INSTALLATION, OPERATION AND TROUBLESHOOTING

MM9000 - CLEAR COMMAND USER MANUAL

MARINE PROPULSION SYSTEMS

Released by After Sales dept.

Data subject to change without notice. We decline all responsibility for the use of non-original components or accessories wich have not been tested and submitted for approval.

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SW15623.OE

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Revision List

Revision	Date	Revision Description
Rev -	11/03	Revision - was a PRELIMINARY manual printed to support Production.
Rev A	4/03	Released and Signed Off.
Rev B	6/04	Updated with most current Forms and Manual Modules.
Rev C	8/04	Included ELR 1167 and 1150
Rev C.1	2/08	Replaced Field Service Test Unit (MM13927) manual with current revision (reformatted). Replaced forms MMC-172 International FASSC List, MMC-165 Warranty Policy with current revision.
Rev C.2	5/08	Replaced MMC-280 & MMC-329 Control Head Variations current revision.
Rev C.3	1/09	Replaced MMC-165 - Rev G 1/09 Electronic Propulsion Systems Limited Warranty Replaced MMC-123, MMC-151, MMC-172 - Factory Authorized Sales & Service Center Lists
Rev C.4	04/09	Replaced MMC-123, MMC-151, MMC-172 - Factory Authorized Sales & Service Center Lists
Rev C.5	09/09	Reviewed and replaced all external forms and documents with current revisions.
Rev C.6	05/11	Reformatted to FrameMaker9, Updated Software number, Revised preface per ELR00113, updated all external documents with current revision level, Revised per ELR00048
Rev C.7	09/11	Added MMC-343, changes made per ELR00144
Rev C.8	01/13	Changed name to ZF Marine Propulsion Systems Miramar, LLC

Preface

IMPORTANT: Keep this manual in a safe place for future reference. It contains essential information about the installation and operation of the ZF Marine Propulsion Systems Miramar control system for your vessel.

ClearCommand Processor List

The processors for the systems listed below have software which includes several featured options. Information about these options is contained in this manual, along with all standard instructions for 9000 series Processors. All vessels with ClearCommand Processors will not necessarily use all the featured options. Decide on their utility based upon your application.

Below is an example of the 9000 Series Part Numbering system. This is just a guide, there are more options available than shown below.

9000 Series Part Numbering / Identification Guide													
			Part Number										
			90010	91000	91102	91202	91212	92000	92102	92112	92212	95232	96232
Engine / Throttle	None	0	X										
	Mechanical	1		X	X	X	X						
	Electrical	2						X	X	X	X		
	Premium Mechanical	5										X	
	Premium Electrical	6											X
Gear / Clutch	None	0	X	X				X					
	Mechanical	1			X				X	X			
	Solenoid	2				X	X				X	X	X
	Mechanical Gear / Solenoid 2 Speed	3											
	Solenoid Gear / Solenoid 2 Speed	4											
Troll	None	0		X	X	X		X	X				
	Mechanical	1	X				X			X			
	Solenoid	2											
	Autotroll	3										X	X
	Mechanical Governed Troll	5											
	Solenoid Governed Troll	6											

For example a 91212 is a ClearCommand Processor with Mechanical Engine, Solenoid Clutch, Mechanical Troll and 2 stations. Each number in the part number signifies a different quality of the processor that fits your needs. The last number in each Processor part number is the number of stations that are being used.

Available Options for the Processors Covered in this Manual

- Dynamic Positioning Interface
- Station 4 / Joystick Interface
- CANtrak Display
- Engine Room/Remote Switch (Station 1 only)
- Station 2 Lockout
- Speed Boost — Loaded w/Software
- Fixed Neutral Delay — Loaded w/Software

Conventional Symbols Used in the Manual

Throughout this manual special attention should be paid to the following symbols.

	WARNING: Personal Injury may result if this message is disregarded.
	CAUTION: Damage to equipment may occur if this message is disregarded.
	IMPORTANT: Contains essential Information about a topic.
	NOTE: Contains noteworthy information that may help to clarify a topic.

Important Information

	WARNING: Personal Injury could occur if the following steps are not followed exactly.
	CAUTION: On Control Systems with more than one Processor, ZF Marine Propulsion Systems Miramar highly recommends that ALL UNITS utilize the same software revision for each Processor.
	CAUTION: Electro-static discharge can damage this equipment. Personnel working on this equipment must be grounded to the chassis with an Anti-static Wrist Strap.
	CAUTION: Disconnect the Power from the Processor whenever welding is being done on the vessel. Failure to do so can cause permanent damage to the Processor.
	CAUTION: This equipment is designed to work with other ZF Marine Propulsion Systems Miramar designed equipment. DO NOT operate this equipment with any other manufacturers equipment unless approved so in writing by ZF Marine Propulsion Systems Miramar Engineering Department.

Optional Features Information

WARNING: If the Dynamic Positioning (DP) Interface option is being used, it is the operator's responsibility to operate the vessel per the DP system manufacturer's requirements. Please call your ZF Marine Propulsion Systems Miramar representative for any questions with any installation/operational questions prior to Sea Trials.

WARNING: If the DP/JS Interface option is being used, it is the operator's responsibility to operate the vessel per the DP system manufacturer's requirements. Please call your ZF Marine Propulsion Systems Miramar representative for any questions with any installation/operational questions prior to Sea Trials.

CAUTION: The DP pigtail MUST NOT be used to connect any other device such as a remote station Control Head. Failure to meet this requirement will nullify the Processor warranty, cause an unsafe operating condition and/or damage the Processor.

CAUTION: If the DP option is being utilized with a multi-screw application, ALL Processors MUST HAVE the DP pigtail connected to the DP System. Failure to comply with this requirement could cause an unsafe operating condition with possible severe personal injury and/or property damage.

CAUTION: If the DP option with Troll is being utilized with a multi-screw application, the Dynamic Positioning System is responsible for any transmission damage that may occur due to Trolling with one screw and operating with the clutch fully engaged on another screw (i.e., "dragging" a screw through the water).

CAUTION: Misapplication of the Speed Boost feature can damage the transmission or other equipment. Before using Speed Boost, the transmission representative must be consulted about its use, and any limitations on clutch engagement as a function of engine speed. The person(s) implementing Speed Boost have the responsibility for ensuring it is properly adjusted and for any damage that might occur.

How to Use the Manual

This manual is written describing all possible options available for this processor. Your vessel may not require all of these options. Refer only to the sections that apply to your vessel. If you wish to use one of the available options listed, please contact a technician from ZF Marine Propulsion Systems Miramar Sales & Service Organization (SSO). For more information on an SSO in your area, please see Section 13: Appendix C - Sales and Service Information.

NOTE: ZF Marine Propulsion Systems Miramar is not liable for any damage incurred if these notices are not followed exactly.

1 Introduction

This manual is written to document every possible system option.

Your system may not include every available option for single or twin screw reverse reduction gear applications.

Only those sections that apply to your specific installation are relevant to your vessel.

If additional options described within this manual are desired, contact your dealer for availability/ compatibility with your system.

1.1 Basic Theory of Operation

The ClearCommand Marine Propulsion Control System (hereafter referred to as ClearCommand or System) is electronic and requires a 12 or 24 VDC power supply, one Processor per engine/clutch and one Control Head per remote station. The ClearCommand commands the vessel's throttle and shift using a single Control Head lever.

One electric cable per Control Head lever connects the remote station(s) to the Processor(s). Only one remote station will have command at a given time and the Station-in-Command is indicated by a red light located on the Control Head. Station transfer is accomplished by pressing the Control Head mounted transfer button.

1.1.1 9120 Processor (Throttle-Servo 2, Shift-Solenoid) or 9122 Processor (Throttle-Servo 2, Shift-Solenoid, Troll-Solenoid).

The 9120 or 9122 System is designed for pleasure and light commercial marine vessels that require remote control of:

9120

- mechanically actuated engines
- solenoid activated clutches

9122

- mechanically actuated engines
- solenoid activated clutches
- solenoid activated trolling valves

The **9120** or **9122** Processor is typically mounted in the engine room area and is connected mechanically to the vessel's main engine throttle selector lever with standard 33C type push-pull cables.

The **9120** Processor controls the electrical Ahead and Astern Shift Solenoids at the transmission, via electric cable.

The **9122** Processor controls the electrical Transmission and Trolling Valve Solenoids for shift and trolling functions, via electric cable.

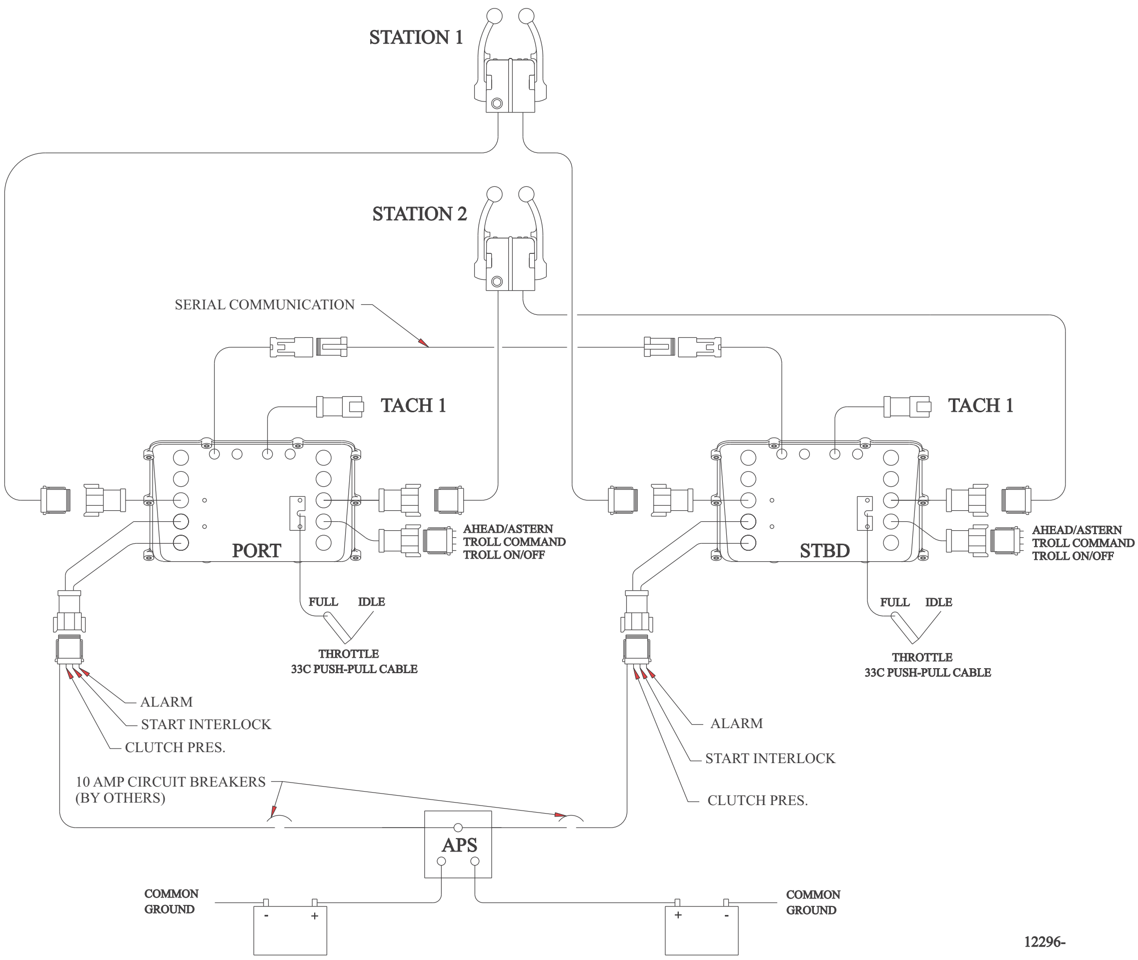

Figure 1-1: Basic 9120 or 9122 ClearCommand System Diagram

1.1.2 9121 Processor (Throttle-Servo 2, Shift-Solenoid, Troll-Servo 1)

The **9121** System is designed for pleasure and light commercial marine vessels that require remote control of:

- mechanically actuated engines
- solenoid activated clutches
- mechanical trolling valves.

The Processor is typically mounted in the engine room area and is connected mechanically to the vessel's main engine throttle selector lever and trolling valve with standard 33C type push-pull cables.

The transmission is controlled via electrical cables connected to the Ahead and Astern Shift Solenoids.

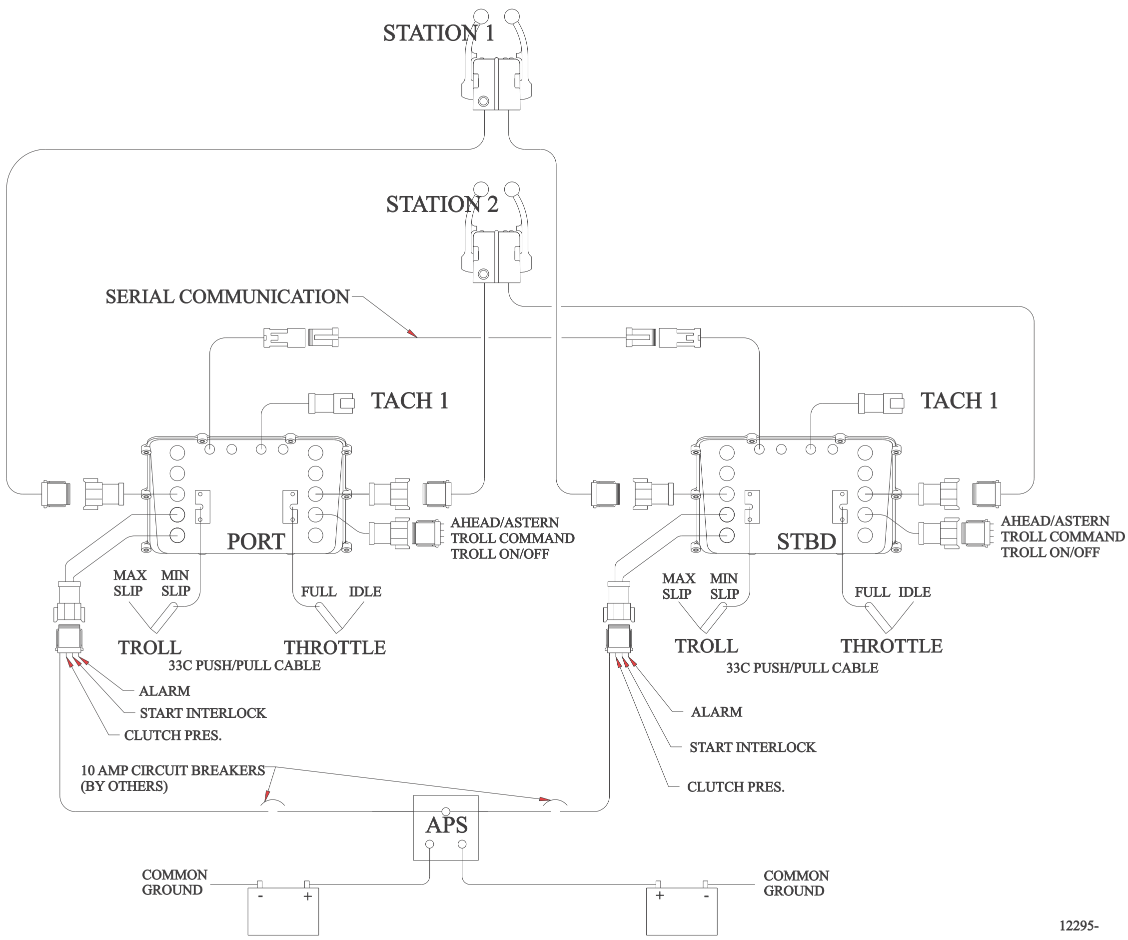

Figure 1-2: Basic 9121 ClearCommand System Diagram

1.1.3 9210 Processor (Throttle-Electronic, Shift-Servo 1)

The **9210** System is designed for pleasure and light commercial marine vessels that require remote control of:

- electronic engine governors
- mechanically actuated clutches

The Processor is typically mounted in the engine room area and is connected to the electronic governor with a two-conductor, shielded, electric cable.

The transmission is controlled mechanically using standard 33C type push-pull cable.

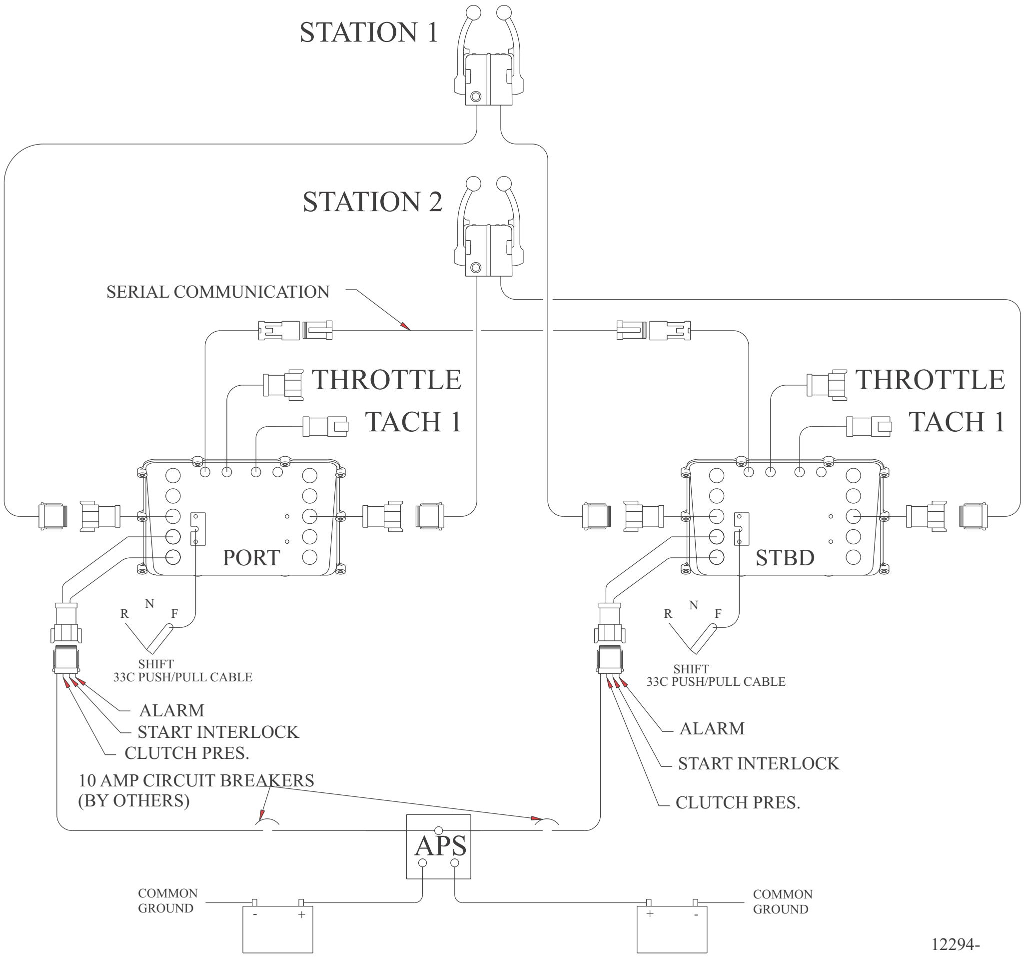

Figure 1-3: Basic 9210 ClearCommand System Diagram

1.1.4 9211 Processor (Throttle - Electronic, Shift - Servo 1, Troll - Servo 2)

The **9211** System is designed for pleasure and light commercial marine vessels that require remote control of:

- electronic engine governors
- mechanically actuated clutches
- mechanically actuated trolling valves.

The Processor is typically mounted in the engine room area and is connected to the electronic governor with a two-conductor, shielded, electric cable.

The transmission and trolling valve are controlled mechanically using a standard 33C type push-pull cable.

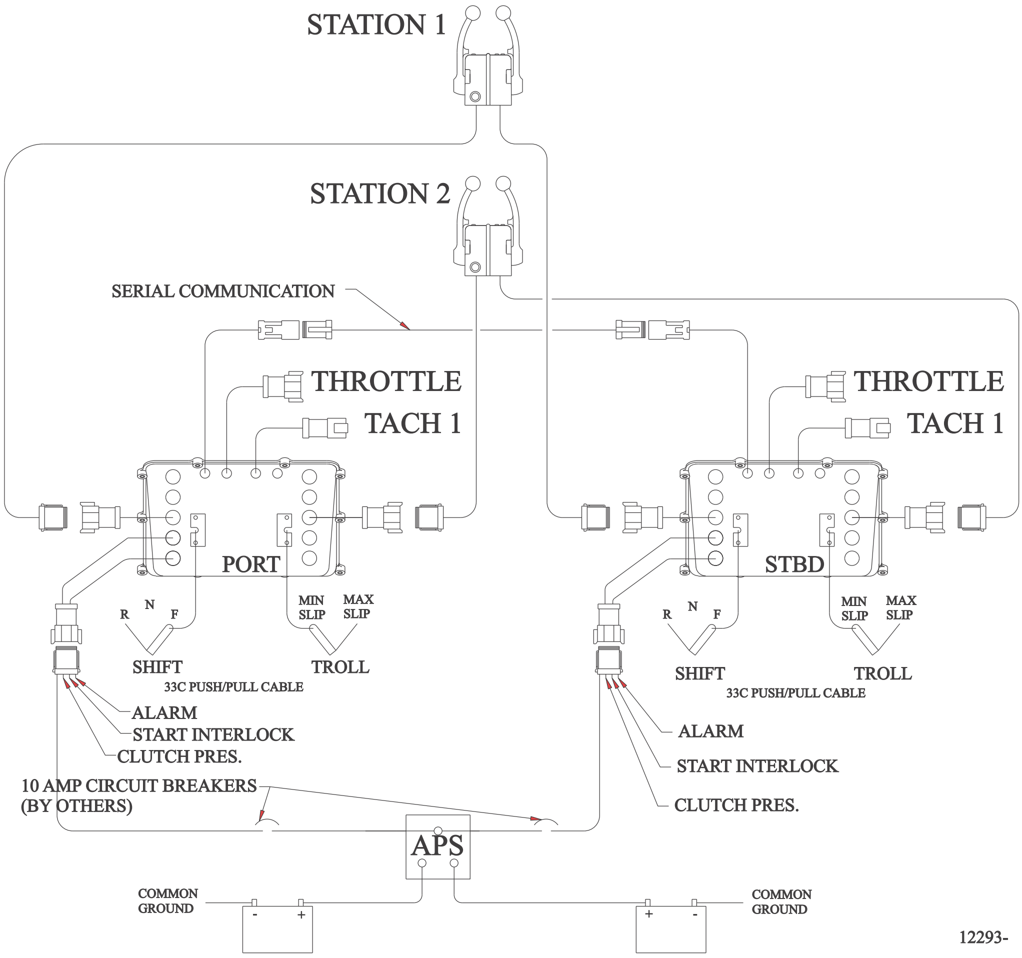

Figure 1-4: Basic 9211 ClearCommand System Diagram

1.1.5 9221 Processor (Throttle - Electronic, Shift - Solenoid, Troll - Servo 2)

The **9221** System is designed for pleasure and light commercial marine vessels that require remote control of:

- electronic engine governors
- solenoid activated clutches
- mechanically actuated trolling valves

The Processor is typically mounted in the engine room area and is connected to the electronic governor with a two-conductor, shielded, electric cable.

The transmission's Ahead and Astern solenoids are connected via 2 two-conductor cables, and the trolling valve is controlled mechanically using a standard 33C type push-pull cable.

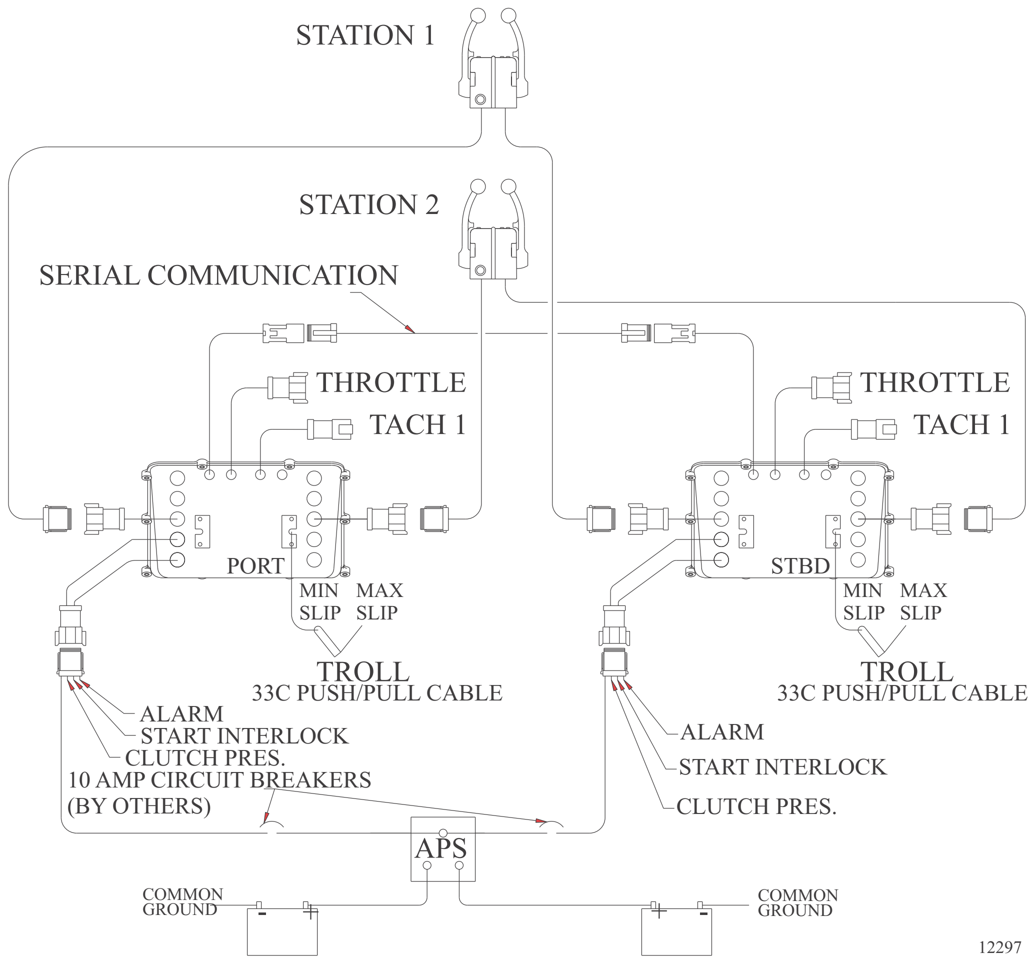

Figure 1-5: Basic 9221 ClearCommand System Diagram

1.2 System Features

1.2.1 Standard Features

- Station-in-Command indication. (Section 2.2: Taking Command)
- Up to five Remote Stations. (Section 2.2: Taking Command)
- Single Control Head lever command of speed and direction. (Section 2.3: Basic Operation)

2 Operation

2.1 DC Power On

When DC power is turned ON to the Processor:

- A short steady tone, followed by an intermittent tone, will sound at all Remote Stations indicating that no station has command.
- The Start Interlock relay contact will remain open, preventing engine start.
- Throttle:
  Servo: The throttle servo will drive to Idle.
  Electric: The throttle signal will be commanded to Idle.
- Shift:
  Servo: The Shift servo will drive to Neutral.
  Solenoid: The Ahead and Astern shift solenoids will be de-energized, commanding Neutral.
- Troll:
  Servo: The trolling valve servo will drive to lock-up.
  Solenoid: The trolling valve solenoids are commanding lock-up.

2.2 Taking Command

To take command at any one of the up to five Remote Stations:

- Ensure all Control Head's lever(s) at that Station are in the Neutral detent (vertical position)

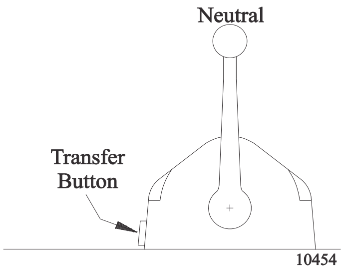

Figure 2-1: Station taking Command

- Depress the transfer button for 1/2 second.

The Slow Repetitive tone will stop at all Stations, and the red LED indicator light will turn ON at the Control Head of the Station that had assumed command of the Control System.

NOTE: If Start Interlock is used: Once a Station is in command the Start Interlock relay contact will close, allowing the engine to start.

NOTE: Only one Station can have command at a time.

2.3 Basic Operation

2.3.1 Normal Operating Mode

A The Control Head has three detents; Ahead, Astern and Neutral.

B With the Control Head lever positioned in the Neutral (vertical) detent, the Processor will command Neutral and the throttle at Idle revolutions per minute (RPM).

C Movement of the Control Head's lever 15 degrees to the Ahead or Astern detent will command Ahead or Astern clutch engagement, while the engine RPM remains at Idle.

D Further movement of the Control Head lever through the next 65 degrees, will increase the engine RPM in proportion to the Control Head's lever position.

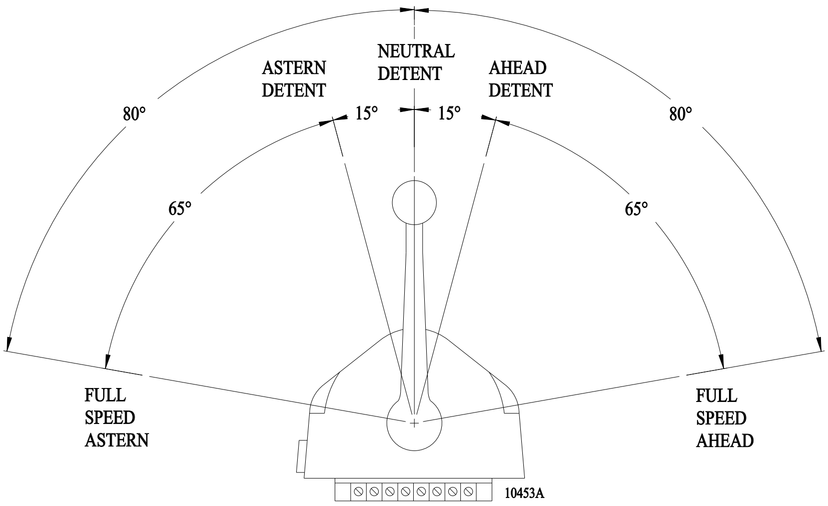

Figure 2-2: Control Head Detents

2.3.2 Trolling Valve Operation

WARNING: Personal Injury may result if this message is disregarded.

The operation is quite different in Systems equipped with Trolling Valves. Troll Mode is a feature that must be turned On and Off at the Control Head. On initial power-up, Troll Mode is disabled.

A The Control Head has three detents; Ahead, Astern and Neutral. To turn ON Troll Mode, place the Control Head lever in any of the above mentioned detents.

- With the Control Head lever positioned in the Neutral (vertical) detent, the Processor will command Neutral, the trolling valve will be at lock-up and the throttle at Idle rpm.

B Depress and hold the transfer button for two (2) seconds.

- The solid red indicator light on the Control Head will begin blinking rapidly, indicating the system is now in Troll Mode.

NOTE: If system is set for Twin Screw operation, ensure all Control Head levers are in the same detent (Neutral, Ahead or Astern).

C Once the system has been placed in Troll Mode, movement of the Control Head's lever 15 degrees to the Ahead or Astern detent will command Ahead or Astern clutch engagement and the trolling valve commanded to minimum pressure, while the engine RPM remains at Idle.

D Further movement through the selectable 25, 35, 45, or 55 degrees, will increase the clutch pressure to maximum while the throttle remains at Idle.

E Further movement through the next 40, 30, 20, or 10 degrees will increase throttle to full, except when 45 degrees is selected (where throttle is limited to 75% of full) and 55 degrees is selected (where throttle is limited to 10% of full).

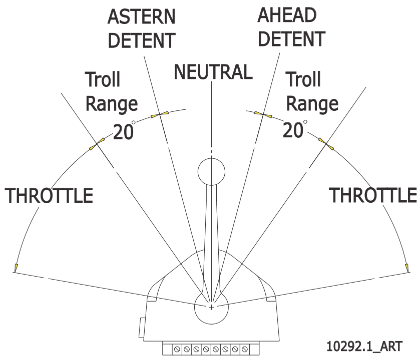

Figure 2-3: Control Head 20 Degree Troll Range - Type 1

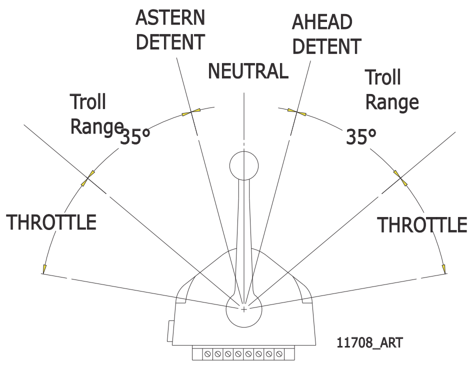

Figure 2-4: Control Head 35 Degree Troll Range - Type 2

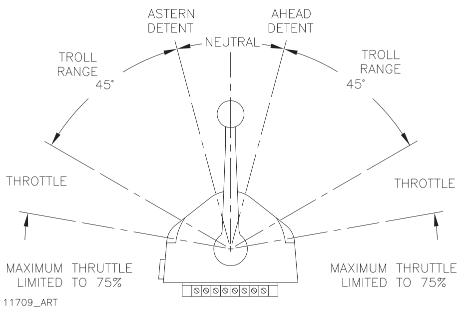

Figure 2-5: Control Head 45 Degree Troll Range - Type 3

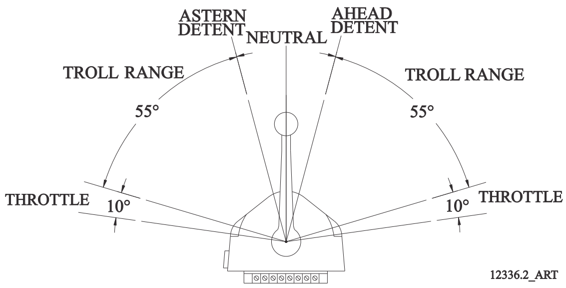

Figure 2-6: Control Head 55 Degree Troll Range - Type 4

F To turn Troll Mode OFF, place the Station-in-Command into a detent (Neutral, Ahead, or Astern).

G Depress and hold the Transfer Button until the red indicator light on the Control Head becomes lit steady (approximately 2 seconds) then release the button. When the red indicator light is a steady red, Troll Mode is disabled.

2.4 Start Interlock (if used)

The engine start signal is blocked unless all of the following are true:

- DC power has been turned ON to the Control System. (Reference Section 2.1: DC Power On)
- A Remote Station is in command. (Reference Section 2.2: Taking Command)
- The Control System is commanding Neutral.

2.5 Station Transfer

WARNING: Personal Injury may result if this message is disregarded.

Command can be transferred as follows:

A The Station-in-Command's lever(s) may be left in any position.

B Place the Control Head's lever(s) of the receiving Station in the Neutral/Idle detent position (refer to Figure 2-7: Remote Stations Before Transfer of Command)

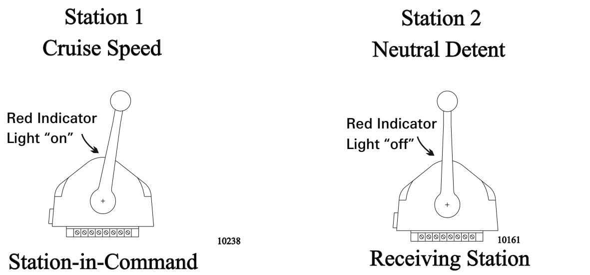

Figure 2-7: Remote Stations Before Transfer of Command

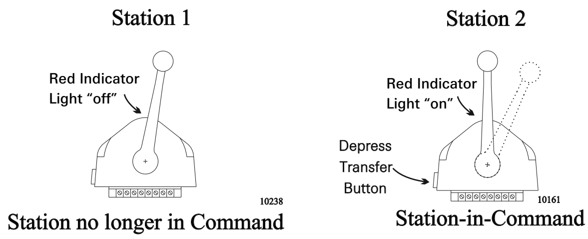

Figure 2-8: Remote Station Transfer after Transfer of Command

C At the Station taking command (Receiving Station), depress and hold the transfer button for 1/2 second (refer to Figure 2-8: Remote Station Transfer after Transfer of Command).

- The red LED indicator light at the receiving Station's Control Head will illuminate, indicating that the Station has taken command.
- The red LED indicator light will go OFF at the transferring Station's Control Head, indicating that the Station no longer is in command.

D The commanded positions of the Throttle and Clutch will remain unchanged for one second after the red LED lights. This allows the operator time to move the Control Head's lever(s) to a position approximately matching the last Station, which will allow the vessel to maintain present speed and direction.

2.6 Proportional Pause

The proportional pause provides a means of safely reversing the vessel's direction. A variable pause is introduced into the clutch command signal to allow time for the engine RPM's to drop to Idle and for the vessel's speed through the water to slow. This pause is set during Section 7: Sea Trials.

2.7 Warm-up Mode

This feature allows the operator to increase the engine's RPM, while the Clutch remains in Neutral. Warm-Up Mode is operational only when the Control Head lever is moved in the Ahead direction.

	**WARNING: Personal Injury may result if this message is disregarded.**

The system is placed into Warm-Up Mode as follows:

A At the Station-in-Command, ensure that the Control Head's lever is in the Neutral detent position (refer to Figure 2-9: Control Head Warm-Up Mode).

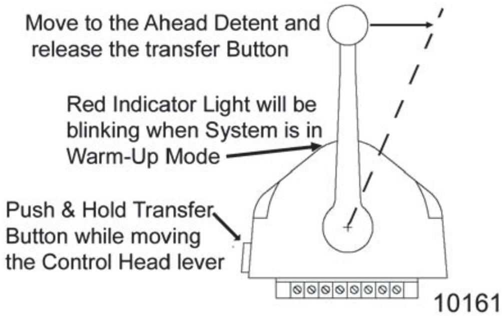

Figure 2-9: Control Head Warm-Up Mode

B Depress and <u>hold</u> the transfer button.

C After one second, move the Control Head's lever to the Ahead detent, while continuing to hold the transfer button.

D Now release the transfer button.

- The red LED indicator light will blink slowly, indicating Warm-Up Mode is activated and the Clutch has remained at Neutral.

E The operator can start the engine, if required, and increase the RPM through the entire throttle range by moving the Control Head's lever forward through the next 65 degrees.

F When the Control Head's lever is returned to the Neutral detent, the red LED will discontinue blinking and remain lit steady. After one second in Neutral, the Processor will automatically reset to normal operation with full control of the clutches and engine.

G The next movement of the Control Head's lever will engage the Ahead or Astern clutch (Normal Operation).

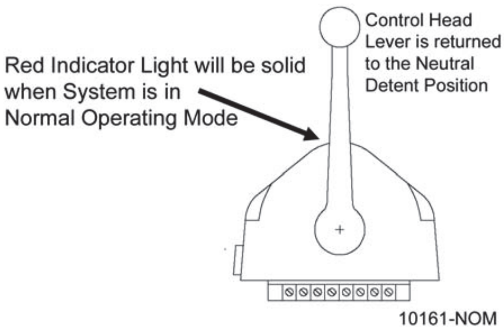

Figure 2-10: Control Head Normal Operating Mode

2.8 High/Low Idle

The Control System provides the input to the engine, so that it may run at the standard Idle speed (typically adjusted at the governor or carburetor), or it can provide a second elevated Idle speed.

2.8.1 Low Idle

- The factory default setting is for Low Idle Only.
- When the System is initially powered-up, it will always command Low Idle, even when High Idle is selected.

2.8.2 High Idle

- If High Idle is desired, it may be programmed during Dock Trials.
- High Idle is programmable up to a maximum setting of 20% of Full Throttle.
- High Idle is automatically selected when in Warm-Up Mode.

2.8.3 Selecting Between High and Low Idle

WARNING: Personal Injury may result if this message is disregarded.

Refer to Figure 2-11: High/Low Idle Mode Selection when selecting between Low and High Idle (or vice versa) at the Station-in-Command

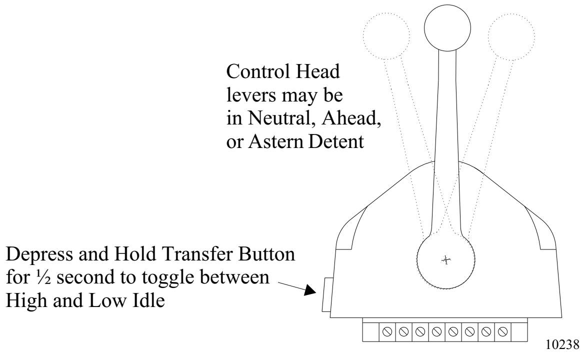

Figure 2-11: High/Low Idle Mode Selection

A The Control Head’s lever(s) may be in the Neutral, Ahead or Astern detents when making a selection.

B Depress and hold the transfer button for 1/2 second and then release.

- If the System was in Low Idle it will toggle to High Idle, and vice versa.

C To return to the previous Idle setting, depress and hold the transfer button again for 1/2 second and then release.

NOTE: In Twin Screw applications, always program both Processors for the same amount of High Idle. In Twin Screw applications, both the Port and Starboard Processors will always be in High or Low Idle at the same time.

2.9 One Lever Mode (Twin Screw)

NOTE: One Lever Operation may be used in Troll Mode or in Non-Troll Mode.

NOTE: The Green LED will always be lit while in One Lever Operation, no matter what position the Master Control Head lever is in.

The system supports a mode of operation referred to as One Lever Mode, which allows the operator to control both engines and transmissions with a single Control Head lever. The Port or the Starboard lever at any Remote Station can be designated by the operator as the **Master lever**. The designation can be changed by the operator at any time. Most of the features (synchronization, troll, etc.) available in normal operation are available while operating in One Lever Mode.

- The Processor defaults to One Lever Mode disabled.
- One Lever Mode can be disabled or enabled in the Set Up Procedures.
- When One Lever Mode is enabled, the operation must be turned ON and OFF as described below.

WARNING: Personal Injury may result if this message is disregarded.

2.9.1 Turning ON One Lever Operation

A At the Station-in-Command, move the Port and Starboard Control Head levers to the Ahead detent.

B Depress and Hold the transfer button while moving the Port or Starboard Control Head's lever out of the Ahead detent. Do Not Release the Transfer Button until the green LED turns ON, indicating One Lever Operation is now active.

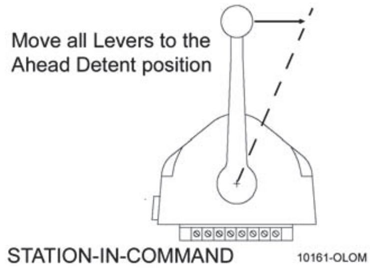

Figure 2-12: Step A) One Lever Operation Mode

- The Control Head lever which the operator chose to move out of the Ahead detent, becomes the **Master lever**.

- The Control Head lever which was left in the Ahead detent is now inactive.

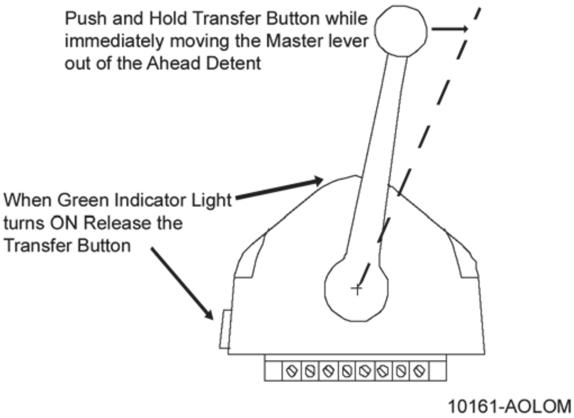

Figure 2-13: Step B) One Lever Operation Mode

NOTE: The Control Head lever designated by the operator to be inactive in One Lever Operation, may be left in the Ahead detent or moved fully forward. Moving the lever fully forward is recommended, because it moves it out of the way and prevents accidental bumps while operating.

2.9.2 Turning OFF One Lever Operation

A Place the **Master lever** into the Neutral detent.

B Place the inactive Control Head lever into the Neutral detent.

- Whenever the inactive lever is moved to the Neutral detent, One Lever operation is turned OFF. The green LED will turn OFF, indicating that the control system is now in normal operating mode.

WARNING: It is strongly recommended that the Master lever **is returned to the Neutral/Idle position prior to turning OFF One Lever Operation.**
Do not attempt to transfer command from one Remote Station to another while in One Lever Operation. Always turn One Lever Operation OFF prior to transferring.
Failure to observe these recommendations may result in a sudden change in the vessel’s direction.

2.10 Engine Synchronization (Twin Screw)

Engine Synchronization must be selected during Set Up to have automatic synchronization.

NOTE: The Control System offers two types of synchronization, Active or Equal Throttle.

Synchronization is automatic and only operates when the Ahead clutch is engaged, consequently it can be left ON full time. When synchronization has been selected during set up, the Control System will always power-up with synchronization ON.

In order for synchronization to become active and work toward synchronizing the engines' RPM's, the Synchronization Criteria listed below must be met.

2.10.1 Synchronization Criteria

- Both Control Heads must be commanding 5% or greater of the throttle range.
- The Control Head levers must be within 10% of one another (+/- approximately 6 degrees).
- Both Control Head levers are commanding Ahead clutch engagement.

NOTE: The use of Value 03 for Function Code E7 should be avoided in the 9000 Series Processors with mechanical throttle control.
Symptom:
When selected, Value 03 (Active Synchronization, no Synch if Tach signal lost) for Function Code E7 (Synchronization) may give the operator the appearance that synchronization is not functioning. This is due to the fact that the Control Head's green Synch indication LED does not light until both engine RPM's are within the "Active Synch Deadband". "Active Synch Deadband" is the maximum allowable difference in engine RPM, where the Processors consider the system synchronized adequately. Once obtained, the control system does not attempt to match
the RPM's any closer.
When in this Mode of Operation, there is no indication to the operator that the Control Head levers are matched close enough to start the synchronization process. Additionally, the green indication LED does not blink while working toward synchronization.
Cause:
Function Code E7, Value 03, is operating as designed. Due to the imprecise positioning of mechanical push-pull cables, the ability to position the cables within the "Active Synch Deadband" is severely impaired.
Solution:
All Processors with mechanical throttle control, where synchronization is desired, must set the Value of Function Code E7 to Value 01 (Active Synchronization reverts to Equal Throttle Synchronization if Tach Signal is lost)

2.10.2 Synchronization Types

The following types of synchronization use the same criteria, indications, and are turned ON and OFF as described in following Sections.

2.10.2.1 Equal Throttle Synchronization (Twin Screw) (default)

Equal Throttle synchronization simply commands the same throttle to both engines (i.e. push-pull cables travel the same distance; electronic signals are the same). With Equal Throttle Synchronization the Processors do not receive tachometer signals representative of the engines RPM's.

CAUTION: The Control System will remain synchronized as long as the Control Head's levers are in close proximity to one another. If a lever is moved to a point where the 10% throttle window is exceeded, a 10% increase or decrease in engine RPM would occur with one engine, resulting in a sudden change in the vessel's direction.

NOTE: In order for Equal Throttle Synchronization to work properly in Systems with mechanical Throttles, the bends in the push-pull cables must be kept to a minimum. There can be no back-lash in the linkage or cables. Both Governors or Carburetors must provide equal engine RPM with equal movement of their selector levers. If these conditions can not be met, Active Synchronization is recommended.

2.10.2.2 Active Synchronization (Twin Screw) (default Disabled)

Active Synchronization must be enabled during Set Up and a Tach Sensor Wire Harness must be used.

The Processors each receive a tachometer signal representing engine RPM from their respective engines. These signals are compared with one another over a serial communication line. If the Synchronization Criteria is met, the throttle command signal of the engine running at the higher RPM is lowered, until the RPM's of both engines match.

2.10.3 Synchronization Indications

The green LED located on the Control Head indicates the status of synchronization.

- In Active Synchronization the green LED **blinks** every time there is a change in the commanded throttle.
- When the green LED is lit **steady**, the engines are synchronized.
- When the green LED is **not lit**, the engines are not synchronized and the Control System is not attempting to do so.

2.10.4 Turning Synchronization OFF:

A Ensure that the Control Head's levers are positioned to a point where Synchronization Criteria are met.

B Press and hold the transfer button until the green LED blinks twice and then goes out (approximately 2 seconds).

C Synchronization is now OFF.

2.10.5 Turning Synchronization ON:

A Ensure that the Control Head's levers are positioned to a point where Synchronization Criteria are met.

B Press and hold the transfer button until the green LED lights (approximately 2 seconds).

- The green LED will blink as the system is working toward synchronization.
- The green LED will become solid when the engines are synchronized.

2.10.6 Turning Synchronization ON and OFF when Control Head Levers are not within a 10% (6 degree) Window of One Another:

The actual synchronizing of the engines occurs when the Control Head levers are within the 10% (approximately 6 degrees) window of one another. However, synchronization can be turned ON or OFF when the Control Head levers are apart more than the 10% (approximately 6 degrees) window of one another.

- When synchronization is turned ON by pressing the transfer button, the green LED will light after two seconds and stay lighted as long as the transfer button is depressed.
- When turning OFF synchronization by pressing the transfer button for two seconds, the green LED will blink twice indicating that synchronization is turned OFF.

2.11 Control System's Configurability

The Processor is designed in a way which allows it to be easily configured by the installer to meet the varying needs of a wide variety of vessels. Below you will find a list and a brief description of the groups of these functions.

2.11.1 Processor Functions

Within this section of adjustable parameters, there are up to five different adjustments:

- **A0** Processor Identification - Assigns each Processor in multi-screw application a unique identifying number. **This function must be the second function set during Set Up.**
- **A1** Number of Engines - Lets the Processor know how many other Processors need to be communicated with. **This function must be the first function set during Set Up.**
- **A2** One Lever Operation - Allows the installer to disable or enable One Lever Mode capability.
- **A3** Station Expander - Allows the Processor to communicate with the Station Expander (SE).
- **A4** Neutral Indication Tone - When turned ON, produces a short 200 Hz tone to indicate Neutral.

Detail information on each function is found in Section 5.7.3.1: Basic Processor Troubleshooting Functions.

2.11.2 Throttle Functions

2.11.2.1 Basic Throttle Functions

This section applicable to both electronic and servo Throttle adjustment:

- **E1** Throttle in Neutral - Adjusts the position of the Throttle while in Neutral
- **E5** Throttle Pause following Shift - Allows a pause prior to applying speed above Idle.
- **E6** High Idle - Programs a second elevated Idle RPM.
- **E7** Synchronization - Allows the installer to select synchronization and select the type of synchronization.

Detail information on each function is found in Section 5.6.2.1: Throttle Basic Functions.

2.11.2.2 Servo Throttle Functions

This section along with Section 2.11.2.1: Basic Throttle Functions allows the adjustment of the Servo Throttle:

- **E0** Engine Throttle Profile - Select whether the Throttle Servo pushes or pulls to increase speed.
- **E2** Throttle Minimum - Once set mechanically at the Idle stop, this Function Code allows the position of the push-pull cable to be adjusted electrically in order to eliminate "dead lever". Dead lever in this case can be described as a movement of the Control Head lever without a change in the engine's RPM.
- **E3** Throttle Maximum - Adjusts the position or amount of travel of the push-pull cable at Full Throttle.
- **E4** Throttle Maximum Astern - Limits the amount of the Astern Throttle Servo movement.

Detail information on each function is found in Section 5.7.0.1: Throttle Servo Functions.

2.11.2.3 Electronic Throttle Functions

This section along with Section 2.11.2.1: Basic Throttle Functions allows the adjustment of the Electronic Throttle:

- **E0** Engine Throttle Profile - Selects the type of Throttle Command signal.
- **E2** Throttle Minimum - Adjusts the Throttle Command signal at Idle.
- **E3** Throttle Maximum - Adjusts the Throttle Command signal at Full Throttle.
- **E4** Throttle Maximum Astern - Limits the amount of the Astern Throttle Command signal.

Detail information on each function is found in Section 5.7.0.2: Throttle Electronic Functions.

2.11.3 Clutch Functions

2.11.3.1 Basic Clutch Functions

The following functions are available for all types of clutches.

- **C0** Clutch Pressure Interlock - Selects the Clutch Pressure Interlock option.
- **C1** Clutch Interlock Delay - Determines when the Clutch Pressure Interlock becomes active.
- **C2** Proportional Pause - Selects between an In-Gear, Neutral, or Fixed Neutral delay.
- **C3** Proportional Pause Time - Selects the maximum delay during a full speed reversal.
- **C4** Proportional Pause Ratio - Determines if the Ahead and Astern reversal times are the same or if Astern is one half of Ahead.

Detail information on each function is found in Section 5.7.1: Clutch Functions.

2.11.3.2 Clutch Servo Functions

This section along with the Section 2.11.3.1: Basic Clutch Functions Section allows the adjustment of Clutch servo related items:

- **C5** Clutch Servo Direction - Determines if the servo pushes or pulls for Ahead and Astern.
- **C6** Clutch Ahead - Adjusts the amount of clutch servo travel in Ahead.
- **C7** Clutch Astern - Adjusts the amount of clutch servo travel in Astern.

Detail information on each function is found in Section 5.7.1.2: Clutch Servo Functions.

2.11.3.3 Clutch Solenoid Functions

This section along with the Basic Clutch Functions Section allows the adjustment of Clutch Solenoid related items:

- **C5** Shift Solenoid Type - Selects the approximate current levels for the 12 or 24 VDC ZF Hurth Solenoids.
- **C6** ZF-Hurth Duty Cycle Ahead - Fine tunes the maximum current level to the Ahead Proportional Solenoid.
- **C7** ZF-Hurth Duty Cycle Astern - Fine tunes the maximum current lever to the Astern Proportional Solenoid.

Detail information on each function is found in Section 5.7.1.3: Clutch Solenoid Functions.

2.11.4 Troll Functions

2.11.4.1 Basic Troll Functions (All Processors with Troll Function)

The following functions are available for all Processors with the option of Trolling Valve Control feature.

- **L4** Troll Throttle Limit - Allows an increase in Throttle while slipping the Clutch.
- **L5** Troll Pulse Duration - Selects the amount of time for Troll Pulse Percentage.
- **L6** Troll Pulse Percentage - Selects the percentage of Troll Minimum when first engaging the Clutch with Troll.

Detail information on each function is found in Section 5.7.2: Troll Functions.

2.11.4.2 Troll Servo Functions

NOTE: The following Troll Functions are available for the 9001 Troll Actuator or Integrated Servo Troll command.

This section, along with the Basic Troll Functions Section allows the adjustment of servo Trolling Valve related items:

- **L0** Troll Enable and Control Head Lever Range - Turns Troll ON (Integrated) and sets the degrees of Control Head lever movement dedicated to Troll.
- **L1** Troll Servo Direction - Determines if the Troll push-pull cable is retracted or extended at Lock-up.
- **L2** Troll Minimum Pressure - Adjusts the Troll push-pull cables position at minimum Shaft rotation.
- **L3** Troll Maximum Pressure - Adjusts the Troll push-pull cable’s position at maximum Shaft rotation (not maximum pressure).

Detail information on each function is found in Section 5.7.2: Troll Functions.

2.11.4.3 Integrated Troll Solenoid Functions

This section, along with the Basic Troll Functions Section, allows the adjustment of solenoid Trolling Valve related items:

- **L0** Troll Enable and Control Head Lever Range -Turns Troll ON and sets the degrees of Control Head lever movement dedicated to Troll.
- **L1** Troll Valve Function - Selects the proper current range for a particular gear. **This Function must be the 3rd function set if ZF Hurth Gears are used.**
- **L2** Troll Minimum Pressure - Adjusts the amount of current at minimum Shaft rotation.
- **L3** Troll Maximum Pressure - Adjusts the amount of current at maximum Shaft rotation (not maximum pressure).

Detail information on each function is found in Section 5.7.2.1.2: Troll Solenoid L1 Function.

2.11.5 Troubleshooting Functions

2.11.5.1 Basic Troubleshooting Functions

- **H0** Diagnostics - Allows the installer/technician to look at various inputs to the Processor.
- **H1** Return to Factory Defaults - Returns all settings to the factory default values.

Detail information on this function is found in Section 5.7.2: Troll Functions.

2.11.5.2 Additional Troubleshooting Functions

- **H2** Driver Fault Detection Enable - Allows the Processor to monitor the clutch and/or troll solenoids.

Detail information on this function is found in Section 5.7.2: Troll Functions.

2.12 Audible Tones

2.12.1 Basic Processor Tones

The Processor can produce numerous tones which inform the operator of the status of the system or if any faults were to occur. These tones are emitted from all Remote Stations regardless of whether they are in command or not.

2.12.1.1 Slow Repetitive Tone

Detail information on this tone is in Section 10: Troubleshooting.

This tone is normal when DC power is first applied to the System. This tone indicates that system initialization has occurred, no Remote Station has command, the operator can accept command at any Remote Station.

2.12.1.2 One Long, Three Short Tones

Detail information on this tone is in Section 10: Troubleshooting.

This tone indicates that the command signal from a Control Head's potentiometer has gone out of range.

2.12.1.3 Steady Tone

Detail information on this tone is in Section 10: Troubleshooting.

This tone indicates that the software program within the Processor has quit running, due to low voltage or component failure.

2.12.1.4 Five (5) Second Steady Tone

Detail information on this tone is in Section 10: Troubleshooting.

This tone indicates that there has been a loss of Serial Communication.

2.12.1.5 Three (3) Second Steady Tone

Detail information on this tone is in Section 10: Troubleshooting.

This tone is heard if there is a stuck transfer button, or when entering Back-up Mode, or if a Troll Solenoid error occurs. (Back-up Mode and Troll Solenoid is not available for all Processors.)

2.12.1.6 Five Seconds On, Five Seconds Off - High Repetitive Rate Tone

Detail information on this tone is in Section 10: Troubleshooting.

This tone indicates that Function Code **A3** Station Expander (SE) has had the value **01** Enabled entered, but the Processor and Station Expander cannot communicate.

2.12.2 Throttle (Servo 2) Tones

The following Tones are in addition to the Basic Processor Tones.

2.12.2.1 One Long - Two Short Tones

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that the feedback potentiometer signal from Servo 2 (Throttle) has gone out of range.

2.12.2.2 One Long, Two Short - High Repetitive Tone

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that Servo 2 (Throttle) cannot reach the commanded position. This tone is also referred to as Servo 2 Jam Tone.

2.12.3 Clutch (Servo 1) Tones

The following Tones are in addition to the Basic Tones listed in Section 2.12.1: Basic Processor Tones.

2.12.3.1 One Long - One Short Tone

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that the feedback potentiometer signal from Servo 1 (Clutch) has gone out of range.

2.12.3.2 One Long, One Short -High Repetitive Rate Tone

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that Servo 1 (Clutch) cannot reach the commanded position. This tone is also referred to as Servo 1 Jam Tone.

2.12.4 Clutch Solenoid Tones

2.12.4.1 One Long - One Short Tone

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that a fault was detected with either the Ahead or Astern Clutch Solenoid.

2.12.5 Troll Integrated Servo (Servo 1) Tones

The following Tones are in addition to the Basic Tones listed in Section 2.12.1: Basic Processor Tones.

2.12.5.1 One Long - One Short Tone

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that the feedback potentiometer signal from Servo 1 (Troll) has gone out of range.

2.12.5.2 One Long, One Short -High Repetitive Rate Tone

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that Servo 1 (Troll) cannot reach the commanded position. This tone is also referred to as Servo 1 Jam Tone.

2.12.6 Troll Integrated (Servo 2) Tones

The following Tones are in addition to the Basic Tones listed in Section 2.12.1: Basic Processor Tones.

2.12.6.1 One Long - Two Short Tones

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that the feedback potentiometer signal from Servo 2 (Troll) has gone out of range.

2.12.6.2 One Long, Two Short - High Repetitive Tone

Detail information on this tone is in Section 10: Troubleshooting.
This tone indicates that Servo 2 (Troll) cannot reach the commanded position. This tone is also referred to as Servo 2 Jam Tone.

2.12.7 9001 Trolling Actuator Tones (Servo 3)

The following Tones are in addition to the Basic Tones listed in Section 2.12.1: Basic Processor Tones.

2.12.7.1 One Long, Four Short Tones

Detail information on this tone is in the Manual supplied with the 9001 Trolling Actuator.
This tone indicates that there is a feedback error in the Trolling Actuator.

2.12.7.2 One Long, Four Short - High Repetitive Rate Tone

Detail information on this tone is in the Manual supplied with the 9001 Trolling Actuator.
This tone indicates that Trolling Actuator Servo cannot reach the commanded position.

2.12.8 Troll Integrated Solenoid Tones

2.12.8.1 Three Second Steady Tone

This tone indicates that the Troll Solenoid is OPEN or shorted. Refer to the Error Code displayed for further information.

2.13 Push Button Set Up

There are four push buttons mounted to the Processor's circuit board. These push buttons allow the installer/technician access to all of the Functions required for programming and troubleshooting the Processor.

A full description of their usage is provided in Section 5.1.2: Push Buttons.

2.14 Visual System Diagnostics, Set Up And Status Indication

There are four, seven segment LED's (hereafter referred to as the Display LED) mounted to the Processor's circuit board. The Display LED is visible through a transparent window in the Processor's cover. The information displayed on the Display LED is used in conjunction with the push buttons to program the Processor. The Display LED also displays Error Codes in the event that an anomaly is detected.

For a full description of the Display LED, its capability and usage, refer to Section 5.1.1: Processor Display LED.

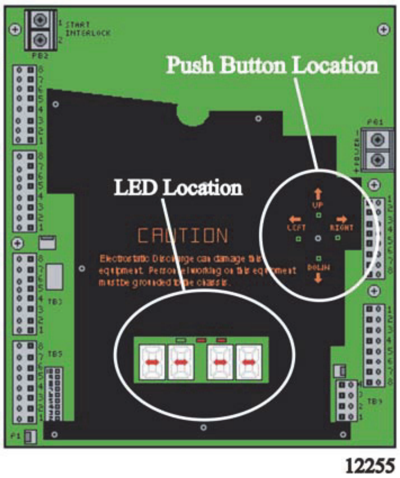

Figure 2-14: Circuit Board Shield Layout

2.15 Pluggable Connections

2.15.1 Standard Pluggable Processor

The standard Processor comes from the factory with five Pigtail Connectors for easy, mistake free pluggable installations. Not all Processors are supplied with all of these pigtails.

The following is a list of the pigtail connectors used in the standard Processor:

- **Two** Remote Station pigtails. Three additional Stations can be connected directly to the standard Processor.
- **One** pigtail connector provides the connections for DC Power, Start Interlock, Clutch Pressure Interlock and External Alarm.
- **One** pigtail connector is provided for serial communication between multiple Processors.
- **One** pigtail connector is provided for the Tach Sensor input used in synchronization.

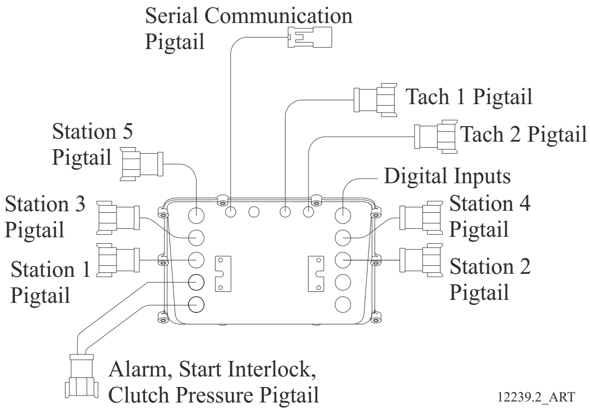

Figure 2-15: Standard Processor Pluggable Connections View

2.15.2 ClearCommand 9000 Series Pluggable Processors

The 9000 Series Processors come from the factory with standard five Pigtail Connectors listed in Section 2.15.1: Standard Pluggable Processor and additional Pigtails depending on the Processor's features. Refer below to the Processor being used on this System for the list of additional pigtails.

9120 and **9121** Processors

- **One** pigtail connector is provided for clutch Ahead and Astern Solenoid signals.

9122 Processor

- **One** pigtail connector is provided for clutch Ahead and Astern Solenoid signals, the troll solenoids.

9210 and **9211** Processors

- **One** pigtail connector is provided for electronic connection to the engine governor.

9221 Processor

- **One** pigtail connector is provided for electronic connection to the engine governor.
- **One** pigtail connector is provided for clutch Ahead and Astern Solenoid signals.

2.16 Optional Features Operation

2.16.1 System Failure External Alarm

- This optional feature is designed to provide a status signal to an external alarm circuit.
- The status signal is in the form of an open or closed relay contact. When the contact is closed, the Processor is functioning normally. When the contact opens, this indicates the software program has quit running due to a component failure or loss of DC power.
- A full explanation is provided in Section 8.1: External Alarm Capability.

2.16.2 Clutch Pressure Interlock

- The purpose of the Clutch Pressure Interlock is to prevent high engine RPM when the Clutch is not fully engaged.
- A full explanation of the Clutch Pressure Interlock is provided in Section 8.2: Clutch Pressure Interlock.

2.16.3 Station Expander (SE)

- The SE is a separate Processor housed in an enclosure that allows the connection of up to five additional Remote Control Stations.
- The SE communicates with the Processor over the serial communication line.
- A full explanation of the installation, operation and adjustment of the SE is provided in the Installation Manual provided with the SE.
- Additional information can be found in Section 8.3: Station Expander (SE).

2.16.4 Multiple Screw Installations

This Manual, as written, is intended for Single and Twin Screw applications only.

The Processor has the capability of controlling Triple, Quad and Quint Screw vessels. In order to do so, contact your ZF Marine Propulsion Systems Miramar, LLC representative for the required information and materials.

2.16.5 9001 Mechanically Actuated Trolling Valve Control

- The purpose of a Trolling Valve is to lower the Clutch pressure, which allows the Clutch Plate to slip.
- A full explanation is provided in the Installation Manual provided with the 9001 Trolling Actuator.
- Further information on Trolling Valve Control can be found in Section 8.4: 9001 Actuator Trolling Valve Control.

3 Plan the Installation

NOTE: ZF Marine Propulsion Systems Miramar, LLC recommends that the system be installed in accordance with ABYC, E-11 and P24.

3.1 System Requirements

The first step when installing a System is to carefully plan the installation. This includes finding proper mounting locations for the Processor(s) and Control Heads. The decision must be made on where power is going to be sourced and how the power will be routed to the Processor(s). Once the locations have been decided, lengths of electrical wiring, Harnesses and push-pull cables must be determined.

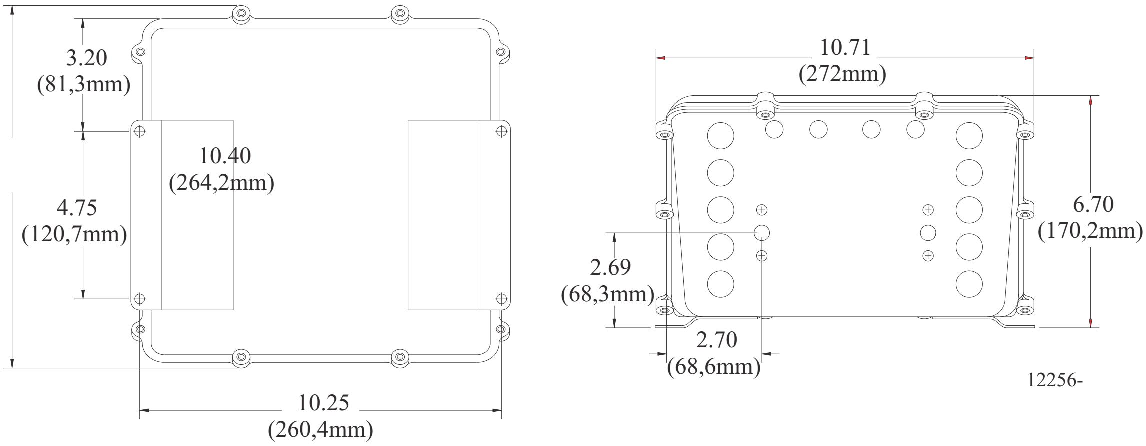

Figure 3-1: Processor Dimensions

- Bonding is required for maximum electromagnetic compatibility (EMC) performance. Refer to MMC-287 Grounding (Bonding).
- Locate the Processor such that the push-pull cables have the shortest, most direct path to the selector lever. The push-pull cable length should not exceed 20 feet (6,0m), the bend radius should not be less than 10 inches (254mm) and the total degrees of bends must be less than 270 degrees.

Only when the previous items have been completed, should you start the actual installation. The following sections describe the requirements for installing the components and selecting mounting locations.

3.1.1 Processor(s)

Processors required per engine:

- Single Screw: One (1) Processor
- Twin Screw: Two (2) Processors

Mounting Hardware is installer supplied.

Installation/Troubleshooting Manual is included with the Processor.

The following items must be taken into account when selecting the location for the Processor(s):

- The Processor is spray proof, but not water proof. Therefore, an area must be selected that typically stays dry.
- The engine room is the preferred location for mounting the Processor.
- If the engine room is too small, locate in any area where it is easily accessible, as long as all of the criteria listed are met.
- Bulkhead mounting is the preferred method due to ease of access for wiring and adjustments. However, the Processor can be mounted in any attitude as long as the Display LED window and push buttons are accessible.

WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !

- Do not mount the Processor on the engine, transmission, or in any location that will subject it to excessive vibration.
- Do not mount the Processor to the transom when the vessel is equipped with a surface piercing drive system, due to vibration concerns.
- Locate the Processor(s) away from sources of high heat, such as an engine exhaust manifolds or turbochargers. Allow 4 feet (1,2m) of clearance or more.
- Do not mount the Processor(s) in close proximity to gas engine ignition systems, alternators, generators or any equipment producing strong magnetic fields. Allow 4 feet (1,2m) clearance or more.

CAUTION: Strong magnetic fields can influence the Processor's electronic circuits and void your warranty.

3.1.2 Control Head(s)

Refer to MMC-280 400 Series Control Head Variations for information on the various Control Heads available and their dimensions.

- The 400 and MC2000 Series Control Heads are spray proof from the top, but must be protected from the weather on the underside.
- The 700 Series Control Heads are fully water proof.
- Control Heads are available with pluggable pigtails or may be hard-wired (no pigtails).
- When a 400 or MC2000 Series Control Head must be mounted in a location where the underside may be exposed to the weather, consider using a Weather Mount Enclosure. Refer to the MMC-279 400 Series Weather Mount Enclosure for specific information.
- Ensure that the clearance is sufficient for the Control Head's lever to reach full Ahead and full Astern.
- Retrofit applications may require an Adapter Pad to cover the old Control Head cutout. A variety of Adapters and Cover Pads are available. Refer to MMC-288 References and Parts Source for details.
- The Control Head can be mounted at any location on the vessel, as long as all of the criteria listed above are met.

3.1.3 Standard Wire Harnesses

(Refer to the MMC-288 References and Parts Source)

The following lists the various Harnesses that plug into the Standard Processor:

3.1.3.1 Control Head Harnesses

- One Control Head Harness is required for every Control Head lever at every Remote Station.
- The Control Head Harnesses are available in various lengths.
- Harnesses are available with plugs on both ends or a plug on the Processor side only.
- The Harness from the Port side of a Control Head is always routed to the Port Processor.
- The Harness from the Starboard side of a Control Head is always routed to the Starboard Processor.

3.1.3.2 Power, Start Interlock, Clutch Pressure, Alarm Harness

- One Harness required per Processor.
- The Harness is plugged at one end only.
- In addition to the DC power and Start Interlock, the Harness also contains cables if required: Clutch Oil Pressure Switch and External Alarm Circuit.
- All of the cables in the Harness are the same length. Therefore, order a length that will reach all of the previously mentioned items, if required.
- The Harness is available in lengths up to 30 feet (9,14m).

3.1.3.3 Serial Communication Harness

The Serial Communication Harness is only required in Twin Screw applications or when an external trolling valve actuator (9001) is utilized. The Harness connects the Port Processor to the Starboard Processor.

- One Harness required per two Processors.
- The Harness is plugged at both ends.
- Refer to MMC-288 References and Parts Source for available harnesses

3.1.4 Tach Sensor Harness

There are two Tach Sensor Harnesses available:

1. The first is the AC Coupled Sensor Harness, which is designed for inputs from items such as Mechanical Senders, Magnetic Pickup Sensors, the Alternator AC Stator Terminal or the negative Coil Terminal.
2. The second Harness is designed for Active Sensors with an Open Collector output, such as Hall Effect Sensors.
    - This Harness is only required when Active Synchronization is required.
    - One Harness per Processor is required.
    - The Harness is plugged on one end only.

Determine the source of the tachometer signal, which can be provided by a mechanical tachometer sender, magnetic pickup, alternator's pre-rectified output, the negative side of the coil (gasoline engine) or an engine's electronically produced signal. Refer to SER-161 Engine Tach Sender Req..

3.1.5 Additional Harnesses

(Refer to the Parts List in MMC-288 References and Parts Source)

The following lists the various Harnesses that plug into the Processor:

3.1.5.1 Throttle Harness

- One Harness required per Processor.
- There are 4 types of Throttle Harnesses: Voltage, Current, PWM (Pulse Width Modulation), and Frequency.
- Most Throttle Harnesses are plugged at the Processor side only.
- Some Throttle harness types are available with plugs on both ends.

3.1.5.2 Clutch Harness

- One Harness required per Processor.
- The Harness consists of 2 two-conductor cables.
- The cables supply power to the Ahead and Astern Clutch Solenoids
- All of the cables in the Harness are the same length. Therefore, order a length that will reach all of the previously mentioned items, if required.

3.1.5.3 Clutch/Troll Harness

- One Harness required per Processor.
- The Harness consists of:
    - 2 two-conductor cables for Ahead and Astern Clutch Solenoids.
    - 2 two-conductor cables for Troll ON/OFF and Troll Proportional Solenoids.

NOTE: Some transmissions only utilize one solenoid for troll, therefore, the harness would consist of only three cables.

- The Power for the clutches and troll are supplied by the Processor's power source.
- All of the cables in the Harness are the same length. Therefore, order a length that will reach all of the previously mentioned items, if required.

3.1.6 Standard Electric Cables

(Refer to the MMC-288 References and Parts Source)

The following lists the various equivalent electric cables for the basic connections to the Standard Processor:

3.1.6.1 Control Head Electric Cable

If the Control Head is hard-wired (no plugs) the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Seven-conductor with shield, twisted.
- Color Code – black, brown, red, orange, green, blue, and violet.
- 18 AWG (nearest metric equivalent - #1).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm)

3.1.6.2 Power, Start Interlock, Clutch Pressure, Alarm Electric Cable

3.1.6.2.1 Power Electric Cable Requirements

If ***Power*** is hard-wired, (no plugs) the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, black and red with violet stripe, twisted.
- 14 AWG (#2,5 metric) or 12 AWG (#4 metric) may be used to crimp directly to the Processor terminals. Refer to S-214 Automatic Power Selector Model: 13505 for cable length and additional wire size requirements.
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.6.2.2 Start Interlock Electric Cable Requirements

If ***Start Interlock*** is hard-wired (no plugs) the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, both yellow with red stripe, twisted.
- 16 AWG (#1,5 metric).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.6.2.3 Clutch Pressure Interlock Electric Cable Requirements

When the ***Clutch Pressure Interlock*** option is utilized, a pressure switch with a normally open contact must be installed on the transmission, along with a Shuttle Valve

If the Clutch Pressure Switch is hard-wired (no plugs) the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, both light blue.
- 16 AWG (#1,5 metric).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.6.2.4 External Alarm Circuit Electric Cable Requirements

If the ***External Alarm Circuit*** is hard-wired (no plugs) the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, red and black, twisted.
- 16 AWG (#1,5 metric).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.6.3 Serial Communication Electric Cable Requirements

The Serial Communication Harness is only required in Twin Screw applications or when an external trolling actuator (9001) is utilized. The electric cable connects the Port Processor to the Starboard Processor.

- Required only when hard-wiring the Processor.
- Refer to MMC-288 References and Parts Source.

3.1.6.4 Tach Sensor Electric Cable Requirements

The cable selected depends on what type of Sensor is being used:

3.1.6.4.1 AC Tach Input

- Two-conductor, twisted, shielded.
- 20 AWG (#0,5 metric)
- 300 V, 165 C, UL VW1, stranded tinned copper
- Maximum outside diameter: 0.390 inches (9,9mm)

3.1.6.4.2 Open Collector (Active)

- Three-conductor, twisted, shielded
- 20 AWG (#0,5 metric)
- 300 V, 165 C, UL VW1, stranded tinned copper
- Maximum outside diameter: 0.390 inches (9,9mm)

3.1.7 Additional Electric Cables

(Refer to the Parts List in MMC-288 References and Parts Source)

Depending on the requirements of the installer, the installation may use Harnesses, Electric Cables or a combination of both. The various 9000 Series Processors may use all or a combination of the below listed harnesses or cables. Refer to Table PREFACE-1 Processor List located after the cover sheet of this manual to determine which harnesses are required.

The following lists the various equivalent electric cables:

3.1.8 Throttle Electric Cable Requirements

If Throttle is hard-wired, (no plugs) to the Processor, the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, red and black, twisted, shielded.
- 16 AWG (#1,5 metric).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.9 Clutch Electric Cable Requirements

If Clutch Solenoids are hard-wired, (no plugs) to the Processor, the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, red and black, twisted.
- 16 AWG (#1,5 metric).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.10 Clutch/Troll Electric Cable

3.1.10.1 Clutch Solenoid Electric Cable Requirements

If ***Clutch Solenoids*** are hard-wired, (no plugs) to the Processor, the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, red and black, twisted.
- 16 AWG (#1,5 metric).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.10.2 Troll Solenoid Electric Cable Requirements

If ***Troll Solenoids*** are hard-wired, (no plugs) to the Processor, the electric cable must meet the following specifications or may be ordered from ZF Marine Propulsion Systems Miramar, LLC:

- Two-conductor, red with violet stripe and black, twisted.
- 14 AWG (#2,5 metric).
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3.1.11 Tachometer Sensors

There are two types of Tachometer Sensors available through ZF Marine Propulsion Systems Miramar, LLC, Mechanical (p/n 8902) and Magnetic Pickup (p/n 8912). Both types provide two separate outputs, one for the tachometer(s) and the second output provides the Processor's tachometer signal requirement. If a sensor other than one supplied by ZF Marine Propulsion Systems Miramar, LLC is used, it must meet the criteria provided below for each type:

3.1.11.1 AC Coupled Sensors

- The signal must have a minimum amplitude of +/- 1.5 V (3.0 V P-P).
- The signal's maximum amplitude must not exceed +/- 100 V (200 V P-P).
- The frequency of the signal must be no lower than 30 Hz at Idle.
- The signal's frequency may not exceed 8 KHz at Full Throttle.

3.1.11.2 Alternator

- The pre-rectified stator AC terminal may be used as the tach source.
- The signal is inputted to the AC Coupled Sensor input.
- The signal must meet the same criteria as any AC Coupled Sensor Signal (refer to Section Section 3.1.11.1: AC Coupled Sensors).

3.1.11.3 Point side of the Coil

- When the signal is sourced from the coil or an electronically produced tach signal (used on some gasoline engines) the signal is connected to the AC Coupled Sensor input.
- The signal must meet the same criteria as any AC Coupled Sensor Signal (refer to Section Section 3.1.11.1: AC Coupled Sensors).

3.1.11.4 Active Sensors (Open Collector Output)

- The sink current ability of the Sensor may be no lower than 2 mA.
- The operational current may not exceed 50 mA.
- The Sensor must have a maximum saturation voltage of 0.8 V.
- An operational voltage requirement of 9- 10 VDC.
- A minimum frequency of 5 Hz at Idle.
- A maximum frequency of 8 KHz at Full Throttle.

3.2 Installer Supplied Tools And Parts

3.2.1 Required Tools

Anti-static wrist strap (included with Processor).
Screwdriver – medium Phillips, #2.
Wire cutter, stripper & crimper (Thomas & Betts model WT-2000 or equivalent).
7/16 inch Nut Driver or Socket with ratchet & medium extension.
5/16 inch Wrench – open end.
Screwdriver – small straight slot.
Saw with blade suitable for Console Top Panel.
Drill Motor with 9/32 inch and 7/32 inch drill bits.

3.2.2 Optional Tools

Calibrated Digital Multimeter (Fluke 80 Series or equivalent).
Service Field Test Unit (P/N 13927, available through ZF Marine Propulsion Systems Miramar, LLC)
Field Test Control Head - Dual (P/N 14000)

3.2.3 Required Parts

3.2.3.1 Processor's Utilizing a Servo

- 33C type push-pull cables. The cables are measured from the end of the threads to the end of the threads. Available in 1 foot (0,3m) increments. (If 43C type push-pull cables are required, a 43C Conversion Kit is available from ZF Marine Propulsion Systems Miramar, LLC. Refer to MMC-345 43C Cable Conversion Kit)
- Many engines, transmissions and inboard/outboard (I/O) drives are delivered with mounting kits. If not, contact the engine of gear dealer or manufacture for a factory Cable Connection Kit. Refer to MMC-280 400 Series Control Head Variations to show other connection options.

3.2.3.2 All Remote Stations

- An engine STOP switch must be located at each Remote Station.

WARNING: An Engine STOP Switch MUST be installed at every remote operating station. Refer to CFR 46, Section 62.35-5 (US Coast Guard) and ABYC P-24.5.8.

3.3 DC Power Source

One of the most important (and often overlooked) items for proper operation of your control system is a clean, dedicated, and reliable source of DC Power.

The wiring used to supply power from the power source (battery) through the various components (fuses, distribution panel, relays, etc.) to the Processors must be sized for a voltage drop of 10% or less using 10 amps as the maximum current draw. Refer to **ABYC** Standard E-11, Table X to determine the appropriate wire gauge for the necessary conductor length.

When using ZF Marine Propulsion Systems Miramar, LLC supplied 14 gauge power cable, and in accordance with **ABYC** Standard E-11, the distance from a 12 volt power source (battery or DC Distribution Panel) shall not exceed 15 feet (4,6m). In 24 volt systems, the maximum cable length is 20 feet (6,1m).

It is recommended by ZF Marine Propulsion Systems Miramar, LLC that an Automatic Power Selector (APS) and a second power source (battery) be used. Refer to S-214 Automatic Power Selector Model: 13505 for examples of power supplies.

3.3.1 Processor Power

The items listed below will help ensure optimum performance from your control system.

- The Processor requires a battery source of 12 or 24 VDC.
- Two 5 ampere (when isolated power supplies are required) or one 10 ampere trip-free thermal circuit breaker(s) with manual On/ Off actuation
- The use of an APS (Automatic Power Selector) is strongly recommended.
- Power should come from the vessel's DC Distribution Panel.
- Do not use engine starting batteries on a 12 VDC system, unless an APS is installed.
- The cables feeding power from the battery to the Processor must be sized large enough to keep voltage drop, due to current flow, below 10%. Refer to S-214 Automatic Power Selector Model: 13505.

The Processor's power cable(s) maximum lengths are listed in MMC-288 References and Parts Source and examples of the various wiring options are shown in S-214 Automatic Power Selector Model: 13505. Ultimately, it is the boat builder or installer's responsibility to ensure that the vessel's wiring meets the requirements of American Boating & Yachting Council standard E-11, for AC and DC Electrical Systems on Boats.

4 Installation

NOTE: Before starting the actual installation of the Control System, make sure you have the correct parts and tools on hand. See Section Section 3: Plan the Installation. Read ALL the instructions pertinent to each part before beginning the installation of the part.

CAUTION: Static electricity can destroy electronic components. Connect the wrist strap provided, to the Processor frame whenever working on the Processor with the enclosure cover open. This will drain any static charge you may have on your person.

4.1 Processor

A Secure the Processor to the mounting surface with three 1/4 inch or M6 fasteners, leaving the fourth fastener unused at this time.

B Connect the Processor to the Hull or Bonding Bus by running a 12 AWG or larger wire between the Processor's fourth mounting fastener and the Bonding Bus. (The Processor is bonded if mounted directly to a metallic surface that is connected to a metal hull) (Refer to MMC-287 Grounding (Bonding))

4.2 Control Head(s)

4.2.1 400, MC2000 and 700 Series Control Heads

Refer to the appropriate Control Head Dimensions and Variations Service Sheet in Section 11: Appendix A - System Components and Specifications for installation.

4.2.2 500 Series Control Heads

Refer to the Installation Manual supplied with the 500 Series Control Head Assembly for installation instructions.

4.2.3 Handheld Remote Controls

Refer to the Installation Manual supplied with the Handheld Remote for installation instructions.

4.3 Wire Harness Installation

The standard Off-the-Shelf Processor has five Pigtails with plugs on the ends. Two of the plugs are for Remote Stations and one each for Power/Start Interlock, Serial Communication, and Tach Sensor. Additional Harnesses required will depend on the actual installation. Four different styles of plugs are utilized but are inserted in an identical fashion as follows:

4.3.1 Plug Insertion and Extraction

Prior to inserting the plug, pay close attention to the number of pins and the keying of the plug. The plug is designed to be inserted one way only, but can be forced together in the opposite orientation. Refer to Figure 4-1: Harness Plug Keying to insert plug correctly.

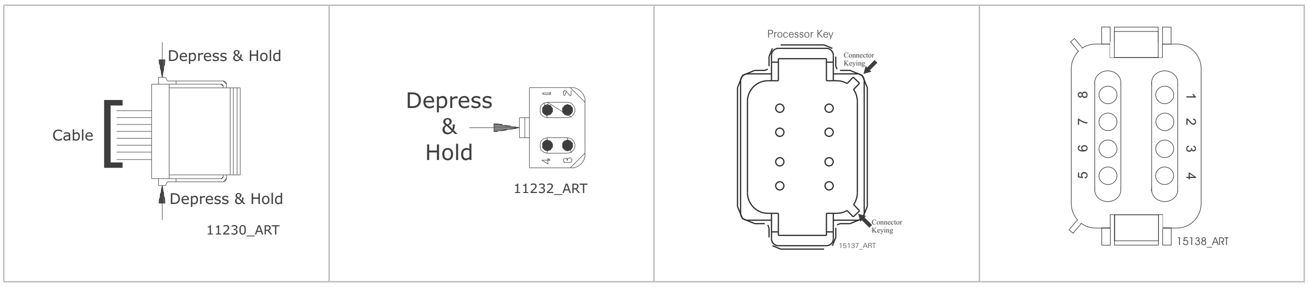

Figure 4-1: Harness Plug Keying

- When connecting the plugs, ensure that the locking mechanisms are depressed and held until the plug is fully connected or disconnected. Refer to Figure 4-1: Harness Plug Keying

4.3.2 Standard Power/Start Interlock Harness

The Power Harness has a minimum of two cables (DC Power and Start Interlock) and may have two more optional cables (Clutch Pressure Interlock and External Alarm Circuit).

4.3.2.1 DC Power Cable

(Refer to S-214 Automatic Power Selector Model: 13505)

A Insert the black, twelve pin plug into the Processor's Power/Start Interlock Pigtail's Socket.
B Run the cable to the DC Distribution Panel or the optional Power Relay.
C Strip back the appropriate amount of PVC jacketing and conductor insulation.
D Crimp the appropriate connectors to the conductors.
E Terminate the conductors to the DC Power Source.

4.3.2.2 Start Interlock Cable

A Run the cable to the Engine's Starter Solenoid.
B Disconnect the Starter Switch wire from the Solenoid.
C Strip back the appropriate amount of PVC jacketing and conductor insulation.
D Connect one of the conductors to the Solenoid's Starter Switch terminal.

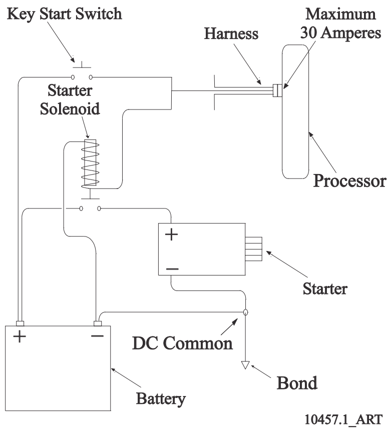

Figure 4-2: Start Interlock Connections

4.3.2.3 Butt splice the second wire to Starter Switch wire.

4.3.2.4 External Alarm Circuit Cable (optional)

Refer to Section Section 8.1: External Alarm Capability for installation information.

4.3.2.5 Clutch Pressure Switch Cable (optional)

Refer to Section Section 8.2: Clutch Pressure Interlock, for installation information.

4.3.3 Standard Control Head Harness

Depending on whether a pluggable or hard-wired (not pluggable) Control Head(s) is selected, will determine the procedure for terminating the Harness at the Remote Station.

- The first installation procedure (Section Section 4.3.3.1: Control Head Harness with Two Connectors) below is written for the pluggable Control Head.
- If a hard-wired Control Head(s) is selected, follow the information provided in the second procedure (Section Section 4.3.3.2: Control Head Harness with One Plug):

NOTE: For Twin Screw, Dual Lever Control Heads must be connected to the same numbered Station on both Processors.

4.3.3.1 Control Head Harness with Two Connectors

A At the Port Processor, insert the grey, eight pin plug into the Station 1 pigtail plug.
B Run the cable to the Control Head located at Station 1.
C Insert the grey, eight pin plug into the Control Head's Port pigtail plug.
D Ensure that the cable has a strain relief close to the Control Head to relieve the strain on the connections.
E Repeat Steps A) thru D) for the Starboard Processor.
F Repeat Steps A) thru E) with Station 2.
G When Stations 3, 4 and 5 are to be installed, they each require the removal of the watertight seal located on the Processor enclosure in the Station cable entry holes.

4.3.3.2 Control Head Harness with One Plug

A At the Port Processor, insert the grey, eight pin plug into the Station 1 pigtail plug.
B Run the cable to the Port side of the Control Head located at Station 1.
C Connect the conductors to the Control Head as described in the appropriate Control Head Dimensions and Variations Service Sheet in Section 11: Appendix A - System Components and Specifications.
D Provide a strain relief in close proximity to the Control Head's terminal block.
E Repeat Steps A) thru D) for the Starboard Processor.
F Repeat steps A) thru E) with Station 2.
G When Stations 3, 4 and 5 are to be installed, they each require the removal of the watertight seal located on the Processor enclosure in the Station cable entry holes.

4.3.4 Serial Communication Harness (Multi Screw)

Not required for Single Screw applications.

4.3.4.1 Twin Screw Applications

A At the Processors, remove the watertight seals from the Serial pigtail connectors.
B At the Port Processor, insert the Serial harness's grey, six (6) pin plug into the Serial pigtail connector.
C Run the harness to the Starboard Processor.
D Insert the harness's grey, six (6) pin plug into the Starboard Processor's Serial pigtail connector.

E Secure the Serial Harness at least every 18 in. (45,72 cm).

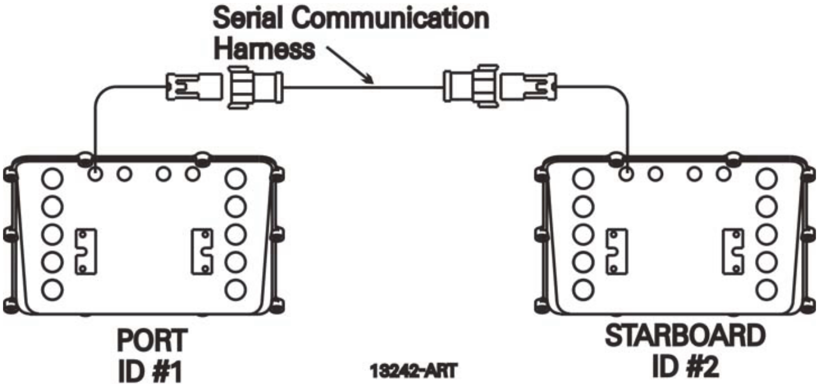

Figure 4-3: Twin Screw Serial Harness Connections

4.3.5 Tach Sensor Harness (required for Active Synchronization)

A At the Processors, remove the watertight seals from the Tach Sender pigtail plugs.
B At the Port Processor, insert the grey, four pin plug into the Tach Sender pigtail plug.
C Run the cable to the source of the Tach signal.
D Connect the conductors to the Tach source in the appropriate manner, keeping in mind that some sources are polarity sensitive. (black- negative, red- positive)
E Repeat steps A) thru C) on the Starboard side.

CAUTION: Electro-static discharge can damage this equipment. Whenever the Cover is removed, you must be grounded to the chassis with the Anti-static Wrist Strap provided. Failure to do so may cause permanent damage to the electronic circuits.

4.3.6 Additional 9000 Series Harnesses

4.3.6.1 Throttle Harness

The appropriate Throttle Harness should have been selected in Section Section 3.1.5.1: Throttle Harness. The Processors Throttle pigtail connects directly to the engine interface using this Throttle Wire Harness.

A Connect the plug end of the Harness into the Throttle pigtail connector at the Processor.
B Run the cable to the engine interface.
C Refer to the engine documentation for termination points at the engine interface.
D If Twin Screw, repeat steps A) thru C) on the opposite side.

4.3.6.2 Clutch Harness

	NOTE: Ensure Port Processor connects to the Port Solenoid and the Starboard Processor connects to the Starboard Processor.

A Plug the grey, 12 pin plug into the Clutch pigtail connector at the Processor.
B Run the cables to the Ahead and Astern solenoids at the transmission.
C Plug the DIN connector into the Ahead and Astern Solenoids.
D If Twin Screw, repeat steps A) thru C) on the opposite side.

4.3.6.3 Clutch/Troll Harness

	NOTE: Ensure Port Processor connects to the Port Solenoid and the Starboard Processor connects to the Starboard Processor.

A Plug the grey, 12 pin plug into the Clutch pigtail connector at the Processor.
B Run the cables to the transmission.
C Plug the DIN connector into the Ahead and Astern Solenoids.
D Plug the DIN connector into the Troll proportional solenoid, and if installed the Troll ON/OFF solenoid.
E If Twin Screw, repeat steps A) thru D) on the opposite side.

4.4 Hard-Wired Cable

Liquid Tight Connector All cables that enter the Enclosure must go through a Liquid Tight Connector in order to maintain the moisture resistant integrity of the Processor. These connectors must be assembled as shown in Figure 4-4: Liquid Tight Installation

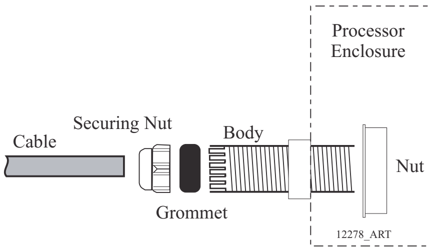

Figure 4-4: Liquid Tight Installation

4.4.1 Standard Processor Cable Holes

1. When hard-wiring a Processor or installing additional Station pigtails, the cables must enter the enclosure through Liquid Tight Connectors in the appropriate holes as shown in Figure 4-5: Standard Enclosure Cable HolesStation 5
2. Station 3
3. Station 1
4. Alarm, Clutch Pressure, and Start Interlock
5. Power
6. Station 4
7. Station 2
8. Serial Communication
9. Tachometer

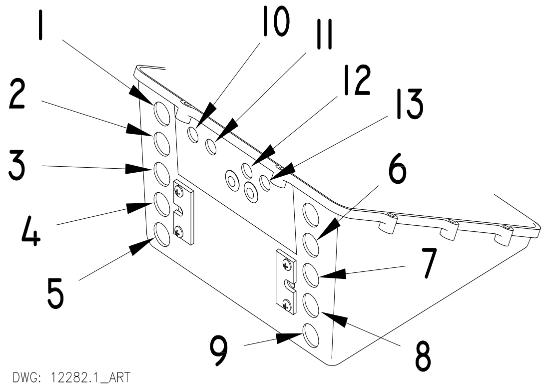

Figure 4-5: Standard Enclosure Cable Holes

4.4.2 Standard Circuit Board Connections

On a Standard Processor, in lieu of using Harnesses for Control Heads, Power, Serial Communication and Tachometer, the Processor can be ordered with no pigtails installed. The above connections then must be hard-wired directly to the circuit board

On Standard Processors using pigtails, additional Stations may also be connected to the Processor by connecting pigtails or hard-wiring directly to the circuit board.

Refer to Figure 4-6: Standard Circuit Board Hard-Wired Termination Points for specific termination points.

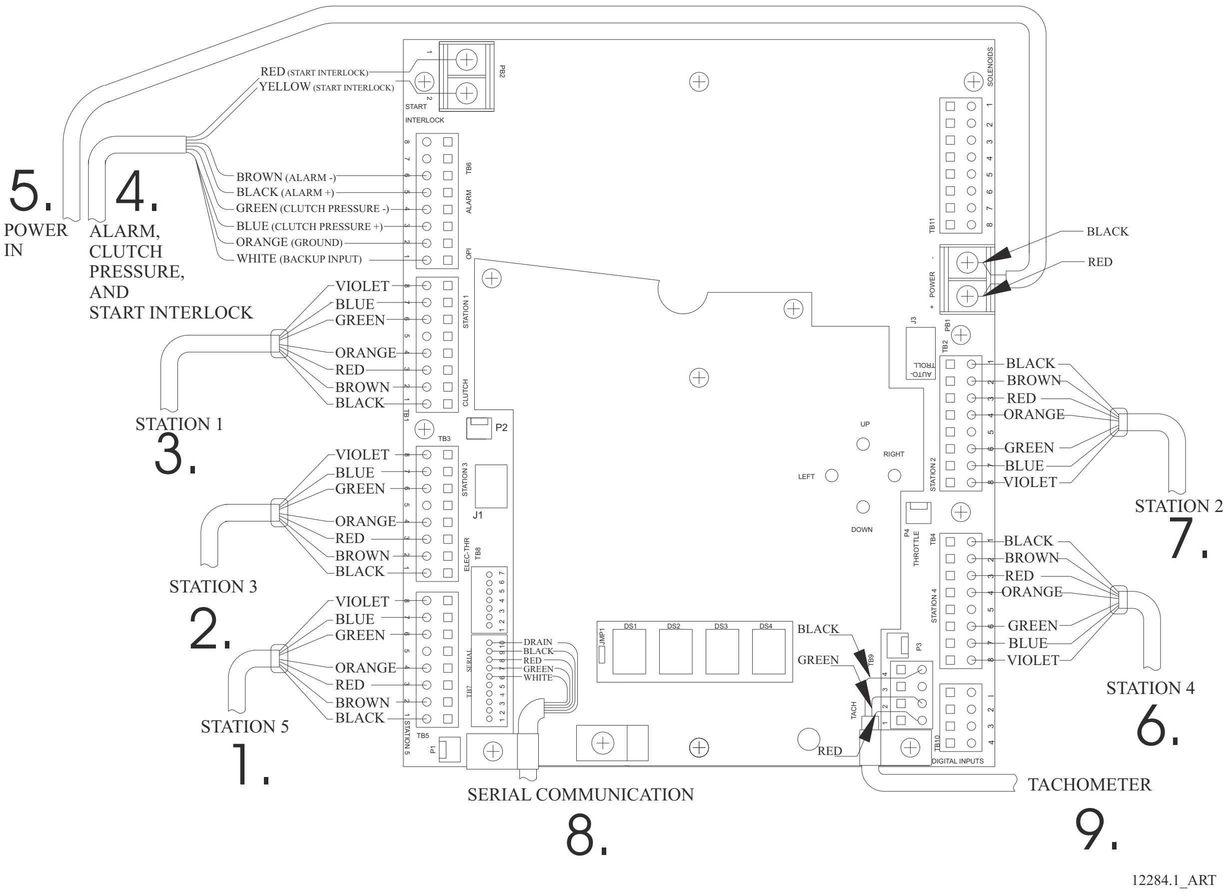

Figure 4-6: Standard Circuit Board Hard-Wired Termination Points

1. 2. 3. 6. 7.	Station 5: TB5 Station 3: TB3 Station 1: TB1 Station 4: TB4 Station 2: TB2	Black - 1, Brown - 2, Red - 3, Orange - 4, Green - 6 Blue - 7 Violet - 8	4.	Alarm: TB6	Brown - 6 Black - 5
5.	Power In: PB1	Black - Negative Red - Positive		Clutch Pressure: TB6	Green - 4 Blue - 3
8.	Serial Communication: TB7	White - 6 Green - 7 Red - 8 Black - 9 Drain - 10		Start Interlock: PB2 Ground: TB6 Backup Input: TB6	Red - 1 Yellow - 2 Orange - 2 White - 1
9.	Tachometer: TB9	Red - 1 Green - 2 Black - 4			

4.4.3 9000 Series Hard-Wired Connection Locations

Table 4-1: ClearCommand Processor Optional Hard-Wiring Cable List

ZF Marine Propulsion Systems Miramar, LLC	ENGINE	CLUTCH	TROLL
Processor Part No.	**Electronic**	**Solenoid**	**Solenoid**
9120 (Figure 4-7: 9120 and 9121 Enclosure Cable Holes)		10	
9121 (Figure 4-7: 9120 and 9121 Enclosure Cable Holes)		10	
9122 (Figure 4-8: 9122 Enclosure Cable Holes)		10	11
9210 (Figure 4-9: 9210 and 9211 Enclosure Cable Holes)	12		
9211 (Figure 4-9: 9210 and 9211 Enclosure Cable Holes)	12		
9221 (Figure 4-10: 9221 Enclosure Cable Holes)	12	10	

All cables that enter the Enclosure must go through a Liquid Tight Connector in order to maintain the moisture resistant integrity of the Processor. These connectors must be assembled as shown in Figure 4-4: Liquid Tight Installation.

When hard-wiring a Processor or installing additional Station pigtails, the cables must enter the enclosure through Liquid Tight Connectors in the appropriate holes. Refer to the appropriate Section for the Cable Hole designations for the Processor being used on this application.

4.4.3.1 9120 and 9121 (Clutch Solenoid) Cable Hole Locations

1. Station 5
2. Station 3
3. Station 1
4. Alarm, Clutch Pressure, and Start Interlock
5. Power
6. Station 4
7. Station 2
8. Serial Communication
9. Tachometer
10. Clutch Solenoids

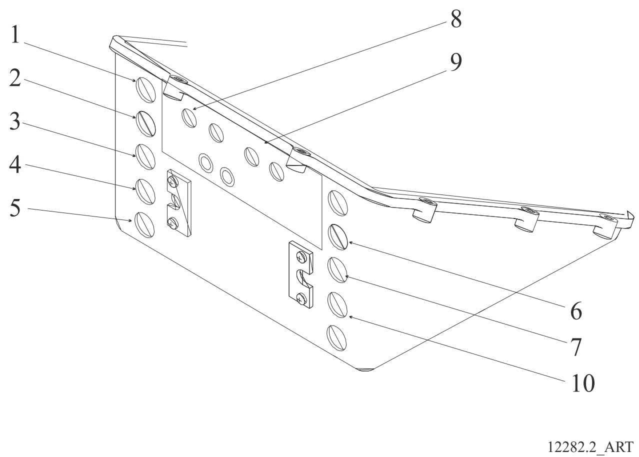

Figure 4-7: 9120 and 9121 Enclosure Cable Holes

4.4.3.2 9122 (Clutch/Troll Solenoid) Cable Hole Locations

1. Station 5
2. Station 3
3. Station 1
4. Alarm, Clutch Pressure, and Start Interlock
5. Power
6. Station 4
7. Station 2
8. Serial Communication
9. Tachometer
10. Clutch Solenoid
11. Troll Solenoid

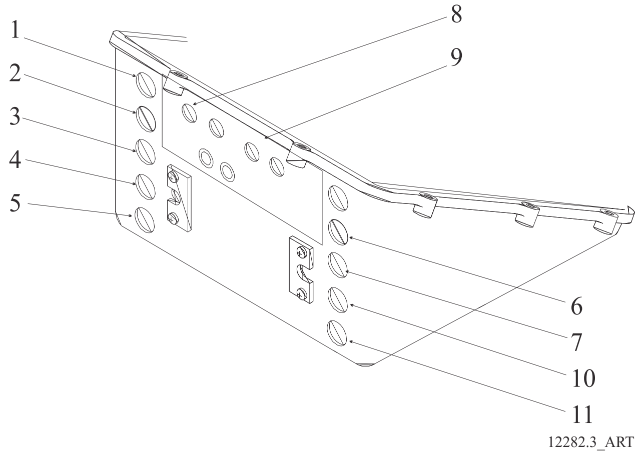

Figure 4-8: 9122 Enclosure Cable Holes

4.4.3.3 9210 and 9211 (Throttle Electronic) Cable Hole Locations

1. Station 5
2. Station 3
3. Station 1
4. Alarm, Clutch Pressure, and Start Interlock
5. Power
6. Station 4
7. Station 2
8. Serial Communication
9. Tachometer
10. Not Used
11. Not Used
12. Throttle Signal

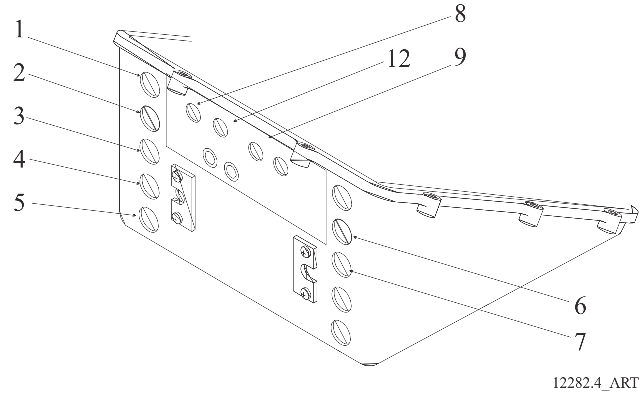

Figure 4-9: 9210 and 9211 Enclosure Cable Holes

4.4.3.4 9221 (Throttle Electronic and Clutch Solenoid) Cable Hole Locations

1. Station 5
2. Station 3
3. Station 1
4. Alarm, Clutch Pressure, and Start Interlock
5. Power
6. Station 4
7. Station 2
8. Serial Communication
9. Tachometer
10. Clutch Solenoids
11. Not Used
12. Throttle Signal

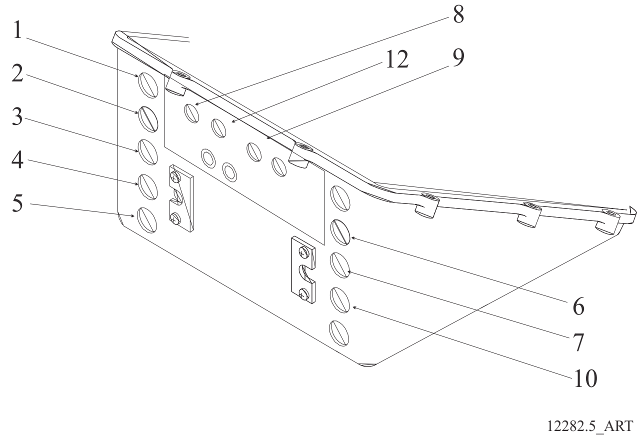

Figure 4-10: 9221 Enclosure Cable Holes

4.4.4 9000 Series Circuit Board Termination Points

On the 9000 Series Processors, in lieu of using Harnesses for engine, clutch, or troll connections the Processors can be ordered with no pigtails installed or the pigtails be removed. The above connections must then be hard-wired directly to the circuit board.

Refer to Table 4-1: ClearCommand Processor Optional Hard-Wiring Cable List for the Processor being used in this application.

Locations 1 - 9 circuit board termination points are the same for all Processors and are shown on Figure 4-5: Standard Enclosure Cable Holes.

Refer to Figure 4-6: Standard Circuit Board Hard-Wired Termination Points for specific termination points for the engine, clutch or troll connections required for the Processor being used in this application.

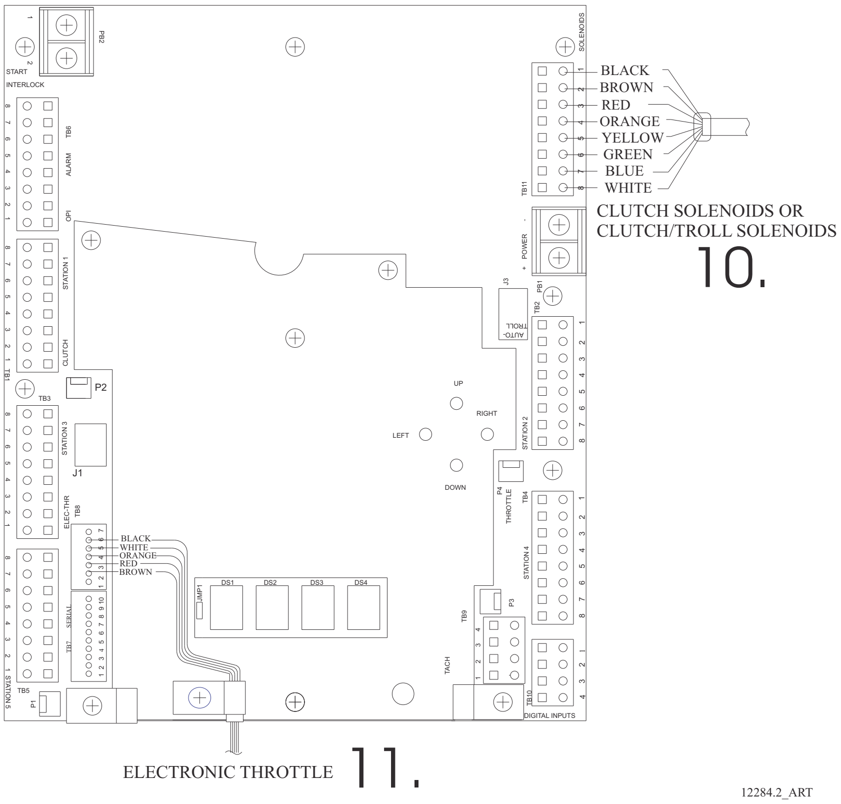

Figure 4-11: 9000 Series Circuit Board Hard-Wired Termination Points

12.	Throttle: TB8	Brown - 3, Red - 4, Orange - 5, White - 6, Black - 7	10	Clutch: TB11	Black - 1 Brown - 2 Yellow - 5 Green - 6
			10 & 11.	Clutch/Troll: TB11	Black - 1 Brown - 2 Red - 3 Orange - 4 Yellow - 5 Green - 6 Blue - 7 White - 8

4.4.5 Locations 1 - 9 Installation

4.4.5.1 Seven-Conductor Control Head Cable (Locations 1, 2, 3, 6, and 7)

A Run the seven-conductor cable from the Remote Station to the Processor.

B Support the cables using clamps or straps not more than 18 inches (0,5m) apart if not contained in a conduit. Verify cable location protects the cable from physical damage.

C Label each seven-conductor cable at both ends with the station it connects, and Port or Starboard.

D Place on your wrist the anti-static wrist strap provided, attach the strap to ground, and then remove the cover from the Processor.

E Run the seven-conductor cable for each remote station through the corresponding liquid tight cable grip on the Processor to the appropriate Station terminal block. Do not tighten cable grip at this time.

F Strip the PVC jacket and shielding back approximately 4 1/2 inches (114,3mm) on the seven-conductor cable.

G Strip the wire 3/8 inch (9,5mm) on each lead.

H Pull the Shield wire back against the PVC jacket and slide and shrink a piece of 3/8 inch W. X 1 inch L. heat-shrink over the cable as shown in Figure 4-12: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink

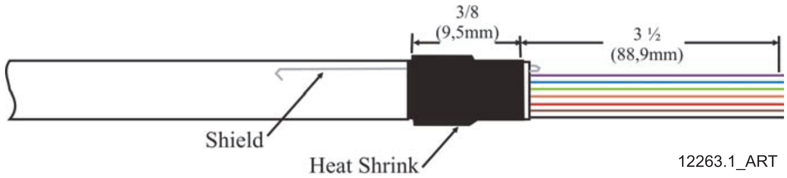

Figure 4-12: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink

I Secure the seven-conductor cable to the frame using a conductive Clamp. Ensure that the Clamp and Shield wire come in contact with one another. Refer to Figure 4-13: Clamp Views.

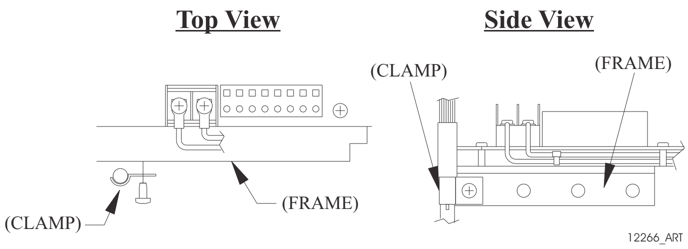

Figure 4-13: Clamp Views

J Clip the Shield wire so that it is flush with the Clamp.

K Connect the conductors to the appropriate pins as shown on Table 4-2: Processor Circuit Board Terminal Strip Color Coded Connections for Remote Stations, using a small slotted screwdriver as shown in Figure 4-14: Terminal Strip Cable Connections

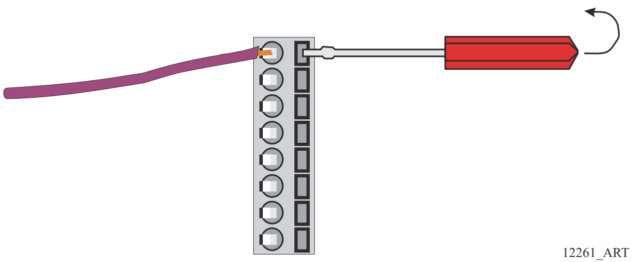

Figure 4-14: Terminal Strip Cable Connections

L Connect the other station's seven-conductor cables to the appropriate station terminal strips in the same way.

Table 4-2: Processor Circuit Board Terminal Strip Color Coded Connections for Remote Stations

Conductor Color	Processor Termination	Left Hand Control Head	Right Hand Control Head
Black	Station 1 thru 5, Pin 1	Pin 1	Pin 1
Brown	Station 1 thru 5, Pin 2	Pin 2	Pin 2
Red	Station 1 thru 5, Pin 3	Pin 3	Pin 3
Orange	Station 1 thru 5, Pin 4	Pin 4	Pin 4
Green	Station 1 thru 5, Pin 6	Pin 6	Pin 6
Blue	Station 1 thru 5, Pin 7	Pin 5	Pin 7
Violet	Station 1 thru 5, Pin 8	N/C	Pin 8
		Jumper between Pins 3 and 7.	Jumper between Pins 3 and 5.

4.4.5.2 Start Interlock Cable (Location 4)

4.4.5.2.1 Connection at the Starter Solenoid

A Run the length of two-conductor cable between the Engine’s Starter Solenoid and the Processor.
B Disconnect the Starter Switch wire from the Solenoid.
C Strip back the appropriate amount of PVC jacketing and conductor insulation.
D Connect one of the conductors to the Solenoid’s Starter Switch terminal.
E Butt splice the second wire to Starter Switch wire.

4.4.5.2.2 Connection at the Processor

A Install a liquid tight connector into entry hole (No. 4). (Refer to Figure 4-5: Standard Enclosure Cable Holes for entry hole location and Figure 4-4: Liquid Tight Installation for cable grip installation.)
B Run enough of the two-conductor power cable through the liquid tight cable grip so that it can be routed to PB2 on the Circuit Board as shown in Figure 4-10: 9221 Enclosure Cable Holes.
C Strip back 2 inches (50,8mm) of the PVC jacketing. Refer to Figure 4-15: Two-Conductor Start Interlock Cable
D Strip each wire 3/8-inch (9,5mm).
E Place a 3/8 inch (9,5mm) section of shrink tubing over the cable and heat.

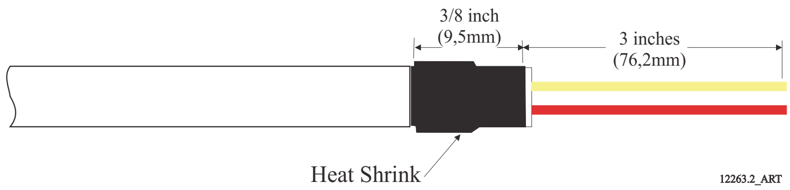

Figure 4-15: Two-Conductor Start Interlock Cable

F Crimp fork or ring terminals to the wires.
G Connect the two-conductor cable to PB2, red lead to the terminal labeled (1) and yellow lead to the terminal labeled (2), as indicated on Figure 4-5: Standard Enclosure Cable Holes.
H Tie wrap the start interlock cable to the Processor’s frame.

4.4.5.3 Power Cable (Location 5)

A Run the length of two-conductor power cable between the DC Power Source and the Processor.

B Make the connections at the vessel's DC Power Source, but do not turn power ON.

C Install a liquid tight connector into the DC POWER entry hole (No. 5). (Refer to Figure 4-5: Standard Enclosure Cable Holes for entry hole location and Figure 4-4: Liquid Tight Installation for cable grip installation.)

D Run enough of the two-conductor power cable through the liquid tight cable grip so that it can be routed as shown in Figure 4-5: Standard Enclosure Cable Holes.

E Strip back 3 inches (76,2mm) of the PVC jacketing. Refer to Figure 4-16: Two-Conductor Power Cable

F Strip each wire 3/8-inch (9,5mm).

G Place a 3/8 inch (9,5mm) section of shrink tubing over the cable and heat

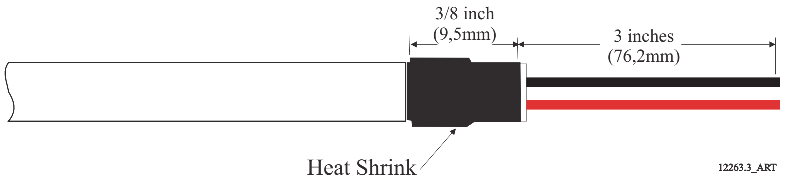

Figure 4-16: Two-Conductor Power Cable

H Crimp fork or ring terminals to the wires.

I Connect the two-conductor cable to PB1, red lead to the terminal labeled (+) and black lead to the terminal labeled (-), as indicated on Figure 4-10: 9221 Enclosure Cable Holes.

J Tie wrap the power cable to the Processor's frame.

4.4.5.4 Serial Communication Cable (Location 8)

A Install 1/2 inch (12,7mm) liquid tight cable grips into hole (No.8) of the Port and Starboard Processors. (Refer to Figure 4-5: Standard Enclosure Cable Holes for entry hole location and Figure 4-4: Liquid Tight Installation for cable grip installation.)

B Run a four-conductor, shielded cable from the Port to the Starboard Processors.

C Strip back 3 inches (76,2mm) of PVC jacketing from both ends of the cable.

D Strip each wire 3/8 inch (9,5mm).

E Clip the drain wire flush with the PVC jacketing on the Starboard Processor only.

F Place a 1 inch (25,4mm) section of shrink tubing over each end of the cable

G On the Port end of the cable, bend the drain wire back and tuck it under the shrink tubing so that the drain wire end is exposed past the shrink tubing. (Refer to Figure 4-18: AC Type Tachometer Cable)

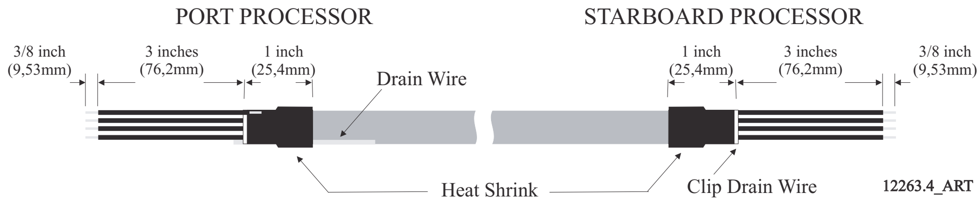

Figure 4-17: Four-Conductor Serial Communication Cable

H Shrink the Tubing with a heat gun.

I Insert the four-conductor cable through the liquid tight connectors and tighten the nuts

J Secure the cables internally using a Clamp as shown in Figure 4-13: Clamp Views. Make certain that the drain wire makes contact with the Clamp's metallic surface.

K Clip the exposed drain wires flush with the Clamps.

L Connect the conductors to the terminal block as listed in Table 4-3: Processor Circuit Board Terminal Strip Color Coded Connections for Serial Communication

Table 4-3: Processor Circuit Board Terminal Strip Color Coded Connections for Serial Communication

PORT PROCESSOR	Conductor Color	STARBOARD PROCESSOR
Termination A		**Termination B**
TB7-6	White	TB7-6
TB7-7	Green	TB7-7
TB7-8	Red	TB7-8
TB7-9	Black	TB7-9
Clamp	Silver (Drain Wire)	No Connection

4.4.5.5 Tachometer Cable (Location 9)

A Run a two- or three-conductor shielded cable from the Port Processor to the Port engine’s tachometer source. (Refer to Section Section 3.1.4: Tach Sensor Harness)

NOTE: Three-conductor cable is required with Open Collector Type (Hall Effect) Tachometer Senders only.

B Run a two- or three-conductor shielded cable from the Starboard Processor to the Starboard engine’s tachometer source.

C Install a 1/2 inch (12,7mm) liquid tight cable grip into hole (No. 9) of the Port and Starboard Processors. (Refer to Figure 4-5: Standard Enclosure Cable Holes for entry hole location and Figure 4-4: Liquid Tight Installation for cable grip installation)

D Strip back 2 inches (50,8mm) of PVC jacketing from both ends of the cable.

E Strip the ends of each conductor back 3/8 inch (9,5mm).

F Clip off the drain wire flush with the PVC jacketing at the Tachometer source side only.

G Place a 7/8 inch (22,23mm) section of shrink tubing over each end of the cable.

H At the Processor side, bend the drain wire back and tuck it under the shrink tubing so that the grain wire end is exposed past the shrink tubing. (Refer to Figure 4-18: AC Type Tachometer Cable and Figure 4-19: Open Collector Tachometer Cable).

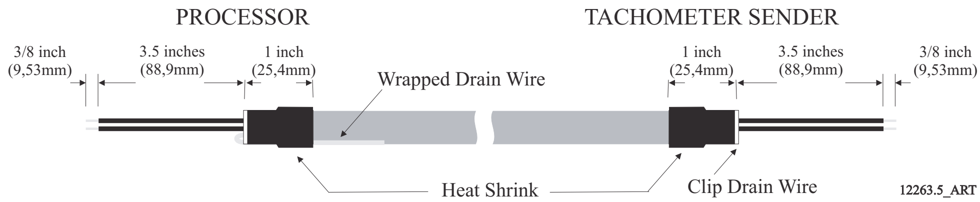

Figure 4-18: AC Type Tachometer Cable

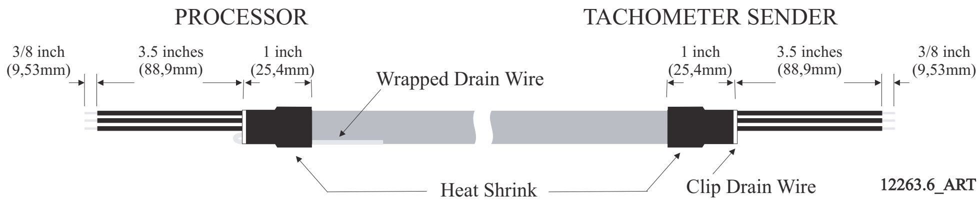

Figure 4-19: Open Collector Tachometer Cable

I Shrink the tubing with a heat gun.
J Insert the cable ends through the liquid tight connectors and tighten the nuts.
K Secure the cables internally using a Clamp as shown in Figure 4-13: Clamp Views. Make certain that the drain wire makes contact with the Clamp’s metallic surface.
L Clip the exposed drain wires flush with the Clamps.
M Connect the conductors to the terminal block as listed in Table 4-4: Processor Circuit Board Terminal Strip Color Coded Connections for Tachometer.

Table 4-4: Processor Circuit Board Terminal Strip Color Coded Connections for Tachometer

Termination	Conductor Color	Description	Notes
TB9-1	Red	Sensor Supply (+9VDC)	Required when Open Collector (i.e., Hall Effect Sensors) only
TB9-2	Green	AC Type Tachometer Input	The green wire connects here when AC Type Tach Sensors (i.e., Mechanical Senders, Magnetic Pickup, Alternator AC, etc.) are being used.
TB9-3	Green	Open Collector Tachometer Input	The green wire connects here when an Open Collector Type Tach Sender is used.
TB9-4	Black	Return for Tachometer Input	Negative connection for both types of Senders.
Clamp	Silver	Drain wire (Shield) connection.	Connection made at Processor side only.

4.4.6 Locations 10 and 11 Installation

4.4.6.1 Clutch Cable (Location 10)

A single four-conductor cable must connect the two Shift cables to the Processor through a 12 pin plug.

4.4.6.1.1 Processor Termination

A Install a liquid tight connector into hole no.10.
B Run a 32 inch (0,82m) piece of four-conductor cable through the liquid tight connector and tighten, leaving 16 inches (0,41m) outside of the Processor.
C Strip back 4 inches (101,6mm) of the PVC jacket inside the Processor.
D Slide a 1 inch (24,5mm) piece of heat shrink over the end of the cable as shown in Figure 4-20: Clutch Cable Heat Shrink in Processor.

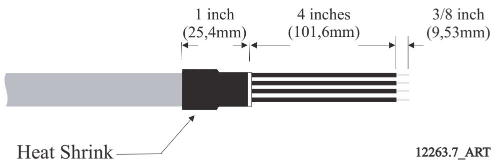

Figure 4-20: Clutch Cable Heat Shrink in Processor

E Strip back 3/8 inch (9,53mm) from the four conductors and connect to the Processor as shown in Table 4-5: Clutch Termination Table.

4.4.6.1.2 Plug Termination

A Strip back 2 1/4 inches (57,15mm) of PVC jacketing.

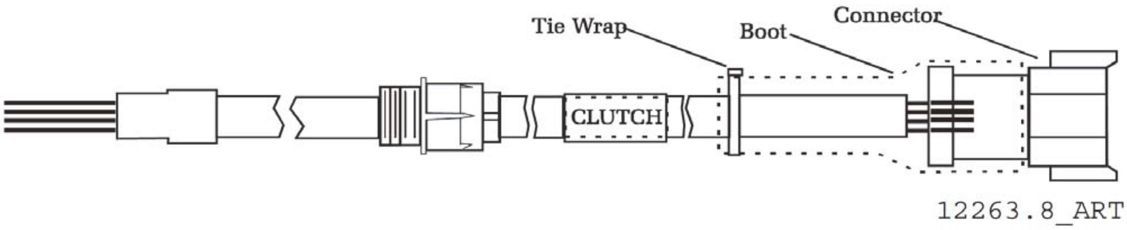

Figure 4-21: Clutch Cable Plug Termination Connections

B Slide the boot onto the cable.
C Strip back 1/4 inch (6,35mm) from the four conductors.
D Crimp Pins onto the eight conductors.
E Insert the pins into the appropriate terminations as shown in Table 4-5: Clutch Termination Table.
F Slide the boot over the connector.
G Tie-wrap the boot in place.

Table 4-5: Clutch Termination Table

Description	Conductor Color	Processor Termination	Plug Termination
Ahead Clutch Solenoid (+)	Brown	TB11-2	Pin 3
Ahead Clutch Solenoid (-)	Green	TB11-6	Pin 4
Astern Clutch Solenoid (+)	Black	TB11-1	Pin 5
Astern Clutch Solenoid (-)	Yellow	TB11-5	Pin 6

4.4.6.2 Clutch/Troll Cable (Location 10 & 11)

A single eight-conductor cable must connect the two Shift and two Troll cables to the Processor through a 12 pin plug.

4.4.6.2.1 Processor Termination

A Install a liquid tight connector into hole no.10.
B Run a 32 inch (0,82m) piece of eight-conductor cable through the liquid tight connector and tighten, leaving 16 inches (0,41m) outside of the Processor.
C Strip back 4 inches (101,6mm) of the PVC jacket inside the Processor.
D Slide a 1 inch (24,5mm) piece of heat shrink over the end of the cable as shown in Figure X

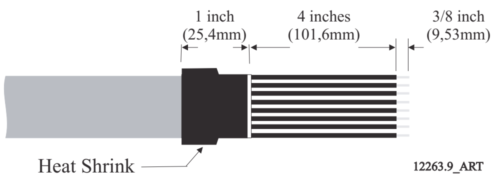

Figure 4-22: Clutch/Troll Cable Heat Shrink in Processor

E Strip back 3/8 inch (9,53mm) from the eight conductors and connect to the Processor as shown in the Table 4-6: Clutch/Troll Termination Table.

4.4.6.2.2 Plug Termination

A Strip back 2 1/4 inches (57,15mm) of PVC jacketing.

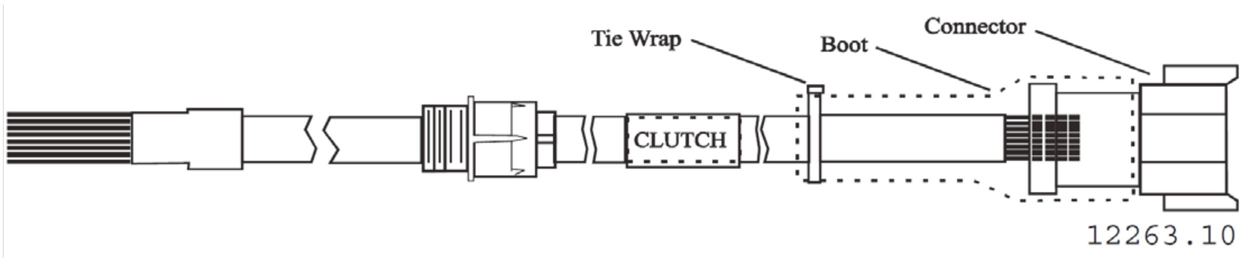

Figure 4-23: Clutch Cable Plug Termination Connections

B Slide the boot onto the cable.
C Strip back 1/4 inch (6,35mm) from the eight conductors.
D Crimp Pins onto the eight conductors.
E Insert the pins into the appropriate terminations as shown in Table 4-6: Clutch/Troll Termination Table.
F Slide the boot over the connector.
G Tie-wrap the boot in place.

Table 4-6: Clutch/Troll Termination Table

Description	Conductor Color	Processor Termination	Plug Termination
Ahead Clutch Solenoid (+)	Brown	TB11-2	Pin 3
Ahead Clutch Solenoid (-)	Green	TB11-6	Pin 4
Astern Clutch Solenoid (+)	Black	TB11-1	Pin 5
Astern Clutch Solenoid (-)	Yellow	TB11-5	Pin 6
Troll On/Off Solenoid (+)	Orange	TB11-4	Pin 9
Troll On/Off Solenoid (-)	White	TB11-8	Pin 10
Troll Proportional Solenoid (+)	Red	TB11-3	Pin 11
Troll Proportional Solenoid (-)	Blue	TB11-7	Pin 12

4.4.7 Locations 10 Installation

4.4.7.1 Clutch Cable (Location 10)

A single four-conductor cable must connect the two Shift cables to the Processor through a 12 pin plug.

4.4.7.1.1 Processor Termination

A Install a liquid tight connector into hole no.10.
B Run a 32 inch (0,82m) piece of four-conductor cable through the liquid tight connector and tighten, leaving 16 inches (0,41m) outside of the Processor.
C Strip back 4 inches (101,6mm) of the PVC jacket inside the Processor.

D Slide a 1 inch (24,5mm) piece of heat shrink over the end of the cable as shown in Figure 4-20: Clutch Cable Heat Shrink in Processor.

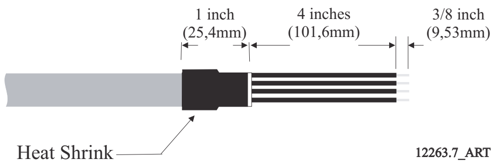

Figure 4-24: Clutch Cable Heat Shrink in Processor

E Strip back 3/8 inch (9,53mm) from the four conductors and connect to the Processor as shown in Table 4-5: Clutch Termination Table.

4.4.7.1.2 Plug Termination

A Strip back 2 1/4 inches (57,15mm) of PVC jacketing.

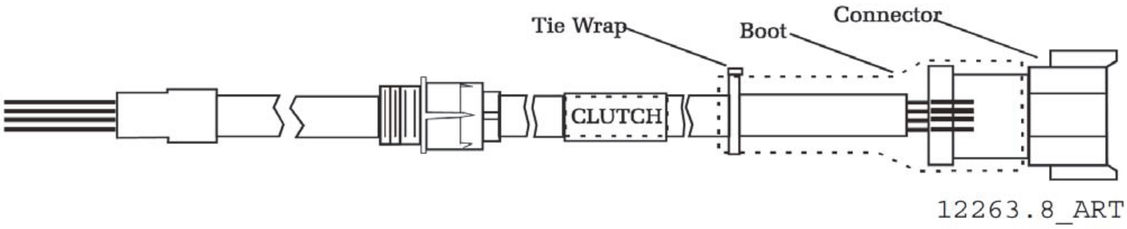

Figure 4-25: Clutch Cable Plug Termination Connections

B Slide the boot onto the cable.
C Strip back 1/4 inch (6,35mm) from the four conductors.
D Crimp Pins onto the eight conductors.
E Insert the pins into the appropriate terminations as shown in Table 4-5: Clutch Termination Table.
F Slide the boot over the connector.
G Tie-wrap the boot in place.

Table 4-7: Clutch Termination Table

Description	Conductor Color	Processor Termination	Plug Termination
Ahead Clutch Solenoid (+)	Brown	TB11-2	Pin 3
Ahead Clutch Solenoid (-)	Green	TB11-6	Pin 4
Astern Clutch Solenoid (+)	Black	TB11-1	Pin 5
Astern Clutch Solenoid (-)	Yellow	TB11-5	Pin 6

4.4.8 Location 12 Installation

4.4.8.1 Throttle Cable (Location 12)

A 2-conductor shielded cable is required when hard-wiring the engine to the Processor.

A Install a 1/2 inch Liquid Tight Connector into hole no.12 of the Processor.
B Run the throttle cable through the connector so that 4 inches (101,6mm) of the cable is pulled through.
C Tighten the Liquid Tight Connector nut.
D Strip back the PVC jacket to within 1/2 inch (12,7mm) of the enclosure.
E Clip the shield wire to 3/4 inch (19,1mm) of length.

F Pull back the shield wire and solder to a 2 1/2 inch (63,5mm), 18 AWG, green/yellow wire as shown in Figure 4-26: Engine Shield.

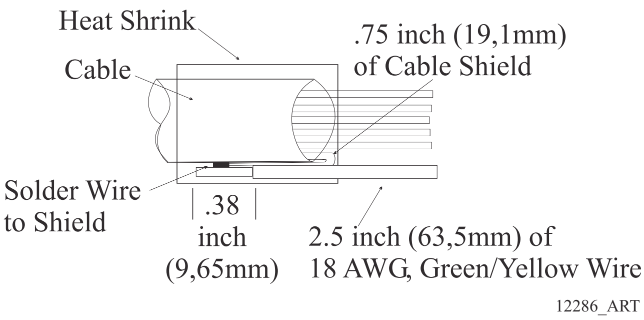

Figure 4-26: Engine Shield

G Slide a 1 inch (25,4mm) section of heat-shrink over the soldered connection and shrink.

H The termination point on TB8 depends on the type of engine to which the Processor is interfacing. The following table lists the termination points.

Table 4-8: Throttle Termination Table

Throttle Type	Termination
DC Voltage (0 to 5.0 VDC)	Signal- TB8-5, Return- TB8-7
Current (4.0 to 20.0 mA.)	Signal- TB8-4, Return- TB8-7
PWM (0 to 99%)	Signal- TB8-3, Return- TB8-7
Frequency (	Signal- TB8-6, Return- TB8-8
Idle Validation	(+)- TB8-1, (-)- TB8-2

4.5 Engine Stop Switches

An engine stop switch(s) must be located at all Remote Stations and capable of stopping the engine at any RPM. Refer to the installation instruction supplied with the switch and the engine installation instructions for manufactures recommendations.

	**WARNING: An Engine Stop Switch at each Remote Station is an absolute requirement. Refer to CFR 46, SEC. 62.35-5 and ABYC P-24.5.8.**

4.6 Push-Pull Cable Connections

4.6.1 Processor

A Remove the #10-32 jam nut and the two rubber seals from the end of each push-pull cable that is to connect to the Processor(s) only; discard the seals, but save the nuts.

B Remove one screw from each Cable Anchor Clip and loosen the other screw. Swing the two Clips clear. Refer to Figure 4-27: Processor Cable Clamp Rotation.

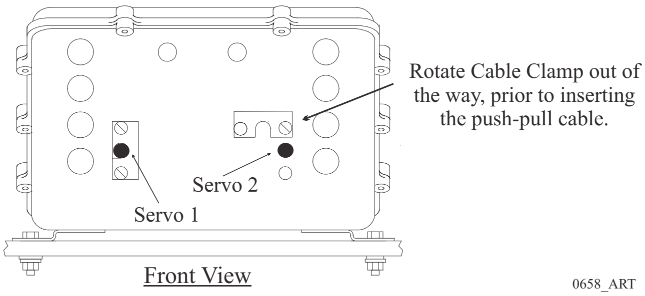

Figure 4-27: Processor Cable Clamp Rotation

C Insert the appropriate push-pull cable into the Processor according to the labels located above the cable clips on the Processor enclosure.

D When the push-pull cable end is visible within the Processor interior, reinstall the #10-32 jam nut.

E Connect the push-pull cables to the hex nuts (See Figure 4-28: Push-Pull Cable Interior Connection). Use a 7/16 inch socket to turn the hex nut onto the cable rod end until there is approximately 5/16 inch (7,9mm) of thread showing beyond the jam nut.

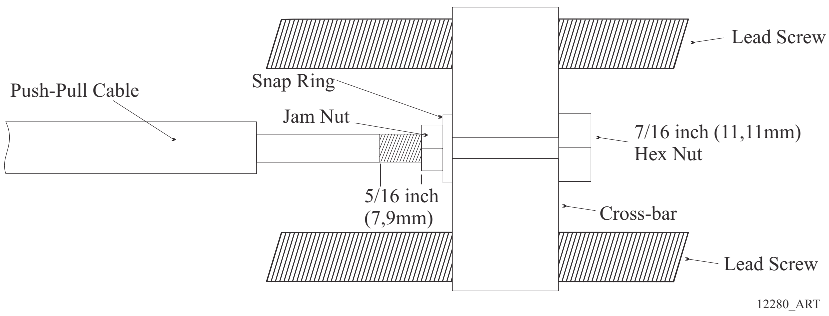

Figure 4-28: Push-Pull Cable Interior Connection

F Use a 7/16 inch socket wrench and a 5/16-inch open end wrench to tighten the jam nuts.

G Position the Cable Anchor Clips to secure the cables to the Processor housing.

H Install the screws removed in step B).

I Tighten all Cable Anchor Clip screws.

4.6.2 Throttle Selector Lever

A Ensure that the Throttle push-pull cable and the engine's throttle lever are in close proximity to one another at Idle. If so, proceed to step C) and if not continue with step B).

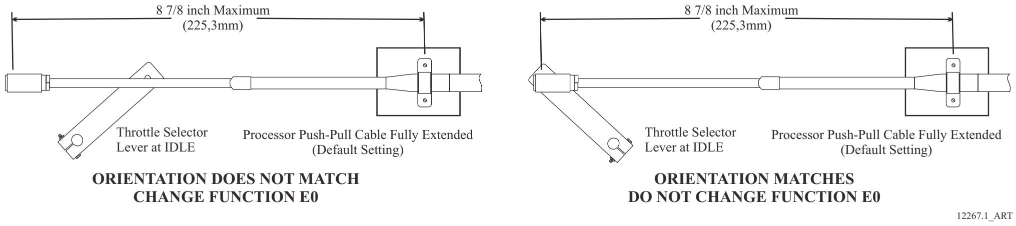

Figure 4-29: Throttle Push-Pull Idle Orientation to Selector Lever

B If the throttle lever is at the opposite side from the push-pull cable, change the Throttle Servo Direction E0 as described in Section Section 5.7.0.1.1: Function Code E0 – Throttle Servo Direction.

C Adjust the ball joint on the Throttle cable to match the throttle lever at the Idle stop position.

D Ensure that adequate cable threads are showing.

E Tighten the jam nut.

4.6.3 Shift Selector Lever

CAUTION: Mis-adjusted Shift Push-Pull Cables can cause damage to the Transmission's Clutch Pack. Ensure adjustments are made correctly and completely.

A Check the engine and transmission to see if the push-pull cable anchor brackets have been installed. If the brackets are not on the transmission, select from MMC-289 Morse Clutch and Throttle Kit or fabricate brackets as shown in MMC-290 Universal Mounting Kit.

B Turn power ON to the Control System, to ensure that Neutral/ Idle is commanded.

C With the Shift Push-Pull cable disconnected at the clutch selector lever, adjust the Shift cable's ball joint at the transmission to align with the clutch selector lever at Neutral. The push-pull cable must form a 90 degree angle to the clutch selector lever. (Refer to Figure 4-30: Shift Push-Pull Cable Neutral Connection at Transmission)

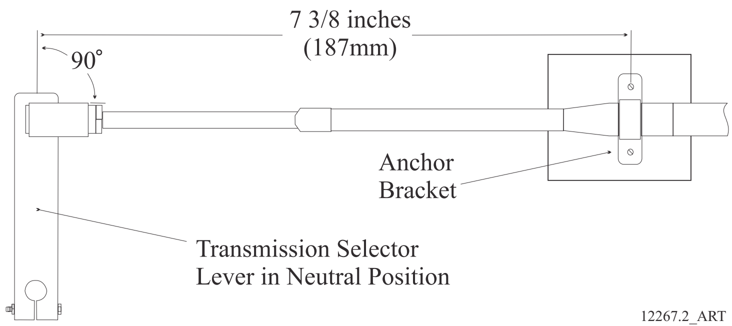

Figure 4-30: Shift Push-Pull Cable Neutral Connection at Transmission

D Connect the ball joint to the clutch selector lever.

4.6.4 Trolling Valve Selector Lever

CAUTION: Mis-adjusted Troll Push-Pull Cables can cause damage to the Transmission's Clutch Pack. Ensure adjustments are made correctly and completely.

A Check the trolling valve to see if the push-pull cable anchor brackets have been installed. If the bracket are not on the trolling valve, select from MMC-289 Morse Clutch and Throttle Kit or fabricate brackets as shown in MMC-290 Universal Mounting Kit - Universal Mounting Kit.

B Observe the present position of the trolling valve push-pull cable in relation to the trolling valve selector lever in the full pressure (lock-up) position. Depending on the installation, the Troll push-pull cable may be fully extended or fully retracted when at maximum pressure.

- If the push-pull cable end and the troll selector lever are in close proximity to one another, no adjustment is required at this time.
- If the push-pull cable end is at the opposite side from the selector lever, the cable's polarity must be changed with Function Code **L1**, as described in Section Section 5.7.2.1.2: Troll Solenoid L1 Function**.**

C Secure the Trolling Valve selector lever at the full pressure position with wire, tie-wrap, etc.

D Further adjustments of the Trolling Valve are performed during Sea Trials as described in Section F-226 9000 Series Sea Trial Report**.**

NOTE: The Trolling Valve push-pull cable polarity (Function Code L1) cannot be changed if the Trolling function is not turned On with Function Code L0 as described in Section Section 5.7.2.1.1: Function Code L0 – Troll Enable and Control Head Lever Troll Range.

5 Set up Procedure

The Processor utilizes push buttons in conjunction with Display LED's to program, adjust, calibrate and set up the various features. The push buttons also allow you to access and display information regarding the health of the System. The following paragraphs explain how to locate and use the push buttons and Display LEDs:

5.1 Processor Components Used In Set Up

- Each Processor has a Display LED and Push Buttons.
- The Display LED can be viewed through a window on the Processor's cover as shown in Figure 5-1: Typical Processor Cover

Figure 5-1: Typical Processor Cover

- The Processor enclosure cover must be removed to access the Push Buttons as shown in Figure 5-2: Processor Shield Push Button and Display LED Locations
- The **Display LED** is used to view the Function Codes and the Values for those Functions (Section 5.1.1: Processor Display LED).

- The **Push Buttons** are used to scroll through Function Codes, select Function Codes and set the Values of the Function Codes. (Section 5.1.2: Push Buttons)

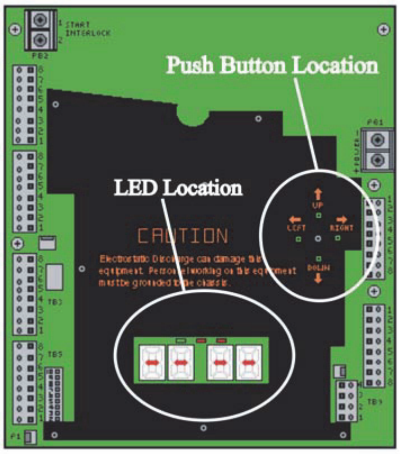

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Figure 5-2: Processor Shield Push Button and Display LED Locations

5.1.1 Processor Display LED

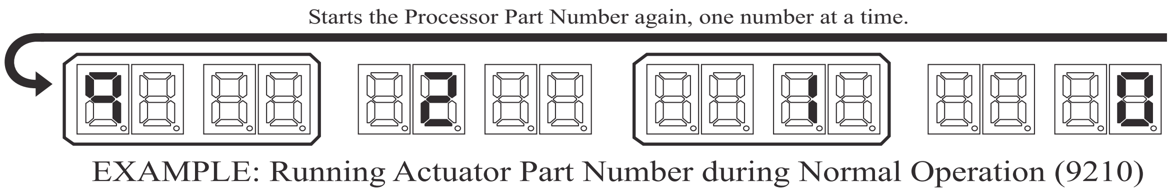

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Figure 5-3: Display LED at Normal Operation

- The Processor's Display LED has four 7-segment LED's, which light up to show either letters or numbers.
- The Display LED will have the Processor Part Number showing in a running pattern during Normal operation (Figure 5-3: Display LED at Normal Operation)
- The first two digit Display LED's to the left, indicate the **Function Code**, which is alphanumeric.
- The second two digit Display LED's indicate the numeric **Value** that is programmed into the Processor for the Function Code displayed to the left.
- A **decimal point** indicator is located on the bottom right corner of each Display LED.

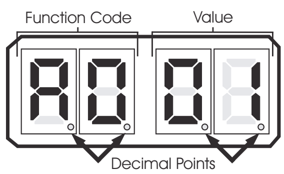


Figure 5-4: Display LED Designations

5.1.2 Push Buttons

The Processor has four Push Buttons located on the Circuit Board. They are identified by the words LEFT, RIGHT, UP and DOWN silk-screened on the Shield covering the Circuit Board.

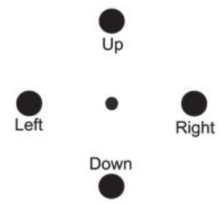


Figure 5-5: Circuit Board Push Buttons

5.1.2.1 Up and Down Push Buttons

Pressing the Up or Down Push Buttons once has the following functions:

- Stops Normal Operation Display (running Processor Part Number) and activates the Function Menu.
- While in the Function Menu, scrolls through the Function Codes one at a time.
- When an Error Code (Refer to Section 10.8: Error Codes) is displayed, scrolls through the error messages one at a time.
- When in Set Up Mode, increases (Up) or decreases (Down) the Value one digit at a time.

5.1.2.2 Left and Right Push Buttons

Pressing and holding the Left and Right Push Buttons simultaneously has the following functions:

- Activates Set Up Mode as indicated by the blinking Display LED. (must hold the buttons until the blinking begins)
- While in Set Up Mode, deactivates Set Up Mode, saves the displayed Value to memory and returns to the Function Menu. (must hold the button until the blinking stops)

5.1.2.3 Left Push Button Only

Pressing the Left Push Button once has the following functions:

- Deactivates Set Up Mode <u>without</u> any changes to the Value being stored to memory. The Left Push Button must be held down until function code stops blinking. The default value will then be displayed.
- While in Function Menu, changes the Display LED to the Error Menu, if any errors are present. (has no effect if there are no errors stored)
- While in the Error Menu, changes the Display LED back to the Function Menu.

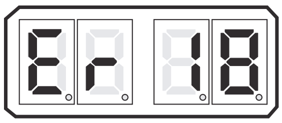


Figure 5-6: Display LED Error Menu Example

5.1.2.4 Right Push Button Only

Pressing the Right Push Button once has the following functions:

- While in the Error Menu, clears inactive errors. (Active errors blink, inactive do not)
- While in Set Up Mode or Function Menu, allows the Value of the current Function Code to be displayed with all four Display LEDs.

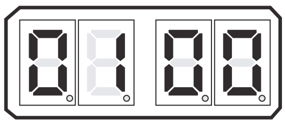


Figure 5-7: Display LED Four Digit Value

5.2 Activating Set Up Mode

	NOTE: To Escape from the Set Up procedure at any time without saving the changed value to memory, depress the Left Push Button. The Function Code will stop flashing and the Function will be saved with the original Value.

A The Display LED is in Normal operating condition with the red running Processor Part Number.

B Depressing either the Up or Down Push Button will activate the Function Menu.

C Depressing the Up or Down Push Button will scroll through the Function Codes one at a time.

D Once the desired Function Code is visible on the Display LED, press and hold down the Left and Right Push Buttons simultaneously, until the Function Code begins to blink.

E Depressing the Up Push Button will increase the Value of the Function, while pressing the Down Push Button will decrease the Value of the Function. (Pressing and holding the Up or Down Push Button will increase or decrease the Value rapidly)

5.3 Storing Values To Memory

Once the desired Value has been reached in Set Up Mode, the Value is stored to memory as follows:

A Depress and hold the right push button first. Then while still depressing the right button, depress and hold the Left push button until the Function Code stops blinking.
- The new Value is now programmed into memory.
- Set Up Mode is exited.

B Depress the Up or Down Push Button until the next required Function Code is reached.

C Reactivate Set Up Mode.

	NOTE: If no Push Buttons are pressed for five minutes, the selected Mode of operation is automatically exited and the System returns to Normal Mode. If no Push Buttons are pressed for five minutes while in Set Up Mode, it will be exited without the changes stored to memory.

5.4 Set Up Function Codes And Values

The following tables list the Function Codes' Name, Default Value and Range or available Options. Each of the Function Codes are explained in further detail in the referenced sections.

	NOTE: SINGLE SCREW APPLICATIONS: The Function Values may be entered and stored in any order. TWIN SCREW APPLICATIONS: The A1 Function must be set FIRST, and the A0 Function must be set SECOND. The rest of the Function Values may be entered and stored in any order.

Table 5-1: Function Codes

Function Code	Function Name	Value Range or Options
PROCESSOR FUNCTIONS (Section 5.6.1: Processor Functions)		
A0	Processor Identification	01, 02, 03, 04, 05
A1	Number of Engines	01, 02, 03, 04, 05
A2	One Lever Operation	00 - Disabled; 01 - Enabled
A3	SE (Station Expander)	00 - Disabled; 01 - Enabled

Table 5-1: Function Codes

Function Code	Function Name	Value Range or Options
A4	Neutral Indication Tone	00 – No Tone 01 – Tone upon engaging Neutral Detent 02 – Tone upon shifting to Neutral
THROTTLE FUNCTIONS (Section 5.6.2: Throttle Functions)		
E0	Engine Throttle Profile OR Throttle Servo Direction	01 - Caterpillar (PWM) (* to 92%) 02 - Cummins Centry (Voltage) (0.9 to 4.5 VDC) 03 - Cummins Quantum (Voltage) (0.9 to 1.2 - 4.0 VDC) 04 - Detroit Diesel (Voltage) (0.64 to 4.65 VDC) 05 - MTU or MAN (Current) (4.0 to 20.0 mA) 06 - Scania (Voltage (0.42 to 2.95 VDC) 07 - John Deere (Voltage) (0.5 to 4.5 VDC) 08 - Volvo (Voltage) (0.6 to 3.6 VDC) 09 - Detroit Diesel (Frequency) (120.64 to 360.9 Hz) 10 - Detroit Diesel (Frequency) (120.64 to 463.5 Hz) 20 – Pull [Retracted] for Throttle Increase 21 – Push [Extended] for Throttle Increase
E1	Throttle in Neutral	00.0 to 25.0% of Throttle Range
E2	Throttle Minimum	00.0 to 20.0% Will always be 10% or more below Maximum.
E3	Throttle Maximum	10.0 to 100.0% Will always be 10% or more above Minimum.
E4	Throttle Maximum Astern	00.0 to 100.0% of Throttle Maximum
E5	Throttle Pause Following Shift	00.0 to 05.0 Seconds
E6	High Idle	00.0 to 20.0% of Throttle Maximum
THROTTLE FUNCTIONS continued (Section 5.6.2: Throttle Functions)		
E7	Synchronization	00 – Equal Throttle (Open Loop) Synchronization 01 - Active (Closed Loop) Synchronization (reverts to Equal if Tach Signal lost) 02 - No Synchronization 03 - Active (Closed Loop) Synchronization (no synchronization if Tach Signal is lost)
CLUTCH FUNCTIONS (Section 5.7.1: Clutch Functions)		
C0	Clutch Pressure Interlock	00 – Not Installed 01 – Installed 02 – Throttle Clutch Pressure Interlock Mode
C1	Clutch Interlock Delay	00.5 to 10.0 Seconds
C2	Proportional Pause	00 – In-Gear 01 – Neutral 02 – Fixed Neutral Delay Enabled (NOTE: If C2 is set to 02, C3 will set Fixed Neutral Delay duration.)
C3	Proportional Pause Time	00 to 99 Seconds

Table 5-1: Function Codes

Function Code	Function Name	Value Range or Options
C4	Proportional Pause Ratio	00 – 2:1 Ahead to Astern vs. Astern to Ahead 01 – 1:1 Ahead to Astern vs. Astern to Ahead
C5	Shift Solenoid Type OR Clutch Servo Direction	00 - All Shift Solenoids except ZF-Hurth 01 - ZF-Hurth Proportional Solenoids with 12V Power 02 - ZF-Hurth Proportional Solenoids with 24V Power 20 – Pull [Retracted] for Ahead 21 – Push [Extended] for Ahead
C6	ZF-Hurth Duty Cycle Ahead OR Clutch Ahead	00 to 100% ZF-Hurth Ahead Lockup Percentage PWM
C7	ZF-Hurth Duty Cycle Astern OR Clutch Astern	00 to 100% ZF-Hurth Astern Lockup Percentage PWM
TROLL FUNCTIONS (Only Available and Displayed When Troll is Enabled) (Section 5.7.2: Troll Functions)		
L0	Troll Enable and Control Head Troll Lever Range	00 – No Troll 01 – 20 Degrees- Type 1 02 – 35 Degrees- Type 2 03 – 45 Degrees- Type 3 (Throttle limited to 75%) 04 – 55 Degrees- Type 4 (Throttle limited to 10%))
L1	Troll Valve Function or Troll Servo Direction	0 - Normal, No Current when at Lock-up 01 - Inverse, No Current when at Lock-up 02 - Normal, Maximum Current when at Lock-up. Preset for ZF220-550, 12VDC Systems. 03 - Normal, No Current when at Lock-up. Preset for ZF220-550, 24VDC Systems. 04 - Normal, No Current when at Lock-up. Preset for ZF2000, 24 VDC Systems. 05 - Inverse, No Current when at Lock-up. Preset for ZF6000, 1900 or 2500, 24VDC Systems. 06 - Preset for 12VDC ZF Hurth Systems. 07 - Preset for 24VDC ZF Hurth Systems20 – Cable Fully Retracted at Lock-up. 21 – Cable Fully Extended at Lock-up.
L2	Troll Minimum Pressure	01.0 to 80.0% Will always be at least 10% below Maximum.
L3	Troll Maximum Pressure	20.0 to 100.0% Will always be at least 10% above Minimum.
L4	Troll Throttle Limit	00 to 20% of Maximum Throttle.
L5	Troll Pulse Duration	00.0 to 09.9 Seconds.
L6	Troll Pulse Percentage	00.1 to 100.0% of available Troll Servo range.
TROUBLESHOOTING FUNCTIONS (Section 5.7.3: Troubleshooting Functions)		

Table 5-1: Function Codes

Function Code	Function Name	Value Range or Options
H0	Diagnostic	Input Voltage (+/- 0.5VDC) Tachometer Sensor Frequency Station No.1 Lever A/D Station No.2 Lever A/D Station No.3 Lever A/D Station No.4 Lever A/D Station No.5 Lever A/D Servo 1 Feedback A/D Servo 2 Feedback A/D Transfer Button, Stations 1, 2, 3, 4, & 5 Software Revision Level
H1	Return to Factory Defaults	Store to Return to Factory Defaults (For Authorized Personnel Only)
H2	Driver Fault Detection Enable	Allows the Processor to monitor the clutch and/or troll solenoids.

Table 5-2: Processors Function Code Defaults

Function Code	Default Values					
	9120	9121	9122	9210	9211	9221
PROCESSOR FUNCTIONS						
A0	00	00	00	00	00	00
A1	01	01	01	01	01	01
A2	00	00	00	00	00	00
A3	00	00	00	00	00	00
A4	00	00	00	00	00	00
THROTTLE FUNCTIONS						
E0	20	20	20	06	06	06
E1	00.0	00.0	00.0	00.0	00.0	00.0
E2	00.0	00.0	00.0	08.0	08.0	08.0
E3	33.0	00.0	33.0	59.0	59.0	59.0
E4	100.0	100.0	100.0	100.0	100.0	100.0
E5	00.5	00.5	00.5	00.5	00.5	00.5
E6	00.0	00.0	00.0	00.0	00.0	00.0
E7	02	02	02	00	00	00

Table 5-2: Processors Function Code Defaults

Function Code	Default Values					
	9120	9121	9122	9210	9211	9221
CLUTCH FUNCTIONS						
C0	00	00	00	00	00	00
C1	01.0	01.0	01.0	01.0	01.0	01.0
C2	00	00	00	00	00	00
C3	03	03	03	03	03	03
C4	00	00	00	00	00	00
C5	00	00	00	20	20	00
C6	100	100	100	80	80	100
C7	100	100	100	80	80	100
TROLL FUNCTIONS						
L0	00	00	00	00	00	00
L1	20	20	00	20	20	20
L2	70.0	70.0	100	70.0	70.0	70.0
L3	90.0	90.0	25.0	90.0	90.0	90.0
L4	00	00	00	00	00	00
L5	00.6	00.6	00.6	00.6	00.6	00.6
L6	90.0	90.0	25.0	90.0	90.0	90.0
TROUBLESHOOTING FUNCTIONS						
H0	00	00	00	00	00	00
H1	00	00	00	00	00	00
H2	00	00	00	--	--	00

5.5 Field Service Test Unit (Break-out Box) and Multimeter Use

Refer to the MM13927 Field Service Test Unit Reference Manual for more information on the use of the Field Service Test Unit (Break-out Box).

- To aid in adjusting Table 5-2: Processors Function Code Defaults list of Processor signals, ZF Marine Propulsion Systems Miramar, LLC recommends the use of ZF Marine Propulsion Systems Miramar, LLC Field Service Test Unit (P/N 13927) (Break-out Box) and a calibrated Multimeter.

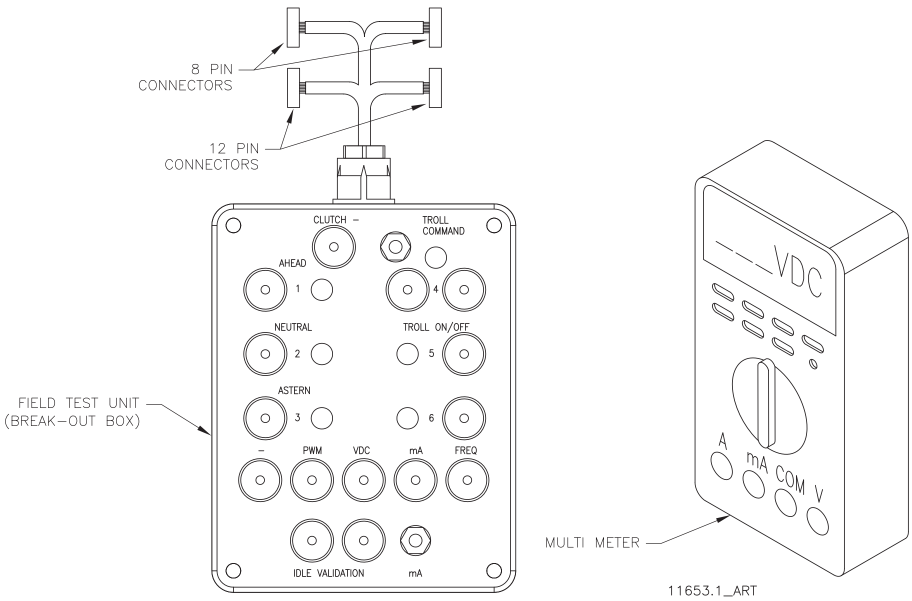


Figure 5-8: Service Field Test Unit and Multimeter

E1 E2 E3 E4 E6	Throttle in Neutral (Section 5.7: Function Code E1 – Throttle in Neutral) Throttle Minimum (Section 5.7.0.1.2: Function Code E2 – Throttle Minimum) Throttle Maximum (Section 5.7.0.1.3: Function Code E3 – Throttle Maximum) Throttle Maximum Astern (Section 5.7.0.0.1: Function Code E4 – Throttle Maximum Astern) High Idle (Section 5.6.2.1.2: Function Code E6 – High Idle)
L2 L3 L4	Trolling Minimum (Section 5.7.2.1.4: Function Code L2 – Solenoid Troll Minimum Pressure) Trolling Maximum (Section 5.7.2.1.6: Function Code L3 – Solenoid Troll Maximum Pressure) Troll Throttle Limit (Section 5.7.2.1.8: Function Code L4 – Solenoid Troll Throttle Limit)
C6 C7	ZF-Hurth Duty Cycle Ahead (Section 5.7.1.3.2: Function Code C6 – ZF-Hurth Duty Cycle Ahead) ZF-Hurth Duty Cycle Astern (Section 5.7.1.3.3: Function Code C7 – ZF-Hurth Duty Cycle Astern)

- For Functions **E1**, **E2**, **E3**, **E4**, **E6**, and **L4** connect the 8-Pin connector of the Service Field Test Unit into the Processor Throttle connector and to the Throttle Wire Harness.

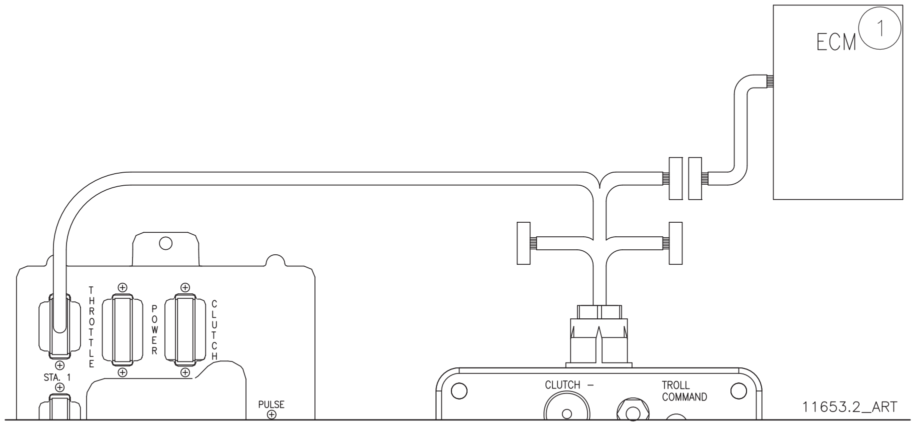


Figure 5-9: E1, E2, E3, E4, E6, L4 Processor, Test Unit, and Multimeter Connections

- For Functions **L2**, **L3**, **C6**, and **C7** connect the 12-Pin connector of the Service Field Test Unit to the Processor Clutch connector and to the Clutch Wire Harness.

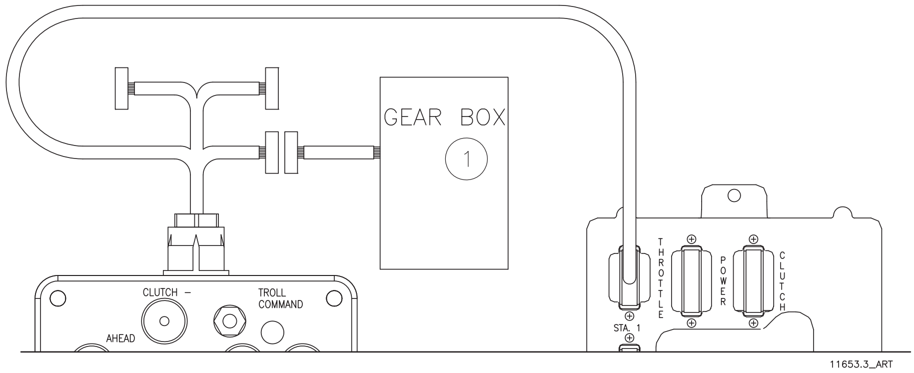


Figure 5-10: L2, L3, C6, and C7 Processor, Test Unit, and Multimeter Connections

5.6 System Programming And Adjustments

**NOTE: SINGLE SCREW APPLICATIONS: The Function Values may be entered and stored in any order.
TWIN SCREW APPLICATIONS: The A1 Function must be set FIRST, and the A0 Function must be set SECOND. The rest of the Function Values may be entered and stored in any order.**

NOTE: Power must be turned ON to the Processors when programming or making any adjustments to the System.

NOTE: In order to prevent nuisance alarms when first setting up a System, some Function Codes take up to 5 minutes to become ACTIVE. The Functions affected by this are the functions that rely on the Serial Communication, such as A0, A1, A2, A3, E7, and L0. Cycling power Off, then On, expedites these features making the Functions available immediately.

5.6.1 Processor Functions

5.6.1.1 Function Code A0 – Processor Identification

In applications where there is more than one screw, the system must know which Processor is where. Every Processor must have its own unique identifying number. At no time can two or more Processors be identified by the same Processor Identification Number.

The available Values for this Function are:

00 (Default Value), 01, 02, 03, 04 and 05.

NOTE: If Processors are not connected by a serial communication cable, leave the A0 function code at Default Value.

NOTE: In twin screw or more applications, the Value of Function Code A0 can be changed only after the Value in Function Code A1 has been changed to 02 or higher.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **A0**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **A0**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

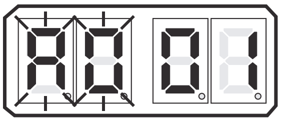


Figure 5-11: Display LED Function A0 **Set Up Activated**

5.6.1.2 Function Code A1 – Number of Engines

NOTE: If Processors are not connected by a serial communication cable, leave the A1 function code at Default Value.

The total number of engines must be entered into the memory of each of the Processors. All Processors in an installation must have the same value entered.

The available Values for this Function are:

01 Single Screw (Default Value)
02 Twin Screw
03 Triple Screw
04 Quad Screw

05 Quint Screw

NOTE: Twin screw or more applications require Function Code A1 Values changed on all Processors prior to changing the Value of Function Code A0.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **A1**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

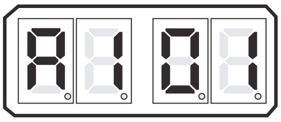


Figure 5-12: Display LED Function A1 **Set Up Activated**

NOTE: Before continuing set up, wait 5 minutes or cycle power.

5.6.1.3 Function Code A2 – One Lever Operation

In Twin Screw or more applications, the System has the ability to command all engines and transmissions to the same speed and direction with a single Control Head lever. This Function allows this Feature to be enabled or disabled. (Refer to Section 2.9: One Lever Mode (Twin Screw) for operation instructions)

The available Values for this Function are:

00 Disabled (Default Value)

01 Enabled

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **A2**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

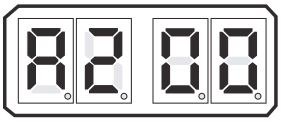


Figure 5-13: Display LED Function A2 **Set Up Activated**

5.6.1.4 Function Code A3 – SE (Station Expander)- Optional

NOTE: This Manual does not go into detail on the Station Expander installation and adjustments. For further information on the Station Expander, see MMC-343 Station Expander User Instructions.

The SE is a separate unit, which gives the System the ability to increase the number of Remote Stations, if more than five Remote Stations are required. (Refer to Section 8.3: Station Expander (SE) for further information)

The available Values for this Function are:

- **00** Disabled (Default Value)
- **01** Enabled

To change the Value (Refer to Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **A3**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

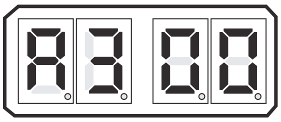


Figure 5-14: Display LED Function A3 **Set Up Activated**

5.6.1.5 Function Code A4 – Neutral Indication Tone

This Function allows the installer to turn ON a 1/2 second, low frequency tone to indicate Neutral.

The available Values for this Function are:

- **00** Disabled (Default Value)
- **01** Tone sounds when the Control Head’s lever reaches Neutral
- **02** Tone sounds when the Processor commands Neutral

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **A4**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

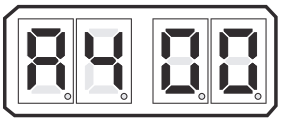


Figure 5-15: Display LED Function A4 **Set Up Activated**

5.6.2 Throttle Functions

5.6.2.1 Throttle Basic Functions

5.6.2.1.1 Function Code E5 – Throttle Pause Following Shift

The available Values for this Function are **00.0** seconds to **05.0** seconds.

The Default Value is **00.5** seconds.

This Function programs the amount of delay between the point that Clutch engagement is commanded and throttle is allowed to increase above Idle.

NOTE: This Function is typically programmed during Dock Trials. Refer to the appropriate Section 6.8: Throttle Pause Following Servo Shift, or Section 6.9: Throttle Pause Following Solenoid Shift.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code E5.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

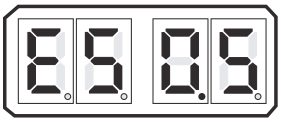


Figure 5-16: Display LED Function E5 **Set Up Activated**

5.6.2.1.2 Function Code E6 – High Idle

This Function Code Programs the RPM of the second, elevated Idle.

The available Values for this Function are **00.0** to **20.0**% of Throttle Maximum.

The Default Value is **00.0**%.

The Value selected is a percentage of the Value selected in Function Code E3 – Throttle Maximum.

NOTE: This Function is typically programmed during Dock Trials or Sea Trials. Refer to Section 6.5: High Idle.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **E6**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

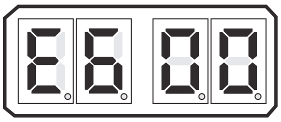


Figure 5-17: Display LED Function E6 **Set Up Activated**

5.7 Function Code E1 – Throttle in Neutral

This Function allows the engine RPM at Neutral to be adjusted independently of the RPM at Idle Ahead and Astern.

The available Values for this Function are **00.0** to **25.0** percent of the Throttle Range.

The Default Value is **00.0**%.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **E1**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory

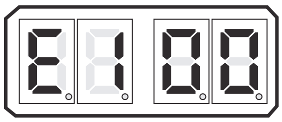


Figure 5-18: Display LED Function E1 **Set Up Activated**

5.7.0.0.1 Function Code E4 – Throttle Maximum Astern

This Function limits the amount of Throttle permitted in Astern.

The available Values for this Function are **00.0**% to **100.0**%.

The Default Value is **100.0**% of Throttle Maximum.

The Value selected is a percentage of the Value selected in Function Code **E3** – Throttle Maximum.

Example: A Value of **50.0** will allow 50% of Throttle Maximum when commanding Astern. The Value selected is a matter of personal preference.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code E4.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

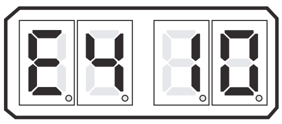


Figure 5-19: Display LED Function E4 **Set Up Activated**

5.7.0.0.2 Function Code E7 – Synchronization

This Function Code selects the type of Synchronization, if Synchronization is required. The types are described in Section 2.10: Engine Synchronization (Twin Screw).

The available Values for this Function are:

00 Equal Throttle (Open Loop) Synchronization

01 Active (Closed Loop) Synchronization (reverts to Equal Throttle Synch if there is no Tachometer Sensor signal)

02 No Synchronization **(Default Value)**

03 Active (Closed Loop) Synchronization (reverts to no Synchronization if there is no Tachometer Sensor signal)

The Default Value is **02**.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **E7**.

B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

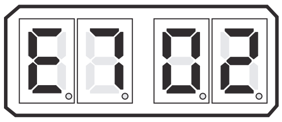


Figure 5-20: Display LED Function E7 **Set Up Activated**

5.7.0.1 Throttle Servo Functions

This section along with Section 5.6.2.1: Throttle Basic Functions allows the adjustment of Throttle Servo related items:

5.7.0.1.1 Function Code E0 – Throttle Servo Direction

This Function determines if the Throttle Push-Pull cable is fully extended or retracted when at Idle.

The available Values for this Function are:

20 Fully Retracted [Pull] at Idle (Default Value)

21 Fully Extended [Push] at Idle

To determine and change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Ensure that the engine's Governor or Carburetor lever is at the Idle position.
- If the Throttle Push-Pull cable's ball joint is close to the Throttle lever's position, no change is required to this Function Code.
- If the Throttle Push-Pull cable's ball joint is at the opposite side of the lever's position, continue with the next step.

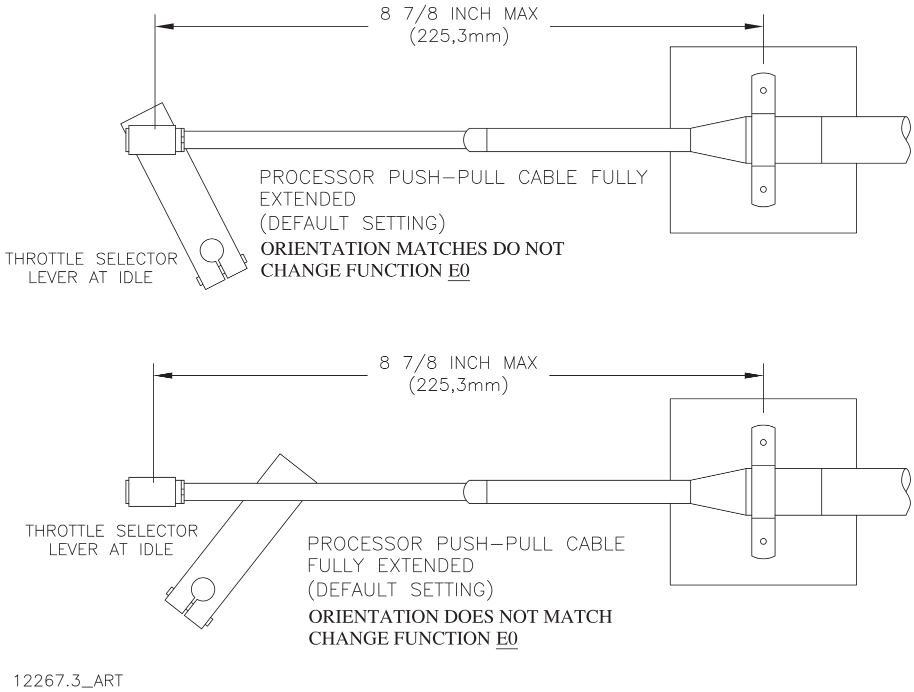


Figure 5-21: Throttle Push-Pull Cable Orientation

B Scroll to Function Code **E0**.
C Activate Set Up Mode.
D Scroll Up or Down until the Value **21** is displayed.

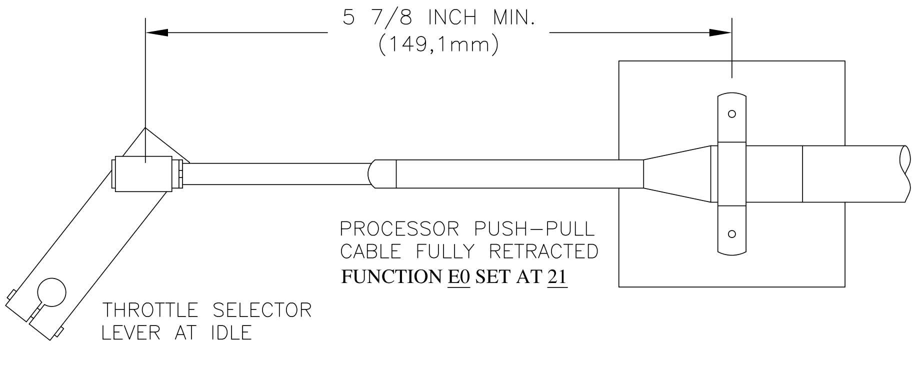


Figure 5-22: Example: Throttle Push-Pull Cable Fully Retracted Position for Idle

E Store the Value to memory. (The Throttle Push-Pull cable should drive to the fully retracted position.)
F Do not connect the ball joint to the throttle lever at this time.

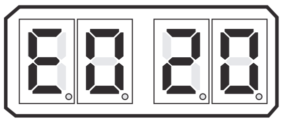


Figure 5-23: Display LED Function E0 **Set Up Activated**

5.7.0.1.2 Function Code E2 – Throttle Minimum

This Function further adjusts the Push-Pull cable's Idle position electronically. The primary purpose is to adjust the Push-Pull cable/Throttle Selector Lever's position so that any further movement will result in an increase in engine RPM. (No Dead-band)

The available Values for this Function are **00.0** to **20.0**%.

The Default Value is **00.0**%. This value will always be 10% or more below **E3** Throttle Maximum.

To determine and change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Ensure that the Throttle push-pull cable is connected to the Throttle lever.
B Scroll to Function Code **E2**.
C Activate Set Up Mode.
D Scroll Up until the engine RPM begins to increase above Idle.
E Scroll Down until Idle RPM is reached.
F Store the Value to memory.

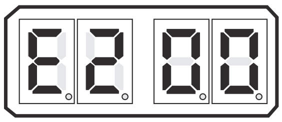


Figure 5-24: Display LED Function E2 **Set Up Activated**

5.7.0.1.3 Function Code E3 – Throttle Maximum

This Function adjusts the position of the Throttle Push-Pull cable at Full Throttle.

The available Values for this Function are **10.0**% to **100.0**%.

The Default Value is **33.0**%. This value will always be 10% or more above **E2** Throttle Minimum.

The Value entered is the percentage of the servo's maximum travel of 3.00 inches (76,2mm).

Example: A Value of **50.0**, will equal 1.50 inches (38,1mm) of travel from Idle to Full Throttle.

To determine and change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

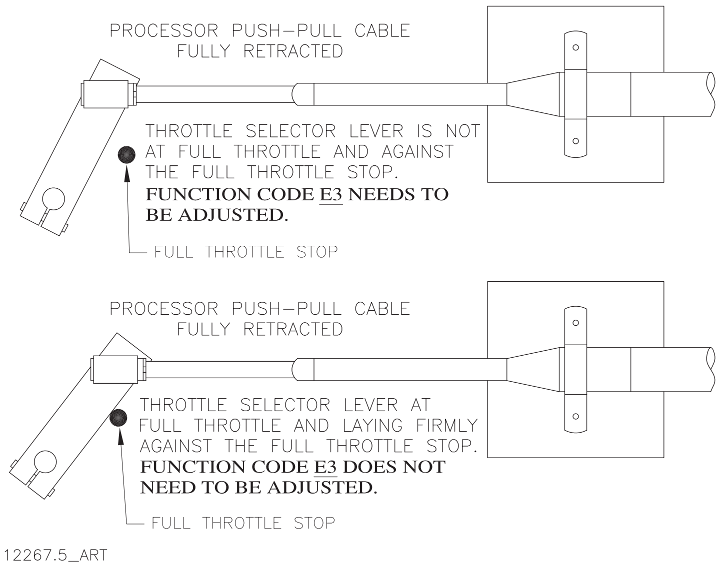


Figure 5-25: Throttle Push-Pull Cable Full Throttle Position

A Take command at a Remote Station.

B Move the Control Head lever to the Full Ahead position.

C Check to see if the Throttle Push-Pull cable reaches the Full Throttle stop.

- If the Throttle lever is firmly (not bound) against the Full Throttle stop, no adjustment to Function Code **E3** is required.
- If the Throttle lever does not reach the Full Throttle stop, continue with the next step.

D Scroll to Function Code **E3**.

E Activate Set Up Mode.

F Scroll Up until the Throttle lever is firmly (not bound) against the Full Throttle Stop.

G Store the Value to memory.

H Return the Control Head lever to the Neutral/Idle position.

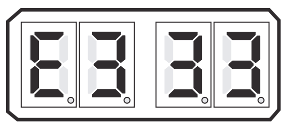


Figure 5-26: Display LED Function E3 Set Up Activated

5.7.0.2 Throttle Electronic Functions

5.7.0.2.1 Function Code E0 – Engine Throttle Profile

This Function selects the appropriate Throttle Signal range for various engines

The available Values for this Function are listed below:

1. Caterpillar (PWM) (8 to 92%)
2. Cummins Centry (Voltage) (0.9 to 4.5 VDC)
3. Cummins Quantum (Voltage) (0.9 to 1.2 - 4.0 VDC)
4. Detroit Diesel (Voltage) (0.64 to 4.65 VDC)
5. MTU or MAN (Current) (4.0 to 20.0 mA)
6. Scania (Voltage (0.42 to 2.95 VDC)
7. John Deere (Voltage) (0.5 to 4.5 VDC)
8. Volvo (Voltage) (0.6 to 3.6 VDC)
9. Detroit Diesel (Frequency) (120.64 to 360.9 Hz)
10. Detroit Diesel (Frequency) (120.64 to 463.5 Hz)

The Default Value is set to **06** Scania Profile.

To determine and change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **E0**.
B Activate Set Up Mode.
C Scroll Up or Down until the desired Value is displayed.
D Store the Value to memory.

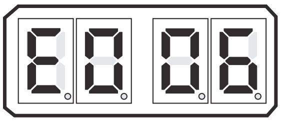


Figure 5-27: Display LED Function E0 **Set Up Activated**

5.7.0.2.2 Function Code E2 – Throttle Minimum

This Function allows the throttle signal at Idle to be fine tuned from the Value provided by the **E0** Throttle Profile.

The available Values for this Function are **00.0** to **20.0**%.

The Default Value is **08.0**%.

To determine and change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **E2**.
B Activate Set Up Mode.
C Scroll Up until the engine RPM at Idle begins to increase above Idle RPM.
D Scroll Down until Idle RPM is reached.
E Store the Value to memory.

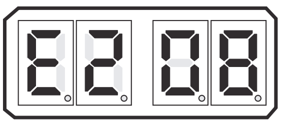


Figure 5-28: Display LED Function E2 **Set Up Activated**

5.7.0.2.3 Function Code E3 – Throttle Maximum

This Function allows the throttle signal at Full to be fine tuned from that provided by the **E0** Throttle Profile.

The available Values for this Function are **10.0**% to **100.0**%. The Value entered is the percentage of the throttle's range from Idle to Full.

EXAMPLE: A Value of **50.0**, will equal a 2.10 VDC throttle signal when the Volvo profile is selected, which has a throttle range of 0.6 to 3.6 VDC.

The Default Value is **59.0**%.

To determine and change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Take command at a Remote Station.
B Move the Control Head lever to the Full Ahead position.
C Measure the throttle signal.
D Scroll to Function Code **E3**.
E Activate Set Up Mode.
F Scroll Up until the throttle signal is at Full Throttle.
G Store the Value to memory.
H Return the Control Head lever to the Neutral/Idle position.

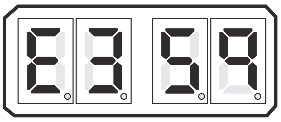


Figure 5-29: Display LED Function E3 **Set Up Activated**

5.7.1 Clutch Functions

5.7.1.1 Clutch Basic Functions

5.7.1.1.1 Function Code C0 – Clutch Pressure Interlock

NOTE: This adjustment is to be set to Enabled only if the optional Clutch Pressure Switch is being used with this application.

This Function enables or disables the feature and allows for two different modes of behavior when a Clutch Pressure Switch is used. Refer to Section 8.2: Clutch Pressure Interlock for detailed information.

The available Values for this Function are:

00 Not Installed (Default Value)
01 Installed
02 Throttle Clutch Pressure Interlock Mode

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **C0**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

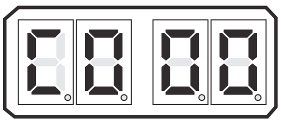


Figure 5-30: Display LED Function C0 **Set Up Activated**

5.7.1.1.2 Function Code C1 – Clutch Interlock Delay

NOTE: This adjustment is to be used only if the optional Clutch Pressure Switch is being used with this application.

This Function works together with Function Code **C0** – Clutch Pressure Interlock. Refer to Sections Section 8.2: Clutch Pressure Interlock for operational details.

The available Values are **00.5** to **10.0** seconds. The Default Value is **01.0** seconds.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory)

A Scroll to Function Code **C1**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

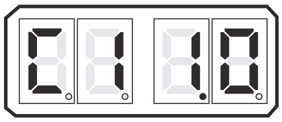


Figure 5-31: Display LED Function C1 **Set Up Activated**

5.7.1.1.3 Function Code C2 – Proportional Pause

This Function selects whether the Clutch stays engaged or at Neutral when performing a Full Speed Reversal.

The In-Gear Delay is most commonly used.

The Neutral Delay is used when a Shaft Brake is installed.

The amount of time is adjustable with Function Code **C3** Proportional Pause Time.

- The delay programmed is maximum and proportional when Values **00** and **01** are used.
- The programmed delay is fixed when Value **02** is selected and Function Code **C4** Proportional Pause
- Ratio is set to **01** (1:1 Ratio). When **C4** is set to **00**, the pause from Astern through Neutral to Ahead is 1/2 of the selected value.

The available Values are:

00 In-Gear (Default)
01 Neutral
02 Fixed Neutral Delay Enabled

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

E Scroll to Function Code **C2**.
F Activate Set Up Mode.
G Scroll Up or Down to the desired Value.
H Store the Value to memory.

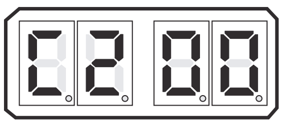


Figure 5-32: Display LED Function C2 Set Up Activated

NOTE: If C2 Proportional Pause is set to 02 Fixed Neutral Delay Enabled, Function C3 Proportional Pause Time will set the Fixed Neutral Delay duration.

5.7.1.1.4 Function Code C3 – Proportional Pause Time

The Proportional Pause Time feature provides engine deceleration, followed by a pause in throttling to the commanded speed in the new desired direction, upon a Full-Speed Reversal. This pause time is proportional to how much throttle is being commanded and for how long. In order to build up to the pause value set, the vessel must be at full throttle and Ahead six (6) times the pause set. The default pause from Astern to Ahead is 1/2 the Proportional Pause **C2** value set.

When **C2** Proportional Pause is set to **00**, the throttle position drops to Idle and the transmission remains engaged Ahead; the pause that follows is in proportion to the prior Control Head lever position and how long the lever had been in that position before the reversal.

This Function selects the amount of time that the Clutch will stay engaged or at Neutral (depending on **C2** setting) while performing a Full Speed Reversal.

The available Values are 00 to 99 seconds. The default Value is 03 seconds.

NOTE: The Value for this Function Code should be determined during the Sea Trial.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

- A Scroll to Function Code **C3**.
- B Activate Set Up Mode.
- C Scroll Up or Down to the desired Value.
- D Store the Value to memory.

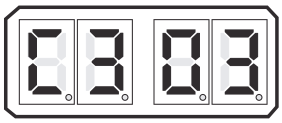


Figure 5-33: Display LED Function C3 **Set Up Activated**

5.7.1.1.5 Function Code C4 – Proportional Pause Ratio

00 - 2:1 Ratio

This is the default setting and determines how the value set in the Proportional Pause Time **C3** Function is applied. The number of seconds selected is for an Ahead to Astern maneuver only. An Astern to Ahead maneuver will be 1/2 of the Proportional Pause Time selected. This is the typical selection since most vessels do not reach the same throttle in Astern as they would in Ahead. Therefore, the time required to get to a sufficient water speed for a safe reversal is significantly less.

01- 1:1 Ratio

When this setting is selected, the value set in the Proportional Pause Time **C3** is the same for both Ahead to Astern, as with Astern to Ahead maneuvers. This may be selected when the vessel reaches the same water speed in both directions, as would be the case with a Double Ended Ferry. Another application where this option may be selected would be the control of a Bow or Stern Thruster.

This Function Code selects whether the Proportional Pause Time is the same in Ahead and Astern or whether the time in Ahead is twice that in Astern. Standard vessels with a bow and a stern typically select a pause which is twice as much in Ahead compared to Astern.

This is because much more speed is obtainable in Ahead, then Astern. Consequently, more time is required to slow down from Ahead as compared to Astern.

NOTE: When the Controls are installed on a vessel such as a double ended Ferry or the Controls are being used to control a thruster, the proportional pause should be the same in Ahead as Astern or port and starboard in the case of a thruster.

The available Values for this Function are:

00 2:1 Ahead to Astern vs. Astern to Ahead (Default Value)

01 1:1 Ahead to Astern vs. Astern to Ahead

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **C4**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

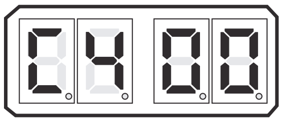


Figure 5-34: Display LED Function C4 **Set Up Activated**

5.7.1.2 Clutch Servo Functions

This section along with Section 5.7.1.1: Clutch Basic Functions allows the adjustment of Clutch Servo related items:

5.7.1.2.1 Function Code C5 – Clutch Servo Direction

This Function allows the Processor to be programmed to retract the Push-Pull cable for Ahead or extend for Ahead.

The available Values are:

20 Pull [Retracted] for Ahead (Default)

21 Push [Extended] for Ahead

If required, change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Position the Clutch Selector Lever to the Ahead position.
B Move a Control Head’s lever into the Ahead detent.

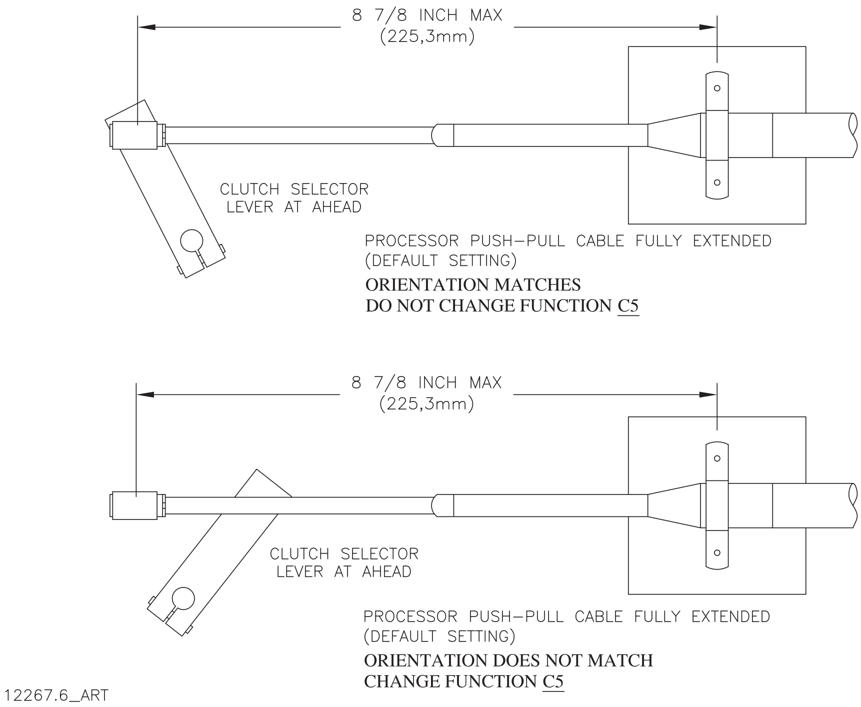


Figure 5-35: Clutch Push-Pull Cable Orientation

C Check the Shift Push-Pull cable to see if it drove in the correct direction.
- If the cable drove in the correct direction, no change to this Function Code is required.
- If the cable drove in the opposite direction, continue with the next step.

D Scroll to Function Code **C5**.

E Activate Set Up Mode.

F Scroll Up to change the Value to **21**.

G Store the Value to memory.

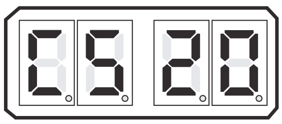


Figure 5-36: Display LED Function C5 **Set Up Activated**

5.7.1.2.2 Function Code C6 – Clutch Ahead Travel

This function adjusts the amount of Clutch push-pull cable travel in both the Ahead and the Astern directions.

The available Values are **00.0** to **100.0** percent of the maximum available travel from Neutral to Ahead.

The Default Value is **80**%.

To determine, and if required, change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Move the Control Head lever to the Ahead detent.

B Move the Clutch Selector Lever to the Ahead stop.

C Does the cable's ball joint and lever align?

- If yes, no further adjustment of this Function is required.

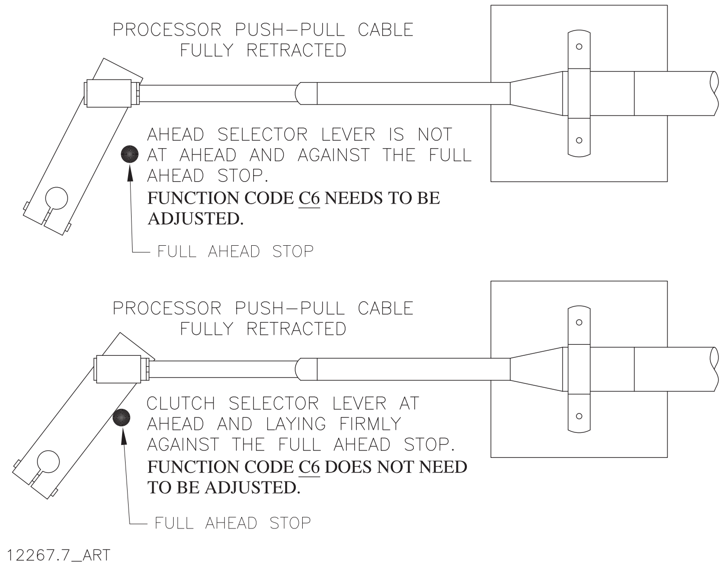


Figure 5-37: Clutch Push-Pull Cable Ahead Position

- If no, continue with the next step.

D Scroll to Function Code **C6**.

E Activate Set Up Mode.

F Scroll Up or Down until the ball joint and lever align perfectly.

G Store the Value to memory.

H Return the Control Head lever to the Neutral/Idle position.

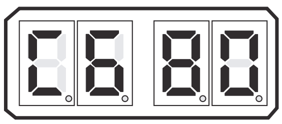


Figure 5-38: Display LED Function C6 **Set Up Activated**

5.7.1.2.3 Function Code C7 – Clutch Astern Travel

This function is only required when the distance from Neutral to Astern differs from Neutral to Ahead.

This Function Code allows the independent adjustment of Astern travel. Otherwise, the Value selected in Function Code **C6** is automatically entered for Function Code **C7**.

The available Values are **00.0** to **100.0** percent of the available travel from Neutral to Astern.

The Default Value is **80**%.

To determine, and if required, change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

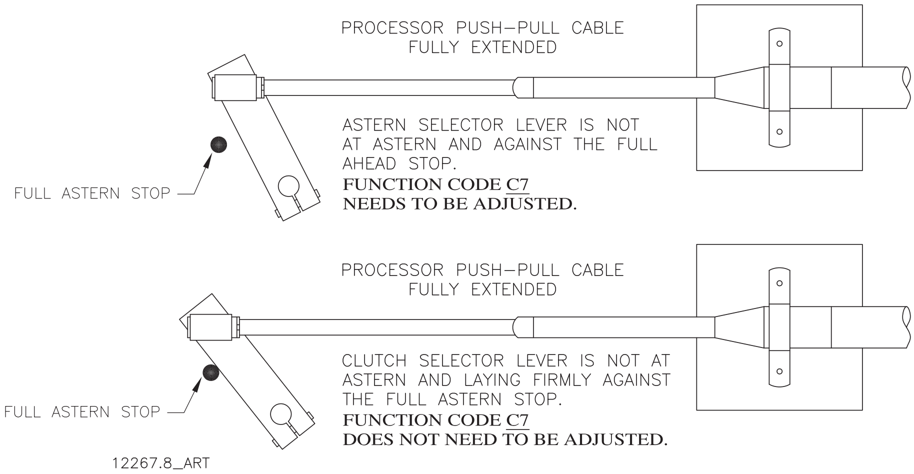


Figure 5-39: Clutch Push-Pull Cable Astern Position

A Move the Control Head lever to the Astern detent.

B Move the Clutch Selector Lever to the Astern stop.

C Does the cable's ball joint and lever align?

- If yes, no further adjustment of this Function is required.
- If no, continue with the next step.

D Scroll to Function Code **C7**.

E Activate Set Up Mode.

F Scroll Up or Down until the ball joint and Clutch Selector lever aligns perfectly.

G Connect the ball joint to the Clutch Selector lever.

H Store the Value to memory.

I Return the Control Head lever to the Neutral/Idle position.

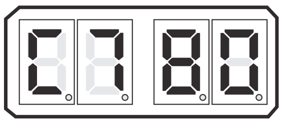


Figure 5-40: Display LED Function C7 Set Up Activated

5.7.1.3 Clutch Solenoid Functions

This section along with Section 5.7.1.1: Clutch Basic Functions allows the adjustment of Clutch Solenoid related items:

5.7.1.3.1 Function Code C5 – Shift Solenoid Type

This Function Code must be left at the default value unless a ZF-Hurth Gear is installed with proportional Ahead and Astern Solenoids. When values **01** or **02** are selected, the current is limited to the solenoids.

The available Values are:

00 - All Shift Solenoids except ZF-Hurth (DEFAULT)
01 - ZF-Hurth Proportional Solenoids with 12V Power
02 - ZF-Hurth Proportional Solenoids with 24V Power

The default value of **00** is used with most types of solenoids, with the exception of the ZF-Hurth Gears with proportional Ahead and Astern solenoids.

CAUTION: The maximum amount of current to these solenoids MUST be limited by the control system. Failure to do so can cause permanent damage to the solenoids. Depending on the voltage applied to the solenoids, adjust the Value to 01 for 12V power and 02 for 24V power.

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **C5**.
B Activate Set Up Mode.
C Scroll Up to change the Value.
D Store the Value to memory.

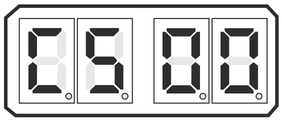


Figure 5-41: Display LED Function C5 **Set Up Activated**

5.7.1.3.2 Function Code C6 – ZF-Hurth Duty Cycle Ahead

This function adjusts the maximum current available to the Ahead Proportional Solenoid. Failure to limit the current may result in permanent damage to the solenoid.

The available Values are **00.0** to **100.0** percent Duty Cycle of the applied voltage.

The Default Value is **100**%.

To determine, and if required, change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Ensure that Troll is not selected (no rapidly blinking LED).
B Connect an amp meter in series with the Ahead solenoid signal.
C Move the Control Head lever to the Ahead detent.
D Scroll to Function Code **C6**.
E Activate Set Up Mode.
F Scroll Up or Down until the appropriate maximum current level is reached.
G Store the Value to memory.
H Return the Control Head lever to the Neutral/Idle position.

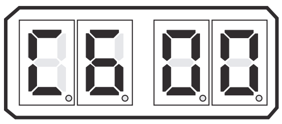


Figure 5-42: Display LED Function C6 **Set Up Activated**

5.7.1.3.3 Function Code C7 – ZF-Hurth Duty Cycle Astern

This function limits the amount of current delivered to the Astern Proportional Solenoid. Failure to limit the current may result in permanent damage to the solenoid.

The available Values are **00.0** to **100.0** percent Duty Cycle of the applied voltage.

The Default Value is **100**%.

To determine, and if required, change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Ensure that Troll is <u>not</u> selected (no rapidly blinking LED).
B Connect an amp meter in series with the Astern solenoid signal.
C Move the Control Head lever to the Astern detent.
D Scroll to Function Code **C7**.
E Activate Set Up Mode.
F Scroll Up or Down until the appropriate minimum current level is reached.
G Store the Value to memory.
H Return the Control Head lever to the Neutral/Idle position.

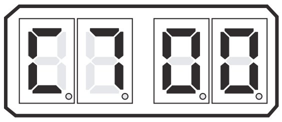


Figure 5-43: Display LED Function C7 **Set Up Activated**

5.7.2 Troll Functions

5.7.2.1 Basic Troll Command Functions

The <u>**Basic Troll Functions**</u> that are common on all Processors with Trolling Valve control is **L0**, **L4**, and **L5**.

NOTE: All Troll Functions other than L0 will not be displayed on the Processor Display LED if Function L0 is set to 00. To utilize Troll and display the rest of the Troll Functions, a value other than 00 needs to be entered for Function L0.

NOTE: If the Control System does not offer integrated Troll control, a 9001 Troll Actuator is required to offer Trolling Valve Control.

Integrated Troll Control
All Troll Functions other than L0 will not be displayed on the Processor Display LED if Function L0 is set to 00. To utilize Troll and display the rest of the Troll Functions, a value other than 00 needs to be entered for Function L0.

9001 Troll Actuator
All the Function Codes relating to Troll will not be displayed, unless an external Troll Actuator (p/n 9001) is connected to the Processor. Installation and adjustment details are included with the Troll Actuator.

The following is a brief outline of the Basic Troll Function adjustments.

5.7.2.1.1 Function Code L0 – Troll Enable and Control Head Lever Troll Range

This Function Code tells the Processor whether or not:

- A 9001 Trolling Actuator or integrated Troll Control exists.
- How the trolling valve is to be controlled.

There are four types which can be used to control any trolling valve.

How these different Types function and when and where they may be applied is described in the Trolling Actuator's Installation Manual for the 9001 Trolling Actuator and in Section 2.4: Start Interlock (if used) for Integrated Troll Control.

The available Values are:

00 No Troll (Default Value)
01 20 Degrees – Type 1
02 35 Degrees – Type 2
03 45 Degrees – Type 3 (Throttle limited to 75%).
04 55 Degrees - Type 4 (Throttle limited to 10%).

To change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **L0**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory

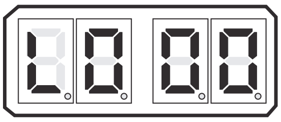


Figure 5-44: Display LED Function L0 Set Up Activated.

NOTE: Function Codes L1 thru L6 are not displayed on the Processor Display LED unless Function Code L0 is set to a Value other than 00.

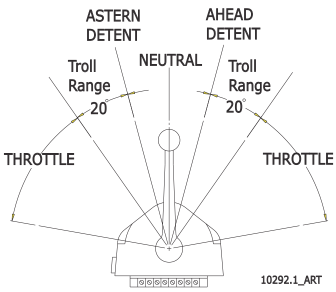


Figure 5-45: Control Head 20 Degree Troll Range - Type 1

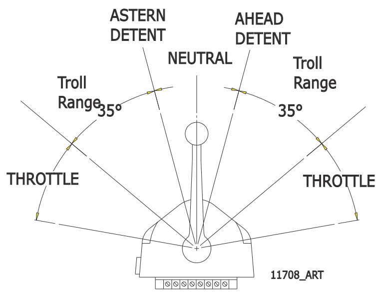


Figure 5-46: Control Head 35 Degree Troll Range - Type 2

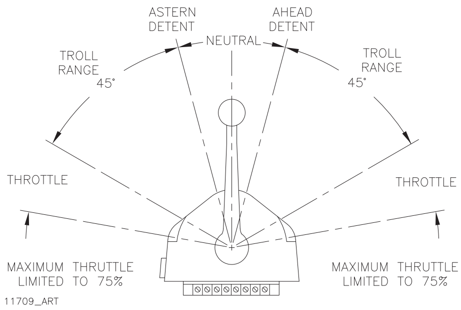


Figure 5-47: Control Head 45 Degree Troll Range - Type 3

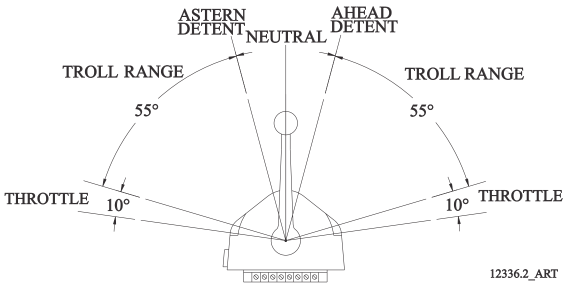


Figure 5-48: Control Head 55 Degree Troll Range - Type 4

5.7.2.1.2 Troll Solenoid L1 Function

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor's Integrated Troll command.

Function Code **L1** presets the profile and the amount of current delivered to the Trolling Valve's proportional solenoid.

The Values for this Function are listed below:

00 - Normal, No Current when at Lock-up

01 - Inverse, No Current when at Lock-up

02 - Normal, Maximum Current when at Lock-up. Preset for ZF220-550, 12VDC Systems.

03 - Normal, No Current when at Lock-up. Preset for ZF220-550, 24VDC Systems.

04 - Normal, No Current when at Lock-up. Preset for ZF2000, 24 VDC Systems.

05 - Inverse, No Current when at Lock-up. Preset for ZF670, 1900 or 2500, 24VDC Systems.

06 - Preset for 12VDC ZF Hurth Systems.

07 - Preset for 24VDC ZF Hurth Systems.

The default value is **00**.

To determine, and if required, change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Scroll to Function Code **L1**.

B Activate Set Up Mode.

C Scroll Up or Down to the appropriate Value for the Trolling Valve.

D Store the Value to memory

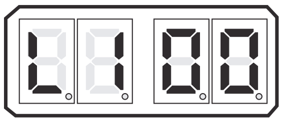


Figure 5-49: Display LED Function L1 Set Up Activated

5.7.2.1.3 Troll Servo L1 Function

L1 – Troll Servo Direction

This section along with the Basic Troll Functions allows the adjustment of the Processor's Integrated Servo Troll command.

This Function Code determines whether the Troll Push-Pull cable is fully extended or retracted when at Lock-up.

The available Values are:

20 Lock-up – Push-Pull cable fully retracted. (Default Value)

21 Lock-up – Push-Pull cable fully extended.

To determine, and if required, change the Value (Refer to Sections Section 5.2: Activating Set Up Mode and Section 5.3: Storing Values To Memory):

A Move the Troll Selector Lever to the Lock-up (Full Pressure) position.

B Check to see if the Push-Pull cable's ball joint are in close proximity to one another.

- If so, no adjustments of Function Code **L1** Troll Servo Direction are required.
- If they are not, continue with the next step.

C Scroll to Function Code **L1**.

D Activate Set Up Mode.

E Scroll Up or Down to Value **20** or **21**.

F Store the Value to memory

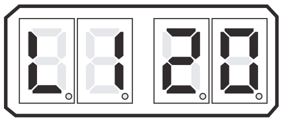


Figure 5-50: Display LED Function L1 Set Up Activated

5.7.2.1.4 **Function Code** L2 **– Solenoid Troll Minimum Pressure**

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor's Integrated Solenoid Troll command.

This Function fine tunes the amount of current delivered to the proportional solenoid, so that clutch pressure is at the minimum point where shaft rotations are still possible.

The hydraulic pressure on the Clutch plate can typically be decreased to a point where the shaft is rotating at 30% to 50% of normal shaft RPM at Idle.

The available Values are **0.00** to **80.0** percent of the maximum current available. The Default Value is **10.0**%. The Value selected <u>must</u> always be at least 20% below or above (Normal/ Inverted) the value selected with Troll Maximum Pressure **L3**.

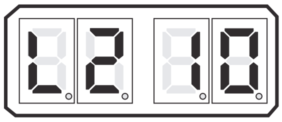


Figure 5-51: Display LED Solenoid Function L2 Set Up Activated

A Move the Control Head lever to the Ahead detent.
B Scroll to the Function Code.
C Activate Set Up Mode.
D Scroll Up or Down to the appropriate Value.
E Store the Value to memory

5.7.2.1.5 **Function Code L2 – Servo Troll Minimum Pressure**

This Function Code along with the Basic Troll Command Functions allows the adjustment of the Processor's Integrated Servo Troll command.

Function **L2** adjusts the Troll Push-Pull cable travel to the point where clutch pressure is at the minimum point where shaft rotations are still possible.

The hydraulic pressure on the Clutch plate can typically be decrease to a point where the shaft is rotating at 30% to 50% of normal shaft RPM at Idle.

The available Values are **0.10** to **80.0** percent of the 3.00 inches (76,2mm) of Troll Push-Pull cable travel.

The Default Value is **70.0**%.

The Value selected <u>must</u> always be at least 10% below the Troll Maximum Pressure **L3** selected.

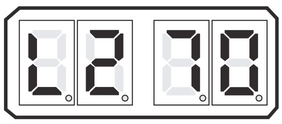


Figure 5-52: Display LED Servo Function L2 Set Up Activated

A Move the Control Head lever to the Ahead detent.
B Scroll to the Function Code.
C Activate Set Up Mode.
D Scroll Up or Down to the appropriate Value.
E Store the Value to memory

5.7.2.1.6 Function Code L3 – Solenoid Troll Maximum Pressure

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor’s Solenoid Integrated Troll command.

Function **L3** fine tunes the amount of current delivered to the proportional solenoid, so that clutch pressure is at the maximum point prior to Clutch Plate lock-up.

The hydraulic pressure on the Clutch plate can typically be decreased to a point where the shaft is rotating at approximately 70% of normal shaft RPM at Idle. Attempts to increase pressure above this point typically results in Clutch Plate lock-up.

The available Values are **20.0** to **100.0** percent of the maximum current available. The Default Value is **25.0**%. The Value selected <u>must</u> be at least 20% above or below (Normal/ Inverse) the Troll Minimum Pressure **L2** selected.

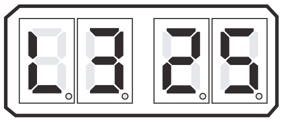


Figure 5-53: Display LED Solenoid Function L3 **Set Up Activated**

A Move the Control Head lever to the Ahead detent.
B Scroll to Function Code.
C Activate Set Up Mode.
D Scroll Up or Down to the appropriate Value.
E Store the Value to memory

5.7.2.1.7 Function Code L3 – Servo Troll Maximum Pressure

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor’s Servo Troll command.

This Function adjusts the Troll Push-Pull cable travel to the point where clutch pressure is at the maximum point, yet not quite at normal shaft RPM at Idle.

The hydraulic pressure on the Clutch plate can typically be decreased to a point where the shaft is rotating at approximately 70% of normal shaft RPM at Idle.

The available Values are **20.0** to **100.0** percent of the 3.00 inches (76,2mm) of Troll Push-Pull cable travel.

The Default Value is **90.0**%.

The Value selected <u>must</u> be at least 10% above the Troll Minimum Pressure **L2** selected.

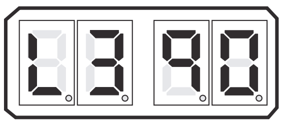


Figure 5-54: Display LED Servo Function L3 **Set Up Activated**

A Move the Control Head lever to the Ahead detent.
B Scroll to Function Code.
C Activate Set Up Mode.
D Scroll Up or Down to the appropriate Value.
E Store the Value to memory

5.7.2.1.8 Function Code L4 – Solenoid Troll Throttle Limit

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor's Solenoid Troll command.

Function **L4** allows an increase in throttle above Idle while commanding clutch slippage. The throttle increases linearly to the Value set while commanding Troll Minimum to Troll Maximum.

The Values available to this Function are **00** to **20** percent of Throttle Maximum.

The default value is **00**% of Throttle Maximum.

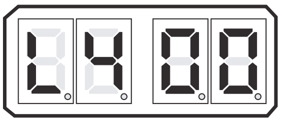


Figure 5-55: Display LED Solenoid Function L4 **Set Up Activated**

A Scroll to Function Code **L4**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory

	NOTE: Do not make any adjustments to Function Codes L5 and L6 until the vessel has been sea trialed and Function Codes L0, L1, L2, L3, and L4 have been properly adjusted.

	NOTE: For 9001 Troll Actuator detailed instructions on the adjustments of L5 and L6 can be found in the MM9001 Trolling Actuator's Installation Manual.

	NOTE: For Integrated Troll detailed instructions on the adjustment of L5 can be found in the following Section 5.7.2.1.9: Function Code L5 – Troll Pulse Duration. The adjustment of Integrated Servo Troll L6 in Section 5.7.2.1.9: Function Code L5 – Troll Pulse Duration, or Integrated Solenoid Troll L6 in Section 5.7.2.1.10: Function Code L6 – Solenoid Troll Pulse Percentage.

5.7.2.1.9 Function Code L5 – Troll Pulse Duration

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor's Integrated Troll command.

Function **L5** determines the length of time that the Value selected in Function Code **L6** is applied.

The available Values for this Function are **00.0** to **09.9** seconds.

The default Value is **00.6** seconds.

A With Troll selected, place the Control Head lever into the Ahead detent.

- If the vessel lunges forward or the shaft takes too long to start rotating, continue with the next step.

B Scroll to Function Code **L5**.

C Activate Set Up Mode.

D Scroll Up or Down to the desired Value.

E Store the Value to memory.

5.7.2.1.10 Function Code L6 – Solenoid Troll Pulse Percentage

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor's Solenoid Troll command.

Function Code **L6** selects the percentage of available Troll signal when first engaging the Clutch while in Troll.

The available Values for this Function are **01.0**% to **100.0**%

The default Value is **90.0**%.

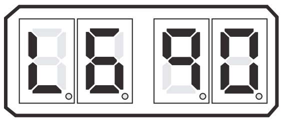


Figure 5-56: Display LED Function L6 **Set Up Activated**

A With Troll selected, place the Control Head lever into the Ahead detent.
- If the vessel lunges forward or the shaft takes too long to start rotating, continue with the next step.

B Scroll to Function Code **L6**.

C Activate Set Up Mode.

D Scroll Up or Down to the desired Value

E Store the Value to memory

5.7.2.1.11 Function Code L6 – Servo Troll Pulse Percentage

This Section along with the Basic Troll Command Functions allows the adjustment of the Processor's Servo Troll command.

This Function Code selects the percentage of available Troll Servo Range the Processor's push-pull cable travels when first engaging the Clutch while in Troll.

The available Values for this Function are **01.0**% to **100.0**%

The default Value is **90.0**%.

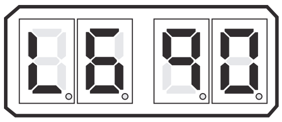


Figure 5-57: Display LED Function L6 **Set Up Activated**

A With Troll selected, place the Control Head lever into the Ahead detent.
- If the vessel lunges forward or the shaft takes too long to start rotating, continue with the next step.

B Scroll to Function Code **L6**.

C Activate Set Up Mode.

D Scroll Up or Down to the desired Value

E Store the Value to memory

5.7.3 Troubleshooting Functions

5.7.3.1 Basic Processor Troubleshooting Functions

5.7.3.1.1 Function Code H0 - Diagnostics

This Function is used during troubleshooting and is explained in detail in Section 10.4: Troubleshooting Diagnostic Menu.

5.7.3.1.2 Function Code H1 – Return to Factory Defaults

This Function may be used during troubleshooting.

(Do not make any adjustments to this Function Code, unless directed to do so by ZF Marine Propulsion Systems Miramar, LLC Service or Engineering Departments).

5.7.3.2 Additional 9000 Series Troubleshooting Function

5.7.3.2.1 Function Code H2 - Driver Fault Detection Enable

The **H2** Function is available only on Processors with integrated Clutch and/or Troll Solenoids (i.e. 9120, 9121, 9122, and 9221).

The Processor can be programmed to monitor the current flow through the clutch and/or Troll solenoids. When this option is selected, if the current level is too high or too low, an alarm is sounded and an Error Code is produced.

Table 5-3: Solenoid Error Status Enable lists the required value that needs to be entered to monitor the Ahead, Astern, Neutral, Troll Command, and Troll ON/OFF solenoids.

NOTE: Function Codes 32 through 63 are reserved for future expansion and should not be used at this time.

Table 5-3: Solenoid Error Status Enable

Ahead	Astern	Neutral	Troll Command	Troll On/Off	Value
0	0	0	0	0	00
1	0	0	0	0	01
0	1	0	0	0	02
1	1	0	0	0	03
0	0	1	0	0	04
1	0	1	0	0	05
0	1	1	0	0	06
1	1	1	0	0	07
0	0	0	1	0	08
1	0	0	1	0	09
0	1	0	1	0	10
1	1	0	1	0	11
0	0	1	1	0	12
1	0	1	1	0	13

Table 5-3: Solenoid Error Status Enable

Ahead	Astern	Neutral	Troll Command	Troll On/Off	Value
0	1	1	1	0	14
1	1	1	1	0	15
0	0	0	0	1	16
1	0	0	0	1	17
0	1	0	0	1	18
1	1	0	0	1	19
0	0	1	0	1	20
1	0	1	0	1	21
0	1	1	0	1	22
1	1	1	0	1	23
0	0	0	1	1	24
1	0	0	1	1	25
0	1	0	1	1	26
1	1	0	1	1	27
0	0	1	1	1	28
1	0	1	1	1	29
0	1	1	1	1	30
1	1	1	1	1	31

6 Dock Trials

WARNING: It is imperative that the information provided in the previous Sections has been read and followed precisely, prior to attempting a Dock Trial.

CAUTION: With I/O or Outboard applications, do not attempt to shift into or out of gear with engines stopped. This may cause a jam condition or damage to the linkage to some clutch configurations.

NOTE: On twin screw applications, the following tests must be performed on both sides. If any of the following tests fail, consult section Section 10: Troubleshooting.

6.1 Control Heads (Engines Stopped)

A Turn power ON to the Control System.

B The Control Head at each Remote Station should produce an intermittent tone.

C Perform each of the following steps on all Remote Stations.

1. Move the Control Head's lever(s) full Ahead and full Astern. Ensure that there are no obstructions to the movement, the Processor reacts to the lever movement, and that no tones are generated.
2. Place the Control Head's lever(s) in the Neutral position.
3. Depress and hold the Station transfer button while moving the Control Head's lever(s) to the Ahead detent. Release the transfer button.
    - The red LED on the Control Head should blink, indicating Warm-up Mode has been entered. Warm-up Mode only operates in the Ahead direction.

6.2 Start Interlock (Engines Stopped)

A Turn the Processor DC power OFF.

- Verify that the engine(s) will not start.

B Turn Processor DC power ON. Do not take command at a Remote Station.

- Verify that the engine(s) will not start.

C Take command at a Remote Station. Place the Control Head's lever(s) to approximately 50% of the throttle range.

- Verify that the engine(s) will not start.

D Place the Control Head's lever(s) in the Neutral/Idle position. Take command at a Remote Station.

- Verify that the engine(s) will start in this position.

6.3 Engine Stop Switches

- Start the engine(s) and verify that the Stop switches (normally push buttons) function correctly at all Remote Stations.

6.4 Push-Pull Cables

A Check that all Push-Pull cable connecting fasteners are tightened securely.

B In the Processor(s) check that the Push-Pull cable jam nuts are securely tightened. A loose hex nut can back off the Push-Pull cable threaded end and effectively change the cable length.

6.5 High Idle

A Place the Station in command into Warm-up Mode.

B Adjust Function Code E6 to the desired engine RPM, as described in Section Section 5.6.2.1.2: Function Code E6 – High Idle.

C Return the Control Head's lever to the Neutral/Idle position.

6.6 Control Head Servo Command

A Start the engine(s) and let them run at Neutral/Idle.

B Place one Control Head lever at a time into the Ahead detent, the Astern detent and then Neutral. Confirm that the push-pull cable movement is in the direction commanded.

- If incorrect, perform the steps described in Section Section 5.7.1: Clutch Functions for transmission push-pull.

C Place the Control System into Warm-Up Mode and confirm that there is control of speed.

D Run the throttle up to approximately 20% of the throttle range for at least 10 seconds.

E Return the lever to the Neutral/Idle position.

F Repeat steps A) thru E) at the remaining Control Head levers.

6.7 Control Head Solenoid Command

A Start the engine(s) and let them run at Neutral/Idle.

B Place one Control Head lever at a time into the Ahead detent, the Astern detent and then Neutral. Confirm that the movement of the vessel is in the correct direction.

- If incorrect, reverse the electric cable connections at the shift solenoids.

C Place the Control System into Warm-Up Mode and confirm that there is control of speed.

D Run the throttle up to approximately 20% of the throttle range for at least 10 seconds.

E Return the lever to the Neutral/Idle position.

F Repeat steps A) thru E) at the remaining Control Head levers.

6.8 Throttle Pause Following Servo Shift

NOTE: A Test Control Head and a stop-watch are recommended to determine the correct setting for the Throttle Pause. If a Test Control Head is not available, a second person may be needed.

A Move the Station in command's lever to the Ahead detent, while monitoring the Shaft.

B Start the stop-watch as soon as the Clutch Push-Pull cable stops moving.

C When the Shaft begins to rotate, stop the stop-watch.

D Record the time expired on the stop-watch.

E Program Function Code E5 as described in Section Section 5.6.2.1.1: Function Code E5 – Throttle Pause Following Shift.

NOTE: If the time recorded in Section Section 6.8: Throttle Pause Following Servo Shift, step D exceeds 5.0 seconds, a Clutch Pressure Interlock is required. Refer to Section Section 8.2: Clutch Pressure Interlock.

6.9 Throttle Pause Following Solenoid Shift

NOTE: A Test Control Head and a stop-watch are recommended to determine the correct setting for the Throttle Pause. If a Test Control Head is not available, a second person may be needed.

A Move the Station in command's lever to the Ahead detent, start the stop-watch while monitoring the Shaft.

B When the Shaft begins to rotate, stop the stop-watch.

C Record the time expired on the stop-watch.

D Program Function Code **E5** as described in Section Section 5.6.2.1.1: Function Code E5 – Throttle Pause Following Shift.

NOTE: If the time recorded in Section Section 6.9: Throttle Pause Following Solenoid Shift, step D exceeds 5.0 seconds, a Clutch Pressure Interlock is required. Refer to Section Section 8.2: Clutch Pressure Interlock.

6.10 Trolling Valve

6.10.1 Troll Servo Adjustments

WARNING: It is preferable to adjust the Trolling Valve during sea trials. However, in some cases adjustment of Troll Minimum Pressure (L2) can be accomplished while at the dock. Do Not attempt to make any Troll adjustments unless the dock and the mooring lines are capable of securing the vessel with full thrust from at least one screw.

A Verify that the Troll Push-pull cable is positioned at the Full Pressure (Lock-up) position.

B If connected, disconnect the push-pull cable from the Trolling Valve lever.

C Secure the Troll lever using wire or rope so that the position cannot change due to vibration or if accidentally bumped.

6.10.1.1 Troll Minimum Pressure Adjustment at the Dock

NOTE: The Gear oil must reach normal operating temperature before the Trolling Valve can be accurately adjusted. The adjustment of the Minimum Pressure point must be done one screw at a time when tied to a dock.

A Verify that the Troll push-pull cable is positioned at the Full Pressure (lock-up) position.

B With the engine running, place the Station-in-Command's lever into the Ahead Detent.

C Measure the Shaft RPM at Idle with a Shaft Tach and record on Table 6-1: Shaft RPM at Idle

Table 6-1: Shaft RPM at Idle

Port	Starboard

D Return the Control Head lever to the Neutral detent.

- If connected, disconnect the push-pull cable from the Trolling Valve lever.

E Move the Control Head lever to the Ahead detent.

F Manually position the Troll lever to the point where the Shaft rotation is 30 to 50% of that measured in Table 6-1: Shaft RPM at Idle above.

G If not previously selected, enable Troll with Function Code **L0**.

H Depress the Transfer Button until the red LED begins blinking rapidly (approximately 2 seconds).
I Scroll to Function Code **L2** (Troll Minimum Pressure) and activate Set Up Mode.
J Scroll Up or Down until the Push-pull cable aligns with the troll lever.
K Store the Value to Memory.
L Return the Control Head lever to the Neutral Detent.
M Repeat steps A) thru L) on the opposite side if required.

6.10.2 Troll Solenoid Adjustments

WARNING: It is preferable to adjust the Trolling Valve during sea trials. However, in some cases adjustment of Troll Minimum Pressure (L2) can be accomplished while at the dock. Do Not attempt to make any Troll adjustments unless the dock and the mooring lines are capable of securing the vessel with full thrust from at least one screw.

6.10.2.1 Troll Minimum Pressure Adjustment at the Dock

NOTE: The Gear oil must reach normal operating temperature before the Trolling Valve can be accurately adjusted. The adjustment of the Minimum Pressure point must be done one screw at a time when tied to a dock.

A Verify that the appropriate Value is selected with Function Code **L1** (Trolling Valve Function) for the Gear.
B Connect a Service Field Test Unit in-line with the Clutch Harness and Pigtail as shown in theMM13927 Field Service Test Unit Reference Manual.
C With the engine running, place the Station-in-Command's lever into the Ahead Detent.
D Measure the Shaft RPM at Idle with a Shaft Tach and record on Table 6-1: Shaft RPM at Idle.

Table 6-2: Shaft RPM at Idle

Port	Starboard

E Return the Control Head lever to the Neutral detent.
F Move the Control Head lever to the Ahead detent.
G Manually position the Troll lever to the point where the Shaft rotation is 30 to 50% of that measured in Table 6-1: Shaft RPM at Idle above.
H If not previously selected, enable Troll with Function Code **L0**.
I Depress the Transfer Button until the red LED begins blinking rapidly (approximately 2 seconds).
J Scroll to Function Code **L2** (Troll Minimum Pressure) and activate Set Up Mode.
K Scroll Up or Down until the push-pull cable aligns with the troll lever.
L Store the Value to Memory.
M Return the Control Head lever to the Neutral Detent.
N Repeat steps A) thru M) on the opposite side if required.

7 Sea Trials

WARNING: It is imperative that the information provided in the previous Sections has been read and followed precisely, prior to attempting a Sea Trial. If any of the following tests fail, discontinue the Sea Trial immediately and return to the dock. Consult Section Troubleshooting or a ZF Facility prior to resuming the Sea Trial.

NOTE: On twin screw applications, the following tests must be performed on both sides. During the course of the Dock Trial and Sea Trials, fill out the Trial Report. Retain this information for future use.

7.1 Full Speed Setting - Servo Throttle

A Warm-up the engine(s) and transmission(s) and slowly move into open water.
B Gradually move the lever(s) to Full speed.
C If synchronization is installed, disable synchronization as explained in Section Section 2.10.4: Turning Synchronization OFF:.
- If the engine RPM is low, check whether the engine throttle lever is against the full speed stop.
- If the engine RPM is high, decrease by using Function Code E3, as explained in Section Section 5.7.0.1.3: Function Code E3 – Throttle Maximum.

D For twin screw applications, check that matching Idle, Mid-range and Full speed Control Head lever positions cause equal RPM in both engines.
- If RPM's do not match, check push-pull cable travel. If travel does not match when the Control Head levers are side by side, adjust Function Code E3 refer to Section Section 5.7.0.1.3: Function Code E3 – Throttle Maximum.

7.2 Full Speed Setting - Electronic Throttle

A Warm-up the engine(s) and transmission(s) and slowly move into open water.
B Gradually move the lever(s) to Full speed.
C If synchronization is installed, disable synchronization as explained in Section Section 5.7.0.0.2: Function Code E7 – Synchronization.
- If the engine RPM is low, refer to the MM13927 Field Service Test Unit Reference Manual.
- If the engine RPM is high, decrease by using Function Code **E3**, as explained in Section Section 5.7.0.1.3: Function Code E3 – Throttle Maximum.

D For twin screw applications, check that matching Idle, Mid-range and Full speed Control Head lever positions cause equal RPM in both engines.

7.3 Proportional Pause

The proportional pause feature provides engine deceleration when making a direction change. The pause is variable and in proportion to:
- The Control Head's lever position prior to the reversal.
- How long the Control Head's lever has been in that position prior to the reversal.

The pause is In-Gear or at Neutral, depending on the Function Code **C2** Proportional Pause setting. The sequence of events, are as follows for the three different Reversal Pause types:

7.3.1 In-Gear Delay [C200]

- The Throttle position drops to Idle.
- The Transmission remains engaged in Ahead or Astern.
- The Control System pauses at this position until the delay has timed out.
- The Transmission shifts to the opposite gear (Astern or Ahead).
- The Throttle position moves to the Control Head's present lever position.

7.3.2 Neutral Delay [C201]

- The Throttle position drops to Idle.
- The Transmission shifts to Neutral.
- The Control System pauses at this position until the delay has timed out.
- The Transmission shifts to the opposite gear (Astern or Ahead).
- The Throttle position moves to the Control Head's present lever position.

7.3.3 Fixed Neutral Delay [C202]

CAUTION: The Fixed Neutral Delay feature was added in order to accommodate Thruster Control installations. Damage to the drive train may occur when used for reverse reduction gear applications.

- The Throttle drops to Idle.
- The Transmission shifts to Neutral.
- The Control System pauses at this position for the amount of time programmed (duration) with Function **C3** Proportional Pause Time (regardless of prior throttle setting).
- The Transmission shifts to the opposite gear (Port or Starboard)
- The Throttle position moves to the Control Head's present commanded position.

7.3.4 Calculating Proportional Pause Time C3

NOTE: The pause on a through Neutral shift is proportional to the speed commanded and the time at that speed. The Values listed for Function Code C3, Proportional Pause Time, are the maximum possible delays. When shifting from Idle Ahead to Idle Astern or vice-versa the delay is zero. The time required to build up to the maximum pause is six times the Value selected. In addition, in order to build up to the maximum delay Value, the System must be commanding Full Throttle. The Pause when shifting from Astern to Ahead is either half or the same as the Ahead to Astern delay depending on the Value selected for Function Code C4 Proportional Pause Ratio.

NOTE: A stop-watch is required to accurately program the Proportional Pause Time.

The amount of pause required is determined as follows:

A Place the Control Head lever(s) to the Full Ahead position.

B Leave the Control Head lever(s) at this position for whichever of the following two is longer:
- Sixty seconds.
- The vessel's speed through the water reaches maximum.

C Quickly move the Control Head lever(s) to Ahead Idle or Neutral, (depending on Function Code **C4** setting) while starting the stop-watch.

D When the engine(s) RPM reaches Idle and the vessel's speed through the water is within two knots of the standard Idle Ahead speed, stop the stop-watch.

E Program Function Code **C3**, Proportional Pause Time, as described in the Set Up Procedures, to the time expired on the stop-watch.

7.3.5 Testing The Proportional Pause

CAUTION: It is critical that the Proportional Pause is tested as outlined below to ensure that it was properly programmed. Failure to do so could cause damage to the transmission.

A Position the boat in open water and slowly increase the Throttle to 25% of the speed range.
B Leave the Control Head lever(s) at this position for at least 60 seconds.
C Quickly move the Control Head lever(s) to Idle Astern.
- The engine(s) RPM should drop to Idle.
- The Clutch should stay engaged or shift to Neutral for 25% of the time selected with Function Code **C3** Proportional Pause Time.
- Once the time has expired, the Clutch should Shift to Astern.
- The engine RPM will drop slightly when the Astern load is placed on the engine, but not to the point where it comes close to stalling.

D Increase the Throttle slightly until the vessel starts moving in the opposite direction.
- If the engine stalled or came very close to stalling, increase the Value of Function Code **C3** by one second. Repeat steps A) through C).
- If the engine does not stall or come close to stalling, proceed with the next step.

E Repeat steps A) through D) with the Throttle at 50%, 75%, and 100% of the speed range.
- If the engine stalls at any time, increase the Value of Function Code **C3** by one second and repeat the steps A) through D) again.

F Once a Full Speed Reversal is successful without coming close to stalling, the Proportional Pause is properly adjusted.

7.4 Synchronization Test (Twin Screw Only)

7.4.1 Equal Throttle Synchronization

A Move both Control Head levers side by side to approximately 25% of the Throttle range.
B If previously disabled, enable the synchronization by depressing the transfer button for two seconds.
- The green LED on the Control Head should illuminate, indicating synchronization.

C Check the engine tachometers to see if they are within 1% of one another.
D Move both Control Head levers side by side to approximately 50% of the Throttle range.
E Check the engine tachometers to see if they are within 1% of one another.
F Move both Control Head levers side by side to approximately 75% of the Throttle range.
G Check the engine tachometers to see if they are within 1% of one another.
H Move both Control Head levers side by side to 100% of the Throttle range.
I Check the engine tachometers to see if they are within 1% of one another.
- While synchronized, if the tachometers have a greater than 1% difference at any engine RPM, Active Synchronization is recommended.

7.4.2 Active Synchronization

A Move both Control Head levers side by side to approximately 25% of the Throttle range.
B If previously disabled, enable the synchronization by depressing the transfer button for two seconds.
- The green LED on the Control Head may blink while driving toward synchronization.
- Once the engine RPM's are within 1% of one another, the green LED will remain solidly lit.

C Check the engine tachometers to see if they are within 1% of one another.
D Move both Control Head levers side by side to approximately 50% of the Throttle range.
E Check the engine tachometers to see if they are within 1% of one another.
F Move both Control Head levers side by side to approximately 75% of the Throttle range.
G Check the engine tachometers to see if they are within 1% of one another.

H Move both Control Head levers side by side to 100% of the Throttle range.

I Check the engine tachometers to see if they are within 1% of one another.

While synchronized, if the tachometers have a greater than 1% percent difference at any engine RPM, or if they appear to be continually “hunting” for the correct RPM, refer to section Troubleshooting.

Trolling Valve Adjustments

7.4.3 Integrated Servo Trolling

7.4.3.1 Enabling Troll

Press and hold the Transfer Button for two seconds with the Control Head lever in the Neutral detent.

- The Control Head’s red LED should begin blinking rapidly, indicating that Troll is enabled.
- If not, refer to Section Section 5.7.2.1.1: Function Code L0 – Troll Enable and Control Head Lever Troll Range.

NOTE: Do not attempt the following adjustments until the Gear Oil temperature has reached a minimum of 140 degrees F (60 degrees C).

7.4.3.2 Troll Minimum Pressure Adjustments (Function Code L2)

A The red LED should still be blinking rapidly. If not, enable troll.

B If connected, disconnect the Troll push-pull cable from the Troll selector lever.

C Move the Control Head lever to the Ahead detent.

D Using a Shaft Tach, measure the RPM of the Shaft and record on Table 7-1: Shaft RPM at Idle.

Table 7-1: Shaft RPM at Idle

Port	Starboard

E Manually move the Troll selector lever while periodically measuring the Shaft RPM. The typical Trolling Valve can be adjusted so that the Shaft is rotating a 30 to 50 percent of the RPM’s measured and recorded on Table 7-1: Shaft RPM at Idle

F Once the desired RPM has been reached, scroll to Function Code **L2**. Adjust the Value as described in Section Section 5.7.2.1.5: Function Code L2 – Servo Troll Minimum Pressure until the Troll push-pull cable aligns with the Troll selector lever.

G Enter the Value into memory.

H Leave the push-pull cable disconnected.

7.4.3.3 Troll Maximum Pressure Adjustments (Function Code L3)

A Leave the Control Head lever in the Ahead detent with Troll enabled.

B Manually position the Troll selector lever while monitoring the Shaft RPM. The typical trolling valve can be adjusted to 70 to 80 percent of the RPM’s measured and recorded on Table 7-1: Shaft RPM at Idle.

C Once the desired RPM has been reached, scroll to Function Code **L3**. Adjust the Value as described in Section Section 5.7.2.1.7: Function Code L3 – Servo Troll Maximum Pressure until the Troll push-pull cable aligns with the Troll selector lever.

D Enter the Value into memory.

E Connect the push-pull cable.

NOTE: On Twin Screw applications, the Troll Minimum and Maximum Pressure adjustments must be done one side at a time initially. Once each Trolling Valve has been adjusted individually, they must be operated as a pair and adjusted further, as necessary.

7.4.4 Integrated Solenoid Trolling

NOTE: It is strongly recommended that the Field Service Test Unit (P/N 1400) is utilized when adjusting the Proportional Solenoid.

The Values selected for Function Code **L1** in Section Section 5.7.2.1.2: Troll Solenoid L1 Function, are approximations for the various types of Gears. The actual amount of current required for satisfactory troll operation may differ from the preset Values.

Table 7-2: Troll Valve Adjustments provides typical current requirements for some of the ZF Gears. As stated previously, the actual current required to provide satisfactory operation may differ slightly from those listed. Table 7-2: Troll Valve Adjustments also lists the typical pressure range in bars during troll operation.

The approach taken for adjusting the Trolling Valve may be based purely on Shaft RPM, where the **L1** preset is used and the Value is increased or decreased based on the Shaft RPM only.

The most effective approach is to use a combination of the **L1** preset, Shaft RPM and the measurement of the current flowing to the proportional solenoid or pressure applied to the clutch plate.

Regardless of which approach is used, always adjust the **L1** preset to the appropriate Value prior to adjusting the Troll Minimum **L2** and Troll Maximum **L3** Function Codes.

Table 7-2: Troll Valve Adjustments

Model Number	Troll Current		Troll Pressure		Comments
	Minimum	Maximum	Minimum	Maximum	
ZF 25- 80	12VDC- 900 mA. 24VDC- 450 mA.	12VDC- 1260 mA. 24VDC- 630 mA.	1 Bar (15 PSI)	8 Bar (116 PSI)	Main shift control valve is proportional. The Minimum & Maximum Troll currents listed are at lock-up. Exceeding the Maximum current may damage the solenoid. Current below the Minimum listed may damage the clutch pack when the engine rpm exceeds 1000.
ZF90- 110TS, 220- 311, 220A, 325, 350, 550 & 665	200 mA.	300 mA.	1 Bar (15 PSI)	4 Bar (58PSI)	One variable current control valve in addition to Ahead & Astern solenoids. Increased current equals increased pressure.
ZF600, 1900	160 mA.	350 mA.	1 Bar (15 PSI)	6 Bar (87 PSI)	Two Solenoids in addition to Ahead & Astern solenoids; one On/ Off, one variable current control valve. Increased current equals decreased pressure. The ZF1900 Gear may also be ordered with Auto-Troll, which is not supported by the 9000 Series Processors.
ZF2000	150 mA.	300 mA.	1 Bar (15 PSI)	4 Bar (58 PSI)	Two Solenoids in addition to Ahead & Astern solenoids; one On/ Off, one variable current control valve. Increased current equals increased pressure.
ZF2500	175 mA.	350 mA.	1 Bar (15 PSI)	6 Bar (87 PSI)	Two Solenoids in addition to Ahead & Astern solenoids; one On/ Off, one variable current control valve. Increased current equals decreased pressure. The ZF2500 Gear may also be ordered with Auto-Troll, which is not supported by the 9000 Series Processors.
ZF4500- 7500	n/a	n/a	n/a	n/a	These series of Gears are available with Auto-Troll only and are not supported by the 9000 Series Processors.

7.4.4.1 Enabling Troll

Press and hold the Transfer Button for two seconds with the Control Head lever in the Neutral detent

- The Control Head's red LED should begin blinking rapidly, indicating that troll is enabled.
- If not, refer to Section Section 5.7.2.1.1: Function Code L0 – Troll Enable and Control Head Lever Troll Range.

NOTE: Do Not attempt the following adjustments until the Gear oil temperature has reached a minimum of 140 degrees F (60 degrees C).

NOTE: The effects of the following adjustments are not immediate. Allow enough time for the Shaft RPM to stabilize between any changes to the L2 and L3 Values.

7.4.4.2 Troll Minimum Pressure Adjustment (Function Code L2)

A Ensure that the Control Head lever is at the Neutral / Idle position.

B If the red LED is blinking rapidly, disable Troll by pressing the Transfer Button until the red LED becomes lit solid.

C Connect a Service Field Test Unit (P/N 14000) and Ammeter to the Troll Command Signal output as described in the MM13927 Field Service Test Unit Reference Manual.

D Move the Control Head lever to the Ahead detent.

E Using a Shaft Tach, measure the RPM of the Shaft and record.

F Depress and hold (approximately 2 seconds) the Transfer Button until the red LED starts blinking rapidly.

G Measure the Shaft RPM and record.

H Adjust the Value of Function Code **L2** until the Shaft RPM is 30 to 50% of that measured in step E.

I Enter the new Value into memory.

J If twin screw application, repeat steps A through H on the opposite side.

NOTE: Adjust the Value of L2 based on the desired vessels water speed or shaft RPM. Do not base the adjustment on the response time (how quickly or slowly the shaft begins to rotate after shifting from Neutral to Ahead or Astern). The response time may be adjusted later with Function Codes L5 and L6.

7.4.4.3 Troll Maximum Pressure Adjustment (Function Code L3)

A Place one Control Head lever in the Ahead detent with Troll enabled.

B If twin screw, ensure that the opposite lever is at the Neutral/ Idle position.

C Scroll to Function Code **L3** and enter Setup Mode as described in Section Section 5.7.2.1.6: Function Code L3 – Solenoid Troll Maximum Pressure.

D Increase or decrease the Value until the Shaft RPM is 70 to 80% of that measured in step E of Section Section 7.4.4.2: Troll Minimum Pressure Adjustment (Function Code L2).

E Enter the new Value into memory.

F If twin screw, repeat steps A through E on the opposite side.

NOTE: On Twin Screw applications, the Troll Minimum and Troll Maximum pressure adjustments should be done one side at a time initially. Once each Trolling Valve has been adjusted individually, they must be operated as a pair and adjusted further, as necessary.

7.4.5 Troll Throttle Limit Adjustment (Function Code L4)

CAUTION: Consult the Trolling Valve's Installation Manual prior to programming any increased throttle above Idle, while slipping the Clutch. Failure to adhere to the Transmission manufactures directives may permanently damage the clutch pack and void the warranty.

- The Value programmed for Function Code **L4** is a percentage of the throttle range. The Throttle Range is the difference between Throttle Maximum (**E3**) and Throttle Minimum (**E2**).
- The maximum percentage of the Throttle Range which the Value can be set to is **20**%.
- The adjustment of this Function Code is a matter of personal preference. There is not set procedure which determines when increased throttle should be used and what percentage of the range it should be set to.

7.4.6 Troll Pulse Duration (Function Code L5) & Troll Pulse Percentage (Function Code L6) Adjustments

Whenever Troll is enabled (red LED blinking rapidly) and the Control Head lever is moved from Neutral/Idle to the Ahead or Astern detent, the current to the Proportional Solenoid is delivered at a value which causes a higher clutch pressure for a set period of time. The period of time where the higher pressure is commanded is adjustable with this Function.

The default Value of **00.6** seconds has been found to be adequate with most applications. However, if the shaft takes unreasonably long to begin rotating, or if an excessive surge is felt when commanding Ahead with Troll selected, the amount of time that the higher pressure is commanded may be adjusted with the Troll Pulse Duration Function.

The Troll Pulse Percentage's Value automatically changes to the same Value selected with Troll Maximum (Function Code **L3**). As with Troll Pulse Duration, experience has showed us that commanding this higher clutch pressure is adequate in most applications. In the event that the shaft takes unreasonably long to begin to rotate, or an excessive surge is produced every time Ahead is commanded with Troll, the Value can be increased or decreased.

When the need to adjust these Values arises, it is recommended that small adjustments to each of these Functions are made instead of one large adjustment to one or the other. After each small adjustment, test the vessel's response prior to making further adjustments.

7.4.7 Integrated ZF-Hurth Solenoid Trolling

NOTE: It is strongly recommended that the Field Service Test Unit (P/N 1400) is utilized when adjusting the ZF-Hurth Solenoid.

7.4.7.1 Enabling ZF-Hurth Troll

A Ensure Function Code **C5** (Shift Solenoid Type) value is set to **01** or **02** (refer to Section Section 5.7.1.3.1: Function Code C5 – Shift Solenoid Type)**.**

B Place the Control System into Troll Mode by pressing and holding the transfer button for approximately 2 seconds, until the red LED begins blinking rapidly.

C Move the Control Head lever into the Ahead Detent.

7.4.7.2 Troll Maximum Current Adjustment

Ensure that the current to the Ahead and Astern Solenoids do not exceed the current rating of the Solenoid.

A This is accomplished by connecting an amp meter in series with the Ahead and then the Astern solenoid signal.

B Place the Control Head lever into the Ahead and the Astern detent without Troll selected (Control Head red LED lit solid).

C Adjust Function Code **C6** for Ahead and **C7** for Astern as described in Sections Section 5.7.1.2.2: Function Code C6 – Clutch Ahead Travel and Section 5.7.1.2.3: Function Code C7 – Clutch Astern Travel.

7.5 Sea Trial Report

The purpose of this Sea Trial Report is to provide a convenient checklist and record of installation, dock trial set up, and sea trial performance of the ZF Marine Propulsion Systems Miramar, LLC Propulsion Control System. Please enter ALL of the information. We recommend that this form remains aboard the vessel, and a copy is sent to ZF Marine Propulsion Systems Miramar, LLC with the Warranty Registration located at the end of this manual.

9000 Series Sea Trial Report

The purpose of this Sea Trial Report is to provide a convenient checklist and record of installation, dock trial set up, and sea trial performance of the ZF Marine Propulsion Systems Miramar 9000 Series Propulsion Control System. Please enter ALL information. We recommend a copy of this completed form remain aboard the vessel, and require that you fax a copy to ZF Marine Propulsion Systems Miramar at 425-493-1569.

Table F-226-1: Vessel Information

Your Name:		Date:	
Contact Name:		Telephone:	
Vessel Owner:		Vessel name:	
Builder:		Hull #:	
Engine Manufacturer		Model:	
HP:		RPM:	
Transmission Manufacturer		Model:	
Ratio:		No. of Screws:	
No. of Stations (max 5):		Sta. 1 Location	
Sta. 2 Location		Sta. 3 Location	
Sta. 4 Location		Sta. 5 Location	

Table F-226-2: Processor Information

Processor Information	Port		Stbd	
Processor Serial Numbers				
Is the Processor subject to excessive heat? (Above 70 degrees C)	Yes ☐	No ☐	Yes ☐	No ☐
At least 4 feet (1,2m) from strong magnetic fields?	Yes ☐	No ☐	Yes ☐	No ☐
Accessible for checkout, adjustments, and maintenance?	Yes ☐	No ☐	Yes ☐	No ☐
Are the Processors bonded (grounded)?	Yes ☐	No ☐	Yes ☐	No ☐
Are all Electric Cables supported every 18 inches (45,72cm)?	Yes ☐	No ☐	Yes ☐	No ☐
Does the Shift push-pull cable travel in the correct direction?	Yes ☐	No ☐	Yes ☐	No ☐
Is the amount of push-pull cable travel set properly for Shift?	Yes ☐	No ☐	Yes ☐	No ☐
Does the Throttle push-pull cable travel in the correct direction?	Yes ☐	No ☐	Yes ☐	No ☐
Is the amount of push-pull cable travel set properly for Throttle?	Yes ☐	No ☐	Yes ☐	No ☐
Are all of the push-pull cable’s fasteners tightened?	Yes ☐	No ☐	Yes ☐	No ☐
Are the electrical cable connections tight at the Processors and Control Heads?	Yes ☐	No ☐	Yes ☐	No ☐
Is the Processor’s Start Interlock Circuit being used? If not, what type of start interlock is being used?	Yes ☐	No ☐	Yes ☐	No ☐
Is there an Engine Stop Switch installed at each Remote Station?	Yes ☐	No ☐	Yes ☐	No ☐

Table F-226-2: Processor Information

Processor Information	Port		Stbd	
What is the length of the Control Head Harness?	Sta. 1	Sta. 2	Sta. 1	Sta. 2
	Sta. 3	Sta. 4	Sta. 3	Sta. 4
	Sta. 5		Sta. 5	

Table F-226-3: Power Supply

Processor Information	Port		Stbd	
What is the source of Processor power and how is it charged?				
Is there a backup power supply? APS or other, explain.	Yes ☐	No ☐	Yes ☐	No ☐
Are the power cables protected by 10 Ampere Circuit Breakers?	Yes ☐	No ☐	Yes ☐	No ☐
What is the Voltage when not being charged?	Battery	Processor	Battery	Processor
What is the Voltage when connected to Shore Power?	Battery	Processor	Battery	Processor
What is the Voltage when the engines are running?	Battery	Processor	Battery	Processor

Table F-226-4: Dock Trials

Processor Information	Port		Stbd	
Does the engine start remotely when the Control System is turned OFF?	Yes ☐	No ☐	Yes ☐	No ☐
Does the Engine Stop Switch function at all Stations, regardless of RPM?	Yes ☐	No ☐	Yes ☐	No ☐
Can all Remote Stations take command?	Yes ☐	No ☐	Yes ☐	No ☐
Does the Warm-up Indicator Light blink in Ahead?	Yes ☐	No ☐	Yes ☐	No ☐
What is the Low Idle RPM?		RPM		RPM
High Idle RPM (optional)		RPM		RPM
Does the vessel surge forward with Control Head lever in the Ahead Detent?	Yes ☐	No ☐	Yes ☐	No ☐

Table F-226-5: Record at Dock

Processor Information		Port	Stbd
Throttle in Neutral (Cummins Quantum only)	VDC, mA., Hz. or %		
Throttle Minimum	VDC, mA., Hz. or %		
Throttle Maximum	VDC, mA., Hz. or %		
Troll Minimum (signal)	mA		
Troll Maximum (signal)	mA		

Table F-226-6: Sea Trials

Processor Information	Port		Stbd	
Do the Dual Control Head levers match position and RPM throughout the speed range?	Yes ☐	No ☐	Yes ☐	No ☐
Is Synchronization operational?	Yes ☐	No ☐	Yes ☐	No ☐

Table F-226-7: Record during Sea Trial

Processor Information	Port	Stbd
Engine Idle RPM		
Shaft Idle RPM (Calculate the Shaft Idle RPM as follows: Engine Idle RPM/Gear Ratio)		
Full Throttle RPM		
Troll Minimum (Shaft RPM) RPM (Actual) (The desired Troll Minimum can be calculated as follows: Shaft Idle RPM x 0.3)		
Troll Maximum (Shaft RPM) RPM (Actual) (The desired Troll Maximum can be calculated as follows: Shaft Idle RPM x 0.7)		

Table F-226-8: Processor Parameters Record

Function Code	Function Name	Port	Stbd
PROCESSOR FUNCTIONS			
A0	Processor Identification		
A1	Number of Engines		
A2	One Lever Operation		
A3	SE (Station Expander)		
A4	Neutral Indication Tone		
A5	Engine Room Only / Station 2 Lockout		
A6	DP Mode		
A7	DP Transfer Lockout		

THROTTLE FUNCTIONS		Port	Stbd
E0	Engine Throttle Profile OR Throttle Servo Direction		
E1	Throttle in Neutral		
E2	Throttle Minimum		
E3	Throttle Maximum		
E4	Throttle Maximum Astern		
E5	Throttle Pause Following Shift		
E6	High Idle		
E7	Synchronization		

DP FUNCTIONS		Port	Stbd
D0	Engine Idle Speed		
D1	Engine Full Speed		
D2	Engine Speed in DP Troll		
D3	Gear Ratio		
D4	AutoTroll Slip at Min Prop Shift Speed		
D5	AutoTroll Slip at Max Prop Shift Speed		
D6	Troll Lockup Transition Delay		

CLUTCH FUNCTIONS		Port	Stbd
C0	Clutch Pressure Interlock		
C1	Clutch Interlock Delay		
C2	Proportional Pause		
C3	Proportional Pause Time		
C4	Proportional Pause Ratio		
C5	Shift Solenoid Type OR Clutch Servo Direction		
C6	ZF-Hurth Duty Cycle Ahead OR Clutch Ahead		
C7	ZF-Hurth Duty Cycle Astern OR Clutch Astern		
C8	Fixed Neutral Delay		

TROLL FUNCTIONS		Port	Stbd
(Only Available and Displayed When P/N 9001 Troll Actuator Is Connected To The Processor OR when L0 is programmed to a value other then 0 with integrated troll)			
L0	Troll Enable and Control Head Troll Lever Range		
L1	Troll Valve Function OR Troll Servo Direction		
L2	Troll Minimum Pressure		
L3	Troll Maximum Pressure		
L4	Troll Throttle Limit		
L5	Troll Pulse Duration		
L6	Troll Pulse Percentage		

Speed Boost Functions		Port	Stbd
F0	Boost Percent		
F1	Boost Duration		
F2	Boost Start Delay		
F3	Boost Bypass Clutch Delay		

ABS Functions		Port	Stbd
P0	ABS Transfer Modes		
P1	Transfer Time Out		
P2	Station 4 Transfer Mode		

Comments (Please use additional paper as necessary):
General Installation Condition:
Any Irregularities:

Is the Installation and Troubleshooting Manual on board?	Yes ☐	No ☐	If No, request copy?	Yes ☐	No ☐
Is the Operator Card on board?				Yes ☐	No ☐
Is a copy of this completed Report aboard?				Yes ☐	No ☐
Is a copy of this completed Report?				Yes ☐	No ☐

Inspector: ______________________ Date: ____________

Company: ______________________ Contact info: ____________

8 Control Options

8.1 External Alarm Capability

CAUTION: The Processor's Alarm circuit is limited to a maximum current of 0.5 Amperes and a maximum voltage of 100 Volts DC. Exceeding these limits will permanently damage the Alarm circuit.

The Processor comes equipped with a normally open relay contact for connection to an external Status Indication circuit. The relay energizes, closing the contact when the Circuit Board has power applied and the software program is running normally. In the event of a power loss or the software program detects an anomaly, the relay de-energizes and the contact opens.

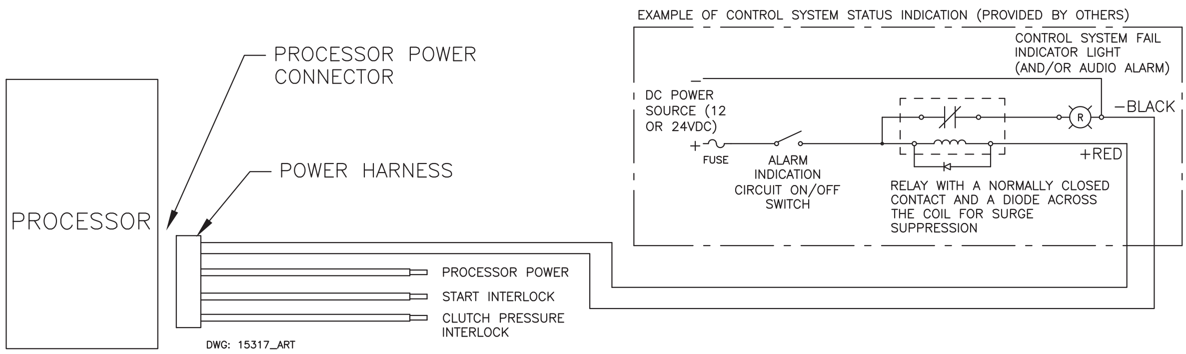


Figure 8-1: External Alarm Connections Processor Hard-Wired Example

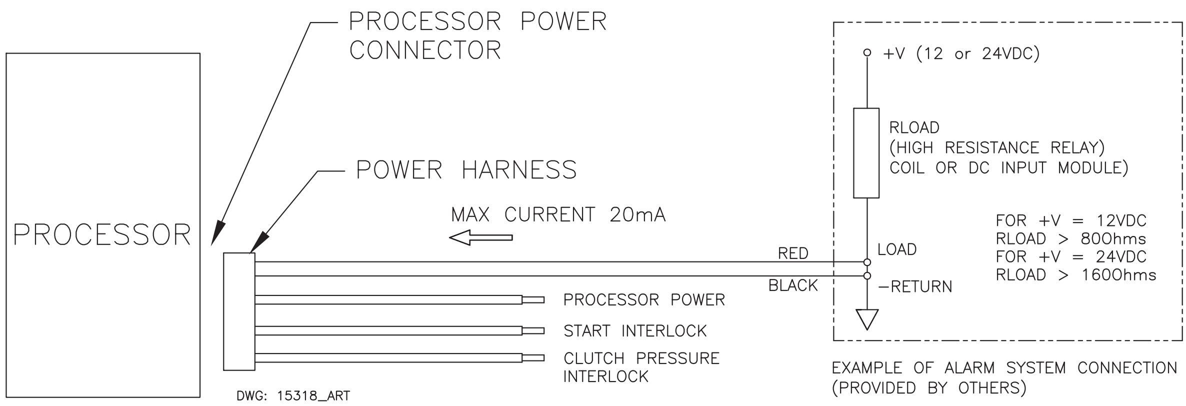


Figure 8-2: External Alarm Connections Processor Hard-Wired Example

8.1.1 Installation

(Refer to Figure 8-1: External Alarm Connections Processor Hard-Wired Example or Figure 8-2: External Alarm Connections Processor Hard-Wired Example)

The following items should be considered when designing and installing the Status Indication Panel:

- The Power Wire Harness (p/n 13631-#) must be used if an External Alarm is required.
- The Processor's Alarm Circuit uses a "dry" contact. Therefore, the polarity of the conductors is not a concern.
- The External Status Indication Circuit must <u>not</u> use the same power source as the Processor.

- Since the External Status Indication Circuit is activated on a loss of power to the Processor, an On/Off Switch is strongly recommended.
- Figure 8-1: External Alarm Connections Processor Hard-Wired Example and Figure 8-2: External Alarm Connections Processor Hard-Wired Example are an example of a suitable circuit, but not necessarily the only circuit acceptable.

A Plug the Power Wire Harness into the Processor's Power pigtail.

B Run the two-conductor Alarm cable to the location of the Status Indication Circuit.

C Connect the black and red conductors to the Status Indication Circuit as shown in Figure 8-1: External Alarm Connections Processor Hard-Wired Example or Figure 8-2: External Alarm Connections Processor Hard-Wired Example.

8.2 Clutch Pressure Interlock

NOTE: The Clutch Pressure Interlock C0 must be set to be used. Refer to section 5.7.1.1.1: Function Code C0 – Clutch Pressure Interlock.

The Clutch Pressure Interlock uses a Pressure Switch which monitors the Ahead and Astern Clutch pressures. The Pressure Switch must have a Normally Open (N.O.) contact that closes when adequate Clutch pressure is reached. The primary function of the Interlock is to prevent high engine RPM when the Clutch is not fully engaged. The Interlock option must be selected with Function Code **C0**. There are two selectable methods of operation as described below:

8.2.1 C0 Methods of Operation

8.2.1.1 01 - Installed

When selected, the Interlock will command the Throttle to Idle, if low or a loss of pressure occurs while cruising. The Interlock is activated when the Pressure Switch's contact opens for the minimum period of time selected with Function Code **C1**.

If adequate Clutch pressure is not reached in the time programmed in Function Code **E5**, throttle will be allowed to increase above Idle. The Throttle will remain at this commanded speed for the time programmed in Function Code **C1** and then returned to Idle, unless adequate pressure is reached during this time.

The Throttle will remain at Idle until the Control Head's lever is returned to Idle, the Pressure Switch contact closes and a speed command above Idle is commanded.

8.2.1.2 02 - Throttle Clutch Pressure Interlock

This option is typically selected when the Clutch takes longer than five seconds to reach full pressure. The Throttle will remain at Idle until there is a closure of the Pressure Switch's contact. This prevents speeds above Idle prior to full Clutch engagement.

In the event of a loss of Clutch pressure while cruising, the Throttle will be returned to Idle after the time selected with Function Code **C1** has expired. Once a closure of the Switch is sensed, indicating adequate pressure, the Throttle immediately returns to the commanded signal, without having to return the Control Head lever to Idle first, as is the case with Value **01**.

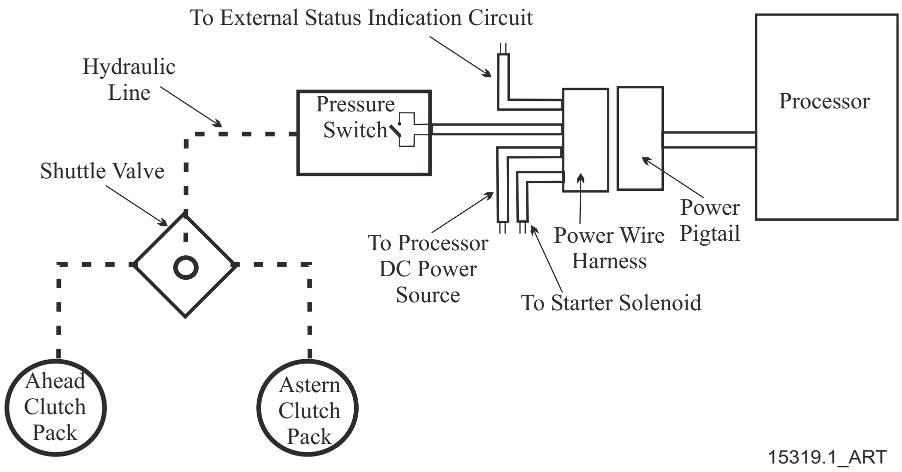


Figure 8-3: Clutch Pressure Switch with Processor Harness Diagram

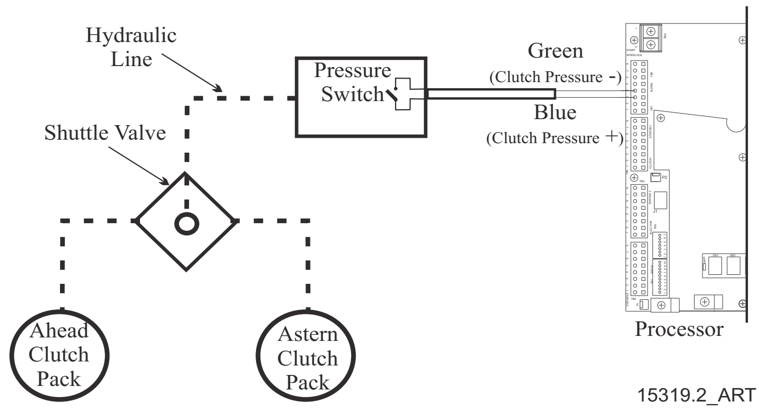


Figure 8-4: Clutch Pressure Switch with Processor Hard-Wired Diagram

The installation of the Clutch Pressure Switch is the same for both methods of operation. (Refer to Figure 8-3: Clutch Pressure Switch with Processor Harness Diagram or Figure 8-4: Clutch Pressure Switch with Processor Hard-Wired Diagram)

A Install a Shuttle Valve on or near the Transmission.

B Connect hydraulic line from the Ahead and Astern Clutches.

C Connect a hydraulic line that is no longer than 5 feet (1,524m)and at approximately the same height between the Shuttle Valve and the Pressure Switch.

D Connect the Power Wire Harness's Clutch Pressure Interlock cable to the Pressure Switch's normally open contact.

E Calibrate the Pressure Switch to close when adequate Clutch Pressure is reached. (Refer to the Transmission manufactures Installation Manual)

8.3 Station Expander (SE)

The Processor allows up to five Remote Stations. The SE allows up to an additional four Remote Stations for a total of nine Stations. The SE and Processor communicate via the Serial Communication cable. Control Heads connected to the SE offer all of the functionality of a standard Remote Station.

For detailed information on the operation, installation and adjustment of the SE, refer to MMC-343 Station Expander User Instructions.

8.4 9001 Actuator Trolling Valve Control

Most Marine Transmissions offer an optional Trolling Valve. A Trolling Valve controls the amount of pressure applied to the Clutch Plate. By doing so, the speed of the propeller can be reduced without decreasing engine RPM.

The Processor allows the operator to control, with a single lever, the Trolling Valve, Clutch and Throttle. In order to do so, a separate Trolling Actuator [p/n 9001] must be installed.

The Trolling Actuator and the main Processor(s) communicate with one another via the Serial Communication cable. The Trolling Actuator contains two Servos, which allows the control of two Trolling Valves with a single Actuator. This option is available only for Processors that do not have Integrated Servo or Solenoid Trolling.

For detailed information on the operation, installation and adjustment of the Trolling Actuator, refer to the Trolling Actuator Installation Manual supplied with the Actuator.

9 Periodic Checks and Maintenance

The items listed below should be checked on an annual basis or less, when noted:

9.1 Control Heads

- Check the terminal strip for signs of corrosion or a loose connection.
- If used, disconnect the Deutsch connector and check the pins and sockets for signs of moisture and corrosion.

9.2 Processor

- Check all terminal connections for signs of corrosion or loose connections.
- Un-plug and inspect all Deutsch connectors for signs of moisture or corrosion.
- While in the vicinity of the Processor, move the Station-in-Command's lever. If the Servo's are excessively noisy, apply a light coating of silicone grease to the stainless steel lead screws. If there are no Stations in close proximity to the Processor(s), use a Field Service Control Head or have someone assist.

9.2.1 Throttle Servo Processor

- Check mechanical connections within the Processor and at the Throttle selector lever.
- Check the mechanical movement of the Throttle lever from Idle to Full. Ensure that the cable does not bind while positioning the Throttle at Idle or Full speed.

9.2.2 Clutch Servo Processor

- Check mechanical connections within the Processor and at the Transmission selector lever.
- Check the mechanical movement of the Clutch selector lever from Neutral to Ahead, and Neutral to Astern. Ensure that the cable does not bind while positioning the Control Head lever at Ahead or Astern. Ensure that the Clutch selector lever and the Push-Pull cable form a 90 degree angle at Neutral.

9.2.3 Troll Integrated Servo Processor

- Check mechanical connections within the Processor and at the Troll selector levers.
- Check the mechanical movement of the Troll selector lever from Lock-up to Minimum pressure and back to Lock-up. Ensure that the cable moves smoothly and does not bind while positioning the Control Head lever.

9.3 Power Supply

9.3.1 Battery

WARNING: Batteries contain sulfuric acid and emit hydrogen gas while charging. Therefore, specific safety precautions must be adhered to while handling and servicing. Specific information on handling and servicing batteries can be obtained from the Battery Council International, Battery Service Manual.

CAUTION: In many newer batteries, the vent cap is permanently attached, preventing access to the electrolyte for water level and specific gravity tests. Attempting to pry off these caps could result in premature battery failure.

The following tests should be performed in the intervals specified:

9.3.1.1 Quarterly (Every 3 Months)

- Check the level of the water (electrolyte) within the Lead-Acid batteries. The plates must be covered. If not, add a small amount of distilled water.

- Check the voltage of the battery. The battery must have a chance to "rest" (no charging and no load for a couple of hours) prior to testing. The following table represents a fully charged battery:

Table 9-1: Fully Charged Battery

Lead Acid Batteries	Gel Cell or AGM Batteries
12V – 12.6 to 12.8V	12V – 12.4 to 12.6V
24V – 25.2 to 25.6V	24V – 25.0 to 25.4V

- Check the battery terminals for signs of corrosion, acid build-up or loose connections.

9.3.1.2 Semi-Annually (Every 6 Months)

- Check the specific gravity of your Lead-Acid battery(s) with a Hydrometer. The reading for a fully charged lead acid battery is 1.260 to 1.280.

9.3.1.3 Annually (Every 12 Months)

WARNING: The Battery Load Test should be performed by a qualified Marine Electrician only.

The tests performed on quarterly and semi-annual basis, give a relatively good indication of the batteries' health. However, the only way to accurately determine the actual health of your battery is to perform a Battery Load Test.

- There are two types of Battery Load Tests performed in the field, Performance and Service. In order to determine the actual health of your battery a Performance Load Test is recommended. The Service Load Test determines how well your battery performs in the boat and doesn't take into account the battery's original rating, which could result in misleading results. The Performance Load Test places an accurate load on the battery and compares the results to the battery manufacture's specification. The battery should be replaced if the results are 80% or less than the manufacture specifications.

9.3.2 Power Cables, Distribution Panels, etc.

- Check all of the connections from the battery to the DC Distribution Panel to the APS for loose or corroded connections.
- Measure the voltage at the battery and at the Processor while the Clutch or Throttle Servo is driving. There should be no more than 10% difference between these two points. If so, check all devices and connections for excessive voltage drop.

NOTE: If an APS is used in the circuit to supply power to the Processor, account for the 0.7V drop across the APS. Example: 12.6V @ battery – 1.26V (10% drop) – 0.7V (APS drop) = 10.64V (Minimum allowable voltage)

10 Troubleshooting

10.1 General

The ClearCommand Control System consists of one Processor per engine, typically mounted in the engine room, and one to five Control Heads located at the vessel's Remote Stations.

In the event that a malfunction occurs, review the appropriate Processor System Diagram and the descriptions in Section 10.1.1: Control Systems Examples. Become familiar with the various components, their functions and location on the vessel.

Section 10.1.2: Typical System Main Components, is a list of the main components that make up a typical system, along with a brief description of their functions:

10.1.1 Control Systems Examples

10.1.1.1 9120 (Throttle Servo 2, Shift Solenoid) Processor and 9122 (Throttle Servo 2, Shift Solenoid, Troll Solenoid) Processor

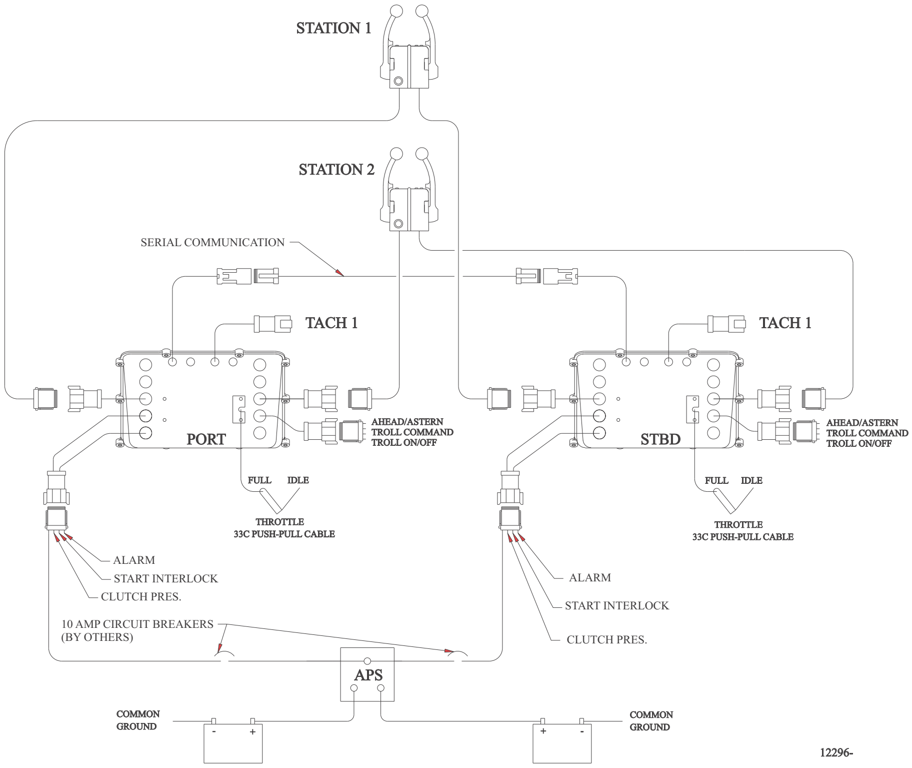


Figure 10-1: 9120 and 9122 Basic Twin Screw, Two Station Diagram

- The **9120** Processor is designed to precisely control speed and direction on vessels equipped with mechanical Throttle and Solenoid Clutch Selectors.
- The **9122** Processor is designed to precisely control speed, direction, and trolling valve on vessels equipped with mechanical Throttle, Solenoid Clutch and Trolling Valve Selectors.

10.1.1.2 9121 (Throttle Servo 2, Shift Solenoid, Troll Servo 1) Processor

The **9121** Processor is designed to precisely control speed, direction, and trolling valve on vessels equipped with mechanical Throttle and Trolling Valve, and Solenoid Clutch Selectors.

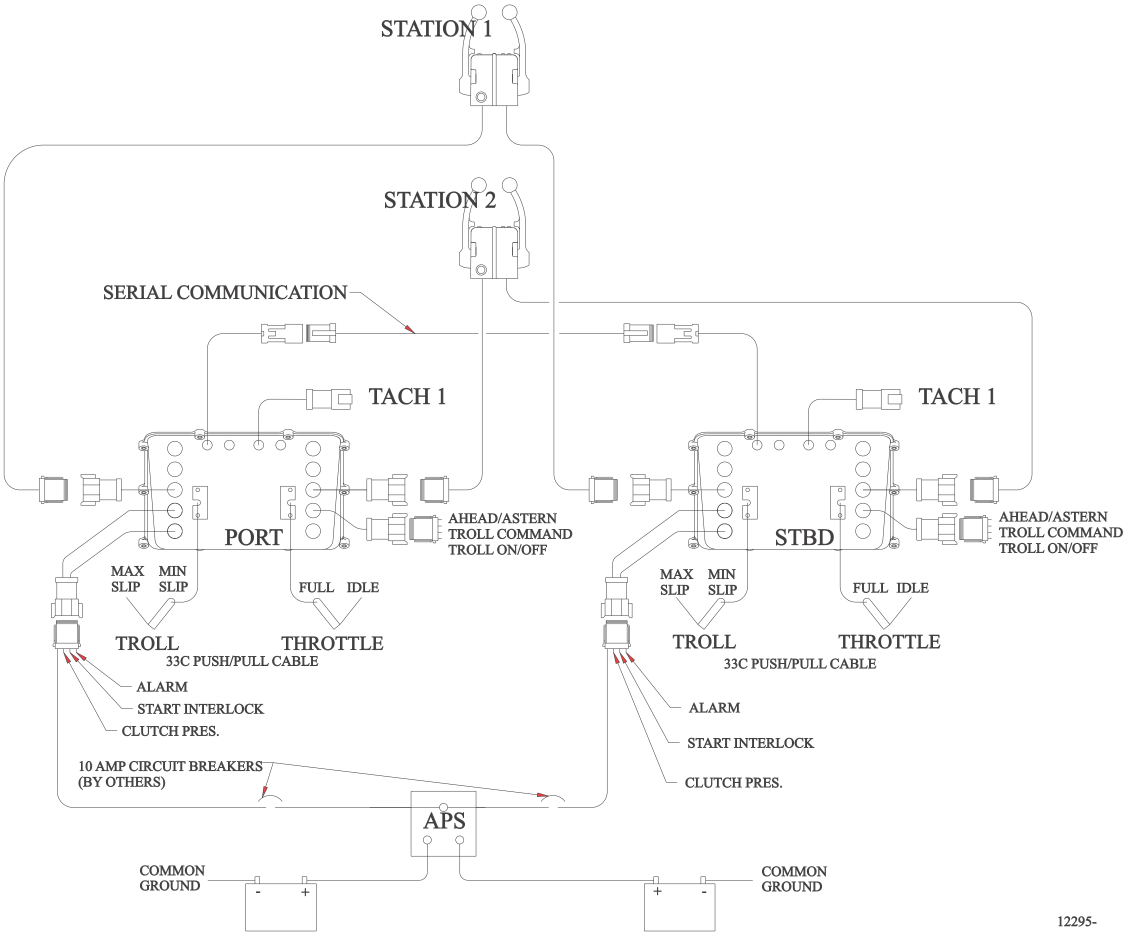


Figure 10-2: 9121 Basic Twin Screw, Two Station Diagram

10.1.1.3 9210 (Throttle Electronic, Shift Servo 1) Processor

The **9210** Processor is designed to precisely control speed and direction on vessels equipped with electronic Throttle, and mechanical Clutch Selectors.

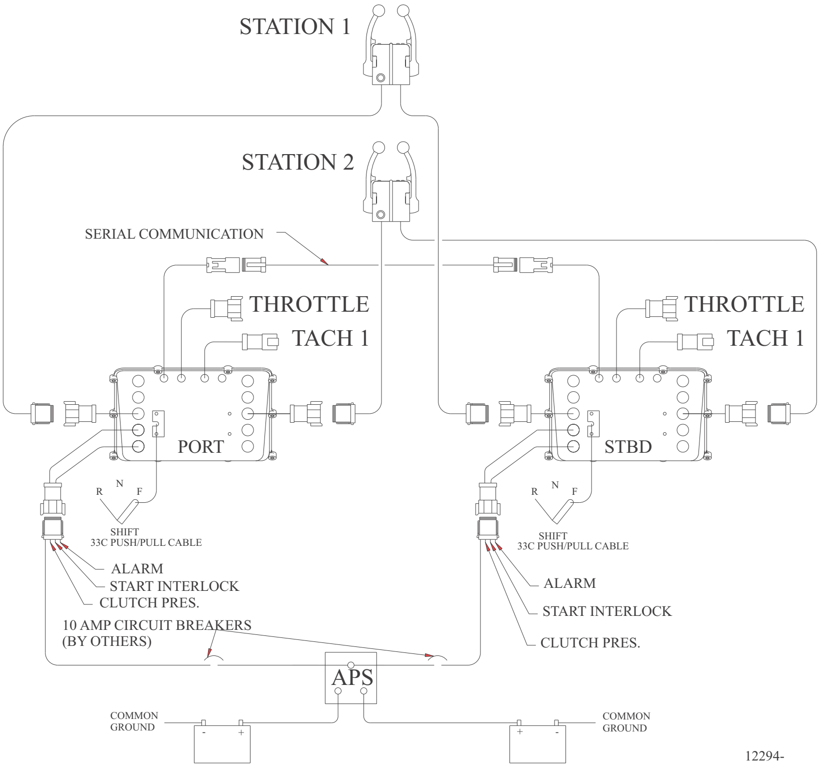


Figure 10-3: 9210 Basic Twin Screw, Two Station Diagram

10.1.1.4 9211 (Throttle Electronic, Shift Servo 1, Troll Servo 2) Processor

The **9211** Processor is designed to precisely control speed, direction, and trolling valve on vessels equipped with electronic Throttle, and mechanical Clutch and Troll Selectors.

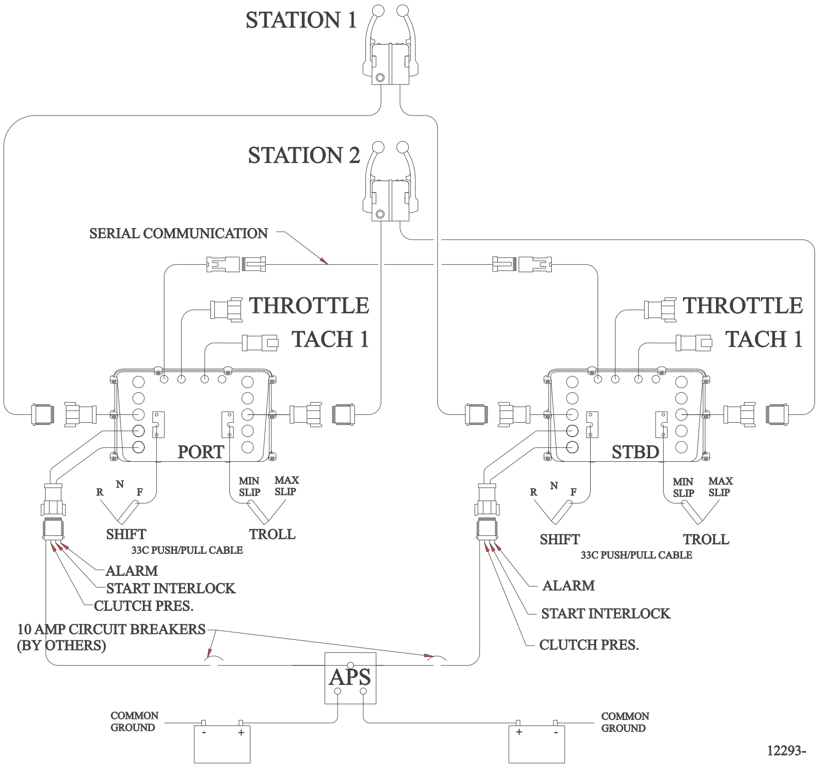


Figure 10-4: 9211 Basic Twin Screw, Two Station Diagram.

10.1.1.5 9221 (Throttle Electronic, Clutch Solenoid, Troll Servo 2) Processor

The **9221** Processor is designed to precisely control speed, direction, and trolling valve on vessels equipped with electronic Throttle, solenoid Clutch selection, and mechanical Troll selector.

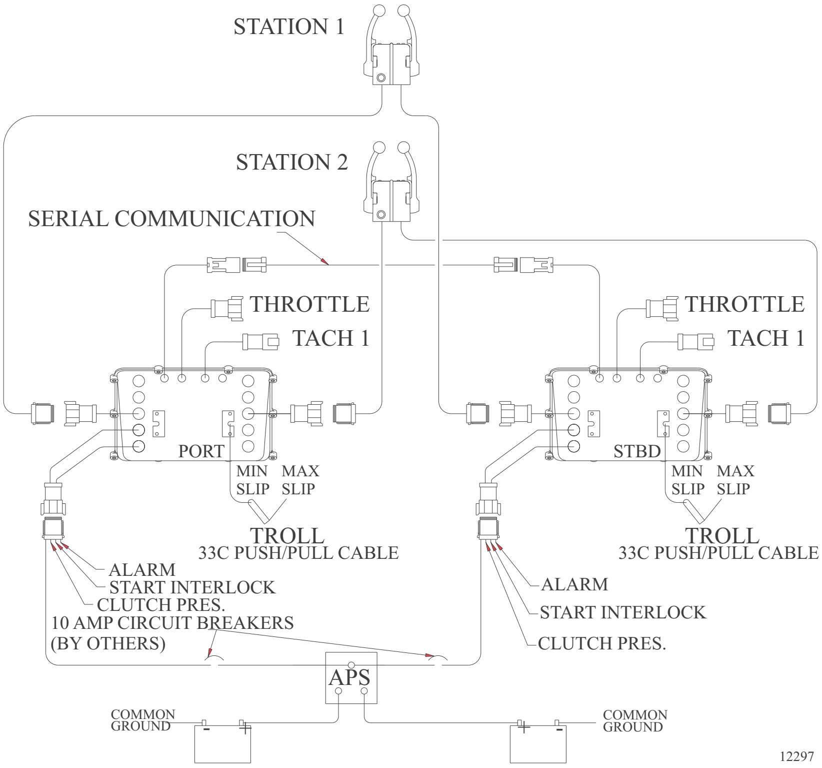


Figure 10-5: 9221 Basic Twin Screw, Two Station Diagram

10.1.2 Typical System Main Components

10.1.2.1 Control Head

The primary function of the Control Head is to send out a variable DC voltage to the Processor. This DC voltage is representative of the Control Head's present lever position. In addition to the primary function, the Control Head also has audible (Sound Transducer) and visual (LED) status indications, along with a Transfer Button for taking command and performing other system functions.

10.1.2.2 Processor

The Processor receives the variable DC voltage from the Control Head(s) and converts these inputs to the appropriate electronic or electric outputs at the correct time and sequence to the Governor and Gear Box. The information regarding throttle type, throttle/ clutch sequencing, etc., are all stored on memory within the Processor.

10.1.2.3 Power Source

All electronic equipment must have power in order to operate. Ensuring a properly charged reliable power source is available is crucial. The Processor requires a 12 or 24 VDC power system. The minimum voltage at which the Processor will continue to operate is 8.00 VDC. The maximum allowable voltage is 30 VDC. Exceeding these limits will not damage the Processor, but will render it unusable temporarily. The power supply must be capable of delivering 10 amperes to each Processor on a continual basis and current surges up to 20 amperes.

All cable calculations should be based on a 10 ampere draw with no more than 10% voltage drop.

10.1.2.4 Electrical Cables and Harnesses

The function of the Electrical Cables and Harnesses are to move electrical information from one point to another. The ZF Marine Propulsion Systems Miramar, LLC' System has electrical cables and/or pluggable Harnesses. These Harnesses may have plugs on one end or both, depending on its purpose.

There are Harnesses available for Control Head Interface, DC Power, Start Interlock, Clutch Oil Pressure Interlock and External System Status Indication Circuit. Not all of the above harnesses may be used. In addition, the application may require Harnesses for one or more of the following: Engine Interface, Shift Interface, Troll Interface, Serial Communication and Tachometer Sensor Signal.

10.1.2.5 Push-Pull Cables

The primary function of a Push-Pull cable is to allow a physical movement on one end to be felt at the opposite end with a minimum of back-lash. The Push-Pull cables are mechanically connected to the Processor's cross-bars on one end and the governor and/or transmission selector levers on the end. The Processor uses the 33C Type push-pull cable as standard, or 43C Type with a special adapter.

Table 10-1: ClearCommand Processor Push-Pull Reference

ZF Marine Propulsion Systems Miramar, LLC	ENGINE	CLUTCH	TROLL
Processor Part No.	**Mechanical**	**Mechanical**	**Mechanical**
9120	Servo 2		
9121	Servo 2		Servo 1
9122	Servo 2		
9210		Servo 1	
9211		Servo 1	Servo 2
9221			Servo 2

Prior to attempting to troubleshoot the System, get as much information as possible from the owner or operator. Inspect the System for signs of mis-adjustments, loose connections, physical damage or water incursion.

Pay special attention to the following items:

- DC Power Source
- Component Location
- Component Condition
- Interconnecting Wiring and Harnesses
- Wire Terminations
- Plug and Socket Pins
- Mechanical connections at the Throttle and Transmission Selector Levers
- Mechanical connections within the Processor

10.2 Troubleshooting Questions

Prior to lifting a tool or stepping on board the vessel, many problems can be resolved by asking the customer the following basic questions:

A Is the System installed on a Single, Twin or Multiple Screw vessel?

- If the System is installed on a Single Screw vessel, this question does not have much value in narrowing down the source of the problem.
- If the System is installed on a Twin or more Screw application, this question is quite useful, if you ask the following question.
  - Does the problem or symptom occur on the Port, Starboard or both sides?
    - If the problem or symptom occurs on one side only, you have effectively eliminated 50% of the possible causes. For example, the symptom only occurs on the Port side. All of the components on the Starboard side have been eliminated as potential causes.

B What is the Part Number and Serial Number of the Processor?

- Whenever the factory is called for technical assistance, the part number and serial number will be required. These numbers provide the Service Technician information about the operating characteristics of the Processor. The numbers are located on the Processor's front cover.

C How many Remote Stations are there?

- If only one Remote Station is present, not much will be gained by asking this question. However, if more than one Remote Station is being used, command should be taken from one of the other Stations to see if the problem occurs from another station.
- If the problem occurs from more than one Remote Station, the odds are that the Control Heads are not the cause of the trouble.
- If the problem occurs at one Remote Station only, there is a greater chance of the Control Head or the Control Head Harness of being the cause.

D Are any tones generated when the problem occurs?

The tones are used to bring the operator's attention to a possible condition or problem.

The following basic tones can be produced on all Systems:

- **Slow Repetitive Tone** (Refer to Section 10.5.1.1: Slow Repetitive Tone)
- **One Long- Three Short Tones** (Refer to Section 10.5.1.2: One Long - Three Short Tones)
- **Steady Tone** (Refer to Section 10.5.1.3: Steady Tone)
- **Three Second Steady Tone** (Refer to Section 10.5.1.4: Three Second Steady Tone)
- **Five Seconds On, Five Seconds Off - High Repetitive Rate Tone** (Refer to Section 10.5.1.6: Five Seconds On, Five Seconds Off - High Repetitive Rate Tone)
- **Five Second Steady Tone** (Refer to Section 10.5.1.7: Five Second Steady Tone).

The following tones can be produced on all Systems utilizing Servo 1:

- **One Long, One Short - High Repetitive Rate Tone** (Refer to Section 10.5.2.2: One Long, One Short - High Repetitive Rate Tones)
- **One Long - One Short Tone** (Refer to Section 10.5.2.1: One Long - One Short Tone)

The following tones can be produced on all Systems utilizing Servo 2:

- **One Long - Two Short Tones** (Refer to Section 10.5.3.1: One Long - Two Short Tones)
- **One Long, Two Short - High Repetitive Rate Tones** (Refer to Section 10.5.3.2: One Long, Two Short - High Repetitive Rate Tones)

The following tone can be produced on all Systems using Solenoid Clutches:

- **One Long - One Short Tone** (Refer to Section 10.5.4.1: One Long - One Short Tone)

E Are there any Error Messages displayed on the Processor's Display LED?

In addition to generating a tone, at any time the system detects a malfunction or fault, an error message will be displayed at the Processor. Refer to Table 10-6: Basic Control System Error Codes for an explanation of the errors.

F What is the status of the Control Head in command's red LED?

- The red LED(s) will be in one of the following states:

- Lit Steady: When the red LED is **Lit Steady**, this indicates that the Station is in command and in Normal operative mode.
- Not Lit: When the red LED is **Not Lit**, that Station is not in command, or there is no power to the Control System.
- Blinking Slowly: A **Slow Blinking** red LED indicates that the Control Head is in Throttle Only Mode (Warm-up Mode).
- Blinking Rapidly: A red LED that is **Blinking Rapidly** indicates that the System is in Troll Mode.

G Has anything on the vessel changed shortly prior to or when the problem arose?

This question is often overlooked, but should be considered. Obvious changes such as additions or changes to the electrical/ electronic equipment onboard can affect the electrical load and in turn the Processor's power supply.

Ask the operator if any changes or maintenance to the vessel's machinery have occurred lately. Items which are significant to you, the technician, may not seem so to the casual owner or operator. An example would be changes to the engine's fuel system.

Ask about changes, that when initially considered, appear to have nothing to do with the Control System. An example where this really occurred was on a vessel which had recently been repainted. For unknown reasons, the painter took it upon himself to disconnect the connections at a Control Head and then reconnected it incorrectly.

In many cases, these simple questions can resolve a problem with no further action from you, the technician. Take the time to consider these questions. In the long run, you will save yourself and the customer a lot of time and money.

10.3 Troubleshooting Problem Resolution

If the problem could not be resolved by asking the questions in the previous section, a careful inspection of the Control System may be the next step. Even in situations where the problem was found and corrected, it is good practice to always perform a careful inspection of the entire Control System each and every time you are asked aboard a boat.

Always verify that the installation of the System is in compliance with the Installation Manual by carefully inspecting the following:

10.3.1 DC Power

A Ensure that the Processor(s) is connected to a properly charged 12 or 24 VDC battery through a 10 Ampere circuit breaker.

B To ensure reliable power to the Processors an APS (Automatic Power Selector) is strongly recommended. The APS take inputs from two separate power sources. Whichever power source is at the higher voltage level, will be automatically switched through.

C Refer to S-214 Automatic Power Selector Model: 13505.

10.3.2 Component Location

10.3.2.1 Control Heads

There are virtually no restrictions regarding the location of the 400 Series and MC2000 Series Control Heads, as long as the bottom is protected from the environment. The 500 Series Control Heads must be mounted to a console and the 700 Series are waterproof from top to bottom.

Refer to Section 11: Appendix A - System Components and Specifications - Control Head Reference Sheet for Installation requirements.

10.3.2.2 Processors

The Processors are typically mounted in the engine room, while maintaining a minimum distance of 4 feet (1,22m) from sources of high heat and EMI (Electro Magnetic Interference) or RFI (Radio Frequency Interference).

Refer to Section 3: Plan the Installation, for Installation requirements.

10.3.3 Component Condition

10.3.3.1 Control Heads

Inspect for any signs of corrosion due to water incursion. If hard-wired, ensure that all the fork connectors are properly secured to the terminal. Verify all wires are fully crimped and do not pull loose.

10.3.3.2 Processors

Inspect the Processor for any signs of physical damage.

10.3.4 Interconnecting Wiring and Harnesses

A Inspect the wire terminations for loose connections, corrosion or wire strands.

B Inspect the Harness's pins and sockets for bent pins, torn boots or any signs of corrosion.

The first step in troubleshooting a problem with the Propulsion System is to determine if the problem is with the Control System or something external to the System. In all cases a Control System malfunction will alert the operator of the potential problem. This is accomplished through the audible tone emitted at all Remote Stations. When an audible tone is emitted, it will be accompanied by an Error Message at the Processor. Also, in many cases, the Control System will alert the operator to a problem external to the Control System.

The following are examples of components both internal and external to the Control System which could be a source of trouble:

Table 10-2: Examples of Components (Internal/External)

Internal	External
1) Processor 2) Control Head 3) Interconnecting Wiring (Harnesses) 4) Push-Pull Cable	1) DC Power Source 2) Engine 3) Transmission 4) Push-Pull Cable

The following pages should give you a good guideline for making this determination. There is no need to troubleshoot the system to any point further than one of the main components listed above. If the fault is found to be with a Control System component, that component is simply replaced. If the fault is found to be with one of the external components, replace or repair the defective component or contact a qualified mechanic.

10.4 Troubleshooting Diagnostic Menu

The Processor has built in diagnostics designed to assist the technician in determining the cause of a problem. The following information is available to view at any time:

- Applied Battery Voltage
- Tachometer Sender Frequency
- Stations 1- 5 A/D's
- Stations 1- 5 Transfer Button Status
- Servo 2 Feedback A/D's
- Servo 1 Feedback A/D's
- Software Revision Level

In order to access this information, follow the steps below:

A Locate the Display LED on the Port or Starboard Processor. The Display LED will have the Processor Part Number displayed in a running pattern moving from left to right while the program is running in Normal Operation.

B Depress the Up or Down Push Button to activate the Function Code List. The characters A001 will be shown on the Display like Figure 10-6: Display Function Code List

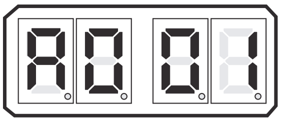


Figure 10-6: Display Function Code List

C Depress the Up or Down Push Button repeatedly until H000 is displayed like Figure 10-7: Display Troubleshooting Function.

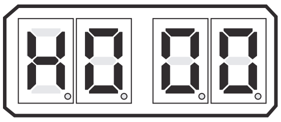


Figure 10-7: Display Troubleshooting Function

D Depress and hold the Left and Right Push Buttons simultaneously until the H0 begins to blink. (Figure 10-8: Display Troubleshooting Function Blinking) Release the Push Buttons; the applied battery voltage will now be displayed:

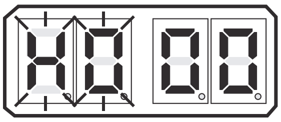


Figure 10-8: Display Troubleshooting Function Blinking

- The displayed value is in “real time” and provides a rough estimate of the DC voltage applied to the Processor. The reading is accurate to within 0.50 DC. Refer to Figure 10-9: Example Display of Applied Battery Voltage

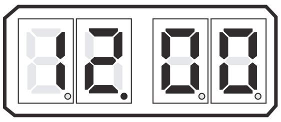


Figure 10-9: Example Display of Applied Battery Voltage

E In addition to the applied battery voltage, scrolling through the Diagnostics Menu by pressing the Up or Down Push Button can also show the Tachometer Sender Frequency (Figure 10-10: Example Display of Tach Sensor Frequency):

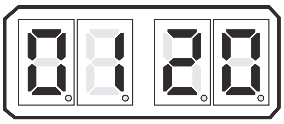
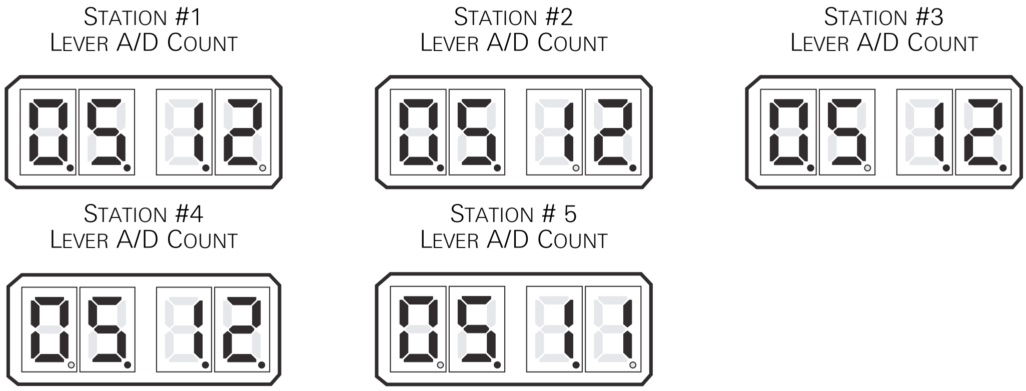


Figure 10-10: Example Display of Tach Sensor Frequency

- The information shown is the actual frequency outputted by the Tachometer Sender. This signal is utilized in “Closed Loop” Synchronization or “Closed Loop” Troll (future) systems
- The Control Head’s lever position, and the resulting outputs of Stations # 1, 2, 3, 4, and 5’s Control Heads can always be monitored. This is regardless of whether that Station is in command or not. Note the placement of the decimal points in the examples below, which

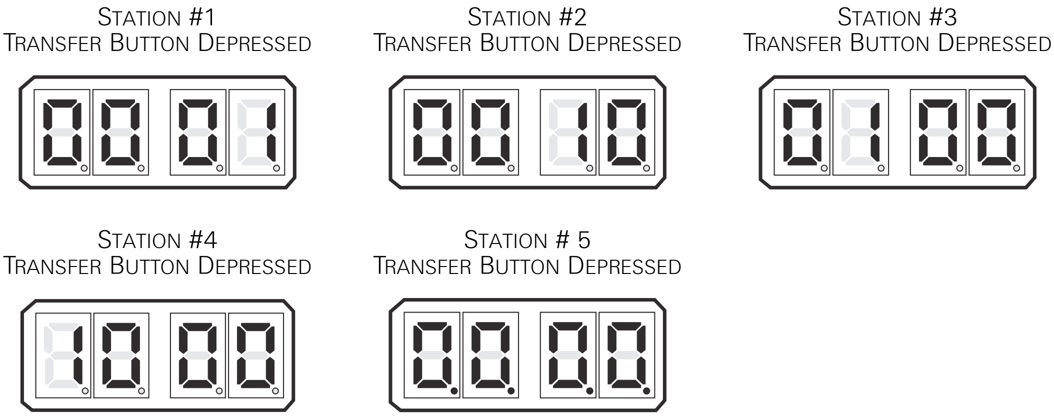
show all five Stations with the lever positioned at the Neutral/Idle position. This will be covered in further detail later.

Figure 10-11: Example Display Control Head Lever Current Positions



F The current status of all the Control Head's Transfer Buttons can be monitored within the Diagnostic Menu. A 1 indicates a closure (depressed Transfer Button) of the switch, while a 0 indicates an open switch. This will also be covered in more detail later.

Figure 10-12: Example Display Control Head Transfer Button Status View



G Depressing the Up or Down Push Button one more time will show the current revision level of the software. This feature will provide invaluable information in the years to come. Determining the characteristics or capabilities of a certain Processor will be as simple as selecting this feature.

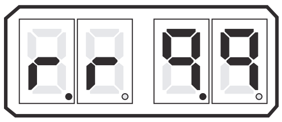


Figure 10-13: Example Display Software Revision Level View

H Pressing the Up or Down (Scroll) Push Button once more, returns you to the Applied Battery Voltage. (Figure 10-9: Example Display of Applied Battery Voltage)

I The Diagnostic Menu can be exited two ways:

- Do not touch any Push Buttons for 5 minutes. The system will automatically exit.
- Depress the Left Push Button until **H000** appears. You may now scroll through the Set Up Menu.

10.5 Troubleshooting Audible Tones

As mentioned previously, there are various tones emitted from the Control Head if an error were to occur.

10.5.1 Basic Control System Tones

These basic tones are as follows:

10.5.1.1 Slow Repetitive Tone

The Slow Repetitive Tone, also referred to as the "Initialization Tone" is the tone you hear at all Remote Stations when power is initially applied to the control system. When this tone is heard, you know for a fact that the following are true:

- Power has just been applied to the system.
- The Software Program is running normally.
- The Processor is commanding the throttle to Idle.
- The Processor is commanding the clutch to Neutral.

This is a normal tone when power has first been applied to the Processor and no Control Head has taken command. However, the tone may also be an indication of a problem, if during normal operation the engine's throttle drops to Idle, followed by the clutch to Neutral, the Control Head's red LED goes out and a slow repetitive tone is heard at all remote stations. This indicates that the voltage at the Processor has momentarily dropped below 8 VDC and then returned to a normal operational level. This could be due to:

- Loose battery power cable connection.
- Under-charged or defective battery.
- Voltage drop due to current flow.

In order to pinpoint the exact cause of the low voltage at the Processor, perform the following checks:

A Check the Display on the Processor for Error Messages. Error Message **57** may appear indicating Under Voltage. One or more of Error Messages **43** through **54** may also be displayed. This is due to the momentary loss of serial communication between the two Processors. Take note that the Under Voltage error is not only dependent on low voltage, it is also dependent on the duration of the low voltage. The possibility exists that an error message would not be displayed if the duration of the low voltage was short enough. However, the other symptoms mentioned above still occur.

B In either case, follow the procedure listed under **Diagnostic Menu** (Section 10.4: Troubleshooting Diagnostic Menu) until the Applied Battery Voltage is displayed. Take note of the applied voltage.

C Go to the battery or Main Distribution Panel which is feeding power to the Processor. With a DC Voltmeter, measure the voltage at this power source. The battery voltage should be greater than 12.4 Volts in 12 VDC systems and 24.8 Volts in 24 VDC systems. If not, the battery or it's charging system needs servicing.

D The voltage differential between the power source and the Processor should not exceed 1.2 Volts in 12 VDC systems and 2.4 Volts in 24 VDC systems. If so, there is high resistance somewhere between the battery and Processor.

NOTE: If an APS is being utilized in the power circuit, take into account the 0.7 VDC forward voltage drop of the diodes. This would increase the permissible differential between power source and Processor from 1.2 to 1.9 VDC in 12 VDC circuits and 2.4 to 3.1 VDC in 24 VDC circuits.

E High resistance, resulting in a differential voltage of 1.2 Volts (12 VDC Systems) or 2.4 Volts (24 VDC Systems) or greater, may be the result of corroded or tarnished connections, dirty or pitted relay contacts or an improperly sized power cable.

F If the voltage differential is less than 1.2 Volts (12 VDC Systems) or 2.4 Volts (24 VDC Systems), which is what you would typically expect, a loose connection may exist between the power source and the Processor. The vibration experienced while the vessel is underway may intermittently cause the circuit to open. Check all the connections between the power source and the Processor for a loose bolts, nuts, etc.

10.5.1.2 One Long - Three Short Tones

This tone indicates that there is an invalid command signal at the Station-in-Command.

The Processor expects a DC voltage, representative of the Control Head's present lever position. This voltage is referred to as the "**Command Signal**". In normally functioning Control Heads, the command signal is between approximately 0.8VDC at Full Astern to 4.10 VDC at Full Ahead.

The command signal is converted by the Processor to a digital representation, referred to as an A/D Count. More on A/D Counts later. If the command signal drops below 0.6VDC or exceeds 4.40 VDC, the tone will be generated.

At the same time the tone is heard, throttle command drops to Idle and the clutch will be commanded to Neutral. The following items will cause this to occur:

- An open or high resistance connection between the Control Head and Processor.
- Out of calibration Control Head.
- A defective Control Head.
- A defective A/D Converter in the Processor.

The exact cause of the malfunction can be found as follows:

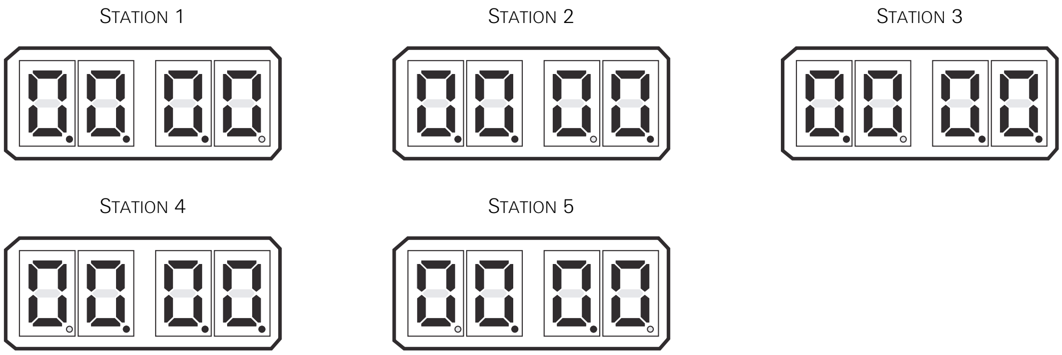
A Check the Processor's Display for error messages. Most likely, one of error messages **13** thru **32** will be shown. The exact number shown depends on which remote station is experiencing the problem and whether the command signal was too high or too low.

B Enter the Diagnostic Menu as outlined in Section 10.4: Troubleshooting Diagnostic Menu.

C Depress the Up or Down (Scroll) Push Button until the appropriate Remote Station is displayed.

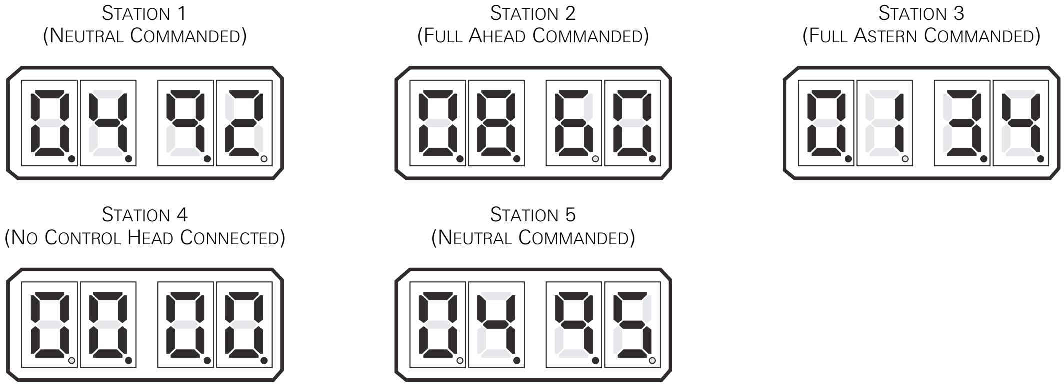
- The Remote Station are identified by the position of the decimal points.
- Station 1 has no decimal point after the first digit to the far right. The remaining three digits all have decimal points.
- If the digit to the far left had no decimal point following it, but the remaining three do, this would represent Station 4.

Figure 10-14: Display Examples of Remote Stations



D The examples in Figure 10-14: Display Examples of Remote Stations are shown with no Control Heads connected to any Remote Stations. When a Control Head is connected, the appropriate A/D (Analog/Digital) value for the present position of the Control Head's lever will be shown, as in the examples below:

Figure 10-15: Display Examples of Remote Stations A/D Value



E An A/D value of 910 or greater will generate an Error Code. The code will be **13** to **22** (Control Head # Faulted High), depending on which Station has the high Command Signal.

- If the A/D value is greater than 910, but less than 990, one of the following may be the cause:
  1. The Control Head's potentiometer is out of calibration.
  2. The potentiometer is defective.

     In either case, it is recommended that the Control Head is replaced.
- If the A/D value is 995 or higher, most likely the potentiometer's ground has been lost.
- Right hand Control Heads have a jumper between pins 3 and 5 if a Harness is used. This jumper provides the potentiometers ground.
- Left hand Control heads have a jumper between pins 3 and 7 is a Harness is used. This jumper provides the potentiometers ground.
- The potentiometer ground connection for Control Heads which are hard-wired to the Processor is through the yellow wire (pin 5 on right hand and pin 7 on left hand).

F If the A/D value is 100 or less, one of Error Codes **23**- **32** (Control Head # Faulted Low) will be shown.

- If the A/D value is less than 100, but greater than 75, the following may be the cause:
  1. The Control Head's potentiometer is out of calibration.
  2. The potentiometer is defective.
  3. A high resistance connection exists on pin 6 (green wire) between the Control Head and Processor.
- If the A/D value is less than 75:
  1. There is an open wire between pin 6 (green wire) of the Control Head and the Processor.
  2. There is an open wire between pin 7 (blue wire) of a right hand Control Head and the Processor.
  3. There is an open wire between pin 5 (blue wire) of a left hand Control Head and pin 7 (blue wire) of the Processor.

10.5.1.3 Steady Tone

The Steady Tone is an indication to the operator that something has gone wrong within the Control System. The Steady Tone will typically be accompanied by an Error Message on the Processor's Display. If the tone is heard, the Processor's Display must be referred to in order to further diagnosis the problem.

The Transfer Button is shorted - Tone will cease when command is taken at another Station.

If the Transfer Button becomes shorted for 12 seconds or more during Normal Operation, a steady tone will be produced at all Remote Stations as long as the Transfer Button remains shorted. Full System control remains. Transferring to another Remote Station silences the Steady Tone. Command cannot be regained at the Station until the problem is rectified.

10.5.1.4 Three Second Steady Tone

This tone could indicate one of three things.

- Transfer Button on the Control Head in command is stuck.
- If the Processor for this System includes the use of Back-up Mode, this tone would indicate that there has been a switch closure requesting Back-up Mode.
- If the Processor for this System includes Integrated Solenoid Trolling Valve control, this tone would indicate that there has been a Troll Solenoid error. Refer to the Error Code displayed.

10.5.1.5 Three Second Steady Tone, followed by a Slow Repetitive Tone

This tone indicates that there has been a shorted Transfer Button on power-up. Command can be gained at any other Remote Station, which silences the Slow Repetitive Tone.

10.5.1.6 Five Seconds On, Five Seconds Off - High Repetitive Rate Tone

Loss of communication with Station Expander (SE) or the Troll Actuator (p/n 9001). This tone cannot be cleared unless all Error Codes (Active and In-Active) have been cleared.

10.5.1.7 Five Second Steady Tone

Loss of Serial Communication.

10.5.2 Servo 1 Control System Tones

10.5.2.1 One Long - One Short Tone

This tone indicates that the feedback signal, which represents the position of the Servo 1 cross-bar, is out of the expected range.

This tone will be accompanied by Error Code **63** or **64**.

- If Error Code **63** is displayed, the signal received from the feedback potentiometer is higher than expected. This is due to one of the three following reasons:
    1. The orange wire (ground) between the potentiometer and plug are not making contact, or have a high resistance contact.
    2. The potentiometer is out of calibration.
    3. The potentiometer is defective.
- If Error Code **64** is displayed, the signal received from the feedback potentiometer is lower than expected. This is due to one of the following reasons:
    1. The green (signal) or orange (reference voltage) wires between the potentiometer and plug are not making contact or have a high resistance contact.
    2. The potentiometer is out of calibration.
    3. The potentiometer is defective.
    4. The Control Circuit is defective.

The Servo 1 feedback signal can be viewed within the Diagnostic Menu. The Value displayed depends on the direction and amount of push-pull cable travel. As a general rule:

- When the Value displayed is **1023** or **0**, the problem is with the wiring between the potentiometer and plug.
- If the displayed Value varies, the potentiometer is defective.
- When the Value is slightly too high or too low when fully extended, the potentiometer requires calibration.

10.5.2.2 One Long, One Short - High Repetitive Rate Tones

This tone is also referred to as a **Jam Tone**. When sounded, Servo 1 is unable to reach the commanded position. In most cases when a **Jam Tone** is encountered, it can be cleared by moving the Control Head lever back to the point prior to where the tone was first encountered.

The tone will be accompanied by Error Code **62** and is typically caused by one of the following reasons:

- Stiff or frozen selector lever.
- Mis-adjusted push-pull cable.
- Defective push-pull cable.
- Low battery voltage.
- Defective Processor.

In order to isolate the cause to one of these five items, follow the steps below:

A Disconnect the push-pull cable from the selector lever.

B Move the Control Head lever to Ahead, Astern, and back to Neutral.
  - If the tone ceases continue with step C.
  - If the tone is still present, skip ahead to step D.

C Grab a hold of the selector lever and manually reposition the lever.
  - If the selector lever is very stiff it needs servicing.
  - If the selector lever moves freely, the push-pull cable's travel is mis-adjusted and needs to be corrected.

D If the tone did not cease in step B, remove the push-pull cable from the Processor.

E Move the Control Head lever back and forth from Neutral to Ahead to Astern.
  - If the tone ceases, the push-pull cable is defective and needs to be replaced.
  - If the tone did not cease, check the DC Voltage to the Processor by accessing the Diagnostic Menu **H0**. If the voltage is adequate, replace the Processor.

10.5.3 Servo 2 Control System Tones

10.5.3.1 One Long - Two Short Tones

This tone indicates that the feedback signal, which represents the position of the Servo 2 cross-bar, is out of expected range.

This tone will be accompanied by Error Code **66** or **67**.

- If Error Code **66** is displayed, the signal received from the feedback potentiometer is higher than expected. This is due to one of the three following reasons:
  1. The orange wire (ground) between the potentiometer and plug are not making contact, or have a high resistance contact.
  2. The potentiometer is out of calibration.
  3. The potentiometer is defective.
- If Error Code **67** is displayed, the signal received from the feedback potentiometer is lower than expected. This is due to one of the following reasons:
  1. The green (signal) or orange (reference voltage) wires between the potentiometer and plug are not making contact or have a high resistance contact.
  2. The potentiometer is out of calibration.
  3. The potentiometer is defective.
  4. The Control Circuit is defective.

The Servo 2 feedback signal can be viewed within the Diagnostic Menu. The Value displayed depends on the direction and amount of push-pull cable travel. As a general rule:

- When the Value displayed is **1023** or **0**, the problem is with the wiring between the potentiometer and plug.
- If the displayed Value varies, the potentiometer is defective.
- When the Value is slightly too high or too low when fully extended, the potentiometer requires calibration.

10.5.3.2 One Long, Two Short - High Repetitive Rate Tones

This tone is also referred to as a **Jam Tone**. When sounded, Servo 2 is unable to reach the commanded position. In most cases when a **Jam Tone** is encountered, it can be cleared by moving the Control Head lever back to the point prior to where the tone was first encountered.

The tone will be accompanied by Error Code **65** and is typically caused by one of the following reasons:

- Stiff or frozen selector lever.
- Mis-adjusted push-pull cable.
- Defective push-pull cable.
- Low battery voltage.
- Defective Processor.

In order to isolate the cause to one of these five items, follow the steps below:

A Turn the power ON to the Processor.
  - If the tone is not present continue with step C)
  - If the tone is present, check the DC voltage to the Processor by accessing the Diagnostic Menu **H0**. If the voltage is adequate continue with step B.

B Disconnect the push-pull cable from the selector lever.
  - If the tone is still present after cycling power, replace the Processor.
  - If the tone is no longer present, continue with step C)

C If disconnected, reconnect the push-pull cable.

D Depress the Transfer Button while moving the Control Head lever to the Ahead detent.

E Release the transfer button and continue to move the Control Head lever through the speed range.
  - If the tone does not sound until the Control Head lever is close to full throttle, Function Code **E3** Throttle Maximum is mis-adjusted.
  - If the tone sounds earlier than full throttle, continue with step F).

F Disconnect the push-pull cable from the selector lever.

G Manually reposition the selector lever (Idle to Full).
  - If the selector lever is very stiff it needs to be serviced.
  - If the selector lever moves freely, the push-pull cable is defective and needs replacing.

10.5.4 Clutch Solenoid Control System Tones

10.5.4.1 One Long - One Short Tone

This tone can be produced if solenoid monitoring is turned ON with Function Code **H2**.

When this tone is sounded this tone will also be accompanied by one of the following error codes:

1 - Clutch Astern Shorted
2 - Clutch Astern Open
5 - Clutch Ahead Shorted
6 - Clutch Ahead Open

10.6 Troubleshooting Station Transfer

In order to transfer command from one Remote Station to another, the following must occur:

- There must be a valid “Command Signal” at the Station being transferred to.
- The “Command Signal” must indicate that the Control Head’s lever(s) is at the Neutral/Idle position.
- The Transfer Button must be depressed which takes the “Station Select” signal from 5.00 VDC to 0.00 VDC.

If a transfer from one Remote Station to another is requested, but does not take place; the items required for successful transfer can be tested as follows:

10.6.1 Command Signal

The Command Signal is a DC voltage which varies in relationship to the Control Head’s lever position.

The Processor provides each Control Head 5.00 +/- 0.20VDC, which is referred to as the “Reference Voltage”.

The Reference Voltage is applied to a 5K Ohm Potentiometer in the Control Head.

The potentiometer’s “Wiper” taps off a portion of the Reference Voltage and sends it back to the Processor.

The amount of DC voltage which is tapped off, is dependant on the position of the Control Head’s lever.

When the lever is fully Astern, a small portion of the Reference Voltage is tapped off by the wiper, and therefore, the voltage is at its lowest point (approximately 0.80 VDC).

When the lever is positioned fully Ahead, a larger portion is tapped off and the voltage is at its highest point (approximately 4.10 VDC).

10.6.2 A to D Counts

Since all the calculations within the control system are performed digitally, these DC voltages are expressed as and converted to a digital representation.

- The “Reference Voltage” (approximately 5.00 VDC) by which all analog inputs are based, is represented as 1023 A/D (Analog to Digital) Counts.
- This allows for the possibility of a 1024 possible positions when 0 is included in the count.
- The value of the Command Voltage with the lever at the Neutral/Idle position is 49- 51% of the Reference Voltage when measured at the Station terminal block. The actual value read by the Processor is 2% below that value or 47% to 49% of 1023 A/D Counts (485- 505 A/D).

NOTE: The A/D values listed for Full Ahead and Full Astern represent the point where maximum throttle is reached. The A/D count when the Control Head lever is physically at it’s maximum point will be higher, but may not exceed the out-of-range values listed in Table 10-3: Control Head Lever A/D Counts.

- The Command Signal at Full Ahead is 82- 84% of the Reference Voltage when measured at the Station terminal block. The actual value read by the Processor is 2% below that value or 80- 82% of 1023 A/D Counts (821- 841 A/D).
- The Command Signal at Full Astern is 17 - 19% of the Reference Voltage when measured at the Station terminal block. The actual value read by the Processor is 2% below that value or 15- 17% of 1023 A/D Counts (153- 173 A/D).
- Since the Command Signal is based on a percentage of the Reference Voltage, the distance of the Control Head from the Processor has no impact on the performance of the system.
- The amount of voltage drop, due to current flow, is the same for both the Reference and Command Voltages.
- The relationship between the Reference and Command Voltages when thought of as a percentage, will remain the same regardless of distance. For instance, here are two examples.

Example 1

Reference Voltage 5.00 VDC1023 A/D Counts

Command Voltage2.45 VDC501 A/D Counts

Example 2

Reference Voltage4.80 VDC1023 A/D Counts

Command Voltage2.35 VDC501 A/D Counts

As you can see by the examples, even though the Command Voltages are different between Examples 1 and 2, the resulting A/D counts, are the same because of the different Reference Voltages. This would result in the Processor commanding the identical outputs (Clutch & Throttle) in both cases.

A The A/D count for a specific Control Head's lever can be seen on the Processor's Display by following the steps outlined in Section 10.4: Troubleshooting Diagnostic Menu.

B Once the appropriate remote station is reached, ensure that the displayed A/D Count represents the Neutral/Idle position (485- 505 A/D counts). Command will not be accepted unless the Control Head's lever is at the Neutral/Idle position.

The following table shows the appropriate A/D Counts for various Control Head lever positions:

Table 10-3: Control Head Lever A/D Counts

Control Head Lever Position	A/D Count	Control Head Lever Position	A/D Count
Lever Out of Range Low	100	Full Astern	153 - 173
Neutral/ Idle	485 - 505	Ahead Shift Point	537
Full Ahead	821 - 841	Lever Out of Range High	910

10.6.3 Remote Station Select

The second required item for taking command is "Station Select" or depressing of the Transfer Button.

- The Transfer Button can be tested by entering the Diagnostic Menu **H0**.

  A Depress the Up or Down (scroll) Push Button until four zeroes are displayed without decimal points as shown in Figure 10-16: Display Station A/D's No Station Transfer Button Depressed.

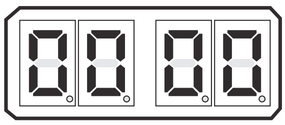


Figure 10-16: Display Station A/D's No Station Transfer Button Depressed

  B For Stations 1 - 4 when the Transfer Button is depressed, the **0** which represents that remote station, will change to a **1** as shown in Figure 10-17: Example Display Station A/D's Transfer Button Depressed for Stations 1 - 4. For Station 5 when the Transfer Button is depressed, all four decimal points will light as shown in Figure 10-18: Display Station A/D/s Transfer Button Depressed for Station 5

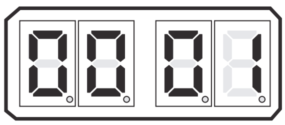


Figure 10-17: Example Display Station A/D's Transfer Button Depressed for Stations 1 - 4

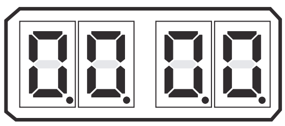


Figure 10-18: Display Station A/D/s Transfer Button Depressed for Station 5

- Whenever command cannot be gained at a particular remote station, the Station Select and Command Signals are the first to be investigated. If either the Command Signal is out of range or the Station Select is inoperable, command will not be accepted at that remote station.

10.7 Troubleshooting Stuck Transfer Button

The Transfer Button is a normally open, momentary switch. The only time the switch should close is when it is depressed to take command or when entering or departing various other functions. In the event that the Transfer Button became stuck in the closed position, the following will occur:

- The Transfer Button would have to be closed for 15 seconds or more.
- The throttle and clutch are not affected.
- A solid tone is heard from all remote stations, until the button's contact opens or transfer to another remote station has taken place.

If a Control Head that is not in command has a stuck transfer button, the following will happen:

- If Control Head levers are positioned at Neutral/Idle, a solid tone is heard from all remote stations.
- If Control Head levers are positioned other than Neutral/Idle, a three (3) second tone is heard from all remote stations.
- Error Code **33** - **42**, depending on which remote station, will be shown on the Processor Display.
- Command can be taken at any other operational remote station.
- After one (1) second command can be regained at the remote station with the stuck button as long as the problem has been corrected by depressing the transfer button.

If a stuck Transfer Button is suspected, this can be verified by looking at the Station Select status (**1** or **0**) as outlined in Section 10.6.3: Remote Station Select.

- An Error Code **33** - **42** will be shown on the Display, depending on which Station is experiencing the problem.

10.8 Error Codes

As stated previously, if a problem with the Control System is detected, the Processor is programmed to display numerous Error Codes to aid in the isolation of the cause. The following tables list these Error Codes, along with a brief description.

10.8.1 Clutch Solenoid Error Codes

Table 10-4: Clutch Solenoid Control System Error Codes

Error No.	Title	Description
1	Clutch Astern Shorted	The Astern Clutch Solenoid is requiring more current than expected.
2	Clutch Astern Open	The Astern Clutch Solenoid should be drawing current but is not.
3	Clutch Neutral Shorted	The Neutral Clutch Solenoid is requiring more current than expected.
4	Clutch Neutral Open	The Neutral Clutch Solenoid should be drawing current but is not.
5	Clutch Ahead Shorted	The Ahead Clutch Solenoid is requiring more current than expected.
6	Clutch Ahead Open	The Ahead Clutch Solenoid should be drawing current but is not.

10.8.2 Troll Solenoid Error Codes

Table 10-5: Troll Solenoid Control System Error Codes

Error No.	Title	Description
7	Troll ON/OFF Shorted	The Troll ON/OFF Solenoid is requiring more current than expected.
8	Troll ON/OFF Open	The Troll ON/OFF Solenoid should be drawing current but is not.
9	Troll Command Shorted	The Troll Proportional Solenoid is requiring more current than expected.

Table 10-5: Troll Solenoid Control System Error Codes

Error No.	Title	Description
10	Troll Command Open	The Troll Proportional Solenoid should be drawing current but is not.

10.8.3 Basic Control System Error Codes

Table 10-6: Basic Control System Error Codes

Error No.	Title	Description
13	Station No.1 Faulted High	Station No.1 Control Head's lever position is out of range. The input appears to be too high.
14	Station No.2 Faulted High	Station No.2 Control Head's lever position is out of range. The input appears to be too high.
15	Station No.3 Faulted High	Station No.3 Control Head's lever position is out of range. The input appears to be too high.
16	Station No.4 Faulted High	Station No.4 Control Head's lever position is out of range. The input appears to be too high.
17	Station No.5 Faulted High	Station No.5 Control Head's lever position is out of range. The input appears to be too high.
18	Station No.6 Faulted High	Station No.6 Control Head's lever position is out of range. The input appears to be too high.
19	Station No.7 Faulted High	Station No.7 Control Head's lever position is out of range. The input appears to be too high.
20	Station No.8 Faulted High	Station No.8 Control Head's lever position is out of range. The input appears to be too high.
21	Station No.9 Faulted High	Station No.9 Control Head's lever position is out of range. The input appears to be too high.
22	Station No.10 Faulted High	Station No.10 Control Head's lever position is out of range. The input appears to be too high.
23	Station No.1 Faulted Low	Station No.1 Control Head's lever position is out of range. The input appears to be too low.
24	Station No.2 Faulted Low	Station No.2 Control Head's lever position is out of range. The input appears to be too low.
25	Station No.3 Faulted Low	Station No.3 Control Head's lever position is out of range. The input appears to be too low.
26	Station No.4 Faulted Low	Station No.4 Control Head's lever position is out of range. The input appears to be too low.
27	Station No.5 Faulted Low	Station No.5 Control Head's lever position is out of range. The input appears to be too low.
28	Station No.6 Faulted Low	Station No.6 Control Head's lever position is out of range. The input appears to be too low.
29	Station No.7 Faulted Low	Station No.7 Control Head's lever position is out of range. The input appears to be too low.

Table 10-6: Basic Control System Error Codes

Error No.	Title	Description
30	Station No.8 Faulted Low	Station No.8 Control Head's lever position is out of range. The input appears to be too low.
31	Station No.9 Faulted Low	Station No.9 Control Head's lever position is out of range. The input appears to be too low.
32	Station No.10 Faulted Low	Station No.10 Control Head's lever position is out of range. The input appears to be too low.
33	Station No.1 Button Stuck Closed	Station No.1 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
34	Station No.2 Button Stuck Closed	Station No.2 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
35	Station No.3 Button Stuck Closed	Station No.3 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
36	Station No.4 Button Stuck Closed	Station No.4 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
37	Station No.5 Button Stuck Closed	Station No.5 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
38	Station No.6 Button Stuck Closed	Station No.6 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
39	Station No.7 Button Stuck Closed	Station No.7 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
40	Station No.8 Button Stuck Closed	Station No.8 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
41	Station No.9 Button Stuck Closed	Station No.9 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
42	Station No.10 Button Stuck Closed	Station No.10 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
43	CAN Communication Stuffing Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a stuffing error.
44	CAN Communication Form Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a form error.
45	CAN Communication Acknowledge Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is an acknowledge error.
46	CAN Communication Bit 1 Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a Bit 1 error.
47	CAN Communication Bit 0 Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a Bit 0 error.
48	CAN Communication CRC Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a CRC error.
49	CAN Communication Bus Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a Bus failure error. The error cannot be recovered from without cycling power to the Processor.

Table 10-6: Basic Control System Error Codes

Error No.	Title	Description
50	Comm. Error Time-out System 1	Communication with System 1 has been too long without a Refresh message.
51	Comm. Error Time-out System 2	Communication with System 1 has been too long without a Refresh message.
52	Comm. Error Time-out System 3	Communication with System 1 has been too long without a Refresh message.
53	Comm. Error Time-out System 4	Communication with System 1 has been too long without a Refresh message.
54	Comm. Error Time-out System 5	Communication with System 1 has been too long without a Refresh message.
55	SE Communication Error	Communication with the Station Expander has been too long without a Refresh message.
56	High Battery Voltage Fault	The applied battery voltage is 30VDC or higher for at least two seconds.
57	Low Battery Voltage Fault	The applied battery voltage is 10VDC or lower for at least two seconds.
58	Reset Due to Software Watchdog	The system has had an unexpected Reset, due to a software/ hardware fault.
59	Reset Due to Software Fault	The system has had an unexpected Reset, due to a software fault.
60	Reset Due to Hardware Watchdog	The system has had an unexpected Reset, due to a software/ hardware fault.
61	Oscillator Watchdog	The system’s Oscillator has had an unexpected fault.

10.8.4 Servo 1 Error Codes

Table 10-7: Servo 1 Error Codes

Error No.	Title	Description
62	Servo 1 Jam	Servo one is unable to make any progress toward its commanded position.
63	Servo 1Feedback High	Servo one’s position feedback voltage is higher than the acceptable range.
64	Servo 1 Feedback Low	Servo one’s position feedback voltage is lower than the acceptable range.

10.8.5 Servo 2 Error Codes

Table 10-8: Servo 2 Error Codes

Error No.	Title	Description
65	Servo 2 Jam	Servo two is unable to make any progress toward its commanded position.
66	Servo 2 Feedback High	Servo two’s position feedback voltage is higher than the acceptable range.
67	Servo 2 Feedback Low	Servo two’s position feedback voltage is lower than the acceptable range.

10.9 Basic Problem Causes And Solutions

The following table lists the various Error Codes and provides possible causes and solutions. Error Codes appearing on the Port side Processor's Display LED are port side errors and vice versa. The Causes and Solutions provided are the most likely, but are not the only possible causes for the Errors Codes listed.

10.9.1 Basic Control System Problem Causes and Solutions

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
13	a.	Station No.1 Control Head is defective.	a.	Replace Station No.1 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
14	a.	The Station No.2 Control Head is defective.	a.	Replace Station No.2 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
15	a.	The Station No.3 Control Head is defective.	a.	Replace Station No.3 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
16	a.	The Station No.4 Control Head is defective.	a.	Replace Station No.4 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
17	a.	The Station No.5 Control Head is defective.	a.	Replace Station No.5 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
18	a.	The Station No.6 Control Head is defective.	a.	Replace Station No.6 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
19	a.	The Station No.7 Control Head is defective.	a.	Replace Station No.7 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
20	a.	The Station No.8 Control Head is defective.	a.	Replace Station No.8 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
21	a.	The Station No.9 Control Head is defective.	a.	Replace Station No.9 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
22	a.	The Station No.10 Control Head is defective.	a.	Replace Station No.10 Control Head.
	b.	No continuity between pin 5's of the Control Head Harness connectors.	b.	Ensure that the red conductor is properly crimped to pin 5 at both connectors.
	c.	Control Head jumper (pin 3 to 5 or 7) is missing.	c.	Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
23	a.	The Station No.1 Control Head is defective.	a.	Replace Station No.1 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
24	a.	The Station No.2 Control Head is defective.	a.	Replace Station No.2 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
25	a.	The Station No.3 Control Head is defective.	a.	Replace Station No.3 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
26	a.	The Station No.4 Control Head is defective.	a.	Replace Station No.4 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
27	a.	The Station No.5 Control Head is defective.	a.	Replace Station No.5 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
28	a.	The Station No.6 Control Head is defective.	a.	Replace Station No.6 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
29	a.	The Station No.7 Control Head is defective.	a.	Replace Station No.7 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
30	a.	The Station No.8 Control Head is defective.	a.	Replace Station No.8 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
31	a.	The Station No.9 Control Head is defective.	a.	Replace Station No.9 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
32	a.	The Station No.10 Control Head is defective.	a.	Replace Station No.10 Control Head.
	b.	No continuity between pin 6's of the Control Head Harness connectors.	b.	Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity.
	c.	No continuity between pin 7's of the Control Head Harness connectors.	c.	Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
33	a.	The Station No.1 transfer button was held down for 15 seconds or longer	a.	Clear the Error Code from memory
	b.	The Station No.1 Control Head transfer button is defective	b.	Replace the Control Head
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. In addition, ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
34	a.	The Station No.2 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.2 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
35	a.	The Station No.3 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.3 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
36	a.	The Station No.4 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.4 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
37	a.	The Station No.5 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.5 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
38	a.	The Station No.6 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.6 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
39	a.	The Station No.7 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.7 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
40	a.	The Station No.8 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.8 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
41	a.	The Station No.9 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.9 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
42	a.	The Station No.10 transfer button was held down for 15 seconds or longer.	a.	Clear the Error Code from memory.
	b.	The Station No.10 Control Head transfer button is defective.	b.	Replace the Control Head.
	c.	The Control Head Harness is miswired.	c.	Ensure that the orange conductor is crimped to pin 4 at both ends and the red wire is crimped to pin 5 at both ends of the Harness.
	d.	The Control Head's Pigtail is miswired.	d.	Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
43	a.	The Serial Harness is in excess of 120 feet (37m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
44	a.	The Serial Harness is in excess of 120 feet (37m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
45	a.	The Serial Harness is not connected at one or more Processors.	a.	Ensure that the Serial Harness is properly seated at all Processors.
	b.	The Serial Harness is incorrectly wired.	b.	Refer to the Serial Plug pin-out in Section 10: Troubleshooting. Correct or replace the Harness.
	c.	Loss of power to one of the Processors.	c.	Restore Power to the Processor.
46	a.	The Serial Harness is in excess of 120 feet (37m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
47	a.	The Serial Harness is in excess of 120 feet (37m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
48	a.	The Serial Harness is in excess of 120 feet (37m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
49	a.	The Serial Harness is in excess of 120 feet (37m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
50	a.	The Serial Harness is not connected at Processor ID No.1.	a.	Connect the Serial Harness into Processor ID No.1.
	b.	None of the Processors has ID No. 1 selected.	b.	Identify one of the Processors as ID No.1 with the A0 function.
	c.	Loss of power to Processor ID No.1.	c.	Restore power to Processor ID No.1.
51	a.	The Serial Harness is not connected at Processor ID No.2.	a.	Connect the Serial Harness into Processor ID No.2.
	b.	None of the Processors has ID No.2 selected.	b.	Identify one of the Processors as ID No.2 with the A0 function.
	c.	Loss of power to Processor ID No.2	c.	Restore power to Processor ID No.2.
52	a.	The Serial Harness is not connected at Processor ID No.3.	a.	Connect the Serial Harness into Processor ID No.3.
	b.	None of the Processors has ID No.3 selected.	b.	Identify one of the Processors as ID No.3 with the A0 function.
	c.	Loss of power to Processor ID No.3.	c.	Restore power to Processor ID No.3.
53	a.	The Serial Harness is not connected at Processor ID No.4.	a.	Connect the Serial Harness into Processor ID No.4.
	b.	None of the Processors has ID No.4 selected.	b.	Identify one of the Processors as ID No.4 with the A0 function.
	c.	Loss of power to Processor ID No.4.	c.	Restore power to Processor ID No.4.
54	a.	The Serial Harness is not connected at Processor ID No.5.	a.	Connect the Serial Harness into Processor ID No.5.
	b.	None of the Processors has ID No.5 selected.	b.	Identify one of the Processors as ID No.5 with the A0 function.
	c.	Loss of power to Processor ID No.5.	c.	Restore power to Processor ID No.5.

Table 10-9: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
55	a.	The Serial Harness is not connected to the SE.	a.	Connect the Serial Harness to the SE.
	b.	The Serial Harness is not connected to the Processor reporting the fault.	b.	Connect the Serial Harness to the Processor reporting the fault.
	c.	No power to the SE.	c.	Turn power 'On' to the SE.
56	a.	The battery is being overcharged.	a.	Repair or replace the charging system.
	b.	There's a loose terminal on the battery while being charged.	b.	Clean and tighten the battery posts and terminals.
57	a.	Battery will not take a charge and is defective.	a.	Replace the battery.
	b.	The battery is not being properly charged.	b.	Repair or replace the charging system.
	c.	There's a high resistance connection between the battery and the Processor.	c.	Locate and repair the high resistance connection.
58	a.	External Interference, such as a lightning strike.	a.	If the error message is displayed once and you are able to clear the error, take no further actions at this time. If the error cannot be cleared, replace the Processor.
	b.	Component failure.	b.	Replace the Processor.
59	a.	External Interference, such as a lightning strike.	a.	If the error message is displayed once and you are able to clear the error, take no further actions at this time. If the error cannot be cleared, replace the Processor.
	b.	Component failure.	b.	Replace the Processor.
60	a.	External Interference, such as a lightning strike.	a.	If the error message is displayed once and you are able to clear the error, take no further actions at this time. If the error cannot be cleared, replace the Processor.
	b.	Component failure.	b.	Replace the Processor.
61	a.	External Interference, such as a lightning strike.	a.	If the error message is displayed once and you are able to clear the error, take no further actions at this time. If the error cannot be cleared, replace the Processor.
	b.	Component failure.	b.	Replace the Processor.

10.9.2 Servo 1 Clutch Problem Causes and Solutions

Table 10-10: Servo 2 Throttle Problem Causes and Solutions

Error No.	Causes		Solutions	
62	a.	Excessive Clutch Push-Pull cable travel.	a.	Readjust Function Code C6 and or C7.
	b.	The load on the Push-Pull cable exceeds 40 Lbs.	b.	Contact a certified Marine Transmission technician to determine the cause of the excessive load.
	c.	The Push-Pull cable is defective.	c.	Replace the Push-Pull cable.
	d.	The Processor’s Clutch Servo (Servo 1) is defective.	d.	Replace the Processor.
	e.	Low battery voltage.	e.	Charge, repair or replace the battery, charging system or power distribution system.
63	a.	The Clutch Servo’s feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Clutch Servo’s feedback potentiometer is defective.	b.	Replace the Processor or replace the potentiometer.
	c.	The Processor’s Circuit Board is defective.	c.	Replace the Processor or the Circuit Board.
64	a.	The Clutch Servo’s feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Clutch Servo’s feedback potentiometer is unplugged from the Circuit Board.	b.	Plug the feedback potentiometer’s brown plug into the Circuit Board.
	c.	The Clutch Servo’s feedback potentiometer is defective.	c.	Replace the Processor or the feedback potentiometer.
	d.	The Processor’s Circuit Board is defective.	d.	Replace the Processor or the Circuit Board.

10.9.3 Servo 1 Troll Problem Causes and Solutions

Table 10-11: Servo 1 Clutch Problem Causes and Solutions

Error No.	Causes		Solutions	
62	a.	Excessive Troll Push-Pull cable travel.	a.	Readjust Function Code L2 and / or L3.
	b.	The load on the Push-Pull cable exceeds 40 Lbs.	b.	Contact a certified Marine Transmission technician to determine the cause of the excessive load.
	c.	The Push-Pull cable is defective.	c.	Replace the Push-Pull cable.
	d.	The Processor’s Troll Servo (Servo 1) is defective.	d.	Replace the Processor.
	e.	Low battery voltage.	e.	Charge, repair or replace the battery, charging system or power distribution system.
63	a.	The Troll Servo’s feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Troll Servo’s feedback potentiometer is defective.	b.	Replace the Processor or replace the potentiometer.
	c.	The Processor’s Circuit Board is defective.	c.	Replace the Processor or the Circuit Board.

Table 10-11: Servo 1 Clutch Problem Causes and Solutions

Error No.	Causes		Solutions	
64	a.	The Troll Servo's feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Troll Servo's feedback potentiometer is unplugged from the Circuit Board.	b.	Plug the feedback potentiometer's brown plug into the Circuit Board.
	c.	The Troll Servo's feedback potentiometer is defective.	c.	Replace the Processor or the feedback potentiometer.
	d.	The Processor's Circuit Board is defective.	d.	Replace the Processor or the Circuit Board.

10.9.4 Servo 2 Throttle Problem Causes and Solutions

Table 10-12: Servo 2 Troll Problem Causes and Solutions

Error No.	Causes		Solutions	
65	a.	Excessive Throttle Push-Pull cable travel.	a.	Readjust Function Code E2 or E3.
	b.	The load on the Push-Pull cable exceeds 40 Lbs.	b.	Contact a certified engine technician to determine the cause of the excessive load.
	c.	The Push-Pull cable is defective.	c.	Replace the Push-Pull cable.
	d.	The Processor's Throttle Servo (Servo 2) is defective.	d.	Replace the Processor.
	e.	Low battery voltage.	e.	Charge, repair or replace the battery, charging system or power distribution system.
66	a.	The Throttle Servo's feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Throttle Servo's feedback potentiometer is defective.	b.	Replace The Processor or the potentiometer.
	c.	The Processor's Circuit Board is defective.	c.	Replace the Processor or the Circuit Board
67	a.	The Throttle Servo's feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Throttle Servo's feedback potentiometer is unplugged from the Circuit Board.	b.	Plug the feedback potentiometer's brown plug into the Circuit Board.
	c.	The Throttle Servo's feedback potentiometer is defective.	c.	Replace the Processor or the feedback potentiometer.
	d.	The Processor's Circuit Board is defective.	d.	Replace the Processor or the Circuit Board.

10.9.5 Servo 2 Troll Problem Causes and Solutions

Table 10-13: Servo 2 Troll Problem Causes and Solutions

Error No.	Causes		Solutions	
65	a.	Excessive Troll Push-Pull cable travel.	a.	Readjust Function Code L3 or L3.
	b.	The load on the Push-Pull cable exceeds 40 Lbs.	b.	Contact a certified engine technician to determine the cause of the excessive load.
	c.	The Push-Pull cable is defective.	c.	Replace the Push-Pull cable.
	d.	The Processor's Troll Servo (Servo 2) is defective.	d.	Replace the Processor.
	e.	Low battery voltage.	e.	Charge, repair or replace the battery, charging system or power distribution system.
66	a.	The Troll Servo's feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Troll Servo's feedback potentiometer is defective.	b.	Replace The Processor or the potentiometer.
	c.	The Processor's Circuit Board is defective.	c.	Replace the Processor or the Circuit Board
67	a.	The Troll Servo's feedback potentiometer is out of calibration.	a.	Replace the Processor or calibrate the potentiometer.
	b.	The Troll Servo's feedback potentiometer is unplugged from the Circuit Board.	b.	Plug the feedback potentiometer's brown plug into the Circuit Board.
	c.	The Troll Servo's feedback potentiometer is defective.	c.	Replace the Processor or the feedback potentiometer.
	d.	The Processor's Circuit Board is defective.	d.	Replace the Processor or the Circuit Board.

10.10 Problems Without Error Codes

In addition to the Error Codes listed above, some problems may not necessarily generate Error Codes. The following give some examples where the Processor may not detect a fault, though the operation may not be perfect:

10.10.1 Basic Control System Problems Without Error Codes

A **SYMPTOM:** No audible tones heard at one Control Station when power is first applied to the Processor. All other features function normally.

Cause		Remedy	
a.	Incorrectly wired Station Harness/ Cable or Pigtail.	a.	Verify that the black wire is properly connected to pin 1 on the Control Head and Pin 8 at the Processor.
b.	The Control Head's Sound Transducer is defective.	b.	Measure the AC voltage at pins 1 & 3 of the Control Head. If 20-25 VAC is present, replace the Control Head.

B **SYMPTOM:** The Control Head's red LED doesn't light when in command, but otherwise functions properly.

Cause		Remedy	
a.	Incorrectly wired Station Harness/ Cable or Pigtail.	a.	Verify that the brown wire is properly connected to pin 2 on the Control head and pin 2 at the Processor.
b.	The Control Head's red LED or circuit is open.	b.	Measure the DC voltage at pins 2 & 3 at the Control. The measurement will be approximately 2.20 VDC when the red LED is lit. If 4.00 VDC is measured, the red LED or its circuit is open. Replace the Control Head.

C **SYMPTOM:** When power is turned ON to the Processor, there are no tones from any of the Remote Stations, the Control Head red LED does not light when the Transfer Button is pressed, and the Display is not lit at the Processor**.**

Cause		Remedy	
a.	No power to the Processor.	a.	Disconnect the Power Harness from the Processor. Measure the DC voltage at pins 10 (+) and 11 (-) of the Harness plug. If 12 or 24 VDC is not present, check the circuit breakers, switches and cables feeding power to the Processor. Correct the power source as required.
b.	The battery's polarity is reversed at the Processor.	b.	Disconnect the Power Harness from the Processor. Connect a voltmeter's red lead to pin 10 and the black lead to pin 11 of the Harness's plug. If negative voltage is measured, reverse the wires.
c.	Defective Processor.	c.	If Causes a. and b. were not the fault, replace the Processor.

D **SYMPTOM:** The engine begins to turn-over while starting and then stops. A slow repetitive tone is heard from all Remote Stations.

Cause		Remedy	
a.	The voltage available at the Processor has dropped too low, due to the starter's current requirement	a.	Supply power to the Processor from a battery other that the starting battery or supply power from two sources through an APS (Automatic Power Selector)
b.	Battery charge is too low	b.	Recharge/ replace the battery or supply battery power from two sources through an APS.

E **SYMPTOM:** Active Synchronization is inoperable.

Cause		Remedy	
a.	There is no Tachometer Sensor signal at the Port or Starboard Processor.	a.	The Tachometer Sensor frequency can be seen on the Processor's Display by accessing the Diagnostic Menu H0. If the frequency is not measured, check the Tachometer Sensor and the wiring.
b.	Loss of Serial Communication between the Processors.	b.	If Active Synchronization is inoperative due to a lack of Serial Communications, one or more Error Codes will be displayed indicating the loss of communication.
c.	The Processor's Identification number(s) have not been set properly.	c.	All Processors must have a unique identification number as set with Function Code A0. Refer to Section 5.6.2.1: Throttle Basic Functions.
d.	The correct number of engines has not been set.	d.	All Processor must have the same number of engines selected as programmed with Function Code A1. Refer to Section 5.6.2.1: Throttle Basic Functions.

10.10.2 Servo Clutch Control System Problems Without Error Codes

A **SYMPTOM:** Cannot obtain Warm-up Mode while moving the Control Head lever in the Ahead direction, only in the Astern direction.

Cause		Remedy	
a.	The Processor is sensing that the Control Head's lever is moving in the Astern direction		Depress the Transfer Button while moving the Control Head lever in the Astern direction. If the LED begins to blink, the Control Head is incorrectly wired. • Check the colors of the wires at pins 5 and 7. • A right hand Control Head should have yellow at pin 5 and blue at pin 7. • A left hand Control Head should have blue at pin 5 and yellow at pin 7. • The Clutch Servo's direction of travel must be changed with Function Code C5 if the yellow and blue wires are reversed.

10.10.3 Servo Throttle Control System Problems Without Error Codes

A **SYMPTOM:** The engine RPM's vary, without moving the Control Head lever (synchronization disabled).

Cause		Remedy	
a.	Problem with the Governor or Carburetor.	a.	Observe the Throttle push-pull cable. If variations are seen, proceed to Step b.

Cause		Remedy	
b.	Erratic Command Signal.	b.	Refer to Command Signal testing in Section 10.6.1: Command Signal and Section 10.6.2: A to D Counts. If variations of the A/D counts occur, connect the Control Head to another Station (if available) on the Processor. If variations persist, replace the Control Head.

B **SYMPTOM:** The engine's Idle is too high.

Cause		Remedy	
a.	Idle was not adjusted mechanically correct at the Idle stop.	a.	Adjust the Throttle Push-Pull cable as specified in Section 5.6.2.1: Throttle Basic Functions.
b.	Function Code E2 Throttle Minimum is incorrectly set.	b.	Adjust Throttle Minimum as specified in Section 5.6.2.1: Throttle Basic Functions.
c.	The Governor or Carburetor is incorrectly adjusted.	c.	After Causes a. and b. have been eliminated, contact a certified engine mechanic to properly adjust.

10.10.4 Solenoid Clutch Control System Problems Without Error Codes

A **SYMPTOM:** Cannot obtain Warm-up Mode while moving the Control Head lever in the Ahead direction, only in the Astern direction.

Cause		Remedy	
a.	The Processor is sensing that the Control Head's lever is moving in the Astern direction		Depress the Transfer Button while moving the Control Head lever in the Astern direction. If the LED begins to blink, the Control Head is incorrectly wired. • Check the colors of the wires at pins 5 and 7. • A right hand Control Head should have yellow at pin 5 and blue at pin 7. • A left hand Control Head should have blue at pin 5 and yellow at pin 7. • Ahead and Astern Solenoid Wires need to be reversed.

10.10.5 Electronic Throttle Control System Problems Without Error Codes

A **SYMPTOM:** The engine RPM's vary, without moving the Control Head lever (synchronization disabled).

Cause		Remedy	
a.	Problem with the Governor.	a.	Connect the Break-out Box (p/n 13927) as shown in the Throttle Testing Section of the Service Field Test Unit Manual. If variations are seen, proceed to Step B). If no variations are seen, contact a certified engine mechanic.
b.	Erratic Command Signal.	b.	Refer to Command Signal testing. If variations of the A/D counts occur, connect the Control Head to another Station (if available) on the Processor. If variations persist, replace the Control Head.

B SYMPTOM: The engine's Idle speed is too high.

Cause		Remedy	
a.	Function Code **E2** Throttle Minimum is incorrectly set.	a.	Adjust Throttle Minimum as specified in Section 5.6.2.1: Throttle Basic Functions.

Cause		Remedy	
b.	Function Code **E6** High Idle is programmed to a value other than **00.0**.	b.	Decide whether High Idle is required or not. If not required, set the value of **E6** to **00.0**. If the High Idle feature is required, press the Transfer Button for approximately 1/2 second to toggle to Low Idle.
c.	The Governor or its Control Module is incorrectly adjusted or faulty.	c.	After Causes a. and b. have been eliminated, contact a certified engine mechanic to properly adjust.

10.11 Synchronization Troubleshooting

If you encounter a problem with Synchronization, it will more than likely one of the following; failure to attempt to synchronize, synchronizing at different RPM's or RPM variations of one or both engines while synchronized. Each problem is distinct and the cause may differ depending on the type of Synch. Therefore, each type is discussed individually.

10.11.1 Equal Throttle Synchronization

10.11.1.1 Basic Equal Throttle Synchronization Troubleshooting

A **SYMPTOM:** Will not synchronize

Cause		Remedy	
a.	Synchronization is Disabled	a.	At the Station-in-Command, move both Control Head levers to more than 5% of the speed range. Press and hold the transfer button for 5 seconds. If synch is disabled, the green LED will light as long as the button is pressed. If synch was enabled, the green LED would have blinked twice.
b.	The Serial Communication Harness is not plugged into both Processors.	b.	Plug the Serial Communication Harness into both Processors.
c.	The Port and Starboard Processors are not set up for Twin Screw operation.	c.	Scroll to Function Code A1, on the Port and Starboard Processor. Enter a Value of 02 into both Processors.
d.	The Port and Starboard Processors have the same ID number.	d.	On the Port Processor, scroll to Function Code A0 and enter a Value of 01. On the Starboard Processor, scroll to Function Code A0 and enter a Value of 02.

10.11.1.2 Servo Clutch Equal Synchronization Troubleshooting

A **SYMPTOM:** Will not synchronize

Cause		Remedy	
a.	The Processor(s) think Astern is being commanded.	a.	Place both the Port and Starboard Processors into Warm-up Mode by pressing the transfer button while moving the Control Head levers to the Ahead detent. Both red LED's on the Control Head should be blinking. If not, reverse the wires at pins 5 and 7 at the Control Head. Change the Clutch direction with Function Code C5.

10.11.1.3 Servo Throttle Equal Synchronization Troubleshooting

A **SYMPTOM:** The green LED is lit solid, though the Engine RPM's differ by a significant amount.

Cause		Remedy	
a.	The throttle travel from Idle to Full is set differently on the Port and Starboard Processors.	a.	Scroll to Function Codes E2 and E3 on both Processors and compare the Values. The Values of E2 and E3 must be the same for both Processors.
b.	The engines run at different RPM's with equal travel of the Governors'/ Carburetors' selector lever.	b.	While underway at cruising speed, decrease the Value of Function Code E3 on the Processor running at the higher RPM until both engine are at the same RPM. This is not a normal condition and is masking the actual problem with the engine. Top speed may be sacrificed by doing so. Install Tach Senders and enable Active Synchronization with Function Code E7.
c.	Excessive back-lash in the push-pull cable(s) or linkage.	c.	Remove the excessive back-lash or install Tach Senders and enable Active Synchronization with Function Code E7.
d.	Excessive bends in the push-pull cable(s).	d.	Reroute the push-pull cable(s) or install Tach Sender and enable Active Synchronization with Function Code E7.

B **SYMPTOM:** One or both of the engines continually changes RPM (hunts). Will not synchronize properly.

Cause		Remedy	
a.	A Control Head's Command Signal is varying.	a.	Scroll to the Diagnostic Menu Function Code H0. Go to the appropriate Station A/D Count's display. The Value should not change by more than +/- 1 A/D Count. If so, check the connections and if good, replace the Control Head.
b.	The push-pull cable's travel from Idle to Full is too short.	b.	Lengthen the Governor or Carburetor's selector lever and attach the push-pull cable to a point where the travel is in excess of 2.00 inches (50,8mm).

C **SYMPTOM:** Will not synchronize..

Cause		Remedy	
a.	Excessive bends in the push-pull cable(s).	a.	Reroute the push-pull cable(s) or install Tach Sender and enable Active Synchronization with Function Code E7.

10.11.2 Active Synchronization

10.11.2.1 Basic Active Synchronization Troubleshooting

A **SYMPTOM:** The green LED is lit solid, though the Engine RPM's differ by a significant amount.

Cause		Remedy	
a.	The Tach Sender signal has been lost by one or both Processors.	a.	Scroll to Function Code H0. Go to the Value for the Tach Sender's input frequency. If the frequency displayed is 0000, the signal has been lost and the system diverted to Equal Throttle Synch. Correct the wiring or replace the Sender.

B **SYMPTOM:** Will not synchronize.

Cause		Remedy	
a.	Synchronization is Disabled	a.	At the Station-in-Command, move both Control Head levers to more than 5% of the speed range. Press and hold the transfer button for 5 seconds. If synch is disabled, the green LED will light as long as the button is pressed. If synch was enabled, the green LED would have blinked twice.
b.	The Serial Communication Harness is not plugged into both Processors.	b.	Plug the Serial Communication Harness into both Processors.
c.	The Port and Starboard Processors have the same ID number.	c.	On the Port Processor, scroll to Function Code A0 and enter a Value of 01. On the Starboard Processor, scroll to Function Code A0 and enter a Value of 02.
d.	The Port and Starboard Processors are not set up for twin screw operation.	d.	Scroll to Function Code A1, on the Port and Starboard Processor. Enter a Value of 02 into both Processors.

10.11.2.2 Servo Throttle Active Synchronization Troubleshooting

A **SYMPTOM:** One or both of the engines continually changes RPM. Will not synchronize properly.

Cause		Remedy	
a.	A Control Head's Command Signal is varying.	a.	Scroll to the Diagnostic Menu Function Code H0. Go to the appropriate Station A/D Count's display. The Value should not change by more than +/- 1 A/D Count. If so, check the connections and if good, replace the Control Head.
b.	The engine(s) is not running smoothly.	b.	Increase the engines' RPM's in Warm-up Mode. Scroll to Function Code H0 and display the Tach Sender's input frequency. If the frequency is varying, check the push-pull cable for movement. If the push-pull cable is not moving, swap the Port and Starboard Tach Senders. If the frequency still varies on the same side, the engine needs servicing.
c.	Defective Tach Sender	c.	Same procedure as b. However, if the frequency variations move to the opposite side, replace that Tach Sender.

10.11.2.3 Servo Clutch Active Synchronization Troubleshooting

A **SYMPTOM:** Will not synchronize.

Cause		Remedy	
a.	The Processor(s) think Astern is being commanded.	a.	Place both the Port and Starboard Processors into Warm-up Mode by pressing the transfer button while moving the Control Head levers to the Ahead detent. Both red LED's on the Control Head should be blinking. If not, reverse the wires at pins 5 and 7 at the Control Head. Change the Clutch direction with Function Code C5.

10.11.2.4 Electronic Throttle - Equal Throttle Synch Problem Causes and Solutions

A **SYMPTOM:** The green LED is lit solid, though the Engine RPM's differ by a significant amount.

Cause		Remedy	
a.	Function Code E7 is set to 00 and the Throttle Minimum and Throttle Maximum Values differ between the Port and Starboard Processors.	a.	Scroll to Function Codes **E2** and **E3** on both Processors and compare the Values. The Values of **E2** and **E3** must be the same for both Processors. Adjust as necessary.
b.	The engines run at different RPM's with the same throttle command signals.	b.	Active Synchronization MUST be Enabled.

B **SYMPTOM:** One or both of the engines continually changes RPM (hunts). Will not synchronize properly

Cause		Remedy	
a.	A Station-in-Command Control Head's Command Signal is varying.	a.	Scroll to the Diagnostic Menu Function Code **H0**. Go to the appropriate Station A/D Count's display. The Value should not change by more than +/- 1 A/D Count. If so, check the connections and if good, replace the Control Head.
b.	One or both of the Tach Signals isn't being read intermittently. Function Code **E7** is set to a Value of **01 or** 03**.**	b.	Scroll to Function Code **H0** on both Processors and display the frequency of the Tach Signal. If variations of the signal are measured, the cause must be determined

C **SYMPTOM:** Synchronization does not function. The Control Head's green LED does not light.

Cause		Remedy	
a.	The Processors think Astern is being commended when the Control Head lever is positioned to the Ahead Detent.	a.	Place both the Port and Starboard Processor into Warm-up Mode by pressing the Transfer Button while moving the Control Head levers to the Ahead detent. Both Control Head's red LEDs should be blinking. If not, the 7-conductor's connections at pins 5 and 7 are reversed.
b.	The Serial Communication Harness is not properly installed.	b.	Ensure the Serial Harness' plugs are fully inserted into the Port and Starboard Processor's Pigtails.
c.	The Processors are not programmed for twin screw.	c.	Scroll to Function Code **A1** on both Processors and verify that the Value of both is set to **02**.
d.	Both Processors are set to the same ID number.	d.	Scroll to Function Code **A0** and verify that the Port and Starboard Processors have different ID numbers.
e.	Function Code **E7** Value is set to **02**.	e.	Depending on the installation, change the Value of **E7** to **00**, **01**, or **03**.
f.	Function Code **E7** is set to **03** and no Tach Signal is present.	f.	Determine why there is no Tach Signal present.

10.12 Troubleshooting Wire Harnesses

The following Sections list the various Harnesses manufactured for use with the Processor. These tables are invaluable when troubleshooting a suspected interface problem or when manufacturing your own Harnesses.

10.12.1 Basic Control System Harnesses

10.12.1.1 Serial Wire Harnesses

Table 10-14: Wire Harness - Serial Communication (p/n 13316-XX)

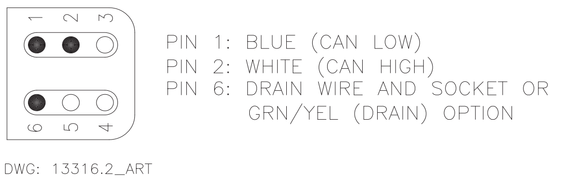
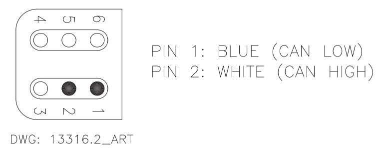
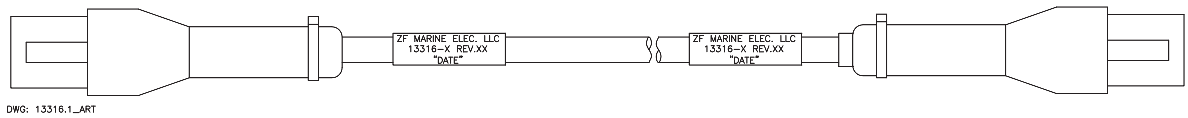
Termination A	Termination B
	
	

Table 10-15: Wire Harness - Serial Communication Multi-Screw (p/n 15544-XX)

<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
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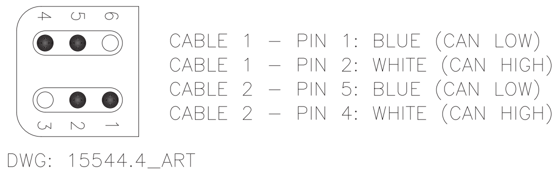
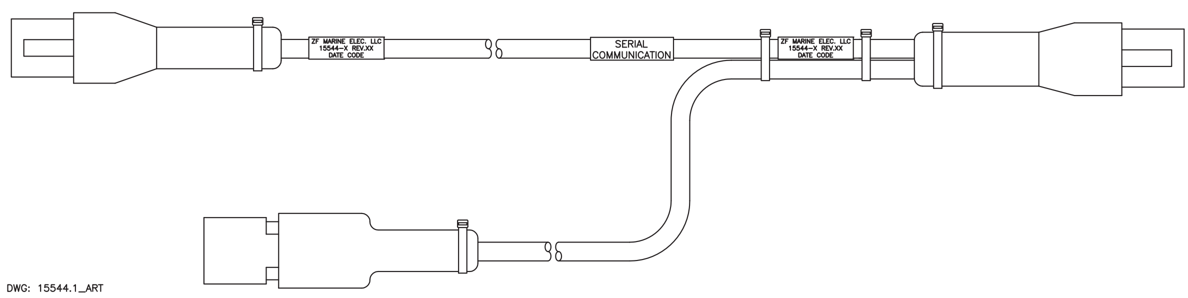
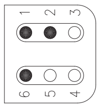
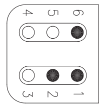
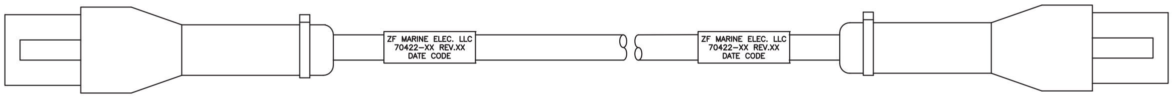
</td><td rowspan="2">
</td></tr>
<tr><td>
</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

Table 10-16: Wire Harness - Serial Communication / CANtrak (p/n 70422-XX)

<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>
PIN 1: BLUE (CAN LOW)
PIN 2: WHITE (CAN HIGH)
PIN 6: GREEN/YELLOW (SHIELD) OR (OPTIONAL)
DWG: 70422.2_ART</td><td>
PIN 1: BLUE (CAN LOW)
PIN 2: WHITE (CAN HIGH)
PIN 6: GREEN/YELLOW (SHIELD) OR (OPTIONAL)
DWG: 70422.3_ART</td></tr>
<tr><td colspan="2">
DWG: 70422.1_ART</td></tr>
</table>

10.12.1.2 Throttle Wire Harnesses

Table 10-17: Wire Harness - Throttle, Voltage (IVECO, Cummins) (p/n 13432-XX)

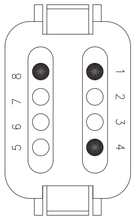
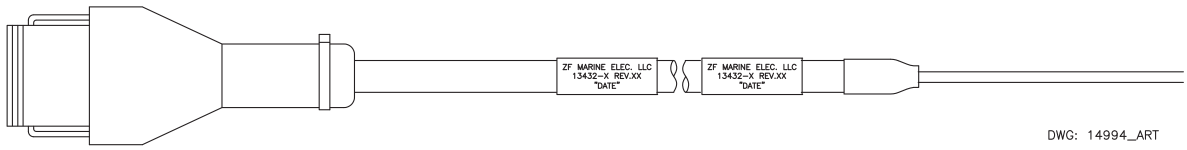
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>
PIN 1: BLACK (DC RETURN)
PIN 4: RED (+) (VDC)
PIN 8: GREEN/YELLOW (SHIELD)
DWG: 14993_ART</td><td>N/A</td></tr>
<tr><td colspan="2">
DWG: 14994_ART</td></tr>
</table>

Table 10-18: Wire Harness- Throttle, Current (MAN, MTU) (p/n 13494-XX)

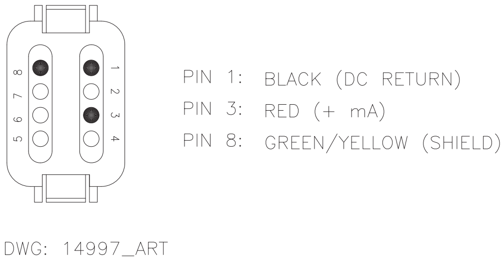
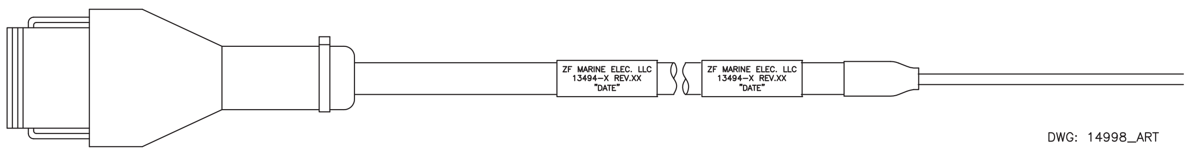
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>
</td><td>N/A</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

Table 10-19: Wire Harness - Throttle, Voltage (Cummins Plug), (p/n 13565-XX)

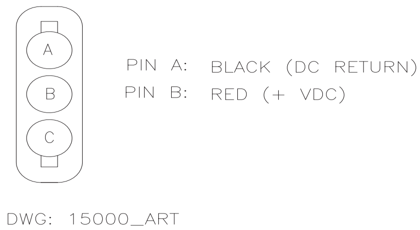
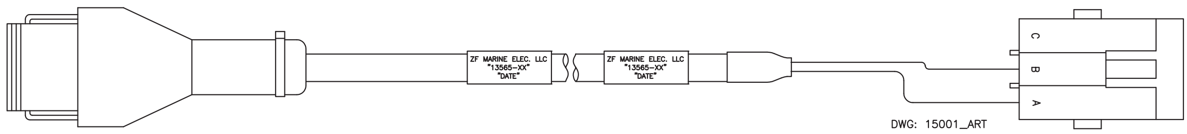
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

Table 10-20: Voltage Throttle Harness Pin-Out (p/n 14148-XX)

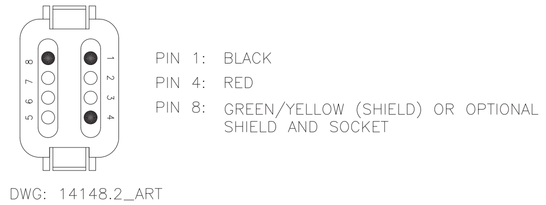
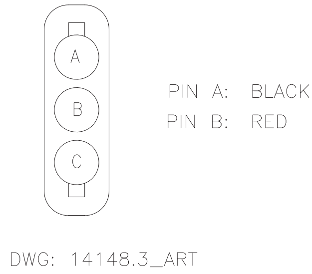
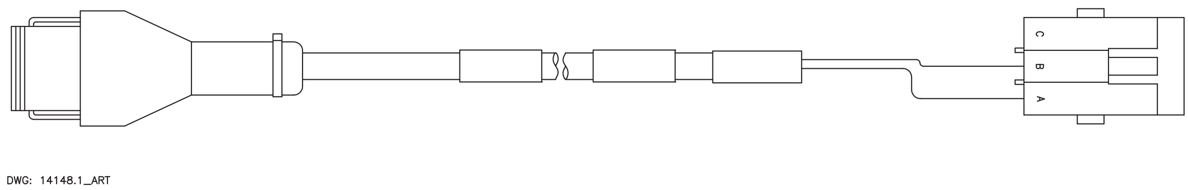
Termination A	Termination B
	
	

Table 10-21: Wire Harness - Throttle (Pulse width modulation [PWM]), (p/n 13533-XX)

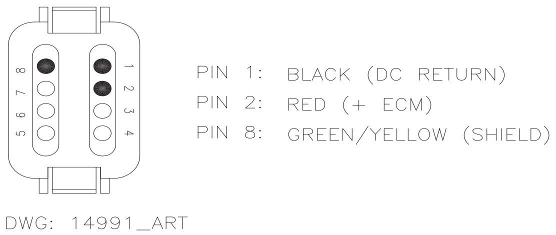
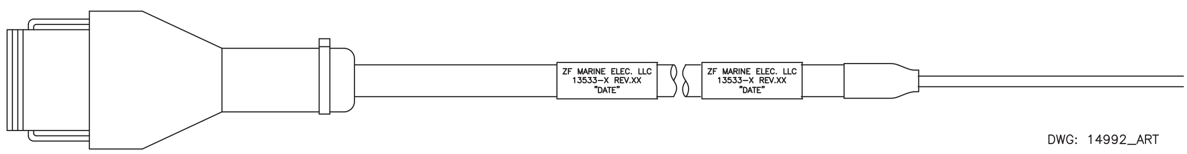
Termination A	Termination B
	N/A
	

Table 10-22: Voltage Throttle Harness Pin-Out (p/n 71262-XX)

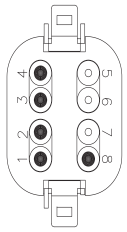
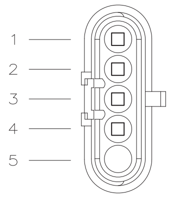
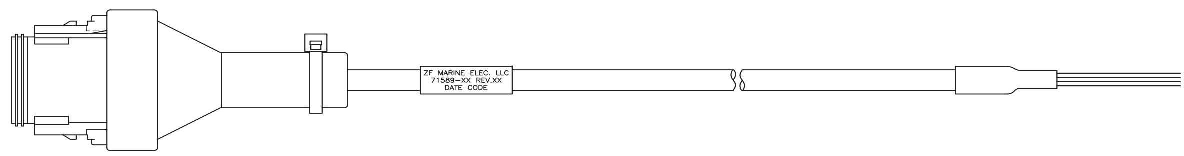
Termination A	Termination B
 PIN 1: GREEN (– ISOLATED RETURN) PIN 2: WHITE (+ THROTTLE V OUT 2) PIN 3: BLACK (– ISOLATED RETURN) PIN 4: RED (+ THROTTLE V OUT 1) PIN 8: SHIELD DWG: 71262.2_ART	 PIN 1: RED W/ JUMPER TO PIN 2 PIN 2: JUMPER PIN 1 TO PIN 2 PIN 3: BLACK W/ JUMPER TO PIN 4 PIN 4: JUMPER PIN 3 TO PIN 4 DWG: 71262.3_ART
 DWG: 71262.1_ART	

Table 10-23: Cable, throttle, MAN EDC (p/n 14421-XX)

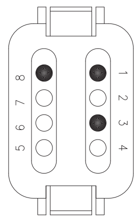
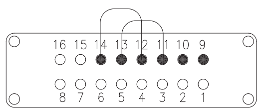
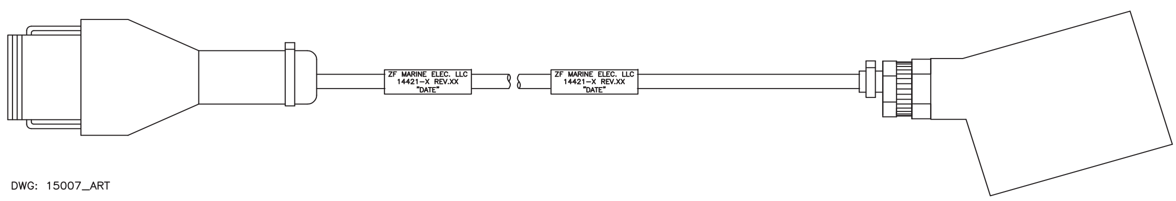
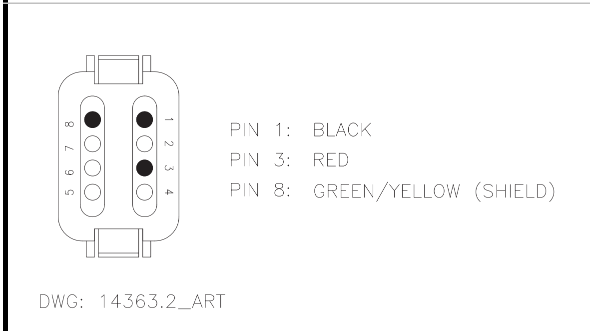
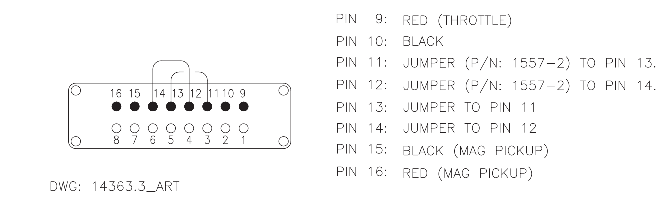
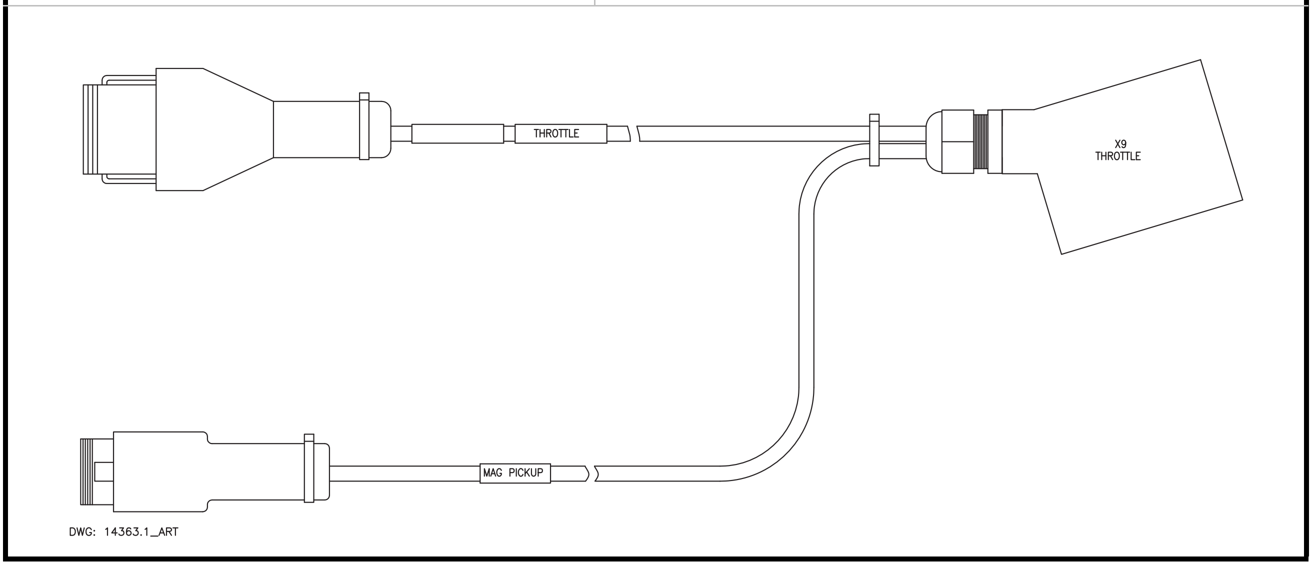
Termination A	Termination B
 PIN 1: BLACK (DC RETURN) PIN 3: RED (mA +) PIN 8: GREEN/YELLOW (SHIELD) DWG: 15005_ART	 PIN 9: RED (mA) PIN 10: BLACK (DC RETURN) DWG: 15006_ART
 DWG: 15007_ART	

Table 10-24: Wire Harness - Throttle Current w/ Mag Pickup, Man (Non-Common Rail) (p/n 14363-XX)

<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>
</td>
<td rowspan="2">
</td></tr>
<tr><td>
</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

10.12.1.3 Clutch Wire Harnesses

Table 10-25: Wire Harness - Clutch, Ahead, Astern (p/n 15719-XX)

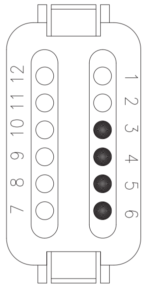
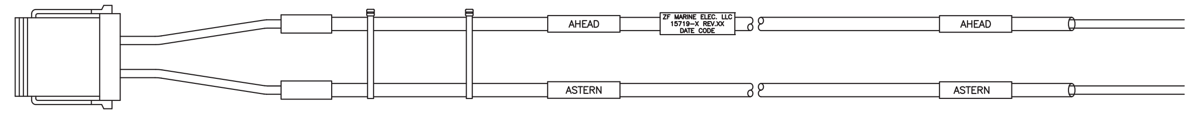
Termination A	Termination B
 PIN 3 AHEAD: RED PIN 4 AHEAD: BLACK PIN 5 ASTERN: RED PIN 6 ASTERN: BLACK DWG: 15719.2_ART	N/A
 DWG: 15719.1_ART	

Table 10-26: Wire Harness - Ahead / Astern Troll on/off Command (p/n 15725-XX)

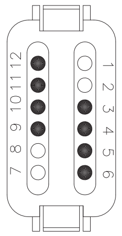
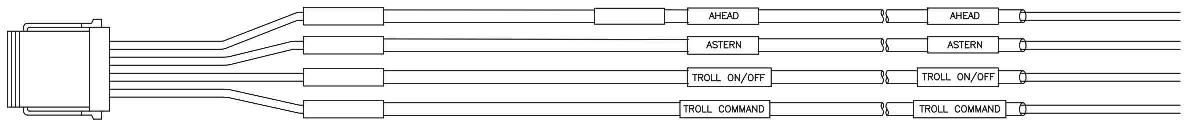
Termination A	Termination B
 PIN 3: RED (+) (AHEAD SOLENOID) PIN 4: BLACK (–) (AHEAD SOLENOID) PIN 5: RED (+) (ASTERN SOLENOID) PIN 6: BLACK (–) (ASTERN SOLENOID) PIN 9: RED (+) (TROLL ON/OFF) PIN 10: BLACK (–) (TROLL ON/OFF) PIN 11: RED (+) (TROLL COMMAND) PIN 12: BLACK (–) (TROLL COMMAND) DWG: 15021_ART	N/A
 DWG: 15022_ART	

Table 10-27: Wire Harness - Clutch with Troll Command (p/n 15732-XX)

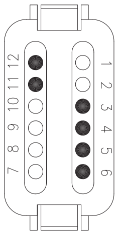
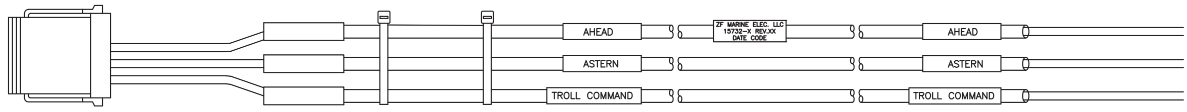
Termination A	Termination B
 PIN 3: RED (+) (AHEAD SOLENOID) PIN 4: BLACK (−) (AHEAD SOLENOID) PIN 5: RED (+) (ASTERN SOLENOID) PIN 6: BLACK (−) (ASTERN SOLENOID) PIN 11: RED (+) (TROLL COMMAND) DWG: 15019_ART	N/A
 DWG: 15020_ART	

Table 10-28: Wire Harness- Clutch, Ahead, Astern, Troll Command, Troll On-Off (p/n 70390-XX)

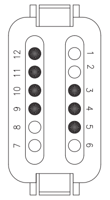
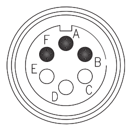
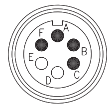
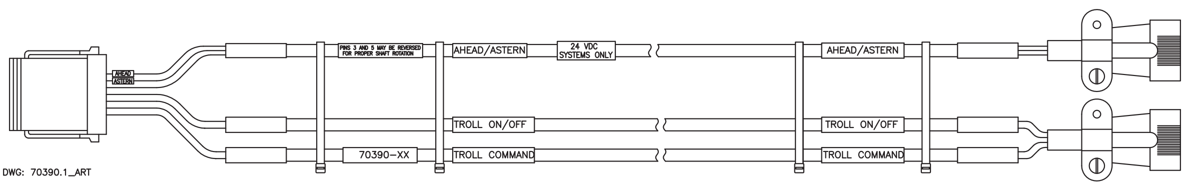
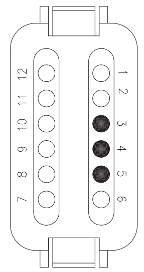
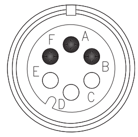
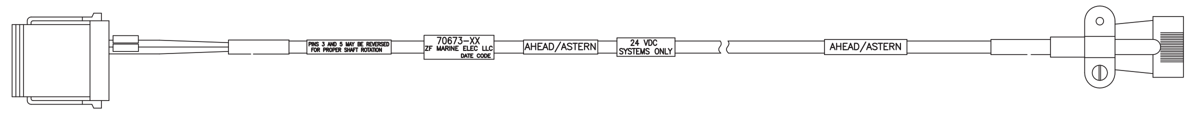
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td rowspan="2">
PIN 3: RED (+) (CABLE #1 AHEAD)
PIN 4: BLACK (–) (CABLE #1 AHEAD/ASTERN)
PIN 5: WHITE (+) (CABLE #1 ASTERN)
PIN 9: RED (+) (CABLE #2 TROLL ON/OFF)
PIN 10: BLACK (–) (CABLE #2 TROLL ON/OFF)
PIN 11: RED (+) (CABLE #3 TROLL COMMAND)
PIN 12: BLACK (–) (CABLE #3 TROLL COMMAND)
DWG: 70390.2_ART</td><td>
PIN A: RED (+) (CABLE #1 AHEAD)
PIN B: WHITE (+) (CABLE #1 ASTERN)
PIN F: BLACK (–) (CABLE #1 AHEAD)
DWG: 70390.3_ART</td></tr>
<tr><td>
PIN A: RED (+) (CABLE #3 TROLL COMMAND)
PIN B: RED (+) (CABLE #2 TROLL ON/OFF)
PIN C: BLACK (–) (CABLE #2 TROLL ON/OFF)
PIN F: BLACK (–) (CABLE #3 TROLL COMMAND)
DWG: 70390.4_ART</td></tr>
<tr><td colspan="2">
DWG: 70390.1_ART</td></tr>
</table>

Table 10-29: Wire Harness- Clutch, Ahead, Astern, ZFF Transmission (p/n 70673-XX)

Termination A	Termination B
 PIN 3: RED (+) (AHEAD) PIN 4: BLACK (−) PIN 5: WHITE (+) (ASTERN) DWG: 70673.2_ART	 PIN A: RED (+) (AHEAD) PIN B: WHITE (+) (ASTERN) PIN F: BLACK (−) (DC RETURN) DWG: 70673.3_ART
 DWG: 70673.1_ART	

10.12.1.4 Power Wire Harnesses

Table 10-30: Power, Start Interlock Harness Pin-Out (p/n 13756-XX)

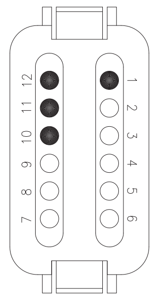
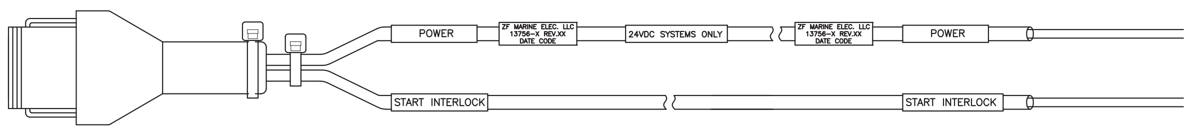
Termination A	Termination B
 PIN 11: BLACK (POWER) PIN 10: RED (POWER) PIN 1: YELLOW W/RED (START INTERLOCK) PIN 12: YELLOW W/RED (START INTERLOCK) DWG: 14985_ART	N/A
 DWG: 14986_ART	

Table 10-31: Wire Harness - Power, SI & Clutch Pressure Switch (p/n 13552-XX)

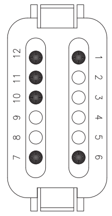
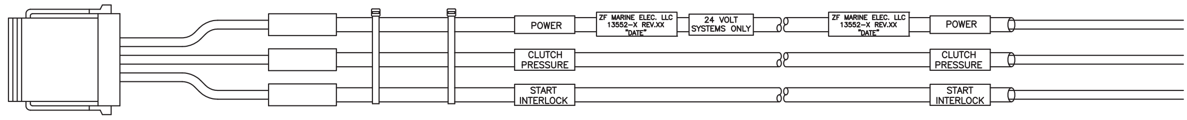
Termination A	Termination B
 PIN 1: YELLOW W/RED (START INTERLOCK) PIN 6: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 7: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 10: RED (POWER) PIN 11: BLACK (POWER) PIN 12: YELLOW W/RED (START INTERLOCK) DWG: 14987_ART	N/A
 DWG: 14988_ART	

Table 10-32: Wire Harness - Power, SI, Clutch Pressure Switch & Alarm (p/n 13631-XX)

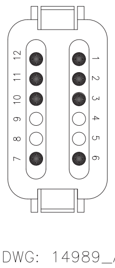
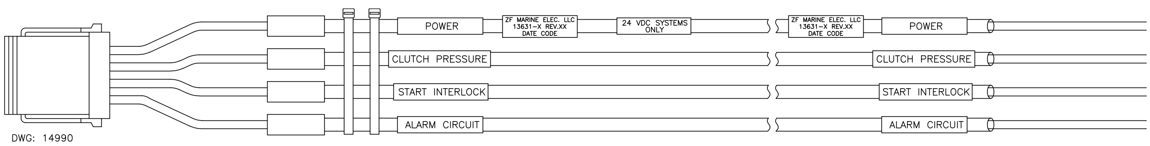
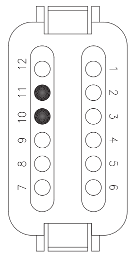
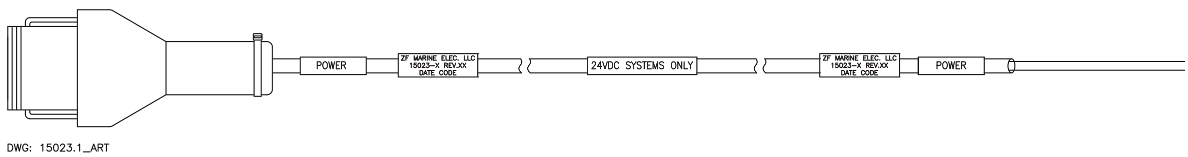
Termination A	Termination B
 PIN 1: YELLOW W/RED (START INTERLOCK) PIN 2: RED (ALARM CIRCUIT) PIN 3: BLACK (ALARM CIRCUIT) PIN 6: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 7: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 10: RED (POWER) PIN 11: BLACK (POWER) PIN 12: YELLOW W/RED (START INTERLOCK) DWG: 14989_ART	N/A
 DWG: 14990	

Table 10-33: Wire Harness- Power Use W/existing St Intlk Only (p/n 15023-XX)

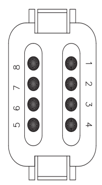
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>


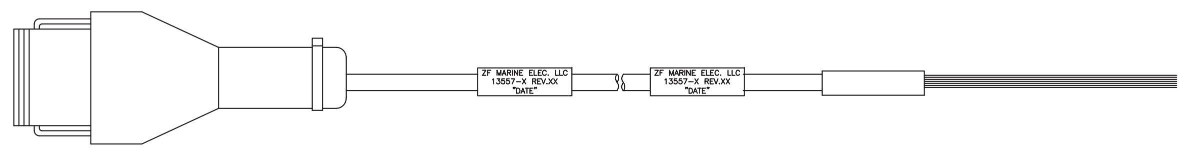
PIN 10: RED
PIN 11: BLACK
DWG: 15023.2_ART
</td><td>N/A</td></tr>
<tr><td colspan="2">


DWG: 15023.1_ART
</td></tr>
</table>

10.12.1.5 Control Head Wire Harnesses

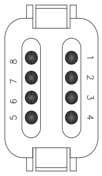
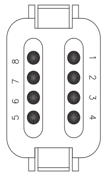
Table 10-34: Wire Harness - Control Head One Connector (p/n 13557-XX)

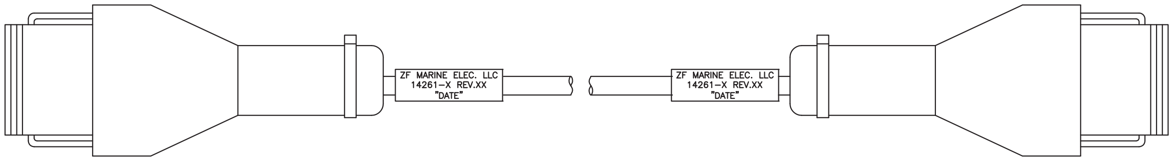
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>


PIN 1: GREEN/YELLOW (SHIELD) OR OPTIONAL SHIELD TO SOCKET
PIN 2: BROWN RED LED (+)
PIN 3: VIOLET GREEN LED (–) (SYNC)
PIN 4: ORANGE TRANSFER BUTTON (+)
PIN 5: RED GROUND
PIN 6: GREEN LEVER COMMAND SIGNAL
PIN 7: BLUE VREF (+5VDC)
PIN 8: BLACK TONE (+)
DWG: 13557.2_ART
</td><td>N/A</td></tr>
<tr><td colspan="2">


DWG: 13557.1_ART
</td></tr>
</table>

Table 10-35: Wire Harness - Control Head Two Connectors (p/n 14261-XX)

Termination A			Termination B		
					
PIN 1:	GREEN/YELLOW	(SHIELD) OR OPTIONAL SHIELD TO SOCKET	PIN 1:	GREEN/YELLOW	(SHIELD) OR OPTIONAL SHIELD TO SOCKET
PIN 2:	BROWN	RED LED (+)	PIN 2:	BROWN	RED LED (+)
PIN 3:	VIOLET	GREEN LED (-) (SYNC)	PIN 3:	VIOLET	GREEN LED (-) (SYNC)
PIN 4:	ORANGE	TRANSFER BUTTON (+)	PIN 4:	ORANGE	TRANSFER BUTTON (+)
PIN 5:	RED	GROUND	PIN 5:	RED	GROUND
PIN 6:	GREEN	LEVER COMMAND SIGNAL	PIN 6:	GREEN	LEVER COMMAND SIGNAL
PIN 7:	BLUE	VREF (+5VDC)	PIN 7:	BLUE	VREF (+5VDC)
PIN 8:	BLACK	TONE (+)	PIN 8:	BLACK	TONE (+)
DWG: 14261.2_ART			DWG: 14261.2_ART		



DWG: 14261.1_ART

NOTE: (P/N 14261) Starboard Side of Control Head - Jumper Pins 3 to 5;
Port Side of Control Head - Jumper Pins 3 to 7

10.13 Processor Pigtails

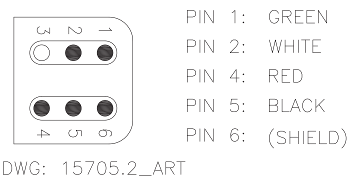
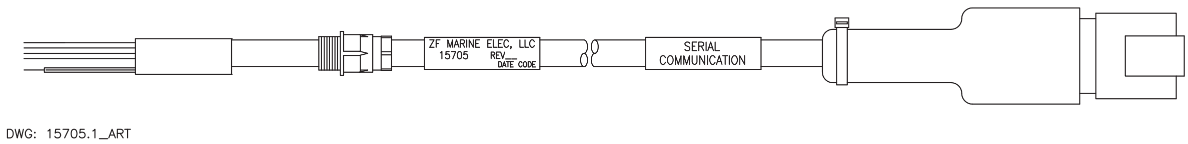
The number and types of Pigtails used varies with the different Processors and their configurations. The basic off-the-shelf Processors are available with no Pigtails (hard-wired) or pre-wired for up to a total of eight Pigtails when all five Remote Stations are being used.

The following Tables describe the pin outs and functions of the conductors within the various Pigtails.

10.13.1 Basic Processor Pigtails

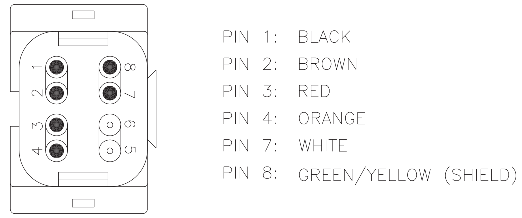
10.13.1.1 Serial Wire Harnesses Processor Pigtails

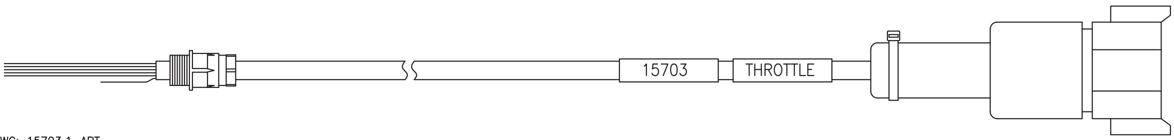
Table 10-36: Wire Harness - Serial Communication, Processor Lead (p/n 15705-XX)

<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>N/A</td><td>
</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

10.13.1.2 Throttle Wire Harnesses Processor Pigtails

Table 10-37: Wire Harness - Throttle, Processor Lead (p/n 15703-XX)

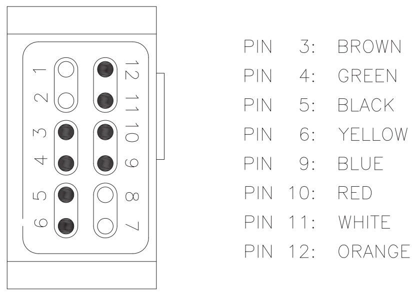
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>N/A</td><td>

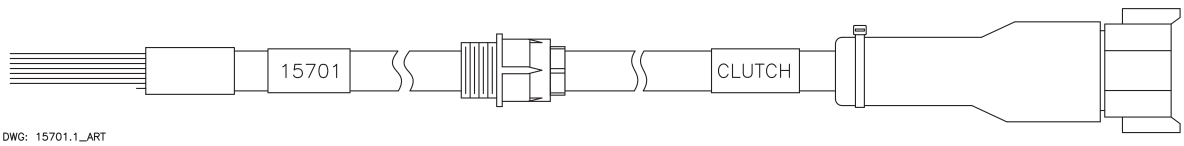
DWG: 15703.2_ART</td></tr>
<tr><td colspan="2">

DWG: 15703.1_ART</td></tr>
</table>

10.13.1.3 Clutch Wire Harnesses Processor Pigtails

Table 10-38: Wire Harness - Solenoid Clutches, Processor Lead (p/n 15701-XX)

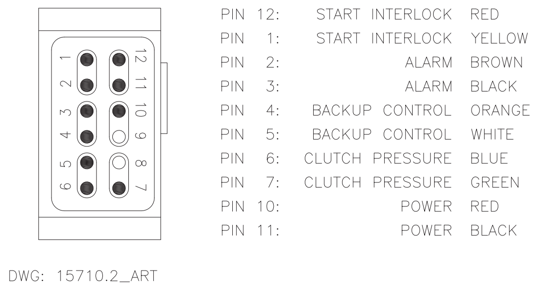
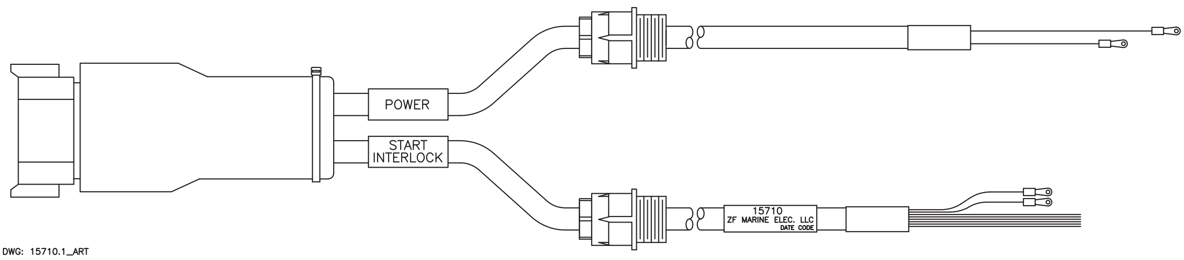
<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>N/A</td><td>

DWG: 15701.2_ART</td></tr>
<tr><td colspan="2">

DWG: 15701.1_ART</td></tr>
</table>

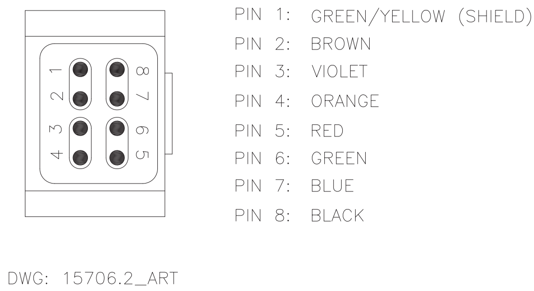
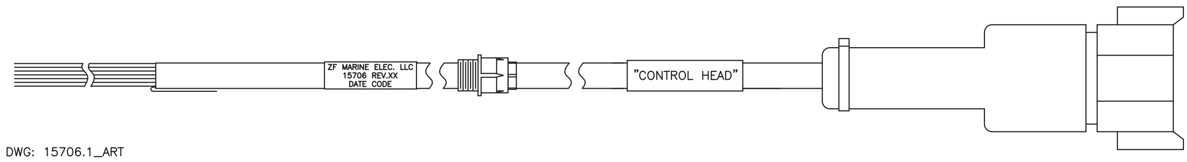
10.13.1.4 Power Wire Harnesses Processor Pigtails

Table 10-39: Power, Start Interlock, Clutch Oil Pressure Switch, and Alarm Pigtail Pin-Out (p/n 15710-XX)

<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>
</td><td>N/A</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

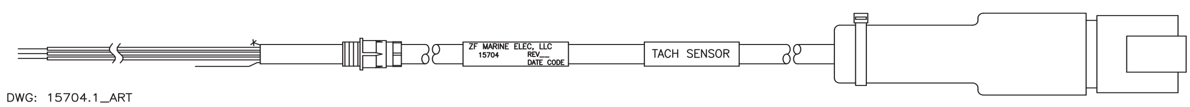
10.13.1.5 Control Head Wire Harnesses **Processor Pigtails**

Table 10-40: Wire Harness - Control Head, Processor Lead (p/n 15706-XX)

<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>N/A</td><td>
</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

10.13.1.6 Mag Pickup Wire Harnesses Processor Pigtails

Table 10-41: Wire Harness - Mag Pickup, Processor Lead (p/n 15704-XX)

<table>
<tr><th>Termination A</th><th>Termination B</th></tr>
<tr><td>N/A</td><td>
</td></tr>
<tr><td colspan="2">
</td></tr>
</table>

11 Appendix A - System Components and Specifications

400 Series Control Head Variations

Revision List

Rev	Date	Description
- to N.1	07/10	Previous date unavailable
N.2	02/15/12	Added compass distance note

This Service Sheet reflects all current variations of the standard 3-detent ZF 400 Series Control Heads.

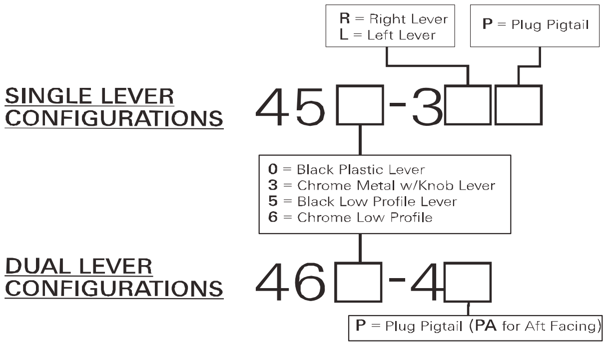


Figure MMC-280-1: Part Numbering Configurations

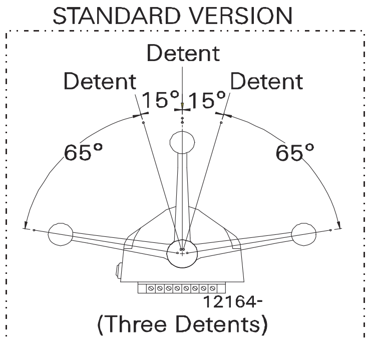


Figure MMC-280-2: Detents Available

1. Requirements:

   MicroCommander/ClearCommand: one (1) 8-Conductor Cable per Control Head lever.

   Pluggable MicroCommander/ClearCommand: one (1) Control Head Harness per Control Head lever.

   CruiseCommand: one (1) Control Head Harness per Control Head lever.

   Included with the Control Head:

   - Gasket
   - Mounting screws and washers
   - Terminals (For 8-Conductor or 1-Connector Harnesses)
   - Watertight cable grip for the cable entrance on the Processor (For 8-Conductor)

   When the Control Head is properly mounted on a console, it is spray proof from the top only. An adhesive gasket must be used to seal it to the mounting surface. However, below the mounting surface it needs protection from water or spray. Consider using a Weather Mount Enclosure, which is available from ZF.

2. Mounting And Installation:
    - A Select the desired mounting locations and make cutouts per template. Refer to Figure MMC-280-3: Dimensions.
    - B Check that the four mounting screws will start into the Control Head. Remove the Control Head from the cutout.
    - C Remove the backing from the adhesive gasket and apply the gasket adhesive side to the console around the cutout.
    - D Run cable/harnesses between Processor and Control Head. Label both ends with the Station ID. (EXAMPLE: Port, Center, or Starboard; Port Thrust, Port Throttle; etc.)

    There are two types of Control Head connections available: Plug or Terminal Connected. Both types may be used with MicroCommander, ClearCommand, or CruiseCommand using the appropriate cable or harness. Follow the appropriate steps for the Control Head that has been supplied for your system.

WARNING: Do not mount control head less than 100mm from Compass.
Mounting control head too close to compass can cause the compass to malfunction.

3. Type 1 - Pluggable

    Plug Control Head cable into the pigtail at the Control Head. (Ensure the correct Processor Cable is being plugged into the corresponding Control Head lever pigtail).

    When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected. Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.
4. Type 2 - Hard-wired
    - A Strip back the PVC cover on the shielded cable approximately 2-1/2" (63,5mm) at the Control Head.
    - B At the Control Head end of the cable strip and cut off the shielding and drain wire flush with the end of the PVC cover (the drain wire at the Control Head is not connected to ground).
    - C Strip 3/8" (9,5mm) insulation off each wire.
    - D Twist the individual strands of the wires to minimize fraying.
    - E Crimp a locking fork terminal (included with each Control Head) to each of the conductors.
    - F Make connections to the Control Head as indicated in the following TERMINAL CONNECTIONS diagrams.

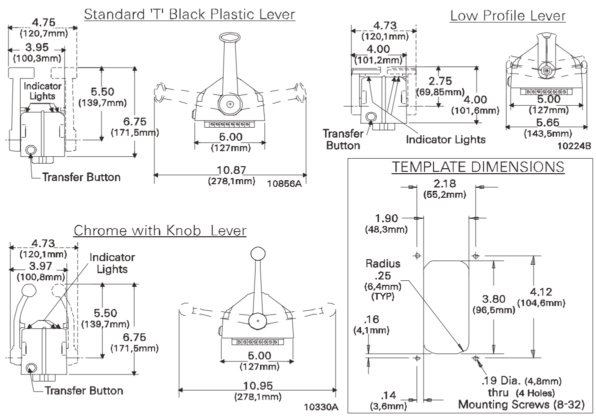


Figure MMC-280-3: Dimensions

ALWAYS REFER TO THE MANUAL THAT IS SUPPLIED WITH THE CONTROL SYSTEM FOR ANY UNIQUE CONTROL HEAD CONNECTIONS FOR YOUR SYSTEM.

When cable connections are complete, MOUNT Control Head to the console using the four (4) mounting screws and washers supplied with the Control Head.

WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !

5. CABLE/HARNESS CONNECTIONS:

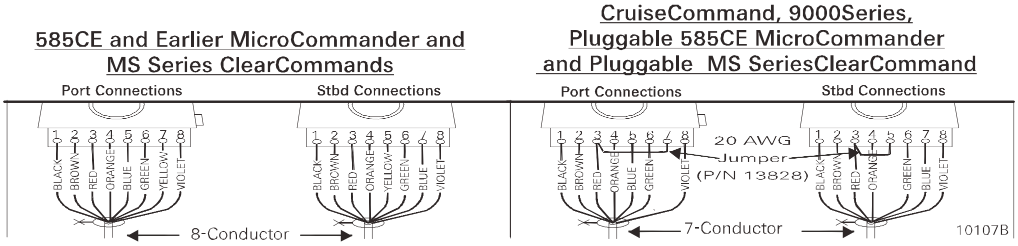


Figure MMC-280-4: Terminal Connections

Cable/Jumper connections 5 and 7 at the Port and Starboard terminal block are direction sensitive.

MicroCommander/ClearCommand			
Port Lever:		Starboard Lever:	
Terminal 3	Red	Terminal 3	Red
Terminal 5	Blue	Terminal 5	Yellow
Terminal 7	Yellow	Terminal 7	Blue

CruiseCommand/9000 Series			
Port Lever:		Starboard Lever:	
Terminal 3	Red & JUMPER	Terminal 3	Red & JUMPER
Terminal 5	Blue	Terminal 5	JUMPER
Terminal 7	JUMPER	Terminal 7	Blue

6. Pluggable Connections
   Pluggable Control Heads are supplied with a harness pigtail for each lever. When disconnecting/connecting the plugs, ensure that the release button or buttons are <u>depressed and held</u> until plug is fully disconnected or connected. Disconnecting/connecting plugs without depressing and holding the release button or buttons WILL damage the plug.
7. AFT FACING CONTROL HEADS

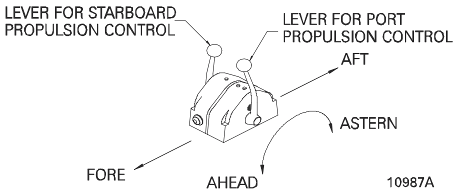
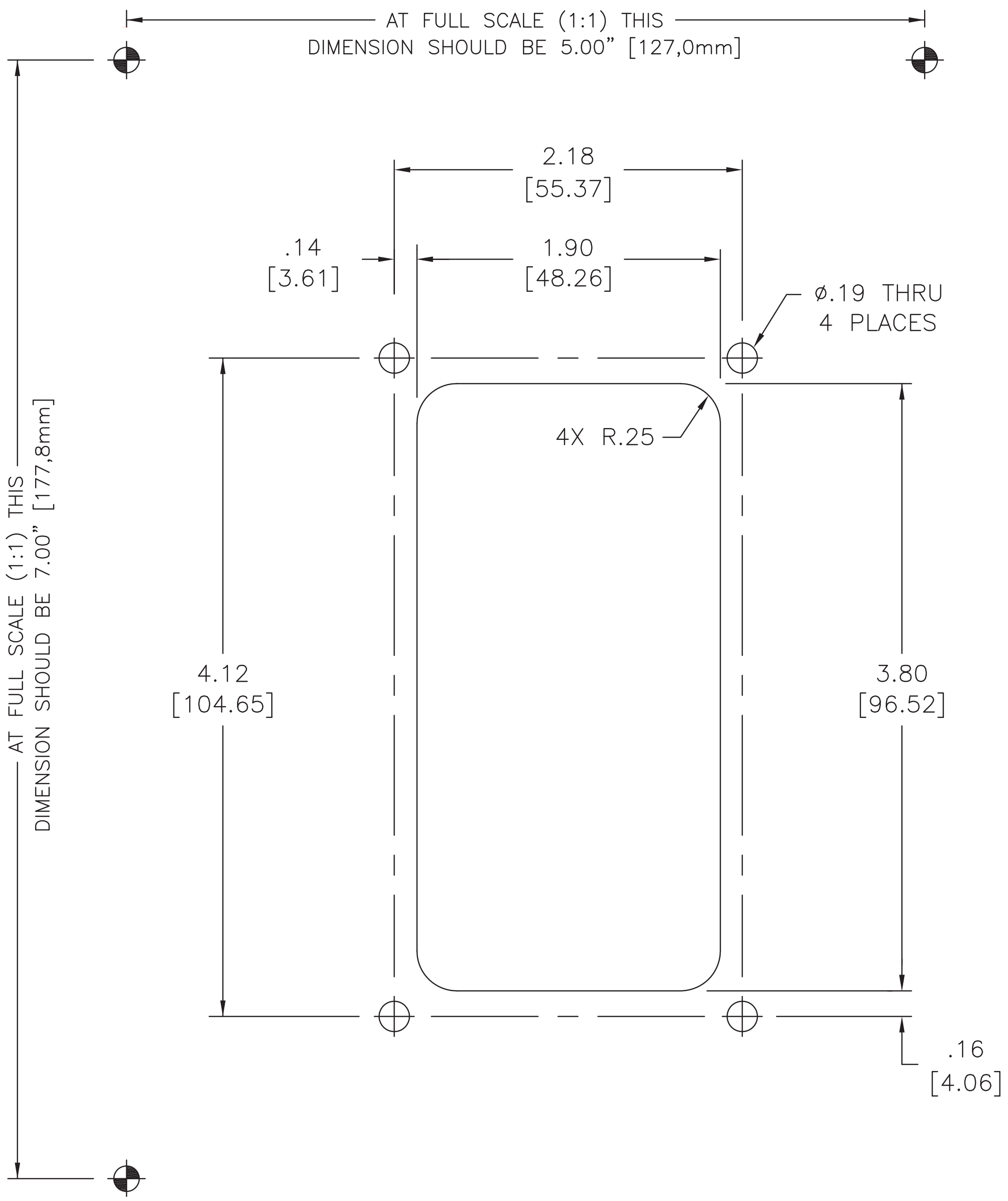


Figure MMC-280-5: AFT Facing Control Head

<u>For dual lever Control Head Stations</u> that have the user facing aft: Reverse connections 5 and 7.

<u>For single lever Control Head Stations</u> that have the user facing aft and the one Control Head lever on the user's right, reverse connections 5 and 7.

Handheld Control is a Station option. Contact your ZF Dealer for further information on Handheld requirements and options.



⚠	**WARNING:** Do not mount control head less than 100mm from Compass. Mounting control head too close to compass can cause the compass to malfunction.

⚠	**WARNING:** Note that the dimensions are out of scale, pay attention to properly size the cut out before use !

MC2000 Series Standard Control Head Variations

Revision List

Rev	Date	Description
- to E.1	03/11	Previous date unavailable
E.2	02/15/12	Added compass distance note

This Service Sheet reflects all current variations of the standard 3-detent ZF MC2000 Series Control Heads.

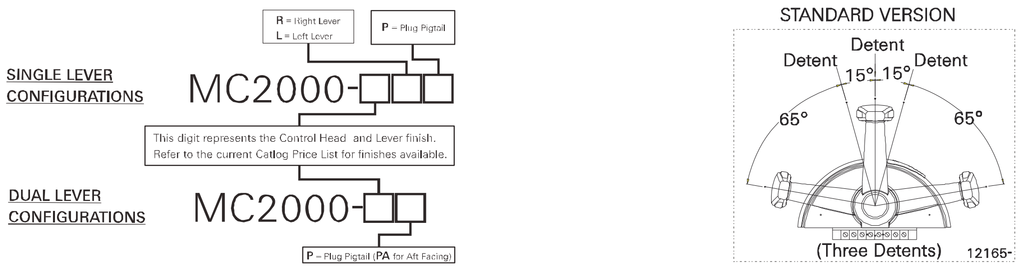


Figure MMC-329-1: Part Numbering Configurations Detents Available

REQUIREMENTS:

MicroCommander/ClearCommand: one (1) 8-Conductor Cable per Control Head lever.
Pluggable MicroCommander/ClearCommand: one (1) Control Head Harness per Control Head lever.
CruiseCommand: one (1) Control Head Harness per Control Head lever.
Included with the Control Head:

- Mounting screws
- Terminals (For 8-Conductor or 1-Connector Harnesses)
- Watertight cable grip for the cable entrance on the Processor (For 8-Conductor)

When the Control Head is properly mounted on a console, it is spray proof from the top only. An adhesive gasket is mounted on the bottom of the Control Head to seal it to the mounting surface. However, below the mounting surface it needs protection from water or spray. Consider using a Weather Mount Enclosure, which is available from ZF.

MOUNTING AND INSTALLATION:

A Select the desired mounting locations and make cutouts per template. Refer to Figure MMC-329-2: Dimensions.

B Check that the two mounting screws will start into the Control Head. Remove Control Head from cutout.

C Run cable/harnesses between Processor and Control Head. Label both ends with the Station ID. (EXAMPLE: Port, Center, or Starboard; Port Thrust, Port Throttle; etc.)

⚠	**WARNING: Do not mount control head less than 250mm from Compass.** **Mounting a control head too close to compass can cause the compass to malfunction.**

Dimensions

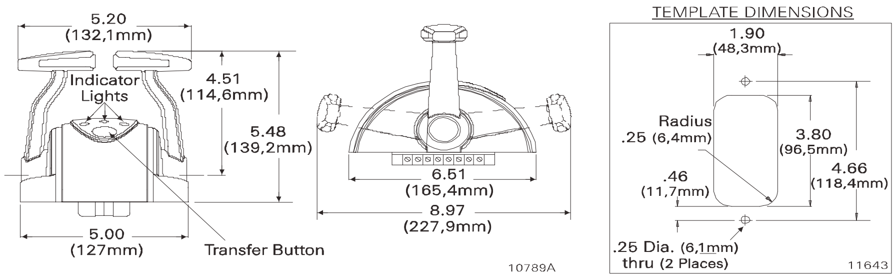


Figure MMC-329-2: Dimensions

There are two types of Control Head connections available: Plug or Terminal Connected. Both types may be used with MicroCommander, ClearCommand, or CruiseCommand using the appropriate cable or harness. Follow the appropriate steps for the Control Head that has been supplied for your system.

Pluggable

A Plug Control Head cable into the pigtail at the Control Head. (Ensure the correct Processor Cable is being plugged into the corresponding Control Head lever pigtail).

B When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected.

C Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

Standard Cable

A Strip back the PVC cover on the shielded cable approximately 2-1/2" (63,5mm) at the Control Head.

B At the Control Head end of the cable strip and cut off the shielding and drain wire flush with the end of the PVC cover (the drain wire at the Control Head is not connected to ground).

C Strip 3/8" (9,5mm) insulation off each wire.

D Twist the individual strands of the wires to minimize fraying.

E Crimp a locking fork terminal (included with each Control Head) to each of the conductors.

F Make connections to the Control Head as indicated in the following TERMINAL CONNECTIONS diagrams.

ALWAYS REFER TO THE MANUAL THAT IS SUPPLIED WITH THE CONTROL SYSTEM FOR ANY UNIQUE CONTROL HEAD CONNECTIONS FOR YOUR SYSTEM.

When cable connections are complete, MOUNT Control Head to the console using the two (2) mounting screws and washers supplied with the Control Head.

⚠	**WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !**

CABLE/HARNESS CONNECTIONS:

Dual Control Head Connections

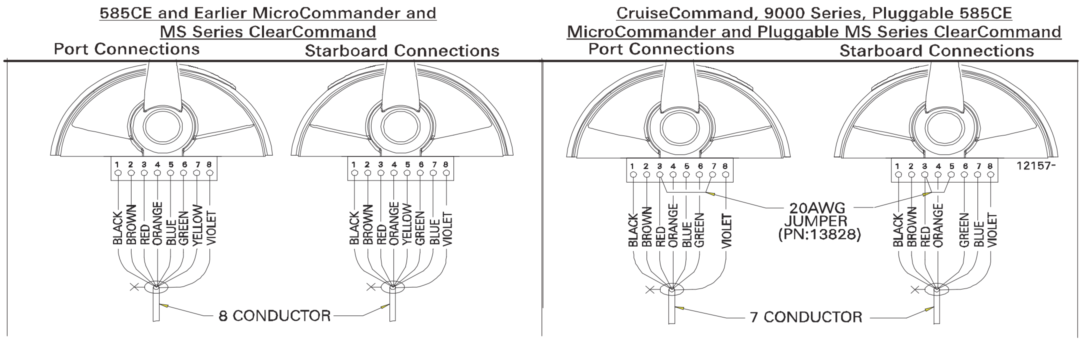


Figure MMC-329-3: Terminal Connections

Cable/Jumper connections 5 and 7 at the Port and Starboard terminal block are direction sensitive.

MicroCommander/ClearCommand		CruiseCommand/9000 Series	
Port Lever:	Starboard Lever:	Port Lever:	Starboard Lever:
Terminal 3 Red	Terminal 3 Red	Terminal 3 Red & JUMPER	Terminal 3 Red & JUMPER
Terminal 5 Blue	Terminal 5 Yellow	Terminal 5 Blue	Terminal 5 JUMPER
Terminal 7 Yellow	Terminal 7 Blue	Terminal 7 JUMPER	Terminal 7 Blue

Pluggable Connections

Pluggable Control Heads are supplied with a harness pigtail for each lever. When disconnecting/connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully disconnected or connected. Disconnecting/connecting plugs without depressing and holding the release button or buttons WILL damage the plug.

Aft Facing Control Heads

For dual lever Control Head Stations that have the user facing aft: Reverse connections 5 and 7.

For single lever Control Head Stations that have the user facing aft and the one Control Head lever on the user's right, reverse connections 5 and 7.

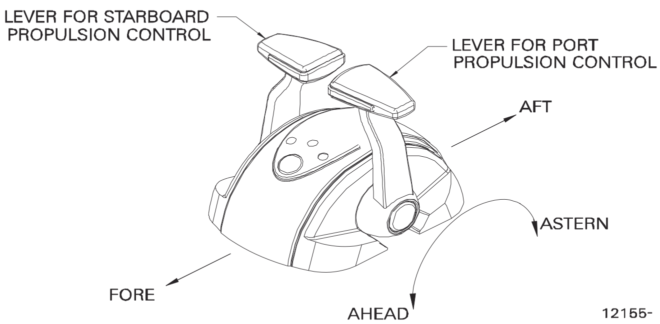
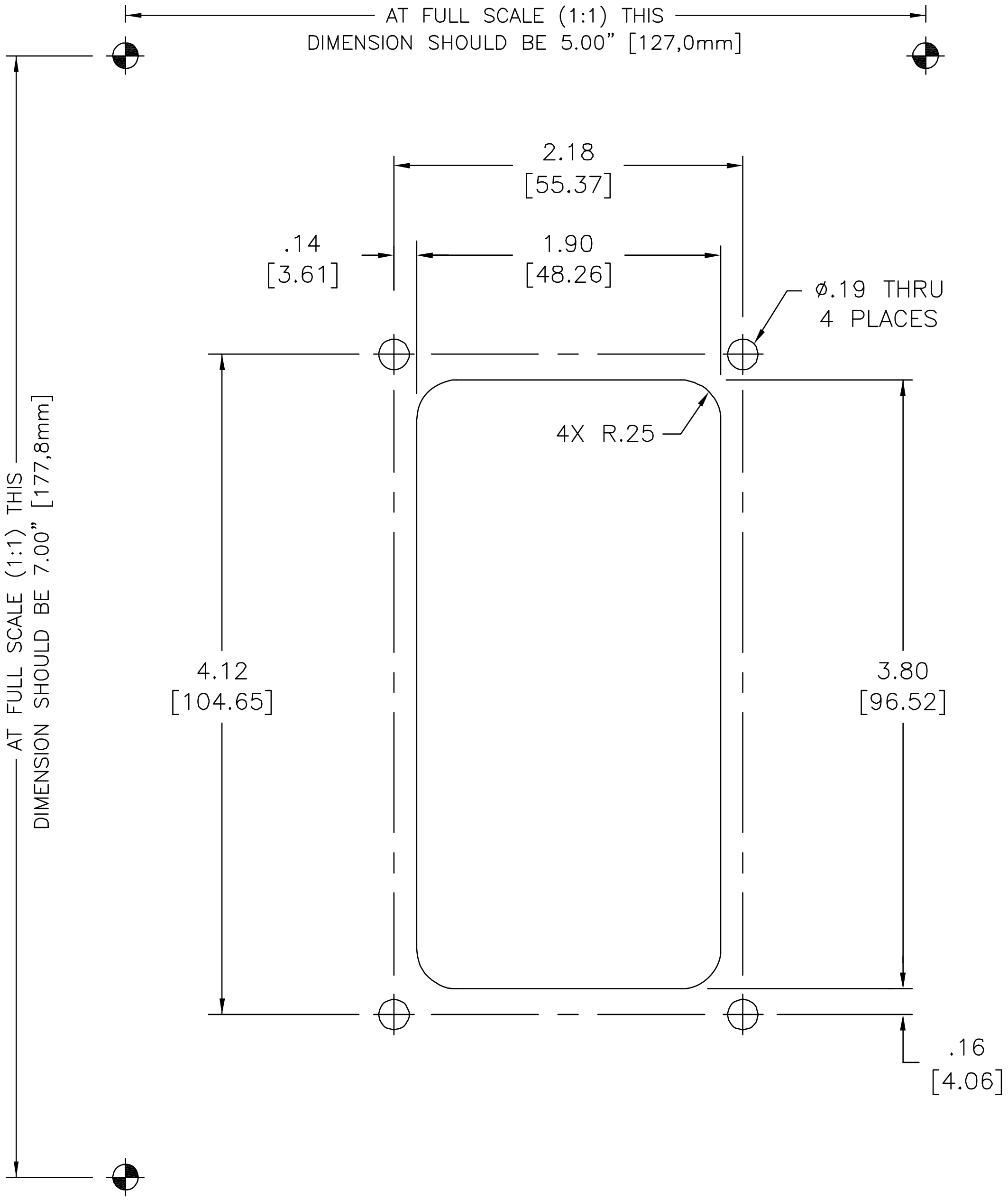


Figure MMC-329-4: AFT Facing Control Head

Handheld Control is an option. Contact your ZF Dealer for further information on Handheld requirements and options.



⚠	**WARNING:** Do not mount control head less than 250mm from Compass. Mounting a control head too close to compass can cause the compass to malfunction.

⚠	WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !

700 Series Standard Control Head Variations

This Service Sheet reflects all current variations of the standard 3-detent ZF Marine Electronics 700 Series Control Heads.

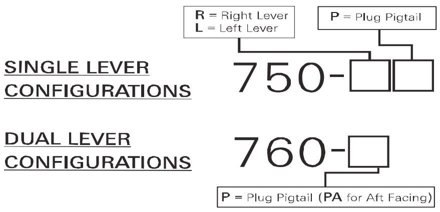


Figure MMC-307-1: Part Numbering Configurations

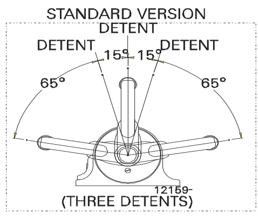


Figure MMC-307-2: Detents Available

1. REQUIREMENTS:

   MicroCommander/ClearCommand: one (1) 8-Conductor Cable per Control Head lever.

   Pluggable MicroCommander/ClearCommand: one (1) Control Head Harness per Control Head lever.

   CruiseCommand: one (1) Control Head Harness per Control Head lever.

   Included with the Control Head:

   - (4) Flat-washer - Stainless Steel, 1/4 inch
   - (4) Screw - Stainless Steel, Philip Pan Head, 1/4 inch-20 x 1-3/4 inch
   - (4) Nut - Stainless Steel, 1/4 inch-20
   - (14) Terminal - Flanged For, #6
   - (2) Liquid Tight Connector (in addition to those installed at the factory)

   When the Control Head is properly mounted on a console, the Control Head is watertight.

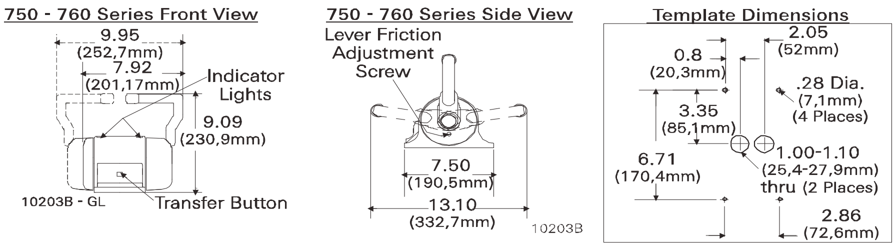


Figure MMC-307-3: Dimensions

2. MOUNTING AND INSTALLATION:

   Select the desired mounting locations and drill screw and cable holes as indicated on the template diagram. Refer to the Dimensions Diagram on the next page.

   Run cable/harnesses between Processor and Control Head. Label both ends with the Station ID. (EXAMPLE: Port, Center, or Starboard; Port Thrust, Port Throttle; etc.)

   There are two types of Control Head connections available: Plug or Terminal Connected. Both types may be used with MicroCommander, ClearCommand, or CruiseCommand using the appropriate cable or harness. Follow the appropriate steps for the Control Head that has been supplied for your system.

⚠	**WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !**

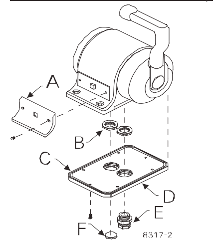
3. Standard Cable
    - A Remove the six screws holding the bottom cover of the Control Head housings and set aside.
    - B Insert cable through the correct cable grip in the bottom cover.
    - C Strip back the PVC cover on the shielded cable approximately 2-1/2" (63,5mm) at the Control Head.
    - D At the Control Head end of the cable strip and cut off the shielding and drain wire flush with the end of the PVC cover (the drain wire at the Control Head is not connected to ground).
    - E Strip 3/8" (9,5mm) insulation off each wire.
    - F Twist the individual strands of the wires to minimize fraying.
    - G Crimp a locking fork terminal (included with each Control Head) to each of the conductors.

    Make connections to the Control Head as indicated in the following TERMINAL CONNECTIONS diagrams.
4. Pluggable
    - A Plug Control Head cable into the pigtail at the Control Head. (Ensure the correct Processor Cable is being plugged into the corresponding Control Head lever pigtail).
    - B When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected. Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

    ALWAYS REFER TO THE MANUAL THAT IS SUPPLIED WITH THE CONTROL SYSTEM FOR ANY UNIQUE CONTROL HEAD CONNECTIONS FOR YOUR SYSTEM.

    When cable connections are complete:
    - A Replace Control Head bottom cover using the six (6) mounting screws removed earlier. Ensure seal is in place.
    - B Tighten watertight cable grip(s).
    - C Remove front cover from the Control Head
    - D Mount Control Head with supplied hardware.
    - E Replace front cover when mounting is complete.
5. Bottom Panel Assembly Designations
    - A Front Cover
    - B Cable Grip Nut
    - C Seal
    - D Bottom Cover
    - E 750-R = Plug; 750-L & 760 = Watertight Cable Grip (Cable O.D..275 -.393 [7mm - 10mm)
    - F 750-L = Plug; 750-R & 760 = Watertight Cable Grip (Cable O.D..275 -.393 [7mm - 10mm)

Bottom Panel Assembly



6. CABLE/HARNESS CONNECTIONS:

MicroCommander/ClearCommand			
Port Lever:		**Starboard Lever:**	
Terminal 3	Red	Terminal 3	Red
Terminal 5	Blue	Terminal 5	Yellow
Terminal 7	Yellow	Terminal 7	Blue

CruiseCommand/9000 Series			
Port Lever:		**Starboard Lever:**	
Terminal 3	Red & JUMPER	Terminal 3	Red & JUMPER
Terminal 5	Blue	Terminal 5	JUMPER
Terminal 7	JUMPER	Terminal 7	Blue

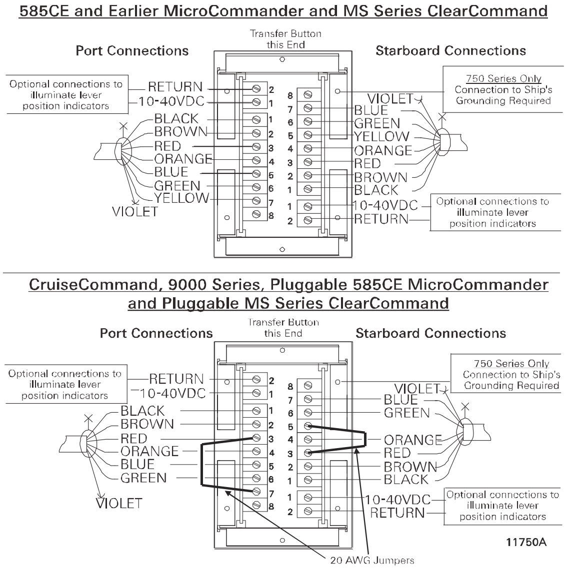


Figure MMC-307-4: Dual Control Head Connections

7. Pluggable Connections

Pluggable Control Heads are supplied with a harness pigtail for each lever. When disconnecting/connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully disconnected or connected. Disconnecting/connecting plugs without depressing and holding the release button or buttons WILL damage the plug.

8. Aft Facing Control Head

For dual lever Control Head Stations that have the user facing aft: Reverse connections 5 and 7.

For single lever Control Head Stations that have the user facing aft and the one Control Head lever on the user's right, reverse connections 5 and 7.

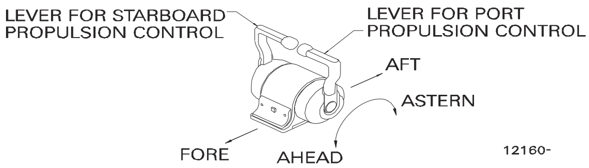
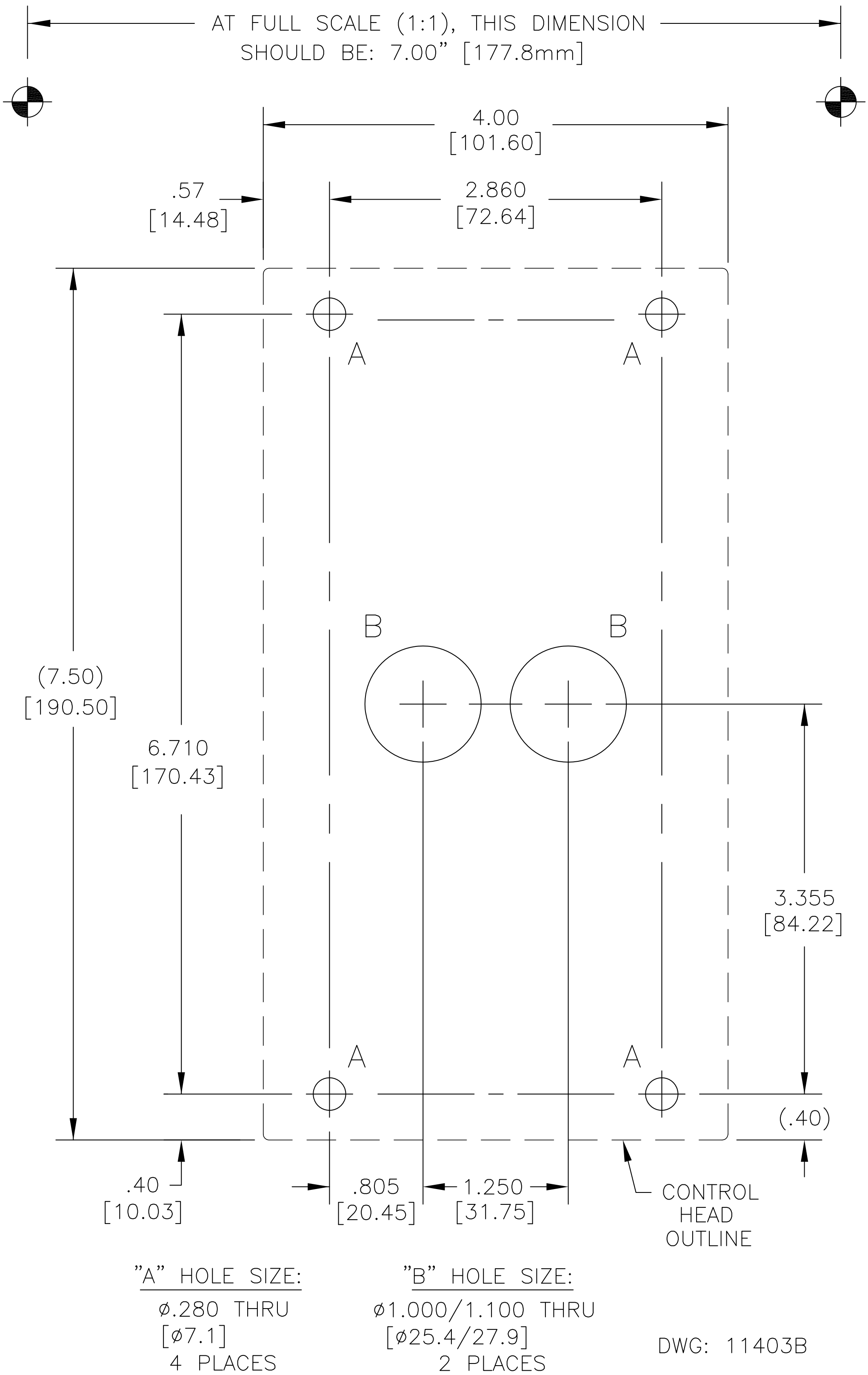


Figure MMC-307-5: Aft Facing Control Head

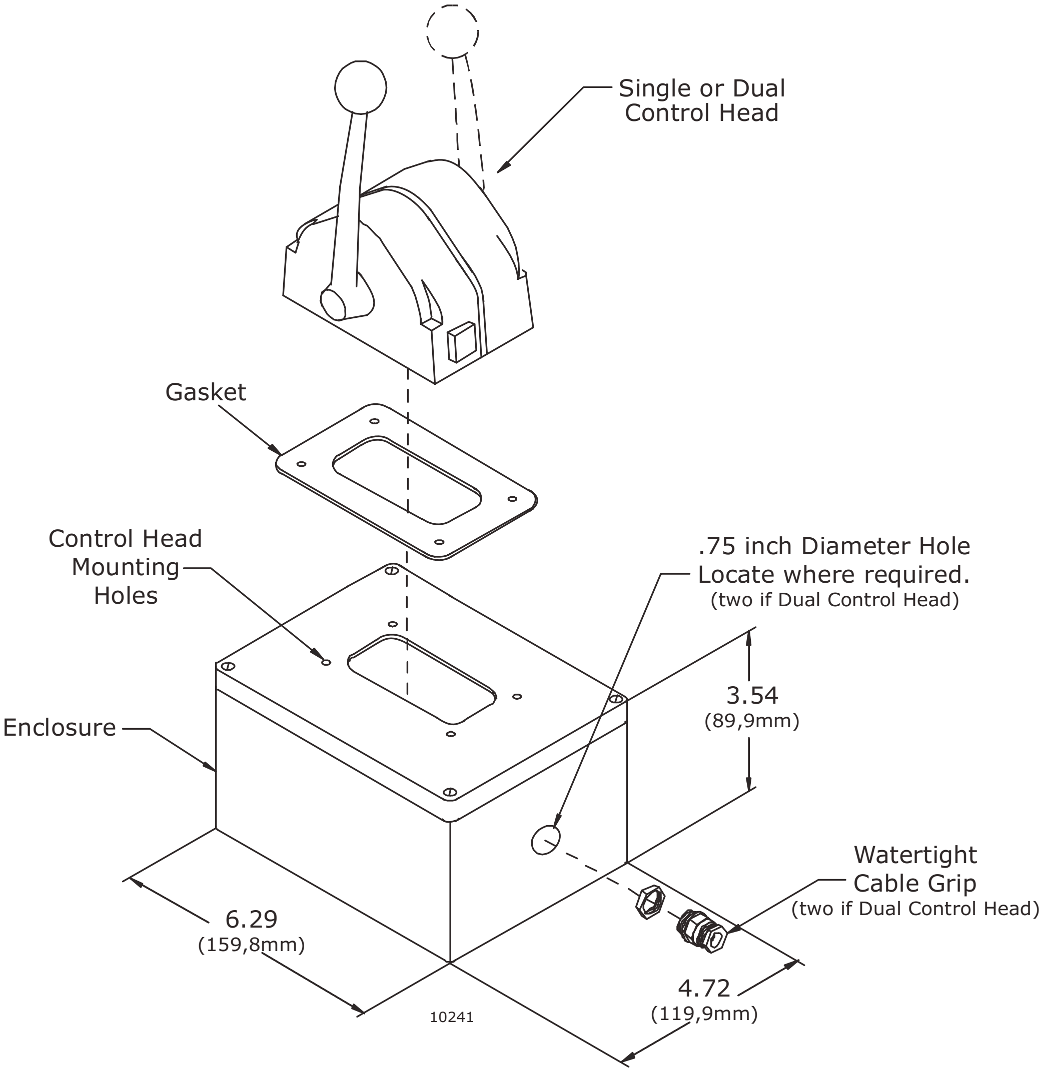
Handheld Control is a Station option. Contact your ZF Marine Electronics Dealer for further information on Handheld requirements and options.



⚠	WARNING: Do not mount control head less than 600mm from Compass. Mounting control head too close to compass can cause the compass to malfunction.

⚠	WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !

400 Series Weather Mount Enclosure



Deck Mount or Exposed Mount

Ideal for outside Weather Mount

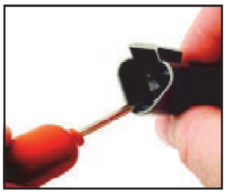
To prevent internal condensation and moisture build up the mount is drilled to allow air circulation.

Part No. 12110

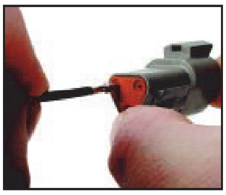
DT Type

Step 1: Contact Removal

1. Remove wedgelock using needlenose pliers or a hook shaped wire. Pull wedge straight out.



2. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.



3. Hold the rear seal in place, as removing the contact may displace the seal.

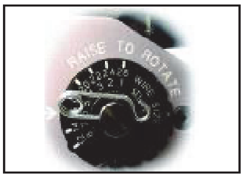
Step 2: Wire Stripping

Solid Contacts

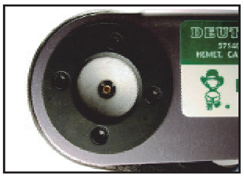
Contact Part Number	Wire Gauge Range	Strip Length (inches)
0460-202-20141 0462-201-20141	20 AWG 20 AWG	.156-.218 .156-.218
0460-202-16141 0462-201-16141	16, 18 & 20 AWG 16, 18 & 20 AWG	.250-.312 .250-.312
0460-215-16141 0462-209-16141	14 AWG 14 AWG	.250-.312 .250-.312
0460-204-12141 0462-203-12141	12 & 14 AWG 12 & 14 AWG	.222-.284 .222-.284
0460-204-08141 0462-203-08141	8 & 10 AWG 8 & 10 AWG	.430-.492 .430-.492
0460-204-0490 0462-203-04141	6 AWG 6 AWG	.430-.492 .430-.492

Step 3: Contact Crimping

Use Crimp Tool #HDT48-00

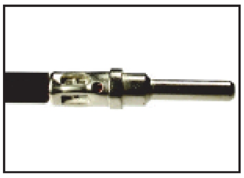


1. Strip insulation from wire. (See Step 2).
2. Raise selector knob and rotate until arrow is aligned with wire size to be crimped.
3. Loosen locknut, turn adjusting screw in until it stops.



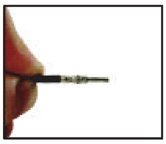
4. Insert contact with barrel up. Turn adjusting screw counter–clockwise until contact is flush with indentor cover. Tighten locknut.

5. Insert wire into contact. Contact must be centered between indicators. Close handles until crimp cycle is completed.
6. Release handles and remove crimped contact.

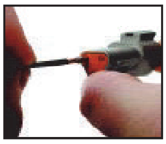


7. Inspect terminal to ensure that all strands are in crimp barrel. **NOTE:** Tool must be readjusted for each type/size of contact. Use HDT04-08 for size 8 and 4 contacts.

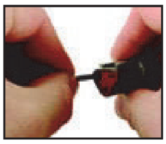
Step 4: Contact Insertion



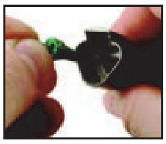
1. Grasp crimped contact approximately (25.2 mm) one inch behind the contact barrel.



2. Hold connector with rear grommet facing you.



3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that contact is properly locked in place.



4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.

NOTE: The receptacle is shown –use the same procedure for plug.

DEUTSCH INDUSTRIAL PRODUCTS DIVISION

LADD Exclusive Authorized U.S. Distributor (800) 223-1236

Automatic Power Selector (APS) Model: 13505

ATTACHMENTS: DC POWER SOURCE DWG 11488

A GENERAL INFORMATION

The APS, Model 13505, provides a simple, solid state solution to the need for routing redundant DC power sources for vital electronic equipment while maintaining isolation of the DC power sources.

Two independent batteries rated at the same nominal voltage are wired to separate terminals on the APS and internal diodes maintain total isolation between them. A single output terminal is wired to the ZF Marine Propulsion Control System.

The APS is rated for loads of up to 70 Amps on 12-24VDC systems. The unit is ruggedly constructed with heavy-duty wiring studs and epoxy-potted components in an anodized aluminum case.

B APS SPECIFICATIONS

Model: 13505

Maximum Load Current: 70 amps

Operating Temperature: - 40 degrees C to +80 degrees C; derate linearly from 100% @ 50 degrees C to 70% @ 80 degrees C

Voltage Drop: 0.7 VDC @ 50% load; 0.9 VDC @ full load

Dimensions: 3.25" x 4.5" x 3.1" (8,3 x 11,4 x 7,9 cm)

C MATERIALS PROVIDED

The single APS is supplied with a hardware packet containing (6) hex nuts, (3) lock washers, (4) self-tapping mounting screws, (1) instructions diagram.

> NOTE: Not all of the hardware will be used in the installation; some spares are provided. Nut size is M-6.

The twin APS is supplied with (2) single APS hardware packets.

D INSTALLATION

Refer to Drawing 11488 DC Power Source Kit.

1. Shut off all charging sources and disconnect the negative (ground) side of each battery which will be wired to the APS.
2. Mount the APS(s) in a suitable location which will keep wire runs to a minimum length, and is preferably ventilated, for cooler operation. The case of the APS is electrically isolated from the internal diodes, so mounting on either a metal or non-metal surface is acceptable.
3. Complete the wiring as indicated.
4. Reconnect the negative battery posts.

E IMPORTANT NOTE ABOUT BATTERY SOURCES

Whenever the load is turned on, it can be drawing power from the batteries. Therefore, if the batteries are not simultaneously being recharged, or if charging will not be available for an extended period, it is recommended that the load be shut off to prevent complete discharge of batteries.

NOTES: UNLESS OTHERWISE SPECIFIED

1. WIRE SIZE (REF ABYC E 11.16.1.2.9, TABLE X 3%).

12VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET [METRIC]	WIRE GAUGE AWG [METRIC EQUIV.]
0-15 FT. [0-4,6M]	12 AWG [#4]
15-25 FT. [4,6M-7,6M]	10 AWG [#6]
25-40 FT. [7,6M-12,2M]	8 AWG [#10]
40-70 FT. [12,2-21,3M]	6 AWG [#16]

24VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET [METRIC]	WIRE GAUGE AWG [METRIC EQUIV.]
0-20 FT. [0-6,1M]	14 AWG [#2,5]
20-30 FT. [6,1M-9,1M]	12 AWG [#4]
30-50 FT. [9,1M-15,2M]	10 AWG [#6]
50-80 FT. [15,2-24,3M]	8 AWG [#10]

2. WIRE SIZE (RECOMMENDED: TWISTED PAIR)

12VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET [METRIC]	WIRE GAUGE AWG [METRIC EQUIV.]
0-20 FT. [0-6,1M]	14 AWG [#2,5]
20-30 FT. [6,1M-9,1M]	12 AWG [#6]

24VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET [METRIC]	WIRE GAUGE AWG [METRIC EQUIV.]
0-40 FT. [0-12,2M]	14 AWG [#2,5]
40-65 FT. [12,2M-19,8M]	12 AWG [#4]

3. AUTOMATIC POWER SELECTOR (APS) OUTPUT IS STRICTLY FOR ZF MARINE ELECTRONIC CONTROLS.

4. POWER SOURCES MAY BE 12VDC OR 24VDC.

5. PART NUMBER: 13983 (SINGLE SCREW KIT MATERIAL LIST)
SEE SHEET 3 FOR BOM AND WIRING

PART NUMBER: 13984 (TWIN SCREW KIT MATERIAL LISTS)
SEE SHEETS 4 AND 5 FOR BOM AND WIRING

6. MAXIMUM WIRE SIZE ALLOWED IN FUSEHOLDER IS 12 AWG. IF A LARGER WIRE SIZE IS REQUIRED FOR INSTALLATION, THE CUSTOMER SHALL PROVIDE AN APPROPRIATE FUSE AND FUSE HOLDER. (SUGGESTED MANUFACTURER BLUE SEA SYSTEMS, MAXI FUSE BLOCK SERIES).

7. IF THIS CONFIGURATION IS USED WITH AN ELECTRONIC ENGINE, THE THE CIRCUIT BREAKER MUST BE TURNED ON PRIOR TO APPLYING POWER TO THE REMOTE SWITCH.

8. FOR SUGGESTED HARDWARE STACKING FOR SYSTEMS UTILIZING MULTIPLE OUTPUTS FROM THE APS, SEE SHEET 2.

REVISION

ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	QC/CE APR
	A	REVISED WIRING TO APS	JC 6-01	-	-
	B	ADDED FLAGNOTES 6 AND 7	TJ 7-02	-	-
	C	ADDED FLAGNOTE 8, REVISED FLAGNOTE 6.	TJ 3-03	-	-
	D	REVISED FLAGNOTES 1 AND 2.	MW 4-03	-	-
	E	MOVED DRAWING TO NEW FORMAT AND UPDATED. ADDED NEW SHEET 2, CREATING 4 SHEETS.	D.MONTZ 10/05/06	C.ESTES 10/11/06	RBH 10/12/06
	F	SHEET 2, ADDED SCHEMATIC DIAGRAM. SHEETS 3 AND 4: ADDED DIODES DIODES TO APS (3 PLACES) PER SHEET 2 SCHEMATIC. REVISED PER ECN 5141.	RAC 12/15/08	RSA 12/15/08	RBH 12/15/08
	G	SHEET 3: ADDED "FOR TWIN SCREW APPLICATION ONLY" REVISED WITHOUT ECN.	GJG 07/20/10	AHN 07/20/10	JDS 07/20/10
	H	EXTENSIVE CHANGES TO ALL SHEETS. UPDATED APS, CIRCUIT BREAKERS AND REMOTE SWITCH SCHEMATIC TO NEW ZF WIRING DIAGRAM DRAWING STANDARDS. SEE ECN ARCHIVES FOR PREVIOUS CONFIGURATION. REVISED PER ECN 5787.	RAC 08/11/12	AHN 08/18/12	RBH 08/18/12
	I	NOT USED	-	-	-
	J	ALL SHEETS: CHANGED ALL "ZF MARINE, MUKILTEO" REFERENCES TO "ZF MARINE, MARIMAR". REVISED PER ECN 6146.	RAC 01/15/13	DSF 01/15/13	JDS 01/15/13

SHEET INDEX

SHEET	DESCRIPTION
1	NOTES
2	AUTOMATIC POWER SELECTOR (APS): DIMENSIONS AND HARDWARE STACKING
3	SINGLE SCREW, SINGLE APS CONNECTIONS
4	TWIN SCREW, SINGLE APS CONNECTIONS
5	TWIN SCREW, DUAL APS CONNECTIONS

UNLESS OTHERWISE SPECIFIED TOLERANCES
FRAC. = ±1/64 IN.
.X = ±.05
.XX = ±.01
.XXX = ±.005
ANGLE = ±2°

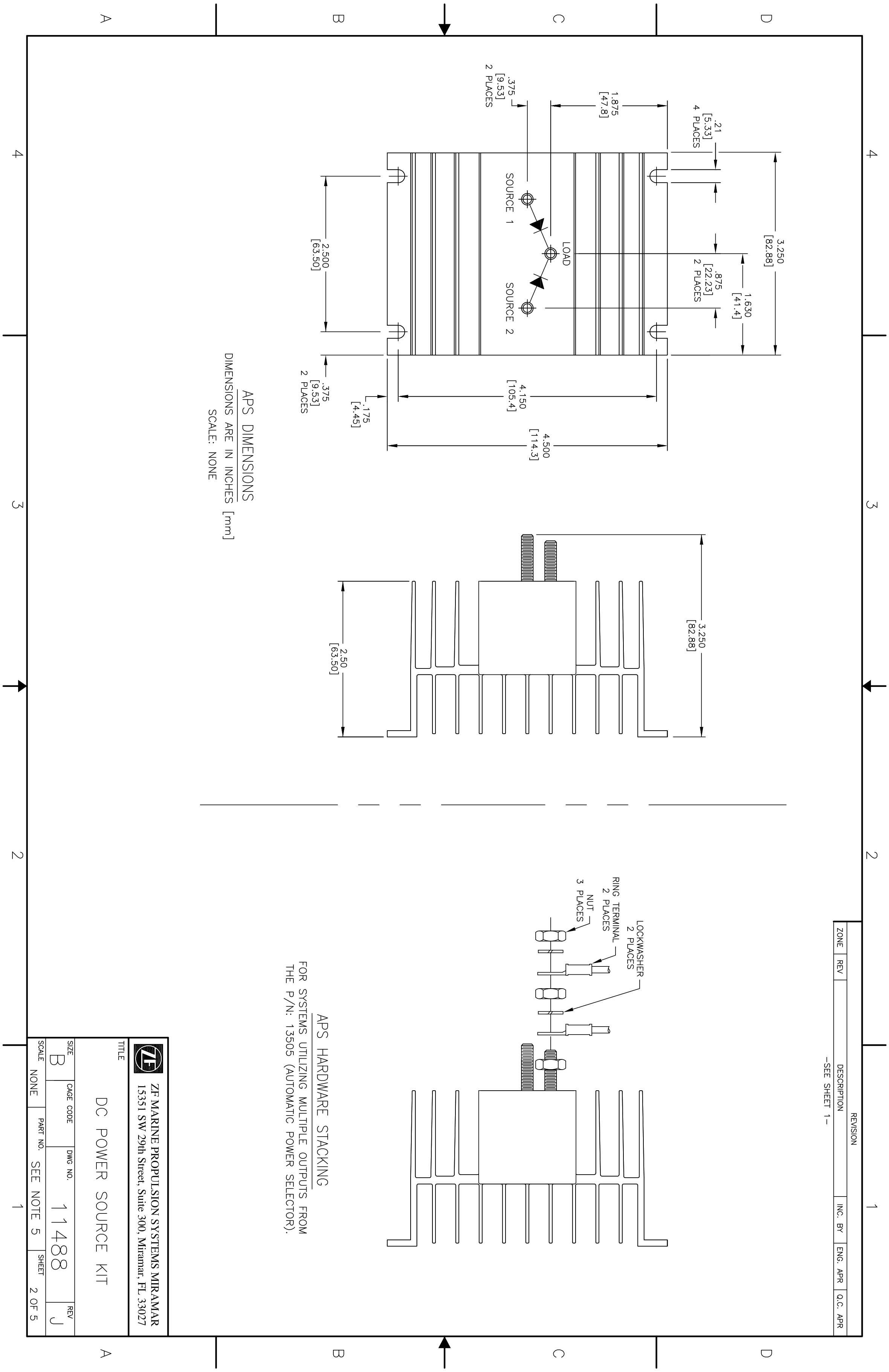
DIMENSIONS ARE IN INCHES [mm]
INTERPRET PER ANSI Y14.5M-1982
DIMENSIONS APPLY PRIOR TO FINISH
BREAK ALL SHARP EDGES
DO NOT SCALE DRAWING

	APPROVAL	DATE
DRN	M.WILSON	1-30-01
ENG	JHC	1-30-01
CHK	-	-
QC	-	-
MFG	-	-

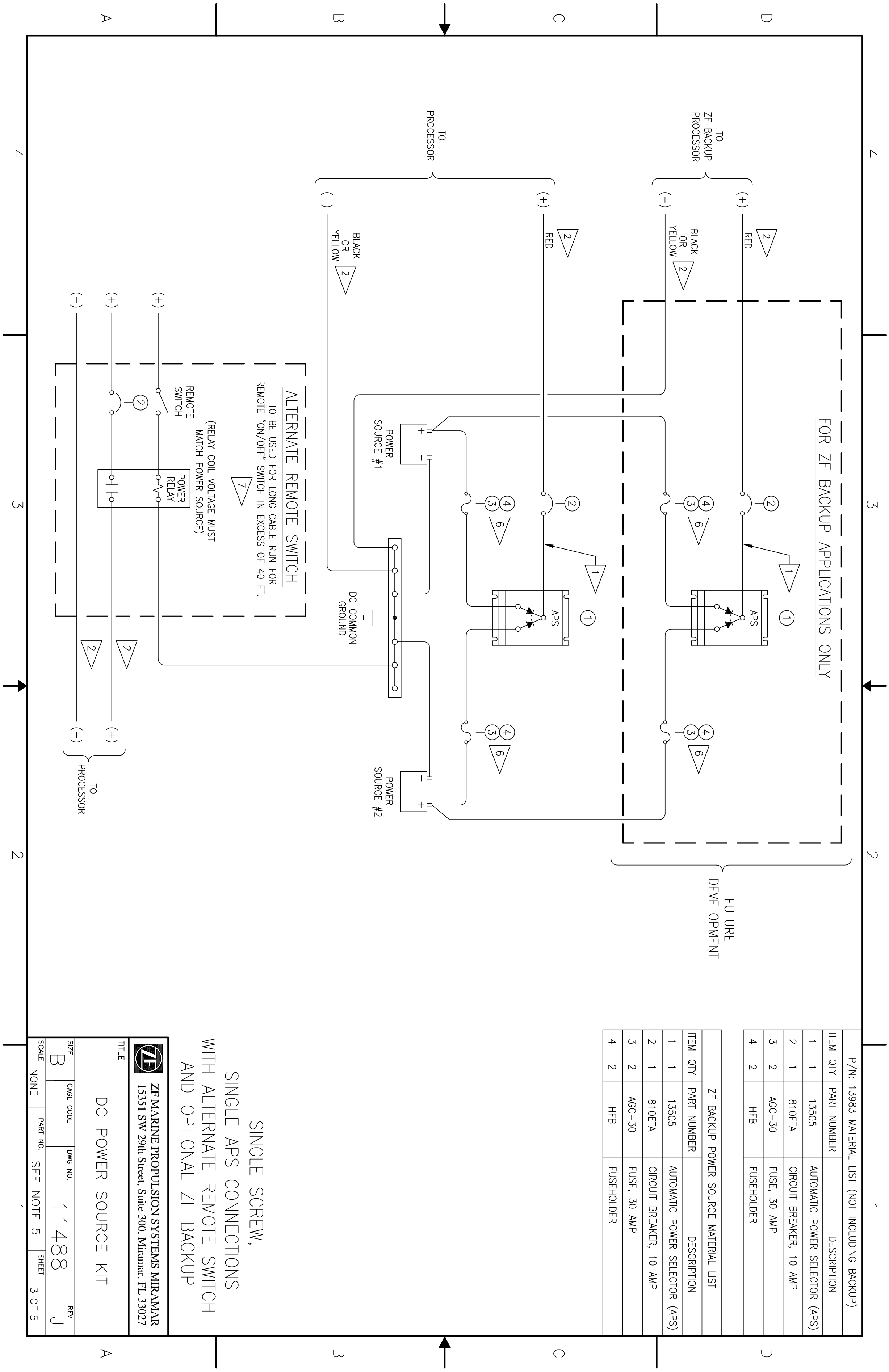
ZF MARINE PROPULSION SYSTEMS MIRAMAR
15351 SW 29th Street, Suite 300, Miramar, FL 33027

TITLE: DC POWER SOURCE KIT

SIZE: B | CAGE CODE: | DWG NO.: 11488 | REV: J
SCALE: NONE | PART NO.: SEE NOTE 5 | SHEET: 1 OF 5



WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !

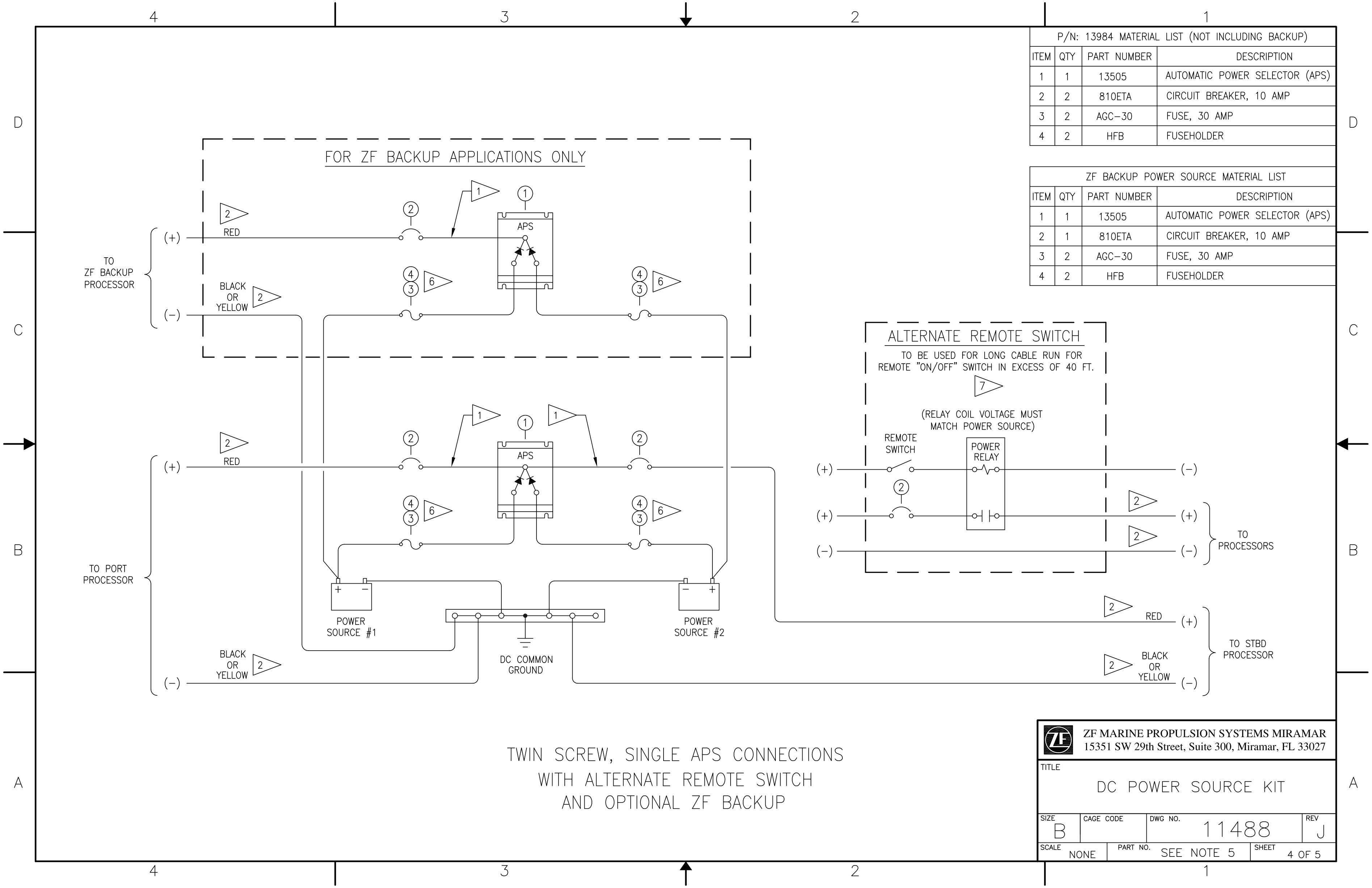


P/N: 13983 MATERIAL LIST (NOT INCLUDING BACKUP)

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

ZF BACKUP POWER SOURCE MATERIAL LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER



P/N: 13984 MATERIAL LIST (NOT INCLUDING BACKUP)			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	2	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

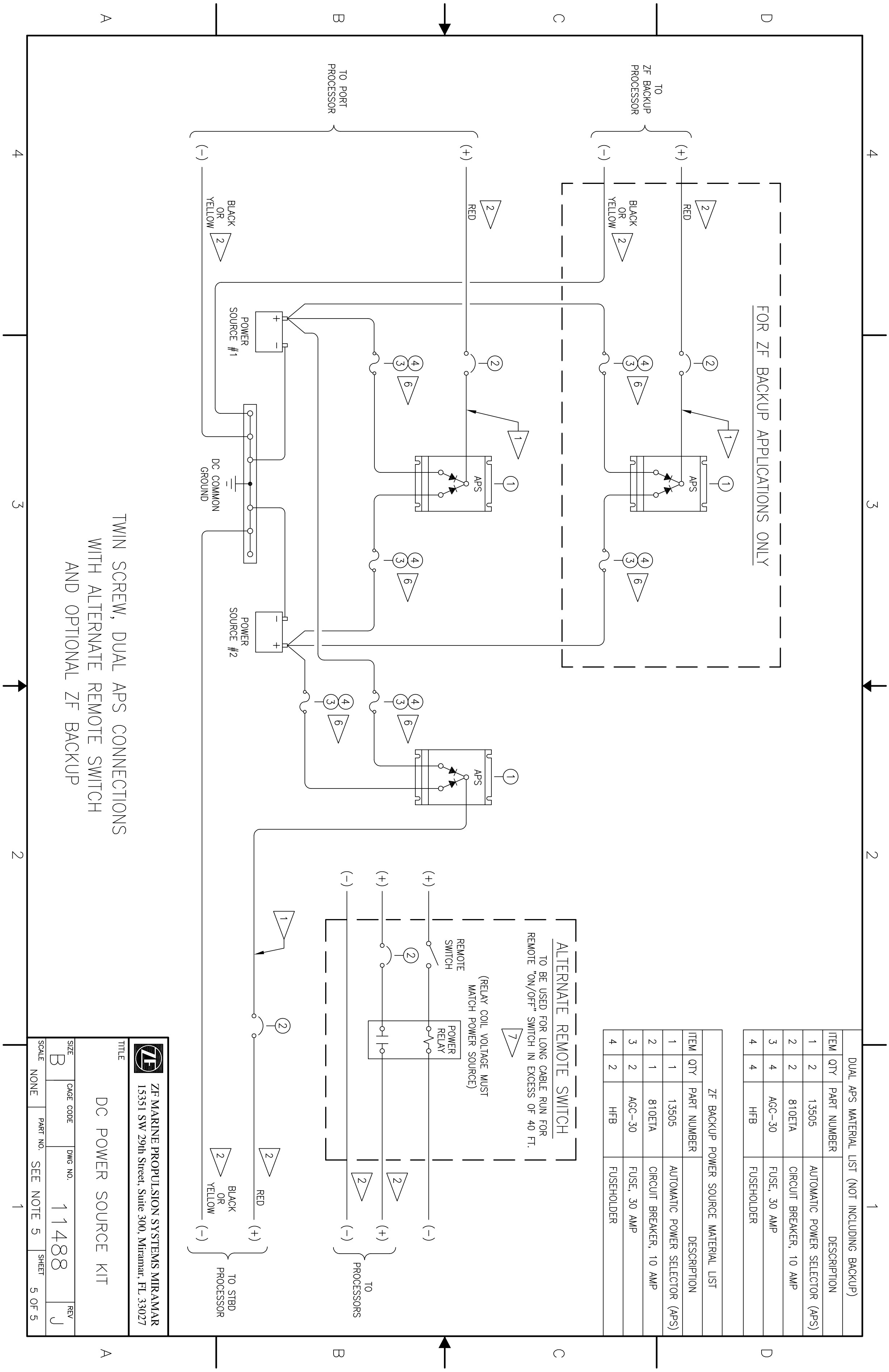
ZF BACKUP POWER SOURCE MATERIAL LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

TWIN SCREW, SINGLE APS CONNECTIONS
WITH ALTERNATE REMOTE SWITCH
AND OPTIONAL ZF BACKUP

ZF MARINE PROPULSION SYSTEMS MIRAMAR
15351 SW 29th Street, Suite 300, Miramar, FL 33027

TITLE: DC POWER SOURCE KIT

SIZE: B | CAGE CODE: | DWG NO.: 11488 | REV: J
SCALE: NONE | PART NO.: SEE NOTE 5 | SHEET: 4 OF 5



DUAL APS MATERIAL LIST (NOT INCLUDING BACKUP)

ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	13505	AUTOMATIC POWER SELECTOR (APS)
2	2	810ETA	CIRCUIT BREAKER, 10 AMP
3	4	AGC-30	FUSE, 30 AMP
4	4	HFB	FUSEHOLDER

ZF BACKUP POWER SOURCE MATERIAL LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

Grounding (Bonding)

Grounding (Bonding) - 46 CFR 111.05 and ABYC Section E-11: July 2012

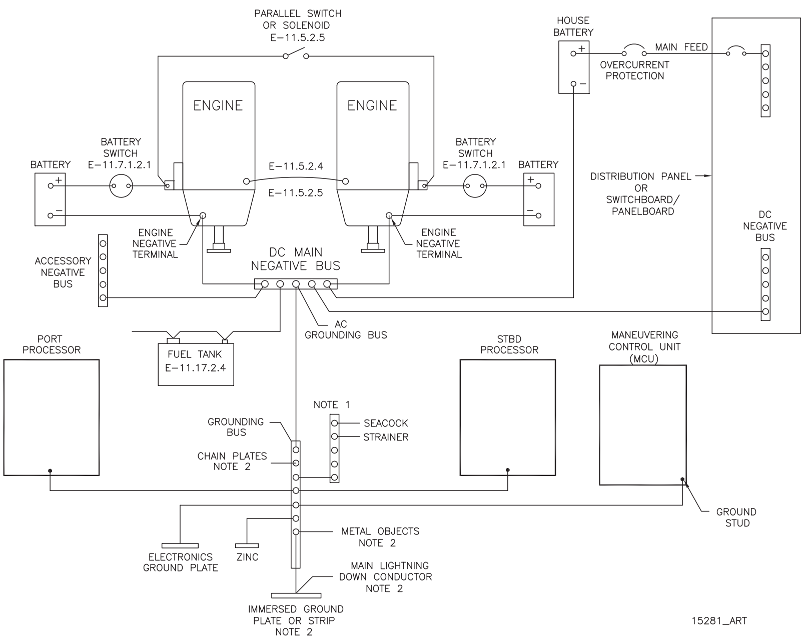
Grounding (Bonding) should be done according to ABYC Section E-11 and Code of Federal Regulations 46 CFR 111.05.

Each grounded system must have only one point of connection to ground regardless of the number of power sources operating in parallel in the system.

A vessel's hull must not carry current as a conductor. A metallic hull, or the bonding and DC grounding systems, shall not be used as a return conductor.

There are some limited exceptions: (1) Impressed current cathodic protection systems. (2) Limited and locally grounded systems, such as a battery system for engine starting that has a one-wire system and the ground lead connected to the engine. (3) Insulation level monitoring devices if the circulation current does not exceed 30 milliamperes under the most unfavorable conditions. (4) Welding systems with hull return except vessels subject to 46 CFR Subchapter D.

Grounding conductors should be identified via a green or green with a yellow stripe jacket, and shall not be used as a return. Where grounding conductors are attached to Processors or other CE marked devices – a tinned copper braid is the preferred grounding method - per References: CFR Sec. 111.05-11, Sec. 111.05-13 and ABYC E-11 sect. 11.4.



[a] Grounding diagram is used courtesy of American Boat and Yacht Council.
All parts of figure except processors and processor connection ©
2003 American Boat and Yacht Council

Metal - Hull Vessels

The hull of a metal hull vessel may serve as the common grounding conductor. If it is desirable for the item being installed to be bonded to the vessel grounding system, and the installation or mounting method does not provide the desired path, a separate grounding conductor may be required.

References and Parts Sources

References

A American Boat & Yacht Council (ABYC)
3069 Solomons Island Road
Edgewater, MD 21037-1416
- E-3 Wiring Identification on Boats
- E-11 AC and DC Electrical Systems on Boats
- H-2.4e or 32.4g Ambient Temp. 50 degrees C
- P-24 Electric/Electronic Propulsion Controls

B Code of Federal Regulations
33 CFR 183 Subpart I - Electrical Systems
33 CFR 183.410 Ignition protection
33 CFR 183.415 Grounding
33 CFR 183.425 Conductors: General
33 CFR 183.430 Conductors in circuit of less than 50 Volts
33 CFR 183.445 Conductors: Protection
33 CFR 183.455 Over-current and Protection: General
46 CFR 111.01 - 15(b) Ambient Temp. Machinery Spaces 50 degrees C
46 CFR 111.05- System Grounds

C Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096
- J1171 External Ignition Protection
- J1428 Marine Circuit Breakers
- J378 Marine Engine Wiring

D National Marine Manufacturers Association
401 North Michigan Avenue
Chicago, IL 60611

E Underwriters Laboratories

Parts Source

Anti-Static Wrist Strap - - - - - - - - - P/N 517 [Thomas & Betts (P/N AWCC)]
Automatic Power Selector - - - - - - - P/N 13505
Circuit Breaker- UL Approved - - - - - - P/N 810 [E-T-A (P/N 41-2-514-LN2-10)]
Fuse- - - - - - - - - - - - - - - - - - - P/N 1030 [Bussman (P/N. GDC-1A)]
Relay 12 VDC - - - - - - - - - - - - - P/N 1114 [Potter-Brumfield (P/N KRPA5D6-12)]
Relay 24 VDC - - - - - - - - - - - - - P/N 1122 [Potter-Brumfield (P/N KRPA5D6-24)]
Service Field Test Unit (Break-out Box) - P/N 13927
WAGO Tool - - - - - - - - - - - - - - - P/N 397 [WAGO (P/N 236-332)]
Field Test Control Head - Dual - - - - - P/N 14000

Engine Tachometer Sender Requirements

Engine Type	Engine	Model	Sender	Comments
Gasoline	Inboard	3, 4, 6, 8 Cylinder	Alternator's Stator AC Terminal or Point Side of the Coil	N/A
Gasoline	Outboard	4, 6, 8, 14 Pole	Alternator's Stator AC Terminal or Point Side of the Coil	N/A
Diesel	Caterpillar	Most Older & 3208, D336, D346, D348, D398, D399 & D334	8902	N/A
Diesel	Caterpillar	3116, 3126, 3176, 3196, 3406, 3408, 3306, 3412, 3056, 3512 & 3516	8922	Some use 8912. New engines have Magnetic Pickup already installed on flywheel.
Diesel	Caterpillar	All Electronic	N/A	Use ECM output. Outputs 12 PPR.
Diesel	Cummins	Most Older & 555	8902	N/A
Diesel	Cummins	B & C Series, KTA19M3, MTA855, * KTA1150M	8912	Most have Magnetic Pickup already installed on flywheel.
Diesel	Detroit	DDEC Electronic System	8902	Must have Detroit data-link output module.
Diesel	Detroit	53, 71, & 92 Series	8902	Engines manufactured before 1976 use Aetna Part No. 8152 drive key with Sender.
Diesel	Detroit	8.2 Liter 2 Cycle, Some 71 & 92 Series	8912	N/A
Diesel	EMD	Mechanical Sender Applications	8902	N/A
Diesel	EMD	Flywheel Applications	8912	N/A
Diesel	Hino	All Engines	8902	250 HP: Tach drive on front Port side of engine. 310HP: Tach drive on rear center, just below the head.
Diesel	John Deere	Older Engines	8902	Tach drive usually at rear Starboard side of engine.
Diesel	John Deere	Newer Engines	8912	Magnetic Pickup usually already installed.

Engine Type	Engine	Model	Sender	Comments
Diesel	Lehman (Ford)	All Engines	8902	Engine built after 1977 require the Aetna Part No. 8619 tachometer drive adapter.
Diesel	Lugger	All Engines	8912	N/A
Diesel	MAN	In-line	8902	N/A
Diesel	MAN	V-Engines	8902	An extension tachometer cable Aetna Part No. 9212 is usually required.
Engine Type	Engine	Model	Sender	Comments
Diesel	MAN	826	8912	It may be necessary to manufacture a mounting plate for the magnetic pickup.
Diesel	MAN	2840, 2842, 2848, 2866 & 2886	8912	N/A
Diesel	MTU	All Engines	8902	N/A
Diesel	Perkins	1980 and earlier	8902	N/A
Diesel	Perkins	4-236 & 6-354	8902	Perkins Part No. 8875 drive adapter needed on 1980 and newer engines.
Diesel	Perkins	4-107, 4-108 & M-800TI	8902	N/A
Diesel	Perkins	4-154	N/A	Aetna Part No. 8709 Magnetic Sensor must be used in lieu of SAE drive.
Diesel	Perkins	M-135, M225, M-300 & M30	8912	N/A
Diesel	Volvo	70, 100 & 120 A or B Series	8902	N/A
Diesel	Volvo	3, 6A, 17 & 30	8912	N/A
Diesel	Volvo	31 & Up, 41	N/A	Aetna Part No. 8709 Magnetic Sensor must be used in lieu of SAE drive.
Diesel	Volvo	40, 60, 61 & Up, 71 & Up, 100C & Up, 102, 121C & Up, 122, 2010 & 2020	N/A	Magnetic pickup already installed on cam gear.
Diesel	Volvo	42 & 43	N/A	Connect at blower box. Black wire is ground and grey is signal
Diesel	Volvo	2030 & 2040	N/A	Magnetic pickup already installed on cam gear.
Diesel	Yanmar	All Engines	N/A	A metric Magnetic pickup is already installed on all engines.

P/N 8902 Dual Mechanical Sender
P/N 8912 Dual Magnetic Pickup (3/4-16)
P/N 8922 Single Magnetic Pickup (5/8-18) Available through Aetna Engineering only.

Morse Clutch and Throttle Kit Selection
Pre-Engineered Throttle Connection Kits

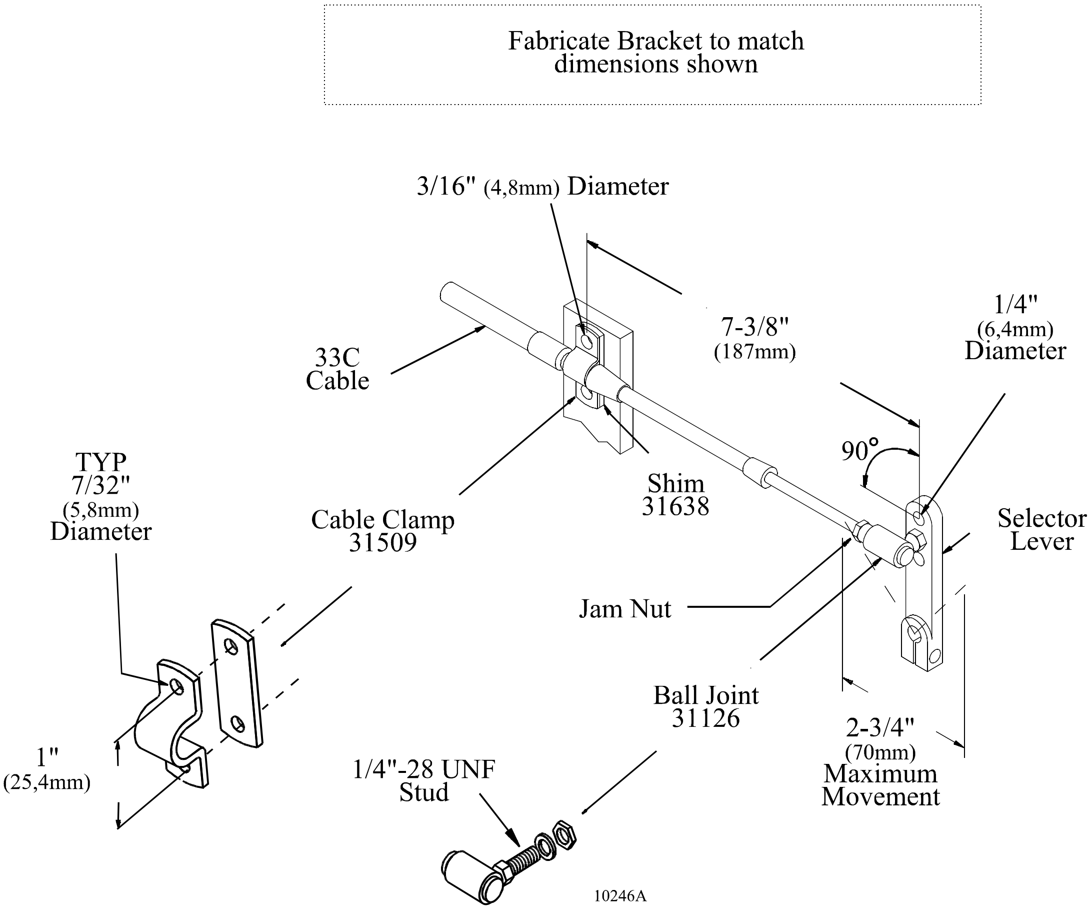
MAKE	ENGINE MODEL	KIT NO.
Caterpillar	3208NA 3208TA 334, 3304, 3306 3406 & 343 3408	300172 305403 36680 36680 36680
Cummins	A11 w/MVSGOV AFC Fuel Pump V504M, V555M, V903M, VT903M, VTA903M, NT855M, VT171OM, VTA171OM, KT & KTA 1150M, KT & KTA 2300M, 1975 and later	36680 300580
General Motors	3, 4, & 6-71 w/var.sp.gov. 6, 8, 12 V-71 & 6, 8 V-92 w/var.sp.gov. 6-71 inclined 2, 3, 4-53 w/left hand gov. Right hand gov. 6V-53 Rear entry 6V-53 Front entry 6, 8V-71 Front entry 12, 16V-149	41736 41736 36680 36680 36680 36680 36680 36680
Perkins	4, 236M 6, 3544M; T6, 3544M; ST6, 3544M; SST6, 3544M 4, 108 W/shut off	48931 302026 303878

MAKE	TRANSMISSION MODEL	KIT NO.
Allison	M & MH	41482
Borg Worner	70, 71, 72 In line w/red gear rear entry	301474
Capital	12400 2, 3, & 4 HD & HE	36680 36680
MerCruiser	Inboard w/o Warner reduction gear	62355
Paragon	HF-7	36680
Twin Disc	MG508, 509, 510, 510A, 512, 514C, 514CHP, 518, 521, 527, 530, 540 MG502, 506, 507, W/x9994, xA7022, A7048 Valves	42577 63696
Twin Disc Trolling Valve	MG509, 510A, 511A, 514C	307171

ENGINE MAKE	KIT NO.
Chrysler 1975 & later	300465

ENGINE MAKE	KIT NO.
Evinrude/Johnson 55-235 H.P. 1978 to date	301729
Mercury 40-300 H.P.	301901
Mercruiser I/O	302123
OMC Sterndrive I/O	300557
Volvo I/O Engine and out drive brackets are provided by Volvo	

Universal Mounting Kit



43C Cable Conversion Kit

Rev	Date	Revision Description
A	8/03	Added 9000 Series.
A.1	10/11	Converted document name from MM13821 to MMC-345

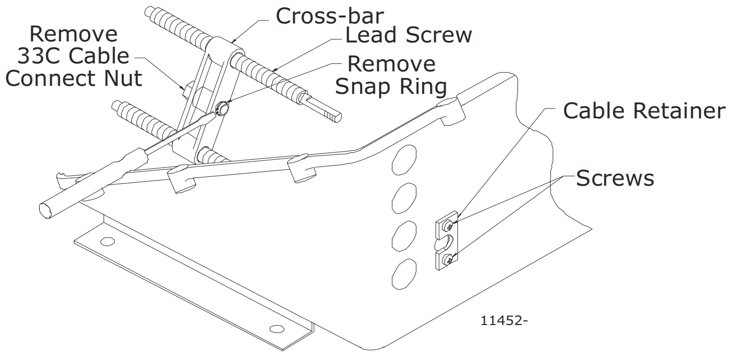


Figure 1: Actuator/Processor Preparation

	**CAUTION: Static electricity can destroy electronic components. Anytime the Actuator/Processor cover is off, use an anti-static wrist strap and connect it to the Actuator/Processor frame. This will drain any static charge you may have on your person.**

	**NOTE: 43C cable and jam nut are supplied by others.**

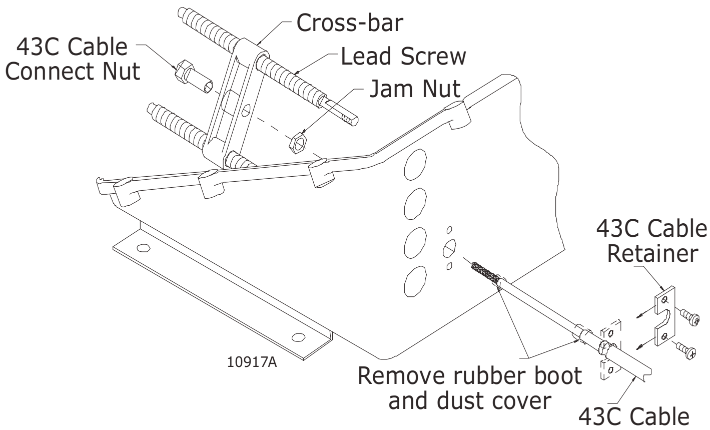


Figure 2: Actuator/Processor Cable Installation

Station Expander User Instructions

Table of Contents

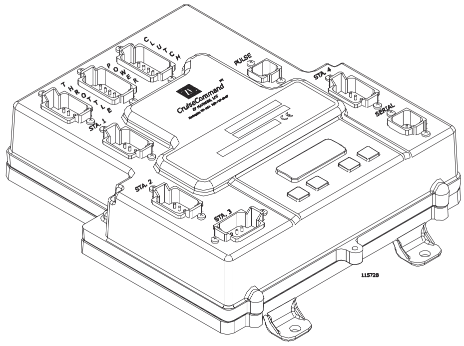


Figure MMC-343-1: Station Expander

The station expander (SE) is designed to be an addition to the 9000 Series / CruiseCommand Processors. The station expander allows the user to install more than the maximum allowed control heads (up to four).

MMC-343: 1 Features

- Station-in-Command Indication
- Audible and Visual Indicators
- Key-Pad Set Up
- Plug-in Cable Connections
- Built-in Diagnostics
- Addition of One to Four Remote Stations

The Station Expander receives the variable DC voltage from the Control Head(s) and serially communicates these inputs to the Processor.

MMC-343: 2 Required Parts

- One Station Expander required per Processor.
- Mounting Hardware is installer supplied.
- System Operation Manual included with the Processor.

MMC-343: 3 Location

NOTE: Read the MMC-165 Warranty in section 12: Appendix B - Sales and Service Information. Improper mounting location may cancel warranty.

- Expanders are spray proof, but must not be immersed.
- An engine room location of the Expanders is preferred.
    - If the engine room is too small, locate in any area where it is accessible for electrical connections.

Bulkhead mounting preferred for ease of access for wiring and adjustments.

The Expander can be mounted in any attitude as long as the LED on the front cover is readable.

Do not mount the Expander on the engine, on the transmission, or in any location that will subject it to excessive vibration.

Refer to Figure MMC-343-4: Station Expander Dimensions, for Expander dimensions.

Locate Expander(s) away from heat sources, such as engine exhaust manifolds turbochargers. Allow 4 feet (1,2m) of clearance, or more, between the Expander(s) and such heat sources.

CAUTION: Electro-magnetic fields can influence the Station Expander's electronic circuits.

Do not mount close to gas engine ignition systems, alternators, or electric motors. Allow 4 feet (1,2m) of clearance between the Expander and alternators or electric motors.

A threaded hole is provided for connection to the vessel's bonding system.

MMC-343: 4 Station Expander Power

The Station Expander requires:

- A battery source of 12 or 24 volts DC
- A 10 ampere circuit breaker with manual reset
- Automatic Power Selector (refer to S-214 Automatic Power Selector Model: 13505)

NOTE: The Processor and the Station Expander may use the same Automatic Power Selector, but the Station Expander MUST have a separate circuit breaker.

The power source should be the same as the processors power source which can be either 12 or 24 volts DC. It is important to keep the length of power cable short to reduce voltage drop.

CAUTION: It is important that the wire size from the battery to the circuit breaker panel is large enough to keep voltage drop due to current flow, to less than 3% of 7 amps. The DC return to the battery must be large enough to supply all current requirements with a voltage drop of less than 3%. Refer to ABYC E-9.

It is recommended by ZF Marine Propulsion Systems Miramar that an Automatic Power Selector (APS) and a second power source be used. Refer to S-214 Automatic Power Selector Model: 13505 and Section 7.2 Power Cable.

MMC-343: 5 Harnesses

Below is a general list of Wire Harnesses available to Station Expander. A complete harness list and part numbers are located in section MMC-343: 13 Parts List.

Stations 2-4 connectors on the Station Expander are sealed with plugs at the factory. Every connector should either have inserted a Wire Harness or plug. Do not leave a connector empty.

- **(2) Power Wire Harness** (Station Expander to Power connections)
- **(4) Control Head Wire Harness** (Station Expander to Control Head)
- **(5) Serial Communication Wire Harness** (Processor to Station Expander to 2nd (etc.) Processor)

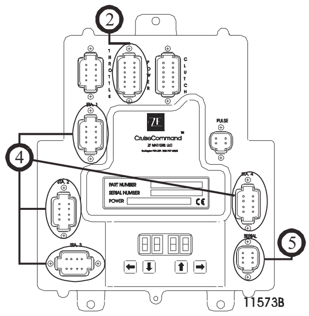


Figure MMC-343-2: Station Expander Harness Connector Locations

The Harnesses use one or both of the plug connector types detailed in Figure MMC-343-3: Harness Plug Connectors. When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected. Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

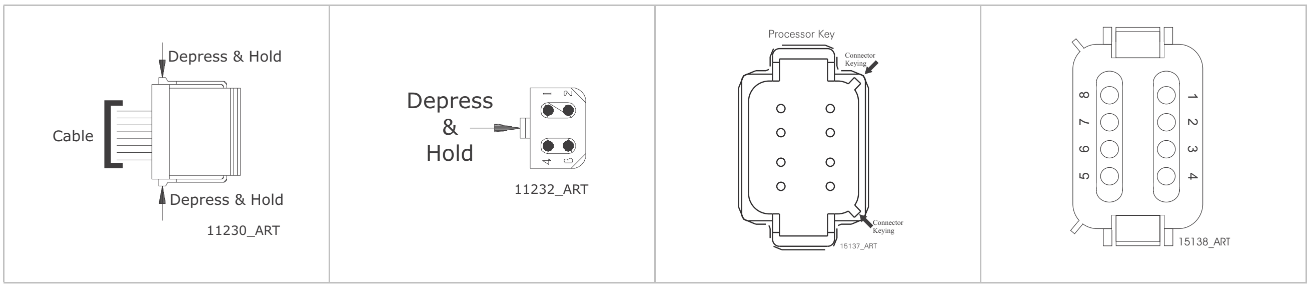


Figure MMC-343-3: Harness Plug Connectors

Ensure that the harness cable lengths are long enough to make one complete run from the Station Expander to:

- the power supply
- the remote station.
- the Port and Starboard Processor

MMC-343: 6 Tools For Installation

6.1 Required

- Screwdriver – med. Phillips #2
- Hole saw -- 1 inch (25,4mm)
- Drills -- 9/32 inch (7,2mm) and 7/32 inch (5,6mm)
- Saw (appropriate type of saw for cutting material Control Head will be mounted on)

6.2 Optional

Wire cutter, stripper, crimper (Recommend Thomas & Betts WT-2000) (if using single terminated harnesses)

MMC-343: 7 Installation

Before starting the actual installation of the Station Expander, make sure you have the correct parts and tools. See section MMC-343: 6 Tools For Installation. Read ALL the instructions pertinent to each part before beginning the installation of that part

NOTE: When connecting the plugs, ensure that the release buttons are depressed and held until plug is fully connected. To disconnect the plugs, the release buttons MUST be held depressed until plug is disconnected.

NOTE: When installing the harness cable, support the cables using clamps or straps not more than 18 inches (0,5m) apart, unless contained in a conduit. Install each cable so it is protected from physical damage. Refer to ABYC Standard E-9.

7.1 Station Expander

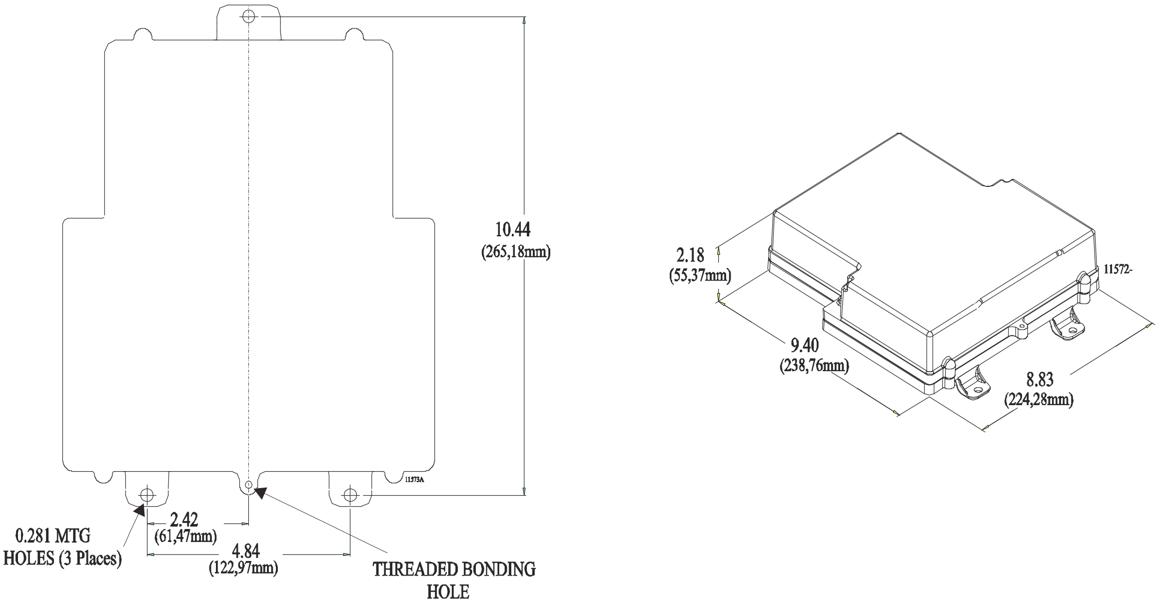


Figure MMC-343-4: Station Expander Dimensions

A Place the Station Expander on the mounting surface and mark the three screw holes.
B Remove the Expander and drill the screw holes.
C Secure the Expander using 1/4 inch or M6 fasteners.
D Connect to the Bonding System.

WARNING: When connecting the Power Harness to the Station Expander be sure the power is OFF.

A Insert the Wire Harness plug into the **POWER** connector on the Station Expander.
B Continue with the following Sections that apply to this application.

WARNING: Note that the dimensions are out of scale, pay attention to properly size the cut out before use !

7.2 Power Cable

It is critical to design and wire the Control System in a manner where the chance of losing power to the Control System is kept to a minimum.

ZF Marine Propulsion Systems Miramar recommends that two power sources are utilized along with the APS see document S-214 Automatic Power Selector Model: 13505 for more information.

A Install the Power cable from the Station Expander to the DC Power Source.

- Install each cable so it is protected from physical damage.

B Review the DC Power Supply documents to confirm termination points for power connection.

NOTE: Repeat for all Station Expanders.

7.3 Control Head Harnesses

There are two choices of Control Head Harnesses depending on the type of Control Head being used with this application.

- Plug at Station Expander end of harness only. (terminal connection Control Heads)
- Plug at Station Expander and Control Head ends. (Plug connection Control Heads)

The distance of the Control Head from the Station Expander is limited to the length of an uninterrupted 7-conductor harness. This cable may never be spliced.

A Install the Control Head Wire Harness between each Control Head and the appropriate Station Expander.

B **Label** each harness at **both ends** with the station it connects, and Port, Center, or Starboard for Multi Screw applications.

CAUTION: Ensure that each Control Head is plugged into the same Numbered Station Connector on each Station Expander.
EXAMPLE: Station 1 Control Head will plug into the Station 1 connector on the Port Station Expander and the Station 1 connector on the Starboard Station Expander. Failure to do this will result in incorrect Station Transfer.

Install each harness so it is protected from physical damage.

When installing the cable, support using clamps or straps not more than 18 inches (0,5m) apart, unless contained in a conduit. Refer to the ABYC Standard E-9.

7.4 Engine Stop Switch

The Installer supplies the Stop Switches. Refer to the information supplied with the Stop Switches for installation.

WARNING: Each Station must have some method to stop the engine, refer to CFR 46, SEC. 62.35-5 and ABYC P-24.5.8.

7.5 Control Heads

Refer only to the following Sections that relate to the Control Heads used.

- Mounting
  - 400 Series Control Head:

    A Use the template supplied inMMC-280 400 Series Control Head Variations and drill the screw holes and the corner cutout holes.

    B Saw between the corner cutout holes.

   C Check that the four mounting screws will start into the Control Head.
   D Remove the Control Head.
   E Strip the adhesive cover from the gasket and apply the adhesive side to the console.

- 700 Series Control Head:
   A Use the template supplied inMMC-307 700 Series Standard Control Head Variations and drill the screw holes and the corner cutout holes.
   B Drill the screw holes and the cable holes.
- MC2000 Series Control Head:
   A Use the template supplied inMMC-329 MC2000 Series Standard Control Head Variations and drill the screw holes and the corner cutout holes.
   B Saw between the corner cutout holes.
- Check that the two mounting screws will start into the Control Head 500 Series Control Head Assembly:

  Refer to Installation Manual supplied with the 500 Series Control Head Assembly for installation instructions.

MMC-343: 8 Set Up Procedures

NOTE: Main Processor function should be set to A3-01 to enable station expander.

The Station Expander utilizes push buttons in conjunction with Display LED's to program, adjust, calibrate and set up the various features. The push buttons also allow you to access and display information regarding the health of the System.

The following paragraphs explain how to locate and use the push buttons and Display LEDs:

8.1 Station Expander Components Used In Set Up

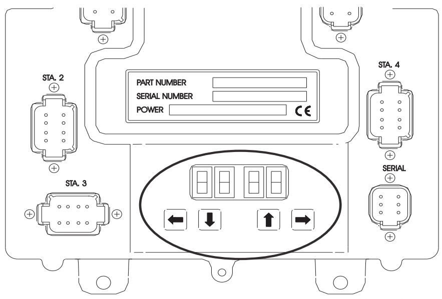


Figure MMC-343-5: Station Expander Display LED and Arrow Push Buttons

Each Station Expander has a Display LED and Arrow Push Buttons located on the front cover. (Figure MMC-343-5: Station Expander Display LED and Arrow Push Buttons)

- The Display LED is to view the Function Codes and Values. It consists of four 7-segment display pads.
- The Arrow Push Buttons are used to scroll through and select the Function Codes, and set the Values.

8.2 Station Expander Display LED

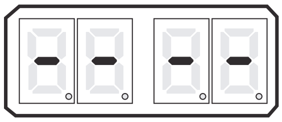


Figure MMC-343-6: Display LED at Normal Operation

- The Station Expander's Display LED has four 7-segment LED's, which light up to show either letters or numbers.
- The Display LED during Normal operation has running red center dash lines (Figure MMC-343-6: Display LED at Normal Operation)
- The first two digit Display LED's to the left, indicate the Function Code, which is alphanumeric.

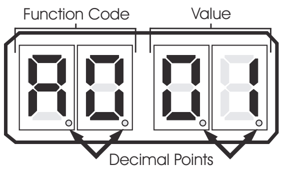


Figure MMC-343-7: Display LED Designations

- The second two digit Display LED's indicate the numeric Value that is currently programmed into the Station Expander for the Function Code displayed to the left.
- A decimal point indicator is located on the bottom right corner of each Display LED. (Figure MMC-343-7: Display LED Designations)

8.3 Push Buttons

There are four Push Buttons with arrows located below the Display LED on the Station Expander cover. These push buttons are used to scroll through, select, and store the Functions and Values. The direction of the arrow indicates "Left", "Down", "Up", and "Right". See Figure MMC-343-5: Station Expander Display LED and Arrow Push Buttons.

- "Up" and "Down" Push Buttons

  Pressing the "Up" or "Down" Push Buttons *once* has the following functions:
  - Stops Normal Operation Display (running red center dash lines) and activates the Function Menu.
  - While in the Function Menu, scrolls through the Function Codes one at a time.
  - When in Set Up Mode, increases (Up) or decreases (Down) the Function Value one digit at a time.
  - When an Error Code is displayed, scrolls through the error messages one at a time.

	NOTE: Refer to Troubleshooting section of the processor manual for steps to be taken for Error Messages.

- "Left" and "Right" Push Buttons

  Pressing and *holding* the "Left" and "Right" Push Buttons *at the same time* has the following functions:
  - Activates Set Up Mode as indicated by the blinking Display LED. (Operator must hold the buttons down until the blinking begins, then release.)
  - While in Set Up Mode, deactivates Set Up Mode, saves the displayed Value to memory, and returns to the Function Menu. (Operator must *hold* the buttons down until the blinking stops, then *release*.)
- "Left "Push Button Only

  Pressing the "Left" Push Button *once* has the following functions:

- Deactivates Set Up Mode WITHOUT any changes to the Function Value stored in memory. (Operator must *hold* the button down until function code stops blinking, then *release*.) The previously saved Function Value will then be displayed.

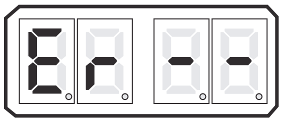


Figure MMC-343-8: Error Menu Example

- While in Function Menu, changes the Display LED to the Error Menu, if any errors are present. (has no effect if there are no errors stored)
- While in the Error Menu, changes the Display LED back to the Function Menu.

- "Right" Push Button Only

  Pressing the "Right" Push Button *once* has the following function:

  - While in the Error Menu, clears inactive errors. (Active errors blink, inactive do not)

  Pressing and *holding* the "Right" Push Button has the following function:

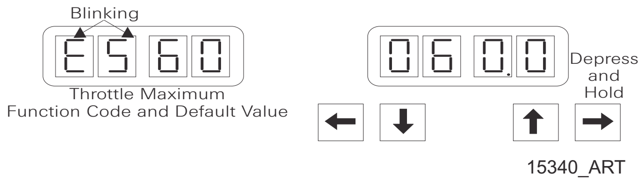


Figure MMC-343-9: Display LED Four Digit Value

- While in Set Up Mode, or Function Menu, allows the Function Value of the current Function Code to be displayed with all four Display LEDs.

MMC-343: 9 Activating Set Up Mode and Storing a Value

	NOTE: To escape from the set up procedure at any time without saving the changed value. Depress the LEFT Arrow Push Button. The Function Code will stop flashing and the Function will be saved with the original value.

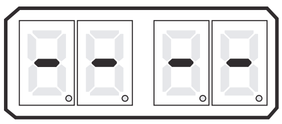


Figure MMC-343-10: Display Normal Operating Condition

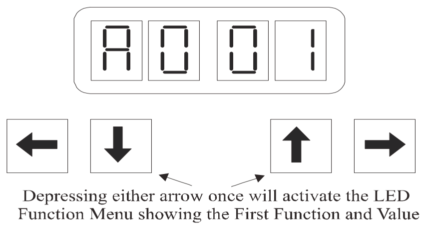


Figure MMC-343-11: Display Function Menu Activated

A The Display is in Normal Operating condition with red running center dash lines.

B Depressing either the Up or Down Arrow Push Button will activate the Function Menu. (refer to Figure MMC-343-11: Display Function Menu Activated)

C Depressing either the Up or Down Arrow Push Button will scroll through the Function Menu one at a time.

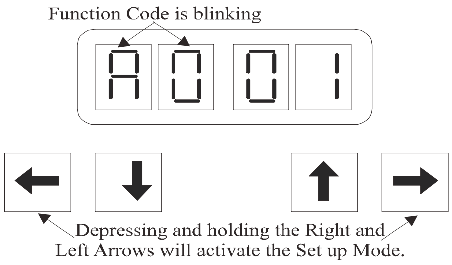


Figure MMC-343-12: Display with Set up Activated

D Once the desired Function Code is visible on the Display, **depressing** and **holding** the Left and Right Arrow Push Buttons at the same time will activate Set Up. The left two Display pads will begin to blink, indicating that the value is ready to be changed. Refer to Figure MMC-343-12: Display with Set up Activated

E Depressing either the Up or Down arrow push buttons will change the Value of the Function. Holding down either the Up or Down arrow push buttons will scroll quickly through the values.

F When the value required is displayed, depress and hold the Right and Left Arrow push buttons until the Display Function Code stops blinking and becomes solid. The new Value is now set into memory.

G Depressing either the Up or Down arrow push buttons will now scroll through the Function Codes.

MMC-343: 10 Set Up Functions & Values

The following table lists the various Function Codes, the Function's Name, Default Value and Range. Each Function will be explained in one of the following Sections.

Table MMC-343-1: Functions List

Function Code	Function Name	Default Value	Value Range or Options
STATION EXPANDER FUNCTIONS			
A0	Station Expander Identification	01	01, 02, 03, 04, 05 (Must match Processor Identification set in the 9000 Series / CruiseCommand Processor the Expander is connected to.)
H0	Diagnostic	00	Input Voltage (+/- 0.5VDC)
			Tachometer Sensor Frequency
			Station 1 Lever A/D
			Station 2 Lever A/D
			Station 3 Lever A/D
			Station 4 Lever A/D
			Transfer Button, Stations 1, 2, 3 & 4
			Software Revision Level
H1	Erase EPROM	00	Store to Erase (For Authorized Personnel Only)

10.1 A0 - Station Expander Identification

CAUTION: This feature MUST be the SAME value as set in the 9000 Series / CruiseCommand Processor the Expander is connected to.

In applications where there is more than one screw, the system must have some way of determining which Station Expander is where. Every Station Expander must have it's own identifying unique number that corresponds to the Processor it is connected to. At no time can two Station Expanders be identified by the same Station Expander Identification Number.

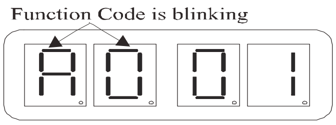


Figure MMC-343-13: Display with A0 - Station Expander Identification Set Up Activated

The values of this Function are **01** (Default Value), **02**, **03**, **04**, and **05.**

To change the value:

A Depress any Arrow Push-Button to stop running center dash lines.

B This is the first code on the Function Menu List and the Function Code for Station Expander Identification.

C Activate Set Up Mode. Refer to section MMC-343: 9: Activating Set Up Mode and Storing a Value.

D Depress either the Up or Down arrows to change the Value of the Function.

E When the value required is displayed, store the value. Refer to section MMC-343: 9: Activating Set Up Mode and Storing a Value.

10.2 H0 - Diagnostic

This Function is used during Troubleshooting. Refer to the 9000 Series / CruiseCommand Manual supplied with the Control System for information on this Function.

10.3 H1 - Erase EPROM

This Function is used during Adjustments or Troubleshooting. **(For Authorized Personnel Use ONLY)**

MMC-343: 11 Dock Trials

Ensure 9000 Series / CruiseCommand System has been installed, adjusted, and tested before performing the following tests for the Station Expander.

11.1 Control Head (Engines Stopped)

A Turn the power ON to the control system**.**

WARNING: Turn OFF the control system power before disconnecting from the batteries. Do not disconnect battery terminals when engine is operating.

B The Control Head at each station will produce an intermittent tone.

C Take command at a remote station.

D Perform each of the following steps on all Control Heads.

- Move each Control Head lever full Ahead and full Astern. Ensure correct 9000 Series / CruiseCommand Processor and Station Expander reacts to lever movement.

NOTE: This will check that the Control Head is operating. * On Twin Screw or more applications ensure the Port Control Head lever operates the Port Processor and the Starboard Control Head lever operates the Starboard Processor, etc. *

- Place the Control Head levers in the Neutral detent position.
- Depress and hold the station transfer button.
- Move the Control Head levers to the Ahead detent position before releasing the transfer button.
- The red indicator light on the Control Head should blink, indicating 9000 Series / CruiseCommand has been placed in Warm-up Mode. Warm-up Mode only operates in the Ahead direction.
    - If the red indicator light blinks, continue with Control Head testing
    - If the red indicator light does not blink, check connections as stated in Section 7.5 Control Heads.

11.2 Engine Stop Switches Test (Engines Running)

A Start engine(s).

B Verify that all Engine Stop Switches function correctly at all stations.

Refer to information supplied by engine manufacturer or switch supplier for set up and adjustments.

CAUTION: An Engine Stop Switch at each station is an absolute requirement. Refer to CFR46, SEC. 62.35-5 and ABYC P-24.5.8.

WARNING: Do not attempt to continue tests until Engine Stop Switches function correctly.

MMC-343: 12 Periodic Checks and Maintenance

12.1 Station Expander

Check all terminal connections for signs of corrosion or loose connections.

12.2 Control Head

Verify once a year that Control Head terminals are secure and free of corrosion. Apply a light coating of Teflon grease, or corrosion block, to the contacts.

MMC-343: 13 Parts List

Part No.	Description

13.1 Control Heads

A Single Screw

Part No.	Description
450-3L or 3R	Left or Right Control Head, 'T' Lever
453-3L or 3R	Left or Right Control Head, Chrome Knob Lever
455-3L or 3R	Left or Right Control Head, Black Low Profile Lever
456-3L or 3R	Left or Right Control Head, Chrome Low Profile Lever
456-3LP or 3R P	Left or Right Control Head, Chrome Low Profile Lever, Pluggable
521-4	Control Head, Single Lever Tournament Style - Aluminum
521-5	Control Head, Single Lever Tournament Style - Chrome
750-L or –R	Left or Right Control Head, Heavy Duty
MC2000-1L or 1R	Left or Right Black Control Head, Black Lever
MC2000-2L or 2R	Left or Right Chrome Control Head, Chrome Lever
MC2000-4L or 4R	Left or Right Black Control Head, Chrome Lever
MC2000-4LP or 4RP	Left or Right Black Control Head, Chrome Lever, Pluggable
MC2000-5L or 5R	Left or Right Black Control Head, Gold Lever

B Twin Screw (Synchronization Indication)

Part No.	Description
460-4	Control Head, 'T' Lever
460-4P	Control Head, 'T' Lever, Pluggable
463-4	Control Head, Chrome Knob Lever
463-4P	Control Head, Chrome Knob Lever, Pluggable
464-4	Control Heads, Split, with Single Levers, Chrome Knobs (pair)
465-4	Control Head, Black Low Profile Lever
466-4	Control Head, Chrome Low Profile Lever
522-4	Control Head, Dual Lever Tournament Style - Aluminum
522-5	Control Head, Dual Lever Tournament Style - Chrome
760	Control Head, Heavy Duty
760P	Control Head, Heavy Duty, Pluggable
MC2000-1	Black Head, Black Levers
MC2000-1P	Black Head, Black Levers, Pluggable
MC2000-2	Chrome Head, Chrome Levers
MC2000-2P	Chrome Head, Chrome Levers, Pluggable
MC2000-3	Gold Head, Gold Levers
MC2000-4	Black Head, Chrome Levers
MC2000-4P	Black Head, Chrome Levers, Pluggable
MC2000-5	Black Head, Gold Levers

13.2 Cable (Electric)

180	8-Cond. Shielded Cable	Per/ft.
350	8-Cond. Shielded Cable	500’ Spool
11811	8-Cond. Shielded Cable	1000’ Spool
212	2-Cond. Power Cable	Per/ft.
349	2-Cond. Power Cable	250’ Spool
183	2-Cond. Start Interlock Cable	Per/ft.
355	2-Cond. Start Interlock Cable	250’ Spool

13.3 Wire Harness (Plug)

Replace the # after the Part Number with the length of harness required. EXAMPLE: 13316-10; 13316-20; 13316-30

13316-#	Serial Communication (Twin Screw)
13408-#	Serial Communication (Multiple Screw)
15544-#	Serial Communication - CruiseCommand (Multiple Screw)
13432-#	Throttle, Voltage
13494-#	Throttle, Current
13533-#	Throttle, PWM
14363-#	Throttle, MAN
15027-#	Throttle, Frequency
13322-#	Clutch – Ahead/Astern/Clutch Power
13324-#	Clutch – Ahead/Astern/Neutral/Clutch Power
13240-#	Clutch – Ahead/Astern/Troll/Troll CMD/Clutch Power
14310-#	Clutch – Ahead/Astern/Troll CMD/Clutch Power
14925-#	MAN with Troll
14542-#	MAN without Troll
13239-#	Magnetic Pickup or Pulse Transmitter
13422-#	ZF Autotroll (MS70-13231 only)
15364-	ZF Autotroll (MS570-15382 Cannon Connector only)
15208-	ZF Autotroll (MS570-15382 Harting Connector only)
13552-#	Power/Start Interlock/Clutch Pressure
13756-#	Power/Start Interlock
15023-#	Power
13557-#	Control Head - 1 Connector
14261-#	Control Head - 2 Connectors

13.4 Test Unit

13927	Service Field Test Unit
14000	Field Test Control Head - Dual

12 Appendix B - QFA & DVTP

(Qualitative Failure Analysis & Design Verification Test Procedure)

9000 Series Micro/ClearCommand Servo Throttle - Servo Clutch QFA & DVTP

Revision List

Rev	Date	Description
A	4/15/05	Release authored by Joe Case, approved by Robert Anderson, verified by Jeff Turner.
A.1	02/23/2012	Revised per ELR00158

Qualitative Failure Analysis

The following qualitative failure analysis is provided to show compliance with:

- Subchapter K Small Passenger Vessels, 46 CFR 121.620
- Subchapter L Offshore Supply Vessels, 46 CFR 130.120
- Subchapter T Small Passenger Vessels, 46 CFR 184.620:

Propulsion engine control systems.

a A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.

1. One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.
2. A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

b In addition to the requirements of paragraph (a) of this section, a vessel must have a reliable means for shutting down a propulsion engine, at the main pilot house control station, which is independent of the engine's speed control.

c A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

d All microprocessor or computer based systems must meet the requirements of part 62 in subchapter F of this chapter.

Propulsion control.

a Each vessel must have--

1. A propulsion-control system operable from the pilothouse; and
2. A means at each propulsion engine of readily disabling the propulsion-control system to permit local operation.

b Each propulsion-control system operable from the pilothouse must enable--

1. Control of the speed of each propulsion engine;
2. Control of the direction of propeller-shaft rotation;
3. Control of propeller pitch, if a controllable-pitch propeller is fitted; and
4. Shutdown of each propulsion engine.

c The propulsion-control system operable from the pilothouse may constitute the remote stopping-system required by Sec. 129.540 of this subchapter.

d Each propulsion-control system, including one operable from the pilothouse, must be designed so that no one complete or partial failure of an easily replaceable component of the system allows the propulsion engine to over-speed or the pitch of the propeller to increase.

Propulsion engine control systems.

a A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.

1. One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.
2. A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

b In addition to the requirements of paragraph (a), a vessel must have a reliable means for shutting down a propulsion engine, at the main pilothouse control station, which is independent of the engine's speed control.

c A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

The ZF Marine Propulsion Systems Miramar MicroCommander/ClearCommand 9000 Series (servo throttle, servo clutch version) marine engine controls offer single lever control of speed and direction. Each enclosure houses an independent Control Processor and requires separate power supplies. The system operates on 12 or 24VDC power and can have up to five remote stations depending on the application. The system sequences the operation of speed and shift in order to prevent an inexperienced operator from mishandling the engine or transmission.

A requirement of the ZF Marine Propulsion Systems Miramar MicroCommander/ClearCommand system is that there be an engine 'STOP' button at each remote station.

A standard feature is an alarm contact (normally open) to interface with the main alarm system of the vessel. This switch will open and activate the alarm system with a power loss or CPU failure. In addition, ZF Marine Propulsion Systems Miramar provides audible tones at the Control Head locations to indicate system faults.

ITEM NUMBER	FAILED COMPONENT	ALARM STATUS	INITIAL RESULT	FINAL OUTCOME
1	ZF Marine Propulsion Systems Miramar Control Head	Audible Tone Will Sound At Control Head	Throttle Resets To Idle	No Increase In Engine Rpm
			Clutch Shifts To Neutral	No Increase In Shaft Speed
2	Loss Of Power Supply	Alarm Circuit Will Open	Throttle Remains At Last Commanded Position	No Increase In Engine Rpm
			Clutch Remains At Last Commanded Position	No Increase In Shaft Speed
3	ZF Marine Propulsion Systems Miramar Throttle Feedback Potentiometer	Audible Tone Will Sound At Control Head	Throttle Resets To Idle	No Increase In Engine Rpm
			Clutch Remains At Last Commanded Position	No Increase In Shaft Speed
4	ZF Marine Propulsion Systems Miramar Clutch Feedback Potentiometer	Audible Tone Will Sound At Control Head	Throttle Resets To Idle	No Increase In Engine Rpm
			Clutch Remains At Last Commanded Position	No Increase In Shaft Speed

Design Verification Test Procedure

The MicroCommander/ClearCommand 9000 Series (servo throttle, servo clutch version) Propulsion Control System is compliant to the environmental design standards in 46 CFR 62.25-30.

The following test procedure covers the 4 items included in the Qualitative Failure Analysis; 1) Control Head Potentiometer failure, 2) Loss of power supply, 3) Throttle Feedback Potentiometer failure, and 4) Clutch Feedback Potentiometer failure.

Failure: Control Head Potentiometer failure.

a **Results**: The Processor will shift to Neutral (if needed) and throttle will go to Idle, (if needed).

b Test Procedure

1. Turn power ON to both Port and Starboard Processors. Take command at a Control Head.
2. Move the Port and Starboard Control Head levers to approximately ½ Ahead.
3. Locate the green wire coming from the Port Control Head in command, connecting to pin 6 of the respective terminal block on the Processor circuit board. Disconnect it from the Processor circuit board.
    - The Port Processor will shift to Neutral (if needed) and throttle will go to Idle (if needed).
    - The Port Control Head will give an audible tone indicating a faulty potentiometer.
4. Move the Port and Starboard Control Head levers back to Neutral. Reconnect the green wire.
5. Take command at the Control Head
6. Repeat for Starboard side.

Failure: Power failure to MicroCommander/ClearCommand 9000 Series

A power failure to the MicroCommander/ClearCommand 9000 Series circuit board will have the same results as a failed microprocessor

a Results

1. Throttle and clutch will remain at last commanded position.
2. LED at Control Heads will not be lit.
3. Opposite engine still under power has full control.

b Test Procedure.

1. Turn power ON to both Port and Starboard Processors. Take command at a Control Head.
2. Move the Port and Starboard Control Head levers to approximately ½ Ahead.
3. Turn power OFF to the Port side only.
    - Port side throttle and clutch will remain at last commanded position.
    - LED on the Port side of the Control Head in command will go OFF.
    - The Port Control Head will no longer have command of the engine and gear.
    - The Starboard Control Head will still have full command of the Starboard engine and gear.
4. Turn power ON to the Port Processor. Return Control Head lever to Neutral. Take command of the Port side.
    - The Port Control Head will operate as usual-(Non-volatile memory)
5. Repeat test for Starboard Processor.

Failure: Throttle Feedback Potentiometer failure

a **Results**: Throttle will go to Idle (if needed).

b **Test Procedure**.

1. Turn power ON to both Port and Starboard Processors. Take command at a Control Head.
2. Move the Port and Starboard Control Head levers to approximately ½ Ahead.
3. On the Port Processor, locate the 3-pin plug above the throttle servo on the Processor's main circuit board. Disconnect the plug from the circuit board.
    - The Port Processor will move the throttle to Idle.
    - The Port Control Heads will give an audible tone indicating a faulty throttle feedback potentiometer.
4. Move the Port and Starboard Control Head levers back to Neutral.
5. Replace the 3-pin plug.
6. Acknowledge the error by pressing the transfer button.
7. Repeat test for Starboard Processor.

Failure: Clutch Feedback Potentiometer failure

a **Results**: Clutch will remain at last commanded position. Throttle will go to Idle (if needed).

b **Test Procedure**.

1. Turn power ON to both Port and Starboard Processors. Take command at a Control Head.
2. Move the Port and Starboard Control Head levers to approximately ½ Ahead.
3. On the Port Processor, locate the 3-pin plug above the clutch servo on the Processor's main circuit board. Disconnect the plug from the circuit board.
    - The Port Processor clutch servo will remain at last commanded position. Throttle servo will drive to Idle.
    - The Port Control Heads will give an audible tone indicating a faulty clutch feedback potentiometer.
4. Move the Port and Starboard Control Head levers back to Neutral.
5. Replace the 3-pin plug.
6. Acknowledge the error by pressing the transfer button.
7. Repeat test for Starboard Processor.

ClearCommand 9000 Series Throttle - Solenoid Clutch QFA & DVTP

Revision List

Rev	Date	Description
-	4/19/04	Initial Release authored by Tim Jones, approved by Robert Anderson, verified by Jimmy D Smith.

Qualitative Failure Analysis

The following qualitative failure analysis is provided to show compliance with:

- Subchapter K Small Passenger Vessels, 46 CFR 121.620
- Subchapter L Offshore Supply Vessels, 46 CFR 130.120
- Subchapter T Small Passenger Vessels, 46 CFR 184.620

121.620 Propulsion engine control systems.

a A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.

b One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.

c A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

d In addition to the requirements of paragraph (a) of this section, a vessel must have a reliable means for shutting down a propulsion engine, at the main pilot house control station, which is independent of the engine's speed control.

e A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

f All microprocessor or computer based systems must meet the requirements of part 62 in subchapter F of this chapter.

130.120 Propulsion control.

a Each vessel must have--

1. A propulsion-control system operable from the pilothouse; and
2. A means at each propulsion engine of readily disabling the propulsion-control system to permit local operation.

b Each propulsion-control system operable from the pilothouse must enable--

1. Control of the speed of each propulsion engine;
2. Control of the direction of propeller-shaft rotation;
3. Control of propeller pitch, if a controllable-pitch propeller is fitted; and
4. Shutdown of each propulsion engine.

c The propulsion-control system operable from the pilothouse may constitute the remote stopping-system required by Sec. 129.540 of this subchapter.

d Each propulsion-control system, including one operable from the pilothouse, must be designed so that no one complete or partial failure of an easily replaceable component of the system allows the propulsion engine to over speed or the pitch of the propeller to increase.

184.620 Propulsion engine control systems.

a A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.

1. One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.
2. A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

b In addition to the requirements of paragraph (a), a vessel must have a reliable means for shutting down a propulsion engine, at the main pilothouse control station, which is independent of the engine's speed control.

c A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

The ZF Marine Propulsion Systems Miramar ClearCommand 9000 Series (electronic throttle, solenoid clutch version) marine engine controls offer single lever control of speed and direction. Each enclosure houses an independent Control Processor and requires separate power supplies. The system operates on 12 or 24VDC power and can have up to five remote stations depending on the application. The system sequences the operation of speed and shift in order to prevent an inexperienced operator from mishandling the engine or transmission.

A standard feature is an alarm contact (normally open) to interface with the main alarm system of the vessel. This switch will open and activate the alarm system with a power loss or CPU failure. In addition, ZF Marine Propulsion Systems Miramar provides audible tones at the Control Head locations to indicate system faults.

ITEM NUMBER	FAILED COMPONENT	ALARM STATUS	INITIAL RESULT	FINAL OUTCOME
1	ZF Marine Propulsion Systems Miramar CONTROL HEAD	AUDIBLE TONE WILL SOUND AT CONTROL HEAD	THROTTLE RESETS TO IDLE	NO INCREASE IN ENGINE RPM
			CLUTCH SHIFTS TO NEUTRAL	NO INCREASE IN SHAFT SPEED
2	LOSS OF POWER SUPPLY	ALARM CIRCUIT WILL OPEN	THROTTLE RESETS TO IDLE CLUTCH SHIFTS TO NEUTRAL	NO INCREASE IN ENGINE RPM NO INCREASE IN SHAFT SPEED

Design Verification Test Procedure

The ClearCommand 9000 Series (electronic throttle, solenoid clutch version) Propulsion Control System is compliant to the environmental design standards in 46 CFR 62.25-30.

The following test procedure covers the 2 items included in the Qualitative Failure Analysis; 1) Control Head Potentiometer failure, and 2) Loss of power supply.

Failure: Control Head Potentiometer failure.

a Results:

- The Processor will shift to Neutral (if needed) and throttle will go to Idle, (if needed).

b Test Procedure

1. Turn power on to both Port and Starboard Processors. Take command at a Control Head.
2. Move the Port and Starboard Control Head levers to approximately ½ Ahead.
3. Locate the green wire coming from the Port Control Head in command, connecting to pin 6 of the respective terminal block on the ClearCommand 9000 Series circuit board. Disconnect it from the ClearCommand 9000 Series circuit board.

c The Port Processor will shift to Neutral and throttle will go to Idle.

d The Port Control Head will give an alarm tone indicating a faulty potentiometer.

1. Move the Port and Starboard Control Head levers back to Neutral. Reconnect the green wire.
2. Repeat for Starboard side.

Failure: Power failure to ClearCommand 9000 Series

A power failure to the ClearCommand 9000 Series circuit board will have the same results as a failed microprocessor

a Results

1. Throttle signal to Idle and shift to Neutral.
2. LED at Control Heads will not be lit.
3. Opposite engine still under power has full control.

b Test Procedure.

1. Turn power on to both Port and Starboard Processors. Take command at a Control Head.
2. Move the Port and Starboard Control Head levers to approximately ½ Ahead.
3. Turn power off to the Port side only.
    - Port side will go to Neutral Idle.
    - LED on the Port side of the Control Head in command will go off.
    - The Port Control Head will no longer have command of the engine and gear.
    - The Starboard Control Head will still have full command of the Starboard engine and gear.
4. Turn power on to the Port Processor. Take command of the Port side.
5. The Port Control Head will operate as usual-(Non-volatile memory)
6. Repeat test for Starboard Processor.

9000 Series Electronic Throttle - Servo Clutch Qualitative Failure Analysis & Design Verification Test Procedure				
Document #	AUTHOR	CHECKED	APPROVED	DATE
ENG-144 Rev A	Tim Jones	Jim D Smith	Robert Anderson	4-19-04

Qualitative Failure Analysis

The following qualitative failure analysis is provided to show compliance with:

- Subchapter K Small Passenger Vessels, 46 CFR 121.620
- Subchapter L Offshore Supply Vessels, 46 CFR 130.120
- Subchapter T Small Passenger Vessels, 46 CFR 184.620:

Propulsion engine control systems.

A A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.

- One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.

B A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

C In addition to the requirements of paragraph (a) of this section, a vessel must have a reliable means for shutting down a propulsion engine, at the main pilot house control station, which is independent of the engine's speed control.

D A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

E All microprocessor or computer based systems must meet the requirements of part 62 in subchapter F of this chapter.

Propulsion control.

A Each vessel must have--

- A propulsion-control system operable from the pilothouse; and
- A means at each propulsion engine of readily disabling the propulsion-control system to permit local operation.

B Each propulsion-control system operable from the pilothouse must enable--

1. Control of the speed of each propulsion engine;
2. Control of the direction of propeller-shaft rotation;
3. Control of propeller pitch, if a controllable-pitch propeller is fitted; and
4. Shutdown of each propulsion engine.

C The propulsion-control system operable from the pilothouse may constitute the remote stopping-system required by Sec. 129.540 of this subchapter.

D Each propulsion-control system, including one operable from the pilothouse, must be designed so that no one complete or partial failure of an easily replaceable component of the system allows the propulsion engine to over speed or the pitch of the propeller to increase.

Propulsion engine control systems.

A A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.

- One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.
- A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

B In addition to the requirements of paragraph (a), a vessel must have a reliable means for shutting down a propulsion engine, at the main pilothouse control station, which is independent of the engine's speed control.

C A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

The ZF Marine Propulsion Systems Miramar, LLC ClearCommand 9000 Series (electronic throttle, servo clutch version) marine engine controls offer single lever control of speed and direction. Each enclosure houses an independent Control Processor and requires separate power supplies. The system operates on 12 or 24VDC power and can have up to five remote stations depending on the application. The system sequences the operation of speed and shift in order to prevent an inexperienced operator from mishandling the engine or transmission.

A standard feature is an alarm contact (normally open) to interface with the main alarm system of the vessel. This switch will open and activate the alarm system with a power loss or CPU failure. In addition, ZF Marine Propulsion Systems Miramar, LLC provides audible tones at the Control Head locations to indicate system faults.

Item No.	Failed Component	Alarm Status	Initial Result	final Outcome
1.	ZF Marine Propulsion Systems Miramar Control Head	Audible tone will sound at Control Head	Throttle resets to Idle.	No increase in Engine RPM
			Clutch Shifts to Neutral.	No increase in shaft speed.
2.	Loss of Power Supply	Alarm Circuit will OPEN.	Throttle resets to Idle.	No increase in Engine RPM
			Clutch remains in last commanded position	No increase in shaft speed.

Design Verification Test Procedure

The ClearCommand 9000 Series (electronic throttle, servo clutch version) Propulsion Control System is compliant to the environmental design standards in 46 CFR 62.25-30.

The following test procedure covers the 2 items included in the Qualitative Failure Analysis; 1) Control Head Potentiometer failure, and 2) Loss of power supply.

A **Failure**: Control Head Potentiometer failure.

- **Results**: The Processor will shift to Neutral (if needed) and throttle will go to Idle, (if needed).
- Test Procedure:
  - Turn power on to both Port and Starboard Processors. Take command at a Control Head.
  - Move the Port and Starboard Control Head levers to approximately ½ Ahead.
  - Locate the green wire coming from the Port Control Head in command, connecting to pin 6 of the respective terminal block on the ClearCommand 9000 Series circuit board. Disconnect it from the ClearCommand 9000 Series circuit board.
    - The Port Processor will shift to Neutral and throttle will go to Idle.
    - The Port Control Head will give an alarm tone indicating a faulty potentiometer.
  - Move the Port and Starboard Control Head levers back to Neutral. Reconnect the green wire.
  - Repeat for Starboard side.

B **Failure:** Power failure to ClearCommand 9000 Series

(A power failure to the ClearCommand 9000 Series circuit board will have the same results as a failed microprocessor)

- Results:
    - Throttle signal to Idle and clutch servo will remain at last commanded position.
    - LED at Control Heads will not be lit.
    - Opposite engine still under power has full control.
- Test Procedure:
    - Turn power on to both Port and Starboard Processors. Take command at a Control Head.
    - Move the Port and Starboard Control Head levers to approximately ½ Ahead.
    - Turn power off to the Port side only.
    - Port side will go to Idle and clutch servo will remain at last commanded position.
    - LED on the Port side of the Control Head in command will go off.
    - The Port Control Head will no longer have command of the engine and gear.
    - The Starboard Control Head will still have full command of the Starboard engine and gear.
    - Turn power on to the Port Processor. Take command of the Port side. The Port Control Head will operate as usual-(Non-volatile memory)
    - Repeat test for Starboard Processor.

9000 Series Servo Throttle - Solenoid Clutch, Qualitative Failure Analysis & Design Verification Test Procedure				
Document #	AUTHOR	CHECKED	APPROVED	DATE
ENG-145 Rev A	Tim Jones	Jim D Smith	Robert Anderson	4/19/04

QUALITATIVE FAILURE ANALYSIS

The following qualitative failure analysis is provided to show compliance with:

- Subchapter K Small Passenger Vessels, 46 CFR 121.620
- Subchapter L Offshore Supply Vessels, 46 CFR 130.120
- Subchapter T Small Passenger Vessels, 46 CFR 184.620:

Propulsion engine control systems.

A A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.
- One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.

B A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

C In addition to the requirements of paragraph (a) of this section, a vessel must have a reliable means for shutting down a propulsion engine, at the main pilot house control station, which is independent of the engine's speed control.

D A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

E All microprocessor or computer based systems must meet the requirements of part 62 in subchapter F of this chapter.

Propulsion control.

A Each vessel must have:
- A propulsion-control system operable from the pilothouse; and
- A means at each propulsion engine of readily disabling the propulsion-control system to permit local operation.

B Each propulsion-control system operable from the pilothouse must enable:
- Control of the speed of each propulsion engine;
- Control of the direction of propeller-shaft rotation;
- Control of propeller pitch, if a controllable-pitch propeller is fitted; and
- Shutdown of each propulsion engine.

C The propulsion-control system operable from the pilothouse may constitute the remote stopping-system required by Sec. 129.540 of this subchapter.

D Each propulsion-control system, including one operable from the pilothouse, must be designed so that no one complete or partial failure of an easily replaceable component of the system allows the propulsion engine to over speed or the pitch of the propeller to increase.

Propulsion engine control systems.

A A vessel must have two independent means of controlling each propulsion engine. Control must be provided for the engine speed, direction of shaft rotation, and engine shutdown.
- One of the means may be the ability to readily disconnect the remote engine control linkage to permit local operation.
- A multiple engine vessel with independent remote propulsion control for each engine need not have a second means of controlling each engine.

B In addition to the requirements of paragraph (a), a vessel must have a reliable means for shutting down a propulsion engine, at the main pilothouse control station, which is independent of the engine's speed control.

C A propulsion engine control system, including pilothouse control, must be designed so that a loss of power to the control system does not result in an increase in shaft speed or propeller pitch.

The ZF Marine Propulsion Systems Miramar ClearCommand 9000 Series (servo throttle, solenoid clutch version) marine engine controls offer single lever control of speed and direction. Each enclosure houses an independent Control Processor and requires separate power supplies. The system operates on 12 or 24VDC power and can have up to five remote stations depending on the application. The system sequences the operation of speed and shift in order to prevent an inexperienced operator from mishandling the engine or transmission.

A standard feature is an alarm contact (normally open) to interface with the main alarm system of the vessel. This switch will open and activate the alarm system with a power loss or CPU failure. In addition, ZF Marine Propulsion Systems Miramar provides audible tones at the Control Head locations to indicate system faults.

Item No.	Failed Component	Alarm Status	Initial Result	final Outcome
1.	ZF Marine Propulsion Systems Miramar Control Head	Audible tone will sound at Control Head	Throttle resets to Idle.	No increase in Engine RPM
			Clutch Shifts to Neutral.	No increase in shaft speed.
2.	Loss of Power Supply	Alarm Circuit will OPEN.	Throttle remains at last commanded position.	
			Clutch Shifts to Neutral	No increase in shaft speed.

DESIGN VERIFICATION TEST PROCEDURE

The ClearCommand 9000 Series (servo throttle, solenoid clutch version) Propulsion Control System is compliant to the environmental design standards in 46 CFR 62.25-30.

The following test procedure covers the 2 items included in the Qualitative Failure Analysis; 1) Control Head Potentiometer failure, and 2) Loss of power supply.

A **Failure: Control Head Potentiometer failure**.
- **Results:** The Processor will shift to Neutral (if needed) and throttle will go to Idle, (if needed).
- Test Procedure:
  - Turn power on to both Port and Starboard Processors. Take command at a Control Head.
  - Move the Port and Starboard Control Head levers to approximately ½ Ahead.
  - Locate the green wire coming from the Port Control Head in command, connecting to pin 6 of the respective terminal block on the ClearCommand 9000 Series circuit board. Disconnect it from the ClearCommand 9000 Series circuit board.
  - The Port Processor will shift to Neutral and throttle will go to Idle.
  - The Port Control Head will give an alarm tone indicating a faulty potentiometer.
  - Move the Port and Starboard Control Head levers back to Neutral. Reconnect the green wire.
  - Repeat for Starboard side.

B **Failure: Power failure to** ClearCommand 9000 Series

(A power failure to the ClearCommand 9000 Series circuit board will have the same results as a failed microprocessor)

- **Results**:
    - Throttle signal will remain at last commanded position to and clutch shifts to neutral.
    - LED at Control Heads will not be lit.
    - Opposite engine still under power has full control.
- Test Procedure:
    - Turn power on to both Port and Starboard Processors. Take command at a Control Head.
    - Move the Port and Starboard Control Head levers to approximately ½ Ahead.
    - Turn power off to the Port side only.
        - Port side throttle will remain at last commanded position and clutch will shift to neutral.
        - LED on the Port side of the Control Head in command will go off.
        - The Port Control Head will no longer have command of the engine and gear.
        - The Starboard Control Head will still have full command of the Starboard engine and gear.
    - Turn power on to the Port Processor. Take command of the Port side.
        - The Port Control Head will operate as usual-(Non-volatile memory)
    - Repeat test for Starboard Processor.

13 Appendix C - Sales and Service Information

Factory Authorized Sales & Service - North America

USA

Alabama

Company:	Gulf Coast Air & Hydraulics
Contact:	Chuck Moorehead, Mike Ellis
Address:	PO Box 161134
	Mobile, AL 36613
Shipping:	3415 Halls Mills Road
	Mobile, AL 33693
Phone:	251-666-6683
Fax:	251-666-6684
Email:	cmoore41984@aol.com
Website:	www.wegetstuffdone.com

California

Company:	TDC Equipment
Contact:	Terry Brown
Address:	15886 Manufacture Lane
	Huntington Beach, CA 92649
Phone:	714-373-8099
Fax:	714-898-1996
Email:	tbrown@tdcequipment.com
Website:	www.tdcequipment.com

Company:	Trans Pacific Distributors
Contact:	Henry Bramhall
Address:	1941 Walters Court
	Fairfield, CA 94533
Phone:	707-426-6670
Fax:	707-426-0206
Email:	sales@marinegate.com

Florida

Company:	Control Masters
Contact:	Ed Raffaniello
Address:	14603 Beach Blvd Ste 600
	Jacksonville, FL 32250
Phone:	904-260-9756
Fax:	904-260-9727
Email:	edr@controlmastersinc.com
Website:	www.controlmastersinc.com

Company:	D.S. Hull Company, Inc.
Contact:	Lou Moran
Address:	3320 SW Third Ave
	Ft Lauderdale, FL 32258
Phone:	954-463-4307
Fax:	954-527-4173
Email:	loudshull@yahoo.com

Company:	H & H Marine Sales & Service
Contact:	John Fox, Andy Glen
Address:	10220 San Martin Blvd. N
	St Petersburg, FL 33702
Phone:	727-576-0923
Fax:	727-576-9727
Email:	hhmarine@ij.net

Company:	Yacht Equipment & Parts
Contact:	Jim Monroe, Lee Moore
Address:	3355 SW 2nd Ave
	Ft Lauderdale, FL 33315
Phone:	954-463-7222
Phone:	800-349-9224
Fax:	954-463-9009
Email:	jmonroe@bowboat.com

Company:	ZF Marine Propulsion Systems Miramar – US Headquarters
Contact:	A.J. Halavacs
Address:	15351 SW 29th Street, Ste 300
	Miramar, FL 33027
Phone:	954-441-4040
Fax:	954-441-4140
Email:	aj.halavacs@zf.com
Website:	www.zf-marine.com

Louisiana

Company:	Donovan Marine, Inc.
Contact:	Steve Garver, Richard McConnell
Address:	6316 Humphreys Street
	Harahan, LA 70123
Phone:	504-488-5731
Phone:	800-347-4464
Fax:	504-486-3258
Email:	rbenton@donovanmarine.com

Company:	ZFI Marine – Gulf Coast
Contact:	Mike Gauthreaux, Laura Heckler
Address:	161 James Drive West, Suite 120
	St Rose, LA 70087
Phone:	504-443-0501
Fax:	504-443-0504
Email:	mike.gauthreaux@zf.com
Website:	www.zf-marine.com

Michigan

Company:	Marysville Marine North
Contact:	Randy Hall, John Dillon
Address:	1551 Michigan Ave
	Marysville, MI 48040
Phone:	810-364-7653
Phone:	800-367-0987
Fax:	810-364-4112
Email:	rhall@marysvillemarine.com
Website:	www.marysvillemarine.com

New Jersey

Company:	Airline Hydraulics Corporation
Contact:	Bernie Keppel
Address:	428 Woodbine-Ocean View Road
	Ocean View, NJ 08230
Phone:	609-624-3700
Fax:	909-624-0863
Email:	sales@airlinehyd.com
Website:	www.airlinehyd.com

Ohio

Company:	Marysville Marine - Ohio
Contact:	Jeff Mechan
Address:	1470 South Danbury Rd
	Port Clinton, OH 43452
Phone:	419-734-3104
Fax:	coming soon
Email:	jmechan@marysvillemarine.com
Website:	www.marysvillemarine.com

Tennessee

Company:	Marysville Marine South
Contact:	Randy Hall
Address:	127 Industrial Drive
	White House, TN 37188
Phone:	615-672-1142
Fax:	615-851-9465
Email:	rhall@marysvillemarine.com
Website:	www.marysvillemarine.com

Texas

Company:	Donovan Marine, Inc.
Contact:	Trey Grant
Address:	4757 South Loop East
	Houston, TX 77033
Phone:	713-734-4171
Phone:	800-669-8392
Fax:	713-734-167
Email:	treygrant@donovanmarine.com

Virginia

Company:	Engines 1
Contact:	Tim Walters
Address:	PO Box 7788
	Portsmouth, VA 23707
Shipping:	3504 Shipwright Street
	Portsmouth, VA 23703
Phone:	757-673-7200
Phone:	800-548-6252
Fax:	757-673-7211
Email:	info@engines1.com
Website:	www.engines1.com

Washington

Company:	Fisheries Supply Co
Contact:	Mike Gibbons
Address:	1900 N. Northlake Way
	Seattle, WA 98103
Phone:	206-632-4462
Phone:	800-426-6930
Fax:	206-634-4600
Email:	mail@fisheriessupply.com
Website:	www.fisheriessupply.com

Company:	Pinnacle Marine Services
Company:	Dave Hanson
Address:	160 Cascade Place, #229
	Burlington, WA 98233
Phone:	360-404-2063
Fax:	360-404-2064
Email:	pinnmar@aol.com

Company:	PPC – Systems, Inc
Contact:	Bill Mol
Address:	12147 Bayhill Road
	Burlington, WA 98233
Phone:	360-336-9698
Fax:	360-757-8747
Cell:	206-915-0712
Email:	ppcsystemsinc@verizon.net

Company:	ZFI Marine – West Coast
Contact:	Bud Bloom, Kevin Zwicker
Address:	12125 Harbour Reach Dr Ste B
	Mukilteo, WA 98275
Phone:	425-583-1900
Fax:	425-493-1579
Email:	bud.bloom@zf.com; kevin.zwicker@zf.com
Website:	www.zf-maine.com

Wisconsin

Company:	Marysville Marine West
Contact:	Brian Hunter
Address:	282 Progress Way
	Sun Prairies, WI 53590
Phone:	608-825-3875
Phone:	800-992-3878
Fax:	608-825-2790
Email:	bhunter@marysvillemarine.com
Website:	www.marysvillemarine.com

CANADA

Eastern Canada

Company:	CMC Electronics
Contact:	Mark Newcomb
Address:	40 Thornhill Drive, Unit 6
	Dartmouth, Nova Scotia
	Canada B3B 1S1
Phone:	902-468-8480
Fax:	902-468-8484
Email:	mark.newcomb@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Brian Sibley
Address:	8 Brown Street / PO Box 5
	Yarmouth, Nova Scotia
	Canada B5A 1N1
Phone:	902-742-3423
Fax:	902-742-5593
Email:	brian.sibley@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Bill Taaffe, Dave Duff
Address:	29 Hallett Cresent
	St John’s, Newfoundland
	Canada A1B 3T2
Phone:	709-726-2422
Fax:	709-726-2428
Email:	bill.taaffe@cmcelectronics.ca; dave.duff@cmcelectronics.ca

Central Canada

Company:	CMC Electronics
Contact:	Graham Taylor
Address:	3600 B Laird Road Unit 12
	Mississauga, Ontario
	Canada L5L 6A7
Phone:	905-607- 4262
Fax:	905-607-1576
Email:	graham.taylor@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Michel Roy
Address:	566 Duphare Street East
	Mantane, Quebec
	Canada G4W 3P6
Phone:	418-562-6637
Fax:	418-562-5335
Email:	michel.roy@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Walter Timmerman
Address:	600 Dr Frederik Phillips Blvd
	Ville St Laurent, Quebec
	Canada H4M 2S9
Phone:	514-748-3000, ext 4800
Fax:	514-748-3006
Email:	walter.timmerman@cmcelectronics.ca

Western Canada

Company:	Western Marine
Contact:	Bill Falk, Alan Stovell
Address:	1494 Powell Street
	Vancouver, British Columbia
	Canada V5L 5B5
Phone:	604--253-7721
Phone:	800-663-0600
Fax:	604-253-2656
Email:	astovell@westernmarine.com

Company:	CMC Electronics
Contact:	Jeff Bailey
Address:	3839 Still Creek Ave
	Burnaby, British Columbia
	Canada V5C 4E2
Phone:	604-435-1455
Fax:	604-435-2231
Email:	Jeffrey.Bailey@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Brad Funk, Jim Goodfellow
Address:	6680 Mirah Road
	Saanichton, British Columbia
	Canada V8M 1Z4
Phone:	250-544-1561
Fax:	250-544-2061
Email:	brad.funk@cmcelectronics.ca; jim.goodfellow@cmcelectronics.ca

Factory Authorized Service Centers - North America

USA

Alaska

Company:	Alaska Professional Marine
Contact:	Keith Stephens
Address:	PO Box 32083
	Juneau, AK 99803
Shipping:	1900 Fritz Cove Road
	Juneau, AK 99803
Phone:	907-780-3960
Fax:	907-789-0054

Company:	Brick's Electronics
Contact:	Brick Lobaugh
Address:	1035 Mendenhall Pennisula Road
	Juneau, AK 99801
Phone:	907-789-2787
Fax:	907-789-4778
Email:	bricks@gci.neet

Company:	Kodiak DC Electric
Contact:	Dennis McCuster
Address:	2561 Beaver lake Drive
	Kodiak, AK 99615
Phone:	907-486-5323
Email:	debmccusker@yahoo.com

Company:	Kodiak Service
Contact:	Fred Lentz
Address:	PO Box 1018
	Kodiak, AK 99615
Phone:	907-486-6556
Fax:	907-486-6022
Email:	ksci@worldnethtt.net

Company:	Rainbow Glacier Company
Contact:	Karl Johnson
Address:	PO Box 821
	Haines, AK 99827
Phone:	907-766-2218
Fax:	907-766-2585

Company:	Redden Marine Supply Formerly - Kachemak Gear Shed
Contact:	John and Butch
Address:	3625 East End Road
	Homer, AK 99603
Phone:	907-235-7993
Fax:	907-235-7233

Company:	Spaulding Sports Supply
Contact:	Steve Spaulding
Address:	2017 Badger Road
	North Pole, AK 99708
Phone:	907-488-6998
Phone:	907-488-5242
Fax:	907-488-6385

Company:	The Bay Company
Contact:	Chet Powell, Mike Ottesen
Address:	431 Front Street
	Wrangell, AK 99929
Phone:	907-874-3340
Fax:	907-874-2592

Company:	Timber & Marine
Contact:	Ken Perry
Address:	2547 Tongass Avenue
	Ketchikan, AK 99001
Phone:	907-225-6644
Fax:	907-225-0644

Company:	Wikan Enterprises
Contact:	Sheri and John Wikan
Address:	PO Box 929
	Petersburg, AK 99833
Shipping:	103 Dock Street
	Petersburg, AK 99833
Phone:	907-772-4155
Fax:	907-772-4153
Email:	wikanent@alaska.com

Arizona

Company:	Aramark / Lake Powell Resorts & Marinas
Contact:	Mark Suttie
Address:	PO Box 1597
	Page, AZ 86040
Phone:	928-645-1186
Fax:	928-645-1101
Email:	suttee-mark@aramark.com

Company:	Desert Recreation, Inc.
Contact:	Jim Ronnie
Address:	315 Long Ave.
	Bull head, City, AZ 86429
Phone:	928-754-4391
Fax:	928-754-3335
Email:	desrec@ctaz.com

Company:	Donn’s Boat Shop, Inc.
Contact:	Donn DeVore
Address:	PO box 3826
	Page, AZ 86040
Shipping:	486 Haul Road
	Page, AZ 86040
Phone:	928-645-0313
Fax:	928-645-0323
Email:	boatfxr@donnsboatshop.com

Company:	Mobile Marine Repair, Inc.
Contact:	Steve Ringleman
Address:	PO Box 2988
	Page, AZ 86040
Phone:	928-645-1406
Fax:	928-645-1406

Company:	Old West Marine Service
Contact:	Len Cook, Jason Giffen
Address:	PO Box 4798
	Page, AZ 86040
Shipping:	1002 Vista
	Page, AZ 86040
Phone:	928-645-2705
Fax:	928-645-2542
Email:	oldwest@oldwestmarine.com

Company:	Skipperliner
Contact:	Jay Phelps, Jerry Apalategui
Address:	PO Box 3058
	Page, AZ 86040
Shipping:	550 Haul Road
	Page, AZ 86040
Phone:	928-645-2444
Fax:	928-645-5753

Company:	Skipperliner – Lake Pleasant
Contact:	Mike Montgomery, Glenn Carson
Address:	40202 N. 87th Ave
	Peoria, AZ 85382
Phone:	928-501-2444
Fax:	928-501-2443
Email:	phelpsjy@skipperliner.com

Company:	Tony's Dri-Dock & Marine
Contact:	Tony Ferrando
Address:	PO Box 897
	Page, AZ 86040
Shipping:	902 Hemlock
	Page, AZ 86040
Phone:	928-645-2732
Fax:	928-645-5237

Arkansas

Company:	Dreamchaser Houseboats
Contact:	Tiny Joe
Address:	PO Box 356
	Mt Ida, AR 71957
Shipping:	60 Marina Drive
	Mt Ida, AR 71957
Phone:	870-867-3480
Fax:	870-867-2665

California

Company:	Bayside Marine Electric
Contact:	Mike Vihel
Address:	PO BOX 685
	Bayside, CA 95524
Phone:	707-498-9999

Company:	Fishing Boats Unlimited
Contact:	Tony Greyshock, Jason Greyshock
Address:	624 Terminal Way
	Costa Mesa, CA 92627
Phone:	949-642-0882
Fax:	949-642-0419
Email:	crew@fishingboatsunlimited.com
Website:	www.fishingboatsunlilmited.com

Company:	Channel Coast Marine
Contact:	Marc Hermann
Address:	2949 W. 5th Street
	Oxnard, CA 93030
Phone:	805-985-0220
Fax:	805-985-7707

Company:	Chris Marine
Contact:	Chris Schjoth
Address:	14265 Holiday Road
	Redding, CA 96003
Phone:	530-275-3097
Fax:	530-275-3096

Company:	Dependable Marine
Contact:	Ernie Monroe, Syd Arnold
Address:	3134 Main Street
	San Diego, CA 92113
Phone:	619-226-2015
Fax:	619-226-0027
Email:	erniedepmar@aol.com

Company:	Easley Consulting
Contact:	Ron Easley
Address:	1048 Irvine Ave #315
	Newport Beach, CA 92660
Phone:	949-287-1619
Email:	roneasley93@yahoo.com

Company:	Fish Head Marine
Contact:	Robert Johnson (RJ)
Address:	603 Seagaze Dr Ste 162
	Oceanside, CA 92054
Phone:	760-271-0829
Email:	fishheadmarine@gmail.com

Company:	Hoffman Yacht Management
Contact:	Soren Megling
Address:	2330 172 Shelter Is Dr
	San Diego, CA 92106
Phone:	619-990-1409
Email:	steve@hoffmanyachtmgt.com

Company:	John Gumb Yacht Management, LLC
Contact:	Charles (Boomer) Walling
Address:	2330 Shelter Is Dr Ste 160
	San Diego, CA 92106
Phone:	619-247-6697
Fax:	619-437-4324
Email:	dgum@pacbell.net

Company:	Johnson Hicks Marine, Inc.
Contact:	Joe Donatini, Mark Egon, Larry Scroggins
Address:	333 C Lake Ave
	Santa Cruz, CA 95062
Phone:	831-475-3383
Fax:	831-475-1498
Email:	jhme6@cs.com

Company:	Jones Valley & Shasta Lake Resorts
Contact:	Mike Han, Kip Fatout
Address:	22300 Jones Valley Marina Road
	Redding, CA 96003
Phone:	530-275-7950
Fax:	530-275-3523

Company:	Outbound Yacht Service
Contact:	Kevin Ryan
Address:	34241 Pacific Coast Hwy #105
	Dana Point, CA 92629
Phone:	949-488-0652
Fax:	949-489-0704
Email:	kevin@outboundyachtservices.com

Company:	Reliable Marine Electronics
Contact:	Roger Nunez
Address:	1925 Lafeyette Street
	Alameda, CA 94501
Phone:	510-885-0525
Fax:	510-885-0526
Email:	radarrog@aol.com

Company:	Ron’s Marine Service
Address:	5449 Maricopa Dr
	Simi Valley, CA 93063
Phone:	310-508-2228
Email:	ronsmarine@sbcglobal.net

Company:	Scoles Marine Services
Contact:	Brian Scoles
Address:	615 LeHarve Avenue
	Lake Elsimore, CA 92530-5386
Phone:	909-678-6171
Fax:	909-678-7807

Company:	Sherrill’s Marine Service
Contact:	Robert Sherrill, Caleb Linn
Address:	PO Box 2112eet
	Avalon, CA 90704
Phone:	310-510-1610
Fax:	310-510-1352

Company:	Ship Shape Marine
Contact:	Tony Travis
Address:	909 Marina Village Pkwy, #186
	Alameda, CA 94501
Phone:	510-206-0420
Email:	Shipshapemarine@gmail.com

Connecticut

Company:	Mystic River Marina
Contact:	Greg Schroder
Address:	36 Quarry Road
	Mystic, CT 06355
Phone:	860-536-3936

Delaware

Company:	Hinckley Yacht Service
Contact:	Tom Turner
Address:	PO Box 369
	Oxford, MD 21654
Shipping:	Bank Street
	Oxford, MD 21654
Phone:	410-226-5113
	Covers Delaware & Maryland

Florida

Company:	ATM Marine, Inc.
Contact:	Mike Handschmann
Address:	18730 Lenaire Drive
	Miami, FL 33157
Phone:	305-251-7547
Cell:	786-429-7068
Fax:	305-926-3813
Email:	atmmarine1@bellsouth.net

Company:	Dave Gillen Diesel
Contact:	Dave Gillen
Address:	811 N.E. 3RD Street
	Dania Beach, FL 33004
Phone:	954-927-6500
Fax:	954-927-6090
Email:	Gillenda@GillenDiesel.net
Website:	www.Gillendiesel.net

Company:	Mega Yacht Service
Contact:	Dave Laschomb
Address:	408 SE STREAMLET AVE
	Port St. Lucy, FL 34983
Phone:	772-284-9638
Email:	megayacht@bellsouth.net

Company:	Naval Electrical Systems
Contact:	Alain Lauchy
Address:	14681 SW 124th Pl
	Miami, FL 33186
Phone:	305-962-7104
Email:	lauchy33@yahoo.com

Company:	Sea Wiz
Contact:	Melody Dodamead
Address:	PO Box 501396
	Marathon, FL 33050
Shipping:	8025 Gulf Stream Blvd
	Marathon, FL 33050
Phone:	305-289-4044
Cell:	305-289-3090
Fax:	305-481-0449

Company:	Yacht Electric Corporation
Contact:	Enrique Giner
Address:	7770 NW 53rd Street
	Miami, FL 33166
Phone:	404-376-8599
Fax:	770-979-4872

Georgia

Company:	J & W Marine Services
Contact:	Jerry Sumrel
Address:	3292 McEver Road, Suite 103
	Buford, GA 30518
Phone:	404-376-8599
Fax:	770-979-4872

Company:	Mobile Marine
Contact:	Painter Stevenson
Address:	4603 Countryside Drive
	Flowery Branch, GA 30542
Phone:	770-480-3805
Fax:	770-965-1864
Email:	sst3485@aol.com

Company:	On Site Marine Service
Contact:	Tim McNeil
Address:	2835 Still Meadows Way
	Buford, GA 30519
Shipping:	6109 Holiday Road
	Buford, GA 30518
Phone:	770-614-0106
Fax:	770-271-1909
Cell:	404-867-1235

Hawaii

Company:	Uhane Enterprises, LLC
Contact:	Jack Womack
Address:	74-425 Kealakehe Parkway #11
	Kailua-Kona, HI 96740
Phone:	808-557-9622
Fax:	808-329-4157
Email:	kalani444@aol.com

Iowa

Company:	S & S Rentals, Inc.
Contact:	Greg Stirn
Address:	PO Box 389
	Lansing, IA 52151
Shipping:	990 South Front Street
	Lansing, IA 51251
Phone:	563-538-4135
Fax:	563-538-4454

Kentucky

Company:	Monticello Mobile Marine
Contact:	Mark Tucker, Pam Tucker
Address:	PO BOX 1090
	Monticello, KY 42633
Shipping:	472 Barleson Sub Rd
	Monticello, KY 42633
Phone:	606-307-7077
Fax:	606-348-3587
Email:	mark@monticellomobilemarine.com
Website:	www.monticellomobilemarine.com

Company:	Pluckebaum Custom Boats, Inc.
Contact:	Jamie Donahue
Address:	1231 State Road 1793
	Prospect, KY 40059
Phone:	502-228-0111
Fax:	502-228-4767

Company:	The Boat Doctor
Contact:	Ancil Shelton
Address:	950 Duncan Valley Rd
	Monticello, KY 42633
Phone:	606-348-3484
Fax:	606-307-4960

Louisiana

Company:	Total Electric Service of Arcadiana
Contact:	Barry LaGrange
Address:	200 Rue Degravelle
	New Iberia, LA 70563
Phone:	337-367-6756
Fax:	337-367-6765

Maryland

Company:	Hinckley Yachts Services
Contact:	Tom Turner
Address:	PO Box 369
	Oxford, MD 51654
Shipping:	Bank Street
	Oxford, MD 51654
Phone:	410-226-5113
Fax:	410-226-5602
	Covers Delaware & Maryland

Company:	Middle River Electronics
Contact:	John Weaver, Darren Weaver
Address:	233 C Nanticoke Road
	Baltimore, MD 21221
Phone:	410-687-6474
Fax:	410-687-3353

Massachusetts

Company:	Niemiec Marine
Contact:	Martin Niemiec
Address:	173 Popes Island
	New Bedford, MA 02740
Phone:	508-997-7390
Fax:	508-997-8978

Nevada

Company:	A & M Marine
Contact:	Jim Bell, Scott Wall
Address:	1630 Foothill Drive
	Boulder City, NV 89005
Phone:	702-293-1321
Fax:	702-293-5896
Cell:	609-517-5595
Email:	anmmarine@aol.com

Company:	Callville Bay Resort & Marina
Contact:	Carl Ward
Address:	HCR 30 Box 100
	Las Vegas, NV 89124
Phone:	702-565-4813
Fax:	702-566-9899

New Jersey

Company:	Authority Marine Service
Contact:	Scott Self
Address:	1 Marine Bay Ct
	Highland, NJ 07732
Phone:	732-291-0012
Email:	authoritymarineservice@verizon.net

Company:	Martek Electronics
Contact:	Charles Hewitt
Address:	47 South Shore Road
	Marmora, NJ 08223
Phone:	609-390-3355
Fax:	609-369-0849
Cell:	609-517-5595

New York

Company:	Den-Mac Sales
Contact:	Dennis McGowen
Address:	8 Ramick Drive West
	Amityville, NY 11701
Phone:	631-842-8967
Fax:	631-842-5274

Company:	Montauk Marine Basin, Inc
Contact:	Mark Jarboe
Address:	PO Box 610
	Montauk, NY 11954
Shipping:	426 Westlake Drive
	Montauk, NY 11954
Phone:	631-668-5900
Fax:	631-668-5659
	Covers 60 miles west only

North Carolina

Company:	Demann Marine Power
Contact:	Tom Demann
Address:	107 Bryan Road
	Wilmington, NC 28412
Phone:	910-791-6222
Fax:	910-791-7056

Company:	Griffin Marine, Inc.
Contact:	Don Griffin, Don Griffin Jr., Casey Carr
Address:	PO Box 458
	Wanachese, NC 27981
Shipping:	898 Harbor Road
	Wanachese, NC 27981
Phone:	252-473-1422
Fax:	252-473-4654
Email:	griffinmarine@mindspring.com

Company:	Marine Control Systems
Contact:	Gary Sorenson
Address:	76 May Apple Lane
	Franklyn, NC 28734
Phone:	828-508-4201
Fax:	828-369-7572

Oregon

Company:	Cook Engine & Co.
Contact:	Jeff Dykes
Address:	503 NE Tomahawk Island Drive
	Portland, OR 97217
Phone:	503-289-8466
Fax:	503-286-2836
Email:	sales@cookengine.com

Company:	Curry Marine
Contact:	Terry Wheeler, Scot Graf, Laurie Wheeler
Address:	PO Box 610
	Newport, OR 97365
Shipping:	1211 SE Bay Blvd
	Newport, OR 97365
Phone:	541-265-7655
Fax:	541-265-4226

Company:	George’s Marine Electric
Contact:	Bill Elderkin, Paul Kepford
Address:	PO Box 5530
	Charleston, OR 97420
Phone:	541-888-5209
Fax:	541-888-9557

Company:	Sells Marine
Contact:	Paul Wilson
Address:	1111 NE Marine Drive
	Portland, OR 97211
Phone:	503-285-3838

Puerto Rico

Company:	Yacht Specialty
Contact:	David Davila
Address:	RR #2 Box 693
	San Juan, PR 00926
Phone:	787-755-4406
Fax:	787-755-4406
Cell:	787-397-7518

South Carolina

Company:	MacKay Communications
Contact:	Tony Smircic
Address:	1369 B Ashley River Road
	Charleston, SC 29407
Phone:	865-966-8481
Fax:	843-571-5301

Company:	Tidal Marine Electronics Ltd.
Contact:	Jeff Sechrest
Address:	1643 B Savannah Hwy, Suite 340
	Charleston, SC 29407
Phone:	843-763-8553
Fax:	843-763-8554
Email:	tidalmarineelec@aol.com

Tennessee

Company:	Simpson Marine Electronics
Contact:	R.S. Simpson
Address:	PO Box 22213
	Knoxville, TN 37933
Shipping:	665 Chapel Point Lane
	Knoxville, TN 37922
Phone:	865-966-8481
Fax:	865-966-9707

Texas

Company:	Lakewood Yacht Service
Contact:	Dennis Osborne, Danny Baldwin
Address:	POBox 536
	Seabrook, TX 37933
Shipping:	2301 Nasa Road 1
	Seabrook, TX 77586
Phone:	281-474-2885
Fax:	281-474-2885
Email:	jjohnston@lakewoodyachtservice.com

Utah

Company:	Aramark – Halls Crossing
Contact:	Mark Grahn
Address:	PO Box 5101
	Lake Powell, UT 84533
Phone:	435-684-7019
Fax:	281-474-2885

Company:	Bullfrog Boat Shop
Contact:	Tami Luckson
Address:	PO Box 4055
	Lake Powell, UT 84533
Phone:	435-684-3018
Fax:	435-684-3005

Company:	Offshore Marina, Inc.
Contact:	Daryl Hickson, Chris Pear
Address:	PO Box 330330
	Lake Powell, UT 84533
Shipping:	Hwy 276, Mile Marker 30
	Lake Powell, UT 84533
Phone:	435-788-2303
Fax:	offshoremarinaLP@aol.com
Email:	435-788-2303

Virginia

Company:	Bluewater Yacht Sales
Contact:	Craig Messick
Address:	26 Marina Yacht Charters
	Hampton, VA 23702
Phone:	757-723-0793
Fax:	757-723-3320

Washington

Company:	Anacortes Yacht Charters
Contact:	Sandy
Address:	2415 T Avenue, #112
	Anacortes, WA 98221
Phone:	360-293-4555
Fax:	360-293-6683

Company:	Complete Controls
Contact:	Jim Palmer
Address:	9306 NE 7th Street
	Vancouver, WA 98664
Phone:	360-904-7525
Fax:	360-254-7846
Email:	palmer.jim@comcast.net

Company:	Islands Marine Center, Inc
Contact:	Ron Meng
Address:	PO Box 88
	Lopez Island, WA 98261
Shipping:	Fisherman’s Bay Road
	Lopez Island, WA 98261
Phone:	360-468-3377
Fax:	360-468-2283

Company:	Marine Service Center, Inc. – ANA
Contact:	Skip Dassler
Address:	2417 T Avenue
	Anacortes, WA 98221
Phone:	360-293-8200
Fax:	360-293-9648

Company:	Maritime Fabrications / LaConner Maritime
Contact:	Tony Ford, Joe Franett
Address:	PO Box 816
	LaConner, WA 98257
Shipping:	920 W. Pearle Jensen Way
	LaConner, WA 98257
Phone:	360-466-3629
Fax:	360-466-3632

Company:	North Harbor Diesel, Inc.
Contact:	Dave Williams, Mike Curran
Address:	720 30th Street
	Anacortes, WA 98221
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	Seattle, WA 98103
Phone:	206-547-1395
Fax:	206-547-3789

Company:	Puget Sound Yacht Service
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Address:	9611 146th Place SE
	Snohomish, WA 98296
Phone:	206-660-3630
Fax:	206-483-0710
Email:	psyachtservice@aol.com

Company:	Radar Marine Electronics
Contact:	Bill Pulse
Address:	16 Squallicum Mall Blvd
	Bellingham, WA 98225
Phone:	360-733-2012
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Company:	Reliance Marine Electronics
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	Seattle, WA 98107
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Email:	randy@wolfenet.com
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Company:	Trimer S.A.
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Electronic Propulsion Control Systems Limited Warranty

A Limited Warranty: Your ZF product was designed and manufactured by experienced engineers and craftsmen. ZF Marine Propulsion Systems Miramar, LLC warrants for the period indicated below, each product manufactured by ZF Marine Propulsion Systems Miramar, LLC to be free from defects in materials and workmanship. If during the applicable warranty period a product is determined by ZF Marine Propulsion Systems Miramar, LLC to be in breach of this limited warranty, ZF Marine Propulsion Systems Miramar, LLC, at its option, will repair or replace the defective product.

B Warranty Exclusions: This warranty covers only failures due to defects in materials or workmanship that occurs during normal use. This warranty does not cover damage that occurs in shipment, failures that are caused by products not supplied by ZF Marine Propulsion Systems Miramar, LLC, failures that result from installation that is not in compliance with ZF specifications, accident, misuse, abuse, neglect, water damage, mishandling, misapplication, setup adjustments, improper maintenance, alterations, modification or service by anyone other than a ZF Authorized Service Center, damage that is attributable to acts of God or other causes unrelated to defects in materials and workmanship.

C Warranty Period: The length of the applicable warranty period will depend on the use of your vessel. For Commercial Craft the standard warranty period is for 24 months from the date of original shipment by ZF or 12 months after commissioning of the craft, whichever occurs first. A commercial craft is defined as any vessel used for any commercial purpose including but not limited to any use as a workboat, passenger vessel, charter or rental fleet.

D For Pleasure Craft the warranty period is 36 months from the date of original shipment by ZFME or 24 months after commissioning of the craft, whichever occurs first. A Pleasure Craft is any vessel that is or has not been used for any commercial purpose including but not limited to any use as a workboat, passenger vessel, charter or rental fleet.

E Repair or replacement parts provided under this Warranty will not be covered by the remainder of the unexpired warranty in effect on the complete unit.

F No Coverage Under Warranty: The exclusive remedy under this warranty is the repair or replacement of the defective component and this warranty specifically does not provide coverage for:

1. Towing or transportation of the vessel, or travel to and from the job site or vessel.
2. Original installation charges or start-up costs.
3. Loss of use or income from the vessel and/or rental of equipment during the performance of warranty repairs.

G To Obtain Warranty Service: Please go to www.zf.com or call 1-425-583-1900 or (U.S. only) 1-800-546-5455 for the nearest ZF Factory or Authorized Service Center.

1. The Service Center will contact ZF Service Department for a Service Return Authorization (SRA) number. Return the product freight prepaid, marked clearly with the SRA number, and with a description of the malfunction included.
2. If there are defects covered by this warranty, ZF will, at its option, either repair or replace the defective part or product. If after inspection, ZF determines that the product is not defective, ZF will charge a testing fee and return the product to the sender, freight collect.
3. Repair or replacement during the warranty period will not extend the warranty period.
4. All SRA claims must be requested and submitted within 30 days from the date of repair service.
5. Claims for over 3 hours labor must be pre-approved by the ZF Service Department.

This warranty is expressly in lieu of all other warranties, express or implied. Except to the extent prohibited by applicable law, ZF hereby disclaims all other implied or express warranties of any kind, including warranties of merchantability and fitness for a particular purpose. Under no circumstances shall ZF be liable for any incidental or consequential damages sustained in connection with the product or its use, including any costs or damages that result from loss of use of the product or any engine or boat with which it is used. ZF does not authorize any representative or agent to assume for it any obligation or liability other than those expressly set forth above. Some States and other jurisdictions do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of consequential damages, so above limitations may not apply to you. All implied warranties, if any, are limited to the duration of this express warranty. This warranty gives you legal rights, and you may have other rights that may vary from State to State.

Warranty Registration

Processor, Serial #			Serial #		
Number of Remote Stations					
Purchase Date					
Dealer's Name					
Installer's Name					
Phone Number			Cell Number		
E-Mail Address			Fax Number		
Purchaser's Name					
Street Address					
City		State		Zip	
Phone					
YOUR VESSEL:					
Engine, Make & Model					
Length					
Manufacturer					

ZF Marine Propulsion Systems Miramar, LLC. Product First Seen At:

Boat Show	Dealer	Magazine	Friend

REFERENCE MANUAL

MM13927 FIELD SERVICE TEST UNIT

MARINE PROPULSION SYSTEMS

Released by After Sales dept.

Revisions List

Rev	Date	Revision Description
A	11/02	Revised Section 1.0 Table 1
B	2/03	Revised manual to current ZF Marine Propulsion Systems Miramar manual standards. Revised Section 3.0
C	4/03	Deleted Section 2.1.6
D	10/03	Revising to add 9000 Series and 2-Speed information
E	06/07	Brought Entire Manual up to current ZF Standards. Software revised to SW70203.3 adding Joystick display. ELR 1401: Table 1, 2, 3, and 4 Item #3 changed from 13316-XX to 70422-xx Made CANtrak consistent throughout manual. Renamed Figures without CANtrak
E.1	07/10	Reformatted, updated inserted images
E.2	01/13	Name change to ZF Marine Propulsion Systems Miramar, LLC

1 Introduction

Refer to Bulletin 02-008 for Service Field Test Unit (Part No. 13927) recommendations. Refer to Figure MM13927-1: .Service Field Test Unit (Break-out Box) for an example of the Test Unit and a Multimeter

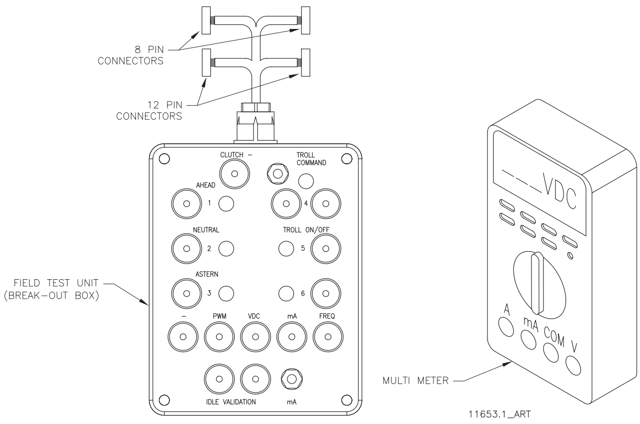


Figure MM13927-1: .Service Field Test Unit (Break-out Box)

The Service Field Test Unit, hereafter referred to as the “Break-out Box”, is recommended for use with all CruiseCommand Processors (Part No. 785CE) and with ClearCommand Processors (Part No. 9XXX Series) that have pluggable (Pigtail) Throttle, Clutch or Troll Connections.

The procedures for testing the various outputs of the ClearCommand and CruiseCommand Processors are similar, with the exception of where they connect to the respective Processor. Figure MM13927-2: CruiseCommand Connector Locations indicates the location of the connectors on the CruiseCommand Processor and Figure MM13927-3: Example of CLEARCommand Pigtail Locations the typical pigtail plugs on a 9000 Series ClearCommand Processor.

	NOTE: Not all ClearCommand Processors have all of the pigtails shown in Figure MM13927-3: Example of CLEARCommand Pigtail Locations. Only the pigtails that are required for a specific application are installed in a ClearCommand Processor.

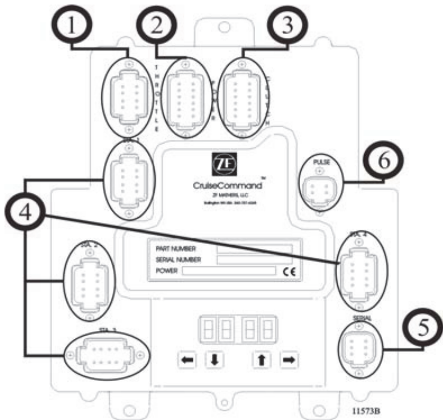


Figure MM13927-2: CruiseCommand Connector Locations

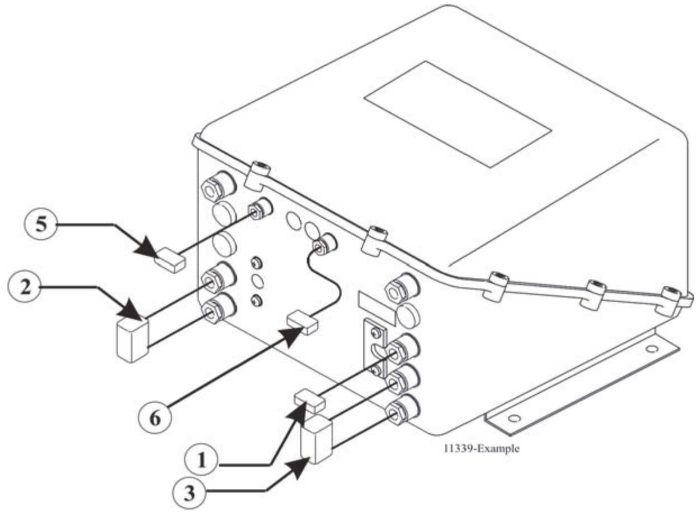


Figure MM13927-3: Example of CLEARCommand Pigtail Locations

Designation #	Description	Harness Type	Harness Use
1	Black 8 Pin	Throttle Connector/Pigtail	The throttle signal is output from this connector/pigtail. The signal may be in the form of Pulse Width Modulation (PWM), Voltage, Current, or Frequency.
2	Black 12 Pin	Power Connector/Pigtail	This connector/pigtail contains the inputs and outputs for Main Processor Power, Start Interlock, Clutch Oil Pressure Interlock, and External Alarm Circuit.
3	Gray 12 Pin	Clutch Connector/Pigtail	The external connections for Clutch Power, Ahead, Astern, and Neutral Solenoids, Troll On/ Off, and Proportional Solenoids are made at this connector/pigtail.
4	Gray 8 Pin	Control Head Connector	All the required connections for the Remote Control Stations are made at these connectors.
5	Gray 6 Pin	Serial Communication Connector/Pigtail	The Serial Communication connections between multiple Processors in applications with more than one Processor at this connector/pigtail.
6	Gray 4 Pin	Tachometer Sensor Connector/ Pigtail	The input signal from a Tachometer or Shaft Speed Sensor connects to this connector/pigtail.

The actual procedures for using the Break-out Box are the same for CruiseCommand and ClearCommand Processors. However, the adjustment within the Processor to obtain the correct output may differ. The appropriate Installation Manual must be referred to when making the adjustments.

2 Procedure

2.1 Throttle Signal Testing

Depending on which Processor is being tested, it may have the capability of sourcing one or all of the following: DC Voltage, Current, PWM (Pulse Width Modulation) or Frequency.

NOTE: The following procedures and drawings pertain to both the CruiseCommand and ClearCommand Processors.

2.1.1 DC Voltage

A Ensure that power is removed from the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-4: Throttle Connection (DC Voltage).

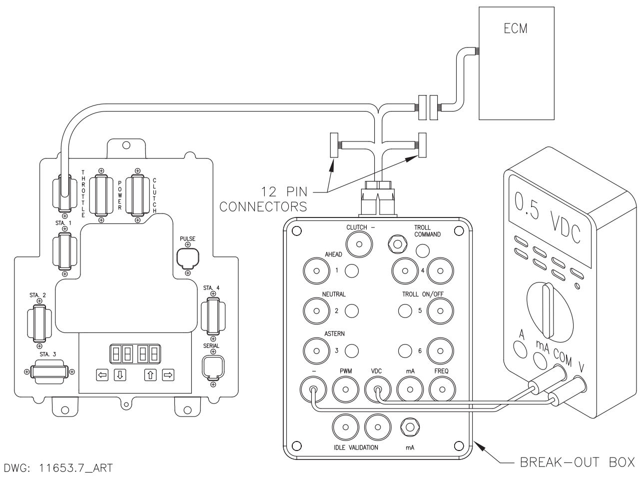


Figure MM13927-4: Throttle Connection (DC Voltage)

D Set up the Multimeter to measure DC Volts and plug the black lead into the Break-out Box black socket labeled "-" and the red lead into the socket labeled "VDC".

E Turn power 'On' to the Processor and take command at any Remote Station.

F The appropriate Idle Voltage for the application should be measured at this time.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

H The appropriate Full Throttle Voltage for the application should be measured at this time.

2.1.2 Current (mA)

A Ensure power is removed from both the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-5: Throttle Connection (Current mA).

D Set up the Multimeter to measure current (mA.) and plug the black lead into the Break-out Box black socket labeled "-" and the red lead into the socket labeled "mA".

E Turn power 'On' to the Processor and take command at any Remote Station.

F Depress and hold the Push-button Switch labeled "mA." The appropriate Current (mA.) for the application should be measured.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

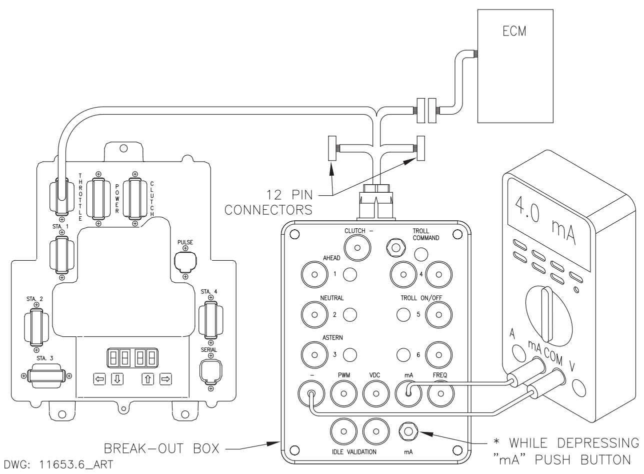


Figure MM13927-5: Throttle Connection (Current mA)

H Depress and hold the "mA." Push-button. The appropriate Full Throttle Current (mA.) for the application should be measured at this time.

2.1.3 PWM (Pulse Width Modulation) with DC Voltmeter

A Ensure power is removed from both the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-6: Throttle Connection (PWM with DC Voltmeter) labeled "-" and the red lead into the socket labeled "PWM".

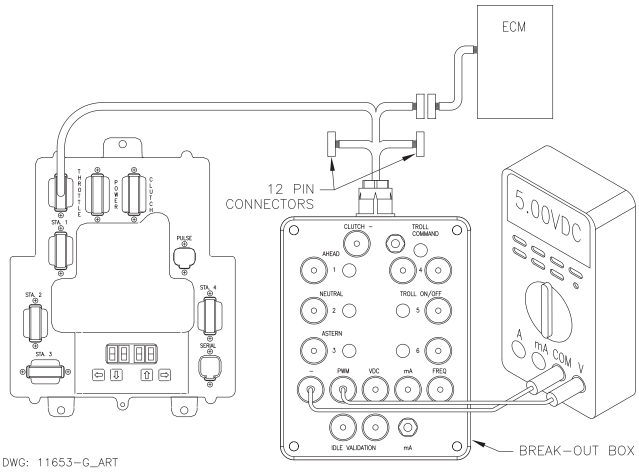


Figure MM13927-6: Throttle Connection (PWM with DC Voltmeter)

D Turn power 'On' to the Caterpillar ECM (Electronic Control Module) **Only**. **Do Not** apply power to the Processor at this time.

E Depending on the type of Caterpillar ECM (PEEC or ADEMS), the measurement should be approximately 5.00 or 12.00 VDC. Record the measurement as shown in Drawing Figure MM13927-6: Throttle Connection (PWM with DC Voltmeter).

F Set up the Multimeter to DC Volts and plug the black lead into the Break-out Box black socket Turn power 'On' to the Processor and take command at any Remote Station.

G Record the DC Voltage at this time. The measurement should be 7- 9% of the voltage measured in step F).

H Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

I The measurement should be 91- 93% of the voltage measured in step F) [e.g. Idle = 8% of 12 VDC reference or 0.96 VDC; Full Throttle = 92% of 12 VDC reference or 11.04 VDC.

2.1.4 PWM (Pulse Width Modulation) with Duty Cycle Meter

A Ensure power is removed from both the Engine electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-7: Throttle connection (PWM with Duty Cycle Meter).

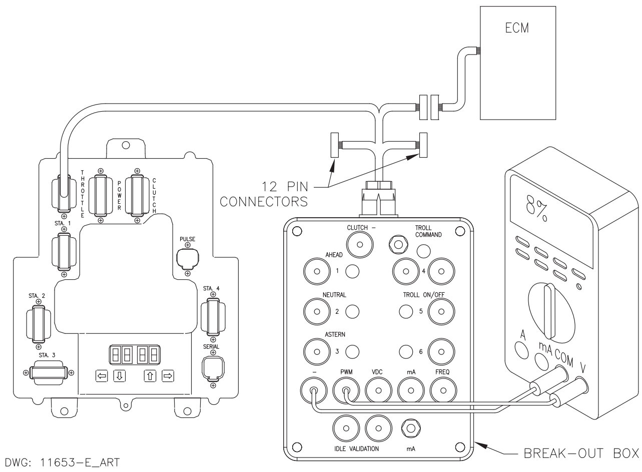


Figure MM13927-7: Throttle connection (PWM with Duty Cycle Meter)

D Set up the Multimeter to measure Duty Cycle and plug the black lead into the Break-out Box black socket labeled "-" and the red lead into the socket labeled "PWM".

E Turn power 'On' to the Caterpillar ECM (Electronic Control Module) and to the Processor.

F The measurement should be approximately 8% duty Cycle.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

H The measurement will increase from 8% to 91- 93%.

2.1.5 Frequency (Hz.)

A Ensure power is removed from both the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-8: Throttle Connection (Frequency Hz).

D Set up the Multimeter to measure Frequency and plug the black lead into the Break-out Box black socket labeled "-" and the red lead into the socket labeled "FREQ".

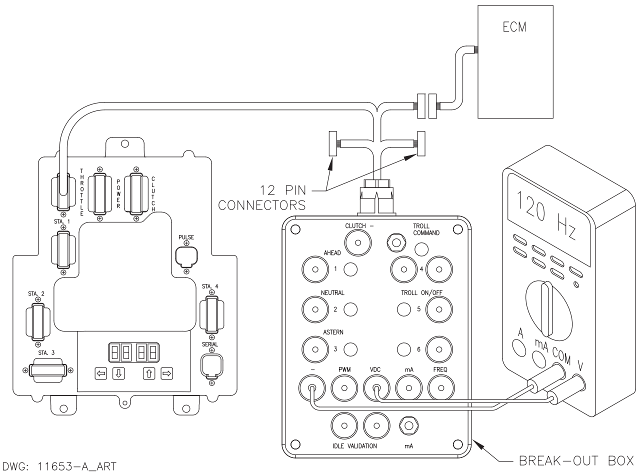


Figure MM13927-8: Throttle Connection (Frequency Hz)

E Turn power 'On' to the Processor and take command at any Remote Station.

F The appropriate Idle Frequency for the application should be measured at this time.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

H The appropriate Full Throttle Frequency for the application should be measured at this time.

2.2 Clutch Testing

2.2.1 Neutral Solenoid Testing

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-9: Clutch Connections Neutral Solenoid.

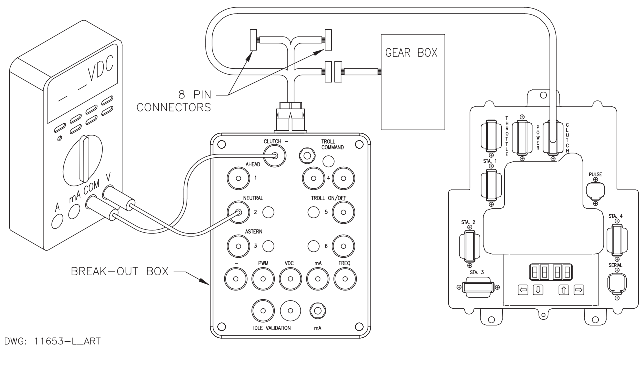


Figure MM13927-9: Clutch Connections Neutral Solenoid

D Turn power 'On' to the Processor and take command at any Remote Station with the Control Head lever in the Neutral/Idle position.

E The measurement on the Neutral Test Point should be 12 or 24 VDC, depending on the Solenoid's rating and the LED adjacent to the socket should be illuminated.

F Move the Control Head lever to the Ahead Detent position. The voltage should drop to 0 VDC in CruiseCommand systems and remain at 12 or 24 VDC in ClearCommand systems. The adjacent LED should go out in CruiseCommand systems and stay on in ClearCommand systems.

2.2.2 Ahead Solenoid Testing

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-10: Clutch Connections Ahead Solenoid.

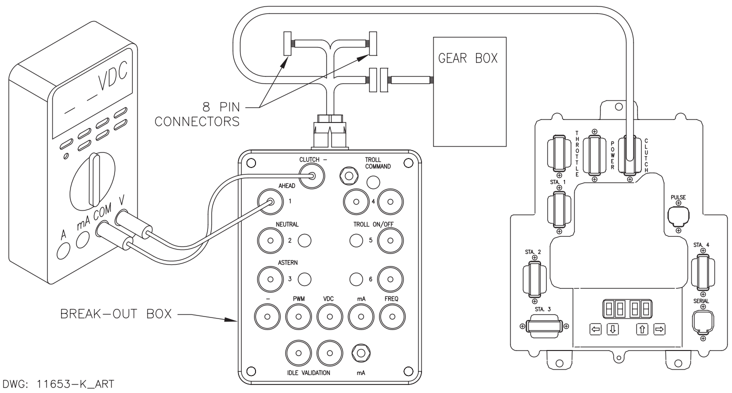


Figure MM13927-10: Clutch Connections Ahead Solenoid

D Set up the Multimeter to measure DC Volts and plug the black lead into the Break-out Box socket labeled "CLUTCH -" and the red lead into the socket labeled "AHEAD".

E Turn power 'On' to the Processor and take command at any Remote Station with the lever in the Neutral/Idle position.

F The measurement should be 0 VDC and the adjacent LED should not be lit.

G Position the Control Head lever into the Ahead detent. The measurement should be 12 or 24 VDC depending on the Ahead Solenoid's rating. The LED adjacent to the Ahead plug on the Break-out Box should be lit.

H Return the Control Head lever to the Neutral/Idle position.

2.2.3 Astern Solenoid Testing

A Ensure power is removed from both the Processor and the Clutch Supply Power.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-11: Clutch Connections Astern Solenoid.

D Set up the Multimeter to measure DC Volts and plug the black lead into the Break-out Box socket labeled "CLUTCH -" and the red lead into the socket labeled "ASTERN".

E Turn power 'On' to the Processor and take command at any Remote Station with the Control Head lever in the Neutral/Idle position.

F The measurement should be 0 VDC and the adjacent LED should not be lit.

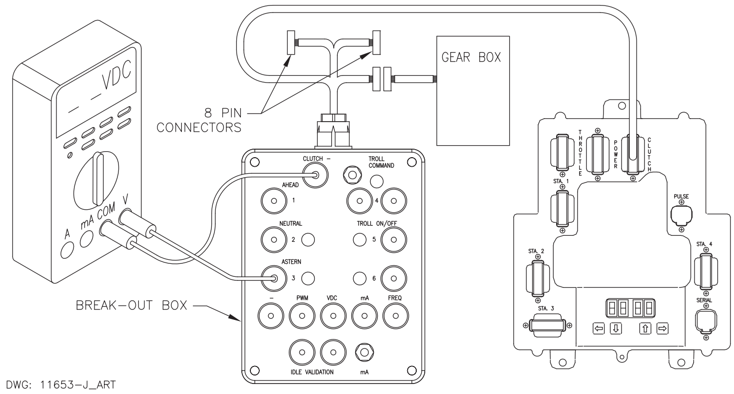


Figure MM13927-11: Clutch Connections Astern Solenoid

G Position the Control Head lever into the Astern detent. The measurement should be 12 or 24 VDC depending on the Astern Solenoid's rating. The LED adjacent to the Astern plug on the Break-out Box should be lit. Return the Control Head lever to the Neutral/Idle position.

2.3 Troll Testing

2.3.1 Troll On/Off Solenoid

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-12: Troll Connections Troll On/Off Solenoid.

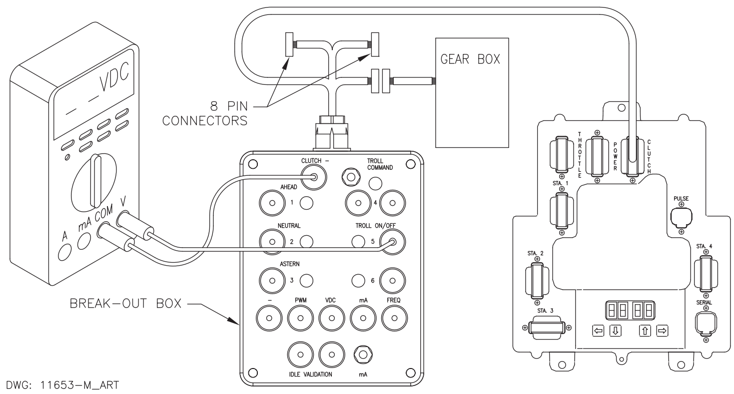


Figure MM13927-12: Troll Connections Troll On/Off Solenoid

D Set up the Multimeter to measure DC Volts and connect the black lead to the socket labeled "CLUTCH –" and the red lead to the socket labeled "TROLL ON/OFF" as shown in Figure MM13927-12: Troll Connections Troll On/Off Solenoid.

E Turn power 'On' to the Processor and the Clutch Power Supply and take command at a Remote Station with the Control Head lever in the Neutral/Idle position.

F Depress the Transfer Button again for approximately 2 seconds until the red LED begins blinking at a fast rate (Troll Mode Indication).

G The measurement should be 0 VDC.

H Position the Control Head lever to the Ahead detent. The measurement should now be 12 or 24 VDC, depending on the Solenoid's rating.

I Position the Control Head lever further forward while monitoring the DC Voltmeter. The measurement should go from 12 or 24 VDC to 0 VDC at the same time the red LED on the Control Head becomes lit solid.

2.3.2 Troll Command (Proportional Solenoid) Testing with Amp Meter

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-13: Troll Connections (Proportional Solenoid).

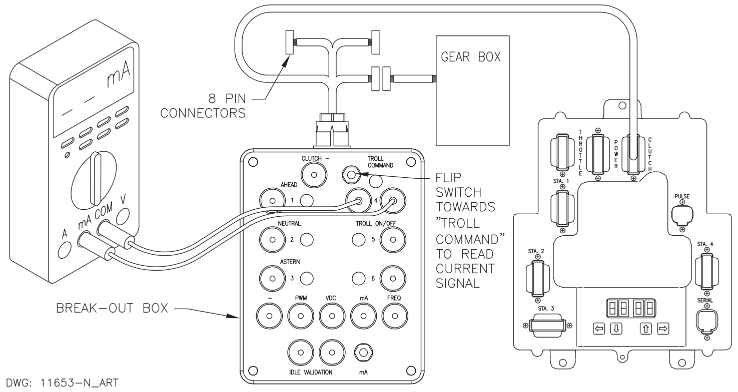


Figure MM13927-13: Troll Connections (Proportional Solenoid)

D Set up the Multimeter to measure (mA.) and connect the black lead to black socket and the red lead to the red socket labeled "TROLL COMMAND" as shown in Figure MM13927-13: Troll Connections (Proportional Solenoid).

E Turn power 'On' to the Processor and the Clutch Power Supply and take command at a Remote Station with the Control Head lever in the Neutral/Idle position.

F Depress the Transfer Button again for approximately 2 seconds until the red LED on the Control Head begins blinking at a fast rate (Troll Mode Indication).

G Flip switch away from "Troll Command" to read current through meter.

H Move the Control Head lever to the Ahead detent. The current measurement should be the correct value for minimum clutch pressure (shaft rotations). This value varies depending on the type of Marine Gear. Refer to the Literature provided with the Trolling Valve and the Processor for specifics.

I Slowly advance the Control Head lever while monitoring the current. The current should increase or decrease, depending on the Gear type, in proportion with the Control Head lever movement. Once again, refer to the Literature provided with the Trolling Valve and the Processor for specific values.

J Continue to move the Control Head lever forward until the red LED stops blinking (lit steady). The current should drop to 0 mA.

2.4 2-Speed Testing

2.4.1 2nd Gear Disengaged

A Ensure power is removed from the Processor.

B Disconnect the Clutch/2-Speed Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch/2-Speed Harness as shown in Figure MM13927-14: 2-Speed Connections.1653

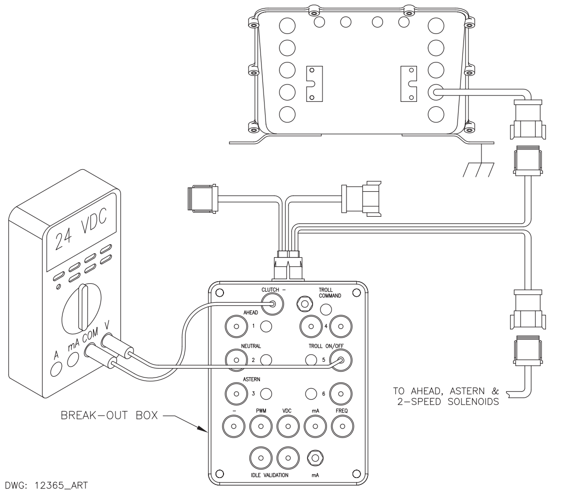


Figure MM13927-14: 2-Speed Connections

D Set up the Multimeter to measure DC Volts and connect the black lead to the socket labeled "CLUTCH - " and the red lead to the socket labeled "TROLL ON/OFF" as shown in Figure MM13927-14: 2-Speed Connections.

E Turn power 'On' to the Processor and take command at any Remote Station.

F The voltage measurement should be approximate 0 VDC.

2.4.2 2nd Gear Engaged

A Leave the Break-out Box and Multimeter in the same position as left in Section 2.4.1: 2nd Gear Disengaged.

B Start the engine(s).

C Depress the Transfer Button while moving the lever(s) into the Ahead detent (red LED should be blinking, indicating Warm-up Mode).

D Continue to move both Control Head lever(s) forward until the RPM programmed for Function Code **U1** has been reached.

E The voltage measurement at the Multimeter should now be 12 or 24 VDC, depending on the Solenoid's rating.

F Return the Control Head levers to the Neutral/Idle position and shut down the engines.

G Turn power Off to the Processor(s).

H Unplug the Break-out Box from the Pigtail and Harness plugs and reconnect the Harness to the Pigtail.

2.5 Parts List

ZF Marine Propulsion Systems Miramar Part No.	Part Name
13927	Service Field Test unit (Break-out Box)
MM13927	Technical Manual
	Multimeter
14000	Test Control Head - Dual

14 Appendix D - System Drawings

– NOTES –

1. DO NOT MOUNT CONTROL SYSTEM COMPONENTS ON REDUCTION GEAR, ENGINE, OR IN ANY LOCATION SUBJECT TO EXCESSIVE VIBRATION.
2. DO NOT MOUNT CONTROL COMPONENTS NEAR SOURCES OF HIGH HEAT (EXHAUST DUCTS, ETC.). MAXIMUM ALLOWABLE AMBIENT TEMPERATURE IS 70°C.
3. DO NOT MOUNT CONTROL COMPONENTS NEAR SOURCES OF STRONG ELECTROMAGNETIC FIELDS (STARTERS, GENERATORS, ETC.).
4. MOUNT CONTROL COMPONENTS IN A LOCATION ACCESSIBLE FOR SET UP, MONITORING AND MAINTENANCE.
5. ALL ELECTRICAL CABLES ARE TO BE SUITABLE FOR MARINE APPLICATION AND MEET ALL APPLICABLE REGULATORY REQUIREMENTS.
6. START INTERLOCK RELAY HAS NORMALLY OPEN CONTACTS. CONTACTS ARE CLOSED WHEN SYSTEM IS OPERATING AND COMMANDING NEUTRAL. MAXIMUM OF 5 AMP, MAXIMUM OF 30V.
7. THE CONTROL PROCESSOR WILL BE PROVIDED SHIP'S SUPPLY OF 12 OR 24 VDC, PROTECTED BY A 10 AMP RATED CIRCUIT BREAKER.
8. CONTROL FAILURE ALARM RELAY CONTACTS ARE CLOSED WHEN THE PROCESSOR IS OPERATING. THE RELAY CONTACTS OPEN IF EITHER THE PROCESSOR FAILS OR POWER FAILS. THE CONTACTS ARE RATED FOR A MAXIMUM OF .5A, MAXIMUM CONTACT DRY RATING OF 100V. DO NOT EXCEED THIS RATING. IT IS THE SHIPYARD'S RESPONSIBILITY TO UTILIZE THE ALARM CONNECTION IN AN APPROPRIATE ALARM CIRCUIT.
9. CAUTION:
   THIS PART CONTAINS ELECTRONIC COMPONENTS WHICH CAN BE DESTROYED BY STATIC ELECTRICITY. PERSONNEL SHOULD GROUND THEMSELVES TO DISSIPATE ANY STATIC ELECTRICITY PRIOR TO WORKING INSIDE THE PART.
10. PRESSURE SWITCH SETPOINT (N.O. CONTACTS) MUST BE SET AT 150 PSI OR AS RECOMMENDED BY TRANSMISSION MANUFACTURER. WHEN CONTACTS CLOSE THIS INDICATES TO THE CONTROL PROCESSOR WHEN THE CLUTCH IS SUFFICIENTLY ENGAGED TO ALLOW A SPEED COMMAND ABOVE IDLE SPEED. THIS IS A SAFETY FEATURE THAT PROTECTS THE CLUTCH AND ITS USE IS RECOMMENDED. THIS IS SET AT THE FACTORY, BUT SHOULD BE VERIFIED PRIOR TO SEA TRIALS.
11. THE CONTROL PROCESSOR'S MOUNTING FEET MUST BE CONNECTED TO THE VESSEL'S GROUNDING SYSTEM.
12. NOT USED
13. FREQUENCY INPUT FOR ENGINE SYNCHRONIZATION:
    (INPUT PULSES EITHER AC TYPE TACH INPUT OR OPEN COLLECTOR TYPE INPUT)
    AC COUPLED INPUT (TB9–2) : MINIMUM FREQUENCY 30Hz
    MAXIMUM FREQUENCY 8000Hz.
    OPEN COLLECTOR INPUT (TB9–3) : MINIMUM SINK CURRENT 2mA.
    MAX SENSOR OUTPUT SATURATION VOLTAGE 0.8V.
    REFER TO THE CONTROL SYSTEM MANUAL FOR ADDITIONAL LIMITS FOR THESE INPUTS.
14. REFER TO THE CONTROL SYSTEM MANUAL FOR ADDITIONAL INFORMATION ON THE AUTOMATIC POWER SELECTOR (APS).
15. NOT USED
16. ENSURE THAT SHIELD ON THE SHIELDED CABLE IS CONNECTED ONLY AT ONE END TO THE CHASIS AND THAT THE DRAIN WIRE DOES NOT TOUCH ANY OTHER CONDUCTIVE SURFACE. REFER TO THE INSTALLATION MANUAL FOR ADDITIONAL INFORMATION.
17. ENSURE THAT DRAIN WIRE ON SHIELDED CABLE IS CONNECTED ONLY WHERE INDICATED INSIDE HOUSING AND THAT DRAIN WIRE DOES NOT TOUCH ANY OTHER CONDUCTIVE SURFACE. FOR PROCESSORS WITH A SERIAL COMMUNICATIOn PIGTAIL, SHIELD TERMINATION IS DONE AT THE FACTORY. REFER TO THE INSTALLATION MANUAL FOR ADDITIONAL INFORMATION.
18. THIS CONNECTOR PROVIDES THE FOLLOWING FUNCTIONS: POWER INPUT, START INTERLOCK OUTPUT, CLUTCH PRESSURE INPUT, ALARM OUTPUT. THE EXTERNAL WIRE HARNESS ATTACHED TO THIS CONNECTOR DETERMINES WHICH FUNCTIONS ARE USED. POWER AND START INTERLOCK ARE REQUIRED, CLUTCH PRESSURE AND ALARM MAY BE OPTIONAL BASED ON CUSTOMER OR REGULATORY REQUIREMENTS.
19. THE PROCESSOR SHOWN COMES EQUIPPED WITH TWO STATIONS PRE-WIRED. THREE ADDITIONAL STATIONS MAY BE ADDED BY EITHER HARD WIRING CABLE INTO THE LOCATIONS SHOWN ON SHEET TWO OF THIS DRAWING OR BY ACQUIRING THE ADDITIONAL WIRE HARNESS'S REQUIRED FROM ZF MARINE ELECTRONICS.
20. THE SERVO POTENTIOMETER IS DESIGNED TO INTERFACE TO TYPE 33C PUSH/PULL CABLES. USE A HIGH OR PREMIUM QUALITY PUSH/PULL CABLE (FOR EXAMPLE TELEFLEX TFXTREME) FOR IMPROVED RELIABILITY AND DURABILITY. FURTHERMORE, THE WEAR AND OPERATION OF THE PUSH/PULL CABLE AND SERVO POSITIONER SHOULD BE CHECKED ON A ROUTINE BASIS FOLLOWING THE CABLE MANUFACTURER'S SPECIFICATIONS, EVERY 400 TO 500 HOURS OF VESSEL OPERATION, OR THE BEGINNING OF THE OPERATING SEASON.
21. NOT USED
22. NUMBER AND CONFIGURATION OF SERVO'S WILL VARY BY PART NUMBER OF CLEARCOMMAND.

REVISION

ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	Q.C. APR
	A	REVISED FLAGNOTE 16, TABLE 1	MW 04/05	TJ 04/05	RH 04/05
	B	REVISED NOTE 13: (ADDED TB9–2 & TB9–3) ZONE C3, TABLE I: ADDED P/N: 91204 AND 92205. SHEET 3: CHANGED TACH SENSOR, ADDED NOTE 13 CALLOUT.	RAC 06/03/05	CME 06/03/05	RBH 06/06/05
	C	ADDED PROCESSORS 91004, 91203, 91214, 91224, 92004, 92104, 92113, 92115, 92202, 92213, 92214, 92220, 92222, AND 92225. UPDATED ALL NOTES. ADDED SHEET 4. UPDATED FORMAT.	C.KEW 09/06	CME 09/29/06	RBH 10/02/06
	D	ADDED PROCESSOR 92103.	RAC 08/25/08	CME 08/29/08	RBH 08/29/08
	E	ADDED PROCESSOR 92200.	RAC 09/21/09	AHN 09/21/09	RBH 09/21/09

INDEX

UNLESS OTHERWISE SPECIFIED TOLERANCES
FRAC. = ±1/64 IN.
.X = ±.050
.XX = ±.010
.XXX = ±.005
ANGLE = ±2°

DIMENSIONS ARE IN INCHES [mm]
INTERPRET PER ANSI Y14.5M–1982 DIMENSIONS APPLY PRIOR TO FINISH
BREAK ALL SHARP EDGES
DO NOT SCALE DRAWING

	APPROVAL	DATE
DRN	M.WILSON	7/16/03
ENG	T.JONES	7/16/03
CHK		
QC	R.B.H.	7/16/03
MFG	R.Z.	7/16/03

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE: CLEARCOMMAND ALL CONFIGURATION TWIN SCREW – SYSTEM DRAWING

SIZE: B | CAGE CODE: | DWG NO.: 12284 | REV: E
SCALE: NONE | PART NO.: SEE NOTE 23 | SHEET: 1 OF 4

23 SEE TABLE I BELOW FOR SPECIFIC CONFIGURATION TO PART NUMBER.

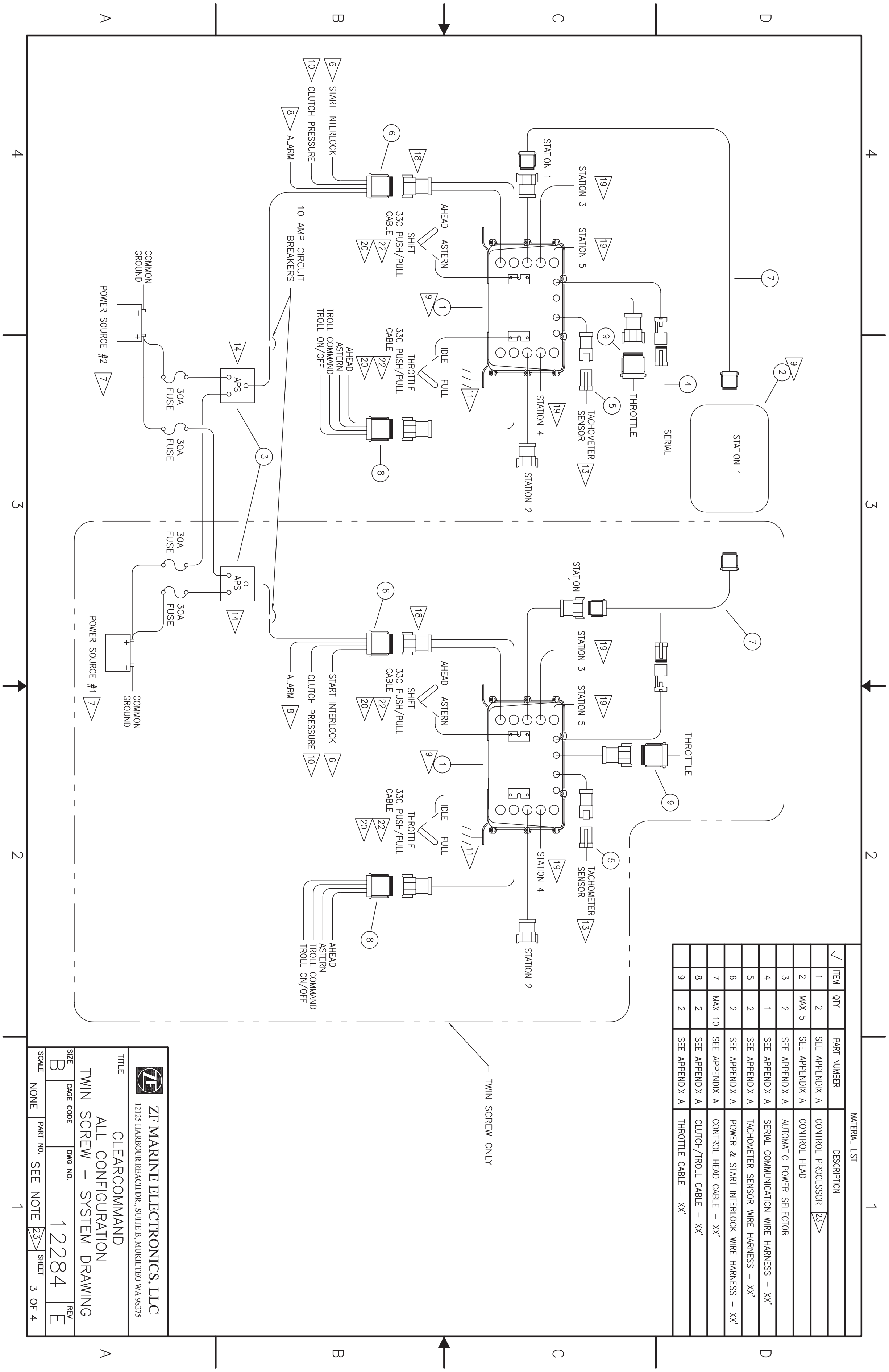
REVISION					
ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	Q.C. APR
		—SEE SHEET 1—			

TABLE I		WIRE HARNESS					
		CLUTCH WIRE HARNESS	THROTTLE WIRE HARNESS	MAG PICKUP WIRE HARNESS	SERIAL COMM WIRE HARNESS	CONTROL HEAD WIRE HARNESS	POWER/S.I./ALARM/C.P. WIRE HARNESS
CONTROL PROCESSOR	P/N: 91000			✓	✓		
	P/N: 91002			✓	✓	✓ (X2)	✓
	P/N: 91004			✓	✓	✓ (X4)	✓
	P/N: 91200			✓	✓		
	P/N: 91202	✓		✓	✓	✓ (X2)	✓
	P/N: 91203	✓		✓	✓	✓ (X3)	✓
	P/N: 91204	✓		✓	✓	✓ (X4)	✓
	P/N: 91210	✓		✓	✓		
	P/N: 91212	✓		✓	✓	✓ (X2)	✓
	P/N: 91214	✓		✓	✓	✓ (X4)	✓
	P/N: 91220	✓		✓	✓		
	P/N: 91222	✓		✓	✓	✓ (X2)	✓
	P/N: 91224	✓		✓	✓	✓ (X4)	✓
	P/N: 92000		✓	✓	✓		
	P/N: 92002		✓	✓	✓	✓ (X2)	✓
	P/N: 92004		✓	✓	✓	✓ (X4)	✓
	P/N: 92100		✓	✓	✓		
	P/N: 92102		✓	✓	✓	✓ (X2)	✓
	P/N: 92103		✓	✓	✓	✓ (X3)	✓
	P/N: 92104		✓	✓	✓	✓ (X4)	✓
	P/N: 92110		✓	✓	✓		
	P/N: 92112		✓	✓	✓	✓ (X2)	✓
	P/N: 92113		✓	✓	✓	✓ (X3)	✓
	P/N: 92200	✓	✓	✓	✓		✓
	P/N: 92202	✓	✓	✓	✓	✓ (X2)	✓
	P/N: 92205	✓	✓	✓	✓	✓ (X5)	✓
	P/N: 92210	✓	✓	✓	✓		
	P/N: 92212	✓	✓	✓	✓	✓ (X2)	✓
	P/N: 92213	✓	✓	✓	✓	✓ (X3)	✓
	P/N: 92214	✓	✓	✓	✓	✓ (X4)	✓
	P/N: 92215		✓	✓	✓	✓ (X5)	✓
	P/N: 92220	✓	✓	✓	✓		
	P/N: 92222	✓	✓	✓	✓	✓ (X2)	✓
	P/N: 92225	✓	✓	✓	✓	✓ (X5)	✓

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

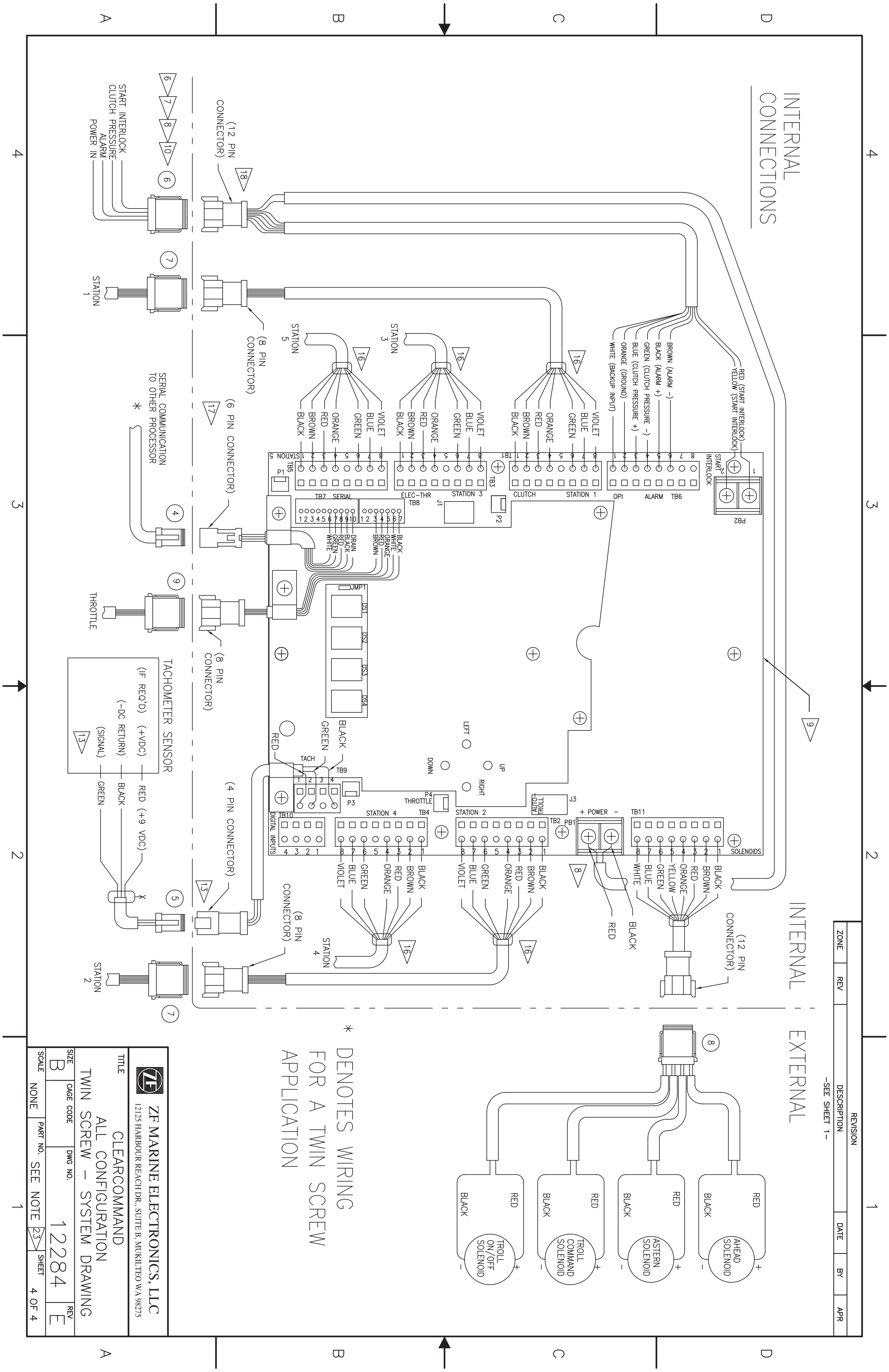
TITLE: CLEARCOMMAND ALL CONFIGURATION TWIN SCREW – SYSTEM DRAWING

SIZE	CAGE CODE	DWG NO.	REV
B		12284	E
SCALE: NONE	PART NO. SEE NOTE 23		SHEET 2 OF 4



MATERIAL LIST

✓	ITEM	QTY	PART NUMBER	DESCRIPTION
	1	2	SEE APPENDIX A	CONTROL PROCESSOR 23
	2	MAX 5	SEE APPENDIX A	CONTROL HEAD
	3	2	SEE APPENDIX A	AUTOMATIC POWER SELECTOR
	4	1	SEE APPENDIX A	SERIAL COMMUNICATION WIRE HARNESS – XX'
	5	2	SEE APPENDIX A	TACHOMETER SENSOR WIRE HARNESS – XX'
	6	2	SEE APPENDIX A	POWER & START INTERLOCK WIRE HARNESS – XX'
	7	MAX 10	SEE APPENDIX A	CONTROL HEAD CABLE – XX'
	8	2	SEE APPENDIX A	CLUTCH/TROLL CABLE – XX'
	9	2	SEE APPENDIX A	THROTTLE CABLE – XX'


INTERNAL CONNECTIONS
EXTERNAL
* DENOTES WIRING FOR A TWIN SCREW APPLICATION
ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275
CLEARCOMMAND
ALL CONFIGURATION
TWIN SCREW - SYSTEM DRAWING
12284
E
SEE NOTE 23
NONE
4 OF 4
AHEAD SOLENOID
ASTERN SOLENOID
TROLL COMMAND SOLENOID
TROLL ON/OFF SOLENOID
TACHOMETER SENSOR
SERIAL COMMUNICATION TO OTHER PROCESSOR
THROTTLE
STATION 1
STATION 2
STATION 3
STATION 4
STATION 5
START INTERLOCK
CLUTCH PRESSURE
ALARM
POWER IN

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