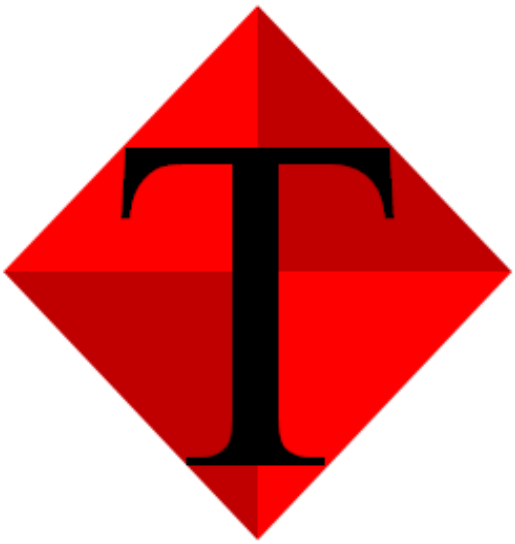
TETRA-DS IV™
Operation Manual

Version 1.0



2012 1

Dongbu Robot

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Important Safety Instructions

- Please make sure to read the operations manual before using the product.
- Do not use the product with increased power input beyond specification.
- To prevent damage from fire or shock, avoid exposing the product to water or humidity.
- Do not disassemble the product or optional items.
- Do not operate the product at a location with long carpet hair or fur.
- Do not touch the internal components with the battery installed or while charging.

Inappropriate Operation

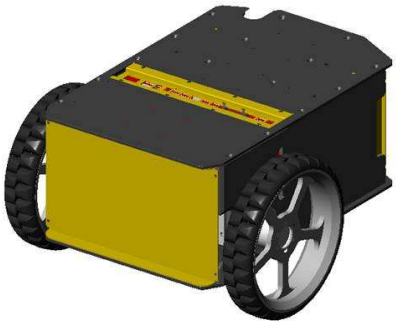
Damages caused by careless or inappropriate operation will not be covered by our free warrany. Refer to below for examples of inappropriate/careless operations that may cause damage.

- Operating the robot on top of a table or allowing the robot to fall from a high area through carelessness.
- Operating the robot with payload beyond recommended weight.
- Allowing the robot to become wet.
- Continuing to use the robot with hair, thread, or other similar materials wrapped around the wheels, axles, and gears.
- Disassembling or exposing the internal components of the robot without removing the battery first or while battery is charging.
- All other inappropriate or careless actions that results in damage to the robot.

Chapter 1. Introduction

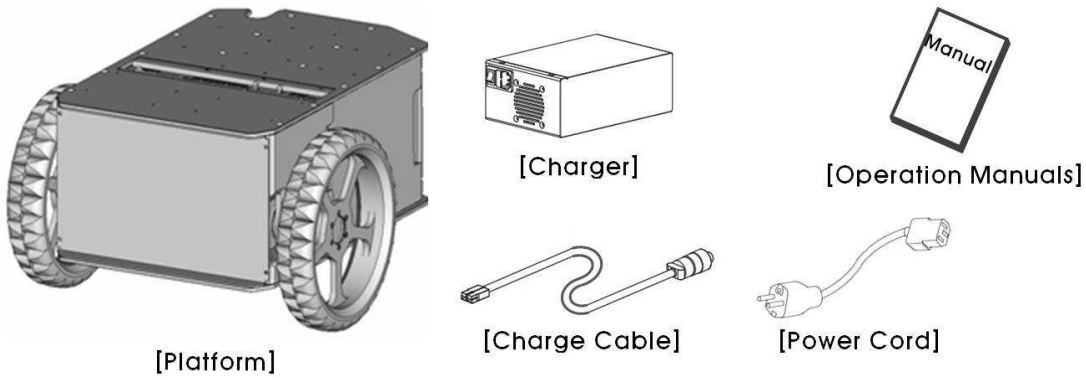
1-1. Platform Packages

'TETRA-DS IV™' is an advanced indoor robot platform used for developing and testing autonomous robot locomotion technology and programming. Refer to the diagram below for the image of the 'TETRA-DS IV™'.



<Diagram 1-1> Image of TETRA-DS IV™ (Basic Model)

TETRA-DS IV™ is composed of the parts shown in diagram 1-2. When the box is first opened, check to make sure all of the parts are included. Contact and notify the local service center for any missing parts. The package components shown below may change according to the model or manufacturing circumstances.



<Diagram 1-2> TETRA-DS IV™ Package

1-1-1. Basic Components

- TETRA-DS IV™ Platform
  - DRCP and installed Battery (Selected Battery)
- Charger Set

- Charger –Battery
- 220V AC Power Cord
- Charge Cable

■ Operating Manuals

- TETRA-DS IV™ Operation Manual
- DRSP-HAL Operation Manual
- DRSP-Serial Operation Manual

1-1-2. Optional Components and Attachments

■ Laser Range Finder Module

- HOKUYO社 URG-04LX-UG01, mounting bracket and connection cable
- SICK社 LMS100 series, mounting bracket and connection cable

■ Absolute Localization Sensor Module

- Hagisonic社 StarGazer™, mounting bracket and connection cable

■ Ultrasonic sensor Module

- Ultrasonic sensor(7EA), mounting bracket and connection cables

■ Bumper Sensor Module

■ Supplementary and Replacement batteries

1-1-3. User-supplied Components

■ Available Power Ports

- 12V (2A) for LRF(Laser Range Finder)
- 12V (1A), 5V (1A) for Stargazer
- 8.1V (2A) for Smart motor(Dongbu Robot HerkuleX)
- 24V (4A) for SBC(Single Board Computer)
- 12V (3A) for LCD monitor
- 12V (2A), 5V (1A) for sensor modules (Ultrasonic sensor module, Gyroscope module)

■ Available Communication Port

- LAN (1 port)
- USB (2 ports)

1-2. Technical Support

Feel free to share your knowledge or recommendations for improvement on our website

below or to ask questions if you are having a problem and can't find answer to your question in the operation manual.

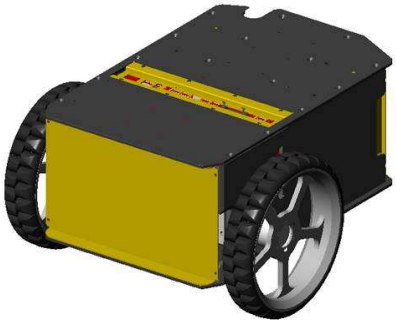
http://www.dongburobot.com/jsp/cms/view.jsp?code=100120

or, contact us by email or phone using the address and phone number below.

dongburobot@dongbu.com, +82-80-329-5482

Chapter 2. What is TETRA-DS IV™?

'TETRA-DS IV™' is an advanced indoor robot platform used for developing and testing autonomous robot locomotion technology and programming.

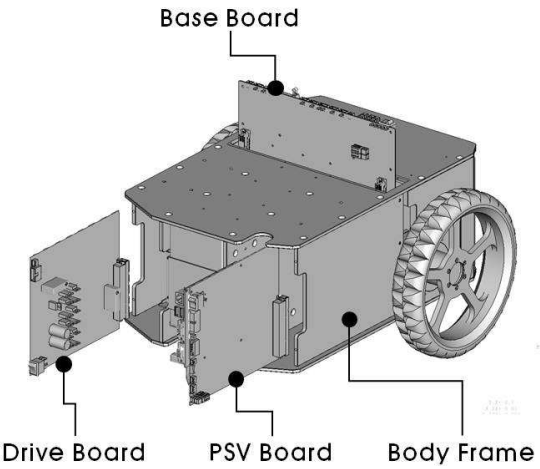


<Diagram 2-1> BASIC model of TETRA-DS IV™

2-1. TETRA-DS IV™ Components

Platform is composed of the body and control boards as shown in the diagram 2-2.

Modular design of the control boards allow for easy maintenance and future upgrade.



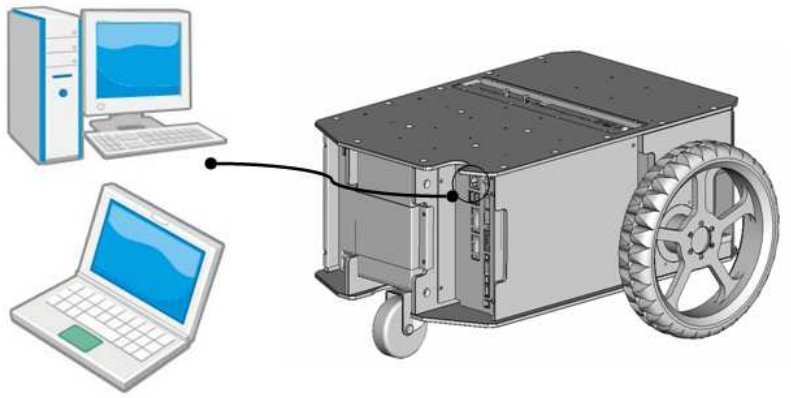
<Diagram 2-2> Components of TETRA-DS IV™

2-2. Connection to TETRA-DS IV™

To operate the platform, Ethernet cable is used to connect the platform to the PC using the Ethernet port at the rear of the platform. Refer to the diagram 2-3.

Installed components are controlled by the provided 'DRSP-HAL (DongbuRobot Software

Platform-Hardware Abstraction Layer) service. DRSP-HAL is a unified TCP/IP communications API which is a type of device driver. Refer to the separately provided 'DRSP-HAL' manual for the details concerning the DRSP-HAL.



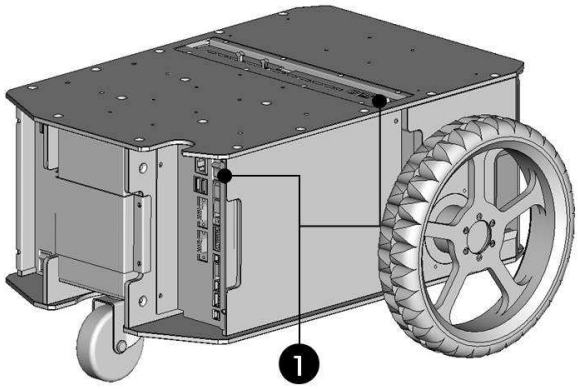
<Diagram 2-3> Connection to TETRA-DS IV™

Chapter 3. Quick Start

Follow the steps outlined below to perform simple basic tests on TETRA-DS IV™ after the purchase.

Step 1. Turning On Main Power Switch

Use the main power switch located at the rear or top of the platform (Diagram 3-1) to turn the main power ON(①). As the switches at the top and rear have Logical OR structure, only one of the switches should be used to turn on the platform power. Unused switch should be set to OUT. When the main power is switched on, status LEDs at the top and rear of the platform light up and the buzzer sounds to notify the user of the robot status. Blinking red status LED and the buzzer sound is an indication of low battery. Use the provided charger to charge the platform battery before proceeding to the next step. Refer to the section 5-1-6 "Battery and Charger" of this manual for more information on using the charger.

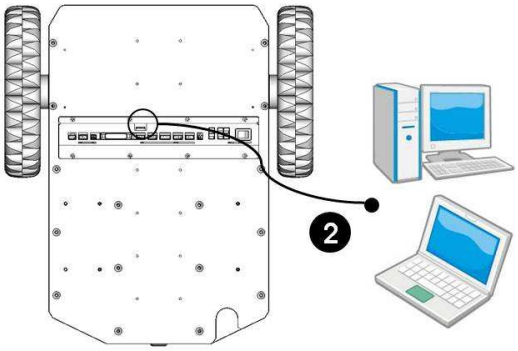


<Diagram 3-1> Turn Main Power Switch ON

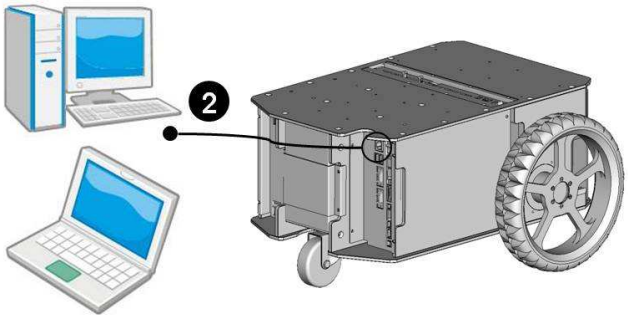
Step 2. Connecting to TETRA-DS IV™

For the basic model, use the USB extension cable (②) to connect the platform to the PC using the USB port at the top of the platform (Diagram 3-2). Basic model comes equipped with 'USB2Serial Converter' to communicate with the controller.

For the model that comes with the Embedded Module(VIA SBC) installed (Diagram 3-3), use the LAN cable(②) to connect the platform to the PC or notebook computer using the Ethernet port at the back of the platform. User must provide the required cable as neither the USB cable or the LAN cable is included with the platform.



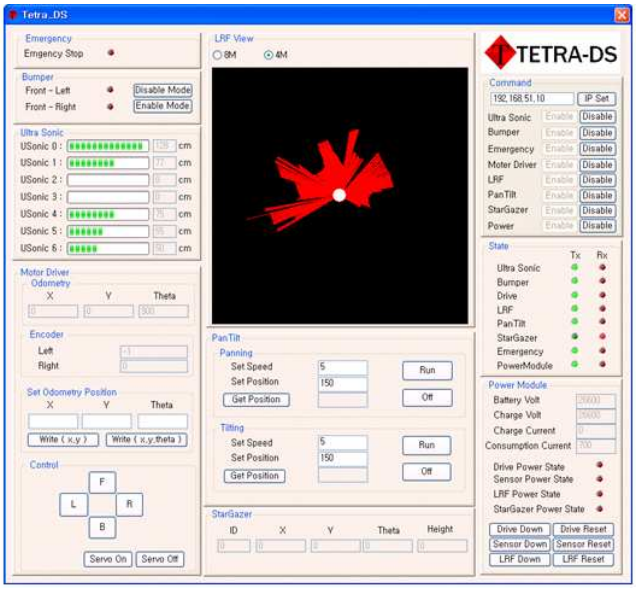
<Diagram 3-2> Connecting to TETRA-DS IV™ with USB Cable



<Diagram 3-3> Connecting to TETRA-DS IV™ with Ethernet Cable (Embedded board)

Step 3. Using PMP to Control TETRA-DS IV™

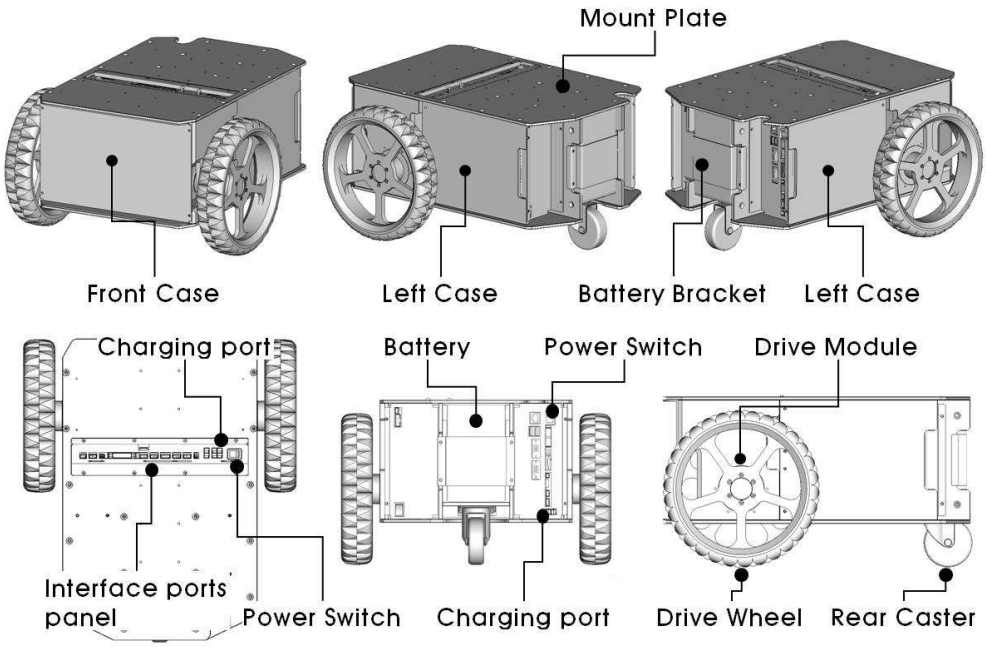
As shown in diagram 3-4, run the included PMP (Platform Management Program) to operate or check platform status. Depending on the version of the program, PMP screen may vary from the diagram 3-4. Provided PMP is for Windows only. Linux is not supported.



<Diagram 3-4> Execute PMP (Windows OS)

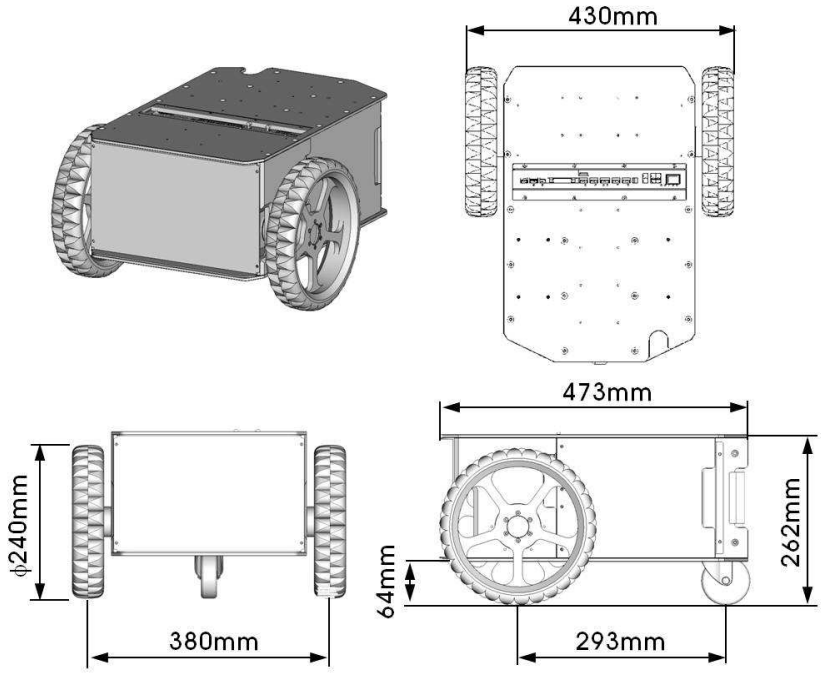
Chapter 4. Mechanical Hardware Specifications

Layout of the TETRA-DS IV™ components are as shown in the diagram 4-1 below. Use of differential drive and high performance AC servo motor provides superior speed and payload handling to the platform. Mounting holes are provided at top of the platform to conveniently attach various sensors and devices utilized for developing autonomous movement software. Rear of the platform contains the interface ports to connect the attached sensors and devices to the controller hardware.



<Diagram 4-1> Components Layout of TETRA-DS IV™

Physical dimensions and the mechanical specifications of the platform are shown in the diagram 4-2 and table 4-1.



<Diagram 4-2> Physical Dimensions of TETRA-DS IV™

<Table 4-1> Mechanical Specifications of TETRA-DS IV™

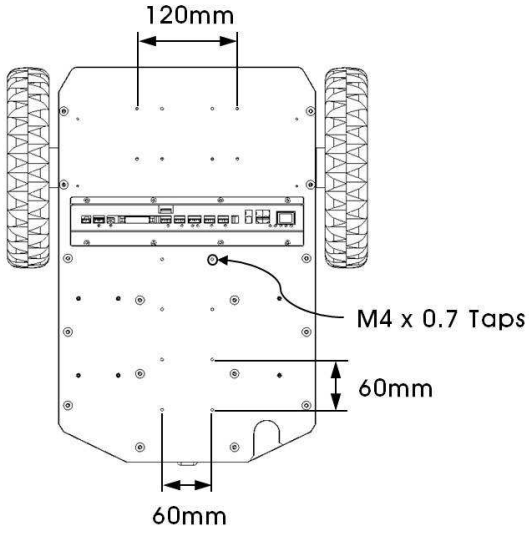
ITEM		SPECIFICATION
Body	Dimension	L473×W430×H262mm
	Weight	about 20kg
Driving Part	Locomotion	2-Wheel Differential Drive (AC Servo Motor)
	Speed	max. 2.0m/s
	Reduction Ratio	15 : 1
	Payload	80kg
	Tread	380mm
	Clearance	64mm
Wheel Part	Diameter	240mm
	Width	50mm

4-1. Components

- Mount Plate
- Motors and Encoders
- Caster

4-1-1. Mount Plate

Various sensors such as laser scanner, position sensors, and other devices utilized for developing autonomous movement software can be mounted on the mount plate at top of the platform. Mount plate has number of pre-drilled mount taps to make attaching various sensors and devices more convenient. Mounting brackets for some of the most common sensors are available for sale separately. Refer to the diagram 4-3 for the dimensions and location of the mount taps.



<Diagram 4-3> Dimensions of Taps on Mount Plate

4-1-2. Motors and Encoders

TETRA-DS IV™ drive system uses an advanced AC servo motors with high speed and torque output. Highly precise optical encoder attached to each servo motor provides advanced ' Dead-Reckoning' through precise speed and position detection. Refer to the table 4-2 for information on drive motor, decelerator, and encoder comprising the drive system.

<Table 4-2> Motor, Reducer & Encoder Specifications of TETRA-DS IV™

ITEM	UNIT	SPECIFICATION
Nominal Power	W	100
Driving Voltage	Vdc	24
Nominal Speed	r/min	3000
Max. Speed	r/min	3000
Encoder	PPR	2500
Pulse per revolution	PPR	10000 (Quadratic)

Reduction Ratio	-	15 : 1

4-1-3. Casters

Casters installed at the rear of the platform are capable of smooth 360 degrees swivel movement, providing stable straight and turning motion to the platform. Caster wheels are made of plastic which may wear out after prolonged use. Contact customer support center to inquire about replacement casters.

<Diagram 4-4> Dimensions of Rear Caster

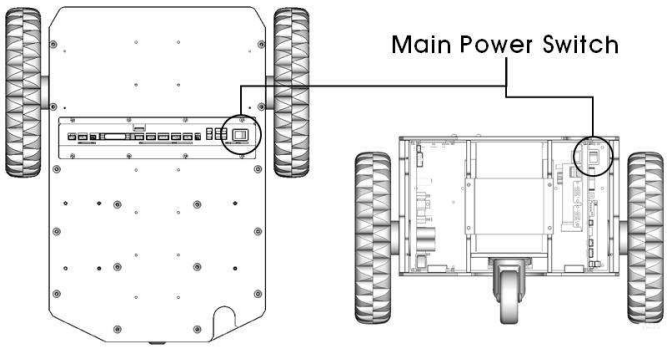
Chapter 5. Electrical Hardware Specifications

5-1. Components

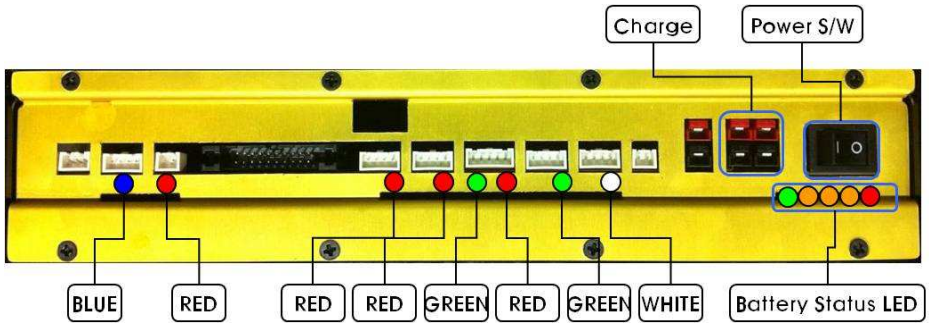
- Main Power Switch
- Emergency Button
- Battery Status LED
- Top Case Interface Ports
- Rear Case Interface Ports
- Battery and Charger

5-1-1. Main Power Switch

Main power switch for turning on and off the platform power is located at the top and rear of the platform as shown in diagram 5-1 below. As the switches at the top and rear have Logical OR structure, only one of the switches should be used to turn on the platform power. Unused switch should be set to OUT. Once the power is switched on, status LEDs light up and Embedded Module starts to boot (only for models with Embedded Module installed). Once the Embedded Module completes the booting process, buzzer will sound (Do,re,mi,fa,sol,ra,si,do) to notify the user booting process has been completed. If red status LED starts to blink and buzzer starts to sound (Do,si,ra,sol.fa,mi,re,do), it is an indication of low battery power. Use the supplied charger to charge the platform battery before operating the platform. Diagram 5-2 below shows the power switch, charging port, and status LEDs located at the top of the platform.



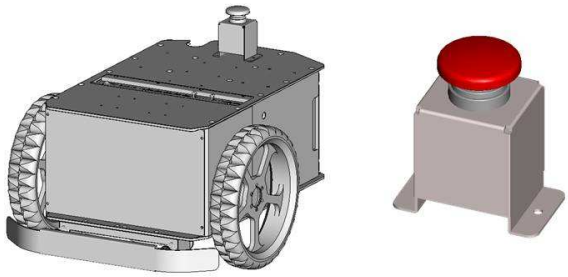
<Diagram 5-1> Main Power Switch



<Diagram 5-2> Status LED (Top)

5-1-2. Emergency Button

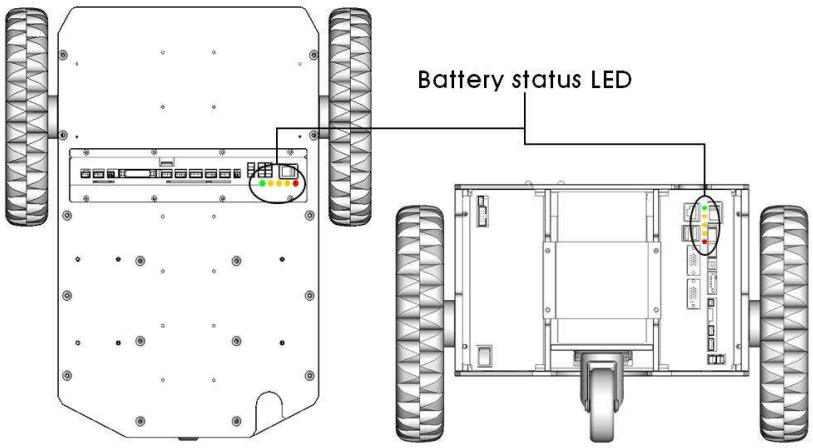
Emergency button located at top of the platform as shown in diagram 5-3 is used in case of an error or to perform various tests that require the drive motors to be stopped. When emergency button is pressed, platform is forced to come to a complete stop and the drive motors will not operate regardless of the commands given. To operate the drive motors normally, turn the emergency stop button clockwise to disengage the emergency stop.



<Diagram 5-3> Emergency Button

5-1-3. Battery Status LED

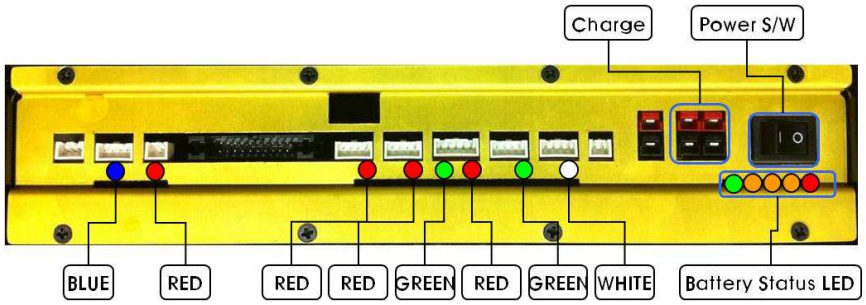
As shown in diagram 5-4, battery status LEDs are located at the top and rear of the platform. 5 LEDs are used to indicate the battery level according to the table 5-1 below. Diagram 5-5 shows the battery status LED when the platform power is on with high battery level. Diagram 5-6 shows the battery status LED when the platform is at Cut-off state due to below the minimum battery level.



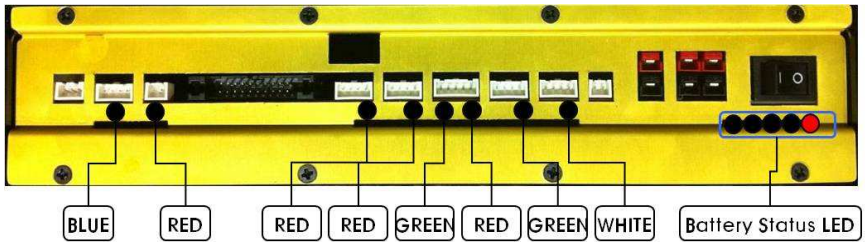
<Diagram 5-4> Battery Status LED

<Table 5-1> Voltage and Status LED Lighting according to Battery Level

Battery Level	Status LED	Voltage	Remarks
100%		28V	
80%		27V	
70%		26V	
60%		25.5V	
50%		25V	
20%		24V	
10%		23V	Yellow,Yellow,Yellow,Red Flicks
5%		22V	Red Flicks, Melody "do, re, mi, fa, sol, la and si, do"
Under 5%		21V	Red Flicks, Cut-Off(Fig. 5-5)



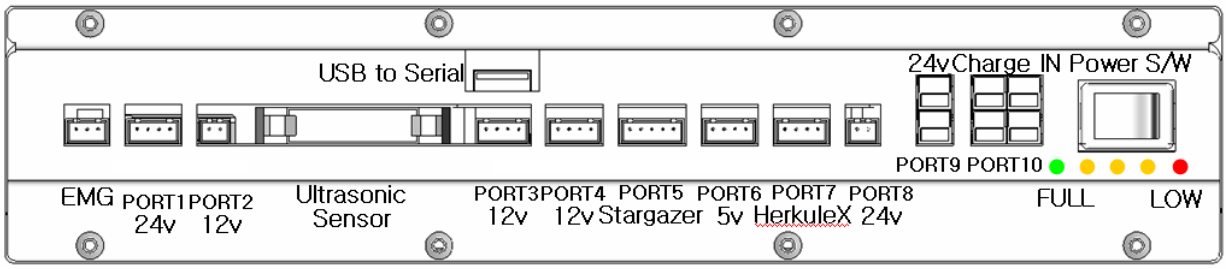
<Diagram 5-5> Power ON with high battery level



<Diagram 5-6> Cut-OFF state

5-1-4. Interface Ports on Top Case

Diagram 5-7 below shows the various interface ports located at top of the platform and the table 5-2 shows the pin map of each interface port.



<Diagram 5-7> Interface Ports on Top Case

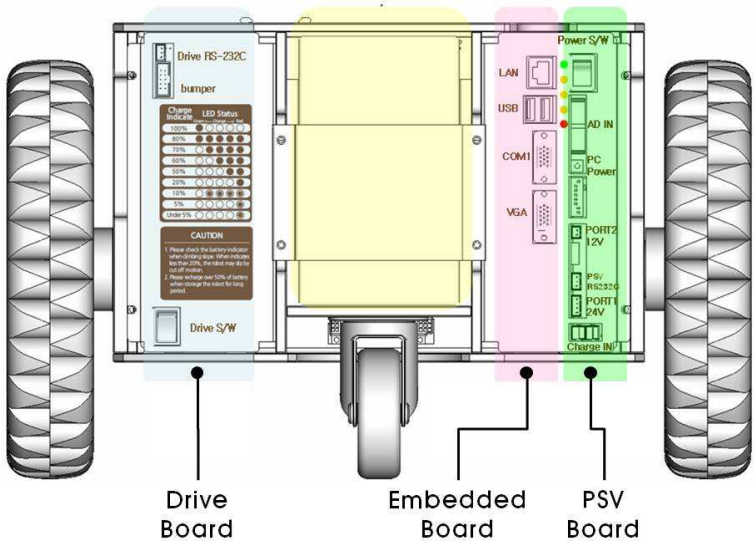
<Table 5-2> Pin Map Information of Ports on Top Case

ITEM	CONNE-CTOR	Pin No.	Pin DESCRIPTION	SPECIFICAT-ION	DEVICE	Power On/Off	Remark
EMG	SAW250 (Yeonho)	1	Signal	EMG	EMG SW	X	
		2	5V	500mA			
		3	GND	GND			
PORT1	SAW250 (Yeonho)	1	22~28V	2A	SBC Power	O	Battery Voltage
		2	22~28V	2A			
		3	GND	GND			
		4	GND	GND			
PORT2	SAW250 (Yeonho)	1	12V	3A	LCD Power	O	
		2	GND	GND			
PORT3	SAW250 (Yeonho)	1	COM6 RXD	RS-232C	12V Device Power	O	P3,P4 Common
		2	COM6 TXD	RS-232C			
		3	12V	1.5A			
		4	GND	GND			
PORT4	SAW250	1	COM5 RXD	RS-232C	12V	O	

	(Yeonho)	2	COM5 TXD	RS-232C	Device Power		
		3	12V	1.5A			
		4	GND	GND			
PORT5	SAW250 (Yeonho)	1	COM7 RXD	TTL	Stargazer Power	O	
		2	COM7 TXD	TTL			
		3	5V	1A			
		4	12V	2A			
		5	GND	GND			
PORT6	SAW250 (Yeonho)	1	COM8 RXD	TTL	5V Device Power	O	
		2	COM8 TXD	TTL			
		3	5V	1A			
		4	GND	GND			
PORT7	SAW250 (Yeonho)	1	COM1 RXD	TTL	HerkuleX Power	O	Connect VIA COM1 port to PSV CN5
		2	COM1 TXD	TTL			
		3	8.1V	1A			
		4	GND	GND			
PORT8	SAW250 (Yeonho)	1	22~28V	2A		X	Battery Voltage
		2	GND	GND			
PORT9	PP15 Anderson	1	22~28V	10A		X	Battery Voltage
		2	GND	GND			
PORT10	PP15 Anderson	1	22~28V	10A	Charge	X	Battery Voltage
		2	22~28V	10A			
		3	GND	GND			
		4	GND	GND			

5-1-5. Interface Ports on Rear Case

As shown in diagram 5-8, rear of the platform contains various ports required for making connections to the Drive Board, Embedded Board, and PSV Board. Table 5-3 shows the pin map of each interface port.



<Diagram 5-8> Interface Ports on Rear Case

<Table 5-3> Pin Map Information of Rear Case Ports and Modules

SECTION	ITEM	CONNECTOR	Pin No.	Pin DESCRIPTION	SPECIFICATION	REMARK
Drive Board	Drive RS-232C	SAW250 (Yeonho)	1	RXD	UART(RS-232C) Comm. port 115200bps	Direct Control using User PC
			2	TXD		
			3	GND		
	Bumper	HIF3-10PA-2.54DS (HIROSE)	1	bumper0	Bumper Signal (Active LOW)	1. 0,1,7 Active - Forward Stop 2. 3,4,5 Active – Backward Stop
			2	bumper1		
			3	bumper2		
			4	bumper3		
			5	bumper4		
			6	bumper5		
			7	bumper6		
			8	bumper7		
			9	15V		
			10	GND		
PSV Board	AD IN	HIF3-10PA-2.54DS (HIROSE)	1	Analog input0	Voltage Range : 0V~5V Resolution : 8bit	Caution! Do not supply over 5V
			2	Analog input1		
			3	Analog input2		
			4	Analog input3		
			5	Analog input4		
			6	Analog input5		
			7	Analog input6		
			8	Analog input7		
			9	5V		
			10	GND		
	PSV RS-232C	SAW250 (Yeonho)	1	RXD	UART(RS-232C) Comm. port 115200bps	Direct Control using User PC
			2	TXD		
			3	GND		
	PORT3	SAW250	1	22v~28v	24V Power	Same as

		(Yeonho)	2	22v~28v	(User PC Power)	PORT1 on Top Case
			3	GND		
			4	GND		
	PORT2	SAW250 (Yeonho)	1	12V	12V Power (LCD Power)	Same as PORT2 on Top Case
			2	GND		

5-1-6. Battery and Charger

TETRA-DS IV™ can be equipped with any one of the three different types of batteries available. Each type of battery requires a matching charger. Specifications for each type of battery and matching charger are shown in the table 5-4 below. Installed battery will eventually die (no longer able to hold charge) after long period of use in the platform. Do not disassemble the dead battery without first contacting our customer support center for instructions. User is entirely responsible for any damages or injuries that may arise from modifying or disassembling the battery. Again, it is important to contact our customer service center for instructions prior to replacing or disassembling the battery.

<Table 5-4> Specifications of Battery and Charger

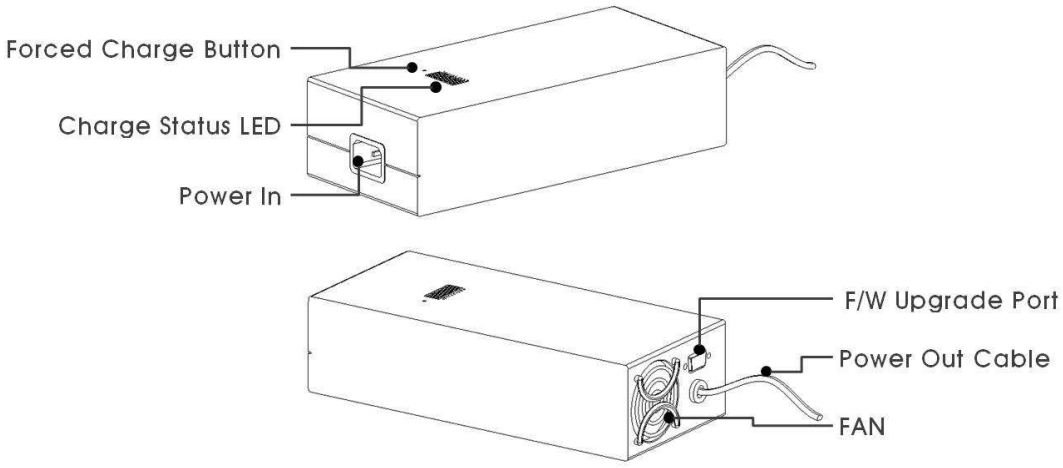
SECTION	ITEM	Lead-acid	Ni-MH	Li-Po
Battery	Weight	4.7kg	3.2kg	5kg
	Nominal Voltage	24V	24V	24V
	Capacity	7Ah	10Ah	20Ah
Charger	Input Voltage	AC 110~220V	AC85~245V	AC100~220V
	Output Voltage	27~29.4V	24~29V	24~29V
	Charge Method	CC/CV	CC/CV	CC/CV
	Power	180W	120W	450W

Battery life will decrease drastically if the battery is used for long period without recharge or if the battery repeatedly becomes completely discharged due to repeated lengthy period of storage. To prevent complete discharge of the battery during lengthy period of storage, battery should first be charged above 50% level and the main power switch turned off before storing. Refer to the charger section below for information on charging completely discharged battery.

Ni-MH Battery Charger

Ni-MH battery charger includes AC 220V power cord and battery charge cable to

charge the Ni-MH battery installed in the platform. Refer to the diagram 5-9 for the charger layout.



<Diagram 5-9> Components Layout of Charger (Ni-MH Battery)

Power In

Connection for 220V AC power cord.

Charge Status LED

Charge status LED shows the status of the charger. LEDs lights up sequentially when charging the battery installed in the platform.

F/W Upgrade Port

Charger firmware upgrade port. Not for use by the consumer.

Charge Cable

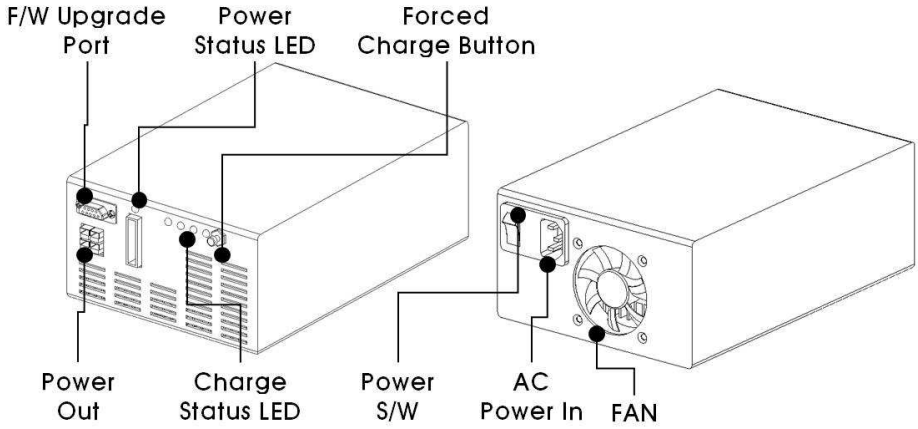
Connects to the battery charge port located at side of the platform.

Press and hold the 'Forced Charge Button' shown in diagram 5-9 to charge completely discharged Ni-MH battery.

Make sure to use only the provided matching charger to charge the battery installed in the platform. Using any other charger may result in damaging the platform voiding the warranty.

Li-Po Battery Charger

Li-Po battery charger includes AC 220V power cord and battery charge cable to charge the Li-Po battery installed in the platform. Refer to the diagram 5-10 for the charger layout.



<Diagram 5-10> Components Layout of Charger (Li-Po Battery)

Power S/W

Charger power switch. Power should be turned on only when charging.

AC Power In

Connection for 220V AC power cord.

Power Status LED

Shows the On/Off state of the charger. LED lights up when charger power is on.

Charge Status LED

LED showing the battery charge status.

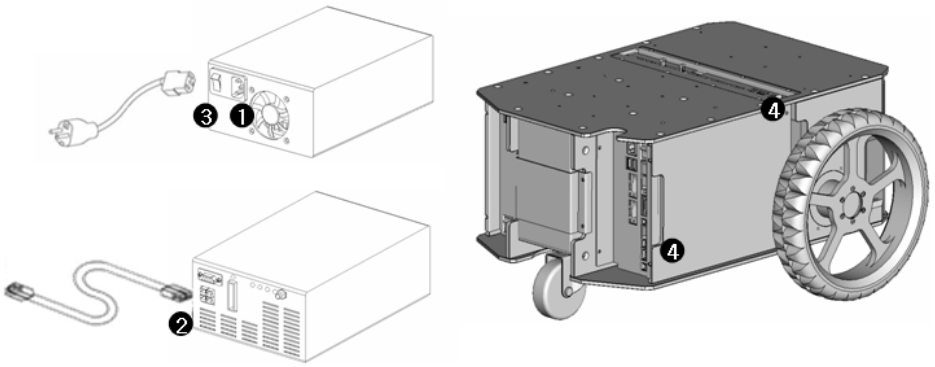
F/W Upgrade Port

Charger firmware upgrade port.

Forced Charge Button

Used for force charging the battery. Forced Charge Button should only be used when force charge is required. Use of unnecessary force charge may cause damage to the platform and void the warranty service.

For normal charge sequence, follow the steps outlined in diagram 5-11.



<Diagram 5-11> Normal Charge Procedures (Li-Po Charger Case)

Step 1.

Connect the 220V AC cord to the charger and plug the other end to the 220V wall socket.

Step 2.

Connect the charger cable to the charger.

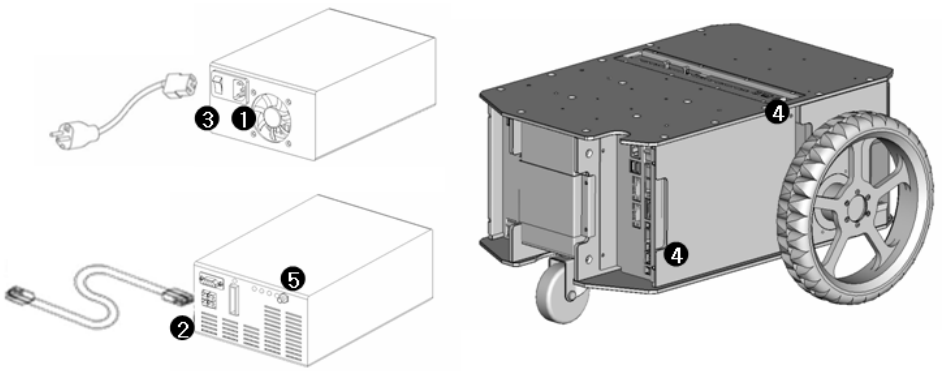
Step 3.

Turn on the charger.

Step 4.

Connect the charger cable to the platform.

Completely discharged battery cannot be charged using normal charging method. To charge completely discharged battery, press and hold the forced charge button and connect the charge cable to the platform to charge. Follow the steps in diagram 5-12 to force charge the battery. Contact customer support center if battery is still not charged even after using force charge method.



<Diagram 5-12> Forced Charge Procedures (In case of Li-Po Battery)

Step 1.

Connect the 220V AC cord to the charger and plug the other end to the 220V wall socket.

Step 2.

Connect the charger cable to the charger..

Step 3.

Turn on the charger.

Step 4.

Press and hold the forced charge button on the charger.

Step 5.

Connect the charger cable to the platform.

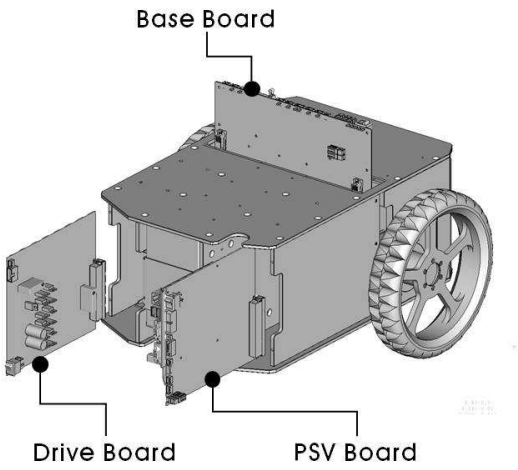
Make sure to use only the provided matching charger to charge the battery installed in the platform. Using any other charger may result in damaging the platform voiding the warranty.

Chapter 6. Control Hardware Specifications

All TETRA-DS IV™ models have our modular DRCP (DongbuRobot Control Hardware Platform) installed. Form factor and modular design of the control boards allow the boards to fit into the slots in the DRCP, providing easy maintenance and expansion capability. Damaged board can be simply taken out for repair or replacement.

6-1. DRCP Components of DRCP

Components of modular control hardware platform DRCP is shown in diagram 6-1 below. Dirve board and the PSV board connects to the Base board using the internal slots in the platform. PSV board is a PS(Power&Sensor) board and Embedded Board combined into one single board.



<Diagram 6-1> Components of DRCP

6-2. Components

- Embedded Board
- PSV Board
- Drive Board
- BASE Board

6-2-1. VIA Embedded Board

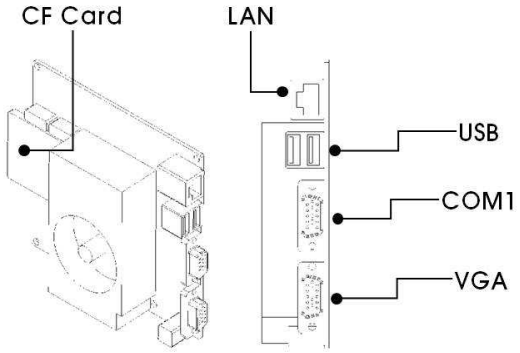
Main control board operates on Linux OS and runs unified communications service DRSP-HAL to control various devices installed in the platform. Refer to table 6-1 below for board

specifications.

<Table 6-1> Specifications of the VIA Embedded Board

ITEMS	SPECIFICATIONS
SBC	VIA SBC(EPIA-N800)
HDD	8G CF Card
RAM	DDR2 1G
Serial	RS-232C – 4 Ports
USB	4 Ports
RJ45(LAN)	1 Ports
OS	Ubuntu

Diagram 6-2 below shows the ports comprising the VIA Embedded Board.

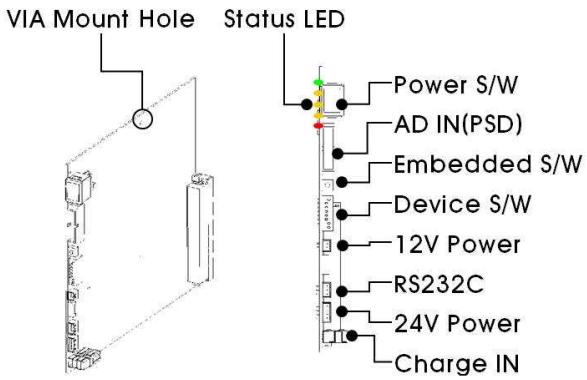


<Diagram 6-2> Components Layout of VIA Embedded Board

Refer to the manufacturers' website (www.viaembedded.com) for technical details on VIA SBC.

6-2-2. PSV Board

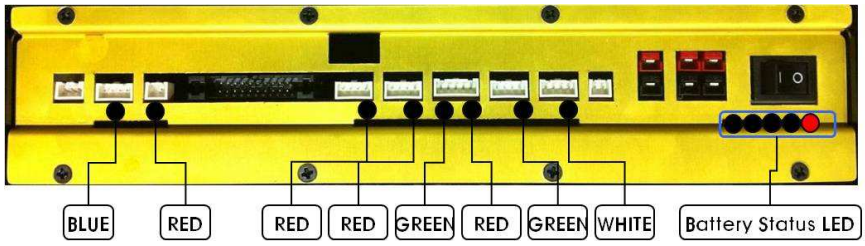
Power/Sensor board supplies power to the various devices installed on the platform, turns drive board power on and off, monitors and manages power usage. PSV board also collects and transmits data from the installed sensors such as the ultrasonic sensor and PSD sensor. Diagram 6-3 below shows the layout of the PSV board.



<Diagram 6-3> Components Layout of PSV Board

Cut-OFF

Platform contains Cut-Off function to prevent the installed battery from discharging completely. Cut-Off function activates when the battery voltage falls below 21.5V and cuts power to all devices other than the PSV Main MCU. Use the matching battery charger to charge the battery when Cut-Off becomes activated. Power S/W has to be turned off and back on for the platform to function normally after the Cut-Off.



<Diagram 6-4> Cut-OFF Status of TETRA-DS IV™

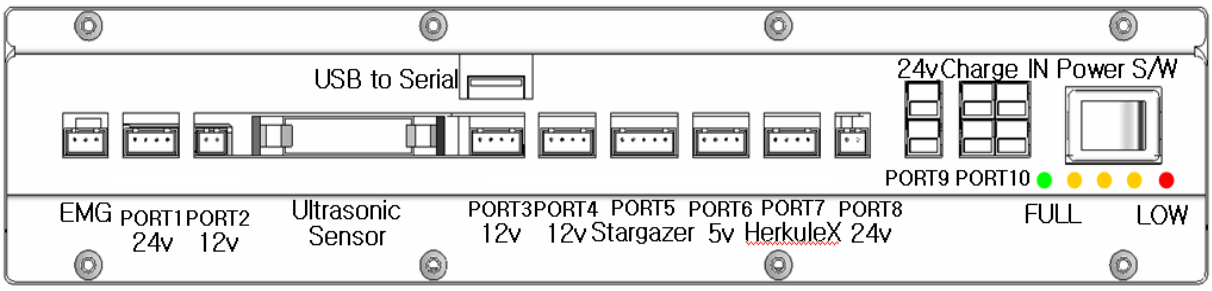
Device Power Switch

Device power switch is used to power on/off various devices installed on the platform. If the switch is ON, VIA embedded board is able to power on/off the connected devices. If the power switch is OFF, power to the connected devices are cut off and VIA embedded board is not able to power on/off the devices. Table 6-2 shows the devices related to each switch.

<Table 6-2> Peripheral Devices Power ON/OFF Selection Switches

S/W No.	Related Device	CONTENTS
S/W 1	PORT6,Ultrasonic Sensor Module	5V,12V
S/W 2	PORT5(Stargazer Module)	5V,12V

S/W 3	PORT3,PORT4	12V
S/W 4	PORT7(HerkuleX)	8.1V
S/W 5	Reserved	If ON, can't control Power PORT2
S/W 6	PORT1(SBC)	24V
S/W 7	Reserved	
S/W 8	Reserved	



<Diagram 6-4> Interface Ports on Top Case

RS-232C Port

Serial port used for communicating with the VIA embedded board. Communication is by RS-232C at baudrate of 115,200bps. Refer to the Chapter 9-2 for more information on PSV board control command protocols.

Various functions are offered by the PSV board through the 'Power Service' and 'Sensor Service' portion of the provided DRSP-HAL service. Refer to the separate DRSP-HAL operating manual for more detailed information.

6-2-3. Drive Board

Drive board controls the high performance AC servo motors installed in the platform and also coordinates input from the bumper sensor and the emergency stop button to work together with the servo motors to provide increased level of safety to the platform motion. Refer to table 6-3 for drive board specifications and table 6-4 for AC servo motor specifications.

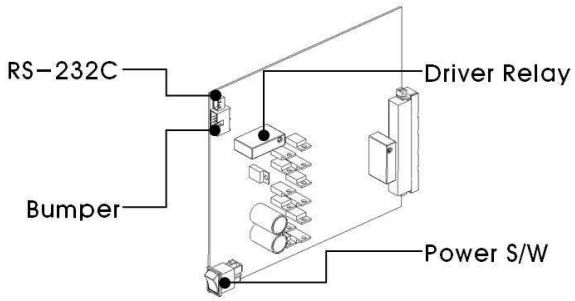
<Table 6-3> Specifications of Drive Board

ITEMS	SPECIFICATION
Input Voltage	DC 24V, +10% ~ -15%

Motor	AC Servo Motor			
Max. Motor No.	2 Axis			
Control Type	PWM Voltage Control			
Feedback	Encoder (Voltage Input Type)			
Input Command	Communication with PC/Controller			
Communication	RS-232C (115200bps)			
Protection	Tracking error, Emergency Stop, Overvoltage, Undervoltage, Overload			
Alarm	Motor Power off if Alarms occur (Relay control)			
W×D×H	210mm × 180mm × 25mm			
Peripheral	Sub-ITEM	No.	Type	Range(V)
	No. Bumper Input	8	Buffer IN	Active LOW LOW : 0, HIGH : 3
	EMG	1	Photo-coupler IN	Active LOW LOW : 0, HIGH : 3

<Table 6-4> Specifications of AC Servo motor

ITEMS	UNIT	SPECIFICATION
Flange Size	mm	60
Rated Output	kW	0.1
Poles	-	8
Rated Speed	r/min	3000
Maximum Speed	r/min	5000
Rated Torque	N·m	0.32
	kgf·cm	3.24
Rated Currnet	$A_{(rms)}$	6.2
Phase Resistance	Ω	0.128
Phase Inductance	mH	0.3
Encoder	-	15 wire 2500PPR
Weight	kg	0.78
Driving Voltage	V dC	24



<Diagram 7-7> Components Layout of Drive Board

Power S/W

Drive board power on/off switch is initially set to on position. When the switch is set to on position, embedded board is able to turn on/off power to the drive board. If the switch is set to off position, power to the drive board is disconnected and power control through embedded board does not become possible. Check the power switch setting if the drive motors are not operational when the platform is being controlled through the embedded board.

RS-232C Port

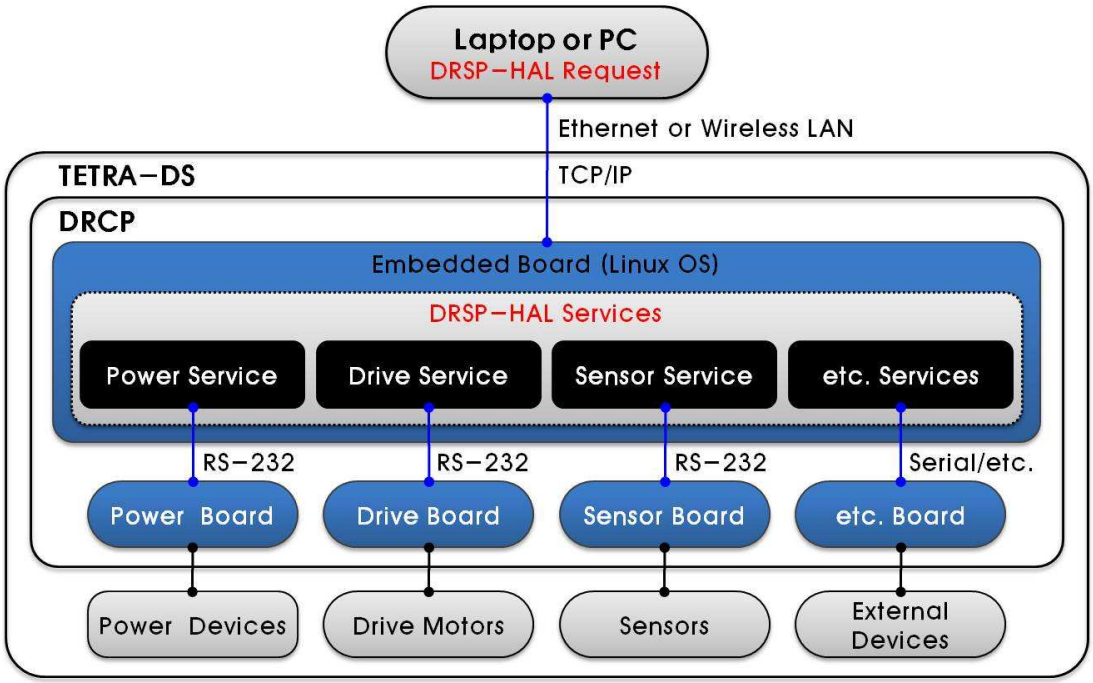
Serial port used for communicating with the VIA embedded board. Communication is by RS-232C at baudrate of 115,200bps. Refer to the Chapter 9-3 for more information on drive board control command protocols.

Various functions are offered by the drive board through the 'Driver Service' portion of the provided DRSP-HAL service. Refer to the separate DRSP-HAL operating manual for more detailed information.

Chapter 7. Control Scheme

7-1. Control Schematic Diagram

TETRA-DS IV™ is controlled by the DRSP-HAL service through unified TCP/IP communications protocol. Diagram 7-1 shows the platform control schematic.



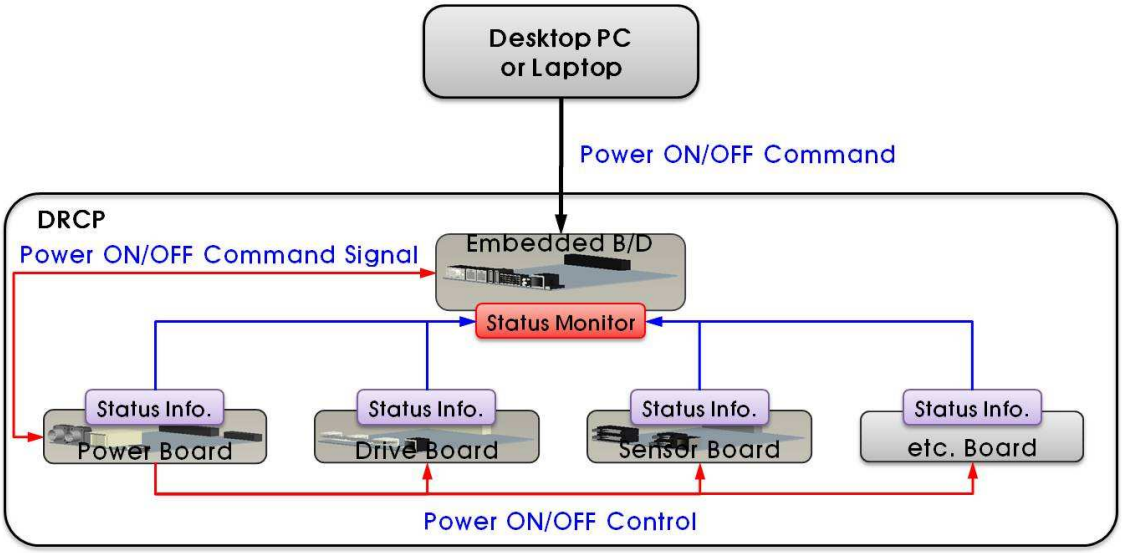
<Diagram 7-1> Control S/W Schematic Diagram

As shown in diagram 7-1, platform communicates with the PC or notebook computer through the LAN cable or wireless LAN using only TCP/IP protocol. When DRSP-HAL request is sent from the PC or the notebook computer, command is sent through the DRSP-HAL service in the embedded board installed in the DRCP to the relevant lower level board. Once the command is received by the lower level board, attached device is approached and commanded task performed. Various boards and devices comprising the DRCP communicates with the embedded board through serial or other device supported communications protocol.

7-2. Power Control Schematic Diagram

To accommodate certain situations where power to the devices installed in the platform need to be controlled individually, DRCP installed in the platform has been designed with the capability to control the power to installed boards individually through the DRSP-HAL service. As shown in the diagram 7-2, command to turn on/off power to the specific device is sent

from the PC or notebook computer to the embedded board in the DRCP through the DRSP-HAL service. The command is then sent from the embedded board to the PSV board which in turn controls the power to the connected boards and related devices.



<Diagram 7-2> Power Control Schematic Diagram (Embedded Board Installed Model)

Refer to the separate DRSP-HAL operating manual for more detailed information.

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Chapter 8. Accessories & Optional Parts

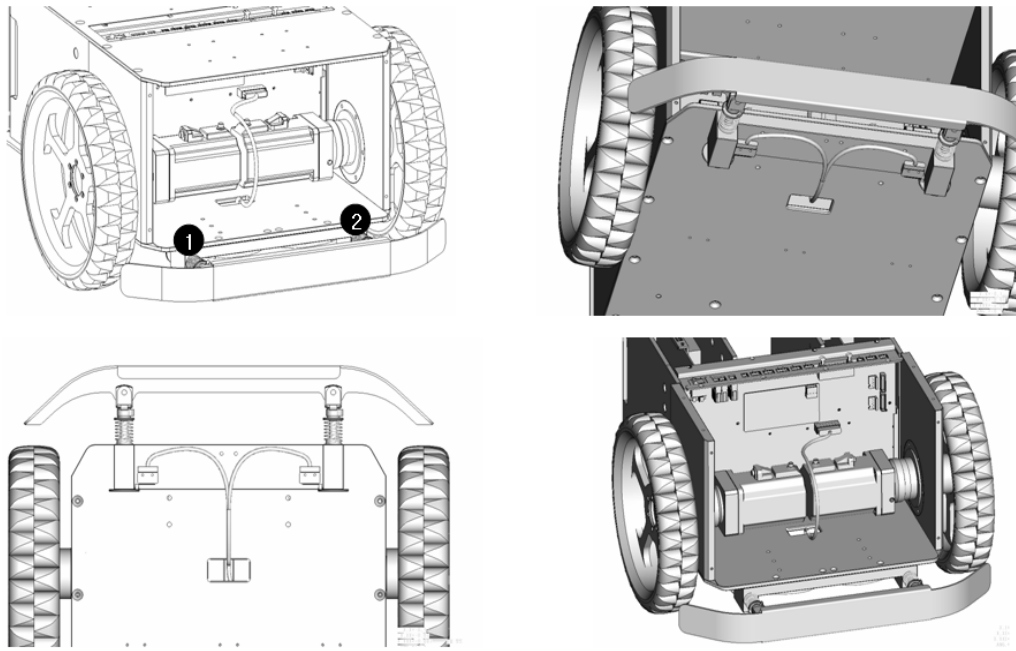
TETRA-DS IV™ supports variety of sensors required for development of autonomous navigational software. Most of the common sensors used for software development can be selected and ordered as optional part at the time of order. As DRSP-HAL service is provided for the option parts, they can be easily utilized when developing autonomous navigation software for the platform. Refer to the separate DRSP-HAL operating manual for more detailed information.

Option parts supported by the platform are as follows..

8-1. Bumper Sensor Module

Bumper mechanism for detecting collision is offered as option part. When sensors detect a collision, it is able to determine the location of the obstacle by dividing the collision position into three distinct areas. Bumper mechanism has two micro switches that act as sensors. Location of the bumper sensors are as shown in diagram 8-1 below. When collision occurs with an obstacle, location of the collision is determined by combining signals from two micro switches. Refer to the micro switch positions in diagram 8-1 when using DRSP-HAL service to process data from the bumper sensors.

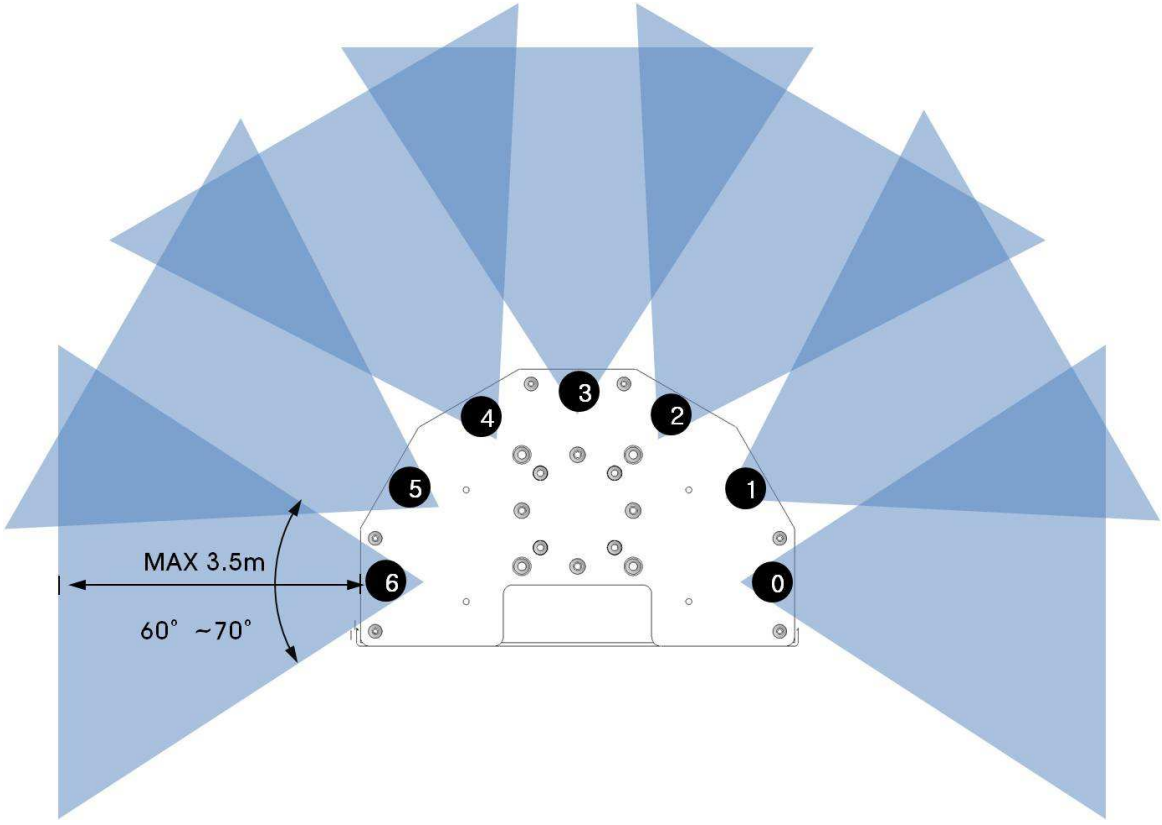
Refer to the separate DRSP-HAL operating manual for more detailed information.



<Diagram 8-1> Bumper Sensors Configuration

8-2. Ultrasonic Sensors Module

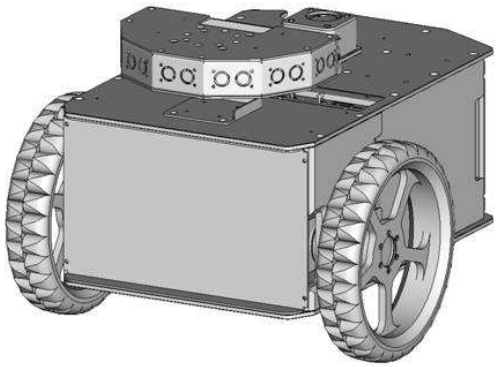
Ultrasonic sensor module is available as option part for detecting nearby obstacles. Diagram 8-2 below shows the ultrasonic sensors installed in half circular pattern.



<Diagram 8-2> Angle and maximum distance of Ultrasonic Sensors

There are total of 7 ultrasonic sensors installed in the module in half circular pattern. Diagram 8-2 shows the location of each sensor and diagram 8-3 shows the image of the platform with the ultrasonic sensor module installed at the top. Refer to the sensor positions in diagram 8-2 when using DRSP-HAL service to process data from the ultrasonic sensors.

Refer to the separate DRSP-HAL operating manual for more detailed information.



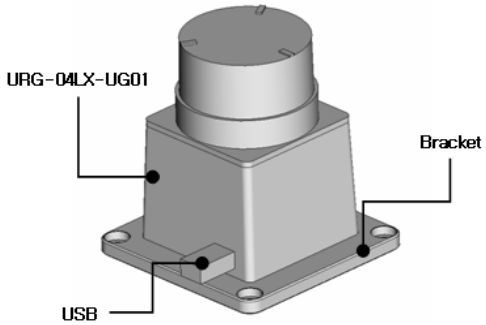
<Diagram 8-3> Ultrasonic Sensors Module of TETRA-DS IV™

8-3. Laser Rangefinder

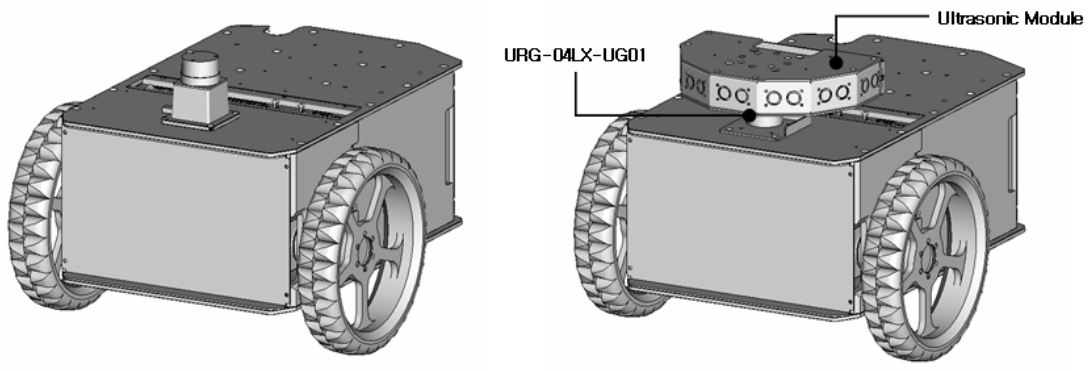
Mounting brackets are available as option part for laser rangefinders. Laser rangefinders are used to measure the distance to an obstacle around the TETRA-DS IV™ platform. Two officially supported laser rangefinder models are HOKUYO URG series and SICK LMS100 series.

8-3-1. HOKUYO URG-04LX-UG01

Diagram 8-4 below shows the HOKUYO URG-04LX-UG01 laser rangefinder. URG-04LX-UG01 supported by the platform as option part can be installed on the platform by either of the method shown in diagram 8-5. URG-04LX-UR01 mounting bracket should be removed if it is being installed together with the ultrasonic sensor module. Position of the URG-04LX-UG01 will be reversed if it is being installed on the ultrasonic sensor module. Refer to the separate DRSP-HAL operating manual for information on DRSP-HAL service for URG-04LX-UG01.



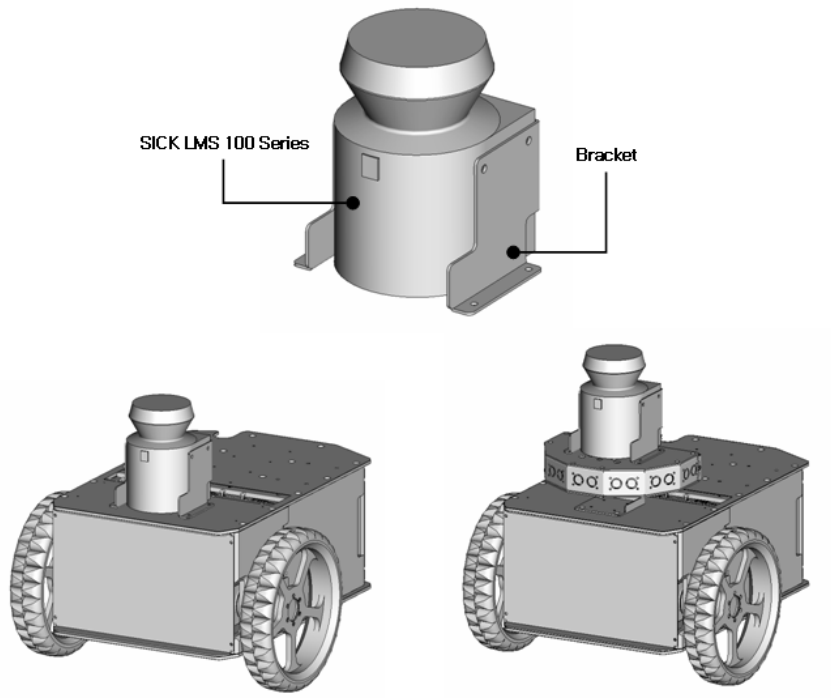
<Diagram 8-4> Option Part – HOKUYO URG-04LX-UG01



<Diagram 8-5> TETRA-DS IV™ URG-04LX-UG01 Module is installed in the appearance

8-3-2. SICK LMS100 Series

Diagram 8-6 shows the SICK laser scanner LMS100 Series mounting bracket and the laser scanner installed on the platform. Refer to the separate DRSP-HAL operating manual for information on DRSP-HAL service for LMS100 series laser scanner.

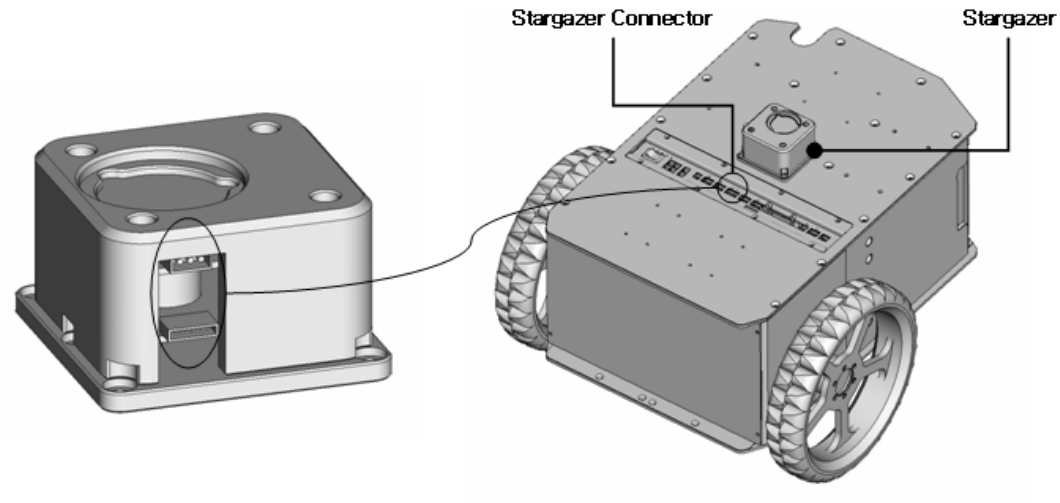


<Diagram 8-6> Option Part – SICK LMS100 Series

8-4. Absolute Localization Sensor

Mounting bracket is available as option part for the HAGISONIC StarGazer. StarGazer is an absolute localization sensor which can be utilized for developing autonomous navigation software for TETRA-DS IV™.

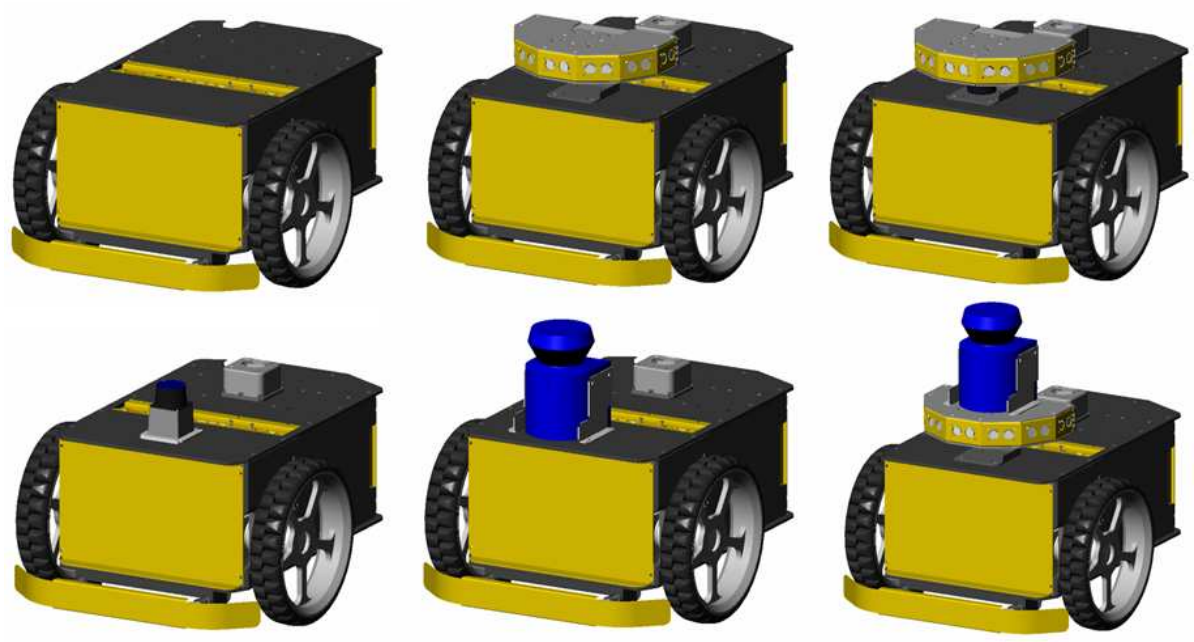
Diagram 8-7 shows the platform with the option part StarGazer installed. Refer to the separate DRSP-HAL operating manual for information on DRSP-HAL service for the StarGazer.



<Diagram 8-7> Option Part – HAGISONIC StarGazer™

8-5. Combination of Option Parts

As shown in diagram 8-8, various option parts can be combined and installed on the platform according to the needs of the user.



<Diagram 8-8> Several Combinations of Option Parts

Chapter 9. Control Hardware Protocol

9-1. Rules of Communication

Most of the data is transmitted using ASCII Code (Some DATA Packets are in Binary format). Each communications packet is composed of STX, DATA, ETX, and LRC. Multiple data within the same packet are separated by ' ; ' (0x3b).(excluding some commands)

ITEMS	CONTENTS
STX	0x02
ETX	0X03
LRC	STX, LRC exclusive-OR LRC = DATA[0]^DATA[1]^....^DATA[N]^ETX

9-2. Communications Packet Operation Methods

Packet contains following FLAG values in response to requests from control boards.

9-2-1 FLAG – 0x30 : OK

Requested protocol completed and reply from the control board shows no error.

9-2-2 FLAG – 0x31 : Protocol ERROR

Reply from the control board when error is detected in the request protocol.

Examples

- When function requested does not exist
- Value beyond range
- Incorrect data packet length.
-

9-2-2 FLAG – 0x32 : FAIL

Value received when there is a failure performing the requested command. Communication will be terminated after the party receiving the 0x32 sends ACK packet. Specific protocol can be used to receive more detailed information on the error.

9-3. PSV Board Protocol

<Table 9-1> Protocol commands summary of PSV Board

ITEMS	DATA Type	COMMAND	CONTENTS
Power status Read	ASCII	PDR	Request Power Status
Cumulative current Read	HEX	PIC	Request Cumulative Current (1000 data)
Cumulative voltage Read	HEX	PIV	Request Cumulative Voltage (1000 data)
Cumulative buffer erase(V,I)	ASCII	PIE	Initialize Cumulative Voltage/Current
Cumulative Sampling time setting	ASCII	PIT	Set Sampling time for Cumulative Voltage/Current
LED status command	ASCII	PLC	Set Status LED
Melody command	ASCII	PME	Output Specified Melody
Drive Power	ASCII	PA1	Drive Module ON/OFF
Sensor Power	ASCII	PA2	PORT6,Ultrasonic ON/OFF
PORT3,PORT4 Power	ASCII	PA3	PORT3,PORT4 (Scanner) ON/OFF
PORT1 Power	ASCII	PA4	PORT1(SBC) ON/OFF
PORT5 Power	ASCII	PA6	PORT5(Stargazer) ON/OFF
Embedded Power	ASCII	PA7	Embedded Module ON/OFF (12V)
PORT2 Power	ASCII	PB2	PORT2(LCD) ON/OFF
PORT7 Power	ASCII	PB3	PORT7(HerkuleX) ON/OFF
Sensor Data Read	HEX	Sar	Ultrasonic Sensor(7EA), Analog Input(8bit, 8EA)
Version Read	ASCII	VER	Version Information

9-3-1 Power status Read

Shows the platform battery voltage, consumption current, and power on/off state of various ports.

Transmitter	STX	P	D	R	ETX	LRC
Receiver	STX	D0	;	D1	;	D2	;	D3	;	D4	;	D5	;	D6	;	D7	;	D8	ETX	LRC

DATA	CONTENTS
D0	Battery Voltage (100mV)
D1	0
D2	0
D3	System Current (100mA)
D4	0

D5	0			
D6	BIT3	BIT2	BIT1	BIT0
	PORT1	PORT3,PORT4	PORT6,Ultrasonic	Drive
D7	BIT3	BIT2	BIT1	BIT0
	0	Embedded	PORT5 (Stargazer)	0
D8	BIT3	BIT2	BIT1	BIT0
	0	PORT7 (HerkuleX)	PORT2 (LCD)	0

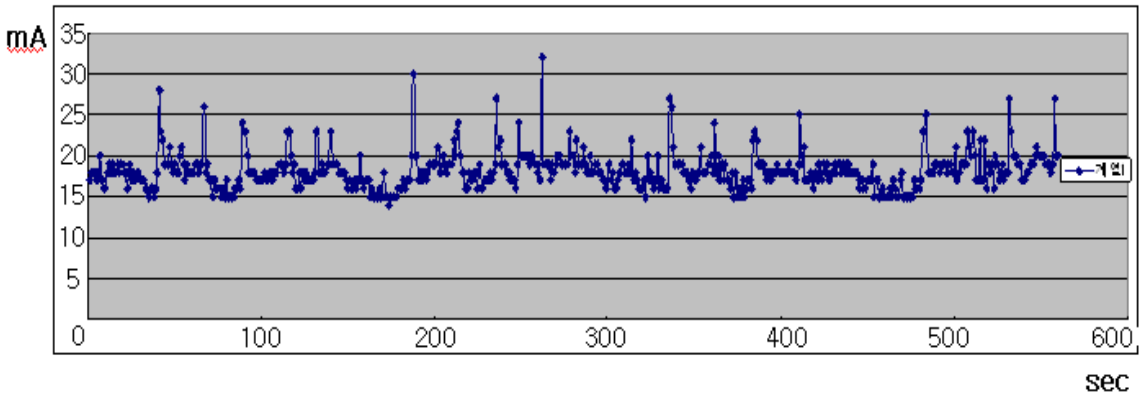
Example)

Transmitter	**STX**	**P**	**D**	**R**	**ETX**	**LRC**						
Receiver	**STX**	**0x32**	**0x36**	**0x32**	**0x3b**	**0x30**	**0x3b**	**0x30**	**0x3b**	**0x34**	**0x3b**	
		2	6	2	;	0	;	0	;	4	;	
		0x30	**0x3b**	**0x30**	**0x3b**	**0x31**	**0x34**	**0x3b**	**0x36**	**0x3b**	**0x36**	**ETX**	**LRC**
		0	;	0	;	1	4	;	6	;	6		

DATA	CONTENTS			
D0	Battery Voltage 26.2V			
D1	0			
D2	0			
D3	System Current 400mA			
D4	0			
D5	0			
D6	BIT3	BIT2	BIT1	BIT0
	PORT1 ON	PORT3,PORT4 ON	PORT6 ON	Drive OFF
D7	BIT3	BIT2	BIT1	BIT0
	0	Embedded ON	PORT5 ON	0
D8	BIT3	BIT2	BIT1	BIT0
	0	PORT7 ON	PORT2 ON	0

9-3-1 Cumulative current Read

Platform saves the consumption current data at specified time intervals. Sampling time which is initially set to 500msec can be changed by a specific command. 1Byte is reserved for each data and total of 1,000 data can be saved. Data is saved in FIFO(First In First Out) format. Saved data can be used to monitor the platform current consumption as shown in diagram 10-1.



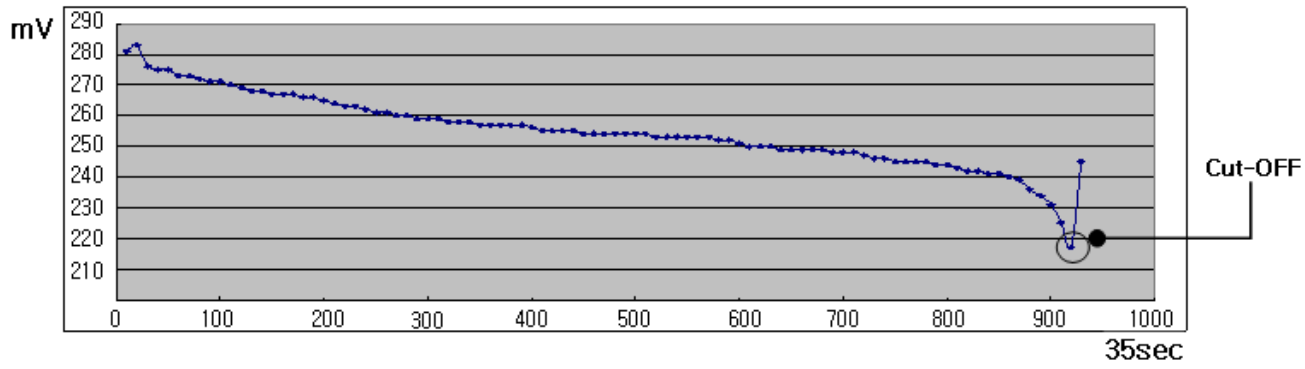
<Diagram 9-1> Current consumption graph

Transmitter	**STX**	**P**	**I**	**C**	**ETX**	**LRC**						
Receiver	**STX**	**N1**	**N0**	**D0**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	
				D8	**D9**	**D10**	**D11**	**D12**	**D13**	**D14**	**D15**	
				D16	**D17**	**D18**	**D19**	**D20**	**D21**	**D22**	**D23**	
							:					
							:					
				D976	**D977**	**D978**	**D979**	**D980**	**D981**	**D982**	**D983**	
				D984	**D985**	**D986**	**D987**	**D988**	**D989**	**D990**	**D991**	
				D992	**D993**	**D994**	**D995**	**D996**	**D997**	**D998**	**D999**	**ETX**	**LRC**

DATA	CONTENTS
N0	Number of Data low byte (HEX)
N1	Number of Data high byte (HEX)
D0~D999	Cumulative current DATA (HEX), Unit : mA

9-3-2 Cumulative voltage Read

Platform saves the battery voltage data at specified time intervals. Sampling time which is initially set to 500msec can be changed by a specific command. 1Byte is reserved for each data and total of 1,000 data can be saved. Data is saved in FIFO(First In First Out) format. Saved data is used to monitor the battery voltage levels as shown in diagram 10-2. Actual voltage value is DATA+100. For example, if the data value is 0x95, actual voltage value is 0x95(HEX)+100(DEC) = 249(DEC) = Battery voltage 24.9V.



<Diagram 9-2> Voltage consumption graph

Transmitter	STX	P	I	V	ETX	LRC					
Receiver	STX	N1	N0	D0	D1	D2	D3	D4	D5	D6	D7
				D8	D9	D10	D11	D12	D13	D14	D15
				D16	D17	D18	D19	D20	D21	D22	D23
							:				
							:				
				D976	D977	D978	D979	D980	D981	D982	D983
				D984	D985	D986	D987	D988	D989	D990	D991
				D992	D993	D994	D995	D996	D997	D998	D999	ETX	LRC

DATA	CONTENTS
N0	Number of Data low byte(HEX)
N1	Number of Data high byte(HEX)
D0~D999	Cumulative voltage DATA (HEX) - 100, Unit : mV

9-3-3 Cumulative buffer erase

Initializes PSV board cumulative voltage and current data buffer.

Transmitter	STX	P	I	E	ETX	LRC
Receiver	STX	FLAG	ETX	LRC		

9-3-4 Cumulative sampling time setting

Set platform battery voltage and consumption current sampling time. Value range 1~99.

Transmitter	STX	P	I	T	C1	C0	ETX	LRC
Receiver	STX	FLAG	ETX	LRC				

ITEMS	CONTENTS
C0	1 digit(500msec)
C1	2 digit (500msec)

Example) Set sampling time to 5sec

Transmitter	STX	P	I	T	1	0	ETX	LRC
	0x02	0x50	0x49	0x54	0x31	0x30	0x03	0x4f
Receiver	STX	0	ETX	LRC				
	0x02	0x30	0x03	0x33				

9-3-5 LED Status Command

Command used to controls the platform status LED.

Shows battery status at power on.

Transmitter	STX	P	L	C	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	LED Status				
	LED0	LED1	LED2	LED3	LED4
0	LED changes according to battery voltage				
1	OFF	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	OFF	ON
3	OFF	OFF	OFF	ON	OFF
4	OFF	OFF	ON	OFF	OFF
5	OFF	ON	OFF	OFF	OFF
6	ON	OFF	OFF	OFF	OFF
7	ON	OFF	OFF	OFF	ON
8	OFF	ON	OFF	ON	OFF
9	ON	ON	ON	ON	ON

9-3-6 Melody command

Command used to set platform buzzer melody.

Transmitter	STX	P	M	E	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	Buzzer Melody
0	Buzzer OFF
1	Do(4), Re, Mi, Fa, Sol, Ra, Si, Do(5)
2	Do(5), Si, Ra, Sol, Fa, Mi, Re, Do(4)
3	Mi, Re#, Mi, Re#, Mi, Si, Re, Do, Ra
4	Sol, Sol, Ra, Ra, Sol
5	Do(4), Mi, Sol, Do(5)
6	Do(4)
7	Mi
8	Sol
9	Do(5)

9-3-7 Drive power

Controls drive board input power.

Transmitter	STX	P	A	1	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-8 Sensor power

Controls ultrasonic sensor module power and turns on/off Port6 5V power.

Transmitter	STX	P	A	2	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-9 PORT3, PORT4 power

Turns on/off PORT3 and PORT4 12V power.

Transmitter	STX	P	A	3	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-10 PORT1 power

Turns on/off PORT1 input power. PORT1 voltage is equal to battery voltage.

Transmitter	STX	P	A	4	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-11 PORT5 power

Turns on/off PORT5 5V and 12V input power.

Transmitter	STX	P	A	6	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-12 Embedded board power

Turns on/off Embedded board input power.

Transmitter	STX	P	A	7	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-13 PORT2 power

Turns on/off PORT2 12V input power.

Transmitter	STX	P	B	2	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-14 PORT7 power

Turns on/off PORT7 8.1V input power. PORT7 can be used to power our HerkuleX smart servo.

Transmitter	STX	P	B	3	DATA	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

DATA	CONTENTS
0	OFF
1	ON

9-3-15 Sensor Data Read

Read data from the ultrasonic sensor module and analog input port. Make sure analog port input voltage does not exceed 5V as it may cause damage to the platform.

Transmitter	STX	S	a	r	ETX	LRC							
Receiver	STX	N	U0_H	U0_L	U1_H	U1_L	U2_H	U2_L	U3_H	U3_L			
			U4_H	U4_L	U5_H	U5_L	U6_H	U6_L	0	0			
			S0	S1	S2	S3	S4	S5	S6	S7			
			L0	L1	L2	L3	L4	L5	L6	L7			
			AD0	AD1	AD2	AD3	AD4	AD5	AD6	AD7	ETX	LRC	

DATA	CONTENTS
N	Number of Data (HEX)
U0 ~ U6	#0 sensor ~ #6sensor Ulatrasonic sensor DATA (HEX)
S0 ~ S7	Distance DATA(HEX), Unit : cm when Sharp PSD 2Y0A21(10cm~80cm) is connected to analog input port.
L0 ~ L7	Distance DATA(HEX), Unit : cm when Sharp PSD 2Y0A02(20cm~150cm) is connected to analog input port
AD0 ~ AD7	DATA(HEX) shown in 8bit(0~255) when 0V~5V value is entered into Analog Input port **Caution!! Input exceeding 5V may cause damage to the platform.**

9-3-16 Version Read

Command to read PSV board version data.

Transmitter	STX	V	E	R	ETX	LRC											
Receiver	STX	D0	;	D1	;	D2	;	D3	;	D4	;	D5	;	D6	;	D7	ETX	LRC

DATA	CONTENTS
D0	Module type (1:Drive Module 2:PSV Module)
D1	yr 2 digit
D2	yr 1 digit
D3	month 2 digit
D4	month 1 digit
D5	date 2 digit
D6	date 1digit
D7	Version

9-4. Drive Board Protocol

<Table 9-2> Protocol commands summary of Drive Board

ITEMS	DATA Type	COMMAND	CONTENTS
Drive Status Read	ASCII	AA	Error Exist, Motor Power On/Off, In Position motion Patten Run State, Servo On/Off
Encoder Position Read	ASCII	AC0	Read current encoder data (Encoder)
Coordinates Read	ASCII	AC1	Read coordinates data (X, Y, θ)
Coordinates Change	ASCII	CX	Change coordinates data
Velocity Control(speed)	ASCII	BE	Command velocity for velocity control loop
Velocity Control(position)	ASCII	BH	Command velocity for position control loop
Error Reset	ASCII	CG	Clear error
Servo On/Off	ASCII	DB	Servo ON/OFF (Motor On/Off)
Control Mode change	ASCII	CZ	Select control loop (Velocity/Position)
Version Read	ASCII	VER	Version information

9-4-1 Drive status Read

Read drive board status. Refer to table 9-3 for error Codes.

Transmitter	STX	A	A	ETX	LRC						
Receiver	STX	FLAG	DATA0	DATA1	DATA2	DATA3	DATA4	DATA5	DATA6	DATA7	ETX	LRC

DATA	CONTENTS							
	BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
DATA0	0	0	1	Left Servo ON/OFF	Left Error	Left In Position	Left RUN	Left Power ON/OFF
DATA1	Left motor Error Code							
DATA2	0	0	1	Right Servo ON/OFF	Right Error	Right In Position	Right RUN	Left Power ON/OFF
DATA3	Right motor Error Code							
DATA4	0	0	0	0	Bumper7	Bumper6	Bumper5	Bumper4
DATA5	0	0	0	0	Bumper4	Bumper3	Bumper2	Bumper1
DATA6	0	0	0	0	0	0	0	EMG
DATA7	0	0	0	0	0	0	DIR1	DIR0

DIR1	DIR0	Direction of movement
0	0	Rotate Left, Stop
0	1	Advance
1	0	Reverse
1	1	Rotate Right

<Table 9-3> Error Code

CODE	CONTENTS	CAUSE	MEASURES
0x30 ('0')	Normal state		
0x31 ('1')	Emergency Stop	1) When emergency stop button is pressed	Disengage button
0x32 ('2')	Motor hall sensor error	1) Motor hall sensor error 2) Motor wire disconnected	Check motor/motor wire
0x33 ('3')	Encoder error	1) Encoder wire error 2) Motor wire disconnected, wired incorrectly 3) Drive device Gain setup error 4) Power Module damaged 5) Encoder receiver faulty	Check encoder wiring Check motor wiring system Gain Tuning
0x34 ('4')	Detect Over Voltage	1) Power voltage over maximum 2) Power Module damaged 3) Decelerator setting faulty	Check power voltage Check drive board Change parameter setup
0x35 ('5')	Detect Under Voltage	1) Power voltage below minimum	Check power voltage
0x36 ('6')	Detect Over Load	1) Motor torque exceeds maximum drive device output 2) Torque Limit setup error 3) Speed/Acc/Dec setup faulty 4) Obstacle in the path	Check maximum motor torque. Change torque limit setup Change Acc/Dec setup remove obstacle
0x37 ('7')	Detect Over Speed	1) Speed command exceeds maximum speed	Change maximum speed of the drive device
0x38 ('8')	Detect Following Error	1) Following Parameter setup error 2) Drive device Gain setup error 3) encoder/motor wiring faulty	Change parameter setup Check encoder/motor wiring

9-4-2 Encoder Position Read

Read Left and right motor encoder position data.

10bytes are reserved for each of left and right motor encoder data.

Transmitter	STX	A	C	0	ETX	LRC

Receiver	STX	FLAG	Left Encoder position (10 Bytes)	Right Encoder position (10 Bytes)	ETX	LRC

9-4-3 Coordinates Read

Use left/right encoder position data to read current platform coordinates.

Initial coordinates are as follows when platform is first powered up : X = 0(mm), Y = 0(mm), θ = 900(0.1°)

10bytes are reserved for each of X, Y, θ.

Transmitter	STX	A	C	1	ETX	LRC
Receiver	STX	FLAG	X (10 Bytes)	Y (10 Bytes)	θ (10 Bytes)	ETX	LRC

Example) Coordinates X = 56.6mm, Y = 198.4, θ = 58.9°

Transmitter	STX	A	C	1	ETX	LRC						
Receiver	STX	0x30	0x20	0x20	0x20	0x20	0x20	0x20	0x35	0x36	0x2e	0x36
		0							5	6	.	6
			0x20	0x20	0x20	0x20	0x20	0x31	0x39	0x38	0x2e	0x34
								1	9	8	.	4
			0x20	0x20	0x20	0x20	0x20	0x20	0x35	0x38	0x39	0x2e	ETX	LRC
									5	8	9	.		

9-4-4 Coodinates Change

Change current platform coordinates (X, Y, θ). Coordinates change command is only possible when Servos are OFF.

Transmitter	STX	C	X	X (100um)	;	Y (100um)	;	θ (0.1°)	ETX	LRC
Receiver	STX	FLAG	ETX	LRC						

9-4-5 Velocity Control (Speed Mode)

Velocity control command of the driver board speed LOOP. Speed LOOP Velocity control command sets the left/right motor speed to 0(mm/sec) to prevent improper motion if driver board loses communication with the controller and does not receive command within the set time period. Initial value is 2000msec.

Transmitter	STX	B	E	Left Wheel Speed (mm/sec)	;	Right Wheel Speed (mm/sec)	ETX	LRC
Receiver	STX	FLAG	ETX	LRC				

9-4-6 Velocity Control (Position Mode)

Drive board position LOOP velocity control command.

Transmitter	STX	B	H	Left Wheel Speed (mm/sec)	;	Right Wheel Speed (mm/sec)	ETX	LRC
Receiver	STX	FLAG	ETX	LRC				

9-4-7 Error Reset

Reset all drive board errors.

Transmitter	STX	C	G	ETX	LRC
Receiver	STX	FLAG	ETX	LRC	

9-4-8 Servo ON/OFF

Drive board Left/Right servo on/off command.

Transmitter	STX	B	D	Left Servo (1 : ON, 0 : OFF)	Right Servo (1 : ON, 0 : OFF)	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

9-4-9 Control Mode Change

Drive board position control mode and velocity control mode change command.

Velocity control mode

Transmitter	STX	C	Z	1	1	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

Position control mode

Transmitter	STX	C	Z	0	0	ETX	LRC
Receiver	STX	FLAG	ETX	LRC			

9-4-10 Version Read

Command to read drive board version data.

Transmitter	STX	V	E	R	ETX	LRC									
Receiver	STX	D0	;	D1	;	D2	;	D3	;	D4	;	D5	;	D6	;	D7	ETX	LRC

DATA	CONTENTS
D0	Module type (1:Drive Module 2:PSV Module)
D1	Yr 2 digits
D2	Yr 1digit
D3	Month 2 digits
D4	Month 1 digit
D5	Date 2 digits
D6	date 1 digit
D7	Version