Anti Rolling Gyro

ARG250T INSTALLATION MANUAL

Model : MSM-25000T-A1

MITSUBISHI
HEAVY INDUSTRIES, LTD.

Preface

This installation manual is for installation agent that is selected by the Sales Agent.

This installation manual summarized important information for proper installation of Anti Rolling Gyro (**ARG**). Please be sure to read this manual before installation.

Please be sure to submit this manual to customers who operate the **ARG**.

Important Notice

■Purpose and Application of Use

- The **ARG** suppresses a rolling motion of the ship.
- The **ARG** applies a principle that the Gyro torque (force) is generated by inclination of the flywheel rotation at high speed.

■General Information

- In order to safely install and operate the **ARG**

  (a) Only the repairmen, who have received the specified training about the **ARG**, are permitted to perform the test run and inspection other than items mentioned in this manual.

  (b) Before installation of the **ARG**, carefully read this manual of the **ARG** for comprehending the details. If starting the work with insufficient knowledge, it may cause the **ARG** failure or an accident resulting in injury or death.

  (c) Do not disassemble and modify the **ARG** by yourself.
  If the **ARG** is disassembled or modified by the user,
  －It may cause a decrease in the **ARG** performance.
  －It may endanger human life.
  －It may cause a health problem.
  －It may cause damage to the **ARG** or ship.

- Depending on the type of the ship, it may be necessary for you to use multiple **ARG**s. In this case, the methods of installation and electric wires are somewhat different from those described in this manual.
- Please observe the applicable governmental and local laws and regulations.
- Please observe the governmental and local regulations for exportation of the **ARG**.
- Please observe the governmental and local regulations for disposal of the **ARG**.

■Important Information for Installation and Operation Safety

- The most important purpose of safety measures is to prevent the persons from an accident resulting in injury or death as well as to protect the **ARG** and ship from avoidable trouble.
- For preventing injury/death in an accident and the **ARG** from damage, follow the cautions, rules, and instructions described in this manual and attached operational instructions giving the top priority to safety. If ignored,
  (a) It may endanger human life.
  (b) It may cause a health problem.
  (c) It may cause damage to the **ARG** or ship.
- Mitsubishi Heavy Ind., Ltd. cannot foresee all possible danger existing in the **ARG**, resulting from human error, and in the environment where the **ARG** is used.
  There are many “Musts”, “Can’ts” and “Don’ts”, and it is impossible to mention all in this manual, attached operation instructions, or warning labels.
  Therefore, general safety measures must be taken in addition to the instructions described in this manual.
- Mitsubishi Heavy Ind., Ltd. is not responsible for any damage and hindrance resulting from user’s carelessness or lack of required attention to the specified rules shown in this manual and attached operation instructions.

■About Installation Manual

- This installation manual is written for native readers of English. When this **ARG** is handled by non-English-speaking people, give the people fully training on safety.
- The copyright of this manual is held and reserved by Mitsubishi Heavy Industries, Ltd. No drawing and no technical description in this manual regardless of partial or whole may be published, reproduced, copied, photographed, translated, or transcribed into electronic medium without written permission of MHI in advance.
- The **ARG** may differ from the pictures and drawings shown in this manual.
- The contents of this manual may be changed without prior notice.
- Carefully keep this manual in a certain place so that anybody can read it as the need arises.
- If there are any questions or doubts, please contact the Sales Agent.(“Contact” (last page))

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1 Safety Precautions

1.1 Warning description

■ Description of Labels

"Warning labels" and "Warning descriptions" in this manual warn expected dangerous situation that may occur during installation and operation.
If they are ignored, serious injuries or accidents corresponding to the respective warning sign may result. In extreme case, there is also a possibility of death, damage to the **ARG** or ship, and environmental fracture.

Warnings	Meanings of Warnings
IMPORTANT	Indicates "IMPORTANT" subjects that are observed in handling the **ARG**. If the **ARG** is handled with ignoring this indication, it could result in death or serious accident.
DANGER	Indicates a dangerous situation. If ignored, it could result in death, serious injury, serious property damage or environmental damage.
CAUTION	Indicates a dangerous situation. If ignored, it could result in minor injury, property damage or environmental damage.

■ Meanings of the symbols

Symbols	Meanings	Examples
Prohibition sign	"⃠" indicates prohibition. Detail is shown in the inside of the symbol, or shown by illustration or sentence near the symbol. The right illustration means "**DO NOT DISASSEMBLE**".	DO NOT DISASSEMBLE
Caution sign	"△" indicates danger or caution. Detail is shown in the inside of the symbol, or shown by illustration or sentence near the symbol. The right illustration means "**DANGER OF ELECTRIC SHOCK**".	DANGER OF ELECTRIC SHOCK
Direction sign	"●" indicates mandatory contents. Detail is shown by illustration, or sentence near the symbol or inside the symbol.	(General direction)

Anti Rolling Gyro
Model : MSM-25000T-A1

1.2 Warning labels

Do not disassemble.

危 険 DANGER
分解禁止
分解、改造や機能部品の流用はしないで下さい。
DO NOT DISASSEMBLE
Do not disassemble or modify the ARG or use a substitute for any of its parts.

Do not place objects.

注 意 CAUTION
積載禁止
ARG 本体カバーの上に物を載せたり、人が乗ったり、腰掛けたりしないで下さい。
DO NOT PLACE OBJECTS
Do not place objects, sit on or step on the ARG cover.

Danger of electric shock.

危 険 DANGER
感電危険
コネクタを外さないで下さい。
DANGER OF ELECTRIC SHOCK
Do not remove electrical connector.

Hot surface
（Both covers）

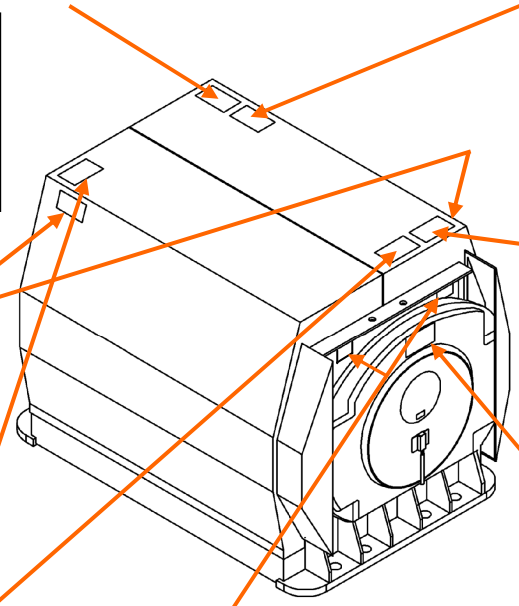
注 意 CAUTION
高温注意
ARG 本体（特にダンパ）は高温になるので手を触れないで下さい。
HOT SURFACE
Do not touch ARG (e.g. damper) during operation.

Hot surface
（Both dampers）

注 意 CAUTION
高温注意
ARG 本体（特にダンパ）は高温になるので手を触れないで下さい。
HOT SURFACE
Do not touch ARG (e.g. damper) during operation.

Do not close.

危 険 DANGER
閉塞禁止
ARG 本体の通風口をふさがないで下さい。
DO NOT CLOSE
Do not close the blowholes of the ARG unit.

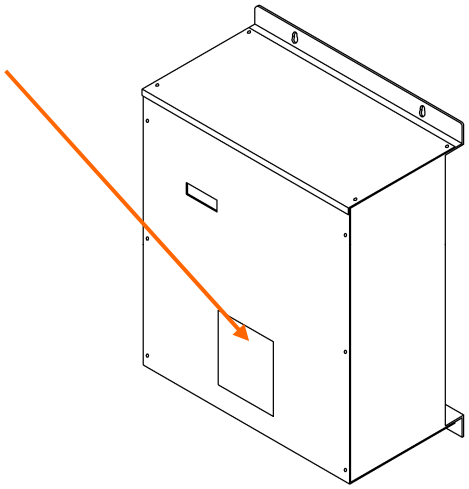


Connector

ARG unit

Danger of electric shock.
Do not disassemble.
Do not close.

危 険 DANGER
感電危険
電気配線作業は電気工事の有資格者が行って下さい。
DANGER OF ELECTRIC SHOCK
Wiring must be performed by qualified personnel.
分解禁止
モータドライバのふたを開けないで下さい。
DO NOT DISASSEMBLE
Do not open the Motor Driver's lid.
閉塞禁止
モータドライバの通風口をふさがないで下さい。
DO NOT CLOSE
Do not close the blowholes of the Motor Driver.



Motor Driver

1.3 Precautions of installation/test run

Observe the following when installing and performing test run.

IMPORTANT

General Precautions

- Be sure to read this manual and understand the contents before installing the **ARG**.
- Be sure to read operation instructions and understand the contents before operating the **ARG**.

Installation Environment

The installation environment must be as specified in this manual.

Check of Products

Do not install damaged parts or do not install with some parts missing.

Installation location

Choose the location for installing the **ARG** unit appropriately in consideration for ship's center of gravity, balance and reinforcement besides convenience.

Not doing so could result in deterioration in the performance of ship.

Installation

- The crane must be operated by qualified personnel. Observe the contents of this manual for operation.
- Wiring must be performed by qualified personnel.
- Be sure to use the Motor Driver supplied by MHI. Observe the contents of this manual for operation.

Test Run

- Only the repairmen, who have received the specified training about the **ARG**, are permitted to perform the test run.
- If abnormality occurs during operation of the **ARG**, immediately turn off the switch to shut down the **ARG**. Contact the Sales Agent.("Contact" (last page)

Disposal

Observe the governmental and local regulations for disposal of the **ARG**.

1.4 Check of Products

DANGER

Do not install damaged parts or do not install with some parts missing.
Doing so could result in injury or malfunction.
（Refer to page 14）

Do not store the ARG unit, Motor Driver and its related parts in the following locations.
Doing so could result in malfunction.
- Locations exposed to direct sunlight or water/rain.
- Locations without flat surface.
- Locations exposed to dust.
- Locations exposed to vibration.

（Refer to page 14）

1.5 Before installation

⚠ DANGER

Do not disassemble or modify without authorization, and do not use the ARG for other purposes.
Doing so could result in damage, malfunction, injury or electric shock.
（Refer to page 28）

Choose the location for installing the ARG unit appropriately in consideration for ship's center of gravity, balance and reinforcement besides convenience.
Not doing so could result in deterioration in the performance of ship.
（Refer to page 28）

Ventilate the work space if the work related to the ARG is in closed space.
Not doing so could result in poisoning depending on the materials to be used.
（Refer to page 28）

Do not install the ARG unit in the following locations.
Doing so could result in electric shock, malfunction, damage to ship or fire.

- Locations exposed to wave, rain, wind or direct sunlight.
- Locations exposed to harmful gases, dust, liquid or oil mist.
- Locations without flat surface.
- Locations where strength and stiffness of the hull is not enough to withstand the maximum gyro torque (moment), and a member from which the load can not be transferred to the major members of hull.
- Locations exposed to vibration.
- Locations where ambient temperature is not -10 to 40℃.
  If the temperature expected to be 40□ or higher, ventilation is required to cool the **ARG** unit down.
- Locations exposed to flammable materials or heat-sensitive items.
- Locations without a space of 200mm (7.9inches) around the **ARG** unit. But if there are enough space where the inspection and maintenance can be performed, this space (200mm (7.9inches)) could be a target.
- Locations where passengers can touch the **ARG** unit easily.

（Refer to page 28）

⚠ DANGER

Do not install the Motor Driver in the following locations.
Doing so could result in electric shock, malfunction or fire.
- Locations exposed to wave, rain, wind or direct sunlight.
- Locations exposed to harmful gases, dust, liquid or oil mist.
- Locations without flat surface.
- Locations exposed to vibration.
- Locations where ambient temperature is not -10 to 40℃.
  If the temperature expected to be 40□ or higher, ventilation is required to cool the Motor Driver down.
- Locations exposed to flammable materials or heat-sensitive items.
- Locations without a space of 200mm (7.9inches) around the Motor Driver.
- Locations where passengers can touch the **ARG** unit easily.

（Refer to page 32）

1.6 Installation

⚠ DANGER

The Motor Driver's weight is approximately 15kg / 33.1lbs.
Do not drop the Motor Driver when installing and removing one.
Doing so could result in injury or malfunction.
（Refer to page 39）

Do not short R/L1, S/L2, T/L3 power input terminal of the Motor Driver and U/T1, V/T2, W/T3 connecting terminal of the ARG unit between terminals.
Doing so could result in malfunction or fire.
（Refer to page 44）

Do not solder the socket contact and cable.
Doing so could result in electric shock or fire.
（Refer to page 52）

Be sure to turn off the power supply before performing wiring.
Not doing so could result in electric shock.
（Refer to page 42）

Do not operate switches or perform wiring with wet hands.
Doing so could result in electric shock.
（Refer to page 42,52）

DANGER

The Motor Driver is still charged with an electric voltage just after turning off the power supply. If performing the wiring after turning off the Motor Driver, wait for at least 5 minutes after turning off the power supply. Further, make sure that the lamp of "the Touch panel" is off.
Not doing so could result in electric shock.
（Refer to page 50）

The ARG unit is heavy (approximately 700kg / 1543lbs).
Use crane which is suitable for weight of the ARG unit.
Not doing so could result in injury or damage to the **ARG** unit and ship.
（Refer to page 34）

Be sure to sling up the ARG unit with the attached hanger.
Not doing so could result in injury or damage to the **ARG** unit and ship.
（Refer to page 34）

Make sure the following items when slinging up or moving the ARG unit.
Not doing so could result in injury or damage to the **ARG** unit or ship.
- Eyebolts of hanger and attachment hanger bolts (M8) are tightened by regular torque.
- Eyebolts of hanger are tightened in correct direction as shown in Figure 4-3.

（Refer to page 34）

Be sure to install the Motor Driver in the correct direction.
Not doing so could let water enter inside and result in electric shock or fire.
（Refer to the Figure 4-8）
（Refer to page 39）

Install the Motor Driver in a metal or nonflammable surface.
Not doing so could result in fire.
（Refer to page 39）

The Motor Driver must be connected only to a matched ARG unit. Make sure that the serial number (ARG S/N) on the nameplate of the Motor Driver has a same serial number as the ARG unit.
Not doing so could result in injury or malfunction.(Refer to the Figure 4-9）
（Refer to page 39）

Take off the metallic items (wristwatch, ring, etc.) from your body before starting work.
Not doing so could result in electric shock.
（Refer to page 42）

⚠ DANGER

Use insulated tools.
Not doing so could result in electric shock.
（Refer to page 42）

Wiring must be performed by qualified personnel.
Not doing so could result in electric shock, malfunction or fire.
（Refer to page 42）

Use appropriate tools for wiring.
Not doing so could result in electric shock or fire.
（Refer to page 44）

Be sure to perform wiring correctly.
Not doing so could result in electric shock or fire.
（Refer to page 44）

Be sure to insulate electrical wiring connections.
Not doing so could result in electric shock or fire.
（Refer to page 44）

Be sure to install the circuit breaker switch between the power supply of the ship and the Motor Driver.
Not doing so could result in electric shock or fire.
（Refer to page 44）

Be sure to use electric cables specified in this manual.
They must be as short as possible and their conductors must be as thick as possible. Be sure to use cables for ship use. They must be conformed to standards or regulations of your country.
Not doing so could result in fire.
（Refer to page 44）

Use crimp terminals of appropriate shape, size and power rating for each unit.
Not doing so could result in electric shock or fire.
（Refer to page 44）

Connect the ground lead of each Motor Driver to the ground connection point in the ship. Connect the ARG ground lead by securing the one of the hanger installation bolt.
Not doing so could result in electric shock.
（Refer to page 45）

Fix cable with clamps so that the cable from the Motor Driver isn't pulled.
Not doing so could result in electric shock.
（Refer to page 50）

⚠ DANGER

Be sure to place the lid of the Motor Driver and secure it with screws after completing wiring and inspection.
Not doing so could result in electric shock, malfunction or fire.
（Refer to page 50）

Be sure to use appropriate tools and follow the procedure shown in p52 to p59 for assembling the connector.
Using inappropriately assembled cable could result in electric shock, malfunction or fire.
（Refer to page 52）

Make sure the cable line from the small hole (crimp side of the socket contact), and then crimp it.
Not doing so could result in electric shock or fire.
（Refer to page 52）

Do not mix the power connector parts with safety device connector parts.
Doing so could result in electric shock or fire.
（Refer to page 52）

⚠ CAUTION

Do not place objects, sit on or step on the ARG cover.
The **ARG** cover is not made of strengthened material. If you place objects, sit on or step on the **ARG** cover, it could result in damage. During operation, the **ARG** components inside the cover are rotating at high speed. Therefore, broken **ARG** cover could cause injury or malfunction.
（Refer to page 34）

Never remove the electric wires that have already been connected inside the Motor Driver.
Doing so could result in malfunction.
（Refer to page 45）

Do not use the Motor Driver terminals other than those described in the wiring diagram of this manual.
Doing so could result in malfunction.
（Refer to page 45）

The adjustment work of the touch panel (Refer to page 50) must be performed by qualified personnel, who has completed ARG maintenance training.
Wrong key operation could result in malfunction or trouble.
（Refer to page 45）

⚠ CAUTION

Do not hit the ARG unit or the Motor Driver against the neighboring equipment or people when moving the ARG unit or the Motor Driver. And, do not give a strong shock.
Doing so could result in injury or damage to the **ARG** or ship.
（Refer to page 34）

Be careful of the ARG cover's edge when handling the ARG cover.
Not doing so could result in injury.
（Refer to page 34）

Be sure to remove the ARG hanger after moving the ARG unit.
Not doing so could result in injury.
Keep the **ARG** hanger because it is used at maintenance.
（Refer to page 35）

Take measure against galvanic corrosion when installing the ARG unit in an aluminum ship. Give electric insulation treatment or anodic protection, etc. to the surface of the ship on which the ARG unit is installed. Refer to Figure 4-7 for the example of insulation.
Not doing so could result in damage to ship.
（Refer to page 36）

Use all installation parts attached.
Not doing so could result in damage to the **ARG** unit or ship.
（Refer to page 36）

Be sure to tighten the installation bolts and nuts by regular torque.
Loosening bolts and nuts could result in damage to the **ARG** unit or ship.
（Refer to page 36）

Re-tighten the installation bolts and nuts by regular torque after 1 or 2 days from installation.
Loosening bolts and nuts could result in damage to the **ARG** unit or ship.
（Refer to page 36）

Be sure to use the Motor Driver supplied by MHI.
Not doing so could result in malfunction.
（Refer to page 39）

Make sure that the power generator of the ship is same as the specified Motor Driver's input voltage.
Using different power supply voltage to the Motor Driver could result in malfunction.
（Refer to page 42）

⚠ CAUTION

If the power supply of the ship is three-phase@200-240VAC, use the three-phase power supply for the Motor Driver.
If single-phase@220-240VAC is used for the Motor Driver, the power supply of the ship becomes unsteady and could result in malfunction.
（Refer to page 42）

1.7 Installation（With anti-vibration rubber）

⚠ DANGER

Adjust the compression length of rubber to 6mm by using the Shim.
Not doing so could result in damage to the **ARG** unit or ship.
（Refer to page 86）

⚠ CAUTION

Regular torque is as follows. Do not tighten with wrong torque.
Doing so could result in malfunction. （Refer to page 88）

No	Without anti-vibration rubber	With anti-vibration rubber
1	300 N·m±10% （30 kgf·m±10%） （2,610lbs·in±10%）	130 N·m±10% （13kgf·m±10%） （1,131 lbs·in±10%）

Use all installation parts attached.
Not doing so could result in damage to the **ARG** unit or ship.
（Refer to page 88）

Be sure to tighten the installation bolts and nuts by regular torque.
Loosening bolts and nuts could result in damage to the **ARG** unit or ship.
（Refer to page 88）

Re-tighten the installation bolts and nuts by regular torque after 1 or 2 days from installation.
Loosening bolts and nuts could result in damage to the **ARG** unit or ship.
（Refer to page 88）

1.8 Test Run

DANGER

Do not remove the ARG cover.
During operation, the inner parts of the **ARG** are rotating at high speed.
Doing so could result in injury.
（Refer to page 61）

Do not close blowholes of the ARG.
The inside of the **ARG** unit and the Motor Driver becomes high in temperature by closing blowholes.
It could result in malfunction or fire.
（Refer to page 61）

The ARG is not waterproofed. Never operate the ARG when it is exposed to seawater / rain.
Doing so could result in electric shock or malfunction.
（Refer to page 61）

Do not remove the ARG connector during operation.
Doing so could result in electric shock.
（Refer to page 61）

If you notice an unusual noise, vibration or any other abnormality during operation of the ARG, immediately turn off the power supply to shut down the ARG.
Keeping the **ARG** running under abnormal conditions could result in unexpected accident.
（Refer to page 61）

Use all installed ARG units.
Using only a few of them could lead to excessive load, and it could result in malfunction.
（Refer to page 61）

If the 80 or 90 of the thermo label discolors, contact the Sales Agent.
Not doing so could result in damage to ship, malfunction of the **ARG** or injury.
（Refer to page 61）

If there is any oil leakage from the damper, contact the Sales Agent.
Not doing so could result in damage to ship, malfunction of the **ARG** or injury.
（Refer to page 61）

⚠ CAUTION

Do not allow extraneous materials and dust to enter through the blowholes of the ARG unit.
Doing so could result in malfunction.
（Refer to page 62）

Do not approach the ARG unit while the ARG is operating.
Doing so could result in injury.
（Refer to page 62）

It takes approximately 1 hour until the ARG completely stops after the remote switch has been turned off.
Do not approach the ARG unit and the Motor Driver until the ARG completely stops.
Doing so could result in injury.
（Refer to page 62）

Do not touch the ARG unit during operation or soon after the ARG stops.
Doing so could result in a skin burn due to the hot surface.
（Refer to page 62）

Do not damage electric cables when handling the ARG cover.
Doing so could result in malfunction.
（Refer to page 62）

1.9 Disposal

⚠ DANGER

Observe the governmental and local regulations for disposal of the ARG.

2 Check of Products

2.1 After taking out products from the shipping box

The **ARG** consists of the **ARG** unit, Motor Driver and its related parts.
Before installing the **ARG** to your ship, please check your products according to Table 2-1 to make sure that you have received parts as shown Figure 2-1, 2-2 and 2-3.
Please prepare items shown in Table 2-2 (p.19).

DANGER

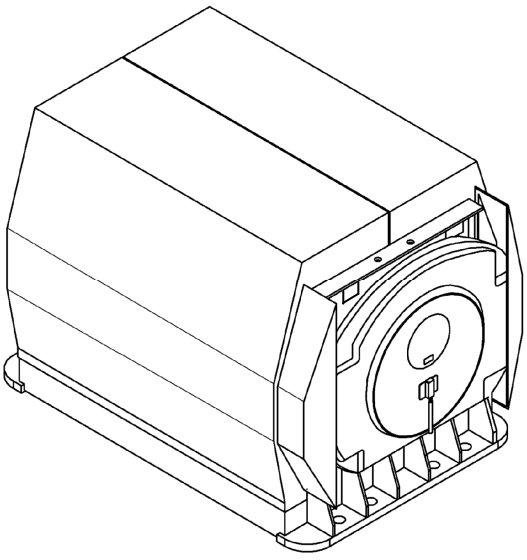
Do not install damaged parts or do not install with some parts missing.

Doing so could result in injury or malfunction.

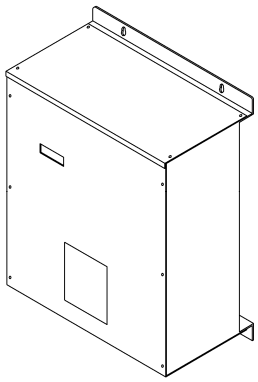
Do not store the ARG unit, Motor Driver and its related parts in the following locations.

Doing so could result in malfunction.

- Locations exposed to direct sunlight or water/rain.
- Locations without flat surface.
- Locations exposed to dust.
- Locations exposed to vibration.



ARG unit
（MSM-25000T-A1、1EA）



Motor Driver
（MAA-2000/4000A-A200、1EA）

Figure 2-1 Checking of the delivered **ARG** （No.1）

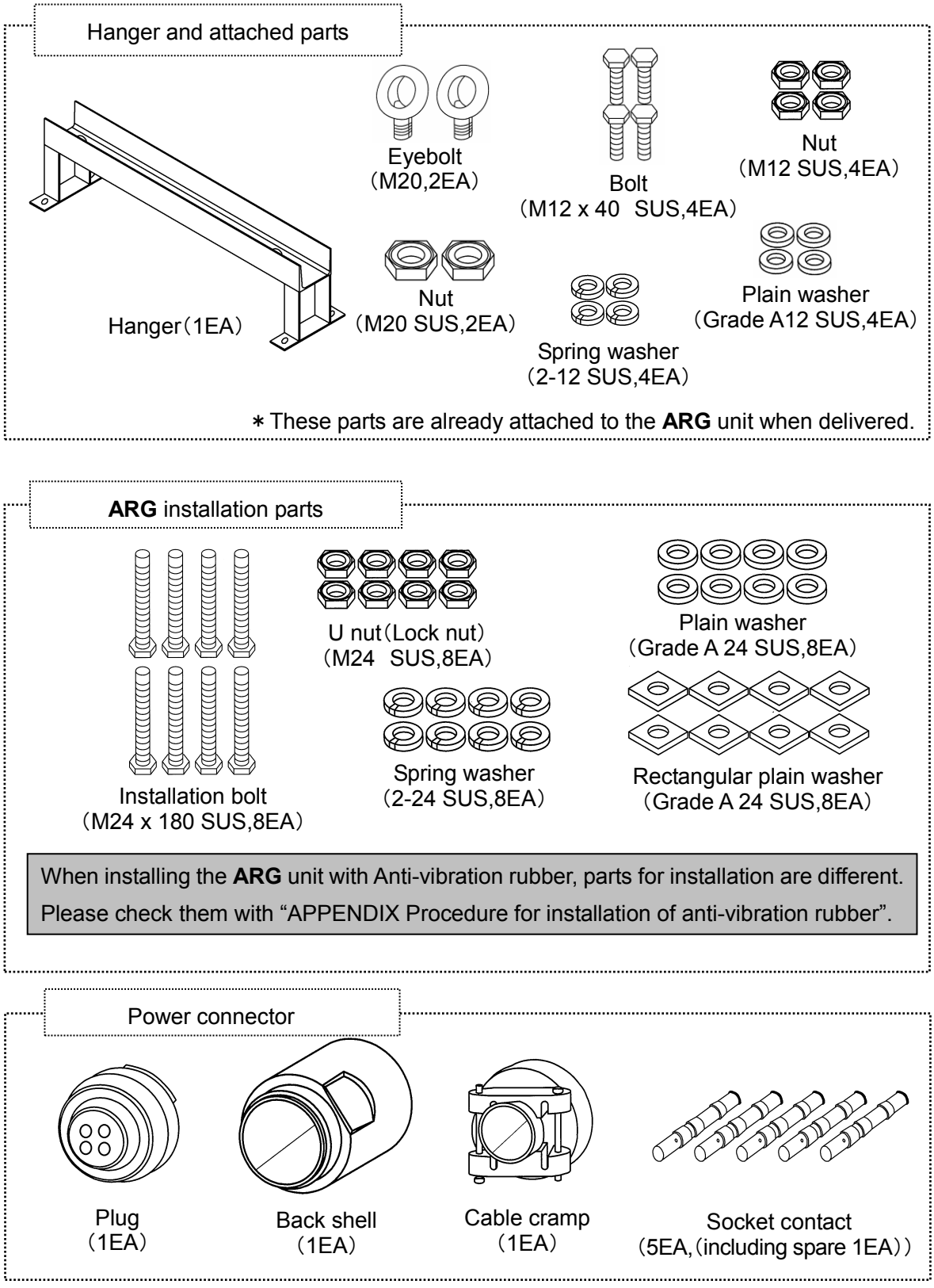


Figure 2-2　Checking of the delivered **ARG**（No.2）

Anti Rolling Gyro
Model：**MSM-25000T-A1**

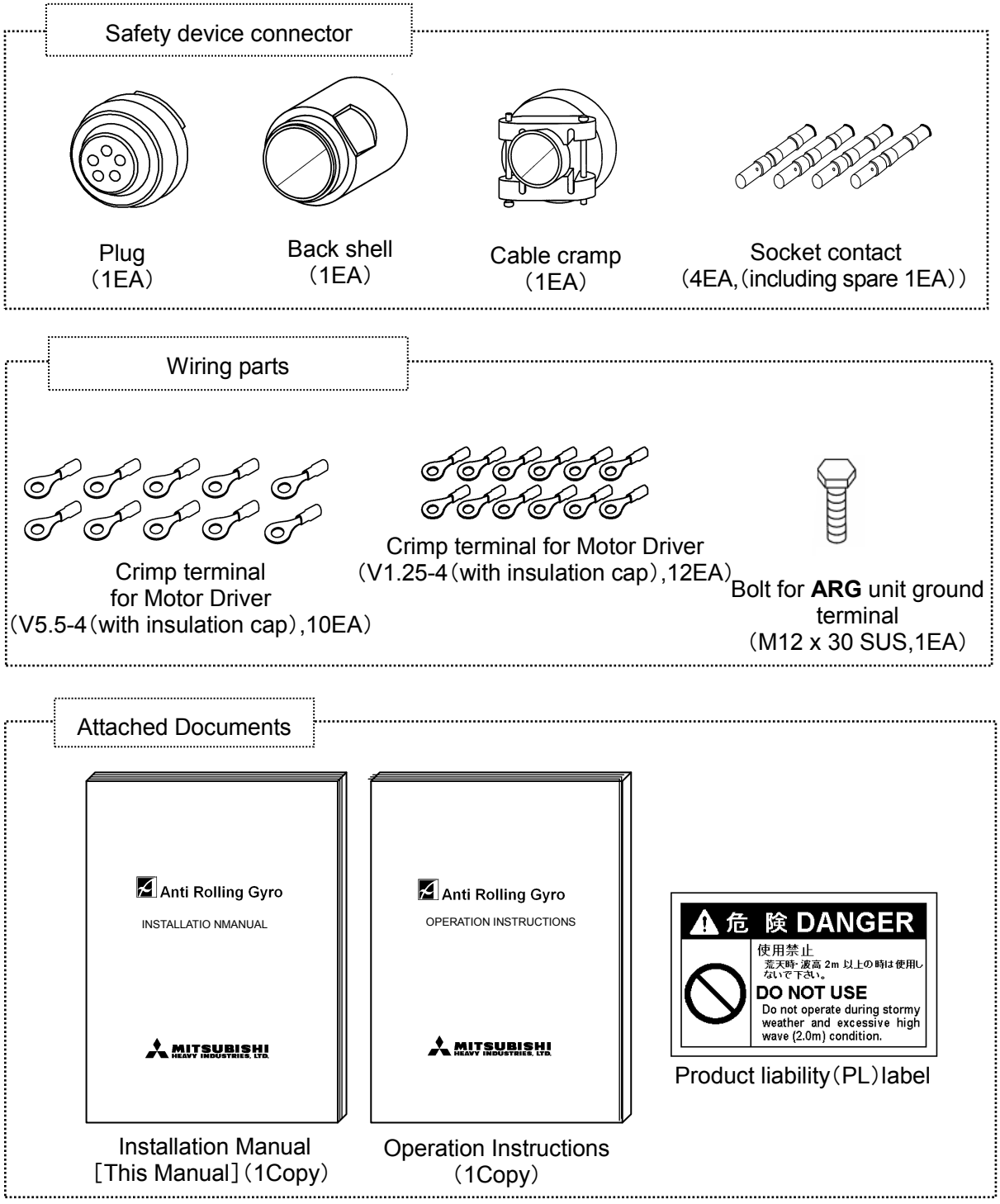


Figure 2-3　Checking of the delivered **ARG**（No.3）

Table 2-1 **ARG** Parts Check List No.1

Item	Nomenclature	Number	Customer Check list
ARG unit	MSM-25000T-A1	1EA	☐
Motor Drive	MAA-2000/4000A-A200	1EA	☐
Hanger and its attached parts	Hanger	1EA	☐
	Eyebolt（M20）	2EA	☐
	Nut（M20 SUS）	2EA	☐
	Bolt（M12 x 40 SUS）	4EA	☐
	Nut（M12 SUS）	4EA	☐
	Spring washer（2-12 SUS）	4EA	☐
	Plain washer（Grade A 12 SUS）	4EA	☐
ARG Installation parts*1	Installation Bolt（M24 x 180 SUS）	8EA	☐
	U nut（Lock nut）（M24 SUS）	8EA	☐
	Spring washer（2-24 SUS）	8EA	☐
	Plain washer（Grade A 24 SUS）	8EA	☐
	Rectangular plain washer (Grade A 24 SUS)	8EA	☐
Power connector	Plug	1EA	☐
	Back shell	1EA	☐
	Cable cramp	1EA	☐
	Socket contact	5EA (Including 1EA spare)	☐
Safety device connector	Plug	1EA	☐
	Back shell	1EA	☐
	Cable cramp	1EA	☐
	Socket contact	4EA (Including 1EA spare)	☐

*1：When installing **ARG** unit with Anti-vibration rubber, parts for installation are different. Please check them with “APPENDIX Procedure for installation of anti-vibration rubber”.

Table 2-1 **ARG** Parts Check List No.2

Item	Nomenclature	Number	Customer Check list
Wiring Parts	Crimp terminal for Motor Driver （V5.5-4（with insulation cap））	10EA	□
	Crimp terminal for Motor Driver （V1.25-4（with insulation cap））	12EA	□
	Bolt for the **ARG** unit ground terminal （M12 x 30 SUS）	1EA	□
Attached Documents	Installation manual［This manual］	1Copy	□
	Operation Instructions	1Copy	□
	Product liability (PL) label	1EA	□

Table 2-2 Customer procurement items

No.	Item	Quantity	Notes
1	220-240V 50/60Hz single-phase ac generator; or 200-240V 50/60Hz three-phase ac generator	1set	Each generator must be able to power the **ARG** that consumes a maximum of more than 4.8kW @Single-phase, more than 4.3kW @Three-phase.
2	Circuit breaker switch	1set	Three-phase AC200-240VAC,30A single-phase AC220-240VAC,30A
3	Power cable for use between the **ARG** unit and Motor Driver	1set	Cable for ship use : 4.0 mm^2 / AWG 11 minimum x 3 cores with shield Outer diameter : φ18-25mm/φ0.7-1.0inches MHI supplies connector for the **ARG** unit side.
4	Power cable for use between power supply and Motor Driver	1set	Cable for ship use : Core thickness : 4.0mm^2 / AWG 11 minimum **(Note)** Three-phase power supply : 3cores Single-phase power supply : 2cores Outer diameter : φ18-25mm/φ0.7-1.0inches with shield.
5	Electric cable between remote switch and Motor Driver	1set	Cable for ship use : two-core cable with 1.00 mm^2 or thicker conductors (with shield)
6	Remote switch	1set	Must be a latch type switch. Move the lever reciprocity to remote control the **ARG**'s starting and stopping operation. (No voltage connect switch) more than 24VDC
7	Electric cable between start check lamp and the Motor Driver	1set	Cable for ship use : two-core cable with 1.00 mm^2 / AWG 17 or thicker conductors (with shield)
8	Start check lamp*	1set	Lamp specification : 24VDC, under 50mA (LED lamps, etc)
9	Electric cable between rotation rate check lamp and the Motor Driver	1set	Cable for ship use : 1.00mm^2 /AWG 17 minimum x 2 cores with shield
10	Rotation rate check lamp*	1set	24VDC, 50mA maximum (rated)
11	Electric cable for safety device between the **ARG** unit and Motor Driver	1set	Cable for ship use : 1.25mm^2 /AWG 16 minimum x 2 cores with shield MHI supplies connector for the **ARG** unit side.
12	Motor Driver installation bolts and washers	1set	M6 x 4EA, No.6 x 4EA, 2-6 x 4EA
13	Ground lead (for the **ARG** unit & Motor Driver)	1set	Cable for ship use : 5.5mm^2 / AWG 9 minimum x single core Outer diameter : φ10-14mm/φ0.4-0.5inches
14	Heat shrinkage tube	As required	For assembling the connectors
15	Insulation tape	As required	For cable wiring

(**Note**) This specifies only for 1 **ARG**. If you use more than 2 **ARG**s with same cable thickness, please choose appropriate cable thickness that meet required capacity according to this manual.

2.2 **ARG** unit

①Specifications

Table 2-3 **ARG** unit specifications （1EA）

Item	Specifications
Name	**ARG**250T
Model	MSM-25000T-A1
Dimensions	1020mm(width) x 720mm(depth) x 700mm(height) 40.2 inches(width) x 28.3 inches(depth) x 27.6 inches(height)
Weight	Approx. 700kg / 1543 lbs
Power supply	Supplied by exclusive Motor Driver (MAA-2000/4000A-A200) (Single-phase 220 to 240VAC 50/60Hz / Three phase 200 to 240VAC 50/60Hz)
Ambient temperature	-10 to 40℃
Power consumption*1)	Single-phase：Approx. 4.8kW(Max)　3.5kW(Max) (Steady-state) Three-phase：Approx. 4.3kW(Max)　3.0kW(Max) (Steady-state)
Angular momentum	Approx. 5000Nms
Rotational speed	Approx. 3750rpm
Noise *2)	80dBA maximum
Vibration *2)	1 m/s^2 maximum
Performance	・ The **ARG** suppresses rolling motion of the ship. ・ The **ARG** applies a principle that the Gyro torque (force) is generated by inclination of the flywheel rotating at high speed. ・ The **ARG** stops automatically in abnormal conditions (excessive load, abnormal temperature, etc.).
Others	Start up duration to the rated speed: Approx. 40 minutes To stop the operation completely from the steady-state: Approx. 60 minutes

*1) Power consumption varies with the customer generator.
*2) Measurement as per MHI's specification.
The measurements data depend on measurements conditions (installation place, measurements method, etc.).

②External view

As shown in Figure 2-4, main external parts consist of Frame, Damper and Cover. Main internal parts are Gimbal and high speed rotating Flywheel.

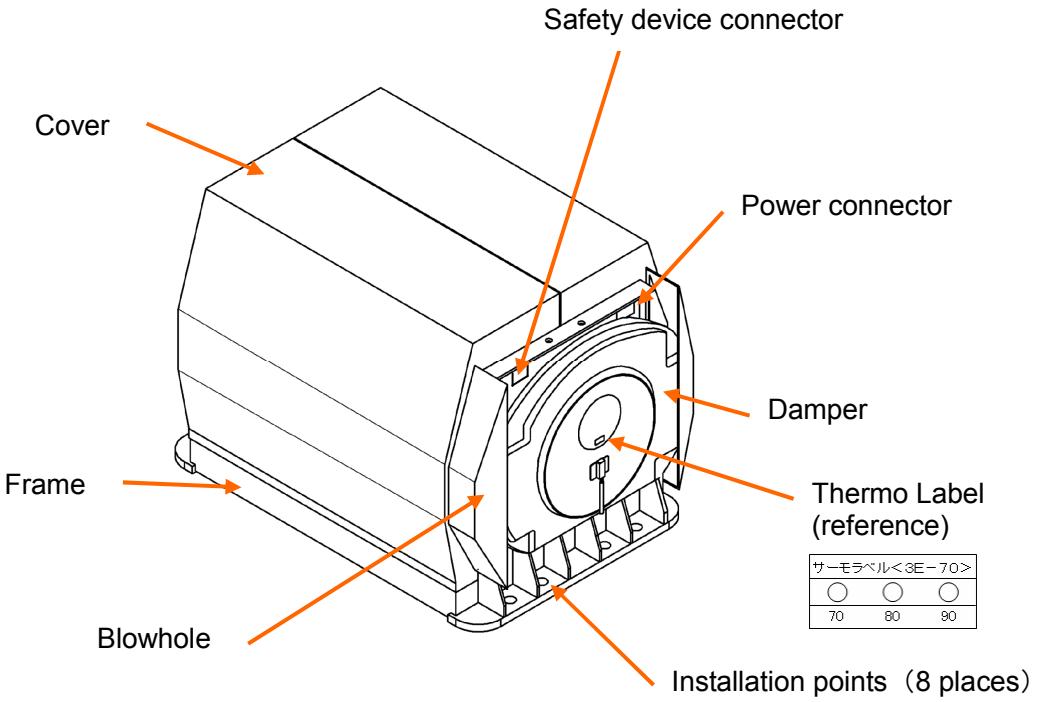
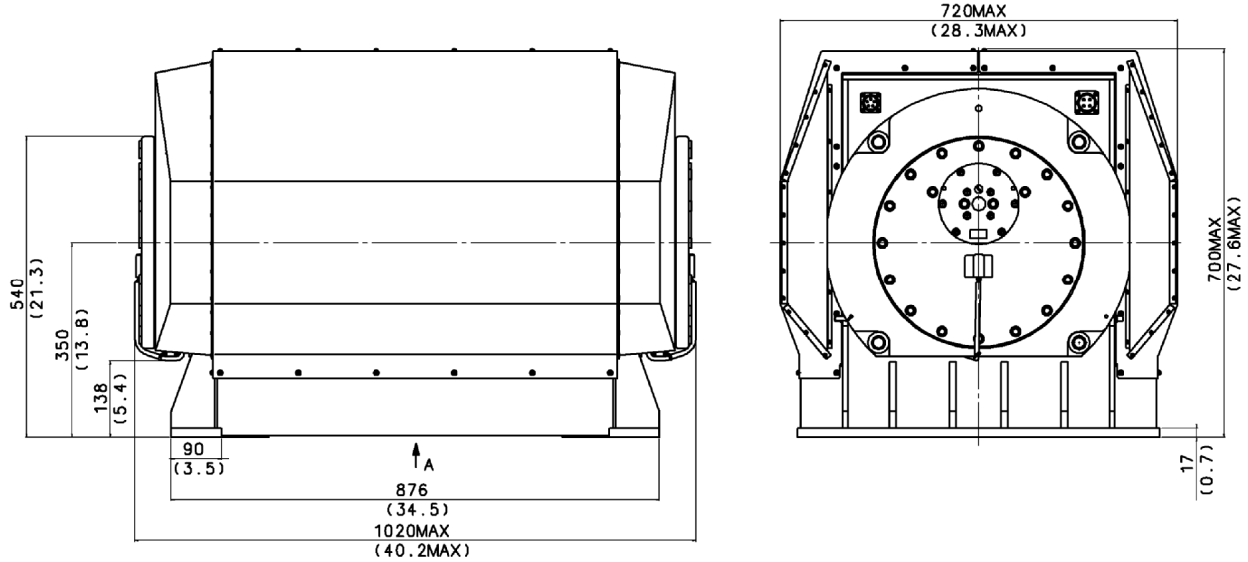


Figure 2-4 **ARG** unit external view

Anti Rolling Gyro
Model：**MSM-25000T-A1**

③Dimensions

The dimensions of the **ARG** unit are shown in Figure2-5.



unit：mm(inch)

Figure 2-5　Dimensions for the **ARG** unit

④Nameplate

Make sure the nameplate on the **ARG** unit, which must be as shown in Figure 2-6.

Figure 2-6 Nameplate for the **ARG** unit

2.3 Motor Driver

① Specifications

Table 2-4 Motor Driver Specifications（1EA）

Item	Specifications
Model	MAA-2000/4000A-A200
Dimensions	350mm(width) x189mm(depth) x 400mm(height) 13.8 inches(width) x 7.4 inches(depth) x 15.7 inches(height)
Weight	Approx. 15kg / 33.1lbs
Control method	Inverter control
Ambient temperature	-10 to 40℃
Humidity	5 to 95% (with no condensation)
Power supply *3)	Single-phase 220 to 240VAC 50/60Hz / Three-phase 200 to 240VAC 50/60Hz
Function（outer connecting terminal）(Please prepare by customer)	① Remote switch: connect to the Motor Driver to remote control the **ARG** operation (ON/OFF). The **ARG** can be switched on/off by this remote switch. ② Start check lamp: connect to the Motor Driver to make sure the **ARG** is in operation or not. ③ Rotation rate check lamp: connect to the Motor Driver to make sure the **ARG** had reached the rated rotational speed (steady-state) or not.
Others	The **ARG**'s operating condition is checked by Monitoring window

*3) The Motor Driver is able to use both single-phase and three-phase. Please choose appropriate power input as needed.

② External view

External view of the Motor Driver is shown in Figure 2-7. The terminal and inverter is installed inside.

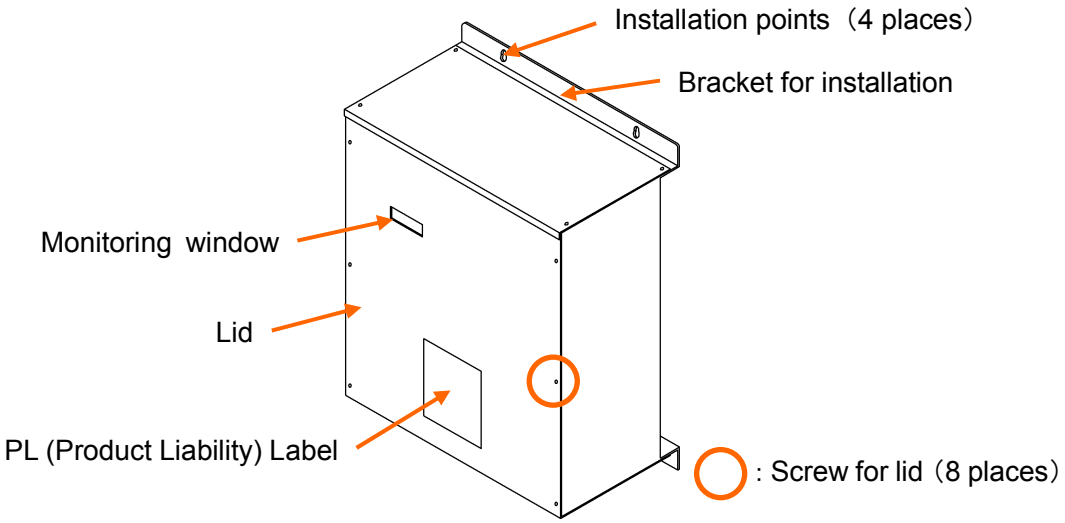


Figure 2-7 Motor Driver External view

③Dimensions

The dimensions of the Motor Driver are shown in Figure 2-8.

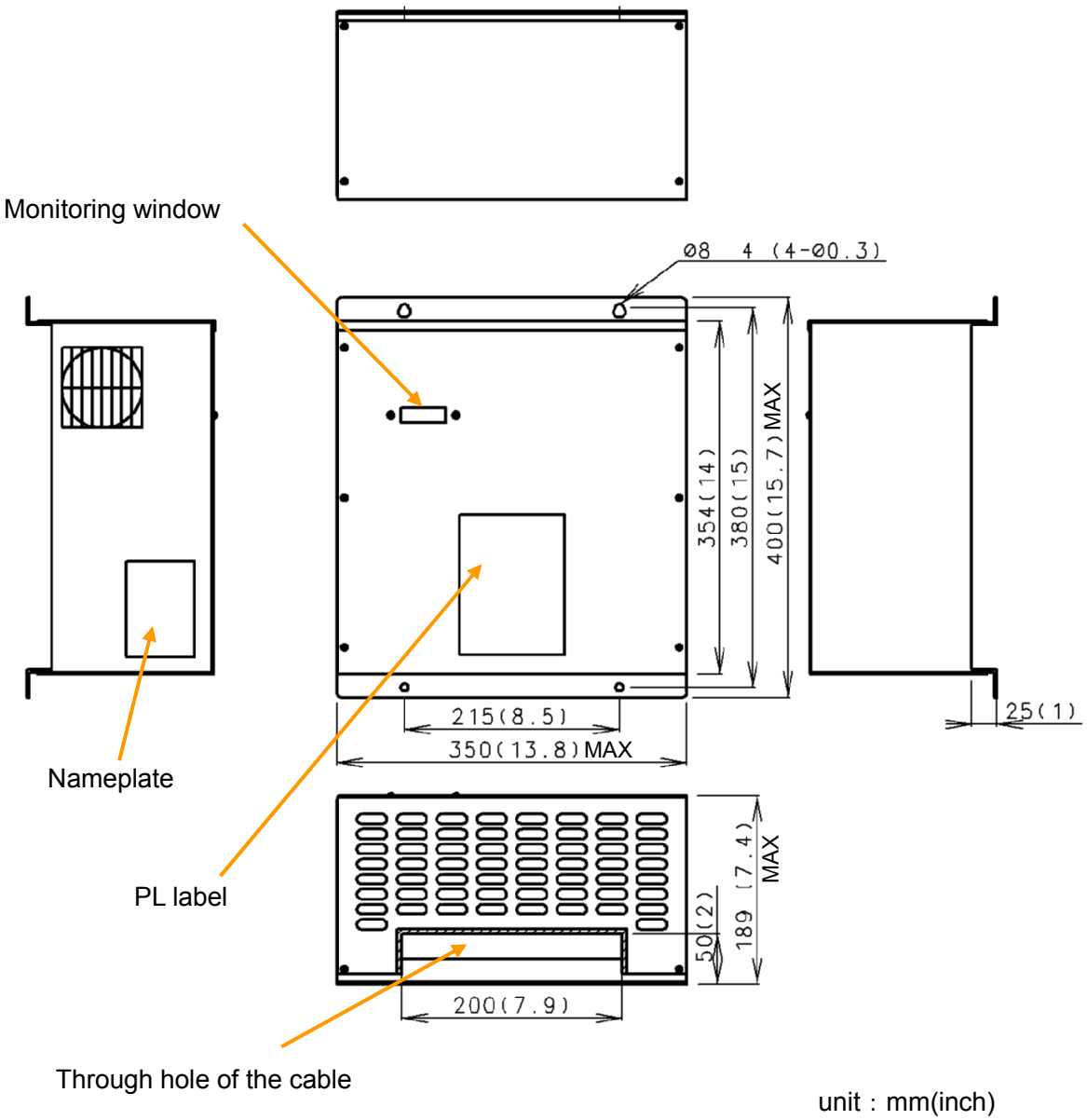


Figure 2-8 Dimensions for Motor Driver

④Nameplate

Make sure the nameplate on the Motor Driver, which must be as shown in Figure 2-9.

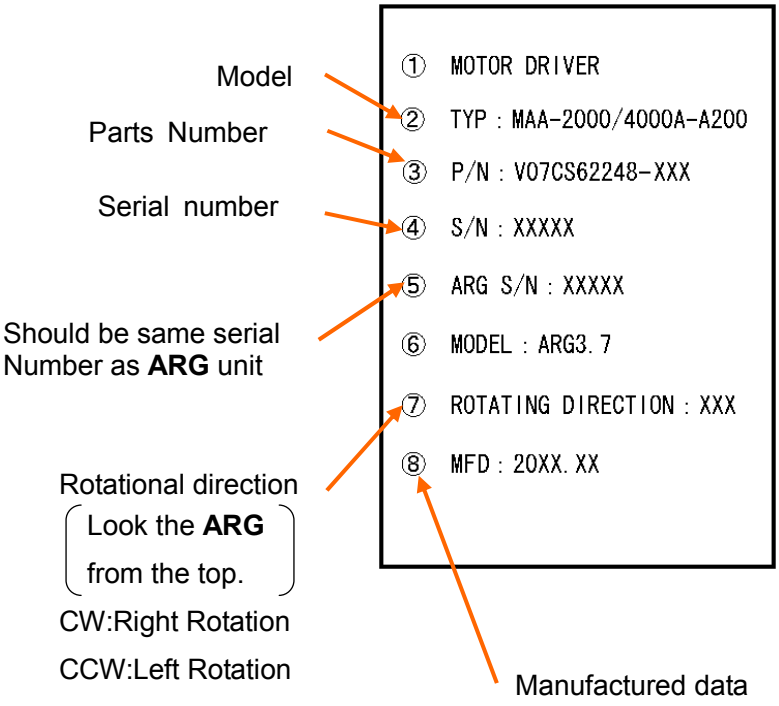


Figure 2-9 Nameplate for the Motor Driver

3 Before installation

3.1 **ARG** Gyro torques (moment)

In order to suppress the rolling of a ship due to waves or other external forces, every **ARG** exerts a maximum torque of 50kN·m/1EA(approximately 5,100kgf·m/442,500lbs·in/1EA)on the hull of the ship, as shown in Figure 3-1.

M(moment) : Maximum 50kN·m(approximately 5,100kgf·m/442,500lbs·in)
F(force) : Maximum 13.5kN×4
(1,380kgf×4/3,042lbs×4)

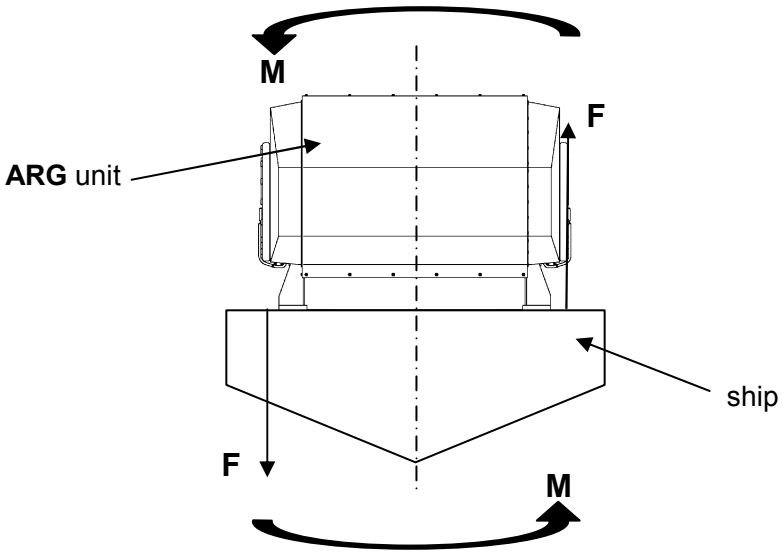
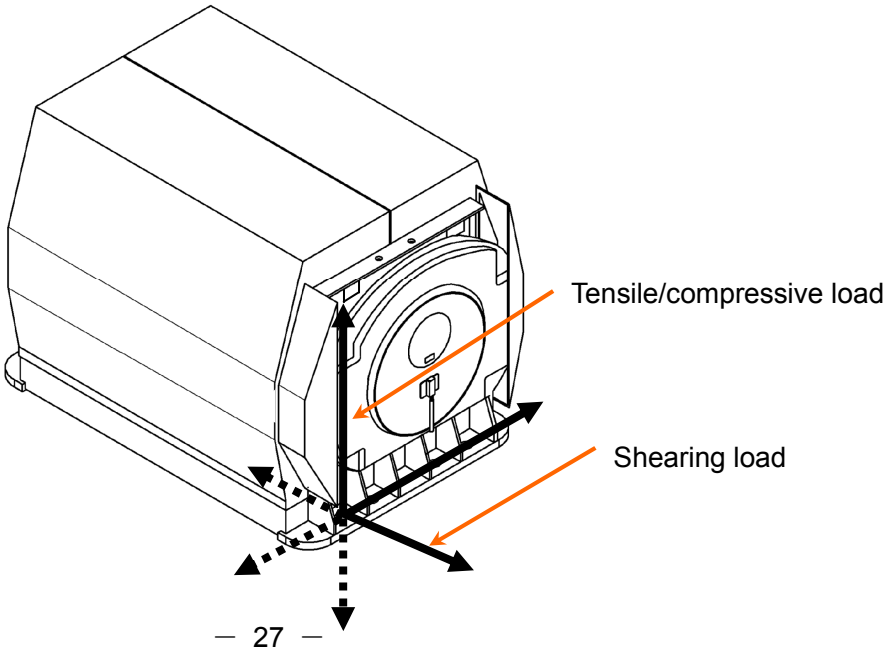


Figure 3-1 Gyro-generated torques (moments)

If the maximum torque (moment) shown in the above diagram is generated, each of installation bolts of the **ARG** must bear the loads of the magnitudes as shown below.

Tensile/compressive load on each bolt····· 13.5kN (1380kgf/3,042lbs)
Shearing load on each bolt····· 3.3kN (337kgf/742lbs)



3.2 Installation location and reinforcements for installation

(1) Installation location and reinforcements for the **ARG** unit.

⚠ DANGER

Do not disassemble or modify without authorization, and do not use the ARG for other purposes.

Doing so could result in damage, malfunction, injury or electric shock.

Choose the location for installing the ARG unit appropriately in consideration for ship's center of gravity, balance, and reinforcement besides convenience.

Not doing so could result in deterioration in the performance of ship.

Ventilate the work space if the work related to the ARG is in closed space.

Not doing so could result in poisoning depending on the materials to be used.

Do not install the ARG unit in the following locations.

Doing so could result in electric shock, malfunction, damage to ship or fire.

- Locations exposed to wave, rain, wind or direct sunlight.
- Locations exposed to harmful gases, dust, liquid or oil mist.
- Locations without flat surface.
- Locations where strength and stiffness of the hull is not enough to withstand the maximum gyro torque (moment), and a member from which the load can not be transferred to the major members of the hull.
- Locations exposed to vibration.
- Locations where ambient temperature is not -10 to 40℃. If the temperature expected to be 40℃ or higher, ventilation is required to cool the **ARG** unit down.
- Locations exposed to flammable materials or heat-sensitive items.
- Locations without a space of 200mm (7.9inches) around the **ARG** unit. But if there are enough space where the inspection and maintenance can be performed, this space (200mm (7.9inches)) could be a target.
- Locations where passengers can touch the **ARG** unit easily.

① Install the **ARG** unit in a place withstanding the maximum gyro torque (moment) described in section 3.1 in the hull. (For example, a place where the load is transmitted to the strength material of the hull)

②If the installation part of the hull is not strong enough, an adequate reinforcement is required. (Refer to Figure 3-2)

ARG installation surface

ARG installation surface (side view)

ARG installation surface (bottom view)

Example of addition of FRP rib, and reinforcement with iron plate

Example of setting up iron trestle for FRP ship

Figure 3-2 Reinforcement of ship

③Install the **ARG** unit so that their longer sides are perpendicular to the centerline of the ship as shown in Figure 3-3.

Serial number (S/N) for the **ARG** unit and the Motor Driver
Odd serial number : counterclockwise, (look the **ARG** unit from the top)
Even serial number : clockwise, (look the **ARG** unit from the top)

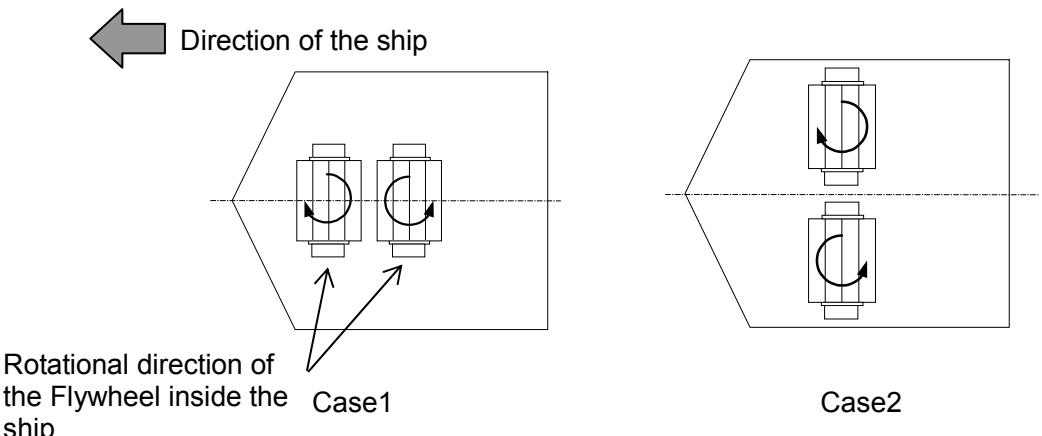


Figure 3-3 Installation direction of the **ARG** unit

④If multiple **ARG** units are installed, the **ARG**s next to each other must rotate in the opposite directions as shown in Figure 3-3.
The **ARG** unit and the Motor Driver with even serial numbers rotate clockwise, (Looking the **ARG** unit from the top) and with odd serial numbers rotate counterclockwise (Looking the **ARG** unit from the top).Please make sure that the **ARG** unit and the Motor Driver has same serial number as a matched set. When multiple **ARG** units are used, two types of the units (clockwise rotation type and counterclockwise rotation type) must be used in pairs.

＜For example：Multiple **ARG** installation＞
(Case1) Install 4 **ARG**s
Odd serial number (S/N)：S/N 0001, S/N 0003（2 units）
Even serial number(S/N)：S/N 0002, S/N 0004（2 units）

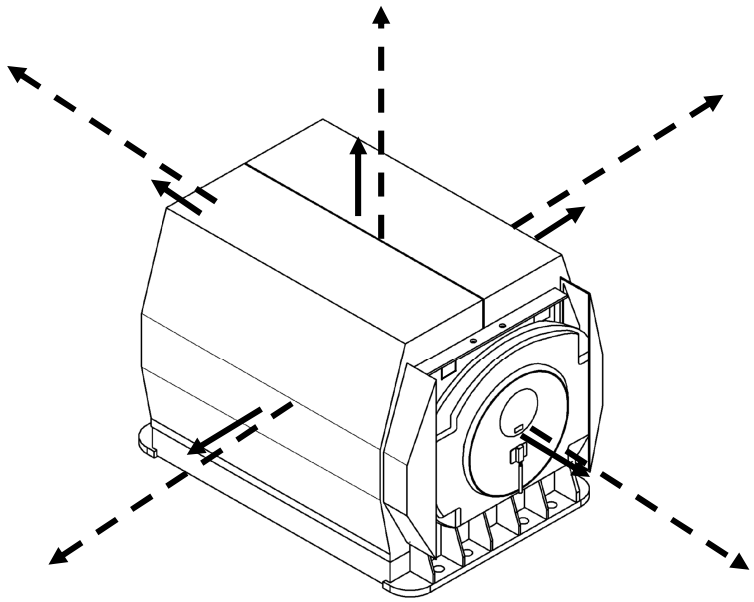
(Case2) Install 3 **ARG**s
Odd serial number (S/N)：S/N 0001 S/N 0003（2 units）
Even serial number(S/N)：S/N 0002（1unit）

OR

Odd serial number (S/N)：S/N 0001（1 unit）
Even serial number(S/N)：S/N 0002, S/N 0004（2 units）

（**CAUTION**）Serial number does not need to be consecutive number as described above.

⑤Select the ARG installation area in consideration of space where can perform the periodic inspection as shown in Figure 3-4.



⟶ Keep a space of more than 200mm (7.9 inches) around the **ARG** unit. The **ARG** unit installation area will become high in temperature owing to generation of heat by **ARG** unit. Please ventilate the **ARG** unit installation area forcedly so that the ambient temperature of the **ARG** unit installation area will be -10 to 40℃.

⇢ Keep a space of more than 700mm (27.6 inches) around the **ARG** unit, and also more than1000mm (39.4 inches) in one of four directions, front side, back side, left side and right side of the **ARG** unit. (If the installation space is limited.)

Figure 3-4 Installation space for the **ARG** unit

(2)Installation location for the Motor Driver

Refer to Figure 3-5 for installation space of the Motor Driver. Since the Motor Driver is ventilated forcedly by the fan inside, make sure to have a space of more than100mm (3.9 inches) on the top and bottom surfaces and more than 200mm (7.9 inches) on the side of the Motor Driver to provide enough ventilation.

DANGER

Do not install the Motor Driver in the following locations.

Doing so could result in electric shock, malfunction or fire.

- Locations exposed to wave, rain, wind or direct sunlight.
- Locations exposed to harmful gases, dust, liquid or oil mist.
- Locations without flat surface.
- Locations exposed to vibration.
- Locations where ambient temperature is not -10 to 40℃. If the temperature is expected to be 40℃ or higher, ventilation is required to cool the Motor Driver down.
- Locations exposed to flammable materials or heat-sensitive items.
- Locations without a space of 200mm (7.9inches) around the Motor Driver.
- Locations where passengers can touch the **ARG** unit easily.

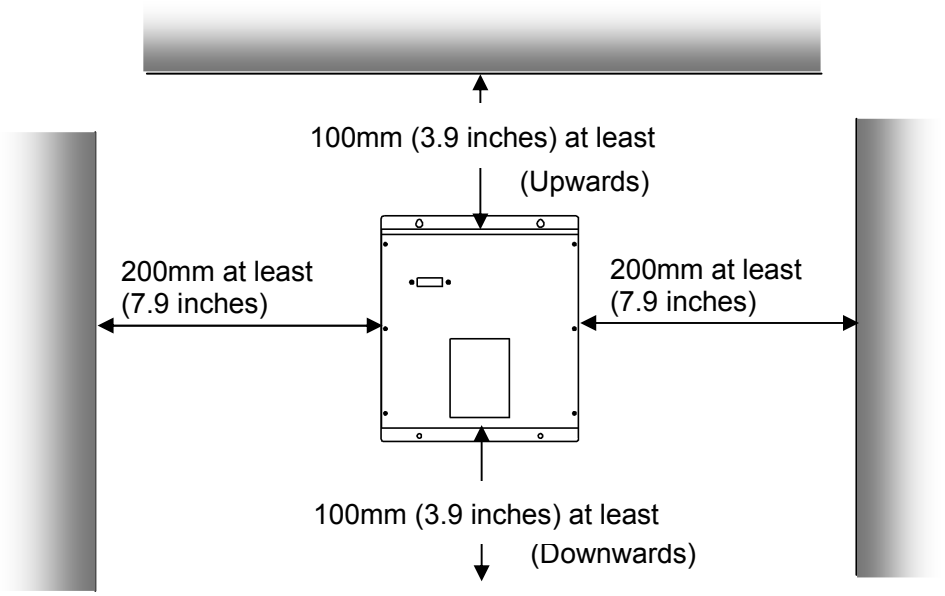


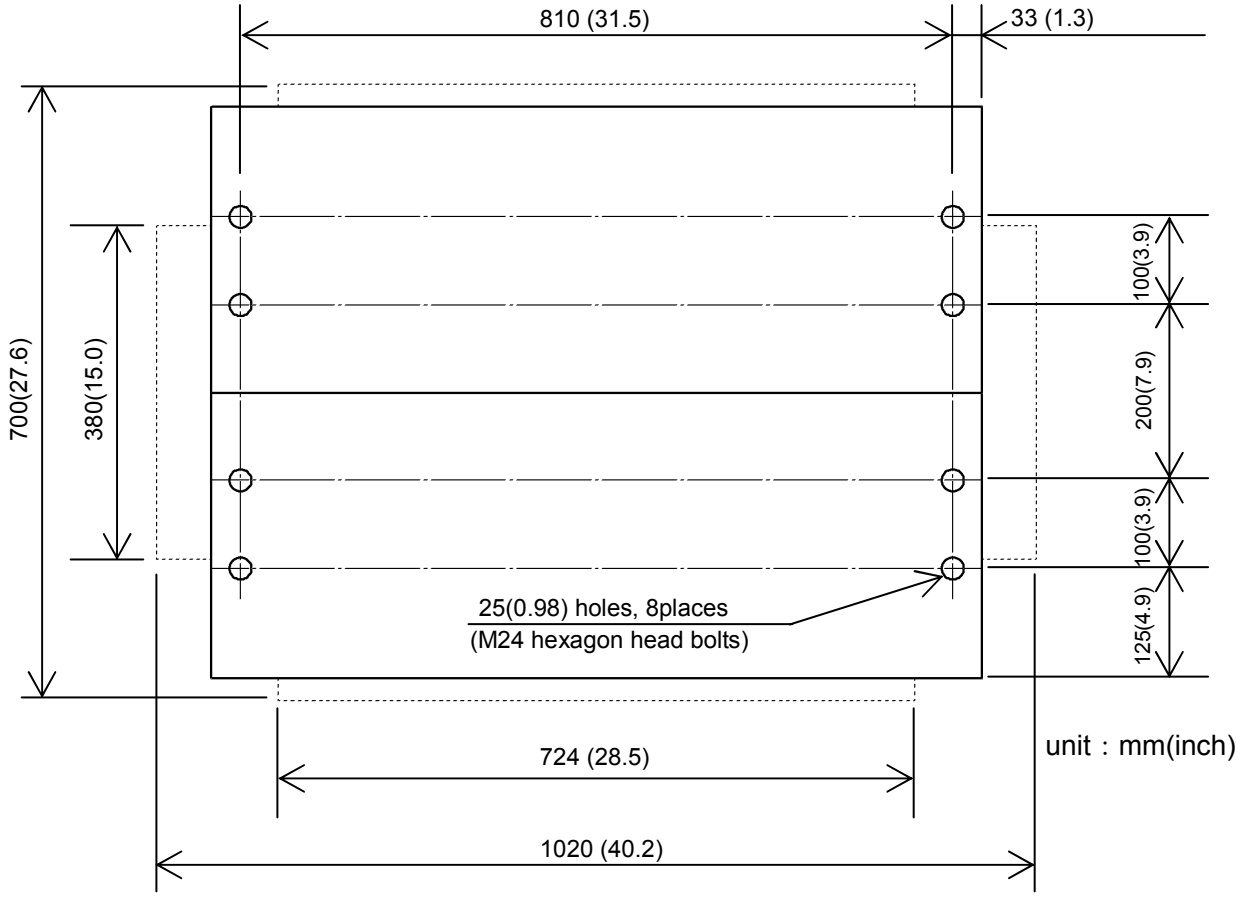
Figure 3-5 Installation of the Motor Driver

4 Installation

4.1 Installation of the **ARG** unit

(1) Installation holes

Make the installation holes in the hull according to the holes in the frame of each **ARG** unit as shown in Figure 4-1.



Note) The dotted line indicates the **ARG** unit. It needs space as shown in the Figure 3-4 to install the **ARG** unit.

When installing **ARG** unit with Anti-vibration rubber, parts for installation are different.

Figure 4-1 Dimensions for drilling the **ARG** unit installation holes

(2) Installation and fixing of the **ARG** units in ship

① Sling up the **ARG** unit by its supplied hanger as shown in Figure 4-2, and install the **ARG**.

⚠ DANGER

The ARG unit is heavy (approximately 700kg / 1543lbs). Use crane which is suitable for weight of the ARG unit.

Not doing so could result in injury or damage to the **ARG** unit or ship.

Be sure to sling up the ARG unit with the attached hanger.

Not doing so could result in injury or damage to the **ARG** unit or ship.

Make sure the following items when slinging up or moving the ARG unit.
Not doing so could result in injury or damage to the **ARG** unit or ship.

- Eyebolts of hanger and attachment hanger bolts (M8) are tightened by regular torque.
- Eyebolts of hanger are tightened in correct direction as shown in Figure 4-3.

⚠ CAUTION

Do not place objects, sit on or step on the ARG cover.

The **ARG** cover is not made of strengthened material. If you place objects, sit on or step on the **ARG** cover, it could result in damage. During operation, the **ARG** components inside the cover are rotating at high speed. Therefore, broken **ARG** cover could cause injury or malfunction.

Do not hit the ARG unit or the Motor Driver against the neighboring equipment or people when moving the ARG unit or the Motor Driver.
And, do not give a strong shock.

Doing so could result in injury or damage to the **ARG** or ship.

Be careful of the ARG cover's edge when handling the ARG cover.

Not doing so could result in injury.

⚠ CAUTION

Be sure to remove the ARG hanger after moving the ARG unit.

Not doing so could result in injury.
Keep the **ARG** hanger because it is used at maintenance.

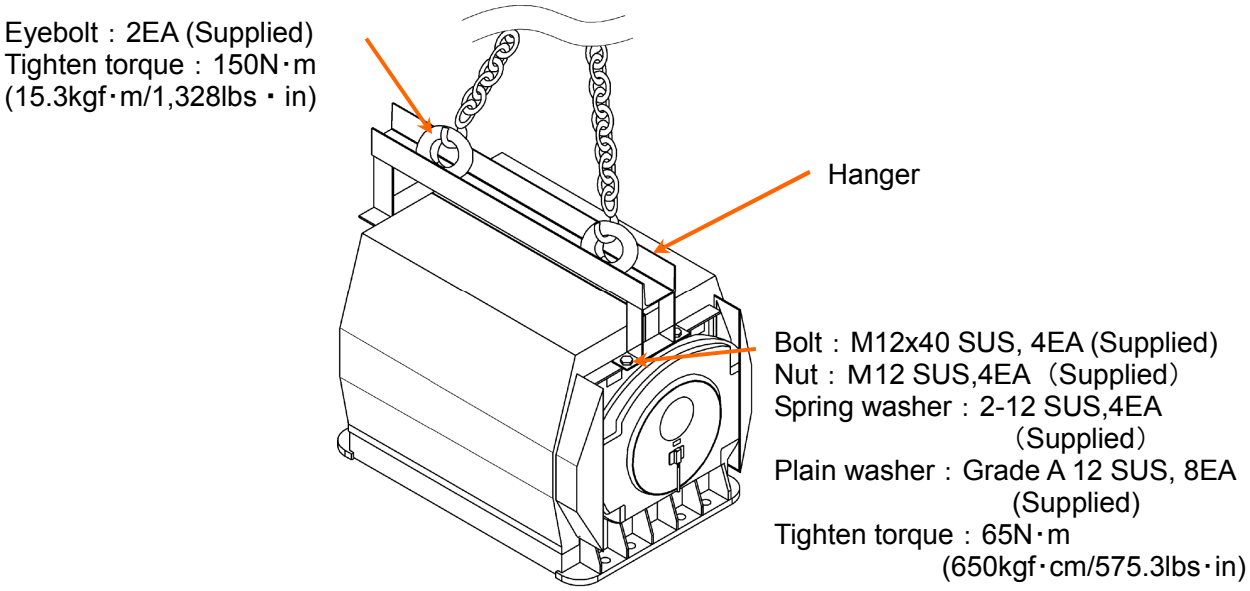


Figure 4-2 Sling up the **ARG** unit

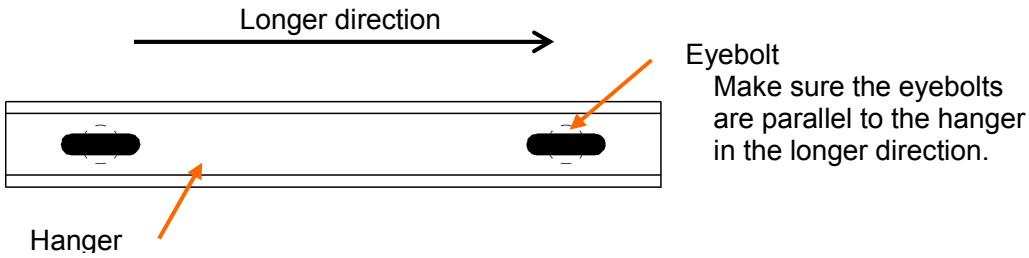


Figure 4-3 Installation direction of eyebolts

② When there is no vibration/noise expected, install the **ARG** unit firmly on the hull, as shown in page 37 Figure 4-4 and page 38 Figure 4-6. Fit the plain washer, spring washer and nuts over each hole in the **ARG** unit frame, pass the installation bolt with the rectangular plain washer from underneath the hull board, then fasten the bolt with the washers and nuts that have been placed on the **ARG** unit frame. **When installing the ARG unit with Anti-vibration rubber, refer to "APPENDIX Procedure for installation of anti-vibration rubber".**
③ If the ship is made of fiber reinforced plastic (FRP), it recommends reinforcing by overlaying with FRP.
④ To prevent each bolt from loosing, be sure to use U nut (lock nut) to fasten it.
⑤ The installation bolts are 180mm/7.1 inches long. Cut them down to match the thickness of the hull board (including the reinforcement, if used).
⑥ Tighten the either bolts little by little and evenly to a final torque of 300N・m(approximately 30kgf・m/2610lbs・in)in a diagonal sequence.（Refer to Figure 4-5）
⑦ The stainless bolts might be burnt due to the fastening. It is recommended to apply the anti-burning grease, etc. that can be purchased locally, and then tighten the U nut.

⚠ CAUTION

Take measure against galvanic corrosion when installing the ARG unit in an aluminum ship.
Give electric insulation treatment or anodic protection, etc. to the surface of the ship on which the ARG unit is installed.
Refer to Figure 4-7 for the example of insulation.

Not doing so could result in damage to ship.

Use all installation parts attached.

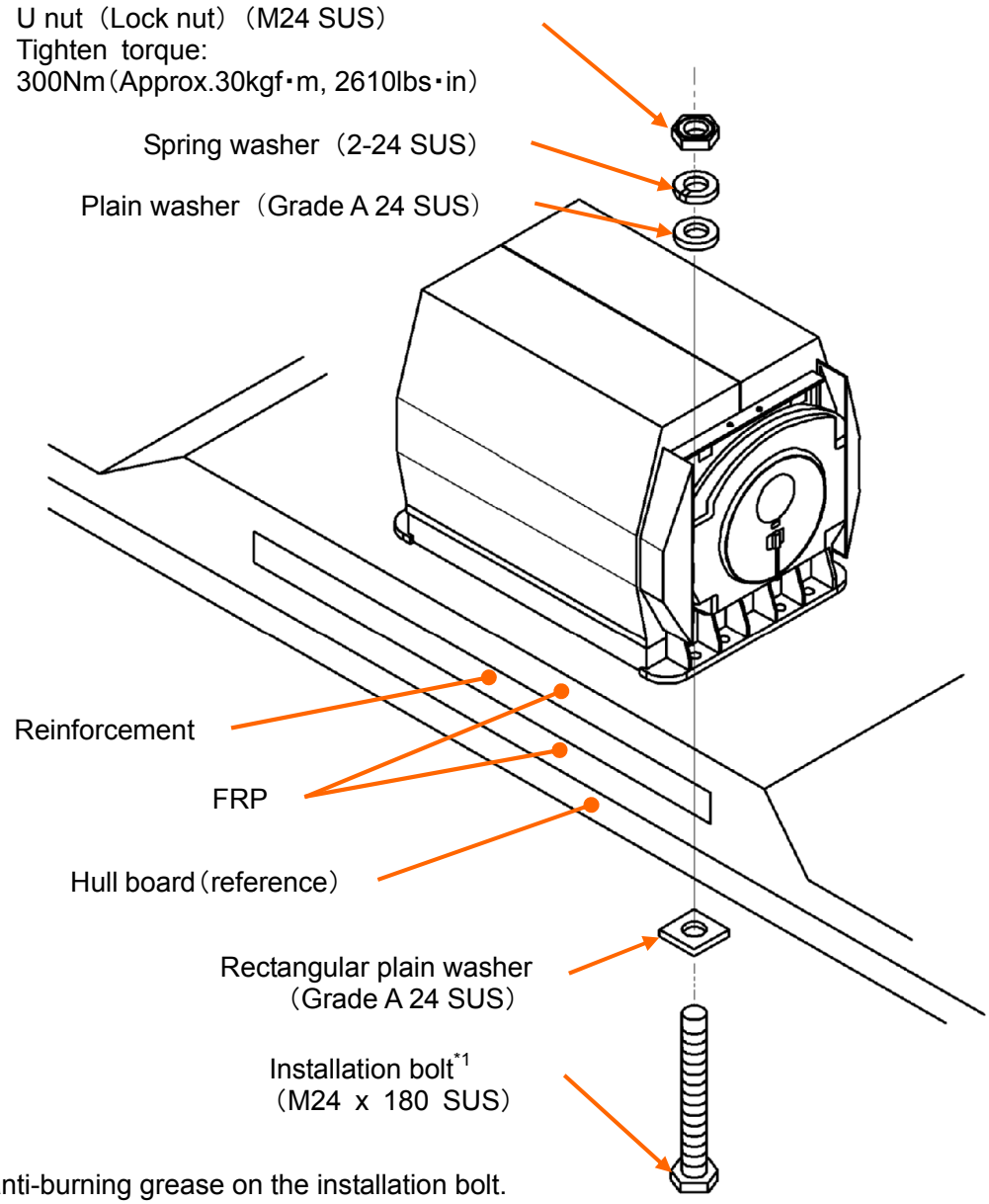
Not doing so could result in damage to the **ARG** unit or ship.

Be sure to tighten the installation bolts and nuts by regular torque.

Loosening bolts and nuts could result in damage to the **ARG** unit or ship.

Re-tighten the installation bolts and nuts by regular torque after 1 or 2 days from installation.

Loosening bolts and nuts could result in damage to the **ARG** unit or ship.



*1 Spread with anti-burning grease on the installation bolt.

When installing **ARG** unit with Anti-vibration rubber, parts for installation are different.
Please check them with “APPENDIX Procedure for installation of anti-vibration rubber”.

Figure 4-4 Installation of the **ARG** unit

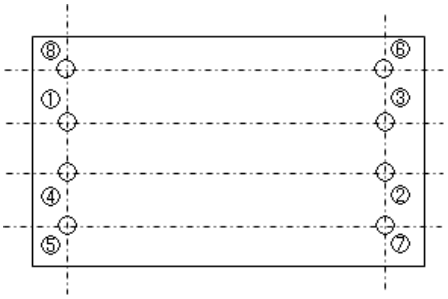


Figure 4-5 Bolts installation order（example）

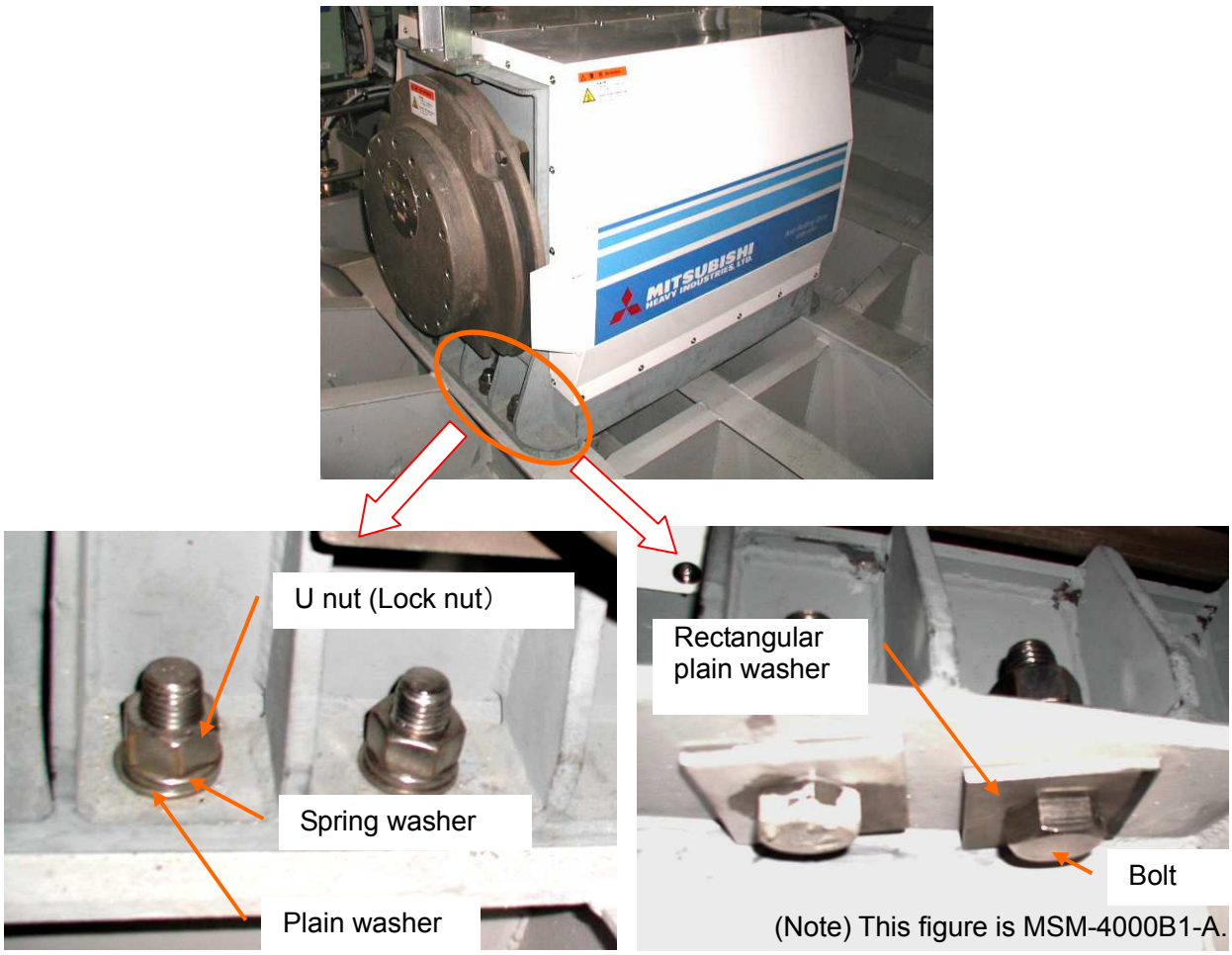


Figure 4-6 Installation of the **ARG** unit

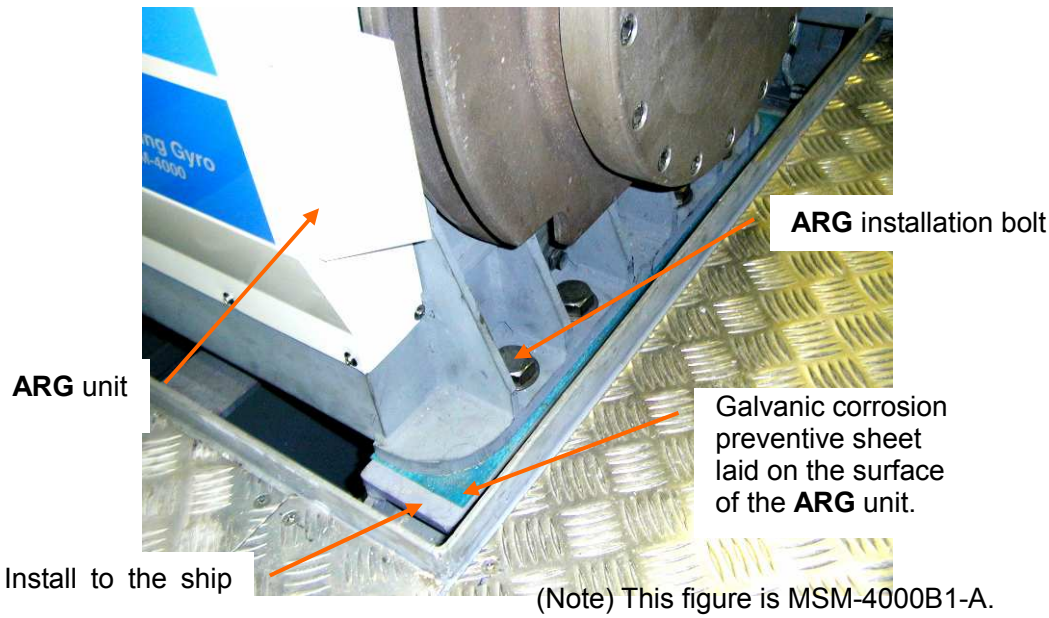


Figure 4-7 Galvanic corrosion preventive to the **ARG** unit

4.2 Installation of the Motor Driver

(1) Installation direction

⚠ DANGER

The Motor Driver's weight is approximately 15kg / 33.1lbs.
Do not drop the Motor Driver when installing and removing one.

Doing so could result in injury or malfunction.

Be sure to install the Motor Driver in the correct direction.

Not doing so could let water enter inside and result in electric shock or fire.（Refer to the Figure 4-8）

Install the Motor Driver in a metal or nonflammable surface.

Not doing so could result in fire.

The Motor Driver must be connected only to a matched ARG unit. Make sure that the serial number (ARG S/N) on the nameplate of the Motor Driver has a same serial number as the ARG unit.

Not doing so could result in injury or malfunction.
(Refer to the Figure 4-9）

⚠ CAUTION

Be sure to use the Motor Driver supplied by MHI.

Not doing so could result in malfunction.

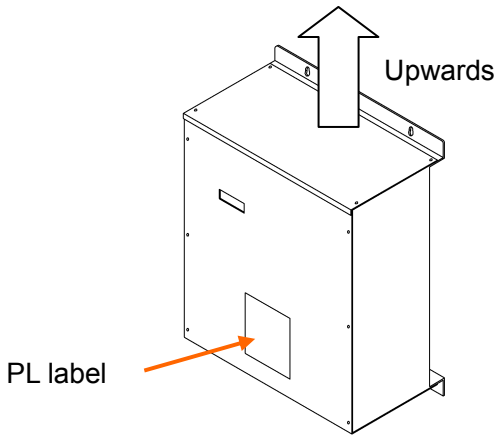


Figure 4-8　Installation direction of the Motor Driver

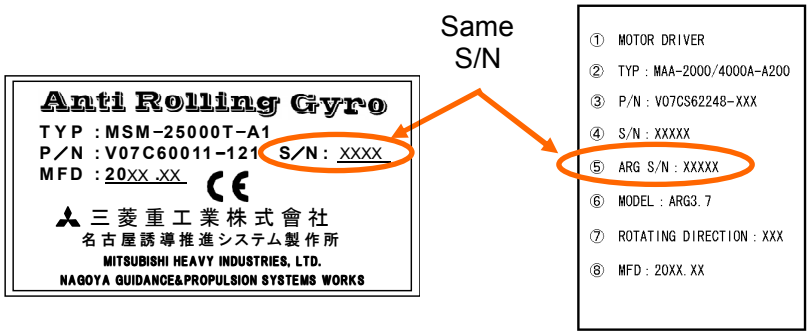


Figure 4-9　Combination of the **ARG** unit and Motor Driver

(2) Installation method
Install the Motor Driver following procedure.
Refer to the Figure 2-8 (page25) about installation dimensions.

① Attach the plain washer, spring washer and screw to the attachment hole on the upper side of the hull board. Then do not tighten screw completely and open the gap to the extent that the bracket can be inserted between the hull board and the screw head.（Refer to the Figure 4-10）
② Hang the Motor Driver on screws which are attached.
（Refer to the Figure 4-11）
③ Attach the plain washer, spring washer and screw to the hull board according to lower the attachment hole.
（Refer to the Figure 4-12）
④ Tighten the lower screws and upper screws.

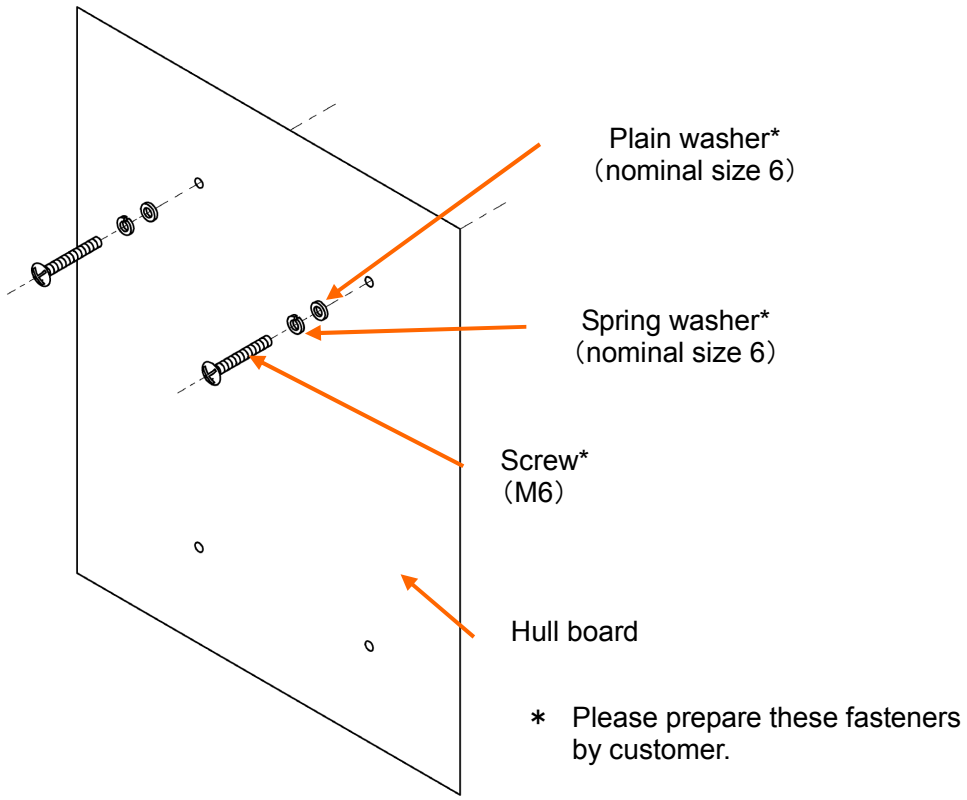


Figure 4-10　Procedure 1 for Motor Driver installation

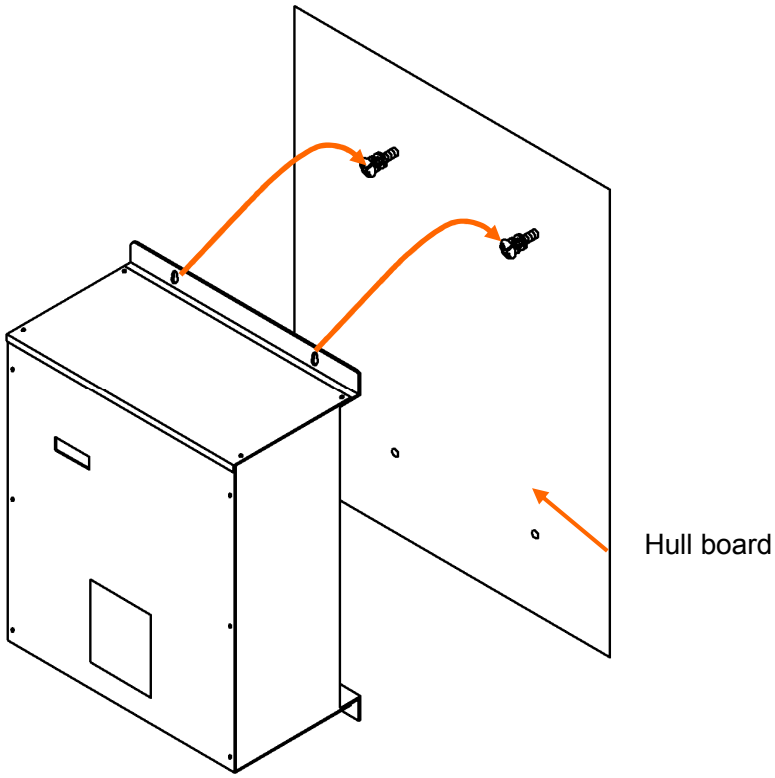


Figure 4-11 Procedure 2 for Motor Driver installation

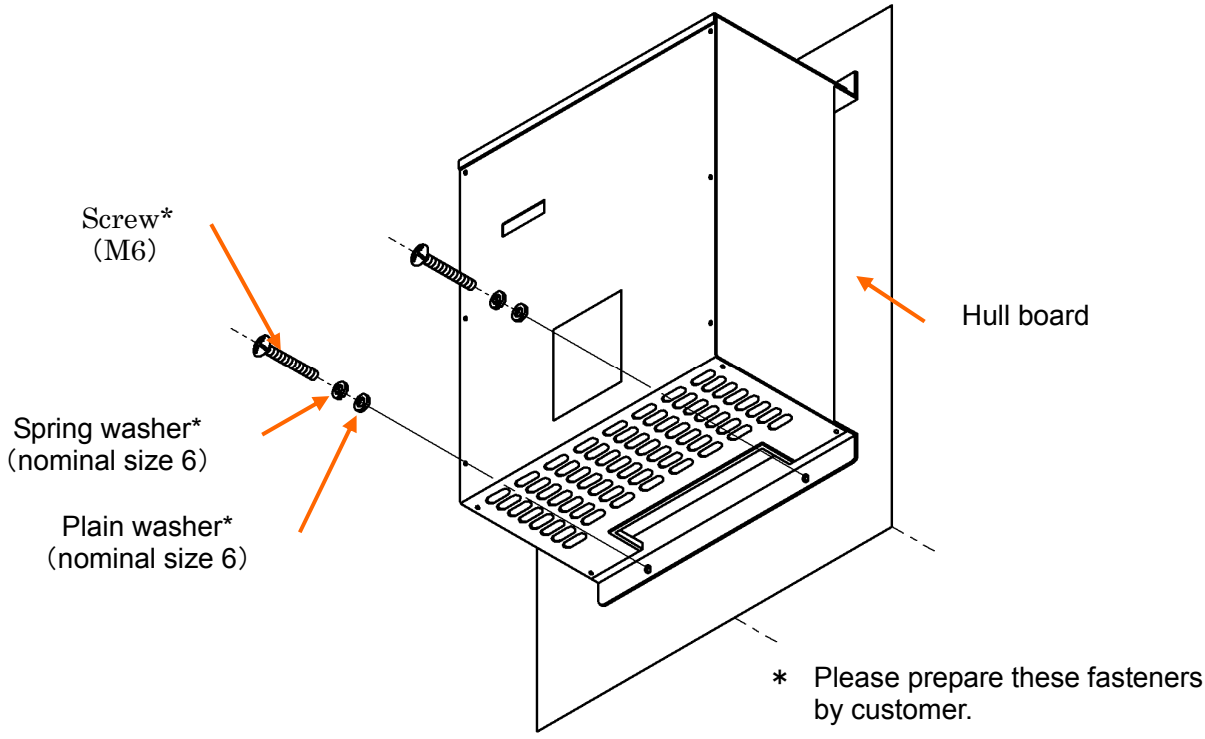


Figure 4-12 Procedure 3 for Motor Driver installation

4.3 Wiring

(1) Before wiring

① The Motor Driver is able to use single-phase power supply@220-240VAC or three-phase power supply @200-240VAC. If the power supply of the ship is three-phase@200-240VAC, then use the three-phase power supply for the Motor Driver. If the power supply of the ship is single-phase@220-240VAC, then use the single-phase power supply for the Motor Driver.

⚠ DANGER

Be sure to turn off the power supply before performing wiring.

Not doing so could result in electric shock.

Do not operate switches or perform wiring with wet hands.

Doing so could result in electric shock.

Take off the metallic items (wristwatch, ring, etc.) from your body before starting work.

Not doing so could result in electric shock.

Use insulated tools.

Not doing so could result in electric shock.

Wiring must be performed by qualified personnel.

Not doing so could result in electric shock, malfunction, or fire.

⚠ CAUTION

Make sure that the power generator of the ship is same as the specified Motor Driver's input voltage.

Using different power supply voltage to the Motor Driver could result in malfunction.

If the power supply of the ship is three-phase @200-240VAC,use the three-phase power supply for the Motor Driver.

If single-phase@220-240VAC is used for the Motor Driver, the power supply of the ship becomes unsteady and could result in malfunction.

② The Motor Driver has useful accessories (outer connecting terminals) described in Table 4-1. Select the remote switch and lamp that meet the specification as described in Table 2-2. Be sure to use the remote switch. Please decide whether or not to use.

Table 4-1 The Motor Driver accessories(outer connecting terminal)

Nomenclature	Performance
Remote switch (This switch must be used.)	The remote switch, to be provided by customer, is able to remote control the **ARG**. The switch must be a latch type to hold an input. Move the lever reciprocity to remote control the **ARG**'s starting and stopping operation. (No voltage connect switch)
Start check lamp	The lamp (light emitting diode (LED) type, etc.) 24VDC and 50mA MAX (rated) prepared by customer (optional) can check the **ARG** unit's operation. Operated : Lamp is ON Not operated : Lamp is OFF
Rotation rate check lamp	The lamp (light emitting diode (LED) type, etc.) 24VDC and 50mA MAX (rated) prepared by customer(optional) can check the **ARG** unit's rotational speed if the rotational speed of the **ARG** unit has reached the steady-state. It takes approximately 40 minutes to become steady-state after the switch is turned on. Steady-state : Lamp is ON Other state (Other speed) : Lamp is OFF

(2) Wiring（system）

① Page46 Figure 4-13 shows the overall electric system diagram.
② Page47 Figure 4-14 shows the overall electric circuit diagram for single-phase power supply@220-240VAC.
③ Page48 Figure 4-15 shows the overall electric circuit diagram for three-phase power supply@200-240VAC.
④ In reference to ② and ③ above, if the start check lamp or rotation rate check lamp is not used, disconnect the terminal between the start check lamp（"+24"-"Y1"） or rotation rate check lamp（"+24"-"Y2"）.

⚠ DANGER

Do not short R/L1, S/L2, T/L3 power input terminal of the Motor Driver and U/T1, V/T2, W/T3 connecting terminal of the ARG unit between terminals.

Doing so could result in malfunction or fire.

Use appropriate tools for wiring.

Not doing so could result in electric shock or fire.

Be sure to perform wiring correctly.

Not doing so could result in electric shock or fire.

Be sure to insulate electrical wiring connections.

Not doing so could result in electric shock or fire.

Be sure to install the circuit breaker switch between the power supply of the ship and the Motor Driver.

Not doing so could result in fire.

Be sure to use electric cables specified in this manual. They must be as short as possible and their conductors must be as thick as possible. Be sure to use cables for ship use. They must be conformed to standards or regulations of your country.

Not doing so could result in fire.

Use crimp terminals of appropriate shape, size and power rating for each unit.

Not doing so could result in electric shock or fire.

DANGER

Connect the ground lead of each Motor Driver to the ground connection point in the ship. Connect the ARG ground lead by securing the one of the hanger installation bolt.

Not doing so could result in electric shock.

CAUTION

Never remove the electric wires that have already been connected inside the Motor Driver.

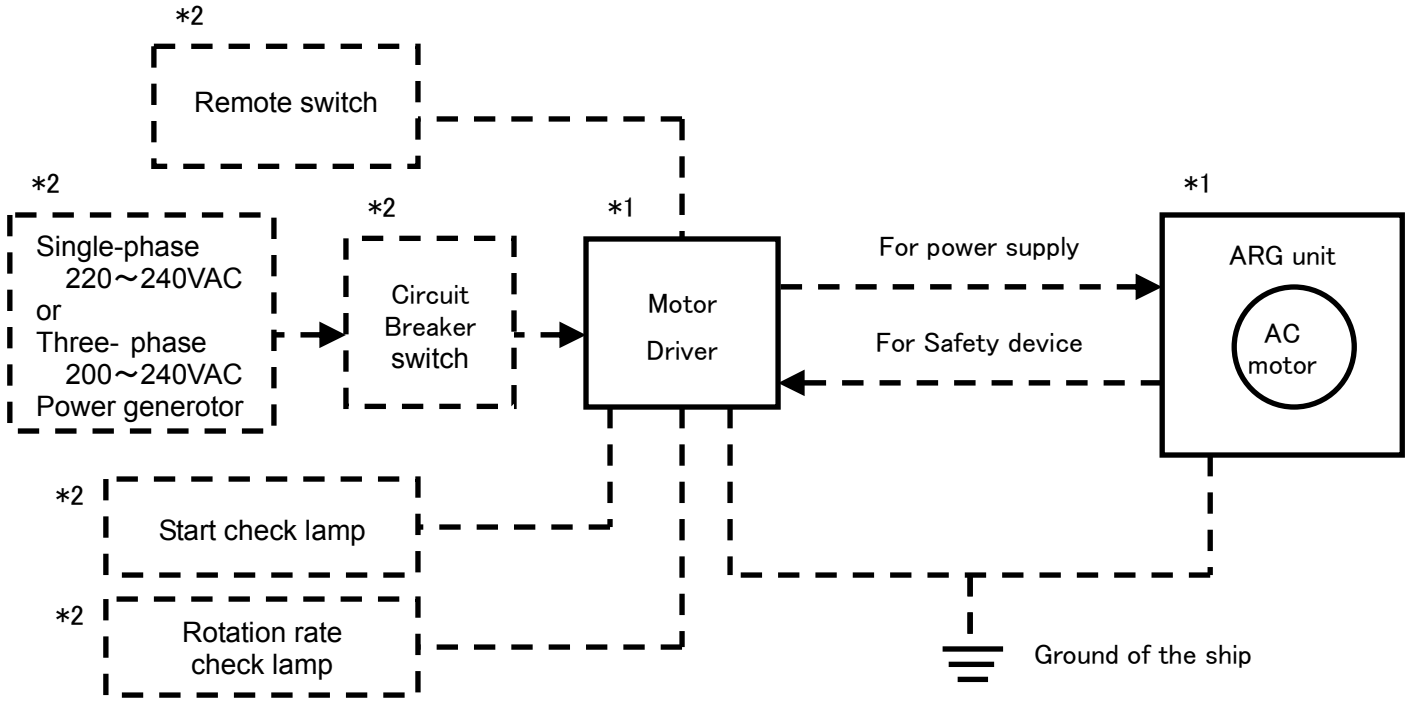
Doing so could result in malfunction.

Do not use the Motor Driver terminals other than those described in the wiring diagram of this manual.

Doing so could result in malfunction.

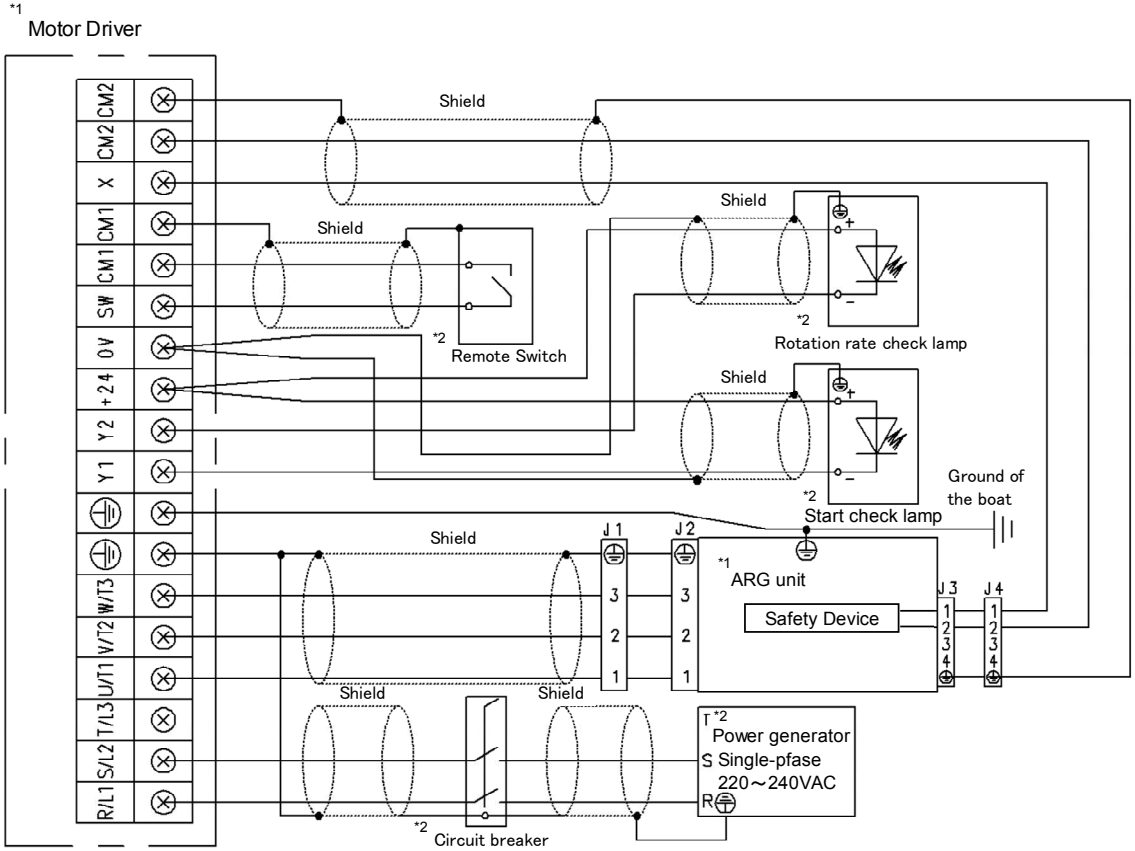
The adjustment work of the touch panel (Refer to page 50) must be performed by qualified personnel, who has completed ARG maintenance training.

Wrong key operation could result in malfunction or trouble.



(Note1) The items marked *1 are supplied by MHI.
All cables and parts *2 must be prepared and wired by customer.
(Note2) The power supply to the **ARG** must be controlled by the circuit breaker switch.
(Note3) Connect the grounding point of the Motor Driver/**ARG** unit with the grounding point of the ship, and then ground them.
(Note4) Use the remote switch to start and stop the **ARG**.
(Note5) The circuit breaker switch and the remote switch must be used.

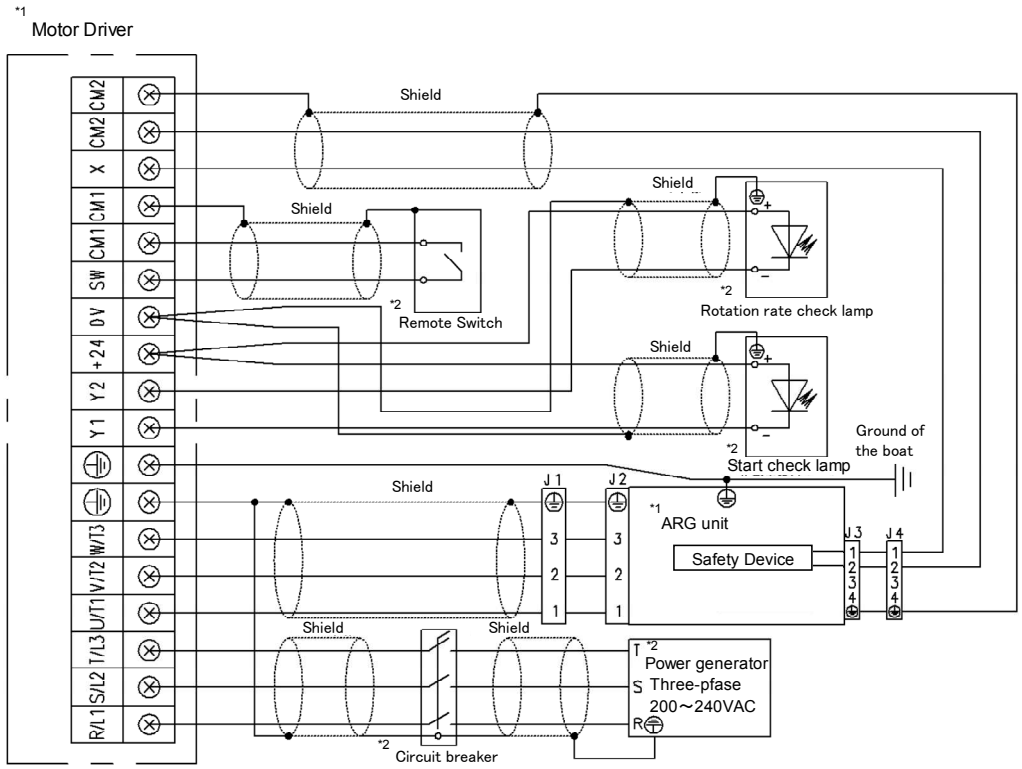
Figure 4-13 Overall electric system diagram



For single-phase
Power supply
@220-240VAC

(Note1) The items marked *1 are supplied by MHI.
All cables and parts *2 must be prepared and wired by customer.
(Note2) The power supply to the **ARG** must be controlled with the circuit breaker switch.
(Note3) Connect the grounding point of the Motor Driver/**ARG** unit with the grounding point of the ship, and then ground them.
(Note4) Use the remote switch to start and stop the **ARG**.
(Note5) The No.1,2,3, ⏚ in J1 and the No.1,2,3,4, ⏚ in J4 indicates the connector pin number. Check its number to cor above.
(Note6) Make sure to use a remote switch.
(Note7) If start check lamp is not used, open the circuit between the"+24" terminal and the"Y1" terminal.
(Note8) If rotation rate check lamp is not used, open the circuit between the"+24" terminal and the"Y2" terminal.

Figure 4-14 Overall electric circuit diagrams (for single-phase power supply)



For three-phase
Power supply
@220-240VAC

(Note1) The items marked *1 are supplied by MHI.
All cables and parts *2 must be prepared and wired by customer.
(Note2) The power supply to the **ARG** must be controlled with the circuit breaker switch.
(Note3) Connect the grounding point of the Motor Driver/**ARG** unit with the grounding point of the ship, and then ground them.
(Note4) Use the remote switch to start and stop the **ARG**.
(Note5) The No.1,2,3, ⏚ in J1 and the No.1,2,3,4, ⏚ in J4 indicates the connector pin number. Check its number to cor above.
(Note6) Make sure to use a remote switch.
(Note7) If start check lamp is not used, open the circuit between the"+24" terminal and the"Y1" terminal.
(Note8) If rotation rate check lamp is not used, open the circuit between the"+24" terminal and the"Y2" terminal.

Figure 4-15 Overall electric circuit diagrams (for three-phase power supply)

(3) Connection terminal size for the Motor Driver

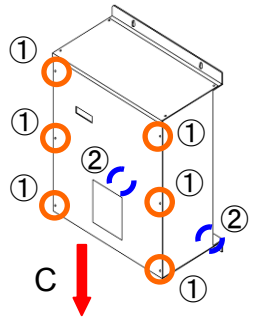
Table 4-2 indicates the connecting terminal and its bolt size for the Motor Driver. Crimp terminal is supplied to customer.
Please see Figure 4-16 for the location of the connecting terminals.

Table4-2 Connecting terminal and its screws size for the Motor Driver

Terminal name	Terminal screw size	Crimp terminal size (Supplied)	Descriptions
R/L1, S/L2, T/L3	M4	V5.5-4	Input terminal from the power supply
U/T1, V/T2, W/T3	M4	V5.5-4	Output terminal to the **ARG** unit
X, CM2	M4	V1.25-4	Terminals for safety device
Y1, Y2, CM1, SW, +24	M4	V1.25-4	Terminals for accessories (for outer connections)
⏚ (Ground)	M4	V5.5-4	Ground connecting terminal to the ship

(4) Wiring method of the Motor Driver

① Remove the lid to perform the wiring for the cable and the Motor Driver.
Take off 8 screws of the lid to remove the lid. Perform the wiring on the terminal board inside the Motor Driver.



How to remove the lid

A. Take off ①screws of the lid.（six screws）
B. Take off ②screws of the lid.（two screws）
C. Pull the lid in the direction of the arrow.
(Do the opposite steps to close the lid.)

② Perform the following cable connection on the terminal board inside the Motor Driver.

Connecting cable	Terminal name of the Motor Driver
Cable between the **ARG** unit and the Motor Driver（For power）	U/T1, V/T2, W/T3
Cable between the circuit breaker switch and the Motor Driver	R/L1, S/L2, T/L3
Cable between the remote switch and the Motor Driver	CM1, SW
Cable between the **ARG** unit and the Motor Driver （For safety device）	X, CM2
Cable between the start check lamp and the Motor Driver	+24, Y1
Cable between the rotation rate check lamp and the Motor Driver	+24, Y2
Cable between the ship's ground and the Motor Driver	⏚ (Ground)

③ After removing the lid, there are terminal board with a safety cover as shown in Figure 4-16

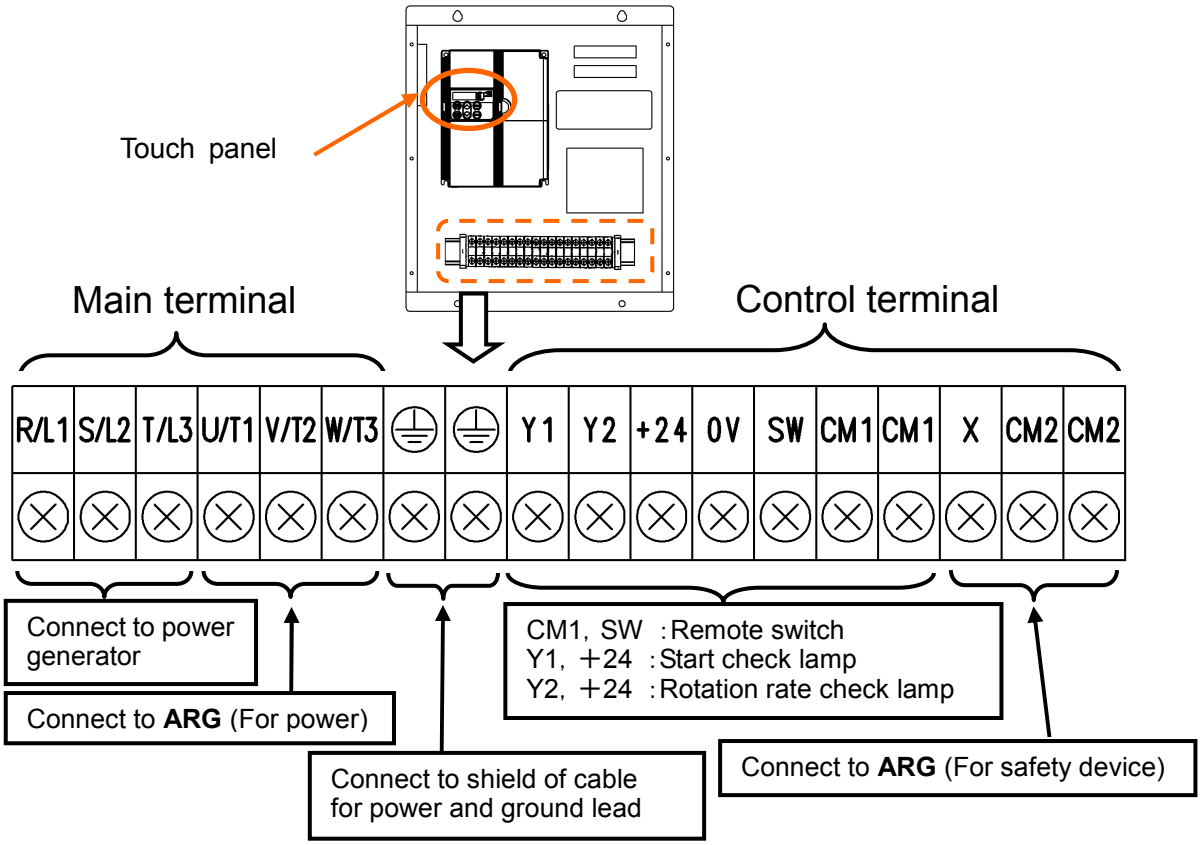


Figure 4-16 Terminal arrangement of the Motor Driver

⚠ DANGER

The Motor Driver is still charged with an electric voltage just after turning off the power supply. If performing the wiring after turning off the Motor Driver, wait for at least 5 minutes after turning off the power supply. Further, make sure that the lamp of "the Touch panel" is off.

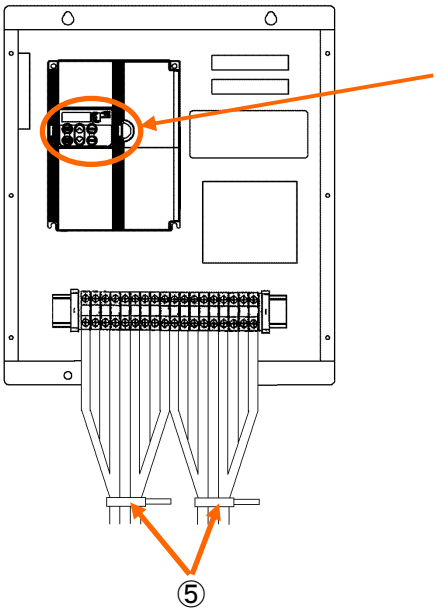
Not doing so could result in electric shock.

Fix cable with clamps so that the cable from the Motor Driver isn't pulled.

Not doing so could result in electric shock.

Be sure to place the lid of the Motor Driver and secure it with screws after completing wiring and inspection.

Not doing so could result in electric shock, malfunction or fire.



The Motor Driver is still charged with an electric voltage just after turning off the power supply. If performing the wiring after turning off the Motor Driver, wait for at least 5 minutes after turning off the power supply.
Further, make sure that the lamp of “the Touch panel” is off.
Not doing so could result in electric shock.

Figure 4-17 How to check the electric voltage just after turned off the Motor Driver

④ After performing the wiring completely, place the safety cover on terminal board, tie down the electric wire and place the lid and tighten it with 8 screws. Please let the cable through the hole of the lid’s bottom.

⑤ Fix cable by a clamp so that the cable from the Motor Driver is not pulled.

(6) Wiring of the **ARG**

Perform wiring correctly as shown in Figure 4-13, 4-14.

① Assemble the connector（For power and safety device）
Please assemble the cables using the supplied connector (crimp type) to connect the **ARG** unit and Motor Driver according to the steps below.
If the assembling is not performed in the correct order, you will not be able to assemble it. Using an inappropriately assembled cable will cause malfunction to the whole system.

⚠ DANGER

Do not operate switches or perform wiring with wet hands.

Doing so could result in electric shock.

Do not solder the socket contact and cable.

Doing so could result in electric shock or fire.

Be sure to use appropriate tools and follow the procedure shown in p52 to p59 for assembling the connector.

Using inappropriately assembled cable could result in electric shock, malfunction or fire.

Make sure the cable line from the small hole (crimp side of the socket contact), and then crimp it.

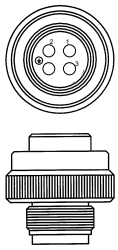
Not doing so could result in electric shock or fire.

Do not mix the power connector parts with safety device connector parts.
Doing so could result in electric shock or fire.

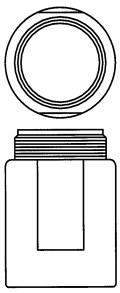
a) Make sure that the following parts are included in the box.

The size of the power connector is different from the safety device connector.

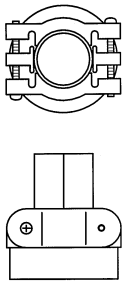
i) Power connector



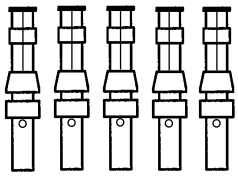
Plug（1EA）



Back shell（1EA）

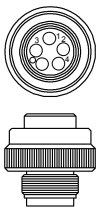


Cable clamp（1EA）

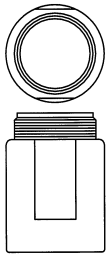


Socket contact（5EA）
(including 1EA spare）

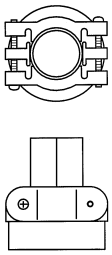
ii) Safety device connector



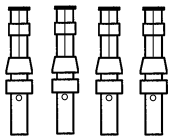
Plug（1EA）



Back shell（1EA）



Cable clamp（1EA）



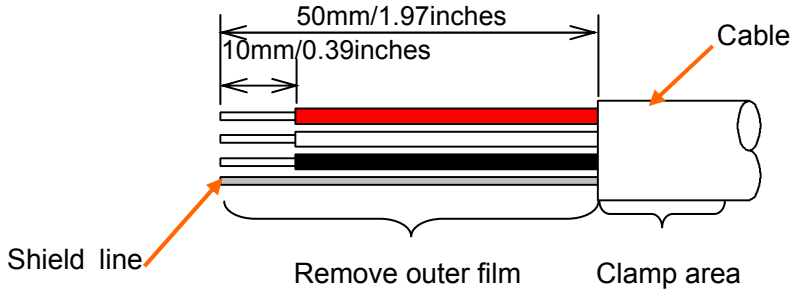
Socket contact（4EA）
（including 1EA spare）

b) Pass the cable, which is prepared by customer, through the cable clamp shown above. If the cable prepared by customer could not go though the cable clamp shown above, remove the outer film and roll up by insulate tape to make the cable thinner and make sure that the rolled up cables can go through the cable clamp.

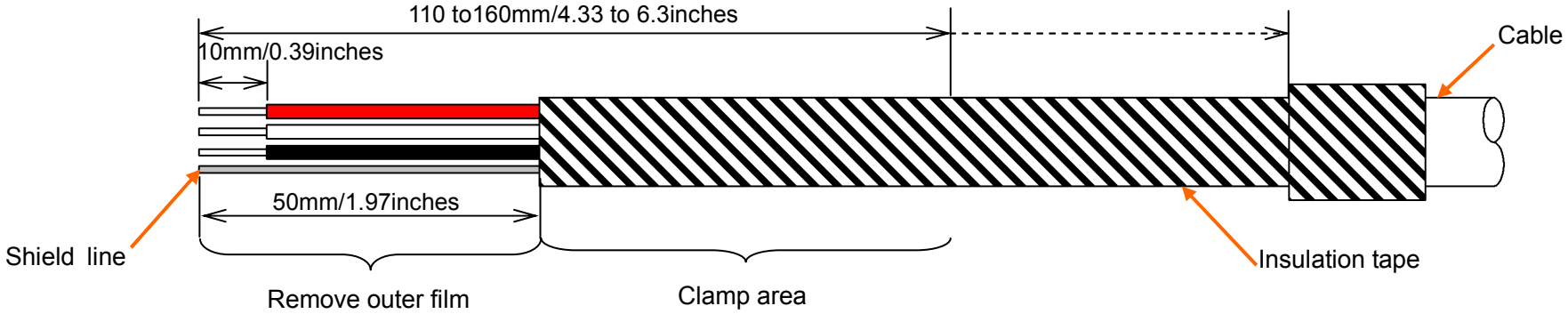
c) Remove the insulation film of the cable according to the dimensions below.
Roll up the shield line.

i) Power connector

＜If cable **can** go through the cable clamp＞



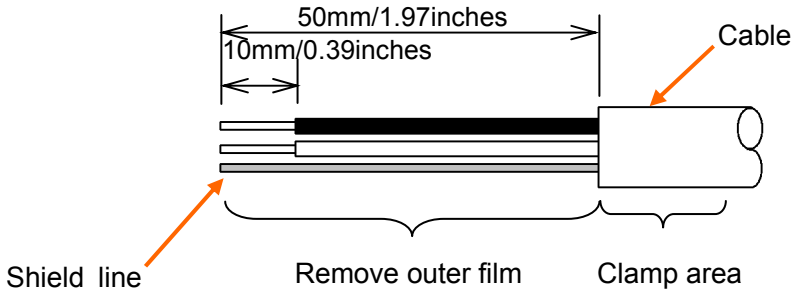
＜If cable **can not** go through the cable clamp＞



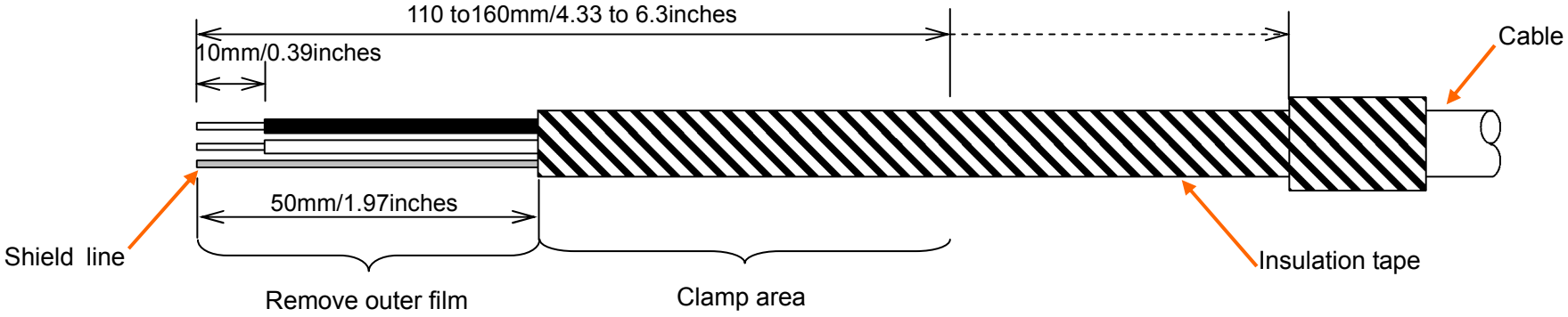
∗ These picture are nearly actual size.

ii) Safety device connector

＜If cable **<u>can</u>** go through the cable clamp＞

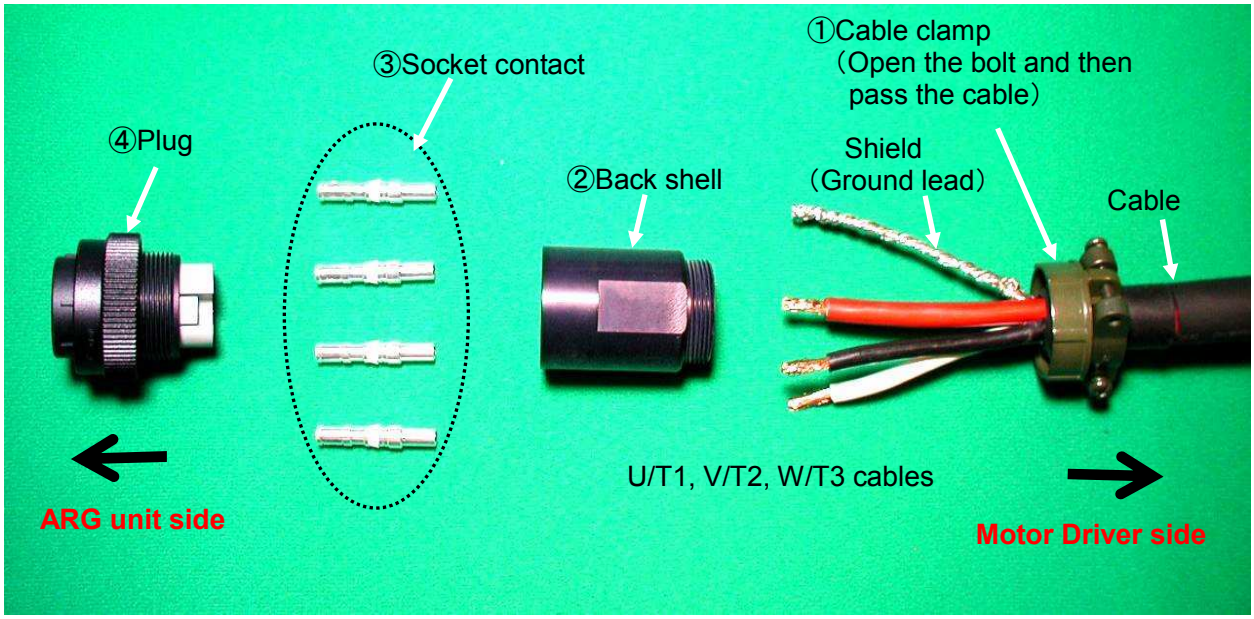


＜If cable **<u>can not</u>** go through the cable clamp＞



∗ These picture are nearly actual size.

d) Connector assembling orders are ①→④ as shown below.



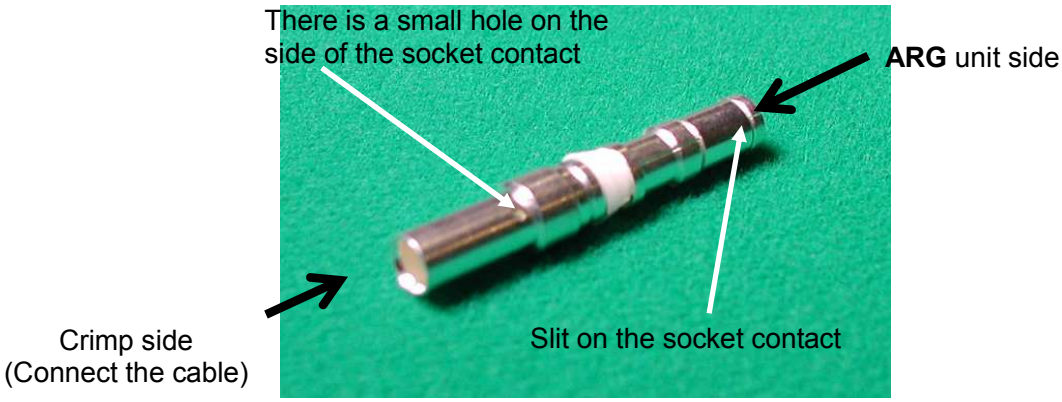
（Note）This figure shows an example for power connector.

e) Let cable clamp (①) and back shell (②) pass through the cable.

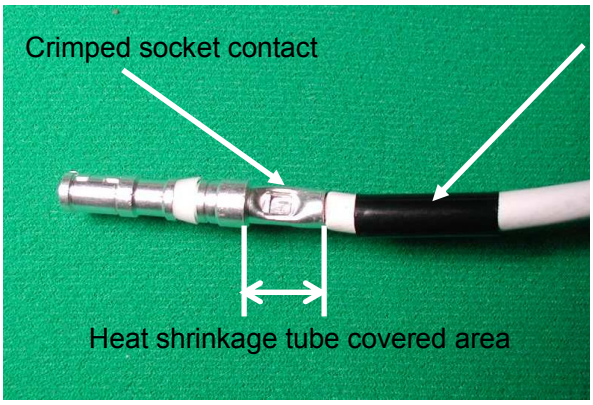
f) Check the crimp side of the socket contact (③).
The side with a small hole in the cylinder surface is the one to be connected with the cable. The side with a slit in the cylinder is the one to be connected with the connector (male) of the **ARG** unit.
(Refer to below figure.)

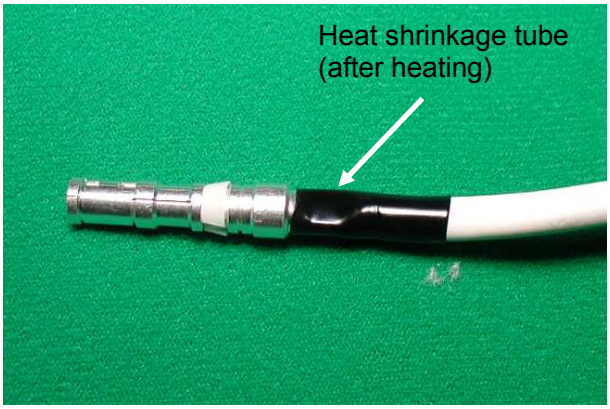
g) Pass the heat shrinkage tube through the cable.

h) Install the cable, which outer film was removed, to the bottom of the socket contact (③), and then crimp it.



i) After crimping the each cable, insulate it with heat shrinkage tube. For insulating the crimped area with heat shrinkage tube, refer to the photos below. Cover all the shield line with heat shrinkage tube.

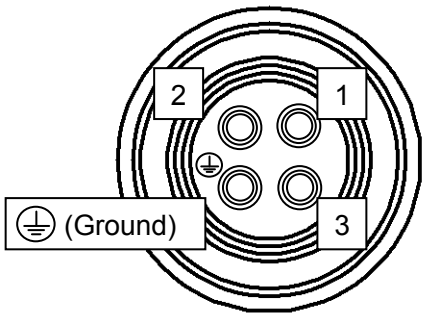




j) Insert the crimped socket contact (③) into plug (④) until it is locked. Refer to the photo below.
Make sure that the outlet of the plugs and the corresponding cables are as follows.

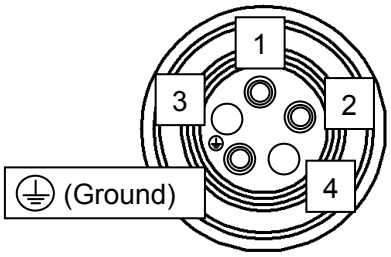
i) Power connector

Plug side	1	—	U/T1	Cable side
	2	—	V/T2	
	3	—	W/T3	
⏚ (Ground)		—	shield (⏚)	

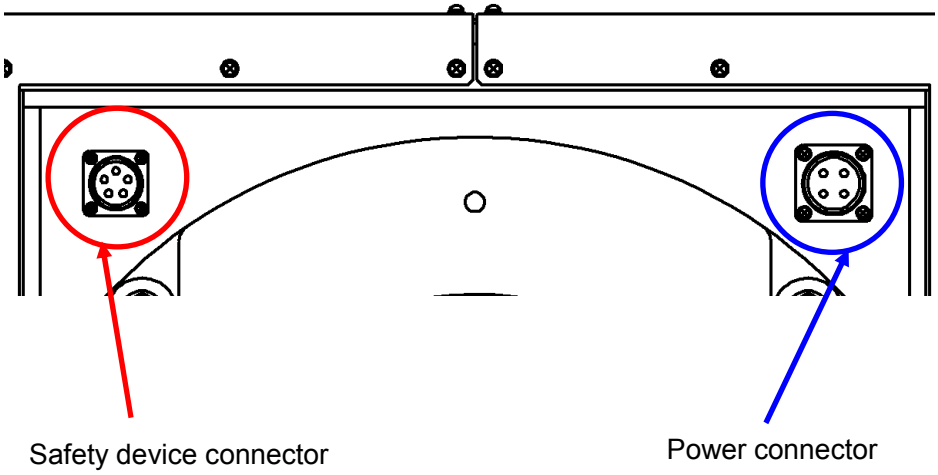


ii) Safety device connector

Plug side	1	—	X	Cable side
	2	—	CM2	
	3	—	Not use.	
	4	—	Not use.	
⏚ (Ground)		—	shield (CM2)	



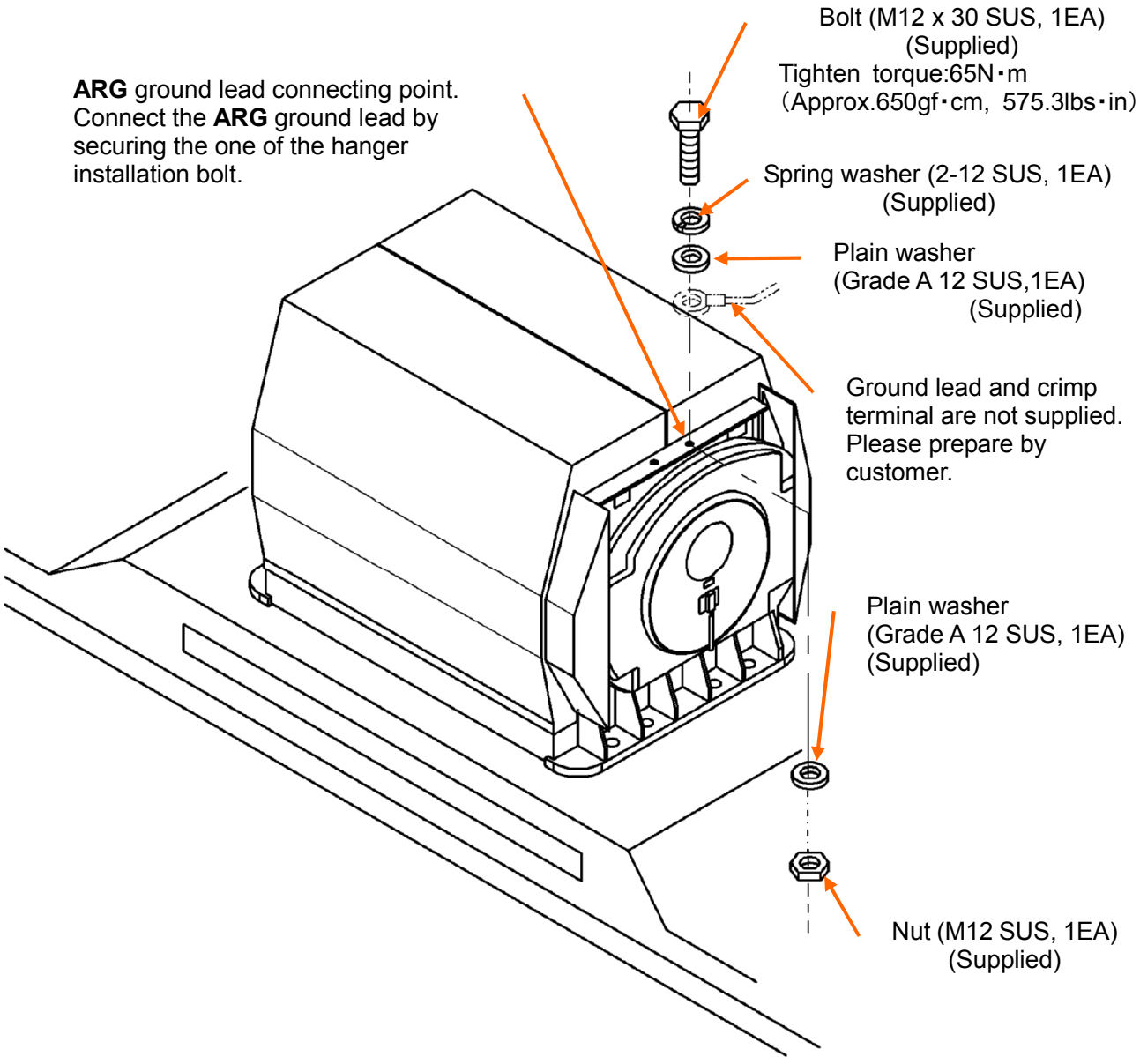
k) Connect the Plug (④) and Back shell (②).
l) Connect the Cable clamp (①) to Back shell (②), and then tighten the cable clamp thread.
m) Connect the assembled connector (female) and the **ARG** unit connector (male). Make sure that it is locked and connected properly.



Example of the connection

② Ground lead connection for the **ARG** unit

Connect the ship's ground lead and the **ARG** unit's ground lead.
Connecting of the **ARG** unit's ground lead is shown in Figure 4-18.



5 Test Run

5.1 Before test run

Check the following before doing the test run.

(1) Check the prohibited condition in attached "Anti Rolling Gyro Operation instructions".

⚠ DANGER

	**Do not remove the ARG cover.** During operation, the inner parts of the **ARG** are rotating at high speed. Doing so could result in injury.
	Do not close blowholes of the ARG unit. The inside of the **ARG** unit becomes high in temperature by closing blowholes. It could result in malfunction or fire.
	**The ARG is not waterproofed.** **Never operate the ARG when it is exposed to seawater / rain.** Doing so could result in electric shock or malfunction.
	**Do not remove the ARG connector during operation.** Doing so could result in electric shock.
	**If you notice an unusual noise, vibration or any other abnormality during operation of the ARG, immediately turn off the power supply to shut down the ARG.** Keeping the **ARG** running under abnormal conditions could result in unexpected accident.
	Use all installed ARG units. Using only a few of them could lead to excessive load, and it could result in malfunction.
	If the 80 or 90 of the thermo label discolors, contact the Sales Agent. Not doing so could result in damage to ship, malfunction of the **ARG** or injury.
	If there is any oil leakage from the damper, contact the Sales Agent. Not doing so could result in damage to ship, malfunction of the **ARG** or injury.

⚠ CAUTION

	**Do not allow extraneous materials and dust to enter through the blowholes of the ARG unit.** Doing so could result in malfunction.
	Do not approach the ARG unit while the ARG is operating. Doing so could result in injury.
	It takes approximately 1 hour until the ARG completely stops after the remote switch has been turned off. **Do not approach the ARG unit and the Motor Driver until the ARG completely stops.** Doing so could result in injury.
	**Do not touch the ARG unit during operation or soon after the ARG stops.** Doing so could result in a skin burn due to the hot surface.
	**Do not damage electric cables when handling the ARG cover.** Doing so could result in malfunction.

(2) Attach the product liability (PL) label below (PROHIBITED USE Don't operate during stormy weather and excessive high wave condition) to somewhere around the remote switch to start and stop the **ARG**.

(3) Perform the inspection according to the check sheet in Table 5-1.
This inspection must be performed by the specified agents that have received the training.

Table 5-1 Initial Inspection List （ 1 / 4 ）

ARG Initial Inspection List (1/4)

This inspection should be performed by the specified agent that have received the training by MHI about the ARG.

Customer's Name :					
Boat Name :					
Installed ARG Model	: MSM-2000	: MSM-12500T	: MSM-4000	: MSM-25000T	: MSM-37500T
Number of ARG Installed	: ARG2000	: ARG125T	: ARG4000	: ARG250T	: ARG375T
Inspected ARG's S/N	: ARG2000	: ARG125T	: ARG4000	: ARG250T	: ARG375T
Inspection Date :					
Inspection Place :					
Inspector :					

◎ : Indispensable item

△ : If possible

No.	Inspection Area	Inspection Item	Criteria	Priority	Result	Disposal
1	ARG Installation	Check the installation condition.	The ARG should be installed in accordance with the installation manual.	◎		Request the user to improve.
		Check the hull strength and reinforcement where the ARG unit installed.	The ARG unit should be set up at the hull that is strong enough to withstand the maximum ARG torque.	◎		
			There should be no rust, crack or gap on the installation part of the hull.	◎		
		Check loosening installed bolt and nut.	The bolt should be tightened with the lock nut.	◎		Request the user to tighten with the lock nut.
			There should be no loosening installed bolt or spring washer.	◎		Tighten.
			When the Anti-vibration rubber is used, the ARG unit should be installed in accordance with the installation manual.	◎		Request the user to install in accordance with the installation manual.
			The nut should be tightened following specified torque. When the Anti-vibration rubber is not used: MSM-2000, MSM-12500T : 130N・m MSM-4000, MSM-25000T : 300N・m When the Anti-vibration rubber is used: MSM-2000, MSM-12500T : 130N・m MSM-4000, MSM-25000T : 130N・m MSM-37500T : 300N・m	◎		Tighten by specified torque.
		Check the installation environment.	The ARG unit should not be installed in place where likely to get covered in seawater or rainwater.	◎		Request the user to improve.
			There should be no flammables around.	◎		
			There should be no objects on the ARG.	◎		
			There should be enough ventilation to cool the ARG unit down.	◎		
			The ventilation of the ARG unit should not be obstructed. (ex. Closing the ARG' unit's blowholes, Covering the ARG unit)	◎		
2	External view of ARG unit	Check the rust, deformation, crack or interference defect.	There should be no rust, deformation, crack or interference defect.	◎		Replace the ARG unit.
			The ARG unit should not be left trace of covered with seawater and water.	◎		Replace the ARG unit.
			The sealing label should be stuck(not peeled off) on the Cover.	◎		If the sealing label is peeled off, notify the user that warranty becomes invalid. Inspect the inside of the ARG unit.(Refer to ＊)
			There should be no loosening screw of the Cover .	◎		Apply Loctite 262 to the Cover screw and tighten it.
			There should be no loosening bolt of the Damper.	◎		Inspect the inside of the ARG unit.(Refer to ＊) If the inside of the ARG unit does not have abnormality, replace the Damper bolt.
			There should be no crack of welding portion.	◎		Replace the Cover.
			The Cover should not be cut or deformed intentionally.	◎		Replace the Cover.
		(＊)Inspect the inside of the ARG (If the sealing label is peeled off or bolt of the Damper are loosening .)	There should be no interference defect between the Flywheel and the other parts. (ex. the Gimbal, the Frame, the Cover)	＊		Replace the ARG unit.
			There should be no loosening installed bolt or nut for the ARG unit.	＊		Replace the ARG unit.
			There should be no extraneous material in the winding of the inner motor.	＊		Replace the ARG unit.
			There should be no extraneous material between the gap of the inner motor.			

Table 5-1 Initial Inspection List (2 / 4)

ARG Initial Inspection List (2/4)

This inspection should be performed by the specified agent that have received the training by MHI about the ARG.

No.	Inspection Area	Inspection Item	Criteria	Priority	Result	Disposal
2	External view of ARG unit		There should be no burnout or exposure of conductor of the electric cable or the inner motor's winding.	*		Replace the ARG unit.
			The electric cable should be fixed to the cable clamp.	*		Repair.
			There should be no rust in the parts of the ARG unit.	*		Replace the ARG unit.
			There should be no crack in the main parts.	*		
			①Root R at the foot of the Flywheel axis		①	①Replace the ARG unit.
			②Rib of the Gimbal		②	②Replace the ARG unit.
			③Rib and rectangular lumber of the Frame		③	③Replace the ARG unit.
			Swing the Gimbal by hand, there should be no interference defect between the Gimbal and other parts.	*		Replace the ARG unit.
			Swing the Gimbal by hand, the play of the Damper should be less than 7.0 deg p-p.	*		Replace the Damper.
			There should be no peeling of rubber sheets and acoustic insulating material on the inside of the Cover.	*		Repair or replace the Cover.
		Check the thermo label of the Damper.	Check the discoloration of the thermo label as follows.	◎		
			①No discoloration			①No problem.
			②Red orange(70℃)			②No problem.
			③Blue(80℃)			③Request the user to improve ventilation, and replace the Damper.
			④Red(90℃)			④Request the user to improve ventilation, and replace the Damper.
		Check the oil leakage from the Damper.	There should be no amount of transparent oil leakage from the Damper.	◎		Replace the Damper.
		Check the adjusting screw hole of the Damper.	Confirm the adjusting screw hole is full of the resin filler.	◎		Replace the Damper.
		Check the connecting of the connector.	The connector of cable side should be locked properly to the connector of ARG unit side.	◎		Repair the connector or replace.
		Check the connector assembly.	The socket contact should be inserted in connector until it is locked.	◎		Repair the connector or replace.
		Check the grounding.	The grounding should be performed.	◎		Request the user to improve.
3	The Motor Driver	Check the installation.	The Motor Driver's serial number (S/N) should be same as the ARG unit's.	◎		Replace the correct Motor Driver.
		Check the installation environment.	The Motor Driver should not be installed in place where likely to get covered in seawater or rainwater.	◎		Request the user to improve.
			The Motor Driver should be installed in correct direction.	◎		
			There should be no flammables around.	◎		
			There should be enough ventilation to cool the Motor Driver down.	◎		
			The ventilation of the Motor Driver should not be obstructed.	◎		
		Check the rust, crack or extraneous material.	There should be no rust, deformation or crack.	◎		Replace the Motor Driver.
			The Motor Driver should not be left trace of covered with seawater and water.	◎		Replace the Motor Driver.
			There should be no rust in the boards.	◎		Replace the Motor Driver.
			There should be no rust in the terminals.	◎		Replace the Motor Driver.
			There should be no extraneous material in the inside of the Motor Driver.	◎		Remove extraneous materials.
		Check loosening installed screw.	The spring washer should be compressed securely.	◎		Tighten.
			There should be no loosening installed screw.	◎		Tighten.
		Check the wiring.	The wiring should be connected in accordance with the installation manual.	◎		Request the user to wire in accordance with the installation manual.
		Check the grounding.	The grounding should be performed.	◎		Request the user to improve.
		Check the using parts and cable.	The using electric parts and cable should be in accordance with the installation manual.	◎		Request the user to improve.
		Check the voltage, electric capacity from the power supply.	The power supply to the Motor driver shall be as follows: Voltage:(three-phase)200-240VAC (single-phase)220-240VAC Capacity(kW): MSM-2000, MSM-12500T/1EA (three-phase)3.4kW over (single-phase)3.8kW over MSM-4000, MSM-25000T/1EA (three-phase)4.8kW over (single-phase)4.3kW over MSM-37500T/1EA (three-phase)5.2kW over (single-phase)5.5kW over	◎	Voltage: V Capacity(Power): KW	Request the user to improve.

Table 5-1 Initial Inspection List （ 3 / 4 ）

ARG Initial Inspection List (3/4)

This inspection should be performed by the specified agent that have received the training by MHI about the ARG.

No.	Inspection Area	Inspection Item	Criteria	Priority	Result	Disposal
4	Check the operation.	Check the starting of the ARG unit.	The ARG unit should start.	◎		Refer to the installation manual.
			Motor Driver： MAA-2000/4000A-A200,MAA-7500A-A200 ・The fan of the inverter should rotate. ・The fan of the Motor Driver should rotate.	◎		Replace the Motor Driver.
		Check the start check lamp.	When the remote switch is on, the start check lamp should light on.	◎		Check the wiring. Check the lamp, which should match one specified in the installation manual.
		Check the rotation rate check lamp.	When rotational speed becomes steady-state(When frequency(rotational speed)becomes steady), the rotation rate check lamp should light on.	◎		Check the wiring. Check the lamp, which should match one specified in the installation manual. Check the voltage and the capacity (KW) of the power supply (generator).
		Check the time to reach the normal rotational speed.	The time to reach the normal rotational speed shall be as follows. (The time that rotational speed of the Touch panel become steady after the starting) MSM-2000, MSM-12500T：Approximately 30 minutes MSM-4000, MSM-25000T：Approximately 40 minutes MSM-37500T：Approximately 45 minutes	◎	min	Check the function code data of the Motor Driver, which is correct compared with the specification. Check the voltage and the capacity (KW) of the power supply (generator).
		Check the rotational direction.	Look at the ARG unit from the top and the rotational direction shall be; ARG S/N even number：Clock wise(CW) ARG S/N odd number：Counter clock wise(CCW)	◎		MAA-2000/4000-A200： Check the function code data of the Motor Driver, which is correct compared with the specification. ・If the function code data is not correct → Change the correct code. ・If the function code data is correct → Check the connection of U/T1,V/T2,W/T3 terminal of the Motor Driver and 1,2,3 terminal of the ARG connector. MAA-2000/4000A-A200,MAA-7500A-A200： Check the connection of U/T1,V/T2,W/T3terminal of the Motor Driver and 1,2,3 terminal of the ARG connector.
		Measure the Motor Driver's current [A] one hour later after the starting.	Current criteria are as follows. MSM-2000, MSM-12500T Three-phase：the Touch panel ：≦11A Single-phase：the Touch panel ：≦12A MSM-4000, MSM-25000T Three-phase：the Touch panel ：≦13A Single-phase：the Touch panel ：≦15A (S/N 1001～) Three-phase：the Touch panel ：≦15A Single-phase：the Touch panel ：≦19A MSM-37500T Three-phase：the Touch panel ：≦18A Single-phase：the Touch panel ：≦20A	◎	A	Check the wiring. Check the voltage and the capacity (KW) of the power supply (generator). Check the assembly state of the connector. →If you can not find wrong points of the ARG unit after checking as shown above, replace the ARG unit.
		Measure the Motor Driver's voltage [V] one hour later after the starting.	The Touch panel ：180-200V	◎	V	Request the user to increase the voltage and the capacity (KW) of the power supply (generator).
		Measure the Frequency [Hz] one hour later after the starting.	Frequency criteria are as follows. MSM-2000, MSM-12500T ： the Touch panel ：149～158Hz MSM-4000, MSM-25000T ： the Touch panel ：126～133Hz MSM-37500T ：the Touch panel ：107～114Hz	◎	Hz	Request the user to increase the voltage and the capacity (KW) of the power supply (generator).

Table 5-1　Initial Inspection List （ 4 / 4 ）

ARG Initial Inspection List (4/4)

This inspection should be performed by the specified agent that have received the training by MHI about the ARG.

No.	Inspection Area	Inspection Item	Criteria	Priority	Result	Disposal
4	Check the operation. (continue)	Check the unusual noise or vibration.	There should be no unusual noise or vibration.	◎		Decrease rotational speed / Use the Anti-vibration rubber / Replace the ARG unit and so on.
		Check the noise.	Measure the noise at the place as show below. ①Around the ARG unit(distance of 1[m] from the ARG unit) ②Cockpit ③Cabin	◎	①　dBA ②　dBA ③　dBA	Measure and record.
5	Condition of usage	Check the supplied PL label.	The supplied PL label should be stuck to somewhere around the remote switch.	◎		Request the user to stick the PL label.
		Check the alarm code of the Motor Driver.	—	◎	Alarm code ① ② ③ ④	Check and record.
		Check the cumulative run time.	—	◎	Cumulative run time	Check and record.
		Take photographs of the ARG unit and installation place.	—	◎	—	—
		Measure the anti rolling effect etc.	Measure GM[m].(Metacentric Height) Measure the rolling angle/angular velocity of the hull when the ARG unit is on and off respectively. (Check and record the measurement condition shown below.) ①Measurement date ②Wave height(Hearing from the captain) ③Rolling condition(calm, rough, or stormy) ④Steering or not ⑤Measurement place	△	—	Measure and record.

5.1 Test Run

Operate the **ARG** according to the procedure below.

(1) Starting

① "Turn ON" the power generator for the **ARG** on the ship.

↓

② "Turn ON" the circuit breaker switch.

↓

③ "Turn ON" the remote switch. *1

↓

④ Make sure that the start check lamp is "ON".

＜40 minutes later*2＞

⑤ Make sure that the rotation rate check lamp is "ON".

⑥ Make sure that there is no unusual noise and vibration during the **ARG** operation.

⑦ If the test run is performed on the sea, anti-rolling function becomes effective in approximately 40 minutes after starting.

*1) If number of the Monitoring window is same as below number shown in Table 5-2, **ARG** is normal.

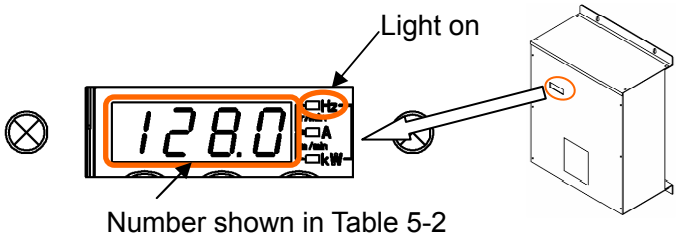
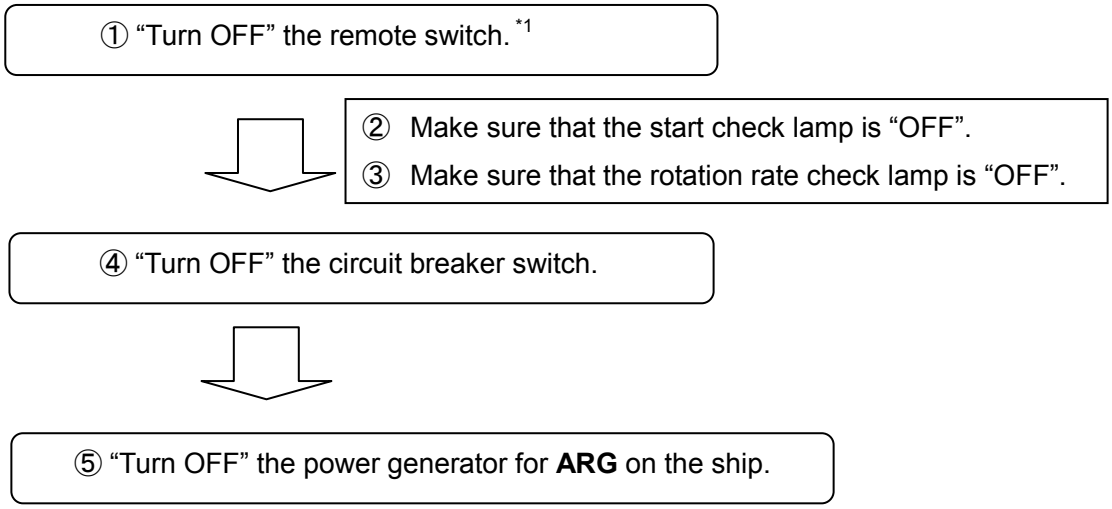


Table 5-2 Indication of the Monitoring window

Elapsed Time	Standing	0 to 40 min	40 min after
Indication	Blink number between 126 and 133	Increase number from 0 to126	Steady state between 126 and 133

*2) The **ARG** takes approximately 40 minutes to reach rated rotational speed after turning on the remote switch.

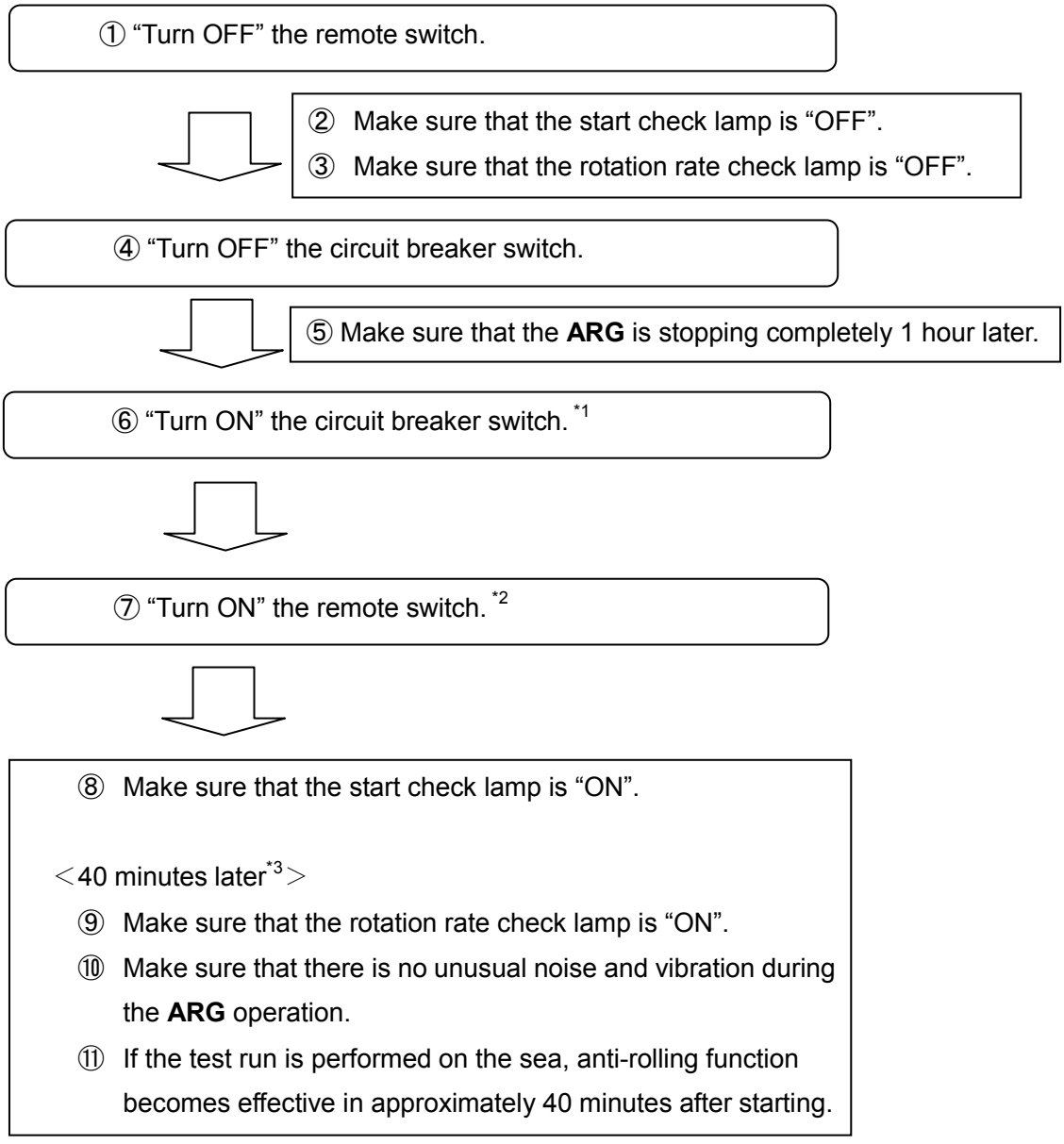
(2) Stopping



*1) After turning off the power supply to the **ARG**, the **ARG** stops its operation gradually. It takes approximately 1 hour until the system stops completely.

5.2 Restarting

Operate the **ARG** according to the procedure below if the **ARG** is restarted due to anomalies.



*1) It takes approximately 1 hour until the **ARG** completely stops after the remote switch has been turned off. If you turn on the switch back before the **ARG** unit has stopped completely, self shutdown circuit may occur due to over current.
In this case, release the over current of the Motor Driver and then restart the **ARG**.
It will be better not to restart the **ARG** for at least 1 hour after shutdown.

*2) If number of the Monitoring window is same as shown in Table 5-2, the **ARG** is normal.

*3) The **ARG** takes approximately 40 minutes to reach rated rotational speed after turning on the remote switch.

5.3 Automatic Fast return functions

(1) Description of the functions

The **ARG** has a function called “automatic fast return functions”. It is a function that the **ARG** will not be turned off even when the main power generator is turned off for a moment. This function is valid under the following conditions.

- If the ship temporary uses an electricity from the ground to start the **ARG** and then change it from the ship (power generator) to supply the electricity.
- If there are some power generators on the ship and want to change the generator to get applicable electric capacity during the **ARG**’s operation.

A customer does not need to prepare extra parts or wirings to get this function.

(2) Procedure for automatic fast return functions

A customer does not need to do special operation to get this function.

Table 5-3 describes the procedure to automatically recover the **ARG** after the main power generator is temporarily turned off. When you use this automatic fast return function, check carefully this procedure, the start check lamp and rotation rate check lamp all the time.

Table 5-3 Procedure for automatic fast return function

No.	Operation	**ARG**’s condition	Power generator	Remote switch	Start check lamp	Rotational rate check lamp
1	The **ARG** is in operation	Steady-state rotational speed	ON	ON	ON	ON
2	Change the power generator (Turn off the main power generator)	Reduce the rotational speed	OFF		OFF	OFF
3	Change the power generator (Turn on the main power generator)	Restarting	ON		ON	OFF
4	————————	Steady-state rotational speed	ON		ON	ON

Note 1) When temporarily turning off the main power generator with the Automatic Fast return function used, keep the remote switch ON all the time. If you change it to OFF during its operation, the **ARG** will be applied with excessive current and it will start the protective function of the Motor Driver, causing the whole system to stop.

Note 2) If you operate the **ARG** for the first time, follow the procedure below and Section 5.1 “Test run”. If you turn on the **ARG** by the main power generator or the circuit breaker switch with the remote switch set to ON, it starts the automatic fast return function. Then the **ARG** takes for a while to start.

①Main power generator is ON → ②Circuit breaker switch is ON

→ ③Remote switch is ON

5.5 Safety functions

The **ARG** has a safety device to stop the **ARG** automatically.
When the **ARG** is operated under the following conditions, the safety device operates and the **ARG** stops.

- Ambient temperature of the **ARG** becomes high.
- The **ARG** generates excessive load by the operation under stormy weather or excessive high wave condition.
- One of the Damper breaks down.

If the safety device operates, the start check lamp and rotation check lamp are turned off even when the remote switch is still “on”. (Refer to Table 5-4)
Please contact the Sales Agent according to No.5 of Table 6-1 in paragraph 6, if there is
possibility that the safety device operates.

Table 5-4 The safety functions operates

No.	Operation	**ARG**’s condition	Power generator	Remote switch	Start check lamp	Rotation rate check lamp
1	The safety functions operates	Stop (Reduce the rotational speed)	ON	ON	OFF	OFF

6 What to do in case of operational problems

(1) If any abnormally is found after installation, check the system according to Table 6-1.
(2) If none of the symptoms in Table 6-1 applies, please contact your sales agent whose address is shown at the end of this manual.

Table 6-1 Fault finding table for the **ARG**

No.	Problem	Possible cause	Step to take
1	The **ARG** does not operate even though the power switch is ON.	Power circuit is incorrectly wired.	Check the wiring including below. ・ Check if primary power is available. ・ Check the connection of the terminals R/L1, S/L2, T/L3 of the Motor Driver, which must be connected to the power supply. ・ Check the connection of the terminals U/L1, V/L2, W/L3 of the Motor Driver, which must be connected to the **ARG** unit. ・ Check the terminals other than specified in this manual are not used. ・ Check the connection between the power supply and the **ARG**. The connector of the **ARG** must be latched completely. ・ Check the connecting terminals of the Motor Driver, which must not have any foreign metal residue attached.
		Signal circuit is incorrectly wired.	Check the wiring including below. ・ Check the remote switch wiring is not open-circuited. ・ Check if there is no short circuit between “CM1” and “SW” of the Motor Driver when the remote switch is OFF. ・ Check the safety device wiring is not open-circuited. ・ Check the connecting terminals of the Motor Driver, which must not have any foreign metal residue attached. ・ Test the circuit of connector area or wires to check the connection failure.
		Circuit breaker switch is not turned on.	・ Turn on the circuit breaker switch again according to the procedures in this manual.
		Power generator is not producing enough power.	・ Check the capacity of the power generator, which must exceed the mass of the total **ARG**’s power used. ・ Check the phase of the power generator and the R/L1,S/L1,T/L3 terminals of the Motor Driver if they are using a same phase.
		Restart of the **ARG** is attempted before it completely stops after shutdown.	・ Stop the **ARG** completely, and then restart according to the procedures in this manual. ・ Check the remote switch was on when turned on the main power generator. Make sure to turn off the remote switch and then turn on the main power generator, then turn on the remote switch.
		Remote switch is not used.	・ Connect the remote switch between “CM1” and “SW” of the Motor Driver.
		Remote switch is not “OFF”	・ Turn on the remote switch.
		Select the wrong type of the remote switch.	・ Check the correct remote switch as specified in this manual.
		Wrong starting steps were taken (turned on the automatic fast return function).	Restart the **ARG** as follows. ① Power generator supply: ON ② Circuit breaker switch: ON ③ Remote switch: ON

Table 6-1 Fault finding table for the **ARG**

No.	Problem	Possible cause	Step to take
2	Breaker switch trips immediately after it has been turned on.	Power circuit is incorrectly wired.	・ Check the short circuit of the power circuit between the power generator and the **ARG** unit. ・ Check the ground lead and shield line, which must be connected to only the terminal specified in this manual. ・ Check the Motor Driver's terminal. It must be the one specified in this manual. ・ Check the connecting terminals of the Motor Driver, which must not have any foreign metal residue attached.
		Ground fault.	・ Check the short circuit of the power circuit between the power generator and the **ARG** unit. ・ Check the ground lead and shield line, which must be connected to only the terminal specified in this manual. ・ Check the Motor Driver's terminal. It must be the one specified in this manual. ・ Check the connecting terminals of the Motor Driver, which must not have any foreign metal residue attached.
3	Start check lamp does not light on.	Signal circuit is incorrectly wired.	Check the wirings including below. ・ Check the operation lamp connection between +24 and Y1. ・ Check the ground lead and shield line, which must be connected to only the terminal specified in this manual. ・ Check the connecting terminals of the Motor Driver, which must not have any foreign metal residue attached.
		Selected wrong type of lamp.	・ Check the lamp, which must be the one specified in this manual (+24VDC, 50mA maximum).
		Lamp bulb has blown.	・ Change the lamp bulb.
		Connection failure	・ Check the start check lamp wiring is not open-circuit.
4	Rotation rate check lamp does not light on.	Signal circuit is incorrectly wired.	Check the wirings including below. ・ Check the rotation rate check lamp's connection between "+24" and "Y2". ・ Check the ground lead and shield line, which must be connected to only the terminal specified in this manual.
		Selected wrong type of lamp	・ Check the lamp, which must be the one specified in this manual (+24VDC, 50mA maximum).
		Lamp bulb has blown.	・ Change the lamp bulb.
		Connection failure	・ Check the start check lamp wiring is not open-circuited.
5	The **ARG** stops after turned on or during the operation	Power generator is not producing enough power.	・ Check the capacity of the power generator, which must exceed the mass of the total **ARG**'s power used. ・ Check the phase of the power generator and the R/L1,S/L2,T/L3 terminals of the Motor Driver if they are using a same phase. ・ The power generator used to supply the **ARG** is also used for another equipment, which consumes large amount of electricity and it causes the power generator to insufficiently produce the power.
		Electric shutdown because other equipment is turned on.	・ If other equipment is turned on, it decreases the voltage momentary and it stops the **ARG**. Please turn on the other equipment first, and then turn on the **ARG**.
		Operation of the safety device	・ When the **ARG** is operated under high ambient temperature, stormy weather or excessively high wave (2.0m) conditions, the **ARG** may stop. Cool the ambient temperature to 40℃ or less by ventilation, and contact the Sales Agent.

Table 6-1 Fault finding table for the **ARG**

No.	Problem	Possible cause	Step to take
6	**GPS**, radio or other equipment makes noise after the **ARG** is in operation.	The **ARG**'s noise is affecting the other equipment's noise.	・ Check the type of the connecting line for the **ARG** whether appropriate shield line is used. ・ Check the both side of the shield line if it is grounded to the designated point specified in this manual. ・ Keep the distance between other equipment and the **ARG** and/or its wirings. ・ Check the earth connection between the **ARG** and the ship. ・ Adjust sensitivity when the image of the Fish Finder is noisy and distorted, Refer to the operation instructions of the Fish Finder.
7	The **ARG** makes unusual noise or vibration.	Selected wrong rotational direction.	・ Check the serial number of the **ARG** unit and the Motor Driver to check they are the same. ・ Check the connection of U/T1,V/T2,W/T3 terminal of the Motor Driver and 1,2,3 terminal of the **ARG** connector.
		Effect of resonance	・ There is a mechanical resonance point in the **ARG** during the time that rotational speed becomes steady. Please wait until it becomes steady rotational speed. ・ If there is a resonance to the hull or wall, take appropriate measures to increase the strength and rigidity of the material of the hull or wall.
		Effect of environmental temperature.	・ When the environmental temperature is low, the bearings might make some noise especially just after the starting. Wait until the rotational speed becomes steady, and then make sure that it does not make the noise any longer.

(Note) To restart the **ARG**, please follow the Section 5 "Test run" of this manual.

APPENDIX

MSM-25000T-A1

Procedure for installation of anti-vibration rubber

Procedure for installation of anti-vibration rubber

Vibration of the **ARG** unit transmits as follows.
From the **ARG** Flange → Ship
Or
From the **ARG** Flange → Bolt → Ship

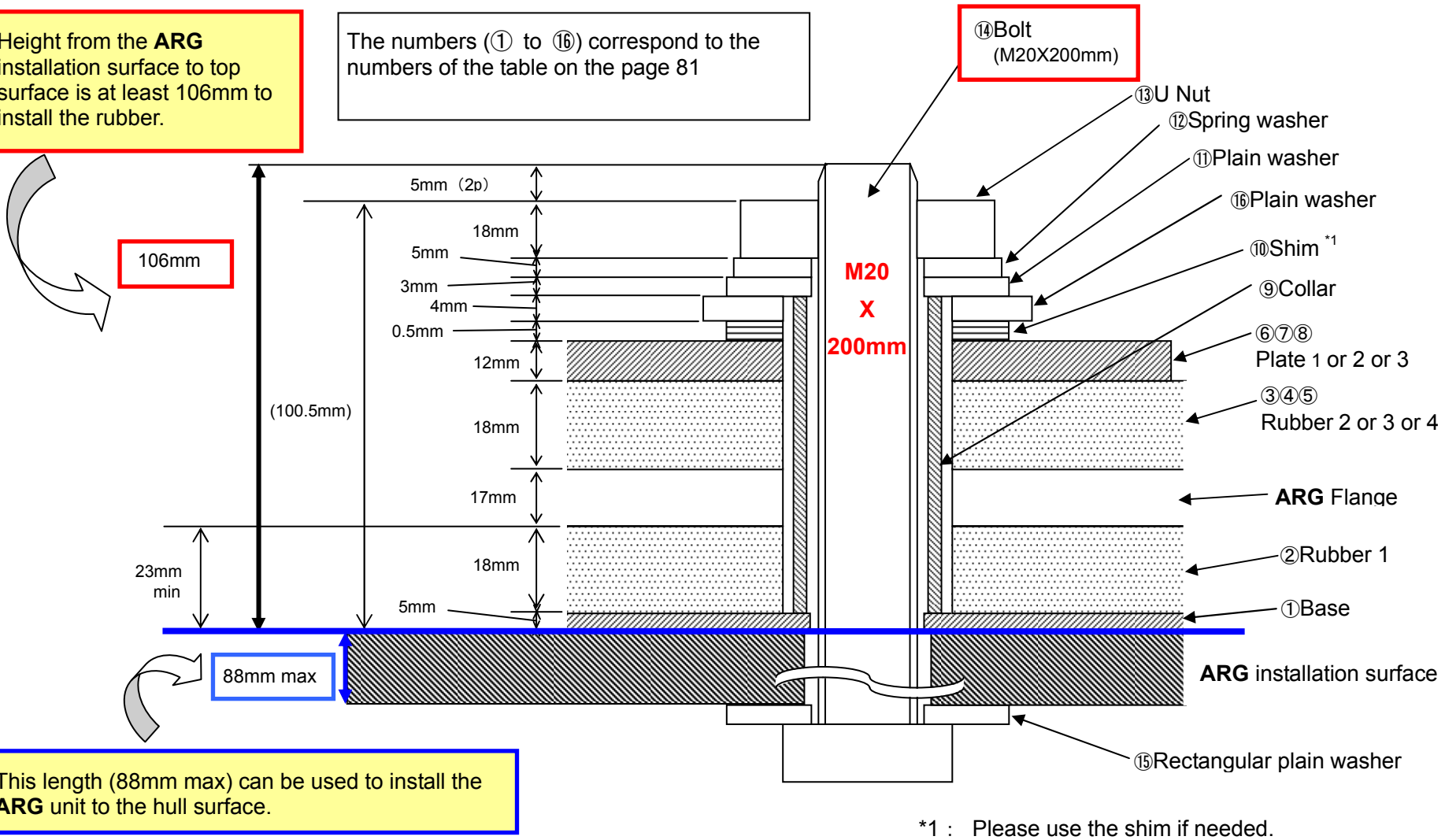
The installed rubber between the **ARG** Flange and the ship can prevent the vibration between the **ARG** Flange and the ship. Also, the collar(⑨) and the rubber between the **ARG** Flange and the ship can create the condition “non-contact”, and it can prevent the vibration of : the **ARG** Flange → Bolt → Ship.
From the above, vibration is prevented by configuration shown in the Figure A1 (page 77).
Example of the anti-vibration rubber is shown in Figure A2 (page 78).

Height of the **ARG** unit changes from 700 to 723mm, therefore, height of the **ARG** unit increases 23mm. (in order to install the rubber)

The height from the **ARG** installation surface to the top surface must be at least 106mm.The distance from the **ARG** installation surface to the bottom, 88mm at most, can be used for installation of the **ARG** unit to the ship. Thus, the length of the installation bolts must be approx. 200mm. (Refer to Figure A1.)

Height from the **ARG** installation surface to top surface is at least 106mm to install the rubber.

The numbers (① to ⑯) correspond to the numbers of the table on the page 81



This length (88mm max) can be used to install the **ARG** unit to the hull surface.

*1 : Please use the shim if needed.

CAUTION

Figure A1

Example of anti-vibration installation

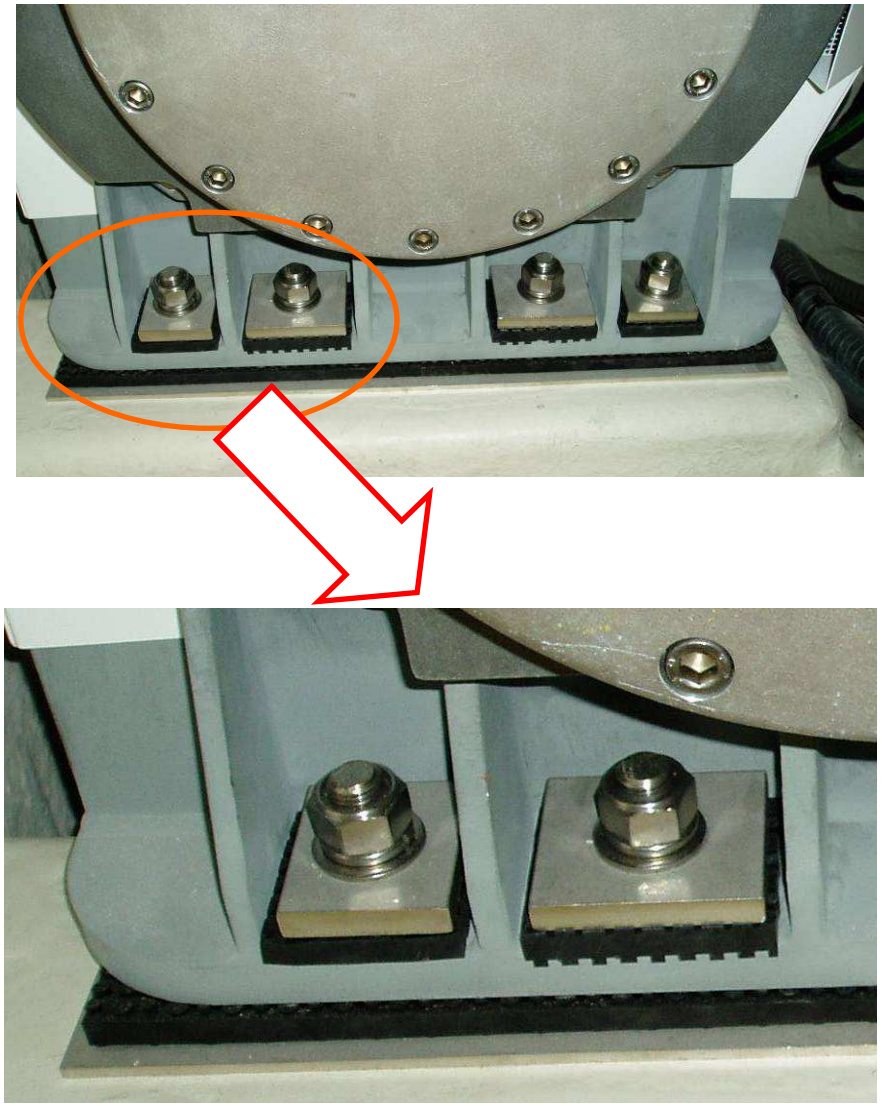


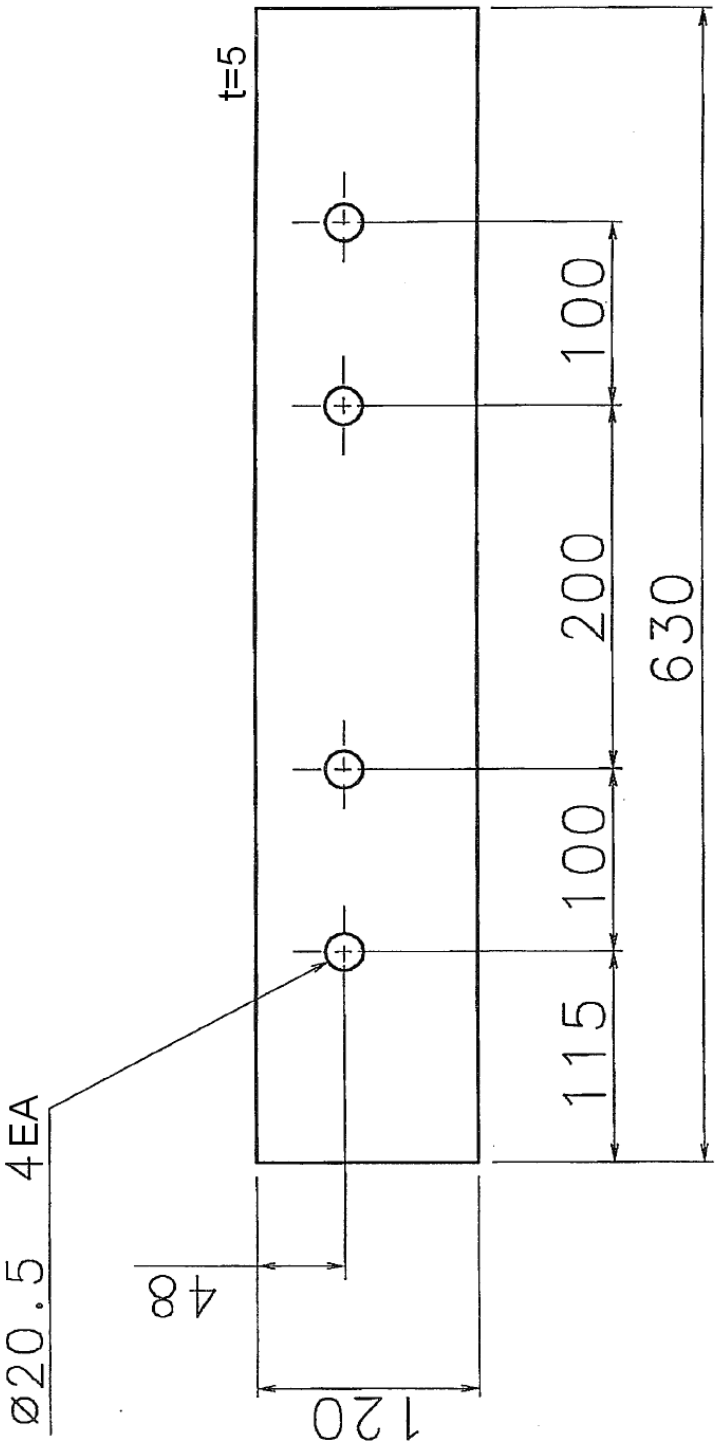
Figure A2

1. Parts List

The list of parts prepared with MHI is shown in the following table.

No.	Part name	Part number/size	Material	Number by 1 **ARG**	Figure No.
1	Base	120 x 630 x 5	SUS	2	Figure A3
2	Rubber 1	100 x 305 x 18	—	4	Figure A4
3	Rubber 2	68 x 65 x 18	—	4	Figure A4
4	Rubber 3	68 x 86 x 18	—	2	Figure A4
5	Rubber 4	51 x 86 x 18	—	2	Figure A4
6	Plate 1	68 x 59 x 12	SUS	4	Figure A5
7	Plate 2	68 x 80 x 12	SUS	2	Figure A5
8	Plate 3	51 x 80 x 12	SUS	2	Figure A5
9	Collar	φ24.5 x 66 (inner diameter φ20.5)	Steel Zn Plated	8	Figure A6
10	Shim	φ40 x t0.5 (inner diameter φ25)	SUS	16	Figure A6
11	Plain washer	Grade A 20	SUS	8	Figure A6
12	Spring washer	2-20	SUS	8	Figure A6
13	Nut (Lock nut)	M20	SUS	8	Figure A6
14	Bolt	M20 x 200	SUS	8	Figure A6
15	Rectangular plain washer	Grade A 20	SUS	8	Figure A6
16	Plain washer	Grade A 24, t=4mm	SUS	8	Figure A6

(note) When th(note) When the anti-vibration rubber is put up, the **ARG** Installation parts of P.17 become unnecessary.



① Base (2EA)

Figure A3

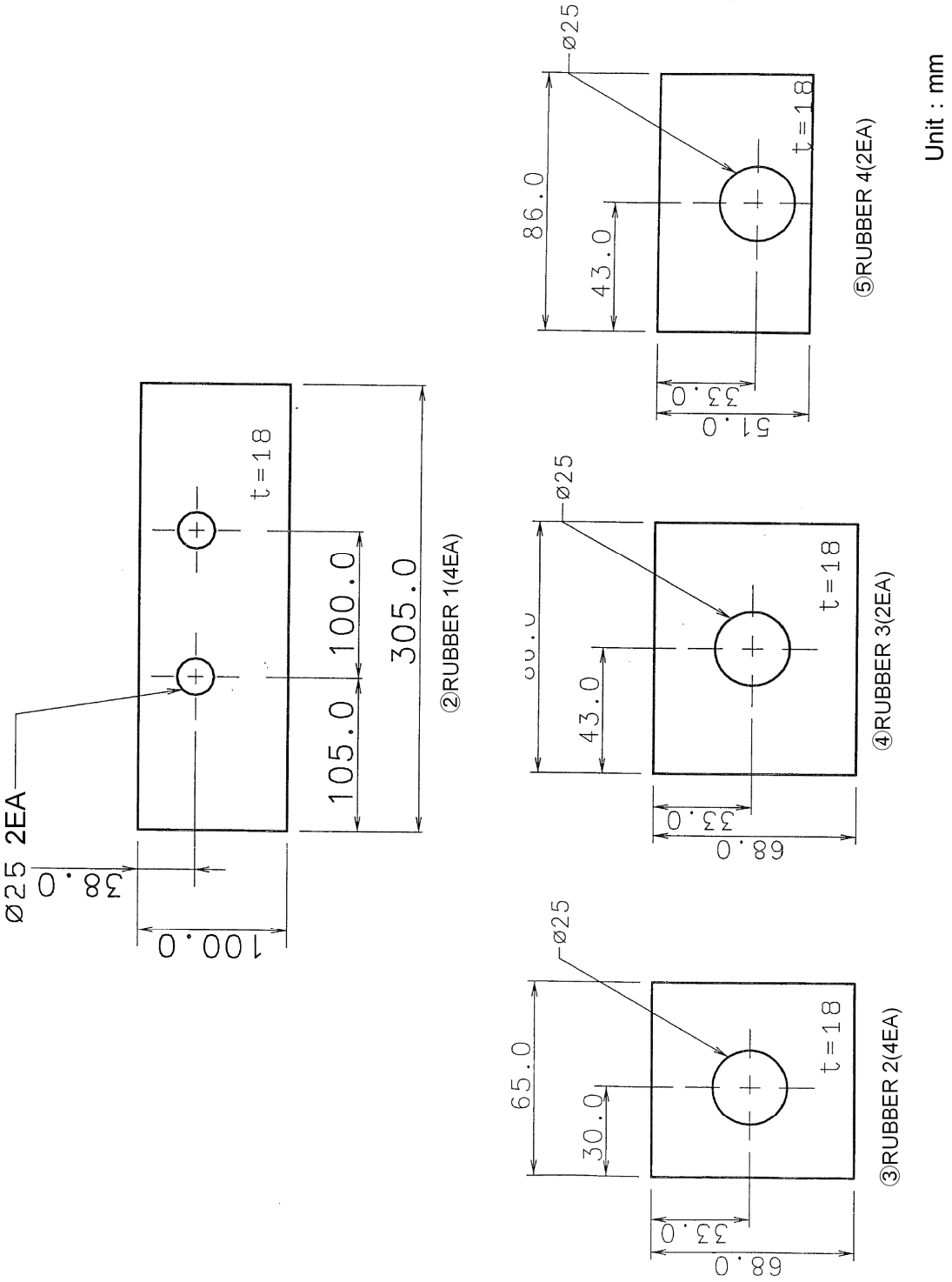
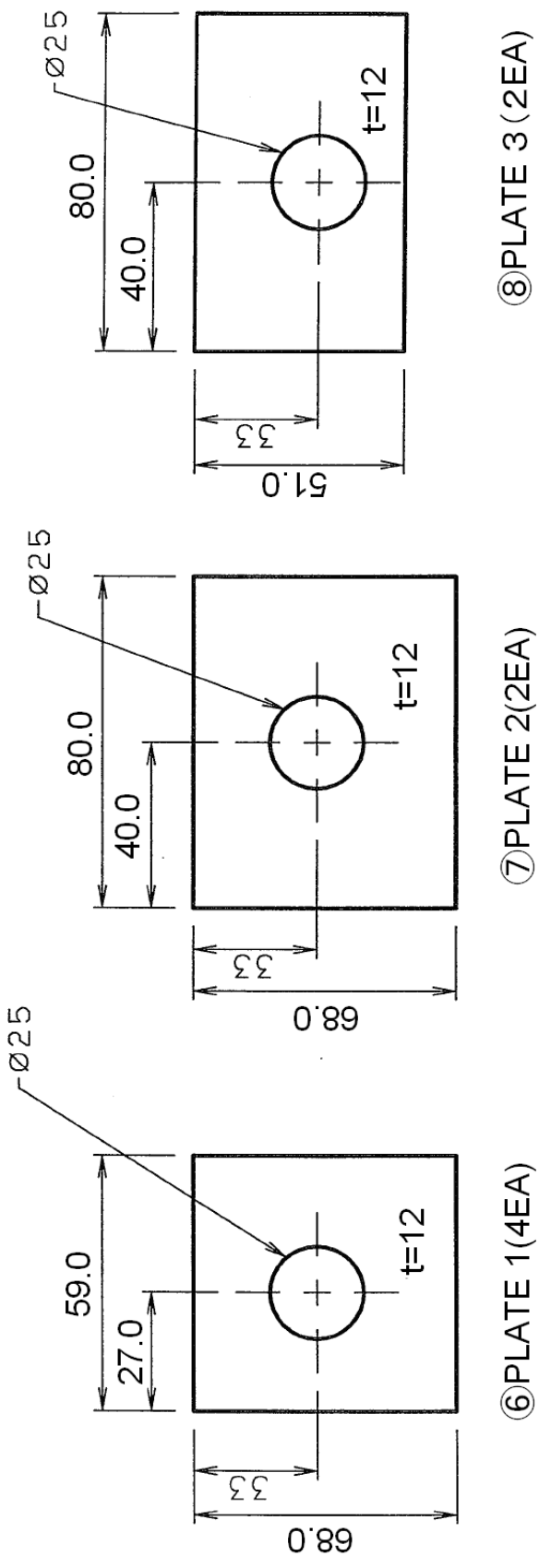

Ø25 2EA
38.0
100.0
t=18
105.0
100.0
305.0
②RUBBER 1(4EA)
Ø25
86.0
43.0
53.0
51.0
t=18
⑤RUBBER 4(2EA)
Ø25
43.0
53.0
68.0
t=18
④RUBBER 3(2EA)
Ø25
65.0
30.0
53.0
68.0
t=18
③RUBBER 2(4EA)
Unit : mm

Figure A4



Unit : mm

Figure A5

⑨ Collar
（φ24.5 x 66（inner diameter φ20.5）,8EA）

⑩ Shim
（φ40 x t0.5（inner diameter φ25）

⑪ Plain washer
（Grade A 20 SUS,8EA）

⑫ Spring washer
（2-20 SUS,8EA）

⑬ Nut（Lock nut）
（M20 SUS,8EA）

⑭ Bolt
（M20 x 200 SUS,8EA）

⑮ Rectangular plain washer
（Grade A 20 SUS,8EA）

⑯ Plain washer
（Grade A 24 ,t=4 SUS,8EA）

Figure A6

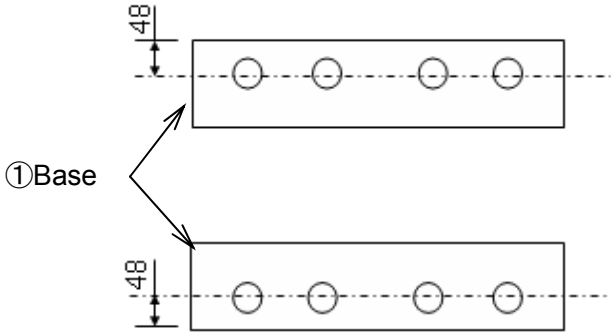
2. Installation

<Procedure>

The numbers (① to ⑯) correspond to the numbers of the table on the page 79.

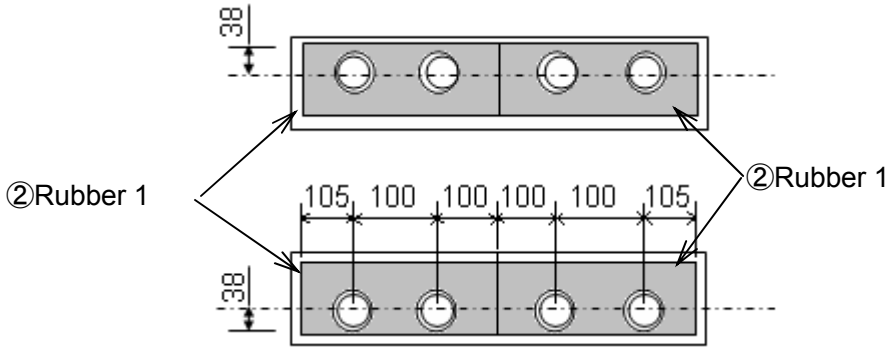
The following figures show views seen from the top of the **ARG** unit.

1. Place the Base(①) on the **ARG** installation surface.
   MHI recommends to glue up and fix the Base(①) on the installation surface so that there is no gap between Base(①) and installation surface.



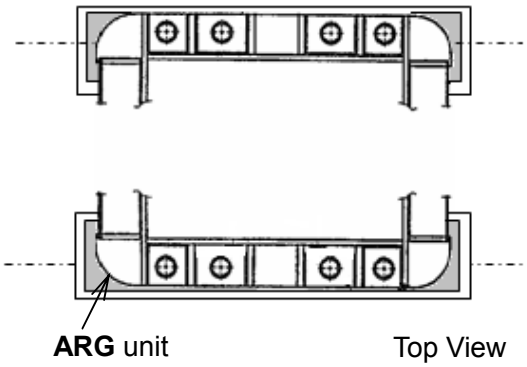
Top View Unit : mm

2. Place the rubber 1(②) on the Base(①).



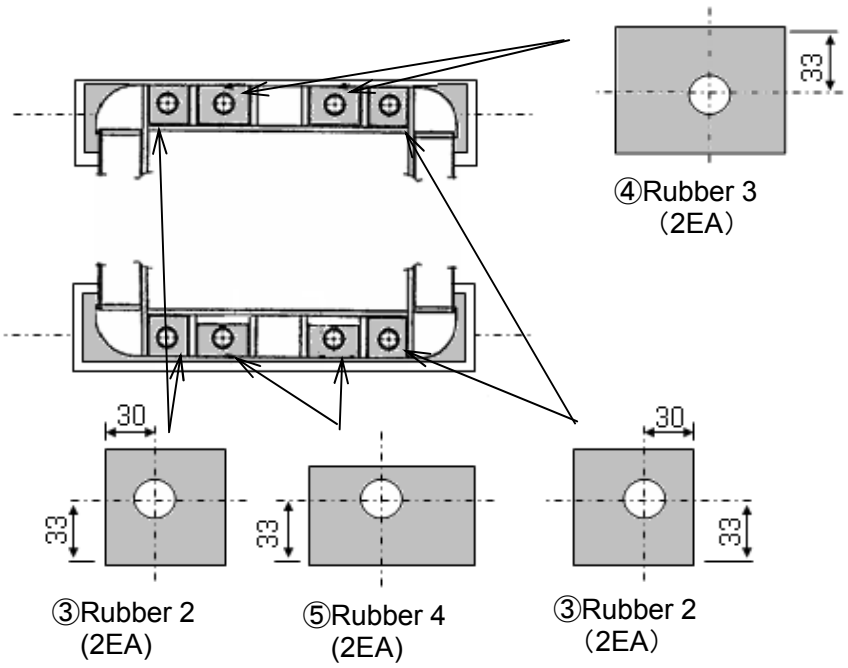
Top View Unit : mm

3. Place the **ARG** unit on the rubber1(②).



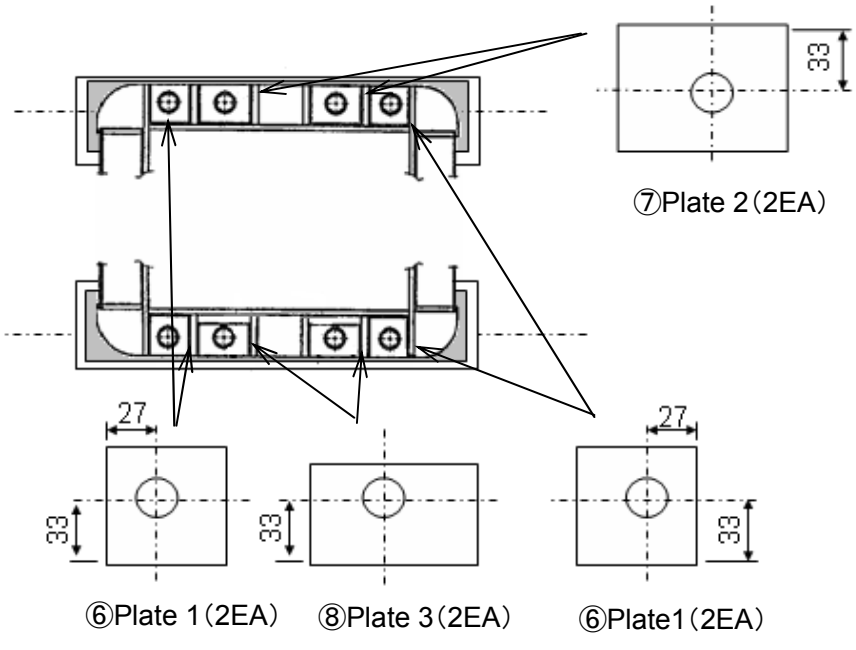
Top View Unit : mm

4. Place rubber 2(③), rubber 3(④) and rubber 4(⑤) on the **ARG**'s flange.



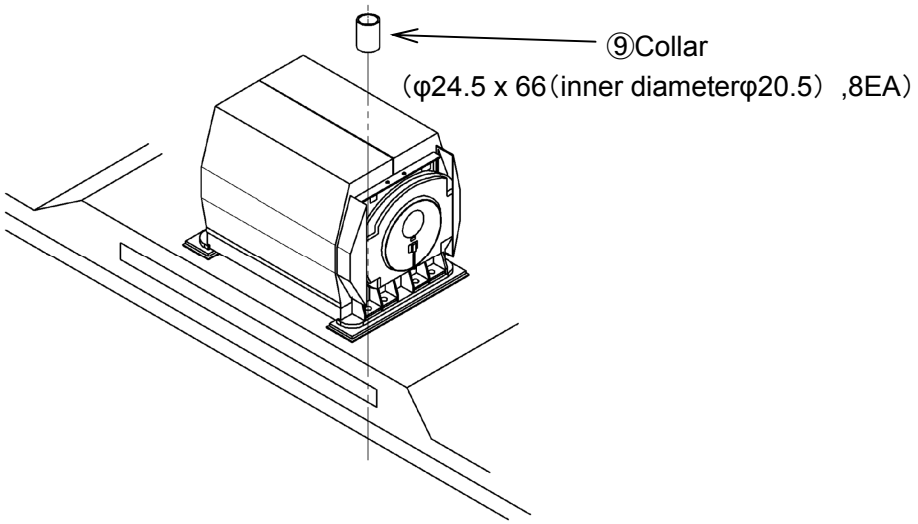
Top View Unit : mm

5. Place the plate 1(⑥), plate 2(⑦) and plate 3 (⑧) on the rubber 2(③), rubber 3(④) and rubber 4 (⑤) respectively.



Top View Unit:mm

6. Insert the collar (⑨).

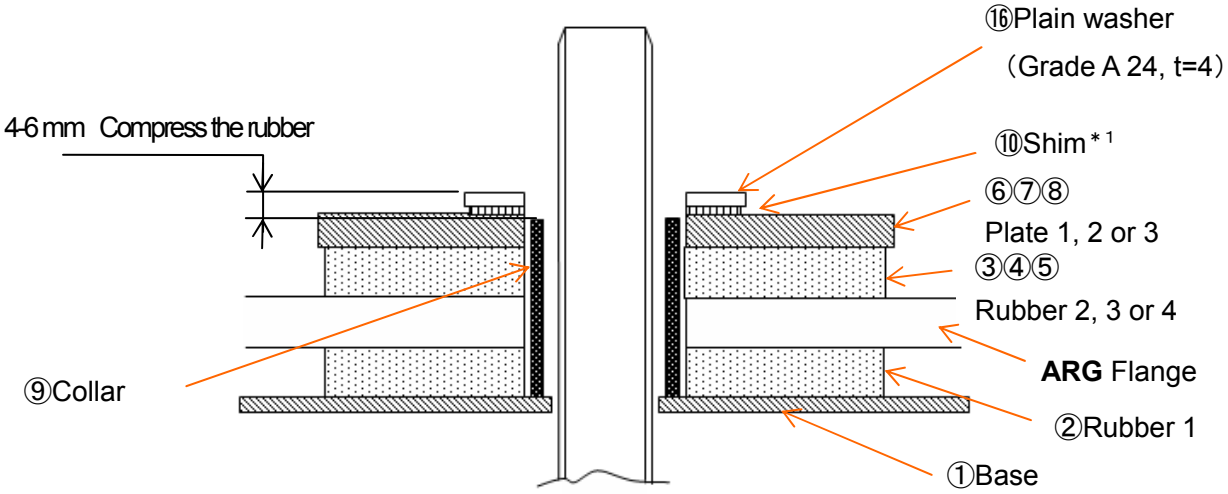


7. Adjust the compression length of the rubber from 4 to 6mm by using the shim(⑩) and plain washer(⑯) as shown in the Figure A7.

DANGER

Adjust the compression length of the rubber from 4 to 6mm by using the Shim.

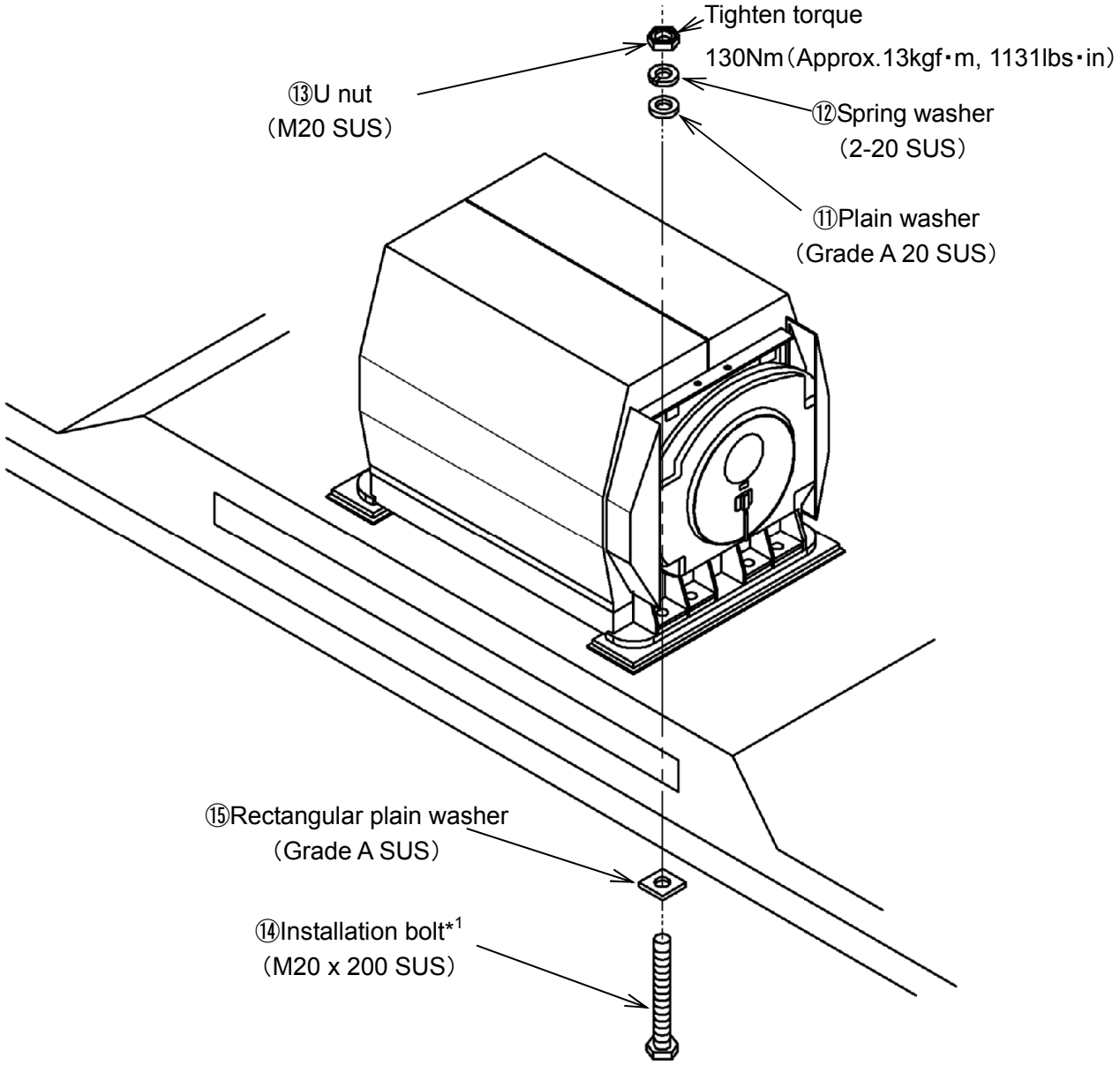
Not doing so could result in damage to the **ARG** unit or ship.



*1 Please use Shim if needed to adjust the compression length 4 to 6mm.

Figure A7

8. Assemble parts as shown in the Figure A8.
   Apply the anti-burning grease to bolts (⑭)(8EA).
   Tighten eight bolts little by little and evenly to a torque of 130Nm (approximately 13kgf･m (1131lbs･in)) in a diagonal sequence.



*1 Spread with anti-burning grease on the installation bolt.

Figure A8

⚠ CAUTION

Regular torque is as follows. Do not tighten with wrong torque.

Doing so could result in malfunction.

No	Without anti-vibration rubber	With anti-vibration rubber
1	300 N·m±10% (30 kgf·m±10%) (2,610lbs·in±10%)	130 N·m±10% (13kgf·m±10%) (1,131 lbs·in±10%)

Use all installation parts attached.

Not doing so could result in damage to the **ARG** unit or ship.

Be sure to tighten the installation bolts and nuts by regular torque.

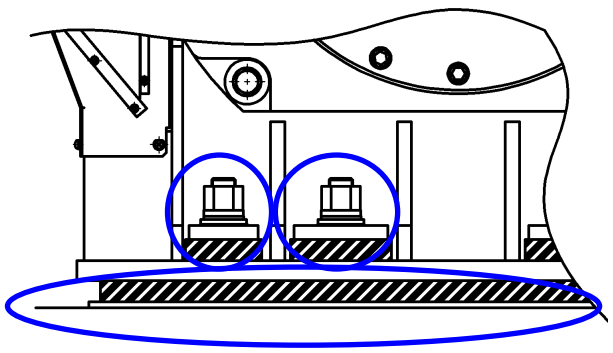
Loosening bolts and nuts could result in damage to the **ARG** unit or ship.

Re-tighten the installation bolts and nuts by regular torque after 1 or 2 days from installation.

Loosening bolts and nuts could result in damage to the **ARG** unit or ship.

9. Please check that there is no gap in parts shown as follows after tightening installation bolts and nuts.
   - Between rubber 1,2,3,4 and the **ARG** flange.
   - Between rubber 2,3,4 and plate.
   - Between plate and washer.
   - Between base and rubber.

   Please check that each parts is tightened securely and do not move.



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