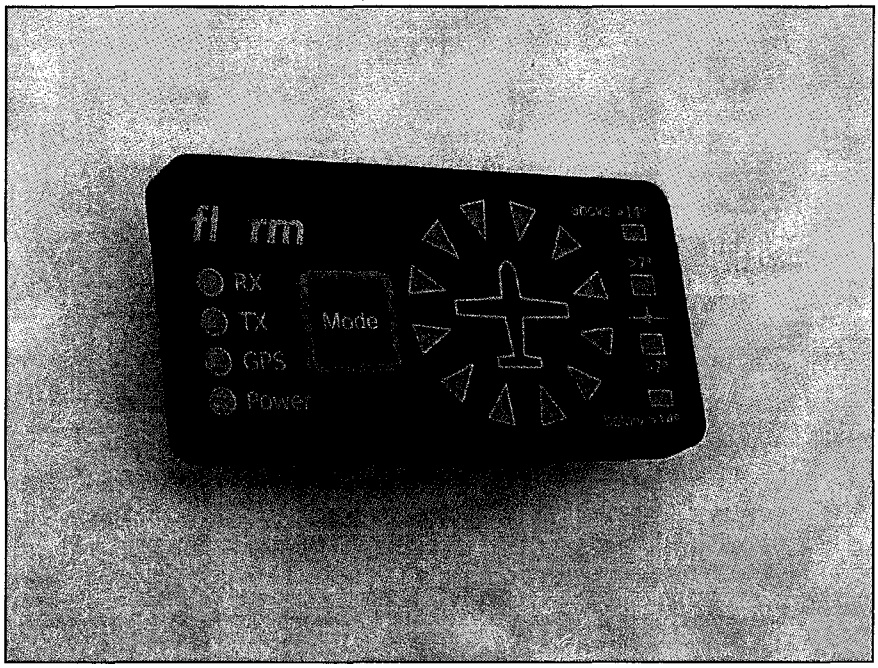
SECTION 9

Airplane Flight Manual-Supplement AVE 18

FLARM Collision Warning System

If the FLARM Collision Warning System is installed into the AQUILA AT01, this AFM-Supplement is applicable and must be inserted into Section 9 of the Airplane Flight Manual. The Information in this AFM-Supplement adds or replaces information of the basic Airplane Flight Manual.



The technical content of this Airplane Flight Manual Supplement is approved under the authority of DOA No. EASA.21J.025.

Schönhagen, 17/12/2007

AQUILA Aviation by Excellence AG AQUILA Head of Airworthiness DOA EASA.21J.025

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0.1 LIST OF REVISIONS AND AMENDMENTS

Revision	Reason for Amendment/Revision	Affected Pages	Date of Issue
A.11	Publication of AVE 16 to 21 (minor change AT01-00245)	all	30/11/2007

0.2 LIST OF EFFECTIVE PAGES

Page	Revision	Date
AVE18-1 to AVE18-10	A.11	30/11/2007

Page	Revision	Date

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1. GENERAL

This supplement provides a general description of the FLARM Collision Warning system, its basic operation and its integration into the AQUILA AT01. For a detailed description of the FLARM system and full operating instructions, refer to the Operating Manual version 3.11E dated 16 August 2007 or any later effective version.

INTRODUCTION

The gliding scene has been confronted with dramatic mid air collision accidents over the past years. With the extreme fine shape and relatively high cruise speed of modern gliders, the human vision has reached its limits of detection. Another aspect is the limited airspace restricted to VFR operation that creates an augmentation of traffic density in certain areas and the associated airspace complexity that request more pilot attention for navigation. These aspects have a direct impact on the probability of collisions also affecting powered aircraft or rotorcraft operations.

The present collision warning system as well as other similar equipment is neither required by technical specifications nor by operation regulations in the general aviation, but is recognized by the regulators as an important step towards the improvement of aviation safety. Therefore such equipment is not considered as essential for VFR flights and may be used for “situational awareness only” on the basis of not interfering with certified equipment necessary for safe flight/landing and not representing a hazard for the aircraft or persons on board.

Correct antenna installation has a great effect on the transmission/reception range of the FLARM system. The pilot shall care that no masking of the antenna occurs especially when the antennas (GPS + COM) are located in the cockpit.

The FLARM system will only give warnings of other aircraft that are likewise equipped with a compatible unit. The FLARM system does not communicate with Mode A/C/S transponders and is not detected by ACAS/TCAS/TPAS or Air Traffic Control. Likewise FLARM does not communicate with FIS-B, TIS-B or ADS-B systems.

The software versions must be regularly updated according to the instructions given in the installation manual. If a version mismatch exists, an error indication is displayed during the start-up process after the activation of the system. In this case, the system will not become operational.

A circuit breaker provides a simple disconnection of all components related to the Collision Avoidance function (FLARM, TR-DVS and other parts used with the installation) from the electrical system (avionic bus) in the case of smoke, fire, electromagnetic interferences or when flying over territories where the SRD frequency is not available for air-to-air communication. This circuit breaker is labelled adequately.

Important Note (refer also to the Operating Manual of FLARM):

Operation of FLARM is forbidden in aircrafts registered in the USA or Canada. Likewise, the use of FLARM is forbidden when other aircrafts, which are not registered in the US or Canada, are operating in the territory of the USA or Canada.

2. OPERATING LIMITATIONS

The AQUILA AT01 is limited to operations under VFR conditions only. The airplane must be furnished with all equipment required for VFR operations that is defined in the Minimum Equipment List in section 2 of the basic Airplane Flight Manual.

The FLARM Collision Warning System is installed as optional equipment whose failure is uncritical under all operational conditions. Furthermore, in accordance with the Operating and the Installation Manual of the FLARM Collision Warning System, the following apply:

1. The FLARM installation is compliant for **"situation awareness only"**. The following placards must be installed in the vicinity of the respective component:
   - On the instrument panel, adjacent to the FLARM display unit:

     FOR INFO in VMC ONLY

   - In the right section of the instrument panel, adjacent to the corresponding circuit breaker:

     FLARM

2. Manoeuvring must not be based solely on the use of the information presented on the FLARM display or its aural annunciations. FLARM does not give any guidance on avoiding actions. The azimuth and height accuracy of the computed traffic cannot always provide reliable warnings and only the most threatening traffic is announced. Therefore, it is the pilot responsibility to evaluate by any means the real traffic position and altitude, the obstacle shape, the terrain and the meteorological situation prior to executing any evasion manoeuvre. Under no circumstances should a pilot or crewmember adopt different tactics or deviate from the normal principles of safe airmanship.
3. It is the pilot's responsibility to verify prior to entering any foreign state territory that the SRD frequency is permitted for the use in air-to-air communications. When such an acceptance does not explicitly or implicitly exist, the equipment shall be disengaged. This verification is part of the flight planning.
4. The pilot shall not intentionally generate uncoordinated warnings that might frighten other aircraft's pilot. Any intentional manoeuvre of this kind has to be carefully coordinated and agreed in advance. Unexpected reactions might be especially hazardous when lateral, vertical or time separations are small.
5. The operation of the FLARM Collision Warning System is limited for non-commercial flights under day-VFR conditions. The FLARM system may not be used for navigation purposes or acrobatics manoeuvres.

In addition, the operating limitations of the basic Airplane Flight Manual apply as well.

3. EMERGENCY PROCEDURES

In the case of fire, smoke, smells of electrical burning or electromagnetic interferences caused by the FLARM Collision Warning System or its components, deactivate the system by pulling the corresponding circuit breaker. For further actions, follow the relevant emergency procedure defined in the basic Airplane Flight Manual.

4. NORMAL PROCEDURES

GENERAL

It is recommended to carry the FLARM Operating Manual version 3 or later on board of the aircraft. To gain optimum use out of the information provided in this manual, the pilot should know the hardware version, the software version, the serial number and the obstacle database name currently installed in the FLARM unit.

ACTIVATION AND SELF-TEST

The FLARM system is activated when the **ALT**/**BAT**-Master Switch and the Avionics Master Switch is engaged. Before activating the system, make sure that the corresponding circuit breaker is pushed in.

When activated, the FLARM unit performs a self-test routine, quickly lights up all LEDs and displays either error codes or version numbers of the installed hardware and software. Refer to the Operating Manual of the FLARM system for a detailed description of the information displayed and how the error code and version numbers are indicated. If an error code is being displayed, the unit will not be ready for operation.

When the self-test routine is completed, FLARM shifts to the normal operating mode and waits until it has acquired an adequate GPS positioning. When engaging the FLARM system after a long period of deactivation or in a totally new location, this procedure may take *several minutes*. Without a proper GPS positioning, the unit is not ready for operation.

Before departure, the pilot must ensure that the FLARM system is operative indicated at least by the illuminated green status LEDs “Power”, “GPS” and “SEND” (TX) (refer to the Operating Manual of FLARM for more information).

OPERATING MODES

FLARM may be operated in two different modes, “*NEAREST”* and “*COLLISION”*. When activated, the unit operates automatically in the “*NEAREST”* mode which is the default

setting. The warnings given are identical in both modes, and generally relate to an immediate threat to which the pilot should initiate immediate and appropriate actions.

When operating in the "*NEAREST"* mode, the unit also reports the presence of other aircrafts operating in the vicinity, even though calculations indicate that they do not represent a threat. As soon as FLARM detects the risk of a collision, it automatically switches over to the "*COLLISION"* mode, followed by an automatic reversion into the "*NEAREST"* mode after the risk of collision has mitigated.

In both modes, the pilot can suppress the display and the acoustic warning: after double pushing the pushbutton on the display unit, FLARM will suppress all visual and acoustic signals relating to traffic, obstacles or other threats. While warnings are suppressed, FLARM nevertheless continues to transmit signals for reception by other aircrafts.

AIRBORNE AND ALERTS

As soon as other operative compatible units are within reception range, the "RECEIVE" (RX) status-LED starts to illuminate. But only the direction of the most imminent or dangerous threat is shown on the horizontal and vertical LED indicators with a flashing red display. The first warning level for another aircraft is initiated when less than 18 seconds remain to the possible calculated collision; the second warning level is initiated when less than 13 seconds remain and the third level when less than 8 seconds remain. In the case of obstacles, the lead time of the warning is larger.

When a number of hazardous approaches with moving or fixed objects have been determined, the FLARM system indicates a warning only for the most dangerous threat according to the results of the threat calculation algorithm. It is not possible for the pilot to select the indication of further threats. The warning LEDs indicate only the earliest likely collision that could occur.

Depending upon the phase of the flight, FLARM uses different movement models, forecasting methods and warning calculations to provide the pilot with the best possible support without causing a distraction. For example, when a sailplane is circling, the system sensitivity is reduced. Although these models and processes have been optimised, they nevertheless represent a compromise.

The calculated threat might also be an obstacle (e.g. cables, antenna masts, cable cars, avalanche dynamite wires, power lines). In the case of fixed obstacles, the unit does not signal a specific direction to the detected threat, the warning relates always to a fixed obstacle in the direction of movement. Obstacle warnings are dependent on correctly stored information in the internal data base that is up-to-date. However, the unit cannot give warnings of fixed objects that have either been incorrectly stored or not stored at all and hence not existing in the data base.

Whether and how avoiding actions have to be taken is solely a matter of the pilot, who must base his decision on his own observations of the airspace and environmental situation.

LINE OF SIGHT

Compatible FLARM units must be within reception range in order to provide a warning. The detection range is very much determined by the type, installation and position of the radio antenna as well as the relative positions of the two aircraft. Under optimum conditions, the internal antenna may provide a head-on range of up to 5 km. Under normal conditions, the reception range is about 2 km. The radio signals can only be received in the direct line of sight. There is no FLARM signal between two aircraft on opposite sides of the same mountain.

GPS SIGNAL QUALITY

FLARM has to determine its current position for correct operation. For this reason, FLARM will only operate in the presence of a three-dimensional GPS reception of good quality. GPS reception is greatly influenced by the installation and position of the GPS-antenna as well as the aircraft attitude. In particular during turns, when flying close to mountain slopes and in areas known for poor reception, the GPS signal quality may be reduced leading to a rapid deterioration of the height calculation accuracy. FLARM resumes operation as soon as the GPS reception quality is sufficient.

PRESSURIZED CABIN

FLARM use an internal pressure sensor to determine the pressure altitude. This is an important element to verify the GPS positioning quality and to ensure an accurate and smooth altitude processing. When installed in a pressurized aircraft, the FLARM system will not operate correctly until it is properly connected to an external static port.

PREDICTED FLIGHT PATH AND ACCURACY

The vertical bearing indication is inaccurate and fluctuates when both aircrafts are close together or at similar heights, respectively, or when the GPS reception is poor.

FLARM precalculates the own flight path of the aircraft for less than the next 30 seconds. This prediction is based on the current position and movement data as well as a movement prediction model that is optimised for the respective user. This forecast is afflicted by a number of uncertainties that increase with an extension of the forecast period. There is no guarantee that the aircraft will actually follow the predicted flight path. For this reason, the warnings indicated might not be accurate in all cases.

EFFECT OF WIND

Movements calculated from GPS data relate to a fixed terrestrial coordinate system. In strong wind conditions, there may be a substantial difference between aircraft heading and track leading to a distorted indication of aircraft-related threat direction. If the wind

speed is one third of True Airspeed (TAS) and the yaw-free aircraft Heading is 90° relative to the wind, then the threat indication displayed has an error of about 18°. If the wind is very strong, the track might deviate from the aircraft heading even more. Under such circumstances and when circling, the displayed direction of the threats are unusable.

DATA PROTECTION

The transmitter has no influence on what the receiver in the other aircraft does with the received data. It is possible that this data may be gathered and stored by the other aircraft or ground stations and used for other purposes. This opens up a range of possibilities, some of which may be in the transmitters interest, (e.g. automated generation of a sailplane launch logging system, aircraft tracking, last position recovery), while others may not be in his interest (e.g. detecting tailing of other aircraft, airspace infringements, failure to take avoiding action prior to a collision). When FLARM makes a transmission, the signal contains also an identification code of the transmitter. The user may -- even though this is not recommended -- reconfigure the unit so that identification is generated randomly and alters at one-minute intervals, making the traceability difficult.

5. PERFORMANCE

No change to the basic Airplane Flight Manual.

6. WEIGHT AND BALANCE

The change of the empty weight and corresponding centre of gravity after the installation or removal of the FLARM Collision Warning System has to be determined and recorded in accordance with section 6 of the basic Aircraft Flight Manual.

7. SYSTEMS DESCRIPTION

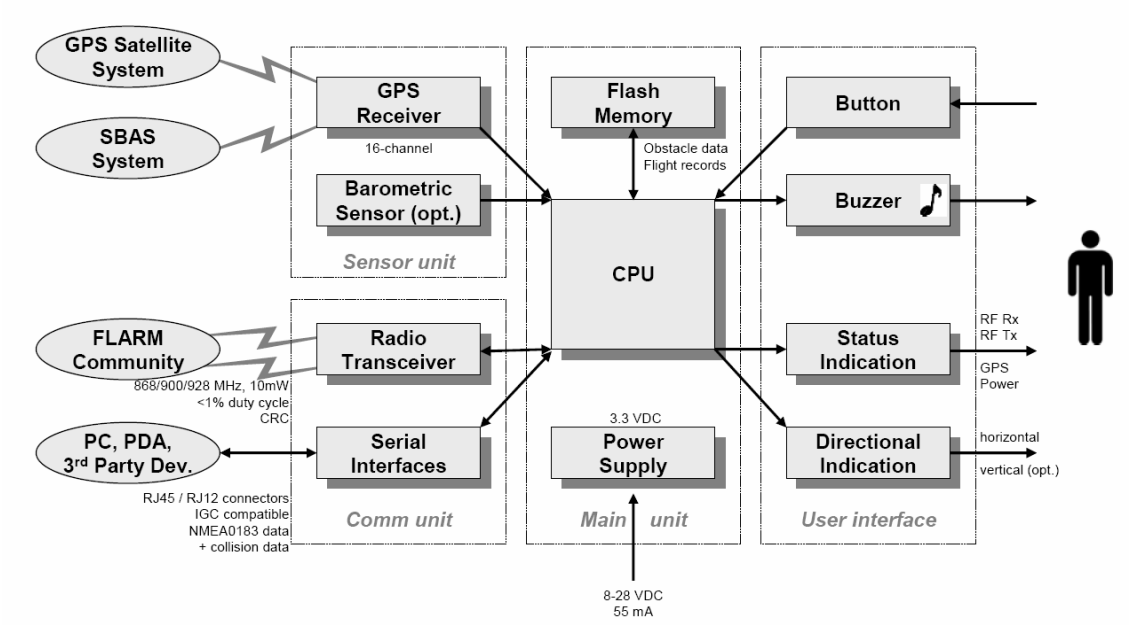
SYSTEMS DESCRIPTION

FLARM receives position and movement information from an internal GPS receiver with an external GPS antenna. An optional pressure sensor further enhances the accuracy of position measurements. The predicted flight path is calculated by FLARM based on the information described above and transmitted by radio signals. Provided that they are within reception range, the transmitted signals are received by further aircraft also equipped with FLARM or compatible devices. All incoming signals are analysed and the extracted data is compared with the own predicted flight path determined by calculation. At the same time, FLARM compares the predicted flight path with known data on obstacles stored in an internal database.

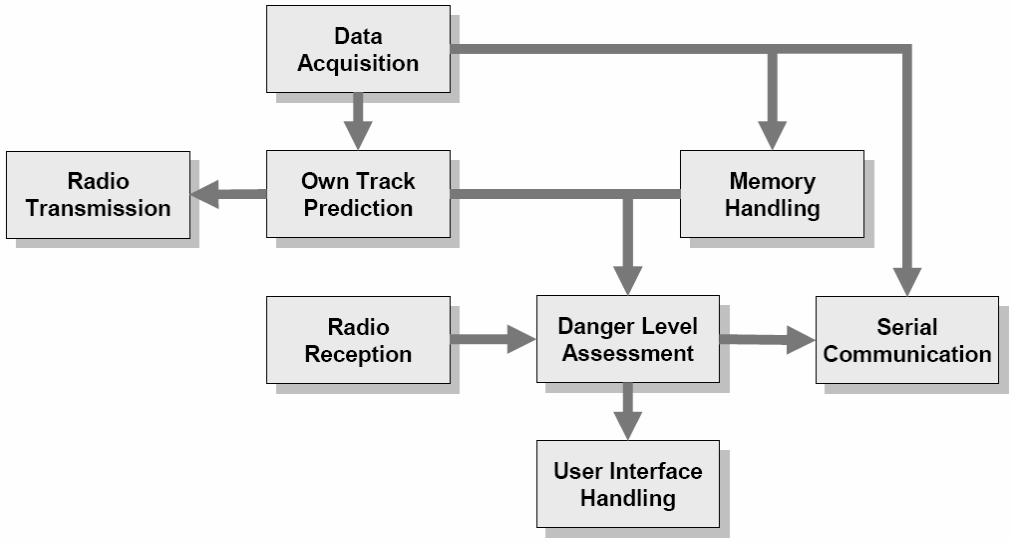
The GPS and collision warning information received from other aircraft may also be made available for other equipment installed in the aircraft (e.g. external displays, speech synthesizer, PDA, Moving Maps, etc.) via a serial data output.

Obstacle information stored in the database has been simplified; for example, FLARM assumes that a power wire is slung absolutely straight between two fixed points with no sag. Likewise, data for power lines does not include all intermediate masts.

HARDWARE SCHEME



IN-FLIGHT SOFTWARE SCHEME



RADIO TRANSMISSION

The FLARM system uses a data communication frequency in the free Non-Specific Short Range Device (SRD) frequency range, sub band f, between 868.0 – 868.6 MHz

and with an ERP power of less than 10 mW (duty cycle 1%). This band is regulated for European applications in the documents ERC/REC 70-03 annex 1(f) and ERC/DEC/(01)04. This band is free for any ground-ground applications and gets no official protection against external interferences. ITU's recommendation for this band in region 1 is "mobile except aeronautical mobile". FLARM is not considered as aeronautical mobile radio.

There are national differences with regard to frequency allocations and operating conditions between countries. To be used for air-to-air applications, some countries require an authorization to be granted by each national communication authority. In Switzerland, BAKOM/OFCOM has granted this authorization for the FLARM application on the 23 March 2004. On the 29 May 2005 FOCA confirmed to BAKOM/OFCOM that no Radio License will be required for FLARM. The aircraft pilot and owner is solely responsible for ensuring that his use of FLARM conforms to local regulations.

The radio transmission protocol used places no limit on the number of units that may be operated within a given range. However, an increasing number of units within reception range is associated with a reduction of the probability that a single coded signal will be received ("graceful degradation"). The probability that subsequent signals from the same transmitter will not be received is usually small. FLARM is designed to receive and process signals from up to 50 aircrafts within reception range. A high number of FLARM units within reception range has no influence on the reception range itself.

INTEGRATION INTO THE AQUILA AT01

The FLARM system is connected to the Avionic Bus of the electrical system of the AQUILA AT01 and is protected by a 1 A circuit breaker which enables the disconnection of the FLARM system from the electric power supply. The circuit breaker is adequately labelled and installed in the right section of the instrument panel among the other circuit breakers. Besides of the FLARM unit which is installed underneath the base plate of the instrument panel, a GPS-antenna, radio antenna and a display unit is part of the FLARM system. The GPS-antenna is installed on support brackets inside of the instrument panel of the AQUILA AT01, the radio antenna is mounted on the backside of the instrument panel and the display unit is located in the left section of the instrument panel above the cockpit watch. To provide the indication of collision warning alerts also on the FLYMAP display, both systems may be connected via a data cable (refer also to the Installation Manual of the FLARM system). For a detailed description of the integration of the FLARM system into the aircraft, refer to the effective revision of the Maintenance Manual of the AQUILA AT01, document no. MM-AT01-1020-100.

8. HANDLING, SERVICE AND MAINTENANCE

In order to increase the service life of the FLARM Collision Warning System, it should always be deactivated during engine start-up and shut-down since electrical surges during the start-up and shut-down process may cause damage to the unit.