



Steering System Installation & Service Manual

STEERING GEAR SYSTEM: TS2-25-1-35

STEERING CONTROL SYSTEM: Full Follow-Up EW 200
Full Follow-Up LC 100
Non Follow-Up JO 100

MOTOR STARTER & ALARMS: None

REFERENCE: JQ061388
VESSEL: 42.8m Mid-Shore Patrol Vessel
HULL NUMBER: 6094, 6095, 6096, 6097, 6098, 6099,
6101, 6102, 6103
SHIPYARD: Irving Shipyard
APPROVAL SOCIETY: LR/TC
AGENT: None

DATE OF ISSUE: September 14, 2010

WARNING: IN ORDER TO MAINTAIN SAFE VESSEL OPERATION JASTRAM STRONGLY RECOMMENDS THAT ALL STEERING SYSTEMS HAVE SOME MEANS OF AUXILIARY STEERING. REVIEW ALL TECHNICAL DESCRIPTIONS AND DOCUMENTATION AND CONFIRM THAT ADEQUATE AUXILIARY STEERING IS FITTED.

WARNING: IN ORDER TO MAINTAIN SAFE VESSEL OPERATION CREW MUST REVIEW ALL TECHNICAL DESCRIPTIONS AND DOCUMENTATION AND KNOW PROCEDURES REQUIRED TO QUICKLY TRANSFER TO THE AUXILIARY MEANS OF STEERING.

This manual is subject to change without prior notice.

Manual replacement cost: \$100.00 each.



1 STEERING GEAR - TECHNICAL INFORMATION

THIS SECTION INCLUDES:

- 1.1 SCOPE OF SUPPLY
- 1.2 TECHNICAL SPECIFICATIONS
- 1.3 HYDRAULIC SCHEMATICS
- 1.4 TECHNICAL DESCRIPTION

REF: JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD



1.1 SCOPE OF SUPPLY - STEERING GEAR

<u>QTY.</u>	<u>DESCRIPTION</u>
4	CYLINDER, S-300-17
2	TILLER ASSEMBLY, S-300-17-35-2
8	CYLINDER FLEX HOSE – 1/2" NOM. W/ELBOW
4	CYLINDER FLEX HOSE – 1/2" NOM.
8	CYLINDER 3-WAY SHUT-OFF VALVE – 3/4" NOM.
2	DOUBLE ACTING RELIEF AND BYPASS VALVE, DARB - 10 GPM
1	HELM PUMP, H58
1	HEADER TANK, 1.5L
2	RESERVOIR & MANIFOLD ASSEMBLY w/
1	POWER STEERING MANIFOLD, PSM 200
4	PUMP & MOTOR ASSEMBLY – 2HP, 600/3/60 with/ CHECK
1	STEERING WHEEL – 36"

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1.2 TECHNICAL SPECIFICATIONS

Steering Gear Model

Jastram Twin S2-25-1-35

Rudder Stock Diameter	72mm (by others)
Torque (each rudder)	2.5 Tm at +/-35 deg.
Relief Pressure	1875 psi
Normal Working Pressure	1500 psi
Steering Angle (max.)	+/- 37 deg.
Electronic Steering Angle Limit	+/- 35 deg.
Rudder Speed	28 sec. thru +35 deg. to -35 deg.

Cylinder Model

Jastram S-300-17 (Qty 4)

Maximum Design Pressure	1875 psi
Bore x Stroke x Rod	4" x 17.04" x 1.5"
Displacement (2 cylinders, +/- 35 deg.)	188 cu. in.
Directional Porting	3/4-16UN SAE Str. Thd. "O"-Ring Port, Fitting -08

Reservoir & Manifold Assembly

Jastram Reservoir (Qty 2)

Reservoir Capacity	10 US gal.
Maximum Ambient Temperature	104 ⁰ F (40 ⁰ C)
Oil Maximum Operating Temperature	150 ⁰ F (65 ⁰ C)
Directional Porting	3/4-16UNF SAE Str. Thd. "O"-Ring Port Fitting -08
Pump Suction Porting	1" NPT Port
Pump Pressure Porting	7/8-14UNF SAE Str. Thd. "O"-Ring Port Fitting -10

Power Steering Manifold

Jastram PSM200 – Single Speed

4-Way Solenoid (directional)	Vickers
Solenoid Voltage	24 VDC
Solenoid Holding Current	1.25 Amp
Output Flow Rate Setting	1.7 gpm
System Relief Setting	1500 psi

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Pump & Motor Assembly

Jastram (Qty 4)

Motor	2 hp, 600/3/60
Full Load Speed	1740 rpm
Full Load Amperage	2.1 Amp
Locked Rotor Current	17.5 gpm
Service Factor	1.15
Pump	Fixed Displacement Vane Pump
Maximum Flow	2.0 gpm at 1200 rpm
Suction Port	1" NPT Port
Pressure Port	3/4-16UNF SAE Str. Thd. (JIC) 37° Flare Male Fitting -08

Helm Pump

Jastram H-58

Manual Number of Turns (+/-15 deg.)	15-3/4 turns
Manual Number of Turns (+/-35 deg.)	32-1/2 turns
Max. Design Pressure (at Lock Valve)	1875 psi
Dry Weight	12.2 lb / 5.6 kg
Displacement	5.8 cu. in. / rev.
Directional Porting	3/8" NPT Port
Filler / Vent Porting	1/4" NPT Port

Double Acting Relief and Bypass Valve

Jastram DARB - 10 GPM (Qty 2)

Maximum Design Pressure	1875 psi.
Relief Pressure Setting	1875 psi.
Maximum Rated Flow	10 gpm
Dry Weight	6.6 lb / 3.0 kg
Directional Porting	1-1/16-12UN SAE Str. Thd. "O"-Ring Port Fitting -12

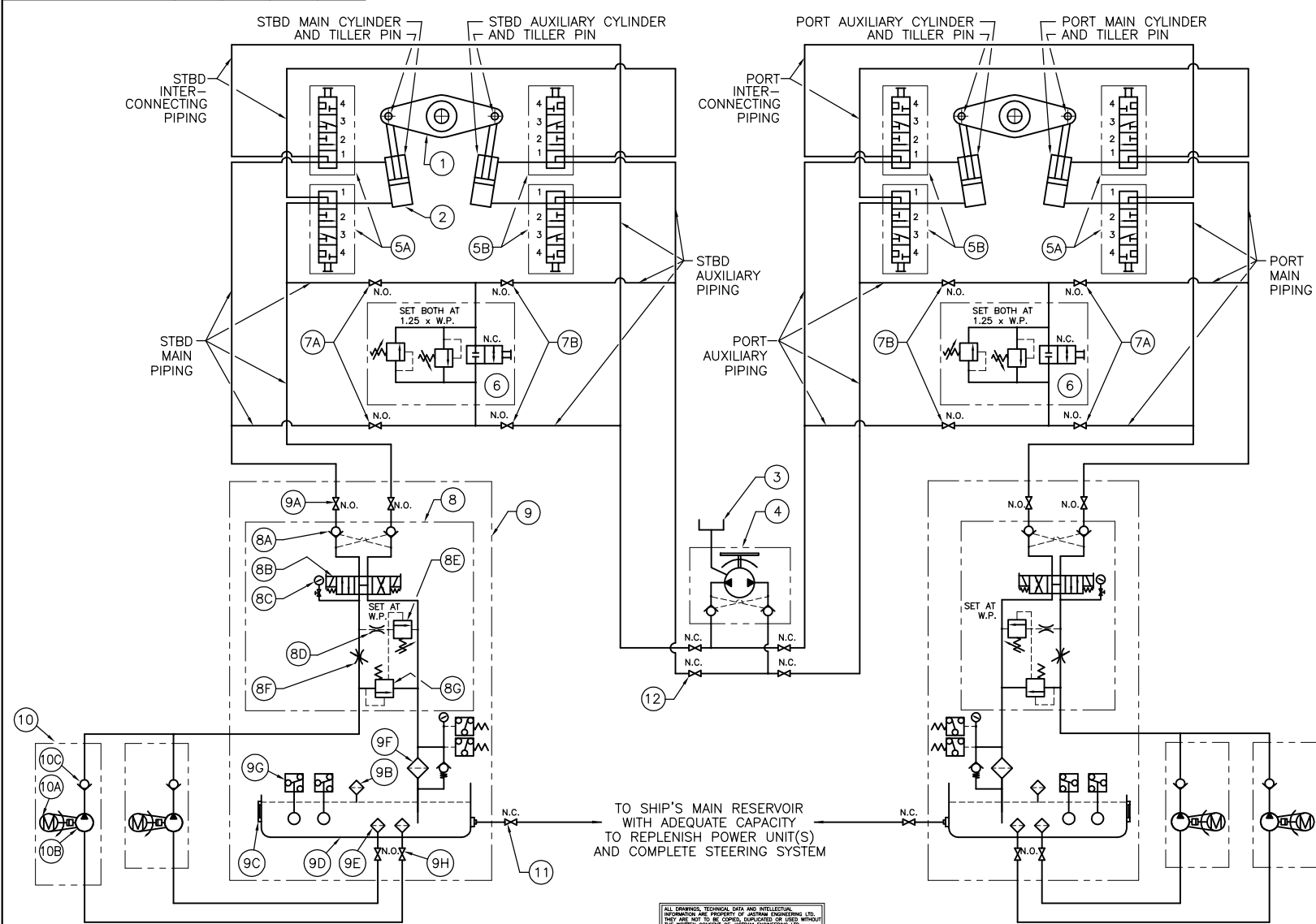


1.3 HYDRAULIC SCHEMATICS

CONDITION	3-WAY VALVE POSITIONS		DARB ISOLATION VALVE POSITIONS	
	5A	5B	7A	7B
NORMAL	1	1	N.O.	N.O.
MAIN PIPING FAILURE	3	1	CLOSED	N.O.
AUXILIARY PIPING FAILURE	1	3	N.O.	CLOSED
INTERCONNECTING PIPING FAILURE	2	2	N.O.	N.O.
MAIN CYLINDER ISOLATION	* 4	1	N.O.	N.O.
AUXILIARY CYLINDER ISOLATION	1	* 4	N.O.	N.O.

*PRIOR TO SELECTING VALVE POSITION FOR CYLINDER, REMOVE CYLINDER'S TILLER PIN.

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QTY.	ITEM	DESCRIPTION
2	1	TILLER
4	2	CYLINDER
1	3	HEADER TANK
1	4	HELM PUMP
4	5A	3-WAY SHUT-OFF VALVE - MAIN PIPING
4	5B	3-WAY SHUT-OFF VALVE - AUX. PIPING
2	6	DARB
4	7A	DARB ISOLATION VALVE - MAIN PIPING
4	7B	DARB ISOLATION VALVE - AUX. PIPING
2	8	POWER STEERING MANIFOLD
1	8A	DUAL PILOT OPERATED CHECK
1	8B	4-WAY DIRECTIONAL SOLENOID
1	8C	PRESSURE GAUGE AND ISOLATOR
1	8D	ORIFICE
1	8E	SYSTEM RELIEF
1	8F	FLOW CONTROL ORIFICE
1	8G	PILOT OPERATED FLOW CONTROL
2	9	RESERVOIR & MANIFOLD ASSEMBLY
2	9A	ISOLATION VALVE
1	9B	AIR BREATHER AND FILLER
1	9C	SIGHT & TEMPERATURE GAUGE
1	9D	RESERVOIR
2	9E	SUCTION LINE STRAINER
1	9F	RETURN LINE FILTER w/
		FILTER BYPASS
		DIFFERENTIAL PRESSURE GAUGE &
		DIFFERENTIAL PRESSURE SENSOR
2	9G	LOW LEVEL SENSOR AND JUNCTION BOX
2	9H	PUMP ISOLATION VALVE - LOCKABLE
4	10	PUMP AND MOTOR ASS'Y, 2HP
1	10A	ELECTRIC MOTOR
1	10B	PUMP
1	10C	CHECK
2	11	RESERVOIR ISOLATION VALVE
4	12	HELM PUMP ISOLATION VALVE

- NOTES:
1. ALL SOLENOID OPERATED VALVES ARE SHOWN IN THEIR DE-ENERGIZED STATE.
 2. N.O. - NORMALLY OPEN.
N.C. - NORMALLY CLOSED.
HPU - HYDRAULIC POWER UNIT.
DARB - DOUBLE ACTING RELIEF & BYPASS.
W.P. - WORKING PRESSURE.
 3. SEE INDIVIDUAL COMPONENT O.A.D. DWG'S FOR LOCATION OF PRESSURE AND FLOW ADJUSTMENTS AS WELL AS ELECTRICAL CONNECTIONS.
 4. 3-WAY SHUT-OFF VALVES (ITEMS 5) ARE MOUNTED DIRECTLY ON CYLINDERS.
 5. SHIPYARD IS RESPONSIBLE FOR PLACING IDENTIFICATION LABELS ON ALL MAIN AND AUXILIARY 3-WAY AND DARB ISOLATION VALVES ONCE INSTALLATION IS COMPLETE.

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Jastram			
JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel: (604) 989-1111 Fax: (604) 989-0334			
DATE: 20-07-10	SCALE: N/A	DRAWN: D.B.	APPROVED: N/A
TITLE: HYDRAULIC SCHEMATIC FOR TWIN S2-X-1-X			DRAWING NUMBER: D-611520

REF: JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD



1.4 TECHNICAL DESCRIPTION - STEERING GEAR

Drawing No.	Description
N.A.	Technical Specifications - Steering Gear
D-611520	Hydraulic Schematic

GENERAL

The steering system used in this vessel consists of two identical steering gears (port and starboard). Each steering gear can obtain a maximum of 2.5 T.m at +/- 35 degrees, at a working pressure of 1500 P.S.I.

Each steering gear is protected from external forces on the rudder by a double acting relief and bypass valve (items 6 on the hydraulic schematic). The DARB valve is set to 1.25 times the working pressure. In this system, the DARB setting is 1875 P.S.I.

Each rudder's steering system consists of a main and auxiliary steering gear. The design is such that a failure in either system will not render the other inoperable. A failure anywhere in the system can be isolated and steering quickly regained.

The main steering gear's piping is independent of the auxiliary piping. These independent hydraulic lines are tied together at the 3-way shut off valves (items 5A and 5B) and at the DARB isolation valves (items 7A and 7B). The operation of these valves is described in the table on the hydraulic schematic. Through this piping and valve arrangement, if the main and auxiliary lines are isolated from one another, the DARB will still function to protect the steering gear.

Each main steering gear is operated by two motor and pump assemblies teed together into a single manifold assembly mounted on a 10 gal. reservoir. The reservoir comes equipped with two low level sensors. The auxiliary steering gear is operated by a helm pump (item 4) normally isolated from the main steering gear by four high pressure shut-off valves (items 12). These valves are installed to ensure that hydraulic fluid will not leak down from the helm reservoir (item 3) into the hydraulic power unit reservoirs over time.

MAIN STEERING GEAR

Each main steering gear is power operated. Its hydraulic power unit consists of two motor driven pump assemblies (items 10) and a reservoir and manifold assembly (item 8) incorporating a power steering manifold mounted on a 10 gal. tank (item 9D). The reservoir is provided with two low-oil alarm sensors (item 9G).

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The power steering manifold incorporates a four way directional solenoid (item 8B) with manual over-ride plungers. These allow for local manual control of the steering gear power unit. The power steering manifold contains a dual pilot operated check (item 8A) at its outlet to lock the steering gear in position.

If the main piping or hydraulic power unit should fail, it can be isolated at its two 3-way shut-off valves and two DARB shut-off valves as described in the table for main piping failure.

If the main cylinder should require isolating from the tiller this can be accomplished by removing its cylinder to tiller pin and turning the cylinder's two 3-way shut-off valves as described in the table for main cylinder isolation. One cylinder only being in operation, the torque delivered to the rudder is reduced and the rudder speed is increased.

AUXILIARY STEERING GEAR

Auxiliary steering is provided from the steering gear compartment. It is intended that the auxiliary manual steering be used for emergency purposes only. The auxiliary steering gear is manually operated from the helm pump located in the steering gear compartment. Manual operation is accomplished by opening the appropriate port or starboard helm pump isolation valves located below the helm pump. The helm pump is provided with a dual pilot operated check valve to lock the steering gear in position.

The circumstances requiring emergency steering might be a failure of one of the port or starboard steering control systems or a failure somewhere in one of the port or starboard main steering gear. The use of manual steering may involve aligning the failed steering gear to zero degrees or turning it as required for maneuvering.

The hydraulic power unit isolation valves (items 9A) are to be closed shortly after the opening of the helm pump isolation valves in order to avoid fluid leakage from the helm reservoir to the main reservoir during manual operation of the steering gear.

If the auxiliary piping should fail, it can be isolated at its two 3-way shut off valves and two DARB shut-off valves as described in the table for auxiliary piping failure.

If the auxiliary cylinder should require isolating from the tiller this can be accomplished by removing its cylinder to tiller pin and turning the cylinder's two 3-way shut-off valves as described in the table for auxiliary cylinder isolation. One cylinder only being in operation, the torque delivered to the rudder is reduced and the rudder speed is increased.

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CYLINDER INTERCONNECTING PIPING

The cylinder interconnecting lines allow the steering gear and DARB valve to be operational after a single failure in either the main or auxiliary piping. The interconnecting piping directs hydraulic fluid from the remaining operable pump unit to both cylinders.

In the event that the cylinder interconnecting piping should fail, isolation of these lines can be achieved at the four 3-way shut-off valves as described in the table for interconnecting piping failure.



2 STEERING GEAR - INSTALLATION

THIS SECTION INCLUDES:

- 2.1 INSTALLATION
- 2.2 PIPING DIAGRAM
- 2.3 OVERALL DIMENSIONS
- 2.4 COMMISSIONING AND TESTING



2.1 INSTALLATION

STEERING GEAR

The selected steering gear will provide the rated torque at the working pressure indicated over the appropriate steering angle.

A permanent reference mark should be made on the rudder stock which indicates when the steering gear is at zero degrees.

Refer to the steering gear arrangement overall dimension drawing and lay out the dimensions accordingly. Ensure that adequate clearance is provided near cylinder ports for the shut off valves and flex hoses. It is highly recommended that the shipyard provide external mechanical stops to limit the rudder movement at its hard-over maximums. The mechanical stops should be placed against the rudder and should not operate using the cylinders in any way. Once installed, the arrangement should remove the possibility of the cylinder's piston reaching the end of its travel.

To ensure SAFE and EFFICIENT operation, the steering gear must be installed under the following conditions:

- a suitable bearing must be provided by the shipyard for supporting the loads transmitted through the rudder stock.
- both rudder stock and tiller hub bore must be dry and free of grease - clean with solvent before installation
- the tiller hub and rudder stock must be matched to ensure adequate surface contact.
- the clearance of the key and key way (if fitted) must not be excessive.
- a positive locking device must be provided by the shipyard to secure the tiller to the rudder stock.
- the cylinder mounting pad supporting structure must be capable of withstanding the maximum rated rudder torque transmitted through the steering gear.
- the cylinders and tiller assembly are mounted on the same horizontal plane.
- the side of the cylinder rod end which is embossed with the word "UP" must face upwards.
- the tiller and cylinders must swing freely without obstruction from flexible hoses and piping.



PIPING

Refer to the piping diagram and overall dimension drawings and determine the final locations of the hydraulic components. Ensure that adequate clearance is provided around each component for interconnecting lines, access to adjustments and maintenance.

All piping, tubing, fittings and hoses are to be supplied by the shipyard unless otherwise specified. The piping and tubing sizes contained in the piping diagram are Jastram's recommended sizes. These are provided for reference only. The shipyard may use other construction types or materials. When choosing a suitable standard, consideration should be given to length of a particular piping run, the type of steering (manual or power) and the normal working pressure expected. Special care should be taken when selecting the nominal diameter of piping for manual hydraulic systems to ensure that piping losses are kept to a minimum. Too many restrictions in manual hydraulic systems will make them feel unnecessarily stiff.

When installing the piping, be certain to keep the working environment clean. Check that the following conditions are met:

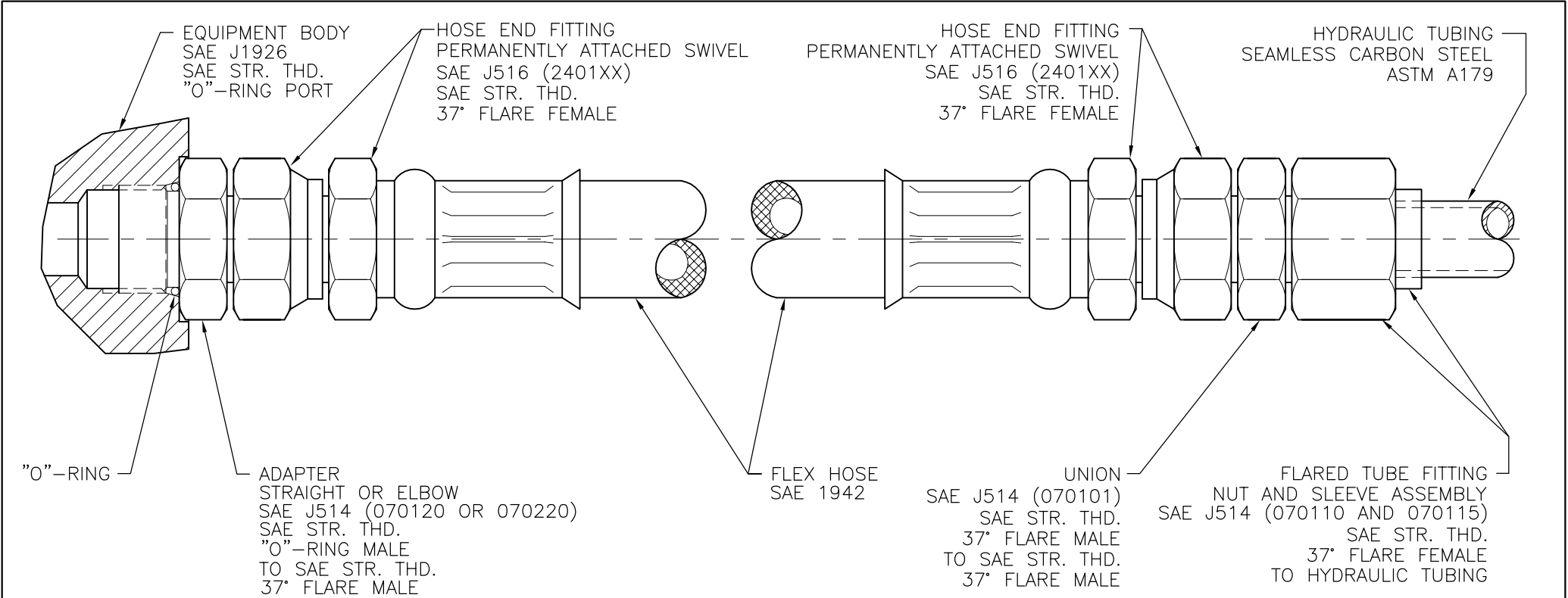
- hydraulic lines run as straight as possible and avoid goosenecks.
- hydraulic lines are rigidly supported by clamps.
- flex hoses should be used between two points where movement or vibration is to be expected. Hoses should be installed so that they bend but do not twist.
- ensure that the length of flex hose is kept to a minimum (excessively long flex hoses can cause stiff steering).
- all tubing, flex hoses, connectors and fittings are thoroughly cleaned (follow the manufacturer's recommendations).
- rags, plastic caps, etc., have not been left inside hydraulic lines.
- air bleed fittings should be provided in the lines where the possibility exists for trapping air.
- the hydraulic oil must be free of contamination.

DO NOT USE BLACK PIPE

Jastram recommends the use of the following hydrocarbon based ISO grade 32 fluids when filling the system:

- Shell Tellus 32
- Chevron EP 32
- Gulf 32 AW
- Exxon Nuto H32

DO NOT USE TRANSMISSION OR BRAKE FLUID



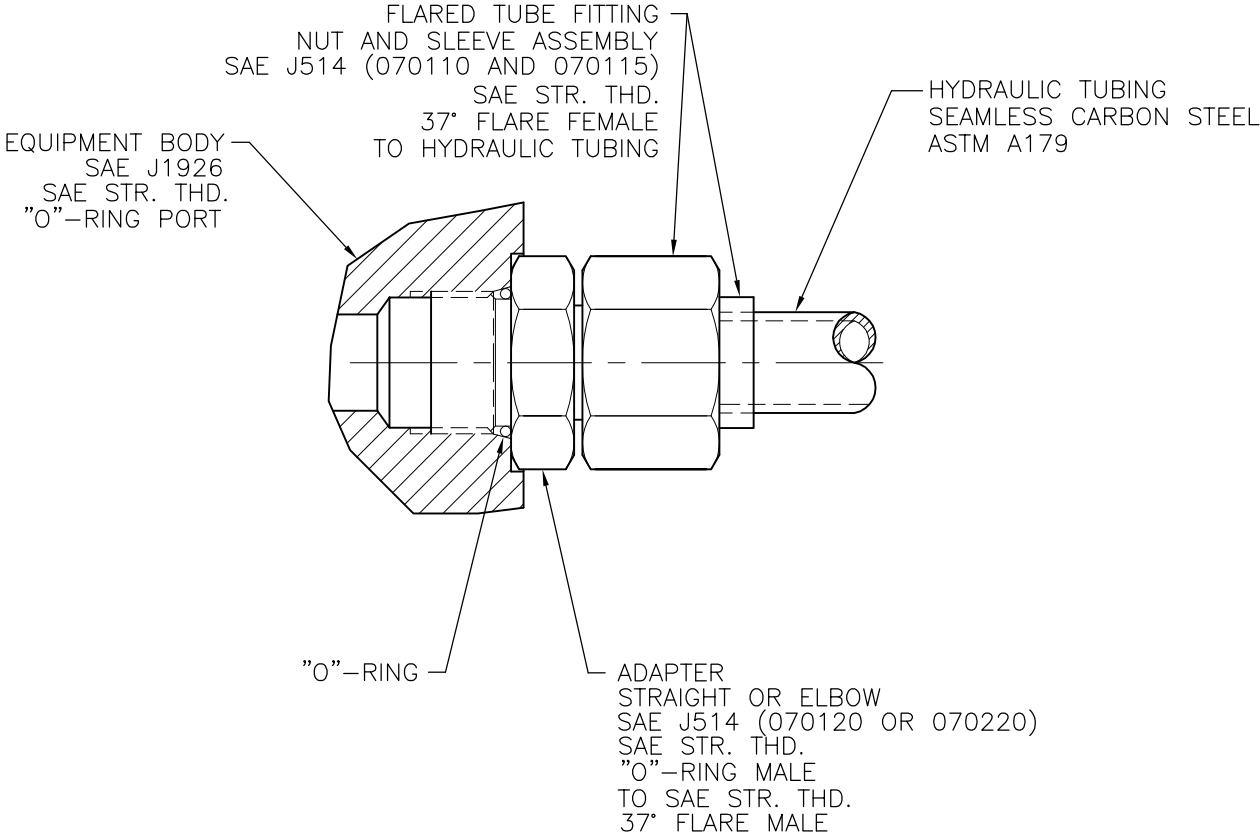
NOTES:

1. ALL PIPES FITTINGS AND HOSES TO BE SHIPYARD SUPPLIED UNLESS OTHERWISE INDICATED ON PIPING DIAGRAM.
2. ALL FITTINGS TO BE MANUFACTURED TO SAE SPECIFICATIONS FOR MATERIALS.
3. FOLLOW FITTING MANUFACTURER'S RECOMMENDED PRACTICE FOR TUBE AND FITTING PREPARATION AND ASSEMBLY PROCEDURES.
4. ALL TUBING TO BE ADEQUATELY SUPPORTED TO ELIMINATE VIBRATION AND TO ENSURE THAT PIPING LOADS ARE NOT TRANSMITTED TO EQUIPMENT.
5. EACH FLEX HOSE ASSEMBLY TO BE LESS THAN 30" IN LENGTH UNLESS OTHERWISE APPROVED BY THE ATTENDING SURVEYOR.
6. MANUFACTURER'S RECOMMENDED PRACTICE TO BE FOLLOWED WHEN ATTACHING PERMANENT CRIMP HOSE FITTING TO HOSE.

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	
ALL DIMENSIONS IN INCH(mm)			

A	24-01-97	SEE DCN 970001	9H
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334			
DATE: 02-10-96 (D/M/Y)	SCALE: NTS	DRAWN: G.C.	APPR. G.C. N/A ENG. PROD.
TITLE: TYPICAL "O"-RING PORT, FLEX HOSE AND TUBING ASSEMBLY			DRAWING NUMBER: B-601136



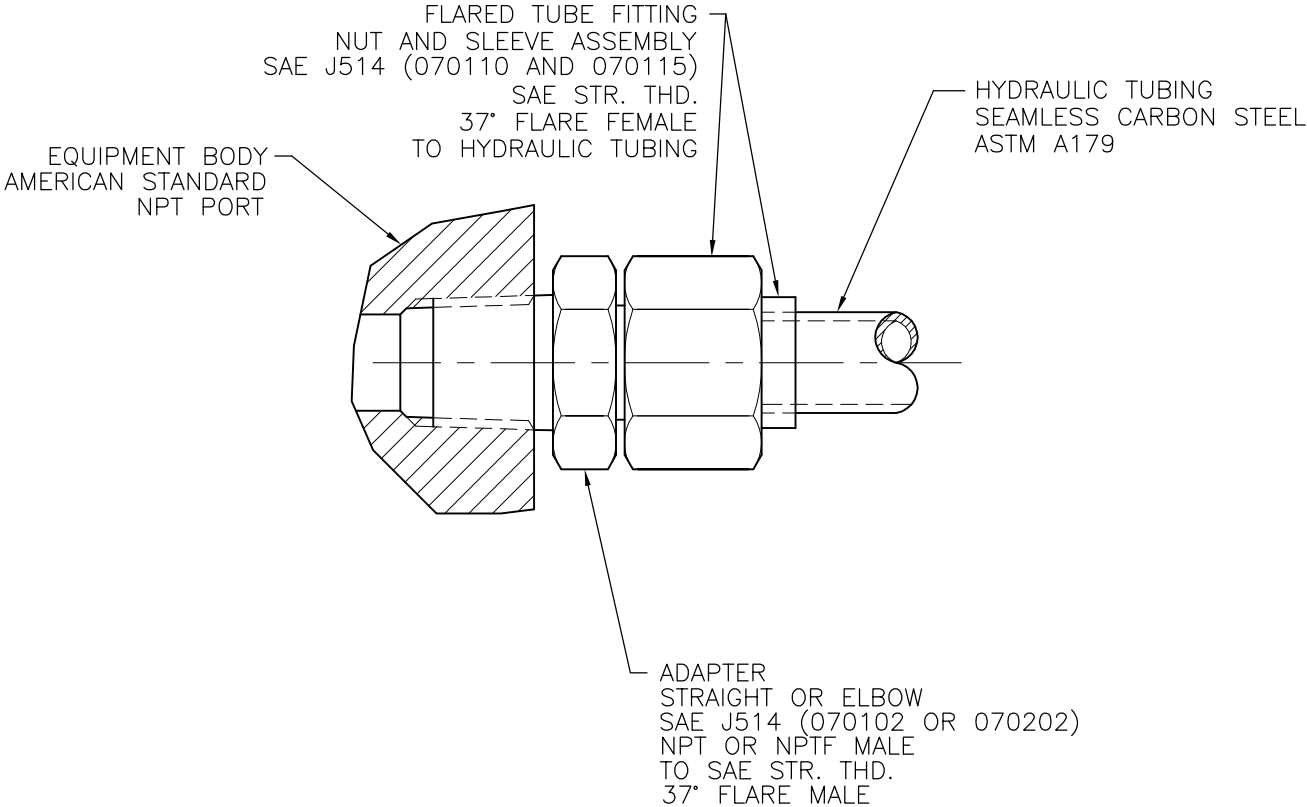
NOTES:

1. ALL PIPES FITTINGS AND HOSES TO BE SHIPYARD SUPPLIED UNLESS OTHERWISE INDICATED ON PIPING DIAGRAM.
2. ALL FITTINGS TO BE MANUFACTURED TO SAE SPECIFICATIONS FOR MATERIALS.
3. FOLLOW FITTING MANUFACTURER'S RECOMMENDED PRACTICE FOR TUBE AND FITTING PREPARATION AND ASSEMBLY PROCEDURES.
4. ALL TUBING TO BE ADEQUATELY SUPPORTED TO ELIMINATE VIBRATION AND TO ENSURE THAT PIPING LOADS ARE NOT TRANSMITTED TO EQUIPMENT.

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	
ALL DIMENSIONS IN INCH(mm)			

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DATE: 02-10-96 (D/M/Y)	SCALE: NTS	DRAWN: G.C.	APPR. G.C. N/A ENG. PROD.
TITLE: TYPICAL "O"-RING PORT AND TUBING ASSEMBLY			DRAWING NUMBER: B-601137



NOTES:

1. ALL PIPES FITTINGS AND HOSES TO BE SHIPYARD SUPPLIED UNLESS OTHERWISE INDICATED ON PIPING DIAGRAM.
2. ALL FITTINGS TO BE MANUFACTURED TO SAE SPECIFICATIONS FOR MATERIALS.
3. FOLLOW FITTING MANUFACTURER'S RECOMMENDED PRACTICE FOR TUBE AND FITTING PREPARATION AND ASSEMBLY PROCEDURES.
4. ALL TUBING TO BE ADEQUATELY SUPPORTED TO ELIMINATE VIBRATION AND TO ENSURE THAT PIPING LOADS ARE NOT TRANSMITTED TO EQUIPMENT.
5. APPLY PIPE THREAD SEALANT SUITABLE FOR HYDRAULIC APPLICATIONS TO ALL BUT THE FIRST TWO THREADS OF NPT MALE THREAD OF ADAPTER. DO NOT USE TEFLON TAPE.

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	
ALL DIMENSIONS IN INCH(mm)			

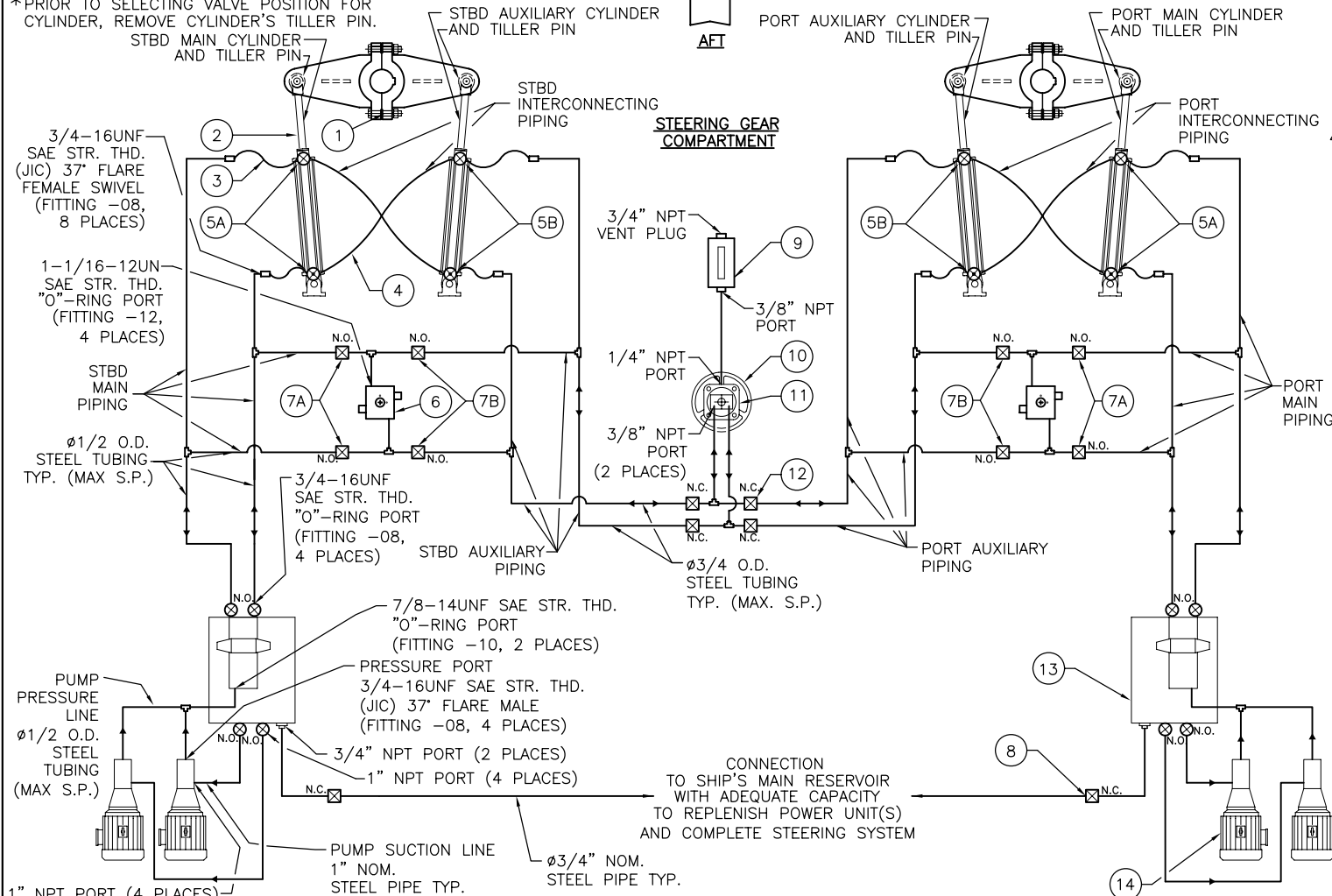
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DATE: 02-10-96 (D/M/Y)	SCALE: NTS	DRAWN: G.C.	APPR. G.C. N/A ENG. PROD.
TITLE: TYPICAL NPT PORT AND TUBING ASSEMBLY			DRAWING NUMBER: B-601138



2.2 PIPING DIAGRAM

CONDITION	3-WAY VALVE POSITIONS		DARB ISOLATION VALVE POSITIONS	
	5A	5B	7A	7B
NORMAL	1	1	N.O.	N.O.
MAIN PIPING FAILURE	3	1	CLOSED	N.O.
AUXILIARY PIPING FAILURE	1	3	N.O.	CLOSED
INTERCONNECTING PIPING FAILURE	2	2	N.O.	N.O.
MAIN CYLINDER ISOLATION	* 4	1	N.O.	N.O.
AUXILIARY CYLINDER ISOLATION	1	* 4	N.O.	N.O.

*PRIOR TO SELECTING VALVE POSITION FOR CYLINDER, REMOVE CYLINDER'S TILLER PIN.



NOTES:

1. HELM PUMP SHOWN FROM REAR VIEW.
2. N.O. - NORMALLY OPEN.
N.C. - NORMALLY CLOSED.
W.P. - WORKING PRESSURE.
S.P. - SYSTEM PRESSURE.
HPU - HYDRAULIC POWER UNIT.
DARB - DOUBLE ACTING RELIEF AND BYPASS.

QTY.	ITEM	DESCRIPTION
2	1	S-300-17-35-2 SPEC. TILLER
4	2	S-300-17 CYLINDER
8	3	FLEX HOSE - 1/2" NOM.
4	4	FLEX HOSE - 1/2" NOM.
4	5A	3-WAY SHUT-OFF VALVE - MAIN PIPING
4	5B	3-WAY SHUT-OFF VALVE - AUXILIARY PIPING
2	6	DARB - 10 GPM
4	7A	DARB SHUT-OFF VALVE-MAIN PIPING-1/2" NOM. (BY OTHERS)
4	7B	DARB SHUT-OFF VALVE-AUX. PIPING-1/2" NOM. (BY OTHERS)
2	8	LOW PRESSURE SHUT-OFF VALVE - 3/4" NOM. (BY OTHERS)
1	9	HEADER TANK - 1.5 L
1	10	STEERING WHEEL
1	11	H-58 HELM PUMP
4	12	HELM PUMP SHUT-OFF VALVE - 3/4" NOM. (BY OTHERS)
2	13	RESERVOIR & MANIFOLD ASSEMBLY
4	14	PUMP & MOTOR ASSEMBLY - 2HP

NOTES (CONTINUED):

3. ALL PIPES, FITTINGS AND HOSES TO BE SHIPYARD SUPPLIED UNLESS OTHERWISE INDICATED.
4. SHIPYARD IS RESPONSIBLE FOR DETERMINING PIPE AND TUBING WALL THICKNESS AND HOSE CONSTRUCTION STANDARDS BASED ON MAXIMUM WORKING PRESSURES AS INDICATED. WHERE PRESSURES ARE NOT INDICATED, PIPES OR TUBE ARE SUBJECT TO LOCAL HYDROSTATIC PRESSURE ONLY. MAXIMUM PRESSURE OF HELM PUMP AUTOFILL LINE (IF SHOWN) IS 30 PSI.
5. PIPING AND TUBING SIZES SHOWN ARE SUGGESTED MINIMUM DIAMETERS. SHIPYARD IS RESPONSIBLE FOR DETERMINING PIPE AND TUBING DIAMETERS BASED ON FLOW RATES AS INDICATED AS WELL AS LENGTH OF PIPING RUN EXPECTED.
6. AVOID "GOOSENECKED" PIPING. SHIPYARD TO PROVIDE AIR BLEED FITTINGS ON PIPING AS REQ'D.
7. ALL PIPES TO BE THOROUGHLY CLEANED PRIOR TO START-UP.
8. FILL SYSTEM WITH ISO 32 HYDRAULIC FLUID.
9. SEE INDIVIDUAL COMPONENT O.A.D. DWG'S FOR LOCATIONS OF PRESSURE AND FLOW ADJUSTMENTS AS WELL AS ELECTRICAL CONNECTIONS.
10. SHIPYARD IS RESPONSIBLE FOR PLACING IDENTIFICATION LABELS ON ALL MAIN AND AUXILIARY 3-WAY AND DARB ISOLATION VALVES ONCE INSTALLATION IS COMPLETE.
11. RESERVOIR (ITEM 9) TO BE LOCATED AT HIGHEST POINT IN STEERING SYSTEM.

STEERING GEAR TORQUE: 17,930 lb.ft (2.5 Tm) AT $\pm 35^\circ$
 MAX. SYSTEM PRESSURE: 1875 PSI (12.9 MPa) - SET AT ITEMS 6, DARB VALVE
 NORMAL WORKING PRESSURE: 1500 PSI (10.3 MPa) - SET AT ITEMS 9, RESERVOIR & MANIFOLD ASS'Y
 FLOW RATE: 1.7 GPM (6.6 L/min) - SET THRU CONTROL SYSTEM

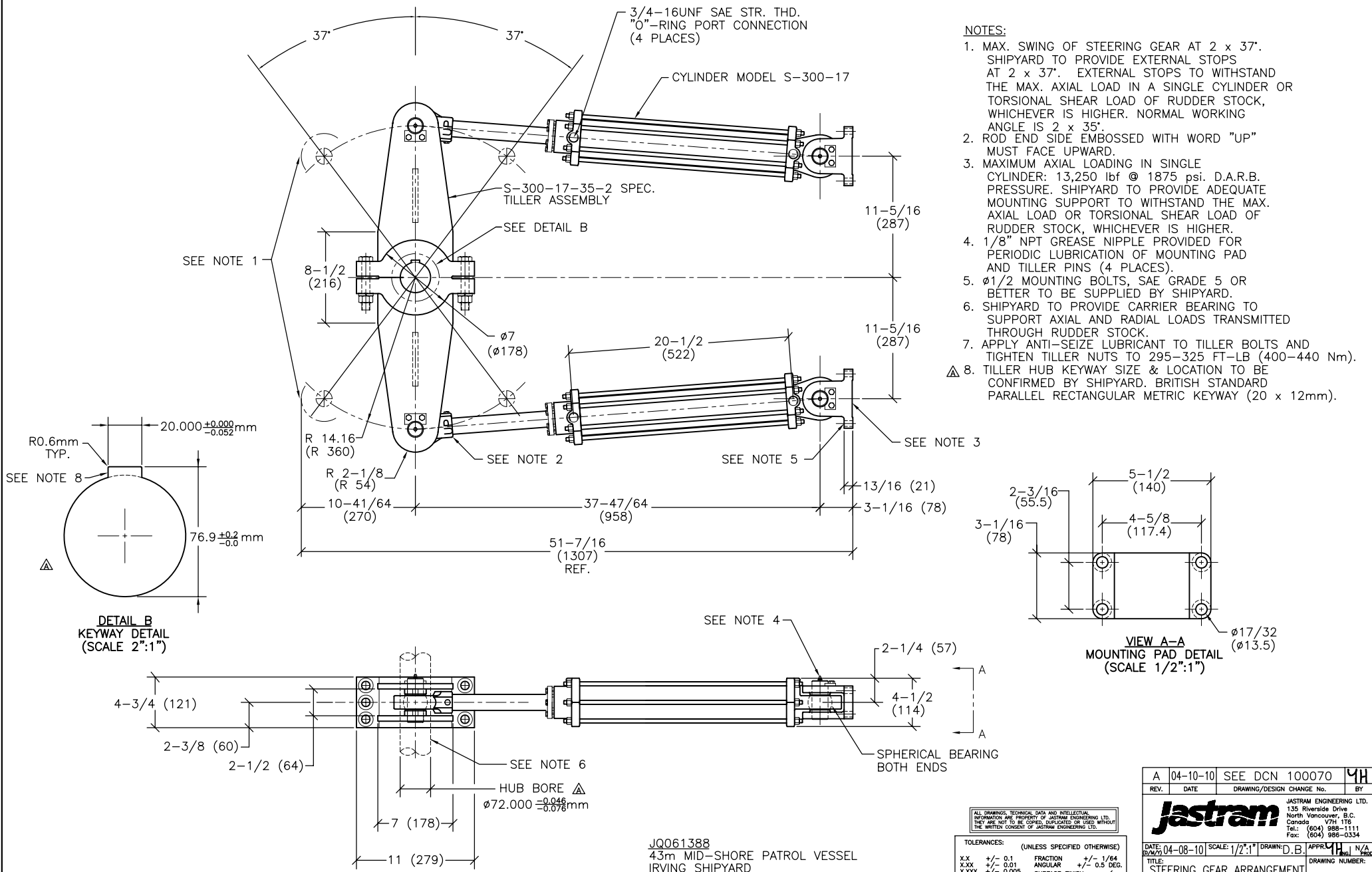
JQ061388
 43m MID-SHORE PATROL VESSEL
 IRVING SHIPYARD

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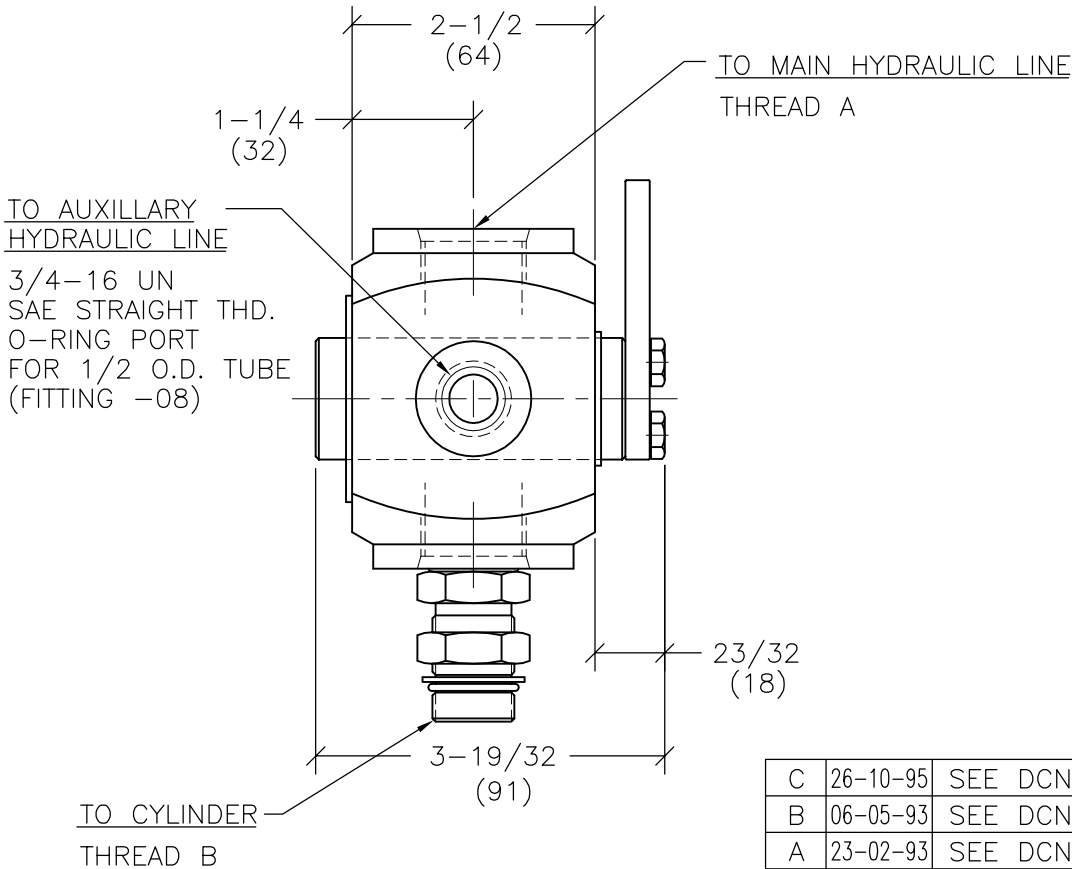
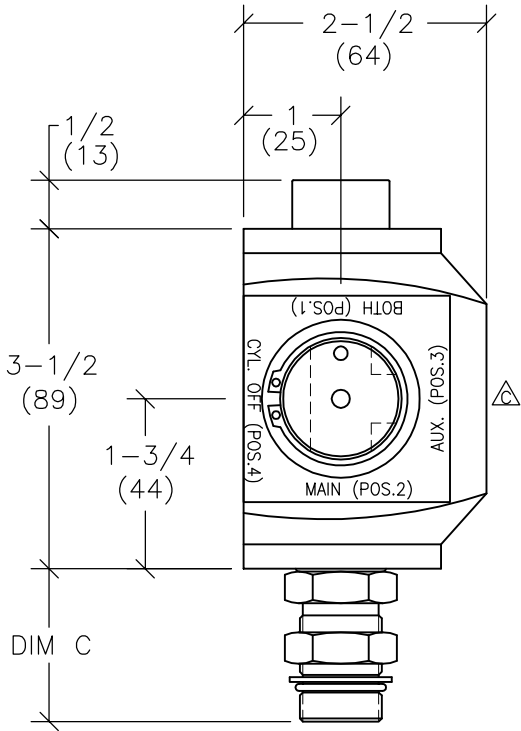
A	12-10-10	SEE DCN 100073	C2
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334			
DATE:	21-07-10	SCALE: N/A	DRAWN: D.B. APPR: C2
TITLE:	PIPING DIAGRAM FOR TWIN S2-25-1-35 STEERING GEAR		
DRAWING NUMBER:	D-601654		



2.3 COMPONENT OVERALL DIMENSIONS



	APPLICATION	THREAD A	THREAD B	DIM C
A	S-300 CYLINDERS	3/4-16UNF SAE STRAIGHT THD. "O"-RING PORT FOR 1/2" O.D. TUBE (FITTING -08) 2 PLACES	3/4-16UNF SAE STRAIGHT THD.	1-9/16 (40)
	S-400, S-500 CYLINDERS	1-1/16-12UN SAE STRAIGHT THD. "O"-RING PORT FOR 3/4" O.D. TUBE (FITTING -12) 2 PLACES	1-1/16-12UN SAE STRAIGHT THD.	2 (51)



NOTES: 1. 3-WAY SHUT OFF VALVE SHOWN IN "BOTH" OPEN OPERATING POSITION.
2. REFER TO OWNER'S MANUAL FOR OPERATING PRINCIPAL.

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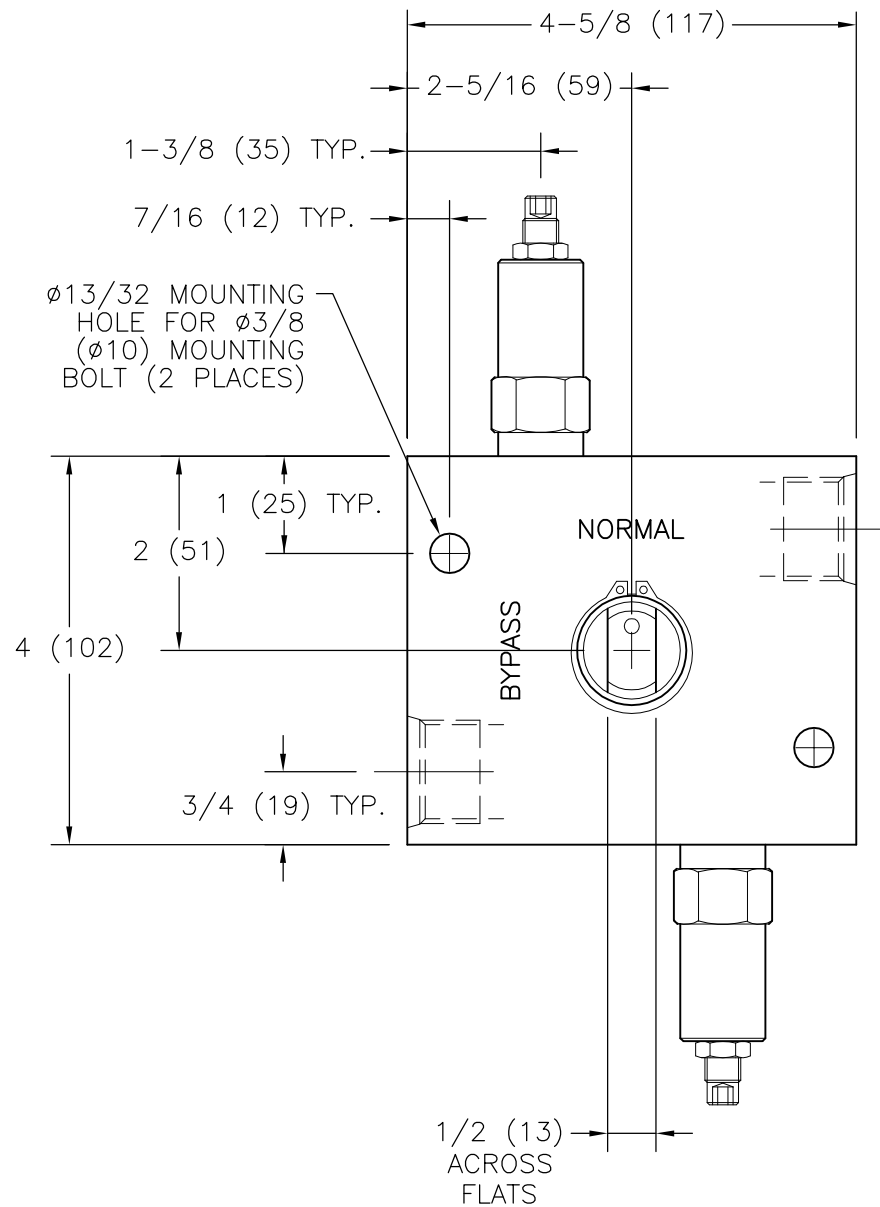
TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓
ALL DIMENSIONS IN INCH(mm)			

C	26-10-95	SEE DCN 950079	
B	06-05-93	SEE DCN 930035	G.C.
A	23-02-93	SEE DCN 930008	G.C.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY

Jastram

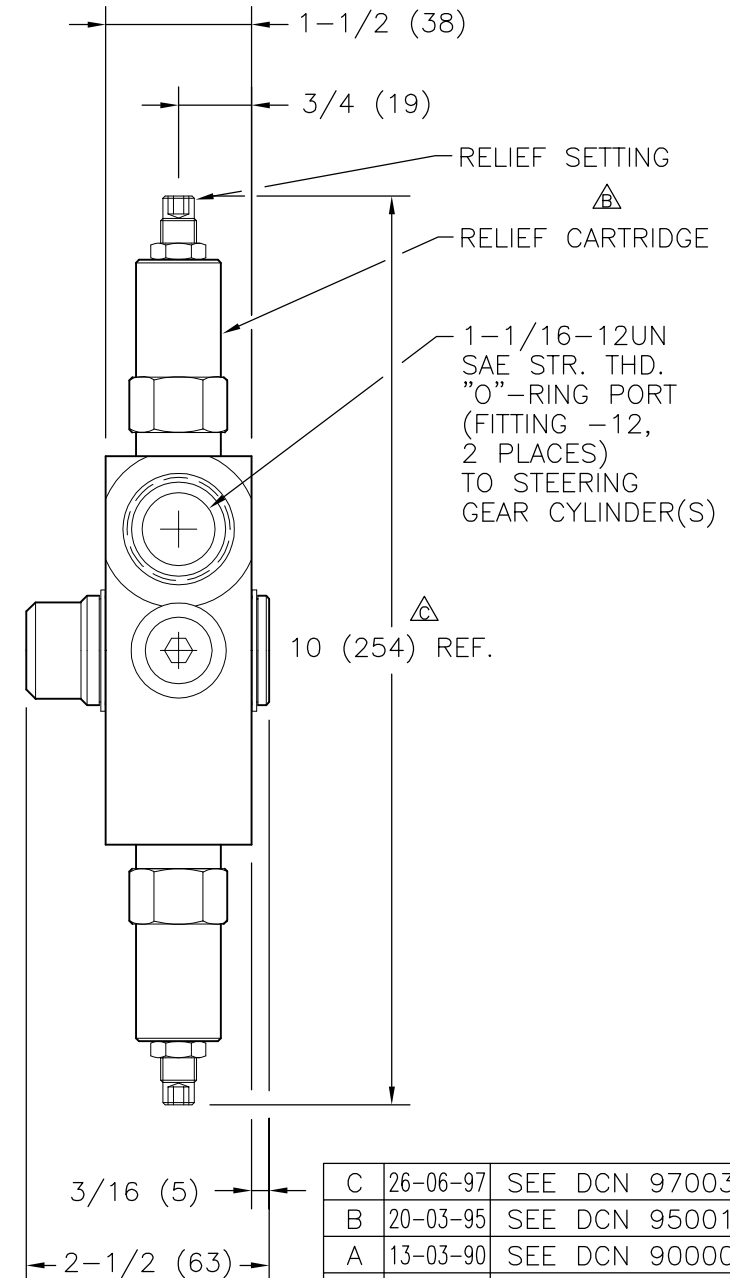
JASTRAM ENGINEERING LTD.
467 Mountain Highway
North Vancouver, B.C.
Canada V7J 2L3
Tel.: (604) 986-0714
Fax: (604) 986-0334

DATE: 08-04-92	SCALE: N.T.S.	DRAWN: M.L.	APPR: G.C. L.L. ENG. PROD.
TITLE: 3-WAY SHUT OFF VALVE O.A.D. (1/2" & 3/4" NOM.)			DRAWING NUMBER: C-421008



NOTES:

1. DOUBLE ACTING RELIEF AND BYPASS VALVE SHOWN IN NORMAL OPERATING POSITION.
2. TO BYPASS CYLINDER, MANUALLY POSITION SPOOL (WITH A SPANNER) TO THE POSITION INDICATING "BYPASS".



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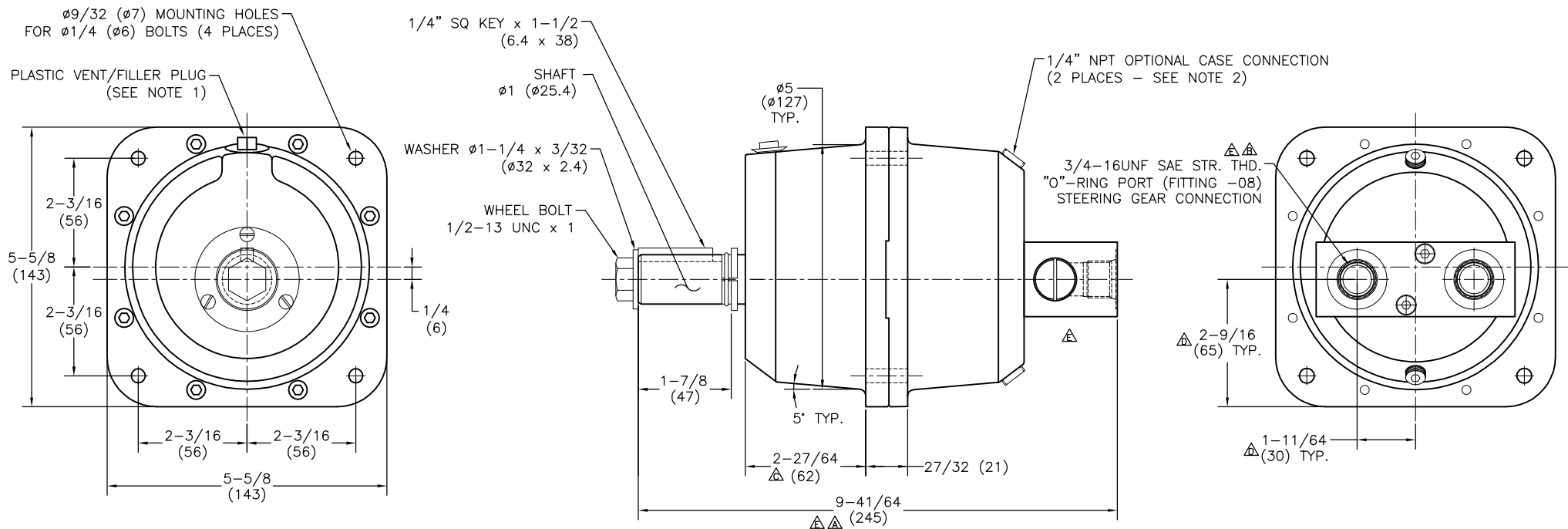
TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
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X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓
ALL DIMENSIONS IN INCH(mm)			

C	26-06-97	SEE DCN 970034	J.L.
B	20-03-95	SEE DCN 950017	L.L.
A	13-03-90	SEE DCN 900006	J.G.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY

Jastram

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467 Mountain Highway
North Vancouver, B.C.
Canada V7J 2L3
Tel.: (604) 986-0714
Fax: (604) 986-0334

DATE: 17-12-03	SCALE: 1":1"	DRAWN: G.C.	APPR. L.L.
TITLE: DARB-10, 20, 30 VALVE O.A.D.	DRAWING NUMBER: C-421001		



NOTES:

1. H58 HELM PUMP MUST BE USED WITH A HEADER TANK OR AUTOFILL SYSTEM.
2. TO ALLOW OIL EXPANSION IN HOT WEATHER CONDITIONS PIERCE UPPER HELM STATION VENT PLUG WITH $\phi 1/16$ " ($\phi 1\text{mm}$) DRILL. IF HELM IS TO BE USED AS A LOWER STATION, REMOVE PLASTIC VENT PLUG AND REPLACE WITH CASE CONNECTION PLUG.
3. ATTACH TOP CONNECTION TO BOTTOM OF UPPER HELM STATION, HEADER TANK, OR AUTOFILL SYSTEM. ATTACH BOTTOM CONNECTION TO TOP OF LOWER HELM STATION.
4. INSTALL IN ACCESSIBLE LOCATION.

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)

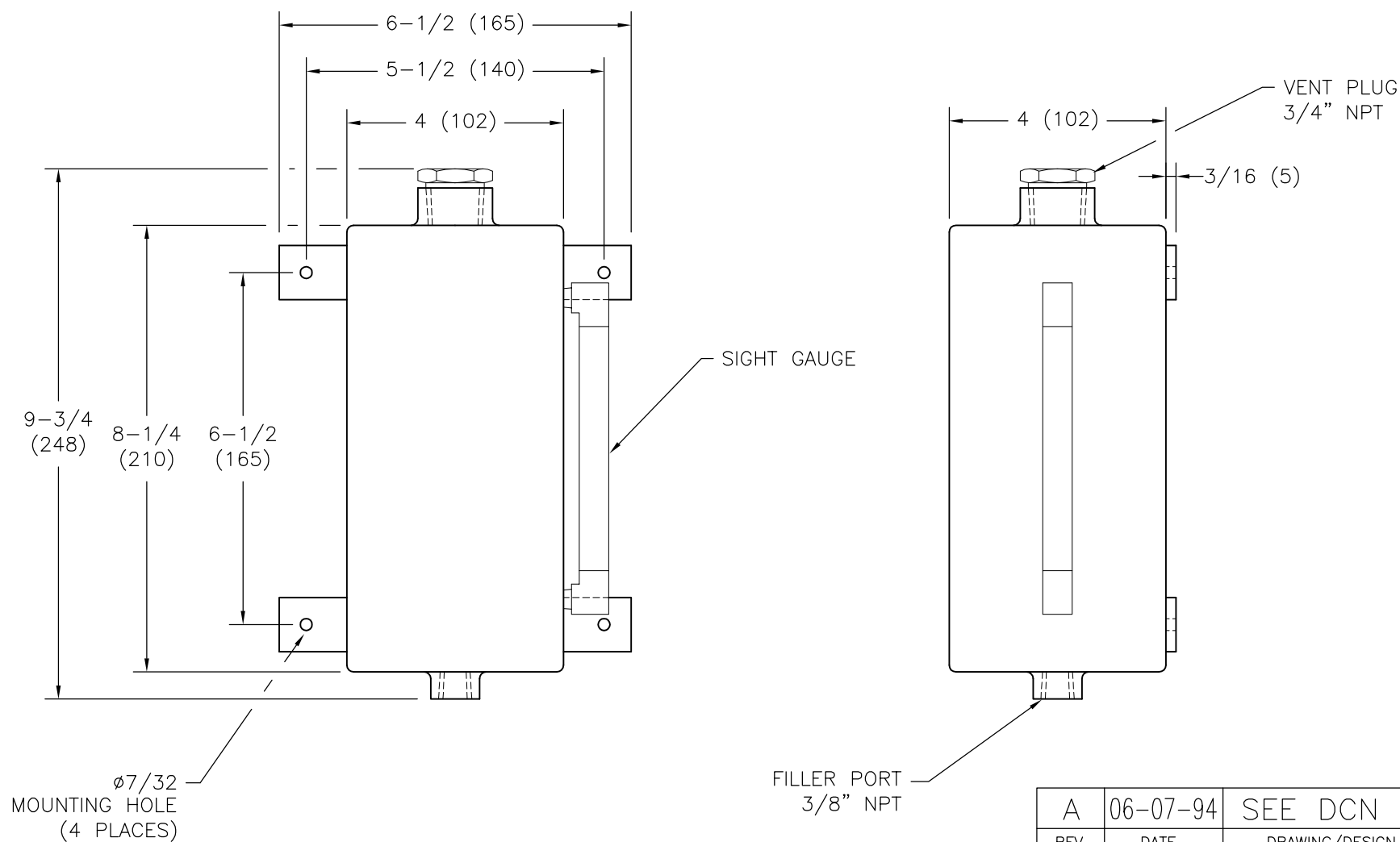
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	

ALL DIMENSIONS IN INCH(MM)

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
E	23-12-09	SEE DCN 090105	
D	13.01.05	SEE DCN 050005	
C	29.01.91	SEE DCN 900041	
B	12.12.90	SEE DCN 900032	
A	16.11.90	SEE DCN 900022	

DATE: 13-01-05	SCALE: 1":1"	DRAWN: G.Q.	APPR: [Signature]
TITLE: H26/36/58 HELM PUMP OVERALL DIMENSION		DRAWING NUMBER: D-331003	

JASTRAM ENGINEERING LTD.
1335 Riverside Drive
North Vancouver, B.C.
Canada V7H 1T6
Tel.: (604) 986-1111
Fax: (604) 986-0334



NOTES:

- HEADER TANK MAXIMUM CAPACITY
0.4 U.S. GALLON (1.5 L)

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)

X.X	+/- 0.1	FRACTION	+/- $\frac{1}{64}$
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	$\frac{-}{\sqrt{\quad}}$

ALL DIMENSIONS IN INCH(mm)

A	06-07-94	SEE DCN 940039	
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
<div>JASTRAM ENGINEERING LTD. 467 Mountain Highway North Vancouver, B.C. Canada V7J 2L3 Tel.: (604) 986-0714 Fax: (604) 986-0334</div>			
DATE: 17-12-03	SCALE: $\frac{3}{8}$ " : 1"	DRAWN: G.C.	APPR.
TITLE: HEADER TANK - 1.5 L OVERALL DIMENSIONS			DRAWING NUMBER: B-521011

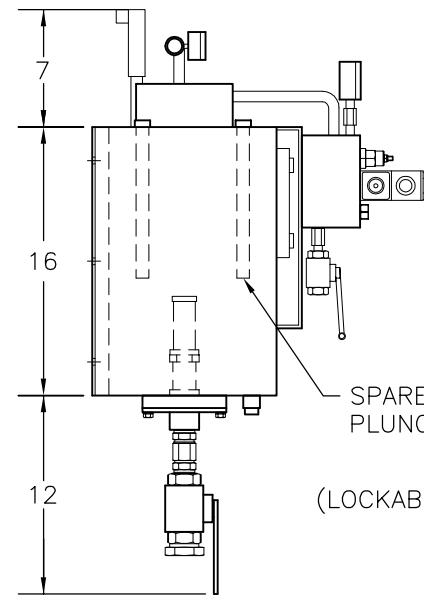
NOTES:

1. LIFT FROM RESERVOIR ONLY.
2. SET SLOW SPEED BEFORE FAST SPEED.
3. NOMINAL RESERVOIR SIZE, 10 US GAL.

JQ061388

43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

SOLENOID JUNCTION BOX - 1/2" NPT CONDUIT PORT



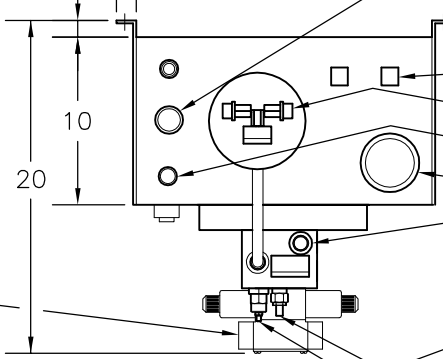
SERVICE FILTER GAUGE
IN-TANK RETURN LINE FILTER

SIGHT & TEMPERATURE
GAUGE (SELF-CLOSING)

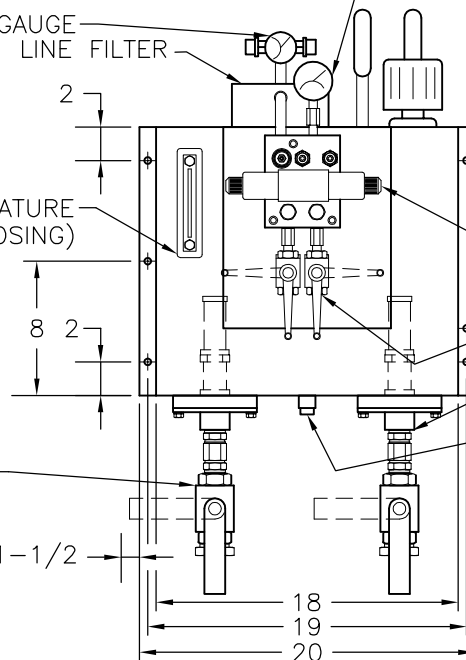
SPARE PORT
PLUNGER PIPE

ISOLATION VALVE
(LOCKABLE) & CONNECTION
TO PUMP SUCTION
1" NPT PORT 1-1/2"
(2 PLACES)

1 TYP. 1-3/16 TYP.



CONNECTION TO MAIN RESERVOIR - 3/4" NPT PORT
LOW LEVEL SENSOR (2 PLACES)
CONNECTION - 1/2" NPT CONDUIT PORT
FILTER CLOGGING SENSOR W/DIN PLUG (2 PLACES)
1/2" NPT PORT (SPARE)
FILLER & AIR BREATHER
TO PUMP(S) PRESSURE LINE - 7/8-14UNF
SAE STR. THD. "O"-RING PORT (FITTING -10)
RUDDER SPEED ADJUSTEMENT
SYSTEM RELIEF SETTING
WORKING PRESSURE GAUGE AND ISOLATOR



Ø13/32" MOUNTING HOLE FOR 3/8" (M10)
MOUNTING SCREWS (6 PLACES)
4-WAY DIRECTIONAL SOLENOID
W/ MANUAL OVERRIDE PLUNGERS
ISOLATION VALVES & CONNECTION TO MAIN
PIPING - 3/4-16UNF SAE STR. THD.
"O"-RING PORT (FITTING -08, 2 PLACES)
SUCTION LINE STRAINER (2 PLACES)
RESERVOIR DRAIN - 1/2" NPT PORT

TOLERANCES:

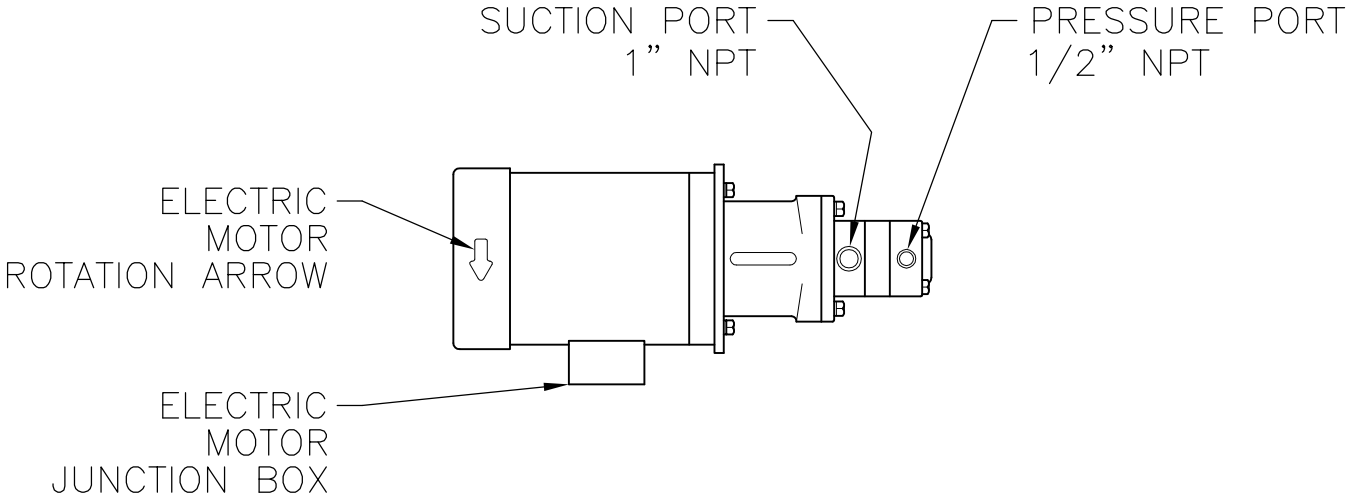
(UNLESS SPECIFIED OTHERWISE)

X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓

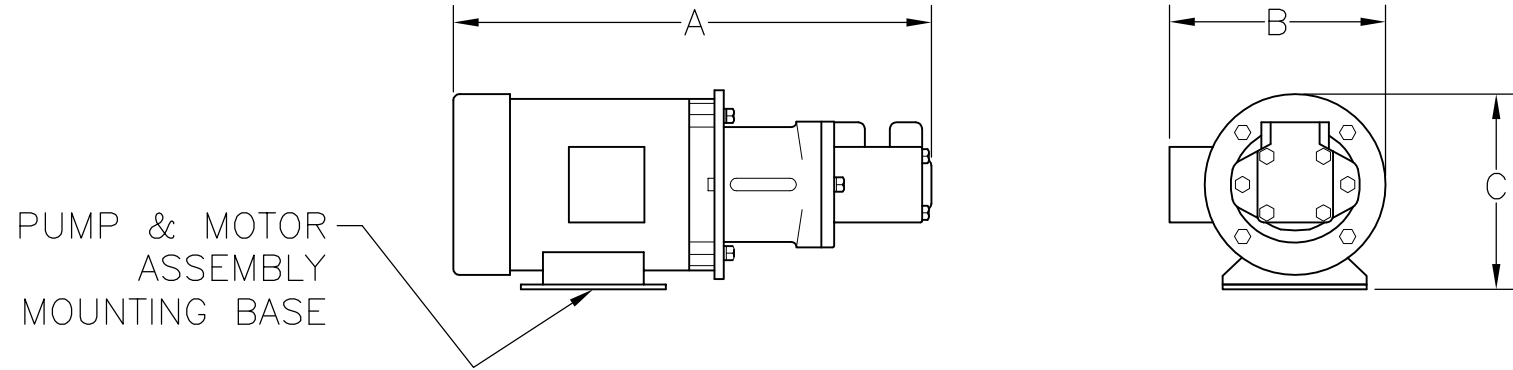
ALL DIMENSIONS IN INCH(mm)

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Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334			
DATE: 21-07-10	SCALE: N.T.S.	DRAWN: D.B.	APPR. N/A
TITLE: RESERVOIR AND MANIFOLD ASS'Y OVERALL DIMENSIONS			DRAWING NUMBER: B-521319



A	20 1/4"
B	8 3/4"
C	7"





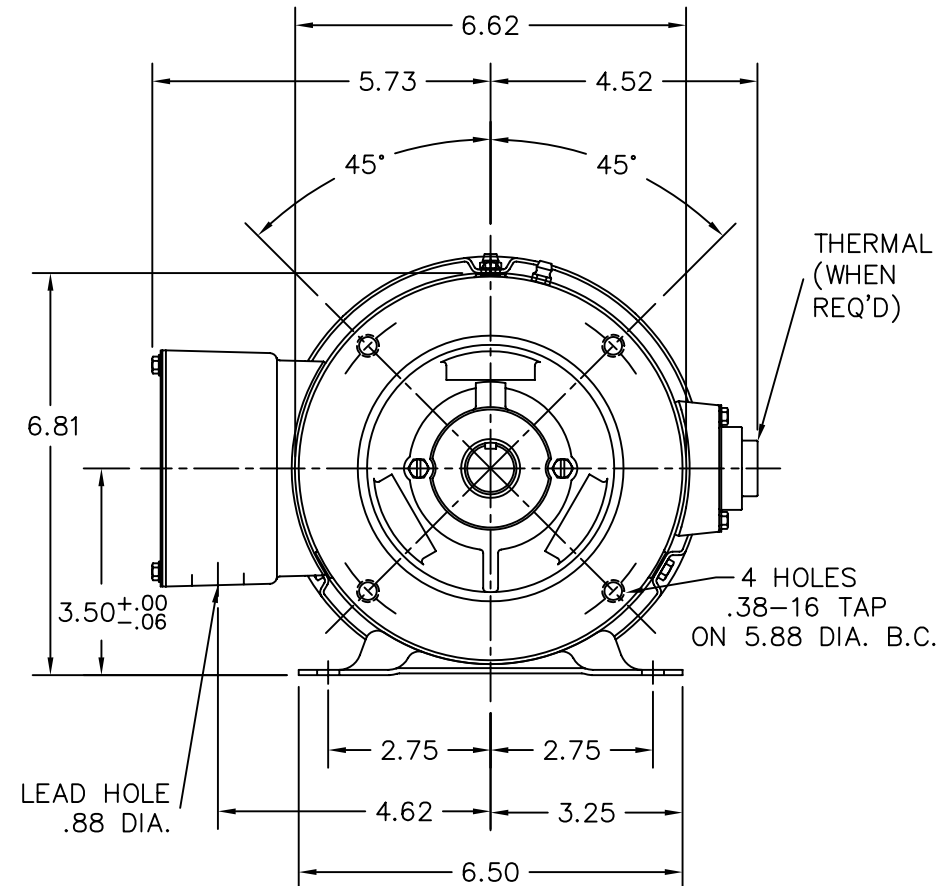
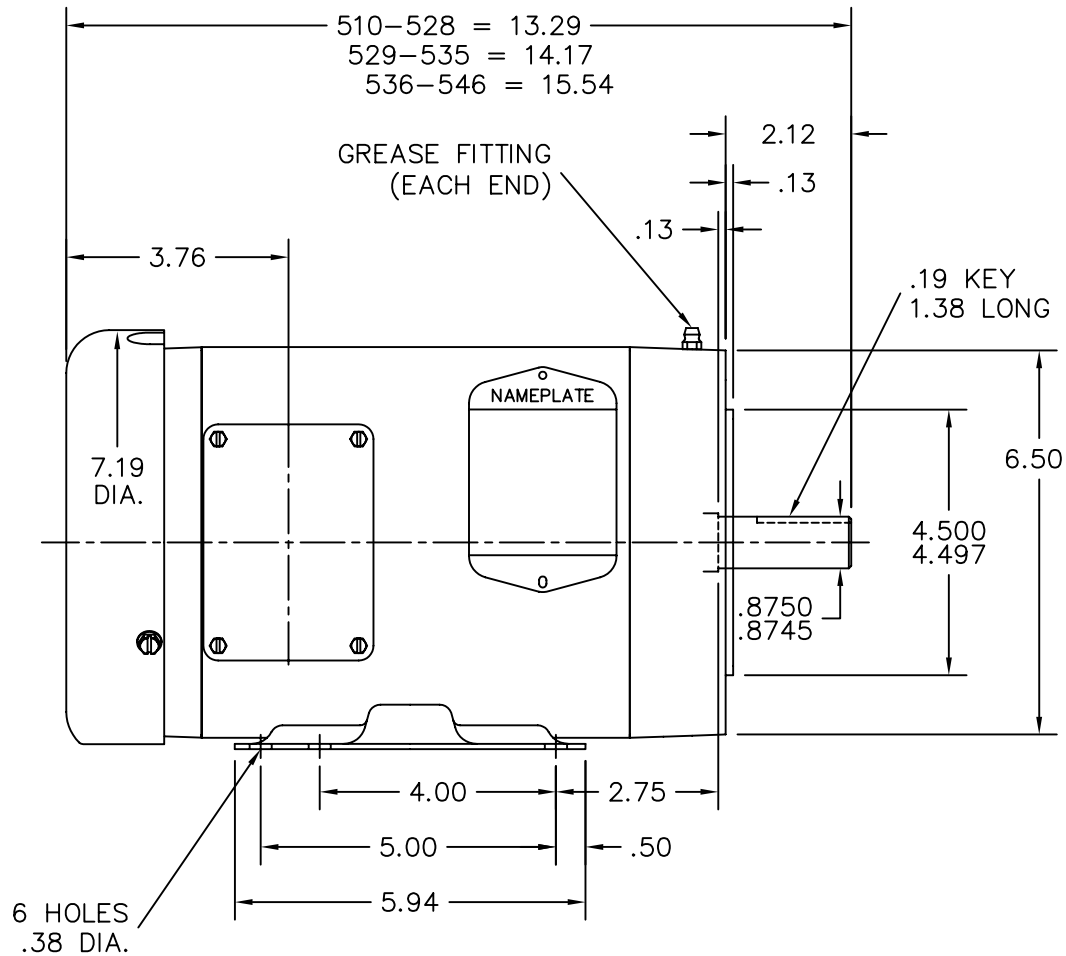
NOTES:

1. SEE "TECHNICAL SPECIFICATIONS – STEERING GEAR" FOR PUMP AND MOTOR INFORMATION.

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓ 125
ALL DIMENSIONS IN INCH(mm)			

REV.	DATE	DRAWING/DESIGN CHANGE No.		BY
		JASTRAM ENGINEERING LTD. 467 Mountain Highway North Vancouver, B.C. Canada V7J 2L3 Tel.: (604) 986-0714 Fax: (604) 986-0334		
DATE: (D/M/Y)	19-02-04	SCALE:	N/A	DRAWN: C.S.
TITLE: PUMP AND MOTOR ASSEMBLY O.A.D.				APPR.  N/A ENG. PROD.
				DRAWING NUMBER: B-521194



CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

REV. DESC: UPDATED TO CURRENT STD

REV. LTR: P BY: RMP REVISED: 07:20:46 04/15/2004 TDR: 330185

35LYA002

FILE: AAA00002416

REF: 35LYA002

MTL: -

BALDOR ELECTRIC Co.

STD HORZ 143-5TC TEFC 35M



2.4 COMMISSIONING & TESTING

<p>READ THE TECHNICAL DESCRIPTION AND REVIEW ALL RELEVANT SCHEMATICS TO FAMILIARIZE YOURSELF WITH THE STEERING SYSTEM BEFORE PROCEEDING TO START UP.</p>

GENERAL CHECK LIST

Ensure that the installation requirements of this manual are satisfied before proceeding with the commissioning and testing.

Before the steering gear is commissioned it is suggested that the hydraulic reservoir low oil level alarm be tested and used throughout the following procedure. It should be confirmed that the directional solenoid can be operated either manually or through the control system.

If the solenoid does not have provision for manual operation then the steering control system should be set up enough for simple port and starboard commands to be given. The remainder of the steering control system can be commissioned once the steering gear is tested and performs satisfactorily.

Before starting the hydraulic power unit and operating the steering gear confirm that the following conditions are met:

- the hydraulic reservoirs are completely full of oil.
- all the shut off valves on the cylinders and at the outlets of the hydraulic manifold are opened.
- any shut off valves in line with the pump are opened and wired or locked in this position.
- the relief valve for setting the normal working pressure is adjusted to its minimum setting.

CYLINDERS

Ensure that all the grease nipples on the tiller pins, cylinder mounting pad pins and tiller thrust bearings have been lubricated.



HYDRAULIC POWER UNIT START-UP

Before starting, make sure the area around the steering gear and pump motor is clear of equipment and personnel. The start-up procedure is best performed by two people. One to start and stop the pump and control the solenoid and the other to monitor the operation of the pump and steering gear.

Determine the correct direction of pump rotation from the arrows embossed on the pump housing or sticker on the electric motor. Momentarily start the pump and confirm the pump shaft is turning correctly. If the pump is turning backwards then stop it immediately. A three phase electric motor's direction may be switched by swapping any two leads of its three phase supply.

As soon as it is determined that the pump is turning correctly operate the directional solenoid to port and starboard. Bring up the working pressure at the relief valve and the steering gear speed at the flow control valve just enough to allow the steering gear to turn at a manageable speed. Have someone watch the steering gear to ensure that it does not turn all the way to the mechanical stops at its maximum angle. Continue to turn the steering gear back and forth to remove the air from the system. This should be repeated until the steering gear responds immediately and smoothly to both port and starboard commands.

PRESSURE TESTING AND DARB SETTING

The piping diagram or technical specifications should be referenced for the individual component settings. Refer to the overall dimension drawings for the locations of pressure and flow adjustments.

The first setting to be made on the steering hydraulic system should be the Double Acting Relief and Bypass (DARB) valve. Jastram presets the DARB valve at the factory, but the valve relief accuracy should be checked on board.

Before this valve is set it is suggested that the power unit motor overload alarm be tested (please see the Motor Starter and Alarm section of this manual).

The DARB valve contains two cross port relief valves that are usually set to 1.25 times the normal working pressure. Please note that motor and hydraulic pump are sized for working pressure, not for DARB pressure. Therefore, minimum time should be spent running the hydraulic system at pressure higher than the normal working pressure. Motor temperature and overload alarm are to be monitored throughout the following procedure.



To set the DARB pressure do the following:

- close all the shut-off valves on the cylinder ports.
- with the pump running give the directional solenoid a constant command in one direction.
- bring up the setting on the power steering manifold pressure relief valve and DARB valve (also the pressure compensator setting if a variable displacement pump is fitted) until the pressure gauge is reading slightly above the required DARB relief pressure.
- determine which DARB relief adjustment is operational for that directional solenoid command and set this adjustment to the required pressure. Secure the setting.
- turn the directional solenoid the other direction and set the other DARB relief adjustment to the same setting and again secure the setting.

Both port and starboard hydraulic lines have now been tested slightly above their maximum pressure so this is a good time to check for leaks and correct any that are found. Use a flashlight and run your finger under all the fittings to look for leaks.

NORMAL WORKING OR BACK-UP RELIEF PRESSURE SETTING

The next setting will be the normal working pressure on a fixed displacement pump system or the back-up relief setting on a variable displacement pump system. Both of these adjustments are made at the relief valve on the power steering manifold. To set these do the following:

- with the cylinder shut-off valves still closed and the pump running, again give the solenoid a command.
- adjust the relief setting down to the required value and secure the setting.

If the steering gear being commissioned has a fixed displacement pump system then this will be the final pressure setting. If so, the shut-off valves on the cylinders may now be opened and the commissioning may proceed with the flow control setting described below.



PRESSURE COMPENSATOR AND LOAD SENSE PRESSURE SETTINGS (VARIABLE DISPLACEMENT PUMPS SYSTEMS ONLY)

The next settings will be for variable displacement pump systems only. Refer to the overall dimension drawing for the pump and set the pressure compensator by completing the following:

- with the cylinder shut off valves still closed and the pump running, again give the solenoid a command.
- adjust the slotted pressure compensator adjustment screw down to the normal working pressure of the system.

The load sense setting of variable displacement pumps is preset at the factory so they should not require adjusting. Confirm the following:

- open all the cylinder shut off valves.
- allow the pump to idle with no command at the directional solenoid.
- the pressure gauge should read approximately 300 psi.
- if the pressure gauge is out by more than 25 psi remove the O-ring boss plug that covers the adjustment screw and reset the load sense using a hex socket wrench (Allen wrench). Some slight leakage may occur once the o-ring is removed but this will cease after it is replaced

This will complete all the settings on a variable displacement pump system.

FLOW CONTROL SETTING (FIXED DISPLACEMENT PUMPS SYSTEMS ONLY)

The next setting will be for fixed displacement pump systems only - the flow control of variable displacement systems is set through the steering control system. The flow control is set by timing the steering gear from hardover to hardover. It is recommended that the rudder angle limit switches of the steering control system be set before attempting this adjustment.

To set the flow control, alternately adjust the flow control valve and time the steering gear from hardover to hardover until the required time is reached. Secure the flow control setting. If the system installed is using an engine driven pump, the hardover speed adjustment should be made at the engine RPM for which the pump has been sized.



AUTO-FILL VALVE SETTING (HELM PUMP AUTO-FILL SYSTEMS ONLY)

The auto-fill valve should be set before connecting the helm pump air bleed line to the auto-fill line.

Complete the auto-fill line installation as described on the piping diagram. To set the auto-fill valve, disconnect the helm pump air bleed line from the air bleed isolation valve between helm pump and isolation valve. Install a low pressure gauge (typically 100 psi gauge) on the isolation valve. Open the air bleed isolation valve, and start up the hydraulic power unit to induce flow in the auto-fill line.

Disconnect the auto-fill return line from the hydraulic reservoir. Check that oil is circulating and that air is purged from the auto-fill line (steady and clear return flow). Increase the flow setting at the auto-fill valve if oil does not circulate.

After a steady flow has been achieved, the pressure reading at the air-bleed isolation valve must not exceed 15 psi. If it does, reduce the flow setting at the auto-fill valve.

At last, and while the hydraulic power unit is still running, re-connect the auto-fill line on the hydraulic reservoir, close the helm pump air bleed isolation valve, remove the pressure gauge and connect the helm pump air bleed line to the isolation valve. Open the isolation valve and turn the helm pump to purge any trapped air.



3 STEERING GEAR - MAINTENANCE

THIS SECTION INCLUDES:

- 3.1 MAINTENANCE
- 3.2 COMPONENT ASSEMBLIES AND PART LISTS
- 3.3 COMPONENT MANUALS
- 3.4 TROUBLE SHOOTING



3.1 MAINTENANCE

ROUTINE MAINTENANCE

Refer to the steering gear arrangement drawing for the locations of grease nipples. The following points should be lubricated on a regular basis:

- cylinder rod end bearings.
- cylinder mounting pad bearings.
- tie bar bearings.
- rudder stock bearing surfaces.

The return line filter is provided with a service filter gauge. This gauge should be read when the steering gear pump is delivering its largest normal flow to determine the condition of the filter. The filter should be changed in a regular maintenance program.

All manual and power steering systems should have their operation routinely checked. At this time the piping and fittings should be checked for leaks.

Worn or defective parts should be replaced as soon as a problem becomes evident in order to reduce the possibility of the problem affecting or damaging other components. Jastram components and their parts are listed in this section and in the component manuals to allow the customer to reference and order replacement parts if necessary.

On S Model cylinders, the seal retainer should be tightened if leakage is detected on the cylinder rod. Install a new locking wire after this operation.

ORDERING

Please see the Distributors Directory section of this manual for a list of local suppliers.



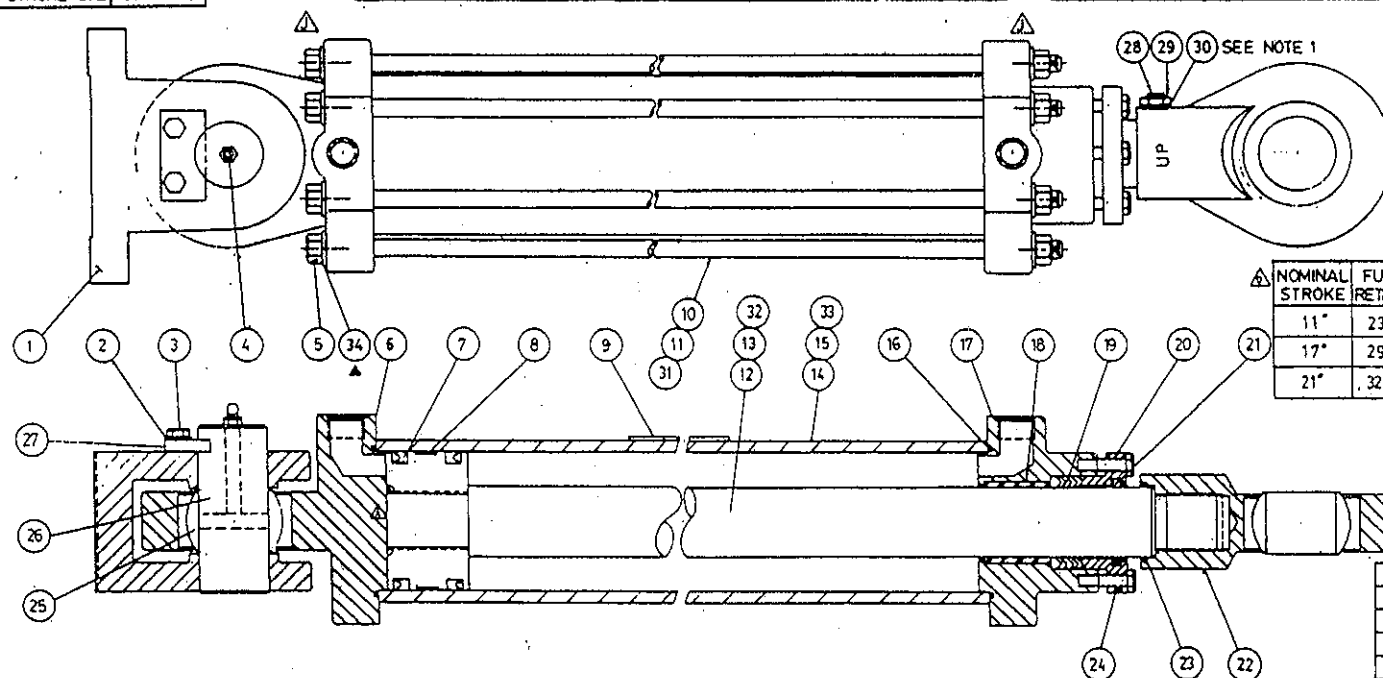
3.2 COMPONENT ASSEMBLIES AND PART LISTS

6	--	31	211008-3	TIE ROD, 21" STROKE	
1	--	32	201003-3	PISTON & ROD ASS'Y, 21" STROKE	INSEP ASS'Y
1	--	33	211004-3	BARREL, 21" STROKE	
12	12	34	314006	FLAT WASHER	

--	1	--	15	211004-2	BARREL, 17" STROKE	
2	2	2	16	201151	O-RING - 151 3 X 3 1/16 X 1/32	BUNA-N 70 DURE
1	1	1	17	211000-1	HEAD	
1	1	1	18	211013-1	BEARING SLEEVE	
1	1	1	19	207002	V-PACKING	
6	6	6	20	306004	HEX HD. CAPSCREW	
1	1	1	21	208004	ROD WIPER	
1	1	1	22	211009-1	S-300 ROD END	
1	1	1	23	201029	O-RING - 029 1 1/2 X 1 5/8 X 1/16	BUNA-N 70 DURE
1	1	1	24	211011-1	SEAL RETAINER	
2	2	2	25	403006	SPHERICAL BEARING	
1	1	1	26	211007-1	MOUNTING PAD PIN	
1	1	1	27	211015-1	PIN KEEPER	
1	1	1	28	211039-1	SET SCREW	
1	1	1	29	327005	HEX NUT	
1	1	1	30	320002	LOCK WASHER	

DASH NO.	ITEM NO.	PART NO.	DESCRIPTION	SPEC
-3	-2	-1		
1	1	1	211010-1	MOUNTING PAD
2	2	2	320004	LOCKWASHER
2	2	2	306005	HEX HEAD CAPSCREW
1	1	1	512001	GREASE NIPPLE
12	12	12	327002	HEX NUT
1	1	1	211002-1	TAIL
2	2	2	205004	U-CUP
1	1	1	216002	WEAR RING
1	1	1	901005	SERIAL/IDENT LABEL
--	6	10	211008-1	TIE ROD, 11" STROKE
--	6	11	211008-2	TIE ROD, 17" STROKE
--	1	12	201003-1	PISTON/ROD ASSY, 11" STROKE
--	1	13	201003-2	PISTON/ROD ASSY, 17" STROKE
--	1	14	211004-1	BARREL, 11" STROKE

CYL. MODEL	DASH NO.	APPLICATION	ASS'Y NO.
S-300-11	-1	11" STROKE CYL	201000-1
S-300-17	-2	17" STROKE CYL	201000-2
S-300-21	-3	21" STROKE CYL	201000-3



NOTES:

1. TIE ROD NUTS (ITEM NO.5) TIGHTENING TORQUE IS 34 LB.FT.

CUSTOMER PARTS LIST

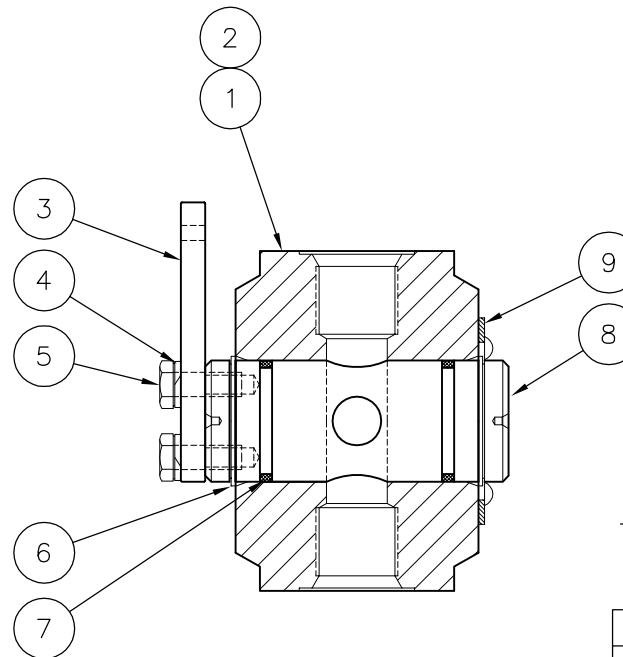
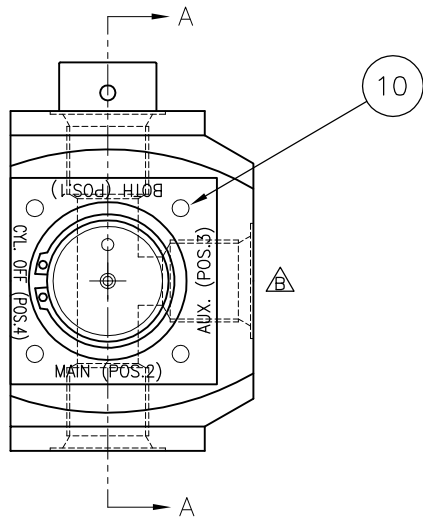
K	03-12-96	SEE DCN 960073	
J	28-05-96	SEE DCN 960019	
I	30-01-95	SEE DCN 950008	
H	31-05-94	SEE DCN 940037	
G	18-04-94	SEE DCN 940032	
F	09-03-94	SEE DCN 940026	
E	11-01-93	SEE DCN 930008	
D	03-02-93	SEE DCN 930006	
C	12-06-90	SEE DCN 900032	
B	05-28-90	SEE DCN 900015	
A	03-07-90	SEE DCN 900004	
--	1-18-90	PRODUCTION ISSUE	

ALL DIMENSIONS ARE IN INCHES
UNLESS OTHERWISE SPECIFIED
TOLERANCES:
FRACTIONS DECIMALS ANGLES
FRACTIONS DECIMALS ANGLES
FRACTIONS DECIMALS ANGLES

Justus
10000
S-300 CYLINDER ASSEMBLY
0-201000

DASH No.	APPLICATION	ASSEMBLY No.
-1	S-300 CYLINDERS	401016-1
-2	S-400, S-500 CYLINDERS	401016-2

	No.		ITEM No.	PART No.	DESCRIPTION	SPEC.
	-2	-1				
	QTY.					
△	-	1	1	411042-1	3-WAY SHUT OFF VALVE BODY (S-300)	
△	1	-	2	411042-2	3-WAY SHUT OFF VALVE BODY (S-400/500)	
	1	1	3	411046-1	3-WAY SHUT OFF VALVE HANDLE	
	2	2	4	320001	LOCKWASHER	
	2	2	5	306057	HEX HD. CAPSCREW	
	2	2	6	345003	SNAP RING	
△	2	2	7	201121	0-RING-121, 1-1/16 ID x 1-1/4 OD x 3/32 SEC.	BUNA N70 DURO
	1	1	8	411043-1	3-WAY SHUT OFF VALVE SPOOL	
	1	1	9	411072-1	3-WAY SHUT-OFF VALVE OPERATION PLATE	
	4	4	10	343018	DRIVE SCREW	
	1	3	11	553006	SHIPPING PLUG (NOT SHOWN)	
	2	-	12	553008	SHIPPING PLUG (NOT SHOWN)	



SECTION A-A

CUSTOMER COPY

NOTES:

1. 3-WAY SHUT OFF VALVE SHOWN IN NORMAL OPERATING POSITION.
2. SEE APPLICATION TABLE FOR PART No.
3. FINISH HONE BODY AND LAP FIT TO SPOOL ON ASSEMBLY.
4. BODY AND SPOOL ARE SUPPLIED AS AN INSEPARABLE ASSEMBLY.
5. REFER TO OWNER'S MANUAL FOR OPERATING PRINCIPLE.

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)

X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓

ALL DIMENSIONS IN INCH(mm)

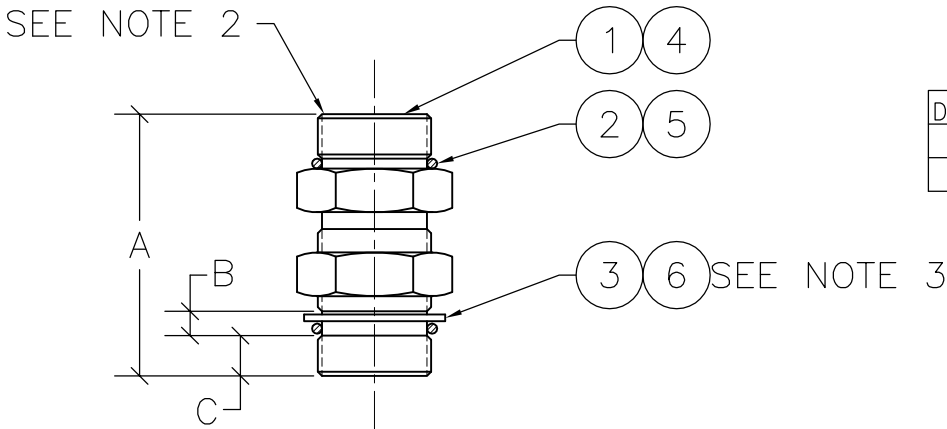
D	26-11-02	SEE DCN 020045	10
C	05-08-99	SEE DCN 990027	G.C.
B	26-10-95	SEE DCN 950079	G.C.
A	07-05-93	SEE DCN 930035	G.C.
-	05-02-92	PRODUCTION ISSUE	L.L.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY

Jastram

JASTRAM ENGINEERING LTD.
467 Mountain Highway
North Vancouver, B.C.
Canada V7J 2L3
Tel.: (604) 986-0714
Fax: (604) 986-0334

DATE: 02-20-91	SCALE: N.T.S.	DRAWN: M.L.	APPR: G.C. L.L. PROD
TITLE: 3-WAY SHUT OFF VALVE ASS'Y (1/2" & 3/4" NOM.)	DRAWING NUMBER: C-401016		

No.		ITEM No.	PART No.	DESCRIPTION	SPEC.
-2	-1				
QTY.					
-	1	1	544001	-08 BULK HEAD TUBE UNION w/ NUT	
-	2	2	203908	"0"-RING-908, 41/64 ID x 13/16 OD x 3/32 SEC.	
-	1	3	401019-3	CAPTIVE WASHER, 1.025 ID x 23/32 OD x 0.05 SEC.	
1	-	4	544002	-12 BULK HEAD TUBE UNION w/ NUT	
2	-	5	203912	"0"-RING-912, 59/64 ID x 1-5/32 OD x 7/64 SEC.	
1	-	6	401019-4	CAPTIVE WASHER, 1.45 ID x 1-1/8 OD x 0.05 SEC.	



DASH No.	APPLICATION	DIM A	DIM B	DIM C	ASSEMBLY No.
-1	S-300 CYLINDERS	1-15/16	3/16	5/16	401019-1
-2	S-400, S-500 CYLINDERS	2-7/16	1/4	3/8	401019-2

CUSTOMER PART LIST

- NOTES: 1. SUPPLIED AS AN INSEPERABLE ASSEMBLY. SEE APPLICATION TABLE FOR ASSEMBLY PART No.
2. MACHINE OFF 37°, BOTH SIDES.
3. CAPTIVE WASHER MADE ON ASSEMBLY. SEE PARTS LIST DESCRIPTION FOR DIMENSIONS.

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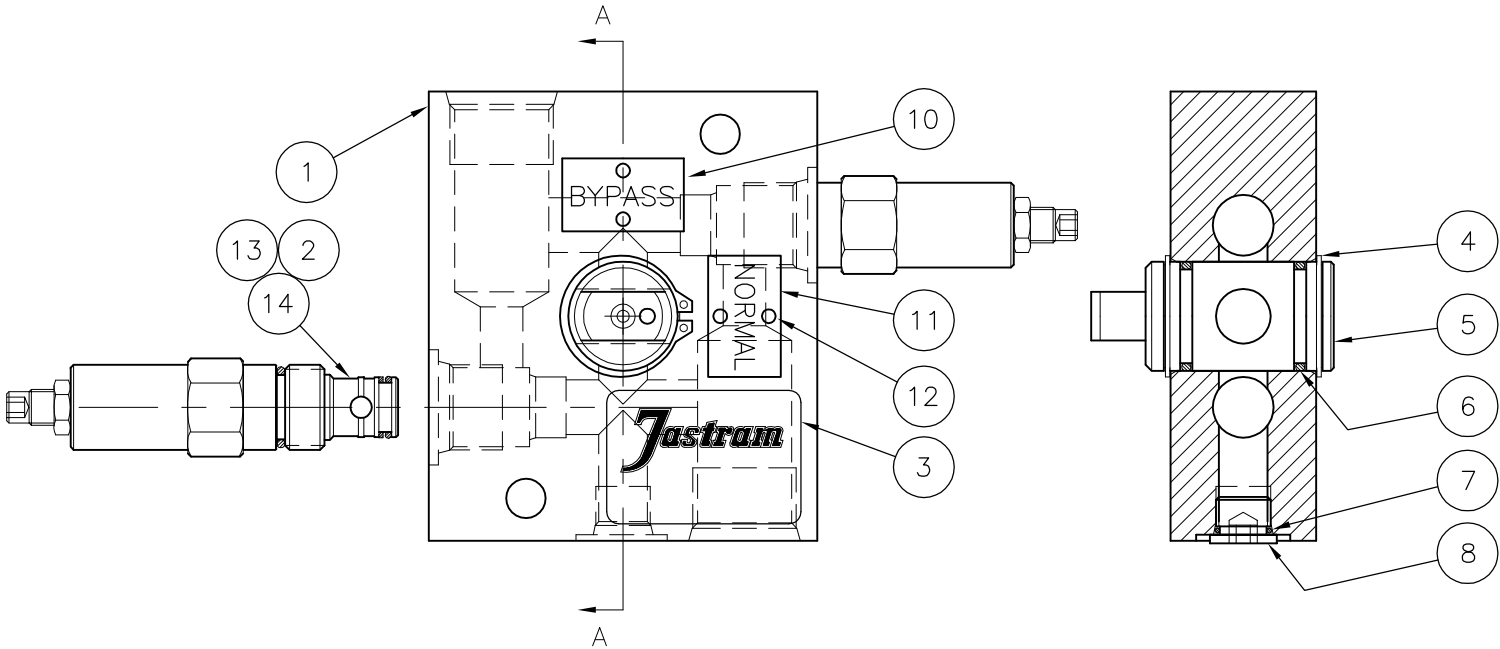
TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓
ALL DIMENSIONS IN INCH(mm)			

-	13-05-93	PRODUCTION ISSUE		✓
REV.	DATE	DRAWING/DESIGN CHANGE No.		BY
		JASTRAM ENGINEERING LTD. 485 Mountain Highway North Vancouver, B.C. Canada V7J 2L3 Tel.: (604) 986-0714 Fax: (604) 986-0334		
		DATE: 07-05-93	SCALE: N.T.S.	DRAWN: M.L.
TITLE:		APPR. G.C. ENG. BY L.L. PROD.		
3-WAY SHUT OFF VALVE ADAPTOR UNION ASSEMBLY		DRAWING NUMBER:		
		B-401019		

DASH No.	APPLICATION	ASSEMBLY No.
-1	DARB 10 GPM	401003-1
-2	DARB 30 GPM	401003-2
-3	DARB 20 GPM	401003-3

No.				ITEM No.	PART No.	DESCRIPTION	SPEC.
-4	-3	-2	-1				
QTY.							
-	1	1	1	1	411013-1	DARB VALVE BODY	
-	-	-	2	2	549001	RELIEF CARTRIDGE - 10 GPM	
-	1	1	1	3	901009	SERIAL / IDENT. LABEL	
-	2	2	2	4	345002	SNAP RING	
-	1	1	1	5	411012-1	DARB VALVE SPOOL	
-	2	2	2	6	201119	"O"-RING-119, 15/16 ID x 1-1/8 OD x 3/32 SEC.	BUNA N70 DURO
-	1	1	1	7	203906	"O"-RING-906, 15/32 ID x 5/8 OD x 5/64 SEC.	BUNA N70 DURO
-	1	1	1	8	554002	PLUG	
-	2	2	2	9	553008	SHIPPING PLUG (NOT SHOWN)	
-	1	1	1	10	411106-1	LABEL "BYPASS"	
-	1	1	1	11	411106-2	LABEL "NORMAL"	
-	4	4	4	12	343018	DRIVE SCREW	
-	-	2	-	13	549002	RELIEF CARTRIDGE - 30 GPM	
-	2	-	-	14	549003	RELIEF CARTRIDGE - 20 GPM	

CUSTOMER PARTS LIST



SECTION A-A

NOTES:

1. DOUBLE ACTING RELIEF AND BYPASS VALVE SHOWN IN NORMAL OPERATING POSITION.
2. SEE APPLICATION TABLE FOR ASSEMBLY NUMBER.
3. FINISH HONE BODY AND LAP FIT TO SPOOL ON ASSEMBLY.
4. BODY AND SPOOL ARE SUPPLIED AS AN INSEPARABLE ASSEMBLY.

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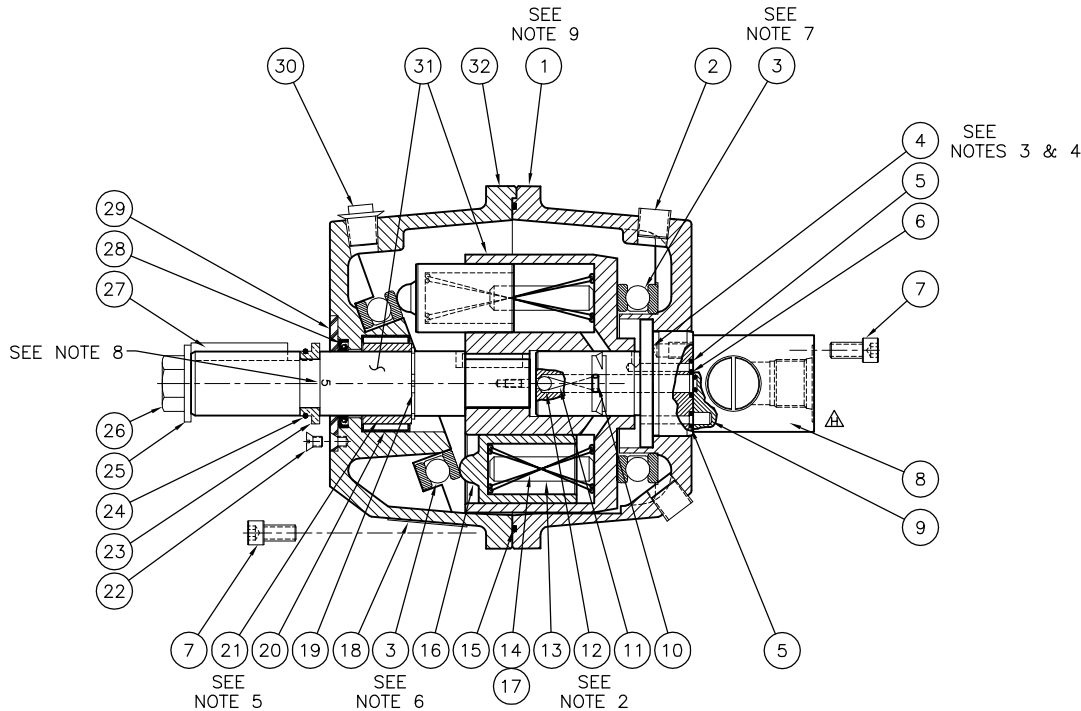
TOLERANCES:				(UNLESS SPECIFIED OTHERWISE)	
X.X	+/- 0.1	FRACTION	+/- 1/64		
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.		
X.XXX	+/- 0.005	SURFACE FINISH			
ALL DIMENSIONS IN INCH(mm)					

E	12-02-01	SEE DCN 010017	
D	26-06-97	SEE DCN 970034	G.C.
C	09-05-95	SEE DCN 950030	G.C.
B	11-03-93	SEE DCN 930019	G.C.
A	23-11-90	SEE DCN 900032	J.G.
-	22-02-90	PRODUCTION ISSUE	L.L.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY

Jastram

JASTRAM ENGINEERING LTD.
467 Mountain Highway
North Vancouver, B.C.
Canada V7J 2L3
Tel.: (604) 986-0714
Fax: (604) 986-0334

DATE: 02-02-90	SCALE: 1":1"	DRAWN: G.C.	APPR. W.P.
TITLE: DARB-10, 20, 30 VALVE ASSEMBLY			DRAWING NUMBER: C-401003



DASH No.	ITEM No.	PART No.	DESCRIPTION	SPEC
	1	311002-2	REAR HOUSING	
	2	509001	SQUARE HEAD PIPE PLUG	
	2	401001	THRUST BEARING	
Δ	1	311036-1	PINTLE	
Δ	2	201006	O-RING -006, 1/8 ID x 1/4 OD x 1/16 SEC	BUNA-N 70 DURO
	2	201011	O-RING -011, 5/16 ID x 7/16 OD x 1/16 SEC	BUNA-N 70 DURO
	10	7	304012	SOCK. HD. CAP SCREW
Δ	1	8	401114-1	LOCKVALVE
	1	9	347005	SPRING PIN
Δ	2	10	347020	SPRING PIN
	2	11	602012	SPRING
	2	12	601001	CYCLE BALL
	6	13	311005-2	SPRING INSERT
	6	14	602020	SPRING
	1	15	202004	O-RING, 125mm ID x 129mm OD x 2mm SEC
	6	16	311027-1	H58 PISTON
	6	17	602020	SPRING
	1	18	901003	SERIAL/ID LABEL
	1	19	345001	EXTERNAL SNAP RING
	1	20	405001	NEEDLE BEARING OUTER RACE
	1	21	406001	BEARING SLEEVE INNER RACE
	3	22	311001	FLAT HD. SCREW
	1	23	311008-1	WHEEL STOP (2 PIECES)
	1	24	201019	O-RING -019, 13/16 ID x 15/16 OD x 1/16 SEC
Δ	1	25	316015	WASHER
	1	26	309001	HEX HD. CAP SCREW
Δ	1	27	311004-2	KEY
	1	28	209003	SHAFT SEAL
	1	29	311020-1	WHEEL DISK
	1	30	553003	SQUARE HEAD FLANGED PIPE PLUG
	1	31	301000-3	H58 ROTOR & SHAFT ASSEMBLY
	1	32	311006-4	H58 FRONT HOUSING

NOTES:

1. ASSEMBLY NO. 301007-1
2. SEAT CYCLE BALL (ITEM 12) TO PINTLE (ITEM 4) DURING ASSEMBLY.
- Δ 3. SEAL PINTLE AND REAR HOUSING (ITEM 1) MATING SURFACE WITH PERMATX "FORM-A-GASKET No. 3".
- Δ 4. PINTLE AND REAR HOUSING VERTICAL AXIS TO BE ALIGNED WITHIN $\pm 2^\circ$ TO ENSURE PUMP SUCTION AND DISCHARGE TIMING.
5. BOND BEARING SLEEVE (ITEM 21) TO SHAFT (ITEM 31) WITH LOCTITE No. 620. USE SNAP RING (ITEM 19) AS A STOP TO LOCATE SLEEVE.
- Δ 6. FRONT THRUST BEARING (ITEM 3) MUST BE INSTALLED WITH RACE SMALL BORE ON PISTON SIDE. PEEN FRONT HOUSING SPIGOT AT 2, 4, 8 & 10 O'CLOCK TO HOLD THRUST BEARING IN PLACE FOR ASSEMBLY. ENSURE PISTON RACE SPINS FREELY.
7. REAR THRUST BEARING (ITEM 3) MUST BE INSTALLED WITH RACE SMALL BORE ON REAR HOUSING SIDE.
8. STAMP TEXT "5" ON SHAFT AT LOCATION SHOWN.
- Δ 9. SEAL FRONT HOUSING (ITEMS 32, 37 OR 39) AND REAR HOUSING MATING SURFACE WITH PERMATX "RTV BLACK SILICONE ADHESIVE SEALANT".

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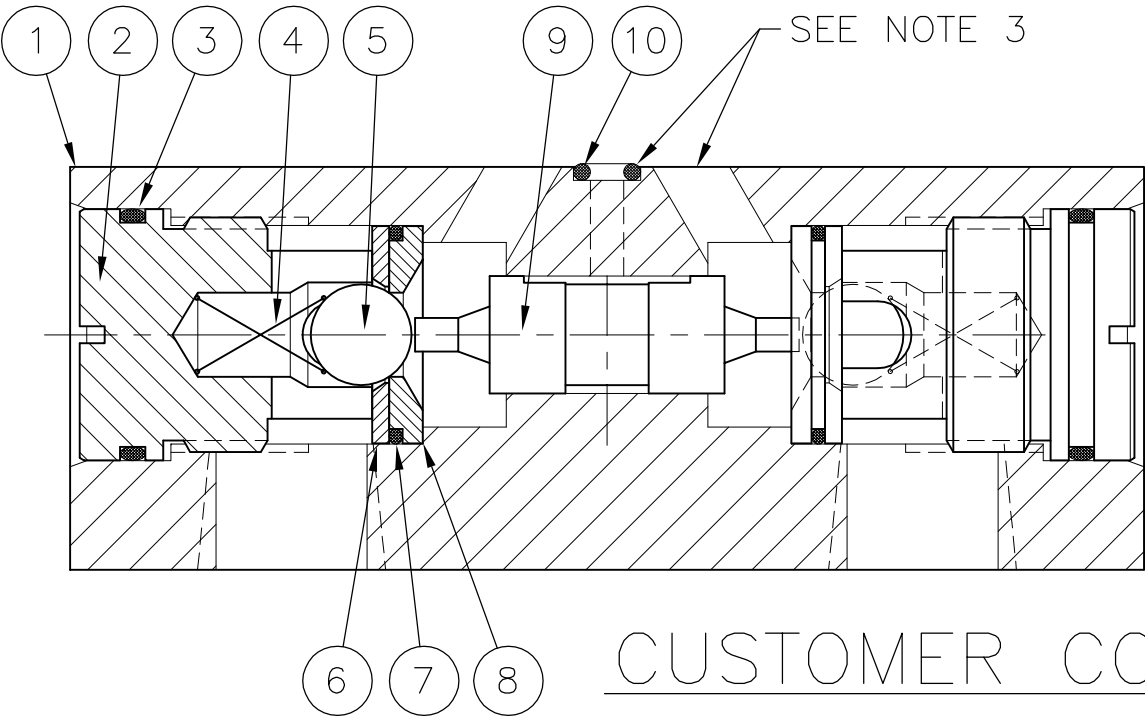
H	04-06-10	SEE DCN 090105	
G	28-12-03	SEE DCN 030075	G.C.
F	13-07-00	SEE DCN 000046	C.S.
E	20-08-99	SEE DCN 990030	C.S.
D	30-10-97	SEE DCN 960034	C.S.
C	16-08-95	SEE DCN 950070	G.C.
B	01-05-95	SEE DCN 950023	G.C.
A	02-03-94	SEE DCN 940023	L.L.
-	08-06-93	PRODUCTION ISSUE	L.L.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 986-1111 Fax: (604) 986-0334			
DATE:	07-01-04	SCALE: 1"=1"	DRAWN: G.C. APPR: G.C. J.L.L.
TITLE:	H58 HELM PUMP ASSEMBLY		
DRAWING NUMBER:	D-301007		

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TOLERANCES:	(UNLESS SPECIFIED OTHERWISE)		
X.X	± 0.1	FRACTION	$\pm 1/64$
X.XX	± 0.01	ANGULAR	± 0.5 DEG.
X.XXX	± 0.005	SURFACE FINISH	
ALL DIMENSIONS IN INCH(MM)			

NOTES:

- 1. ASSEMBLY No. 401041-1
- 2. SEAT CYCLE BALL (ITEM 5) TO BALL SEAT (ITEM 8) ON ASSEMBLY.
- 3. APPLY ADHEASIVE TAPE TO COVER PORTS AND HOLD O-RING (ITEM 10) IN PLACE.

DASH No.	ITEM No.	PART No.	DESCRIPTION	SPEC.
-1				
QTY.				
1	1	411087-1	BODY	
2	2	411088-1	END CAP	
2	3	201019	O-RING -019, 13/16 ID x 15/16 OD x 1/16 SEC	BUNA-N 70 DURO
2	4	602016	SPRING	
2	5	601005	CYCLE BALL	
2	6	411085-1	BALL SEAT WASHER	
2	7	201017	O-RING -017, 11/16 ID x 13/16 OD x 1/16 SEC	BUNA-N 70 DURO
2	8	411086-1	BALL SEAT	
1	9	411001-2	SPOOL (FOR H58)	
1	10	201006	O-RING -006, 1/8 ID x 1/4 OD x 1/16 SEC	BUNA-N 70 DURO
2	11	553002	SHIPPING PLUG (NOT SHOWN)	

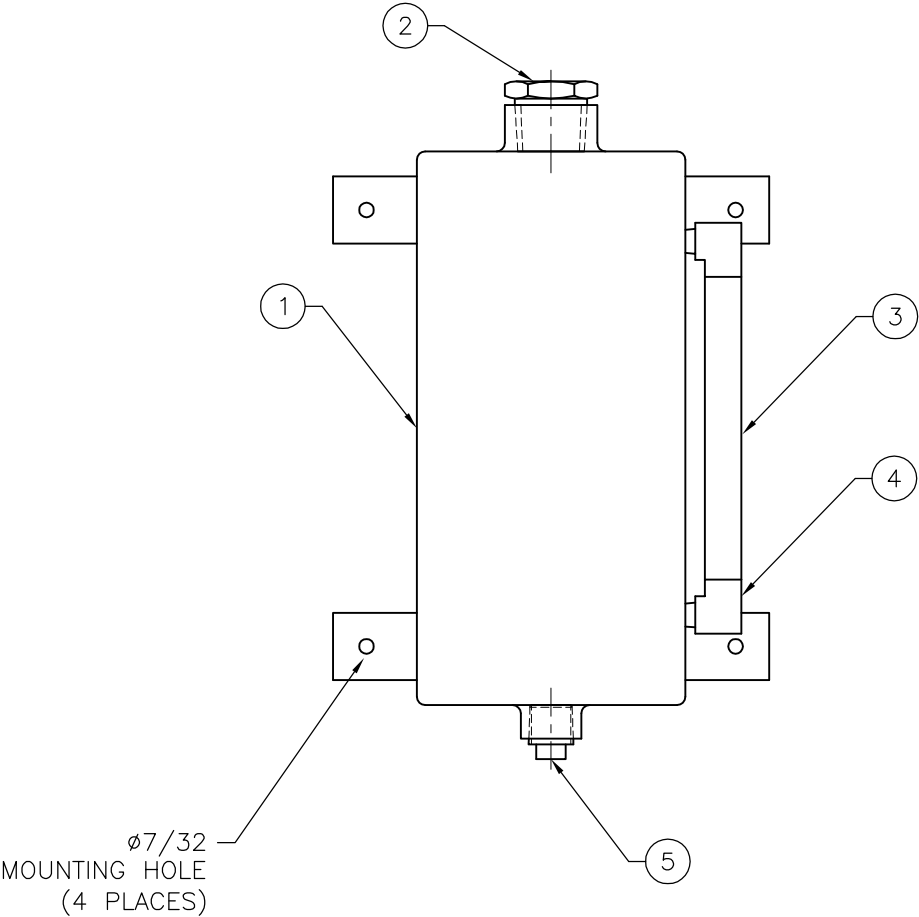


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C	22-01-04	SEE DCN 030075	
B	12-11-98	SEE DCN 980055	C.S.
A	07-06-96	SEE DCN 960032	G.C.
-	07-06-96	PRODUCTION ISSUE	G.C.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
<div><div>Jastram</div><div>JASTRAM ENGINEERING LTD. 467 Mountain Highway North Vancouver, B.C. Canada V7J 2L3 Tel.: (604) 986-0714 Fax: (604) 986-0334</div></div>			
DATE: (D/M/Y)	21-01-04	SCALE: 2":1"	DRAWN: G.C.
TITLE: 3/8" LOCKVALVE ASS'Y (FOR H58 HELM PUMP)			APPR. W.P. PROD.
			DRAWING NUMBER: B-401041

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ITEM No.	PART No.	DESCRIPTION	SPEC.
1	511014-1	RESERVOIR	
2	553027	VENT PLUG 3/4" NPT	
3	505003	SIGHT GAUGE	
4	516005	1/4" NPT ELBOW	
5	553002	SHIPPING PLUG	

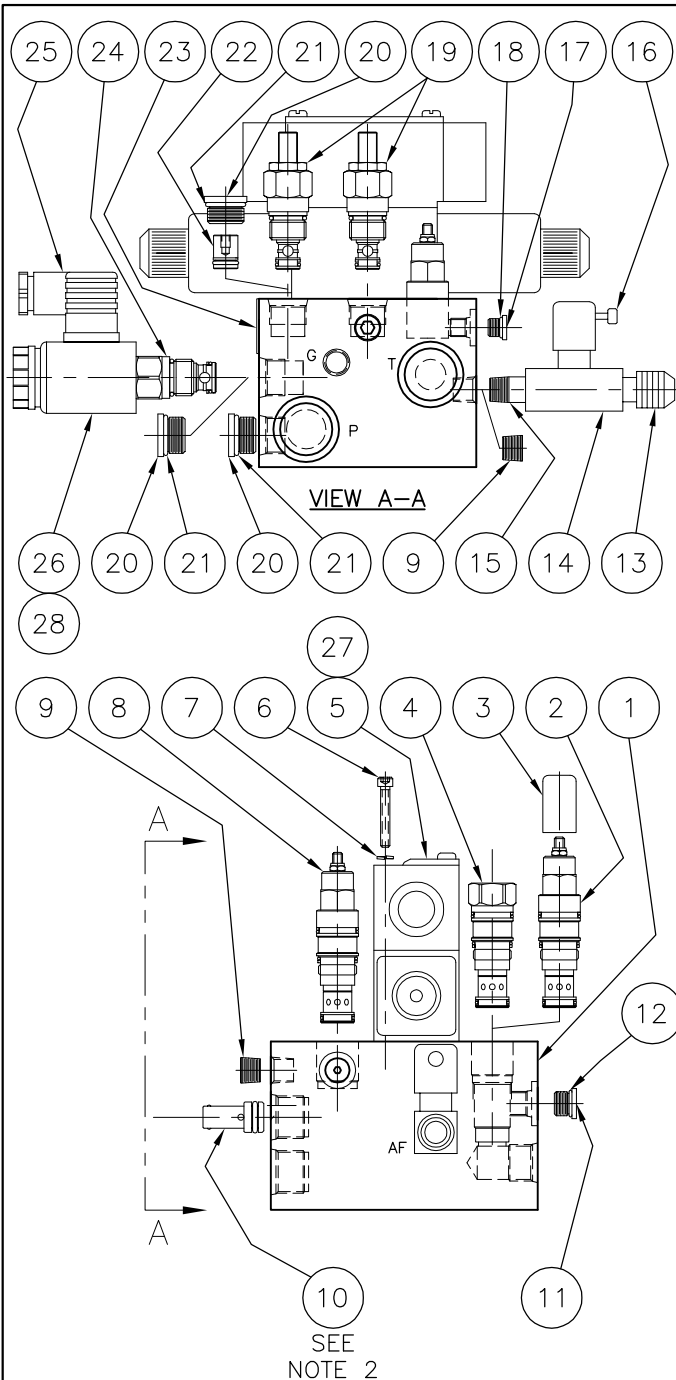


- NOTES:
- 1. HEADER TANK MAXIMUM CAPACITY 0.4 U.S. GALLON (1.5 L)
 - 2. PART No. 501012-1

CUSTOMER COPY

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334			
DATE: 10-07-08 (D/M/Y)	SCALE: N/A	DRAWN: C.Z.	APPR. YH ENG. N/A PROD.
TITLE: HEADER TANK - 1.5 L ASSEMBLY			DRAWING NUMBER: B-501012

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
SEE
NOTE 2

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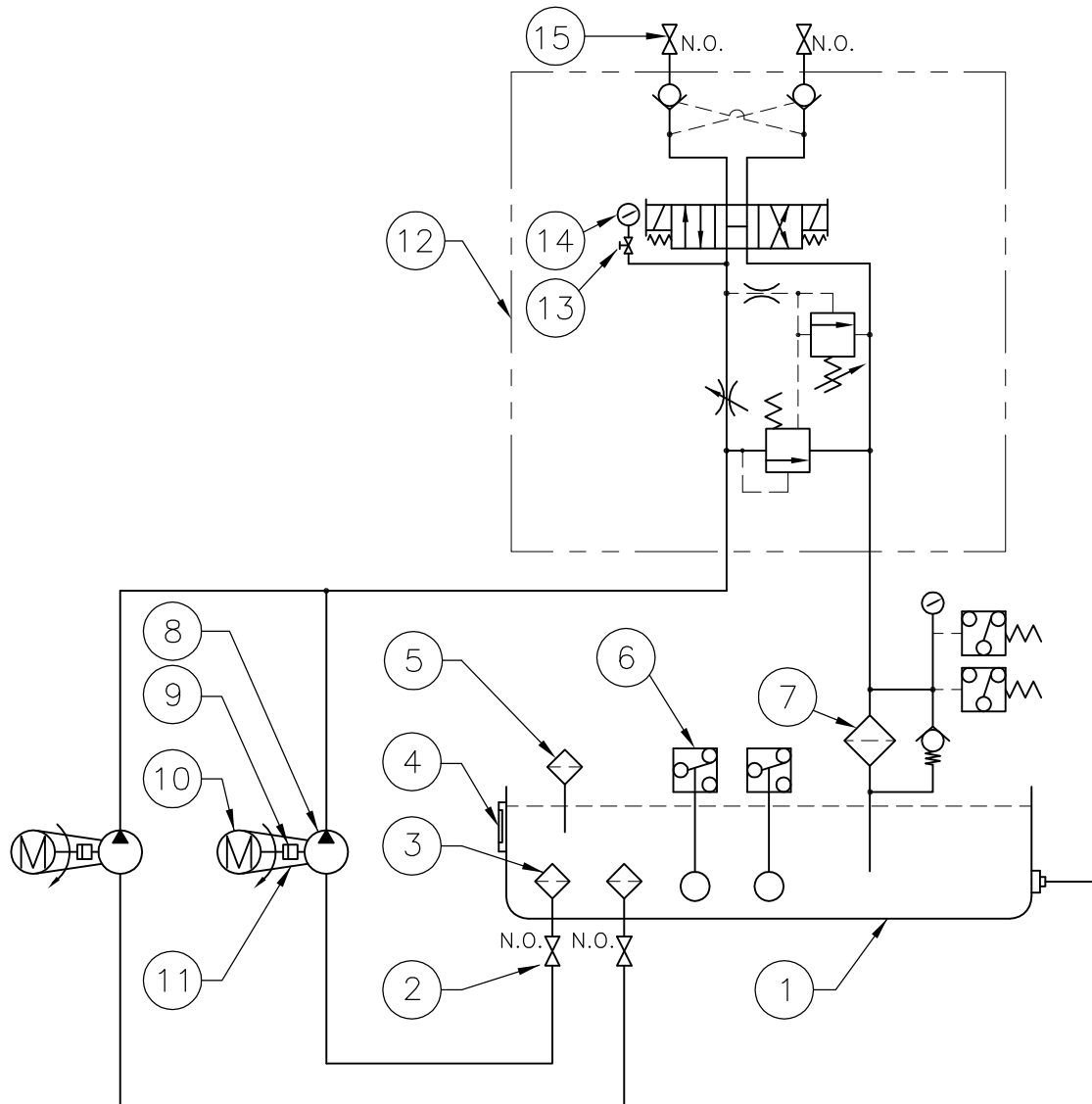
No.									ITEM No.	PART No.	DESCRIPTION	SPEC.
-9	-8	-7	-6	-5	-4	-3	-2	-1				
QTY.												
1	1	1	1	1	1	1	1	1	1	411117-1	MANIFOLD BODY	
-	2	2	2	2	-	-	-	-	2	550018	COUNTERBALANCE CARTRIDGE	
-	2	2	2	2	-	-	-	-	3	553021	CARTRIDGE COVER	
2	-	-	-	-	2	2	2	2	4	546007	PILOT OPERATED CHECK CARTRIDGE	
-	1	1	1	1	1	1	1	1	5	548007	DIRECTIONAL SOLENOID, OPEN CENTER, 24 VDC	
4	4	4	4	4	4	4	4	4	6	301005	SOCKET HEAD CAPSCREW	
4	4	4	4	4	4	4	4	4	7	325015	HIGH COLLAR LOCKWASHER	
1	1	1	1	1	1	1	1	1	8	549013	MODULATING ELEMENT CARTRIDGE	
2	1	2	1	2	1	2	1	2	9	508003	SOCKET HEAD PIPE PLUG, 1/4NPT	
-	1	-	1	-	1	-	1	-	10	401064-1	AUTO-FILL CARTRIDGE	
2	2	2	2	2	2	2	2	2	11	554004	PLUG	
2	2	2	2	2	2	2	2	2	12	203905	"O"-RING-905, 13/32 ID x 9/16 OD x 5/64 SEC.	BUNA N90 DURO
-	1	-	1	-	1	-	1	-	13	516004	FITTING	
-	1	-	1	-	1	-	1	-	14	550017	NEEDLE VALVE	
-	1	-	1	-	1	-	1	-	15	513015	FITTING	
-	1	-	1	-	1	-	1	-	16	332002	THUMB SCREW	
1	1	1	1	1	1	1	1	1	17	554001	PLUG	
1	1	1	1	1	1	1	1	1	18	203903	"O"-RING-903, 19/64 ID x 27/64 OD x 1/16 SEC.	BUNA N90 DURO
2	2	2	1	1	2	2	1	1	19	550016	FLOW CONTROL CARTRIDGE	
1	1	1	3	3	1	1	3	3	20	554005	PLUG	
1	1	1	3	3	1	1	3	3	21	203908	"O"-RING-908, 41/64 ID x 13/16 OD x 3/32 SEC.	BUNA N90 DURO
-	-	-	1	1	-	-	1	1	22	401069-1	CAVITY PLUG ASSEMBLY	SUB-ASS'Y
1	1	1	1	1	1	1	1	1	23	901037	SERIAL / IDENT. LABEL	
1	1	1	-	-	1	1	-	-	24	548046	2-SPEED CARTRIDGE	
1	1	1	-	-	1	1	-	-	25	836000	DIN PLUG	
-	1	1	-	-	1	1	-	-	26	548047	COIL, 24VDC	
1	-	-	-	-	-	-	-	-	27	548052	DIRECTIONAL SOLENOID, OPEN CENTER, 12 VDC	
1	-	-	-	-	-	-	-	-	28	548057	COIL, 12VDC	

APPLICATION	DASH No.	ASS'Y No.
1-SPEED, NO AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-1	401072-1
1-SPEED, W/ AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-2	401072-2
2-SPEED, NO AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-3	401072-3
2-SPEED, W/ AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-4	401072-4
1-SPEED, NO AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-5	401072-5
1-SPEED, W/ AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-6	401072-6
2-SPEED, NO AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-7	401072-7
2-SPEED, W/ AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-8	401072-8
2-SPEED, NO AUTO-FILL, W/ DUAL P.O. CHECK, 12VDC	-9	401072-9

CUSTOMER PARTS LIST

REV.	DATE	DRAWING/DESIGN CHANGE No.		BY
Jastram		JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334		
DATE: 06-07-05 (M/Y)	SCALE: 1":2"	DRAWN: Y.H.	APPR:  ENG.	N/A PROD
TITLE: PSM 200 SUB-ASSEMBLY			DRAWING NUMBER: C-401072	



NOTES: 1. SEE APPLICATION TABLE FOR ASSEMBLY NUMBER.
2. INSERT ITEM 10 BEFORE ITEM 8. GREASE "O"-RING.



ITEM	QTY	DESCRIPTION	MANUFACTURERS PART NO.
1	1	RESERVOIR	JASTRAM BULKHEAD – 10 GALLON
2	2	SUCTION BALL VALVE	JB–551013
3	2	SUCTION STRAINER	JB–547036
4	1	SIGHT/TEMP. GAUGE	JB–552007
4A	1	PUSH TO READ	JA–501000–2
5	1	FILLER/BREATHER	JB–547023
6	2	LEVEL SWITCH	JB–552014
7A	1	RETURN LINE FILTER	JB–547024
7B	1	ELEMENT	JB–547025
7C	1	FILTER GAUGE	JB–552002
7D	2	FILTER CLOGGING SENSOR	JB–552011
8	2	PUMP	JB–502005
9A	2	COUPLING – INSERT	SRL075
9B	2	COUPLING – PUMP	MS075 3/4
9C	2	COUPLING – MOTOR	MS075 7/8
10	2	ELECTRIC MOTOR	BALDOR CM3558T–5–IEEE45
11	2	BELL HOUSING	MAGNALOY M056452A
12	1	MANIFOLD	JA–401072–1
13	1	GAUGE SNUBBER	JB–551008
14	1	GAUGE	JB–552004
15	2	BALL VALVE	JB–551004

JQ061388

43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

REV.	DATE	DRAWING/DESIGN CHANGE No.		BY			
		JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334					
DATE: (D/M/Y)	09-09-10	SCALE:	N/A	DRAWN:	D.B.	APPR.	 ENG. N/A PROD.
TITLE: RESERVOIR/MANIFOLD ASS'Y SCHEMATIC & PARTS LIST						DRAWING NUMBER: B-M20632	

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3.3 COMPONENT MANUALS

GENERAL

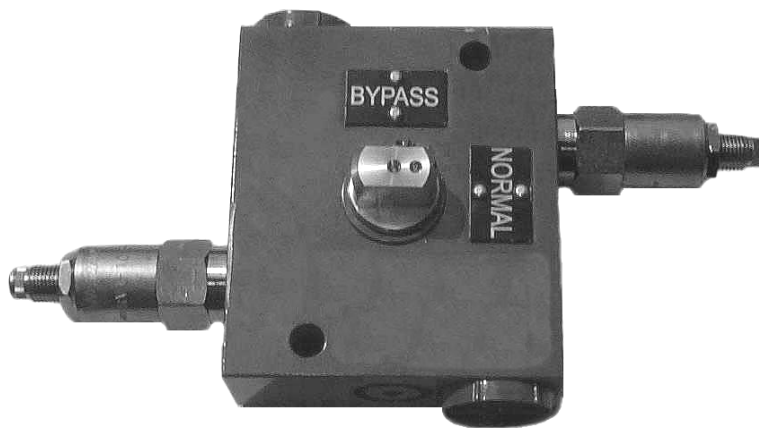
The following standard component manuals contain information on the individual components and **not** the specific system as described throughout this manual. These standard component manuals may contain general system drawings that are included to assist in understanding the general function of these components. If a discrepancy exists between the information contained in a standard component manual and the earlier sections of this manual, earlier sections should be followed.

Reference should be made to these standard component manuals for such information as:

- general descriptions of the component.
- component specifications.
- installation particulars and overall dimensions.
- component set up and adjustment locations.
- maintenance and parts information.
- component trouble shooting.

Component Manual

**Double Acting Relief Bypass Valve
Model: DARB 10/20/30**



Document No.: MAN00401

Revision: -

This manual is subject to change without prior notice.



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1 INTRODUCTION

1.1 Description

The Double Acting Relief and Bypass Valve (DARB) has two modes of operation:

In "Normal" mode the DARB automatically protects the steering system against hydraulic shock and over-pressurization. If impact occurs between the rudder and an underwater object or if there is an internal pressure build-up which causes the hydraulic pressure to exceed a preset limit the DARB allows oil to bypass from the pressurized line to the non-pressurized, preventing possible damage to the steering gear, its lines and flexible hoses.

In the "Bypass" mode the DARB allows for emergency steering capability by way of tiller or block and tackle steering, if such secondary means of steering are provided for.

A DARB valve is mandatory if the steering system is subject to classification approval.

Flow rate (max):

P/N 401003-1	10 gpm (38 L/min.)
P/N 401003-2	30 gpm (116 L/min.)
P/N 401003-3	20 gpm (76 L/min.)

Pressure (max): 1875 psi (125 bar)

Weight: 8 lbs (3.6 kg)

2 INSTALLATION

2.1 Mounting

Refer to Figure 1 for overall dimensions, mounting details and line connections.

The DARB should be installed as close as possible to the cylinder.

In the case where a single equal displacement cylinder steering system is used, the DARB should be secured firmly between the cylinder ports. In a multiple cylinder steering system the DARB should be installed between the cylinders.



Installation

Page 3 of 6

The use of flexible hoses between the DARB and the cylinder ports is not recommended.

While the DARB will allow excessive pressure to bypass the hydraulic system, it is recommended that external rudder stops be installed to prevent mechanical damage to the cylinders and rudder when the system hits the hardover position.

Once installed the DARB must be secured in the Normal position. Care should be taken that the DARB is not shifted accidentally into the Bypass position.

After installation the system should be filled with ISO Grade 32 oil.

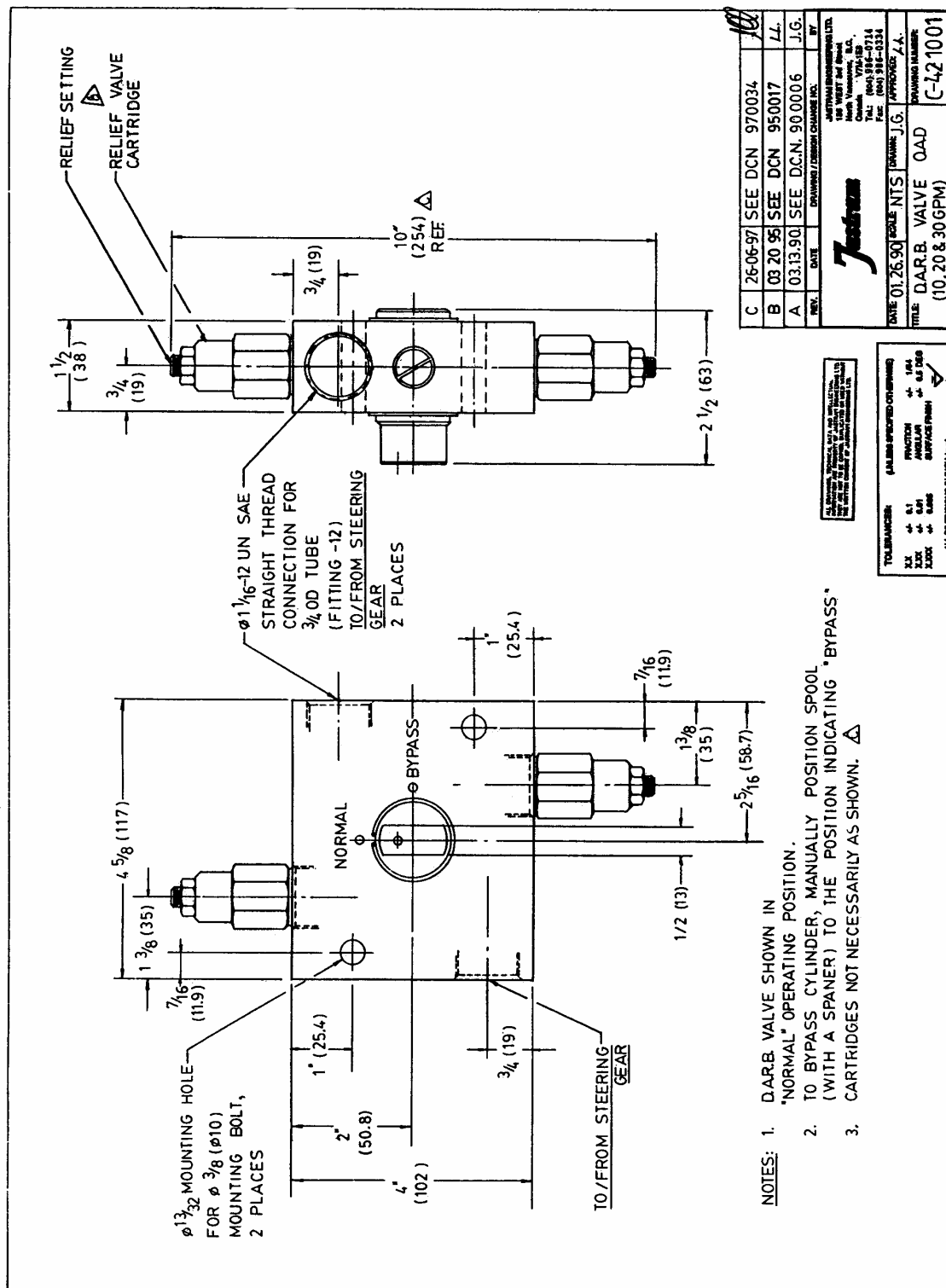


Figure 1 – D.A.R.B. Valve Overall Dimensions

3 SETUP AND TESTING

WARNING: ALL SET UP AND TESTING PROCEDURES MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The DARB is factory preset at 1250 psi. When supplied as part of a complete steering system the setting will be preset at the actual system working pressure times 1.25, to a maximum of 1875 psi.

Turning the relief valve clockwise will increase the relief setting. Turning the valve counter clockwise will reduce the pressure setting. Be certain to set both relief valves to the same pressure rating.

WARNING: DO NOT CHANGE PRESSURE SETTINGS UNLESS THE NEW PRESSURE RELEASE CAN BE VERIFIED WITH A PRESSURE GAUGE.

Check for oil leaks at all connecting ports and system piping.

4 MAINTENANCE AND PARTS LISTS

WARNING: ALL INSPECTION AND MAINTENANCE MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The DARB is virtually maintenance free; however, over time parts may become worn and require replacement.

Once a year, do a visual inspection of the DARB and check the operating pressure of the relief valves. If there is an O-ring leaking or if there is any other sign of wear, replace the worn or faulty components.



5 TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE SUDDEN LOSS OF STEERING.

The chart below gives some general solutions for simple problems. If a problem cannot be resolved, contact the factory.

SYMPTOM	CAUSE	CORRECTION
No steering	DARB is in Bypass position.	Switch to Normal position.
Cylinder moves, then stops, then moves again	Relief pressure setting too low.	Adjust pressure setting.



Component Manual

Hydraulic Helm Pump Model: H



Document No.: MAN00302
Revision: A

This manual is subject to change without prior notice.



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1 INTRODUCTION

1.1 Description

All Jastram's 'H' helm pumps are positive displacement axial piston pumps, ideally suited to deliver precise amounts of hydraulic oil at very slow turning rates. The pumps are designed to operate in 'non-pressurized' hydraulic systems requiring only two lines from the helm pump to the cylinder. The pump has sufficient internal capacity to act as a small vented oil reservoir and just filling the helm pump housing with oil is all that is required to get the pump operational. (Note: H58 requires header tank or auto-fill system).

Any number of helm pumps may be connected in parallel in the hydraulic system.

All helm pumps are equipped with an externally mounted lockvalve, which prevents rudder feedback and isolates each helm pump in a multiple station system.

All helm pump housings are made of corrosion resistant die cast aluminum and are powder coated for added protection. The externally removable shaft seal is held in position by a retainer ring, providing a safeguard against 'blow out' of seal due to internal pressure build up (H20/26/36/58 only).

2 INSTALLATION

2.1 Mounting

All helm pumps may be mounted at any angle between their vertical and horizontal axis. Please refer to the appropriate overall dimension drawing for detailed mounting and connection information.

All helm pumps can be mounted in front or behind a dashboard. Four mounting bolts are required. Before cutting the appropriate hole into the dashboard, ensure there is access to the vent hole of the pump. Ensure there is sufficient space between the wheel and the dashboard so that the operator's hands are free to hold to the wheel throughout its full turning circle.

When mounting the aluminum body of the helm pump directly onto a steel bulkhead, use plastic spacers between the mounting bolts to prevent electrolysis.

Use correct steering wheel sizes in applications.

MODEL	STEERING WHEEL SIZE	
	min diameter	max diameter
H20	14"	24"
H26, H36	20"	30"
H58	30"	36"
H60, H90, H110	36"	60"

Contact manufacturer if a chain sprocket is to be installed on to the pump shaft

Seamless hydraulic steel tubing, or copper tubing (minimum working pressure of 1000 psi (69 bar) is recommended. Use following table as a guideline for tubing size.

HELM PUMP MODEL	Distance between Helm and Cylinder			Min. Wall Thickness	
	50FT	65FT	95FT	Tube Dia.	Wall
H20/H26/H36	1/2"	5/8"	5/8"	1/2"	0.035"
H58	5/8"	5/8"	3/4"	5/8"	0.049"
H60/H90	5/8"	5/8"	3/4"	3/4"	0.049"
H110	3/4"	3/4"	1"	1"	0.065"

Nominal tube outside diameter and wall thickness based on SAE standards

WARNING: DO NOT USE PLASTIC TUBING OR FLEXIBLE HOSES.

Standard ISO grade 32 oil must be used within a Jastram hydraulic steering system.

WARNING: DO NOT USE TRANSMISSION OIL OR BRAKE FLUID.

Start filling the helm pump by pouring hydraulic oil into the vent hole and by turning the pump continuously in one direction until the helm feels solid. Then reverse rotation until helm feels solid again. Repeat these steps several times, each time exerting some pressure on the wheel when the hardover position is reached. Exerting pressure will allow remaining entrapped air to pass through the lockvalve into the pump housing.

CAUTION: Check oil level often while filling the system.

In multiple station applications, ensure that only the most upper helm pump is vented by piercing a small hole into the vent/filler plug or by installing a header tank or auto-fill system to the uppermost helm pump.

A slight stiffness for the first few days may be caused by, some air still trapped in the system. Frequently turning the helm will help to ensure that the last of the air is worked out of the system.

Upon completion of steering gear and hydraulic system installation the steering gear must be checked to ensure that:

- Steering direction corresponds to the wheel turning direction
- All fittings are tight and no leaks are visible
- Oil level is full at upper station or at header tank sight glass
- If auto-fill system is installed, pump case pressure is less than 15 psi (1 bar)
- If cylinder isolation valves are installed, valves must be in the open position
- All cylinder/tiller bolts and nuts and the cylinder mounting bolts are securely tightened.

For more detailed information please refer to your steering system manual.



3 MAINTENANCE AND PARTS LISTS

WARNING: ALL INSPECTION AND MAINTENANCE MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The 'H' helm pumps were designed for heavy-duty commercial applications and are virtually maintenance free.

To exchange shaft seal:

- a) Remove screws from retainer ring and pry out seal.
- b) Insert new seal and attached retainer ring.
- c) Refill housing with oil.

For any other parts, please contact your local dealer.

After initial installation or re-filling of the pump check oil level daily for the first month.

Once a year visually inspect the helm pump for damage, wear, hydraulic leaks and corrosion. If any of the above is apparent, remove helm pump and remedy the problem.

Refer to appropriate assembly drawing for parts breakdown.

4 TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE SUDDEN LOSS OF STEERING.

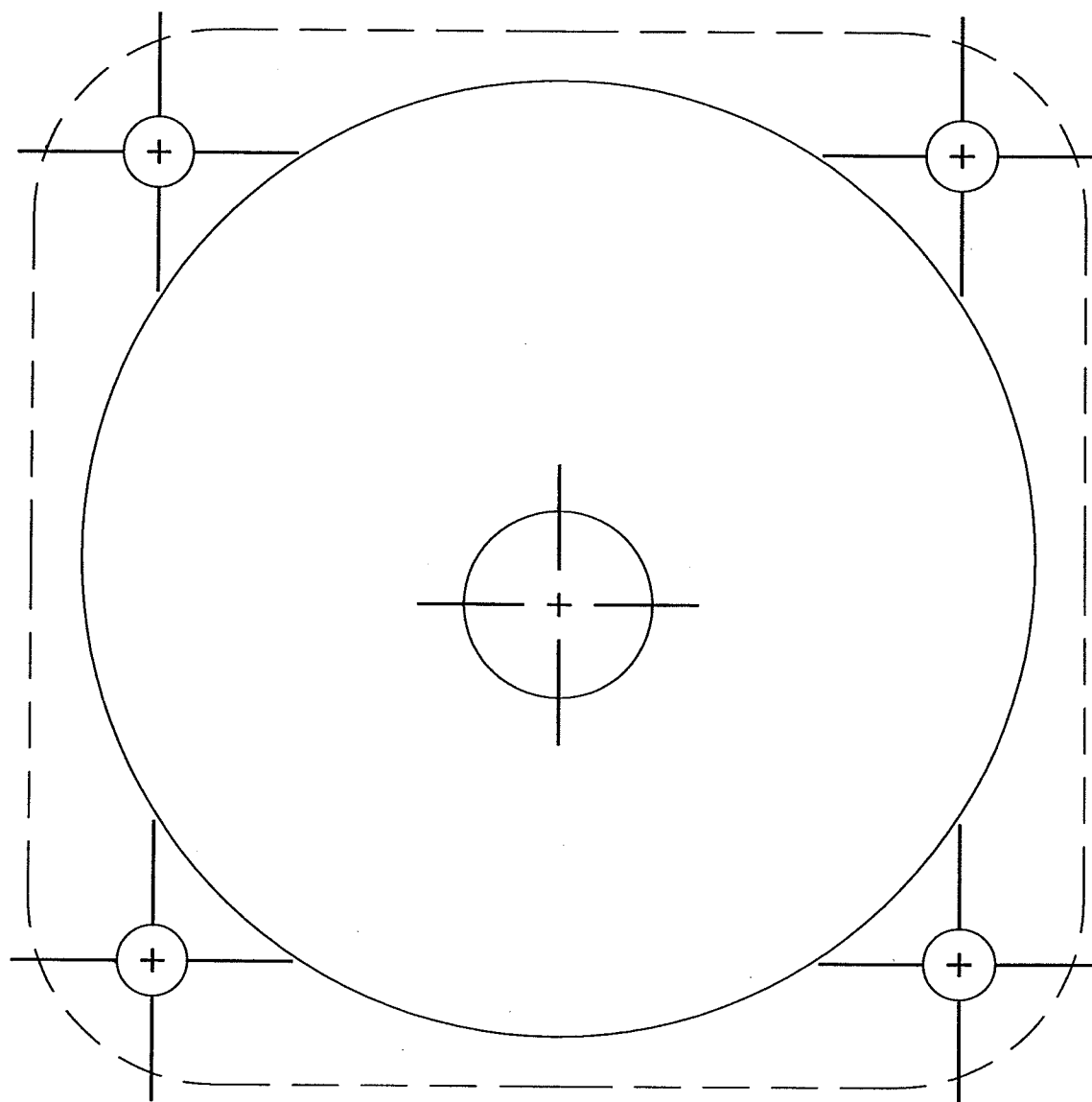
The chart below gives some general solutions for simple problems. If a problem cannot be resolved, contact the factory.

SYMPTOM	CAUSE	CORRECTION
Stiff steering	Steering Wheel undersized	Install large diameter steering wheel.
	Isolation valves not fully opened.	Open isolation valves fully.
	Tubing size too small.	Use larger size of tubing.
	New rudder stock bearing too tight.	Refer to manufacturer's recommendations.
	Binding, misalignment due to incorrect installation.	Correct misalignment.
Steering gear responds very slowly.	Faulty piston seals or rod seals.	Replace seals in cylinder.
	Excessive air trapped in system.	Purge air out of system.

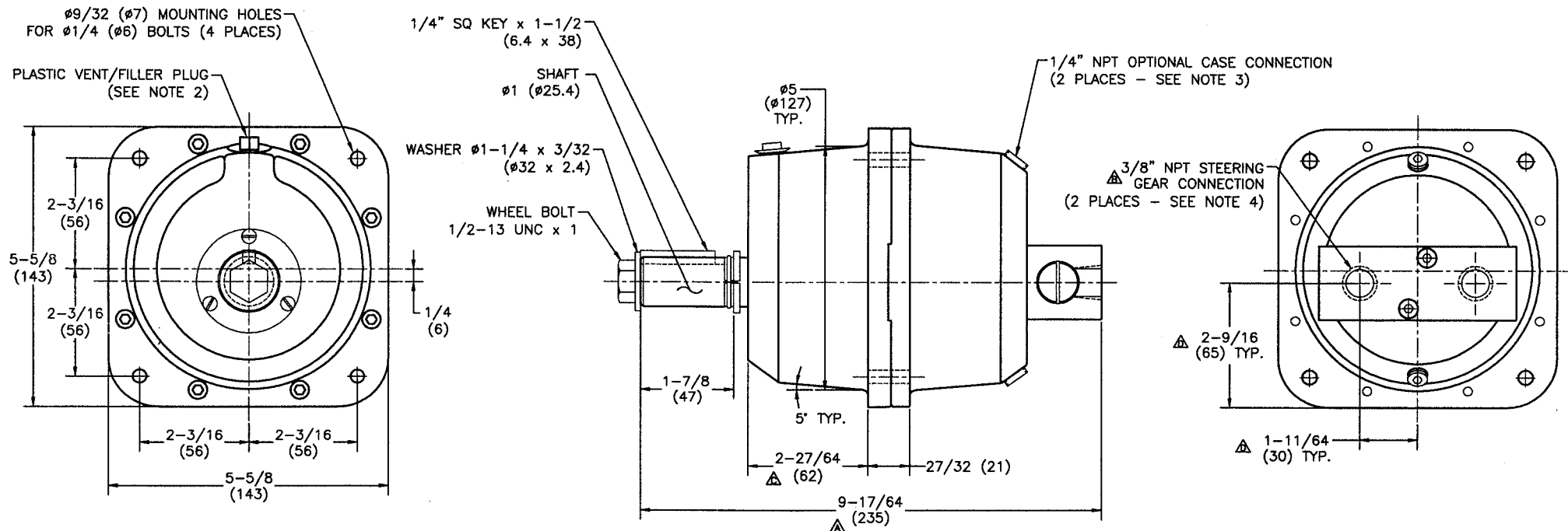
IMPORTANT NOTICE FOR USERS OF
JASTRAM MODEL H58 HELM PUMP

TO ENSURE EASE OF OPERATION, IT IS
RECOMMENDED THAT A MINIMUM OF 5/8" O.D.
HYDRAULIC TUBING AND A MINIMUM WHEEL
DIAMETER OF 30" BE USED,

TO ENSURE EASE OF AIR REMOVAL, THE H58 HELM
PUMP MUST BE USED WITH A HEADER TANK OR
OTHER EXTERNAL FILLING SYSTEM.



Helm Pump
Installation Template
For Models H20/26/36/58

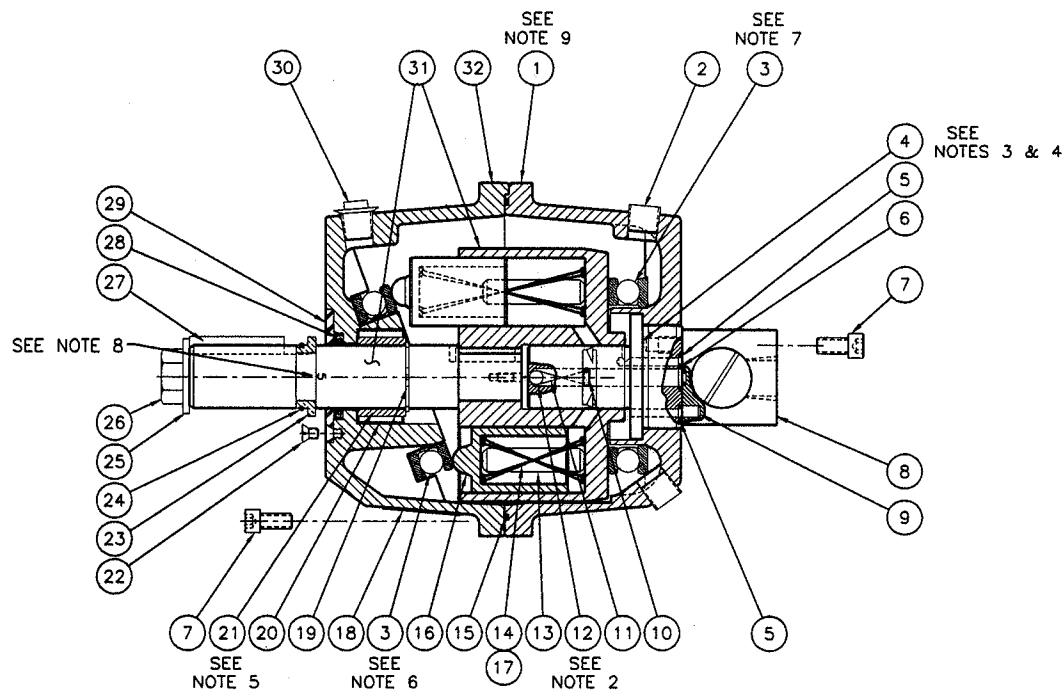


NOTES:

1. H58 HELM PUMP MUST BE USED WITH A HEADER TANK OR AUTOFILL SYSTEM.
2. TO ALLOW OIL EXPANSION IN HOT WEATHER CONDITIONS PIERCE UPPER HELM STATION VENT PLUG WITH $\phi 1/16$ " ($\phi 1\text{mm}$) DRILL. IF HELM IS TO BE USED AS A LOWER STATION, REMOVE PLASTIC VENT PLUG AND REPLACE WITH CASE CONNECTION PLUG.
3. ATTACH TOP CONNECTION TO BOTTOM OF UPPER HELM STATION, HEADER TANK, OR AUTOFILL SYSTEM. ATTACH BOTTOM CONNECTION TO TOP OF LOWER HELM STATION.
4. DO NOT OVER TIGHTEN FITTINGS.
5. INSTALL IN ACCESSIBLE LOCATION.

TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
F.F.	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓
ALL DIMENSIONS IN INCH(MM)			

D	13.01.05	SEE DCN 050005	
C	29.01.91	SEE DCN 900041	L.L.
B	12.12.90	SEE DCN 900032	L.L.
A	16.11.90	SEE DCN 900022	L.L.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
JASTRUM ENGINEERING LTD. 467 Mountain Highway North Vancouver, B.C. Canada V7J 2G3 Tel.: (604) 986-0714 Fax: (604) 986-0334			
DATE	13-01-05	SCALE	1"=1'
TITLE	H26/36/58 HELM PUMP OVERALL DIMENSION	DRAWN	G.Q.
APPR.		BY	L.L.
DRAWING NUMBER:	D-331003		



NOTES:

1. ASSEMBLY NO. 301007-1
2. SEAT CYCLE BALL (ITEM 12) TO PINTLE (ITEM 4) DURING ASSEMBLY.
3. SEAL PINTLE AND REAR HOUSING (ITEM 1) MATING SURFACE WITH PERMATX "FORM-A-GASKET No. 3".
4. PINTLE AND REAR HOUSING VERTICAL AXIS' TO BE ALIGNED WITHIN $\pm 2^\circ$ TO ENSURE PUMP SUCTION AND DISCHARGE TIMING.
5. BOND BEARING SLEEVE (ITEM 21) TO SHAFT (ITEM 31) WITH LOCTITE No. 620. USE SNAP RING (ITEM 19) AS A STOP TO LOCATE SLEEVE.
6. FRONT THRUST BEARING (ITEM 3) MUST BE INSTALLED WITH RACE SMALL BORE ON PISTON SIDE. PEEN FRONT HOUSING SPIGOT AT 2, 4, 8 & 10 O'CLOCK TO HOLD THRUST BEARING IN PLACE FOR ASSEMBLY. ENSURE PISTON RACE SPINS FREELY.
7. REAR THRUST BEARING (ITEM 3) MUST BE INSTALLED WITH RACE SMALL BORE ON REAR HOUSING SIDE.
8. STAMP TEXT "5" ON SHAFT AT LOCATION SHOWN.
9. SEAL FRONT HOUSING (ITEMS 32, 37 OR 39) AND REAR HOUSING MATING SURFACE WITH PERMATX "RTV BLACK SILICONE ADHESIVE SEALANT".

DASH No.	ITEM No.	PART No.	DESCRIPTION	SPEC
-1	1	311002-2	REAR HOUSING	
	2	509001	SQUARE HEAD PIPE PLUG	
	3	401001	THRUST BEARING	
	4	311036-1	PINTLE	
	5	201006	O-RING -006, 1/8 ID x 1/4 OD x 1/16 SEC	BUNA-N 70 DURO
	6	201011	O-RING -011, 5/16 ID x 7/16 OD x 1/16 SEC	BUNA-N 70 DURO
	7	304012	SOCK. HD. CAP SCREW	
	8	401041-1	3/8" LOCKVALVE (FOR H58)	SUB-ASS'Y
	9	347005	SPRING PIN	
	10	347020	SPRING PIN	
	11	602012	SPRING	
	12	601001	CYCLE BALL	
	13	311005-2	SPRING INSERT	
	14	602020	SPRING	
	15	202004	O-RING, 125mm ID x 129mm OD x 2mm SEC	BUNA-N 70 DURO
	16	311027-1	H58 PISTON	
	17	602020	SPRING	
	18	901003	SERIAL/ID LABEL	
	19	345001	EXTERNAL SNAP RING	
	20	405001	NEEDLE BEARING OUTER RACE	
	21	406001	BEARING SLEEVE INNER RACE	
	22	311001	FLAT HD. SCREW	
	23	311008-1	WHEEL STOP (2 PIECES)	
	24	201019	O-RING -019, 13/16 ID x 15/16 OD x 1/16 SEC	BUNA-N 70 DURO
	25	316015	WASHER	
	26	309001	HEX HD. CAP SCREW	
	27	311004-2	KEY	
	28	209003	SHAFT SEAL	
	29	311020-1	WHEEL DISK	
	30	553003	SQUARE HEAD FLANGED PIPE PLUG	
	31	301000-3	H58 ROTOR & SHAFT ASSEMBLY	INSEP. ASS'Y
	32	311006-4	H58 FRONT HOUSING	

CUSTOMER COPY

G	28-12-03	SEE DCN 030075	
F	13-07-00	SEE DCN 000046	C.S.
E	20-08-99	SEE DCN 990030	C.S.
D	30-10-97	SEE DCN 960034	C.S.
C	16-08-95	SEE DCN 950070	G.C.
B	01-05-95	SEE DCN 950023	G.C.
A	02-03-94	SEE DCN 940023	L.L.
-	08-06-93	PRODUCTION ISSUE	L.L.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY

Justam
 467 Mountain Highway
 North Vancouver, B.C.
 Canada V7L 2L3
 Tel.: (604) 988-0714
 Fax: (604) 988-0334

DATE: 07-01-04 SCALE: 1"=1" DRAWING: G.C. APPR: G.C. L.L.
 TITLE: H58 HELM PUMP ASSEMBLY DRAWING NUMBER: 0-301007

ALL DIMENSIONS ARE IN INCHES (mm) UNLESS SPECIFIED OTHERWISE.
 TOLERANCES: (UNLESS SPECIFIED OTHERWISE)
 FRACTION ANGULAR SURFACE FINISH
 X.X +/- 0.1 FRACTION ANGULAR +/- 1/64
 X.XX +/- 0.01 ANGULAR +/- 0.5 DEG
 X.XXX +/- 0.005 SURFACE FINISH
 ALL DIMENSIONS IN INCH (mm)

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1 INTRODUCTION

1.1 Description

The Power Steering Manifold 200 (PSM 200) is a stand alone, solenoid operated, hydraulic manifold which allows for the interface of electronic steering controls to hydraulic steering systems. The PSM 200 is supplied as part of a hydraulic power unit or on its own for use with an engine or electric motor driven pump.

The input and the output flow relationship for the PSM 200 is described in section 1.2. The maximum input flow is 15 gpm and the maximum output flow is 8 gpm. Excessive flows are discharged to the return line through the pressure compensated flow control valve. This arrangement minimizes heat buildup. The output flow rate to the cylinder remains constant, thus providing a constant hardcover-to-hardcover time regardless of engine's RPM.

A built-in pressure relief valve protects the hydraulic components of the steering system from over-pressurization. A built-in lockvalve isolates the PSM 200 from any external loads exerted by the rudder through the steering gear. This lockvalve also ensures the steering gear stays at a fixed position when no rudder command is given. Optional counterbalance valves, in replacement of pilot operated check valves, are for systems where "run away" rudder conditions might occur.

An optional 2 -way solenoid valve provides a "dual speed" feature allowing the rudder to turn at a normal and a fast rudder speed. The normal speed can be used when traveling under autopilot and the fast speed when additional maneuverability is required.

The PSM 200 comes with an optional auto-fill valve that ensures that any air trapped in the helm pump piping is constantly being purged. Auto-fill valve incorporates a spring loaded check valve inducing a constant back-pressure in the return line. A flow control valve is used to set the flow to 0.5 gpm at the factory. Please refer to installation section of this manual for information pertaining to auto-fill settings.

1.2 Specifications

For an Input Flow of:	Then the Maximum allowable Output Flow is:
4 gpm (15L/min)	4 gpm (15L/min)
8 gpm (30L/min)	8 gpm (30L/min)
9 gpm (34L/min)	8 gpm (30L/min)
10 gpm (38L/min)	8 gpm (30L/min)
15 gpm (57L/min)	5 gpm (19L/min)

Maximum Air Ambient Temperature:	104°F (40°C)
Oil Maximum Operating Temperature	150°F (65°C)
Output Flow Adjustment:	Zero to Maximum Output Flow
Maximum System Pressure:	1500 psi (103 bar). Factory Pre-set at 1000 psi (69 bar)
Directional Solenoid Valve:	4-Way. Voltage Options 12/24/32 VDC, 110/220 VAC
Dual Speed Solenoid Valve:	2-Way. Voltage Options 12/24/32 VDC, 110/220 VAC
Recommended Filtration:	10 Micron Nominal. (Filter Not Supplied)
Recommended Oil:	ISO 32 (eg. Shell Tellus 32, Chevron EP32, Gulf 32AW, Exxon Nuto H32).

Part number	Description	Lbs (Kg)
	PSM 200-wxyz	
	w = 1 single adjustable speed, 2 dual adj speed	
	X = 0 NO auto-fill valve, = 1 auto-fill valve	
	Y = 0 lock valves, = 1 c-balance valve	
	Z = 1 12VDC, = 2 24VDC, = 3	
JA-401052-1	PSM 200-1002, 1 speed, no auto-fill, lock valve, 24 VDC	15.0 (6.8)
JA-401052-2	PSM 200-1102, 1 speed, auto-fill, lock valve, 24 VDC	15.2 (6.9)
JA-401052-3	PSM 200-2002, 2 speed, no auto-fill, lock valve, 24 VDC	15.9 (7.2)
JA-401052-4	PSM 200-2102, 2 speed, auto-fill, lock valve, 24 VDC	16.1 (7.3)
JA-401052-5	PSM 200-1012, 1 speed, no auto-fill, lock valve, 24 VDC	15.9 (7.2)

CAUTION: All specifications are subject to change without prior notice.

2 INSTALLATION

2.1 Mounting - Hydraulic Installation

Refer to Figure 1 for mounting and connection information.

Refer to Figure 2 for a typical piping layout of an engine driven system.

NOTE: If the PSM 200 is supplied as part of a hydraulic power unit, only the outlet ports (ports C) need to be connected. The inlet port (port C) and return port (port T) will be pre-plumbed.

- a) Connect the hydraulic pump outlet to the PSM 200 inlet port (port P).
- b) Connect the PSM 200 return port (port T) to the inlet port of the return line filter.

IMPORTANT: A filter should be installed in the return line.
--

- c) Connect the two outlet ports (ports C) to the steering gear.
- d) If auto-fill option is present, connect the auto-fill line-out to the auto-fill flow control valve, and the return line to the tank while ensuring that fluid is returned to tank below fluid level.

2.2 Wiring

WARNING: ALL WIRES MUST BE SECURELY CONNECTED. A LOOSE WIRE OR SHORT CIRCUIT MAY CAUSE AN ERRONEOUS STEERING COMMAND.
--

Refer to Figure 3 for wiring information.

- a) Connect the directional solenoid wires to the electronic steering control device as specified in the control devices manual (ie, Jog Lever Manual, Amplifier Unit Manual or Autopilot Manual).
- b) If supplied, connect the fast speed solenoid to a remote selector switch or as indicated in the electronic steering control device manual.

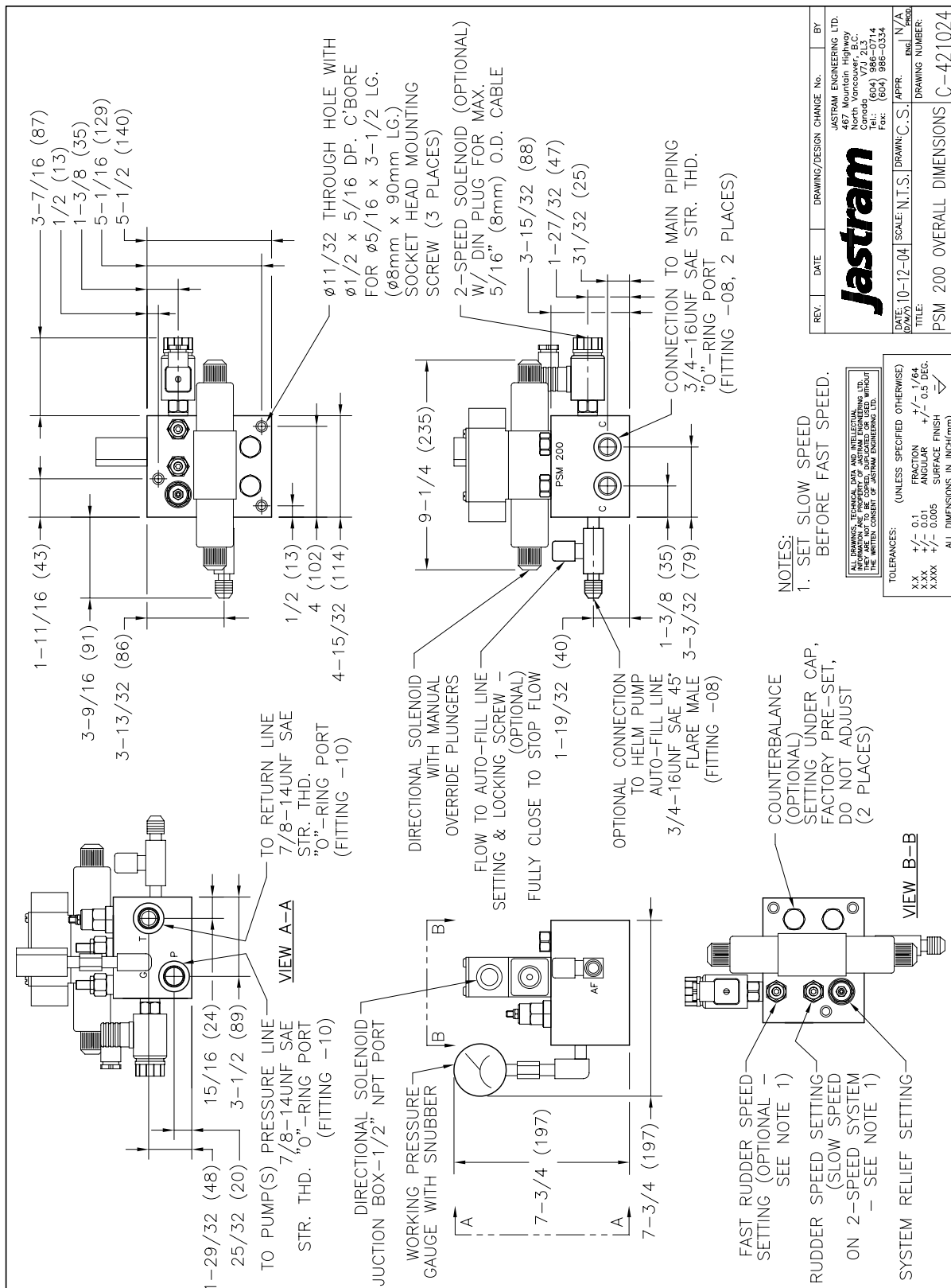


Figure 1 – Power Steering Manifold Overall Dimensions





3 SETUP AND TESTING

WARNING: ALL SET UP AND TESTING PROCEDURES MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

3.1 Preparation

To ensure SAFE and EFFICIENT operation of the PSM 200 manifold the following conditions **must be met prior** to starting up the steering gear system:

- All tubing, flexible hose and fitting connections are tight and thoroughly cleaned as per manufacturer's recommendations.
- Rags, plastic caps, etc. have not been left inside tubing or hoses.
- The PSM 200 manifold is properly mounted and secured.
- All adjustable screws are in a locked position.
- All mechanical components in the steering system are free to move as required.
- Oil is available at the pump inlet. If uncertain loosen the inlet fitting slightly to allow oil to escape. Re-tighten fitting when finished.
- Pump rotation is correct (motor rotation if the PSM 200 is supplied as part of a hydraulic power unit).
- All electrical connections are correct according to electronic control device's manual.
- All electrical connections are secure and insulated.
- All personnel are clear from any moving machinery.

3.2 Start Up

- a) Start the hydraulic pump.

WARNING: WHEN TURNING THE STEERING HARDOVER TO HARDOVER DO NOT EXCEED THE MAXIMUM PRESSURE RATING OR LOADS OF THE STEERING SYSTEM.

- b) While monitoring the system pressure, shift the directional solenoid valve by manually inserting a slender rod in one end. Keep the rod inserted until the steering gear reaches hard over. Repeat for the opposite side of directional solenoid valve. This will indicate that the hydraulic system is functioning properly.

- c) Energize the directional solenoid valve by giving a command at the electronic control device. Observe the steering gear movement. A port or starboard command should give the corresponding steering direction. Wires at the directional solenoid can be changed if the steering direction is wrong.
- d) Turn the steering gear from hardover to hardover with the steering control device until the steering gear responds instantly to a command. This will ensure that any trapped air has been removed from the system.

3.3 Adjustments

Refer to Figure 1 for the location of the relief valve and flow control settings.

- a) Set the system relief valve to the required system pressure by loosening the relief lock nut and turning the relief set screw. Turning the set screw in a clockwise direction increases the relief valve pressure, counterclockwise decreases the pressure.

NOTE:

- Jastram brass cylinders are designed to operate with the PSM 200 set at a maximum pressure of 1000 psi (69 bar).
- Jastram steel cylinders are designed to operate with the PSM 200 set at a maximum pressure of 1500 psi (103 bar).
- Jastram K-Rams are designed to operate at with the PSM 200 set at a maximum pressure of 1000 psi (69 bar) or 1200 psi (83 bar) depending on steering angle.
- b) Set the steering gear hard over time by loosening the flow control locknut and turning the flow control set screw. Turning the set screw in a counterclockwise direction increases flow to the steering gear (decreases hard over time). A clockwise adjustment decreases flow (increases hard over time).

WARNING: SECURE THE RELIEF VALVE AND FLOW CONTROL ADJUSTMENTS ONCE THEY ARE SET.

- c) Auto-fill valve is factory set to 0.5 gpm of flow. Under most set-ups this will produce less than 15 psi back pressure at the helm shut-off valve. To check the back pressure:

- 1) Connect a low pressure gauge (0-100 psi) to the helm pump side of the helm shut-off valve;
- 2) Ensure pump is on and there is oil flow in the helm pump lines;
- 3) Read the pressure on the gauge;
- 4) If the pressure exceeds 15 psi, reduce Auto-fill flow until the gauge reads 15 psi or below;
- 5) Disconnect the low pressure gauge and reconnect the helm piping to helm pump shut of valve.

4 MAINTENANCE AND PARTS LISTS

WARNING: ALL INSPECTION AND MAINTENANCE MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The PSM 200 should be inspected periodically for the following:

- Mounting bolts and fittings are secure.
- Flow control set screw and relief valve are secured in position.
- There is no visible leakage at any fittings or PSM 200 components.
- All electrical connections are secure, wires and cables are in good condition.

Seals and mechanical components are subject to wear over time. When internal leakage or steering system performance becomes unacceptable, seal or component replacement is recommended.

Refer to Figure 4 for parts breakdown.

No.										ITEM No.	PART No.	DESCRIPTION	SPEC.
-9	-8	-7	-6	-5	-4	-3	-2	-1					
QTY.													
1	1	1	1	1	1	1	1	1	1	1	411117-1	MANIFOLD BODY	
-	2	2	2	2	-	-	-	-	-	2	550018	COUNTERBALANCE CARTRIDGE	
-	2	2	2	2	-	-	-	-	-	3	553021	CARTRIDGE COVER	
2	-	-	-	-	2	2	2	2	2	4	546007	PILOT OPERATED CHECK CARTRIDGE	
-	1	1	1	1	1	1	1	1	1	5	548007	DIRECTIONAL SOLENOID, 24 VDC	
4	4	4	4	4	4	4	4	4	4	6	301005	SOCKET HEAD CAPSCREW	
4	4	4	4	4	4	4	4	4	4	7	325015	HIGH COLLAR LOCKWASHER	
1	1	1	1	1	1	1	1	1	1	8	549013	MODULATING ELEMENT CARTRIDGE	
2	1	2	1	2	1	2	1	2	2	9	508003	SOCKET HEAD PIPE PLUG	
1	1	1	1	1	1	1	1	1	1	10	552001	PRESSURE GAUGE, 0-3000 PSI	
1	1	1	1	1	1	1	1	1	1	11	551008	SNUBBER	
1	1	1	1	1	1	1	1	1	1	12	513016	FITTING	
2	2	2	2	2	2	2	2	2	2	13	553009	SHIPPING PLUG	
-	1	-	1	-	1	-	1	-	1	14	401064-1	AUTO-FILL CARTRIDGE	SUB-ASS'Y
2	2	2	2	2	2	2	2	2	2	15	553006	SHIPPING PLUG	
2	2	2	2	2	2	2	2	2	2	16	554004	PLUG	
2	2	2	2	2	2	2	2	2	2	17	203905	"O"-RING-905, 13/32 ID x 9/16 OD x 5/64 SEC.	BUNA N90 DURO
-	1	-	1	-	1	-	1	-	1	18	516004	FITTING	
-	1	-	1	-	1	-	1	-	1	19	550017	NEEDLE VALVE	
-	1	-	1	-	1	-	1	-	1	20	513015	FITTING	
-	1	-	1	-	1	-	1	-	1	21	332002	THUMB SCREW	
1	1	1	1	1	1	1	1	1	1	22	554001	PLUG	
1	1	1	1	1	1	1	1	1	1	23	203903	"O"-RING-903, 19/64 ID x 27/64 OD x 1/16 SEC.	BUNA N90 DURO
2	2	2	1	2	2	1	2	1	24	550016	FLOW CONTROL CARTRIDGE		
1	1	1	3	3	1	1	3	3	25	554005	PLUG		
1	1	1	3	3	1	1	3	3	26	203908	"O"-RING-908, 41/64 ID x 13/16 OD x 3/32 SEC.	BUNA N90 DURO	
-	-	1	1	1	-	-	1	1	27	401069-1	CAVITY PLUG ASSEMBLY	SUB-ASS'Y	
1	1	1	1	1	1	1	1	1	28	901037	SERIAL / IDENT. LABEL		
1	1	1	-	1	1	-	1	-	29	548046	2-SPEED CARTRIDGE		
1	1	1	-	1	1	-	1	-	30	836000	DIN PLUG		
-	1	1	-	1	1	-	1	-	31	548047	COIL, 24VDC		
1	-	-	-	-	-	-	-	-	32	548052	DIRECTIONAL SOLENOID, 12 VDC		
1	-	-	-	-	-	-	-	-	33	548057	COIL, 12VDC		

MODEL	APPLICATION	DASH No ASS'Y No.
PSM200-10021	1-SPEED, NO AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-1 401052-1
PSM200-11021	1-SPEED, W/ AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-2 401052-2
PSM200-20021	2-SPEED, NO AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-3 401052-3
PSM200-21021	2-SPEED, W/ AUTO-FILL, W/ DUAL P.O. CHECK, 24VDC	-4 401052-4
PSM200-10121	1-SPEED, NO AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-5 401052-5
PSM200-11121	1-SPEED, W/ AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-6 401052-6
PSM200-20121	2-SPEED, NO AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-7 401052-7
PSM200-21121	2-SPEED, W/ AUTO-FILL, W/ DUAL C'BALANCE, 24VDC	-8 401052-8
PSM200-20012	2-SPEED, NO AUTO-FILL, W/ DUAL P.O. CHECK, 12VDC	-9 401052-9

SEE NOTE 2

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CUSTOMER PARTS LIST

Jastram

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REV.	DATE	DRAWING/DESIGN	CHANGE No.	BY
	19-01-05	SCALE: 1"=2"	DRAWN: C.S.	APPR: N/A
TITLE:				DRAWING NUMBER:
PSM 200 ASSEMBLY				C-401052

Figure 4 - PSM 200 Assembly

5 TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE SUDDEN LOSS OF STEERING.

The chart below gives some general solutions for simple problems. If a problem cannot be resolved, contact the factory.

SYMPTOM	CAUSE	CORRECTION
Pump running, steering gear does not respond when given a command.	Inlet and return lines are reversed at the PSM 200.	Correct the lines. Refer to Figure 1 and Figure 2.
	System relief valve set too low.	Increase relief pressure.
	Flow control set too low.	Increase flow.
	Wires are loose or incorrect wiring.	Refer to Figure 3 – Wiring Diagram or appropriate control device manual.
	No power to directional solenoid.	Check power source.
	Optional DARB valve is in the bypass position.	Select normal position on DARB valve.
Steering gear goes hard over on its own.	Faulty wiring or short circuit.	Check wiring connections. Refer to Figure 3 or appropriate control device manual.
Noisy hydraulic pump or hydraulic system.	Excessive air trapped in the system.	Check the oil level in header tank, fill if installed. Check that all hoses and fittings are tight. Ensure air can be bled from system, and re-bleed.
Oil temperature too high.	Filter plugged.	Service filter.
	Pump is oversized. Too much flow for the system.	Replace pump with one sized correctly.

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THE COMPANY'S WARRANTY PROGRAM

1. The Company warrants each Product manufactured, installed or repaired by it to be free from defective materials or workmanship for a period of eighteen months from the date of shipping of such Product to the customer of the Company or one year after sea trials, whatever comes first, and, if any Product is proven to be defective in materials or workmanship, the Company will, at its sole option and as the sole remedy of the customer, repair or replace such Product without charge to the customer, provided the customer:
 - (a) gives immediate notice of any alleged defects upon discovery by the customer;
 - (b) maintains and uses the product strictly in accordance with its intended use, the Company's recommendations, if any, and all applicable federal, provincial and municipal government laws, rules and regulation; and
 - (c) does not alter or repair the Product without the written approval of the Company.
2. Unless otherwise agreed all Products are sold, repaired or replaced F.O.B. the Company's facility at 135 Riverside Drive, North Vancouver, British Columbia, V7H 1T6, Canada.
3. No Products may be returned to the Company without its prior written approval.
4. The Company accepts no liability for any Products resold, leased, rented, or used in any manner by persons other than the original purchaser of the Products unless, at the time the Products were purchased, the Company agrees in writing to extend the warranties herein contained to such third parties.
5. The warranties contained herein will not apply to any Products which have not been properly maintained or have been repaired by anyone other than the Company or an authorized representative thereof, were used for purposes other than those for which they were designed, were subject to obvious neglect, abuse, or misuse, or stress at angles other than reasonably contemplated in the normal use of the Products.

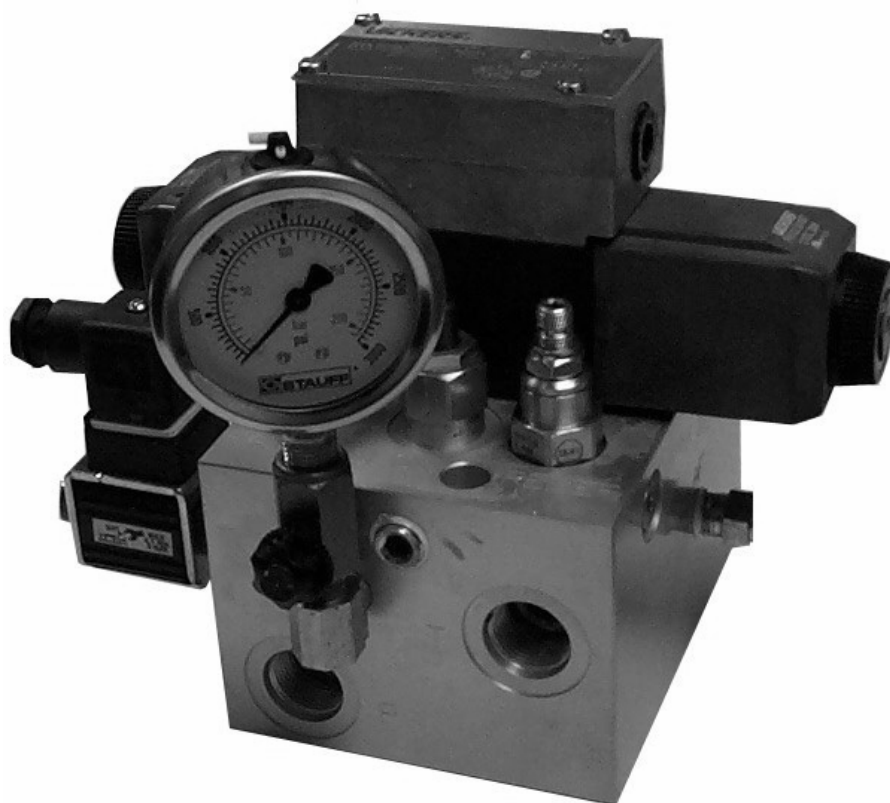


6. Except as herein provided for the repair or replacement of defective Products, the Company shall have no liability for any loss, personal injury, damage, expense (including removal, installation or re-installation of Product), loss of revenue, loss of profit, loss of use, damages consequential upon loss of use, or any other consequential damage, directly or indirectly caused by or resulting from any negligence of the Company, or accident, or the use of failure of any Products, or from improper or inadequate manufacture of assembly, maintenance or inspection.

7. Unless the Company acknowledges in writing any statements, specifications, desired qualities or characteristics of Products, or potential for loss by a customer, the Company will be deemed to have no notice of any such statement, specification, desired qualities or characteristics of Products, or potential for loss.

Component Manual

**Power Steering Manifold
Model: PSM 200**



**Document No.: MAN00703
Revision: -**

This manual is subject to change without prior notice.



3.4 TROUBLESHOOTING

SYMPTOM	CAUSE	CORRECTION
Steering gear does not respond to solenoid command.	Flow control valve is set too low.	Turn flow control valve to increase flow.
	Working pressure relief valve is set too low.	Turn relief valve to increase working pressure.
	Bypass valve open.	Check that all cross line valves including the DARB are in their normal (closed) position.
	Shut-off valve closed in the piping.	Check that all shut off valves are in their normal (open) position.
	Pump is turning backwards.	Reverse the direction of the electric motor.
	Flow control dumping valve stuck due to contamination.	Refer to power steering manifold manual.
	Electronic steering control system not operating.	Refer to steering control manual.
Steering gear doesn't turn smoothly.	Air in the manual lines.	Open the bypass valve and turn all the manual helm pumps continuously until all the air in the manual lines is removed.
		Remove goosenecks from manual and filler lines.
	Air in the power steering lines.	Open the bypass valve and operate the directional solenoid continuously until all the air in the power steering lines is removed.
	Air in the steering gear.	Set the working pressure to its lowest setting where the steering gear will still turn and operate the steering gear between its mechanical stops.
	FFU steering control system is not set properly	Refer to FFU steering control manual.
Steering gear doesn't turn at correct speed.	Flow control incorrectly set.	Re-set flow control.



SYMPTOM	CAUSE	CORRECTION
Steering gear goes hardover by itself.	Directional valve stuck due to contamination.	In an emergency shut the pump off or turn power steering manifold's flow control to off. The directional valve must be replaced with one free of contamination.
	Short circuit in steering control system.	Turn off power to steering control system. Find fault.
Manual helm pump is noisy.	Air in manual lines.	Fill helm pump reservoir and remove air from manual system.
Power steering pump is noisy.	Pump is turning backwards.	Reverse the direction of the electric motor.
	Air entering pump suction line.	Fill the pump reservoir.
	Engine driven pump is cavitating.	Reduce restrictions in pump suction line by increasing diameter of suction line and reducing elbows.
		Relocate pump reservoir closer and above pump.

HPU FAILURE:

- 1-REDUCE VESSEL SPEED
ON FAILED SIDE ONLY:
- 2-TURN MOTOR STARTER TO LOCAL
- 3-STOP HPU
- 4-CLOSE HPU'S SHUT-OFF VALVES LABELED "13A"
- 5-OPEN HELM PUMP SHUT-OFF VALVES LABELED "12"
- 6-STEER WITH HELM PUMP AT REDUCED VESSEL SPEED

MAIN PIPING FAILURE:

- 1-REDUCE VESSEL SPEED
ON FAILED SIDE ONLY:
- 2-TURN MOTOR STARTER TO LOCAL
- 3-STOP HPU
- 4-CLOSE HPU'S SHUT-OFF VALVES LABELED "13A"
- 5-CLOSE VALVES LABELED "7A"
- 6-SET VALVES LABELED "5A" TO POSITION 3
- 7-OPEN HELM PUMP SHUT-OFF VALVES LABELED "12"
- 8-STEER WITH HELM PUMP AT REDUCED VESSEL SPEED

AUXILIARY PIPING FAILURE:

- 1-REDUCE VESSEL SPEED
ON FAILED SIDE ONLY:
- 2-TURN MOTOR STARTER TO LOCAL
- 3-CLOSE VALVES LABELED "7B"
- 4-SET VALVES LABELED "5B" TO POSITION 3
- 5-TURN MOTOR STARTER TO REMOTE
- 6-REPLENISH HPU RESERVOIR AS REQUIRED BY
TEMPORARILY OPENING VALVE LABELED "8"
- 7-STEER NORMALLY WITH HPU

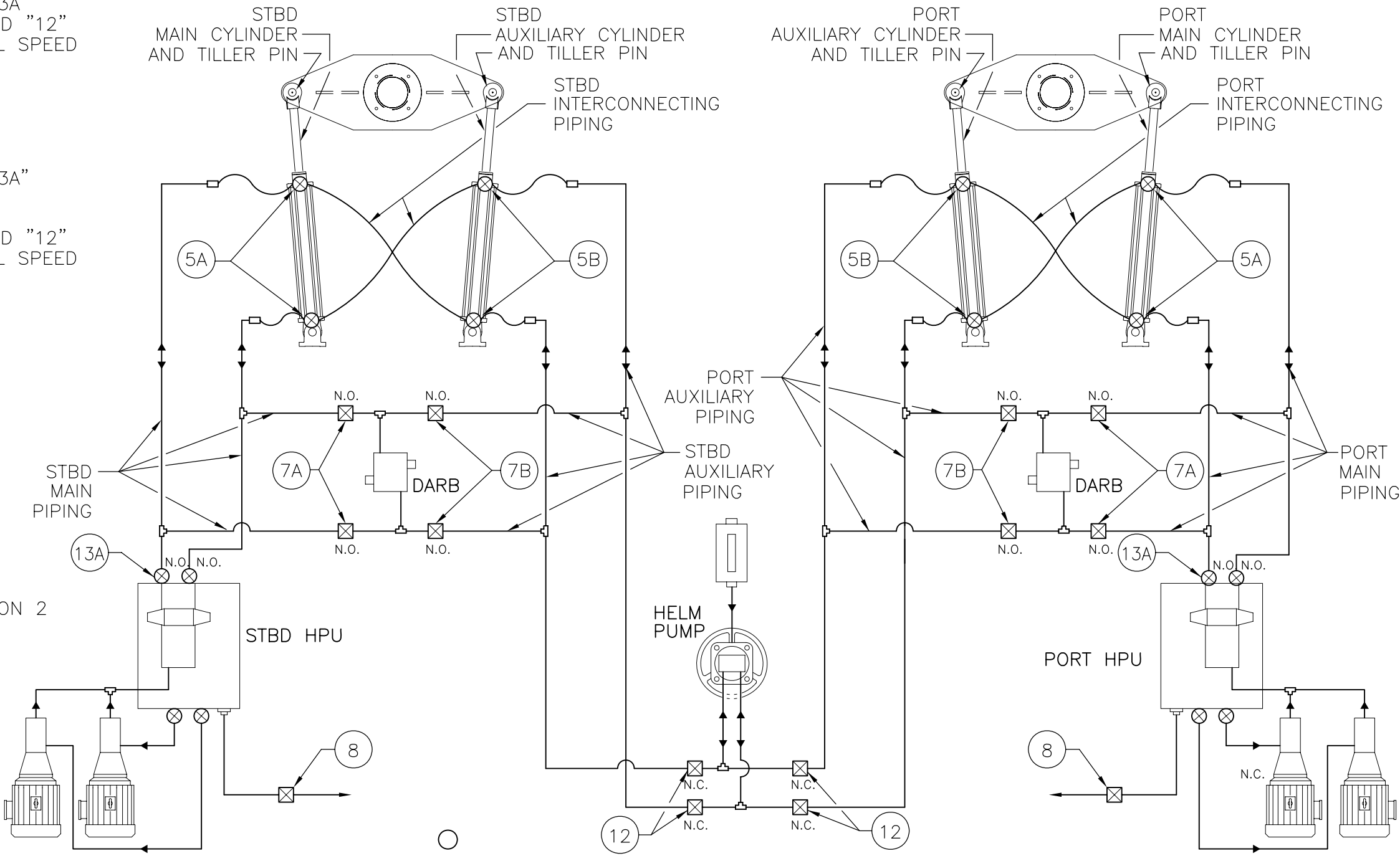
INTERCONNECTING PIPING FAILURE:

- 1-REDUCE VESSEL SPEED
ON FAILED SIDE ONLY:
- 2-TURN MOTOR STARTER TO LOCAL
- 3-SET VALVES LABELED "5A" & "5B" TO POSITION 2
- 4-TURN MOTOR STARTER TO REMOTE
- 5-REPLENISH HPU RESERVOIR AS REQUIRED BY
TEMPORARILY OPENING VALVE LABELED "8"
- 6-STEER NORMALLY WITH HPU

DARB FAILURE:

- ON FAILED SIDE ONLY:
- 1-CLOSE VALVES LABELED "7A" & "7B"
- 2-REPLENISH HPU RESERVOIR AS REQUIRED BY
TEMPORARILY OPENING VALVE LABELED "8"
- 3-STEER NORMALLY WITH HPU

EMERGENCY CHANGE-OVER PROCEDURES
FOR STEERING GEAR PIPING





4 STEERING CONTROL - TECHNICAL INFORMATION

THIS SECTION INCLUDES:

- 4.1 SCOPE OF SUPPLY
- 4.2 TECHNICAL DESCRIPTION - STEERING CONTROL
- 4.3 TECHNICAL DESCRIPTION - RUDDER ANGLE INDICATION
- 4.4 ELECTRICAL SCHEMATICS

REF: JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD



4.1 SCOPE OF SUPPLY - STEERING CONTROL & RUDDER ANGLE INDICATION

<u>QTY.</u>	<u>DESCRIPTION</u>
2	DIGITAL STEERING CONTROLLER, DSC 100-302
3	MODE CONTROL PROCESSOR, MCP 100-20
1	MODE CONTROL PANEL, CP-36-2
4	TAKE-OVER PUSHBUTTON
2	RUDDER FEEDBACK UNIT, RFU 2000-1210
1	ELECTRIC WHEEL, EW 200-31
2	LEVER CONTROLLER, LC 100-2
6	JOG LEVER, JO 100-1
6	RUDDER ANGLE INDICATOR, RAI 380
1	RUDDER ORDER INDICATOR, ROI 380
1	EMERGENCY STATION JUNCTION BOX

REF: JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD



4.2 TECHNICAL DESCRIPTION - STEERING CONTROL

Drawing No.	Description
D-751661	Steering Control Cabling Diagram
N.A.	Technical Description - Rudder Angle Indication

GENERAL

This vessel is fitted with two independent rudders. Each of the port and starboard rudders has its own complete steering system. The port and starboard rudders are entirely independent of one another.

Each of the port and starboard steering systems has its own control system. These control systems are completely independent of one another and will be referred to as the port and starboard systems respectively. Full Follow-Up (FFU) and Non Follow-Up (NFU) steering control is provided at the wheelhouse, port wing and starboard wing stations.

The power supply for each port and starboard control system is derived from the port and starboard steering feeder circuits via either the Unit 1 or Unit 2 motor starters (by others). Overcurrent protection devices for each control system are provided in their respective motor starters.

The cables and components for the two steering control systems are laid out in order to isolate the two systems on a port and starboard basis throughout the length of the vessel.

Rudder angle indication (RAI) is available at the wheelhouse, port wing and starboard wing stations as well as at the Emergency Steering Station Junction Box. Separate rudder angle indication systems are provided for each of the port and starboard steering gears. The port and starboard rudder angle indication systems are completely independent from each other as well as from the port and starboard steering control systems.

REMOTE STEERING CONTROL

Two separate and completely independent steering control systems are provided. Each of the port and starboard systems is capable of Full Follow-Up (FFU) synchronized as well as Non Follow-Up (NFU) independent steering controls. The FFU input devices are the Electric Wheel (EW 200) and Lever Controllers. The NFU command input devices are the port and starboard Jog Levers (JO 100) located at the wheelhouse, port wing and starboard wing stations.

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The mode of steering control at the wheelhouse is selected using the Steering Mode Control Panel (CP-36-2). This panel contains four illuminated steering mode pushbuttons: "STANDBY", "SYNC HELM", "INDEP JOG" and "AUTOPILOT". Two additional pushbuttons are provided in order to control dimming of the illuminated steering mode buttons. This Control Panel also contains a "FAULT" indicator and audio device in order to alert the operator to any fault within the main steering control systems.

In the STANDBY mode, the directional solenoid valve outputs of the port and starboard steering control systems are turned off. In this mode, both the port and starboard remote steering control systems are inactive.

In the SYNC HELM mode, the FFU synchronized steering will be active at the wheelhouse. Full Follow-Up synchronized control of the port and starboard rudders is provided through the use of the Electric Wheel (EW 200-31). The EW 200 contains separate potentiometers that provide synchronized rudder position commands to the port and starboard steering control systems. Rudder order signals are also provided to the Rudder Order Indicator (ROI 380) to display the FFU rudder command of the Electric Wheel. This indicator allows the operator to simply dial in the desired rudder angle and let the closed loop FFU control systems take care of moving the rudder to the desired position.

In the INDEP JOG mode, the NFU independent steering will be active at the wheelhouse. NFU control of the port and starboard rudders is provided through the use of the independent Jog Levers (JO 100) located at the wheelhouse. Each Jog Lever contains a set of micro-switches to provide port and starboard directional commands to the steering controllers.

When the AUTOPILOT mode is selected, an autopilot take-over handshake is initiated between each DSC and the autopilot system. A dry contact in each DSC (\pm REQ.) will close, providing autopilot request signals to the autopilot system. When the autopilot system receives these request signals and is ready to assume control of the rudder, the autopilot system will close dry contacts (\pm ACK.) providing each DSC with an autopilot acknowledge signal. Once each DSC receives the autopilot acknowledge signal, the DSC will look to the autopilot's command signals (\pm ANALOG) for rudder position commands.

Each wing station has Take-Over Pushbuttons. The Take-Over Pushbutton can be used to take over the control from any station at any time. When the LEVER Take-Over Pushbutton is pressed either at the port wing station or starboard wing station, the Lever Controller (LC 100-2) FFU synchronized steering will be active at that station. The LC 100 contains separate potentiometers that provide synchronized rudder position commands to the port and starboard steering control systems. When the JOG Take-Over Pushbutton is pressed either at the port wing station or starboard wing station, the port and starboard Jog Levers will be active and will control the port or starboard rudder at that station.

REF: JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD



STEERING COMPARTMENT

Local control of the port and starboard, main and auxiliary steering gear is provided in the steering compartment by means of manual override plungers on the hydraulic power unit's 4-way directional solenoids.

The port and starboard, FFU and NFU steering control power supplies are routed through the Unit 1 and Unit 2 motor starters (by others) to the Emergency Station Junction Box through cables 16PA, 16PB, 16SA and 16SB. Along with these power supplies, there are their respective switched power signals. The switched power signals are used to energize relays which connect the rudder command signals to the hydraulic power unit directional solenoids.

The control voltage for each directional solenoid is routed through each RFU 2000 to take advantage of the rudder angle limit switches contained in these units. These limit switches serve to stop the hydraulic cylinder travel before any mechanical stops are reached. The switches are cam operated and are directly coupled to the rudder stock through a mechanical linkage. Each RFU's limit switch circuit is completely independent of the rudder feedback circuits also contained in this unit.

Supplementary NFU control of the port and starboard steering gears is provided at the Emergency Station Junction Box. The emergency station contains separate systems for the port and starboard steering gears. Each of these emergency systems consists of a rotary switch, Jog Lever and Rudder Angle Indicator. Each rotary switch is provided for completely disconnecting the wheelhouse steering control systems from the power supplies. The switch's positions are "LOCAL", "OFF" and "REMOTE". In the switch's OFF position, both the remote steering control and the local emergency steering control are disconnected. In the LOCAL position, the NFU Jog Levers on the Emergency Station Junction Box provide independent NFU control of each rudder. In the REMOTE position, the DC power supplies to the wheelhouse steering control systems are connected.

Rudder angle indication is available in the steering compartment through the use of a mechanical indicator strip mounted on the tiller.

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43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD



4.3 TECHNICAL DESCRIPTION - RUDDER ANGLE INDICATION

Drawing No.	Description
D-751661	Steering Control Cabling Diagram
N.A.	Technical Description - Steering Control

GENERAL

This vessel's rudder angle indicating system gives rudder position reference in the wheelhouse, port wing and starboard wing stations for each of the port and starboard rudders, as well as on the Emergency Station Junction Box in the steering compartment.

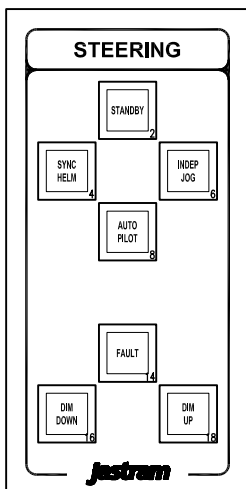
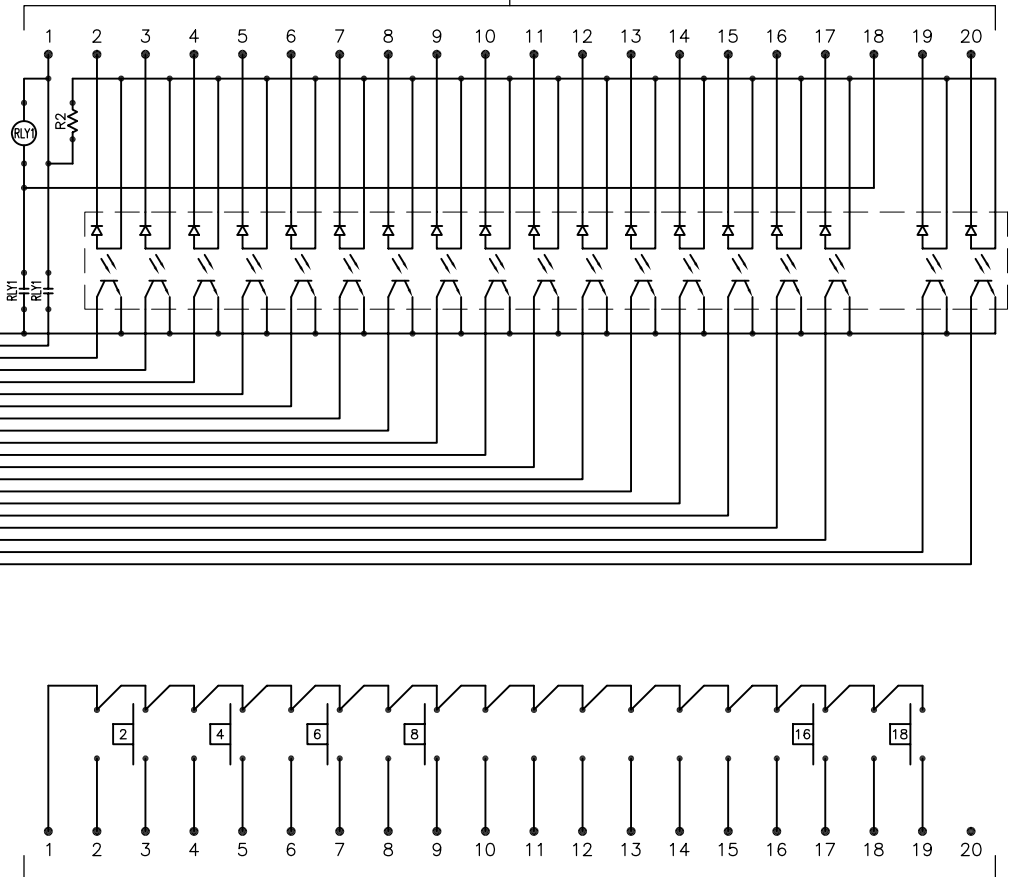
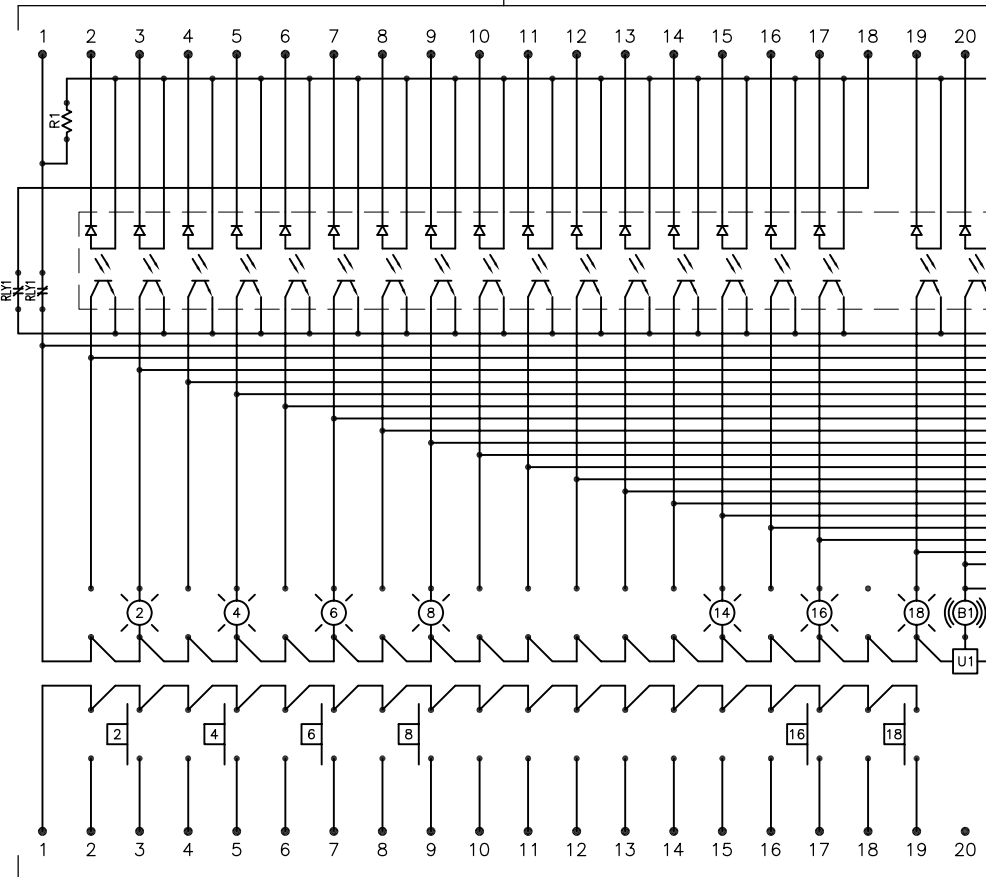
Each RAI system consists of three Rudder Angle Indicators (RAI 380) with a RAI 380 on the Emergency Station Junction Box and a Rudder Feedback Unit (RFU 2000). These items are shown in the Steering Control Cabling Diagram.

All the circuitry necessary to drive the RAI is contained within each RFU 2000. Each RFU 2000 is mechanically linked to the ship's rudders and converts the position of the rudders into an electronic signal. This signal is called the rudder angle indicator signal. Each RFU also contains limit switches, which serve to stop the steering gear before its mechanical stops are reached. The circuit for these switches is independent of each RFU 2000's rudder angle indication circuitry.

The power supplies for the RAI systems are shown to be independent of the steering control power supplies. The feeder circuit and short-circuit protection is to be provided by the shipyard as indicated.





4.4 ELECTRICAL SCHEMATICS



INDICATOR	COLOR
2	GREEN
4	GREEN
6	GREEN
8	GREEN
14	RED
16	AMBER
18	AMBER

1. ALL INDICATORS ARE 24 VDC LED'S WITH THE ANODES (POSITIVE) SIDE CONNECTED.
2. ALL PUSH BUTTON CONTACTS ARE DPST NORMALLY OPEN MOMENTARY CONTACTS.
3. REGULATOR U1 IS A 12 VDC FIXED VOLTAGE REGULATOR.
4. AUDIO DEVICE B1 IS A 12 VDC, 85 dBA AUDIO INDICATOR.

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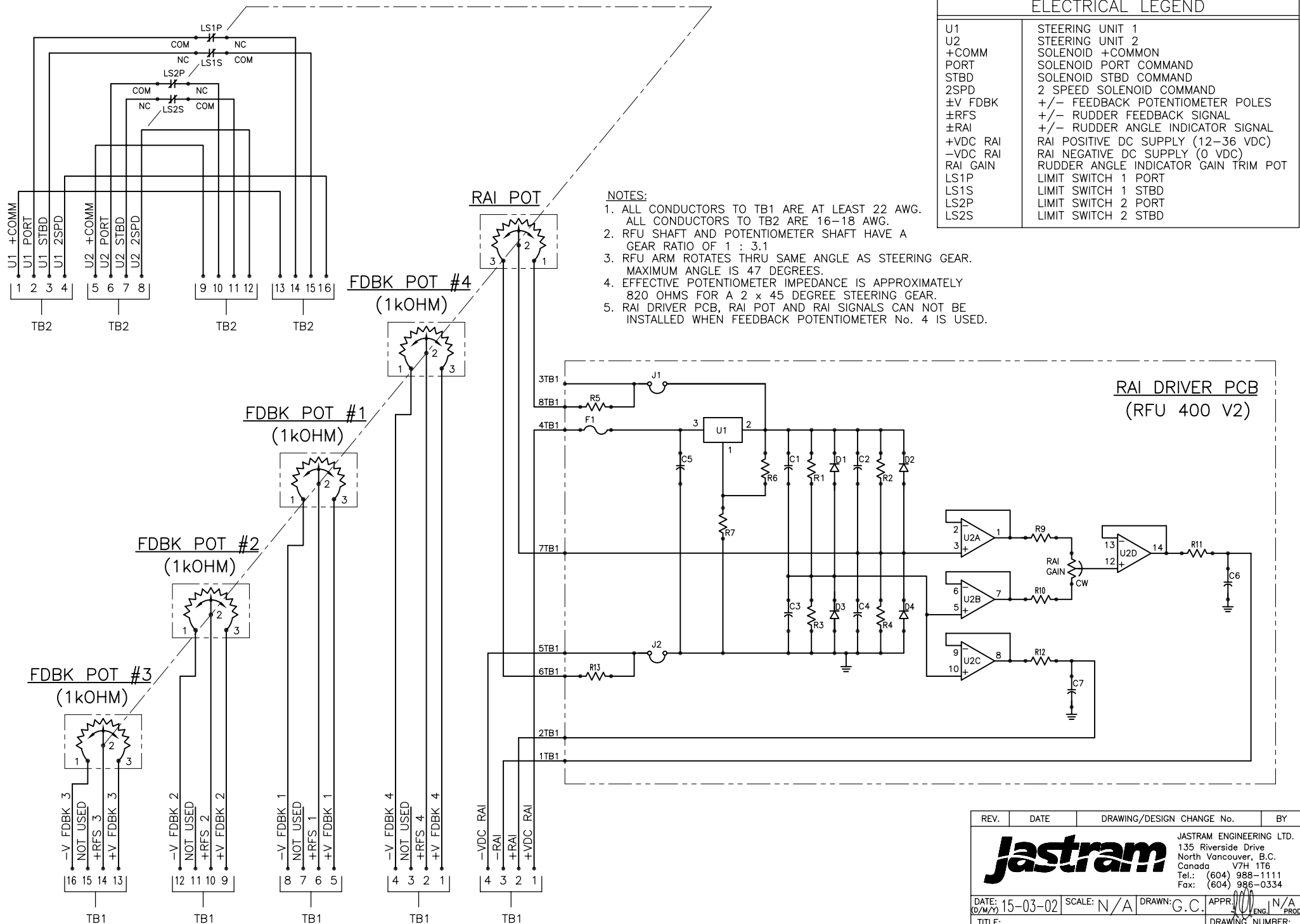
REV.	DATE	DRAWING/DESIGN CHANGE No.		BY
		JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334		
		DATE: 27-07-10 SCALE: N/A DRAWN: P.K. APPR:  N/A (D/M/Y) ENG. PROD.		
TITLE: CP-36-2 CONTROL PANEL ELECTRICAL SCHEMATIC		DRAWING NUMBER: C-762033		

ELECTRICAL LEGEND

U1	STEERING UNIT 1
U2	STEERING UNIT 2
+COMM	SOLENOID +COMMON
PORT	SOLENOID PORT COMMAND
STBD	SOLENOID STBD COMMAND
2SPD	2 SPEED SOLENOID COMMAND
±V FDBK	+/- FEEDBACK POTENTIOMETER POLES
±RFS	+/- RUDDER FEEDBACK SIGNAL
±RAI	+/- RUDDER ANGLE INDICATOR SIGNAL
+VDC RAI	RAI POSITIVE DC SUPPLY (12-36 VDC)
-VDC RAI	RAI NEGATIVE DC SUPPLY (0 VDC)
RAI GAIN	RUDDER ANGLE INDICATOR GAIN TRIM POT
LS1P	LIMIT SWITCH 1 PORT
LS1S	LIMIT SWITCH 1 STBD
LS2P	LIMIT SWITCH 2 PORT
LS2S	LIMIT SWITCH 2 STBD

NOTES:

1. ALL CONDUCTORS TO TB1 ARE AT LEAST 22 AWG.
ALL CONDUCTORS TO TB2 ARE 16-18 AWG.
2. RFU SHAFT AND POTENTIOMETER SHAFT HAVE A GEAR RATIO OF 1 : 3.1
3. RFU ARM ROTATES THRU SAME ANGLE AS STEERING GEAR.
MAXIMUM ANGLE IS 47 DEGREES.
4. EFFECTIVE POTENTIOMETER IMPEDANCE IS APPROXIMATELY 820 OHMS FOR A 2 x 45 DEGREE STEERING GEAR.
5. RAI DRIVER PCB, RAI POT AND RAI SIGNALS CAN NOT BE INSTALLED WHEN FEEDBACK POTENTIOMETER No. 4 IS USED.



SEE NOTE 5

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Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 986-1111 Fax: (604) 986-0334				
DATE: 15-03-02	SCALE: N/A	DRAWN: G.C.	APPR: [Signature]	ENG: N/A
TITLE: RFU 2000 ELECTRICAL SCHEMATIC	DRAWING NUMBER: C-761454			

ELECTRICAL LEGEND

±V CMND	+/- FFU COMMAND POTENTIOMETER POLES
±ROS	+/- RUDDER ORDER COMMAND SIGNAL
±ROI	+/- RUDDER ORDER INDICATOR SIGNAL
+VDC ROI	ROI POSITIVE DC SUPPLY (12-36 VDC)
-VDC ROI	ROI NEGATIVE DC SUPPLY (0 VDC)
ROI GAIN	RUDDER ORDER INDICATOR GAIN TRIM POT

PORT
STBD

ELECTRIC
WHEEL
SHAFT

ELECTRIC WHEEL
DETAIL

ROI POT

NOTES:

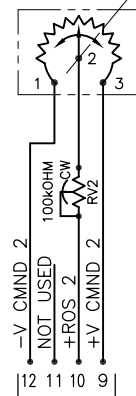
1. ALL CONDUCTORS 22 AWG.
2. 4.26:1 RATIO MECHANICAL LINK BETWEEN ELECTRIC WHEEL SHAFT AND COMMAND POTENTIOMETER SHAFT.
3. ELECTRIC WHEEL SHAFT ROTATES THRU 1367° FROM ITS HARDOVER TO HARDOVER POSITIONS.
4. EFFECTIVE POTENTIOMETER IMPEDANCE APPROXIMATELY 944 OHMS.
5. ROI DRIVER PCB, ROI POT AND ROI SIGNALS CAN NOT BE INSTALLED WHEN COMMAND POTENTIOMETER No. 3 IS USED.

CMND POT #3
(1kOHM)

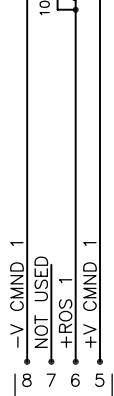
CMND POT #1
(1kOHM)

CMND POT #2
(1kOHM)

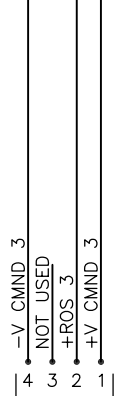
ROI DRIVER PCB
(RFU 400 V2)



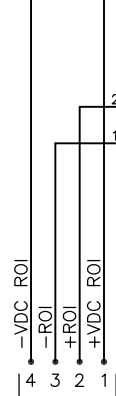
TB1



TB1

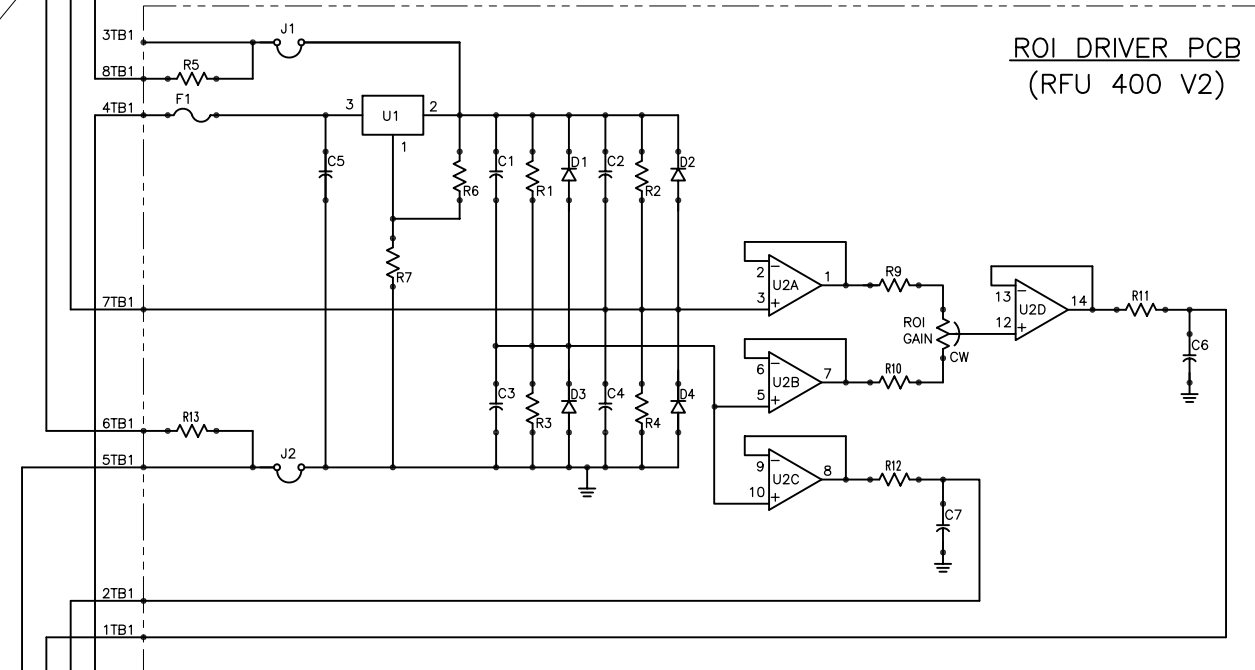


TB1



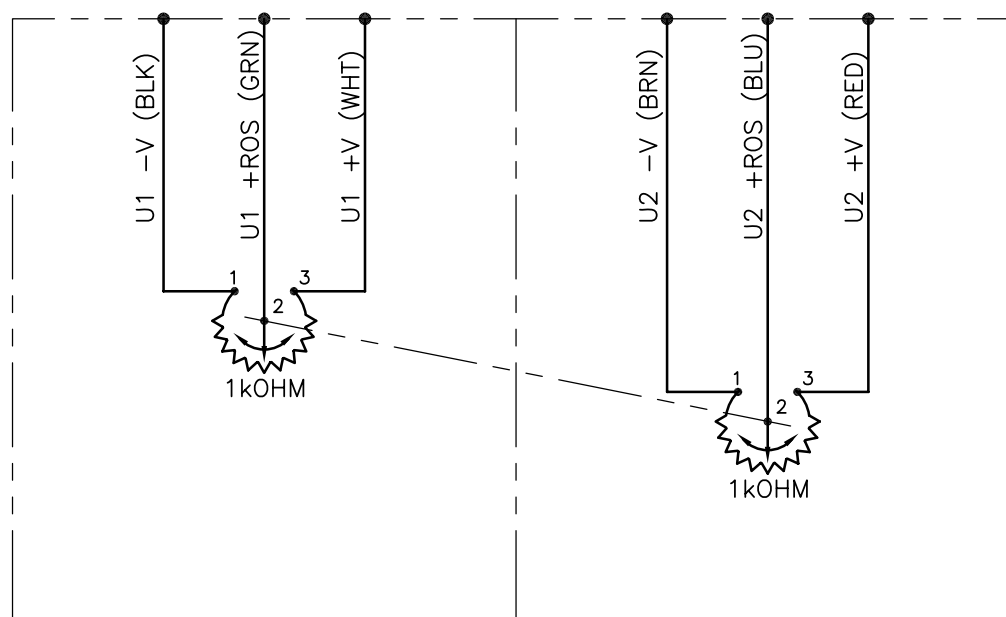
TB1

SEE NOTE 5



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Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334				
DATE: 07-05-02	SCALE: N/A	DRAWN: G.T.	APPR: [Signature]	N/A
TITLE: EW 200 ELECTRICAL SCHEMATIC	DRAWING NUMBER: C-761468			

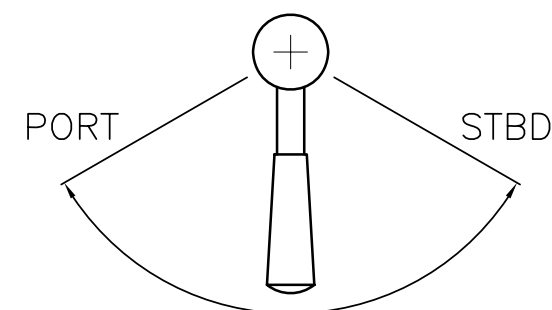
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LEVER CONTROLLER
RUDDER ORDER
POTENTIOMETER
(LC-1)

LEVER CONTROLLER
SECOND RUDDER
ORDER POTENTIOMETER
OPTIONAL (LC-2)



ELECTRICAL LEGEND	
U1/U2	STEERING UNIT 1 / STEERING UNIT 2
±V	+/- FFU POTENTIOMETER POLES
+ROS	FFU RUDDER ORDER SIGNAL

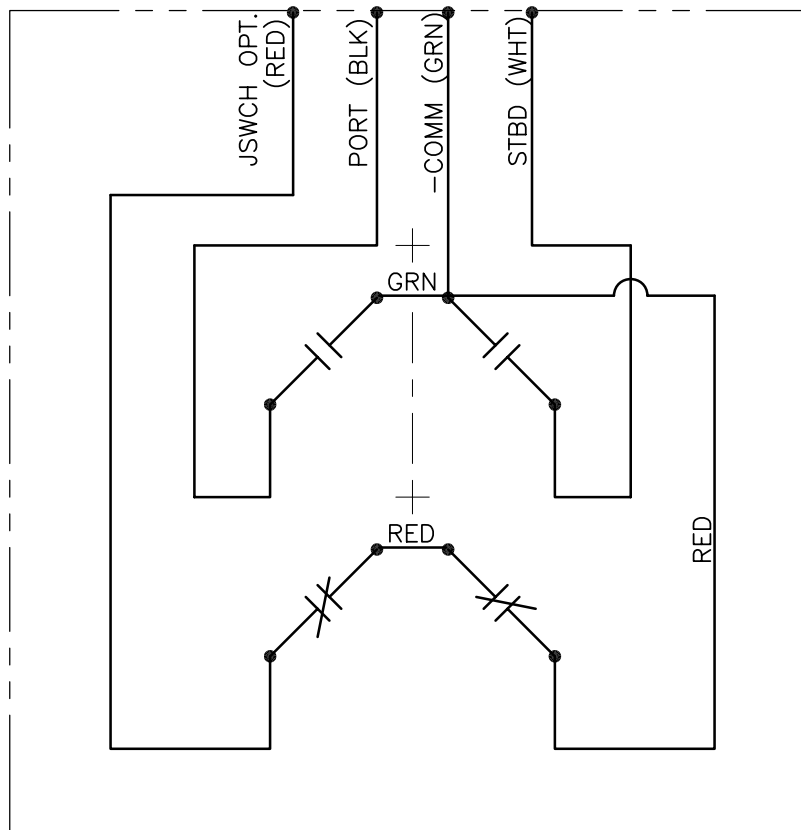


LEVER CONTROLLER DETAIL

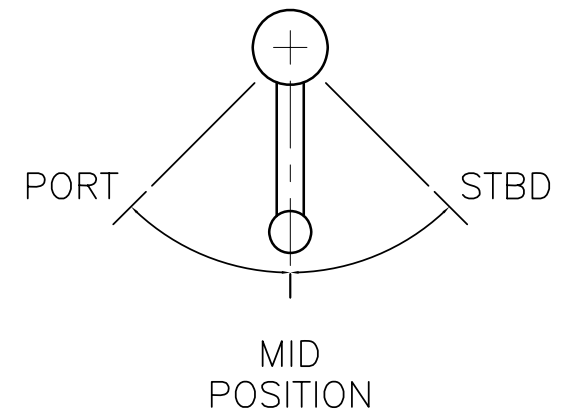
- NOTES:
1. ALL CONDUCTORS 16-18 AWG.
 2. 1:2.2 RATIO MECHANICAL LINK BETWEEN LEVER CONTROLLER HANDLE AND RUDDER ORDER POTENTIOMETER SHAFT.
 3. LEVER CONTROLLER HANDLE ROTATES THRU 120° FROM ITS HARDOVER TO HARDOVER POSITIONS.
 4. EFFECTIVE POTENTIOMETER IMPEDANCE APPROXIMATELY 776 OHMS.

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JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334			
DATE: 30-11-95	SCALE: N/A	DRAWN: G.T.	APPR.  N/A
TITLE: LEVER CONTROLLER ELECTRICAL SCHEMATIC			DRAWING NUMBER: B-761143





ELECTRICAL LEGEND	
JSWCH	JOG LEVER RELAY SWITCH
PORT	SOLENOID PORT COMMAND
-COMM	JOG LEVER -COMMON
STBD	SOLENOID STBD COMMAND



JOG LEVER DETAIL

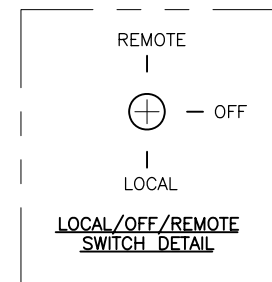
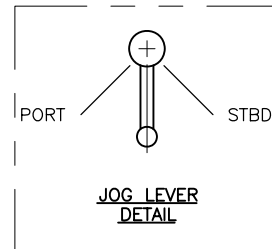
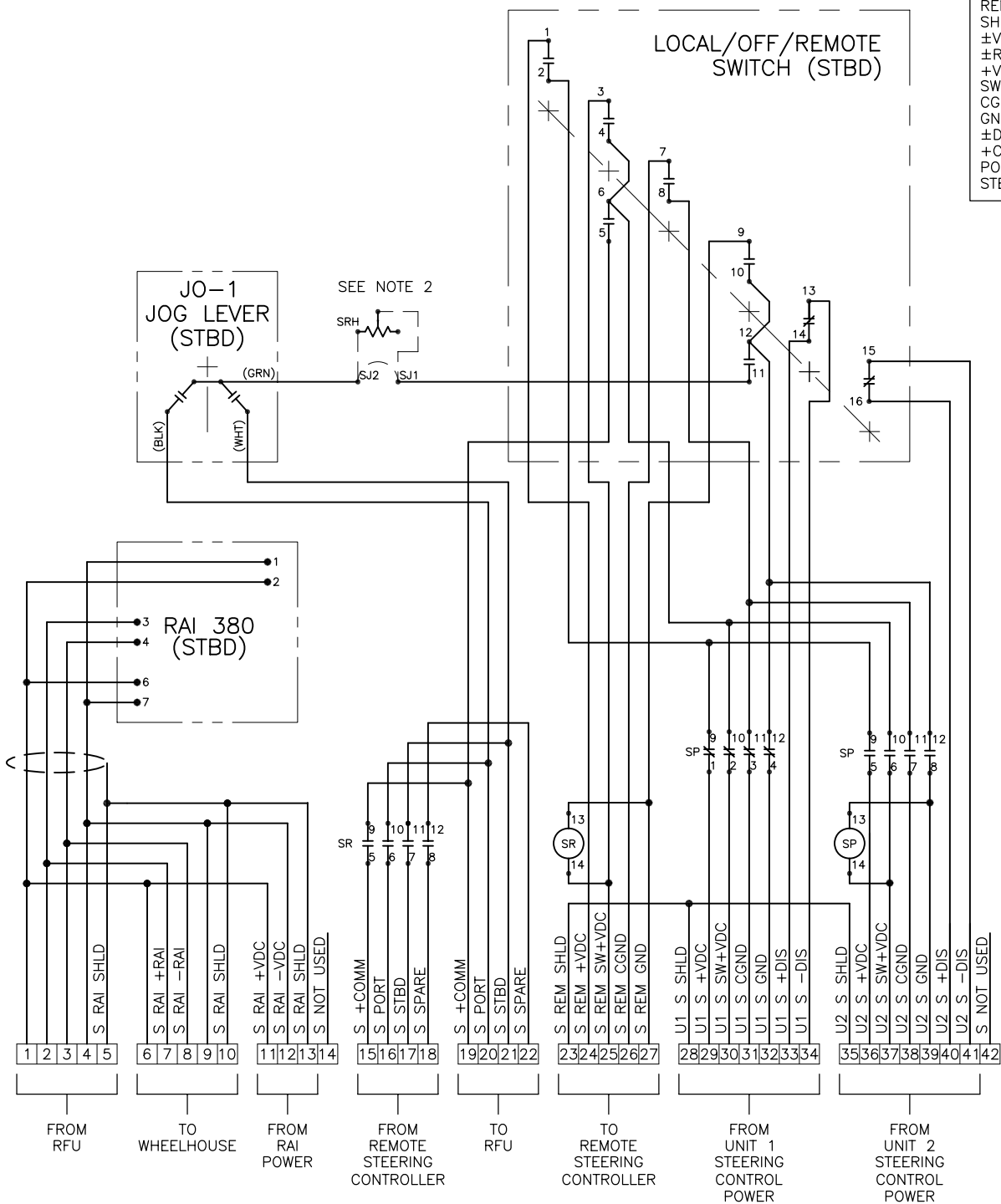
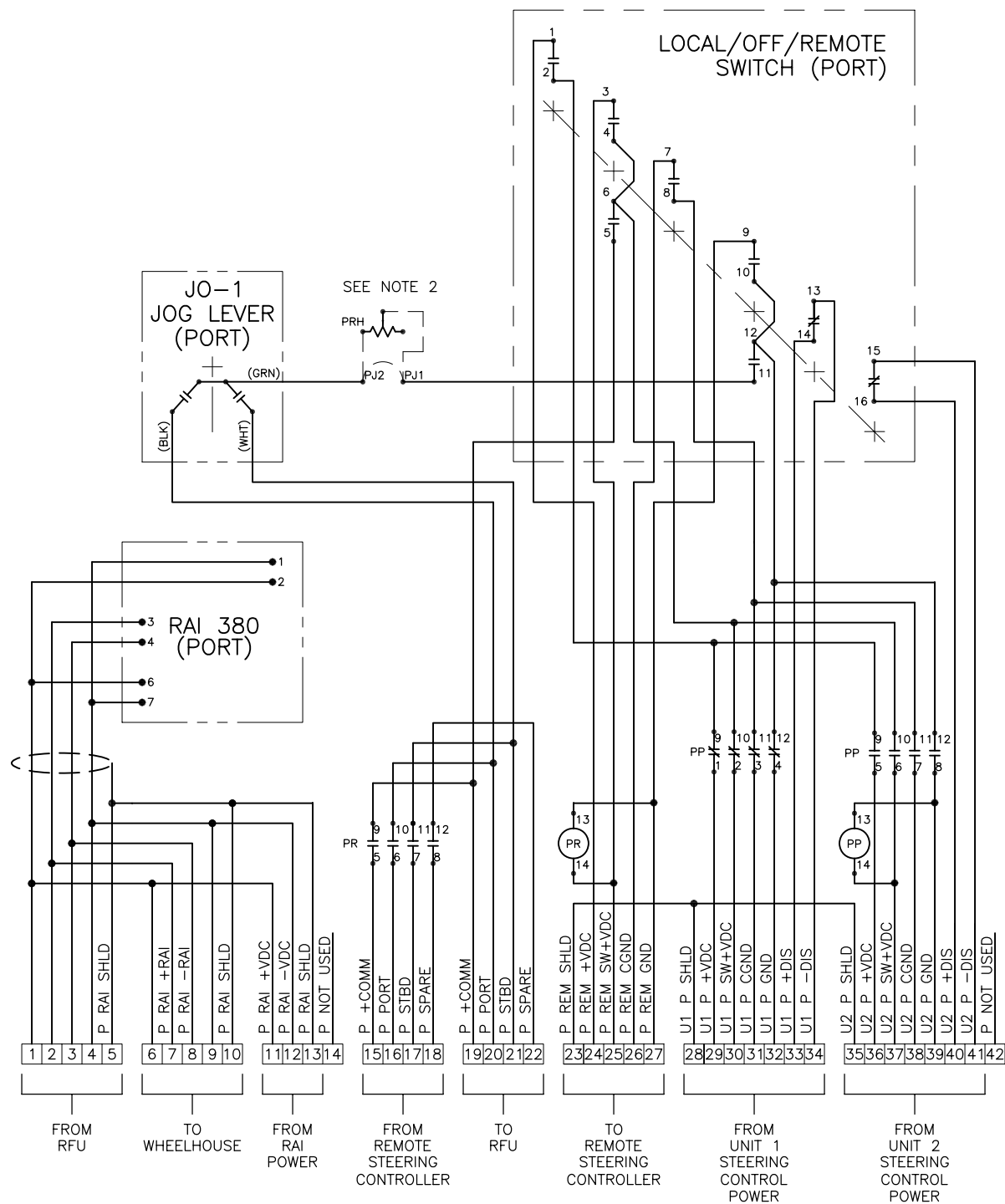
- NOTES:
1. JOG LEVER SPRING LOADED TO MID POSITION.
 2. ALL CONDUCTORS 16-18 AWG.
 3. NORMALLY CLOSED CONTACTS AND RED CONDUCTORS USED FOR OPTIONAL DODGE FUNCTION ONLY.
 4. NORMALLY CLOSED CONTACTS ARE AVAILABLE AS STANDARD PART OF MICRO-SWITCH

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DATE: 25-05-93	SCALE: N/A	DRAWN: M.L.	APPR.  N/A
TITLE: JO-1 & JO-1D JOG LEVER ELECTRICAL SCHEMATIC			DRAWING NUMBER: B-761037

ELECTRICAL LEGEND

P	PORT STEERING SYSTEM
S	STBD STEERING SYSTEM
U1	UNIT 1 STEERING SYSTEM
U2	UNIT 2 STEERING SYSTEM
RAI	RUDDER ANGLE INDICATION SYSTEM
REM	REMOTE STEERING CONTROL SYSTEM
SHLD	CABLE SHIELDING
±VDC	+/- VDC FOR RAI SYSTEM
±RAI	+/- RUDDER ANGLE INDICATOR SIGNALS
+VDC	STEERING CONTROL POWER SUPPLY POSITIVE
SW+VDC	STEERING CONTROL SWITCHED POWER SUPPLY POSITIVE
CGND	STEERING CONTROL PRINTED CIRCUIT BOARD GROUND
GND	STEERING CONTROL POWER SUPPLY GROUND
±DIS	+/- DISCONNECTED INDICATOR CONTACTS
+COMM	SOLENOID +COMMON
PORT	SOLENOID PORT COMMAND
STBD	SOLENOID STBD COMMAND



SWITCH POSITION	CONTACTS							
	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16
REMOTE	X	X		X	X			
OFF							X	X
LOCAL			X			X	X	X

X = CONTACT CLOSED


NOTES:

1. ALL CONDUCTORS TO BE 16 AWG, EXCEPT THOSE CONNECTING TO THE PORT & STBD RAI'S WHICH USE 20 AWG. SHIELDED CABLE.
2. INSTALL ZERO OHM JUMPER ACROSS TERMINALS PJ1 & PJ2 AND ACROSS SJ1 & SJ2 FOR SYSTEM WITH "ON-OFF" SOLENOID VALVES. INSTALL 25 Ohm, 10 W VARIABLE RHEOSTAT ACROSS TERMINALS PJ1 & PJ2 AND ACROSS SJ1 & SJ2 FOR SYSTEM WITH PROPORTIONAL SOLENOID VALVES.
3. RHEOSTATS ARE PROVIDED FOR REDUCING THE SPEED OF STEERING GEAR FITTED WITH PROPORTIONAL SOLENOID VALVE WHEN LOCAL RFU CONTROL IS USED.
4. ALL RELAYS ARE FOUR POLE, DOUBLE THROW RELAYS WITH 24 VDC COILS AND CONTACTS RATED FOR 10 AMPS @ 24 VDC.

PORT
SYSTEM
CONNECTIONS

STBD
SYSTEM
CONNECTIONS

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Jastram				
JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334				
DATE: 12-06-07	SCALE: N/A	DRAWN: A.L.	APPR: 	N/A
TITLE: EMERGENCY STATION JUNCTION BOX ELECTRICAL SCHEMATIC				DRAWING NUMBER: D-761841



5 STEERING CONTROL - INSTALLATION

THIS SECTION INCLUDES:

- 5.1 INSTALLATION
- 5.2 CABLING DIAGRAM
- 5.3 COMPONENT OVERALL DIMENSIONS
- 5.4 TERMINAL BLOCK CONFIGURATION
- 5.5 WIRING DIAGRAM
- 5.6 COMMISSIONING AND TESTING



5.1 INSTALLATION

CABLING

Refer to the cabling diagram contained in this section and install the cables as shown.

The shipyard is to confirm final cabling layout and component locations, as well as cable construction standards. Check the cabling or wiring diagram for the type of cable and number of conductors. For ease of installation the cable conductors should be color coded and have an insulation diameter of less than 1/8 inch (3 mm).

Cables, terminal blocks, disconnect switches and overcurrent protection on power supplies are not supplied by Jastram and should be provided as indicated on the cabling and wiring diagrams.

Before installing the cabling check that the following conditions are met:

- terminal blocks (if fitted) should be housed in fire and water resistant enclosures.
- cables and components should not be placed in close proximity to high current or voltage devices (e.g. electric motors).
- to avoid damage, components and their cables should not be installed in unrelated machinery or work spaces.
- ensure that the cable ends can terminate to Jastram supplied components approximately as shown in the cabling diagram. The general location of cable terminations are represented in the diagram.
- if the system to be installed has its components distributed on a port and starboard or unit 1 and unit 2 basis, then the cables and components for each system should be separated as widely as practical throughout the length of the vessel.



COMPONENT INSTALLATION

Refer to the overall dimension drawings for information on installing the components.

Overall dimension drawings are contained in this section of the manual and also in the installation sections of the individual component manuals (see section 6).

During installation be certain the following conditions are met:

- for good system performance it is important that the rudder feedback units and their linkages are installed correctly. Follow the mounting arrangement drawing in the rudder feedback unit manuals exactly.
- it is not recommended that any components be mounted on the underside of the decks. Mounting the units upside down makes service difficult.
- mount all components where the surrounding temperature is kept below 90 F (50 C).

WIRING

Please see the **General Instructions For Plug Assembly** before assembling the Jastram supplied cable plug ends.

Label the terminals of terminal blocks (if fitted).



5.2 CABLING DIAGRAM

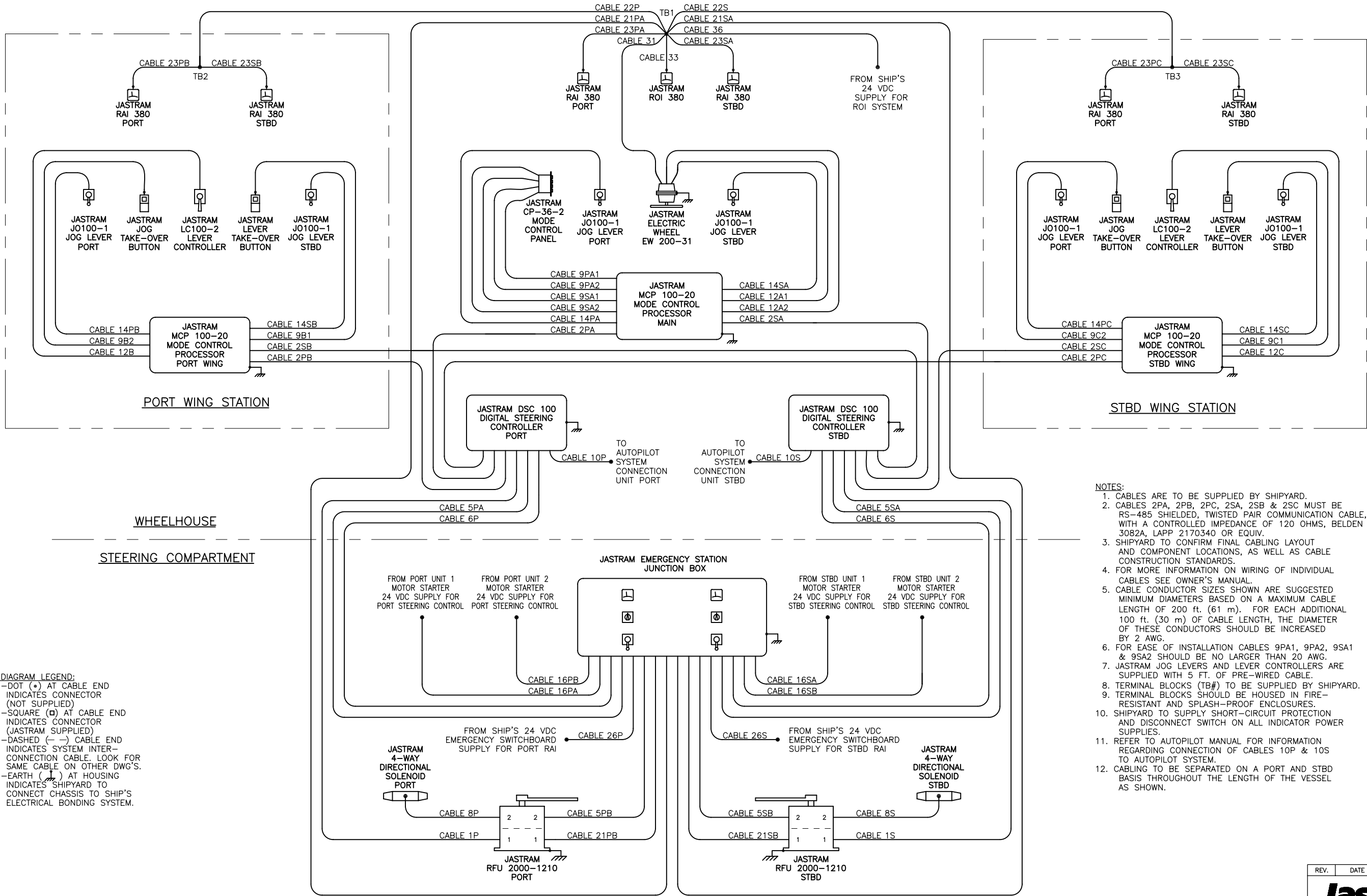


DIAGRAM LEGEND:
-DOT (•) AT CABLE END INDICATES CONNECTOR (NOT SUPPLIED)
-SQUARE (■) AT CABLE END INDICATES CONNECTOR (JASTRAM SUPPLIED)
-DASHED (---) CABLE END INDICATES SYSTEM INTER-CONNECTION CABLE. LOOK FOR SAME CABLE ON OTHER DWG'S.
-EARTH (⏏) AT HOUSING INDICATES SHIPYARD TO CONNECT CHASSIS TO SHIP'S ELECTRICAL BONDING SYSTEM.

- NOTES:
1. CABLES ARE TO BE SUPPLIED BY SHIPYARD.
 2. CABLES 2PA, 2PB, 2PC, 2SA, 2SB & 2SC MUST BE RS-485 SHIELDED, TWISTED PAIR COMMUNICATION CABLE, WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIV.
 3. SHIPYARD TO CONFIRM FINAL CABLING LAYOUT AND COMPONENT LOCATIONS, AS WELL AS CABLE CONSTRUCTION STANDARDS.
 4. FOR MORE INFORMATION ON WIRING OF INDIVIDUAL CABLES SEE OWNER'S MANUAL.
 5. CABLE CONDUCTOR SIZES SHOWN ARE SUGGESTED MINIMUM DIAMETERS BASED ON A MAXIMUM CABLE LENGTH OF 200 ft. (61 m). FOR EACH ADDITIONAL 100 ft. (30 m) OF CABLE LENGTH, THE DIAMETER OF THESE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.
 6. FOR EASE OF INSTALLATION CABLES 9PA1, 9PA2, 9SA1 & 9SA2 SHOULD BE NO LARGER THAN 20 AWG.
 7. JASTRAM JOG LEVERS AND LEVER CONTROLLERS ARE SUPPLIED WITH 5 FT. OF PRE-WIRED CABLE.
 8. TERMINAL BLOCKS (TB#) TO BE SUPPLIED BY SHIPYARD.
 9. TERMINAL BLOCKS SHOULD BE HOUSED IN FIRE-RESISTANT AND SPLASH-PROOF ENCLOSURES.
 10. SHIPYARD TO SUPPLY SHORT-CIRCUIT PROTECTION AND DISCONNECT SWITCH ON ALL INDICATOR POWER SUPPLIES.
 11. REFER TO AUTOPILOT MANUAL FOR INFORMATION REGARDING CONNECTION OF CABLES 10P & 10S TO AUTOPILOT SYSTEM.
 12. CABLING TO BE SEPARATED ON A PORT AND STBD BASIS THROUGHOUT THE LENGTH OF THE VESSEL AS SHOWN.

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NO.	CONDUCTORS	SHIELDED
1P	20 4(2PAIR)	YES
1S	20 4(2PAIR)	YES
* 2PA	18 4(2PAIR)	YES
* 2PB	18 4(2PAIR)	YES
* 2PC	18 4(2PAIR)	YES
* 2SA	18 4(2PAIR)	YES
* 2SB	18 4(2PAIR)	YES
* 2SC	18 4(2PAIR)	YES
** 5PA	12 3	YES
5PB	14 3	YES
** 5SA	12 3	YES
5SB	14 3	YES
** 6P	12 3	YES
** 6S	12 3	YES
8P	14 3	YES
8S	14 3	YES
9B1	20 6	YES
9B2	20 6	YES
9C1	20 6	YES
9C2	20 6	YES
9PA1	20 7	YES
9PA2	20 9	YES
9SA1	20 7	YES
9SA2	20 9	YES
10P	20 6	YES
10S	20 6	YES
12A1	20 3	YES
12A2	20 3	YES
12B	18 6	YES
12C	18 6	YES
14PA	18 3	NO
14PB	18 3	NO
14PC	18 3	NO
14SA	18 3	NO
14SB	18 3	NO
14SC	18 3	NO
** 16PA	12 3	YES
** 16PB	12 3	YES
** 16SA	12 3	YES
** 16SB	12 3	YES
21PA	16 4	YES
21PB	16 4	YES
21SA	16 4	YES
21SB	16 4	YES
22P	16 9	YES
22S	16 9	YES
23PA	20 4	YES
23PB	20 4	YES
23PC	20 4	YES
23SA	20 4	YES
23SB	20 4	YES
23SC	20 4	YES
26P	16 2	YES
26S	16 2	YES
31	20 4	YES
33	20 4	YES
36	16 2	YES

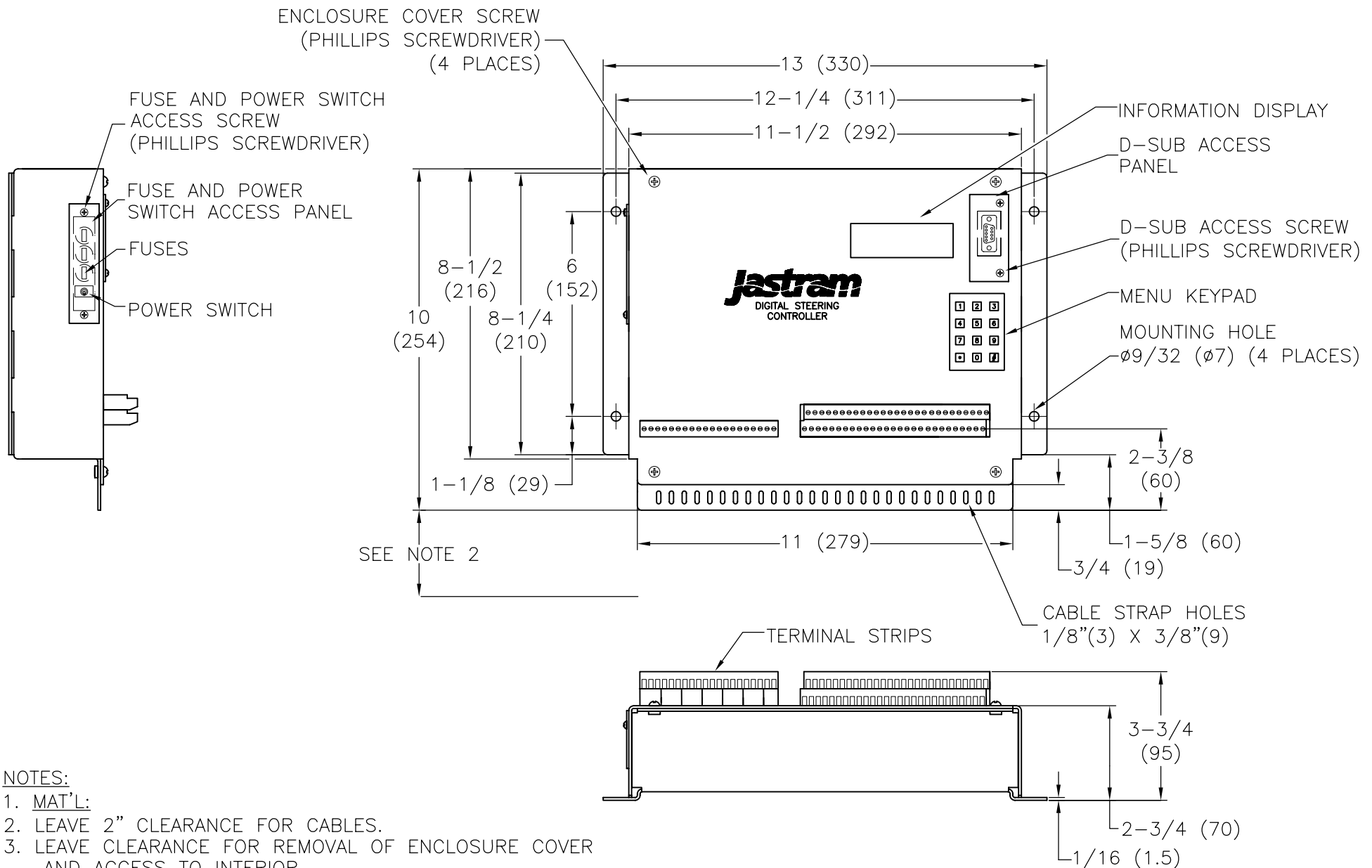
* SEE NOTE 2
** SEE NOTE 5

JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

REV.	DATE	DRAWING/DESIGN	CHANGE No.	BY
Jastram				
JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334				
DATE: 07/07/27-07-10	SCALE: N/A	DRAWN: P.K.	APPR: P.K.	N/A
TITLE: STEERING CONTROL CABLING DIAGRAM	DRAWING NUMBER: D-751661			



5.3 COMPONENT OVERALL DIMENSIONS



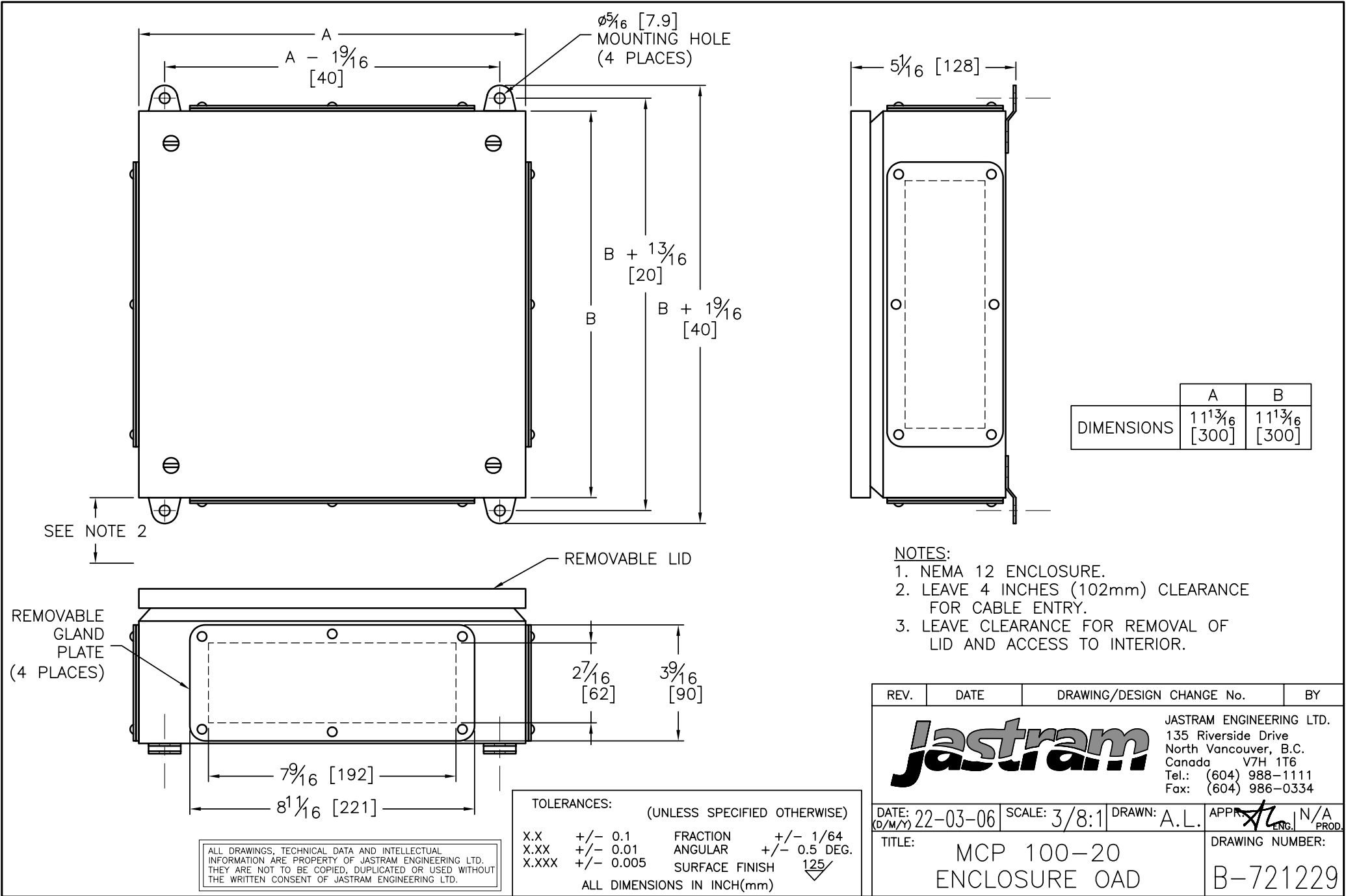
NOTES:

1. MAT'L:
2. LEAVE 2" CLEARANCE FOR CABLES.
3. LEAVE CLEARANCE FOR REMOVAL OF ENCLOSURE COVER AND ACCESS TO INTERIOR.
4. USE 1/8" BLADE SCREWDRIVER FOR TERMINAL BLOCKS.

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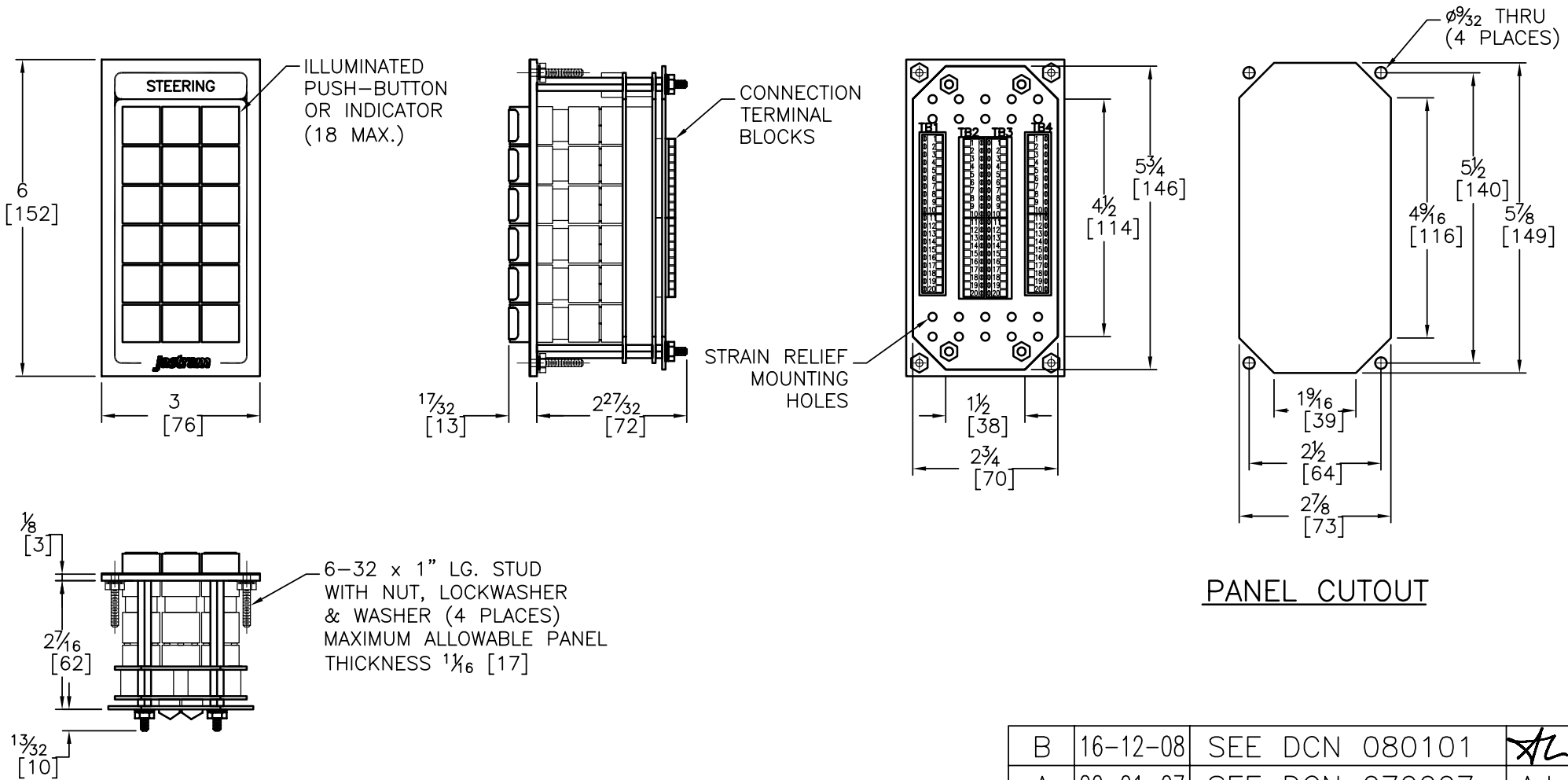
TOLERANCES:				(UNLESS SPECIFIED OTHERWISE)	
X.X	+/- 0.1	FRACTION	+/- 1/64		
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.		
X.XXX	+/- 0.005	SURFACE FINISH			
ALL DIMENSIONS IN INCH(mm)					

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334			
DATE: 03-03-03	SCALE: 1/2"=1"	DRAWN: A.N.	APPR: N/A
TITLE:	DRAWING NUMBER:		
DIGITAL STEERING CONTROLLER (DSC) OVERALL DIMENSIONS	C-721164		



	A	B
DIMENSIONS	$11\frac{13}{16}$ [300]	$11\frac{13}{16}$ [300]

NOTES:			
1. NEMA 12 ENCLOSURE.			
2. LEAVE 4 INCHES (102mm) CLEARANCE FOR CABLE ENTRY.			
3. LEAVE CLEARANCE FOR REMOVAL OF LID AND ACCESS TO INTERIOR.			
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
		Jastram	
		JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334	
DATE:	22-03-06	SCALE:	3/8:1
DRAWN:	A.L.	APP'D:	<i>[Signature]</i>
TITLE:	MCP 100-20 ENCLOSURE OAD		DRAWING NUMBER: B-721229



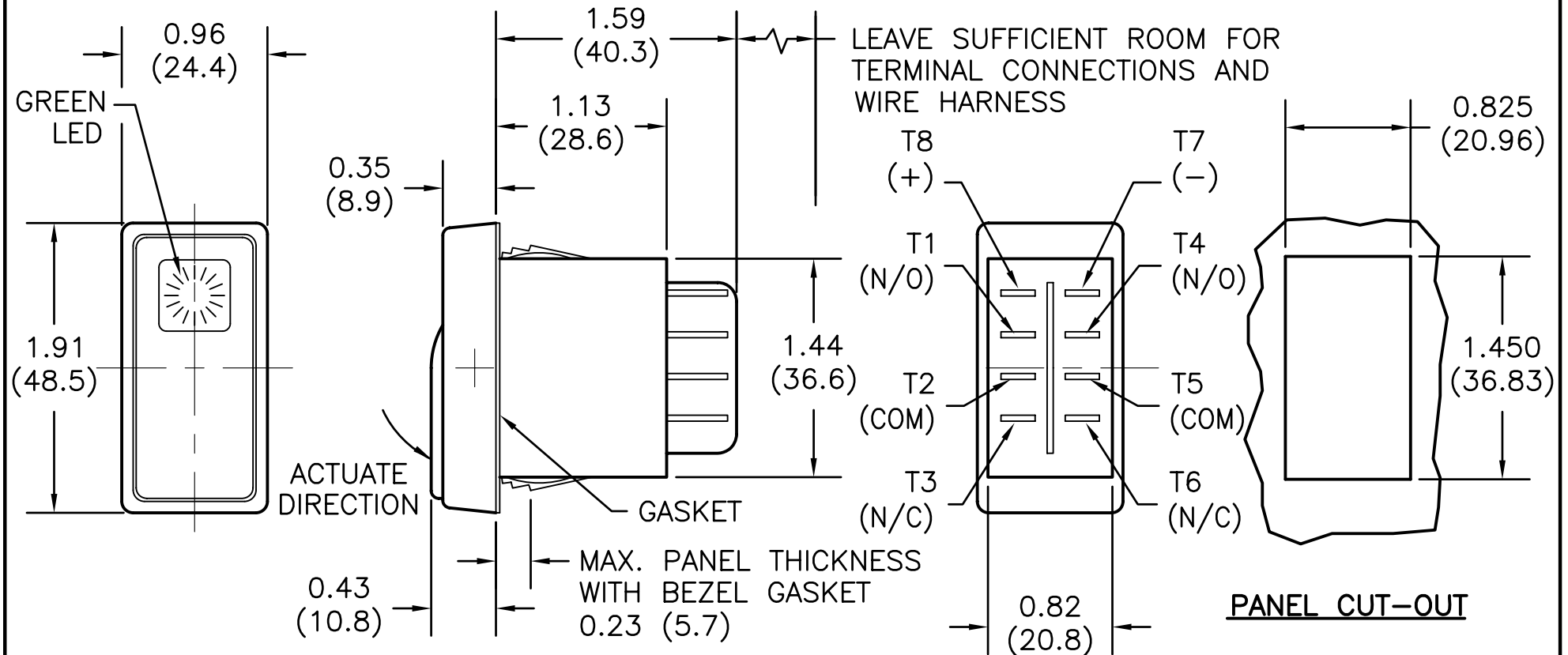
NOTES:

1. QUANTITY AND LOCATION OF ILLUMINATED PUSH-BUTTONS AND / OR INDICATORS MAY VARY.
2. FOUR CABLE STRAIN RELIEF STRAPS SUPPLIED WITH COMPONENT.

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓
ALL DIMENSIONS IN INCH[mm]			

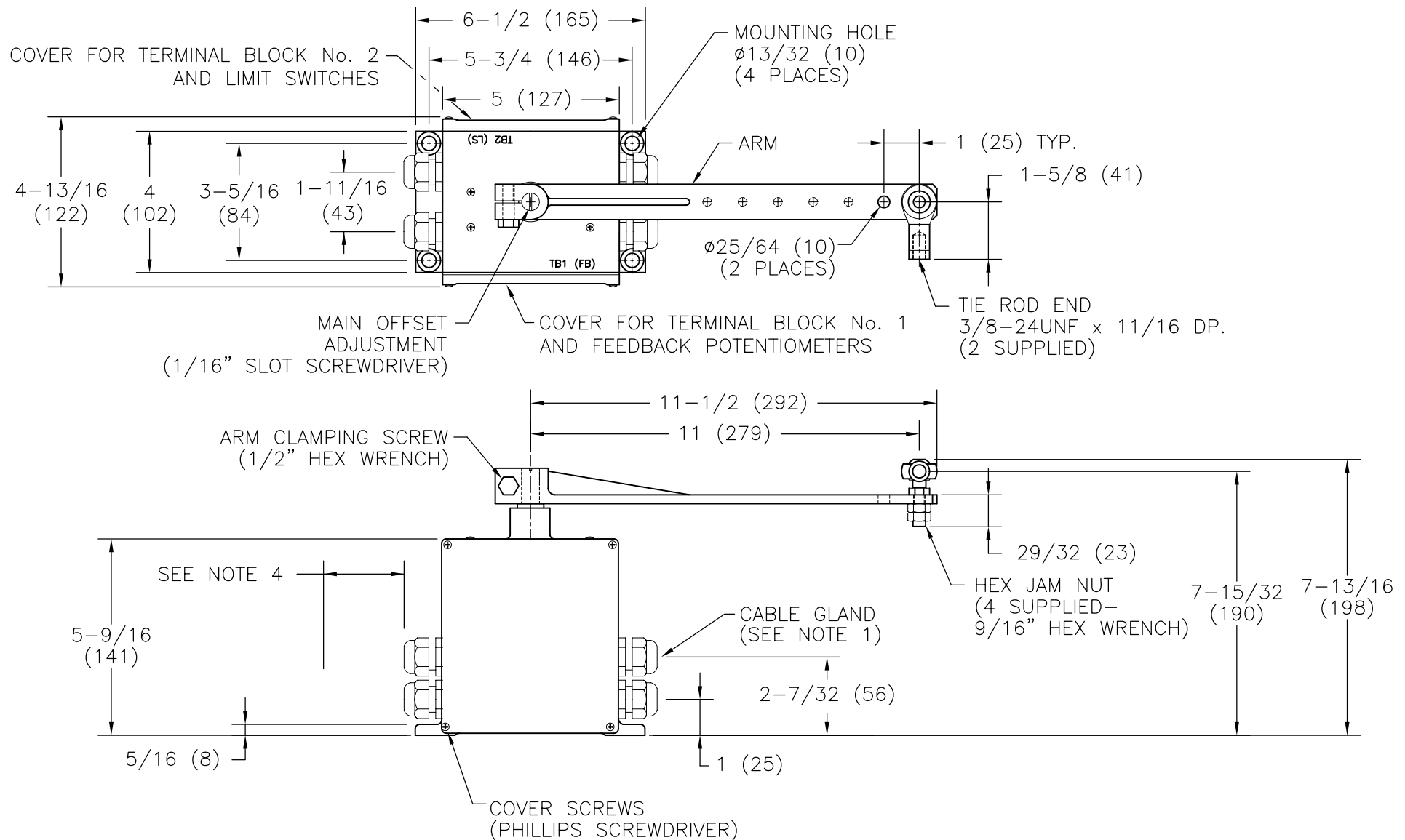
B	16-12-08	SEE DCN 080101	AL
A	22-01-07	SEE DCN 070007	A.L.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334			
DATE: 14-03-05	SCALE: 1/2":1"	DRAWN: G.T.	APPR. G.T. N/A PROD.
TITLE: CP(AP)36-2 CONTROL (ALARM) PANEL OVERALL DIMENSIONS			DRAWING NUMBER: B-721201

**NOTES:**

1. PUSHBUTTON IS A DOUBLE POLE MOMENTARY ILLUMINATED ROCKER SWITCH.
2. TERMINALS 7 AND 8 ARE POLARITY DEPENDENT POWER SUPPLY FOR LED.
3. TERMINALS ARE ¼" (6.3 mm) SPADE TYPE.

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REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="font-size: 2em; font-weight: bold; letter-spacing: -2px;">Jastram</div> <div> <p>JASTRAM ENGINEERING LTD.</p> <p>135 Riverside Drive</p> <p>North Vancouver, B.C.</p> <p>Canada V7H 1T6</p> <p>Tel.: (604) 988-1111</p> <p>Fax: (604) 986-0334</p> </div> </div>			
DATE: (D/M/Y)	09-09-03	SCALE: 1":1"	DRAWN: G.C.
TITLE:		DRAWING NUMBER:	
TAKEOVER PUSHBUTTON OVERALL DIMENSIONS		A-721167	

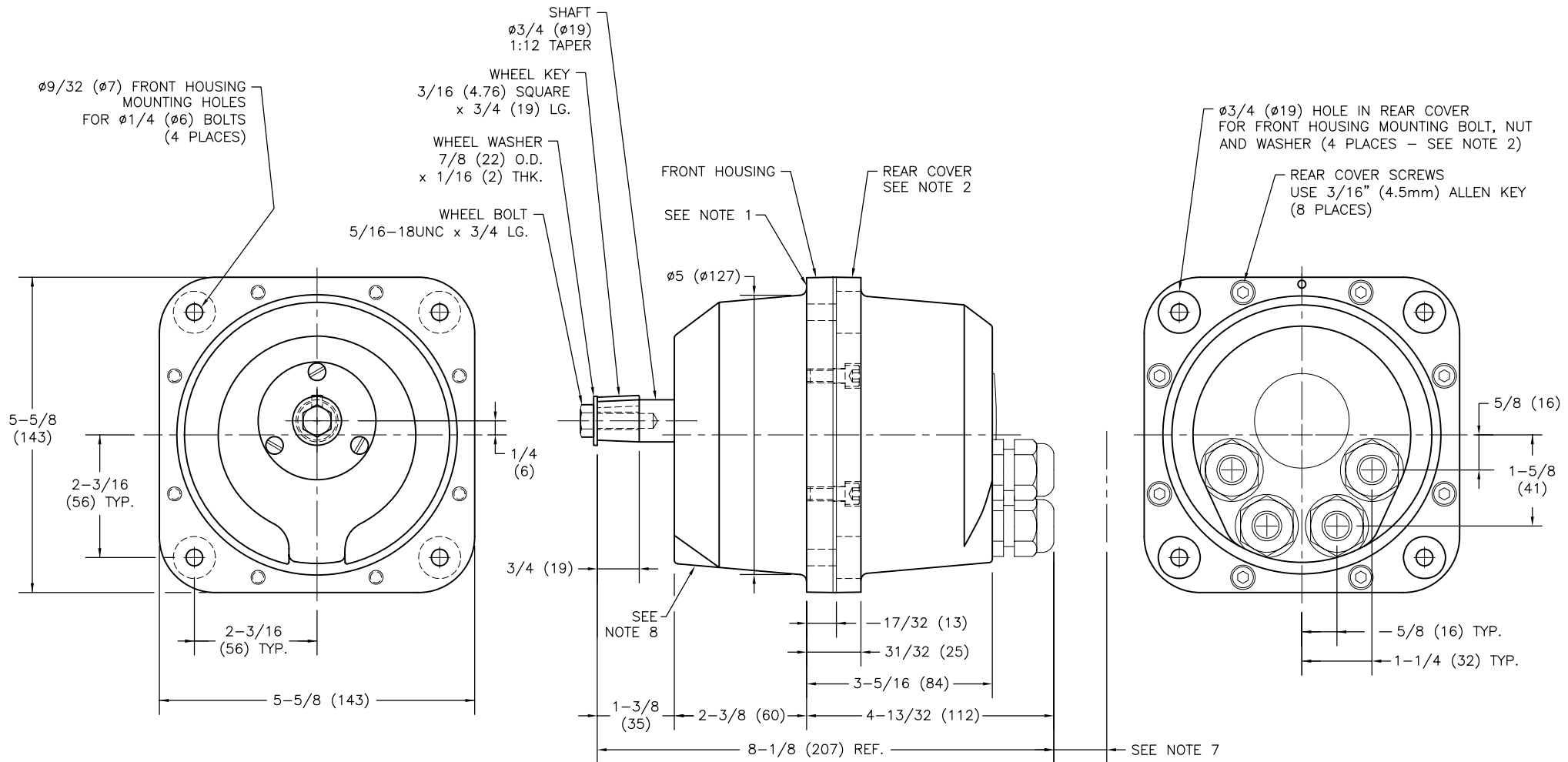
**NOTES:**

1. CABLE GLANDS (SUPPLIED BY JASTRAM) ACCEPT CABLE JACKET DIAMETERS BETWEEN 1/4" (6mm) TO 1/2" (13mm).
2. SEE RFU MOUNTING ARRANGEMENT FOR ARM LINKAGE DETAILS AND ENSURE ARM CAN SWING FROM HARDOVER TO HARDOVER.
3. FEEDBACK UNIT BODY CAN BE MOUNTED AT ANY ORIENTATION WITH RESPECT TO ARM.
4. LEAVE 4 INCHES CLEARANCE FROM EACH GLAND FOR CABLES.
5. LEAVE CLEARANCE FOR REMOVAL OF COVERS AND ACCESS TO INTERIOR.
6. TIE ROD END JAM NUTS MUST BE USED AS SHOWN TO PREVENT LOOSENING OF RFU ARM.

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TOLERANCES:				(UNLESS SPECIFIED OTHERWISE)	
X.X	+/- 0.1	FRACTION		+/- 1/64	
X.XX	+/- 0.01	ANGULAR		+/- 0.5 DEG.	
X.XXX	+/- 0.005	SURFACE FINISH			✓
ALL DIMENSIONS IN INCH(mm)					

REV.	DATE	DRAWING/DESIGN CHANGE No.		BY	
Jastram		JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 988-0334			
DATE:	03-08-01	SCALE:	N.T.S.	DRAWN:	G.C.
APPR:		ENG:		PROD:	
TITLE:		RUDDER FEEDBACK UNIT (RFU 2000) O.A.D.			DRAWING NUMBER:
					C-721147




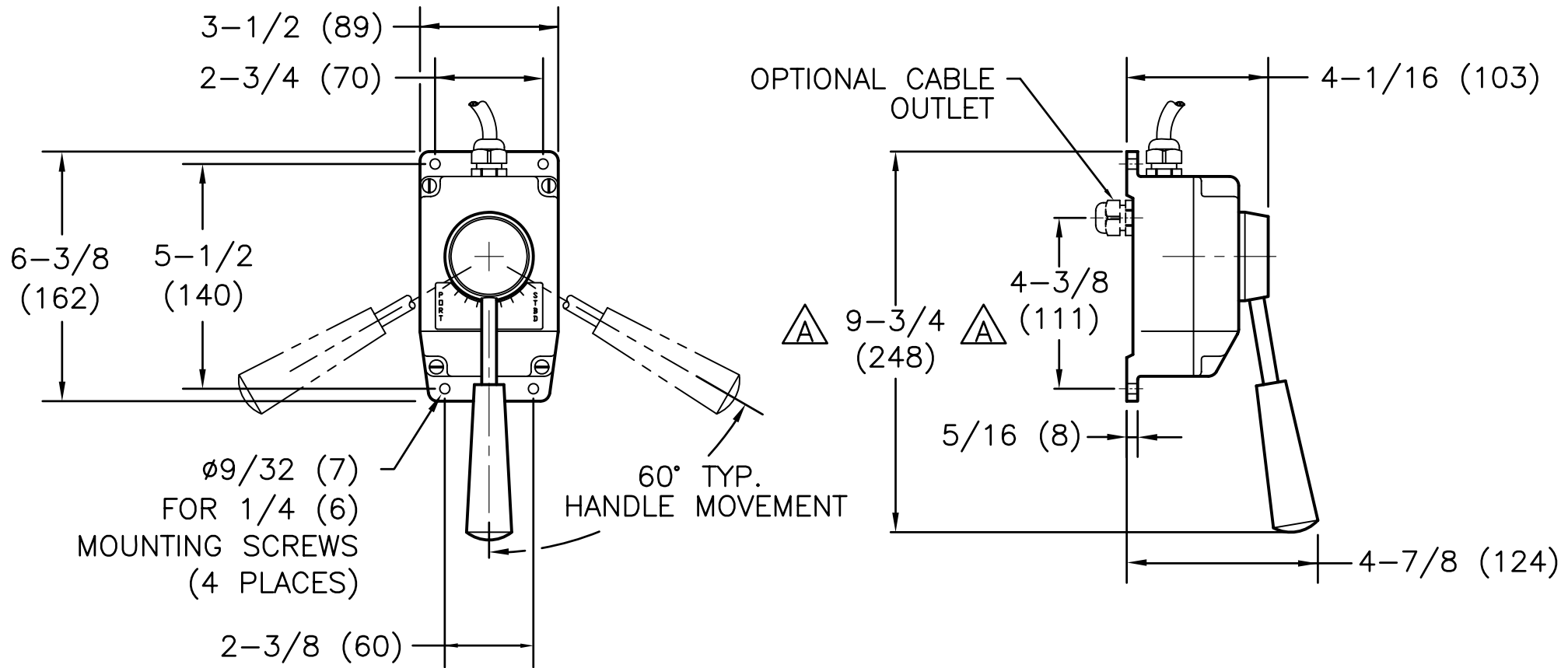
NOTES:

- PREFERRED MOUNTING SURFACE WILL ALLOW FOR REMOVAL OF REAR COVER.
- LEAVE CLEARANCE FOR REMOVAL OF REAR COVER AND ACCESS TO INTERIOR. REAR COVER CAN BE REMOVED WITH FRONT HOUSING MOUNTED IN STEERING CONSOLE.
- ELECTRIC WHEEL CAN BE MOUNTED AT ANY ORIENTATION WITHIN $\pm 45^\circ$ OF HORIZONTAL POSITION SHOWN.
- UNIT IS SELF-LUBRICATING. DO NOT FILL UP WITH OIL OR GREASE.
- WHEEL TURNS 1367° (3.8 TURNS) BETWEEN CLUTCHED HARDOVER STOPS.
- CABLE GLANDS (SUPPLIED BY JASTRAM) ACCEPT CABLE JACKET DIAMETERS BETWEEN 1/4" (6mm) TO 1/2" (13mm).
- LEAVE 4 INCHES CLEARANCE FROM EACH GLAND FOR CABLES.
- SHAFT FRICTION ADJUSTMENT IS LOCATED 1" (25mm) UNDER PIPE PLUG. USE 3/16" (4.5mm) ALLEN KEY TO ADJUST.

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TOLERANCES:			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	125
ALL DIMENSIONS IN INCH(mm)			

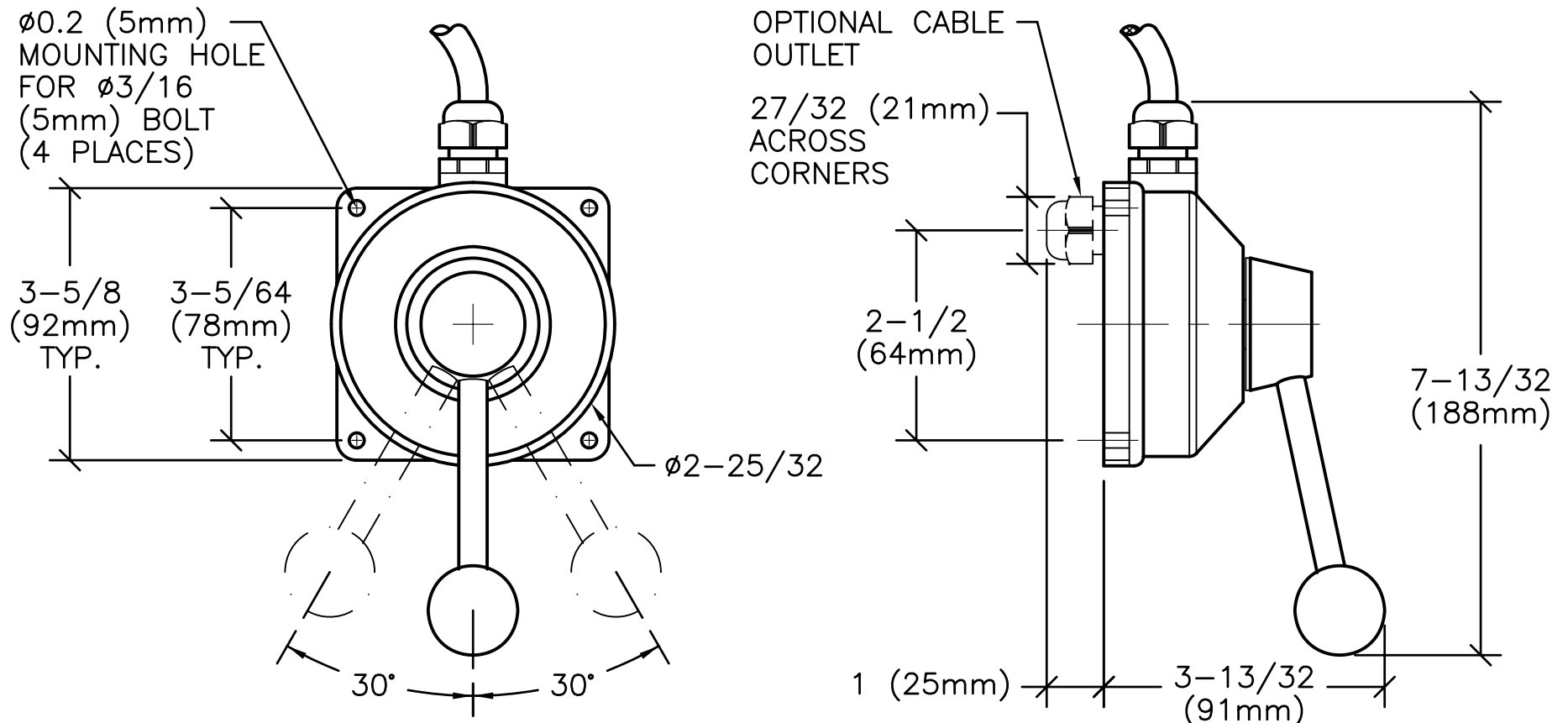
REV.	DATE	DRAWING/DESIGN	CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334				
DATE:	10-05-02	SCALE:	3/4":1"	DRAWN:
TITLE:	EW 200 OVERALL DIMENSIONS			APPR:  N/A DRAWING NUMBER: C-721157

NOTES:

1. LEVER CONTROLLER COMES PRE-WIRED WITH 4 ft. (1.2m) OF CABLE.

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A	30-07-02	SEE DCN 020033	GT
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram		JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334	
DATE: (D/M/Y)	17-02-92	SCALE: $1/4":1"$	DRAWN: G.L.
TITLE:		LEVER CONTROLLER OVERALL DIMENSIONS	
		APPR. G.C. L.L. ENG. PROD.	DRAWING NUMBER: A-721021



NOTE: 1. JOG LEVER COMES PRE-WIRED WITH 4' (1.2m) OF CABLE.

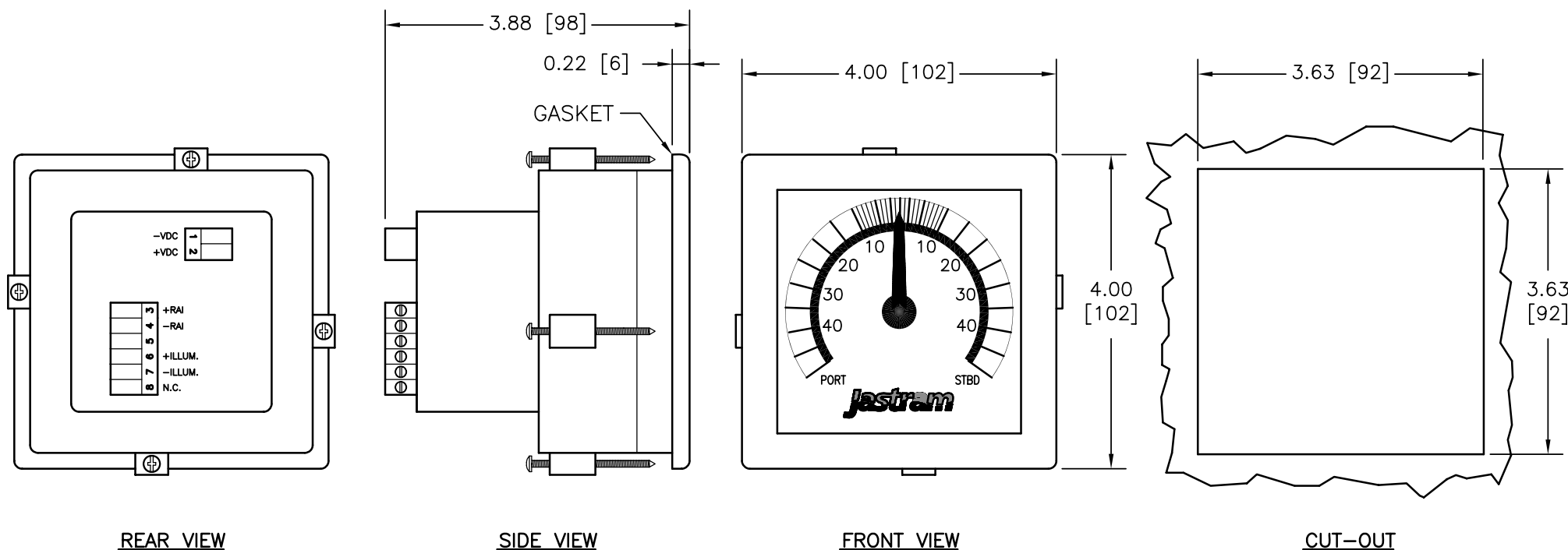
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TOLERANCES:

(UNLESS SPECIFIED OTHERWISE)

X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	
ALL DIMENSIONS IN INCH(mm)			

A	28-03-94	SEE DCN 940031	
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
<p>JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334</p>			
DATE: (D/M/Y)	28-03-94	SCALE: N.T.S.	DRAWN: G.L.
TITLE: JOG LEVER OVERALL DIMENSIONS		APPR. G.C. ENG.	L.L. PROD.
		DRAWING NUMBER: A-721018	



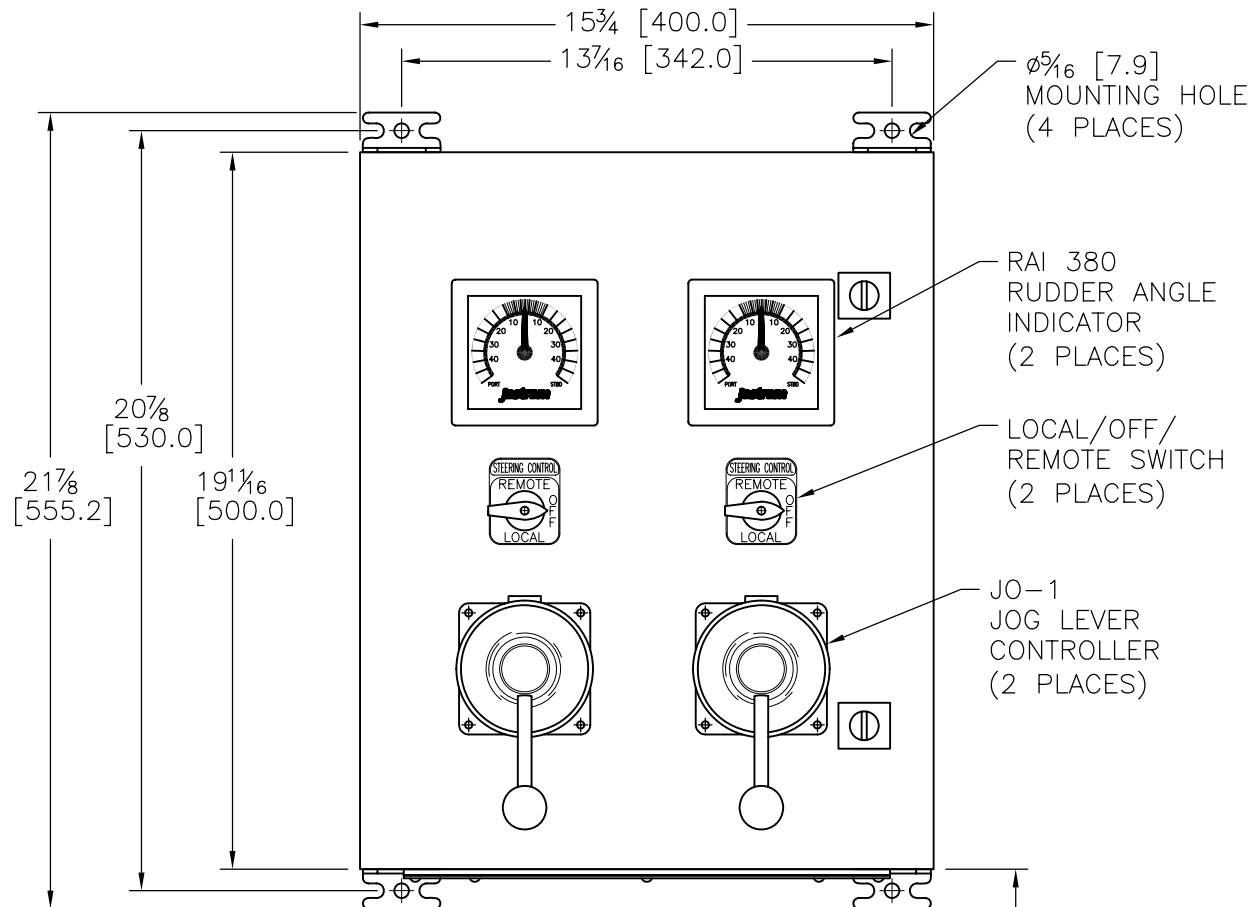
- NOTES:**
1. RUDDER ORDER INDICATOR (ROI 380) IS IDENTICAL EXCEPT \pm ROI TERMINALS REPLACE \pm RAI.
 2. INDICATOR PROTECTION RATING: IP 52 (STANDARD), IP 66 (WITH OPTIONAL GASKET AND ADDITIONAL MOUNTING CLIPS).
 3. SEE RUDDER ANGLE INDICATOR CONFIGURATION (B-741246) FOR OPTIONAL DIMMER CONNECTION DETAILS.

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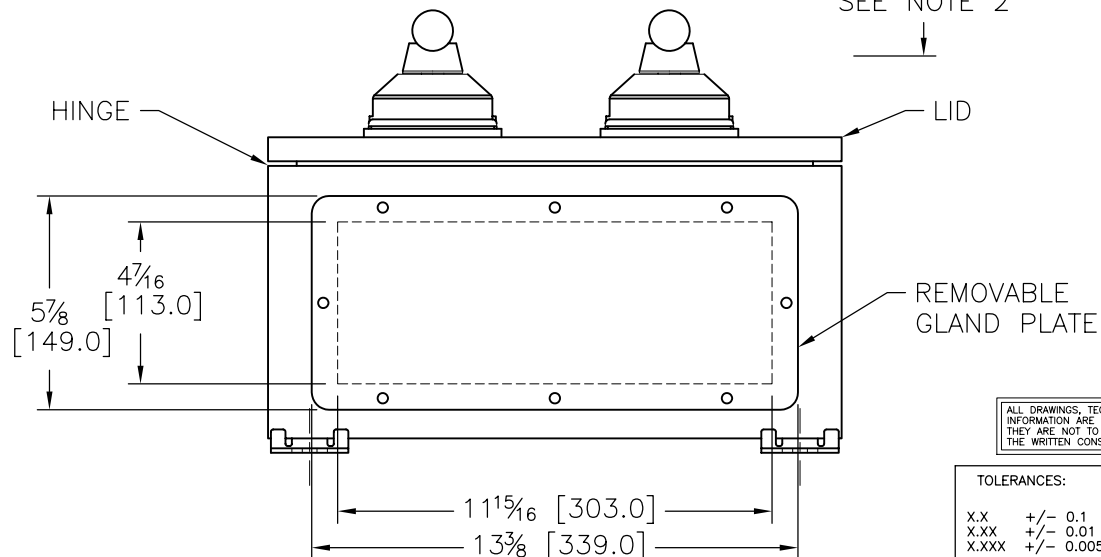
TOLERANCES: (UNLESS SPECIFIED OTHERWISE)

X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	
ALL DIMENSIONS IN INCH(mm)			

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334			
DATE: 23-10-06	SCALE: 3/4"=1"	DRAWN: A.L.	APPR: N/A
TITLE: RUDDER ANGLE INDICATOR (RAI 380) O.A.D.			DRAWING NUMBER: B-721242



SEE NOTE 2



NOTES:

1. NEMA 4 ENCLOSURE.
2. LEAVE 4 INCHES (102mm) CLEARANCE FOR CABLE ENTRY.
3. LEAVE CLEARANCE FOR OPENING LID AND ACCESS TO INTERIOR.

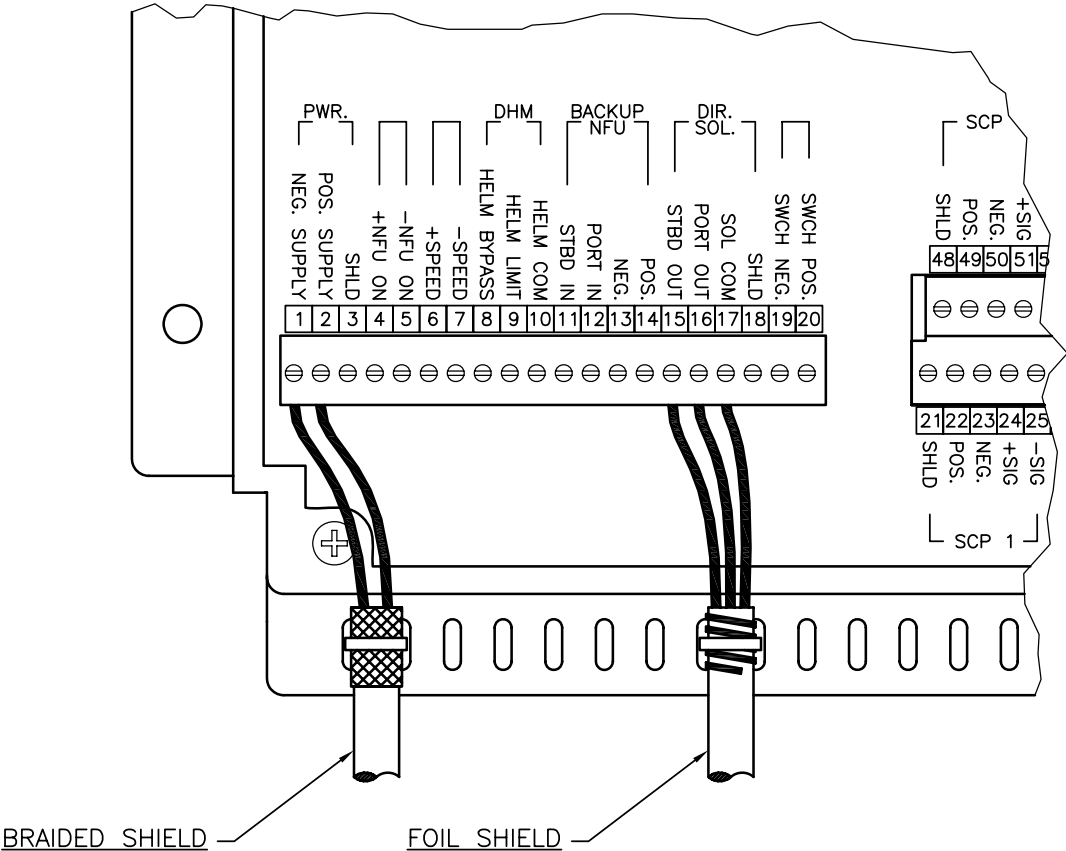
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THE WRITTEN CONSENT OF JASTRAM ENGINEERING LTD.

TOLERANCES:				(UNLESS SPECIFIED OTHERWISE)	
X.X	+/- 0.1	FRACTION		+/- 1/16	
X.XX	+/- 0.01	ANGULAR		+/- 0.5 DEG.	
X.XXX	+/- 0.005	SURFACE FINISH			✓
ALL DIMENSIONS IN INCH(mm)					

REV.	DATE	DRAWING/DESIGN	CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334				
DATE: 12-06-07	SCALE: 3/8":1"	DRAWN: A.L.	APPR:	N/A
TITLE: EMERGENCY STATION JUNCTION BOX OVERALL DIMENSIONS	DRAWING NUMBER: C-721261			



5.4 TERMINAL BLOCK CONFIGURATION




NOTES:

BRAIDED SHIELD

1. PULL BRAIDED SHIELD BACK OVER CABLE OUTER JACKET.
2. STRAP CABLE TO BOTTOM HOUSING AS SHOWN TO ENSURE SOLID CONNECTION BETWEEN CABLE SHIELDING AND BOTTOM HOUSING.

FOIL SHIELD

1. WRAP SHIELD WIRE BACK OVER CABLE OUTER JACKET.
2. STRAP CABLE TO BOTTOM HOUSING AS SHOWN TO ENSURE SOLID CONNECTION BETWEEN CABLE SHIELDING AND BOTTOM HOUSING.
3. ENSURE BOTTOM HOUSING HAS SOLID CONNECTION TO SHIP'S ELECTRICAL BONDING SYSTEM.

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
<div><div>Jastram</div><div>JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334</div></div>			
DATE: 26-03-07 (D/M/Y)	SCALE: N/A	DRAWN: G.T.	APPR.  N/A ENG. PROD.
TITLE: DSC SHIELD CONNECTION CONFIGURATION			DRAWING NUMBER: B-741257

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TOP

BOTTOM

BUTTONS	SHIELD	1	TB11
	+5V	2	
	DIM UP	3	
	DIM DOWN	4	
	BUTTON 0	5	
	BUTTON 1	6	
	BUTTON 2	7	
	BUTTON 3	8	
	BUTTON 4	9	
	BUTTON 5	10	
	BUTTON 6	11	INDICATORS
	BUTTON 7	12	
	BUTTON 8	13	
	BUTTON 9	14	

TOP

BOTTOM

COMM TO DSC	SHIELD POS. NEG. +SIG. -SIG.	1 2 3 4 5	TB1
ANALOG FFU 1	SHIELD +V 1 ROS 1 GND	1 2 3 4	TB3
NFU	NFU COM NFU PORT NFU STBD	1 2 3	TB5
ANALOG FFU ROI	SHIELD FU +ROI FU -ROI	1 2 3	TB7
LAMPS	+V SUP +V SUP -LAMP GND SHIELD	1 2 3 4 5	TB9

NOTES:

1. MCP 100-10 CONTAINS A SINGLE PRINTED CIRCUIT BOARD FOR USE WITH A SINGLE STEERING CONTROL SYSTEM.
2. MCP 100-11 CONTAINS A SINGLE PRINTED CIRCUIT BOARD IN CONJUNCTION WITH THE ADIS MODULE.
3. MCP 100-12 CONTAINS A SINGLE PRINTED CIRCUIT BOARD IN CONJUNCTION WITH THE DDIS MODULE.
4. MCP 100-20 CONTAINS TWO COMPLETELY INDEPENDENT AND IDENTICAL PRINTED CIRCUIT BOARDS FOR USE WITH A DUAL, UNIT 1 & UNIT 2 OR INDEPENDENT, PORT & STBD STEERING CONTROL SYSTEM.

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A	05-11-09	SEE DCN 090085	
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
		JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334	
DATE: (D/M/Y)	04-04-05	SCALE: N/A	DRAWN: G.T.
TITLE:		DRAWING NUMBER:	
MCP TERMINAL BLOCK CONFIGURATION		A-741204	

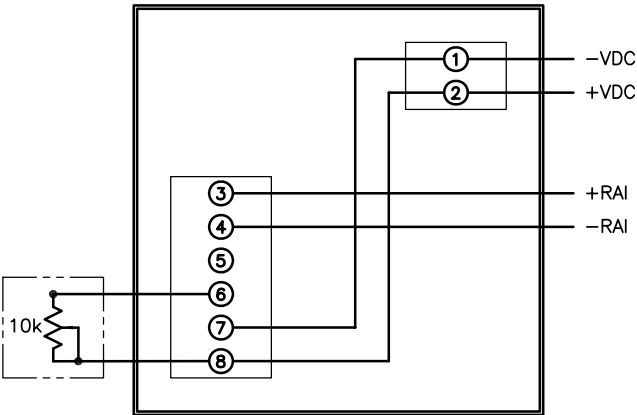


FIGURE 1

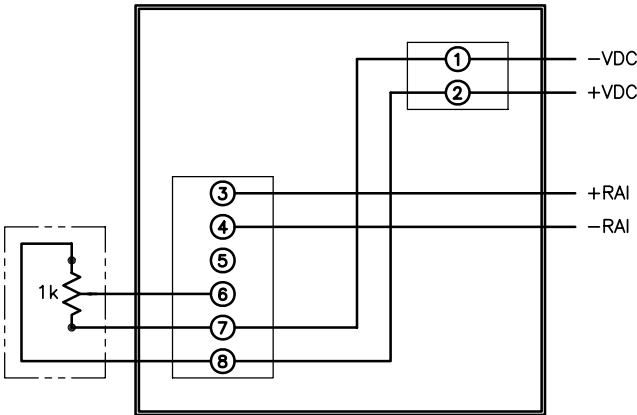


FIGURE 2

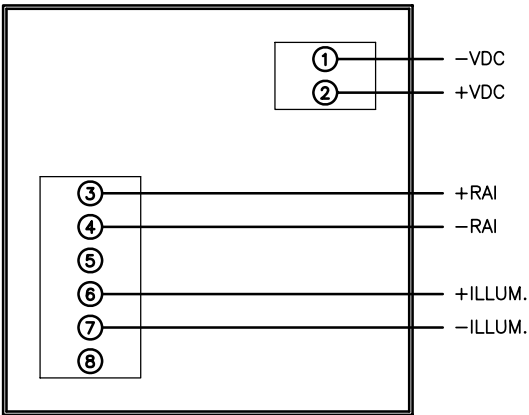


FIGURE 3

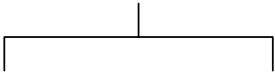
NOTES:

1. FIGURE 1 ILLUSTRATES A METHOD FOR DIMMER CONNECTION THAT ADDS AN OPTIONAL 10kOhm POTENTIOMETER IN SERIES WITH THE ILLUMINATION INPUT (TERMINAL 6). THIS METHOD IS PREFERRED IF THE CONSUMPTION HAS TO BE KEPT LOW, HOWEVER ITS DISADVANTAGE IS THE ILLUMINATION CANNOT BE SET TO TOTAL DARKNESS.
2. FIGURE 2 ILLUSTRATES A METHOD FOR DIMMER CONNECTION THAT ADDS AN OPTIONAL 1kOhm POTENTIOMETER AS A VOLTAGE DIVIDER. THIS METHOD HAS THE ADVANTAGE THAT THE ILLUMINATION CAN BE SET TO TOTAL DARKNESS. THE DISADVANTAGE IS THAT THE CONSUMPTION OF THE POTENTIOMETER IS APPROXIMATELY 24 mA, EVEN IF ILLUMINATION IS SET TO TOTAL DARKNESS.
3. FIGURE 3 ILLUSTRATES A METHOD FOR DIMMER CONNECTION THAT USES AN EXTERNAL VOLTAGE FOR ILLUMINATION. THE REGULATION RANGE FROM DARKNESS TO FULL ILLUMINATION IS FROM 5-30 VDC. THE CONSUMPTION IS 30 mA @ 30 VDC.

REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
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DATE: (D/M/Y)	25-10-06	SCALE: N/A	DRAWN: A.L. APPR: <i>[Signature]</i> N/A
TITLE: RAI/ROI DIMMER CONFIGURATION			DRAWING NUMBER: B-741246

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TB1

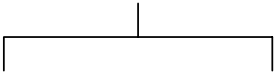


- 1P • P +VDC
- 2P • P +RAI
- 3P • P -RAI
- 4P • P -VDC
- 5P • P SHLD

- 1S • S +VDC
- 2S • S +RAI
- 3S • S -RAI
- 4S • S -VDC
- 5S • S SHLD

- 1R • R +VDC
- 2R • R +ROI
- 3R • R -ROI
- 4R • R -VDC
- 5R • R SHLD

TB2/TB3



- 1P • P +VDC
- 2P • P +RAI
- 3P • P -RAI
- 4P • P -VDC
- 5P • P SHLD



- 1S • S +VDC
- 2S • S +RAI
- 3S • S -RAI
- 4S • S -VDC
- 5S • S SHLD

ELECTRICAL LEGEND

P	PORT RUDDER ANGLE INDICATOR SYSTEM
S	STBD RUDDER ANGLE INDICATOR SYSTEM
R	RUDDER ORDER INDICATOR SYSTEM
±VDC	± RUDDER ANGLE/ORDER INDICATOR POWER SYSTEM
±RAI	± RUDDER ANGLE INDICATOR SIGNAL
±ROI	± RUDDER ORDER INDICATOR SIGNAL
SHLD	CABLE SHIELDING

- NOTES
1. TERMINAL BLOCKS AND JUMPERS NOT SUPPLIED.
 2. TERMINAL BLOCKS SHOULD BE HOUSED IN FIRE RESISTANT AND SPLASH PROOF ENCLOSURES.

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 <div>JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334</div>			
DATE: (D/M/Y)	27-07-10	SCALE: N/A	DRAWN: P.K.
TITLE: TERMINAL BLOCK CONFIGURATION			APPR.  N/A ENG. PROD.
			DRAWING NUMBER: B-741343



5.5 WIRING DIAGRAM

REF: JQ061388
 43m MID-SHORE PATROL VESSEL
 IRVING SHIPYARD



DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 1 OF 19	APPR. <i>Pia</i>
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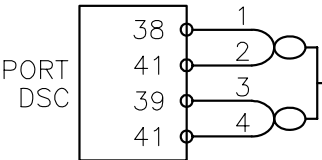
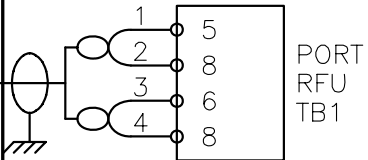
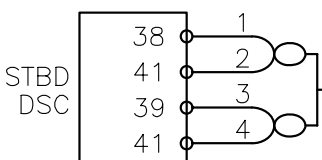
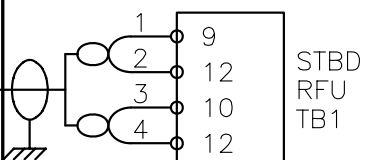
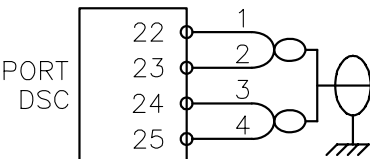
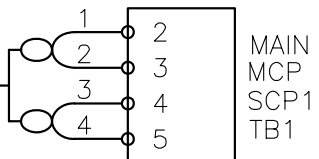
WIRING DIAGRAM LEGEND

TB#	–	TERMINAL BLOCK NUMBER
DSC	–	DIGITAL STEERING CONTROLLER (DSC 100-302)
MCP	–	MODE CONTROL PROCESSOR (MCP 100-20)
SCP1/2	–	STATION CONTROL PROCESSOR BOARD 1/2 (INSIDE MCP)
RFU	–	RUDDER FEEDBACK UNIT (RFU 2000-1210)
CP	–	STEERING MODE CONTROL PANEL (CP-36-2)
T.O.	–	TAKE-OVER PUSH BUTTON
EW	–	ELECTRIC WHEEL (EW 200-31)
LC	–	LEVER CONTROLLER (LC 100-2)
JOG	–	JOG LEVER (JO 100-1)
RAI	–	RUDDER ANGLE INDICATOR (RAI 380)
ROI	–	RUDDER ORDER INDICATOR (ROI 380)
APCU	–	AUTOPILOT CONNECTION UNIT (NOT SUPPLIED)
ESJB	–	EMERGENCY STATION JUNCTION BOX TERMINAL BLOCK
MAIN	–	WHEELHOUSE MAIN STATION
P-WING	–	PORT WING STATION
S-WING	–	STBD WING STATION
MSA	–	MOTOR STARTER & ALARM UNIT TERMINAL BLOCK (NOT SUPPLIED)

REF: JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

Jastram

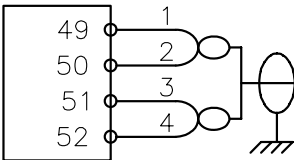
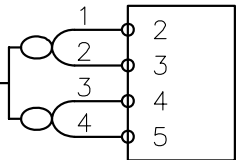
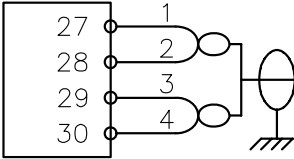
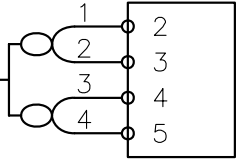
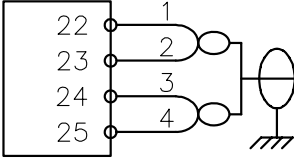
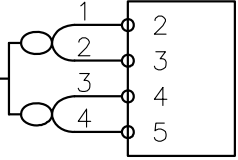
DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 2 OF 19	APR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
 <p>PORT DSC</p>	<p>CABLE 1P 20 AWG/2 PAIR/SHIELDED</p>	 <p>PORT RFU TB1</p>
<p>NOTES: - CABLE 1P IS TO BE AN INDIVIDUALLY SHIELDED TWISTED-PAIR CABLE. - CABLE SHIELDING IS TO BE CONNECTED TO RFU HOUSING USING GREEN SCREW TERMINAL INSIDE RFU.</p>		
 <p>STBD DSC</p>	<p>CABLE 1S 20 AWG/2 PAIR/SHIELDED</p>	 <p>STBD RFU TB1</p>
<p>NOTES: - CABLE 1S IS TO BE AN INDIVIDUALLY SHIELDED TWISTED-PAIR CABLE. - CABLE SHIELDING IS TO BE CONNECTED TO RFU HOUSING USING GREEN SCREW TERMINAL INSIDE RFU.</p>		
 <p>PORT DSC</p>	<p>CABLE 2PA 18 AWG/2 PAIR/SHIELDED</p>	 <p>MAIN MCP SCP1 TB1</p>
<p>NOTES: - CABLE 2PA MUST BE RS-485 SHIELDED, TWISTED-PAIR COMMUNICATION CABLE WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIVALENT. - #1 AND #2 LEADS ARE THE POWER CONNECTIONS. - #3 AND #4 LEADS ARE THE DATA SIGNAL CONNECTIONS. - CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		

REF: JQ061388
43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

Jastram

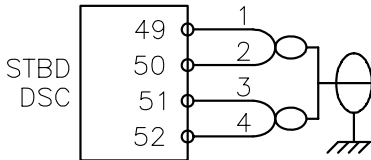
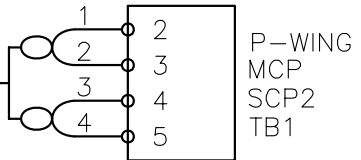
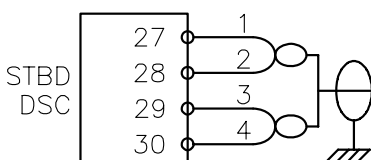
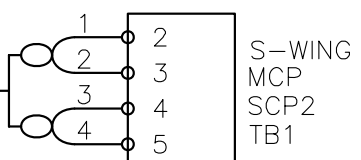
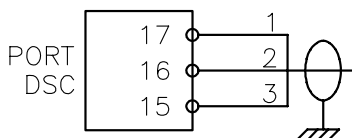
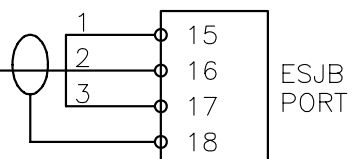
DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 3 OF 19	APR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
 <p>PORT DSC</p>	<p>CABLE 2PB 18 AWG/2 PAIR/SHIELED</p>	 <p>P-WING MCP SCP1 TB1</p>
<p>NOTES: - CABLE 2PB MUST BE RS-485 SHIELED, TWISTED-PAIR COMMUNICATION CABLE WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIVALENT.</p> <p>- #1 AND #2 LEADS ARE THE POWER CONNECTIONS.</p> <p>- #3 AND #4 LEADS ARE THE DATA SIGNAL CONNECTIONS.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		
 <p>PORT DSC</p>	<p>CABLE 2PC 18 AWG/2 PAIR/SHIELED</p>	 <p>S-WING MCP SCP1 TB1</p>
<p>NOTES: - CABLE 2PC MUST BE RS-485 SHIELED, TWISTED-PAIR COMMUNICATION CABLE WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIVALENT.</p> <p>- #1 AND #2 LEADS ARE THE POWER CONNECTIONS.</p> <p>- #3 AND #4 LEADS ARE THE DATA SIGNAL CONNECTIONS.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		
 <p>STBD DSC</p>	<p>CABLE 2SA 18 AWG/2 PAIR/SHIELED</p>	 <p>MAIN MCP SCP2 TB1</p>
<p>NOTES: - CABLE 2SA MUST BE RS-485 SHIELED, TWISTED-PAIR COMMUNICATION CABLE WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIVALENT.</p> <p>- #1 AND #2 LEADS ARE THE POWER CONNECTIONS.</p> <p>- #3 AND #4 LEADS ARE THE DATA SIGNAL CONNECTIONS.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		

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43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
	CABLE 2SB 18 AWG/2 PAIR/SHIELED	
<p>NOTES: - CABLE 2SB MUST BE RS-485 SHIELED, TWISTED-PAIR COMMUNICATION CABLE WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIVALENT.</p> <p>- #1 AND #2 LEADS ARE THE POWER CONNECTIONS.</p> <p>- #3 AND #4 LEADS ARE THE DATA SIGNAL CONNECTIONS.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		
	CABLE 2SC 18 AWG/2 PAIR/SHIELED	
<p>NOTES: - CABLE 2SC MUST BE RS-485 SHIELED, TWISTED-PAIR COMMUNICATION CABLE WITH A CONTROLLED IMPEDANCE OF 120 OHMS, BELDEN 3082A, LAPP 2170340 OR EQUIVALENT.</p> <p>- #1 AND #2 LEADS ARE THE POWER CONNECTIONS.</p> <p>- #3 AND #4 LEADS ARE THE DATA SIGNAL CONNECTIONS.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		
	CABLE 5PA 12 AWG/3/SHIELED	
<p>NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		

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43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

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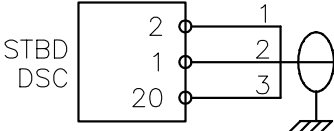
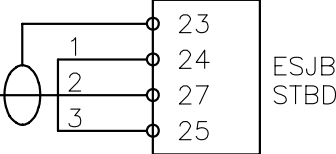
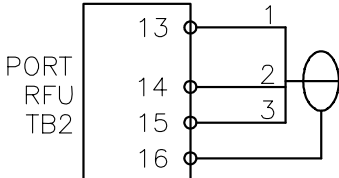
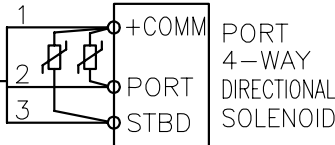
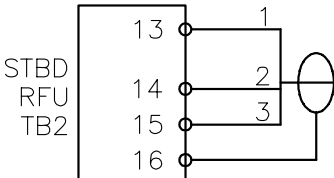
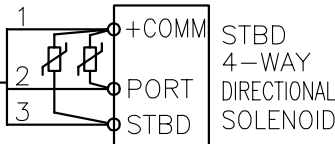
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
<p>ESJB PORT</p>	CABLE 5PB 14 AWG/3/SHIELDED	<p>PORT RFU TB2</p>
<p>STBD DSC</p>	CABLE 5SA 12 AWG/3/SHIELDED	<p>ESJB STBD</p>
<p>NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		
<p>ESJB STBD</p>	CABLE 5SB 14 AWG/3/SHIELDED	<p>STBD RFU TB2</p>
<p>PORT DSC</p>	CABLE 6P 12 AWG/3/SHIELDED	<p>ESJB PORT</p>
<p>NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		

REF: JQ061388
 43m MID-SHORE PATROL VESSEL
 IRVING SHIPYARD

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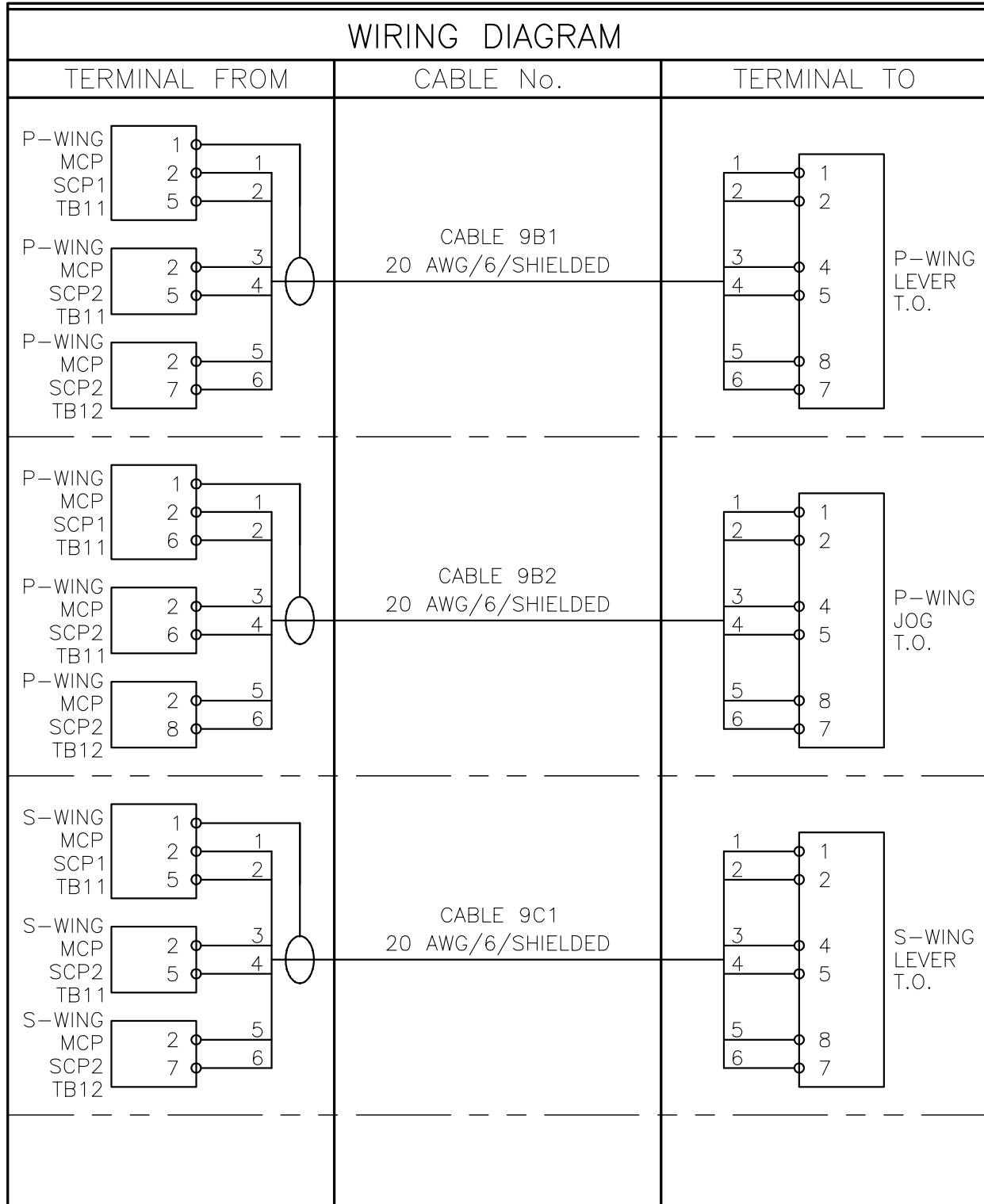
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
 <p>STBD DSC</p>	CABLE 6S 12 AWG/3/SHIELDED	 <p>ESJB STBD</p>
<p><u>NOTES:</u> - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.</p> <p>- CABLE SHIELDING IS TO BE CONNECTED TO DSC AS SHOWN IN SHIELD CONNECTION DIAGRAM (B-741257).</p>		
 <p>PORT RFU TB2</p>	CABLE 8P 14 AWG/3/SHIELDED	 <p>PORT 4-WAY DIRECTIONAL SOLENOID</p>
<p><u>NOTES:</u> - ENSURE THAT METAL OXIDE VARISTORS ARE INSTALLED ACROSS EACH OF THE HYDRAULIC STEERING DIRECTIONAL SOLENOIDS.</p>		
 <p>STBD RFU TB2</p>	CABLE 8S 14 AWG/3/SHIELDED	 <p>STBD 4-WAY DIRECTIONAL SOLENOID</p>
<p><u>NOTES:</u> - ENSURE THAT METAL OXIDE VARISTORS ARE INSTALLED ACROSS EACH OF THE HYDRAULIC STEERING DIRECTIONAL SOLENOIDS.</p>		

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 43m MID-SHORE PATROL VESSEL
 IRVING SHIPYARD

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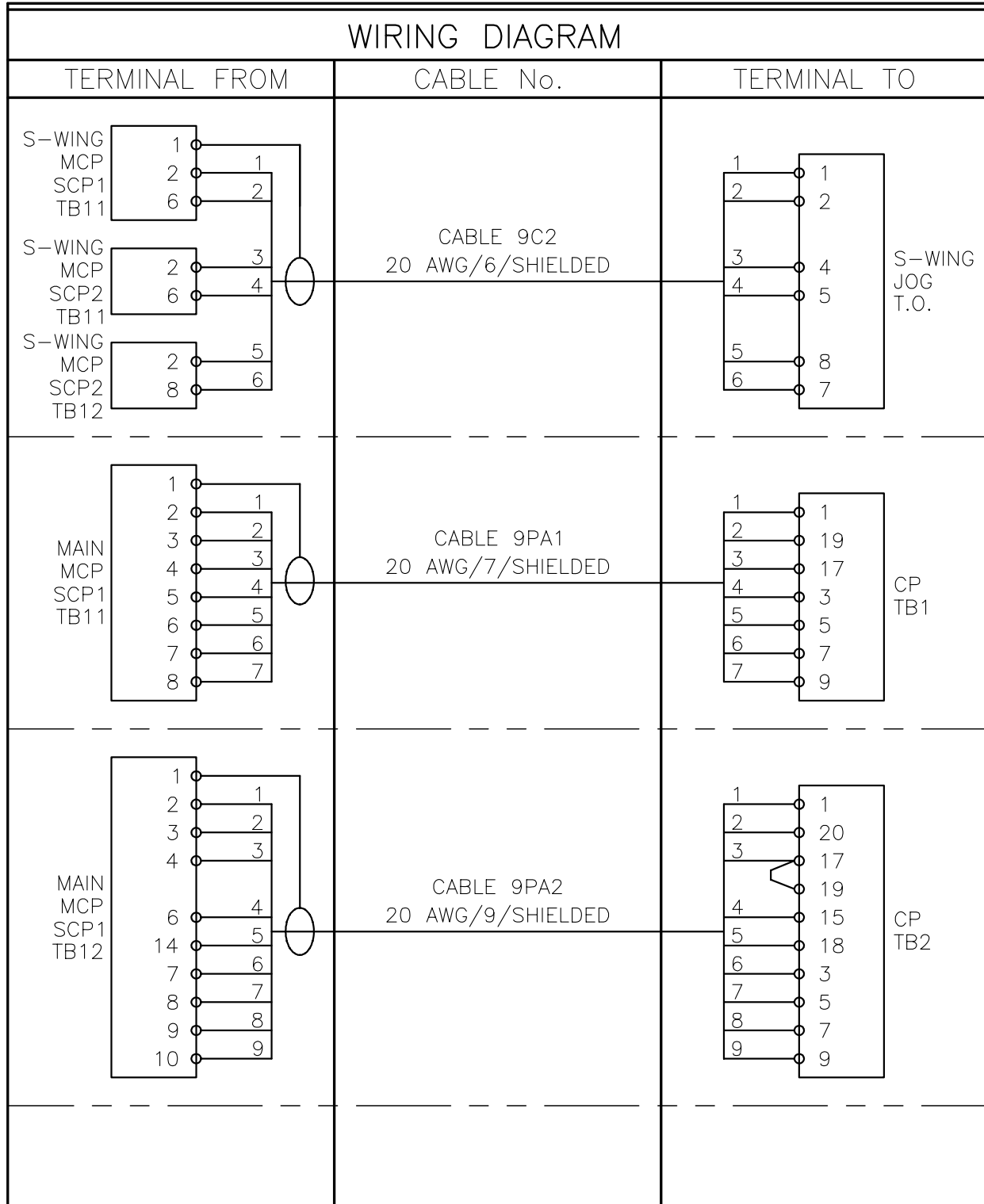
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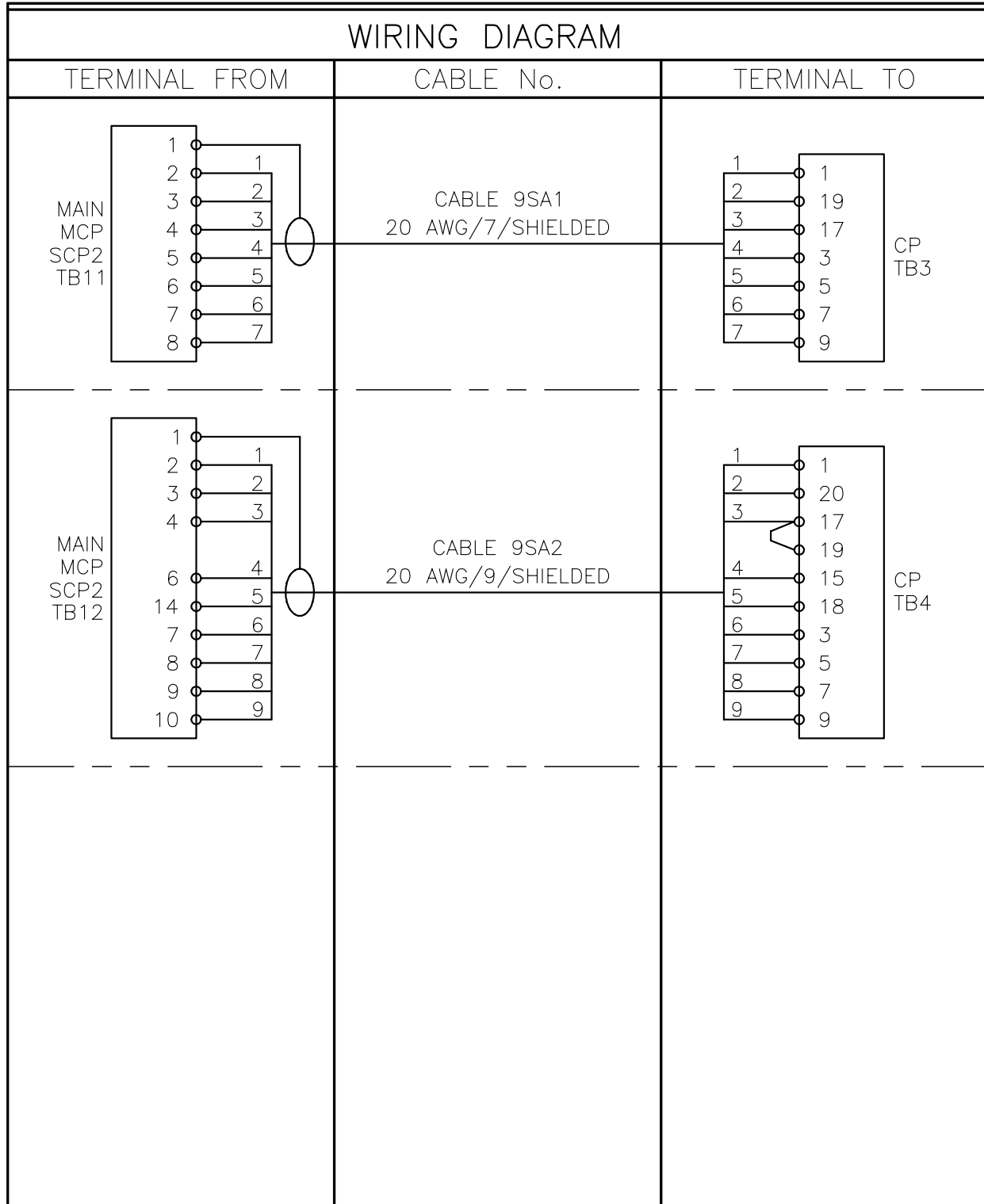
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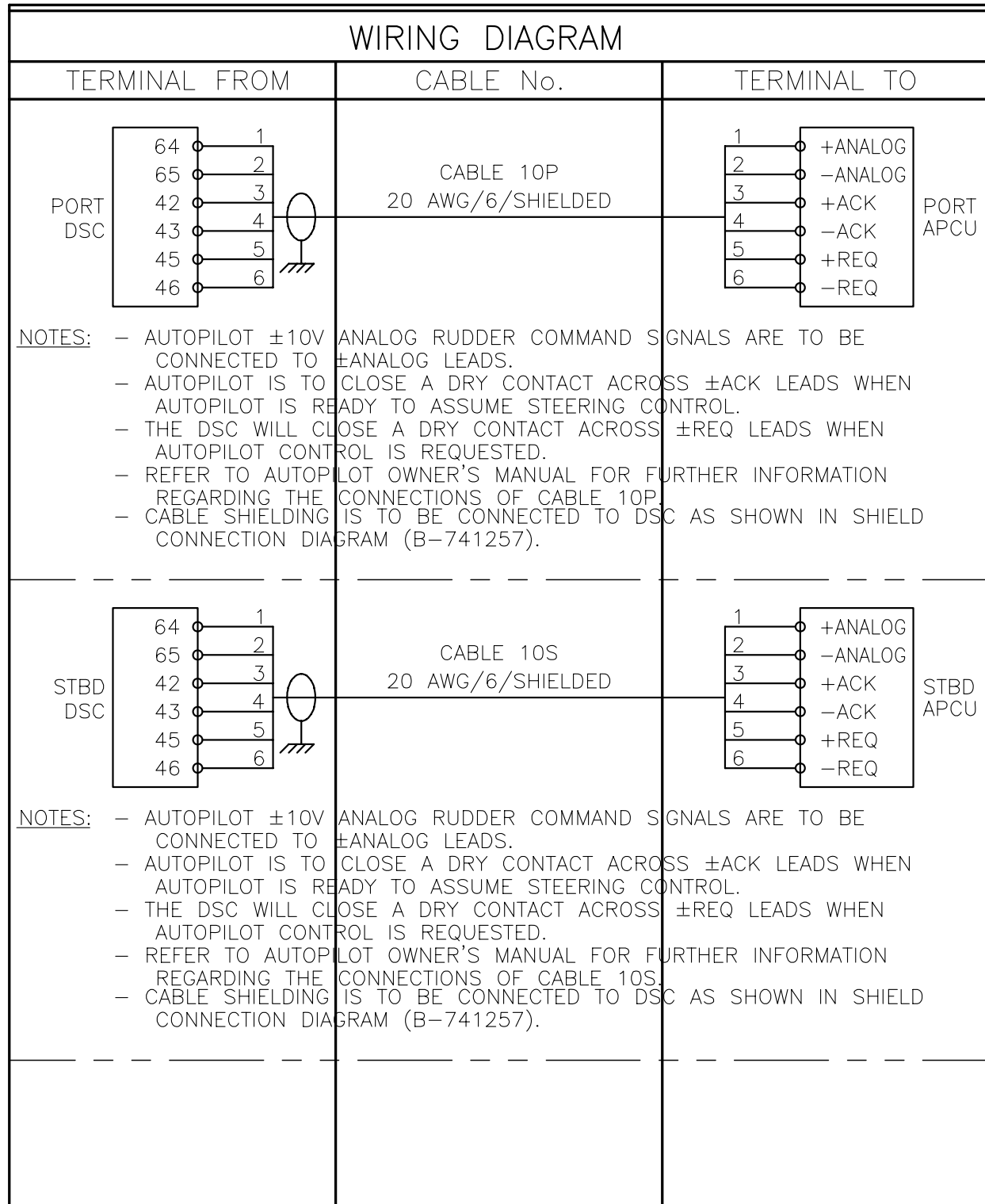
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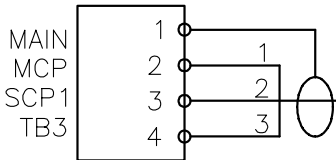
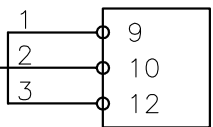
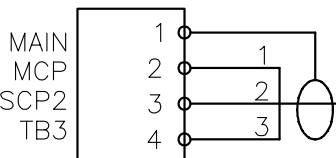
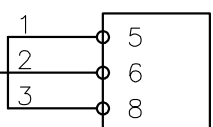
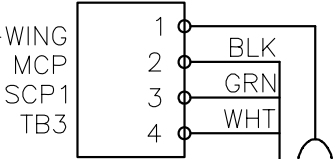
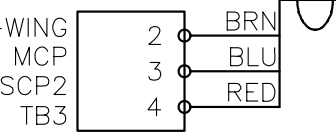
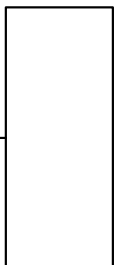
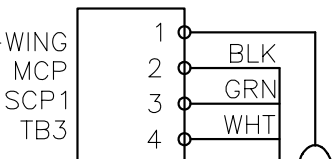
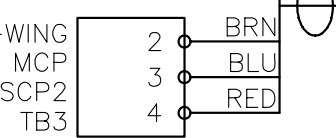
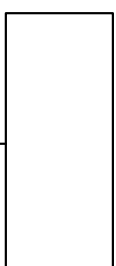
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 IRVING SHIPYARD

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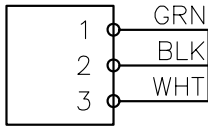
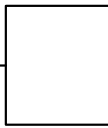
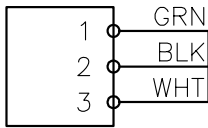
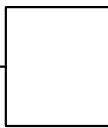
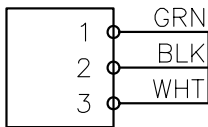
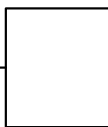
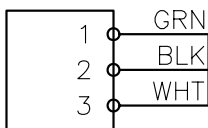
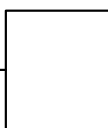
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
MAIN MCP SCP1 TB3 	CABLE 12A1 20 AWG/3/SHEIDED	 EW
MAIN MCP SCP2 TB3 	CABLE 12A2 20 AWG/3/SHEIDED	 EW
P-WING MCP SCP1 TB3  P-WING MCP SCP2 TB3 	CABLE 12B 18 AWG/6/SHEIDED	 P-WING STATION LC
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH LEVER CONTROLLER.		
S-WING MCP SCP1 TB3  S-WING MCP SCP2 TB3 	CABLE 12C 18 AWG/6/SHEIDED	 S-WING STATION LC
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH LEVER CONTROLLER.		

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 43m MID-SHORE PATROL VESSEL
 IRVING SHIPYARD

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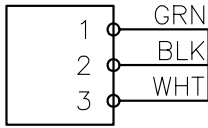
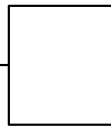
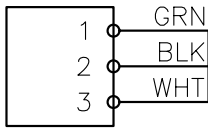
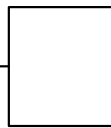
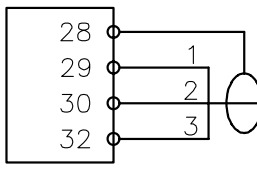
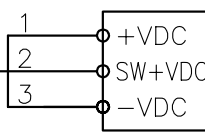
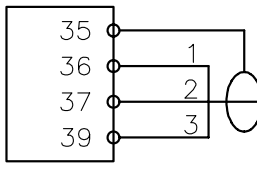
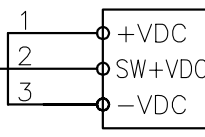
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
MAIN MCP SCP1 TB5 	CABLE 14PA 18 AWG/3/NOT SHIELDED	 WHEEL HOUSE JOG PORT
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH JOG LEVER. - IF JOG LEVER STEERING DIRECTION IS BACKWARDS REVERSE CABLE LEADS BLK AND WHT.		
P-WING MCP SCP1 TB5 	CABLE 14PB 18 AWG/3/NOT SHIELDED	 P-WING STATION JOG PORT
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH JOG LEVER. - IF JOG LEVER STEERING DIRECTION IS BACKWARDS REVERSE CABLE LEADS BLK AND WHT.		
S-WING MCP SCP1 TB5 	CABLE 14PC 18 AWG/3/NOT SHIELDED	 S-WING STATION JOG PORT
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH JOG LEVER. - IF JOG LEVER STEERING DIRECTION IS BACKWARDS REVERSE CABLE LEADS BLK AND WHT.		
MAIN MCP SCP2 TB5 	CABLE 14SA 18 AWG/3/NOT SHIELDED	 WHEEL HOUSE JOG STBD
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH JOG LEVER. - IF JOG LEVER STEERING DIRECTION IS BACKWARDS REVERSE CABLE LEADS BLK AND WHT.		

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43m MID-SHORE PATROL VESSEL
IRVING SHIPYARD

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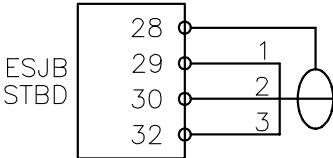
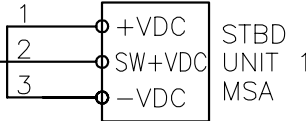
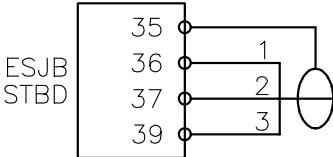
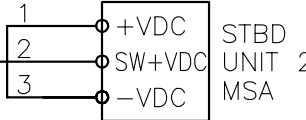
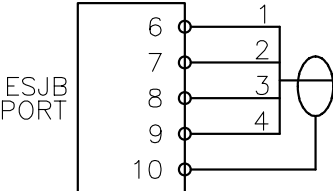
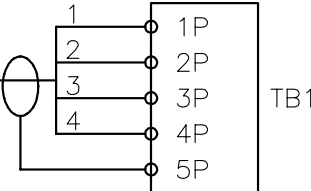
DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 13 OF 19	APPR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
P-WING MCP SCP2 TB5 	CABLE 14SB 18 AWG/3/NOT SHIELDED	 P-WING STATION JOG STBD
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH JOG LEVER. - IF JOG LEVER STEERING DIRECTION IS BACKWARDS REVERSE CABLE LEADS BLK AND WHT.		
S-WING MCP SCP2 TB5 	CABLE 14SC 18 AWG/3/NOT SHIELDED	 S-WING STATION JOG STBD
NOTES: - 5 FT. OF PRE-WIRED CABLE SUPPLIED WITH JOG LEVER. - IF JOG LEVER STEERING DIRECTION IS BACKWARDS REVERSE CABLE LEADS BLK AND WHT.		
ESJB PORT 	CABLE 16PA 12 AWG/3/SHIELDED	 PORT UNIT 1 MSA
NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.		
ESJB PORT 	CABLE 16PB 12 AWG/3/SHIELDED	 PORT UNIT 2 MSA
NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.		

REF: JQ061388
 43m MID-SHORE PATROL VESSEL
 IRVING SHIPYARD

Jastram

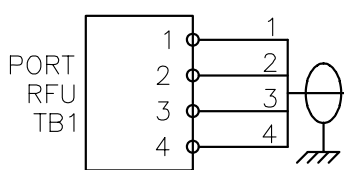
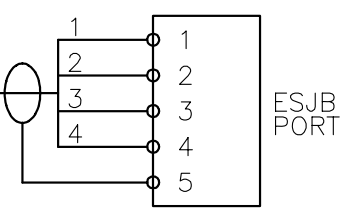
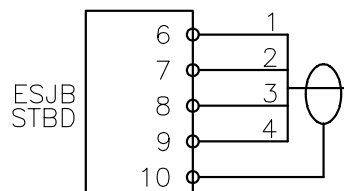
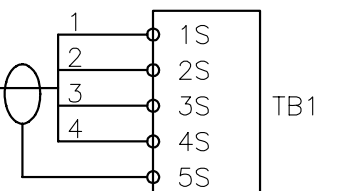
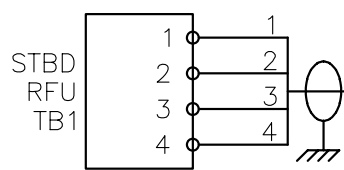
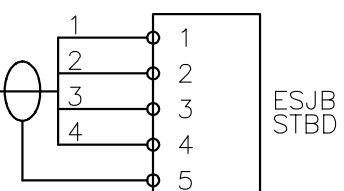
DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 14 OF 19	APPR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
 <p>ESJB STBD</p>	<p>CABLE 16SA 12 AWG/3/SHIELDED</p>	 <p>STBD UNIT 1 MSA</p>
<p>NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.</p>		
 <p>ESJB STBD</p>	<p>CABLE 16SB 12 AWG/3/SHIELDED</p>	 <p>STBD UNIT 2 MSA</p>
<p>NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.</p>		
 <p>ESJB PORT</p>	<p>CABLE 21PA 16 AWG/4/SHIELDED</p>	 <p>TB1</p>
<p>NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.</p>		

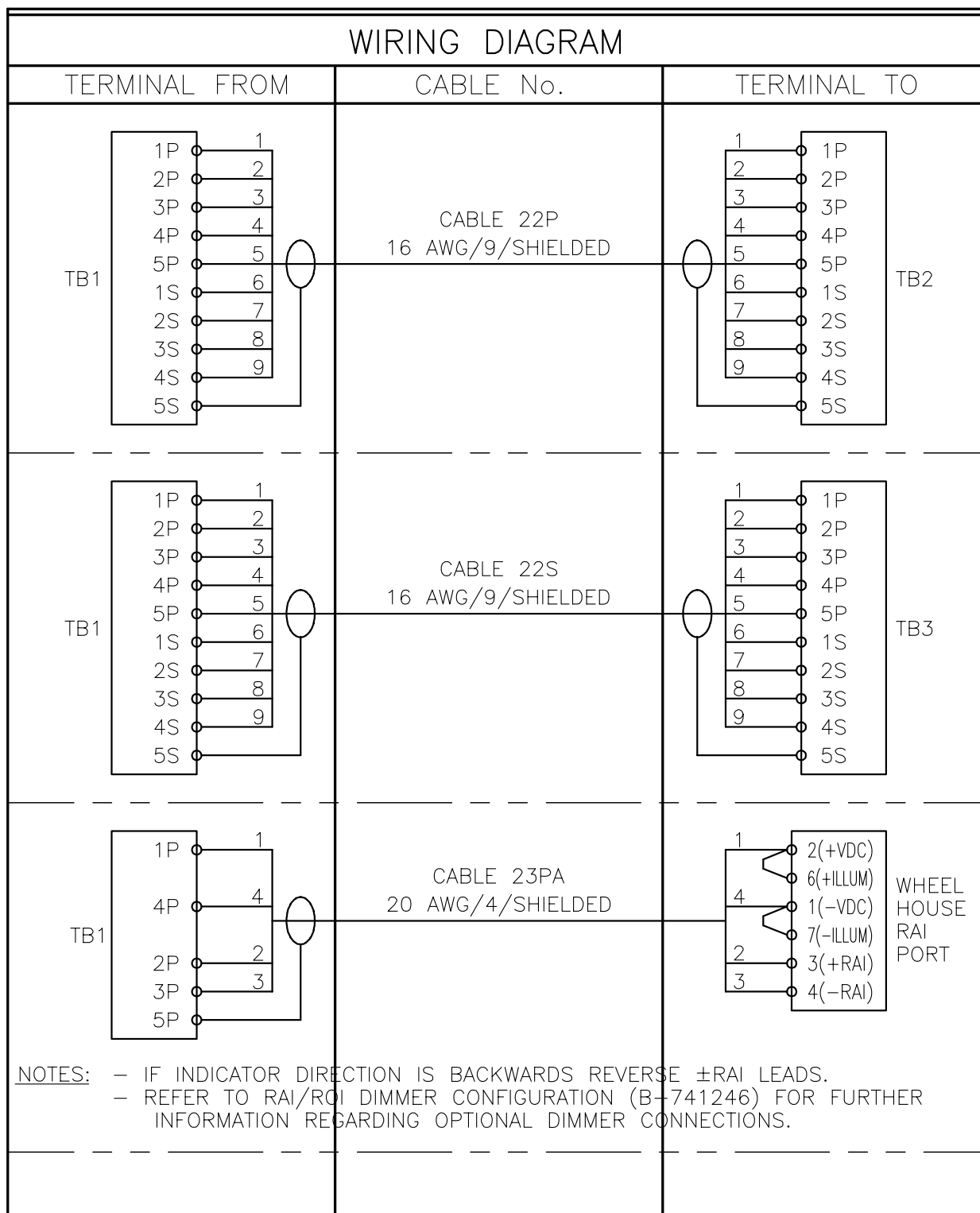
REF: JQ061388
 43m MID-SHORE PATROL VESSEL
 IRVING SHIPYARD

Jastram

DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 15 OF 19	APPR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
PORT RFU TB1 	CABLE 21PB 16 AWG/4/SHEILED	 ESJB PORT
NOTES: - CABLE SHIELDING IS TO BE CONNECTED TO RFU HOUSING USING GREEN SCREW TERMINAL INSIDE RFU.		
ESJB STBD 	CABLE 21SA 16 AWG/4/SHEILED	 TB1
NOTES: - CABLE CONDUCTOR SIZE IS THE SUGGESTED MINIMUM DIAMETER BASED ON A MAXIMUM CABLE LENGTH OF 200 ft (61 m). FOR EACH ADDITIONAL 100 ft (30 m) OF CABLE LENGTH, THE DIAMETER OF CABLE CONDUCTORS SHOULD BE INCREASED BY 2 AWG.		
STBD RFU TB1 	CABLE 21SB 16 AWG/4/SHEILED	 ESJB STBD
NOTES: - CABLE SHIELDING IS TO BE CONNECTED TO RFU HOUSING USING GREEN SCREW TERMINAL INSIDE RFU.		

DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 16 OF 19	APPR. <i>Pia</i>
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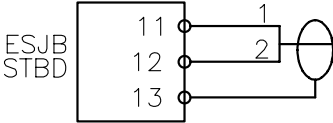
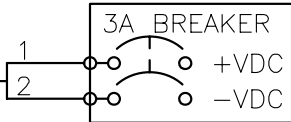
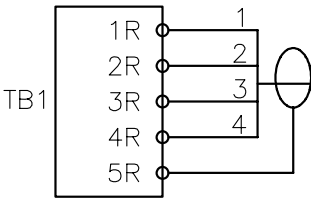
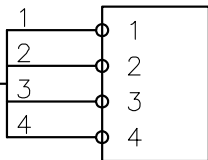
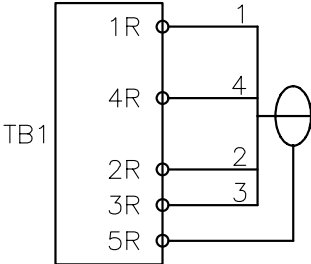
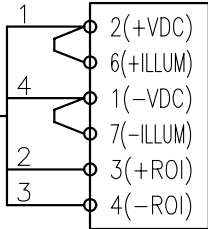
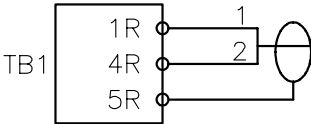
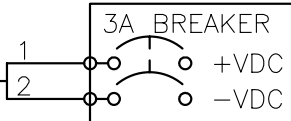
DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 17 OF 19	APPR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
<p>TB2</p>	<p>CABLE 23PB 20 AWG/4/SHIELDED</p>	<p>P-WING STATION RAI PORT</p>
<p>NOTES: - IF INDICATOR DIRECTION IS BACKWARDS REVERSE \pmRAI LEADS. - REFER TO RAI/ROI DIMMER CONFIGURATION (B-741246) FOR FURTHER INFORMATION REGARDING OPTIONAL DIMMER CONNECTIONS.</p>		
<p>TB3</p>	<p>CABLE 23PC 20 AWG/4/SHIELDED</p>	<p>S-WING STATION RAI PORT</p>
<p>NOTES: - IF INDICATOR DIRECTION IS BACKWARDS REVERSE \pmRAI LEADS. - REFER TO RAI/ROI DIMMER CONFIGURATION (B-741246) FOR FURTHER INFORMATION REGARDING OPTIONAL DIMMER CONNECTIONS.</p>		
<p>TB1</p>	<p>CABLE 23SA 20 AWG/4/SHIELDED</p>	<p>WHEEL HOUSE RAI STBD</p>
<p>NOTES: - IF INDICATOR DIRECTION IS BACKWARDS REVERSE \pmRAI LEADS. - REFER TO RAI/ROI DIMMER CONFIGURATION (B-741246) FOR FURTHER INFORMATION REGARDING OPTIONAL DIMMER CONNECTIONS.</p>		

DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 18 OF 19	APPR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
<p>TB2</p>	<p>CABLE 23SB 20 AWG/4/SHIELDED</p>	<p>P-WING STATION RAI STBD</p>
<p>NOTES: - IF INDICATOR DIRECTION IS BACKWARDS REVERSE \pmRAI LEADS. - REFER TO RAI/ROI DIMMER CONFIGURATION (B-741246) FOR FURTHER INFORMATION REGARDING OPTIONAL DIMMER CONNECTIONS.</p>		
<p>TB3</p>	<p>CABLE 23SC 20 AWG/4/SHIELDED</p>	<p>S-WING STATION RAI STBD</p>
<p>NOTES: - IF INDICATOR DIRECTION IS BACKWARDS REVERSE \pmRAI LEADS. - REFER TO RAI/ROI DIMMER CONFIGURATION (B-741246) FOR FURTHER INFORMATION REGARDING OPTIONAL DIMMER CONNECTIONS.</p>		
<p>ESJB PORT</p>	<p>CABLE 26P 16 AWG/2/SHIELDED</p>	<p>FROM SHIP'S 24 VDC SUPPLY FOR PORT RAI SYSTEM</p>
<p>NOTES: - SHIPYARD TO SUPPLY 3 AMP BREAKER FOR RAI POWER SUPPLY AS SHOWN.</p>		

DRAWING No. A-M10669	DRAWING DATE 27-07-10	SHEET 19 OF 19	APPR. <i>Pia</i>
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WIRING DIAGRAM		
TERMINAL FROM	CABLE No.	TERMINAL TO
	CABLE 26S 16 AWG/2/SHIELDED	 <p>FROM SHIP'S 24 VDC SUPPLY FOR STBD RAI SYSTEM</p>
NOTES: - SHIPYARD TO SUPPLY 3 AMP BREAKER FOR RAI POWER SUPPLY AS SHOWN.		
	CABLE 31 20 AWG/4/SHIELDED	 <p>EW</p>
	CABLE 33 20 AWG/4/SHIELDED	 <p>ROI</p>
NOTES: - IF INDICATOR DIRECTION IS BACKWARDS REVERSE \pm ROI LEADS. - REFER TO RAI/ROI DIMMER CONFIGURATION (B-741246) FOR FURTHER INFORMATION REGARDING OPTIONAL DIMMER CONNECTIONS.		
	CABLE 36 16 AWG/2/SHIELDED	 <p>FROM SHIP'S 24 VDC SUPPLY FOR ROI SYSTEM</p>
NOTES: - SHIPYARD TO SUPPLY 3 AMP BREAKER FOR ROI POWER SUPPLY AS SHOWN.		



5.6 COMMISSIONING & TESTING

READ THE TECHNICAL DESCRIPTION AND REVIEW ALL RELEVANT SCHEMATICS TO FAMILIARIZE YOURSELF WITH THE STEERING SYSTEM BEFORE PROCEEDING TO START UP.

GENERAL

Please insure that the installation requirements, contained within the **Steering Control - Installation** section of this manual were satisfied before proceeding with the commissioning and testing. The **Steering Control - Component Manuals** section should be referenced for individual component's commissioning and testing.



6 STEERING CONTROL - MAINTENANCE

THIS SECTION INCLUDES:

- 6.1 MAINTENANCE
- 6.2 COMPONENT ASSEMBLIES AND PART LISTS
- 6.3 COMPONENT MANUALS
- 6.4 TROUBLE SHOOTING



6.1 MAINTENANCE

GENERAL

General maintenance would include:

- Periodic inspection of the individual components, connections and cabling.

PLUG ASSEMBLY

Please see the **General Instructions For Plug Assembly** for information of the receptacle plugs used on the individual components.

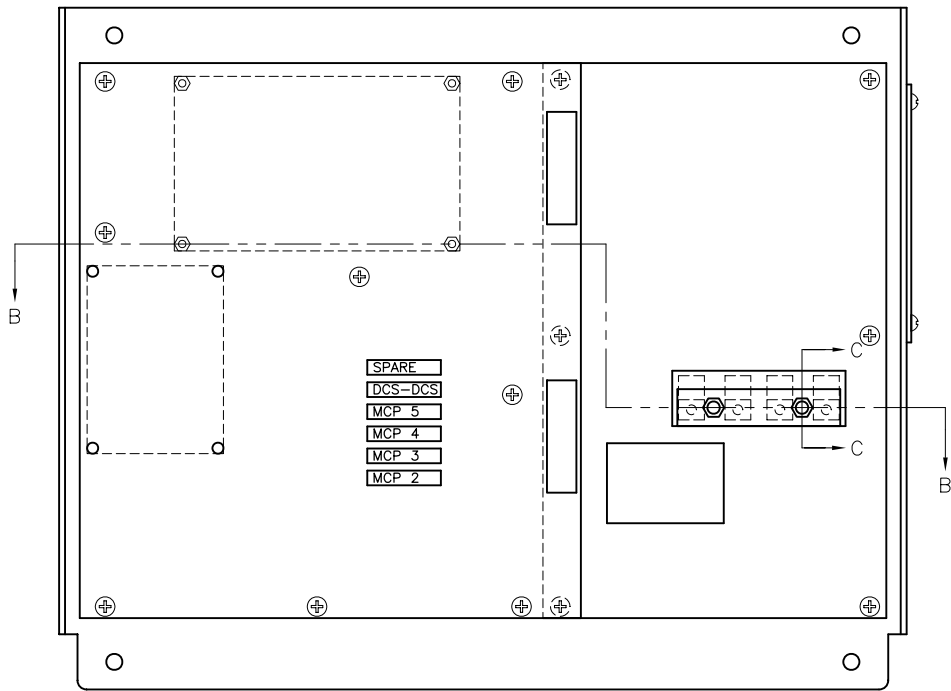
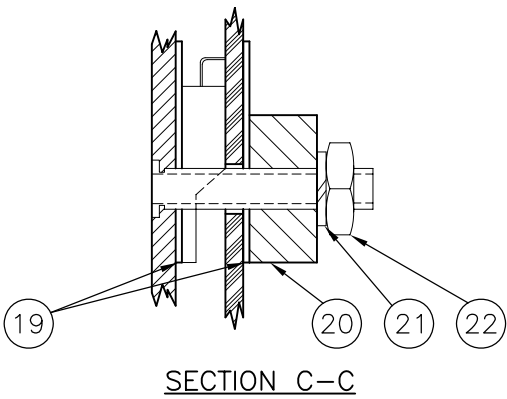
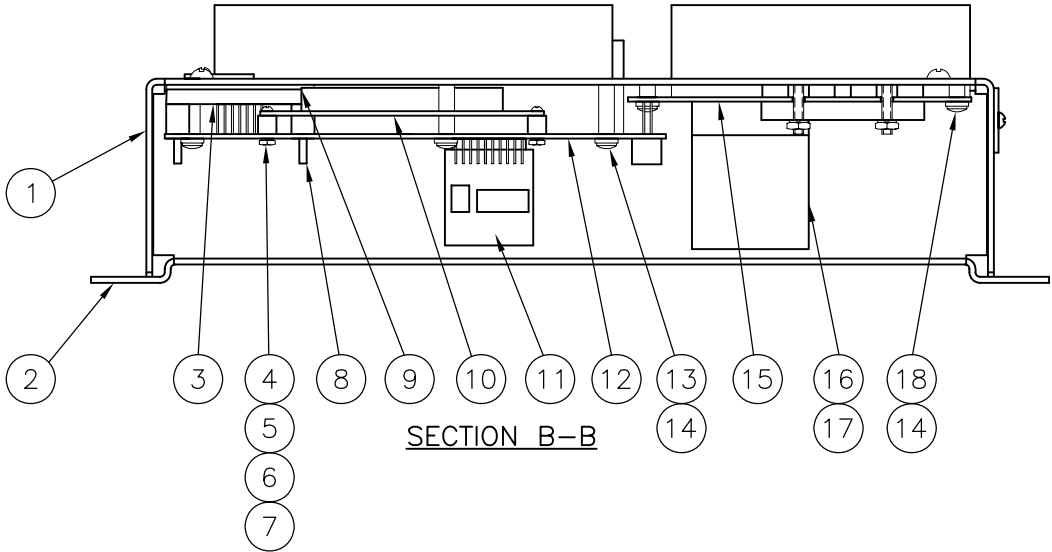
ORDERING

Please see the **Distributors Directory** section for a list of local suppliers.

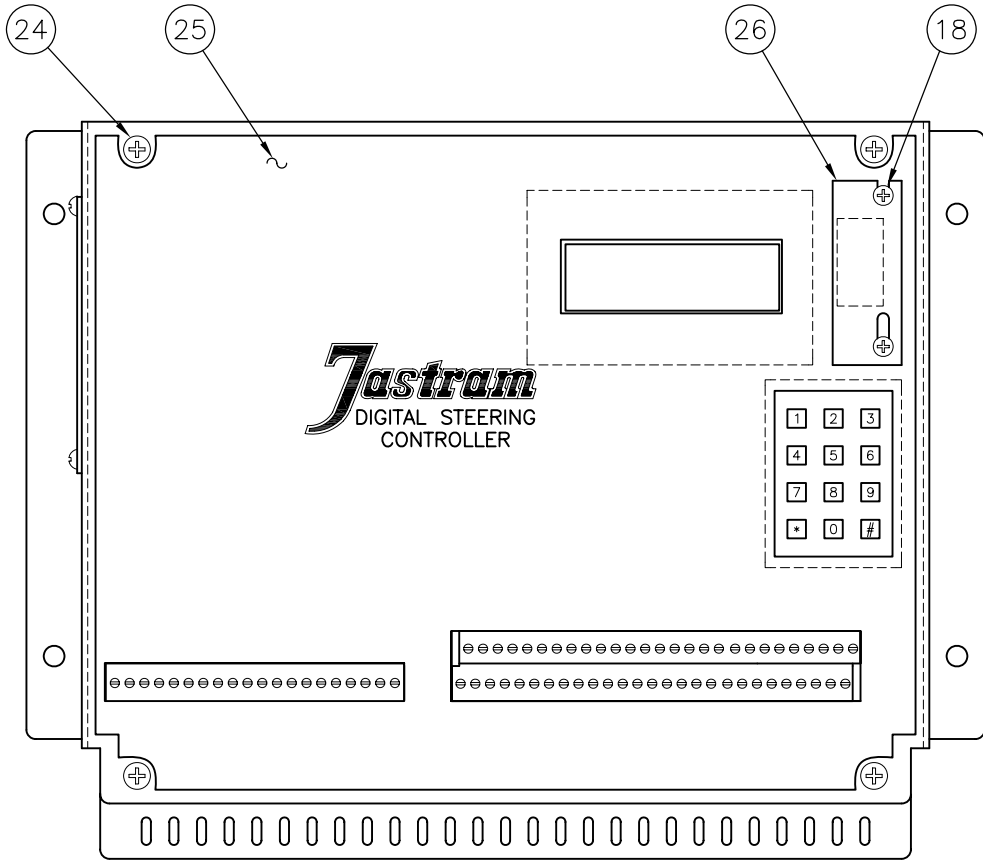
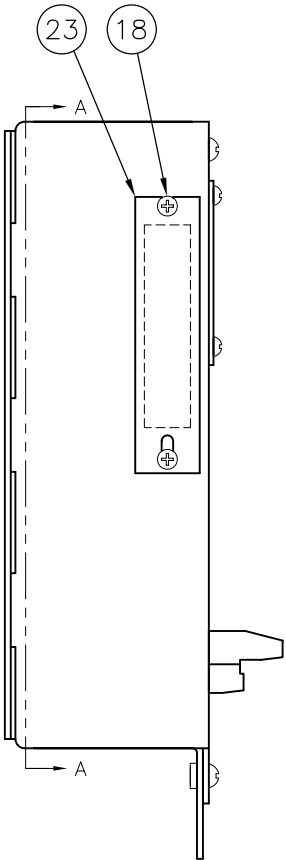


6.2 COMPONENT ASSEMBLIES AND PART LISTS

DASH No.									ITEM No.	PART No.	DESCRIPTION	SPEC.
-9	-8	-7	-6	-5	-4	-3	-2	-1				
QUANTITY												
14	14	14	14	14	14	14	14	14	14	829006	INSULATING WASHER, #6	
1	1	1	1	1	1	1	1	1	15	701128-1	DSC POWER PCB ASSEMBLY	
0	1	0	0	1	0	0	0	0	16	△821064	OUTPUT RELAY, 12 VDC	
1	0	1	1	0	1	1	1	1	17	821052	OUTPUT RELAY, 24 VDC	
10	10	10	10	10	10	10	10	10	18	312014	PAN. HD. PHIL. SCREW, #6-32 x 1/4"	
2	2	2	2	2	2	2	2	2	19	711163-1	THERMAL INSULATING STRIP	
1	1	1	1	1	1	1	1	1	20	711164-1	HEAT SINK BAR	
2	2	2	2	2	2	2	2	2	21	322006	LOCKWASHER, #6	
2	2	2	2	2	2	2	2	2	22	329004	HEX NUT, #6-32	
1	1	1	1	1	1	1	1	1	23	711157-1	FUSE COVER	
4	4	4	4	4	4	4	4	4	24	312048	PAN. HD. PHIL. SCREW, #10-32 x 3/8"	
1	1	1	1	1	1	1	1	1	25	711160-1	DSC LEXAN COVER	
1	1	1	1	1	1	1	1	1	26	711158-1	D-SUB COVER	



VIEW A-A
BOTTOM ENCLOSURE REMOVED FROM VIEW



DASH No.									ITEM No.	PART No.	DESCRIPTION	SPEC.
-9	-8	-7	-6	-5	-4	-3	-2	-1				
QUANTITY												
1	1	1	1	1	1	1	1	1	1	701121-1	DSC TOP ENCLOSURE ASS'Y	
1	1	1	1	1	1	1	1	1	2	701122-1	DSC BOTTOM ENCLOSURE ASS'Y	
1	1	1	1	1	1	1	1	1	3	831020	KEYPAD	
4	4	4	4	4	4	4	4	4	4	350017	1/4" ROUND SPACER, # 2 x 1/4"	
4	4	4	4	4	4	4	4	4	5	312049	PAN. HD. PHIL. SCREW, #2-56 x 1/2"	
4	4	4	4	4	4	4	4	4	6	322021	LOCKWASHER, #2	
4	4	4	4	4	4	4	4	4	7	329018	HEX NUT, #2-56	
4	4	4	4	4	4	4	4	4	8	812038	LOCKING PCB SUPPORT, 3/8: LG.	
1	1	1	1	1	1	1	1	1	9	711162-1	KEYPAD GASKET	
1	1	1	1	1	1	1	1	1	10	701130-1	LCD PCB ASSEMBLY	
2	1	3	4	0	2	1	1	0	11	701129-1	CAN I/O PCB ASSEMBLY	
1	1	1	1	1	1	1	1	1	12	701127-1	DSC MAIN PCB ASSEMBLY	
8	8	8	8	8	8	8	8	8	13	312035	PAN. HD. PHIL. SCREW, #6-32 x 5/8"	

MODEL	DASH No.	APPLICATION	ASSEMBLY No.
DSC 100-102	-1	1 x MCP, 0 x DSC-DSC, 24 VDC	701126-1
DSC 100-202	-2	2 x MCP, 0 x DSC-DSC, 24 VDC	701126-2
DSC 100-112	-3	1 x MCP, 1 x DSC-DSC, 24 VDC	701126-3
DSC 100-212	-4	2 x MCP, 1 x DSC-DSC, 24 VDC	701126-4
DSC 100-101	-5	1 x MCP, 0 x DSC-DSC, 12 VDC	701126-5
⚠ DSC 100-502	-6	5 x MCP, 0 x DSC-DSC, 24 VDC	701126-6
⚠ DSC 100-312	-7	3 x MCP, 1 x DSC-DSC, 24 VDC	701126-7
⚠ DSC 100-111	-8	1 x MCP, 1 x DSC-DSC, 12 VDC	701126-8
⚠ DSC 100-302	-9	3 x MCP, 0 x DSC-DSC, 24 VDC	701126-9

- NOTES:
1. INSTALL CAN PCB WITH COMPONENT SIDE TOWARDS LCD.
 2. APPLY THERMAL PASTE TO TOP & BOTTOM OF ITEM 19 PRIOR TO MOUNTING PCB SUB-ASSEMBLY.
 3. ITEM No. 1, 9 AND 25 SUPPLIED AS AN INSEPARABLE ASSEMBLY. TRIM OPENINGS OF ITEM 25 UPON ASSEMBLY.

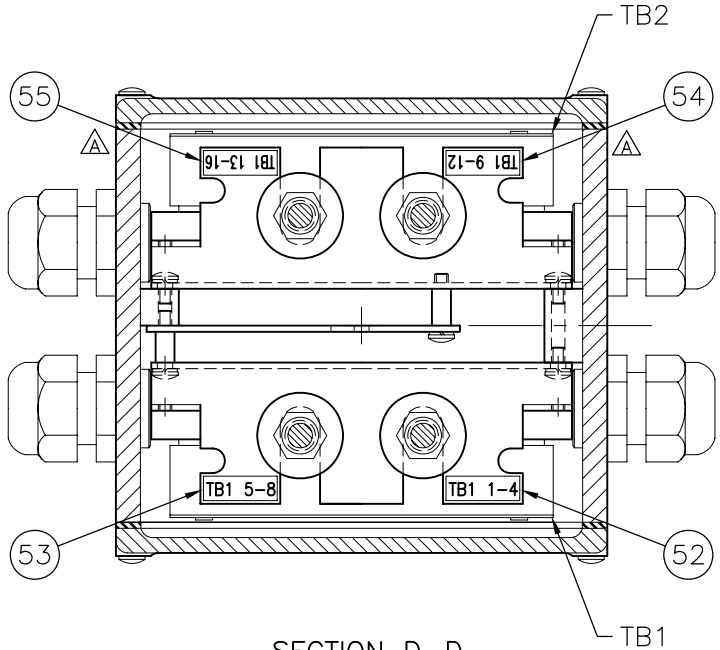
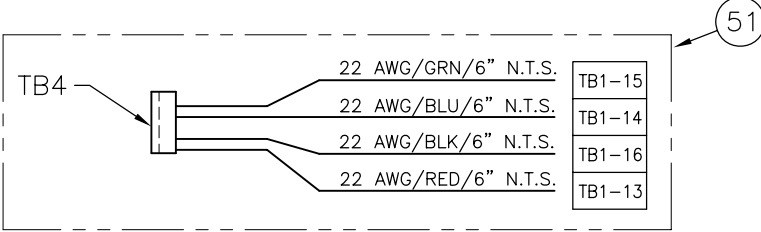
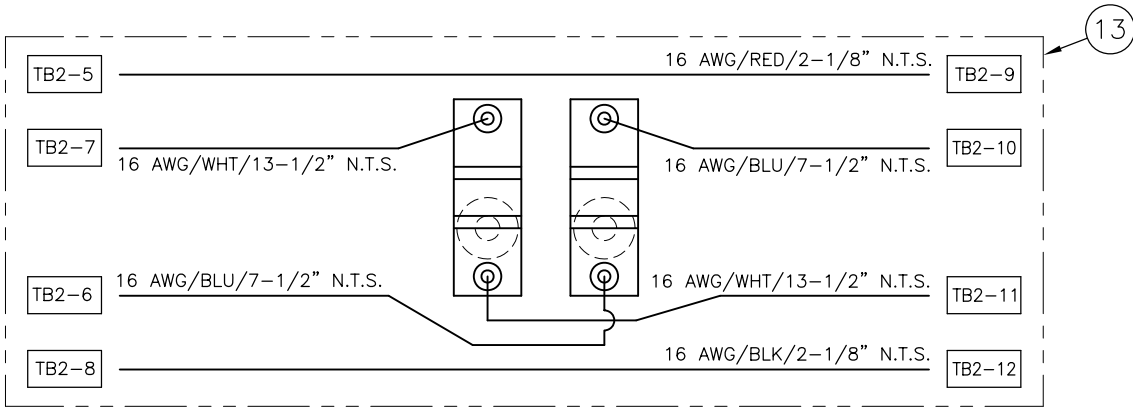
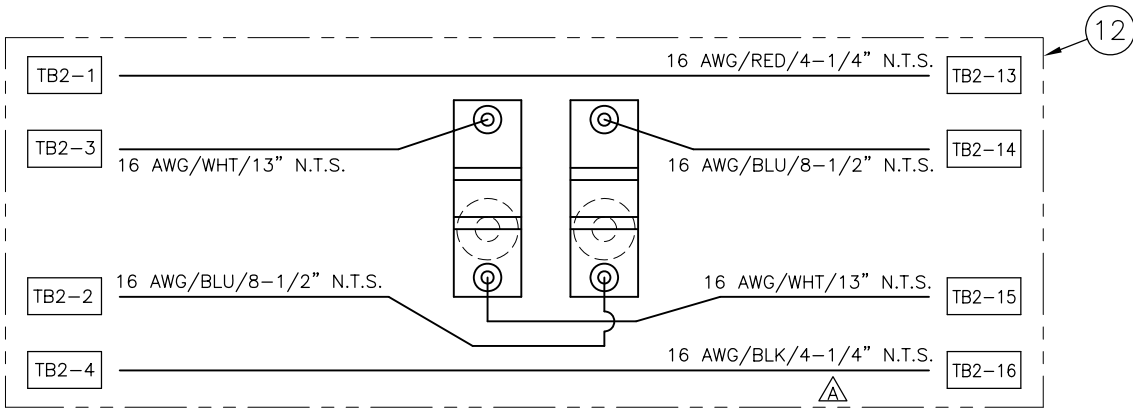
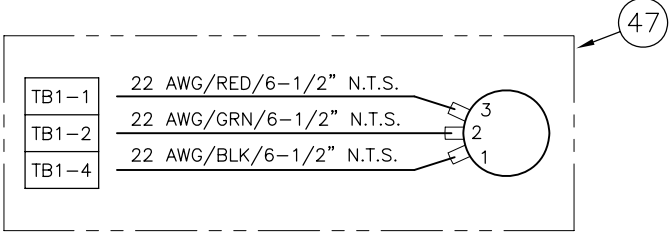
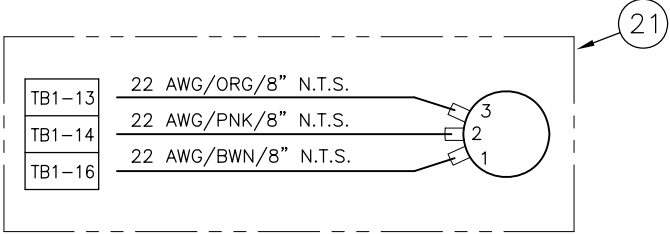
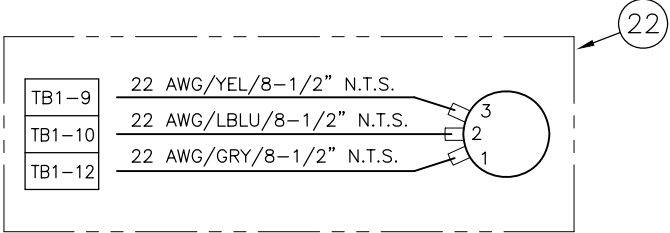
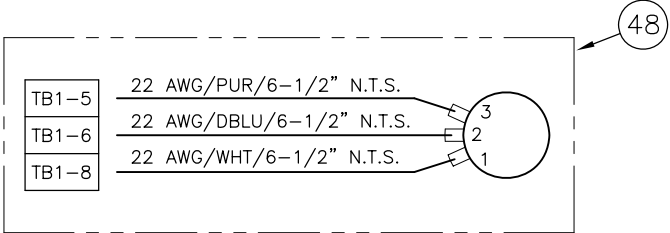
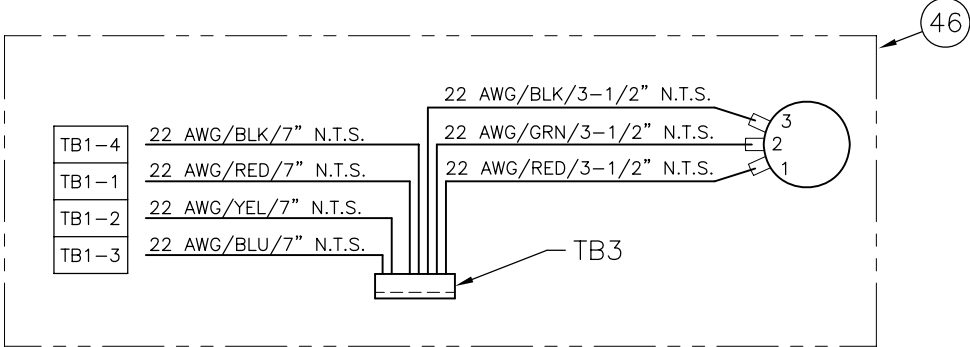
CUSTOMER COPY

B	28-07-10	SEE DCN 100051	Pe
A	15-01-08	SEE DCN 080005	G.T.
REV.	DATE	DRAWING/DESIGN CHANGE No.	BY
Jastram JASTRAM ENGINEERING LTD. 135 Riverside Drive North Vancouver, B.C. Canada V7H 1T6 Tel.: (604) 988-1111 Fax: (604) 986-0334			
DATE: 28-05-03	SCALE: 3/4":1"	DRAWN: A.N.	APPR. G.T. N/A
TITLE: DSC 100 ASSEMBLY	DRAWING NUMBER: D-701126		

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓
ALL DIMENSIONS IN INCH(mm)			

MODEL	DASH No.	APPLICATION	ASSEMBLY No.
RFU 2000-1210	-1	ONE SET LIMIT SWITCHES, TWO POTS (1 FDBK & 1 RAI), WITH RAI DRIVER BOARD	701110-1
RFU 2000-1310	-2	ONE SET LIMIT SWITCHES, THREE POTS (2 FDBK & 1 RAI), WITH RAI DRIVER BOARD	701110-2
RFU 2000-2200	-3	TWO SETS LIMIT SWITCHES, TWO POTS (2 FDBK)	701110-3
RFU 2000-2300	-4	TWO SETS LIMIT SWITCHES, THREE POTS (3 FDBK)	701110-4
RFU 2000-2310	-5	TWO SETS LIMIT SWITCHES, THREE POTS (2 FDBK & 1 RAI), WITH RAI DRIVER BOARD	701110-5
RFU 2000-2210	-6	TWO SETS LIMIT SWITCHES, TWO POTS (1 FDBK & 1 RAI), WITH RAI DRIVER BOARD	701110-6
RFU 2000-1101	-7	ONE SET LIMIT SWITCHES, ONE POT (1 FDBK), WITH HALL EFFECT FEEDBACK BOARD	701110-7
RFU 2000-2110	-8	TWO SETS LIMIT SWITCHES, ONE POT (1 RAI), WITH RAI DRIVER BOARD	701110-8



SECTION D-D
FOR CLARITY, SHAFT COMPONENTS
ARE REMOVED IN VIEW

NOTES:

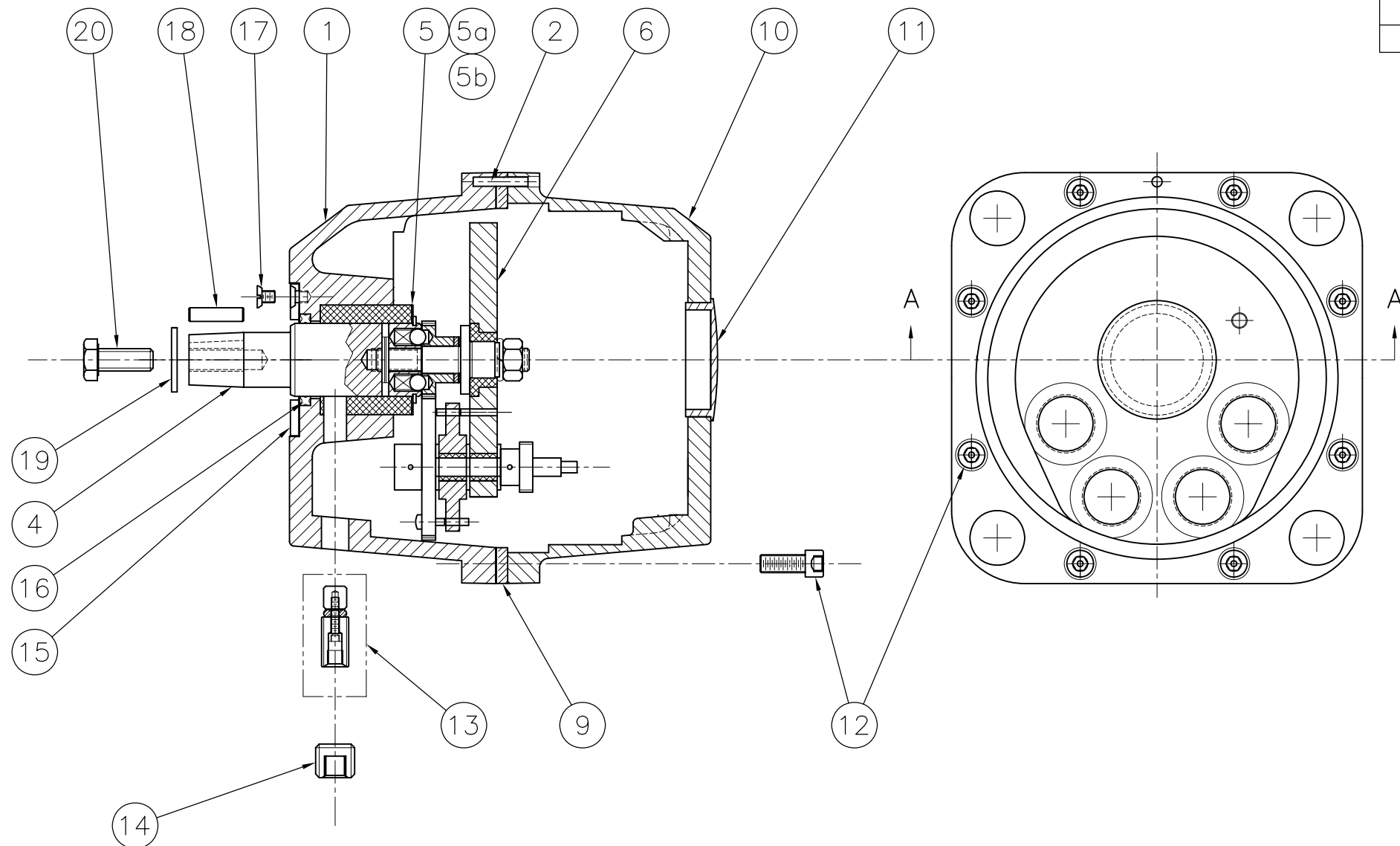
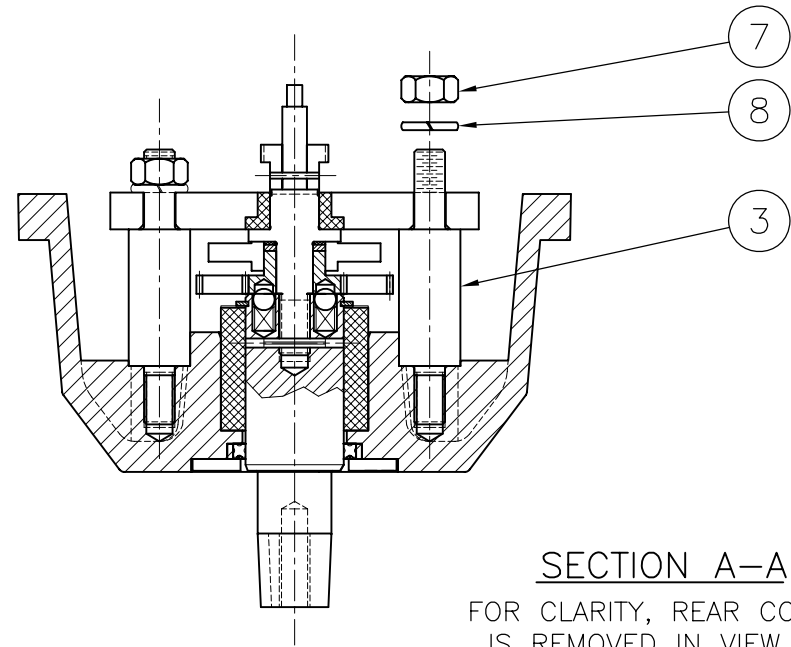
1. LOCKTIGHT IN PLACE WITH REMOVABLE THREADLOCKER No. 242.
2. ADD CABLE GLANDS 1A & 1B FOR LIMIT SWITCH SET No. 1.
ADD CABLE GLANDS 2A & 2B FOR LIMIT SWITCH SET No. 2.
ADD REMAINING CABLE GLANDS IN ORDER 3 THRU 6 AS REQUIRED.
3. SCREW HEAD TO BE PAINTED GREEN FOR GROUND LUG IDENTIFICATION.
4. GREASE SHAFT BEARING, O-RING, CAM SURFACE AND CAM SCREW
THREAD WITH LUBRIPLATE No. 105 (WHITE GREASE).
5. APPLY CLEAR SILICONE TO LAST THREAD OF LIMIT SWITCH
SCREW (ITEMS 4-7), CABLE GLAND (ITEM 18) AND BLANKING
PLUG (ITEM 20) PRIOR TO INSERTION IN ENCLOSURE.
6. ALIGN POT GEAR (ITEMS 21, 22, 46-48) FOR MINIMAL WEAR AND BACKLASH.
7. SEE APPLICATION TABLE FOR ASSEMBLY NUMBER.
8. LOCKTITE IN PLACE WITH REMOVABLE THREADLOCKER No.242.

CONNECTOR TERMINAL LEGEND

TB# TERMINAL BLOCK No.
TB#-# TERMINAL BLOCK No.-TERMINAL No.

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B	02-04-08	SEE DCN 080025	GT
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DATE: 13-11-01 (D/M/Y)	SCALE: 1":1"	DRAWN: G.C.	APPR. G.C. N/A ENG. PROD.
TITLE: RFU 2000 ASSEMBLY (SHEET 2 OF 2)			DRAWING NUMBER: D-701110

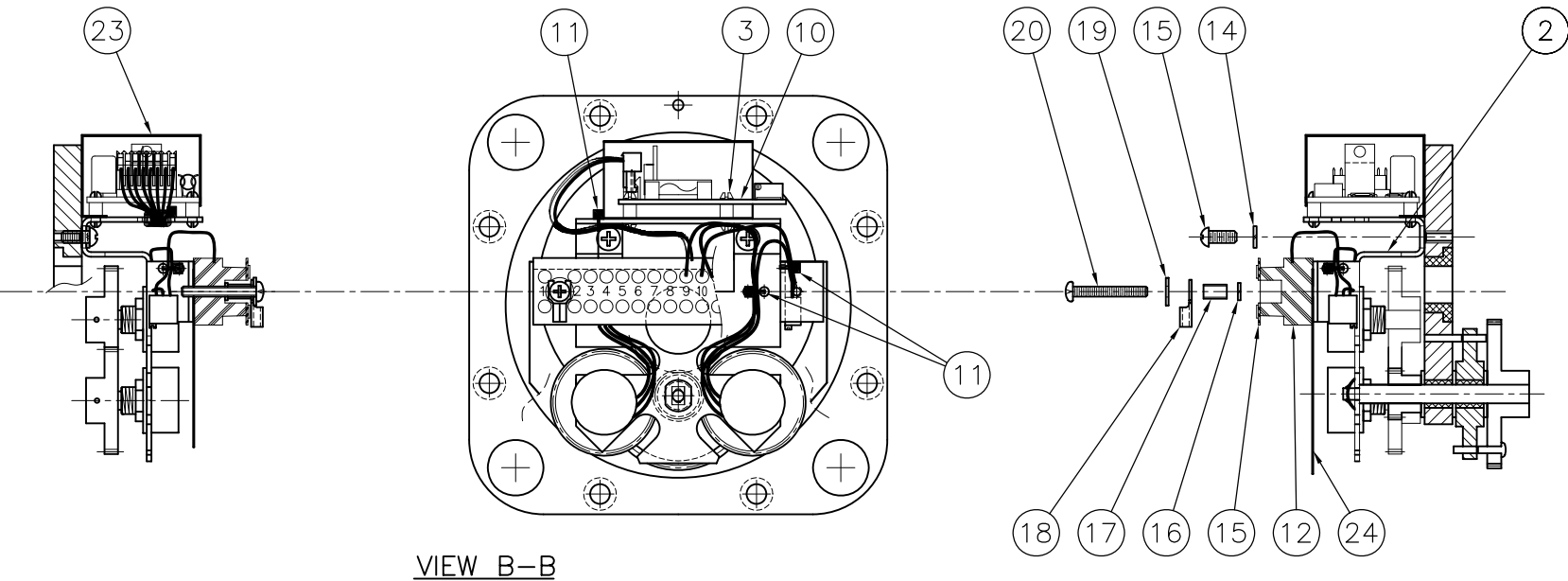
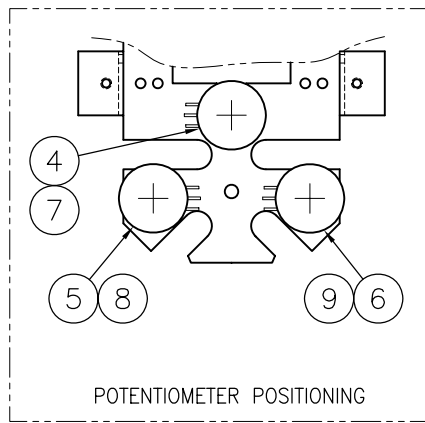
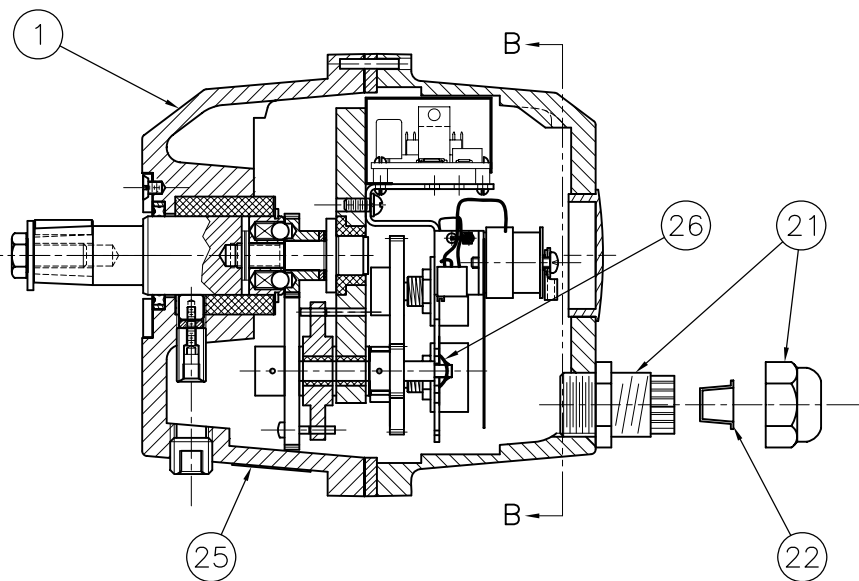
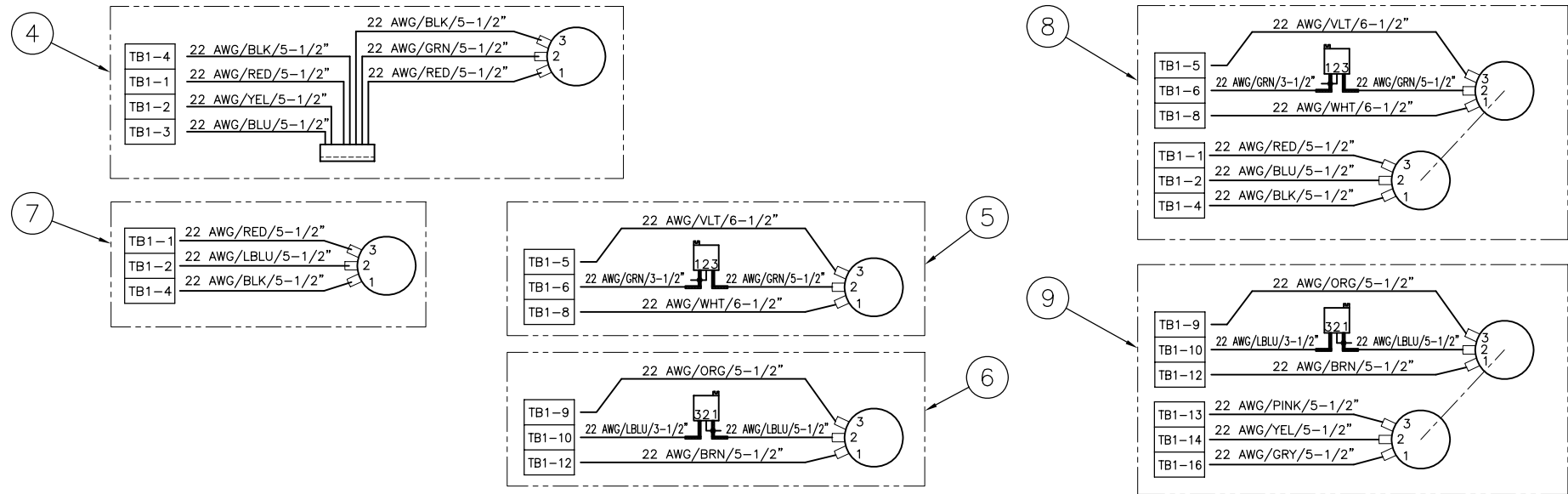


DASH No.			ITEM No.	PART No.	DESCRIPTION	SPEC.
-2	-1	-0				
QUANTITY						
		1	1	701124-1	EW200 FRONT HOUSING ASS'Y	
		1	2	347001	SPRING PIN	
		2	3	711143-1	EW200 CENTER PLATE STAND-OFF	
		1	4	701132-1	EW200 SHAFT & CLUTCH ASS'Y	
		1	5	353003	SHIM RING	
		-	5a	353005	SHIM RING	
		-	5b	353006	SHIM RING	
		1	6	701123-1	EW200 CENTER PLATE ASS'Y	
		2	7	329013	HEX NUT	
		2	8	322015	LOCKWASHER	
		1	9	711153-1	EW200 GASKET	
		1	10	711140-1	EW200 REAR COVER	
		1	11	553018	HOLE PLUG	
		8	12	304013	SETSCREW	
		1	13	701133-1	EW200 FRICTION BRAKE ASS'Y	
		1	14	508003	SKT HD PIPE PLUG	
		1	15	311020-1	H20-H58 HELM PUMP WHEEL DISK	
		1	16	217001	QUAD RING	
		3	17	311001	SCREW, FLAT SLOT	
		0.75"	18	116004	YELLOW BRASS SQR BAR	
		1	19	316002	FLATWASHER	
		1	20	309002	SCREW, HEX HD	

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TITLE: EW200 ASSEMBLY SHEET 1 OF 2	DRAWING NUMBER: D-701120		



DASH No.						ITEM No.	PART No.	DESCRIPTION	SPEC.
-7	-5	-4	-3	-2	-1				
QUANTITY									
1	1	1	1	1	1	1	701120-0	EW200 MECHANICAL SUB ASS'Y	
1	1	1	1	1	1	2	711144-1	EW200 POT. MOUNTING PLATE	
-	-	-	4	-	4	3	350008	MINI PCB STANDOFF	
-	-	-	1	-	1	4	701191-1	EW 200 ROI POTENTIOMETER HARNESS ASS'Y	
-	1	1	1	1	1	5	701192-1	EW 200 CMND POT ASS'Y-NO. 1	
-	1	-	-	1	1	6	701192-2	EW 200 CMND POT ASS'Y-NO. 2	
-	1	-	-	-	-	7	701192-3	EW 200 CMND POT ASS'Y-NO. 3	
1	-	-	-	-	-	8	701193-1	EW 200 DUAL CMND POT ASS'Y-NO. 1	
1	-	-	-	-	-	9	701193-2	EW 200 DUAL CMND POT ASS'Y-NO. 2	
-	-	-	1	-	1	10	701020-2	IDB V1 PCB ASS'Y - RFU400 & EW200	
4	4	2	3	4	5	11	828013	NYLON CABLE TIE	
1	1	1	1	1	1	12	810084	TERMINAL STRIP	
1	1	1	1	1	1	13	810083	MARKED MARKING PLATE WITH PIN	
2	2	2	2	2	2	14	322007	LOCKWASHER	
2	2	2	2	2	2	15	312020	SCREW, PAN PHIL	
2	2	2	2	2	2	16	322006	LOCKWASHER	
2	2	2	2	2	2	17	350015	SPACER	
2	2	2	2	2	2	18	840013	FORK 16-14AWG NO INSUL	
2	2	2	2	2	2	19	316006	FLATWASHER	
2	2	2	2	2	2	20	312017	SCREW, PAN PHIL	
4	4	4	4	4	4	21	852023	CABLE GLAND	
4	4	4	4	4	4	22	553017	TAPERED PLUG	
-	-	-	1	-	1	23	711194-1	EW200 INSULATION SHEET	
-	1	1	1	1	1	24	711195-1	EW200 COVER SHEET	
1	1	1	1	1	1	25	901037	SERIAL No. LABEL	
1	1	1	1	1	1	26	353004	SPRING GRIP FASTENER	

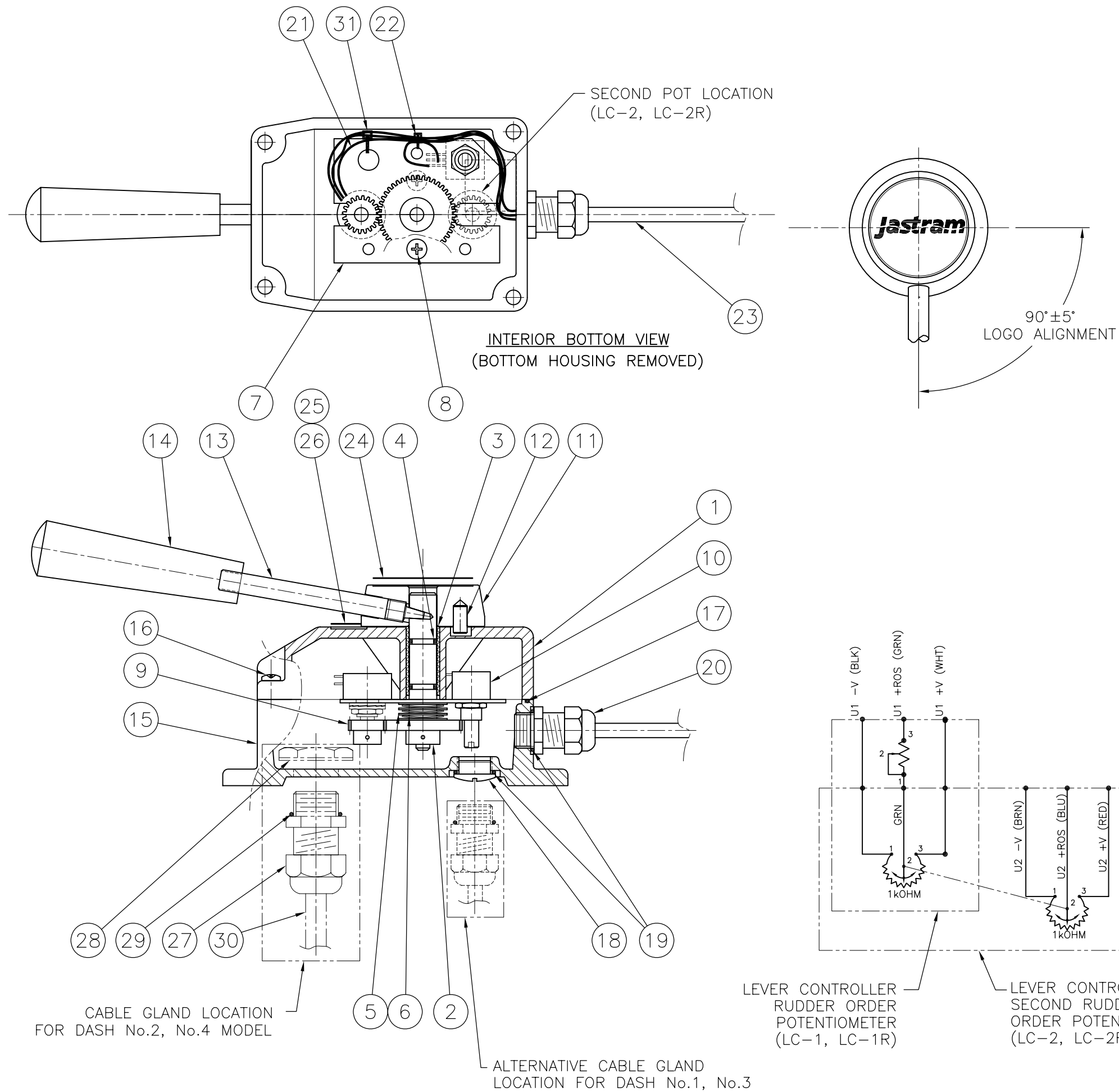
MODEL	DASH No.	APPLICATION	ASSEMBLY No.
EW 200 - 31	-1	3 POTS(1 ROI & 2 CMND POTS) W/ DRIVER	701120-1
EW 200 - 20	-2	2 COMMAND POTS W/OUT DRIVER BOARD	701120-2
EW 200 - 21	-3	2 POTS(1 ROI & 1 CMND POT) W/ DRIVER	701120-3
EW 200 - 10	-4	1 COMMAND POT W/OUT DRIVER BOARD	701120-4
EW 200 - 30	-5	3 COMMAND POTS W/OUT DRIVER BOARD	701120-5
EW 200 - 40	-7	2 DUAL COMMAND POTS W/OUT DRIVER BOARD	701120-7

NOTES:
1. SEE APPLICATION TABLE & POTENTIOMETER POSITIONING TABLE FOR ASSEMBLY NUMBER.

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TITLE: EW200 ASSEMBLY SHEET 2 OF 2			DRAWING NUMBER: D-701120

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DASH No.				ITEM No.	PART No.	DESCRIPTION	SPEC.
-4	-3	-2	-1				
QUANTITY							
1	1	1	1	1	711091-1	LC LEVER TOP HOUSING	
1	1	1	1	2	701059-1	LC LEVER MAINSHAFT ASSY	
1	1	1	1	3	404003	BEARING SLEEVE	
2	2	2	2	4	201012	O-RING	
4	4	4	4	5	316010	FLAT WASHER	
6	6	6	6	6	326001	WAVE SPRING WASHER	
1	1	1	1	7	711087-1	LC POT MOUNTING PLATE	
2	2	2	2	8	312043	SCREW, PAN PHIL	
2	1	2	1	9	701058-1	1K OHM POT ASSY (LC-1/2)	
-	1	-	1	10	815012	POT 10K PCB MOUNT	
1	1	1	1	11	711088-1	LC LEVER HUB	
1	1	1	1	12	343020	DOWEL PIN	
1	1	1	1	13	711084-1	JOG & LC HANDLE SHAFT	
1	1	1	1	14	132008	LC LEVER KNOB	
1	1	1	1	15	711090-1	LC LEVER BOTTOM HOUSING	
4	4	4	4	16	312028	SCREW, PAN PHIL	
1	1	1	1	17	202005	O-RING	
2	1	2	1	18	852036	DUMMY PLUG	
2	2	2	2	19	201014	O-RING	
-	1	-	1	20	852035	CABLE GLAND	
-	1	-	1	21	823001	WIRE (GRN)	
-	3	-	3	22	828013	NYLON CABLE TIE	
-	1	-	1	23	856005	CABLE	
1	1	1	1	24	901033	LEXAN LOGO DISK	
-	-	1	1	25	901034	LABEL BODY, LC100	
1	1	-	-	26	901035	LABEL BODY, LC100 REVERSE	
1	-	1	-	27	852021	CABLE GLAND	
1	-	1	-	28	852022	NUT, CABLE GLAND	
1	-	1	-	29	201016	O-RING	
1	-	1	-	30	856003	CABLE	
3	-	3	-	31	828015	NYLON CABLE TIE	

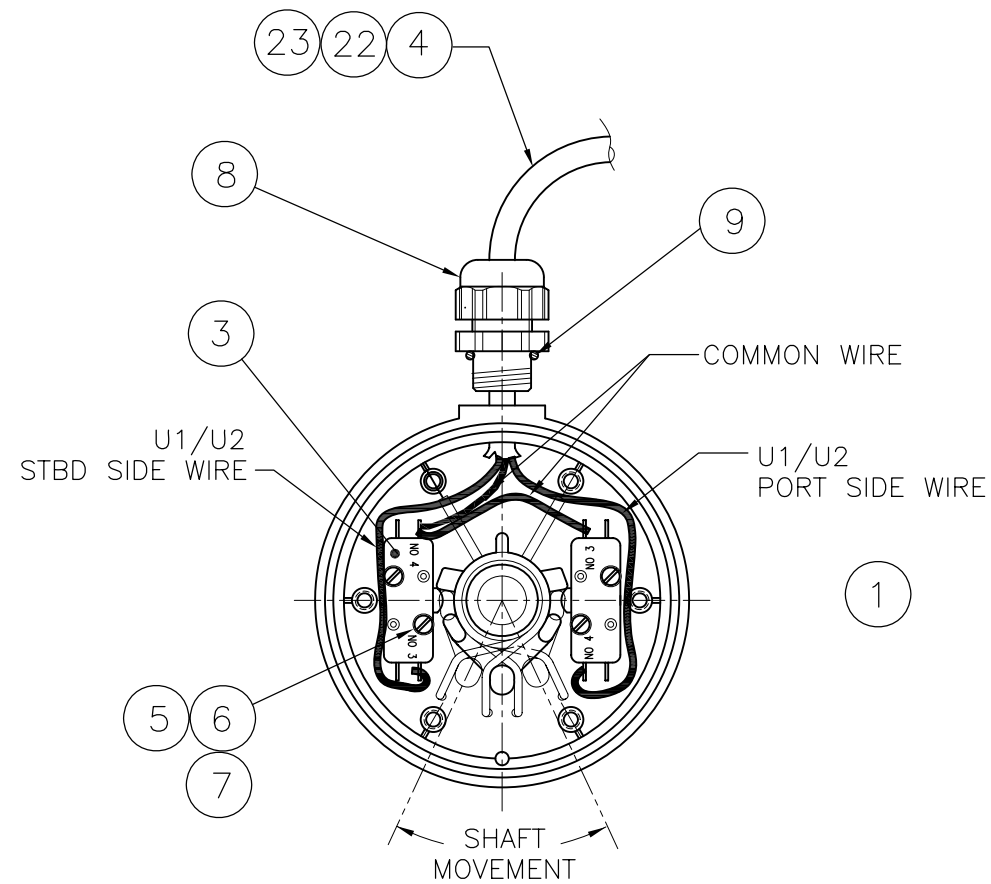
MODEL	DASH No.	APPLICATION	ASSEMBLY No.
LC 100 - 1	-1	LEVER CONTROLLER W/ 1 POT	701008 - 1
LC 100 - 2	-2	LEVER CONTROLLER W/ 2 POTS	701008 - 2
LC 100 - 1R	-3	LEVER CTRL REV SCALE W/ 1 POT	701008 - 3
LC 100 - 2R	-4	LEVER CTRL REV SCALE W/ 2 POTS	701008 - 4

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TOLERANCES: (UNLESS SPECIFIED OTHERWISE)			
X.X	+/- 0.1	FRACTION	+/- 1/64
X.XX	+/- 0.01	ANGULAR	+/- 0.5 DEG.
X.XXX	+/- 0.005	SURFACE FINISH	✓
ALL DIMENSIONS IN INCH(mm)			

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TITLE: LEVER CONTROLLER ASSEMBLY			DRAWING NUMBER: D-701008

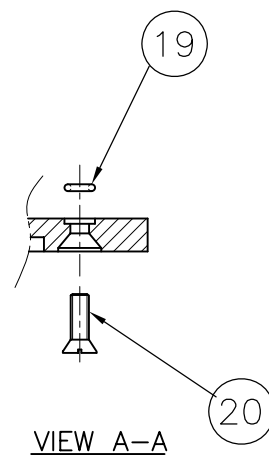
WIRING DIAGRAM



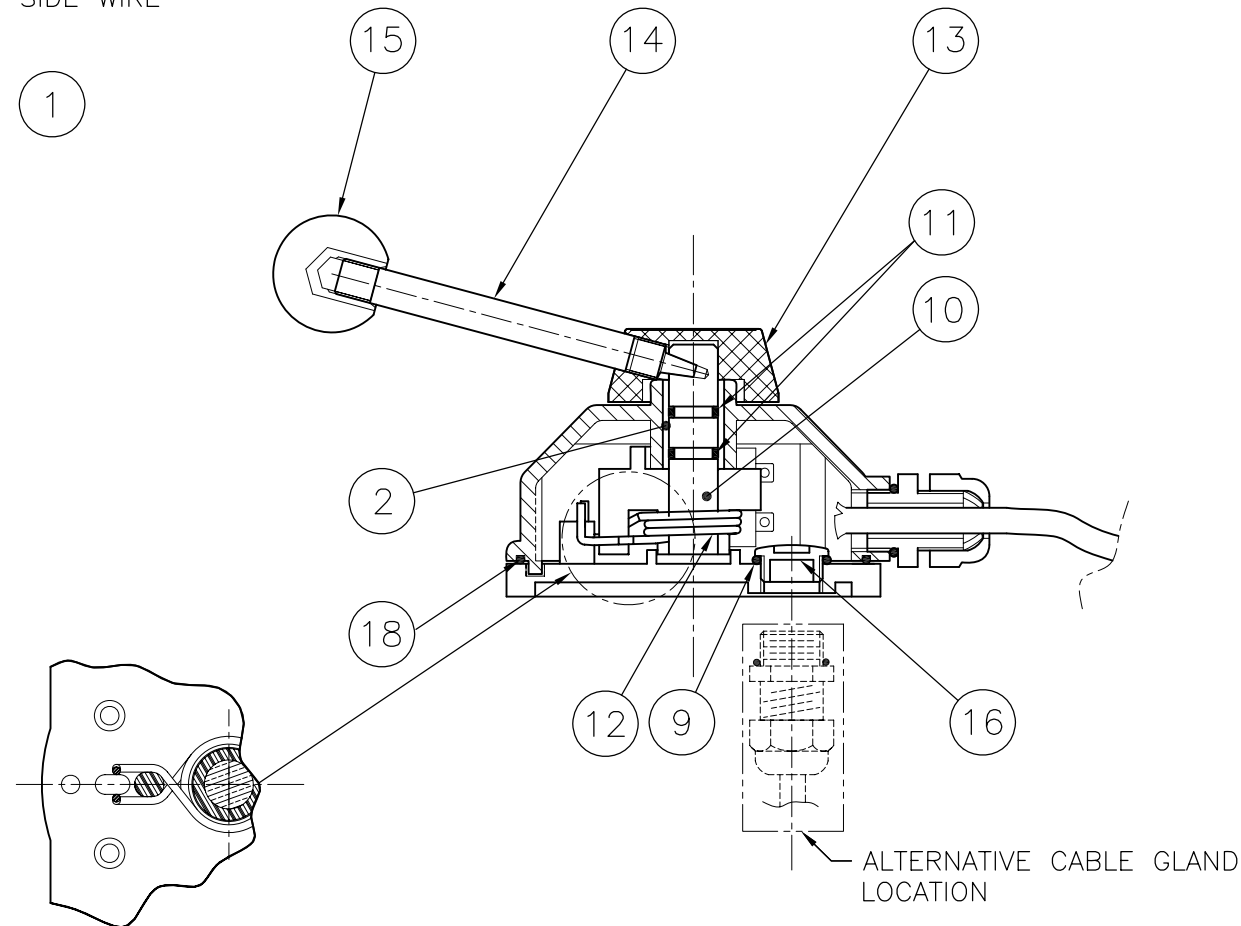
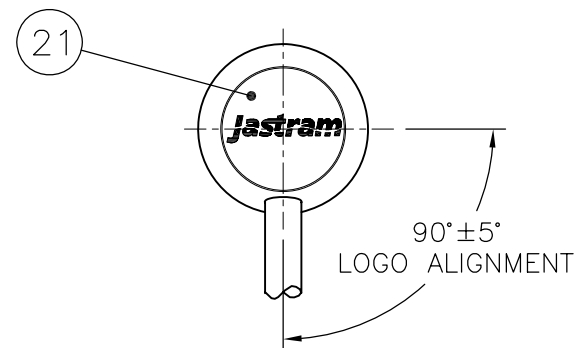
INTERIOR BOTTOM VIEW

	OPTION 1	OPTION 2
U1 PORT	BLACK	BLACK
U1 -COMM	GREEN	ORANGE
U1 STBD	WHITE	YELLOW
U2 PORT	BROWN	BROWN
U2 -COMM	BLUE	BLUE
U2 STBD	RED	RED

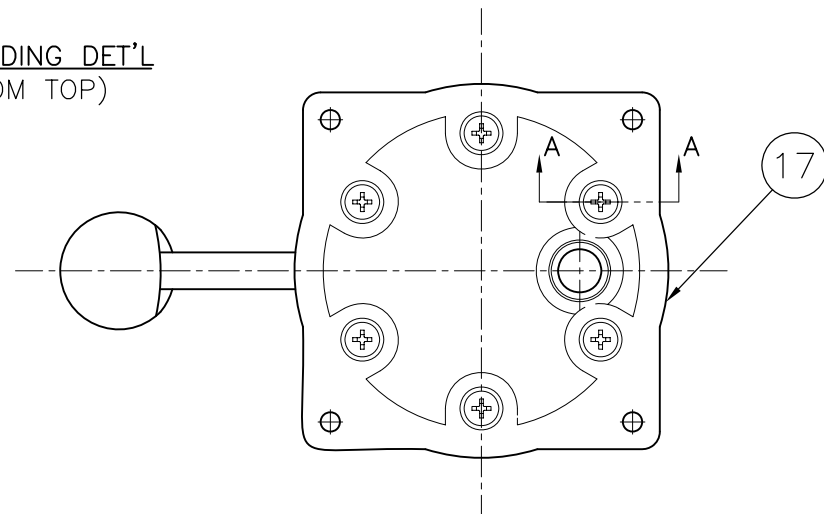
WIRING COLOUR CODE



VIEW A-A



SPRING-LOADING DET'L
(VIEW FROM TOP)



DASH No.				ITEM No.	PART No.	DESCRIPTION	SPEC.
-4	-3	-2	-1				
QUANTITY							
		1	1	1	711080-1	JOG LEVER BODY	
		1	1	2	404006	BEARING SLEEVE	
		4	2	3	857002	MICRO SWITCH	
		-	5	4	856005	CABLE	
		4	4	5	316005	FLAT WASHER	
		-	4	6	312006	SCREW, PAN PHIL	
		4	-	7	312007	SCREW, PAN PHIL	
		1	1	8	852035	CABLE GLAND	
		2	2	9	201014	O-RING	
		1	1	10	701057-1	JOG LEVER SHAFT	
		2	2	11	201012	O-RING	
		1	1	12	605002	TORSION SPRING	
		1	1	13	711082-1	JOG LEVER HUB	
		1	1	14	711084-1	JOG & LC HANDLE SHAFT	
		1	1	15	132007	JOG LEVER KNOB HANDLE	
		1	1	16	852036	DUMMY PLUG	
		1	1	17	711081-1	JOG LEVER BOTTOM PLATE	
		1	1	18	202003	O-RING	
		6	6	19	201008	O-RING	
		6	6	20	312042	SCREW, FLAT PHIL	
		1	1	21	901032	LEXAN LOGO DISK	
		5	-	22	856006	CABLE	
		1	1	23	828015	NYLON CABLE TIE	

MODEL	DASH No.	APPLICATION	ASSEMBLY No.
JO 100 - 1	-1	JOG LEVER W/ 1 SET MICROSWITCH	701005-1
JO 100 - 2	-2	JOG LEVER W/ 2 SETS MICROSWITCH	701005-2

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DATE: 25-08-08	SCALE: N/A	DRAWN: P.K.	APPROVED: N/A
TITLE: JOG LEVER ASSEMBLY			DRAWING NUMBER: D-701005



6.3 COMPONENT MANUALS

GENERAL

The following standard component manuals contain information on the individual components and **not** the specific system as described throughout this manual. These standard component manuals may contain general system drawings that are included to assist in understanding the general function of these components. If a discrepancy exists between the information contained in a standard component manual and the earlier sections of this manual, earlier sections should be followed.

Reference should be made to these standard component manuals for such information as:

- general descriptions of the component.
- component specifications.
- installation particulars and overall dimensions.
- component set up and adjustment locations.
- maintenance and parts information.
- component trouble shooting.

System Manual

Digital Steering Control System Model: DSC 100 and MCP 100



Document No.: MAN01504
Revision: B

This manual is subject to change without prior notice.



Document History

Document No. MAN01504

Jastram DSC 100 & MCP 100

Rev.	Date	DCN No.	Action / Changes / References
-	20-02-06	-	Original Issue
A	27-11-07	070102	Update wiring info and include section 4.2.
B	25-03-10	100018	Update DSC Specifications in section 1.1.



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PREFACE

INTRODUCTION

Jastram's Digital Steering Control system provides an advanced form of rudder position control for a wide variety of vessels and ships. The Digital Steering Control system consists of five basic components:

- The main Digital Steering Controller
- At least one Mode Control Processor
- At least one steering input device
- A rudder feedback unit
- A steering gear hydraulic power unit

The main Digital Steering Controller can communicate with up to five Mode Control Processors installed at various locations on the vessel. Each Mode Control Processor can accommodate a wide variety of steering input device options.

**NOTE:**

This manual assumes that the mechanical steering gear and the hydraulic power unit have been successfully commissioned and tested prior to application of power to the Digital Steering Control System.

AUDIENCE

Sections 1 and 2 of this manual provide a description, specifications, installation information and commissioning information for each of the inputs and outputs of the main Digital Steering Controller and the Mode Control Processor. This information is to be used during the design and layout of the vessels steering control system in order to select the desired modes and locations of steering control as well as to determine what ancillary devices may be required. Specific installation information is also provided for those installing and connecting the equipment.

Section 3 provides a description of the system operation for each type of steering mode and each of the configuration options. This information provides vessel operators with a detailed description of how the vessels rudder position will be controlled and how the overall system will be operated.

Section 4 provides the information necessary to commission and calibrate the steering control system.

CONVENTIONS

Acronyms

DSC – Digital Steering Controller

MCP – Mode Control Processor
SCP – Station Control Processor (individual circuit board inside MCP)
DH – Digital Helm pump
DHM – Digital Helm Manifold
RFU – Rudder Feedback Unit
RAI – Rudder Angle Indicator
ROI – Rudder Order Indicator
NFU – Non Follow Up
FFU – Full Follow Up
HPU – Hydraulic Power Unit

**NOTE:**

This is a note, which presents interesting and useful information.

**CAUTION:**

If this information is not followed, the result could cause damage to the hardware, software or possibly injury to people.

**WARNING:**

IF THIS INFORMATION IS NOT HEHEDED, INJURY OR DEATH OF PEOPLE AND DESTRUCTION OF PROPERTY MAY RESULT.

1 DSC

1.1 GENERAL

**WARNING:**

IN ORDER TO MAINTAIN SAFE VESSEL OPERATION JASTRAM STRONGLY RECOMMENDS THAT ALL STEERING SYSTEMS HAVE SOME MEANS OF AUXILIARY STEERING. REVIEW ALL TECHNICAL DESCRIPTIONS AND DOCUMENTATION AND CONFIRM THAT ADEQUATE AUXILIARY STEERING IS FITTED.

**WARNING:**

IN ORDER TO MAINTAIN SAFE VESSEL OPERATION CREW MUST REVIEW ALL TECHNICAL DESCRIPTIONS AND DOCUMENTATION AND KNOW PROCEDURES REQUIRED TO QUICKLY TRANSFER TO THE AUXILIARY MEANS OF STEERING.

Description

The Digital Steering Controller (DSC) is the main control component of the digital steering control system. The DSC communicates with up to five Mode Control Processor(s) (MCP) at various locations on the vessel. Each MCP is connected to the DSC through a single communication cable thereby reducing the cabling and termination requirements to each of the steering control stations.

The DSC also connects to the Rudder Feedback Unit (RFU) and the directional solenoid valve of the Hydraulic Power Unit (HPU) in order to provide the closed loop positional control of the steering gear. Connection interfacing to a variety of autopilot systems is provided through the DSC as is the optional connections to a backup Non Follow Up controller.

The firmware program running in the DSC manages all of the MCP's in order to ensure that only one steering input device is able to control the position of the rudder at any given time. The same DSC can be used to control either on-off or proportional type directional solenoid valves. On-off valves control the flow of hydraulic fluid in fixed manner while proportional valves vary the flow of hydraulic fluid allowing the rudder to accelerate and decelerate during rudder movements.

The DSC is configured and commissioned through the use of a portable PC and a proprietary software program. The DSC can also be configured and commissioned using the keypad and LCD screen on the DSC. When the DSC is operating in its run mode the LCD screen is used to provide real-time operating information such as the station and mode in control, the commanded rudder position, the actual rudder position and the status of the solenoid outputs. The LCD screen will also provide information on current and past fault conditions that may have occurred.

See also: [2.1](#) MCP General Description

Specifications

Enclosure Protection:	IP 22, NEMA 2
Operable Ambient Temperature:	-25°C to +70°C
Supply Voltage:	12 or 24VDC, -30% +30%
Power Consumption:	Dependent on system configuration approx. 7 Watts, DSC only
EMC Protection:	EN60945, 2005
Dimensions:	Approx. 13" x 10" (330mm x 254mm) see drawing 5.1
Weight:	4.25 Lbs. (1.93 kg)
Maximum rudder speed:	8 seconds (on-off) 5 seconds (proportional)
Rudder position accuracy	$\pm 1/2^\circ$
Safe distance to compass:	2 Ft. (0.63 m)
Short Circuit Protection:	Controller (F1), 4 Amps Directional Solenoid (F2), 4 Amps DHM/Speed Solenoids (F3), 4 Amps
Mounting:	Bulkhead any orientation

Installation

The DSC is to be bulkhead mounted in an indoor location protected from exposure to the weather. See Drawing [5.1](#) for DSC Overall Dimensions.

Choose a location that will allow for easy viewing of the information display, removal of the DSC lid and access to the fuse cover (left side) and the serial port cover (front). Ensure there is adequate space to run the necessary cables and to strap them to the DSC. The DSC is provided with strain relief slots in order to strap the cables to the DSC enclosure bottom.

The DSC can be mounted using four 1/4" (6mm) screws or bolts with washers. Ensure proper grounding of the DSC enclosure to the hull or ship's electrical bonding system.



NOTE:

The DSC enclosure top, including the circuits, can be separated and removed from the DSC enclosure bottom without removing the enclosure bottom from its shipboard mounting location.

Commissioning

The Digital Steering Control system can be commissioned in either of two ways, using a PC or laptop running Jastram's DSC Setup Software or through the keypad and display screen on the front of the DSC enclosure.

Prior to commissioning, ensure that steering gear and hydraulic system are properly commissioned and in normal operating condition. Have the technical data of the steering gear handy such as the hard over angles, rudder speed, directional valve type and solenoid specifications.

For information regarding commissioning using the DSC Setup Software see section [4.1](#).

For information regarding commissioning using the keypad and display screen see section [4.2](#).

1.2 SERIAL LINKS

1.2.1 DSC To MCP Communications

Description

The DSC is provided with communication links for up to five MCP's. These communication links transmit and receive all of the information required by the MCP over a single four conductor, twisted pair cable. Due to this simple design only one cable is required to run from the DSC to each present or possible future steering control station.



NOTE:

During vessel construction, an extra cable could be run between the DSC and the flybridge of a vessel even if no control components are presently installed at the flybridge station. Controls can then be added to the flybridge at a later date without having to dismantle overheads to run new cables.

The DSC is provided with built in components to communicate with one MCP. Each additional MCP requires a pluggable I/O circuit card to be installed in the DSC's MCP communication slot to complete the interface.

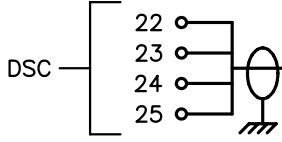

This connection also supplies the necessary power to the MCP. The power being sent to the MCP is derived directly from the power supplied to the DSC.

See also: [2.2.1 MCP to DSC Communications](#)

Specifications

Cable: 2 twisted shielded pairs, 120Ω controlled impedance, RS485 communication cable, Belden® 9842 or equiv.
 Maximum cable length: 230m (750 ft.)
 Connector: 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	24 AWG/4/SHIELDED	

The DSC to MCP communication cable must be RS-485 shielded, twisted pair, communication cable with a controlled impedance of 120 Ohms, Belden® 9842 or equivalent. This cable's shielding is to be connected to the DSC enclosure. See Drawing [5.4](#) for DSC Shield Connection Configuration.

Up to five MCP's may be connected to each DSC. Additional MCP's are connected to the DSC using the following terminals:

MCP #2 connects to DSC terminals 48 to 52
 MCP #3 connects to DSC terminals 26 to 30
 MCP #4 connects to DSC terminals 53 to 57
 MCP #5 connects to DSC terminals 31 to 35

Connection of additional MCP's 2 through 5 will require the installation of CAN I/O PCB's (see item #11 in drawing [5.2](#) DSC 100 Assembly) at the following locations:

MCP #2 requires CAN I/O PCB Assembly connected to J14
 MCP #3 requires CAN I/O PCB Assembly connected to J17
 MCP #4 requires CAN I/O PCB Assembly connected to J15
 MCP #5 requires CAN I/O PCB Assembly connected to J18

Commissioning

Each MCP installed in the system must be enabled through the DSC and then each enabled MCP requires information input as to the modes of steering control and options available for each station.

For information regarding commissioning using the DSC Setup Software, see section [4.1.1](#).

For information regarding commissioning using the keypad and display screen see section [4.2.2](#).

1.2.2 DSC To DSC Communications

Description

Two DSC's can pass information between each other through an additional communication channel. This communication channel is only used when two Digital Steering Control systems need to share information. Two systems may need to share information in an independent rudder system using either digital FFU inputs or when the autopilot interfacing is done in a master / slave arrangement. Use of this communication channel requires a pluggable I/O circuit card to be installed in the DSC's inter-DSC communication slot to complete the interface.

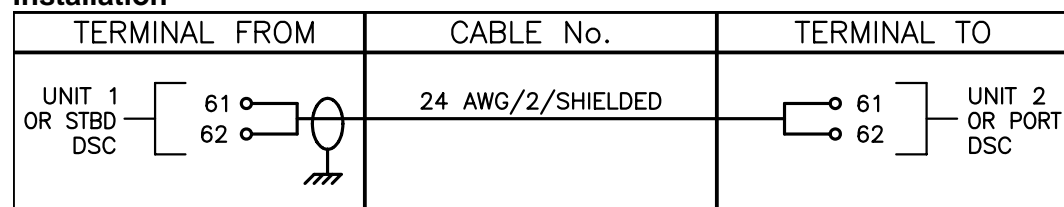
Specifications

Cable: 1 twisted shielded pair, 120Ω controlled impedance, RS485 communication cable, Belden® 9841 or equiv.

Maximum cable length: 230m (750 ft.)

Connector 5.08mm pitch screw terminals

Installation



The DSC to DSC communication cable must be RS-485 shielded, twisted pair, communication cable with a controlled impedance of 120 Ohms, Belden® 9841 or equivalent. This cable's shielding is to be connected to the DSC enclosure. See Drawing [5.4](#) for DSC Shield Connection Configuration.

Connection of the DSC to DSC communication will require the installation of a CAN I/O PCB (see item #11 in drawing [5.2](#) DSC 100 Assembly) connected to J16.

Commissioning

Systems using DSC to DSC communication in an independent rudder system or master / slave autopilot arrangement need to have these functions turned on. Dual synchronization is turned on through the DSC Setup Software in the System Configuration Window (see section [4.1.1](#)) or through the DSC menu of the keypad setup (see section [4.2.1](#)). Master / Slave autopilot arrangement is turned on through the DSC Setup Software in the Autopilot Configuration Window (see section [4.1.1](#)) or through the Autopilot menu of the keypad setup (see section [4.2.5](#)).

1.3.1 Power Supply

The power supply for the Digital Steering Control System is typically derived from the ship's power source or from Jastram's Motor Starter and Alarm Unit. The DSC has a power switch on the side of the enclosure. After this power switch, the supply is split into three separate circuits each provided with its own short circuit protection fuse. The power supply is monitored by the DSC and a fault condition can be displayed if the power supply falls out of an acceptable range.

Specifications

Supply Voltage:	12 or 24VDC, -10% +20%
Power Consumption:	Dependent on system configuration approx. 7 Watts, DSC only
Short Circuit Protection:	Controller (F1), 4 Amps Directional Solenoid (F2), 4 Amps DHM/Speed Solenoids (F3), 4 Amps
Connector:	5.08mm pitch screw terminals

TERMINAL FROM	CABLE No.	TERMINAL TO
<p>DSC — [2 20 1] — [] — GND</p>	16 AWG/3/SHIELDED	<p>10A BREAKER POS. SWCH POS. GND</p> <p>TO MAIN POWER SUPPLY FOR STEERING CONTROL</p>

The steering control power supply can be derived from the ship's main service switchboard or from Jastram's Motor Starter & Alarm unit. The steering control power supply is to be provided with a 10 Amp breaker and local disconnect switch adjacent to the hydraulic power unit controlling the rudder.

If a Switched Positive signal is used, this signal is to be on when the hydraulic power unit pump is running and off when the hydraulic power unit pump is stopped.

**CAUTION:**

Ensure main steering control power supply is turned off prior to connection to the DSC. Check the polarity of power supply connections to the DSC. Do not turn on the main steering control power supply until all connections are made and checked.

**WARNING:**

IN SOME INSTALLATIONS THE POWER SUPPLY TO THE MAIN STEERING CONTROL SYSTEM MUST BE DISCONNECTED IN ORDER TO INVOKE OPERATION OF THE AUXILIARY STEERING GEAR. THE MAIN STEERING CONTROL SYSTEM POWER SUPPLY CAN BE DISCONNECTED AT ITS SOURCE OR BY USING THE POWER SWITCH LOCATED ON THE LEFT SIDE OF THE DSC ENCLOSURE.

Commissioning

The DSC must be told if it is connected to a 12 or 24 VDC supply. The DSC can also be set up to monitor the input power and display an alarm if the supply falls out of an acceptable range. These settings are input through the DSC Setup Software in the System Configuration Window (see section [4.1.1](#)) or through the DSC menu of the keypad setup (see section [4.2.1](#)).

1.3.2 Rudder Feedback

Description

The rudder feedback signal is an analog signal that represents the actual position of the rudder the DSC is controlling. The rudder feedback input is capable of supply power to and receiving signals from a resistive device such as a potentiometer or from a device outputting a differential analog voltage signal.

The rudder feedback signal is calibrated by the DSC and therefore it is not necessary to make precise adjustments of the feedback signal with respect to the actual rudder position. The polarity of the rudder feedback signal can also be corrected at the DSC, therefore if the polarity of the signal must be reversed in order to attain a stable system, this can be done through the DSC setup program without removing any of the connections.

The DSC monitors the rudder feedback signals in order to freeze the rudder position if a failure in the signals is detected.

Specifications

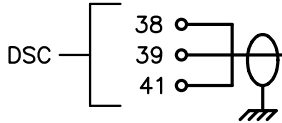
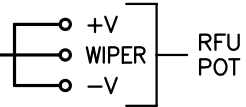
Power Supply Output: 12 or 24VDC, -10% +20%

Potentiometer Supply: 5 VDC

Potentiometer Range: 1k Ω to 10k Ω
 Maximum Differential Input: ± 4 VDC
 Differential Input Impedance: 133 k Ω
 Maximum Rudder Angle: $\pm 65^\circ$
 Cable Break Protection: Yes
 Connector: 5.08mm pitch screw terminals

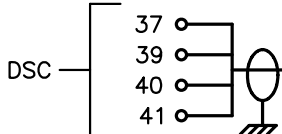
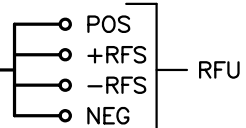
Installation

1. Potentiometer feedback connections.

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/3/SHIELDED	

This cable's shielding is to be connected to the DSC enclosure. See Drawing [5.4](#) for DSC Shield Connection Configuration. If a potentiometer type rudder feedback signal is used, jumpers J8 and J10 in the DSC must be set to the 'SE' position. Jumper J39 can also be shorted in order to enable feedback cable break protection.

2. Differential analog feedback connections.

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/4/SHIELDED	

This cable's shielding is to be connected to the DSC enclosure. See Drawing [5.4](#) for DSC Shield Connection Configuration. If differential analog type rudder feedback signal is used, jumpers J8 and J10 in the DSC must be set to the 'DF' position.

Feedback cable break can not be used with differential analog feedback therefore jumper J39 must be removed.

The POS / NEG connections provide a supply that can be used to power the rudder feedback circuit. This power supply output is the same voltage level as the main input voltage.

Commissioning

In order to commission the system's rudder feedback, the DSC must be setup for either potentiometer (single ended) or differential input through the use of the jumpers on the DSC main circuit board. Once the jumpers are properly set the system must be told where the rudder's two hard over positions and center position are located. This procedure is done through the DSC Setup Software's Rudder Feedback Calibration window (see section [4.1.2](#)), or through the keypad

setup's Calibration screen (see section [4.2.4](#)). If the polarity of the feedback signal is backwards it can easily be reversed in the DSC Setup Software's Rudder Feedback Configuration window (see section [4.1.1](#)), or through the keypad setup's Calibration screen (see section [4.2.5](#)).

1.3.3 Autopilot Solenoid Command Signals

Description

The DSC can interface with autopilot systems outputting either directional solenoid command signals or analog rudder order signals.



NOTE:

Whenever possible, the autopilot command interfacing should use the analog command signals described in [1.3.4](#). An autopilot which outputs analog rudder command signals will normally not require its own rudder feedback signal.

The solenoid command input provides interfacing to autopilot systems only capable of outputting on-off type directional solenoid command signals. The input is capable of receiving signals from a positive common or negative common autopilot output. These autopilot command signals are optically isolated by the DSC providing galvanic isolation. This type of autopilot command signal requires that the autopilot system includes its own rudder feedback signal.

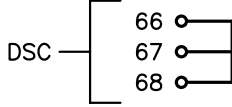
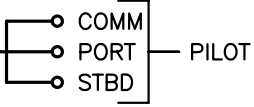
When this type of autopilot command signal is used in a dual independent rudder system the two steering control systems will operate in a master / slave arrangement. The autopilot system will send its command signals to one of the DSC's in order to control the 'master' rudder. The remaining rudder will operate as the 'slave' rudder and will receive its positional commands from the 'master' DSC through the use of the DSC to DSC communication channel.

See also: [1.3.4](#) Autopilot Analog Command Signals
[1.3.5](#) Autopilot Acknowledge
[1.4.4](#) Autopilot Request

Specifications

Command Voltage:..... 12 or 24VDC
 Command Format: Common positive or common negative
 Galvanic Isolation: Yes (optical)
 Cable Break Protection No
 Connector: 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/3/NOT SHIELDED	

These connections may be combined in the same cable as the autopilot 'Request' and 'Acknowledge' handshake signals (see [1.3.5](#) and [1.4.4](#)).

Autopilot solenoid command signals may be positive common or negative common and may be either 12 or 24 VDC.

Autopilots are interfaced to the steering control system using either these solenoid command signals or the analog command signals (see [1.3.4](#)).

Commissioning

If the autopilot is interfaced using the solenoid command signals, the Autopilot Type must be set to 'On-Off' through the DSC Setup Software's Autopilot Configuration window (see section [4.1.1](#)), or through the keypad setup's Autopilot menu screen (see section [4.2.5](#)). No other commissioning procedures are required for this type of interface.

1.3.4 Autopilot Analog Command Signals

Description

The DSC can interface with autopilot systems outputting either directional solenoid command signals or analog rudder order signals.



NOTE:

Whenever possible, the autopilot command interfacing should use analog command signals. An autopilot which outputs analog rudder command signals will normally not require its own rudder feedback signal.

The analog command input provides interfacing to autopilot systems capable of outputting one or more differential analog command signals representing the autopilot's desired rudder position. The signal is a differential voltage signal proportional to the autopilot's rudder command. Normally this signal is within $\pm 10V$ where 0V defines a midship rudder command and the $\pm 10V$ defines ± 45 degree hard over commands. The voltage levels expected on this input are adjustable through the DSC. This type of autopilot command signal does not require that the autopilot system include its own rudder feedback signal. Analog command inputs allow the system to retain proportional steering control which will accelerate and decelerate the rudder during rudder movements commanded by the autopilot.

Most analog autopilot systems are able to output two isolated analog command signals. When this is available, dual independent rudder systems will receive commands from separate autopilot output channels and each DSC will continue to operate independently. When only one analog command signal is available, the two steering control systems must be set up to operate in a master / slave arrangement as described in section [1.3.3](#), however proportional control of the rudder can be maintained.

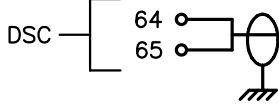
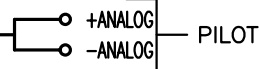
See also: [1.3.3](#) Autopilot Solenoid Analog Command Signals
[1.3.5](#) Autopilot Acknowledge

1.4.4 Autopilot Request

Specifications

Maximum Differential Input:..... $\pm 10\text{VDC}$
 Differential Input Impedance: 110 k Ω
 Galvanic Isolation: No
 Connector:..... 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/2/SHIELDED	

This cable's shielding is to be connected to the DSC enclosure. See Drawing [5.4](#) for DSC Shield Connection Configuration. These connections may be combined in the same cable as the autopilot 'Request' and 'Acknowledge' handshake signals (see [1.3.5](#) and [1.4.4](#)).

Autopilots are interfaced to the steering control system using either these analog command signals or the solenoid command signals (see [1.3.3](#)).

Commissioning

If the autopilot is interfaced using the analog command signals, the Autopilot Type must be set to 'Analog' through the DSC Setup Software's Autopilot Configuration window (see section [4.1.1](#)), or through the keypad setup's Autopilot menu screen (see section [4.2.5](#)). Other adjustment parameters for the analog command signals are also described in these sections.

1.3.5 Autopilot Acknowledge

Description

The Autopilot Acknowledge signal is one half of the DSC / Autopilot handshake which is designed to ensure that control will not be transferred unless both systems agree. The other half of the handshake is the Autopilot Request signal described in section [1.4.4](#). The DSC will not move the rudder in response to autopilot rudder commands until both the request and acknowledge conditions have been met.

The Autopilot Acknowledge input reads the status of a dry contact which is part of the autopilot system. When the autopilot system is ready to output steering commands and assume control of the rudder it is to close the dry contact connected to this input. Autopilot systems normally refer to this signal as 'auto on' or 'drive engage'.



NOTE:

Refer to specific autopilot system for information pertaining to the availability and functionality of this interface signal.

See also [1.4.4](#) Autopilot Request

Specifications

Signal Type: Dry contact by autopilot system
 Cable Break Protection Yes
 Connector: 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
DSC — [42 ○ 43 ○]	20 AWG/2/NOT SHIELDED	[○ ACK ○ ACK] — PILOT

These connections may be combined in the same cable as the autopilot 'Command' signal and 'Request' handshake signal (see [1.3.3](#) or [1.3.4](#) and [1.4.4](#)).

The autopilot acknowledge signal may be output directly by the autopilot system as a dry contact. Alternatively an external relay may be used in order to change an autopilot's acknowledge or clutched output signal from a voltage to a dry contact.



CAUTION:

The steering control system will not transfer to control of the rudder position to the autopilot unless a contact closure is present across the autopilot acknowledge terminals.

Commissioning

There are no specific commissioning procedures associated with this connection.

1.3.6 Backup NFU System

Description

These connections allow for a backup NFU jog lever to be directly connected to the HPU's directional solenoid valve. The backup NFU system's power supply and command signals are isolated from the DSC through the use of a directional solenoid control relay. Whenever the control relay is de-energized the backup NFU system, including its power supply, is directly connected to the directional solenoid valve (see [1.4.1](#)). The directional solenoid control relay also provides a dry contact output to indicate the status of the backup NFU system. This output is described in section [1.4.5](#).

In case of a failure in the main power supply to the DSC, the backup NFU system is automatically made operational. The backup system can also be invoked on demand by disconnecting the main power supply to the DSC or by turning off the DSC power switch on the side of the DSC enclosure. The DSC can be

configured so that the backup NFU system will also be activated whenever the JOG mode of steering control is selected at the main steering control station.

The backup NFU system is only capable of outputting on-off signals to the directional solenoid valve, therefore the backup NFU system can not provide acceleration and deceleration of the steering gear. For operation with a proportional directional solenoid valve, a rheostat is connected in series with the backup system's power supply. This rheostat provides current limitation and rudder speed control for the backup NFU system. See drawing [5.4](#) DSC Backup NFU Simplified Schematic.

See also: [1.4.5](#) Backup NFU Status Output

Specifications

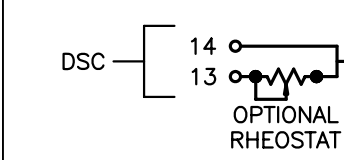
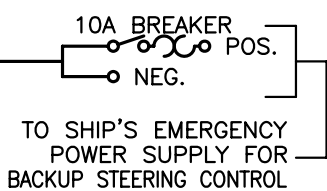
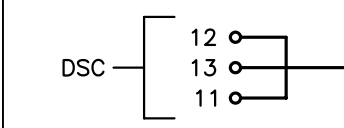
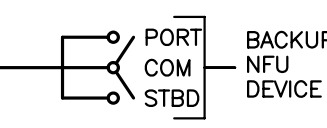
Supply Voltage: 12 or 24 VDC

Power Consumption: Dependent on directional solenoid

Short Circuit Protection: No

Connector: 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	16 AWG/2/NOT SHIELDED	
	16 AWG/3/NOT SHIELDED	

The backup steering control power supply is to be provided with a 10 Amp breaker.

Install optional 25 Ohm, 50 Watt adjustable rheostat in series with the negative line of the backup steering control power supply for use with proportional 4-way directional solenoid valves. On-off type directional solenoid valves do not require optional rheostat. Optional rheostat facilitates rudder speed adjustment under backup steering control when used with a proportional steering control system. Rheostat kits are available from Jastram. See drawing [5.5](#) DSC Backup NFU Rheostat Mounting Arrangement.

If backup NFU steering is backwards reverse the port and starboard leads at the NFU device.

Commissioning

If the Backup NFU system is used with a proportional solenoid valve, the adjustable rheostat must be adjusted in order to attain the required rudder speed under NFU control.

1.4 OUTPUTS

1.4.1 Directional Solenoid

Description

The directional solenoid output provides the port and starboard rudder commands to the 4-way directional solenoid valve on the Hydraulic Power Unit. The solenoid common signal is a positive 12V or 24V signal that is connected to the common wire of the 4-way directional valve. The PORT and STBD command signals provide on-off or proportional commands to pull the spool of the 4-way valve in either direction. The directional solenoid outputs are generated either by the DSC or by the backup NFU system described in section [1.3.6](#). The directional solenoid outputs from the DSC are provided with short circuit protection via Fuse #2 on the DSC.

On-Off commands output full voltage signals that completely shift the spool of a directional valve giving on-off control of rudder position. Proportional commands output a pulse width modulated signal that controls the current flow to a proportional directional valve. Increasing the current to a proportional valve increases the amount of spool shift and therefore the flow rate of the hydraulic fluid. The proportional signals allow the DSC to control the acceleration, deceleration and speed of the rudder movements. Proportional control provides for smooth quiet operation of the rudder and reduces wear and tear on the mechanical components of the steering gear.

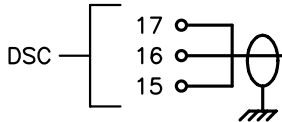
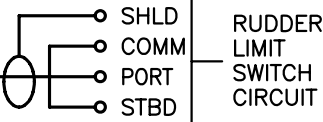
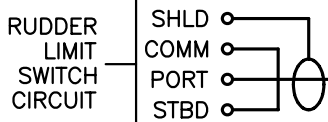

The directional solenoid output signals from the DSC are only operational if the switched power signal is applied to the DSC. Arranging the signals in this manner will ensure that the directional solenoids are only being energized when power steering is available. The DSC monitors certain signals such as rudder feedback in order to shut down the directional solenoid outputs and hold the present rudder position if a failure in the signal is detected.

The directional solenoid output signals are routed through the RFU to take advantage of rudder angle limit switches contained in the RFU. These limit switches serve to stop the steering gear travel before any mechanical stops are reached. The adjustable limit switches are cam operated and directly coupled to the rudder stock through a mechanical linkage.

Specifications

Output Voltage	12 or 24 VDC
Output Format	Common positive, switching negative
Maximum Output Power	48 W
PWM Frequency	2 kHz
Connector:	5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	16 AWG/3/SHIELDED	
	16 AWG/3/SHIELDED	

Cable conductor (16 AWG) is the suggested minimum diameter based on a maximum cable length of 200 ft. (61 m). For each additional 100 ft. (30 m) of cable length, the diameter of cable conductors should be increased by 1 AWG. This cable's shielding is to be connected to the DSC enclosure. See Drawing [5.4](#) for DSC Shield Connection Configuration.

High transient voltages can occur when an inductive load such as a directional solenoid valve is energized and de-energized. In order to protect the system against these potentially harmful voltages transient voltage suppressors should be installed at the directional solenoid valve.

Directional solenoid signals are to be routed through rudder angle limit switches which serve to stop the steering gear travel before any mechanical stops are reached. Rudder limit switches are to be coupled to the rudder stock through a mechanical linkage.

Commissioning

Information regarding the type and specifications of the directional solenoid used are entered through the DSC Setup Software's Valve Settings window (see section [4.1.1](#)), or through the keypad setup's DSC menu screen (see section [4.2.1](#)).

1.4.2 Fast Rudder Solenoid**Description**

This output provides commands to control a high speed flow control solenoid valve included with an on-off directional valve. The DSC controls this output sending a full voltage signal to energize the high speed valve that will increase the flow rate of the HPU. This output signal is only operational if the switched power signal is applied to the DSC. Arranging the signal in this manner ensures that the solenoid is only being energized when power steering is available.

This signal allows the operator to select between two levels of rudder speed with an on-off HPU. In the Fast Rudder mode of steering control, the DSC controls this output in order to step the rudder speed up and down during larger rudder

movements. The rudder speed is reduced during final approach to the commanded rudder position. Controlling the rudder position in this manner provides for more precise and quiet control of rudder movements as well as reducing wear and tear on the mechanical components of the steering gear.

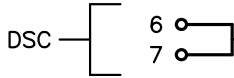
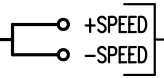
Specifications

Output Voltage 12 or 24 VDC

Maximum Output Power 48 W

Connector 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	16 AWG/2/NOT SHIELDED	

Fast rudder solenoid valves are not fitted with all steering systems. Proportional steering control systems will not include a fast rudder solenoid valve. Refer to the steering gear hydraulic system for information regarding the utilization of this output.

Commissioning

If the Fast Rudder Solenoid output is used the Dual Speed option must be turned on through the DSC Setup Software's System Configuration window (see section [4.1.1](#)), or through the keypad setup's DSC menu screen (see section [4.2.1](#)).

1.4.3 Digital Helm Manifold Solenoids

Description

These signals provide control of the Digital Helm Manifold (DHM) Bypass and Limit solenoid valves. When the Bypass solenoid is energized the digital helm pump's hydraulic output lines are connected together allowing the helm pump to turn without pumping hydraulic fluid to the steering gear. Energizing the bypass solenoid puts the digital helm pump into its power steering mode of operation. With the Bypass solenoid de-energized the digital helm pump is directly connected to the steering gear and therefore in its manual mode of operation. If power to the DSC fails or is disconnected manual steering control will be automatically invoked.

The Limit solenoid valve serves to provide feel on the helm when the rudder position commanded by the digital helm is at hard over. When the digital helm's rudder command reaches hard over the DSC will energize the limit solenoid which will not allow the digital helm to continue turning. The number of wheel turns representing a hard over to hard over command is adjustable through the DSC setup.

These output signals are only operational if the switched power signal is applied to the DSC. Arranging the signals in this manner ensures that the solenoids are only being energized when power steering is available. This arrangement also

causes manual steering to be automatically invoked whenever power steering is not available.

See also: [2.3.5](#) Digital FFU Command Device

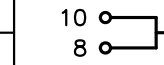
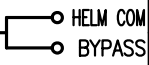
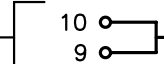
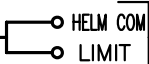
Specifications

Output Voltage 12 or 24 VDC

Maximum Output Power 48 W

Connector 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
DSC — 	16 AWG/2/NOT SHIELDED	 DHM BYPASS SOLENOID VALVE
DSC — 	16 AWG/2/NOT SHIELDED	 DHM LIMIT SOLENOID VALVE

Digital Helm Manifold (DHM) solenoid valves are not fitted with all steering systems. Only steering control systems using Jastram's Digital Helm Pump will include a DHM.

Refer to the steering gear hydraulic system and drawing [5.7](#) Digital Helm & Manifold Hydraulic Schematic for information regarding the utilization of this output.

Commissioning

There are no specific commissioning procedures associated with this connection.

1.4.4 Autopilot Request

Description

The Autopilot Request signal is one half of the DSC / Autopilot handshake which is designed to ensure that control will not be transferred unless both systems agree. The other half of the handshake is the Autopilot Acknowledge signal described in section [1.3.5](#). The DSC will not move the rudder in response to autopilot rudder commands until both the request and acknowledge conditions have been met.

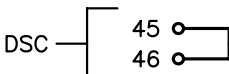
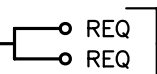
The Autopilot Request is a normally open dry contact in the DSC. This normally open contact closes when Autopilot control is selected through the use of the MCP's steering mode selector inputs described in section [2.3.1](#). This dry contact output can be used by the autopilot system in order to automatically switch the autopilot from a standby mode to the auto mode when autopilot control is requested. Autopilot systems normally refer to this as remote mode selection.

See also: [1.3.5](#) Autopilot Acknowledge

Specifications

Signal Type: Dry contact
 Maximum Switching Capacity 0.5 Amps
 Connector: 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
DSC — 	20 AWG/2/NOT SHIELDED	 — PILOT

These connections may be combined in the same cable as the autopilot 'Command' signal and 'Acknowledge' handshake signal (see [1.3.3](#) or [1.3.4](#) and [1.3.5](#)).

The autopilot request contact can be used by the autopilot system in order to automatically switch the autopilot from a standby mode to the auto mode when autopilot control is requested. Autopilot systems normally refer to this as remote mode selection.

The use of this signal is optional as some autopilot systems do not include an option for remote mode selection.

Commissioning

There are no specific commissioning procedures associated with this connection.

1.4.5 Backup NFU Status

Description

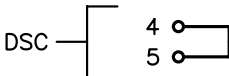
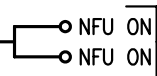
The Backup NFU Status Output is a normally open dry contact in the DSC. This contact will be open whenever the backup NFU system described in section [1.3.6](#) is engaged and closed whenever the main control system is in use. The contact is used to tell another piece of equipment, such as an emergency station or solenoid selector control unit when the backup NFU system is available. See drawing [5.5](#) DSC Backup NFU Simplified Schematic.

See also: [1.3.6](#) Backup NFU System

Specifications

Signal Type: Dry contact
 Maximum Switching Capacity 10 Amps
 Connector: 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
DSC — 	16 AWG/2/NOT SHIELDED	 — BACKUP NFU SYSTEM

The Backup NFU status contact will be open whenever the backup NFU system engaged and closed whenever the main control system is in use.

Commissioning

There are no specific commissioning procedures associated with this connection.

1.4.6 General Alarm Contact

Description

The DSC contains a normally closed dry contact for connection to a general alarm system. This dry contact will be closed when the DSC is operating normally with no existing fault conditions. When a fault is detected by the DSC, this dry contact will open. The contact will also open if there is a failure in the power supply to the DSC.

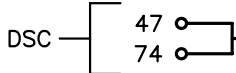
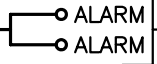
Specifications

Signal Type: Dry contact

Maximum Switching Capacity 0.5 Amps

Connector: 5.08mm pitch screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
DSC — 	20 AWG/2/NOT SHIELDED	 GENERAL ALARM SYSTEM

General alarm dry contact is closed when the DSC is operating normally with no existing fault conditions.

Commissioning

There are no specific commissioning procedures associated with this connection.

2 MCP

2.1 GENERAL

Description

The Mode Control Processor (MCP) consists of one or two Station Control Processor (SCP) circuit boards. An MCP may contain two SCP's when two DSC's are communicating to the same steering control station. This may be the case in an independent rudder system or a system with redundant controllers.

The MCP is connected to each DSC through a single communication cable thereby reducing the cabling and termination requirements to each of the steering control stations. The MCP provides the necessary connections for each of the peripheral devices at that control station such as the command input devices, rudder indicators and steering mode selection buttons.

The MCP is configured and commissioned through the use of a portable PC and proprietary software connected to the DSC. The configuration and commissioning procedures can also be carried out using the Keypad and LCD screen on the DSC.

See also: [1.1](#) DSC General Description

Specifications

Enclosure Protection:	IP 55, NEMA 12
Operable Ambient Temperature:	-25°C to +70°C
Supply Voltage:	Supplied from DSC
Power Consumption:	Dependent on system configuration approx. 1 Watt, MCP only
EMC Protection:	EN60945, 2005
Dimensions:	Approx. 12" x 8" (300mm x 200mm) see drawing 5.8
Weight:	9 Lbs. (4.1 kg)
Safe distance to compass:	2 Ft. (0.63 m)
Short Circuit Protection:	Yes 1.5 Amp fuse
Mounting:	Bulkhead

Installation

The MCP is to be bulkhead mounted in a location protected from exposure to severe weather and heavy seas. See Drawing [5.8](#) for MCP Overall Dimensions.

Choose a location that will allow for easy removal of the MCP lid and access to the interior of the enclosure. Leave adequate space and cable length in order to be able to run the cables through the provide cable gland plate.

The MCP can be mounted using four ¼" (6mm) screws or bolts with washers. Ensure proper grounding of the DSC enclosure to the hull or ship's electrical bonding system.

Commissioning

For each MCP, certain options for the devices connected to it must be configured using the DSC Setup Software (see section [4.1](#)) or through the DSC's keypad entry (see section [4.2.2](#)). Analog input devices and rudder indicators connected to each MCP must also be calibrated using the DSC Setup Software in the SCP Meter Calibration and SCP Command Calibration windows (see section [4.1.2](#)) or through the DSC's keypad entry (see section [4.2.4](#)).

2.2 SERIAL LINKS

2.2.1 MCP To DSC Communications

Description

The DSC is provided with communication links for up to five MCP's. These communication links transmit and receive all of the information required by the MCP over a single four conductor, twisted pair cable. Therefore only one cable is required to run from the DSC to each present or possible future steering control station.



NOTE:

During vessel construction, an extra cable could be run between the DSC and the flybridge of a vessel even if no control components are presently installed at the flybridge station. Controls can then be added to the flybridge at a later date without having to dismantle overheads to run new cables.


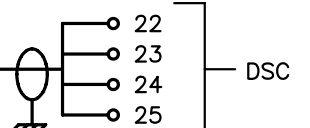
The DSC is provided with built in components to communicate with one MCP. Each additional MCP requires a pluggable I/O circuit card to be installed in the DSC to complete the communication interface.

This connection also supplies the necessary power to the MCP. The power being sent to the MCP is derived directly from the power supplied to the DSC.

Specifications

Cable: 2 twisted shielded pairs, 120Ω controlled impedance, RS485 communication cable, Belden 9842 or equiv.
 Maximum cable length: 230m (750 ft.)
 Cable Break Protection Yes
 Connector: 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	24 AWG/4/SHIELDED	

The MCP to DSC communication cable must be RS-485 shielded, twisted pair, communication cable with a controlled impedance of 120 Ohms, Belden® 9842 or equivalent. This cable's shielding is to be connected to the DSC enclosure. See Drawing [5.4](#) for DSC Shield Connection Configuration.

Up to five MCP's may be connected to each DSC. Additional MCP's are connected to the DSC using the following terminals:

MCP #2 connects to DSC terminals 48 to 52

MCP #3 connects to DSC terminals 26 to 30
MCP #4 connects to DSC terminals 53 to 57
MCP #5 connects to DSC terminals 31 to 35

Connection of additional MCP's 2 through 5 will require the installation of CAN I/O PCB's (see item #11 in drawing [5.2](#) DSC 100 Assembly) at the following locations:

MCP #2 requires CAN I/O PCB Assembly connected to J14

MCP #3 requires CAN I/O PCB Assembly connected to J17

MCP #4 requires CAN I/O PCB Assembly connected to J15

MCP #5 requires CAN I/O PCB Assembly connected to J18

Commissioning

Each MCP installed in the system must be enabled through the DSC and then each enabled MCP requires information input as to the modes of steering control and options available for each station.

For information regarding commissioning using the DSC Setup Software, see section [4.1.1](#).

For information regarding commissioning using the keypad and display screen see section [4.2.2](#).

2.3 INPUTS

2.3.1 Steering Mode Selection

Description

This connection provides the common to and the inputs from a series of momentary action push buttons. There are two dedicated dimmer inputs to provide dim up, dim down and lamp test functions for the indicator illumination as well as 10 configurable steering mode selection inputs. Through the DSC configuration set up, functions are assigned to each of the 10 configurable inputs while unused inputs are turned off. Any of the configurable inputs can be assigned functions for steering mode, rudder speed control and station transfer.

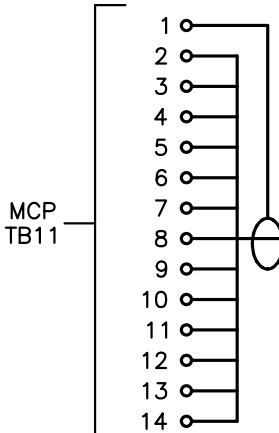
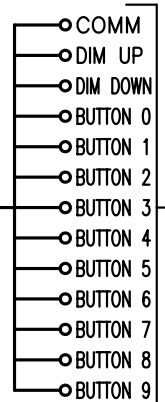
Specifications

Contact Format..... Momentary Action, Normally Open

Signal Format..... Sourcing 5V (COMM) from MCP

Connector..... 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
 <p>MCP TB11</p>	20 AWG/13/SHIELDED	 <p>MODE SELECTION BUTTONS</p>

Number of conductors required will depend on the number of mode selection buttons used.

Mode selection buttons are to be momentary action, normally open contacts.

Commissioning

Each mode selection button is assigned a specific function through the DSC Setup Software in the SCP Configuration Window (see section [4.1.1](#)) or through the DSC's keypad entry SCP menu (see section [4.2.2](#)).

2.3.2 NFU Command Device

Description

This input is available for connection of a standard NFU jog lever type input device containing port and starboard micro-switches. The micro-switches are connected to provide time dependent, momentary, port and starboard directional commands to the MCP. NFU input devices normally only provide on-off signals to the directional valve. However, if a proportional system is used the directional valve output can be setup to include a predetermined amount of ramping which will allow for some acceleration and deceleration of a proportional steering system.

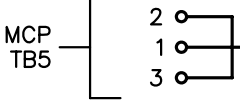
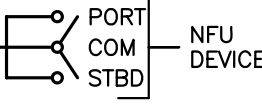
This input is integral to the main DSC control system and is not a separate backup system. A NFU device connected to this input can be arranged to provide either discrete selection or seamless transferring capability between NFU and Digital FFU steering input devices. This allows the operator to control the rudder position using either device without having to expressly select the mode using an input selector button.

See also: [1.3.6](#) Backup NFU System
[2.3.5](#) Digital FFU Command Device

Specifications

Contact Format..... Momentary Action
Signal Format..... Sourcing 12 or 24V from MCP
Cable Break Protection No
Connector..... 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/3/NOT SHIELDED	

If NFU steering is backwards reverse the port and starboard leads at the NFU device.

Commissioning

In addition to assigning a mode button for this input there are a number of options available to determine how this NFU device will function. These options include seamless transfer with a digital helm, autopilot dodging and rudder speed parameters. If a NFU device is connected to the primary MCP then the system must be configured with the SCP 1 NFU Mode set to 'Connected to SCP 1'. These configuration settings are available through the use of the DSC Setup Software (see section [4.1.1](#)) or through the DSC keypad entry (see section [4.2](#)).

2.3.3 Analog FFU Command Device #1

Description

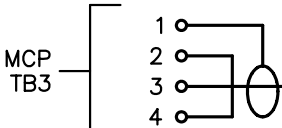
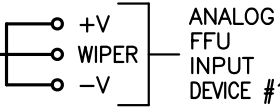
This input connects to a resistive potentiometer in an analog FFU controller such as a FFU Lever Controller or an analog helm device. The potentiometer provides an analog rudder order command signal to the MCP. A Rudder Order Indicator (ROI) is available to display the present rudder command at this input. FFU input devices can provide full control of either on-off or proportional directional valves.

See also: [2.4.3](#) Analog Rudder Order Indicator

Specifications

Potentiometer Supply: 5 VDC
 Potentiometer Range: 1k Ω to 5k Ω
 Cable Break Protection Yes
 Connector 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/3/SHIELDED	

Commissioning

Each analog FFU command device must be calibrated through the SCP Command Calibration window of the DSC Setup Software (see section [4.1.2](#)) or through the Calibration menu of the keypad setup (see section [4.2.4](#)). The calibration procedure informs the system of the input device's midship, port maximum and starboard maximum positions. The polarity of each FFU command input device can also be reversed in the SCP Configuration window of the DSC Setup Software (see section [4.1.1](#)) or through the SCP menu of the keypad setup (see section [4.2.2](#)).

2.3.4 Analog FFU Command Device #2

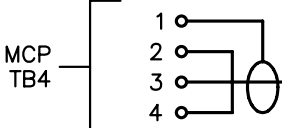
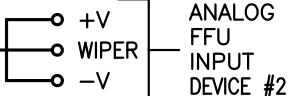
Description

This input connects to a second FFU controller in exactly the same way as described above except that there is no rudder order indicator output available.

Specifications

Potentiometer Supply: 5 VDC
 Potentiometer Range: 1k Ω to 5k Ω
 Cable Break Protection Yes
 Connector 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/3/SHIELDED	

Commissioning

Each analog FFU command device must be calibrated through the SCP Command Calibration window of the DSC Setup Software (see section [4.1.2](#)) or through the Calibration menu of the keypad setup (see section [4.2.4](#)). The calibration procedure informs the system of the input device's midship, port maximum and starboard maximum positions. The polarity of each FFU command input device can also be reversed in the SCP Configuration window of the DSC Setup Software (see section [4.1.1](#)) or through the SCP menu of the keypad setup (see section [4.2.2](#)).

2.3.5 Digital FFU Command Device

Description

The FFU Digital Input is connected to a steering control device such as a Digital Helm that uses an incremental optical encoder. The incremental optical encoder outputs a 2-bit quadrature signal capable of expressing magnitude and direction. An optical encoder, unlike a potentiometer, uses no wearing parts to produce its signals and therefore has an exceptionally high service life. This connection provides a 5V supply to power the optical encoder. Since an incremental input device does not have any built in hard stops, the number of turns of the device which will represent a hard over to hard over command can be programmed through the DSC. FFU input devices can provide full control of either on-off or proportional directional valves.

Upon selecting the digital device as the active mode of steering control, the system will initialize the current rudder position as the starting rudder command. The MCP then reads the 2-bit input pulses from the encoder and determines how much the input device has been turned and in which direction. This information is used to alter the rudder position command signal. An ROI signal is available to display the present rudder command of this input.

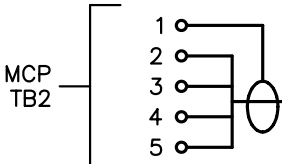
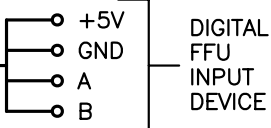
A digital FFU device can be arranged to provide seamless transferring capability between NFU and Digital FFU steering input devices. This allows the operator to control the rudder position using either device without having to expressly select the mode using an input selector button.

See also: [2.4.4](#) Digital Rudder Order Indicator
[1.4.3](#) Digital Helm Manifold Solenoids
[2.3.2](#) NFU Command Device

Specifications

Encoder Supply: 5 VDC
 Encoder Format..... Dual channels, 90° offset
 Cable Break Protection Yes
 Connector..... 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/4/SHIELDED	

Commissioning

The only commissioning procedure required for the Digital FFU device is to select how many turns of the wheel is desired to represent a hard over to hard over command. This adjustment is performed through the System Configuration window of the DSC Setup Software (see section [4.1.1](#)), or through the DSC Menu of the keypad setup (see section [4.2.1](#)). The polarity of the Digital input device can also be reversed in the SCP Configuration window of the DSC Setup Software (see section [4.1.1](#)) or through the SCP menu of the keypad setup (see section [4.2.2](#)).

2.4 OUTPUTS

2.4.1 Steering Mode Indication

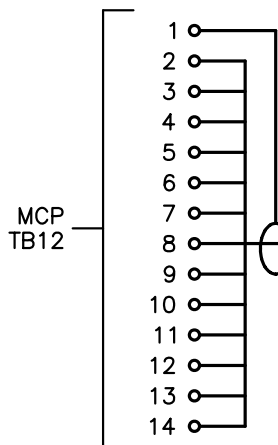
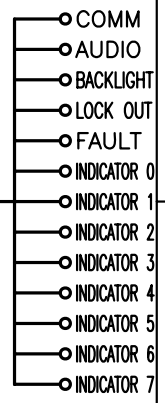
Description

The steering mode indicator output provides dimmable signals for illumination of steering mode indicators. The output provides a common 12V or 24V supply for driving the positive side of the indicators and a pulse width modulated signal sinking to ground for turning on each indicator. The pulse width modulated signal provides control over the level of illumination using the up and down dimmer input buttons. Eight configurable steering mode outputs are available as well as dedicated outputs for FAULT, LOCK OUT and general backlighting indicators. One dedicated non-dimming output is provided for activation of an audio device. Steering modes are assigned to the configurable outputs through the DSC while unused outputs are turned off. Any of the configurable outputs can be assigned functions for either steering mode, rudder speed control or station transfer.

Specifications

Indicator Common	12 of 24 VDC from MCP
Indicator Signal Format	PWM controlled (except audio) sinking to ground
PWM Frequency.....	78 Hz
Output Current.....	50mA per indicator
Connector.....	3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
 <p>MCP TB12</p>	20 AWG/13/SHIELDED	 <p>MODE INDICATORS</p>

Number of conductors required will depend on the number of mode indicators used. Activating dimmer inputs together performs a test of the indicator outputs.

Commissioning

Each mode indicator is assigned a specific output through the DSC Setup Software in the SCP Configuration Window (see section [4.1.1](#)) or through the

DSC's keypad entry SCP menu (see section [4.2.2](#)). The fault indicator and audio indicator outputs can also be turned on or off through the same windows.

2.4.2 Rudder Angle Indicator

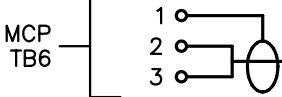

Description

This output provides signals to display the actual position of the rudder being controlled by the DSC. The signal providing information for this output is derived from the rudder feedback unit connected to the DSC. Therefore, this rudder angle indicator signal is not independent of the steering control system as is required for classification purposes.

Specifications

Signal Format Differential voltage
 Max. Output Voltage ± 1.3 V
 Max. Output Current ± 20 mA
 Connector 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/2/SHIELDED	

If the rudder angle indication is backwards reverse +/-RAI leads at the indicator.

Commissioning

Rudder angle indicators connected to this output will require an adjustment to ensure that the indicator reads the proper port and starboard hard over angles as well as the zero degree midship position. The procedure for making this adjustment through the DSC Setup Software is described in section [4.1.2](#) or through the keypad setup in section [4.2.4](#).

2.4.3 Analog Device #1 Rudder Order Indicator

Description

The analog rudder order indicator output displays the current rudder position command present at the FFU Analog Command Device #1. This output will always reflect the Analog Command Device #1 even when it is not the active mode of steering control. This allows the operator to see and modify the commanded rudder position prior to activating that mode of steering control.

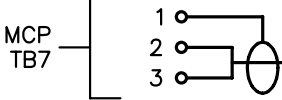
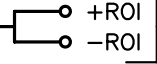
See also: [2.3.3](#) Analog FFU Command Device #1

Specifications

Signal Format Differential voltage
 Max. Output Voltage ± 1.3 V
 Max. Output Current ± 20 mA

Connector 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/2/SHIELDED	 ANALOG FFU #1 RUDDER ORDER INDICATOR

If the analog FFU device #1 rudder order indication is backwards reverse +/-ROI leads at the indicator.

Commissioning

Rudder order indicators connected to this output will require an adjustment to ensure that the indicator reads the proper port and starboard hard over angles as well as the zero degree midship position. The procedure for making this adjustment through the DSC Setup Software is described in section [4.1.2](#) or through the keypad setup in section [4.2.4](#).

2.4.4 Digital Device Rudder Order Indicator

Description

This output displays the current rudder position command present at the FFU Digital Command Device. Upon selecting the digital device as the active mode of steering control, the system initializes the current rudder position as the starting rudder command. Therefore, prior to selecting the digital device as the active mode of steering control, this output will display the actual position of the rudder. After initialization, the digital rudder order indicator will display the position commanded by the digital device.

This arrangement will allow a single indicator to act as a rudder angle indicator and a rudder order indicator. Although, this output does not provide independent rudder angle indication as is required by classification.

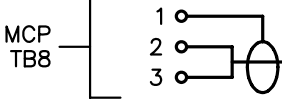
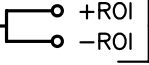
For dual independent rudder systems, the digital rudder order indicator displays the average of the port and starboard rudders prior to initialization.

See also: [2.3.5](#) Digital FFU Command Device

Specifications

Signal Format Differential, constant voltage
 Max. Output Voltage ± 1.3 V
 Max. Output Current ± 20 mA
 Connector 3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/2/SHIELDED	 DIGITAL FFU RUDDER ORDER INDICATOR

If the digital FFU device rudder order indication is backwards reverse +/-ROI leads at the indicator.

Commissioning

Rudder order indicators connected to this output will require an adjustment to ensure that the indicator reads the proper port and starboard hard over angles as well as the zero degree midship position. The procedure for making this adjustment through the DSC Setup Software is described in section [4.1.2](#) or through the keypad setup in section [4.2.4](#).

2.4.5 Indicator Backlighting

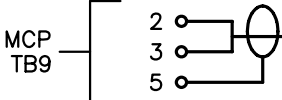
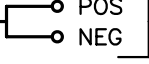
Description

The indicator backlighting output provides the necessary signals to illuminate the rudder angle and rudder order indicators. The indicator lighting can be connected to a full power source or to a dimmed power source that is controlled by the dimmer buttons connected to the steering mode selection inputs. Multiple indicators lights are to be connected in parallel to this output. The number of indicators connected will not affect the level of illumination.

Specifications

Indicator Common	12 of 24 VDC from MCP
Indicator Signal Format	PWM controlled sinking to ground
PWM Frequency.....	80 Hz
Output Current.....	1000mA
Connector.....	3.81mm pitch pluggable screw terminals

Installation

TERMINAL FROM	CABLE No.	TERMINAL TO
	20 AWG/2/SHIELDED	 INDICATOR BACKLIGHT

If dimmer controlled backlighting is not required connect indicator backlight NEG lead to terminal 4 instead of terminal 5.

Commissioning

There are no specific commissioning procedures associated with this connection.



3 SYSTEM OPERATION

3.1 POWER UP

With no power applied to the system, all solenoids controlled by the system will be de-energized. Therefore, if the system includes a digital helm with manual backup, the operator will have control of the rudder position through the use of the manual helm pump. In addition, the backup NFU system will be connected to the directional valve providing power steering control of the rudder through the backup NFU system, if one is connected.

Upon restoration of power after a power failure, the system will turn on and resume control of the rudder under the same mode of steering control that was active prior to the power failure. The system can also be set up, through the DSC program, to always turn on in STANDBY/MANUAL mode at the main control station. Under this power-up option the Station Transfer function, if provided, will also be invoked in order to allow for immediate resumption of steering control at remote stations.

In some cases a switched power supply will be provided to the DSC in addition to the main power supply. The switched power supply is to be connected through an auxiliary contact on the hydraulic power unit's motor starter contactor or through a pump sensor on an engine driven system. This switched power supply is used by the DSC to determine if the hydraulic pump is running or stopped. When the pump is not running the DSC will automatically turn off the directional valve outputs and switch to manual steering if provided.

When the switched power supply is turned off (i.e. pump stopped), the system will remain on but all of the solenoid outputs will be turned off. The indicator for the last selected steering station and mode will begin to flash and the system will switch to STANDBY/MANUAL mode with its indicator on steady. The station transfer function, if provided, will also be engaged and the audio output will sound. The flashing indicator shows the operator which station and mode the system will return to when the pump is turned back on. While the system is in this state the operator can change the mode of steering that the system will return to and silence the audio signal by pressing any of the mode buttons. The flashing indicator will follow the selected mode. If the operator selects the STANDBY/MANUAL mode the system will change to STANDBY/MANUAL and the flashing indicator will turn off. The station transfer function will also be disengaged and the audio indicator will turn off. This allows the operator to turn off the hydraulic pump and place the steering control system in a standby mode.

When the hydraulic pump is turned back on the switched power supply will return to the DSC. When the switch power supply returns, the solenoid outputs will be turned on, the last selected station and mode (flashing indicator) will be re-selected, changing the indicator to steady and the station transfer function, if provided, will remain engaged. If the audio output is still on it will be turned off at this time. If, while the pump was stopped, the operator selected STANDBY/MANUAL mode the system will simply remain in STANDBY/MANUAL.

3.2 STATION TRANSFER

The selection of steering modes and transfer of steering control between stations is performed through the use of the various steering mode buttons, the station transfer button and the station lock out indicator. Only one steering station and mode can be in operation at any given time. When a mode of steering control is selected at an active steering station that station's mode indicator will be on steady. Changing the mode of steering control is done by pressing the button for the mode of steering control desired. If no stations are set up as secured stations then operators are free to take control at any station at any time.

Individual steering stations can be set up to include a station lock out function in order to ensure that steering control is not inadvertently transferred to an unauthorized station. Secured stations will have a LOCKED OUT indicator which will show when control is not available at that station.

When the operator wishes to transfer steering control from an active station to a secured station, the TRANSFER button at the active station must first be pressed. Upon pressing the active station's TRANSFER button, all LOCKED OUT indicators at secured stations will turn off and all TRANSFER indicators will flash three times accompanied by three beeps of the audio indicator. While the station transfer function is engaged steering control remains with the active steering mode until such time that another steering mode button is pressed.

To take steering control while the transfer function is engaged, the operator must push the desired steering mode button at the desired control station. Once a station takes over steering control the TRANSFER indicators will turn off and all LOCKED OUT indicators at secured stations will turn on except at the active station. If the operator initiates the transfer function, it can be cancelled from the active station by re-selecting a steering mode at that station.

Unsecured stations will not have a LOCKED OUT indicator and may take steering control from any other station at any time.

3.3 STEERING MODES

3.3.1 Standby / Manual Mode

In the STANDBY/MANUAL mode none of the power steering input devices are active and the directional solenoid outputs are turned off. In this mode the digital helm manifold solenoids will also be turned off which will give the operator manual control of the steering gear through the use of the manual helm pump if provided.

3.3.2 NFU

NFU steering control is an open loop, time dependent mode of steering control. The steering system will move the rudder in the port or starboard direction as

long as the NFU input device is activated to port or starboard. When the NFU input device is released the rudder movement is stopped.

When NFU mode is selected the NFU input device connected to the MCP will provide the port and starboard directional solenoid commands. The NFU input device includes momentary port and starboard micro-switches. A jog lever is a NFU input device with port and starboard micro-switches operated by a spring centered lever.

Systems including a NFU input device and a Digital FFU input device can be configured through the DSC setup program to operate these two modes of steering control in a seamless transfer arrangement. This means that the operator can use either the NFU jog lever or the Digital Helm without the having to expressly select the mode using an input selector button.

A NFU input device can also be configured through the DSC setup program to provide a “dodge” function while the system is operating under autopilot control. Under autopilot control, operation of the NFU input device will momentarily move the rudder from the position commanded by the autopilot system. Once the NFU device is released control of the rudder position will be returned to the autopilot.

NFU steering will normally only provide on-off (also known as ‘bang-bang’) control of the rudder even when a proportional directional valve is used. The DSC, in this case, has the ability to provide a certain amount of acceleration and deceleration of a proportional rudder control system even in NFU steering mode. This will ensure that a proportional system is used to its full advantage.

NFU mode for the main control station can be arranged to engage the backup NFU steering system. This setting is selected through the DSC setup program. In this arrangement selecting NFU mode at the main station will disconnect the DSC’s directional valve outputs and connect the backup NFU system in its place. The backup NFU system will not provide acceleration and deceleration of a proportional rudder control system.

See also: [2.3.2](#) NFU Command Device

[1.3.6](#) Backup NFU System

3.3.3 Analog FFU #1

FFU steering control is a closed loop system that compares a commanded rudder position with an actual rudder position and moves the rudder accordingly to cause the rudder to follow up to the commanded position. FFU steering control allows the operator to dial in a desired rudder position and then let the steering control system take care of placing the rudder at the desired position.

An analog FFU input devices such as a lever controller, joystick or electric wheel use a resistive potentiometer to provide the rudder position command signal. The signal generated by this potentiometer is called a Rudder Order Signal. The rudder order signal is connected to the MCP. Certain FFU input devices such as an electric wheel do not provide a physical representation of the rudder order

signal. The MCP is capable of outputting a signal to drive a Rudder Order Indicator (ROI) which will continuously display the position of the potentiometer and therefore the commanded rudder position of the analog FFU input #1.

When ANALOG FFU #1 mode is selected, the rudder will immediately move to the position commanded by the analog FFU #1 input. The ROI is useful in order to modify the Rudder Order Signal prior to selecting analog FFU #1 as the active mode of steering control.

See also: [2.3.3](#) Analog FFU Command Device #1
 [2.4.3](#) Analog Rudder Order Indicator

3.3.4 Analog FFU #2

ANALOG FFU #2 mode operates the rudder in the same FFU manner as described for Analog FFU #1 except that it uses a second command device connected to a separate MCP input. The MCP does not provide a Rudder Order Indicator signal for this device.

See also: [2.3.4](#) Analog FFU Command Device #2

3.3.5 Digital FFU

FFU steering control is a closed loop system that compares a commanded rudder position with an actual rudder position and moves the rudder accordingly to cause the rudder to follow up to the commanded position. FFU steering control allows the operator to dial in a desired rudder position and then let the steering control system take care of placing the rudder at the desired position.

A digital FFU input devices uses an incremental optical encoder to provide the rudder position command signal. The signal generated by this encoder is called a Rudder Order Signal. The rudder order signal is connected to the MCP. Digital FFU input devices do not provide a physical representation of the rudder order signal. The MCP is capable of outputting a signal to drive a Rudder Order Indicator (ROI) which will continuously display the rudder position commanded by the digital FFU input.

When DIGITAL FFU mode is selected the current rudder position is initialized as the starting digital FFU command, therefore when this mode is selected the rudder will not change its position. Once this mode has been selected the encoder signals will modify the digital FFU command as the encoder is turned. Since an incremental input device does not have any built in hard stops, the number of turns of the device which will represent a hard over to hard over command can be programmed through the DSC setup program. Each time DIGITAL FFU mode is selected the system will re-initialize the current rudder position.

Prior to selecting DIGITAL FFU mode, the ROI signal will display the current rudder position. Once DIGITAL FFU mode has been initialized the ROI will begin to change its angle depending on how the digital FFU input device is turned.

Systems including a digital FFU input device and a NFU input device can be configured through the DSC setup program to operate these two modes of steering control in a seamless transfer arrangement. This means that the operator can use either the Digital Helm or the NFU jog lever without the having to expressly select the mode using an input selector button.

One form of digital FFU input device is a Digital Helm. This device combines power steering control and backup manual steering control in the same helm unit. The Digital Helm operates like a normal manual helm pump and at the same time contains a digital optical encoder that rotates as the helm is turned. The hydraulic lines of the Digital Helm are connected through a Digital Helm Manifold. The digital helm manifold contains Bypass and Limits solenoid operated valves.

When the DSC is on and the system is in any steering mode other than STANDBY/MANUAL the Bypass solenoid is energized. With this solenoid energized hydraulic flow from the digital helm circulates through the manifold which allows the digital helm to be turned without pumping hydraulic fluid to the steering gear. When the Bypass solenoid is de-energized either, automatically or deliberately, the digital helm will operate the steering gear manually.

The Digital Helm Manifold's Limit solenoid valve serves to provide feel on the helm, when the rudder position commanded by the digital helm is at hard over. When the rudder position commanded by the digital FFU device corresponds to port or starboard hard over the DSC will turn on the hard over limit solenoid which will stop the flow of hydraulic fluid through the Digital Helm Manifold. Stopping the hydraulic flow will cause the helm to stop turning giving the operator feedback that the command is at hard over. As soon as the helm is turned slightly in the opposite direction the Limit solenoid is released allowing the helm to turn freely in the other direction.

See also: [2.3.5](#) Digital FFU Command Device
 [2.4.4](#) Digital Rudder Order Indicator
 [1.4.3](#) Digital Helm Manifold Solenoids

3.3.6 **Autopilot**

Upon selecting AUTOPILOT mode the AUTOPILOT indicator will begin to flash. At the same time the Autopilot Request output contact will close (see [1.4.4](#)). This contact can be used by the autopilot system to indicate that control is requested or to automatically switch the autopilot system to AUTO mode. The steering control system will be in a standby state waiting for a response from the autopilot system and the rudder will remain stationary.

After the autopilot receives the autopilot request signal and it is ready to assume control of the rudder the autopilot system is to close an autopilot acknowledge contact (see [1.3.5](#)) connected to the DSC. Only after the request and acknowledge conditions are met will the steering system change the mode of steering control to AUTOPILOT. At this time the AUTOPILOT indicator will

change from flashing to steady. The rudder position will then be controlled by the autopilot system through either the Autopilot Solenoid Command Signals (see [1.3.3](#)) or the Autopilot Analog Command Signals (see [1.3.4](#)).

Once the AUTOPILOT button is pressed the autopilot transfer process is started and the autopilot request signal is sent out. If the DSC does not receive the autopilot acknowledge signal from the autopilot system within 10 seconds, the audio indicator will begin to beep. If the autopilot acknowledge signal is not received within 20 seconds the audio indicator will change to a steady signal. The operator can cancel the autopilot request and stop the audio signal at any time by re-selecting another mode of steering control. If, while the system is operating in autopilot mode, the autopilot acknowledge signals is lost, the directional solenoid outputs will be turned off and the AUTOPILOT indicator will begin to flash.

A NFU input device connected to an MCP can be configured through the DSC setup program to provide a “dodge” function while the system is operating under autopilot control. Under autopilot control, operation of the NFU input device will momentarily move the rudder from the position commanded by the autopilot system. Once the NFU device is released control of the rudder position will be returned to the autopilot.

Autopilot rudder command signals are interfaced to the steering control system through either directional solenoid command signals or through analog rudder order signals. Directional solenoid command signals are similar to NFU type input signals in that the steering system will move the rudder in the port or starboard direction as long as the autopilot port or starboard command is present. When the autopilot command is released the rudder movement is stopped. This type of interface requires that the autopilot system has its own rudder feedback signal. Directional solenoid command signals can not take full advantage of a proportional rudder control system although a limited amount of acceleration and deceleration can be applied without confusing the autopilot system.

Analog rudder order signals are similar to FFU type input signals in that the steering system receives an analog signal representing a desired rudder position. The steering control system then takes care of moving the rudder to the desired position. This type of autopilot interface normally does not require that the autopilot system have its own rudder feedback signal. Analog rudder command signals allow a proportional rudder control system to accelerate and decelerate the steering gear throughout its movements.

3.4 RUDDER SPEED

The RUDDER SPEED button and indicator are used to toggle the system between slow and fast rudder speeds. Selection of rudder speed will affect steering control systems differently depending on which type of directional valve is used, either an on-off valve with a high speed solenoid or a proportional directional valve.

On-Off Directional Valves

For systems using an on-off directional valve with a high speed solenoid, the rudder speeds are determined by the fast and slow flow settings on the hydraulic power unit. When the rudder speed setting is toggled to the slow setting the high speed solenoid will always be off and the rudder will always move at the slow speed. When the rudder speed setting is toggled to the fast rudder setting the high speed solenoid will be controlled by the DSC.

Under NFU control, the high speed solenoid will turn on a short time after the directional valve is turned on. This will allow the rudder to step up to the fast speed if the NFU device is activated long enough. Upon releasing the NFU device the system will immediately turn off the high speed solenoid while holding the directional valve on for a short time longer. This will provide a short step down of the rudder speed when the NFU device is released. The amount of step up and step down time under NFU control is adjustable through the DSC setup program.

Under any FFU mode, the steering control system will turn on the high speed solenoid whenever the difference between the commanded rudder position and the actual rudder position is greater than a programmed angle for a specific length of time. The high speed solenoid will turn off when the difference between the commanded rudder position and the actual rudder position is less than the programmed angle. The angle and time at which the high speed solenoid will be switched is adjustable through the DSC setup program. This arrangement allows the system to step the rudder speed up and down depending on the magnitude of the commanded rudder movement.

Autopilot systems interfaced with directional solenoid command signals will operate as described for NFU modes and those interfacing with analog rudder command signals will operate as described for FFU modes.

Proportional Directional Valves

For systems using proportional directional valves, the rudder speeds are determined by fast rudder and slow rudder profiles configured through the DSC setup program. Fast rudder speed is input as the number of seconds desired to move the rudder from one hard over to the other. This number should not exceed about 90% of the hydraulic system's maximum output flow. The slow rudder speed is input as a percentage of the fast rudder speed. Values are also programmed, in seconds, for acceleration and deceleration of the rudder in FFU and NFU modes. Separate values are input for FFU and NFU modes. This is so that shorter acceleration and deceleration can be used under open loop NFU control when you would like the rudder to stop moving immediately upon releasing the NFU input device.

Proportional directional valves are controlled by the DSC through a PID loop which constantly adjusts rudder speed giving the best rudder performance through smooth, quite and precise positioning of the steering gear. Toggling between slow and fast rudder speeds allows the DSC to change the directional valve current profile and alter the flow rate of the hydraulic system.

3.5 DUAL INDEPENDENT SYSTEMS

Vessels with twin independent rudder systems will have two independent DSC / MCP systems installed. At each steering control station one MCP may be used that contains independent circuit boards for the port and starboard systems. Each steering control device will have independent input sensors (i.e. potentiometers or encoders) operated by a common handle or wheel. Analog FFU input devices with two potentiometers will naturally be synchronized because they are absolute devices coupled to the same shaft. Digital FFU input devices use incremental encoders which are not naturally synchronized. Upon initialization of a digital FFU input the port and starboard rudders may be at different angles, therefore the two rudders must follow a synchronization procedure upon selection of the DIGITAL FFU mode.

Twin independent systems using a digital FFU input device must include a communication line between the port and starboard DSC's (see [1.2.2](#)). Upon selection of the DIGITAL FFU mode the port and starboard DSC's will pass information between them as to the actual position of each rudder. Now each system will know the position of both rudders. The two systems will calculate the average of the two rudder positions and that average will be used in each system as the initial digital FFU rudder position. This process will ensure that when a synchronized DIGITAL FFU mode is selected both rudders will start at the same position. Each time the DIGITAL FFU mode is selected the two systems will go through the initialization process, even if DIGITAL FFU mode is already selected.

Using the average of the two rudder angle will provide the most stability when switching from an independent mode to the synchronized DIGITAL FFU mode. If both rudders were already at the same angle then the average will be that angle and the rudders will not move. If both rudders were at opposite hard over angles then upon selecting DIGITAL FFU mode the two rudders will move to the midship position.

If, due to a failure in the DSC-DSC communication link, one system does not receive the other system's rudder position, it will assume that the other rudder position is the same as its own. This will ensure that if one of the two control systems is shut down when synchronized DIGITAL FFU mode is selected, the system that is running will not move to some arbitrary angle.

**NOTE:**

With twin independent rudder systems, an autopilot system only capable of controlling one rudder can be used by operating the two systems in a master-slave arrangement.

Through the DSC setup program one DSC can be setup as the 'master' system and the other system will be set up as the 'slave' system. The autopilot will be interfaced with master system and under AUTOPILOT mode the autopilot will control the position of the master system's rudder. When the slave system is placed in the AUTOPILOT mode it will receive rudder position commands from

the master system via the DSC-DSC communication link. This will ensure that under AUTOPILOT control the port and starboard rudders remain synchronized.

3.6 FAULT CHECKING AND INDICATOR TESTING

During operation the steering controller continuously performs self checking procedures in order to detect any faults within the system. If a fault is detected the system will activate the audio output and flash the fault indicator at all stations. The fault will be locked in even if the condition is transient. Activating any mode selection input will acknowledge and silence the fault. Upon initial acknowledgement of the fault, the audio signal will be silenced and the fault indicator will change from flashing to steady if the fault conditions remains or turn off if the fault condition has been rectified. In order to extinguish a steady fault indication the fault must first be rectified and then acknowledged by activating any mode selection input. See section [4.3.2](#) for information on error logging.

Pressing the dim up and dim down inputs together will perform a test of all steering mode indication outputs. All indicator outputs will turn on at full brightness.

4 CONFIGURATION AND CALIBRATION

4.1 DSC SETUP SOFTWARE

Software Installation

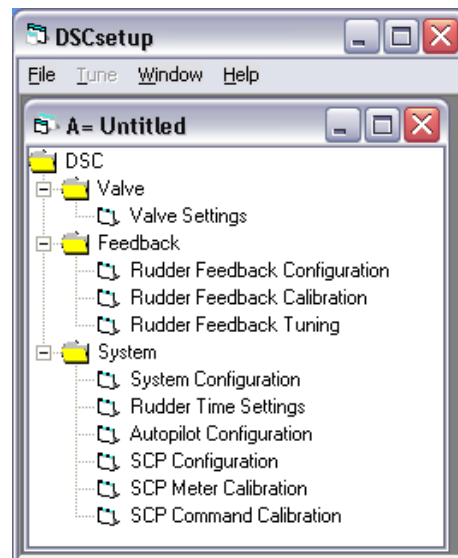
1. Start the computer.
2. Insert Jastram's Digital Steering Controller Software CD into your computer.
3. From the Taskbar START button, choose the RUN... command, type:
D:\setup (or letter corresponding to CD drive)
and press the ENTER key.

The installer program will prompt for the information it needs. Unless absolutely necessary, use the default choices for installation parameters such as the destination directory for the installed files.

Getting Started



To start the program, click the START button from the Taskbar. From the Start menu choose ALL PROGRAMS. From the Program list choose DSC SETUP then click on the DSC Setup program icon.

After a few seconds a window called DSCsetup appears.



DSCsetup follows the conventions of a typical Windows application. The window called DSCsetup is the application framework which contains the DSC menu bar and up to 2 Setup Windows labeled A and B.

Each Setup Window contains the complete configuration and parameter data of a Digital Steering Controller.

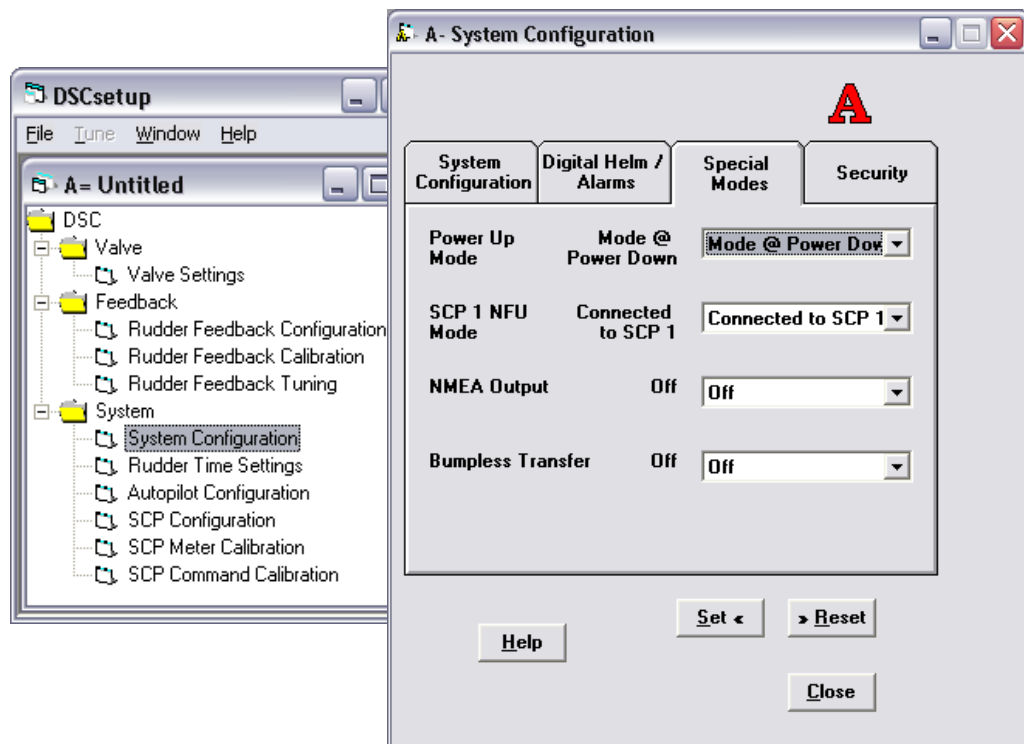
The data are contained in folders  and Property Sheets  arranged in an outline format.

Folders can contain other Folders and

Property Sheets.

Property Sheets contain specific configuration and parameter data to be displayed and changed.

The contents of Folders or Property Sheets are displayed by double-clicking on the icons to open the item. When a Property Sheet is opened, a window containing the appropriate information appears.

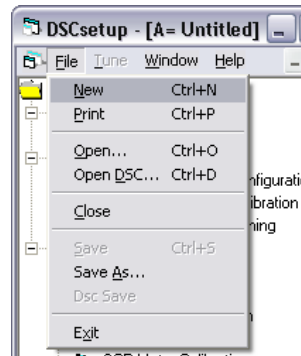


DSCsetup has default settings for all of the specifications of a system... valve settings, feedback configuration, autopilot configuration etc. These settings may have little or nothing to do with the system you will be controlling.

Use DSCsetup “off-line” to create configuration data for a new Controller; and “on-line” to insert previously generated configuration data into a DSC or to configure, calibrate and tune the system.

Values entered in Data Entry Blocks do not become effective until the SET button is clicked. The RESET button will put the current / existing values back into the Data Entry Blocks. DSC SAVE under the FILE menu bar puts these current values into the DSC’s memory.

OPEN DSC under the FILE menu bar connects to a DSC in “on-line” mode and that controller’s configuration information (if an RS-232 cable connects the computer and DSC) is displayed. When a DSC is connected “on-line” the word ‘connected’ will appear in the bottom left of the Setup Window.



When on-line, effective values are immediately applied to the DSC, but can be lost by turning off power – until DSC SAVE is selected.

OPEN under the FILE menu bar shows you the contents of an existing Setup in “off-line” mode.

SAVE or SAVE AS under the FILE menu bar stores an on-line or off-line Setup into a file with a .dsc extension.

DSC SAVE is only available in on-line mode, to make changes to the Setup of a DSC permanent.

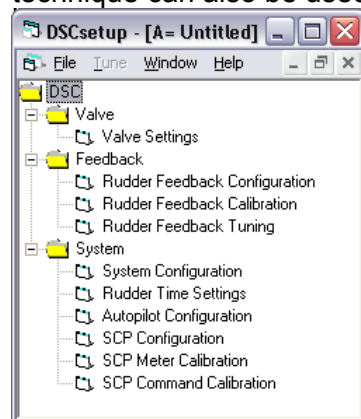
The contents of one Setup can be copied into another Setup by dragging and dropping the DSC Folder icon or individual Property Sheet icon of the source Setup into the appropriate icon of the destination Setup.

A DSC can also be loaded with a previously created configuration:

1. Open a previously created off-line Setup using OPEN.
2. Open an on-line DSC Setup using OPEN DSC then tile the windows.
3. Drag and drop the off-line Setup onto the on-line Setup.
4. Use DSC SAVE to write the new Setup to the DSC memory.

4.1.1 Setup Software Configuration

Configuration usually takes place off-line (but can also be done on-line). Off-line configuration, as described below, collects most of the installation data without being attached to an operational DSC. The information is eventually transferred to a DSC by an on-line step. Off-line configuration is appropriate when operational data is available before the DSC is hooked up and running. This technique can also be used to modify the parameters of an operating controller.



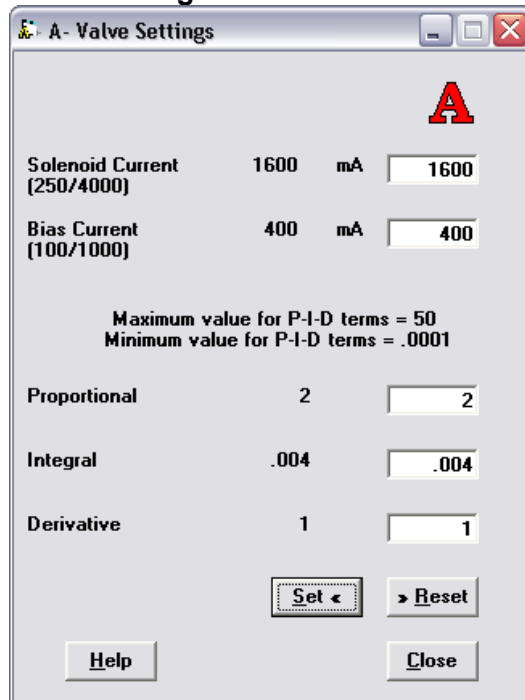
When you start DSCsetup a new, blank Setup window appears. The setup Property Sheets that will require information during the configuration process are Valve Settings, Rudder Feedback Configuration, System Configuration, Rudder Time Settings, Autopilot Configuration and SCP Configuration.

Calibration procedures are steps in the installation of the system which are performed on-line after the system is configured (see Calibration [4.1.2](#)).

**NOTE:**

Once configuration data has been entered in each Property Sheet, click the SET button before closing the Property Sheet.

The following sections describe each Configuration Property Sheet and the information to be entered.

Valve Settings Window


A - Valve Settings

Solenoid Current (250/4000) 1600 mA 1600

Bias Current (100/1000) 400 mA 400

Maximum value for P-I-D terms = 50
Minimum value for P-I-D terms = .0001

Proportional 2 2

Integral .004 .004

Derivative 1 1

Set < > Reset

Help Close

These settings are only applicable to proportional solenoid valves and are therefore greyed out if on-off type solenoid valve is selected. Effective values appear to next to the Data Entry Blocks. See Directional Solenoid Output Section [1.4.1](#) and valve manufacturer's specifications for Solenoid Current and Bias Current of the particular valve. The Bias Current for proportional valves can be obtained from the valve's flow gain curves and is usually set to about 25% of the valve's Solenoid Current.

The Proportional, Integral and Derivative terms on this Property Sheet are derived through a tuning process for specific solenoid valves and adjustment of these values is

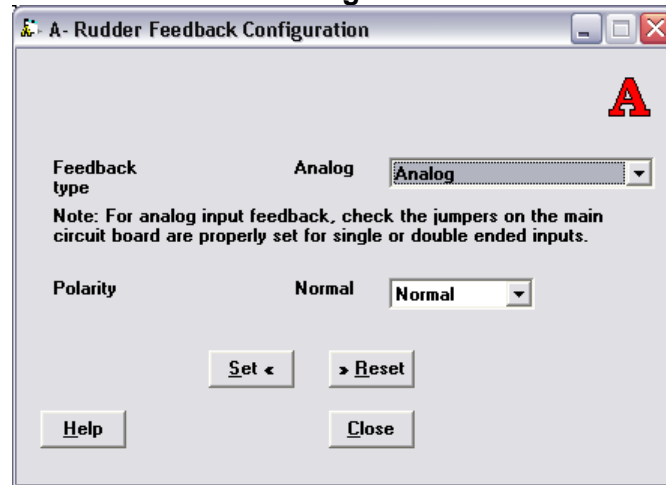
normally not required.

**CAUTION:**

The Proportional, Integral and Derivative terms on this Property Sheet should only be adjusted by someone familiar with the tuning process of a PID controller and the desired response of a proportional hydraulic solenoid valve.

Enter the appropriate new values in the Data Entry Blocks. When finished, click the SET button before clicking the CLOSE button.

Rudder Feedback Configuration Window

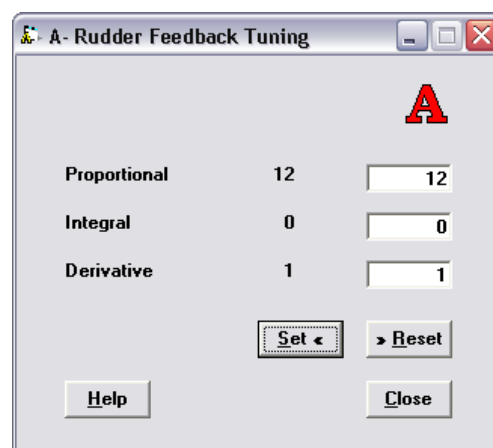


Two drop down lists allow for the selection of the Feedback Type and Polarity of the rudder feedback signal. The available feedback types are Analog and Resolver. Normally this setting is left as Analog which will accommodate both single ended potentiometer type inputs as well as double ended or differential

type feedback signals. Be sure to set the jumpers on the DSC circuit board for the correct single ended or double ended analog inputs (see section [1.3.2](#)).

The Polarity drop down list allows for the selection of Normal or Reverse polarity of the rudder feedback signal. If the rudder feedback direction displayed on the bottom left line of the DSC's LCD screen does not correspond with the actual direction of the steering gear then the polarity can be swapped to correct this condition. This condition is normally checked once the system is connected to the feedback of the steering gear to be controlled.

Select the appropriate setting from the drop down lists. When finished, click the SET button before clicking the CLOSE button.



Rudder Feedback Tuning Window

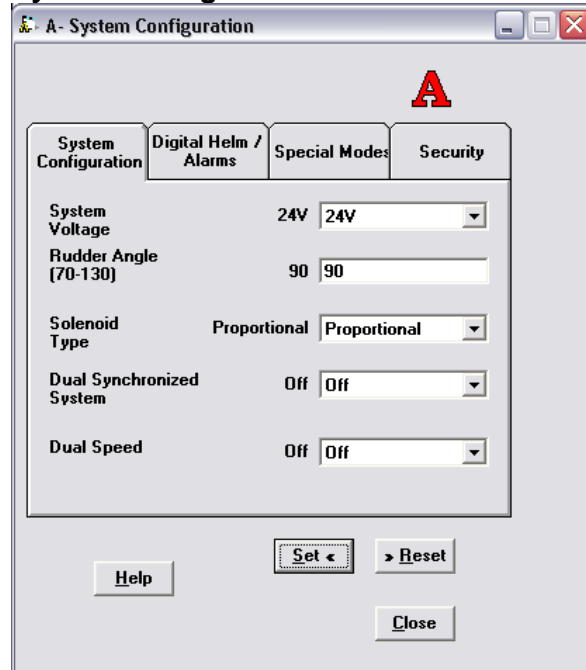
The Rudder Feedback Tuning Window contains the Proportional, Integral and Derivative (PID) values for the feedback loop. These values are derived through a tuning process and adjustment of these values is normally not required. The PID parameters are only applicable to proportional rudder systems, therefore these data fields are greyed out for on-off rudder systems.



CAUTION:

The Proportional, Integral and Derivative terms on this Property Sheet should only be adjusted by someone familiar with the tuning process of a PID controller and the desired response of a proportional steering control system.

System Configuration Window

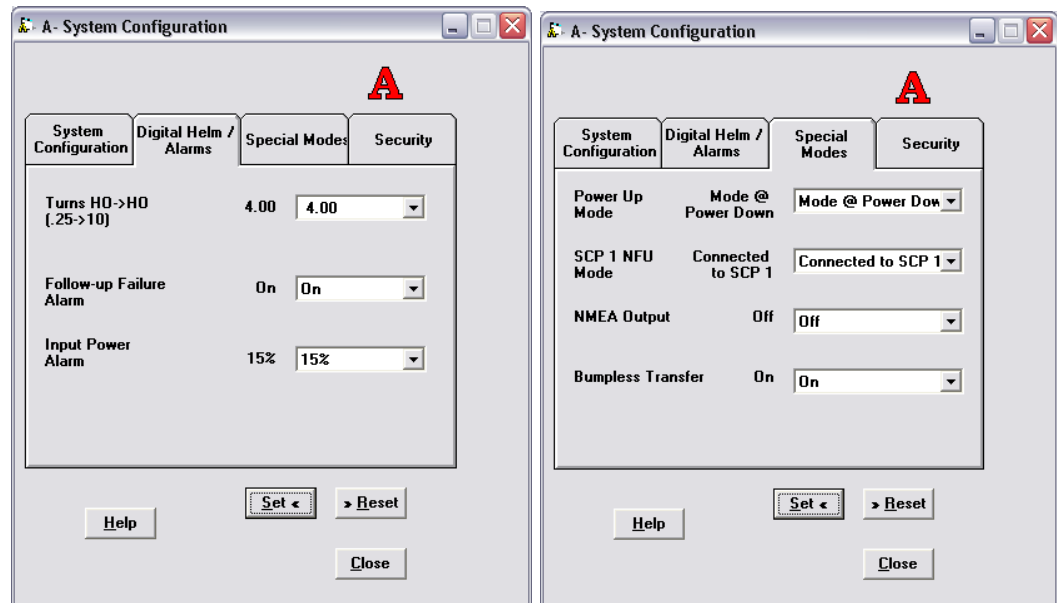


The screenshot shows the 'System Configuration' window with the 'System Configuration' tab selected. The window has a title bar 'A- System Configuration' and a red 'A' logo. The tab is divided into four sections: System Configuration, Digital Helm / Alarms, Special Modes, and Security. The System Configuration section contains the following settings:

Parameter	Value
System Voltage	24V
Rudder Angle (70-130)	90
Solenoid Type	Proportional
Dual Synchronized System	Off
Dual Speed	Off

At the bottom of the window are buttons for 'Help', 'Set', 'Reset', and 'Close'.

The System Configuration Window consists of four different Window Tabs. Under the System Configuration Tab settings are adjusted for the system voltage (12 or 24 volts), rudder angle, solenoid type (on-off or proportional), synchronized system (on or off) and dual speed control (on or off). The Dual Synchronized system steering is turned on only for dual rudder systems using a digital helm input device or interfaced to a single output autopilot.



The two screenshots show the 'System Configuration' window with the 'Digital Helm / Alarms' tab selected. The window has a title bar 'A- System Configuration' and a red 'A' logo. The tab is divided into four sections: System Configuration, Digital Helm / Alarms, Special Modes, and Security. The Digital Helm / Alarms section contains the following settings:

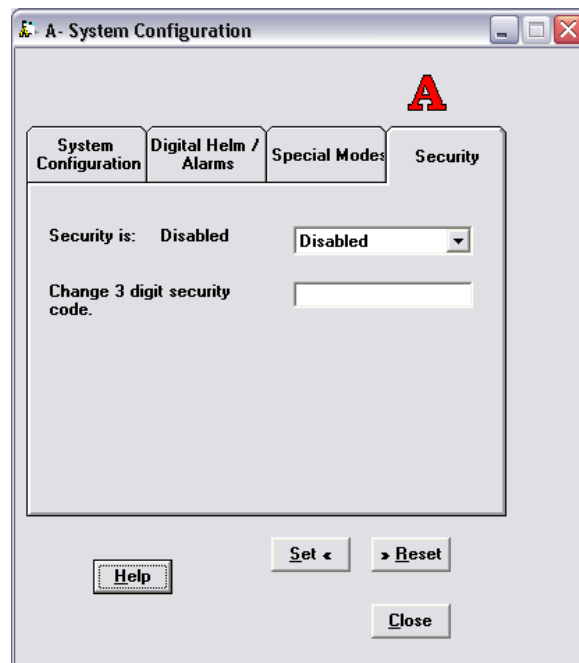
Parameter	Value
Turns HO->HO (.25->10)	4.00
Follow-up Failure Alarm	On
Input Power Alarm	15%

At the bottom of the window are buttons for 'Help', 'Set', 'Reset', and 'Close'.

The Digital Helm / Alarms tab allows for the selection of the number of wheel turn for hard over to hard over of a Digital Helm device (see section [2.3.5](#)) as well as selections for two alarm conditions. When the FFU Failure Alarm is turned on the system will monitor the steering gear's response to FFU commands and set an alarm if the steering gear does not respond within a set time frame. The DSC can also be set to monitor the voltage level of the incoming power supply. If the voltage level of the power supply varies outside of a set range ($\pm 10\%$ or $\pm 15\%$) the DSC will set an alarm.

There are four settings under the Special Modes Tab. The first setting determines what mode of control will be engaged when the system is powered up. The two available options are for the system to power up in the mode and station the system was in when the power to the DSC was turned off or the system can be set to power up in the standby mode at the main station. The transfer function will also be engaged on systems with more than one MCP using the lockout function. This is to ensure that no station is locked out after a brief interruption in system power. The second setting is determined by how the main station's NFU input is connected to the system (see sections [1.3.6](#) and [2.3.2](#)). If the main station NFU input is set up as a backup NFU input device then "Direct to Solenoid" should be selected. If the main station NFU is part of the main system and connected to the MCP then "Connected to SCP1" should be selected. The NMEA output setting is used to turn on or off the DSC's NMEA output. NMEA data is output from the DSC's RS-232, DB-9 connector. When the NMEA output is turned on, online communication with a DSC is not possible. If on, this output must first be turned off using DSC Keypad setup (see section [4.2.1](#) for information on turning NMEA off).

The last setting turns the seamless transfer setting on or off. When seamless transfer is turned on an analog FFU input device will not become active unless the device's analog rudder command position is within $\pm 3^\circ$ of the actual rudder angle (see section [3.3.3](#)).

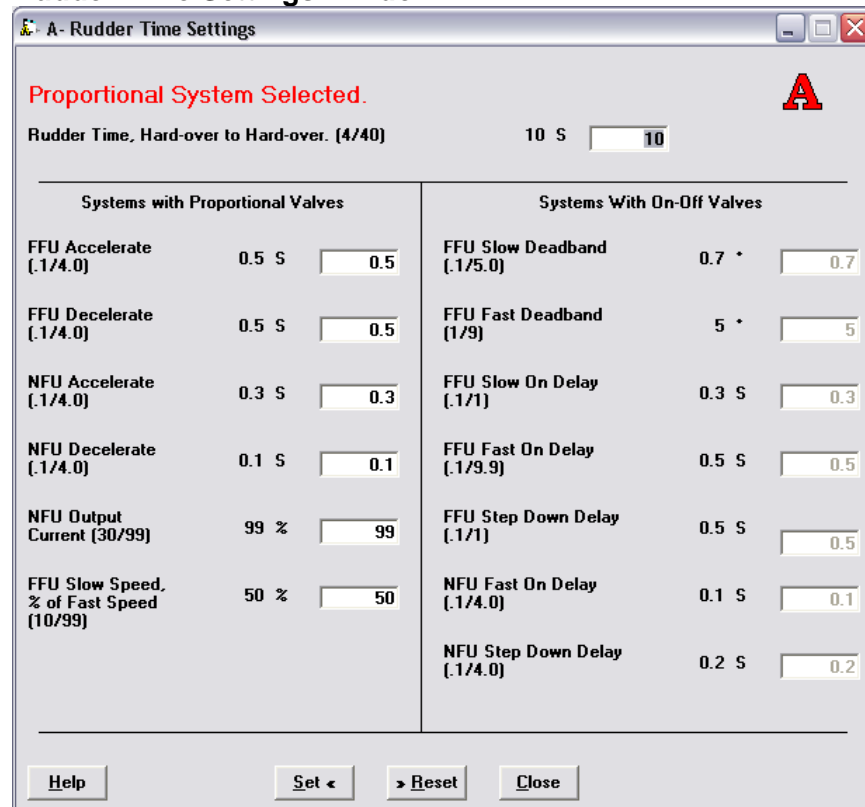


The security tab allows for the DSC settings to be protected by a security code. When the security feature is enabled each of the window's 'SET' buttons is greyed out and the DSC SAVE function cannot be performed. In order to enable the 'SET' buttons and the DSC SAVE function the proper three digit security code must be entered. The three digit security code can be changed once the original security code is first entered. When connecting with a security protected DSC on-line, a warning window will appear stating that the DSC security is enabled.



Select the appropriate settings from the drop down lists and enter the appropriate values in the Data Entry Blocks. When finished, click the SET button before clicking the CLOSE button.

Rudder Time Settings Window



Proportional System Selected.

Rudder Time, Hard-over to Hard-over. (4/40) 10 S 10

Systems with Proportional Valves		Systems With On-Off Valves	
FFU Accelerate (1/4.0)	0.5 S 0.5	FFU Slow Deadband (1/5.0)	0.7 * 0.7
FFU Decelerate (1/4.0)	0.5 S 0.5	FFU Fast Deadband (1/9)	5 * 5
NFU Accelerate (1/4.0)	0.3 S 0.3	FFU Slow On Delay (1/1)	0.3 S 0.3
NFU Decelerate (1/4.0)	0.1 S 0.1	FFU Fast On Delay (1/9.9)	0.5 S 0.5
NFU Output Current (30/99)	99 % 99	FFU Step Down Delay (1/1)	0.5 S 0.5
FFU Slow Speed, % of Fast Speed (10/99)	50 % 50	NFU Fast On Delay (1/4.0)	0.1 S 0.1
		NFU Step Down Delay (1/4.0)	0.2 S 0.2

Help Set < > Reset Close

The Rudder Time Settings Window provides control over how the system moves the rudder from one position to another. In the first field enter the time, in seconds, required or desired for the rudder to move from hard over to hard over. For a proportional valve this will be the desired hard over to hard over time under fast rudder speed control. Ensure that the hydraulic system is capable of moving the rudder at a rate slightly faster than this value with the spool of the proportional valve fully shifted. For on-off valves enter the number of seconds it takes for the hydraulic system to move the rudder from one hard over to the other when shifting only the directional valve and not engaging any high speed flow solenoid valve.

The remaining Data Entry Blocks are separated into two groups. Enter data in the blocks on the left for systems using proportional solenoid valves and on the right for systems using on-off solenoid valves. Systems set up for proportional valves will have the right side entries greyed out and the left side will be greyed out for on-off solenoids.

For proportional valves, the FFU Accelerate and FFU Decelerate values determine the amount of time, in seconds, the rudder will take to accelerate from a standstill to maximum rotational speed and decelerate from maximum rotational speed to a standstill.

The NFU Accelerate and NFU Decelerate values provide the same control over the rudder speed while operating in the Non Follow Up mode of steering control. The NFU Decelerate value should be quite small in order to avoid the rudder overshooting the desired position when the NFU input device is released.

The NFU Output Current value is used to limit the current to the proportional valve while operating under Non Follow Up steering control. Since NFU control does not actively monitor and control the rotational speed of the rudder, limiting the NFU Output Current will limit the maximum rotational speed of the rudder while using the NFU input device.

The FFU Slow Speed value will determine the rotational speed of the rudder when the Fast Rudder mode is toggled off. This value is a percentage of the fast rudder speed value entered at top of the window. If the hard over to hard over time entered at the top of the window is 12 seconds and the FFU Slow Speed value is set to 50% then this will result in 12 and 24 second hard over to hard over times when the Fast Rudder mode is toggled on and off respectively. This value will also affect the NFU output current by applying this additional reduction factor to the output current when operating the NFU device with the Fast Rudder mode toggled off.

For systems with on-off valves, the FFU Slow Deadband data entry block contains the value in degrees for the system sensitivity under FFU control. This value should be set as low as possible without causing the system to overshoot or oscillate. The final setting will be dependent on the overall rudder speed and hydraulic response and should therefore be fine tuned during calibration.

FFU Fast Deadband determines the angular difference between the FFU commanded angle and the actual rudder angle where the system will engage the hydraulic power unit's high speed solenoid when operating in Fast Rudder mode.

FFU Slow On Delay controls the number of seconds the system will wait before sending an initial command to the directional solenoid valve. This setting is used to ensure that when the rudder movement changes direction it will pause for a brief moment in the stopped position before proceeding in the opposite direction. This will reduce hydraulic hammering and mechanical wear and tear during rudder movements that can be induced when a hydraulic system instantly tries to change direction of the rudder.

FFU Fast On Delay is used to ensure that if a large change in rudder command is given (i.e. larger than the FFU Fast Speed Angle) the system will first step through the slow rudder movement for a period of time before energizing the high speed solenoid. Again, this will help reduce hammering and wear and tear on the mechanical components.

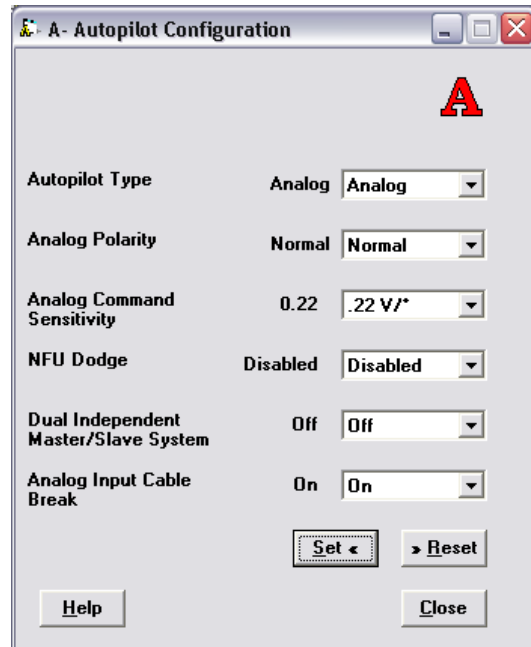
FFU Step Down Delay will cause the directional valve to remain energized for a period of time after the controller has determined that rudder has reached its final position. This will allow the system to step down through slow rudder movement before stopping. This value should be kept low in order to avoid inducing an overshoot of the desired position.

NFU Fast On Delay is used to ensure that when NFU commands are given the system will be allowed to first step through the slow rudder movement before the high speed solenoid is energized. This setting is similar to the FFU Fast On Delay setting described above.

NFU Step Down Delay will ensure that the rudder is given time to step down through slow rudder movement before stopping. When the NFU input device is released the high speed solenoid will be turned off immediately and the directional valve solenoid will be held on for this amount of time. This setting should be long enough to allow for the step down procedure but not long enough to cause excessive overshooting of the desired rudder position under NFU control.

Enter the appropriate values in the Data Entry Blocks. When finished, click the SET button before clicking the CLOSE button.

Autopilot Configuration Window

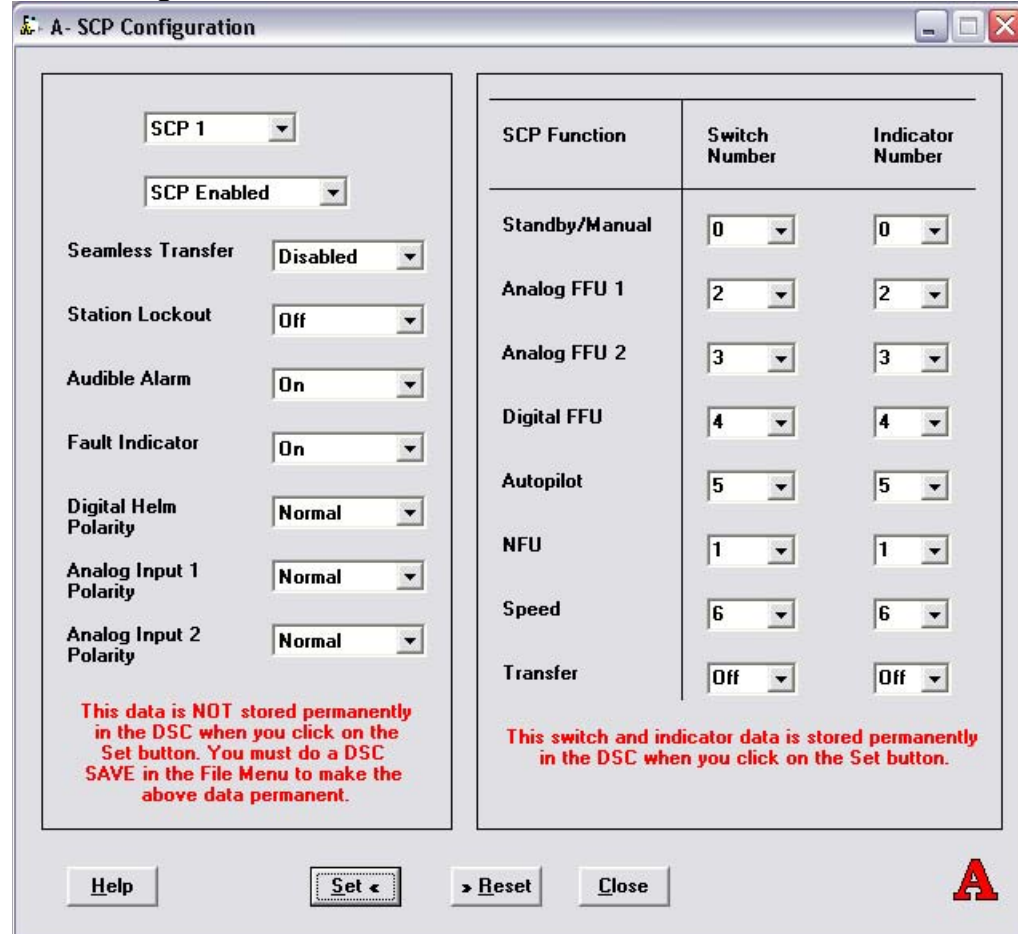


The Autopilot Configuration Window consists of six drop down lists. The first drop down list allows for the selection of Analog or On-Off type autopilot interface types. Review the available interface types for the autopilot installed and choose the appropriate setting from the list. When analog interfacing is used the polarity of the autopilot's analog command signals can be selected using the second drop down list. When analog interfacing is used the sensitivity of the autopilot's analog command signal can be adjusted using the Analog Command Sensitivity list. If the autopilot commands a 20 degree rudder position and the

rudder moves to 30 degrees then you will want to increase the number of volts per degree so that the rudder will stop at the commanded 20 degree angle. If the NFU Dodge function is enabled then operation of a NFU input device that is connected to the MCP will cause the rudder to move away from the autopilot's commanded position while in Autopilot Control mode. Once the NFU device is released, control of the rudder will be given back to the autopilot system. The Dual Independent Master / Slave drop down list will only be used on a dual independent rudder system where the autopilot is only capable of controlling one rudder. In this case the DSC's which includes the autopilot interfacing will be selected as the MASTER and the second DSC will be set up as the SLAVE. For master / slave systems to operate they will require the use of the DSC to DSC communication line (see section [1.2.2](#)). The final drop down list is used to turn the autopilot analog cable break alarm function on or off. This setting should be turned off if an on-off autopilot interface is used or if an analog autopilot disconnects its analog outputs when the autopilot is not in the AUTO mode of control.

Select the appropriate setting from the drop down lists. When finished, click the SET button before clicking the CLOSE button.

SCP Configuration Window



SCP 1

SCP Enabled

Seamless Transfer Disabled

Station Lockout Off

Audible Alarm On

Fault Indicator On

Digital Helm Polarity Normal

Analog Input 1 Polarity Normal

Analog Input 2 Polarity Normal

This data is NOT stored permanently in the DSC when you click on the Set button. You must do a DSC SAVE in the File Menu to make the above data permanent.

SCP Function	Switch Number	Indicator Number
Standby/Manual	0	0
Analog FFU 1	2	2
Analog FFU 2	3	3
Digital FFU	4	4
Autopilot	5	5
NFU	1	1
Speed	6	6
Transfer	Off	Off

This switch and indicator data is stored permanently in the DSC when you click on the Set button.

Help Set > Reset Close

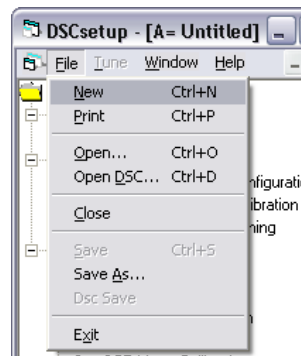
The SCP Configuration Window is where the system is told how many control stations there are and what modes of steering control are available at each steering control station. SCP's 1 through 5 are selected using the first drop down list and then all of the remaining fields will take on the values for that particular SCP. Each SCP is enabled or disabled using the second drop down list. The next drop down list enables or disables the Digital Helm seamless transfer function (see sections [3.3.2](#) and [3.3.5](#)). When two or more stations are connected remote stations can be selected as locked out stations. When a station's lockout is enabled, control can not be taken at that station unless the TRANSFER mode is first engaged by the active station. Station lockout can be enabled or disabled at various steering control stations on the vessel. Each SCP has an audio output that can be turned on or off through the use of the Audible Alarm drop down list. The audio output sounds to indicate certain functions of the SCP and when a failure condition exists within the system. Each SCP also has an output used to illuminate a FAULT indicator. This indicator can be enabled and disabled through the use of the Fault Indicator drop down list. Each SCP is provided with one FFU Digital command input and two FFU Analog command inputs. The polarity of each of these inputs can be chosen using the Digital Input Polarity, Analog Input 1 Polarity and Analog Input 2 Polarity drop down lists. The remaining drop down lists located on the right hand side of the window are used

to assign individual station modes and functions to certain switch inputs and indicator outputs (see Drawing [5.9](#) - MCP Terminal Block Configuration). If a certain mode or function is not used, the OFF setting should be chosen from the drop down list.

Select the appropriate setting from the drop down lists for each SCP. When finished, click the SET button before clicking the CLOSE button.

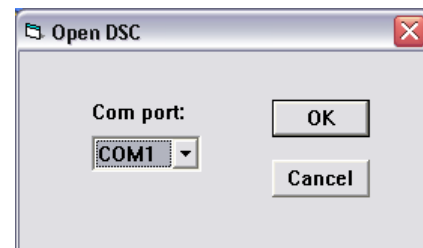
4.1.2 System Calibration

Calibration is done with a functioning Digital Steering Control system loaded with the appropriate configuration and an operating hydraulic steering gear. DSCsetup communicates with the DSC through a standard male-female 9-pin RS-232 serial cable connected to the D-Sub port located just to the right of the DSC display window. If required, an RS-232 to USB interface cable to connect to a computer which does not have a standard serial port.

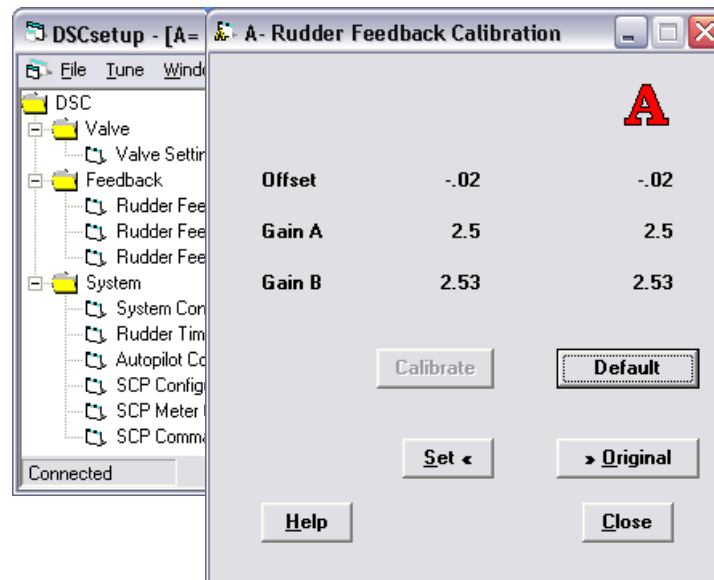


To begin on-line calibration, turn on the DSC and the computer. Start the DSCsetup application, and from the File menu select OPEN DSC.

Identify which communication port the RS-232 cable is connected to.



When communication is established, the word CONNECTED appears in a gray stripe at the bottom of a new Setup window containing the current data from the controller.

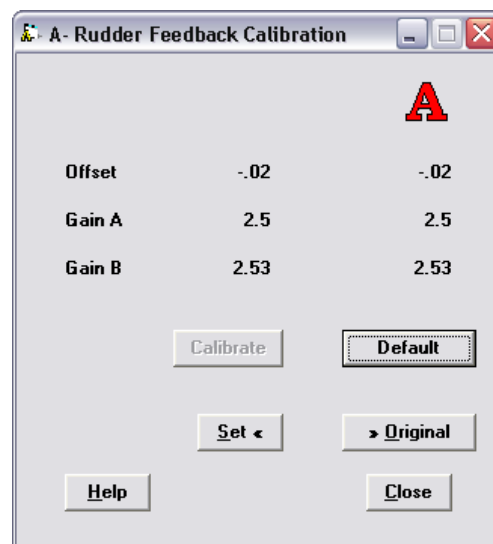


Values immediately to the right of the parameter names are the current operational values in the DSC. The Data Entry Blocks are where you enter new parameter values. Clicking the SET button puts the values into effect, and moves the values from the Data Entry Blocks to the current value side, but new settings are not permanent until

DSC SAVE is selected from the File menu. The RESET button restores the Data Entry Blocks to the last Set values (the values just to the right of the parameter names).

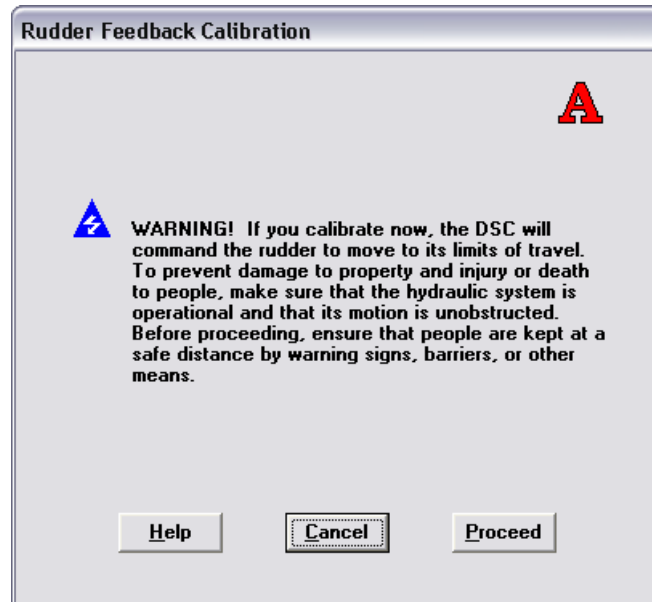
**NOTE:**

Once calibration data has been entered in each Property Sheet, click the SET button before closing the Property Sheet.

Rudder Feedback Calibration Window

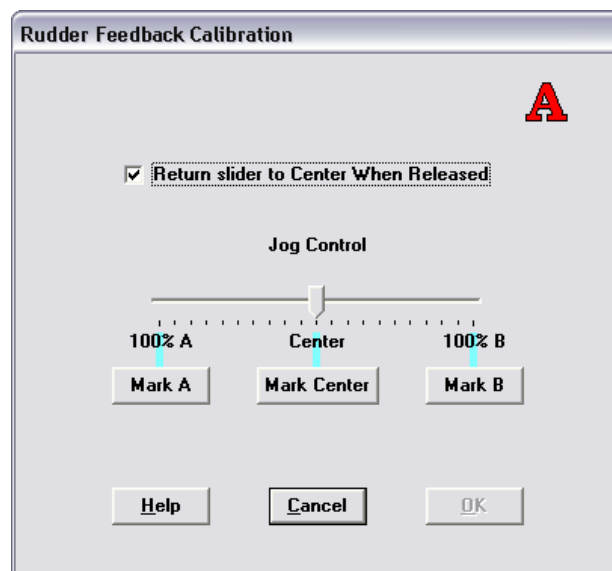
This procedure calibrates the rudder feedback signals by informing the DSC what signal levels to expect from the feedback unit for midships, hard port and hard starboard rudder positions.

SET will transfer the values in the right column to the DSC. The ORIGINAL button will restore the last set values to the right column. DEFAULT will set the right column to nominal values of 0, 1 and 1. The CALIBRATE button will advance you to the actual calibration procedure. After selecting CALIBRATE a warning screen will appear.



WARNING:
IF THIS INFORMATION IS NOT HEEDDED, INJURY OR DEATH OF PEOPLE AND DESTRUCTION OF PROPERTY MAY RESULT.

Click on the PROCEED button to enter the feedback calibration screen.

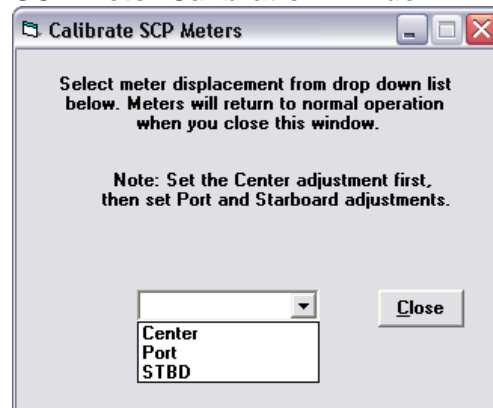


For proportional systems, the 'Jog Control' slider will act as a variable non follow-up control. As you advance the slider farther from center, the rudder will move faster. For on-off systems, advance the slider until the directional valve solenoid is energized. Using the 'Jog Control' slider, move the rudder to midships and click the MARK CENTER button. Then move the rudder to either port or starboard hard over and click the MARK A or MARK B button. It is not

critical which one you click. Then move the rudder to the opposite hard over and click the opposite MARK A or MARK B button. Once the midships and hard over positions have been entered you will be able to click on the OK button which will bring you back to the initial Rudder Feedback Calibration window with the new values indicated on the right side of the screen.

Click the SET button before closing in order to accept the new values and to enter them to the DSC.

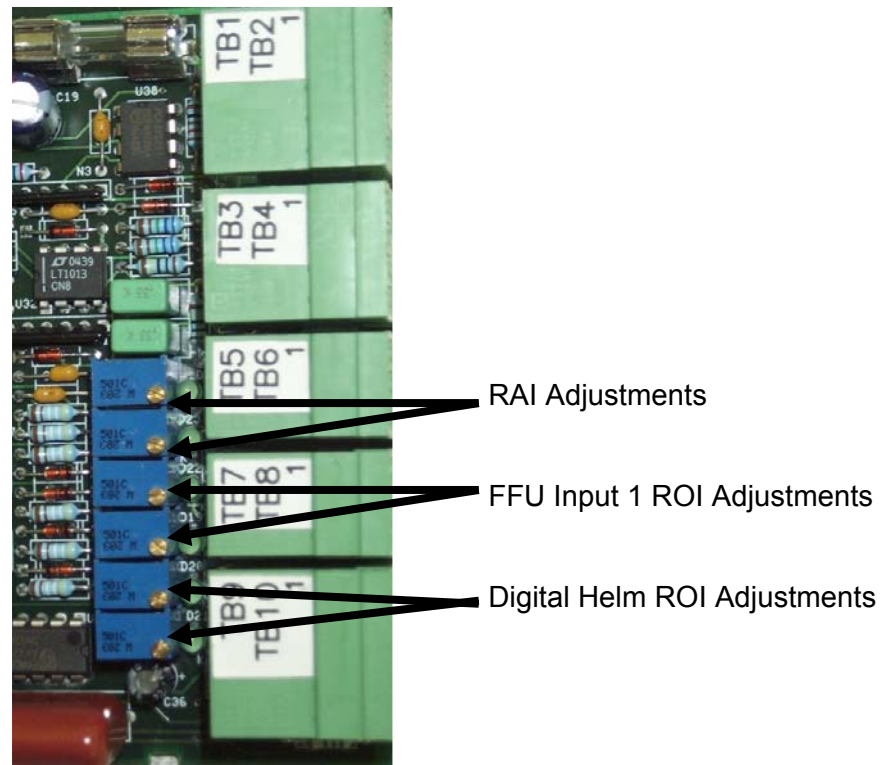
SCP Meter Calibration Window



If any rudder indicators are connected to the SCPs, an adjustment will be required to ensure that the indicators display the correct rudder angle and command. From the drop down list first select the CENTER option. All indicators connected to the SCPs should now read exactly midships. If this is not the case make the appropriate adjustment to the indicator offset at each indicator. Next select PORT from the drop down list. All indicators

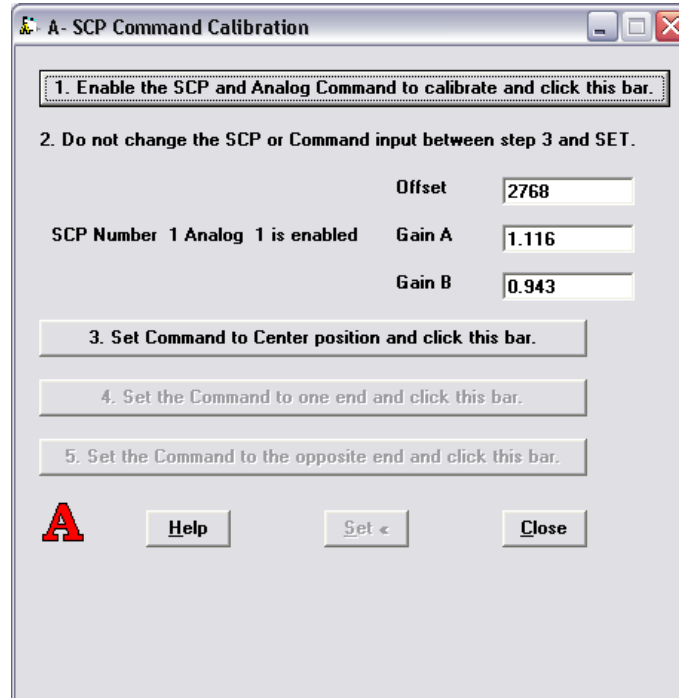
should now read some angle to port. If this is not the case then the indicator signal polarity must be reversed at each indicator that is not displaying a port angle. With PORT selected from the drop down list each set of indicators connected to the SCP's for Rudder Angle, Digital Helm Rudder Order and/or FFU Input 1 Rudder Order may require a gain adjustment to ensure that each indicator displays the correct hard over angle.

Indicator gain adjustments are made on each of the SCP circuit boards contained in each station MCP.



With PORT selected from the drop down list an LED will be on beside three of the six indicator trimmers. Adjust the trimmer indicated by the LED for each of the indicator types used in order to ensure that the indicator displays the correct hard over angle. After the port adjustment has been made, select STBD from the drop down list and repeat the adjustment for each indicator type used. With STBD selected the opposite three LED's will be lit to indicate which trimmers to adjust.

SCP Command Calibration Window



1. Enable the SCP and Analog Command to calibrate and click this bar.

2. Do not change the SCP or Command input between step 3 and SET.

Offset	2768
Gain A	1.116
Gain B	0.943

SCP Number 1 Analog 1 is enabled

3. Set Command to Center position and click this bar.

4. Set the Command to one end and click this bar.

5. Set the Command to the opposite end and click this bar.

A

Each SCP will accommodate up to two analog FFU command inputs. Each analog FFU command input must be calibrated through the use of the SCP Command Calibration Window. Once the window is selected it is a simple matter of following the displayed instructions. First the input to be calibrated must be engaged by selecting the mode using the mode input selector. Once the input to be calibrated is selected, click on the first bar.

The selected device will be displayed in the screen next to the 'Gain A' parameter. Then move the input device to its center position and click the second bar. Once the center position has been set move the input device to hard over port or starboard and click the next bar, then repeat the process for the opposite hard over clicking the last bar. After this step is complete new values for OFFSET, GAIN A and GAIN B will appear in the Data Blocks.

Click the SET button before closing in order to accept the new values and to enter them to the DSC. Repeat this process for each of the analog FFU input devices in the system.

After completing calibration of the system it can be returned to its normal run mode. Select FILE and DSC SAVE in order to permanently write information to the DSC's non-volatile memory. Once DSC SAVE has been performed the system should be shut down and rebooted. The system will now operate in its normal run mode.

4.2 DSC KEYPAD SETUP

To enter DSC Keypad Setup mode hold down any key on the DSC while applying power. If the security feature is enabled the following screen will be displayed:

```
ENTER THREE DIGIT
PASSWORD

# OR * = EXIT
```

Once the correct password has been entered, or if the security feature is not enabled, the following initial setup screen will appear:

```
1=DSC      2=SCP
3=TIMING   4=CALIBRATE
5=PILOT    6=SECURITY
ANY OTHER=EXIT CAL
```

From the initial setup screen six different submenus can be selected by pressing the appropriate key 1 through 6. Any other key will cause the DSC to exit setup mode and return to run mode. When exiting setup mode in this manner, the DSC will save all information to its non volatile memory updating any data that had been modified. In order to exit the setup mode without saving changes simply cycle the power without exiting the setup mode. The DSC will re-boot in the run mode using the last saved data.

4.2.1 DSC Menu

The DSC menu is used to configure settings pertaining to the DSC. Press 1 from the initial screen to enter the DSC submenu. The following screen will be displayed:

DSC Submenu 1

```
1=RUDDER ANGLE
2=SYSTEM VOLTAGE
3=DIGITAL FFU HO-HO
*=NEXT 0=EXIT #=BACK
```

Select 1, 2 or 3 or press * to move to the second DSC submenu screen or 0 to return to the initial DSC Setup screen.

For additional information refer to the System Configuration Window description in section [4.1.1](#).

Press 1 to enter the electrical limits of the steering gear angle.

```
RUDDER ANGLE
070 DEGREES (10/150)

*=EXIT #=BACK SPACE
```

Enter three digits for the total steering angle. The system will automatically return to the previous screen.

From the DSC submenu press 2 to enter the system voltage.

```
SYSTEM VOLTAGE = 24V
1=12V
2=24V
ANY OTHER=NEXT
```

Select 1 or 2 corresponding to the system voltage applied to the DSC.

From the DSC submenu press 3 to alter the number of wheel turns for a digital helm input device.

```
DIGITAL HELM (04.00)
1=INCREASE 1/4 TURN
2=DECREASE 1/4 TURN
ANY OTHER=NEXT
```

Select 1 or 2 to increase or decrease the desired number of helm turns.

From the initial DSC submenu, press * to advance to the next DSC submenu screen. Three subsequent configuration options will be shown.

DSC Submenu 2

```
1=SOLENOID TYPE
2=SOLENIOD CURRENT
3=BIAS CURRENT
*=NEXT 0=EXIT #=BACK
```

Enter the appropriate solenoid valve information in each of the three data screens.

For additional information refer to the Valve Settings Window description in section [4.1.1](#).

```
SOLENOID TYPE (2)
1=ON-OFF
2=PROPORTIONAL
ANY OTHER=NEXT
```

The solenoid type screen offers selection for either on-off or proportional solenoid valves.

```
SOLENIOD CURRENT
1.600 A (.250/4.000)
*=EXIT #=BCKSPC
```

Solenoid current is configured by entering four digits.

```
VALVE BIAS CURRENT
0.400 A (.100/1.000)
*=EXIT #=BACK SPACE
```

Valve bias current is also configured by entering four digits.

From the second DSC submenu, press * to advance to the next DSC submenu screen. Three subsequent configuration options will be shown.

DSC Submenu 3

1=POWER UP MODE
 2=STATION 1 NFU MODE
 3=ALARM SETTINGS
 *=NEXT 0=EXIT #=BACK

Key 1, 2 or 3 to configure any of these options.

For additional information refer to the System Configuration Window description in section [4.1.1](#).

POWER UP MODE (1)
 1=MODE @ POWER DOWN
 2=SCP 1, STANDBY
 ANY OTHER=NEXT

Select 1 or 2 to configure how the system will behave during startup.

SCP 1 NFU IS (2)
 1=CONNECTED DIRECT
 2=CONNECTED TO SCP 1
 ANY OTHER=NEXT

Select 1 or 2 to configure how the main station NFU input device is connected to the system.

FFU ALARM (2)
 1=ON
 2=OFF
 ANY OTHER=NEXT

Select 1 or 2 to configure the FFU alarm function. Press any other key to advance to the next alarm setting.

INPUT POWER ALARM(3)
 1=15%, 2=10%
 3=OFF
 ANY OTHER=NEXT

Select 1, 2 or 3 to configure the level of the input power supply alarm. Any other key returns to the third DSC submenu.

From the third DSC submenu, press * to advance to the next DSC submenu screen. Three subsequent configuration options will be shown.

DSC Submenu 4

1=DUAL SYNCH SYSTEM
 2=DUAL SPEED
 3=NMEA OUTPUT
 *=NEXT 0=EXIT #=BACK

Key 1, 2 or 3 to configure any of these options.

For additional information refer to the System Configuration Window description in section [4.1.1](#).

DUAL SYSTEM (2)
 1=ON
 2=OFF
 ANY OTHER=NEXT

Select 1 or 2 to turn the dual synchronizing function on or off.

DUAL SPEED (2)
1=ON
2=OFF
ANY OTHER=NEXT

Select 1 or 2 to turn the dual speed function on or off.

NMEA OUTPUT (2)
1=ON
2=OFF
ANY OTHER=NEXT

Select 1 or 2 to turn the NMEA output function on or off. Any other key returns to the fourth DSC submenu.

**NOTE:**

The NMEA output must be turned off in order to allow communication with a laptop running the DSC Setup Software program.

From the fourth DSC submenu, press * to advance to the next DSC submenu screen. One remaining configuration option will be shown.

DSC Submenu 5

1=BUMPLESS TRANSFER

Key 1 to configure bumpless transfer. * returns to the first DSC submenu.

*=NEXT 0=EXIT #=BACK

For additional information refer to the System Configuration Window description in section [4.1.1](#).

BUMPLESS TRANSFER(1)
1=ON
2=OFF
ANY OTHER=EXIT

Select 1 or 2 to turn the bumpless transfer function on or off.

Press 0 from any other the DSC submenus to return to the initial setup screen.

4.2.2 SCP Menu

The SCP menu is used to configure settings pertaining to the SCP circuit inside the MCP. Press 2 from the initial screen to enter the SCP submenu. The following screen will be displayed:

SCP Selection Submenu

```
SCP MENU
ENTER SCP NUMBER,
1 TO 5
ANY OTHER=EXIT
```

Select SCP station 1 through 5 or press any other key to return to the initial DSC Setup screen.

Once a station number is selected the display will advance to the submenu screens for that station. After scrolling through the station's submenus the display will return to this SCP menu. The following SCP menu screens will be the same for each of the five SCP stations.

SCP Configuration Submenu

```
SCP 1 ON
1=ON
2=OFF
ANY OTHER=NEXT
```

Press 1 or 2 to turn this station on or off. Any other key will proceed to the next screen.

For additional information refer to the SCP Configuration Window description in section [4.1.1](#).

```
SCP 1 LOCKOUT OFF
1=ON
2=OFF
ANY OTHER=NEXT
```

Press 1 or 2 to turn this station's lockout function on or off.

```
SCP 1 AUDIO ON
1=ON
2=OFF
ANY OTHER=NEXT
```

Press 1 or 2 to turn this station's audio output on or off.

```
SCP 1 SEAMLESS
TRANSFER OFF
1=ON 2=OFF
ANY OTHER=NEXT
```

Press 1 or 2 to turn this station's seamless transfer function on or off.

SCP Switch Assignment

```
SCP 1 STANDBY/MANUAL
SWITCH # = 0
INDICATOR # = 0
#=CHANGE 0..9, *=NEXT
```

Press # to change the switch and indicator assignment for Standby/Manual function or * if no change is necessary.

Determine the switch input and indicator output used for the each available mode of steering control (see Drawing [5.9](#) – MCP Terminal Block Configuration). Pressing # will advance to the following switch assignment screen. Pressing * will skip to the next mode function.

For additional information refer to the SCP Configuration Window description in section [4.1.1](#).

```
SCP 1 STANDBY/MANUAL
0 TO 9 = SWITCH #
ANY OTHER=FUNCTION
NOT USED
```

Key the appropriate switch number 0 through 9 or any other key to disable the function.

```
SCP 1 STANDBY/MANUAL
0 TO 7=INDICATOR #
ANY OTHER=FUNCTION
NOT USED
```

Key the appropriate indicator number 0 through 9 or any other key to disable the function.

Next mode function.

```
SCP 1 ANALOG INPUT 1
SWITCH # = 1
INDICATOR # = 1
#=CHANGE 0..9, *=NEXT
```

Press # to change the switch and indicator assignment for Analog 1 function or * if no change is necessary.

```
SCP 1 ANALOG INPUT 2
SWITCH # = 2
INDICATOR # = 2
#=CHANGE 0..9, *=NEXT
```

Press # to change the switch and indicator assignment for Analog 2 function or * if no change is necessary.

```
SCP 1 DIGITAL HELM
SWITCH # = 3
INDICATOR # = 3
#=CHANGE 0..9, *=NEXT
```

Press # to change the switch and indicator assignment for Digital Helm function or * if no change is necessary.

```
SCP 1 AUTOPILOT
SWITCH # = 4
INDICATOR # = 4
#=CHANGE 0..9, *=NEXT
```

Press # to change the switch and indicator assignment for Autopilot function or * if no change is necessary.

```
SCP 1 NON FOLLOWUP
SWITCH # = 5
INDICATOR # = 5
#=CHANGE 0..9,*=NEXT
```

Press # to change the switch and indicator assignment for Non Followup function or * if no change is necessary.

```
SCP 1 SPEED
SWITCH # = 6
INDICATOR # = 6
#=CHANGE 0..9,*=NEXT
```

Press # to change the switch and indicator assignment for Non Followup function or * if no change is necessary.

```
SCP 1 TRANSFER
SWITCH # = NONE
INDICATOR # = NONE
#=CHANGE 0..9,*=NEXT
```

Press # to change the switch and indicator assignment for Non Followup function or * if no change is necessary.

After completing the last switch mode assignment the system will proceed to the input polarity screen.

SCP FFU Input Polarity

```
PRESS * TO SET SCP 1
FFU POLARITY, OR ANY
OTHER KEY TO RETURN
TO THE SCP MENU.
```

Press * if any of the FFU input devices connected to SCP 1 display the incorrect rudder polarity.

For additional information refer to the SCP Configuration Window description in section [4.1.1](#).

```
ON THE NEXT SCREEN,
KEYS 1->6 CHANGE THE
POLARITY DATA, ELSE
EXIT. ANY KEY=NEXT
```

SCP 1	NRM	INV
ANLG FFU1	1	2 (1)
ANLG FFU2	3	4 (3)
DIGITAL	5	6 (5)

Press keys 1 through 6 to select device polarity as normal or inverted.

Current input device polarity is shown in the parentheses. Press any key other than 1 through 6 to return to the SCP Selection Submenu.

4.2.3 Rudder Time Settings Menu

The Rudder Time Settings menus are used to configure variables which determine how the system will control movement of the rudder from one position to another. Different settings are accessible based on whether the system is controlling an on-off directional valve or a proportional directional valve.

The first screen under this menu is for the overall hard over to hard over rudder speed.

Rudder Timing

HO-HO SPEED
28.0 S (4.00/40.00)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE

Enter the hard over to hard over rudder speed in seconds.

For proportional valve systems the number entered here is the desired hard over to hard over time under fast rudder speed control. Ensure that the hydraulic system is capable of moving the rudder at a rate slightly faster than this value with the spool of the proportional valve fully shifted. For on-off valve systems the number entered here is the number of seconds it takes for the hydraulic system to move the rudder from one hard over position to the other when shifting only the directional valve and not engaging the high speed flow solenoid valve.

Rudder Timing Proportional Submenu

FFU ACCELERATE
0.3 S (.1/4.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE

Enter the number of seconds for rudder acceleration in FFU modes of steering.

For additional information refer to the Rudder Time Settings Window description in section [4.1.1](#).

FFU DECELERATE
0.7 S (.1/4.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE

Enter the number of seconds for rudder deceleration in FFU modes of steering.

NFU OUTPUT CURRENT
99 % OF MAX (30/99)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE

Enter the required current to be sent to the proportional valve in NFU modes as a percentage of the valve max. current.

NFU ACCELERATION
0.1 S (.1/4.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE

Enter the number of seconds for rudder acceleration in NFU modes of steering.

NFU DECELERATION
0.1 S (.1/4.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE

Enter the number of seconds for rudder deceleration in NFU modes of steering.

Rudder Timing On-Off Submenu

```
FFU SLOW DEADBAND
0.5 DEGREES (.1/5)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE
```

Enter the system sensitivity or deadband in degrees.

For additional information refer to the Rudder Time Settings Window description in section [4.1.1](#).

```
FFU FAST DEADBAND
5 DEGREES (1/9)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE
```

Enter the angle at which the system should step down from fast rudder speed to slow rudder speed in FFU modes.

```
FFU SLOW ON DELAY
0.2 S (.1/1.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE
```

Enter the time delay desired for engaging the directional solenoid valve in FFU modes of steering.

```
FFU FAST ON DELAY
0.6 S (.1/9.9)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE
```

Enter the time delay desired for engaging the high flow (fast rudder) valve in FFU modes of steering.

```
FFU STEP DOWN DELAY
0.1 S (.1/1.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE
```

Enter the time delay desired for stepping down from fast rudder to slow rudder in FFU modes of steering.

```
NFU FAST ON DELAY
0.6 S (.1/4.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE
```

Enter the time delay desired for engaging the high flow (fast rudder) valve in NFU modes of steering.

```
NFU STEP DOWN DELAY
0.1 S (.1/4.0)
0 TO 9 FOR DATA
*=NEXT #=BACK SPACE
```

Enter the time delay desired for stepping down from fast rudder to slow rudder in NFU modes of steering.

After completing the rudder time settings the system will return to the initial setup screen.

4.2.4 Calibration Menu

The Calibration menu is used to perform system calibration once the control system is connected to an operating hydraulic steering gear. Calibration is required for the rudder feedback device and each of the analog command input devices as well as for any rudder angle or rudder order indicator connected to the MCP. Upon selecting calibration the following screen will be displayed:

Calibration Submenu

CALIBRATION MENU
1=CAL CMND/FBCK/MTRS
2=PID PARAMETERS
ANY OTHER=EXIT

Select 1 to calibrate signals.

From the calibration submenu, press 1 to proceed to the next calibration screen. Option 2 should only be selected by someone familiar with the tuning process of a PID controller and the desired response of a proportional steering control system. For additional information refer to the Rudder Feedback Tuning Window description in section [4.1.1](#).

CMND/FBCK/MTR Submenu

CALIBRATION MENU
1=CALIBRATE FEEDBACK
2=CALIBRATE COMMAND
0=EXIT OTHER=NEXT

Select 1 to calibrate rudder feedback unit or 2 to calibrate any analog command input device.

Press any other key to proceed to the next screens adjusting the rudder feedback signal polarity and for calibrating the rudder angle and rudder order indicators.

Calibrate Feedback Submenu

FEEDBACK CALIBRATION
1=HELM NFU
2=KEYPAD NFU
*=EXIT

Select 1 to move the rudder using a FFU input device or 2 to move the rudder using the keypad.

If 1 is selected from the feedback calibration screen, any FFU command input device can be used to move the rudder. The FFU command input device will act like a non follow up input such that if the input device is in the midships position the rudder will remain stationary. When the input device is turned to port or stbd of midships the rudder will move in that direction until the input device is returned to midships, at which time the rudder will stop. If 2 is selected the keypad buttons can be used to move the rudder. Keypad buttons 1, 2 and 3 will move the rudder at increasing speeds in one direction and buttons 4, 5 and 6 will move the rudder at increasing speeds in the opposite direction. Varying the speed of rudder movement is only possible if the system is using a proportional directional valve. Moving the rudder can also be done by any other available mechanical means.

When 1 is selected to move the rudder using a FFU command input device the following screens will be displayed:

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```
SET RUDDER TO CENTER
HELM IS VARIABLE NFU
CENTER=STOP RUDDER
0=SET      OTHERS=EXIT
```

Move rudder to midships position and then press 0 to store the position.

```
RUDDER TO ONE END
HELM IS VARIABLE NFU
CENTER=STOP RUDDER
0=SET      OTHERS=EXIT
```

Move the rudder to one hard over position and then press 0 to store the position.

```
RUDDER TO OTHER END
HELM IS VARIABLE NFU
CENTER=STOP RUDDER
0=SET      OTHERS=EXIT
```

Move the rudder to the opposite hard over position and then press 0 to store the position.

When 2 is selected to move the rudder using the keypad the following screens will be displayed:

```
SET RUDDER TO CENTER
1=-> 2=->-> 3=->->->
4=<- 5=<-<- 6=<-<-<-
0=SET      OTHERS=EXIT
```

Move rudder to midships position and then press 0 to store the position.

```
RUDDER TO ONE END
1=-> 2=->-> 3=->->->
4=<- 5=<-<- 6=<-<-<-
0=SET      OTHERS=EXIT
```

Move the rudder to one hard over position and then press 0 to store the position.

```
RUDDER TO OTHER END
1=-> 2=->-> 3=->->->
4=<- 5=<-<- 6=<-<-<-
0=SET      OTHERS=EXIT
```

Move the rudder to the opposite hard over position and then press 0 to store the position.

After programming the three rudder positions the values will be displayed as similar to the following screen:

```
RUDDER OFFSET/GAIN
OFFSET A GAIN B GAIN
-00250 1.2500 1.2500
0=ACCEPT * =REJECT
```

Press 0 to accept the values or * to reject them and repeat calibration.

After calibrating the rudder position the system will return to the CMND/FBCK/MTR Submenu.

Calibrate Command Submenu

```
ENABLE SCP AND INPUT
TO CALIBRATE. SET
COMMAND TO CENTER.
```

Enable and center the device to be calibrated and then press 0 to store the

```
0 WHEN SET *= EXIT
```

midship position.

```
ENABLE SCP AND INPUT
SET COMMAND TO ONE
END
0 WHEN SET *= EXIT
```

Move the device input to one extreme and then press 0 to store the position.

```
ENABLE SCP AND INPUT
SET COMMAND TO THE
OPPOSITE END
0 WHEN SET *= EXIT
```

Move the device input to the other extreme and then press 0 to store the position.

After programming the three device positions the values will be displayed as similar to the following screen:

```
COMMAND OFFSET/GAIN
OFFSET A GAIN B GAIN
-00250 1.2500 1.2500
0=ACCEPT *=REJECT
```

Press 0 to accept the values or * to reject them and repeat calibration.

After calibrating the input device, the system will return to the CMND/FBCK/MTR Submenu. Each available FFU analog input device will require calibration by following the above steps, enabling each device before programming the three positions.

By proceeding to the next screen following the CMND/FBCK/MTR Submenu a screen will be displayed allowing for selection of the rudder feedback unit polarity.

Feedback Polarity Submenu

```
FEEDBACK POLARITY
IS NORMAL
1=NORMAL 2=INVERTED
ANY OTHER=NEXT
```

If the angle shown on the bottom left line of the display in run mode shows the incorrect rudder direction then the rudder feedback polarity will have to be swapped. Proceed to the next screen for calibrating the rudder angle and rudder order indicators connected to the steering control system.

SCP Meter Adjustment Submenu

ADJUST SCP METERS
 1=CENTER, 2=PORT,
 3=STBD
 ANY OTHER=EXIT

Press 1, 2 or 3 to send the indicators to midships, port hard over or stbd hard over.

For additional information refer to the SCP Meter Calibration Window description in section [4.1.1](#).

USE CENTERING SCREW
 ON METER, SET METER
 TO CENTER.
 ANY KEY=NEXT

Ensure all indicators show midships.

SET ADJUSTMENTS NEXT
 TO THE LIGHTED LED
 FOR METER FULL SCALE
 ANY KEY=NEXT

Adjust indicator gain using the trimmer potentiometers on the MCP circuit board so that indicators show hard over angle.

SET ADJUSTMENTS NEXT
 TO THE LIGHTED LED
 FOR METER FULL SCALE
 ANY KEY=NEXT

Adjust indicator gain using the trimmer potentiometers on the MCP circuit board so that indicators show hard over angle.

4.2.5 Autopilot Menu

The autopilot menu is used to configure the system for various types and settings of interfacing to the vessel's autopilot. In the first screen enter the type of signals used by the autopilot for affecting rudder movement.

Pilot Type Submenu

AUTOPILOT IS (1)
 1=ON-OFF TYPE
 2=ANALOG OUTPUT
 ANY OTHER=NEXT

Press 1 for on-off interfacing or 2 if autopilot can output analog rudder position command signals.

For additional information refer to the Autopilot Configuration Window description in section [4.1.1](#).

If 1 is selected then system will proceed directly to the Autopilot System Configuration screen shown below. If 2 is selected the following screens will be displayed:

AUTOPILOT .22V/DGR
 1=INCREASE V/DEGREE
 2=DECREASE B/DEGREE
 ANY OTHER=NEXT

Press 1 or 2 to increase or decrease sensitivity of analog autopilot signals.

PILOT POLARITY (1)
 1=NORMAL
 2=INVERT

ANY OTHER = NEXT

If the command angle shown in autopilot mode is the incorrect direction then the autopilot polarity will have to be swapped.

CABLE BREAK IS (1) 1=ON 2=OFF ANY OTHER = NEXT

Select 1 to enable monitoring of the autopilot's analog command signals.

AUTOPILOT SYS CFG(0) 0=INDEPENDENT 1=MASTER 2=SLAVE ANY OTHER=NEXT
--

Press 0, 1 or 2 to select the autopilot control options.

For single rudder systems or dual rudder systems independently interfaced to the autopilot select option 0. Options 1 and 2 are used in independent rudder system with only one system interfaced to the autopilot system.

4.2.6 Security Menu

The security menu is used to prevent un-authorized modification of the system parameters. The user can implement password protection using a three digit key. When the security menu is entered one of the following two display screens will be shown:

SECURITY IS DISABLED 1=ENABLE SECURITY 2=ENTER PASSWORD ANY OTHER KEY = EXIT

This screen will be displayed if security is disabled. Press 1 to enable security.

SECURITY IS ENABLED 1=DISABLE SECURITY 2=ENTER PASSWORD ANY OTHER KEY = EXIT

This screen will be displayed if security is enabled. Press 1 to disable security.

To enter a security password press 2 and the following screen will be displayed:

ENTER THREE DIGIT PASSWORD # OR * = EXIT
--

Enter three digits for security password.

After three digits have been entered the system will return to the initial setup screen.

When security is enabled the user will be prompted for the password when entering the keypad setup mode. Upon entering keypad setup mode the following screen will be displayed:

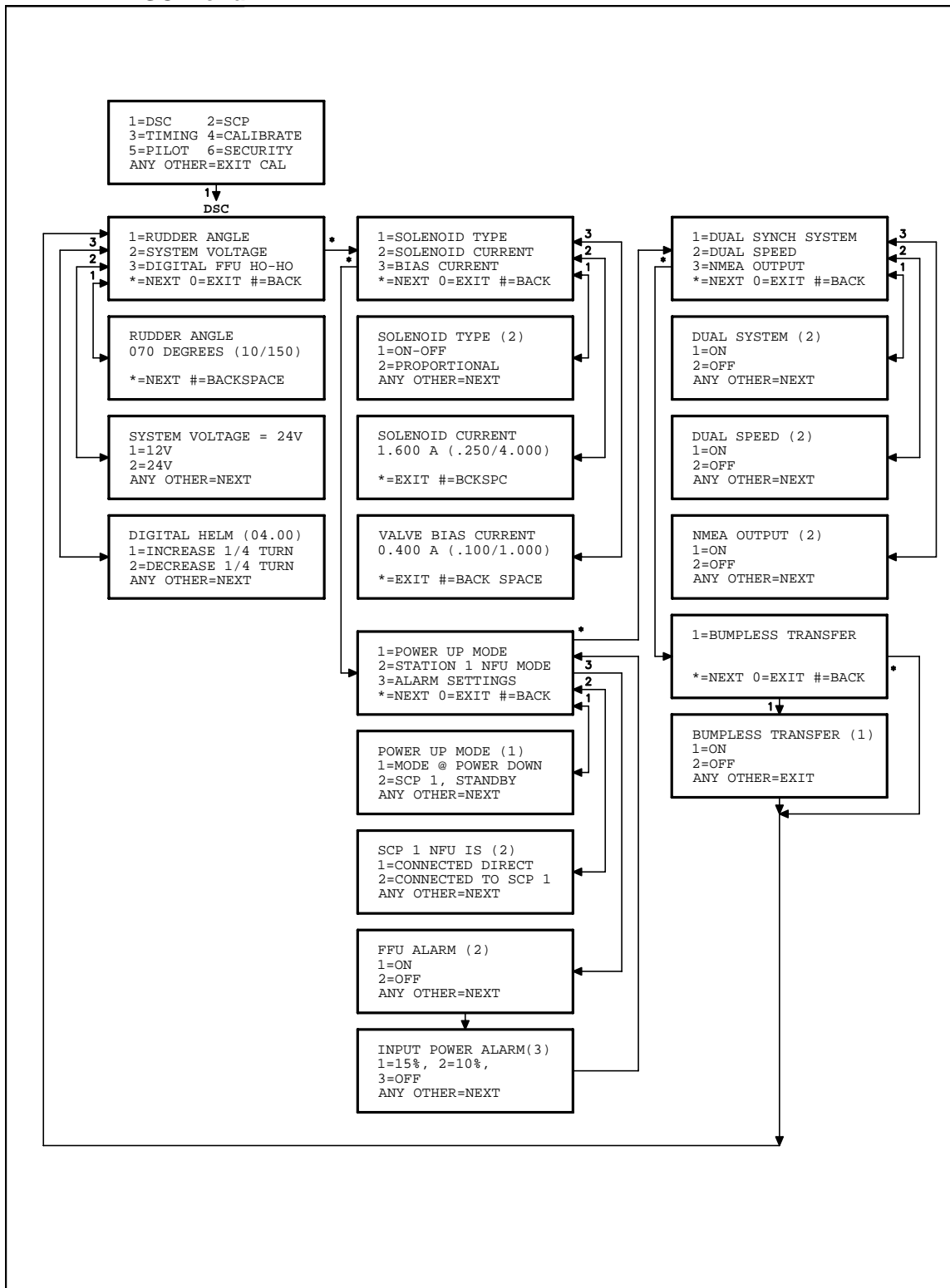
ENTER THREE DIGIT
PASSWORD TO PROCEED.

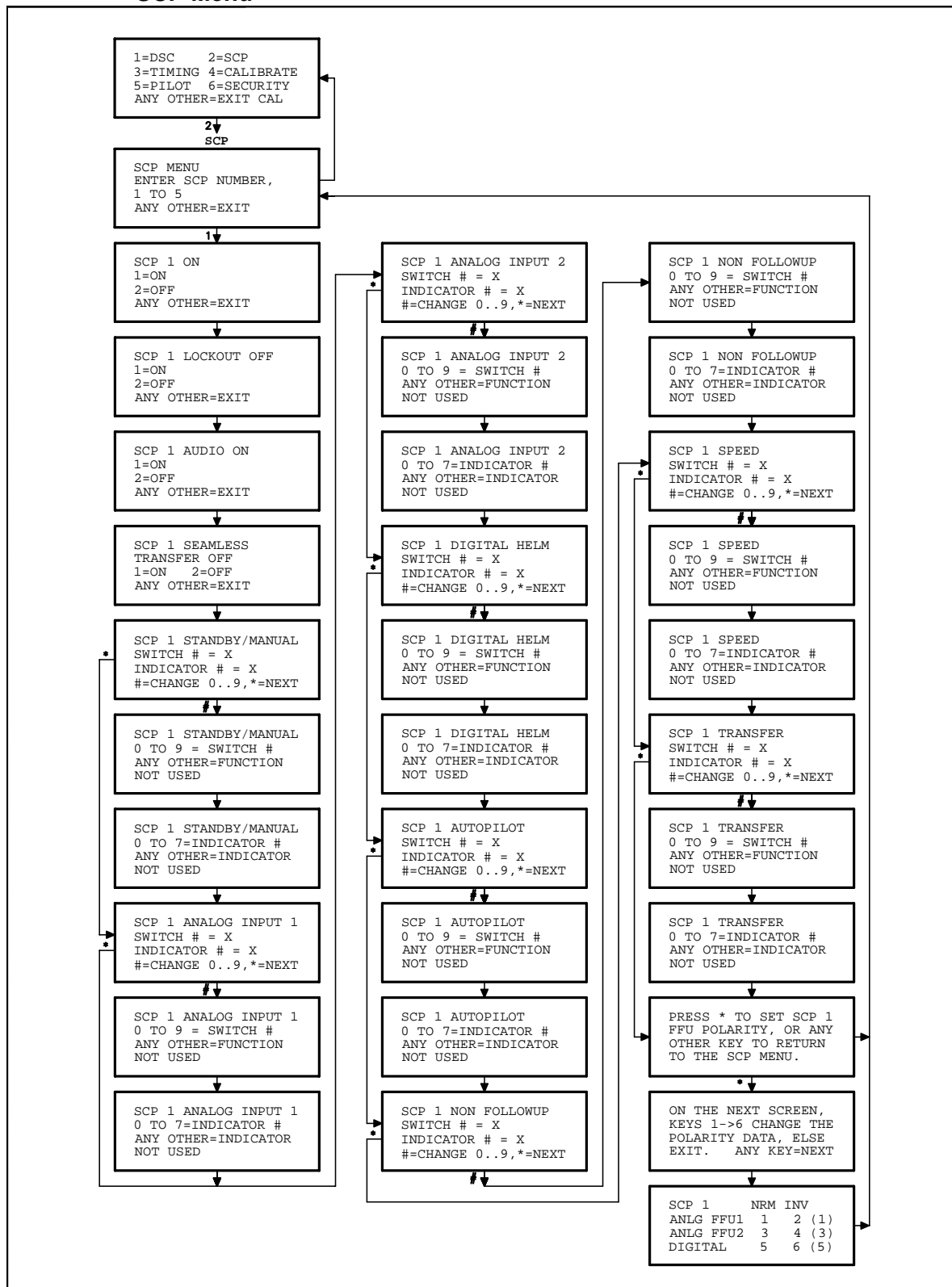
ILLEGAL KEY = EXIT.

If the correct password is entered the system will proceed to the initial setup screen. If the password entered is incorrect the system will return to run mode and changes to the system parameters will not be permitted.

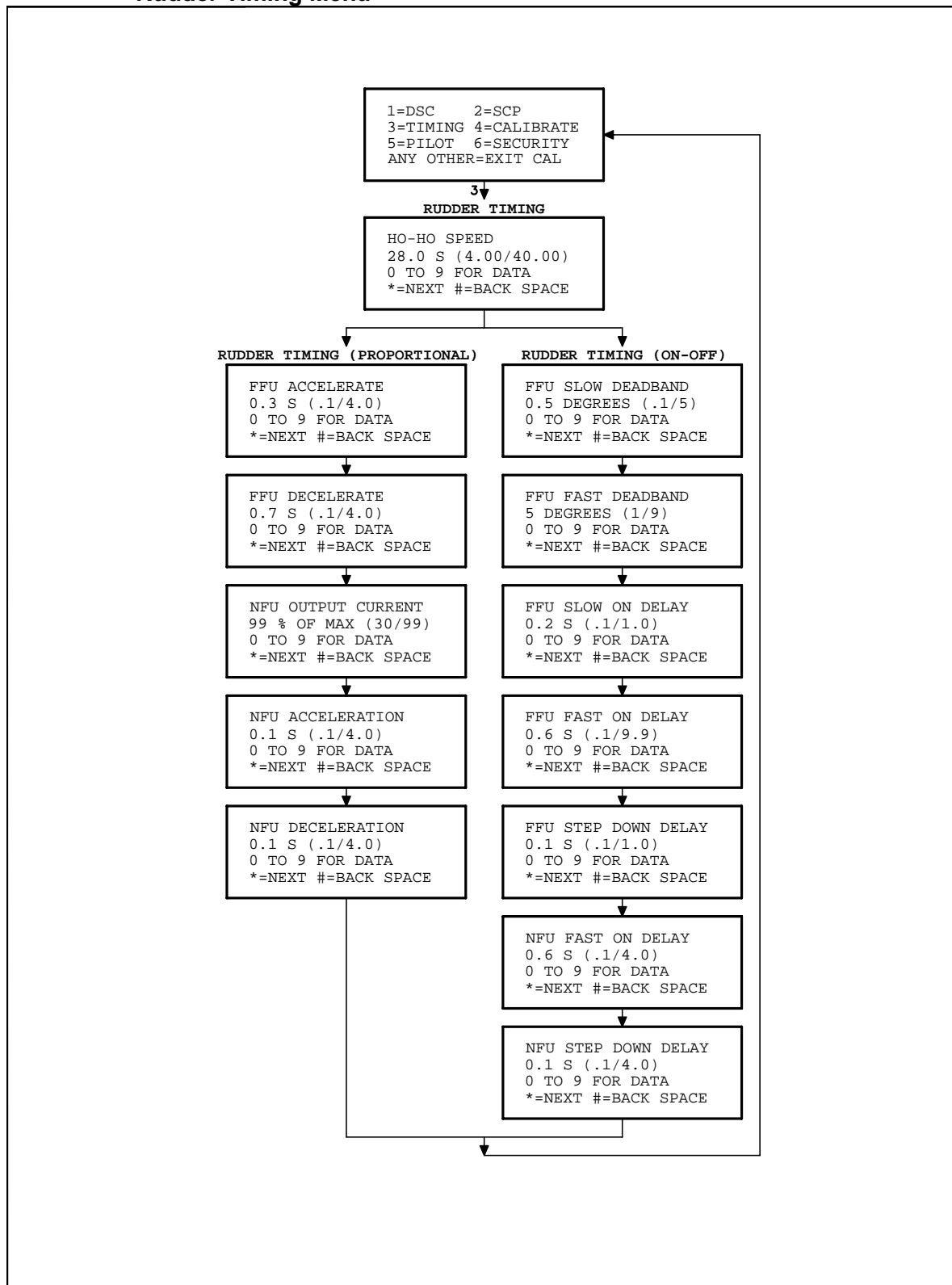
4.2.7 Keypad Setup Flowcharts

DSC Menu





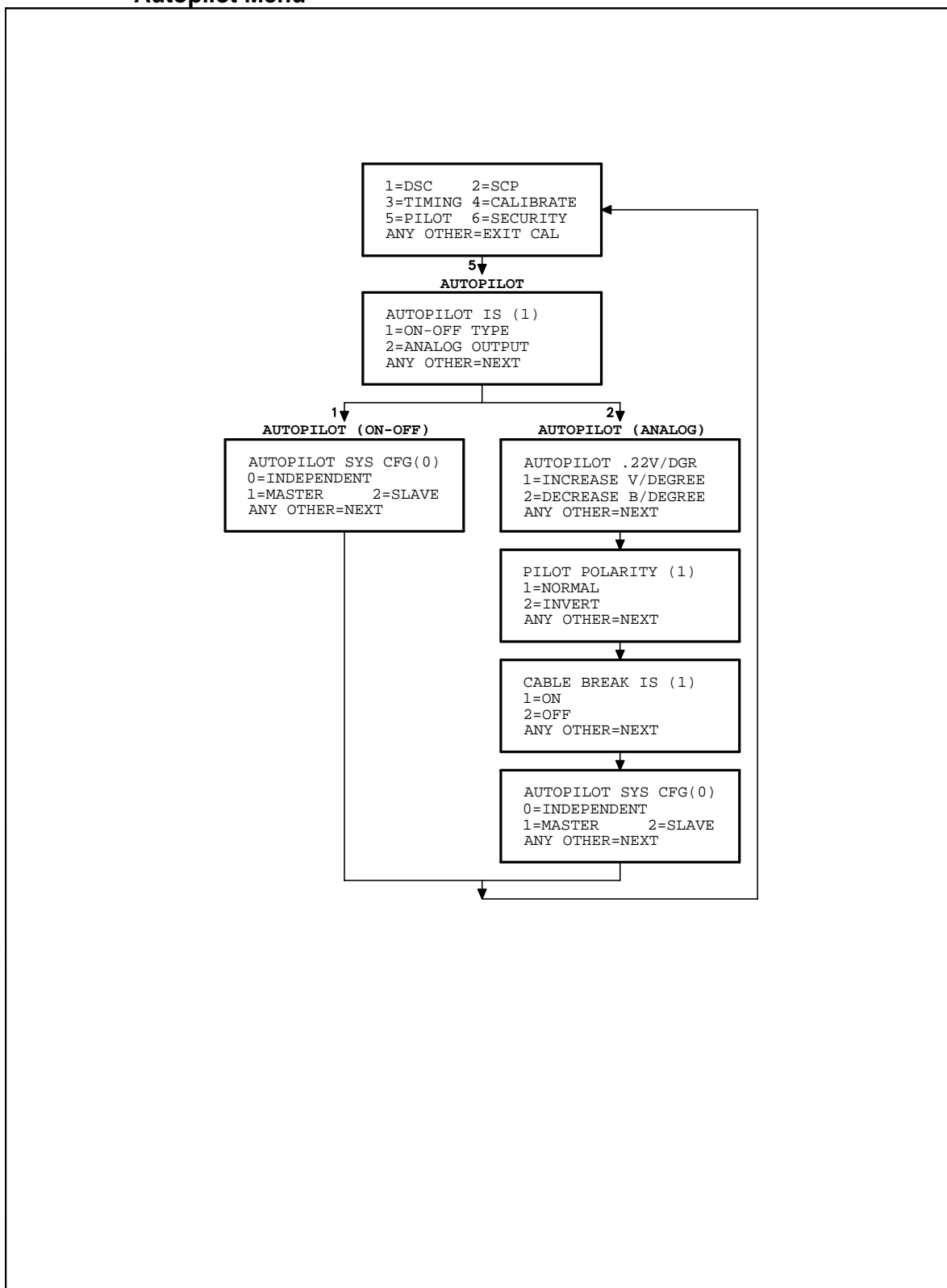
Rudder Timing Menu



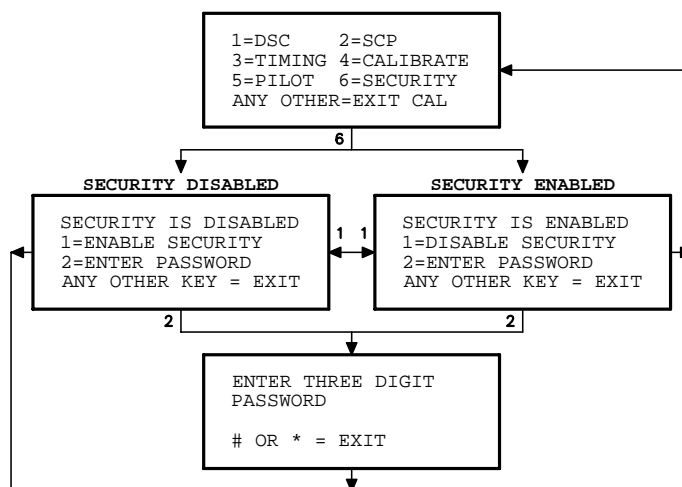

```

graph TD
    Start([START]) --> Menu1[1=DSC 2=SCP  
3=TIMING 4=CALIBRATE  
5=PILOT 6=SECURITY  
ANY OTHER=EXIT CAL]
    Menu1 -- 4 --> CalibMenu[4  
CALIBRATION  
CALIBRATION MENU  
1=CAL CMND/FBCK/MTRS  
2=PID PARAMETERS  
ANY OTHER=EXIT]
    CalibMenu -- 1 --> Menu2[1  
CALIBRATION MENU  
1=CALIBRATE FEEDBACK  
2=CALIBRATE COMMAND  
*=EXIT OTHER=NEXT]
    CalibMenu -- 2 --> PidMenu[PID PARAMETERS  
1=CURRENT OUTPUT  
2=RUDDER FEEDBACK  
ANY OTHER=EXIT]
    Menu2 -- 1 --> FeedbackCal[FEEDBACK CALIBRATION  
1=HELM NFU  
2=KEYPAD NFU  
*=EXIT]
    Menu2 -- 2 --> EnableSCP1[2  
ENABLE SCP AND INPUT  
TO CALIBRATE. SET  
COMMAND TO CENTER.  
0 WHEN SET *=EXIT]
    FeedbackCal -- 2 --> SetRudderC[2  
SET RUDDER TO CENTER  
1=-> 2=->-> 3=->->->  
4=-<- 5=-<-<- 6=-<-<-<-  
0=SET OTHERS=EXIT]
    SetRudderC -- 0 --> RudderOne[0  
RUDDER TO ONE END  
1=-> 2=->-> 3=->->->  
4=-<- 5=-<-<- 6=-<-<-<-  
0=SET OTHERS=EXIT]
    RudderOne -- 0 --> RudderOther[0  
RUDDER TO OTHER END  
1=-> 2=->-> 3=->->->  
4=-<- 5=-<-<- 6=-<-<-<-  
0=SET OTHERS=EXIT]
    RudderOther -- 0 --> RudderOffset1[0  
RUDDER OFFSET/GAIN  
OFFSET A GAIN B GAIN  
-00250 1.2500 1.2500  
0=ACCEPT *=REJECT]
    EnableSCP1 -- 0 --> EnableSCP2[0  
ENABLE SCP AND INPUT  
SET COMMAND TO ONE  
END  
0 WHEN SET *=EXIT]
    EnableSCP2 -- 0 --> EnableSCP3[0  
ENABLE SCP AND INPUT  
SET COMMAND TO THE  
OPPOSITE END  
0 WHEN SET *=EXIT]
    EnableSCP3 -- 0 --> CommandOffset[0  
COMMAND OFFSET/GAIN  
OFFSET A GAIN B GAIN  
-00250 1.2500 1.2500  
0=ACCEPT *=REJECT]
    CommandOffset -- 0 --> FeedbackPolarity[0  
FEEDBACK POLARITY  
IS NORMAL  
1=NORMAL 2=INVERTED  
ANY OTHER=NEXT]
    FeedbackPolarity -- 3 --> AdjustSCP[3  
ADJUST SCP METERS  
1=CENTER, 2=PORT,  
3=STBD  
ANY OTHER=NEXT]
    AdjustSCP -- 2 --> CenteringScrew[2  
USE CENTERING SCREW  
ON METER, SET METER  
TO CENTER.  
ANY KEY=NEXT]
    CenteringScrew -- 1 --> SetAdjustments1[1  
SET ADJUSTMENTS NEXT  
TO THE LIGHTED LED  
FOR METER FULL SCALE  
ANY KEY=NEXT]
    SetAdjustments1 -- 1 --> SetAdjustments2[1  
SET ADJUSTMENTS NEXT  
TO THE LIGHTED LED  
FOR METER FULL SCALE  
ANY KEY=NEXT]
    SetAdjustments2 -- 1 --> SetRudderC
    SetAdjustments2 -- 2 --> RudderPTerm[2  
RUDDER P-TERM  
012.00000  
0 TO 9 FOR DATA  
*=EXIT #=BACK SPACE]
    SetAdjustments2 -- 3 --> RudderITerm[3  
RUDDER I-TERM  
000.00000  
0 TO 9 FOR DATA  
*=EXIT #=BACK SPACE]
    SetAdjustments2 -- 1 --> RudderDTerm[1  
RUDDER D-TERM  
001.00000  
0 TO 9 FOR DATA  
*=EXIT #=BACK SPACE]
    SetAdjustments2 -- 0 --> RudderOffset2[0  
RUDDER OFFSET/GAIN  
OFFSET A GAIN B GAIN  
-00250 1.2500 1.2500  
0=ACCEPT *=REJECT]
    RudderOffset2 -- 0 --> SetRudderC
    RudderPTerm -- 2 --> RudderITerm
    RudderITerm -- 2 --> RudderDTerm
    RudderDTerm -- 2 --> PidMenu
    RudderPTerm -- 1 --> PidMenu
    RudderITerm -- 1 --> PidMenu
    RudderDTerm -- 1 --> PidMenu
    RudderPTerm -- 0 --> PidMenu
    RudderITerm -- 0 --> PidMenu
    RudderDTerm -- 0 --> PidMenu
    PidMenu -- 1 --> PidParams1[1  
PID PARAMETERS  
1=P-TERM, 2=I-TERM,  
3=D-TERM  
ANY OTHER=NEXT]
    PidParams1 -- 3 --> PTerm[3  
CURRENT P-TERM  
002.00000  
0 TO 9 FOR DATA  
*=EXIT #=BACK SPACE]
    PidParams1 -- 2 --> ITerm[2  
CURRENT I-TERM  
000.00399  
0 TO 9 FOR DATA  
*=EXIT #=BACK SPACE]
    PidParams1 -- 1 --> DTerm[1  
CURRENT D-TERM  
000.00000  
0 TO 9 FOR DATA  
*=EXIT #=BACK SPACE]
    PTerm -- 3 --> PidParams2[3  
PID PARAMETERS  
1=P-TERM, 2=I-TERM  
3=D-TERM  
ANY OTHER=EXIT]
    ITerm -- 2 --> PidParams2
    DTerm -- 1 --> PidParams2
    PidParams2 -- 3 --> RudderPTerm
    PidParams2 -- 2 --> RudderITerm
    PidParams2 -- 1 --> RudderDTerm
    PidParams2 -- 0 --> PidMenu
  
```

Autopilot Menu



Security Menu



4.3 DSC RUN MODE

4.3.1 Display Screen

While operating in the run mode the LCD screen on the DSC shows a number of pieces of valuable information.



The first line on the left displays the current FFU rudder position command angle. When the input device is moved to port a P will be displayed in front of the angle. If this is not the case the input device polarity can be changed using the SCP configuration window. If a problem exists with connections of the selected input device, 'C BRK' will be displayed in place of the angle.

The second line on the left displays the currently active station number and mode of steering control.

The third line on the left displays the value of the signal being sent to the four-way directional solenoid valve. This value is displayed in amps. When the DSC is turning the rudder to port a P will be displayed in front of the current value. If this is not the case, connections to the directional valve's port and starboard solenoids must be swapped.

The fourth line on the left displays the current rudder position. When the rudder is to port of midships a P will be displayed in front of the angle. If this is not the case the feedback signal polarity can be changed using the Rudder Feedback Configuration window. If the angle displayed on this line is not the same as the actual angular position of the rudder then the rudder feedback signal must be calibrated. If a problem exists with connections of the selected feedback unit, 'C BRK' will be displayed in place of the angle.

If the system has any current or stored errors the words 'SYS ERROR' will appear in the first line on the right side of the display. In order to scroll through any stored error codes any button on the keypad can be pressed. The stored error codes will be displayed in the second line. Refer to the next section for a description of the error codes.

The third line on the right of the display shows the status of specific solenoid signals. When the letter designation of a particular solenoid is displayed its output is one. Status of the following solenoids is displayed:

P = Port on-off directional solenoid

S = Starboard on-off directional solenoid

H = High Speed on-off solenoid



B = Bypass solenoid of digital helm manifold
L = Limit solenoid of digital helm manifold

The fourth line on the right of the shows the current level of the power supply connected to the DSC.

4.3.2 Error Codes

To scroll through stored error codes press any key on DSC while in run mode.

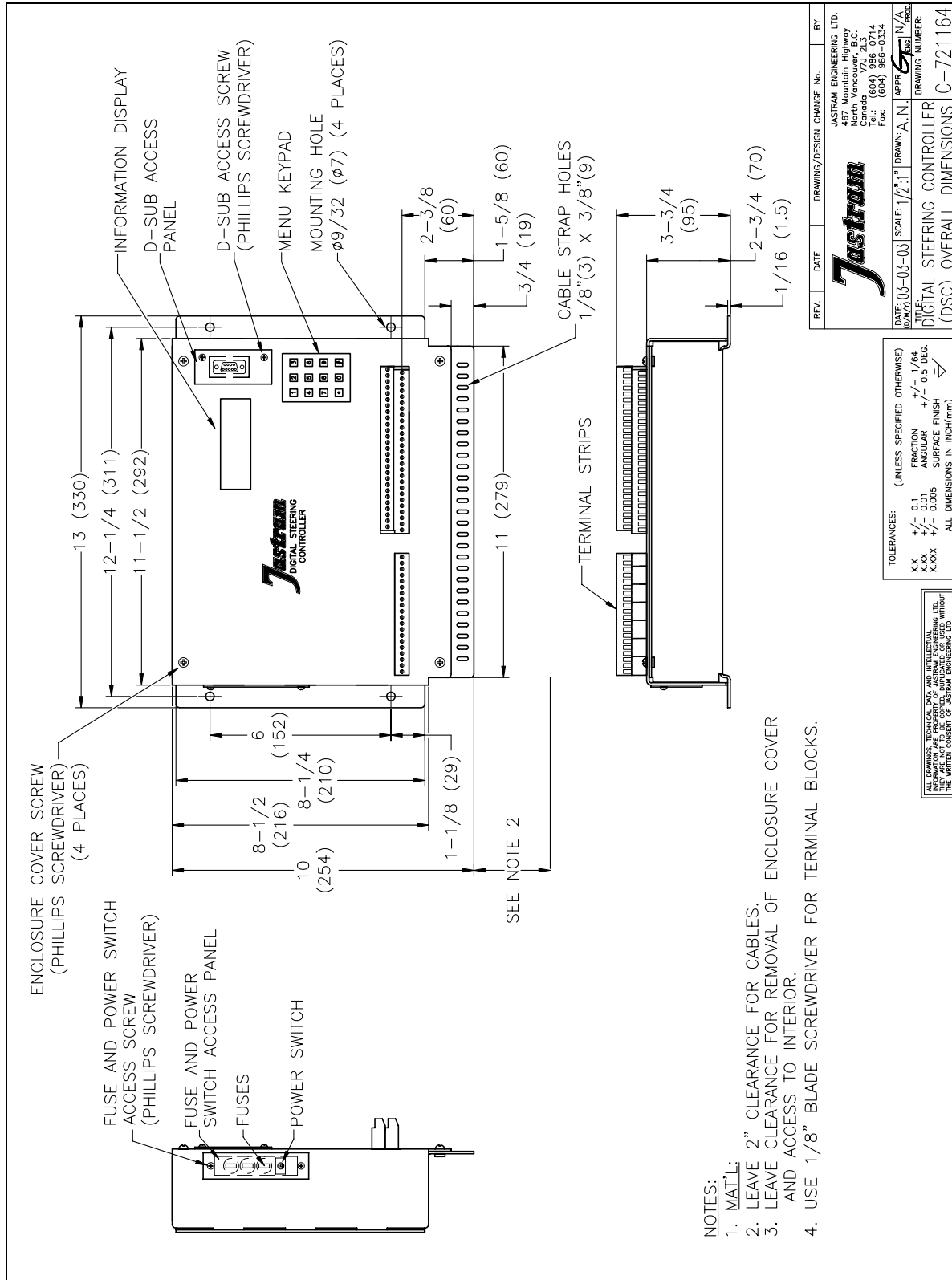
To clear old error codes enter DSC Keypad Setup by holding down any key while applying power. Stored alarm codes are cleared upon exiting Keypad Setup.

Up to eight alarm codes will be stored in DSC memory. After eight alarm codes have been stored, oldest alarm codes in DSC memory will be replaced by new alarm codes.

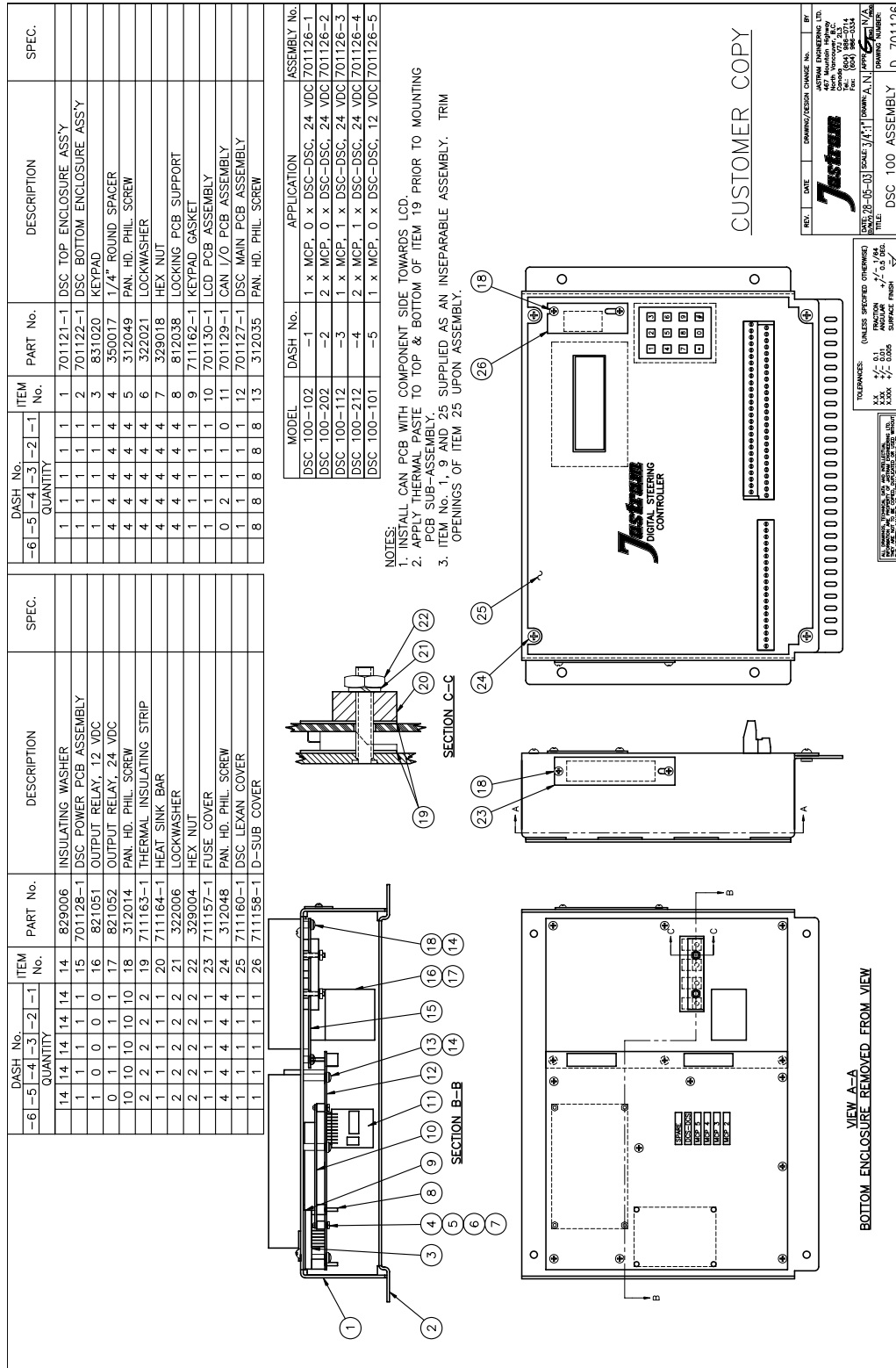
CODE	DESCRIPTION
PWR SUP	POWER SUPPLY INPUT OUT OF RANGE
FLW UP FL	RUDDER NOT FOLLOWING UP TO COMMANDED POSITION
AP ACK	AUTOPILOT ACKNOWLEDGE SIGNAL LOST
AP CB	AUTOPILOT COMMAND CABLE BREAK
FBK CB	RUDDER FEEDBACK SIGNAL CABLE BREAK
SCP1 COM	STATION CONTROL PROCESSOR #1 COMMUNICATION FAULT
CB S1 A1	CABLE BREAK, STATION #1, ANALOG COMMAND INPUT #1
CB S1 A2	CABLE BREAK, STATION #1, ANALOG COMMAND INPUT #2
CB S1 DH	CABLE BREAK, STATION #1, DIGITAL HELM COMMAND INPUT
SCP2 COM	STATION CONTROL PROCESSOR #2 COMMUNICATION FAULT
CB S2 A1	CABLE BREAK, STATION #2, ANALOG COMMAND INPUT #1
CB S2 A2	CABLE BREAK, STATION #2, ANALOG COMMAND INPUT #2
CB S2 DH	CABLE BREAK, STATION #2, DIGITAL HELM COMMAND INPUT
SCP3 COM	STATION CONTROL PROCESSOR #3 COMMUNICATION FAULT
CB S3 A1	CABLE BREAK, STATION #3, ANALOG COMMAND INPUT #1
CB S3 A2	CABLE BREAK, STATION #3, ANALOG COMMAND INPUT #2
CB S3 DH	CABLE BREAK, STATION #3, DIGITAL HELM COMMAND INPUT
SCP4 COM	STATION CONTROL PROCESSOR #4 COMMUNICATION FAULT
CB S4 A1	CABLE BREAK, STATION #4, ANALOG COMMAND INPUT #1
CB S4 A2	CABLE BREAK, STATION #4, ANALOG COMMAND INPUT #2
CB S4 DH	CABLE BREAK, STATION #4, DIGITAL HELM COMMAND INPUT
SCP5 COM	STATION CONTROL PROCESSOR #5 COMMUNICATION FAULT
CB S5 A1	CABLE BREAK, STATION #5, ANALOG COMMAND INPUT #1
CB S5 A2	CABLE BREAK, STATION #5, ANALOG COMMAND INPUT #2
CB S5 DH	CABLE BREAK, STATION #5, DIGITAL HELM COMMAND INPUT

5 DRAWINGS

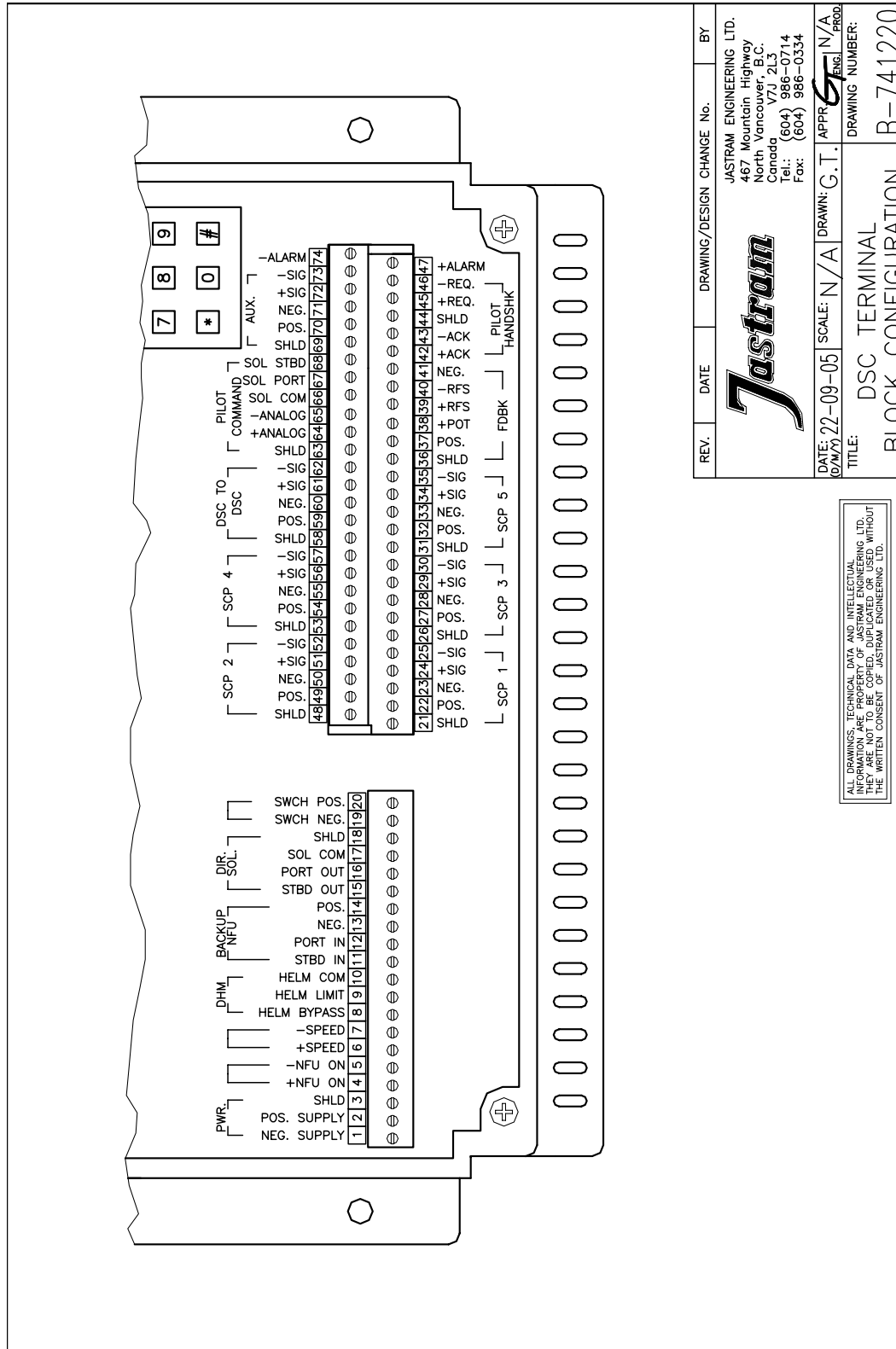
- 5.1 DSC OVERALL DIMENSIONS
- 5.2 DSC ASSEMBLY
- 5.3 DSC TERMINAL BLOCK CONFIGURATION
- 5.4 DSC SHIELD CONNECTION CONFIGURATION
- 5.5 DSC BACKUP NFU SIMPLIFIED ELECTRICAL SCHEMATIC
- 5.6 DSC BACKUP NFU RHEOSTAT MOUNTING ARRANGEMENT
- 5.7 DIGITAL HELM & MANIFOLD HYDRAULIC SCHEMATIC
- 5.8 MCP OVERALL DIMENSIONS
- 5.9 MCP TERMINAL BLOCK CONFIGURATIONS



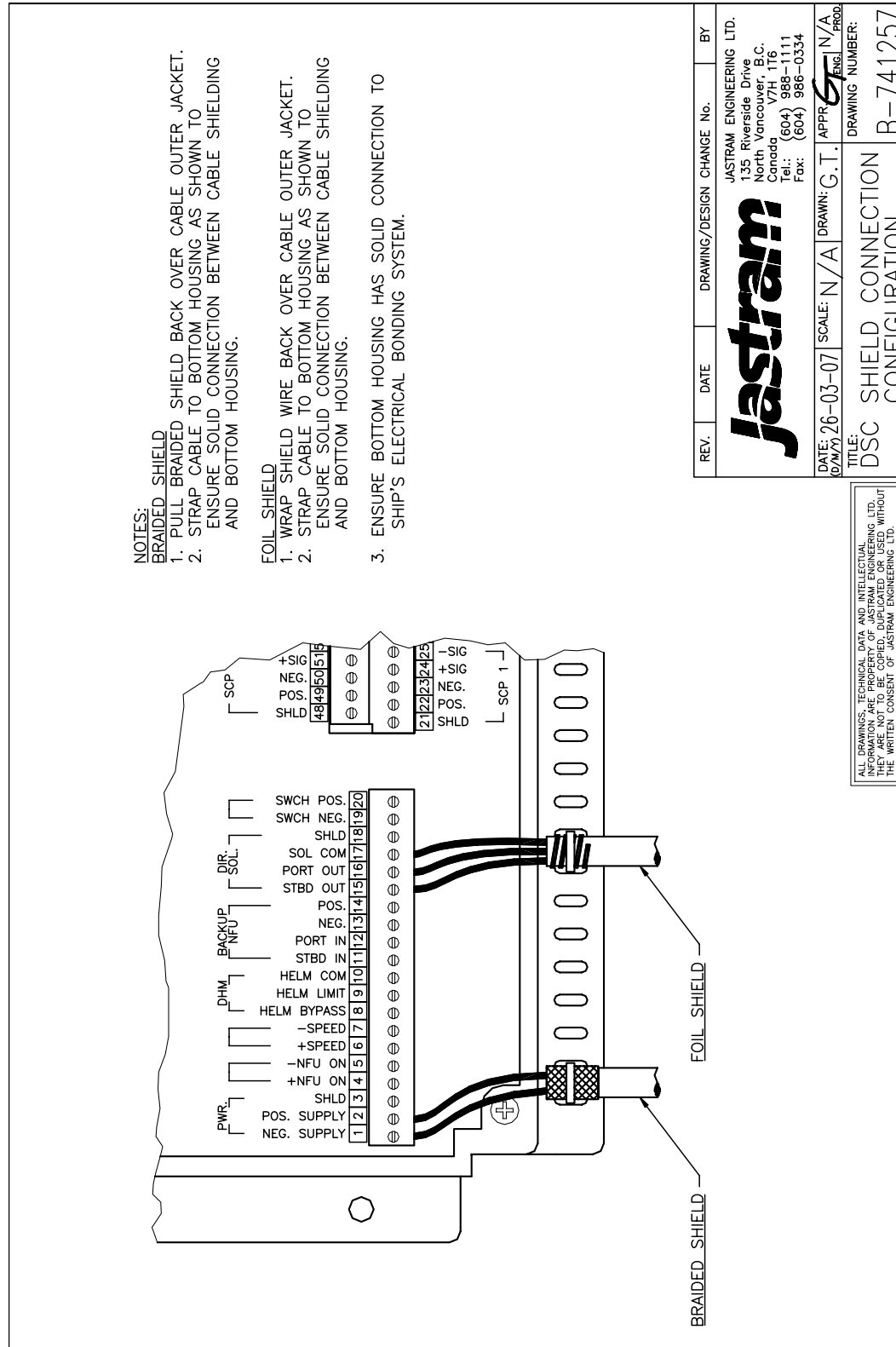
5.1 DSC OVERALL DIMENSIONS



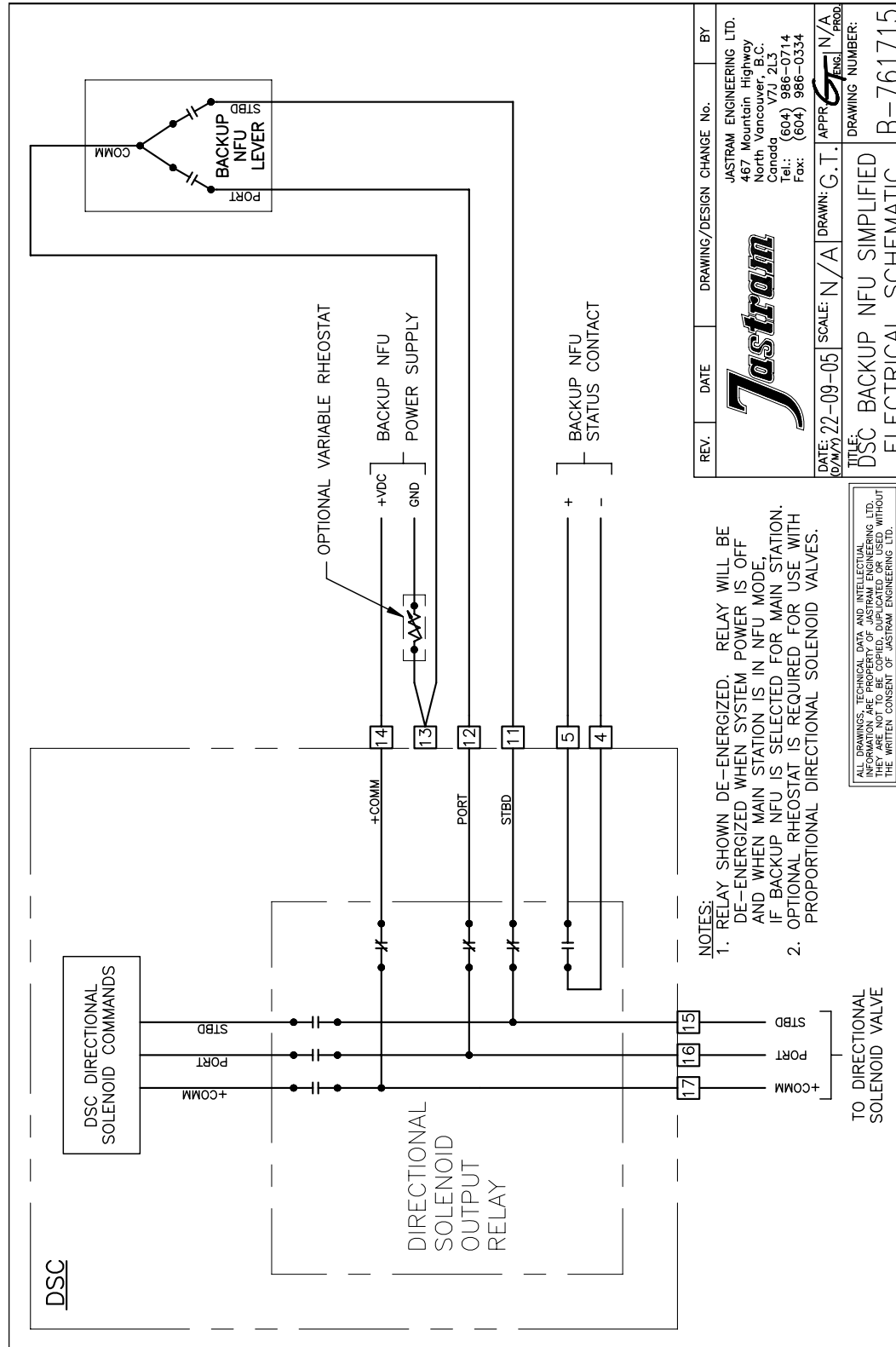
5.2 DSC ASSEMBLY



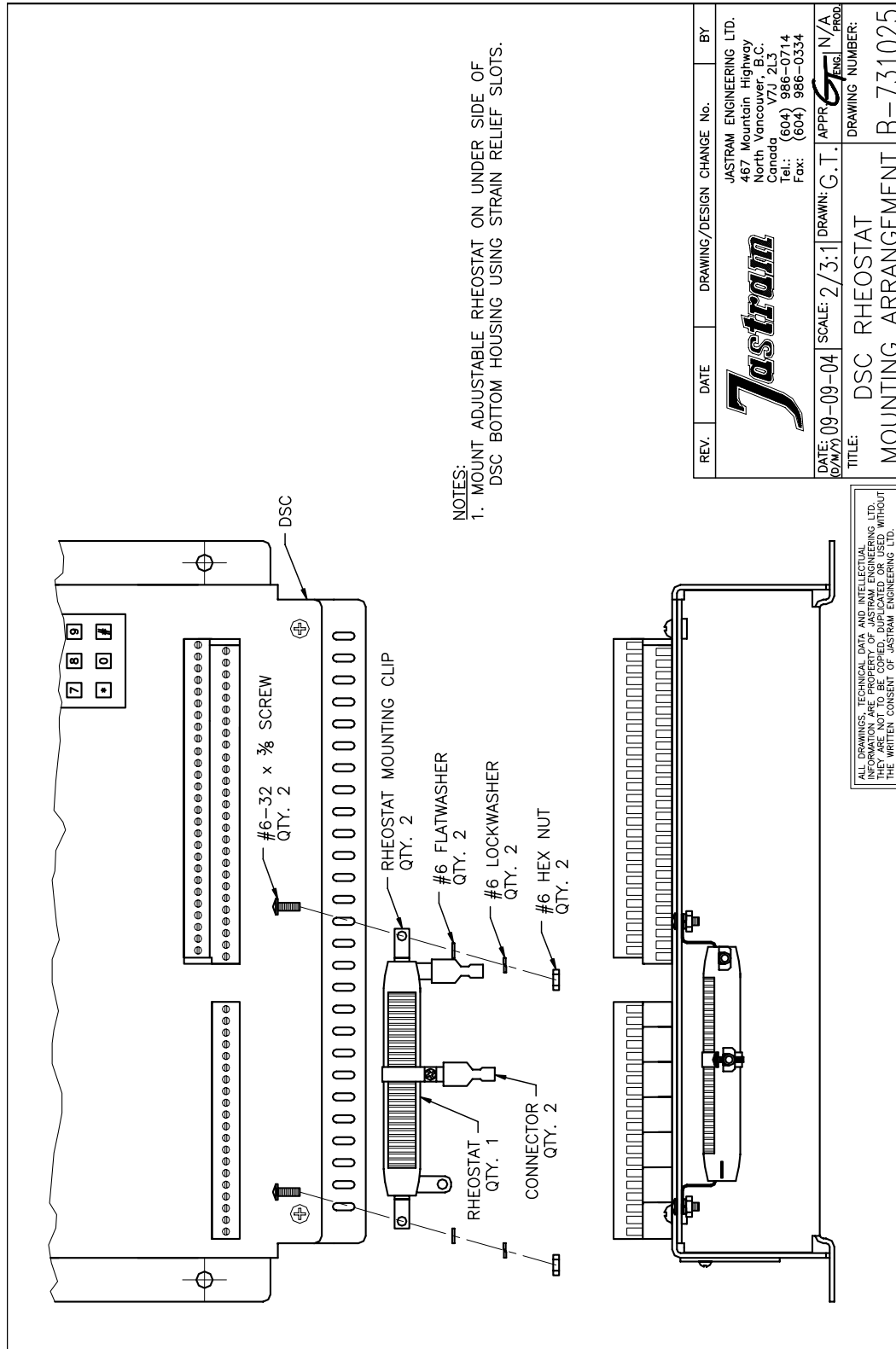
5.3 DSC TERMINAL BLOCK CONFIGURATION



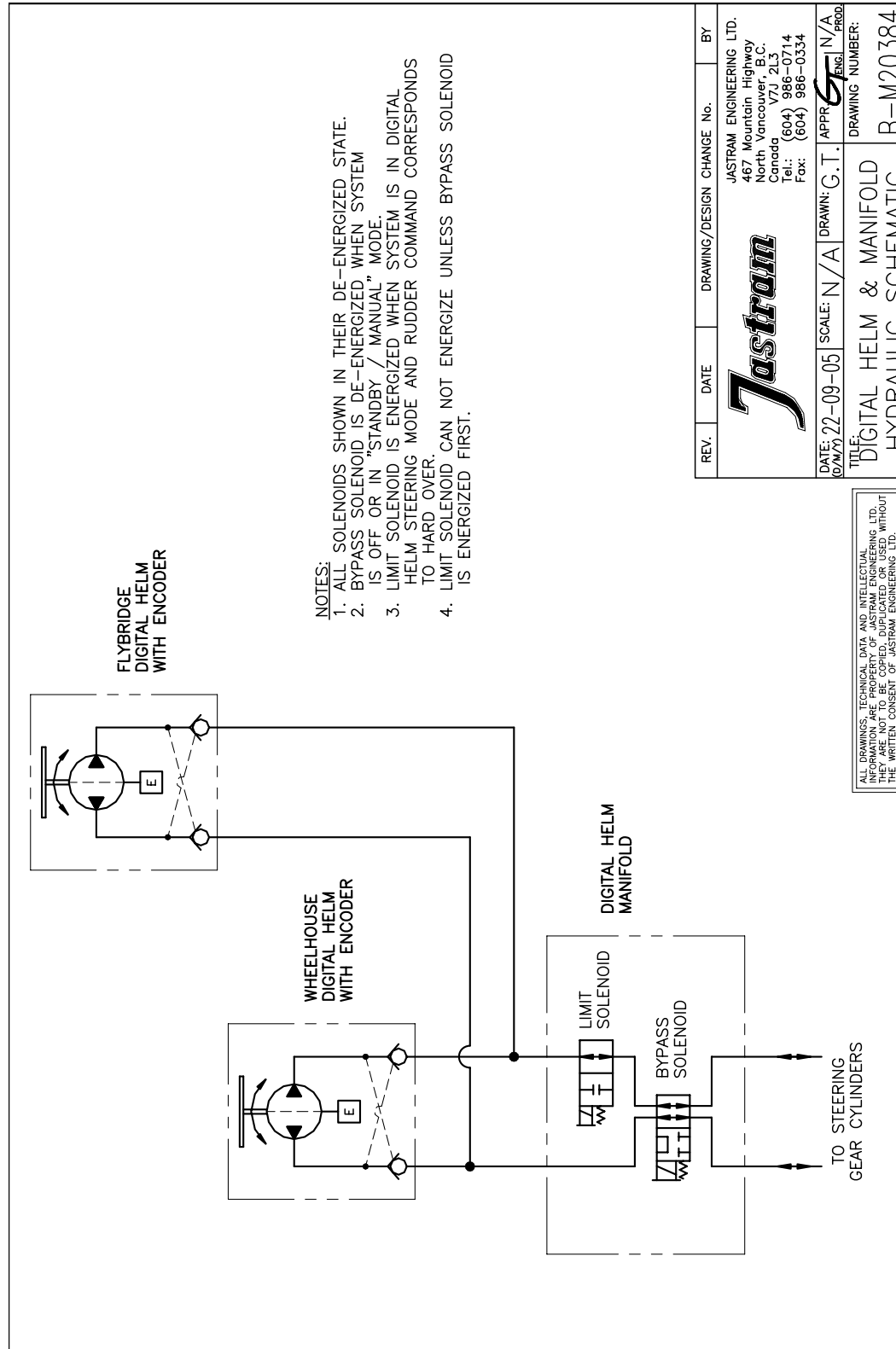
5.4 DSC SHIELD CONNECTION CONFIGURATION



5.5 DSC BACKUP NFU SIMPLIFIED SCHEMATIC



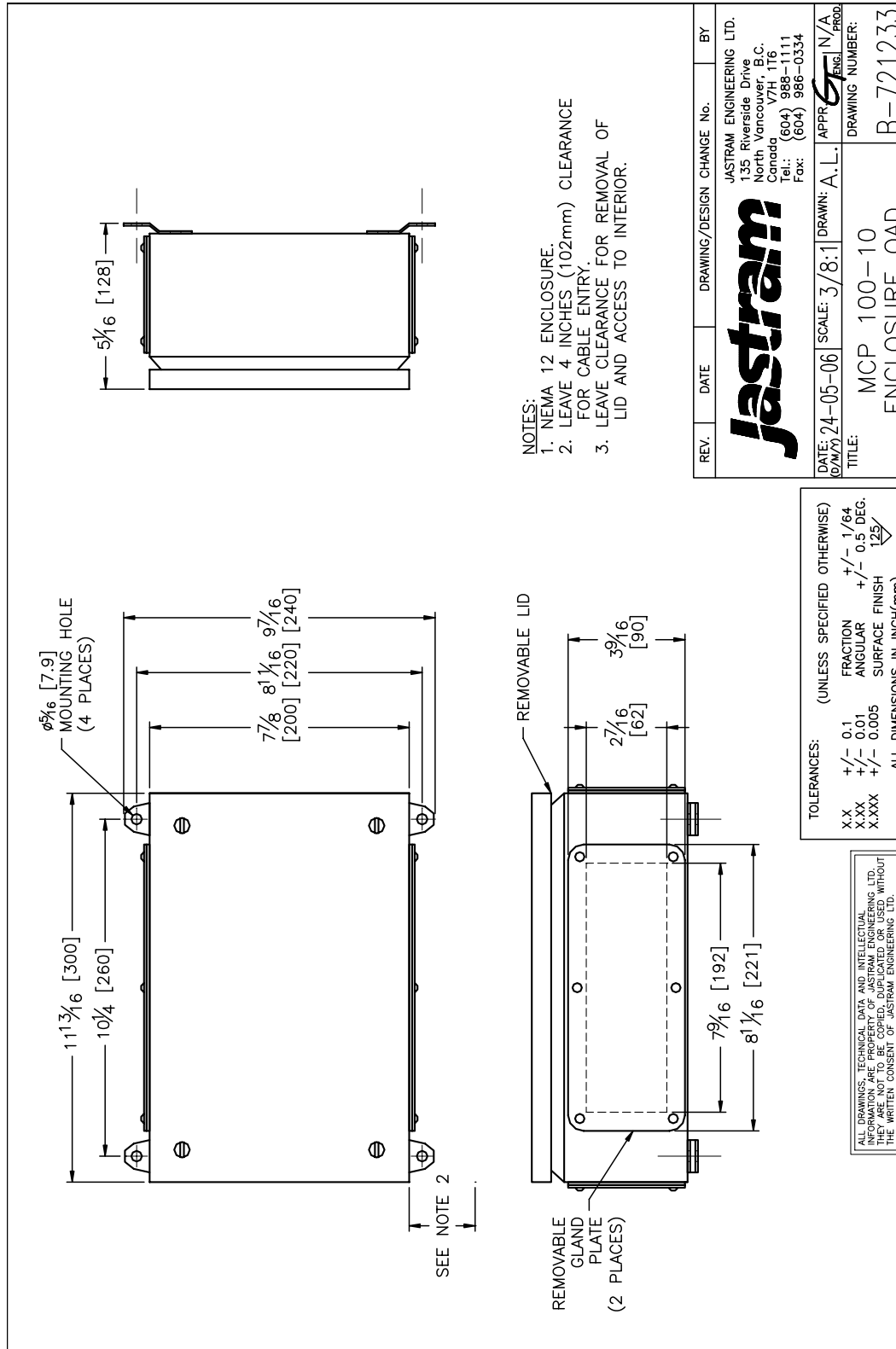
5.6 DSC BACKUP NFU RHEOSTAT MOUNTING ARRANGEMENT



5.7 DIGITAL HELM & MANIFOLD HYDRAULIC SCHEMATIC

DRAWINGS

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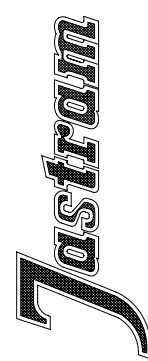

5.8 MCP OVERALL DIMENSIONS

BOTTOM		TOP		BOTTOM	
INDICATORS	SHIELD +V SUP AUDIO BACKLIGHT LOCK OUT FAULT	1 2 3 4 5 6 7 8 9 10 11 12 13 14	TB12	COMM TO DSC	1 2 3 4 5
	IND. 0 IND. 1 IND. 2 IND. 3 IND. 4 IND. 5 IND. 6 IND. 7	1 2 3 4 5 6 7 8 9 10 11 12 13 14	TB11		SHIELD POS. NEG. +SIG. -SIG.
BUTTONS		SHIELD DIM UP DIM DOWN BUTTON 0 BUTTON 1 BUTTON 2 BUTTON 3 BUTTON 4 BUTTON 5 BUTTON 6 BUTTON 7 BUTTON 8 BUTTON 9		FFU 1	1 2 3 4 5
				NFU	SHIELD +V 1 ROS 1 GND
				FFU ROI	NFU COM NFU PORT NFU STBD
				LAMPS	SHIELD FU +ROI FU -ROI
					+V SUP +V SUP -LAMP GND SHIELD
					SHIELD DH +ROI DH -ROI
					SHIELD POS. NEG. +SIG. -SIG
					DH ROI
					AUX. COMM
					RAI
					FFU 2
					DIGITAL HELM

NOTES:

- MCP 100-10 CONTAINS A SINGLE PRINTED CIRCUIT BOARD FOR USE WITH A SINGLE STEERING CONTROL SYSTEM.
- MCP 100-20 CONTAINS TWO COMPLETELY INDEPENDENT AND IDENTICAL PRINTED CIRCUIT BOARDS FOR USE WITH A DUAL, UNIT 1 & UNIT 2 OR INDEPENDENT, PORT & STBD STEERING CONTROL SYSTEM.

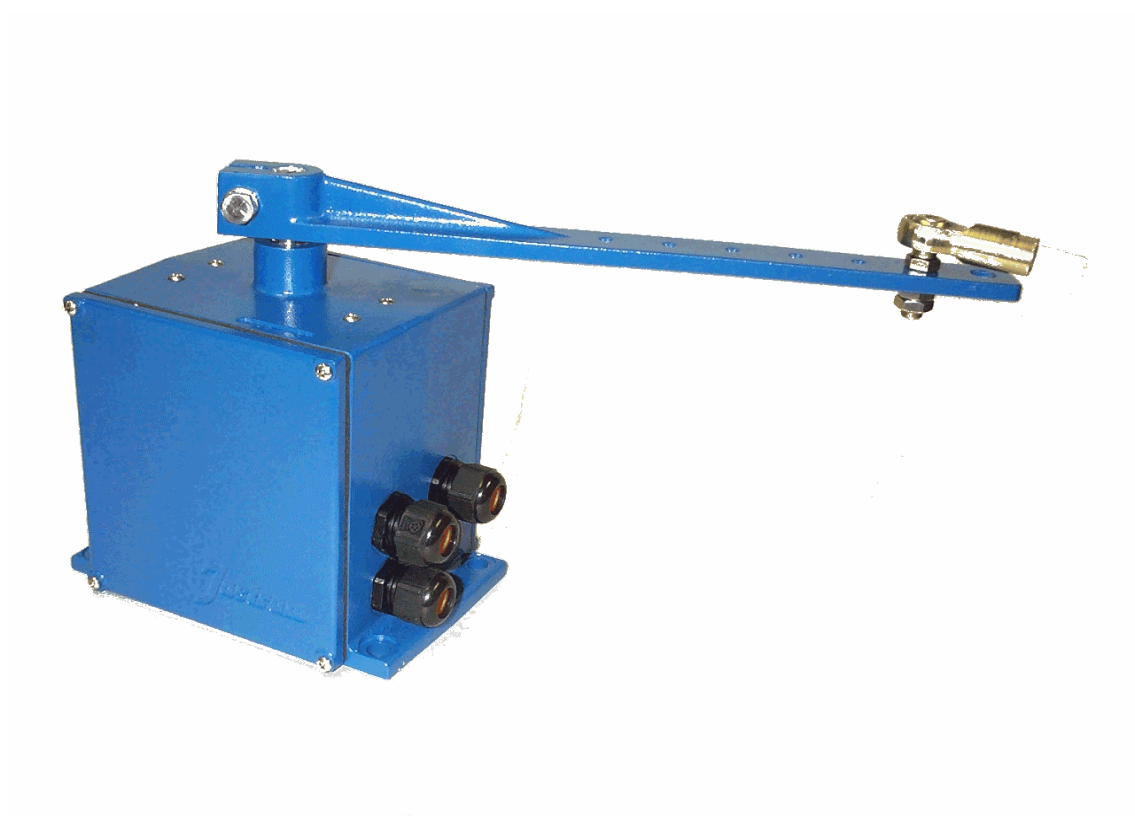
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TITLE: MCP TERMINAL BLOCK CONFIGURATION			DRAWING NUMBER: A-741204	

5.9 MCP TERMINAL BLOCK CONFIGURATION

Component Manual

**Rudder Feedback Unit
Model: RFU 2000**



Document No.: MAN01208

Revision: -

This manual is subject to change without prior notice.



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1 INTRODUCTION

1.1 Description

The RFU is mechanically linked to the ship's rudder and converts the position of the rudder into electronic signals. One type of signal that the RFU 2000 can output is used by a rudder angle indicator (RAI) to display the rudder position to the vessel's operators; this signal is referred to as the rudder angle signal. Another signal output by the RFU 2000 can be used by a full follow-up solenoid controller as a rudder position reference; this reference signal is referred to as the rudder feedback signal. The RFU 2000 can output one rudder angle signal and up to three rudder feedback signals or up to four rudder feedback signals when no rudder angle indicator signal is needed.

To generate a rudder angle signal, Jastram's RFU 2000 operates in "stand alone" mode. The RFU contains a circuit board that regulates its own power supply. This configuration ensures that all electronic circuitry necessary to develop a rudder angle signal is contained within the RFU. The separation of this circuitry from the rudder feedback signals ensures an accurate rudder angle indicator signals regardless of the status of the other devices connected to the RFU.

Two types of devices are available in the RFU 2000 to generate the rudder feedback signal; the standard is a potentiometer type. An optional contact free Hall Effect is also available. To accommodate other special potentiometer models or steering gear angles greater than 47 degrees, please contact the factory.

Jastram's RFU 2000 also contains one or optionally two sets of limit switches which electrically cut off the solenoid controller's signal to the 4-way hydraulic solenoid valve at the rudder's hardover positions. These hardover limit switches prevent possible damage to the steering gear (see Fig. 1).

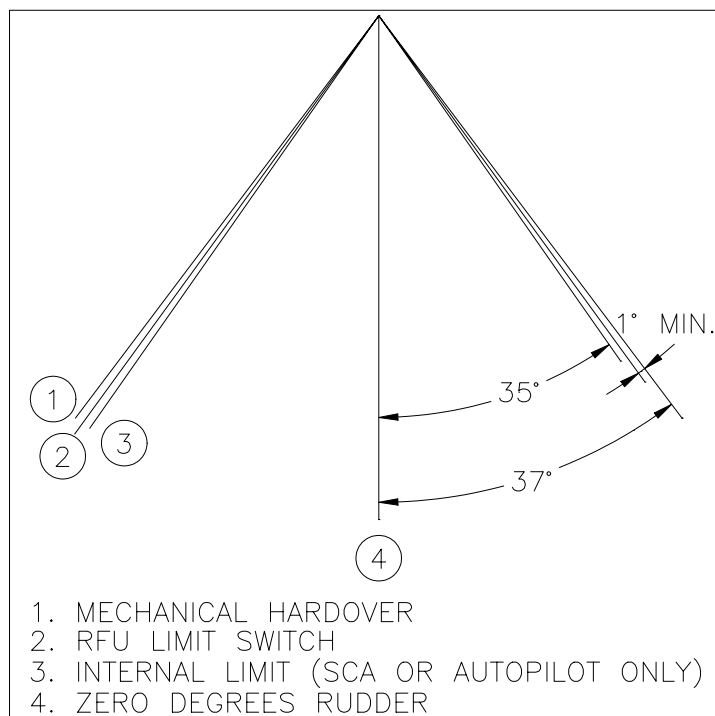


Figure 1 – Typical Rudder Travel Limits (Angles may vary)

The solenoid controller's signal for an optional fast speed 2-way solenoid valve used in some systems is accommodated in the RFU 2000's cabling layout. The 2-way solenoid controller signal is passed through the RFU along with the port and starboard signals to the 4-way solenoid valve. This signal is unaffected by the limit switches.

1.2 Specifications

Enclosure

All Metal Box Construction
 Tough Powder Coat Paint
 Stainless Steel Shaft
 Extra Long Shaft Bushing
 Water-Tight Cable Glands with Blanking Plugs
 Neoprene Cover Gasket
 Heavy-duty Tie Bar Rod Ends with Nylon Bushings
 Full Signal Shielding Capability



Hardover Limit Switching

Quantity	1 or 2 Sets
AC Rating (max.)	250 VAC, 10 Amp
DC Rating (max.)	125 VDC, 100 Watt
Operating Cycles	1 Million

Potentiometer Feedback

Quantity	Up to 4
Resistance	1 kOhm $\pm 10\%$
Linearity Tolerance	1%
Operating Cycles	10 Million Turns
Rudder Angles	-47 to +47 degrees (max.)

Rudder Angle Indicator Driver Board (Optional)

Potentiometer Device	
Reverse and Over-Voltage Protection	
Power Supply	12-36 VDC $\pm 10\%$, <100 mAmp
Operating Voltage (VCC)	8.2 VDC
Circuit Protection Fuse	250 mA, 250 V, 5 mm x 20 mm
Adjustable Gain	5 mAmp (max.)

Recommended Rudder Angle Indicator Specifications

Internal Resistance	200 - 500 Ohm
Current	0.9 mAmp (± 45 deg.)
Relative Tolerance	2%

NOTE: Multiple Jastram RAI accommodated in series or parallel to a maximum number of five.
Parallel connection is recommended.

Environmental

Operating Temperature	-20 to +60 deg. C
Splash Proof Enclosure	

CAUTION: All specifications are subject to change without prior notice.

Customer Specified Non-Standard Options

Feedback Potentiometer Impedance

Feedback Potentiometer Center Tap

 ± 67 Degree Steering AngleNon-Wearing Hall Effect Feedback Device (± 45 Degree Rudders Only)**Specifications are subject to change without notice.****Further information is available from Jastram Engineering Ltd.****CAUTION:** All specifications are subject to change without prior notice.

2 INSTALLATION

2.1 Mounting

WARNING: ALTHOUGH RESISTANCE TO RADIO FREQUENCY (RF) INTERFERENCE HAS BEEN INCORPORATED INTO THE RFU'S DESIGN, DO NOT PLACE THE RFU AND ITS CABLES IN CLOSE PROXIMITY TO RF TRANSMITTING EQUIPMENT OR HIGH CURRENT OR HIGH VOLTAGE DEVICES.

NOTE: Avoid mounting the RFU upside down. If the RFU is mounted upside down all signals and switches will be reversed.

- a) The RFU body can be mounted at any orientation with respect to the arm. The suggested orientation for the RFU body points the cable glands as shown in Figure 2. This will help to ensure that clearance is maintained between the cables and the tiller as steering gear turns. Mount the box in a location that allows both covers to be removed and the internal components such as the terminal strips, limit switch cams and potentiometers to be accessed. Ensure that the 90 degree angles shown are maintained (i.e dimensions A=B and C=D).
- b) Refer to Figure 3 for RFU overall dimensions and mounting hole pattern. Note the clearances required.
- c) Link the RFU and tiller arms with the tie rod (not supplied) using rod ends (Jastram supplied) and lock nuts.

- d) Mount the rod ends so that the steering gear can rotate through the full range without causing binding at the rod end.
- e) Turn the rod ends on the threaded tie rod until dimension A equals dimension B as shown in Figure 2. Fix dimension B by tightening lock nuts on tie rod.

IMPORTANT:

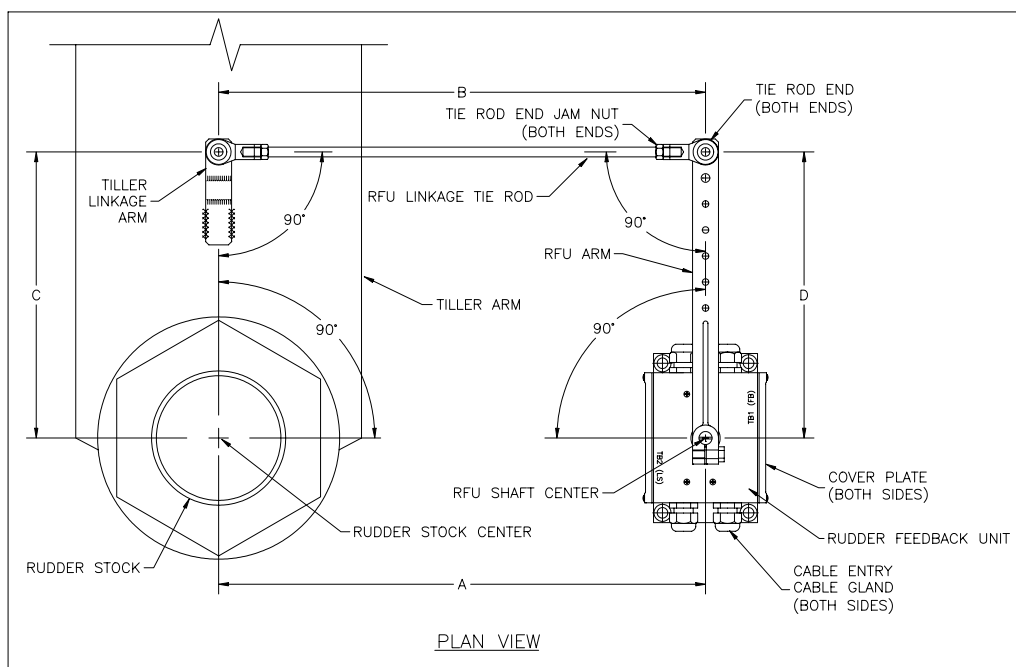


Figure 2 – RFU Mounting Arrangement

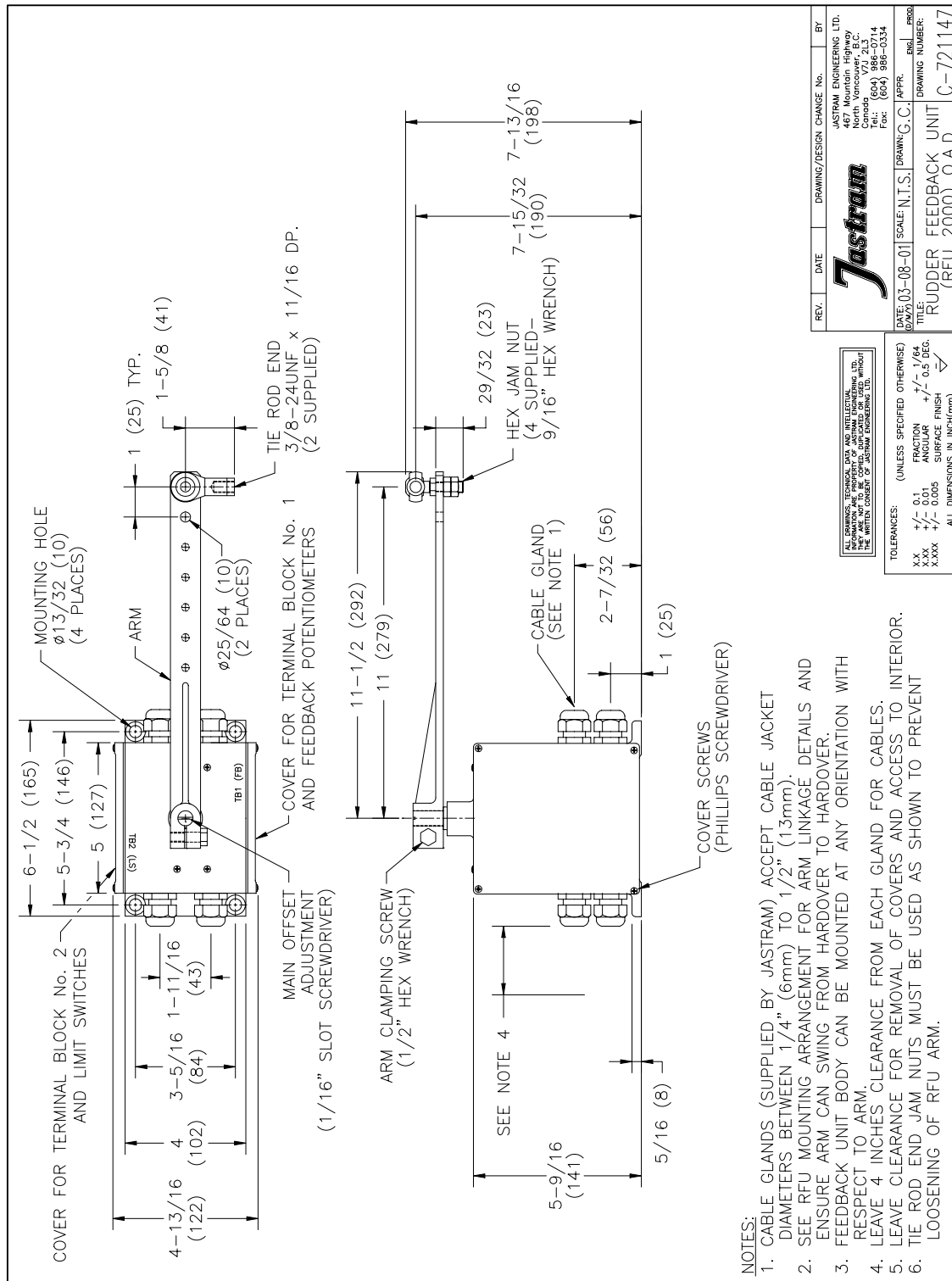


Figure 3 – RFU 2000 Overall Dimensions

3 SETUP AND TESTING

WARNING: ALL SET UP AND TESTING PROCEDURES MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

WARNING: DO NOT LET THE STEERING GEAR GO ALL THE WAY HARD OVER TO ITS MECHANICAL STOPS UNDER POWER. READ THE FOLLOWING INSTRUCTIONS COMPLETELY BEFORE ATTEMPTING ADJUSTMENTS.

NOTE: Jastram's wiring diagrams are laid out to eliminate a reversed polarity condition wherever possible. However, this condition may still occur. This section will assist in identifying and correcting a reversed polarity condition. If this condition is indicated in any of the subsequent steps, turn off all power to the RFU and solenoid controller. Refer to the manufacturer's manual of the device identified and determine how to reverse the \pm polarity of the signal leads. Once the polarity is switched, re-apply power to the system.

3.1 Rudder Angle Indication

Factory Pre-Settings

Some adjustments to the RFU are made at the trimmer potentiometers (trim pots) located on the rudder angle indicator driver circuit board. All bold type names in this section refer to particular trim pots. Each trim pot can be located by reading the labels on the RFU's circuit board or by referring to Figure 4.

WARNING: TO AVOID POSSIBLE ELECTRIC SHOCK OR DAMAGE TO THE COMPONENTS CARE MUST BE TAKEN WHEN MAKING ADJUSTMENTS TO THE RUDDER ANGLE INDICATOR DRIVER BOARD. WHEN POWER IS SUPPLIED TO THE RFU ONLY TOUCH THE SCREW HEADS OF THE TRIM POTS.

The following is the factory pre-settings on the trim pot:

RAI GAIN set at 10 turns CW from CCW maximum.

NOTE: These trim pot pre-settings should be used before proceeding with RFU calibration. Multi-turn trim pots do not have hard stops at the end of their 25 turns of travel. They do however, emit a "clicking" noise when the end of screw travel is reached.

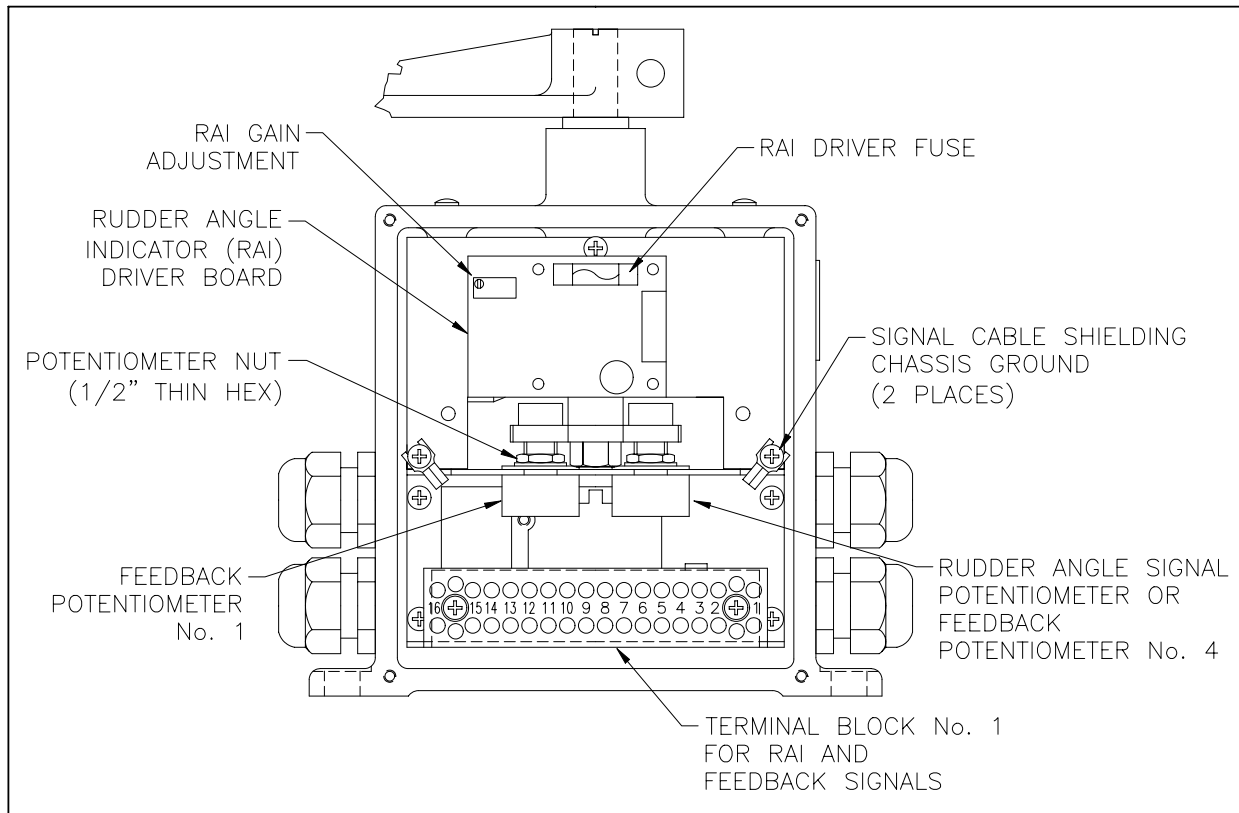


Figure 4 – RFU Internal Configuration – RAI and Feedback Side

Application of Power

- Check all connections on the power supply, RFU and RAIs.
- Do not turn hydraulic power unit (HPU) on. Do not apply the ship's DC power supply to the solenoid controller.
- Apply the ship's DC power supply for RAI.
- If a voltmeter is available, check that 12-36 VDC rudder angle indicator power supply is present at terminal block number 1, terminals 1 (TB1-1) and 4 (TB1-4) with positive on terminal 1.

Rudder Angle Indicator Signal Centering

- a) Manually center the ship's rudder.
- b) For this rudder position the RAI should display zero degrees. If this is the case proceed to next section on RAI Swing Adjustment.
- c) Loosen the RFU arm clamping screw (see Fig. 3).
- d) With a screwdriver inserted in the Main Offset Adjustment slot, rotate the shaft until the RAI reads zero degrees. Alternatively, measure the DC voltage across TB1-2 and TB1-3 and rotate the shaft until zero volts appears across these terminals.
- e) Re-tighten RFU arm clamping screw.

Rudder Angle Indicator Swing Adjustment

- a) Turn the rudder to a known angle near the port (or starboard) hardover.
- b) Confirm that the RAIs are displaying the correct direction of port (or starboard) rudder angle. If this is not the case, a reverse polarity condition exists at that indicator. If a reverse polarity condition exists at most of the indicators, the problem is most easily corrected by swapping the cable conductors to terminals TB1-2 and TB1-3. Correct indicators as a group or individually, and repeat step (b).
- c) Adjust the **RAI GAIN** trim pot on the rudder angle indicator driver board until the angles shown on the RAIs match the known angle of the rudder.

3.2 Rudder Feedback**Initial Performance**

- a) Check all connections on the power supply, RFU, solenoids and full follow-up solenoid controller.

WARNING: TO AVOID POSSIBLE ELECTRIC SHOCK OR DAMAGE TO THE COMPONENTS CARE MUST BE TAKEN WHEN MAKING ADJUSTMENTS TO THE FEEDBACK POTENTIOMETERS. WHEN POWER IS SUPPLIED TO THE RFU, TOUCH ONLY THE POTENTIOMETER HOUSINGS AND NUTS.

NOTE: Read both steps (b) and (c) before proceeding.

- b) Center the full follow-up solenoid controller and turn on the HPU.
 - c) Momentarily switch on the power supply to the solenoid controller and take note of what happens.
- i. If the rudder moves toward a hardover position turn the solenoid controller off immediately. The device must be sending a hardover command. Refer to the solenoid controller owner's manual. Correct and repeat both step (b) and (c).

NOTE: A reverse polarity feedback condition for a individual feedback potentiometer (pot) can be corrected by swapping the cable conductors to the following terminals:

- Feedback Potentiometer 1 TB1-5 and TB1-8
- Feedback Potentiometer 2 TB1-9 and TB1-12
- Feedback Potentiometer 3 TB1-13 and TB1-16
- Feedback Potentiometer 4 TB1-1 and TB1-4

- ii. If rudder stays in a midship position operate the solenoid controller within the rudder mechanical hardover stops. Confirm that a port turn of the solenoid controller corresponds to a port turn of the rudder. If this is not the case a reverse polarity condition exist at the solenoid controllers output. Correct and repeat both step (b) and (c).

Rudder Feedback Signal Centering

- a) Refer to the manual for the solenoid controller and review the requirements and recommended procedures for centering the feedback signal.

NOTE: A feedback pot's center position can be measured when a center voltage reference signal and voltmeter are available. Refer to the wiring diagrams supplied with the RFU or the system being installed. When connected to a cable, terminal block number 1, terminal 7 (TB1-7), TB1-11, TB1-15 and TB1-3 carry center voltage reference signals. When this signal is available, a correctly centered pot will measure zero volts with a voltmeter between the following terminals:

- Feedback Potentiometer 1 TB1-6 and TB1-7
- Feedback Potentiometer 2 TB1-10 and TB1-11
- Feedback Potentiometer 3 TB1-14 and TB1-15
- Feedback Potentiometer 4 TB1-2 and TB1-3

When no center voltage reference signal is available, a pot's zero position can be found by balancing the voltages between the following terminals:

- Feedback Potentiometer 1 TB1-5 to TB1-6 with TB1-6 to TB1-8
- Feedback Potentiometer 2 TB1-9 to TB1-10 with TB1-10 to TB1-12
- Feedback Potentiometer 3 TB1-13 to TB1-14 with TB1-14 to TB1-16
- Feedback Potentiometer 4 TB1-1 to TB1-2 with TB1-2 to TB1-4

- b) If a rudder angle indicator driver board is not fitted then the first feedback pot must be centered at the RFU shaft following procedures (c) through (f) below. When a rudder angle indicator driver board is fitted or when centering the second, third or fourth feedback pots, proceed to section (g) below.
- c) Manually center the ship's rudder.
- d) Loosen the RFU arm clamping screw (see Fig. 3).
- e) With a screwdriver inserted in the Main Offset Adjustment slot, rotate the shaft until the solenoid controller indicates zero degrees. Alternatively when a voltmeter is available, measure the DC voltage across the appropriate terminals and rotate the shaft until the correct voltage appears.
- f) Re-tighten RFU arm clamping screw.
- g) Manually center the ship's rudder.

WARNING: ALWAYS START THE CENTERING PROCESS BY MAKING ADJUSTMENTS AT THE MAIN OFFSET SHAFT FOR EITHER THE RAI OR THE FIRST FEEDBACK SIGNAL. IF CENTERING AT A POTENTIOMETER REQUIRES TURNING THE HOUSING MORE THAN THE EQUIVALENT OF ONE GEAR TOOTH, THEN DISENGAGE THE POTENTIOMETER GEAR FROM THE MAIN GEAR COMPLETELY AND JUMP TO THE NEXT GEAR TOOTH.

- h) While holding the pot body and keeping the pot gear fully engaged with the main gear, loosen the appropriate feedback pot nut until the pot body can just turn (see Fig. 4).
- i) Turn the pot body until the solenoid controller indicates zero degrees. Alternatively when a voltmeter is available, measure the DC voltage across the appropriate terminals and rotate the pot body until the correct voltage appears.
- j) Re-tighten the pot nut and check to ensuring that no backlash is present between the pot gear and the main gear.
- k) Repeat from step (g) for each additional feedback pot.

3.3 Setting Limit Switch Cams

WARNING: TO AVOID POSSIBLE ELECTRIC SHOCK OR DAMAGE TO THE COMPONENTS CARE MUST BE TAKEN WHEN MAKING ADJUSTMENTS TO THE LIMIT SWITCH CAMS. WHEN POWER IS SUPPLIED TO THE FEEDBACK UNIT ONLY TOUCH THE LIMIT SWITCH CAMS AND SET SCREWS.

- a) Refer to Figure 5 and loosen all of the limit switch cam set screws.
- b) Ensure that the port and starboard cams are not inadvertently triggering the switches
- c) Turn the rudder to the desired starboard RFU limit switch position (see Figure. 1).
- d) Position the starboard number 1 cam in line with its limit switch and rotate the cam until the limit switch is just triggered and tighten the cam set screw.
- e) Using the solenoid controller try to turn the rudder towards midships. If the rudder will turn in this direction then proceed to step (g). If the rudder will not turn toward midships, then the starboard solenoid controller command is being routed through the wrong limit switch.
- f) Turn the power supply to the solenoid controller off and switch the port and starboard leads at the solenoid controller and at the solenoid. Re-apply the power to the solenoid controller and repeat step (e).
- g) Turn the rudder to the starboard hardover position and confirm that the limit switch is triggering at the required hardover angle. If the starboard limit switch is not triggering in the correct position then repeat the procedure for setting this limit switch from step (c).
- h) Turn the rudder to the desired port RFU limit switch position.
- i) Position the port number 1 cam in line with its limit switch and rotate the cam until the limit switch is just triggered and tighten the cam set screw.
- j) Using the solenoid controller turn the rudder towards midships and then back toward the port hardover position and confirm that the limit switch is triggering at the required hardover angle. If the port limit switch is not triggering in the correct position then repeat the procedure from step (h).
- k) If additional limit switches are supplied repeat procedures (c) through (j) for the number 2 cams and limit switches.

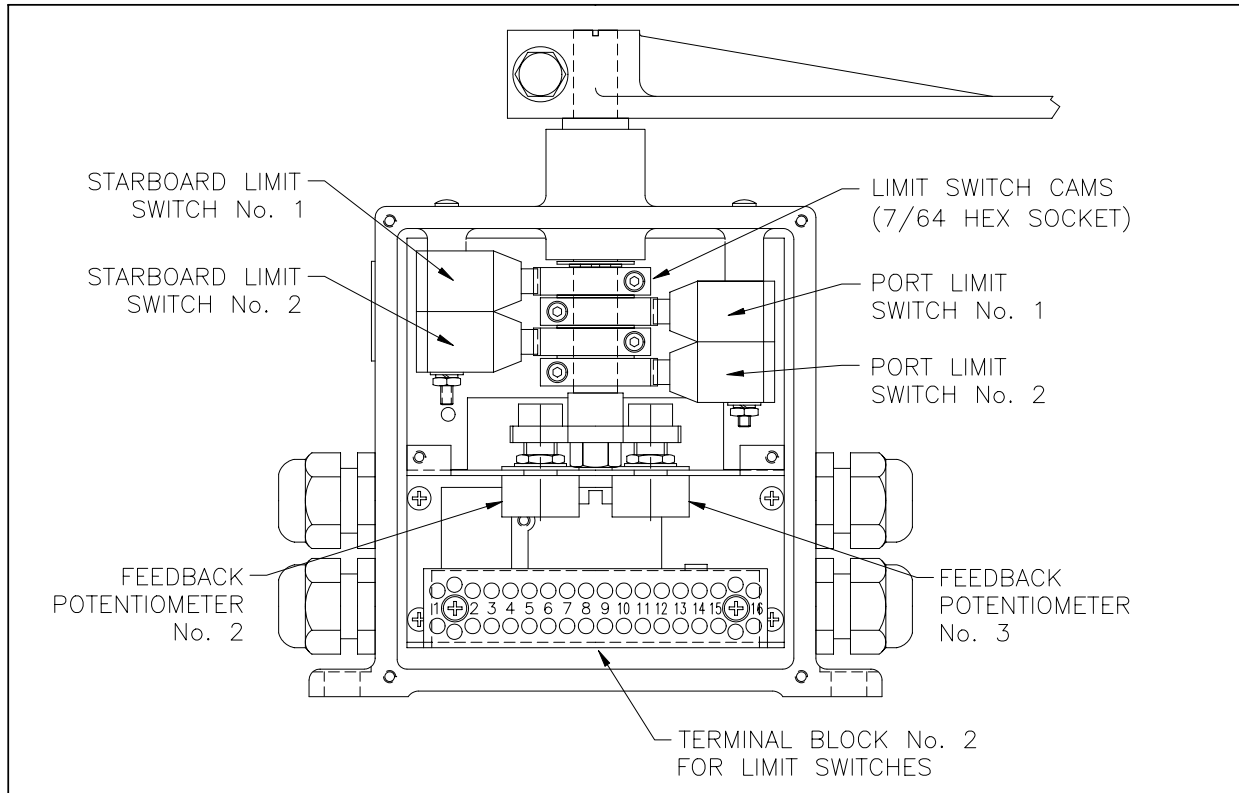


Figure 5 – RFU 2000 Internal Configuration – Limit Switch Side

3.4 Finishing

- a) When all adjustments have been made and system performs satisfactorily, ensure that all potentiometer nuts, cam set screws and arm clamping screws are tight.
- b) Ensure that the cable glands have either a cable or the plastic shipping plug in place to prevent moisture from entering the feedback unit. Tighten all cable glands with a wrench.
- c) Confirm that the rudder angle indicator and feedback cable's shielding is terminated on only one end of the cable.
- d) Confirm the feedback linkage is secure and that lock nuts are used throughout.
- e) Replace both RFU lids with gasket and tighten hold down screws until the gasket is half compressed.

4 MAINTENANCE AND PARTS LISTS

WARNING: ALL INSPECTION AND MAINTENANCE MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The wearing parts on the RFU are the linkage rod ends, shaft bushing, rudder angle limit switches, cams and potentiometers.

Linkage Rod Ends

These parts can be lubricated and should be periodically checked for excessive clearance due to wear. The rod end jam nuts must be periodically checked to ensure that they remain tight.

Cams

The cam lobes should be periodically lubricated with light grease. The grease should be placed on the area of the cam lobe that makes contact with the limit switch trigger.

Shaft Bushing

The shaft bushing used by Jastram incorporates a material that is impregnated with oil. This eliminates the requirement for periodic lubrication over the life of the bushing. The clearance between the shaft and bushing should be checked periodically for excessive wear. This can be determined by checking the amount of play at the RFU arm end. If the vertical motion at the end of the arm exceeds 1/4 inch then it is likely the bushing needs replacement. It is recommended that the shaft bushing and shaft O-ring be replaced by qualified Jastram personnel.

Rudder Angle Indicator Driver Printed Circuit Board (PCB)

This unit should not require replacement unless it has been damaged by corrosion or by excessive current or voltage. Its replacement is simple and no special tools are required. Care must be taken to ensure the working environment is free of excessive moisture and metal particles or chips. Make sure the wiring harness is re-inserted with its pins in their proper positions in the PCB terminal block.

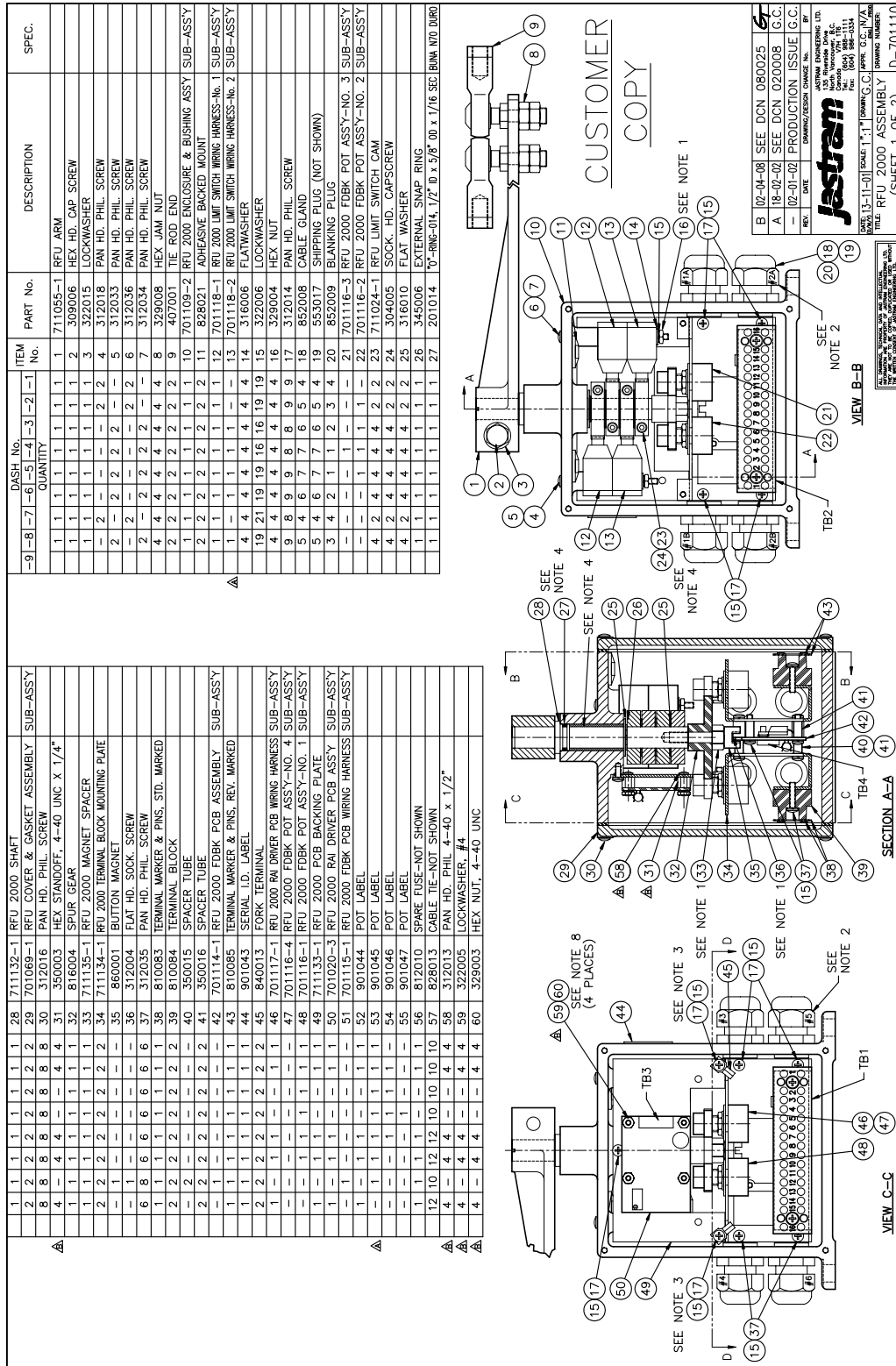
Potentiometers

A potentiometer contains a signal wiper that wears against its resistive element to produce a varying voltage. Although Jastram selects potentiometers with very high cycle life these devices will wear in time. Signs of wear are most often seen in the rudders midship position as flickering in the rudder angle indicator or control system. Potentiometers and gear assemblies are available from Jastram with or without their associated wiring harnesses. We strongly recommend that at the first sign of wear of any one potentiometer a complete replacement set be purchased. It is recommended that potentiometers be replaced by qualified Jastram personnel.

These components are available from any of our distributors.

Troubleshooting

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Troubleshooting

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Jastram

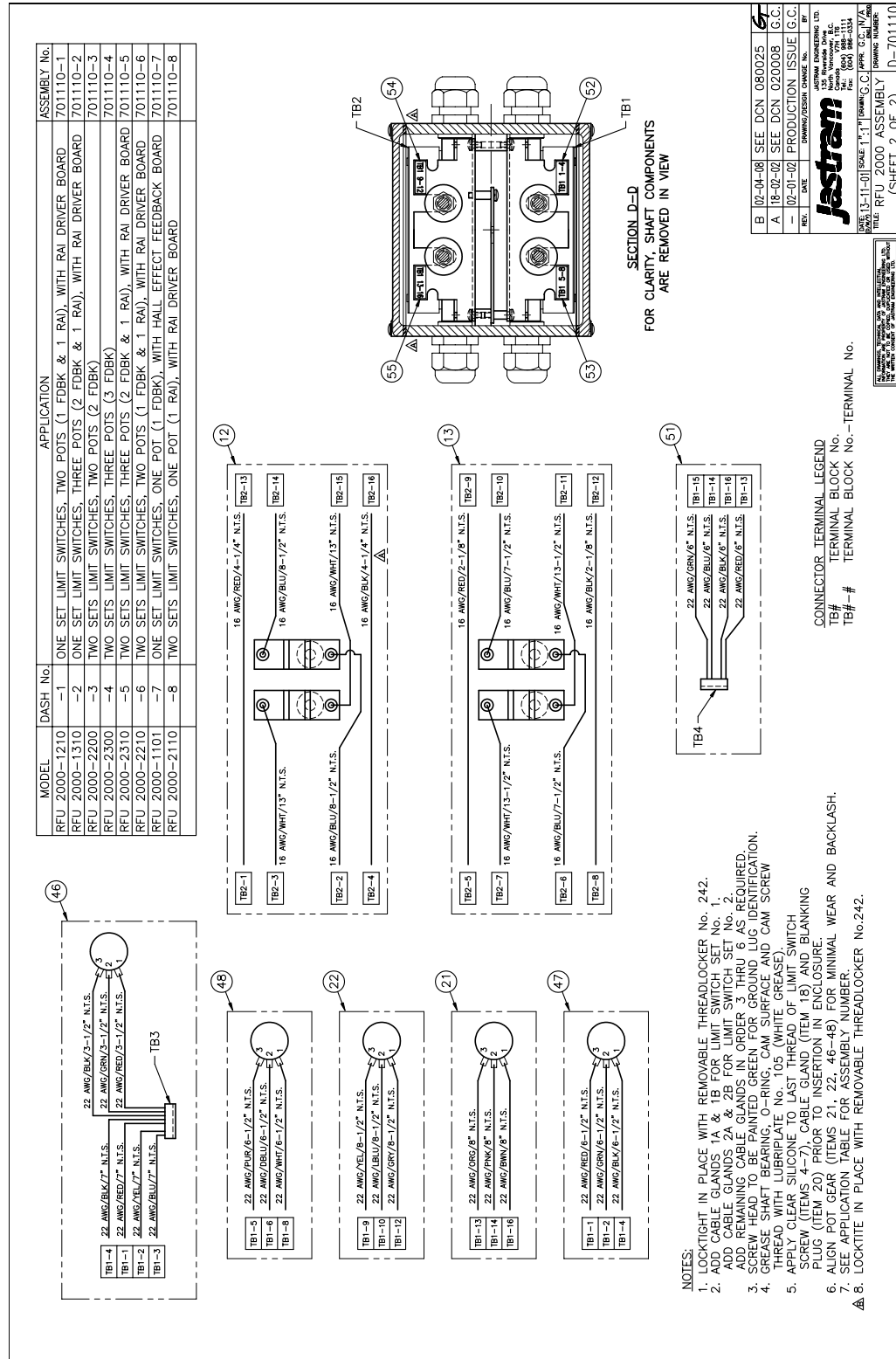


Figure 7 – RFU 2000 Assembly and Customer Parts List (Page 2 of 2)

5 TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE SUDDEN LOSS OF STEERING.

The table below gives some general solutions for simple problems. If a problem cannot be resolved, contact the factory.

SYMPTOM	CAUSE	CORRECTION
Solenoid controller does not turn rudder through its entire angle.	Limit switches triggering.	Set the limit switch cams.
RAI points wrong direction.	RAI signal polarity is reversed.	Swap the leads to the \pm RAI terminals at the back of the indicator.
Steering gear overshoots the limit switch setting.	Cams or limit switches worn.	Inspect parts and reset limit switches.
Port and starboard hardover angles are different.	The rudder's hardover angles are not the same.	Do nothing. The RFU is giving the correct indication.
	RFU mounting geometry is not correct.	Correct the mounting geometry and re-calibrate.
	RFU shaft is incorrectly centered.	Reset the zero position. If the rudders zero position is not accurately known then turn the steering gear to hardover. Turn the RFU shaft until the RAI reads the average of the port and starboard hardover angles.
In FFU mode the system always swings to hardover.	Feedback signal polarity is reversed.	Refer to section 3.2 and swap the cable's \pm voltage signals to the feedback potentiometer.
In FFU mode the rudder is unable to turn to its internal limit position.	Feedback signal gain is too large.	Adjust the feedback gain at the FFU controller.



Component Manual

**Electric Wheel
Model: EW 200**



**Document No.: MAN00902
Revision: A**

This manual is subject to change without prior notice.

Document History



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Document History

Document No. MAN00902

Jastram EW 200

Rev.	Date	DCN No.	Action / Changes / References
-	12-03-04	-	Original Issue
A	12-02-10	090083	Update figures and add document history



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INTRODUCTION

1.1 Description

The Jastram full follow up electric wheel (EW 200) is a waterproof electronic steering input device. Designed specifically for marine service, it provides a precise means for controlling the rudder when used with an amplifier or autopilot.

By simply turning the wheel, the EW 200 provides a command signal for the Steering Control Amplifier to move the rudder to the desired steering position. It provides three turns hardover to hardover and incorporates a slip clutch which protects the internal components from damage due to overturning of the wheel. Wheel tension can be adjusted to suit personal feel.

The EW 200 outputs two different signals. The first type of signal is the rudder command signal. The rudder command signal is used by a full follow-up solenoid controller as a rudder position command. The other type of signal output by the EW 200 is the rudder order indicator signal. The rudder order indicator signal is used to display the rudder command position to the vessel's operator. The EW 200 can output up to three independent rudder command signals when no rudder order indicator signal is needed or up to two rudder command signals and one rudder order signal is used.

To generate the rudder order indicator signal, Jastram's EW 200 operates in "stand alone" mode. The EW contains a circuit board that regulates its own power supply and generates the necessary signals to drive a rudder order indicator. This configuration ensures that all electronic circuitry necessary to develop a rudder order signal is contained within the EW.



1.2 Specifications

Enclosure

All Metal Construction
 Tough Powder Coat Paint
 Stainless Steel Shaft
 Extra Large Shaft Bushing
 Water-Tight Cable Glands with Blanking Plugs
 Neoprene Gasket
 Self Lubricated Internal Mechanism
 Full Signal Shielding Capability
 Total weight: 5.5 lbs.

Command Potentiometer

Quantity	Up to 3
Resistance	1 kOhm $\pm 10\%$
Linearity Tolerance	1.5%
Operating Cycles	2 Million

Rudder Order Indicator Driver Board (Optional)

Potentiometer Device	
Reverse and Over-Voltage Protection	
Power Supply	12-36 VDC $\pm 10\%$, <100 mAmp
Operating Voltage (VCC)	8.2 VDC
Circuit Protection Fuse	250 mA, 250 V, 5 mm x 20 mm
Adjustable Gain	5 mAmp (max.)

Recommended Rudder Order Indicator Specifications

Internal Resistance	200 - 500 Ohm
Current	0.9 mAmp (± 45 deg.)
Relative Tolerance	2%

Environmental

Operating Temperature	-20 to +60 deg. C
Splash Proof Enclosure	

CAUTION: All specifications are subject to change without prior notice.



INSTALLATION

1.3 Mounting

WARNING: ALTHOUGH RESISTANCE TO RADIO FREQUENCY (RF) INTERFERENCE HAS BEEN INCORPORATED INTO THE EW'S DESIGN, DO NOT PLACE THE EW AND ITS CABLES IN CLOSE PROXIMITY TO RF TRANSMITTING EQUIPMENT OR HIGH CURRENT OR HIGH VOLTAGE DEVICES.

- a) Refer to Figure 1 for EW mounting arrangement and Figure 2 for EW overall dimensions and hole pattern. Note the clearances required.
- b) Mount the EW 200 so that the rear cover can easily be removed for adjustment of the potentiometers and ROI driver.
- c) The EW 200 should be mounted with the label "DOWN" facing downward, for ease of making adjustments. However, if the EW 200 is being accessed from the top, it might be beneficial to install it upside down.
- d) See Figure 1 for location of the EW 200 shaft friction adjustment.
- e) Ensure that cable shielding is grounded to ship's bonding system.
- f) Refer to Figure 5 EW 200 Electrical Schematic for wiring the EW.

WARNING: CABLE WIRES MUST BE SECURELY CONNECTED. A LOOSE WIRE OR SHORT CIRCUIT MAY CAUSE AN ERRONOUS STEERING COMMAND.

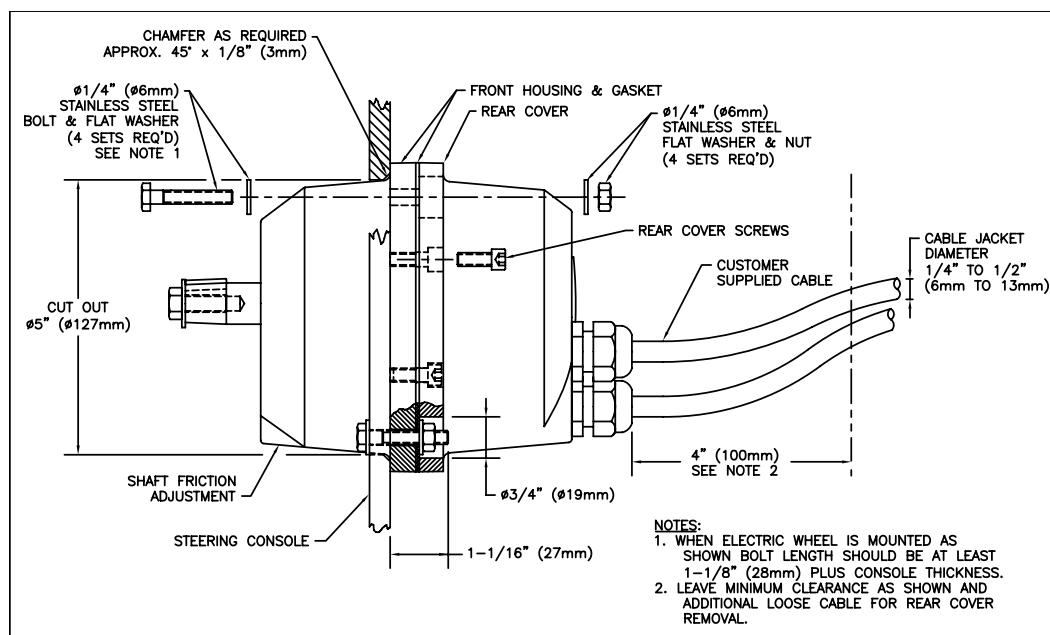


Figure 1 – EW 200 Mounting Arrangement

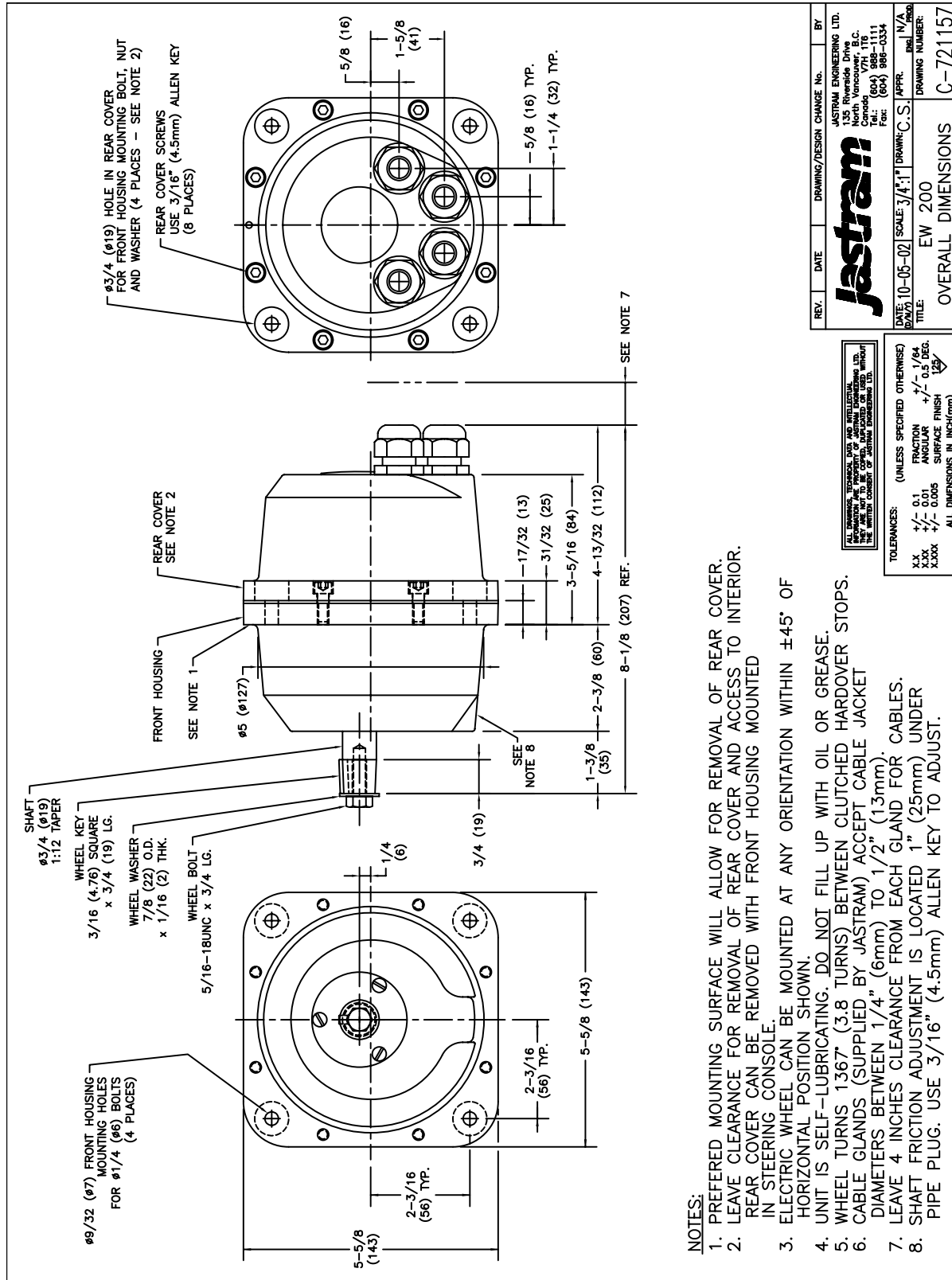


Figure 2 – EW 200 Overall Dimensions



SETUP AND TESTING

1.4 Rudder Order Command

The EW 200's Rudder Order Command potentiometers are factory preset and normally require no adjustment. If the EW's commanded port and starboard hard over positions do not match, an adjustment can be made at the potentiometer gear assembly. Refer to Figure 3 EW 200 Internal Configuration.

1.4.1 Rudder Command Signal Centering

- a) Turn the EW 200 to port hardover and note the commanded port rudder position.
- b) Turn the EW 200 to stbd hardover and note the commanded stbd rudder position.
- c) Calculate the difference between the port and starboard positions. Add half of the difference to the smaller of the port or stbd rudder positions. This calculated rudder position is the new rudder command the potentiometer must be adjusted to.
- d) While holding the pot body and keeping the pot gear fully engaged with the main gear, loosen the appropriate rudder command pot nut until the pot body can just turn.
- e) Carefully turn the pot body until the commanded rudder position reaches the value calculated in step (c).
- f) Re-tighten the pot nut and check to ensure that no backlash is present between the pot gear and the main gear.
- g) Re-check the port and starboard commanded rudder positions and repeat steps (a) through (g) as required and for each additional rudder command pot.

1.4.2 Rudder Command Signal Gain Adjustment

Attenuation to the rudder command signals can be made at the gain adjustment trimmer potentiometers (trim pot) if required. Refer to Figure 3 for trim pot locations. If command signals gain adjustments are not required proceed to section 3.2.

The following is the factory pre-setting on the command gain trim pots:

COMMAND GAIN set at CW maximum.



NOTE: Multi-turn trim pots do not have hard stops at the end of their 25 turns of travel. They do, however, emit a "clicking" noise when the end of screw travel is reached.

1.5 Rudder Order Indication (Optional):

If optional rudder order driver board is not installed then proceed to section 3.3.

Adjustments to the Rudder Order Indicator signals are made at the trim pot located on the rudder order indicator driver circuit board. Refer to Figure 3 for trim pot location.

WARNING: TO AVOID POSSIBLE ELECTRIC SHOCK OR DAMAGE TO THE COMPONENTS CARE MUST BE TAKEN WHEN MAKING ADJUSTMENTS TO THE RUDDER ORDER INDICATOR DRIVER BOARD. WHEN POWER IS SUPPLIED TO THE EW ONLY TOUCH THE SCREW HEAD OF THE TRIM POT.

The following is the factory pre-setting on the rudder order indicator trim pot:

ROI GAIN set at 10 turns CW from CCW maximum.

NOTE: Multi-turn trim pots do not have hard stops at the end of their 25 turns of travel. They do, however, emit a "clicking" noise when the end of screw travel is reached.

Application of Power

- a) Check all connections on the power supply, EW and ROIs.
- b) Do not turn hydraulic power unit (HPU) on. Do not apply the ship's DC power supply to the solenoid controller.
- c) Apply the ship's DC power supply for ROI.
- d) If a voltmeter is available, check that 12-36 VDC rudder order indicator power supply is present at terminal block number 1, terminals 1 (TB1-1) and 4 (TB1-4) with positive on terminal 1.

Rudder Order Indicator Centering & Gain Adjustment

- a) After applying power to the EW 200, turn the wheel to port hardover.
- b) Confirm that the ROI is displaying an angle to port. If this is not the case, a reverse polarity condition exists at that indicator.
- c) Adjust the **ROI GAIN** trim pot on the rudder order indicator driver board until the angle shown on the ROI matches the desired angle of the rudder command. Note the angle displayed on the ROI.
- d) Turn the wheel to stbd hardover and note the stbd angle displayed on the ROI.
- e) If the port and stbd hardover angles displayed on the ROI are equal then proceed to section 3.3.
- f) If the port and stbd hardover angles displayed on the ROI are not equal then calculate the difference between the port and stbd angles. Add half of this difference to the smaller of the port or stbd ROI angles. This calculated angle is the new ROI angle the ROI potentiometer must be adjusted to.
- g) Locate the ROI potentiometer. If improved access to the potentiometer is desired, the terminal block may be removed from the potentiometer mounting plate while maintaining all of the electrical connections.
- h) While holding the pot body and keeping the pot gear fully engaged with the main gear, loosen the pot nut until the pot body can just turn.
- i) Carefully turn the pot body until the angle displayed on the ROI reaches the value calculated in step (f).
- j) Re-tighten the pot nut and check to ensure that no backlash is present between the pot gear and the main gear.
- k) Re-check the port and stbd ROI angles and repeat steps (a) through (k) as required.

1.6 Finishing

- a) When all adjustments have been made and system performs satisfactorily, ensure that all potentiometer nuts are tight.
- b) Ensure that the cable glands have either a cable or the plastic shipping plug in place to prevent moisture from entering the unit. Tighten all cable glands with a wrench.
- c) Confirm that the rudder order indicator and command cable's shielding is terminated on only one end of the cable.
- d) Replace the EW cover and tighten hold down bolts until the gasket is half compressed.

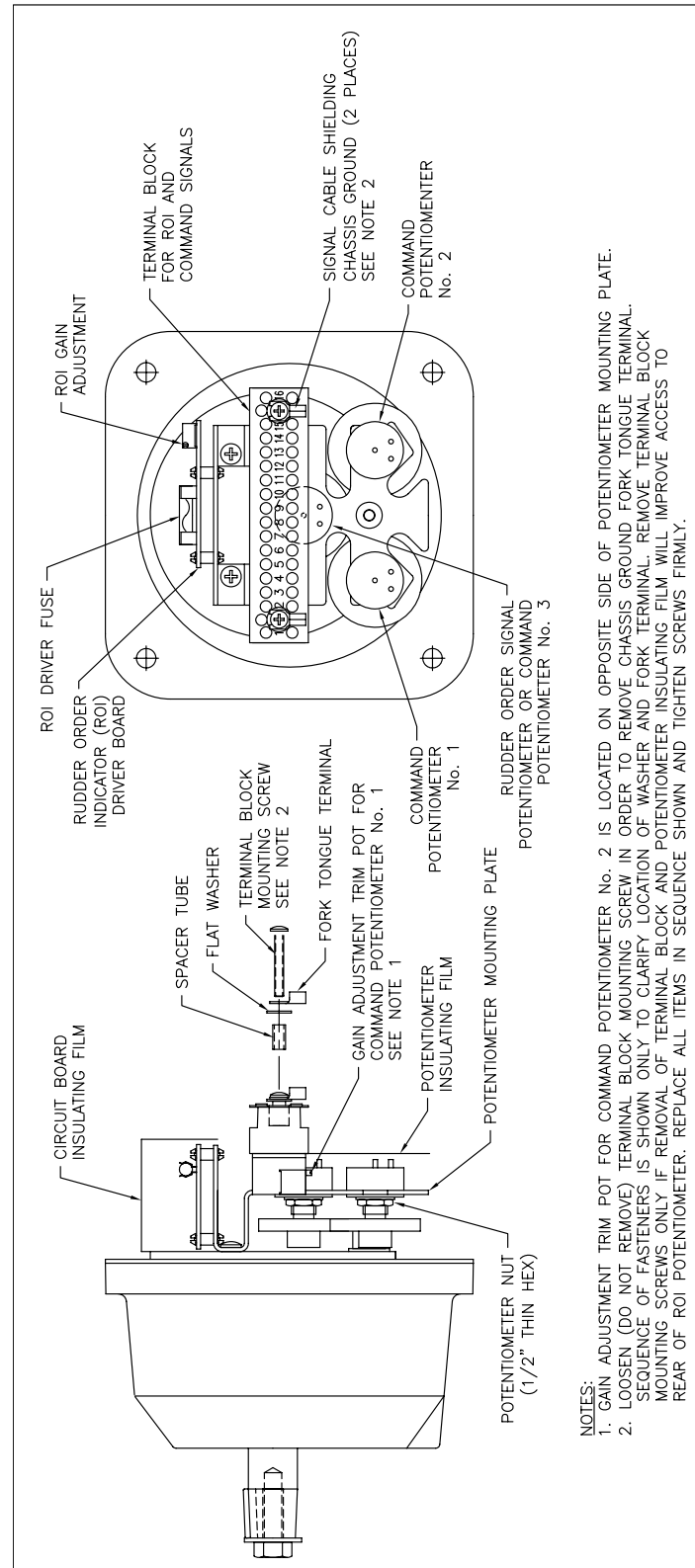


Figure 3 – EW 200 Internal Configuration



MAINTENANCE AND PARTS LISTS

WARNING: ALL INSPECTION AND MAINTENANCE MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The wearing parts on the EW 200 are the shaft bushings and potentiometers.

Shaft Bushings

The shaft bushings used by Jastram incorporate a material that is impregnated with oil. This eliminates the requirement for periodic lubrication over the life of the bushings. If excessive play is felt during operation of the EW then it is likely the bushing needs replacement. It is recommended that the shaft bushing and shaft O-ring be replaced by qualified Jastram personnel.

Rudder Order Indicator Driver Printed Circuit Board (PCB)

This unit should not require replacement unless it has been damaged by corrosion or by excessive current or voltage. Its replacement is simple and no special tools are required. Care must be taken to ensure the working environment is free of excessive moisture and metal particles or chips. Make sure the wiring harness is re-inserted with its pins in their proper positions in the PCB terminal block.

Potentiometers

A potentiometer contains a signal wiper that wears against its resistive element to produce a varying voltage. Although Jastram selects potentiometers with very high cycle life these devices will wear in time. Signs of wear are most often seen in the rudders midship position as flickering in the rudder angle indicator or control system. Potentiometers and gear assemblies are available from Jastram with or without their associated wiring harnesses. We strongly recommend that at the first sign of wear of any one potentiometer a complete replacement set be purchased. It is recommended that potentiometers be replaced by qualified Jastram personnel.

These components are available from any of our distributors.

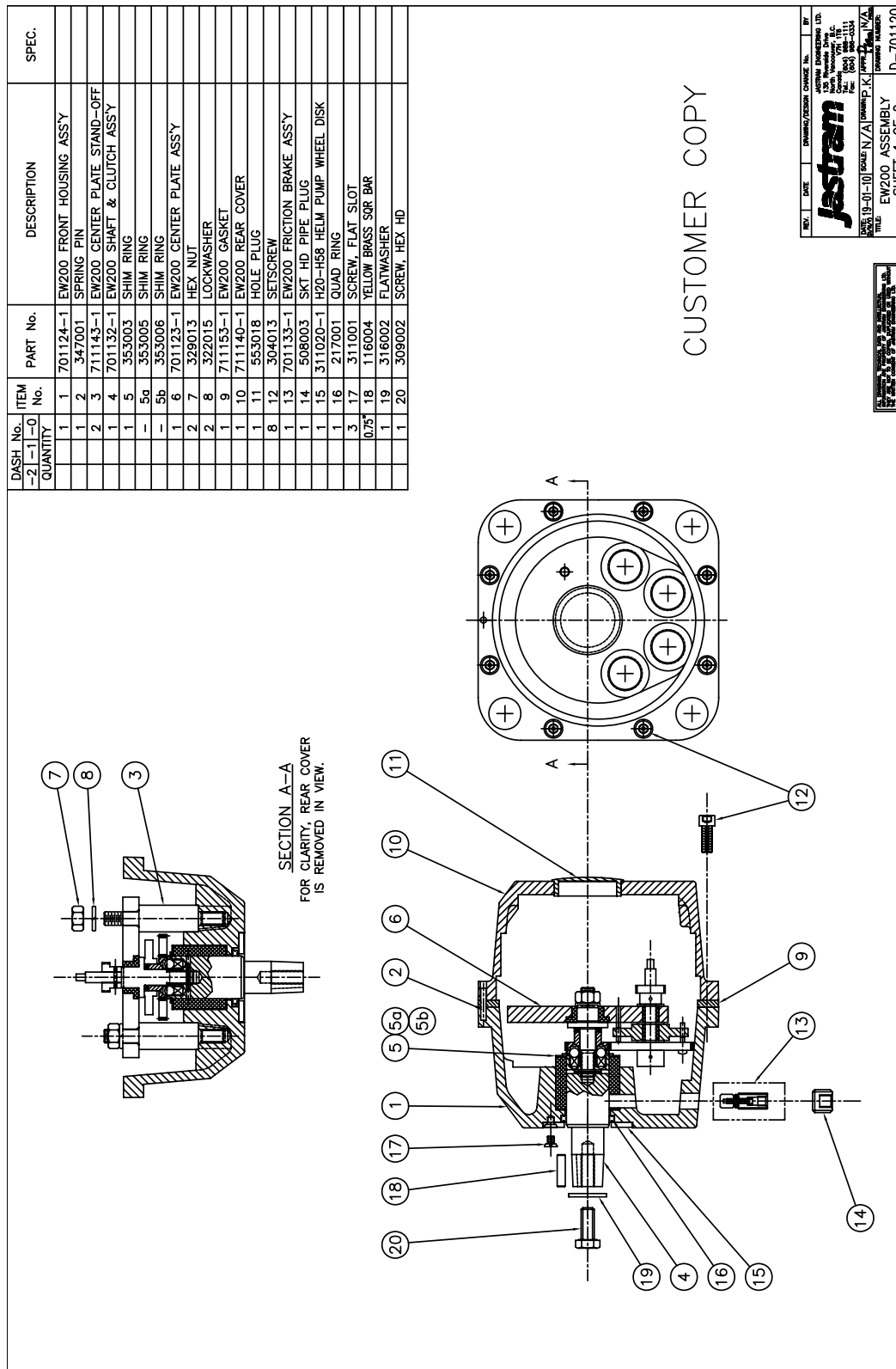
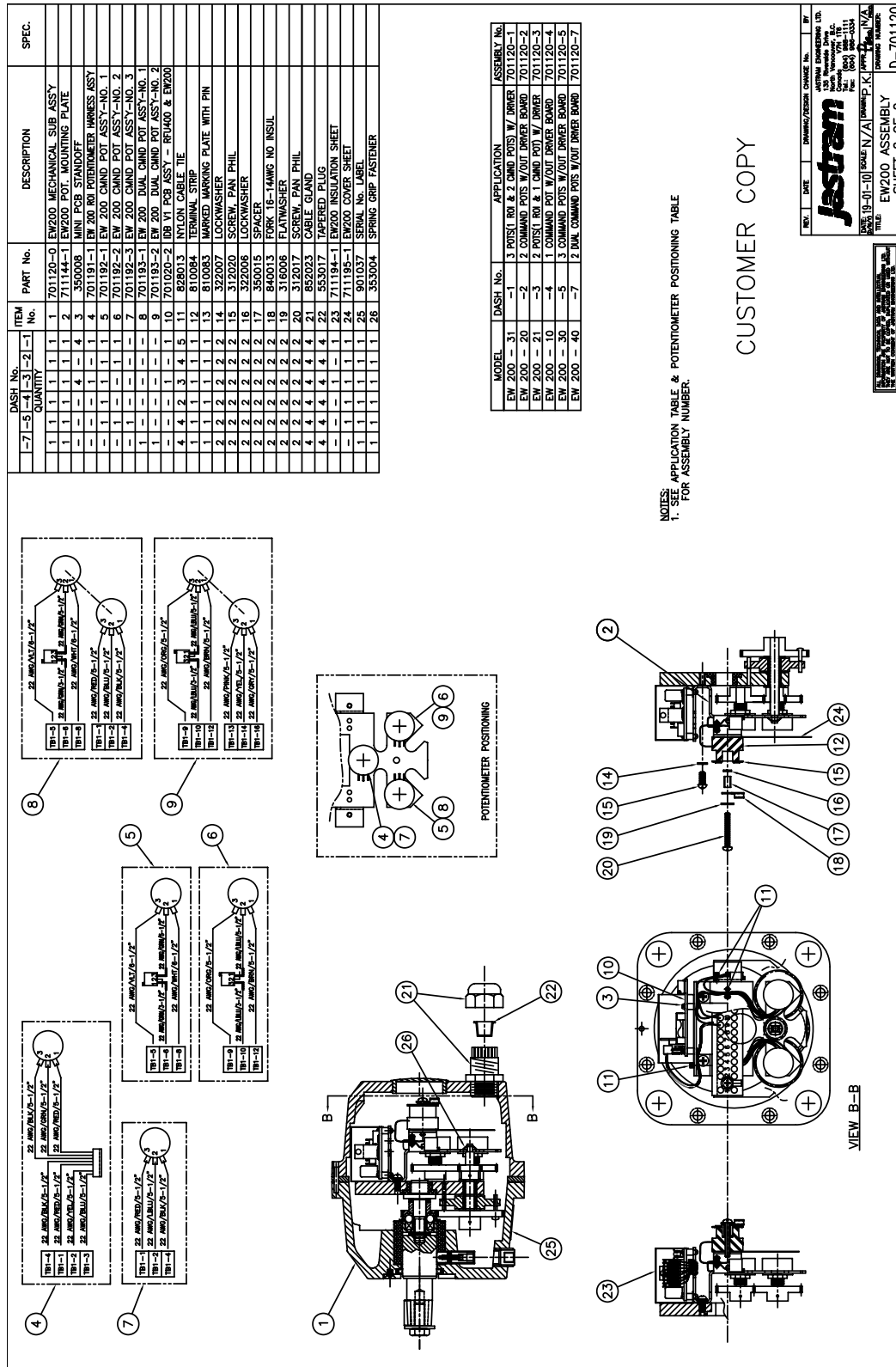


Figure 4 – EW 200 Assembly (Sheet 1 of 2)





TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE SUDDEN LOSS OF STEERING.

The table below gives some general solutions for simple problems. If a problem cannot be resolved, contact the factory.

SYMPTOM	CAUSE	CORRECTION
EW 200 operates steering in wrong direction	Wires reversed.	Reverse +V and –V wires. Refer to Fig. 5.
Hardover angles are not the same	Potentiometer incorrectly centered.	Refer to Set Up procedure
EW 200 does not function.	Wiring incorrect.	Refer to Fig. 5 and amplifier or autopilot manual.
EW 200 operates steering erratically.	Potentiometer worn.	Replace potentiometer.

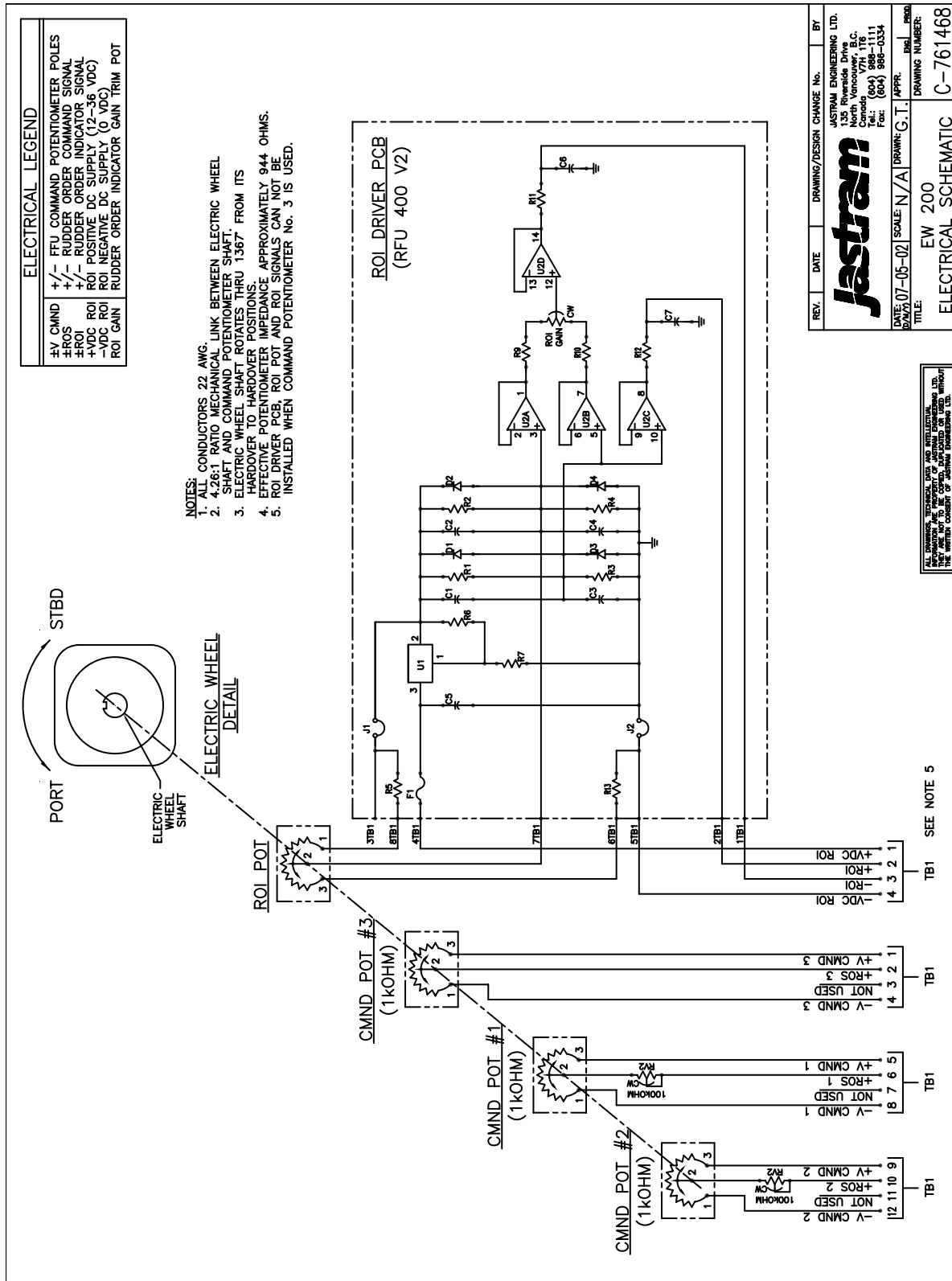


Figure 6 – EW 200 Electrical Schematic

Component Manual

**Lever Controller
Model: LC100**



**Document No.: MAN01001
Revision: A**

This manual is subject to change without prior notice.

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1 INTRODUCTION

1.1 Description

The Jastram full follow up lever controller (LC100) is a waterproof electronic steering input device designed specifically for marine service. When used in conjunction with an amplifier or autopilot it provides a precise means for controlling the rudder.

Simply moving the lever handle to either port or starboard causes the rudder to “follow up” to the required steering position. The lever angle corresponds with the rudder position.

Graduations are marked on the LC100 housing to indicate degrees of rudder. The LC100 comes pre-wired with 4ft (1.2m) of cable.

For reference, an electrical schematic of the LC100 is shown below.

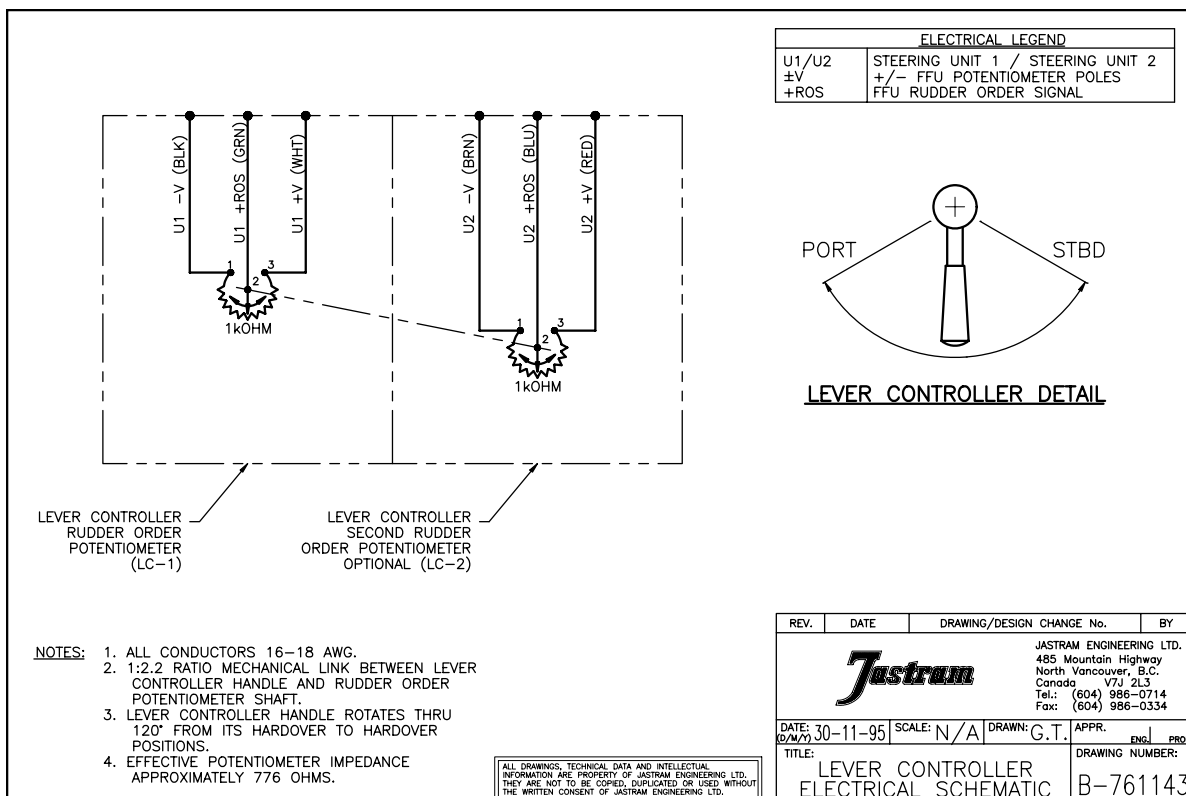


Figure 1 – Lever Controller Electrical Schematic

1.2 Specifications

Enclosure

Plastic Construction
Stainless Steel Handle Shaft
Water Resistant Cable Gland

Potentiometer

Impedance	1 kOhm
Linearity	$\pm 1\%$
Operating Cycles	10 million

CAUTION: All specifications are subject to change without prior notice.
--

2 INSTALLATION

2.1 Mounting and Connection

The LC100 lever controller may be mounted in any convenient location.

Refer to Figure 2 for installation dimensions.

WARNING: TO AVOID ACCIDENTAL OPERATION, USE A MECHANICAL GUARD AROUND THE LC100 HANDLE.

For through console mounting, the cable and watertight cable gland can be relocated to the bottom of the housing. To do this:

- a) Remove the bottom plate
- b) Interchange the gland fitting and the plug
- c) Re-route the cable through the fitting on the bottom. Be certain the O-ring located between the housing top and bottom is installed, when re-assembling.

WARNING: ALL LEVER CONTROLLER WIRES MUST BE SECURELY CONNECTED. A LOOSE WIRE OR SHORT CIRCUIT MAY CAUSE AN ERRONEOUS STEERING COMMAND.

Refer to Figure 3 for wiring the LC100

CAUTION: It is highly recommended that short circuit protection be provided on the power supply to the lever controller.

Additional LC100 lever controllers are connected through a relay or switching unit.

Installation

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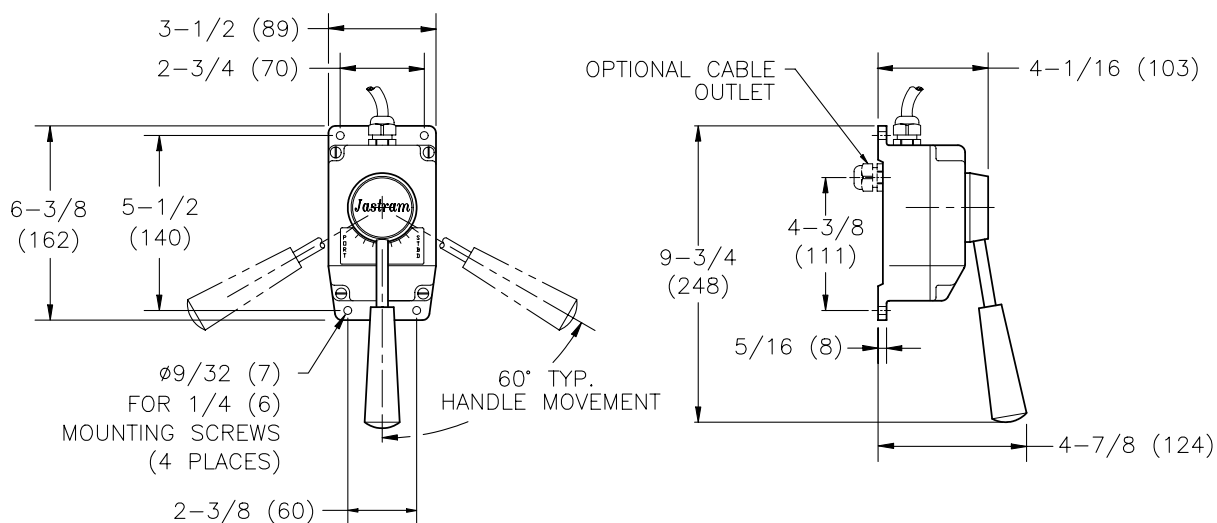


Figure 2 – Lever Controller Overall Dimensions

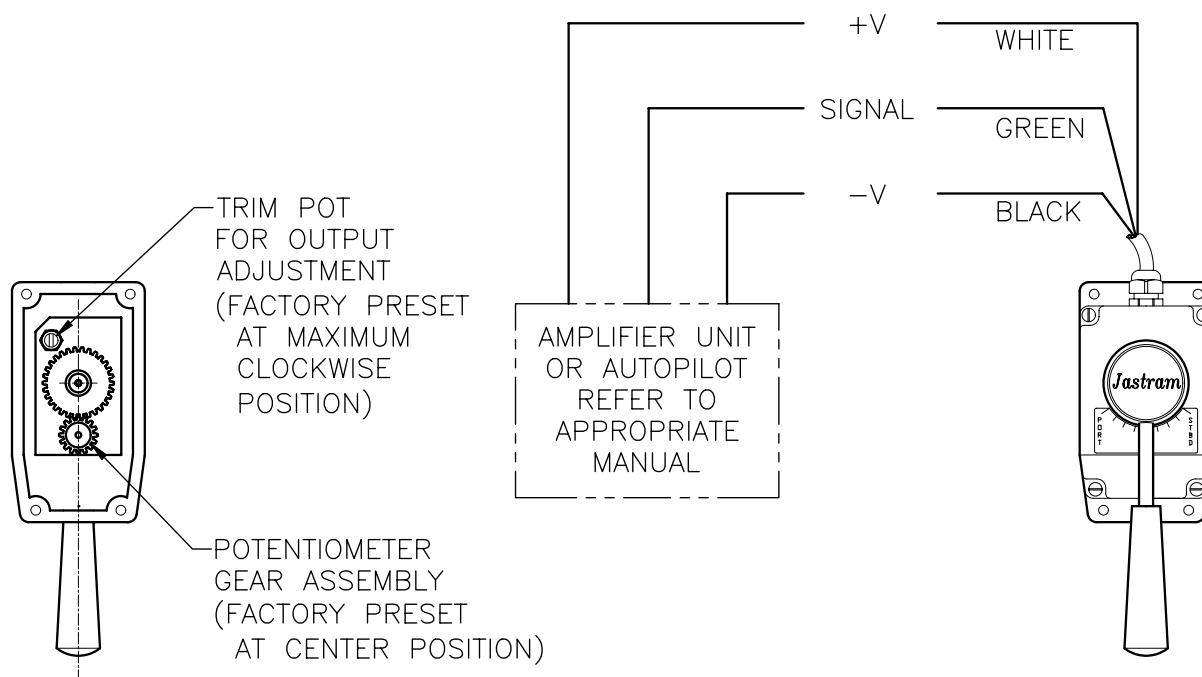


Figure 3 – Lever Controller Wiring Diagram

3 SETUP AND TESTING

WARNING: ALL SET UP AND TESTING PROCEDURES MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The LC100 potentiometer is factory preset and normally requires no adjustment. If the rudder hardover positions do not match, an adjustment can be made at the potentiometer gear assembly. Refer to Figure 3.

To make adjustments:

- a) Take note of both rudder hardover positions.
- b) Separate the LC100 top and bottom housing.
- c) Loosen the nut located at the potentiometer gear assembly.
- d) Carefully rotate the potentiometer until both hardover positions are equal. Be certain the gears mesh and there is no play between them when re-tightening the nut.

The small trimpot inside the LC100 allows for fine adjustment of the output signal. It should be adjusted so that the steering gear stops a few degrees before either hard over position is reached. It can also be used to match the output signals of two or more LC100 lever controllers. It is factory preset and normally requires no adjustment.

4 MAINTENANCE AND PARTS LISTS

WARNING: ALL INSPECTION AND MAINTENANCE MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The Jastram LC100 lever controller does not have any components that require routine maintenance.

The most common component replaced is the:

Lever Controller Potentiometer Gear Assembly Part No. JA-701058-1.

When replacing the potentiometer assembly, make sure the teeth of the lock-washers, located under the retaining nut, mesh correctly.

5 TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE SUDDEN LOSS OF STEERING.

The table below gives some general solutions for simple problems. If a problem cannot be resolved, contact the factory.

SYMPTOM	CAUSE	CORRECTION
LC100 operates steering in wrong direction.	Wires reversed.	Reverse +V and -V wires. Refer to Figure 3.
Hardover angles are not the same.	Potentiometer incorrectly centered.	Refer to Set Up procedure.
LC100 does not function.	Wiring incorrect.	Refer to Figure 3 and amplifier or autopilot manual.
LC100 operates steering erratically.	Potentiometer worn.	Replace potentiometer.

Component Manual

Jog Lever
Model: JO100



Document No.: MAN01401
Revision: B

This manual is subject to change without prior notice.



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1 INTRODUCTION

1.1 Description

The Jastram Jog Lever is a permanently mounted, waterproof, electrical switch specifically designed for marine service.

The spring-centered lever is moved to port or starboard as desired to provide non follow-up (time dependent) electric control of the steering gear. It is pre-wired with 5 ft (1.5 m) of cable.

There are two models of Jog Levers:

- Model JO100-1 is supplied with one set of micro switches.
- Model JO100-2 is supplied with two sets of micro switches where redundancy is required.

1.2 Specifications

Enclosure

Plastic Construction
Stainless Steel Handle Shaft
Water Resistant Cable Gland

Cable

5 ft. of Pre-Wired Cable 18 AWG, 3 Conductor, Stranded, Copper Wire.

Port / Starboard Switching

Current Rating	10 Amp
Voltage Rating	250 VAC
Operating Cycles	10 million

CAUTION: All specifications are subject to change without prior notice.

2 INSTALLATION

2.1 Mounting and Connection

The jog lever controller may be mounted vertically or horizontally in any convenient location.

Refer to Figure 1 for overall dimensions.

WARNING: TO AVOID ACCIDENTAL OPERATION, USE A MECHANICAL GUARD AROUND THE JOG LEVER HANDLE.

The cable and the watertight cable gland can be relocated to the bottom of the housing. To do this:

- a) Remove the bottom plate
- b) Interchange the gland fitting and the plug
- c) Re-route the cable through the fitting on the bottom. Be certain all the O-ring seals are replaced in their correct locations when re-assembling.

WARNING: ALL JOG LEVER CONTROLLER WIRES MUST BE SECURELY CONNECTED. A LOOSE WIRE OR SHORT CIRCUIT MAY CAUSE AN ERRONEOUS STEERING COMMAND.

Refer to Figure 2 for wiring of the jog lever to a 4-way directional solenoid valve.

CAUTION: It is highly recommended that short circuit protection be provided on the power supply to the jog lever controller.

Additional jog levers are connected in parallel.

Installation

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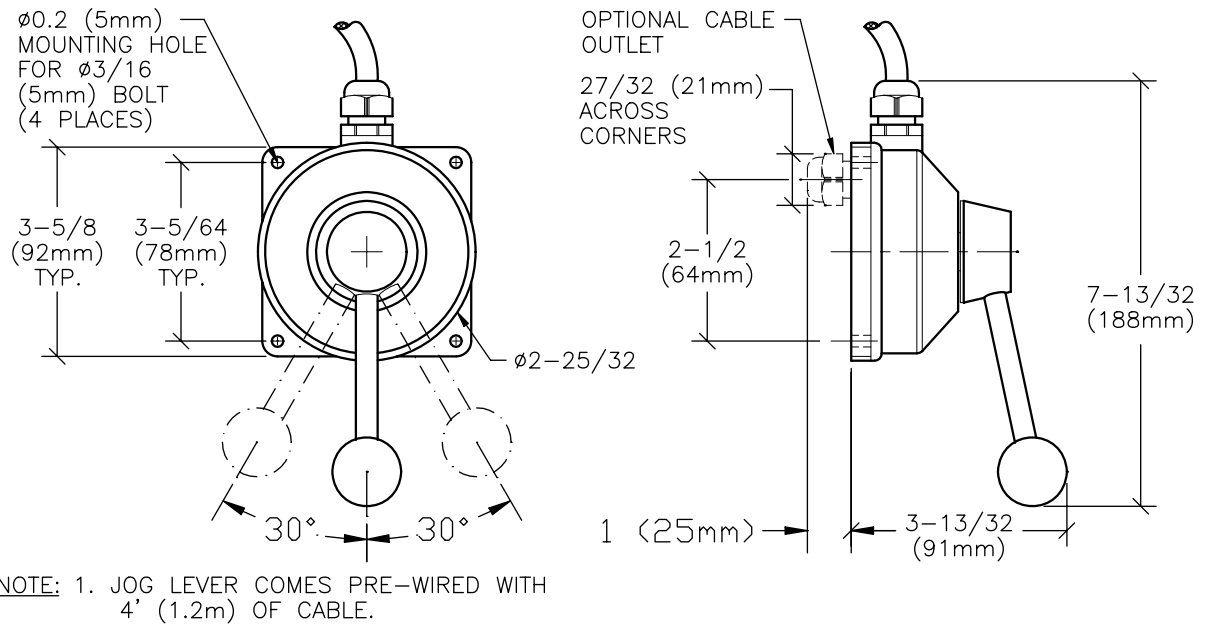


Figure 1 – Jog Lever Overall Dimensions

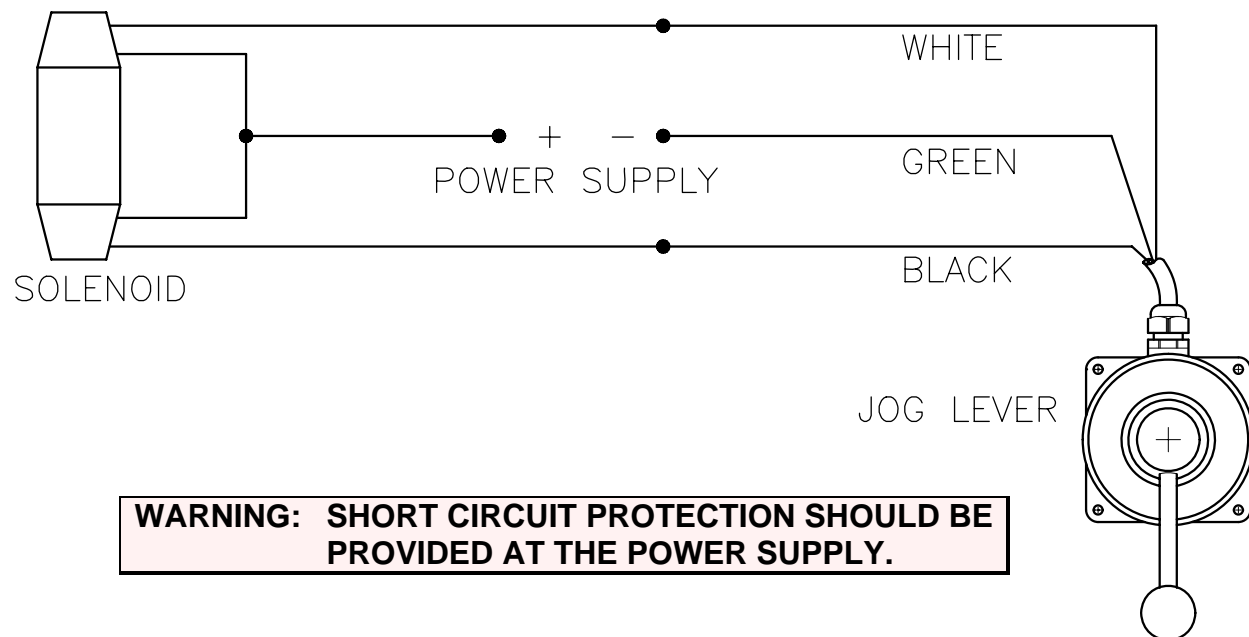


Figure 2 – Jog Lever Wiring Diagram



3 MAINTENANCE AND PARTS LISTS

WARNING: ALL INSPECTION AND MAINTENANCE MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

The Jastram Jog Lever does not contain any components that require routine maintenance.

The most common components replaced are:

Jog Spring	Part No. JB-605002
Jog Micro Switch	Part No. JB-857002

These components are available from any of our distributors.

4 TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE SUDDEN LOSS OF STEERING.

The table below gives some general solutions for simple problems. If a problem cannot be resolved, contact the factory.

SYMPTOM	CAUSE	CORRECTION
Jog does not return to center.	Spring not working.	Replace spring.
Jog does not function.	Micro switch not working.	Replace micro switch.
	No power.	Check power source.
	Solenoid not working.	Refer to manufacturers manual for corrections.
Jog operates steering in the wrong direction.	Solenoid wires are reversed.	Reverse the port and starboard connections at the solenoid. Refer to Figure 2.
Jog operates steering in only one direction.	Solenoid is wired incorrectly.	Check that the positive wire from the power supply is going to both port and starboard solenoids. Refer to Figure 2.



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Component Manual

Rudder Angle Indicator & Rudder Order Indicator
Model: RAI 280/380/580 & ROI 280/380/580



Document No.: MAN01106
Revision: -

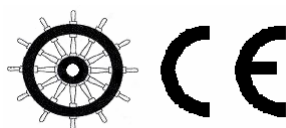
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Document History

Document No. MAN01106

Jastram RAI 280/380/580 or ROI 280/380/580

Rev.	Date	DCN No.	Action / Changes / References
-	13-02-07	-	Original Issue



APPROVED ACCORDING TO THE
EUROPEAN MARINE EQUIPMENT
DIRECTIVE MED96/98/EC AS AMENDED.



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1 INTRODUCTION

1.1 Description

Jastram indicators accurately show the rudder angle position on a backlit analog display. The indicators are designed to be flush-mounted into any convenient panel or console.

Each indicator is supplied with mounting screws and is rated for IP52 protection (from the front). An IP52 rating protects against dust and dripping water. Optional seal kits consisting of additional mounting screws and gasket are available for IP66 protection (from the front). An IP66 rating is dust-tight and protects against heavy seas.

Reverse scale indicators are available for installation at aft-facing stations.

The RAI 280/380/580 Rudder Angle Indicator displays the rudder angle and is designed to be used with a Jastram Rudder Feedback Unit (RFU). Refer to the appropriate RFU or custom system manual for wiring details.

The Jastram ROI 280/380/580 Rudder Order Indicator displays the rudder order command at a Full Follow-Up (FFU) steering controller. The ROI 280/380/580 is designed to be used with Jastram steering controllers. Refer to the appropriate system manual for wiring details.

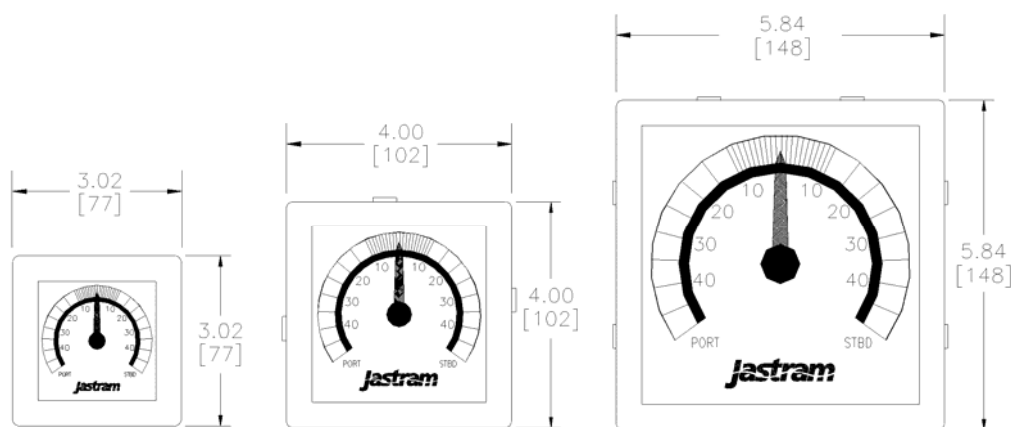


Figure 1 - RAI 280/380/580 & ROI 280/380/580

1.2 Specifications

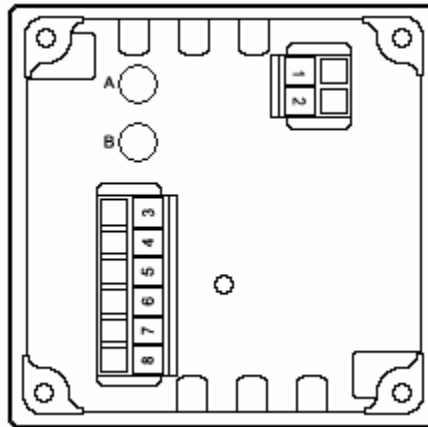


Figure 2 - Terminal Block Configuration

#	FUNCTION	NOTE
1	0V	Power supply connection maximum 150 mA
2	24V	
3	+RAI / +ROI	Signal input connections
4	-RAI / -ROI	
5	NC	No connection
6	+Illumination	Illumination input connections Range 5-30 VDC, maximum 30 mA
7	-Illumination	
8	NC	No connection
A	Max. Adjustment	Sealed by calibrated label
B	Min. Adjustment	

Signal Inputs:

0 Volts at 0 Degrees
 ± 1 Volts at ± 50 Degrees
 1 k Ω input resistance

Component	Jastram Part Number
RAI 280	JB-801035
RAI 380	JB-801034
RAI 380 (Reverse Scale)	JB-801033
RAI 580	JB-801038
RAI 280 Seal Kit	JB-801037
RAI 380 Seal Kit	JB-801036

CAUTION: All specifications are subject to change without prior notice.

2 INSTALLATION

2.1 Mounting

Mounting follows the standard DIN mounting for indicators. Use the fixing clamps to mount the indicator from the rear.

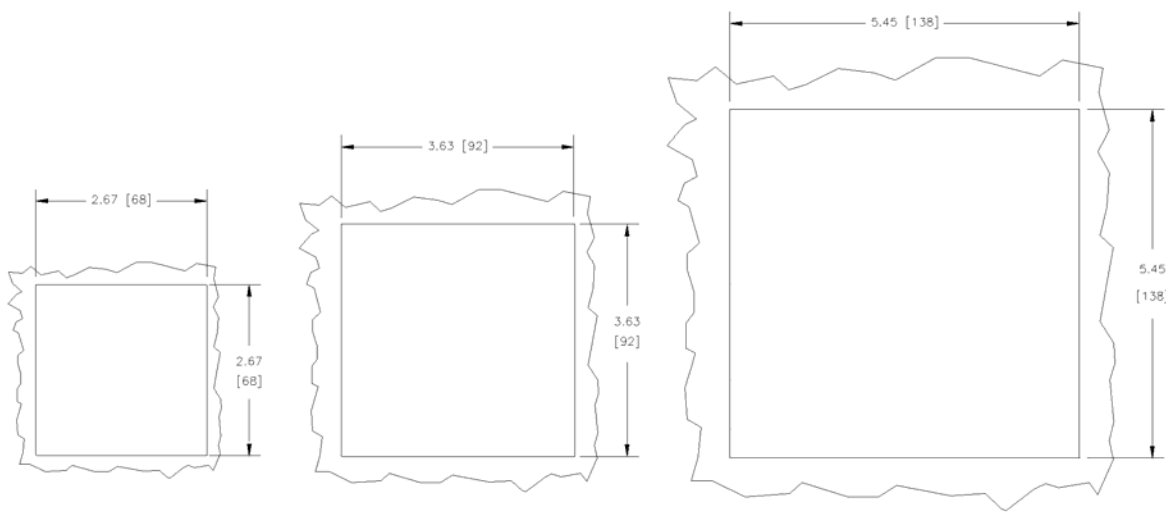


Figure 3 - Indicator Cut-Outs (280, 380, 580)

2.2 IP66 Protection

Standard protection is IP52. If the indicator is to be mounted for IP66 protection, then the additional screws and gasket must be used.

The gasket must be carefully mounted in the groove on the backside of the frame. The rounded side of the gasket should face towards the front of the indicator and the flat side should be oriented towards the rear of the indicator.

2.3 Additional Indicators

Additional indicators are to be connected in parallel. A maximum of six indicators can be connected per system.

3 DIMMER CONFIGURATION

WARNING: MAKE SURE YOU HAVE SWITCHED OFF THE POWER SUPPLY BEFORE INSTALLING THIS PRODUCT.

The three configurations below illustrate different ways to connect a dimmer on the Jastram indicators.

3.1 Dimmer Configuration #1 (Series Resistance)

Figure 1 illustrates a method for dimmer connection that adds a 10 k Ω (1/2 W) potentiometer in series with the illumination input (terminal 6).

ADVANTAGE: current consumption is lower.
DISADVANTAGE: illumination cannot be set to total darkness.

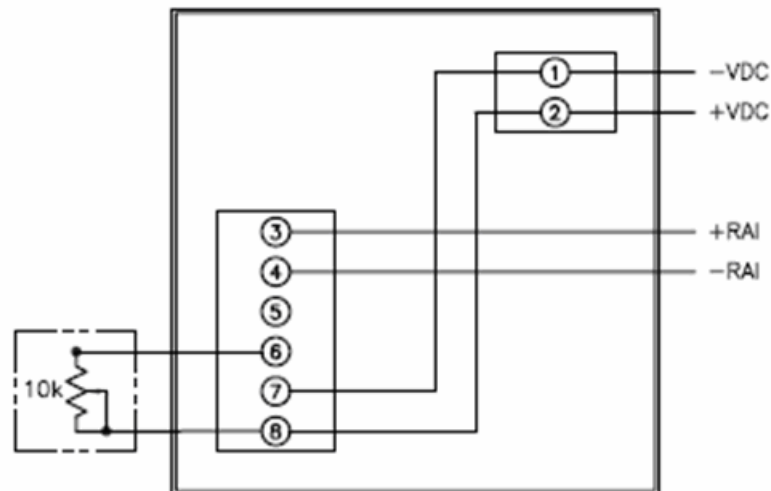


Figure 4 - Dimmer Configuration #1 (Indicator Rear View)

3.2 Dimmer Configuration #2 (Voltage Divider)

Figure 2 illustrates a method for dimmer connection that adds a 1 k Ω (1/2 W) potentiometer as a voltage divider.

ADVANTAGE: illumination can be set to total darkness.
DISADVANTAGE: consumption of the potentiometer is approx. 24 mA.

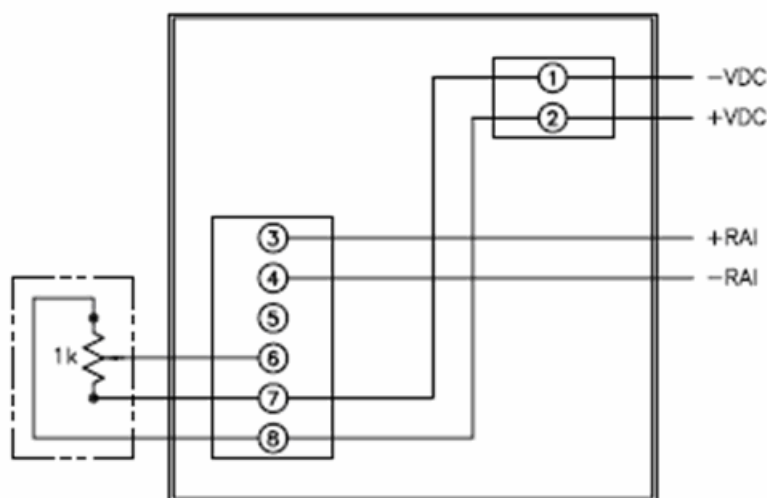


Figure 5 - Dimmer Configuration #2 (Indicator Rear View)

3.3 Dimmer Configuration #3 (External Illumination Voltage)

Figure 3 illustrates how to connect the dimmer if an external voltage is used for the illumination. The regulation range from darkness to full illumination is from 5-30 VDC. The consumption is 30 mA @ 30 VDC.

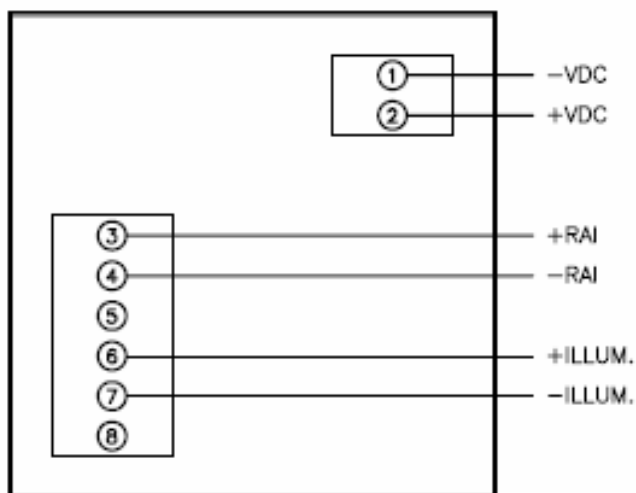


Figure 6 - Dimmer Configuration #3 (Indicator Rear View)



4 COMMISSIONING

WARNING: ALL SET UP AND TESTING PROCEDURES MUST BE PERFORMED WHILE THE VESSEL IS STATIONARY AND NOT UNDERWAY.

WARNING: SHORT CIRCUIT PROTECTION SHOULD BE PROVIDED AT THE POWER SUPPLY.

4.1 Indicator Commissioning

See the appropriate system manual in regards to commissioning the indicator signals (\pm RAI / \pm ROI).

4.2 Indicator Status Indication

The Jastram indicators are also equipped with an amber LED indicator located in the bottom corner of the scale.

Normal Operation

After power up, the LED will initially flash twice and then will remain off. If there is an internal error (e.g. the microprocessor is stopped), the LED will continue to flash. This error condition cannot be corrected and the supplier must be contacted.

Operation Outside of Normal Input Range

After power up, the LED will flash once. After 10 seconds the pointer will indicate the error condition by pointing towards the bottom of the scale (6 o'clock position). This will continue until the input is adjusted to be inside the nominal input range of $\pm 1V$.

Normal input range is $\pm 2\%$ of nominal input voltage.



5 TROUBLESHOOTING

WARNING: FAILURE TO CORRECT ANY PROBLEM CAN CAUSE MISLEADING OR WRONG RUDDER ANGLE INDICATION.

The Jastram indicators do not contain any components that require routine maintenance.

The chart below gives some general solutions for simple problems. If a problem cannot be resolved, contact the supplier.

SYMPTOM	CAUSE	CORRECTION
System will not operate.	Power not supplied	Check wiring
	Power supply wired backwards	Reverse polarity
	Incorrect wiring	Check wiring at indicator and source
Indicator needle moves in the wrong direction.	Reverse indicator wiring	Reverse terminals 3 and 4 at back of indicator
Indicator's port and starboard hard-over angles are not the same.	Rudder's hardover angles are not the same	Ensure correct rudder geometry at the RFU
	RFU arm not installed correctly	Check RFU mounting geometry
Indicator's illumination not working.	Incorrect wiring	Adjust dimmer according to RAI / ROI Dimmer Configuration (Section 3)



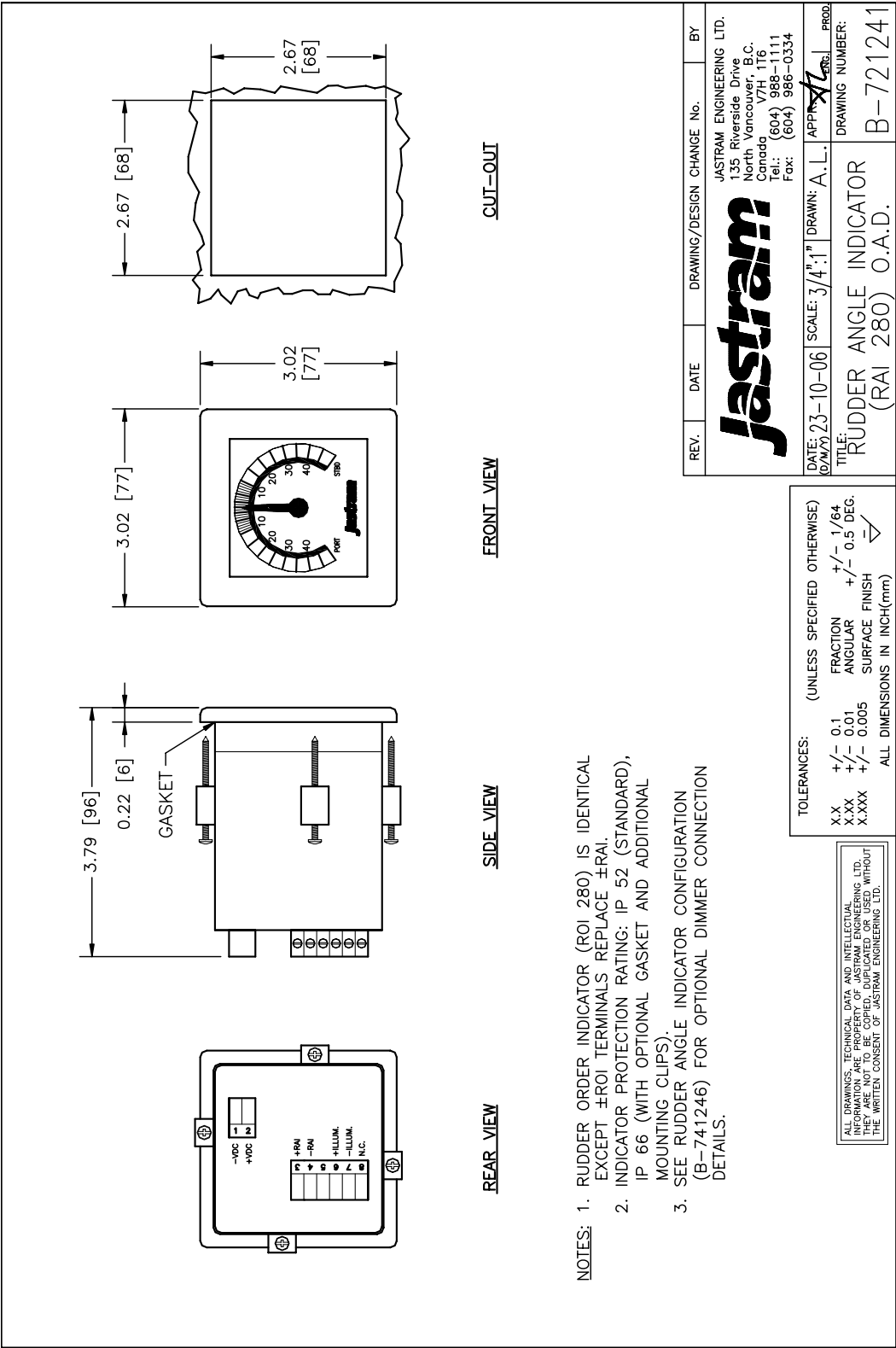
6 DRAWINGS

6.1 Rudder Angle Indicator (RAI 280) Overall Dimensions

6.2 Rudder Angle Indicator (RAI 380) Overall Dimensions

6.3 Rudder Angle Indicator (RAI 580) Overall Dimensions

6.4 RAI / ROI Dimmer Configuration

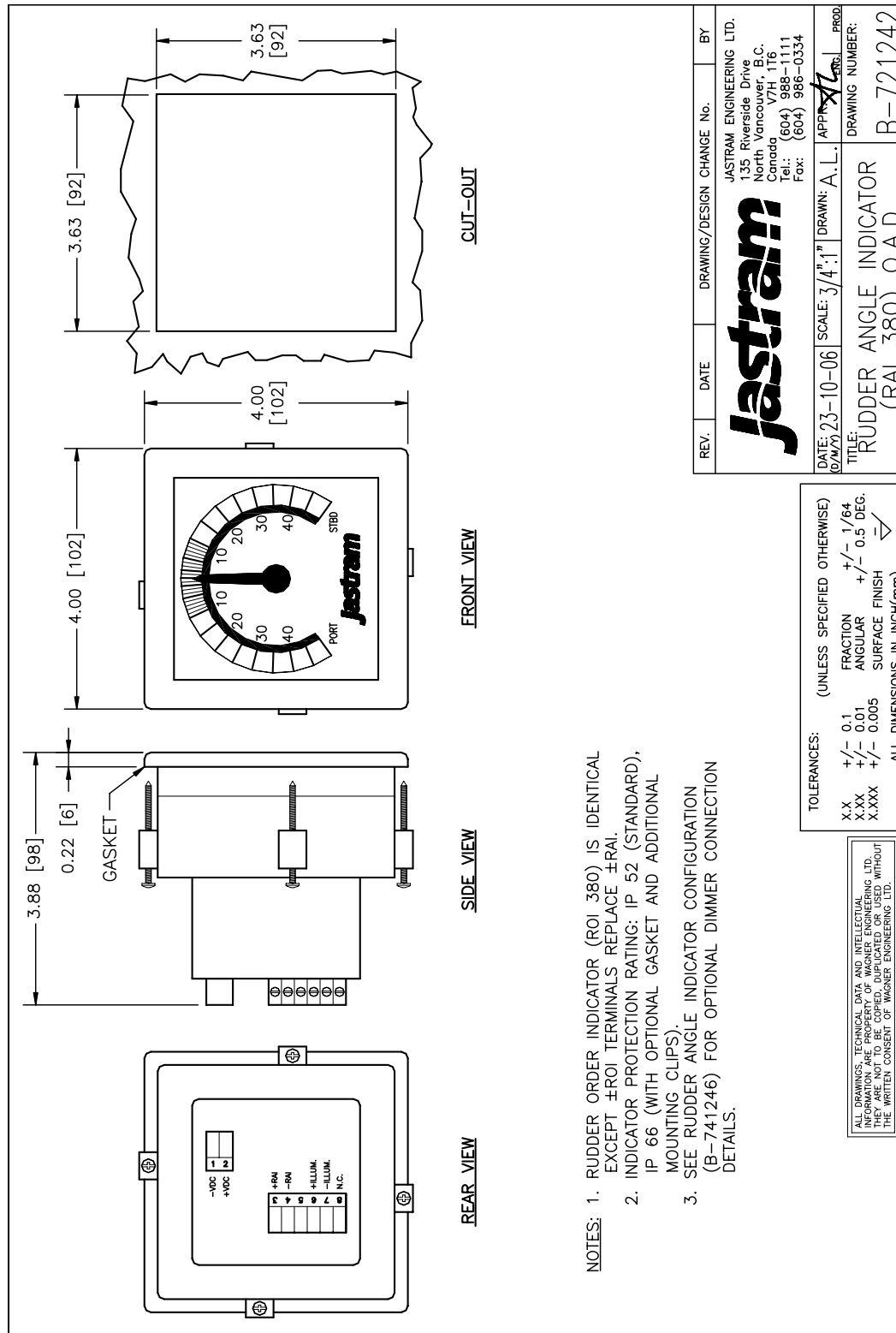


Drawing 6.1 – RUDDER ANGLE INDICATOR (RAI 280) OVERALL DIMENSIONS

Drawings



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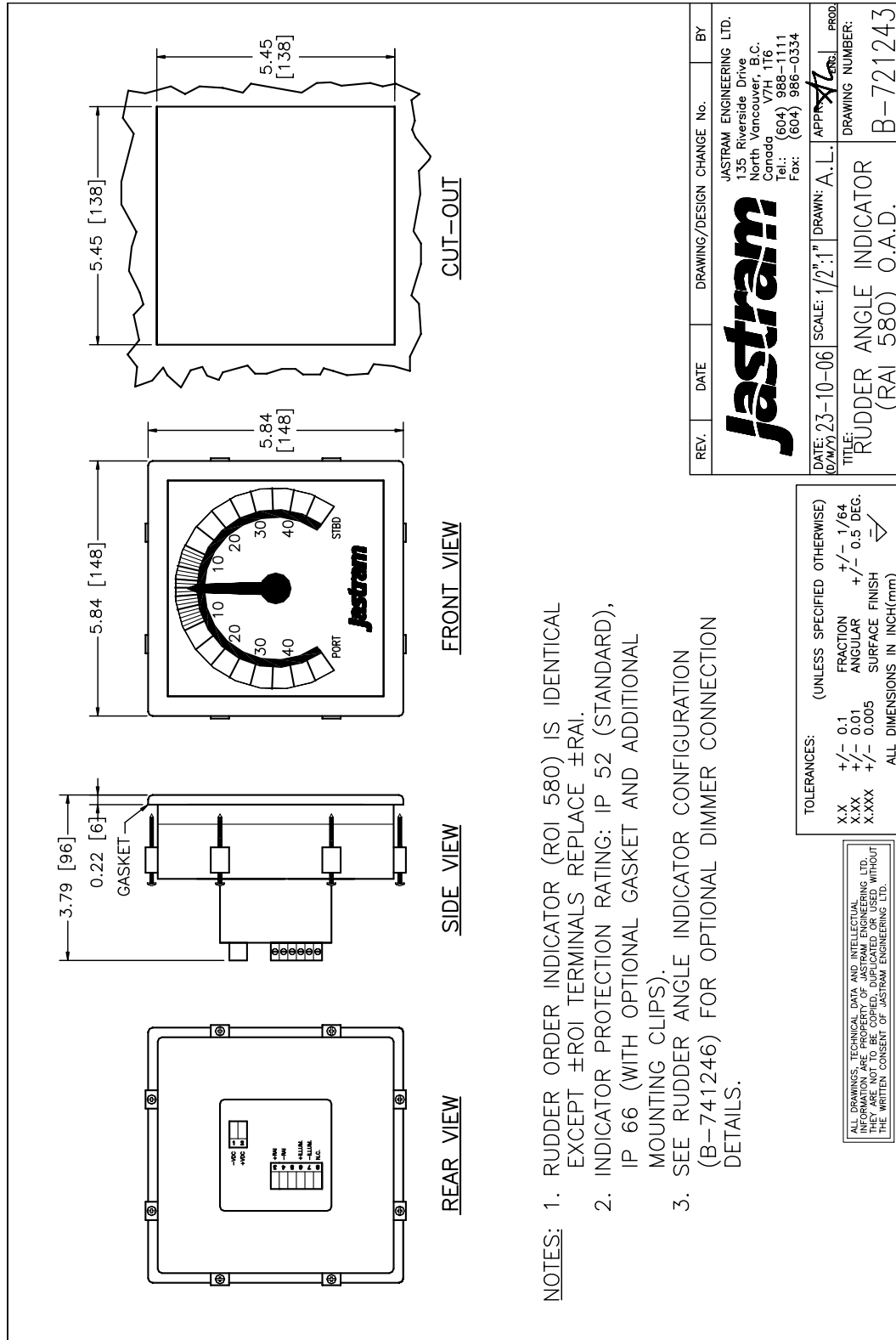


Drawing 6.2 – RUDDER ANGLE INDICATOR (RAI 380) OVERALL DIMENSIONS

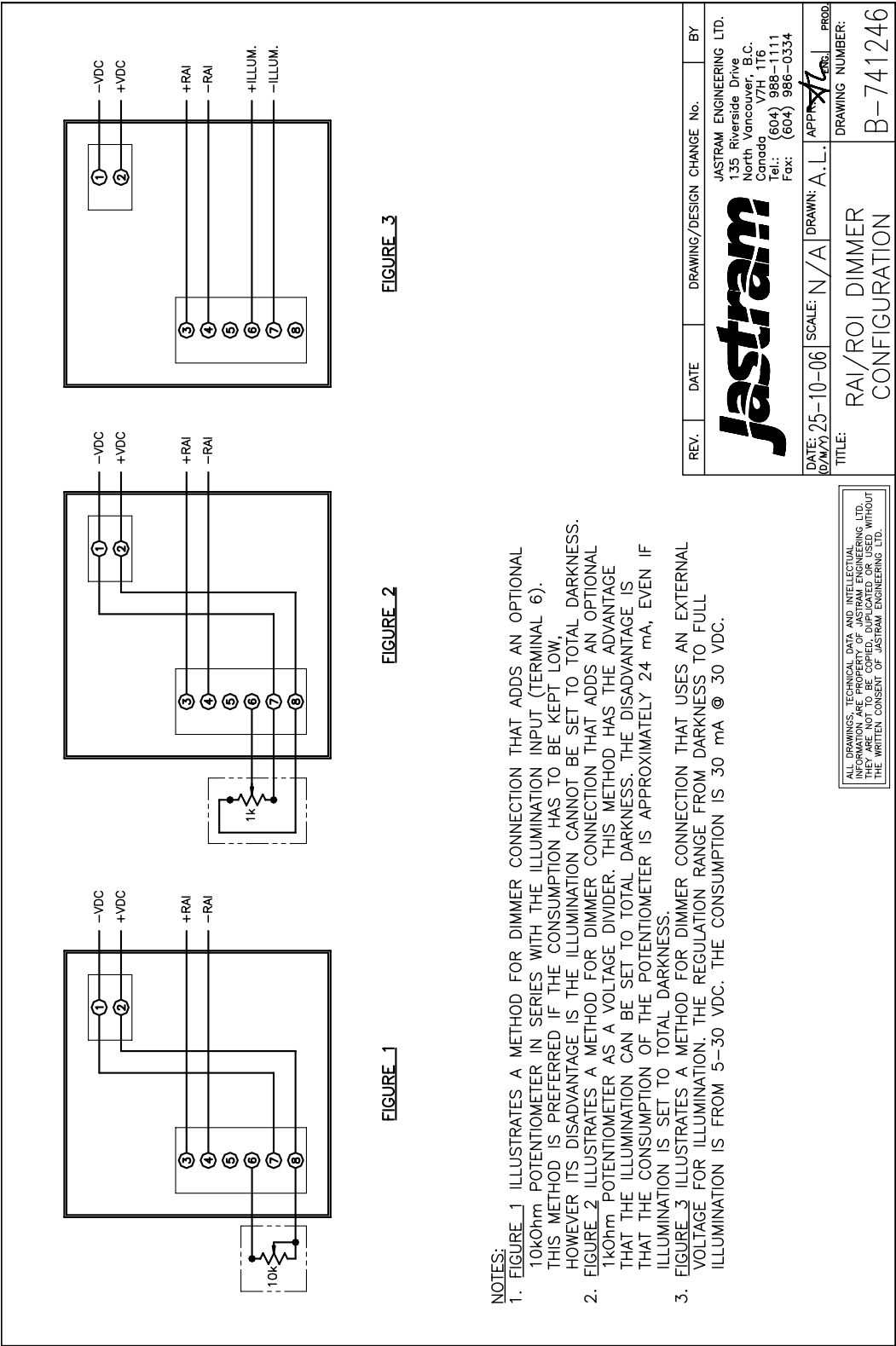
Drawings



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Drawing 6.3 – RUDDER ANGLE INDICATOR (RAI 580) OVERALL DIMENSIONS



Drawing 6.4 – RAI / ROI DIMMER CONFIGURATION



6.4 TROUBLESHOOTING

Please also see the **Steering Gear - Trouble Shooting** section for other trouble shooting tips.

Problem: Steering gear does not respond to electrical command.

Cause: Solenoid valve may not be electrically energized. Solenoid coil may be burned out.
Manifold flow control valve may be in the OFF position.
Double Acting Relief Bypass (DARB) valve set to BYPASS position.
One of the manually operated helm pumps (if installed) may have a leaking lockvalve; evidenced by the helm steering wheel turning when the solenoid valve is energized.
Engine driven pump may have broken driving belt.
Engine driven pump turning in wrong direction.
Pump RPM too low. Vane pumps will not operate below 400 RPM.
Too much air in system.

Corrections: Check wiring. Manually operate 4-Way valve to confirm the problem is electrical.
Rotate manifold flow control to correct position and secure with setscrew provided.
Set the relief valve to the NORMAL position.
Clean the contaminated lockvalve, which is mounted to the rear of each helm pump.
Replace belt.
Change pump direction.
Change pulley ratio to bring minimum RPM to 600. Do not allow pump to go above 1800 RPM.
Tighten all fittings. Insure that the pump suction is connected to the header tank. Remove any goosenecks in the piping.

EMERGENCY CHANGE-OVER PROCEDURES FOR STEERING CONTROL

STEERING ALARM:

ON FAILED SIDE ONLY:

- 1—STOP MOTOR OF FAILED SYSTEM.
- 2—START MOTOR OF REMAINING SYSTEM.
- 3—SELECT DESIRED STEERING MODE AND RESUME NORMAL STEERING.

AUTOPILOT STEERING FAILURE:

- 1—SWITCH MODE CONTROL PANEL TO "SYNC HELM" MODE.
- 2—STEER NORMALLY USING SYNCHRONIZED ELECTRIC WHEEL.

SYNCHRONIZED ELECTRIC WHEEL FAILURE:

- 1—SWITCH MODE CONTROL PANEL TO "INDEP JOG" MODE.
- 2—STEER NORMALLY USING PORT AND STARBOARD INDEPENDENT JOG LEVERS.

INDEPENDENT JOG LEVER FAILURE:

- 1—REDUCE VESSEL SPEED.
- 2—SWITCH MODE CONTROL PANEL TO "STANDBY" MODE.

COMPLETE FAILURE OF REMOTE STEERING:

- 1—REDUCE VESSEL SPEED.
- 2—IN STEERING COMPARTMENT TURN EMERGENCY STATION SELECTORS TO "LOCAL" AND TURN MOTOR STARTER "LOCAL/REMOTE" SWITCHES TO "LOCAL".
- 3—CONTROL RUDDER AT EMERGENCY STATION JOG LEVERS.

EMERGENCY STATION JOG LEVER FAILURE:

- 1—REDUCE VESSEL SPEED.
- 2—IN STEERING COMPARTMENT TURN EMERGENCY STATION SELECTORS TO "OFF".
- 3—CONTROL RUDDER USING HPU MANUAL OVERRIDE PLUNGERS.

HPU FAILURE

- 1—FOLLOW EMERGENCY CHANGE-OVER PROCEDURES FOR STEERING GEAR.



7 MOTOR STARTER AND ALARMS - TECHNICAL INFORMATION

THIS SECTION INCLUDES:

- 7.1 SCOPE OF SUPPLY
- 7.2 TECHNICAL SPECIFICATIONS
- 7.3 TECHNICAL DESCRIPTION
- 7.4 ELECTRICAL SCHEMATICS

CUSTOM MOTOR STARTER & ALARMS ARE NOT SUPPLIED FOR THIS VESSEL



8 MOTOR STARTER AND ALARMS - INSTALLATION

THIS SECTION INCLUDES:

- 8.1 INSTALLATION
- 8.2 CABLING DIAGRAM
- 8.3 COMPONENT OVERALL DIMENSIONS
- 8.4 WIRING DIAGRAM
- 8.5 COMMISSIONING AND TESTING

CUSTOM MOTOR STARTER & ALARMS ARE NOT SUPPLIED FOR THIS VESSEL



9 MOTOR STARTER AND ALARMS - MAINTENANCE

THIS SECTION INCLUDES:

- 9.1 MAINTENANCE
- 9.2 COMPONENT ASSEMBLIES AND PART LISTS
- 9.3 TROUBLE SHOOTING

CUSTOM MOTOR STARTER & ALARMS ARE NOT SUPPLIED FOR THIS VESSEL



THE COMPANY'S WARRANTY PROGRAM

1. The Company warrants each Product manufactured, installed or repaired by it to be free from defective materials or workmanship for a period of eighteen months from the date of shipping of such Product to the customer of the Company or one year after sea trials, whatever comes first, and, if any Product is proven to be defective in materials or workmanship, the Company will, at its sole option and as the sole remedy of the customer, repair or replace such Product without charge to the customer, provided the customer:
 - (a) gives immediate notice of any alleged defects upon discovery by the customer;
 - (b) maintains and uses the product strictly in accordance with its intended use, the Company's recommendations, if any, and all applicable federal, provincial and municipal government laws, rules and regulation; and
 - (c) does not alter or repair the Product without the written approval of the Company.
2. Unless otherwise agreed all Products are sold, repaired or replaced F.O.B. the Company's facility at 135 Riverside Drive, North Vancouver, British Columbia, V7H 1T6, Canada.
3. No Products may be returned to the Company without its prior written approval. All Products returned must be shipped 'freight prepaid'.
4. The Company accepts no liability for any Products resold, leased, rented, or used in any manner by persons other than the original purchaser of the Products unless, at the time the Products were purchased, the Company agrees in writing to extend the warranties herein contained to such third parties.
5. The warranties contained herein will not apply to any Products which have not been properly maintained or have been repaired by anyone other than the Company or an authorized representative thereof, were used for purposes other than those for which they were designed, were subject to obvious neglect, abuse, or misuse, or stress at angles other than reasonably contemplated in the normal use of the Products.

Schedule "E"



6. Except as herein provided for the repair or replacement of defective Products, the Company shall have no liability for any loss, personal injury, damage, expense (including removal, installation or re-installation of Product), loss of revenue, loss of profit, loss of use, damages consequential upon loss of use, or any other consequential damage, directly or indirectly caused by or resulting from any negligence of the Company, or accident, or the use of failure of any Products, or from improper or inadequate manufacture of assembly, maintenance or inspection.
7. Unless the Company acknowledges in writing any statements, specifications, desired qualities or characteristics of Products, or potential for loss by a customer, the Company will be deemed to have no notice of any such statement, specification, desired qualities or characteristics of Products, or potential for loss.



Authorized Service Agents

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Gulf Coast Air & Hydraulics	Mobile AL	334-666-6683	334-666-6684	www.wegetstuffdone.com	Chuck Moorehead	mooreheadch@gmail.com
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