

# Robot Controller for Autonomous Systems

Robust Pose Estimation, Path Planning & Control, Collision Avoidance

## Key Features

### Hardware

- 4-Core x86 Intel processor
- 8 GB RAM
- High Precision 6-axis IMU
- High Precision GPS/RTK
- 4 independent CAN channels
- Gigabit ethernet
- 4G/LTE
- Wifi
- Customizable IO (including Safety IOs)

### Software

- Realtime Linux operating system
- Robust Pose Estimation
- Fast Iterative Path Planning
- Path Planning for Agriculture Applications
- Accurate Motion Control

## Applications

- Autonomous driving
- Industrial robotics
- Agriculture robotics



System-on-Module	
Processor	Intel Atom
CPU type	4-Core Intel Atom x5-E3940 (4x 1.6 GHz)
RAM	8 GB DDR3L
Graphics	Intel HD Graphics Gen 9

IMU		
Sensor type	Bosch BMI088	
Accelerometer	16-bit triaxial	
	Dynamic Range	±3, ±6, ±12, ±24g (configurable)
	Sensitivity	10920, 5460, 2730, 1365 LSB/g
Gyroscope	16-bit triaxial	
	Dynamic Range	125, 250, 500, 1000, 2000°/s (configurable)
	Sensitivity	262.14, 131.07, 65.53, 32.76, 16.38 LSB/°/s

Sensor type (optional)	Analog Devices ADIS16465	
Accelerometer	32-bit triaxial	
	Dynamic range	±8g
	Sensitivity	262,144,000 LSB/g
Gyroscope	32-bit triaxial	
	Dynamic Range:	±500°/s
	Sensitivity:	2,621,440 LSB/°/s

### GPS

Sensor type	Ublox ZED-F9P	
Receiver type	Multi-band GNSS high precision receiver	
Accuracy of time pulse signal	RMS 99%	30 ns 60 ns
Frequencz of time pulse	0.25 Hz to 10 MHz (configurable)	
RTK Support	Yes	
Horizontal Position Accuracy	PVT <sup>1</sup> RTK <sup>2</sup>	1.5 m 0.01 m
Vertical Position Accuracy	PVT <sup>1</sup> RTK <sup>2</sup>	2 m 0.01 m

### 4G/LTE

Sensor type	Ublox MPC1-L2
LTE FDD category	4
LTE Bands	1,3,5,7,8,20
HSDPA category	24
HSUPA category	6
UMTS Bands	1,2,5,8
GSM Bands	Quad

### CAN

Sensor type	Peak System PCAN-miniPCIe FD
Channels	4x High/speed CAN channels (ISO 11898-2)
Bit rates	25kbit/s up to 1 Mbit/s
Galvanic isolation	Up to 300V

- 1 24 hours static
- 2 Measured using 1 km baseline and patch antennas with good ground planes. Does not account for possible antenna phase center offset errors. ppm limited to baselines up to 20 km.

<b>Network</b>	
Wifi	802.11 ac/abgn 3T3R
Ethernet	Gigabit ethernet

<b>I/O</b>	
H-Bridge Outputs	2
24V Inputs	23
24V Outputs	8
24V Safety Outputs	4
Relais	4
5V Analog Inputs	4
5V Inputs	4
5V Open Drain Outputs	2

<b>Mechanical characteristics</b>	
Housing	Black anodized aluminum
	300 x 300 x 120 mm
Mounting holes	M8
Weight	6.1 kg

<b>Power</b>	
Power consumption	Depends on the power drawn from connected devices
	Max 100W

<b>Environment condition</b>		
Temperature	Operating	-40°C to +45°C
	Storage	-40°C to +85°C
Protection class	Splash water proof	

## Special Features

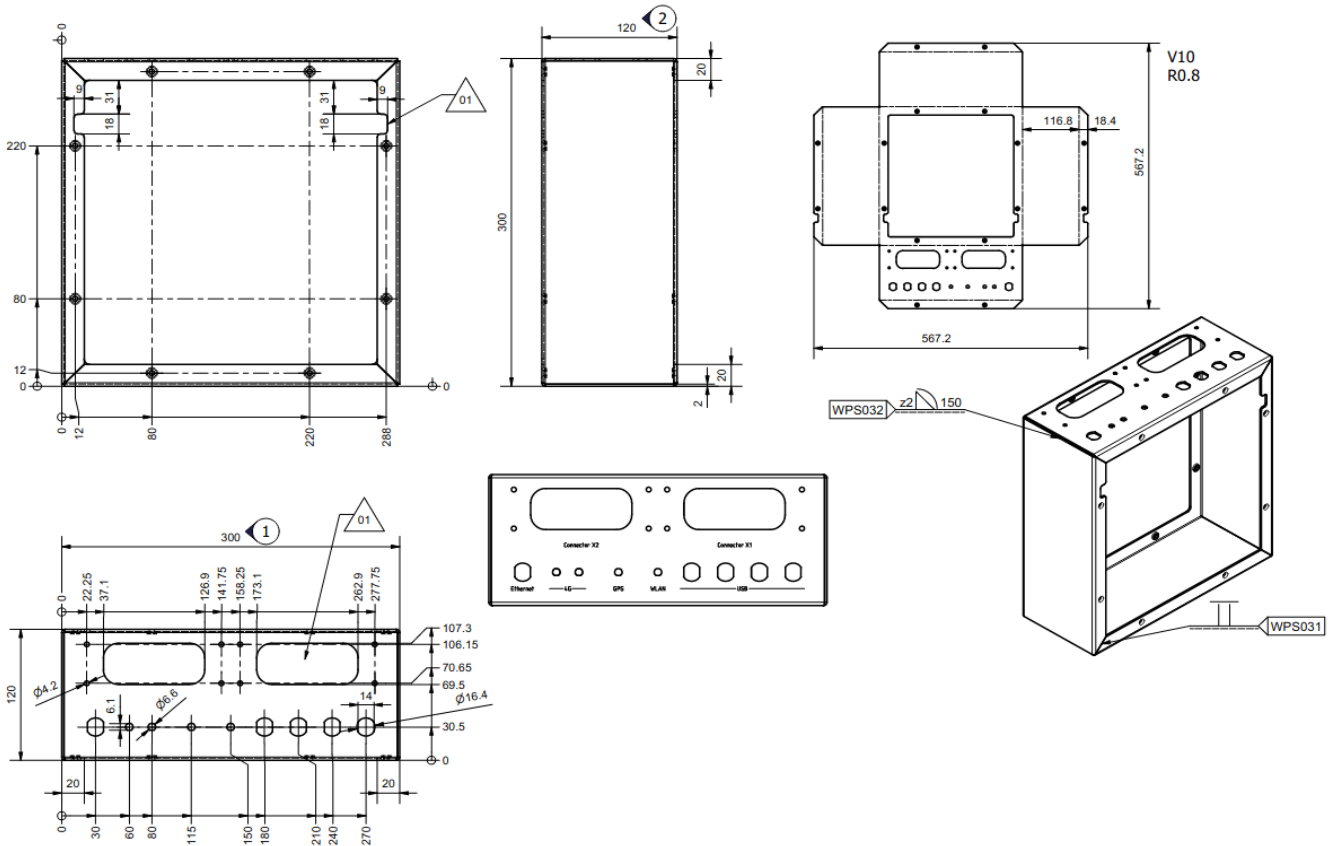
### Hardware Features

- **High precision on board sensors.** With the onboard high precision IMU and GPS sensors most robotic applications are covered. For more advanced needs Stettbacher's cameras can be connected.
- **Versatile communication options.** Be it out in a field using LTE/4G, in a factory setting using WiFi or your custom protocol that bridges to Ethernet, the robot controller has it all.
- **Flexible interfacing options.** The robot controller offers many interfaces. Custom Ios (FPGA enabled) enable the use of SPI, I2C, Modbus, RS232, RS485 and many more. Additionally four independent, galvanic isolated CAN channels are available.
- **Extendable and future proof.** The robot controller is designed to last. The main processing unit of the box is connected through the industry standard COM Express Type 6. If it does not fit the needs anymore simply upgrade to an adequate and even more powerful option.
- **RTK ready.** RTCM Messages or GPS correction information can be passed to the GPS chip to make use of differential GPS and get absolute position measurements in the cm range.
- **Safety ready.** Four dedicated outputs are able to output one of two safety voltages that can be connected. This allows for easy integration of various safety concepts by using a dedicated safety controller.
- **Passively cooled - yet powerful.**

### Software Features

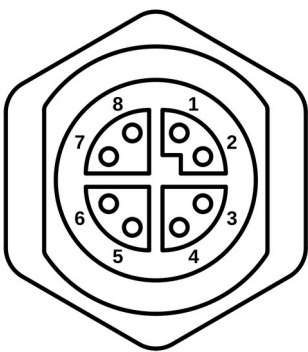
- **Robust pose estimation.** The high-performance embedded computer module combined with the high precision on board sensors enable Stettbacher's *TitanFuse* algorithm to perform outstanding. *TitanFuse* is Stettbacher's robust sensor fusion algorithm capable of reliably and accurately fusing the onboard sensors (IMU, GPS). Additionally it can handle odometry information from various sources (wheel speed, camera, lidar) which can be supplied to enhance performance.
- **Fast iterative path planning.** Stettbacher's *TitanNavFlex*, a reliable and fast solution for global path planning, runs on the robot controller with ease. It is capable of planning collision free paths in complex environments.
- **Path planning for agriculture.** Stettbacher's *TitanNavFarm*, is a capable of passing every spot on a field. The planned path is always straight on the given field and ground pressure is optimized and distributed in order to protect the soil. Be it mowing, seeding or weeding – *TitanNavFarm* has you covered.
- **Accurate motion control.** Stettbacher's *TitanMotion* keeps the vehicle on track. In combination with *TitanFuse* and *TitanNav* overall path deviation on average can be held within 3 cm.
- **Linux real time operating system.** The robot controller runs a purpose built Linux operating system patched with a real time extension (RTAI). This allows running high-demanding control loops directly on the same CPU.

## Housing dimensions



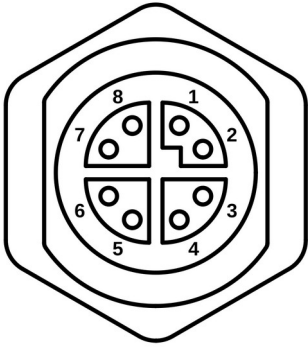
## USB Connector

Pin Assignment	
1	VBUS
2	GND
3	USB_P
4	USB_N
5	SSTX_P
6	SSTX_N
7	SSRX_P
8	SSRX_N

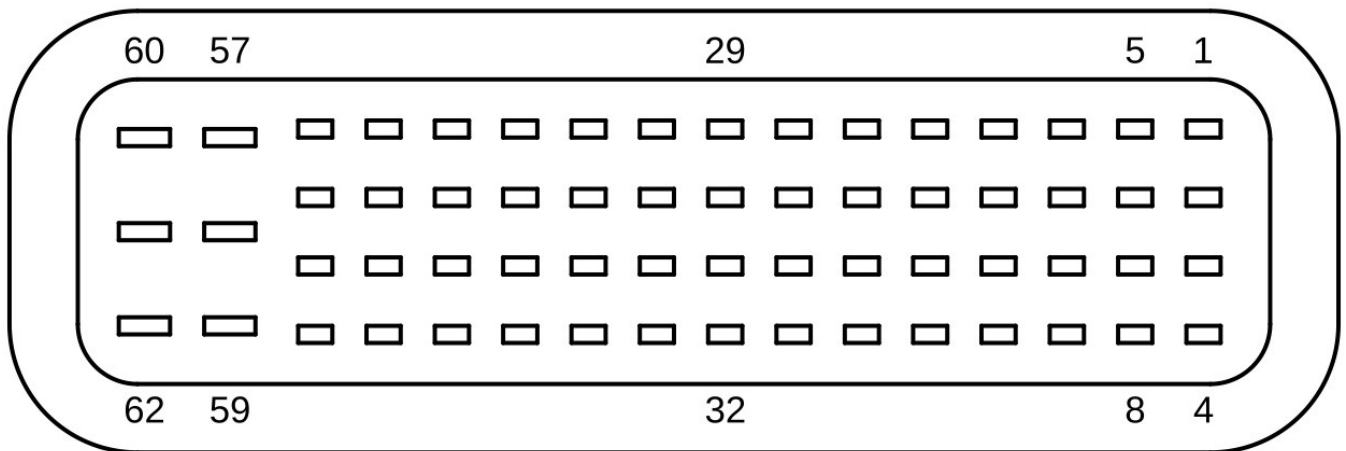


female

## Ethernet Connector

 <p style="text-align: center;">female</p>	Pin Assignment	
	1	DA+
	2	DA-
	3	DB+
	4	DB-
	5	DD+
	6	DD-
	7	DC-
8	DC+	

## X1/X2 Connector



Pin Assignment X1		
1	24V H-Bridge Out 1	6 A max
2	24V H-Bridge Out 2	6 A max
3	Supply 24V	0.2 A max
4	GND	0.2 A max
5	Custom 24V Input	
6	5V Analog Input AI3	
7	Analog GND	0.1 A max
8	Analog Supply 5V	0.1 A max
9	RS485 A	

10	RS485 B	
11	GND	
12	Supply 24V	5 A max
13	RS232 Tx	
14	RS232 Rx	
15	GND	
16	GND	
17	CAN 0 GND	
18	CAN 0 High	
19	CAN 0 Low	
20	Supply 12V	
21	CAN 1 GND	
22	CAN 1 High	
23	CAN 1 Low	
24	GND	
25	CAN 2 GND	
26	CAN 2 High	
27	CAN 2 Low	
28	Supply 24V	
29	CAN 3 GND	
30	CAN 3 High	
31	CAN 3 Low	
32	GND	
33	NC	
34	NC	
35	NC	
36	NC	
37	Custom 24V Input DI23	
38	Supply 24V	1 A max
39	24 V Output (Relais K3) DO1	
40	GND	
41	GND	
42	GND	
43	GND	
44	GND	
45	24V Safety Output (Safety_1) DO19	1 A max
46	24V Safety Output (Safety_2) DO18	1 A max
47	24V Safety Output (Safety_1) DO17	1 A max

48	24V Safety Output (Safety_1) DO16	1 A max
49	Custom 24V Input DI19	
50	Custom 24V Input DI18	
51	Custom 24V Input DI17	
52	Custom 24V Input DI16	
53	Custom 24V Input DI22	
54	Relais K1 NC	6 A max
55	Relais K1 CO	6 A max
56	Relais K1 NO	6 A max
57	24V Safety_1 Supply Input	1 A max
58	24V Safety_2 Supply Input	1 A max
59	H-Bridge GND	
60	GND	
61	24V Supply Input	5A max
62	H-Bridge 24V Supply Input	6A max



Pin Assignment X2		
1	Relais K2 NO	6 A max
2	Relais K4 NO	6 A max
3	Relais K5 NO	6 A max
4	Relais K6 NO	6 A max
5	Relais K2 CO	6 A max
6	Relais K4 CO	6 A max
7	Relais K5 CO	6 A max
8	Relais K6 CO	6 A max
9	Relais K2 NC	6 A max
10	Relais K4 NC	6 A max
11	Relais K5 NC	6 A max
12	Relais K6 NC	6 A max
13	Custom 24V Input DI0	
14	Custom 24V Input DI1	
15	Custom 24V Input DI2	
16	Custom 24V Input DI3	
17	Custom 24V Input DI4	
18	Custom 24V Input DI5	
19	Custom 24V Input DI6	
20	Custom 24V Input DI7	
21	Custom 24V Input DI8	
22	Custom 24V Input DI9	
23	Custom 24V Input DI10	
24	Custom 24V Input DI11	
25	Custom 24V Input DI12	
26	Custom 24V Input DI13	
27	Custom 24V Input DI14	
28	Custom 24V Input DI15	
29	GND	
30	GND	
31	GND	
32	GND	
33	Custom 24V Output DO8	1 A max
34	Custom 24V Output DO9	1 A max
35	Custom 24V Output DO10	1 A max
36	Custom 24V Output DO11	1 A max
37	Custom 24V Output DO12	1 A max

38	Custom 24V Output DO13	1 A max
39	Custom 24V Output DO14	1 A max
40	Custom 24V Output DO15	1 A max
41	NC	
42	NC	
43	NC	
44	NC	
45	5V Supply	
46	GND	
47	5V Open Drain Output	0.02 A max
48	5V Open Drain Output	0.02 A max
49	Custom 5V Input JOY_I0	
50	Custom 5V Input JOY_I1	
51	Custom 5V Input JOY_I2	
52	Custom 5V Input JOY_I3	
53	Custom 5V Analog Input AI0	
54	Custom 5V Analog Input AI1	
55	Custom 5V Analog Input AI2	
56	NC	
57	NC	
58	NC	
59	NC	
60	NC	
61	NC	
62	NC	

## Order Information

Order No.	Description	IMU Type	Operating Temperature
SSP1001-0100-000	Robot Controller	BMI088	-40°C to +85°C
SSP1001-0101-000		ADIS16465	-40°C to +85°C

## Accessory Order Information

Order No.	Description
SSP5120-0500-002	Ethernet cable, 2 meter
SSP5120-0500-010	Ethernet cable, 10 meter
SSP5120-0500-050	Ethernet cable, 50 meter
SSP1001-0200-030	USB cable, 30 cm
SSP1001-0200-050	USB cable, 50 cm
SSP1001-0200-100	USB cable, 1 meter

## Revision History

Revision	Date	Changes
1.0	2023-04-20	Initial version
1.1	2023-04-25	Extended special features section