FMA120 Protocols

V0.6

Contents

1. FMA110 DATA PROTOCOL

1.1 AVL data array

Because the smallest information amount that can be written is one bit, there can be some bits left unused when result is byte array. Any unused bits should be left blank.

Codec ID	Number of Data	Data	Number of Data
1 Byte	*1 Byte*	…	*1 Byte*

Number of data – number of encoded data (number of records)
In FMA120 codec ID is 08

1.2 Data

AVL Data	…	AVL Data

AVL data – encoded data element

1.3 AVL Data

Timestamp	Priority	GPS Element	IO Element
8 Bytes	*1 Byte*	*15 Bytes*	...

Timestamp – difference, in milliseconds, between the current time and midnight, January 1, 1970 UTC.

1.4 Priority

0	Low
1	High
2	Panic
3	Security

1.5 GPS Element

Longitude	Latitude	Altitude	Angle	Satellites	Speed
4 Bytes	*4 Bytes*	*2 Bytes*	*2 Bytes*	*1 Byte*	*2 Bytes*

X Longitude[1]
Y Latitude[1]
Altitude In meters above sea level[1]
Angle In degrees, 0 is north, increasing clock-wise [1]
Satellites Number of visible satellites[1]
Speed Speed in km/h. 0x0000 if GPS data is invalid[1]

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

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

d Degrees
m Minutes
s Seconds
ms Milliseconds
p Precision (10000000)

If longitude is in west or latitude in south, multiply result by –1. 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
Convered to DEC: 547146368
For more information see two's compliment arithmetics.

1.6 IO element

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

Event IO ID – if data is acquired on event – this field defines which IO property has changed and generated an event. If data cause is not event – the value is 0.

[1] If record is without valid coordinates – (there were no GPS fix in the moment of data acquisition) – Longitude, Latitude and Altitude values are last valid fix, and Angle, Satellites and Speed are 0.

N 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

Permanent I/O elements (are always sent to server if enabled)				
Property ID	**Property Name**	**Bytes**	**Description**	**Type**[1]
1	Digital Input Status 1	1	Logic: 0 / 1	M
2	Digital Input Status 2	1	Logic: 0 / 1	M
3	Digital Input Status 3	1	Logic: 0 / 1	M
9	Analog Input 1	2	Voltage: mV, 0 – 30 V	M
16	Total Distance	4	Total distance: m	M
21	GSM level	1	GSM signal level value in scale 1 – 5	M
24	Speed	2	Value in km/h, 0 – xxx km/h	M
66	External Power Voltage	2	Voltage: mV, 0 – 30 V	M
67	Battery Voltage	2	Voltage: mV, 0 – 30 V	O
68	Battery Current	2	Current, mA	O
69	GPS Status	1	States: 0 – GPS module is turned off, 2 – working, but no fix, 3 – working with GPS fix, 4 – GPS module is in sleep state, 5 – antenna is short circuit	M
71	Dallas Temperature ID 4	8	Dallas sensor ID number	M
72	Dallas Temperature	4	10 * Degrees (°C), -55 - +115, if 3000 – Dallas error	M
73	Dallas Temperature 2	4	10 * Degrees (°C), -55 - +115, if 3000 – Dallas error	M
74	Dallas Temperature 3	4	10 * Degrees (°C), -55 - +115, if 3000 – Dallas error	M
75	Dallas Temperature 4	4	10 * Degrees (°C), -55 - +115, if 3000 – Dallas error	M
76	Dallas Temperature ID 1	8	Dallas sensor ID number	M
77	Dallas Temperature ID 2	8	Dallas sensor ID number	M
78	iButton ID	8	iButton ID number	M
79	Dallas Temperature ID3	8	Dallas sensor ID number	M
80	Data Mode	1	0 – home on stop, 1 – home on move, 2 – roaming on stop, 3 – roaming on move, 4 – unknown on stop, 5 – unknown on move	M
179	Digital Output 1 state	1	Logic: 0 / 1	M
180	Digital Output 2	1	Logic: 0 / 1	M

	state			
181	PDOP	2	Probability * 10; 0-500	M
182	HDOP	2	Probability * 10; 0-500	M
199	Odometer Value (Virtual Odometer)	4	Distance between two records: m	M
200	Deep Sleep	1	0 – not deep sleep mode, 1 – deep sleep mode	M
205	Cell ID	2	GSM base station ID	M
206	Area Code	2	Location Area code (LAC), it depends on GSM operator. It provides unique number which assigned to a set of base GSM stations. Max value: 65536	M
239	Ignition	1	0 – ignition off, 1 – ignition on	M
240	Movement Sensor	1	0 – not moving, 1 – moving	M
241	GSM Operator Code	4	Currently used GSM Operator code	M
LVCAN I/O elements (are sent to server if configured)				
Property ID	Property Name	Bytes	Description	Type
81	LVCAN Speed	1	Value in km/h	A[2]
82	LVCAN Accelerator Pedal Position	1	Value in persentages, %	A[2]
83	LVCAN Total Fuel Used	4	Value in liters multiplied by 10, L*10	A[2]
84	LVCAN Fuel Level (liters)	2	Value in liters, L	A[2]
85	LVCAN Engine RPM	2	Value in rounds per minute, rpm	A[2]
87	LVCAN Vehicle Distance	4	Value in meters, m	A[2]
89	LVCAN Fuel Level (percentage)	1	Value in percentages, %	A[2]
90	LVCAN Door Status	2	Door status value: Min – 0, Max – 16128 Door status is represented as bitmask converted to decimal value. Possible values: 0 – all doors closed, 0x100 (256) – front left door is opened, 0x200 (512) – front right door is opened, 0x400 (1024) – rear left door is opened, 0x800 (2048) – rear right door is opened, 0x1000 (4096) – hood is opened, 0x2000 (8192) – trunk is opened, 0x3F00 (16128) – all doors are opened, or combinations of values	A[2]
100	LVCAN Program Number	4	Value: Min – 0, Max – 999	A[2]
101	LVC ModuleID	8	Module ID	A[2]
102	LVC Engine Work Time	4	Engine work time in minutes	A[2]
103	LVC Engine Work Time (counted)	4	Total Engine work time in minutes	A[2]

105	LVC Total Mileage (counted)	4	Total Vehicle Mileage, m	A[2]
107	LVC Fuel Consumed (counted)	4	Total Fuel Consumed,liters * 10	A[2]
110	LVC Fuel Rate	2	Fuel Rata, liters *10	A[2]
111	LVC AdBlue Level (percent)	1	AdBlue, %	A[2]
112	LVC AdBlue Level (liters)	2	AdBlue level, L	A[2]
114	LVC Engine Load	1	Engine load, %	A[2]
115	LVC Engine Temperature	2	Engine Temperature, 10 * Degrees (°C),	A[2]
118	LVC Axle 1 Load	2	Axle 1 load, kg	A[2]
119	LVC Axle 2 Load	2	Axle 2 load, kg	A[2]
120	LVC Axle 3 Load	2	Axle 3 load, kg	A[2]
121	LVC Axle 4 Load	2	Axle 4 load, kg	A[2]
122	LVC Axle 5 Load	2	Axle 5 load, kg	A[2]
123	LVC Control State Flags	4	Control state flags **Byte0 (LSB):** **0x01** – STOP **0x02** – Oil pressure / level **0x04** – Coolant liquid temperature / level **0x08** – Handbrake system **0x10** – Battery charging **0x20** – AIRBAG **Byte1:** **0x01** – CHECK ENGINE **0x02** – Lights failure **0x04** – Low tire pressure **0x08** – Wear of brake pads **0x10** – Warning **0x20** – ABS **0x40** – Low Fuel **Byte2:** **0x01** – ESP **0x02** – Glow plug indicator **0x04** – FAP **0x08** – Electronics pressure control **0x10** – Parking lights **0x20** – Dipped headlights **0x40** – Full beam headlights **Byte3:** **0x40** – Passenger's seat belt **0x80** – Driver's seat belt	A[2]
124	LVC Agricultural Machinery Flags	8	Agricultural machinery flags **Byte0 (LSB):** **0x01** – Mowing **0x02** – Grain release from hopper **0x04** – First front hydraulic turned on **0x08** – Rear Power Take-Off turned on **Byte1:**	A[2]

			0x01 – Excessive play under the threshing drum **0x02** – Grain tank is open **0x04** – 100% of Grain tank **0x08** – 70% of Grain tank **0x10** – Drain filter in hydraulic system of drive cylinders is plugged **0x20** – Pressure filter of drive cylinders hydraulic system is plugged **0x40** – Alarm oil level in oil tank **0x80** – Pressure filter of brakes hydraulic system is plugged **Byte2:** **0x01** – Oil filter of engine is plugged **0x02** – Fuel filter is plugged **0x04** – Air filter is plugged **0x08** – Alarm oil temperature in hydraulic system of chasis **0x10** – Alarm oil temperature in hydraulic system of drive cylinders **0x20** – Alarm oil pressure in engine **0x40** – Alarm coolant level **0x80** – Overflow chamber of hydraulic unit **Byte3:** **0x01** – Unloader drive is ON. Unloading tube pivot is in idle position **0x02** – No operator! **0x04** – Straw walker is plugged **0x08** – Water in fuel **0x10** – Cleaning fan RPM **0x20** – Trashing drum RPM **Byte4:** **0x02** – Low water level in the tank **0x04** – First rear hydraulic turned on **0x08** – Standalone engine working **0x10** – Right joystick moved right **0x20** – Right joystick moved left **0x40** – Right joystick moved front **0x80** – Right joystick moved back **Byte5:** **0x01** – Brushes turned on **0x02** – Water supply turned on **0x04** – Vacuum cleaner **0x08** – Unloading from the hopper **0x10** – High Pressure washer (Karcher) **0x20** – Salt (sand) disperser ON **0x40** – Low salt (sand) level **Byte6:** **0x01** – Second front hydraulic turned on **0x02** – Third front hydraulic turned on **0x04** – Fourth front hydraulic turned on **0x08** – Second rear hydraulic turned on **0x10** – Third rear hydraulic turned on	

			0x20 – Fourth rear hydraulic turned on 0x40 – Front three-point Hitch turned on 0x80 – Rear three-point Hitch turned on **Byte7:** **0x01** – Left joystick moved right **0x02** – Left joystick moved left **0x04** – Left joystick moved front **0x08** – Left joystick moved back **0x10** – Front Power Take-Off turned on	
125	LVC Harvesting Time	4	Harvesting Time, minutes	A^2
126	LVC Area of Harvest	4	Area of Harvest, m^2	A^2
127	LVC Mowing Efficiency	4	Mowing efficiency, (m^2)/h	A^2
128	LVC Grain Mown Volume	4	Mown Volume, kg	A^2
129	LVC Grain Moisture	2	Grain Moisture in proc, %	A^2
130	LVC Harvesting Drum RPM	2	Harvesting Drum RPM, RPM	A^2
131	LVC Gap Under Harvesting Drum	1	Gap Under Harvesting Drum, mm	A^2
132	LVC Security State Flags	8	Security State Flag **Byte0 (LSB):** Every two bits in this byte correspond to a different CAN bus number. 00 – CAN not connected, connection not required 01 – CAN connected, but currently module not received data 10 – CAN not connected, require connection 11 – CAN connected Example: Byte0 - 0F hex – 00001111 binary CAN4, CAN3, CAN2, CAN1 **Byte1:** **Not used** **Byte2:** **0x20** – bit appears when any operate button in car was put **0x40** – bit appears when immobilizer is in service mode **0x80** – immobiliser, bit appears during introduction of a programmed sequence of keys in the car. **Byte3:** **0x01** – the key is in ignition lock **0x02** – ignition on **0x04** – dynamic ignition on **0x08** – webasto **0x20** – car closed by factory's remote control **0x40** – factory-installed alarm system is actuated (is in panic mode) **0x80** – factory-installed alarm system is emulated	A^2

			by module **Byte4:** **0x01** – parking activated (automatic gearbox) **0x10** – handbrake is actuated (information available only with ignition on) **0x20** – footbrake is actuated (information available only with ignition on) **0x40** – engine is working (information available only when the ignition on) **0x80** – revers is on **Byte5:** **0x01** – Front left door opened **0x02** – Front right door opened **0x04** – Rear left door opened **0x08** – Rear right door opened **0x10** – engine cover opened **0x20** – trunk door opened **Byte6:** **0x01** – car was closed by the factory's remote control **0x02** – car was opened by the factory's remote control **0x03** – trunk cover was opened by the factory's remote control **0x04** – module has sent a rearming signal **0x05** – car was closed three times by the factory's remote control - High nibble (mask 0xF0 bit) **0x80** – CAN module goes to sleep mode **Byte7:** **Not used**	
133	LVC Tacho Total Vehicle Distance	4	Tacho Total Vehicle Distance, m	A^2
134	LVC Trip Distance	4	Trip Distance, m	A^2
135	LVC Tacho Vehicle Speed	2	Tacho Vehicle Speed, km/h	A^2
136	LVC Tacho Driver Card Presence	1	Tacho Driver Card Presence **0x00** – No driver card **0x01** – Driver1 card presence **0x02** – Driver2 card presence **0x03** – Driver1 and driver2 cards present	A^2
137	LVC Driver1 States	1	Driver1 States**0xX0** – break/rest **0xX1** – availability **0xX2** – work **0xX3** – driving **0x0X** – no time-related warning detected **0x1X** – limit #1: 15 min before 4 1/2 h **0x2X** – limit #2: 4 1/2 h reached (continuous driving time exceeded) **0x3X** – limit #3: 15 minutes before optional warning 1 **0x4X** – limit #4: optional warning 1 reached **0x5X** – limit #5: 15 min before optional warning **0x6X** – limit #6: optional warning 2 reached	A^2

138	LVC Driver2 States	1	Driver2 States (the same states like Driver1 States)	A^2
139	LVC Driver1 Continuous Driving Time	2	Driver1 Continuous Driving Time, minutes	A^2
140	LVC Driver2 Continuous Driving Time	2	Driver2 Continuous Driving Time, minutes	A^2
141	LVC Driver1 Cumulative Break Time	2	Driver1 Cumulative Break Time, minutes	A^2
142	LVC Driver2 Cumulative Break Time	2	Driver2 Cumulative Break Time, minutes	A^2
143	LVC Driver1 Duration Of Selected Activity	2	Driver1 Duration Of Selected Activity, minutes	A^2
144	LVC Driver2 Duration Of Selected Activity	2	Driver2 Duration Of Selected Activity, minutes	A^2
145	LVC Driver1 Cumulative Driving Time	2	Driver1 Cumulative Driving Time, minutes	A^2
146	LVC Driver2 Cumulative Driving Time	2	Driver2 Cumulative Driving Time, minutes	A^2
147	LVC Driver1 ID High	8	Driver1 ID High	A^2
148	LVC Driver1 ID Low	8	Driver1 ID Low	A^2
149	LVC Driver2 ID High	8	Driver2 ID High	A^2
150	LVC Driver2 ID Low	8	Driver2 ID Low	A^2
151	LVC Battery Temperature	2	10* Degrees, (°C)	A^2
152	LVC Battery Level (percent)	1	Value in percentages, %	A^2
160	LVC DTC Errors	1	DTC faults count	O
161	LVC Slope Of Arm	2	Value in °	O
162	LVC Rotation Of Arm	2	Value in °	O
163	LVC Eject Of Arm	2	Value in m * 10	O
164	LVC Horizontal Distance Arm Vechicle	2	Value in m * 10	O
165	LVC Height Arm Above Ground	2	Value in m * 10	O
166	LVC Drill RPM	2	-	O

167	LVC Amount Of Spread Salt Square Meter	2	Value in g/m^2	O
168	LVC Battery Voltage	2	Value in V * 10	O
169	LVC Amount Spread Fine Grained Salt	4	Value in tons * 10	O
170	LVC Amount Spread Coarse Grained Salt	4	Value in tons * 10	O
171	LVC Amount Spread DiMix	4	Value in tons * 10	O
172	LVC Amount Spread Coarse Grained Calcium	4	Value in m^3 * 10	O
173	LVC Amount Spread Calcium Chloride	4	Value in m^3 * 10	O
174	LVC Amount Spread Sodium Chloride	4	Value in m^3 * 10	O
176	LVC Amount Spread Magnesium Chloride	4	Value in m^3 * 10	O
177	LVC Amount Spread Gravel	4	Value in tons * 10	O
178	LVC Amount Spread Sand	4	Value in tons * 10	O
183	LVC Width Pouring Left	2	Value in m * 100	O
184	LVC Width Pouring Right	2	Value in m * 100	O
185	LVC Salt Spreader Work Hours	4	Value in h * 10	O
186	LVC Distance During Salting	4	Value in km * 10	O
187	LVC Load Weight	4	Value in kg	O
188	LVC Retarder Load	1	Value in % Valid range: 0 – 125%	O
189	LVC Cruise Time	4	Value in min	O
190	LVC CNG Status	1	0 – engine not on CNG 1 – engine on CNG	O
191	LVC CNG Used	4	Value in kg * 10	O
192	LVC CNG Level	2	Value in % * 10	O
193	LVC Oil level	1	0 – Oil level/pressure warning off 1 – Oil level/pressure warning on	O
Eventual I/O elements (generate and send record to server only if appropriate conditions are met)				
Property ID	**Property Name**	**Bytes**	**Description**	**Type**
155	Geofence zone 01	1	Event: 0 – target left zone, 1 – target entered zone	ME
156	Geofence zone 02	1	Event: 0 – target left zone, 1 – target entered zone	ME

157	Geofence zone 03	1	Event: 0 – target left zone, 1 – target entered zone	ME
158	Geofence zone 04	1	Event: 0 – target left zone, 1 – target entered zone	ME
159	Geofence zone 05	1	Event: 0 – target left zone, 1 – target entered zone	ME
175	Auto Geofence	1	Event: 0 – target left zone, 1 – target entered zone	ME
249	Jamming	1	1 – jamming start, 0 – jamming stop	ME
250	Trip	1	1 – trip start, 0 – trip stop	ME
251	Immobilizer	1	0 – iButton not connected, 1 – iButton connected (Immobilizer), 2 – iButton connected (Authorized Driving)	ME
253	Green driving type	1	1 – harsh acceleration, 2 – harsh braking, 3 – harsh cornering	ME
254	Green driving value	1	Depending on green driving type: if harsh acceleration or braking – g*100 (value 123 -> 1.23g), if harsh cornering – degrees (value in radians)	ME
255	Over Speeding	1	At over speeding start km/h, at over speeding end km/h	ME

[1] M – mandatory (available on all hardware revisions), A – additional hardware required, O – optional (hardware dependent), E – event only.

1.7 Example

```
Received data:
080400000113fc208dff000f14f650209cca80006f00d6040004000403010115031603000
1460000015d0000000113fc17610b000f14ffe0209cc580006e00c0050001000403010115
031601000146000015e0000000113fc284945000f150f00209cd200009501080400000000
4030101150016030001460000015d0000000113fc267c5b000f150a50209cccc000930068
0400000004030101150016030001460000015b0004
```

08 - Codec ID
04- Number of Data (4 records)

1'st record data

00000113fc208dff - Timestamp in milliseconds (1185345998335 → 1185345998,335 in Unix Timestamp = 25 Jul 2007 06:46:38 UTC)
00 - Priority

GPS Element

0f14f650 - Longitude 253032016 = 25,3032016° N
209cca80 - Latitude 547146368 = 54,7146368 ° E
006f - Altitude 111 meters
00d6 - Angle 214°
04 - 4 Visible sattelites
0004 - 4 km/h speed

IO Element

00 – IO element ID of Event generated (in this case when 00 – data generated not on event)
04 – 4 IO elements in record
03 – 3 IO elements, which length is 1 Byte
01 – IO element ID = 01
01 – 1'st IO element's value = 1
15 – IO element ID = 21
03 – 21'st IO element's value = 3
16 – IO element ID = 22
03 – 22'nd IO element's value = 3
00 – 0 IO elements, which value length is 2 Bytes
01 – 1 IO element, which value length is 4 Bytes
46 – IO element ID = 70
0000015d – 70'th IO element's value = 349
00 – 0 IO elements, which value length is 8 Bytes

2'nd record data

00000113fc17610b 00 0f14ffe0209cc580006e00c7050001 000403010115031601000146000001 5e00

3'd record data

00000113fc284945 00 0f150f00209cd20000950108040000 000403010115001603000146000001 5d00

4'th record data

00000113fc267c5b 00 0f150a50209cccc0009300680400000 00403010115001603000146000001 5b00

04 – Number of Data (4 records)

2. SENDING DATA OVER TCP/IP

2.1 AVL data packet

AVL packet is used to encapsulate AVL data and send it to server.

Four zeros	Data length	Data	Crc

Four zeros	Four zero bytes (0x00)
Data length	Number of bytes in data field (Integer)
Data	Any AVL data array
CRC	16bit CRC value of data (Integer). Polynomial 0xA001.

2.2 Communication with server

First when module connects to server, module sends its IMEI. IMEI is sent the same way as encoding barcode. First comes short identifying number of bytes written and then goes IMEI as text (bytes).

For example IMEI 123456789012345 would be sent as 000F313233343536373839303132333435

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.

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:
000F313233343536373839303132333435
Server accepts the module:
01
Module sends data packet:

AVL data packet header	***AVL data array***	***CRC***
Four zero bytes, 'AVL data array' length – 254	CodecId – 08, NumberOfData – 2. (Encoded using continuous bit stream. Last byte padded to align to byte boundary)	CRC of 'AVL data array'
00000000000000FE	0802...(data elements)...02	00008612

Server acknowledges data reception (2 data elements):
00000002

3. SENDING DATA OVER UDP/IP

3.1 UDP channel protocol

UDP channel is a transport layer protocol above UDP/IP to add reliability to plain UDP/IP using acknowledgment packets. The packet structure is as follows:

UDP datagram			
UDP channel packet x N	Packet length	2 bytes	Packet length (excluding this field) in big endian byte order
	Packet Id	2 bytes	Packet id unique for this channel
	Packet Type	1 byte	Type of this packet
	Packet payload	m bytes	Data payload

Packet Type	
1	Data packet requiring acknowledgment

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	2 bytes	0x0003
Packet id	2 bytes	same as in acknowledged packet
Packet type	1 byte	0x01

3.2 Sending AVL data using UDP channel

AVL data are sent encapsulated in UDP channel packets (*Data payload* field).

AVL data encapsulated in UDP channel packet		
AVL packet id (1 byte)	Module IMEI	AVL data array

AVL packet id (1 byte) – id identifying this AVL packet
Module IMEI – IMEI of a sending module encoded the same as with TCP
AVL data array – array of encoded AVL data

Server response to AVL data packet	
AVL packet id (1 byte)	Number of accepted AVL elements (1 byte)

AVL packet id (1 byte) – id of received AVL data packet

Number of AVL data elements accepted (1 byte) – number of AVL data array entries from the beginning of array, which were accepted by the server.

Scenario:

Module sends UDP channel packet with encapsulated AVL data packet (*Packet* type=1).

Server sends UDP channel packet with encapsulated response (*Packet type*=1)

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***
Len – 253, Id – 0xCAFE, Packet type – 01	AVL packet id – 0xDD, IMEI – 1234567890123456	CodecId – 08, NumberOfData – 2. (Encoded using continuous bit stream)
00FDCAFE01	DD000F313233343536373839303132333435	0802…(data elements)…02

Server must respond with acknowledgment:

UDP channel header	***AVL packet acknowledgment***
Len – 5, Id – 0xCAFE, Packet type – 01	AVL packet id – 0xDD, NumberOfAcceptedData – 2
0005CAFE01	DD02

4. SENDING DATA USING 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).

SM data (TP-UD)	
AVL data array	*IMEI:* 8 bytes

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

5. 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.

5.1 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***	***Bytes 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.

5.2 Structure

SMS Data Structure			
	Size (bits)	Field	Description
	8	CodecId	CodecId = 4
	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.
ElementCount *		GPSDataElement	GPS data elements.
		Byte-aling padding	Padding bits to align to 8-bits boundary
	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).

GPSDataElement				
		Size (bits)	Field	Description
		1	ValidElement	ValidElement=1 – there is a valid GpdDataElement following,

GPSDataElement				
				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 + 2^{13} – 1
		14	LatitudeDiff	Difference from previous element‘s latitude LatitudeDiff = prevLatitude – Latitude + 2^{13} – 1
	DifferentialCoords == 0	21	Longitude	Longitude= {(LongDegMult + 18 * 10^8) * (2^{21} – 1)} over {36*10^8}
		20	Latitude	Latitude=(LatDegMult + 9*10^8) * (2^{20} – 1) over {18*10^8}
		8	Speed	Speed in km/h.

Longitude	longitude field value of *GPSDataElement*
Latitude	latitude field value of *GPSDataElement*
LongDegMult	longitude in degrees multiplied by 10^7 (integer part)
LatDegMult	latitude in degrees multiplied by 10^7 (integer part)
prevLongitude	longitude field value of previous *GPSDataElemen*
prevLatitude	latitude field value of previous *GPSDataElement*

5.3 Decoding GPS position

When decoding GPS data with *DifferentialCoords*=1, *Latitude* and *Longitude* values can be computed as follows: *Longitude*=*prevLongitude* – *LongitudeDiff* + 2^{13} – 1, Latitude=*prevLatitude* – *LatitudeDiff* + 2^{13} – 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:

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

6. CHANGE LOG

03680

Nr.	Date	New version number	Comments
1	161012	0.1	File created
2	161012	0.1	Table of I/O Elements updated to correspond 01.21.xx branch
3	170225	0.2	Table of I/O Elements updated with LVCAN Door Status element
4	170228	0.3	Table of I/O Elements updated
5	170329	0.4	Dallas Temperature ID 1/2/3/4 property ID changes
6	170609	0.5	Table of I/O Elements updated to correspond 01.26.xx
7	171023	0.6	Table of I/O Elements updated with LVC Oil level element Updated I/O Elements table parameters: LVC Control State Flags parameter, LVC Security State Flags, LVC Agricultural machinery flags, LVC Tachograph driver card presence, LVC Driver1 states, LVC Driver2 states