC of “AVL Data Array”
00000000000000FE	08**02**...(data elements)...**02**	00008612

Server acknowledges data reception (2 data elements): **`00000002`**

- **Examples**

Hexadecimal stream of AVL Data Packet receiving and response in these examples are given in hexadecimal form. The different fields of packets are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

1'st example
Receiving one data record with each element property (1 byte, 2 bytes, 4 byte and 8 byte).

Received data in hexadecimal stream:
`000000000000003608010000016B40D8EA30010000000000000000000000000000000105021503010101425E0F01F10000601A014E000000000`

Parsed:

AVL Data Packet

	AVL Data Packet Part	HEX Code Part
	Zero Bytes	00 00 00 00
	Data Field Length	00 00 00 36
	Codec ID	08
	Number of Data 1 (Records)	01
AVL Data	Timestamp	00 00 00 01 6B 40 D8 EA 30 (GMT: Monday, June 10, 2019 10:04:46 AM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	01
	N of Total ID	05
	N1 of One Byte IO	02
	1’st IO ID	15 (AVL ID: 21, Name: GSM Signal)
	1’st IO Value	03
	2’nd IO ID	01 (AVL ID: 1, Name: DIN1)
	2’nd IO Value	01
	N2 of Two Bytes IO	01
	1’st IO ID	42 (AVL ID: 66, Name: External Voltage)
	1’st IO Value	5E 0F

N4 of Four Bytes IO	01
1’st IO ID	F1 (AVL ID: 241, Name: Active GSM Operator)
1’st IO Value	00 00 60 1A
N8 of Eight Bytes IO	01
1’st IO ID	4E (AVL ID: 78, Name: iButton)
1’st IO Value	00 00 00 00 00 00 00 00
Number of Data 2 (Number of Total Records)	01
CRC-16	00 00 C7 CF

Server response: `00000001`

2'nd example
Receiving one data record with one or two different element properties (1 byte, 2 byte).

Received data in hexadecimal stream:
`000000000000002808010000016B40D9AD80010000000000000000000000000000000103021503010101425E100000010000F22A`

Parsed:

AVL Data Packet

	AVL Data Packet Part	HEX Code Part
	Zero Bytes	00 00 00 00
	Data Field Length	00 00 00 28
	Codec ID	08
	Number of Data 1 (Records)	01
AVL Data	Timestamp	00 00 01 6B 40 D9 AD 80 (GMT: Monday, June 10, 2019 10:05:36 AM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	01
	N of Total ID	03
	N1 of One Byte IO	02
	1’st IO ID	15 (AVL ID: 21, Name: GSM Signal)
	1’st IO Value	03
	2’nd IO ID	01 (AVL ID: 1, Name: DIN1)
	2’nd IO Value	01
	N2 of Two Bytes IO	01
	1’st IO ID	42 (AVL ID: 66, Name: External Voltage)
	1’st IO Value	5E 0F
	N4 of Two Bytes IO	00
	N8 of Two Bytes IO	00
	Number of Data 2 (Number of Total Records)	01
	CRC-16	00 00 F2 2A

Server response: `00000001`

3'rd example
Receiving two or more data records with one or more different element properties.

Received data in hexadecimal stream:
`000000000000004308020000016B40D57B480100000000000000000000000000000001010101000000000000016B40D5C198010000000000000000`
`1010101010000000020000252C`

Parsed:

AVL Data Packet

AVL Data Packet Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Field Length	00 00 00 43
Codec ID	08
Number of Data 1 (Records)	02

AVL Data (1'st record)	Timestamp	00 00 01 6B 40 D5 7B 48 (GMT: Monday, June 10, 2019 10:01:01 AM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	01
	N of Total ID	01
	N1 of One Byte IO	01
	1’st IO ID	01 (AVL ID: 1, Name: DIN1)
	1’st IO Value	00
	N2 of Two Bytes IO	00
	N4 of Two Bytes IO	00
	N8 of Two Bytes IO	00
AVL Data (2'nd record)	Timestamp	00 00 01 6B 40 D5 C1 98 (GMT: Monday, June 10, 2019 10:01:19 AM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	01
	N of Total ID	01
	N1 of One Byte IO	01
	1’st IO ID	01 (AVL ID: 1, Name: DIN1)
	1’st IO Value	01
	N2 of Two Bytes IO	00
	N4 of Two Bytes IO	00
	N8 of Two Bytes IO	00
	Number of Data 2 (Number of Total Records)	02
	CRC-16	00 00 25 2C

Server response: `00000002`

- ## Codec8 protocol sending over UDP

UDP is a transport layer protocol above UDP/IP to add reliability to plain UDP/IP using acknowledgment packets.

- **AVL Data Packet**

The packet structure is as follows:

UDP Datagram	
Example	2 bytes
Packet ID	2 bytes
Not Usable Byte	1 byte
Packet Payload	Variable

Example – packet length (excluding this field) in big ending byte order.
Packet ID – packet ID unique for this channel.
Not Usable Byte – not usable byte.
Packet payload – data payload.

- Acknowledgment packet

Acknowledgment packet should have the same Packet ID as acknowledged data packet and empty Data Payload. Acknowledgement should be sent in binary format.

Acknowledgment Packet

Packet Length	Packet ID	Not Usable Byte
2 bytes	2 bytes	1 byte

Packet Length – packet length by sending/response data.
Packet ID – same as in acknowledgment packet.
Not Usable Byte – always will be `0x01`.

- Sending AVL Packet Payload using UDP channel

Below table represents Sending Packet Payload structure.

AVL data encapsulated in UDP channel packet

AVL Packet ID	IMEI Length	Module IMEI	AVL Data Array
1 byte	2 bytes	15 bytes	X bytes

AVL Packet ID – ID identifying this AVL packet.
IMEI Length – always will be `0x000F`.
Module IMEI – IMEI of a sending module encoded the same as with TCP.
AVL Data Array – array of encoded AVL data (same as TCP AVL Data Array).

- Server response Packet Payload using UDP channel

Below table represents Server Response Packet Payload structure.

Server Response to AVL Data Packet

AVL Packet ID	Number of Accepted AVL Elements
1 byte	1 byte

- **Communication with server**

Module sends UDP channel packet with encapsulated AVL data packet. Server sends UDP channel packet with encapsulated response module validates AVL Packet ID and Number of accepted AVL elements. If server response with valid AVL Packet ID is not received within configured timeout, module can retry sending.

- Example:

Module sends the data:

UDP Channel Header	AVL Packet Header	AVL Data Array
Length – 0x00FE, Packet ID – 0xCAFE Not Usable Byte – 0x01	AVL Packet ID – 0xDD, IMEI Length – 0x000F IMEI – 0x313233343536373839303132333435 (Encoded using continuous bit stream. Last byte padded to align to byte boundary)	Codec ID – 0x08, Number of Data – 0x02 (Encoded using continuous bit stream)
00FECAFE01	DD000F3133343536373839303132333435	0802…(data elements)…02

Server must respond with acknowledgment:

UDP Channel Header	AVL Packet Acknowledgment
Length – 0x0005, Packet ID – 0xCAFE, Not Usable Byte – 0x01	AVL Packet ID – 0xDD, Number of Accepted Data – 0x02
0005CAFE01	DD02

- **Example**

Hexadecimal stream of AVL Data Packet receiving and response in this example are given in hexadecimal form. The different fields of packet are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

Received data in hexadecimal stream:
`003DCAFE0105000F33353230393330383634303336353508010000016B4F815B30010000000000000000000000000000000103021503010101`

Parsed:

AVL Data Packet

AVL Data Packet Part		HEX Code Part
UDP Channel Header	Length	00 3D
	Packet ID	CA FE
	Not usable byte	01

AVL Packet Header	AVL packet ID	05
	IMEI Length	00 0F
	IMEI	33 35 32 30 39 33 30 38 36 34 30 33 36 35 35
AVL Data Array	Codec ID	08
	Number of Data 1 (Records)	01
	Timestamp	00 00 01 6B 4F 81 5B 30 (GMT: Thursday, June 13, 2019 6:23:26 AM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	01
	N of Total ID	03
	N1 of One Byte IO	02
	1’st IO ID	15 (AVL ID: 21, Name: GSM Signal)
	1’st IO Value	03
	2’nd IO ID	01 (AVL ID: 1, Name: DIN1)
	2’nd IO Value	01
	N2 of Two Bytes IO	01
	1’st IO ID	42 (AVL ID: 66, Name: External Voltage)
	1’st IO Value	5D BC
	N4 of Two Bytes IO	00
	N8 of Two Bytes IO	00
	Number of Data 2 (Number of Total Records)	01

Server response in hexadecimal stream: `0005CAFE010501`

Parsed:

Server Response to AVL Data Packet

Server Response Part		HEX Code Part
UDP Channel Header	Length	00 05
	Packet ID	CA FE
	Not usable byte	01
AVL Packet Acknowledgment	AVL packet ID	05
	Number of Accepted Data	01

Codec 8 Extended

- **Protocols overview**

Codec8 Extended is using for FMBXXX family devices. This protocol looks familiar like Codec8 but they have some differences. Main differences between are shown in below table:

	Codec8	Codec8 Extended
Codec ID	0x08	0x8E
AVL Data IO element length	1 byte	2 bytes
AVL Data IO element total IO count length	1 byte	2 bytes
AVL Data IO element IO count length	1 byte	2 bytes
AVL Data IO element AVL ID length	1 byte	2 bytes
Variable size IO elements	Does not include	Includes variable size elements

- **Codec 8 Extended protocol sending over TCP**
- **AVL data packet**

Below table represents AVL data packet structure:

0x00000000 (Preamble)	Data Field Length	Codec ID	Number of Data 1	AVL Data	Number of Data 2	CRC-16
4 bytes	4 bytes	1 byte	1 byte	X bytes	1 byte	4 bytes

Preamble – the packet starts with four zero bytes.
Data Field Length – size is calculated starting from Codec ID to Number of Data 2.
Codec ID – in Codec8 Extended it is always `0x8E`.
Number of Data 1 – a number which defines how many records is in the packet.
AVL Data – actual data in the packet (more information below).
Number of Data 2 – a number which defines how many records is in the packet. This number must be the same as "Number of Data 1".
CRC-16 – calculated from Codec ID to the Second Number of Data. CRC (Cyclic Redundancy Check) is an error-detecting code using for detect accidental changes to RAW data. For calculation we are using CRC-16/IBM.

Note: for FMB630, FMB640 and FM63XY, minimum AVL packet size is 45 bytes (all IO elements disabled). Maximum AVL packet size is 255 bytes. For other devices, minimum AVL packet size is 45 bytes (all IO elements disabled). Maximum AVL packet size is 1280 bytes.

- AVL Data

Below table represents AVL Data structure:

Timestamp	Priority	GPS Element	IO Element
8 bytes	1 byte	15 bytes	X bytes

Timestamp – a difference, in milliseconds, between the current time and midnight, January, 1970 UTC (UNIX time).
Priority – field which define AVL data priority (more information below).
GPS Element – locational information of the AVL data (more information below).
IO Element – additional configurable information from device (more information below).

- Priority

Below table represents Priority values. Packet priority depends on device configuration and records sent.

Priority	
0	Low
1	High
2	Panic

- GPS element

Below table represents GPS Element structure:

Longitude	Latitude	Altitude	Angle	Satellites	Speed
4 bytes	4 bytes	2 bytes	2 bytes	1 byte	2 bytes

Longitude – east – west position.
Latitude – north – south position.
Altitude – meters above sea level.
Angle – degrees from north pole.
Satellites – number of visible satellites.
Speed – speed calculated from satellites.

Note: Speed will be `0x0000` if GPS data is invalid.

Longitude and latitude are integer values built from degrees, minutes, seconds and milliseconds by formula:

$$\left(d + \frac{m}{60} + \frac{s}{3600} + \frac{ms}{3600000}\right) * p$$

Where:
d – Degrees; m – Minutes; s – Seconds; ms – Milliseconds; p – Precision (10000000)
If longitude is in west or latitude in south, multiply result by –1.

Note:
To determine if the coordinate is negative, convert it to binary format and check the very first bit. If it is `0`, coordinate is positive, if it is `1`, coordinate is negative.

Example:
Received value: `20 9C CA 80` converted to BIN: `00100000 10011100 11001010 10000000` first bit is 0, which means coordinate is positive converted to DEC: `547146368`. For more information see two's complement arithmetic.

- IO Element

Event IO ID	2 bytes
N of Total IO	2 bytes
N1 of One Byte IO	2 bytes

Event IO ID – if data is acquired on event – this field defines which IO property has changed and generated an event. For example, when if Ignition state changed and it generate event, Event IO ID will be 0xEF (AVL ID: 239). If it's not eventual record – the value is 0.

1'st IO ID	2 bytes
1'st IO Value	1 byte
...	
N1'th IO ID	2 bytes
N1'th IO Value	1 byte
N2 of Two Bytes	2 bytes
1'st IO ID	2 bytes
1'st IO Value	2 bytes
...	
N2'th IO ID	2 bytes
N2'th IO Value	2 bytes
N4 of Four Bytes	2 bytes
1'st IO ID	2 bytes
1'st IO Value	4 bytes
...	
N4'th IO ID	2 bytes
N4'th IO Value	4 byte
N8 of Eight Bytes	2 bytes
1'st IO ID	2 bytes
1'st IO Value	8 byte
...	
N8'IO ID	2 bytes
N8'IO Value	8 bytes
NX of X Byte IO	2 bytes
1'st IO ID	2 bytes
1'st IO Length	2 bytes
1'st IO Value	Defined by lenght
...	
NX'th IO ID	2 bytes
NX'th Length	2 bytes
NX'th Value	Defined by lenght

N – a total number of properties coming with record (N = N1 + N2 + N4 + N8).
N1 – number of properties, which length is 1 byte.
N2 – number of properties, which length is 2 bytes.
N4 – number of properties, which length is 4 bytes.
N8 – number of properties, which length is 8 bytes.
NX – a number of properties, which length is defined by length element. **N'th IO ID** - AVL ID.
N'th Lenght - AVL ID value lenght.
N'th IO Value - AVL ID value.

- **Communication with server**

Communication with server is the same as with Codec8 protocol, except in Codec8 Extended protocol Codec ID is 0x8E.

- Example:

Module connects to server and sends IMEI:
`000F333536333030373034323434313033`
Server accepts the module:
`01`
Module sends data packet:

AVL Data Packet Header	AVL Data Array	CRC-16
Four Zero Bytes – 0x00000000, "AVL Data Array" length – 0x000000FE	Codec ID – 0x8E, Number of Data – **0x02** (Encoded using continuous bit stream. Last byte padded to align to byte boundary)	CRC of "AVL Data Array"
00000000000000FE	8E**02**...(data elements)...**02**	00008612

Server acknowledges data reception (2 data elements): **`00000002`**

- **Example**

Hexadecimal stream of AVL Data Packet receiving and response in this example are given in hexadecimal form. The different fields of packet are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

Received data in hexadecimal stream:
`000000000000004A8E010000016B412CEE000100000000000000000000000000000000010005000100010100010011001D00010010015E2C88`
`A000E000000001DD7E06A00000100002994`

Parsed data:

AVL Data Packet

AVL Data Packet Part	HEX Code Part

AVL Data	Zero Bytes	00 00 00 00
	Data Field Length	00 00 00 4A
	Codec ID	8E
	Number of Data 1 (Records)	01
	Timestamp	00 00 01 6B 41 2C EE 00 (GMT: Monday, June 10, 2019 11:36:32 AM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	00 01
	N of Total ID	00 05
	N1 of One Byte IO	00 01
	1’st IO ID	00 01 (AVL ID: 1, Name: DIN1)
	1’st IO Value	01
	N2 of Two Bytes IO	00 01
	1’st IO ID	00 11 (AVL ID: 17, Name: Axis X)
	1’st IO Value	00 1D
	N4 of Two Bytes IO	00 01
	1’st IO ID	00 10 (AVL ID: 16, Name: Total Odometer)
	1’st IO Value	01 5E 2C 88
	N8 of Two Bytes IO	00 02
	1’st IO ID	00 0B (AVL ID: 11, Name: ICCID1)
	1’st IO Value	00 00 00 00 35 44 C8 7A
	2’nd IO ID	00 0E (AVL ID: 14, Name: ICCID2)
	2’nd IO Value	00 00 00 00 1D D7 E0 6A
	NX of X Byte IO	00 00
	Number of Data 2 (Number of Total Records)	01
	CRC-16	00 00 29 94

Server response: `00000001`

- **Codec8 Extended protocol sending over UDP**

- **UDP channel protocol**

AVL data packet is the same as with Codec8, except Codec ID is changed to `0x8E`.

- **Communication with server**

Module sends UDP channel packet with encapsulated AVL data packet. Server sends UDP channel packet with encapsulated response module validates AVL Packet ID and Number of accepted AVL elements. If server response with valid AVL Packet ID is not received within configured timeout, module can retry sending.

- Example:

Module sends the data:

UDP Channel Header	AVL Packet Header	AVL Data Array
Length – 0x00FE, Packet ID – 0xCAFE Not Usable Byte – 0x01	AVL Packet ID – 0xDD, IMEI Length – 0x000F IMEI – 0x313233343536373839303132333435 (Encoded using continuous bit stream. Last byte padded to align to byte boundary)	Codec ID – 0x8E, Number of Data – 0x02 (Encoded using continuous bit stream)
00FECAFE01	DD000F3133343536373839303132333435	8E02…(data elements)…02

Server must respond with acknowledgment:

UDP Channel Header	AVL Packet Acknowledgment
Length – 0x0005, Packet ID – 0xCAFE, Not Usable Byte – 0x01	AVL Packet ID – 0xDD, Number of Accepted Data – 0x02
0005CAFE01	DD02

- **Example**

Hexadecimal stream of AVL Data Packet receiving and response in this example are given in hexadecimal form. The different fields of packet are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

Received data in hexadecimal stream:
`005FCAFE0107000F3335323039333038363430333635358E010000016B4F831C680100000000000000000000000000000000010005000100010`
`10015E2C880002000B000000003544C87A000E000000001DD7E06A000001`

Parsed:

AVL Data Packet

AVL Data Packet Part		HEX Code Part
	Length	00 5F
UDP Channel Header	Packet ID	CA FE
	Not usable byte	01
	AVL packet ID	05
AVL Packet Header	IMEI Length	00 0F
	IMEI	33 35 32 30 39 33 30 38 36 34 30 33 36 35 35
	Codec ID	8E
	Number of Data 1 (Records)	01
	Timestamp	00 00 01 6B 4F 83 1C 68 (GMT: Thursday, June 13, 2019 6:25:21 AM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	00 01
	N of Total ID	00 05
	N1 of One Byte IO	00 01
AVL Data Array	1'st IO ID	00 01 (AVL ID: 1, Name: DIN1)
	1'st IO Value	00 01
	N2 of Two Bytes IO	00 01
	1'st IO ID	00 11 (AVL ID: 17, Name: Axis X)
	1'st IO Value	00 1D
	N4 of Two Bytes IO	00 01
	1'st IO ID	00 10 (AVL ID: 16, Name: Total Odometer)
	1'st IO Value	01 5E 2C 88
	N8 of Two Bytes IO	00 02
	1'st IO ID	00 0B (AVL ID: 11, Name: ICCID1)
	1'st IO Value	00 00 00 00 35 44 C8 7A
	2'nd IO ID	00 0E (AVL ID: 14, Name: ICCID2)
	2'nd IO Value	00 00 00 00 1D D7 E0 6A
	NX of X Byte IO	00 00

Server response in hexadecimal stream: `0005CAFE010701`

Parsed:

Server Response to AVL Data Packet

Server Response Part		HEX Code Part
	Length	00 05
UDP Channel Header	Packet ID	CA FE
	Not usable byte	01
AVL Packet Acknowledgment	AVL packet ID	07
	Number of Accepted Data	01

Codec 16

- **Protocol overview**

Codec16 is using for FMB630/FM63XY devices. This protocol looks familiar like Codec8 but they have some differences. Main differences between are shown in table below:

	Codec8	Codec16
Codec ID	0x08	0x10
AVL Data IO element ID event length	1 byte	2 bytes
AVL Data IO element AVL ID length	1 byte	2 bytes
Generation Type	Not Using	Is Using

Note: Codec16 is supported from firmware – 00.03.xx and newer. (FMB630/FM63XY) || AVL ID's which are higher than 255 will can be used only in Codec16 protocol.

- ## Codec 16 protocol sending over TCP

- **AVL data packet**

Below table represents AVL data packet structure:

0x00000000 (Preamble)	Data Field Length	Codec ID	Number of Data 1	AVL Data	Number of Data 2	CRC-16
4 bytes	4 bytes	1 byte	1 byte	X bytes	1 byte	4 bytes

Preamble – the packet starts with four zero bytes.
Data Field Length – size is calculated starting from Codec ID to Number of Data 2.
Codec ID – in Codec16 it is always 0x10.
Number of Data 1 – a number which defines how many records is in the packet.
AVL Data – actual data in the packet (more information below).
Number of Data 2 – a number which defines how many records is in the packet. This number must be the same as "Number of Data 1".
CRC-16 – calculated from Codec ID to the Second Number of Data. CRC (Cyclic Redundancy Check) is an error-detecting code using for detect accidental changes to RAW data. For calculation we are using CRC-16/IBM.

Note: for FMB630 and FM63XY, minimum AVL packet size is 45 bytes (all IO elements disabled). Maximum AVL packet size is 255 bytes.

- AVL Data

Below table represents AVL Data structure:

Timestamp	Priority	GPS Element	IO Element
8 bytes	1 byte	15 bytes	X bytes

Timestamp – a difference, in milliseconds, between the current time and midnight, January, 1970 UTC (UNIX time).
Priority – field which define AVL data priority (more information below).
GPS Element – location information of the AVL data (more information below).
IO Element – additional configurable information from device (more information below).

- Priority

Below table represents Priority values. Packet priority depends on device configuration and records sent.

Priority	
0	Low
1	High
2	Panic

- GPS element

Below table represents GPS Element structure:

Longitude	Latitude	Altitude	Angle	Satellites	Speed
4 bytes	4 bytes	2 bytes	2 bytes	1 byte	2 bytes

Longitude – east – west position.
Latitude – north – south position.
Altitude – meters above sea level.
Angle – degrees from north pole.
Satellites – number of visible satellites.
Speed – speed calculated from satellites.

Note: Speed will be `0x0000` if GPS data is invalid.

Longitude and latitude are integer values built from degrees, minutes, seconds and milliseconds by formula:

$$\left(d + \frac{m}{60} + \frac{s}{3600} + \frac{ms}{3600000}\right) * p$$

Where:
d – Degrees; m – Minutes; s – Seconds; ms – Milliseconds; p – Precision (10000000)
If longitude is in west or latitude in south, multiply result by –1.

Note:
To determine if the coordinate is negative, convert it to binary format and check the very first bit. If it is `0`, coordinate is positive, if it is `1`, coordinate is negative.

Example:
Received value: `20 9C CA 80` converted to BIN: `00100000 10011100 11001010 10000000` first bit is 0, which means coordinate is positive converted to DEC: `547146368`. For more information see two's complement arithmetic.

- IO Element

Event IO ID	2 bytes
Generation Type	1 byte
N of Total IO	1 byte
N1 of One Byte IO	1 byte
1'st IO ID	2 bytes
1'st IO Value	1 byte
...	
N1'th IO ID	2 bytes
N1'th IO Value	1 byte
N2 of Two Bytes	1 byte
1'st IO ID	2 bytes
1'st IO Value	2 bytes
...	
N2'th IO ID	2 bytes
N2'th IO Value	2 bytes
N4 of Four Bytes	1 byte
1'st IO ID	2 bytes
1'st IO Value	4 bytes
...	
N4'th IO ID	2 bytes
N4'th IO Value	4 byte
N8 of Eight Bytes	1 byte
1'st IO ID	2 bytes
1'st IO Value	8 byte
...	
N8'IO ID	2 bytes
N8'IO Value	8 bytes

Event IO ID – if data is acquired on event – this field defines which IO property has changed and generated an event. For example, when if Ignition state changed and it generate event, Event IO ID will be 0xEF (AVL ID: 239). If it's not eventual record – the value is 0.

Generation type - data event generation type. More information about it you can find here.
N – a total number of properties coming with record (N = N1 + N2 + N4 + N8).
N1 – number of properties, which length is 1 byte.
N2 – number of properties, which length is 2 bytes.
N4 – number of properties, which length is 4 bytes.
N8 – number of properties, which length is 8 bytes.
N'th IO ID - AVL ID.
N'th IO Value - AVL ID value.

- Generation type

Value	Record Created
0	On Exit
1	On Entrance
2	On Both
3	Reserved
4	Hysteresis
5	On Change
6	Eventual
7	Periodical

- **Communication with server**

Communication with server is the same as with Codec8 protocol, except in Codec16 protocol Codec ID is `0x10` and has generation type.

- Example:

Module connects to server and sends IMEI:
`000F333536333037303432343431303133`
Server accepts the module:
`01`
Module sends data packet:

AVL Data Packet Header	AVL Data Array	CRC-16
Four Zero Bytes – 0x00000000, “AVL Data Array” length – 0x000000FE	Codec ID – 0x10, Number of Data – **0x02** (Encoded using continuous bit stream. Last byte padded to align to byte boundary)	CRC of “AVL Data Array”
00000000000000FE	10**02**...(data elements)...**02**	00008612

Server acknowledges data reception (2 data elements): **`00000002`**

- **Example**

Hexadecimal stream of AVL Data Packet receiving and response in this example are given in hexadecimal form. The different fields of packet are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

Received data in hexadecimal stream:
```
000000000000005F10020000016BDBC7833000000000000000000000000000000000000B05040200010000030002000B00270042563A0000000
00000000000000000000000000000000000B05040200010000030002000B00260042563A00000200005FB3
```

Parsed data:

AVL Data Packet

	AVL Data Packet Part	HEX Code Part
	Zero Bytes	00 00 00 00
	Data Field Length	00 00 00 5F
	Codec ID	10
	Number of Data 1 (Records)	02
AVL Data (1'st record)	Timestamp	00 00 01 6B DB C7 83 30 (GMT: Wednesday, July 10, 2019 12:06:54 PM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	00 0B
	Generation Type	05
	N of Total ID	04
	N1 of One Byte IO	02
	1’st IO ID	00 01 (AVL ID: 1, Name: DIN1)
	1’st IO Value	00
	2’nd IO ID	00 03 (AVL ID: 3, Name: DIN3)
	2’nd IO Value	00
	N2 of Two Bytes IO	02
	1’st IO ID	00 0B (AVL ID: 11, Name: ICCID1)
	1’st IO Value	00 27
	2’nd IO ID	00 42 (AVL ID: 66, Name: External Voltage)
	2’nd IO Value	56 3A
	N4 of Two Bytes IO	00
	N8 of Two Bytes IO	00
AVL Data (2'nd record)	Timestamp	00 00 01 6B DB C7 87 18 (GMT: Wednesday, July 10, 2019 12:06:55 PM)
	Priority	01
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	00 0B
	Generation Type	05

N of Total ID	04
N1 of One Byte IO	02
1'st IO ID	00 01 (AVL ID: 1, Name: DIN1)
1'st IO Value	00
2'nd IO ID	00 03 (AVL ID: 3, Name: DIN3)
2'nd IO Value	00
N2 of Two Bytes IO	02
1'st IO ID	00 0B (AVL ID: 11, Name: ICCID1)
1'st IO Value	00 26
2'nd IO ID	00 42 (AVL ID: 66, Name: External Voltage)
2'nd IO Value	56 3A
N4 of Two Bytes IO	00
N8 of Two Bytes IO	00
Number of Data 2 (Number of Total Records)	02
CRC-16	00 00 5F B3

Server response: `00000002`

- **Codec16 Extended protocol sending over UDP**
- **UDP channel protocol**

AVL data packet is the same as with Codec8, except Codec ID is changed to `0x10`.

- **Communication with server**

Module sends UDP channel packet with encapsulated AVL data packet. Server sends UDP channel packet with encapsulated response module validates AVL Packet ID and Number of accepted AVL elements. If server response with valid AVL Packet ID is not received within configured timeout, module can retry sending.

- Example:

Module sends the data:

UDP Channel Header	AVL Packet Header	AVL Data Array
Length – 0x00FE, Packet ID – 0xCAFE Not Usable Byte – 0x01	AVL Packet ID – 0xDD, IMEI Length – 0x000F IMEI – 0x313233343536373839303132333435 (Encoded using continuous bit stream. Last byte padded to align to byte boundary)	Codec ID – 0x10, Number of Data – 0x02 (Encoded using continuous bit stream)
00FECAFE01	DD000F313334353637383930313233343 5	1002…(data elements)…02

Server must respond with acknowledgment:

UDP Channel Header	AVL Packet Acknowledgment
Length – 0x0005, Packet ID – 0xCAFE, Not Usable Byte – 0x01	AVL Packet ID – 0xDD, Number of Accepted Data – 0x02
0005CAFE01	DD02

- **Example**

Hexadecimal stream of AVL Data Packet receiving and response in this example are given in hexadecimal form. The different fields of packet are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

Received data in hexadecimal stream:
`015BCAFE0101000F33353230393430383532333135393210070000015117E40FE800000000000000000000000000EF050504000100`
`0EF01010042111A000001`

Parsed:

AVL Data Packet

AVL Data Packet Part		HEX Code Part
UDP Channel Header	Length	01 5B
	Packet ID	CA FE
	Not usable byte	01

AVL Packet Header	AVL packet ID	07
	IMEI Length	00 0F
	IMEI	33 35 32 30 39 34 30 38 35 32 33 31 35 39 32
AVL Data Array	Codec ID	10
	Number of Data 1 (Records)	01
	Timestamp	00 00 01 51 17 E4 0F E8 (GMT: Wednesday, November 18, 2015 12:00:01 AM)
	Priority	00
	Longitude	00 00 00 00
	Latitude	00 00 00 00
	Altitude	00 00
	Angle	00 00
	Satellites	00
	Speed	00 00
	Event IO ID	00 EF
	Generation type	05
	N of Total ID	05
	N1 of One Byte IO	04
	1'st IO ID	00 01 (AVL ID: 1, Name: DIN1)
	1'st IO Value	00
	2'nd IO ID	00 03 (AVL ID: 3, Name: DIN3)
	2'nd IO Value	00
	3'rd IO ID	00 B4 (AVL ID: 180, Name: DOUT2)
	3'rd IO Value	00
	4'th IO ID	00 EF (AVL ID: 239, Name: Ignition)
	4'th IO Value	00
	N2 of Two Bytes IO	01
	1'st IO ID	42 (AVL ID: 66, Name: External Voltage)
	1'st IO Value	11 1A
	N4 of Two Bytes IO	00
	N8 of Two Bytes IO	00
	Number of Data 2 (Number of Total Records)	01

Server response in hexadecimal stream: `0005CAFE010700`

Parsed:

Server Response to AVL Data Packet

Server Response Part		HEX Code Part
UDP Channel Header	Length	00 05
	Packet ID	CA FE
	Not usable byte	01
AVL Packet Acknowledgment	AVL packet ID	07
	Number of Accepted Data	00

Differences between Codec 8, Codec 8 Extended and Codec 16

In the table below you will see differences between Codec8, Codec8 Extended and Codec16.

	Codec8	Codec8 Extended	Codec16
Codec ID	0x08	0x8E	0x10
AVL Data IO element length	1 byte	2 bytes	2 bytes
AVL Data IO element total IO count length	1 byte	2 bytes	2 bytes
Generation Type	Is Using	Not Using	Is Using
AVL Data IO element IO count length	1 byte	2 bytes	1 byte
AVL Data IO element AVL ID length	1 byte	2 bytes	2 bytes
Variable size IO elements	Does not include	Includes variable size elements	Does not include

Codec for communication over GPRS messages

In this chapter you will find information about every Codec protocol which are using for communication over GPRS messages and differences between them.

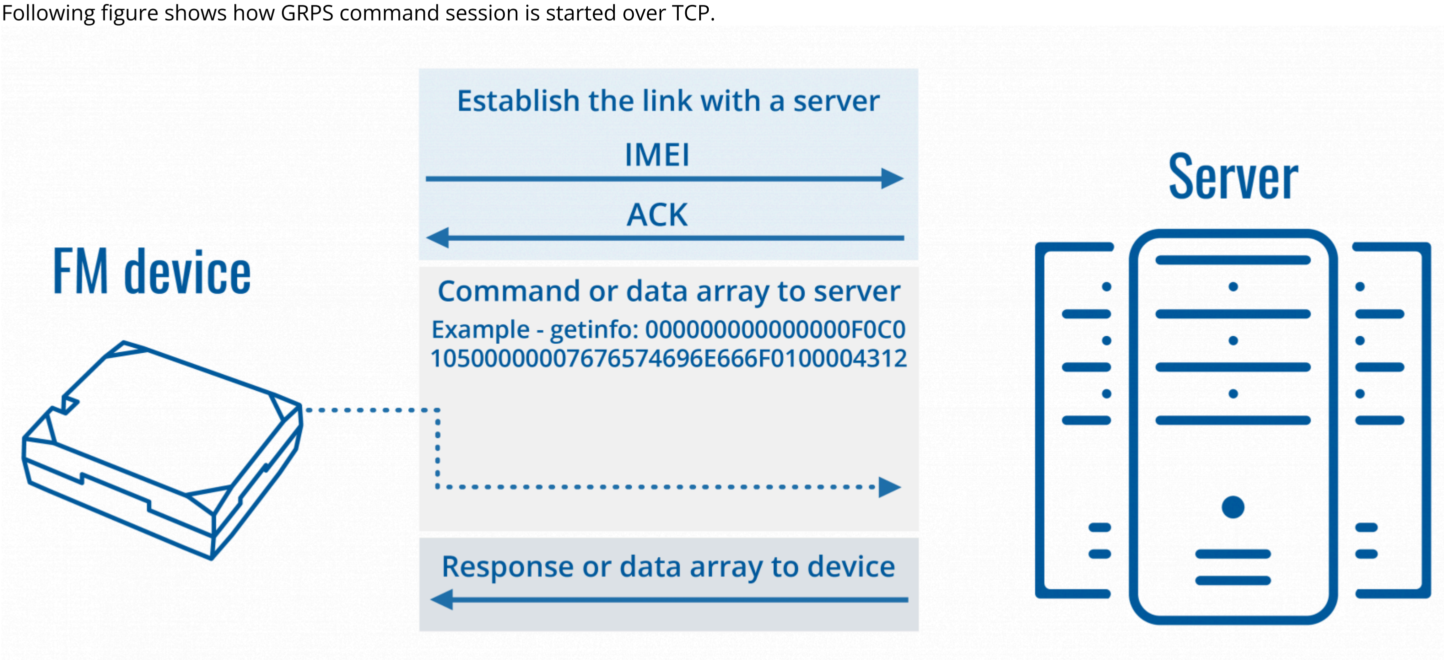
Codec 12

- **About Codec12**

Codec12 is original and main Teltonika protocol for device-server communication over GPRS messages. Codec12 GPRS commands can be used for sending configuration, debug, digital outputs control commands or other (special purpose command on special firmware versions). This protocol is also necessary for using FMB630/FM6300/FM5300/FM5500/FM4200 features like: Garmin, LCD communication, COM TCP Link Mode.

- **GPRS command session**

Following figure shows how GRPS command session is started over TCP.



First, Teltonika device opens GPRS session and sends AVL data to server (refer device protocols). Once all records are sent and correct sent data array acknowledgment is received by device then GPRS commands in Hex can be sent to device.
The ACK (acknowledge of IMEI from server) is a one byte constant 0x01. The acknowledgement of each data array send from device is four bytes integer – number of records received.
Note, that GPRS session should remain active between device and server, while GPRS commands are sent. For this reason, active datalink timeout (global parameters in device configuration) is recommended to be set to 259200 (maximum value).

- **General Codec12 message structure**

The following diagram shows basic structure of Codec12 messages.

Command message structure:

0x00000000 (Preamble)	Data Size	Codec ID	Command Quantity 1	Type (0x05)	Command Size	Command	Command Quantity 2	CRC-16
4 bytes	4 bytes	1 byte	1 byte	1 byte	4 bytes	X bytes	1 byte	4 bytes

Response message structure:

0x00000000 (Preamble)	Data Size	Codec ID	Response Quantity 1	Type (0x06)	Response Size	Response	Response Quantity 2	CRC-16
4 bytes	4 bytes	1 byte	1 byte	1 byte	4 bytes	X bytes	1 byte	4 bytes

Preamble - the packet starts with four zero bytes.
Data Size - size is calculated from Codec ID field to the second command or response quantity field.
Codec ID - in Codec12 it is always `0x0C`.
Command/Response Quantity 1 - it is ignored when parsing the message.

Type - it can be 0x05 to denote command or 0x06 to denote response.
Command/Response Size – command or response length.
Command/Response – command or response in HEX.
Command/Response Quantity 2 - a byte which defines how many records (commands or responses) is in the packet. This byte will not be parsed but it's recommended that it should contain same value as Command/Response Quantity 1.
CRC-16 – calculated from Codec ID to the Command Quantity 2. CRC (Cyclic Redundancy Check) is an error-detecting code using for detect accidental changes to RAW data. For calculation we are using CRC-16/IBM.

Note that difference between commands and responses is message type field: `0x05` means command and `0x06` means response.

- ## Command coding table

Command has to be converted from ASCII characters (char) to hexadecimal (HEX):

Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
0	00	Null	32	20	Space	64	40	@	96	60	`
1	01	Start of heading	33	21	!	65	41	A	97	61	a
2	02	Start of text	34	22	"	66	42	B	98	62	b
3	03	End of text	35	23	#	67	43	C	99	63	c
4	04	End of transmit	36	24	$	68	44	D	100	64	d
5	05	Enquiry	37	25	%	69	45	E	101	65	e
6	06	Acknowledge	38	26	&	70	46	F	102	66	f
7	07	Audible bell	39	27	'	71	47	G	103	67	g
8	08	Backspace	40	28	(	72	48	H	104	68	h
9	09	Horizontal tab	41	29	)	73	49	I	105	69	i
10	0A	Line feed	42	2A	*	74	4A	J	106	6A	j
11	0B	Vertical tab	43	2B	+	75	4B	K	107	6B	k
12	0C	Form feed	44	2C	,	76	4C	L	108	6C	l
13	0D	Carriage return	45	2D	-	77	4D	M	109	6D	m
14	0E	Shift out	46	2E	.	78	4E	N	110	6E	n
15	0F	Shift in	47	2F	/	79	4F	O	111	6F	o
16	10	Data link escape	48	30	0	80	50	P	112	70	p
17	11	Device control 1	49	31	1	81	51	Q	113	71	q
18	12	Device control 2	50	32	2	82	52	R	114	72	r
19	13	Device control 3	51	33	3	83	53	S	115	73	s
20	14	Device control 4	52	34	4	84	54	T	116	74	t
21	15	Neg. acknowledge	53	35	5	85	55	U	117	75	u
22	16	Synchronous idle	54	36	6	86	56	V	118	76	v
23	17	End trans. block	55	37	7	87	57	W	119	77	w
24	18	Cancel	56	38	8	88	58	X	120	78	x
25	19	End of medium	57	39	9	89	59	Y	121	79	y
26	1A	Substitution	58	3A	:	90	5A	Z	122	7A	z
27	1B	Escape	59	3B	;	91	5B	[	123	7B	{
28	1C	File separator	60	3C	<	92	5C	\	124	7C	|
29	1D	Group separator	61	3D	=	93	5D	]	125	7D	}
30	1E	Record separator	62	3E	>	94	5E	^	126	7E	~
31	1F	Unit separator	63	3F	?	95	5F	_	127	7F	□

- ## Command parsing example

Hexadecimal stream of command and answer in this example are given in hexadecimal form. The different fields of message are separate into different table columns for better readability and understanding.

- ## GPRS commands examples

Hexadecimal stream of GPRS command and answer in these examples are given in hexadecimal form. The different fields of messages are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

1'st example: Sending *getinfo* SMS command via GPRS Codec12

Server request in hexadecimal stream:
`000000000000000F0C010500000007676574696E666F0100004312`

Parsed:

Server Command

Server Command Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 0F
Codec ID	0C
Command Quantity 1	01
Command Type	05
Command Size	00 00 00 07

Command	67 65 74 69 6E 66 6F
Command Quantity 2	01
CRC-16	00 00 43 12

Note that Server Command converted from HEX to ASCII means *getinfo*

Device response in hexadecimal stream:
```
00000000000000900C010600000088494E493A323031392F372F323220373A3232205254433A323031392F372F323220373A3533205253543A
312053523A302042523A302043463A302046473A3020464C3A302054553A302F302055543A3020534D533A30204E4F4750533A303A33302047
41543A302052533A332052463A36352053463A31204D443A30010000C78F
```

Parsed:

Device Answer

Device Answer Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 90
Codec ID	0C
Response Quantity 1	01
Response Type	06
Response Size	00 00 00 88
Response	49 4E 49 3A 32 30 31 39 2F 37 2F 32 32 20 37 3A 32 32 20 52 54 43 3A 32 30 31 39 2F 37 2F 32 32 20 37 3A 35 33 20 52 53 54 3A 32 20 45 52 52 3A 31 20 53 52 3A 30 20 42 52 3A 30 20 43 46 3A 30 20 46 47 3A 30 20 46 4C 3A 30 20 54 55 3A 30 2F 30 20 55 54 3A 30 20 53 4D 53 3A 30 20 4E 4F 47 50 53 3A 30 3A 33 30 20 47 50 53 3A 31 20 53 41 54 3A 30 20 52 53 3A 33 20 52 46 3A 36 35 20 53 46 3A 31 20 4D 44 3A 30
Response Quantity 2	01
CRC-16	00 00 C7 8F

Note that Device Response converted from HEX to ASCII means:
INI:2019/7/22 7:22 RTC:2019/7/22 7:53 RST:2 ERR:1 SR:0 BR:0 CF:0 FG:0 FL:0 TU:0/0 UT:0 SMS:0 NOGPS:0:30 GPS:1 SAT:0 RS:3 RF:65 SF:1 MD:0

2'nd example: Sending *getio* SMS command via GPRS Codec12

Server request in hexadecimal stream:
```
000000000000000D0C010500000005676574696F01000000CB
```

Parsed:

Server Command

Server Command Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 0D
Codec ID	0C
Command Quantity 1	01
Command Type	05
Command Size	00 00 00 05
Command	67 65 74 69 6F
Command Quantity 2	01
CRC-16	00 00 00 CB

Note that Server Command converted from HEX to ASCII means *getio*

Device response in hexadecimal stream:
```
00000000000000370C01060000002F4449313A31204449323A30204449333A302041494E313A302041494E323A313639323420444F313A3020
```

Parsed:

Device Answer

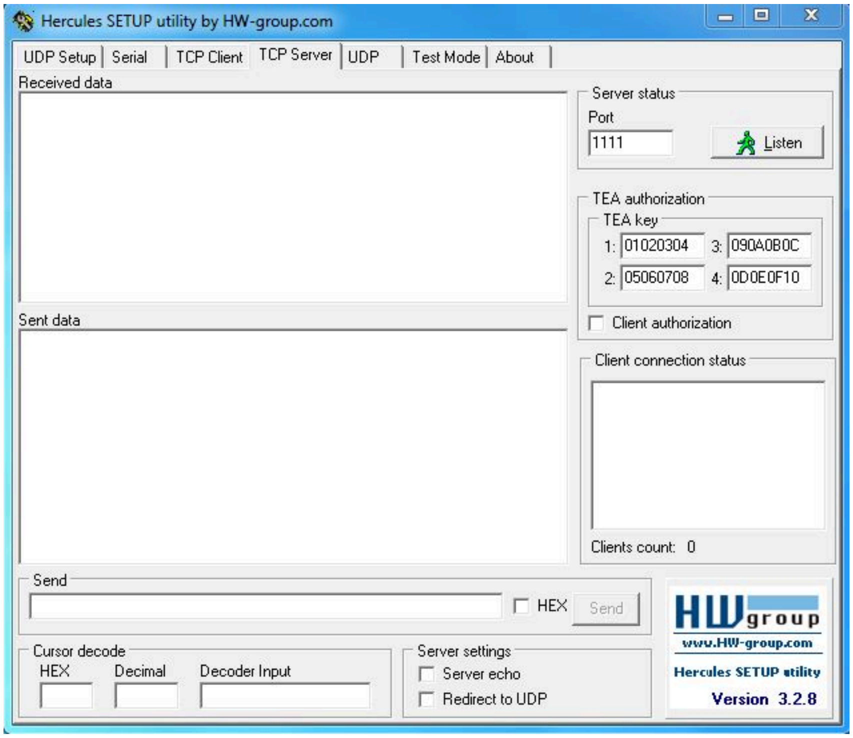
Device Answer Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 37
Codec ID	0C
Response Quantity 1	01
Response Type	06
Response Size	00 00 00 2F

Response	44 49 31 3A 31 20 44 49 32 3A 30 20 44 49 33 3A 30 20 41 49 4E 31 3A 30 20 41 49 4E 32 3A 31 36 39 32 34 20 44 4F 31 3A 30 20 44 4F 32 3A 31
Response Quantity 2	01
CRC-16	00 00 66 E3

Note that Device Response converted from HEX to ASCII means:
DI1:1 DI2:0 DI3:0 AIN1:0 AIN2:16924 DO1:0 DO2:1

- **Communication with server**

The GSM/GPRS commands can be sent from a terminal program. We recommend to use Hercules (in TCP server mode). Simply write command as explained below into Hercules Send field, check HEX box and click Send button. Note that the TCP server must be listening on specified port (see Port field and Listen button below).



- **FMXX and Codec12 functionality**
- **Garmin**

All information is provided in “FMXX and Garmin development.pdf” document.

- **COM TCP Link Mode**

All information is provided in “FMxx TCP Link mode test instructions.pdf” document.

Codec 13

- **About Codec13**

Codec13 is original Teltonika protocol for device-server communication over GPRS messages and it is based on Codec12 protocol. Main differences of Codec13 are that timestamp is using in messages and communication is one way only (Codec13 is used for Device -> Server sending).

- **General Codec13 message structure**

The following diagram shows basic structure of Codec 13 messages:

0x00000000 (Preamble)	Data Size	Codec ID	Command Quantity 1	Type	Command Size	Timestamp	Command	Command Quantity 2	CRC-16
4 bytes	4 bytes	1 byte	1 byte	1 byte	4 bytes	8 bytes	X bytes	1 byte	4 bytes

Preamble – the packet starts with preamble field (four zero bytes).
Data Size – size is calculated from Codec ID field to the second Command Quantity field.
Codec ID – in Codec13 it is always `0x0D`.
Command Quantity 1 – `0x01`, it is ignored when parsing the message.

Command Type – it is always `0x06` since the packet is direction is FM->Server.
Command Size – command size field includes size of timestamp too, so it is equal to size of payload + size of timestamp.
Timestamp – a difference, in milliseconds, between the current time and midnight, January, 1970 UTC (UNIX time).
Command – actual received data.
Command Quantity 2 – a byte which defines how many records (commands) is in the packet. This byte will not be parsed but it's recommended that it should contain same value as Command/Response Quantity 1.
CRC-16 – calculated from Codec ID to the Second Number of Data. CRC (Cyclic Redundancy Check) is an error-detecting code using for detect accidental changes to RAW data. For calculation we are using CRC-16/IBM.

Note: Codec13 packets are used only when "Message Timestamp" parameter in RS232 settings is enabled.

- ### Command parsing example

Hexadecimal stream of GPRS command in this example is given in hexadecimal form. The different fields of message are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

Sending *getinfo* SMS command via GPRS Codec13.

Hexadecimal stream:
`0000000000000170D01050000000F0000016C0A81C320676574696E666F0100006855`

Parsed:

Server Command

Server Command Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 17
Codec ID	0D
Command Quantity 1	01
Command Type	06
Command Size	00 00 00 0F
Timestamp	00 00 01 6C 0A 81 C3 20
Command	67 65 74 69 6E 66 6F
Command Quantity 2	01
CRC-16	00 00 68 55

Note that Server Command converted from HEX to ASCII means *getinfo*

Codec 14

- ### About Codec14

Codec14 is original Teltonika protocol for device-server communication over GPRS messages and it is based on Codec12 protocol.
Main difference of Codec14 is that, device will answer to GPRS command if device physical IMEI number matches specified IMEI number in GPRS command.

Codec14 GPRS commands can be used for sending configuration, debug, digital outputs control commands or other (special purpose command on special firmware versions).

- ### FMB firmware requirements

Implemented in base firmware from FMB.Ver.03.25.04.Rev.00 and newer.

- ### General Codec14 message structure

The following diagram shows basic structure of Codec14 messages.

Command message structure

0x00000000 (preamble)	Data size	0x0E (Codec ID)	Command quantity	0x05 (Message type)	Command size + IMEI size (8 bytes)	IMEI (HEX)	Command	Command quantity	CRC-16
4 bytes	4 bytes	1 bytes	1 bytes	1 bytes	4 bytes	8 bytes	X bytes	1 bytes	4 bytes

Response message structure

0x00000000 (preamble)	Data size	0x0E (Codec ID)	Response quantity	0x06 / 0x11 (Message type)	Response size + IMEI size (8 bytes)	IMEI (HEX)	Response	Response quantity	CRC-16
4 bytes	4 bytes	1 bytes	1 bytes	1 bytes	4 bytes	8 bytes	X bytes	1 bytes	4 bytes

Preamble – the packet starts with four zero bytes.
Data Size – size is calculated from Codec ID field to the second command or response quantity field.
Codec ID – in Codec14 it is always `0x0E`.
Command/Response Quantity 1 – it is ignored when parsing the message.
Type – if it is request command from server it has to contain 0x05. The response type field will contain `0x06` if it's ACK or `0x11` if it's nACK.
Explanation: If command message IMEI is equal to actual device IMEI, received command will be executed and response will be sent with ACK (`0x06`) message type field value. If command message IMEI doesn't match actual device IMEI, received command won't be executed and response to server will be sent with nACK (`0x11`) message type field value.
Command/Response Size – command or response length.
Note: make sure that size is IMEI size 8 + actual command size. Minimal value is 8 because Codec14 always contain IMEI and it's 8 bytes.
IMEI (HEX) – it is send as HEX value. Example if device IMEI is 123456789123456 then IMEI data field will contain `0x0123456789123456` value.
Command/Response – command or response in HEX.
Command/Response Quantity 2 - a byte which defines how many records (commands or responses) is in the packet. This byte will not be parsed but it's recommended that it should contain same value as Command/Response Quantity 1.
CRC-16 – calculated from Codec ID to the Second Number of Data. CRC (Cyclic Redundancy Check) is an error-detecting code using for detect accidental changes to RAW data. For calculation we are using CRC-16/IBM.

- ## GPRS in Codec14 examples

Hexadecimal stream of GPRS command and answer in this example are given in hexadecimal form. The different fields of message are separate into different table columns for better readability and some of them are converted to ASCII values for better understanding.

Sending *getver* SMS command via GPRS Codec14:

Server requests in Hexadecimal stream:
`000000000000000160E01050000000E0352093081452251676574766572010000D2C1`

Parsed:

Server Command

Server Command Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 16
Codec ID	0E
Command Quantity 1	01
Command Type	05
Command Size	00 00 00 0E
IMEI	00 00 00 0E
Command	03 52 09 30 81 45 22 51
Command Quantity 2	01
CRC-16	00 00 D2 C1

Note that Server Command converted from HEX to ASCII means *getver*

Device ACK response in hexadecimal stream:
```
00000000000000AB0E0106000000A303520930814522515665723A30332E31382E31345F3034204750533A41584E5F352E31305F3333333320
204D6F643A313520494D45493A33353230393330383134353232353120496E69743A323031382D31312D323220373A313320557074696D653A
3A36304244443030313632363120535043 3A312830292041584C3A30204F42443A3020424C3A312E362042543A340100007AAE
```

Parsed:

Device Answer

Device Answer Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 37
Codec ID	0E
Response Quantity 1	01
Response Type	06
Response Size	00 00 00 A3
IMEI	03 52 09 30 81 45 22 51
Response	56 65 72 3A 30 33 2E 31 38 2E 31 34 5F 30 34 20 47 50 53 3A 41 58 4E 5F 35 2E 31 30 5F 33 33 33 33 20 48 77 3A 46 4D 42 31 32 30 20 4D 6F 64 3A 31 35 20 49 4D 45 49 3A 33 35 32 30 39 33 30 38 31 34 35 32 32 35 31 20 49 6E 69 74 3A 32 30 31 38 2D 31 31 2D 32 32 20 37 3A 31 33 20 55 70 74 69 6D 65 3A 31 37 32 33 34 20 4D 41 43 3A 36 30 42 44 44 30 30 31 36 32 36 31 20 53 50 43 3A 31 28 30 29 20 41 58 4C 3A 30 20 4F 42 44 3A 30 20 42 4C 3A 31 2E 36 20 42 54 3A 34
Response Quantity 2	01
CRC-16	00 00 7A AE

Note that Device Response converted from HEX to ASCII means:
Ver:03.18.14_04 GPS:AXN_5.10_3333 Hw:FMB120 Mod:15 IMEI:352093081452251 Init:2018-11-22 7:13 Uptime:17234 MAC:60BDD0016261 SPC:1(0) AXL:0 OBD:0 BL:1.6 BT:4

Device nACK response in hexadecimal stream:
`00000000000000100E0111000000080352093081452468010000032AC`

Parsed:

Device Answer

Device Answer Part	HEX Code Part
Zero Bytes	00 00 00 00
Data Size	00 00 00 10
Codec ID	0E
Response Quantity 1	01
Response Type	11
Response Size	00 00 00 08
IMEI	03 52 09 30 81 45 24 68
Response Quantity 2	01
CRC-16	00 00 32 AC

Differences between Codec 12, Codec 13 and Codec 14

In the table below you will see differences between Codec12, Codec13 and Codec14.

	Codec12	Codec13	Codec14
Communication	Server - Device Communication	One-way (Device -> Server communication)	Server - Device Communication
Codec ID	0x0C	0x0D	0x0E
Response Message Type	0x06	-	0x06 (if it is ACK) or 0x11 (if it is nACK)
Command / Response size	Only Command/Response	Only Command	Command/Response + IMEI
Timestamp	Not Using	Is Using	Not Using
IMEI	Not Using	Not Using	Is Using

24 Position SMS Data Protocol

24-hour SMS is usually sent once every day and contains GPS data of last 24 hours. TP-DCS field of this SMS should indicate that message contains 8-bit data (i.e. TP-DCS can be `0x04`).
Note, that 24 position data protocol is used only with subscribed SMS. Event SMS use standard AVL data protocol.

- ### Encoding

To be able to compress 24 GPS data entries into one SMS (140 octets), the data is encoded extensively using bit fields. Data packet can be interpreted as a bit stream, where all bits are numbered as follows:

Byte 1	Byte 2	Byte 3	Byte 4 ...
Bits 0 - 7	Bits 8 - 15	Bits 16 - 24	Bits 25 - ...

Bits in a byte are numbered starting from least significant bit. A field of 25 bits would consist of bits 0 to 24 where 0 is the least significant bit and bit 24 – most significant bit.

- ### Structure

Below in the tables you will see SMS Data Structure:

SMS Data Structure

8	Codec ID	Codec ID = 4 (0x04)
35	Timestamp	Time corresponding to the first (oldest) GPS data element, represented in seconds elapsed from 2000.01.01 00:00 EET.
5	ElementCount	Number of GPS data elements

SMS Data Structure

ElementCount *		GPSDataElement	GPS data elements
		Byte - align padding	Padding bits to align to 8 - bits boundary represented in seconds elapsed from 2000.01.01 00:00 EET.
	64	IMEI	IMEI of sending device as 8 byte long integer

The time of only the first GPS data element is specified in Timestamp field. Time corresponding to each further element can be computed as elementTime = Timestamp + (1 hour * elementNumber).

GPS Data Element

		Size (bits)	Field	Description
		1	ValidElement	ValidElement = 1 – there is a valid Gps Data Element following, ValidElement = 0 – no element at this position
ValidElement == 1		1	DifferentialCoords	Format of following data
	DifferentialCoords == 1	14	LongitudeDiff	Difference from previous element's longitude. LongitudeDiff = prevLongitude – Longitude + 213 – 1
		14	LatitudeDiff	Difference from previous element's latitude LatitudeDiff = prevLatitude – Latitude + 213 – 1
	DifferentialCoords == 0	21	Longitude	Longitude = {(LongDegMult + 18 * 108) * (221 – 1)} over {36*108}
		20	Latitude	Latitude = (LatDegMult + 9*108) * (220 – 1) over {18*108}
		8	Speed	Speed in km/h

Longitude - longitude field value of GPSDataElement
Latitude - latitude field value of GPSDataElement
LongDegMult - longitude in degrees multiplied by 107 (integer part)
LatDegMult - latitude in degrees multiplied by 107 (integer part)
prevLongitude - longitude field value of previous GPSDataElemen
prevLatitude - latitude field value of previous GPSDataElement

- **Decoding GPS position**

When decoding GPS data with DifferentialCoords = 1, Latitude and Longitude values can be computed as follows: Longitude = prevLongitude – LongitudeDiff + 213 – 1, Latitude = prevLatitude – LatitudeDiff + 213 – 1.
If there were no previous non-differential positions, differential coordinates should be computed assuming prevLongitude = prevLatitude = 0.
When Longitude and Latitude values are known, longitude and latitude representation in degrees can be computed as follows:

$$LongDeg = \frac{Longitude * 360}{2^{21} - 1} - 180 \qquad LatDeg = \frac{Latitude * 180}{2^{20} - 1} - 90$$

- **SMS Events**

When Configured to generate SMS event user will get this SMS upon event:
<Year/Month/Day> <Hour:Minute:Second> P:<profile_nr> <SMS Text> Val:<Event Value> Lon:<longitude> Lat:<latitude> Q:<HDOP>

Example:
2016./04/11 12:00:00 P:3 Digital Input 1 Val:1 Lon:51.12258 Lat: 25.7461 Q:0.6

Sending data using SMS

This type data sending is using for FMBXXX devices which can be configured in SMS Data Sending settings.

- **Data sending via SMS**

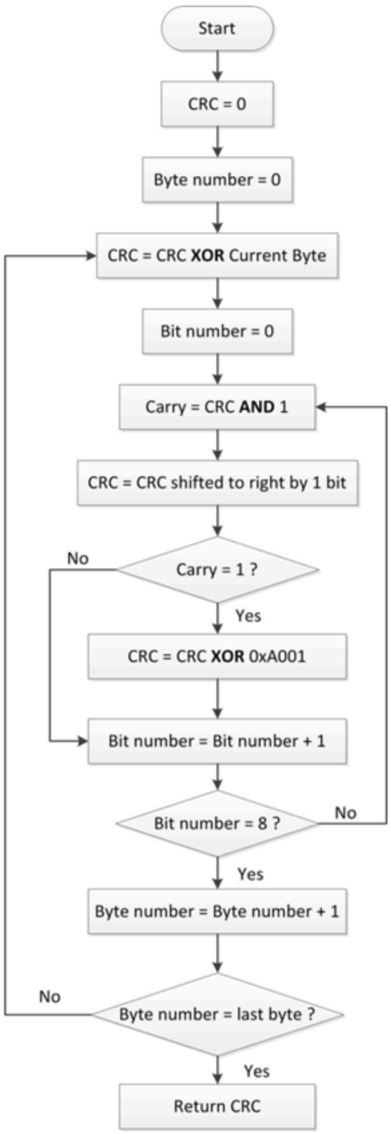
AVL data or events can be sent encapsulated in binary SMS. TP-DCS field of these SMS should indicate that message contains 8-bit data (for example: TP-DCS can be `0x04`).

SMS data (TP-UD)	
AVL data array	**IMEI**
X bytes	8 bytes

AVL data array – array of encoded AVL data.
IMEI – IMEI of sending module encoded as a big endian 8 byte long number.

CRC-16

CRC (Cyclic Redundancy Check) is an error-detecting code using for detect accidental changes to RAW data. The algorithm how to calculate CRC-16 (also known as CRC-16/IBM) you will find below.



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