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FAI AEROMODELLING COMMISSION (CIAM)
ELECTRONIC DEVICES IN COMPETITIONS WORKING GROUP (EDIC-WG)

References:
FAI web site: www.fai.org
CIAM website: www.fai.org/aeromodelling

To: CIAM web site under AMRT Approvals
CIAM Technical Secretary
F1 Sub Committee

Copy: Manufacturer Concerned

Date: 05 March 2024

CIAM APPROVAL FOR F1Q Energy Limiter

Approval Reference: **F1QEL003**
Manufacturer: **Mikko Sivonen**
Manufacturer Contact: **mikko.sivonen@gmail.com**
Device Name/s: **MS limiter**

(i)   This document gives formal approval from the above date for the AMRT equipment described below to be used for competitions under the Sporting Code Section 4: Aeromodelling – Class F1 – Free Flight.

(ii)   This document is the initial approval for this type of AMRT and only applies to the functions relevant to the F competition class rules.

(iii)   Tests undertaken by EDIC-WG (or such representative as it may appoint), are specifically concerned with the functions relevant to the F1 competition class rules.
Other functions of the equipment are not part of this approval and the relevance of this document does not extend beyond the specific validation and certification purposes mentioned above.

(iv)   This document does not constitute a guarantee of compatibility of the device listed above with any associated devices with which it may be interconnected.

(v)   This document does not constitute any guarantee and/or statement by EDIC-WG, CIAM and/or FAI as to the reliability of the device listed above.

(vi)   This approval is not concerned with National and other regulations relating to electronic equipment and compliance with such regulations is not the responsibility of the FAI.

(vii)   This approval is not concerned with, and the FAI has no responsibility for, matters related to:
(a) Intellectual property and intellectual property rights and/or,
(b) Relations of the manufacturer listed above with any other entities except with FAI and its agents or as they affect the FAI, its agents and this approval.

EQUIPMENT

1 PRINCIPLE OF OPERATION

The ms limiter measures time and consumed energy and monitors ESC pulse from timer, supply voltage and current. The motor is stopped when energy or time limit is reached, ESC pulse width drops below 1.02 ms, the maximum voltage or current has exceeded, or voltage has dropped below minimum.

2 HARDWARE

2.1 Equipment Name

"ms limiter"

2.2 Hardware Version

Official hardware version is **4.09** and it is printed on the printed circuit board between minus connectors on the display side of the board. Shrink tube must be removed to be able to see the hardware version number.

2.3 External Features

The 'ms' energy limiter consists of a single electronic board equipped with an OLED display. It features built-in 3.5mm bullet power connectors, cables with 3-pin and 2-pin male female JR/Futaba connector for digital I/O signals, and a tact switch for energy limit setting.

2.4 Current/Voltage sensing

The voltage is measured with resistor divider and the current is measured through a shunt resistor. Both voltage and current are digitized through a 16-bit ADCs.

3 FIRMWARE

The firmware of the ms limiter, as well as its version number, reside in the flash memory of the microcontroller. They are read-protected and cannot be altered in any way by the user.

3.1 Firmware version

The currently supported firmware version is **V1.1**. The firmware version is displayed when the ms limiter is turned on.

3.2 Sampling rate

Current and Voltage sample rate exceeds 40 samples/s.

3.3 Minimum current threshold

The minimum current threshold is to 0.5 Amps.

3.4 Calibration

Each device is individually calibrated. Calibrating parameters are stored in the program memory of the microcontroller. User manipulation of the calibration parameters is not possible.

3.5 Energy calculation

Time period of the measurement/calculation cycle is measured and the energy consumed during the measurement/calculation cycle is counted with the formula: voltage x current x time (s).

3.6 Displayed information

When switched on, the ms limiter displays in sequence its firmware version and serial number, the values of the previous flight (consumed energy, motor running time and stop source) and allowed energy and time setup values.

3.7 Displayed resolution

The resolution for the displayed energy is 1 Joule.
The resolution for the displayed motor time it is 1/10 of a second.

3.8 Programmability of the target energy limit

The value of the target energy limit is programmable with the resolution of 1 Joule through a small tact switch placed next to the display

3.9 Recording capabilities

The ms limiter holds the programmed target energy limit and records the value of the energy consumed in the last cycle. This value is also stored in the non-volatile memory of the microcontroller to be shown at the next power up of the ms limiter. These values are read-protected and cannot be altered in any way by the user.

3.10 Digital I/O

3.10.1 Start switch

The ms limiter is armed when the switch is pressed (negative edge, contact closed) and starts counting the energy when the switch is released (positive edge, contact open).

3.10.2 Input/output signals

- BAT+ red (3.5 mm bullet male) - battery plus
- BAT- black (2.0 mm bullet male) - battery minus
- ESC+ red (3.5 mm bullet female) - ESC plus connector
- ESC- black (2.0 mm bullet female) - ESC minus connector
- ESC BEC (3-pin JR male) - connected to the ESC
- TIM BEC (3-pin JR female) - connected to the timer
- TIM START/STOP (3-pin JR female), connected to the timer
  - brown - GND
  - red - Start signal to the timer (active low, external pull-up resistor is required)
  - yellow - Stop signal to the timer (30ms, active low, external pull-up resistor is required)
- START BUTTON (2-pin 2.54 female), connector for the start button, wire length 45 mm
  - brown - GND
  - red - Start signal to the timer (normally open button, 5V)

4 TECHNICAL DATA

- Dimensions: 38 x 24 x 5 mm
- Weight: 10 g (with wires and connectors)
- Current measurement method: voltage developed on a shunt resistor
- Shunt resistance: 0.01 ohm
- Voltage range: 5.5 - 20 V (LiPo 2S – 4S)
- Current range: 0 - 20 A
- Accuracy of energy measurement: < ± 0.5 %, resolution 1 J
- Energy setup range: 300 – 1650 J
- Time setup range: 1.0 – 30.0 s
- Operating conditions: -20 - +50 °C

5   VERIFICATION OF THE MS LIMITER

5.1   Testing equipment

- regulated DC power supply capable of 0 to 24 volts, 20 Amps output (Telcom AV-8-30NF)
- precision constant current electronic load capable of 20 Amps (Atorch DL-24P)
- digital multimeter (Peaktech 3360 DMM - 60.000 counts)
- digital multimeter (Aneng AN8008 - 10.000 counts)
- digital storage oscilloscope (Tektronics TDS220)
- automatic stopwatch with 1/100 second resolution started by the start switch and stopped by the limiter when the energy limit is reached. No manual intervention is required
- start switch connected to the EL to start energy accumulation

5.2   Test sequence

Two identical tests are performed in which the power load and the energy limit are changed.

5.2.1   TEST #1 - 800 Joules / 40 Watts

- set the energy limit to 800 joules in the device
- connect the start button
- connect a servo tester to the TIM BEC cable, pulse length 1.75mS
- connect the scope to the 'Stop signal to the timer' pin, trigger on the first negative edge
- connect the automatic stopwatch
- connect the scope to the 'Control signal to the ESC'
- set the power supply for a voltage of 10 volts
- set the electronic load to 40 Watts and apply the load. Resulting current will be 4 Amps
- press and hold the start switch for 2 seconds, then release it: the stopwatch starts, the limiter starts to count and displays the energy consumed
- monitor the pulse duration of the signal to the ESC. The pulse duration must be 1.75ms. When the energy limit is reached the pulse duration must instantly turn to 1.0ms and a 30ms negative pulse must be issued on TIM START/STOP signal (motor stop signal)
- make sure the automatic stopwatch has stopped and verify that it displays a time of 20 seconds (20s ± 2% = 19.6s to 20.4s)

5.2.2   TEST #2 - 1600 Joules / 80 Watts

Same as TEST #1 except that the energy limit and load are set to 1600 Joules 80 Watts respectively. In the last step of the test verify that the stopwatch displays a time of 20 seconds ± 2% (20s ± 2% = 19.6s to 20.4s).

6   CONDITIONS OF APPROVAL

6.1   This Approval is only applicable to devices of the type described and manufactured to the same production standards as the example evaluated.

6.2   This Approval is not applicable to any device which has been subject to repair or modification by person(s) other than the original manufacturer or his authorised agent.

6.3   Withdrawal of Approval

If after this Approval has been issued, inconsistencies of performance are found in further examples of the device(s), Approval may be withdrawn upon notice to the manufacturer.

6.4   Changes to F1Q Class Rules

If the F1Q class rules are amended in any manner that affects the technical specification of the F1QEL, the validity of this Approval will be subject to review.
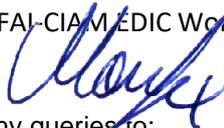
6.5   Expiry of Approval

This Approval remains active until it is either superseded or withdrawn. A list of all currently active Approvals can be obtained from the FAI CIAM website.

7   PRODUCTION STATUS

At the date issue of this Approval, the device is current production.

8   MANUFACTURER'S CHANGES

The manufacturer must make notification of any changes to hardware and/or firmware to the Chairman of EDIC-WG so that a decision can be made on any further testing that might be required to maintain CIAM Approval of the F1QEL. This includes changes that are applicable to any additional functions of the device that do not necessarily form part of the F1 requirements.

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