

RX

SCARA ROBOT

ASSEMBLY AND WIRING MANUAL

About this Manual

Purpose

This manual provides the information required for the Selection, Wiring, Connection, Setup, Trial Operation, Tuning and Functions of the RX - Scara robots range and DX4 Servo Drive (referred to as **DX4**).

Please read and understand this manual to ensure correct usage of the product.

Terms

Terms that may be used in this manual are defined as follows.






Term	Meaning
Motor	A Rotary Servo Motor.
Drive	A Servo Drive, which is used for controlling the motion of the Motor.
Servo System	A Servo Control System that includes a Motor, a Drive with a host controller and peripheral devices.
Servo ON	Supplying power to the Motor.
Servo OFF	Not supplying power to the Motor.
Motion Perfect	The PC Tool for commissioning and programming the Trio product suite.
STO	The Safe Torque Off function provides a safe means for preventing the Drive from generating torque in the Motor.
Fully Closed Loop	Dual encoder feedback

Safety

Installation and transportation of robots and robotic equipment shall be performed by qualified personnel and should conform to all national and local codes. Please read this manual and other related manuals before installing the robot system or before connecting cables. Always keep this manual handy for easy access.

Conventions

Important safety considerations are indicated throughout the manual by the following symbols. Be sure to read the descriptions shown with each symbol.

Symbol	Description
 DANGER	Indicates a hazard with a high level of risk that, if not avoided, may result in death or serious injury.
 WARNING	Indicates a hazard with a medium or low level of risk which, if not avoided, could result in minor or moderate injury.
 CAUTION	Indicates a potentially hazardous situation that, if not avoided, could cause equipment damage, loss of data, performance degradation, or unexpected results.
 IMPORTANT	Indicates precautions or restrictions that must be observed. Also indicates alarm displays and other precautions that will not result in machine damage.
 NOTE	Provides additional information to emphasize or supplement important points of the main text.

Safety Precautions

General Precautions



- Never remove covers, cables, connectors, or optional devices while power is being supplied to the Drive.
 - Wait for five minutes after turning the power supply OFF and then make sure that the CHARGE indicator is not lit before starting wiring or inspection work.
 - Never touch the power supply terminals after turning OFF the power supply while the CHARGE lamp is lit, because high voltages may still be present in the Drive.
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- Use a power supply that is appropriate for the product, check number of phases, voltage, frequency, and AC/DC type.
 - Connect the ground terminals on the Drive and Motor to ground poles according to local electrical codes.
 - Never damage, pull on, apply excessive force to, place heavy objects on, or pinch cables.
 - Never attempt to disassemble, repair, or modify the product.
 - Make sure that the device is in an emergency stop state at any time when the product has been connected to the machine and ready for the operation.
 - Never touch inside the Drive.
-



- The Drive heat sinks, regenerative resistors, Motor, and other components can be very hot while power is ON or soon after the power is turned OFF. Implement safety measures, such as installing covers, so that hands and parts such as cables do not come into contact with hot components.
 - For the control power supply, use a power supply device with double insulation or reinforced insulation.
 - Never use the product in an environment that is subject to water, corrosive gases, or flammable gases, or near flammable materials.
 - Never attempt to use a Drive or Motor that is damaged or that has missing parts.
 - Install external emergency stop circuits that shut OFF the power supply and stop operation immediately when an error occurs.
 - In locations with poor power supply conditions, install the necessary protective devices (such as AC reactors) to ensure that the input power is supplied within the specified voltage range.
 - Always use a Noise Filter to minimize the effects of electromagnetic interference.
 - Always use a Motor and Drive in one of the specified combinations.
 - Never touch a Drive or Motor with wet hands.
-

Storage Precautions



- Follow all instructions on the packages, and never place an excessive load on the product during storage.
 - Never install or store the product in any of the following locations.
 - Locations that are subject to direct sunlight
 - Locations that are subject to ambient temperatures that exceed product specifications
 - Locations that are subject to relative humidity that exceed product specifications
 - Locations that are subject to corrosive or flammable gases
 - Locations that are subject to dust, salts, or iron powder
 - Locations that are subject to water, oil, or chemicals
 - Locations that are subject to vibration or shock that exceeds product specifications
 - Locations that are subject to radiation
-

Installation Precautions



- Install the Drive in a control cabinet that provides fire and electrical protection.
 - Install the Drive and Motor in a way that will support their mass.
 - Never install or store the product in any of the following locations.
 - Locations that are subject to direct sunlight
 - Locations that are subject to ambient temperatures that exceed product specifications
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 - Locations that are subject to corrosive or flammable gases
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 - Locations that are subject to water, oil, or chemicals
 - Locations that are subject to vibration or shock that exceeds product specifications
 - Locations that are subject to radiation
 - Never allow any foreign matter to enter a Drive or a Motor with a Cooling Fan.
 - Never cover the outlet from cooling fan of Drive or Motor.
 - Never step on or place a heavy object on the product.
 - Install the Drive in the specified orientation.
 - Provide the specified clearances between the Drive and the control cabinet as well as with other devices.
-

Wiring Precautions



- Never bypass the electromagnetic contactor in the wiring between the Drive and the Motor.
 - Firmly connect the power terminal to the Motor terminal.
 - Provide an adequate air gap around the Drive installation.
 - Use shielded twisted-pair cables or screened unshielded multi-twisted-pair cables for I/O Signal Cables and Encoder Cables.
 - The wiring length of the command input line is up to 3 meters, and the wiring length of the encoder is up to 20 meters.
 - Minimize the frequency that the power supply is turned ON and OFF.
-

Operation Precautions



- In order to prevent accidents, please test the Motor with no load (not connected to the Drive shaft).
 - When starting to operate on the supporting machine, set the user parameters that match the machine in advance.
 - Note that the signals for the Forward Drive Prohibit (P-OT) and the Reverse Drive Prohibit (N-OT) are disabled during JOG operation.
 - When overtravel occurs, the power supply to the Motor is turned OFF and the brake is released. If the Motor is used to drive a vertical load, set the Motor to enter a 'zero-clamped' state after the Motor stops. Also, install safety devices (such as an external brake or counterweight) to prevent the moving parts of the machine from falling.
 - If not using auto-tuning, make sure that an appropriate moment of inertia ratio is setup to avoid vibration.
 - If an alarm occurs, reset it after troubleshooting the cause and ensuring safety.
 - Never use the brake of the Motor for normal braking.
-

Maintenance Precautions



- Wiring and inspections must be performed only by qualified engineers.
 - Disconnect all connections to the Drive when testing the insulation resistance of the Drive.
 - Never use gasoline, thinner, alcohol, acid or alkaline detergent to avoid discoloration or damage to the casing.
 - When replacing the Drive, transfer the user parameters from the replaced Drive to new Drive.
 - Never change the wiring while the power is on.
 - Never disassemble the Motor without permission.
-

Disposal Precautions



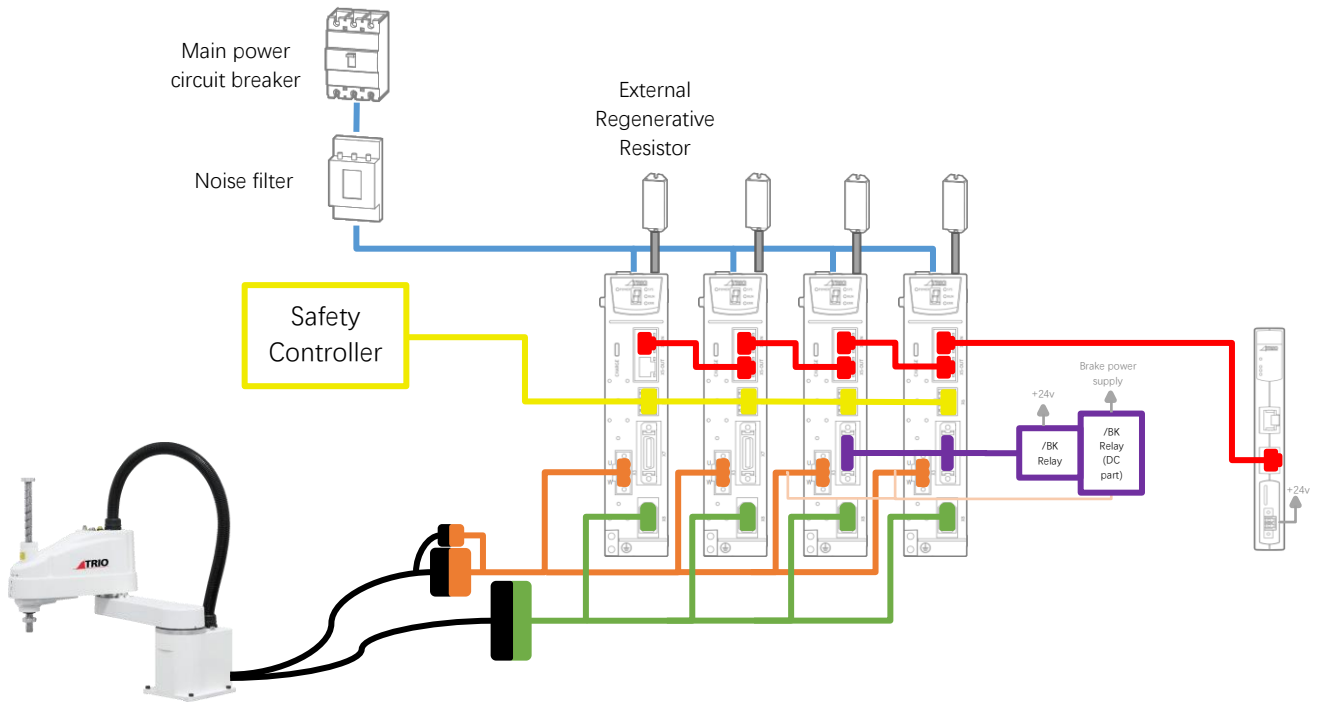
- When disposing of the product, treat it as ordinary industrial waste. However, local ordinances and national laws must be observed. Implement all labeling and warnings as required.
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Chapter 1 System Configuration overview

Example Diagram

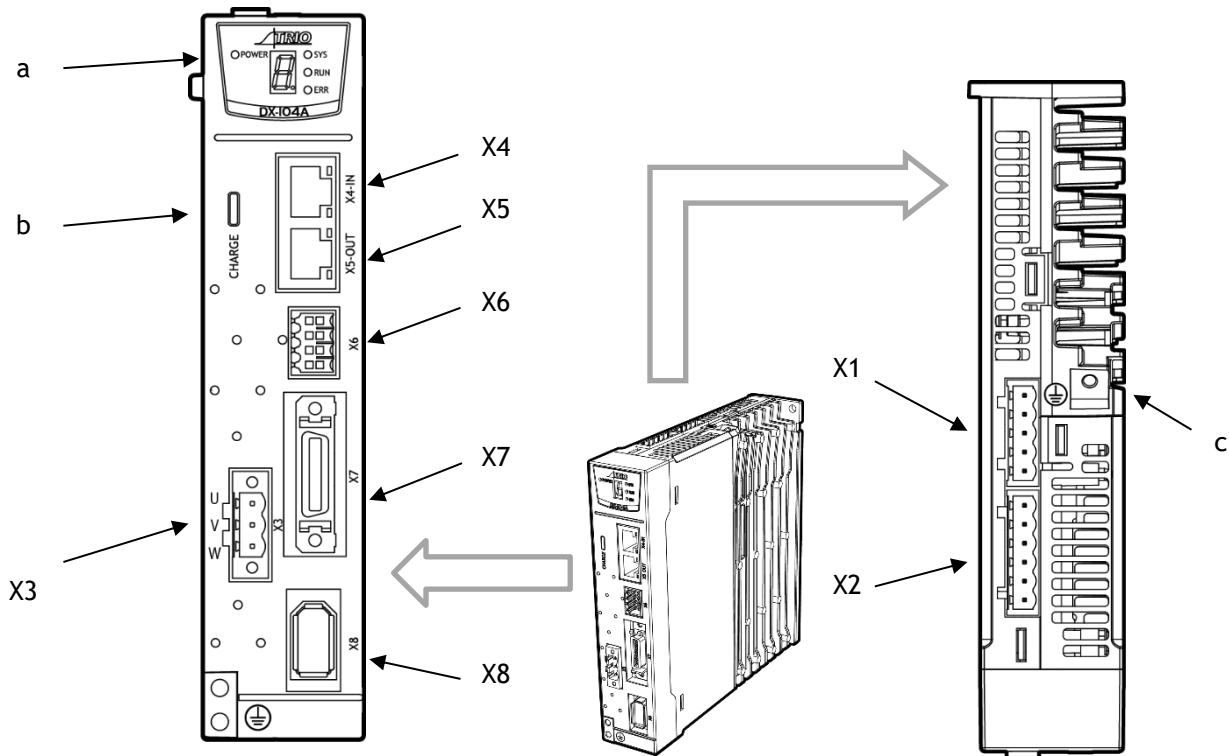


Minimum system configuration is:

- Scara robot body
- 4 DX4 Drives
- 4 Regen resistors
- Trio Controller
- 24v power supply
- Brake power supply
- Circuit breaker
- Main power noise filter
- PC for commissioning
- Robot Encoder cable
- Robot Motor power cable
- EtherCAT, Ethernet, STO, IO cable

Chapter 2 DX4 Servo drive

2.1 Part names



No.	Name	Description
X1	Control Circuit Connector	Control power supply (5 pins)
X2	Main Circuit Connector	Main circuit power supply (6 pins)
a	Status Display	Drive status display
b	CHARGE Indicator Lamp	Main circuit power supply indicator ⁽¹⁾
X3	Motor Connector	Motor power
c	Grounding Terminal	Ground terminal for motor power cable
X4	EtherCAT Input Connector	EtherCAT input (RJ45)
X5	EtherCAT Output Connector	EtherCAT output (RJ45)
X6	Safety Connector	Safe Torque Off (STO)
X7	I/O Signal Connector	Digital I/O and external encoder input
X8	Encoder Connector	Encoder signals

(1): When the main circuit power is turned OFF, the CHARGE indicator will be lit as long as the internal capacitor remains charged. Do not touch the main circuit or Motor terminals while this indicator is illuminated as there is possibility of electric shock.

Chapter 3 Wiring and Connections

3.1 Precautions for Wiring

3.1.1 General Precautions



- Never change any wiring while power is being supplied in case of risk of electric shock or injury.
-



- Wiring and inspections must be performed only by qualified engineers.
 - Check all wiring and power supplies carefully.
 - Incorrect wiring or incorrect voltage application to the output circuits may cause short-circuit failures. If a short-circuit failure occurs as a result of any of these causes, the holding brake will not work. This could damage the machine or cause an accident that may result in death or injury.
 - Connect the AC and DC power supplies to the specified Drive terminals.
-



- Wait for at least five minutes after turning OFF the power supply and then make sure that the CHARGE indicator is not lit before starting wiring or inspection work. Never touch the power supply terminals while the CHARGE lamp is lit after turning OFF the power supply because high voltages may still be present in the Drive.
 - Observe the precautions and instructions for wiring and trial operation precisely as described in this document.
 - Check the wiring to be sure it has been performed correctly. Connectors and pin layouts are sometimes different for different models. Always confirm the pin layouts in technical documents before operation.
 - Use shielded twisted-pair cables or screened unshielded multi-twisted-pair cables for I/O Signal Cables and Encoder Cables.
 - The cable used for main circuit power to the Drive must be guaranteed to work at 75°C.
 - Observe the following precautions when wiring the Drive's main circuit terminals.
 - Do not turn on the power supply to the Drive until all wiring, including the main circuit terminals, has been completed.
 - Ensure that power is removed from the Drive before wiring connectors.
 - Insert only one wire per insertion hole in the main circuit terminals.
 - Ensure that conductor wires (e.g. whiskers) do not come into contact with adjacent wires.
 - Install Type C MCB and other safety measures to provide protection against short circuits in external wiring.
-

**NOTE**

- Whenever possible, use the Cables specified by Trio.
- Securely tighten cable connector screws and lock mechanisms to prevent mechanical failure during operation.
- Ensure that power lines (e.g. Main Circuit Cable) and low-current lines (e.g. I/O Signal Cables or Encoder Cables) are separated by at least 30 cm. Do not bundle power lines and low-current lines through the same duct.

**IMPORTANT**

- Use a Type C MCB to protect the main circuit.
The Drive connects directly to a commercial power supply; it is not isolated through a transformer or other device. Always use a Type C MCB to protect the Servo System from accidents involving different power system voltages or other accidents.
- Install an earth leakage breaker.
To configure a safer system, install a ground fault detector against overloads and short-circuiting, or install a ground fault detector combined with a Type C MCB.

3.1.2 Countermeasures against Noise

**IMPORTANT**

- Refer to DX4 Servo drive Product Manual, Noise Filters and Grounding sections before continuing with this manual

3.1.3 Recommended EMC Filters

To comply with the limits based on IEC/EN 61800-3 second environment (C2) the Drive and Motor must be installed with an EMC/RFI filter. For the whole system, 4 units of DX4 drives, recommended filters are:

RX-400 ... 700-SR	EMC C2 (three phase supply)	EMC C2 (single phase supply)
4 units of DX4 drives (100 W to 400 W depending on model)	Schaffner FN3270H-10-44	Schaffner FN2090-10-06

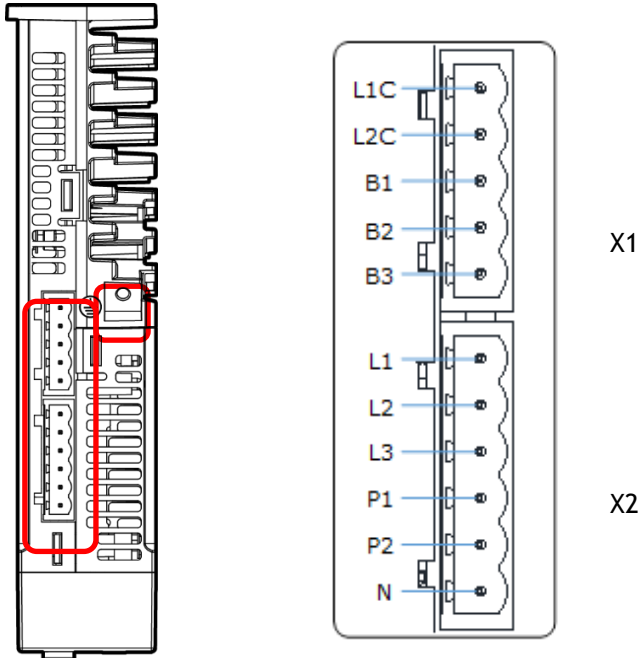
These filters have been tested with cable lengths of 3m and 20m.

3.2 Power Supply (X1, X2)


3.2.1 Terminals Arrangement

The power supply to Drive includes main circuit terminals and control circuit terminals.

Signal Diagram



Pin Layout

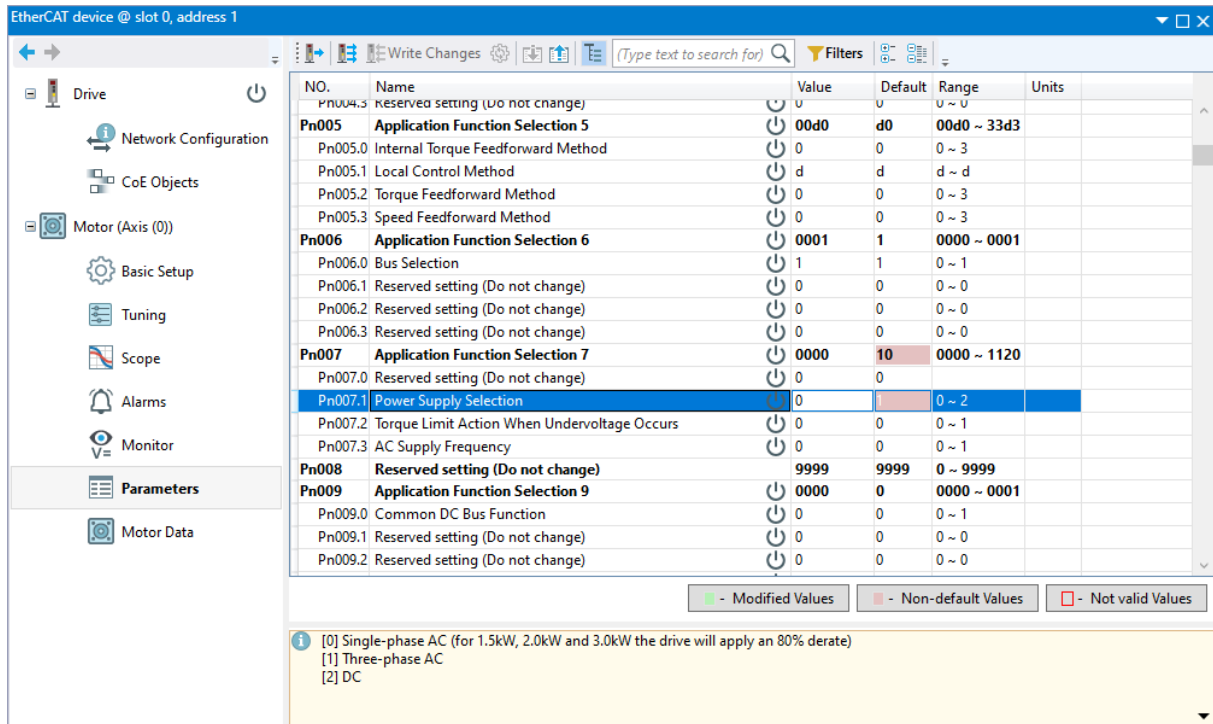
Symbols	Name	Specifications and Reference
L1, L2, L3	Main circuit power supply input terminals	Three-phase, 200 V ac to 240 V ac, -15% to +10%, 50 Hz or 60 Hz
L1C, L2C	Control power supply terminals	Single-phase, 200 V ac to 240 V ac, -15% to +10%, 50 Hz or 60 Hz
B1, B2, B3	Regenerative Resistor terminal	There is a factory fit short between B2 and B3. When the busbar capacitance is insufficient, remove the short wiring, and connect an external regenerative resistor between B1 and B2.
P1, P2, N	DC terminals	There is a factory fit short between P1 and P2. <ul style="list-style-type: none"> For using a DC reactor, remove the short wiring, and connect a DC reactor between P1 and P2. For using a DC power supply, connects P2 to the positive pole, and connects N to negative pole. For the common DC bus, connect all P2 of Drive to the positive pole, and N to the negative pole.
	Ground terminal	Always connect this terminal to prevent electric shock.



IMPORTANT

- Refer to DX4 Servo drive Product Manual, Chapter 3: Wiring and connections, for wiring diagram indications.

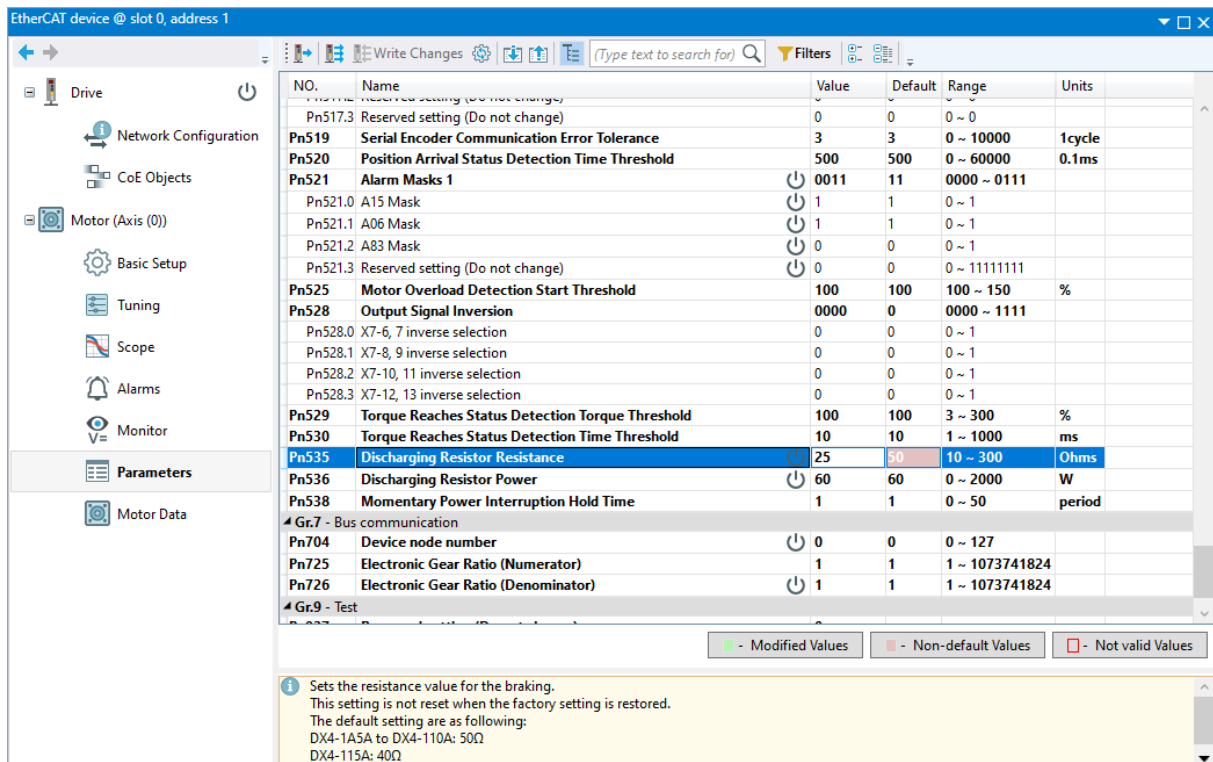
In case of using Single phase AC, parameter Pn007.1 has to be set to “0”:



3.2.2 External regenerative resistor

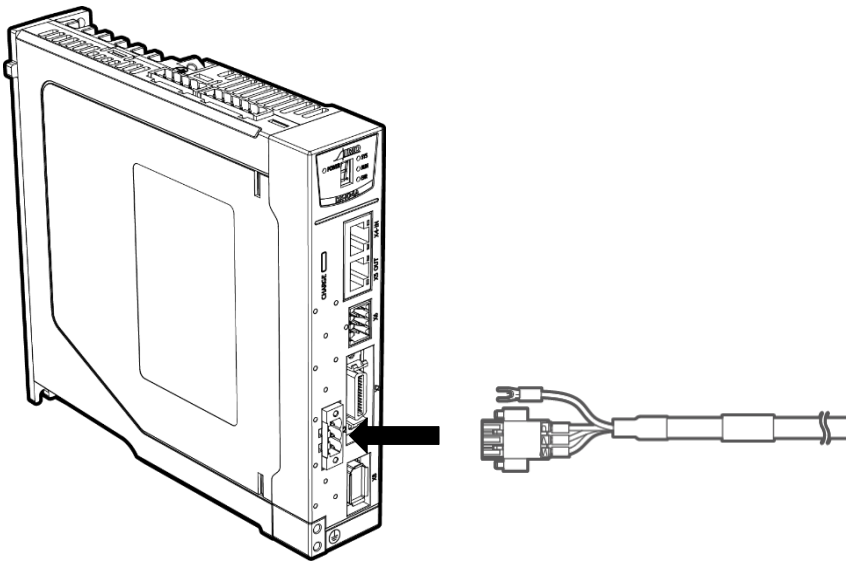
Use external regenerative resistor of 60W at 250hm in every servo drive.

Specifications	Drive configuration
60W 250hm	Pn535 (resistance value) Pn536 (power value)



3.3 Motor Power (X3)

Connection Diagram



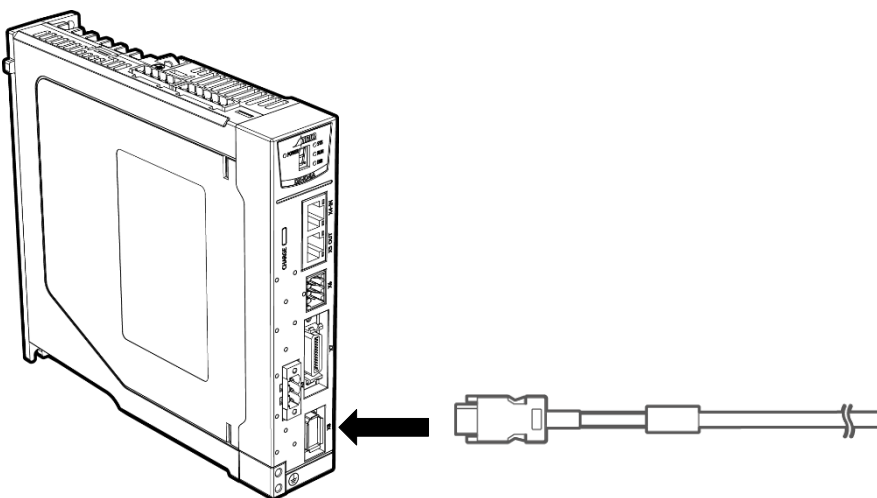
Terminals Arrangement

Terminals		Pin Layout					
Robot connection side		A1	U1	J1-axis motor power line	B1	U4	J4-axis motor power line
		A2	V1		B2	V4	
		A3	W1		B3	W4	
		A4	U2	J2-axis motor power line			
		A5	V2				
		A6	W2				
		A7	U3	J3-axis motor power line			
		A8	V3				
		A9	W3				
		A10	PE1	Protective grounding wire 1	B20	PE2	Protective grounding wire 2

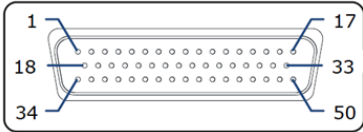
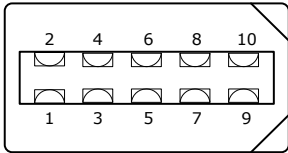
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3.4 Encoder (X8)

Connection Diagram



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Shell	FG	Frame ground																																																																																											

3.4.1 Encoder Battery Connection

Absolute encoders are fitted on motors with an encoder type of L; e.g. MXL-02A0630LA222. These encoders require a battery supply to retain the absolute encoder data when the Drive power is removed.

This battery supply is provided by an in-line battery fitted into the back of the robot which allows the encoder supply to be retained when the Encoder Cable is removed from the Drive.



- To retain absolute encoder data, ensure that the Control power supply to the Drive is ON when the battery supply is removed.

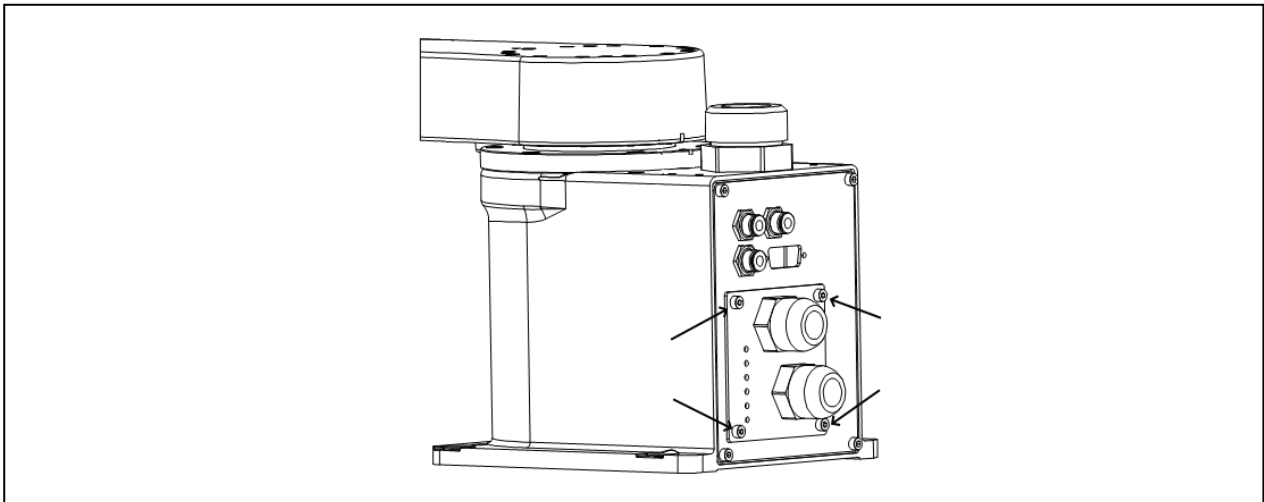
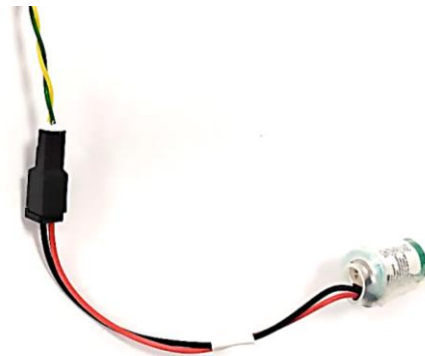


Fig 3.1 Back plate where batteries are stored (RX3&RX6)

The following picture shows one of the four batteries that are installed in RX Scara series.



3.4.2 Finding calibration position

Calibrating is performed at the factory with no loads on the robot system, based on the robot parameters and the special tools and software. This calibration method is the most precise one. Every robot is provided with its calibration values.

The data of home position may be lost due to electrical or software problems. The stored zero position can be regarded as the reference when you perform calibration by teaching method.

The process consists of place robot in specific position by hand, allowing encoders to be at ± 0.5 turn. At that position, the system can calculate the offset position if manufacture calibration values are set into the configuration software.

To calibrate the home position of J1, J2, J3 and J4 axis for RX3/RX6 Robot follow the procedures below:

1. Turn power off for all axis drives.
2. Move J1, J2, J3 and J4 to the position as shown in the figures.
3. Align the mark on the different arms as shown in the figures.
4. Replace batteries of J1, J2, J3 and J4 or unplug and then plug them again so absolute encoders multi turn is set to 0.
5. Set manufacture calibration values of every axis in system software.

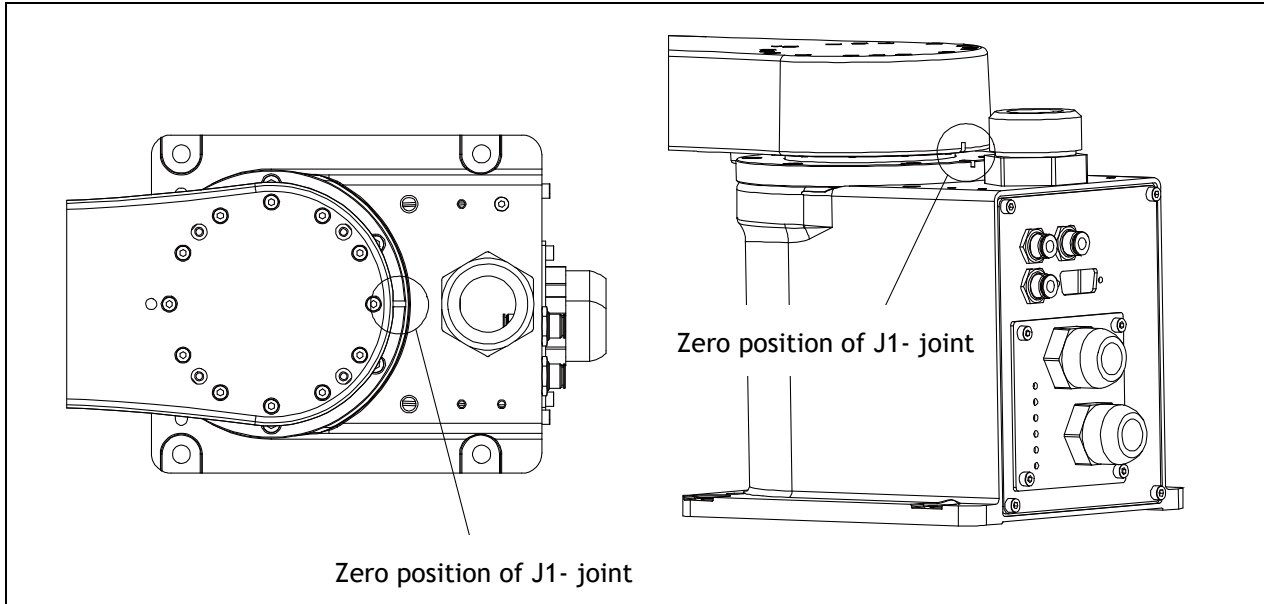


Fig 3.1 Home position of Joint #1 (RX3&RX6)

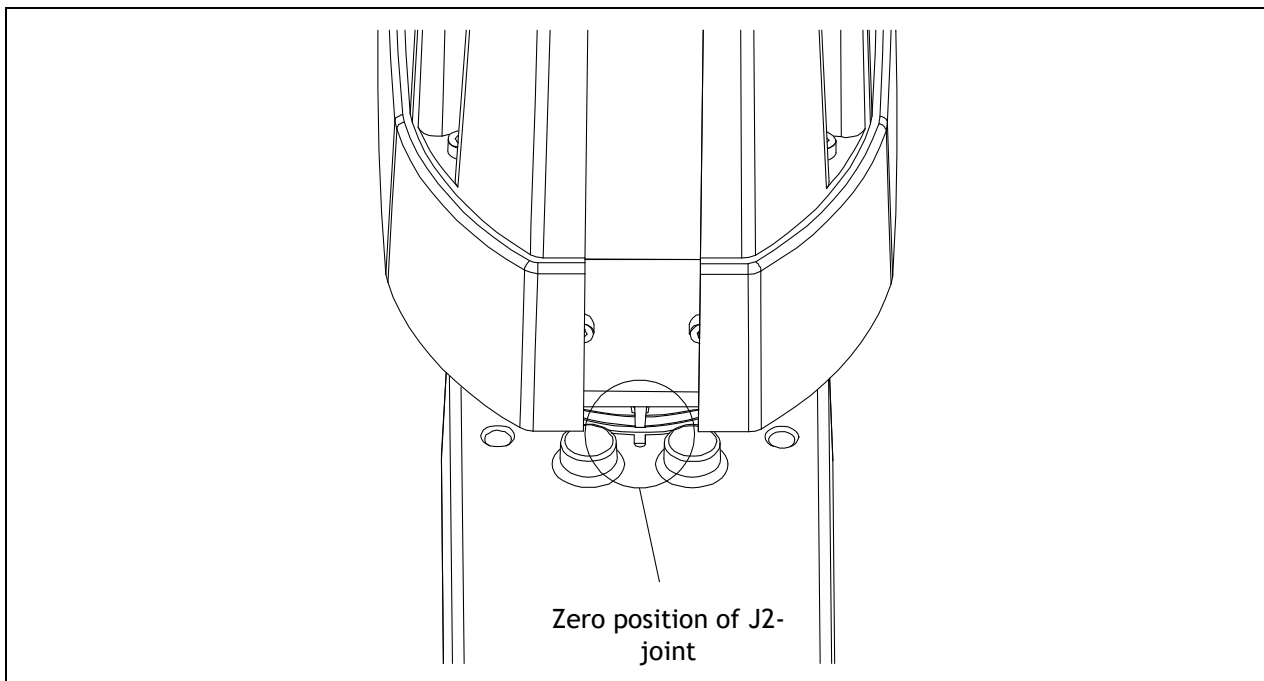


Fig 3.2 Home position of Joint #2 (RX3 & RX6)

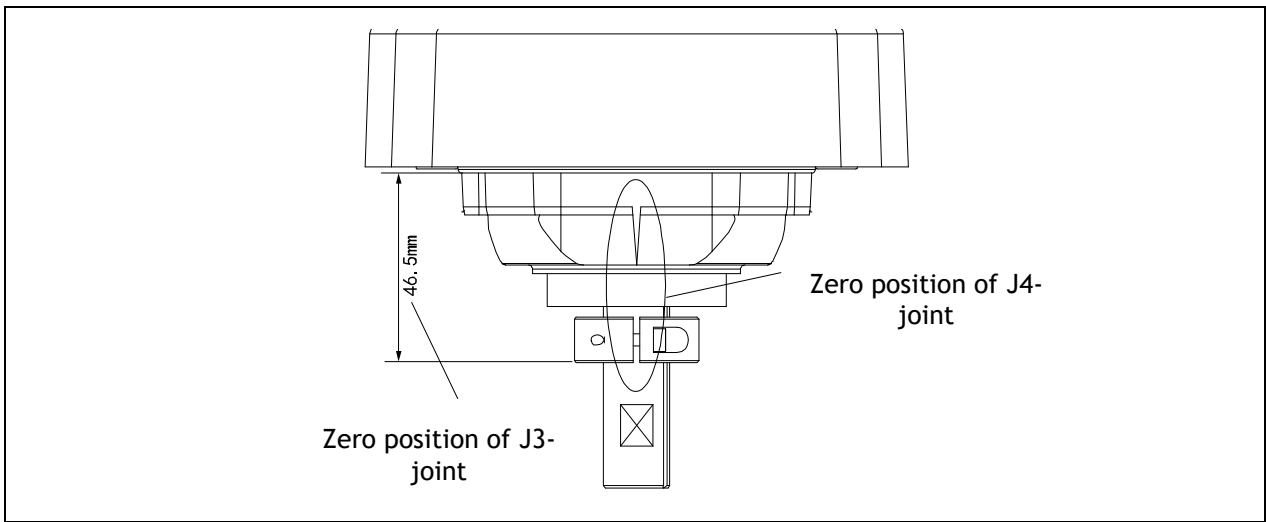


Fig 3.3 Home position of Joint #3 and #4 (RX3)

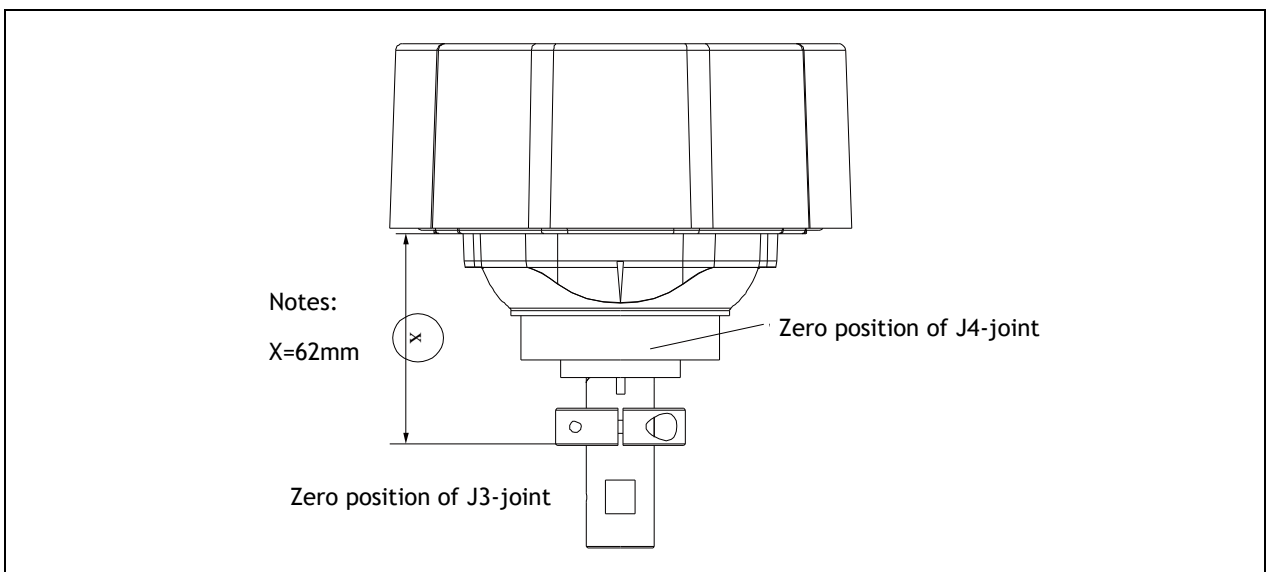


Fig 3.4 Home position of Joint #3 and #4 (RX6)

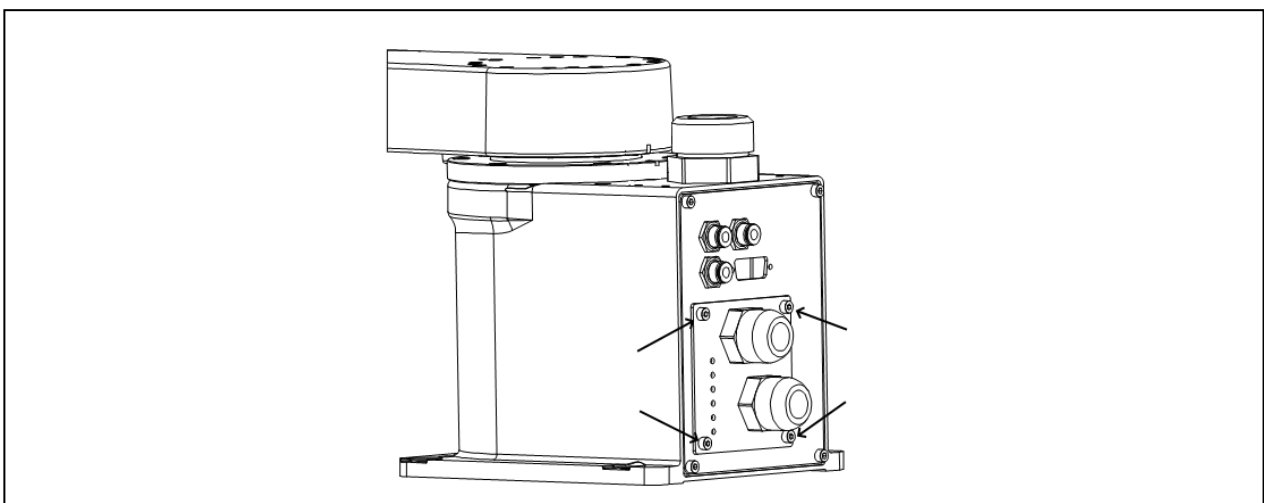
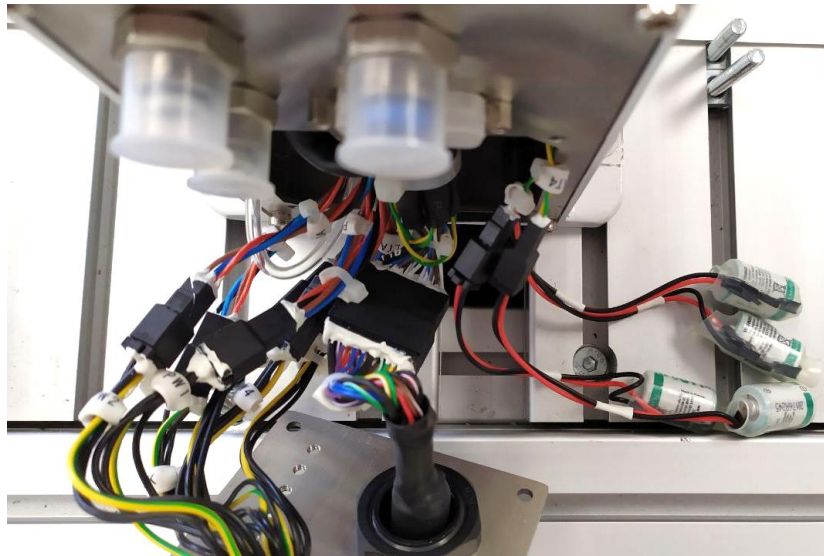


Fig 3.1 Back plate where batteries are stored (RX3&RX6)



NOTE

It is possible that some errors must be cleared after batteries are replaced.

To clear errors, go to Intelligent Drives Configuration in Motion Perfect and open the EtherCAT device with the error, like in the picture below:

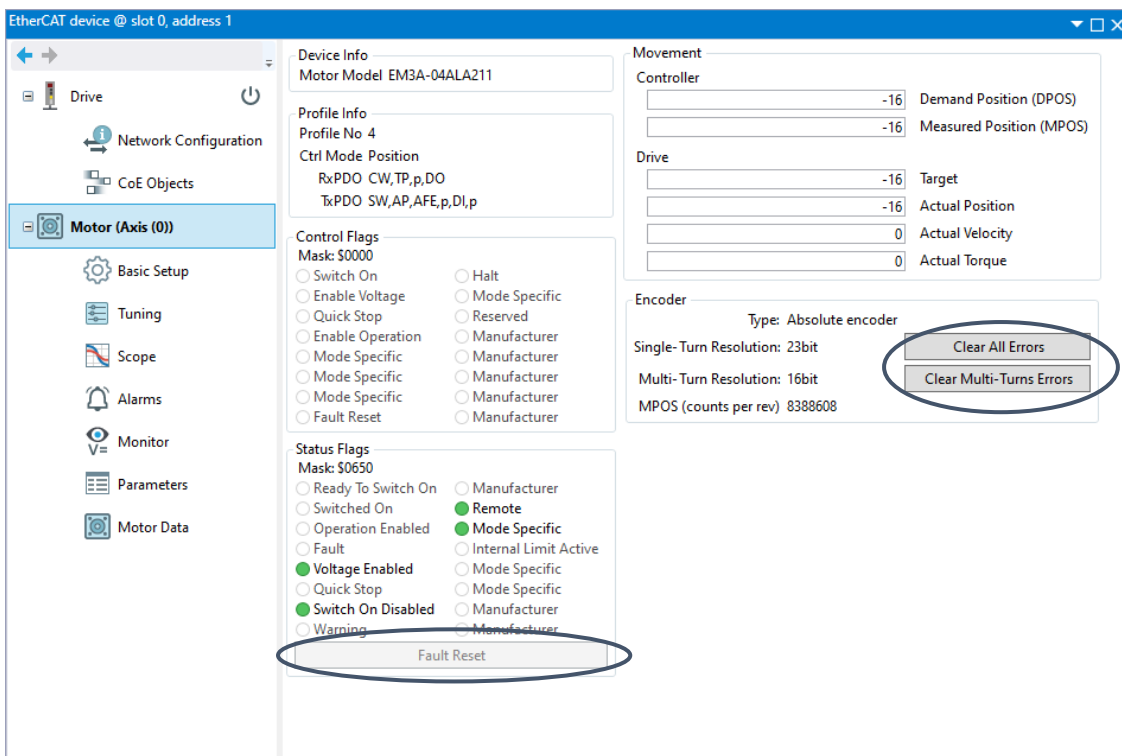


Fig 3.5 EtherCAT device error reset

Press over “Clear Multi-Turn Errors”, then “Clear All Errors” and finally “Fault Reset”.

After do that with all error drives, restart the EtherCAT network.

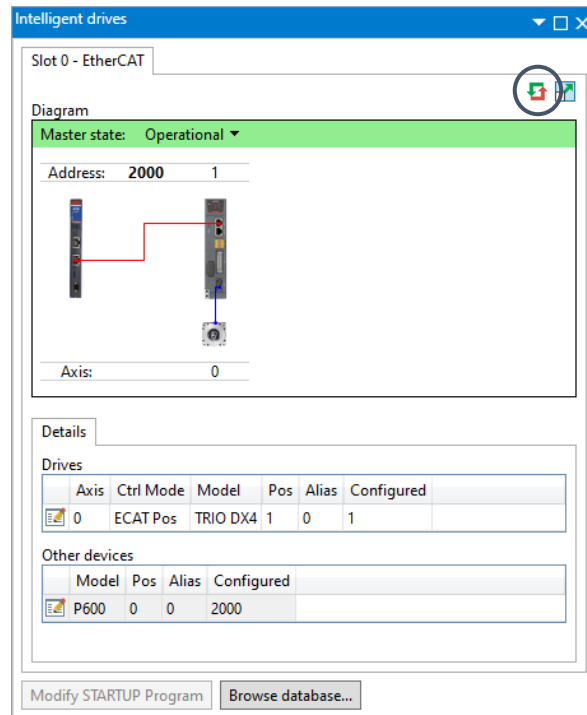


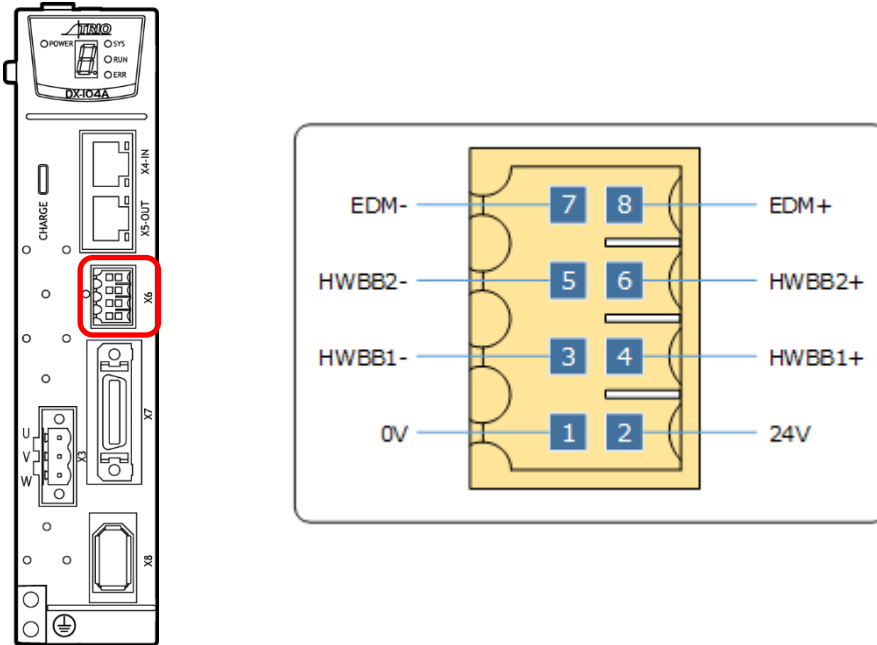
Fig 3.6 EtherCAT network restart

ADD NEW HOME_POS COMMAND EXAMPLE TO SET CALIBRATED VALUES

Chapter 4 STO

4.1 Terminals Arrangement (X6)

Signal Diagram



Pin Layout



- Please use the PELV/SELV switching power supplying to the IO signal of the STO function.
- The external signal shall meet the Idle-current principle.

Pin	Signal	Name	Function
1	0 V	24 V Power Supply	— (Do not use these pins because they are connected to internal circuits)
2	24 V		
3	HWBB1-	HWBB1 Input	The STO function takes effect when the HWBB1 or the HWBB2 signals is turned OFF.
4	HWBB1+		
5	HWBB2-	HWBB2 Input	
6	HWBB2+		
7	EDM-	External Device Monitor Output	Turns ON when the HWBB1 signal or the HWBB2 signal is turned OFF.
8	EDM+		

4.2 Safety Function Device Connection

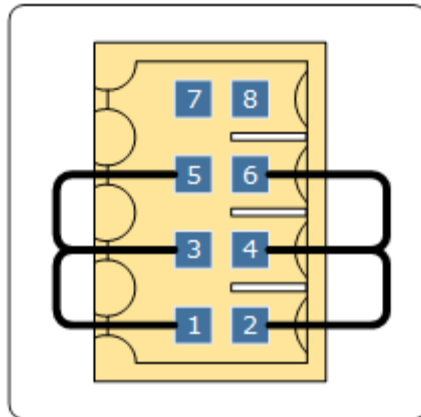
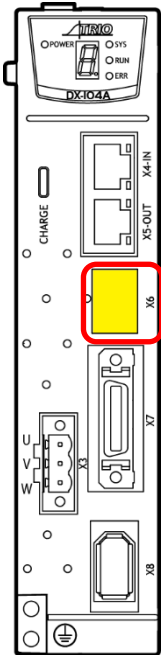
4.2.1 Disconnecting a Safety Function Device

If a safety function device is not connected, keep the Safety Connector plugged into the X6 port, and the shorting pins on the connector remain in the default state.



WARNING

- In this case, the STO function will be disabled and the Drive will not be able to implement the safety function by the Safety Function Device.



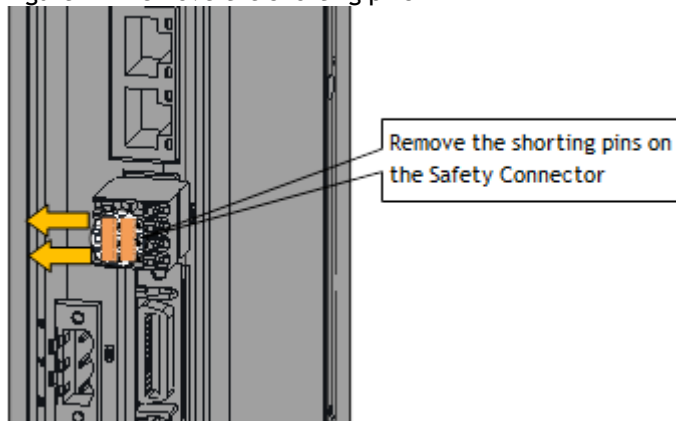
CAUTION

- If the shorting pins are removed and the Safety Function Device is not connected, the Drive will enter safe state and not supply the current to the Motor, so that the Motor cannot output torque. At that time, the Panel Operator will display **SAF**.

4.2.2 Connecting a Safety Function Device

Step 1 Remove the shorting pins on the Safety Connector as shown in Figure 4-1.

Figure 4-1 Remove the shorting pins



Step 2 Wiring the Safety Function Device

Connect the Safety Function Device to the X6 port according to the wiring example shown in **Error! Reference source not found..**

Chapter 5 Holding Brake

A holding brake is used to hold the position of the moving part of the machine when the drive is turned off, so that moving part does not move due to gravity or an external force.



IMPORTANT

ONLY AXIS 3 AND AXIS 4 have holding brakes.

The brake integrated into the motor is a de-energization brake. It is used only to hold the motor once stationary and cannot be used for braking.

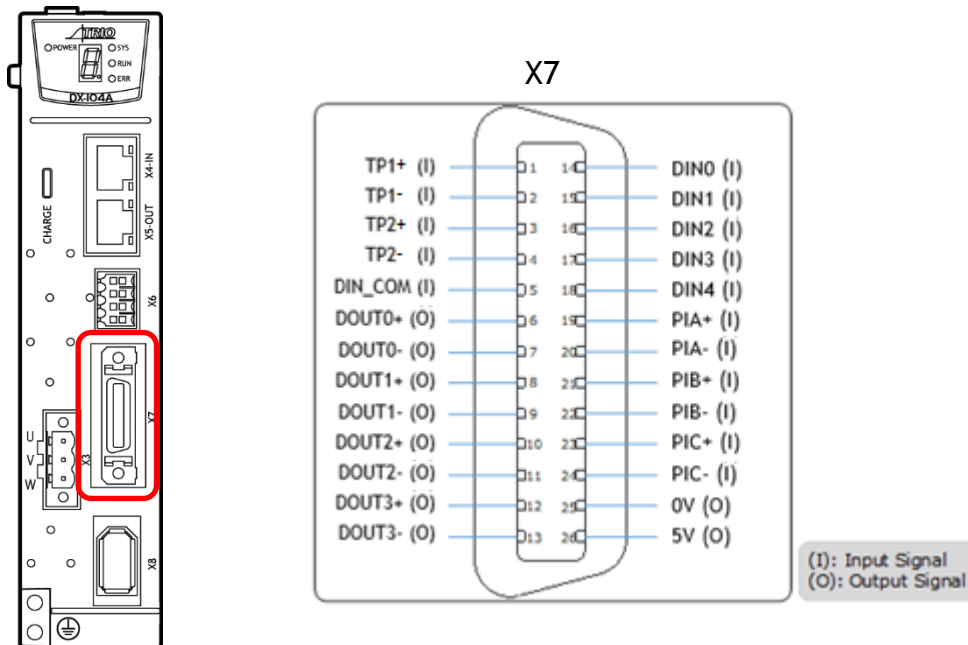
Use the holding brake only to hold a motor that is stationary.

Motors of axis 3 and axis 4 have a holding brake. A digital output on the drive can be assigned for brake control. Any of the digital outputs on the drive can be configured as the brake control output.

The assignment is made by selecting from the Basic Setup page in the drive commissioning screens or by writing directly to parameter Pn511.

Parameter	Setting	+ Pin	- Pin	Meaning
Pn511.0	4	X7-6	X7-7	The /BK signal is output from X7-6 and X7-7.
Pn511.1	4	X7-8	X7-9	The /BK signal is output from X7-8 and X7-9.
Pn511.2	4	X7-10	X7-11	The /BK signal is output from X7-10 and X7-11.
Pn511.3	4	X7-12	X7-13	The /BK signal is output from X7-12 and X7-13.

Selecting a digital output in the Basic Setup screen will enable the brake control timing parameters.



Pin	Name	Type	Function
6	DOUT0+	Output	General purpose digital output 0.
7	DOUT0-	Output	

Pin	Name	Type	Function
8	DOUT1+	Output	General purpose digital output 1.
9	DOUT1-	Output	
10	DOUT2+	Output	General purpose digital output 2.
11	DOUT2-	Output	
12	DOUT3+	Output	General purpose digital output 3.
13	DOUT3-	Output	

In the case of using DOUT0, Pn511.0 is set with value 4 as shown in the picture below:

The screenshot shows the 'Parameters' section of the EtherCAT configuration tool. The parameter list includes:

NO.	Name	Value	Default	Range	Units
Pn508	Brake Engage Timeout	50	50	10 ~ 100	10ms
Pn509	Digital Input Signal Allocations 1	7770	7777	0000 ~ 7777	
Pn509.0	X7-14 Signal Allocation	0	7	0 ~ 7	
Pn509.1	X7-15 Signal Allocation	7	7	0 ~ 7	
Pn509.2	X7-16 Signal Allocation	7	7	0 ~ 7	
Pn509.3	X7-17 Signal Allocation	7	7	0 ~ 7	
Pn510	Digital Input Signal Allocations 2	0007	7	0000 ~ 0007	
Pn510.0	X7-18 Signal Allocation	7	7	0 ~ 7	
Pn510.1	Reserved setting (Do not change)	0	0		
Pn510.2	Reserved setting (Do not change)	0	0		
Pn510.3	Reserved setting (Do not change)	0	0		
Pn511	Digital Output Signal Allocations	dcb4	dcb4	0000 ~ dddd	
Pn511.0	X7-6,7 Signal Allocation	4	a	0 ~ d	
Pn511.1	X7-8,9 Signal Allocation	b	b	0 ~ d	
Pn511.2	X7-10,11 Signal Allocation	c	c	0 ~ d	
Pn511.3	X7-12,13 Signal Allocation	d	d	0 ~ d	
Pn512	Digital Input Signals (Low Bits) from Bus Master	0	0	0 ~ 1111	
Pn513	Digital Input Signals (High Bits) from Bus Master	0	0	0 ~ 1	
Pn514	Digital Input Signals Filter Time	1	1	0 ~ 1000	1cycle
Pn515	Alarm Output Signal Filter Time	1	1	0 ~ 3	2cycle
Pn516	Digital Input Signal Inversion 1	0000	0	0000 ~ 1111	
Pn516.0	X7-14 inverse selection	0	0	0 ~ 1	
Pn516.1	X7-15 inverse selection	0	0	0 ~ 1	
Pn516.2	X7-16 inverse selection	0	0	0 ~ 1	

The parameter Pn511.0 is highlighted in blue, indicating it is a modified value. The legend at the bottom indicates: Green square for Modified Values, Red square for Non-default Values, and White square for Not valid Values.

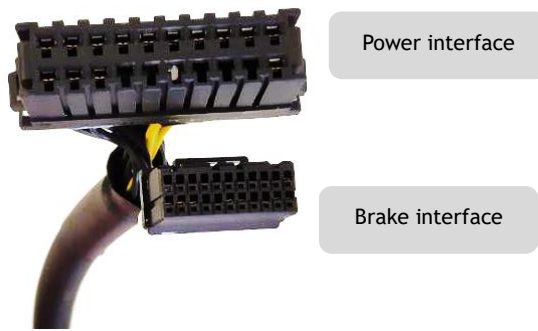
Information box: Select function assigned to digital output:
 [0] COIN/VCMP, [1] TGON, [2] S-RDY, [3] CLT,
 [4] BK, [5] PGC, [6] OT, [7] RD,
 [8] TCR, [9] LM, [a] Remote0, [b] Remote1
 [c] Remote2, [d] Remote3



IMPORTANT

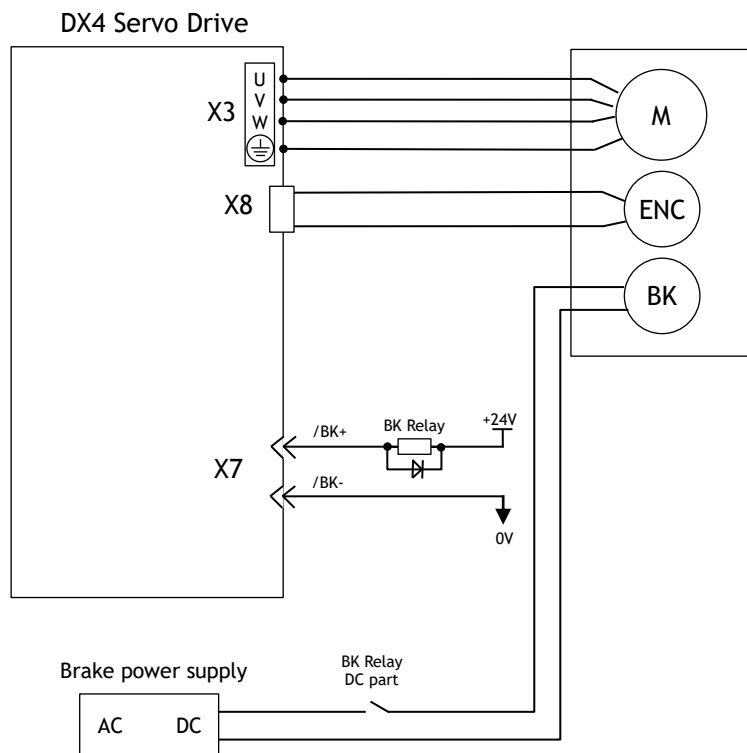
To know more about braking signal and its features please, refer to DX4 Servo drive product manual, Chapter 6, section 6.4.1 Holding brake.

Brake signals must be connected to motor brake through power cable with brakes.



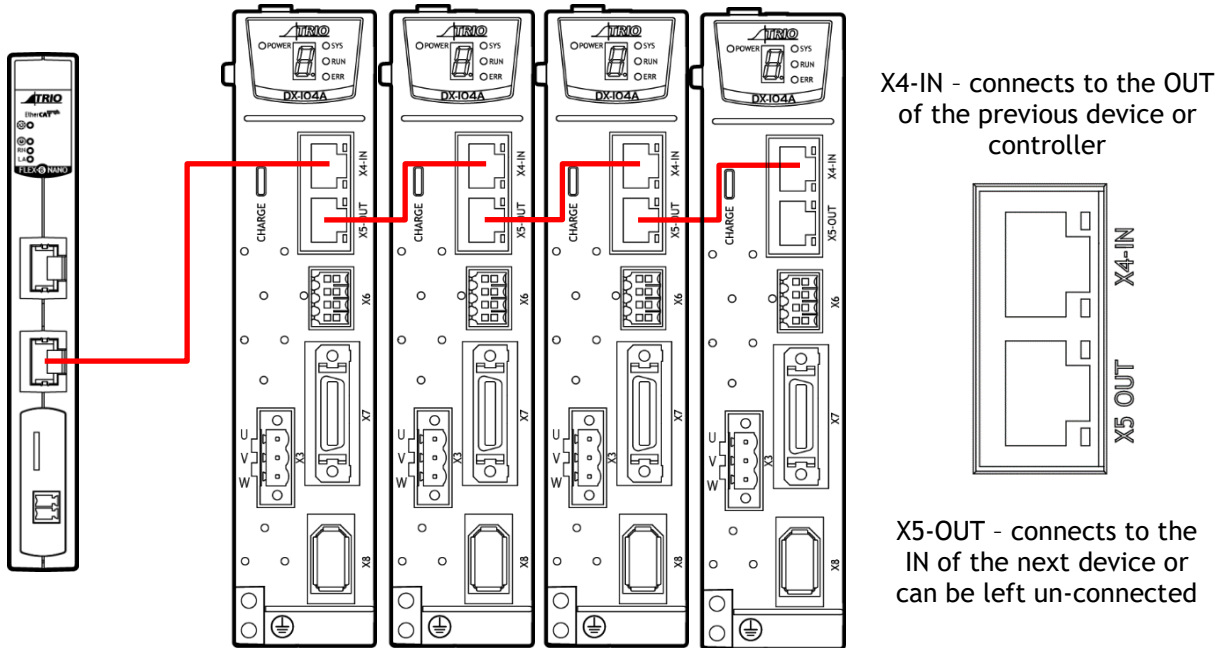
- Refer to section 3.3 for pin-out information.

Brake relay circuit example:



Chapter 6 EtherCAT Communication (X4, X5)

Connection Diagram



EtherCAT communication (X4-IN and X5-OUT) are RJ45 terminals. The communication cable from the network master or controller should be connected to X4-IN and X5-OUT should be connected to the X4-IN terminal of the next Drive (or network device).

Cable Description

Use category 5 (CAT5e SF/UTP) Ethernet communications cables for network connections. Metal shielded connectors are recommended to prevent signal interference.

Depending on the robot model, the set of drives power range will be different.

Robot type		Max load capacity	Drive wattage			
			Axis 1	Axis 2	Axis 3	Axis 4
RX3	RX3-400-SR	3 Kg	200w	100w	100w	100w
RX6	RX6-500-SR	6 Kg	400w	200w	100w	100w
	RX6-600-SR		400w	200w	100w	100w
	RX6-700-SR		400w	200w	100w	100w

Chapter 7 Revision History

Date	Version	Revised Contents
May, 2021	V0.01	First Draft

Trio Motion Technology Limited

 www.triomotion.uk