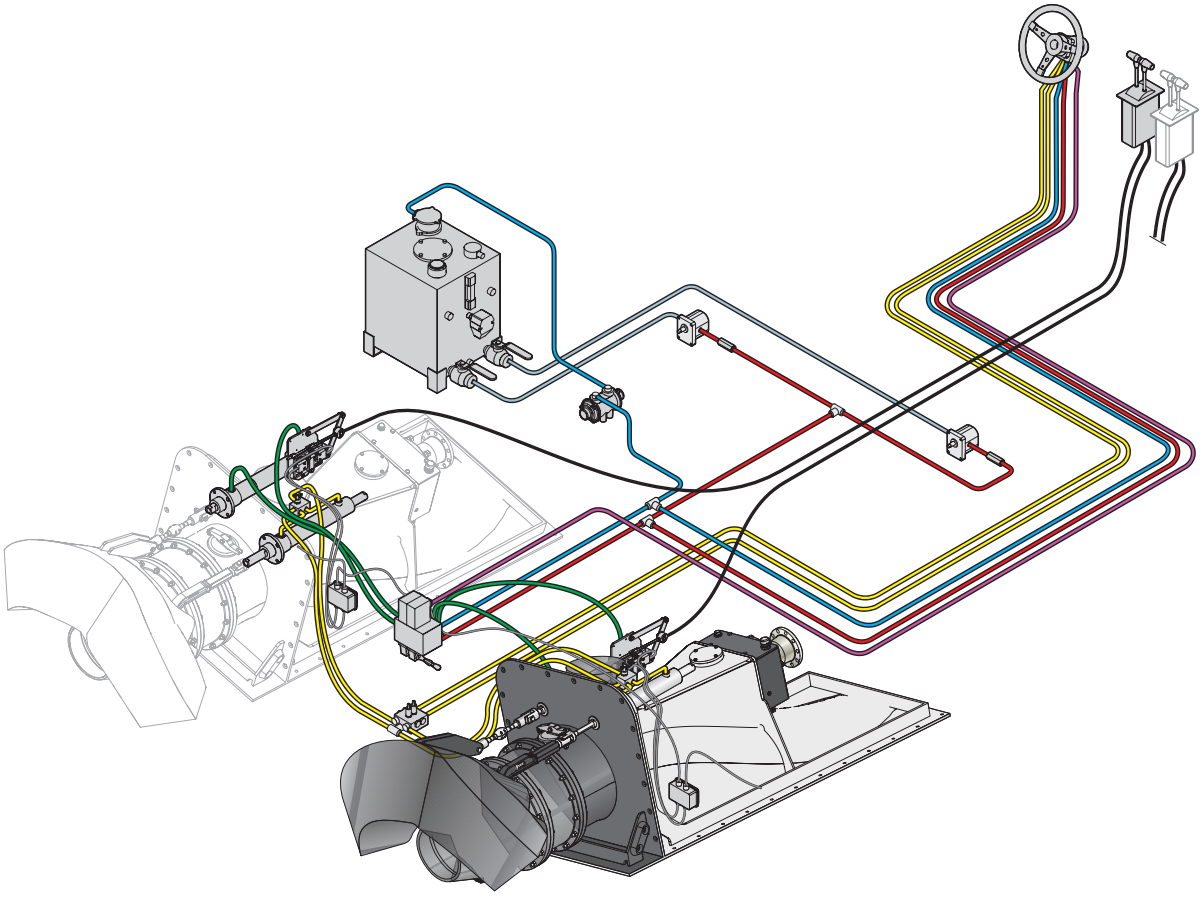
Rolls-Royce

Installation manual
Kamewa waterjets



Kamewa FF-series

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Preface

Thank you for choosing us as the supplier of the water jet unit for your application.

This publication is intended as a guide for a safe and trouble-free installation of the water jet unit system. The instructions are the result of many years of practical experience of water jet unit installations all over the world. Departures from recommended procedures can however be necessary or desirable, in which case your Rolls-Royce representative will be glad to offer his assistance in finding a solution for your particular installation.

It is the sole responsibility of the installer to ensure that the installation work is carried out in a satisfactory manner, that it is operationally in good order, that the approved materials and accessories are used and that the installation meets all applicable rules and regulations.

This publication has been published primarily for professionals and qualified personnel. Persons reading this publication are assumed to have a grounding in marine drive systems and to be able to carry out related mechanical and electrical work.

Rolls-Royce accepts no responsibility for any damage that occurs as a consequence of work carried out by non-authorized personnel. Carefully read through the safety instructions before beginning to install the water jet units.

Please feel free to contact Rolls-Royce if you have any queries regarding this equipment.

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About the installation manual

In the installation manual you find safety precautions, step-by-step instructions how to install the water jet unit and control system, precaution against corrosion, sea trial instructions and finally technical information about the water jet unit systems.

Drawings and documents are enclosed in section “DRAWINGS”.

1. Safety precautions

1.1 General

Read this chapter very carefully. It concerns your safety. This chapter describes how the safety information is presented in the Installation Manual. It also gives a general account of basic safety precautions to be taken when installing and testing the water jet unit.

This is how you should interpret the warning texts in this guide:

Warning!

If these instructions are not followed, there is a risk of personal injury, serious damage to the product or property or major operating faults.

Caution!

Draws attention to factors that may cause damage or operational faults of the product or to property.

NOTE!

Draws attention to important information that facilitates maintenance or operation.

Undertaking any work envisaged by this document may either directly or indirectly create risks to (1) the safety and health of the person undertaking the work or (2) the water jet unit and/or its components whilst the work is being undertaken.

It is the responsibility of the user to ensure that appropriate controls and precautions are identified and applied in relation to the work envisaged by this document in accordance with relevant statutory, legal and industry requirements to protect the health and safety of the persons undertaking the work.

It is also the user's responsibility to ensure that appropriate controls and precautions are identified and applied in relation to work envisaged by this document to protect against risks to the water jet unit and/or its components whilst the work is being undertaken.

Neither this document, nor its use, in any way absolves the user from their responsibility to ensure that the controls and precautions referred to above are implemented.

If, whilst undertaking any work envisaged by this document, you become aware of any Rolls-Royce product design related feature which could create risk to a person undertaking work or to the water jet unit and/or its

components please contact After Sales department at Rolls-Royce Oy Ab immediately.

It is the user's responsibility to make all relevant hazard identifications and risk assessments of all the activities associated with the use of this document.

It is the user's responsibility to design and implement safe systems of work and to supply safe equipment (including, without limitation, safety equipment) and training (including, without limitation, health and safety training) to anyone using this document to work on products to which it relates.

A user without the relevant experience of working in accordance with this document or with products, or similar products, to which it relates should seek appropriate advice to enable them to identify the appropriate health and safety controls and precautions and controls and precautions to protect against risks to the water jet unit and/or its components whilst work is being undertaken. Technical assistance can be sought from Rolls-Royce and will be subject to Rolls-Royce's terms and conditions.

1.2 Installation

⚠ *Caution!*

Plan in advance so that you have enough room for a safe installation and (future) dismantling. Plan the compartments so that all service points are accessible. Coming into contact with rotating components, hot surfaces or sharp edges when servicing and inspecting the water jet unit must not be possible.

⚠ *Caution!*

All parts of the water jet unit, the bearing housing, hydraulic cylinders, sensors etc. must be protected in order to avoid damages during installation.

⚠ *Warning!*

All rotating parts between the engine and the water jet unit must be covered. This to avoid personal injury, to protect the shaft from foreign objects which may hit the shaft during operation and cause damage. In case of shaft failure the shaft must be protected or it may cause personal injury and serious damage to the boat.

⚠ *Warning!*

Never work alone when installing heavy components, even when using a secure lifting equipment such as a lockable block and tackle. Most lifting devices require two people, one to see to the lifting device and one to ensure that the components do not get caught and damaged.

⚠ *Caution!*

Prior to welding, check that the electrical system of the boat is disconnected. If the electronic control system is installed, all power supplies must be disconnected before welding work starts. Supply filters might be damaged and control system function can be jeopardised.

⚠ *Warning!*

Always wear protective goggles if there is a risk of splinters, grinding sparks and splashes from acid or other chemicals. Your eyes are extremely sensitive and an injury to them can result in you losing your sight.

⚠ *Caution!*

Avoid skin contact with oil! Long term or repeated skin contact with oil can lead to the loss of natural oils from the skin. This leads to irritation, dry skin, eczema and other skin problems. Old oil is more dangerous to your health than new. Use protective gloves and avoid oil-soaked clothes and rags. Wash regularly, especially before meals. Use special skin creams to help clean and to stop your skin drying out.

⚠ *Caution!*

Most chemicals intended for the product (bearing housing oil, hydraulic oil and gearbox oils), or chemicals intended for the installation (sealants, paints and solvents) are harmful to your health. Read the instructions on packaging carefully! Always follow protective measures (using a protective mask, goggles, gloves etc.). Make sure that other personnel are not unknowingly exposed to harmful substances in the air that they breathe for example. Ensure that ventilation is good. Deal with used and excess chemicals as directed.

⚠ *Caution!*

Ensure that the warning or information decals on the product are always visible. Replace decals which are damaged or painted over.

⚠ *Caution!*

Using other hydraulic oil than the specified in this guide may cause malfunctions when manoeuvring the boat. This may cause personal injury and equipment damage.

1.3 Starting-up

⚠ *Caution!*

Check that there are no foreign objects in the inlet duct or impeller housing.

⚠ *Caution!*

Check the oil level in the bearing housing before starting-up.

⚠ *Caution!*

Check the oil level in the hydraulic oil tank before starting-up.

⚠ *Caution!*

Carry out visual inspections prior to sea trial, check that there are no oil or water leakage.

⚠ *Caution!*

The water jet unit must not be operated dry, since the rubber bearing and the mechanical sealing require water lubrication.

1.4 Sea trial

⚠ *Warning!*

The braking effect is extremely powerful if the reversing bucket control is shifted to full astern when driving ahead at high speed. Avoid heavy and sudden steering and ahead/astern manoeuvres. There is a risk of those on board falling down or overboard.

⚠ *Warning!*

If full steering lock is applied at high speed the boat will turn sharply. This produces high side forces and may cause personal injury and equipment damage.

⚠ *Warning!*

Never drive close to bathers or in areas where it is reasonable to expect that there may be people in the water. Take care when manoeuvring in harbours for example. Because of the power of the water expelled by the jet of water, injury can be caused even when manoeuvring at low speeds. The suction in the inlet duct presents a risk to people and objects in the water under the boat and close to the inlet opening. There is a danger that these may be adhered to the inlet duct and cause major damage or suffer serious injury. It is the responsibility of the captain/operator to ensure that the area around the inlet opening is clear of people or objects.

Warning!

Never open the inspection hatch or the anode hatch when the engine is operating.

Warning!

The water jet unit hydraulic system operates under extremely high pressure. This pressure may be high even when the engine is not operating. Always take great care when opening nipples. Carelessness can result in injury. In addition, the oil may be hot and cause scalding.

Warning!

The intermediate shaft should only be adjusted with engine turned off.

1.5 After sea trial

Caution!

When the boat is not in use, we recommend that the reversing bucket(s) of the water jet unit(s) is in the "full ahead" position to ensure that the cylinder rod is inside the reversing cylinder. This to protect the piston rod from corrosion and fouling.

On all models except for FF550, we recommend you to protect the steering cylinder against corrosion and fouling by turning the steering wheel so that the cylinder rod is inside the steering cylinder.

2. Water jet unit installation

2.1 General

This chapter is intended as a guide for the installation of the water jet unit. The instructions are not comprehensive and do not cover every possible installation, but are to be regarded as recommendations and guidelines applying to Rolls-Royce standards.

These recommendations are the result of many years practical experience of water jet unit installations from all over the world. Departures from recommended procedures can however be necessary or desirable, in which case your Rolls-Royce representative will be glad to offer his assistance in finding a solution for your particular installation.

It is the sole responsibility of the installer to ensure that the installation work is carried out in a satisfactory manner, that it is operationally in good order, that the approved materials and accessories are used and that the installation meets all applicable rules and regulations.

Before installing the water jet unit, check that there are no transport damages. Also check that all parts are delivered according to the delivery list.

Plan installation with care

Great care must be taken in the installation of water jet units and their components if they are to operate satisfactorily. Always make absolutely sure that the correct specifications and drawings and any other data are available before starting work. This will allow planning and installation to be carried out correctly right from the start.

Plan the engine room so that it is easy to carry out routine service operations involving the replacement of components.

Prior to installation

NOTE!
To simplify the installation remove the reversing bucket from the water jet unit.

Caution!
Components of the water jet unit, the bearing housing, hydraulic cylinders, sensors etc. must be protected to avoid damages during installation.

Recommended lubricants and sealants

For a list of agents to be used when installing, recommended by Rolls-Royce, see page 45 “Recommended lubricants and sealants”.

2.2 Storage before installation

If the water jet unit has to be stored before installation, the following must be followed:

- Storage temperature must be above +5°C, air humidity between 10-90%, non-condensed.
- The water jet unit must not be stored in the sunlight, it has to be stored in its original package and must be protected against dust and moisture.
- If the water jet unit is to be stored for a period longer than 3 months, the "laying-up" instructions in the instruction manual must be followed.

2.3 Planning the hull

The water jet unit can be bolted to aluminium, GRP, carbon fibre or steel hulls. It can be welded to aluminium hulls. The area in front of the inlet duct must be free from keel, slips or similar which may cause cavitation, which in turn may reduce the efficiency of the water jet unit or even cause damages.

One or several fins may be installed on the side of the water jet units without disturbing the water supply.

The water jet unit can be installed on both displacement and planing boats as single, twin, triple or quadruple systems.

The inlet duct is a welded construction, which can be suited to V-bottomed hulls during manufacturing.

When installing the water jet unit to steel hulls, we recommend you to install additional zinc anodes on the hull. However these additional zinc anodes must not disturb the water flow into the inlet duct of the water jet unit.

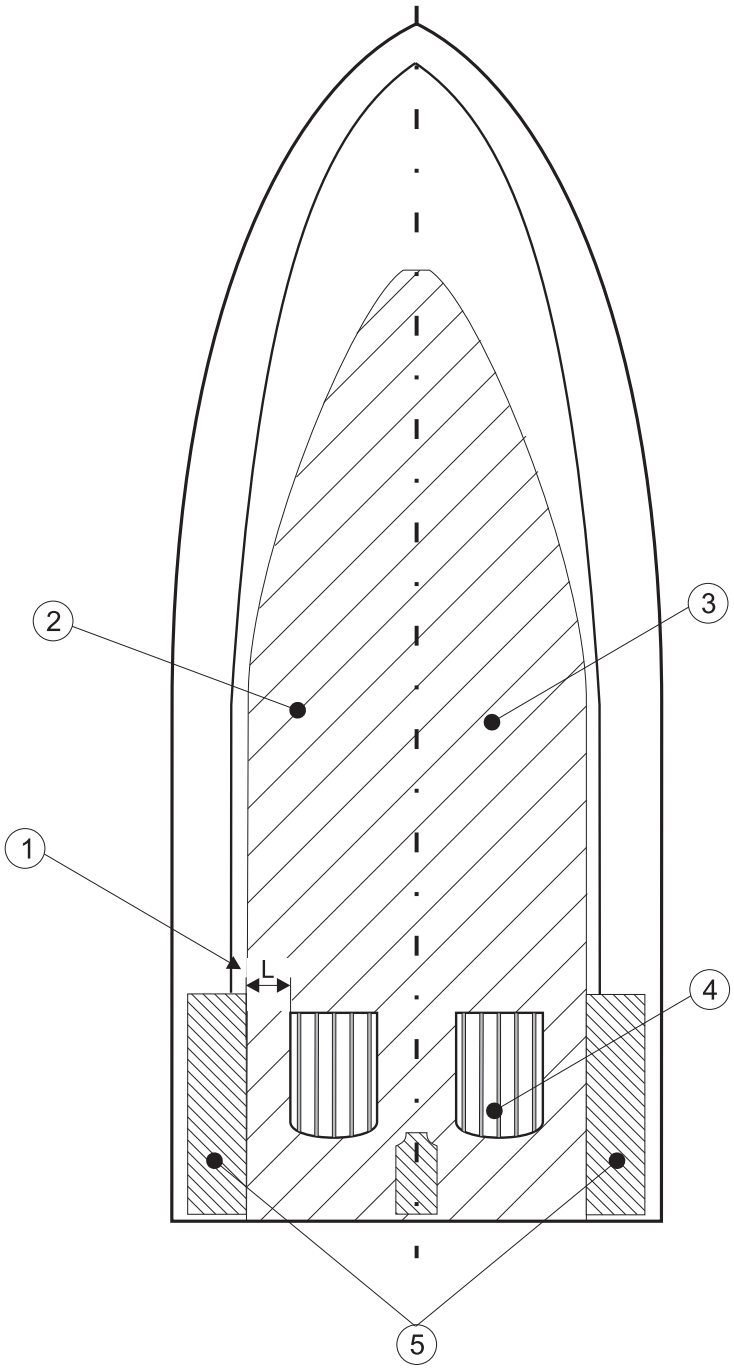


Figure 2-1. Planning the hull for water jet unit installation

1 The distance (L) must not be shorter that half of the width of the inlet.
2 This area must be free from sea-water intakes and exhaust outlets.
3 This area must be free from keel, slips or similar that will reduce the efficiency of the water jet unit.
4 The inlet duct of the water jet unit.
5 Sea-water intake, fins, echo-sounder sensors, log-sensor, etc.

Casting mould

When installing the water jet unit to GRP hull, it is a good idea to make a casting mould for the water jet unit when manufacturing the boat.

Cooling system

NOTE!

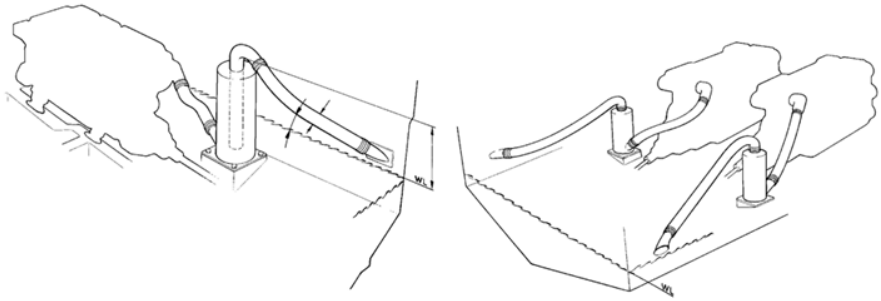
For more information see the engine installation manual or contact Rolls-Royce.

Sea-water intakes are placed according to the figure on page 13 “Planning the hull for water jet unit installation”.

Exhaust system

NOTE!
For more information see the engine installation manual or contact your Rolls-Royce representative.

The exhaust outlets are installed according to the instructions in the engine installation manual. But the exhaust outlets must not make the boat or the water jet unit dirty. Nor should the exhaust outlets be installed so there is risk of backwash. The exhaust outlets must be placed over the water line. Rolls-Royce recommend that the exhaust outlets are installed according to the figure below.



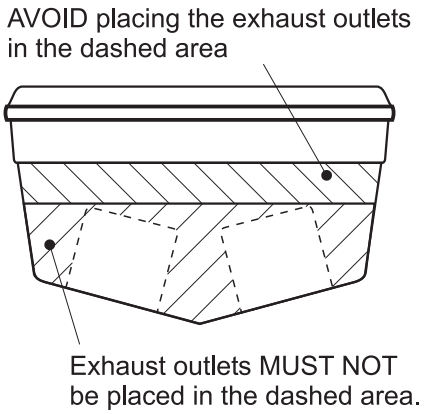


Figure 2-2. Planning the exhaust system.

2.4 Preparation of the hull

The water jet unit can be installed to the boat as a single, twin, triple or quadruple installation. The water jet unit can be bolted or welded (aluminium hull) to the hull.

NOTE!

This chapter only describes the installation procedure of single- and twin water jet unit installation. In case of a triple- or quadruple water jet unit installation contact Rolls-Royce for more information.

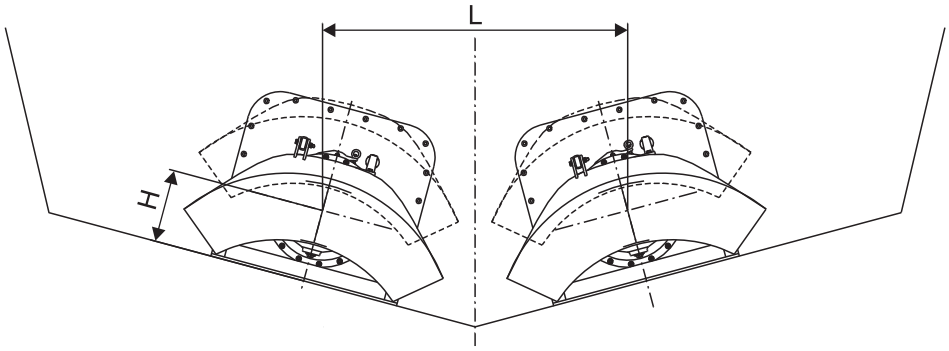
When preparing the hull, the dimensions of the preliminary installation hole must be about 50 mm smaller on each side than the dimensions on the actual general assembly drawing.

NOTE!

Refer to the enclosed general drawing if you need the measurements of the water jet unit.

Twin installation

FF-series	H (mm)
FF550	460



Distance L = The distance between waterjet unit centerlines at transom.

NOTE!

The distance L must be selected so there is at least 50 mm space between the reversing buckets when they are in the upper position.

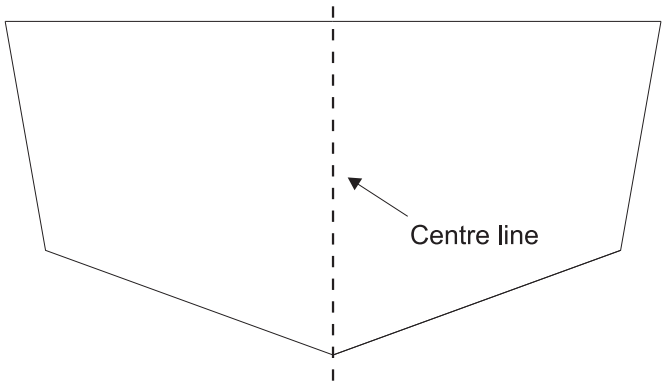
Preparation of the hull

The hull is prepared for installation by first drawing the limits of the holes on the hull. The next procedure is to cut out the holes. Thereafter the hull is prepared for the installation of the water jet units.

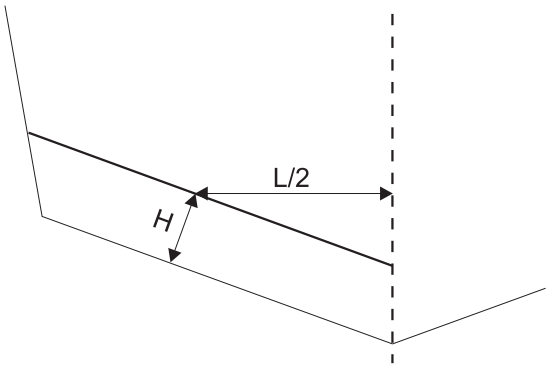
NOTE!
Refer to general assembly drawing for necessary dimensions of the water jet unit.

Draw the limits of hole on the hull:

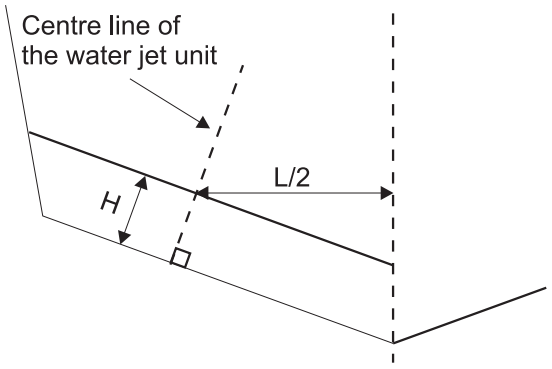
1. Draw the centre line of the hull on the stern.



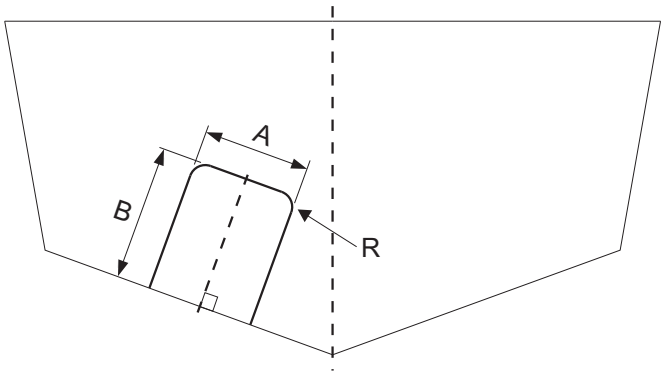
2. Draw a help line at the height (H) on the stern parallel to the hull bottom. At the distance (L/2) from the centre line of the stern on the height (H) from the bottom, there is the point where the centre point of the water jet unit will be when installed at distance (L) between the water jet units.



3. Draw the centre line of the water jet unit.

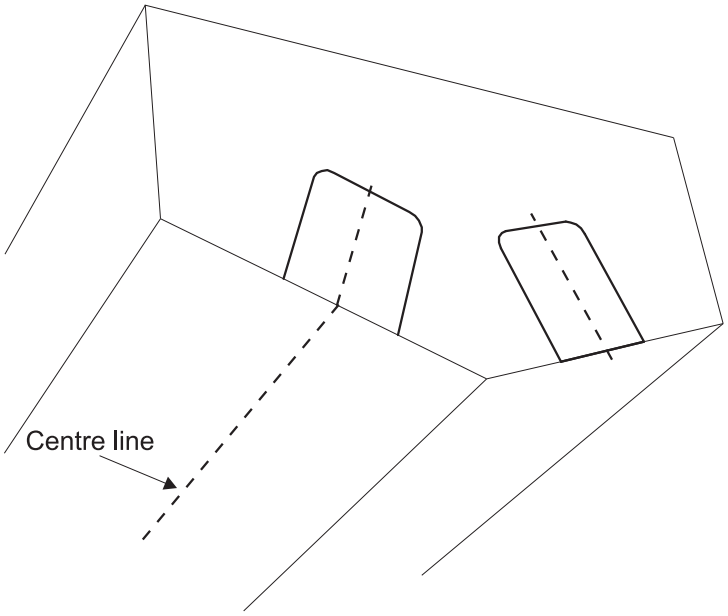


4. Draw the width (A) and the height (B) of the hole. Note the radius (R) in the upper corners.



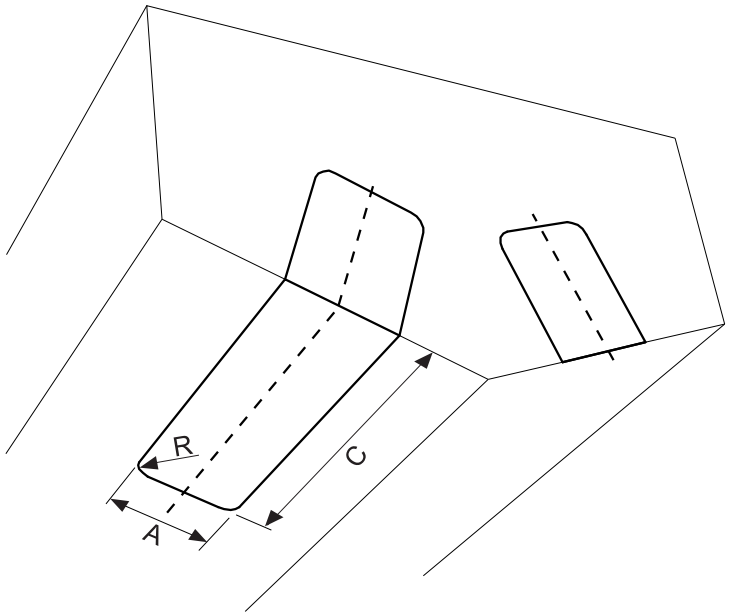
5. Repeat steps 2 to 4 for the starboard water jet unit.

6. Draw the centre line of the water jet unit on the hull bottom.



7. Draw the length (C) of the hole on the hull bottom. Draw the width of the hole (A). Note the radius (R).

8. **Bolt installation only:** Draw the contour of the area to be immersed in the hull bottom. This area is about 5 mm wider than the bottom plate of the water jet unit. It is necessary to lower the water jet unit in the hull bottom, to achieve a smooth hull bottom.



NOTE!

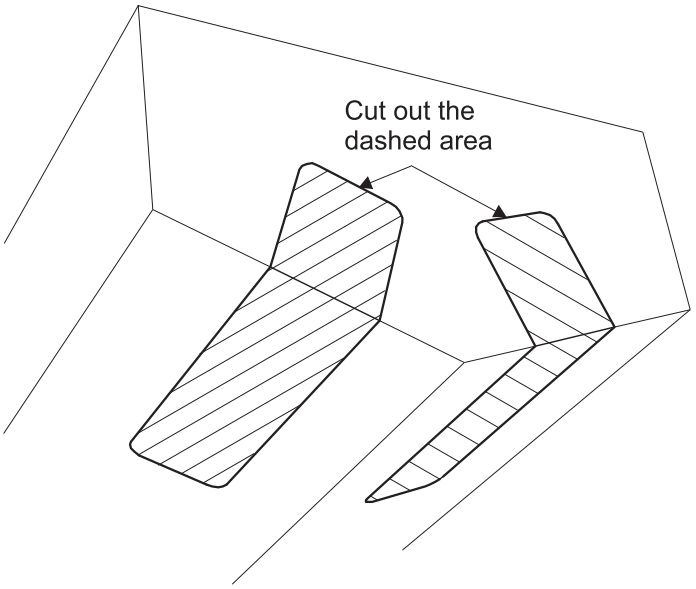
When manufacturing a GRP hull, it is a good idea to prepare the area to be immersed by using a casting mould. The depth of the immersion is presented in section “Single installation”.

9. Repeat steps 6 and 7, step 8 in case of bolt installation, for the starboard water jet unit.

10. The limits of the holes are now drawn. The hull is prepared for the next procedure, to cut out the holes.

Cut out the holes:

1. Cut out the holes along the drawn lines.



2. If the water jet units are to be bolted to the hull, see “Bolting the water jet units to the hull”.
3. If the water jet units are to be welded to the hull, the holes have to be adapted to the size of the water jet units.

Preparation for welding:

1. Lift up the water jet unit against the hull. As you observe the hole is not big enough to suite the water jet unit. Therefore the hole has to be done more accurate.

Warning!

Ensure that the water jet unit is secured properly by an approved lifting device, if not there is a risk of equipment damage and personal injury.

2. Draw new lines around the contour of the water jet unit on the hull stern and bottom.
3. Lower down the water jet unit and cut out the correct size of the hole.
4. Lift up the water jet unit and test if it is possible to install the water jet unit in the hull. If not, repeat steps 1 to 3 until it is possible.
5. Repeat step 1 to 4 when finishing the hole for the other water jet unit.
6. The hull is now prepared for welding. See page 21 “Welding the water jet units to the hull” for further instructions.

2.5 Welding the water jet units to the hull

The water jet unit can be welded to aluminium hulls.

NOTE!
Water jets with casted inlet ducts must always be bolted to the hull.

Prior to welding

Caution!
All parts of the water jet unit, the bearing housing, hydraulic cylinders, sensors etc., must be protected in order to avoid damages during welding.

Caution!
Prior to welding, check that the boat's electrical system is disconnected.

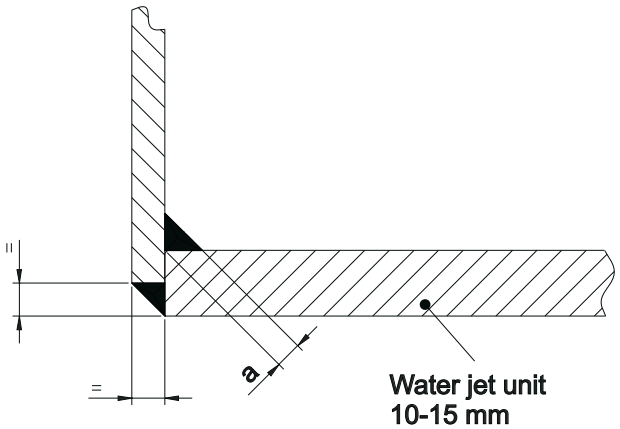
Caution!
When welding closer than 10 m from the Kamewa control system equipment, all power supplies must be disconnected before welding work starts. Supply filters might be damaged and the function of the control system may be jeopardized.

Welding joints

Two kind of weld joints are actual for this operation; fillet weld and butt weld.

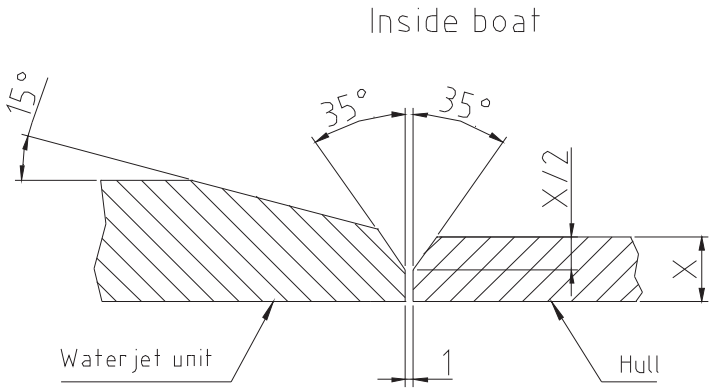
Fillet weld

The dimension (a) must be at least as thick as the hull. Welding procedure according to Figure 2-4.

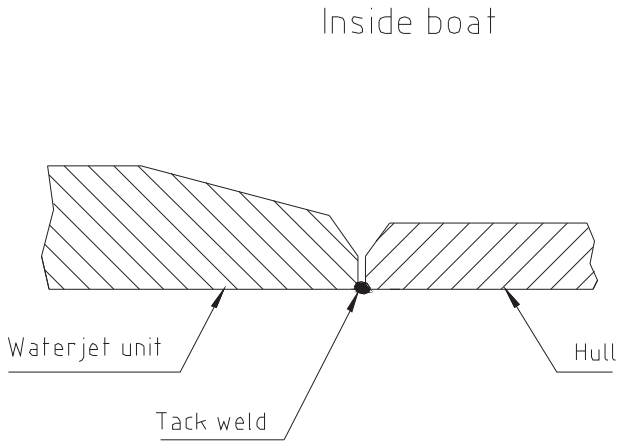


Butt weld

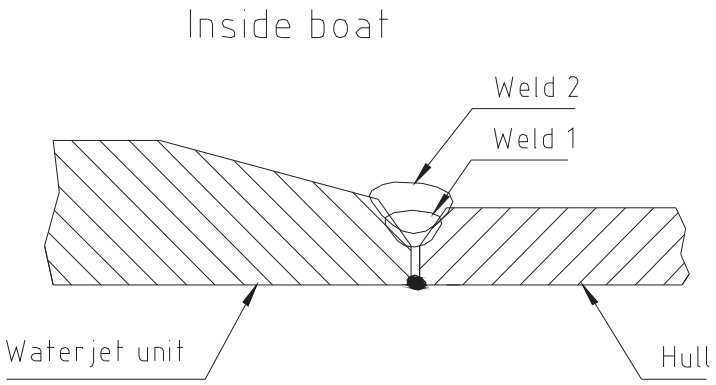
1. Prepare the hull plate as show in the figure below.



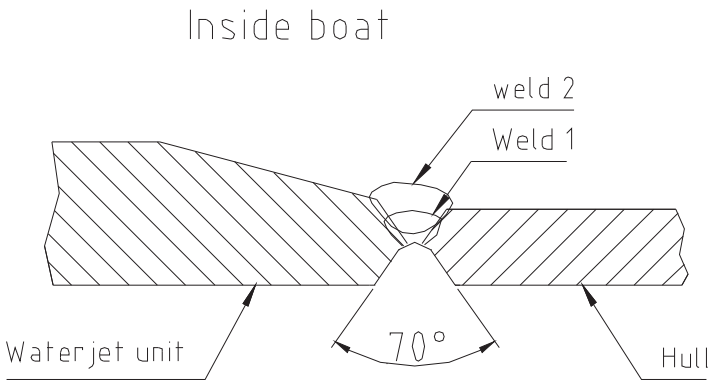
2. Apply 10 mm long tack welds from the outside of the boat, distance between tack welds to be approx. 150 mm.



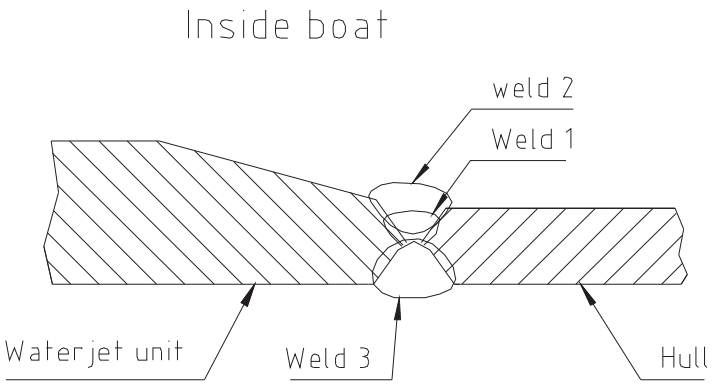
3. Weld two welds joints from the inside of the boat, welding direction and weld joint lengths according to Figure 2-4. Note! The two inside weld joints have to be trapped.



4. Open the root side as shown in the picture below.



5. Weld one weld joint from the outside of the boat, welding direction and weld joint lengths according to Figure 2-4. For thicker bottom plates two weld joints may be required also from the outside.



Welding information:

- Welding process: MIG (131)
- Filler metal: DIN1732: S-AlMg4,5Mn (e.g. OK Autrod 18.16)
- Shielding gas: EN 439–S I1+0.03NO (e.g. AGA MISON)

Installation procedure

Prepare for welding:

1. Install temporary stringers on the outside of the hull bottom and stern near to the hole, see the figure below. This is done to prevent damage to the water jet unit caused by heat stresses during welding.
2. Lift up the water jet unit to the hull and push it ahead. Ensure that the water jet unit is in its correct position.

⚠ Warning!

Ensure that the water jet unit is secured properly by an approved lifting device, if not there is a risk of equipment damage and personal injury.

3. Install auxiliary supports on the hull bottom to hold the water jet unit against the hull. Install one support more aft, the second support in the middle of the water jet unit and the last support more fore.

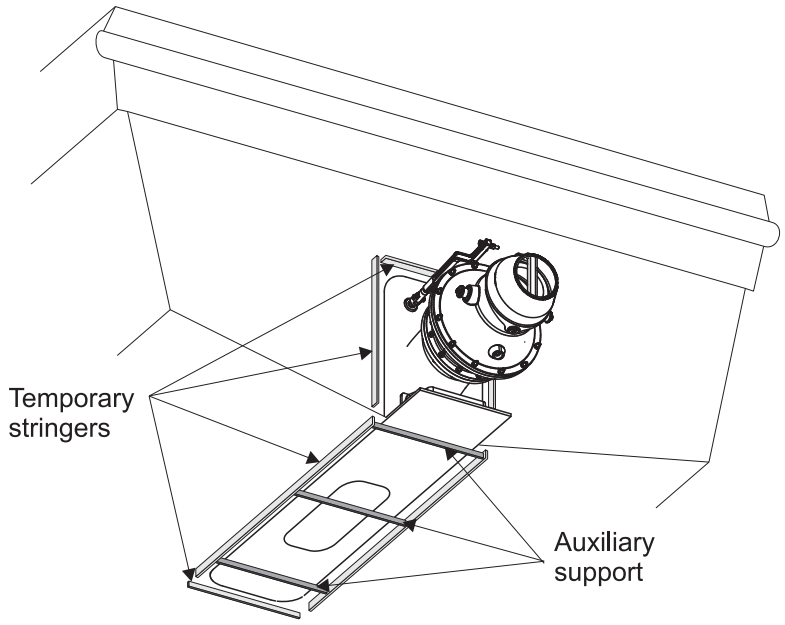


Figure 2-3. Temporary stringers and auxiliary supports.

4. Lower down the water jet unit so it is supported by the auxiliary supports. However it's a good idea to still secure the water jet unit with the lifting device as long as it won't prevent the welding.

Welding:

1. The water jet unit shall be welded together with the hull according to the instructions in the figure below. Especially observe the welding direction and the length of the weld joints.

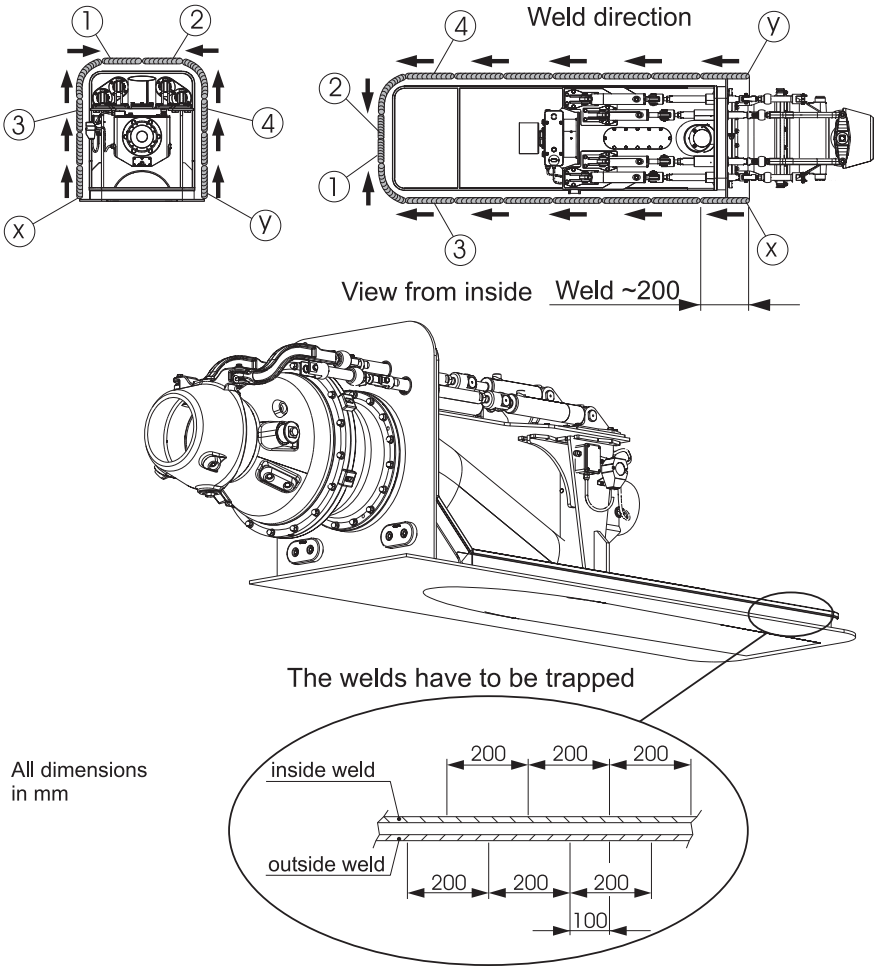


Figure 2-4. Welding direction and weld joints.

2. Weld the bottom inside the boat. Start with weld joint (1) continue with (2) then (3) and so on.

3. Remove the auxiliary supports from the hull bottom.

4. Weld the bottom outside the boat, weld V-grooves as described on section “Butt weld”. The weld joints have to be trapped as illustrated in the figure above to achieve best possible strength.

5. Weld the stern inside the boat. Start with weld joint (1) continue with (2) then (3) and so on.

6. Weld the stern outside the boat. The weld joints have to be trapped as illustrated in the figure above to achieve best possible strength.

7. Weld possible bulkheads, stringers etc. in the boat structure to the waterjet.

After welding is completed:

1. Remove the temporary stringers.
2. Grind the weld joints on the outside of the boat to achieve a smooth bottom surface of the hull.
3. Paint the water jet unit as described in the painting instructions.

Painting

Anti-fouling paint

The waterjet is not anti-fouling painted at factory expect for the inside of the inlet pipe and inlet grid. All painted surfaces on the outside of the waterjet must be painted with anti-fouling before the boat is launched.

Apply the anti-fouling paint as follows:

- Clean the surfaces from grease and oil with a suitable washing detergent.
- Remove salt and other dirt with high pressured fresh water.
- Activate the surface by grinding lightly with fine (grit 220–320) sand paper.
- Remove dust by using compressed air.
- A thin layer of Hempadur 45182 or equal epoxy tie coating can be applied. Let it dry before applying the anti-fouling paint.
- Apply the anti-fouling paint within three (3) days after the epoxy tie coating has been applied.

The water jet unit can be anti-fouling painted with the same type of anti-fouling paint as the boat, provided that the paint does not contain copper or any other harmful elements for aluminium. If local legalization does not allow the use of anti-fouling paint, contact Rolls-Royce for advice on alternative methods.

Drying times according to the paint manufacturer's instructions.

Touching up paintwork damage

Any scratched water jet unit component must be repaired. Observe the following before painting a component:

NOTE!
If a corrosive damage to the inlet duct is deeper than 3 mm, contact Rolls-Royce.

1. Wash the area to be painted with fresh water.

   ⚠ Caution!
   Be careful when using pressure washers. High water pressure can damage components on the water jet unit.

2. Leave the area to dry.

3. In order to remove all oxidation layers grit blast (SA 2,5) or grind (grit 100-120) the damaged surface locally and level out any unevenness.
4. Remove dust by using compressed air.
5. Paint the area as described below.

Painting

Spray painting:

1. Spray 3 layers with “Intershield 803”.
2. Spray 1 layer with HEMPADUR 45182 or equal epoxy tie coating.
3. Spray 1 layer with anti-fouling paint.

Drying times according to the paint manufacturer’s instructions.

Painting with brushes:

1. Apply 5 layers of “Intershield 803”.
2. Apply 1 layer of HEMPADUR 45182 or equal epoxy tie coating.
3. Apply 2 layers of anti-fouling paint.

Drying times according to the paint manufacturer’s instructions.

Do not apply “anti-fouling paint” on cylinder rods and anodes.

Correction of damages in the painting

Should an area or a component of the water jet unit be scratched during installation, the damaged painting must be remedied. Observe the following before painting a component:

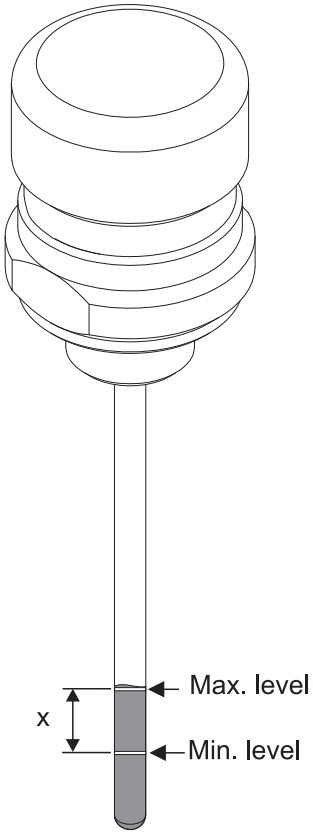
1. Grind the damaged area to be painted by using sand paper (grit 120-150).
2. Remove dust by using compressed air.
3. Paint the area as described earlier.

2.6 Marking of oil dipstick

The oil level in the bearing housing is checked with the oil dipstick. The oil dipstick must be marked as follows:

1. Fill the bearing housing with oil of prescribed quality and quantity, see page 45 section “Recommended lubricants and sealants”. Wait until the oil level has stabilized.
2. Pull out the oil dipstick and mark the max. level of the oil level.
3. Mark the min. level “x” mm lower, as illustrated below.

Individual marking is required because of different deadrise angles of the vessels, which means different levels on the oil dipstick.



FF-series	Distance x
FF550	see below

FF550 only:

1. Mark the max. level on the dipstick 5 mm above the oil level.
2. Mark the min. level 5 mm below the oil level, i.e. 10 mm below the max. level.

2.7 Connection of the bearing housing alarm sensor

NOTE!
This instruction is valid for models equipped with the bearing housing alarm sensor.

The alarm sensor is installed on the water jet unit at factory, the cable is connected to the temperature sensor in the bearing housing. When installing the main control station, connect the alarm sensor to the alarm system. Connect as illustrated in the enclosed drawing 105 601 04.

The alarm set point is +70°C and shall not be changed.

2.8 Connection of the bearing housing oil cooler

NOTE!
This instruction is valid for models equipped with the bearing housing oil cooler.

The bearing housing oil cooler is installed on the water jet unit at factory, hoses are connected to the bearing housing. The outlet of the cooler is connected to the water jet unit inlet duct. Before launching the boat, the inlet of the cooler must be connected to the sea water circuit of the engine cooling system.

Requirements of the cooling water to be supplied

- water flow: min.10 l/min
- temperature: max. +35°C
- pressure: min. 0.04 MPa

3. Hydraulic system installation

3.1 General

The purpose of the following instructions is to give directions for the installation of the hydraulic system equipment with regard to location, environment and maintenance.

It is the sole responsibility of the installer to ensure that the installation work is carried out in a satisfactory manner, that it is operationally in good order, that the approved materials and accessories are used and that the installation meets all applicable rules and regulations.

Arrival inspection

Immediately upon arrival the goods must be unpacked and inspected. Remarks, if any, should be forwarded to Rolls-Royce as soon as possible.

Purity

Before taking the system into service it is of utmost importance that the system is clean. Contamination of any type in the hydraulic oil can jeopardize the maneuver function of the boat and dramatically reduce the running hours (shorter service interval).

Plan installations with care

Great care must be taken in the installation of the hydraulic system if it is to operate satisfactorily. Always make absolutely sure that the correct specifications and drawings and any other data are available before starting work. This will allow planning and installation to be carried out correctly right from the start.

Plan the installation so that it is easy to carry out routine service operations involving replacement of components.

Hydraulic oil quality

The hydraulic oil shall have a viscosity grade according to ISO VG 46 (46 cSt/40°C) with EP additives and fulfil the requirements of DIN 51524, part 2.

The cleanliness of the hydraulic oil should be maintained at ISO 4406 code 16/13. This code allows a maximum of 640 particles per millilitre greater than 5µm and a maximum of 80 particles per millilitre greater than 15µm.

Warning!

Using other oil than the specified above may cause malfunctions when manoeuvring the boat. This may cause personal injury and equipment damage.

3.2 Storage before installation

If the hydraulic power pack has to be stored before installation, the following must be followed:

- Storage temperature must be above +5°C, air humidity max. 80% non-condensed.
- The hydraulic power pack must not be stored in the sunlight, it has to be stored in its original package and must be protected against dust and moisture.

3.3 Installation drawings

1. Hydraulic diagram
2. Hydraulic power pack
3. Counter balance valves
4. Oil cooler
5. Check valve

NOTE!
Refer to section “DRAWINGS” in the printed version.

3.4 Installing

NOTE!
The position numbers in text refers to the enclosed “Hydraulic power pack, assembly drawing”, see page 35 “Installation drawings.

PTO-pump

Installation requirements

The hydraulic pump is PTO driven (power take-off) and should be installed on the gearbox primary side or on the engine. Rolls-Royce does not supply bell housing, couplings etc. Accordingly the gearbox or engine manufacturer should be contacted for appropriate items.

Read more about the PTO-pump in the enclosed PTO-pump data sheet.

Note that the PTO-pump should be installed in a position that assures an oil level at or above the centre line of PTO-pump (mounted with drain-connection pointing up), as stated on the hydraulic diagram.

NOTE!
Consult Rolls-Royce if you need more information about how to install the PTO-pump.

Hydraulic power pack

Installation requirements

The hydraulic power pack shall be placed so it is easily accessible for maintenance and replacement of components. As manual operation of the directional control valves is possible it is important that the hydraulic power pack is placed so the control valves are easily accessible.

The filter connections and valves on the valve manifold, breather/filler cap are other components that should be easily accessible during maintenance operations.

In order to have a static pressure to the suction port of the PTO-pump, the bottom of the hydraulic tank must be at least 0,5 m above the PTO-pump.

The hydraulic power pack and hydraulic connections to and from the tank must not be placed close to hot objects (e.g. the engine exhaust manifold) as the oil in the hydraulic system could be overheated.

Installing

Install the hydraulic power pack in the boat:

1. Install the hydraulic power pack horizontally.
2. There are four pre-drilled mounting holes in the feet of the hydraulic power pack. These mounting holes are used when tightening the hydraulic power pack to the hull. Tighten the screws properly to avoid that the hydraulic power pack will come loose during operation.
3. Connect the cables according to the system drawing.
4. The cables delivered with the control system fits directly into the directional valve connectors.

Hydraulic oil cooler

Installation

Connect the hydraulic oil cooler to the sea water circuit of the engine cooling system. The hydraulic oil cooler is designed for a water flow of 30 l/min. The hydraulic oil cooler should be connected to a bypass circuit.

Install the hydraulic oil cooler before the engine. The inlet water temperature to the hydraulic oil cooler must be below 40°C.

One direction check valve

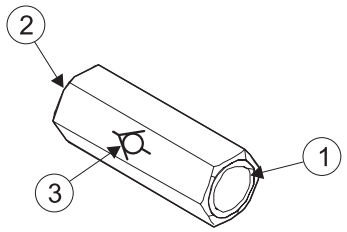


Figure 3-1. The one direction check valve.

1 Connection
2 Connection (PTO-pump side)
3 Symbol of flow direction

The one direction check valve is used in twin installations to ensure the correct direction of the oil flow. Install the one direction check valve when connecting the pressure line from the hydraulic pump to the hydraulic power pack.

Counter balance valve

Install the counter balance valves close to the cylinders. Note that there can be counter balance valves with different settings in the system. Identify the right location for each counter balance valve by checking the connection size in the hydraulic diagram.

Hydraulic hoses and pipes

Installation requirements

⚠ ***Caution!***

It is of utmost importance for a safe operation of the boat that the hydraulic system is clean and free from contamination. All pipes and hoses used in the system must be flushed before connected to the system.

Installing

Before connecting pipes and flexible hoses to the system:

1. Use pipes and hoses of prescribed quality, information is found on the hydraulic diagram.
2. Flush all pipes and flexible hoses accurately. This to keep the system free from any contamination. If the pipes and hoses are clean when connecting them to the system, the system is ready for start-up without further flushing.

3. Connect the hydraulic system according to the hydraulic diagram. Useful information is also available on the hydraulic power pack assembly drawing. Information on pipes, hoses and connections are found on those drawings.

3.5 Starting-up

Flushing

The hydraulic power pack and PTO-pump are cleaned thoroughly in the factory after the factory test run. Therefore are no further cleaning or flushing of the components needed.

It is the responsibility of the installer to ensure that all pipes and hoses connected to the system have been flushed before the installation.

Adjustments

The relief valve and load sensing valve on the PTO-pump are pre-adjusted and shall not be changed. All valves on the hydraulic power pack are pre-adjusted and shall not be changed.

Likewise, the counter balance valves are pre-adjusted and shall not be changed.

Start-up

The start-up procedure:

1. Check that the installation of the components are made according to the installation instructions.
2. Disconnect the drain-connection of the PTO-pump and top up the PTO-pump with oil of prescribed quality.

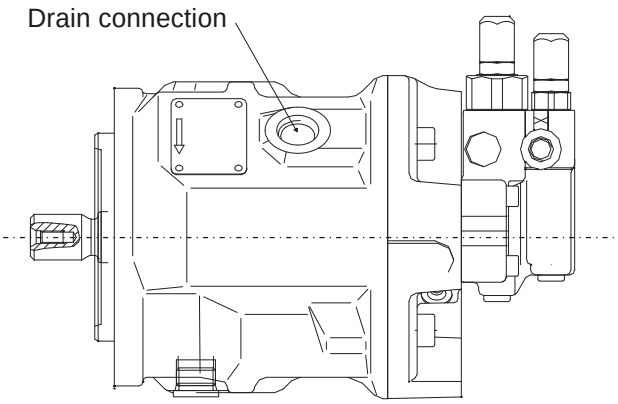


Figure 3-2. Drain connection on the PTO-pump.

3. Fill the tank half full with oil of prescribed quality (check the level indicator). The oil is preferably filled from a separate pump unit with filter or else via the filler cap of the hydraulic power pack.

   ⚠ ***Caution!***

   If the oil tank cover has been opened or removed, the oil tank has to be cleaned thoroughly before continuing the start-up procedure.

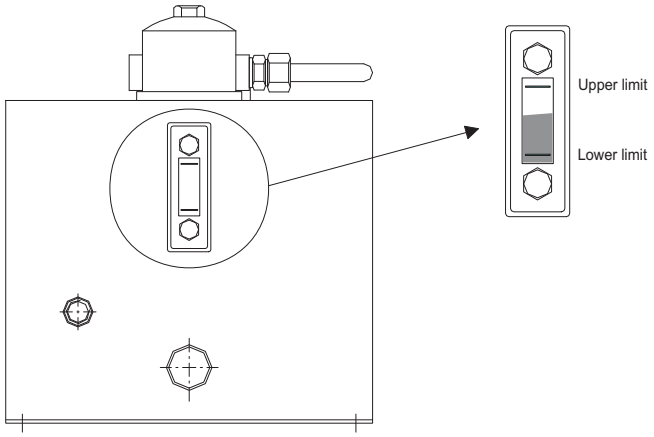


Figure 3-3. The level indicator on the front of the hydraulic power pack.

4. In order to avoid damage to the PTO-pump, the suction line must be ventilated by loosening the suction connection until the whole suction hose is filled with oil.

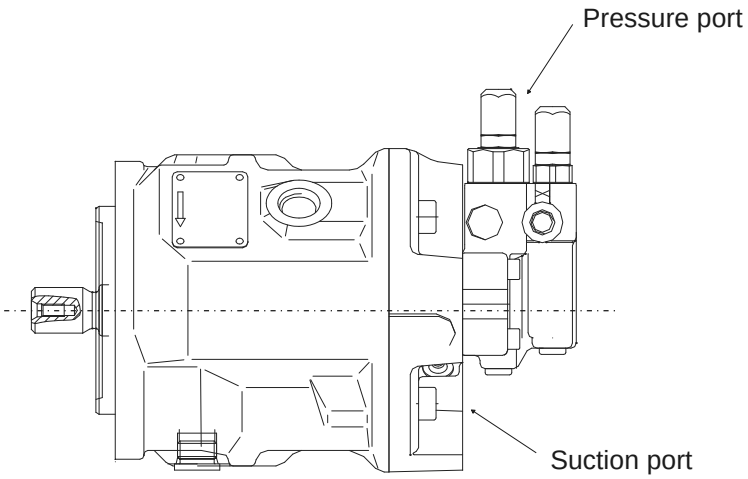


Figure 3-4. The suction connection on the PTO-pump.

5. Connect a pressure gauge to the test connection TPS1 (M16 Mini-test connection) of the hydraulic power pack.

6. Start the engine.

   ⚠ ***Caution!***

   The water jet unit must not be operated dry, since the rubber bearing and the mechanical sealing require water lubrication.

7. Let the PTO-pump run for 0.5 hours. Regularly check pressure and oil level on the hydraulic power pack.

8. After the PTO-pump is stopped, check the filter for oil contamination. If necessary, drain the tank, fill up with clean oil and change the filter elements.

9. Check the oil level in the tank, fill up if necessary.

4. Precaution against corrosion

4.1 Galvanic corrosion

A boat that lies in the water constitutes a galvanic element since different metals (or metal alloys) such as steel and aluminium are in electrical contact with each other while in the same electrolyte, namely salt water. This produces galvanic corrosion.

In popular terms, this can be compared with the similar electrochemical process that goes on in a starter battery. It is called a galvanic element. In a non-battery context the result of this process is called galvanic corrosion.

Measuring with calomel or Zn electrode connected to a digital probe tester

1. Connect the calomel or Zn electrode to the digital probe tester measurement cable.
2. Connect the probe tester tip to a good ground connection, e.g. the ground screw on the inside of the water jet unit. Set the tester for D.C. measurement.
3. Carefully remove the protective sleeve over the calomel electrode probe tip. The protective sleeve is filled with a saturated salt solution (NaCl) and must be replaced after measurement with the salt solution in it. Dry the tip with a clean paper tissue or equivalent after measurement.
4. Dip the electrode in water approximately 30 cm (12") from the drive/shield water jet unit. The measurement result is the mean value for the complete drive and shield water jet unit. The result should lie between (minus) -900 mV and -1100 mV in case of calomel electrode and between -100 mV and +100 mV in case of Zn electrode.

To check individual parts such as bolts, hydraulic cylinders etc., move the electrode so that the tip is directed towards an aluminium surface, about 5 mm away from the surface where the stainless part is fitted.

The measurement result here should also lie between -900 mV and -1100 mV, but values below - 800 mV (calomel) or + 200 mV (Zn) next to the impeller can be accepted.

If the result exceeds this (i.e. a higher more positive value such as for example -800 mV/calomel or + 200 mV/Zn), the proportion of "noble" metals such as stainless steel, bronze etc., is too great for the anodes to overcome the corrosion current. The amount of anodes should be increased or the problem must be solved in another way depending on the situation.

The result may also be stray currents caused by incorrect or wrongly connected (+) cable(s) exposed to bilge water.

There is overprotection risk if the digital tester gives a result less than -1100 mV. This could also be caused by stray currents from separate ground cables for VHF radio or other equipment fitted with separate ground cables which are wrongly connected.

The reason may also be that the anodes provide too much protection current, e.g. magnesium anodes in salt water.

The quality of water varies in harbours around the world. Some areas give different results due to salt and pollution content in the water. It is important that, if the anodes disappear fast, the reason is investigated. If there is no fault found in the boat system, the solution for this water condition could be just to add more anodes.

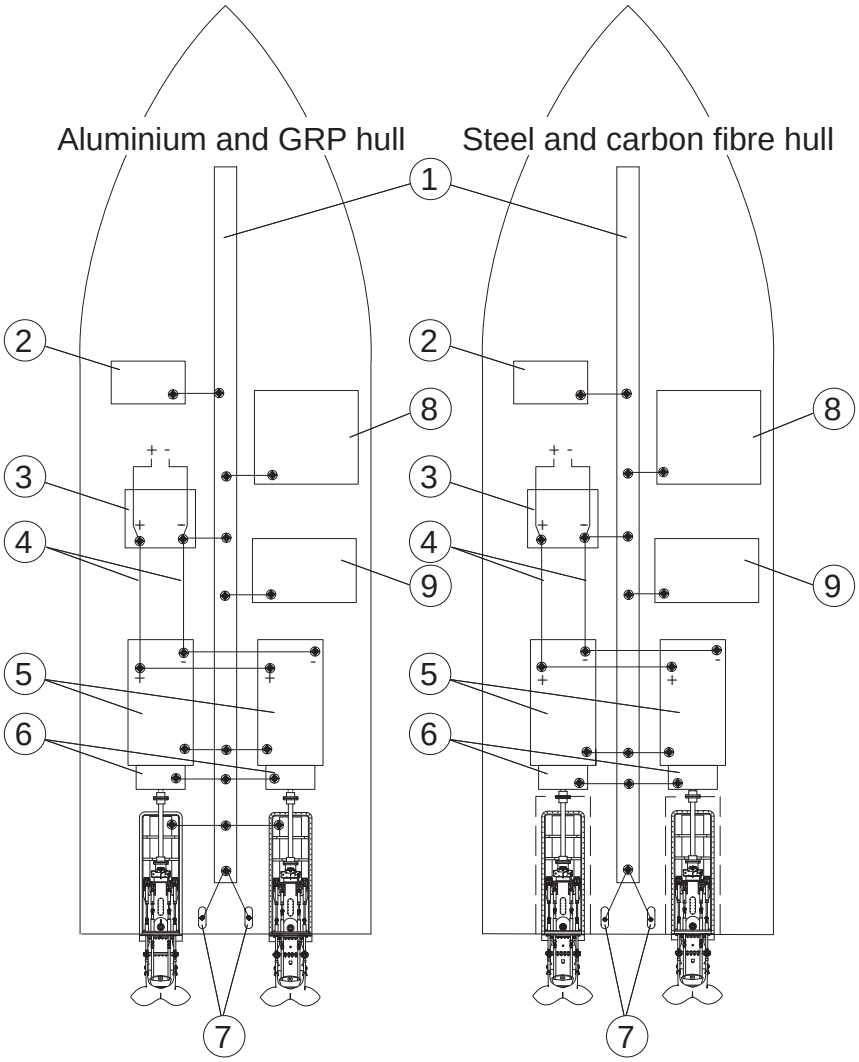


Figure 4-1. Earth bonding system for water jets

1. Negative earth bonding strip
2. Earth plate to water
3. Battery
4. Starter cables
5. Engine
6. Reduction gear
7. Hull anodes
8. All metal items, electrical and other accessories grounded by a reliable cable
9. Fuel tank



NOTE!

Aluminium and GRP hulls: Hull anodes must be located so that they are always submerged. Anode shape and installation must be selected so that the resistance and flow disturbance to the water jet is always minimized.



NOTE!

Steel and carbon fibre hulls: Water jet units must be electrically isolated from the hull, reduction gear/clutch and engine.

5. Technical information

5.1 Technical data

FF-series	Power range	Max. rpm 1)
FF550	300–1500 kW	1650 rpm

1) = Max. rpm of the impeller shaft.

5.2 Weights

FF-series	Weight (dry unit)	Entrained water 1)	Entrained water 2)
FF550	960 kg	485 l	395 l

1) = Entrained water totally.
2) = Entrained water inside transom.

5.3 Recommended lubricants and sealants

Lubricants of the bearing housing

FF-Series	Quantity	Quality recommend by Rolls-Royce
FF550	7 l	Transmission oil (ISO VG 68 with EP-additives)

Sealants when installing

Sealant	Quality recommend by Rolls-Royce
Between water jet unit and hull	Sikaflex® 252 Bostik® 2639 3M® 5200
Installation paste on threads	CRC® aluminium paste
Hydraulic connections	Loctite® P.S.T
Threads - securing Threads - locking	Loctite® 243 Loctite® 270

5.4 Calculation formulas

To find power (kW):

$$P = \frac{2\pi \times T \times N}{1000}$$

Where:

P = Power (kW)

T = Torque (Nm)

N = Engine speed RPM/60 (RPS)

To find torque (Nm):

$$T = \frac{P}{2\pi \times N} \times 1000$$

Where:

P = Power (kW)

T = Torque (Nm)

N = Engine speed RPM/60 (RPS)

5.5 Conversion factors

Metric to U.S. factors	Multiply by
mm ⇒ inches	0.03937
kg ⇒ lb	2.205
N ⇒ lbf	0.2248
Nm ⇒ lbf ft	0.738
l ⇒ U.S. gallon	0.2642
m^3 ⇒ cu ft	35.315
m/s ⇒ ft/min	196.85

°C to °F: $$°C = \frac{5}{9} \times (°F - 32)$$

U.S. to metric factors	Multiply by
inches ⇒ mm	25.40
lb ⇒ kg	0.454
lbf ⇒ N	4.448
lbf ft ⇒ Nm	1.356
U.S. gallon ⇒ l	3.785
cu ft ⇒ m^3	0.0283
ft/min ⇒ m/s	0.00508

°F to °C: $$°F = \frac{9}{5} \times (°C + 32)$$

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Rolls-Royce Compact Control System for Waterjets

USER MANUAL

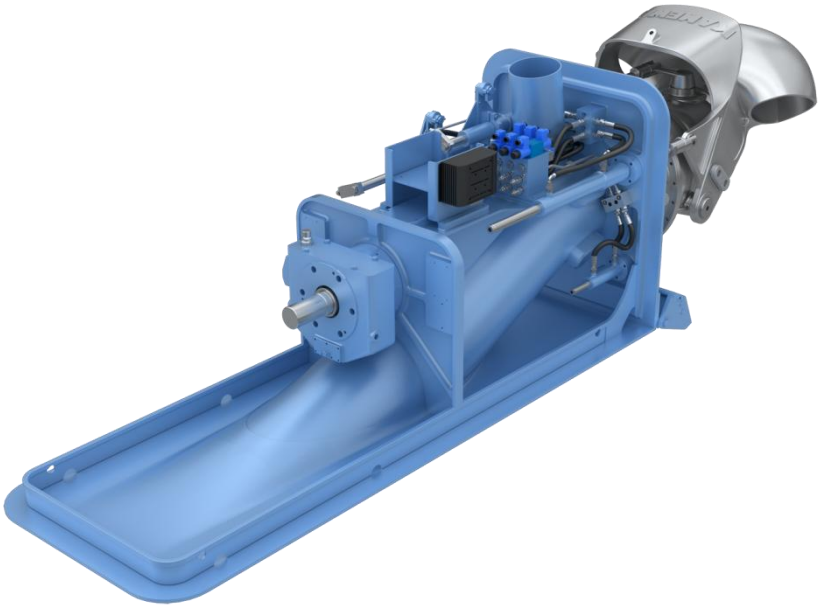




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1 General information

1.1 Symbols used



WARNING:
This symbol alerts to hazards which could cause serious injuries as well as damage to the equipment if ignored.



CAUTION:
This symbol alerts to possible faults which could arise from improper operation. They could cause damage to the equipment if ignored.



NOTE:
This symbol indicates important items of information.

1.2 Storage and transport

The packaging material used to store or transport the parts of the control system must provide shock protection. Optimal protection is provided by the original packaging materials.

Conformance with permissible ambient conditions (see Technical data) must be assured.

1.3 Unpacking

Immediately upon arrival the goods must be unpacked and inspected. Make sure that the packaging and the contents are undamaged! Inform the post office or freight carrier of any damage. Damaged merchandise must be retained until the matter has been settled.

Check that the delivery is complete and agrees with the shipping documents and your order (refer to nameplate for type and version). Remarks, if any, should be forwarded to Rolls-Royce as soon as possible.
Keep the original packaging materials for future storage or shipping of the components.

If you have any questions, please contact your supplier of the Rolls-Royce Sales Office responsible for your area.

1.4 Dismantling, packaging, disposal

For reuse at a later time, the control system components must be carefully packed. Optimum packaging is provided by the original packaging. When disposing of the equipment, observe local regulations.

1.5 Product overview

All equipment delivered with control system is labeled including information of that specific item.



1.6 Warranty

The product has a limited warranty. Please note that the warranty will be void if the equipment is misused or not handled in accordance to prescribed standards, for example dismantling the equipment to a level greater than described.

2 Safety instructions

2.1 Intended application

Rolls-Royce Compact Control System is used to control the steering nozzle angle, the reversing bucket position and, if installed, the interceptor position of the Rolls-Royce Waterjet system along with RPM of the main engines. The steering nozzle angle determines the port/starboard direction of flow from the Waterjet, which in turn, induces a turning moment to the vessel in the direction that the nozzle is pointing. The reversing bucket position determines the amount of the total Waterjet flow that is deflected ahead, which in turn, induces a proportional reversing force. The engine RPM relates to the power output of the Waterjet and the thruster RPM relates to the magnitude of transverse thrust applied at the bow. Maneuvering is performed from a control station equipped with control devices.

2.2 General safety instructions

This control system has been manufactured for safe operation according to the state of the art in engineering and conforms to the applicable regulations and European standards (see Technical data) and it has left the manufacturer's works in perfect condition. However, if used improperly or for purposes other than the intended purpose, it may be dangerous. It is essential that every person responsible for maneuvering is not only aware of the different control modes, but also knows what measures to be taken in case of a failure.



WARNING:

- ***Operating this control system in any way other than as described in these instructions may compromise the safety and function of the control system and is therefore impermissible.***
- ***The notes and warnings in these installation and operating instructions must be strictly adhered to!***

2.3 Installation, start-up, operation

When the installation is planned, ample consideration must be given to the space required for installing components, commissioning and maintenance of the equipment.

Installation requirements

Equipment must not be mounted close to radio transmitters, radio aerials or in places, where high intensity of field from radio signals or disturbing electric equipment can be expected. In doubtful cases we ask you to consult Rolls-Royce instead of an incorrect installation.

Outdoor installation

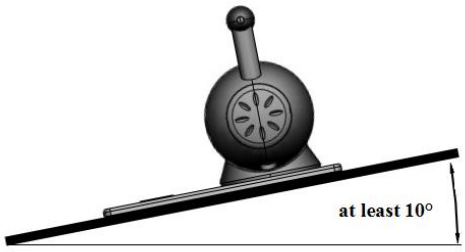
All control panels are supplied for so called desk mounting. They are as standard designed with a degree of protection IP 56 (splash proof) and could be used for outdoor installation.

The panels are, however, not designed to be continuously exposed to water and strong sunshine.

Therefore, if control panels are mounted outdoors in bridge stand, the stand must be designed with a protecting cover, which is used when the control station is not used.

The cover must be designed so that the movement of the levers are not obstructed. It is also necessary to ensure that the stand is built tight enough to prevent dampness from penetrating. Heating and venting in the desk should also be arranged in order to avoid condensation.

Panels should be mounted to a tilted desk so that the rain and splashing water will flow down the slope.





WARNING:

- ***Qualified personnel must carry out all electrical installations, and all work must be executed in accordance with the rules or the classification society.***
- ***Always wear protective goggles if there is a risk of splinters, grinding sparks and splashes from acid or other chemicals. Eyes are extremely sensitive and an injury to them can result in loss of sight.***
- ***Do not use components not approved by RR-Marine jointly with Compact Control System. If other products are used, the guaranty will be abolished.***



CAUTION:

- ***These devices may only be installed, connected electrically, commissioned, operated and serviced by properly trained personnel authorized by the system operator.***

- ***The personnel must be familiar with these operating instructions and must adhere to the instructions described therein.***
- ***Make sure that the power supply ratings match the data specified on the part Technical data before you connect the instrument to a power source.***
- ***A clearly identified mains disconnecting device must be installed at hand.***
- ***Check that all connections have been properly made before powering up the system!***
- ***Damaged equipment that may be dangerous must not be operated and should be clearly identified as being defective.***
- ***Any troubleshooting of the control system is to be performed exclusively by authorized, trained personnel.***
- ***If faults cannot be remedied, the vessel must be removed from service and secured to prevent accidental start-up.***
- ***Repairs not described in these operating instructions may only be performed at the manufacturer's works or by the Rolls-Royce Service Organization.***
- ***Make sure that every control station including backup station(s) can be taken in command before casting off for a trip.***

2.4 Electrical installations

General

Electric connections must be made by skilled electricians. Check that electric devices are consistent with the drawings and that the equipment has been connected according to the interface drawings. Properly mount all cable support parts to prevent sagging or twisting of supply cables.

Grounding

All controller units of the control system are to be grounded in accordance with the classification society and the interface drawings.

EMI avoidance

It is important to use shielded cables for control-, data- and bus cables to minimize electromagnetic interference (EMI).

Control-, data- and bus cables must not be installed together with high power cables or highly EMI generating cables.

Minimum distance between power cables and control-, data- and bus cables must be 0,3m (12 in). Minimum distance between highly EMI generating cables and control-, data-, and bus cables must be 0,5m (20 in).



WARNING:

- ***Qualified personnel must carry out all electrical installations, and all work must be executed in accordance with the rules or the classification society.***



CAUTION:

- ***These devices may only be installed, connected electrically, commissioned, operated and serviced by properly trained personnel authorized by the system operator.***
- ***Make sure that the power supply ratings match the data specified on the part Technical data before you connect the instrument to a power source.***
- ***A clearly identified mains disconnecting device must be installed at hand.***
- ***Check that all connections have been properly made before powering up the system!***

3 System overview

3.1 Control system architecture

Rolls-Royce Compact Control System is applicable for the FF-series, A-series and smaller S-series Waterjets. The system is designed to suit patrol boats, yachts, ferries, and similar vessels.

For the designer and builder the attraction of the Compact Control System is that it can be configured from a range of standardized jet components to suit a particular vessel. Control devices are calibrated and key hydraulic components installed on the jets at the factory in case of A3- and FF-series Waterjets. This simplifies the building phase and shortens installation and commissioning times.

Installation and commissioning is simple. All bridge Control Devices are connected directly to CAN bus by standard CAN+power cable. Cables with connectors are available with different lengths. This approach is giving the system a plug-in assembly and simplified cabling which is included in the Rolls-Royce scope of supply as standard. It is also easy to add functionalities and features later on due to the modular CAN based solution and configurable standard software.

The compact control system has standard interface to engine, gear clutch and autopilot, with an option for Bow Thruster, Voyage Data Recorder and DP. Options of either manual or Automatic Interceptor Control, which link interceptor movements to steering commands, are available. For the operator, control stations can be configured to suit individual requirements and preferences for the human/machine interface. Users can select from lever(s), steering device or joystick mounted in the console or on the arms of the chair. A color touch screen presents system status and performance data. As each propulsion line is independent there is ample redundancy, and a number of interlocks enhance safety.

Control station configurations:

- 1 to 3 control station indoor or outdoor
- 1 x lever unit per station
- One or two steering device per station
- 1 x joystick per station (optional)
- 1 x booster lever unit per station (optional)
- 1 x bow thruster control unit per station (optional)
- Docking station (Clutch panel and Joystick) (optional)
- Touch screen on each station for non-critical functions (optional)
- Independent Backup system (optional)

Waterjet configurations:

- Twin installation
- Twin + Booster installation
- Quad installation
- Single jet installation

NOTE:
Please note that all of these features are not always part of the control system delivered by Rolls-Royce.

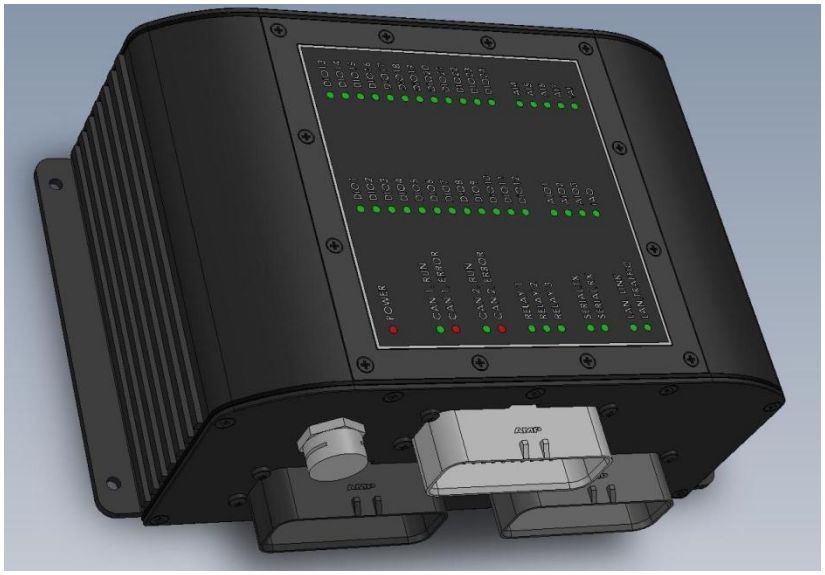
3.2 Backup system (optional)

As a complement to the main system there is also a backup system available for each Waterjet to be used if there is a failure in the main control system. The backup system is electrically separated from the main system and has its own power supply.
The backup system is of "non follow up" type and controls the reversing bucket and the steering nozzle by direct activation of the hydraulic control valve. Also main engine RPM and gear clutch can be controlled by the backup system. If backup system is included to the delivery, a backup control panel and indication panel for each Waterjet is added on one or two control stations, normally the main control station.

3.3 Main components

3.3.1 Micro Marine Controller - MIO

Micro Marine Controller is a marine certified comprehensive controller tailored for use on Waterjets. Compact construction is optimized for marine purposes and various software configurations allow it to be optimized for a particular application.



3.3.2 Control panels

Steering device

Main purpose of the steering device is to control movement of steering nozzles, but also other implementations are available. Depending on system setup, the control device can be used as a Z-axis of the joystick and, in case interceptors and Automatic Interceptor Control are installed, steering device controls the movement of interceptors as well.

Available steering devices are:

Steering knob



Steering knob for single installation



Steering knob for twin installation



Steering knob for quad installation

Steering tiller



Steering tiller for single installation



Steering tiller for twin installation



Steering tiller for quad installation

Steering wheel



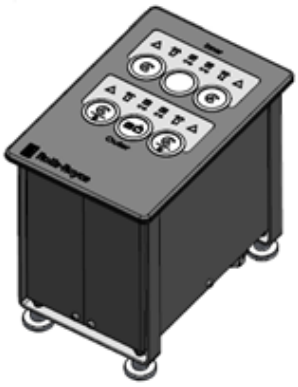
Steering column



Steering wheel panel for single installation



Steering wheel panel for twin installation



Steering wheel panel for quad installation

Lever(s)

Lever is used for controlling the thrust, which means simultaneous control of both the reversing bucket and the engine RPM. The port control lever controls port reversing bucket(s) and engine(s) RPM, and the STBD lever controls STBD reversing bucket(s) and engine(s) RPM. A relationship between the bucket position and RPM compared to the lever position can be defined and parametrized such that it corresponds to the user requirements.

Trim switches are used for manual interceptor control. There are separate trim switches for port and starboard side. Trim switches are to be connected to the lever unit.

Mirrored levers are available for turned control station installations. Booster lever is available for booster jet RPM control.



Single lever



Twin lever



Quad lever



Trim switch



Booster lever

3-axis joystick

Joystick is an additional control device with X-Y-Z axes (Z=rotary), to be used for docking or slow maneuvering purposes. The joystick can be added on one or all three control stations.



3- axis joystick

Backup control panel

Backup panel is connected to backup system and used for controlling steering nozzles, reversing bucket, gear clutch and engine RPM.



Backup panel

Indication panel

Indication panel is used together with backup system and is indicating the movement of steering nozzle and reversing bucket.



Indication panel

Bow thruster control panel

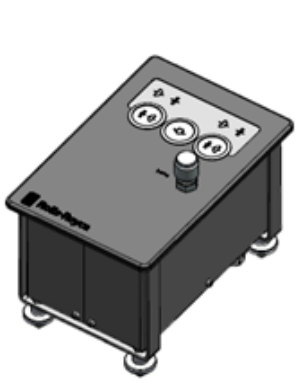
Bow thruster interface can be used either manually with separate bow thruster control panel or can be integrated into joystick maneuvering if applicable.



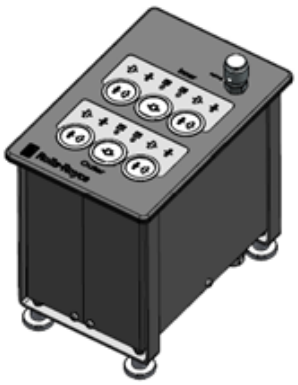
Bow thruster panel

Separate clutch control panel

Instead of using steering device and twin lever with clutch control, a separate clutch control panel can be used instead together with 3-axes joystick. This is applicable for second and/or third control station only.



Clutch panel for twin installation



Clutch panel for quad installation

3.3.3 Graphical User Interface

Graphical User interface (later GUI) is a touch screen based top-quality product of Rolls-Royce, providing a so-called Panel Computer System. A display is combined with a powerful computer in one casing. A sophisticated design concept reduces the demand of cabling at minimum demand of space.

The GUI operates as centralized control- and display platform, processing and visualizing all available data in the system. The display system is designed for flush mounting into wheelhouse control consoles and provides front side water protection. By means of an innovative operation concept, all relevant information and operations are controlled from one position. The connection of GUI to the control system is performed by industrial CAN-bus.

Up to four Waterjet units can be centrally operated and controlled from one panel. The attractive and futuristic design of the panels meets customer's high demands.
All available data are processed graphically and visualized individually.

The GUI features a bright and daylight qualified display with high resolution.
The high luminous intensity and the wide angle of view ensure the readability of alarms in any case.

The operating system of the integrated computer ensures highest degree of system stability and excuses even shut downs of power supply. Moving parts as e.g. hard discs or fans are substituted by innovative components. GUI is provided with a passive cooling system; it is shock-insensitive and emits no disturbing ambient noise produced by rotating parts such as fans and hard disks.

The Graphical User Interface provides following functions:
• Visual indication of Waterjets actual behavior
• Operating of Backflush and Automatic Interceptor Control
• Alarms list
• Basic settings and adjustments



7" Panel computer



10" Panel computer

3.4 Hydraulic system

Refer to Appendix B, Hydraulic diagrams

Standard hydraulic system
Jets FF67, 40A3, 45A3, 50A3 and 56A3
Manifold mounted on WJ DMN900000034

Certified hydraulic system
Jets FF67, 40A3, 45A3, 50A3 and 56A3
Manifold mounted on WJ DMN900000080

Standard hydraulic system
Jets FF37, FF41, FF45, 32A3, and 36A3
Manifold mounted on WJ DMN000200072

4 Electrical connections and interfaces

4.1 CAN cabling

All control panels are connected to control system by bridge CAN bus. This setup varies according to project.

All controllers within main system are connected to each other by system CAN bus. Number of controllers connected varies according to Waterjet installation.

Refer to Appendix C, Cabling:
CAN cabling for controller units DMN900000085
CAN cable, type B DMN900000046
CAN cable, type C DMN900000047
CAN cable, type B-C RRM000201004
CAN cable, type C-B RRM000201003

Thick cabling

The maximum length for Compact Control System CAN bus is 70 meters and maximum number of control panel units is 10. In order to have more length or more panels, the system has to be built using thick N-type CAN cabling and each control station has to be provided with CAN repeater boxes for each bus. Power supply is needed for each CAN repeater box. Controller units will be connected to thick CAN bus with connection boxes.

In case of system CAN (e.g. bow thruster controller) no CAN repeater is needed. N-type cable will simply be installed between two connection boxes that are connected to the controllers.

Refer to Appendix C, Cabling:
CAN Repeater box DMN000220967
Connection box, mid-thick, controller on jet RRM000203993
Connection box, mid-thick, separate controller RRM000201207
Connection box, thick-mid RRM000207955



NOTE:
It is recommended to supply power for the CAN Repeater box(es) and the main controller unit on the same bus (port or starboard) from the same battery bank.

4.2 Control unit cable set

All control units are delivered with a cable set. The type of the cable set varies according to type and size of the Waterjet and installation location of the control unit.

Refer to Appendix C, Cabling:
***Controller on Jet, no backup* DMN900000086**
Separate controller, no backup DMN900000087
Controller on Jet, with backup DMN900000098
Separate controller, with backup DMN900000099
Booster jet controller DMN000201509
Bow thruster controller DMN000201179

4.3 Power supply

The power supply must always be connected according to actual classification society regulations.

The power supply to the different systems must be taken from sources with high priority, so that the supplies are not jeopardized.

All Rolls-Royce Compact Control System equipment should be free floating, no negative connection to hull.

We would also like to point out the importance that no power supply is connected to the system until the installation is checked and approved.

General recommendations:
• The control unit power supply (power supply A and B) should be connected to two different uninterrupted sources, with high priority.
• Separate circuit breakers and/or fuses for each feeding line to the control system must be provided.
• The back-up and indication system should be connected to emergency source, separated from the main supply.

Refer to Appendix D, Interface drawings DMN900000045



CAUTION:
When welding closer than 10 m from the Rolls-Royce control system equipment, all power supplies must be disconnected before welding work starts. Supply filters might be damaged and control system function jeopardized.

4.4 Engine interface

Isolated RPM command, which is either 4…20mA or 0…5V, is provided for the main engine. RPM command can be scaled to desired scale and curve can be adjusted by the service tool.

When the main engine is stopped an "Engine Stopped" signal is applied for the control system in order for the system to prevent unnecessary alarms.

When the main engine is at idle speed an "Engine at Idle Speed" signal is applied for the control system in order to prevent engaging a clutch when the main engine is not running at idle speed.

An “Engine Start Interlock” signal is provided for the main engine in order to prevent engine startup when a clutch gear is engaged and/or engine RPM command is above 20%.

Engine start interlock bypass

If a complete control system failure occurs, the engine start interlock will prevent the engine from starting. In a single jet installation, this will leave the vessel with no means of propulsion.

Therefore it is mandatory to install a bypass switch across the engine start interlock relay in order to be able to use the engine in this unlikely situation. Alternatively, a relay with a manually lockable test option can be used as the engine start interlock relay. Refer to the appropriate engine schematics for details.

This bypass switch is optional for multiple jet vessels.

Backup System

With backup system there are two different RPM controls available, either same analog output as in main system or two binary outputs for increasing and decreasing RPM. This must be set in commissioning.

When backup is active the “Backup Active” binary signal is available and active.

Refer to appendix D, Interface drawings:
Engine interface, no backup DMN900000050
Engine interface, with backup DMN900000088

4.5 Clutch interface

The “Clutch In”, “Clutch Reverse” and “Clutch Out” output signals are provided for the gear clutch. Potential free “Clutch Engaged” feedback signal is applied for control system. Optional clutch interface box is available in order to facilitate the installation. Clutch interface box includes protective diodes and relays and it can be connected either to relays controlling the gear or straight to gear coils.

Backup system
Potential free relay-contacts are provided for gear clutch control. “Clutch In” relay-contact is available for simulating the “Clutch Engaged” feedback signal if one is not available by the gear clutch.

Refer to appendix D, Interface drawings:
Clutch interface, no backup DMN900000051
Clutch interface, with backup DMN900000089

4.6 Hydraulic oil tank alarms interface

Depending on the type of the waterjet unit, the hydraulic oil tank can be equipped with thermostatic switch and/or level switch. Alarm indications will be provided on controller unit(s) and control panel(s). Alarm message will also be provided on GUI if one is installed.

Refer to appendix D, Interface drawings DMN900000054

4.7 Bearing housing alarms interface

Depending on the type of the waterjet unit, the bearing housing can be equipped with thermostatic switch and/or level switch. Alarm indications will be provided on controller unit(s) and control panel(s). Alarm message will also be provided on GUI if one is installed.

Refer to appendix D, Interface drawings DMN900000101

4.8 Optional interfaces

4.8.1 Autopilot interface

An autopilot mode cannot be selected from the control system supplied by Rolls-Royce, but an indication LED “Autopilot in Command” is lit on the steering devices when steering is controlled by the autopilot. The autopilot can control steering either by analog signal (±10VDC or 4…20mA) or two discrete input signals (so called solenoid drive).

When the autopilot mode is activated, the “In Command” LED on all of the steering devices is turned off. The thrust is still controlled by levers. If control is taken over by backup controller or autopilot override function is performed, while in autopilot mode, the autopilot LED is flashing.

Autopilot override function
Rolls-Royce Compact Control System is provided with an optional autopilot override function. When override function is enabled, steering control can be quickly returned from the autopilot to the steering device. In case of steering knob or wheel, the control is returned by turning the steering device over the threshold value either in port or starboard direction. The threshold value can be adjusted by Rolls-Royce service engineer during the commissioning. In case of steering tiller, the command is returned by pressing the override button on the top of the tiller.

Refer to appendix D, Interface drawings DMN900000052

NOTE:
The autopilot is not part of Rolls-Royce’s delivery.

If system is fitted with Automatic Interceptor Control AIC and solenoid drive type autopilot, AIC is disabled when autopilot is active.

4.8.2 System alarm interface

Alarm interface provides one relay-contact for indication of control system failure and one relay-contact for indication of control system warning.

Refer to appendix D, Interface drawings DMN900000053

4.8.3 VDR/RS422 serial interface

Rolls-Royce Compact Control System can be connected to Voyage Data Recorder (VDR) via the RS-422 serial interface. The interface merely sends data and shall be used for monitoring the status of the control system. No control actions can be performed via this interface. Communication is achieved in accordance with the NMEA 0138 standard.

Obtainable common data:
- Alarms
- Station in command and steering mode
- Status of the autopilot (active/inactive)
- Status of the clutch command
- Status of the backup system (active/inactive)

Obtainable data for each waterjet unit separately:
- Measured steering angle
- Measured reversing bucket angle
- Steering command
- Bucket command
- RPM command signal to engine

Data transmission:
- Baud rate 4800 baud
- Data bits 8
- Parity none
- Stop bits 1
- Cycle time 1 second

Refer to appendix D, Interface drawings DMN900000100

4.8.4 Bow thruster interface

Two interfaces available, either a hydraulic or analog interface with option of 4...20mA or +/-10V signals. Bow thruster can be controlled either manually with separate bow thruster control panel or can be integrated into joystick maneuvering if applicable.

Refer to appendix D, Interface drawings DMN000200086

4.8.5 DP and Joystick interface

As an option Rolls-Royce Compact Control system can be equipped with DP and Joystick interface. The interface allows vessel's DP and joystick system to control the waterjets. Interface unit has one interface for DP system and one interface for joystick system. Both interfaces are similar. DP and joystick systems control waterjet's steering nozzle position, reversing bucket position and engine rpm command.

Interface unit is connected to Bridge CAN bus and can be located to bridge area, instrument room area or to thruster room. Every waterjet in the installation will have it's own DP interface unit excluding the booster jet which will be deactivated in DP or joystick mode.

Refer to appendix D, Interface drawings DMN000221019

5 Operation



CAUTION:
Read this chapter carefully before casting off on your first trip.

5.1 General

This is a general description for the operation of the Rolls Royce Compact Control System. Compact Control System is electrically controlled thrust controlling system designed specifically for small and medium sized vessel. All propulsion devices are integrated into the control system such that control device movements correspond to exact vessel movements. When equipped with joystick, the control system integrates control of Waterjet steering and reversing functions together with engine RPM in such a way that translation and rotation commands are as simple as moving the joystick in the direction you want the vessel to move and rotate.

The system can be configured for a single, twin, twin with booster or quad waterjet installation. The basic system, which includes all necessary functions, can be expanded with a number of standard options in order to fit the actual installation.

For safety and proper function it is recommended that the control system is inspected according to the routines stated in part Maintenance. All instructions for service and maintenance of the control system are also included in part Maintenance.

See part System Overview for more information about the different units and functions of the control system. If there are any questions about the operating instructions please consult Rolls-Royce Marine Global Support Network (GSN) before proceeding.



NOTE:
Operating a boat with Waterjet units is different from operating the boat with propellers. Therefore, it is essential that every person responsible for maneuvering is not only aware of the different control modes, but also knows what measures to be taken in case of a failure. For more information, see part Troubleshooting.

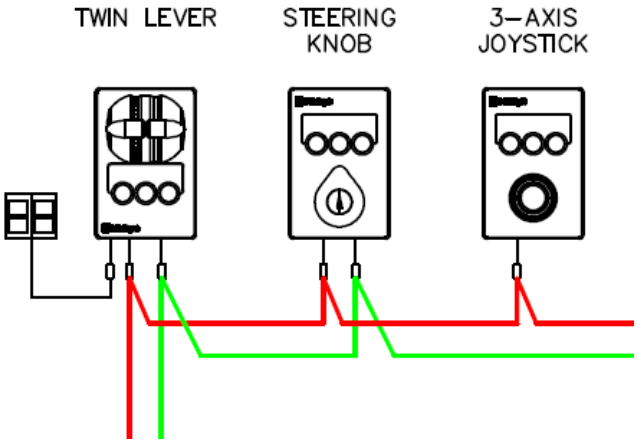
5.2 Operator interface

The control devices are the main user interface for controlling a vessel. Feedback of information to the user during operation, such as system status, settings and alarms, is in the form of LED indication and/or display where available.

Refer to appendix E, Symbols and buttons

5.2.1 Control station

The Compact Control System can be equipped with up to three control stations. The basic control station consists of steering device and lever unit. Optional devices are GUI-panel, 3-axis joystick, interceptor controls, bow thruster control, booster lever, backup panel and feedback indicators.



5.2.2 Reconnecting the control system

If a control failure is generated by any reason, e.g. system has failed to move the reversing bucket or steering nozzle to ordered position within a certain time, the control system will be disconnected and a red error LED is lit accordingly. The LED will be flashing as long as the control failure is active. When flashing is halted and red LED lights steady, the control system can be reconnected by “Reconnect System” push button. In case a Rolls-Royce Graphical User Interface (GUI) is installed, the corresponding alarm will be activated on the display.

When "reconnect" is pushed the control system will return to normal operation and attempt to position the reversing bucket or steering nozzle. If it fails to position, a control failure will be detected again, the buzzer is activated and the control system will be disconnected as a result. When control failure does not re-occur, the Waterjet unit will return to normal operation.

The control system also detects failures of sensors (e.g. feedback sensors etc.) that for the moment are not in operation and which will result in an I/O failure.

It is always recommended to place the control handles in a position roughly corresponding to actual speed and course before pushing the "reconnect" push button.



WARNING:

- ***It is of most importance to make sure that there is no one in the engine room when reconnecting the system. Moving cylinders may cause severe injuries!***

- ***Engine RPM will rise to the level set by the RPM command (thrust lever or idle level) immediately when the reconnect-button is pressed. Depending on the current vessel speed, this might result as a rapid acceleration. This may cause severe injuries as well as damage to the equipment!***



CAUTION:
Do not hold the reconnect button down for a long time! System will reconnect within approximately one second when the reconnect button is held down if there is no fault preventing reconnection. Control panel will go to calibration mode if reconnect buttons are held down simultaneously for a long time.

Refer to chapter 6.5.1 "Calibrating a control device" for more information on the calibration.



NOTE:
If the control failure is indicated it is of most importance that mode of operation or control station are not changed before the faulty control handle or sensor is located and repaired. The control failure will also be generated if any of the control units fail.

5.2.3 Transferring command from control station/device to another

Command is on control devices that has a steady green light on one of the "in Command" LEDs. Only one control station at a time can be in command.

To release command, press "Take/Release Command" push button. Push button starts to flash on all of the control devices on all applicable control stations. If control is not taken by any other control device, control will be returned back after 30 seconds to station on which control was released.

To take control, press "Take/Release Command" push button while it is flashing. If control device is not in position that correspond the actual state of bucket, steering nozzle or interceptor feedback signals, flashing light on control device will indicate it. The more frequent the flashing is the closer to actual state it is. Steady light will indicate the exact correspondence between control and feedback signals.



NOTE:
When transferring control between control devices, both controls <u>should</u> be placed in its intermediate position.

5.2.4 Clutch control

Handling of gear clutches can be done either by clutch control on the lever panel or an additional clutch panel. The “Clutch Open” and “Clutch Closed” LEDs will indicate the actual state of the clutch.

Engaging the clutch

First, set the lever in its intermediate position. Make sure that engine idle RPM is not increased and the reversing bucket is in its zero thrust position. It is possible to engage the clutch without setting the lever in exact zero position, but Rolls-Royce recommends that to be done.

Second, press “Clutch In/ Clutch Out” push button. The “Clutch Closed” LED starts to flash. The “Clutch Open” LED will light steady and “Clutch Closed” LED will flash until clutch state is changed. If an interlock is active, the “Clutch Closed” LED will flash yellow for three seconds.

Disengaging the clutch

First, set the lever or joystick in its intermediate position. It is possible to disengage the clutch without setting lever in zero position but Rolls-Royce recommends that to be done.

Second, press “Clutch In/ Clutch Out” push button. The “Clutch Open” LED starts to flash. The “Clutch Closed” LED will light steady and “Clutch Open” LED will flash until clutch state is changed.

Backflush operation

The “Clutch Reverse” will be activated by pressing the “Backflush” push button on the lever or the clutch panel. “Clutch Reverse” is activated and will stay reversed as long as the button is held down. The operation will be done only on the waterjets with the clutch disengaged and engine idle RPM not increased. The “Clutch Closed” LED will flash blue while the back flush operation is active.

The backflush operation can also be performed using the GUI panel.

Refer to chapter 4.3.3 Settings

Clutch interlock

If “Clutch Out” symbol remains, when clutching in, and “Clutch In” symbol flashes yellow, then clutch interlock is active. This is due to one or more of four interlock conditions; System is in disconnect-mode, bucket is not between 35…65% of the range, RPM output is more than 10% (engine at idle) and lever position is not between -2…2.



CAUTION:
Make sure that the engine idle RPM is not increased while engaging/disengaging the clutch.



NOTE:
It is preferable to set the lever or joystick in its intermediate position while engaging/disengaging the clutch, meaning that the reversing bucket is in zero thrust position and engine idle RPM is not increased.

5.2.5 Idle RPM control

The engine idle RPM can be adjusted with the idle knob located on the thrust lever and on the additional clutch panel if one available. The control system interprets that the engine is running at idle speed when the engine RPM is under 10 % of the range. However the RPM level that activates the optional “Engine at idle speed” input signal varies depending on the engine manufacturer.

Alternatively idle RPM can be adjusted using the GUI if idle knob is not available.

Refer to chapter 4.2.3 Settings

5.2.6 Interceptor control

There is two type of interceptor control available: basic interceptor control with rocker switch for each side and automatic interceptor control ability for maneuvering the vessel with interceptors.

Refer to chapter 4.4 Interceptor auto/manual mode of operation

5.2.7 Dimmer

Each control device has a dimming push button. Each time constantly pressed the luminous intensity of LEDs is changed. First time pressed it gets brighter and second time pressed it fades.

5.2.8 Dead handle alarm function

If a control device is moved, that for the moment is not in command, the buzzer will be sounding as long as the device is moved. In this way, the operator can pay attention to the fact that the control device is not in command.

5.2.9 3-axis joystick

If vessel is equipped with joystick, the control system combines control of steering and reversing functions together with engine RPM of all waterjets controlled by system in such a way that translation and rotation commands are as simple as moving the joystick in the direction you want the vessel to move and rotate.

Refer to chapter 4.3.3 "3-axis joystick" for more information on maneuvering with joystick

5.2.10 Bow thruster control

If bow thruster interface is applicable, then bow thruster can be operated with Rolls-Royce control panel supplied. Start / Stop button is used for activating / de-activating bow thruster and corresponding LED symbols will be lit. The knob is used for driving bow thruster thrust proportionally. Bow thruster functions can also be integrated with 3-axes joystick.

5.2.11 Backup control

If Backup system is applicable, take command button on backup control panel can be pressed in order for switching over from main control system to backup system or vice verse. When the back-up system is connected, the main system is automatically disconnected.

The spring return manipulator is used for controlling the steering nozzle and reversing bucket in backup mode. Please observe the indication panel, since the backup system is of non follow-up type. The manipulator uses direct activation of the hydraulic control valves and gives a signal as long as it is effected.

Shift button is used for secondary functions. By pressing Shift button and using manipulator, engine RPM and clutch gear can be controlled.



NOTE:
When the command is returned from backup system to main system, reversing bucket will be set to zero thrust position and therefore the lever needs to be moved to zero thrust position first before thrust command can be applied.

5.2.12 Booster jet control

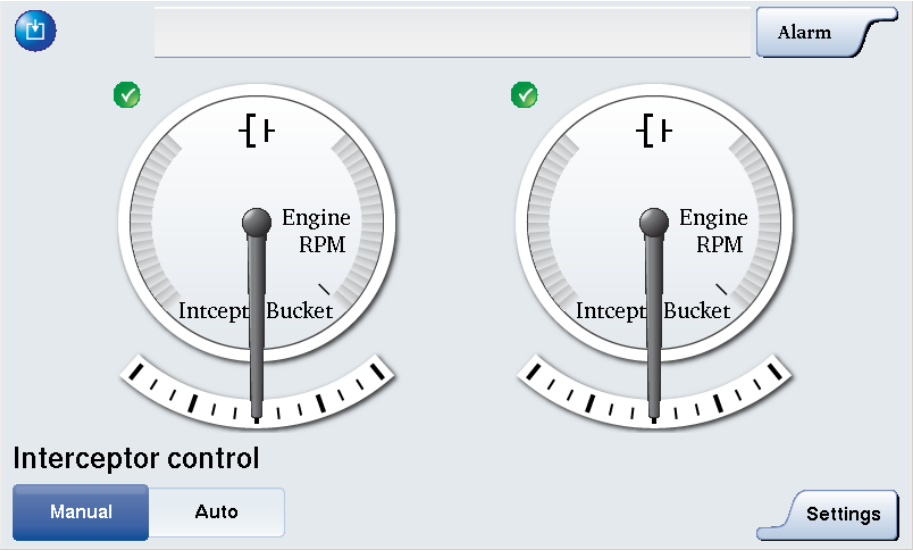
Twin jet installation can be equipped with a booster jet. It is a non-steerable waterjet unit without reversing bucket or interceptor. Booster jet will provide additional thrust for the vessel. Booster jet is controlled by booster lever unit including RPM command, clutch in/out, backflush and reconnect operations. Booster jet is available

with optional autoclutch function that disengages the clutch of the booster jet when the booster lever is set near to its zero thrust position.

NOTE:
Clutch has to be engaged at least on one of the steerable jets in order to engage the booster clutch.

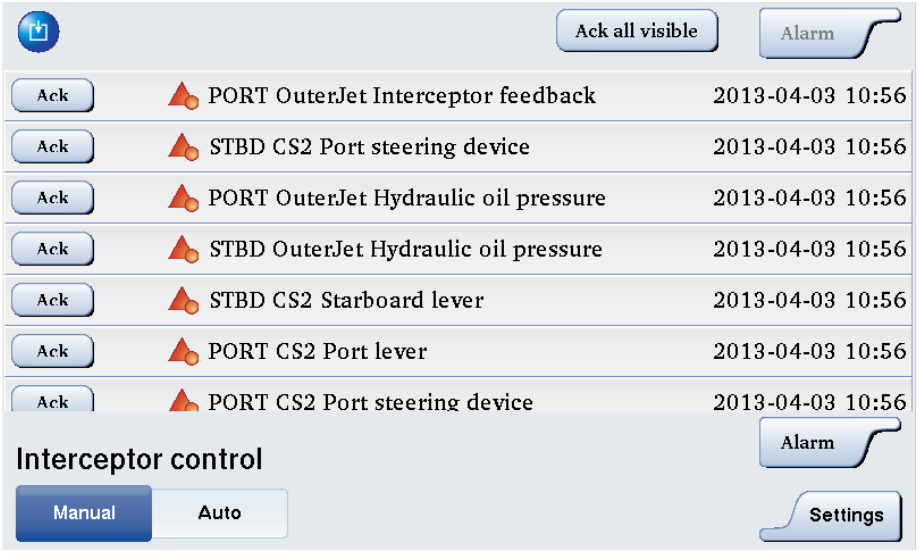
5.3 Graphical User Interface GUI

5.3.1 Main view



Following functions are displayed and controlled:
• Real time feedback signals from steering, bucket and interceptor controls.
• Engine RPM and clutch control signal
• CAN-bus status
• Active/inactive control station
• Automatic/Manual interceptor handling (Integrated interceptors are an option)

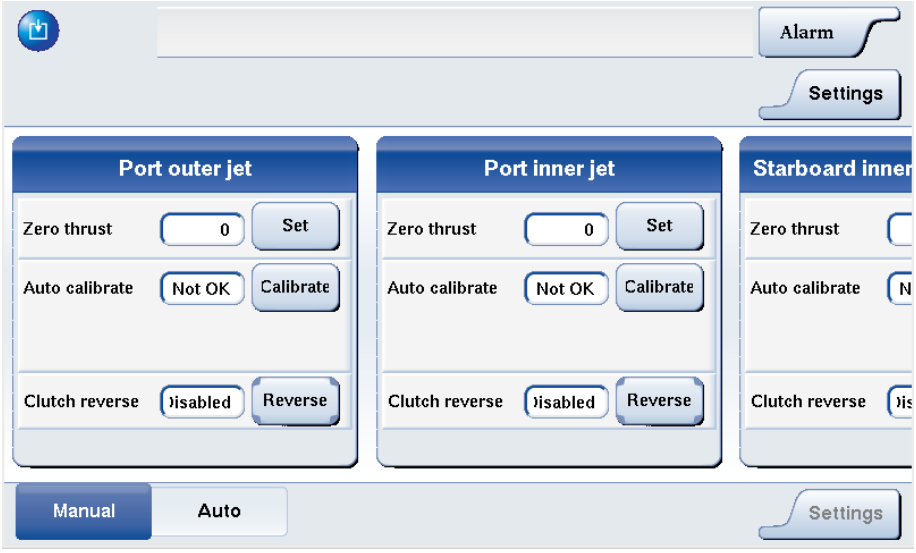
5.3.2 Alarms



To enter in alarms list, press “Alarm” tab at upper right corner of the GUI. Alarms are sorted in time based matter. The one that has been activated last is always on top of the list. All alarms, including inactive ones (the blue triangle), stays on list until acknowledged. Exiting the menu is done by pressing “Alarm” tab at lower right corner.

More information about the alarms:
Refer to Appendix F, Troubleshooting guide DMN000214539

5.3.3 Settings



There is number of functions that can be executed by the settings menu. To enter in settings menu, press “Settings” tab at lower right corner of the GUI. User will be prompted for password, which is 1234. Exiting the menu is done by pressing “Settings” tab at upper right corner.

Setting of the three levels of idle speed

Idle RPM can be set by the GUI if lever with idle control is not available. There are three pre-defined levels of idle speed that can be set. The set value is percentage of the scaled RPM range. Low value can be set between 1…20%, medium value between 1…50% and high value between 1…70%.

Zero thrust adjustment

Normally zero thrust is set at commissioning using the Service Tool, however, it is possible to adjust zero thrust additional +/-10%, of the reverse buckets range, using GUI settings. Adjustment is done by pressing "Set" tab and then giving a new value. Default value is 50%, which corresponds to zero thrust position set by the service tool. One equals to -10% and 100 equals to +10%.

Auto calibration of hydraulic cylinder feedback sensors

Actual range of the feedback signals can be calibrated by pressing "Calibrate" tab. Hydraulics must be running and it is preferable to keep clutch disengaged while auto calibration is executing. User will be prompted to accept the "Start Auto Calibration?". All hydraulic cylinders of the Waterjet are driven back and forth to its extreme positions. When auto calibration is completed without errors, an OK will be indicated at box next to "Calibrate" tab.

Backflush operation

To activate "Clutch Reverse", the "Reverse" tab needs to be pressed and held down. After approximately two seconds, "Clutch Reverse" is activated and will stay reversed for three seconds or as long as the tab is held down. The back flush operation of the Waterjet unit can only be activated when engine idle RPM is not increased and clutch is disengaged. If these conditions don't apply, clutch reverse will be indicated as "Disabled".

Dimming

Brightness of the display can be adjusted with dimming buttons. Buttons are located under the power button on the right side of the 7" panel computer. With 10" panel computer, dimming buttons are located on the settings page.

5.4 Maneuvering

5.4.1 General

At each control station, the vessel can be maneuvered by one or more of the following control devices; the steering knob, steering wheel, steering tiller, lever unit or 3-axis joystick. The control station can be equipped with steering device and joystick. The lever(s) with clutch control are always part of the station equipment.

The vessel can also be maneuvered using the backup system in case of a failure in the main control system. Backup system is optional.

5.4.2 Steering device (knob/tiller/wheel) and lever unit

Imparting forward and aft thrust command to the vessel is accomplished via the control levers. The lever controls the thrust, which means simultaneous control of both the reversing bucket and the engine RPM signal. The port control lever controls port reversing bucket and engine RPM, and the STBD lever controls STBD reversing bucket and engine RPM. The relation between the lever-, bucket position and RPM signal are defined at the Service Tool and can be adjusted by service engineer. When the lever is in its intermediate position, the engine is set at idle RPM and reversing bucket is set to a position giving equal ahead and astern thrust, resulting in zero thrust. The zero thrust can be adjusted by GUI settings.

The vessel's heading is controlled by turning the steering device in the desired direction of rotation. That is accomplished by rotating the steering nozzles from side to side. Steering nozzles and hence the vessel heading are jointly controlled by the steering device.

Thrust dependent steering command

With this option, the steering nozzle movement is integrated to the thrust command produced by lever. This means that nozzle movement is reduced when more forward thrust is set.

Maneuvering sideways

For maneuvering sideways towards starboard, turn the steering nozzles to port side, set the starboard thrust lever in astern position (the reversing bucket is fully down) and simultaneously maneuver the port thrust lever ahead to a position where the bucket is fully up and ahead thrust is balancing the astern thrust from the starboard Waterjet unit, moving vessel in sideways.

For maneuvering sideways towards port, turn the steering nozzles to starboard side, set the port thrust lever in astern position (the reversing bucket is fully down) and simultaneously maneuver the starboard thrust lever ahead to a position where the bucket is fully up and ahead thrust is balancing the astern thrust from the starboard Waterjet unit, moving a vessel in sideways.

If more side-force is required, increase the thrust lever position towards astern which then also will require increase of the thrust lever set to ahead resulting in more side force.

While moving the boat in sideways by maneuvering the thrust lever also keep the course of the boat by maneuvering the steering nozzles. The bow of the boat will turn

the same way as the steering nozzles are moved independent of going ahead or astern or maneuvering towards port or starboard.

Performing a crash stop

This instruction describes how to perform a crash stop in cause of an *emergency situation*.

First, slide the lever in opposite to moving direction of the vessel.

Second, when speed of the vessel has almost stopped, slide the lever back to zero thrust position.



WARNING:
Performing a crash stop may cause severe injuries for anyone on board and/or material damage

5.4.3 3-axis joystick

There are three axes on joystick; X-axis for moving boat sideways, Y-axis for moving boat lengthwise and Z-axis for rotational movement. A steering device on same control station can be configured for use as Z-axis. Rotation in sideways movement can be compensated by turning the Z-axis for opposite direction.

The push button on top of the joystick is for transferring between “High Gain” and “Low Gain” modes. High gain means higher engine RPM level resulting more thrust. Pure rotation (no transverse or alongship movements ordered) can be performed in zero thrust position by turning Z-axis. When this is performed in “High Gain” mode and Z-axis is turned to its extreme, nozzles are turned to maximum and Port and Starboard buckets are on opposite ends, e.g. the Port one is up and Starboard is all the way down. For a clockwise turn, starboard Waterjet unit is given thrust in the astern and port Waterjet unit ahead direction. For a counter clockwise turn, the thrust directions are reversed.

If system is fitted with Bow Thruster interface, bow thruster functions can be integrated to joystick maneuvering. This happens by adjusting joystick together with bow thruster in commissioning.



NOTE:
The joystick system is perfectly adjusted during ideal conditions, compensation is necessary in practical maneuvering situations. For example when vessel picks up speed, hydrodynamic forces are added or when currents and wind prevail.

If for some reason (failure etc.) uneven number or pair of Waterjets is available, then X-axis of the Joystick is disabled. This is indicated by flashing yellow triangle symbol on Joystick and can be acknowledged when symbol is lit steady .

When using Joystick with Quad installation, operator can choose whether using one pair of Jets or all four Jets combined. When using just one pair, outer Waterjets for instance, inner Waterjets must be disabled. This means that both clutches are disengaged and/or both engines are shut down.

When using Joystick with Twin + Booster installation, booster unit must be disabled. System does this automatically by disengaging the clutch gear when transferring to joystick mode.

5.4.4 Backup panel

The vessel can be maneuvered using the backup system in case of a failure in the main control system.

Operating the boat with the backup system:
1. Activate the backup system by pressing the “Take Control” button for few seconds. The “In Command” LED will be lit and beeping sound will be active to indicate that the backup system is activated. The “In Command” LED in all other backup stations available will be flashing.

2. The boat is operated by moving the manipulator in port, starboard, ahead or astern direction. If the “Shift” button is pushed the manipulator will instead control the clutch in/out function and engine speed (RPM+/-).

3. In order to see the actual positions of the reversing bucket and the steering nozzle observe the indication panel.

When control is released from backup station the “Release Control” button is pressed for few seconds and control is released back to main system.

ECR station

Engine room local control (ECR) differs from other backup controls in way that it cannot be overrun. If control is taken to ECR station, the green ECR LED is lit on all backup control stations applicable for that particular Waterjet. Control cannot be taken

from any other station and must be released from ECR station before taken to another station.

5.5 Interceptor auto/manual mode of operation

In case Automatic Interceptor Control option is installed and activated, the steering device can be set in a way that only interceptors are used for steering when steering is controlled in limited range close to zero steering, when running over a certain engine RPM level. When steering device is turned over 30%, it will control both the interceptor and steering nozzle accordingly. Automatic Interceptor Control is deactived when using solenoid drive type autopilot or unequal number of Waterjets are active



NOTE:
If for some reason (failure etc.) unequal number of Waterjets is available, then Automatic Interceptor Control is disabled. This is indicated on GUI by AIC selection button.

When using Automatic Interceptor Control with Quad installation, operator can choose whether using one pair of Jets or all four Jets combined. When using just one pair, outer Waterjets for instance, inner Waterjets must be disabled. This means that both clutches are disengaged and/or both engines are shut down.

5.6 Bucket

Controlling of bucket is performed either by Lever or by Joystick.

Case of Lever, the movement of bucket corresponds to movement of lever accordingly. In the center detent position the bucket will be positioned in its zero thrust position. When lever is slide to front, the bucket will move upward and when slide back the bucket will move downward.

Case of Joystick, the Y-axis movement corresponds exactly to movement of lever, but X and Z-axes cause opposite direction movement of port and starboard side buckets. Dependency between movement of joystick and buckets are defined by Service Tool.

5.7 Steering nozzle

Controlling of the steering nozzle is performed either by steering device or by joystick.

Case of steering device, the steering nozzle movement corresponds to movement of steering device accordingly. In the intermediate position the steering nozzle will be

positioned in its center position. When steering device is rotated to counterclockwise, the steering nozzle will move towards port and when turned clockwise the steering nozzle will move towards starboard.

Case of joystick, Z-axis movement corresponds exactly to movement of steering device and X-axis movement corresponds exactly opposite to movement of steering device. Dependency between movement of joystick and steering nozzles are defined by Service Tool.

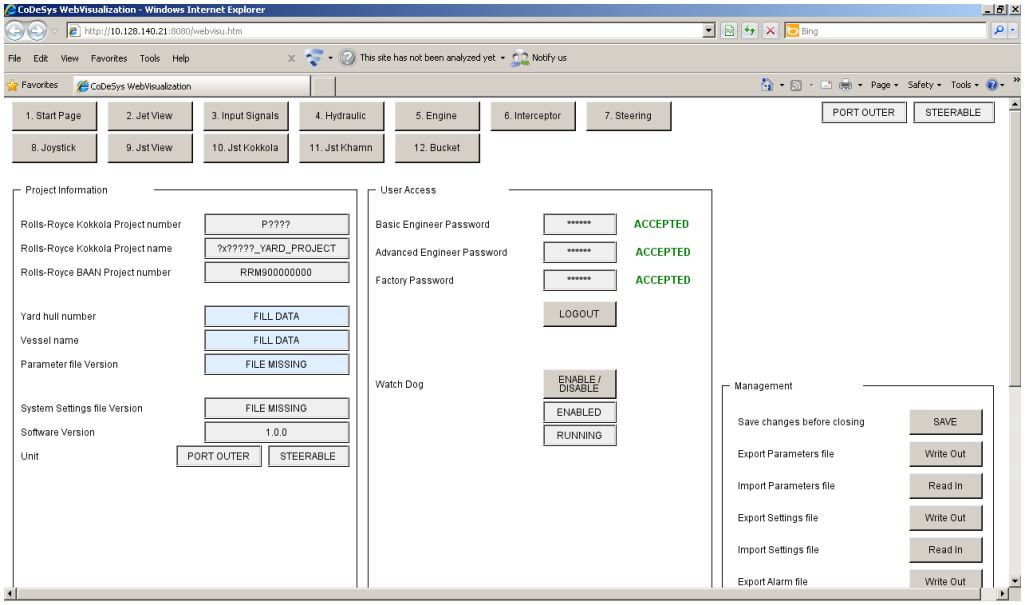
6 System configuration

6.1 Start-up

The Waterjet system is tested at factory as complete package. At startup it is necessary to make sure that control devices, CAN busses, interface cables and power supplies are in perfect fit and installed according to this manual.

6.2 Service tool

The service tool is a web browser based tool for adjusting and troubleshooting the waterjet unit and Compact Control System. This is used only by Rolls-Royce service engineers.



6.3 System settings

Characteristics of the control system and Waterjet unit are specified by system settings. All control units are delivered with system settings corresponding to the waterjet implementation.

6.4 Parameters

Parameters are defined and generated at commissioning. Parameters determine correspondence between control command and output signals for engine, clutch gear, bow thruster, steering nozzle, reversing bucket and interceptor control. Also calibration and auto tuning values are stored at parameter file.

6.5 Calibration

6.5.1 Calibrating a control device

1. To be able to calibrate a control device, the control system needs to be in disconnect mode and control device not in command.
This happens by rebooting (take power off) system and wait for it to start up.

2. Keep left and right push-buttons pressed down. Calibration mode warning (flashing red lights and beeping sound) will appear five seconds before the calibration mode is entered. When flashing red lights go off, release the buttons. Panel is now in calibration mode. Make sure control device is in its intermediate position (Zero detent) and press the center push button once.

3. While beeping, move the control device throughout its extreme positions (Port, Starboard, Ahead and Astern) and, when done, press center push button once to finalize the calibration.

6.5.2 Auto calibration of feedback sensors (Main system)

Operator can perform auto calibration only by GUI settings. If GUI is not applicable for your system a service engineer must be called to perform it by service tool. Actual range of the feedback signal is calibrated by driving the hydraulic cylinder back and forth to its extreme positions. Naturally, hydraulics needs to be running when calibrating. When auto calibration is completed without errors, an OK message will be indicated to the user.

6.5.3 Auto calibration of feedback sensors (Backup system)

Operator can perform auto calibration by Backup control panel. This is done by pressing both “Shift” and “Dimmer” buttons for 5 seconds. The Disconnect/Error LED is flashing while calibration.

Actual range of the feedback signal is calibrated by driving the hydraulic cylinder back and forth to its extreme positions. Naturally, hydraulics needs to be running when calibrating. When auto calibration is completed without errors, an OK message will be indicated to the user.

6.5.4 Auto tuning of the hydraulics

Characteristics of the hydraulic system, meaning proportional valves, hydraulic cylinders and piping, are determined and compensated by auto tuning. Only the speed of each hydraulic cylinder is defined by the user. This can only be done by Rolls-Royce service engineer.

7 Troubleshooting

Refer to appendix F, Troubleshooting guide DMN000214539

8 Maintenance

This chapter describes all relevant maintenance procedures and activities to be carried out by the crew.

The following warnings and cautions are for your safety, for the prevention of injury from electric shock and for a safe operation of the equipment. Also see chapter 2.

- While performing maintenance tasks, always position the equipment (and yourself) on a stable and safe surface.
- Ensure that all accessible cables cannot be walked on, tripped over or damaged by transportable items.
- If a device is damaged or fails to function correctly, disconnect it from the power source. Refer to the system drawings to locate the nearest fuse/circuit breaker.
- Do not attempt to repair any sub-component yourself – consult a qualified Rolls-Royce service technician.

Maintenance activities:

- Visually inspect every cable (CAN cables, interface cables) and make sure that they are not damaged in any way (fractions, abrasions, dents, bends etc.).
- Check all the cable connectors and make sure that they are not damaged and that they are properly connected.
- Check all controller units in the engine room that they are tightly fitted. Tighten if needed.
- Check all control panel units on the bridge that they are tightly fitted and that unit stays firmly in its place while operating. Tighten if needed.



NOTE:
In case of damaged cables or connectors, it is highly recommended to order replacement parts from Rolls-Royce Marine to ensure that the specifications will be met.



WARNING:

- ***Do not use components not approved by RR-Marine jointly with Compact Control System. If other products are used, the guaranty will be abolished.***
- ***Changes or modifications to the system not expressly approved by Rolls-Royce Marine could void the warranty or the user's ability to operate the equipment.***
- ***Protect Rolls-Royce equipment against possible solvents when cleaning the vessel.***



CAUTION:
It is very important that you are connected to ground before touching any electronic components.The life span of electronics can be affected by damage caused by electrostatic discharge. This can happen if a charged tool or person touches a component. Therefore it is very important that all tools and personnel are discharged by touching a grounded point before the printed circuit board or any of the components are touched. It is equally important to discharge the package with the new component before opening it.

A person walking on a carpet can be charged with up to fifteen thousand volt (15000 V). In worst case, some sensitive components can be destroyed when discharged with about 100 V.

9 Technical data

Control system
Power supply: 19 – 29VDC, < 200mV RMS

Control Panels
Degree of protection:
Front side IP 56, rear side IP 22
Weight appr.: 1,5kg

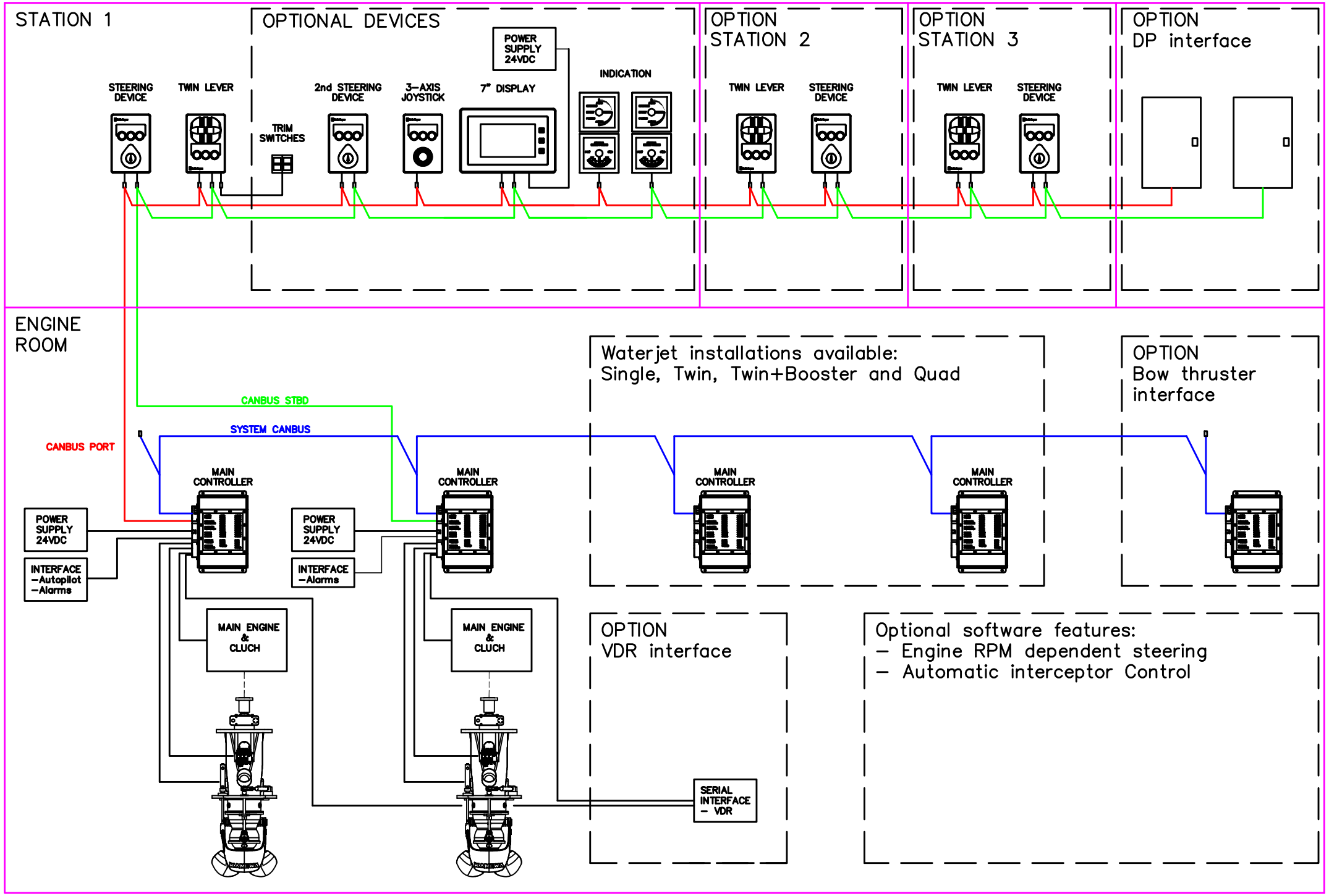
MIO Controller
Operating voltage: 18...32 VDC
Operating temperature: -25°C…70°C
Weight appr.: 1,95kg
Degree of protection: IP 67
Dimensions: W x H x D 230 x 138 x 82 mm
Atmel 400MHz 32-bits Embedded ARM
Microprocessor running on Linux
32MB SDRAM
128MB NAND Flash
Cyclone II FPGA
Real time clock with battery backup
Status LEDs for all IOs and communication ports
Internal temperature measurement
Interfaces:
2x CAN
1x RS422
1x LAN
Digital In/Out (24x Short circuit protected)
Digital Out (3x Relays)
Analog In (7 + 1 Isolated)
Analog Out (3 + 1 Isolated)

7” GUI Panel PC
Operating voltage: 18...32 VDC
Visible screen diameter: 154mm x 93mm
Operating temperature: -15°C...55°C
Storage temperature: -20°C...70°C
Weight appr.: 2,2 kg
Degree of protection:
Front side IP 66, rear side IP 22
Vibration: 0,7g
Dimensions: W x H x D
270 x 181 x 60 mm
Processor: Intel Celeron M, ULV373, 1.0GHz
Memory: 512MB DDR SO-DIMM
Interfaces:
2x CAN
2x 10/100 Mbit Ethernet, RJ45
2x USB

10” GUI Panel PC
Operating voltage: 18...32 VDC
Visible screen diameter: 210mm x 158mm
Operating temperature: -15°C...55°C
Storage temperature: -20°C...70°C
Weight appr.: 1,6 kg
Degree of protection:
Front side IP 56, rear side IP 22
Vibration: 0,7g
Dimensions: W x H x D
252 x 198 x 36 mm
Processor: Quad Core ARM Cortex A9
Memory: 1 GB DDR3
Interfaces:
2x CAN
2x 10/100 Mbit Ethernet, RJ45
2x USB

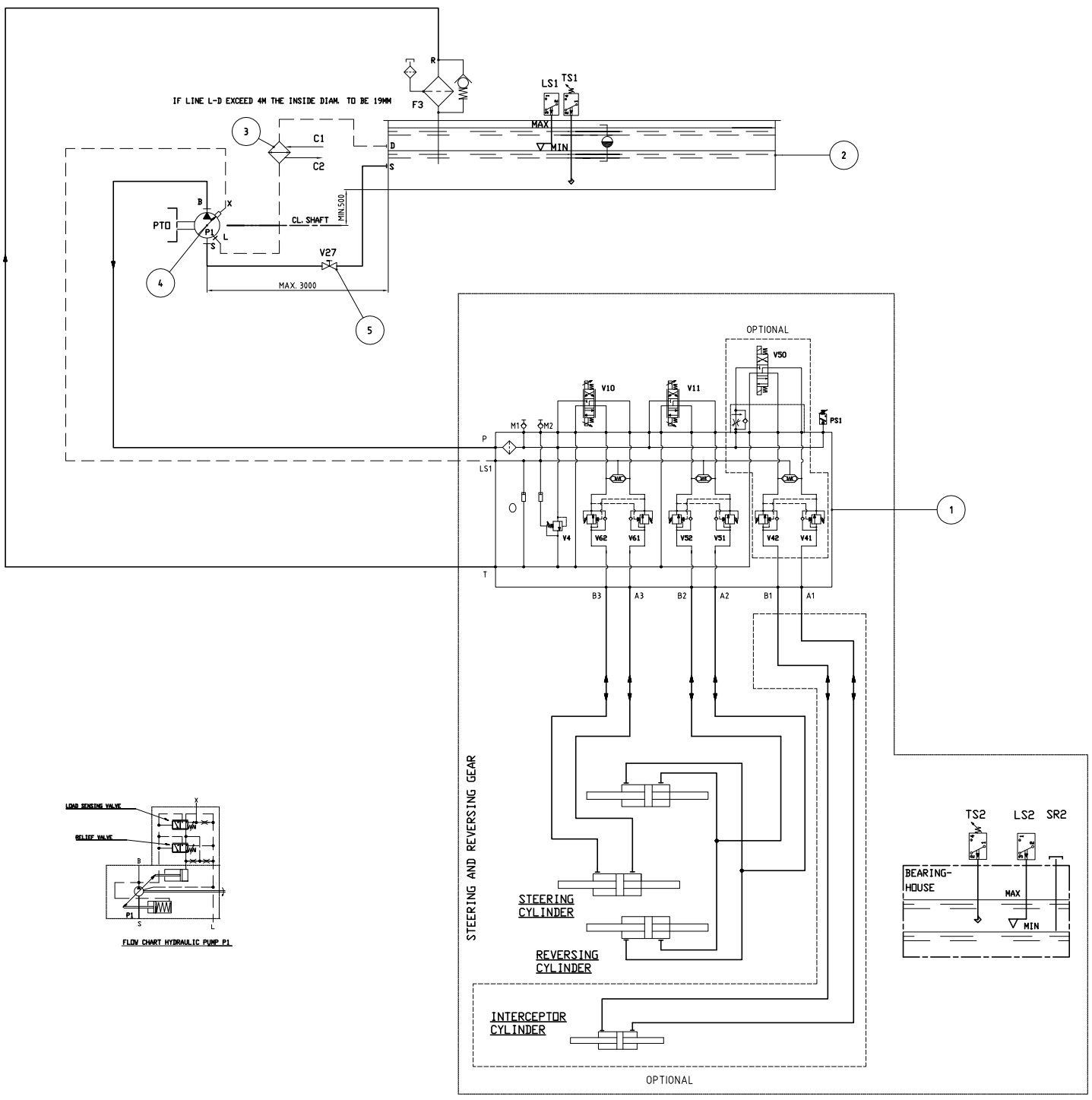
10 Appendixes

Appendix A, System Lay-out


STATION 1
OPTIONAL DEVICES
POWER SUPPLY 24VDC
INDICATION
STEERING DEVICE
TWIN LEVER
TRIM SWITCHES
2nd STEERING DEVICE
3-AXIS JOYSTICK
7" DISPLAY
OPTION STATION 2
TWIN LEVER
STEERING DEVICE
OPTION STATION 3
TWIN LEVER
STEERING DEVICE
OPTION DP interface
ENGINE ROOM
Waterjet installations available:
Single, Twin, Twin+Booster and Quad
OPTION Bow thruster interface
CANBUS STBD
SYSTEM CANBUS
CANBUS PORT
MAIN CONTROLLER
MAIN CONTROLLER
MAIN CONTROLLER
MAIN CONTROLLER
POWER SUPPLY 24VDC
INTERFACE -Autopilot -Alarms
POWER SUPPLY 24VDC
INTERFACE -Alarms
MAIN ENGINE & CLUCH
MAIN ENGINE & CLUCH
OPTION VDR interface
SERIAL INTERFACE - VDR
Optional software features:
- Engine RPM dependent steering
- Automatic interceptor Control

Appendix B, Hydraulic diagrams

No	Pcs	Revision	Date	Drawn	Appr.
B	1	V11 changed to 8 or 16 lpm	13-08-30	JL	
C	2	63A3 added, BOM-list removed	13-10-18	JL	



HYDRAULIC SYSTEM

DESIGN PRESSURE: 17.5 MPa
TOTAL OIL VOLUME: 25 LIT

HYDRAULIC PTO-DRIVEN PUMP (P1)(ITEM 4)

P1 VARIABLE DISPLACMENT PISTON PUMP:
DISPLACEMENT: 28 cc
CONTROL DEVICE: PRESSURE/FLOW CONTROL WITH INTERNAL BLEED ORIFICE

CONTROL VALVES — INCL. IN MANIFOLD ITEM 01

B →
V10 STEERING: PROPORTIONAL 4 lpm
V11 REVERSING: PROPORTIONAL 8 / 16 lpm
V50 TRIMTAB: ON-OFF / PROPORTIONAL 4 lpm

C →

JET	HYDRAULIC CYLINDERS	INCL. IN STEERING AND REVERSING GEAR.
40A3	STEERING (1x): ø50/ø32 x 123 REVERSING (2x): ø50/ø32 x 249	
45A3	STEERING (1x): ø50/ø32 x 136 REVERSING (2x): ø50/ø32 x 261	
50A3	STEERING (1x): ø50/ø32 x 170 REVERSING (2x): ø60/ø40 x 289	
56A3	STEERING (1x): ø60/ø40 x 170 REVERSING (2x): ø60/ø40 x 317	
63A3	STEERING (1x): ø60/ø40 x 191 REVERSING (2x): ø60/ø40 x 357	
FF67	STEERING (1x): ø50/ø32 x 170 REVERSING (2x): ø60/ø40 x 317	

INTERCEPTOR (1x): ø40/ø25 x 90

LIST OF COMPONENTS FOR REMOTE SUPERVISION

ITEM	DESCRIPTION *)	SETTING POINT	DELAY
PS 1	SWITCH/ALARM LOW HYDRAULIC OIL PRESSURE	1.5 MPa	5 SEC
TS 1	SWITCH/ALARM HIGH HYD. OIL TEMPERATURE	T > 70°C	-
TS 2	SWITCH/ALARM HIGH LUB. OIL TEMP. BEARING	T > 70°C	-
LS 1	SWITCH/ALARM LOW HYDRAULIC OIL LEVEL	-	5 SEC
LS 2	SWITCH/ALARM LOW LUB. OIL LEVEL, BEARING	-	5 SEC

*) SEE ALSO WIRING DIAGRAM

PRESSURE VALVE SETTINGS (MPa)		
P1	HYDR. PUMP/RELIEF VALVE	14
P1	LOAD SENSING VALVE	2.0
V4	SAFETY VALVE	16
V41/V42	COUNTER BALANCE VALVE (RELIEF/PILOT PRESS.)	12/4
V51/V52	COUNTER BALANCE VALVE (RELIEF/PILOT PRESS.)	12/4
V61/V62	COUNTER BALANCE VALVE (RELIEF/PILOT PRESS.)	12/4

EXTERNAL TUBING (not Rolls-Royce delivery)

LOCATION	TYPE OF TUBE	DIMENSIONS INSIDE DIA. MM	DESIGN PRESS. MPa
B-P	STEEL TUBE / FLEXIBLE HOSE	16	17.5
S-S	STEEL TUBE / FLEXIBLE HOSE	30	0.6
LS1-X	STEEL TUBE / FLEXIBLE HOSE	10	17.5
L-D	STEEL TUBE / FLEXIBLE HOSE	16	0.6
T-R	STEEL TUBE / FLEXIBLE HOSE	19	0.6
C1	FLEXIBLE HOSE	13	0.6
C2	FLEXIBLE HOSE	13	0.6

EXTERNAL WATER FEEDING (Not Rolls-Royce delivery)

MAX. 20 lpm SEAWATER OR SWEETWATER
MAX. 32°C WATER INLET TEMP.

VALVE NORMALLY OPEN
VALVE NORMALLY CLOSED

Hydraulic diagram

Manifold mounted on WJ

Checked: ILMA | Previous Orig.
Approved: ILMA | Weight kg
Orig./ Date: JL 10-10-26 | Scale: - | Format: A1 | Sheet: of

Rolls-Royce

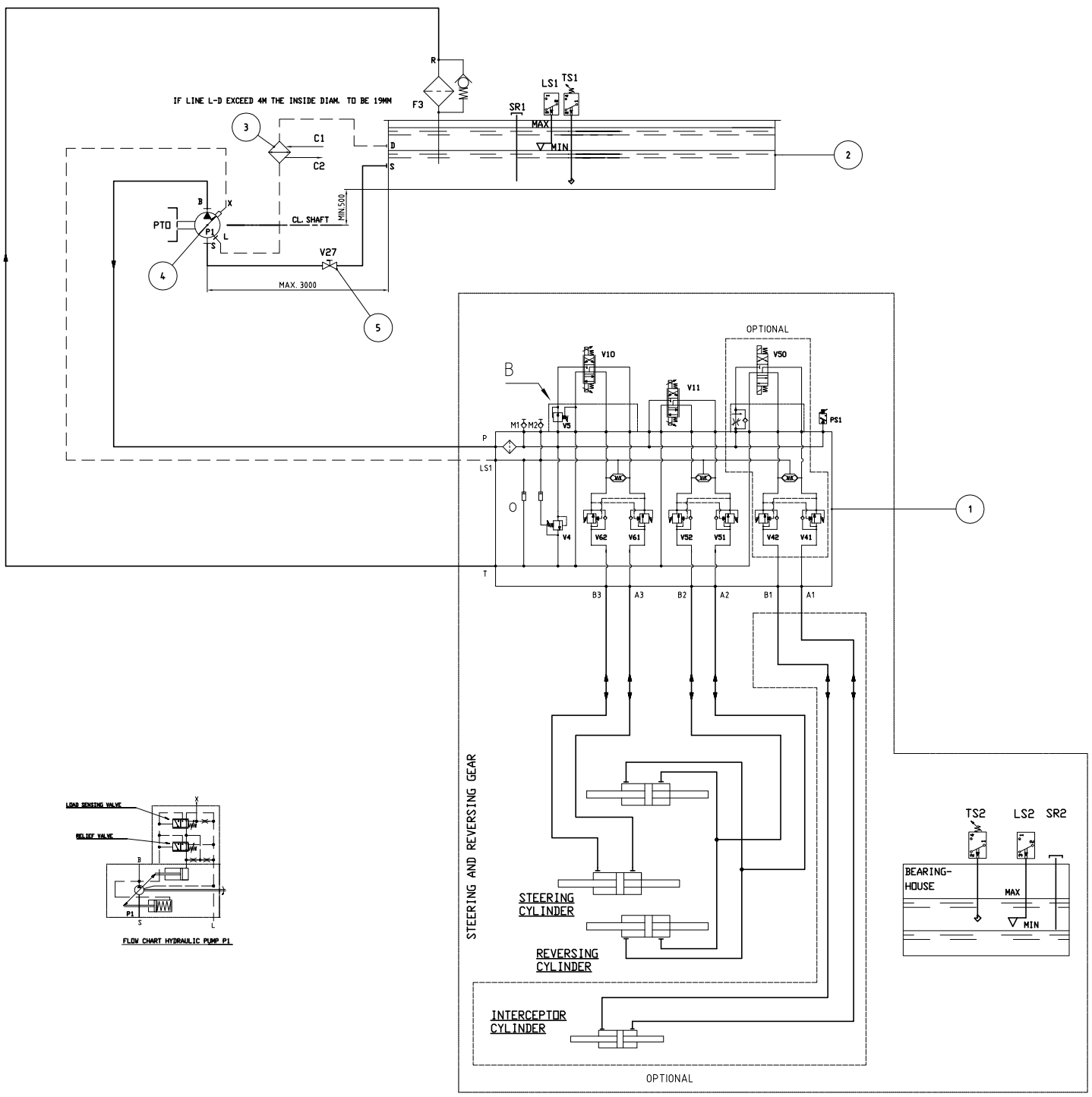
Rolls-Royce OY AB
Waterjets Kokkola

Drawing no.: DMN900000034 | Revision: C

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Rolls-Royce Marine Essential LIMITED

No	Pcs	Revision	Date	Drawn	Appr.
B	2	V5 added, V11 16 lpm added	13-08-30	JL	
C	2	63A3 added, BOM-list removed	13-10-18	JL	



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TS 2	SWITCH/ALARM HIGH LUB. OIL TEMP. BEARING	T > 70°C	
LS 1	SWITCH/ALARM LOW HYDRAULIC OIL LEVEL	-	5 SEC
LS 2	SWITCH/ALARM LOW LUB. OIL LEVEL, BEARING	-	5 SEC

※) SEE ALSO WIRING DIAGRAM

PRESSURE VALVE SETTINGS (MPa)

B →

P1	HYDR. PUMP/RELIEF VALVE	14
P1	LOAD SENSING VALVE	2.0
V4	SAFETY VALVE	16
V5	SAFETY VALVE	8
V41/V42	COUNTER BALANCE VALVE (RELIEF/PILOT PRESS.)	12/4
V51/V52	COUNTER BALANCE VALVE (RELIEF/PILOT PRESS.)	12/4
V61/V62	COUNTER BALANCE VALVE (RELIEF/PILOT PRESS.)	12/4

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L-D	STEEL TUBE / FLEXIBLE HOSE	16	0.6
T-R	STEEL TUBE / FLEXIBLE HOSE	19	0.6
C1	FLEXIBLE HOSE	13	0.6
C2	FLEXIBLE HOSE	13	0.6

EXTERNAL WATER FEEDING (Not Rolls-Royce delivery)

MAX. 20 lpm SEAWATER OR SWEETWATER
MAX. 32°C WATER INLET TEMP.

VALVE NORMALLY OPEN
VALVE NORMALLY CLOSED

Hydraulic diagram (Certified)

Manifold mounted on WJ

Rolls-Royce
Rolls-Royce OY AB
Wärtsilän Kaikola

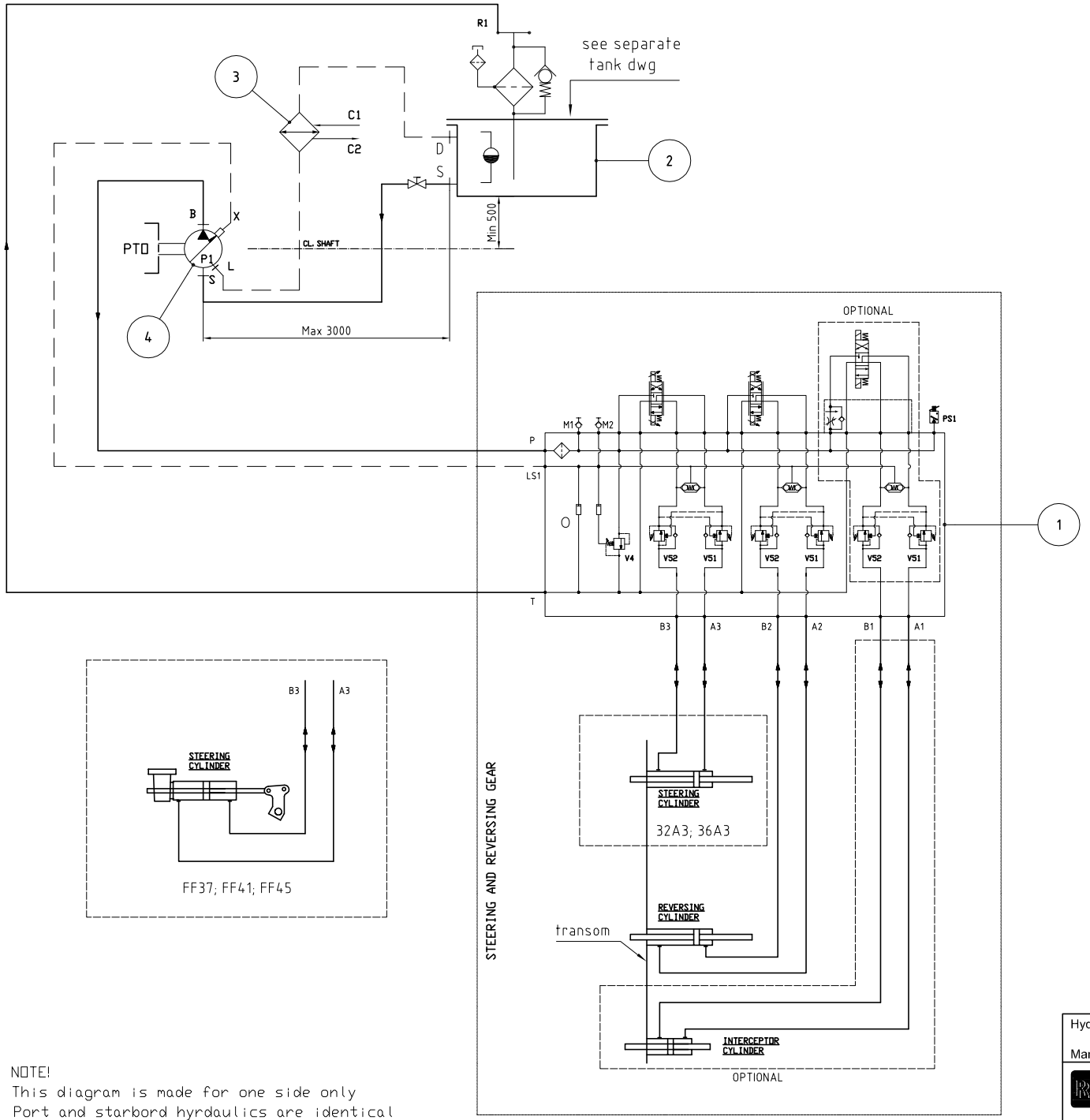
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TP	
Approved	Weighting
TP	
Dgn. / Date	Scale	Format	Sheet
JL 11-08-31	-	A1	of

Drawing no. DMN900000080 — Revision C

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DRAWING TEMPLATE UNITED

No	Pcs	Revision	Date	Drawn	Appr.
B	1	Ø50/Ø32 x124 (Ø50/Ø25 x 124)	13-09-12	JL	



NOTE!
This diagram is made for one side only
Port and starbord hyrdaulics are identical

HYDRAULIC SYSTEM
DESIGN PRESSURE: 12.5 MPa
TOTAL OIL VOLUME: 25 LIT

HYDRAULIC PTO-DRIVEN PUMP (P1)(ITEM 4)

P1 VARIABLE DISPLACMENT PISTON PUMP:
DISPLACEMENT: 18 cc
CONTROL DEVICE: PRESSURE/FLOW CONTROL WITH INTERNAL BLEED ORIFICE

CONTROL VALVES — INCL. IN MANIFOLD ITEM 01

STEERING: PROPORTIONAL 4 lpm
REVERSING: PROPORTIONAL 8 lpm
INTERCEPTOR: ON-OFF / PROPORTIONAL 4 lpm

B →

JET	HYDRAULIC CYLINDERS	INCL. IN STEERING AND REVERSING GEAR.
32A3	STEERING: Ø50/Ø32 x 124 REVERSING: Ø50/Ø25 x 170	
36A3	STEERING: Ø50/Ø32 x 140 REVERSING: Ø50/Ø25 x 200	
FF37	STEERING: Ø40/Ø20 x 90 REVERSING: Ø50/Ø25 x 170	
FF41	STEERING: Ø40/Ø20 x 90 REVERSING: Ø50/Ø25 x 200	
FF45	STEERING: Ø40/Ø20 x 90 REVERSING: Ø50/Ø25 x 200	

INTERCEPTOR: Ø40/Ø25 x 90

LIST OF COMPONENTS FOR REMOTE SUPERVISION

ITEM	DESCRIPTION *)	SETTING POINT	DELAY
PS 1	SWITCH/ALARM LOW HYDRAULIC OIL PRESSURE	1.5 MPa	5 SEC

PRESSURE VALVE SETTINGS (MPa)

P1	HYDR. PUMP/RELIEF VALVE	10
P1	LOAD SENSING VALVE	2.0
V4	SAFETY VALVE	12
V51/V52	COUNTER BALANCE VALVE (RELIEF/PILOT PRESS.)	7/2.3

EXTERNAL TUBING (not Rolls-Royce delivery)

LOCATION	TYPE OF TUBE	DIMENSIONS INSIDE DIA. MM	DESIGN PRESS. MPa
B-P	STEEL TUBE / FLEXIBLE HOSE	12	12.5
S-S	STEEL TUBE / FLEXIBLE HOSE	24	0.6
LS1-X	STEEL TUBE / FLEXIBLE HOSE	9	12.5
L-D	STEEL TUBE / FLEXIBLE HOSE	12	0.6
T-R	STEEL TUBE / FLEXIBLE HOSE	15	0.6
C1	FLEXIBLE HOSE	13/45	0.6
C2	FLEXIBLE HOSE	13/45	0.6

EXTERNAL WATER FEEDING (Not Rolls-Royce delivery)

MAX. 20 lpm SEAWATER OR SWEETWATER
MAX. 40°C WATER INLET TEMP.

VALVE NORMALLY OPEN
VALVE NORMALLY CLOSED

Hydraulic diagram

Manifold mounted on WJ

Rolls-Royce

Rolls-Royce OY AB
Waterjets Kokkola

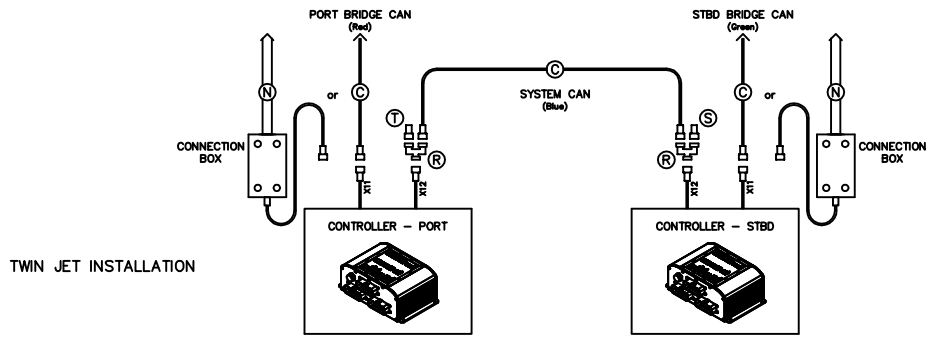
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Drawing no: DMN000200072	Revision: B

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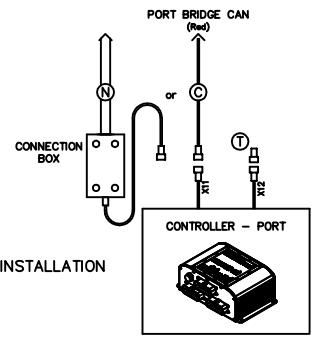
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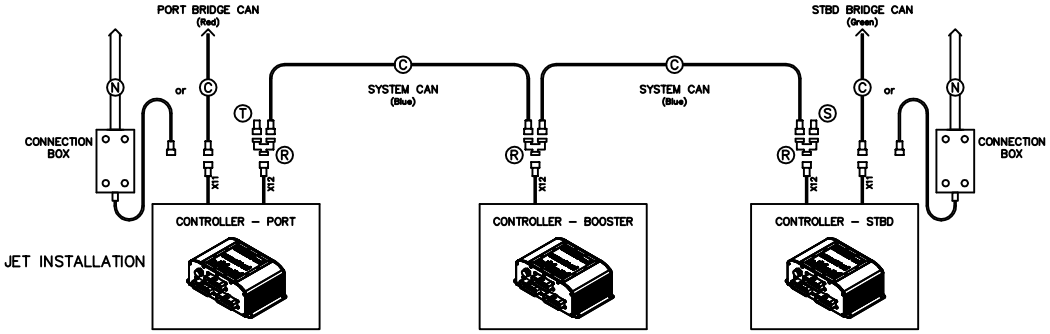
Appendix C, Cabling



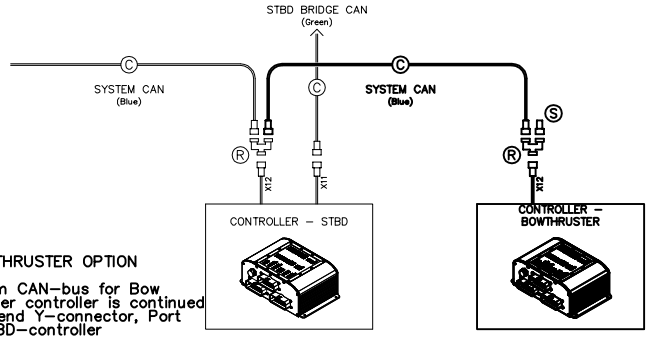
TWIN JET INSTALLATION



SINGLE JET INSTALLATION

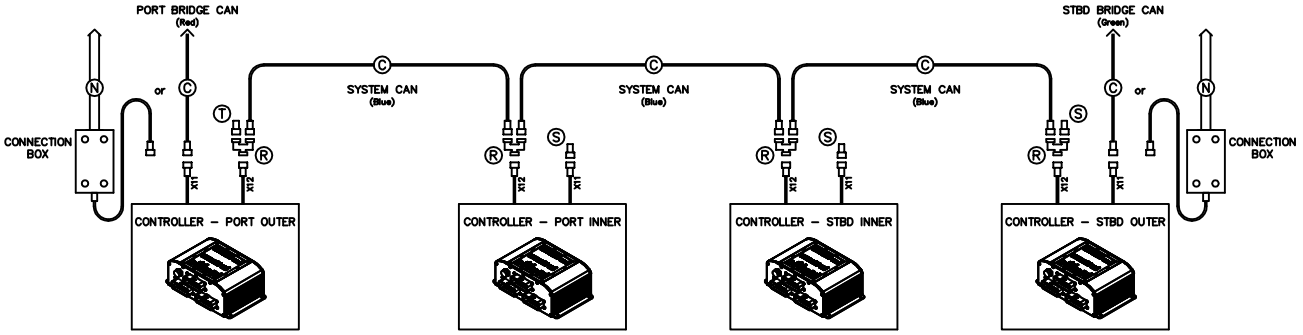


TWIN + BOOSTER JET INSTALLATION

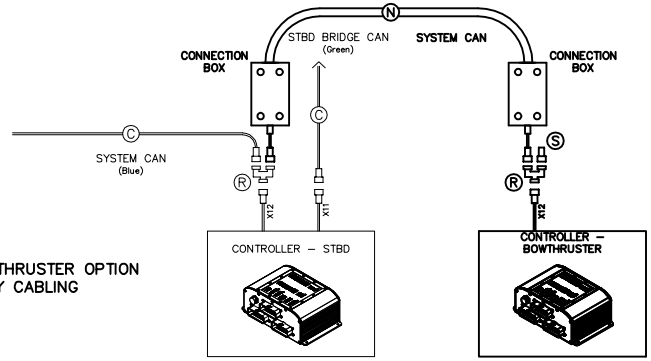


BOW THRUSTER OPTION

System CAN–bus for Bow Thruster controller is continued from end Y–connector, Port or STBD–controller



QUAD JET INSTALLATION



BOW THRUSTER OPTION
HEAVY CABLING

System assembly configurations drawing
CAN cabling for main controllers
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce

Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
MMK Nov. 7th 2012	1:1	A3	1 of 1

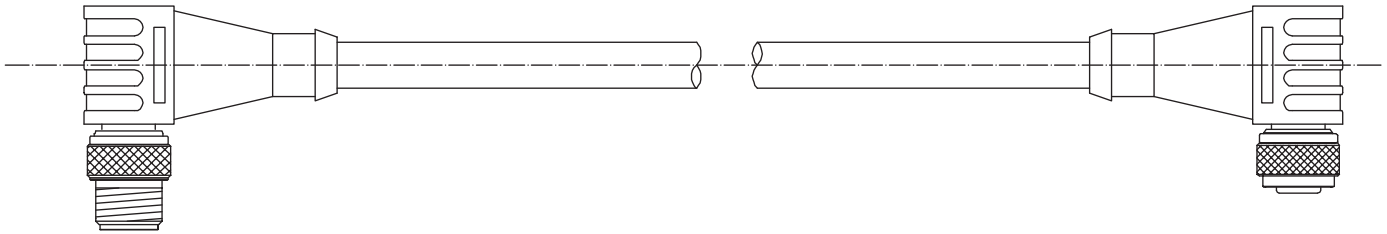
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Revision: E

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Acess List

RR OY S Info. Class: LIMITED



M12 Male, 90deg
5–pos
A–coded

M12 Female, 90deg
5–pos
A–coded

LENGHT	PART NUMBER
0.3m	RRM900001581
0.5m	RRM900001582
1m	RRM900001583
2m	RRM900001584
2,5m	RRM900002419
3m	RRM900002659

SPECIFICATION

Type	Flexible Devicenet MID 80°C 300V
Protection Class	IP68
Contacts	Gold plated CuZn
Outer jacket	PUR, Light Grey
Power conductors	2x1.04mm2 (AWG17)
Data conductors	2x0.52mm2 (AWG20)
Shielding	3 level foil
Approvals	NEC AWM CEC AWM–I/II A/B FT1



Cable
Type B
RR Control System

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Checked:	Previous Drg:
Approved:	Weight kg:

Origin. / Date:	Scale:	Format:	Sheet:
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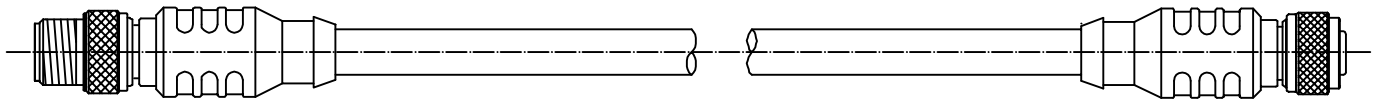
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Revision: B

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Acess List

RR OY S Info. Class: LIMITED



M12 Male, straight
5–pos
A–coded

M12 Female, straight
5–pos
A–coded

LENGHT	PART NUMBER
1m	RRM900001585
4m	RRM900001586
6m	RRM900001587
10m	RRM900001588
15m	RRM900001589
20m	RRM900001590

SPECIFICATION	
Type	Flexible Devicenet MID 80°C 300V
Protection Class	IP68
Contacts	Gold plated CuZn
Outer jacket	PUR, Light Grey
Power conductors	2x1.04mm2 (AWG17)
Data conductors	2x0.52mm2 (AWG20)
Shielding	3 level foil
Approvals	NEC AWM CEC AWM–I/II A/B FT1



Cable
Type C
RR Control System

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

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Approved:	Weight kg:

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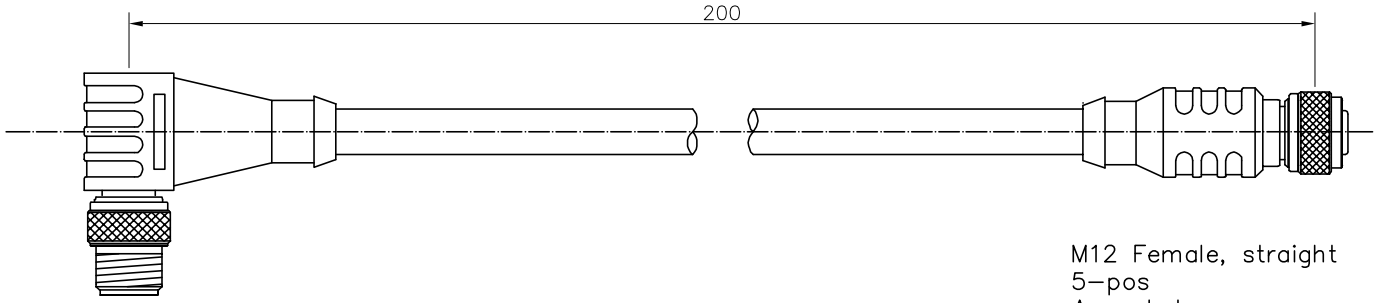
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Acess List

RR OY S Info. Class: LIMITED



M12 Male, 90deg
5–pos
A–coded

M12 Female, straight
5–pos
A–coded

SPECIFICATION	
Type	Flexible Devicenet MID 80°C 300V
Protection Class	IP68
Contacts	Gold plated CuZn
Outer jacket	PUR, Light Grey
Power conductors	2x1.04mm2 (AWG17)
Data conductors	2x0.52mm2 (AWG20)
Shielding	3 level foil
Approvals	NEC AWM CEC AWM–I/II A/B FT1



Cable
Type B-C; l=0.2m
RR Control System

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Checked:	Previous Drg:
Approved:	Weight kg:

Origin. / Date:	Scale:	Format:	Sheet:
JL 12-05-11	1:1	A3	1 of 1

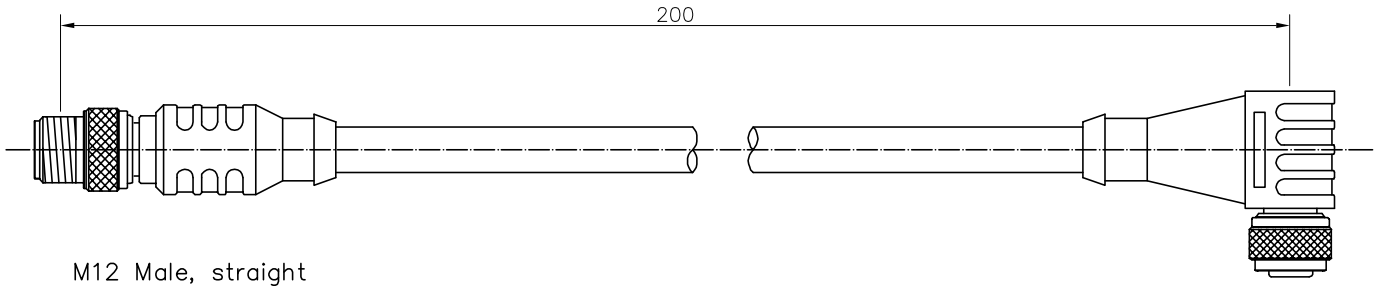
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Revision: A

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Acess List

RR OY S Info. Class: LIMITED



M12 Male, straight
5–pos
A–coded

M12 Female, 90deg
5–pos
A–coded

SPECIFICATION	
Type	Flexible Devicenet MID 80°C 300V
Protection Class	IP68
Contacts	Gold plated CuZn
Outer jacket	PUR, Light Grey
Power conductors	2x1.04mm2 (AWG17)
Data conductors	2x0.52mm2 (AWG20)
Shielding	3 level foil
Approvals	NEC AWM CEC AWM–I/II A/B FT1



Cable
Type C-B; l=0.2m
RR Control System

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Checked:	Previous Drg:
Approved:	Weight kg:

Origin. / Date:	Scale:	Format:	Sheet:
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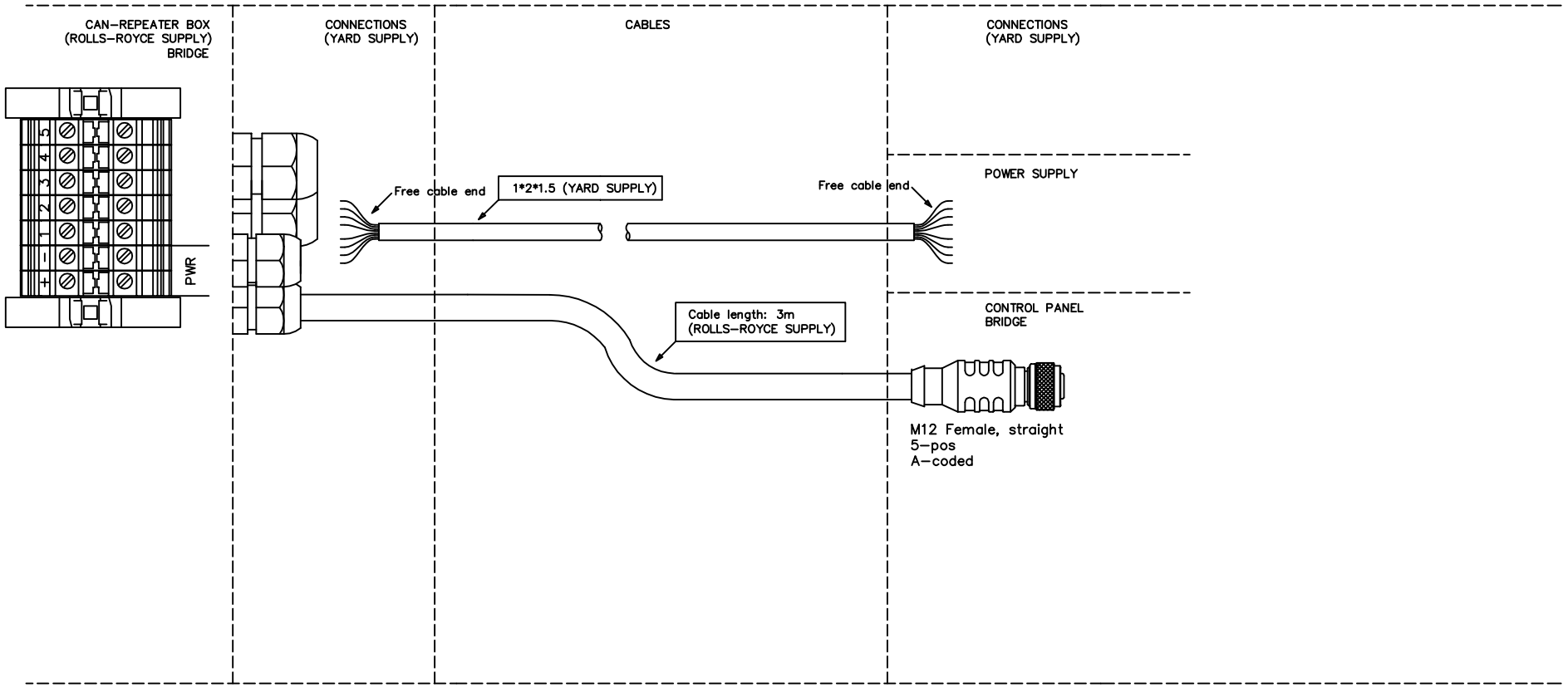
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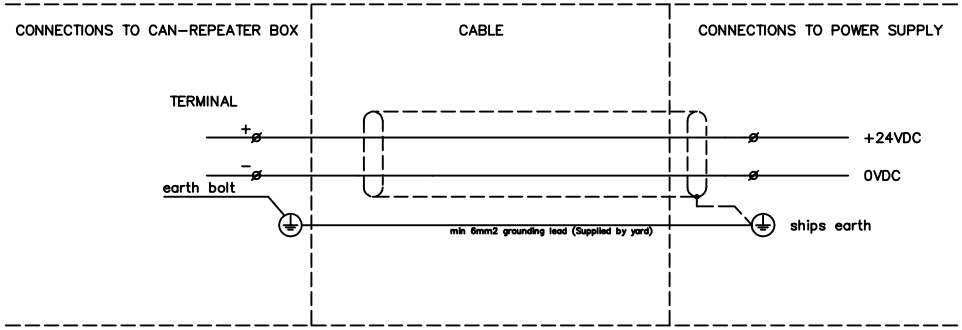
Acess List

RR OY S Info. Class: LIMITED

LAYOUT



EXAMPLE CONNECTION – POWER SUPPLY



NOTE!

Use the same power supply with the controller unit and the CAN repeater box on the same bus:

If CAN repeater is located on MAIN system/PORT bus
– Connect to Supply A

If CAN repeater is located on MAIN system/STBD bus
– Connect to Supply B

If CAN repeater is located on BACKUP system/PORT bus
– Connect to Supply B

If CAN repeater is located on BACKUP system/STBD bus
– Connect to Supply A

CONNECTION DETAILS		
Terminal	Wire	Signal description
+	1	24VDC
–	2	0VDC

Interface Description
CAN-Repeater box with filter
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

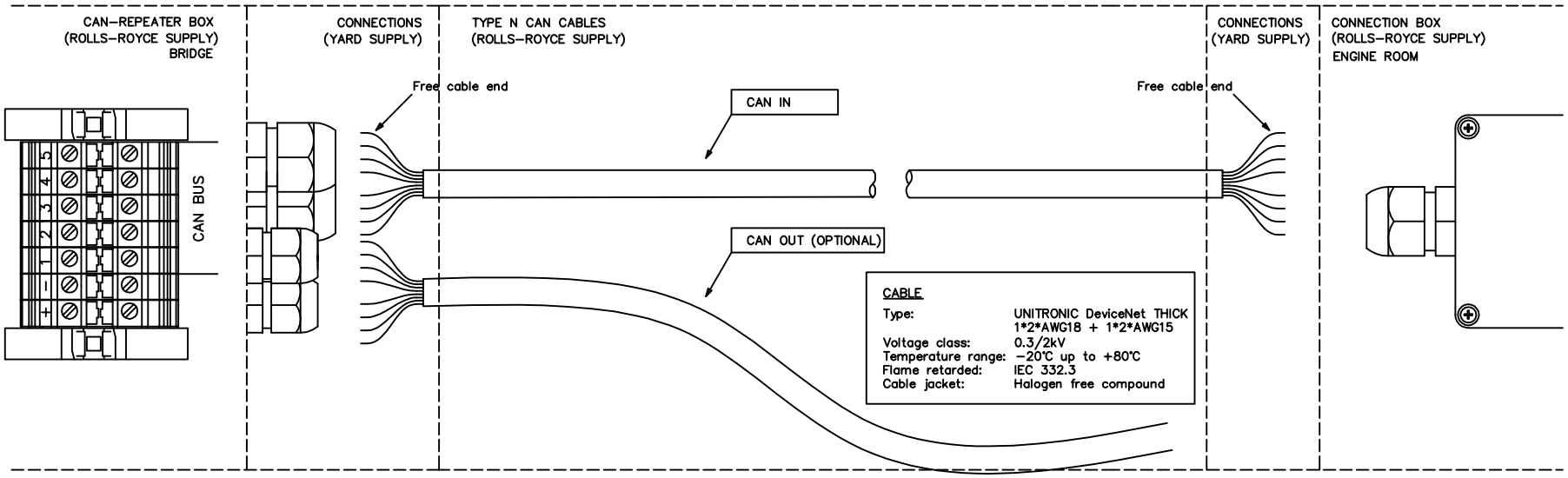
Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK May 6th 2014 | Scale: 1:1 | Format: A3 | Sheet: 1 of 2
Drawing no: DMN000220967 | Revision: A

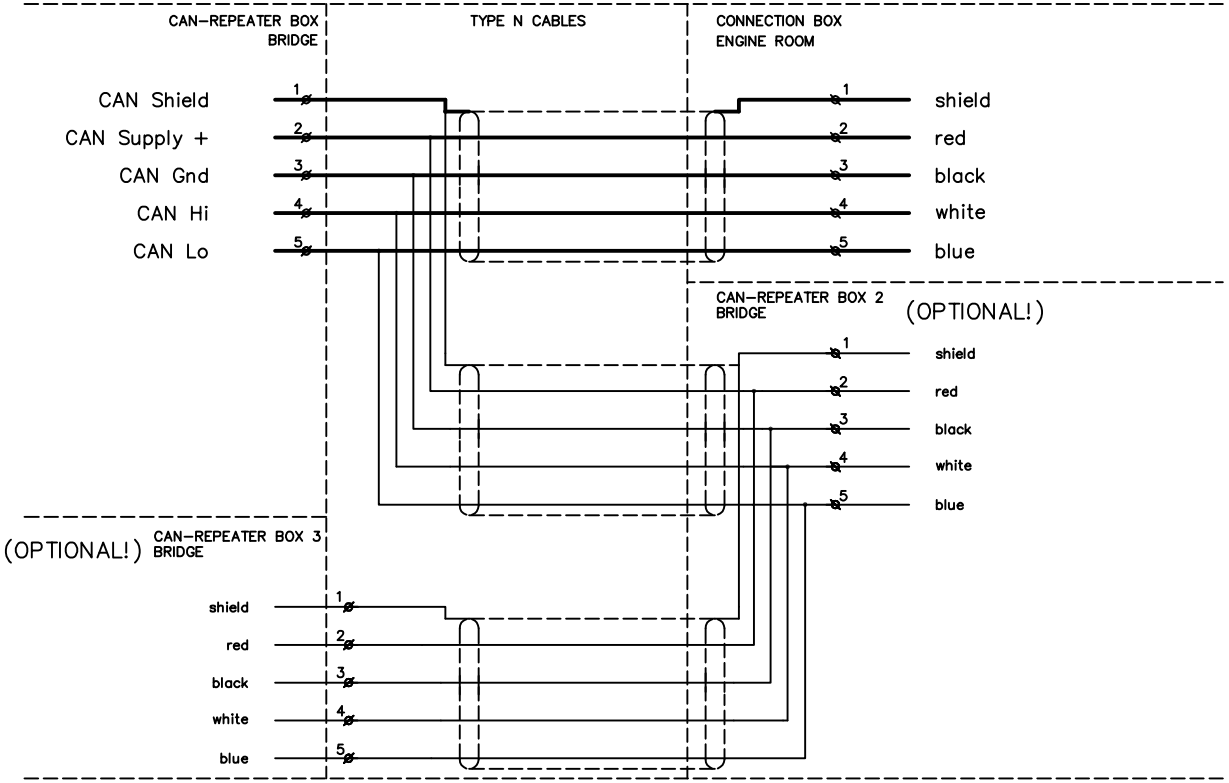
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Access List
RR-OY-S Proj. Class: LIMITED

LAYOUT



EXAMPLE CONNECTION – CAN BUS



NOTE!

Installations with more than one Control Station:

Connect the CAN OUT–cable to the CAN–Repeater box exactly the same way as the CAN IN–cable. Please see example connection for details.

CONNECTION DETAILS	
Terminal	Signal description
1	SHIELD
2	RED
3	BLACK
4	WHITE
5	BLUE

Interface Description
CAN-Repeater box with filter
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

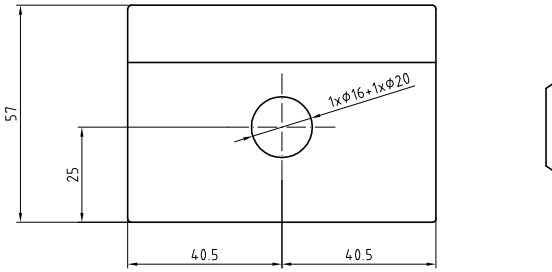
Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

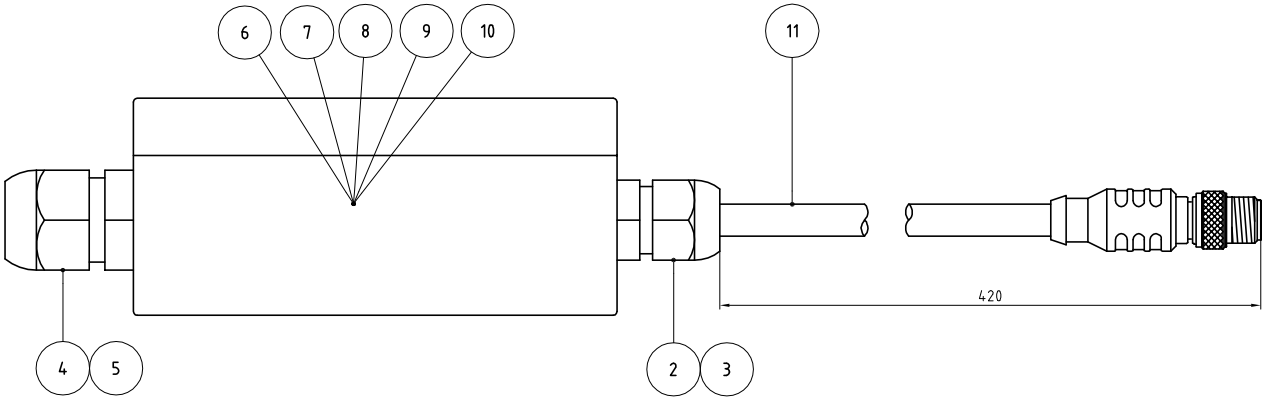
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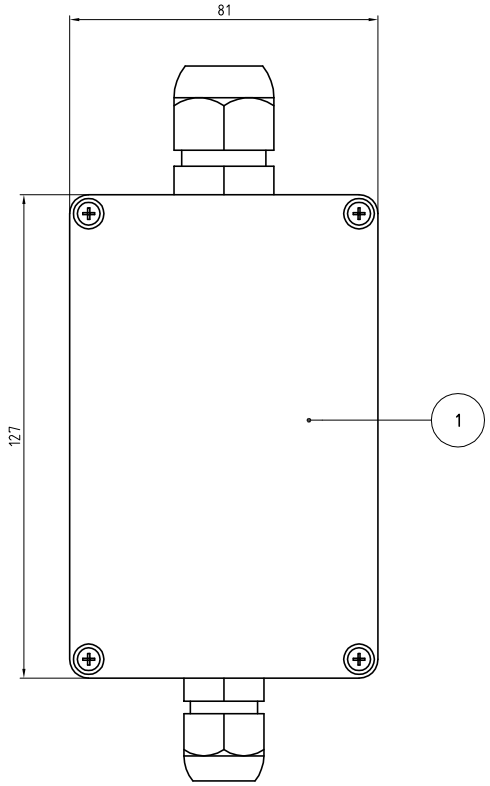
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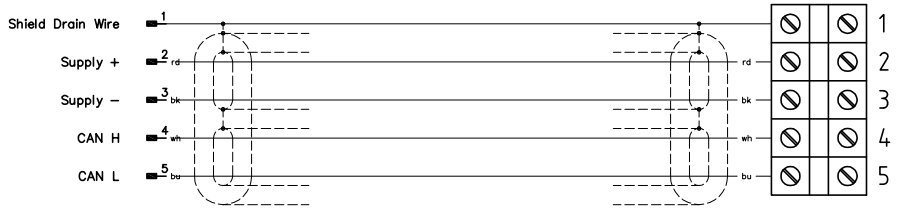
Access List
RR-OY-S Proj. Class: LIMITED

No	Pcs	Revision	Date	Drawn	Appr.









Item.no	No of	Description	Material	Dim./standard	Code / remark
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10	1	Identification Plate	Phoenix	ZB5 2-5	RRM900002391
9	2	Socket End	Phoenix	E/MK1	10228731_2745049
8	1	End Plate	Phoenix	D-MBK/E	10228722_2745047
7	5	Terminal Block	Phoenix	MBK3/E-Z	10228702_2745043
6	1	Terminal Rail	NS 15	L 70	RRM900002390
5	1	Hexagon Nut	Skintop	SM-M20x1.5	RRM000201206
4	1	Cable Gland	Skintop	MS-M20x1.5	RRM000201205
3	1	Hexagon Nut	Skintop	SM-M16x1.5	RRM900002389
2	1	Cable Gland	Skintop	MS-M16x1.5	RRM900002388
1	1	Connection Box	Fibox AL	081306	10228103_2745030

Connection Box
CAN Mid-cable to Thick
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce

Rolls-Royce OY AB
Waterjets Kokkola

Origin. / Date: JL 12-09-07 | Scale: 1:1 | Format: A2 | Sheet: of

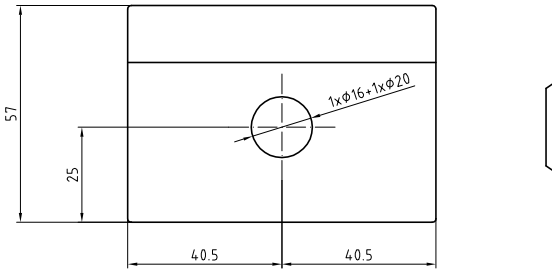
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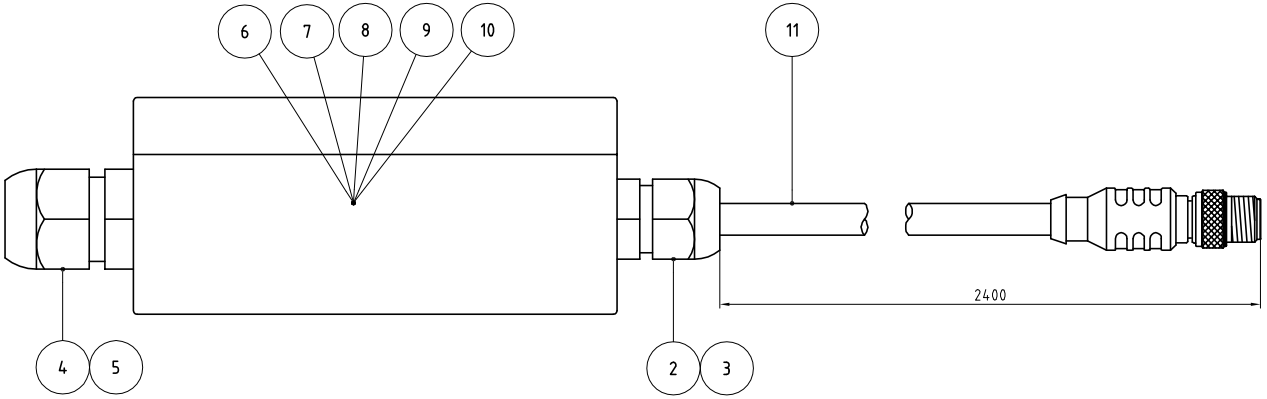
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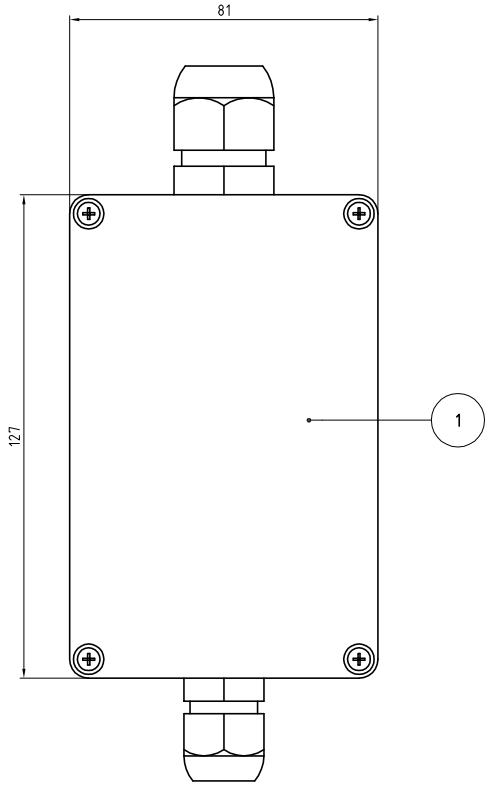
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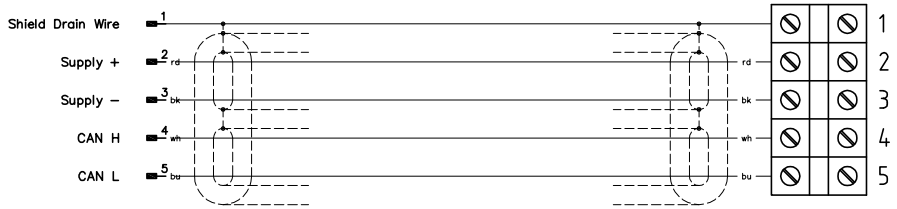
RR Corp. AB S Info. Class: LIMITED

No	Pcs	Revision	Date	Drawn	Appr.









Item.no	No of	Description	Material	Dim./standard	Code / remark
11	1	Cable	Turck	RSC-5723	
10	1	Identification Plate	Phoenix	ZB5 2-5	RRM900002391
9	2	Socket End	Phoenix	E/MK1	10228731_2745049
8	1	End Plate	Phoenix	D-MBK/E	10228722_2745047
7	5	Terminal Block	Phoenix	MBK3/E-Z	10228702_2745043
6	1	Terminal Rail	NS 15	L 70	RRM900002390
5	1	Hexagon Nut	Skintop	SM-M20x1.5	RRM000201206
4	1	Cable Gland	Skintop	MS-M20x1.5	RRM000201205
3	1	Hexagon Nut	Skintop	SM-M16x1.5	RRM900002389
2	1	Cable Gland	Skintop	MS-M16x1.5	RRM900002388
1	1	Connection Box	Fibox AL	081306	10228103_2745030

Connection Box
CAN Mid-cable to Thick
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce

Rolls-Royce OY AB
Waterjets Kokkola

Origin. / Date: JL 12-05-29 | Scale: 1:1 | Format: A2 | Sheet: of

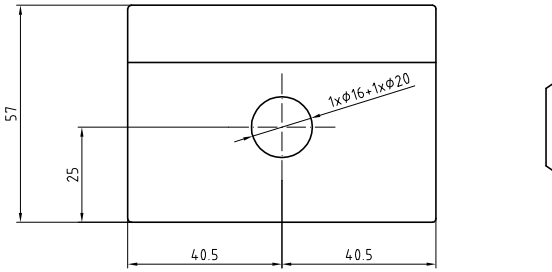
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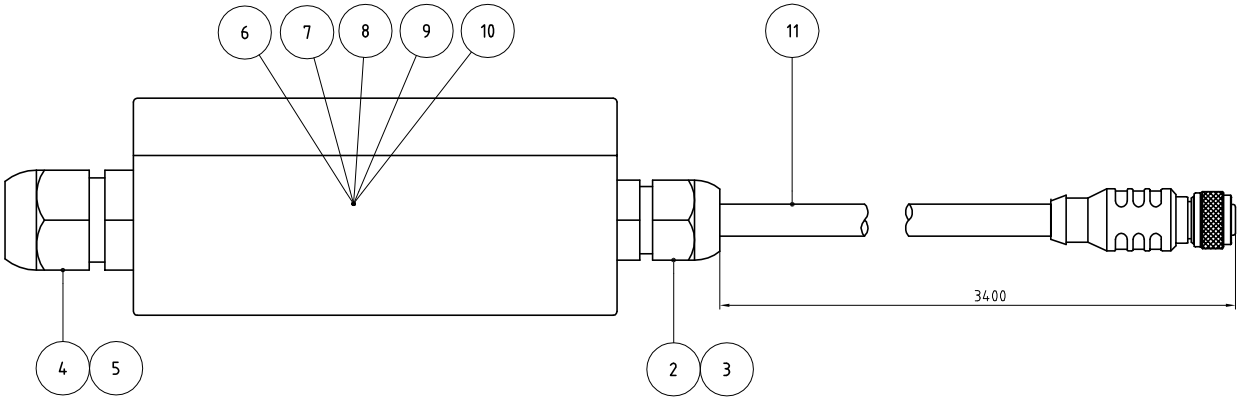
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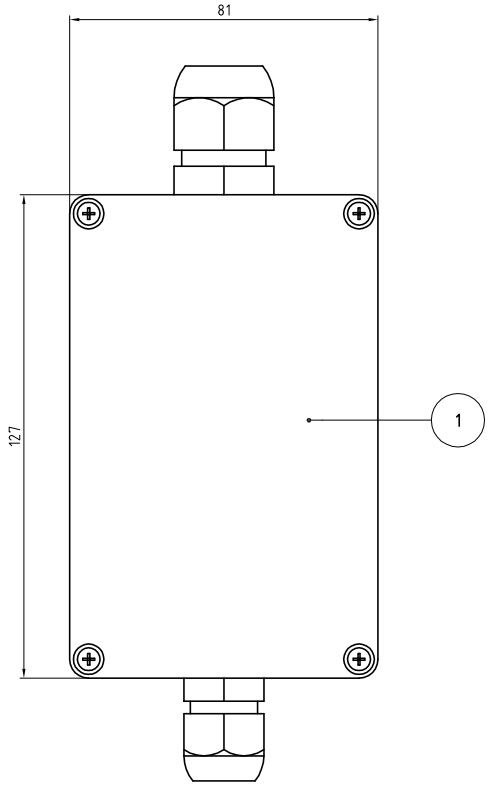
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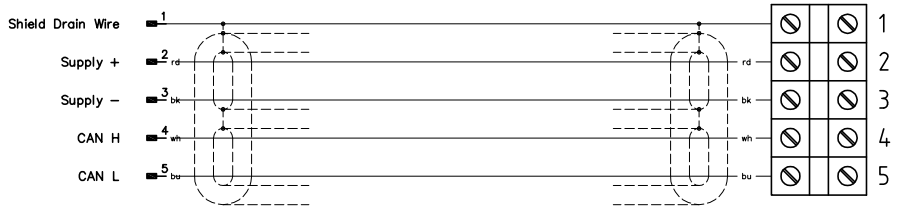
RR Corp AB Info. Class: LIMITED

No	Pcs	Revision	Date	Drawn	Appr.









Item.no	No of	Description	Material	Dim./standard	Code / remark
11	1	Cable	Turck	RSC-5723	
10	1	Identification Plate	Phoenix	ZB5 2-5	RRM900002391
9	2	Socket End	Phoenix	E/MK1	10228731_2745049
8	1	End Plate	Phoenix	D-MBK/E	10228722_2745047
7	5	Terminal Block	Phoenix	MBK3/E-Z	10228702_2745043
6	1	Terminal Rail	NS 15	L 70	RRM900002390
5	1	Hexagon Nut	Skintop	SM-M20x1.5	RRM000201206
4	1	Cable Gland	Skintop	MS-M20x1.5	RRM000201205
3	1	Hexagon Nut	Skintop	SM-M16x1.5	RRM900002389
2	1	Cable Gland	Skintop	MS-M16x1.5	RRM900002388
1	1	Connection Box	Fibox AL	081306	10228103_2745030

Connection Box
CAN Thick-cable to Mid
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce

Rolls-Royce OY AB
Waterjets Kokkola

Origin. / Date: JL 13-02-20 | Scale: 1:1 | Format: A2 | Sheet: of

Drawing no: RRM000207955 | Revision: A

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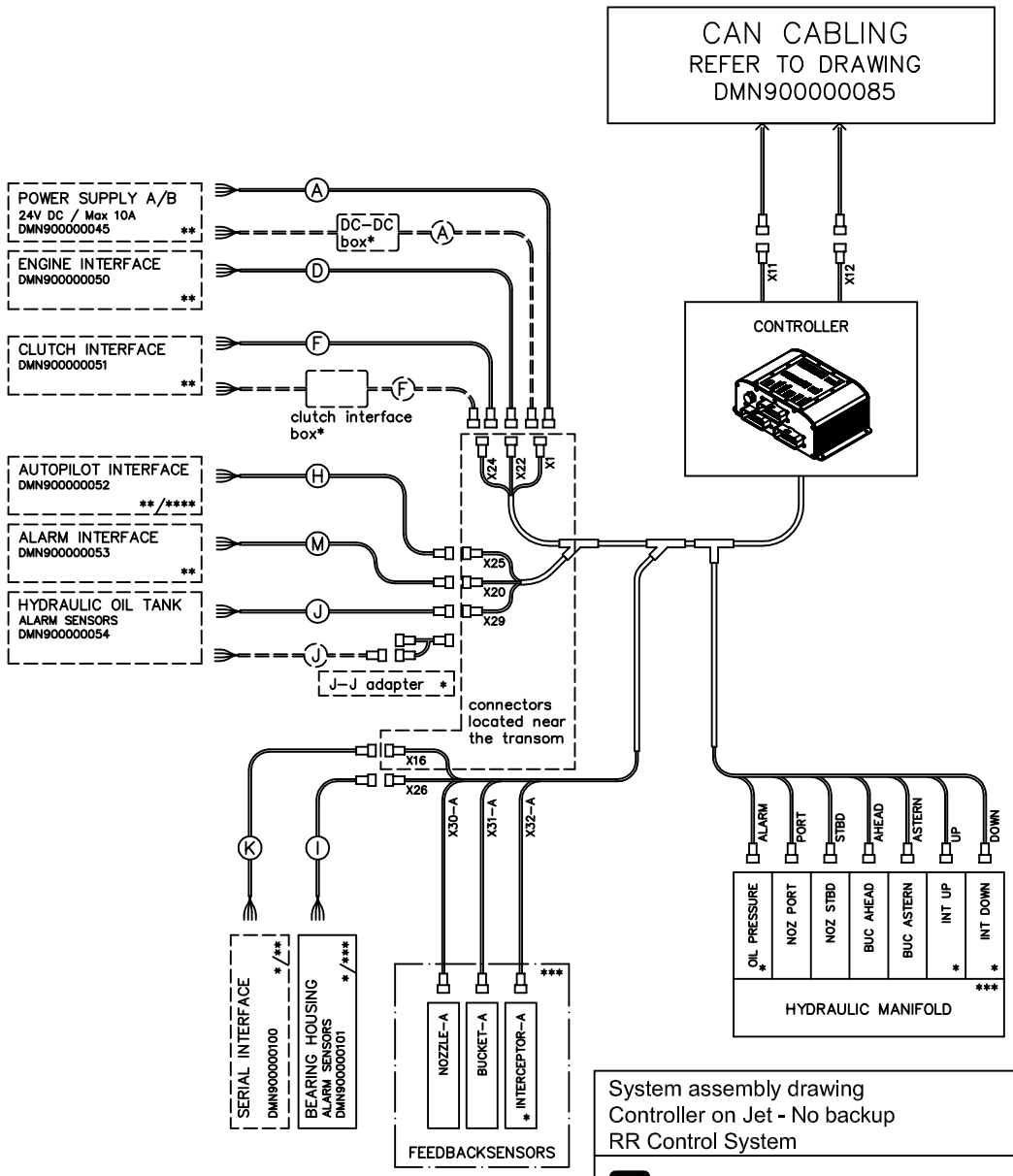
Access Lst

RR Oy AB S Info. Class: LIMITED

EXPLANATIONS:

* : Optional device / interface
** : Yard supply
*** : Installed on jet
**** : Connected only on Port outer controller

CABLE SPECIFICATIONS		
TYPE	**LENGHT (m)**	**PART NUMBER**
A	5	RRM900001457
	20	RRM900001896
D	5	RRM900001470
	20	RRM900001897
F	5	RRM900001471
	20	RRM900001895
H	5	RRM900001898
	20	RRM900001472
M	5	RRM900001474
	20	RRM900001901
J	5	RRM900001473
	20	RRM900001900
K	5	RRM900002564
	20	RRM900002565
I	0,7	RRM900002566
	2	RRM900002567
	8	RRM900002648



System assembly drawing
Controller on Jet - No backup
RR Control System

Checked:
Previous Drg:
Approved:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: ToP Oct. 27th 2011
Scale: 1:1
Format: A3
Sheet: 1 of 1
Drawing no: DMN900000086
Revision: G

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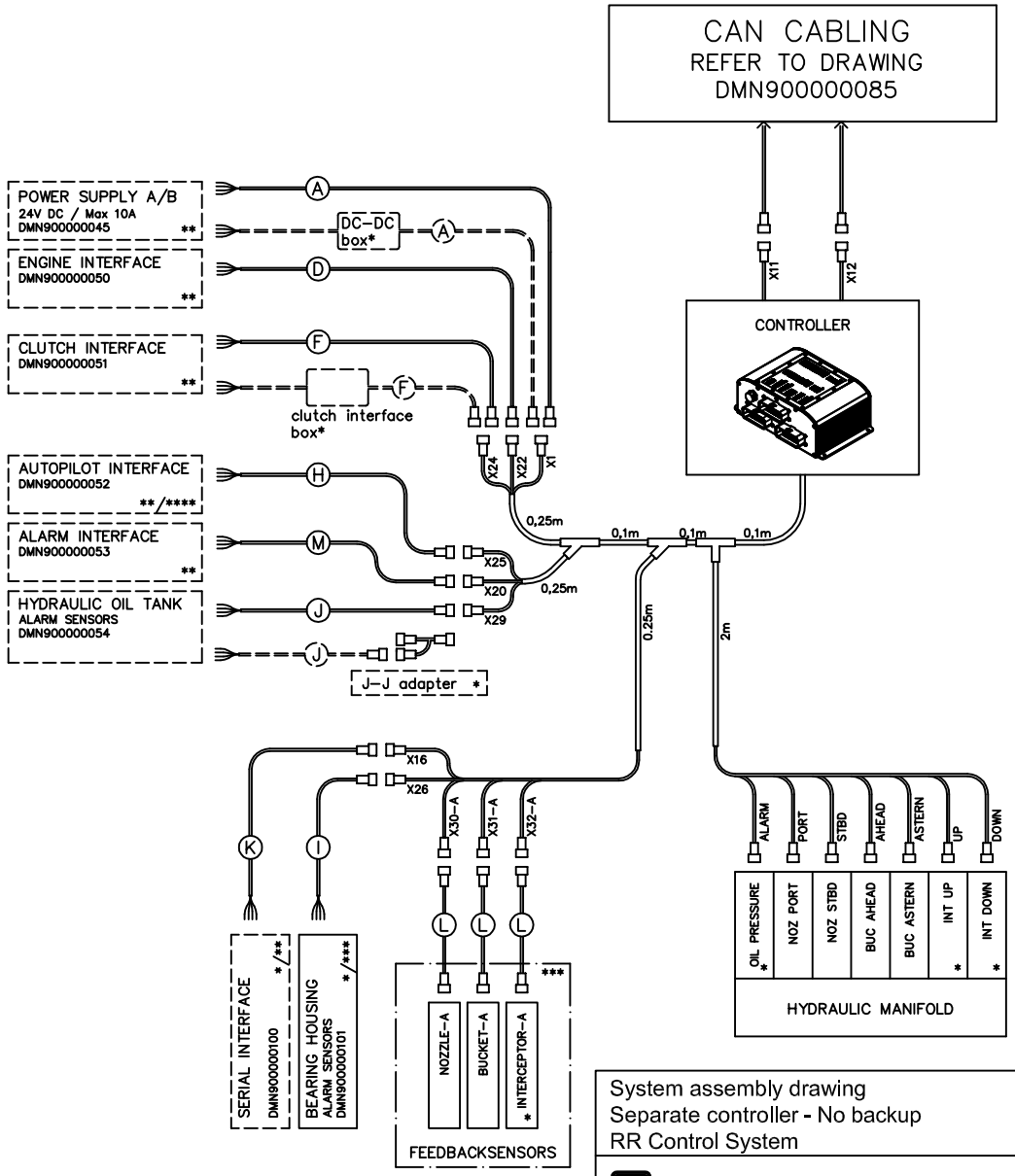
Access List

RR OY S Info. Class: LIMITED

EXPLANATIONS:

* : Optional device / interface
** : Yard supply
*** : Installed on jet
**** : Connected only on Port outer controller

CABLE SPECIFICATIONS		
TYPE	**LENGHT (m)**	**PART NUMBER**
A	5	RRM900001457
	20	RRM900001896
D	5	RRM900001470
	20	RRM900001897
F	5	RRM900001471
	20	RRM900001895
H	5	RRM900001898
	20	RRM900001472
M	5	RRM900001474
	20	RRM900001901
J	5	RRM900001473
	20	RRM900001900
K	5	RRM900002564
	20	RRM900002565
I	0,7	RRM900002566
	2	RRM900002567
	8	RRM900002648
L	2	RRM900001829
	5	RRM900001899



System assembly drawing
Separate controller - No backup
RR Control System

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Checked:	Previous Drg:
Approved:	Weight kg:

Origin. / Date:	Scale:	Format:	Sheet:
ToP Oct. 27th 2011	1:1	A3	1 of 1

Drawing no: DMN900000087
Revision: H

Access List

RR OY'S Info. Class: LIMITED

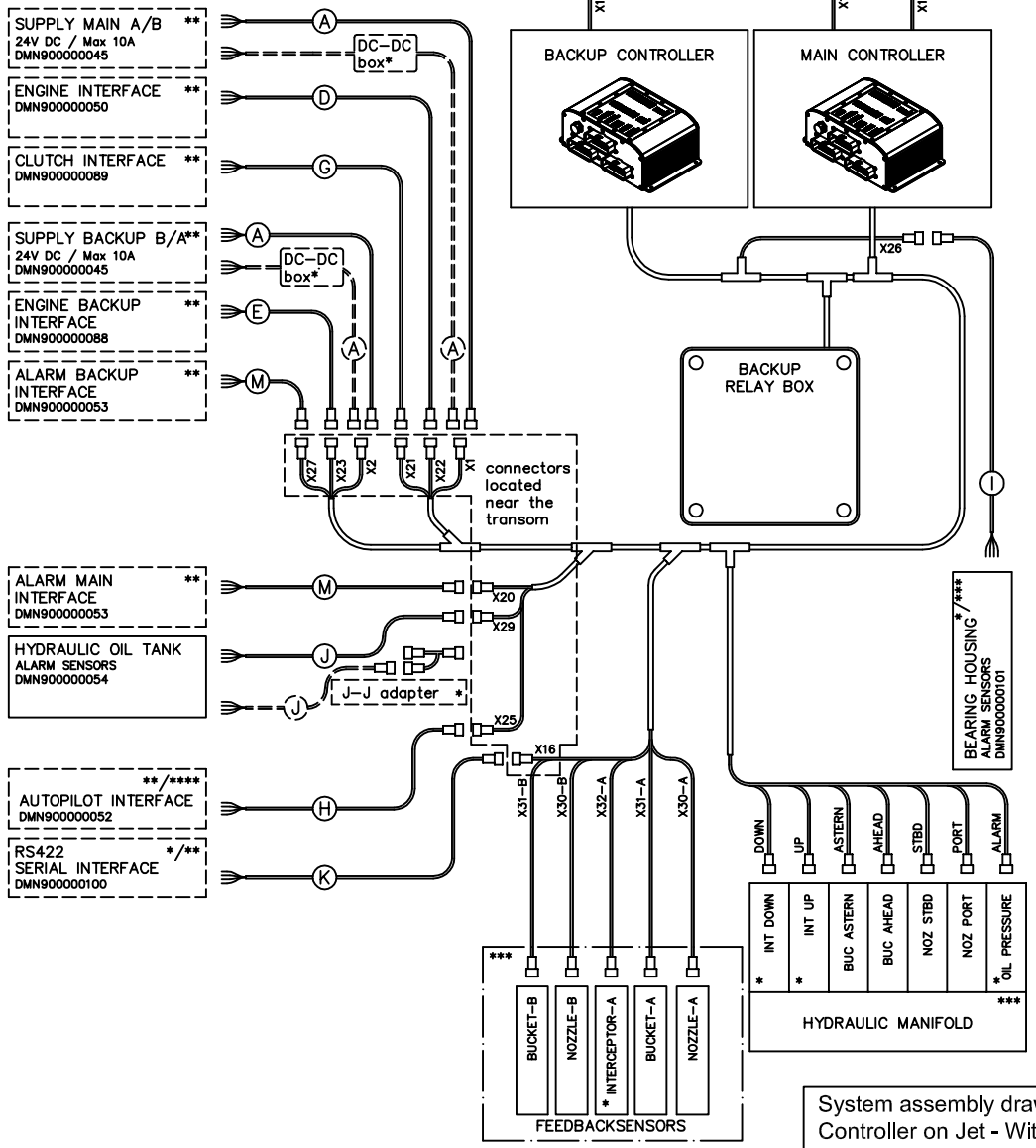
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EXPLANATIONS:

* : Optional device / interface
** : Yard supply
*** : Installed on jet
**** : Connected only on Port outer controller

BACKUP CABLING
REFER TO DRAWING
DMN900000108

CAN CABLING
REFER TO DRAWING
DMN900000085



CABLE SPECIFICATIONS		
TYPE	**LENGHT (m)**	**PART NUMBER**
A	5	RRM900001457
	20	RRM900001896
D	5	RRM900001470
	20	RRM900001897
G	5	RRM900002657
	20	RRM900002658
H	5	RRM900001898
	20	RRM900001472
E	5	RRM900002562
	20	RRM900002563
M	5	RRM900001474
	20	RRM900001901
J	5	RRM900001473
	20	RRM900001900
K	5	RRM900002564
	20	RRM900002565
I	0,7	RRM900002566
	2	RRM900002567
	8	RRM900002648

System assembly drawing
Controller on Jet - With backup
RR Control System

Checked:
Previous Drg:
Approved:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: ToP Nov. 9th 2011
Scale: 1:1
Format: A3
Sheet: 1 of 1
Drawing no: DMN900000098
Revision: G

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Acess List

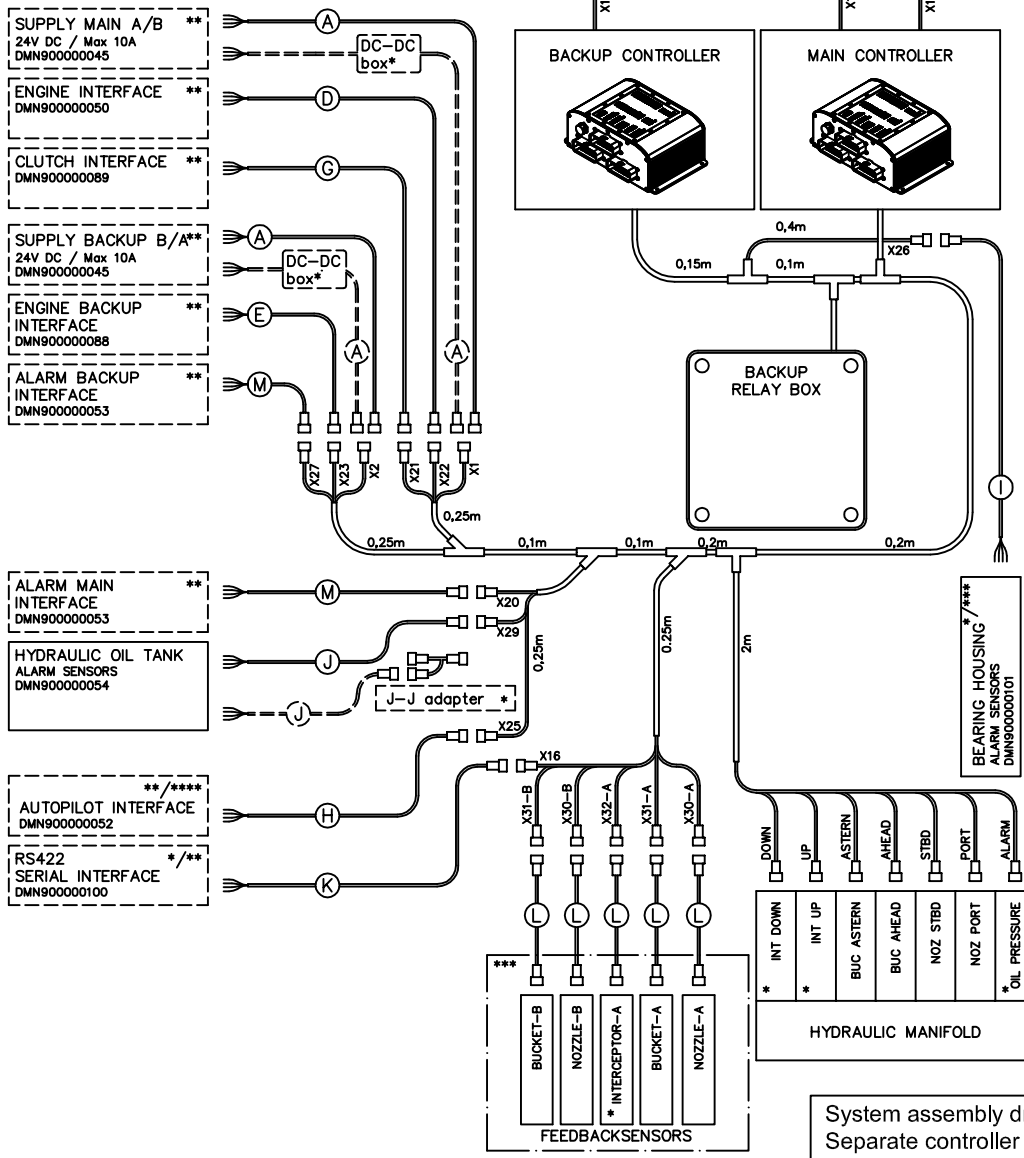
RR OY'S Info. Class: LIMITED

EXPLANATIONS:

* : Optional device / interface
** : Yard supply
*** : Installed on jet
**** : Connected only on Port outer controller

BACKUP CABLING
REFER TO DRAWING
DMN900000108

CAN CABLING
REFER TO DRAWING
DMN900000085



CABLE SPECIFICATIONS		
TYPE	**LENGHT (m)**	**PART NUMBER**
A	5	RRM900001457
	20	RRM900001896
D	5	RRM900001470
	20	RRM900001897
G	5	RRM900002657
	20	RRM900002658
H	5	RRM900001898
	20	RRM900001472
E	5	RRM900002562
	20	RRM900002563
M	5	RRM900001474
	20	RRM900001901
J	5	RRM900001473
	20	RRM900001900
K	5	RRM900002564
	20	RRM900002565
I	0,7	RRM900002566
	2	RRM900002567
	8	RRM900002648
L	2	RRM900001829
	5	RRM900001899

System assembly drawing
Separate controller - With backup
RR Control System

Checked:
Previous Drg:
Approved:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: ToP Oct. 17th 2011
Scale: 1:1
Format: A3
Sheet: 1 of 1
Drawing no: DMN900000099
Revision: J

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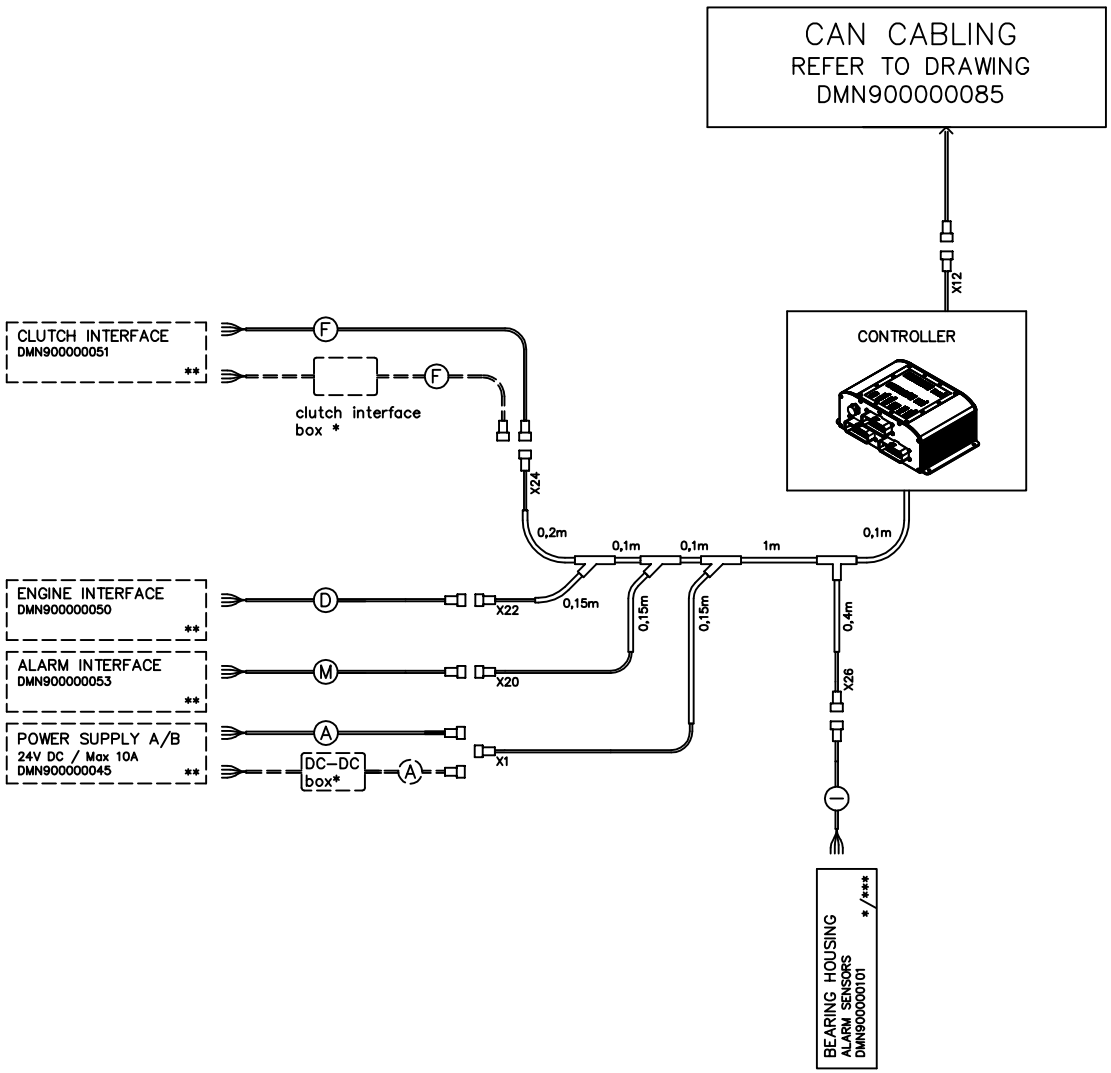
Acess List

RR OY'S Info. Class: LIMITED

EXPLANATIONS:

* : Optional device / interface
** : Yard supply
*** : Installed on jet
**** : Connected only on Port outer controller

CABLE SPECIFICATIONS		
TYPE	**LENGHT (m)**	**PART NUMBER**
A	5	RRM900001457
	20	RRM900001896
D	5	RRM900001470
	20	RRM900001897
F	5	RRM900001471
	20	RRM900001895
M	5	RRM900001474
	20	RRM900001901
I	0,7	RRM900002566
	2	RRM900002567
	8	RRM900002648



System assembly drawing
Booster unit
RR Control System

Checked:
Previous Drg:
Approved:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Dec 11th 2012
Scale: 1:1
Format: A3
Sheet: 1 of 1
Drawing no: DMN000201509
Revision: D

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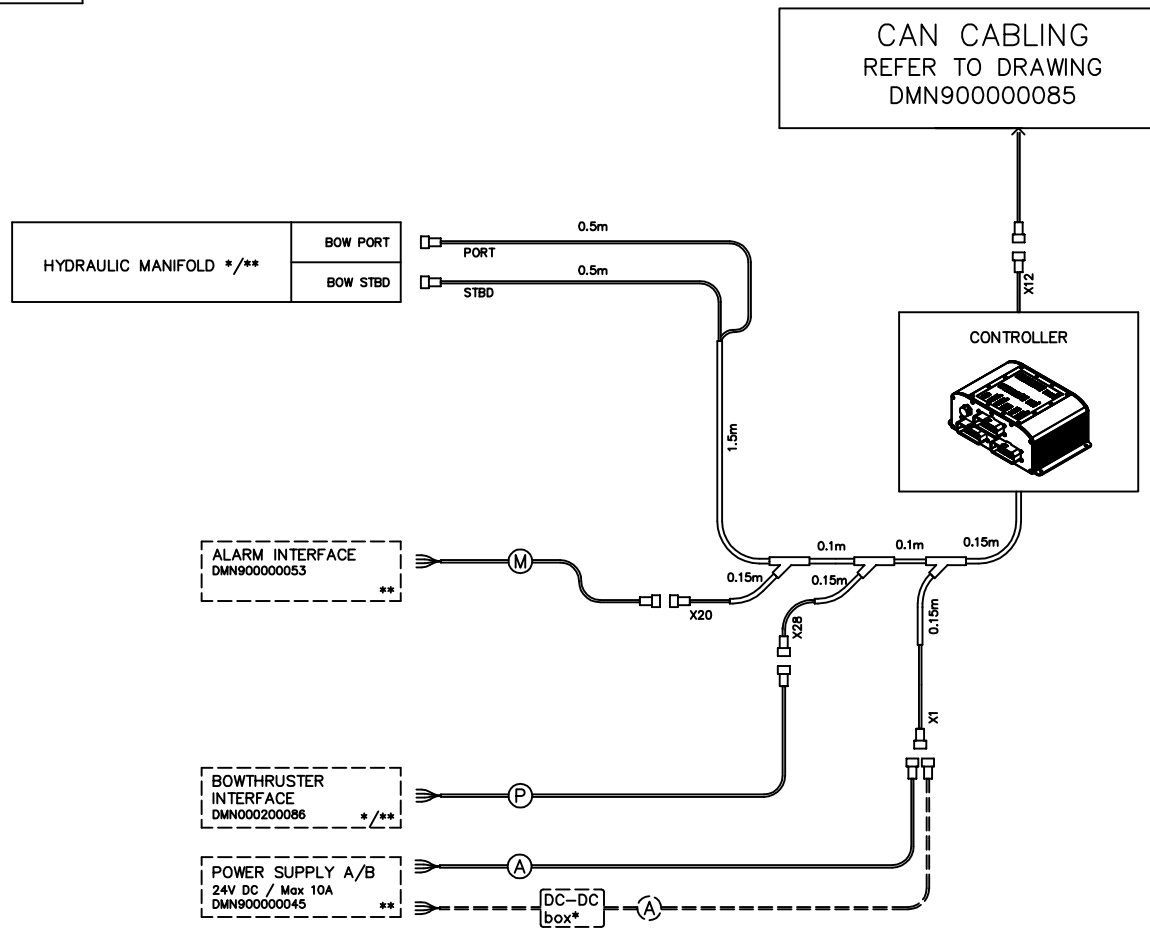
Acess List

RR OY'S Info. Class: LIMITED

EXPLANATIONS:

* : Optional device / interface
** : Yard supply
*** : Installed on jet
**** : Connected only on Port outer controller

CABLE SPECIFICATIONS		
TYPE	**LENGHT (m)**	**PART NUMBER**
A	5	RRM900001457
	20	RRM900001896
M	5	RRM900001474
	20	RRM900001901
P	20	RRM00020213



System assembly drawing
Bowthruster
RR Control System

Checked:
Previous Drg:
Approved:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

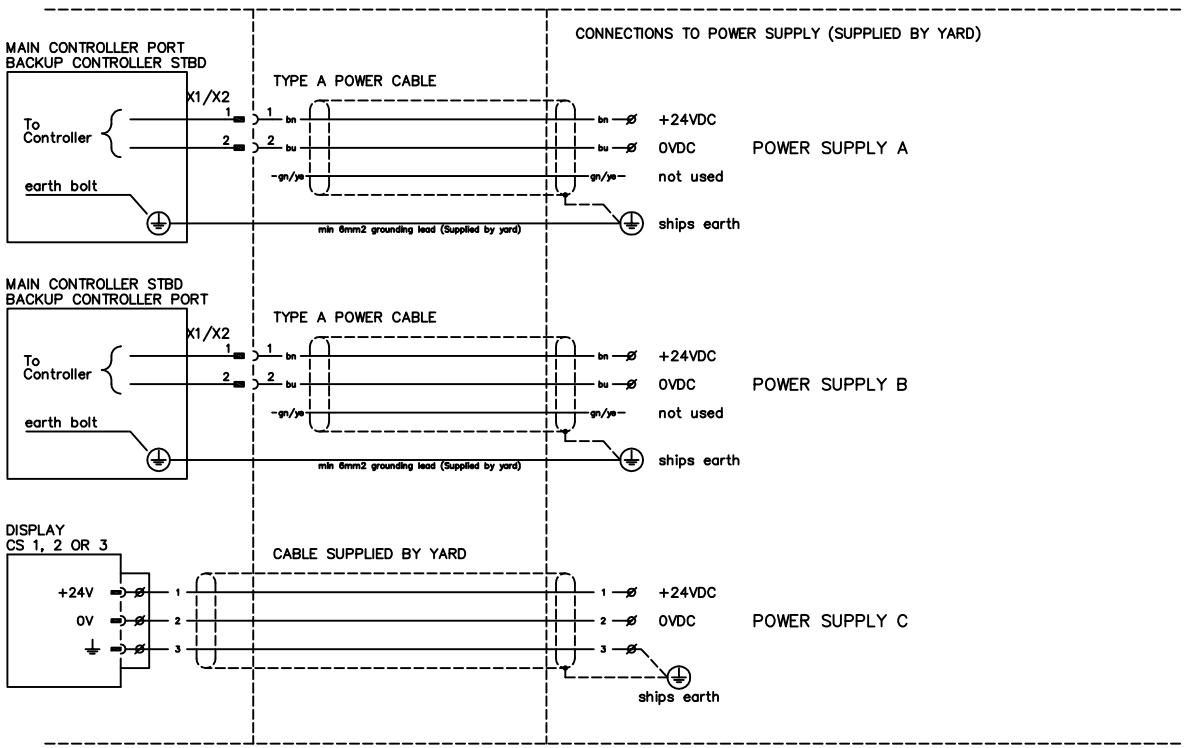
Origin. / Date: MMK Oct. 30th 2012
Scale: 1:1
Format: A3
Sheet: 1 of 1
Drawing no: DMN000201179
Revision: D

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Acess List
RR OY S Info. Class: LIMITED

Appendix D, Interface drawings

EXAMPLE CONNECTION



CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	Brown	24VDC Supply voltage Supply Requirements: Permissible voltage range :19–29VDC Hold up time (loss of power) :10ms at 24VDC Ripple : < 200mV RMS
Pin 2	Blue	0VDC
	Green/Yellow	Not used.

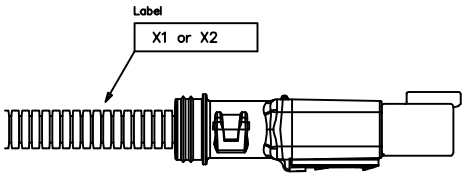
POWER CONSUMPTION		
A or B (CONTROLLERS)	FUSE MAX 10A Maximum power consumption: Typical power consumption:	 200W / Controller 25–80W / Controller
C (DISPLAYS)	FUSE MAX 6A Typical power consumption:	 20W / Display

NOTE:
Take Power Supply A and B (controllers) from sources with high priority. For example A from Port engine battery bank and B from Stbd engine battery bank. Take power supply C (display) from common source like service battery bank.

NOTE:
Example on the left side, shows installation with one display and two waterjets. Specific installation may have more or less equipments. If there is more than one display, all displays can take power from same source (C). If there is more than two waterjets, each waterjet should take power from own source. It is advisable to have a different power source for backup system if applicable.

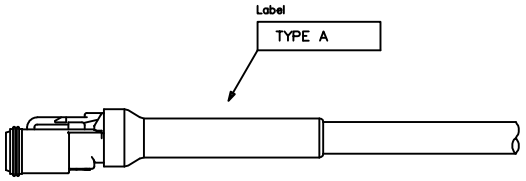
TYPE A POWER CABLE

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DT04–2P
Contacts: Gold plated

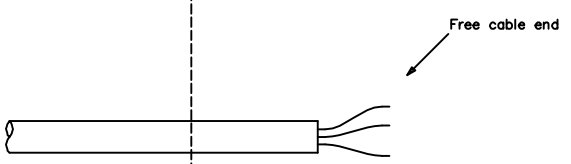
TYPE A POWER CABLE



CABLE CONNECTOR
Type: Deutsch DT06–2S
Contacts: Gold plated

CABLE
Type: Tyco C–Lite CL90–3Gx1.5–SO
Voltage class: 0.6/1kV
Temperature class: 90°C
Flame retarded: IEC 60332–1,–3
Cable jacket: Zerohal

CONNECTIONS TO POWER SUPPLY (SUPPLIED BY YARD)



Interface Description
Power Supply
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
ILMA 11-05-24	1:1	A3	1 of 2

Drawing no: DMN900000045
Revision: D

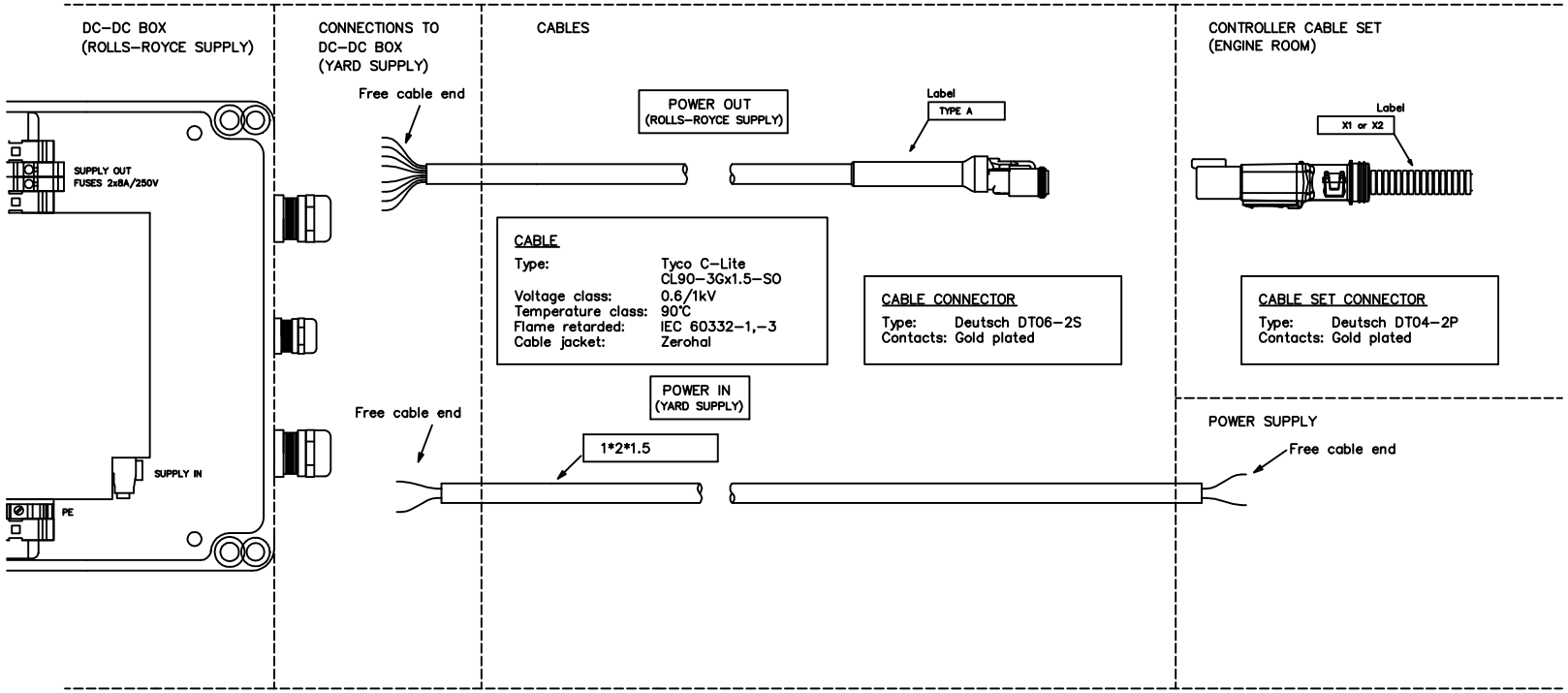
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RR OY © Info. Class: LIMITED

DC–DC BOX

OPTIONAL DEVICE!

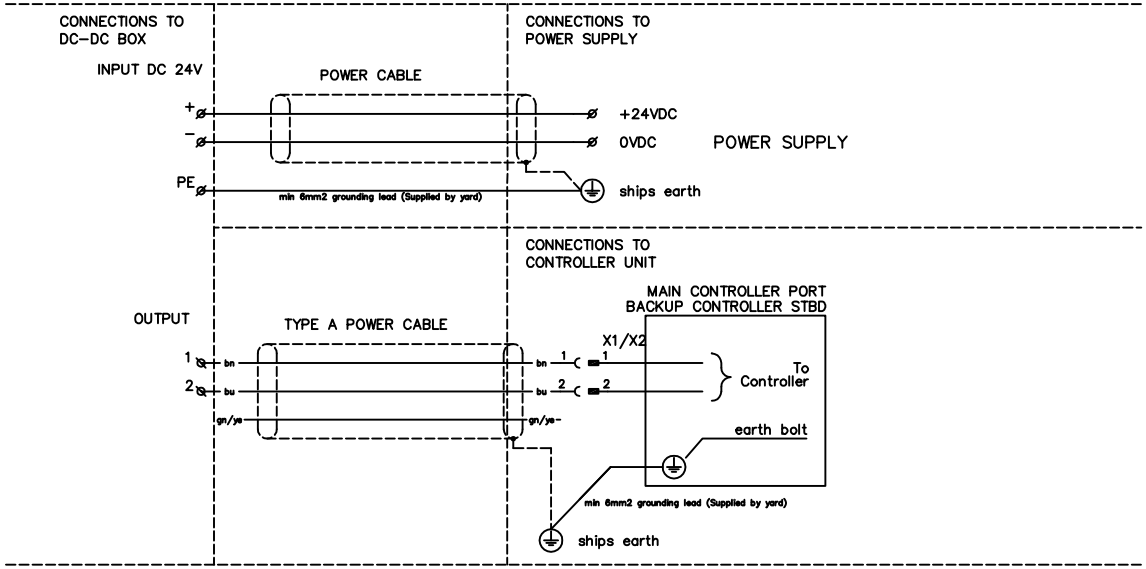
LAYOUT



CABLE LEAD–TROUGHS



CONNECTION



POWER SUPPLY SPECIFICATION	
24VDC Supply voltage	
Supply Requirements:	
Permissible voltage range	:19–29VDC
Hold up time (loss of power)	:10ms at 24VDC
Ripple	: < 200mV RMS
FUSE MAX 10A	
Maximum power consumption:	200W / Controller
Typical power consumption:	25–80W / Controller

Interface Description
Power Supply
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
ILMA 11-05-24	1:1	A3	2 of 2

Drawing no: DMN900000045 | Revision: D

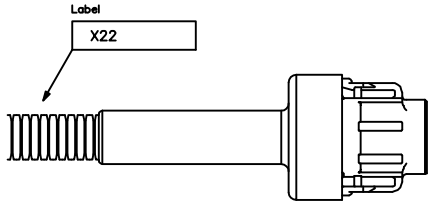
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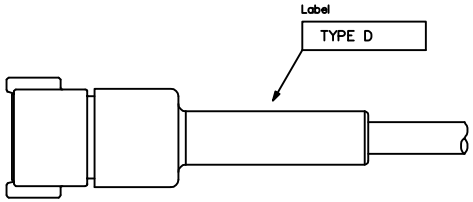
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DTM06-8SA
Contacts: Gold plated

TYPE D INTERFACE CABLE

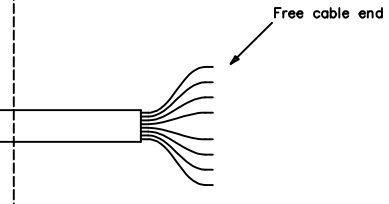


CABLE CONNECTOR
Type: Deutsch DTM04-8PA
Contacts: Gold plated

CABLE

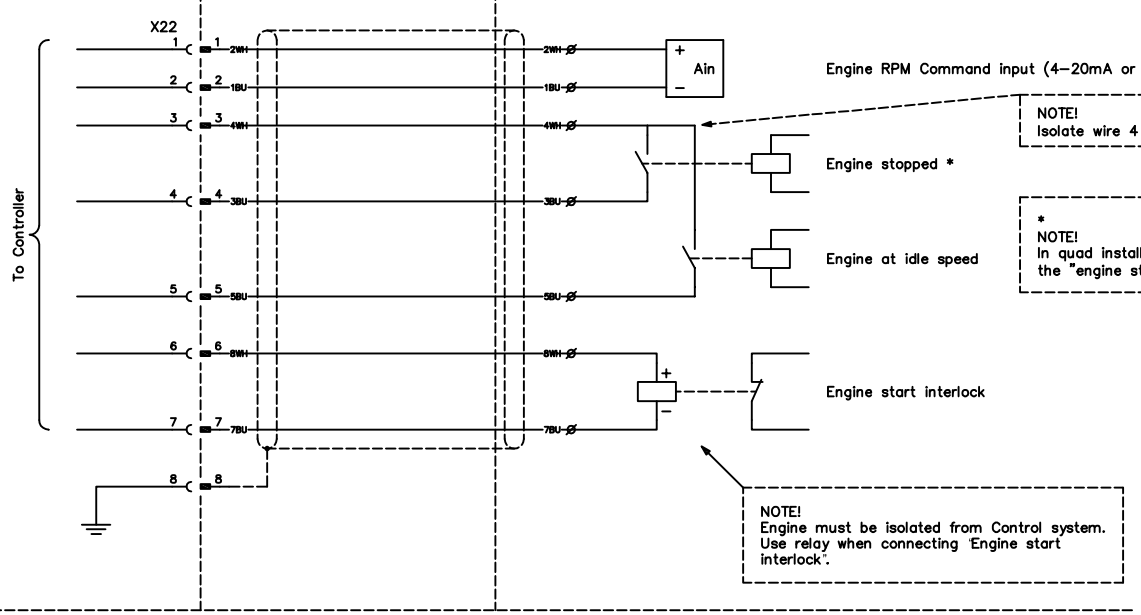
Type:	Tyco C-Lite CL90-4x2x0.5-P0
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO ENGINE (SUPPLIED BY YARD)



EXAMPLE CONNECTION

CONTROLLER CABLE SET (ENGINEROOM) | TYPE D INTERFACE CABLE | CONNECTIONS TO ENGINE (SUPPLIED BY YARD)



CONNECTION DETAILS

Connector	Wire	Signal description
Pin 1	2 white	RPM command + (Isolated 4–20mA or 0–5V) Signal can be scaled by the Rolls-Royce service engineer. E.g. 0.8V–3.0V where 0% command is 0.8V and 100% command is 3.0V). mA output: Load < 400ohm V output: Load > 5k ohm
Pin 2	1 blue	RPM command – (Isolated 4–20mA or 0–5V)
Pin 3	4 white	24VDC reference for inputs. If not used, isolate the wire by connecting to a terminal block for example.
Pin 4	3 blue	Potential free "engine stopped" input signal from engine. Closed when engine stopped. Optional to use (except in quad installation) but recommended to avoid alarms when engine is not running.
Pin 5	5 blue	Potential free "idle speed" input signal from engine to prevent clutch command when engine is not at the idle speed. Closed when idle speed. Optional to use. If input is not available interlock is made based on engine rpm command (output from control system).
Pin 6	8 white	"Engine start interlock" output signal from control system. 24VDC signal (max 0.5A). Active if clutch is closed or rpm command above 20%.
Pin 7	7 blue	0V reference for "Engine start interlock" output.
Pin 8	Shield	Cable shield (Do NOT connect at the engine side)
	6 white	Not used.

Interface Description
Engine
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
ILMA 11-05-05	1:1	A3	1 of 1

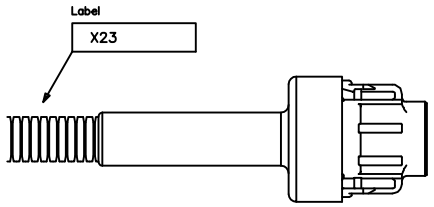
Drawing no: DMN900000050
Revision: D

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Access List
RR-OY-S Info Class: LIMITED

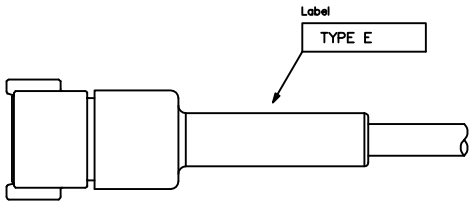
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DTM06-8SB
Contacts: Gold plated

TYPE E INTERFACE CABLE

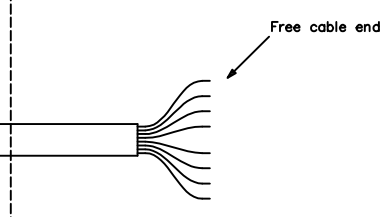


CABLE CONNECTOR
Type: Deutsch DTM04-8PB
Contacts: Gold plated

CABLE

Type:	Tyco C-Lite CL90-4x2x0.5-PO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO ENGINE (SUPPLIED BY YARD)

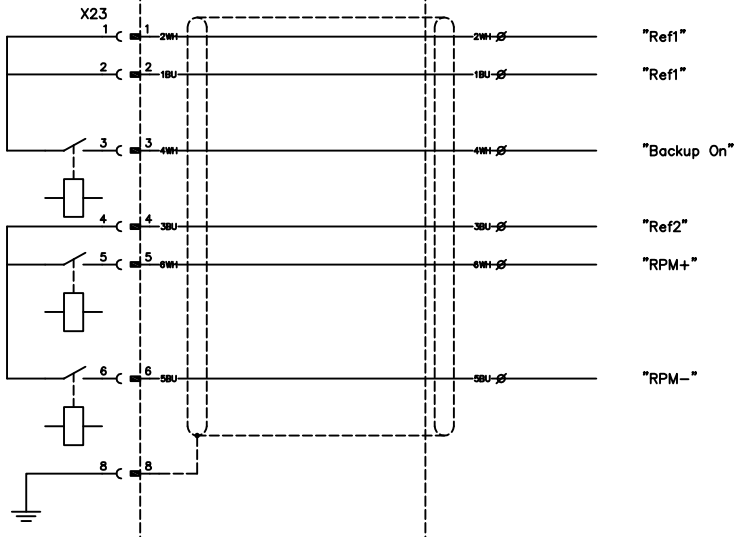


EXAMPLE CONNECTION

BACKUP RELAY BOX (ENGINEROOM)

TYPE E INTERFACE CABLE

CONNECTIONS TO ENGINE (SUPPLIED BY YARD)



CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	2 white	"Ref 1" Reference voltage for engine backup interface
Pin 2	1 blue	"Ref 1" Reference voltage for engine backup interface
Pin 3	4 white	Potential free "Backup On" relay-contact (max 5A). Closed contact = backup is active.
Pin 4	3 blue	"Ref 2" Reference voltage for engine backup interface
Pin 5	6 white	Potential free "RPM +" relay-contact (max 5A). Closed contact = increase RPM (while backup system is active).
Pin 6	5 blue	Potential free "RPM -" relay-contact (max 5A). Closed contact = decrease RPM (while backup system is active).
Pin 7	8 white	Not used.
-	7 blue	Not used
Pin 8	Shield	Cable shield (Do NOT connect at the engine side)

Interface Description
Engine - With Backup
RR Control System

Checked:
Approved:
Previous Drg:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
ToP Oct. 26th 2011	1:1	A3	1 of 1

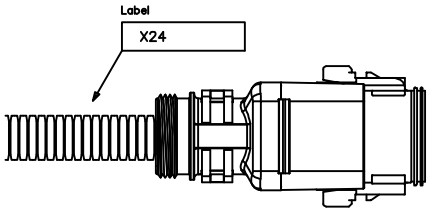
Drawing no: DMN900000088
Revision: D

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Access List
RR-OY-S Info Class: LIMITED

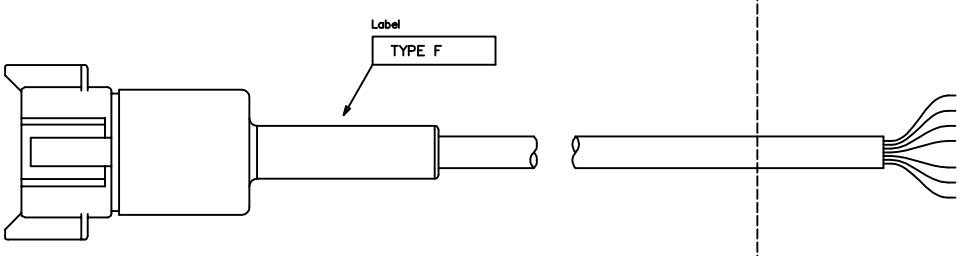
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DT06-8SA
Contacts: Gold plated

TYPE F INTERFACE CABLE

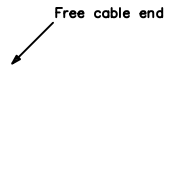


CABLE CONNECTOR
Type: Deutsch DT04-8PA
Contacts: Gold plated

CABLE

Type:	Tyco C-Lite CL90-7x1.5-SO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO REDUCTION GEAR (SUPPLIED BY YARD)



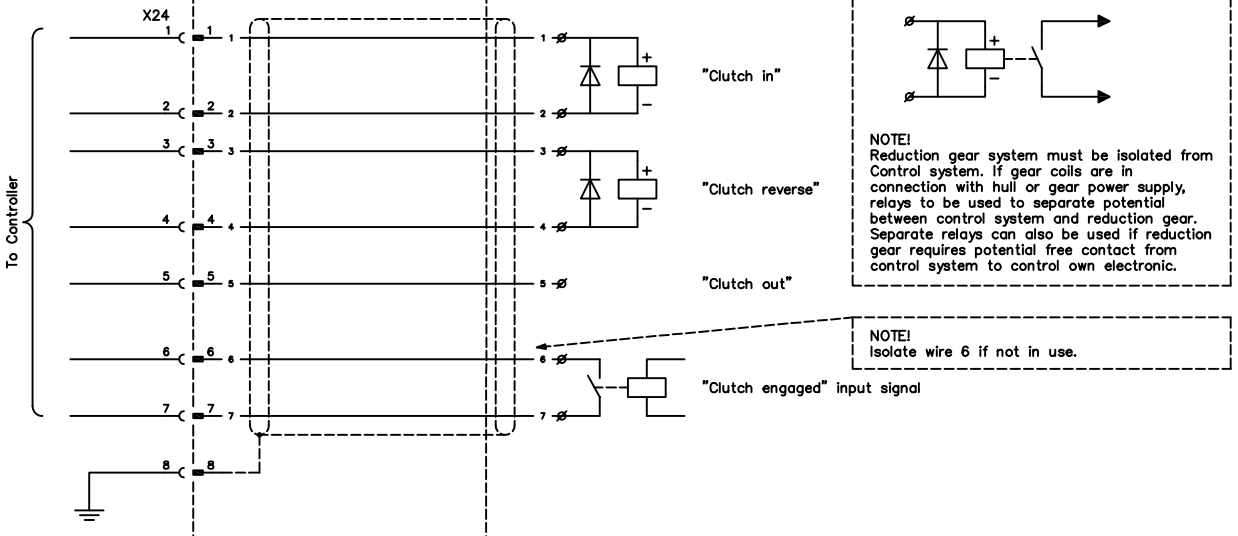
NOTE!
In order to engage the clutch, these conditions have to be met:
- Engine is running on idle speed (if "idle speed"-signal is not used, the rpm command must be < 10%)
- Reversing bucket is in the middle position (blocked if hydraulic pump is on jet)
- Thrust lever is < 20% ahead or astern
- Backflush is disengaged
- "Engine stopped" is not active (blocked if the signal is not in use)

EXAMPLE CONNECTION

CONTROLLER CABLE SET (ENGINEROOM)

TYPE F INTERFACE CABLE

CONNECTIONS TO REDUCTION GEAR (SUPPLIED BY YARD)



NOTE!
Reduction gear system must be isolated from Control system. If gear coils are in connection with hull or gear power supply, relays to be used to separate potential between control system and reduction gear. Separate relays can also be used if reduction gear requires potential free contact from control system to control own electronic.

NOTE!
Isolate wire 6 if not in use.

CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	1	"Clutch in" output signal from control system. 24VDC signal (max 1.0A). Use protection diode with inductive devices like coils
Pin 2	2	0VDC reference.
Pin 3	3	"Clutch reverse" (backflush) output signal from control system. 24VDC signal (max 1.0A). Use protection diode with inductive devices like coils
Pin 4	4	0VDC reference.
Pin 5	5	"Clutch out" output signal from control system. 24VDC signal (max 1.0A). Use protection diode with inductive devices like coils. This output is active if "Clutch in" and "Clutch reverse" outputs are not active.
Pin 6	6	24VDC reference for "Clutch engaged" input. If not used, isolate the wire by connecting to a terminal block for example.
Pin 7	7	Potential free "Clutch engaged" input signal from reduction gear to indicate that clutch is engaged (i.e. closed). Optional to use.
Pin 8	Shield	Cable shield (Do NOT Connect at the clutch side).

Interface Description
Clutch - No Backup
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
MMK Apr 18th 2013	1:1	A3	1 of 5

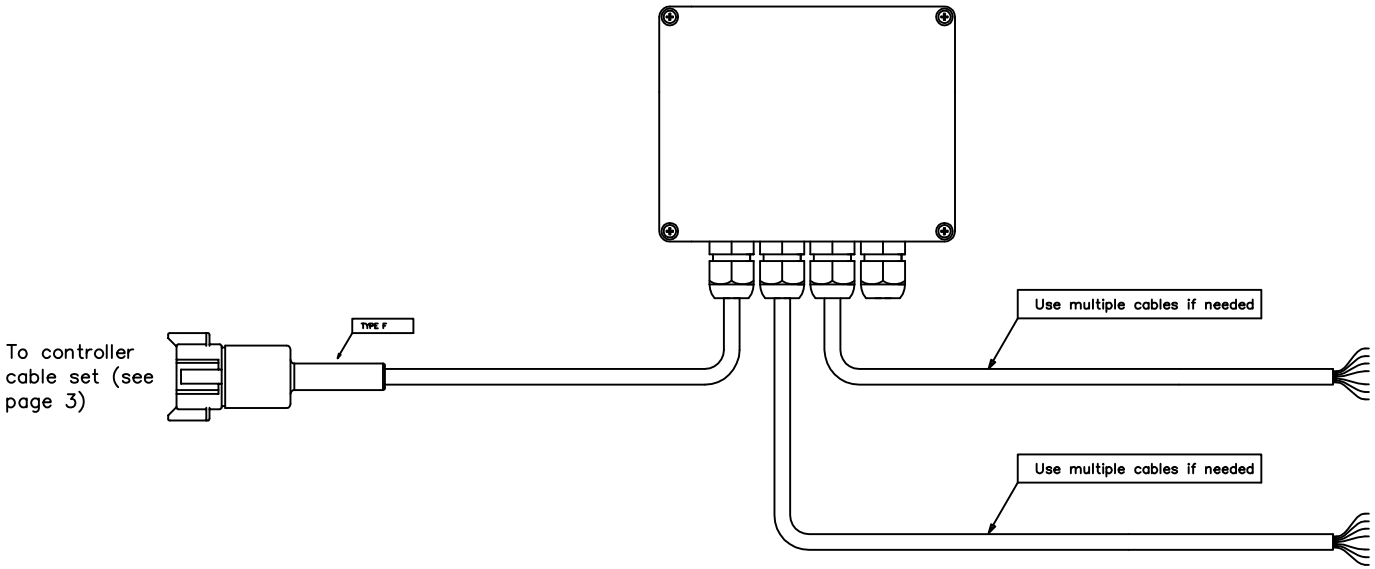
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Access Left
RR OY S Info. Class: LIMITED

CLUTCH INTERFACE BOX

OPTIONAL DEVICE!



Interface Description Clutch - No Backup RR Control System		Checked:	Previous Drg:	
		Approved:	Weight kg:	
Rolls-Royce Rolls-Royce OY Propulsion Kokkola	Origin. / Date: MMK Apr 18th 2013	Scale: 1:1	Format: A3	Sheet: 2 of 5
	Drawing no: DMN900000051			Revision: F

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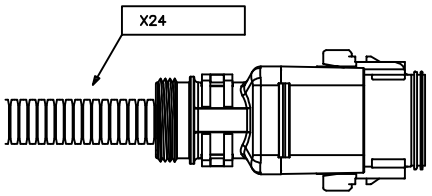
RR OY S Info. Class: LIMITED

CLUTCH INTERFACE BOX

OPTIONAL DEVICE!

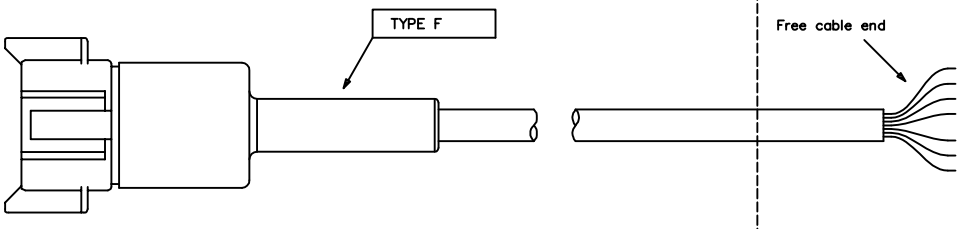
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DT06-8SA
Contacts: Gold plated

TYPE F INTERFACE CABLE (5m or 20m)



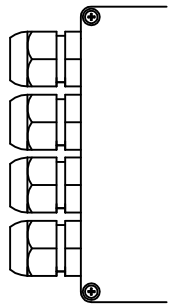
CABLE CONNECTOR
Type: Deutsch DT04-8PA
Contacts: Gold plated

CABLE

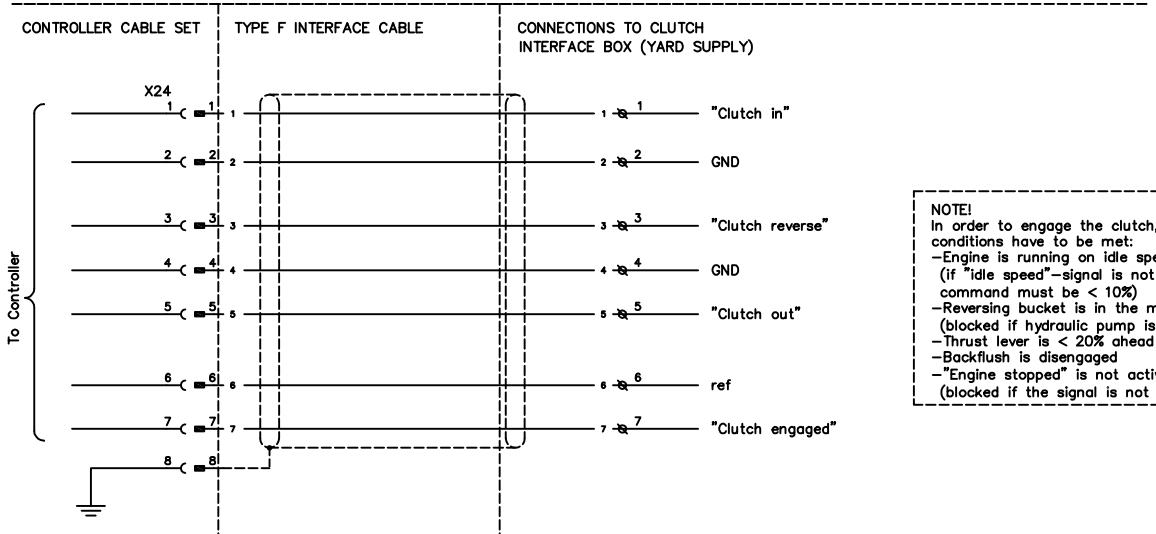
Type:	Tyco C-Lite CL90-7x1.5-SO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO CLUTCH INTERFACE BOX (YARD SUPPLY)

CLUTCH INTERFACE BOX (ROLLS-ROYCE SUPPLY)



CONNECTION



NOTE!
In order to engage the clutch, these conditions have to be met:
- Engine is running on idle speed (if "idle speed"-signal is not used, the rpm command must be < 10%)
- Reversing bucket is in the middle position (blocked if hydraulic pump is on jet)
- Thrust lever is < 20% ahead or astern
- Backflush is disengaged
- "Engine stopped" is not active (blocked if the signal is not in use)

CONNECTION DETAILS

Terminal	Wire	Signal description
1	1	"Clutch in" output signal from control system. 24VDC signal (max 1.0A).
2	2	0VDC reference.
3	3	"Clutch reverse" (backflush) output signal from control system. 24VDC signal (max 1.0A).
4	4	0VDC reference.
5	5	"Clutch out" output signal from control system. 24VDC signal (max 1.0A). This output is active if "Clutch in" and "Clutch reverse" outputs are not active.
6	6	24 VDC reference for "Clutch engaged" input signal.
7	7	Potential free "Clutch engaged" input signal from reduction gear to indicate that clutch is engaged (i.e. closed). Optional to use.
	Shield	Cable shield.

Interface Description
Clutch - No Backup
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Apr 18th 2013 | Scale: 1:1 | Format: A3 | Sheet: 3 of 5

Drawing no: DMN900000051 | Revision: F

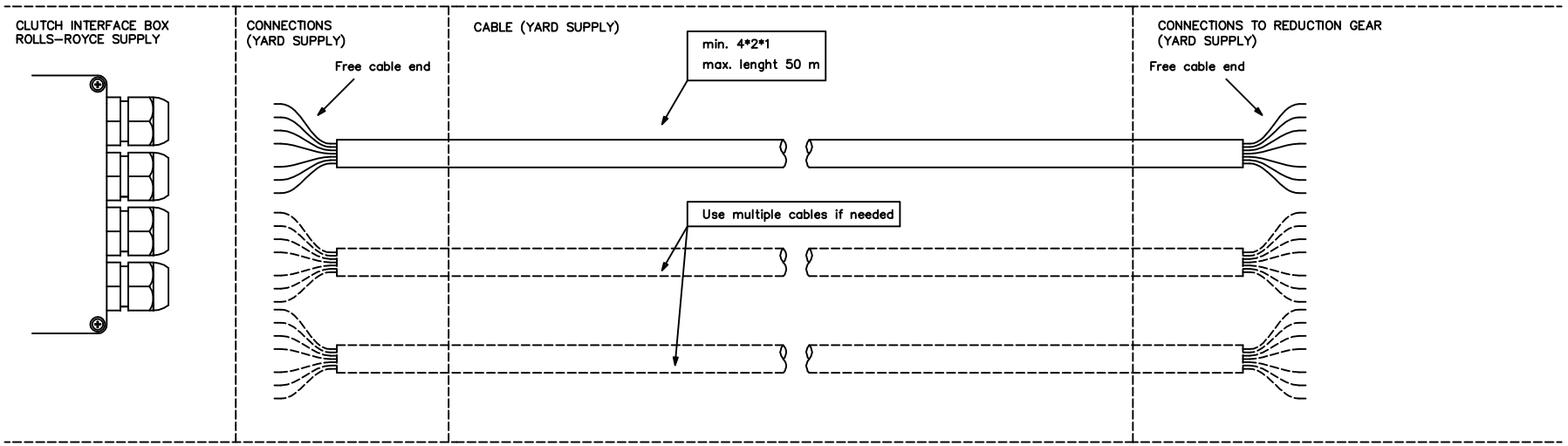
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Access Left
RR OY S Info Class: LIMITED

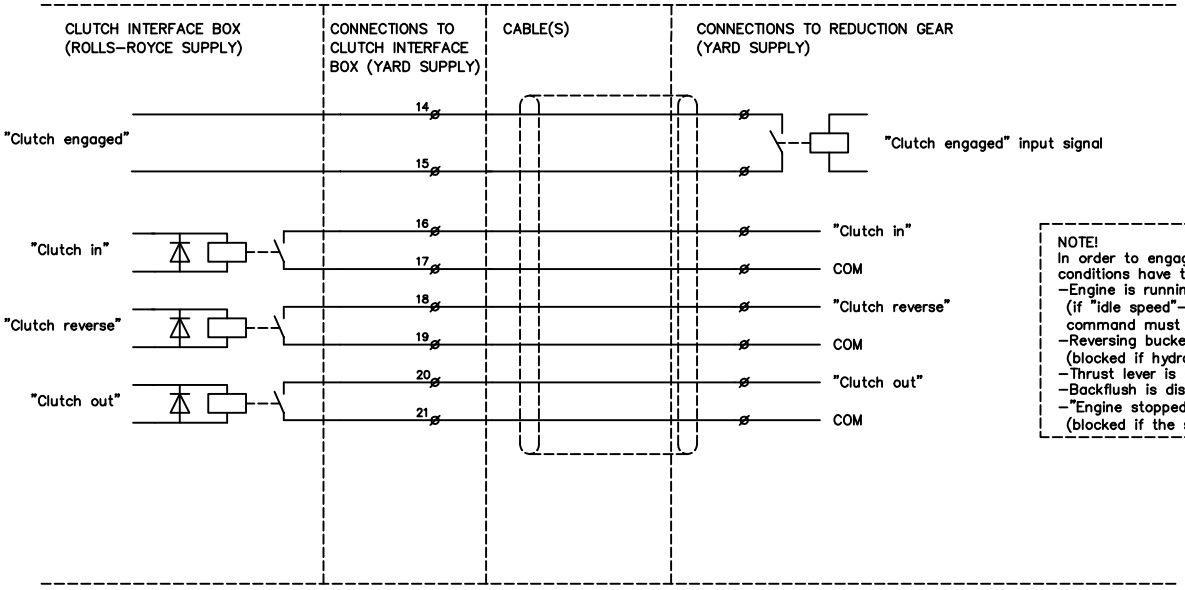
CLUTCH INTERFACE BOX

OPTIONAL DEVICE!

LAYOUT



CONNECTION



NOTE!
In order to engage the clutch, these conditions have to be met:
–Engine is running on idle speed (if "idle speed"–signal is not used, the rpm command must be < 10%)
–Reversing bucket is in the middle position (blocked if hydraulic pump is on jet)
–Thrust lever is < 20% ahead or astern
–Backflush is disengaged
–"Engine stopped" is not active (blocked if the signal is not in use)

CONNECTION DETAILS	
Terminal	Signal description
14	24 VDC reference for "Clutch engaged" input.
15	Potential free "Clutch engaged" input signal from reduction gear to indicate that clutch is engaged (i.e. closed). Optional to use.
16	Potential free contact (NO) for "Clutch in" output signal.
17	Common for "Clutch in" output signal.
18	Potential free contact (NO) for "Clutch reverse" (backflush) output signal.
19	Common for "Clutch reverse" (backflush) output signal.
20	Potential free contact (NO) for "Clutch out" output signal. The contact is closed if "clutch in" and "Clutch reverse" outputs are not active.
21	Common for "Clutch out" output signal.

Interface Description
Clutch - No Backup
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Apr 18th 2013 | Scale: 1:1 | Format: A3 | Sheet: 4 of 5
Drawing no: DMN900000051 | Revision: F

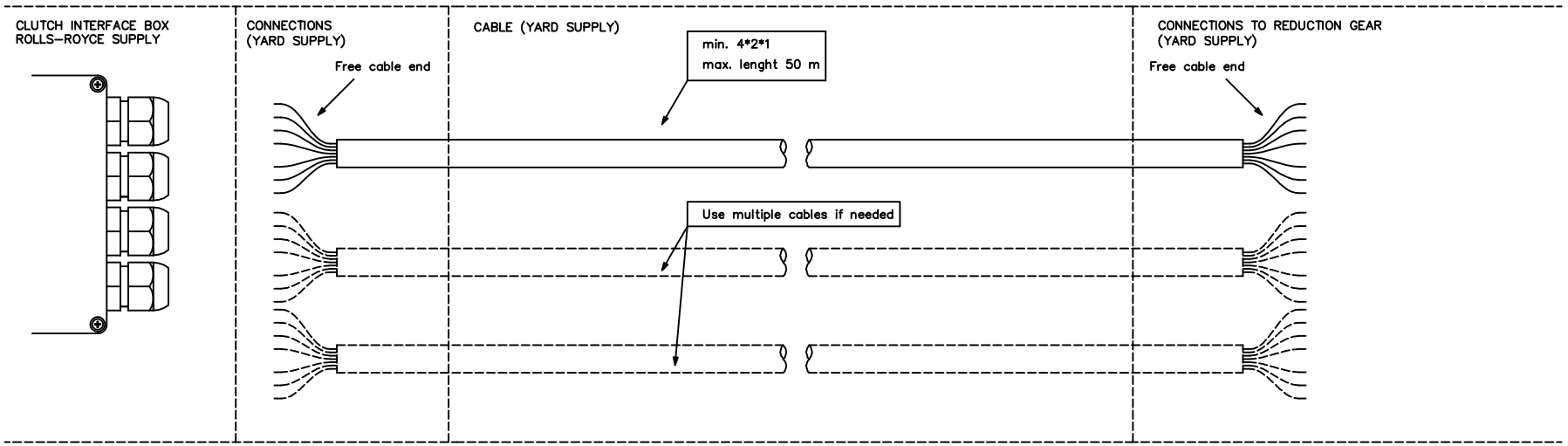
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RR OY S Info. Class: LIMITED

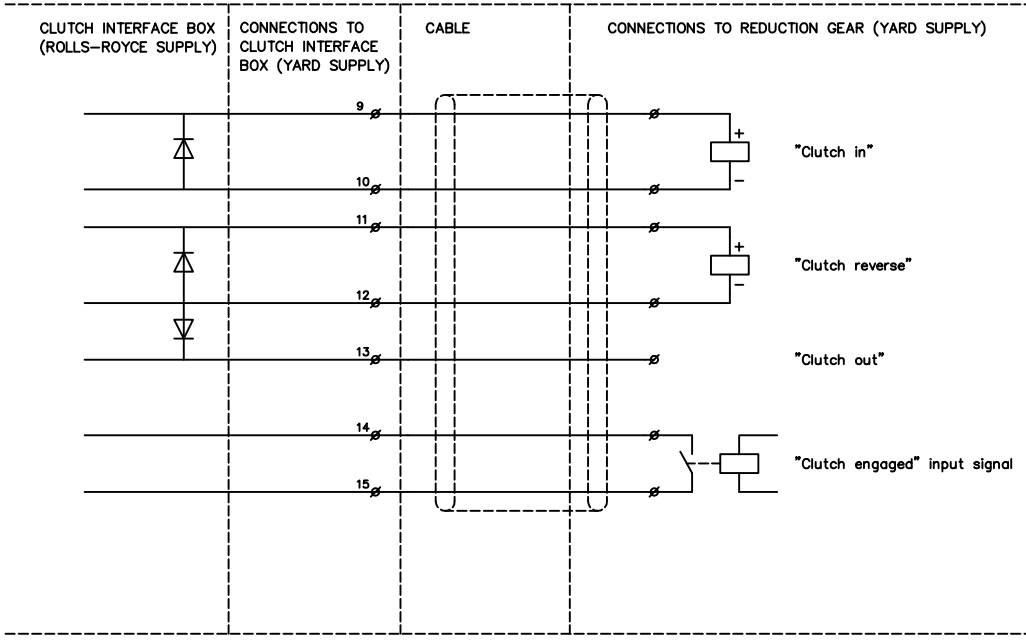
CLUTCH INTERFACE BOX

OPTIONAL DEVICE!

LAYOUT



CONNECTION



NOTE!
In order to engage the clutch, these conditions have to be met:
–Engine is running on idle speed
(if "idle speed"–signal is not used, the rpm command must be < 10%)
–Reversing bucket is in the middle position
(blocked if hydraulic pump is on jet)
–Thrust lever is < 20% ahead or astern
–Backflush is disengaged
–"Engine stopped" is not active
(blocked if the signal is not in use)

CONNECTION DETAILS	
Terminal	Signal description
9	"Clutch in" output signal from control system. 24VDC signal (max 1.0A).
10	Reference for "Clutch in" output signal.
11	"Clutch reverse" (backflush) output signal from control system. 24VDC signal (max 1.0A).
12	Reference for "Clutch reverse" output signal.
13	"Clutch out" output signal from control system. 24VDC signal (max 1.0A). This output is active if "Clutch in" and "Clutch reverse" outputs are not active.
14	24VDC reference for "Clutch engaged" input signal.
15	Potential free "Clutch engaged" input signal from reduction gear to indicate that clutch is engaged (i.e. closed). Optional to use.

Interface Description
Clutch - No Backup
RR Control System

Checked:
Approved:
Previous Drg:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

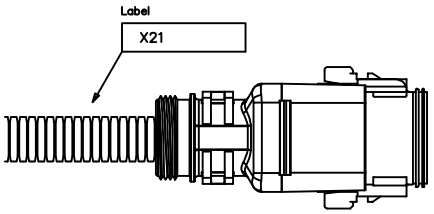
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Revision: F

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Access Lett
RR OY S Info. Class: LIMITED

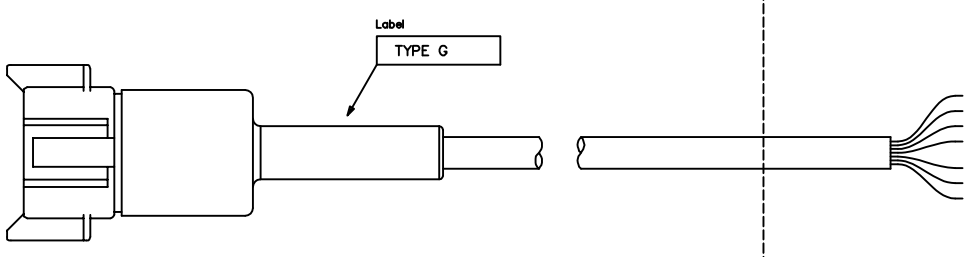
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DT06-12SA
Contacts: Gold plated

TYPE G INTERFACE CABLE



CABLE CONNECTOR
Type: Deutsch DT04-12PA
Contacts: Gold plated

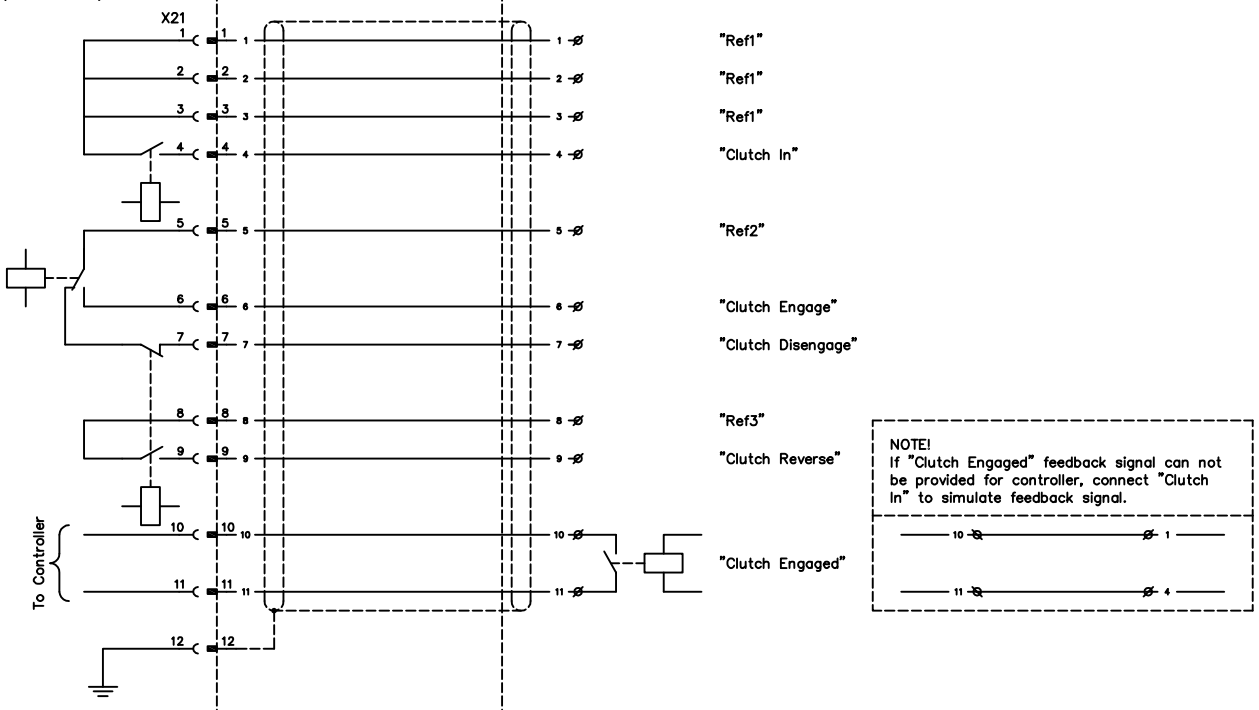
CABLE

Type:	Tyco C-Lite CL90-12X1,0-SO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO REDUCTION GEAR (SUPPLIED BY YARD)

EXAMPLE CONNECTION

BACKUP RELAY BOX (ENGINEROOM) | TYPE G INTERFACE CABLE | CONNECTIONS TO REDUCTION GEAR (SUPPLIED BY YARD)



NOTE!
If "Clutch Engaged" feedback signal can not be provided for controller, connect "Clutch In" to simulate feedback signal.

CONNECTION DETAILS

Connector	Wire	Signal description
Pin 1	1	"Ref1" 24VDC reference.
Pin 2	2	"Ref1" 24VDC reference.
Pin 3	3	"Ref1" 24VDC reference.
Pin 4	4	Potential free "Clutch In" relay-contact to simulate "Clutch Engaged" feedback signal. Closed contact = clutch is engaged.
Pin 5	5	"Ref2" Reference voltage for clutch interface.
Pin 6	6	Potential free "Clutch Engage" relay-contact (max 5.0A). Closed contact = engage clutch. Use protection diode with inductive devices like coils.
Pin 7	7	Potential free "Clutch Disengage" relay-contact (max 5.0A). Closed contact = disengage clutch. Active if "Clutch Engage" and "Backflush" are not active.
Pin 8	8	"Ref3" Reference voltage for clutch interface.
Pin 9	9	Potential free "Clutch reverse" (backflush) relay-contact (max 5.0A). Closed contact = backflush is active. Use protection diode with inductive devices like coils
Pin 10	10	24VDC reference.
Pin 11	11	Potential free "Clutch Engaged" feedback signal from reduction gear to indicate that clutch is engaged (i.e. closed). If feedback signal is not available from reduction gear, use "Clutch In" signal as described on the left.
Pin 12	Shield	Cable shield (Do NOT Connect at the clutch side).

Interface Description
Clutch - With Backup
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: ToP Oct. 26th 2011 | Scale: 1:1 | Format: A3 | Sheet: 1 of 1
Drawing no: DMN900000089 | Revision: C

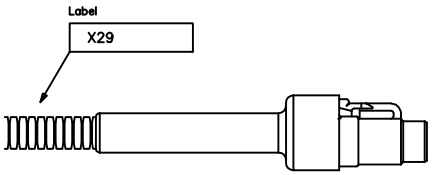
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Addit list

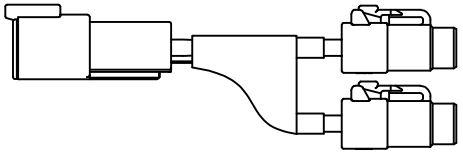
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)

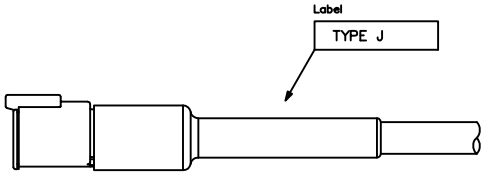


CABLE SET CONNECTOR
Type: Deutsch DTM06-4S
Contacts: Gold plated

ADAPTER Type J-J RRM900002396 (Option)



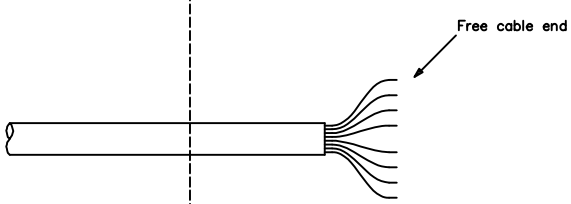
TYPE J INTERFACE CABLE



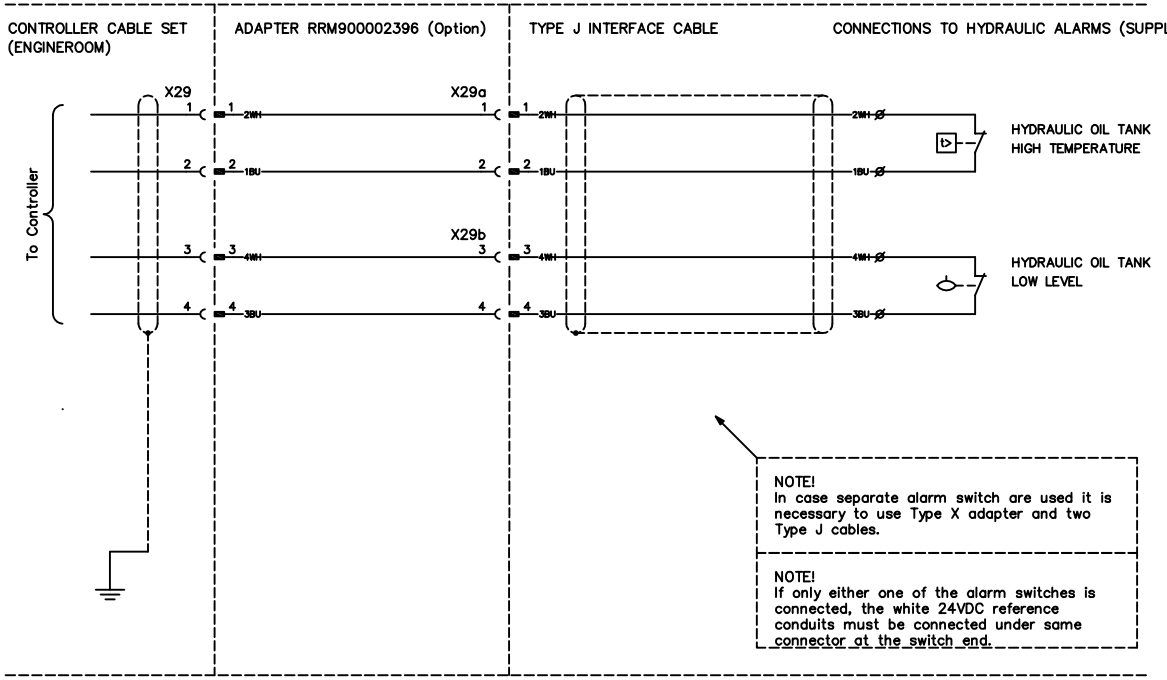
CABLE CONNECTOR
Type: Deutsch DTM04-4P
Contacts: Gold plated

CABLE
Type: Tyco C-Lite CL90-4x2x0.5-PO
Voltage class: 0.6/1kV
Temperature class: 90°C
Flame retarded: IEC 60332-1,-3
Cable jacket: Zerohal

CONNECTIONS TO HYDRAULIC ALARMS (SUPPLIED BY YARD)



EXAMPLE CONNECTION



NOTE!
In case separate alarm switch are used it is necessary to use Type X adapter and two Type J cables.

NOTE!
If only either one of the alarm switches is connected, the white 24VDC reference conduits must be connected under same connector at the switch end.

CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	2 white	24V reference for hydraulic oil tank high temperature switch.
Pin 2	1 blue	Potential free "Hydraulic Oil Temperature" input signal. Open when high temperature. Optional.
Pin 3	4 white	24V reference for hydraulic oil tank low level switch.
Pin 4	3 blue	Potential free "Hydraulic Oil Low Level" input signal. Open when low level. Optional.

Interface Description
Hydraulic oil tank
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
ToP Sept. 15th 2011	1:1	A3	1 of 1

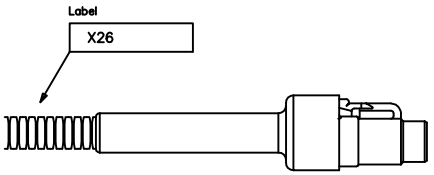
Drawing no: DMN900000054 | Revision: B

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Access List
RR OY S Info Class: LIMITED

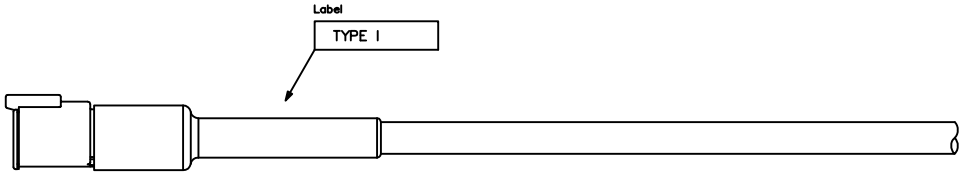
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DTM06-6S
Contacts: Gold plated

TYPE I INTERFACE CABLE

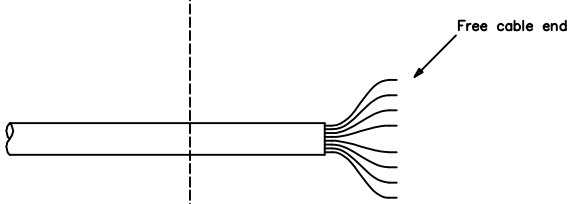


CABLE CONNECTOR
Type: Deutsch DTM04-6P
Contacts: Gold plated

CABLE

Type:	Tyco C-Lite CL90-4x2x0.5-PO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO BEARING HOUSING (SUPPLIED BY YARD)

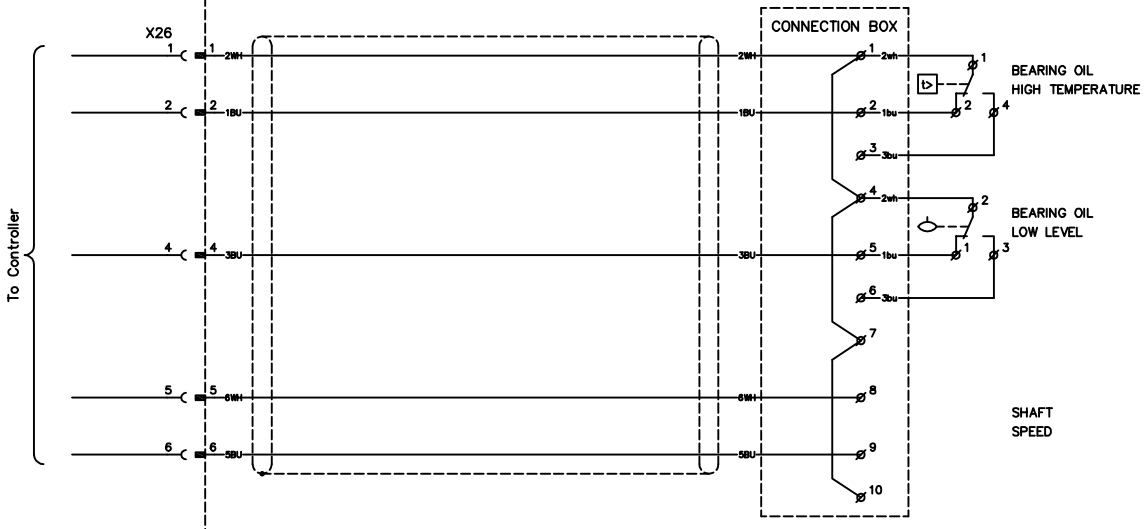


EXAMPLE CONNECTION

CONTROLLER CABLE SET (ENGINEROOM)

TYPE I INTERFACE CABLE

CONNECTIONS TO BEARING HOUSING (SUPPLIED BY YARD)



CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	2 white	24V reference for bearing oil high temperature switch.
Pin 2	1 blue	Potential free "Bearing Oil Temperature" input signal. Open when high temperature. Optional.
Pin 4	3 blue	Potential free "Bearing Oil Level" input signal. Open when low level. Optional.
Pin 5	6 white	Potential free "Shaft Speed" input signal. Frequency signal. Optional.
Pin 6	5 blue	0V reference for shaft speed frequency input.

Interface Description
Bearing housing
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
ToP Nov. 9th 2011	1:1	A3	1 of 1

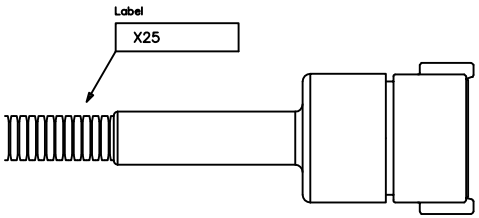
Drawing no: DMN900000101
Revision: B

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Access List
RR OY:S Info. Class: LIMITED

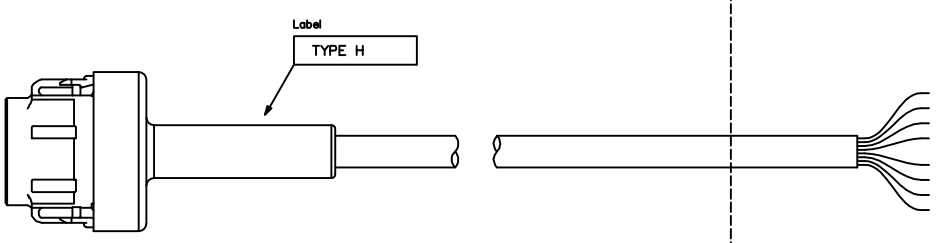
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DTM04-12PA
Contacts: Gold plated

TYPE H INTERFACE CABLE



CABLE CONNECTOR
Type: Deutsch DTM06-12SA
Contacts: Gold plated

CABLE

Type:	Tyco C-Lite CL90-4x2x0.5-PO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO AUTOPILOT (SUPPLIED BY YARD)

CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	2 white	Analog autopilot command + (isolated ±10V or 4-20mA) where: -10V or 4mA correspond full PORT command 0V or 12mA correspond nozzle in the middle +10V or 20mA correspond full STBD command Input is isolated.
Pin 2	1 blue	Analog autopilot command - (isolated ±10V or 4-20mA)
Pin 3	4 white	24V reference voltage for inputs.
Pin 4	3 blue	Potential free " Autopilot Activate" input. Control system follows commands from autopilot when input is activated. If input is open control system follows commands from active steering device.
Pin 5	6 white	Potential free "Steer PORT" input. Solenoid drive type interface for autopilots which has two digital outputs to control nozzle movement. Control system moves nozzle to PORT direction as long as the input is active.
Pin 6	5 blue	Potential free "Steer STBD" input. Solenoid drive type interface for autopilots which has two digital outputs to control nozzle movement. Control system moves nozzle to STBD direction as long as the input is active.
Pin 7	8 white	Autopilot active relay output (max 0.5A)
Pin 8	7 blue	Autopilot active relay output (max 0.5A)
Pin 9		Not used.
Pin 10		Not used.
Pin 11		Not used.
Pin 12	Shield	Cable shield (Do NOT connect at the autopilot side)

Note!
Autopilot shall be connected to PORT OUTER controller unit only.

Note!
Optional input types. Use either analog type or solenoid drive type autopilot interface. Type of the used interface must be activated by the Rolls-Royce service engineer. Please see connection examples from page two.

Note!
When using solenoid drive type autopilot interface, response time, when driving nozzles from side to side, is determined by a parameter. This parameter is adjusted in comissioning by Rolls-Royce service engineer.

Note!
Contact is closed when autopilot is active and control system is in autopilot mode.

Interface Description
Autopilot
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

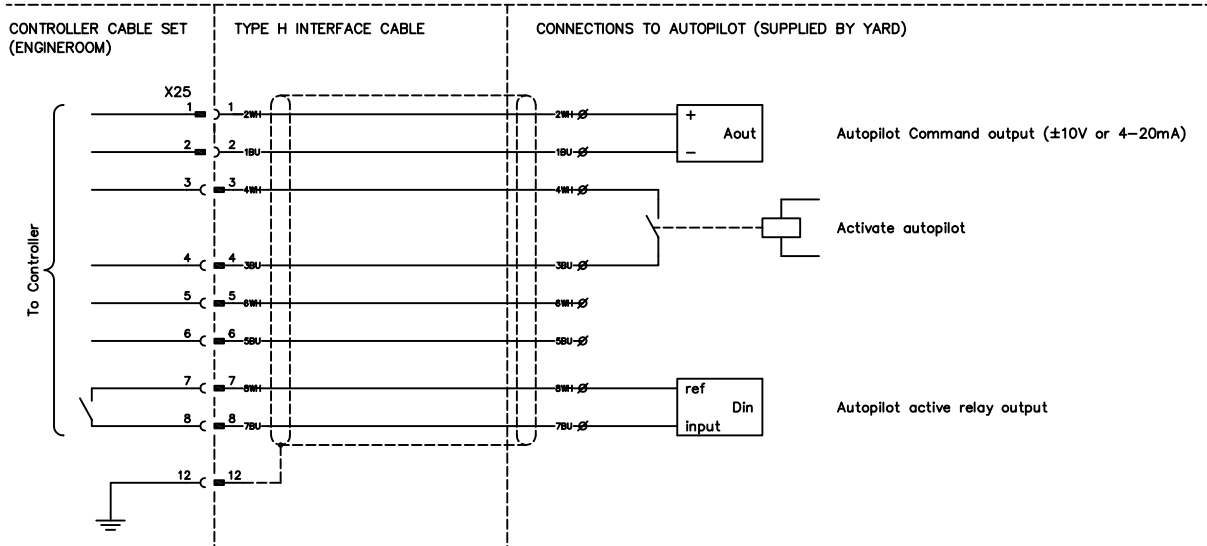
Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: ILMA 11-05-31 | Scale: 1:1 | Format: A3 | Sheet: 1 of 2
Drawing no: DMN900000052 | Revision: E

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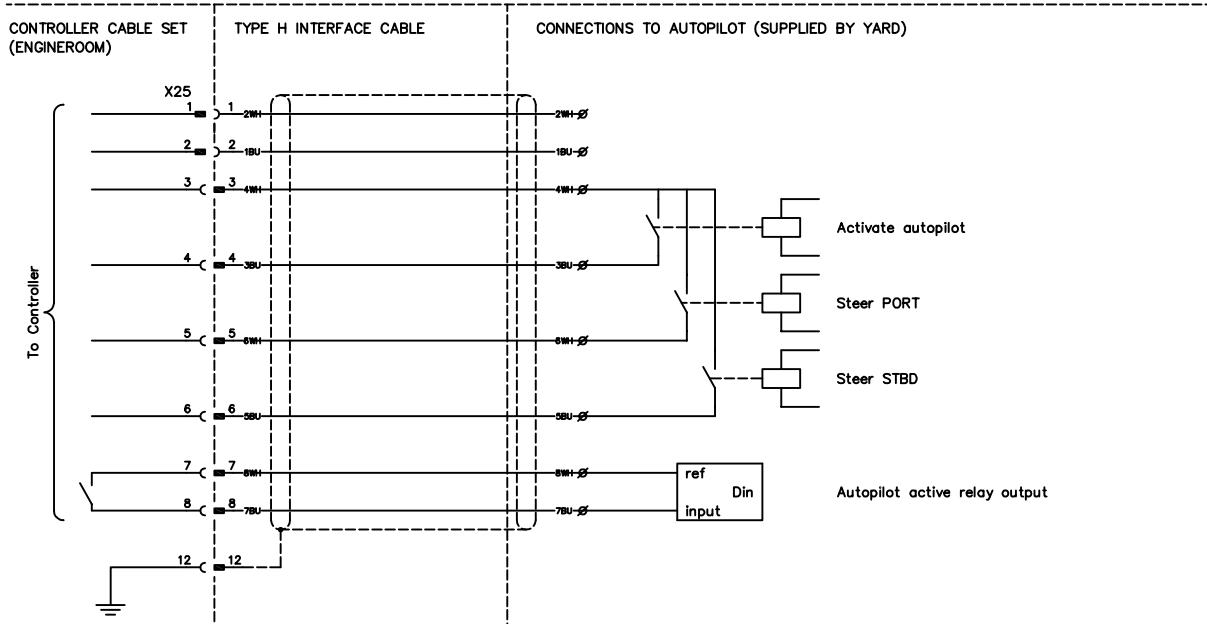
Access List
RR CF Strict. class: LIMITED

EXAMPLE CONNECTION – ANALOG INTERFACE



NOTE!
Autopilot must be isolated from control system. Use potential free contacts when connecting digital input signals.

EXAMPLE CONNECTION – DIGITAL INTERFACE ("SOLENOID DRIVE")



NOTE!
Autopilot must be isolated from control system. Use potential free contacts when connecting digital input signals.

Note!
If "solenoid drive" type interface is used, autopilot need own feedback sensor. This feedback sensor is delivered by autopilot supplier. Install this feedback sensor to PORT nozzle cylinder. Only one feedback sensor is needed, jets are synchronized by the control system.

Interface Description
Autopilot
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: ILMA 11-05-31 | Scale: 1:1 | Format: A3 | Sheet: 2 of 2

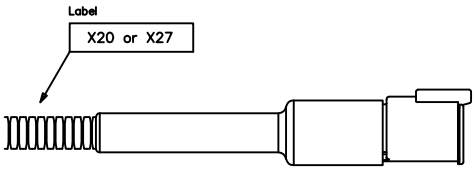
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Access. List
RR OY Strict. class: LIMITED

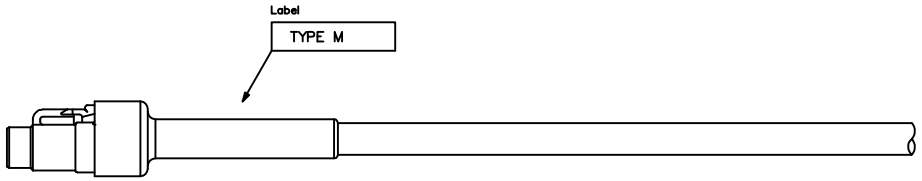
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DTM04-4P
Contacts: Gold plated

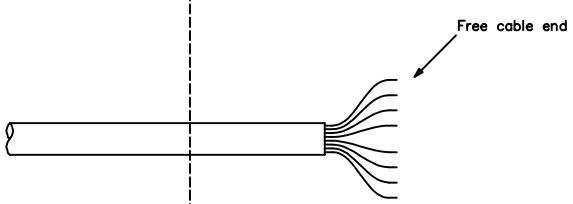
TYPE M INTERFACE CABLE



CABLE CONNECTOR
Type: Deutsch DTM06-4S
Contacts: Gold plated

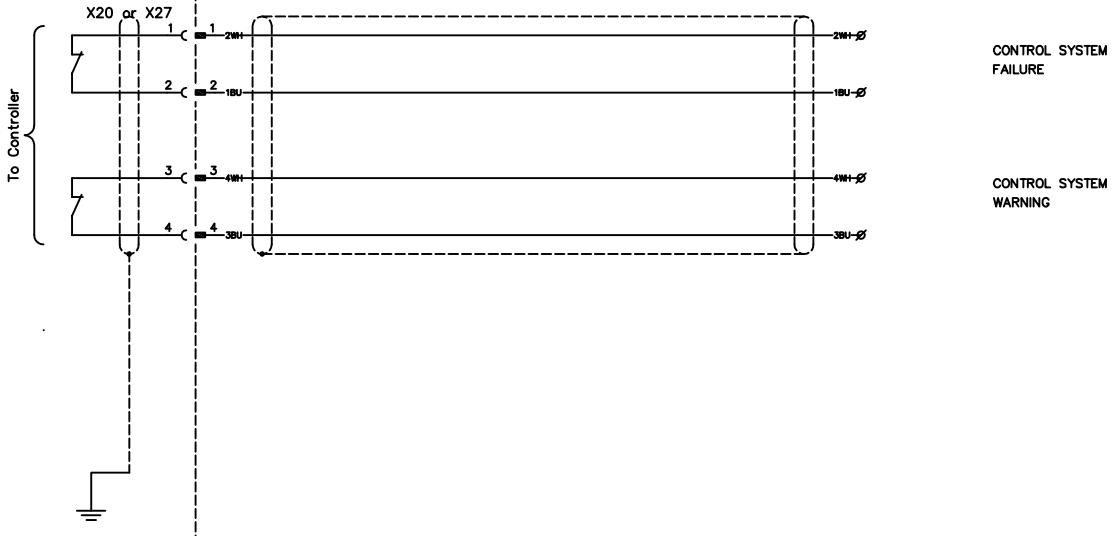
CABLE
Type: Tyco C-Lite CL90-2x2x0.5-PO
Voltage class: 0.6/1kV
Temperature class: 90°C
Flame retarded: IEC 60332-1,-3
Cable jacket: Zerohal

CONNECTIONS TO ALARMS DISPLAY (SUPPLIED BY YARD)



EXAMPLE CONNECTION

CONTROLLER CABLE SET (ENGINEROOM) | TYPE M INTERFACE CABLE | CONNECTIONS TO ALARMS DISPLAY (SUPPLIED BY YARD)



CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	2 white	Voltage reference for control system failure relay.
Pin 2	1 blue	Potential free "Control System Failure" relay output signal. Open when failure. Optional.
Pin 3	4 white	Voltage reference for control system warning relay.
Pin 4	3 blue	Potential free "Control System Warning" relay output signal. Open when warning. Optional.

Interface Description
Control system alarms
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

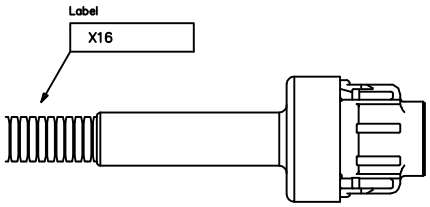
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Drawing no: DMN900000053 | Revision: B

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Access List
RR-OY-S Info Class: LIMITED

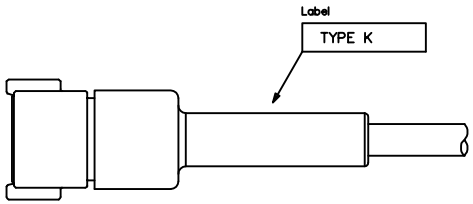
LAYOUT

CONTROLLER CABLE SET (ENGINEROOM)



CABLE SET CONNECTOR
Type: Deutsch DTM06-8SC
Contacts: Gold plated

TYPE K INTERFACE CABLE

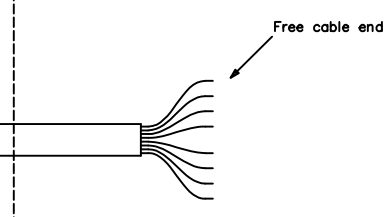


CABLE CONNECTOR
Type: Deutsch DTM04-8PC
Contacts: Gold plated

CABLE

Type:	Tyco C-Lite CL90-4x2x0.5-PO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332-1,-3
Cable jacket:	Zerohal

CONNECTIONS TO ENGINE (SUPPLIED BY YARD)

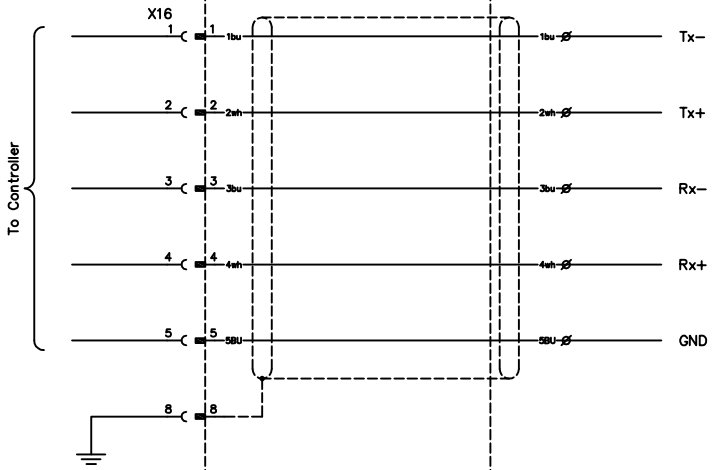


EXAMPLE CONNECTION

CONTROLLER CABLE SET (ENGINEROOM)

TYPE K INTERFACE CABLE

CONNECTIONS TO VDR (SUPPLIED BY YARD)



CONNECTION DETAILS		
Connector	Wire	Signal description
Pin 1	1 blue	RS-422 Tx-
Pin 2	2 white	RS-422 Tx+
Pin 3	3 blue	RS-422 Rx-
Pin 4	4 white	RS-422 Rx+
Pin 5	5 blue	GND
Pin 6	6 white	Not used.
Pin 7	7 blue	Not used.
	8 white	Not used.
Pin 8	Shield	Cable shield (Do NOT connect)

Interface Description
RS422 serial connection
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date:	Scale:	Format:	Sheet:
ToP Nov. 24th 2011	1:1	A3	1 of 1

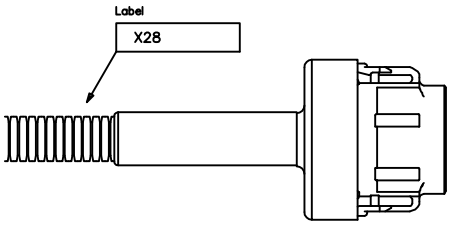
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Revision: B

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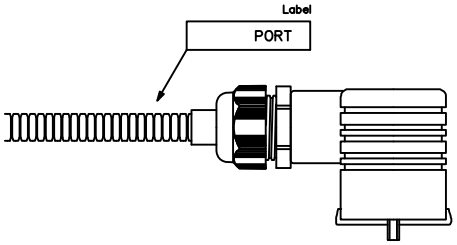
Access List
RR-OY-S Info Class: LIMITED

LAYOUT

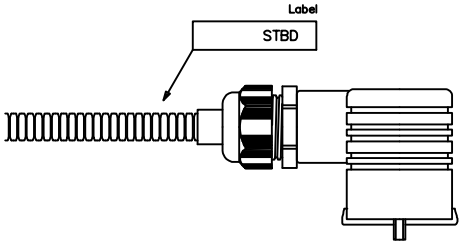
CONTROLLER CABLE SET (INTERFACE CABLING)



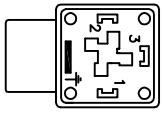
CABLE CONNECTOR
Type: Deutsch DTM06–12SA
Contacts: Gold plated



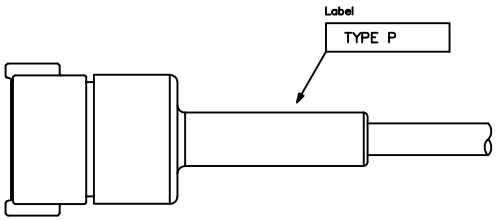
–Hirschmann GDM3016BK



–Hirschmann GDM3016BK



TYPE P INTERFACE CABLE

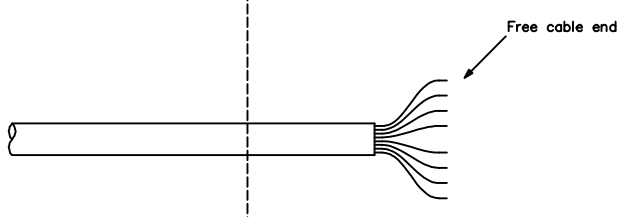


CABLE SET CONNECTOR
Type: Deutsch DTM04–12PA
Contacts: Gold plated

CABLE

Type:	Tyco C–Lite CL90–4x2x0.5–PO
Voltage class:	0.6/1kV
Temperature class:	90°C
Flame retarded:	IEC 60332–1,–3
Cable jacket:	Zerohal

CONNECTIONS TO BOWTHRUSTER (SUPPLIED BY YARD)



CONNECTION DETAILS

Connector	Wire	Signal description
X28, Pin 1	2 white	Analog Bow Thruster command + (isolated ±10V or 4–20mA) where: –10V or 4mA correspond full PORT command 0V or 12mA correspond zero thrust +10V or 20mA correspond full STBD command output is isolated.
X28, Pin 2	1 blue	Analog Bow Thruster command – (isolated ±10V or 4–20mA)
X28, Pin 3	4 white	24V reference voltage for inputs.
X28, Pin 4	3 blue	Potential free "Bow Thruster Ready" input. Control system submits commands for bow thruster when input is activated. If input is open all control system commands are zero.
X28, Pin 5	6 white	24V reference voltage for inputs.
X28, Pin 6	5 blue	Potential free "Bow Thruster Alarm" input. Control system sets all commands to zero and creates a Bow Thruster failure alarm when input is activated.
X28, Pin 7	8 white	"Start Bow Thruster" relay output COMMON (max 0.5A)
X28, Pin 8	7 blue	"Start Bow Thruster" relay output NO (max 0.5A) Contact is closed when Bow Thruster is requested to operate.
X28, Pin 9		Not used.
X28, Pin 10		Not used.
X28, Pin 11		Not used.
X28, Pin 12	Shield	Cable shield (Do NOT connect at the Bow Thruster side)

CONNECTION DETAILS

Connector	Contact	Signal description
PORT	1	PWM–signal for operating proportional hydraulic valve when using hydraulic Bow Thruster (used duty cycle area can be adjusted by Rolls–Royce service engineer) max. current = 1.5 A PWM frequency = 150 Hz
PORT	2	GND
PORT	3	nc

CONNECTION DETAILS

Connector	Contact	Signal description
STBD	1	PWM–signal for operating proportional hydraulic valve when using hydraulic Bow Thruster (used duty cycle area can be adjusted by Rolls–Royce service engineer) max. current = 1.5 A PWM frequency = 150 Hz
STBD	2	GND
STBD	3	nc

Note!
Optional output types. Use either analog type or PWM type Bow Thruster interface.
Please see connection examples from pages two and three.

Interface Description
Bow Thruster
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

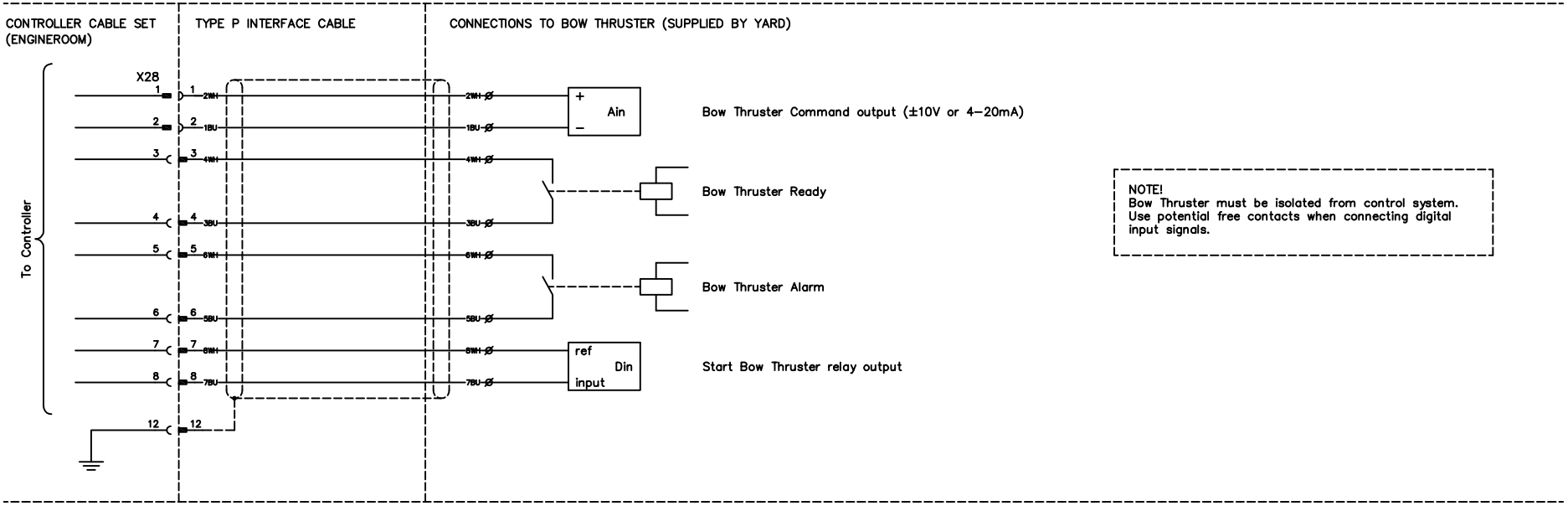
Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Nov. 6th 2012 | Scale: 1:1 | Format: A3 | Sheet: 1 of 3
Drawing no: DMN000200086 | Revision: B

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Access list
RR OY S. Into. Class: LIMITED

EXAMPLE CONNECTION – ANALOG INTERFACE



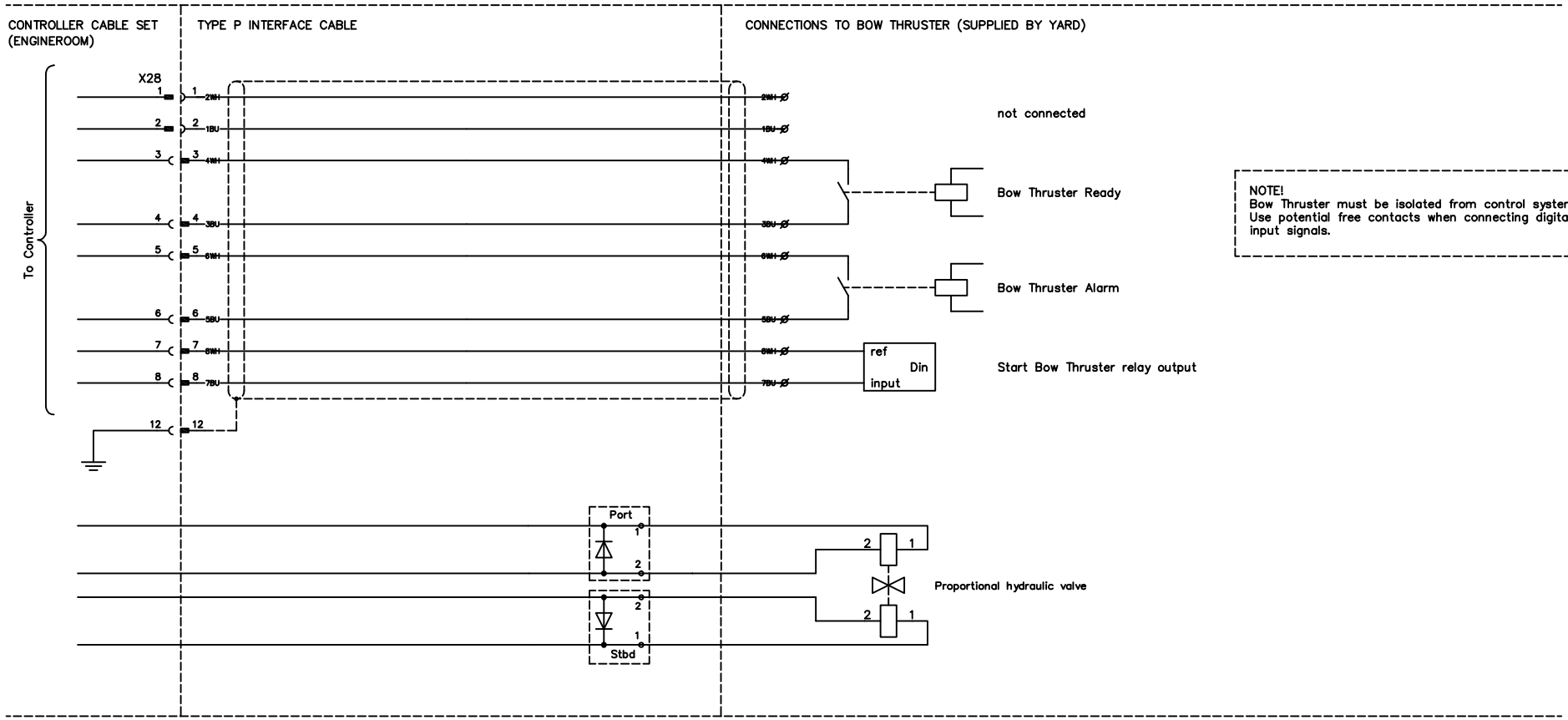
NOTE!
Bow Thruster must be isolated from control system.
Use potential free contacts when connecting digital input signals.

Interface Description Bow Thruster RR Control System		Checked:	Previous Drg:		
		Approved:	Weight kg:		
Rolls-Royce Rolls-Royce OY Propulsion Kokkola	Origin. / Date: MMK Nov. 6th 2012	Scale: 1:1	Format: A3	Sheet: 2 of 3	
	Drawing no: DMN000200086			Revision: B	

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Access Lev:
RR OY:S Info. Class:
LIMITED

EXAMPLE CONNECTION – HYDRAULIC INTERFACE



NOTE!
Bow Thruster must be isolated from control system.
Use potential free contacts when connecting digital input signals.

Interface Description
Bow Thruster
RR Control System

Checked:
Approved:
Previous Drg:
Weight kg:

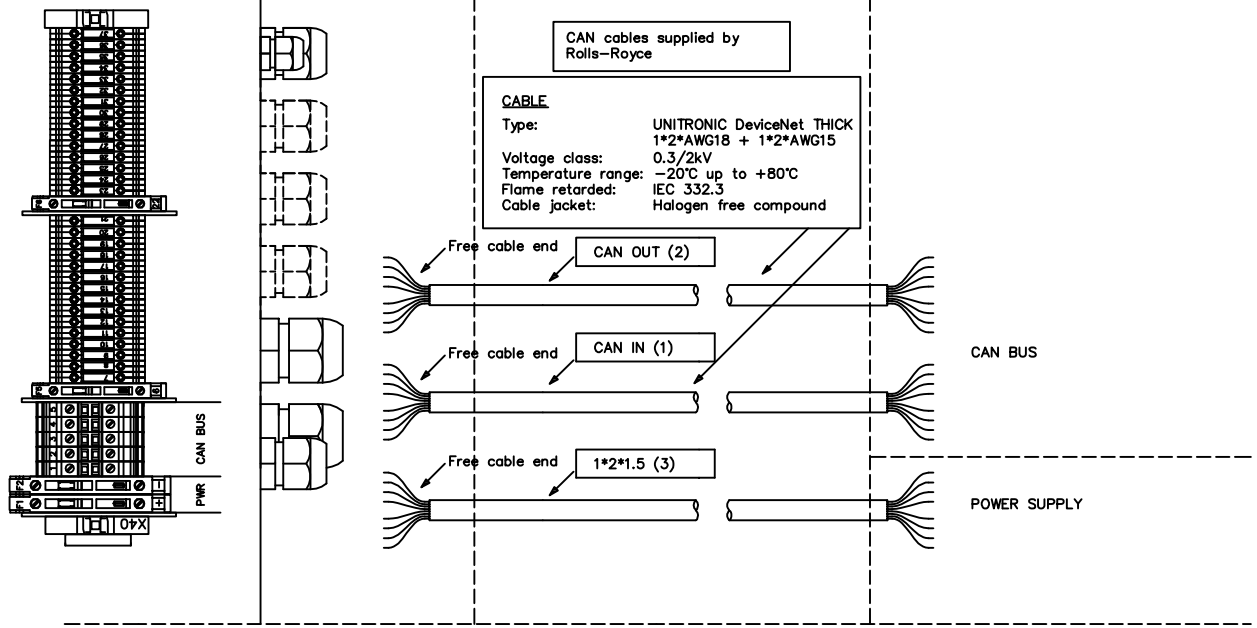
Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

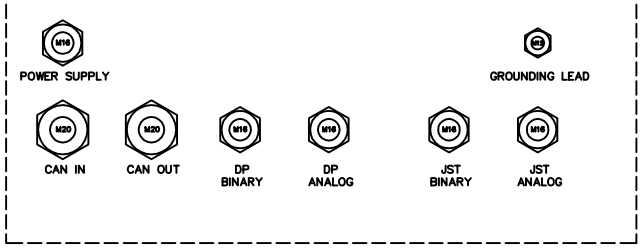
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Access Lev:
RR OY:S Info. Class: LIMITED

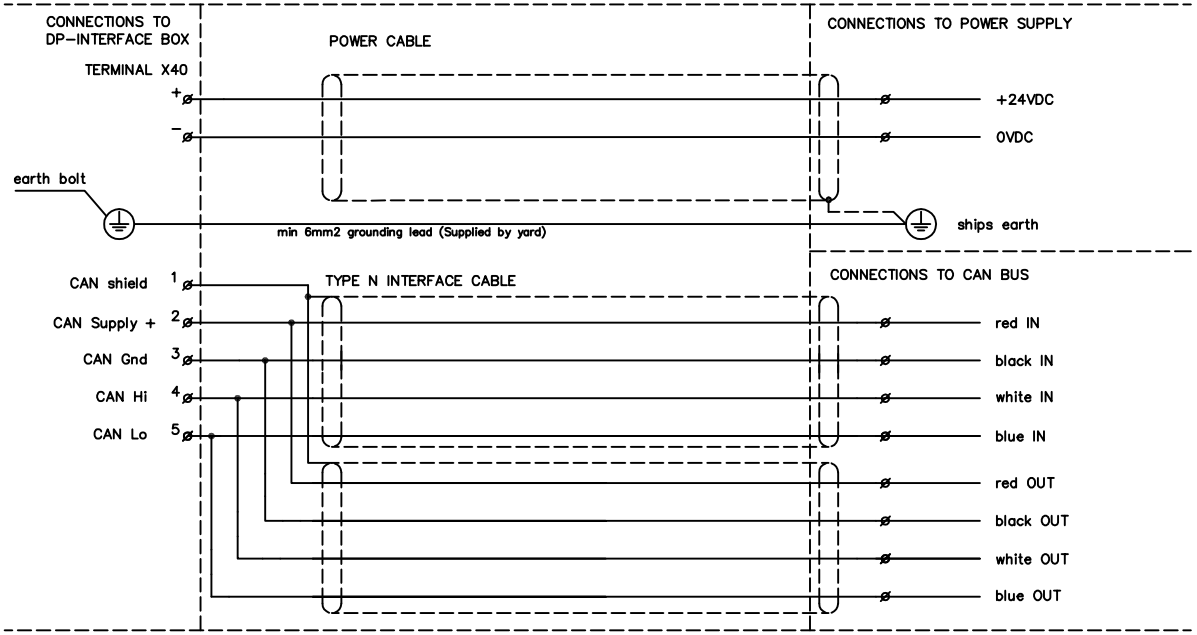
LAYOUT





NOTE!
All cables except CAN cables
and all connections are
to be supplied by yard.

EXAMPLE CONNECTION – CAN BUS AND POWER SUPPLY



CONNECTION DETAILS		
Terminal X40.	Cable	Signal description
+	3	24VDC Supply voltage Supply Requirements: Permissible voltage range :19–29VDC Hold up time (loss of power) :10ms at 24VDC Ripple :< 200mV RMS Current consumption :typically 1A max. 2A
–	3	0VDC
1	1	Shield IN
	2	Shield OUT
2	1	red IN
	2	red OUT
3	1	black IN
	2	black OUT
4	1	white IN
	2	white OUT
5	1	blue IN
	2	blue OUT

Interface Description
DP interface
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Apr 3rd 2014 | Scale: | Format: A3 | Sheet: 1 of 6

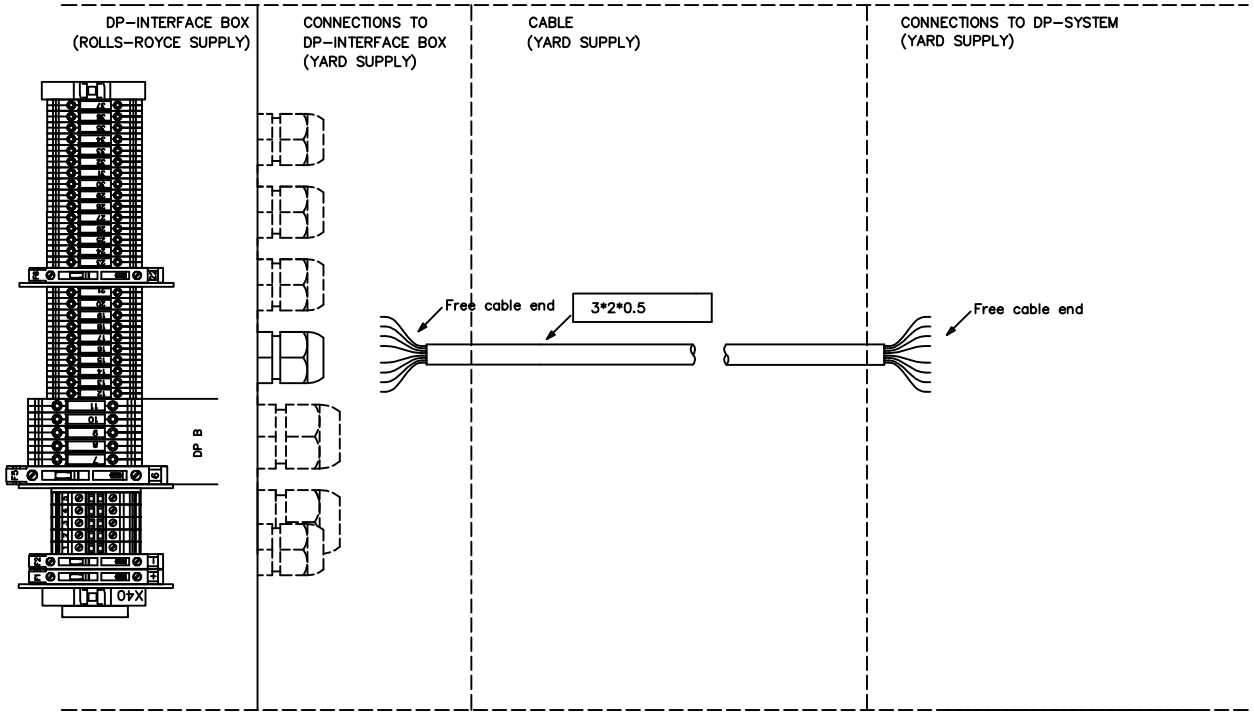
Drawing no: DMN000221019 | Revision: A

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Access List

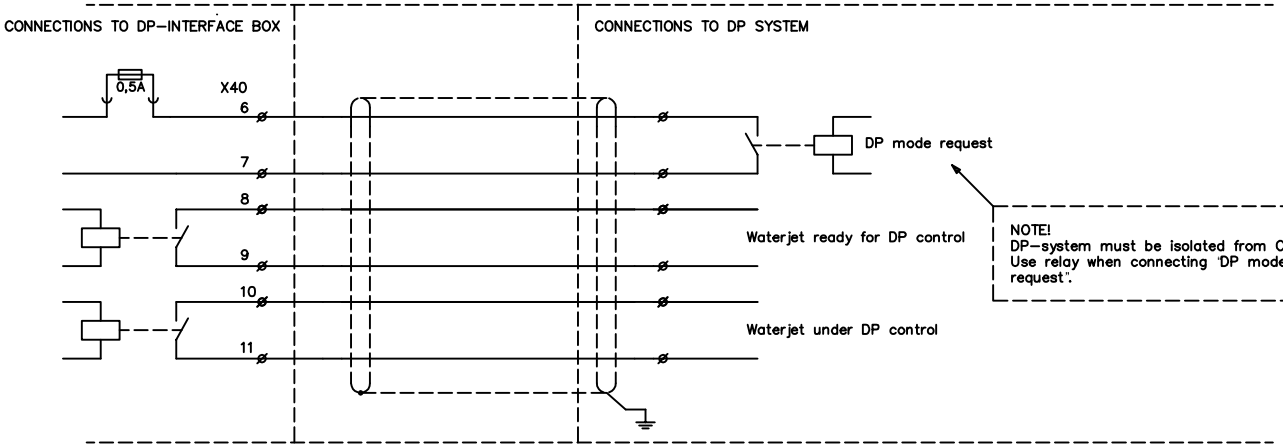
RR-OY-S Proc. Class: LIMITED

LAYOUT



NOTE!
All cables except CAN cables
and all connections are
to be supplied by yard.

EXAMPLE CONNECTION – DP BINARY INTERFACE



NOTE!
DP–system must be isolated from Controller.
Use relay when connecting "DP mode request".

CONNECTION DETAILS	
Terminal X40.	Signal description
6	Reference 24 VDC
7	DP–mode request from DP–system
8	Waterjet ready for DP control, NO (max. 5A)
9	Waterjet ready for DP control, ref (max. 5A)
10	Waterjet under DP control, NO (max. 5A)
11	Waterjet under DP control, ref (max. 5A)

Interface Description
DP interface
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Apr 3rd 2014 | Scale: | Format: A3 | Sheet: 2 of 6

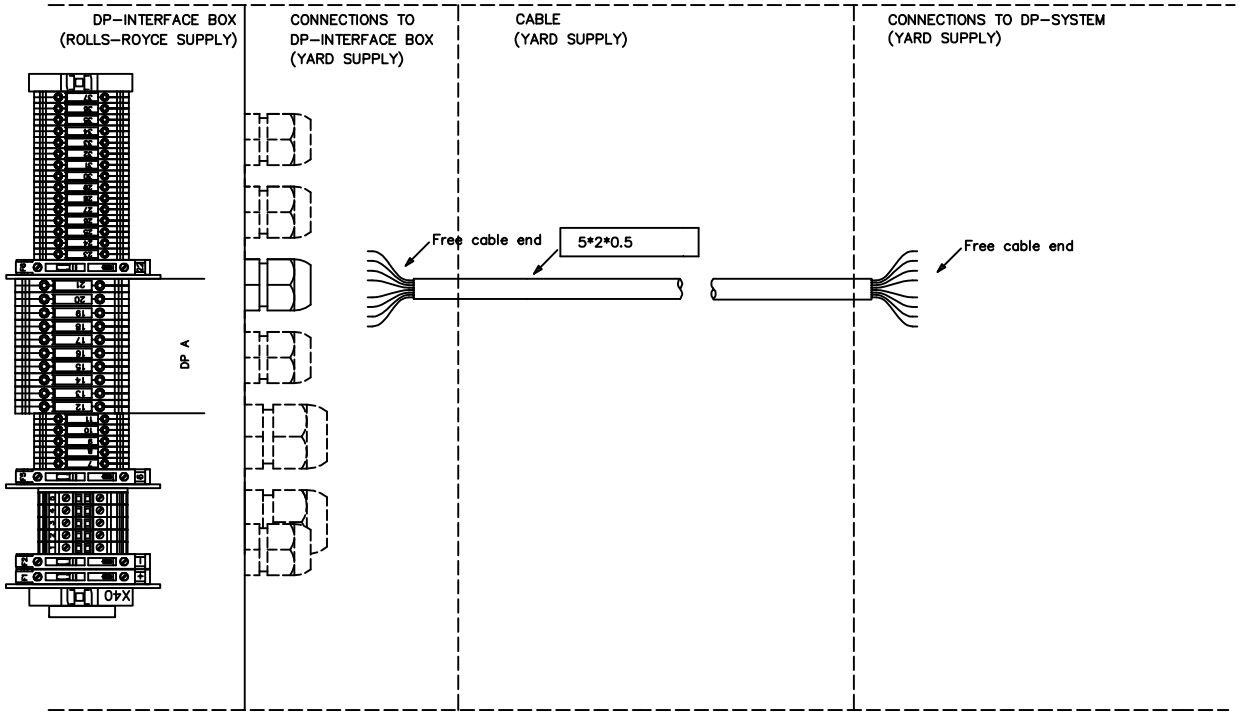
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Access List

RR-OY-S Proj. Class: LIMITED

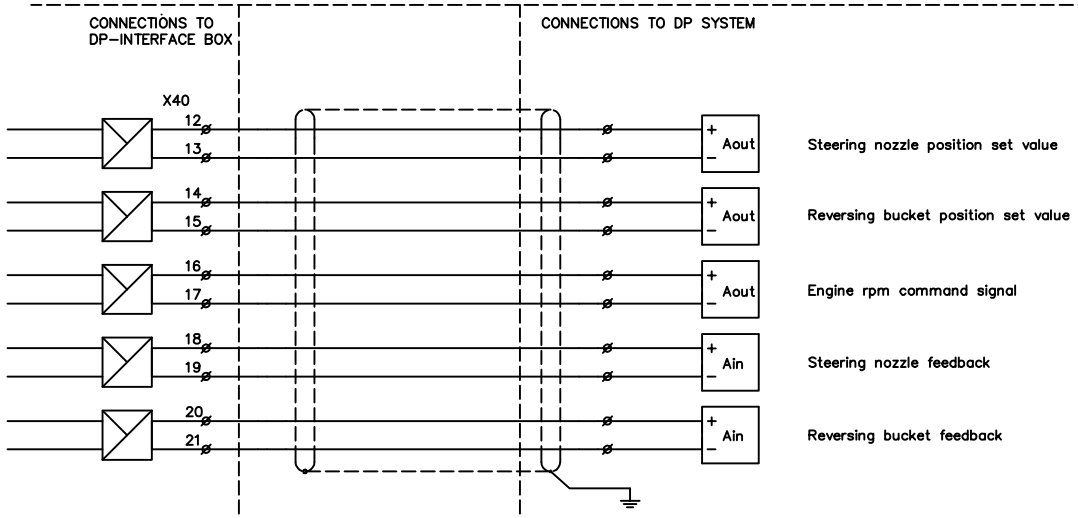
LAYOUT



NOTE!
All cables except CAN cables
and all connections are
to be supplied by yard.

* NOTE!
Feedback signal range might be limited by cylinder end clearance and control loop dead band values and therefore min and max values will not be reached

EXAMPLE CONNECTION – DP ANALOG INTERFACE



CONNECTION DETAILS		
Terminal X40.		Signal description
12	+	Steering nozzle position set value (galvanically isolated 4–20 mA) where: 4 mA correspond full PORT command 12 mA correspond nozzle in the middle 20 mA correspond full STBD command
13	–	
14	+	Reversing bucket position set value (galvanically isolated 4–20 mA) where: 4 mA correspond bucket astern 12 mA correspond bucket in the middle 20 mA correspond bucket ahead
15	–	
16	+	Engine rpm command signal (galvanically isolated 4–20 mA) where: 4 mA correspond idle speed command 20 mA max throttle command
17	–	
18	+	Steering nozzle feedback * (galvanically isolated 4–20 mA) where: 4 mA correspond full PORT conmmand 12 mA correspond nozzle in the middle 20 mA correspond full STBD command
19	–	
20	+	Reversing bucket feedback * (galvanically isolated 4–20 mA) where: 4 mA correspond bucket astern 12 mA correspond bucket in the middle 20 mA correspond bucket ahead
21	–	

Interface Description
DP interface
RR Control System

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

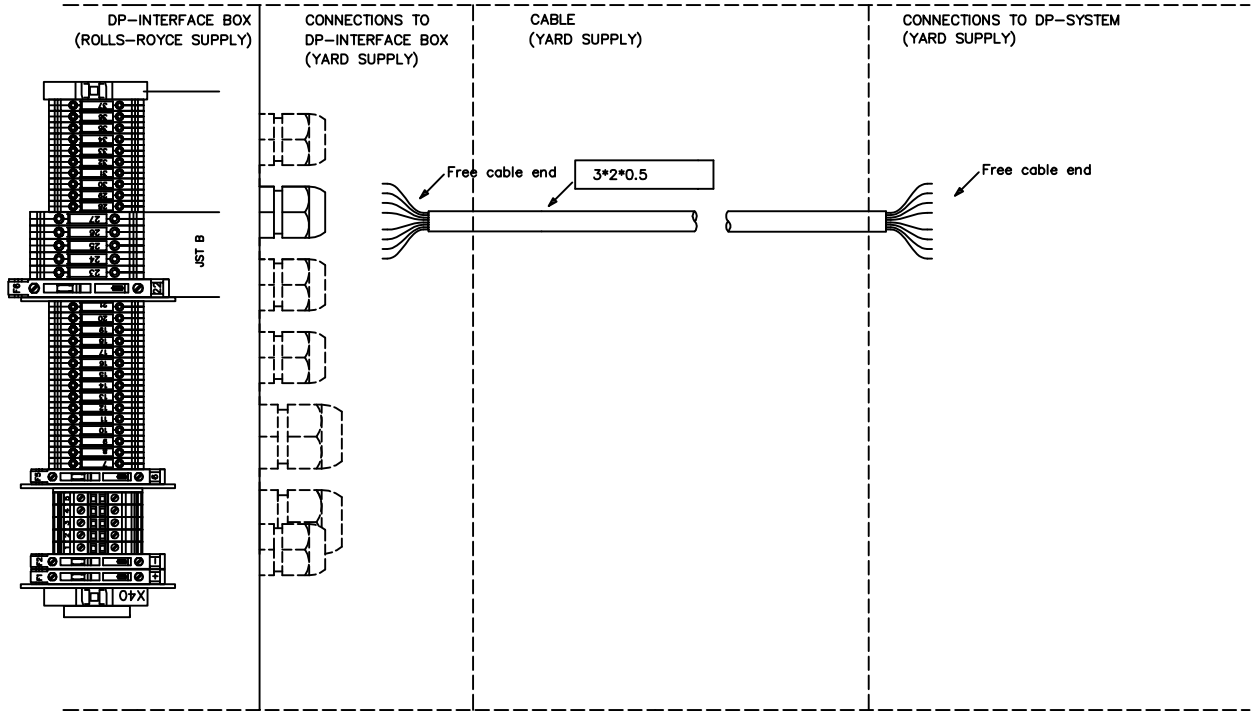
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Approved:	Weight kg:
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Notes List

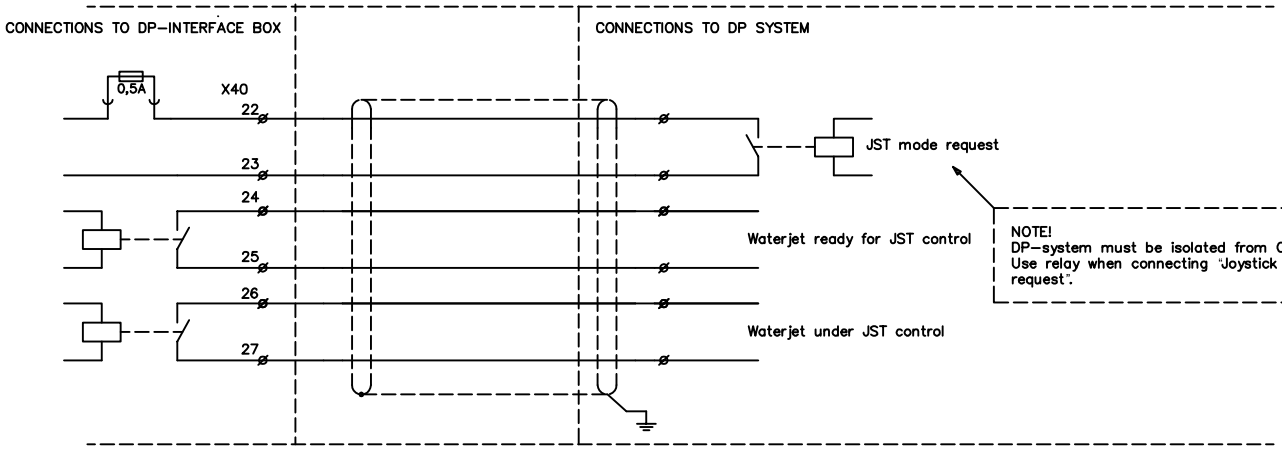
RR OY S Info. Class: LIMITED

LAYOUT



NOTE!
All cables except CAN cables
and all connections are
to be supplied by yard.

EXAMPLE CONNECTION – JOYSTICK BINARY INTERFACE



NOTE!
DP–system must be isolated from Controller.
Use relay when connecting 'Joystick mode request'.

CONNECTION DETAILS	
Terminal X40.	Signal description
22	Reference 24 VDC
23	Joystick mode request from DP–system
24	Waterjet ready for joystick control, NO (max. 5A)
25	Waterjet ready for joystick control, ref (max. 5A)
26	Waterjet under joystick control, NO (max. 5A)
27	Waterjet under joystick control, ref (max. 5A)

Interface Description
DP interface
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Apr 3rd 2014 | Scale: | Format: A3 | Sheet: 4 of 6

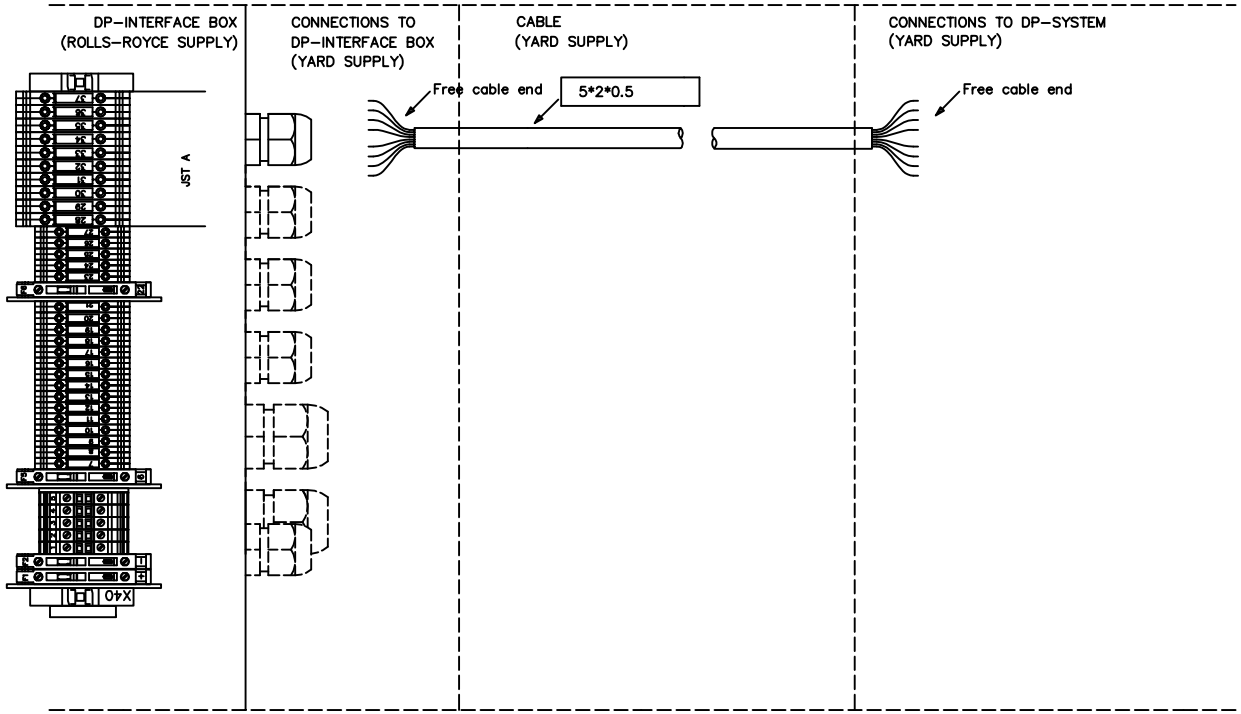
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Access List

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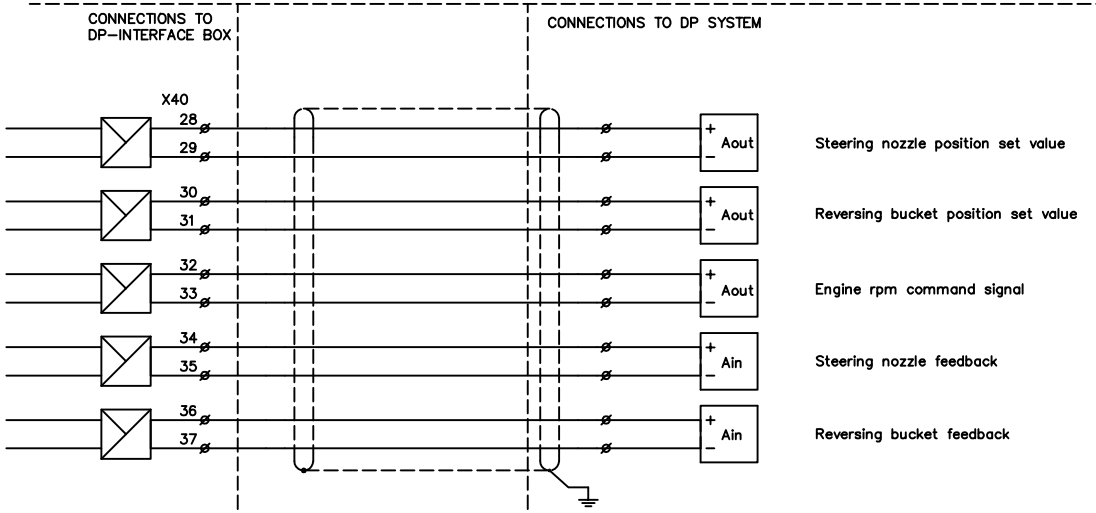
LAYOUT



NOTE!
All cables except CAN cables
and all connections are
to be supplied by yard.

* NOTE!
Feedback signal range might be limited by cylinder end clearance and control loop dead band values and therefore min and max values will not be reached

EXAMPLE CONNECTION – JOYSTICK ANALOG INTERFACE



CONNECTION DETAILS		
Terminal X40.		Signal description
28	+	Steering nozzle position set value (galvanically isolated 4–20 mA) where: 4 mA correspond full PORT command 12 mA correspond nozzle in the middle 20 mA correspond full STBD command
29	–	
30	+	Reversing bucket position set value (galvanically isolated 4–20 mA) where: 4 mA correspond bucket astern 12 mA correspond bucket in the middle 20 mA correspond bucket ahead
31	–	
32	+	Engine rpm command signal (galvanically isolated 4–20 mA) where: 4 mA correspond idle speed command 20 mA max throttle command
33	–	
34	+	Steering nozzle feedback * (galvanically isolated 4–20 mA) where: 4 mA correspond full PORT conmmand 12 mA correspond nozzle in the middle 20 mA correspond full STBD command
35	–	
36	+	Reversing bucket feedback * (galvanically isolated 4–20 mA) where: 4 mA correspond bucket astern 12 mA correspond bucket in the middle 20 mA correspond bucket ahead
37	–	

Interface Description
DP interface
RR Control System

Checked: | Previous Drg:
Approved: | Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Apr 3rd 2014 | Scale: | Format: A3 | Sheet: 5 of 6
Drawing no: DMN000221019 | Revision: A

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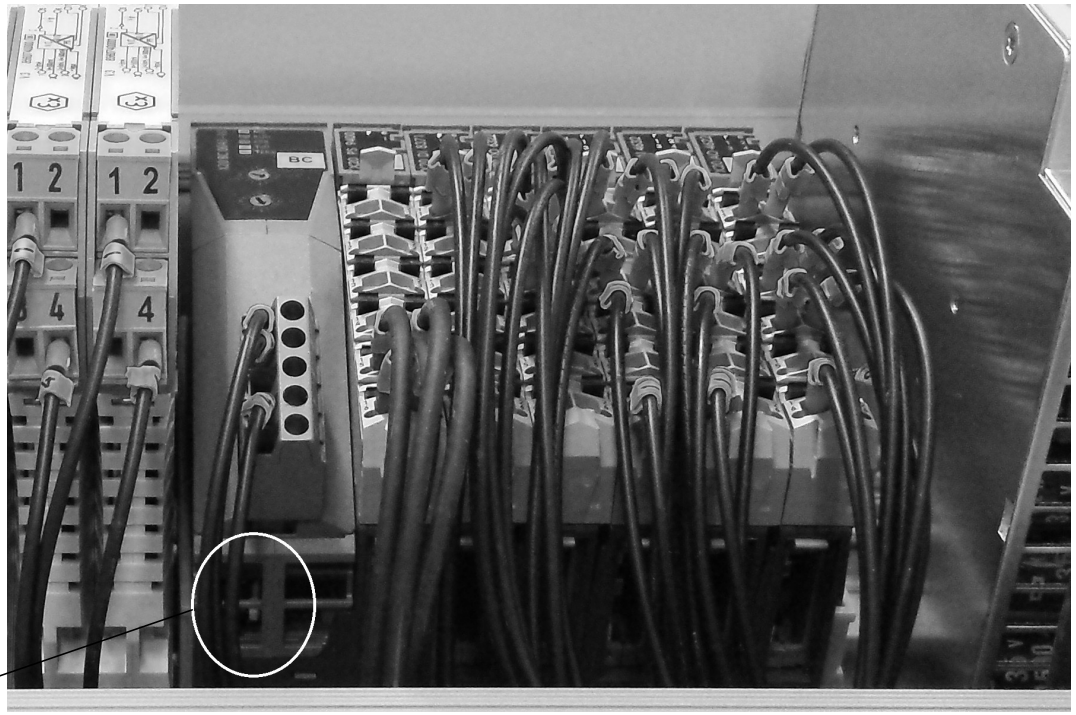
Access List
RR OY S Info Class: LIMITED

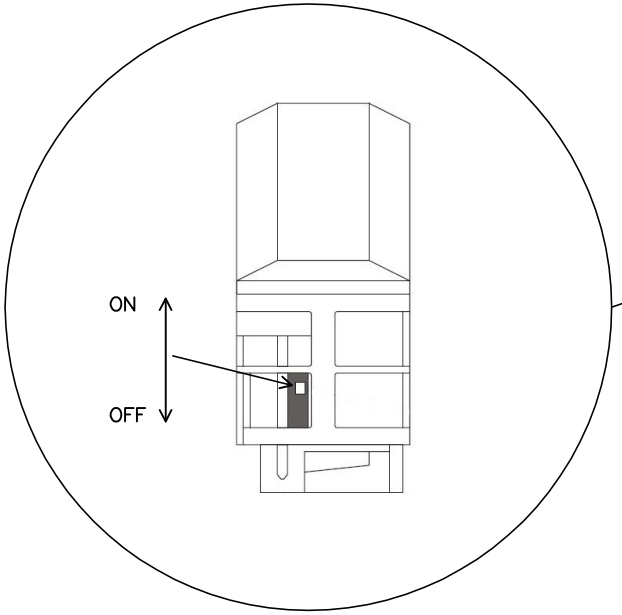
TERMINATING RESISTOR

Depending on the waterjet unit to which the DP interface is connected, the integrated terminating resistor switch of the bus controller module (BC) has to be set as followed:

Port Outer Jet – OFF
Port Inner Jet – ON
Stbd Inner Jet – ON
Stbd Outer Jet – OFF

An active terminating resistor is indicated by the "TERM" LED on the bus controller module (BC).





Interface Description
DP interface
RR Control System

Checked:
Previous Drg:
Approved:
Weight kg:

Rolls-Royce
Rolls-Royce OY
Propulsion Kokkola

Origin. / Date: MMK Apr 3rd 2014
Scale:
Format: A3
Sheet: 6 of 6
Drawing no: DMN000221019
Revision: A

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Access List
RR OY S Info Class: LIMITED

Appendix E, Symbols and buttons

SYMBOLS:



Red (flashing):
Error. It is not possible to use the system and actuators are locked. It is not possible to reset/reconnect.

Red (steady):
Error. It is not possible to use the system and actuators are locked. It is possible to reset/reconnect system.

Yellow (steady):
Warning. It is still possible to use the system.



Green (steady):
In Command, thrust

Green (flashing):
Transfer is active, thrust



Green (steady):
In Command, steering

Green (flashing):
Transfer is active, steering



Green (steady):
In Command, sway and surge (with joystick)

Green (flashing):
Transfer is active, sway and surge (joystick)



Green:
Engine Control Room in command (local control).
(When control is taken to engineroom, buzzer is beeping and led flashing first 6 second. after that stedy light)



Green (steady):
Clutch is open

Green (flashing):
Open clutch command is activated but according feedback clutch is still closed



Green (steady):
Clutch is closed

Green (flashing):
Close clutch command is activated but according feedback clutch is not yet closed.

Yellow (flashing):
Close clutch command is activated but clutch interlock prevents the clutch to engage.

Blue (flashing):
Backflush is activated.

SYMBOLS:



Green:
Autopilot in command



Green:
Indicate that "Maximum power mode" is selected for joystick.



White:
Indicate that system is OFF.



Green:
Indicate that system is ON.

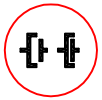


Green:
Bow thruster ON

BUTTONS:



RRM000200302
Receive/Release command



RRM000200303
Clutch In / Clutch Out



RRM000200304
Reconnect system / Reset error

Secondary function:
Adjust backlight brightness



RRM000200584
Reconnect system / Reset error



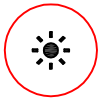
RRM000200305
Secondary Function / SHIFT



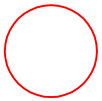
RRM000200305
Backflush



RRM000200306
Start / Stop
On / Off



RRM000200307
Adjust backlight brightness



RRM000200308
Blank button

Appendix F, Troubleshooting guide

Troubleshooting guide

Title	Document No.	Issue No.
Rolls-Royce Compact Control System	**DMN000214539**	**C**

Authors	E-mail	Date
Mikko Kavonius		**5.3.2013**

Summary

This document provides instructions and useful information concerning possible problems that may occur with the Rolls-Royce Compact Control System.

Additional keywords	Retention category

Circulation:	Circulation for approval:	Approved by:

Project	Sub-system		
N/A	N/A		
Process	**Project number** N/A	**Order number** N/A	
File DMN000214539_ROCCS_Troubleshooting_R3.docx	**Document No.** DMN000214539	**Issue No.** B	**Page** 1 of 16

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1 Change History

Issue No.	Reason for issue	Originator	Date issued
A	First issue	MIKA	05.03.2013
B	System alarm list updated	MIKA	15.11.2013
C	System alarm list updated	MIKA	01.10.2014

2 Basic operation faults

This chapter contains information and possible solutions to some minor problems that may occur during basic operations and which do not trig an alarm.

System does not respond to control command

Possible reason	**Solution**
Trying to operate from an inactive control station or device	Transfer control to the appropriate control station or device
System is in disconnect-mode	Press and hold down the reconnect-button
Clutch is disengaged	Engage the clutch
Engine is not running (hydraulics is not running)	Start the engine

Clutch will not engage, yellow clutch symbol is flashing on the control panel

Possible reason	**Solution**
Trying to operate from an inactive control station or device	Transfer control to the appropriate control station or device
Engine RPM is too high	Reduce the engine RPM to idle speed
Engine is not running	Start the engine
Position of the thrust lever is >20% ahead or astern	Reduce the thrust
System is in disconnect-mode	Press and hold down the reconnect-button

System does not respond to idle rpm command

Possible reason	**Solution**
Trying to operate from an inactive control station or device	Transfer control to the appropriate control station or device
System is in disconnect-mode	Press and hold down the reconnect-button
Engine idle RPM already at the min/max value	
Engine is not running	Start the engine

Engine will not start

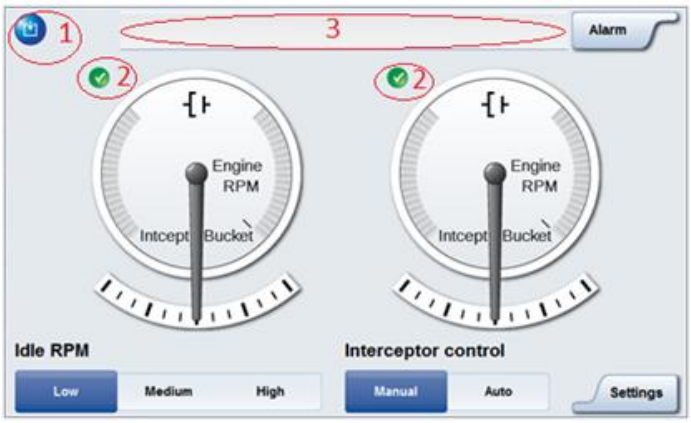
Possible reason	**Solution**
Engine start interlock is active	Ensure that the clutch is disengaged and the RPM command is <10%

Autopilot will not activate

Possible reason	**Solution**
Joystick-mode is active	Transfer control to the main control device

3 GUI overview

The Guided User Interface can be used to help to locate the problem. All necessary information is found on the main view:



Main view of the GUI

1. Control station status:

Blue symbol = Station is active

Gray symbol = Station is inactive

Control station is activated by pressing the “Take Command” button of the control panel.

2. Bridge CAN bus status:

Green symbol = OK

Red symbol = NOT OK

3. Alarm message field

In case of a system alarm (refer to 4. System alarms) an alarm message is viewed on the GUI. The most recent alarm message is shown on the main view of the GUI. Other alarm messages can be found in the alarm list where they are sorted in time-based matter.

Alarm list opens by touching the alarm-button. Alarm messages can be acknowledged individually for each alarm by pressing the “Ack” button next to the alarm. Alternatively all of the alarms can be acknowledged at a time by pressing the “Ack all visible” button. Acknowledging an inactive alarm removes it from the list.

Alarm messages are provided on the GUI with a triangle symbol that indicates the status of the alarm:

 The alarm has not been acknowledged and it is active.

 The alarm has been acknowledged but it is still active.

 The alarm has become inactive.

Before the actual alarm message there is the text “PORT” or “STBD” indicating from which side (bridge CAN) the alarm is coming from.

4 System alarms

The functioning of the MIO-unit is designed to protect the whole system in case of exceptional situations by locking the outputs and / or cancelling the operation in progress. In this case, an alarm message is provided and viewed on the GUI. Alarm message is also sent to the RS422-interface, if available.

When a system alarm occurs, the siren of the control panel will make a beeping sound. This will also happen if trying to operate from an inactive control station.

There are two types of alarms:

System failure (high priority)

- A red triangle is flashing on the control panel.
- Operating the jet in question is prevented.
- After the cause of the failure is removed, the red triangle stops flashing and the system has to be reconnected with the reconnect-button of the control panel. Red triangle will disappear once the system has reconnected.

System warning (low priority)

- A yellow triangle is lit on the control panel.
- Operating the jet in question is still possible.
- After the cause of the warning is removed, the yellow triangle disappears.

NOTE! When operating with a joystick, a flashing yellow triangle on the joystick panel indicates a joystick related alarm. When the cause of the alarm is removed, the yellow triangle will turn steady and the alarm has to be acknowledged with the reconnect-button of the joystick panel (yellow triangle disappears).

NOTE! In case of interceptor failure, other cylinders (nozzle and bucket) can still be operated normally. Interceptor feedback failure will be reported with a flashing yellow triangle on the control panel. While the feedback failure is active, interceptor can be driven up in order to maintain maneuverability of the vessel. When the feedback fault is repaired, the yellow triangle will stop flashing and hence the interceptor can be returned to normal operation by pressing the reconnect button on the control panel.

4.1 List of system alarms

Alarm ID 1 = OuterJet Bucket feedback

Alarm ID 2 = OuterJet Steering feedback

Alarm ID 3 = OuterJet Interceptor feedback

Alarm ID 4 = OuterJet Bucket control

Alarm ID 5 = OuterJet Steering control

Alarm ID 6 = OuterJet Interceptor control

Alarm ID 7 = OuterJet Hydraulic oil pressure

Alarm ID 8 = OuterJet Hydraulic oil temperature

Alarm ID 9 = OuterJet Hydraulic oil level

Alarm ID 10 = OuterJet Bearing oil level

Alarm ID 11 = OuterJet Bearing oil temperature

Alarm ID 12 = OuterJet Low power supply

Alarm ID 13 = InnerJet Bucket feedback

Alarm ID 14 = InnerJet Steering feedback

Alarm ID 15 = InnerJet Interceptor feedback

Alarm ID 16 = InnerJet Bucket control

Alarm ID 17 = InnerJet Steering control

Alarm ID 18 = InnerJet Interceptor control

Alarm ID 19 = InnerJet Hydraulic oil pressure

Alarm ID 20 = InnerJet Hydraulic oil temperature

Alarm ID 21 = InnerJet Hydraulic oil level

Alarm ID 22 = InnerJet Bearing oil level

Alarm ID 23 = InnerJet Bearing oil temperature

Alarm ID 24 = InnerJet Low power supply

Alarm ID 25 = OuterJet Control Unit Digital/Analog Output

Alarm ID 26 = JST Error, Uneven pair of waterjets

Alarm ID 27 = InnerJet Control Unit Digital/Analog Output

Alarm ID 28 = Autopilot command failure

Alarm ID 29 = CS1 Port lever

Alarm ID 30 = CS1 Starboard lever

Alarm ID 31 = CS1 Port steering device

Alarm ID 32 = CS1 Starboard steering device

Alarm ID 33 = CS1 Joystick

Alarm ID 34 = CS1 Booster lever

Alarm ID 35 = Joystick mode and PO not available

Alarm ID 36 = CS1 Bow thruster control

Alarm ID 37 = CS2 Port lever

Alarm ID 38 = CS2 Starboard lever

Alarm ID 39 = CS2 Port steering device

Alarm ID 40 = CS2 Starboard steering device

Alarm ID 41 = CS2 Joystick

Alarm ID 42 = CS2 Booster lever

Alarm ID 43 = CS2 Bow thruster control

Alarm ID 44 = CS2 Clutch control

Alarm ID 45 = CS3 Port lever

Alarm ID 46 = CS3 Starboard lever

Alarm ID 47 = CS3 Port steering device

Alarm ID 48 = CS3 Starboard steering device

Alarm ID 49 = CS3 Joystick

Alarm ID 50 = CS3 Booster lever

Alarm ID 51 = CS3 Bow thruster control

Alarm ID 52 = CS3 Clutch control

Alarm ID 53 = Port outer jet not available

Alarm ID 54 = Port inner jet not available

Alarm ID 55 = Booster jet not available

Alarm ID 56 = Starboard outer jet not available

Alarm ID 57 = Starboard inner jet not available

Alarm ID 58 = Bow thruster not available

Alarm ID 59 = OuterJet DP Interface

Alarm ID 60 = Bow thruster alarm

Alarm ID 61 = InnerJet Calibration Error

Alarm ID 62 = InnerJet DP Interface

Alarm ID 63 = OuterJet Calibration Error

Alarm ID 64 = Booster jet disconnected

4.2 Alarm status IDs

In the alarm list file (*.csv) that can be exported from the MIO-unit, alarm messages are provided with alarm status ID which gives more detailed information about the alarm.

Error	Status
NO ERROR	0
AIO_ERROR_I_OUT	1
AIO_ERROR_SHORT_CIRCUIT	2
AIO_ERROR_OVERTEMP	3
AIO_ERROR_EINVAL	4
AI Output value is less than r_OUT_MIN –limit value	10
AI Output value is greater than r_OUT_MAX –limit value	11
AI Input value is out of range (input signal value is less than overlim percent*input signal minimum value which is set by r_OVER_LIM)	12
AI Input value is out of range (input signal value is greater than overlim percent*input signal minimum value which is set by r_OVER_LIM)	13
AI Input signal is less than hardware defined minimum value	14
AI Input signal is greater than hardware defined maximum value	15
AI WireBreak	16
DIO_ERROR_OPEN_CIRCUIT	20
DIO_ERROR_SHORT_CIRCUIT	21
DIO_ERROR_SHORT_EINVAL	22
DI_ALARM	23
CAN_NODE_ERROR_AI0	30
CAN_NODE_ERROR_AI1	31
CAN_NODE_ERROR_AI2	32
CAN_NODE_ERROR_POWER	33
CAN_NODE_ERROR_OVERRUN	34
CAN_NODE_ERROR_PASSIVE	35
CAN_NODE_ERROR_NOT_ALIVE	36
Control Fail	40
Controller not alive	41
Calibration Error	42
Calibration Error Channel fail	43
Step tuning Error	44
Speed tuning Error	45
Joystick Error, Not enough thrusters OR Joystick mode and PO not available	46
Autopilot command failure	47

4.3 Alarm details

This chapter provides more information and possible causes concerning the alarms.

4.3.1 Feedback Alarms

Alarm ID: 1, 2, 3, 13, 14, 15

Priority: Failure

Explanation: The feedback value is out of the calibrated range.

Possible reasons:

- Wirebreak
- Feedback sensor is not calibrated
- Selected feedback signal type does not match with the actual signal
- Feedback sensor is out of order

4.3.2 Control Alarms

Alarm ID: 4, 5, 6, 16, 17, 18

Priority: Warning

Explanation: The feedback value is not acceptable, in other words, movement of the cylinder does not follow the command value.

Possible reasons:

- Hydraulics is not running when the control command is given
- System is in disconnect-mode
- Tuning values do not meet with the actual cylinder behaviour
- Fault in the mechanics
- Fault in the hydraulics

4.3.3 Oil Pressure Alarm

Alarm ID: 7, 19

Priority: Warning

Explanation: Hydraulic oil pressure is too low / fault in the sensor or wiring.

NOTE! This alarm is blocked if the engine is not running or if the pump is installed on the jet and the clutch is disengaged.

Possible reasons:

- Hydraulics is not running
- Fault in the hydraulics

4.3.4 Oil Temperature Alarms

Alarm ID: 8, 11, 20, 23

Priority: Warning

Explanation: Temperature of the hydraulic oil or the bearing oil is too high / fault in the sensor or wiring.

4.3.5 Oil Level Alarms

Alarm ID: 9, 10, 21, 22

Priority: Warning

Explanation: Level of the hydraulic oil or the bearing oil is too low / fault in the sensor or wiring.

4.3.6 Control Unit, Digital / Analog Output Alarm

Alarm ID: 25, 27

Priority: Warning

Explanation: Value of the output port is out of range.

NOTE! Check the LEDs of the MIO-unit to locate the faulty port(s) (Refer: 5. LED description). The controller has to be rebooted after the cause of the fault is removed.

DISCRETE OUTPUT

Possible reasons:

- Short circuit or wirebreak in the output

ANALOG OUTPUT

Possible reasons:

- Short circuit or wirebreak in the output
- Error in the D/A Converter
- Overheating in the D/A Converter
- Current overload
- Signal type selected incorrectly

4.3.7 JST Error, Uneven Pair Of Waterjets Alarm

Alarm ID: 26

Priority: Warning

Explanation: Joystick conditions are not met while the system is on JST-mode. The functioning of the X-axis is disabled.

NOTE! In quad installation, jets are considered as pairs in order to retain maneuverability because it is possible to operate with only two of the jets. Port Outer Jet and Starboard Outer Jet form the Outer pair and correspondingly Port Inner Jet and Starboard Inner Jet form the Inner pair.

JST CONDITIONS (TWIN INSTALLATION):

- Clutches are engaged on both of the jets.
- Neither of the jets are in “disconnect”-mode.
- Neither of the jets are in “engine stopped”-mode.

JST CONDITIONS (QUAD INSTALLATION):

- None of the waterjets is in disconnect-mode.
- The same conditions as with twin installation must be fulfilled on one pair of jets (PO&SO / PI&SI) at least.
- Both of the jets of a one pair (outer / inner) must fulfill the same conditions with each other, even if they diverge from the other pair.

4.3.8 Autopilot Command Failure Alarm

Alarm ID: 28

Priority: Warning (failure if AP active)

Explanation: Input value is out of range.

DISCRETE INPUT

Possible reasons:

- Short circuit or wirebreak in the input
- Selected signal type does not match with the actual autopilot signal

ANALOG INPUT

Possible reasons:

- Short circuit or wirebreak in the input
- Selected signal type does not match with the actual autopilot signal
- Malfunction in the autopilot unit

4.3.9 Control Panel Alarms

Alarm ID: 29 – 34, 36 – 52

Priority: Warning (failure if unit is in command)

Explanation: Control unit does not respond.

Possible reasons:

- CAN node ID of the control unit is incorrect
- CAN cables connected crosswise
- CAN-bus fault
- Wirebreak in the control unit
- Power supply fault in the control unit (fuse)

4.3.10 Joystick Mode And PO Not Available Alarm

Alarm ID: 35

Priority: Warning

Explanation: PORT (OUTER) MIO-unit goes off while the joystick-mode is active.

4.3.11 Jet Not Available Alarms

Alarm ID: 53 – 58

Priority: Warning

Explanation: One of the MIO-units does not respond.

Possible reasons:

- System CAN fault
- MIO-unit is disconnected from the power supply
- MIO-unit has crashed

4.3.12 DP Interface Alarm

Alarm ID: 59, 62

Priority: Warning (failure if DP active)

Explanation: DP Interface unit does not respond.

Possible reasons:

- Wirebreak in the interface unit concerning the selected mode (DP/JST)
- DP interface unit has crashed

4.3.13 Bow Thruster Alarm

Alarm ID: 60

Priority: Warning

Explanation: External alarm from the bow thruster MIO-unit.

4.3.14 Calibration Error Alarms

Alarm ID: 61, 63

Priority: Failure

Explanation: The feedback calibration status of the MIO-unit is “NOT OK”.

4.3.15 Low power supply alarm

Alarm ID: 12, 24

Priority: Warning

Explanation: Supply voltage <18 VDC.

5 LED descriptions



The LEDs of the controller unit indicate the statuses of the power supply, communication and I/O. A possible problem may be located by the LEDs with the help of this description.

5.1 Main unit

LED	Description	No light	Green light	Red light	Yellow light	Flashing light
POWER	Power supply status	Power off	Power OK, 18...32VDC	Out of range, <18 or >32 VDC		
STATUS	Application status		Application is running			
CAN 1, RUN						
CAN 1, ERROR						
CAN 2, RUN						
CAN 2, ERROR						
SERIAL, TX	Serial communication, transmit					Active
SERIAL, RX	Serial communication, receive					Active
LAN, 100 Mbps	Local Area Network connection				Link available	Traffic
LAN, 10 Mbps	Local Area Network connection		Link available			Traffic
AIO 1						
AIO 2						
AIO 3						
AI 4	Nozzle feedback			Out of range		Wirebreak
AI 5	Bucket feedback			Out of range		Wirebreak
AI 6	Interceptor feedback			Out of range		Wirebreak
AI 7						
AO-ISO	RPM Command			Output failure		
AI-ISO	Analog autopilot interface			Out of range		
RLY 1	Failure	Failure	OK			
RLY 2	Warning	Warning	OK			
RLY 3	AP Active		Active			
DIO 1	Backup Activated		Active	Error		
DIO 2	Engine Stopped		Active	Error		
DIO 3	Engine at idle speed		Active	Error		
DIO 4	Autopilot - Activate		Active	Error		
DIO 5	Autopilot - Steer port		Active	Error		
DIO 6	Autopilot - Steer stbd		Active	Error		
DIO 7	Alarm - Hydraulic oil pressure	Alarm active	OK	Error		
DIO 8	Alarm - Hydraulic oil temperature	Alarm active	OK	Error		
DIO 9	Alarm - Hydraulic oil level	Alarm active	OK	Error		
DIO 10	Alarm - Bearing oil level	Alarm active	OK	Error		
DIO 11	Alarm - Bearing oil temperature	Alarm active	OK	Error		
DIO 12	24VDC reference		Active	Error		
DIO 13	Start Interlock		Active	Error		
DIO 14	Nozzle PWM	Not in use		Error		OK
DIO 15	Nozzle PWM	Not in use		Error		OK
DIO 16	Bucket PWM	Not in use		Error		OK
DIO 17	Bucket PWM	Not in use		Error		OK
DIO 18	Interceptor PWM	Not in use		Error		OK
DIO 19	Interceptor PWM	Not in use		Error		OK
DIO 20	Clutch IN		Active	Error		
DIO 21	Clutch OUT		Active	Error		
DIO 22	Clutch Reverse		Active	Error		
DIO 23	Clutch engaged		Active	Error		
DIO 24	Shaft speed			Error		

5.2 Backup unit

LED	Description	No light	Green light	Red light	Yellow light	Flashing light
POWER	Power supply status	Power off	Power OK, 18...32VDC	Out of range, <18 or >32 VDC		
STATUS	Application status		Application is running			
CAN 1, RUN						
CAN 1, ERROR						
CAN 2, RUN						
CAN 2, ERROR						
SERIAL, TX	Serial communication, transmit					Active
SERIAL, RX	Serial communication, receive					Active
LAN, 100 Mbps	Local Area Network connection				Link available	Traffic
LAN, 10 Mbps	Local Area Network connection		Link available			Traffic
AIO 1						
AIO 2						
AIO 3						
AI 4	Nozzle feedback			Out of range		Wirebreak
AI 5	Bucket feedback			Out of range		Wirebreak
AI 6						
AI 7						
AO-ISO	RPM Command			Output failure		
AI-ISO						
RLY 1	Failure	Failure	OK			
RLY 2	Warning	Warning	OK			
RLY 3	Activate BackUp		Active			
DIO 1						
DIO 2						
DIO 3						
DIO 4						
DIO 5						
DIO 6						
DIO 7						
DIO 8						
DIO 9						
DIO 10						
DIO 11						
DIO 12	24V Reference		Active	Error		
DIO 13	Activate BackUp		Active	Error		
DIO 14	Nozzle PWM	Not in use		Error		OK
DIO 15	Nozzle PWM	Not in use		Error		OK
DIO 16	Bucket PWM	Not in use		Error		OK
DIO 17	Bucket PWM	Not in use		Error		OK
DIO 18	RPM +	Not in use		Error		OK
DIO 19	RPM -	Not in use		Error		OK
DIO 20	Clutch IN		Active	Error		
DIO 21	Clutch OUT		Active	Error		
DIO 22						
DIO 23	Clutch engaged		Active	Error		
DIO 24						

5.3 Bow thruster unit

LED	Description	No light	Green light	Red light	Yellow light	Flashing light
POWER	Power supply status	Power off	Power OK, 18...32VDC	Out of range, <18 or >32 VDC		
STATUS	Application status		Application is running			
CAN 1, RUN						
CAN 1, ERROR						
CAN 2, RUN						
CAN 2, ERROR						
SERIAL, TX	Serial communication, transmit					Active
SERIAL, RX	Serial communication, receive					Active
LAN, 100 Mbps	Local Area Network connection				Link available	Traffic
LAN, 10 Mbps	Local Area Network connection		Link available			Traffic
AIO 1						
AIO 2						
AIO 3						
AI 4						
AI 5						
AI 6						
AI 7						
AO-ISO	RPM Command			Output failure		
AI-ISO						
RLY 1	Failure	Failure	OK			
RLY 2						
RLY 3	Start Bow Thruster		Active	Error		
DIO 1	Bow Thruster Ready		Active	Error		
DIO 2	External Alarm		Active	Error		
DIO 3						
DIO 4						
DIO 5						
DIO 6						
DIO 7						
DIO 8						
DIO 9						
DIO 10						
DIO 11						
DIO 12						
DIO 13						
DIO 14	Port PWM	Not in use		Error		OK
DIO 15	STBD PWM	Not in use		Error		OK
DIO 16						
DIO 17						
DIO 18						
DIO 19						
DIO 20						
DIO 21						
DIO 22						
DIO 23						
DIO 24						

5.4 Booster unit

LED	Description	No light	Green light	Red light	Yellow light	Flashing light
POWER	Power supply status	Power off	Power OK, 18...32VDC	Out of range, <18 or >32 VDC		
STATUS	Application status		Application is running			
CAN 1, RUN						
CAN 1, ERROR						
CAN 2, RUN						
CAN 2, ERROR						
SERIAL, TX	Serial communication, transmit					Active
SERIAL, RX	Serial communication, receive					Active
LAN, 100 Mbps	Local Area Network connection				Link available	Traffic
LAN, 10 Mbps	Local Area Network connection		Link available			Traffic
AIO 1						
AIO 2						
AIO 3						
AI 4						
AI 5						
AI 6						
AI 7						
AO-ISO	RPM Command			Output failure		
AI-ISO						
RLY 1	Failure	Failure	OK			
RLY 2	Warning	Warning	OK			
RLY 3						
DIO 1						
DIO 2	Engine Stopped		Active	Error		
DIO 3	Engine at idle speed		Active	Error		
DIO 4						
DIO 5						
DIO 6						
DIO 7						
DIO 8						
DIO 9						
DIO 10	Alarm - Bearing oil level	Alarm active	OK	Error		
DIO 11	Alarm - Bearing oil temperature	Alarm active	OK	Error		
DIO 12						
DIO 13	Start Interlock		Active	Error		
DIO 14						
DIO 15						
DIO 16						
DIO 17						
DIO 18						
DIO 19						
DIO 20	Clutch IN		Active	Error		
DIO 21	Clutch OUT		Active	Error		
DIO 22	Clutch Reverse		Active	Error		
DIO 23	Clutch engaged		Active	Error		
DIO 24	Shaft speed			Error		