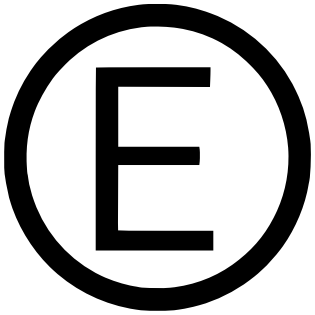
Barsotion EN & TN:
User manual rev.B



Barsotion ROy, 2025

Table of contents

Overview

The EA & TA board computers as a part of Barsotion xAnomalain series are the devices created to control small model rockets flight and write down flight parameters. It was developed for the OKB “Iva” Pike rocket project.

These computers are the logical continuation of Barsotion GBK DeltaAnomalain board computer, used in OKB “Iva” Kilka project.

For the EA & TA developing, some radical principles were adopted:

- As possible new components.
- Manufacturability and simply usage.
- Aesthetics and sophistication.

“By the Will of God and according to the plan”

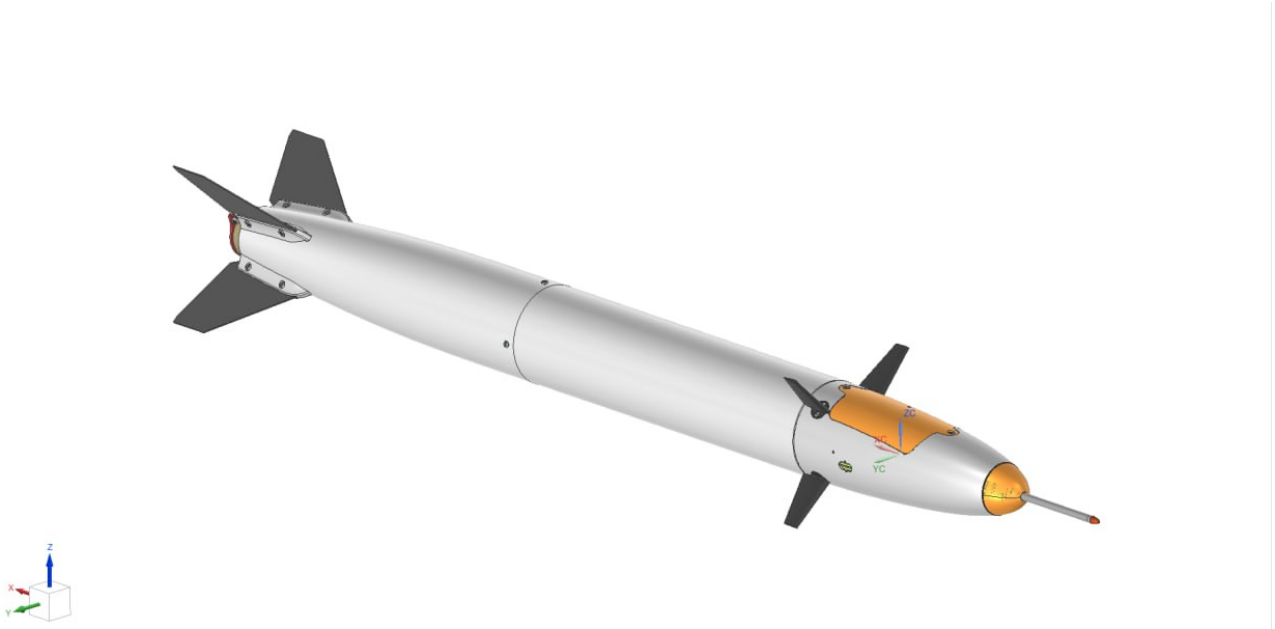


Figure 1: Pike rocket explained view

EA hardware description

The Barsotion GBK EpsilonAnomalain boards (Barsotion-EA) was created as a part of model rocket project Pike.

EA Concepts

The Pike rocket has the following view:

Figure 2: Pike rocket view

The EA board computer (GBK) should be located at the nose of rocket, consist of one board and placed longitudinally. The power source is the 3.7 V 18650 battery with typical capacity around 3000 mA*h. The board computer should contain following sensors:

- Gyroscope & accelerometer (ICM-42688-P was chosen), connected via SPI, that is important because of necessity of ensuring high data read speed;
- Barometer (BMP388 was chosen);
- AH3 air speed sensor connector (4-pin, 3,3V, GND, SDA, SCL);
- Hygrometer (AHT20 was chosen).

The microcontroller should be enough rapid for processing gyroscope's data a few thousand times per second. Reading data from the gyroscope should be synchronized with gyroscope's interrupt channel.

Barometer and hygrometer data reading interrupt synchronization is not needed.

The board computer should contain a flash memory chip, the capacity should not be less than 1 Gbit.

The board computer should have connectors for four MG90S servos. Also it should have a DC-DC boost voltage converter to provide servo feeding. The board

computer should can power down servos if they are not used, because servos have a significant static power consumption.

The board computer should can measure battery voltage and have a power-off option, that allows to power down system by the microcontroller command.

The board computer should switch on by special button pressing. It is supposed that the computer will be connected to the battery a long time before the start so that long working not wanted. The computer should be switched on shortly before the start for saving the battery charge.

The computer should have a small seven-segment led indicator on the board for system status indication and also 4 LEDs:

- Power 3.3 V indication LED;
- TXD0 LED;
- RXD0 LED;
- User-driven LED.

The power indication helps to control the computer is working or not, TXD and RXD indication helps to control the data transmission progress. User-driven LED is needed for simplifying the debug process and improving the computer using user's experience.

Also the board computer should have a buzzer that needed to signal when the rocked landed and waits to be found.

EA Realization

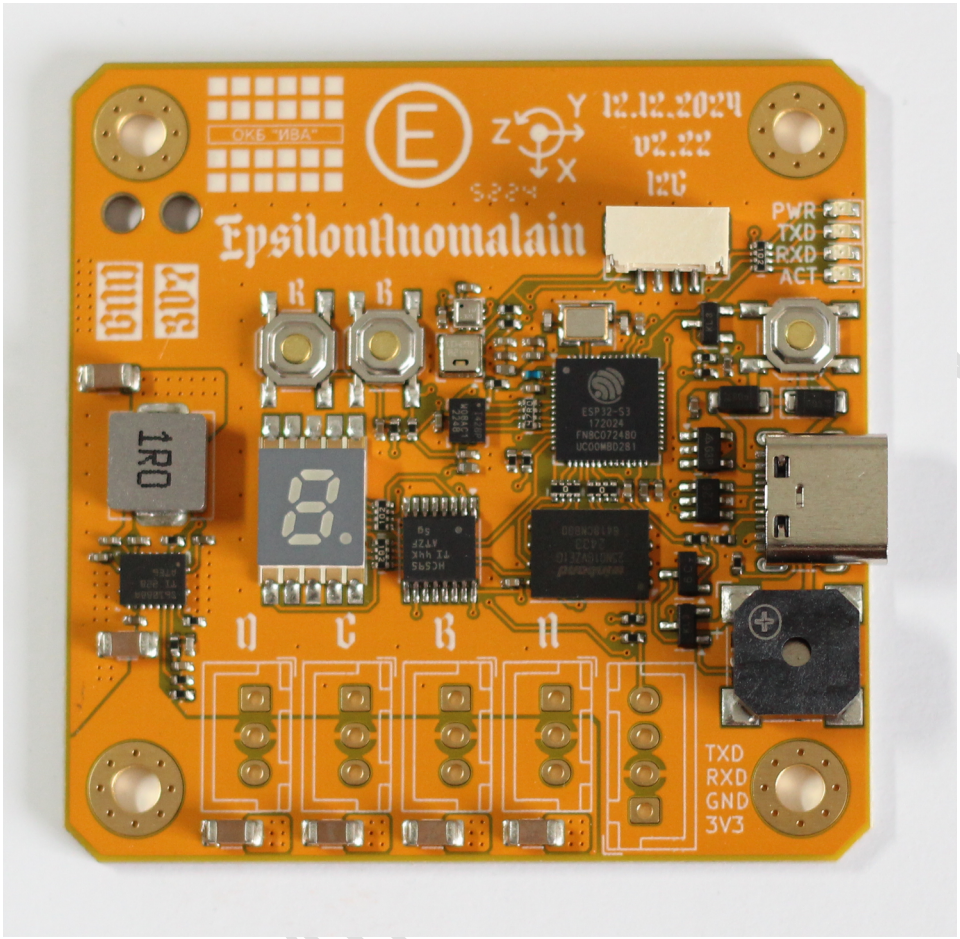


Figure 3: EA explained view

The Barsotion-EA has following characteristics:

- Microcontroller: ESP32-S3FN8;
- Gyroscope & accelerometer: ICM-42688-P;
- Barometer: BMP388;
- Hygrometer: AHT20;
- AH3 board I2C connector;
- Buzzer for sound indication;
- Seven-segment LED indicator driven by 74HC595 shift register;
- USB-C for flashing & debug;

- SPI NAND Flash memory chip W25N01GVZEIG, the capacity is 1 Gbit;
- DC-DC boost voltage converter based on TPS61088 for servo feeding, the schematic is calculated and topology drawn for continious 3 A current;
- Four servo connectors.

EA Dimentions

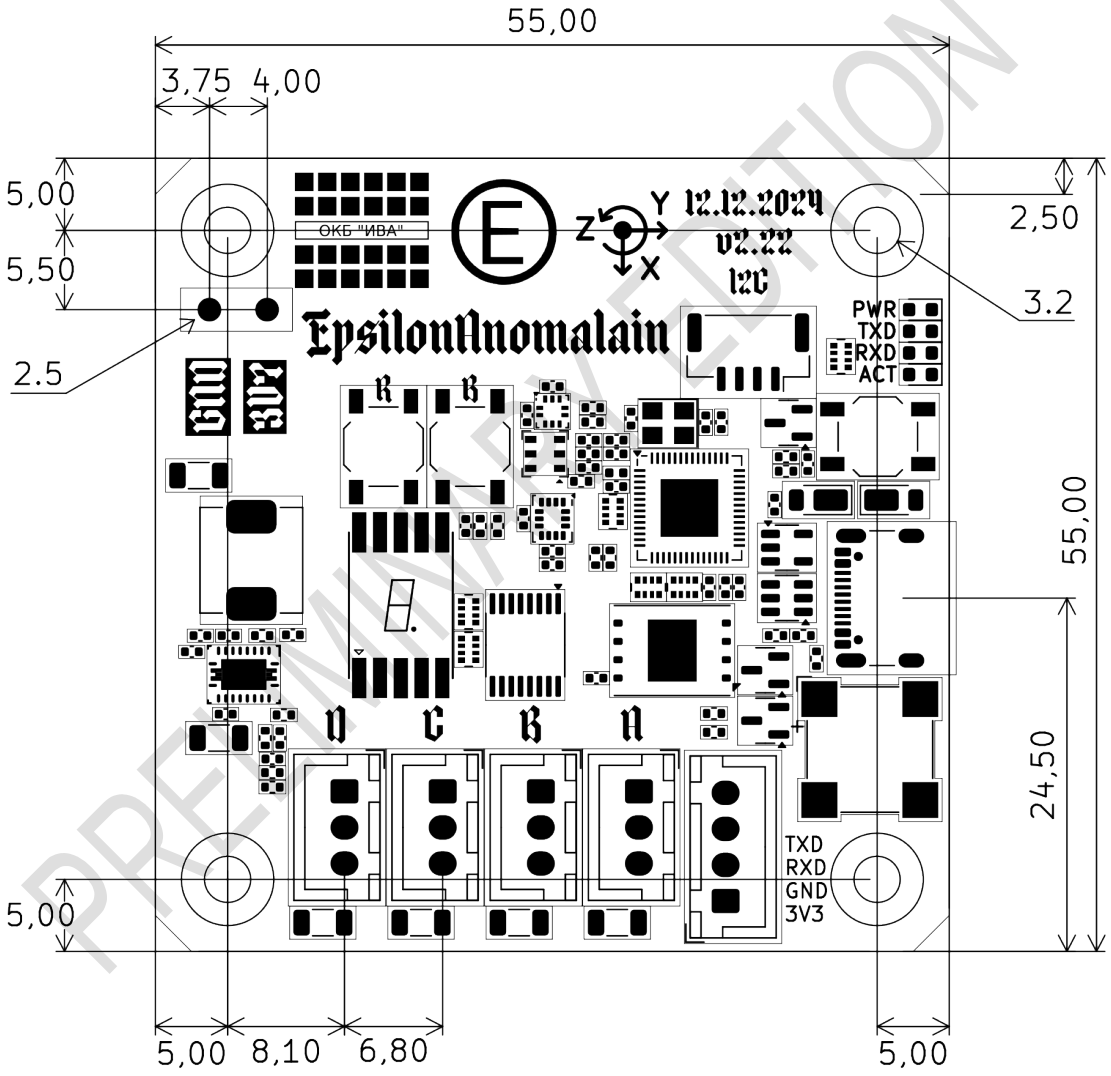


Figure 4: EA dimentions

EA Structural schematic

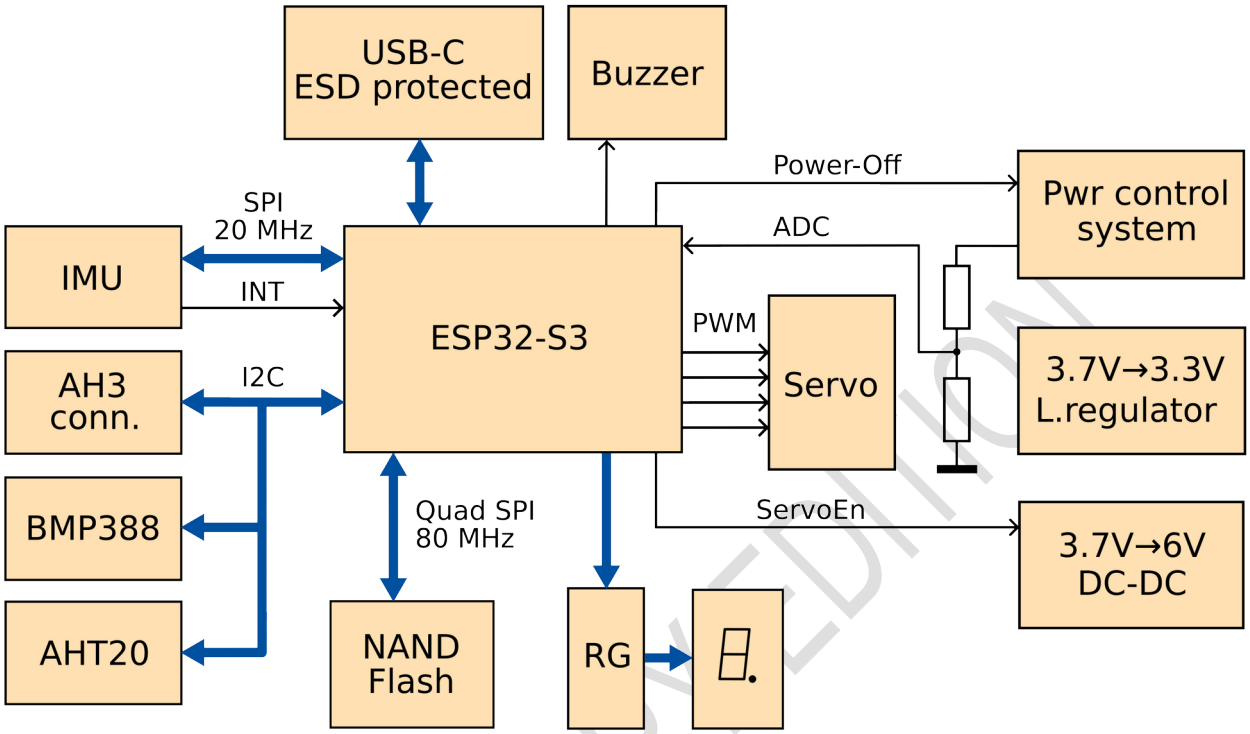


Figure 5: EA structural schematic

EH Topology

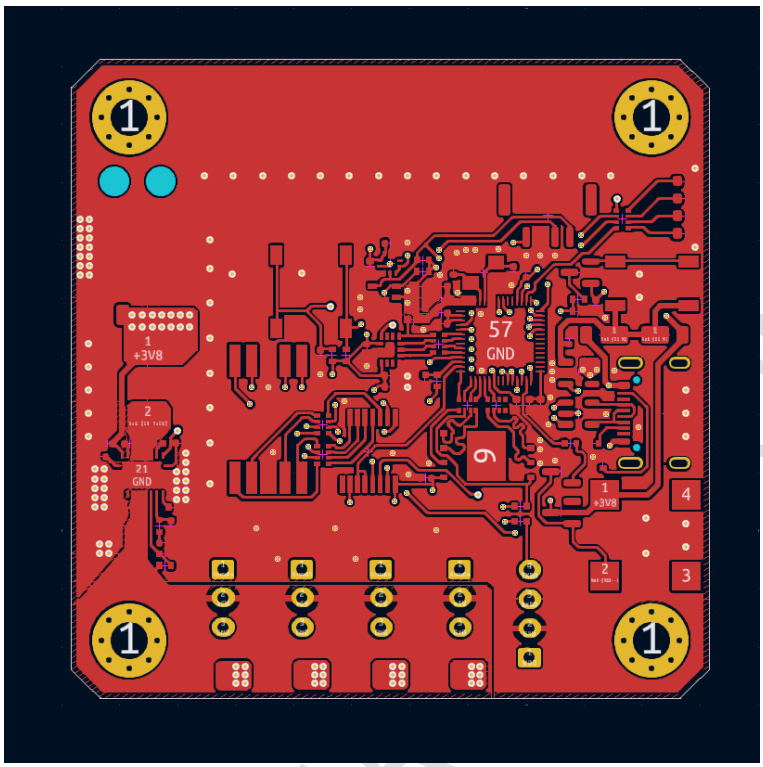


Figure 6: EA Layer 1 - Top signal

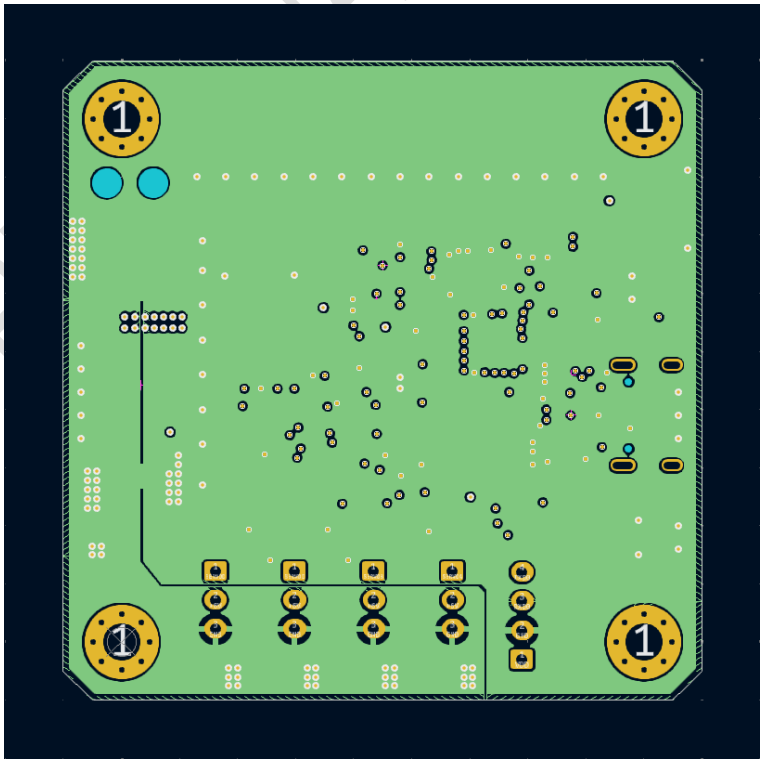


Figure 7: EA Layer 2 - GND

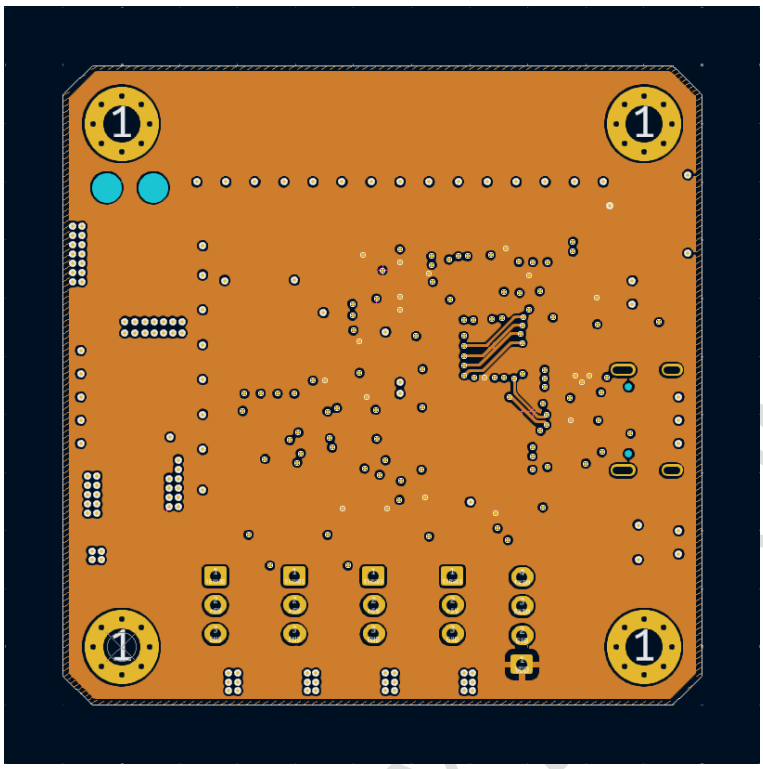


Figure 8: EA Layer 3 - Power

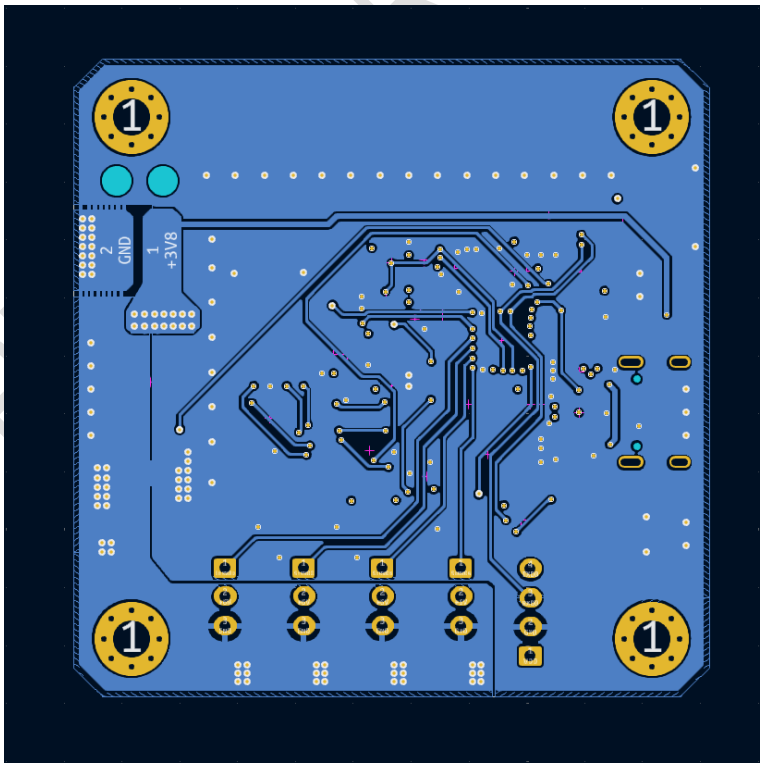


Figure 9: EA Layer 4 - Bottom signal

EA Errata

While the EA tests some errors was finded.

EA_ERR1_Anode

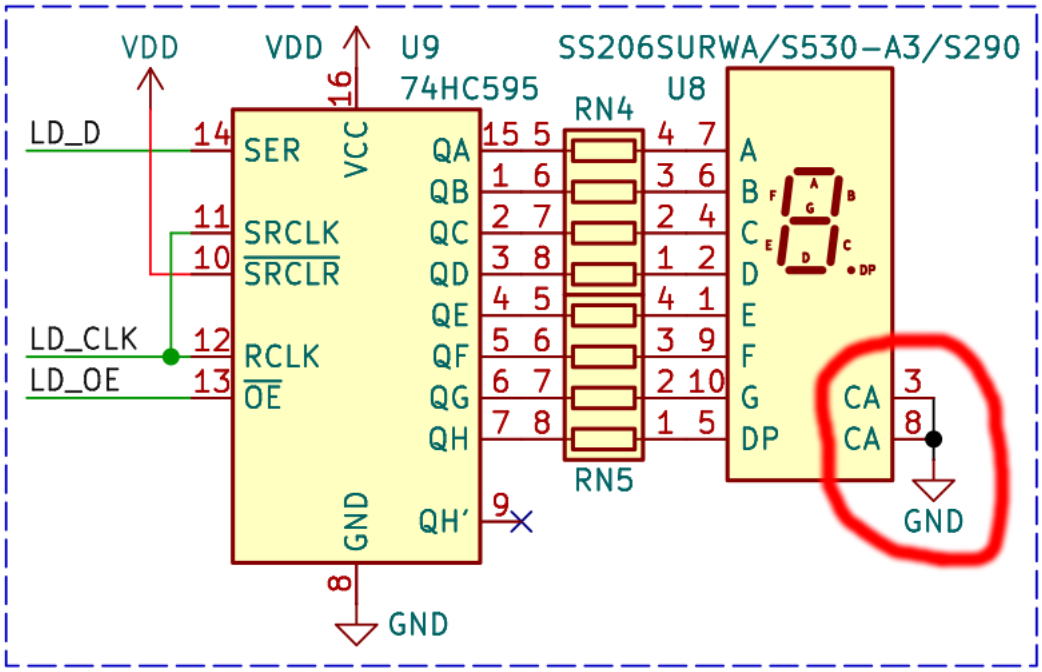


Figure 10: EA_ERR1_Anode

The LED module's common anodes should be routed to +3.3 V power supply, however they are wired to the ground. That is a reason why the led indicator on the EA does not work.

EA_ERR2_Poweroff

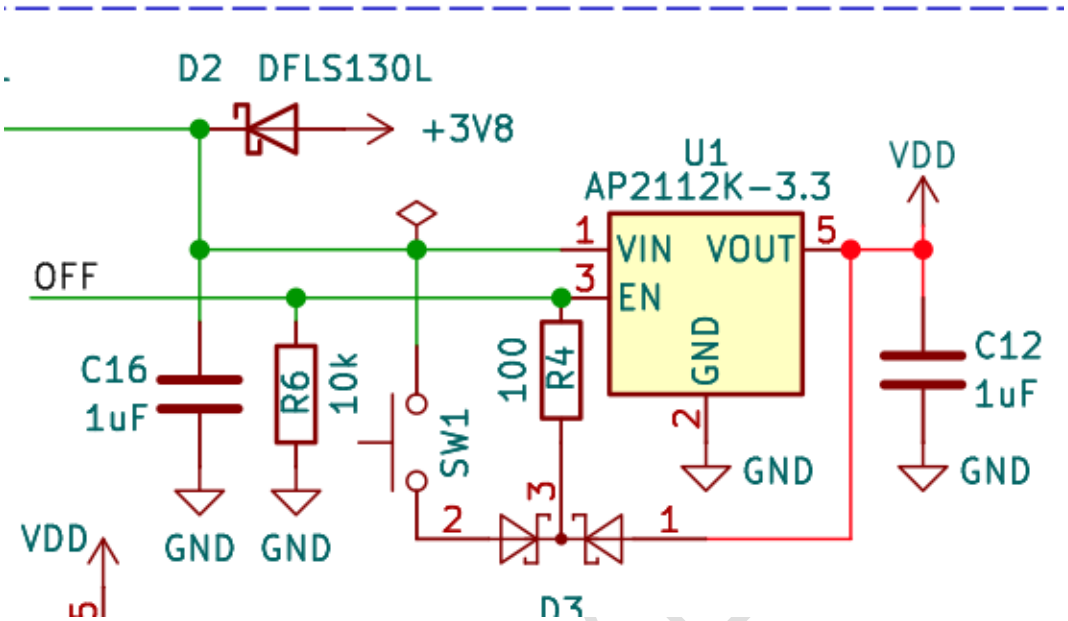


Figure 11: EA_ERR2_Poweroff

The EA boards have a hardware ability to power-off themselves by microcontroller command. It is useful if the battery voltage is low.

The power-off function does not work properly. When the OFF pin (GPIO38) is initialized as output and the logic 0 routed to this pin, the voltage on the VDD line decrease down to 1.8-1.9 V level, after that the GPIO block in the microcontroller stops the working, the OFF pin goes to tri-state condition, VDD capacitors' residual charge provides a high level on the regulator's EN pin and the device restarts.

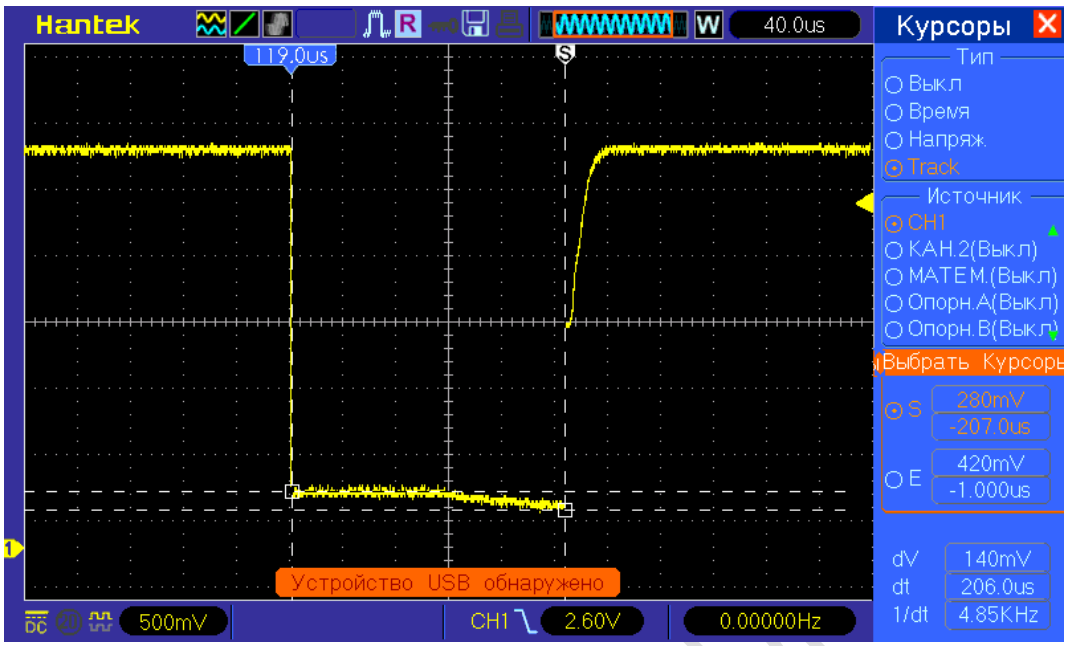


Figure 12: OFF line after POWER-OFF command receiving

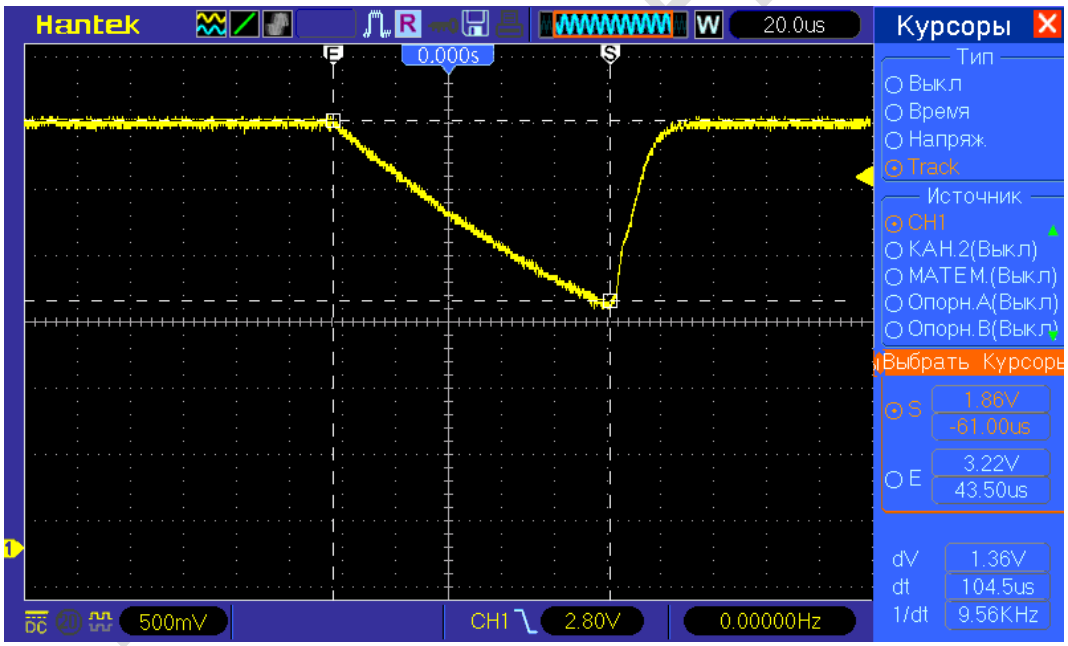


Figure 13: VDD line after POWER-OFF command receiving

EA_ERR3_Servo_supply

This error caused from mistake of understanding the TPS61088 EN (Enable) pin function.

The SERVOEN line is wired directly from microcontroller to TPS61088's EN pin. While the EA developing it means that if the EN pin is not active, there is no voltage on the 6 V output servo feeding line. However the EN pin only enables voltage conversion, not current passing by the converter IC.

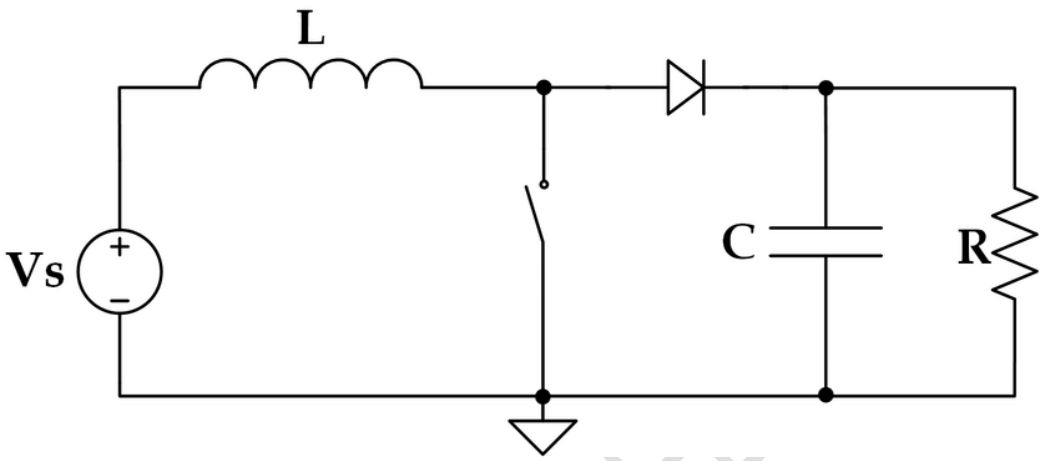


Figure 14: Simplified boost converter circuit

EN pin enables driving the switch. If it is not active, switch is always unlocked, so the converter does not work. However the voltage still can pass through the inductor and diode to the servos. The solving of the problem is to add the transistor to the servo feeding circuit that can break the circuit if it is needed.

EA GitHub repository

Barsotion-EA's KiCad sources, full schematic, pindefs-file are located at a project GitHub repository.

TA hardware description

TA Concepts

The main goal of the TA creation is to fix the EA schematic error and problems. The most of device requirements are the same as for EA. However some extra features was wanted:

- Add the ICM-42688-P ODR frequency quartz stabilization
- Add 2.4 GHz WiFi / Bluetooth / BLE antenna
- Use 4 Gbit Flash chip instead of 1 Gbit
- Change the buzzer connection for allowing the buzzer to work when the board connected to the computer via USB (on the EA board the buzzer can make sound only if the battery connected)

According the EA&TA software architecture, the core 1's cycle time depends on the ICM-42688-P INT1 pin period that is the same as the maximum of accelerometer & gyroscope's ODRs. By default, the ODR frequency is generated from internal RC-source with 1% accuracy. Usual way to get the cycle time is considered in subtraction previous system timer's value from actual. The ESP32-S3's system timer has 1-microsecond accuracy, that does not allows to use ODR 16 kHz or 32 kHz because their periods have non-integer values in microseconds (62.5 & 31.25 microseconds), that causes bigger integral errors while integrating (the tests show that 8 kHz ODR gives smaller integral errors than 16 kHz, which contradicts the theory of numerical methods). The solving of the problem can be in ODR frequency quartz stabilization. If it is used, the ODR frequency has 10 ppm accuracy, so allows to use a constant as the cycle time value.

The 2.4 GHz antenna addition is not needed for rocket project tasks, however this requirement was added for getting more experience in high-frequency circuits topology design.

After the EA tests a curious fact was found: there are W25N01 memory chip pin-to-pin compatible chips with more capacity, for example W25N04. So using memory with more capacity is wanted.

TH Realization

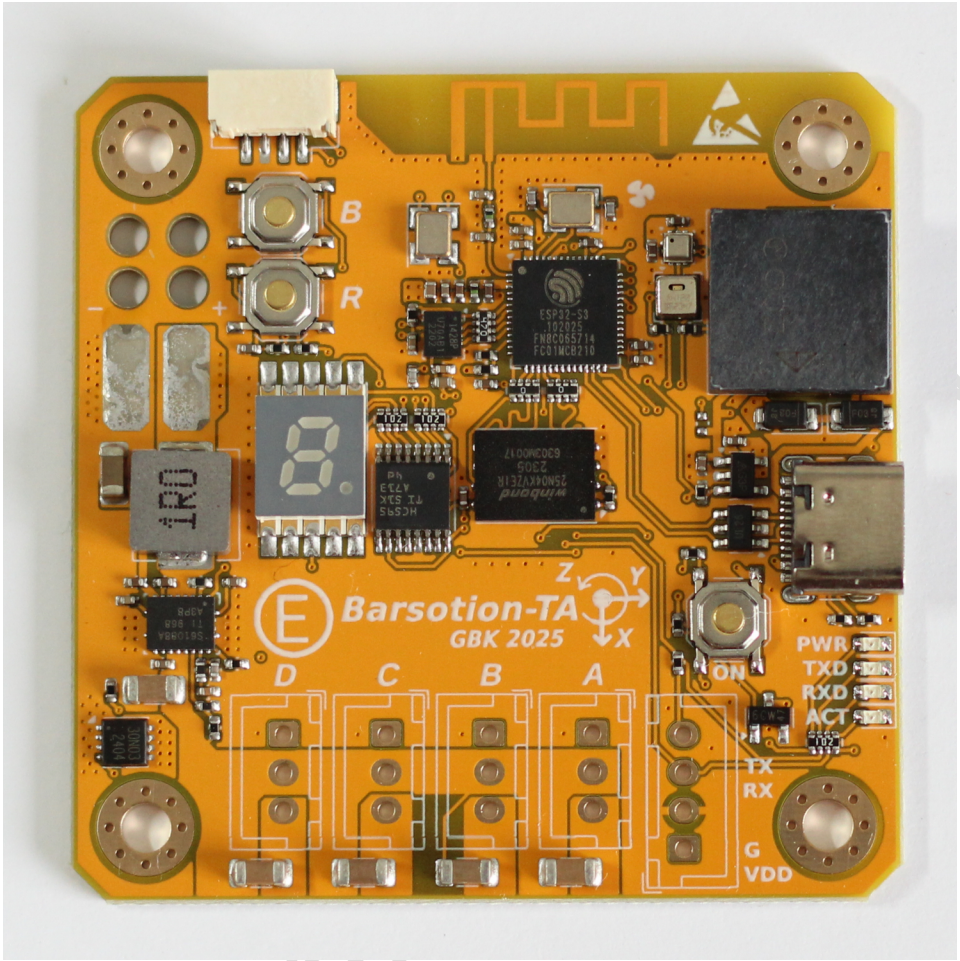


Figure 15: TA (TAv1.6) explained view

Thus, the Barsotion-TA has following characteristics:

- Microcontroller: ESP32-S3FN8;
- 2.4 GHz Wi-Fi / Bluetooth / BLE antenna driven by ESP chip;
- Gyroscope & accelerometer: ICM-42688-P (quartz-stabilized ODR frequency);
- Barometer: BMP388;
- Hygrometer: AHT20;
- AH3 board I2C connector;
- Buzzer for sound indication;
- Seven-segment LED indicator driven by 74HC595 shift register;

- USB-C for flashing & debug;
- SPI NAND Flash memory chip W25N04KVZEIG, the capacity is 4 Gbit
- DC-DC boost voltage converter based on TPS61088 for servo feeding, the schematic is calculated and topology drawn for continious 3 A current;
- Servo powerdown ability thanks to transistor breaking the feeding line;
- Four servo connectors.

TAv1.6

Because of BOM ambiguous interpretation a wrong buzzer was ordered, PKLCS1212E2000-R1 instead of CMT-8504-100-SMT-TR. The producing company agent told that they can deliver right buzzer, however CMT-8504-100-SMT-TR delivering takes two weeks that is much. Also, a schematic error was found in TA boards: wrong transistor Q2 connection caused by incorrect package pinout.

It was decided to re-release the TA boards. A schematic, topology, Gerber, BOM, PNP was fixed and adopted for PKLCS1212E2000-R1 usage. New TA version was indexed as “TA v1.6” or “TAv1.6”.

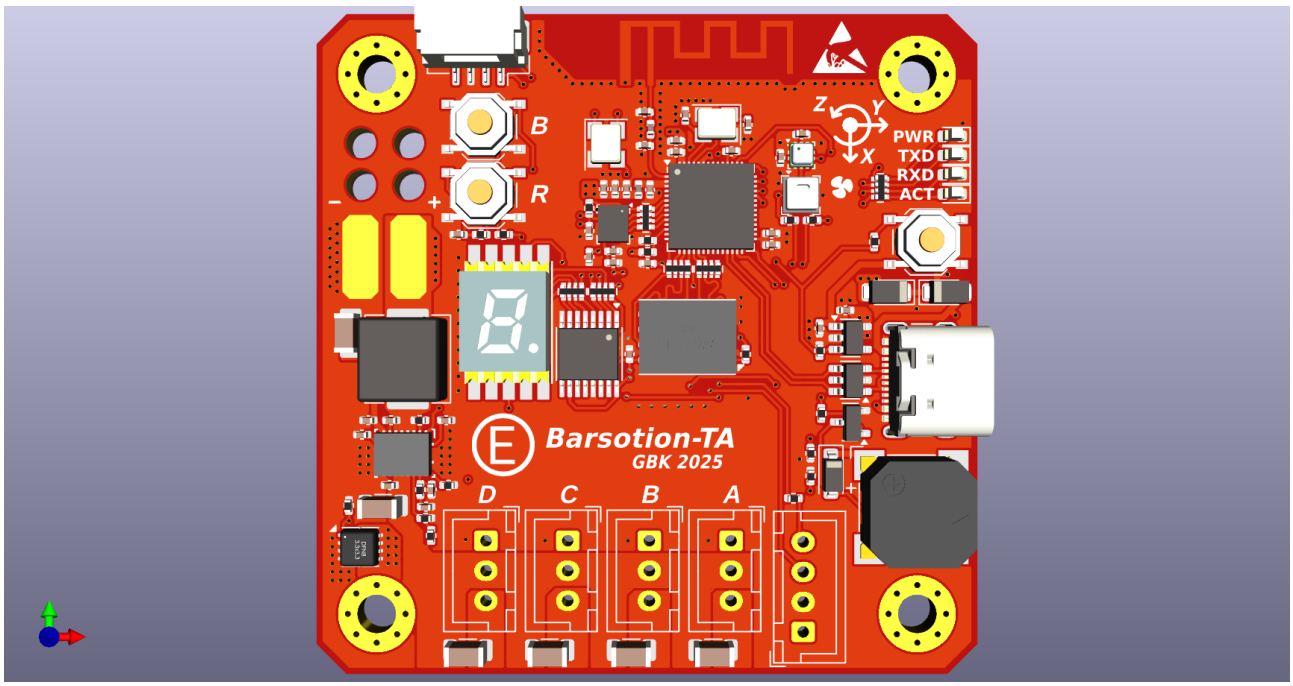


Figure 16: TAv1.5 explained view

TM Dimentions

Dimentions are common for TA & TAv1.6.

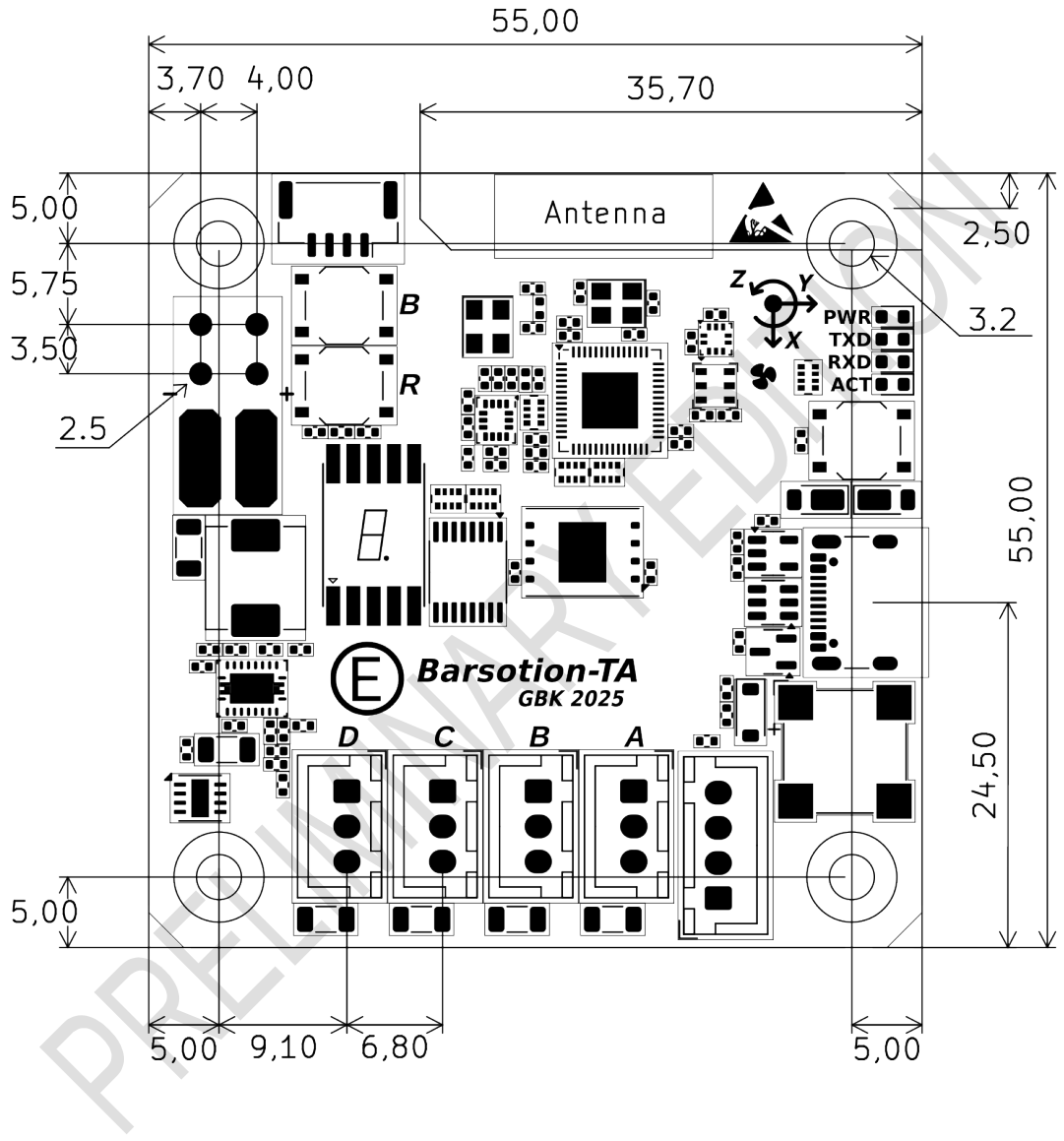


Figure 17: TA dimentions

TA Structural schematic

The TA structural schematic is the same as for EA, but the 32.768 kHz quartz oscillator was added.

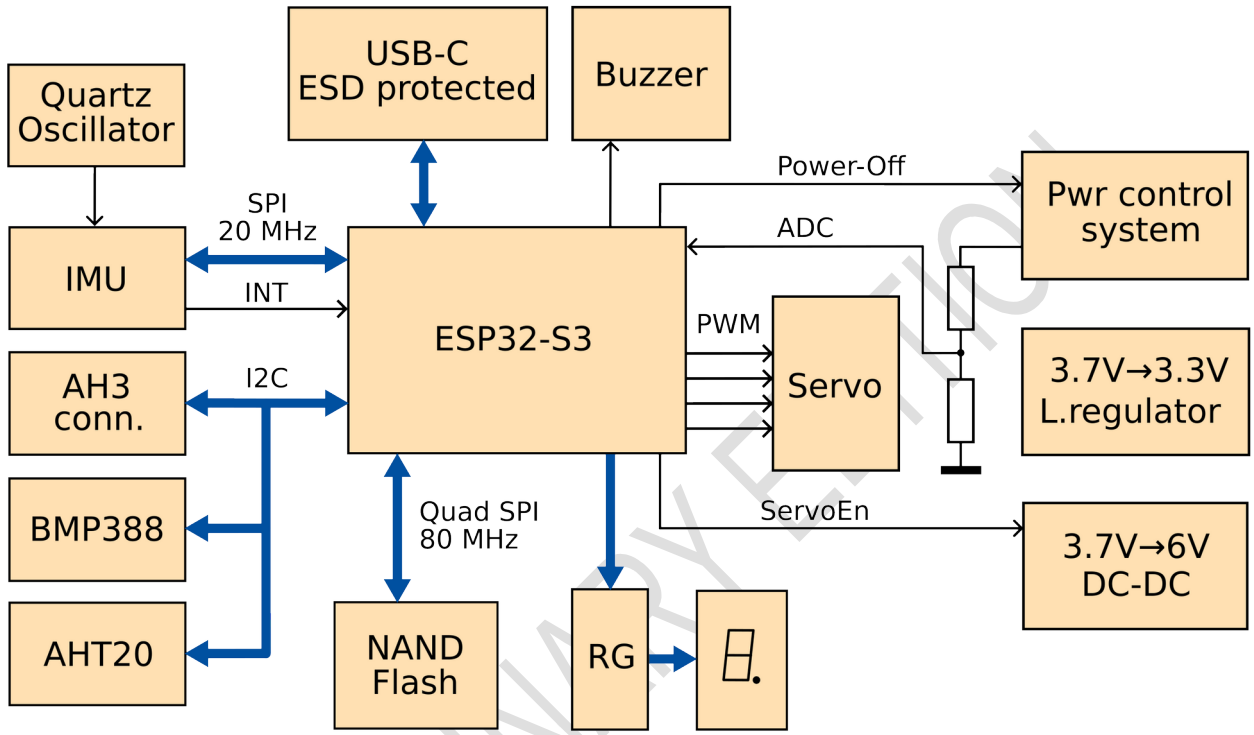


Figure 18: TA structural schematic

TM Topology

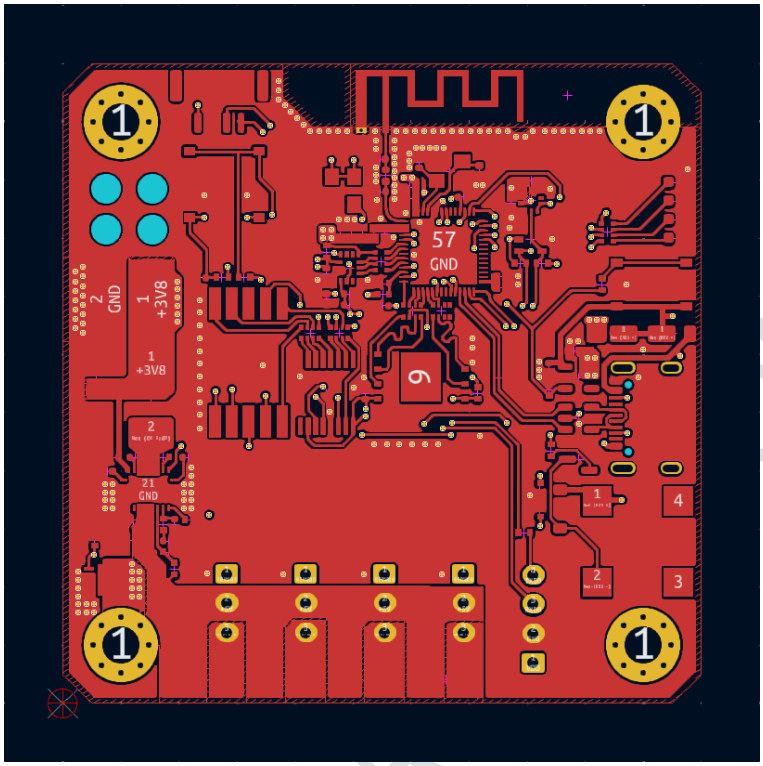


Figure 19: TA Layer 1 - Top signal

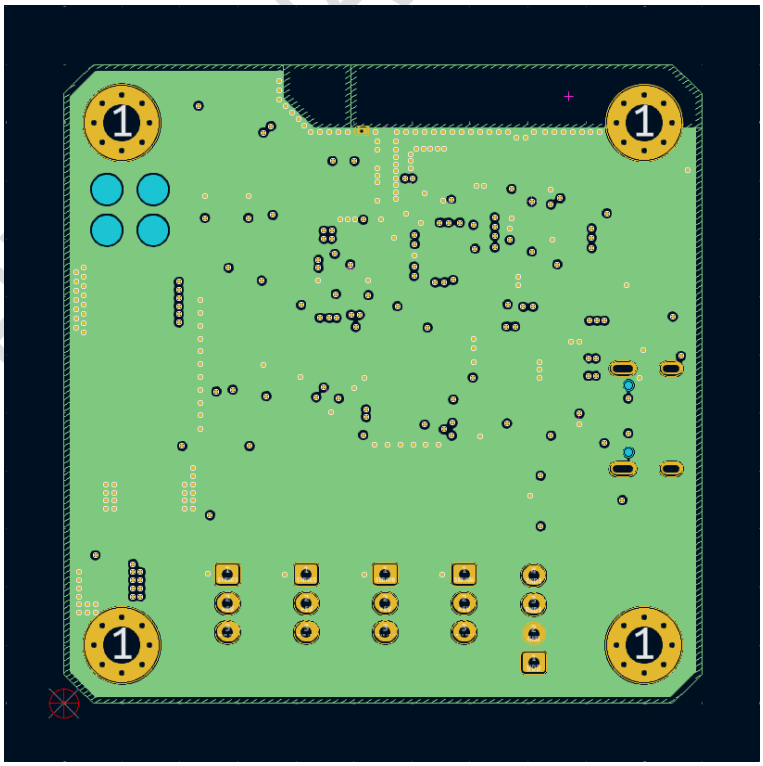


Figure 20: TA Layer 2 - GND

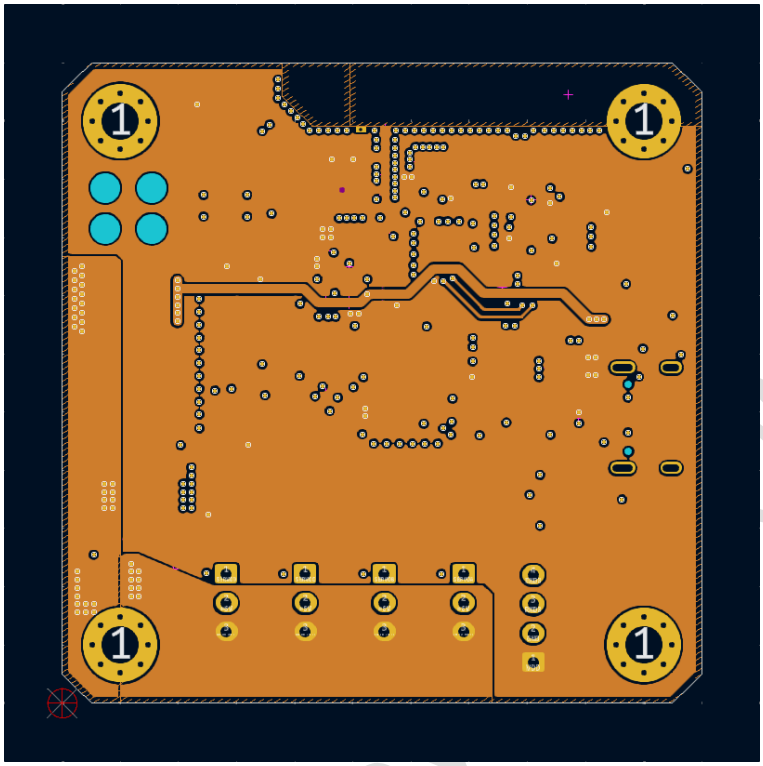


Figure 21: TA Layer 3 - Power

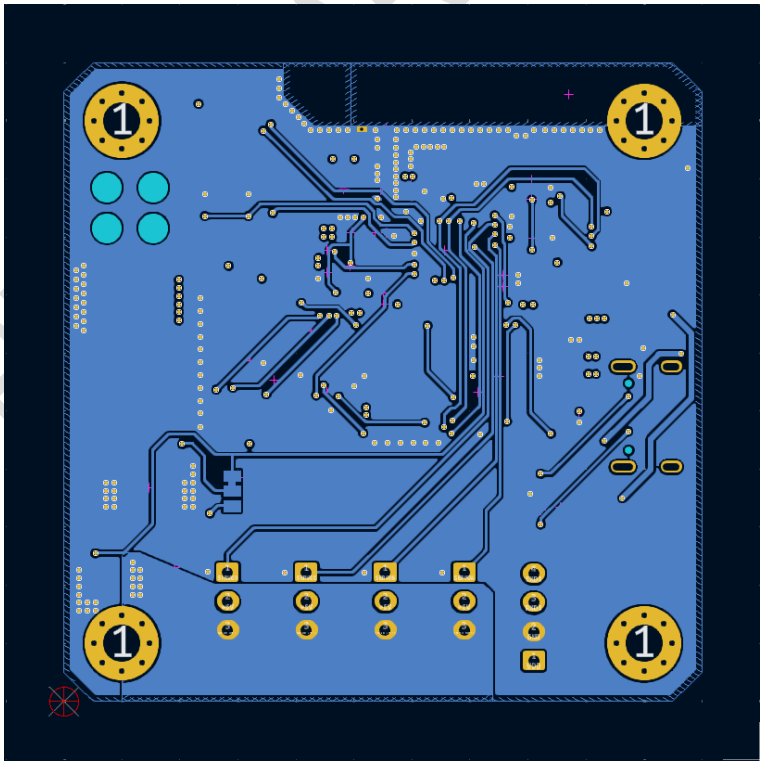


Figure 22: TA Layer 4 - Bottom signal

TAv1.6 Topology

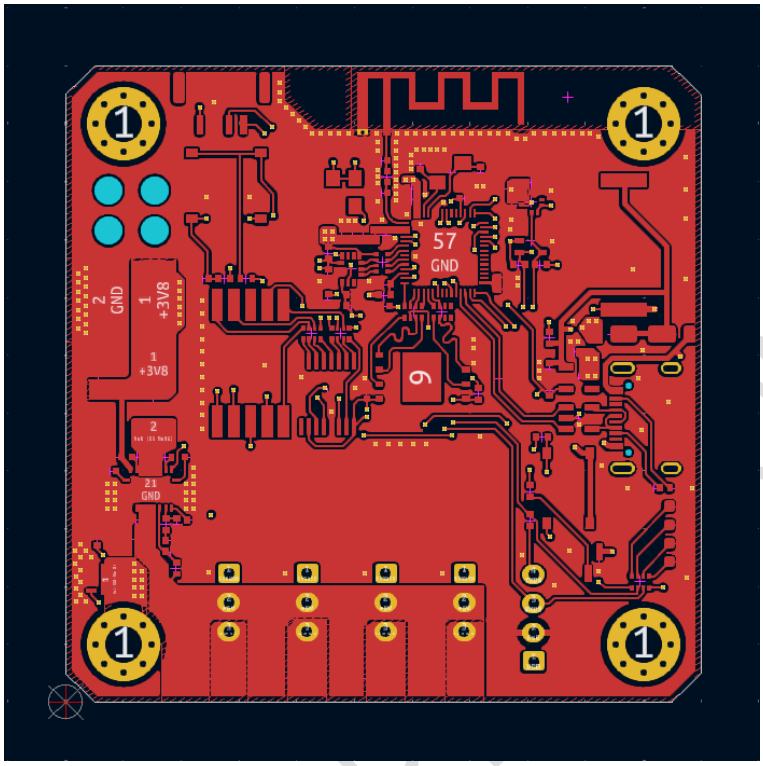


Figure 23: TAv1.6 Layer 1 - Top signal

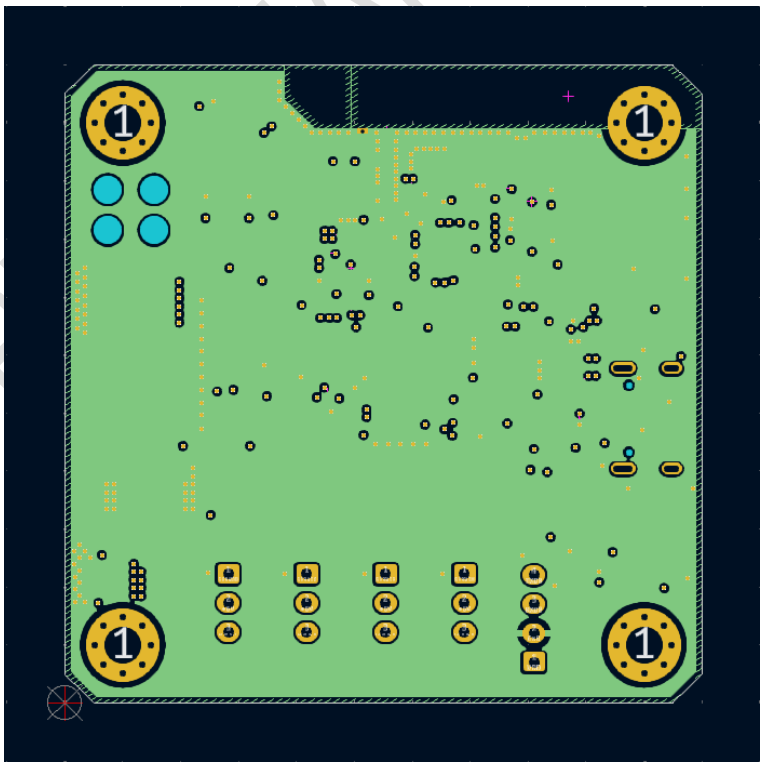


Figure 24: TAv1.6 Layer 2 - GND

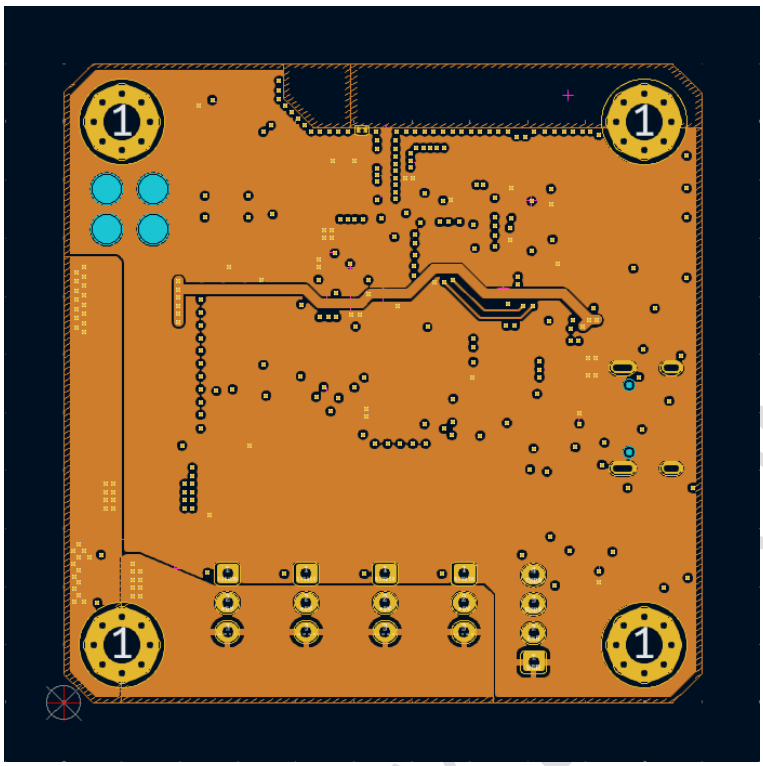


Figure 25: TAv1.6 Layer 3 - Power

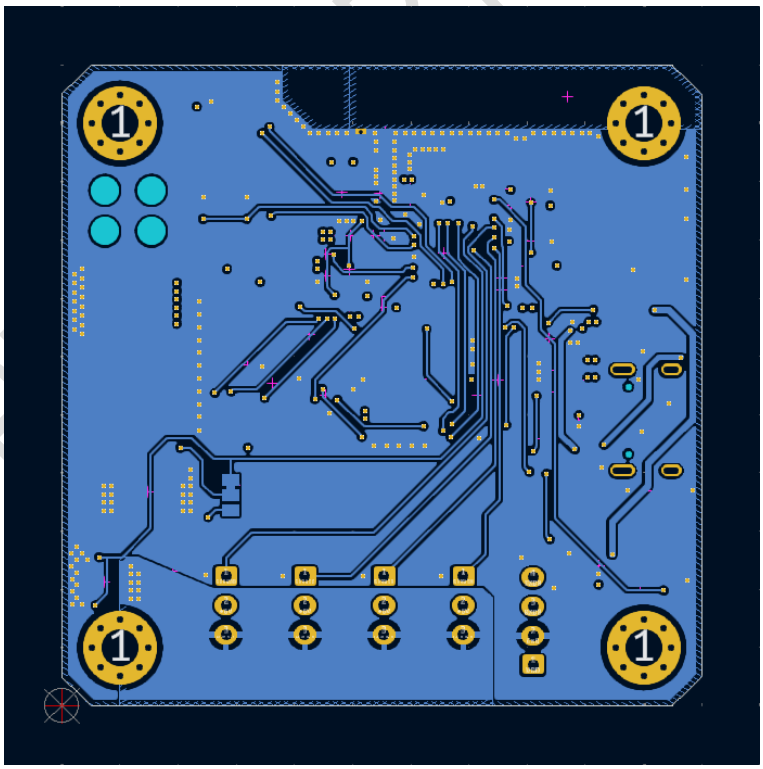


Figure 26: TAv1.6 Layer 4 - Bottom signal

TM Errata

TA_ERR1_Buzzer

TM GitHub repository

Barsotion-TA's KiCad sources, full schematic, pindefs-file are located at a project GitHub repository.

EA & TA placing

The EA / TA board computer is placed in the nose rocket section as shown at the following renders.

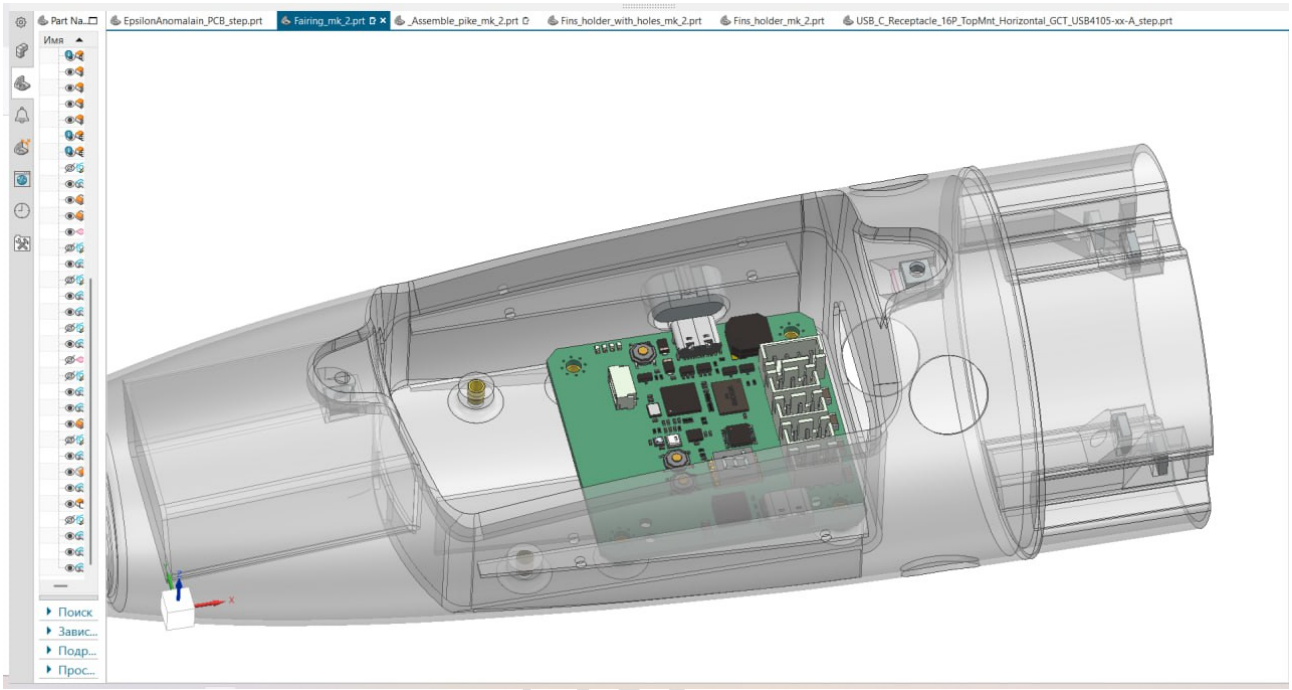


Figure 27: EA / TA placing

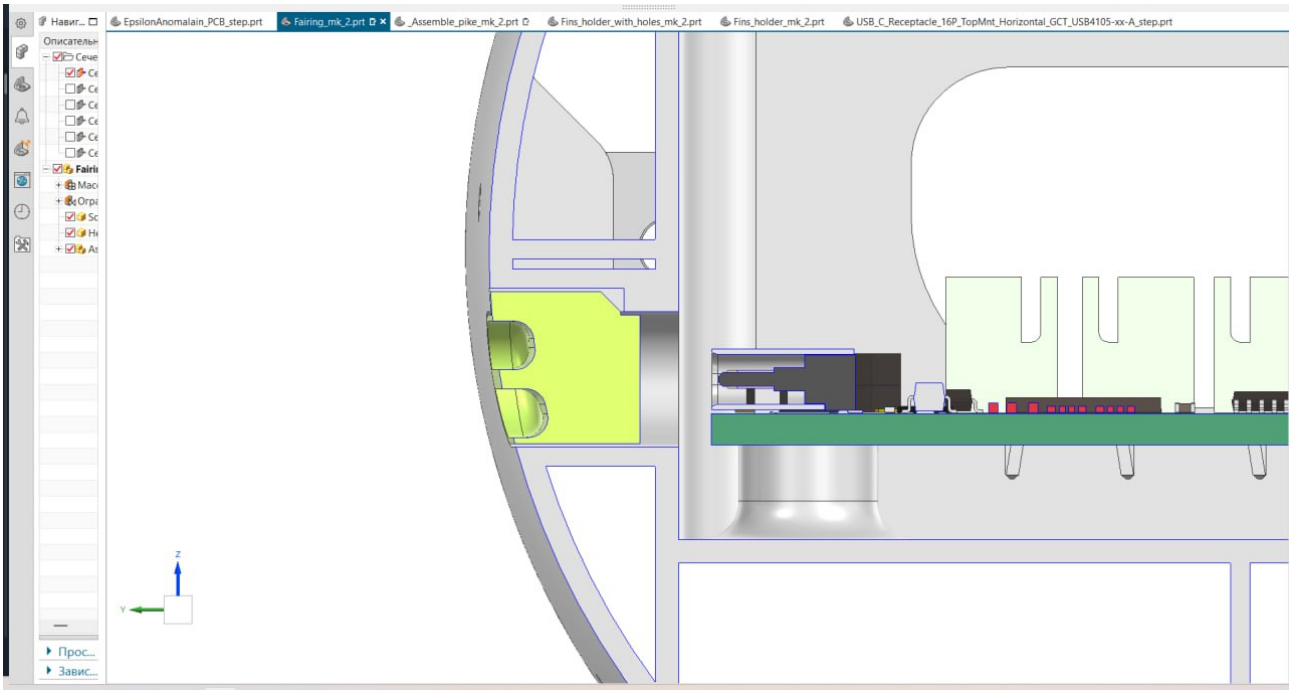


Figure 28: USB-C connector hole

EA & TA software packet

Abstract

The EA & TA software packet is a big complex software product. It is named after a modern philosopher A.Dugin.

Device connection for flashing & communication

EA / TA device PC connection shown at figure. Only one USB-C cable is necessary for connection.

Software building & device flashing are proceeded via Espressif IDE (Eclipse-based). It is recommended to restart device in BOOT-mode before flashing (press “R” button on board when “B” button is pressed).

Communication with device is possible via serial terminal on PC or special command-line utility (see EA & TA PC interface).

Communication is proceeded via a set of ASCII-commands. It can be easily entered to serial terminal. The EA / TA device is ready to receive commands when it has sent a command line marker: “> “.

Commands summary

Command	Description
Servo commands	
SAP	SERVOA add a small positive offset (servo A bias plus).
SAM	SERVOA add a small negative offset (servo A bias minus).
SBP	SERVOB add a small positive offset (servo B bias plus).
SBM	SERVOB add a small negative offset (servo B bias minus).
SCP	SERVOC add a small positive offset (servo C bias plus).
SCM	SERVOC add a small negative offset (servo C bias minus).
SDP	SERVOD add a small positive offset (servo D bias plus).
SDM	SERVOD add a small negative offset (servo D bias minus).
SZERO	Reset zero offsets for all the servos and print.
SPRINT	Print the servo angles (is needed if the servos were rotated

	manually and you need to check the zero-angles).
I2C commands	
TWI-VERIFY	Check the connection of all the supported I2C peripherals.
TWI-RESET	Reset the I2C bus.
BMP388-ID	Get BMP388 ID and check it.
AH3-ID	Get AH3 ID and check it.
Disk commands	
DISK-INFO	Print information about the disk: manufacturer, type, capacity, packet length, number of written packets, disk's percent of usage.
DISK-ERASE	Erase the disk. Checks the number of written packets and packet length, then erases the required amount of 128-KiB blocks.
DISK-ERASE-ALL	Erases all log area of the disk.
PACKET-WROTE	Prints the number of written packets.
Get/set parameters commands	
BOOT-ENTIRE-READ	Reads the disk's boot entire and prints the information about entire encoding version, type of the device (EA or TA), device unique id, packet length, number of written packets, IMU calibration coefficients, IMU cycle frequency in Hz, token value (should be 0x55AA), etc.
PACKET-LEN	Prints the log packet length.
IMU-CYCLE-FREQ	Get IMU cycle frequency in Hz.
DEVICE	Get device's info.
SET-BOOT-ENTIRE	Set boot entire to default state (device type sets to "Noname", device ID sets to "0").
SET-DEVICE-TYPE	Sets the device's type (EA or TA).
SET-DEVICE-ID	Sets device's ID (0-255).
SET-IMU-CYCLE-FREQ	Set IMU cycle frequency in Hz (allowed values: 500, 1000, 2000, 4000, 8000).
LOG-SCENARIO	Prints logging scenario.
SET-LOG-SCENARIO	Sets logging scenario.
IMU commands	
IMU-CALIB	Calibrate IMU and save coefficients.

IMU-CALIB-COEFS	Prints all the IMU calibration coefficients from boot entire.
IMU-CALIB-EPSILON	Read IMU calibration parameter (epsilon).
SET-IMU-CALIB-EPSILON	Set IMU epsilon calibration parameter.
System commands	
POWER-OFF	Device power down (TA only).
RESTART	Restart device.
ACTION	Switches the computer to active mode.
Helper commands	
HELP	Prints available commands.
Debug commands	
PAGE-CONTENTS	Prints disk's page contents.
TEST-ACTION	Writes some packets to the disk as is in Active mode and returns control to user's terminal.
TEST-ACTION-CYCLES	Get number of packet writing cycles for TEST-ACTION command.
SET-TEST-ACTION-CYCLES	Sets number of packet writing cycles for TEST-ACTION command.
PRINT-SYMBOL	Prints an ASCII symbol to onboard display (is only effective for TA).
PROCESSING-ROTATION-TEST	Sends a rotation quaternion to the port is special form for Processing visualization.
IMU-VALUE-TEST	The command allows to check IMU data values (linear accelerations, linear velocities, angle velocities, quaternion components, Euler angles) for errors.
TWI-VALUE-TEST	The command allows to check I2C modules data values (static & dynamic temperature & pressure, onboard temperature & pressure, AH3 & onboard vertical speeds & altitudes, air speed) for errors.
TOGGLE-STATES-INDICATION	Switches on/off printing temporary condition mode to the onboard display if TEST-ACTION command is used. Is only effective for TA.
ADC-VALUE-TEST	Prints to the serial measured battery voltage values.
GOIDA	Prints "Goida" to onboard display. Only effective for TA

PODSTAVA	Prints “Podstava” to onboard display. Only effective for TA.
Machine mode commands	
MM-PACKET-LEN	Same as PACKET-LEN, but does not beepes at the end.
MM-PACKET-WROTE	Same as PACKET-WROTE, but does not beepes at the end.
MM-DISK-READ	Reading disk’s binary data.

Servo control commands

SxP & SxM commands

Created to calibrate servos zero state before flight. This commands, when received, add a small offset to the servo zero state and print zero state to the servos.

SZERO

Resets all the extra offsets added by SxM & SxP commands and prints zero state value to servos.

SPRINT

Prints zero state to the servos. It is needed if servos angles have already calibrated, but were changed manually so it is necessary to set calibrated zero state value to servos.

I2C control commands

TWI-VERIFY

Checks the BMP388 and AH3 connection and prints connection status to the serial.

```
>
> TWI-VERIFY
BMP connected ok.
AH3 connected ok.
>
```

Figure 29: TWI-VERIFY command response

TWI-RESET

Resets the I2C bus. It is needed if the connection was lost but then.

BMP388-ID

Reads BMP388's ID and check it. The proper value is 0x50, if read value is not equal, the system raise the exception.

```
>
> BMP388-ID
BMP388 ID: 0x50, it is a proper value.
>
```

Figure 30: BMP388-ID command response

AH3-ID

Reads AH3's ID and check it. The proper value is 0x74, if read value is not equal, the system raise the exception.

```
>
> AH3-ID
AH3 ID: 0x74, it is a proper value.
>
```

Figure 31: AH3-ID command response

Disk control commands

DISK-INFO

Prints to the serial disk connection status, disk type (from JEDEC ID), capacity information, and if the boot entire is formatted, boot entire information: number of written packets, disk usage status.

```
> DISK-INFO
Device: 25N01, 1Gbit SPI NAND Flash
Packet size: 100
Packet wrote: 3
Wrote: 0.29KiB, 0.00% of total flash
```

Figure 32: DISK-INFO command response

DISK-ERASE

Erases log area of disk. Erasing is necessary before writing information in Flash memory. DISK-ERASE command reads number of written packets and packet length values from boot entire and erases strictly necessary amount of blocks that save user's time and device resource.

DISK-ERASE-ALL

Erases all the log area of disk.

PACKET-WROTE

Reads the number if written packets from the disk's boot entire and prints it to the serial.

```
>
> PACKET-WROTE
20067
>
```

Figure 33: PACKET-WROTE command responce

Get/set parameters commands

BOOT-ENTIRE-READ

Reads the boot entire and writes full information about if to the serial. It prints:

- Boot entire structure version
- Board type (EA or TA)
- Device unique ID (each board computer should have an unique number)
- Log packet length
- Number of written packets
- IMU calibration parameters

```
> BOOT-ENTIRE-READ
Encoding version:       1
Device:                 EA
Device unique ID:       1
Log packet size:        100
Log packet wrote:       3
IMU calibration parameters:
- gyro_bias:    x:0.000000      y:2.870526      z:0.000000
- gyro_eps:     x:2.876356      y:1.572361      z:0.000000
- accel_eps:    x:0.000000      y:0.000000      z:-0.000000
- calibrating temperature: 0.000000 *C
```

Figure 34: BOOT-ENTIRE-READ command response

PACKET-LEN

Reads the packet length value from the disk's boot entire and prints it to the serial.

```
>
> PACKET-LEN
128
>
```

Figure 35: PACKET-LEN command responce

IMU-CYCLE-FREQ

Returns temporary defined IMU processing cycle frequency in Hz.

```
>
> IMU-CYCLE-FREQ
8000
>
```

Figure 36: IMU-CYCLE-FREQ command responce

DEVICE

Prints device's info into the serial: device type (EA or TA) and device's unique ID. The data are read from boot entire.

```
>
> DEVICE
Device: EA; unique ID: 1
>
```

Figure 37: DEVICE command response

SET-BOOT-ENTIRE

Sets boot entire to the default state:

- Sets device as "Noname";
- Sets device's ID as "0" (incorrect);
- Sets log packet size according the software;
- Sets number of written packets to zero;
- Sets IMU cycle frequency to 8000 Hz;
- Sets IMU calibration coefficients to zero;
- Sets number of packet writing cycles for TEST-ACTION to 1000;
- Sets token field to 0x55AA.

SET-DEVICE-TYPE

Sets device's type. The command is necessary because of the importance of having one software for both of EA and TA board computers.

```
>
> SET-DEVICE-TYPE
Enter device type (EA/TA): TA
New device type written successfully
>
```

Figure 38: SET-DEVICE-TYPE command responce

SET-DEVICE-ID

Sets is device's ID. It meant that the ID is the same as board number.

```
>
> SET-DEVICE-ID
Enter device ID (0-255): 1
New ID (1) written successfully
>
```

Figure 39: SET-DEVICE-ID command responce

SET-IMU-CYCLE-FREQ

Sets IMU cycle frequency. After the command input the interface asks user to text the frequency needed. Allowed values: "500", "1000", "2000", "4000", "8000". If the user writes wrong value, the system terminates cycle frequency update and returns an error message.

```
> SET-IMU-CYCLE-FREQ
New IMU cycle frequency in Hz: 8000
New IMU frequency value writed, please restart the device
```

Figure 40: SET-IMU-CYCLE-FREQ command response 1

```
> SET-IMU-CYCLE-FREQ
New IMU cycle frequency in Hz: 9999
Wrong value, allowed values:
* 500
* 1000
* 2000
* 4000
* 8000
```

Figure 41: SET-IMU-CYCLE-FREQ command response 2

LOG-SCENARIO

Prints logging scenario for each step of rocket flight (cps – cycles per second)

```
>
> LOG-SCENARIO
Logging scenario:
* While waiting for start:   1000.00 cps (factor 8)
* While waiting for apogee:  8000.00 cps (factor 1)
* While waiting for landing: 500.00 cps (factor 16)
* While waiting for rescue:  1.00 cps (factor 8000)
>
```

Figure 42: LOG-SCENARIO command responce

SET-LOG-SCENARIO

Sets logging scenario for each step of rocket flight. The logging scenario is set by factors – number of IMU cycles that are for one log packet.

```
>
> SET-LOG-SCENARIO
Setting new logging scenario.
Enter factor while waiting for start: 8
Enter factor while waiting for apogee: 1
Enter factor while waiting for landing: 16
Enter factor while waiting for rescue: 8000
Log scenario was written.
>
```

Figure 43: SET-LOG-SCENARIO command responce

IMU commands

IMU-CALIB

Calibrates the IMU and writes calibration values to the disk.

IMU-CALIB-COEFS

Prints calculated values read from the disk.

```
> IMU-CALIB-COEFS
IMU calibration parameters:
- gyro_bias:    x:1.577705      y:1.577759      z:0.000000
- gyro_eps:     x:0.000000      y:0.000000      z:2.083296
- accel_eps:    x:2.083305      y:-0.000000     z:2.870596
- calibrating temperature: 1.574953 *C
```

Figure 44: IMU-CALIB-COEFS command response

System commands

POWER-OFF

Power down the device. Note that the function does not work on EA.

RESTART

Restarts the software.

ACTION

Switch the device into the Active working mode.

Helper commands

HELP

Prints helper message with all the supported commands descriptions.

Debug commands

PAGE-CONTENTS

Prints page contents. After the user inputs this command, the system asks him, which page he would like to see. Then, after page number receiving, the system prints 2048 bytes of page contents in 16 columns with start addresses on the left hand.

TEST-ACTION

Writes some packets to the disk. The command is created to simulate computer working in the Action mode. After packets writing, the system returns control to user.

TEST-ACTION-CYCLES

Reads number of packets that are to write while TEST-ACTION command processing.

```
>
> TEST-ACTION-CYCLES
1000
>
```

Figure 45: TEST-ACTION-CYCLES command responce

SET-TEST-ACTION-CYCLES

Sets number of packets that are to write while TEST-ACTION command processing. The value is 1000 by default.

```
>
> SET-TEST-ACTION-CYCLES
New TEST-ACTION cycles number: 1000
New TEST-ACTION cycles number is written
>
```

Figure 46: SET-TEST-ACTION-CYCLES command responce

PRINT-SYMBOL

The command writes entered ASCII value to the onboard display. Is only effective for TA.

```
>
> PRINT-SYMBOL
Enter a symbol: A
>
```

Figure 47: PRINT-SYMBOL command responce

PROCESSING-ROTATION-TEST

Sends a rotation quaternion to the port is special form for Processing visualization.

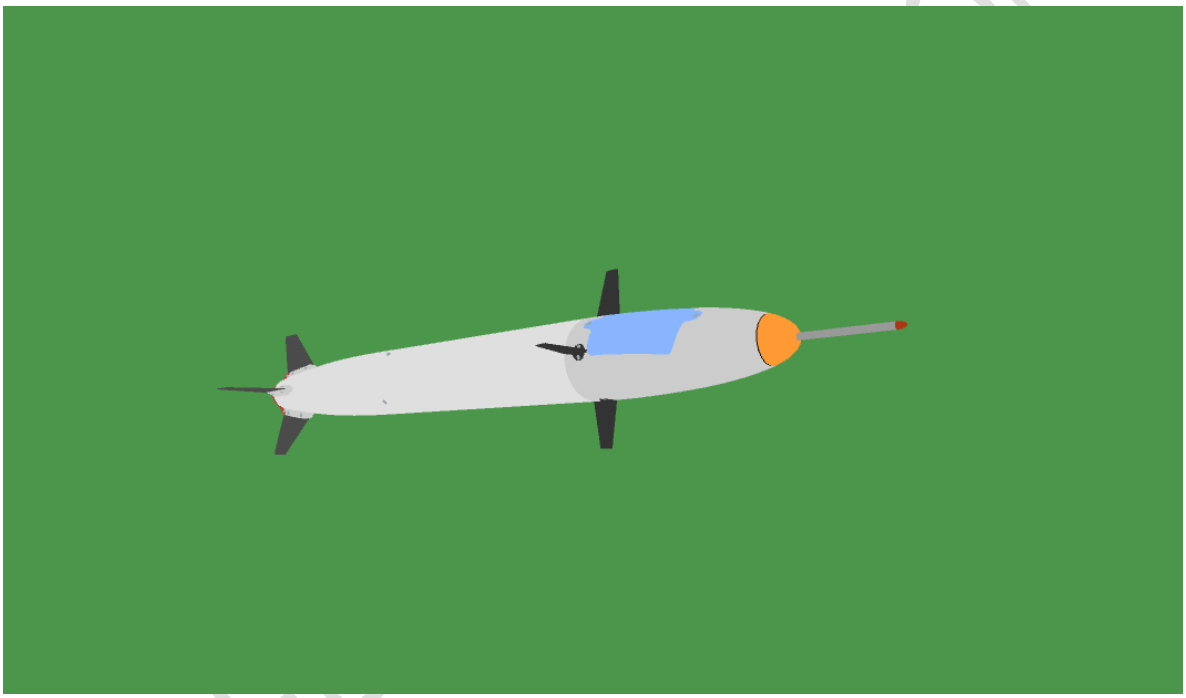


Figure 48: Processing rocket rotation visualization

IMU-VALUE-TEST

The command allows to check IMU data values (linear accelerations, linear velocities, angle velocities, quaternion components, Euler angles) for errors.

TWI-VALUE-TEST

The command allows to check I2C modules data values (static & dynamic temperature & pressure, onboard temperature & pressure, AH3 & onboard vertical speeds & altitudes, air speed) for errors.

TOGGLE-STATES-INDICATION

Switches on/off printing temporary condition mode to the onboard display if TEST-ACTION command is used. Is only effective for TA.

ADC-VALUE-TEST

Prints to the serial measured battery boltage values.

GOIDA

Prints “Goida” to onboard display. Only effective for TA.

PODSTAVA

Prints “Podstava” to onboard display. Only effective for TA.

Machine mode commands

MM-PACKET-LEN

Does the same as PACKET-LEN, however it does not beeps the buzzer. This command is needed for EA & TA PC interface. “MM” means “machine mode”.

MM-PACKET-WROTE

Does the same as PACKET-WROTE, however it does not beeps the buzzer. This command is needed for EA & TA PC interface.

MM-DISK-READ

EA & TA board computers architecture allows to write a big amount of log data. When there are more than hundred megabytes of log data, their reading becomes a difficult task.

The Barsotion DeltaAnomalain board computer used to send log data to PC via serial interface as CSV-strings, so the packets were read, then converted to CSV-string and sent via UART.

This way was not effective because CSV-strings wear more than binary data. EA & TA software packet send packet data in binary form.

MM-DISK-READ command, when received, checks the disk connection and then responds OK, if the connection is valid. Then the board computer waits to sending any bytes via USB. When byte is sent, it sends a packet binary raw data as an answer. It sends packet 0 contents after start, then the address is incremented.

MM-DISK-READ command is used by EA & TA PC interface and allows read log data via USB at temporary maximum possible speed about 60 kilobytes per second.

EA & TA PC interface

For the purpose of reading logs automatically and simplification EA & TA user experience, the GBK Oracle packet of utilities was created.

- gbk-oracle-reader – reads log data from the board computer into .bin file;
- gbk-oracle-decoder – decodes .bin log file to .json format;
- gbk-oracle-visualizer – draws diagrams from .json log.

GBK Oracle Reader

GBK Oracle Reader usage

GBK Oracle utility needs the Python 3 installed on the PC.

The standard launch query look like as shown below.

```
$ python3 gbk-oracle -p /dev/ttyACM0 --output-dir .
```

Utility's '--output-dir' parameter is optional. It sets directory where the log file will be written. By default it is the same directory when program source file is located.

The '-p' parameter defines serial port name. It is usually /dev/ttyACMx for Linux and COMx for Windows systems.

Optional '-b' parameter sets the baudrate. It is maybe useless because USB interface do not mind about baudrate in CDC mode, data samples are transmitted by packets.

GBK Oracle commands

The GBK Oracle utility commands are mostly the same as EA & TA software packet serial interface commands, but there is a new command – DISK-READ.

GBK Oracle utility allows to enter commands . For example for command DISK-READ four writing forms are allowed

- DISK-READ

- DISK_READ
- disk-read
- disk_read

Then the full list of GBK Oracle commands is presented. In the following table ‘xxx-xxx’ form of commands is used in goal to separate GBK Oracle commands from EA & TA software packet commands.

Command	Description
disk-read	Reading disk’s data into the file.
exit	Quit the program.
quit	Quit the program.
sap	SERVOA add a small positive offset (servo A bias plus).
sam	SERVOA add a small negative offset (servo A bias minus).
sbp	SERVOB add a small positive offset (servo B bias plus).
sbm	SERVOB add a small negative offset (servo B bias minus).
scp	SERVOC add a small positive offset (servo C bias plus).
scm	SERVOC add a small negative offset (servo C bias minus).
sdp	SERVOD add a small positive offset (servo D bias plus).
sdm	SERVOD add a small negative offset (servo D bias minus).
szero	Reset zero offsets for all the servos and print.
sprint	Print the servo angles (is needed if the servos were rotated manually and you need to check the zero-angles).
twi-verify	Check the connection of all the supported I2C peripherals.
twi-reset	Reset the I2C bus.
disk-info	Print information about the disk: manufacturer, type, capacity, packet len, number of written packets, disk’s percent of usage.
disk-erase	Erases the disk. Checks the number of written packets and packet len, then erases the required amount of 128-kiB blocks.
disk-erase-all	Erases all the log area of the disk.
packet-wrote	Prints the number of written packets.
boot-entire-read	Reads the disk’s boot entire and prints the information about entire encoding version, type of the device (EA or TA), device unique id,

	packet length, number of written packets, imu calibration coefficients.
packet-len	Prints the log packet length.
imu-cycle-freq	Reads IMU cycle frequency.
device	Reads device's info (type & ID).
log-scenario	Reads logging scenario.
imu-calib-coefs	Reads IMU calibration coefficients.
imu-calib-epsilon	Reads IMU epsilon calibration parameter.
test-action-cycles	Reads number of cycles that are to written while TEST-ACTION command execution.
test-action-factor	Reads TEST-ACTION logging factor and logging frequency.
power-off	Device power down (TA only).
restart	Restarts the board computer software.
action	Switches the computer to active mode.
help	Prints available commands (help message).
test-action	Writes TEST-ACTION-CYCLES cycles to the disk as in is in Action mode.
goida	Prints "Goida" to onboard display, TA only.
podstava	Prints "Podstava" to onboard display, TA only.

GBK Oracle Decoder

```
$ python3 gbk-oracle-decoder [--decoder-version=]
```

The utility provides a simple usage. This string, sended to the bash terminal, decode log.bin file converting it to log.json.

Only one option is available, "—decoder-version". Values 2, 3, 4 are effective now, the value "4" is default.

GBK Oracle Visualiser

The utility to draw diagrams from JSON log file.

GBK Oracle Visualizer usage

```
$ python3 gbk-oracle-visualizer.py <options>
```

GBK Oracle Visualizer options

All the options can be skipped.

Option	Description
-h	Prints help message. If this option used, other do not matter.
--log-filename	Sets source .JSON log filename. “log.json” by default.
--output-dir	Sets custom output dir. The directory name should pass after this option. By default, diagrams are drawn into “log_<month><day><literal>” directory. <literal> is “a”, “b”, “c”, etc.
--decoder-version	Do not affect, useless option (for now).
--start-time	Sets the start drawing time. After “--start-time” time value in microseconds should pass. The program does not draws points whose time is less than set by --start-time option.
--end-time	Sets the end drawing time. After “--end-time” time value in microseconds should pass. The program does not draws points whose time is more than set by --end-time option.
--rpy	Draw Euler angles diagrams.
--accel	Draw accelerations diagrams.
--gyro	Draw angle velocities diagrams.
--invel	Draw linear velocities (inertial) diagrams.
--ah3	Draw AH3 data diagrams (static & dynamic pressure, static & dynamic temperature, altitude, vertical speed, air speed).
--onboard	Draw onboard barometer sensor data diagrams (temperature, pressure, altitude, vertical speed).
--common-i2c	Draw AH3 & onboard barometric sensor comparison diagrams (static temperature, static pressure, altitude, vertical speed).
--servo	Draw servo angles diagram.
--bat-voltage	Draw battery voltage diagram.
--all-i2c	Draw all the I2C devices data diagrams (is equal to “--ah3 --onboard –common-i2c”).

--all-imu	Draw all IMU data diagrams (is equal to “--rpy --accel --gyro –invel”).
--all	Draw all diagrams.

Revision history

Date	Modification
June 15, 2025	New commands, PC interace description updation.
May 8, 2025	TAv1.6, new commands, Log decoder utility addidion.
Apr 29, 2025	Document creation.

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