operation manual

advanced servo motor control unit for up to 7 motors

for AASD Series servo motors

Motion 4 SIM

20.11.2020

Table of 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 necessary parameters for operating 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, it can also be used to operate other servomotors. 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

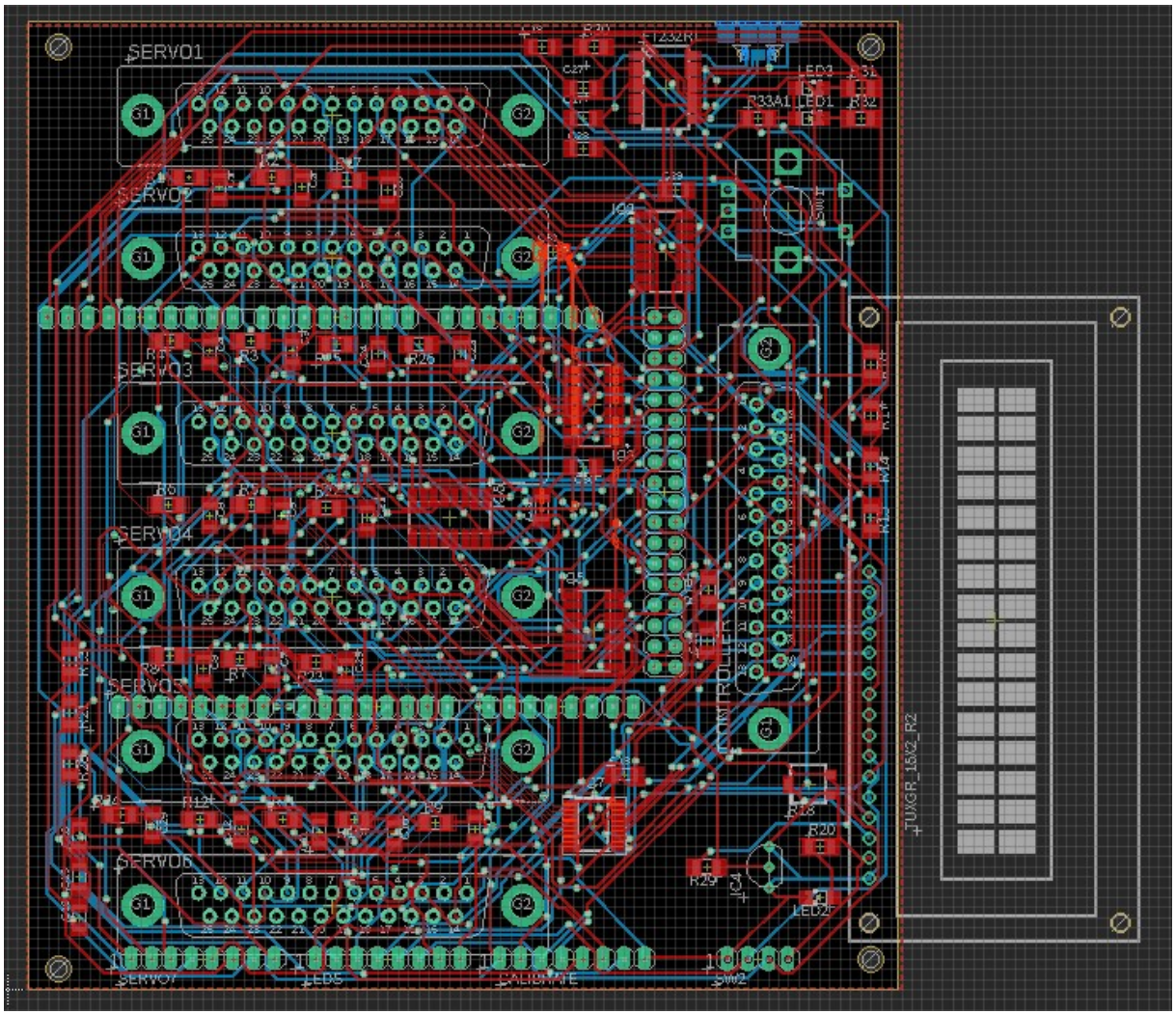
1. Control of 6 + 1 servomotors (optional)
2. Pulse speed up to 550 kHz
3. Step / Dir fashion
4. Query and evaluation of torque (for calibration) and error status
5. Display of parameters via LC display 16x2, full menu
6. Operation via rotary encoder with push button
7. Switch for signal reception
8. Emergency stop switch for the servo functions
9. Serial USB connection for data transfer
10. 32 bit processor
11. Storage of 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

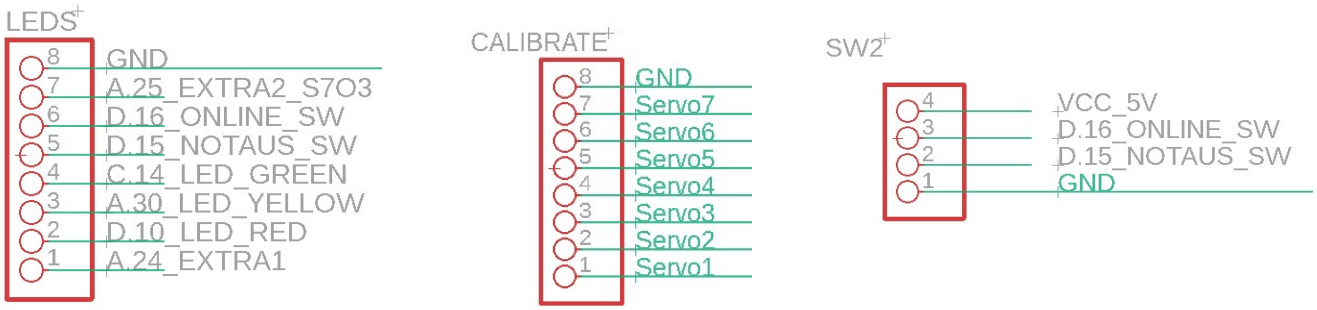
1. Software is menu-driven and easy to use
2. All functions can be parameterized to meet your own requirements
3. Monitoring the status of the motors
4. Automatic calibration of the zero position servomotors
5. Calibration also possible via limit switches
6. Service function for repairing or checking the engines
7. Manual control of each motor individually for testing and maintenance
8. Adjustable direction for inline or foldback placement of servomotor
9. Adjustable screw lead pitch advance per 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 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 for 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



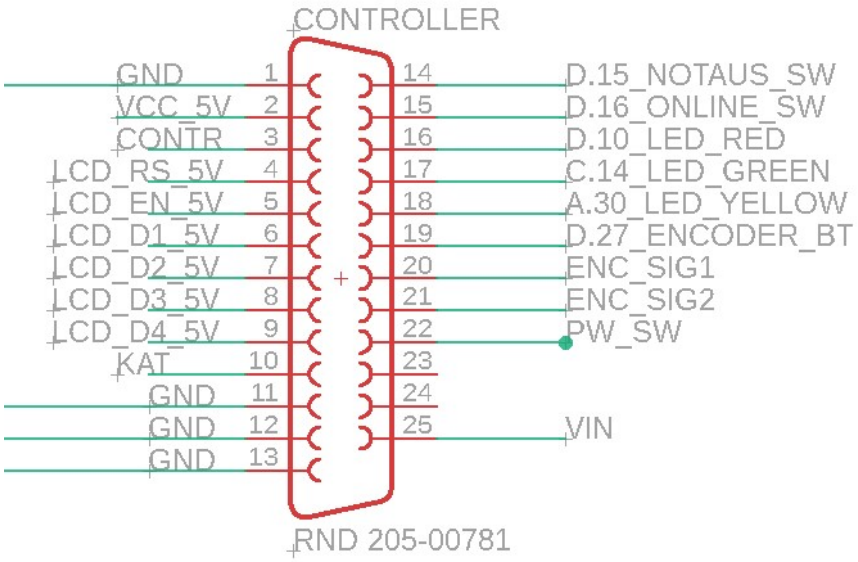
PCB layout V1.04



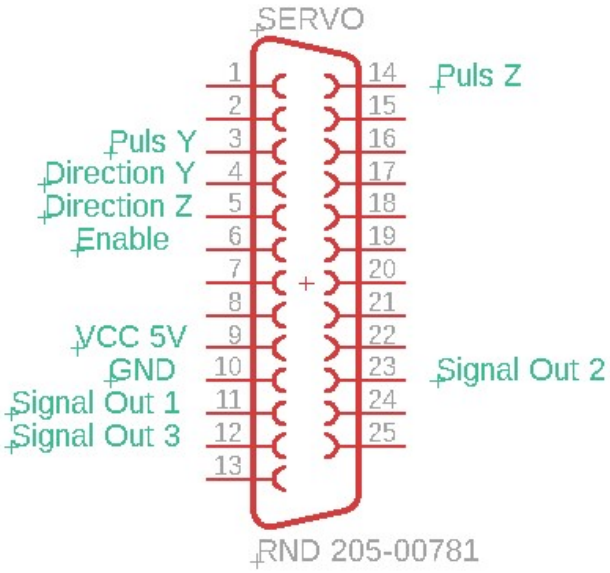
LEDs are switched with 3.3 volts without a series resistor. The calibration switches react to contact with GND. Emergency stop is "normally closed" and online switch is "normally open". These settings can be configured in the software.

Attention:

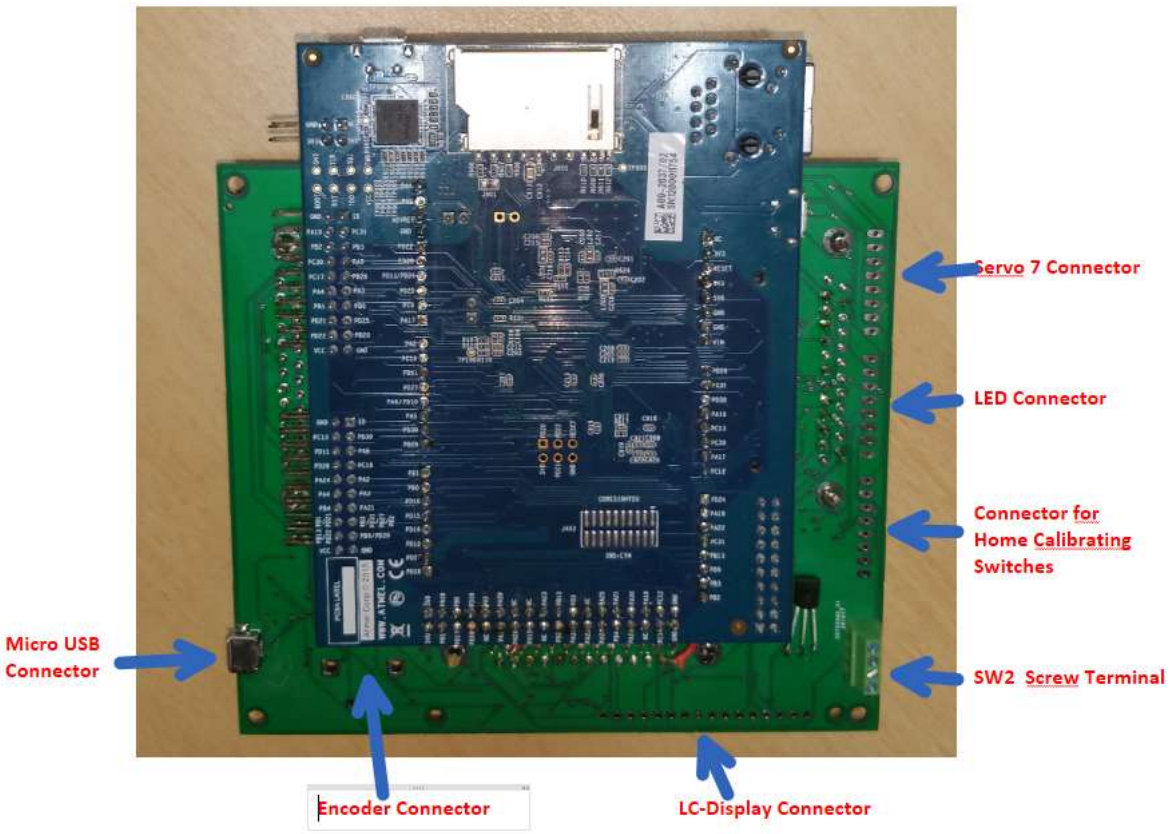
The micro USB port is sensitive to mechanical stress. Please work with caution when trying.

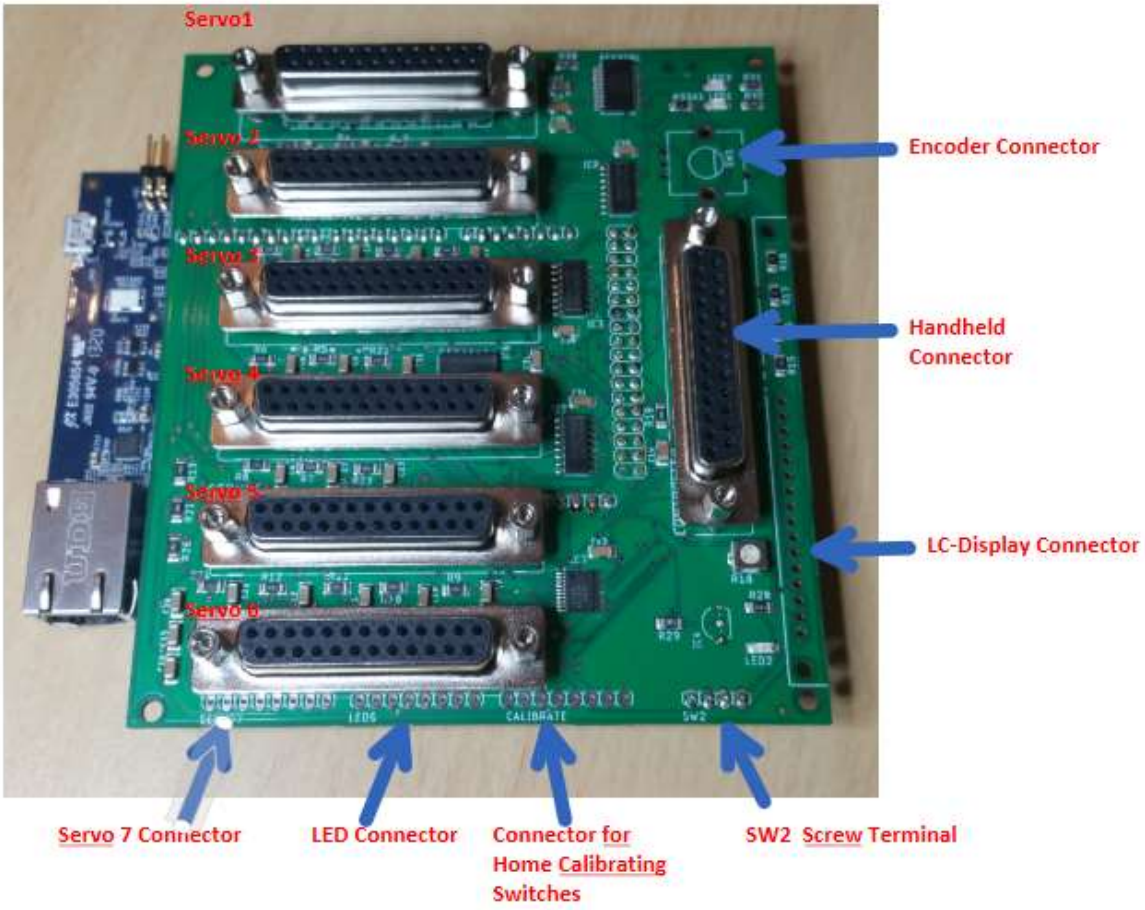


Handheld Connector



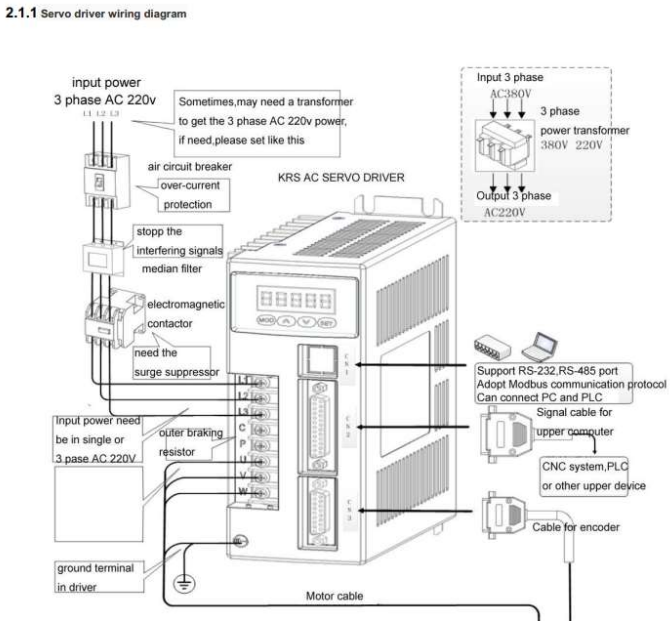
Servo connector


Servo 7 Connector
LED Connector
Connector for Home Calibrating Switches
Micro USB Connector
SW2 Screw Terminal
Encoder Connector
LC-Display Connector


Servo1
Servo 2
Servo 3
Servo 4
Servo 5
Servo 6
Encoder Connector
Handheld Connector
LC-Display Connector
Servo 7 Connector
LED Connector
Connector for Home Calibrating Switches
SW2 Screw Terminal

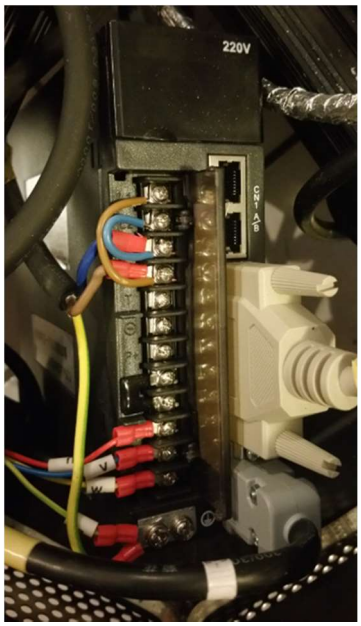
Hardware cabling

Servo motor amplifier wiring



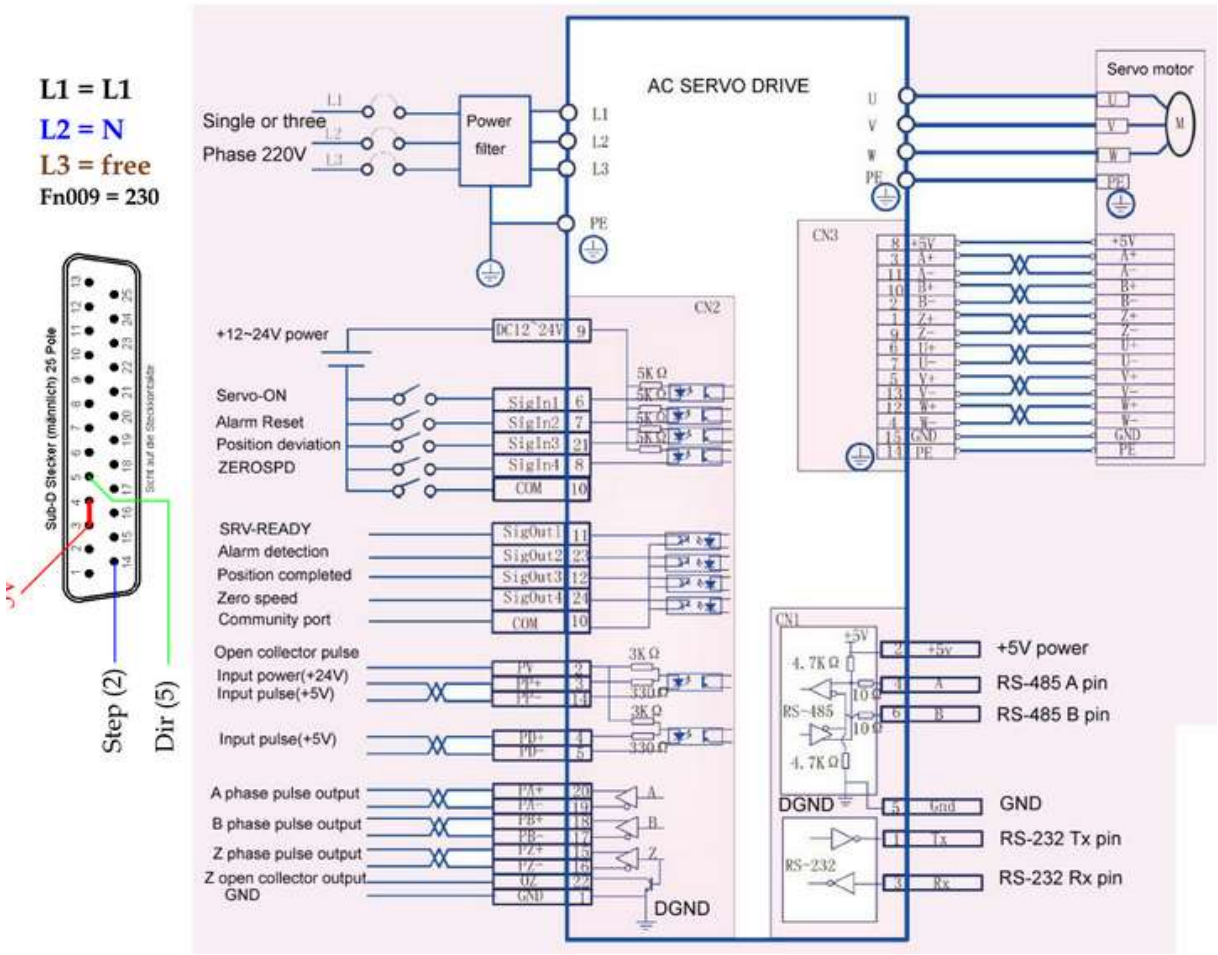
The mains voltage connections are sometimes different, please always consult the manufacturer's data sheet. For example, see also:

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 = 300Pn9 = -300Pn51 = 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)

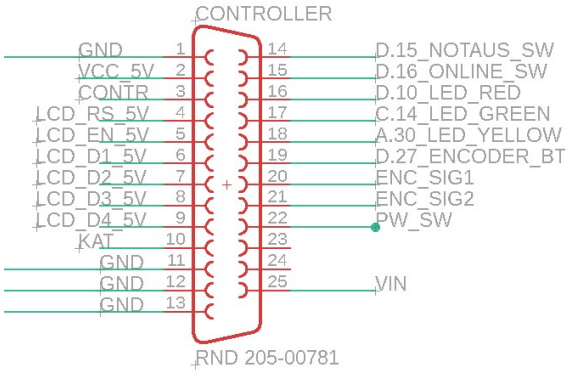
Pn52 = 1 Sigin Port 1 Servo enable

Pn60 = 2 Sigout Port 1 Servo ready

Pn61 = 6 Sigout Port 2 Servo Treach

Pn62 = 4 Sigout Port 3 Servo Preach

Handheld device



For more information see also

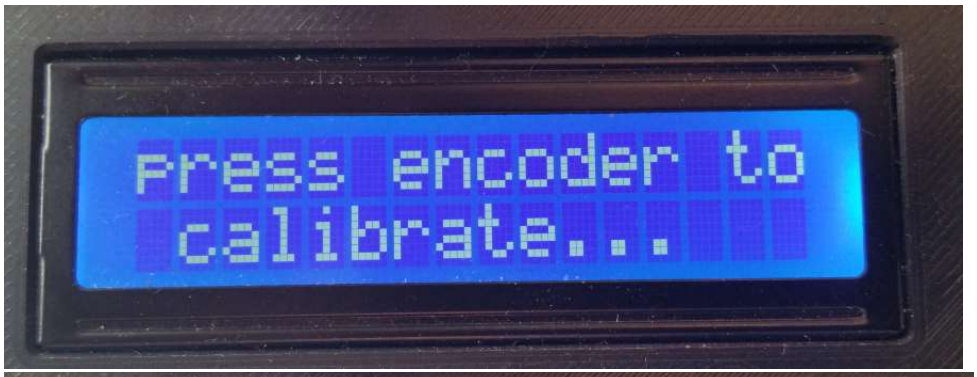
https://github.com/motion4sim/AASD15A-Servo-Controller-for-Motion-Simrigs/tree/master/handheld

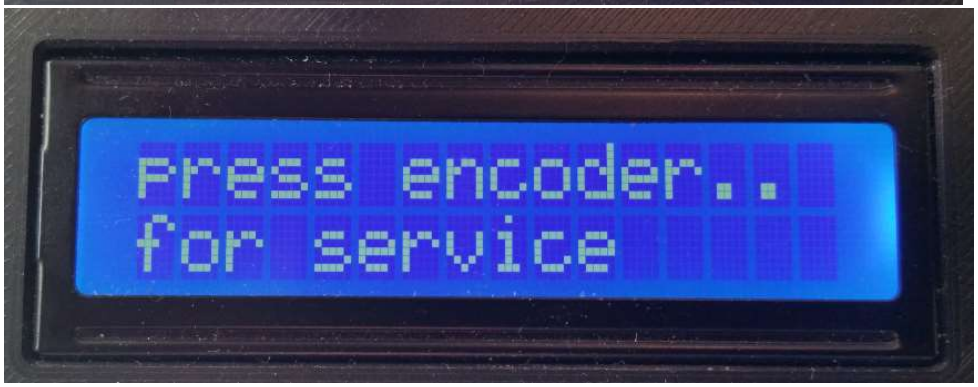
and

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.
It is also possible 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) Attention, 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 are shown in the top line of the display the machine executes.

to parkpos ..	moves to the parking position
preparing ..	calibrate and move to offset position
emergency ..	Emergency stop switch activated
offline..	Offline switch activated according to online status
ready ..	System fully calibrated
standby ..	Move 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.	filter	- Output filters
3.	service	- Menu for manual actuator movements
4.	Actuators	- Actuator settings
5.	Set up	- 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	- current settings save and close menu

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

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 the filter is activated when exceeded.

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 / 10,000,000;
```

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:

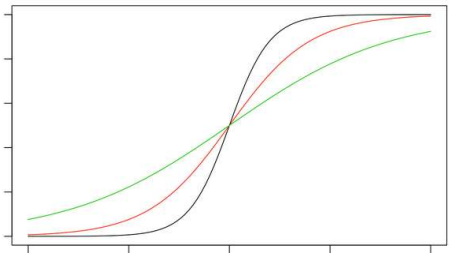
The spike filter operates dynamically and changes the smoothing accordingly. Therefore a further EMA filter was built in for the dynamic change which is controlled by this value.

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 .

: (deactivated) Logistic factor

Logistics filter compresses the pulses for the actuator using the factor



Higher value Steeper rise (blue)

Smaller value, weaker increase (green)

With a smaller increase, the maximum also becomes logistically smaller

Close the submenu and returns to a level above : Back

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 individually. After activating the respective sub-menu, 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 accessed directly without calibrating the actuators when the controller is started. 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 of all actuators. For Change Offset, set "Yes" with the encoder and confirm with Push.

Repair - moving without calibration

Attention be careful:

Start paying attention to the controller You 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 encoders positions depending on the servo with AASD15

10,000

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.

Leadscrewpitch : Pitch of the trapezoidal thread spindle 5, 10.25… in mm per revolution

Actuator length : Length of the linear actuator in mm

Actuators (Submenu 1-8):

rotation : Direction of rotation of the Actuators, CW vs CCW

Park enable : if you activate this option the actuator will not parked

Cal. Offset : Offset in pips is set after calibration. And as lower zero point of the actuator used.

Park position : Offset from the lower zero point of the actuator as the parking position

Calib. speed : Pulse speed for calibration

Low speed : Pulse speed for the slow speed

Procedure 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 arm length

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)

= 100,000 positions / 100 mm

Resolution = 0.001 mm

SET UP

FPS LC display	:	Represents the update rate of the display
		Should be 5-10. Values above 10 are not tested.
LCD online	:	allows updating of the display in online mode
		Should be off for none Interruptions in operation
Emergency Stat	:	ON Servos are turned off (RIG falls down)
		OFF Servos stop but are on.
Online SW	:	Normaly open or normaly closed (included in next FWupdate)
Emergency SW	:	Normaly open 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

Attention: WIP but works well, really smooth

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

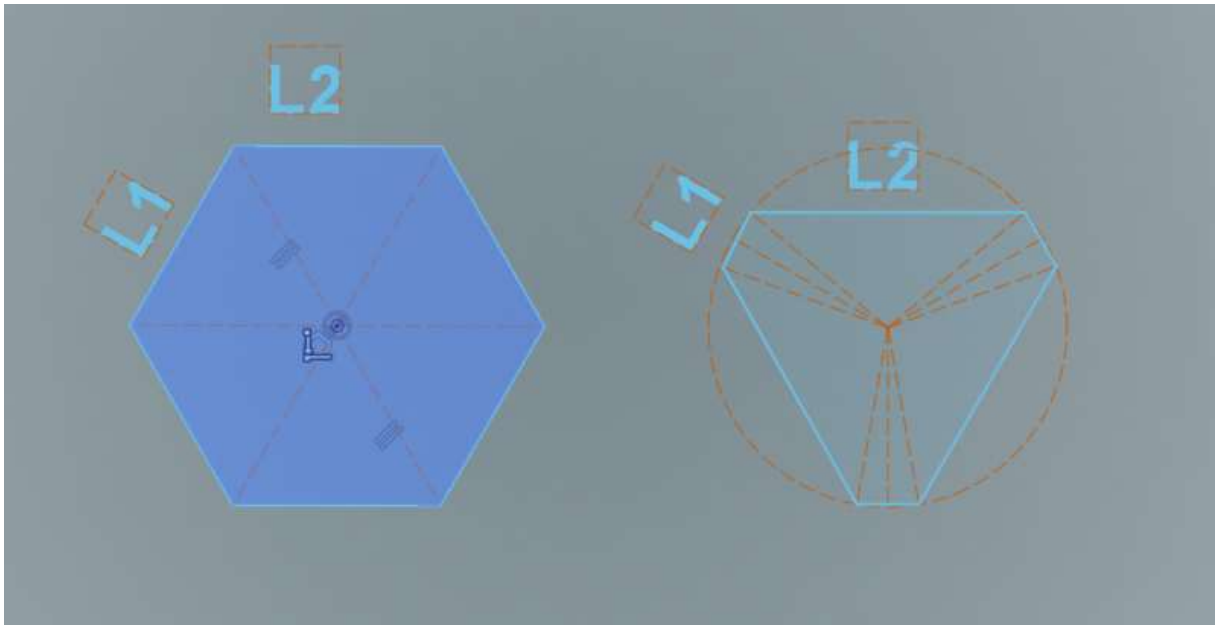
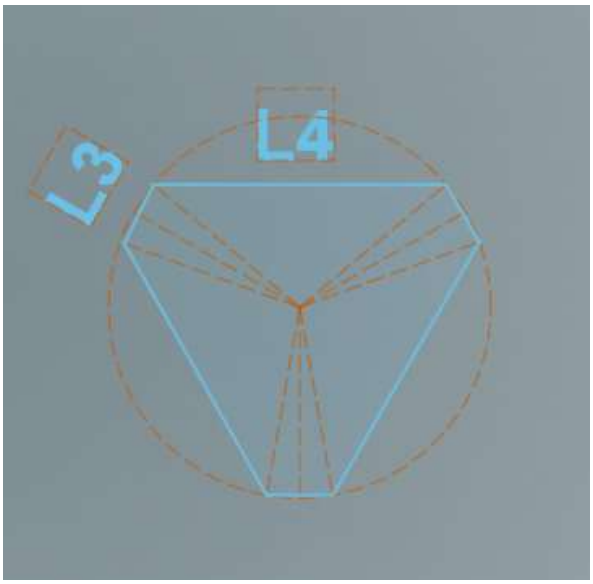


Fig. Left regular and right unequal hexagon

Movement platform: Length L3 and L4

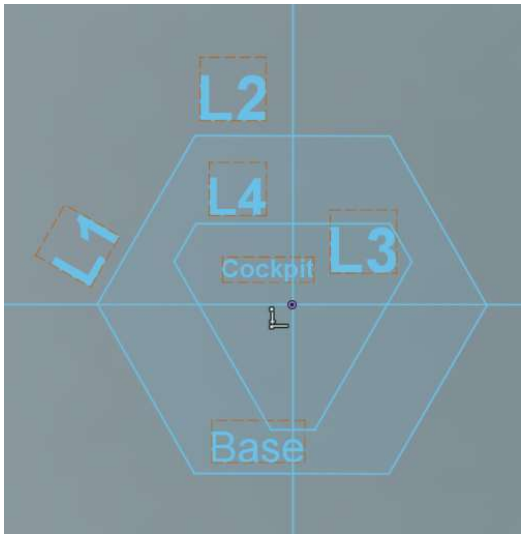
The same geometric basis also applies to the upper platform (the movement platform), but here an unequal-sided hexagon is almost always used as the geometric basis. The corners of which are rotated by 60 degrees to the base.

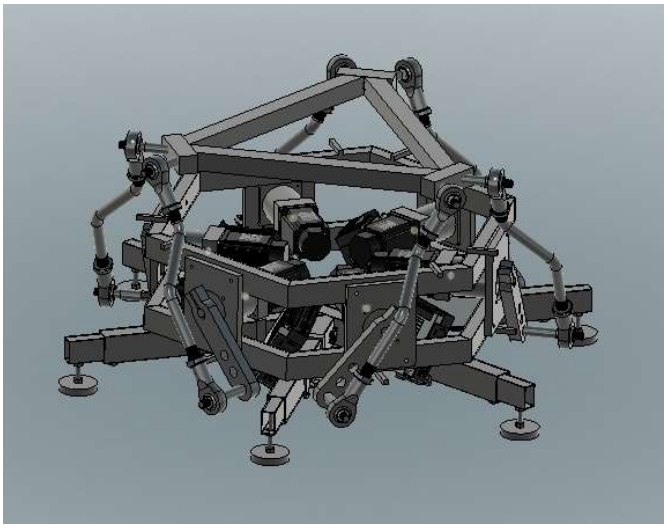


Overview of the geometry:

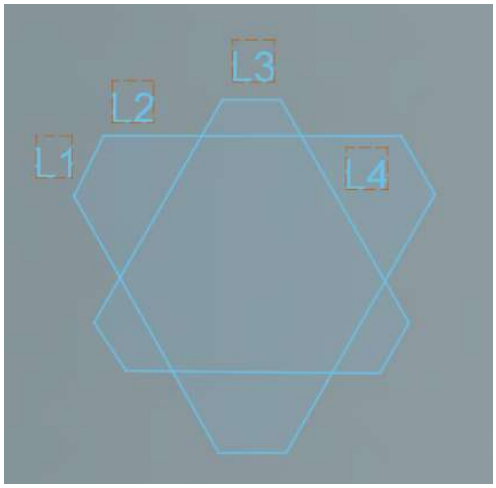
Base L1, L2

Cockpit L3, L4

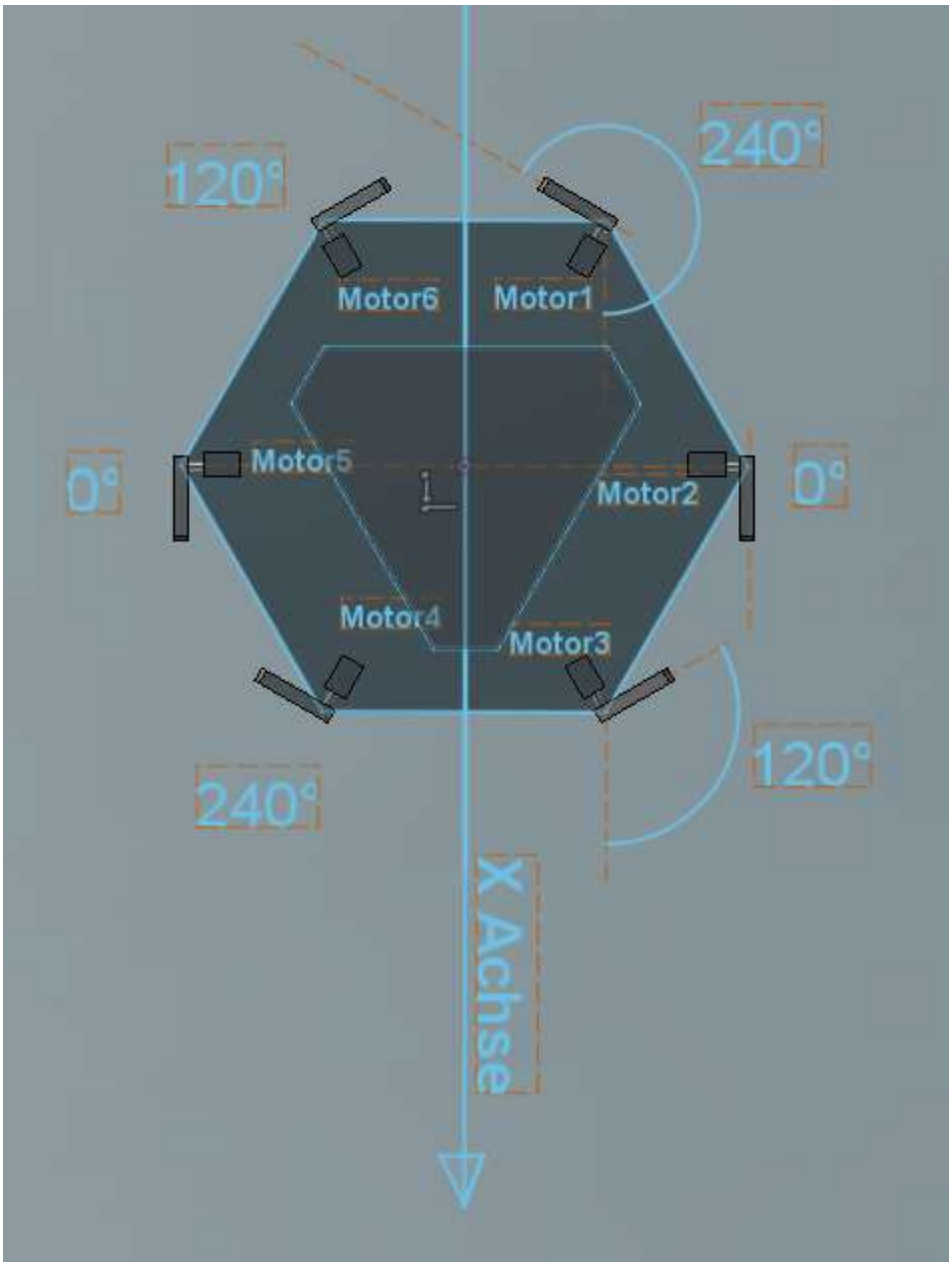


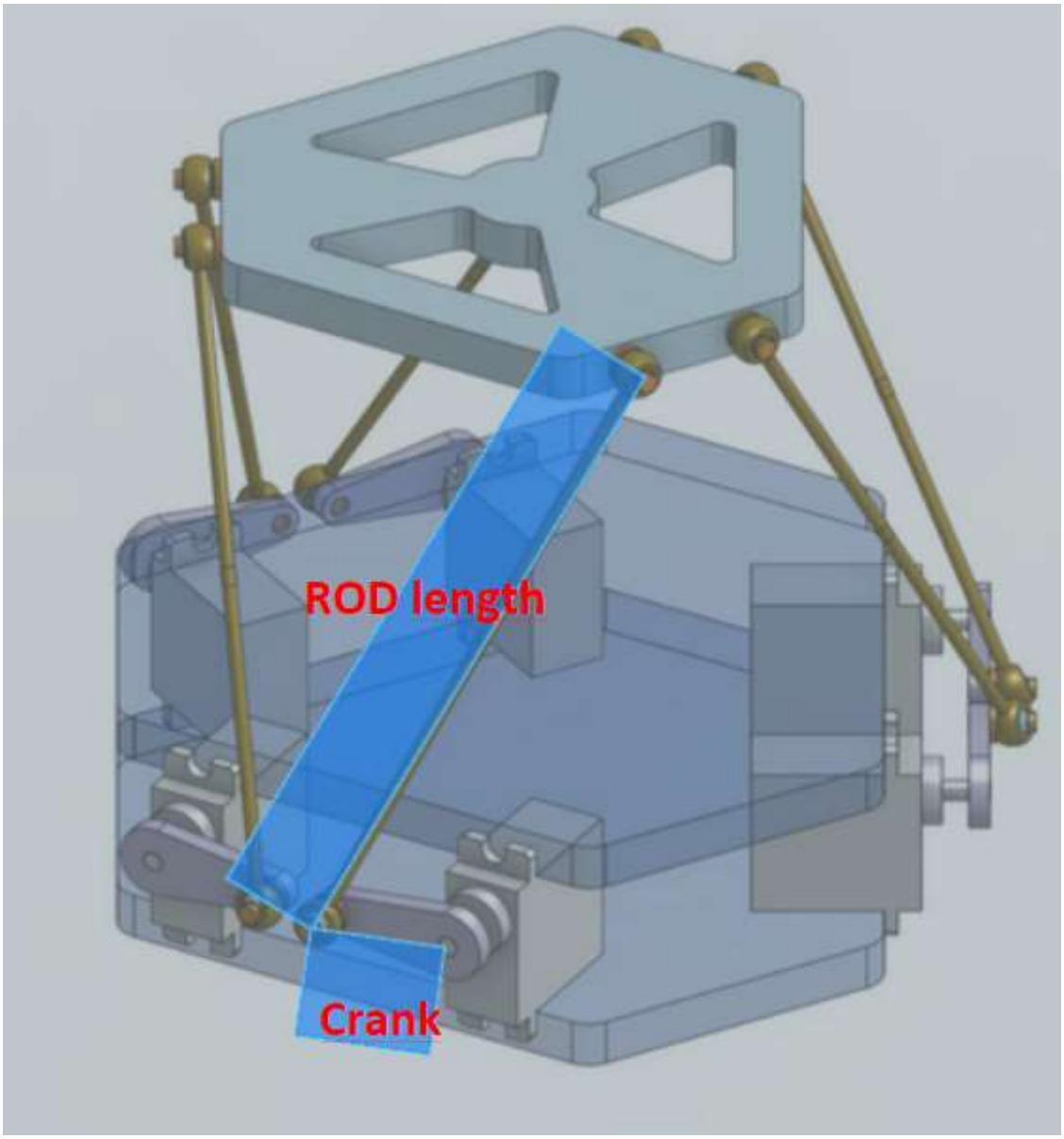


Symmetrical base: Rotating Hexpod



For the calculations with linear actuators, the total length of the actuator in the home position "Rod Length" is required. The value of the range of the actuator is taken from the "Actuator" menu. For rotating actuators you still 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"
For the geometric definition of the home position, you also need the angle of the lever arm in the home position. This can be determined by calculation (18 ° -29 °).




ROD length
Crank

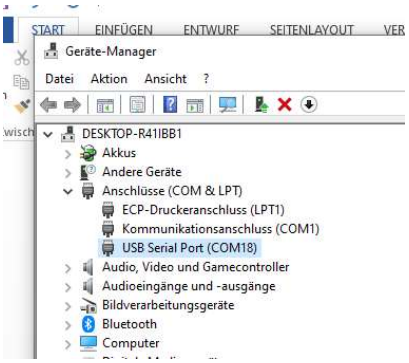
FTDI USB interface

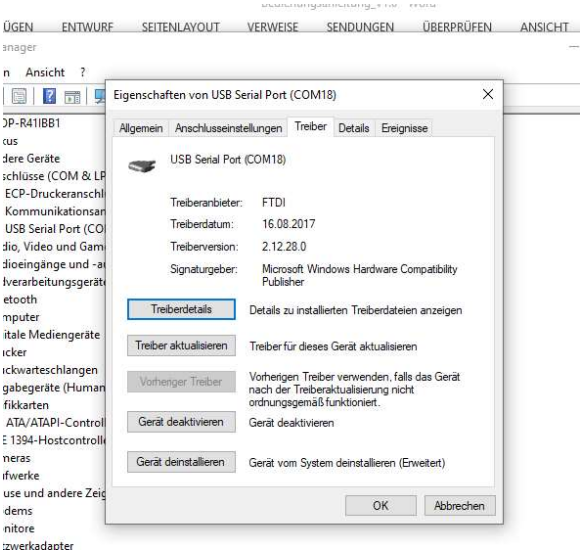
The controller contains an FTDI FT232 RL chip that is installed via USB.

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 transmission / 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

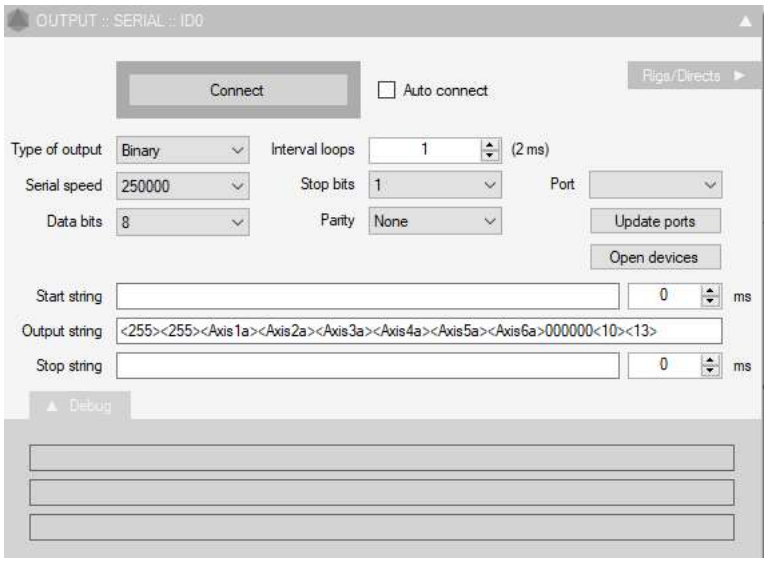
Data output	binary
speed	250,000 baud
Databits	8th bit
Stop bits	1
Parity	None

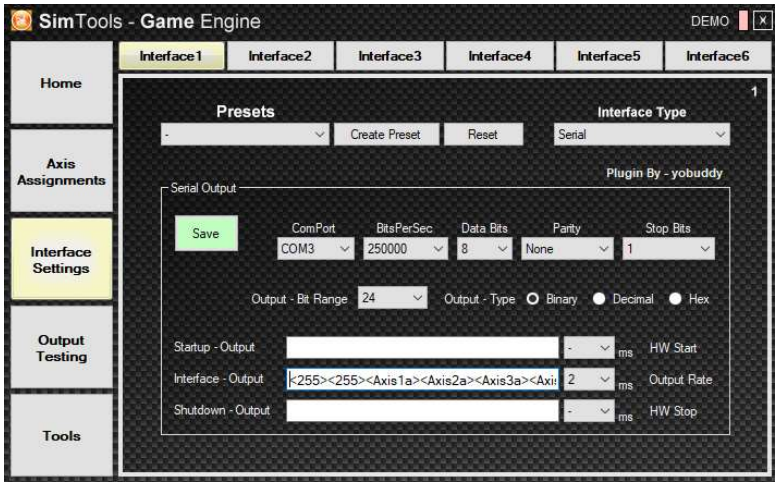
Data format

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

ATTENTION:

The start bytes <255> <255> activate the direct data mode, i.e. the positions are set of the actuators from Simtools or Mover 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

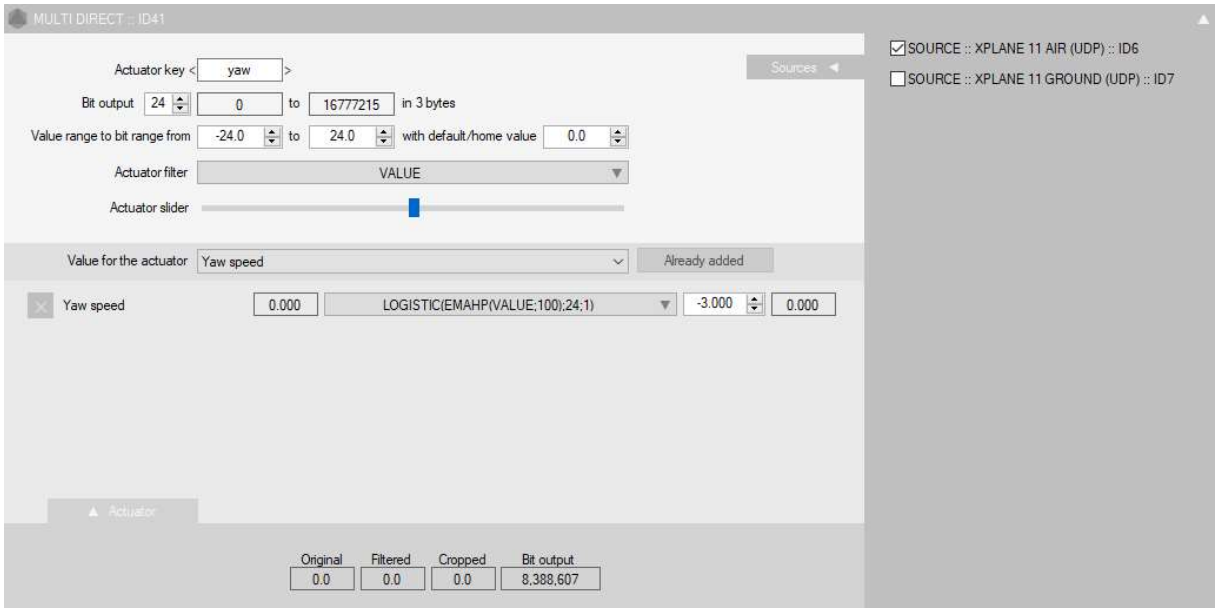
1. Surge Longitutional Movements
2. Sway Laterold Movements
3. Heave vertical movements
4. Yaw Z-axis rotation angle
5. Roll X-axis rotation angle
6. Pitch Y-axis rotation angle

The following settings can be made for the input values. Additionally
The output filters can and will be activated if set.

1. Gain of the input signals
2. Range of values (scaling to the 24bit 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 logistics filter
8. Factor for the logistics filter

Caution

If you use the inverse kinematics, note the setting in your motion cue program (Mover / Simtools etc) there you scale the range of values that you e.g. from Xplane for Yaw
received to eg + -24 degrees to 24bit 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

Regular firmware updates are delivered as required. This can under

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

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

You can also find the update instructions at

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

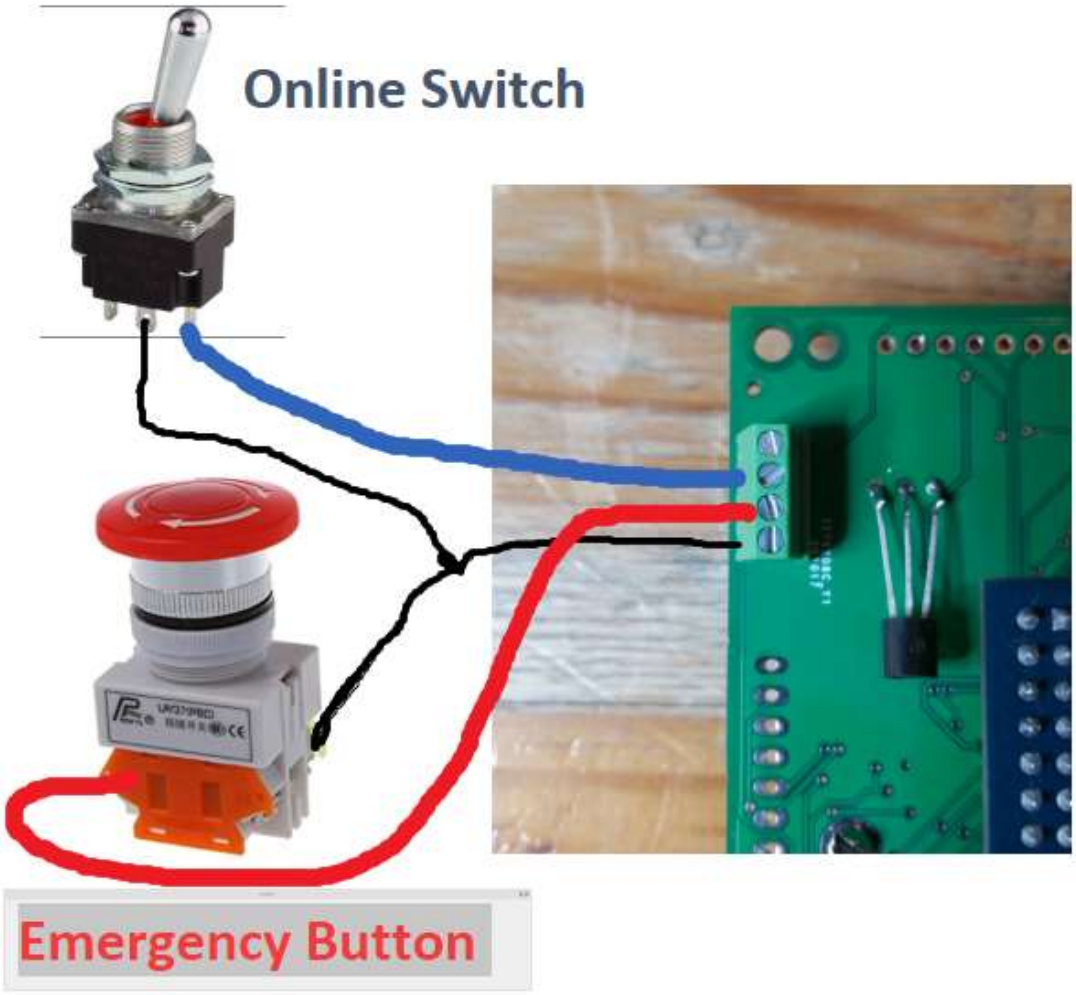
A bootloader tool is required for the update process. You can download it here

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

LED display

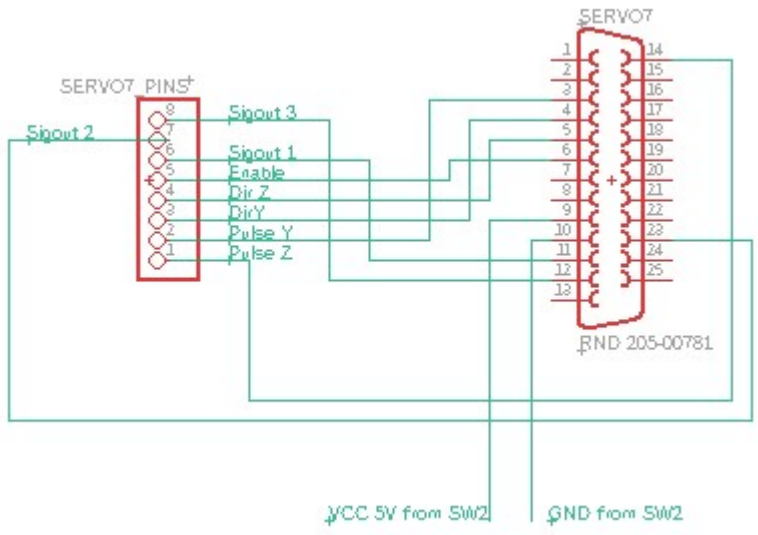
Meaning of the Led	
Green LED lights up	Controller online and receiving data
The red LED lights up	Controller offline, calibrating or moving to parking position
Green and red glow	Movement to Home position to wait for online data
Green and red flashes	Spike filter active

Wiring of the emergency stop switch and online switch



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

Update follows. As of November 20, 2020