GLOSSARY

Autonomous Mobile Robot (AMR): A mobile robot with the ability to autonomously map, localize, and navigate through the surroundings without any static guides.

***Badan Informasi Geospasial* (BIG):** Also referred to as the Indonesian Geospatial Information Agency and previously known as *Badan Koordinasi Survei dan Pemetaan Nasional* is an agency within the Indonesian government which focuses on geospatial information.

Constantly Operating Reference Station (CORS): Stations that are continuously monitoring GNSS signals from satellites providing correction as reference stations.

End-of-Life (EOL): A point when developer or company no longer provide technical support and issuing security patches and updates for a piece of software or hardware.

Global Navigation Satellite System (GNSS): A term to describe satellite systems that provide positioning, navigation, and timing services both globally and regionally.

Networked Transport of RTCM Messages via Internet Protocol (NTRIP): A protocol for streaming correction messages over the internet.

Radio Technical Commission for Maritime Services (RTCM): A convention for messages containing corrections for the implementation of a Digital Global Navigation Satellite System (DGNSS).

Robot Operating System 2 (ROS2): A set of open-source software libraries and tools that are useful for robotic software development.

RQt: A software framework with multiple GUI tools in ROS2 utilized to display data, publish messages onto existing topics, node inspection, and debugging.

RViz2: A software framework in ROS2 mainly utilized to display sensor data.

Simultaneous Localization and Mapping (SLAM): A process to simultaneously estimate the position of a robot while mapping out the surroundings.

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APPENDIX A – RTK-BASED GNSS SETUP

1. Obtaining credentials to use VRS from InaCORS

   - Sign up for a free SBC account through

     http://inacors.big.go.id/sbc/Account/Register

   - The NTRIP username and password, annotated by the square box in Figure A-1, will be used by the NTRIP clients for access to connect to the VRS.

   - Upon login, the NTRIP caster details including address and port can be found under Account Details – User Profile – Preferences as shown in Figure A-2.

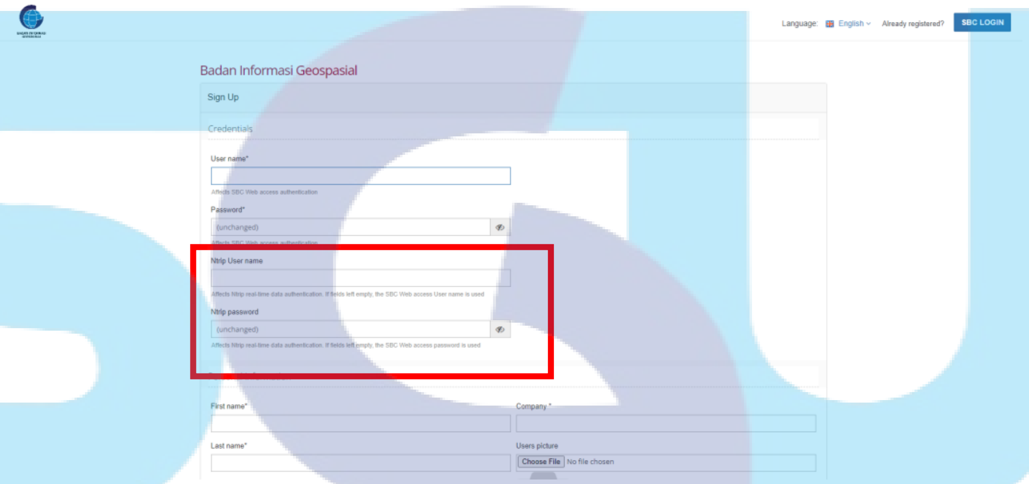


Figure A-1 SBC sign up and NTRIP credentials

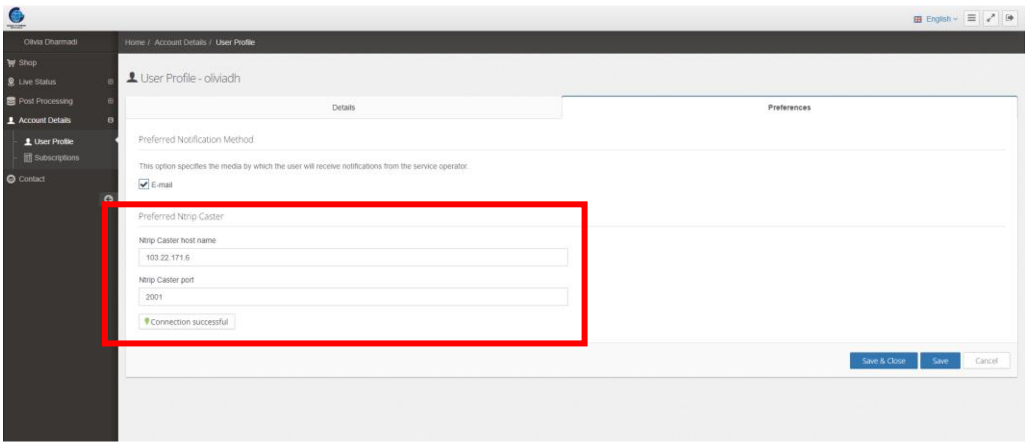


Figure A-2 NTRIP caster details

2. Connecting to the NTRIP client with u-center application (Windows)

- The NTRIP client in u-center application by u-blox can be found under Receiver – NTRIP Client as shown in Figure A-3.
- To connect, provide the credentials and details previously obtained from InaCORS in the NTRIP caster settings section. Have the NTRIP mount point setting to "Nearest-rtcm3" as this will select the closest VRS for use.

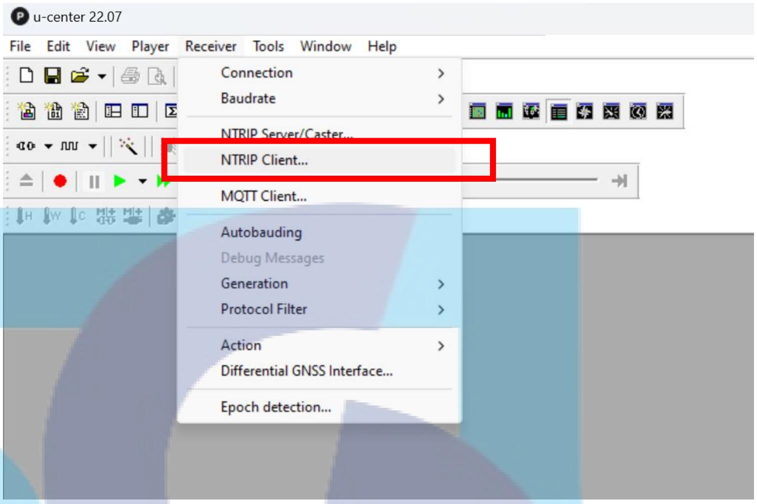


Figure A-3 NTRIP client in u-center application

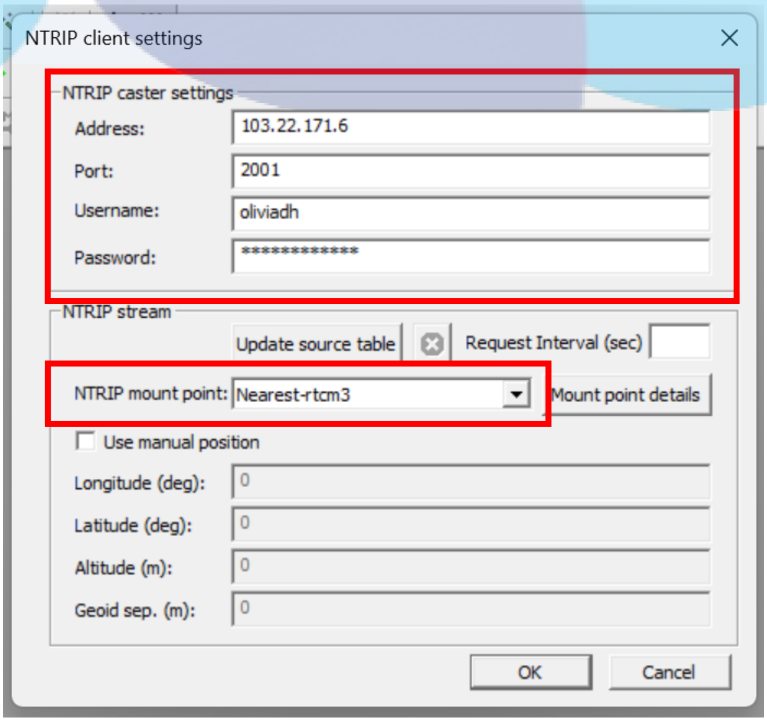


Figure A-4 NTRIP credentials in u-center application

3. Connecting to the NTRIP client in ROS2

- All code related to RTK-based GNSS utilizing u-blox antennas and NTRIP client through ROS2 topics have been compiled in

  https://github.com/olvdhrm/RTK_GPS_NTRIP.git

- Configuration files for the u-blox GNSS antennas can be found under ublox_gps – config as shown in Figure A-5.

- For this thesis, the zed_f9p.yaml file is utilized and includes the parameters that have been configured accordingly as a rover.

- NTRIP caster details and credentials previously obtained from InaCORS are to be provided to the NTRIP client in the ntrip_client_launch.py file as shown in Figure A-6.

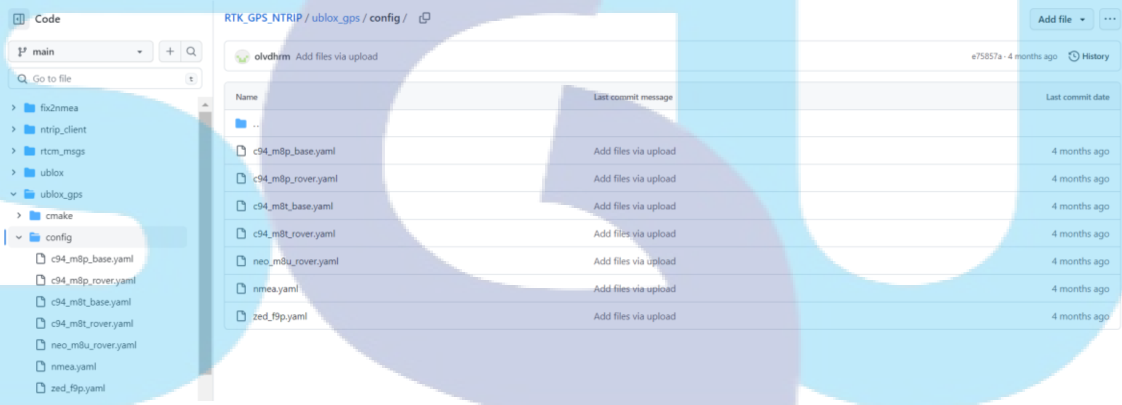


Figure A-5 u-blox GNSS configuration files

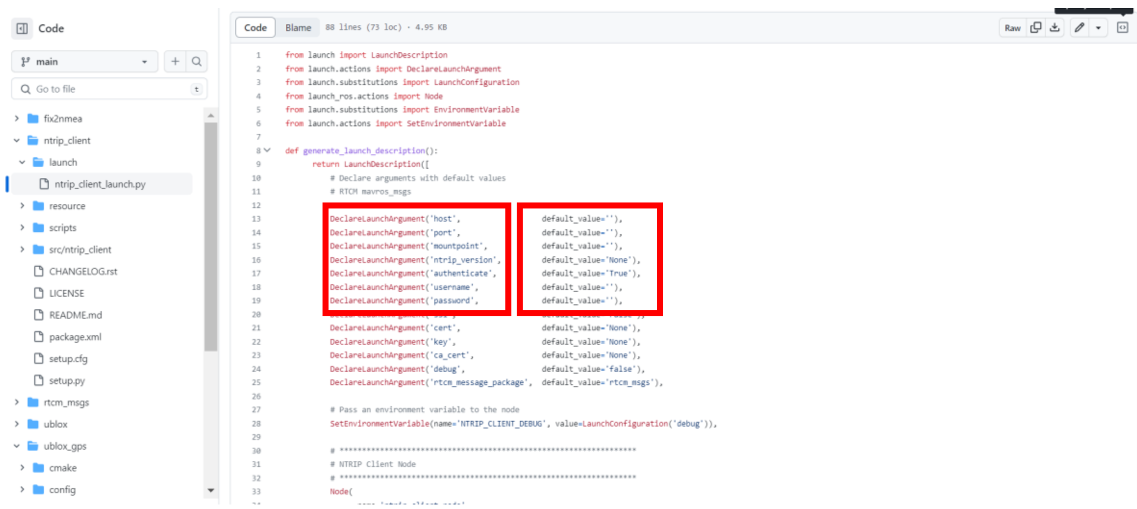
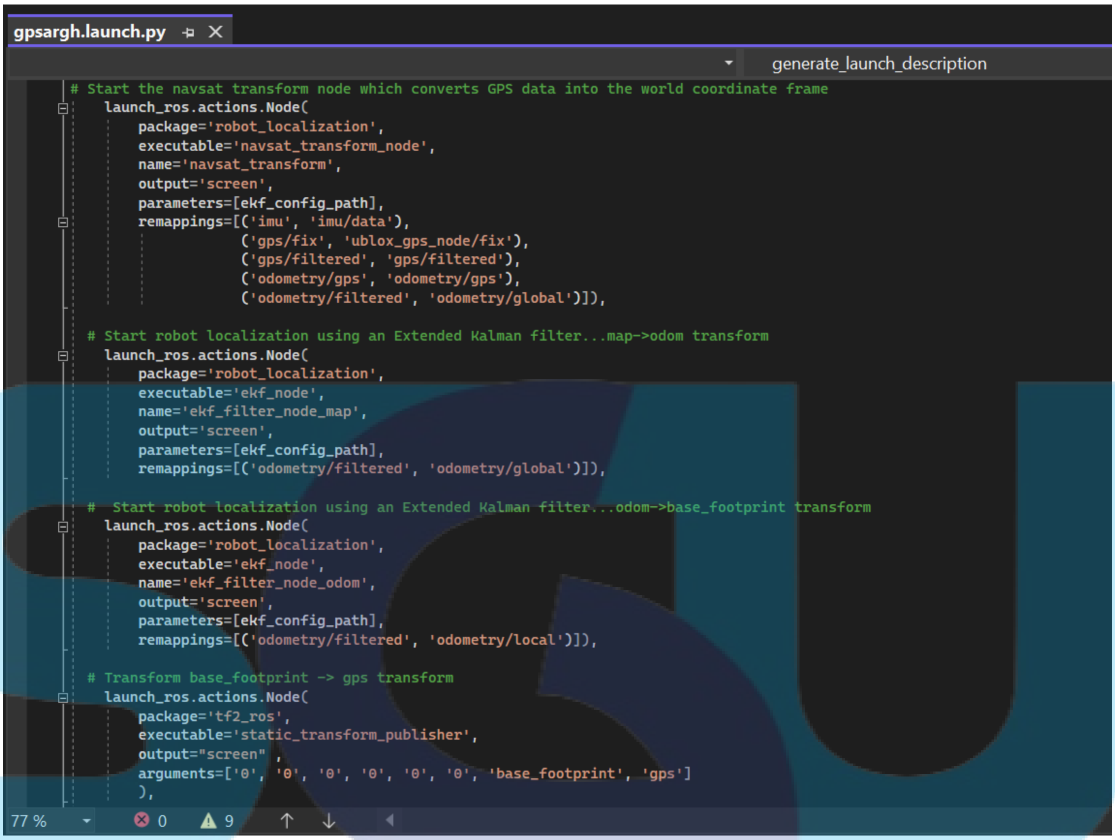


Figure A-6 NTRIP credentials in ROS2

APPENDIX B – LOCALIZATION CONFIGURATION FOR INTEGRATION OF GNSS DATA




```python
# Start the navsat transform node which converts GPS data into the world coordinate frame
launch_ros.actions.Node(
    package='robot_localization',
    executable='navsat_transform_node',
    name='navsat_transform',
    output='screen',
    parameters=[ekf_config_path],
    remappings=[('imu', 'imu/data'),
                ('gps/fix', 'ublox_gps_node/fix'),
                ('gps/filtered', 'gps/filtered'),
                ('odometry/gps', 'odometry/gps'),
                ('odometry/filtered', 'odometry/global')]),

# Start robot localization using an Extended Kalman filter...map->odom transform
launch_ros.actions.Node(
    package='robot_localization',
    executable='ekf_node',
    name='ekf_filter_node_map',
    output='screen',
    parameters=[ekf_config_path],
    remappings=[('odometry/filtered', 'odometry/global')]),

#  Start robot localization using an Extended Kalman filter...odom->base_footprint transform
launch_ros.actions.Node(
    package='robot_localization',
    executable='ekf_node',
    name='ekf_filter_node_odom',
    output='screen',
    parameters=[ekf_config_path],
    remappings=[('odometry/filtered', 'odometry/local')]),

# Transform base_footprint -> gps transform
launch_ros.actions.Node(
    package='tf2_ros',
    executable='static_transform_publisher',
    output="screen" ,
    arguments=['0', '0', '0', '0', '0', '0', 'base_footprint', 'gps']
    ),
```

Figure B-1 Robot localization with RTK GNSS integration

APPENDIX C – BRINGUP OR LAUNCH PROCESS

1. To launch the following packages altogether,

    - Driver for ublox receiver and antennas (ublox_gps)
    - NTRIP client (ntrip_client)
    - Fix to NMEA converter (fix2nmea)

    As shown in Figure C-1 below, run the following command in the terminal

    ros2 launch ublox_gps rtk_combined_launch.py

    Otherwise, follow the instructions in the GitHub repository below

    https://github.com/olvdhrm/RTK_GPS_NTRIP.git

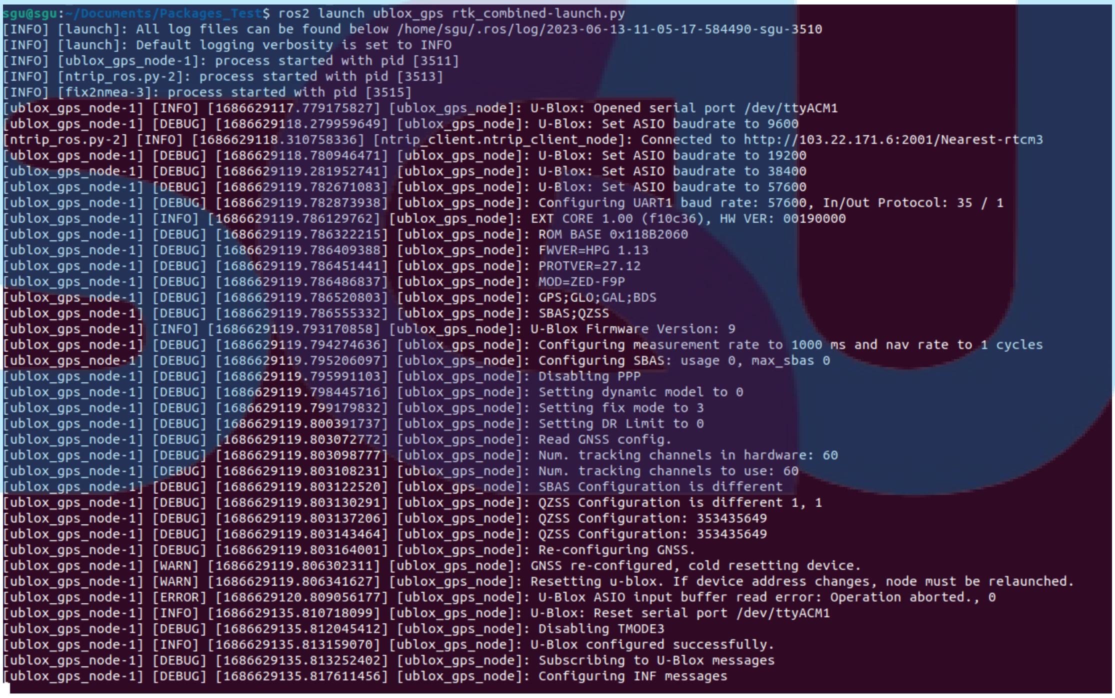


Figure C-1 RTK-based GNSS combined launch

2. To launch the following packages altogether,

    - LinoRobot framework (linorobot2)
    - State estimation and NavSat transformation nodes from robot_localization (robot_localization)

    As shown in Figure C-2 below, run the following command in the terminal

    ros2 launch linorobot2_bringup bringup2.launch.py

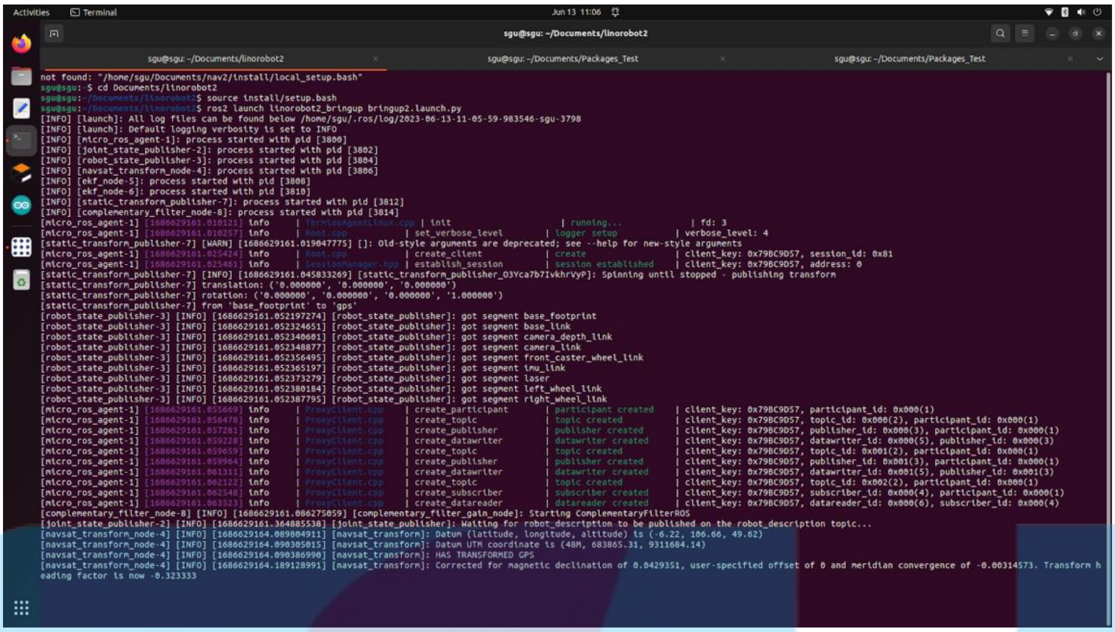


Figure C-2 Linorobot2 framework bringup

3. To perform keyboard teleoperation on the robot. After launching the LinoRobot framework package, run the following command on the terminal

ros2 run turtlebot3_teleop teleop_keyboard

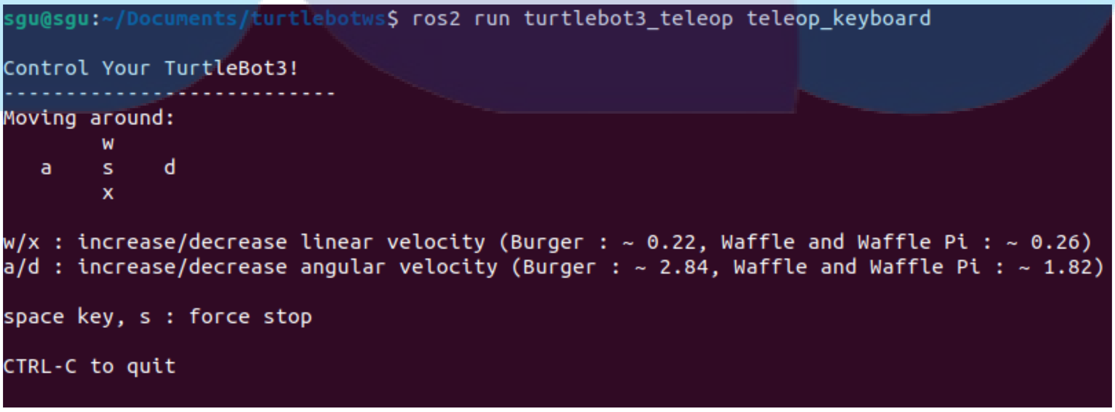


Figure C-3 Keyboard teleoperation

4. To launch the navigation package, run the following command on the terminal

ros2 launch turtlbot3_navigation2 navigation2.launch.py

Figure C-4 Nav2 bringup

APPENDIX D – DATASHEETS

1.2 Performance

Parameter	Specification	
Receiver type	Multi-band GNSS high precision receiver	
Accuracy of time pulse signal	RMS 99%	30 ns 60 ns
Frequency of time pulse signal		0.25 Hz to 10 MHz (configurable)
Operational limits[2]	Dynamics Altitude Velocity	≤ 4 g 80,000 m 500 m/s
Velocity accuracy[3]		0.05 m/s
Dynamic heading accuracy[3]		0.3 deg

Table 1: ZED-F9P-04B specifications

GNSS[4]		GPS+GLO+GAL+BDS	GPS+GLO+GAL	GPS+GAL	GPS+GLO	GPS+BDS	GPS
Acquisition[5]	Cold start	25 s	25 s	30 s	25 s	30 s	30 s
	Hot start	2 s	2 s	2 s	2 s	2 s	2 s
	Aided start[6]	2 s	2 s	2 s	2 s	2 s	2 s
Max navigation update rate[7]	RTK	7 Hz	10 Hz	15 Hz	14 Hz	13 Hz	20 Hz
	PVT	9 Hz	10 Hz	20 Hz	20 Hz	16 Hz	25 Hz
	RAW	15 Hz	18 Hz	25 Hz	25 Hz	25 Hz	25 Hz

1 PPP-RTK position accuracy depends on the quality of the SSR service used, high-quality SSR services can perform similarly to RTK
2 Assuming Airborne 4 g platform
3 50% at 30 m/s for dynamic operation
4 GPS used in combination with QZSS and SBAS
5 Commanded starts. All satellites at -130 dBm. Measured at room temperature.
6 Dependent on the speed and latency of the aiding data connection, commanded starts
7 Measured with primary output only, secondary output disabled (default)

GNSS[4]		GPS+GLO+GAL+BDS	GPS+GLO+GAL	GPS+GAL	GPS+GLO	GPS+BDS	GPS
Convergence time[8]	RTK	< 10 s	< 10 s	< 10 s	< 10 s	< 10 s	< 30 s

Table 2: ZED-F9P-04B performance in different GNSS modes

GNSS		GPS+GLO+GAL+BDS	GPS+GLO+GAL	GPS+GAL	GPS+GLO	GPS+BDS	GPS
Horizontal pos. accuracy	PVT[9]	1.5 m CEP	1.5 m CEP	1.5 m CEP	1.5 m CEP	1.5 m CEP	1.5 m CEP
	SBAS[9]	1.0 m CEP	1.0 m CEP	1.0 m CEP	1.0 m CEP	1.0 m CEP	1.0 m CEP
	RTK[10]	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP	0.01 m + 1 ppm CEP
Vertical pos. accuracy	PVT[9]	2.0 m R50	2.0 m R50	2.0 m R50	2.0 m R50	2.0 m R50	2.0 m R50
	SBAS[9]	1.5 m R50	1.5 m R50	1.5 m R50	1.5 m R50	1.5 m R50	1.5 m R50
	RTK[10]	0.01 m + 1 ppm R50	0.01 m + 1 ppm R50	0.01 m + 1 ppm R50	0.01 m + 1 ppm R50	0.01 m + 1 ppm R50	0.01 m + 1 ppm R50

Table 3: ZED-F9P-04B position accuracy in different GNSS modes

Figure D-1 ZED F9P datasheet – performance

5.5 Default interface settings

Interface	Settings
UART1 output	38400 baud, 8 bits, no parity bit, 1 stop bit. NMEA protocol with **GGA, GLL, GSA, GSV, RMC, VTG, TXT** messages are output by default. UBX and RTCM 3.3 protocols are enabled by default but no output messages are enabled by default.
UART1 input	38400 baud, 8 bits, no parity bit, 1 stop bit. UBX, NMEA and RTCM 3.3 input protocols are enabled by default. SPARTN input protocol is enabled by default.
UART2 output	38400 baud, 8 bits, no parity bit, 1 stop bit. UBX protocol is disabled by default. RTCM 3.3 protocol is enabled by default but no output messages are enabled by default. NMEA protocol is disabled by default.
UART2 input	38400 baud, 8 bits, no parity bit, 1 stop bit. UBX protocol is enabled by default. RTCM 3.3 protocol is enabled by default. SPARTN protocol is enabled by default. NMEA protocol is disabled by default.
USB	Default messages activated as in UART1. Input/output protocols available as in UART1.
I2C	Available for communication in the Fast-mode with an external host CPU in slave mode only. Default messages activated as in UART1. Input/output protocols available as in UART1. Maximum bit rate 400 kb/s.
SPI	Allow communication to a host CPU, operated in slave mode only. Default messages activated as in UART1. Input/output protocols available as in UART1. SPI is not available unless D_SEL pin is set to low (see section D_SEL interface in Integration manual [1]).

Table 23: Default interface settings

Figure D-2 ZED F9P datasheet – default interface settings

3.3 Intel® RealSense™ Tracking Camera T265 Device

Figure 3-3. Intel® RealSense™ Tracking Camera T265

Note: Figure may differ from final production images

3.3.1 Intel® RealSense™ Tracking Camera T265 Mechanical Dimensions

Table 3-13. Intel® RealSense™ Tracking Camera T265 Mechanical Dimensions

Dimension	Min	Nominal	Max	Unit
Width	107.85	108.00	108.15	mm
Height	24.35	24.50	24.65	mm
Depth	12.35	12.50	12.65	mm
Flatness Tolerance	-	0.15	-	mm
Weight	57	60	63	gr

3.3.2 Intel® RealSense™ Tracking Camera T265 Thermals

Table 3-14. Max Skin Temperature

Tracking Camera	Max Skin Temperature (25°C Ambient in Open Environment)
T265	40°C

Figure D-3 T265 Tracking Camera datasheet 1

3.3.3 Intel® RealSense™ Tracking Camera T265 Storage and Operating Conditions

Table 3-15. Storage and Operating Conditions

Condition	Description	Min	Max	Unit
Storage (Still Air), Not Operating	Temperature (Sustained, Controlled)[1]	0	40	°C
	Temperature (Short Exposure)[2]	-30	65	°C
	Humidity, Non-Condensing	90% RH, 30°C		
Operating(3) (Still Air)	Temperature	0	35	°C

NOTES:

1. Controlled conditions should be used for long term storage of product.
2. Short exposure represents temporary max limits acceptable for transportation conditions.
3. Component case temperature limits must be met for all operating temperatures.

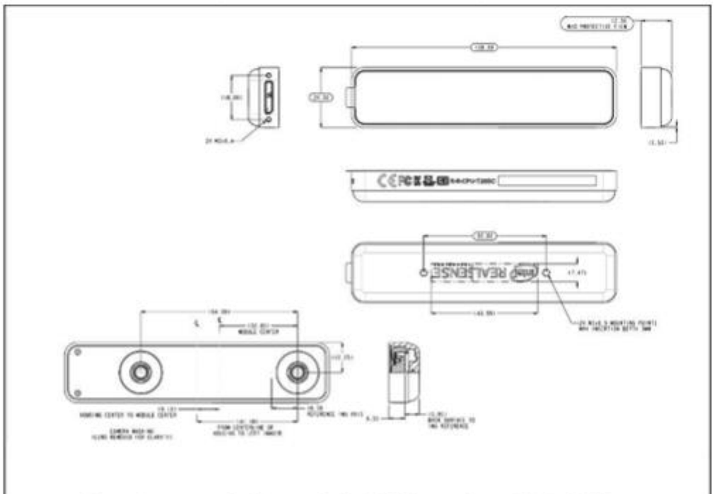
3.3.4 Product Identifier and Material Code

Table 3-16. Product Identifier and Material Code

Production	Product Material Code
Intel® RealSense™ Tracking Camera T265	999AXJ

Figure D-4 T265 Tracking Camera datasheet 2

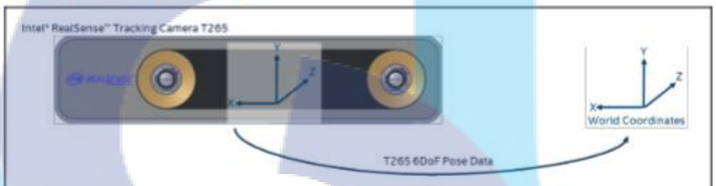
Figure 6-8. Intel® RealSense™ Tracking Camera T265 Center of Tracking Location



Note: Recommended torque for both M3 mounting points is 0.4Nm.

6.8 Tracking System Coordinate System

Figure 6-9. Tracking System Coordinate System



Notes:

1. Positive X direction is towards right imager (same for world coordinates)
2. Positive Y direction is upwards toward the top of the device (same for world coordinates)
3. Positive Z direction is inwards toward the back of the device (same for world coordinates)

Figure D-5 T265 Tracking Camera datasheet 3

Intel® RealSense™ Depth Camera D415 Buy

TECH SPECS

Datasheet

Features

Use environment: Indoor/Outdoor

Image sensor technology: Rolling Shutter

Ideal range: .5 m to 3 m

Depth

Depth technology: Stereoscopic

Minimum depth distance (Min-Z) at max resolution: ~45 cm

Depth Accuracy: <2% at 2 m[1]

Depth Field of View (FOV): 65° × 40°

Depth output resolution: Up to 1280 × 720

Depth frame rate: Up to 90 fps

RGB

RGB frame resolution: 1920 × 1080

RGB frame rate: 30 fps

RGB sensor technology: Rolling Shutter

RGB sensor FOV (H × V): 69° × 42°

RGB sensor resolution: 2 MP

Major Components

Camera module: Intel RealSense Module D415

Vision processor board: Intel RealSense Vision Processor D4

Physical

Form factor: Camera Peripheral

Length × Depth × Height: 99 mm × 20 mm × 23 mm

Connectors: USB-C* 3.1 Gen 1*

Mounting mechanism:
– One 1/4-20 UNC thread mounting point.
– Two M3 thread mounting points.

Figure D-6 D415 Depth Camera specifications

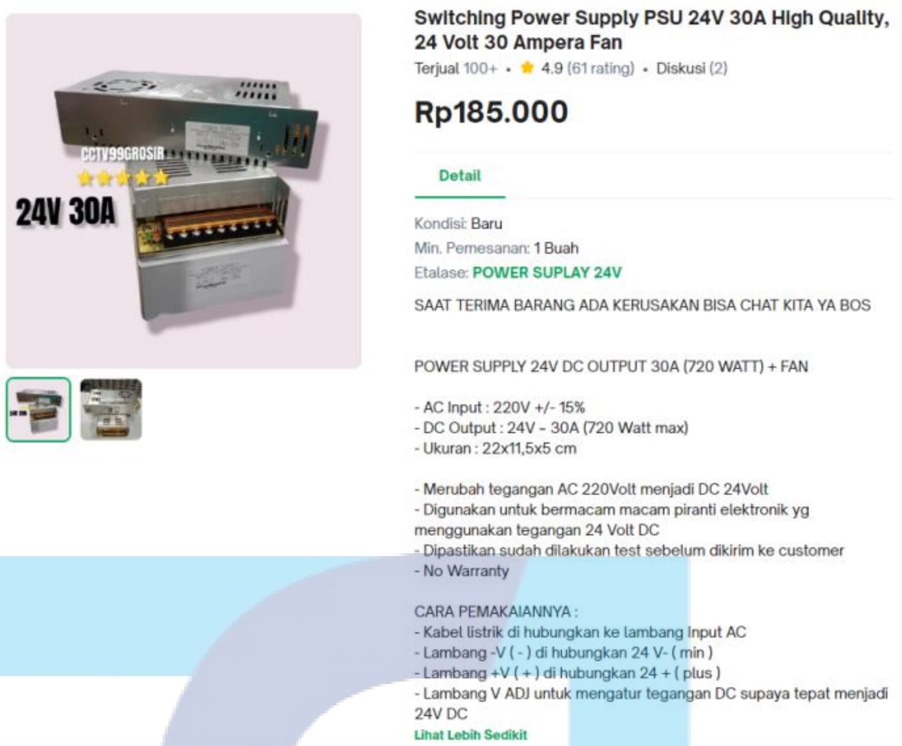
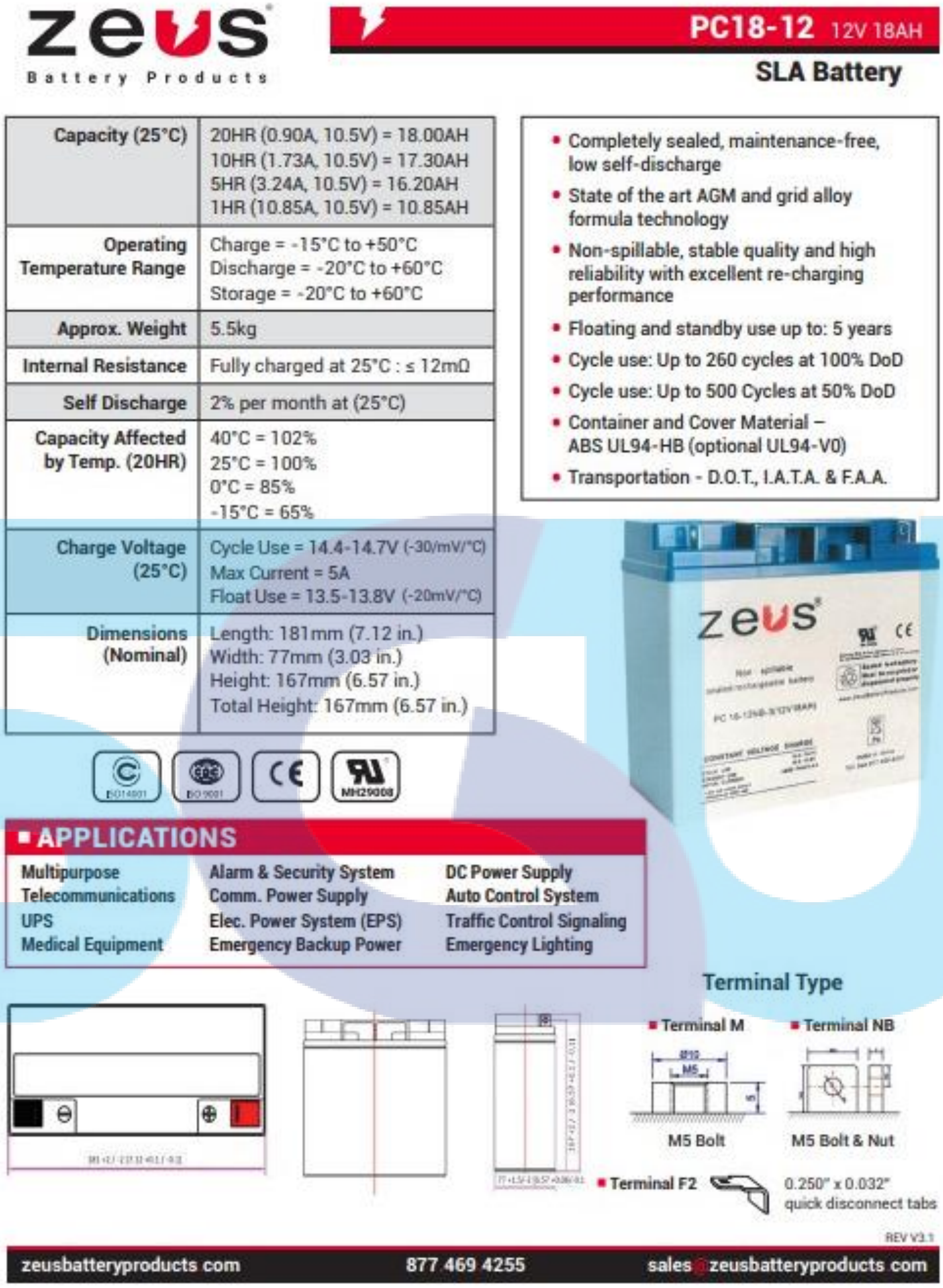


Figure D-7 Power Supply Unit specifications



zeus Battery Products

PC18-12 12V 18AH

SLA Battery

Capacity (25°C)	20HR (0.90A, 10.5V) = 18.00AH 10HR (1.73A, 10.5V) = 17.30AH 5HR (3.24A, 10.5V) = 16.20AH 1HR (10.85A, 10.5V) = 10.85AH
Operating Temperature Range	Charge = -15°C to +50°C Discharge = -20°C to +60°C Storage = -20°C to +60°C
Approx. Weight	5.5kg
Internal Resistance	Fully charged at 25°C : ≤ 12mΩ
Self Discharge	2% per month at (25°C)
Capacity Affected by Temp. (20HR)	40°C = 102% 25°C = 100% 0°C = 85% -15°C = 65%
Charge Voltage (25°C)	Cycle Use = 14.4-14.7V (-30/mV/°C) Max Current = 5A Float Use = 13.5-13.8V (-20mV/°C)
Dimensions (Nominal)	Length: 181mm (7.12 in.) Width: 77mm (3.03 in.) Height: 167mm (6.57 in.) Total Height: 167mm (6.57 in.)

- Completely sealed, maintenance-free, low self-discharge
- State of the art AGM and grid alloy formula technology
- Non-spillable, stable quality and high reliability with excellent re-charging performance
- Floating and standby use up to: 5 years
- Cycle use: Up to 260 cycles at 100% DoD
- Cycle use: Up to 500 Cycles at 50% DoD
- Container and Cover Material – ABS UL94-HB (optional UL94-V0)
- Transportation - D.O.T., I.A.T.A. & F.A.A.

ISO14001 ISO 9001 CE MH29008

APPLICATIONS

Multipurpose	Alarm & Security System	DC Power Supply
Telecommunications	Comm. Power Supply	Auto Control System
UPS	Elec. Power System (EPS)	Traffic Control Signaling
Medical Equipment	Emergency Backup Power	Emergency Lighting

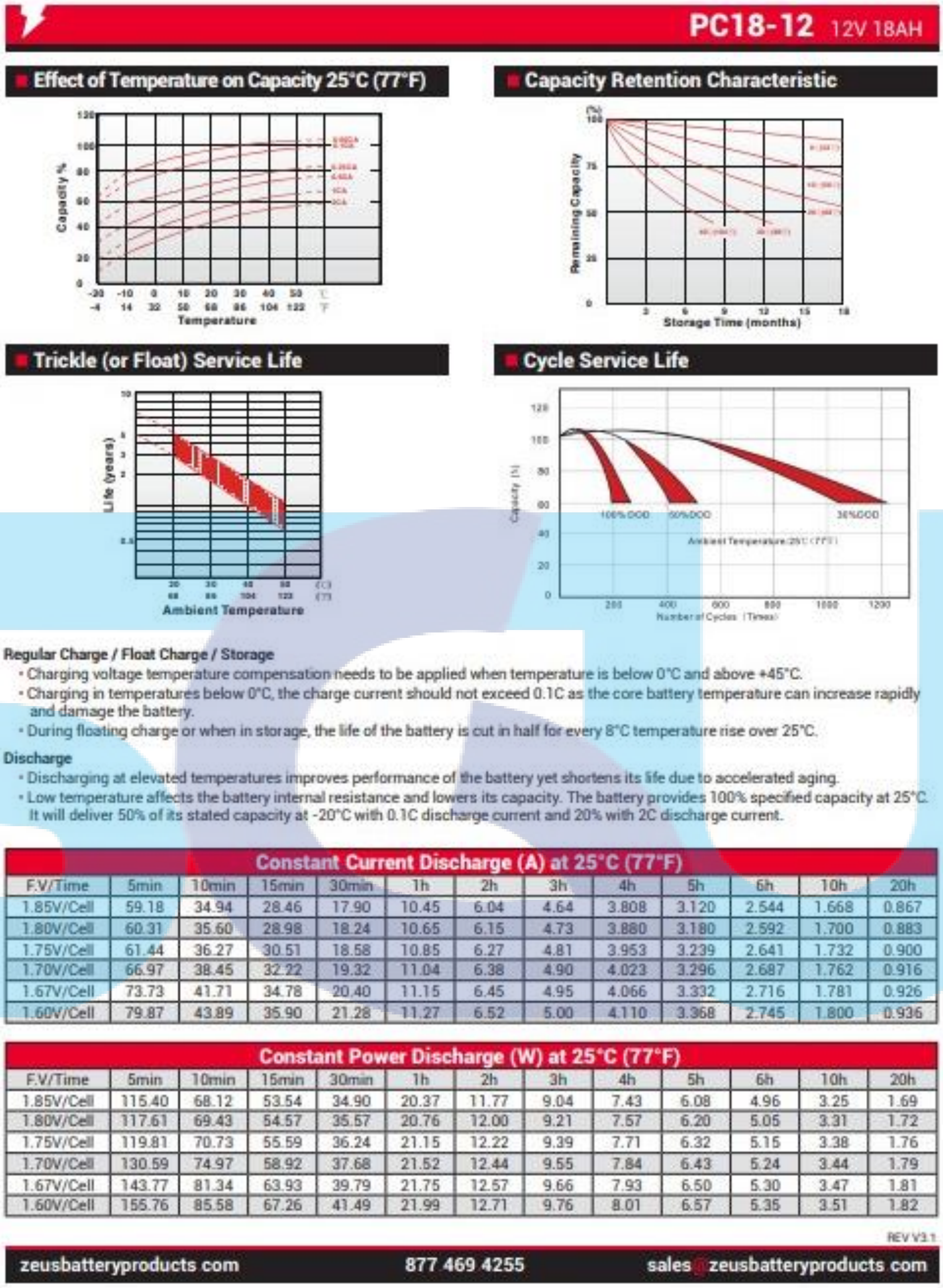
Terminal Type

- Terminal M — M5 Bolt
- Terminal NB — M5 Bolt & Nut
- Terminal F2 — 0.250" x 0.032" quick disconnect tabs

REV V3.1

zeusbatteryproducts.com 877.469.4255 sales@zeusbatteryproducts.com

Figure D-8 Battery datasheet 1



Regular Charge / Float Charge / Storage

- Charging voltage temperature compensation needs to be applied when temperature is below 0°C and above +45°C.
- Charging in temperatures below 0°C, the charge current should not exceed 0.1C as the core battery temperature can increase rapidly and damage the battery.
- During floating charge or when in storage, the life of the battery is cut in half for every 8°C temperature rise over 25°C.

Discharge

- Discharging at elevated temperatures improves performance of the battery yet shortens its life due to accelerated aging.
- Low temperature affects the battery internal resistance and lowers its capacity. The battery provides 100% specified capacity at 25°C. It will deliver 50% of its stated capacity at -20°C with 0.1C discharge current and 20% with 2C discharge current.

Constant Current Discharge (A) at 25°C (77°F)

F.V/Time	5min	10min	15min	30min	1h	2h	3h	4h	5h	6h	10h	20h
1.85V/Cell	59.18	34.94	28.46	17.90	10.45	6.04	4.64	3.808	3.120	2.544	1.668	0.867
1.80V/Cell	60.31	35.60	28.98	18.24	10.65	6.15	4.73	3.880	3.180	2.592	1.700	0.883
1.75V/Cell	61.44	36.27	30.51	18.58	10.85	6.27	4.81	3.953	3.239	2.641	1.732	0.900
1.70V/Cell	66.97	38.45	32.22	19.32	11.04	6.38	4.90	4.023	3.296	2.687	1.762	0.916
1.67V/Cell	73.73	41.71	34.78	20.40	11.15	6.45	4.95	4.066	3.332	2.716	1.781	0.926
1.60V/Cell	79.87	43.89	35.90	21.28	11.27	6.52	5.00	4.110	3.368	2.745	1.800	0.936

Constant Power Discharge (W) at 25°C (77°F)

F.V/Time	5min	10min	15min	30min	1h	2h	3h	4h	5h	6h	10h	20h
1.85V/Cell	115.40	68.12	53.54	34.90	20.37	11.77	9.04	7.43	6.08	4.96	3.25	1.69
1.80V/Cell	117.61	69.43	54.57	35.57	20.76	12.00	9.21	7.57	6.20	5.05	3.31	1.72
1.75V/Cell	119.81	70.73	55.59	36.24	21.15	12.22	9.39	7.71	6.32	5.15	3.38	1.76
1.70V/Cell	130.59	74.97	58.92	37.68	21.52	12.44	9.55	7.84	6.43	5.24	3.44	1.79
1.67V/Cell	143.77	81.34	63.93	39.79	21.75	12.57	9.66	7.93	6.50	5.30	3.47	1.81
1.60V/Cell	155.76	85.58	67.26	41.49	21.99	12.71	9.76	8.01	6.57	5.35	3.51	1.82

REV V3.1

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Figure D-9 Battery datasheet 2

APPENDIX E – BILL OF MATERIAL

No	Item Name	Price/ Qty	Qty	Total Price	Notes
1	Roller Chain 35-1 with Connector CL35-1	Rp119,000.00	2	Rp238,000.00	Passed down
2	Sprocket RS35-30T	Rp49,000.00	2	Rp98,000.00	Passed down
3	Pillow Block UCP 204	Rp28,500.00	8	Rp228,000.00	Passed down
4	Pillow Block UCFL 204	Rp30,500.00	2	Rp61,000.00	Passed down
5	AS S45C 35mm	Rp195.00	900	Rp175,500.00	Passed down
6	AS S45C 25mm	Rp112.00	800	Rp89,600.00	Passed down
7	Aluminium Profile 3030	Rp820.00	512	Rp419,840.00	Passed down
8	Aluminium Plate 2mm 59x46x2mm with Laser Cut Fee	Rp325,000.00	1	Rp325,000.00	Passed down
9	T Hammer Nut M53030	Rp1,950.00	104	Rp202,800.00	Passed down
10	L/ Socket Head Cap Screw M5x15 (10 pcs/ pack)	Rp7,000.00	11	Rp77,000.00	Passed down
11	Gusset 3030 Aluminium Profile Bracket	Rp5,700.00	32	Rp182,400.00	Passed down
12	Steel Screw HTB Grade 10.9	Rp2,600.00	16	Rp41,600.00	Passed down
13	13in Wheel	Rp85,000.00	4	Rp340,000.00	Passed down
14	DKM Motor 24V 90W	Rp300,000.00	2	Rp600,000.00	Passed down
15	1:50 DKM Gearbox	Rp1,500,000.00	2	Rp3,000,000.00	Passed down
16	Rotary Encoder Hanyoung NUX HE50B-8-360-3N-24	Rp687,500.00	1	Rp687,500.00	Passed down
17	Gland PG13.5 Cable	Rp11,600.00	1	Rp11,600.00	Passed down
18	Electronic Case Enclosure Plastic Box with Clear Cover	Rp74,500.00	1	Rp74,500.00	Passed down
19	PCB Printing	Rp10,000.00	1	Rp10,000.00	Passed down
20	AWG12 Cable	Rp2,000.00	12	Rp24,000.00	Passed down
21	3D Printing	Rp140,000.00	1	Rp140,000.00	Passed down
22	Acrylic Laser Cut	Rp70,000.00	1	Rp70,000.00	Passed down
23	Resistors, Capacitors, Jumpers, Terminal Blocks, and Conn-Sill	Rp20,000.00	1	Rp20,000.00	Passed down
24	Teensy 4.1 Board	Rp635,000.00	1	Rp635,000.00	Passed down
25	10cm Pigtail Cable SMA Female to U.FL/UFL	Rp25,000.00	1	Rp25,000.00	Passed down
26	IBT-2 Motor Driver	Rp62,500.00	2	Rp125,000.00	Passed down
27	Optocoupler	Rp9,000.00	2	Rp18,000.00	Passed down
28	Heat Shrink	Rp15,000.00	1	Rp15,000.00	Passed down
29	Cable Jumper Male to Male (20 pcs/ pack)	Rp5,400.00	3	Rp16,200.00	Passed down
30	IMU MPU9250	Rp65,500.00	1	Rp65,500.00	Passed down
31	SparkFun GPSRTK2 Board (ZED-F9P)	Rp3,911,600.00	1	Rp3,911,600.00	Passed down

32	ANN-MB-00-00 Antenna	Rp913,548.00	1	Rp913,548.00	Passed down
33	Battery PC18-12 12V 18Ah	Rp478,900.00	1	Rp478,900.00	
34	Switching Power Supply Unit 24V 30A	Rp185,000.00	1	Rp185,000.00	
35	Intel NUC7I7BNH-16S480 Mini-PC	Rp6,000,000.00	1	Rp6,000,000.00	Passed down
36	Intel NUC6CAYH Mini-PC	Rp2,200,000.00	1	Rp2,200,000.00	Passed down
37	Intel T265 Tracking Camera	Rp6,000,000.00	1	Rp6,000,000.00	Passed down
38	Intel D415 Depth Camera	Rp4,000,000.00	1	Rp4,000,000.00	Passed down
			Total Price	**Rp31,705,088.00**	

CURRICULUM VITAE

OLIVIA DHARMADI

Mechatronics Engineering Student

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EDUCATION

Swiss German University
Bachelor's Degree Mechatronics Engineering — Expected graduation: 2023
Current cumulative GPA: 3.98/ 4.00

Fachhochschule Südwestfalen
Bachelor's Degree Mechatronics Engineering — Expected graduation: 2023
Double degree program and exchange student for Winter 2021 and Summer 2022 semesters

WORK EXPERIENCE

Swiss German University
Teaching Assistant for Mechatronics — April 2023 - Present
Conduct sessions for 2nd semester Mechatronics and Biomedical Engineering students for Physics and Electrical Engineering Labs.

- Prepare and execute pre-session test and post laboratory Q&A sessions to reinforce understanding.
- Oversee laboratory sessions and provide feedback for student reports.

Siemens Healthineers
Mechatronics Fellow at Innovation Think Tank Mechatronic Products — March – August 2022
Implementing the Innovation Think Tank methodology in solving pain points in the healthcare technology industry within the scope of Mechatronic Products.

- Partake in design development of existing medical imaging modalities taking into consideration customer feedback and both technical and clinical requirements.
- Utilized Unity Game Engine to develop virtual use-case testing platforms for 2 existing healthcare modalities for virtual prototyping and product visualization.
- Conducted Design of Experiment to evaluate different sensing methods used in obstacle avoidance systems within the clinical setting.

Industrial Polytechnic Akademi Teknik Mesin Industri Cikarang
Student Trainee Practical Training — November – December 2021

- Practical training in basic operations of lathe and milling machines, mechanical benchwork, technical drawing, reverse engineering, assembly, and welding.
- Practical training in electrical benchwork, circuit and circuit board design, and electrical installation.

ORGANIZATIONAL AND LEADERSHIP EXPERIENCE

Mechatronics Student Association
Head of Academics — March – December 2021
Lead a division within the Mechatronics Student Association with 4 members which aims to aid and enhance the understanding of mechatronics students in academics whilst providing a platform for personal growth.

- Initiated and proposed a peer-to-peer tutoring program to increase productivity and boost the understanding of Mechatronics students in Mechatronics subjects during online classes.
- Facilitated tutoring program for 2 batches over 8 subjects and 22 tutoring sessions since March 2021.
- Provided opportunities for 17 students to help and reinforce their understandings onto their peers.

Mechatronics Day 2021
Head of Mechatronics Day 2021 — February – November 2021
Taking on the theme "Innovation Amidst the Pandemic", Mechatronics Day 2021 introduces and challenges high school students to innovate and create technology-based solutions for problems that emerge in the pandemic.

- Gained support from Indonesia's Ministry of Youth and Sports, ASIOTI (Indonesian IoT Association) and pemimpin.id (a prominent Indonesian platform for personal growth and soft skills development).
- Conducted webinars around the topic of applications of IoT and the Industry 4.0 era with 250 attendees.
- Smart Living Competition and workshop participated by 24 teams of high school students nation-wide.

ACHIEVEMENTS

XL Axiata Future Leaders
Batch 10 Awardee November 2021 - Present

XL Axiata's CSR program that focuses on self and leadership development through 3 core competencies: Effective Communication, Entrepreneurship & Innovation, and Managing Change.

- Selected as one of the 190 scholarship program awardees with an acceptance rate of 0.46%.
- Contributed as a member of the core team as Head of Finance for Jakarta 1 Cohort's social project responsible for overseeing and performing budget planning to financial report.

SKILLS

Indonesian	Native Proficiency
English	Professional Working Proficiency
German	Elementary Proficiency (A2)

- Microsoft Office (Word, Excel, PowerPoint), Microsoft Teams, Google Suite
- Microcontroller programming with Arduino IDE
- Object-oriented programming with C++ and Python
- 3D Design with Autodesk Fusion 360, Siemens NX, and SOLIDWORKS (2016)
- Electrical circuit design and simulation through MultiSIM and PowerSIM
- Electro-pneumatic circuit design and simulation through FluidSIM
- Virtual use-case testing platform development through Unity Game Engine