operation manual

2020

Advanced servo motor control unit for up to 7 motors

For AASD Series

Servomotors

Motion4Sim

11/20/2020

contents

introduction

The M4S-AASD15A servo controller enables the fast and seamless transfer of movement information from the PC simulation to the servo motor. The data exchange takes place between the interface programs such as Simtools, FLyPT Mover, BFF, etc. and the simulation.

The interface software calculates the motion vectors and forwards the values to the M4S servo controller via the USB interface. This controls the servomotors and also offers the option of calculating and smoothing motion cues yourself. The servo motor output stages are connected with DB25 cables.

All parameters necessary to operate the many actuators and actuator types are freely adjustable and configurable. All common servomotors that support STEP / DIR can be used.

Functions

The controller was mainly designed for the AASD servos. However, other servomotors can also be operated with it. It can be used to operate all servomotors whose amplifiers are operated via the Step / Dir function.

The following functions are operated by the controller:

Hardware functions

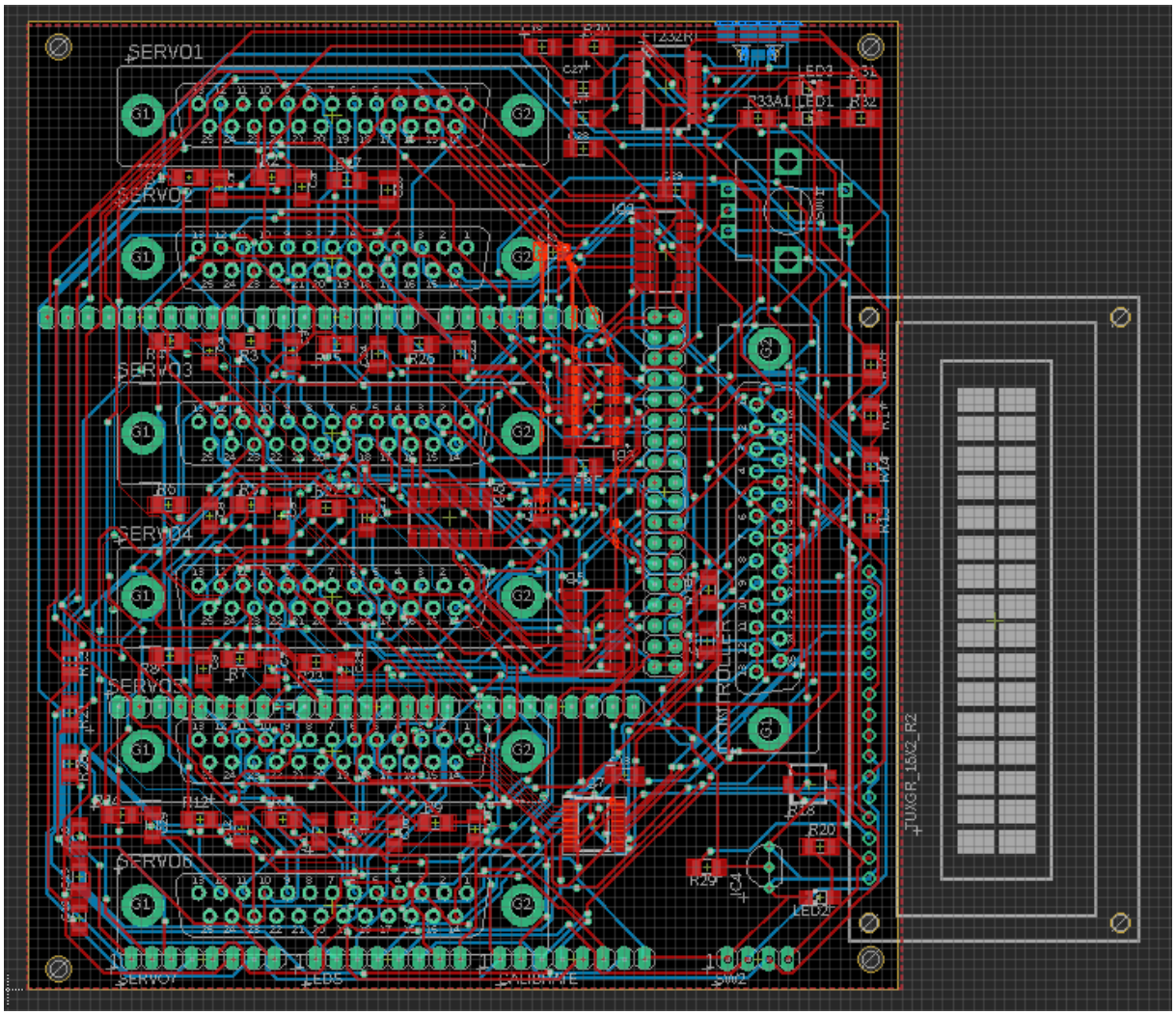
1. Control of 6 + 1 servomotors (optional) Pulse speed up
2. to 550 kHz
3. Step / Dir fashion
4th Query and evaluation of torque (for calibration) as well as error status, display of
5. parameters via LC display 16x2, full menu
6th Operation via rotary encoder with pushbutton switch for
7th signal reception
8th. Emergency stop switch for the servo functions. Serial USB
9. connection for data transfer
10. 32 bit processor
11. Save the settings
12. Control of LEDs for status display (external handheld)
13. Housing (to print yourself)
14. Control unit can be installed 3m away (optional)
15. LC display and encoder can also be installed on the mainboard
16. Automatic home calibration on power up or re-connection without limit switches
17. Limit switches can be optionally installed for home calibration
18. Protection from exceeding physical limits of the actuator
19. Optional Platform Health check, to ensure all actuators are active during gaming
20. Latency as low as 1ms in Mover and Simtools or faster if some tool will support
21. E-stop, Force Offline buttons and switches
22. Usb power supply

Software functions

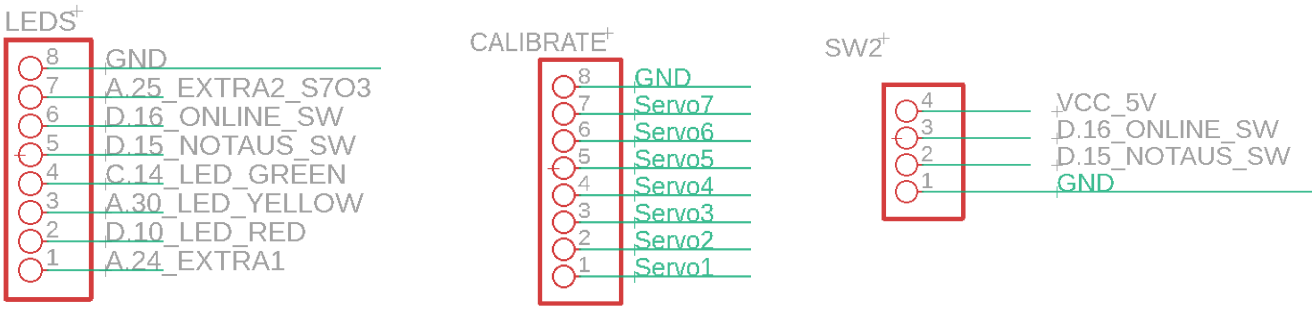
1. Software is menu-driven and easy to use
2. All functions can be parameterized to meet your own requirements. Monitoring
3. of the status of the motors
4th Automatic calibration of the zero position Servomotors calibration also
5. possible via limit switches
6th Service function for repair or control position of the motors Manual control of each
7th motor individually for testing and maintenance Adjustable direction for Inline or
8th. Foldback placement of servomotor Adjustable screw lead pitch advance per
9. revolution freely adjustable
10. Adjustable stroke unlimited

11. Selection of belt reduction ratios or gear ratios freely adjustable
12. Rotating and linear actuators are supported
13. Scaling of the input signals (master gain)
14. Real exponential moving average filter for anti-vibration and smooth pulses on the actuator
15. advanced full adjustable spike filter to automatically eliminate jolts during crashes or unwanted motion cues
16. Offset for each motor (especially for rotating actuators)
17. Variable parking position
18. Actuators individually adjustable (electronic translation, length of the act., DOF system)
19. Speeds for calibration, slow speed and high speed freely adjustable (max. 550 kHz)
20. Inverse kinematics with> 1000 calculations per second (for linear and non-linear actuators)
21. Geometry for steward platforms with 6 DOF and 6 actuators individually adjustable
22. Wash-out filter for each axis (can only be set with inverse kinematics)
23. Evaluation of 24 bit input data (Simtools / Mover)
24. Calculation in 32/64 bit for maximum smoothness of movement
25. 2 different operating modes: direct or inverse kinematics

PCB and connectors



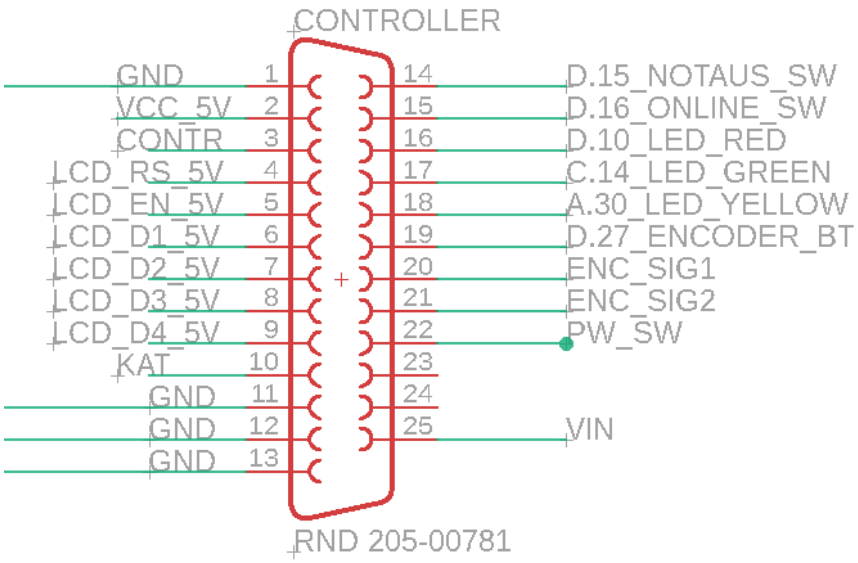
PCB layout V1.04



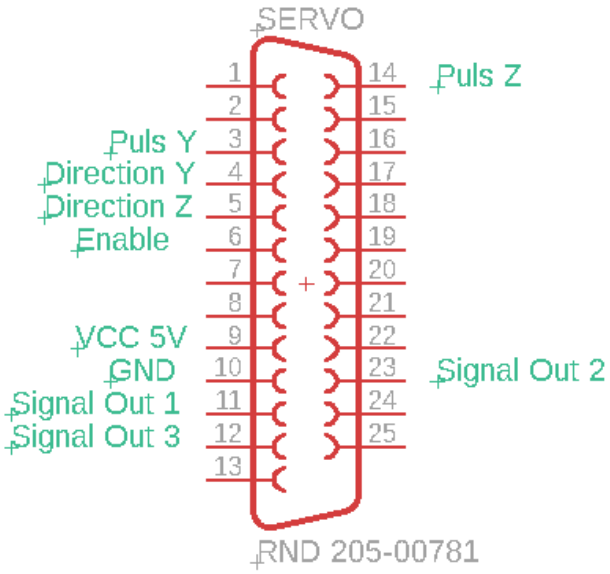
LEDs are switched with 3.3 volts without a series resistor. The calibration switches respond to contact with GND. Emergency stop is "normally closed" and online switch is "normally open". These settings can be configured in the software.

Danger:

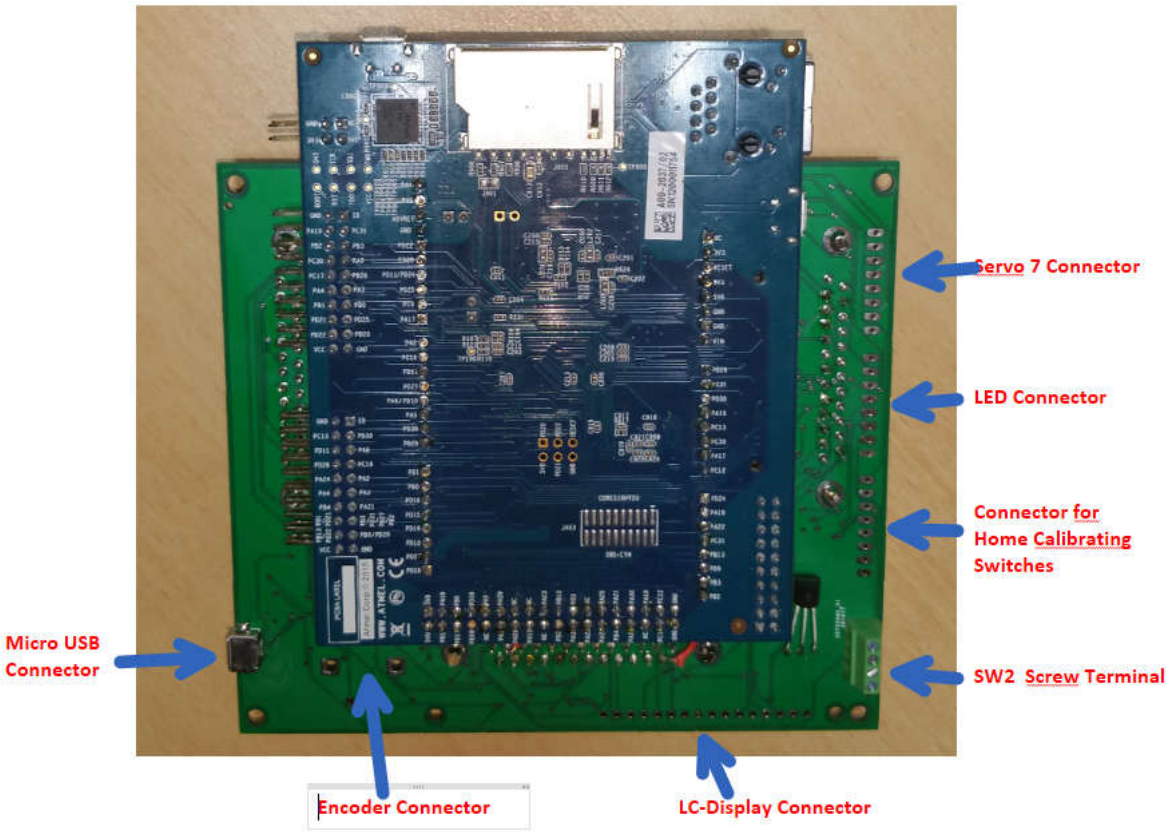
The micro USB port is sensitive to mechanical stress, please work with caution when trying it out.



Handheld Connector



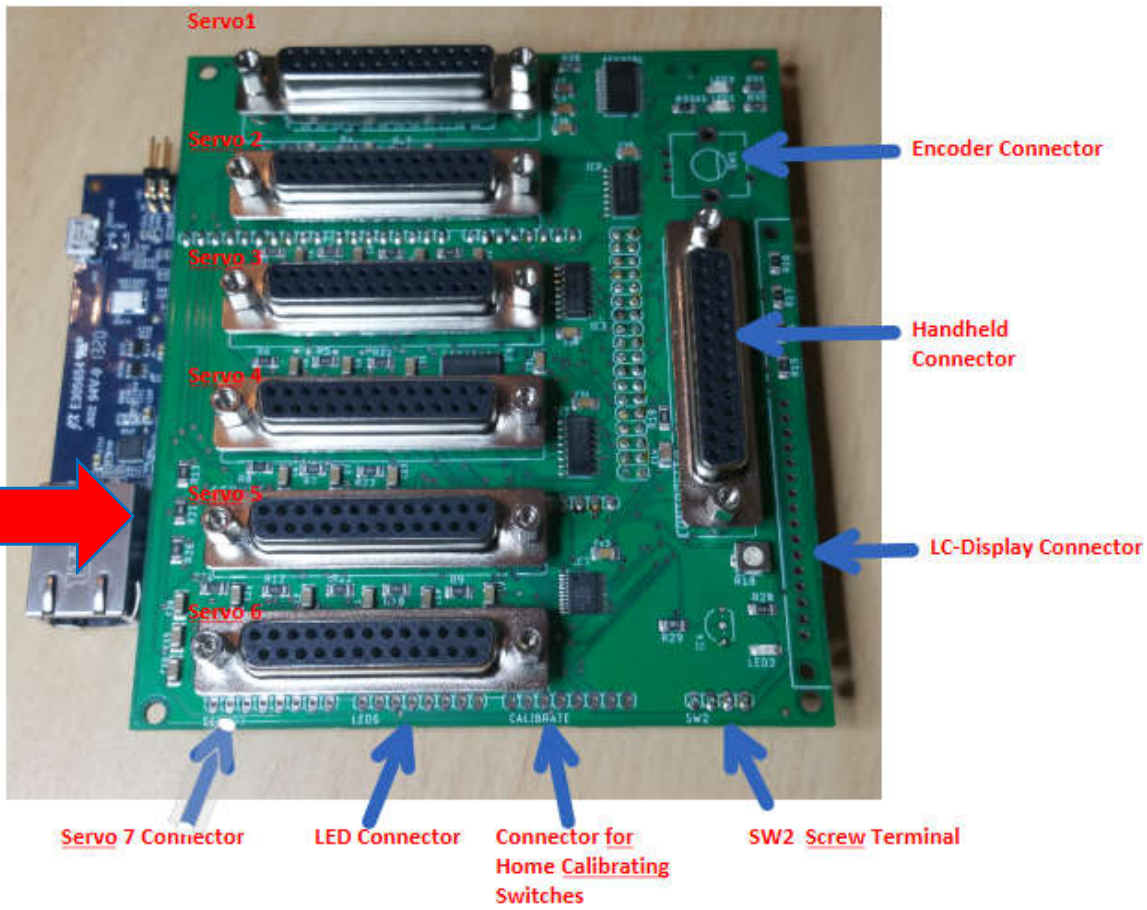
Servo connector



New !!!

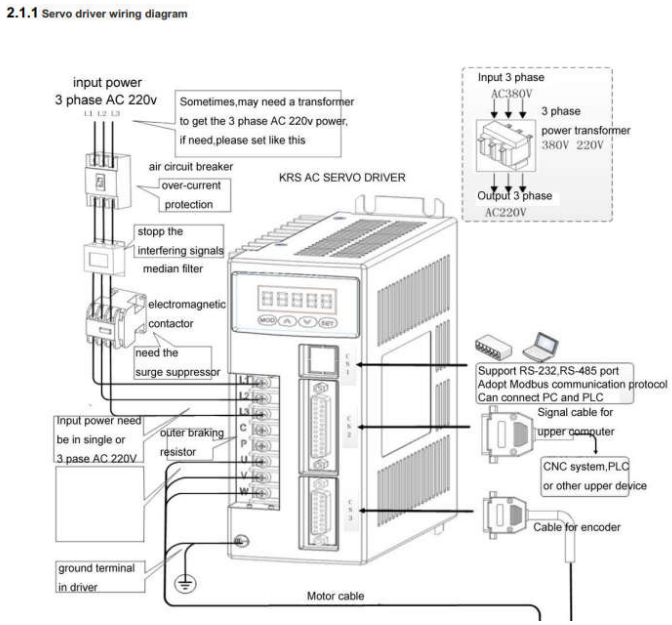
Native USB port

to the right of the ethernet port



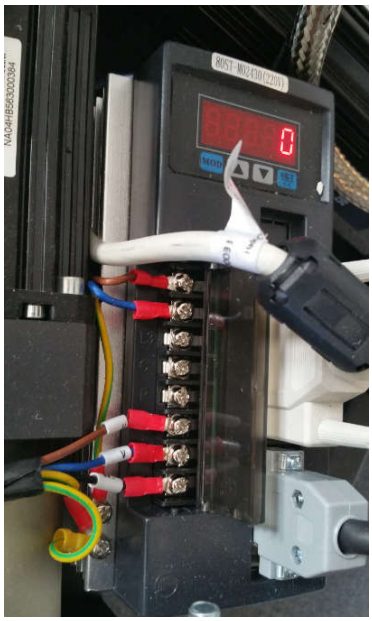
Hardware cabling

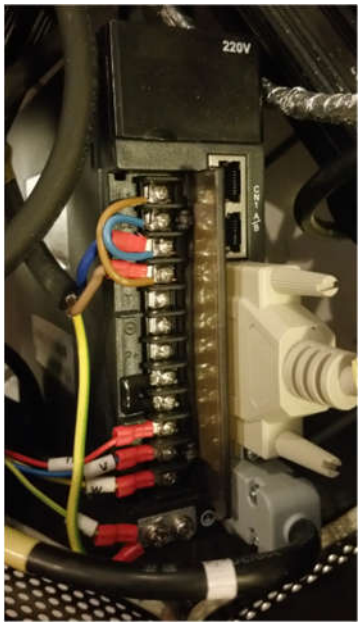
Servo motor amplifier wiring



The mains voltage connections are partly different, please always consult the manufacturer's data sheet. For example, see also:

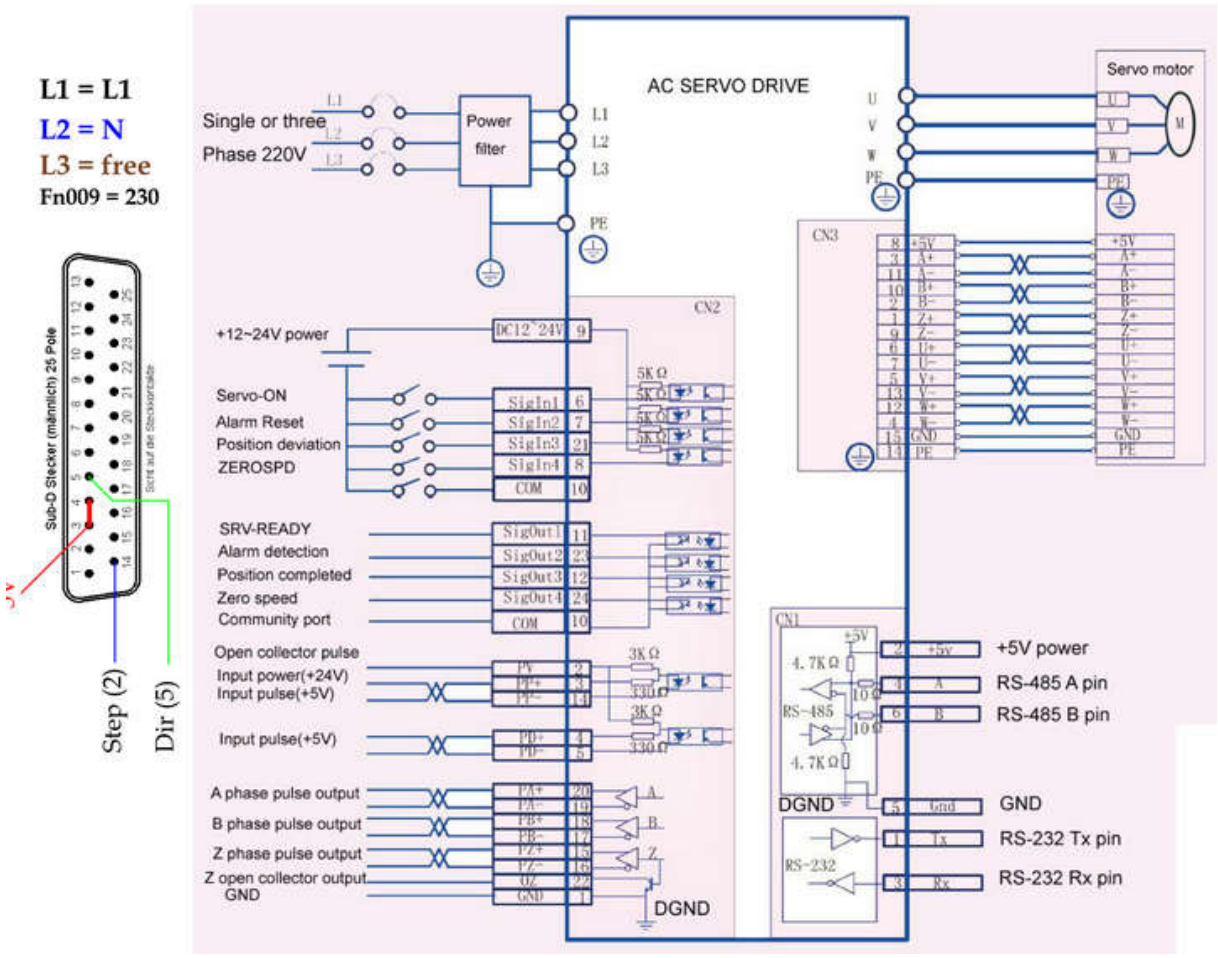
https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion-Simrigs / tree / master / Manuals





2.3 Standard connection

2.3.1 Position control wiring diagram



Settings of the servo amplifier

The controller can be connected to all servos that have a DB25 connection. It is also possible to manufacture your own adapter cables. Ask about compatibility.

AASD-15A Servo Settings:

Push MOD until you see Pn000. This enters the parameter mode.

Change and check these settings on all motors:

FN9 = 230 (230Volts recommend) Check this value if you get errors

Pn8 = 300

Pn9 = -300

Pn51 = 3000

Pn98 = 1-20 - Pulse Multiplier (electronics gear) different to Thanos and SFX for higher resolution

Typically on M4S you can set this to PN98 = 2

PN98 = 1 has to test with EMV interference of your construction by pulsing higher than 300 kpps

Pn109 = 1 - smoothing, 1 = fixed smoothing, 2 = s-Shaped smoothing Pn110 = 30 - Smoothing Filter Time

Pn113 = 20 - Feedforward%

Pn114 = 10 - Feedforward Filter Time (ms) Pn115 = 100 - Gain%

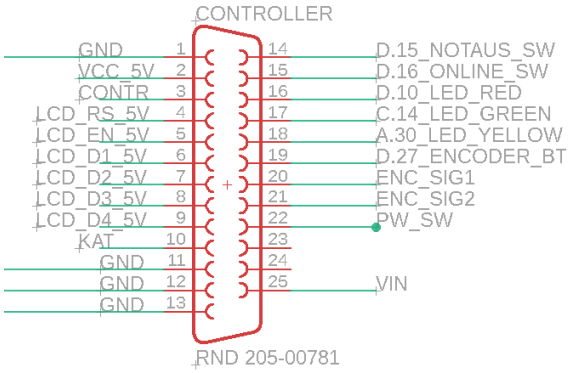
Pn24 = 100

Pn51 = 3000 motorspeed (2500 or 3000 mainly) Pn52 = 1 signal port 1 servo enable

Pn60 = 2 Sigout Port 1 Servo ready Pn61 = 6 Sigout Port 2 Servo Treach

Pn62 = 4 Sigout Port 3 Servo Preach

Hand-held device



For more information see also

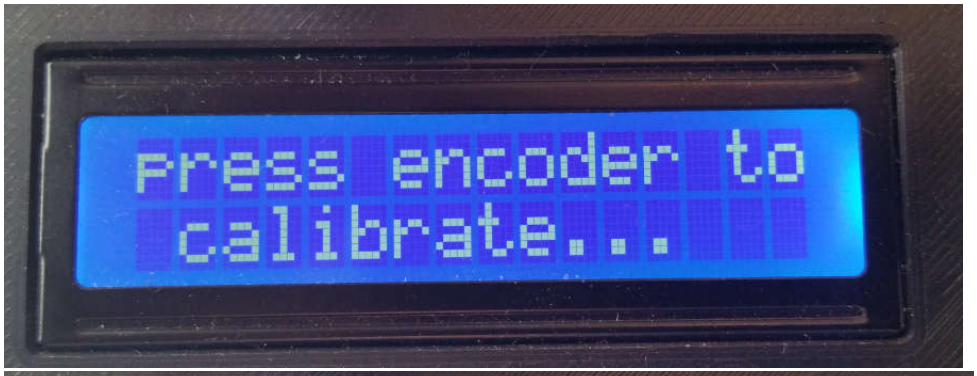
https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion- Simrigs / tree / master / handheld

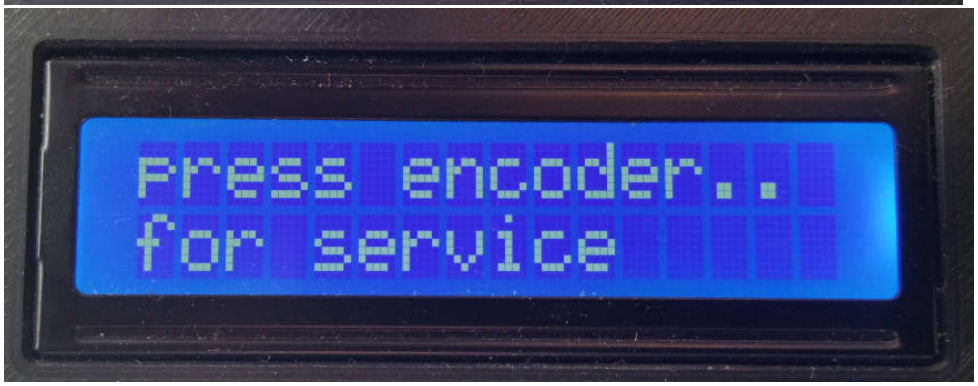
and

https://www.thingiverse.com/thing:4641555

Setting the controller / menu control

When you switch on the controller or supply it with USB voltage, the display is activated and loads the last settings used from the memory. It then waits for user input. When you press the encoder, the automatic calibration is started. There is also the option to turn the encoder to the left. This enables you to access the service menu without performing the calibration. (2nd picture) if you turn the encoder further to the left, there is still the option of performing a firmware reset. (Fig. 3) Caution, all settings will be lost.





In the first case you get to the main screen after pressing the encoder button. Here the status of the first 6 actuators is shown on the right.

X	is	Offline
C.	is	Calibrate
P	is	Preparing (moves to the parking position after calibration)
!	is	Employed
R.	is	Ready to use for motion data

The status of the rig system and the movements the machine is making are shown in the top line of the display.

to parkpos ..	moves to the parking position
preparing ..	calibrate and move to offset position Emergency stop
emergency ..	switch activated
offline..	Offline switch activated according to online status System
ready ..	fully calibrated
standby ..	Moving to the home position
wait uart ..	in home position waiting for serial data
on-line..	Serial data is received and movement takes place

Functions of the encoder on the main screen:

The status of the master gain controller is displayed at the bottom left. (100%)

If you turn the encoder to the left or right, you reduce or increase the amplification of the pulses in 10% steps. The gain has a range of 10% - 400%. The gain can also be changed in online mode.

If you press the encoder you activate the submenu structure. The menu structure is divided as follows.

1. Calibrate	- automatic recalibration
2. Filters	- Output filters
3. Service	- Menu for manual actuator movements
4. Actuators	- Actuator settings
5. Setup	- Settings of the controller
6. Rig	- Settings for Stewart geometry
7. Kinematic	- Input filter for DOF data

8. Reset - Restart the controller
9. Save and return - Save the current settings and close the menu

You can navigate through the menu structure by turning the encoder to the left or right. Activate the respective menu item by pressing the encoder.

Filter menu

The following options can be set.

Filter enabled:

Switch the filter on or off

Filter type :

SMA (not used anymore)

SMA & SPIKE (not used anymore)

EMALP Exponential Moving Average Low Pass Filter (as in Mover) EMALP & SPIKE

Filter samples:

Strength of the selected filter. The larger the value, the smoother the movement

Spike filter :

This filter is designed for excessively strong unwanted movements.
Spike Window which, if exceeded, activates the filter.

100 corresponds approximately to the pulse spacing of half of all possible pulses of the actuator. Try it out for an optimal setup. The lower the value, the sooner the filter is activated. With 1, all pulses are filtered.

_bithalf * RIG . Spikewindow * RIG . Spikewindow *
RIG . Spikewindow / 10000000;

Spike Strength:

This value influences the smoothing of the pulses if the spike filter was activated by exceeding the limit. The strength increases exponentially (filter ^ 4) the greater the overshoot of the window.

Sp.Filter smooth:

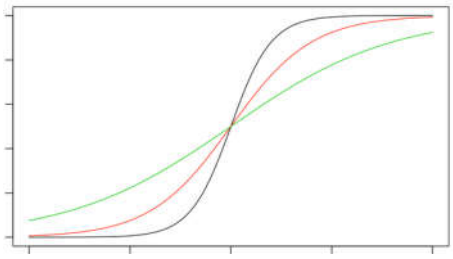
The spike filter operates dynamically and changes the smoothing accordingly. Therefore another EMA filter was built in for the dynamic change, which is controlled by this value.

Small value Spike filter increases quickly and jerkily when triggered and also returns quickly and jerkily after the end of the spike.

Value large Spike filter increases more gently when triggered and also returns more gently to the initial filter value.

Logistic Factor: (deactivated)

Logistics filter compresses the pulses for the actuator using the factor



Larger value Steeper rise (blue) Smaller value

weaker rise (green)

With a smaller increase, the maximum also becomes logistically smaller

Back : Closes the submenu and returns to a level above

Service menu

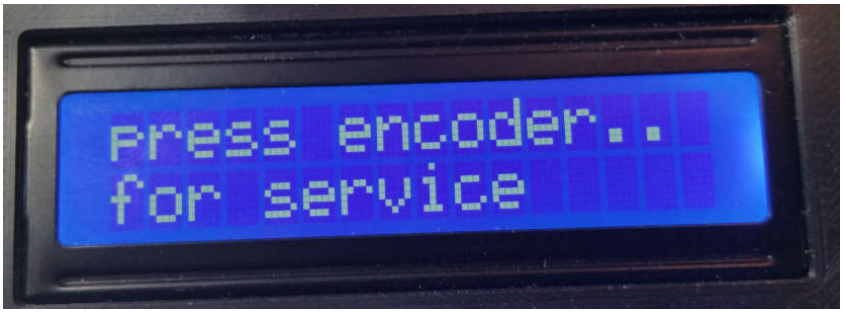
This menu is for testing the actuators and for moving the actuators to special service positions. All actuators can be moved simultaneously or each one individually. After activating the respective submenu, the value of the actuator can be increased or decreased by turning the encoder to the right or left. The value is changed by the value saved in "Multiplier". This menu can also be reached directly when starting the controller without calibrating the actuators. This can be used, for example, to “jack up a Stewart platform” in the event of a repair. A calibration is carried out when the menu is exited.

This function can also be used to save the offset of the individual actuators and all actuators. For Change Offset, set "Yes" with the encoder and confirm with Push.

Repair - moving without calibration

Attention be careful:

Start the controller, note that the emergency stop button is not pressed is. Choose



Move the encoder right or left and select one or all of the actuators to move.

Attention, after exiting the menu, a calibration is carried out.

If you press the emergency stop button, the servos are deactivated depending on the setting in the setup.

Actuators

Actuator	:	
		Linear or rotary
		These values are used for the calculations of the inverse kinematics as well as for calculating the resolution of the actuator.
Encoder PPR	:	Number of encoder positions depending on the servo with AASD15 10000
Electronics gear	:	
		Required for the calculation of the actuator resolution
		PN (98) value from the servo output stage must be the same for all actuators
Gearbox ratio	:	Ratio of used gears. Only reduction possible. Pitch of the
Leadscrewpitch	:	trapezoidal thread spindle 5, 10.25… in mm per revolution
Actuator length	:	Length of the linear actuator in mm

Actuators (submenu for actuator 1-8): Activate by pressing the encoder button

rotation	:	Direction of rotation of the actuator, CW vs CCW
Park enable	:	if you activate this option the actuator will not be parked
Cal. Offset	:	Offset in pulses is set after calibration. And used as the lower zero point of the actuator.
Park position	:	Offset from the lower zero point of the actuator as the parking position
		Offset is calculated in total Global + actuator pulse speed for calibration
Calib. speed	:	
Low speed	:	Pulse speed for the slow speed movement to and from the home position
High speed	:	Operating speed
multiplier	:	Value for changing the offsets

Formula rotating actuators

```
// for 24 bits
_bitmax = 0xffffff;                 // 16777215;
MaxPos =                            RIG . ppr * // Servo encoder positions (10000)
                                    RIG . mechanik_GearRatio_Servo /
                                    RIG . elektrik_GearRatio_Servo /
                                    RIG . Range factor ; // == 2 for rotating actuators
```

So for example:

AASD15A 10000 ppr Encoder

Gearbox 1:50

PN98 = 2

= 10000 * 50/2/2

= 125,000 positions per half round

Resolution depends on the arm length At 180

mm

Formula linear actuators

```
MaxPos                              = ( RIG . ppr * RIG . mechanik_GearRatio_Servo /
                                    RIG . elektrik_GearRatio_Servo * ( RIG . leadscrew_length /
                                    RIG . leadscrew_pitch ));
```

SFX 100 type

AASD15A 10000 ppr Encoder

Gearbox 1: 1

PN98 = 2

Leadscrew = 5

Leadscrew length = 100 mm =

10000 * 1/2 * (100/5)

= 100000 positions / 100 mm

resolution = 0.001 mm

SET UP

FPS LC display	:	Sets the refresh rate of the display
		Should be 5-10. Values above 10 are not tested. Allows the
LCD online	:	display to be updated in online mode. Should be off for no
		interruptions in operation ON Servos are switched off (RIG falls
Emergency Stat	:	down) OFF Servos stop but are on.
Online SW	:	Normaly open or normaly closed (included in next FWupdate) Normaly open
Emergency SW	:	or normaly closed (included in next FWupdate)

It is recommended to deactivate the display in game. The movement is much smoother and softer. The reason for this is that the display needs wait states and thus disrupts the interrupts for pulsing the actuators.

Edit: Has been revised and the display imperceptibly disturbs the movement. Nevertheless, the recommendation is to only leave the display activated for settings during operation.

kinematics

Danger : WIP

For calculations of the inverse kinematics of the Stewart platform, the geometric values of the platform are stored in this menu. These are queried as follows

Basic platform: Length L1 and L2

The basis for this is a regular or irregular hexagon

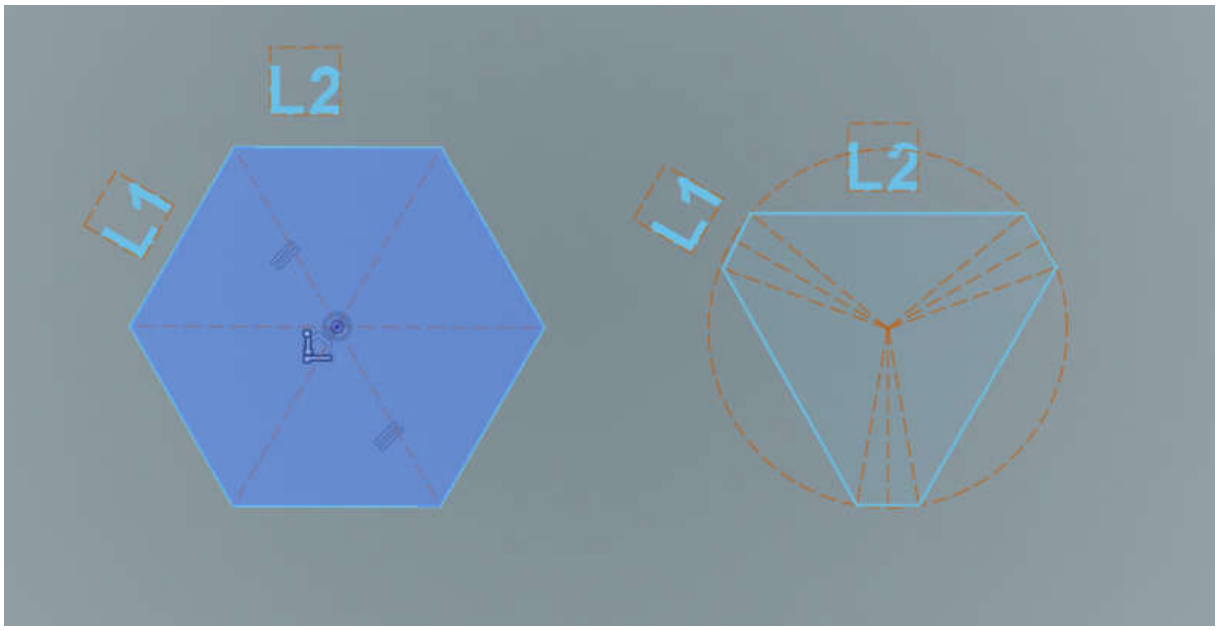
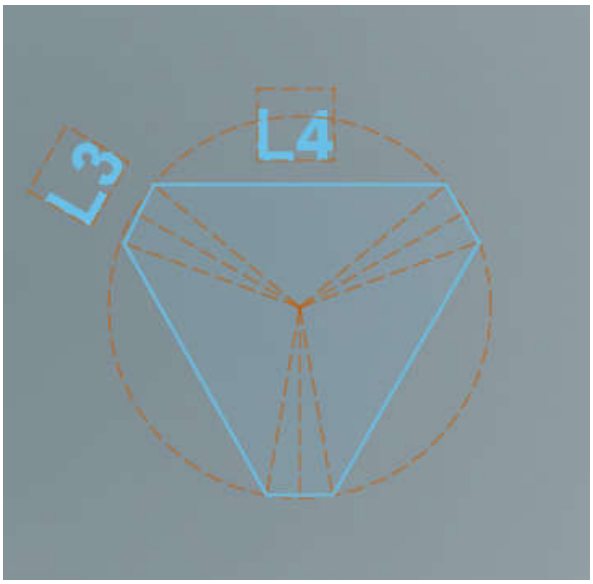


Fig. Left regular and right unequal hexagon

Movement platform: Length L3 and L4

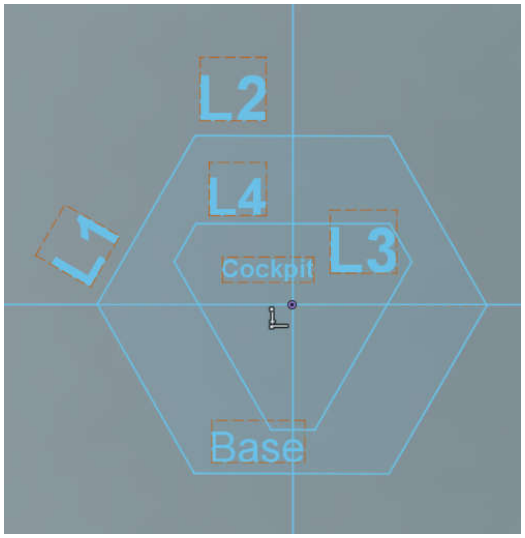
The same geometric basis also applies to the upper platform (the movement platform), but here an unequal-sided hexagon is almost always used as the geometric basis. The corners of which are rotated by 60 degrees to the base.

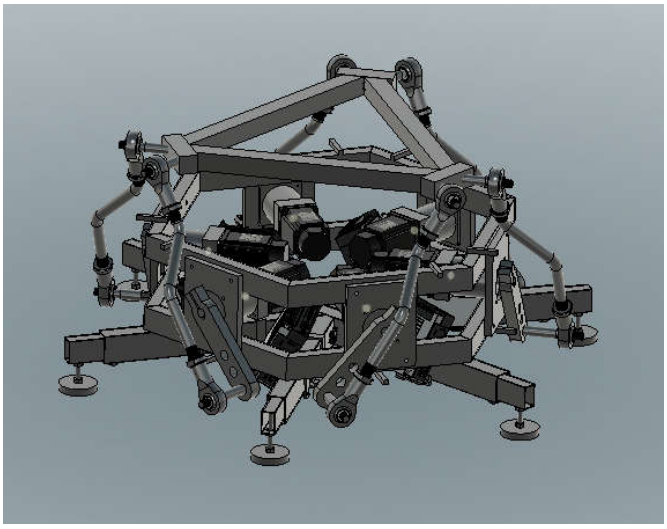


Overview of the geometry:

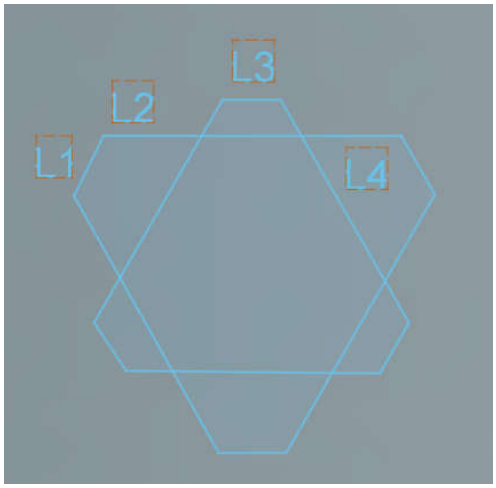
Base L1, L2

Cockpit L3, L4



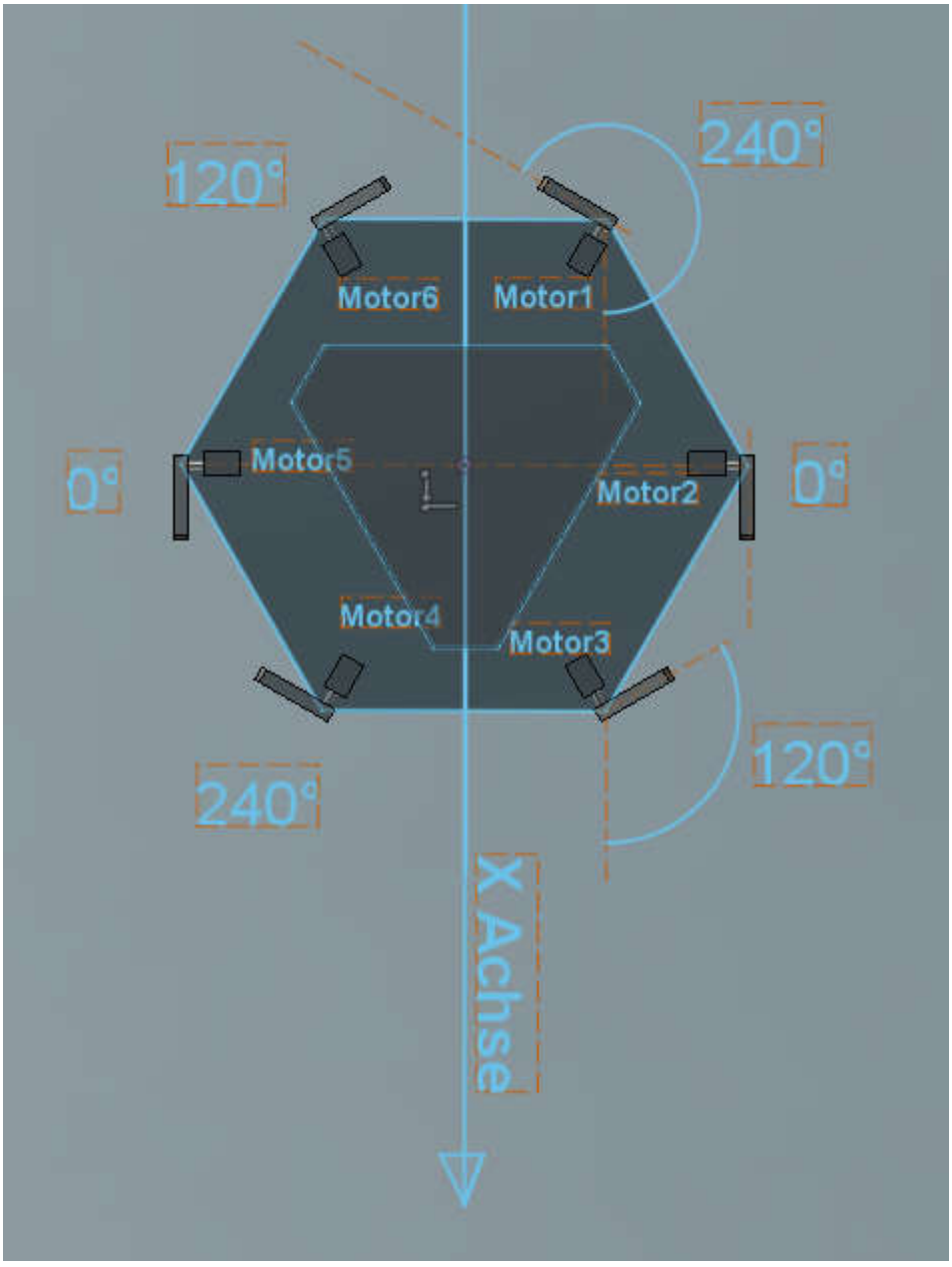


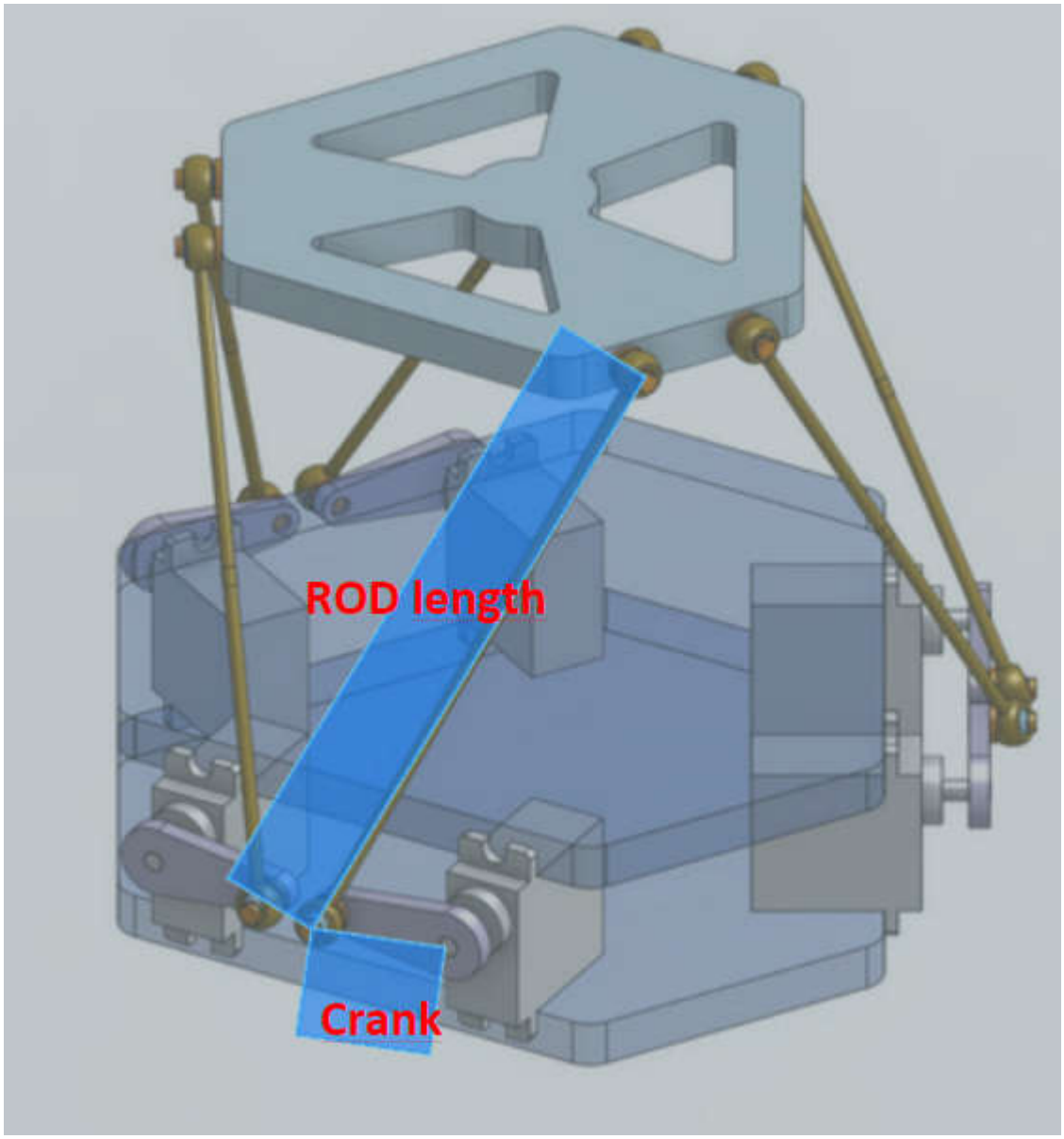
Symmetrical base: Rotating Hexpod



Uneven base: Linear Hexpod

For the calculations with linear actuators, you still need the total length of the actuator in the home position "Rod Length". The value of the range of the actuator is taken from the "Actuator" menu. For rotating actuators you also need the angle of the lever arms of the motors in relation to the X-axis according to the following sketch. These are stored in Crank Angel [1..6]. In addition, the length of the connecting rod "Rod Length" and the length of the lever arms "Crank" To define the home position geometrically, you also need the angle of the lever arm in the home position. This can be determined arithmetically (18 ° -29 °).




ROD length
Crank

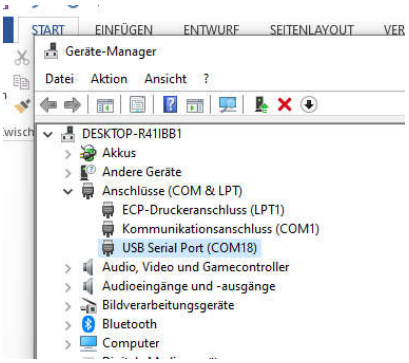
FTDI USB interface

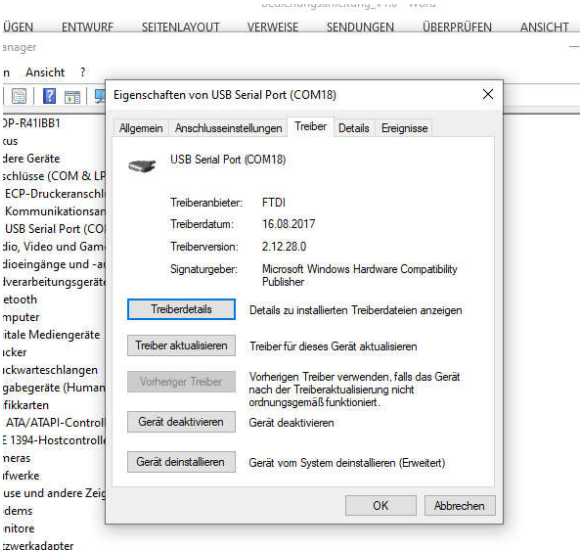
The controller contains an FTDI FT232 RL chip that is installed via USB.

The drivers required for this are usually installed automatically under Windows. But these can also be done via:

https://www.ftdichip.com/Drivers/VCP.htm

downloaded and installed.





Data transfer / interface information

The data transfer is established via the standard USB interface.

The data packet string now is 28 bytes long and includes additional spare motion data slots for up to 8axis

The ID is byte values 0xFF + 0xFF Each
axis is 24 bit wide.
LF + CR is required in the end (0x0A + 0x0D)

ID AXIS1 AXIS2 AXIS3 AXIS4 AXIS5 AXIS6 AXIS7 AXIS8 LF / CR

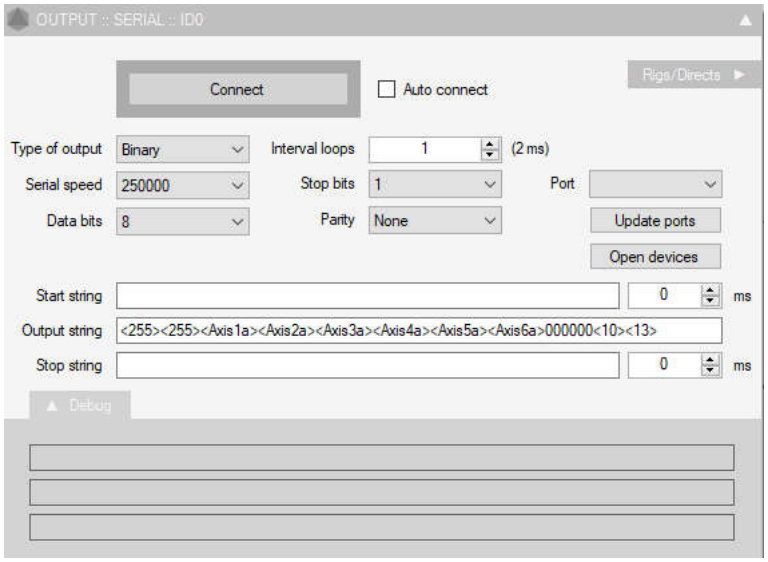
Data output	binary
speed	250,000 baud
Databits	8 bit
Stop bits	1
Parity	None

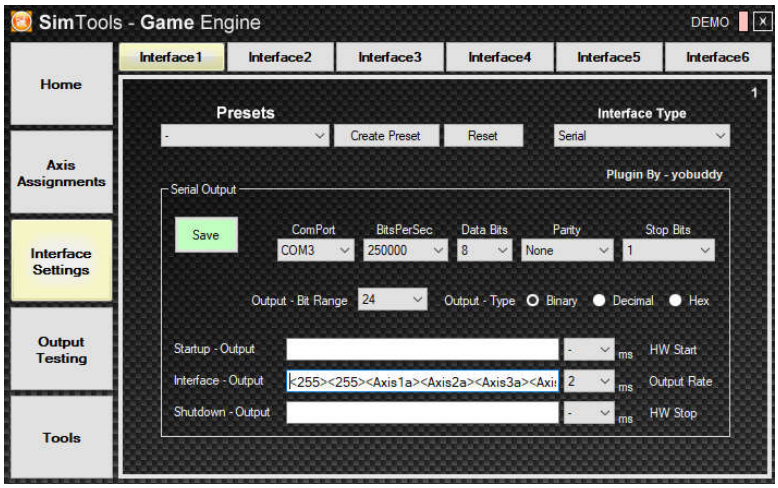
Data format

2 start bytes	<255> <255> or for inverse kinematics <253> <253> 3 bytes (24bit)
24 data bytes	per channel / actuator 8 channels
2 stop bytes	<10> <13>

DANGER:

The start bytes <255> <255> activate the direct data mode, i.e. the positions of the actuators from Simtools or Mover are transmitted directly.
The start bytes <253> <253> activate the "inverse kinematics" here the values for inverse kinematics, i.e. acceleration, speed or position / degree, must be transferred. The values must be transferred standardized to a range. For further information see chapter "Inverse Kinematics"





Kinematics menu

The entries here are recorded individually for each DOF

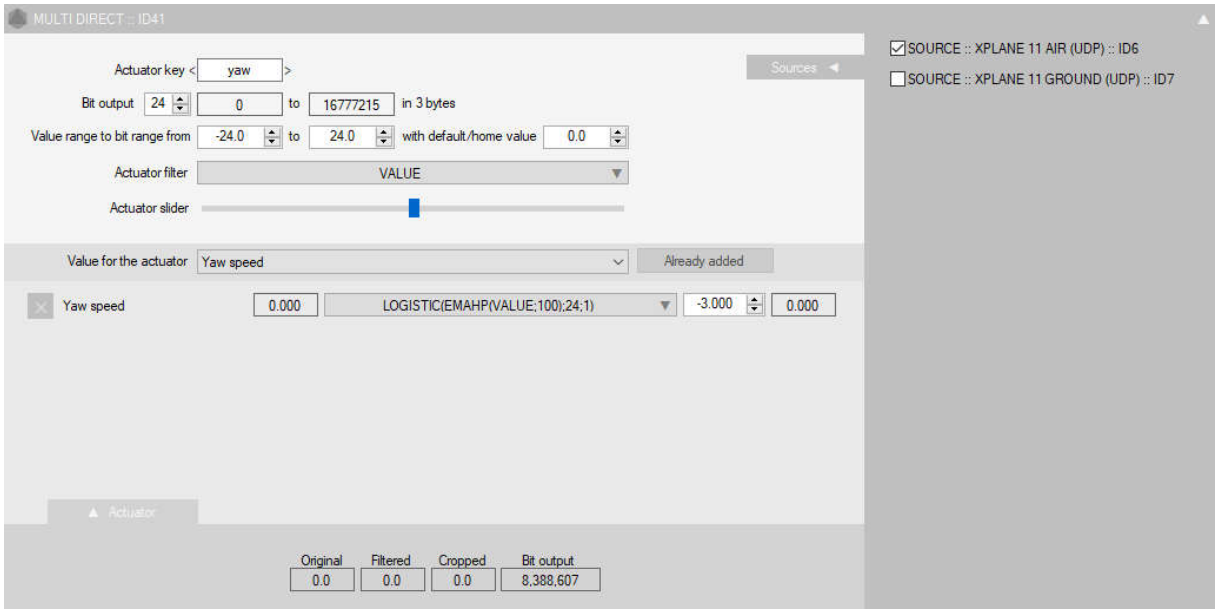
1. Surge Longitutional Movements
2. Sway Laterold Movements
3. Heave Vertical Movements
4. Yaw Z-axis rotation angle
5. Roll X-axis rotation angle
6. Pitch Y-axis rotation angle

The following settings can be made for the input values. In addition, the output filters can and are activated if set.

1. Gain of the input signals
2. Range of values (scaling to the 24-bit input)
3. Activate the washout effect of the axis (high-pass filter)
4. Strength of the washout effect
5. Smoothing of the input values (EMALP filter)
6. Strength of smoothing
7. Activate the logistics filter
8. Factor for the logistics filter

Danger

If you use the inverse kinematics, note the setting in your Motion Cue program (Mover / Simtools etc) there, scale the value range that you receive from Xplane for Yaw to e.g. + -24 degrees to 24 bits so that the controller knows how to evaluate the input data , please adjust the value under Range in the Axis menu. In this case the 48 would be for + -24 degrees.



Firmware update

If necessary, regular firmware updates are delivered. You can find this under

https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion- Simrigs / tree / master / firmware

download and install on the controller according to the separate instructions. It's very easy. The update process is explained in the following video.

https://www.youtube.com/watch?v=c0Djy7tlofE

The update instructions can also be found under

https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion-Simrigs/tree/master/user- guide

A bootloader tool is required for the update process. You can download it here

https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion- Simrigs / tree / master / bootloader

Attention: before you update the firmware you can save the data with the new remote app

You can find this app here:

https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion- Simrigs / blob / master / remote_app /

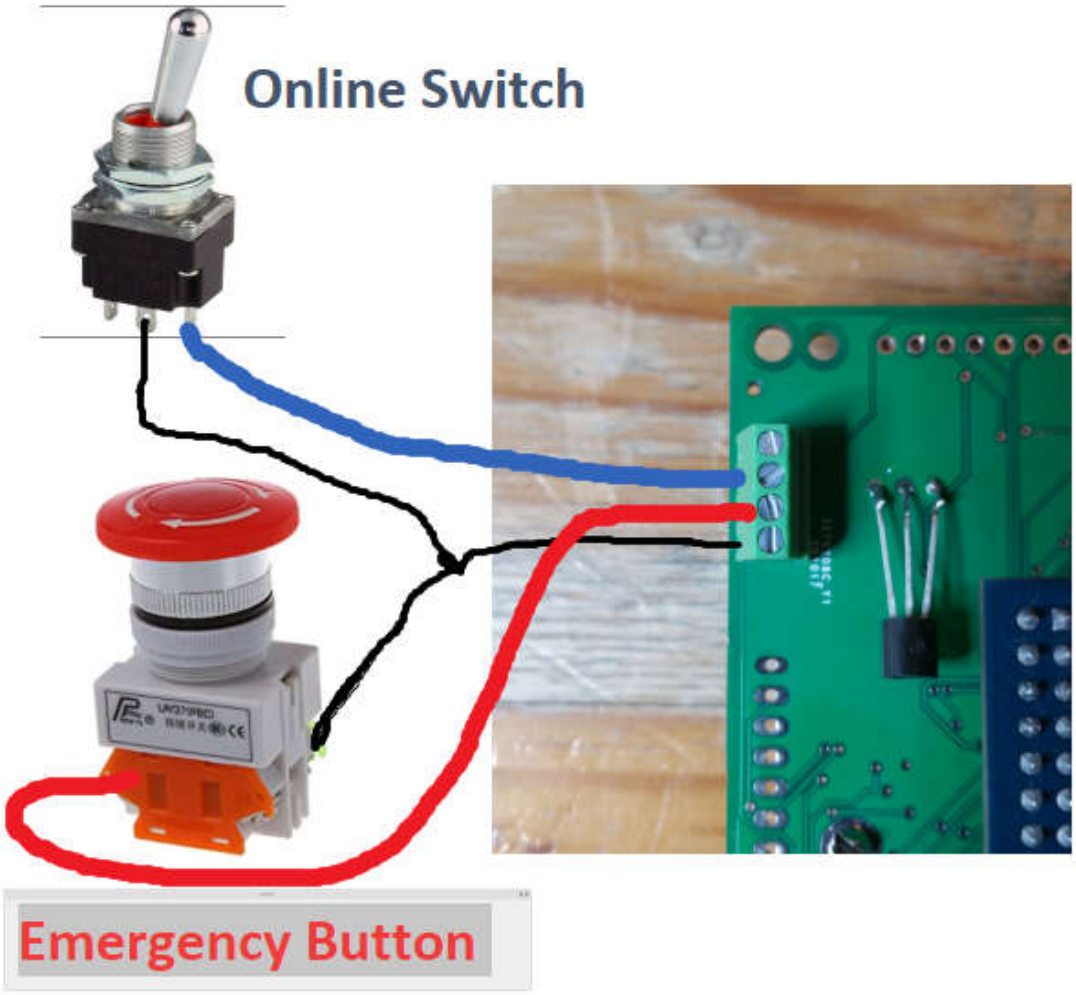
Attention, please reset the controller to the factory settings after every firmware update.

You can find instructions on how to do this later in this document.

LED display

Meaning of the ads	
Green LED lights up	Controller online and receiving data
The red LED lights up	Controller offline, calibration or Moves to the parking position Moves to the
Green and red will light up,	home position to wait for online data Spike filter active
green and red will flash	

Wiring of the emergency stop switch and online switch



Factory reset

Sometimes it is necessary to reset the data in the controller memory to the original state. To do this, use the following instructions

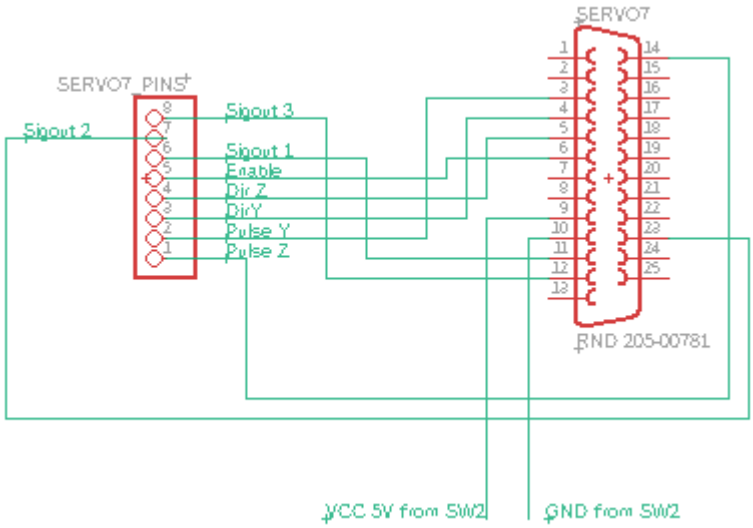
1. Restart the controller
2. Wait until the message "press encoder to calibrate ..." appears in the display
3. Then turn the encoder to the left to open further menu entries

4. Turn until "press encoder .. factory restore" appears in the display. Press the encoder to do this.

5. The data has been reset.

Connection servo 7

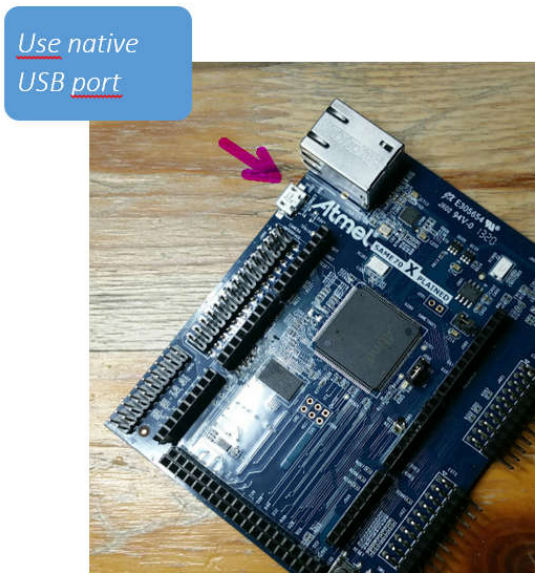
The 7th servomotor can optionally be connected in this way.



The Vcc 5V and GND must be shared by another connector (SW2 or display). In future PCB layout there will be 2 extra contacts for GND and VCC 5V

NEW - Native USB Port - FW-Flash, Remote, Motion

From FW version 1.17b, the native USB port has received additional functions



The following functions are now possible through this port.

1. As before, firmware update of the MCU

2. Access to the Eeprom as well as reading and writing of the controller variables
3. Works as a USB CDC device and also receives telemetry data for standard mode and inverse kinematics.
4. In FLypt Mover, for example, simply set the port and set the baud rate as high as possible.

Disadvantages of motion data via this port:

Due to the software Usbstack, the execution of the pulse engine in the controller is irregularly interrupted, which leads to micro-jerking. It is possible that this feature can be eliminated in future firmwares.

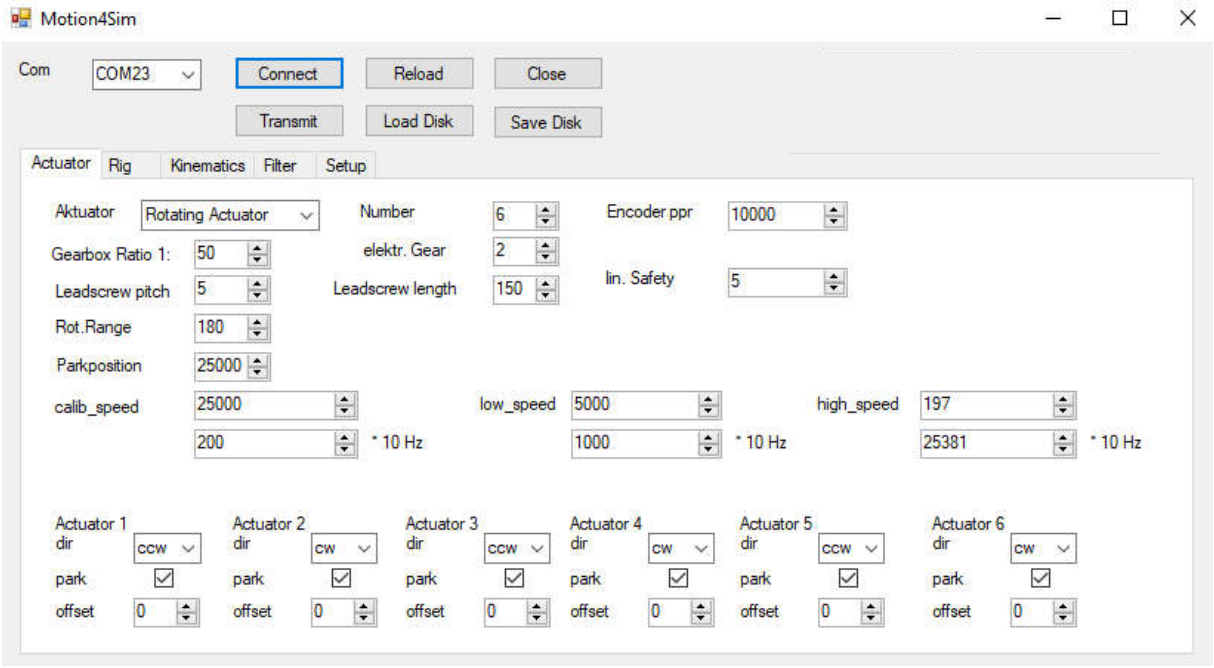
Remote APP

There is now a new smart remote APP for easy editing of the controller configuration. With this, the most important data can be downloaded from the controller, modified, saved and written back.

Download from Gitub:

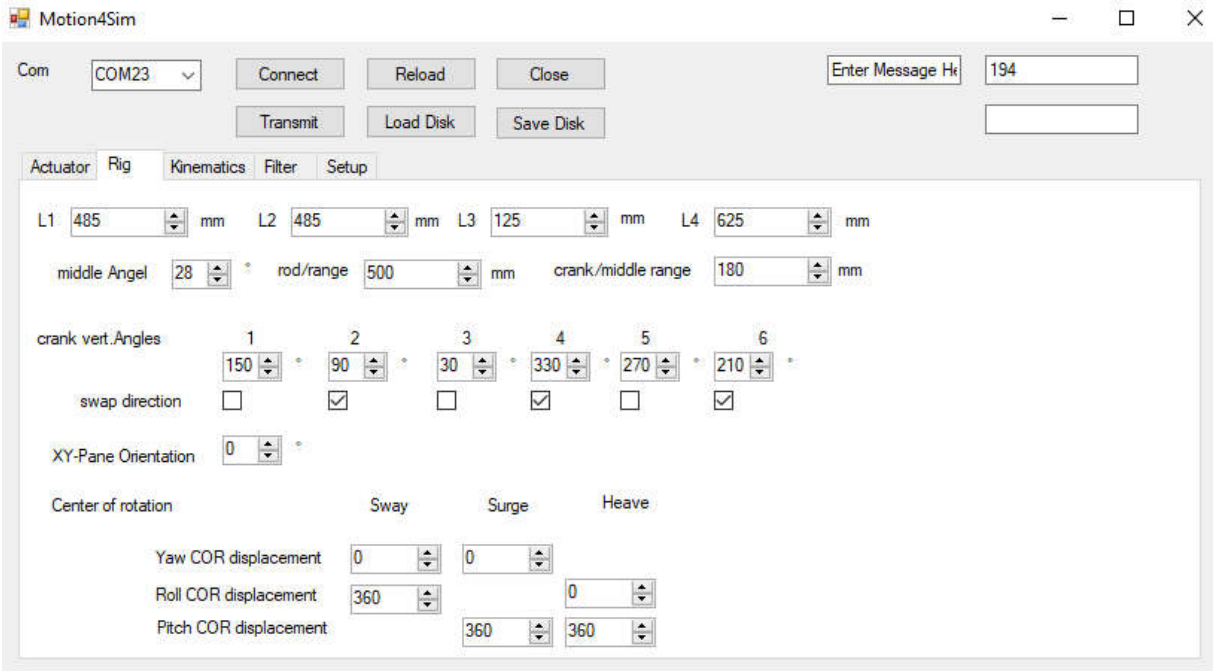
https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion- Simrigs / tree / master / remote_app

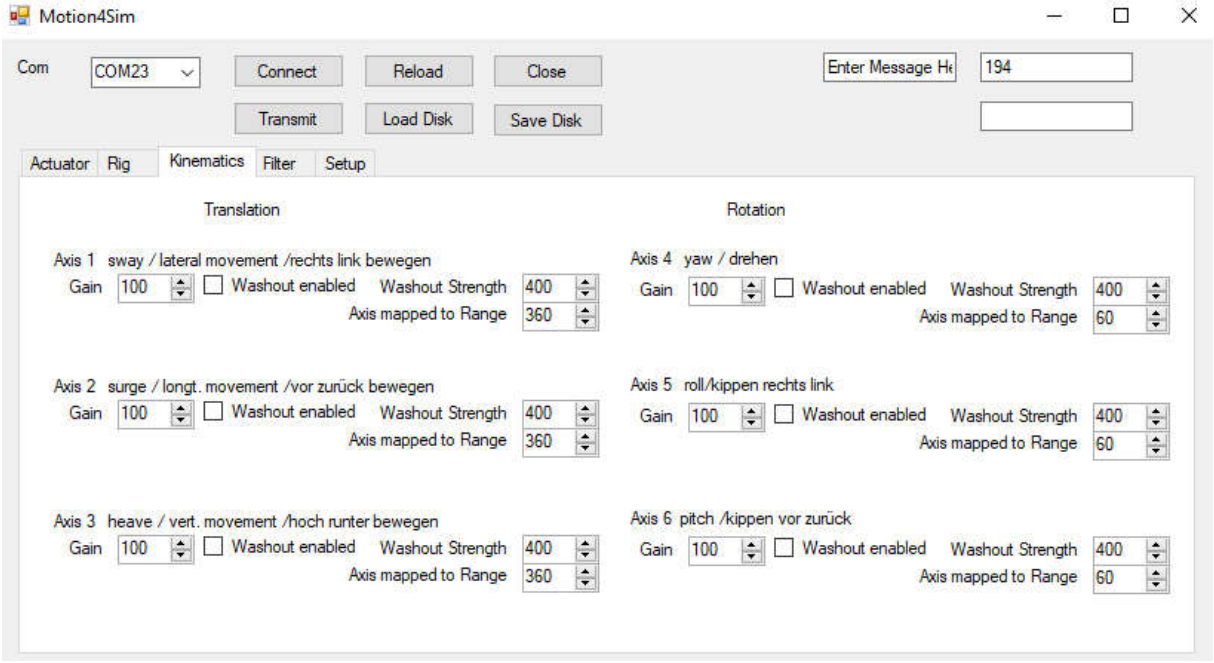
To read out the data, select the appropriate COM port and click "Connect".

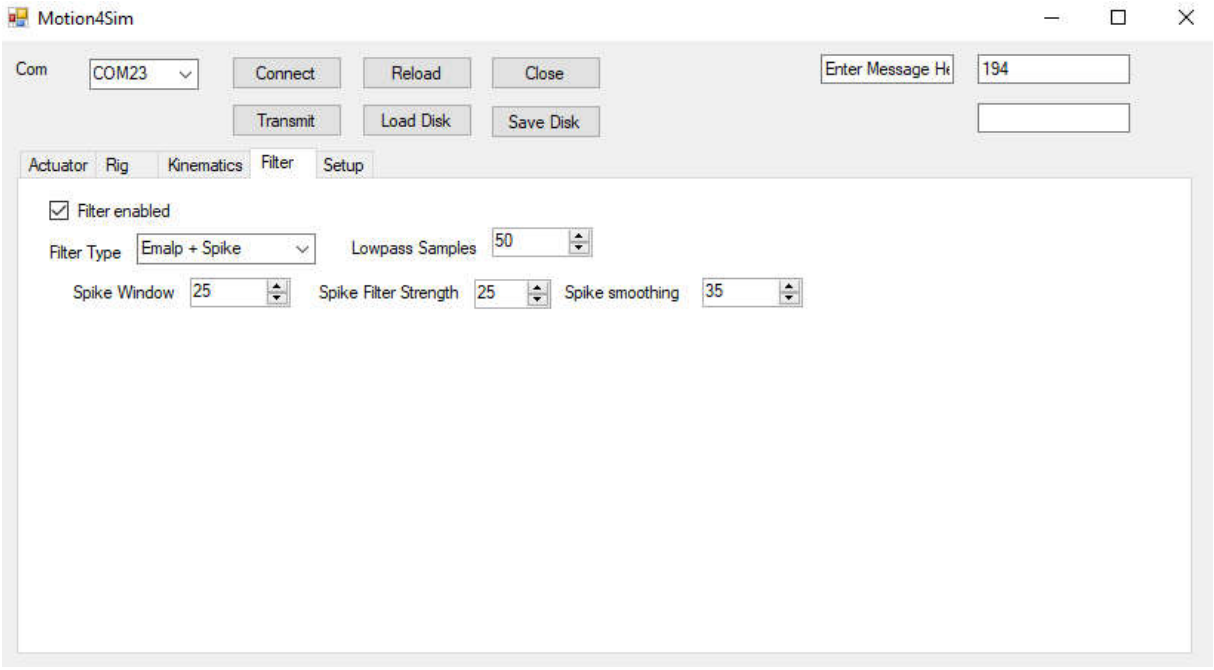


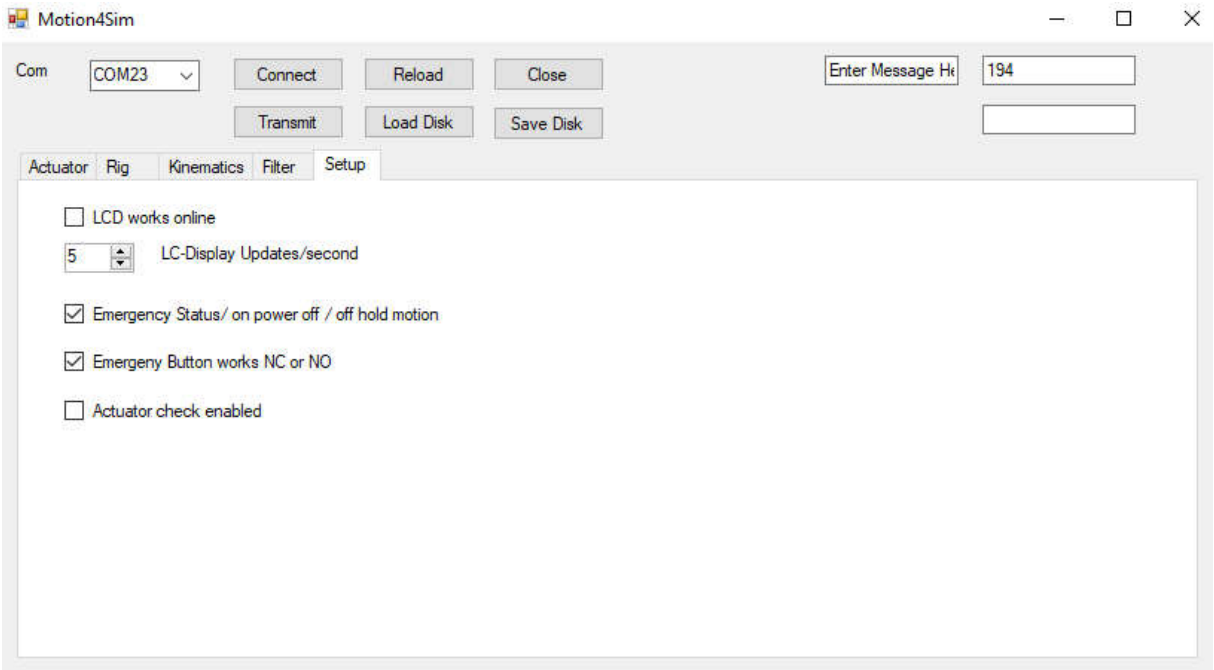
The other buttons are self-explanatory. To save the data back to the controller, select "Transmit". The values can be saved locally with “Load and Save Disk”.

Attention, the data will be transferred and written to the EEprom. The controller then performs a reset. Please never do this in operation.









Attention, the APP is WIP and still contains a number of errors. In addition, no plausibility check is carried out for the values entered.

Have fun

Motion4SIM

Braunsdorf 14.3.21

Update follows.