FAI Sporting Code

Fédération
Aéronautique
Internationale

Section 10 – Microlights and Paramotors

Annex 6

GNSS Flight Recorders and other electronic devices

To Take Effect on 15th March 2017

Section 10 and General Section combined make up the
complete Sporting Code for Microlights and Paramotors

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Sidebars indicate Changes from the 2009 edition, zigzags indicate numbering changes since the 2009 edition.

1 GENERAL

1.1 TITLE AND STATUS

This document is a sub-document of the FAI Sporting Code Section 10 [Microlights and Paramotors] (**S10**) and should be read in conjunction with other documents where the subject matter is appropriate.

1.2 SCOPE

This document deals with the specifications, approval and use of Global Navigation Satellite System (**GNSS**) Flight Recorders (**FR**'s) and other electronic devices used in Microlight and Paramotor championships and record attempts. It also contains the terms of reference for the operation of the CIMA GNSS Flight Recorder Approval Committee (**FRAC**).

1.3 REFERENCES

1.3.1 This document includes quotes from S10 in order to aid clarity, however the prime authority for such wording is the source document.

1.3.2 This document also refers to many other FAI documents:

- Various International Gliding Commission (**IGC**) documents contained in FAI Sporting code Section 3 (S3), especially annex B (**S3B**) "REQUIREMENTS FOR EQUIPMENT USED FOR FLIGHT VALIDATION" and the IGC document "TECHNICAL SPECIFICATION FOR IGC-APPROVED GNSS FLIGHT RECORDERS" (**IGC-FR-TS**).
- The General Aviation Committee (**GAC**) FAI Sporting code Section 2 (**S2**) Annex 4 "REQUIREMENTS FOR EQUIPMENT USED FOR FLIGHT VALIDATION" (**S2-AN4**) and attachments.

1.3.3 In all cases the most recent edition must be used.

1.4 GLOSSARY

For an explanation of the many specialised technical terms and phrases involved in GNSS FR systems, reference should be made to the glossaries in IGC-FR-TS and the FAI Sporting Code General Section (**GS**)

1.5 FAI LIABILITY

FAI takes no responsibility or liability for the consequences of the use of CIMA approved Flight Recorders or other electronic devices for purposes other than validation and certification of flights to FAI/CIMA procedures. Such other purposes include, but are not limited to, navigation, airspace avoidance, terrain avoidance, or other matters concerning flight safety.

1.6 NOMENCLATURE

In this document the words "must", "shall", and "may not" indicate mandatory requirements; "should" indicates a recommendation; "may" indicates what is permitted; and "will" indicates what is going to happen. Where appropriate, words of the male gender should be taken as generic and include persons of the feminine gender. Advisory notes and guidance are in *italic script*.

2 TYPES OF FLIGHT RECORDERS

GNSS FR's fall into several basic categories depending on their capabilities and features and may already be approved by other FAI committees. The table below describes the different approvals required for use in Microlight and Paramotor championships and records.

2.1 TYPE 1 FR's

A type 1 FR is just a flight recorder. In its approved state it must not be capable of displaying any flight information to the pilot or crew in any circumstances, data must be transferable to a PC in the CIMA approved format and the whole system must be approved by FRAC.

2.1.1 Description

2.1.1.1 The Flight Recorder (FR) must indicate to the pilot/crew through visual signals:

- On/off indication,
- Indication of correct or incorrect operation of data gathering and recording
- Indication of "low battery" condition
- Indication of "low storage capacity"
- Indication when the Pilot Event marker (**PEV**) is activated
- Manufacturers name, serial number and firmware version of the FR.

2.1.1.2 The Flight Recorder (FR) may indicate to the pilot/crew through visual signals:

- Other information necessary for the operation of the FR.

2.1.1.3 The FR must be capable of recording track fixes for at least 10 hours at a frequency better or equal to one per 5 seconds. (This will be increased to one per 1 second at a future date.)

2.1.1.4 The FR must be capable of recording at least 99 PEV's.

2.1.1.5 The data acquired by the FR must be transferable from the FR to a PC by the CIMA specified method in the CIMA specified data format.

2.1.1.6 It is highly desirable that:
- The pilot name, competition and task number can be entered into the FR so the resulting transferred data is readily identifiable. (*This will become a mandatory requirement at a future date.*)
- The FR is capable of recording atmospheric altitude as well as GPS altitude.

2.1.2 Conditions Of Use

2.1.2.1 Type 1 FR's may be used in Championships and record claims if they are used in accordance with their approval document.

2.1.3 Required Approvals

2.1.3.1 Each combination of hardware, firmware and data transfer software must be approved by FRAC.

2.2 TYPE 2 FR's

A type 2 FR is a GNSS flight recorder which may also be capable of displaying flight information to the pilot or crew, has an integral pressure altitude sensor and is capable of secure data transfer.

2.2.1 Description

2.2.1.1 The FR must have an Integral Pressure Altitude Sensor and be capable of recording atmospheric altitude.

2.2.1.2 If the FR used for any "without engine power" record claim, the FR must be capable of Means Of Propulsion (**MOP**) recording which must be functioning correctly according to its approval document.

2.2.1.3 The FR must be capable of secure transfer of data.

2.2.2 Conditions Of Use

2.2.2.1 Type 2 FR's may be used in all Microlight and Paramotor record claims so long as it is operated in full accordance with its approval document.

2.2.2.2 A copy of the approval document and confirmation by the Official Observer (**OO**) that all conditions were complied with should be included as part of the claim.

2.2.3 Required Approvals

2.2.3.1 Full IGC approval: The FR is currently approved by the GNSS FR Approval Committee of IGC (**GFAC**) for flights up to and including FAI/IGC world records.

2.3 TYPE 3 FR's

A type 3 FR is a GNSS flight recorder which may also be capable of displaying flight information to the pilot or crew, records GPS altitude but does not have an integral pressure altitude sensor or is not capable of secure data transfer.

2.3.2 Conditions Of Use

2.3.2.1 Type 3 FR's may be used in distance or speed Microlight and Paramotor record claims.

2.3.2.2 The record claim must include:

- Confirmation that the FR was in the aircraft throughout the record attempt flight.
- An electronic copy of the original data as immediately extracted from the FR and a statement countersigned by the OO that that this original data is unadulterated.
- An electronic copy of that data converted into Pseudo-IGC format.
- A precise description, countersigned by the OO, of the software used to transfer and convert the recorded data into Pseudo-IGC format.

2.3.2 Required Approvals

2.3.2.1 Full GAC approval. The FR is approved by GAC in accordance with Sporting Code, Section 2, Annex 4.

2.3.2.2 No approval. The FR is an 'off the shelf' device which satisfies the description above.

3 CIMA APPROVAL FOR FR EQUIPMENT

3.1 POLICY AND GENERAL

CIMA approval of a particular type of GNSS Flight Recorder is achieved after Test and Evaluation (T&E) by FRAC whose terms of reference are given below. When a FR system is submitted for CIMA approval, FRAC examines it for compliance with CIMA rules and procedures for hardware, firmware, software, output data in the required data file format, and security of the FR system both physical and electronic.

FRAC will only approve FR's to Type 1 standard which is primarily designed for championships so conditions that frequently occur in large events are also taken into account, for example, after flight it must be quick and easy to transfer the flight data to a PC in the approved flight data format.

3.2 CIMA GNSS FR APPROVAL COMMITTEE (FRAC)

A committee of at least 3 persons shall be appointed by CIMA to test, evaluate, and approve individual types of GNSS FR's. FRAC members may delegate specialist work to other experts but are responsible for co-ordinating the work and for producing final recommendations.

The detail of the work and any opinions expressed within FRAC discussion are confidential to FRAC and any other experts and CIMA officials who may be involved.

3.2.1 Appointment of FRAC Members

The chairman and members of FRAC will be appointed by CIMA for an agreed period. Members will be eligible for re-appointment.

3.2.2 Correspondence with FRAC

The point of contact with FRAC is the FRAC chairman who will inform other members as necessary and coordinate any responses. In cases where specialist matters are being discussed, the Chairman may authorise direct correspondence with an appropriate FRAC advisor, but the Chairman must be copied with all correspondence.

For communication, email is the recommended method. The details sent by the manufacturer will be treated as confidential to FRAC and any other experts who may be involved.

3.3 SUBMISSION OF FR's TO FRAC

Manufacturers are encouraged to make contact as early as practicable during the design process for a new type of FR. This is because initial discussion with FRAC on the intended design may reveal that changes have to be made.

3.3.1 Evaluation and Testing

Each applicant shall provide as much information as is available on how their model of FR is intended to meet the CIMA Specification. The Chairman will circulate such details to FRAC members and appropriate technical advisors and will co-ordinate comments that will be sent back to the manufacturer.

All FRAC members have the right to ask for hardware for testing themselves. The chairman will notify the manufacturer of those FRAC members who wish to receive equipment for testing. Any excess expenses incurred by individuals (such as postal, excise and tax), shall be paid by the FR manufacturer into the FAI account on request so that individuals can be reimbursed and do not have to pay these expenses themselves.

Upon receipt of all of the formal application material and hardware, FRAC will complete T&E as soon as practicable and normally within 120 days, unless there are unforeseen difficulties. The testing carried out by FRAC will be of a non-destructive nature but FRAC, CIMA or FAI is not liable for any damage to, or loss of, any equipment.

A sample test and evaluation schedule which may be used is at Appendix 1.

3.3.2 Fee to FAI

Before the evaluation process can start the FR manufacturer should apply to FAI on the forms provided and pay the appropriate fee. This fee is returnable upon successful approval or re-approval to type 1 standard. The amount and precise method of deposit will be given on the application form available from the FRAC Chairman.

3.3.3 Re-approval after changes

Any alteration to hardware, firmware or transfer software of a FR will need re-approval.

3.4 CIMA APPROVAL DOCUMENTS FOR SPECIFIC TYPES OF FLIGHT RECORDER

The CIMA approval document for each FR type is produced by FRAC on behalf of CIMA. Before the approval document is finalised, it is circulated several times in successive drafts to FRAC members, other technical experts and consultants, and the manufacturer concerned.

When finally issued, the CIMA approval document gives the detailed procedures under which equipment must be checked, installed in the aircraft, and operated. This document is definitive in terms of how the type of FR is to be operated for flights that are to be validated and certificated to FAI/CIMA criteria.

A sample approval document is at Appendix 2.

3.5 OPERATING PROCEDURES FOR A FLIGHT RECORDER TYPE

Operating procedures for each type of FR will be specified in the CIMA approval document by FRAC, with the objective of making procedures on the day of flight as simple as possible without compromising security.

FRAC must specify procedures which minimise the possibility that either one FR could be substituted with another one, or that the FR could be interfered with without detection.

4 FR EQUIPMENT REQUIREMENTS

For the purposes of CIMA approval, the combination of hardware (the FR unit), its firmware and the data transfer software are treated as a single unit. Any alteration to any of them will require re-submission for approval by FRAC.

4.1 GNSS RECEIVER

The type of GNSS receiver will be tested for accuracy and freedom from anomalies in recording lat/long and altitude, and must be of a type that is acceptable to FRAC.

Fixes recorded on the data file must be based on real GNSS position lines. Predicted fixes must not be recorded such as those from so-called Dead Reckoning (DR) and other forward-prediction algorithms designed for use on the ground if signal is lost due to terrain masking. CIMA approval will not be given if testing shows that a high-speed run followed by a sharp turn, can throw fixes forward of the true position of the aircraft.

4.2 FR ENCLOSURE, DISPLAY AND CONTROLS

The GNSS receiver and the FR memory must be in a sealed enclosure (case) with the connections between them entirely within the case.

The case should have a tamper-proof physical seal across a joint or screw, so that the seal will be broken if it is opened.

The case must have an unbreakable loop or ring whereby it can be attached by sealing wire or plastic sealing tie-wrap to the aircraft.

Reliable pilot operation of in-flight controls such as the operation of the PEV marker button must be easily possible with thick gloves.

The display must not be capable of giving any flight information eg heading, position, ground-speed Etc.

4.3 SHOCK

The FR must continue to function correctly after a violent shock equivalent to a freefall drop of 250mm at any angle of incidence onto concrete.

4.4 UNIQUE SERIAL AND VERSION NUMBERS

The case of the recorder must be permanently marked with the name of the recorder manufacturer, type/model and Serial Number (**S/N**) unique to that FR.

Where a display is available, it must be possible to display the S/N and version number of the hardware and firmware (or software) otherwise this information must also be marked on the case.

Transfer data must include at least the serial number.

4.5 WIRING

Only the following wires may pass through the boundaries of the sealed case:

- Electrical power. Wires carrying electrical power to the FR.
- Antenna. The GNSS receiver antenna (aerial) cable.
- Connector cable for data transfer from FR to PC.

4.6 POSSIBILITY OF RE-PROGRAMMING

It must be shown that it is not possible to alter the firmware of the GNSS receiver or the memory of the FR by connection to an outside source e.g. a PC without the entire memory being wiped clean in the process or to load specific items such as pilot name or competition number.

4.7 POSSIBILITY OF EXTRACTION OF DATA IN FLIGHT

It should not be possible to capture recorded or real-time flight data (e.g. NMEA output) to a PC or other device while the FR is operating in flight recording mode. If it is, the FR must be equipped with a method of physically sealing the data transfer port.

4.8 CONNECTOR CABLE

The connector cable for data transfer from FR to PC must be fitted with either a female RS232 plug which connects directly to the standard 9 pin RS232 serial port of the PC or a USB plug which connects directly to the USB port of the PC.

4.9 DATA TRANSFER SOFTWARE

The data transfer ("short-program") software must be a stand-alone application which does nothing more than transfer the data from the FR to PC, convert it as necessary to CIMA approved format as specified below and allow the file to be saved to the hard disk with a default file name.

The data transfer software must run at least under Microsoft Windows™ (32-bit versions). Versions developed for other operating systems may also approved.

The data transfer software may be copyright but must be licensed as freeware and made freely available on the Internet.

The main page of the data transfer software must have a picture of the FR(s) it is used with and details of which FR firmware version(s) it is approved for use with.

4.9.1 Installation

The data transfer software must be easily installable on any 32 bit Microsoft Windows on a low-specification PC.

Ideally the application should be a stand-alone executable and easily be installed on different PC's.

4.9.2 Resultant file format and content

The file written by the transfer software must be in standard IGC format (see IGC-FR-TS) and include all the mandatory elements as detailed in the data format section below.

4.9.2.1 The correct data source code must be placed in all H and mandatory L records (see below) so an audit trail is maintained.

4.9.3 Before the file is saved

The operator must be presented with various options:

4.9.3.1 The CIMA data format requires that the pilot name, competition number and task number is written to the saved file. If the FR is not capable of retaining this information or the fields transferred from the FR are blank or invalid, a pop-up modal dialog box must be presented to the operator to allow him to enter this information.

4.9.3.2 The operator must be able to enter a time zone offset from UTC to local time which converts all times to this offset, and a note of this made of this in a LCMAOTZN record (see below).

4.9.3.3 The operator should be offered the option to insert a previously saved task (in IGC "C" record format) into the data file in the correct place (see IGC-FR-TS) and a note of the inserted file-name made in a LCMAOTIN record (see below)

4.9.3.4 If the FR only records GPS altitude, the operator should be offered the option to fill the pressure altitude field of 'B' records with the GPS altitude data from the same record. A note of this must be made in a LCMAOPRS record (see below).

4.9.4 File names

When the operator is presented with the 'Save' dialog box, It should be difficult or impossible for the operator to overwrite existing files.

4.9.4.1 The file name presented to the operator should be as follows:

`001T01V1R1_PILOT_name.IGC`

Where:

- Characters 1 – 3 are the pilot's competition number, with leading zeros as necessary. (e.g. number 4 must be 004, this way all files will sort correctly by competition number in alphanumeric order.)

- Character 4 is fixed as T (for Task)

- Characters 5 & 6 are the task number, with leading zeros as necessary.

- Character 7 is fixed as V (for Version)

- Character 8 is the version number of the file, (ie this will be 1 the first time the file is created in the directory, but it will be 2 if the same data is transferred from the FR a second time. This makes it difficult for the operator to overwrite existing data.)

- Character 9 is fixed as R (for Recorder). Note that for full backwards compatibility, analysis programs should appreciate that an underscore '_' (ascii 95) may appear in this position.

- Character 10 is a number 1 to 9 indicating the status of the FR as declared by the pilot; 1 = Primary, 2 = first secondary, 3 = second secondary, Etc. Note that for full backwards compatibility, analysis programs should appreciate that if any other character appears in this position then the status of the FR is unknown.

- Character 11 is an underscore '_' (ascii 95).

- Characters 12 to n is the pilot's name where n may not be more than 150. Pilot name must be in characters A-Z, a-z and 0-9 only (ascii 65-90, 97-122 and 48-57), accented characters etc. must be replaced with their nearest match from within this selection. All spaces in the pilot name must be replaced with the underscore '_' (ascii 95).

- Characters n to n+4 are fixed as .IGC This file suffix is the IGC standard and allows the file to be readily opened in many different flight analysis programs

5 FR DATA FORMAT

The CIMA data format is standard IGC format as described in IGC-FR-TS with some mandatory elements. Mandatory elements of the CIMA format are described here, otherwise reference should be made to IGC-FR-TS which has a very detailed explanation of the IGC data specification.

No record (line) may exceed 76 bytes in length, excluding the CRLF which is hidden and does not appear in text form.

The current CIMA data format specification version is 1.0

5.1 UNITS and UNIT FORMAT

Units and unit format is standard IGC, leading zeros as necessary. [with extra decimal digits in square brackets if the specific use permits]

- Time - UTC (i.e. not local time or GPS internal system time.) – HHMMSS[sss]
- Distance - Kilometres and metres – DDDD[ddd]
- Speed - Kilometres per hour – SSS[sss]
- Date - UTC - DDMMYY (day, month, year)
- Direction – Degrees and decimal degrees true – DDD[ddd]
- Lat - Degrees, minutes and decimal minutes with N,S designators - DDMMmmmN
- Long - Degrees, minutes and decimal minutes with E,W designators - DDDMMmmmE
- Altitude – Metres and centimetres. – AAAAA[aaa]
- Pressure - Millibars to two decimal places – PPPPpp

5.2 DATA SOURCE CODES

Some records, notably H records and CIMA format L records have a single byte code indicating the source of the data.
F = Data was generated internally by the FR
P = Data was entered into the FR by the pilot (eg his name)
O = Data was entered by the operator of the transfer software.
S = Data was generated automatically by the transfer software.

5.3 THREE LETTER CODES

Standard IGC Three Letter Codes (**TLC**) codes as stated in IGC-FR-TS must be used, but the CIMA format requires a few extra.

TLC	Record Type used with	TLC meaning, and notes on how it is to be used
DFS	H	Data File Specification: File is written to a subset of the IGC specification, specifically to CIMA Etc. requirement.
CMA	L	CIMA, indicates data specific to the CIMA format.
TSN	L	Transfer Software Name
TSV	L	Transfer Software Version
TSD	L	Transfer Software Date (date data was transferred from FR to PC)
TST	L	Transfer Software Time (time data was transferred from FR to PC)
TSK	L	Task; Task description or number.
TIN	L	Name of an inserted task description file

5.4 THE A RECORD (FR manufacturer and identification)

The A Record must be the first record in an FR Data File, and includes the FR Serial Number (S/N) unique to the manufacturer of the FR that recorded the flight.

Format of the A Record: `AMMMNNNTEXTSTRING CRLF`

A Record - Description	Size	Element	Remarks
Manufacturer	3 bytes	MMM	Alphanumeric. If the FR manufacturer has an IGC designation, this should be used, otherwise XXX
Unique ID	3 bytes	NNN	Valid characters alphanumeric, If the FR has a three byte S/N, this should be used, otherwise XXX
ID extension	Mandatory	TEXT STRING	FR model,FR Serial number Alphanumeric

5.5 H RECORDS (File header records)

5.5.1 Required H records.

The following H records are required, in the order given below:

```
HZDTEDDMMYY CRLF
HZFXAAAA CRLF
HZPLTPILOT:TEXTSTRING CRLF
HZDTMNNNGPSDATUM:TEXTSTRING CRLF
HZRFWFIRMWAREVERSION:TEXTSTRING CRLF
HZRHWHARDWAREVERSION:TEXTSTRING CRLF
HZFTYFRTYPE:MANUFACTURERSNAME,FRMODELNUMBER,FRSERIALNUMBER CRLF
HZGPS:MANUFACTURERSNAME,MODEL,CHANNELS,MAXALT CRLF
HZPRS:NOTFITTED CRLF
HZDFSFILESPECIFICATION:FAICOMMISSION,SPECVERSION CRLF
HZCIDCOMPETITIONID:TEXTSTRING CRLF
```

H Record - Description	Size	Element	Remarks
Data source code	1 byte	Z	F, P, S or O according to data-source, placed after leading H
Record subtype TLC	3 bytes	CCC	Alphanumeric, placed after data source character.
UTC Date	6 bytes	DDMMYY	Valid characters 0-9. This date should be the date the flight was recorded, not the date the data was transferred from the FR.
FXA accuracy category, metres	3 bytes	AAA	Valid characters 0-9 (Default 500)
Lines on Pilot	As required	TEXT STRING	After relevant TLC; PLT = The pilots name as entered in the FR or transfer software. CID = The pilot’s competition number
GPS Datum	3 bytes	NNN	WGS 84 must be used, 100 =WGS84
Lines on FR name, firmware, hardware	As required	TEXT STRING	After relevant TLC; FTY = FR Type (Manufacturer's name, FR Model Number) RFW = Firmware Revision Version of FR RHW = Hardware Revision Version of FR
HFGPS line	As required	TEXT STRING	Gives the GPS engine manufacturer and type, number of channels, and the maximum GNSS altitude in metres that could be recorded in the IGC file. Use comma separators between each piece of information. For the Russian GLONASS system use the code GLO instead of GPS.

HFPRS line	As required	TEXT STRING	Gives the pressure altitude sensor (Manufacturer and type) and maximum pressure altitude in metres that could be recorded in the IGC file. Use comma separators between each piece of information. If one is not fitted to the FR "NOTFITTED" must be placed in the field.
Data File Specification	As required	TEXT STRING	After relevant TLC; DFS = FAI commission's name,specification version to which the file matches. E.g. CIMA,1.0 Although the default specification is IGC, CIMA uses a subset of the full IGC specification and it is useful to know to which FAI commission's specification the file should exactly match.

5.5.2 Optional H records

Any optional records allowable in the IGC specification are permitted.

5.6 THE I RECORD (Extensions to the fix (B) record)

The I record defines any extensions to the fix (B) Record in the form of a list of the appropriate TLC's, data for which will appear at the end of subsequent B Records. Only one I Record line is included in each file, There are no CIMA mandatory I record extensions but any optional elements allowable in the IGC specification are permitted. See the general specification IGC-FR-TS.

5.7 L RECORDS (Comments)

The L Record (Logbook) is used to specify comments in the file. For the general specification, see IGC-FR-TS.

In the case of the CIMA specification several L records in a specific format are mandatory.

The format is L - CMA – Source code – Data TLC – Description : Data

5.7.1 Required L records

Should be placed in the .IGC file before the first fix (B) record and after the A, H and I records.

```
LCMAZTSNDATATRANSFERSOFTWARENAME:TEXTSTRING CRLF
LCMAZTSVDATATRANSFERSOFTWAREVERSION:TEXTSTRING CRLF
LCMAZTSDDATATRANSFERDATE:DDMMYY CRLF
LCMAZTSTDATATRANSFERTIME:HHMMSS CRLF
LCMAZTSKTASKNUMBER:NNNN CRLF
LCMAZPRSPRESSALTFILL:GNSSALT CRLF
LCMAZTZNTIMEZONEOFFSET:NNNNN CRLF
```

L record - Description	Size	Element	Remarks
IGC manufacturer's designation	3 Bytes	CMA	Normally bytes 2, 3 and 4 of L records should contain the IGC manufacturer's designation TLC, but mandatory CIMA L records should always contain CMA.
Data source	1 Byte	Z	Byte 5 of every LCMA record should reflect the true source of the data, see Data Source Codes above.
Transfer Software name	As required	TEXT STRING	TSN = Name of the software which did the transfer from FR to PC, Alphanumeric.
Transfer Software version	As required	TEXT STRING	TSV = Version number of the software which did the transfer from FR to PC, Alphanumeric.
Transfer date	6 bytes	DDMMYY	TSD = Date the data was transferred from FR to PC; Valid characters 0-9
Transfer time	6 Bytes	HHMMSS	TST = Time the data was transferred from FR to PC; Valid characters 0-9
Task number	4 bytes	NNNN	TSK = Task number, Valid characters 0-9
Pressure altitude fill	As required	TEXT STRING	PRS = GNSSALT Not required unless the transfer software has substituted the pressure altitude data with GNSS altitude data.
UTC Offset	5 bytes	NNNNN	TZN = Time Zone offset from UTC; First byte, either + or – Remainder: HHMM Valid characters 0-9 Not required unless the transfer software has altered all times in the file to this UTC offset.

Inserted task file name	As required	TEXT STRING	TIN = Task Inserted Name, Name of "C" record task description file inserted by the operator. Alphanumeric. Not required unless the transfer software operator has inserted a task description file.
Track date	6 Bytes	DDMMYY	DTE = Date of the first B (fix) record in the file. Valid characters 0-9

5.7.2 Required embedded L records

If the date of a fix (B) record differs from the date of the previous fix (B) record, then an L record shall be inserted between the two containing the new date.

`LCMAZDTETRACKDATE:DDMMYY CRLF`

5.7.3 Optional L records

Any optional records allowable in the IGC specification are permitted.

5.8 B RECORDS (Fix)

B records constitute the bulk of a track file. Not counting the last CRLF, this includes 35 bytes for its basic data plus those for extra characters that are defined in the I Record such as Fix Accuracy (FXA)

The basic data is:

B - UTC - WGS84 latitude - WGS84 longitude - Fix validity - Pressure altitude - GNSS altitude

All of the information within each B-record must have a data issue time within 0.1 seconds of the time given in the B-record.

Where NMEA data is used within the FR, fix data should be taken either from the GGA or GNS sentences. GGA is specific to the US GPS system. GNS is intended for all GNSS systems (GPS, GLONASS, Galileo and future systems), and should be used if it is available from the GNSS board installed.

The format of the basic data is: `BHHMMSSDDMMMMMNDDDMMMMMEVPPPPPGGGGG CRLF`

B record - Description	**Size**	**Element**	**Remarks**
Time UTC	6 bytes	HHMMSS	Valid characters 0-9
Latitude	8 bytes	DDMMmmmN/S	Valid characters N, S, 0-9
Longitude	9 bytes	DDDMMmmmE/W	Valid characters E,W, 0-9
Fix validity	1 byte.	A or V or X	Use A to denote a 3-D fix, V for a 2-D fix and X to denote unknown. Where data in NMEA format is used within the FR, in the GSA sentence (DOP and active satellites), put A in the IGC file for GSA mode 3, and V for GSA mode 2.
Press Alt.	5 bytes	PPPPP	Altitude to the ICAO ISA above the 1013.25 HPa sea level datum, valid characters 0-9, if no data: 00000
GNSS Alt.	5 bytes	GGGGG	Altitude above the WGS84 ellipsoid, valid characters 0-9

5.8.1 Optional B record extension elements

Any optional extension elements allowable in the IGC specification are permitted so long as they are properly described in the I record.

5.9 E RECORDS (Events)

The E-record records specific events in the IGC file, typically a pilot-initiated event (PEV code). It is placed before the individual fix (B) Record for the same time that records where and when the event occurred, there should not be a delay until the next B record is scheduled to be written.

Events must have a Three Letter Code (TLC)

The format of the E-Record is E - time - TLC – description; `EHHMMSSCCCTEXTSTRING CRLF`

E record - Description	**Size**	**Element**	**Remarks**
Time UTC	6 bytes	HHMMSS	Time that the event occurred. Valid characters 0-9
TLC	3 bytes	CCC	Alphanumeric, see IGC-FR-TS for TLC codes PEV = Pilot event ("Mark") button was pressed.
Description	As required	TEXT STRING	Description of the event, i.e. its sequence number.

5.10 OTHER RECORD TYPES

Any other record types allowable in the IGC specification are permitted so long as they conform precisely with the IGC standard.

5.11 EXAMPLE FILE

Below is an example file. The number in [square brackets] is the line number for reference to the explanation below and **should not** be included in the data file.

```
[01]AXXXXXXAFLOS,453456
[02]HFDTE150702
[03]HFFXA025
[04]HPPLTPILOT:JOE BLOGGS
[05]HFDTM100GPSDATUM
[06]HFRFWFIRMWAREVERSION:2.71
[07]HFRHWHARDWAREVERSION:1.3
[08]HFFTYFRTYPE:FA HENN,AFLOS,453456
[09]HFGPS:TRIMBLE,AX23,12,9000
[10]HFPRS:NOTFITTED
[11]HSDFSFILESPECIFICATION:CIMA,1.0
[12]HPCIDCOMPETITIONID:123
[13]I013640FXA
[14]LCMASTSNDATATRANSFERSOFTWARENAME:MYSOFT CRLF
[15]LCMASTSVDATATRANSFERSOFTWAREVERSION:1.34 CRLF
[16]LCMASTSDDATATRANSFERDATE:280702 CRLF
[17]LCMASTSTDATATRANSFERTIME:072232 CRLF
[18]LCMAPTSKTASKNUMBER:0002 CRLF
[19]LCMAOPRSPRESSALTFILL:GNSSALT
[20]LCMAOTZNTIMEZONEOFFSET:+0100
[21]B0853324626036N01657485EX0015700157
[22]E085335PEV
[23]B0853354625940N01657470EX0015600156
[24]B0853374625944N01657460EX0015500155
```

Explanation

Line number	Explanation
1	The A record; The FR manufacturer does not have an IGC designation and the FR's serial number is not three characters long. The FR is an AFLOS and its serial number is 453456
2	Header date record. The FR recorded the date of the flight as 15 July 2002
3	Header fix accuracy record. The FR reported that it is usually accurate to 25 metres
4	Header Pilot name record. The pilot, JOE BLOGGS, put his name in the FR
5	Header GNSS Datum record. The FR was set to the WGS84 Datum
6	Header FR firmware record. The FR was using firmware version 2.71
7	Header FR hardware record. The FR hardware was version 1.3
8	Header FR ID record: The FR manufacturer was FA HENN, model was AFLOS and the serial number 453456
9	Header FR GNSS Engine record: The GNSS engine was made by TRIMBLE, it is model AX12, has 12 channels and GNSS Altitude is reliable to 9000 metres.
10	Header FR Pressure altitude sensor record. The transfer software has detected a pressure altitude sensor was not fitted to the FR
11	Header Data File Specification record: The transfer software wrote that the file is written to the CIMA version 1.0 specification.
12	Header pilot competition number record. The pilots competition number was 123
13	I record: This shows that Fix Accuracy (FXA) is recorded between bytes 36 and 40 on each B-record line.
14	CIMA comment record: The transfer software wrote this line to say it is made by MYSOFT
15	CIMA comment record: The transfer software wrote this line to say it is version 1.34
16	CIMA comment record: The transfer software wrote this line to say the transfer date was 28 July 2002
17	CIMA comment record: The transfer software wrote this line to say the transfer time was 07:22:32
18	CIMA comment record: The pilot entered into the FR that this is Task 2
19	CIMA comment record: The software operator selected that the atmospheric altitude field in the B records should be filled with GNSS altitude.
20	CIMA comment record: A time zone offset of UTC + 1 hours was applied to all time data by the transfer software operator.

21	B Fix record: This shows a fix with unknown accuracy at 08:53:32 the position was 46°26.036'N 016°57.485'E the pressure alt @ 1013.25 Mb was 157 metres (but a press. Alt sensor was not fitted, see the `HFPRS` line, but it is filled with GPS Altitude data, see the `LCMAOPRS` line), the GPS alt was 157 metres.
22	E event record; The TLC indicates the Pilot Event button was pressed at 08:53:35
23	The B fix record inserted at 08:53:35, the same time as the PEV and the location of that event is 46°25.940'N 016°57.470'E.
24	The next scheduled B fix record at 08:53:37. There will be many of them.

Other notes

If a task was inserted as part of the transfer process, the appropriate `LCMASTIN` record followed by the "C" records would be inserted between lines 20 and 21.

6 USE OF FR's IN MICROLIGHT AND PARAMOTOR CHAMPIONSHIPS

Only CIMA Type 1 approved FR's may be used in championships unless previously agreed by FRAC.

6.1 PILOT RESPONSIBILITIES

The FR to be used by a pilot in a championship will normally be supplied by the pilot.

Before the championship starts each FR must be presented together with its CIMA approval document to the organization for inspection and recording of type and serial number. The pilot must be sure it fully complies with any requirements in the approval document e.g. that manufacturer's seals are intact and it is equipped with a data-port sealing device if it is required or it will be rejected by the organization.

The FR case must be labelled with the pilot's name and competition number.

The pilot must make a data transfer cable and a copy of the transfer software available to the organization if required.

It is the pilot's responsibility to ensure that he is fully aware of the functions and capabilities of his FR eg how to operate the PEV marker button, that it has sufficient battery power and that the antenna is correctly positioned Etc.

6.2 ORGANIZATION RESPONSIBILITIES

The organization must record the serial numbers of each pilots FR so there can be no confusion about which FR belongs to whom.

The organization must always be sure that a particular FR was in a particular aircraft during the task. This will involve either sealing the FR to the aircraft or making a check of its serial number and label before and after each task, or both.

6.3 SCORING

6.3.1 If FR data is to be used for scoring, the organizer MUST have visited EVERY location which could affect the scoring and got a GNSS fix of that position. E.g. turnpoints, hidden marker positions, hidden gates Etc. It is NOT acceptable to extract positions from a map in any circumstances.

6.3.2 A scoring zone will normally be a cylinder of 200m radius and of infinite height. To score, a fix point must either be within this circle or the line connecting two sequential track fixes must pass through the circle. Additionally the task may require one of these fixes to be associated with a PEV "mark".

6.3.3 The central point of all briefed turn-points and gates will be defined by a central point obtained from a GNSS fix and must correspond to features appearing both on the ground and on the official map.

6.3.4 Take-off and landing gates close to decks must be min.100m wide.

6.3.5 The width of other gates deployed in tasks is at the discretion of the competition Director, but must not be less than 200m. This should be increased if the ground feature the gate is fixed on is larger than 200m wide or when the task requires in-flight planning where lines are drawn in flight. In this case the equivalent of at least 1mm on the official map must be added to the minimum gate width (a gate would thus be min. 250m wide with a 1:50,000 map or min. 450m wide with a 1:250,000 map).

6.3.6 Gate or point time is taken from the fix immediately before it is crossed.

6.3.7 Complaints about the physical mis-positioning of a scoring zone relative to EVERY location which could affect the scoring (eg turnpoints, hidden gates, timing gates, IP or FP points..) will not be accepted unless it can be shown that the physical position of the location is outside a circle of radius R= Rp/2 where

Rp= Radius or size of the scoring zone defined by the Organizers (ie the physical location must lie inside an inner circle half the width of a gate or radius of a scoring zone)

6.3.8 Penalties may be applied for airspace infringements. If the FR is only equipped with GNSS altitude then the “permitted error” is 50 metres.

6.4 COPYRIGHT

6.4.1 The ownership of the copyright to any flight recorder trace submitted by a pilot to the organizers of a FAI Category 1 or 2 championship for the purposes of flight analysis and scoring is deemed to be relinquished in favour of the FAI.

7 USE OF FR’s IN MICROLIGHT AND PARAMOTOR RECORD CLAIMS

7.1 The observer must be sure that every condition in a FR’s approval document is complied with.

7.2 In the case of type 3 FR’s see the conditions of use above.

7.3 The ownership of the copyright to any flight recorder trace submitted by a pilot to the FAI for the purposes of substantiating a record claim is deemed to be relinquished in favour of the FAI.

8 DEFINITIONS AND CRITERIA FOR FLIGHT ANALYSIS.

These guidelines are written to establish common criteria for track analysis in Microlight and Paramotor championships and should be of particular interest to Designers of track analysis programs and their users.

8.1 FLIGHT LOG ELEMENTS

Flight logs, also known as tracks are basically composed of a sequence of fixes. Each fix is composed of a pair of coordinates (latitude and longitude), altitude and a time mark.

The interval between two consecutive fixes is the logging period.

The track can be viewed as a sequence of points (track points), but for the purpose of its analysis it is also convenient to think of it as a sequence of segments (track segments) defined by pairs of consecutive points.

Speed can be calculated for each segment:

S = segment length / logging period

Acceleration can be calculated for every point (except the first and last ones)

A = speed difference between adjacent segments / logging period

(Note this is longitudinal acceleration, it doesn't include normal acceleration)

8.2 INVALID FIXES

Checking acceleration at every fix is an easy way to detect noise due to signal reception problems. Longitudinal accelerations higher than 2 m/s are very strange in Microlights or Paramotors.

High acceleration points and adjacent segments should be discarded during flight log analysis.

8.3 CROSSING GATES

Gates are defined by two end points forming a segment.

When a track segment cuts the segment formed by the two gate ends, the gate is said to be crossed. This can be done in two different directions. When a task specifies a certain direction for crossing a gate, the inverse crossing is considered incorrect.

8.4 TIMING IN GATES

Crossing time will be taken from the oldest point defining the track segment that crosses the gate. This is the track point just before crossing the gate.

8.5 CROSSING TURN-POINTS

Turn points are defined by a central point, referenced to a ground feature, and a certain radius forming a circle, this is known as the scoring zone.

When a track segment cuts, enters or exits the scoring zone or it entirely lies inside of it, the turn point is said to be crossed. Normally, more than one track segment crosses the scoring zone.

The scoring zone radius is a margin to absorb a number of error sources: GPS error when taking the fix by the organization, GPS error when pilot flies over the point, size of the ground feature, cartographic precision.

If a pilot is flying to and from a certain turn-point, and he decides to turn back at some distance before the actual ground feature, he is taking chances. The only way for a pilot to be sure of flying through a turn-point scoring zone is to fly exactly above the reference ground feature.

8.6 TIMING IN TURN-POINTS

One of the segments that crosses the scoring zone is nearest to the centre. Crossing time will be taken from the oldest point defining this track segment. This it is the track point just before reaching the nearest distance to the ideal centre of the turn-point.

When crossing time is to be checked against an estimation given by the pilot or calculated by the scoring team, a margin equivalent to the logging period (P) must be applied. If a pilot crosses the turn-point up to P seconds too early or too late, he gets a zero (0) time error in the turn-point. If a pilot crosses the turn-point one more second too early or too late, he gets 1 second error in the turn-point.

The logging period (P) applied above must be the maximum allowed, regardless of the specific logging period used by an individual competitor, to avoid random advantage of some pilots over others. P is currently 5 seconds (A6 2.1.1.3)

8.7 TAKE OFF AND LANDING TIME OR POSITION

The best method for measuring start or finish times is by using a start or finish turn-points or gates. However, in the case that take-off or landing times or positions are needed, the following procedures can be used:

8.7.1 Classic classes

- Take-off time: A take-off gate is placed at the end of the take-off deck.

- Landing time: A landing gate is placed at the beginning of the landing deck.

Take-off and landing gates will be defined by a central point obtained from a GNSS fix and sufficient margin on both sides to avoid problems with noise. A total width of 100 m has been proven to be enough.

Basically, the idea is to make measurements while the aircraft has a speed compatible with flight. Otherwise, random measurements are obtained with lower speeds.

8.7.2 Classes PF & PL

- Take-off: Time or position of the oldest fix in the first segment with a speed compatible with flight, which is maintained in the next segments.

- Landing: Time or position of the oldest fix in the last segment with a speed compatible with flight, which was maintained in the previous segments.

9 TESTS FOR ELECTRONIC ‘KICK STICK’ SENSORS

These tests are designed so manufacturers understand the requirement, and to be sufficiently simple that any system can be quickly demonstrated to be compliant with the standard at any time, eg before the system is used to measure a task.

9.1 COMPLIANCE

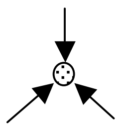
When automatic devices are used to capture the time or validity of a kick to a slalom pole, the device shall conform to the following standard.

9.2 GENERAL SPECIFICATION

All tests shall be conducted on a standard FIS (Federation Internationale du Ski) approved slalom pole. (The full specification can be found at *http://www.fis-ski.com/data/document/kipspeze.pdf*)

The device may be internal or external to the pole but it must be arranged such that there is little or no risk of the device injuring the crew or damaging the aircraft whilst an attempt is being made to strike the stick in flight.

Each of the three tests must be made three times from three equally divided directions. At least all nine tests must succeed consecutively but it is expected that in general use it will be reliable enough that there will be no device errors in a typical international championship.



3 directions
3 tests

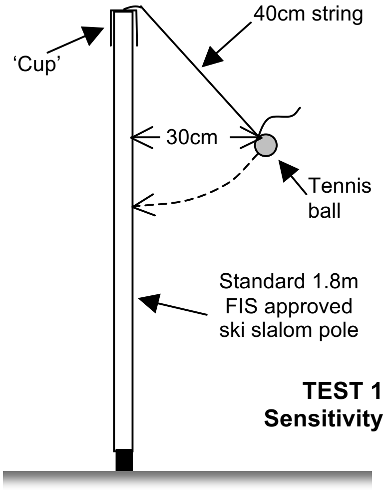
9.3 TEST 1: SENSITIVITY

This is a test to establish that the sensor will reliably register 'the minimum strike' and no further secondary strikes.

A 'cup and ball' device of the stated dimensions is fitted to the slalom pole.

With the pole in a vertical position, the tester pulls the ball away from the pole by holding the short string until it is 30cm from the pole, then releases it from a stationary position to swing and strike the pole. The device must register only the first strike of the ball on the pole.

The 'cup' may be made of any lightweight material of a size which fits reasonably well over the top of the slalom pole, eg an aluminium drinks can cut in half. The 40cm string derives from the centre of the cup to the ball which is a standard tennis ball. A third 30cm string may be fitted to the device as a measure of the distance from the pole that the ball must be released.



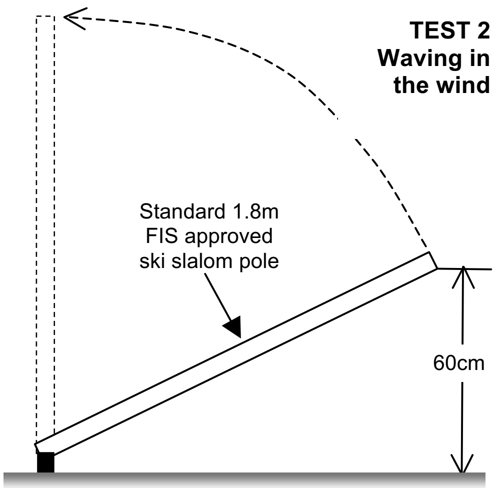
TEST 1 Sensitivity

9.4 TEST 2: WAVING IN THE WIND

This is a test to establish that the device will reliably NOT register a 'strike' when the propeller blast of an aircraft passing close by causes the pole to wave around in the wind.

The vertical pole is bent over until the tip is 60cm from the ground; then the pole is released gently.

The device must NOT register any 'strike' on the pole between release and when it comes to rest back in the vertical position.



TEST 2 Waving in the wind

9.5 TEST 3: MULTIPLE STRIKES

This is a test to establish that the device will only register the first 'strike' and not secondary ones, eg if the pole is struck sufficiently hard that it subsequently hits the ground one or more times.

The vertical pole is struck with sufficient force by a hard object that it hits the ground after being struck. The first strike must register, the secondary strike(s) on the ground must NOT be registered.

APPENDIX 1 TO GNSS FR SPECIFICATION

SAMPLE TEST AND EVALUATION SCHEDULE

The following tests may be carried out under the auspices of each member of FRAC. Members may delegate detailed testing and assessment to other experts who are bound by the same confidentiality as FRAC itself. Results, assessments and opinions will be confidential to FRAC members, their advisors and to CIMA or FAI officials who may be involved if CIMA or FAI policy may be affected. These tests are not necessarily all and FRAC reserve the right to carry out any other non-destructive testing where it is deemed relevant to assessing the probable validity of flight data.

1 GENERAL REQUIREMENTS.

The following aspects will be evaluated:

- Ease of operation and reliability in an air sport environment, particularly at large competitions.
- Integrity of data.
- Fix accuracy
- Recording of errors and anomalies
- Security against unauthorised input, output and changes to data
- Failure recovery
- Data transfer and resultant file structure.

2 PHYSICAL INSPECTION OF THE EQUIPMENT

2.1 Quality of construction and components.

2.2 Layout and type of components. Susceptibility to inadvertent or deliberate production of invalid flight data. sealing, shielding, access, construction of the recorded flight data processor memory and relation to other components.

2.3 Identification: That manufacturer's name, serial number and FR firmware versions are readily accessible.

2.4 Use whilst in a Microlight or Paramotor, e.g. methods of attachment to the aircraft and operation while wearing thick gloves.

2.5 Crashworthiness: Preservation of flight data after impact, damage or power loss. Safety to the user (excessive weight, sharp edges Etc).

2.6 User documentation. Adequately explains the proper use of the equipment and it's limitations e.g. antenna positioning, satellite acquisition, memory capacity, resetting Etc.

3 SYSTEM ACCURACY AND RECORDING CAPABILITY

3.1 Ground Tests.

Several ground runs of the equipment will be made. Runs of up to 12 hours may be undertaken in order to check, amongst other things, memory capacity for long flights. Accuracy will be recorded over surveyed ground positions. Operation of the PEV button.

3.1.1 Temperature of the equipment may be varied during the test runs between +40C and -20C, depending on facilities available to the tester.

3.1.2 The pressure-altitude recording system (if fitted) will be calibrated using standard procedures for barograph calibration and a calibration chart will be produced. (See IGC-FR-TS)

4.2 Flight Tests.

Flight tests will be made in several types of Microlight and Paramotor.

4.2.1 Accuracy. Flights will take place either on accurately-recorded routes or over accurately-surveyed points and/or in aircraft fitted with known GNSS FR equipment used as a "control". Flight data will be compared between the output of a control GNSS device and the equipment under test.

4.2.2 Manoeuvring flight. Tests will be carried out in manoeuvring flight to check for anomalies. FRs will be tested under rapid pitch, roll and turn, and also at extreme attitudes and in high-G situations. The possibility of "throwing forward" fixes by turning rapidly after a high speed run, will also be assessed.

4.2.3 Pressure altitude recording. Tests will be made on the barograph function. (if fitted).

5 SECURITY

5.1 General. Tests will be made to assess the susceptibility of the equipment as a whole to corruption of the recorded flight data by inadvertent or deliberate means.

5.2 Minimum standard. The minimum standard is a positive identification that the case of the FR has not been opened and that it is impossible to extract any flight information from the FR whilst it is recording either through a built-in display or connection to an external device.

5.3 Security protection and procedures before and after flight, and the role of OOs, will be assessed.

6 POWER SOURCE.

Measurements of battery life under different conditions of charge and temperature will be made. A set of fully charged batteries must sustain the device for at least 5 hours and misleading results must not be produced as voltage falls. If there is a significant problem it may be necessary to introduce a LOV code. (See IGC-FR-TS)

7 ELECTROMAGNETIC INTERFERENCE.

Susceptibility to Electromagnetic Interference (EMI) will be assessed to the current European requirements. FR function must be resistant to levels of EMI that could be experienced in Microlight and Paramotor flight, eg engine magneto noise, VHF radio and mobile phone transmissions.

8 TRANSFER SOFTWARE.

Tests will be made to check the speed, reliability and ease of use of the transfer software in the hands of an inexperienced operator.

8.1 Program features: Checks will be made to ensure that the options, file-naming protocol and transformation options are presented exactly in conformance with the CIMA standard and that any data-transformation calculations are correct.

8.2 File format: Checks will be made to ensure the file format is precisely in accordance with the CIMA standard.

8.3 Documentation: Documentation (or ideally source-code) of the transfer software must be included explaining any mathematical conversions or other transformations made by the software.

APPENDIX 2 TO GNSS FR SPECIFICATION

SAMPLE FR APPROVAL DOCUMENT

Fédération Aéronautique Internationale (FAI)
Maison du Sport International, Av. de Rhodanie 54, 1007 Lausanne, Switzerland
Tel: +41 (0)21 345 10 70 - Fax: +41 (0)21 345 10 77
email: sec@fai.org website: www.fai.org

FAI Microlight Commission (CIMA) Flight Recorder approval document

Approval document version
Version reference of this document and number of pages.

Flight recorder name: *Full name of FR*

Manufacturer: *Name, address, telephone, email, website of manufacturer*

Applicable serial numbers: *Either 'All' or state FR serial number range to which this approval applies.*

Hardware version: *State hardware version and where/how this is checked*

Firmware version: *State firmware version and where/how this is checked*

Transfer software name: *State transfer software name and where/how this is checked*

Transfer software version: *State transfer software version and where/how this is checked*

CIMA approval date
Date Combination of hardware / firmware / transfer software stated above was approved by FRAC on behalf of CIMA.

General Description

Hardware: *State size, colour, general configuration, position and type of manufacturer's seals, permitted external connections, type of data transfer cable Etc*

Firmware: *State functions available in the FR.*

Transfer software: *State functions available in the Transfer software and how data is transferred.*

This flight recorder is approved to CIMA Type 1 standard in the hardware / firmware / transfer software configuration above subject to the conditions below.

Special conditions for use in Microlight and Paramotor championships

1 The FR, together with a copy of this document must be presented to the organization before the start of the championship for inspection and recording of serial number.

2 The pilot must make a data transfer cable and a copy of the transfer software available to the organization if required.

3 The FR must have a label on the case with pilot's name and competition number on it.

State method of sealing, procedure for checking serial number and manufacturer's seals what UTC local time offset should be applied, any special procedures for sealing data ports, extracting data or reading data.

Special conditions for use in Microlight and Paramotor records

State Microlight and Paramotor records in which this FR may be used and how the evidence should be presented to FAI.
State method of sealing, procedure for checking serial number, what UTC local time offset should be applied, any special procedures for sealing data ports, extracting data or reading data.