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Version control

Ver.	Date	Summary of changes
7.00	2015-06-11	Completely rewritten. See Chapter 5 for more information.
7.01	2015-06-12	Minor layout corrections.
7.02	2015-07-01	Note added under PFLAE.
7.03	2015-07-29	Corrected <AlarmLevel> and <AlarmType> under PFLAU.
7.04	2015-09-14	Corrected <IDType> under PFLAA.
7.05	2015-03-16	Added description of error 0x43 to PFLAE.
7.06	2016-05-18	Changed 0x43 error description.
7.07	2016-09-09	Increased max range to other aircraft in PFLAA.
7.08	2017-03-08	Changed PFLAE sentence description.

Scope and summary

This document provides information about how to communicate over the serial interface of a FLARM, PowerFLARM, or licensed OEM FLARM device from a FLARM display, PC, or any other device.

The sentence composition is described, as well as all applicable sentences and commands.

This document should be read in combination with the following documents:

- FTD-14 Configuration Specification
- FTD-13 FLARM Compatible Certification Specification

FTD-14 is available on www.flarm.com. FTD-13 can be acquired by developers from FLARM Technology.

Table of contents

1 Overview

This document provides information about how to communicate over the serial interface of a FLARM, PowerFLARM, or licensed OEM FLARM device from a FLARM display, PC, or any other device.

Note that this document, as well as the interface described within it, is proprietary and copyright protected. FLARM is an internationally registered trademark and cannot be used without a license.

The document assumes you are familiar with serial communication and the basics of the NMEA 0183 version 2.0 protocol[1]. The NMEA 0183 standard is a copyright protected document. The copyright is owned by the National Marine Electronics Association, Inc., 7 Riggs Avenue, Severna Park, MD 21146, USA. The NMEA 0183 standard may be purchased from NMEA online at www.nmea.org. NMEA® is a registered trademark of the National Marine Electronics Association Inc. The NMEA Director agreed to this document on March 9, 2005.

The most recent version of this document and test data streams are available to developers from FLARM Technology. You can also subscribe on our website to our newsletter in order to receive the latest news and firmware updates.

There is no formal requirement to have an agreement with FLARM Technology before implementing the data port protocol. However, we would very much appreciate to be informed of any implementations on info@flarm.com. That way, we can inform you of any changes to the protocol and other important issues.

For manufacturers who would like to market their product as "FLARM Compatible", there is a FLARM Compatible certification program. Equipment which fulfills the certification specification can claim to be FLARM Compatible and use the FLARM Compatible logo. Contact us for more information and to receive the certification specification document.

Suggestions to improve this document may be sent to info@flarm.com.

[1] The current version of the NMEA 0183 standard is 4.10.

2 Working Principle

FLARM utilizes position and movement information obtained from an integrated 16-channel GPS receiver and an embedded barometric sensor. The future flight path of the aircraft is predicted and transmitted over a low-power short-range radio channel as a very short digital message once per second. These messages are received by other FLARM devices within range and then compared with own predicted flight path. At the same time, own flight path is compared with fixed obstacles in the optionally installed obstacle database (e.g. power lines, antennas, and aerial railways). If a collision risk is calculated, FLARM warns the pilot of the chronologically closest collision risk.

GPS and collision data are transmitted as serial data to be used in external applications (e.g. external displays). Several manufacturers of avionics and PDA software as well as ground-based applications use FLARM data in their applications.

FLARM's range is subject to the antenna installation in the aircraft. For PowerFLARM Core with external antennas the range is usually more than 10 km. For Classic FLARM, range is typically 3 - 5 km. The effective range can easily be verified with an online tool[2].

Alarms and the three alarm levels are issued depending on the forecasted time to impact, not a geometrical distance. The first alarm level is usually issued at 18 -13 seconds, the second level at 12 - 9 seconds, and the third level at 8 - 0 seconds prior to the predicted impact. Each alarm lasts as long as the alarm level is applicable. Depending on changes to the forecast, alarm levels might change or disappear. Alarms are highly selective, i.e. they are only issued when there is imminent danger. The alarm sensitivity can be configured. As an additional feature, the user can be informed about other aircraft in the vicinity, even when not posing any risk of collision. This traffic information is limited to a configurable horizontal and vertical distance. On Classic FLARM, a 500 m maximum altitude difference is set and cannot be changed. FLARM is designed to handle up to 50 aircraft in range and will experience graceful performance degradation with additional aircraft in range.

To work properly, FLARM must have a 3D GPS fix. Furthermore, the FLARM antenna installation must facilitate a usable range.

FLARM uses for the radio communication between devices a proprietary, patented and copyright protected protocol in regionally different frequency bands. The radio communication is protected against unauthorized access. The design is protected by several patents. The radio communication protocol is not public. Any non-licensed use, dissemination, copying, implementation, or reverse engineering or decompilation of the FLARM radio communication protocol, the

[2] http://flarm.com/support/tools-software/flarm-range-analyzer/

3 Design Philosophy

FLARM cannot warn reliably in all situations. FLARM does not issue resolution advisories. FLARM can only warn of aircraft which are equipped with FLARM (or SSR transponders and ADS-B Out equipment with specific FLARM devices) and of obstacles stored in its database. The use of FLARM does not allow a change of flight tactics or pilot behavior. It is the sole responsibility of the pilot in command to decide upon the use of FLARM. FLARM Technology Ltd. cannot be held liable under any circumstances.

When designing a user interface on a device using the serial data provided on the data ports from FLARM, try to be simple and clear when presenting any data to the pilot. Use a presentation form that is suitable for immediate comprehension of danger level. We do not in general recommend the design of TCAS-style displays, as many light aircraft pilots are not trained to use this kind of display. Do not give any resolution advisories and ensure that your user interface cannot be misinterpreted as such.

For visualization of traffic advisories, we recommend a 12 segment bearing indicator and a 4 segment vertical angle indicator. This applies also to raster displays (LCD, dot matrix, etc.), where the original LED display can be simulated or similar. Aural warnings should consist of beeps with dynamic beep frequency and amplitude, depending on the alert level. Alternatively, simple voice alerts ("traffic 3 o'clock, above") can be used.

Traffic information (non-threat traffic) should only be displayed on maps oriented heading-up or track-up. If displaying traffic information on maps oriented heading-up, be aware that the relative bearing received from FLARM is relative to true track. In such cases, the information must be corrected for variation, deviation and wind. Especially on LED displays, it must be ensured that traffic information is not mixed up with traffic advisories.

Obstacle warnings and Alert Zone warnings should be generic (i.e. without any reference to position or bearing) and not be mixed up with traffic advisories. Do not plot any obstacles on a moving map based on warning information provided by FLARM.

When selecting colors for warnings, ensure that CS 23.1322/22.1322 is complied with. An aircraft collision warning (alarm level 1-3) should be considered as a warning light. An obstacle collision warning should be considered as a warning light (needs to be distinguished from an Alert Zone warning; see PFLAU sentence). An Alert Zone warning should be considered as a caution light. Traffic information should be amber or blue.

Alerts should make the pilot look outside the cockpit, not on a display. Therefore, whenever a warning is given, show only the warning in a conspicuous manner. At

the same time, immediately stop displaying anything that is not relevant, e.g. surrounding aircraft that do not represent a danger.

Errors and degraded functionality should be shown to the user in a clear manner.

Make it clear to the users that they should under no circumstances rely on FLARM, FLARM's serial output or your application using data coming from FLARM.

Users should not be disincentivized to use FLARM. Especially in gliding competitions, pilots might not want to be followed by other aircraft. Some special features in FLARM (e.g. a configurable stealth mode that cannot be changed in-flight and prevents received data being shown on displays and PDA's) ensure that FLARM information cannot be abused to gain a competitive advantage.

4 Data Ports and Settings

All FLARM devices offer connectors for power and bidirectional data. The number and type of ports depends on device type and hardware version:

Classic FLARM	Hardware version 1 (F4, manufactured in 2004): ▪ 1 x Power/Data port (RJ45 connector) Hardware version 2 and higher (F5-F9): ▪ 1 x Power/Data port (RJ45 connector) ▪ 1 x Extension Port (RJ12 connector)
PowerFLARM Portable	All versions: ▪ 1 x Power/Data port (RJ45 connector)
PowerFLARM Core	All versions: ▪ 2 x Power/Data ports (RJ45 and D-sub DE-9 connectors.
PowerFLARM OEM	OEM Board allows up to 2 Power/Data ports.

All ports use the FAI/IGC pin specification for these connectors. An additional pin supplies 3V and max 90mA to connected devices. The specification can be found in the respective installation manual.

All ports have a bidirectional serial interface (RS-232) that can be used to communicate with the FLARM device as described in this document. On Classic FLARM, simple devices should normally be connected to the extension port (if available). Advanced displays and PDA-applications should use the data port (always available). The extension port (if available) must neither be used to supply power to FLARM nor for PC communication (update, download, or configuration).

All ports use 8 data bits, no parity, no handshake, and 1 stop bit for the RS-232 settings. The baud rate can be configured by commands described in FLARM Configuration Specification. A connecting device may thus not assume a particular baud rate is set. It is strongly suggested to implement automatic baud rate detection.

The extension port on some Classic FLARM devices has certain limitations described in this document and in the FLARM Configuration Specification.

FLARM may interrupt RF communication and collision warnings for some seconds upon receiving NMEA commands. Therefore, **sending sentences to FLARM should be avoided during flight.**

5 Important Notes on Protocol Version 7

Additions to protocol version 7 are marked in yellow. In addition, many inaccuracies from earlier versions have been corrected. These are not marked. It is therefore strongly recommended to read the whole Data Port Specification and ensure that all sentences are implemented correctly.

The extensions in version 7 must be activated by the connecting product; see the section on setting `NMEAOUT` in FLARM Configuration Specification. Products which activate version 7 of the protocol **must** fulfill the following requirements:

- Accept changes in version 7 as described in this document
- Process PFLAE messages at any time
- Process PFLAO messages

6 Sentence Composition

This document assumes you are familiar with the full NMEA 0183 version 2.0 specification. FLARM allows input and output.

Sentences consist of NMEA 0183 standard GPRMC, GPGGA and GPTXT sentences and NMEA 0183-style proprietary sentences that start with PFLA, in addition to Garmin®'s proprietary sentence PGRMZ[3]. FLA has been officially assigned by NMEA as the FLARM manufacturer code.

All commands must start with “$” (0x24) and end with <CR><LF> (0x0D0A). All sentences from FLARM start with “$” (0x24) and end with the checksum delimiter "*" (0x2A), followed by two NMEA 0183 standard checksum characters and <CR><LF> (0x0D0A). The checksum is the two-digit hexadecimal representation of XOR of ASCII codes of all characters between, but not including, the $ and *. For matters of simplicity, this document does usually not mention these characters although they must be provided in commands to FLARM and are part of the sentences sent by FLARM.

Fields are delimited with a comma (0x2C), even when a field is "empty". When a field is "omitted", it however means that the comma is absent. The field length is variable. Commands must always include valid ASCII characters.

The sentences are not case sensitive except where explicitly stated.

The maximum number of characters in a sentence is 83, consisting of a maximum of 80 characters between the starting delimiter “$” and the terminating delimiter <CR><LF>.

Sentences not following this syntax are sent by FLARM and must be ignored without further consequences by the receiving device. Design the application fault tolerant.

The value types and ranges for each field in the sentences are specified separately. Values outside the given range should be ignored. The following naming convention is used:

- Integer: number which is written without a fractional component
- Fixed point: real number with a fixed number of digits after the radix point (dot)
- Decimal: number which has ten as its base (e.g. 123)
- Hexadecimal: integer number which has sixteen as its base (e.g. AF)

[3] See 'Garmin Proprietary NMEA 0183 Sentence TECHNICAL SPECIFICATION', part number 190-00684-00, revision B, April 2006. Garmin® is a registered trademark of Garmin Ltd.

- String: a sequence of ASCII characters except NULL
- Floating point: real number with an arbitrary number of digits (within limits as specified) after the radix point (dot)

7 Sentences

All sentences are described in this chapter.

The typical sentence order during normal operation is as follows: GPRMC, (PGRMZ), GPGGA, {PFLAA}$_n$, PFLAU. Which sentences are actually sent depend however on the NMEAOUT setting. On Classic FLARM, PGRMZ is only available on F5 and later. n is an integer >=0, dependent on the chosen baud rate and the number of aircraft within range. When implementing a sentence parser, do not expect the above order to be maintained at all times; also don't observe a specific pattern and expect it to stay unchanged in all hardware versions and in the future, as the implementation might vary from hardware to hardware version, and might be changed in the future.

Carefully read the description and usage given for each sentence on all subsequent pages.

7.1 PFLAU - Operating status, priority intruder and obstacle warnings

Syntax:

PFLAU,<RX>,<TX>,<GPS>,<Power>,<AlarmLevel>,<RelativeBearing>,<AlarmType>,<RelativeVertical>,<RelativeDistance>,<ID>

Description:

Operating status and high priority intruder, Alert Zone, or obstacle warning. Only one per second on the most relevant target. This is the main sentence to be used by connected applications and more or less shows what is visible on the FLARM user interface on Classic FLARM. PFLAU sentences are not affected by user actions like a temporary suppression, mode or volume selection. This sentence is also designed for connected applications with very limited CPU performance. Always track and parse this sentence as it is given the highest priority. Important information might be lost if you only parse PFLAA sentences. Obstacle warnings are currently only given in PFLAU.

Only directional targets (i.e. with a known relative bearing) are output as PFLAU sentences in Classic FLARM. On PowerFLARM devices with an SSR/ADS-B receiver, non-directional targets are output if enabled. This can be enabled / disabled using the $PFLAC,,PCASPFLAU setting.

If data port version >= 7 is selected, Alert Zone information is available only if aircraft is inside an Alert Zone.

In devices with integrated user interface, no mode information is output (e.g. warning vs. nearest mode, sound volume, suppression modes). Connected

devices should maintain their own user dialogue for these settings and can do mode-switching regardless of the mode setting in the FLARM device.

Missing PFLAU sentences indicate a problem with the FLARM device or the communication. Devices should thus warn the user when PFLAU is not received regularly, i.e. after 3 s.

Input / Output:

Only sent by FLARM

Availability on the data port:

Depending on configuration (PFLAC,,NMEAOUT)

Availability on the extension port:

Depending on configuration (PFLAC,,NMEAOUT)

Periodicity:

Sent once every second (1.8 s at maximum)

Parameters:

<RX>	Decimal integer value. Range: from 0 to 99. Number of devices with unique IDs currently received regardless of the horizontal or vertical separation. Because the processing might be based on extrapolated historical data, <Rx> might be lower than the number of aircraft in range, i.e. there might be other traffic around (even if the number is zero). Do not expect to receive <Rx> PFLAA sentences, because the number of aircraft being processed might be higher or lower.
<TX>	Decimal integer value. Range: from 0 to 1. Transmission status: 1 for OK and 0 for no transmission.

<GPS>	Decimal integer value. Range: from 0 to 2. GPS status: 0 = no GPS reception 1 = 3d-fix on ground, i.e. not airborne 2 = 3d-fix when airborne If <GPS> goes to 0, FLARM will not work. Nevertheless, wait for some seconds to issue any warnings.
<Power>	Decimal integer value. Range: from 0 to 1. Power status: 1 for OK and 0 for under- or over-voltage.
<AlarmLevel>	Decimal integer value. Range: from 0 to 3. Alarm level as assessed by FLARM: 0 = no alarm (also used for no-alarm traffic information) 1 = aircraft or obstacle alarm, 13-18 seconds to impact, Alert Zone alarm, or traffic advisory (<AlarmType> = 4) 2 = aircraft or obstacle alarm, 9-12 seconds to impact 3 = aircraft or obstacle alarm, 0-8 seconds to impact **Note:** For Alert Zone alarm the alarm level cannot be more than 1. Every 16 seconds for 4 seconds when inside the zone, alarm level is 1, otherwise is 0.
<RelativeBearing>	Decimal integer value. Range: -180 to 180. Relative bearing in degrees from true ground track to the intruder's position. Positive values are clockwise. 0° indicates that the object is exactly ahead. Field is empty for non-directional targets or when no aircraft are within range. For obstacle alarm and Alert Zone alarm, this field is 0.

<AlarmType>	Hexadecimal value. Range: from 0 to FF. Type of alarm as assessed by FLARM 0 = no aircraft within range or no-alarm traffic information 2 = aircraft alarm 3 = obstacle/Alert Zone alarm (if data port version < 7, otherwise only obstacle alarms are indicated by <AlarmType> = 3) 4 = traffic advisory (sent once each time an aircraft enters within distance 1.5 km and vertical distance 300 m from own ship) xx = Alert Zone alarm (see comment below) When data port >=7, the type of Alert Zone is sent as <AlarmType> in the range 10..FF. Refer to the <ZoneType> parameter in the PFLA0 sentence for a description.
<RelativeVertical>	Decimal integer value. Range: from -32768 to 32767. Relative vertical separation in meters above own position. Negative values indicate that the other aircraft or obstacle is lower. Field is empty when no aircraft are within range For Alert Zone and obstacle warnings, this field is 0.
<RelativeDistance>	Decimal integer value. Range: from 0 to 2147483647. Relative horizontal distance in meters to the target or obstacle. For non-directional targets this value is estimated based on signal strength. Field is empty when no aircraft are within range and no alarms are generated. For Alert Zone, this field is 0.

<ID>	The field is omitted for protocol version < 4. 6-digit hexadecimal value (e.g. “5A77B1”) as configured in the target’s PFLAC,,ID. The interpretation is only delivered in <ID-Type> in the PFLAA sentence (if received for the same aircraft). The <ID> field is the ICAO 24-bit address for Mode-S targets and a FLARM-generated ID for Mode-C targets. The ID for Mode-C targets may change at any time. Field is empty when no aircraft are within range and no alarms are generated. For obstacles this field is set to FFFFFF. In case of Alert Zone warning, the FLARM ID of the Alert Zone station is output.

Example:

$PFLAU,3,1,2,1,2,-30,2,-32,755*

FLARM is working properly and currently receives 3 other aircraft. The most dangerous of these aircraft is at 11 o’clock, position 32m below and 755m away. It is a level 2 alarm.

Example:

$PFLAU,2,1,1,1,0,,0,,,*

FLARM is working properly and receives two other aircraft. They are both out of range.

Example:

$PFLAU,2,1,2,1,1,-45,2,50,75,1A304C*

FLARM is working properly and receives two other aircraft. The most dangerous of these aircraft has and ID “1A304C” and it is at 9 o’clock, position 50m below and 75m away. Level 1 alarm.

Example:

$PFLAU,2,1,2,1,1,0,41,0,0,A25703*

FLARM is working properly and receives the Alert Zone signal. The Alert Zone station ID is A25703 and it is a skydiver drop zone.

7.2 PFLAA - Data on other proximate aircraft

Syntax:

PFLAA,<AlarmLevel>,<RelativeNorth>,<RelativeEast>,
<RelativeVertical>,<IDType>,<ID>,<Track>,<TurnRate>,<GroundSpeed>,
<ClimbRate>,<AcftType>

Description:

Data on other proximate aircraft, intended for connected devices with sufficient CPU performance. This sentence should be treated with utmost flexibility and tolerance on a best effort base. Individual parameters may be empty. The sentence is only sent when port baud rate is 19.2k or higher. In case of serial port congestion or high CPU load, this sentence may be omitted for several objects independent of the alarm level. Non-directional targets (transponder Mode-C/S; protocol version 6 and higher) are output as PFLAA sentences.

Obstacle information is not delivered with this sentence.

Note that in case of many targets within range, individual targets, including the most dangerous one, might not be delivered every second, not regularly, or not at all, due to less strict priority handling for the PFLAA sentence. **Always use** PFLAU **as primary alarm source.** Usually, but not always, the last PFLAA sentence is the one causing the PFLAU content. The other PFLAA sentences are not ordered. Do not expect to receive PFLAU <Rx> times PFLAA sentences, because the number of aircraft being processed might be higher or lower. PFLAA sentences can be based on extrapolated historical data. PFLAA sentences are limited to other aircraft with a horizontal and vertical distance less than the configured range. On Classic FLARM, the vertical distance is always 500 m. Non-moving aircraft are suppressed.

Input / Output:

Only sent by FLARM

Availability on the data port:

Depending on configuration (PFLAC,,NMEAOUT and PFLAC,,BAUD)

Availability on the extension port:

Not available

Periodicity:

Sent when available. Can be sent several times per second with information on several (but not always all) surrounding targets.

Parameters:

<AlarmLevel>	Decimal integer value. Range: from 0 to 3. Alarm level as assessed by FLARM: 0 = no alarm (also used for no-alarm traffic information) 1 = alarm, 13-18 seconds to impact 2 = alarm, 9-12 seconds to impact 3 = alarm, 0-8 seconds to impact
<RelativeNorth>	Decimal integer value. Range: from -20000000 to 20000000. Relative position in meters true north from own position. If <RelativeEast> is empty, <RelativeNorth> represents the estimated distance to a target with unknown bearing (transponder Mode-C/S).
<RelativeEast>	Decimal integer value. Range: from -20000000 to 20000000. Relative position in meters true east from own position. Field is empty for non-directional targets.
<RelativeVertical>	Decimal integer value. Range: from -32768 to 32767. Relative vertical separation in meters above own position. Negative values indicate that the other aircraft is lower. Some distance-dependent random noise is applied to altitude data if stealth mode is activated either on the target or own aircraft and no alarm is present at this time.
<IDType>	Decimal integer value. Range: from 0 to 2. Defines the interpretation of the following field <ID> 0 = random ID, used if stealth mode is activated either on the target or own aircraft 1 = official ICAO 24-bit aircraft address 2 = stable FLARM ID (chosen by FLARM) Field is empty if no identification is known (e.g. transponder Mode-C).

<ID>	6-digit hexadecimal value (e.g. “5A77B1”) as configured in the target’s PFLAC,,ID sentence. The interpretation is delivered in <ID-Type>. Field is empty if no identification is known (e.g. Transponder Mode-C). Random ID will be sent if stealth mode is activated either on the target or own aircraft and no alarm is present at this time.
<Track>	Decimal integer value. Range: from 0 to 359. The target’s true ground track in degrees. The value 0 indicates a true north track. This field is empty if stealth mode is activated either on the target or own aircraft and for non-directional targets.
<TurnRate>	Currently this field is empty.
<GroundSpeed>	Decimal integer value. Range: from 0 to 32767. The target’s ground speed in m/s. The field is 0 to indicate that the aircraft is not moving, i.e. on ground. This field is empty if stealth mode is activated either on the target or own aircraft and for non-directional targets.
<ClimbRate>	Decimal fixed point number with one digit after the radix point (dot). Range: from -32.7 to 32.7. The target’s climb rate in m/s. Positive values indicate a climbing aircraft. This field is empty if stealth mode is activated either on the target or own aircraft and for non-directional targets.

<AcftType>	Hexadecimal value. Range: from 0 to F. Aircraft types: 0 = unknown 1 = glider / motor glider 2 = tow / tug plane 3 = helicopter / rotorcraft 4 = skydiver 5 = drop plane for skydivers 6 = hang glider (hard) 7 = paraglider (soft) 8 = aircraft with reciprocating engine(s) 9 = aircraft with jet/turboprop engine(s) A = unknown B = balloon C = airship D = unmanned aerial vehicle (UAV) E = unknown F = static object

Example:

```
$PFLAA,0,-1234,1234,220,2,DD8F12,180,,30,-1.4,1*
```

There is a glider in the south-east direction, 1.7km away (1.2km south, 1.2km east), 220m higher flying on south track with a ground speed of 30m/s in a slight left turn with 4.5°/s turning rate, sinking with 1.4m/s. Its ID is a static FLARM-ID “DD8F12”. There is no danger.

7.3 PFLAE - Self-test result and errors codes

Syntax:

PFLAE,<QueryType>,<Severity>,<ErrorCode>(,<Message>)

Description:

Self-test results after startup and error information during operation. Always watch out for this sentence. Inform the user when functionality is not available due to errors.

From data port version 7 onwards (`$PFLAC,,NMEAOUT,7x`), the `$PFLAE` sentence contains a textual description of the error in `<message>`, with the sole exception of F4 where this field is omitted.

Connected devices should display that an error in FLARM is present ("ERROR"), the error code, and the message if present. This should be done also for error codes that are not listed below.

Note: The PFLAE sentence can be received at any time during operation, and it is always sent at the end of the start-up. If there is no error during the start-up, sentence `PFLAE,A,0,0` is sent once for acknowledgement. If the error occurred, the error sentence is sent once per second for 30 seconds. If there are more errors, the same procedure is then repeated for the other errors.

Input / Output:

Bidirectional for classic FLARM, i.e. can be requested; only sent by PowerFLARM

Availability on the extension port:

Always available, no configuration

Availability on the data port:

Always available, no configuration

Periodicity:

Sent once after startup and completion of self-test, when errors occur, and when requested

Parameters:

<QueryType>	A = FLARM sends status (requested and spontaneous)

<Severity>	Decimal integer value. Range: from 0 to 3. 0 = no error, i.e. normal operation. Disregard other parameters. 1 = information only, i.e. normal operation 2 = functionality may be reduced 3 = fatal problem, device will not work
<ErrorCode>	Hexadecimal value. Range: from 0 to FFF. Error codes: 11 = Firmware expired (requires valid GPS information, i.e. will not be available in the first minute or so after power-on) 12 = Firmware update error 21 = Power (e.g. voltage < 8V) 22 = UI error 23 = Audio error 24 = ADC error 25 = SD card error 26 = USB error 27 = LED error 28 = EEPROM error 29 = General hardware error 2A = Transponder receiver Mode-C/S/ADS-B unserviceable 2B = EEPROM error 2C = GPIO error 31 = GPS communication 32 = Configuration of GPS module 33 = GPS antenna 41 = RF communication 42 = Another FLARM device with the same Radio ID is

	being received. Alarms are suppressed for the applicable device. 43 = Wrong ICAO 24-bit address or radio ID 51 = Communication 61 = Flash memory 71 = Pressure sensor 81 = Obstacle database (e.g. incorrect file type) 82 = Obstacle database expired. 91 = Flight recorder 93 = Engine-noise recording not possible A1 = Configuration error, e.g. while reading flarmcfg.txt from SD/USB. B1 = Invalid obstacle database license (e.g. wrong serial number) B2 = Invalid IGC feature license B3 = Invalid AUD feature license B4 = Invalid ENL feature license B5 = Invalid RFB feature license B6 = Invalid TIS feature license 100 = Generic error 101 = Flash File System error 110 = Failure updating firmware of external display 120 = Device is operated outside designated region. The device does not work. F1 = Other
<Message>	Field is omitted in data port version < 7 and F4. String. Maximum 40 ASCII characters. Textual description of the error in English. Field may be empty.

Example:

```
$PFLAE,R

$PFLAE,A,0,0
```

FLARM is asked on its status and returns that there is no problem.

Example:

```
$PFLAE,A,2,81*
```

FLARM reports during self-test after startup that there is a problem with the obstacle database (e.g. missing or corrupt) but that FLARM will continue to work with reduced functionality.

Example:

```
$PFLAE,A,3,11,Software expiry*
```

FLARM reports error that the software has expired. FLARM will not work, fatal problem.

Example:

```
FLARM

Hardware v2.00, Software v5.00

Performing Selftest...

o.k. 16 Mbit FLASH memory

o.k. Obstacles

o.k. Logging Init

o.k. RF subsystem

o.k. Pressure subsystem

o.k. UART subsystem

o.k. GPS subsystem connection

$PFLAE,A,0,0
```

FLARM reports successful self-test after startup

7.4 PFLAV - Version information

Syntax:

```
PFLAV,<QueryType>,<HwVersion>,<SwVersion>,<ObstVersion>
```

Description:

Version information after startup. Allow at least 20 s after power-up. Version information should be passed to the user.

Input / Output:

Bidirectional, i.e. can also be requested

Availability on the data port:

Always available, no configuration

Availability on the extension port:

Always available, no configuration

Periodicity:

Sent once after startup and completion of self-test and when requested

Parameters:

<QueryType>	R = request FLARM to send version; other parameters should then be omitted A = FLARM sends version (requested and spontaneous)
<HwVersion>	Decimal fixed point with two digits after radix point (dot) and one before. Range: from 0.00 to 9.99.
<SwVersion>	Decimal floating point value. Maximum two digits before radix point and maximum 4 digits after.
<ObstVersion>	Up to 18 ASCII characters (any character, no special structure); field is empty when no obstacle database is present.

Example:

```
$PFLAV,R
```

```
$PFLAV,A,2.00,5.00,alps20110221_*
```

FLARM is asked on its versions and returns that it has h/w version 2.00, s/w version 5.00 and an obstacle database named ‘alps20110221_’.

Example:

```
$PFLAV,A,2.00,5.00,*
```

FLARM reports that it has h/w version 2.00, s/w version 5.00, but that there is no obstacle database present.

7.5 PFLAR – Reset

Syntax:

PFLAR,<Value>

Description:

Sends a reset command to FLARM, followed by the reset without any read-back.

Input / Output:

Only sent to FLARM

Availability on the data port:

Usually available when on ground, no configuration

Availability on the extension port:

Usually available when on ground, no configuration

Periodicity:

Not applicable

Parameters:

<Value>	Decimal integer value. One of the following values: 0 = Reboot the device, all settings will be retained 33 = Shut down the device into power save mode (except F4). Shuts down the FLARM hardware. FLARM is then not operational. To come back to normal operation, use $PFLAR,0 or $PFLAR,99. 99 = Reboot the device, all settings will reset to default values, user configuration is lost

Example:

$PFLAR,0

FLARM is asked to reboot and reboots.

7.6 GPRMC - NMEA minimum recommended GPS navigation data

Syntax et al.:

See NMEA-spec

Description:

Recommended minimum data. See the official NMEA 0183 specification. Currently, FLARM does not deliver magnetic variation. Note that the time is UTC, not GPS time.

Input / Output:

Only sent by FLARM

Availability on the data port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Availability on the extension port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Periodicity:

Sent once per second

7.7 GPGGA - NMEA GPS 3D-fix data

Syntax et al.:

See NMEA-spec

Description:

GPS fix data. See the official NMEA 0183 specification. Geoid separation (undulation) and MSL altitude are calculated by the GPS, not measured by the pressure transducer. Note that the time is UTC, not GPS time.

Input / Output:

Only sent by FLARM

Availability on the data port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Availability on the extension port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Periodicity:

Sent once per second

7.8 GPGSA - NMEA active satellites and DOP

Syntax et al.:

See NMEA-spec

Description:

Active satellites and DOP, see the official NMEA 0183 specification.

Input / Output:

Only sent by FLARM

Availability on the data port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Availability on the extension port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Periodicity:

On Classic FLARM sentence is sent only on change of satellite configuration. On PowerFLARM sentence is sent every second.

7.9 GPTXT - NMEA text data (ignore)

Syntax et al.:

See NMEA-spec

Description:

Other text coming from GPS or CPU. To be ignored.

Input / Output:

Only sent by FLARM

Availability on the data port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Availability on the extension port:

Depending on configuration (`PFLAC,,NMEAOUT`)

Periodicity:

Sent only when required

7.10 PGRMZ - Garmin's barometric altitude

Syntax:

Treat the following three versions as identical although FLARM currently only delivers the last one:

`PGRMZ,<Value>,F,3`

`PGRMZ,<Value>,F`

`PGRMZ,<Value>,F,2`

Description:

Gives the barometric altitude in feet (1 ft = 0.3028 m) and can be negative.

Input / Output:

Only sent by FLARM (For Classic FLARM, only F5 and later)

Availability on the data port:

Only on devices with pressure sensor. Depending on configuration (`PFLAC,,NMEAOUT`), treated as a FLARM-proprietary sentence

Availability on the extension port:

Depending on configuration (`PFLAC,,NMEAOUT`), treated as a FLARM-proprietary sentence

Periodicity:

Sent once per second (not on F4). The sentence is not delivered when no pressure device is present.

7.11 PFLAS - Debugging information

Syntax:

`PFLAS,R`

Description:

Request debugging information in human readable form. Answer consists of multiple lines of internal variables and other information. Do not parse this information as the structure and content are subject to frequent changes. Currently not available on F4.

Input / Output:

Only sent to FLARM

Availability on the data port:

Usually available when on ground

Availability on the extension port:

Not available

Parameters:

None.

Periodicity:

Not applicable

Example Classic FLARM:

```
www.flarm.com
HW Flarm-IGC06, #0811810354, 0xDD822F, SW v6.01/1.23 Build 7571
libc 1.8.0
2015/03/19, 16:22:56
Stored configuration settings:
-----------------------------------------
Serial# / IGC#          0811810354 / 123
ID          2     14516783  0xDD822F

Voltage                      12.4V/ 12.4V
Err/Uptime       1/   286
Stack start=0x0d20, size=992, max used=625, unused=367, top-SP=426
Pressure/Temp               969.2/28.3C
OSCCAL/GPS conf                   187/3
Frequency / 0TX                   100/1
Debug/lastGPS                     0/  0
Volume                               3
Aircraft Type                      0x1
Privacy Flag                         0
No Track Flag                        0
NMEA out/in                        1/0
Baudrate/Range             19200/ 3000m
FFS/in flight threshold          0/2m/s
FLASH FS status/entries            1/1
Obstacle status                      3
  DB name
  creation date
Logging config/status/int          1/1/4

-----------------------------------------
```

FLARM is asked to give debugging information and does so.

Example PowerFLARM Core:

```
(c) 2011 FLARM Technology GmbH - All Rights Reserved.
Vendor: FLARM Technology GmbH (R), Name: Core
Serial: FLAPFD11E-002217, IGC: 9ON
HW 1.1, SW 6.00, Build 7558, Date 12.03.2015
Uptime: 0 days, 00:00:54
Date/Time (UTC): 2015/03/19, 16:23:32

System Configuration:
  freq                = 100               (Selected frequency)
  cflags              = 0                 (CFLAGS)
  ui                  = 0                 (UI)
  thre                = 0                 (Inflight Threshold)
  range               = 65535             (Range)

  vrange              = 500               (Vertical Range)
  aznradius           = -1                (Alert zone radius)
  aznbottom           = -1000             (Alert zone bottom)
  azntop              = 4000              (Alert zone top)
  aznoffset           = 0                 (Alert zone offset)
  aznbearing          = 0                 (Alert zone bearing)
  azntype             = 41                (Alert zone obstacle type)
  aznfrom             = PERM              (Alert zone active from)
  aznuntil            = OFF               (Alert zone active until)

  logint              = 4                 (Logging interval)
  vol                 = 3                 (Buzzer volume)

  pilot               = undefined         (Pilot)
  copil               = undefined         (Copilot)
  gliderid            = undefined         (Aircraft callsign)
  glidertype          = undefined         (Aircraft type)
  compid              = undefined         (Comp. sig.)
  compclass           = undefined         (Comp. class)

  priv                = 0                 (Stealth Mode)
  notrack             = 0                 (No track flag)
  acft                = 12                (Aircraft type)

  nmeaout             = 1                 (NMEA Output)
  nmeaout1            = 1                 (NMEA Output 1)
  nmeaout2            = 61                (NMEA Output 2)
  baud                = 2                 (Baudrate)
  baud1               = 2                 (Baudrate 1)
  baud2               = 5                 (Baudrate 2)

  ID                  = FFFFFF            (Radio ID)

  pcasrange           = 7408              (PCAS Range)
  adsbrange           = 65535             (ADSB Range)
  pcasvrange          = 610               (PCAS Vertical Range)
  adsbvrange          = 65535             (ADSB Vertical Range)
  xpdr                = 0                 (Transponder)
  rssi_threshold      = -1                (Mode C suppression threshold)
  rssi_bandwidth      = -1                (Mode C suppression bandwidth)
  modec               = 1                 (Mode C processing enabled)
```

```
modesalt          = 1                   (Use Mode S altitude)
ownmodec          = 0                   (Own mode C suppression method)
pcaspflau         = 0                   (Output PCAS targets as $PFLAU)
pcaspflau1        = 0                   (Output PCAS targets as $PFLAU on 1)
pcaspflau2        = 0                   (Output PCAS targets as $PFLAU on 2)
pcasbeep          = 1                   (Beep on PCAS alarms)
brightness        = 100                 (LCD Brightness)
pcascalibration   = 30                  (PCAS calibration)
batterytype       = 0                   (Battery Type)
audioout          = 0                   (Audio Out Enabled)
audiovolume       = 100                 (Audio Volume)

swver             = 6.00                (Software version)
flarmver          = 1.20                (FLARM software version)
hwrev             = 1.1                 (Hardware revision)
devtype           = PowerFLARM-Core     (Device type)
obstname          = alps_20150115_      (Obstacle database name)
obstdate          = 23.01.2015          (Obstacle database date)
igcser            = 9ON                 (IGC Serial)
cap               = OBST;RFB;TIS;IGC;ENL;AZN;DLED;USBH;DP2;AUD  (Device capabilities)
region            = EUR                 (Device region)
build             = 7558                (Build designator)
radioid           = 2,DF08A9            (Radio ID with type)
```

7.12 PFLAQ – Operations progress information

Syntax:

PFLAQ,<Operation>,<Info>,<Progress>

Description:

Progress information for operations which take significant time. Not all values between 0 and 100 will occur. An operation may terminate prematurely. In this case, a $PFLAE will usually be output.

Availability on the data port:

Available

Availability on the extension port:

Available

Input / Output:

Sent by FLARM only

Parameters:

<Operation>	String. Maximum 10 ASCII characters identifying operation in progress: IGC = IGC files download FW = Firmware update (only PowerFLARM) OBST = Obstacle database update DUMP = Diagnostic dump RESTORE = Restore file system (only PowerFLARM) SCAN = Internal consistency check
<Info>	String. Maximum 20 ASCII characters. Complementary info, e.g. the file name currently being processed. Only sent from PowerFLARM but may be empty. In Classic FLARM this field is omitted.
<Progress>	Decimal integer value. Range: from 0 to 100. Indicates the percentage of completion.

Example PowerFLARM:

```
$PFLAQ,OBST,,10*
```

FLARM is reading obstacle license.

Example PowerFLARM:

```
$PFLAQ,IGC,2A8GJ7K1.IGC,55*
$PFLAQ,IGC,2A8GJ7K1.IGC,65*
```

FLARM is saving IGC file on storage medium.

Example on Classic FLARM:

```
$PFLAQ,IGC,25*
$PFLAQ,IGC,60*
```

FLARM is asked to save IGC files to attached medium storage. The device reads out IGC files indicating progress and finally success.

7.13 PFLAO - Alert Zone warnings

Syntax:

PFLAO,<AlarmLevel>,<Inside>,<Latitude>,<Longitude>,<Radius>,<Bottom>,<Top>,<ActivityLimit>,<ID>,<ID-Type>,<ZoneType>

Description:

A vertical cylinder representing an active Alert Zone. For more information, see Alert Zone Specification document.

Input / Output:

Only sent by FLARM

Availability on the data port:

Depending on configuration (PFLAC,,NMEAOUT and PFLAC,,BAUD). Available only when data port version is >= 7 and port baud rate >= 19.2kB. Not available on F4.

Availability on the extension port:

Depending on configuration (PFLAC,,NMEAOUT and PFLAC,,BAUD). Available only when data port version is >= 7 and port baud rate >= 19.2kB. Not available on F4.

Periodicity:

Sent when applicable once per second. Can be sent several times per second with information on several (but not always all) surrounding Alert Zones.

Parameters:

<AlarmLevel>	See $PFLAA. For Alert Zones, the alarm level is 1 upon entry into the zone and it is only active every 16 seconds for 4 seconds while inside. Otherwise, the alarm level remains zero even while flying inside the zone.
<Inside>	Decimal integer value. Range: from 0 to 1. This value is 1 if the zone is active and we are within the horizontal and vertical limits, zero otherwise.
<Latitude>	Decimal integer value. Range: from -900000000 to 900000000. Latitude of the center of the cylinder in WGS84, degrees times 10^7.

<Longitude>	Decimal integer value. Range: from -1800000000 to 1800000000. Longitude of the center of the cylinder in WGS84, degrees times 10^7.
<Radius>	Decimal integer value. Range: from 0 to 2000. Radius of the cylinder in meters.
<Bottom>	Decimal integer value. Range: from -1000 to 6000. Bottom of the cylinder in meters above the WGS84 ellipsoid (not above MSL).
<Top>	Decimal integer value. Range: from 0 to 6000. Top of the cylinder in meters above the WGS84 ellipsoid (not above MSL).
<ActivityLimit>	Decimal integer value. Range: from 0 to 4294967295. End of activity in seconds since 00:00 Jan 1, 1970 UTC. A value of 0 indicates a zone without set end time.
<ID>	See $PFLAA
<ID-Type>	See $PFLAA

<ZoneType>	Hexadecimal value. Range: 10 to FF. Zone types: 41 = Skydiver drop zone 42 = Aerodrome traffic zone 43 = Military firing area 44 = Kite flying zone 45 = Winch launching area 46 = RC flying area 47 = UAS flying area 48 = Aerobatic box 7E = Generic danger area 7F = Generic prohibited area Any other value from 10 to FF, inclusive, means an Alert Zone alarm that has been specified in the latest version of this document. Such Alert Zones should be treated as "Other" Alert Zone.

Example:

```
$PFLAO,1,1,471122335,85577812,2000,100,4550,1432832400,DF4738,2,41*
```

A skydiver drop zone centered at latitude 47.1122335 degrees North, longitude 8.5577812 degrees East, radius 2 km, topping at 4550 m above WGS84 with a FLARM-chosen ID of DF4738. We are currently inside the zone and the corresponding alarm level is 1. The zone will be active until 28 May 2015 @ 17:00:00.

7.14 PFLAI - IGC files readout or trigger an IGC pilot's event

Syntax:

```
PFLAI,<Value>
```

Description:

IGC files readout or trigger an IGC pilot event. PowerFLARM only.

Input / Output:

Can only be requested

Availability on the data port:

Only on PowerFLARM: usually available when on ground, no configuration

Availability on the extension port:

Not available (sentence is not available on Classic FLARM)

Periodicity:

Sent when requested

Parameters:

<Value>	One of the following strings: IGCREADOUT = If a storage medium is connected and the device is not currently in flight (according to IGC criteria), reads out all flight's records as IGC files. PILOTEVENT = Trigger an IGC pilot's event.

Example:

```
$PFLAI,IGCREADOUT*
```

```
$PFLAI,IGCREADOUT,ERROR,<error>*
```

FLARM is asked to save IGC files to attached medium storage but it does not success. <error> is either IO (problem with storage medium) or INFLIGHT (during flight).

Example:

```
$PFLAI,IGCREADOUT*
```

```
$PFLAQ,IGC,,*
```

```
[...]
```

```
$PFLAI,IGCREADOUT,OK*
```

FLARM is asked to save IGC files to attached medium storage. The device reads out IGC files indicating progress and finally success.

Example:

```
$PFLAI,PILOTEVENT*
```

```
$PFLAI,PILOTEVENT,OK*
```

FLARM is asked to trigger pilot event and acknowledges that pilot event has been triggered. IGC logging will continue at 1s interval for 30 seconds.

7.15 PFLAC - Device configuration

Syntax:

`PFLAC,<QueryType>,<ConfigurationItem>,<Value>`

Description:

Configuration read-out information and settings. Settings cannot be changed when the device is moving to prevent misconfiguration during a flight, unless stated differently. Applications should verify the acknowledge sentence of any configuration change. Settings are stored by FLARM and are reloaded at power-up, unless stated differently. Default values are underlined. Factory preset values can differ from default values. Note that other devices might listen to FLARM as well, therefore only send the minimum required as you might configure settings necessary for other applications. If the command is not understood or the parameters are out of range, FLARM answers with `PFLAC,A,ERROR`

Input / Output:

Bidirectional, i.e. can also be requested

Availability on the data port:

Available while on ground, no configuration

Availability on the extension port:

Available while on ground, no configuration

Periodicity:

Sent when requested

Parameters:

<QueryType>	R = request to send content of <ConfigurationItem>; parameter <Value> should then be omitted S = request to set <ConfigurationItem> to <Value> A = FLARM answers request or setting with current content of <ConfigurationItem>
<ConfigurationItem>	See Configuration Specification document.
<Value>	See Configuration Specification document.

Example:

```
$PFLAC,HELLO,GLIDER_PILOTS
```

```
$PFLAC,A,ERROR*
```

FLARM is asked a configuration it does not understand and returns an error.