Premium ClearCommand User Manual

Installation, Operation and Troubleshooting

MM9000-P Rev A.7 01/13

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Table 16-4: Wire Harness - ZF AUTOTROLL/ MTU FCI/ HARTING (9000) (p/n 16184-XX) 401

Table 16-5: AutoTroll Fault Indicator Light Flash List 401

Revisions List

Rev	Date	Revision Description
-	02/2007	Created off-the-shelf manual. Added ELR 1387 changes.
A	07/2007	Reformat Layout
A.1	03/2008	Added DP/JS Ready Output, Command Signal and Control Output
A.2	07/2008	Added Dynamic Positioning 2 (DP2) with Autotroll Functions Codes to Set Up Procedure Section
A.3	03/2009	Added DP2 parameters (A6-03, A6-04) modified speed boost function
A.4	10/2009	Replaced Inserted Forms and Documents to current revisions
A.5	03/2011	Updated Software number, Revised preface per ELR00113, updated all external documents with current revision level
A.6	02/2012	Revised per ELR00148, ELR00158, ELR00174
A.7	01/2013	Added AutoTroll addendum; Appendix F, 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 Premium 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. Look for details of the featured options in the “Operations,” “Set Up Procedures,” “Dock Trials,” “Sea Trials,” and (particularly) “Control Options” sections. All vessels with Premium Processors will not necessarily use all the featured options. Decide on their utility based upon your application.

Table Preface-1: List of Processors

Processor Part Number	Engine	Clutch	Troll
9510X	Servo 2	Servo 1	NO
9512X	Servo 2	Servo 1	Solenoid
9520X	Servo 2	Solenoid	NO
9522X	Servo 2	Solenoid	Solenoid
9610X	Electronic	Servo 1	NO
9612X	Electronic	Servo 1	Solenoid
9620X	Electronic	Solenoid	NO
9622X	Electronic	Solenoid	Solenoid
9623X	Electronic	Solenoid	AutoTroll
X = 0 to 5 remote station pigtails supplied			

Available Options for the Premium Processors

- ABS/ACB Transfer
- 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) or refer to the Sales and Service Organization Documents in this manual.

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 multi-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 will hereafter be referred to as ClearCommand or System.

The System is electronic and requires a 12 or 24 VDC power supply, one Processor per engine/gear and one Control Head per remote station.

The ClearCommand commands the vessel's throttle and shift using a single Control Head lever.

The Processor is typically mounted in the engine room area and is connected by either electric cable harnesses or push-pull cable to the vessel's main engine throttle and transmission.

One wire harness/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.

1.2 9ZYWX Premium Processor

- Z= **5** - Servo/**6** - Electronic
- Y= **1** - Servo/**2** - Solenoid
- W= **0** - No Troll/**2** - Solenoid
- X= Number of Pigtail Remote Stations

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

1.2.1 Throttle:

- servo engine governors
- electronic engine governors

1.2.2 Transmissions:

- servo activated clutches
- solenoid activated clutches
- solenoid controlled trolling valves

Refer to List of Processors Table Preface-1:.

1.3 System Features

1.3.1 Standard Features

Further information regarding the following features can be found in section 2 Operation.

- Sequencing of Clutch and Engine Speed.
- Station-in-Command indication.
- Up to five Remote Stations.

- Command of up to five screws.
- Single Control Head lever command of speed and direction.
- Start Interlock.
- Push Button Station Transfer.
- Proportional (Reversal) Pause on through Neutral Shifts.
- Warm-up Mode.
- High/Low Idle Selection.
- One Lever Mode.
- Engine Synchronization.

Further information regarding the following features can be found in section 5 Set Up Procedures.

- Easily configured to a vessel's control requirements.
- Push Button Set Up.
- Pluggable Connections.

Further information regarding the following feature can be found in section 10.4 Diagnostic Menu.

- Visual system diagnostics, set up, and status indication.

Further information regarding the following feature can be found in section 10.5 Audible Tones.

- Audible system diagnostics and status indications.

1.3.2 Optional Features

Further information regarding each optional feature can be found in section 2.16 Optional Features.

- System failure external alarm contact.
- Auxiliary (Backup) Control System.
- Clutch pressure interlock.
- Engine Room Only/Remote Switch.
- Fixed Neutral Delay.
- Multiple Screw Installations.
- Speed Boost.
- Station 2 Lockout Switch.

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:
  - **Electronic:** The throttle signal will be commanded to Idle.
  - **Servo:** The throttle servo will drive to Idle.
- Shift:
  - **Solenoid:** The Ahead and Astern shift solenoids will be de-energized, commanding Neutral.
  - **Servo:** The Shift servo will drive to Neutral.
- Troll:
  - **Solenoid:** The trolling valve solenoids are commanding lock-up.

NOTE: If utilizing an Engine Room/Remote Switch ensure you have read the Engine Room/Remote Switch explanation in section 2.16 Optional Features, before turning DC Power ON to the Processor(s).

NOTE: If utilizing a Station 2 Lockout Switch ensure you have read the Station 2 Lockout Switch explanation in section 2.16 Optional Features, before turning DC Power ON to the Processor(s).

2.2 Taking Command

- To take command at any one of the Remote Stations:
  - Ensure all Control Head's lever(s) at the Station are in the Neutral detent (vertical position).
  - Depress the transfer button for 1/2 second.

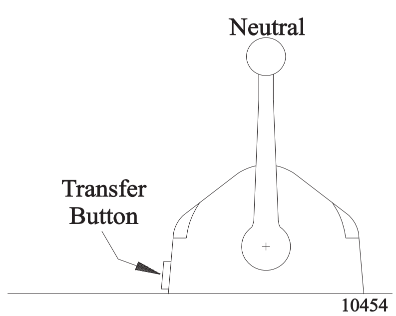

Figure 2-1: Station taking Command

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: If Engine Room/Remote Switch is used: (Refer to section 8 Control Options for more info.) Switch Closed (Engine Room): Only the Engine Room Station can take command of the System. Switch Open (Remote): Command can be taken at any Station.
	NOTE: Only one Station can have command at a time.
	NOTE: If Station 2 Lockout Switch is used: (Refer to section 8 Control Options for more info.) Switch Closed (Station 2 only): When Station 2 has command, no other Remote Station can take command away. (Only Engine Room Station can take away command, if used) Switch Open (Remote): Command can be taken at any 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.

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.

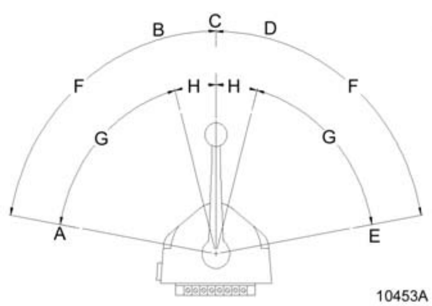

Figure 2-2: Control Head Detents

D Full Speed Astern

E Astern Detent

F Neutral Detent

G Ahead Detent

H Full Speed Ahead

I 80 degrees

J 65 degrees

K 15 degrees

L 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.

2.3.2 DP Operating Mode (Optional)

It is the operator's responsibility to operate the vessel per the DP requirements. Please call your DP representative for any questions regarding operation, before performing Sea Trials.

Refer to section 8 Control Options for further information.

2.3.3 JS Operating Mode (Optional)

It is the operator's responsibility to operate the vessel per the JS requirements. Please call your JS representative for any questions regarding operation, before performing Sea Trials.

Refer to section 8 Control Options for further information.

2.4 Start Interlock

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

- DC power has been turned ON to the Control System.
- A Remote Station is in command.
- The Control System is commanding Neutral.

2.5 Station Transfer

WARNING: Personal injury could occur if the following steps are not followed exactly.

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 2-3: Remote Stations Before Transfer of Command)

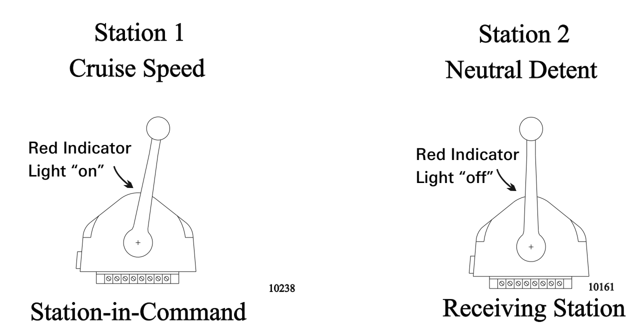

Figure 2-3: Remote Stations Before Transfer of Command

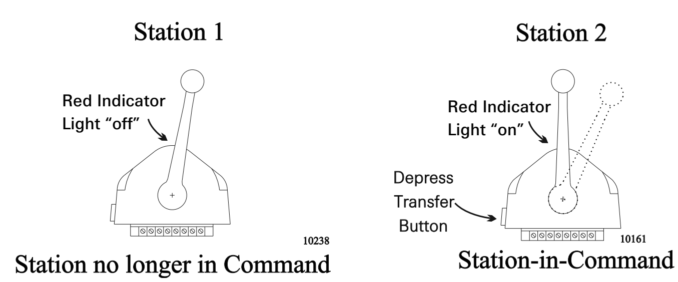

Figure 2-4: Remote Station Transfer after Transfer of Command

C At the Station taking command (Receiving Station), depress and hold the transfer button for 1/2 second (refer to Figure 2-4: 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 (Throttle Only Mode)

	WARNING: Personal Injury could occur if the following steps are not followed exactly.

	NOTE: Warm-up Mode is not available if a DP or JS system is in command.

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.

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 the following Figure).

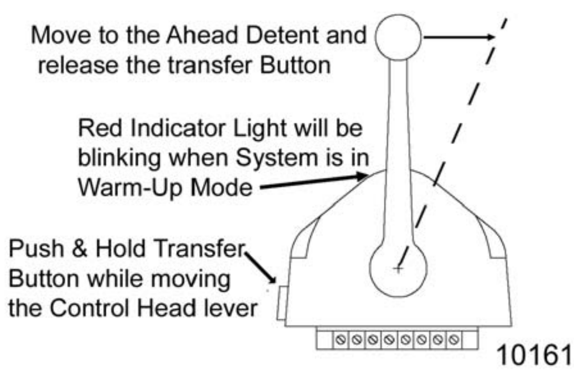

Figure 2-5: Control Head Warm-Up Mode

B Depress and **hold** the transfer button.

C While continuing to hold the transfer button, move the Control Head's lever to the Ahead detent.

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 now 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.

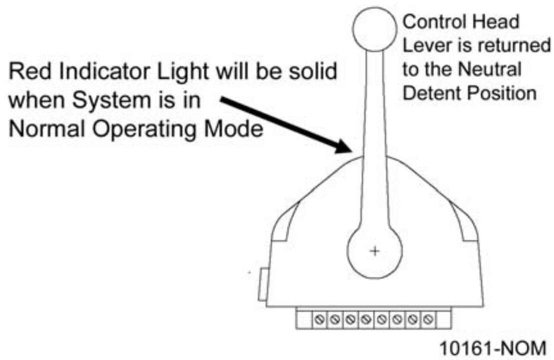

Figure 2-6: Control Head Normal Operating Mode

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

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 could occur if the following steps are not followed exactly.

Refer to the Figure 2-7: High/Low Idle Mode Selection when selecting between Low and High Idle (or vise versa) at the Station-in-Command.

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

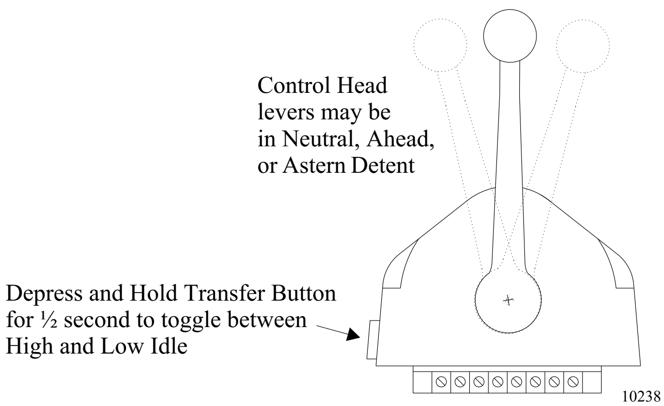

Figure 2-7: High/Low Idle Mode Selection

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 Multiple Screw applications: Always program all the Processors for the same amount of High Idle. All Processors will be in High or Low Idle at the same time.

	NOTE: If the optional DP or JS is in command, the High Idle feature is not available.

2.9 One Lever Mode

	NOTE: This mode is not available for Single Screw Applications

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

One Lever Mode allows the operator to control two (2) to five (5) engines and transmissions with a single Control Head lever. Any of the Control Head levers 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 section 5 Set Up Procedures.
- When One Lever Mode is enabled, the operation must be turned ON and OFF as described below.

	WARNING: Personal Injury could occur if the following steps are not followed exactly.

2.9.1 Turning ON One Lever Operation

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

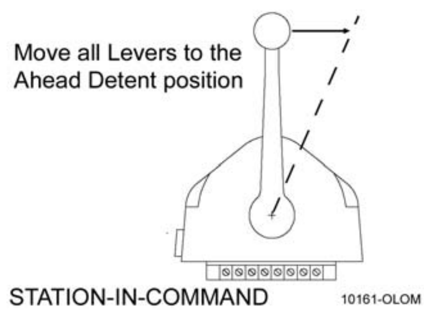

Figure 2-8: One Lever Operation Mode

B Depress and **Hold** the transfer button **while** moving one of the Control Head levers forward, out of the Ahead detent. **Do Not Release the Transfer Button** until the green LED turns ON, indicating One Lever Operation is now active.

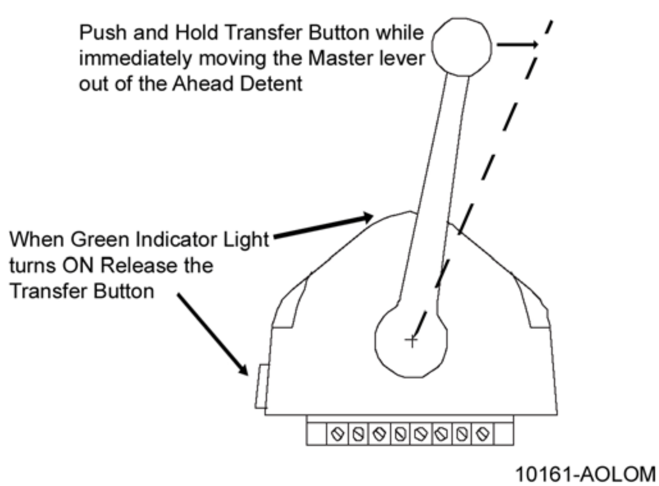

Figure 2-9: One Lever Operation Mode

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

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

NOTE: The Control Head lever(s) 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

WARNING: It is strongly recommended that the Master lever be 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.

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

B Place **all** inactive Control Head levers into the Neutral detent.

- Whenever an inactive lever(s) is moved to the Neutral detent, One Lever Operation is turned OFF and all levers are active.
- In applications with three or more screws, the green LED will turn OFF when any inactive Control Head lever is returned to the Neutral detent. For each inactive lever that is NOT at Neutral detent, its red LED will be blinking.

2.10 Engine Synchronization

This Feature is not available for Single Screw Applications.

NOTE: The Control System offers two (2) types of synchronization, Active or Equal Throttle.

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

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 (work toward synchronizing the engines' RPM's) the Synchronization Criteria listed below must be met.

2.10.1 Criteria

Synchronization Criteria is met when all of the following are true:

- 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 the allowable difference is 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 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 Electronic Synchronization (default Enabled)

Equal Throttle synchronization simply commands the same throttle to all engines. In applications where the engine governor requires a voltage signal, the exact same voltage signal will be applied to all governors.

With Equal Throttle Synchronization the Processors **do not** receive Tachometer signals representative of the Engine's 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 System 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 cannot be met, Active Synchronization is recommended.

2.10.2.2 Active

Active Synchronization must be enabled during Set Up and a Tachometer 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(s) running at the higher RPM is lowered, until the RPM's of all engines match.

2.10.3 Indications

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

- 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.
- In Active Synchronization the green LED **blinks** every time there is a change in the commanded throttle.

2.10.4 Turning OFF/ON when Criteria is Met

2.10.4.1 Turning OFF:

When the Criteria is met, synchronization is automatic and does not need to be turned ON. If the operator elects to turn OFF synchronization, follow the steps below:

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

B At the Station-in-Command, press and **hold** the transfer button until the green LED **blinks twice** and then goes out (approximately 2 seconds).

C Synchronization is now OFF.

2.10.4.2 Turning ON:

Synchronization is automatic and does not need to be turned ON, unless previously turned OFF, as described in the previous Section.

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

B At the Station-in-Command, 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.

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%.

At the Station-in-Command, press and hold the transfer button for at least two seconds:

- If synchronization is being turned ON, the green LED will light after two seconds and stay lighted as long as the transfer button is depressed. When transfer button is released the LED will go out.
- If synchronization is being turned OFF, after two seconds, the green LED will blink twice and then stay off.

2.11 Control Systems' 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. Detailed information on each function is found in section 5 Set Up Procedures.

2.11.1 Processor Functions

A0 Processor Identification - Assigns each Processor in multi screw applications a unique identifying number.

- **SINGLE SCREW: DO NOT ADJUST. Leave at Default Value unless a CANtrak Display is being used.** Refer to section 5 Set Up Procedures.
- **MULTI SCREW:** This function must be the **SECOND FUNCTION SET.**

A1Number of Engines - Lets the Processor know how many other Processors need to be communicated with.

- **SINGLE SCREW**: **DO NOT ADJUST. Leave at Default Value.**
- **MULTI SCREW:** This function must be the **FIRST FUNCTION SET**.

A2One Lever Operation - Allows the installer to disable or enable One Lever Mode capability.

- **SINGLE SCREW**: **DO NOT ADJUST. Leave at Default Value.**

A3Station Expander - THIS PARAMETER IS NOT AVAILABLE AT THIS TIME.

A4Neutral Indication Tone - When enabled, produces a short 200 Hz tone to indicate Neutral.

A5Engine Room/Remote Switch and/or Station 2 Lockout Switch - Allows the installer to enable or disable one or both of these features.

A6DP - Allows the installer to select DP Mode to operate with or without Troll Mode. Entering a value greater than **0**, makes the **P2** Joystick parameter available.

2.11.2 Throttle Functions

2.11.2.1 Basic Throttle Functions

E1 Throttle in Neutral - Adjusts the Throttle when in Neutral, independent of the throttle output when the clutch is engaged.

E5 Throttle Pause following Shift - Allows the adjustment of time between clutch engagement command and when throttle begins to increase 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.

- **SINGLE SCREW: DO NOT ADJUST. Leave at Default Value.**

2.11.2.2 Electronic Throttle Functions

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

E0 Engine Throttle Profile - Selects the throttle signals type and range.

E2 Throttle Minimum - Allows fine tuning of the throttle signal at Idle.

E3 Throttle Maximum - Allows fine tuning of the throttle signal at Full.

E4 Throttle Maximum Astern - Allows the installer to limit the amount of throttle allowed when Full Astern is commanded.

2.11.2.3 Servo Throttle Functions

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

E0 Throttle Servo Direction - Selects 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.

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 Oil Pressure Interlock option. The interlock prevents a throttle signal above Idle from being applied unless adequate clutch pressure is available.

C1 Clutch Interlock Delay - Determines when the Clutch Oil Pressure Interlock becomes active.

C2 Proportional (Reversal) Pause - Selects between an In-Gear, Neutral, or Fixed Neutral delay.

C3 Proportional (Reversal) Pause Time - Selects the maximum delay time during a full speed reversal.

C4 Proportional (Reversal) Pause Ratio - Determines if the Ahead and Astern reversal times are the same or if Astern is 1/2 of Ahead time.

C8 Fixed Neutral Delay - Provides an adjustable fixed Neutral delay regardless of commanded speed and direction.

2.11.3.2 Solenoid Clutch Functions

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

IMPORTANT: The following Functions are to be used on Hurth gears with two (2) proportional solenoids ONLY! Do not use on Hurth gears with ON/OFF solenoids.

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 level to the Astern Proportional Solenoid.

2.11.3.3 Servo Clutch Functions

This section along with the section 2.11.3.1 Basic Clutch Functions 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.

2.11.4 Speed Boost Functions (Optional)

This section applies to electronic throttle signals:

F0Boost Percentage - Programs the amount of throttle applied during initial clutch engagement.

F1Boost Duration - Programs how long the elevated throttle signal will be applied after initial clutch engagement.

F2Boost Start Delay - Programs the amount of time required after clutch engagement is commanded, until the Speed Boost is applied.

F3Boost Bypass Clutch Delay - Controls if speed boost is applied as a function of the reversal delay time. For example if value is set to 10 (10 x 100 millisecond = 1 Second), then speed boost would be applied only if the reversal delay is greater than 1 second. This parameter might be useful for boats that only need speed boost during a crash reversal. (If C4 is set to 00 then F3 must be set to less than 1/2 of C3).

2.11.5 Troll Functions (Optional)

The **L0** Troll function is the only Troll function code displayed unless Troll is activated using **L0**. When activated, Function Codes **L1** through **L6** are displayed.

2.11.5.1 Basic Troll Functions

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

L0 Troll Enable and Control Head Lever Range - Enables and disables Troll. Allows the rest of the parameters to display when enabled. Selects the amount of Control Head lever movement dedicated to Trolling Valve Control.

L4 Troll Throttle Limit - Programs the maximum throttle allowed during trolling operation.

L5 Troll Pulse Duration - Adjusts how long a troll boost is applied when troll operation is initiated.

L6 Troll Pulse Percentage - Adjusts how much the troll is boosted when troll operation is initiated.

2.11.5.2 Solenoid Troll Functions

L1 Troll Valve Function - Selects the proper current range for a particular gear. **If ZF Hurth Gears with two (2) proportional solenoids are used, this Function must be the 3RD function set; eg, after A1 (first) and A0 (second).**

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).

2.11.6 Transfer Functions

P0Transfer Mode - Selects the various options available when transferring from one Remote Station to another.

P1Transfer Time-out - In certain Transfer Modes, selects the amount of time allowed for the transfer sequence to be completed.

P2Station 4 Joystick Mode - Allows the installer to dedicate Station 4 to a Neutral Only/Momentary Switch Closure to enable Joystick use.

NOTE: Parameter P2 is displayed only if Function Code A6 is enabled. (A6 > 0)

2.11.7 Troubleshooting Functions

2.11.7.1 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.

2.11.7.2 Solenoid Troubleshooting Function

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

2.12 Audible Tones

Detailed information on the following tones are in section 10.5 Audible Tones.

2.12.1 Basic 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

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

This tone indicates that the command signal from the Station-in- Command has gone out of the acceptable range.

2.12.1.3 Steady Tone

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

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

2.12.1.5 Three (3) Second Steady Tone

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 (Not enabled)

This tone indicates a loss of communication with the Station Expander.

2.12.2 Clutch Solenoid Tones

2.12.2.1 One Long - One Short Tone (H2 enabled)

This tone indicates that a fault was detected with the Ahead, Neutral, or Astern Clutch Solenoid.

2.12.3 Transfer Tones

2.12.3.1 1/2 Second ON, 1/2 Second OFF Tones

This tone indicates that a Transfer Sequence has been initiated, while in Transfer Mode **03** or Mode **04**.

2.12.3.2 One Second Steady Tone

This tone indicates a press of the transfer button during a transfer sequence in Transfer Mode **03** or Mode **04**.

2.12.4 Clutch (Servo 1) Tones

2.12.4.1 One Long - One Short Tone

This tone indicates that the feedback potentiometer signal from Servo 1 (Clutch) has gone out of range.

2.12.4.2 One Long, One Short -High Repetitive Rate Tone (jam)

This tone indicates that Servo 1 (Clutch) cannot reach the commanded position. This tone is also referred to as Servo 1 Jam Tone.

2.12.5 Throttle (Servo 2) Tones

2.12.5.1 One Long - Two Short Tones

This tone indicates that the feedback potentiometer signal from Servo 2 (Throttle) has gone out of range.

2.12.5.2 One Long, Two Short - High Repetitive Tone (jam)

This tone indicates that Servo 2 (Throttle) cannot reach the commanded position. This tone is also referred to as Servo 2 Jam Tone.

2.12.6 Troll Solenoid Tones

2.12.6.1 Three Second Steady Tone (H2 enabled)

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 (4) 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 control system.

A full description of their usage is provided in section 5 Set Up Procedures.

2.14 Visual System Diagnostics, Set Up And Status Indication

There are four (4), seven (7) 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 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..

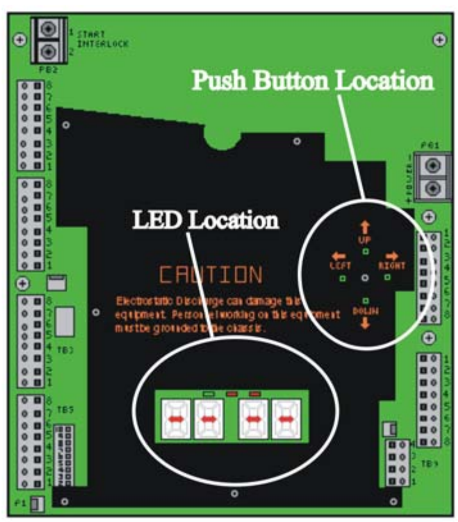

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Figure 2-10: Circuit Board Shield Layout

For a full description of the Display LED, its capability and usage, refer to section 5 Set Up Procedures.

2.15 Pluggable Connections

2.15.1 Processor Pigtails

The Processors come from the factory with enclosure mounted pigtail connectors for easy, mistake-free installations.

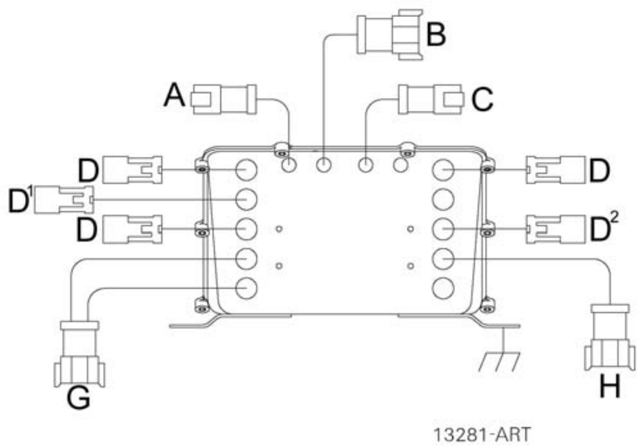

Figure 2-11: Processor Pigtail Locations

Table 2-1: Processor Pigtail List

FIGURE ID	QTY	DESCRIPTION
A	1	Pigtail connector is provided for serial communication between multiple Processors. (This pigtail is also used for CANtrak Display connection.)
B	1	Pigtail connector provides connection for electronic throttle. (Pigtail [B] not supplied if Servo Throttle is used)
C	1	Pigtail connector is provided for the Tachometer Sensor input used in multi screw Active Synchronization.
D	0 - 5	Pigtail connector provides the connections for Remote Station Control Heads.
D^1	1	Pigtail connector provides the connection for a DP system.
D^2	1	Pigtail connector provides the connection for Station 4 or OPTIONAL JS system.
G	1	Pigtail connector provides the connections for DC Power, Start Interlock, (optional) Clutch Oil Pressure Interlock (optional) and External Alarm contact (optional).
H	1	Pigtail connector provides the connection to the solenoid clutch & Troll. (Pigtail [H] not supplied if Servo Shift is used)

2.16 Optional Features

2.16.1 External Alarm Capability

This optional feature can provide a status signal to an external visual or audible 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 Control Options.

2.16.2 Auxiliary Backup Control System

The Backup Control System (BU Sys) provides a control system which is fully independent from the ZF Marine Propulsion Systems Miramar Control System. The BU Sys can control the transmission as well as the engine, but it does not include ZF Marine Propulsion Systems Miramar control logic, safety interlock, and timing circuits. In other words, there is **no protection** for operator errors, such as shifting into gear at elevated rpm's.

If this option is going to be used, please contact a ZF Marine Propulsion Systems Miramar Representative for further information.

2.16.3 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 is provided in section 8 Control Options.

2.16.4 DP Mode

- This feature is defaulted to **Disabled**, and therefore must be set to DP **Enabled with Troll** or DP **Enabled without Troll** during set up.
- The DP system must be connected to the Processor's DP pigtail (on all Processors) to allow DP Mode.
- Refer to the information supplied with the DP system for operational guidelines.
- The ClearCommand and the DP system cannot be in command at the same time.
- When the DP system is in command, only standard transfer between Remote Stations is available. All options of ABS Transfer are not available until the ClearCommand System regains command.
- A DP/Remote Switch is required to switch from Remote to DP operation, and vice versa.

NOTE: High Idle, One Lever Mode, and Synchronization are not available when the DP system is in command.

NOTE: If the ClearCommand system is set up with DP Enabled with Troll and is in Troll Mode when transferred to DP, the DP system will be in Troll Mode.

2.16.5 Engine Room Only/Remote Switch

Station 1 is designated as the Engine Room Station when this feature is used.

When the switch is CLOSED, Station 1 will take command away from any other Remote Station. It also prevents other Remote Stations from taking command away from Station 1.

This feature is defaulted OFF, and therefore must be enabled during set up. Refer to section 5 Set Up Procedures.

A full explanation is provided in section 8 Control Options.

2.16.6 Fixed Neutral Delay

Fixed Neutral Delay is the function which provides for a pause at Neutral whenever a change in vessel direction is commanded, regardless of whether the operator actually stops the Control Head lever at the Neutral detent. This is a useful feature for boats equipped with large propellers and shaft brakes, because it ensures that the shaft brakes will apply on every maneuver. This will help to prevent engine stalls and reduce clutch wear.

Fixed Neutral Delay is independent of, and in addition to, any proportional pause that may have been programmed into the system.

A full explanation is provided in section 8 Control Options.

2.16.7 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.

If this option is going to be used, please contact a ZF Marine Propulsion Systems Miramar Representative for further information.

2.16.8 Station 2 Lockout Switch

Station 2 is designated for lockout when this feature is used.

This feature prevents any Remote Station, other than Station 2 from taking command, except if there is an engine room station which has priority over any other station.

This feature is defaulted OFF, and therefore must be enabled during set up.

Once enabled, the feature is selectable with a toggle switch.

The Engine Room/Remote switch can override the Lockout feature.

A full explanation is provided in section 8 Control Options.

2.16.9 Station 4 Joystick Mode

NOTE: JS Mode is only available when a DP System is being utilized with the ClearCommand System.

- This feature is defaulted to Station 4 **P0** "Transfer Mode per Function Code P0 setting", and therefore must be set to Joystick **P2** "Neutral Only/Momentary Switch Closure" during set up.
- A DP/JS Interface Enclosure is required. Both, the DP pigtail and JS Pigtail, need to be connected to all of the Processor’s DP and Station 4 pigtails (respectively) to allow DP or JS Mode.
- Refer to the information supplied with the DP/JS system for operational guidelines.
- The Standard Control Head and the DP or JS system cannot be in command at the same time.
- When the DP or JS system is in command, only standard transfer between Remote Stations is available. All options of ABS Transfer are not available until the ClearCommand System regains command.
- A DP/Remote/JS Switch is required to enable DP and JS operation and to switch between DP Mode, Remote, and JS Mode.

NOTE: High Idle, Synchronization, and One Lever Mode are not available when the DP or JS system is in command.

NOTE: If the ClearCommand is in Troll Mode when transferred to DP or JS, the DP and JS system will be in Troll Mode.

A full explanation is provided in section 8 Control Options.

2.16.10 Speed Boost

Speed Boost is a temporary increase in the speed command output signal from the Processor. Its purpose is to decrease the possibility of the engine stalling during clutch engagement or reversal of direction (for example, from **Ahead** to **Astern**). The necessity for using Speed Boost should be assessed during Sea Trials, using a "trial and error" exercise.

The primary function of Speed Boost is to prevent an engine from stalling when a heavy load is applied. The Speed Boost signal must be properly set and timed and, when used, must be applied responsibly and carefully.

NOTE: Under normal operating conditions, Speed Boost is generally not required or useful.

A full explanation is provided in section 8 Control Options.

3 Plan The Installation

	NOTE: ZF Marine Propulsion Systems Miramar 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).

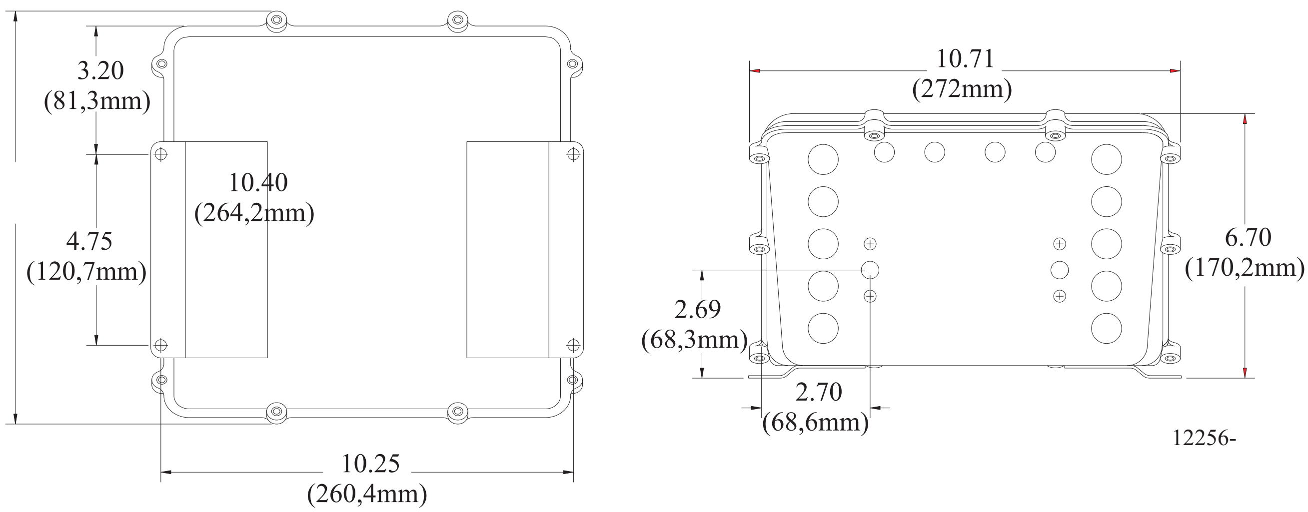

Figure 3-1: Processor Dimensions

Once the locations have been decided, lengths of electrical wiring, harnesses and push-pull cables must be determined.

- Grounding (Bonding) is required for maximum electromagnetic compatibility (EMC) performance. Refer to MMC-287 Grounding (Bonding).
- SERVO PROCESSORS: 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 18 inches (254mm) and the total degrees of bends must be less than 270 degrees.

Only when the locations and lengths of wiring/harnesses have been determined, 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.
- Locate the Processor(s) away from sources of high heat, such as engine exhaust manifolds or turbochargers. Allow 4 feet (1,2m) of clearance or more.
- 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).
- 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, MMC-329 MC2000 Series Standard Control Head Variations, MMC-337 4000 Series Control Head Variations and MMC-307 700 Series Standard Control Head Variations for information on the various Control Heads available and their dimensions.

- Control Heads are available with pluggable pigtails or may be hard-wired (no pigtails).
- Retrofit applications may require an Adapter Pad to cover the old Control Head cutout. A variety of Adapters and Cover Pads are available. If an Adapter/Cover Pad is required, please contact a ZF Marine Propulsion Systems Miramar Representative for further information.
- Ensure that the clearance is sufficient for the Control Head's lever to reach full Ahead and full Astern.
- The Control Head can be mounted at any location on the vessel, as long as all of the criteria listed above are met.
- A Handheld is available to use, instead of a mounted Control Head. Refer to the Installation Manual supplied with the Handheld for additional information on the planning of the installation.
- A 500 Series side mounted Control Head is available to use, instead of a top console mounted Control Head. Refer to the Installation Manual supplied with the 500 Series Control Head for additional information on the planning of the installation.
- The 400 and MC2000 Series Control Heads are spray proof from the top, but must be protected from the weather on the underside.
- 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.
- Minimum distance from compass.
- The 700 Series Control Heads are fully spray proof. (IP56)

3.1.3 CANtrak Display Panel(s)

Refer to Appendix E - CANtrak User Manual for information on the Panel requirements and dimensions.

3.2 Wire Harnesses

For further information regarding Wire Harness requirements, contact a ZF Marine Propulsion Systems Miramar Representative. The following lists the various Harnesses that plug into the Processor:

3.2.1 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 end only.
- The Harness from the Port side of a Control Head must be routed to the Port Processor.
- The Harness from the Starboard side of a Control Head must be routed to the Starboard Processor.

3.2.2 Power, Start Interlock (optional), Clutch Pressure (optional), Alarm Harness (optional)

- One Harness required per Processor Power, Start Interlock, Clutch Pressure Switch, Alarm Pigtail.
- The Harness is plugged at the Processor Pigtail end only.
- In addition to the required DC power and Start Interlock, the Harness has options for Clutch Oil Pressure Switch and External Alarm Circuit that are available.
- 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) for 12 VDC systems, and up to 60 feet (18,2m) for 24 VDC systems.

3.2.3 Serial Communication Harness

The Serial Communication Harness is only required in:

- Multi Screw applications
- When a CANtrak Display is utilized.

The Harness interconnects the Processors to each other. A plug is attached at both ends of the Serial Harness.

- Multi Screw Harness required in Twin Screw applications with CANtrak or Triple Screw or more applications.

Twin Screw: One (1) Serial Harness (part no. 13316-X)

3.2.4 Additional Harnesses

Not all of the following harnesses may be required for your application. For further information regarding Wire Harness requirements, contact a ZF Marine Propulsion Systems Miramar Representative. The following lists the additional Harnesses available that plug into the Processor:

3.2.4.1 Clutch Harness

- One Harness required per Processor.
- The Harness consists of 2 two-conductor cables for Ahead and Astern Clutch Solenoids.

3.2.4.2 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.

3.2.4.3 Throttle Harness

- One Harness required per Processor.
- There are four (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.

3.2.4.4 Tach Sensor Harness

One Harness per Processor is required. The Harness is plugged on one end only. There are two types of Tach Sensor Harnesses available:

1. An 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. A Harness designed for Active Sensors with an Open Collector output, such as Hall Effect Sensors.

This Harness is only required when Active Synchronization is required.

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 Engine Tachometer Sender Requirements located in SER-161 Engine Tach Sender Req.

3.2.4.5 CANtrak Display Panel Multi-drop Harness

The Multi-drop Harness is required for each CANtrak Panel. The Harness provides the Display Panel with power and accesses Control System data by interconnecting with the Control System's Serial Bus.

- One Harness required per Display Panel.
- The Harness consists of:
- **One** (1) 20 ft (6,1m) two-conductor, 14 AWG cable for Power.
- **Two** (2) 1 ft (30,5cm) four-conductor, 20 AWG shielded cables for connection to the Serial Bus.
- The Display requires a power source of 10 - 32 VDC, protected by a 500 mA fuse. and is supplied by others.
- The two (2) four-conductor cables are plugged to allow connection in-line with the Serial Bus.

3.3 Electric Cables

For further information regarding Electric Cable requirements, contact a ZF Marine Propulsion Systems Miramar Representative. The installation may use Harnesses, Electric Cables, or a combination of both. Electric cable may be ordered from ZF Marine Propulsion Systems Miramar, or the cable **MUST** meet the following specifications. The following lists the various equivalent electric cables:

3.3.1 Control Head Cable Requirements

- 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)

3.3.2 Power, Start Interlock (optional), Clutch Pressure (optional), Alarm Cable Requirements (optional)

3.3.2.1 Power Cable

- 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 section 11 Appendix A - System Components and Specifications - 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).

3.3.2.2 Start Interlock Cable

- 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).

3.3.2.3 Clutch Pressure Interlock Cable (optional)

- 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).

3.3.2.4 External Alarm Circuit Cable (optional)

- 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).

3.3.3 Serial Communication

It is strongly recommended that only ZF Marine Propulsion Systems Miramar factory manufactured Harnesses are installed.

3.3.4 Tach Sensor Cable Requirements (optional)

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

3.3.4.1 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)

3.3.4.2 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)

3.3.5 Clutch or Clutch/Troll Cable Requirements

3.3.5.1 Clutch Cable

- 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).

3.3.5.2 Troll Cable Requirements

- 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).

3.3.6 Throttle Cable Requirements

- 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).

3.4 Tachometer Sensors (optional)

There are two types of Tachometer Sensors available through ZF Marine Propulsion Systems Miramar, 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 is used, it must meet the criteria provided below for each type:

3.4.1 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.

3.4.2 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 3.4.1 AC Coupled Sensors).

3.4.3 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 3.4.1 AC Coupled Sensors).

3.4.4 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.

3.5 Engine Room/Remote Switch (optional)

Switch and Electric Cable must meet the following specifications:

3.5.1 Switch Specifications

- One two position maintained Selector Switch)
- An additional normally closed (N.C.) Contact Block is necessary for each additional Processor
- One Switch Operator per System
- Switch Rating: minimum 2.5 mA @ 12 or 24 VDC

3.5.2 Electric Cable Specifications

- Two-conductor,
- 16 AWG (#1,5metric) or larger
- 300V, 105C., UL VW1 stranded tinned copper wire

3.6 Station 2 Lockout Switch (optional)

Switch and Electric Cable must meet the following specifications:

3.6.1 Switch Specifications

- One two position maintained Selector switch
- An additional normally closed (N.C.) Contact Block is necessary for each additional Processor
- One Switch Operator per System
- Switch Rating: minimum 2.5 mA @ 12 or 24 VDC

3.6.2 Wire Specifications

- Two-conductor,
- 16 AWG (#1,5metric) or larger
- 300V, 105C., UL VW1 stranded tinned copper wire

3.7 Interface Enclosures

3.7.1 Dynamic Positioning Only (P/N 70218) (24VDC Only)

3.7.1.1 70218 DP Enclosure to ClearCommand Processor

A **DP Interface Enclosure** (hereafter referred to as **Enclosure**) is required in order to interface with DP systems.

	NOTE: One Enclosure is required per Processor.

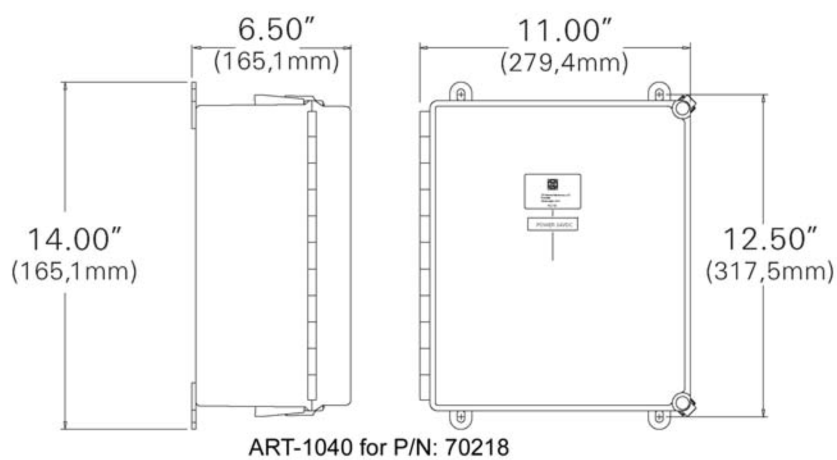

Figure 3-2: Enclosure (P/N 70218) Dimensions

The Enclosure must be mounted in close proximity to its associated Processor and is equipped with a 3 ft. (0,9m) Pigtail connector used for interfacing with the Processor's 18 in. (45,7cm) Pigtail.

The DP Pigtail's connection between the Enclosure and Processor:

Provides Enclosure with:

- A 24VDC Power Supply
- Troll ON/OFF Signal
- DP Ready Signal

Provides Processor with:

- DP Input Command
- DP ON/OFF Switch Input
- DP "In Control" Signal

3.7.1.2 70218 Enclosure to DP System

The hard-wired interface between Enclosure and DP System, the Installer must:

- Drill the Enclosure for wire penetration

- Supply appropriate sized Liquid Tight Connectors
- Make the necessary connections to the Enclosure terminal blocks and to the DP System (refer to the information supplied with the DP System)

The DP System must provide the Enclosure with:

- DP Command Signal (0.70 to 4.10VDC)
- DP ON/OFF Contact (closed when ON)

The Enclosure provides the DP System with:

- DP Ready Signal

3.7.1.3 DP/Remote 2-Position Switch

3.7.1.3.1 Switch Specifications

The switch **must** meet the following specifications:

- A two position maintained Selector Switch)
- An additional normally closed (N.C.) Contact Block is necessary for each additional Enclosure.
- One Switch Operator per System
- Switch Rating: minimum 2.5 mA @ 24 VDC

3.7.1.3.2 Wire Specifications

The electric cable may be ordered from ZF Marine Propulsion Systems Miramar, or **must** meet the following specifications:

- Two-conductor,
- 16 AWG (#1,5 metric) or larger
- 300V, 105C., UL VW1 stranded tinned copper wire

3.7.1.3.3 70218 Enclosure to DP/Remote 2-Position Switch

To hard-wire interface between Enclosure and Switch, the Installer must:

- Drill the Enclosure for wire penetration
- Supply appropriate sized Liquid Tight Connectors
- Make the necessary connections to the Enclosure terminal blocks and to the Switch (refer to the information supplied with the Switch)

The Switch provides the Enclosure with:

- DP Command Signal (0.70 to 4.10VDC)
- DP ON/OFF Contact (closed when ON)

The Enclosure provides:

- DP "Take Control" Signal

3.7.2 DP and JS Connections (P/N 70332)

3.7.2.1 70332 Enclosure to ClearCommand Processor

A **DP/JS Interface Enclosure** (hereafter referred to as **Enclosure**) is required in order to interface with DP/JS systems.

One Enclosure is required per Processor.

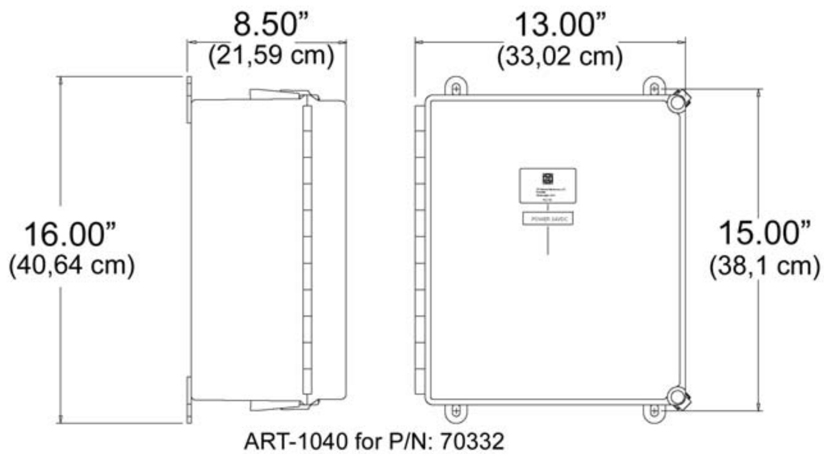

Figure 3-3: Enclosure (P/N 70332) Dimensions

The Enclosure must be mounted in close proximity to its associated Processor and is equipped with two (2) 3 ft. (0,9m) Pigtail connectors that are used for interfacing with the Processor’s 18 in. (45,7cm) Station 4 and Station 5 Pigtails.

The DP/JS Pigtails connection between the Enclosure and Processor

Provides Enclosure with:

- A 24VDC Power Supply
- Troll ON/OFF Signal
- DP Ready Signal
- Joystick Ready Signal

Provides Processor with:

- DP Input Command
- DP ON/OFF Switch Input
- DP “In Control” Signal
- Joystick "In Control" Signal

3.7.2.2 70332 Enclosure to DP System

The hard-wired interface between Enclosure and DP System, the Installer must:

- Drill the Enclosure for wire penetration
- Supply appropriate sized Liquid Tight Cable Connectors
- Make the necessary connections to the Enclosure terminal blocks and to the DP system (refer to the information supplied with the DP System).

The DP System must provide the Enclosure with:

- DP Command Signal (0.70 to 4.10VDC)
- DP ON/OFF Contact (closed when ON)

The Enclosure provides the DP System with:

- DP Ready Signal

3.7.2.3 70332 Enclosure to JS System

The hard-wired interface between Enclosure and JS System, the Installer must:

- Drill the Enclosure for wire penetration
- Supply appropriate sized Liquid Tight Connectors
- Make the necessary connections to the Enclosure terminal blocks and to the JS System (refer to the information supplied with the JS System).

The JS System must provide the Enclosure with:

- Joystick Command Signal (0.70 to 4.10VDC)
- Joystick ON/OFF Contact (closed when ON)

The Enclosure provides the JS System with:

- Joystick Ready Signal

3.7.2.4 DP/JS/Remote 3-Position Switch

3.7.2.4.1 Switch Specifications

The switch **must** meet the following specifications:

- Three position maintained Selector Switch
- Two additional normally open (N.O.) Contact Blocks is necessary for each additional Enclosure.
- One Switch Operator per System
- Switch Rating: minimum 2.5 mA @ 24 VDC

3.7.2.4.2 Wire Specifications

The electric cable may be ordered from ZF Marine Propulsion Systems Miramar, or **must** meet the following specifications:

- Two-conductor,
- 16 AWG (#1,5 metric) or larger
- 300V, 105C., UL VW1 stranded tinned copper wire

3.7.2.4.3 70332 Enclosure to DP/JS/Remote 3-Position Switch

To hard-wired interface between Enclosure and Switch, the Installer must:

- Drill the Enclosure for wire penetration
- Supply appropriate sized Liquid Tight Connectors
- Make the necessary connections to the Enclosure terminal blocks and to the Switch (refer to the information supplied with the Switch)

The Switch provides the Enclosure with:

- Joystick Command Signal (0.70 to 4.10VDC)
- Joystick ON/OFF Contact (closed when ON)

The Enclosure provides:

- DP "Take Control" Signal
- Joystick "Take Control" Signal

3.8 Installer Supplied Tools And Parts

3.8.1 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.

3.8.2 Optional Tools

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

3.8.3 Required Parts for Servo Processors

- 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. 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/gear dealer/manufacturer for a factory Cable Connection Kit. Refer to MMC-290 Universal Mounting Kit, to show other connection options.

3.8.4 Engine Stop Switch

An engine STOP switch **MUST** be located at each Remote Station. The Installer supplies the switches. Refer to the installation instructions supplied with the switch and the engine installation instructions for manufacturers recommendations.

	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.

3.9 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 supplied 14 gauge power cable, and in accordance with **ABYC** Standard E-11, the distance from a 24 volt power source (battery or DC Distribution Panel) shall not exceed 20 feet (6,1m).

ZF Marine Propulsion Systems Miramar highly recommends using an Automatic Power Selector (APS) and a second power source (battery) to supply power to each Processor. Refer to S-214 Automatic Power Selector Model: 13505 for examples of power supplies.

Processor Power

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

- The Processor requires a battery source of 24 VDC.
- When used in conjunction with a DP/JS Enclosure, 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.
- 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%. Reference S-214 Automatic Power Selector Model: 13505.

Contact a ZF Marine Propulsion Systems Miramar representative for the Processor's power cable(s) maximum lengths. Refer to S-214 Automatic Power Selector Model: 13505 for examples of the various wiring options. 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.

3.9.1 DP Interface Enclosure Power

The Enclosure requires 24 VDC power, which is supplied by the Processor through the DP Pigtail. Therefore, the **optional** power source **MUST** be **24 VDC.**

3.9.2 CANtrak Display Power

Refer to Appendix E - CANtrak User Manual for Electrical Specifications.

4 Installation

NOTE: Before starting the actual installation of the Control System, make sure you have the correct parts and tools on hand. Refer to 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 Grounding Bus by running a 12 AWG or larger wire between the Processor's fourth mounting fastener and the Grounding Bus. (The Processor is grounded 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 MMC-280 400 Series Control Head Variations, MMC-329 MC2000 Series Standard Control Head Variations or MMC-307 700 Series Standard Control Head Variations 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 Display Panel(s)

Refer to section 15: Appendix E - CANtrak User Manual for installation.

4.4 Wire Harness Installation

The 9000 Premium Processor is supplied with various Pigtails with connectors depending on the Processor being supplied. – Harnesses required will depend on the actual Processer used.

Four different styles of plugs and connectors are utilized but are inserted in an identical fashion as follows:

4.4.1 Harness Plug Insertion and Extraction

A Prior to inserting the Harness 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 into the connector, but can be incorrectly forced together in the opposite orientation.

B When connecting the plugs, ensure that the locking mechanisms are depressed and held until the plug is fully connected or disconnected.

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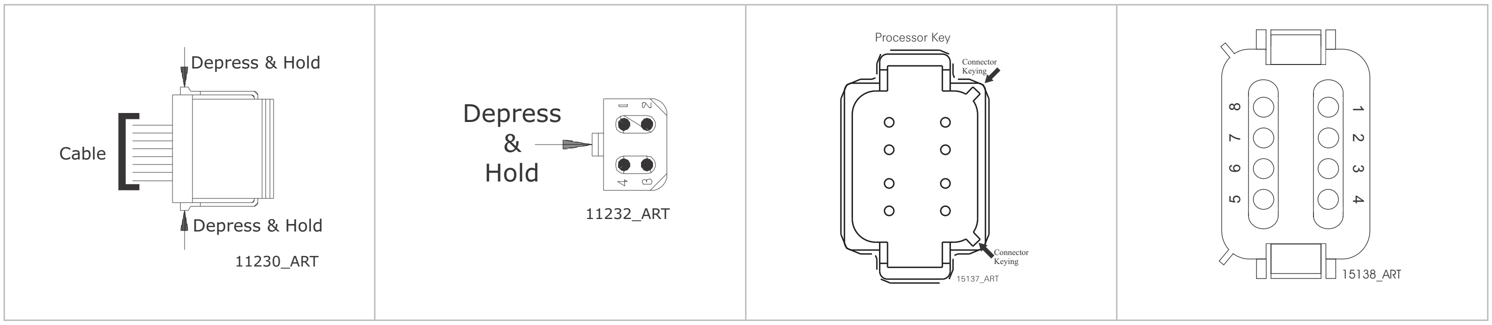

Figure 4-1: Harness Plug Keying

4.4.2 Power/Start Interlock/Alarm/(optional) Clutch Pressure (optional) Harness

This Harness can have a minimum of two (2) cables (DC Power and Start Interlock) up to a maximum of four (4) cables (Power, Start Interlock and/or Clutch Pressure Interlock and External Alarm Circuit).

4.4.2.1 DC Power Cable

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

A Insert the Harness's black, twelve pin plug into the Processor's Power/Start Interlock Pigtail connector.

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.

4.4.2.2 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.

E Butt splice the second wire to Starter Switch wire.

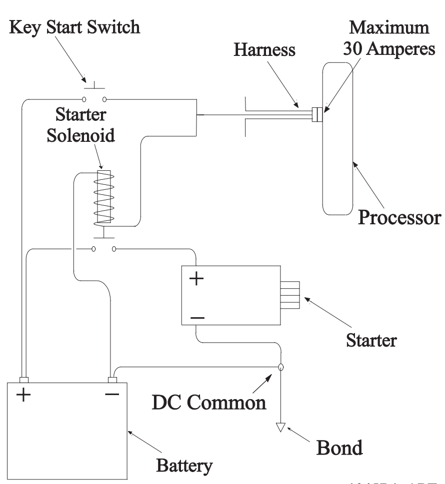

Figure 4-2: Start Interlock Connections

4.4.2.3 External Alarm Circuit Cable (optional)

Refer to section 8: Control Options for installation information.

4.4.2.4 Clutch Pressure Switch Cable (optional)

Refer to section 8: Control Options for installation information.

4.4.3 Serial Communication Harness (Multi Screw)

Not required for Single Screw applications.

4.4.3.1 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).

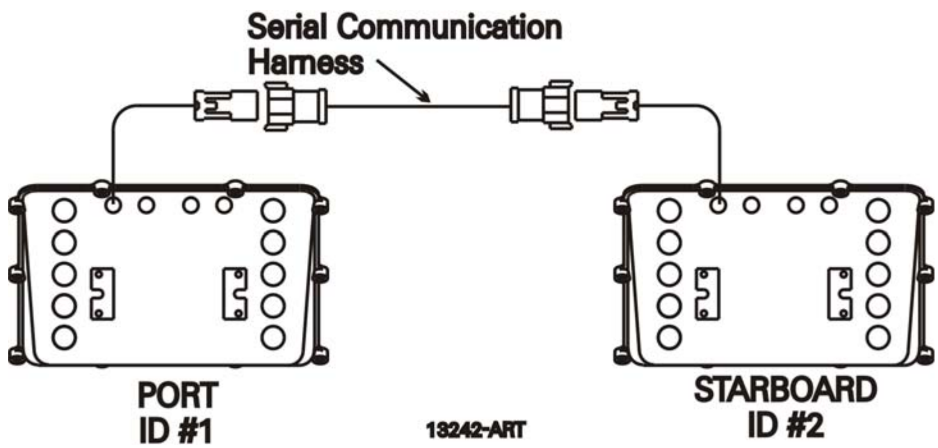

Figure 4-3: Twin Screw Serial Harness Connections

4.4.4 Control Head Harnesses

The procedure for terminating the Harness at the Remote Station depends on what Control Head is selected (pluggable or hard-wired).

- Pluggable: Follow Procedure 1.
- Hard-wired: Follow Procedure 2.

NOTE: Multi Screw Applications: Control Heads must be connected to the same numbered Station Pigtail or Circuit Board Station Terminal on ALL Processors.

4.4.4.1 Procedure 1: Harness with a Plug on Both Ends

A At the Port Processor, insert the harness's grey, eight (8) pin plug into the Station 1 pigtail connector.

B Run the cable to the Port side of the Control Head located at Station 1.

C Insert the harness's grey, eight (8) pin plug into the Control Head's Port pigtail connector.

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) on all Remote Station 1 Control Head pigtails.

F Repeat Steps A) thru E) for all required Stations (i.e. 2, 3, 4, 5).

- If Stations without pigtails are required to be installed, follow the steps in section 4.5: Hard-Wired Cable.

4.4.4.2 Procedure 2: Harness with a Plug on Processor End only

A At the Port Processor, insert the harness's grey, eight (8) pin plug into the Station 1 pigtail connector.

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 all Remote Station 1 Control Heads.

F Repeat Steps A) thru E) for all required Stations (i.e. 2, 3, 4, 5).

- If Stations without Processor pigtails are required to be installed, follow the steps in section 4.5: Hard-Wired Cable.

G Repeat all steps above for strbd side on twin screw applications.

4.4.5 Tach Sensor Harness (optional)

(required for Active Synchronization)

A On all Processors, remove the watertight seals from the Tach Sender pigtail connectors.

B Insert the harness's grey, four pin plug into the Tach Sender pigtail connector at each Processor.

C Run the Tach Sensor Harness cables to the Tach signal source for each engine.

- Connect the conductors to the Tach source in the appropriate manner, keeping in mind that some sources are polarity sensitive. **(black wire - negative, red wire - positive)**

4.4.6 Additional Harnesses

4.4.6.1 Throttle Harness (optional)

The appropriate Throttle Harness should have been selected in section 3: Plan The Installation. The Processor's 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 Multi Screw, repeat steps A) thru C) to all engines.

4.4.6.2 Clutch Harness (optional)

A Plug the grey, twelve (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 Repeat steps A) thru C) for each transmission.

4.4.6.3 Clutch/Troll Harness (optional)

A Plug the grey, twelve (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 Repeat steps A) thru D) for each transmission.

4.4.6.4 CANtrak Multi-drop Harness (optional)

Refer to section 15: Appendix E - CANtrak User Manual for Multi-drop Harness connections.

4.5 Hard-Wired Cable

4.5.1 Liquid Tight (Watertight) 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 (Watertight) Connector Installation:

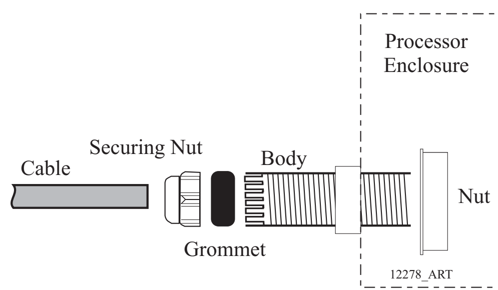

Figure 4-4: Liquid Tight (Watertight) Connector Installation

4.5.2 Processor Enclosure Cable Holes

When hard-wiring a Processor or installing additional Station pigtails, the cables must enter the enclosure through Liquid Tight Connectors in the appropriate holes.

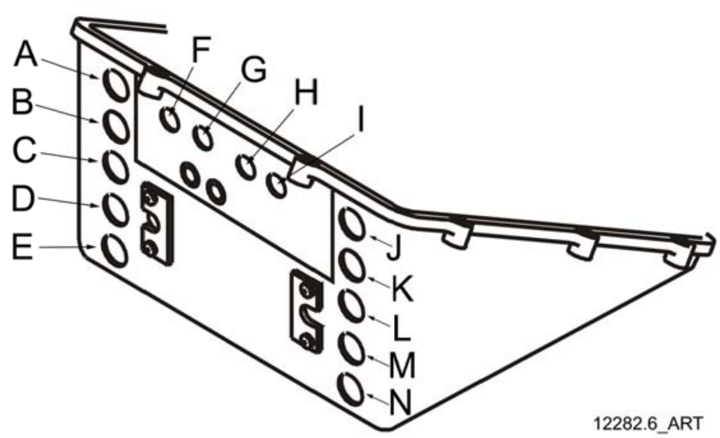

Figure 4-5: Processor Hole Designations

A Dynamic Positioning (DP)

B Station No.3

C Station No.1

D Alarm, Clutch Pressure, Start Interlock

E DC Power
F Serial Communication
G Throttle
H Tachometer
I Engine Room / Remote Switch
J Station 2 Lockout Switch
K Station No.4/Joystick (JS)
L Station No.2
M Clutch Solenoids
N Troll Solenoids

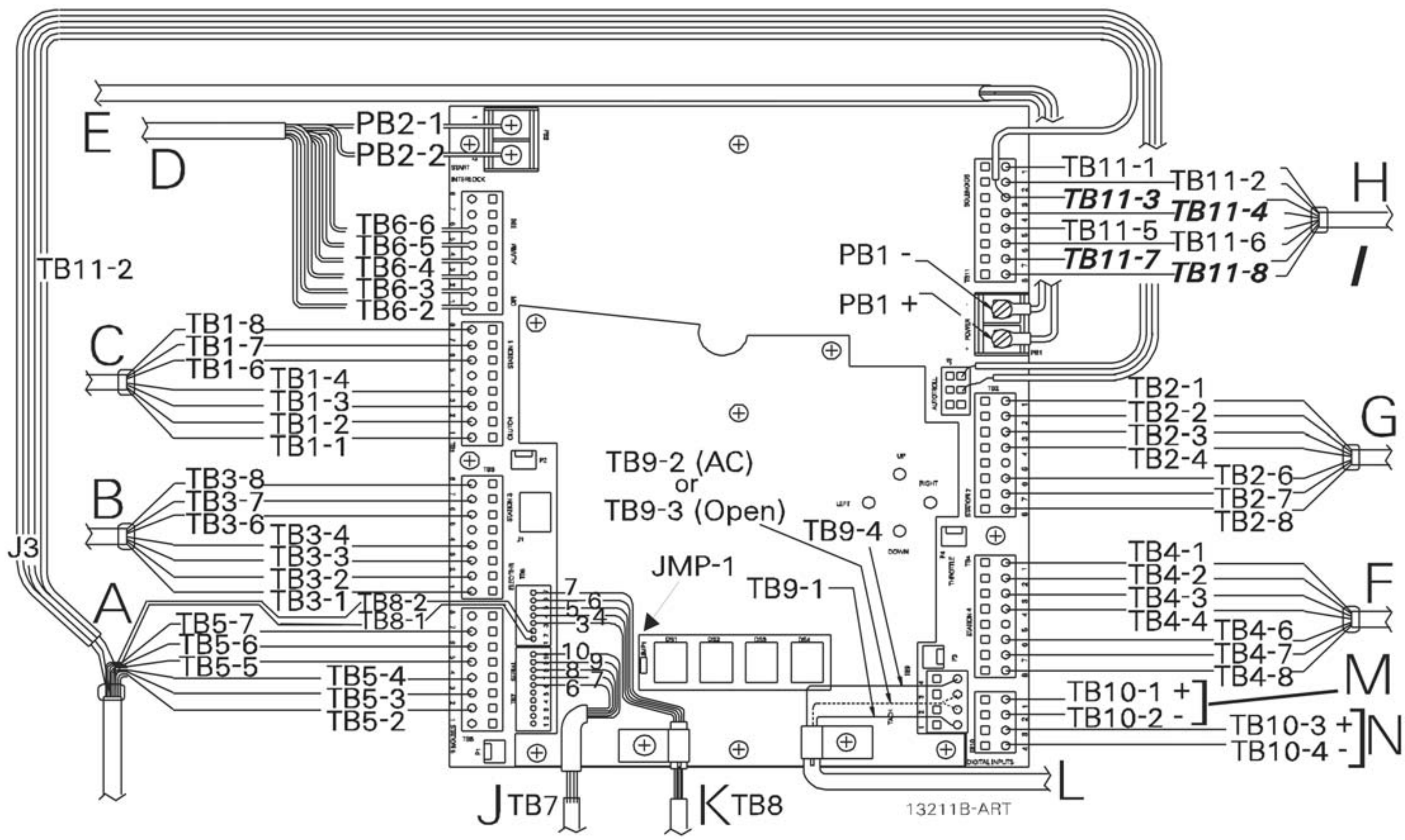

Figure 4-6: Processor Circuit Board Termination Points

Table 4-1: Circuit Board Hard-Wire Termination

Hole	Name	Terminal	Pin	Color	Hole	Name	Terminal	Pin	Color
A.	DP	TB5	2 3 4 6 7	Brown Pink Orange Grey Blue	A	DP	TB8	1 2	Violet Tan
							J3		Red Black

Table 4-1: Circuit Board Hard-Wire Termination

Hole	Name	Terminal	Pin	Color
C.	Station 1	TB1	1 2 3 4 6 7 8	Black Brown Red Orange Green Blue Violet
G.	Station 2	TB2		
B.	Station 3	TB3		
F.	Station 4 (or optional Joystick)	TB4		
E.	Power In	PB1	Negative Positive	Black Red
D.	Start Interlock	PB2	1 2	Red Yellow
	Backup Input:	TB6	1	White
	Ground		2	Orange
	Clutch Pressure		3 4	Blue Green
	Alarm		5 6	Black Brown
L.	Tachometer	TB9	1 2 (AC) or 3 (Open) 4	Red Green or Green Black

Hole	Name	Terminal	Pin	Color
H. I.	Clutch Troll	TB11	1 2 5 6	Black Brown Yellow Green
J.	Serial Communication	TB7	6 7 8 9 10	White Green Red Black Drain
K.	Throttle	TB8	3 4 5 6 7	Brown Red Orange White Black
M.	Engine Room/Remote Switch	TB10	1 2	Positive Negative
N.	Station 2 Lockout Switch		3 4	Positive Negative

4.5.3 Hard-wire Installation

4.5.3.1 Control Head Cable (Locations B, C, F, & G)

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 Number 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.

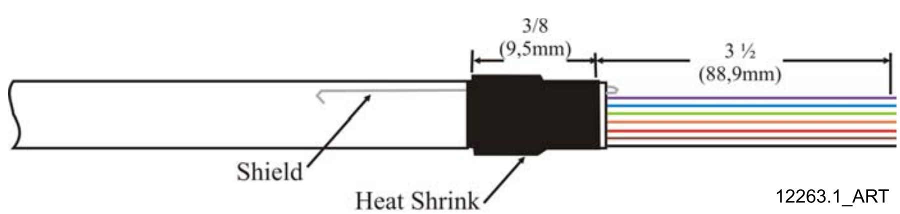

Figure 4-7: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink

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

G 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 4-8: Clamp Views.

H Clip the Shield wire so that it is flush with the Clamp. Strip the wire 3/8 inch (9,5mm) on each lead.

I Pull the Shield Wire back against the PVC jacket.

J Slide and shrink a piece of 3/8 inch (9,5mm) W. X 1 inch (25,4mm) L. heat-shrink over the cable.

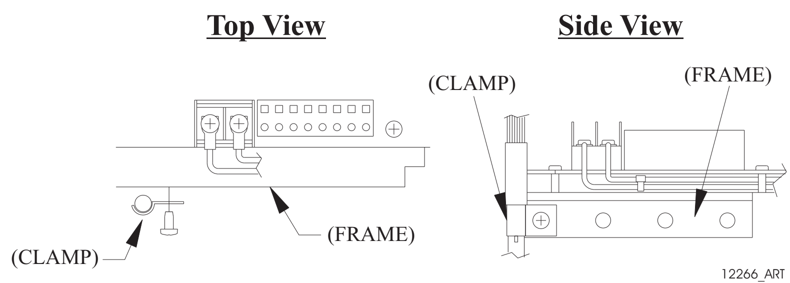

Figure 4-8: Clamp Views

K Connect the conductors to the appropriate Terminal pins, as shown on Table 4-2: Processor and Control Head Hard-Wiring Connections for Remote Stations -w/o DP Interface:, using a small slotted screwdriver as shown in Figure 4-9: Terminal Strip Cable Connections.

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

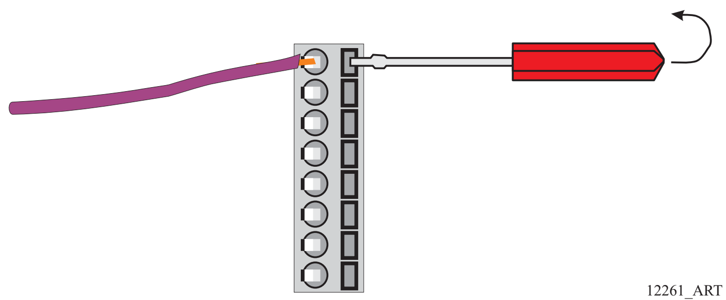

Figure 4-9: Terminal Strip Cable Connections

Table 4-2: Processor and Control Head Hard-Wiring Connections for Remote Stations -w/o DP Interface

Circuit Board Termination	Conductor Color	Left Hand (Port) Control Head Lever	Right Hand (Stbd) Control Head Lever
TB1-1 thru TB5-1	Black	Pin 1	Pin 1
TB1-2 thru TB5-2	Brown	Pin 2	Pin 2
TB1-3 thru TB5-3	Red	Pin 3	Pin 3
TB1-4 thru TB5-4	Orange	Pin 4	Pin 4
TB1-6 thru TB5-6	Green	Pin 6	Pin 6
TB1-7 thru TB5-7	Blue	Pin 5	Pin 7
TB1-8 thru TB5-8	Violet	Pin 8	Pin 8
		Jumper between Pins 3 and 7	Jumper between Pins 3 and 5

4.5.3.2 Eleven-Conductor DP Cable (Location A)

A A shielded cable with a minimum of eleven conductors must be run between the DP Enclosure and 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 Place on your wrist the anti-static wrist strap provided and attach the clip to ground prior to removing the Processor’s cover. Remove the cover.

D Run the cable through a liquid tight cable grip at the Location 2 hole. Allow enough cable to circle the Processor. Do not tighten cable grip at this time.

E Strip the PVC jacket to within 1/2 inch (12,7mm) of the inside of the enclosure.

F Cut the conductors to the appropriate lengths required to reach the terminations list in Table 4-3: Processor Circuit Board Connections to DP Enclosure Circuit Board Terminations:

G Cut the Shield wire to a length of 1/2 inch (12,7mm) and pull it back against the PVC jacket. Slide 1 inch (25,4mm) long piece of heat-shrink over the cable as shown in Figure 4-10: Eleven-Conductor DP Cable.

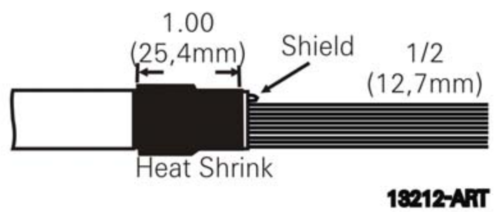

Figure 4-10: Eleven-Conductor DP Cable

H Secure the cable to the frame using a conductive Clamp at the entrance and a tie-wrap thereafter as described in Figure 4-7: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink.

I Connect the conductors to the appropriate pins as shown on Table 4-3: Processor Circuit Board Connections to DP Enclosure Circuit Board Terminations, using a small slotted screwdriver as described in Figure 4-7: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink.

J Connections at the Enclosure will be described in the section 4.8: DP Interface Enclosure.

Table 4-3: Processor Circuit Board Connections to DP Enclosure Circuit Board Terminations

Conductor Color	Processor Termination	DP Enclosure Termination	Description
Brown	TB5-2	Pin 303	DP In-Control (ON=3 to 5 VDC, OFF=0 VDC)
Pink	TB5-3	Pin 111	DP Switch Input (-)
Orange	TB5-4	Pin 110	DP Switch Input (ON=0 VDC, OFF=5 VDC)
Gray	TB5-5	Pin 201	DP Command Input (-)
Green	TB5-6	Pin 200	DP Command Input (0.8 to 4.2 VDC)
Blue	TB5-7	Pin 117	+ 5 VDC Reference
Violet	TB8-1	Pin 301	DP Ready Output (-)
Tan	TB8-2	Pin 305	DP Ready Output (-)
Yellow	TB11-4	Pin 108	Troll ON/OFF (ON=24 VDC, OFF=0 VDC)
Red	J3-2 (+)	Pin 106	+ V Battery (24 VDC)
Black	J3-4 (-)	Pin 109	- V Battery (ground)

4.5.3.3 Seven-Conductor Joystick Cable (Only connected to Station 4)

For Processors set up to be controlled by a DP/Joystick System, the **fourth Station input is now utilized by the DP/Joystick Enclosure Interface**.

A Run a seven-conductor cable between the DP/Joystick Enclosure and 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 Follow the cable preparation and installation as described in Figure 4-7: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink.

D Connect the conductors to the appropriate pins as shown in Table 4-4: Processor Circuit Board Connections to DP/Joystick Enclosure Circuit Board Connections:, using a small slotted screwdriver as described in Figure 4-7: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink.

E Connections at the Enclosure will be described in the DP/Joystick Enclosure Installation Section.

Table 4-4: Processor Circuit Board Connections to DP/Joystick Enclosure Circuit Board Connections

Conductor Color	Processor Termination	Enclosure Termination	Description
Black	TB4-1	TB 156	NOT USED
Brown	TB4-2	Pin 302	Joystick has Control Output (0/ 3 - 5 VDC)
Red	TB4-3	Pin 251	Joystick Switch Input -
Orange	TB4-4	Pin 157	Joystick Switch Input +
Green	TB4-6	Pin 250	Joystick Command Input Voltage +
Blue	TB4-7	Pin 158	+ VDC Reference
Violet	TB4-8	Pin 159	NOT USED

4.5.3.4 Start Interlock Cable (Location D)

- 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.

- Connection at the Processor

A Install a liquid tight connector into entry hole (No. D).

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 4-6: Processor Circuit Board Termination Points.

C Strip back 3 inches (76,2mm) of the PVC jacketing. Refer to Figure 4-11: Two-Conductor Start Interlock Cable.

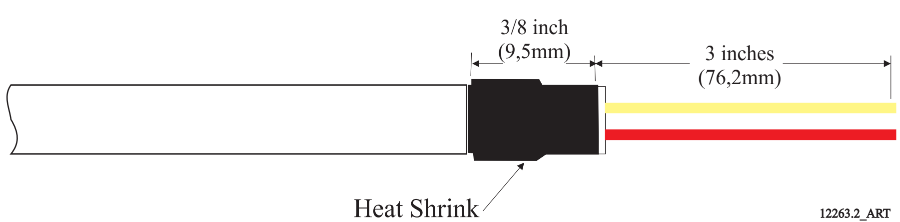

Figure 4-11: Two-Conductor Start Interlock Cable

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.

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 Processor Circuit board Termination Points, Figure 4-17: Clutch Harness Cable.

H Tie wrap the start interlock cable to the Processor's frame.

4.5.3.5 Power Cable (Location E)

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.

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 4-6: Processor Circuit Board Termination Points.

E Strip back 3 inches (76,2mm) of the PVC jacketing. Refer to Figure 4-12: 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.

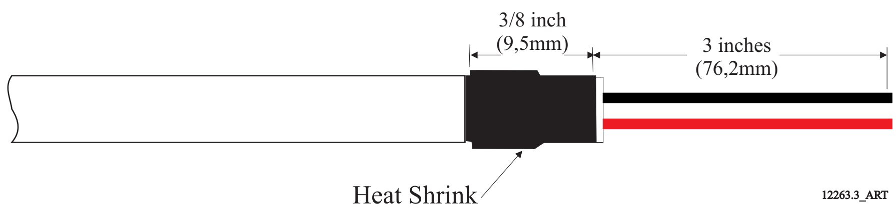

Figure 4-12: Two-Conductor Power Cable

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 4-6: Processor Circuit Board Termination Points.

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

4.5.3.6 Serial Communication Cable (Location J)

A Install 1/2 inch (12,7mm) liquid tight cable grips into appropriate hole of the Port and Starboard Processors.

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 4-13: Four-Conductor Serial Communication Cable.)

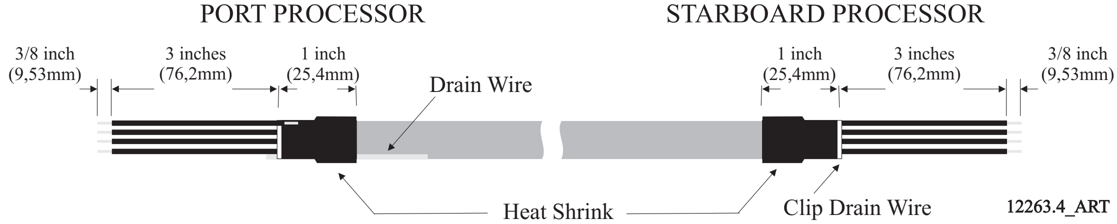

Figure 4-13: Four-Conductor Serial Communication Cable

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. **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 4-5: Processor Circuit Board Connections for Serial Communication Cable

Table 4-5: Processor Circuit Board Connections for Serial Communication Cable

Conductor Color	Port Processor Termination A	Starboard Processor Termination B
White	TB7-6	TB7-6
Green	TB7-7	TB7-7
Red	TB7-8	TB7-8
Black	TB7-9	TB7-9
Silver (Drain Wire)	Clamp	No Connection

4.5.3.7 Tachometer Cable (Location L)

Run a two-conductor (AC Type) or three-conductor (Open) shielded cable from the Port Processor to the Port engine’s tachometer source. (Refer to section 3: Plan The Installation.)

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

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

B Install a 1/2 inch (12,7mm) liquid tight cable grip into the appropriate hole of the Port and Starboard Processors.

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

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

- **Tachometer source side** only: Clip off the drain wire flush with the PVC jacketing.

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

- Processor side: 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 4-14: AC Type Tachometer Cable and Figure 4-15: Open Collector Tachometer Cable.).

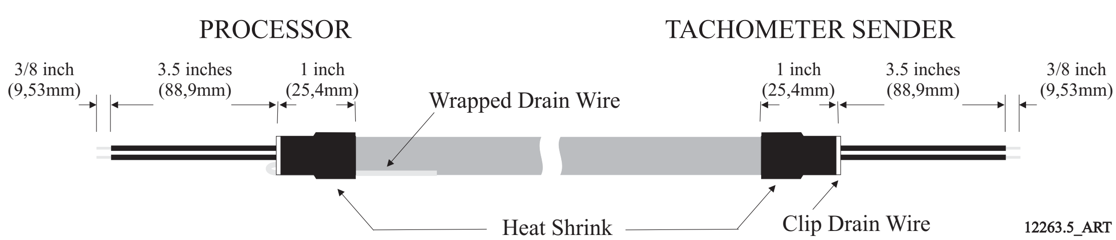

Figure 4-14: AC Type Tachometer Cable

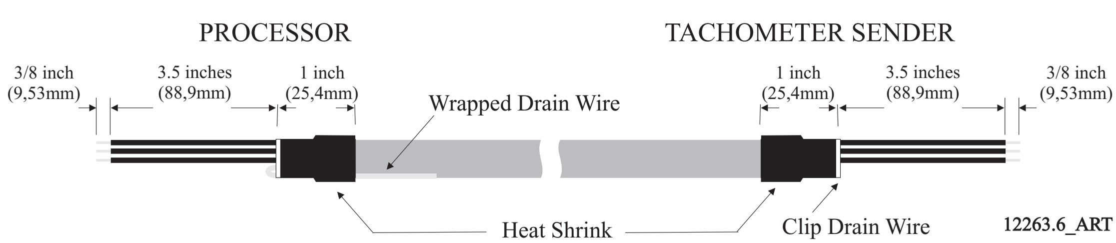

Figure 4-15: Open Collector Tachometer Cable

F Shrink the tubing with a heat gun.

G Insert the cable ends through the liquid tight connectors and tighten the nuts.

H Secure the cables internally using a Clamp. Make certain that the drain wire makes contact with the Clamp's metallic surface.

I Clip the exposed drain wires flush with the Clamps.

J Connect the conductors to the terminal block as listed in Table 4-6: Processor Circuit Board Connections for Tachometer.

Table 4-6: Processor Circuit Board Connections for Tachometer

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

4.5.3.8 Clutch Cable (Location H)

A single four-conductor cable must connect the two Shift solenoids to the Processor through a twelve (12) pin plug.

- Processor Termination

A Install a liquid tight connector into the appropriate hole of the Processor.

B Run a 32 inch (81,28cm) piece of four-conductor cable through the liquid tight connector 16 inches (40,64cm) and tighten. Leave 16 inches (40,64cm) 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 E.

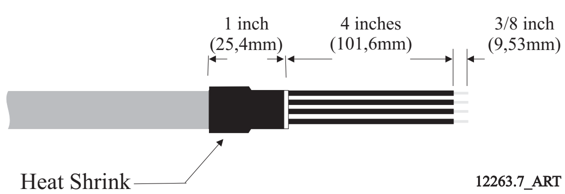

Figure 4-16: Clutch Hard-Wired Cable

E Strip back 3/8 inch (9,53mm) from the four conductors and connect to the Processor as shown in the following Table.

- Plug Termination

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

B Slide the boot onto the cable.

C Strip back 1/4 inch (6,35mm) from the four conductors.

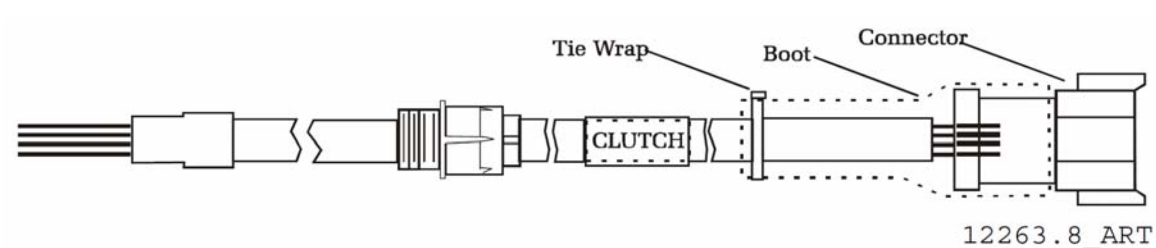

Figure 4-17: Clutch Harness Cable

D Crimp Pins onto the eight conductors.

E Insert the pins into the appropriate terminations as shown in the Processor Circuit board Termination Points Figure.

F Slide the boot over the connector.

G Tie-wrap the boot in place.

Table 4-7: Processor Circuit Board Clutch Connection and Plug Termination

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

4.5.3.9 Clutch/Troll Cable (Location H & *I*)

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

- Processor Termination

A Install a liquid tight connector into hole no.10.

B Run a 32 inch (81,28cm) piece of eight-conductor cable through the liquid tight connector 16 inches (40,64cm) and tighten. Leave 16 inches (40,64cm) 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 4-18: Clutch/Troll Cable Heat Shrink.

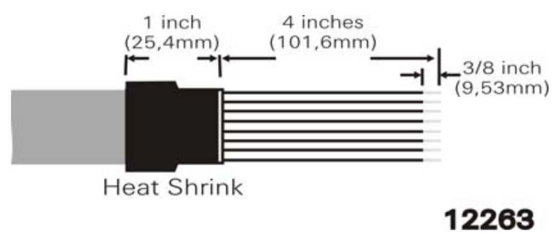

Figure 4-18: Clutch/Troll Cable Heat Shrink

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

- Plug Termination

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

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.

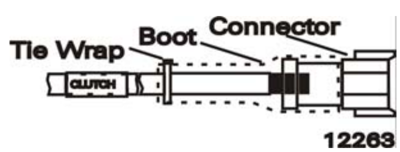

Figure 4-19: Clutch/Troll Cable Plug Connection

E Insert the pins into the appropriate terminations as shown in Table 4-8: Processor Clutch / Troll Circuit Board and Plug Connections.

F Slide the boot over the connector.

G Tie-wrap the boot in place.

Table 4-8: Processor Clutch /Troll Circuit Board and Plug Connections

DESCRIPTION	PROCESSOR		PLUG	
	Conductor Color	Termination	Termination	Conductor Color
Ahead Clutch Solenoid (+)	Brown	TB11-2	Pin 3	Brown
Ahead Clutch Solenoid (-)	Green	TB11-6	Pin 4	Green
Astern Clutch Solenoid (+)	Black	TB11-1	Pin 5	Black
Astern Clutch Solenoid (-)	Yellow	TB11-5	Pin 6	Yellow
Troll ON/OFF Solenoid (+)	Orange	TB11-4	Pin 9	Orange
Troll ON/OFF Solenoid (-)	White	TB11-8	Pin 10	White
Troll Proportional Solenoid (+)	Red	TB11-3	Pin 11	Red
Troll Proportional Solenoid (-)	Blue	TB11-7	Pin 12	Blue

4.5.3.10 Throttle Cable (Location K)

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 the appropriate hole 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 4-20: Engine Shield.

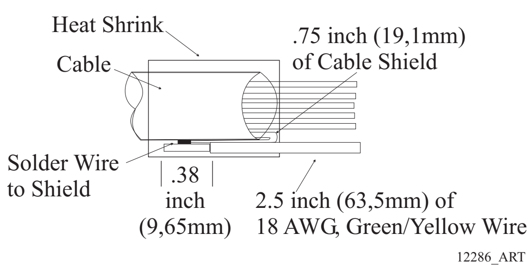

Figure 4-20: Engine Shield

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 4-9: Processor Circuit Board Throttle Connections

THROTTLE TYPE		PROCESSOR TERMINATION		
	Conductor Color	Signal	Return	Conductor Color
DC Voltage (0 to 5.0 VDC)	Orange	TB8-5	TB8-7	Black
Current (4.0 to 20.0 mA.)	Red	TB8-4	TB8-7	Black
PWM (0 to 99%)	Brown	TB8-3	TB8-7	Black
Frequency	White	TB8-6	TB8-7	Black
Idle Validation		Positive TB8-1	Negative TB8-2	

4.5.4 Engine Room/Remote Switch (Location M) (Optional)

For Switch and Operator installation guidelines, refer to the installation instruction supplied with them.

- Connect the cable's conductors to the Switch's contacts per the manufacturers instructions.

A Processor Cable Installation:

B Run the 2-Conductor cable from the location of the Engine Room Switch to the Processor.

C Run the cable through the appropriate liquid tight connector at the Processor.

D Route the cable to TB10 on the Circuit Board, making sure that the cable is NOT laying on the Circuit Board.

E Terminate the cable's conductors to the appropriate points.

F Secure the cable using tie-wraps.

G Repeat steps A) through E) for all Processors.

Table 4-10: Engine Room / Remote Switch Circuit Board Connection Points

Description	Processor Termination	Switch Termination
ER Switch (+)	TB10-1	ER Only/Remote Switch Contact
ER Switch (-)	TB10-2	ER Only/Remote Switch Contact

4.5.5 Station 2 Lockout Switch (Location N) (Optional)

For Switch and Operator installation guidelines, refer to the installation instructions supplied with them.

- Connect the cable's conductors to the switch's contacts per the manufacturers instructions.

A Processor Circuit Board Connections:

B Run the appropriate 2-Conductor cable from the location of the Station 2 Lockout Switch to the Processor.

C Run the cable through the appropriate liquid tight connector at the Processor.

D Route the cable to TB10 on the Circuit Board, making sure that the cable is NOT laying on the Circuit Board.

E Terminate the cable's conductors to the appropriate points.

F Secure the cable using tie-wraps.

G Repeat steps A) through E) for all Processors.

Table 4-11: Station 2 Lockout Switch Circuit Board Connection Points

Description	Processor Termination A	Switch Termination B
LO Switch (+)	TB10-3	Station 2 Lockout Switch Contact
LO Switch (-)	TB10-4	Station 2 Lockout Switch Contact

4.6 Engine Stop Switches

An engine stop switch(s) must be located at all Remote Stations and capable of stopping the engine at any RPM. The Installer supplies the Stop Switches. Refer to the installation instruction supplied with the switch and the engine installation instructions for manufacturers 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.

4.7 Push-Pull Cable Connections

4.7.1 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.

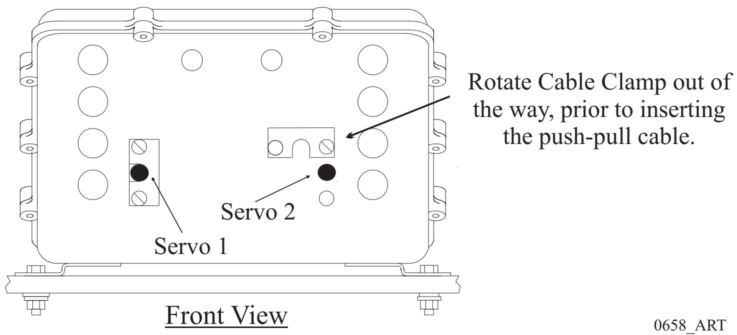

Figure 4-21: Processor Cable Clamp Rotation

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 4-22: Processor Push-Pull Cable Interior Connections). 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.

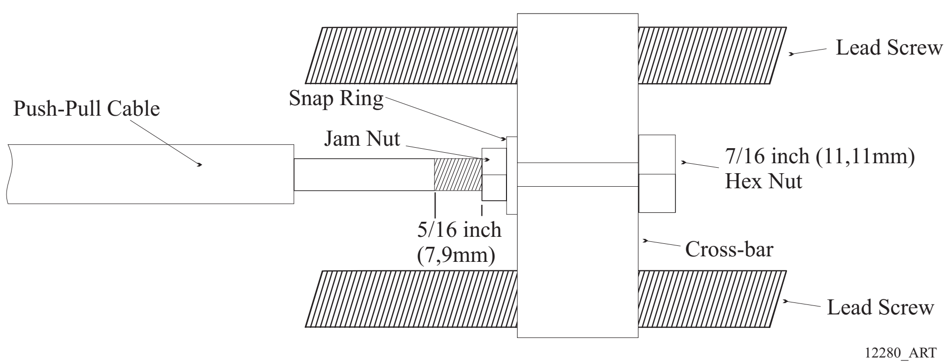

Figure 4-22: Processor Push-Pull Cable Interior Connections

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.

4.7.2 Engine Throttle Selector Lever

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).

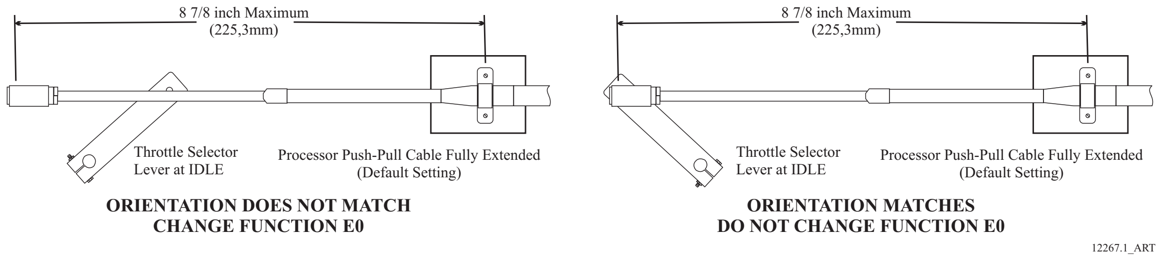

Figure 4-23: Throttle Push-Pull Idle Orientation to Selector Lever

A If the throttle lever is at the opposite side from the push-pull cable, change the Throttle Servo Direction **E0** as described in section 5: Set Up Procedures.

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

C Ensure that adequate cable threads are showing.

D Tighten the jam nut.

4.7.3 Transmission 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 the MMC-289 Morse Clutch and Throttle Kit Selection, 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.

D Connect the ball joint to the clutch selector lever.

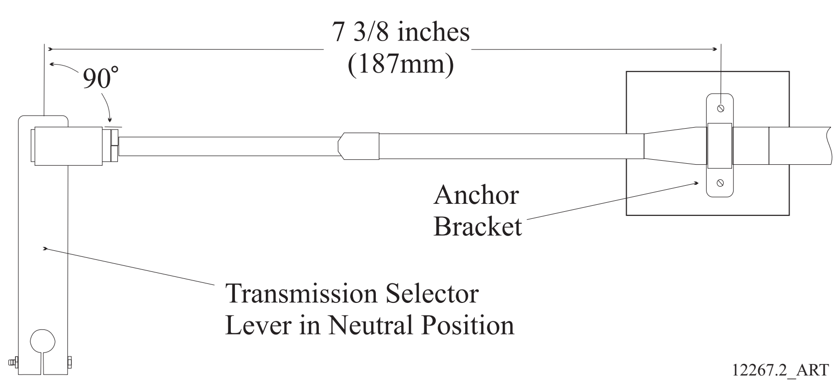

Figure 4-24: Shift Push-Pull Cable Neutral Connection

4.8 DP Interface Enclosure

4.8.1 General Enclosure Requirements

- The Enclosure is water resistant, but should be mounted in a dry location.
- The selected location must take into account:
  - Length of the Enclosure's Pigtail(s), three (3) feet (0,9m),
  - It must mate with the Processor's 18 inch (0,45m) Pigtail(s).
- Mount in any attitude easily accessible for harness connections. Bulkhead mount is preferred.
- Do not mount to the engine, transmission, or any location that will subject the Enclosure to excessive vibration.
- Locate away from heat sources, such as engine exhaust manifolds.

(Contact the factory if these items cannot be located in close proximity)

4.8.2 Enclosure Installation

Secure the Enclosure to the mounting surface with four 1/4 inch or M6 fasteners.

4.8.3 DP Enclosure (P/N 70218)

4.8.3.1 DP Pigtail Requirements to Processor

The selected location must take into account that the length of the Enclosure's DP Pigtail is three feet (0,9m) long and it must mate with the Processor's 18 inch (0,45m) DP Pigtail. **Contact the factory if the Enclosure and Processor cannot be located in such close proximity**.

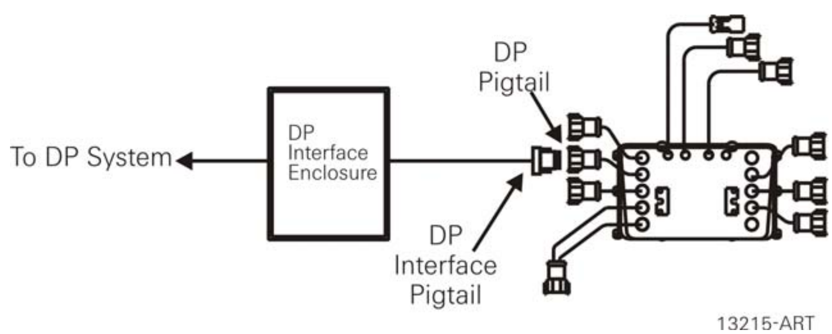

Figure 4-25: Enclosure DP Pigtail to Processor DP Pigtail Connections

4.8.3.2 DP Pigtail to Processor DP Pigtail

Both the Processor and the Enclosure are pre-wired with Pigtails. The Processor's DP Pigtail has a 12-pin Deutsch Socket at the end, while the Enclosure's DP Pigtail has a 12-pin Deutsch Plug at the end.

These connectors mate as shown in Figure 4-25: Enclosure DP Pigtail to Processor DP Pigtail Connections.

A At the Port Enclosure, run the Enclosure Pigtail to the Port Processor's DP Pigtail.

B Insert the Enclosure's Pigtail plug into the Processor's DP Pigtail socket.

C Ensure that the Enclosure Pigtail cable is supported using clamps or straps not more than 18 inches (45,72 cm) apart. Verify cable location protects the cable from physical damage.

D Repeat Steps A) thru C) for all Enclosures and Processors.

4.8.3.3 Processor to Factory DP Enclosure Terminations

Table 4-12: Processor to Enclosure Factory DP Terminations

Processor		Description	Conductor Colors	DP Enclosure	
Circuit Board	Plug			Plug	Termination Block
TB5-2	11	DP has Control Output	Brown	11	Pin 303
TB5-3	10	DP Switch Input (-) to Processor	Pink	10	Pin 111
TB5-4	9	DP Switch Input (+) to Processor	Orange	9	Pin 110
TB5-5	8	DP Command Input (-)	Gray	8	Pin 201
TB5-6	7	DP Command Input (+)	Green	7	Pin 200
TB5-7	6	+ 5 VDC (VREF)	Blue	6	Pin 117
TB8-1	4	DP Ready Output (+) from Processor	Violet	4	Pin 301
TB8-2	5	DP Ready Output (-) from Processor	Tan	5	Pin 305
TB11-4	3	Troll On/ Off Output from Processor	Yellow	3	Pin 108
J3-2	1	+ V Battery	Red	1	Pin 100, 102, 104,106
J3-4	2	- Return	Black	2	Pin 101, 103, 105, 107, 109
Chassis Ground		Shield	Green/ Yellow	12	No Connection

4.8.4 DP Enclosure to DP System

WARNING: Failure to meet these requirements will nullify the Processor warranty and possibly cause an unsafe operating condition and/or damage the Processor.

The following information is utilized with either the DP Interface Enclosure or the DP/JS Interface Enclosure. Connection to the DP System is the same with either Enclosure.

There are two input signals and two output signals required by the Enclosure for proper DP operation. These inputs and outputs must be hard-wired to the Enclosure. The required signals from the Dynamic Positioning system are as follows:

4.8.4.1 DP Command Input

The DP system must provide a variable DC voltage or current which conforms to the following:

- Signal Type (DC Voltage)
  - The analog voltage output of the DP system **MUST** be adjustable in order to meet the Command Voltage requirements listed in Table 4-13: DP Command Voltage Signal Requirements with Function Code A6 set to 02 (w/o Troll) or Table 4-14: DP Command Voltage Signal Requirements with Function Code A6 set to 01 or 03.
  - The command signal input may be generated by a variable resistive device such as a potentiometer (5 K Ohm ± 20%) connected as a voltage divider. The values are relative to the reference voltage (approx. 5.00 VDC) provided on Pin 117 of the Enclosure and applied to the potentiometer terminals.
  - When the command signal is generated by means other than a voltage divider, pins 200 (+) and 201 (-) of the DP Interface Enclosure must be used to input an analog command voltage. No connection to Pin 117 (VREF) is needed. The analog voltage **must** meet the level, isolation, input protection and adjustment requirements listed.

- Electrical Isolation
    - The analog voltage input to the Processor must be electrically isolated from the system that generates the signal in order to protect against ground loops, common mode problems, etc.
- Input Protection
    - The analog voltage input to the Processor **must** be protected against transients, faulty wiring, etc.

Table 4-13: DP Command Voltage Signal Requirements with Function Code A6 set to 02 (w/o Troll)

DESCRIPTION	VOLTAGE EQUIVALENT (Across 220Ω)	A-D COUNT
Error (Out of Range)	4.356	892
Full Speed Ahead	4.312	883
Throttle Release	2.772	568
Ahead Clutch Engagement	2.728	559
Ahead Clutch Disengagement	2.684	550
Neutral	2.640	541
Astern Clutch Disengagement	2.596	532
Astern Clutch Engagement	2.552	523
Throttle Release	2.508	513
Full Speed Astern	0.968	198
Error (Out of Range)	0.924	189
1) Ahead clutch actuation occurs between the Neutral and Idle Ahead states. Astern clutch actuation occurs between the Neutral and Idle Astern states. 2) Measurement to be taken between terminals 5 (-) and 6 (+) of the ClearCommand Processor circuit board's Station No.5 terminal block or the appropriate terminals inside the DP Interface Enclosure.		

Table 4-14: DP Command Voltage Signal Requirements with Function Code A6 set to 01 or 03

DESCRIPTION	VOLTAGE EQUIVALENT (Across 220Ω)	A-D COUNT
Error (Out of Range)	4.356	891
Full Speed Ahead	4.312	882
Throttle Release	3.564	730
Maximum Troll	3.520	721
Ahead Clutch Engagement/ Minimum Troll	2.728	558
Ahead Clutch Disengagement	2.684	549
Neutral	2.640	540
Astern Clutch Disengagement	2.596	531
Astern Clutch Engagement/ Minimum Troll	2.552	522
Maximum Troll	1.760	360
Throttle Release	1.716	351
Full Speed Astern	0.968	198
Error (Out of Range)	0.924	189

Table 4-14: DP Command Voltage Signal Requirements with Function Code A6 set to 01 or 03

DESCRIPTION	VOLTAGE EQUIVALENT (Across 220Ω)	A-D COUNT
1) Ahead clutch actuation occurs between the Neutral and Idle Ahead states. Astern clutch actuation occurs between the Neutral and Idle Astern states. 2) Measurement to be taken between terminals 5 (-) and 6 (+) of the ClearCommand Processor circuit board's Station No.5 terminal block or the appropriate terminals inside the DP Interface Enclosure.		

- Signal Type (4- 20mA)
    - The current signal **MUST** be adjustable in order to meet the current requirements listed in Table 4-15: DP Command Current Signal Requirements with Function Code A6 set to 05 or 08 (w/o Troll) or Table 4-16: DP Command Current Signal Req with Function A6 set to 04, 05, 07, 09 or 093 (w/Troll).
- Electrical Isolation
    - The current input to the Processor must be electrically isolated from the system that generates the signal in order to protect against ground loops, common mode problems, etc.
- Input Protection
    - The current input to the Processor must be protected against transients, faulty wiring, etc.

Table 4-15: DP Command Current Signal Requirements with Function Code A6 set to 05 or 08 (w/o Troll)

DESCRIPTION	CURRENT EQUIVALENT (mA.)	A-D COUNT
Error (Out of Range)	19.8	892
Full Speed Ahead	19.6	883
Throttle Release	12.6	568
Ahead Clutch Engagement	12.4	559
Ahead Clutch Disengagement	12.2	550
Neutral	12.0	541
Astern Clutch Disengagement	11.8	532
Astern Clutch Engagement	11.6	523
Throttle Release	11.4	513
Full Speed Astern	4.4	198
Error (Out of Range)	4.2	189

Table 4-16: DP Command Current Signal Req with Function A6 set to 04, 05, 07, 09 or 093 (w/Troll)

DESCRIPTION	CURRENT EQUIVALENT (mA.)	A-D COUNT
Error (Out of Range)	19.8	891
Full Speed Ahead	19.6	882
Throttle Release	16.2	730
Maximum Troll	16.0	721
Ahead Clutch Engagement/ Minimum Troll	12.4	558
Ahead Clutch Disengagement	12.2	549
Neutral	12.0	540
Astern Clutch Disengagement	11.8	531

Table 4-16: DP Command Current Signal Req with Function A6 set to 04, 05, 07, 09 or 093 (w/Troll)

DESCRIPTION	CURRENT EQUIVALENT (mA.)	A-D COUNT
Astern Clutch Engagement/ Minimum Troll	11.6	522
Maximum Troll	8.0	360
Throttle Release	7.8	351
Full Speed Astern	4.4	198
Error (Out of Range)	4.2	189

4.8.4.2 DP Ready Output (Relay Contacts)

The DP Ready Output indicates to the DP System that it may take control of the ClearCommand Processor. The DP Ready Output is turned ON (closed contacts) if the following conditions exist:

- The Processor is operational.
- The Processor is not in Backup Mode.
- The Processor is not in Engine Room only Mode.
- The Processor is not in Station 2 Lockout Mode.
- For Processors with mechanical clutch and/or throttle servo(s), there are no servo feedback errors or jammed condition.
- The contact is rated at a maximum current of 7 Amperes and a maximum voltage of 250 VAC and 300 VDC.
- The DP system cannot take command unless this contact is CLOSED, and maintained CLOSED while the DP is in-command.
- Refer to section 4.8.3.3: Processor to Factory DP Enclosure Terminations for connections to the Enclosure.

4.8.4.3 DP In Control Output (Relay Contacts)

The DP In Control Output is ON (CLOSED contacts) when the ClearCommand Processor will respond to the DP Command Input (the DP System has control of clutch and throttle). The DP In Control Output is OFF (OPEN contacts) when the DP System doesn't not have control of clutch and throttle.

- The contact is rated at a maximum current of 7 amperes and a maximum voltage of 250 VAC and 300 VDC.
- Refer to section 4.8.3.3: Processor to Factory DP Enclosure Terminations for connections to the Enclosure.

4.8.5 DP/JS Enclosure (P/N 70332)

4.8.5.1 DP Pigtail Requirements

Refer to section 4.8.3: DP Enclosure (P/N 70218) for DP connections.

4.8.5.2 JS Pigtail Requirements to Processor

The selected location must take into account that the Enclosure has DP and JS Pigtails that are three (3) feet (0,9m) long. These Pigtails must mate with the appropriate Processor's 18 inch (0,45m) Pigtails. **Contact the factory if the Enclosure and Processor cannot be located in close proximity.**

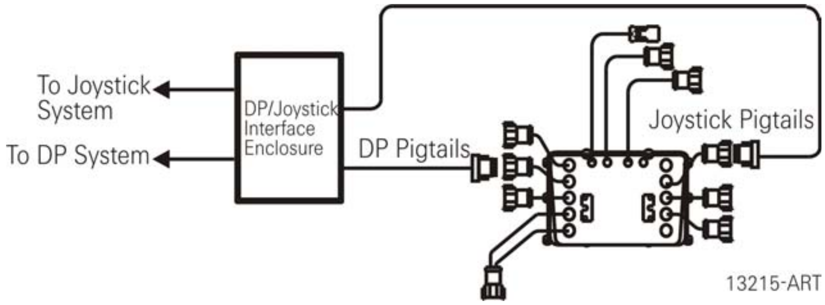

Figure 4-26: DP/JS Enclosure pigtails to Processor Station 5 and Station 4 pigtails

4.8.5.3 JS Pigtail to Processor Station 4 Pigtail

Both the Processor and the Enclosure are pre-wired with Pigtails. The Processor's Station 4 Pigtail has a 8-pin Deutsch Socket at the end, while the Enclosure's JS Pigtail has a 8-pin Deutsch Plug at the end.

These connectors mate as shown in Figure 4-26: DP/JS Enclosure pigtails to Processor Station 5 and Station 4 pigtails.

A At the Port Enclosure, run the Enclosure JS Pigtail to the Port Processor's Station 4 Pigtail.

B Insert the Enclosure's JS Pigtail plug into the Processor's Station 4 Pigtail socket.

C Ensure that the Enclosure JS Pigtail cable is supported using clamps or straps not more than 18 inches (45,72 cm) apart. Verify cable location protects the cable from physical damage.

D Repeat Steps A) thru C) for all Enclosures and Processors

.

Table 4-17: Processor to Enclosure Factory Joystick (JS) Terminations

Processor Sta. 4 Pigtail Circuit Board	Processor Sta. 4 Pigtail Plug	Description	Conductor Colors	DP Enclosure JS Pigtail Termination Block
TB4-11	8	Ground	Black	Pin 156
TB4-2	2	Joystick has Control Output (3 - 5 VDC)	Brown	Pin 302
TB4-3	5	Joystick Switch Input (-)	Red	Pin 251
TB4-4	4	Joystick Switch Input (+)	Orange	Pin 157
TB4-6	6	Joystick Command Input Voltage (+)	Green	Pin 250
TB4-7	7	+ VDC Reference	Blue	Pin 158
Chassis Ground	1	Shield	Green/ Yellow	No Connection

4.8.6 DP/JS Enclosure to JS System

	**WARNING: Failure to meet these requirements will nullify the Processor warranty and possibly cause an unsafe operating condition and/or damage the Processor.**

The following Information is utilized **only** with the DP/JS Interface Enclosure (P/N 70332).

There are two input signals and two output signals required by the Enclosure for proper JS operation. These inputs and outputs must be hard-wired to the Enclosure. The required signals are as follows:

4.8.6.1 JS Command Input

The JS system must provide a variable DC voltage which conforms to the following:

- Signal Type

  The analog voltage output of the JS system **must** be adjustable in order to meet the JS Command Voltage requirements listed in Table 4-18: JS Command Voltage Levels with Function Code A6 set to 03 and System is NOT in Troll Mode or Table 4-19: JS Command Voltage Levels with Function Code A6 set to 03 and System IS IN Troll Mode.

  The command signal input may be generated by a variable resistive device such as a potentiometer (5 K Ohm ± 20%) connected as a voltage divider. The values are relative to the reference voltage (approx. 5.00 VDC) provided on Pin 158 of the Enclosure and applied to the potentiometer terminals.

  When the command signal is generated by means other than a voltage divider, Pins 250 (+) and 251 (-) of the Enclosure must be used to input an analog command voltage. No connection to pin 158 (VREF) is needed. The analog voltage **must** meet the level, isolation, input protection and adjustment requirements listed.

- Electrical Isolation

  The analog voltage input to the Processor or the Enclosure **must** be electrically isolated from the system that generates the signal in order to protect against ground loops, common mode problems, etc.

- Input Protection

  The analog voltage input to the Processor or the Enclosure must be protected against transients, faulty wiring, etc.

Table 4-18: JS Command Voltage Levels with Function Code A6 set to 03 and System is NOT in Troll Mode

STATE	RELATIVE VALUE	ANALOG VOLTAGE[2] (Assuming 5 VDC reference)[f]
Error if analog voltage greater than	88%	4.44 VDC
Full Ahead	82%	4.07 VDC
Idle Ahead [1]	58%	2.89 VDC
Neutral [1]	48%	2.42 VDC ± 0.05 VDC
Idle Astern [1]	39%	1.95 VDC
Full Astern	16%	0.79 VDC
Error if analog voltage less than	9.8%	0.49 VDC

[1]Ahead clutch actuation occurs between the Neutral and Idle Ahead states. Astern clutch actuation occurs between the Neutral and Idle Astern states.
[2]Measurement to be taken between terminals 5 (-) and 6 (+) of the ClearCommand Processor circuit board's Station No.4 terminal block or the appropriate terminals inside the DP/Joystick Interface Enclosure.

Table 4-19: JS Command Voltage Levels with Function Code A6 set to 03 and System IS IN Troll Mode

STATE	RELATIVE VALUE	ANALOG VOLTAGE[2] (Assuming 5 VDC reference)[f]
Error if analog voltage greater than	88%	4.44 VDC
Full Ahead	82%	4.07 VDC
Troll Ahead End (max prop speed)	66%	3.34 VDC
Idle Ahead [1] Troll Ahead Start (min prop speed)	58%	2. 89VDC

Table 4-19: JS Command Voltage Levels with Function Code A6 set to 03 and System IS IN Troll Mode

STATE	RELATIVE VALUE	ANALOG VOLTAGE[2] (Assuming 5 VDC reference)[f]
Neutral [1]	48%	2.42 VDC ± 0.05 VDC
Idle Astern [1] Troll Astern Start (min prop speed)	39%	1.95 VDC
Troll Astern End (max prop speed)	30%	1.51 VDC
Full Astern	16%	0.79 VDC
Error if analog voltage less than	9.8%	0.49 VDC
[1] Ahead clutch actuation occurs between the Neutral and Idle Ahead states. Astern clutch actuation occurs between the Neutral and Idle Astern states. [2] Measurement to be taken between terminals 5 (-) and 6 (+) of the ClearCommand Processor circuit board's Station No.4 terminal block or the appropriate terminals inside the DP/Joystick Interface Enclosure.		

- Signal Type (4- 20mA)
    - The current signal **MUST** be adjustable in order to meet the current requirements listed in **Table 4-20: JS Command Current Signal Requirements with Function Code A6 set to 05 (w/o Troll)** or **Table 4-21: JS Command Voltage Signal Requirements with Function Code A6 set to 04 or 06 (w/ Troll).**
- Electrical Isolation
    - The current input to the Processor must be electrically isolated from the system that generates the signal in order to protect against ground loops, common mode problems, etc.
- Input Protection
    - The current input to the Processor must be protected against transients, faulty wiring, etc.

Table 4-20: JS Command Current Signal Requirements with Function Code A6 set to 05 (w/o Troll)

DESCRIPTION	CURRENT EQUIVALENT (mA.)	A-D COUNT
Error (Out of Range)	19.8	892
Full Speed Ahead	19.6	883
Throttle Release	12.6	568
Ahead Clutch Engagement	12.4	559
Ahead Clutch Disengagement	12.2	550
Neutral	12.0	541
Astern Clutch Disengagement	11.8	532
Astern Clutch Engagement	11.6	523
Throttle Release	11.4	513
Full Speed Astern	4.4	198
Error (Out of Range)	4.2	189

Table 4-21: JS Command Voltage Signal Requirements with Function Code A6 set to 04 or 06 (w/ Troll)

DESCRIPTION	CURRENT EQUIVALENT (mA.)	A-D COUNT
Error (Out of Range)	19.8	891
Full Speed Ahead	19.6	882
Throttle Release	16.2	730

Table 4-21: JS Command Voltage Signal Requirements with Function Code A6 set to 04 or 06 (w/ Troll)

Maximum Troll	16.0	721
Ahead Clutch Engagement/ Minimum Troll	12.4	558
Ahead Clutch Disengagement	12.2	549
Neutral	12.0	540
Astern Clutch Disengagement	11.8	531
Astern Clutch Engagement/ Minimum Troll	11.6	522
Maximum Troll	8.0	360
Throttle Release	7.8	351
Full Speed Astern	4.4	198
Error (Out of Range)	4.2	189

4.8.6.2 Joystick Ready Output (Relay Contact)

The Joystick Ready Output indicates to the Joystick system that it may take command of the ClearCommand Processor. The Joystick Ready Output is turned ON (closed contacts) if the following conditions exist.

- The Processor is operational.
- The Processor is not in Backup Mode.
- The Processor is not in Engine Room Only Mode.
- The Processor is not in Station 2 Lockout Mode.
- For Processors with mechanical clutch and/or throttle servo(s), there are no servo feedback errors or a jammed condition.
- The contact is rated at a maximum current of 7 Amperes and a maximum voltage of 250 VAC and 300 VDC.
- Refer to Appendix C - Sales and Service Information: Drawing 13959 Premium ClearCommand Single Screw for connections to the Enclosure.

4.8.6.3 Joystick In Control Output (Relay Contacts)

The Joystick In Control Output is ON (closed contacts) when the ClearCommand Processor will respond to the Joystick Command Input (the Joystick System has control of clutch and throttle).

The Joystick In Control Output is OFF (open contacts) when the Joystick System does not have control of clutch and throttle.

- The contact is rated at a maximum current of 7 amperes and a maximum voltage of 250 VAC and 300 VDC.
- Refer to Appendix C - Sales and Service Information: Drawing 13959 Premium ClearCommand Single Screw for connections to the Enclosure.

4.9 DP/Remote/JS Selector Switch Inputs

4.9.1 General Switch Requirements

- The switch should be located at the primary Remote Station.
- Each Enclosure requires a dedicated switch contact.
- In multi-screw applications, the contacts should be controlled by a single operator, in order to prevent the possibility of split control.
- Refer to the installation instruction supplied with the switch and it’s operator for installation guidelines.

4.9.2 General Switch Installation

A Drill into the Enclosure a hole of adequate size to accommodate a liquid tight connector for the appropriate sized cables to be used.

B Install a liquid tight connector.

C Run the cable between the Switch and each Enclosure.

- Support the cable using clamps or straps not more than 18 inches (45,72 cm) apart, if not contained in a conduit.
- Verify cable location protects the cable from physical damage.

D Connect the cable's conductors to the switch's contacts per the switch manufacturer's instructions.

E Place on your wrist the anti-static wrist strap provided and attach the clip to ground prior to removing the Enclosure's cover.

F Remove the cover.

G Run the cable through the liquid tight cable grip installed previously.

- Ensure enough cable is inserted to reach all termination points as listed in the appropriate Table for the switch being used. Refer to the following appropriate Section for termination points.
- Refer to Appendix C - Sales and Service Information: Drawing 13959 Premium ClearCommand Single Screw for Enclosure terminal block connection locations.
- Do not tighten cable grip at this time.

H Strip the PVC jacket to within 1/2 inch (12,7mm) of the inside of the enclosure.

I Cut the conductors to the appropriate lengths required to reach the terminations.

J Cut the Shield wire to a length of 1/2 inch (12,7mm) and pull it back against the PVC jacket.

K Slide 1 inch (25,4mm) long piece of heat-shrink over the cable.

L Secure the cable to the frame using a conductive Clamp at the entrance.

M Connect the conductors to the appropriate pins using a small slotted screwdriver or a WAGO Tool as required.

N Secure the cable using tie-wraps.

O Repeat steps A) through L) for all Enclosures.

4.9.3 Switch Interfaces

Refer to the following appropriate Section for specifics on Switch Installation.

- DP Enclosure (P/N 70218) requires the use of a 2-Position Selector Switch (DP/Remote).
- DP/JS Enclosure (P/N 70332) requires the use of a 3-Position Selector Switch (DP/Remote/ Joystick).

4.9.3.1 DP/Remote Switch (P/N 70218 Enclosure Only)

A 2-Position selector switch is required to transfer command to the DP System from a ClearCommand Remote Station. A maintained switch closure is required from the DP System to take and retain control of the ClearCommand Processor (clutch and throttle control)

Table 4-22: DP / Remote Switch Connections to the P/N 70218 DP Interface Enclosure

Description	DP Enclosure Termination	2-Position Switch Termination B
DP Switch Input (+)	Pin 110	DP Contact
DP Switch Input (-)	Pin 111	DP Contact

4.9.3.2 DP/Remote/Joystick Switch (P/N 70332 Enclosure Only)

A 3-Position selector switch is required to transfer command to the DP or Joystick System from a ClearCommand Remote Station. A maintained switch closure is required from the Joystick System to take and retain control of the ClearCommand Processor (clutch and throttle control).

Table 4-23: DP / Remote Switch / Joystick Connections to the P/N 70332 DP / Joystick Enclosure

Description	DP/JS Enclosure Termination A	3-Position Switch Termination B
DP Switch Input (+)	Pin 110	DP Contact
DP Switch Input (-)	Pin 111	DP Contact
JS Switch Input (+)	Pin 154	JS Contact
JS Switch Input (-)	Pin 155	JS Contact

5 Set Up Procedures

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.

Figure 5-1: Typical Processor Cover

- The Processor enclosure cover **must** be removed to access the Push Buttons.
- The **Display LED** is used to view the Function Codes and the Values for those Functions.
- The **Push Buttons** are used to scroll through Function Codes, select Function Codes and set the Values of the Function Codes.

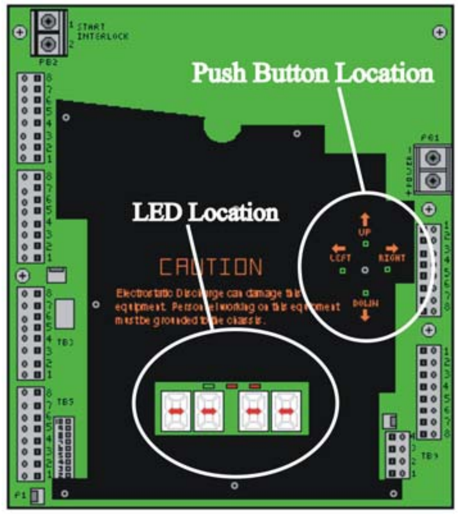

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Figure 5-2: Processor Shield Push Button and Display LED Locations

5.1.1 Processor Display LED

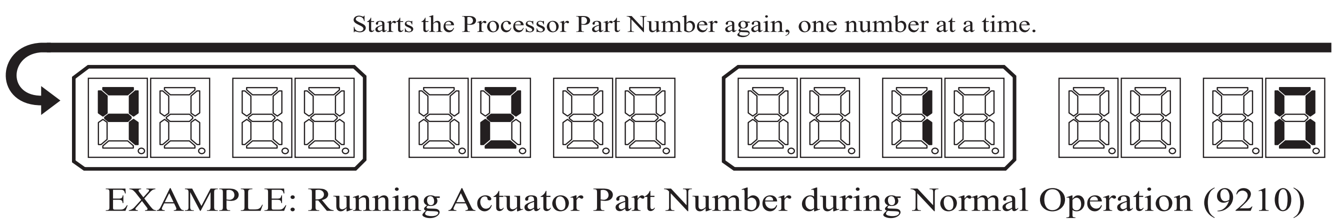

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Figure 5-3: Processor Part Number

- 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: Processor Part Number)
- Parameter display:
  1. The first two digit Display LED's to the left, indicate the **Function Code**, which is alphanumeric.
  2. 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.

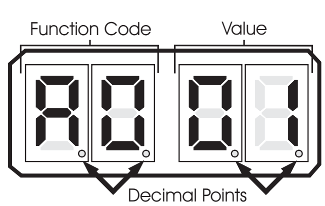


Figure 5-4: Display LED Designations

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.

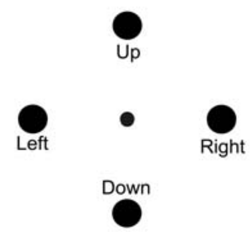


Figure 5-5: Circuit Board Push Buttons

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 is displayed, scrolls through the error messages one at a time. (Refer to Section 10.8 Error Codes)
- 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 **without** any changes to the Value being stored to memory. The Left Push Button must be held down until function code stops blinking. The previously stored 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.

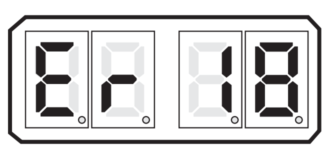


Figure 5-6: Display LED Error Menu Example

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.

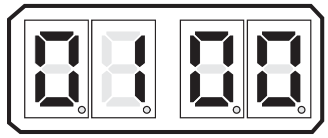


Figure 5-7: Display LED Four Digit Value

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 (5) minutes, the selected Mode of operation is automatically exited and the System returns to Normal Operating Mode.**

If no Push Buttons are pressed for five (5) minutes while in Set Up Mode, it will be exited without the changes stored to memory

5.4 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 following sections.**

	NOTE: **SINGLE SCREW APPLICATIONS: The Function Values may be entered and stored in any order.** **MULTI SCREW APPLICATIONS: The A1 Function must be set FIRST, and the A0 Function must be set SECOND. If ZF Hurth Gears with two (2) proportional solenoids are used, the L1 Function must be the THIRD function set. The rest of the Function Values may be entered and stored in any order.** **Once these parameters are set, either cycle power to the Processors or wait five (5) minutes, before continuing set up.**

5.4.1 (A) Processor Function Codes

Table 5-1: Processor Function Codes

Function Code	Function Name	Default Value	Value Range or Options
A0	Processor Identification	01	01, 02, 03, 04, 05
SINGLE SCREW: DO NOT ADJUST THE ABOVE FUNCTION! Leave at default value set by the factory. MULTI SCREW: Set Function A0 AFTER THE A1 Function Code Has Been Set.			
A1	Number of Engines	01	01, 02, 03, 04, 05
SINGLE SCREW: DO NOT ADJUST THE ABOVE FUNCTION! Leave at default value set by the factory. MULTI SCREW: The A1 Function Code is the FIRST (1ST) Parameter Set. Then set A0.			
A2	One Lever Operation	00	00 - Disabled; 01 - Enabled
SINGLE SCREW: DO NOT ADJUST THE ABOVE FUNCTION! Leave at default value set by the factory.			
A3	This Feature is not available at this time. **DO NOT ADJUST**.		
A4	Neutral Indication Tone	00	00 - No Tone 01 - Tone upon Control Head engaging Neutral 02 - Tone upon Transmission shifting to Neutral
A5	Engine Room/Remote -Station 2 Lockout	00	00 – Both Disabled 01 – Engine Room Lockout Enabled: 02 – Station 2 Lockout Enabled; 03 – Both Enabled
A6	DP Mode	00	00 – DP / JS Modes Disabled 01 – DP / JS Enabled (0-5VDC) w/ Troll 02 – DP / JS Enabled (0-5VDC) w/o Troll 03 – DP / JS Enabled (0-5VDC) w/ AutoTroll 04 – DP / JS Enabled (4-20mA) w/ Troll 05 – DP / JS Enabled (4-20mA) w/o Troll 06 – DP / JS Enabled (4-20mA) w/ AutoTroll 07 – DP (4-20mA) & JS (0-5VDC) Enabled w/ Troll 08 – DP (4-20mA) & JS (0-5VDC) Enabled w/o Troll 09 – DP (4-20mA) & JS (0-5VDC) Enabled w/ AutoTroll

Table 5-1: Processor Function Codes (Continued)

Function Code	Function Name	Default Value	Value Range or Options
A7	DP Transfer Lockout	00	00 - Disabled 01 - Enabled

5.4.2 (E) Basic Throttle Function Codes

Table 5-2: Basic Throttle Function Codes

Function Code	Function Name	Default Value	Value Range or Options
E1	Throttle in Neutral	00.0	00.0 to 25.0% of Throttle Range
E5	Throttle Pause Following Shift	00.5	0.0 to 05.0 Seconds
E6	High Idle	00.0	00.0 to 20.0% of Throttle Range. [Throttle Range = Throttle Max (E3) - Throttle Min (E2)]
E7	Synchronization	02	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)
SINGLE SCREW: DO NOT ADJUST THE ABOVE FUNCTION! Leave at default value set by the factory.			

5.4.3 (E) Electronic Throttle Function Codes

Table 5-3: Electric Throttle Function Codes

Function Code	Function Name	Default Value	Value Range or Options
E0	Engine Throttle Profile	06	01 - Caterpillar (PWM) (8 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 1800 (Frequency) (120.64 to 360.9 Hz) 10 - Detroit Diesel 2300 (Frequency) (120.64 to 463.5 Hz)
E2	Throttle Minimum	8.2	00.0 to 20.0% Must be 10% or more below Throttle Maximum (E3).
E3	Throttle Maximum	59.2	10.0 to 100.0% of Maximum Throttle Allowable Must be 10% or more above Throttle Minimum (E2).

Table 5-3: Electric Throttle Function Codes (Continued)

Function Code	Function Name	Default Value	Value Range or Options
E4	Throttle Maximum Astern	100.0	00.0 to 100.0% of Throttle Maximum (E3)

5.4.4 (E) Servo Throttle Function Codes

Table 5-4: Throttle Servo Function Codes

Function Code	Function Name	Default Value	Value Range or Options
E0	Throttle Servo Direction	20	20 - Push (Extends) for Throttle Increase (Fully retracted at Idle) 21 - Pull (Retracts) for Throttle Increase (Fully retracted at Idle)
E2	Throttle Minimum	00.0	00.0 to 20.0% (00.0 to 00.6") Must be 10% or more below Throttle Maximum (E3).
E3	Throttle Maximum	33.0	10.0 to 100.0% of Maximum Throttle Allowable. (00.3 to 03.0) Must be 10% or more above Throttle Minimum (E2)
E4	Throttle Maximum Astern	100.0	00.0 to 100.0% of Throttle Maximum (E3)

5.4.5 (C) Basic Clutch Function Codes

Table 5-5: Basic Clutch Function Codes

Function Code	Function Name	Default Value	Value Range or Options
C0	Clutch Pressure Interlock	00	**00 – No Interlocks Installed** **01 – Clutch Oil Pressure Interlock Installed** **02 – Throttle/ Clutch Pressure Interlock Installed** **03 – Engine Oil Pressure Interlock Installed** **04 – Engine Oil Pressure & Clutch Oil Pressure Interlocks Installed** **05 – Engine Oil Pressure & Throttle/ Clutch Pressure Interlocks Installed**
C1	Clutch Interlock Delay	1.0	00.5 to 10.0 Seconds
C2	Proportional (Reversal) Pause	00	00 – In-Gear; 01 – Neutral; 02 – Fixed Neutral Delay Enabled (**NOTE**: If **C2** is set to **02**, the setting of **C3** will set Fixed Neutral Delay **C8**.)
C3	Proportional (Reversal) Pause Time	03	00 to 99 Seconds
C4	Proportional (Reversal) Pause Ratio	00	00 – 2:1 Ahead to Astern vs. Astern to Ahead 01 – 1:1 Ahead to Astern vs. Astern to Ahead

Table 5-5: Basic Clutch Function Codes (Continued)

Function Code	Function Name	Default Value	Value Range or Options
C8	Fixed Neutral Delay	00.0	00.0 to 6.0 Seconds (In addition to any Proportional Delay)

5.4.6 (C) Solenoid Clutch Function Codes

Table 5-6: Solenoid Clutch Function Codes

Function Code	Function Name	Default Value	Value Range or Options
C5	Shift Solenoid Type	00	00 - All Shift Solenoids except ZF-Hurth with proportional solenoids 01 - ZF-Hurth with two (2) Proportional Solenoids with 12V Power 02 - ZF-Hurth with two (2) Proportional Solenoids with 24V Power
C6	ZF-Hurth Duty Cycle Ahead	100.0	00 to 100% Duty Cycle
C7	ZF-Hurth Duty Cycle Astern	100.0	00 to 100% Duty Cycle

5.4.7 (C) Servo Clutch Function Codes

Table 5-7: Servo Clutch Function Codes

Function Code	Function Name	Default Value	Value Range or Options
C5	Clutch Servo Direction	20	20 - Pull [Retracts] for Ahead 21 - Push [Extends] for Ahead
C6	Clutch Ahead	80	00-100% of Maximum Ahead Travel from Neutral. (00.0 to 1.5)
C7	Clutch Astern	80	00-100% of Maximum Astern Travel from Neutral. (00.0 to 01.5)

5.4.8 (F) Speed Boost Function Codes

Table 5-8: Speed Boost Function Codes

Function Code	Function Name	Default Value	Value Range or Options
F0	Speed Boost Percent	0.0	0.0 to 50.0% of Throttle Range
F1	Speed Boost Duration	0.0	0.0 to 20.0 Seconds
F2	Speed Boost Start Delay	0.0	0.0 to 10.0 Seconds

Table 5-8: Speed Boost Function Codes (Continued)

Function Code	Function Name	Default Value	Value Range or Options
F3	Speed Boost Bypass Clutch Delay	0.0	0.0 to 99.0 Seconds

5.4.9 (L) Basic Troll Function Codes

Table 5-9: Basic Trolling Function Codes

Function Code	Function Name	Default Value	Value Range or Options
L0	Troll Enable and Control Head Troll Lever Range	00	00 – No Troll 01 – 20 Degrees- Type 1 02 – 35 Degrees- Type 2 03 – 45 Degrees- Type 3 (Throttle limited to 75% of Throttle Range) 04 – 55 Degrees- Type 4 (Throttle limited to 10% of Throttle Range)
L4	Troll Throttle Limit	00	00 to 20% of Throttle Range Throttle Range = throttle Max (E3) - Throttle Min (E2)

5.4.10 (L) Solenoid Troll Function Codes

Table 5-10: Solenoid Troll Function Codes

Function Code	Function Name	Default Value	Value Range or Options
L1	Troll Valve Function (solenoid)	00	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 ZF600, 1900 and 2500, 24VDC Systems. 06 - Preset for 12VDC ZF Hurth Systems with two (2) proportional solenoids. 07 - Preset for 24VDC ZF Hurth Systems with two (2) proportional solenoids
L2	Troll Minimum Pressure	14	01.0 to 80.0% Must be at least 10% below Troll Maximum (L3).
L3	Troll Maximum Pressure	25	20.0 to 100.0% Must be at least 10% above Troll Minimum. (L2)
L5	Troll Pulse Duration	00	00.0 to 09.9 Seconds.
L6	Troll Pulse Percentage	25.0	00.1 to 100.0% of available Troll Range.

Table 5-11: ABS Transfer Function Codes

Function Code	Function Name	Default Value	Value Range or Options
P0	Transfer Mode	00	00 - Neutral Only 01 - Not Used 02 - Lever Match and Neutral; 03 - Request/Relinquish or Relinquish/Receive 04 - Request/Relinquish/Receive or Relinquish/Receive
P1	Transfer Time-out	15.0	0.0 to 99.0 Seconds
P2	Station 4 Joystick Mode (only available if **A6** is > **0**)	00	00 = Transfer Mode per Function Code **P0**. 01 = Neutral Only Momentary Switch closure at Station 4 (Joystick Mode)

5.4.11 Basic Troubleshooting

Table 5-12: Basic Troubleshooting Function Code

Function Code	Function Name	Default Value	Value Range or Options
H1	Erase EPROM	00	Store to Return to Factory Defaults. **(FOR AUTHORIZED PERSONNEL ONLY)**

5.4.12 Electronic Engine/Solenoid Transmission Troubleshooting

Table 5-13: Electronic Engine/Solenoid Transmission Troubleshooting Function Codes

Function Code	Function Name	Default Value	Value Range or Options
H0	Diagnostic	00	Input Voltage (+/- 0.5VDC) Tachometer Sensor Frequency Lever A/D, Stations 1, 2, 3, 4, & 5 Transfer Button, Stations 1, 2, 3, 4, & 5 Software Revision Level

5.4.13 Servo Troubleshooting

Table 5-14: Servo Troubleshooting Function Codes

Function Code	Function Name	Default Value	Value Range or Options
H0	Diagnostic	00	Input Voltage (+/- 0.5VDC) Tachometer Sensor Frequency Lever A/D, Stations 1, 2, 3, 4, & 5 Servo 1 & 2 A/D Feedback Transfer Button, Stations 1, 2, 3, 4, & 5 Software Revision Level

5.4.14 Solenoid Transmissions Troubleshooting

Table 5-15: Solenoid Clutch or Clutch/Troll Troubleshooting Function Code

Function Code	Function Name	Default Value	Value Range or Options
H2	Driver Fault Detection Enable	none	Allows the Processor to monitor the clutch or clutch/troll solenoids.

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

To aid in adjusting the following list of Processor signals, ZF Marine Propulsion Systems Miramar recommends the use of a ZF Marine Propulsion Systems Miramar Field Service Test Unit (P/N 13927) (Break-out Box) and a calibrated Multimeter. Refer to Appendix D - System Drawings: MM13927 Field Service Test Unit for more information on the use of the Field Service Test Unit (Break-out Box).

Table 5-16: Solenoid Clutch Functions requiring Field Service Test Unit and Multimeter

Code	Function Name
C6	ZF-Hurth Duty Cycle Ahead
C7	ZF-Hurth Duty Cycle Astern

Table 5-17: Electric Throttle Functions requiring Field Service Test Unit and Multimeter

Code	Function Name
E1	Throttle in Neutral
E2	Throttle Minimum
E3	Throttle Maximum
E4	Throttle Maximum Astern
E6	High Idle

Table 5-18: Solenoid Trolling Functions requiring Field Service Test Unit and Multimeter

Code	Function Name
L2	Trolling Minimum
L3	Trolling Maximum
L4	Troll Throttle Limit

5.5.1 Initial System Programming and Adjustments

NOTE: If ZF Hurth Gears are used, set the L1 parameter after A1 and A0.

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

NOTE: MULTIPLE SCREW APPLICATIONS WITH NO TROLL: 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: In order to prevent nuisance alarms when first setting up a System, some Function Codes take up to five (5) minutes to become ACTIVE. The Functions affected by this are the functions that rely on Serial Communication, such as A0, A1, A2, A3, E7, and L0. Cycling power OFF, then ON, expedites these features making the Functions available immediately.

5.5.2 Processor Functions

5.5.2.1 Number of Engines

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 (if required, contact a ZF Technician.)
- **04** - Quad Screw (if required, contact a ZF Technician.)
- **05** - Quint Screw (if required, contact a ZF Technician.)

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

5.5.2.1.1 Single Screw

DO NOT ADJUST THIS SETTING. Contact ZF Marine Propulsion Systems Miramar if this Function Code is going to be changed from the default setting.

5.5.2.1.2 Multi Screw

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 **A1.**

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

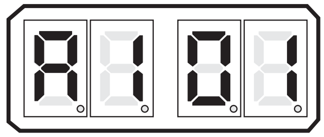


Figure 5-8: Display LED Function A1 Set Up Activated

5.5.2.2 (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.**

5.5.2.2.1 Single Screw

DO NOT ADJUST THIS SETTING. Contact ZF Marine Propulsion Systems Miramar if this Function Code is going to be changed from the default setting.

5.5.2.2.2 Multi Screw

NOTE: In twin screw or more applications, the Value of Function Code A0 must be changed AFTER the Value in Function Code A1 has been changed to 02 or higher on ALL Processors.

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

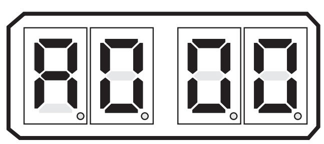


Figure 5-9: Display LED A0

E Repeat on all Processors BEFORE proceeding to the next Function.

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

NOTE: If ZF Hurth Gears are used, set the L1 parameter after A1 and A0.

5.5.2.3 (A2) One Lever Operation

NOTE: If Single Screw Application, leave at default value.

In Multi Screw 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 Operation for operating instructions)

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

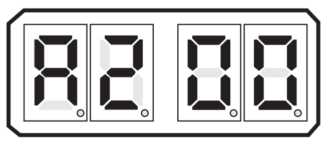


Figure 5-10: Display LED A2

5.5.2.4 (A3) This function is not available at this time.

5.5.2.5 (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 the Transmission to Neutral.

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.

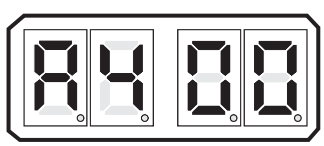


Figure 5-11: Display LED A4

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

5.5.2.6 (A5) Engine Room Lockout/Station No.2 Lockout

This Function Code provides the installer with four different options. The available Values for this Function are:

- **00 Both Disabled** (Default Value)
    - When selected, all five Remote Stations behave in the same manner.
    - No Station has transfer priority or lockout capability.
- **01 Engine Room Lockout Enabled**
    - When the Engine Room switch is CLOSED, command is transferred to Station No.1.
    - When the Engine Room switch is CLOSED, no other station can take command away from Station No.1.
    - When CLOSED on power-up, Station No.1 will be in command without pressing the transfer button.
- **02 Station No.2 Lockout Enabled**
    - When the Station No.2 switch is CLOSED (on or after power-up), any Station may take command. But once Station 2 has taken command, a solid three (3) second tone is sounded to alert the operator that Station 2 Lockout is active and no other Station can take command away (except the Engine Room Station 1 if enabled).
- **03 Both Enabled**
    - When both switches are CLOSED, control is transferred to Station No.1.
    - When both switches are CLOSED, no other station can take command away from Station No.1
    - When both switches are CLOSED on power-up, Station No.1 will be in command without pressing the transfer button.

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 **A5**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

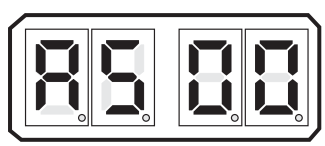


Figure 5-12: Display LED A5

5.5.2.7 Function Code A6 – Station No. 5 / DP

This function allows flexibility to the inputs applied to Stations 4 and 5. The inputs can be from a standard ZF ME supplied Control Head or from a Dynamic Positioning (SP) and Joystick (JS) System. When DP or JS is enabled, Stations 4 and 5 can be independently configured to accept a 0- 5VDC or 4-20mA signal.

The available Values for this Function are:

- **00** - DP & JS Modes Disabled **(Default Value)**
    - When disabled, Station 4 (JS) and Station 5 (DP) are configured to operate with a Standard Control Head.
- **01** - DP & JS Enabled (0- 5VDC) with Troll
    - Both the DP and JS inputs require a 0- 5VDC signal.
- **02** - DP & JS Enabled (0- 5VDC) without Troll
    - Both the DP and JS inputs require a 0- 5VDC signal.
- **03** - DP & JS Enabled (0- 5VDC) with ZF AutoTroll

    - Both the DP and JS inputs require a 0- 5VDC signal. For ZF transmissions equipped with an MTCU (Marine Transmission Control Unit).
- **04** - DP & JS Enabled (4- 20mA) with Troll
    - Both the DP and JS inputs require a 4- 20mA signal.
- **05** - DP & JS Enabled (4- 20mA) without Troll
    - Both the DP and JS inputs require a 4- 20mA signal.
- **06** - DP & JS Enabled (4- 20mA) with ZF AutoTroll
    - Both the DP and JS inputs require a 4- 20mA signal. For ZF transmissions equipped with an MTCU (Marine Transmission Control Unit).
- **07** - DP (4- 20mA) & JS (0- 5VDC) Enabled with Troll
    - DP requires a 4- 20mA signal and JS inputs require a 0- 5VDC signal.
- **08** - DP (4- 20mA) & JS (0- 5VDC) Enabled without Troll
    - DP requires a 4- 20mA signal and JS inputs require a 0- 5VDC signal.
- **09** - DP (4- 20mA) & JS (0- 5VDC) Enabled with ZF AutoTroll
    - DP requires a 4- 20mA signal and JS inputs require a 0- 5VDC signal. For ZF transmissions equipped with an MTCU (Marine Transmission Control Unit).

NOTE: 1.) Function Code value 00 through 03 are used when interfacing with an exiting system with DP Interface Enclosure (Part No. 70218).
2.) New Installations with DC inputs utilize DP Interface Enclosure (Part No. 70332) require Function Code values 00 through 03.
3.) New installations with current inputs utilize DP Interface Enclosure (Part No. 71868) require Function Code values 04 through 09.
4.) When one of Function Code values 07 through 09 is selected, ensure that the 226Ω resistor (R2) is removed from pins 250 and 251 of the DP Interface Enclosure (Part No. 71868).

A Scroll to Function Code **A6**.
B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory.

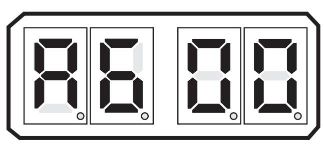


Figure 5-13: Display LED A6

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

5.5.2.8 Function Code A7 – DP Transfer Lockout

When this function is enabled neither a standard Control Head or the Engine Room switch can take control away from the DP system as long as the DP Select Switch is closed.

When disabled, any Control Head can take control away from the DP system when the Control Head's transfer button is pressed and the levers are commanding neutral, regardless of the DP Select Switch position.

NOTE: Function Code A7 is not displayed when A6 is set to 00.

5.5.3 Throttle Functions

The following Throttle Functions are set up in Section 6 Dock Trials

Table 5-19: Throttle Functions Performed during Dock Trials

Code	**Function Name**
E1	Throttle in Neutral
E2	Throttle Minimum
E3	Throttle Maximum
E4	Throttle Maximum Astern
E5	Throttle Pause Following Shift
E6	High Idle

5.5.3.1 (E0) Electric Engine Throttle Profile

This Function, in combination with the Throttle Harness type, configures the throttle output profile to meet the specifications of these various engines. The available Values for this Function are listed below:

- **01** - Caterpillar (PWM) (8 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) **(DEFAULT)**
- **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)

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.

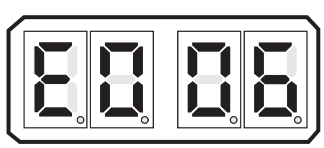


Figure 5-14: Display LED E0 - Electronic

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

5.5.3.2 (E0) Throttle Servo Direction

This Function determines if the Push-Pull cable is fully extended or retracted when at Idle. The available Values for this Function are:

- **20** - Fully Retracted at Idle, extends [Push] for Throttle increase **(Default Value)**

- **21 -** Fully Extended at Idle, retracts [Pull] for Throttle increase

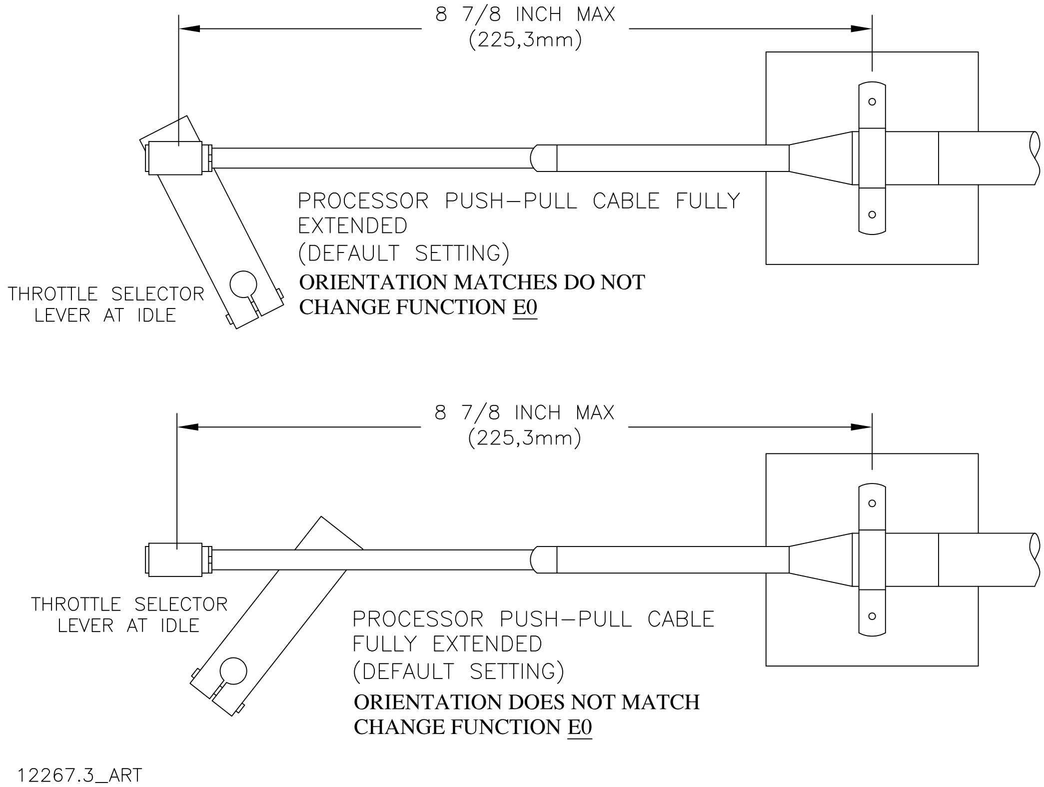


Figure 5-15: Throttle Push-Pull Cable Orientation

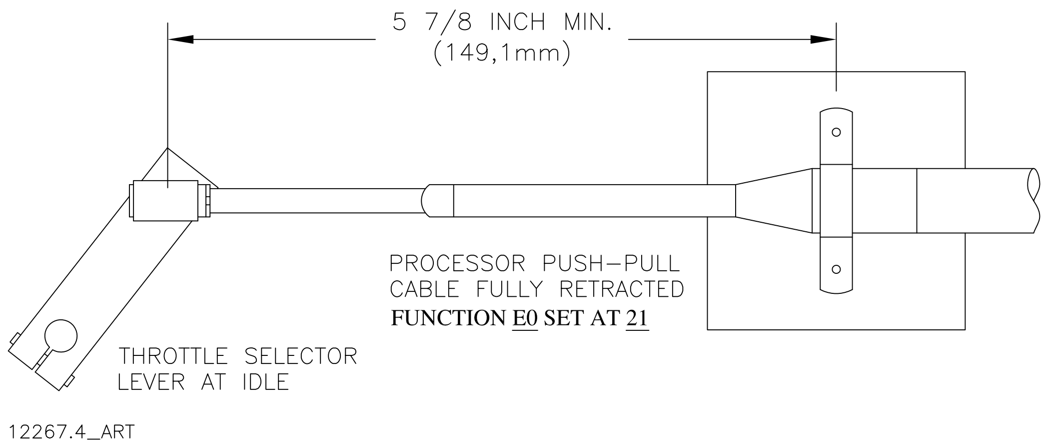


Figure 5-16: Example: Throttle Push-Pull Cable Fully Retracted Position for Idle

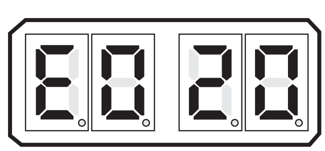


Figure 5-17: Display LED E0 - Servo

To change the Value (Refer to 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.

B Scroll to Function Code **E0**.

C Activate Set Up Mode.

D Scroll Up or Down until Value **21** is displayed.

E Store the Value to memory.
- The Throttle Push-Pull cable's ball joint should drive to the Throttle lever's Idle position.

F Do **not** connect the ball joint to the throttle lever at this time.

5.5.3.3 (E7) Synchronization

This Function Code selects the type of Synchronization, if Synchronization is required. The types are described in Section 2 Operation.

The available Values for this Function are:

- **00** - Equal Throttle (Open Loop)
- **01** - Active (Closed Loop) (reverts to Equal Throttle if there is no Tachometer Sensor signal)
- **02** - No Synchronization **(DEFAULT VALUE)**
- **03** - Active (Closed Loop) (reverts to no Synchronization if there is no Tachometer Sensor signal)

1. Single Screw

   DO NOT ADJUST THIS SETTING. Contact ZF Marine Propulsion Systems Miramar if this Function Code is going to be changed from the default setting.

2. Multi Screw

   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.

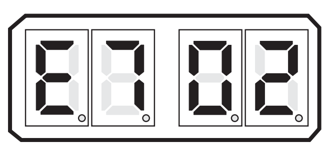


Figure 5-18: Display LED E7

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

5.5.3.4 Basic Clutch Functions

The following Clutch Functions are set up in Section 7 Sea Trials

Table 5-20: Basic Clutch Functions Performed during Sea Trials

Code	**Function Name**
C2	Proportional (Reversal) Pause
C3	Proportional (Reversal) Pause Time

5.5.3.5 (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.

	IMPORTANT: These setting options should be enabled only if the optional Clutch Oil Pressure or Engine Oil Pressure Switch is being used by the application.

This Function enables or disables two specific features, Clutch Oil Pressure Interlock or Engine Oil Pressure Interlock. The Clutch Oil Pressure Interlock has two specific modes of operation: Refer to Section 8 Control Options for detailed information.

- **C0 – 01 (Clutch Oil Pressure Interlock Installed) –** This option commands the engine to idle if adequate clutch oil pressure is not reached in the time designated by Function Code C1 (Clutch Interlock Delay).
- **C0 – 02 (Throttle/ Clutch Oil Pressure Interlock Installed) –** This option will not allow a throttle command above idle until adequate clutch oil pressure is reached. This is irrespective of the C1 value.

This Function also provides the option of an Engine Oil Pressure switch which is used to provide the DP system (via the DP Ready Output) the status of the main engine. In the event that an engine stalls or is not running (low oil pressure), the DP system is notified and can react as required.

The Engine Oil Pressure Switch contact must remain open for at least 500m Sec. before the DP Ready signal is removed. Once the Engine Oil Pressure contact closes, it must remain closed for at least 500m Sec before the DP Ready Signal is provided.

- **C0 – 03 (Engine Oil Pressure Interlock Installed) –** When selected, only the engine oil pressure option is enabled.
- **C0 – 04 (Engine Oil Pressure & Clutch Oil Pressure Interlocks Installed)** – The features discussed in both options 01 and 03 are provided.
- **C0** – **05 (Engine Oil Pressure & Throttle/ Clutch Oil Pressure Interlock Installed)** – The features discussed in options 02 and 03 are provided.

	NOTE: The C002 value is recommended in Gear Boxes that take longer than 10 seconds to reach operating pressure. Refer to Section 8 Control Options for more information on the settings.

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 **C0**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

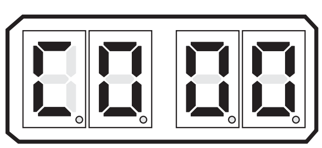


Figure 5-19: Display LED C0

5.5.3.6 (C1) Clutch Interlock Delay

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

This Function works together with Function Code **C0**. Refer to Section 8 Control Options for further information.

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

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 **C1**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

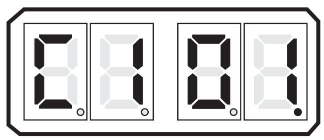


Figure 5-20: Display LED C1

5.5.3.7 (C4) Proportional (Reversal) Pause Ratio

NOTE: If you have any questions about which type of pause is best for your vessel, consult with a ZF Marine Propulsion Systems Miramar representative.

This Function Code selects whether the Proportional (Reversal) 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, than 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 Ratio **(DEFAULT)**
  - This is the default setting and determines how the value set in the Proportional (Reversal) 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 one-half of the **C3** - Proportional (Reversal) 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 (Reversal) 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.

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 **C4.**

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

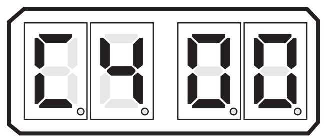


Figure 5-21: Display LED C4

5.5.3.8 (C8) Fixed Neutral Delay

This function provides a pause at Neutral whenever a change in direction is commanded. This pause is in addition to any proportional delay programmed into the system.

The available Values for this Function are **00.0** to **04.0** seconds and are programmable in one tenth of a second intervals.

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 **C8**

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

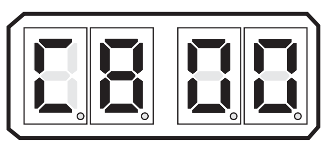


Figure 5-22: Display LED C8

5.5.4 Servo Clutch Functions

5.5.4.1 (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 [Retracts] for Ahead (**Default**)
- **21** - Push [Extends] for Ahead

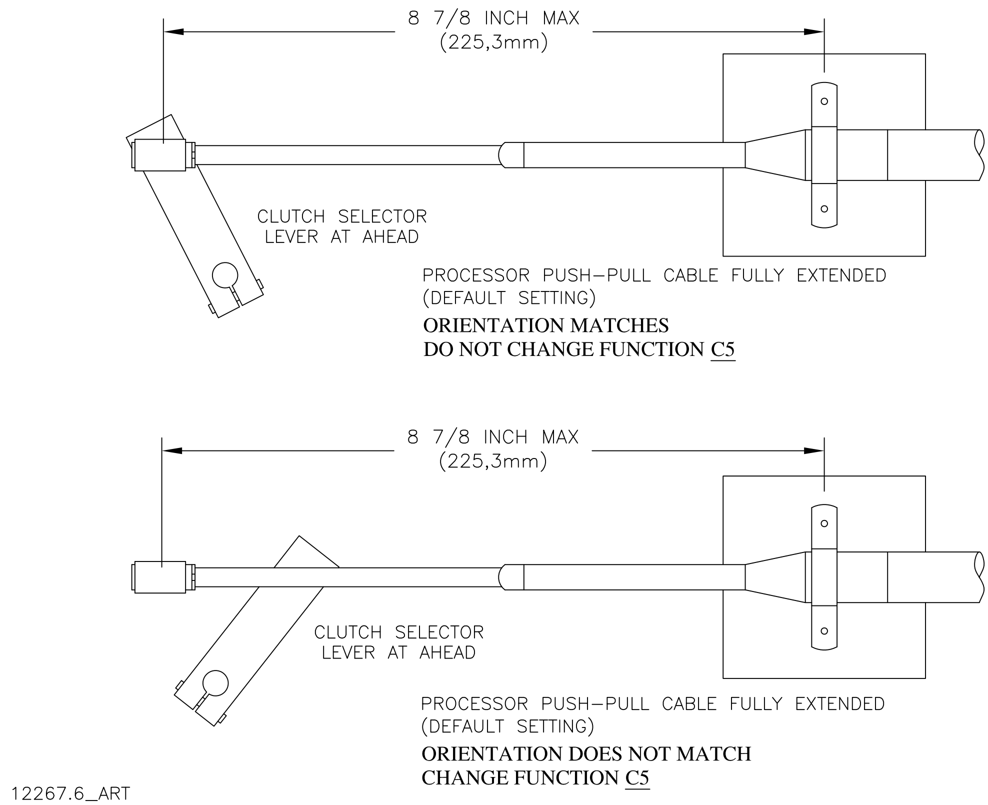


Figure 5-23: Clutch Push-Pull Cable Orientation

To change the Value (Refer to 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 lever into the Ahead detent.

C Check the Shift Push-Pull cable to see if it drove in the correct direction for Ahead.

- 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.

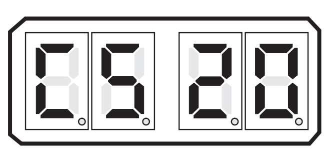


Figure 5-24: Display LED C5 - Servo

5.5.4.2 (C6) Servo 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%** of the maximum available travel from Neutral to Ahead. The Default Value is **80**%.

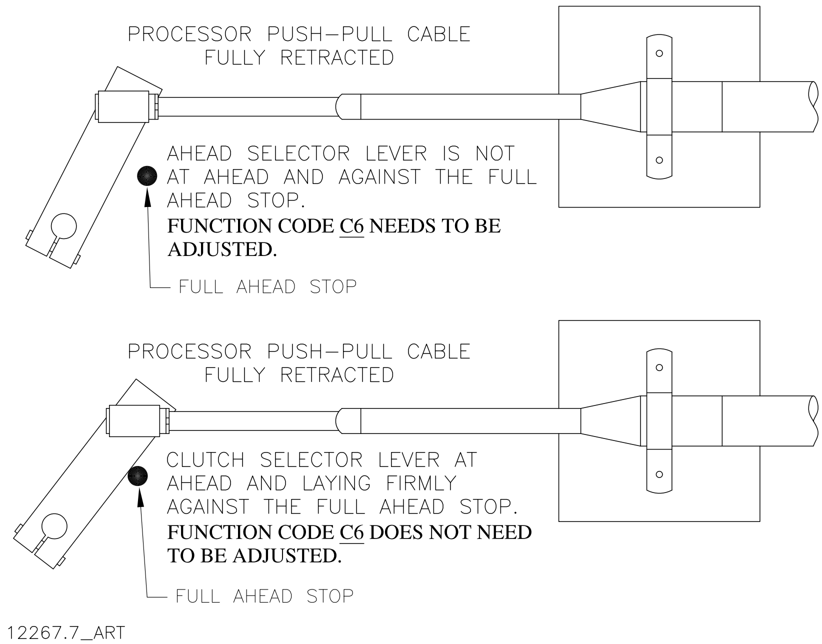


Figure 5-25: Clutch Push-Pull Cable Ahead Position

To change the Value (Refer to 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.
- 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.

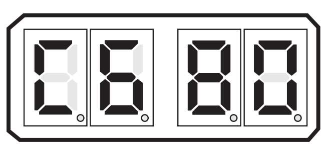


Figure 5-26: Display LED C6 -Servo

G Store the Value to memory.

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

5.5.4.3 (C7) Clutch Astern Travel (Servo)

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%** of the available travel from Neutral to Astern. The Default Value is **80**%.

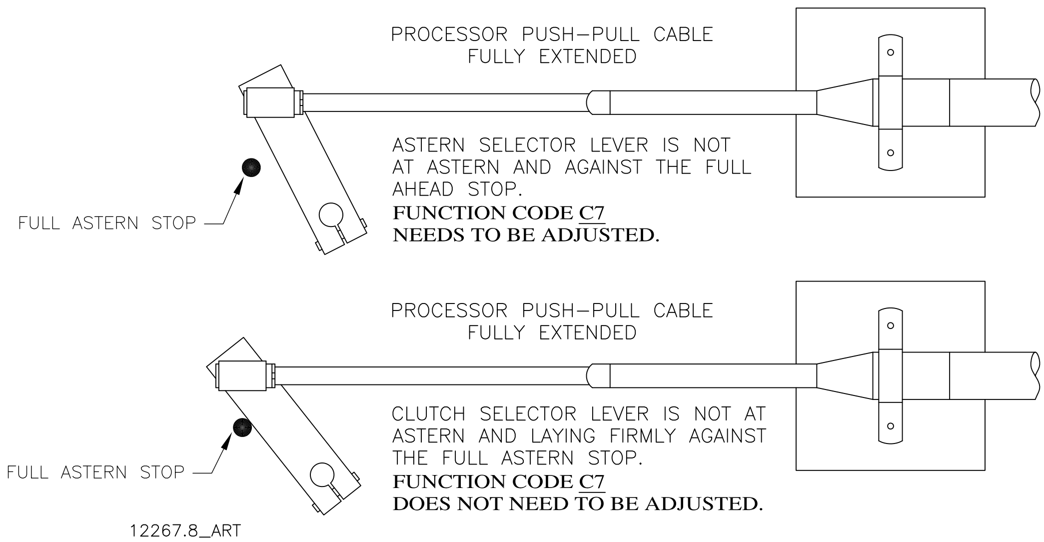


Figure 5-27: Clutch Push-Pull Cable Astern Position

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

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.

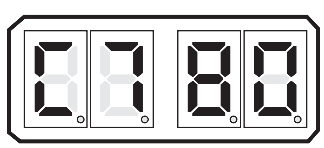


Figure 5-28: Display LED C7 - Servo

H Store the Value to memory.

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

5.5.5 Solenoid Clutch Functions

Table 5-21: Solenoid Clutch Functions Performed during Sea Trials

Code	**Function Name**
C6	ZF-Hurth Duty Cycle Ahead
C7	ZF-Hurth Duty Cycle Astern

5.5.5.1 (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.

NOTE: New ZF Hurth Gears utilize standard On/Off solenoids for Clutch selection. If unsure of your type, contact the ZF Gear Manufacturer.

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

NOTE: The maximum amount of current to ZF Hurth proportional 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.

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.

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 **C5.**

B Activate Set Up Mode.

C Scroll Up to change the Value.

D Store the Value to memory.

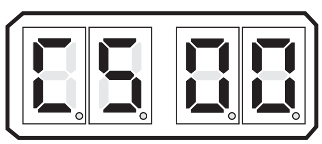


Figure 5-29: Display LED C5 - Solenoid

5.5.6 Troll Functions

The following Troll Function may be accomplished during Dock Trials. Refer to Section 6 Dock Trials.

Table 5-22: Troll Functions that may be performed during Dock Trials

Code	Function Name
L2	Troll Minimum Pressure

The following Troll Functions are accomplished during Sea Trials. Refer to Section 7 Sea Trials

Table 5-23: Troll Functions Performed during Sea Trials

Code	Function Name
L2	Troll Minimum Pressure
L3	Troll Maximum Pressure

Table 5-23: Troll Functions Performed during Sea Trials

Code	Function Name
L4	Troll Throttle Limit
L5	Troll Pulse Duration
L6	Troll Pulse Percentage

	NOTE: If ZF Hurth Gears are used, set the L1 parameter after A1 and A0.

5.5.6.1 (L0) Troll Enable and Control Head Lever Troll Range

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

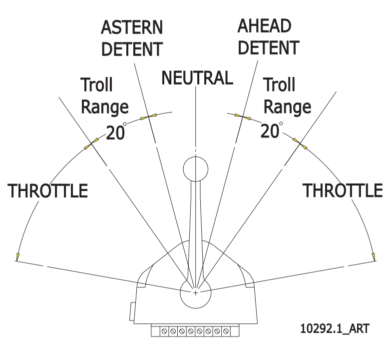


Figure 5-30: Control Head 20 Degree Troll Range - Type 1

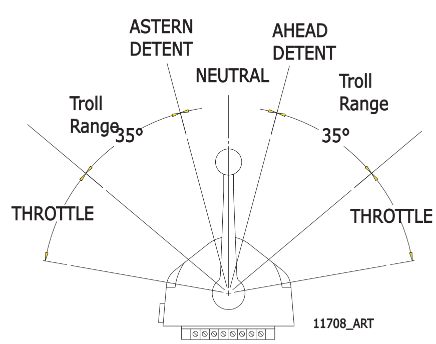


Figure 5-31: Control Head 35 Degree Troll Range - Type 2

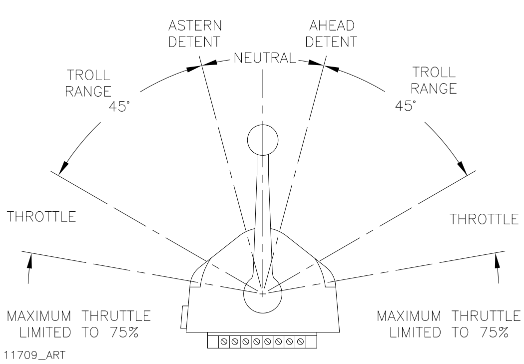


Figure 5-32: Control Head 45 Degree Troll Range - Type 3

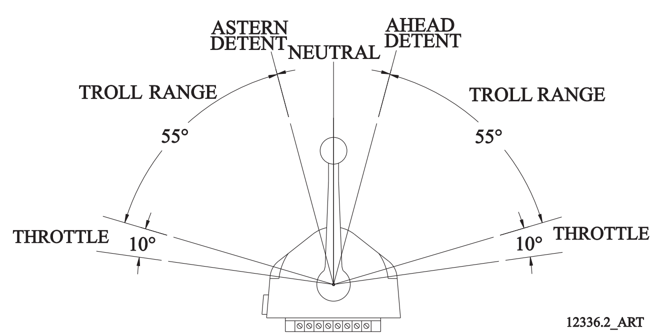


Figure 5-33: Control Head 55 Degree Troll Range - Type 4

A = Throttle

B = Troll Range

C = Astern Detent

D = Neutral Detent

E = Ahead Detent

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 **L0.**

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory

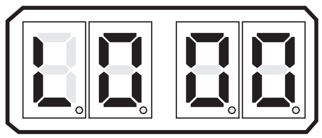


Figure 5-34: Display LED L0

5.5.6.2 (L1) Solenoid Troll Valve Function

CAUTION: This feature MUST be entered and set AFTER A0 - Processor Identification, if ZF Hurth Gears are used. All other features may then be entered and set in any order.

Refer to Table 5-24: (L1) Solenoid Trolling Valve Type Selection to select the correct set up for the trolling valve used with this application. The manner in which the current signal to the Proportional Valve behaves, is determined with this function.

Table 5-24: (L1) Solenoid Trolling Valve Type Selection

VALUE		TROLL VALVE	DESCRIPTION
00	Normal	Reintjes ZF 550 and lower	(DEFAULT) When selected, the current to the Proportional Valve increases as Clutch pressure increases. When Lockup (Full Pressure) is selected, the current drops to 0.
01	Inverse	Twin Disc 6000 Series ZF 600 and higher	When selected, the current to the Proportional Valve increases as Clutch pressure increases. When Lockup (Full Pressure) is selected, the current drops to 0.
02	Normal	ZF 220 - 550 12 VDC	When selected, the current to the Proportional Valve increases as Clutch pressure increases. When Lockup (Full Pressure) is selected, the current drops to 0. Preset for ZF 220 - 550 12 VDC Systems.
03	Normal	ZF 220 - 550 24 VDC	When selected, the current to the Proportional Valve increases as Clutch pressure increases. When Lockup (Full Pressure) is selected, the current drops to 0. Preset for ZF 220 - 550 24 VDC Systems.

Table 5-24: (L1) Solenoid Trolling Valve Type Selection

VALUE		TROLL VALVE	DESCRIPTION
04	Normal	ZF 2000 24 VDC	When selected, the current to the Proportional Valve decreases as Clutch pressure increases. When Lockup (Full Pressure) is selected, the current drops to 0. Preset for ZF 2000 24 VDC Series Systems.
05	Inverse	ZF 600, 1900, 2500 24 VDC	When selected, the current to the Proportional Valve decreases as Clutch pressure increases. When Lockup (Full Pressure) is selected, the current drops to 0. Preset for ZF 600, 1900, or 2500 24 VDC Series Systems.
06		ZF Hurth 12 VDC	Preset for 12 VDC ZF Hurth Systems.
07		ZF Hurth 24 VDC	Preset for 24 VDC ZF Hurth Systems.

Table 5-25: Troll Valve Typical Current/Pressure Requirements for some ZF Gears

Model Number	Current (Minimum)	Current (Maximum)	Pressure (Minimum)	Pressure (Maximum)	Comments
ZF 25- 80 [Old Style with two (2) proportional solenoids]	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 Min & Max Troll currents listed are at lock-up. Exceeding the Max current may damage the solenoid. Current below the Min listed may damage the clutch pack when the engine rpm exceeds 1000.
ZF 25- 80 [New Style with two (2) On/Off and one (1) proportional solenoid]	12VDC - 200 mA. 24VDC - 100 mA.	12VDC - 300 mA. 24VDC - 150 mA.	1 Bar (15 PSI)	8 Bar (116 PSI)	One variable current control valve in addition to Ahead & Astern solenoids. Increased current equals increased pressure
ZF90- 110TS, 220- 311, 220A, 325, 350, 550 & 665	200 mA.	300 mA.	1 Bar (15 PSI)	4 Bar (58 PSI)	One variable current control valve in addition to Ahead & Astern solenoids. Increased current equals increased pressure.
ZF600, 1900	350 mA.	160 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 Autotroll, which is supported by System 9000 Series Processors. Contact your ZF Representative for information.
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

Table 5-25: Troll Valve Typical Current/Pressure Requirements for some ZF Gears

Model Number	Current (Minimum)	Current (Maximum)	Pressure (Minimum)	Pressure (Maximum)	Comments
ZF2500	350 mA	175 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 Autotroll, which is supported by System 9000 Series Processors. Contact your ZF Representative for information.
ZF4500- 7500	n/a	n/a	n/a	n/a	These series of Gears are available with Autotroll only and are supported by System 9000 Series Processors. Contact your ZF Representative for information.

The default value is **00**.

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 **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

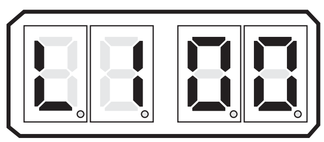


Figure 5-35: Display LED L1 - Solenoid

5.5.7 Troubleshooting Functions

5.5.7.1 (H0) Diagnostics

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

5.5.7.2 (H1) Return to Factory Defaults

This Function may be used during troubleshooting.

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

5.5.7.3 Solenoid Troubleshooting Functions

5.5.7.3.1 (H2) Driver Fault Detection Enable

The **H2** Function is available only on Processors with integrated Clutch and/or Troll Solenoid command.

The Processor can be programmed to monitor the current flow through the Clutch and/or Troll solenoid. 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 5-26: Solenoid Error Status Enable lists the required value that needs to be entered for Function Code **H2**, to monitor the Ahead, Astern, Neutral clutch solenoids and the Troll Command and Troll On/Off.

Table 5-26: Solenoid Error Status Enable

Value	Ahead	Astern	Neutral (optional)	Troll Command	Troll On/Off	Value	Ahead	Astern	Neutral (optional)	Troll Command	Troll On/Off
00	off	off	off	off	off	16	off	off	off	off	ON
01	ON	off	off	off	off	17	ON	off	off	off	ON
02	off	ON	off	off	off	18	off	ON	off	off	ON
03	ON	ON	off	off	off	19	ON	ON	off	off	ON
04	off	off	ON	off	off	20	off	off	ON	off	ON
05	ON	off	ON	off	off	21	ON	off	ON	off	ON
06	off	ON	ON	off	off	22	off	ON	ON	off	ON
07	ON	ON	ON	off	off	23	ON	ON	ON	off	ON
08	off	off	off	ON	off	24	off	off	off	ON	ON
09	ON	off	off	ON	off	25	ON	off	off	ON	ON
10	off	ON	off	ON	off	26	off	ON	off	ON	ON
11	ON	ON	off	ON	off	27	ON	ON	off	ON	ON
12	off	off	ON	ON	off	28	off	off	ON	ON	ON
13	ON	off	ON	ON	off	29	ON	off	ON	ON	ON
14	off	ON	ON	ON	off	30	off	ON	ON	ON	ON
15	ON	ON	ON	ON	off	31	ON	ON	ON	ON	ON

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

5.5.8 Premium Functions

5.5.8.1 Speed Boost Function Codes

Speed Boost is a temporary increase in the speed command output signal from the Processor. Its purpose is to decrease the possibility of the engine stalling during clutch engagement or reversal of direction (for example, from **Ahead** to **Astern**). The necessity for using Speed Boost should be assessed during sea trials, using a "trial and error" exercise; under normal operating conditions it is not generally required.

When considering the use of Speed Boost, make sure to read all Speed Boost information in Section 8 Control Options, and to make no Speed Boost adjustments until function codes **C2** (Proportional Pause), **C3** (Proportional Time), and **C4** (Proportional Pause Ratio) have been properly set.

5.5.8.1.1 (F0) Boost Percent

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 **F0**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

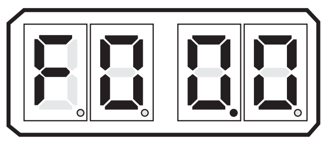


Figure 5-36: Display LED F0

5.5.8.1.2 (F1) Boost Duration

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 **F1**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

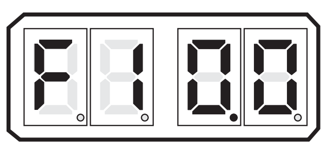


Figure 5-37: Display LED F1

5.5.8.1.3 (F2) Boost Start Delay

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 **F2**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

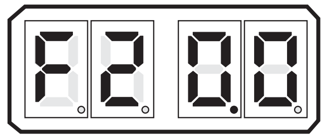


Figure 5-38: Display LED F2

5.5.8.1.4 (F3) Boost Bypass Clutch Delay

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 **F3**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

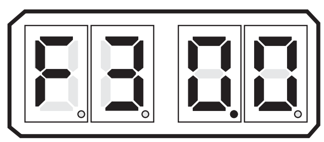


Figure 5-39: Display LED F3

5.5.8.2 Transfer Function Codes (P0, P1, P2)

5.5.8.2.1 Function Code P0 – Transfer Mode

The Default Value is **00**.

- **00** = Neutral Only **(Default Value)**
  1. When selected, transfer from one Remote Station to another can ONLY be accomplished when the receiving Remote Station's Control Head lever is in the Neutral detent.
  2. After the receiving Remote Station's Control Head LED lights, there is a 1 second delay before the receiving Remote Station's Control Head lever has command. This allows the operator time to match the position of the previous Remote Station's Control Head lever.
  3. Once command has been taken, the engine and gear will respond when the Control Head levers are moved Ahead or Astern.
- **02** = Lever Match and Neutral
  1. The operator has two options when selected:
     - **Option 1** requires that the receiving Remote Station's Control Head lever is at the Neutral detent for a transfer to occur.
     - **Option 2** requires that the receiving Remote Station's Control Head levers to be within 10% (+/- 10 Percent) (+/- 33 ADs) (+/- 7.5 Degrees) of the Station-in-Command's Control Head levers for a transfer to take place.
  2. In both options, there is a 1 second delay after the Control Head's re LED is lit before the receiving Remote Station's Control Head levers have command.
  3. Once command has been taken, the command to the engine and gear will respond to the Control Head lever's position immediately.
- **03** = Request / Relinquish or Relinquish / Receive
  1. The operator has two options when selected.

        - **Option 1** requires the operator at the receiving Remote Station request control by pressing the transfer button on the receiving Remote Station's Control Head. The Station-in-Command may now relinquish control by pressing the transfer button on the Station-in-Command Control Head.
        - **Option 2** requires that the operator at the Station-in-Command relinquishes control by pressing the Station-in-Command's Control Head transfer button. The receiving Remote Station accepts command by pressing the receiving Remote Station's Control Head transfer button.
    2. With both options, a 1/2 second ON, followed by a 1/2 second OFF tone wi sounded when the transfer is initiated.
    3. Once command has been taken, the command to the engine and gear will respond to the Control Head lever's position immediately.

- **04** = Neutral Only Request /Relinquish /Receive
    1. The operator has two options when selected.
        - **Option 1** is a three step process. This option requires the operator at the receiving Remote Station request control by pressing the transfer button on the receiving Remote Station's Control Head. The Station-in-Command relinquishes control by pressing the transfer button on the Station-in-Command Control Head. The receiving Remote Station must press the receiving Remote Station Control Head transfer button a second time to receive command.
        - **Option 2** requires that the operator at the Station-in-Command relinquishes control by press the Station-in-Command's Control Head transfer button. The receiving Remote Station accepts command by pressing the receiving Remote Station's Control Head transfer button.
    2. With both options, a 1/2 second ON, followed by a 1/2 second OFF tone wi sounded when the transfer is initiated.
    3. Once command has been taken, the command to the engine and gear will respond to the Control Head lever's position immediately.

A Scroll to Function Code **P0**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

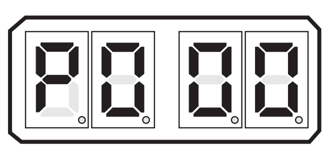


Figure 5-40: Display LED P0

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

5.5.8.2.2 Function Code P1 – Transfer Timeout

The Value selected for this Function determines how much time an operator has to respond to a transfer request or relinquish.

The available Values are **00** to **99** seconds. The Default Value is **15** seconds.

5.5.8.2.3 **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 **P1**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

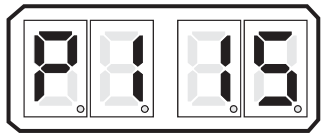


Figure 5-41: Display LED P1

5.5.8.2.4 Function Code P2 – Station 4 Joystick Mode

NOTE: This parameter is displayed ONLY if Function Code A6 is enabled. (A6 > 00)

The Value selected for this Function allows the installer to select the "Neutral Only" remote station transfer mode for Station 4, that is required for Joystick operation. If Station 4 is to be used by a ZF Marine Propulsion Systems Miramar Control Head for normal operation, function code **P2** should be left at the default setting.

The available Values are

- **00** - Transfer Mode per Function Code **P0**;
- **01** - Neutral Only/Momentary Switch closure at Station 4.

The Default Value is **00**.

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 **P2**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

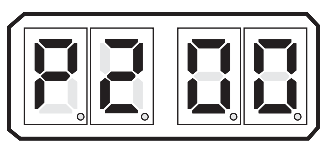


Figure 5-42: Display LED P2

6 Dock Trials

WARNING: It is imperative that the information provided in the previous Sections have been READ and FOLLOWED precisely, PRIOR to attempting a Dock Trial. Dock Trials should be made with engines stopped

CAUTION: With In/Outboard 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 multiple screw applications, the following tests must be performed on all Processors. If any of the following tests fail, consult 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 Take command at a Remote Station.

D 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 operates **only** in the Ahead direction. If the red indicator light **BLINKS**, continue with the testing.
    - If the red indicator light **DOES NOT BLINK**, check connections as stated in the appropriate Appendix A - System Components and Specifications - Control Head Service Sheet.

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.

If any of the above tests fail, verify Start Interlock installation and connections. Refer to section 4: Installation.

6.3 Basic Throttle Settings (Engines Running)

6.3.1 (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%** of the Throttle Range. The Default Value is **00.0%**.

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 **E1**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

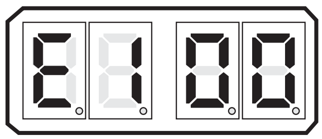


Figure 6-1: Display LED E1

6.3.2 (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 **E3** Throttle Maximum setting.

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 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.

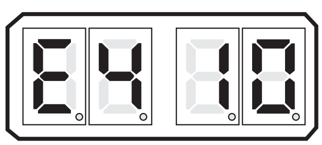


Figure 6-2: Display LED E4

6.3.3 (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 **E3** Throttle Maximum. The Default Value is **00.0%**.

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

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

A Place the Station-in-Command Control Head into Warm-up Mode.

B Scroll to Function Code **E6**.

C Activate Set Up Mode.

D Scroll Up or Down to the desired Value.

E Store the Value to memory.

F Return the Control Head levers to Neutral/Idle.

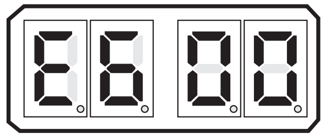


Figure 6-3: Display LED E6

6.4 Servo Throttle Settings (Engines Stopped)

6.4.1 (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 **1-1/2 inches (38,1mm)** of travel from Idle to Full Throttle.

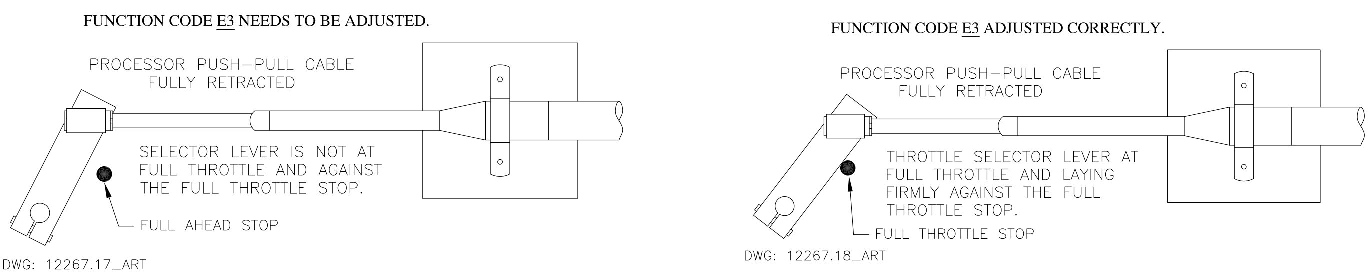


Figure 5-4: Throttle Push-Pull Cable Full Throttle Position

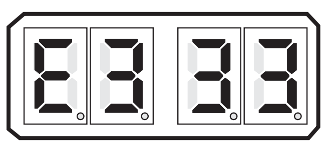


Figure 6-5: Display LED E3 - Servo

To change the Value (Refer to 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 Check to see if the Throttle Push-Pull cable reaches the Full Throttle stop.

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

D Scroll to Function Code **E3**.

E Activate Set Up Mode.

F Scroll Up or Down 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.

6.4.2 (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 is 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 the **E3** Throttle Maximum setting.

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.

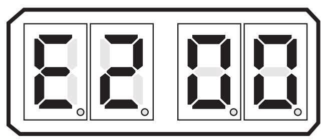


Figure 6-6: Display LED E2 - Servo

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

A Scroll Up until the engine RPM begins to increase above Idle.

B Scroll Down until Idle RPM is reached.

C Store the Value to memory.

6.5 Electric Throttle Settings (Engines Stopped)

6.5.1 (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 change the Value (Refer to 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.

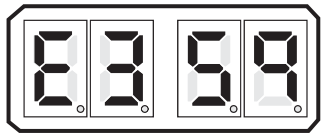


Figure 6-7: Display LED E3 - Electronic

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

6.5.2 (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 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 **E2**.

B Activate Set Up Mode.

C Scroll Up until the engine RPM at Idle begins to increase above Idle RPM.

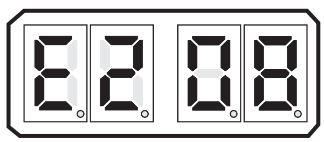


Figure 6-8: Display LED E2 - Electronic

D Scroll Down until Idle RPM is reached.

E Store the Value to memory.

6.6 Engine Stop Switches (Engines Running)

Start the engine(s) and verify that the Stop switches (normally push buttons) function correctly at all Remote Stations. Refer to the information supplied by the 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, 62.35-5 and ABYC P-24.5.8.

	WARNING: Do not attempt to continue tests until all Engine Stop Switches are functioning correctly!

6.7 Servo Checks (Engines Running)

WARNING: Must be done with the boat secured to the dock and only for a brief period.

6.7.1 Push-Pull Cables

A Check that all Push-Pull cable connection fasteners are tightened securely.

B Inside of 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.

6.8 Control Head Command Checks (Engines Running)

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.

- SERVO SHIFT: Confirm that the push-pull cable movement is in the direction commanded. If incorrect, perform the steps described in section 5.5.4.1: (C5) Clutch Servo Direction.
- SOLENOID SHIFT: 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.

6.9 (E5) Throttle Pause Following Shift (Engines Running)

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.

- SERVO THROTTLE: Start the stop-watch as soon as the Clutch Push-Pull cable stops moving.
- ELECTRIC THROTTLE: 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. Record________________.

NOTE: If the time recorded in step C) exceeds 5.0 seconds, a Clutch Pressure Interlock is required. Refer to section 8: Control Options.

6.10 Trolling Valve

6.10.1 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.

Refer to the steps outlined in Troll Solenoid Adjustments in section 7: Sea Trials.

6.11 Engine Room/Remote Switch

Verify Engine Room/Remote Switch and System operates as per section 8: Control Options.

6.12 Station 2 Lockout Switch

Verify that the Station 2 Lockout Switch function operates correctly. For information about this switch, refer to section 8: Control Options.

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 10: Troubleshooting or a ZF Facility prior to resuming the Sea Trial.

WARNING: It is the operator's responsibility to operate the vessel with the DP Interface per the DP system manufacturer's requirements. Please call your ZF Marine Propulsion Systems Miramar representative for any questions regarding installation/operation PRIOR to doing Sea Trials.

NOTE: MULTI SCREW APPLICATIONS: The following tests must be performed on all engines/transmissions. During the course of the Dock Trial and Sea Trials, fill out F-226 9000 Series Sea Trial Report. Retain this information for future use.

7.1 Full Speed Setting

A Warm-up the engine(s) and transmission(s) and slowly move into open water.

B Gradually move the Control Head lever(s) to Full speed.

- **SINGLE SCREW**: Continue with Step 1.
- **MULTI SCREW:** If synchronization is installed, disable synchronization as explained in section 2: Operation. Once disabled, continue with step 1.
    1. If Throttle RPM is LOW: (If RPM is High, continue with 2)
        - **ELECTRIC THROTTLE**: Refer to Appendix D - System Drawings: MM13927 Field Service Test Unit on how to check electric setting.
        - **SERVO THROTTLE**: Check whether the engine throttle lever is against the full speed stop.
    2. If Throttle RPM is HIGH: (If RPM was Low, skip this step)
        - Decrease RPM by adjusting **E3 Throttle Maximum,** as explained in section 6: Dock Trials.

C **MULTI SCREW ONLY:** Check that matching Idle, Mid-range and Full Speed Control Head lever positions cause equal RPM on both engines.

- **ELECTRIC THROTTLE:** If RPM's do not match, adjust **E3 Throttle Maximum**, refer to section 6: Dock Trials.
- **SERVO THROTTLE:** 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 Throttle Maximum**, refer to section 6: Dock Trials.

7.2 Proportional (Reversal) Pause Adjustments

WARNING: Types and timing of proportional (reversal) pauses must be specifically set for each vessel during a Sea Trial. Use extreme caution when maneuvering your vessel before the C2 and C3 function codes are properly set. Any aggressive action could cause the engine(s) to stall.

NOTE: If you have any questions about which type of pause is best suited for your vessel, contact a ZF Marine Propulsion Systems Miramar representative.

The proportional pause feature provides the exact amount of time required for engine deceleration during a change in vessel direction. The pause is variable and in proportion to:

- The position of the Control Head lever before the reversal.
- The length of time the Control Head lever has been in that position.

7.2.1 (C2) Reversal Pause

7.2.1.1 Pause Type Sequences

The sequence of events, are as follows for the three (3) Pause types:

7.2.1.1.1 In-Gear Delay [00]

1. The Throttle position drops to Idle.
2. The Transmission remains engaged in Ahead or Astern.
3. The Control System pauses at this position until the delay has timed out.
4. The Transmission shifts to the opposite gear (Astern or Ahead).
5. The Throttle position moves to the Control Head's present lever position.

7.2.1.1.2 Neutral Delay [01]

1. The Throttle position drops to Idle.
2. The Transmission shifts to Neutral.
3. The Control System pauses at this position until the delay has timed out.
4. The Transmission shifts to the opposite gear (Astern or Ahead).
5. The Throttle position moves to the Control Head's present lever position.

7.2.1.1.3 Fixed Neutral Delay [02]

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.

1. The Throttle position drops to Idle.
2. The Transmission shifts to Neutral.
3. 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).
4. The Transmission shifts to the opposite gear (Starboard or Port).
5. The Throttle position moves to the Control Head's present lever position.

7.2.1.2 Program C2 Type

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

A Scroll to Function Code **C2**

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

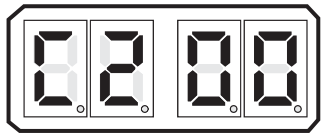


Figure 7-1: Display LED C2

NOTE: If C2 is set to 02 Enabled, C3 will set the Fixed Neutral Delay duration.   If C8 code is also used, that pause will be added to the proportional pause time set through C3.

7.2.2 (C3) Proportional Pause Time

NOTE: The pause on a through Neutral shift is proportional to the speed commanded and the duration of that speed. The Values listed for Function Code C3, are the maximum possible delays. When shifting from Idle Ahead to Idle Astern or vice-versa the delay is zero (0). The time required to build up to the maximum pause is six (6) 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 in section 5: Set Up Procedures.

7.2.2.1 Determine C3 Pause Requirement

NOTE: A stop-watch is required to accurately program the Proportional (Reversal) 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 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 stored during Set Up Procedures) while starting the stop-watch.

D When the engine(s) RPM reaches Idle and the vessel’s speed through the water is within two (2) knots of the standard Idle Ahead speed, stop the stop-watch.
Record Time_______________.

E Program Function Code **C3** to the time expired on the stop-watch.

The available Values are **00** to **99** seconds. The default Value is **04** seconds.

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 **C3**.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

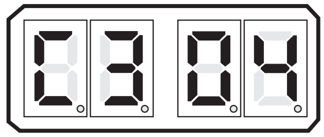


Figure 7-2: Display LED C2

7.2.2.2 Testing C3 Pause Time

CAUTION: It is critical that the **C3** be tested as outlined below, to ensure that it is correctly programmed. Failure to test properly could cause damage to the transmission.

A Position the vessel 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.

- Once the time has expired:
    1. Clutch should Shift to Astern.
    2. 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 **C3** by following the steps in the previous Section. Then begin again with step A) of this Section.
- **If the engine does not stall or come close to stalling**, proceed with the next step.

E Repeat the previous steps with the Throttle at 50%, 75%, and 100% of the speed range.

- **If the engine stalls at any time**, increase the Value of **C3** by one (1) second and begin again with step A) of this Section.

Once a Full Speed Reversal is successful without coming close to stalling, the Proportional Pause is properly adjusted.

7.3 Synchronization

NOTE: SINGLE SCREW: Skip the Synchronization Section and continue with the next Section.
MULTI SCREW: Continue with this Section.

7.3.1 Equal Throttle

A Move both Control Head levers side by side to approximately 25% of the Throttle range.

B If previously disabled, enable the synchronization

- The green LED on the Control Head will light, 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.

7.3.2 Active

A Move both Control Head levers side by side to approximately 25% of the Throttle range.

B If previously disabled, enable the synchronization.

- The green LED on the Control Head may blink while driving toward synchronization.
- The green LED will remain solidly lit once the engine RPM's are within 1% of one another.

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 10: Troubleshooting.

7.4 Trolling Adjustments

7.4.1 Basic Troll Functions

7.4.1.1 (L4) Troll Throttle Limit

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 manufacturers 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 no set procedure which determines when increased throttle should be used and what percentage of the range it should be set to.

The Values available to this Function are **00** to **20%** of Throttle Maximum. The default value is **00%** of Throttle Maximum.

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.

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory

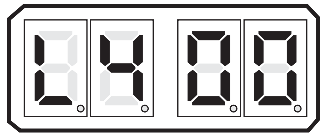


Figure 7-3: Display LED L4 - Solenoid

7.4.2 Solenoid Troll

NOTE: It is strongly recommended that the Field Service Test Unit (P/N 13927) is utilized when adjusting the Proportional Solenoid.

7.4.2.1 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 5.5.6.1: (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.

NOTE: Make Troll adjustment one processor at a time. If more than one at time the other levers on the neutral detent.

7.4.2.2 (L2) Troll Minimum Pressure Adjustment

A Ensure that the Control Head lever is at the Neutral / Idle position.

- **If the red LED is blinking rapidly**, disable Troll by pressing the Transfer Button until the red LED becomes lit solid.

B Connect a Service Field Test Unit (P/N 14000) and Amp meter to the Troll Command Signal output as described in Appendix D - System Drawings: MM13927 Field Service Test Unit.

C Move the Control Head lever to the Ahead detent.

D Using a Shaft Tach, measure the RPM of the Shaft and record in Table 7-1: RPM Measurement of Shaft in Normal Operating Mode.

Table 7-1: RPM Measurement of Shaft in Normal Operating Mode

Port		Starboard	

E Depress and hold (approximately two [2] seconds) the Transfer Button until the red LED starts blinking rapidly.

F Measure the Shaft RPM and record in Table 7-2: RPM Measurement of Shaft in Troll Operating Mode.

Table 7-2: RPM Measurement of Shaft in Troll Operating Mode

Port		Starboard	

G Scroll to the **L2** Function Code and enter Setup Mode.

H Adjust the Value of Function Code **L2** until the Shaft RPM is 30 to 50% of that measured in Table 7-1: RPM Measurement of Shaft in Normal Operating Mode.

I Enter the new Value into memory and Record in Table 7-3: Shaft RPM Measurement of Minimum Troll .

Table 7-3: Shaft RPM Measurement of Minimum Troll

Should be 30 to 50% of Table 2-1:			
Port		Starboard	

J If twin screw application, repeat steps A through I 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.

7.4.2.3 (L3) Troll Maximum Pressure Adjustment

A Place one Control Head lever in the Ahead detent with Troll enabled.

- If twin screw, ensure that the opposite lever is at the Neutral/Idle position.

B Scroll to Function Code **L3** and enter Setup Mode.

C Increase/decrease the Value until the Shaft RPM is 70 to 80% of that measured in Table 7-1: RPM Measurement of Shaft in Normal Operating Mode.

Table 7-4: Shaft RPM Measurement of Maximum Troll

Should be 70 to 80% of Table 7-1: RPM Measurement of Shaft in Normal Operating Mode			
Port		Starboard	

D Enter the new Value into memory.

E If twin screw, repeat steps A through D on the opposite side

7.4.2.4 (L5) Troll Pulse Duration & (L6) Troll Pulse Percentage

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 **L5** Function.

The **L6**'s Value automatically changes to the same Value selected with Troll Maximum (Function Code **L3**). As with **L5**, 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.

If **L5** and **L6** values need to be adjusted, it is recommended that small adjustments be made to each of the functions, instead of a large adjustment being made to one or the other. After each small adjustment, test vessel response before making further adjustments.

7.5 C6 & C7 ZF-Hurth [Old Type with two (2) proportional solenoids] Solenoid Trolling

NOTE: It is strongly recommended that the Field Service Test Unit (P/N 14000) is utilized when adjusting the ZF-Hurth Solenoid.

NOTE: Functions C6 & C7 limit the amount of current to the proportional solenoids. Failure to limit the current in certain solenoids will cause permanent damage to the solenoid.

7.5.1 Enabling ZF-Hurth Troll

A Ensure Function Code **C5** value is set to **01** or **02** (refer to section 5: Set Up Procedures.

B Place the Control System into Troll Mode.

C Move the Control Head lever into the Ahead Detent.

7.5.2 ZF-Hurth Troll Maximum Current Adjustment

A Ensure that the current to the Ahead and Astern Solenoids do not exceed the current rating of the Solenoid. 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).

Adjust Function Code **C6** for Ahead and **C7** as follows:

7.5.2.1 (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%** Duty Cycle of the applied voltage. The Default Value is **100%**.

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.

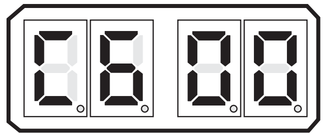


Figure 7-4: Display LED C6

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

7.5.2.2 (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**% Duty Cycle of the applied voltage. The Default Value is **100**%.

A Ensure that Troll is **not** 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.

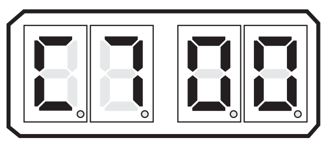


Figure 7-5: Display LED C7

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

7.6 Speed Boost

The primary function of Speed Boost is to prevent the engines from stalling when a heavy load is applied. This feature provides a temporary increase in the speed command output signal from the Processor. Most applications do not require Speed Boost.

Use a "trial and error" exercise during sea trials to assess the necessity for using Speed Boost. For complete instructions about how to proceed, as well as information about Speed Boost function code values and all cautionary notes and directions, refer to section 8: Control Options.

7.7 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 Propulsion Control System. Please enter <u>**ALL**</u> of the information. We recommend that F-226 9000 Series Sea Trial Report remains aboard the vessel, and a copy is sent to ZF Marine Propulsion Systems Miramar along with MMC-163 Warranty Registration.

ZF Marine Propulsion Systems Miramar, LLC
12125 Harbour Reach Dr Ste B
Mukilteo, WA 98275
P - 425-583-1900
F - 425-493-1569
www.zf.com

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 Slipat Min Prop Shift Speed		
D5	AutoTroll Slipat 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: ______________

MAIL COMPLETED COPY TO:
ZF Marine Propulsion Systems Miramar, LLC,12125 Harbour Reach Drive, Suite B, Mukilteo, WA 98275
OR FAX TO: 425-493-1569 ATTN: Service Department

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..

Table 8-1: Key for Figure 8-1: and Figure 8-2: Designators

Designator	Description	Designator	Description
A	DC Power Source (12 or 24 VDC)	E	Control System Fail Indicator Light (and/ or Audio Alarm).
B	Fuse		
C	Alarm Indication Circuit ON/OFF Switch	G	Maximum Current 0.5 A
D	Relay with a Normally CLOSED Contact and a Diode across the Coil for Surge Suppression	F	ZF Marine Propulsion Systems Miramar Processor

For +V = 12 VDC R Load > 0.37 Ohm

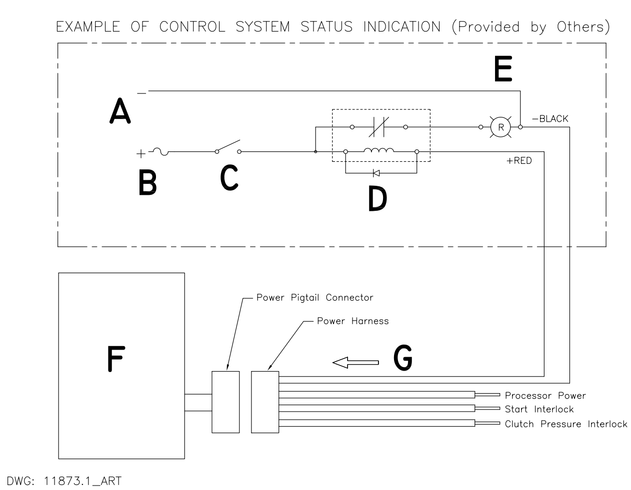


Figure 8-1: External Alarm Harness Example

For +V = 24 VDC R Load > 0.18 Ohm

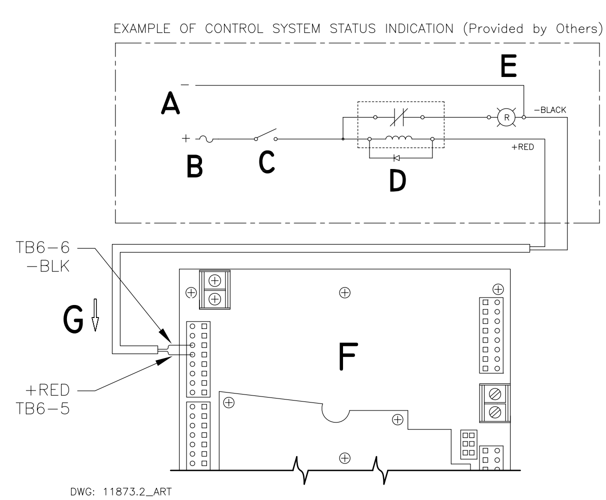


Figure 8-2: External Alarm Hard-Wired Example

8.1.1 Installation

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 not 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 Harness Example and Figure 8-2: External Alarm Hard-Wired Example are examples of a suitable circuit, but are not necessarily the only acceptable circuit.

A Plug the Power Wire Harness into the Processor's Power pigtail.

B Run the Power Wire Harnesses's 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 Harness Example and Figure 8-2: External Alarm Hard-Wired Example.

8.2 Auxiliary (Backup) Control System

The Auxiliary (Backup) System (referred to as BU System hereafter) provides a control system which is fully independent from the ZF Marine Propulsion Systems Miramar Control System. The BU System can control the gear as well as the engine, but it does not include ZF Marine Propulsion Systems Miramar control logic, safety interlock and timing circuits. In other words, there is no protection for operator errors, such as shifting into gear at elevated rpm's.

- Provides redundant throttle and clutch signals in the event of a failure of the Main Control System.
- May be selected at any time by the operator.
- A full explanation of the installation, operation and adjustment of the BU System is provided in the Installation Manual supplied with the BU System.

8.3 CANtrak Display Panel

The Display Panel shows various system information, including but not limited to: Station-in-Command, Control Head lever position, engine RPM, propeller shaft RPM, etc.

The Panel provides transfer direction for Transfer Modes 03 and 04.

The Panel receives information via the serial communications line.

The Panel accepts 12 or 24 VDC power supplies

A full explanation of the installation, operation, and adjustment of the Display Panel is provided in the MM70179 Display Manual and the manufacturers information included with the Panel.

Figure 8-3: Display Panel

8.4 Clutch Pressure Interlock

NOTE: The Clutch Pressure Interlock C0 must be set to be used. Refer to section section 5.5.3.5: (C0) Clutch Pressure Interlock for information on setting Function Code C0.

The Clutch Pressure Interlock uses a Pressure Switch which monitors the Ahead and Astern Clutch pressures to prevent high engine RPM when the clutch is not fully engaged.

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 three selectable methods of operation as described below:

8.4.1 (C0) Methods of Operation

8.4.1.1 (00) Not Installed

This is the default value for this parameter

8.4.1.2 (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 only be allowed to increase to this commanded speed for the time programmed in Function Code **C1** and then returned to Idle.

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.

8.4.1.3 (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 return 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**.

Table 8-2: Figure 8-4: and Figure 8-5: Designator

Designator	Description
A	Shuttle Valve
B	Hydraulic Line
C	Pressure Switch

Designator	Description
D	ZF Marine Propulsion Systems Miramar Processor
E	Ahead Clutch Pack
F	Astern Clutch Pack

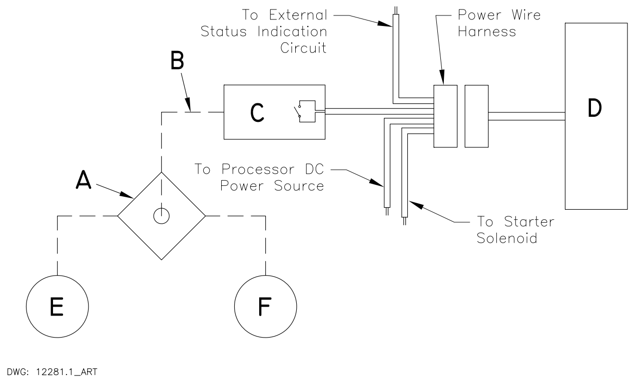


Figure 8-4: With Processor Harness

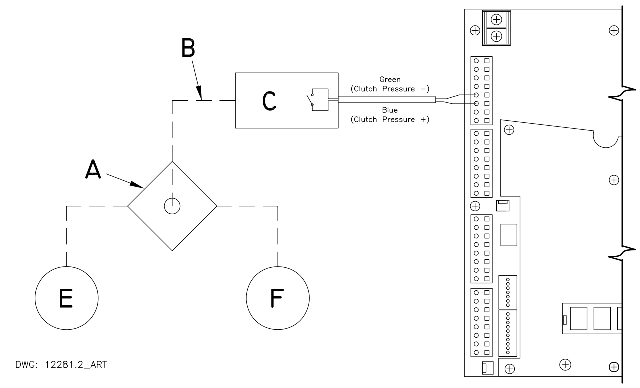


Figure 8-5: With Processor Hard-Wired

8.4.2 Installation

The installation of the Clutch Pressure Switch is the same for both methods of operation. (Refer to Figure 8-4: With Processor Harness and Figure 8-5: With Processor Hard-Wired.)

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 Manufacturers Installation Manual)

8.5 Dynamic Positioning (DP) Mode

Refer to the information supplied with the DP system for operational guidelines. The ClearCommand and the DP systems cannot be in command at the same time.

NOTE: When in DP Mode the following features are not available:

- **Warm-up Mode**
- **One Lever Mode**
- **Synchronization**
- **High Idle Mode**

The following features can override DP Mode:

- **Backup Mode**
- **Engine Room Only Mode**
- **Station 2 Lockout Mode**
- **Servo Feedback Error/Jam Condition**

NOTE: When in DP Mode the Processors will generate the appropriate Error Tones, but the Processors will not generate the Neutral Tone.

NOTE: A ClearCommand system with the Trolling Valve option can be programmed for DP operation with or without Trolling valve operation.

- **When DP operation is programmed with Trolling operation, the system will always operate in Troll Mode Type 3 (35 degrees) when the DP system is in control. This is regardless of the type selected with Function Code L0.**
- **When control is taken away from the DP system with a Remote Station, the control system will remain in the same Mode (Cruise or Troll).**

8.5.1 DP/Remote Switch (P/N 70218 Enclosure Only)

A 2-Position Relay Switch is required to transfer between DP system command and ClearCommand command of clutch and throttle.

- The transfer time when the switch is turned to DP from Remote is 0.5 seconds before the ClearCommand System will release command and the DP system has command.
- Transfer time when switch is turned to Remote from DP is one (1) second. If no remote station takes command by that time, ClearCommand will go to a Neutral/Idle state and generate a "No Station Online" tone.

8.5.2 Control Transfer *to* a DP System *from* a Remote Station

Command of clutch and throttle is transferred to a DP System from a remote station under the following conditions:

- The DP System is connected to all the Processor's DP Interface Enclosures
- The DP Interface Enclosure DP Pigtails are connected to all the Processor's DP Pigtails

- All the Processors have had function code **A6** set to the same code (**A6** = **01** or **A6** = **02**) for type of DP Mode.
- The DP Command Signal at the all Enclosures correspond to the Neutral/Idle state.
- The DP/Remote Switch is turned to DP.

NOTE: In multi-screw applications, the DP System MUST provide a switch closure to each Enclosure simultaneously.

When DP Mode is selected with the DP system:

1. A one second tone is heard at all Remote Stations.
2. The Station-in-Command LED's are **NOT** lit at any Remote Station.
3. If equipped with a Display Panel, *"***DP STATION***"* will be displayed at the top of the Panel.

8.5.3 Control Transfer *from* a DP System *to* a Remote Station

Function Code A7 determines how and when control can be transferred from the DP system to a Remote Station Control Head.

- When A7 is set to 00, any remote station can take control of the clutch and throttle away from the DP system (as long as the levers are positioned at the Neutral/ Idle positions) at any time by depressing the transfer button at that Control Head. To regain DP system command, the DP/ Remote switch MUST be turned to Remote for two (2) seconds and then returned to DP.
- When A7 is set to option 00, control will be transferred away from the DP system, with no station online when the Engine Room switch is closed.
- When A7 is set to option 01, control of the engine and transmission cannot be taken away from the DP system by pressing the Control Head transfer button or closing the Engine Room switch. In order to transfer command away from the DP system, the DP Select switch must be open prior to pressing the transfer button or closing the Engine Room switch. To regain DP system command, close the DP/ Remote switch.

8.6 Engine Room Only/Remote Switch

Station No.1 is typically designated as the Engine Room Station when this feature is used. It also prevents other Remote Stations from taking command away from Station No.1.

- This feature is defaulted OFF, and therefore must be enabled during set up. Refer to section 5: Set Up Procedures.
- When enabled, the feature is selectable with a two-position selector switch, labeled Engine Room Only/Remote. When switched to Engine Room Only the toggle switch is CLOSED and command is locked to Engine Room Station. When switched to Remote the toggle switch is OPEN and any Remote Station can take command away from the Engine Room Station.
- On power up, the system will go to no station on line regardless of the switch's position.

8.6.1 Switch CLOSED *on* Power-up

The Engine Room Station (Station No.1) will NOT take command automatically on Power-up.

- Command at the Engine Room Station is gained by moving the Control Head lever(s) into the Neutral/Idle position and then pressing the Transfer Button.
- ONLY the Engine Room Station (Station No.1) can take command when power is applied to the Processor(s).
- Moving the Engine Room Only/Remote Switch to the Remote (OPEN) position and back to the Engine Room Only (CLOSED) position will take command.

Depressing a Transfer Button at any Remote Station other than the Engine Room, will produce a tone for 2 seconds or for the duration the Transfer Button is pressed. The Remote Station's LED will not light, indicating command has not been take at the Station.

NOTE: The Control Head tone will sound as long as the Transfer Button is depressed at the Remote Station. If it is depressed for up to tem (10) seconds the Stuck Transfer Button Alarm logic initiates. Refer to Appendix B - Stuck Transfer Button Section.

8.6.2 Switch OPEN *on* Power-up

Command is gained by any Remote Station that has the Control Head lever(s) in the Neutral/Idle position and the operator depresses the Transfer Button.

8.6.3 Switch OPEN *after* Power-up

There are two ways of gaining command at the Engine Room Station (Station No.1) after power has been turned ON to the control system.

1. Engine Room Only/Remote Switch is in the Remote (OPEN) position. Take command at the Engine Room Remote Station. Then turn the Engine Room/Remote Switch to Engine Room. Refer to the next section 8.6.3.1: Taking Command with Station Transfer.
2. Turn the Engine Room Only/Remote Switch to Engine Room. Then move the Engine Room Control Head levers to the Neutral/Idle position. Refer to section 8.6.3.2: Taking Command with Switch.

8.6.3.1 Taking Command with Station Transfer

The Engine Room/Remote Switch is in the Remote position and any other Remote Station other than the Station 1 (Engine Room Station) is in command.

A Transfer command to the Engine Room Station as described in section 2: Operation.

B When command is at the Engine Room Station, turn the Engine Room/Remote Switch to Engine Room. This will lock-out all other Remote Stations from taking command.

C Command will remain locked at the Engine Room Station until the Engine Room/Remote Switch is returned to the Remote position. Command then can be transferred to another Remote Station, as described in section 2: Operation.

8.6.3.2 Taking Command with Switch

The Engine Room/Remote Switch is in the Remote position and any other Remote Station other than the Station 1 (Engine Room Station) is in command.

A Turn the Engine Room/Remote Switch to Engine Room.

B Command will be taken away from the Station-in-Command and transferred to the Engine Room (Station No.1) Control Head, regardless of where the Engine Room (Station No.1) Control Head lever(s) are positioned.

- If the Control Head lever(s) **ARE IN** the Neutral/Idle position, the Control Head is in automatically in active command of the control system.

- If Control Head lever(s) **ARE NOT IN** the Neutral/Idle position, the control system will enter a "Safe Mode". The Control Head LED will flash (at the same rate as when in Warm-up Mode), and the control system will output Neutral/Idle. To gain complete command, the operator must place the Control Head lever(s) into the Neutral detent for a period of one (1) to two (2) seconds before the control system will begin to respond. The LED will then function normally for a Station-in-Command.

C Now, if operator presses the Transfer Button at any other Remote Station, a tone will sound for two (2) seconds or for the duration the Transfer Button is pressed. Other Remote Stations cannot take command away from the Engine Room.

8.7 Fixed Neutral Delay

Fixed Neutral Delay is a feature that saves wear and tear on clutches and transmissions, appropriate for any boat equipped with shaft brakes (for example, a tugboat or commercial fishing vessel). Since the brakes are only applied when the system is in Neutral, this Fixed Delay ensures that the system pauses in Neutral long enough for the shaft brake application to take place, even when a Control Head lever is pushed or pulled rapidly from Ahead to Astern or vice versa. The Fixed Neutral Delay function code is C8, with available values of **0.0** to **6.0** seconds, programmable in increments of **0.1** (one-tenth) of a second.

When the Fixed Neutral Delay **C8** function code is set, as described in Section 5 - SET UP PROCEDURE, each time a change in vessel direction is commanded, the system will automatically pause in Neutral for the amount of time entered as the value, regardless of whether the operator actually stops the Control Head lever at the Neutral detent.

The Fixed Neutral Delay time is added to any Proportional (Reversal) Pauses and Proportional (Reversal) Pause Times which have been set with the function codes **C2** and **C3**. When **C8** is set in addition to **C2** and **C3**, the vessel will respond to the proportional pause(s) first and then pause for the amount of time set for Fixed Neutral Delay.

8.8 Joystick (JS) Mode

	WARNING: The JS interface is intended only for Simrad DP/JS Systems.

	WARNING: It is the operator's responsibility to operate the vessel with the DP/JS Interface Enclosure per the JS system manufacturer's requirements. Please call your JS representative for any questions regarding installation/operation PRIOR to Sea Trials.

Refer to the information supplied with the JS system for operational guidelines.

A ClearCommand Remote Station and the JS system cannot be in command at the same time.

NOTE: When in Joystick Mode the following features are not available:

- **Warm-up Mode**
- **One Lever Mode**
- **Synchronization**
- **High Idle Mode**

The following features can override Joystick Mode:

- **Backup Mode**
- **Engine Room Only Mode**
- **Station 2 Lockout Mode**
- **Servo Feedback Error/Jam Condition**

NOTE: When in Joystick Mode the Processors WILL generate the appropriate Error Tones, but the Processors WILL NOT generate the Neutral Tone.

NOTE: A ClearCommand system with the Trolling Valve option can be programmed for JS operation WITH or WITHOUT Trolling valve operation.

- **When DP operation (A6) is programmed with Trolling operation, the system will always operate in Troll Mode Type 3 (35 degrees) when the DP/JS system is in control. This is regardless of the type selected with Function Code L0.**
- **When control is taken away from the DP/JS system with a Remote Station, the control system will remain in the same Mode (Cruise or Troll).**

NOTE: If the ClearCommand System is in Troll Mode while command is transferred to JS, the JS system will be in Troll Mode.

8.8.1 DP/Remote/Joystick Switch (P/N 70332 Enclosure Only)

A 3-Position Relay Switch is required to transfer between the DP system, ClearCommand (Remote), or Joystick command of clutch and throttle.

- The transfer time when the switch is turned to JS from Remote is 0.5 seconds before the ClearCommand System will release command and the JS system has command.
- Transfer time when switch is turned to Remote from JS is one (1) second. If no remote station takes command the time one (1) second expires, ClearCommand will go to a Neutral/Idle state and generate a "No Station Online" tone.

8.8.2 Control Transfer *to* a JS System *from* a Remote Station

Command of clutch and throttle is transferred to a JS System from a remote station under the following conditions:

- The JS System is connected to all the Processor's DP/JS Interface Enclosures
- The DP/JS Interface Enclosure JS Pigtails are connected to all the Processor's Station 4 Pigtails
- All the Processors have had function code **A6** set to the same code (**A6 = 01, 02, etc**.) for type of DP Mode as well as **P2** set to the same value.

- The JS Command Signal at all the Enclosures correspond to the Neutral/Idle state.
- The DP/Remote/Joystick Switch is turned to Joystick.

NOTE: In multi-screw applications, the JS System MUST provide a switch closure to each Enclosure simultaneously.

When JS Mode is selected with the JS system:

1. A one second tone is heard at all Remote Stations.
2. The Station-in-Command LED's are **NOT** lit at any Remote Station.
3. If equipped with a-Display Panel, *"***DP STATION***"* will be displayed at the top of the Panel.

8.8.3 Control Transfer *from* a JS System *to* a Remote Station

When **A7** is set to **00**, any remote station can take control of the clutch and throttle away from the JS system at any time by depressing the transfer button at a remote station that has the Control Head levers in the Neutral/ Idle position.

When **A7** is set to **01**, control of engine and transmission cannot be transferred away from the JS system without first opening the DP Select switch contact to all processors.

To regain JS system command, the DP/ Remote/ Joystick switch MUST be turned to Remote and then returned to Joystick.

8.9 Speed Boost

Speed Boost is a temporary increase in the speed command output signal from the processor. The primary function of Speed Boost is to prevent an engine from stalling when a heavy load is applied. The Speed Boost signal must be properly set and timed and, when used, must be applied responsibly and carefully. Pay particular attention to the Cautions and Notes below.

CAUTION: Misapplication of Speed Boost can damage the transmission or other equipment. Before applying Speed Boost, consult the transmission representative about its use, to discuss any limitations of clutch engagement as a function of engine speed. The person responsible for implementing Speed Boost is the person responsible for making certain it is implemented properly. That person is also responsible for any damage that may occur as a result of the use of Speed Boost.

CAUTION: With a properly set and timed Speed Boost signal, the engine speed should not increase significantly (if at all) during clutch engagement. Engine speed should remain at idle, or slightly above, as the clutch begins to engage, and not rise above idle until after the clutch is fully engaged. Damage to the transmission or other equipment may occur if the Speed Boost signal is not properly set and timed. Adjust the Function Codes as needed to meet this requirement.

NOTE: Speed Boost is NOT required for most applications. Its primary use is with engines that have mechanical governors and where the engine stalls upon clutch engagement or clutch reversal (going from Ahead to Astern or vice versa) typically due to a high gear reduction ratio (4:1 or higher).

NOTE: Speed Boost has been used with some electronic engines where there is a stalling problem due to the engine being unable to respond quickly enough to a sudden load (clutch engagement) especially with boats that have a high gear reduction (typically 4:1 or higher) or to reduce the droop in engine speed (rpm) as clutches engage.

	NOTE: Use of Speed Boost does not guarantee that an engine will not stall. Ultimately, the engine must be capable of producing the power required in the time frame necessary to handle the sudden load of clutch engagement.

8.9.1 Functions

There are four function codes associated with Speed Boost — **F0**, **F1**, **F2**, and **F3**.

8.9.1.1 (F0) Boost Percent

This Function is the percent of throttle to be applied during Speed Boost. (Refer to Figure 8-6: Speed Boost Usage Graph.)

	CAUTION: The range for this function is 0.0 to 20.0%. The range is provided only to allow enough leeway for those rare cases that might need the higher value. In most cases, however, using a value of 20 would very likely cause damage to the transmission.

	NOTE: The value of 0 for F0 means no speed boost is used and the speed command remains at Idle speed (0%) as the clutch is engaged.

The value programmed determines the amount of throttle above idle, which is applied during clutch engagement. This function is the percent of the throttle range. Throttle range is the difference between throttle minimum (function code **E2**) and throttle maximum (function code **E3**).

Boost percent example:

- Throttle minimum = **10.0**
- Throttle maximum = **90.0**
- Throttle range = **90.0 - 10** = **80.0**

If **F0** were set to **1.0**, the amount of boost would be 1% of 80.0, or **0.8**.

The actual applied boost signal would be **10.8** (10.0 + 0.8 = 10.8).

8.9.1.2 (F1) Boost Duration

This Function controls how long the boost is applied. This time starts when the **BOOST START DELAY** has expired. See Figure 8-6: Speed Boost Usage Graph.

A **F1** value of **0.0** is 0 seconds, a value of **2.5** is 2.5 seconds, a value of **5.0** is 5 seconds, etc.

8.9.1.3 (F2) Boost Start Delay

This Function controls how much time elapses after Ahead or Astern clutch engagement has been commanded until Speed Boost is applied. This is an open loop method of applying Speed Boost just before the load hits the engine. (Refer to Figure 8-6: Speed Boost Usage Graph.) This open loop method is the only one available for the premium Processors. Because it has no ability to determine temperature, it is best set to a warm gear so that the fill times are normal.

A **F2** value of **0.0** is 0.0 seconds, a value of **0.1** is 100 milliseconds (one tenth of a second), a value of **0.3** is 300 milliseconds (0.3 seconds), etc.

8.9.1.4 (F3) Boost Bypass Clutch Delay

This function controls whether Speed Boost is applied as a function of the **PROPORTIONAL (REVERSAL) PAUSE TIME (C3)**, instead of every time the clutch is engaged.

For example, if **F3** is set to **01** (1 second), Speed Boost would be applied only if the **PROPORTIONAL (REVERSAL) PAUSE TIME (C3)** is greater than 1 second. A useful application of this function might be when a boat needs a speed boost during a full speed reversal, but not when maneuvering around a dock.

A **F3** value of **00** means 0 seconds, a value of **01** means 1 second, a value of **99** means 99 seconds, etc.

Function Code **C3** is **PROPORTIONAL (REVERSAL) PAUSE TIME** and **C4** is **PROPORTIONAL (REVERSAL) PAUSE RATIO**. If **F3** is set at 5 seconds, **C3** at 8 seconds, and **C4** at the default of 2:1, then Speed Boost will be applied when going from Ahead to Astern any time the **PROPORTIONAL (REVERSAL) PAUSE TIME (C3)** is greater than 5 seconds. However, because **C4** is set to a 2:1 ratio, the **PROPORTIONAL (REVERSAL) PAUSE TIME (C3)** going from Astern to Ahead can be a maximum of 4 seconds (8 seconds divided by 2) and therefore Speed Boost will never be applied when going from Astern to Ahead.

8.9.1.5 Determining Function Codes to be Set

The figure below is a graph of Speed Boost functions. To determine which function codes to set (not all need to be) and the most appropriate values for those functions, a "trial and error" exercise must be performed during sea trials. Typically, the timing of Speed Boost is the most critical function to set, not the amount of Speed Boost.

The four (4) function codes associated with Speed Boost (**F0, F1, F2** and **F3**) work in conjunction with each other to apply the right amount of Speed Boost at the correct time and duration.

No adjustments should be made to Speed Boost until function codes **C2**, **C3,** and **C4** have been properly adjusted.

The primary function of Speed Boost is to prevent an engine from stalling when a heavy load is applied

DO NOT CHANGE THE VALUES OF ANY OF THE SPEED BOOST FUNCTION CODES until you have read the descriptions of their usage and have verified their need.

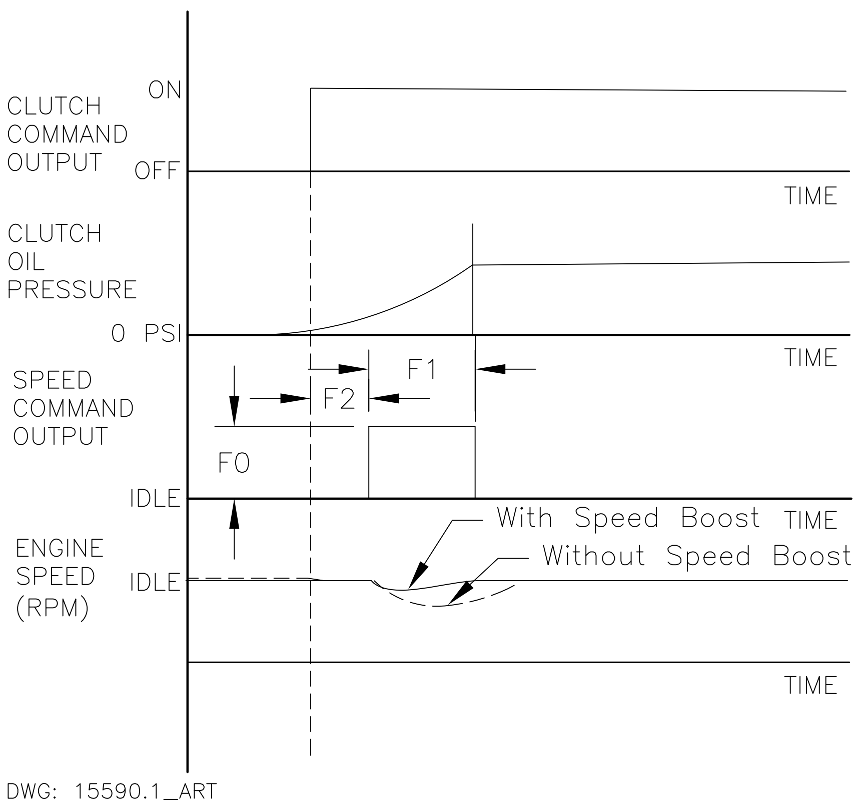


Figure 8-6: Speed Boost Usage Graph

8.9.2 Sea Trial Exercise

If you believe your vessel is a candidate for Speed Boost, you can make a further determination during a Sea Trial by performing the exercises in the following sub-sections. Attempt slow speed reversals initially without Speed Boost and then record the amount of engine droop (how far the engine speed drops below idle). If you determine that Speed Boost is necessary, adjust the function codes based on observations of engine response during slow speed reversals. Attempt a high speed reversal only after adequate testing at slow speeds.

Start by applying **BOOST PERCENT (F0)** and **BOOST DURATION (F1)** in small increments, record the result and work upward from there. For example, for an 1800 RPM engine with Idle set at 600 RPM, try a starting point of 3% or 4% for **BOOST PERCENT (F0)** and a **BOOST DURATION (F1)** of 1 second. If this is unsatisfactory, increase **BOOST DURATION (F1)** to 2 seconds and evaluate those results.

Typically, the timing of Speed Boost is the most critical function to set, not the amount of Speed Boost. You may need to adjust **F2 BOOST START DELAY** to obtain Speed Boost just before the clutches start to transmit significant load to the engine. Again, begin with a small initial value (for example, 200 milliseconds, which is **F2** set to **0.2** seconds).

Observe the engine response when engaging the clutch at slow speed. If the engine speed increases too much during slow speed maneuvering/clutch engagements, use the **F3** function code to link the use of Speed Boost to the **PROPORTIONAL [REVERSAL] PAUSE TIME (C3)** function.

8.9.2.1 Ahead Clutch Engagement

A Take note of the engine RPM at Idle.

B Move the Control Head lever to the Ahead detent while monitoring the engine's tachometer.

C Does the engine RPM drop significantly below the rated droop or, worse yet, stall? If so, Speed Boost may be required.

D If this is a twin screw installation and a significant drop in RPM was witnessed in step C), repeat steps A) through C) on the opposite side. If the same results are experienced, **SPEED BOOST SHOULD BE ATTEMPTED**.

E If the droop on the second engine is insignificant compared to the first, there may be a problem with the engine or the propeller which needs to be addressed. **SPEED BOOST WOULD NOT BE RECOMMENDED AT THIS TIME**.

8.9.2.2 Astern Clutch Engagement

A Take note of the engine RPM at Idle.

B Move the Control Head lever to the Astern detent while monitoring the engine's tachometer.

C Does the engine RPM drop significantly below the rated droop or, worse yet, stall? If so, Speed Boost may be required.

- If this is a twin screw installation and a significant drop in RPM was witnessed in step C), repeat steps A) through C) on the opposite side. If the same results are experienced, **SPEED BOOST SHOULD BE ATTEMPTED**.
- If the droop on the second engine is insignificant compared to the first, there may be a problem with the engine or the propeller which needs to be addressed. **SPEED BOOST WOULD NOT BE RECOMMENDED AT THIS TIME**.

8.9.2.3 Idle Ahead to Idle Astern

A Position the vessel in open water where it can be maneuvered.

B Move one of the Control Head levers into the Ahead detent. In twin screw applications, one lever must remain at Neutral.

C Move the Control Head lever from the Ahead to the Astern detent. Does the engine RPM drop significantly below the rated droop or, worse yet, stall? If so, Speed Boost may be required.

- If this is a twin screw application, repeat steps B) and C) on the opposite side. If significant droop occurs on one side only, there may be a problem with the engine or the propeller which needs to be addressed. **CORRECT THAT PROBLEM BEFORE MAKING A DECISION ABOUT THE USE OF SPEED BOOST**.
- If a significant droop occurred on both sides, **SPEED BOOST MAY BE REQUIRED**.

8.9.2.4 Idle Astern to Idle Ahead

A Position the vessel in open water where it can be maneuvered.

B Move one of the Control Head levers into the Astern detent. In twin screw applications, one lever must remain at Neutral.

C Move the Control Head lever from the Astern to the Ahead detent. Does the engine RPM droop significantly below the rated droop or, worse yet, stall? If so, speed boost may be required.

- If this is a twin screw application, repeat steps B) and C) on the opposite side. If significant droop occurs on one side only, there may be a problem with the engine or the propeller which needs to be addressed. **CORRECT THAT PROBLEM BEFORE MAKING A DECISION ABOUT THE USE OF SPEED BOOST.**
- If significant droop occurred on both sides, **SPEED BOOST MAY BE REQUIRED**.

8.9.2.5 Emergency Reversals

The **REVERSAL PAUSE TIME (C3)** must be properly adjusted prior to determining the need for Speed Boost during emergency reversals.

A Position both Control Head levers (twin screw applications) to Ahead gear and approximately 10% of the speed range.

B Simultaneously move both Control Head levers to approximately 10% of the speed range in Astern.

C A drop of engine RPM below the rated droop would not be unexpected at this time. However, if any of the engines seems about to stall, speed boost should be considered.

D Slowly repeat steps A) through C) in very slight speed increments, with the following considerations in mind:

- Limit the total amount of speed applied in Astern to 20%.
- If at any time the engine stalls or almost stalls, Speed Boost may need to be applied, in conjunction with **C3** and **F3**.

8.10 Station 2 Lockout Switch

This feature prevents any Remote Station from taking command away from Station No. 2, once Station 2 has gained command.

- This feature is defaulted OFF, and therefore must be enabled during set up. Refer to section 5: Set Up Procedures.
- Once enabled, the feature is selectable with a toggle switch.
- The Engine Room/Remote feature can override the Lockout feature.

8.10.1 Switch CLOSED *on* Power-up

- Any Station can take command.
- Once Station No.2 has taken command, no Station can take command away from Station 2. (If the Engine Room Only/Remote switch is enabled and CLOSED also, Station No. 1 is the only Station permitted to take command away from Station No. 2)

8.10.2 Switch CLOSED *after* Power-up

- CLOSING the Lockout Switch will **NOT** automatically transfer command to Station No.2.
- Any Station can take command after CLOSING the Lockout Switch. Once command is transferred to Station No. 2, no other Remote Station can take command away from Station No. 2. (If the Engine Room Only/Remote switch is enabled and CLOSED also, Station No. 1 is the only Station permitted to take command away from Station No. 2)

If this option is going to be used, please contact a ZF Marine Propulsion Systems Miramar Representative for further information.

9 Periodic Checks And Maintenance

The items listed below should be checked on an annual basis, or more frequently where 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.

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.

9.3 CANtrak Display Panel

The Panel requires no maintenance.

- 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.

9.4 DP Interface Enclosure

The Enclosure requires no maintenance.

9.5 DP/JS Interface Enclosure

The Enclosure requires no maintenance.

9.6 Power

- 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 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 ZF Marine Propulsion Systems Miramar 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 System Diagram and become familiar with the various components, their functions and locations on the vessel. The following Sections are a list of the main components that make up a typical system, along with a brief description of their functions:

10.1.1 Control System Examples

10.1.1.1 9510X (X = Zero to Four Pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Servo Throttle and servo Clutch selection,
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

10.1.1.2 9512X (X = Zero to Four Pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Servo Throttle, servo Clutch, and solenoid Troll selection,
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

10.1.1.3 9520X (X = Zero to Four Pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Servo Throttle and solenoid Clutch selection.
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

10.1.1.4 9522X (X = Zero to Four Pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Servo Throttle and solenoid Clutch/Troll selection
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

10.1.1.5 9610X (X = Zero to Four pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Electronic Throttle and servo Clutch selection
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

10.1.1.6 9620X (X = Zero to Five pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Electronic Throttle and solenoid Clutch selection,
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

10.1.1.7 9622X (X = Zero to Four Pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Electronic Throttle and solenoid Clutch/Troll selection,
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

10.1.1.8 96234 (Four Pluggable Remote Stations) Processor

This Processor is designed to precisely control speed and direction on vessels equipped with:

- Electronic Throttle,
- Solenoid Shift
- Autotroll
- Requires ACB Indication and Transfer,
- Requires Dynamic Positioning interface or Joystick interface.

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 and crucial.

- The Processor requires a 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 System requires 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.

In addition, the application may require Harnesses for one or more of the following:

- Engine Interface
- Serial Communication
- Shift Interface
- Shift/Troll Interface
- Tachometer Sensor Signal

- Engine Room/Remote Switch
- Station 2 Lockout Switch

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 on one end to the Processor's cross-bars and the governor and/or transmission selector levers on the other end. The Processor uses the 33C Type push-pull cable as standard, or 43C Type with a special adapter. (Refer to MMC-345 43C Cable Conversion Kit)

There is one Push-Pull cable for Shift, per Processor. These Push-Pull cables are mechanically connected to the Processor's cross-bars on one side and the Transmission selector levers on the other.

There is one Push-Pull cable for Throttle, per Processor. These Push-Pull cables are mechanically connected to the Processor's cross-bars on one side and the Throttle selector levers on the other.

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 Connector Socket Pins
- Mechanical connections at the Selector Levers
- Mechanical connections within the Processor

10.2 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.
    - If the problem occurs on both the Port and Starboard sides, you must ask yourself: What do both sides have in common? Most likely answer to your question would be the DC Power source.

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 (refer to Section 10.5: Audible Tones)

- Slow Repetitive Tone
- One Long- Three Short Tones
- Steady Tone
- Three Second Steady Tone
- Five Seconds On, Five Seconds Off - High Repetitive Rate Tone
- Five Second Steady Tone

The following tones can be produced on all Systems using Servo 1:

- One Long, One Short - High Repetitive Rate Tone
- One Long - One Short Tone

The following tones can be produced on all Systems using Servo 2:

- One Long - Two Short Tones
- 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

The following tone can be produced on all Systems using ABS Transfer Modes:

- 1/2 Second ON, 1/2 Second OFF
- One (1) Second Steady

The following tone can be produced on all Systems using DP and/or Joystick Modes:

- One Long - Three Short Tones

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.

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 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 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 requirements.

10.3.2.3 Engine Room / Remote Switch

This switch is mounted in close proximity to the Engine Room's Control Head.

Refer to Section 3: Plan The Installation for requirements.

10.3.2.4 Station Lockout Switch

The switch is mounted in close proximity to Station No. 2 Control Head.

Refer to Section 3: Plan The Installation for requirements.

10.3.2.5 DP Interface Enclosure

The Enclosure has one DP Pigtail that needs to connect to the Processor's DP-Pigtail. The Enclosure pigtail is 3 feet (0,91m) long and the Processor pigtail is 18 inches (45,7cm).

The Enclosure is 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 requirements.

10.3.2.6 DP/Remote Switch

This switch is mounted in close proximity to the Primary Remote Station.

10.3.2.7 DP/JS Interface Enclosure

The Enclosure has one DP Pigtail that must be connected to the Processor's DP-Pigtail, and one JS Pigtail that must be connected to the Processor's Station 4 Pigtail. The Enclosure pigtails ares 3 feet (0,91m) long and the Processor pigtails are 18 inches (45,7cm).

The Enclosure is 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 requirements.

10.3.2.8 DP/Remote/Joystick Switch

This switch is mounted in close proximity to the Primary Remote Station.

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.

10.3.3.3 Interface Enclosure

Inspect the Enclosure for any signs of physical damage.

10.3.3.4 DP / Remote Switch

Inspect the switch wire terminations for loose or corroded connections.

10.3.3.5 DP / Remote / Joystick Switch

Inspect the switch wire terminations for loose or corroded connections.

10.3.3.6 Engine Room / Remote Switch

Inspect the switch wire terminations for loose or corroded connections.

10.3.3.7 Station 2 Lockout Switch

Inspect the switch wire terminations for loose or corroded connections.

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 10-1: Examples of Components (Internal/External)

Internal	External
Processor Control Head Interconnecting Wiring (Harnesses) Interface Enclosure Switches Push-Pull Cables	DC Power Source Engine Transmission Push-Pull Cables Dynamic Positioning System Joystick System

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 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 (if applicable)
- Servo 1 Feedback A/D's (if applicable)
- 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 10-1: Display Function Code List

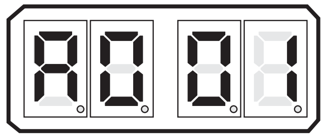


Figure 10-1: Display Function Code List

C Depress the Up or Down Push Button repeatedly until H000 is displayed like Figure 10-2: Display Troubleshooting Function.

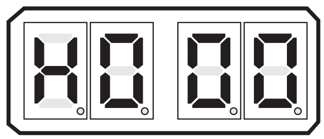


Figure 10-2: Display Troubleshooting Function

D Depress and hold the Left and Right Push Buttons simultaneously until the H0 begins to blink. (Figure 10-3: Display Troubleshooting Function Blinking) Release the Push Buttons; the applied battery voltage will now be displayed:

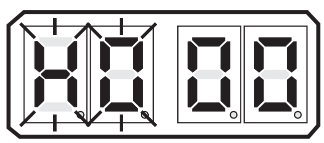


Figure 10-3: Display Troubleshooting Function Blinking

- 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 10-4: Example Display of Applied Battery Voltage

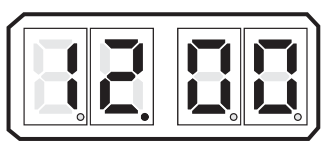


Figure 10-4: Example Display of Applied Battery Voltage

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 10-5: Example Display of Tach Sensor Frequency):

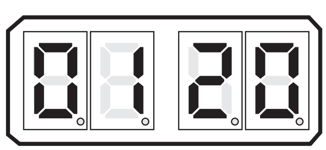
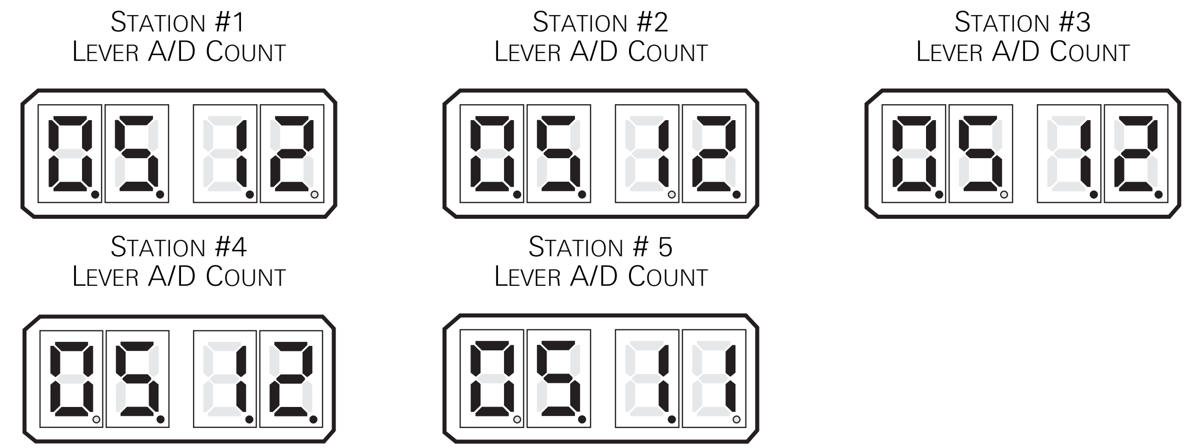


Figure 10-5: Example Display of Tach Sensor Frequency

- 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

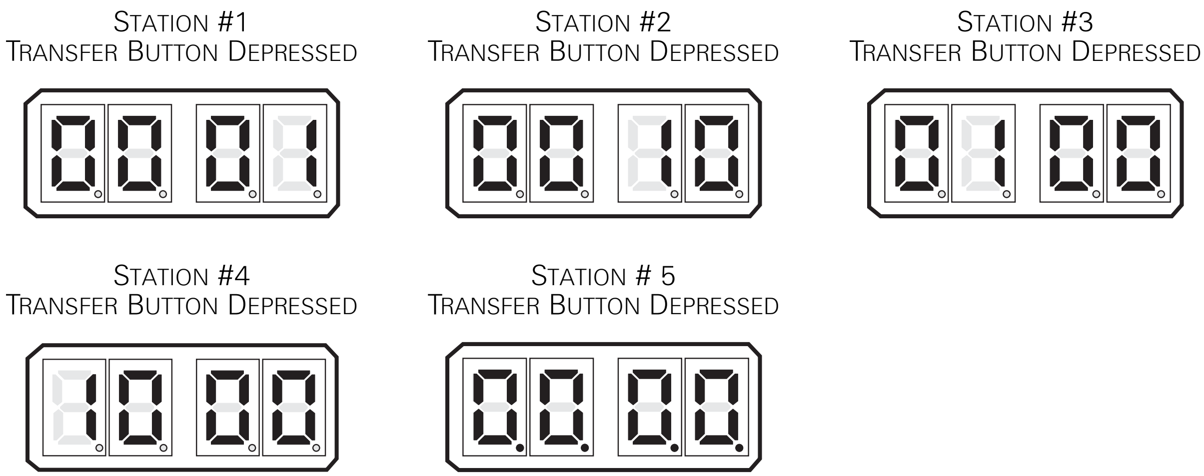
all five Stations with the lever positioned at the Neutral/Idle position. This will be covered in further detail later.

Figure 10-6: 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 10-7: 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.

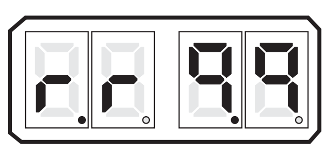


Figure 10-8: Example Display Software Revision Level View

H Pressing the Up or Down (Scroll) Push Button once more, returns you to the Applied Battery Voltage. (Figure 10-4: 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 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, 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, the tone may be an indication of a problem. 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: 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 0.8 VDC 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 (Analog/Digital) Count. More on A/D Counts later. If the command signal drops below 0.6 VDC 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.

The exact cause of the malfunction can be found as follows:

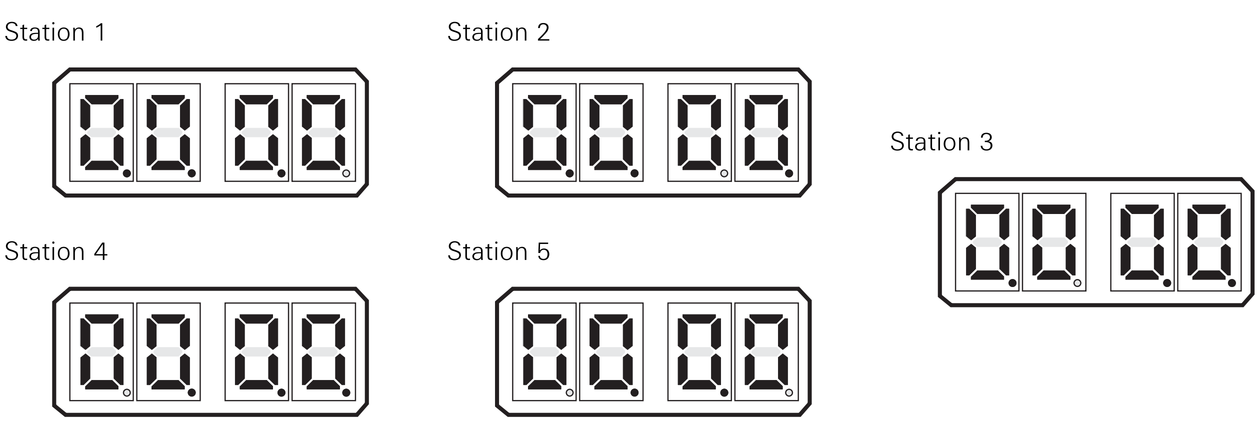
A Check the Processor's Display for error messages. Most likely, one of error messages **13** thru **32** will be shown. The exact number shown depends on which remote station is experiencing the problem and whether the command signal was too high or too low.

B Enter the Diagnostic Menu as outlined in Section 10.4: Diagnostic Menu.

C Depress the Up or Down (Scroll) Push Button until the appropriate Remote Station is displayed.

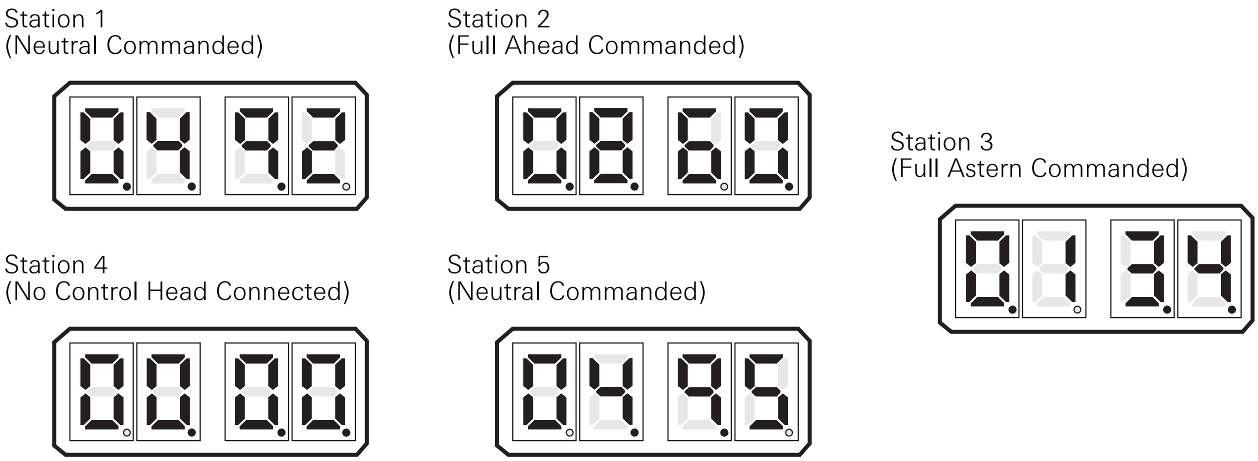
- The Remote Station are identified by the position of the decimal points.
- Station 1 has no decimal point after the first digit to the far right. The remaining three digits all have decimal points.
- If the digit to the far left had no decimal point following it, but the remaining three do, this would represent Station 4.

Figure 10-9: Display Examples of Remote Stations



D The examples in Figure 10-9: 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 10-10: 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.

G If a DP or a DP / Joystick System is being utilized, this tone may also indicate the DP/Joystick command signal is outside of the allowable limits while in control of the ClearCommand System.

- DP / Joystick Ready Signal remains ON

- Audio tone at all Control Heads.
- DP / Joystick Control (LED) Output turns OFF
- Processor commands Neutral/Idle state.

To gain command at the Control Head, ensure the Control Head levers are in the Neutral/ Idle position and depress the transfer button. This will regain command of the gear box and throttle with the ClearCommand System.

To regain command by the DP System, follow the instructions on how to transfer command from a Remote Station to DP System (Section 8.5: Dynamic Positioning (DP) Mode).

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 Clutch Solenoid Control System Tones

10.5.2.1 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

10.5.3 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 following reasons:
    - The orange wire (ground) between the potentiometer and plug are not making contact, or have a high resistance contact.
    - The potentiometer is out of calibration.
    - 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:
    - The green (signal) or orange (reference voltage) wires between the potentiometer and plug are not making contact or have a high resistance contact.
    - The potentiometer is out of calibration.
    - The potentiometer is defective.
    - 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 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 Servo 1 Control System Tones

10.5.4.1 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 following reasons:
    - The orange wire (ground) between the potentiometer and plug are not making contact, or have a high resistance contact.
    - The potentiometer is out of calibration.
    - 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:
    - The green (signal) or orange (reference voltage) wires between the potentiometer and plug are not making contact or have a high resistance contact.
    - The potentiometer is out of calibration.
    - The potentiometer is defective.
    - 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.

10.5.4.2 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.

10.6 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 10-2: 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: 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 10-2: Control Head Lever A/D Counts

Control Head Lever Position	A/D Count
Lever Out of Range Low	100
Full Astern	153 - 173
Neutral/ Idle	485 - 505

Table 10-2: Control Head Lever A/D Counts

Control Head Lever Position	A/D Count
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 10-11: Display Station A/D’s No Station Transfer Button Depressed.

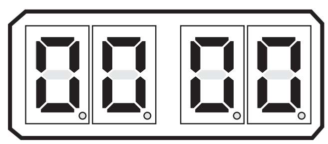


Figure 10-11: Display Station A/D’s No Station Transfer Button Depressed

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 10-12: 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 10-13: Display Station A/D/s Transfer Button Depressed for Station 5

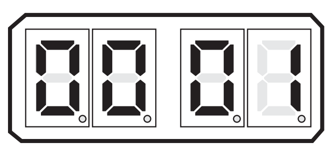


Figure 10-12: Example Display Station A/D’s Transfer Button Depressed for Stations 1 - 4

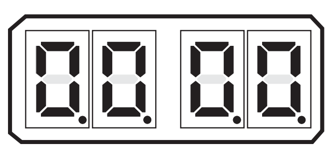


Figure 10-13: Display Station A/D/s Transfer Button Depressed for Station 5

- 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 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.

10.7.1 Engine Room/Remote Switch

A defective (open) switch will prevent the transfer of command on one side (port or starboard) only, while command is transferred to the Engine Room Station on the other side (split control). A switch with a shorted contact will prevent any station, other than Station 1 from taking command on one side.

A suspected faulty switch can be verified by following the steps below:

A Turn the Engine Room/ Remote 'OFF' (open contact).

B Measure the DC voltage across the switch contact.

- If 5.00 ± 0.2 VDC is measured, continue with step C).
- If approximately 0 VDC is measured, skip ahead to step F).

C Turn the Engine Room/ Remote Switch 'ON' (closed contact).

D Measure the DC voltage across the switch contact.

- If 5.00 ± 0.2 VDC is measured, the switch is defective and must be replaced.
- If approximately 0 VDC is measured, continue with step E).

E At the Processor, scroll down to Function Code **A5** and ensure a value of **01** or **03** is entered.

- If **A5** is not set to **01** or **03**, it must be changed.
- If **A5** is set to **01** or **03**, the Processor is defective and must be replaced.

F If 0 VDC was measured in step B), measure the DC voltage at TB10, pins 1 and 2 on the Processor's circuit board.

- If 5.00 ± 0.2 VDC is measured, the cable between the switch and the Processor has an open conductor or is not terminated properly.
- If approximately 0 VDC is measured, continue with step G).

G Disconnect the two conductors from TB10, pins 1 and 2.

H Measure the DC voltage across TB10, pins 1 and 2.

- If approximately 0 VDC is measured, the Processor is defective and must be replaced.
- If 5.00 ± 0.2 VDC is measured, continue with step I).

I Disconnect the two conductors from the switch contact.

J Measure the resistance across the switch contact.

- If infinite resistance is measured, the switch is good and the cable’s conductors are short circuited and must be replaced.
- If approximately 0 Ohms is measured, the switch is defective and must be replaced.

10.7.2 Station 2 Lockout Switch

If the switch itself failed, the failure would be either and OPEN contact (will not CLOSE) or a CLOSED contact (will not OPEN).

If the switch were to fail in a manner where the contact will not CLOSE, the system would not prevent a Remote Station from taking command on one side.

If the switch were to fail in a CLOSED manner, no station would be able to take command away from Station 2, other than Station 1.

A suspected faulty switch can be verified as follows:

A Turn the Station 2 Lockout Switch ‘OFF’ (OPEN contact).

B Measure the DC voltage across the switch contact.

- If 5.00 ± 0.2 VDC is measured, continue with step C).
- If approximately 0 VDC is measured, skip ahead to step F).

C Turn the Station 2 Lockout Switch ‘On’ (closed contact).

D Measure the DC voltage across the switch contact.

- If 5.00 ± 0.2 VDC is measured, the switch is defective and must be replaced.
- If approximately 0 VDC is measured, continue with step E).

E At the Processor, scroll down to Function Code A5 and ensure a value of 01 or 03 is entered.

- If A5 is not set to 02 or 03, it must be changed.
- If A5 is set to 02 or 03, the Processor is defective and must be replaced.

F If 0 VDC was measured in step B), measure the DC voltage at TB10, pins 3 and 4 on the Processor’s circuit board.

- If 5.00 ± 0.2 VDC is measured, the cable between the switch and the Processor has an open conductor or is not terminated properly.
- If approximately 0 VDC is measured, continue with step G).

G Disconnect the two conductors from TB10, pins 3 and 4.

H Measure the DC voltage across TB10, pins 3 and 4.

- If approximately 0 VDC is measured, the Processor is defective and must be replaced.
- If 5.00 ± 0.2 VDC is measured, continue with step I).

I Disconnect the two conductors from the switch contact.

J Measure the resistance across the switch contact.

- If infinite resistance is measured, the switch is good and the cable’s conductors are short circuited and must be replaced.
- If approximately 0 Ohms is measured, the switch is defective and must be replaced.

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 10-3: 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 10-4: 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.
10	Troll Command Open	The Troll Proportional Solenoid should be drawing current but is not.

10.8.3 Basic Control System Error Codes

Table 10-5: 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.

Table 10-5: Basic Control System Error Codes

Error No.	Title	Description
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.
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.

Table 10-5: Basic Control System Error Codes

Error No.	Title	Description
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.

Table 10-5: Basic Control System Error Codes

Error No.	Title	Description
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.
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 10-6: 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 10-7: 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 Solenoid Clutch Problem Causes and Solutions

Table 10-8: Solenoid Clutch Problem Causes and Solutions

Error No.	Causes		Solutions	
1	a.	The Astern Clutch Solenoid is defective.	a.	Replace the Astern Clutch Solenoid.
	b.	The Clutch Harness is incorrectly wired at the Gear Box.	b.	Properly connect the Clutch Harness to the Astern Solenoid.
2	a.	The Astern Clutch Solenoid circuit is Open.	a.	Properly connect the Astern Clutch Solenoid.
	b.	The Astern Clutch Solenoid is defective.	b.	Replace the Astern Clutch Solenoid.
3	a.	The Neutral Solenoid is defective.	a.	Replace the Neutral Solenoid.
	b.	The Neutral Solenoid is incorrectly wired at the Gear Box.	b.	Properly connect the Neutral Solenoid.
4	a.	The Neutral Solenoid circuit is Open.	a.	Properly connect the Neutral Solenoid.
	b.	The Neutral Solenoid is defective.	b.	Replace the Neutral Solenoid.
5	a.	The Ahead Clutch Solenoid Circuit is incorrectly wired at the Gear Box.	a.	Properly connect the Ahead Clutch Solenoid.
	b.	The Ahead Clutch Solenoid is defective.	b.	Replace the Ahead Clutch Solenoid.
6	a.	The Ahead Clutch Solenoid Circuit is Open.	a.	Properly connect the Ahead Clutch Solenoid.
	b.	The Ahead Clutch Solenoid is defective.	b.	Replace the Ahead Clutch Solenoid.

10.9.2 Solenoid Troll Problem Causes and Solutions

Table 10-9: Solenoid Troll Problem Causes and Solutions

Error No.	Causes		Solutions	
7	a.	The Troll On/ Off Solenoid is defective.	a.	Properly connect the Troll On/ Off Solenoid.
	b.	The Troll On/ Off Solenoid is incorrectly wired at the Gear Box.	b.	Replace the Troll On/ Off Solenoid.
8	a.	The Troll On/ Off Solenoid circuit is Open.	a.	Properly connect the Troll On/ Off Solenoid.
	b.	The Troll On/ Off Solenoid is defective.	b.	Replace the Troll On/ Off Solenoid.
9	a.	The Troll Command Solenoid is defective.	a.	Properly connect the Troll Command Solenoid.
	b.	The Troll Command Solenoid is incorrectly wired at the Gear Box.	b.	Replace the Troll Command Solenoid.
10	a.	The Troll On/ Off Solenoid circuit is Open.	a.	Properly connect the Troll On/ Off Solenoid.
	b.	The Troll On/ Off Solenoid is defective.	b.	Replace the Troll On/ Off Solenoid.

10.9.3 Basic Control System Problem Causes and Solutions

Table 10-10: 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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
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.
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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
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 10-10: 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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
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.
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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
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.
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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
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.
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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
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.
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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.		Causes		Solutions
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.
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.

Table 10-10: Basic Control System Problem Causes and Solutions

Error No.	Causes		Solutions	
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 10-10: 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.

10.9.4 Servo 1 Clutch Problem Causes and Solutions

Table 10-11: Servo 1 Clutch 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.

10.9.5 Servo 1 Troll Problem Causes and Solutions

Table 10-12: Servo 1 Troll 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.
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.

10.9.6 Servo 2 Throttle Problem Causes and Solutions

Table 10-13: Servo 2 Throttle 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.

10.9.7 Servo 2 Troll Problem Causes and Solutions

Table 10-14: 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.

Table 10-15: Basic Control System Problems Without Error Codes (Symptom: A)

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.

Table 10-16: Basic Control System Problems Without Error Codes (Symptom: B)

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**.**

Table 10-17: Basic Control System Problems Without Error Codes (Symptom: C)

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.

Table 10-17: Basic Control System Problems Without Error Codes (Symptom: C)

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.

Table 10-18: Basic Control System Problems Without Error Codes (Symptom: D)

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.

Table 10-19: Basic Control System Problems Without Error Codes (Symptom: E)

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: Set Up Procedures.
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: Set Up Procedures.

10.10.2 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.

Table 10-20: Solenoid Clutch Control System Problems Without Error Codes (Symptom: A)

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.

10.10.3 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.

Table 10-21: Servo Clutch Control System Problems Without Error Codes (Symptom: A)

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.

10.10.4 Electronic Throttle Control System Problems Without Error Codes

A **SYMPTOM:** The engine RPM's vary, without moving the Control Head lever (synchronization disabled).

Table 10-22: Electronic Throttle Control System Problems Without Error Codes (Symptom: A)

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.

Table 10-23: Electronic Throttle Control System Problems Without Error Codes (Symptom: B)

Cause		Remedy	
a.	Function Code **E2** Throttle Minimum is incorrectly set.	a.	Adjust Throttle Minimum as specified in Section 5: Set Up Procedures.
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.

10.10.5 Servo Throttle Problems Without Error Codes

A **SYMPTOM:** The engine RPM's vary, without moving the Control Head lever (synchronization disabled)..

Table 10-24: Servo Throttle Problems Without Error Codes (Symptom: A)

Cause		Remedy	
a.	Problem with the Governor or Carburetor.	a.	Observe the Throttle push-pull cable. If variations are seen, proceed to Step b.
b.	Erratic Command Signal.	b.	Refer to Command Signal testing in Section 10.5: Audible Tones. 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.

Table 10-25: Servo Throttle Problems Without Error Codes (Symptom: B)

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: Set Up Procedures.
b.	Function Code E2 Throttle Minimum is incorrectly set.	b.	Adjust Throttle Minimum as specified in Section 5: Set Up Procedures.
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.

10.10.6 DP Problems Without Error Codes

A **SYMPTOM:** DP System will not take command.

Table 10-26: DP Problems Without Error Codes (Symptom: A)

Cause		Remedy	
a.	DP ON/OFF Switch not CLOSING.	a.	Check for proper connections. If connected properly, replace the DP ON/OFF Switch.
b.	Defective DP Interface Enclosure	b.	Check for proper connections. If connected properly, replace the DP Interface Enclosure

10.10.7 DP/JS Problems Without Error Codes

A **SYMPTOM:** DP/JS System will not take command..

Table 10-27: DP/JS Problems Without Error Codes (Symptom: A)

Cause		Remedy	
a.	DP/JS 3-Position Switch not CLOSING.	a.	Check for proper connections. If connected properly, replace the Switch.
b.	Defective DP/JS Interface Enclosure	b.	Check for proper connections. If connected properly, replace the DP/JS Interface Enclosure

10.10.8 Engine Room/Remote Switch Problems Without Error Codes

A **SYMPTOM:** Command of only one side (Port or Starboard) is transferred to Engine Room Station...

Table 10-28: Engine Room/Remote Switch Problems Without Error Codes (Symptom: A)

Cause		Remedy	
a.	Suspected Faulty Switch	a.	Perform the Testing Steps in Section 10.6: Station Transfer to determine remedy.

10.10.9 Station 2 Lockout Switch Problems Without Error Codes

A **SYMPTOM:** The Lockout Switch has failed to OPEN or CLOSE..

Table 10-29: Station 2 Lockout Switch Problems Without Error Codes (Symptom: A)

Cause		Remedy	
a.	Faulty Lockout Switch	a.	Perform the Testing Steps in Section 10.6: Station Transfer to determine remedy.

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

Table 10-30: Basic Equal Throttle Synchronization Troubleshooting (Symptom: A)

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

Table 10-31: Servo Clutch Equal Synchronization Troubleshooting (Symptom: A)

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.

Table 10-32: Servo Throttle Equal Synchronization Troubleshooting (Symptom: A)

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.

Table 10-33: Servo Throttle Equal Synchronization Troubleshooting (Symptom: B)

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..

Table 10-34: Servo Throttle Equal Synchronization Troubleshooting (Symptom: C)

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.

Table 10-35: Basic Active Synchronization Troubleshooting (Symptom: A)

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.

Table 10-36: Basic Active Synchronization Troubleshooting (Symptom: B)

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.

Table 10-37: Servo Throttle Active Synchronization Troubleshooting (Symptom: A)

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 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.

Table 10-38: Electronic Throttle - Equal Throttle Synch Problem Causes and Solutions (Symptom: A)

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

Table 10-39: Electronic Throttle - Equal Throttle Synch Problem Causes and Solutions (Symptom: B)

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.

Table 10-40: Electronic Throttle - Equal Throttle Synch Problem Causes and Solutions (Symptom: C)

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.

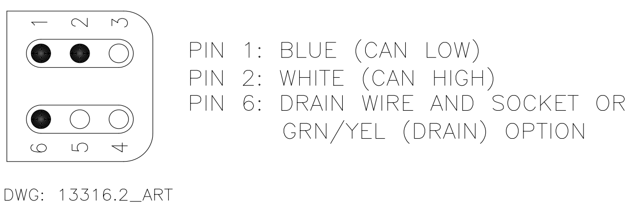
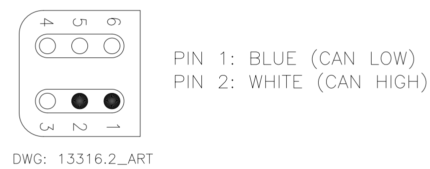
10.12 Wire Harnesses

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 10-41: Wire Harness - Serial Communication (p/n 13316-XX)

Termination A	Termination B
	

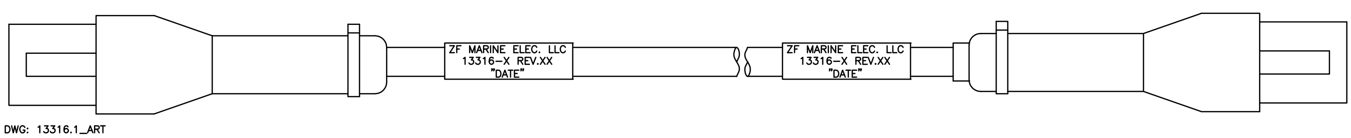
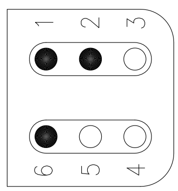


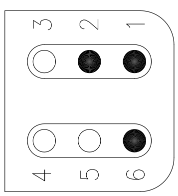
Table 10-42: Wire Harness - Serial Communication Multi-Screw (p/n 15544-XX)

Termination A



PIN 1: BLUE (CAN LOW)
PIN 2: WHITE (CAN HIGH)
PIN 6: DRAIN WIRE (SHIELD)

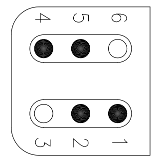
DWG: 15544.2_ART



PIN 1: BLUE (CAN LOW)
PIN 2: WHITE (CAN HIGH)
PIN 6: DRAIN WIRE (SHIELD)

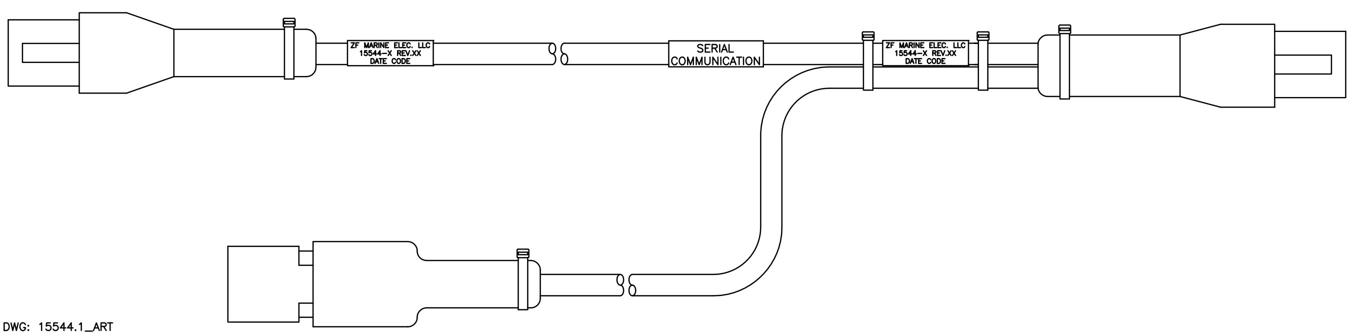
DWG: 15544.3_ART

Termination B



CABLE 1 – PIN 1: BLUE (CAN LOW)
CABLE 1 – PIN 2: WHITE (CAN HIGH)
CABLE 2 – PIN 5: BLUE (CAN LOW)
CABLE 2 – PIN 4: WHITE (CAN HIGH)

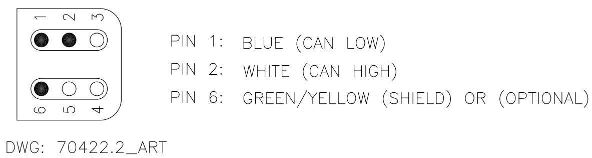
DWG: 15544.4_ART

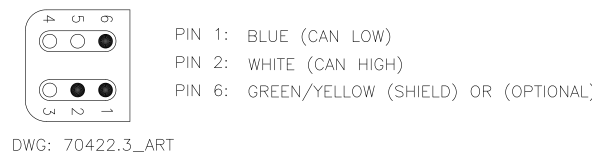


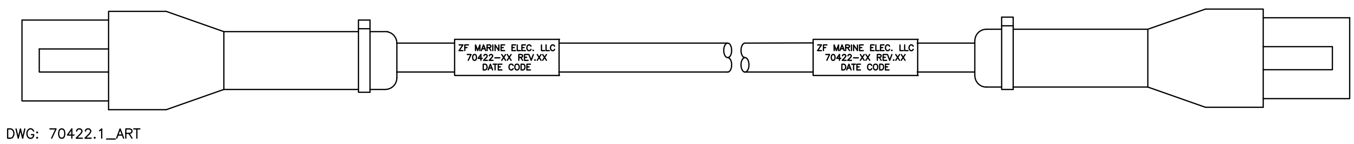
DWG: 15544.1_ART

Table 10-43: Wire Harness - Serial Communication / CANtrak (p/n 70422-XX)

Termination A	Termination B



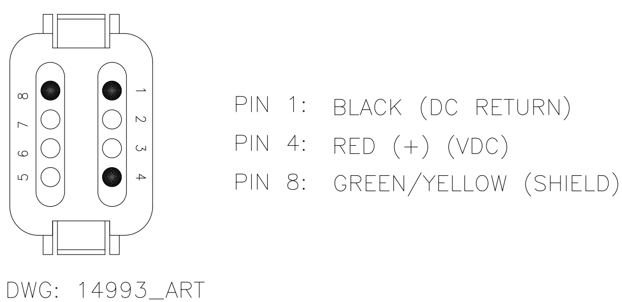




10.12.1.2 Throttle Wire Harnesses

Table 10-44: Wire Harness - Throttle, Voltage (IVECO, Cummins) (p/n 13432-XX)

Termination A	Termination B



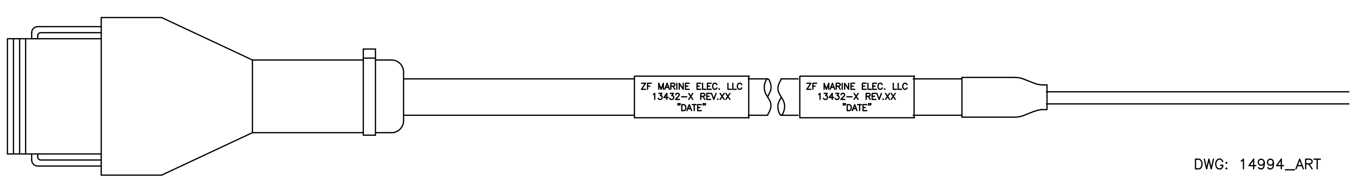
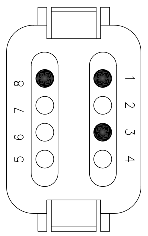


Table 10-45: Wire Harness- Throttle, Current (MAN, MTU) (p/n 13494-XX)

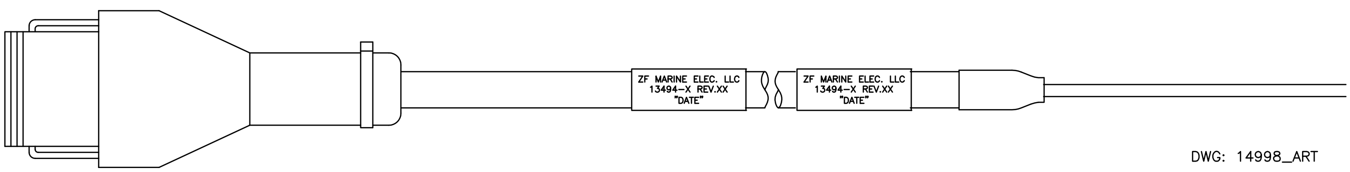
Termination A

Termination B



PIN 1: BLACK (DC RETURN)
PIN 3: RED (+ mA)
PIN 8: GREEN/YELLOW (SHIELD)

DWG: 14997_ART

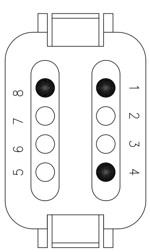


DWG: 14998_ART

Table 10-46: Wire Harness - Throttle, Voltage (Cummins Plug), (p/n 13565-XX)

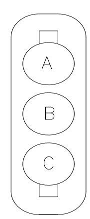
Termination A

Termination B



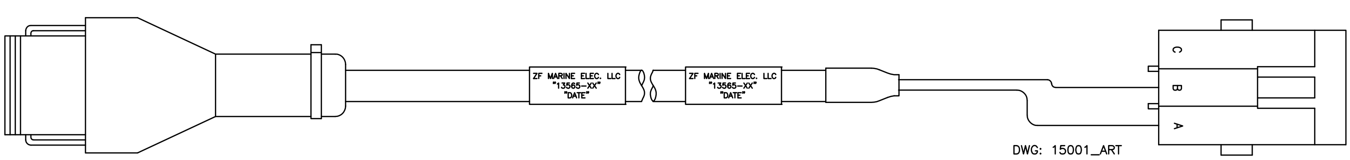
PIN 1: BLACK (DC RETURN)
PIN 4: RED (+ VDC)
PIN 8: GREEN/YELLOW (SHIELD)

DWG: 14999_ART



PIN A: BLACK (DC RETURN)
PIN B: RED (+ VDC)

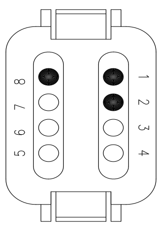
DWG: 15000_ART



DWG: 15001_ART

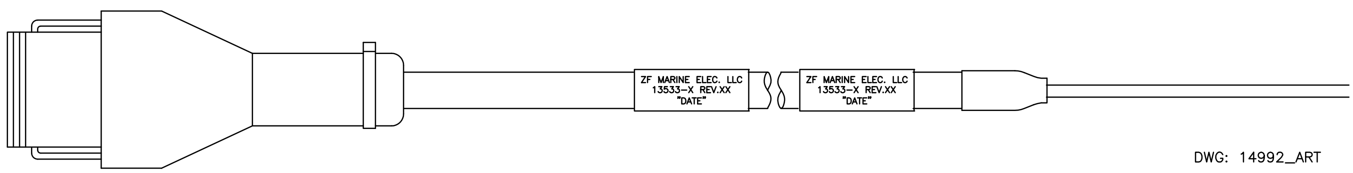
Table 10-47: Wire Harness - Throttle (Pulse width modulation [PWM]), (p/n 13533-XX)

Termination A | **Termination B**



PIN 1: BLACK (DC RETURN)
PIN 2: RED (+ ECM)
PIN 8: GREEN/YELLOW (SHIELD)

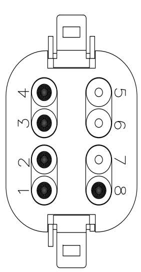
DWG: 14991_ART



DWG: 14992_ART

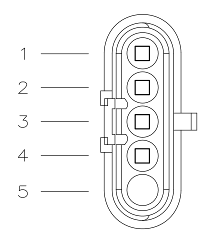
Table 10-48: Voltage Throttle Harness Pin-Out (p/n 71262-XX)

Termination A | **Termination B**



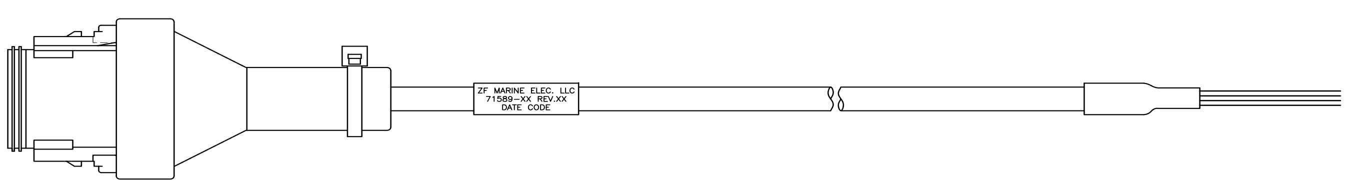
PIN 1: GREEN (– ISOLATED RETURN)
PIN 2: WHITE (+ THROTTLE V OUT 2)
PIN 3: BLACK (– ISOLATED RETURN)
PIN 4: RED (+ THROTTLE V OUT 1)
PIN 8: SHIELD

DWG: 71262.2_ART



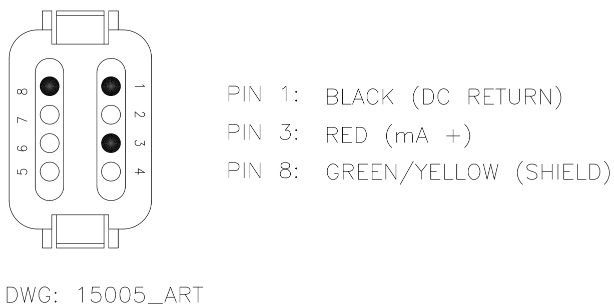
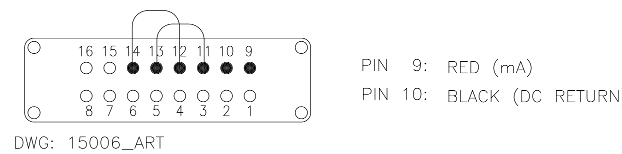
DWG: 71262.3_ART

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: 71262.1_ART

Table 10-49: Cable, throttle, man Edc (p/n 14421-XX)

Termination A	Termination B
	

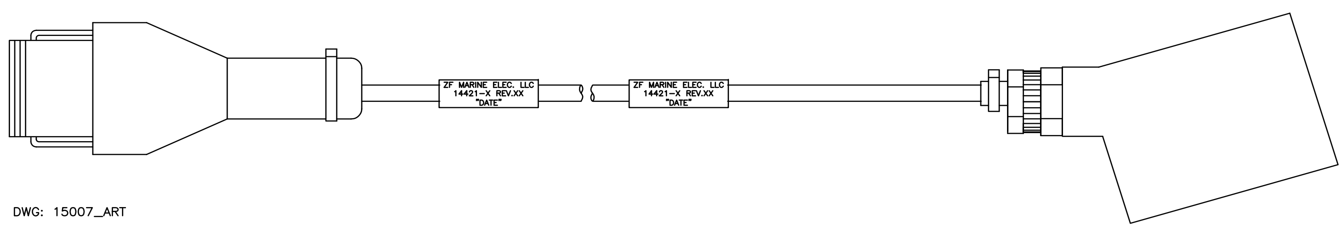
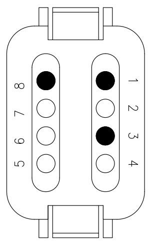


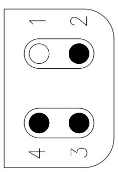
Table 10-50: Wire Harness - Throttle Current w/ Mag Pickup, Man (Non-Common Rail) (p/n 14363-XX)

Termination A



PIN 1: BLACK
PIN 3: RED
PIN 8: GREEN/YELLOW (SHIELD)

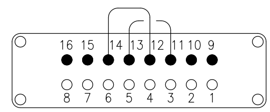
DWG: 14363.2_ART



PIN 2: RED
PIN 3: BLACK
PIN 4: GREEN/YELLOW (SHIELD)

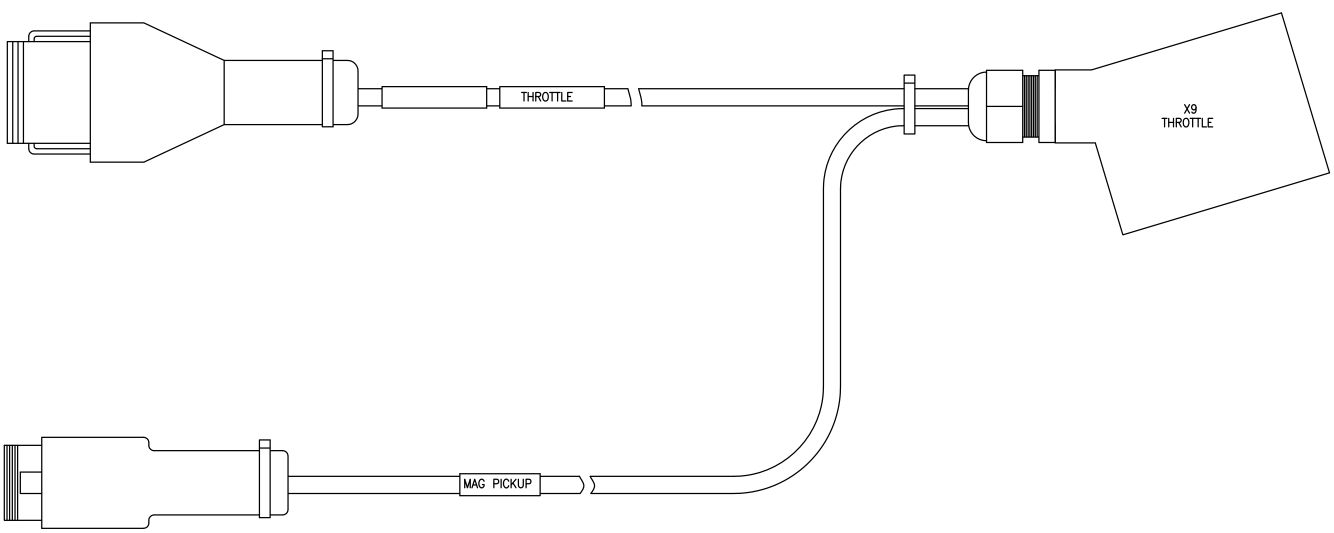
DWG: 14363.4_ART

Termination B



DWG: 14363.3_ART

PIN 9: RED (THROTTLE)
PIN 10: BLACK
PIN 11: JUMPER (P/N: 1557-2) TO PIN 13.
PIN 12: JUMPER (P/N: 1557-2) TO PIN 14.
PIN 13: JUMPER TO PIN 11
PIN 14: JUMPER TO PIN 12
PIN 15: BLACK (MAG PICKUP)
PIN 16: RED (MAG PICKUP)

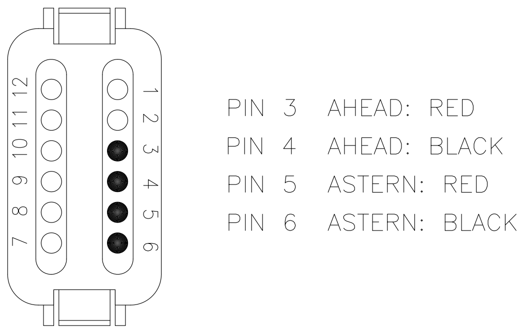


DWG: 14363.1_ART

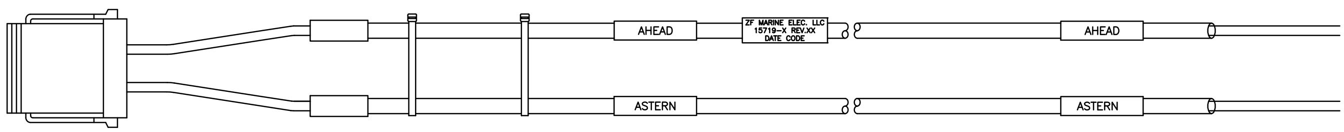
10.12.1.3 Clutch Wire Harnesses

Table 10-51: Wire Harness - Clutch, Ahead, Astern (p/n 15719-XX)

Termination A	Termination B



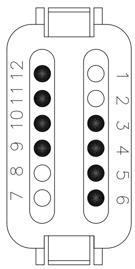
DWG: 15719.2_ART



DWG: 15719.1_ART

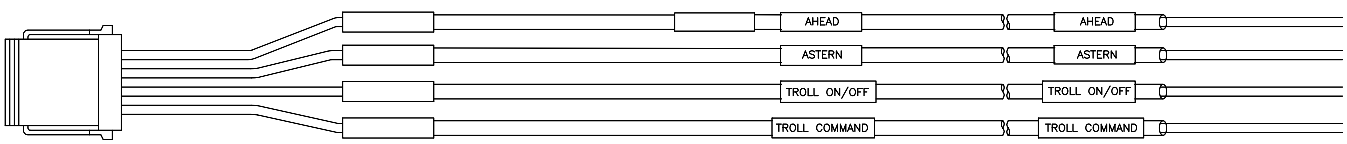
Table 10-52: Wire Harness - Ahead / Astern Troll on/off Command (p/n 15725-XX)

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)

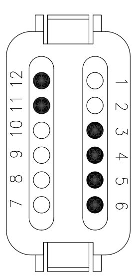
DWG: 15021_ART



DWG: 15022_ART

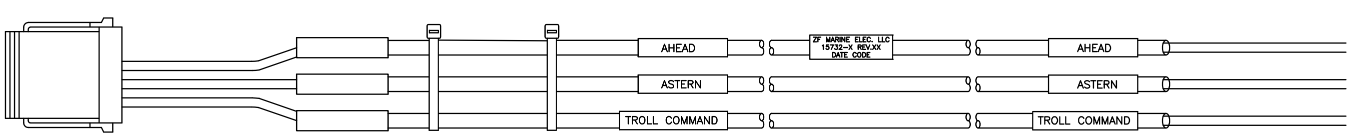
Table 10-53: Wire Harness - Clutch with Troll Command (p/n 15732-XX)

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)

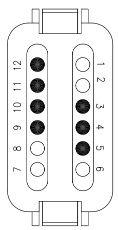
DWG: 15019_ART



DWG: 15020_ART

Table 10-54: Wire Harness- Clutch, Ahead, Astern, Troll Command, Troll On-Off (p/n 70390-XX)

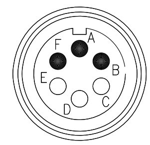
Termination A



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)

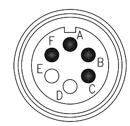
DWG: 70390.2_ART

Termination B



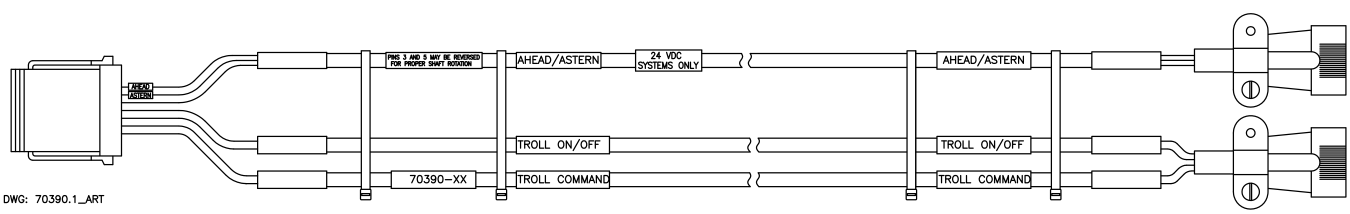
PIN A: RED (+) (CABLE #1 AHEAD)
PIN B: WHITE (+) (CABLE #1 ASTERN)
PIN F: BLACK (–) (CABLE #1 AHEAD)

DWG: 70390.3_ART



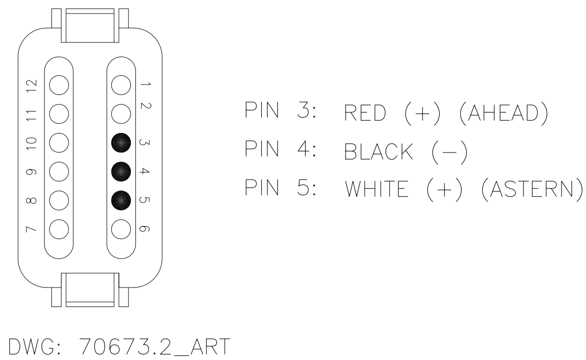
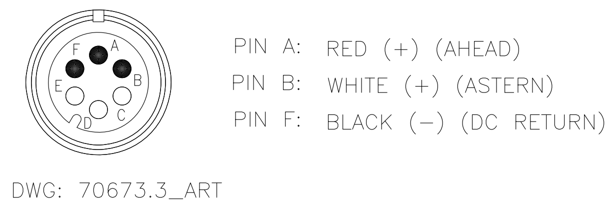
PIN A: RED (+) (CABLE #3 TROLL COMMAND)
PIN B: RED (+) (CABLE #2 TROLL ON/OFF)
PIN C: BLACK (–) (CABLE #2 TROLL ON/OFF)
PIN F: BLACK (–) (CABLE #3 TROLL COMMAND)

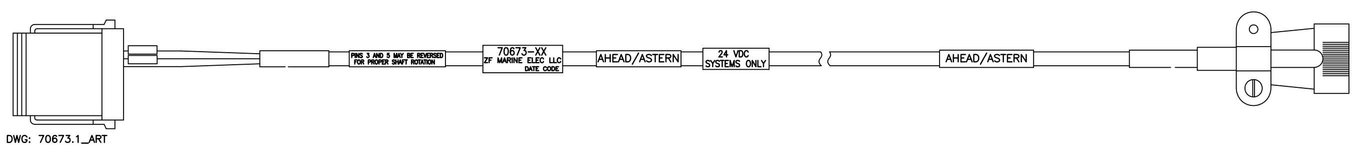
DWG: 70390.4_ART



DWG: 70390.1_ART

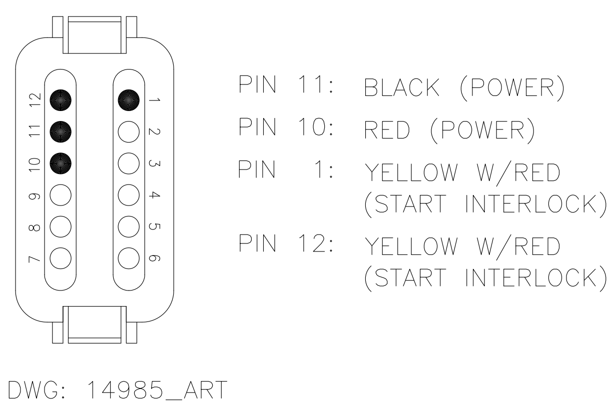
Table 10-55: Wire Harness- Clutch, Ahead, Astern, ZFF Transmission (p/n 70673-XX)

Termination A	Termination B
	



10.12.1.4 Power Wire Harnesses

Table 10-56: Power, Start Interlock Harness Pin-Out **(p/n 13756-XX)**

Termination A	Termination B
	

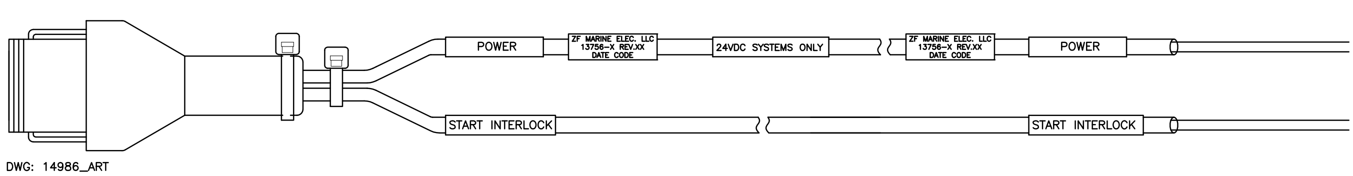
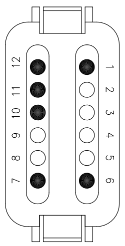


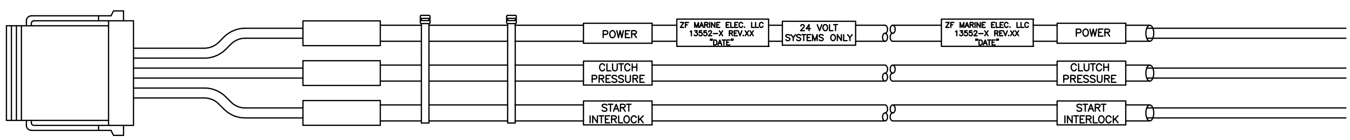
Table 10-57: Wire Harness - Power, Start Interlock & Clutch Pressure Switch (p/n 13552-XX)

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)

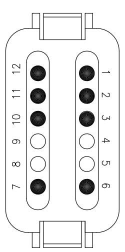
DWG: 14987_ART



DWG: 14988_ART

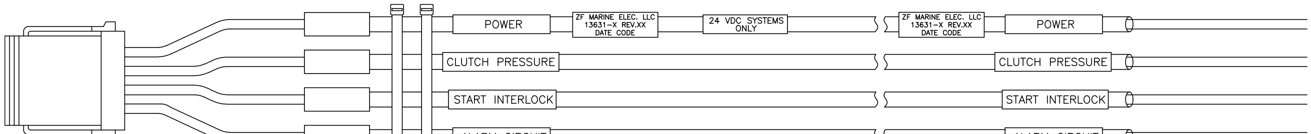
Table 10-58: Wire Harness - Power, Start Interlock, Clutch Pressure Switch & Alarm (p/n 13631-XX)

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)

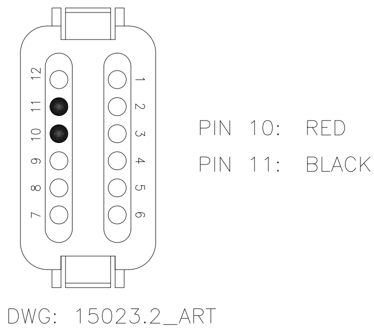
DWG: 14989_ART



DWG: 14990

Table 10-59: Wire Harness- Power Use W/existing St Intlk Only (p/n 15023-XX)

Termination A	Termination B



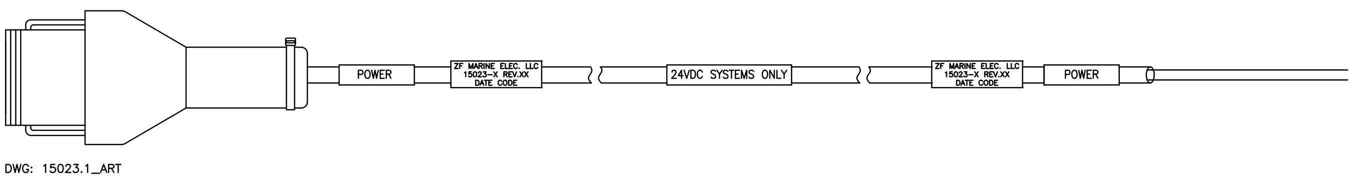
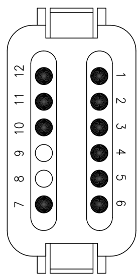


Table 10-60: Wire Harness- Power, Start Interlock, Pressure Switch, Alarm and Backup (p/n 71476-XX)

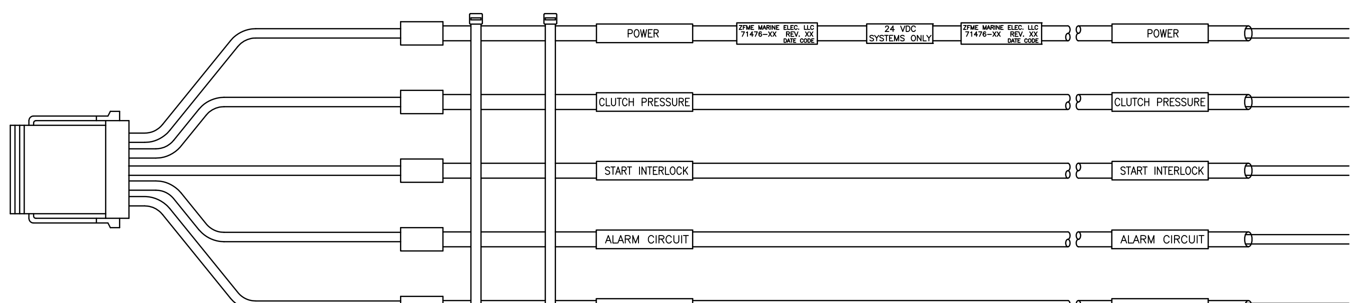
Termination A

Termination B



PIN 1: YELLOW W/RED STRIPE – START INTERLOCK
PIN 2: RED (+) – ALARM
PIN 3: BLK (–) – CIRCUIT
PIN 4: BROWN – BACKUP
PIN 5: BROWN – BACKUP
PIN 6: LIGHT BLUE – CLUTCH PRESSURE
PIN 7: LIGHT BLUE – CLUTCH PRESSURE
PIN 8:
PIN 9:
PIN 10: RED (+) – POWER
PIN 11: BLK (–) – POWER
PIN 12: YELLOW W/RED STRIPE – START INTERLOCK

DWG: 71476.2_ART

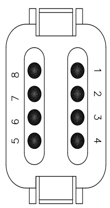


DWG: 71476.1_ART

10.12.1.5 Control Head Wire Harnesses

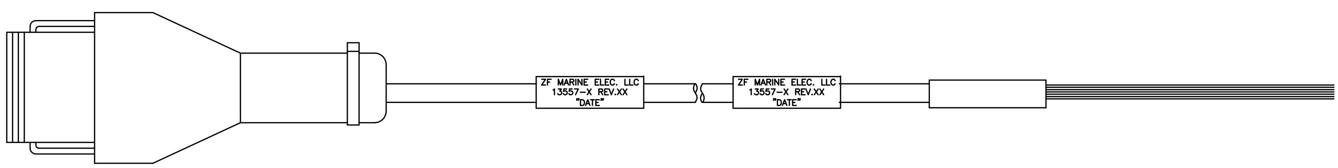
Table 10-61: Wire Harness - Control Head One Connector (p/n 13557-XX)

Termination A | **Termination B**



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 (+)

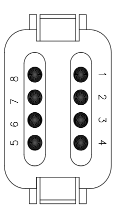
DWG: 13557.2_ART



DWG: 13557.1_ART

Table 10-62: Wire Harness - Control Head Two Connectors (p/n 14261-XX)

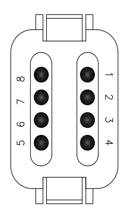
Termination A



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 (+)

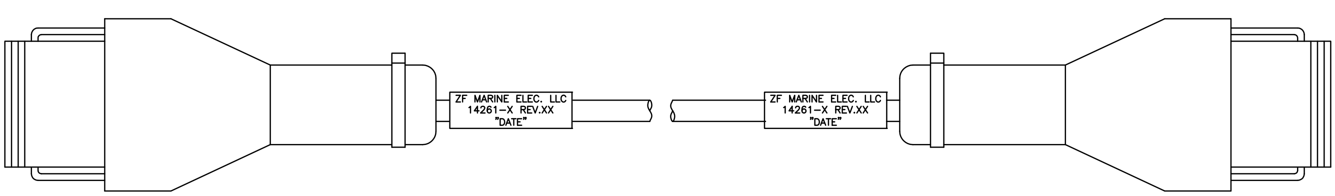
DWG: 14261.2_ART

Termination B



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: 14261.2_ART



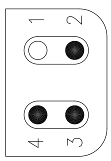
DWG: 14261.1_ART

NOTE: (P/N 14261) Starboard Side of Control Head - Jumper Pins 3 to 5;
Port Side of Control Head - Jumper Pins 3 to 7

10.12.1.6 Tachometer Wire Harnesses

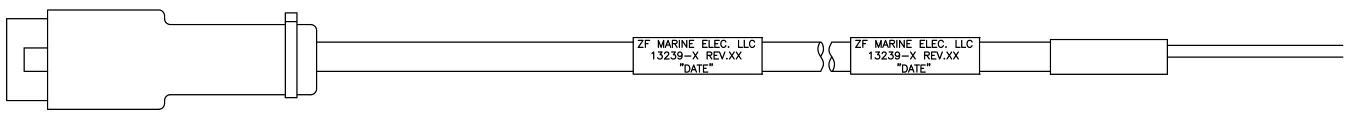
Table 10-63: Wire Harness- Tach Sensor (p/n 13239-XX)

Termination A | **Termination B**



PIN 2: RED
PIN 3: BLACK
PIN 4: GREEN/YELLOW (SHIELD)
OR
OPTION SHIELD AND SOCKET

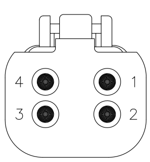
DWG: 13239.2_ART



DWG: 13239.1_ART

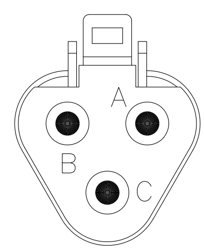
Table 10-64: Wire Harness- Tach Sensor with 3 pin plug (p/n 13334-XX)

Termination A | **Termination B**



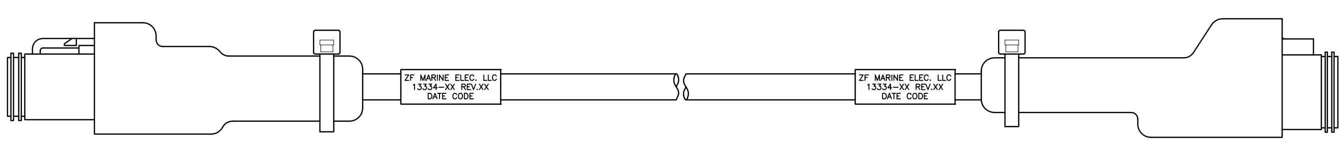
PIN 1: RED
PIN 2: GREEN
PIN 3: BLACK
PIN 4: GREEN/YELLOW (SHIELD)

DWG: 13334.2_ART



PIN A: RED
PIN B: GREEN
PIN C: BLACK

DWG: 13334.3_ART



DWG: 13334.1_ART

10.13 Processor Pigtails

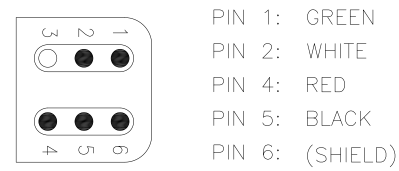
The number and types of Pigtails used varies with the different Processors and their configurations. The basic off-the-shelf Processors are available with no Pigtails (hard-wired) or pre-wired for up to a total of eight Pigtails when all five Remote Stations are being used.

The following Tables describe the pin outs and functions of the conductors within the various Pigtails.

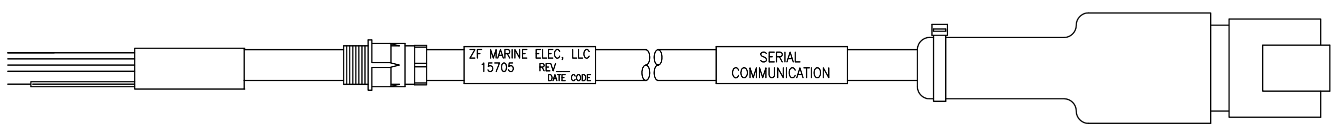
10.13.1 Basic Processor Pigtails

10.13.1.1 Serial Wire Harnesses Processor Pigtails

Table 10-65: Wire Harness - Serial Communication, Processor Lead (p/n 15705-XX)

Termination A	Termination B
	

DWG: 15705.2_ART



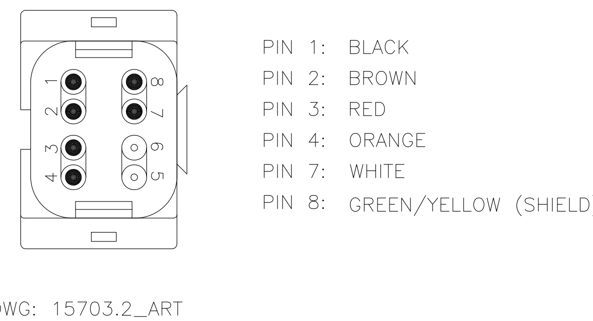
DWG: 15705.1_ART

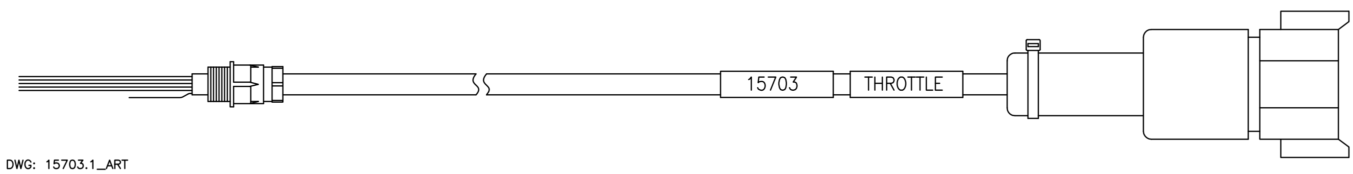
10.13.1.2 Throttle Wire Harnesses Processor Pigtails

Table 10-66: Wire Harness - Throttle, Processor Lead (p/n 15703-XX)

Termination A

Termination B



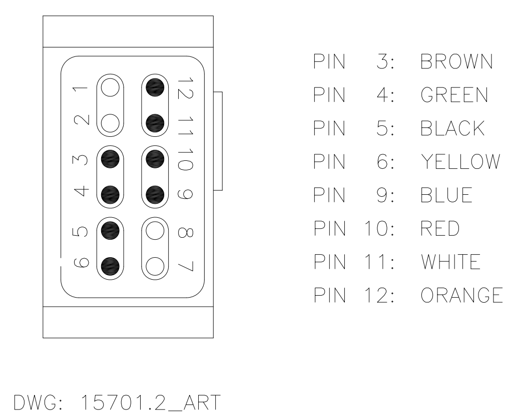


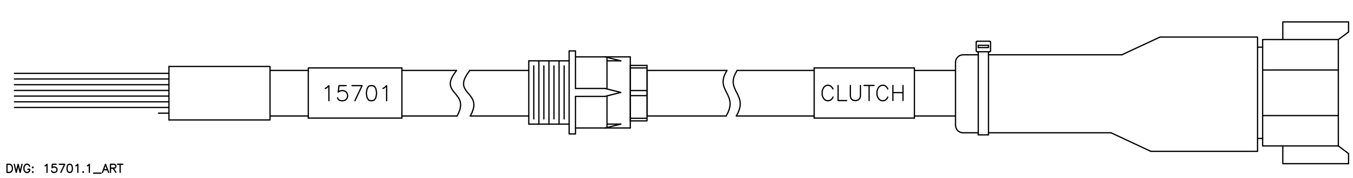
10.13.1.3 Clutch Wire Harnesses Processor Pigtails

Table 10-67: Wire Harness - Solenoid Clutches, Processor Lead (p/n 15701-XX)

Termination A

Termination B

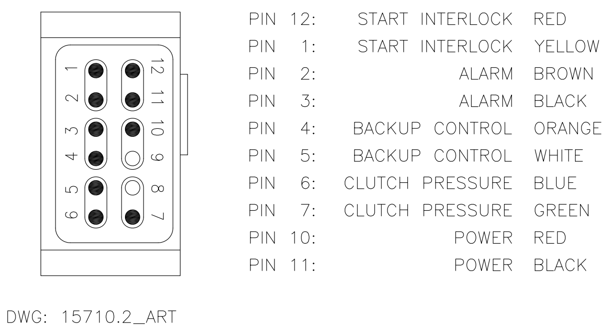


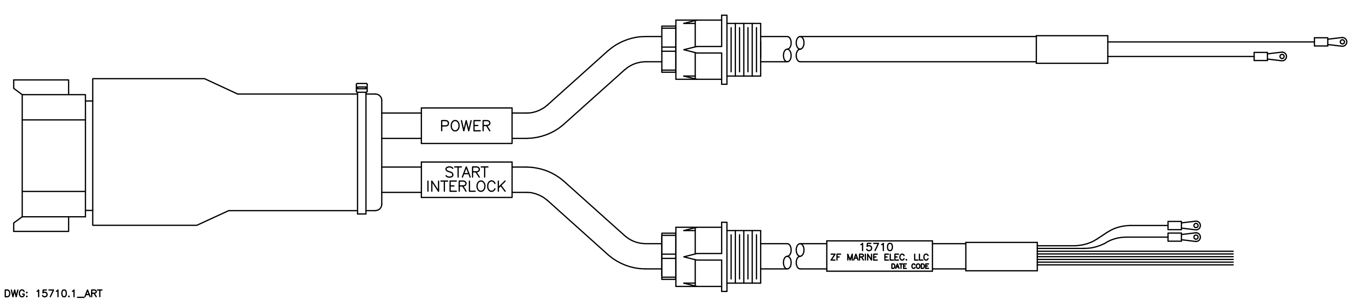


10.13.1.4 Power Wire Harnesses Processor Pigtails

Table 10-68: Power, Start Interlock, Clutch Oil Pressure Switch, and Alarm Pigtail Pin-Out (p/n 15710-XX)

Termination A	Termination B



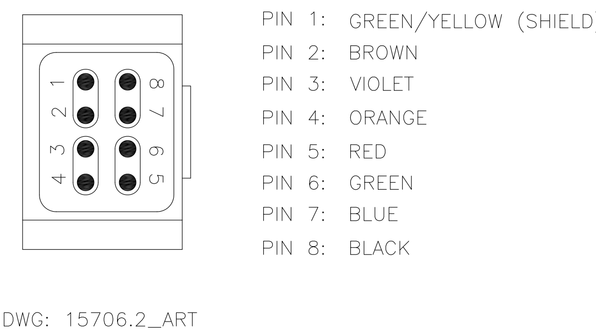


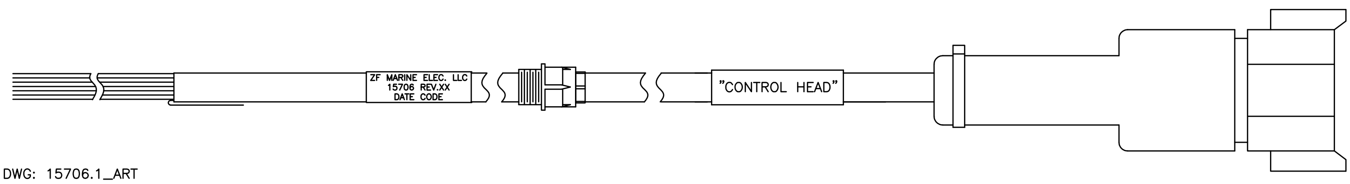
10.13.1.5 Control Head Wire Harnesses Processor Pigtails

Table 10-69: Wire Harness - Control Head, Processor Lead (p/n 15706-XX)

Termination A

Termination B



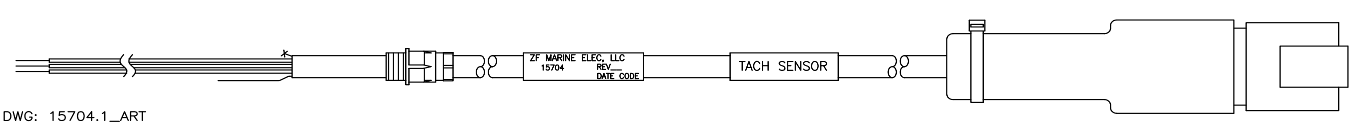


10.13.1.6 Mag Pickup Wire Harnesses Processor Pigtails

Table 10-70: Wire Harness - Mag Pickup, Processor Lead (p/n 15704-XX)

Termination A

Termination B



11 Appendix A - System Components and Specifications

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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.

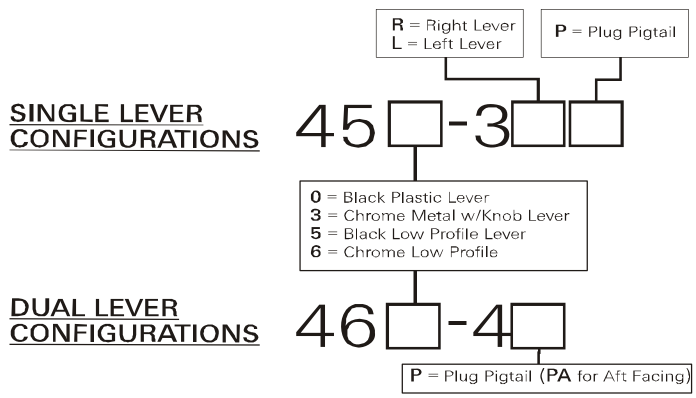


Figure MMC-280-1: Part Numbering Configurations

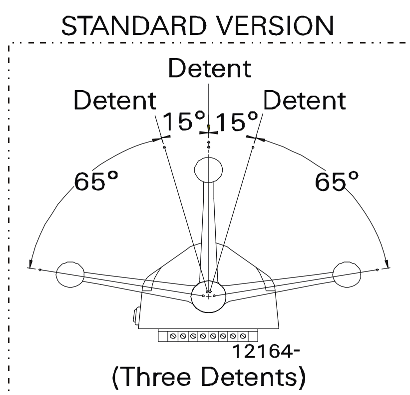


Figure MMC-280-2: Detents Available

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.

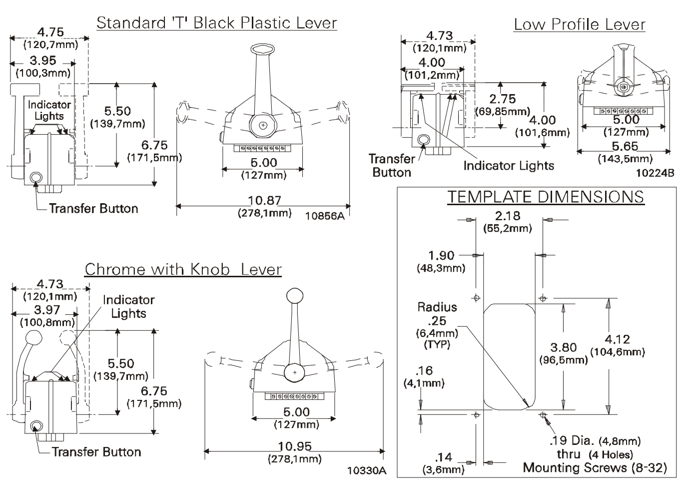


Figure MMC-280-3: Dimensions

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.

5. CABLE/HARNESS CONNECTIONS:

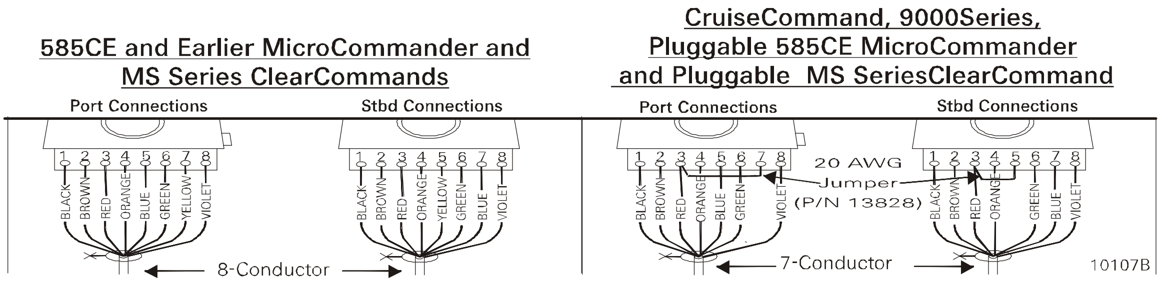


Figure MMC-280-4: Terminal Connections

Cable/Jumper connections 5 and 7 at the Port and Starboard terminal block are direction sensitive.

MicroCommander/ClearCommand				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

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 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.

7. AFT FACING CONTROL HEADS

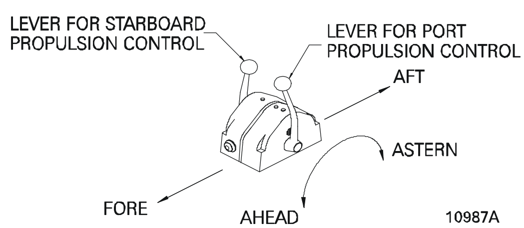
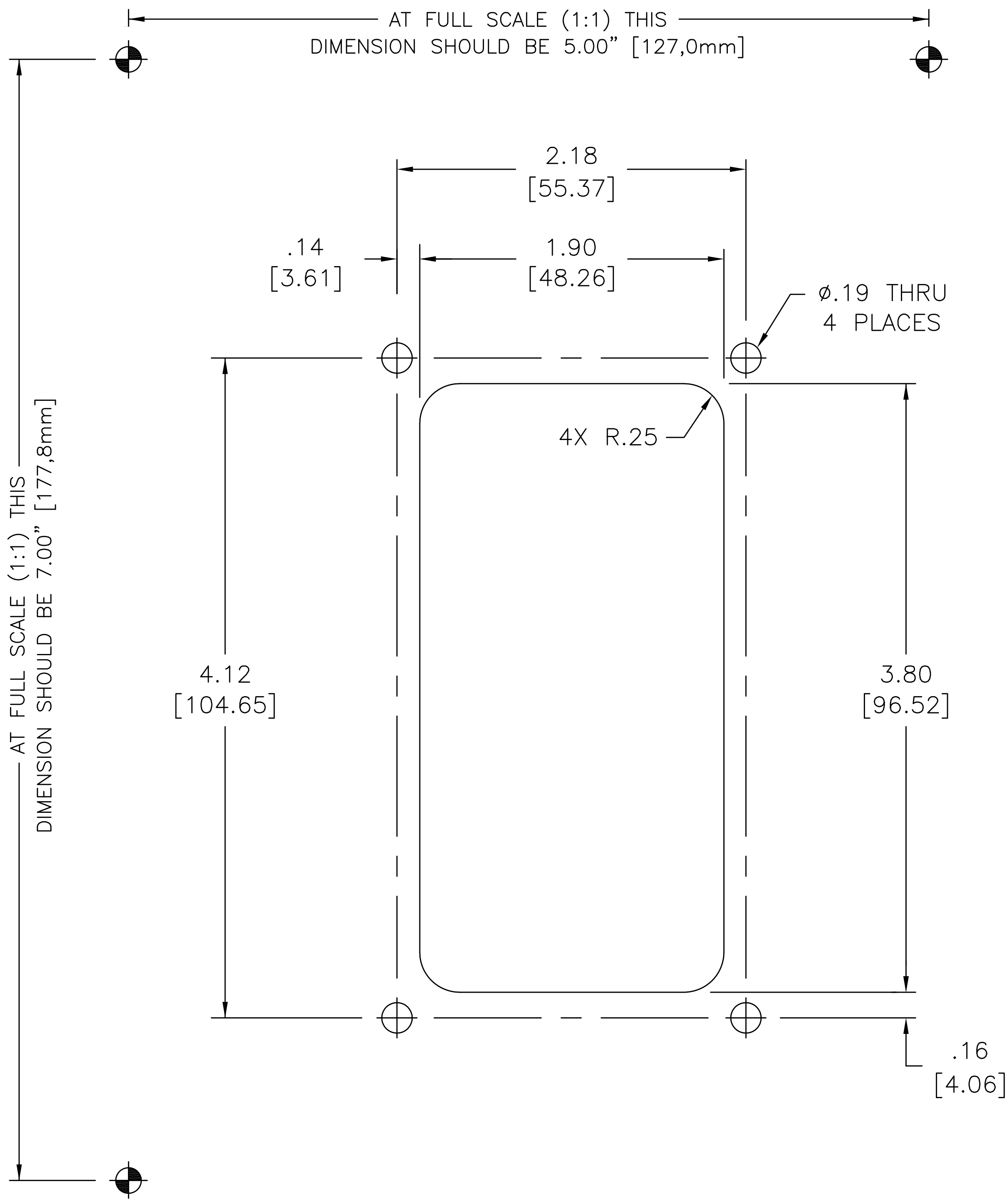


Figure MMC-280-5: AFT Facing Control Head

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.

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.

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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

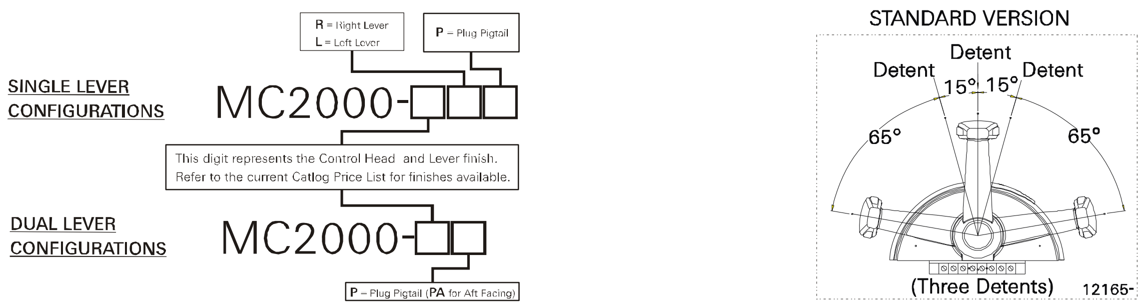


Figure MMC-329-1: Part Numbering Configurations Detents Available

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 control head too close to compass can cause the compass to malfunction.

Dimensions

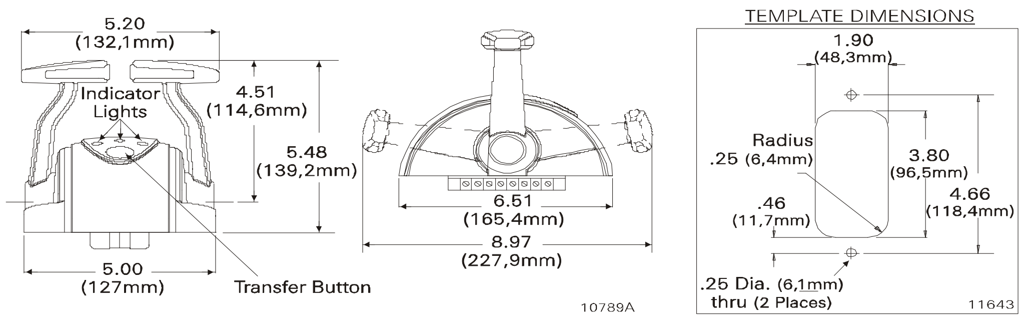


Figure MMC-329-2: Dimensions

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.

CABLE/HARNESS CONNECTIONS:

Dual Control Head Connections

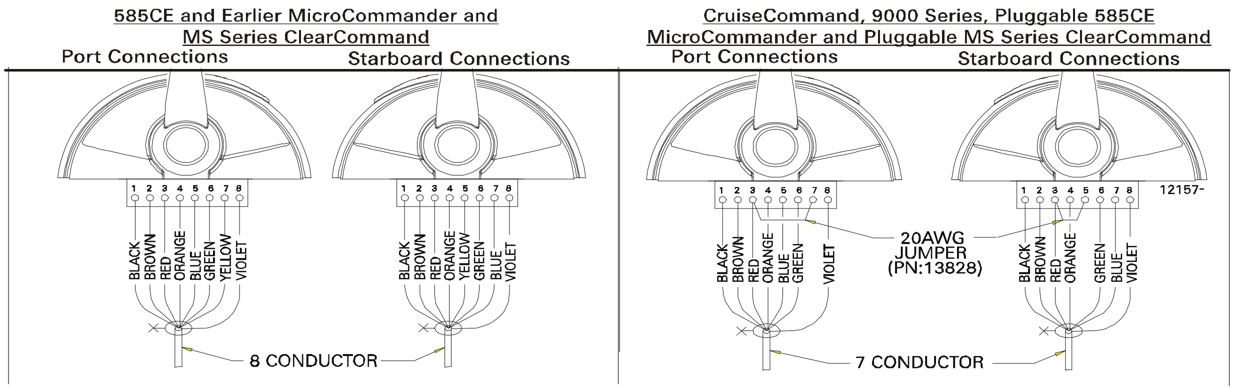


Figure MMC-329-3: Terminal Connections

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.

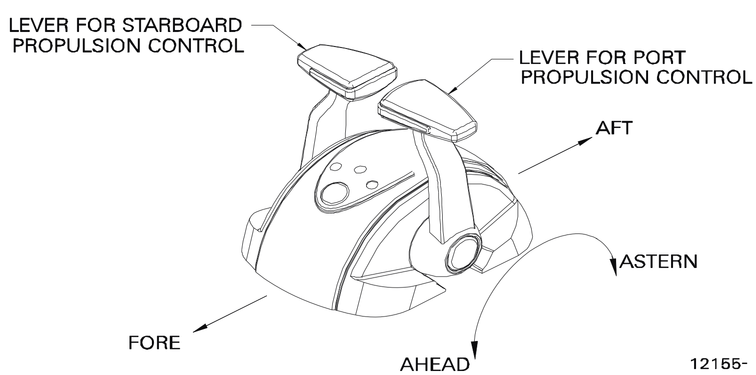
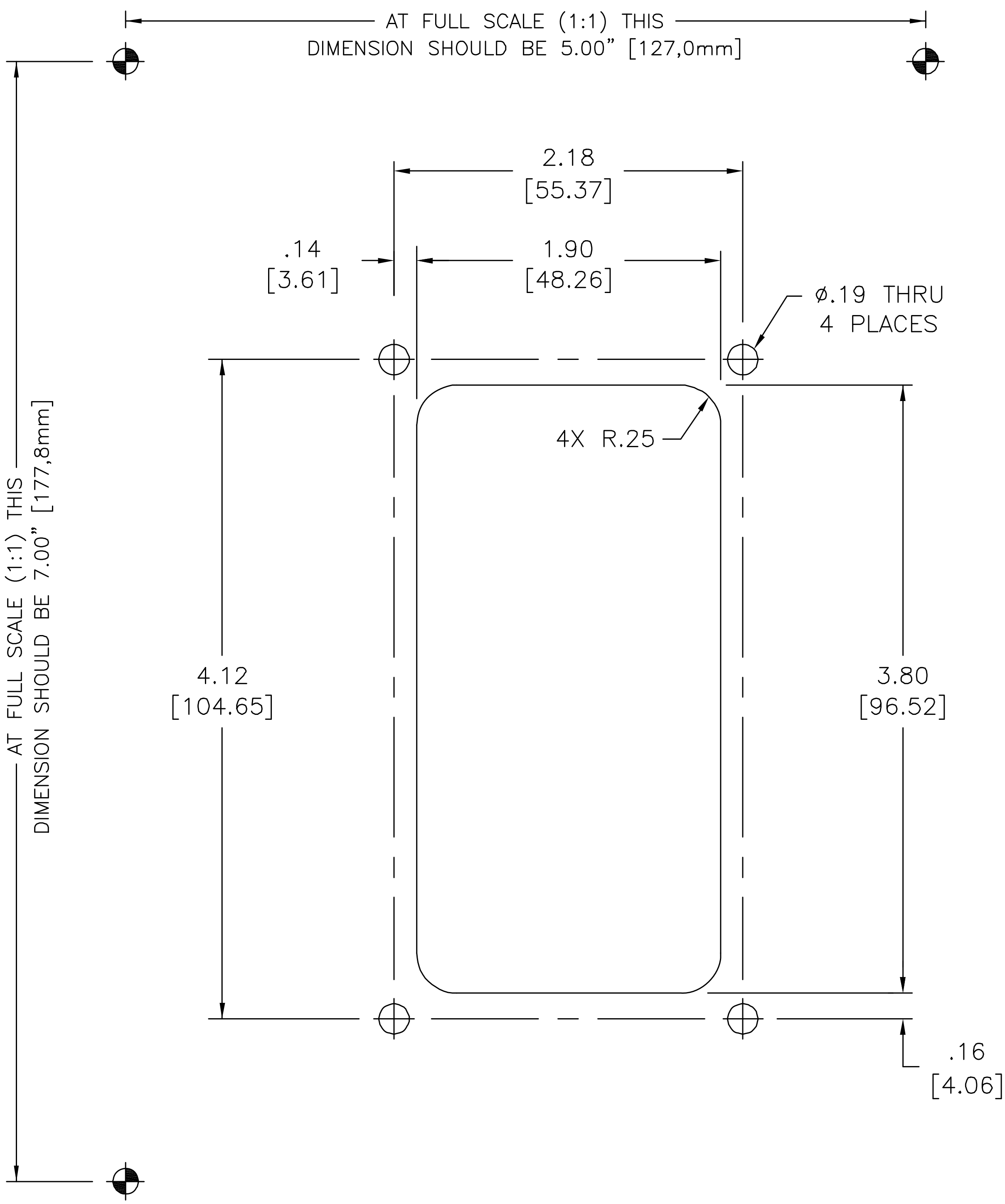


Figure MMC-329-4: AFT Facing Control Head

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 control head too close to compass can cause the compass to malfunction.**

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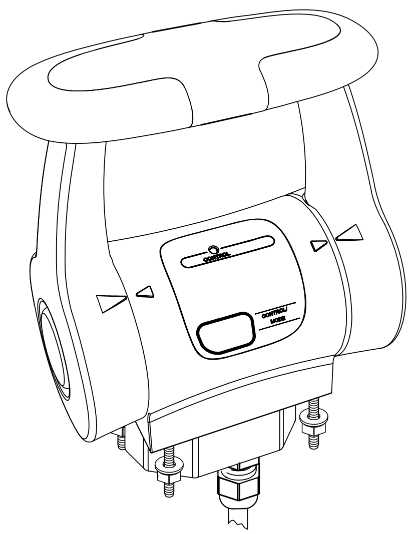
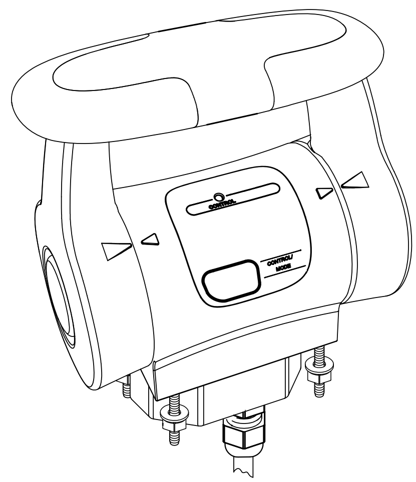
4000 SERIES CONTROL HEAD VARIATIONS

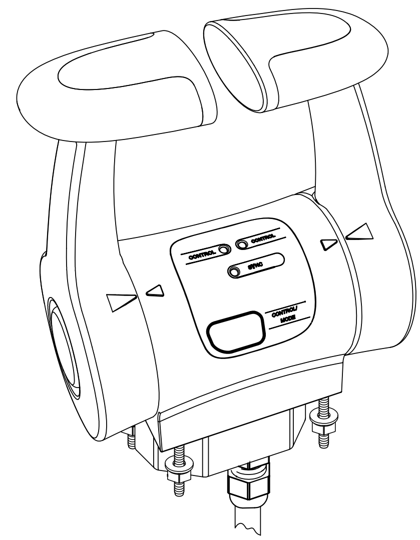
This Service Sheet reflects all current variations of the standard 3-detent (Neutral, Forward, Reverse) ZF Marine Propulsion Systems Miramar 4000 Series Control Heads.



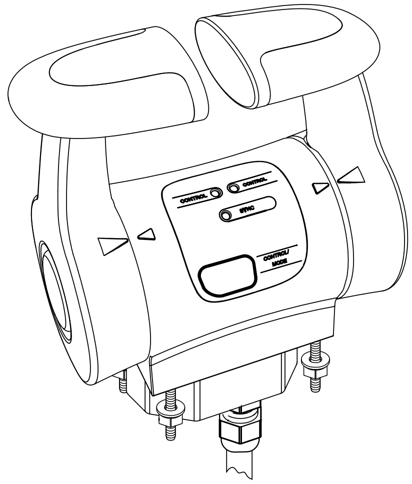
4100 Control Head
(Dwg 13932)
Control Head, 4000 Series, Single Screw. This control head has a bridge between the levers to join them.



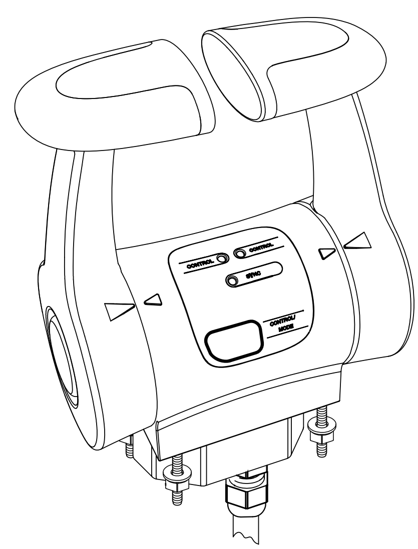
4100LP Control Head (Low Profile)
(Dwg 13932)
Control Head, 4000 Series, Single Screw, Low Profile. This control head has a bridge between the levers to join them.



4200 Control Head
(Dwg 13932)
Control Head, 4000 Series, Twin Screw.



4200LP Control Head (Low Profile)
(Dwg 13932)
Control Head, 4000 Series, Twin Screw, Low Profile.



4200AF Control Head
(Dwg 13932)
Control Head, 4000 Series, Twin Screw, Aft Facing

Requirements:

Control System	Wire Harness Description
MicroCommander/ ClearCommand (non-pluggable)	(1) Control Head wire harness per lever. See Figure MMC-337-2: 9000 Hard Wired Drawing 14119-2, Figure MMC-337-3: Port Processor - Hard wiring Drawing 13932A - 15B and Figure MMC-337-4: Starboard Processor - Hard wiring Drawing 13932A - 15A
Pluggable Micro Commander/Clear Command	(1) Control Head wire harness per lever. See Figure MMC-337-1: Cable / Harness Connections - Pluggable Drawing 14119-1
CruiseCommand	(1) Control Head wire harness per lever. See Figure MMC-337-1: Cable / Harness Connections - Pluggable Drawing 14119-1
MiniCommand	(1) Control Head wire harness per Control Head. See Figure MMC-337-1: Cable / Harness Connections - Pluggable Drawing 14119-1

INCLUDED WITH THE CONTROL HEAD:

Mounting Studs with washers and nuts.

mounting and installation:

1. Select the desired mounting location(s) and make cutout(s) per dimensions shown in Figure MMC-337-9: Control Head Mounting Holes and Cutout – Dwg #13293.
2. Check that the four mounting studs on the Control Head will start into the cutout mounting holes. Remove Control Head from cutout.
3. Run cable/wire harnesses between Processor and Control Head. Label both ends with the Station ID. (EXAMPLE: Port Bridge, Stbd Bridge or Port Wing, etc.).

CONNECTIONS

The 4000 series Control Heads are only available with pluggable connections and must not be modified in any way. However, there are two types of Wire Harnesses available for connecting the Control Head to the Processor (CruiseCommand, ClearCommand, etc.):

- Pluggable on both ends.
- Pluggable on one end and hard wired on the other.

The Wire Harnesses for CruiseCommand and the MiniCommand Processors are always pluggable at both ends. The Wire Harnesses for the 9000 Processors (MicroCommander and ClearCommand) can be pluggable at both ends or pluggable at the Control Head end and hard wired at the Processor end.

PLUGGABLE

1. Plug Control Head wire harness into the corresponding connector/pigtail coming from the Processor. Ensure the correct Processor Cable is being plugged into the correct Control Head pigtail. (Example: Port to Port, Starboard to Starboard.)

When making the connection, ensure that the mating connectors (plug and receptacle) are fully inserted such that the connector latches are locked in place. (Note: To disconnect the connectors, the release button or buttons must be *depressed and held* until the plug and receptacle are fully disconnected.)

CAUTION: Disconnecting plugs without *depressing and holding* the release button or buttons will damage the plug.

CABLE/HARNESS CONNECTIONS PLUGGABLE

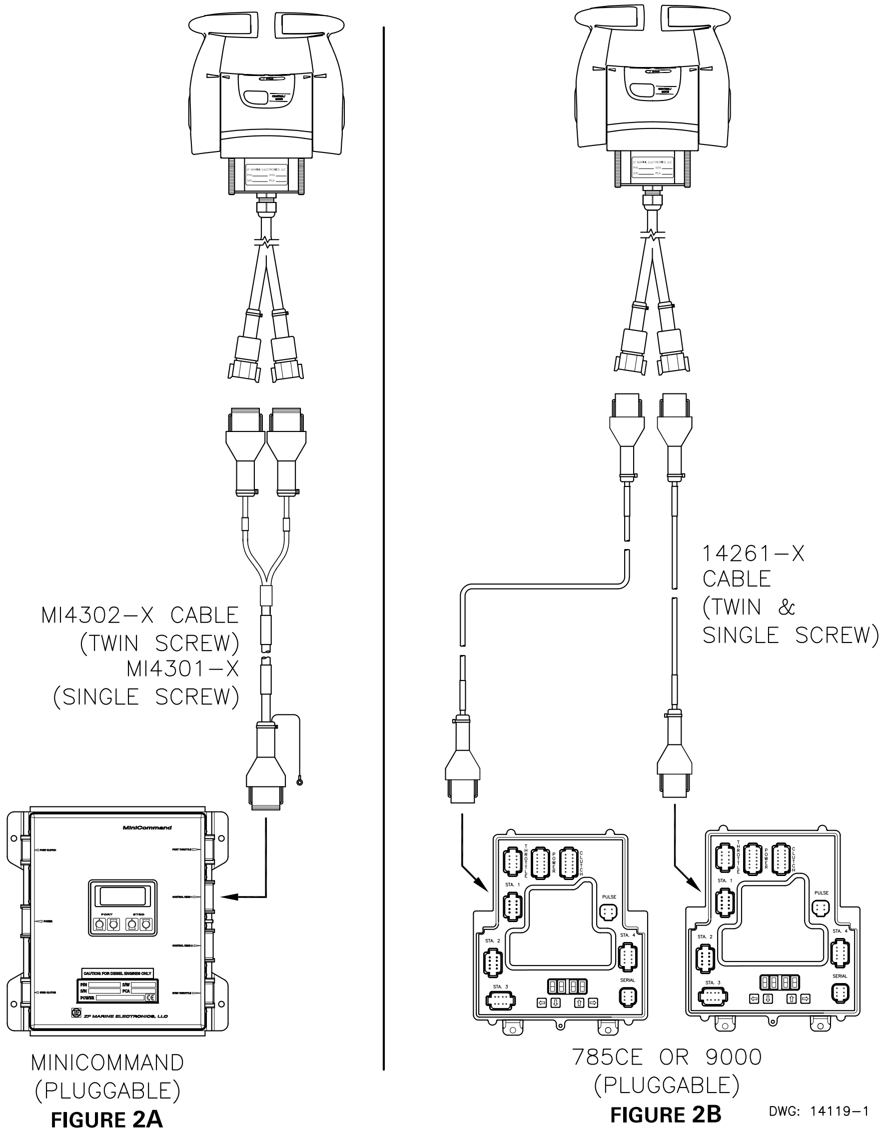


Figure MMC-337-1: Cable / Harness Connections - Pluggable Drawing 14119-1

PLUGGABLE CONNECTIONS

⚠	**WARNING: Pluggable Control Heads are supplied with a harness pigtail for each lever. When disconnecting the plugs, ensure that the release button or buttons are *depressed and held* until the plug is fully disconnected.** **Disconnecting the plugs without *depressing and holding* the release button or buttons WILL damage the plug.**

HARD WIRED CONNECTIONS NON-PLUGGABLE

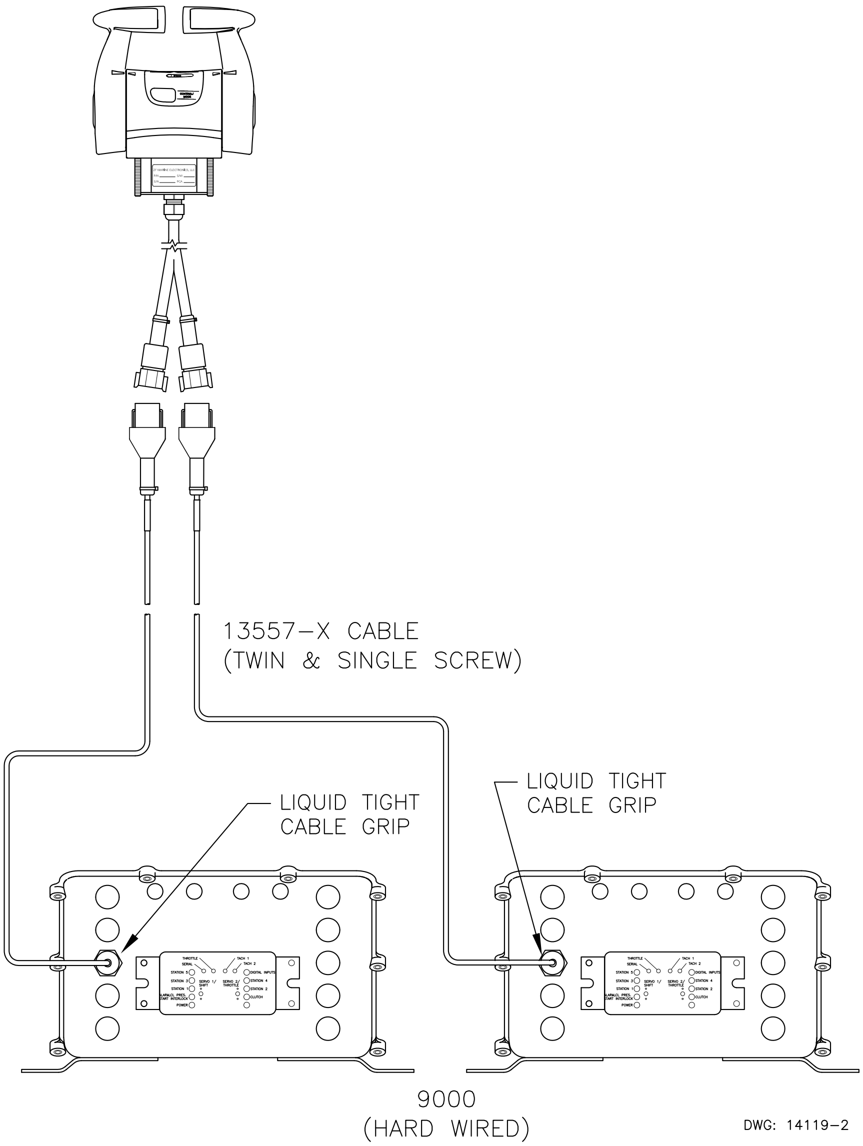


Figure MMC-337-2: 9000 Hard Wired Drawing 14119-2

PORT & STARBOARD PROCESSOR HARD WIRING

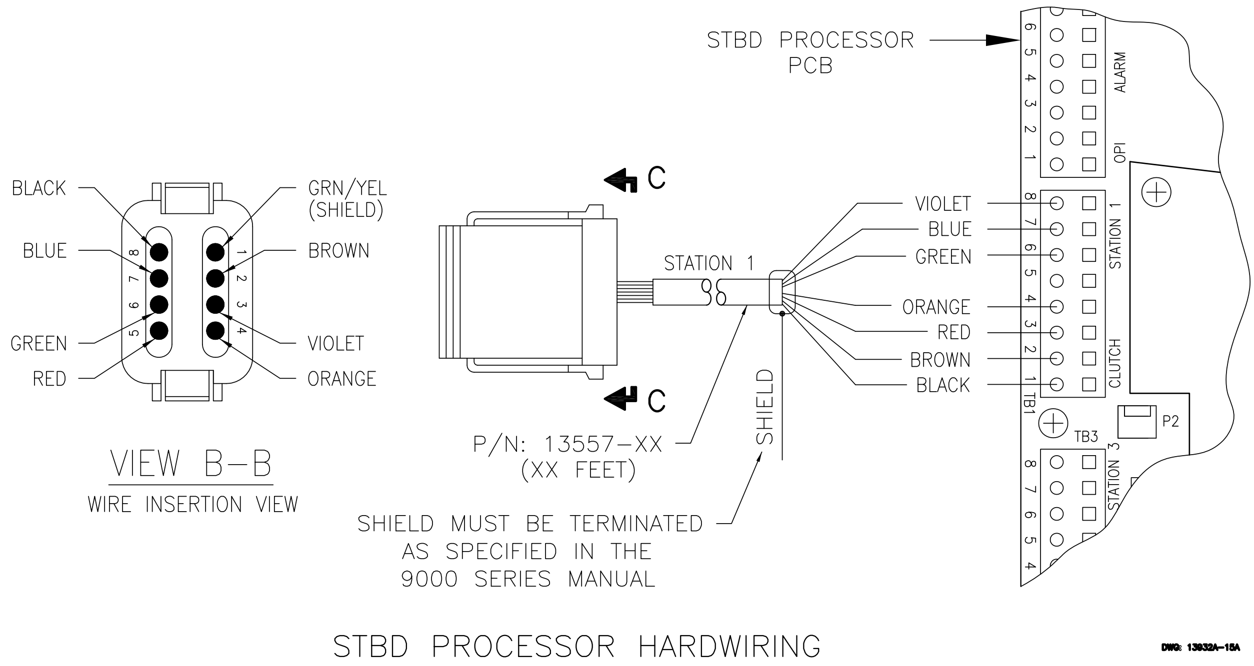


Figure MMC-337-3: Port Processor - Hard wiring Drawing 13932A - 15B

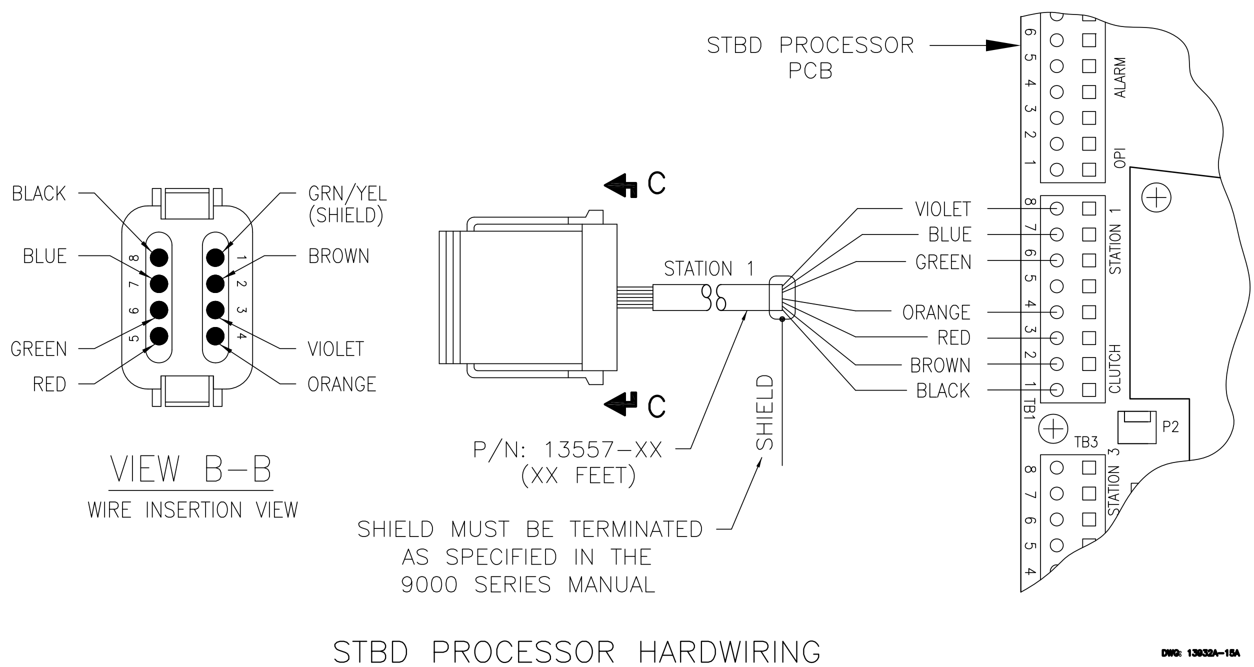


Figure MMC-337-4: Starboard Processor - Hard wiring Drawing 13932A - 15A

4200 CONTROL HEAD FRONT VIEW

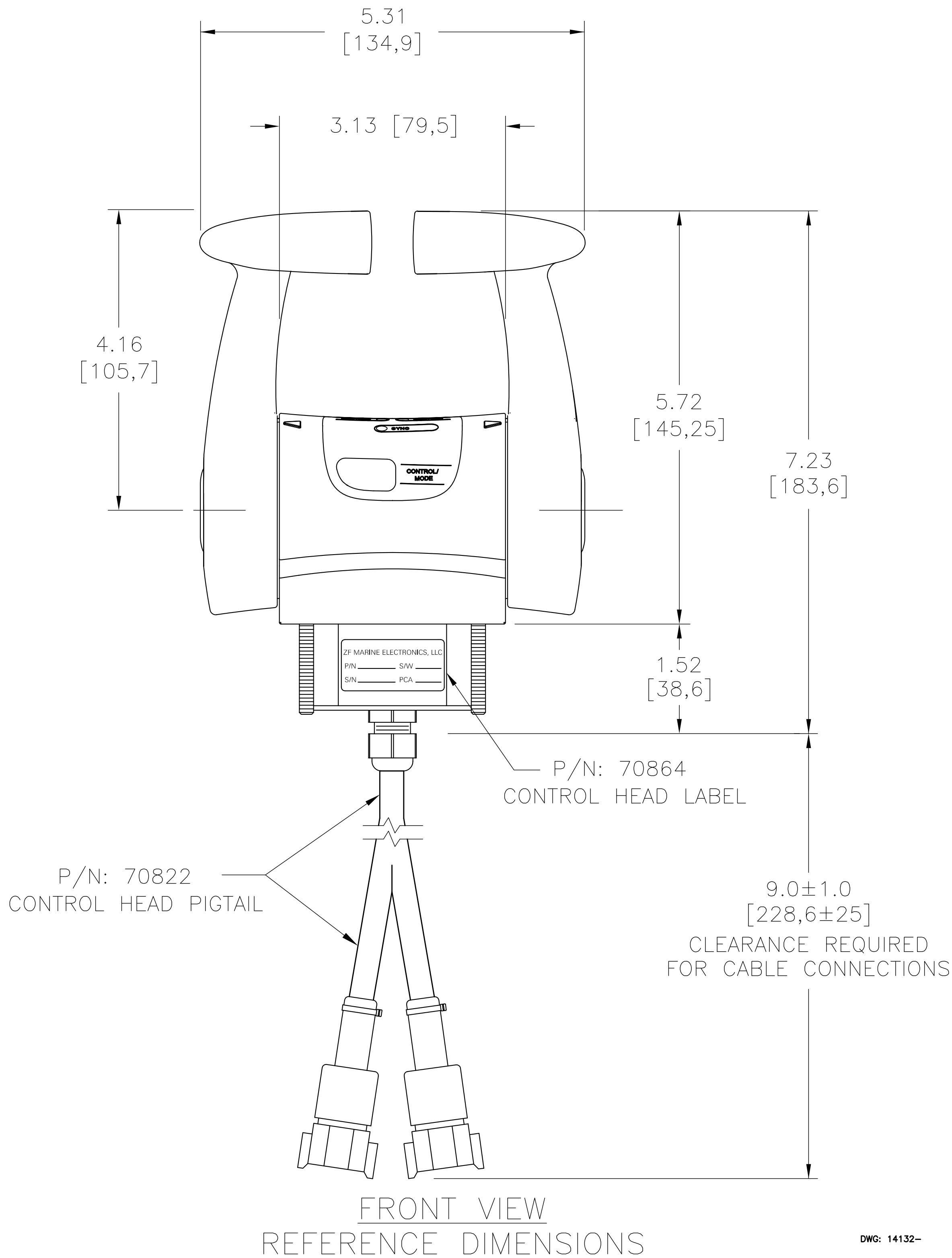


Figure MMC-337-5: 4200 Control Head - Front View Dwg #14132

4200 CONTROL HEAD SIDE VIEW

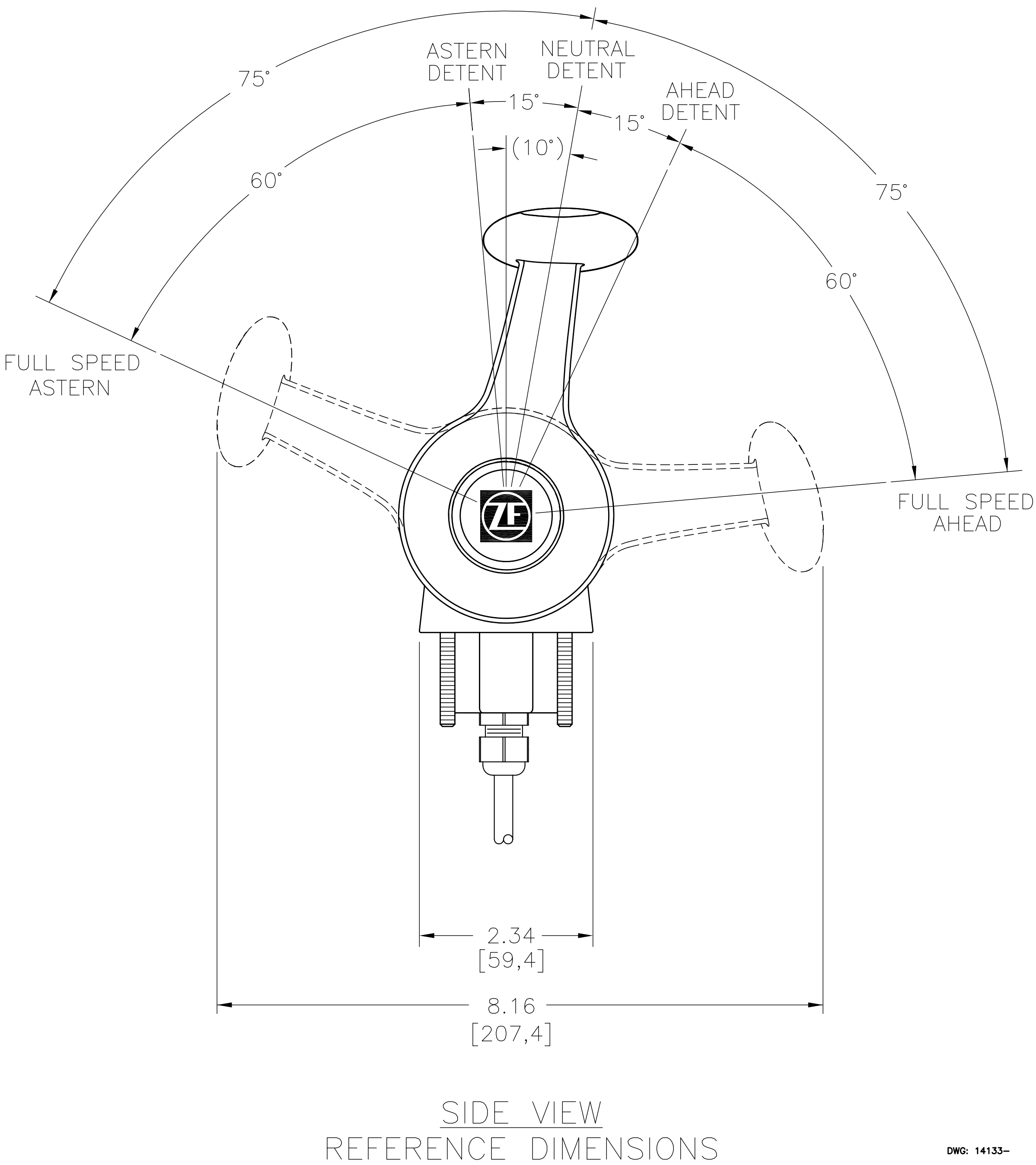


Figure MMC-337-6: 4200 Control Head - Side View Dwg #14133

4100LP CONTROL HEAD FRONT VIEW

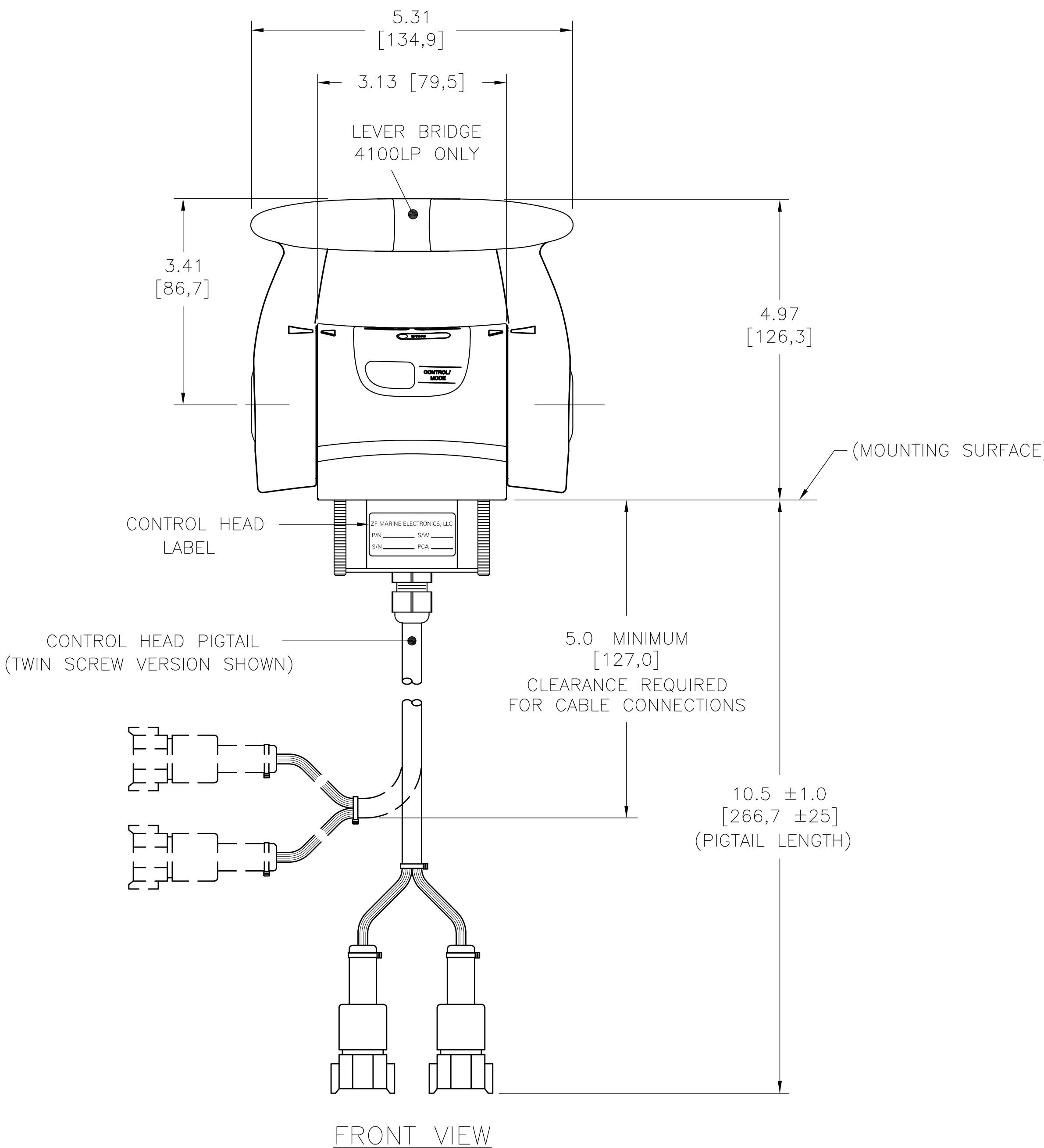


Figure MMC-337-7: 4100LP Control Head – Front View Dwg #13932ART-8

4100LP Control Head Side View

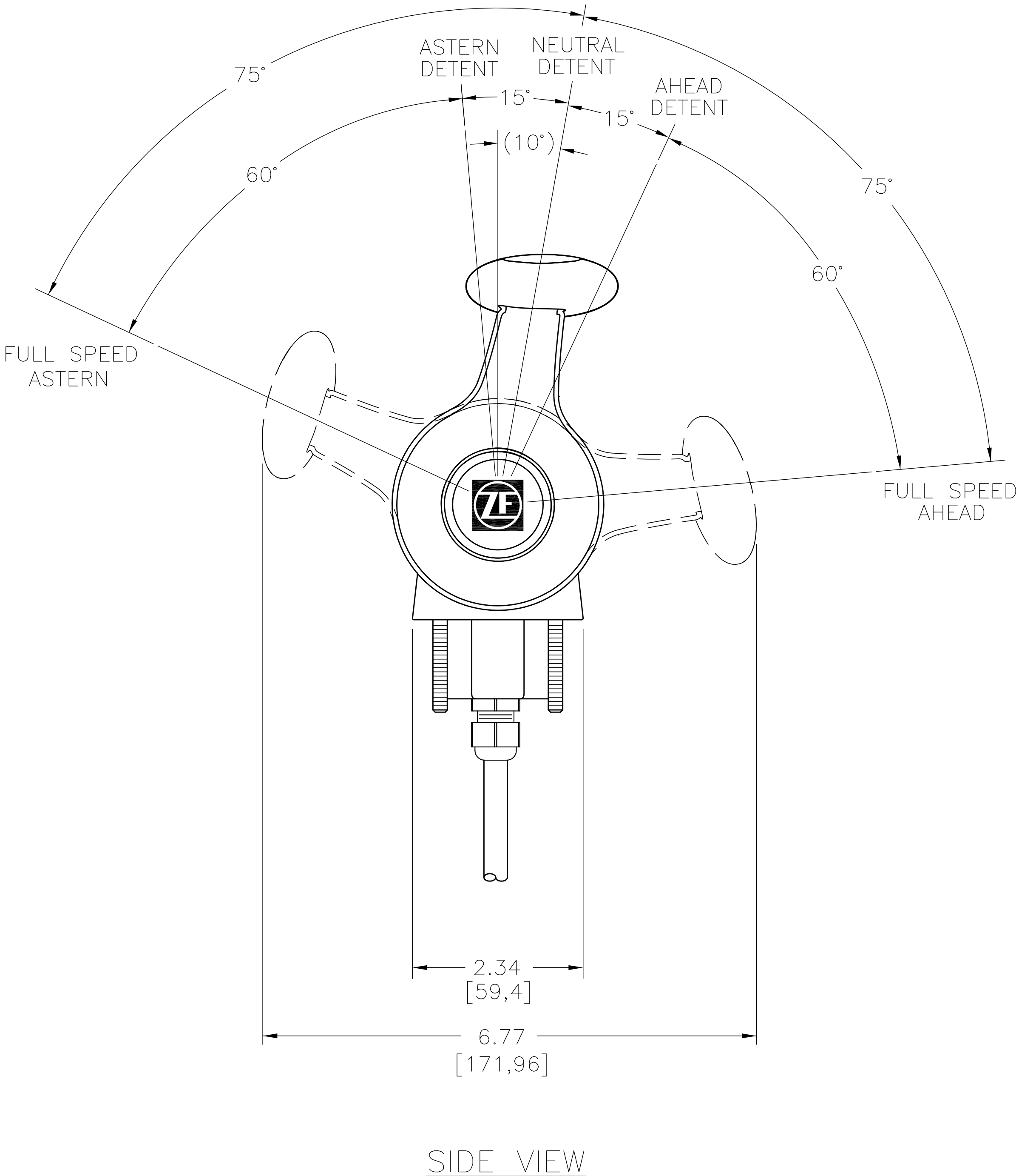


Figure MMC-337-8: 4100LP Control Head – Side View Dwg 13932ART-9

4000 SERIES CONTROL HEAD MOUNTING DIMENSIONS

CAUTION: NOT TO SCALE
DO NOT USE AS A TEMPLATE

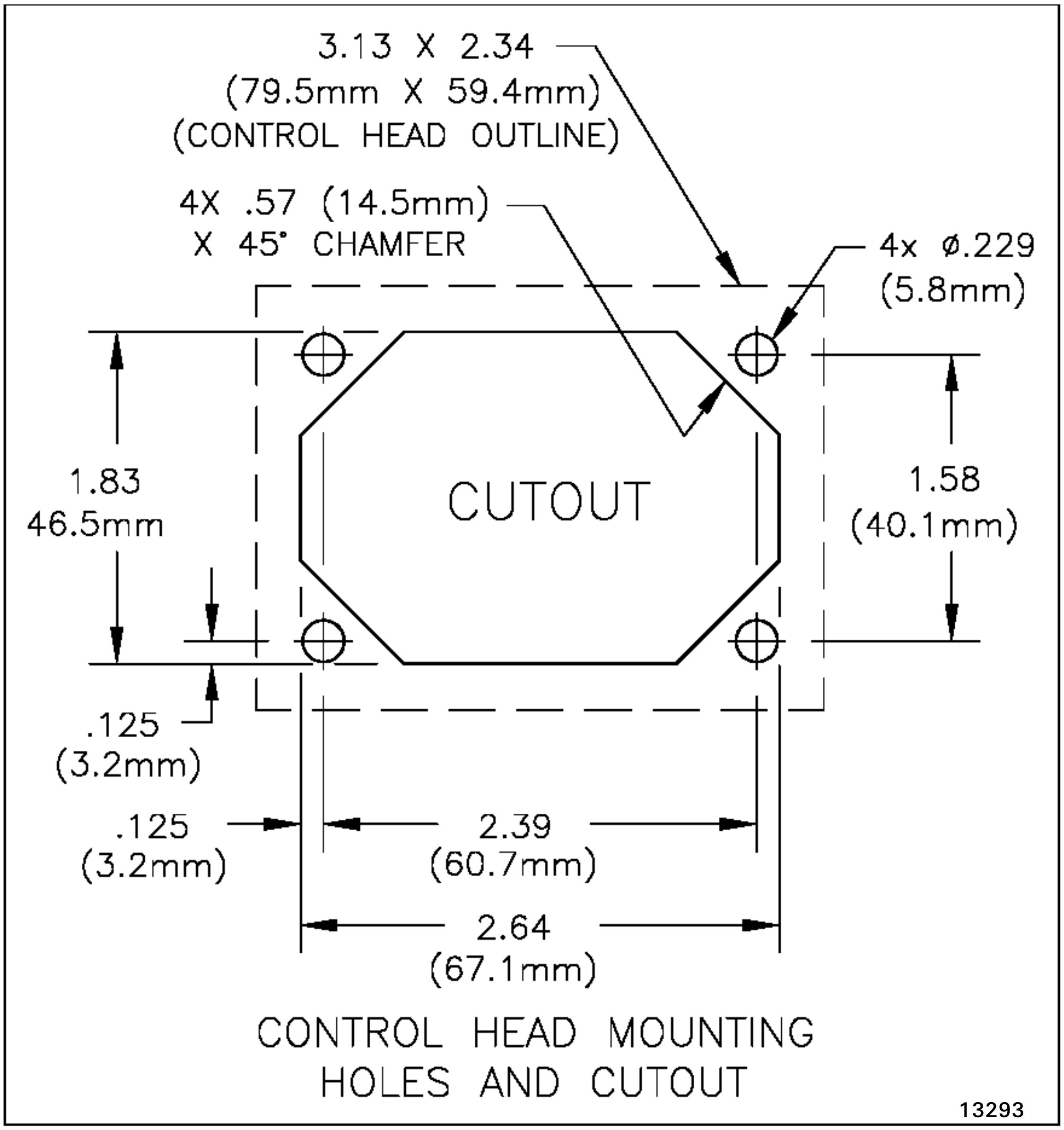


Figure MMC-337-9: Control Head Mounting Holes and Cutout – Dwg #13293

SEE FOLLOWING PAGE FOR TEMPLATE

4000 SERIES CONTROL HEAD MOUNTING CUTOUT

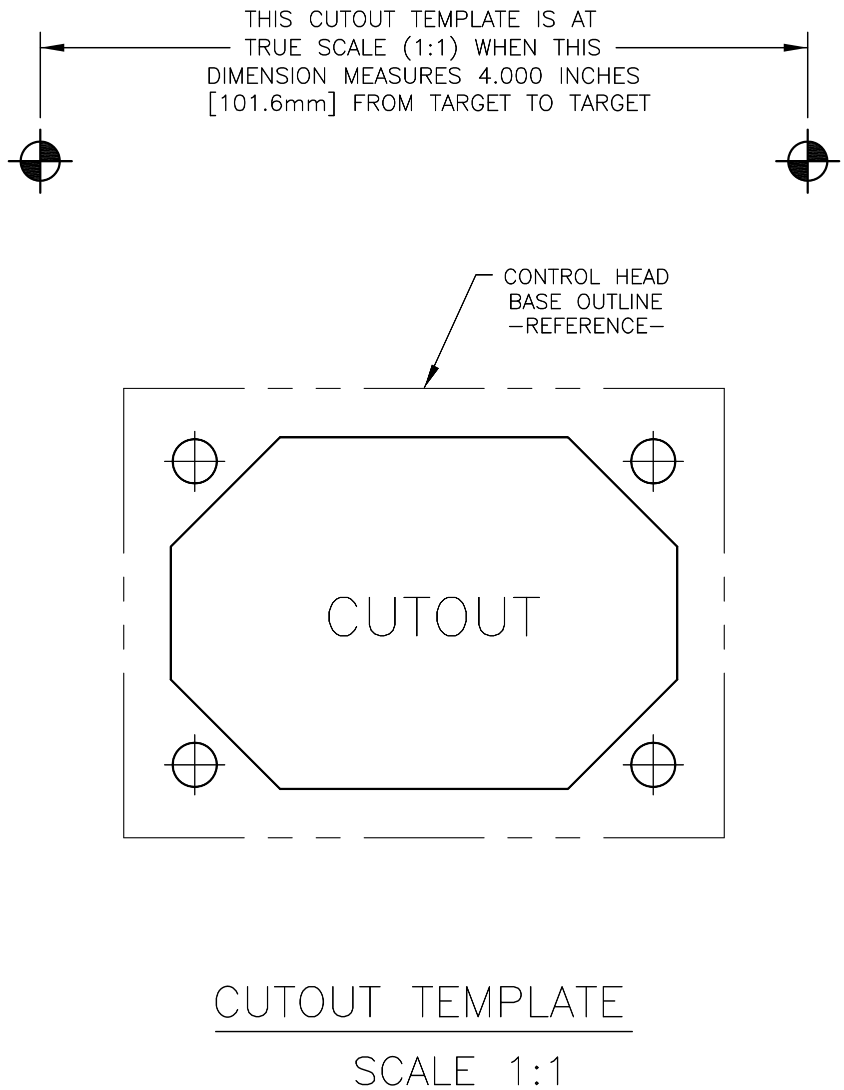


Figure MMC-337-10: Control Head Mounting Holes and Cutout – Dwg #14649

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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.

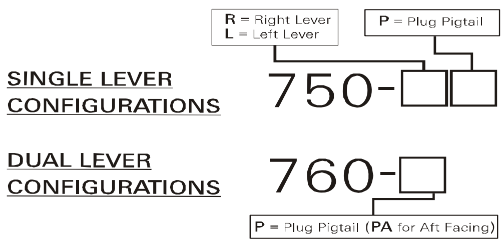


Figure MMC-307-1: Part Numbering Configurations

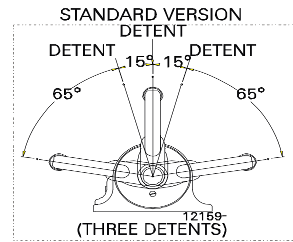


Figure MMC-307-2: Detents Available

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.

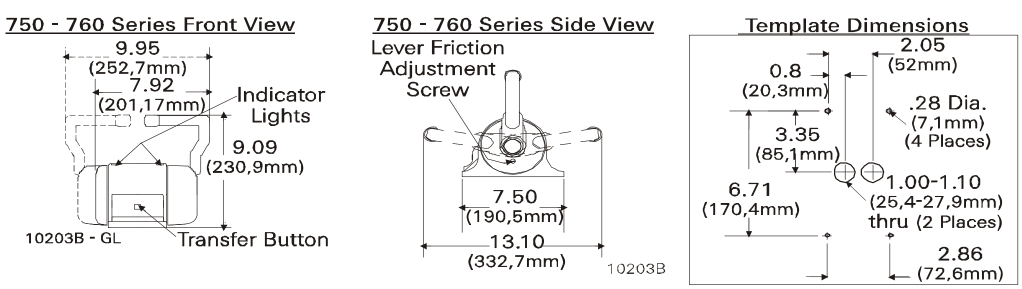


Figure MMC-307-3: Dimensions

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.

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.

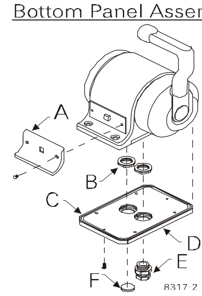
4. Pluggable
   - A Plug Control Head cable into the pigtail at the Control Head. (Ensure the correct Processor Cable is being plugged into the corresponding Control Head lever pigtail).
   - B When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully 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

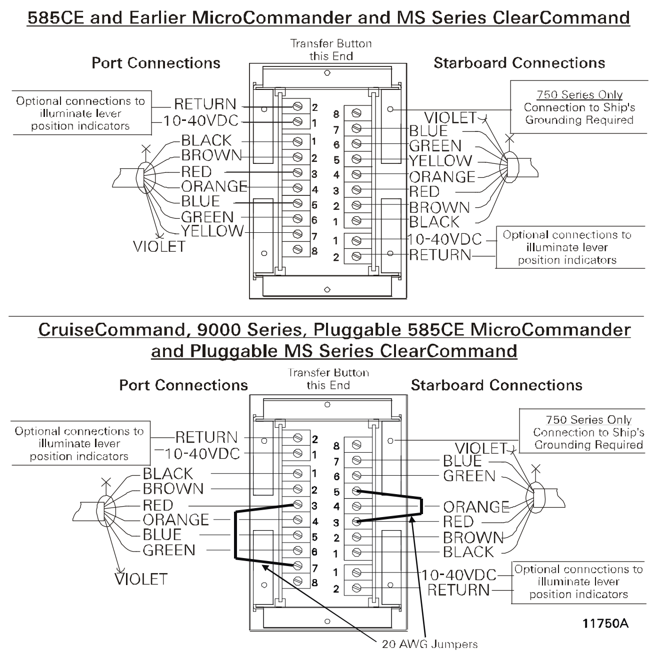


Figure MMC-307-4: Dual Control Head Connections

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.

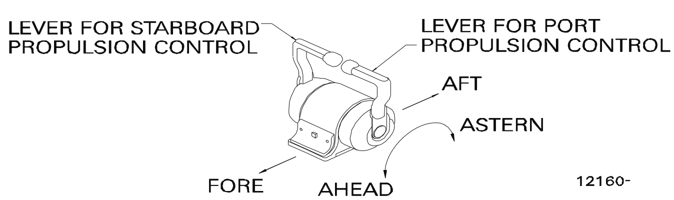
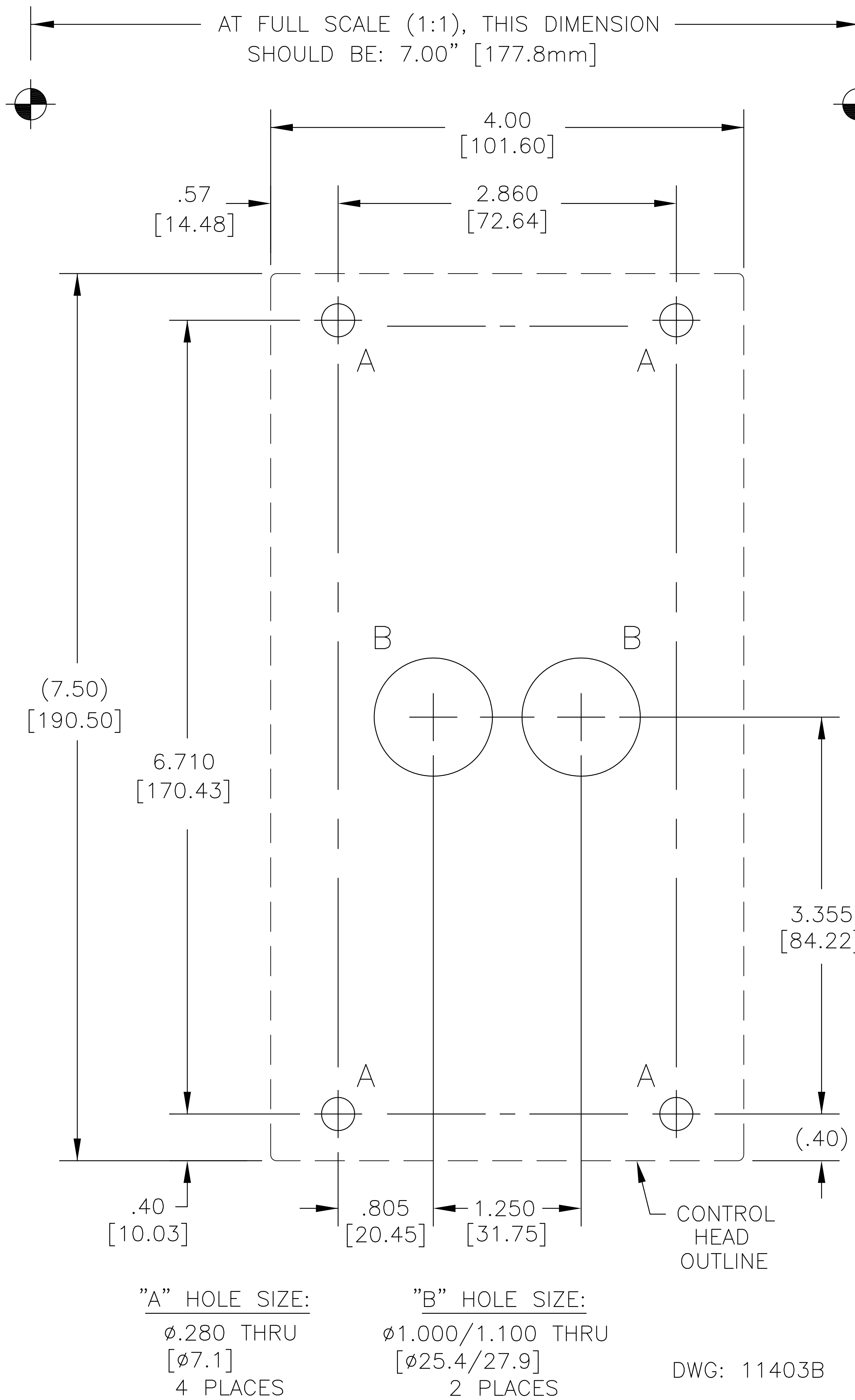


Figure MMC-307-5: Aft Facing Control Head

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.

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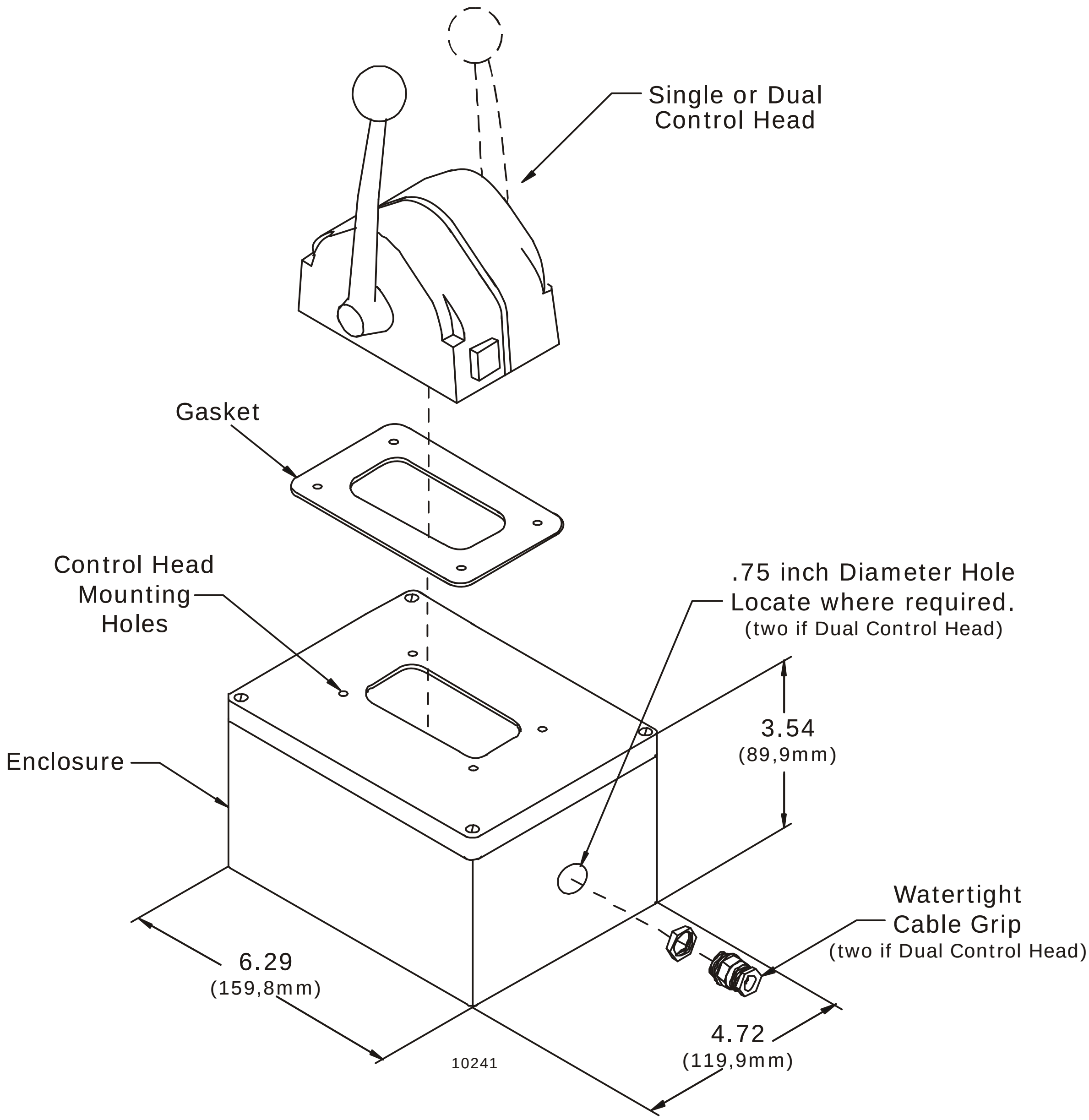
400 Series Weather Mount Enclosure



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.

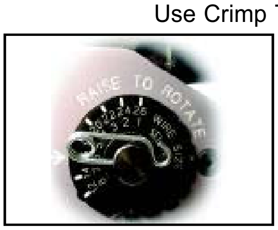
Step 2: Wire Stripping

Solid Contacts

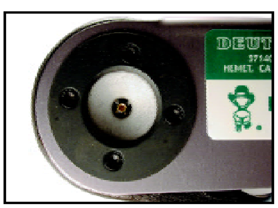
Contact Part Number	Wire Gauge Range	Strip Length (inches)
0460-202-20141 0462-201-20141	20 AWG 20 AWG	.156-.218 .156-.218
0460-202-16141 0462-201-16141	16, 18 & 20 AWG 16, 18 & 20 AWG	.250-.312 .250-.312
0460-215-16141 0462-209-16141	14 AWG 14 AWG	.250-.312 .250-.312
0460-204-12141 0462-203-12141	12 & 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

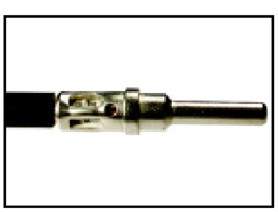


1. Strip insulation from wire. (See Step 2).
2. Raise selector knob and rotate until arrow is aligned with wire size to be crimped.
3. Loosen locknut, turn adjusting screw in until it stops.



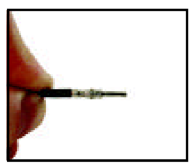
4. Insert contact with barrel up. Turn adjusting screw counter–clockwise until contact is flush with indentor cover. Tighten locknut.

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.

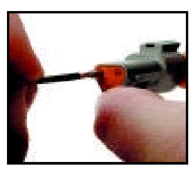


7. Inspect terminal to ensure that all strands are in crimp barrel. **NOTE:** Tool must be readjusted for each type/size of contact. Use HDT04-08 for size 8 and 4 contacts.

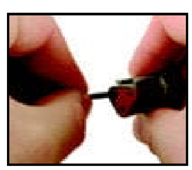
Step 4: Contact Insertion



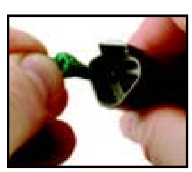
1. Grasp crimped contact approximately (25.2 mm) one inch behind the contact barrel.



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.

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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 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 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 TO APS 93 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 BREAKER 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

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 ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

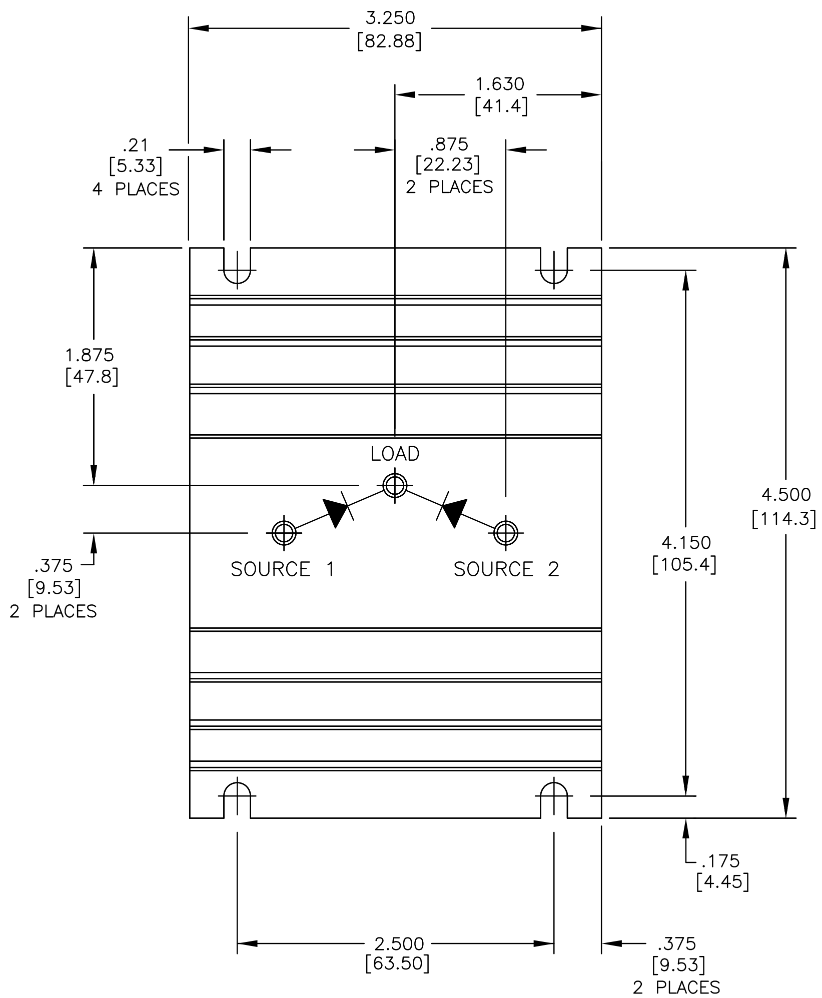
TITLE: DC POWER SOURCE KIT

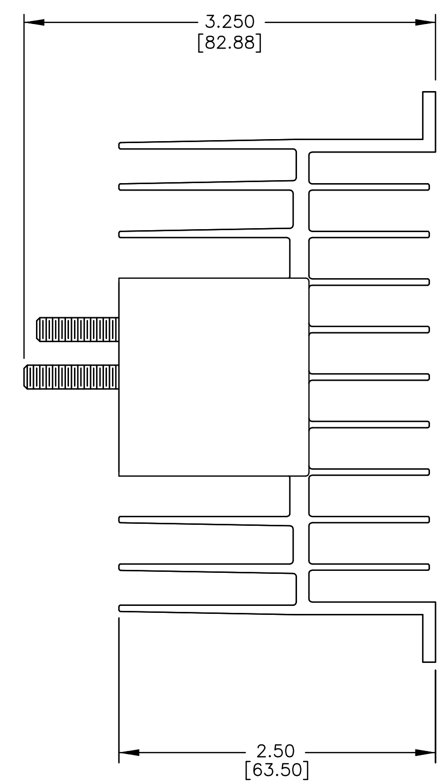
SIZE: B | CAGE CODE: | DWG NO.: 11488 | REV: H

SCALE: NONE | PART NO.: SEE NOTE 5 | SHEET: 1 OF 5

Drawing 11488 DC Power Source Kit

REVISION					
ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	Q.C. APR
		–SEE SHEET 1–			

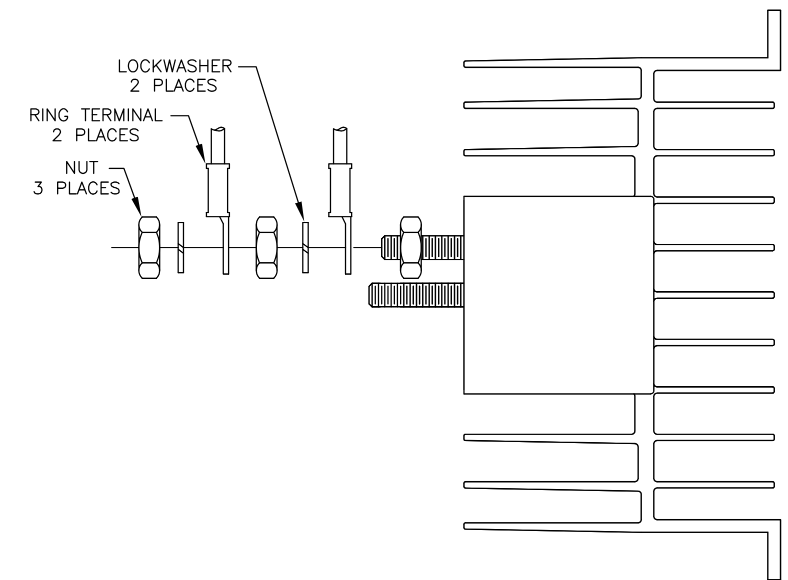




APS DIMENSIONS

DIMENSIONS ARE IN INCHES [mm]

SCALE: NONE



APS HARDWARE STACKING

FOR SYSTEMS UTILIZING MULTIPLE OUTPUTS FROM THE P/N: 13505 (AUTOMATIC POWER SELECTOR).

ZF MARINE ELECTRONICS, LLC

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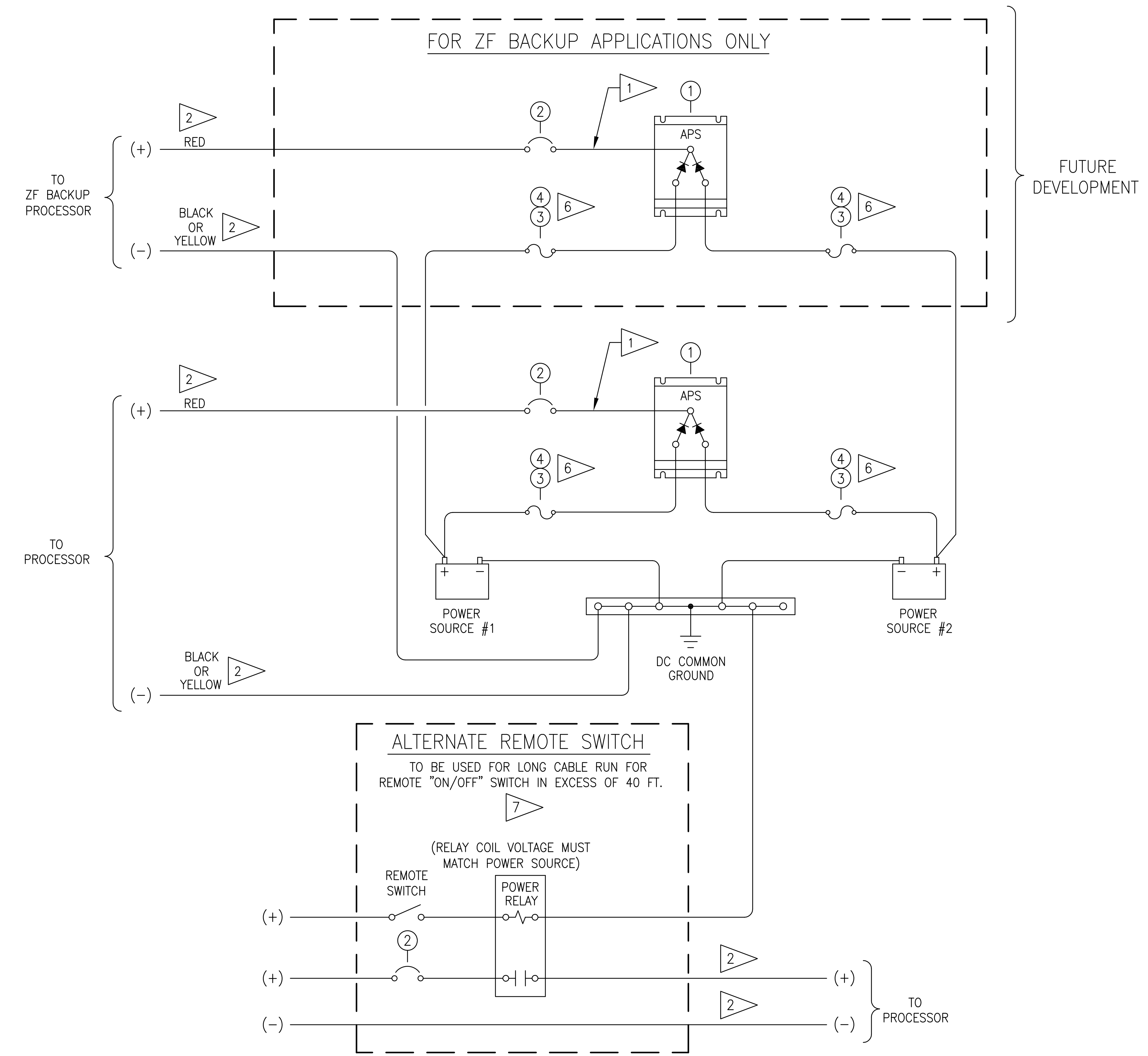
TITLE

DC POWER SOURCE KIT

SIZE	CAGE CODE	DWG NO.	REV
B		11488	H

SCALE	PART NO.	SHEET
NONE	SEE NOTE 5	2 OF 5



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

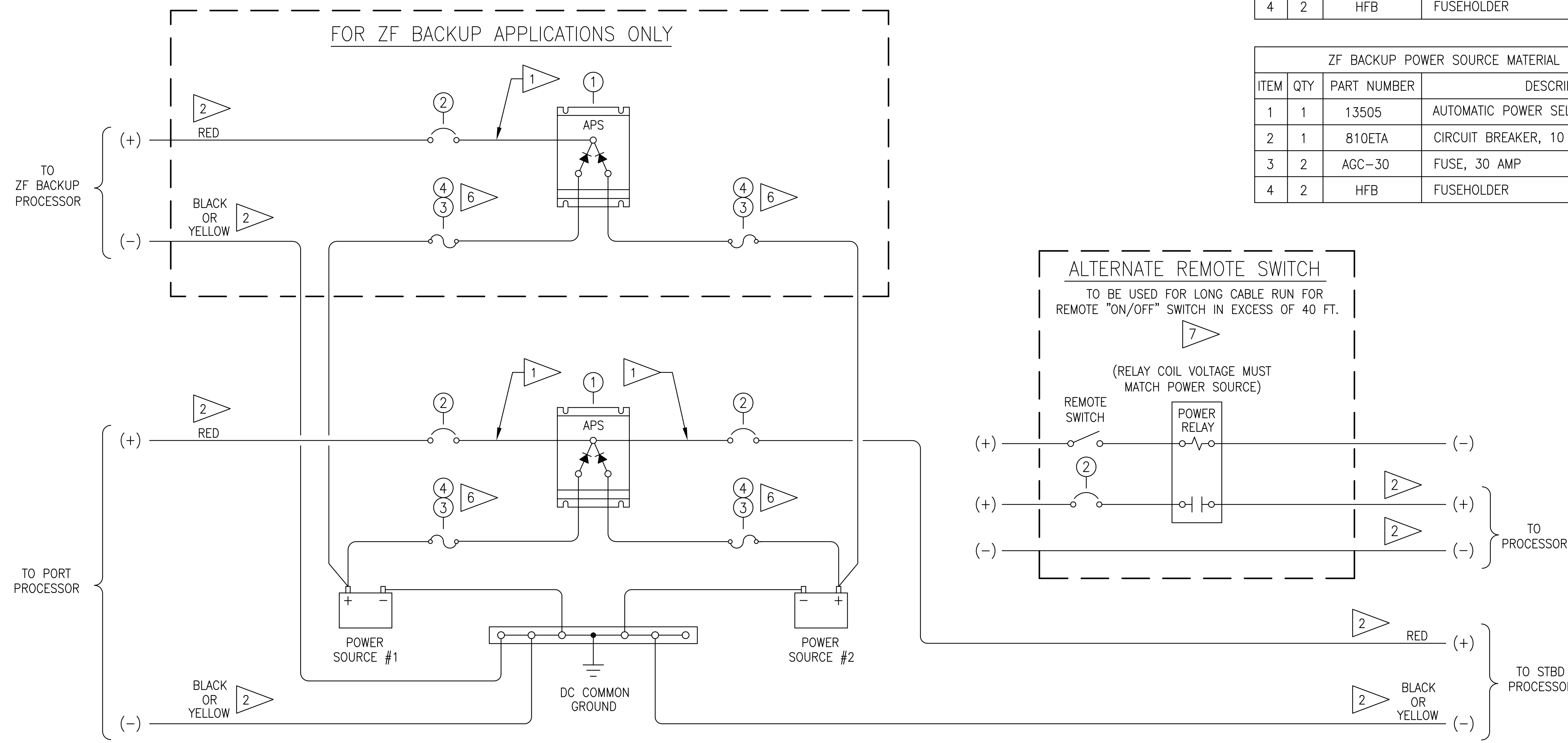
ZF BACKUP POWER SOURCE MATERIAL LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

SINGLE SCREW,
SINGLE APS CONNECTIONS
WITH ALTERNATE REMOTE SWITCH
AND OPTIONAL ZF BACKUP

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE: DC POWER SOURCE KIT

SIZE: B | CAGE CODE: | DWG NO.: 11488 | REV: H
SCALE: NONE | PART NO.: SEE NOTE 5 | SHEET: 3 OF 5



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

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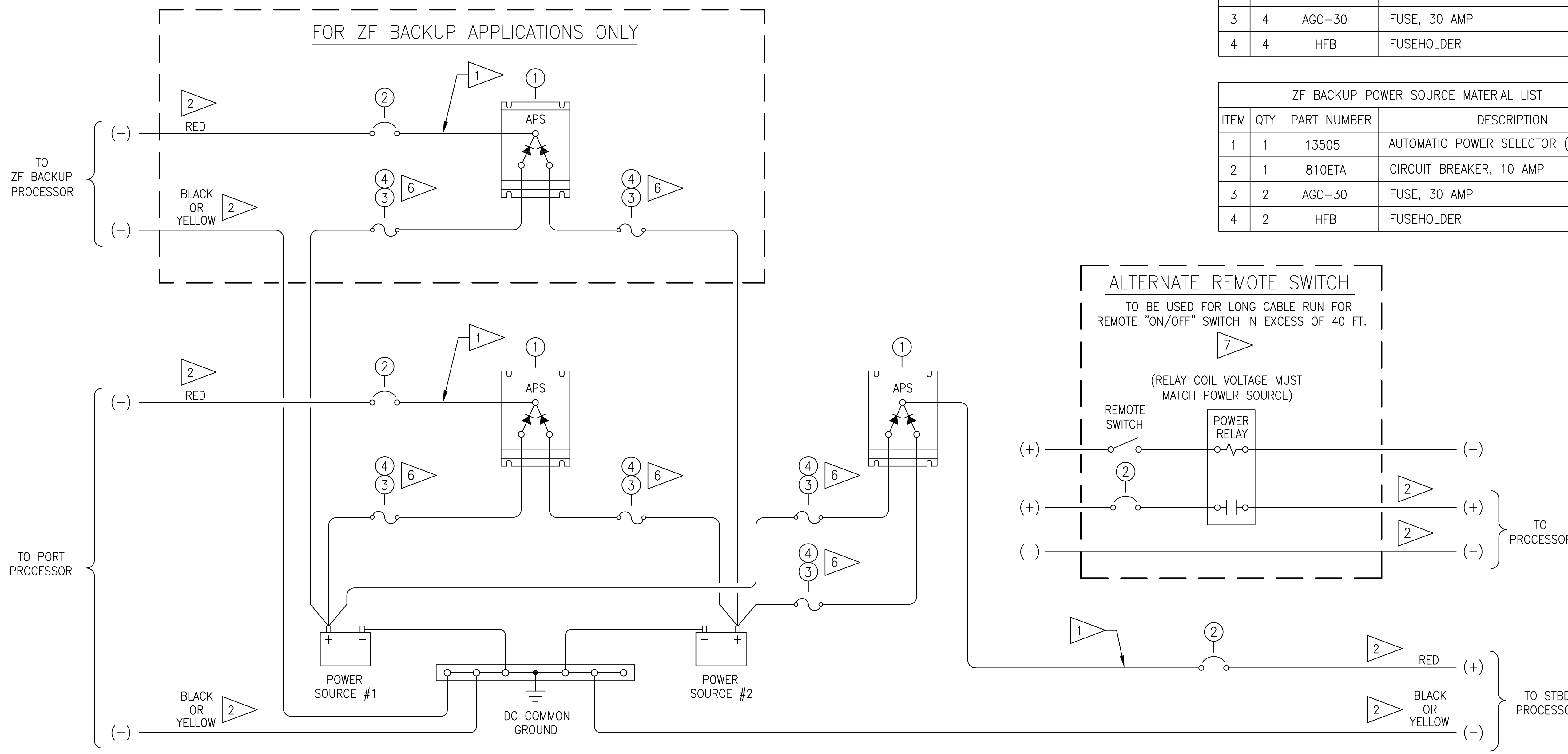
TITLE: DC POWER SOURCE KIT

SIZE	CAGE CODE	DWG NO.	REV
B		11488	H
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

TWIN SCREW, DUAL APS CONNECTIONS
WITH ALTERNATE REMOTE SWITCH
AND OPTIONAL ZF BACKUP

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE: DC POWER SOURCE KIT

SIZE: B | CAGE CODE: | DWG NO.: 11488 | REV: H
SCALE: NONE | PART NO.: SEE NOTE 5 | SHEET: 5 OF 5

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Grounding (Bonding)

Grounding (Bonding) - 46 CFR 111.05 and ABYC Section E-11: July 2012

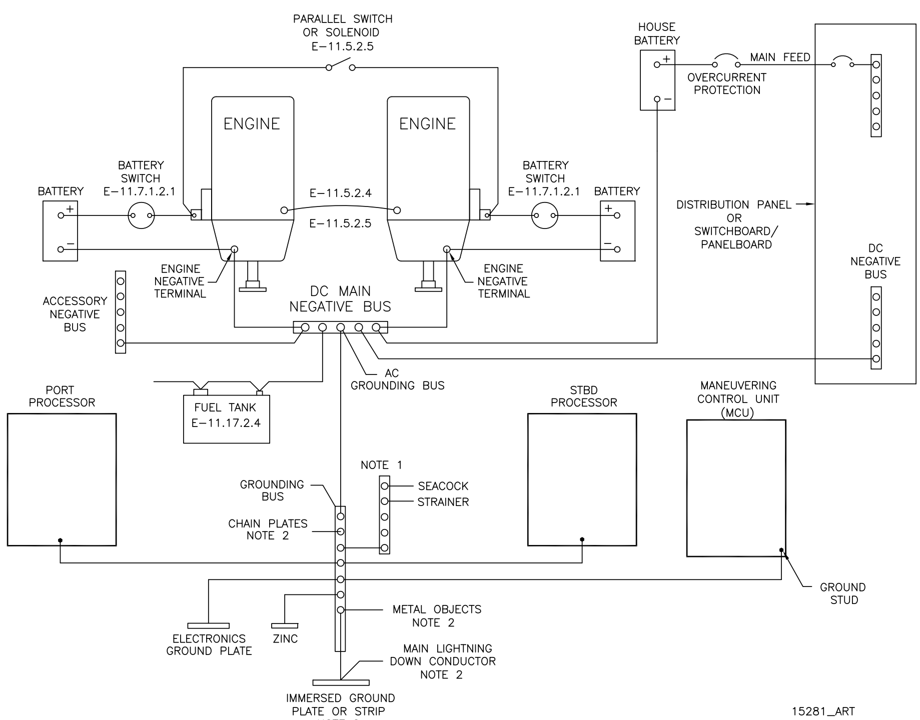
Grounding (Bonding) should be done according to ABYC Section E-11 and Code of Federal Regulations 46 CFR 111.05.

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.

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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

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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.

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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	

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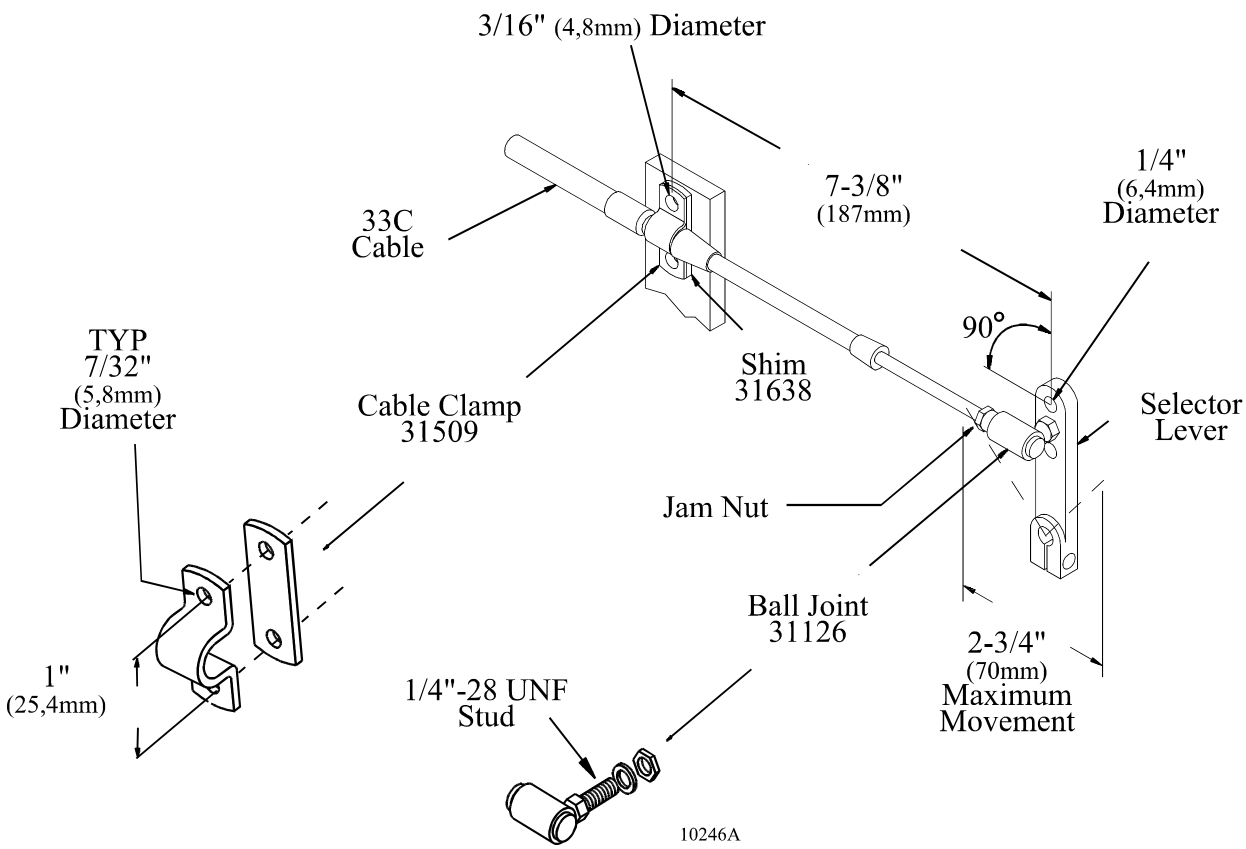
Universal Mounting Kit

Fabricate Bracket to match dimensions shown



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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

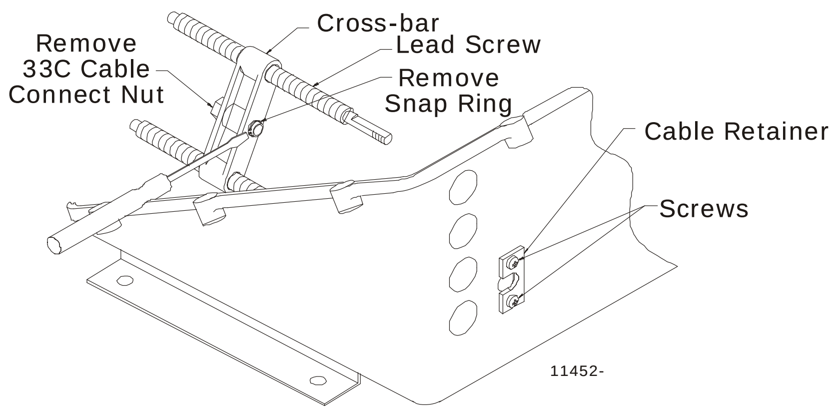

Figure 1: Actuator/Processor Preparation

	**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.**

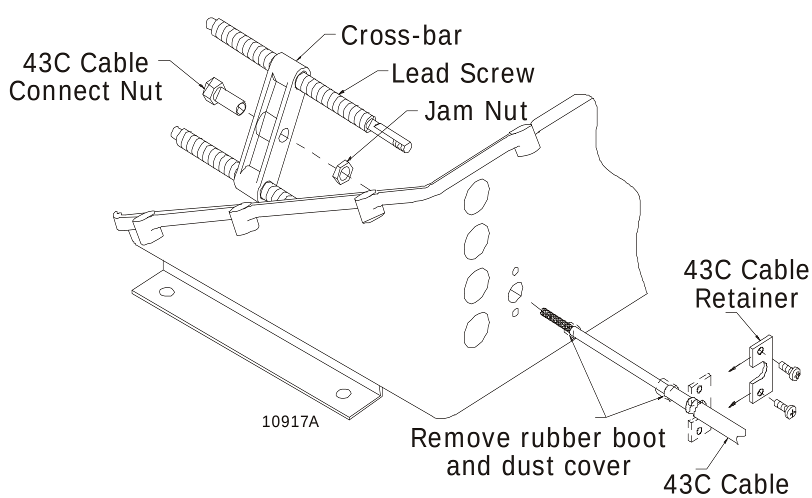

Figure 2: Actuator/Processor Cable Installation

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Station Expander User Instructions

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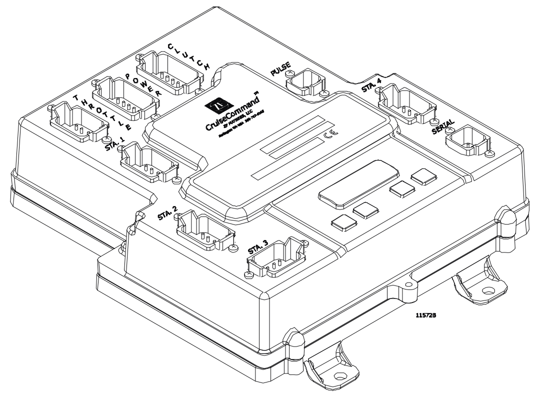

Figure MMC-343-1: Station Expander

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).

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.

2 Required Parts

- One Station Expander required per Processor.
- Mounting Hardware is installer supplied.
- System Operation Manual included with the Processor.

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.

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.

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 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)

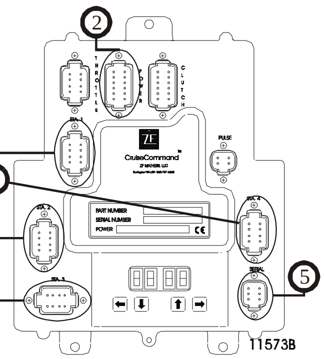

Figure MMC-343-2: Station Expander Harness Connector Locations

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.

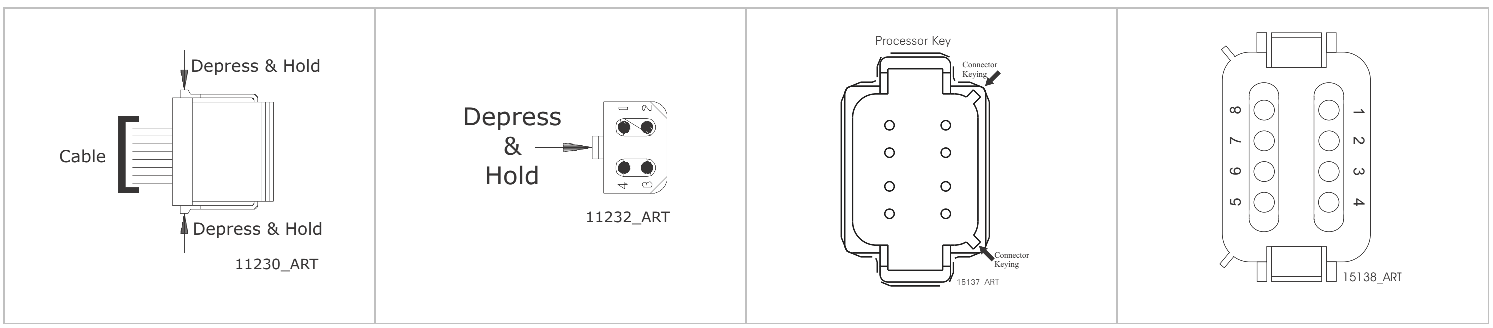

Figure MMC-343-3: Harness Plug Connectors

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

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)

7 Installation

Before starting the actual installation of the Station Expander, make sure you have the correct parts and tools. See section 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

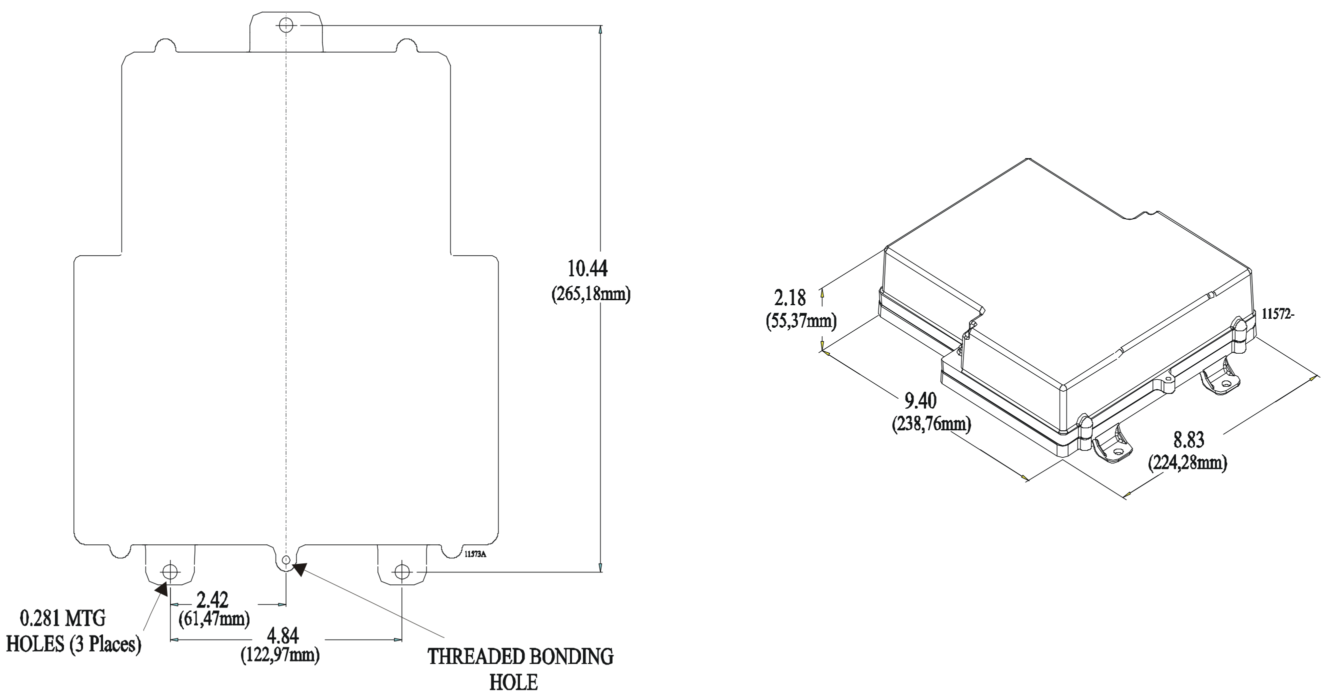

Figure MMC-343-4: Station Expander Dimensions

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.

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.

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

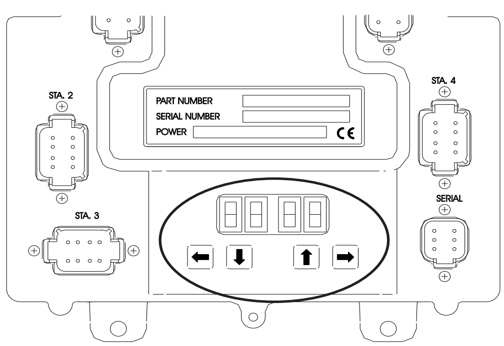

Figure MMC-343-5: Station Expander Display LED and Arrow Push Buttons

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

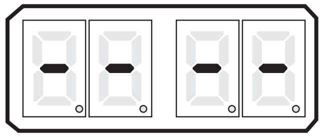

Figure MMC-343-6: Display LED at Normal Operation

- 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.

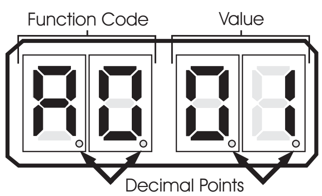

Figure MMC-343-7: Display LED Designations

- 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.

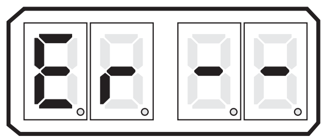

Figure MMC-343-8: Error Menu Example

  - 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:

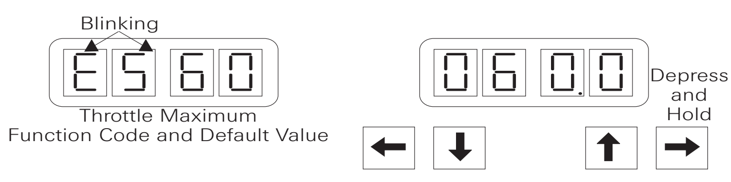

Figure MMC-343-9: Display LED Four Digit Value

  - 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.

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.

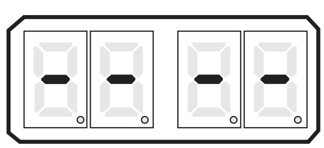

Figure MMC-343-10: Display Normal Operating Condition

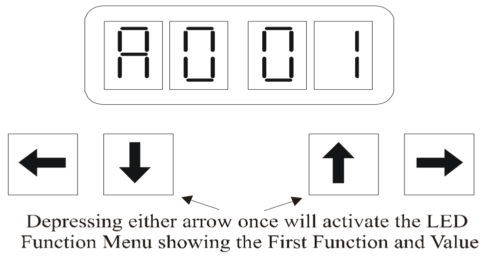

Figure MMC-343-11: Display Function Menu Activated

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.

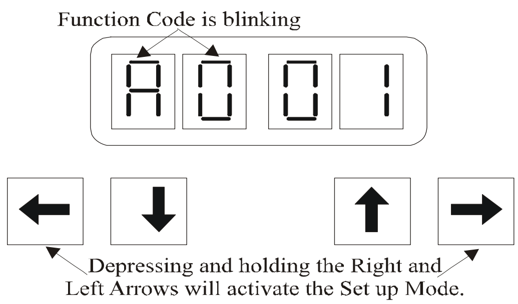

Figure MMC-343-12: Display with Set up Activated

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.

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.)

Table MMC-343-2: Troubleshooting Functions

Function Code	Function Name	Default Value	Value Range or Options
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.

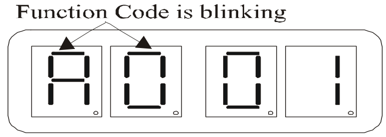

Figure MMC-343-13: Display with A0 - Station Expander Identification Set Up Activated

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 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 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)**

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.

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.

13 Parts List

Part No. **Description**

13.1 Control Heads

A **Single Screw**

450-3L or 3RLeft or Right Control Head, 'T' Lever
453-3L or 3RLeft or Right Control Head, Chrome Knob Lever
455-3L or 3RLeft 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 PLeft 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 –RLeft or Right Control Head, Heavy Duty
MC2000-1L or 1RLeft or Right Black Control Head, Black Lever
MC2000-2L or 2RLeft or Right Chrome Control Head, Chrome Lever
MC2000-4L or 4RLeft or Right Black Control Head, Chrome Lever
MC2000-4LP or 4RPLeft or Right Black Control Head, Chrome Lever, Pluggable
MC2000-5L or 5RLeft or Right Black Control Head, Gold Lever

B **Twin Screw** (Synchronization Indication)

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
MC2000-1PBlack Head, Black Levers, Pluggable
MC2000-2 Chrome Head, Chrome Levers
MC2000-2PChrome Head, Chrome Levers, Pluggable
MC2000-3 Gold Head, Gold Levers
MC2000-4 Black Head, Chrome Levers
MC2000-4PBlack Head, Chrome Levers, Pluggable
MC2000-5 Black Head, Gold Levers

13.2 Cable (Electric)

180	8-Cond. Shielded CablePer/ft.
350	8-Cond. Shielded Cable500' Spool
11811	8-Cond. Shielded Cable1000' Spool
212	2-Cond. Power CablePer/ft.
349	2-Cond. Power Cable250' Spool
183	2-Cond. Start Interlock CablePer/ft.
355	2-Cond. Start Interlock Cable250' 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)

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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.

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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.

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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.

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9000 Series Servo Throttle - Solenoid Clutch, Qualitative Failure Analysis & Design Verification Test Procedure				
Document #	AUTHOR	CHECKED	APPROVED	DATE
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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

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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.

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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

MM13927 Field Service Test Unit

Reference Manual

MM13927 Rev E.2 01/13

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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

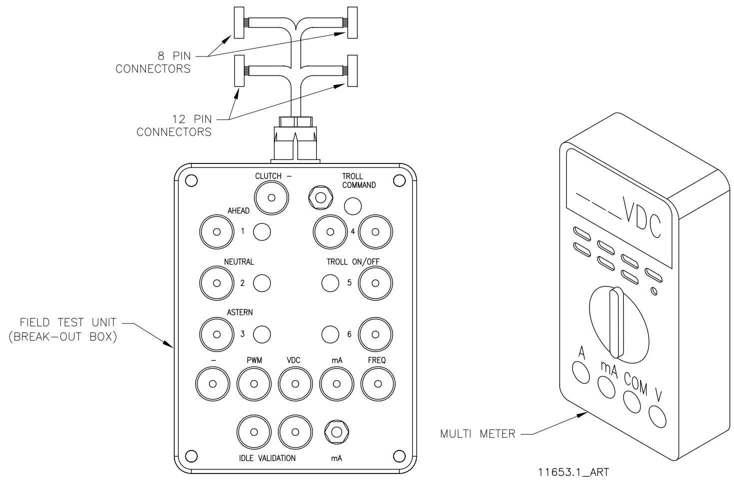


Figure MM13927-1: .Service Field Test Unit (Break-out Box)

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.

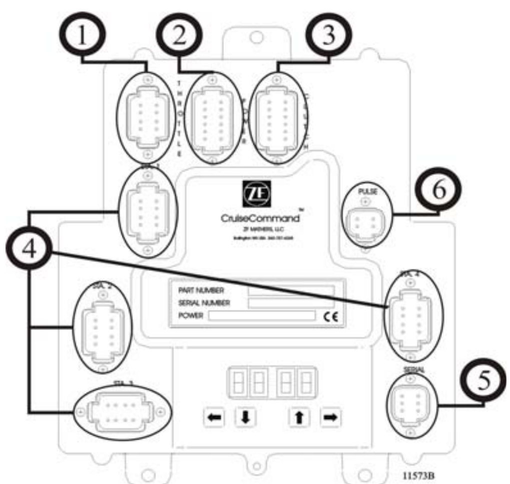


Figure MM13927-2: CruiseCommand Connector Locations

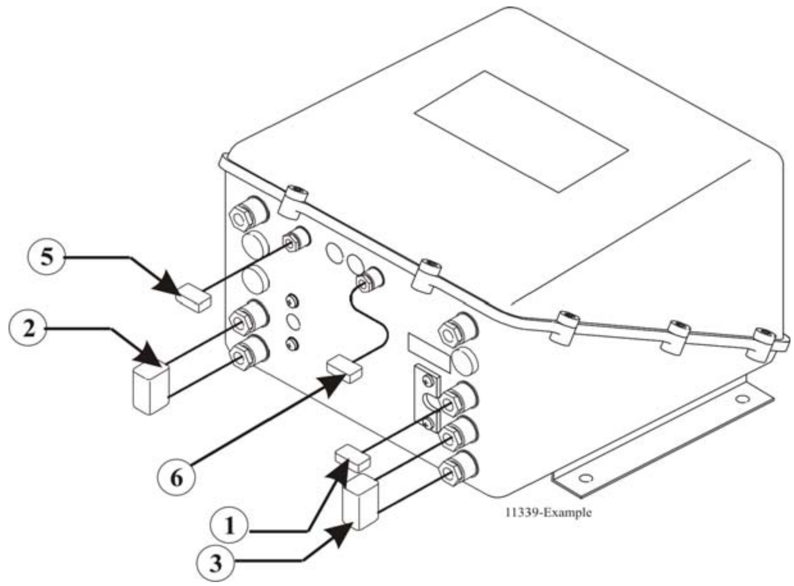


Figure MM13927-3: Example of CLEARCommand Pigtail Locations

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).

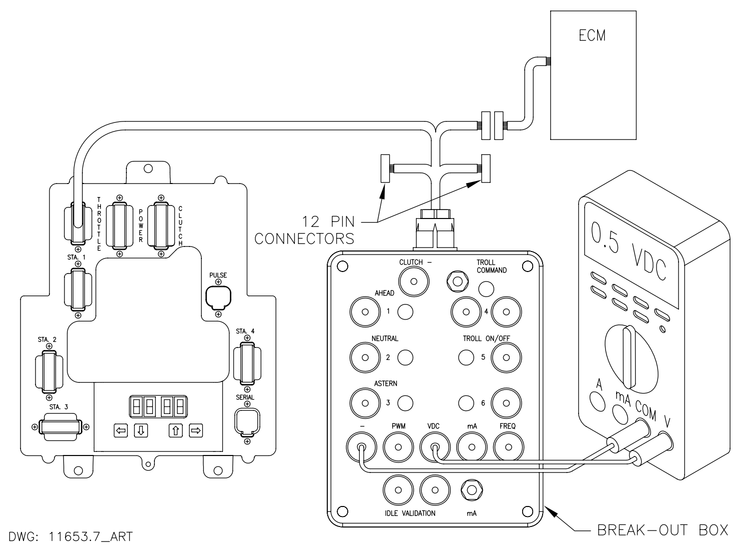


Figure MM13927-4: Throttle Connection (DC Voltage)

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).

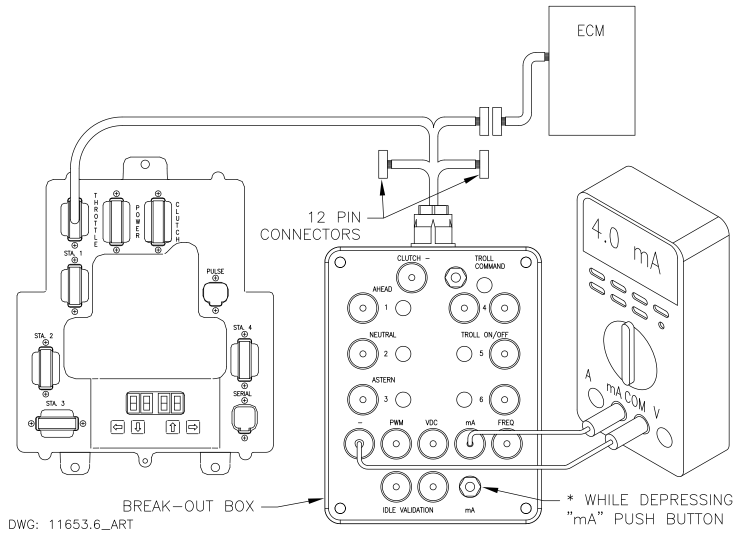


Figure MM13927-5: Throttle Connection (Current mA)

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".

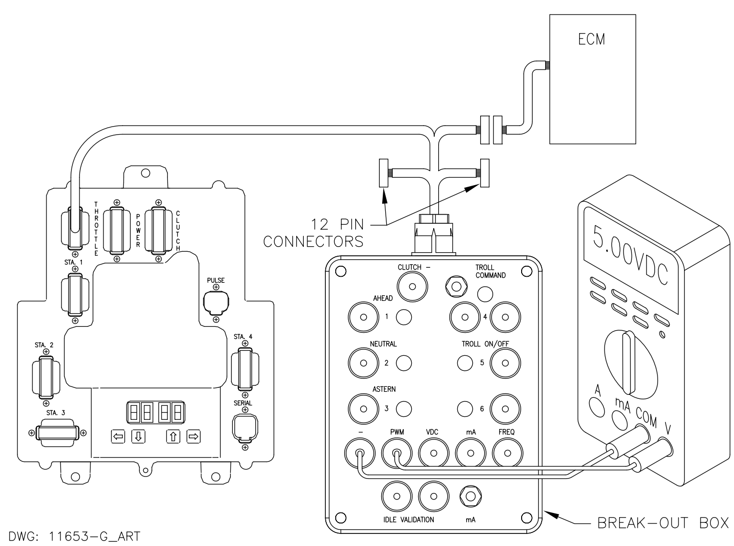


Figure MM13927-6: Throttle Connection (PWM with DC Voltmeter)

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).

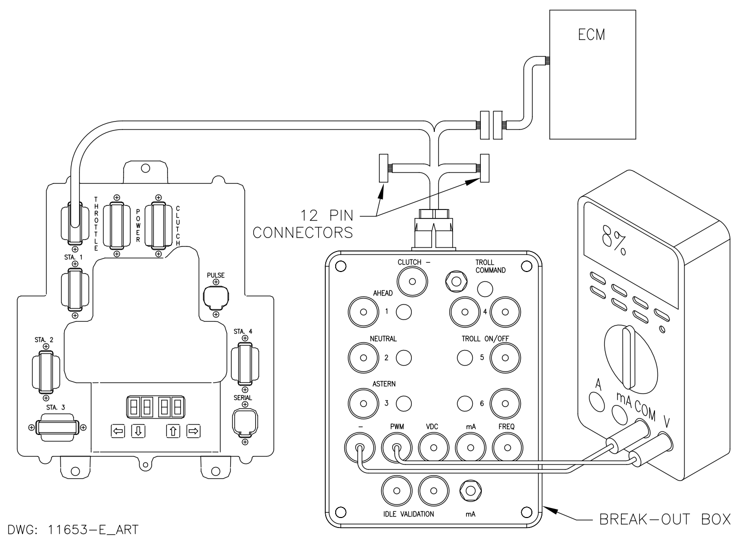


Figure MM13927-7: Throttle connection (PWM with Duty Cycle Meter)

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".

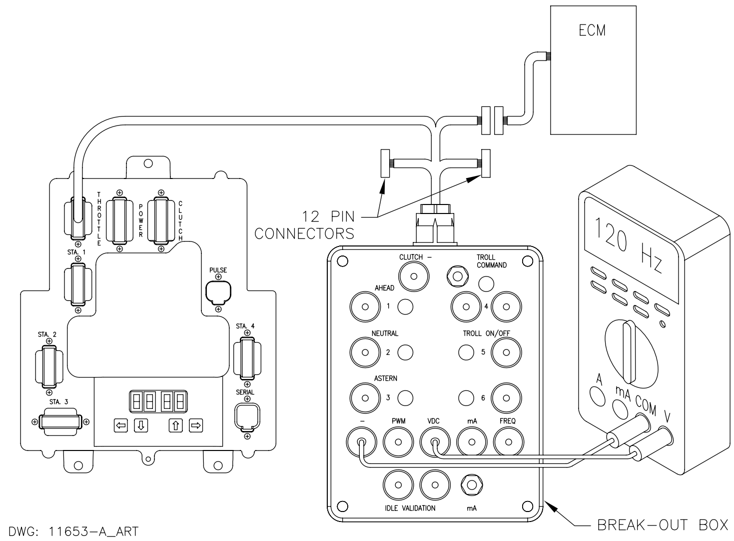


Figure MM13927-8: Throttle Connection (Frequency Hz)

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.

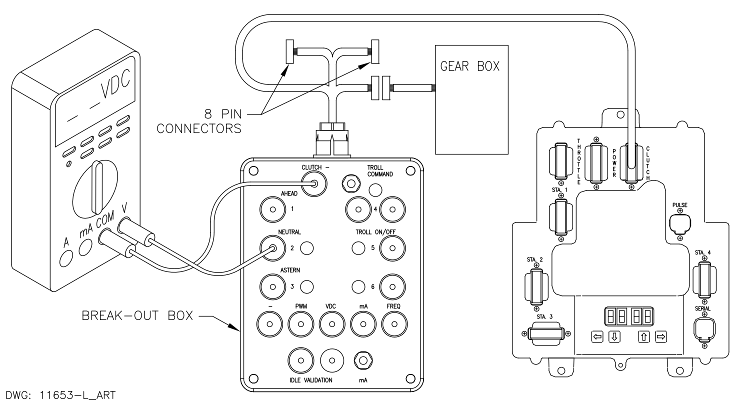


Figure MM13927-9: Clutch Connections Neutral Solenoid

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.

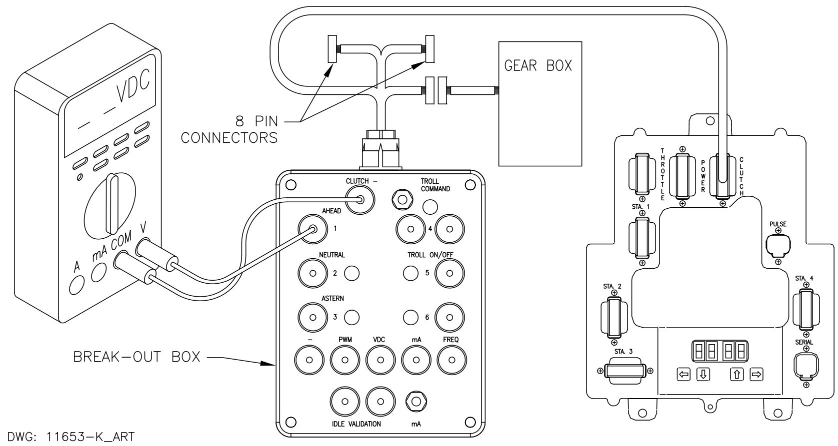


Figure MM13927-10: Clutch Connections Ahead Solenoid

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.

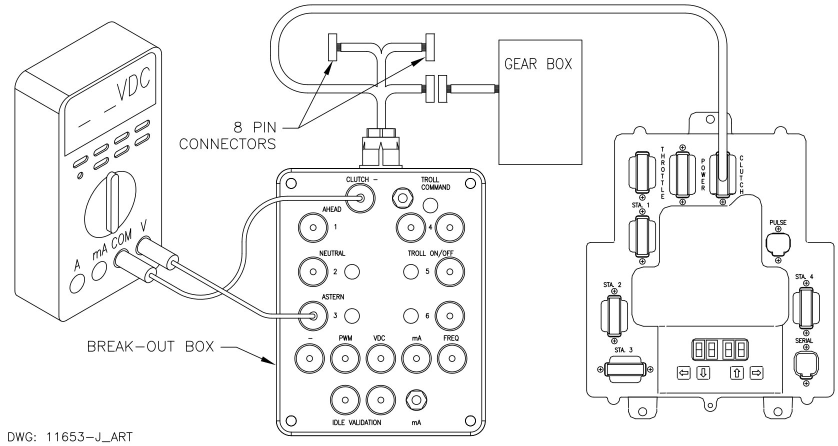


Figure MM13927-11: Clutch Connections Astern Solenoid

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.

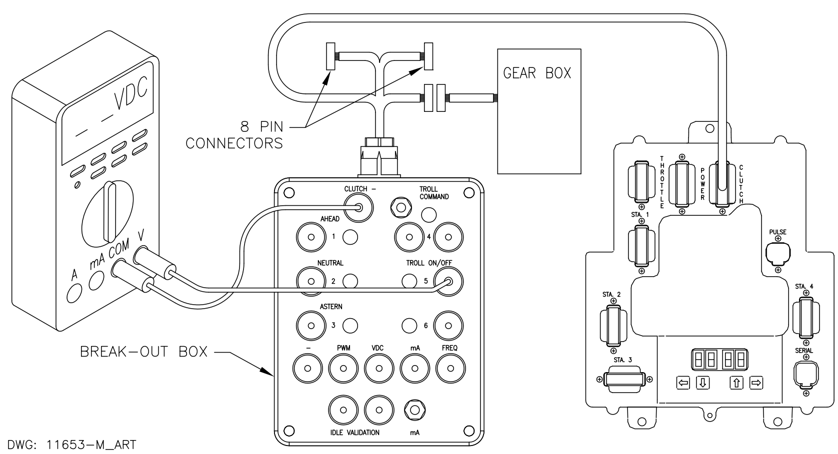


Figure MM13927-12: Troll Connections Troll On/Off Solenoid

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).

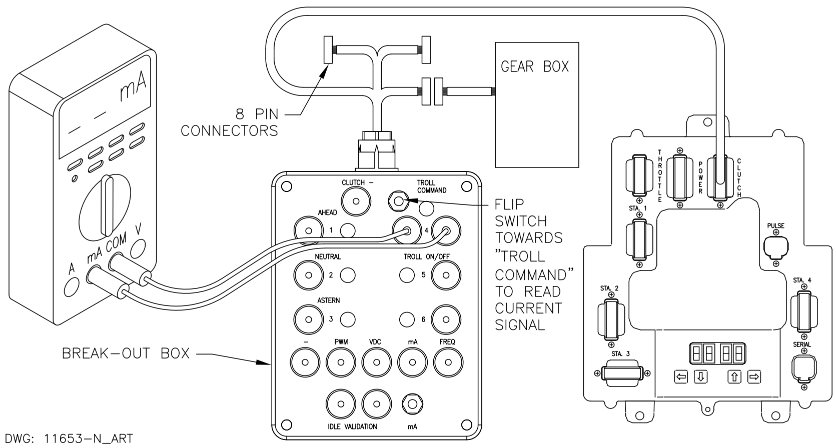


Figure MM13927-13: Troll Connections (Proportional Solenoid)

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

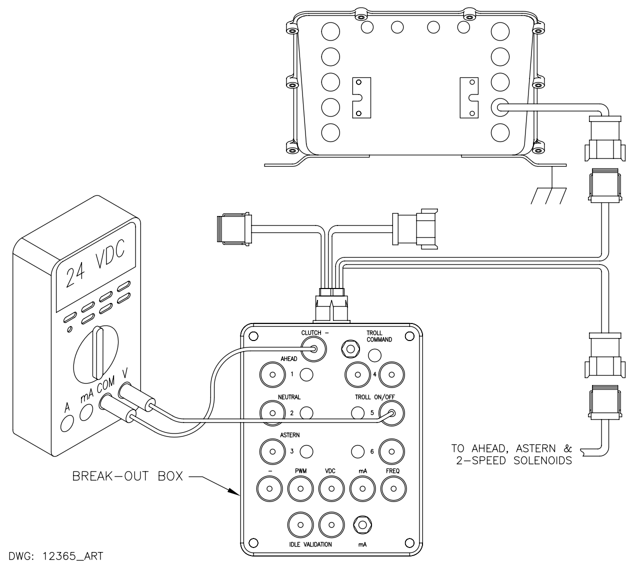


Figure MM13927-14: 2-Speed Connections

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 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 ENGINE, REDUCTION GEAR 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 SHIPS 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 0.5A, 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. IT 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 VESSELS 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 ADDTIONAL LIMITS FOR THESE INPUTS.
14. REFER TO THE CONTROL SYSTEM MANUAL FOR ADDITIONAL INFORMATION.
15. NOT USED
16. ENSURE THAT SHIELD ON THE SHIELDED CABLE IS CONNECTED ONLY AT ONE END TO THE CHASSIS AND THAT THE DRAIN WIRE DOES NOT TOUCH ANY OTHER CONDUCTIVE SURFACE. REFER TO THE INSTALLATION MANUAL FOR DETAILED 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 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 INTER–LOCK ARE REQUIRED, CLUTCH PRESSURE AND ALARM MAY BE OPTIONAL BASED ON CUSTOMER OR REGULATORY REQUIREMENTS.
19. NOT USED
20. NOT USED
21. THE ENGINE ROOM CONTROL HEAD MUST BE CONNECTED TO STATION ONE ON THE PROCESSORS.
22. NOT USED
23. THE SERVO POSITIONER 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 MANUFACTURERS SPECIFICATIONS, OR EVERY 400 TO 500 HOURS OF VESSEL OPERATION OR THE BEGINNING OF THE OPERATING SEASON.
24. NUMBER AND CONFIGURATION OF SERVO'S WILL VARY BY PART NUMBER OF CLEARCOMMAND. REFER TO KEY ON SHEET 2.
25. CONTACT ZF MARINE ELECTRONICS OR REFER TO THE PROCESSOR'S INSTALLATION MANUAL FOR THE OPTIONS AVAILABLE FOR THIS ITEM.
26. THE PROCESSOR CAN ACCOMODATE UP TO 5 STATIONS, EITHER HARD WIRED OR WITH FACTORY INSTALLED PIGTAILS. REFER TO THE KEY ON SHEET 2 FOR THE NUMBER OF FACTORY INSTALLED PIGTAILS.

MATERIAL LIST

√	ITEM	QTY	PART NUMBER	DESCRIPTION
	1	1	SEE TABLE 1	CONTROL PROCESSOR, PREMIUM CLEARCOMMAND
	2	MAX. 5	25	CONTROL HEAD
	3	1	13505	AUTOMATIC POWER SELECTOR
	4	1	810ETA	CIRCUIT BREAKER, 10A, UL1500
	5	1	25	WIRE HARNESS– TACHOMETER SENSOR, XX FEET
	6	1	25	WIRE HARNESS– POWER/START INTLCK/CLUTCH PRESSURE SW., XX FEET
	7	MAX. 5	25	WIRE HARNESS– CONTROL HEAD, XX FEET
	8	1	25	WIRE HARNESS– CLUTCH/TROLL, XX FEET
	9	1	25	WIRE HARNESS– THROTTLE, XX FEET
	10	1	70434–XXX	CLUTCH PRESSURE SWITCH KIT– PRESET AT FACTORY
	11	1 OR 2	25	SWITCH, SELECTOR, TWO POSITION
	12	1 OR 2	25	CONTACT BLOCK, NC
	13	1 OR 2	25	CABLE, 2 CONDUCTOR, 16–18 AWG

INDEX

SHEET	DESCRIPTION
1	GENERAL NOTES
2	TABLE 1, WIRE HARNESS/SERVO CONFIGURATION
3	SYSTEM DRAWING
4	INTERNAL PROCESSOR CONNECTIONS

REVISION

ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	QC/CE APR
	A	SHEET 2: ADDED 9512X, 9522X, 9610X, 9612X	RAC 03/13/08	RSA 03/14/08	RBH 03/14/08

APPROVAL		DATE
DRN	G.GARMAN	5–17–07
ENG	C.ESTES	5/18/07
CHK	–	–
QC	RBH	5/18/07
PUB	–	–

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE: PREMIUM CLEARCOMMAND PROCESSORS, SINGLE SCREW, SYSTEM DRAWING (SEE TABLE 1)

SIZE: B | CAGE CODE: | DWG NO. 13959 | REV: A
SCALE: NONE | PART NO. – | SHEET 1 OF 4

REVISION					
ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	Q.C. APR
		—SEE SHEET 1—			

TABLE 1

PIGTAIL/SERVO CONFIGURATION								
CONTROL PROCESSOR	CLUTCH WIRE HARNESS	THROTTLE WIRE HARNESS	MAG PICKUP WIRE HARNESS	SERIAL COMM WIRE HARNESS	CONTROL HEAD WIRE HARNESS	POWER/S.I./ALARM/CP WIRE HARNESS	SERVO 1	SERVO 2
PN: 9510X			✓	✓	SEE KEY	✓	✓ (CLUTCH)	✓ (THROTTLE)
PN: 9512X			✓	✓		✓	✓ (CLUTCH)	✓ (THROTTLE)
PN: 9520X	✓		✓	✓		✓		✓ (THROTTLE)
PN: 9522X	✓		✓	✓		✓		✓ (THROTTLE)
PN: 9610X		✓	✓	✓		✓	✓ (CLUTCH)	
PN: 9612X		✓	✓	✓		✓	✓ (CLUTCH)	
PN: 9620X	✓	✓	✓	✓		✓		
PN: 9622X	✓	✓	✓	✓	SEE KEY	✓		

5 = MECHANICAL (SERVO 2)
6 = ELECTRONIC

1 = MECHANICAL (SERVO 1)
2 = SOLENOID

0 = NONE
1 = MECHANICAL TROLL (SERVO 1)
2 = SOLENOID TROLL

OF STATIONS WITH FACTORY INSTALLED PIGTAIL

9XXXX

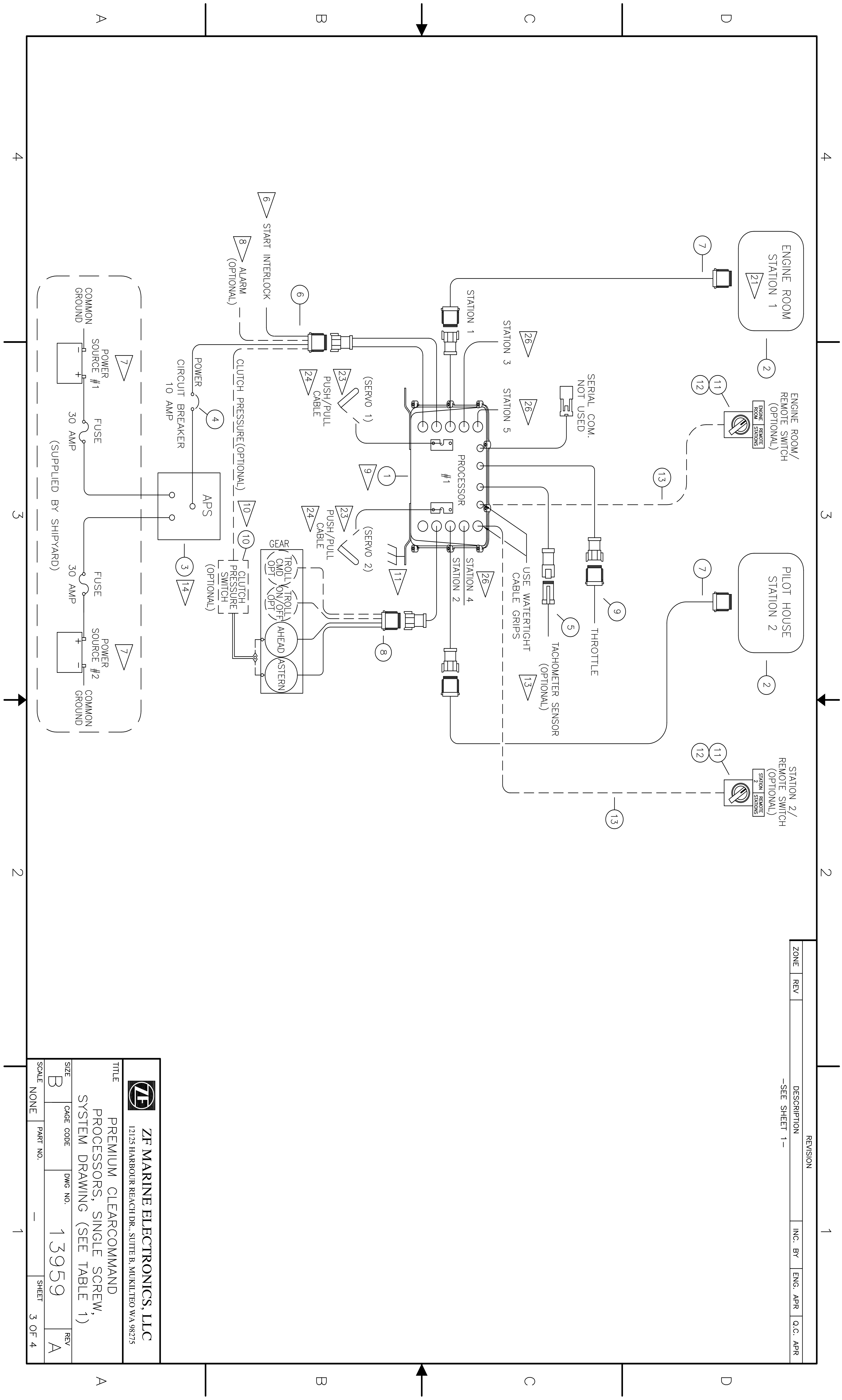
TROLL
GEAR
THROTTLE

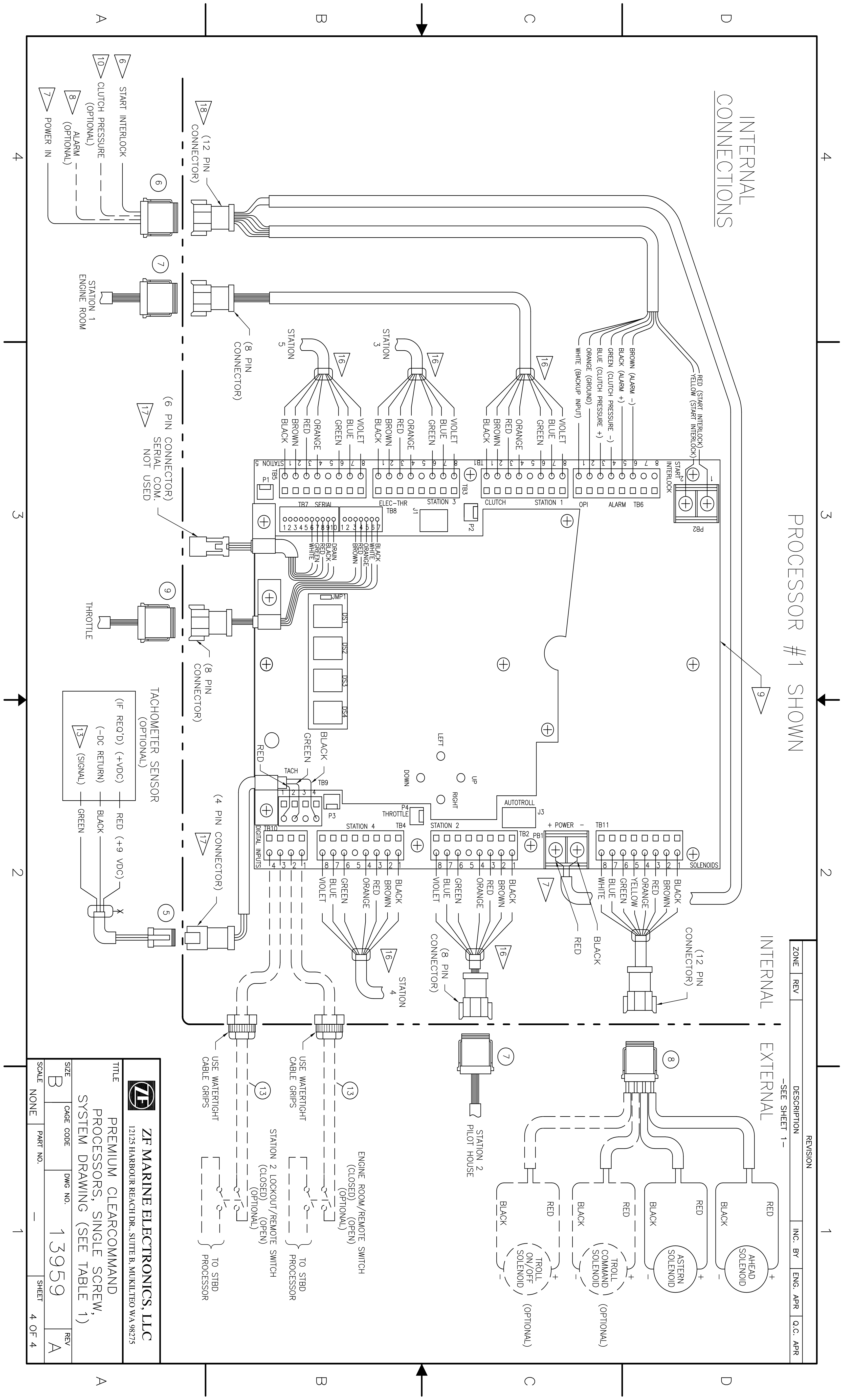
KEY

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE: PREMIUM CLEARCOMMAND PROCESSORS, SINGLE SCREW, SYSTEM DRAWING (SEE TABLE 1)

SIZE	CAGE CODE	DWG NO.	REV
B		13959	A
SCALE NONE	PART NO. —		SHEET 2 OF 4


ENGINE ROOM
STATION 1
PILOT HOUSE
STATION 2
ENGINE ROOM/
REMOTE SWITCH
(OPTIONAL)
STATION 2/
REMOTE SWITCH
(OPTIONAL)
STATION 1
STATION 3
STATION 5
STATION 4
STATION 2
SERIAL COM.
NOT USED
PROCESSOR
#1
(SERVO 1)
(SERVO 2)
PUSH/PULL
CABLE
USE WATERTIGHT
CABLE GRIPS
THROTTLE
TACHOMETER SENSOR
(OPTIONAL)
START INTERLOCK
ALARM
(OPTIONAL)
CLUTCH PRESSURE(OPTIONAL)
CLUTCH
PRESSURE
SWITCH
(OPTIONAL)
GEAR
TROLL
CMD
OPT
TROLL
ON/OFF
OPT
AHEAD
ASTERN
POWER
CIRCUIT BREAKER
10 AMP
APS
POWER
SOURCE #1
POWER
SOURCE #2
FUSE
30 AMP
COMMON
GROUND
(SUPPLIED BY SHIPYARD)
ZONE
REV
REVISION
DESCRIPTION
—SEE SHEET 1—
INC. BY
ENG. APR
Q.C. APR
ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275
TITLE
PREMIUM CLEARCOMMAND
PROCESSORS, SINGLE SCREW,
SYSTEM DRAWING (SEE TABLE 1)
SIZE
B
CAGE CODE
DWG NO.
13959
REV
A
SCALE
NONE
PART NO.
—
SHEET
3 OF 4


INTERNAL CONNECTIONS
PROCESSOR #1 SHOWN
INTERNAL
EXTERNAL
ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275
TITLE
PREMIUM CLEARCOMMAND PROCESSORS, SINGLE SCREW, SYSTEM DRAWING (SEE TABLE 1)
SIZE
B
CAGE CODE
DWG NO.
13959
REV
A
SCALE
NONE
PART NO.
—
SHEET
4 OF 4
ZONE
REV
DESCRIPTION
REVISION
—SEE SHEET 1—
INC. BY
ENG. APR
Q.C. APR
START INTERLOCK
CLUTCH PRESSURE (OPTIONAL)
ALARM (OPTIONAL)
POWER IN
(12 PIN CONNECTOR)
(8 PIN CONNECTOR)
STATION 1 ENGINE ROOM
(6 PIN CONNECTOR) SERIAL COM. NOT USED
THROTTLE
TACHOMETER SENSOR (OPTIONAL)
(4 PIN CONNECTOR)
STATION 2 PILOT HOUSE
AHEAD SOLENOID
ASTERN SOLENOID
TROLL COMMAND SOLENOID
TROLL ON/OFF SOLENOID
(OPTIONAL)
USE WATERTIGHT CABLE GRIPS
ENGINE ROOM/REMOTE SWITCH
STATION 2 LOCKOUT/REMOTE SWITCH
TO STBD PROCESSOR

15 Appendix E - CANtrak User Manual

CANtrak Display User Manual

Installation, Operation and Troubleshooting

MM70179 Rev C.1 01/12

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Legal Information

The information in this manual is believed to be accurate at the time of publication, but no responsibility, direct or consequential, can be accepted for damage resulting from the use of this information. ZF Marine Electronics, LLC, reserves the right to make changes to any of its products without notice.

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Revisions List

Rev	Date	Revision Description
A	8/06	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
B	5/07	Reformatted
C	3/09	Software Revised to SW70203.4, adding station 6 display
C.1	01/12	Revised per ELR00163, SW70203.6

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 Electronics control system for your vessel.

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 Electronics 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 Electronics designed equipment. DO NOT operate this equipment with any other manufacturers equipment unless approved so in writing by ZF Marine Electronics Engineering Department.

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 Electronics' Sales & Service Organization (SSO) or refer to the Sales and Service Organization Documents in this manual.

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

1 Introduction

The CANtrak Display provides a visual representation of various items which are beneficial in the operation of a vessel's propulsion system. The information provided varies from system to system, but may include items such as station in command, transfer status, mode of operation, engine rpm, shaft rpm, etc.

The Display may be configured to provide information on one to five propulsion systems and may be fitted at one or all of the Propulsion Control Stations.

Figure MM70179-1: Display On Power-up

2 Specifications

2.1 Electrical

Display (resolution): 160 x 128 pixels

Power requirements: 10 to 32 VDC

Power consumption: 110 mA @ 12 VDC (backlight off) 130 mA @ 12 VDC (backlight on)

Audible alarm: 80 db @ 2.4 kHz

Wiring protection: Reverse polarity protected (fuse must be installed)

Environmental

Meets BS EN 60945 requirements

Operating temperature: -40 to 70°C (-40 to 158°F)

Humidity range: >95% RH

Degree of protection: Sealed to IP65/NEMA 4

Vibration: Tested to 3.35G RMS, 5 Hz to 2 kHz in X,Y & Z axis.

Salt-spray: Tested for 28 days, conditions 40°C (104°F) @ 93% RH

EMC: Meets the requirements of European Directive 89/336/ EC, using methods and limits defined in BS EN 60945.

2.2 Mechanical

Case material: ACB/ poly carbonate alloy

Case color: Anthracite grey

Dimensions: Bezel size – 4.33" x 4.33" (110mm x 110mm)

Bezel depth: 0.95" (24mm) (including seal)

Panel cut-out: Front mount – 2.52" (64mm) diameter hole with (4) mounting holes 0.17" (4.3mm) diameter

Rear mount – 4.45" x 4.45" (113mm x 113mm) with (4) 0.17" (4.3mm) mounting holes on 2.75" x 5.5" (70mm x 140mm) centers.

Overall case depth: 2.05" (52mm)

3 Theory Of Operation

The CANtrak Display is used in some of ZF Marine Electronics control systems to provide the operator with useful information regarding the propulsion and propulsion control systems. This information is obtained from the ClearCommand/SmartCommand Processors' CAN serial bus. The display is in a simple graphic/text format. The display presently is capable of supplying the following information:

- The name of the Station presently in control.
- The mode of operation (Warm-up, Cruise, Troll, DP Station)
- The percent of throttle (0- 100%) being commanded is displayed numerically.
- The position of the Control Head's lever(s) is displayed graphically.
- The actual engine RPM is displayed numerically.
- The clutch command (ahead, neutral or astern) is displayed graphically.
- The actual shaft RPM is displayed numerically.
- Transfer instructions in Transfer Modes 03 and 04.
- Diagnostic Information.

4 Operation in Cruise Mode

A The Display and Control System's power may be supplied from different sources. Whenever power is first applied to the Display, it will automatically go through a self test and a CAN bus test. Refer to Figure MM70179-2: No Processor Power.

B If no data is present on the CAN bus, the message "No Serial Data" will be visible on the Display. This is the case when there is no power to the Propulsion Control System.

Figure MM70179-2: No Processor Power

C Applying power to the Control System and taking command at a Remote Station establishes communication between the Processor and the Display. The “No Serial Data” messages are no longer visible. If installed in a twin screw application, the Display will appear as shown below.

Figure MM70179-3: Processor Power On

D When the engines are started, the RPM of each engine will be displayed next to the word “Throttle” (Tach Sender inputs must be connected to the Processors).

Figure MM70179-4: Engines Started

E Moving the port and starboard Control Head levers to the Ahead detent engages the Ahead clutches.

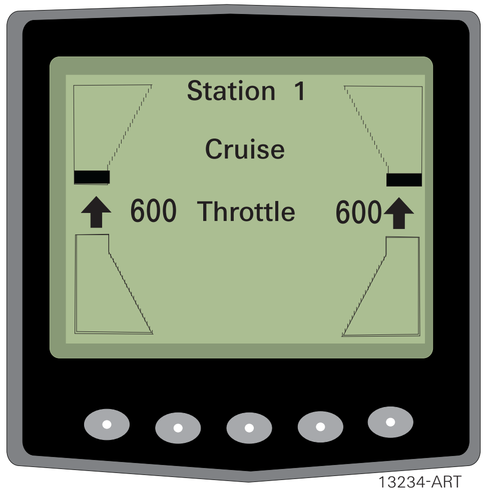


Figure MM70179-5: Ahead Detent

F Moving the Control Head levers further forward to the stops increases the throttle from Idle to Full.

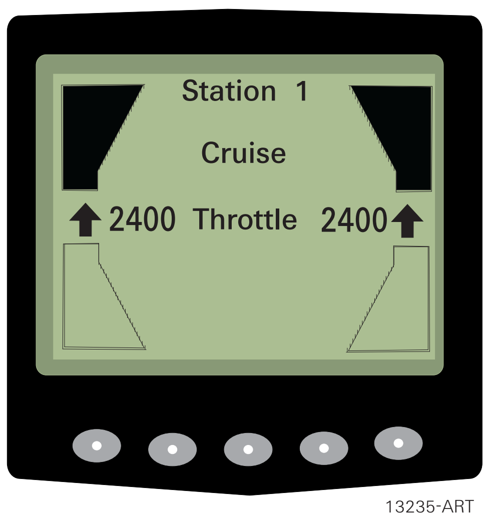


Figure MM70179-6: Full Ahead

G Movement of the levers from Full Ahead to the Astern detent position, decreases throttle to Idle, after the proportional delay expires, the Astern Clutch is commanded On.

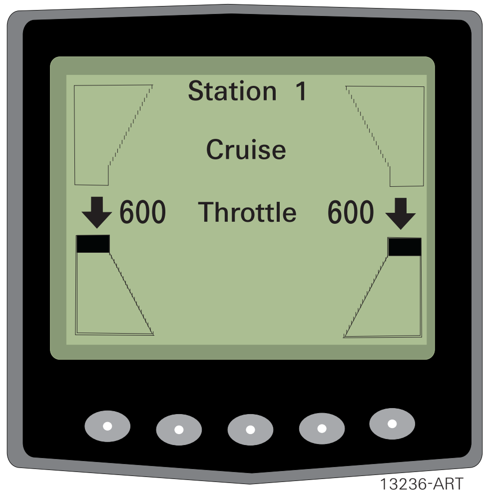


Figure MM70179-7: Astern Detent - Idle Throttle

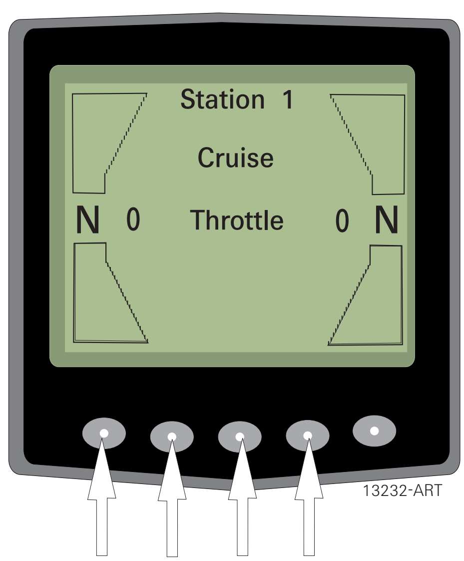
5 Display Configurability

The items displayed, including number of screws, screen brightness and contrast can be configured by the operator. Some of the items which can be displayed are dependent on providing the Processors with the appropriate feedback information (i.e., Shaft RPM, Engine RPM, etc.).

NOTE: All of the items listed below can be displayed on the CANtrak screen. However, if the appropriate feedback information is not provided to the Processor, the value displayed for that item will remain at 0.

In order to make a change, the following procedure must be followed:

A Press any one of the four buttons to the left.



Press any one of these buttons

Figure MM70179-8: Four Buttons

B Press the button labeled “CHNG DISP” located to the far left.

Figure MM70179-9: "CHNG DISP" Button

C Use the Up and Down arrows to enclose the desired area of the screen in a box.

Figure MM70179-10: Up And Down Arrows

- Up to five items may be displayed at a given time.
- All five can be viewed on the Display or some may be left blank.
- The items available for viewing are:

Trolling	(100 is Lockup)
Lever	(100 is Full Ahead Throttle, -100 is Full Astern Throttle)
RPM	(Actual Engine RPM)
Shaft	(Actual Output Shaft RPM)
Shaft Cmd	(Commanded Percent of Lockup)
Blank	(No Item is Displayed)

D Once the desired area of the screen is enclosed in a box, press the middle “SET” button.
- The area will become highlighted as shown below.

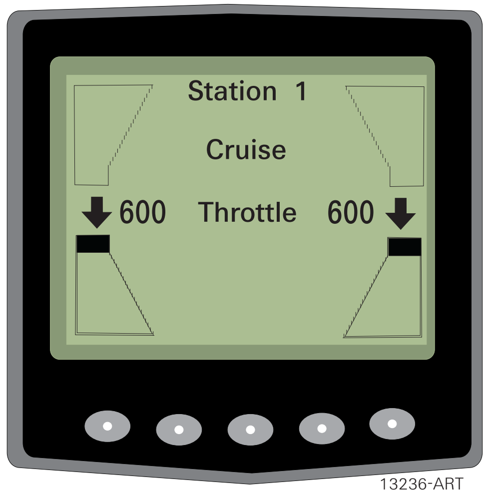


Figure MM70179-11: Full Ahead To Astern Detent

E Use the Up and Down arrows until the highlighted area is blank or the desired item is listed.
F Once highlighted, press the “SET” button.
- The highlighted item is programmed into memory and will be displayed on the screen.

G If any other changes to the items displayed are required, repeat steps A) through F).

6 Parameter Changes

There are two functions performed within the Parameter Change page. The first, “Number Screws”, programs the CANtrak Display to provide information on one to four screws. The second, “Number Pulses” is only required when a Tach Sender input is being utilized. The number entered, depending on the source, represents the number of pulses per revolution of the engine or the output shaft. This value is used to calculate the correct RPM displayed on the CANtrak screen.

In order to make a change, the following procedure must be followed:

A Press any one of the four buttons to the left.
B Press the button labeled “CHNG PARM” located second to the left.
C Use the Up and Down arrows to select “Number Screws” or “Number Pulses”.
D Once the desired area of the screen is enclosed in a box, press the middle “SET” button.

- The area will become highlighted as shown below.

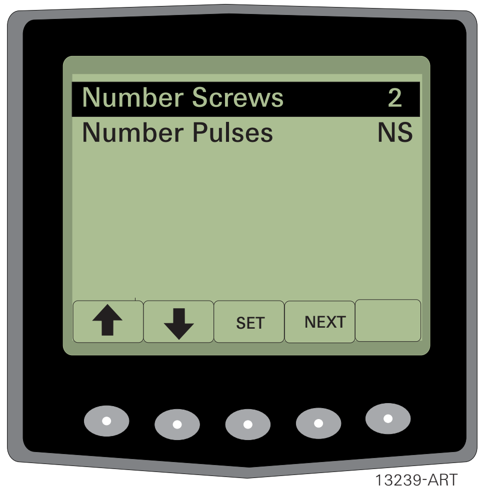


Figure MM70179-12: "Number Screws" Selected

E Press the Up or Down arrow button until the desired number of screws is displayed.

F Press the “SET” button.

- The desired number of screws is programmed into memory and displayed on the screen.

G If a change to “Number Pulses” is required, press the Down arrow once, followed by pressing the “SET” button to highlight.

- The Up and Down arrows are now used to change the number of pulses required.

H Press the “SET” button to program to memory.

I Maximum number of pulses is 1022, per SW70203.6.

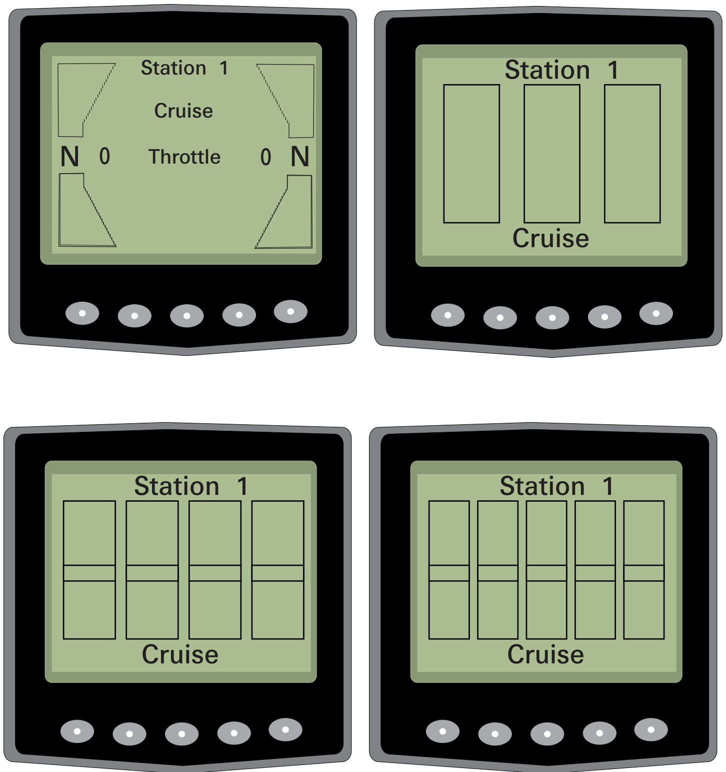
J To exit the Parameter Change page, press the “NEXT” button, the new standard Display screen will reflect the changes that you made.

Single & Twin Screw

Triple Screw

Quad Screw

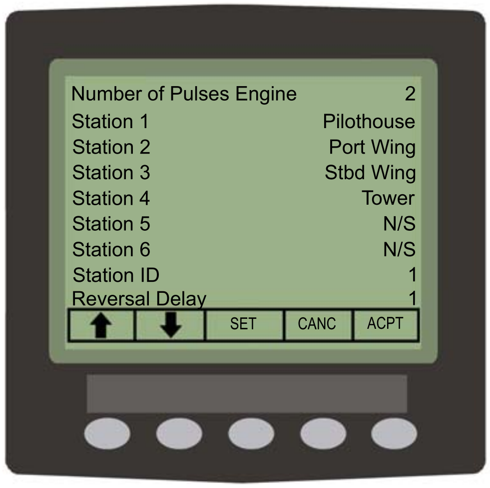
Quint Screw



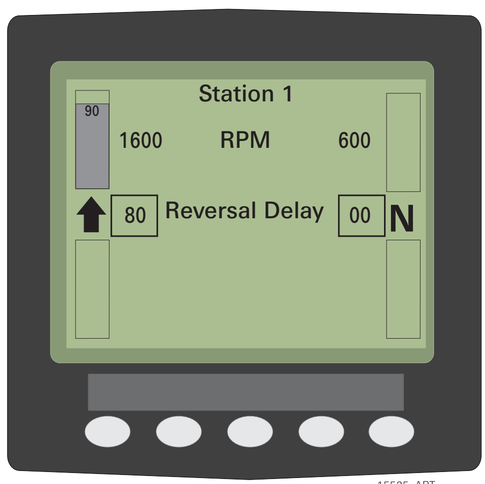
13241-ART

7 Reverse Delay

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.Provides the ability to display the reversal delay on the main page:



15524_ART



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8 Installation

8.1 Required Materials

Display- LCD:

- Part No. 70179. Minimum of (1) for up to 5 screws.

Wire Harness- Display

- Multi-drop, 20' Power, P/N 70186. One required per Display

Termination Resistor,

- Part No. 15133. One required per System.

8.2 Display (Part No. 70179)

8.2.1 ON Console Mounting

A Decide on a suitable location.

- Allow adequate clearance behind the unit to ensure cable connections are not unduly stressed.
- Ensure that there is sufficient length of cable to remove the unit for servicing purposes.
- For best results, ensure there is adequate ventilation behind the unit.

B Using the template supplied as a guide, cut out the hole in the console for the back of the unit and drill (4) 0.170" (4.3mm) holes for the studs provided.

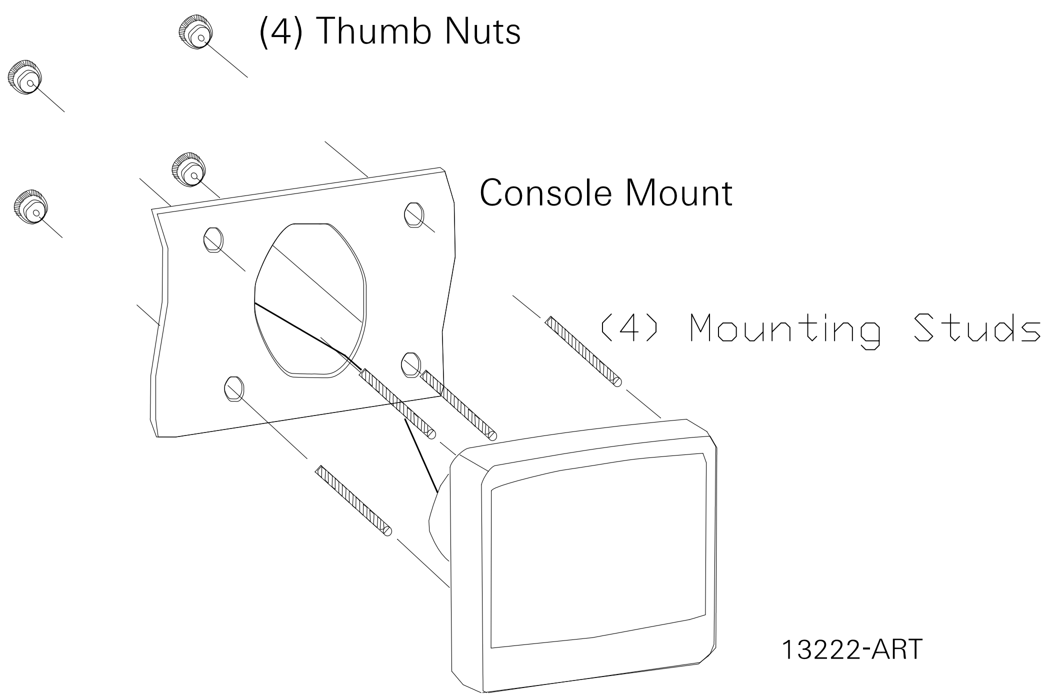


Figure MM70179-13: On Console Mounting

C Screw the (4) studs into the rear of the Display Unit. If required, longer M4 studs can be used (not supplied).

D Connect the Serial Communication Harness into the Plug at the back of the unit.

E Place the unit into position; secure it by screwing the thumb nuts onto the studs.

8.2.2 Behind Console Mounting

If the installation requires the mounting of the Display to be behind the console, a Kit is available through Teleflex Morse Electronics. The part number is 932061.

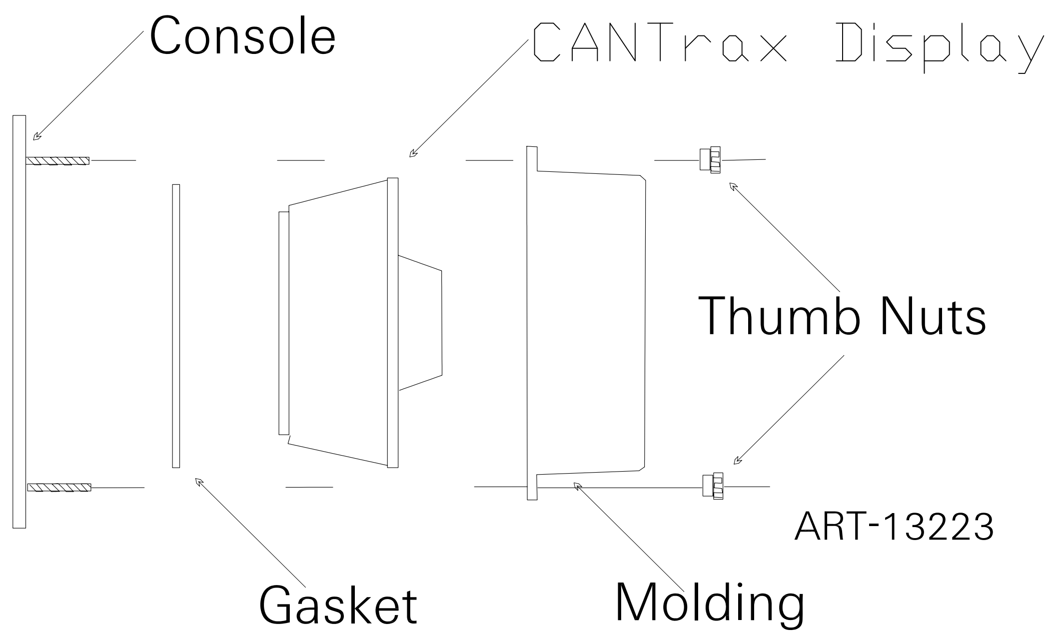


Figure MM70179-14: Behind Console Mounting

8.2.3 TRUNNION MOUNTING

If the installation requires that the Display be mounted in a vertical or near vertical fashion (the angle is adjustable), a kit is available through Teleflex Morse. The part number is 930293.

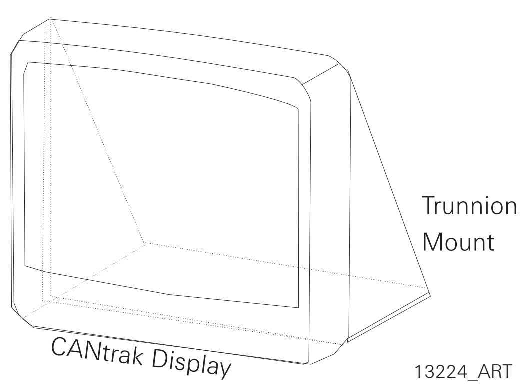
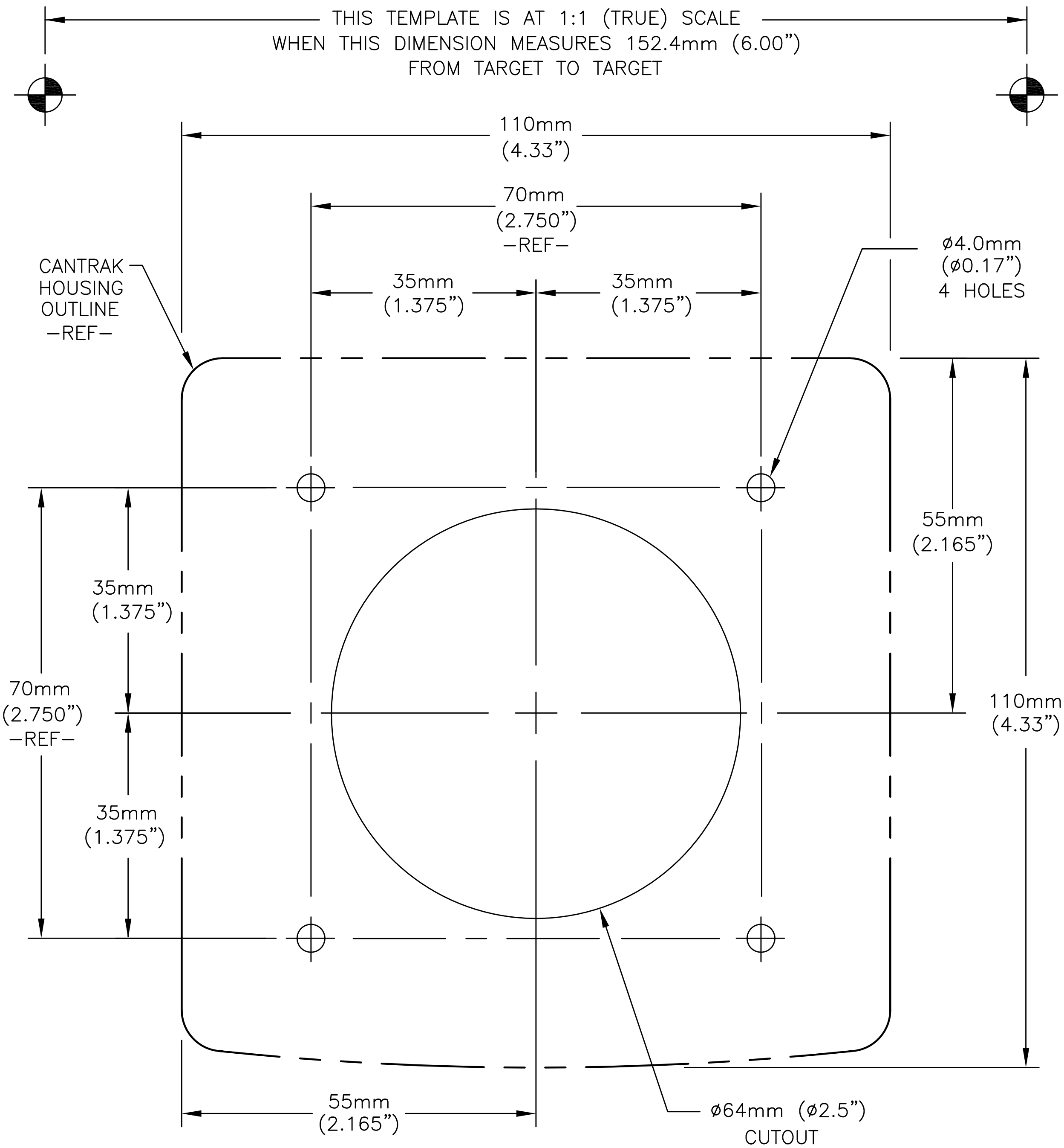


Figure MM70179-15: Trunnion Mounting

8.3 Template

	NOTE: Please double check printed template prior to using.



CANTRAK DISPLAY MOUNTING TEMPLATE

13766A_ART

8.4 Wire Harnesses

The Display ties into the Control System's Serial Communication CAN Bus. In order to do so, a special Wire Harness is required. This Wire Harness (Part No. 70186) plugs into the back of the Display and has three cables emerging at the other end. Two of the cables are short and are provided with plugged ends, allowing connection to the serial bus.

The third cable is long (20'), is not plugged and is provided for connection to the power supply.

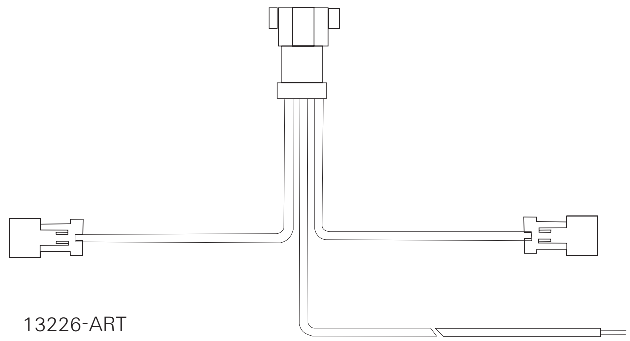


Figure MM70179-16: Wire Harness (70186), Multi-drop

Connecting this Wire Harness to the system is accomplished using standard Twin Screw and Multi-Screw Serial Communication Harnesses.

When an LCD Display is at the end of the Serial Communication Bus, a Termination Resistor Plug (Part No. 15133) is required at that Display.

The following diagrams and tables provide examples of various installations and required Items:

9 System Examples

The following diagrams and tables provide examples of various installations and required Items.

Table MM70179-1: Single Station - Single Screw

Item #	Description	Qty	Part #
1	Display- LCD	1	70179
2	Wire Harness- Display, Multi-Drop, Power 20' (6,10m)	1	70186
3	Wire Harness- Serial Comm., Twin Screw	1	70422-XX
4	Plug- Terminating Resistor	1	15133
5	Pigtail- Serial Comm.	1	Provided with Processor

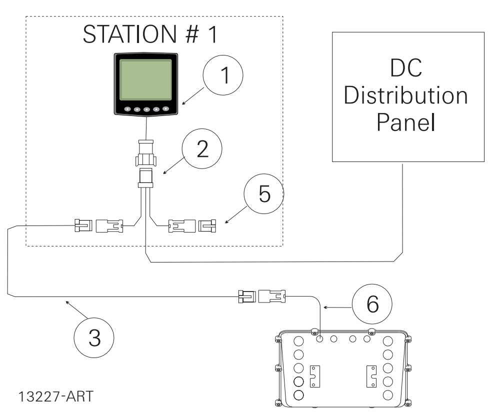


Table MM70179-2: Two Stations - Single Screw

Item #	Description	Qty	Part #
1	Display- LCD	2	70179
2	Wire Harness- Display, Multi-Drop, Power 20' (6,10m)	2	70186
3	Wire Harness- Serial Comm., Twin Screw	1	70422-XX
4	Plug- Terminating Resistor	1	15133
5	Pigtail- Serial Comm.	1	Provided with Processor

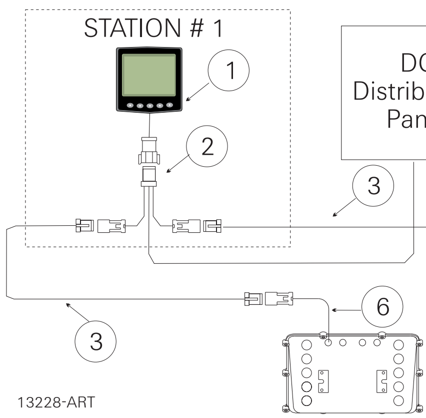


Table MM70179-3: Two Station - Twin Screw

Item #	Description	Qty	Part #
1	Display- LCD	2	70179
2	Wire Harness- Display, Multi-Drop, Power 20' (6,10m)	2	70186
3	Wire Harness- Serial Comm., Twin Screw	2	70422-XX
4	Wire Harness- Serial Comm., Multi-Screw	1	15544-XX
5	Plug- Terminating Resistor	1	15133
6	Pigtail- Serial Comm.	2	Provided with Processor

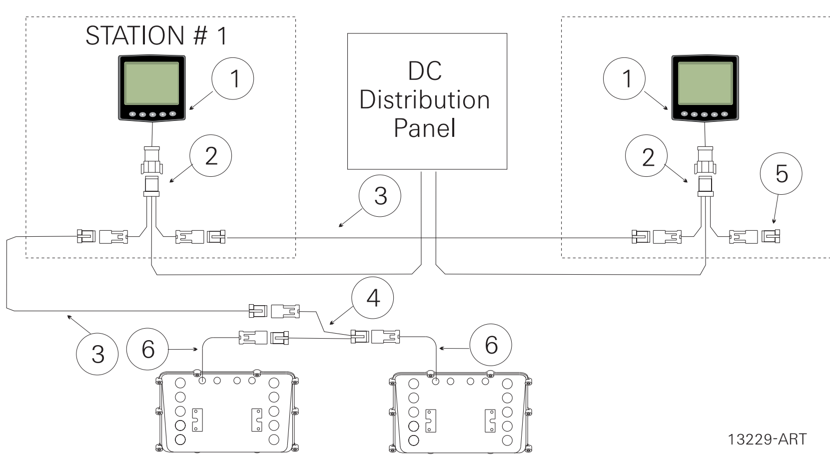
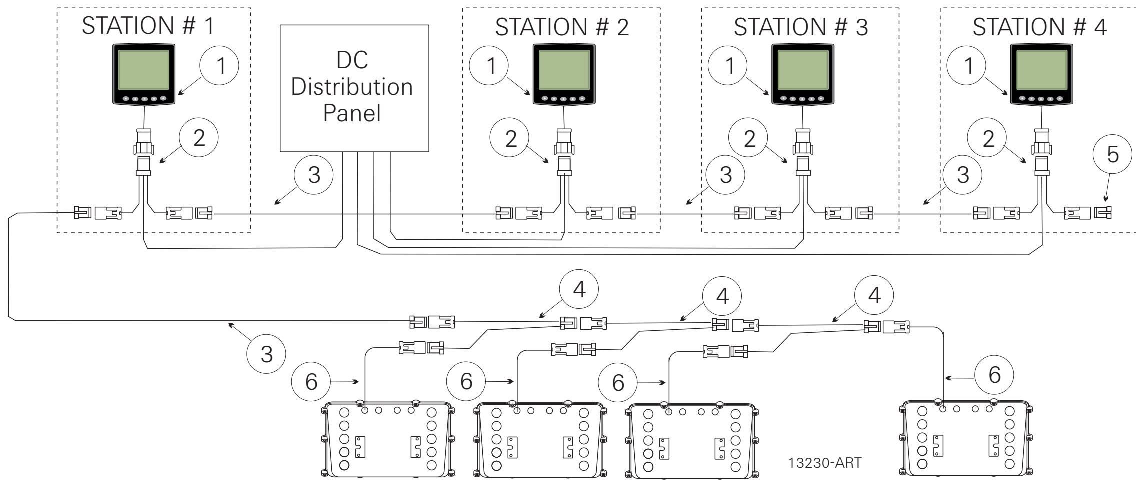


Table MM70179-4: Four Stations - Quad Screw

Item #	Description	Qty	Part #
1	Display- LCD	4	70179
2	Wire Harness- Display, Multi-Drop, Power 20' (6,10m)	4	70186
3	Wire Harness- Serial Comm., Twin Screw	4	70422-XX
4	Wire Harness- Serial Comm., Multi-Screw	3	15544-XX
5	Plug- Terminating Resistor	1	15133
6	Pigtail- Serial Comm.	4	Provided with Processor



16 Appendix F - AutoTroll

AutoTroll Operation Addendum

Rev.- 03/17/08

1. Introduction

This addendum to the 9000 series ClearCommand manual describes the operation, installation and troubleshooting for those ClearCommand systems used with ZF gears equipped with the Marine Transmission Control Unit (MTCU).

2. Operation

2.1 Auto Troll Operation

While the System is in Auto Troll Mode the Processor will provide all inputs and outputs required for the operation of the ZF AutoTroll gear. If an error occurs with the ZF AutoTroll system, the following will occur.

- The red ZF AutoTroll Warning Light, located on the outside of the Processor cover, will flash.
- A 5 second audible tone will be heard at all Control Heads.
- Troll Mode will be blocked.

2.2 AutoTroll Functions (L0 – L6)

This section, along with the Basic Troll Sections, allows the adjustment of AutoTroll related items:

- L0 – Troll Enable and Control Head Lever Troll Range
- L1 – Troll valve selection – Set to one of the following values (Do NOT use codes 01 through 07):
  - set to 08 for a Troll Command output (to the MTCU) of 1.2 to 3.0 VDC
  - set to 09 for a Troll Command output (to the MTCU) of 1.2 to 3.8 VDC
- L2 – Troll Minimum Pressure – Adjusts the voltage for minimum shaft rotation.
- L3 – Troll Maximum Pressure – Adjusts the voltage for maximum shaft rotation
- L4 – Troll Throttle Limit
- L5 – Do NOT use
- L6 – Do NOT use

2.3 AutoTroll Tone

- Five Second Tone

  This tone indicates that an AutoTroll alarm is being received. Refer to the AutoTroll Alarm Light located on the Processor.

3. Plan The Installation

3.1 AutoTroll Wire Harnesses

One of two connector types is used in AutoTroll Control units. One of these connectors is manufactured by Harting, while the other is manufactured by Cannon. Therefore, AutoTroll Harness's are available with both types of connectors.

Table 16-1: AutoTroll Harness Selection Table

Application	Harting Connector	Cannon Connector
	ZF Marine Propulsion Systems Miramar	Harness Part Numbers (XX indicates harness length)
Non - MTU Applications	15208-XX	16160-XX

3.2 AutoTroll Electronic Cable Requirements

The use of an AutoTroll Wire Harness is required. Refer to section 4.4: Wire Harness Installation.

4. Installation

4.1 AutoTroll Harness

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

4.2 Non - MTU Applications

A The Processor connects directly to the AutoTroll Control Unit.

B Run the AutoTroll harness from the Processor to the ZF AutoTroll Control Unit.

C Attach the 18 Pin FCI connector end of the cable to the Processor AutoTroll connector.

D Connect the other end of the supplied AutoTroll harness to the AutoTroll Control Unit.

E If twin Screw, repeat steps A) thru D) on the opposite side.

5. Dock Trials

5.1 Troll Solenoid Adjustments

WARNING: It is preferable to test AutoTroll 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 capable of securing the vessel with full thrust from at least one screw.

6. Sea Trials

6.1 AutoTroll Adjustments

6.1.1 L2 – Trolling Minimum Adjustments

When the value of L1 is set to 08 or 09, the Default Value of this Function is automatically set at 27. (Refer to Figure 16-1: Display LED Function L2) Default Value 27 applies a 1.2 VDC to the AutoTroll Control Unit.

Due to variations in hardware from Processor to Processor, it is possible that the actual voltage being applied may be slightly off from the desired 1.2 VDC. consequently, this function Code allows you to adjust the Troll Minimum Pressure voltage independent of the L1 setting.

This is adjustable anywhere between 00.0% to 99.0% of the voltage output capability of the circuit.

To change the Value refer to section 5.2: Activating Set Up Mode and section 5.3: Storing Values To Memory.

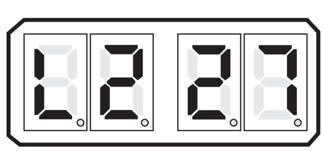


Figure 16-1: Display LED Function L2

A Move the Control Head lever to the Ahead detent.

B Scroll to the Function Code.

C Activate Set Up Mode.

D Scroll Up and Down to the appropriate Value

E Store the Value to memory.

6.1.2 L3 – Trolling Maximum Adjustments

When the value of L1 is set to 08, the Default Value of this function is automatically set at 68.(Refer to Figure 16-2: Display LED Function L308)

When the value of L1 is set at 09, the Default Value of this Function is automatically set at 83.(Refer to Figure 16-3: Display LED Function L309)

Due to variations in hardware from Processor to Processor, it is possible that the actual voltage being applied may be slightly off from the desired 3.0 or 3.8 VDC. Consequently, this Function Code allows you to adjust the Troll maximum Pressure voltage independent of the L1 setting.

The voltage delivered to the AutoTroll control Unit to obtain Maximum Pressure, is set with this function. This is adjustable anywhere between 01.0% to 100.0% of the voltage output capability of the circuit.

To change the Value refer to section 5.2: Activating Set Up Mode and section 5.3: Storing Values To Memory.

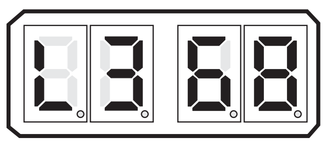


Figure 16-2: Display LED Function L308

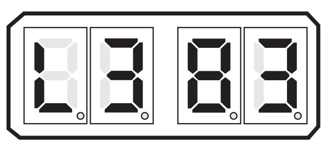


Figure 16-3: Display LED Function L309

A Move the Control Head lever to the Ahead detent.

B Scroll the Function Code

C Activate Set Up Mode.

D Scroll Up or Down to the appropriate Value.

E Store the Value to Memory

6.1.3 L4 – Troll Throttle Limit Adjustment

NOTE: This adjustment may only be accomplished if L1 has been set to 09. Skip this section if L1 is set to 08

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 manufacturers 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 a no set procedure which determines when increased throttle should be used and what percentage of the range it should be set to.

The Values available to this Function are 00 to 20% of Throttle Maximum. the default value is 00% of Throttle maximum. (Refer to Figure 16-4: Display LED Function L4)

To change the Value refer to section 5.2: Activating Set Up Mode and section 5.3: Storing Values To Memory.

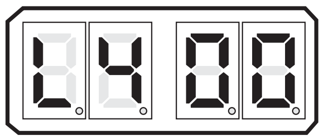


Figure 16-4: Display LED Function L4

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

6.1.4 Troll Pulse Percentage (L6) Adjustments

NOTE: DO NOT ADJUST

6.1.5 Control System Checks

Make the following checks when applying power to the Processor

Table 16-2: Processor Mounting

Processor Serial Number	**Outside PORT**		**Inside PORT**		**Inside STARBOARD**		**Outside STARBOARD**	
Does AutoTroll operate in the correct direction?	YES	NO	YES	NO	YES	NO	YES	NO

7. Troubleshooting

7.1 General

7.1.1 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' System requires 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 Interlock, DC Power, Start Interlock, clutch Oil Pressure Interlock and External System Status Indication Circuit.

In addition, the application may require harnesses for one or more of the following:

- Shift / AutoTroll Interface

Prior to attempting to troubleshoot the System, get as much information as possible from the owner or operator. Inspect the System for signs of misadjustments, loose connections, physical damage or water incursion.

7.2 Audible Tones

- Five (5) Second Tone

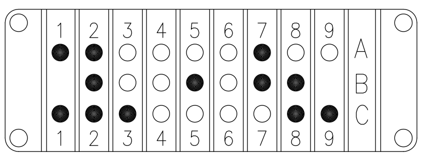
This tone is used to indicate an AutoTroll alarm is being received. Refer to the AutoTroll Alarm Light located on the Processor and the AutoTroll documentation.

7.3 Wire Harnesses

- AutoTroll Harnesses
    - Harting Harnesses

Table 16-3: Wire Harness - ZF AUTOTROLL (9000 Harting) (p/n 15208-XX)

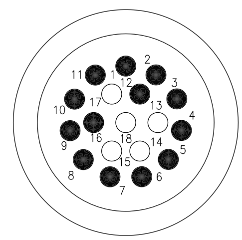
Termination A



PIN A1:	RED
PIN A2:	BLACK
PIN A7:	YELLOW
PIN B2:	TAN
PIN B5:	ORANGE
PIN B7:	BLUE
PIN B8:	BROWN
PIN C1:	VIOLET
PIN C2:	PINK
PIN C3:	GREY
PIN C8:	WHITE
PIN C9:	GREEN

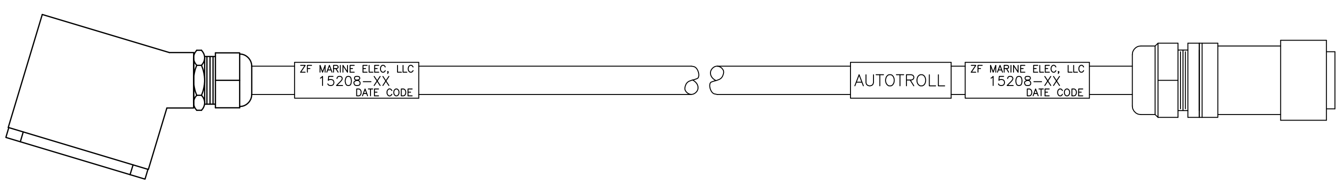
DWG: 12014.3_ART

Termination B



PIN 1:	RED
PIN 2:	BLACK
PIN 3:	YELLOW
PIN 4:	TAN
PIN 5:	ORANGE
PIN 6:	BLUE
PIN 7:	BROWN
PIN 8:	GREEN
PIN 9:	PINK
PIN 10:	GREY
PIN 11:	WHITE
PIN 12:	SHIELD
PIN 16:	VIOLET

DWG: 12014.2_ART

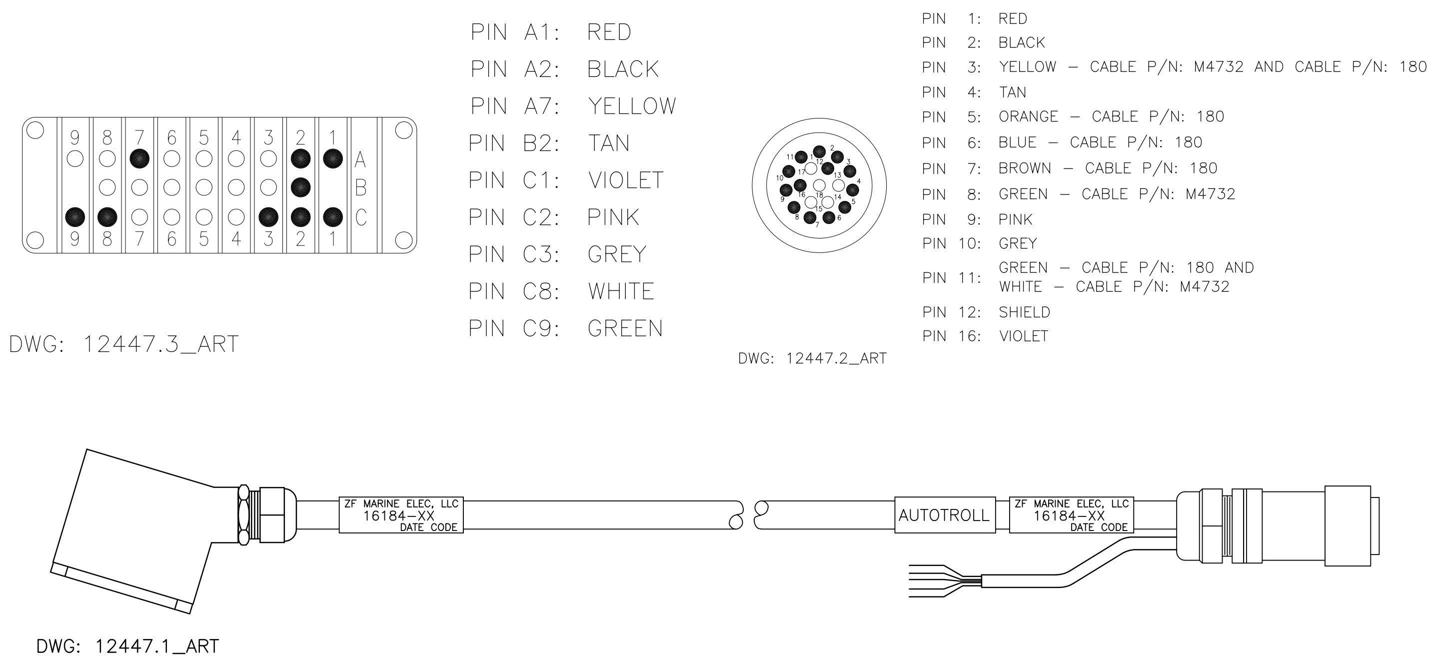


DWG: 12014.1_ART

NOTE: There is no pin B1 and B9 with plug HAN 25 D. The first pin at the "B-row" is pin B2

Table 16-4: Wire Harness - ZF AUTOTROLL/ MTU FCI/ HARTING (9000) (p/n 16184-XX)

Termination A	Termination B



NOTE: There is no pin B1 and B9 with plug HAN 25 D. The first pin at the "B-row" is pin B2

7.4 Troubleshooting AutoTroll

The Processor comes equipped with a RED AutoTroll Fault Indicator Light mounted directly on its Enclosure. The light is controlled by the Marine Transmission Control Unit (MTCU) mounted on the gear. If a fault is detected by the MTCU, the light flashes a specific code sequence to identify the problem.

- Flashing sequence:

Table 16-5: AutoTroll Fault Indicator Light Flash List

Number of Flashes	Nature of Fault
3	Electrical fault in trolling valve.
4	Gear Box fault (Propeller speed cannot be controlled.
6	Failure of engine speed sensor
7	Failure of propeller speed sensor
8	Failure of electronic rated value sensor. Failure of sensor power supply.
9	Electrical system voltage fault.
11	Short circuit in signal lamps. short circuit in slip signal output.
12	Neutral fault (clutch is engaged despite Neutral setting)

CAUTION: If any fault is detected by the system, it is strongly recommended that power be switched OFF to trolling system to prevent damage.

In the event of a complete failure of the AutoTroll Control Unit, the Indicator Light will become lit steady. When this occurs, the system reverts to Non-Troll Mode. Normal Operation is still possible however.

In the event that any of the faults listed above occur. Contact a ZF Transmission Technician.