EDIC FOR FREE FLIGHT V1.2

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EF1 ALTIMETERS TO DETERMINE FLIGHT DURATION

Update Record

Produced by F1 Subcommittee Chairman and developed in Subcommittee and with Chairman EDIC through a number of drafts.

EF1.1 Introduction

The 2017 CIAM Plenary Meeting approved a proposal to have optional confirmation of flight time in flyoffs by review of altimeter records. This has been included in Volume F1 of the Sporting Code at paragraph F1.2.7.

At the time of approval by CIAM the proposal had not been considered by EDIC. The purpose of this document is to propose the minimum specification of altimeters suitable for the intent of that proposal but with improved control to facilitate the application of altimeters:-

a) identification of devices so that a known device is used for a specific flight without requiring the pattern recognition procedure mandated in F1.2.7

b) assurance that the time basis of the altimeter records are accurate and cannot be subject to tampering

c) to require a standard interface for replay of the altimeter records so that this can be carried out in a consistent manner

The nearest equivalent device considered by EDIC is the altimeter used in Space Models. This device detects the moment of launch by a change of altitude which would be suitable for F1B and F1C launched from the ground, but not for F1A models which are released from the towline at altitude. It is not essential to have a specific indication of the moment of launch, which can be found by inspection of the altitude trace, but identifying moment of launch would simplify interpretation of the trace.

Another feature of the space model altimeter is that it accepts only one flight record and can only be used for another flight when it has been read and reset. While this is suitable for the mandatory use of altimeters in all space model flights and provides security against some forms of cheating, it would be unduly restrictive for the optional use of altimeters under the current F1 regulations which may also involve multiple flyoff flights.

In addition to the immediate need to meet the needs of F1.2.7 it is also considered that in future the use of an altimeter could provide altitude data which would allow a determination of the winner in a flyoff restricted below the normal specified durations for flyoffs. This would provide an alternative to the present occurrence of “DT flyoffs” which are outside the 2019 Sporting Code but provide a means to conclude a flyoff when conditions do not allow a normal long duration flyoff. A future change to use altimeters in this application requires the specification of the accuracy of the altitude data given in this document but which is not essential for use under F1.2.7.

EF1.2 Altimeter Specification

a) Use a barometric pressure measurement technique.

b) The calculation of pressure shall include any calibration parameters and recommendations provided by the pressure transducer manufacture

c) The conversion of pressure measurements to altitude must conform to the international standard atmosphere as defined in Manual of the ICAO Standard Atmosphere ICAO 7488/3.

As an example from this reference the relationship of altitude to pressure in the standard atmosphere at 15C is given by

Altitude = $K1 * [1 – (P/P_0)^{K2}]$ metres

where $K1 = -T/L = 44330.769$ metres

$K2 = -R\ L/g_0 = 0.190263$

T is temperature Kelvin

L is lapse rate (deg per metre)

R specific gas constant

g_0 acceleration due to gravity

d) The accuracy of the altitude measurement should be within 2 metres or 0.5% of altitude, whichever is the greater. This should be maintained over a temperature range of -10°C to +50°C with a working range of at least 1000 metres from sites at up to 2000 metres altitude.

e) Altitude should be recorded in metres to at least one decimal place

f) Timing accuracy should be within 1 sec over a time of 1000 sec.

g) The data sampling rate shall be not less than 5 samples per second.

h) Recording capacity must be sufficient for at 40 minutes recording.

i) Be powered by connection to a battery included in the model or by a dedicated battery, either rechargeable or non-rechargeable, having sufficient capacity to operate the altimeter for a minimum of one hour before requiring recharging or replacement.

j) Retain the flight data including after power removed.

k) Be equipped with a data communication interface to be used for accessing data and the software and hardware required for the interface must be defined. It is desirable that a common standard be adopted, to be defined in a future revision of the specification after discussion with manufacturers.

l) Carry a unique serial number allocated to the altimeter by the manufacturer and which is also accessible electronically with the flight data. This serial number may be marked on a durable label securely attached either directly to the altimeter or on leads from which it cannot be removed.

m) Provide an audible and/or visual indication of its operating status. For the purposes of this document 'flashes' shall mean audible beeps and/or visual flashes.

n) Have no configurable settings or adjustments that allow the user to modify its operation such that it will operate outside the requirements of the competition rules.

o) To record multiple flight data sequentially so that the last flight made is shown by the last set of data shown on data playback.

EF1.3 Operation

Following the application of power, the altimeter shall determine whether it is in a Flight Recording Mode or connected to a readout device in Data Communication Mode.

EF1.3.1 Flight Recording Mode

a) On application of power, the altimeter shall indicate readiness to accept flight data by single flashes with a repetition rate of once every second.

b) Multiple flights must be recorded in sequential order so that last flight is identifiable.

c) The altimeter shall continue recording until power is removed or has reached storage limits.

EF1.3.2 Data Communication Mode

Data Communication Mode is required for retrieval of flight data.

In Data Communication Mode the altimeter will indicate that it is connected in this mode and contains flight data by 2 flashes every second.

The altimeter must connect with a digital device such as a computer equipped with a software package that will:

a) Display the firmware revision level of the processing firmware loaded onto the altimeter.

b) Display the unique serial number of the altimeter.

c) Display the full digital output of the altimeter's altitude versus time data in graphical and tabular format for the last flight recorded on the altimeter.

d) Record a file containing the information in (a), (b) and (c).

e) Permit resetting the altimeter so that any previously recorded flight data is deleted and can no longer be retrieved from the altimeter.

When making an official flight for which the competitor might require the altimeter record to be considered, the timekeeper will record the serial number of the altimeter installed in the model for

that flight. This represent the evidence of which altimeter provides the evidence for that flight if required.

EF1.4 Device Approval

All altimeters used to provide flight time information in FAI competitions must be of an approved type. In order to give CIAM approval to a device, the verification procedure must be followed:

a) Record the manufacturer, and the model and software variants of the device tested.

b) Demonstrate that the recorded altitude has a consistent variation with actual altitude and meets the accuracy requirement. . This requires the use of a partial vacuum chamber. To confirm accuracy a calibrated altimeter should be included in the chamber and for consistency of altimeters a number should be tested simultaneously. The procedure is:

   i) Place the altimeters in the chamber and switch on to start flight recording mode

   ii) Reduce pressure in the chamber as smoothly as possible until the pressure has dropped to 85% of the ambient pressure (which represents an altitude gain of 1350m), then continue to 70% pressure (2907m), then slowly restore the pressure to ambient.

   iii) Stop altimeter recording and inspect the altitude traces. It is required that the altitude should change consistently without any reversals of altitude while the pressure was decreasing and increasing. Checks should be made of the altimeter accuracy by the changes between altitude readings at ambient pressure and the 85% and 70% pressures.

c) Check timing accuracy with the following procedure:

   i) Switch on the altimeter to start flight recording mode

   ii) Rapidly raise the altimeter at least 1m while starting a stopwatch

   iii) Approximately 17 minutes later rapidly lower the altimeter while stopping the stopwatch.

   iv) Download the data from the altimeter and check that the time indicated by the trace is not significantly more than one second different from the time recorded on the stopwatch.

d) Check effect of temperature at ambient temperature

   i) Switch on the altimeter to start flight recording mode

   ii) Lower temperature in enclosure containing altimeter to $-10^{o}C$

   iii) Slowly raise the temperature to $50^{o}C$

   iv) Stop altitude recording and inspect altitude traces. Variations of altitude over the temperature range should not exceed 2m

EF2 ENERGY LIMITERS FOR F1Q

Update Record

Produced by F1 Subcommittee Chairman and developed in Subcommittee and with Chairman EDIC through a number of drafts.

EF2.1 Introduction

When F1Q was first introduced the power limitation was by battery size and duration of motor run. In 2012 this was replaced by a concept of energy allowance which was observed by either power measurement and run duration or by an energy limiter. In 2018 the regulation was changed to require an energy limiter. As a mandated electronic device in the model specification it is required that and EDIC specification and approval of devices is established.

An energy limiter for use in F1Q under these regulations will be referred to as an F1QEL.

One feature required by the specification is that the F1QEL has a display showing the energy limit that has been set. This is not available on all energy limiters currently used and it could be appropriate to delay the implementation of this part of the requirements to a later date than the other aspects of the specification.

EF2.2 Requirements

The energy allowed for an F1Q model flight is defined by the Sporting Code. In order to respect the limit it is necessary to ensure that the energy limiters used in F1Q are of adequate accuracy which cannot be adjusted by the competitor. It is necessary that the energy limiter operates according to the set energy limit and that this limit is displayed for easy confirmation by officials.

The F1QEL Specification has been formulated with the following objectives:

a) To accurately limit the consumed energy as required for the competition.

b) To ensure that the EL can only function as required by the rules of the competition and cannot be operated, unintentionally or otherwise, in any other manner.

c) To provide a standard method of operation so that, irrespective of F1QEL manufacture, verification testing can be performed easily with a defined test procedure.

d) To display the value of the energy limit which has been set

e) To define standard connectors for compatibility with test facilities and to reduce the risk of accidental damage during handling by competition officials.

f) To provide a standard method of determining that the F1QEL is of the type for which an approval has been granted.

g) To guarantee the particular version for which the device was approved.

EF2.3 Technical Specifications

This section is the formal technical specification for F1QEL.

a) Current measurement will be by use of resistive shunt resistor or current sensing Hall effect sensor installed in the positive side of the power lead between the battery and the motor controller.

b) Voltage measurement will be made between the positive and negative leads of the battery that supplies power for the motor. The battery voltage measurement is to be taken on the battery side of the measurement device.

c) The method of converting current and voltage to energy units (joules), must be such that the specified accuracy is ensured over the operating range. The calculation will be joules = watts x seconds motor run, where watts=volts x amps

d) The motor will be stopped once the accumulated energy limit has been reached. The stop signal may be either by direct command of the motor through the ESC or by a stop signal sent to timer or other intermediate device which controls the ESC.

e) The F1QEL must have compatibility with ESCs using the nominal 1 to 2 milliseconds (ms) control signal such that no low speed motor drive occurs when “motor stop” is instituted either by the F1QEL or any other device.

f) The supply of power to the F1QEL shall be that available from the ESC motor command connector or from the battery power lead. If the power source to the timer and other devices on the aircraft then it is permissible for this to be supplied via the F1QEL.

g) The connectors of the F1QEL shall be of a universal type compatible with JR/Futaba and must be proof against any misalignment that could result in electrical damage to the F1QEL or connected equipment. An extension lead may be used to satisfy this requirement.

h) Except for setting the maximum energy, there must be no configurable settings or adjustments that allow the user to modify the operation of the F1QEL such that it will operate outside the requirements of the competition rules.

i) The F1QEL must start measuring energy used from the end of a start switch signal indicating the moment of launching the model

EF2.4 Accuracy of the F1QEL

a) The accuracy of the determined energy (joules) shall be within the range +/- 2%. This accuracy must be achieved across input voltage between 4 and 20 volts and across 2 to 20 amps and ambient temperature range of -10 to +50 degrees centigrade.

b) The calculation of the energy shall incorporate any calibration parameters provided by the current sensor manufacturer.

c) The sampling rate of the power measurement used for energy usage determination shall be a minimum of 10 samples per second.

EF2.5 Starting condition

The F1QEL shall initialize using the following procedure:

a) Immediately on application of power to the F1QEL it will zero out the energy accumulator.

b) For the first 5 seconds after application of power the F1QEL must display the firmware revision level.

c) After 5 seconds the F1QEL must display energy consumed on the last run and the current energy setting.

d) The motor command will initialize to the “off state” and will remain there until commanded otherwise.

e) The limiter must have the capability to detect the moment of launching the model via a parallel connection to the start switch of the timer. After the start switch is pressed, the limiter must let pass the motor command signal coming from timer to ESC. The F1QEL must start to accumulate energy consumption (joules) from the time of switch release (when the model is released from the competitor’s hand).

EF2.6 Stopping condition

When the allowed energy amount is reached the F1QEL must generate a motor stop signal and/or set the duration of motor control pulses to 1 ms (motor stop condition).

EF2.7 Technical Considerations

This section is provided as design guidance on F1QELs.

EF2.7.1 Connector Compatibility

The F1QEL shall use standard JR/Futaba type connectors for both the signal in and outputs and the signal from the start switch.

The power connectors will be 3.5mm connectors with a female to accept the positive lead from the battery and a male plug to connect with the positive lead to the ESC. A connector from the F1QEL to the negative lead between the battery and ESC should be fitted with a male 2mm plug.

EF2.7.2 ESC Compatibility

F1QEL specification assumes that when direct control of ESC is used the motor stops at pulses of 1ms. When an ESC is programmable it should be set to operate with the defined motor-on threshold.

EF2.8 Installation Environment

a) The installation and functioning of the F1QEL, the ESC, the motor, and the timer and other devices is the sole responsibility of the competitor, who must ensure that they operate together in the correct manner as required for the rules of the competition.

b) The F1QEL must be installed in such a way that it is protected from mechanical damage.

c) The F1QEL must be placed inside the model in the state as supplied by the manufacturer.

d) The use of any method that modifies the current or voltage sensing at any time is prohibited.

e) In the case when the F1QEL controls the ESC, the ESC must always operate via its series connection to the F1QEL

f) The F1QEL display of energy setting must be readily visible for checking before launch or after the flight.

g) When the F1QEL controls motor stop via a timer, the competitor must be able to demonstrate in ground test that the motor stop is initiated at the same time as the F1QEL display shows reaching the energy limit.

EF2.9 Verification of F1QELs

All F1QDELs used in an F1Q competition are required to be of an approved type. The process of verifying a type for approval is to confirm that the operation and accuracy are according to the specifications.

EF2.9.1 Equipment required for testing.

a) A regulated power supply capable of 0 to 12 volts output.

b) A current source capable of up to 10 amps.

c) A constant current electronic load capable of up to 10 amps.

d) Suitable meters and shunts for reading current and voltage with 1% or better accuracy.

e) Stopwatch capable of at least 0.1 second resolution.

f) A “servo simulator” to generate a motor command pulse.

g) A start switch connected to the EL to indicate the start of EL accumulation.

h) Suitable meter or oscilloscope to monitor motor command output of F1QEL.

EF2.9.2 Test sequence

EF2.9.3 Verification testing will be carried out for two energy limits and loads:

a) Energy limit 800 joules and 40 watts. The voltage for testing will be 10 volts and the current will be 4 amps.

b) Energy limit 1600 joules and 80 watts. The voltage for testing will be 10 volts and the current will be 8 amps.

The following test sequence will be conducted with these two energy limits and load:

c) Set the F1QEL energy limit

d) Apply the simulated load of the appropriate watts using the above test equipment.

e) The stopwatch will be started when the start switch is released.

f) The output from the F1QEL will be monitored. When the motor pulse changes to below 1.2ms or the stop signal is given then the stopwatch will be stopped and the 80 watt load terminated. The time will be recorded.

EF2.9.4 Test Pass/Fail limits

An F1QEL is considered to have passed if it reduces the motor command to below 1.2ms it issues the stop signal within 20 seconds after the start of test. The tolerance is +/-2%,i.e. 19.6 to 20.4 seconds. The same tolerance of +/-2% applies to the displayed energy (e.g 784 to 816 joules for the nominal 800 joule test). Note that this is a statement of accuracy and does not imply any allowance to exceed the maximum motor run allowed in the F1Q rules as an additional constraint as well as energy limits.

An F1QEL is considered to have passed if all the test requirements outlined in this document are satisfied.

EF2.10 Firmware Revision Level

Displaying the firmware revision level shall occur for the first 5 s following the application of power to the F1QEL. On completion of the 5 s period, the display shall continue to show the recorded energy consumption of the last flight and the actual setting of energy amount, until a new energy accumulating start signal is detected

EF2.11 Submission of F1QEL Devices for Approval

The CIAM is establishing a Working Group to assume responsibility for the approval process. The services of a technical expert may be used to undertake the practical testing on behalf of the Working Group. Further details will be advised in due course, together with the specific requirements concerning the presentation of devices for approval.

Devices submitted for approval must be to normal production standard and must incorporate firmware at the revision level that is to be evaluated.

Supporting documentation shall include the sensor manufacturer's data sheet on the pressure sensor device with particular reference to long term drift and temperature variation characteristics. Additional supporting information may be required at the request of the technical expert undertaking the evaluation on behalf of the CIAM Working Group.

Approval, when granted, will relate to a specific hardware/firmware combination. Any subsequent modification to hardware or firmware must be notified to the CIAM committee and advice will be provided concerning any requirements for upgrading the previously granted approval.

EF2.12 Withdrawal of Approved Status

An approved F1QEL may have its Approved Status withdrawn if inconsistencies of performance are found in further examples of the F1QEL.

If, subsequent to the granting of an approval status, the rules of the competition are amended in a manner that affects the technical specification of the F1QEL, the validity of all F1QEL devices on the Approved List will be subject to review.

EF3 FLIGHT TIME RECORDING SYSTEM

Update Record

Produced by F1 Subcommittee Chairman and developed in Subcommittee and with Chairman EDIC through a number of drafts.

EF3.1 Introduction

This section presents a VERY INITIAL DRAFT OF SUGGESTIONS for a possible system to record flight times and transmits this to a central receiver system. The intent of this is for review and consideration of fundamentals before finalising the definition of devices to be approved and used under such a system. Comments on practicality and features would be welcome from all, but especially from potential system developers

EF3.2 Outline

In F5B a telemetry system is used to communicate flight events to a base station. Radio Control duration classes are also working on landing detection systems.

There are many potential advantages for free flight with an automatic flight timing method which transmits the time to a central monitor station, such as:

a) Accurate

b) Possible system

The current optional use of an altimeter to demonstrate flight time provides a starting point for an on-board recording system referred to here as an F1REC. Compared to a basic altimeter, additional features are required for an F1REC:

a) A start of flight indication – by a switch released when launching F1B, F1C, F1E and F1Q or a switch released when the towline leaves an F1A model (hook release, acceleration sensor, etc)

b) A landing detection system. At the simplest level this could be my monitoring altitude until no change was detected for several seconds (which would then be subtracted to give the flight time. This could be augmented by GPS and detection of no change of position for a similar defined time. If further reference was required this could be provided by an accelerometer, again showing no movement for a defined time.

c) The landing system detection could also operate alongside a monitor of the flight time so that timing ceased when the maximum was reached, but there could be advantages in recording when and where the model actually landed (such as after a long DT descent)

d) An advantage of including GPS would be reference to a standard time base so that times of events could be transmitted as actual time of launch and time of landing, reducing dependence on the time base within the device. It would also remove the need for a competitor to have a separate GPS location system.

e) For power models (including electric) a means of detecting the end of the motor run and for electric models the energy consumed as recorded by the energy limiter.

f) Transmission of the flight data to the base station. This would be identified by the unique serial number of the recording device. Possibly a start of flight and end of flight transmission would be sufficient, but with the possibility of monitor reports during the flight. Each transmission would be repeated until acknowledgement was received from the base station. The base station could inform the F1REC of the maximum time for the flight when it acknowledged a start of flight message.

g) Storage of the flight data for use in the event of a communication problem with transmitted information.

EF3.3 Operation

It is assumed that each competitor would be required to have his own F1REC. These would have to be known approved devices which gave no opportunity to modify their operation and each one

identified by a unique serial number. The F1REC would be installed in the model with input from a start switch and a power supply.

When preparing for an official flight the timekeeper would confirm the serial number of the device corresponded to the competitor. The timekeeper would observe the launch and the flight and note any exceptional events, such as a collision or part detached from the model.

It could be possible for the competitor to have a hand held device recording the data transmissions from the model. This would provide confirmation of the data and inform him of motor run and the final flight time. In addition, if the system includes GPS, this device could also serve as his GPS receiver for retrieval of the model.

The base station would receive the data transmitted from the model, detect an infringement (such an over-run, or launch after the end of round) or record a valid flight time for the competitor recorded as using that F1REC.

Detailed sequence of operation when using transmission to a base station and the protocol for handling different categories of communication could be:

a) When preparing to make a flight the timekeeper checks the serial number of the F1REC.

b) When power is applied to the F1REC it clears previous flight data from memory and makes a transmission type 1 to give its identity to the base station, which responds with acknowledgment 1, possibly including the time of the maximum for the flight. The F1REC gives a ready signal (one flash every second) when the acknowledgment has been received and it is ready for flight (if GPS is included when the location has been determined)

c) During the flight the F1REC records data on time, altitude, location, acceleration data, F1Q energy consumption, F1C motor run (according to what is available)

d) At periods during the flight the F1REC periodically (e.g. every 15 seconds?) makes a transmission type 2 to report the instantaneous data values to the base station, which responds with acknowledgement 2.

e) At the end of the flight the F1REC makes a transmission type 3 to give the end of flight signal to the bases station including altitude at time of maximum, flight duration, location, F1Q energy consumption, F1C motor run, the base unit responds with acknowledgement 3 and terminates collecting data from this F1REC.

f) If the periodic type 2 transmissions have not been received for at least 2 consecutive periods or if no end of flight type 3 transmission is received, then the last data received will be taken as the provisional end of flight and the data stored on the F1REC will be checked when the aircraft has been retrieved.

Some modification would be required to have the F1REC operate as a flight recorder without transmission to base station. This could be handled by a switch or setup procedure so that the unit does not wait for acknowledgements from the base station.

EF3.4 Possible extensions

The system would give several additional features which could be invoked for additional measurements of performance or for flight limitations or aids to organisers.

The base station record of the GPS data for each model would give a clear indication of where models were landing during a round and would provide information for adjustment of the maximum for the next round, to avoid hazards or retrieval problems.

Altitude at the time of reaching the maximum duration could be used as an additional indication of performance. The total altitude at the end of each max could be an alternative means of deciding the result instead of a flyoff, or could be used as a first cut in selecting perhaps 10% of competitors for a flyoff. The flyoff could be for a moderate maximum time if required by the conditions and the field size, with altitude then used for any final determination of the winner. One result of inclusion of altitude in the classification of performance would be that maximum could be set to a time suitable for the field and wind conditions, since there would not be the same pressure to have long maxes in order to avoid large flyoffs. Avoiding long maxes in this way would also reduce any consideration of models being timed far away and out of sight.