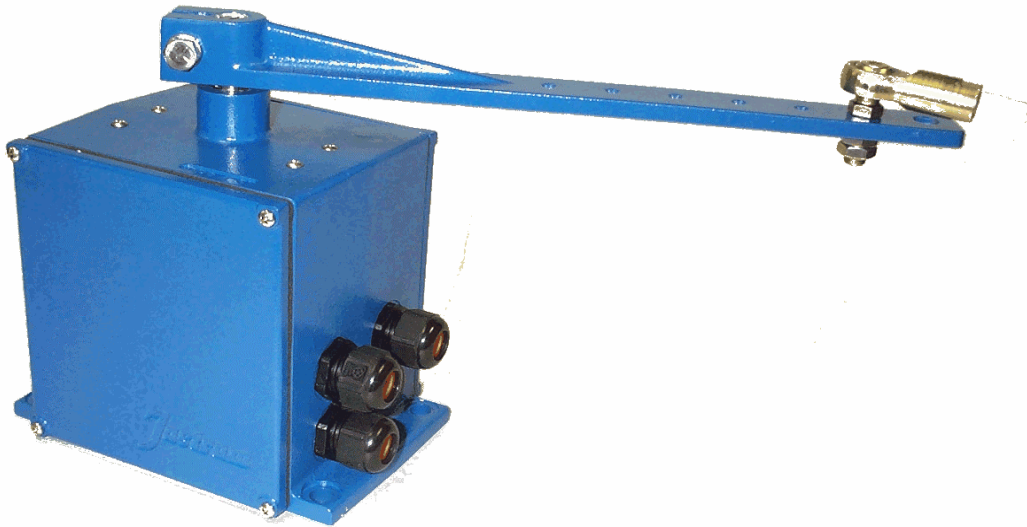




Component Manual

Rudder Feedback Unit
Model: RFU 2000



Document No.: MAN01208W

Revision: -

This manual is subject to change without prior notice.



TABLE OF CONTENTS

1	INTRODUCTION	2
1.1	Description	2
1.2	Specifications	3
2	INSTALLATION	5
2.1	Mounting	5
3	SETUP AND TESTING	8
3.1	Rudder Angle Indication	8
3.2	Rudder Feedback	10
3.3	Setting Limit Switch Cams	13
3.4	Finishing	14
4	MAINTENANCE AND PARTS LISTS	15
5	TROUBLESHOOTING	18

TABLE OF FIGURES

Figure 1	– Typical Rudder Travel Limits	3
Figure 2	– RFU Mounting Arrangement	6
Figure 3	– RFU 2000 Overall Dimensions	7
Figure 4	– RFU Internal Configuration – RAI and Feedback Side	9
Figure 5	– RFU 2000 Internal Configuration – Limit Switch Side	14
Figure 6	– RFU 2000 Assembly and Customer Parts List (Page 1 of 2)	16
Figure 7	– RFU 2000 Assembly and Customer Parts List (Page 1 of 2)	17
Figure 8	– RFU 2000 Component Schematic	19



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, Wagner'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.

Wagner'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).

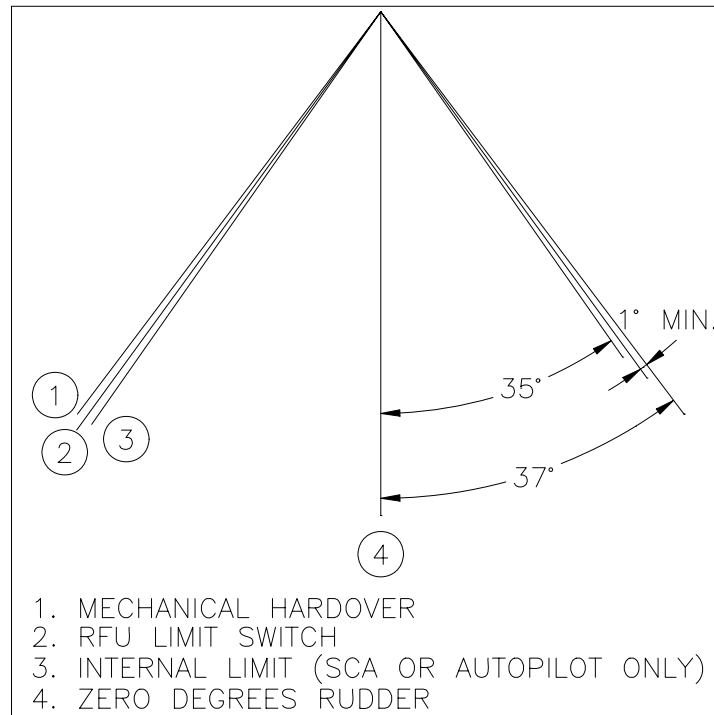


Figure 1 – Typical Rudder Travel Limits (Angles may vary)

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 (\pm 45 deg.)
Relative Tolerance	2%

NOTE: Multiple Wagner 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 Angle
Non-Wearing Hall Effect Feedback Device (± 45 Degree Rudders Only)

**Specifications are subject to change without notice.
Further information is available from Wagner**

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 (Wagner 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:

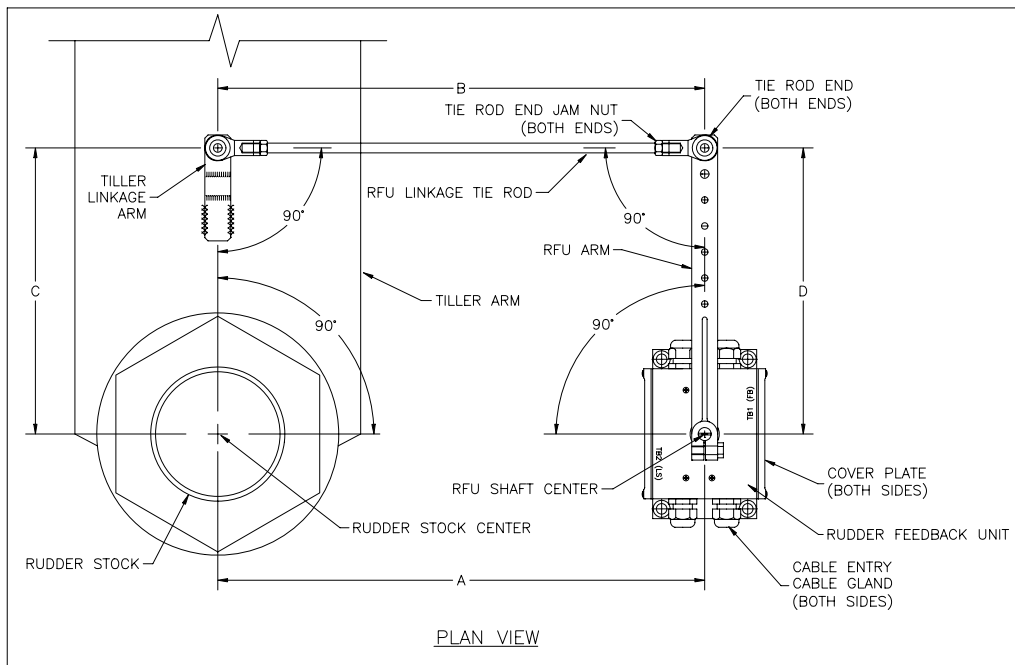


Figure 2 – RFU Mounting Arrangement

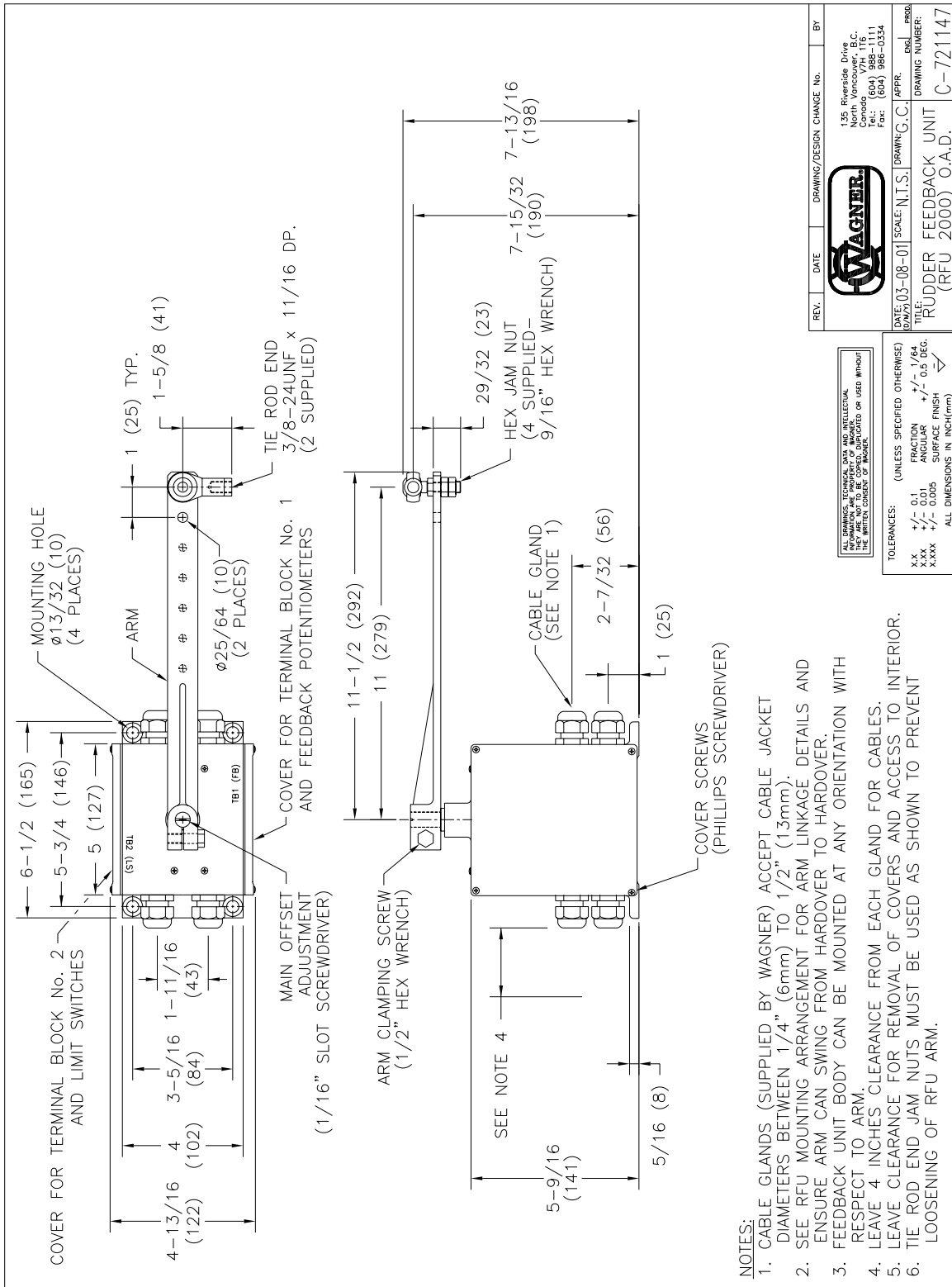


Figure 3 – RFU 2000 Overall Dimensions



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: Wagner'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.

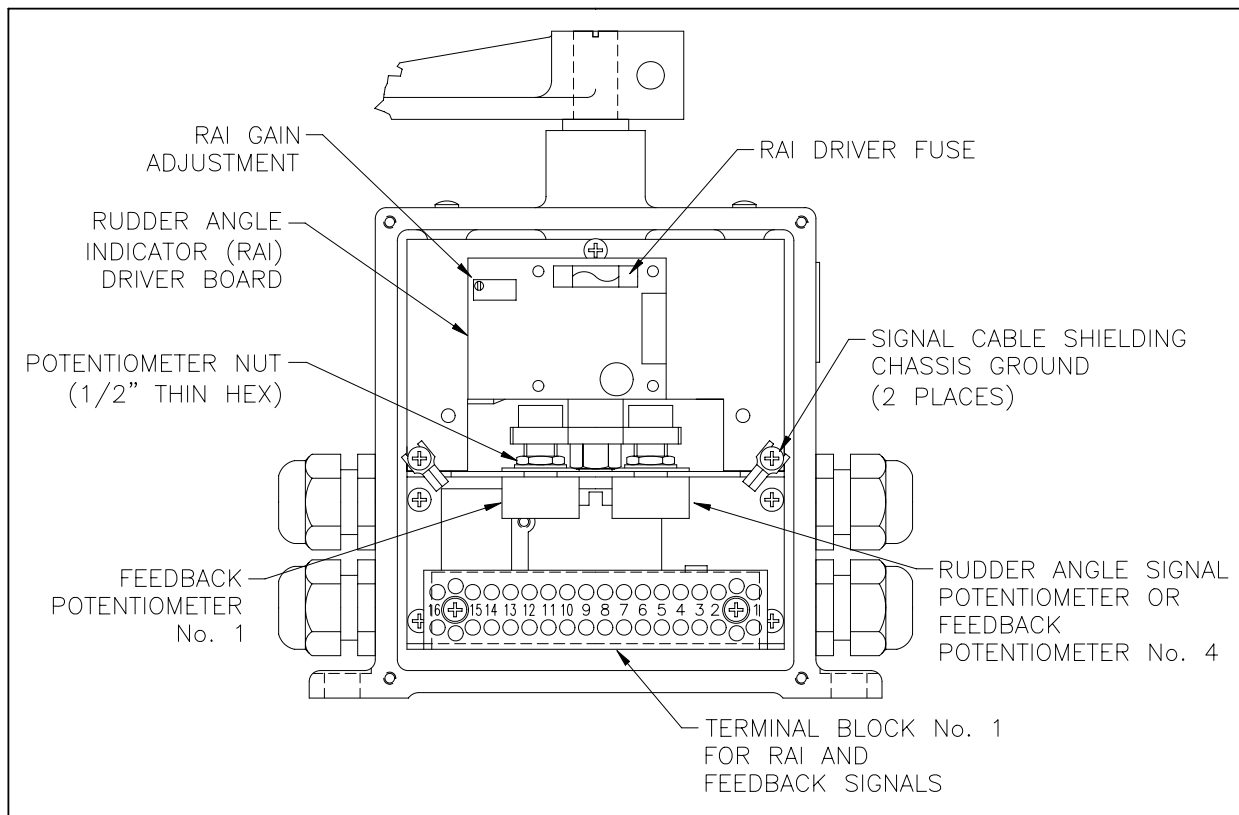


Figure 4 – RFU Internal Configuration – RAI and Feedback Side

Application of Power

- a) Check all connections on the power supply, RFU and RAIs.
- 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 RAI.
- d) 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.

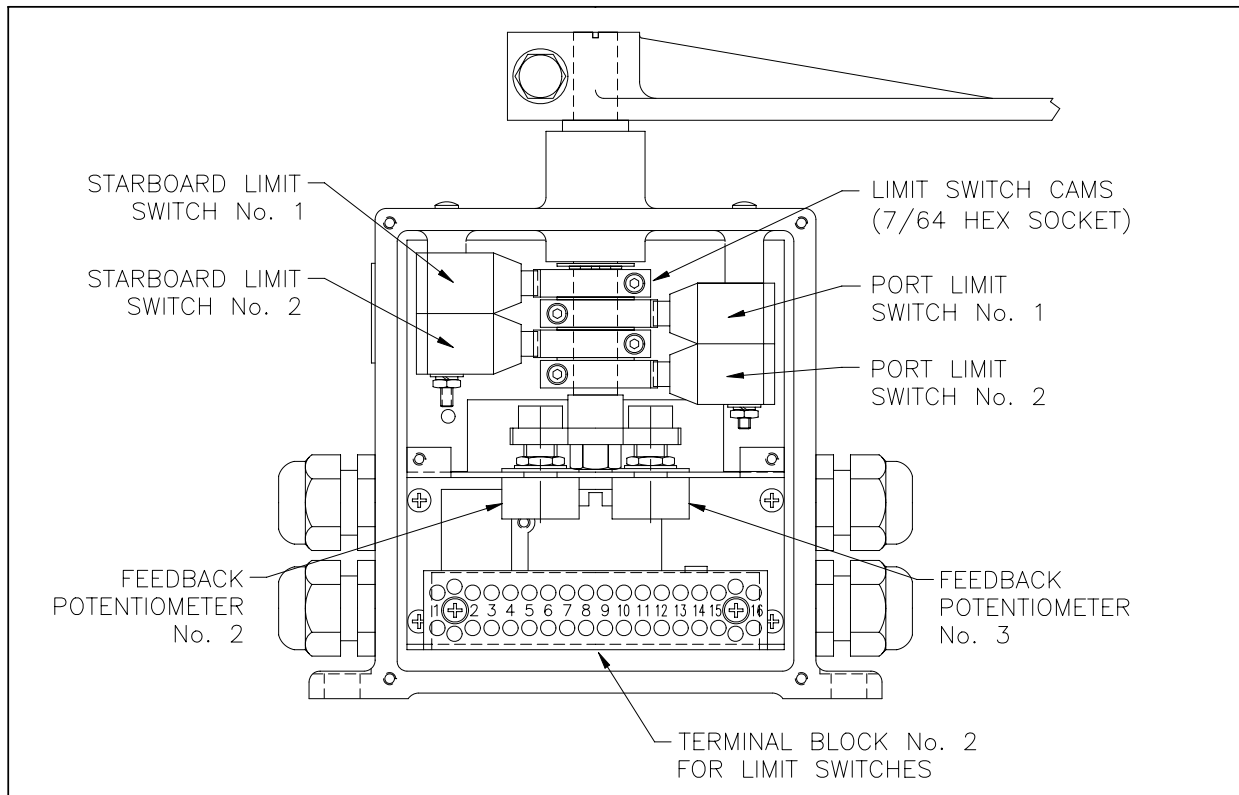


Figure 5 – RFU 2000 Internal Configuration – Limit Switch Side

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 Wagner 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 Wagner 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 Wagner 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 Wagner 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 Wagner personnel.

These components are available from any of our distributors.

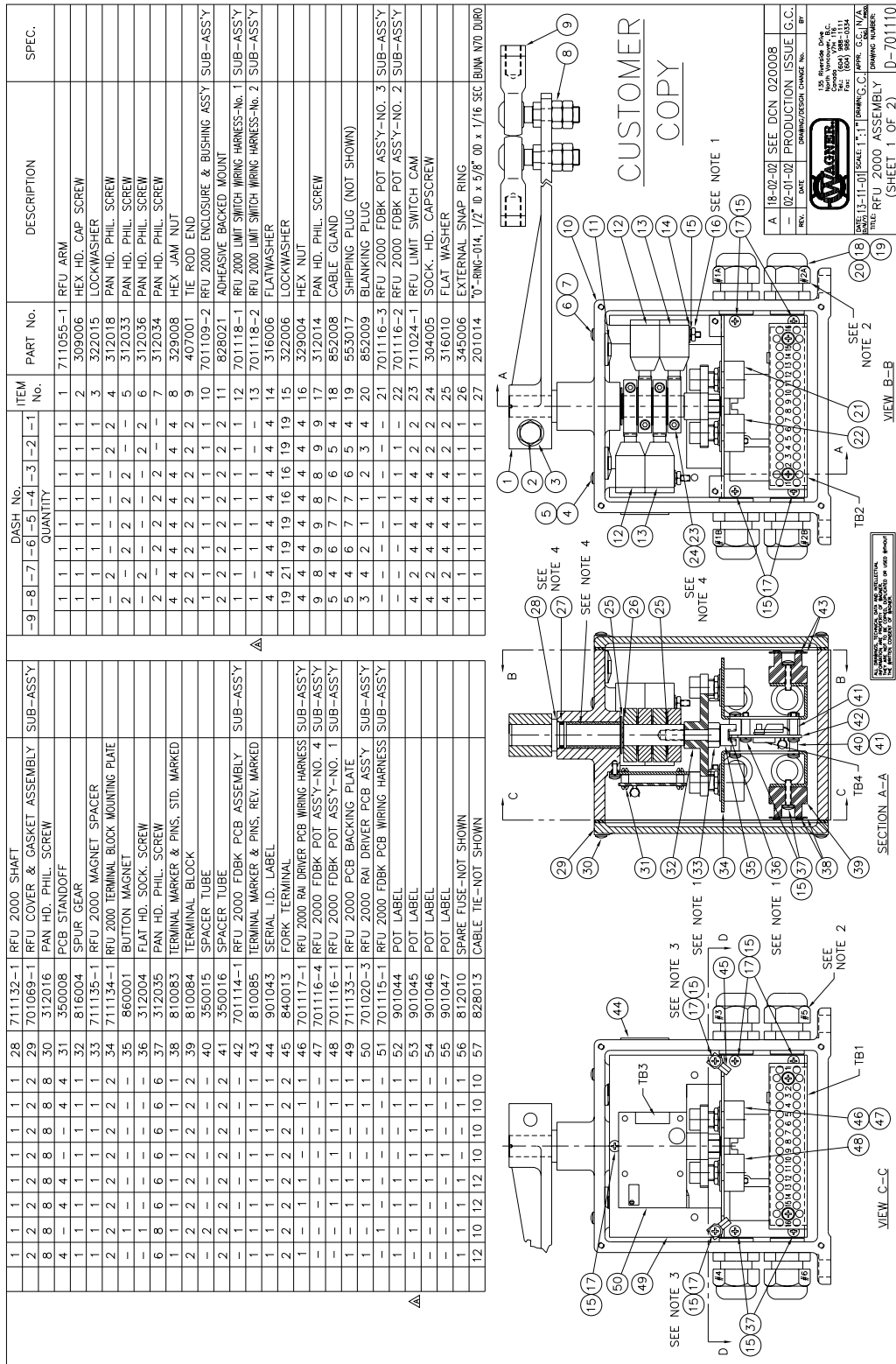


Figure 6 – RFU 2000 Assembly and Customer Parts List (Page 1 of 2)

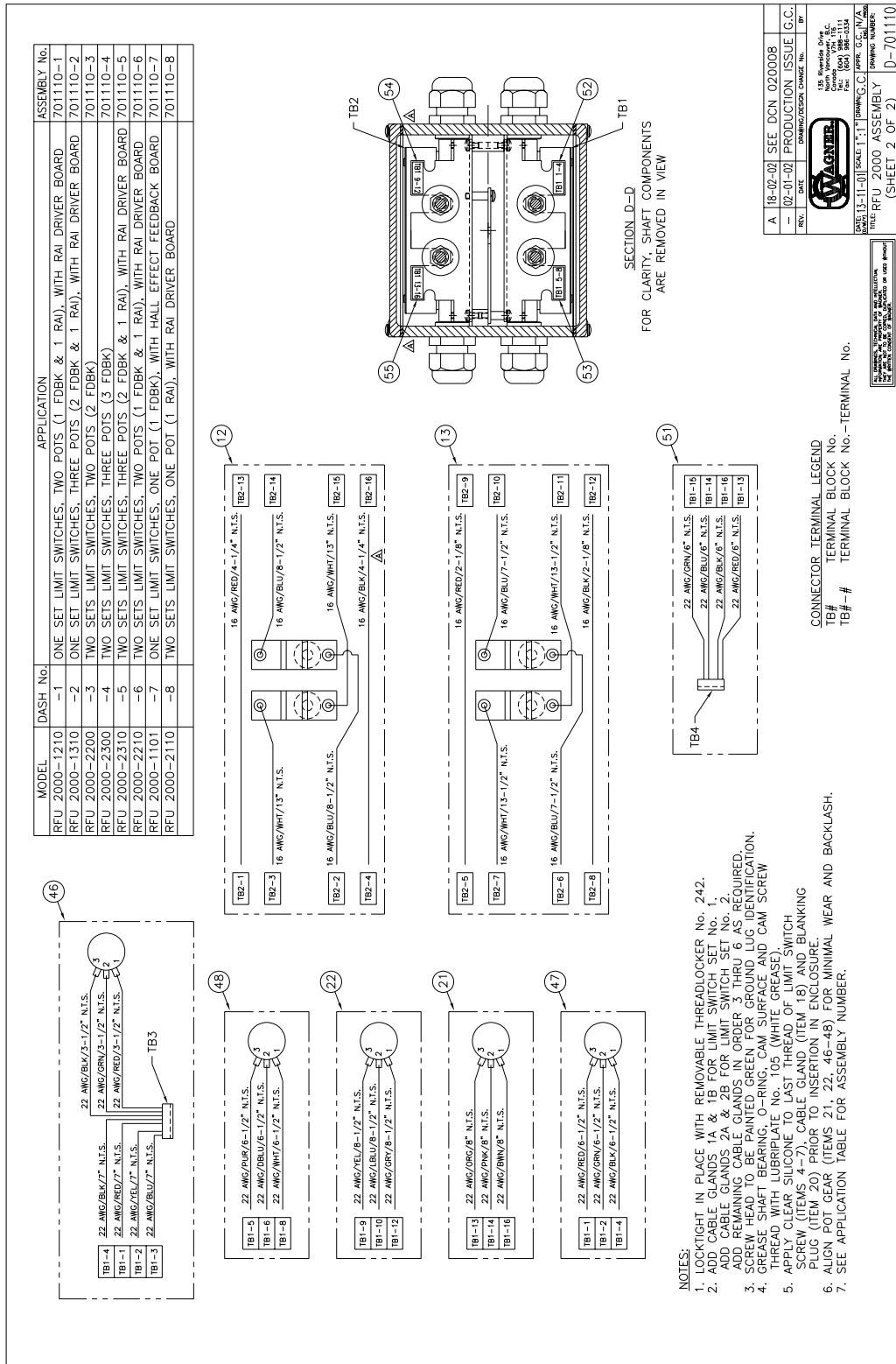


Figure 7 – RFU 2000 Assembly and Customer Parts List (Page 1 of 2)



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.

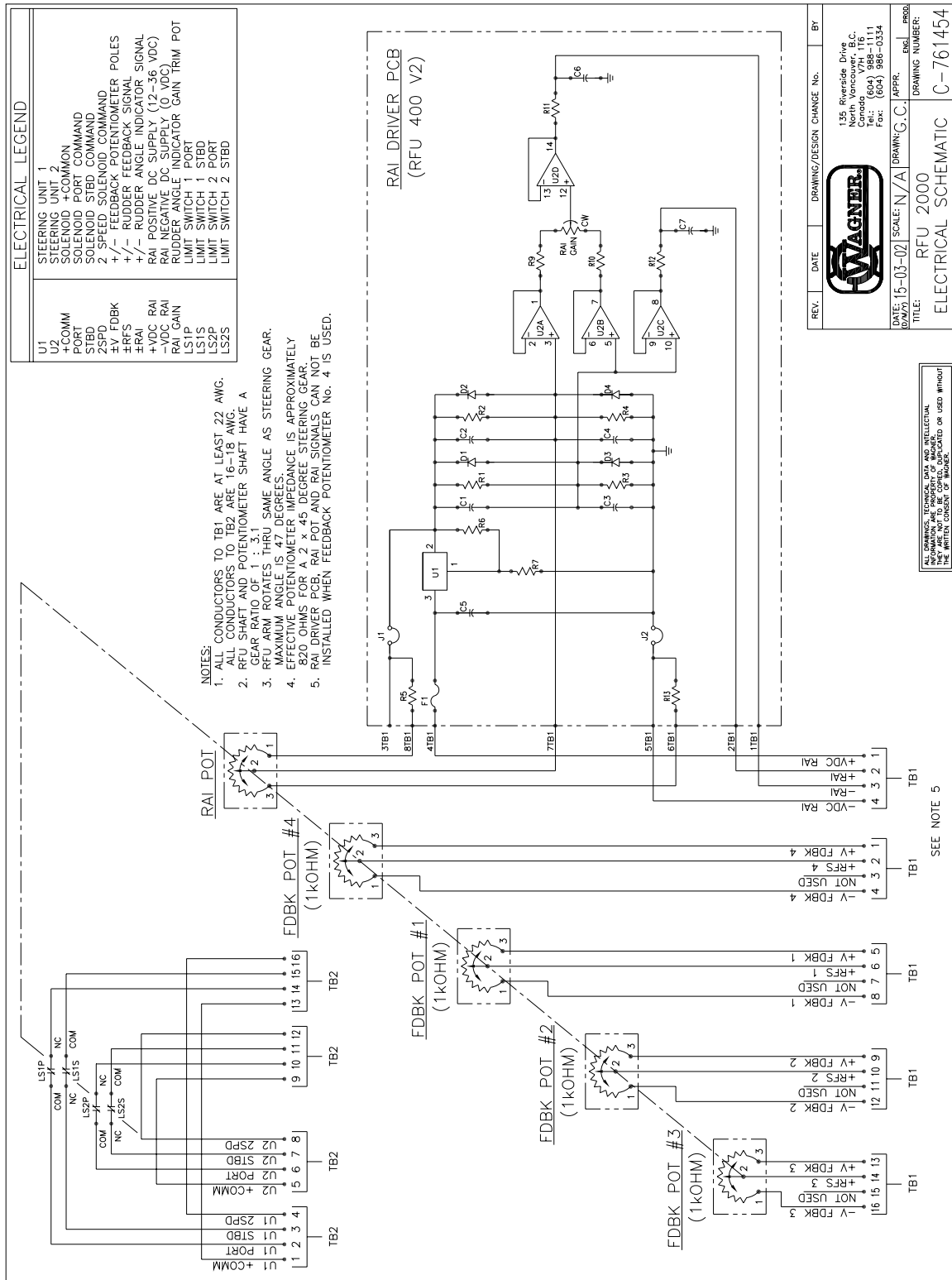


Figure 8 – RFU 2000 Component Schematic