



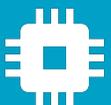
**Subsystems for the
UAS integration into
the airspace**



TR10



Datasheet - User manual



Contents

1	Introduction	3
2	Technical parameters	4
2.1	Technical specification	4
3	Principle of operation	6
3.1	States of operation	6
3.1.1	BOOTLOADER state	6
3.1.2	RUN state	6
3.1.3	CONFIGURATION state	6
3.2	Transitions between states	6
3.2.1	BOOTLOADER to RUN transition	6
3.2.2	RUN to CONFIGURATION transition	7
3.2.3	CONFIGURATION to RUN transition	7
3.2.4	CONFIGURATION to BOOTLOADER transition	7
4	System configuration	8
4.1	System settings	8
4.1.1	Write settings	8
4.1.2	Read settings	8
4.1.3	Settings description	8
4.1.4	Errors	9
4.1.5	Command endings	9
4.1.6	Uppercase and lowercase	9
4.1.7	Settings	9
4.1.8	Example	9
4.2	Commands	10
4.2.1	Commands in BOOTLOADER and CONFIGURATION state	10
4.2.2	Commands in CONFIGURATION state	10
4.2.3	Commands in RUN state	12
5	UART configuration	13
6	Settings	14
6.1	Transponder settings	14
7	Transponder	16
7.1	Initial power up	16
7.2	Using the transponder	16
7.2.1	Pressure altitude	16
7.2.2	Flight ID arbitration	16
7.3	System statistics	16
8	ADS-B subsystem	18
9	CAN bus interface	19
9.1	Communication with the device	19
9.1.1	Device status frames	19
9.1.2	Programming transponder settings	21
9.2	CAN bus settings	25
10	Disclaimer	26

1 Introduction

A Mode 3A/C/S Class 2, ADS-B Out Class A0, Level 2els transponder.

Note:

ICAO addresses are used to provide a unique identity normally allocated to an individual aircraft or registration.

Warning:

Please do not use random ICAO! Address becomes a part of the aircraft's Certificate of Registration and **MUST** be given by Civil Aviation Authority and registered in aircraft database.

2 Technical parameters

2.1 Technical specification

Table 1: Technical parameters

Parameter	Value
Supply Voltage	9-34 V
Current consumption	
Size	53.5x43.5x18 mm
Weight	75 g

RF parameters are subject to change

Table 2: RF Parameters

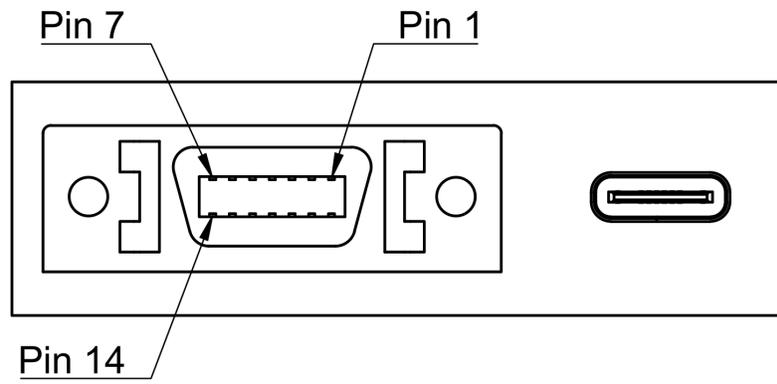
Parameter	Value
Minimum Triggering Level	-69 dBm
Dynamic range	-72 dBm to -18 dBm
1090 MHz transmit power	10 W

The device has a female SMA antenna connector.

The device features a 3M 10214-1210PE main connector and a USB-C connector. The USB-C connector may be used to access the device's UART0 port via a virtual COM port.

Table 3: Connector pinout

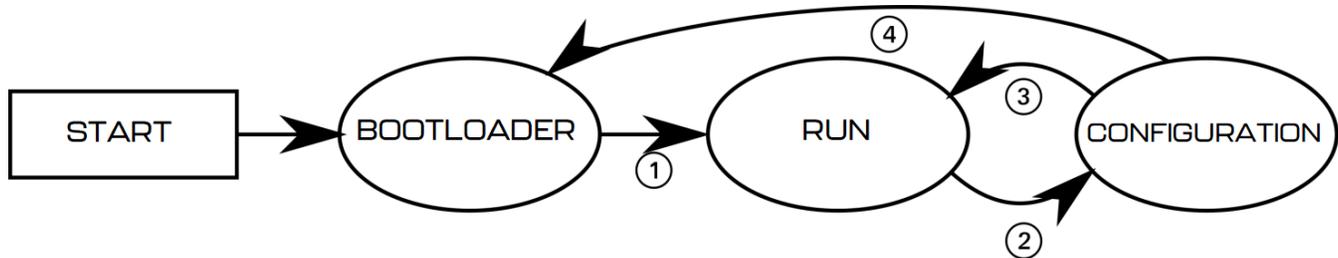
Pin	Function
1	GND
2	CANH
3	UART0_TX
4	UART1_TX
5	IO0
6	IO2
7	VIN
8	GND
9	CANL
10	UART0_RX
11	UART1_RX
12	IO1
13	GND
14	VIN



The connector shield is connected to ground internally.

3 Principle of operation

The module may be put in multiple distinct states: run, bootloader and config. The device operates in run state. The config state allows for programming constant flight parameters. The bootloader state may be used to update the firmware. Each state and transition is described in paragraphs below.



3.1 States of operation

3.1.1 BOOTLOADER state

This is the initial state after powerup. It may be used to program update the device's firmware. The module transitions automatically to RUN state. It is possible to lock the module in this state (i.e. prevent transition to RUN state) using one of BOOTLOADER triggers. After powering up module, it stays in this state for 3 seconds. If no BOOTLOADER trigger is present, it then transitions to RUN state. UART baud is constant and is set to 115200bps. Firmware upgrade is possible using aerobits updater software. For automated firmware upgrading scenarios, aerobits_updater software is available. To acquire this program please contact: support@aerobits.pl.

3.1.2 RUN state

In this state the device has full functionality. It may be programmed with flight data and reply to interrogations.

3.1.3 CONFIGURATION state

In this mode, permanent flight data may be changed. Entering this mode does not inhibit any of the device's functions, except for statistics and interrogation output. Settings may be changed using AT-commands. Changes to settings are stored in non-volatile memory when exiting this state. Additional set of commands is also available, allowing to e.g. reboot module into BOOTLOADER state, check serial number and firmware version. It is possible to lock module in this state (similarly to BOOTLOADER) using suitable command.

3.2 Transitions between states

For each state transition, different conditions must be met, which are described below. Generally, the only stable state is RUN. Module always tends to transition into this state. Moving to other states requires host to take some action.

3.2.1 BOOTLOADER to RUN transition

BOOTLOADER state is semi-stable: the module requires additional action to stay in BOOTLOADER state. The transition to RUN state will occur automatically after a short period of time if no action is taken. To prevent transition from BOOTLOADER state, one of following actions must be taken:

- Send `AT+LOCK=1` command while device is in BOOTLOADER state (always after power on for up to 3s)
- Send `AT+REBOOT_BOOTLOADER` command in CONFIGURATION state. This will move to BOOTLOADER state and will lock module in this state.

If none of above conditions are met, the module will try to transition into RUN state. Firstly it will check firmware integrity. When firmware integrity is confirmed, module will transition into RUN state, if not, it will stay in BOOTLOADER state.

To transition into RUN state:

- If module is locked, send `AT+LOCK=0` command

When module enters RUN mode, it will send `AT+RUN_START` command.

3.2.2 RUN to CONFIGURATION transition

To transition from RUN into CONFIGURATION state:

- Send `AT+CONFIG=1` (using current baud).

When module leaves RUN state, it sends `AT+RUN_END` message, then `AT+CONFIG_START` message on entering CONFIGURATION state. The former is sent using baud from settings, the latter always uses 115200bps baud.

3.2.3 CONFIGURATION to RUN transition

To transition from CONFIGURATION into RUN state:

- Send `AT+CONFIG=0` command.

When module leaves CONFIGURATION state, it sends `AT+CONFIG_END` message, then `AT+RUN_START` message on entering RUN state. The former is always sent using 115200bps baud, the latter uses baud from settings.

3.2.4 CONFIGURATION to BOOTLOADER transition

To transit from CONFIGURATION into BOOTLOADER state, host should do one of the following:

- Send `AT+REBOOT_BOOTLOADER` command.
- Send `AT+REBOOT` and when module enters BOOTLOADER state, prevent transition to RUN state.

When entering the bootloader state, the module sends `AT+BOOTLOADER_START` .

4 System configuration

In RUN state, operation of the module is determined based on stored settings. Settings can be changed in CONFIGURATION state using AT-commands. Settings can be written and read.

Note:

New values of settings are saved in non-volatile memory when transitioning from CONFIGURATION to RUN state.

Settings are restored from non-volatile memory during transition from BOOT to RUN state. If settings become corrupted due to memory fault, power loss during save, or any other kind of failure, the settings restoration will fail, loading default values and displaying the AT+ERROR (Settings missing, loaded default) message as a result. This behavior will occur for each device boot until new settings are written by the user.

4.1 System settings

4.1.1 Write settings

After writing a new valid value to a setting, an AT+OK response is always sent.

```
AT+SETTING=VALUE
```

For example AT+SYSTEM_STATISTICS=1

Response: AT+OK

4.1.2 Read settings

```
AT+SETTING?
```

For example: AT+SYSTEM_STATISTICS?

Response: AT+SYSTEM_STATISTICS=1

4.1.3 Settings description

```
AT+SETTING=?
```

For example: AT+SYSTEM_STATISTICS=?

Response:

```
Setting: SYSTEM_STATISTICS
Description: System statistics protocol(0:none, 1:CSV, 2:JSON)
Access: Read Write
Type: Integer decimal
Range (min.): 0
Range (max.): 2
Preserved: 1
Requires restart: 0
```

4.1.4 Errors

Errors are reported using following structure:

```
AT+ERROR (DESCRIPTION)
```

DESCRIPTION is optional and contains information about error.

4.1.5 Command endings

Every command must be ended with one of the following character sequences: "\n", "\r" or "\r\n". Commands without suitable ending will be ignored.

4.1.6 Uppercase and lowercase

All characters (except preceding AT+) used in command can be both uppercase and lowercase, so following commands are equal:

```
AT+SYSTEM_STATISTICS?
```

```
AT+sYSTEM_stAtISTICS?
```

Note:

This statement is true in configuration state, not in bootloader state. In bootloader state all letters must be uppercase.

4.1.7 Settings

Table 4: Descriptions of system settings.

Setting	Min	Max	Def	Comment
BAUDRATE	0	3	0	Baudrate in RUN state 0 - 115200bps 1 - 921600bps 2 - 3000000bps 3 - 57600bps
SYSTEM_LOG	0	1	0	System logs 0 - disable 1 - enable
SYSTEM_STATISTICS	—	—	None	System statistics protocol: None CSV

4.1.8 Example

As an example, to switch the Aerobits device to CSV protocol, one should send following commands: "<<" indicates command sent to module, ">>" is a response.

```
<< AT+CONFIG=1\r\n
>> AT+OK\r\n
<< AT+ADSB_RX_PROTOCOL_DECODED=1\r\n
>> AT+OK\r\n
<< AT+CONFIG=0\r\n
>> AT+OK\r\n
```

4.2 Commands

Apart from settings, module supports a set of additional commands. Format of these commands is similar to those used for settings, but they do not affect operation of module in RUN state.

4.2.1 Commands in BOOTLOADER and CONFIGURATION state

AT+LOCK

AT+LOCK=1 - Set lock to enforce staying in BOOTLOADER or CONFIGURATION state

AT+LOCK=0 - Remove lock

AT+LOCK? - Check if lock is set

AT+BOOT

AT+BOOT? - Check if module is in BOOTLOADER state

Response:

AT+BOOT=0 - module in CONFIGURATION state

AT+BOOT=1 - module in BOOTLOADER state

4.2.2 Commands in CONFIGURATION state

AT+CONFIG

AT+CONFIG=0 - Transition to RUN state.

AT+CONFIG? - Check if module is in CONFIGURATION state.

Response:

AT+CONFIG=0 - module in RUN state

AT+CONFIG=1 - module in CONFIGURATION state (baudrate 115200)

AT+CONFIG=2 - module in CONFIGURATION state (baudrate as set)

AT+SETTINGS?

AT+SETTINGS? - List all settings. Example output:

```
AT+BAUDRATE=0
AT+BOOT=0
AT+CONFIG=1
AT+DEVICE=TR-1F
AT+FIRMWARE_VERSION=2.72.1.0 (Jun 17 2024)
AT+LOCK=0
AT+SERIAL_NUMBER=22-0000309
AT+SYSTEM_LOG=0
AT+SYSTEM_STATISTICS=0
```

(continues on next page)

(continued from previous page)

```

AT+ADSB_RX_PROTOCOL_DECODED=1
AT+ADSB_RX_PROTOCOL_INC=0
AT+ADSB_RX_PROTOCOL_RAW=0
AT+ADSB_STATISTICS=1
AT+ADSB_TX_EMITTER_CAT=0
AT+ADSB_TX_ENABLED=1
AT+ADSB_TX_ICAO=000000
AT+ADSB_TX_IDENT=
AT+ADSB_TX_ON_BOOT=1
AT+ADSB_TX_PWR=2
AT+ADSB_TX_SQUAWK=0000
AT+ADSB_TX_SURFACE=0
AT+ADSB_TX_TRANSPONDER_PRESENT=0
AT+FLARM_INFO=LIBFLARM-2.03, expires: 2025-03-01, status: OK
AT+FLARM_RX_PROTOCOL_DECODED=1
AT+FLARM_STATISTICS=0
AT+FLARM_TX=1
AT+FLARM_TX_AIRCRAFT_TYPE=13
AT+GNSS_RX_PROTOCOL_RAW=0
AT+SENSOR_PROTOCOL_DECODED=0
AT+ASTERIX_SAC=1
AT+ASTERIX_SIC=129

```

AT+HELP

AT+HELP - Show all settings and commands with descriptions. Example output:

```

SETTINGS:
SYSTEM:
  AT+BAUDRATE=0 [Baudrate of serial interface (0:115200, 1:921600, 2:3000000,
  ↪3:57600)]
  AT+BOOT=0 [Is firmware in bootloader mode]
  AT+CONFIG=1 [CONFIG mode (0:disable, 1:baudrate 115200, 2:baudrate as set)]
  AT+DEVICE=IDME-PRO [Device type's name]
  AT+LOCK=0 [Device in CONFIG mode (0:no lock, 1:lock)]
  AT+SERIAL_NUMBER=18099300000323 [Device's serial number]
  AT+SYSTEM_LOG=0 [System logs (0:disable, 1:enable)]
  AT+SYSTEM_STATISTICS=0 [System statistics protocol(0:none, 1:CSV, 2:JSON)]
  AT+FIRMWARE_VERSION=1.22.5.0 (Aug 7 2024) [Device's firmware version]
GNSS:
  AT+GNSS_RX_PROTOCOL_RAW=0 [GNSS_RX RAW protocol (0:none, 5:NMEA)]
SENSORS:
  AT+SENSORS_PROTOCOL_DECODED=0 [SENSORS decoded protocol (0:none, 1:CSV, 3:JSON)]
COMMANDS:
  AT+3RD_PARTY_LICENSES [Displays licenses of third party software]
  AT+BLUETOOTH_MAC [Bluetooth device mac address]
  AT+DRONE_ID_OPERATOR_ID [Operator message payload]
  AT+HELP [Show this help]
  AT+INFO [Display device information]
  AT+REBOOT [Reboot system]
  AT+REBOOT_BOOTLOADER [Reboot to bootloader]
  AT+SETTINGS_DEFAULT [Loads default settings]
  AT+TEST [Responds "AT+OK"]
  AT+WIFI_MAC [WiFi device mac address]

```

AT+SETTINGS_DEFAULT

AT+SETTINGS_DEFAULT - Set all settings to their default value.

AT+SERIAL_NUMBER

AT+SERIAL_NUMBER? - Read serial number of module.

Response:

```
AT+SERIAL_NUMBER=07-0001337
```

AT+FIRMWARE_VERSION

AT+FIRMWARE_VERSION? - Read firmware version of module.

Response:

```
AT+FIRMWARE_VERSION=2.73.1.0 (Jun 27 2024)
```

AT+REBOOT

AT+REBOOT - Restart module.

AT+REBOOT_BOOTLOADER

AT+REBOOT_BOOTLOADER - Restart module to BOOTLOADER state.

Note:

NOTE: This command also sets lock.

4.2.3 Commands in RUN state

AT+CONFIG=1 - transition to CONFIGURATION state (baudrate 115200). AT+CONFIG=2 - transition to CONFIGURATION state (baudrate as set).

Note:

NOTE: This command also sets lock.

5 UART configuration

Communication between module and host device is done using UART interface.

In CONFIGURATION and BOOTLOADER state transmission baud is fixed at 115200bps.

The UART interface uses settings as described in table below:

Table 5: Descriptions of UART settings.

Parameter	Min.	Typ.	Max	Unit
Baud	57600	921600	3000000	bps
Stop Bits Number	–	1	–	–
Flow Control	–	None	–	–
Parity Bit	–	None	–	–

6 Settings

6.1 Transponder settings

The transponder settings may be programmed using the AT interface or ARINC825 interface. Programming over ARINC825 interface is detailed in chapter 8.

Table 6: Device settings

Setting	Min	Max	De-fault	Comment
AIRCRAFT_STATE	0	2	2	0 - Aircraft is airborne 1 - Aircraft is stationary on the ground 2 - Aircraft is moving on the ground
ICAO	0	0xFFFFFE	0	ICAO number of the aircraft in hexadecimal digits. Altering this value triggers a full system reboot.
CALLSIGN			Empty string	8 character callsign (Flight ID) of the aircraft
AIRCRAFT_REGISTRATION			Empty string	8 character aircraft registration (Flight ID) of the aircraft
MAX_AIRSPEED	0	6	0	Max airspeed (transmitted in short ACAS replies): 0 - no airspeed data 1 - Max airspeed <= 140 kmh 2 - 140 kmh < Max airspeed <= 280 kmh 3 - 280 kmh < Max airspeed <= 560 kmh 4 - 560 kmh < Max airspeed <= 1110 kmh 5 - 1110 kmh < Max airspeed <= 2220 kmh 6 - 2220 kmh < Max airspeed
EMITTER_CATEGORY	0	21	0	Aircraft emitter category. See table below
SQUAWK	0	7777	0	Aircraft's squawk code as 4 octal digits. Altering this value triggers an 18 s alert condition. Values: 7400, 7500, 7600, 7700 trigger a permanent alert condition
STANDBY	0	1	1	Transponder standby switch. A value of 1 puts the transponder in a standby condition where transmissions are inhibited. All other functions are retained. The transponder always starts in standby after powering the device.
TRANSMIT_ALT	0	1	0	Determines whether the transponder transmits its current altitude. When 0, the transponder replies that altitude is not available.
DISPLAY_INTERROGATIONS	0	1	0	When the value is 1, the transponder outputs all received interrogations with a microsecond relative system timer timestamp.
DISPLAY_PRESSURE	0	1	0	Display the current pressure and temperature value

There is a AT+SPI command which triggers an 18 s period in which the Special Purpose Indicator flag is active. The Special Purpose Identification status may be checked using AT+SPI?.

Settings:

- ICAO
- CALLSIGN
- AIRCRAFT_REGISTRATION

- MAX_AIRSPEED
- SQUAWK
- DISPLAY_INTERROGATIONS

are retained after powering off the device.

Settings:

- ICAO
- MAX_AIRSPEED
- DISPLAY_INTERROGATIONS

requires that the device is in config mode to be programmed. Other settings do not require entering the config mode.

The transponder retains all functions in config mode, except for displaying interrogations and system statistics. The device will continue to service interrogations.

Table 7: Emitter categories enumeration values

Enum value	Description
0	Unknown.
1	Light (below 15500 lbs.).
2	Small (15500 - 75000 lbs.).
3	Large (75000 - 300000 lbs.).
4	High-Vortex Large (aircraft such as B-757).
5	Heavy (above 300000 lbs.).
6	High performance (above 5g acceleration and above 400 knots).
7	Rotorcraft.
8	Reserved.
9	Glider, Sailplane.
10	Lighter-Than-Air.
11	Parachutist, Skydiver.
12	Ultralight, hang-glider, paraglider.
13	Reserved.
14	Unmanned Aerial Vehicle.
15	Space, Trans-atmospheric Vehicle.
16	Reserved.
17	Surface Vehicle - Emergency Vehicle.
18	Surface Vehicle - Service Vehicle.
19	Point Obstacle (includes Tethered Balloons).
20	Cluster obstacle.
21	Line obstacle.

7 Transponder

The transponder is a Class 2, Level 2 els device. It has the capability to respond to UF0, UF4, UF5 and UF11 interrogations. Ground-Initated CommB extractions can be performed on registers 0x10, 0x17 and 0x20.

7.1 Initial power up

After the inital power up, the ICAO number must be programmed. The device will not leave standby state if the ICAO number is not programmed.

7.2 Using the transponder

The device boots into the standby state. It will not reply to any interrogations. All other functions are retained. The device will output received interrogations. When prepared for flight, bring the device out of standby by using `AT+STANDBY=0`. The device will reply to interrogations and will emit acquisition squitters. By default, the device starts in On Mode (`AT+TRANSMIT_ALT=0`), where the altitude is reported as not available. To report altitude, use `AT+TRANSMIT_ALT=1`. The default device state is on the ground, stationary. The device will not reply to allcall interrogations in this state. After takeoff, program the device to an airborne state. The device will reply to all interrogations.

The transponder features a soft reply rate limit of 150 replies / second. Constant interrogation at a higher rate will not generate more replies.

7.2.1 Pressure altitude

The device features a precision pressure sensor for pressure-altitude determination. Air/ground state is not inferred. It must be programmed in flight.

7.2.2 Flight ID arbitration

The FlightID is an 8 character string that identifies the aircraft. It may be equal to aircraft registration or callsign. The callsign is assigned by the ATC to an aircraft for a mission or particular flight and is nonpersistent. The aircraft registration is assigned by an aviation authority and is set for a particular aircraft.

On power up, the FlightID is loaded with the aircraft registration. The aircraft registration setting is persistent. It may be empty (unavailable). The transponder will be able to operate and reply to interrogations. The ATC will be notified that Flight ID is unavailable by setting a bit in Data Link Capability register.

If callsign becomes available, the FlightID is loaded with callsign data. If the callsign is then set to an empty value, the FlightID is again loaded with Aircraft Registration. The callsign setting is nonpersistent.

Every FlightID change is broadcast to the ATCs with a Comm-B broadcast. For this reason, aircraft registration and callsign should not be programmed to the same value.

7.3 System statistics

The device transmits system statistics over the AT interface in a CSV format:

```
#S, 9, 1, 29, 29, 8, 8
```

Where:

- the first value corresponds to the amount of Mode S interrogations received. All interrogations are counted, including:
 - interrogations whose intended receipient is not the transponder
 - interrogations received during lockout
 - interrogations received while in standby

- interrogations for which CRC verification's failed
- the second value corresponds to the amount of Mode S replies emitted. If the transponder is in standby, the value corresponds to the amount of replies that would be generated.
- the third value corresponds to the amount of Mode A interrogations received
- the fourth value corresponds to the amount of Mode A replies emitted
- the fifth value corresponds to the amount of Mode C interrogations received
- the sixth value corresponds to the amount of Mode C replies emitted

8 ADS-B subsystem

The device has a capability of transmitting ADS-B data frames. Positional data must be provided over the CAN interface.

Data transmitted in ADS-B frames must have a time of applicability below 100 ms. That means that for every frame, the positional data must be more recent than 100 ms. If that is not the case, the device will internally extrapolate the positional data using the velocities provided. Because of this extrapolation, it is our recommendation that positional data is provided as often as practical, at a frequency over 10 Hz.

If no positional data has been received for 2.6 s, the device will time out and cease to transmit positional ADS-B data. Reaching the timeout will trigger a soft fault. Once data is being provided again, the device will resume to transmit positional frames. The timeouts are on a by frame basis, which means that if positional data is provided, but velocity data is not, the device will not transmit velocity frames only.

The device starts to transmit ADS-B squitters only after initial data is loaded over CAN.

If the device is never provided with positional data, only Identification and Status ADS-B frames will be transmitted. This will not generate a fault.

9 CAN bus interface

The device implements a Controller Area Network bus, compliant with CAN 2.0B and ARINC 825 specifications.

9.1 Communication with the device

9.1.1 Device status frames

The device transmits status frames on the Normal Operation Channel. The Function Code Identifier used to transmit these frames may be programmed in settings as `NOC_ADDRESS`. The Data Object Codes are assigned as follows:

- the setting `BASE_DOC` determines the base Data Object Code
- all frames specify an offset. The resulting Data Object Code is: `BASE_DOC + Offset`.

ARINC 825 Periodic Health Status

Transmitted on Test and Maintenance Channel (LCC=6). The Server FID used to transmit this frame is the same as for Normal Operation Channel frames. The Server ID is configurable via a setting.

Fault frame

Transmitted on Normal Operation Channel (LCC=2). This payload has a Data Object Code offset of 0.

A hard device fault indicates that the device's internal self test has determined that the fault may cause a partial or complete loss of functionality. The device will require repowering.

A soft device fault indicates that the device's internal self test has determined that whilst a fault has occurred and must be addressed, full functionality can and will be retained.

Transmitted on event. It's contents are:

```
BOOL Indicates whether the fault reported is a hard fault
ENUM 7 bit fault code
```

Table 8: Device faults

Fault code	Description	Fault status	Required action
10	Power Amplifier current failed to converge.	Hard fault	Contact support.
50	Attempted to program an invalid ICAO number. The ICAO remains unaltered.	Soft fault	Correct the programming value
51	Attempted to change ICAO in flight. The ICAO remains unaltered. The device continues to service interrogations	Soft fault	Cease attempting to reprogram ICAO in flight
52	Standby cannot be left. An invalid ICAO number is programmed. The device cannot leave standby mode.	Soft fault	Set the correct ICAO
60	ARINC Payload malformed	Soft fault	Check formatting of the ARINC DMC Request payload
61	Programming value out of range	Soft fault	Check range of programmed value
70	Pressure sensor fault. If the device was in Alt mode, it has automatically entered On Mode	Soft fault	Contact support
80	ADS-B data timeout. The devices inhibited transmissions of out-of-date data.	Soft faults	Start providing data again to resume ADS-B transmissions

Statistics frame

Transmitted on Normal Operation Channel (LCC=2) with a rate of 1 Hz. This payload has a Data Object Code offset of 1.

Transmitted once per second. May be turned off via device settings.

It's contents are

```
USHORT Amount of Mode S interrogations received in the last second
USHORT Amount of Mode S replies transmitted in the last second
USHORT Amount of Mode 3A replies transmitted in the last second
USHORT Amount of Mode C replies transmitted in the last second
```

All received interrogations are counted, including:

- interrogations whose intended recipient is not the transponder
- interrogations received during lockout
- interrogations received while in standby
- interrogations for which CRC verification's failed

Note:

Amount of replies transmitted does not include acquisition squitters emitted.

Note:

Amount of replies transmitted does not include ADB-B squitters emitted.

Note:

The transmission counter continues to operate in standby mode, counting replies that would generate a reply. The device does not emit replies in standby mode.

Pressure frame

Transmitted on Normal Operation Channel (LCC=2) with a rate of 1 Hz. This payload has a Data Object Code offset of 2.

Pressure altitude in ft indicated by the onboard pressure sensor.

Note:

Transponder reports pressure-altitude as a 13 bit code in 25 ft increments.

Note:

Transponder uses uncorrected pressure and calculates pressure altitude in reference to 1013.25 hPa. The ATC corrects for atmospheric pressure. For this reason, the transponder may indicate a negative pressure value.

It's contents are

```
LONG Pressure altitude in ft
```

Status frame

Transmitted on Normal Operation Channel (LCC=2) with a rate of 1 Hz. This payload has a Data Object Code offset of 3.

```
USHORT Squawk
BOOL Special purpose identification
BOOL Standby
BOOL Transmit Alt
ENUM Ground state: 2 bit enum
```

9.1.2 Programming transponder settings

The transponder settings may be programmed by transmitting frames in the Directed Message (LCC=3) channel. The device's address may be set using settings. The Well Known Ports used by the device are fixed.

ICAO frame

Accepted on port 48. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

The ICAO number setting is persistent.

The ICAO number may only be reprogrammed after the power up sequence if the standby mode has not been yet left.

Reprogramming the ICAO will trigger a device reboot.

The ICAO number may not be programmed to values above 0xff_ff_fe. Attempts to program invalid values will be ignored. A soft fault will be triggered.

Note:

The transponder with ICAO equal to 0 will not leave standby mode. Attempts to do so will trigger a soft fault. The transponder must be programmed with a valid value and rebooted. ICAO may be programmed to 0 as means of resetting the transponder to default state.

Contents:

```
ULONG ICAO
```

If the device receives a NODATA frame on port 48, it will reply with current settings in the same format and close the connection.

Static flight data frame

Accepted on port 49. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

The static flight data may be programmed in flight.

Contents:

```
ENUM Max airspeed
```

Max airspeed ENUM type is 3 bits wide and is defined as:

- 0 - no airspeed data
- 1 - Max airspeed ≤ 140 kmh
- 2 - $140 \text{ kmh} < \text{Max airspeed} \leq 280$ kmh
- 3 - $280 \text{ kmh} < \text{Max airspeed} \leq 560$ kmh
- 4 - $560 \text{ kmh} < \text{Max airspeed} \leq 1110$ kmh
- 5 - $1110 \text{ kmh} < \text{Max airspeed} \leq 2220$ kmh
- 6 - $2220 \text{ kmh} < \text{Max airspeed}$

If the device receives a NODATA frame on port 49, it will reply with current settings in the same format and close the connection.

Dynamic flight data frame

Accepted on port 50. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

```
USHORT Squawk  
BOOL Special purpose identification  
BOOL Standby  
BOOL Transmit alt  
ENUM Ground state
```

Ground state ENUM type is 2 bits wide and is defined as:

- 0 - aircraft airborne
- 1 - aircraft stationary on the ground
- 2 - aircraft moving on the ground

If the device receives a NODATA frame on port 50, it will reply with current settings in the same format and close the connection.

Callsign frame

Accepted on port 51. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

The callsign setting is nonpersistent.

```
ACHAR Callsign - 1st character
ACHAR Callsign - 2nd character
ACHAR Callsign - 3rd character
ACHAR Callsign - 4th character
ACHAR Callsign - 5th character
ACHAR Callsign - 6th character
ACHAR Callsign - 7th character
ACHAR Callsign - 8th character
```

If the device receives a NODATA frame on port 51, it will reply with current settings in the same format and close the connection.

Aircraft registration frame

Accepted on port 52. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

The aircraft registration setting is persistent.

```
ACHAR Aircraft registration - 1st character
ACHAR Aircraft registration - 2nd character
ACHAR Aircraft registration - 3rd character
ACHAR Aircraft registration - 4th character
ACHAR Aircraft registration - 5th character
ACHAR Aircraft registration - 6th character
ACHAR Aircraft registration - 7th character
ACHAR Aircraft registration - 8th character
```

If the device receives a NODATA frame on port 51, it will reply with current settings in the same format and close the connection.

Note:

It's possible to set the aircraft registration and callsign to a default value by sending a frame with 8 bytes of 0.

Position frame

Accepted on port 53. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

```
FLOAT Position Latitude
FLOAT Position Longitude
```

Note:

This frame is subject to 2.6 s timeout period.

Track velocity frame

Accepted on port 54. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

```
FLOAT Velocity, relative to ground, expressed in kts  
FLOAT Track angle in degrees relative to north, clockwise, expressed as a value  
↪ between 0 - 360
```

Note:

This frame is subject to 2.6 s timeout period.

Note:

If one of the values above is not available, you may use an out-of-range value or NaN

Altitude Geometric and Vertical rate frame

Accepted on port 55. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

```
FLOAT Altitude Geometric in ft above WSG84 ellipsoid  
LONG Vertical rate, where 1 LSB is equal to 1 ft/min
```

Note:

If altitude data is not provided, the device can use the pressure altitude and derived vertical rate. The ADS-B frames indicate the data source (barometric / GNSS)

Note:

This frame is subject to 2.6 s timeout period, after which the device uses the internal barometric data.

Emitter type frame

Accepted on port 56. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

The emitter type setting is persistent.

```
UCHAR Emitter category (0:21)
```

If the device receives a NODATA frame on port 56, it will reply with current settings in the same format and close the connection.

Enum definitions are available in settings.

Accuracy frame

Accepted on port 57. The device will reply with a NODATA frame, acknowledging the reception and close the connection.

```
ULONG Horizontal position accuracy in millimeters
USHORT Horizontal velocity accuracy in millimeters
UCHAR Error probability (0:3)
```

If the device receives a NODATA frame on port 57, it will reply with current settings in the same format and close the connection.

Note:

If data is not provided, system will still operate with default “Unknown” accuracy values.

Note:

If the value of horizontal accuracies is not known and only the error probability enum value is valid, use the max possible value.

Error probability enum is defined as follows:

- 0 - Unknown or $> 1 \times 10^{-3}$
- 1 - 1×10^{-3}
- 2 - 1×10^{-5}
- 3 - 1×10^{-7}

9.2 CAN bus settings

The device has a set of parameters concerning CAN bus operation. These settings are persistent and are only exposed via the AT interface.

Table 9: CAN bus settings

Setting	Min	Max	De- fault	Comment
BITRATE	0	4	0	CAN Bus bitrate: 0 - 125 kpbs 1 - 250 kpbs 2 - 500 kpbs 3 - 1 Mbps
HEARTBEAT	0	1	1	When set to 0, the device will cease to transmit statistics frames
NOC_ADDRESS	0	127	10	Address used for NOC communications
DMC_ADDRESS	0	127	10	Address used for DMC communications
SERVER_ID	0	127	10	Server ID used for Periodic Health Status frame
BASE_DOC	0	16300	10	Base Data Object Code for NOC frames

10 Disclaimer

Information contained in this document is provided solely in connection with Aerobits products. Aerobits reserves the right to make changes, corrections, modifications or improvements to this document, and to products and services described herein at any time, without notice. All Aerobits products are sold pursuant to our own terms and conditions of sale. Buyers are solely responsible for the choice, selection and use of the Aerobits products and services described herein, and Aerobits assumes no liability whatsoever, related to the choice, selection or use of Aerobits products and services described herein. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services, it shall not be deemed a license granted by Aerobits for use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering use, in any manner whatsoever, of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN AEROBITS TERMS AND CONDITIONS OF SALE, AEROBITS DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO USE AND/OR SALE OF AEROBITS PRODUCTS INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED AEROBITS REPRESENTATIVE, AEROBITS PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE.

Information in this document supersedes and replaces all previously supplied information.

© 2024 Aerobits - All rights reserved