ClearCommand 96202
Installation Manual

SM3830 Rev.A1 10/05

ZF Marine Electronics, LLC
ClearCommand

System Specifications

(Sept 2005 Rev.A) October 2005 Rev.A1 Quality Shipyard Hull# 1247

February 2005 (Rev.-)

Vessel Specifications

Power: Twin Screw
Caterpillar 3508
1050 HP @ 1600 RPM
Electric Selection

Transmission: Twin Disc MG5170
5.421:1 Reduction Ratio
Solenoid Selection

Stations: One Remote Station

ClearCommand Specifications:

Control Processor:	96202 (replacing 785CE)
System Serial Number:	3830
Sales Order Number:	SO02471 (96202 Replacement System)
	SO00549 (Original System Parts & Manual)
	SO00550 (Original CruiseCommand Processor)
Drawing Number:	13068A, 4 pages

This System originally shipped with CruiseCommand 785CE Processors. These Processors are being replaced by ClearCommand 96202 Processors.

System 3830 Material List

Material List for 3830 - SO002471		
Quantity	No.	Description
2	96202	CLEARCOMMAND-ELECT ENG,SOL GEAR,2 STA
2	15719-20	WIRE HARNESS, CLUTCH AHEAD/ASTERN 20 FT
5	SM3830	SSN 3830 INSTALLATION MANUAL

IMPORTANT: It is important to keep this Manual in a safe place for future reference. The manual contains answers to questions that may arise during operation or installation of the ZF Marine Electronics Control System and its options.

Preface-1 ClearCommand 96202

ZF Marine Electronics	ENGINE		CLUTCH		Number of Pluggable Stations
Processor Part No.	Servo	Electronic	Servo	Solenoid	
96202		X		X	2

Table Preface-1: ClearCommand 96202

This manual is intended for use with the above Processors.

Preface-2 Conventional Symbols Used in the Manual

Throughout this manual special attention should be paid to the following:

NOTE: Contains helpful information

IMPORTANT: Contains helpful information.

CAUTION: Damage to the equipment may occur if these messages are not followed.

WARNING: Personal injury may result if these messages are not followed.

Preface-3 Important Information

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

CAUTION: On Control Systems utilizing more than one Processor, ZF Marine Electronics highly recommends that ALL UNITS be upgraded to the most current Processor.

CAUTION: Electro-static discharge can damage this equipment. Personnel working on this equipment must be grounded to the chassis with the Anti-static Wrist Strap provided.

CAUTION: Disconnect the Power Harness from the Power Pigtail whenever welding is being done on the vessel. Failure to do so can cause permanent damage.

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.

For the purpose of this manual, the drawings illustrate pluggable systems with two Remote Stations. The Processors described within, may in fact be installed with anywhere from one to five Remote Stations.

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Appendix C

Revisions List

Rev	Date	Revision Description
-	2/05	This manual is created from MM14330-I RevF 11/04 CruiseCommand Installation Manual. Refer only to the Sections appropriate for your System. Refer to Appendix C System Drawing for System Specific Information.
(A) A1	(9/05) 10/05	(Processor replaced with 96202 ClearCommand.) Per JimM Engine and Ratio Chg. (Dwg 13068 revised to A.)

REVISIONS LIST

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 Manual Contents

This manual is divided into 12 Sections which cover, in detail, the features and operation of your system:

- Introduction (Section 1)
- Operation (Section 2)
- Plan the Installation (Section 3)
- Installation (Section 4)
- Set Up Procedures (Section 5)
- Dock Trials (Section 6)
- Sea Trials (Section 7)
- Control Options (Section 8)
- Periodic Checks and Maintenance (Section 9)
- ZF Marine Electronics Service Sheets (Appendix A)
- Troubleshooting (Appendix B)
- System Drawings (Appendix C)

1-2 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.

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

1-2.1 96202 Processor (Throttle - Electronic, Shift - Solenoid, 2 Pluggable Remote Stations)

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

- electronic engine governors
- solenoid activated clutches

1-3 System Features

1-3.1 Standard Processor Features

- Station-in-Command indication. (Section 2-2)
- Single Control Head lever command of speed and direction. (Section 2-3)
- Start Interlock. (Section 2-4)
- Push Button Station Transfer. (Section 2-5)
- Proportional Pause on through Neutral Shifts. (Section 2-6)
- Warm-up Mode. (Section 2-7)
- High/Low Idle Selection. (Section 2-8)
- One Lever Mode. (Section 2-9)
- Engine Synchronization. (Section 2-10)

- Easily configured to a vessel's control requirements. (Section 2-11)
- Audible system diagnostics and status indications. (Section 2-12)
- Push Button Set Up. (Section 2-13)
- Visual system diagnostics, set up, and status indication. (Section 2-14)
- Pluggable Connections. (Section 2-15)

1-3.2 Optional Processor Features

- System failure external alarm contact. (Section 2-16.1)
- Clutch pressure interlock. (Section 2-16.2)
- Station Expander (SE). (Sections 2-16.3)
- Integrated Solenoid Trolling Valve Control (Section 2-16.4)
- Engine Room Only/Remote Switch (Section 2-16.5)
- Lockout Switch (Section 2-16.6)
- DP Mode (Section 2-16.7)
- LCD Panel (Section 2-16.8)
- Backup Control System (Section 2-16.9)
- Speed Boost (Section 2-16.10)

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.
- Shift:
  Solenoid: The Ahead and Astern shift solenoids will be de-energized, commanding Neutral.

2-2 Taking Command

To take command at any one of the Remote Stations:

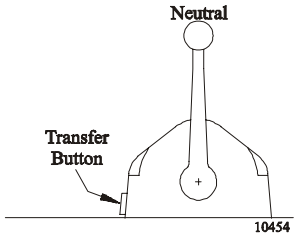


Figure 2-1: Station taking Command

- Ensure all Control Head's lever(s) at that Station are in the Neutral detent (vertical position)
- Depress the transfer button for 1/2 second.

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

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

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

The Operator is now in control of the vessel's screws.

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).

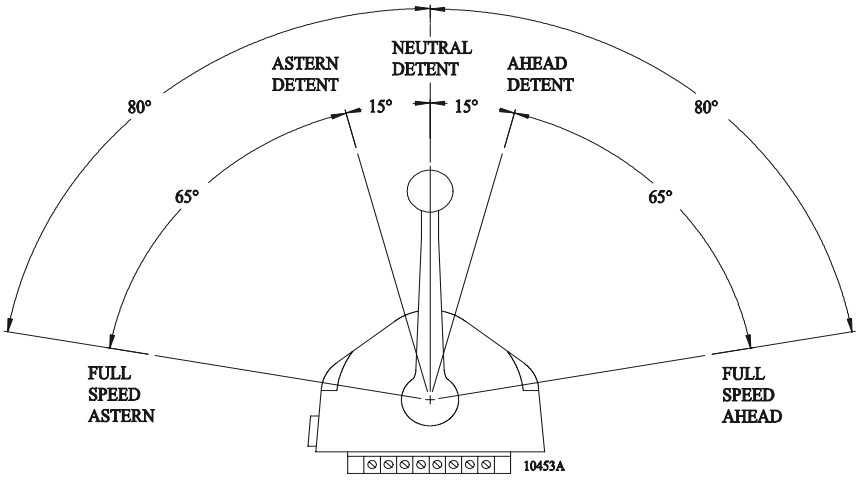


Figure 2-2: Control Head Detents

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.

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.

2-4 Start Interlock (if used)

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

- DC power has been turned ON to the Control System.
- 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.

These Processors offer 4 different means of Station Transfer:

- Neutral Only (Mode P000)
- Lever Match & Neutral (Mode P002)
- Relinquish/Receive or Request/Relinquish (Mode P003)
- Request/Relinquish/Receive (Mode P0004)

The transfer type is selected during initial system setup.

2-5.1 Neutral Only Transfer (Mode P000)

A) The Station-in-Command's lever(s) may be in any position. However, it is recommended that the lever(s) are positioned to the Neutral/Idle position whenever transferring from one station to another.

B) The Operator at the Remote Station taking command MUST place the Control Head lever(s) in the Neutral/Idle position.

C) Depress and hold the receiving Station's Transfer Button until the Control Head's LED(s) is lit.
- Transfer of command is now complete.

2-5.2 Lever Match and Neutral (Mode P002)

WARNING: DO NOT USE THIS MODE OF TRANSFER UNLESS ALL REMOTE STATIONS ARE IN CLOSE PROXIMITY AND WITHIN SIGHT OF ONE ANOTHER. Extreme care must be taken when transferring command with the receiving Station's Control Head lever(s) not in the Neutral/Idle position. First of all, the vessel is moving while no person is physically at the Helm. Secondly, the engine's RPM's can change by as much as 10%, resulting in a sudden increase or decrease in the vessel's speed.

A) The Station-in-Command's lever(s) may be in any position.
- The Operator at the Remote Station taking command MUST have a good view of the Station-in-Command's lever positions.

B) Position the lever(s) of the Station taking command to Neutral or in close proximity (within 10%) of the Station-in-Command's lever(s).

C) Depress and hold the receiving Station's Transfer Button until the Control Head's LED(s) is lit.
- Transfer of control is now complete.

2-5.3 Forward Pass Sequence [Relinquish/ Receive] (Modes P003 & P004)

A) At the Station-in-Command, place the Control Head levers into the Neutral/ Idle position.

B) Depress and hold the transfer button until a solid tone is heard for one second, which indicates that transfer has been activated.
- If equipped with Indication Panels, the message "Push Transfer Button at New Station" will be displayed at all Stations.
- A distinctive 1/2 second ON, 1/2 second OFF tone pattern will sound at all Remote Stations for up to the time set with Function Code **P1** "Transfer Timeout".

C) The Operator at the Remote Station taking command MUST place the Control Head levers in the Neutral/ Idle position.

D) The Operator MUST depress and hold the transfer button within the preset time period until a solid tone is heard, to gain command.

- If the Operator at the Station taking command does not press the transfer button within the preset time period, the transfer process is aborted, the text message disappears (if so equipped) and the tone is silenced.
- If the Operator at the Station taking command does take command within the preset time period, the new Station-in-Command text will appear on the Panel and the text message will disappear.

E) The Remote Station that accepted command is now the Station-in-Command as indicated by the lit red LED(s).

2-5.3.1 Transfer Request Sequence [Request / Relinquish] (Mode P003) 2-Step

A) At any Remote Station not in command, place the Control Head lever into the Neutral/ Idle position.

B) Depress and hold the transfer button until a solid tone is heard for one second. Release the transfer button to activate transfer.
- If equipped with Indication Panels, the message "**Station X Rqsts Xfer**" will be displayed at all Stations.
- A distinctive 1/2 second ON, 1/2 second OFF tone pattern will sound at all Remote Stations for up to the time set with Function Code **P1** "Transfer Timeout".

C) The Operator at the Station-in-Command MUST place the Control Head levers into the Neutral/ Idle position.

D) Depressing the transfer button within the preset time relinquishes control.
- If the Operator at the Station-in-Command does not press the transfer button within the preset time period, the transfer process is aborted, the text message disappears (if so equipped) and the tone is silenced.
- If the Operator at the Station-in-Command does press the transfer button within the preset time period, control is transferred to the new station, the new Station-in-Command text will appear on the Panel and the text message will disappear.

E) The Remote Station that requested control is now the Station-in-Command as indicated by the lit red LED(s).

2-5.3.2 Transfer Request Sequence [Request/ Relinquish/ Receive] (Mode P004) 3-Step

A) At any Remote Station not in command, place the Control Head lever into the Neutral/ Idle position.

B) Depress and hold the transfer button until a solid tone is heard for one second. Release the transfer button to activate transfer.
- If equipped with Indication Panels, the message "**Station X Rqsts Xfer**" will be displayed at all Stations.
- A distinctive 1/2 second ON, 1/2 second OFF tone pattern will sound at all Remote Stations for up to the time set with Function Code **P1** "Transfer Timeout".

C) The Operator at the Station-in-Command MUST place the Control Head levers into the Neutral/ Idle position and press the transfer button until a solid tone is heard for one second to allow the transfer to take place.
- A distinctive 1/2 second ON, 1/2 second OFF tone pattern will sound at all Remote Stations for up to the time set with Function Code **P1** "Transfer Timeout".
- If equipped with an Indication Panel, the message "**Push Transfer Button At The New Station**" will be displayed at all Stations.

D) The Remote Station that requested the transfer must depress the transfer button for a second time.
- If the Operator at the Station requesting control does not press the transfer button within the preset time period, the

transfer process is aborted, the text message disappears (if so equipped) and the tone is silenced.

- If the Operator at the Station requesting control does press the transfer button within the preset time period, control is transferred to the new station, the new Station-in-Command text will appear on the Panel and the text message will disappear.

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.

2-7 Warm-up Mode (Throttle Only Mode)

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

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

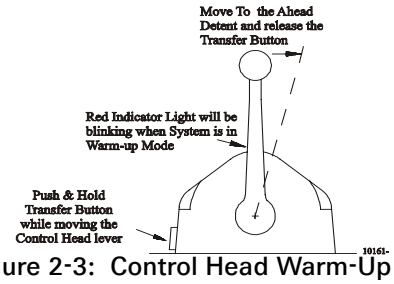


Figure 2-3: Control Head Warm-Up Mode

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

A) At the Station-in-Command, ensure that the Control Head's lever is in the Neutral detent position (refer to Figure 2-3:).

B) Depress and hold the transfer button.

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

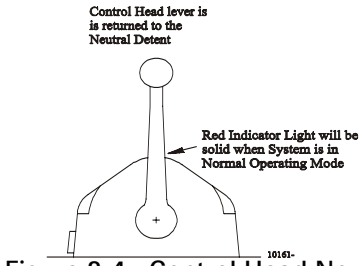


Figure 2-4: Control Head Normal Operating Mode

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

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

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

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

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 Figure 2-5: when selecting between Low and High Idle (or vice versa) at the Station-in-Command.

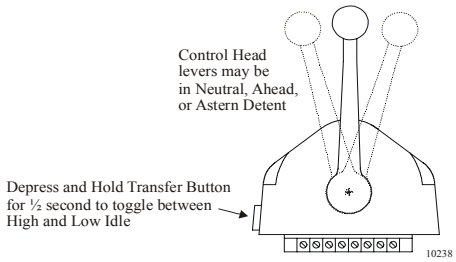


Figure 2-5: High/Low Idle Mode Selection

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

B) Depress and hold the transfer button for 1/2 second and then release.
- If the System was in Low Idle it will toggle to High Idle, and vice versa.

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

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

2-9 *One Lever Mode (Multi Screw)*

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

The system supports a mode of operation referred to as One Lever Mode. One Lever Mode allows the operator to control two to five 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 the 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.

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.
- The Control Head lever which the operator chose to move out of the Ahead detent, becomes the **Master lever**.
- The Control Head lever which was left in the Ahead detent is now inactive.

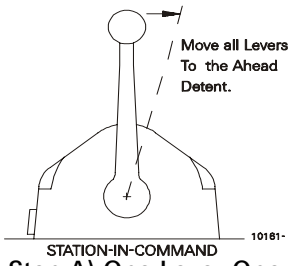


Figure 2-6: Step A) One Lever Operation Mode

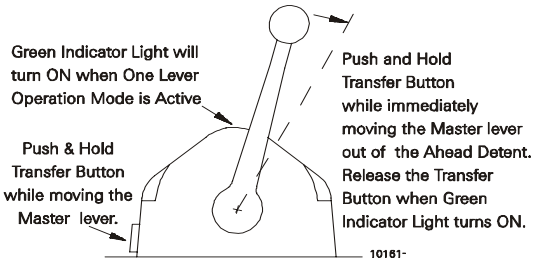


Figure 2-7: Step B) One Lever Operation Mode

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

2-9.2 Turning OFF One Lever Operation

WARNING: It is strongly recommended that the Master lever is returned to the Neutral/Idle position prior to turning OFF One Lever Operation.

- **Do not attempt to transfer command from one Remote Station to another while in One Lever Operation. Always turn One Lever Operation OFF prior to transferring.**
- **Failure to observe these recommendations may result in a sudden change in the vessel's direction.**

A) Place the **Master lever** into the Neutral detent.
B) Place all inactive Control Head levers into the Neutral detent.
- Whenever an inactive lever is moved to the Neutral detent, One Lever Operation is turned OFF for that lever ONLY!
- In applications with three or more screws, the green LED will not turn OFF until all inactive Control Head levers are returned to the Neutral detent.

NOTE:
- In Multiple Srew applications, always program all the Processors for the same amount of High Idle.
- In Multiple Screw applications, all Processors will be in High or Low Idle at the same time.
- High Idle is not available when Transfer Mode **03** or **04** are selected or when a DP system is in control.

2-10 Engine Synchronization (Multi Screw)

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

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

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

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

2-10.1 Synchronization Criteria

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

2-10.2 Synchronization Types

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

2-10.2.1 Equal Throttle Synchronization (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 engines RPM's.

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

2-10.2.2 Active Synchronization (default Disabled)

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 (Section 2-10.1, page 2-6) 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 Synchronization Indications

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

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

2-10.4 Turning Synchronization OFF/ON when Criteria is Met

2-10.4.1 Turning OFF:

When the criterial listed in Section 2-10.1, page 2-6, 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** 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 Section 2-10.4.1.

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.

2-10.5 Turning Synchronization ON/OFF when Criteria is Not Met

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%.

A) 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.

2-11.1 Processor Functions

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

A0 Processor Identification - Assigns each Processor in multi-screw application a unique identifying number. **This function must be the second function set during Set Up.**

A1 Number of Engines - Lets the Processor know how many other Processors need to be communicated with. **This function must be the FIRST FUNCTION SET during Set Up.**

A2 One Lever Operation - Allows the installer to disable or enable One Lever Mode capability.

A3 Station Expander (Optional) - Allows the Processor to communicate with the Station Expander (SE), which provides additional Remote Stations. **Contact the factory if this feature is required.**

A4 Neutral Indication Tone - When enabled, produces a short 200 Hz tone to indicate Neutral.

A5 Engine Room/Remote Switch (Sta. 1)(Optional) and Lockout (Sta. 2)(Optional) - Allows the installer to enable or disable one or both of these features.

A6 DP (Sta. 5)(Optional) - Allows the installer to enable or disable DP Mode with or without trolling valve operation.

Detailed information on each Function is found in Section 5-5.1, page 5-6.

2-11.2 Throttle Functions

2-11.2.1 Basic Throttle Functions

This section applicable to both electronic and servo Throttle adjustment:

E1 Throttle in Neutral - Adjusts the 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.

Detail information on each function is found in Section 5-5.2.1, page 5-8.

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.
Detail information on each function is found in Section 5-5.2.2, page 5-10.

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 Pause - Selects between an In-Gear, Neutral, or Fixed Neutral delay.
C3 Proportional Pause Time - Selects the maximum delay time during a full speed reversal.
C4 Proportional 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.
Detail information on each function is found in Section 5-5.3.1, page 5-11.

2-11.3.2 Solenoid Clutch Functions

This section along with the Basic Clutch Functions Section 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.
Detail information on each function is found in Section 5-5.3.2, page 5-13.

2-11.4 Speed Boost Functions (Optional)

This section applies to electronic throttle signals:
F0 Speed Boost Percentage - Programs the amount of throttle applied during initial clutch engagement.
F1 Speed Boost Duration - Programs how long the elevated throttle signal will be applied after initial clutch engagement.
F2 Speed Boost Start Delay - Programs the amount of time required after clutch engagement is commanded, until the Speed Boost is applied.
Detail information on each function is found in Section 5-5.6.1, page 5-16.

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.

L0 Troll Enable and Control Head Lever Range - Enables and disables Troll. 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 throttle boost is applied when troll operation is initiated.

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

Detail information on each function is found in Section 5-5.4, page 5-15

2-11.6 Integrated Troll Solenoid Functions

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

L1 Troll Valve Function - Selects the current output characteristics. **If ZF Hurth Gears with two (2) proportional solenoids are used, this Function must be the 3RD function set.**

L2 Troll Minimum Pressure - Adjusts the amount of current at minimum Shaft rotation.

L3 Troll Maximum Pressure - Adjusts the amount of current at maximum Shaft rotation (not maximum pressure).

Detail information on each function is found in Section 5-5.4, page 5-15.

2-11.7 Transfer Functions

P0 Transfer Mode - Selects the various options available when transferring from one Remote Station to another.

P1 Transfer Timeout - In certain Transfer Modes, selects the amount of time allowed for the transfer sequence to be completed.

Detail information on each function is found in Section 5-5.6.2, page 5-16.

2-11.8 Troubleshooting Functions

2-11.8.1 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.

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

Detail information on each function is found in Section 5-5.5, page 5-15.

2-12 Audible Tones

Detailed information on the following tones are in Appendix B.

2-12.1 Basic Processor Tones

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

2-12.1.1 Slow Repetitive Tone

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

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

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

2-12.3 Troll Integrated Solenoid Tones (If Troll is used)

2-12.3.1 Three Second Steady Tone

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

2-12.4 Transfer Tones

2-12.4.1 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**..

2-12.4.2 One Second Steady Tone

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

2-13 Push Button Set Up

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

A full description of their usage is provided in Section 5-1.2, page 5-2.

2-14 Visual System Diagnostics, Set Up And Status Indication

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

For a full description of the Display LED, its capability and usage, refer to Section 5-1.1, page 5-1.

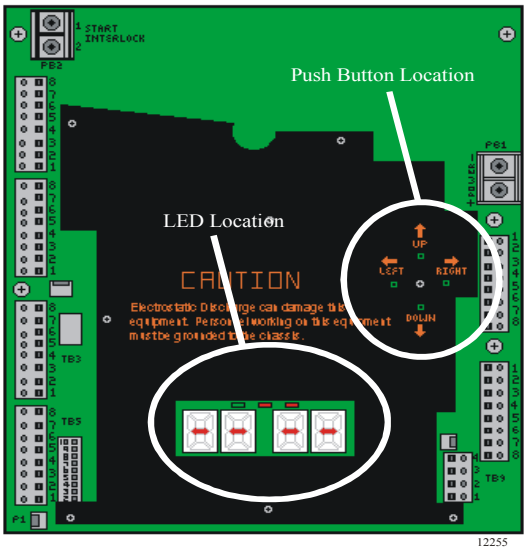


Figure 2-8: Circuit Board Shield Layout

2-15 Pluggable Connections

2-15.1 Processor

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

96202 **2** Station pigtails, 5 standard pigtails

The following is a list of the pigtail connectors supplied for your System. The figure represents all of the pigtails. Your System may not use them all.

Refer to Figure 2-19: for pigtail locations:

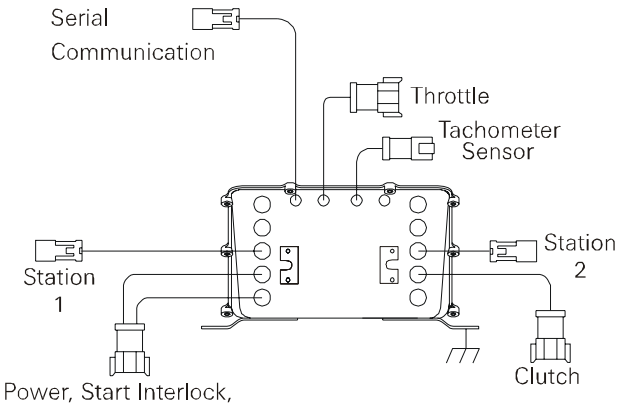


Figure 2-9: Processor Pluggable Connections View

- **Two** pigtail connectors are provided for connection to the Remote Station Control Heads.
- **One** pigtail connector provides the connections for DC Power, Start Interlock, Clutch Oil Pressure Interlock and an External Alarm contact.
- **One** pigtail connector is provided for serial communication between multiple Processors.
- **One** pigtail connector is provided for the Tachometer Sensor input used in multi-screw active synchronization.
- **One** pigtail connector provides connection to the throttle.
- **One** pigtail connector provides connection to the solenoid clutch.

2-16 Optional Features

2-16.1 External Alarm Capability

- This optional feature is designed to 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 8-1, page 8-1.

2-16.2 Clutch Pressure Interlock

- The purpose of the Clutch Pressure Interlock is to prevent high engine RPM when the Clutch is not fully engaged.
- A full explanation of the Clutch Pressure Interlock is provided in Section 8-2, page 8-2.

2-16.3 Station Expander (SE)

- The SE is a separate Processor housed in an enclosure that allows the connection of up to five additional Remote Control Stations.
- The SE communicates with the Processor over the serial communication line.
- A full explanation of the installation, operation and adjustment of the SE is provided in the Installation Manual provided with the SE.
- If this option is going to be used, please contact a ZF Marine Electronics Representative for further information.

2-16.4 Trolling Valve Operation

- When the Control System is set up to control trolling valves, the operation is quite different from Normal Operating Mode.
- Troll Mode is a feature that must be turned On and Off at the Control Head.
- On initial power-up, Troll Mode is disabled.
- If this option is going to be used, please contact a ZF Marine Electronics Representative for further information.

2-16.5 Engine Room Only / Remote Switch

Station No.1 is typically designated as the Engine Room Station when this feature is used.

- When the switch is CLOSED, Station No. 1 will take command away from any other Remote Station, including DP. 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 5-5.1.6, page 5-8.
- If this option is going to be used, please contact a ZF Marine Electronics Representative for further information.

2-16.6 Lockout Switch

This feature prevents any Remote Station, other than Station No. 2 from taking command.

- 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 Only / Remote switch can override the Lockout feature.
- If this option is going to be used, please contact a ZF Marine Electronics Representative for further information.

2-16.7 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: High Idle and One Lever Mode are not available when a DP system is in command.

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

2-16.8 Display Panel

The Display Panel supplies various system information, including but not limited to:

- Station-in-Command
- Control Head lever position
- Engine RPM
- Propeller shaft RPM

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

2-16.9 Backup Control System

The Backup Control System provides a control system which is fully independent from the ZF Marine Electronics Control System. The Backup can control the transmission as well as the engine, but it does not include ZF Marine Electronics 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 Electronics Representative for further information.

2-16.10 Speed Boost

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.

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 or slightly above idle as the clutch begins to engage. A certain amount of droop below idle is normal as the clutch pressure rises and the clutch plates begin to come into contact. The idle speed should not rise until the clutch plates are fully engaged. Transmission damage may occur if this is not followed. Adjust the Function Codes as needed to meet this requirement.

Some vessels have the tendency to stall an engine when engaging the clutch or during emergency reversals. In some applications this can be minimized or eliminated by applying Speed Boost. Processors equipped with this feature can be programmed to temporarily increase the Speed Command Signal to the Governor at the precise time the Clutch Plates begin to come in contact with one another.

NOTE:

1. 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). This is typically due to a high reduction gear ratio (4:1 or higher) or underpowered engine.
2. Speed Boost has been used in some electronic engines where there is a stalling problem due to the engine not being able to respond quickly enough to a sudden load change (clutch engagement). This is especially true with vessels that have a high reduction ratio (4:1 or greater).
3. Speed Boost may also be used to reduce the droop (drop) in engine speed as the clutch engages.
4. 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 during clutch engagement.

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

3 PLAN THE INSTALLATION

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

3-1 System Requirements

The first step when installing a System is to carefully plan the installation. This includes finding proper mounting locations for the Processor(s) and Control Heads. The decision must be made on where power is going to be sourced and how the power will be routed to the Processor(s).

Once the locations have been decided, lengths of electrical wiring and Harnesses and must be determined.

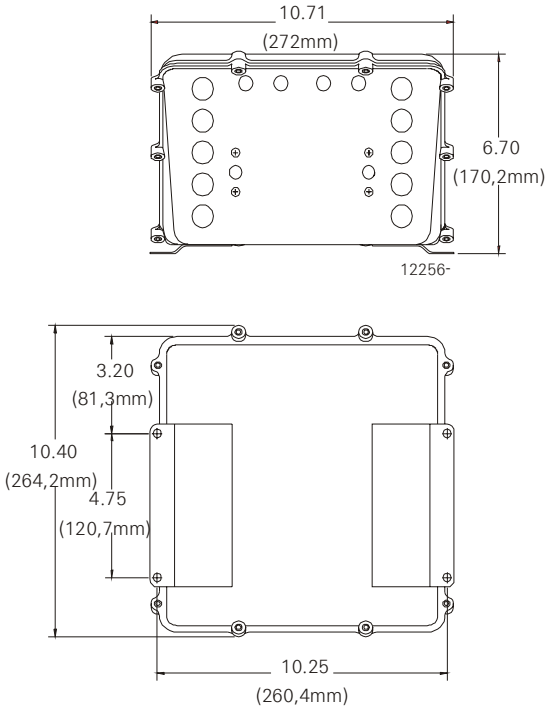


Figure 3-1: Processor Dimensions

- Grounding (Bonding) is required for maximum electromagnetic compatibility (EMC) performance. Refer to Appendix A - Bonding.

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

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

3-1.2 Control Head(s)

Refer to Appendix A - Control Head Variations Service Sheets for information on the various Control Heads available and their dimensions.

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

3-1.3 Wire Harnesses

(Refer to Appendix A - Parts List)
The following lists the various Harnesses that plug into the Processor:

3-1.3.1 Control Head Harnesses

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

3-1.3.2 Power, Start Interlock, Clutch Pressure, Alarm Harness

- One Harness required per Processor.
- The Harness is plugged at one end only.
- In addition to the DC power and Start Interlock, the Harness options for Clutch Oil Pressure Switch and External Alarm Circuit 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).

3-1.3.3 *Serial Communication Harness*

The Serial Communication Harness is only required in:

- Multi Screw applications,
- when an LCD Display is utilized,
- or an external trolling valve actuator (9001) is utilized.

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

Twin Screw:

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

3-1.4 Additional Harnesses

(Refer to Appendix A - Parts List)

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

3-1.4.4 *Tach Sensor Harness*

There are two Tach Sensor Harnesses available:

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

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

3-1.4.5 *Throttle Harness*

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

3-1.4.6 *Clutch Harness*

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

3-1.5 Electric Cables

(Refer to Appendix A - Parts List)

The installation may use Harnesses, Electric Cables or a combination of both.

The following lists the various equivalent electric cables:

3-1.5.7 *Control Head Electric Cable*

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

- Seven-conductor with shield, twisted.

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

3-1.5.8 Power, Start Interlock, Clutch Pressure, Alarm Electric Cable

3-1.5.8.1 Power Electric Cable Requirements

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

- 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 Automatic Power Selector in Appendix A for cable length and additional wire size requirements.
- 300V, 105 degrees C, UL VW1, stranded tinned copper wire.
- Maximum outside diameter: 0.390 inch (9,9mm).

3-1.5.8.2 Start Interlock Electric Cable Requirements

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

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

3-1.5.8.3 Clutch Pressure Interlock Electric Cable Requirements

When the ***Clutch Pressure Interlock*** option is utilized, a pressure switch with a normally open contact must be installed on the transmission, along with a Shuttle Valve If the Clutch Pressure Switch is hard-wired (no plugs) the electric cable may be ordered from ZF Marine Electronics, or must meet the following specifications:

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

3-1.5.8.4 External Alarm Circuit Electric Cable Requirements

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

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

3-1.5.9 Serial Communication

Serial Communication Harnesses are required in Multiple Screw applications. All Processors come equipped with Serial Communication Pigtail Plugs installed.

The Serial Communication Harness mates with these plugs. It is strongly recommended that only factory manufactured Harnesses are installed.

Refer to Appendix A Parts List for part numbers and available lengths.

3-1.5.10 Tach Sensor Electric Cable Requirements

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

3-1.5.10.1 AC Tach Input

- Two-conductor, twisted, shielded.
- 20 AWG (#0,5 metric)

- 300 V, 165 C, UL VW1, stranded tinned copper
- Maximum outside diameter: 0.390 inches (9,9mm)

3-1.5.10.2 Open Collector (Active)

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

3-1.5.11 Throttle Electric Cable Requirements

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

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

3-1.5.12 Clutch Electric Cable

3-1.5.12.1 Clutch Electric Cable Requirements

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

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

3-1.6 Tachometer Sensors

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

3-1.6.13 AC Coupled Sensors

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

3-1.6.14 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 3-17.6.13).

3-1.6.15 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 3-17.6.13).

3-1.6.16 Active Sensors (Open Collector Output)

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

• A maximum frequency of 8 KHz at Full Throttle.

3-2 Installer Supplied Tools And Parts

3-2.1 Required Tools

- Screwdriver – medium Phillips, #2.
- Hole saw - 1 inch (25,4mm)
- Saw with blade suitable for Console Top Panel.
- Drill Motor with 9/32 inch and 7/32 inch drill bits.

3-2.2 Optional Tools

- Calibrated Digital Multimeter (Fluke 80 Series or equivalent).
- Service Field Test Unit (P/N 13927, available through ZF Marine Electronics)
- Wire cutter, stripper, crimper (Recommend Thomas & Betts WT-2000) (Required if using single terminated harnesses)

3-2.3 Engine Stop Switch

An engine STOP switch MUST be located at each Remote Station.

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

3-3 DC Power Source

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

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

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

ZF Marine Electronics highly recommends using an Automatic Power Selector (APS) and a second power source (battery) to supply power to each Processor. Refer to Appendix A - Automatic Power Selector (APS) for examples of power supplies.

3-3.1 Processor Power

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

- The Processor requires a battery source of 12 or 24 VDC.
- Two 5 ampere (when isolated power supplies are required) or one 10 ampere trip-free thermal circuit breaker(s) with manual On/ Off actuation
- The use of an APS (Automatic Power Selector) is strongly recommended.
- Power should come from the vessel's DC Distribution Panel.
- 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 Appendix A - Automatic Power Selector.

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

4 INSTALLATION

NOTE: Before starting the actual installation of the Control System, make sure you have the correct parts and tools on hand. Refer to MM9000-I Plan the Installation Section. Read ALL the instructions pertinent to each part before beginning the installation of the part.

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

4-1 Processor

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

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

4-2 Control Head(s)

4-2.1 400, MC2000 and 700 Series Control Heads

Refer to the appropriate Control Head Dimensions and Variations Service Sheet in Appendix A for installation.

4-2.2 500 Series Control Heads

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

4-2.3 Handheld Remote Controls

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

4-3 Wire Harness Installation

The standard Off-the-Shelf Processor has five Pigtails with plugs on the ends. Two of the plugs are for Remote Stations and one each for Power/Start Interlock, Serial Communication, and Tach Sensor. Additional Harnesses required will depend on the actual installation.

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

4-3.1 Plug Insertion and Extraction

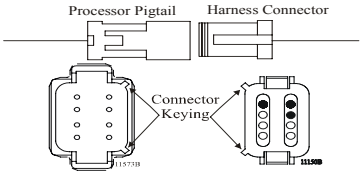


Figure 4-1: Harness Plug Keying

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

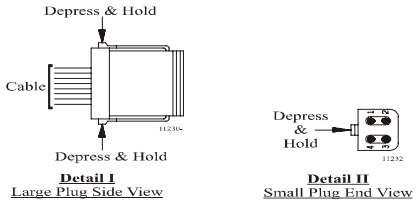


Figure 4-2: Harness Plug Locking Mechanism

B) When connecting the plugs, ensure that the locking mechanisms are depressed and held until the plug is fully connected or disconnected. Refer to Figure 4-2:

4-3.2 Standard Power/Start Interlock Harness

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

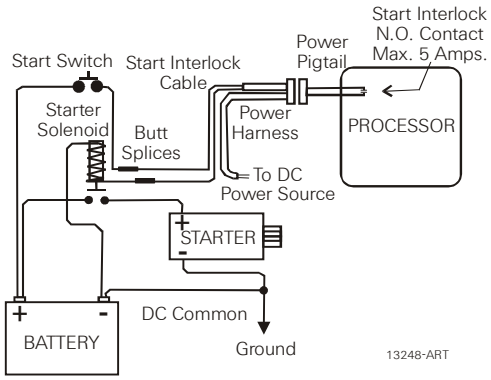
4-3.2.1 DC Power Cable

(Refer to Appendix A - Automatic Power Selector)

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

B) Run the cable to the DC Distribution Panel or the optional Power Relay.
C) Strip back the appropriate amount of PVC jacketing and conductor insulation.
D) Crimp the appropriate connectors to the conductors.
E) Terminate the conductors to the DC Power Source.

4-3.2.2 Start Interlock Cable



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

Figure 4-3: Start Interlock Connections

4-3.2.3 External Alarm Circuit Cable (optional)

Refer to Section 8-1, page 8-1, for installation information.

4-3.2.4 Clutch Pressure Switch Cable (optional)

Refer to Section 8-2, page 8-2, for installation information.

4-3.3 Serial Communication Harness

4-3.3.5 Twin Screw

(Refer to Figure 4-4:)
A) At the Processors, remove the watertight seals from the Serial pigtail plugs.
B) At the Port Processor, insert the Serial harness's grey, six pin plug into the Serial pigtail plug.
C) Run the harness to the Starboard Processor.
D) Insert the harness's grey, six pin plug into the Starboard Processor's Serial pigtail plug.
E) Secure the Serial Harness at least every 18 in. (457,2mm).

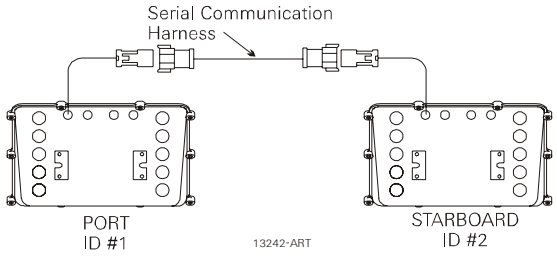


Figure 4-4: Twin Screw Serial Harness Connections

4-3.4 Standard Control Head Harness

Depending on whether a pluggable or hard-wired (not pluggable) Control Head(s) is selected, will determine the procedure for terminating the Harness at the Remote Station.
- The first installation procedure (Section 4-3.4.1) below is written for the pluggable Control Head.
- If a hard-wired Control Head(s) is selected, follow the information provided in the second procedure (Section 4-3.4.1, page 4-3):

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

4-3.4.1 Control Head Harness with Two Connectors

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

4-3.4.2 Control Head Harness with One Plug

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

4-3.5 Tach Sensor Harness (required for Active Synchronization)

A) On all Processors, remove the watertight seals from the Tach Sender pigtail plugs.
B) Insert theTach Sensor Harness's grey, four pin plug into the Tach Sender pigtail plug at each Processor.
C) Run the Tach Sensor Harness cables to the Tach signal source for each engine.
D) 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)

4-3.6 Additional Harnesses

4-3.6.1 Throttle Harness

The appropriate Throttle Harness should have been selected in Section 3-1.4.5, page 3-3. The Processors Throttle pigtail connects directly to the engine interface using this Throttle Wire Harness.

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

4-3.6.2 Clutch Harness

A) Plug the grey, 12 pin plug into the Clutch pigtail connector at the Processor.
B) Run the cables to the transmission.
C) Plug the DIN connector into the Ahead and Astern Solenoids.
D) Repeat steps A) thru C) for each transmission.

4-4 Hard-Wired Cable

4-4.1 Liquid Tight Connector

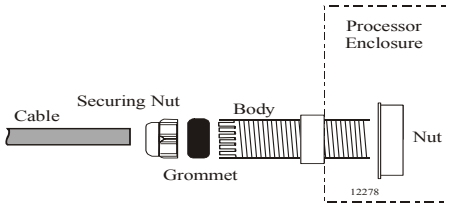


Figure 4-5: Liquid Tight Installation

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 4-5:

4-4.2 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 as shown in Figure 4-5:.

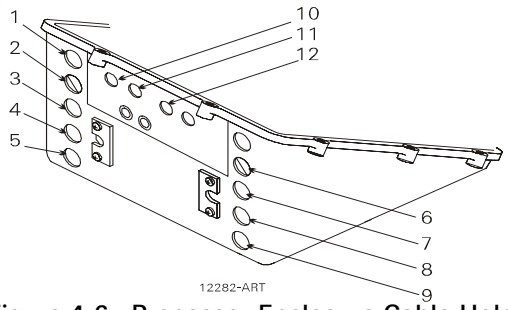


Figure 4-6: Processor Enclosure Cable Holes

1. Station No.3
2. Station No.5/ (optional) DP
3. Station No.1
4. Alarm, Clutch Pressure, and Start Interlock (optional)
5. DC Power
6. Station No.4
7. Station No.2
8. Clutch Solenoids
9. Troll Solenoids (optional)
10. Serial Communication
11. Throttle
12. Tachometer (optional)

4-4.3 Processor Circuit Board Connections

On a 9000 Processor, in lieu of using Harnesses for Control Heads, Power, Serial Communication and Tachometer, the Processor can be ordered with no pigtails installed. The above connections then must be hard-wired directly to the circuit board Also additional Stations may also be connected to the Processor by connecting pigtails or hard-wiring directly to the circuit board. Refer to Figure 4-7: for specific termination points.

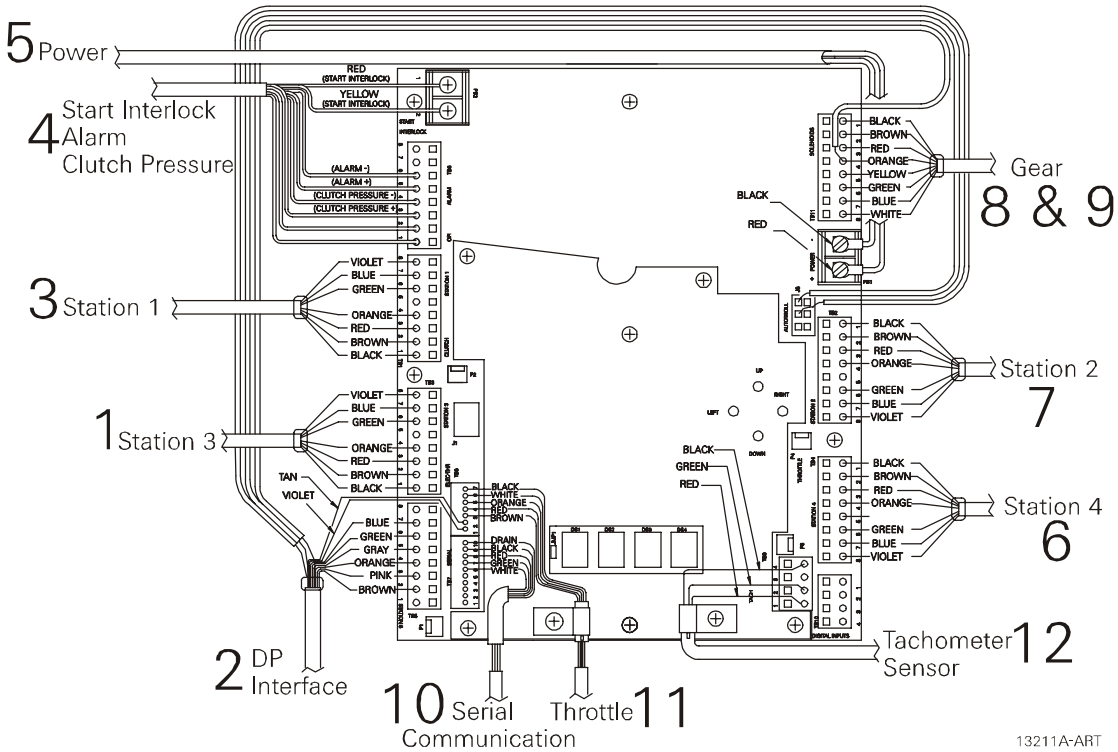


Figure 4-7: Processor Circuit Board Hard-Wired Termination Points

Hole #	Terminal Connection	Wire Cable Connections	Hole #	Terminal Connection	Wire Cable Connections
1. 2. 3. 6. 7.	Station 3: TB5 Station 5: TB3 (not used with DP) Station 1: TB1 Station 4: TB4 Station 2: TB2	Black - 1, Brown - 2, Red - 3, Orange - 4, Green - 6 Blue - 7 Violet - 8	8	Clutch: TB11	Black - 1 Brown - 2 Yellow - 5 Green - 6
2.	DP: TB3 (no Station 5 available) DP: TB8 DP: J3	Brown - 2 Pink - 3 Orange - 4 Gray - 5 Green - 6 Blue - 7 Violet - 1 Tan - 2 Red Black	8 & 9	Clutch /Troll: TB11	Black - 1 Brown - 2 Red - 3 Orange - 4 Yellow - 5 Green - 6 Blue - 7 White - 8
4.	Alarm: TB6 Clutch Pressure: TB6 Start Interlock: PB2 Ground: TB6 Backup Input: TB6	Brown - 6 Black - 5 Green - 4 Blue - 3 Red - 1 Yellow - 2 Orange - 2 White - 1	10.	Serial Communication: TB7	White - 6 Green - 7 Red - 8 Black - 9 Drain - 10
			11.	Throttle: TB8	Brown - 3 Red - 4 Orange - 5 White - 6 Black - 7
5.	Power In: PB1	Black - Negative Red - Positive	12.	Tachometer: TB9	Red - 1 Green - 2 Black - 4

4-4.4 Hard-wire Installation

4-4.4.1 Seven-Conductor Control Head Cable (Locations 1, 2, 3, 6, and 7)

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

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

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

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

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

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

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

H) Pull the Shield wire back against the PVC jacket and slide and shrink a piece of 3/8 inch W. X 1 inch L. heat-shrink over the cable as shown in Figure 4-8:.

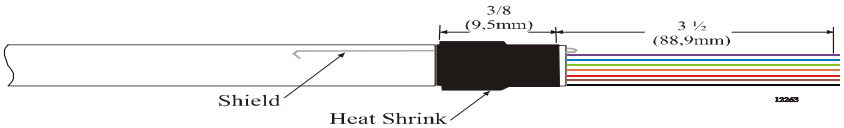


Figure 4-8: Seven-Conductor Control Head Cable Shield Wire and Heat-Shrink

I) Secure the seven-conductor cable to the frame using a conductive Clamp. Ensure that the Clamp and Shield wire come in contact with one another. Refer to Figure 4-9:.

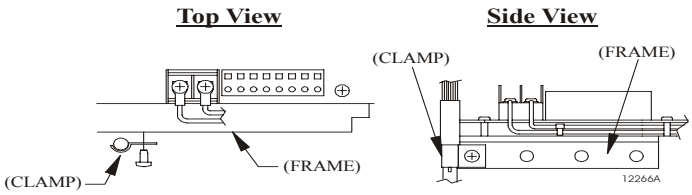


Figure 4-9: Clamp Views

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

K) Connect the conductors to the appropriate pins as shown on Table 4-1:, using a small slotted screwdriver as shown in Figure 4-10:

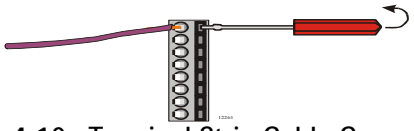


Figure 4-10: Terminal Strip Cable Connections

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

Table 4-1: Processor Circuit Board Connections for Remote Stations

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

4-4.4.2 Eleven-Conductor DP Cable (Location 2/NO Station 5)

If this option is to be used, please contact ZF Marine Electronics.

4-4.4.3 Start Interlock Cable (Location 4)

4-4.4.3.1 Connection at the Starter Solenoid

A) Run the length of two-conductor cable between the Engine's Starter Solenoid and the Processor.

B) Disconnect the Starter Switch wire from the Solenoid.

C) Strip back the appropriate amount of PVC jacketing and conductor insulation.

D) Connect one of the conductors to the Solenoid's Starter Switch terminal.

E) Butt splice the second wire to Starter Switch wire.

4-4.4.3.2 Connection at the Processor

A) Install a liquid tight connector into entry hole (No. 4). (Refer to Figure 4-6:, page 4-4, for entry hole location and Figure 4-5:, page 4-4, for cable grip installation.)

B) Run enough of the two-conductor power cable through the liquid tight cable grip so that it can be routed to PB2 on the Circuit Board as shown in Figure 4-7:, page 4-4.

C) Strip back 2 inches (50,8mm) of the PVC jacketing. Refer to Figure 4-11:

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

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

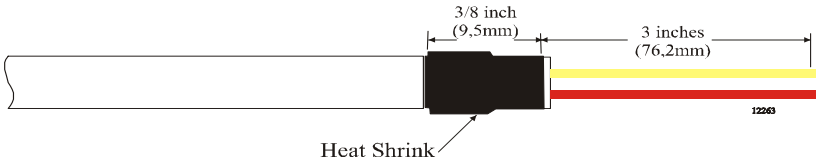


Figure 4-11: Two-Conductor Start Interlock Cable

F) Crimp fork or ring terminals to the wires.
G) Connect the two-conductor cable to PB2, red lead to the terminal labeled (1) and yellow lead to the terminal labeled (2), as indicated on Figure 4-7:, page 4-4.
H) Tie wrap the start interlock cable to the Processor's frame.

4-4.4.4 Power Cable (Location 5)

A) Run the length of two-conductor power cable between the DC Power Source and the Processor.
B) Make the connections at the vessel's DC Power Source, but do not turn power ON.
C) Install a liquid tight connector into the DC POWER entry hole (No. 5). (Refer to Figure 4-6:, page 4-4, for entry hole location and Figure 4-5:, page 4-4, for cable grip installation.)
D) Run enough of the two-conductor power cable through the liquid tight cable grip so that it can be routed as shown in Figure 4-7:, page 4-4.
E) Strip back 3 inches (76,2mm) of the PVC jacketing. Refer to Figure 4-12:
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.

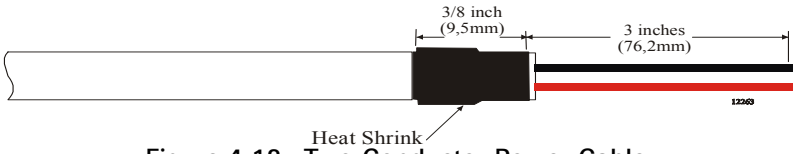


Figure 4-12: Two-Conductor Power Cable

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 4-7:, page 4-4.
J) Tie wrap the power cable to the Processor's frame.

4-4.4.5 Serial Communication Cable (Location 10)

A) Install 1/2 inch (12,7mm) liquid tight cable grips into hole (No.8) of the Port and Starboard Processors. (Refer to Figure 4-6:, page 4-4, for entry hole location and Figure 4-5:, page 4-4, for cable grip installation.)
B) Run a four-conductor, shielded cable from the Port to the Starboard Processors.
C) Strip back 3 inches (76,2mm) of PVC jacketing from both ends of the cable.
D) Strip each wire 3/8 inch (9,5mm).
E) Clip the drain wire flush with the PVC jacketing on the Starboard Processor only.
F) Place a 1 inch (25,4mm) section of shrink tubing over each end of the cable
G) On the Port end of the cable, bend the drain wire back and tuck it under the shrink tubing so that the drain wire end is exposed past the shrink tubing. (Refer to Figure 4-13:)

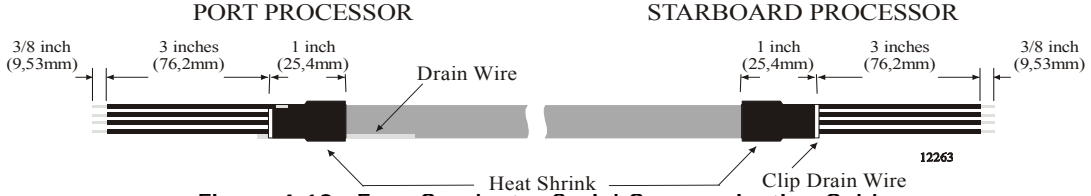


Figure 4-13: Four-Conductor Serial Communication Cable

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 as shown in Figure 4-9:, page 4-6. 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 4-2:

Table 4-2: Processor Circuit Board Connections for Serial Communication

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

4-4.4.6 Tachometer Cable (Location 12)

A) Run a two- or three-conductor shielded cable from the Port Processor to the Port engine's tachometer source. (Refer to Section 3-1.6, page 3-5)

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

B) Run a two- or three-conductor shielded cable from the Starboard Processor to the Starboard engine's tachometer source.
C) Install a 1/2 inch (12,7mm) liquid tight cable grip into hole (No. 9) of the Port and Starboard Processors. (Refer to Figure 4-6:, page 4-4, for entry hole location and Figure 4-5:, page 4-4, for cable grip installation)
D) Strip back 2 inches (50,8mm) of PVC jacketing from both ends of the cable.
E) Strip the ends of each conductor back 3/8 inch (9,5mm).
F) Clip off the drain wire flush with the PVC jacketing at the Tachometer source side only.
G) Place a 7/8 inch (22,23mm) section of shrink tubing over each end of the cable.
H) At the Processor side, bend the drain wire back and tuck it under the shrink tubing so that the drain wire end is exposed past the shrink tubing. (Refer to Figure 4-14: and Figure 4-15:)..

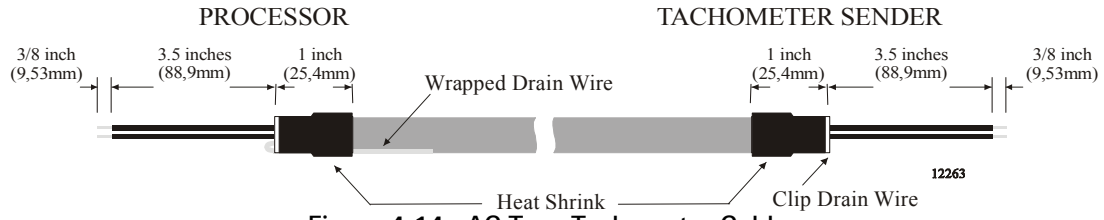


Figure 4-14: AC Type Tachometer Cable

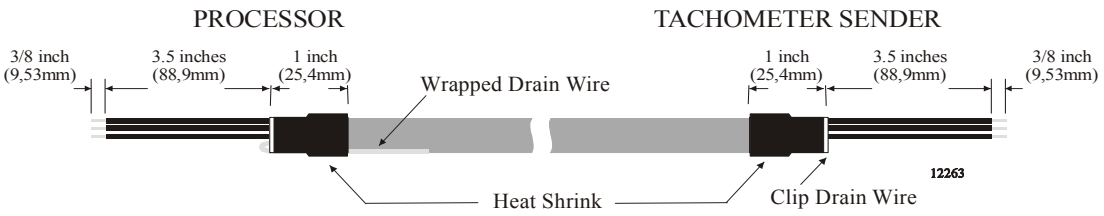


Figure 4-15: Open Collector Tachometer Cable

I) Shrink the tubing with a heat gun.
J) Insert the cable ends through the liquid tight connectors and tighten the nuts.
K) Secure the cables internally using a Clamp as shown in Figure 4-9:, page 4-6. Make certain that the drain wire makes contact with the Clamp's metallic surface.
L) Clip the exposed drain wires flush with the Clamps.
M) Connect the conductors to the terminal block as listed in Table 4-3:.

Table 4-3: Processor Circuit Board Connections for Tachometer

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

4-4.5 Clutch Cable (Location 8)

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

4-4.5.1 Processor Termination

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

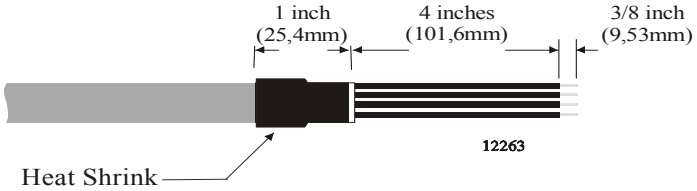


Figure 4-16: Clutch Cable Heat Shrink in Processor

E) Strip back 3/8 inch (9,53mm) from the four conductors and connect to the Processor as shown in Figure 4-7:, page 4-4

4-4.5.2 Plug Termination

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

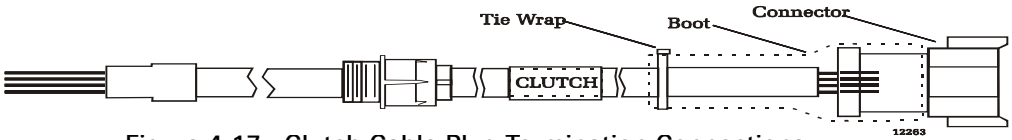


Figure 4-17: Clutch Cable Plug Termination Connections

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

Table 4-4: Clutch Termination Table

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

4-4.6 Throttle Cable (Location 11)

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

A) Install a 1/2 inch Liquid Tight Connector into hole no.12 of the Processor.

B) Run the throttle cable through the connector so that 4 inches (101,6mm) of the cable is pulled through.

C) Tighten the Liquid Tight Connector nut.

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

E) Clip the shield wire to 3/4 inch (19,1mm) of length.

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

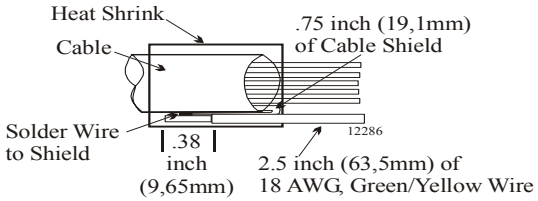


Figure 4-18: Engine Shield

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 4-5: Processor Circuit Board Connections for Throttle

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

4-5 *Engine Stop Switches*

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

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

5 SET UP PROCEDURE

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

The following paragraphs explain how to locate and use the push buttons and Display LEDs:

5-1 Processor Components Used In Set Up

Figure 5-1: Typical Processor Cover

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

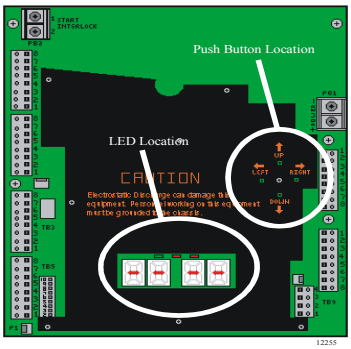
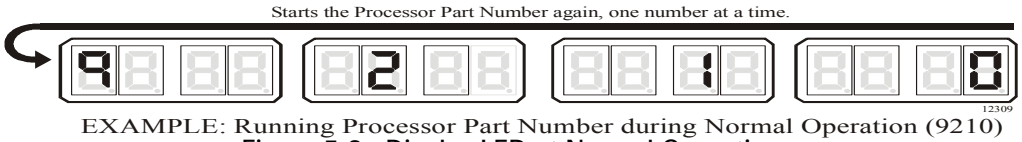


Figure 5-2: Processor Shield Push Button and Display LED Locations

- The Processor enclosure cover must be removed to access the Push Buttons as shown in Figure 5-2:
- The **Display LED** is used to view the Function Codes and the Values for those Functions (Section 5-1.1, page 5-1).
- The **Push Buttons** are used to scroll through Function Codes, select Function Codes and set the Values of the Function Codes. (Section 5-1.2, page 5-1)

5-1.1 Processor Display LED



EXAMPLE: Running Processor Part Number during Normal Operation (9210)

Figure 5-3: Display LED at Normal Operation

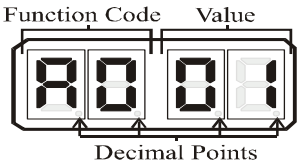


Figure 5-4: Display LED Designations

- 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:)
- The first two digit Display LED's to the left, indicate the **Function Code**, which is alphanumeric.
- The second two digit Display LED's indicate the numeric **Value** that is programmed into the Processor for the Function Code displayed to the left.
- A **decimal point** indicator is located on the bottom right corner of each Display LED.

5-1.2 Push Buttons

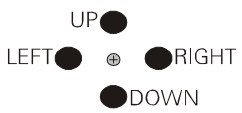


Figure 5-5: Circuit Board Push Buttons

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.

5-1.2.1 ***Up and Down Push Buttons***

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

- Stops Normal Operation Display (running Processor Part Number) and activates the Function Menu.
- While in the Function Menu, scrolls through the Function Codes one at a time.
- When an Error Code (Refer to Section B-1.9, page B-21) is displayed, scrolls through the error messages one at a time.
- When in Set Up Mode, increases (Up) or decreases (Down) the Value one digit at a time.

5-1.2.2 ***Left and Right Push Buttons***

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

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

5-1.2.3 ***Left Push Button Only***

Pressing the Left Push Button once has the following functions:

- Deactivates Set Up Mode without any changes to the Value being stored to memory. The Left Push Button must be held down until function code stops blinking. The default value will then be displayed.

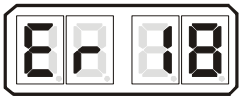


Figure 5-6: Display LED Error Menu Example

- 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.

5-1.2.4 ***Right Push Button Only***

Pressing the Right Push Button once has the following functions:

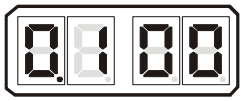


Figure 5-7: Display LED Four Digit Value

- 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.

5-2 Activating Set Up Mode

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

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

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

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

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

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

5-3 Storing Values To Memory

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

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

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

C) Reactivate Set Up Mode.

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

Set Up Function Codes And Values

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

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

Table 5-1: Processor Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Section 5-5.1, page 5-6)			
A0	Processor Identification	00	01, 02, 03, 04, 05
A1	Number of Engines	01	01, 02, 03, 04, 05
A2	One Lever Operation	00	00 – Disabled 01 – Enabled
A3	SE (Station Expander)	00	00 – Disabled 01 – Enabled
A4	Neutral Indication Tone	00	00 – No Tone 01 – Tone upon engaging Neutral Detent 02 – Tone upon shifting to Neutral
A5	Engine Room Lockout/Station 2 Lockout	00	00 – Both Disabled 01 – Engine Room Lockout Enabled 02 – Station 2 Lockout Enabled 03 – Both Enabled
A6	DP/Station 5	00	00 – DP Disabled - Station 5 Enabled 01 – DP with Troll Enabled - Station 5 Disabled 02 – DP without Troll Enabled - Station 5 Disabled

Table 5-2: Throttle Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Section 5-5.2, page 5-8)			
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 (Frequency) (120.64 to 360.9 Hz) 10 - Detroit Diesel (Frequency) (120.64 to 463.5 Hz)
E1	Throttle in Neutral	00.0	00.0 to 25.0% of Throttle Range [Throttle Range = Throttle Maximum (E3) - Throttle Minimum (E2)]
E2	Throttle Minimum	00.0	00.0 to 20.0% Must be 10% or more below Throttle Maximum (E3).
E3	Throttle Maximum	59.0	10.0 to 100.0% of Maximum Throttle Allowable. Must be 10% or more above Throttle Minimum (E2).

Table 5-2: Throttle Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Section 5-5.2, page 5-8)			
E4	Throttle Maximum Astern	100.0	00.0 to 100.0% of Throttle Maximum (E3)
E5	Throttle Pause Following Shift	00.5	00.0 to 05.0 Seconds
E6	High Idle	00.0	00.0 to 20.0% of Throttle Range. [Throttle Range = Throttle Maximum (E3) - Throttle Minimum (2)]
E7	Synchronization	00	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)

Table 5-3: Clutch Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Section 5-5.3, page 5-11)			
C0	Clutch Pressure Interlock	00	00 – Not Installed 01 – Installed 02 – Throttle Clutch Pressure Interlock Mode
C1	Clutch Interlock Delay	00.5	00.5 to 10.0 Seconds
C2	Proportional 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 Pause Time	04	00 to 99 Seconds
C4	Proportional Pause Ratio	00	00 – 2:1 Ahead to Astern vs. Astern to Ahead 01 – 1:1 Ahead to Astern vs. Astern to Ahead
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	00	00 to 100% Duty Cycle
C7	ZF-Hurth Duty Cycle Astern	00	00 to 100% Duty Cycle
C8	Fixed Neutral Delay	00.0	00.0 to 4.0 Seconds (In addition to any Proportional Delay)

Table 5-4: Troll Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Only Available and Displayed When Troll is Enabled) (Section 5-5.4, page 5-15)			
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)
L1	Troll Valve Function	00	0 - Normal, (No Current when at Lock-up) 01 - Inverse (No Current when at Lock-up) 02 - Normal (Maximum Current when at Lock-up) Preset for **ZF220-550, 12VDC Systems**. 03 - Normal (No Current when at Lock-up) Preset for **ZF220-550, 24VDC Systems.** 04 - Normal (No Current when at Lock-up) Preset for **ZF2000**, **24 VDC Systems.** 05 - Inverse (No Current when at Lock-up) Preset for **ZF6000, 1900 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).

Table 5-4: Troll Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Only Available and Displayed When Troll is Enabled) (Section 5-5.4, page 5-15)			
L3	Troll Maximum Pressure	25	20.0 to 100.0% Must be at least 10% above Troll Minimum. (L2)
L4	Troll Throttle Limit	00	00 to 20% of Troll Range [Troll Range = Troll Maximum (L3) - Troll Minimum (L2)]
L5	Troll Pulse Duration	00.6	00.0 to 09.9 Seconds.
L6	Troll Pulse Percentage	25.0	00.1 to 100.0% of available Troll Range.

Table 5-5: Troubleshooting Function Codes

Function Code	Function Name	Value Range or Options
(Section 5-5.5, page 5-15)		
H0	Diagnostic	Input Voltage (+/- 0.5VDC) Tachometer Sensor Frequency Station No.1 Lever A/D Station No.2 Lever A/D Station No.3 Lever A/D Station No.4 Lever A/D Station No.5 Lever A/D Transfer Button, Stations 1, 2, 3, 4, & 5 Software Revision Level
H1	Return to Factory Defaults	Store to Return to Factory Defaults **(For Authorized Personnel Only)**
H2	Driver Fault Detection Enable	Allows the Processor to monitor the clutch and/or troll solenoids.

Table 5-6: Speed Boost Premium-Only Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Section 5-5.6.1, page 5-16)			
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
F3	Speed Boost Bypass Clutch Delay	0.0	0.0 to 99.0 Seconds

Table 5-7: Station Transfer Premium-Only Function Codes

Function Code	Function Name	Default Value	Value Range or Options
(Section 5-5.6.2, page 5-16)			
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 Timeout	15.0	0.0 to 99.0 Seconds

5-4 Field Service Test Unit (Break-out Box) and Multimeter Use

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

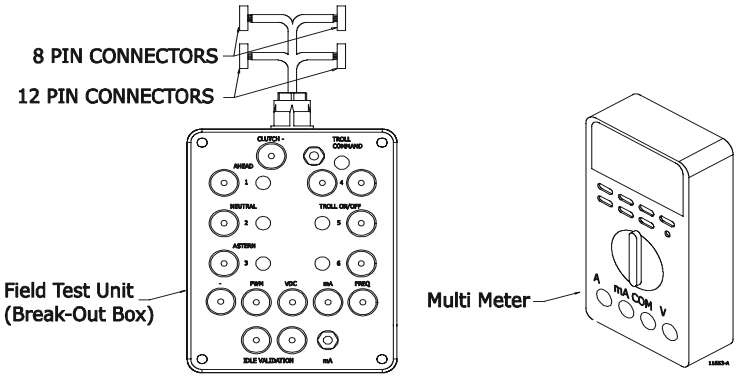


Figure 5-8: Service Field Test Unit and Multimeter

To aid in adjusting the list of Processor signals in the tables below, ZF Marine Electronics recommends the use of ZF Marine Electronics Field Service Test Unit (P/N 13927) (Break-out Box) and a calibrated Multimeter.

C6	ZF-Hurth Duty Cycle Ahead (Section 5-5.3.2.2)
C7	ZF-Hurth Duty Cycle Astern (Section 5-5.3.2.3)

Table 5-8: Clutch Functions Requiring Service Field Test Unit and Multimeter

E1	Throttle in Neutral (Section 5-5.2.1.1)
E2	Throttle Minimum (Section 5-5.2.2.2)
E3	Throttle Maximum (Section 5-5.2.2.3)
E4	Throttle Maximum Astern (Section 5-5.2.1.2)
E6	High Idle (Section 5-5.2.1.4)

Table 5-9: Throttle Functions Requiring Service Field Test Unit and Multimeter

5-5 System Programming And Adjustments

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

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

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

5-5.1 Processor Functions

5-5.1.1 Function Code A0 *– Processor Identification*

In applications where there is more than one screw, the system must know which Processor is where. Every Processor must have its own unique identifying number. At no time can two or more Processors be identified by the same Processor Identification Number.
The available Values for this Function are:
00 (Default Value), **01, 02, 03, 04** and **05.**

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

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

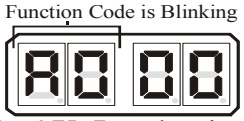


Figure 5-1: Display LED Function A0 Set Up Activated

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.

5-5.1.2 Function Code A1 *– 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
04 Quad Screw
05 Quint Screw

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

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

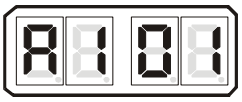


Figure 5-2: Display LED Function A1 Set Up Activated

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.

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

5-5.1.3 Function Code A2 *– One Lever Operation*

In Twin Screw or more applications, the System has the ability to command all engines and transmissions to the same speed and direction with a single Control Head lever. This Function allows this Feature to be enabled or disabled. (Refer to Section 2-9, page 2-5, for operation instructions)
The available Values for this Function are:

00 Disabled (Default Value)
01 Enabled

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

Figure 5-3: Display LED Function A2 Set Up Activated

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.

5-5.1.4 Function Code A3 *– SE (Station Expander)*

NOTE: This Manual does not go into detail on the Station Expander installation and adjustments. For further information on the Station Expander, contact your local ZF Marine Electronics Representative.

The SE is a separate unit, which gives the System the ability to increase the number of Remote Stations, if more than five Remote Stations are required. (Refer to Section 8-3, page 8-4, for further information)
The available Values for this Function are:

00 Disabled (Default Value)
01 Enabled

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

Figure 5-4: Display LED Function A3 Set Up Activated

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

5-5.1.5 Function Code A4 *– Neutral Indication Tone*

This Function allows the installer to turn ON a 1/2 second, low frequency tone to indicate Neutral.
The available Values for this Function are:

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

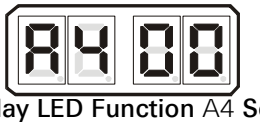


Figure 5-5: Display LED Function A4 Set Up Activated

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.

5-5.1.6 ***Function Code*** 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)

1. When selected, all five Remote Stations behave in the same manner.
2. No Station has transfer priority or lockout capability.

01 Engine Room Lockout Enabled

1. When the Engine Room switch is closed, control is transferred to Station No.1.
2. When the Engine Room switch is closed, no other station can take command away from Station No.1.
3. When closed on power-up, Station No.1 will be in command without pressing the transfer button.

02 Station No.2 Lockout Enabled

1. When the Station No.2 switch is closed, control is transferred to Station No.2.
2. When the Station No.2 switch is closed, no other station can take command away from Station No.2.
3. When closed on power-up, Station No.2 will not be in command unless the transfer button is pressed. However, no other station can take command on power-up.

03 Both Enabled

1. When both switches are closed, control is transferred to Station No.1.
2. When both switches are closed, no other station can take command away from Station No.1
3. When both switches are closed on power-up, Station No.1 will be in command without pressing the transfer button.

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.1.7 ***Function Code*** A6 **–** ***Station No. 5 / DP***

This Function allows Station No.5 to be set-up as a standard Remote Station or as an interface for a Dynamic Positioning (DP) system.

The available Values for this Function are:

00 DP Disabled (Default Value)

When disabled, Station No.5 is configured to operate with a Standard Control Head.

01 DP Enabled with Troll

Station No.5 is configured to operate the clutch, throttle and trolling valve in DP Mode.

02 DP Enabled without Troll

Station No.5 is configured to operate the clutch and throttle in DP Mode.

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.2 Throttle Functions

5-5.2.1 Throttle Basic Functions (E1, E4 through E7)

5-5.2.1.1 Function Code E1 – Throttle in Neutral

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

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

The Default Value is **00.0**%.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

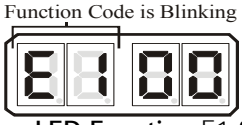


Figure 5-6: Display LED Function E1 Set Up Activated

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.

5-5.2.1.2 **Function Code** E4 **– Throttle Maximum Astern**

This Function limits the amount of Throttle permitted in Astern.

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

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

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

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

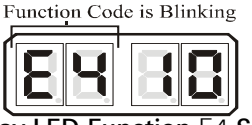


Figure 5-7: Display LED Function E4 Set Up Activated

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.

5-5.2.1.3 **Function Code** E5 **– Throttle Pause Following Shift**

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

The Default Value is **00.5** seconds.

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

NOTE: This Function is typically programmed during Dock Trials. Refer to Section 6-6, page 6-2.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

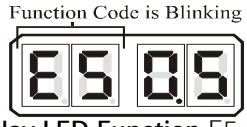


Figure 5-8: Display LED Function E5 Set Up Activated

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

5-5.2.1.4 **Function Code** E6 **– High Idle**

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

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

The Default Value is **00.0**%.

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

NOTE: This Function is typically programmed during Dock Trials or Sea Trials. Refer to Section 6-4, page 6-1

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

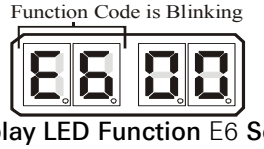


Figure 5-9: Display LED Function E6 Set Up Activated

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

5-5.2.1.5 **Function Code** E7 **– Synchronization**

This Function Code selects the type of Synchronization, if Synchronization is required. The types are described in Section 2-10, page 2-6.

The available Values for this Function are:

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

The Default Value is **02**.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

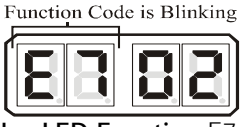


Figure 5-10: Display LED Function E7 Set Up Activated

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.

5-5.2.2 Throttle Electronic Functions (E0, E2, E3)

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

5-5.2.2.1 **Function Code** E0 **– Engine Throttle Profile**

This Function selects the appropriate Throttle Signal range for various engines

The available Values for this Function are listed below:

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 (Frequency) (120.64 to 360.9 Hz)
10 - Detroit Diesel (Frequency) (120.64 to 463.5 Hz)

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

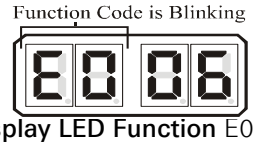


Figure 5-11: Display LED Function E0 Set Up Activated

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

5-5.2.2.2 **Function Code** E2 **– Throttle Minimum**

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

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

The Default Value is **08.0**%.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

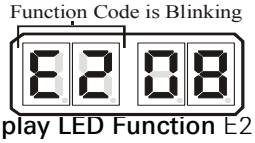


Figure 5-12: Display LED Function E2 Set Up Activated

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

5-5.2.2.3 Function Code E3 – Throttle Maximum

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

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

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

The Default Value is **59.0**%.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

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

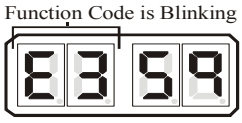


Figure 5-13: Display LED Function E3 Set Up Activated

5-5.3 Clutch Functions

5-5.3.1 Clutch Basic Functions (C0 through C4, C8)

5-5.3.1.1 Function Code C0 – Clutch Pressure Interlock

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

This Function enables or disables the feature and allows for two different modes of behavior when a Clutch Pressure Switch is used. Refer to Section 8-2, page 8-2, for detailed information.

The available Values for this Function are:
00 Not Installed (Default Value)
01 Installed
02 Throttle Clutch Pressure Interlock Mode

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

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.

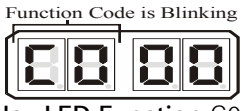


Figure 5-14: Display LED Function C0 Set Up Activated

5-5.3.1.2 Function Code C1 – Clutch Interlock Delay

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** – Clutch Pressure Interlock. Refer to Sections 8-2, page 8-2, for operational details.

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

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.

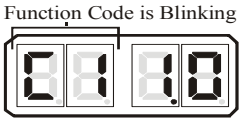


Figure 5-15: Display LED Function C1 Set Up Activated

5-5.3.1.3 Function Code C2 – Proportional Pause

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

The In-Gear Delay is most commonly used.

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

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

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

The available Values are:

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

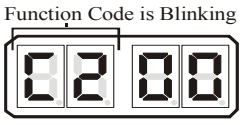


Figure 5-16: Display LED Function C2 Set Up Activated

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.

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

5-5.3.1.4 **Function Code C3 – Proportional Pause Time**

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

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

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

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

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

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

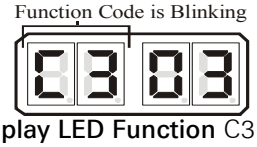


Figure 5-17: Display LED Function C3 Set Up Activated

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.

5-5.3.1.5 **Function Code C4 – Proportional Pause Ratio**

00 - 2:1 Ratio
This is the default setting and determines how the value set in the Proportional Pause Time **C3** Function is

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

01- 1:1 Ratio
When this setting is selected, the value set in the Proportional Pause Time **C3** is the same for both Ahead to Astern, as with Astern to Ahead maneuvers. This may be selected when the vessel reaches the same water speed in both directions, as would be the case with a Double Ended Ferry. Another application where this option may be selected would be the control of a Bow or Stern Thruster.

This Function Code selects whether the Proportional Pause Time is the same in Ahead and Astern or whether the time in Ahead is twice that in Astern. Standard vessels with a bow and a stern typically select a pause which is twice as much in Ahead compared to Astern. This is because much more speed is obtainable in Ahead, then Astern. Consequently, more time is required to slow down from Ahead as compared to Astern.

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

The available Values for this Function are:
00 2:1 Ahead to Astern vs. Astern to Ahead (Default Value)
01 1:1 Ahead to Astern vs. Astern to Ahead

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

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.

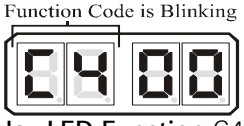


Figure 5-18: Display LED Function C4 Set Up Activated

5-5.3.1.6 Function Code 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 Sections 5-2 and 5-3, page 5-2):

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.

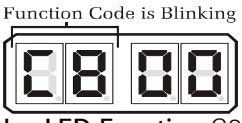


Figure 5-19: Display LED Function C8 Set Up Activated

5-5.3.2 Clutch Solenoid Functions (C5 through C6)

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

5-5.3.2.1 Function Code C5 – Shift Solenoid Type

This Function Code must be left at the default value unless a ZF-Hurth Gear is installed with proportional Ahead and Astern Solenoids.

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

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

CAUTION: The maximum amount of current to 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.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

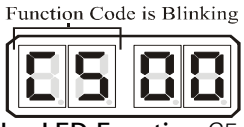


Figure 5-20: Display LED Function C5 Set Up Activated

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

5-5.3.2.2 **Function Code** C6 **– ZF-Hurth Duty Cycle Ahead**

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

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

The Default Value is **100**%.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

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

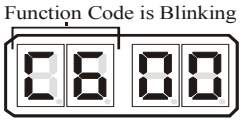


Figure 5-21: Display LED Function C6 Set Up Activated

5-5.3.2.3 **Function Code** C7 **– ZF-Hurth Duty Cycle Astern**

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

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

The Default Value is **100**%.

To change the Value (Refer to Sections 5-2 and 5-3, page 5-2):

A) Ensure that Troll is <u>not</u> selected (no rapidly blinking LED).
B) Connect an amp meter in series with the Astern solenoid signal.

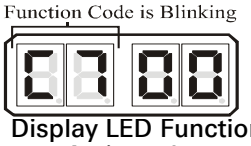


Figure 5-22: Display LED Function C7 Set Up Activated

C) Move the Control Head lever to the Astern detent.
D) Scroll to Function Code **C7**.
E) Activate Set Up Mode.
F) Scroll Up or Down until the appropriate minimum current level is reached.
G) Store the Value to memory.
H) Return the Control Head lever to the Neutral/Idle position.

5-5.4 Troll Functions

NOTE: The only Troll function initially displayed is **L0**. Whe **L0** is set to any Value other than **00**, the remainder of the Troll functions (**L1** through **L6**) will be displayed.

5-5.4.1 Troll Basic Functions (L0, L4, L5)

5-5.4.1.1 Function Code 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%).

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.5 Troubleshooting Functions

5-5.5.1 Basic Processor Troubleshooting Functions

5-5.5.1.1 Function Code H0 - Diagnostics

This Function is used during troubleshooting and is explained in detail in Appendix B - Section B4.

5-5.5.1.2 Function Code H1 – Return to Factory Defaults

This Function may be used during troubleshooting.

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

5-5.5.1.3 Function Code H2 - Driver Fault Detection Enable

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

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

Table 5-10: lists the required value that needs to be entered to monitor the Ahead, Astern, Neutral, Troll Command, and Troll ON/OFF solenoids.

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

Table 5-10: Solenoid Error Status Enable

Ahead	Astern	Neutral	Troll Command	Troll On/Off	Value
0	0	0	0	0	00
1	0	0	0	0	01
0	1	0	0	0	02
1	1	0	0	0	03
0	0	1	0	0	04
1	0	1	0	0	05
0	1	1	0	0	06
1	1	1	0	0	07

Table 5-10: Solenoid Error Status Enable

Ahead	Astern	Neutral	Troll Command	Troll On/Off	Value
0	0	0	1	0	08
1	0	0	1	0	09
0	1	0	1	0	10
1	1	0	1	0	11
0	0	1	1	0	12
1	0	1	1	0	13
0	1	1	1	0	14
1	1	1	1	0	15
0	0	0	0	1	16
1	0	0	0	1	17
0	1	0	0	1	18
1	1	0	0	1	19
0	0	1	0	1	20
1	0	1	0	1	21
0	1	1	0	1	22
1	1	1	0	1	23
0	0	0	1	1	24
1	0	0	1	1	25
0	1	0	1	1	26
1	1	0	1	1	27
0	0	1	1	1	28
1	0	1	1	1	29
0	1	1	1	1	30
1	1	1	1	1	31

5-5.6 Premium Functions

5-5.6.1 Speed Boost Function Codes (F0 - F3)

Do Not attempt to adjust any of the Speed Boost Function Codes until you have read the descriptions of their usage and have verified their need. Refer to Section 8-10, page 8-5.
No adjustments should be made to speed boost until Function Codes **C2** (Proportional Pause), **C3** (Proportional Time), and **C4** (Proportional Pause Ratio) have been properly adjusted.

5-5.6.1.1 Function Code F0 – Speed Boost Percent

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.6.1.2 Function Code F1 - Speed Boost Duration

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.6.1.3 Function Code F2 – Speed Boost Start Delay

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.6.1.4 Function Code F3 – Speed Boost Bypass Clutch Delay

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.6.2 Transfer Function Codes (P0, P1)

5-5.6.2.1 Function Code P0 – Transfer Mode

There are four different Modes of Station Transfer available.
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 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.

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.

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

5-5.6.2.2 **Function Code P1 – Transfer Timeout**

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

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

Contact ZF Marine Electronics if this Function Code is going to be changed from the default setting.

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.

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

NOTE: On multiple screw applications, the following tests must be performed on both sides. If any of the following tests fail, consult Appendix B Troubleshooting.

6-1 *Control Heads (Engines Stopped)*

A) Turn power ON to the Control System.

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

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

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

6-2 *Start Interlock (Engines Stopped)*

A) Turn the Processor DC power OFF.
- Verify that the engine(s) will not start.

B) Turn Processor DC power ON. Do not take command at a Remote Station.
- Verify that the engine(s) will not start.

C) Take command at a Remote Station. Place the Control Head's lever(s) to approximately 50% of the throttle range.
- Verify that the engine(s) will not start.

D) Place the Control Head's lever(s) in the Neutral/Idle position. Take command at a Remote Station.
- Verify that the engine(s) will start in this position.

6-3 *Engine Stop Switches*

Start the engine(s) and verify that the Stop switches (normally push buttons) function correctly at all Remote Stations.

6-4 *High Idle*

A) Place the Station in command into Warm-up Mode.

B) Adjust Function Code E6 to the desired engine RPM, as described in Section 5-6.2.1.2, page 5-10.

C) Return the Control Head's lever to the Neutral/Idle position.

6-5 *Control Head Solenoid Command*

A) Start the engine(s) and let them run at Neutral/Idle.

B) Place one Control Head lever at a time into the Ahead detent, the Astern detent and then Neutral. Confirm that the movement of the vessel is in the correct direction.

- If incorrect, reverse the electric cable connections at the shift solenoids.

C) Place the Control System into Warm-Up Mode and confirm that there is control of speed.
D) Run the throttle up to approximately 20% of the throttle range for at least 10 seconds.
E) Return the lever to the Neutral/Idle position.
F) Repeat steps A) thru E) at the remaining Control Head levers.

6-6 *Throttle Pause Following Solenoid Shift*

NOTE: A Test Control Head and a stop-watch are recommended to determine the correct setting for the Throttle Pause. If a Test Control Head is not available, a second person may be needed.

A) Move the Station in command's lever to the Ahead detent, start the stop-watch while monitoring the Shaft.
B) When the Shaft begins to rotate, stop the stop-watch.
C) Record the time expired on the stop-watch.
D) Program Function Code **E5** as described in Section 5-5.2.1.3, page 5-9

NOTE: If the time recorded in Section 6-6, step C) exceeds 5.0 seconds, a Clutch Pressure Interlock is required. Refer to Section 8-2, page 8-2.

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 Appendix B Troubleshooting Section or a ZF Facility prior to resuming the Sea Trial.

NOTE: In multi-screw applications, the following tests must be performed on all engines. During the course of the Dock Trial and Sea Trials, fill out the Trial Report. Retain this information for future use.

7-1 Full Speed Setting - Electronic Throttle

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

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

C) If synchronization is installed, disable synchronization as explained in Section 5-5.2.1.5, page 5-10.
- If the engine RPM is low, refer to Appendix B - Service Field Test Unit Manual.
- If the engine RPM is high, decrease by using Function Code **E3**, as explained in Section 5-5.2.2.3, page 5-11.

D) For twin screw applications, check that matching Idle, Mid-range and Full speed Control Head lever positions cause equal RPM in both engines.

7-2 Proportional Pause

The proportional pause feature provides engine deceleration when making a direction change. The pause is variable and in proportion to:
- The Control Head's lever position prior to the reversal.
- How long the Control Head's lever has been in that position prior to the reversal.

The pause is In-Gear or at Neutral, depending on the Function Code **C2** Proportional Pause setting. The sequence of events, are as follows for the three different Reversal Pause types:

7-2.1 In-Gear Delay [C200]

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

7-2.2 Neutral Delay [C201]

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

7-2.3 Fixed Neutral Delay [C202]

CAUTION: The Fixed Neutral Delay feature was added in order to accommodate Thruster Control installations. Damage to the drive train may occur when used for reverse reduction gear applications.

- The Throttle drops to Idle.
- The Transmission shifts to Neutral.

- The Control System pauses at this position for the amount of time programmed (duration) with Function **C3** Proportional Pause Time (regardless of prior throttle setting).
- The Transmission shifts to the opposite gear (Port or Starboard)
- The Throttle position moves to the Control Head's present commanded position.

7-3 Calculating Proportional Pause Time C3

NOTE: The pause on a through Neutral shift is proportional to the speed commanded and the time at that speed. The Values listed for Function Code **C3**, Proportional Pause Time, are the maximum possible delays. When shifting from Idle Ahead to Idle Astern or vice-versa the delay is zero. The time required to build up to the maximum pause is six times the Value selected. In addition, in order to build up to the maximum delay Value, the System must be commanding Full Throttle. The Pause when shifting from Astern to Ahead is either half or the same as the Ahead to Astern delay depending on the Value selected for Function Code **C4** Proportional Pause Ratio.

NOTE: A stop-watch is required to accurately program the Proportional Pause Time.

The amount of pause required is determined as follows:

A) Place the Control Head lever(s) to the Full Ahead position.

B) Leave the Control Head lever(s) at this position for whichever of the following two is longer:
- Sixty seconds.
- The vessel's speed through the water reaches maximum.

C) Quickly move the Control Head lever(s) to Ahead Idle or Neutral, (depending on Function Code **C4** setting) while starting the stop-watch.

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

E) Program Function Code **C3**, Proportional Pause Time, as described in the Set Up Procedures, to the time expired on the stop-watch.

7-3.1 Testing The Proportional Pause

CAUTION: It is critical that the Proportional Pause is tested as outlined below to ensure that it was properly programmed. Failure to do so could cause damage to the transmission.

A) Position the boat in open water and slowly increase the Throttle to 25% of the speed range.

B) Leave the Control Head lever(s) at this position for at least 60 seconds.

C) Quickly move the Control Head lever(s) to Idle Astern.
- The engine(s) RPM should drop to Idle.
- The Clutch should stay engaged or shift to Neutral for 25% of the time selected with Function Code **C3** Proportional Pause Time.
- Once the time has expired, the Clutch should Shift to Astern.
- The engine RPM will drop slightly when the Astern load is placed on the engine, but not to the point where it comes close to stalling.

D) Increase the Throttle slightly until the vessel starts moving in the opposite direction.
- If the engine stalled or came very close to stalling, increase the Value of Function Code **C3** by one second. Repeat steps A) through C).
- If the engine does not stall or come close to stalling, proceed with the next step.

E) Repeat steps A) through D) with the Throttle at 50%, 75%, and 100% of the speed range.

- If the engine stalls at any time, increase the Value of Function Code **C3** by one second and repeat the steps A) through D) again.

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

7-4 Synchronization Test

7-4.1 Equal Throttle Synchronization

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

B) If previously disabled, enable the synchronization by depressing the transfer button for two seconds.
- The green LED on the Control Head should illuminate, indicating synchronization.

C) Check the engine tachometers to see if they are within 1% of one another.

D) Move both Control Head levers side by side to approximately 50% of the Throttle range.

E) Check the engine tachometers to see if they are within 1% of one another.

F) Move both Control Head levers side by side to approximately 75% of the Throttle range.

G) Check the engine tachometers to see if they are within 1% of one another.

H) Move both Control Head levers side by side to 100% of the Throttle range.

I) Check the engine tachometers to see if they are within 1% of one another.
- While synchronized, if the tachometers have a greater than 1% difference at any engine RPM, Active Synchronization is recommended.

7-4.2 Active Synchronization

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

B) If previously disabled, enable the synchronization by depressing the transfer button for two seconds.
- The green LED on the Control Head may blink while driving toward synchronization.
- Once the engine RPM's are within 1% of one another, the green LED will remain solidly lit.

C) Check the engine tachometers to see if they are within 1% of one another.

D) Move both Control Head levers side by side to approximately 50% of the Throttle range.

E) Check the engine tachometers to see if they are within 1% of one another.

F) Move both Control Head levers side by side to approximately 75% of the Throttle range.

G) Check the engine tachometers to see if they are within 1% of one another.

H) Move both Control Head levers side by side to 100% of the Throttle range.

I) Check the engine tachometers to see if they are within 1% of one another.

While synchronized, if the tachometers have a greater than 1% percent difference at any engine RPM, or if they appear to be continually "hunting" for the correct RPM, refer to the Appendix B Troubleshooting Section.

7-5 Sea Trial Report

The purpose of this Sea Trial Report is to provide a convenient checklist and record of installation, dock trial set up, and sea trial performance of the ZF Marine Electronics Propulsion Control System. Please enter ALL of the information. We recommend that this form remains aboard the vessel, and a copy is sent to ZF Marine Electronics with the Warranty Registration located at the end of this manual.

7-5.1 Vessel Information

Vessel Name: _____ Hull No. _____ Trial Date: _____

Vessel Type: _____ Dwg No.: _____

Installing Yard/Project Manager: _____ Tel: _____

Owner/Owner's Representative: _____ Tel:: _____

ENGINE DATA: Make: _____ Model: _____ HP (KW): _____ RPM: _____

PROPELLER DATA: No. of Screws: _____ Propeller Type: Fixed ☐ Other ☐ _____

GEAR DATA: Make: _____ Model: _____ Ratio: _____

No. of Remote Stations: _____ Locations: 1. _____ 4. _____

2. _____ 5. _____

3. _____

7-5.2 Control System Checks

Make the following checks prior to applying power to the Processor.

Table 7-1: Sea Trial Processor Mounting

PORT		STBD		Processor Serial Numbers
YES	NO	YES	NO	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	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?
YES	NO	YES	NO	Is there an Engine Stop Switch installed at each Remote Station?
YES	NO	YES	NO	Does Shift operate in the correct direction?
YES	NO	YES	NO	Does Throttle operate in the correct direction?
YES	NO	YES	NO	Is there an Engine Room/Remote Switch installed at the Engine Room Remote Station?
YES	NO	YES	NO	Is there an Lock-out Switch installed at Remote Station 2?

Table 7-1: Sea Trial Power Supply

PORT Outside		STBD Outside		Processor Serial Numbers
				What is the source of Processor power and how is it charged?
YES	NO	YES	NO	Is there a backup power supply? APS or other, explain.

Table 7-1: Sea Trial Power Supply

PORT Outside		STBD Outside		Processor Serial Numbers
YES	NO	YES	NO	Are the power cables protected by 10 Ampere Circuit Breakers?
YES	NO	YES	NO	If separate power supplies are used for each Processors do they have a common ground?
At Battery _____ VDC	At Processor _____ VDC	At Battery _____ VDC	At Processor _____ VDC	What is the Voltage when not being charged?
At Battery _____ VDC	At Processor _____ VDC	At Battery _____ VDC	At Processor _____ VDC	What is the Voltage when connected to Shore Power?
At Battery _____ VDC	At Processor _____ VDC	At Battery _____ VDC	At Processor _____ VDC	What is the Voltage when the engines are running?

Table 7-1: Dock Trials

PORT Outside		STBD Outside		Processor Serial Numbers
YES	NO	YES	NO	Does the engine start 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		
YES	NO	YES	NO	High Idle RPM (optional)
RPM		RPM		
YES	NO	YES	NO	Does the vessel surge forward with Control Head lever in the Ahead Detent?

Table 7-1: Sea Trials

PORT Outside		STBD Outside		Processor Serial Numbers
RPM		RPM		What is the Full Throttle RPM?
YES	NO	YES	NO	Do the Dual Control Head levers match position and RPM throughout the speed range?
Seconds		Seconds		The Full Speed Reversal Delay is set for how many seconds?
YES	NO	YES	NO	Is Synchronization operational?
STA 1	STA 2	STA 1	STA 2	What is the length of the Control Head Harness?
STA 3	STA 4	STA 3	STA 4	
STA 5		STA 5		

7-5.3 Record Parameters

Record information onto the following Tables only after ALL information has been recorded in the previous Section **Control Checks.**

Table 7-1: Record Processor Functions

Function Code	Function Name	Port	Stbd
(Refer to Section 5-5.1, page 5-6)			
A0	Processor Identification		
A1	Number of Engines		
A2	One Lever Operation		
A3	SE (Station Expander)		
A4	Neutral Indication Tone		

Table 7-1: Record Throttle Functions

Function Code	Function Name	Port	Stbd
(Refer to Section 5-5.2, page 5-8)			
E0	Engine Throttle Profile		
E1	Throttle in Neutral		
E2	Throttle Minimum		
E3	Throttle Maximum		
E4	Throttle Maximum Astern		
E5	Throttle Pause Following Shift		
E6	High Idle		
E7	Synchronization		

Table 7-1: Record Clutch Functions

Function Code	Function Name	Port	Stbd
(Refer to Section 5-5.3, page 5-11)			
C0	Clutch Pressure Interlock		
C1	Clutch Interlock Delay		
C2	Proportional Pause		
C3	Proportional Pause Time		
C4	Proportional Pause Ratio		
C5	Shift Solenoid Type		
C6	ZF-Hurth Duty Cycle Ahead		
C7	ZF-Hurth Duty Cycle Astern		
C8	Fixed Neutral Delay		

7-5.4 Comments (Please use additional paper as necessary):

7-5.4.1 General Installation Condition

7-5.4.2 Any Irregularities:

INSPECTOR_____ DATE_____

8 CONTROL OPTIONS

8-1 External Alarm Capability

CAUTION: The Processor's Alarm circuit is limited to a maximum current of 0.5 Amperes and a maximum voltage of 100 Volts DC. Exceeding these limits will permanently damage the Alarm circuit.

The Processor comes equipped with a normally open relay contact for connection to an external Status Indication circuit. The relay energizes, closing the contact when the Circuit Board has power applied and the software program is running normally. In the event of a power loss or the software program detects an anomaly, the relay de-energizes and the contact opens.

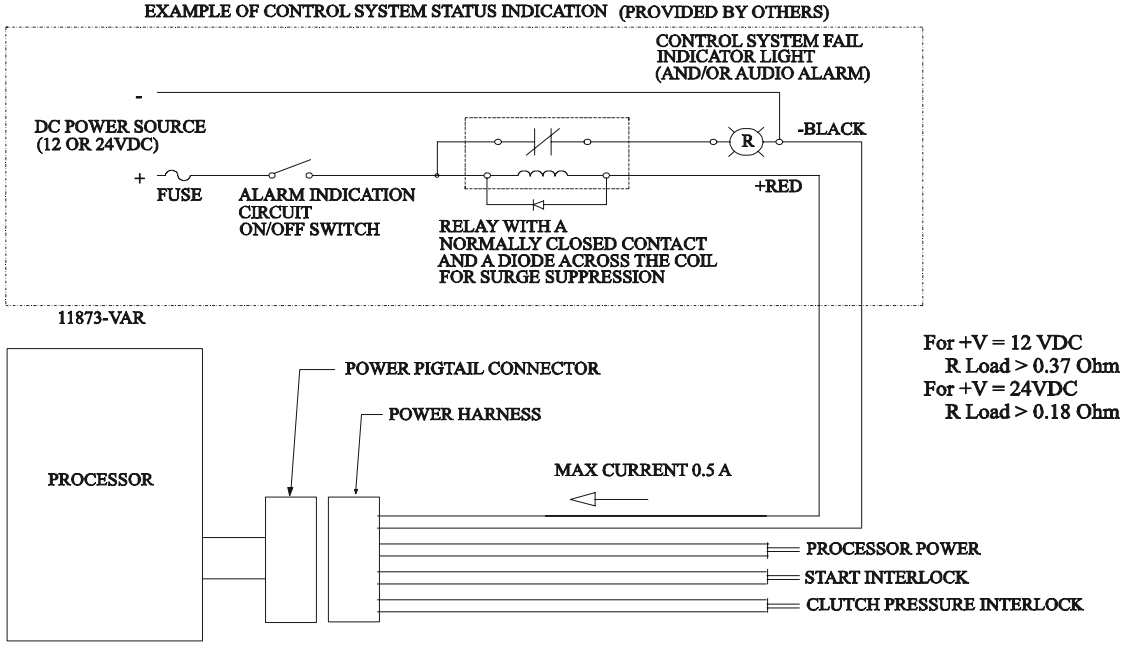


Figure 8-1: External Alarm Connections with Processor Harness Example

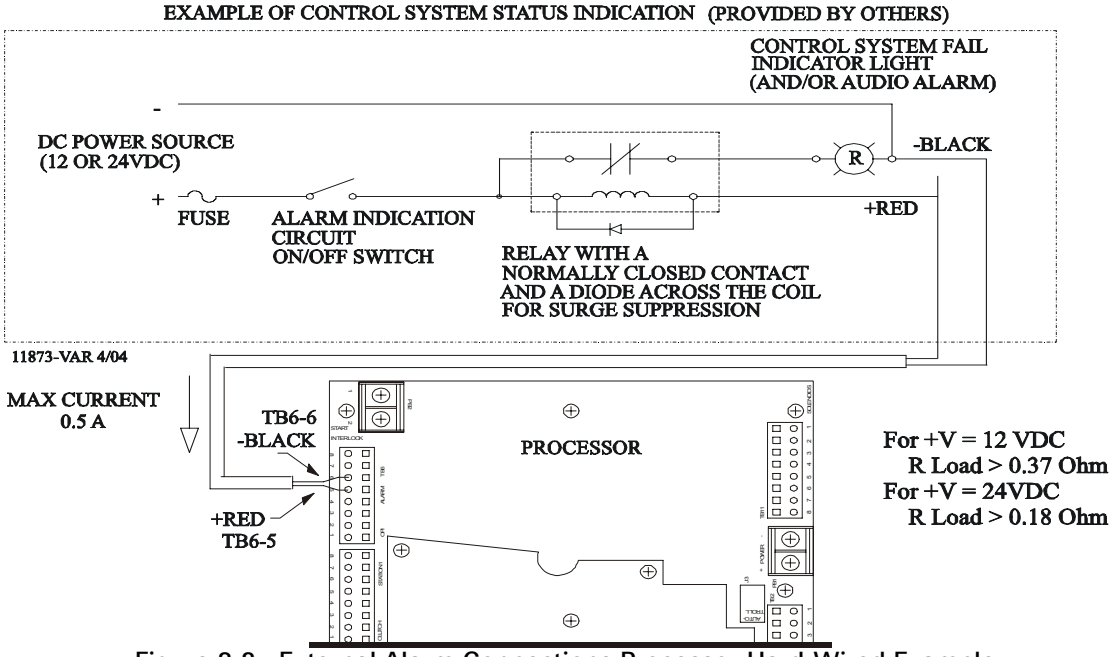


Figure 8-2: External Alarm Connections Processor Hard-Wired Example

8-1.1 Installation

(Refer to Figure 8-1: or Figure 8-2:)

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: and Figure 8-2: are an example of a suitable circuit, but not necessarily the only circuit acceptable.

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

B) Run the two-conductor Alarm cable to the location of the Status Indication Circuit.

C) Connect the black and red conductors to the Status Indication Circuit as shown in Figure 8-1: or Figure 8-2:.

8-2 Clutch Pressure Interlock

NOTE: The Clutch Pressure Interlock C0 must be set to be used. Refer to the Section 5-6.3.1.1, page 5-13, for Function Code C0 – Clutch Pressure Interlock

The Clutch Pressure Interlock uses a Pressure Switch which monitors the Ahead and Astern Clutch pressures. The Pressure Switch must have a Normally Open (N.O.) contact that closes when adequate Clutch pressure is reached. The primary function of the Interlock is to prevent high engine RPM when the Clutch is not fully engaged. The Interlock option must be selected with Function Code **C0**. There are two selectable methods of operation as described below:

8-2.1 C0 Methods of Operation

8-2.1.1 01 - *Installed*

When selected, the Interlock will command the Throttle to Idle, if low or a loss of pressure occurs while cruising. The Interlock is activated when the Pressure Switch's contact opens for the minimum period of time selected with Function Code **C1**.

If adequate Clutch pressure is not reached in the time programmed in Function Code **E5**, throttle will be allowed to increase above Idle. The Throttle will remain at this commanded speed for the time programmed in Function Code **C1** and then returned to Idle, unless adequate pressure is reached during this time.

The Throttle will remain at Idle until the Control Head's lever is returned to Idle, the Pressure Switch contact closes and a speed command above Idle is commanded.

8-2.1.2 02 - *Throttle Clutch Pressure Interlock*

This option is typically selected when the Clutch takes longer than five seconds to reach full pressure. The Throttle will remain at Idle until there is a closure of the Pressure Switch's contact. This prevents speeds above Idle prior to full Clutch engagement.

In the event of a loss of Clutch pressure while cruising, the Throttle will be returned to Idle after the time selected with Function Code **C1** has expired. Once a closure of the Switch is sensed, indicating adequate pressure, the Throttle immediately returns to the commanded signal, without having to return the Control Head lever to Idle first, as is the case with Value **01**.

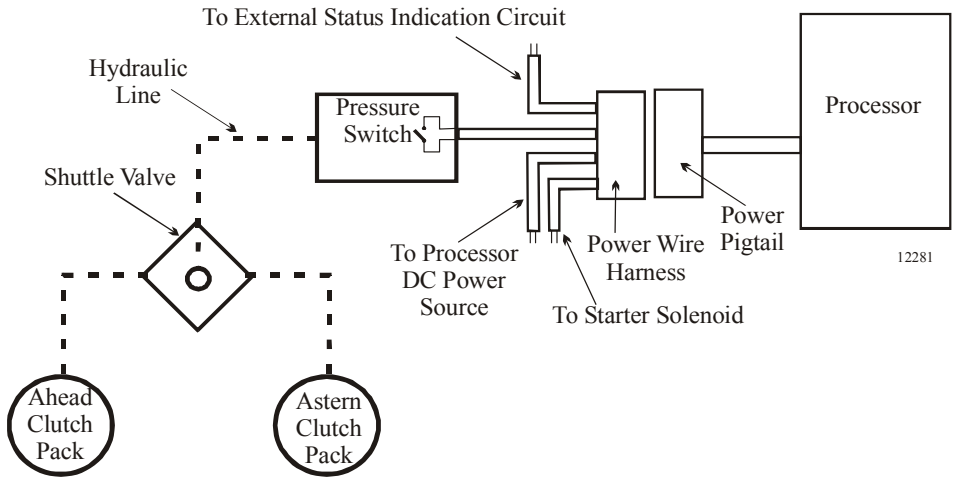


Figure 8-3: Clutch Pressure Switch with Processor Harness Diagram

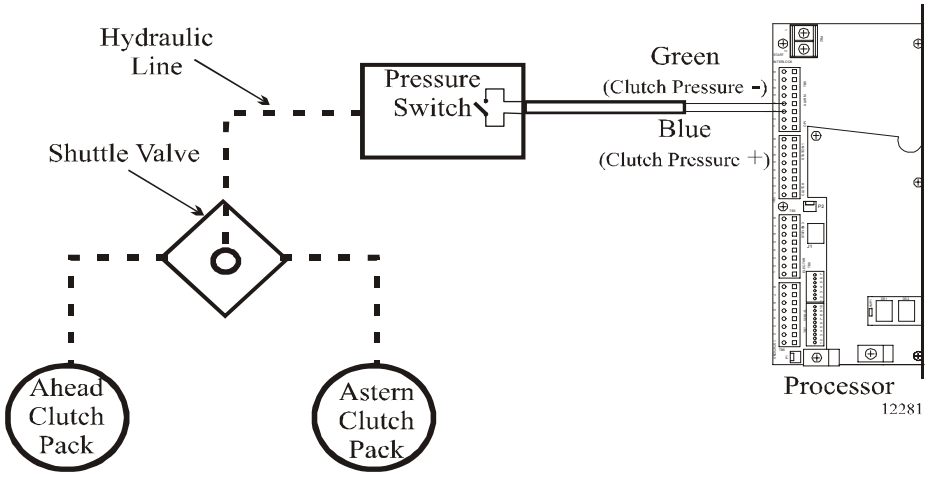


Figure 8-4: Clutch Pressure Switch with Processor Hard-Wired Diagram

8-2.2 Installation

The installation of the Clutch Pressure Switch is the same for both methods of operation. (Refer to Figure 8-3: or Figure 8-4:)

A) Install a Shuttle Valve on or near the Transmission.
B) Connect hydraulic line from the Ahead and Astern Clutches.
C) Connect a hydraulic line that is no longer than 5 feet (1,524m)and at approximately the same height between the Shuttle Valve and the Pressure Switch.
D) Connect the Power Wire Harness's Clutch Pressure Interlock cable to the Pressure Switch's normally open contact.
E) Calibrate the Pressure Switch to close when adequate Clutch Pressure is reached. (Refer to the Transmission manufactures Installation Manual)

8-3 *Station Expander (SE)*

The Processor allows up to five Remote Stations. The SE allows up to an additional four Remote Stations for a total of nine Stations. The SE and Processor communicate via the Serial Communication cable. Control Heads connected to the SE offer all of the functionality of a standard Remote Station.

For detailed information on the operation, installation and adjustment of the SE, refer to the Station Expander Installation Manual supplied with the Expander.

8-4 Trolling Valve Operation

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

8-5 Engine Room Only / Remote Switch

Station No.1 is typically designated as the Engine Room Station when this feature is used. When the switch is CLOSED, Station No. 1 will take command away from any other Remote Station, including DP. It also prevents other Remote Stations from taking command away from Station No.1.

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

8-6 Lockout Switch

This feature prevents any Remote Station, other than Station No. 2 from taking command.

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

8-7 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.
- 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 an Indication Panel, "**DP Station**" will be displayed at the top of the Panel.
- The ClearCommand system can take control away from the DP system at any time, by taking command at a Remote Station.
- The ClearCommand system can be programmed for DP1 operation with or without Trolling valve operation.
  1. 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**.
  2. 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).

NOTE: High Idle and One Lever Mode are not available when a DP system is in command or Transfer Mode **03** or **04** is selected.

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

8-8 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** & **04**.
- The Panel receives information via the serial communications line.

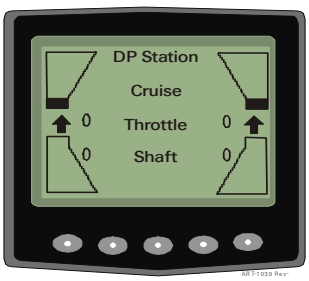


Figure 8-5: Display Panel

- 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 Appendix A MM70179 Display Manual and the manufacturers information included with the Panel.

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

8-9 Backup Control System

The Backup Control System provides a control system which is fully independent from the ZF Marine Electronics Control System. The Backup can control the gear as well as the engine, but it does not include ZF Marine Electronics 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 Backup Control System is provided in the Installation Manual supplied with the Backup System.

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

8-10 Speed Boost

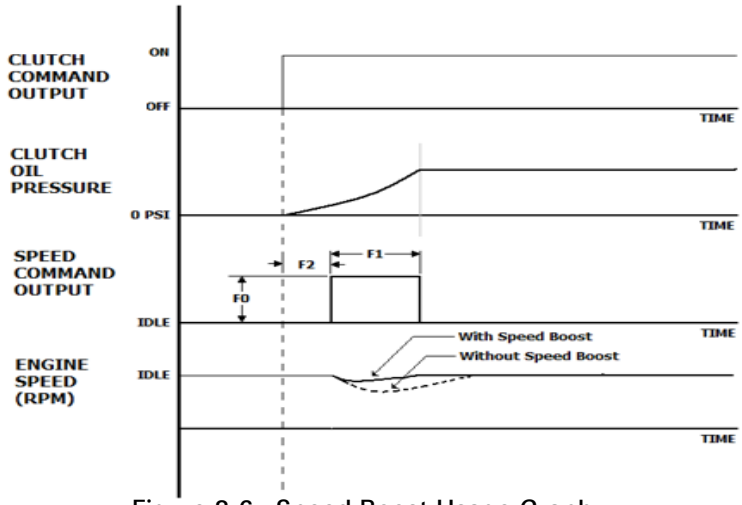


Figure 8-6: Speed Boost Usage Graph

There are four different Function Codes associated with Speed Boost (**F0, F1, F2** and **F3**). They all 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** (Proportional Pause), **C3** (Proportional Time), and **C4** (Proportional Pause Ratio) 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 attempt to adjust any of the Speed Boost Function Codes until you have read the descriptions of their usage and have verified their need.

8-10.1 Speed Boost Percent (F0)

This Function programs the amount of throttle which will be applied when the load is first being applied to the engine.

WARNING: The available range for this Function is 0.0 to 20.0%. Using a value of 20% will likely damage the transmission. This range is provided to allow as much leeway as possible when using this Function, but is not intended to use 20%.

NOTE: A value of **0.0** for Function Code **F0** means Idle Speed.

Units: Percent of Throttle Range [Throttle Range = Throttle Maximum **E3** - Throttle Minimum **E2**]
Default Value: **0.0**
Range: **0.0** to **20.0**

Examples:
- A value of **0.0** results in no Speed Boost being used. The Throttle Command Signal remains at Idle as the Clutch engages.
- A value of **5.0** results in a 5% increase in the Throttle Command Signal during Clutch engagement. If Throttle Maximum were set to 4.5 VDC and Throttle Minimum at 0.5 VDC, the Throttle Range would be 4.0 VDC. 5% of 4.0 VDC equals 0.2 VDC. The Speed Boost Throttle Command Signal would be 0.5 VDC + 0.2 VDC = 0.7 VDC.

8-10.2 **Speed Boost Duration (F1)**

This Function programs how long the elevated speed (Speed Boost Signal) is applied. The duration time programmed begins when Function Code **F2 – Speed Boost Start Delay** has ended.

Units: Seconds
Default: **0.0**
Range: **0.0** to **20.0**
Examples:
- A value of **0.0** is 0.0 seconds.
- A value of **2.5** is 2.5 seconds.
- A value of **5.0** is 5.0 seconds.

8-10.3 **Speed Boost Start Delay (F2)**

This Function determines the amount of time after the Ahead or Astern clutch engagement command has been given (movement of the Control Head lever), to the point where Speed Boost is applied.

NOTE: This is an "open loop" method of applying speed boost just prior to the load hitting the engine. Clutch engagement timing is a function of oil viscosity and heat and these Processors have no method of actually measuring clutch pressure. Therefore, in order to accurately adjust the **F2** Function, it is best to warm up the gear first.

Units: Seconds
Default: **0.0**
Range: **0.0** to **10.0**
Examples:
- A value of **0.0** is 0.0 seconds.
- A value of **0.1** is 100 milliseconds.
- A value of **2.0** is 2 seconds.

8-10.4 **Speed Boost Bypass Clutch Delay (F3)**

In some applications, speed boost is only required when performing an emergency reversal. Engaging the Ahead or Astern clutch from Neutral, or Idle Ahead to Idle Astern maneuvers do not load the engine to the point where a stall occurs. Only when momentum is built up in the Ahead or Astern direction, and an emergency reversal is required, is the load on the engine significate enough to stall the engine.

In these situations, speed boost is not required every time a Clutch engagement is commanded. This Function allows the speed boost to be applied ONLY WHEN the time programmed is exceeded during a reversal. The time required to perform a refersal is programmable with Function Code **C3** (Proportional Pause Time).

Units: Seconds.
Default: **0.0**
Range: **0.0** to **99.0**
Examples:
- A value of **0.0** is 0.0 seconds.
- A value of **1.0** is 1 second.
- A value of **99.0** is 99.0 seconds.

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

9 PERIODIC CHECKS AND MAINTENANCE

The items listed below should be checked on an annual basis or less, when noted:

9-1 Control Heads

- Check the terminal strip for signs of corrosion or a loose connection.
- If used, disconnect the Deutsch connector and check the pins and sockets for signs of moisture and corrosion.

9-2 Processor

- Check all terminal connections for signs of corrosion or loose connections.
- Un-plug and inspect all Deutsch connectors for signs of moisture or corrosion.

9-3 Power Supply

9-3.1 Battery

WARNING: Batteries contain sulfuric acid and emit hydrogen gas while charging. Therefore, specific safety precautions must be adhered to while handling and servicing. Specific information on handling and servicing batteries can be obtained from the Battery Council International, Battery Service Manual.

CAUTION: In many newer batteries, the vent cap is permanently attached, preventing access to the electrolyte for water level and specific gravity tests. Attempting to pry off these caps could result in premature battery failure.

The following tests should be performed in the intervals specified:

9-3.1.1 Quarterly (Every 3 Months)

- Check the level of the water (electrolyte) within the Lead-Acid batteries. The plates must be covered. If not, add a small amount of distilled water.
- Check the voltage of the battery. The battery must have a chance to “rest” (no charging and no load for a couple of hours) prior to testing. The following table represents a fully charged battery:

Table 9-2: Fully Charged Battery

Lead Acid Batteries	Gel Cell or AGM Batteries
12V – 12.6 to 12.8V	12V – 12.4 to 12.6V
24V – 25.2 to 25.6V	24V – 25.0 to 25.4V

- Check the battery terminals for signs of corrosion, acid build-up or loose connections.

9-3.1.2 Semi-Annually (Every 6 Months)

- Check the specific gravity of your Lead-Acid battery(s) with a Hydrometer. The reading for a fully charged lead acid battery is 12.60 to 12.80.

9-3.1.3 Annually (Every 12 Months)

WARNING: The Battery Load Test should be performed by a qualified Marine Electrician only.

The tests performed on quarterly and semi-annual basis, give a relatively good indication of the batteries’ health. However, the only way to accurately determine the actual health of your battery is to perform a Battery Load Test.

- There are two types of Battery Load Tests performed in the field, Performance and Service. In order to determine the actual health of your battery a Performance Load Test is recommended. The Service Load Test determines how well your battery performs in the boat and doesn’t take into

account the battery's original rating, which could result in misleading results. The Performance Load Test places an accurate load on the battery and compares the results to the battery manufacture's specification. The battery should be replaced if the results are 80% or less than the manufacture specifications.

9-3.2 Power Cables, Distribution Panels, etc.

- Check all of the connections from the battery to the DC Distribution Panel to the APS for loose or corroded connections.
- Measure the voltage at the battery and at the Processor while the Clutch or Throttle 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)

APPENDIX A

PARTS LIST

PART NO. **DESCRIPTION**

CONTROL HEADS

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 3RPLeft or Right Control Head, Chrome Low Profile Lever, Pluggable

521-4L or 4RLeft or Right Control Head, Single Lever Tournament Style - Aluminum
521-4LB or 4RBLeft or Right Control Head, Single Lever Tournament Style - Aluminum, Junction Box
521-5L or 4RLeft or Right Control Head, Single Lever Tournament Style - Chrome
521-5LB or 4RBLeft or Right Control Head, Single Lever Tournament Style - Chrome, Junction Box

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

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
522-4B Control Head, Dual Lever Tournament Style - Aluminum, Junction Box
522-5 Control Head, Dual Lever Tournament Style - Chrome
522-5B Control Head, Dual Lever Tournament Style - Chrome, Junction Box

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

CONTROL HEAD ADAPTER PADS (400 and MC2000 Series Only)

1002 Pad Kit - white, blank
1003 Pad Kit - black, blank
1004 Pad Kit - teak, blank
1005 Pad Kit - white, machined
1006 Pad Kit -black, machined
1007 Pad Kit - teak, machined

CABLE (Electric)

180	8-Cond. Shielded Cable	Per/ft.
350	8-Cond. Shielded Cable	500' Spool
11811	8-Cond. Shielded Cable	1000' Spool
212	2-Cond. Power Cable	Per/ft.
349	2-Cond. Power Cable	250' Spool
183	2-Cond. Start Interlock Cable	Per/ft.
355	2-Cond. Start Interlock Cable	250' Spool

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)
13432-#	Throttle, Voltage
13494-#	Throttle, Current
13533-#	Throttle, PWM
14363-#	Throttle, MAN
15027-#	Throttle, Frequency
15719-#	Clutch – Ahead/Astern/Clutch Power
15732-#	Clutch – Ahead/Astern/Troll CMD
15725-#	Clutch – Ahead/Astern/Troll/Troll CMD
13239-#	Magnetic Pickup or Pulse Transmitter
13631-#	Power/Start Interlock/Clutch Pressure/Alarm Circuit
13552-#	Power/Start Interlock/Clutch Pressure
13756-#	Power/Start Interlock
15023-#	Power
13557-#	Control Head - 1 Connector
14261-#	Control Head - 2 Connectors

TEST UNIT

13927	Service Field Test Unit
14000	Field Test Control Head - Dual

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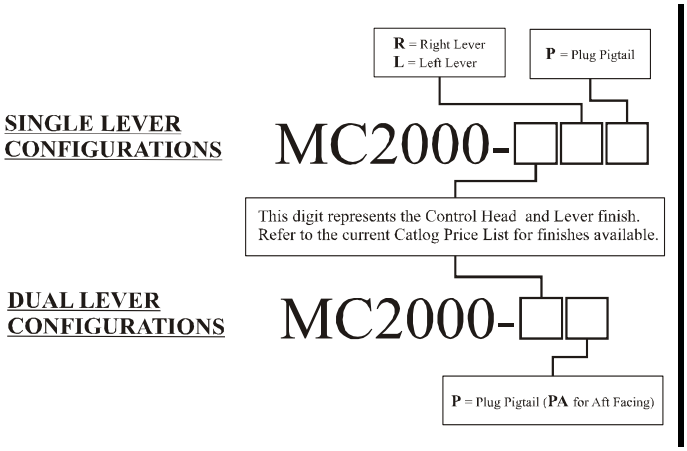
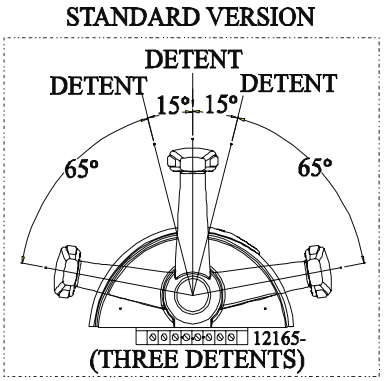
MC2000 Series Standard Control Head Variations

This Service Sheet reflects all current variations of the standard 3-detent ZF Marine Electronics MC2000 Series Control Heads

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 Marine Electronics.

MOUNTING AND INSTALLATION:

Select the desired mounting locations and make cutouts per template. Refer to the Dimensions Diagram.

Check that the two mounting screws will start into the Control Head. Remove Control Head from cutout.

Run cable/harnesses between Processor and Control Head. Label both ends with Station it connects (EXAMPLE: Port, Center, or Starboard; Port Thrust, Port Throttle; etc.)

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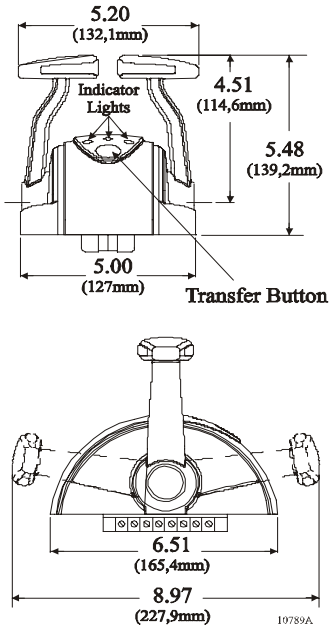
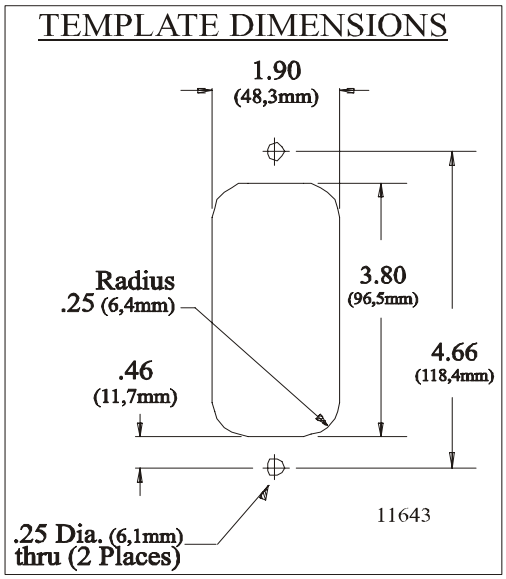
Dimensions





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.

Standard Cable

Strip back the PVC cover on the shielded cable approximately 2-1/2" (63,5mm) at the Control Head.

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).

Strip 3/8" (9,5mm) insulation off each wire.

Twist the individual strands of the wires to minimize fraying.

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.

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.

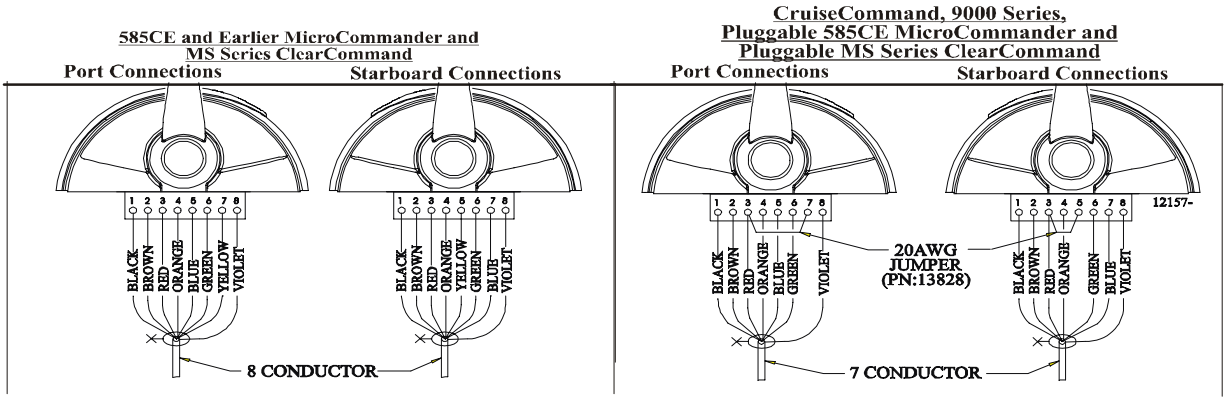
ALWAYS REFER TO THE MANUAL THAT IS SUPPLIED WITH THE CONTROL SYSTEM FOR ANY UNIQUE CONTROL HEAD CONNECTIONS FOR YOUR SYSTEM.

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

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

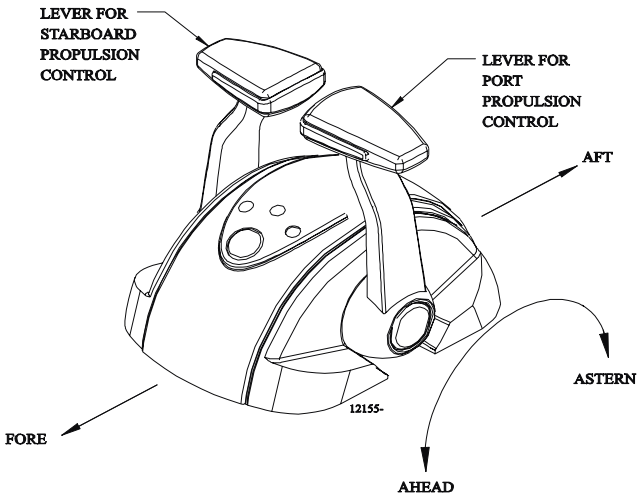
PLUGGABLE CONNECTIONS

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.



Handheld Control is an option. Contact your ZF Marine Electronics Dealer for further information on Handheld requirements and options.

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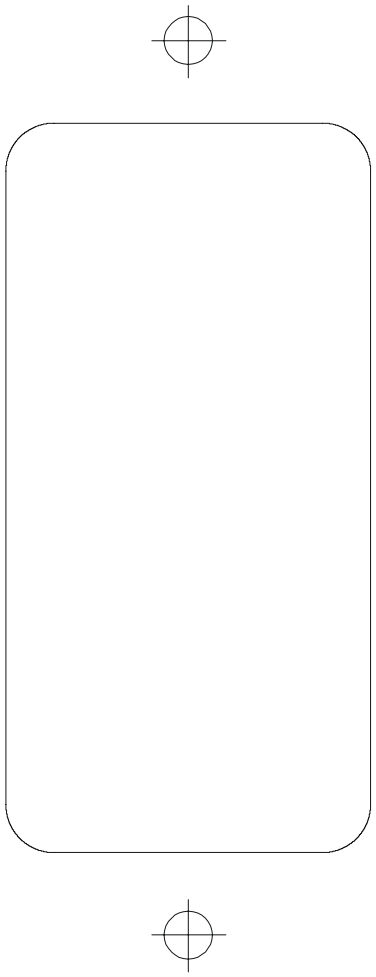
0.25 Diameter (6,1mm) through Holes
(2 Holes)



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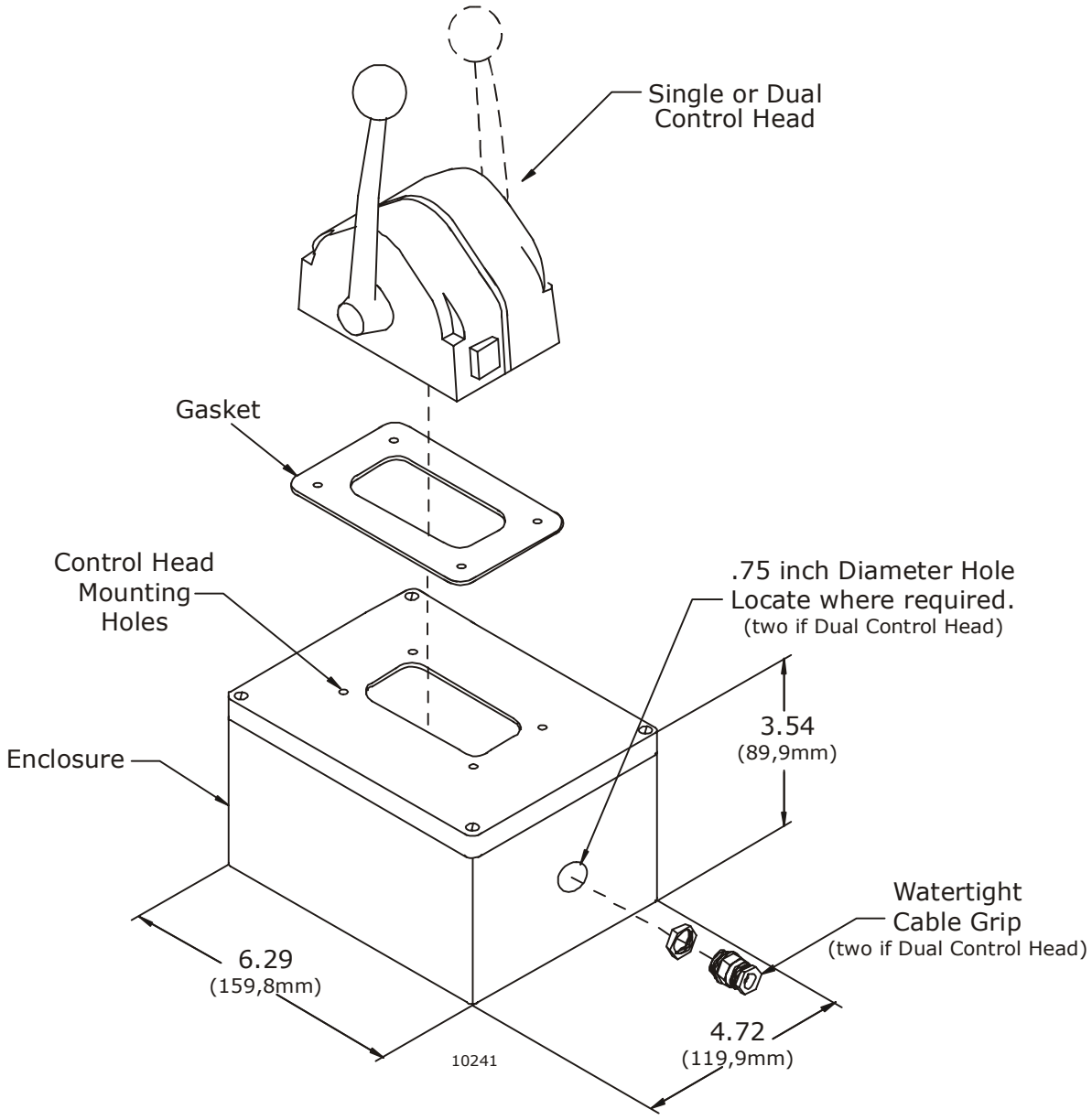
400 Series Weather Mount Enclosure



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.

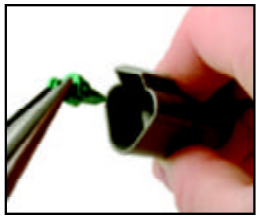
Part No. 12110

.

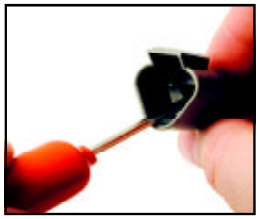
Deutsch Connector Assembly

DT Type

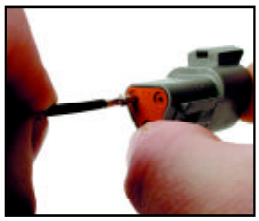
Step 1: Contact Removal



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

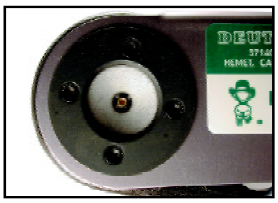
Solid Contacts

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

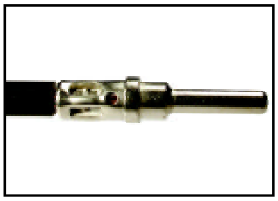
Use Crimp Tool #HDT48-00

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.

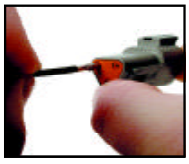
5. Insert wire into contact. Contact must be centered between indicators. Close handles until crimp cycle is completed.
6. Release handles and remove crimped contact.



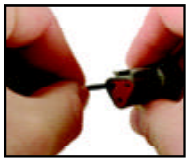
7. Inspect terminal to ensure that all strands are in crimp barrel.**NOTE:** Tool must be readjusted for each type/size of contact. Use HDT04-08 for size 8 and 4 contacts.

Step 4: Contact Insertion

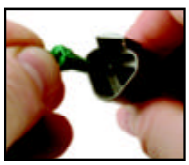
1. Grasp crimped contact approximately (25.2 mm) one inch behind the contact barrel.



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

A) GENERAL INFORMATION

The APS (Automatic Power Selector), 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 Electronics Propulsion Control System.

The APS is rated for loads of up to 70 Amps on 12-24V 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

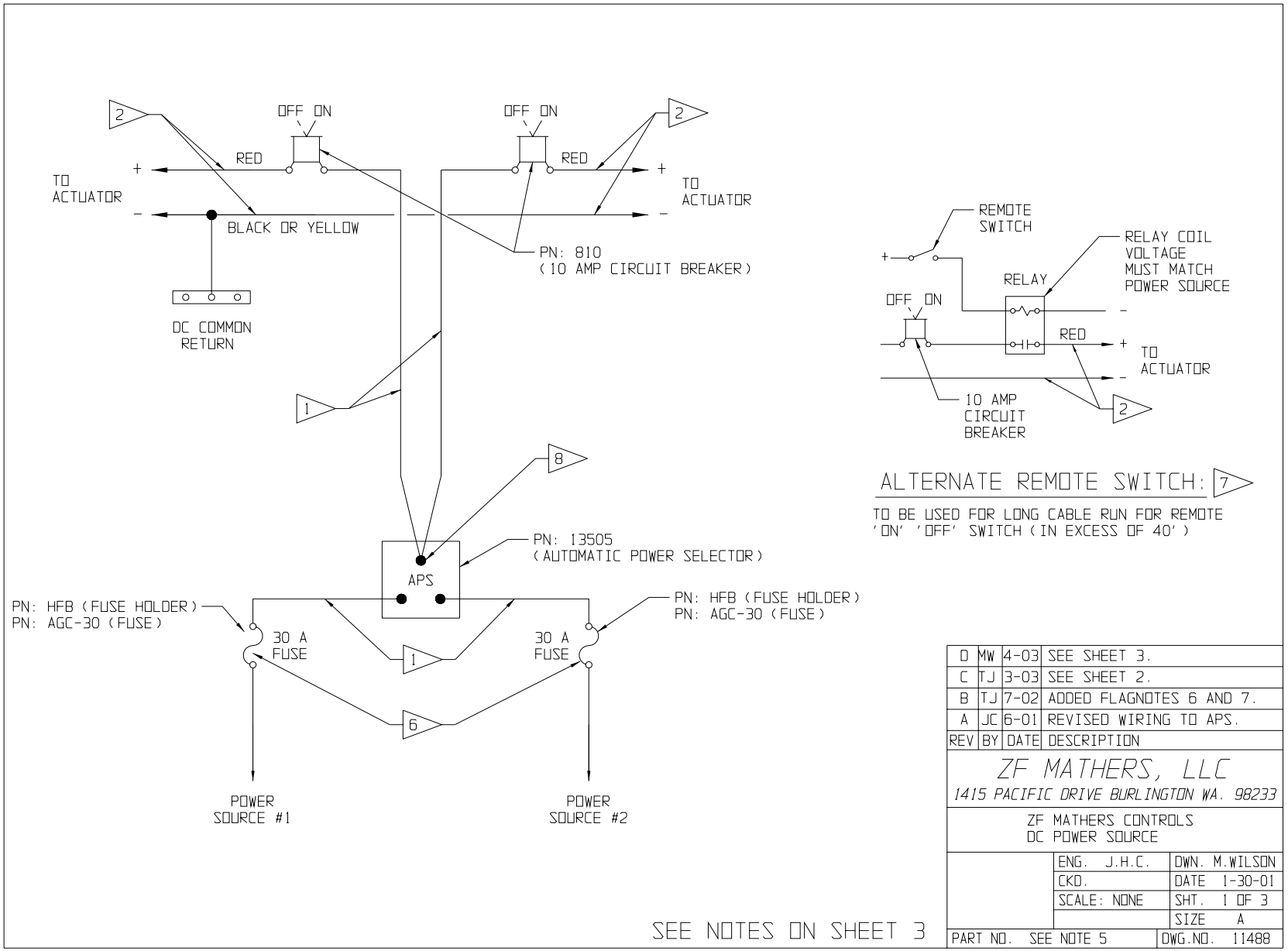
Refer to the installation Drawing 11488D.

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 on either Drawing 11488D-1 or 11488D-2.
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.

Drawing 11488D-1 Twin Screw Single APS Connection & Alternate Remote Switch



REV	BY	DATE	DESCRIPTION
D	MW	4-03	SEE SHEET 3.
C	TJ	3-03	SEE SHEET 2.
B	TJ	7-02	ADDED FLAGNOTES 6 AND 7.
A	JC	6-01	REVISED WIRING TO APS.

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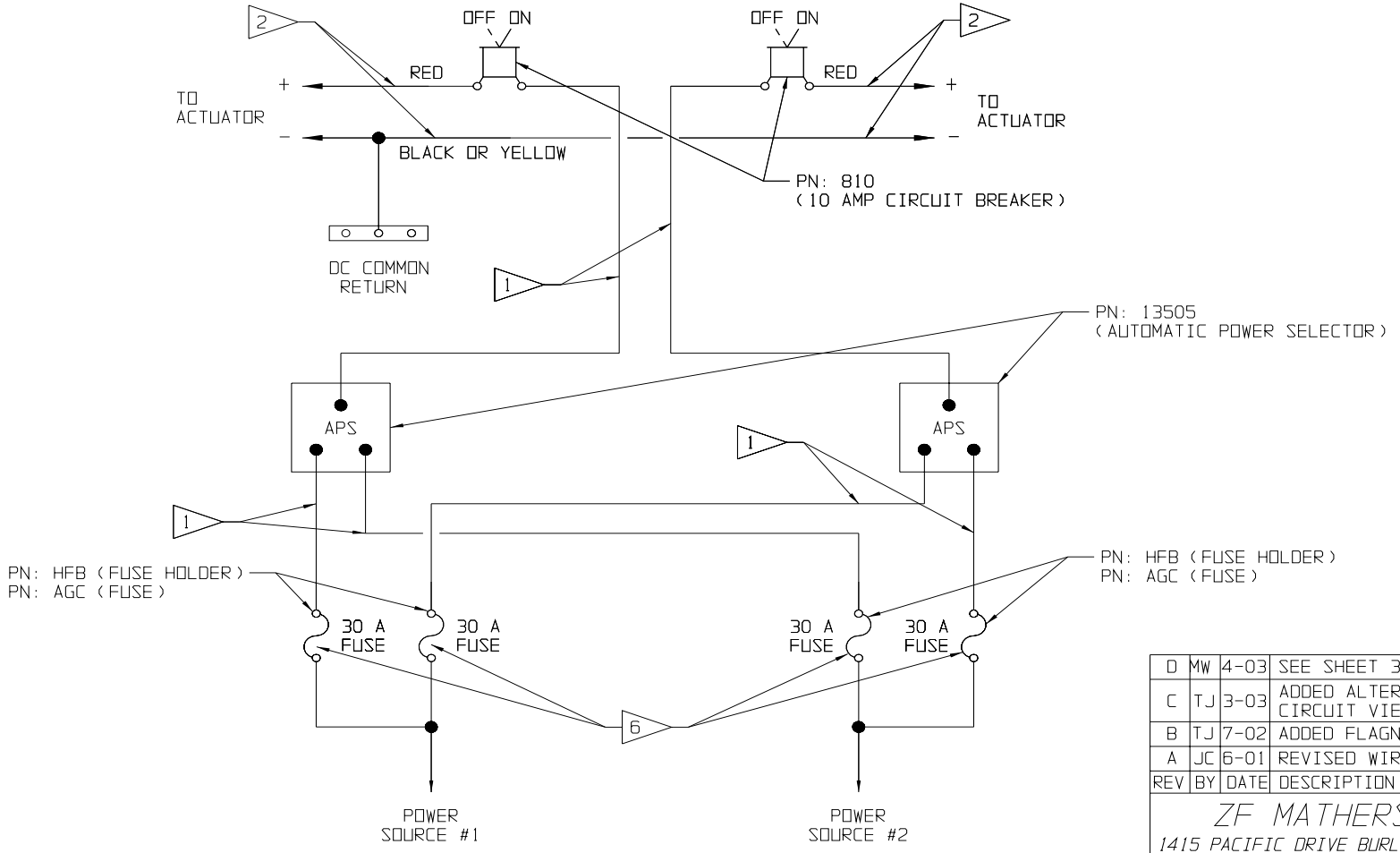
ZF MATHERS CONTROLS
DC POWER SOURCE

	ENG. J.H.C.	DWN. M.WILSON
	CKD.	DATE 1-30-01
	SCALE: NONE	SHT. 1 OF 3
		SIZE A
PART NO. SEE NOTE 5		DWG.NO. 11488

Drawing 11488D-2 Twin Screw Dual APS Connections



ALTERNATE APS CIRCUIT:

SEE NOTES ON SHEET 3

REV	BY	DATE	DESCRIPTION
D	MW	4-03	SEE SHEET 3.
C	TJ	3-03	ADDED ALTERNATE APS CIRCUIT VIEW.
B	TJ	7-02	ADDED FLAGNOTES 6 AND 7.
A	JC	6-01	REVISED WIRING TO APS.

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ZF MATHERS CONTROLS
DC POWER SOURCE

	ENG. J.H.C.	DWN. M.WILSON
	CKD.	DATE 1-30-01
	SCALE: NONE	SHT. 2 OF 3
		SIZE A
PART NO. SEE NOTE 5		DWG.NO. 11488

Drawing 11488D-3 APS Notes Page

NOTES:

1. WIRE SIZE (REF ABYC E9.15.9 10%)

12VDC POWER SYSTEMS:

0-15'	(0-4,6M)	12 AWG (#4 METRIC EQUIVALENT)
15'-25'	(4,6-7,6M)	10 AWG (#6 " ")
25'-40'	(7,6-12,2M)	8 AWG (#10 " ")
40'-70'	(12,2-21,3M)	6 AWG (#16 " ")

24VDC POWER SYSTEMS:

0-20'	(0-6,1M)	14 AWG (#2,5 METRIC EQUIVALENT)
20'-30'	(6,1-9,1M)	12 AWG (#4 " ")
30'-50'	(9,1-15,2M)	10 AWG (#6 " ")
50'-80'	(15,2-24,3M)	8 AWG (#10 " ")

2. WIRE SIZE. (RECOMMENDED TWISTED PAIR)

12VDC POWER SYSTEMS:

0-20'	(0-6,1M)	14 AWG (#2,5 METRIC EQUIVALENT)
20'-30'	(6,1-9,1M)	12 AWG (#4 " ")

24VDC POWER SYSTEMS:

0-40'	(0-12,2M)	14 AWG (#2,5 METRIC EQUIVALENT)
40'-65'	(12,2-19,8M)	12 AWG (#4 " ")

3. APS OUTPUT IS STRICTLY FOR ZF MATHERS CONTROLS.

4. POWER SOURCES MAY BE 12 OR 24 VOLTS DC.

5. SINGLE SCREW KIT - PN: 13983.

PN: 13505 (AUTOMATIC POWER SELECTOR)	QTY 1
PN: 810 (10 AMP CIRCUIT BREAKER)	QTY 1
PN: AGC-30 (30 AMP FUSE)	QTY 2
PN: HFB (FUSE HOLDER)	QTY 2

TWIN SCREW KIT - PN: 13984.

PN: 13505 (AUTOMATIC POWER SELECTOR)	QTY 1
PN: 810 (10AMP CIRCUIT BREAKER)	QTY 2
PN: AGC-30 (30 AMP FUSE)	QTY 2
PN: HFB (FUSE HOLDER)	QTY 2

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. SEE FIGURE 1 BELOW FOR THE SUGGESTED HARDWARE STACK FOR SYSTEMS UTILIZING MULTIPLE OUTPUTS FROM THE PN: 13505 (AUTOMATIC POWER SELECTOR).

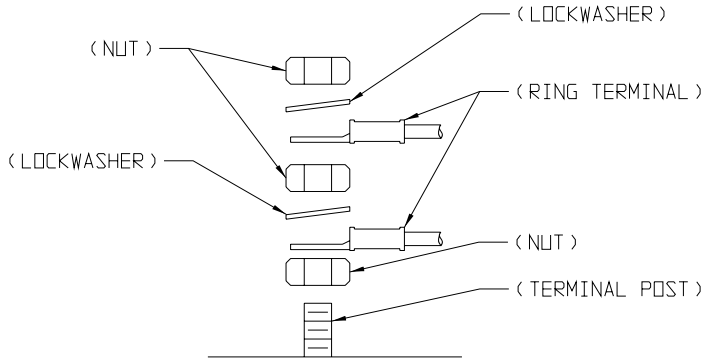

FIGURE 1

REV	BY	DATE	DESCRIPTION
D	MW	4-03	REVISED FLAGNOTES 1 & 2.
C	TJ	3-03	ADDED FLAGNOTE 8. REVISED FLAGNOTE 6.
B	TJ	7-02	ADDED FLAGNOTES 6 AND 7.
A	JC	6-01	SEE SHEET 1.

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ZF MATHERS CONTROLS
DC POWER SOURCE

ENG. J.H.C.	DWN. M.WILSON
CKD.	DATE 1-30-01
SCALE: NONE	SHT. 3 OF 3
	SIZE A
PART NO. SEE NOTE 5	DWG.NO. 11488

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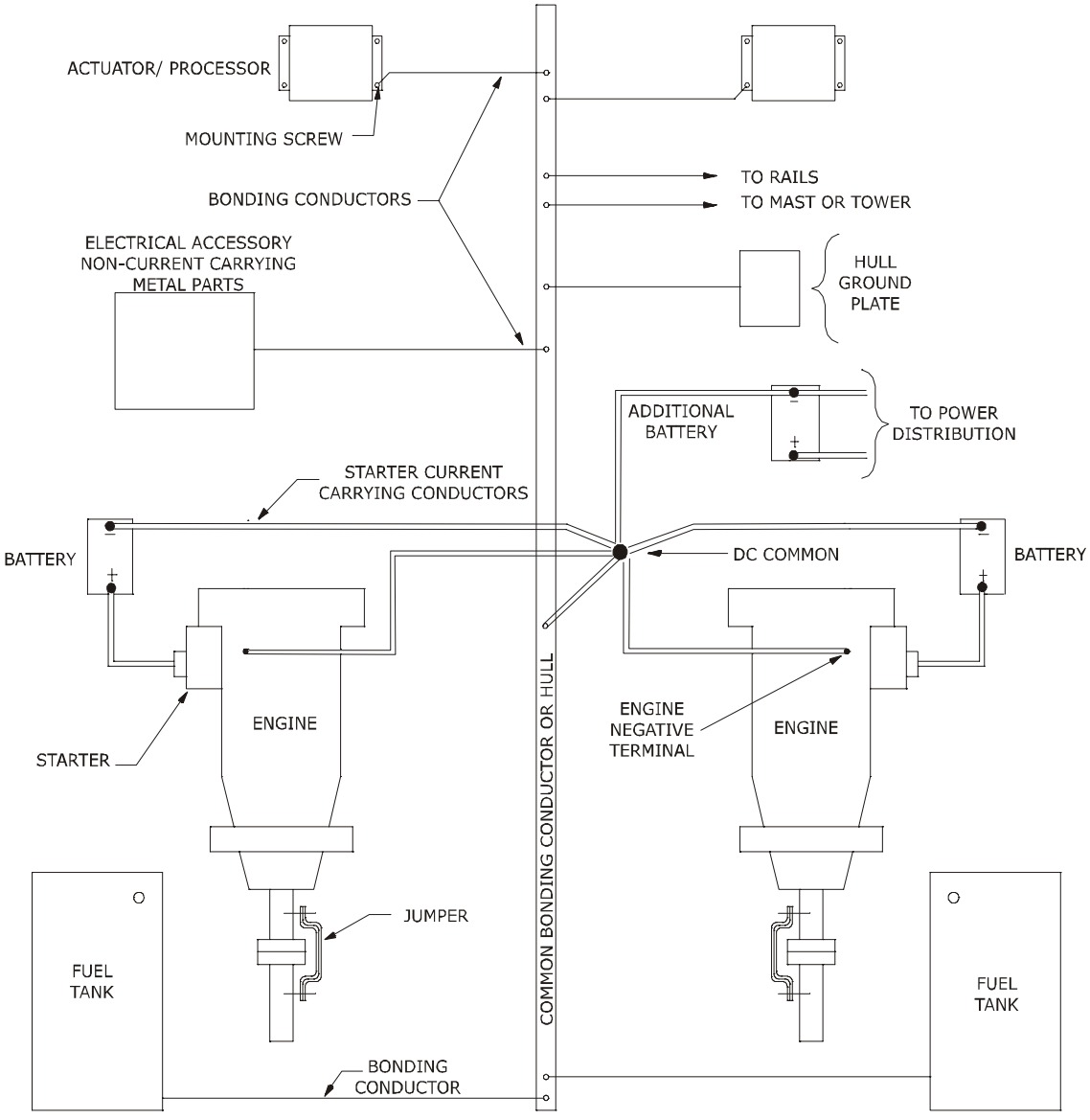
Bonding: A.B.Y.C. E-11, 46 CFR 111.05

All boats equipped with a permanently installed electrical system shall also be equipped with a bonding system. The negative terminal of all batteries should be connected at only one point, the DC common, and from DC common to bond system or hull.

Metal - Hull Vessels

The metallic hull of the vessel may also serve as the common bonding conductor.

If it is desirable for the item being installed to be bonded to the vessel bonding system, and the installation or mounting method does not provide the desired path, a separate bonding conductor may be required.



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Telephone (425) 583-1900
Telefax (425) 493-1569

References and Parts Source

A) REFERENCES

1. 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
2. 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
3. Society of Automotive Engineers
   400 Commonwealth Drive
   Warrendale, PA 15096
   - J1171 External Ignition Protection
   - J1428 Marine Circuit Breakers
   - J378 Marine Engine Wiring
4. National Marine Manufacturers Association
   401 North Michigan Avenue
   Chicago, IL 60611
5. Underwriters Laboratories

B) 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.
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.

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Telefax (425) 493-1569

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.

ZF Marine Electronics, LLC
Mukilteo Plant

Electronic Propulsion Control Systems Three Year Limited Warranty

Your ZF Marine Electronics product has been designed and manufactured by experienced engineers and craftsmen. ZF Marine Electronics LLC, warrants for the period indicated below, each product to be free from defect in material and workmanship. Repair or replacement, at ZF Marine Electronics option, will be provided if the product, upon ZF Marine Electronics inspection, is found to be properly installed and operated in accordance with ZF Marine Electronics Manual. This warranty does not apply to malfunction caused by damage, unreasonable use, misuse, repair or service by unauthorized persons or normal wear and tear.

A) Coverage Under Warranty

Three years from the date of purchase by the original end user.

Year One

No charge for equipment repair, parts and labor. Up to three hours labor toward troubleshooting and replacement of defective equipment.

Year Two and Three

There is no charge for equipment repairs performed at the factory that are covered under warranty. No labor allowance for troubleshooting and replacement of defective equipment.

B) No Coverage Under Warranty

The following will not be covered under warranty.Travel to and from the job site.

1. Adjustment or calibration of any ZF Marine Electronics equipment.
2. Adjustment or calibration of any associated equipment which may include but not limited to push-pull cables, engine governor or carburetor, transmission or trolling valve.
3. Damage due to accidents, improper installation or handling and or improper storage.
4. Damage due to faulty repairs performed by an unauthorized service representative.
5. Damage due to conditions, modifications or installation contrary to published specifications or recommendations.
6. Original installation charges or start-up costs.
7. Battery service including labor charges related to battery service.
8. Rental of equipment during performance of warranty repairs.
9. Unauthorized repair shop labor, without prior approval from ZF Marine Electronics Service Department.
10. Shop supplies such as connectors, wire, cable, etc.

C) Warranty Service

Please go to www.zf-marine.com or Call 1-425-583-1900 or (U.S. only) 1-800-546-5455 for your nearest ZF Marine Electronics Factory Authorized Dealer.

1. Prior to returning any product to the factory, you must contact ZF Marine Electronics Service Department for a Service Return Authorization (SRA) number. Return the product freight prepaid, marked clearly with the SRA number and a description of the malfunction.
2. If there is a defect covered by warranty, ZF Marine Electronics will, at its option, either repair or replace the defective part or product. If after inspection, ZF Marine Electronics determines that the product is not defective, ZF Marine Electronics 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 claims must be submitted within 30 days from date of service.
5. Claims for over 3 hours must be pre-approved by the ZF Marine Electronics Service Department.

This Warranty is expressly in lieu of all other Warranties, express or implied. Except to the extent prohibited by applicable law, ZF Marine Electronics 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 Marine Electronics be liable for any consequential damages sustained in connection with the product or its use, including any costs or damages which result from loss of use of the product or any engine or boat with which it is used. ZF Marine Electronics does not authorize any representative or agent to assume for it any obligation or liability other than those expressly set forth above. Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitation 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 which 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 ( ) _____

Fax Number ( ) _____

E-Mail Address_____

Purchaser's Name_____

Street Address_____

City, State, Zip_____

Phone Number ( ) _____

YOUR VESSEL:

Engine, Make & Model_____

Length_____

Manufacturer_____

ZF Marine Electronics, LLC. Product First Seen At:

Boat Show Dealer Magazine Friend

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APPENDIX B

B1 TROUBLESHOOTING GENERAL

The ClearCommand Control System consists of one Processor per engine, typically mounted in the engine room, and one to five Control Heads located at the vessel's Remote Stations. In the event that a malfunction occurs, review the appropriate System Diagram and become familiar with the various components, their functions and locations on the vessel. Section B1-2, page B1-1, is a list of the main components that make up a typical system, along with a brief description of their functions:

B1-1 Control System Examples

B1-1.1 96202 (Throttle Electronic, Clutch Solenoid, Two Station) Processor

The **96202** is designed to precisely control speed and direction on vessels equipped with electronic Throttle and solenoid Clutch selection.

B1-2 Typical System Main Components

B1-2.1 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.

B1-2.2 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.

B1-2.3 Power Source

All electronic equipment must have power in order to operate. Ensuring a properly charged reliable power source is available is. The Processor requires a 12 or 24 VDC power system. The minimum voltage at which the Processor will continue to operate is 8.00 VDC. The maximum allowable voltage is 30 VDC. Exceeding these limits will not damage the Processor, but will render it unusable temporarily. The power supply must be capable of delivering 10 amperes to each Processor on a continual basis and current surges up to 20 amperes. All cable calculations should be based on a 10 ampere draw with no more than 10% voltage drop.

B1-2.4 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 Electronics' System has electrical cables and/or pluggable Harnesses. These Harnesses may have plugs on one end or both, depending on its purpose. There are Harnesses available for Control Head Interface, DC Power, Start Interlock, Clutch Oil Pressure Interlock and External System Status Indication Circuit.

In addition, the application may require Harnesses for one or more of the following:

- Engine Interface
- Shift Interface
- Serial Communication
- Tachometer Sensor Signal

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. Pay special attention to the following items:

- DC Power Source
- Component Location
- Component Condition
- Interconnecting Wiring and Harnesses
- Wire Terminations
- Plug and Socket Pins

B2 TROUBLESHOOTING QUESTIONS

Prior to lifting a tool or stepping on board the vessel, many problems can be resolved by asking the customer the following basic questions:

A) Is the System installed on a Single, Twin or Multiple Screw vessel?

- If the System is installed on a Single Screw vessel, this question does not have much value in narrowing down the source of the problem.
- If the System is installed on a Twin or more Screw application, this question is quite useful, if you ask the following question.

1. Does the problem or symptom occur on the Port, Starboard or both sides?
   - If the problem or symptom occurs on one side only, you have effectively eliminated 50% of the possible causes. For example, the symptom only occurs on the Port side. All of the components on the Starboard side have been eliminated as potential causes.

B) What is the Part Number and Serial Number of the Processor?

Whenever the factory is called for technical assistance, the part number and serial number will be required. These numbers provide the Service Technician information about the operating characteristics of the Processor. The numbers are located on the Processor's front cover.

C) How many Remote Stations are there?

- If only one Remote Station is present, not much will be gained by asking this question. However, if more than one Remote Station is being used, command should be taken from one of the other Stations to see if the problem occurs from another Station.
- If the problem occurs from more than one Remote Station, the odds are that the Control Heads are not the cause of the trouble.
- If the problem occurs at one Remote Station only, there is a greater chance of the Control Head or the Control Head Harness of being the cause.

D) Are any tones generated when the problem occurs?

The tones are used to bring the operator's attention to a possible condition or problem.

The following basic tones can be produced on all Systems:

Slow Repetitive Tone (Refer to Section B5-1.1, page B5-1)
One Long- Three Short Tones (Refer to Section B5-1.2, page B5-2)
Steady Tone (Refer to Section B5-1.3, page B5-3)
Three Second Steady Tone (Refer to Section B5-1.4, page B5-4)
Five Seconds On, Five Seconds Off - High Repetitive Rate Tone (Refer to Section B5-1.6, page B5-4)
Five Second Steady Tone (Refer to Section B5-1.7, page B5-4).

The following tone can be produced on all Systems using Solenoid Clutches:

One Long - One Short Tone (Refer to Section B5-3.1, page B5-6)

E) Are there any Error Messages displayed on the Processor's Display LED?

In addition to generating a tone, at any time the system detects a malfunction or fault, an error message will be displayed at the Processor. Refer to Table B8-1:, Basic Control System Error Codes, for an explanation of the errors.

F) What is the status of the Control Head in command's red LED?

The red LED(s) will be in one of the following states:

Lit Steady
When the red LED is **Lit Steady**, this indicates that the Station is in command and in Normal operative mode.

Not Lit
When the red LED is **Not Lit**, that Station is not in command, or there is no power to the Control System.

Blinking Slowly

A **Slow Blinking** red LED indicates that the Control Head is in Throttle Only Mode (Warm-up Mode).

Blinking Rapidly

A red LED that is **Blinking Rapidly** indicates that the System is in Troll Mode.

G) Has anything on the vessel changed shortly prior to or when the problem arose?

This question is often overlooked, but should be considered. Obvious changes such as additions or changes to the electrical/ electronic equipment onboard can affect the electrical load and in turn the Processor's power supply.

Ask the operator if any changes or maintenance to the vessel's machinery have occurred lately. Items which are significant to you, the technician, may not seem so to the casual owner or operator. An example would be changes to the engine's fuel system.

Ask about changes, that when initially considered, appear to have nothing to do with the Control System. An example where this really occurred was on a vessel which had recently been repainted. For unknown reasons, the painter took it upon himself to disconnect the connections at a Control Head and then reconnected it incorrectly.

In many cases, these simple questions can resolve a problem with no further action from you, the technician. Take the time to consider these questions. In the long run, you will save yourself and the customer a lot of time and money.

B3 TROUBLESHOOTING PROBLEM RESOLUTION

If the problem could not be resolved by asking the questions in the previous section, a careful inspection of the Control System may be the next step. Even in situations where the problem was found and corrected, it is good practice to always perform a careful inspection of the entire Control System each and every time you are asked aboard a boat. Always verify that the installation of the System is in compliance with the Installation Manual by carefully inspecting the following:

B3-1 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. Refer to Automatic Power Selector information in Appendix A.

B3-2 Component Location

B3-2.1 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 - Control Head Reference Sheet for Installation requirements.

B3-2.2 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 Plan the Installation Section for requirements.

B3-3 Component Condition

B3-3.1 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.

B3-3.2 Processors

Inspect the Processor for any signs of physical damage.

B3-4 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 B3-1: Examples of Components (Internal/External)

Internal	External
1) Processor 2) Control Head 3) Interconnecting Wiring (Harnesses)	1) DC Power Source 2) Engine 3) Transmission

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.

B4 TROUBLESHOOTING DIAGNOSTIC MENU

The Processor has built in diagnostics designed to assist the technician in determining the cause of a problem. The following information is available to view at any time:

- Applied Battery Voltage
- Tachometer Sender Frequency
- Stations 1- 5 A/D's
- Stations 1- 5 Transfer Button Status
- Servo 2 Feedback A/D's (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.

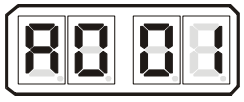


Figure B4-1: Display Function Code List

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 B4-1:

C) Depress the Up or Down Push Button repeatedly until H000 is displayed like Figure B4-2:.

Figure B4-2: Display Troubleshooting Function

D) Depress and hold the Left and Right Push Buttons simultaneously until the H0 begins to blink. (Figure B4-3:) Release the Push Buttons; the applied battery voltage will now be displayed:

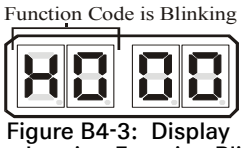


Figure B4-3: Display Troubleshooting Function Blinking

- 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 B4-4:

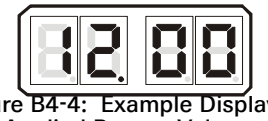


Figure B4-4: Example Display of Applied Battery Voltage

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 B4-5:):

- 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.

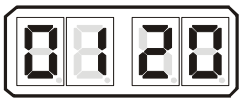


Figure B4-5: Example Display of Tach Sensor Frequency

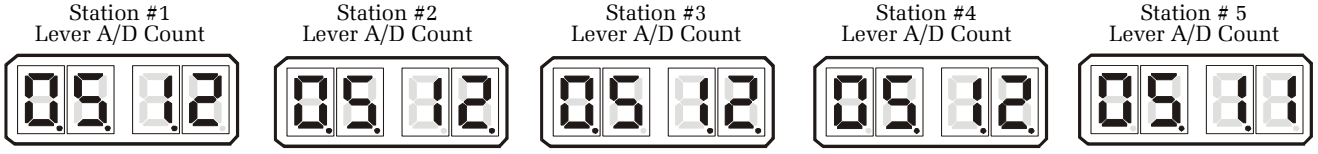


Figure B4-6: Example Display Control Head Lever Current Positions

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.

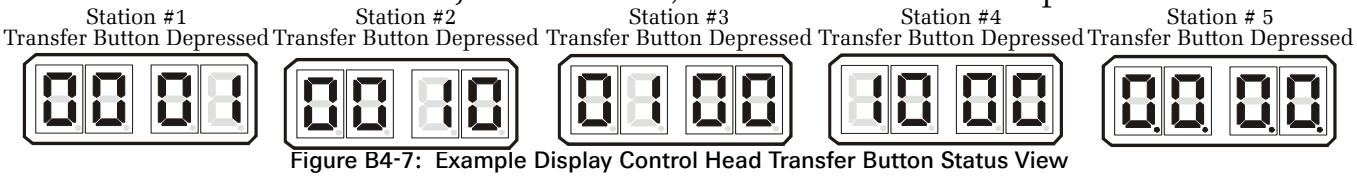


Figure B4-7: Example Display Control Head Transfer Button Status View

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.

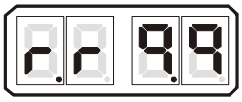


Figure B4-8: Example Display Software Revision Level View

H) Pressing the Up or Down (Scroll) Push Button once more, returns you to the Applied Battery Voltage. (Figure B4-4:)

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.

B5 TROUBLESHOOTING AUDIBLE TONES

As mentioned previously, there are various tones emitted from the Control Head if an error were to occur.

B5-1 Basic Control System Tones

These basic tones are as follows:

B5-1.1 Slow Repetitive Tone

Figure B5-1: Slow Repetitive Tone

The Slow Repetitive Tone, also referred to as the "Initialization Tone" is the tone you hear at all Remote Stations when power is initially applied to the control system. When this tone is heard, you know for a fact that the following are true:

- Power has just been applied to the system.
- The Software Program is running normally.
- The Processor is commanding the throttle to Idle.
- The Processor is commanding the clutch to Neutral.

This is a normal tone when power has first been applied to the Processor and no Control Head has taken command. However, the tone may also be an indication of a problem, if during normal operation the engine's throttle drops to Idle, followed by the clutch to Neutral, the Control Head's red LED goes out and a slow repetitive tone is heard at all remote stations. This indicates that the voltage at the Processor has momentarily dropped below 8 VDC and then returned to a normal operational level. This could be due to:

- Loose battery power cable connection.
- Under-charged or defective battery.
- Voltage drop due to current flow.

In order to pinpoint the exact cause of the low voltage at the Processor, perform the following checks:

A) Check the Display on the Processor for Error Messages. Error Message **57** may appear indicating Under Voltage. One or more of Error Messages **43** through **54** may also be displayed. This is due to the momentary loss of serial communication between the two Processors. Take note that the Under Voltage error is not only dependent on low voltage, it is also dependent on the duration of the low voltage. The possibility exists that an error message would not be displayed if the duration of the low voltage was short enough. However, the other symptoms mentioned above still occur.

B) In either case, follow the procedure listed under **Diagnostic Menu** (Section B4) 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.

B5-1.2 One Long - Three Short Tones

Figure B5-2: One Long - Three Short Tones

This tone indicates that there is an invalid command signal at the Station-in-Command.

The Processor expects a DC voltage, representative of the Control Head's present lever position. This voltage is referred to as the "**Command Signal**". In normally functioning Control Heads, the command signal is between approximately 0.8VDC at Full Astern to 4.10 VDC at Full Ahead.

The command signal is converted by the Processor to a digital representation, referred to as an A/D Count. More on A/D Counts later. If the command signal drops below 0.6VDC or exceeds 4.40 VDC, the tone will be generated.

At the same time the tone is heard, throttle command drops to Idle and the clutch will be commanded to Neutral. The following items will cause this to occur:

- An open or high resistance connection between the Control Head and Processor.
- Out of calibration Control Head.
- A defective Control Head.
- A defective A/D Converter in the Processor.

The exact cause of the malfunction can be found as follows:

A) Check the Processor's Display for error messages. Most likely, one of error messages **13** thru **32** will be shown. The exact number shown depends on which remote station is experiencing the problem and whether the command signal was too high or too low.

B) Enter the Diagnostic Menu as outlined in Section B4

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.

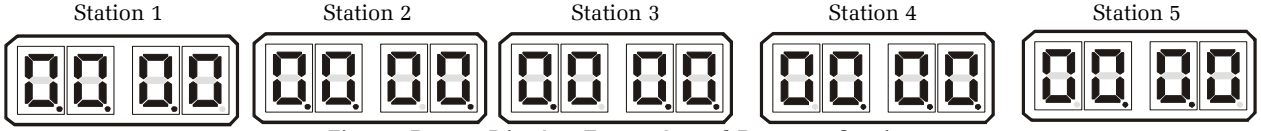


Figure B5-3: Display Examples of Remote Stations

D) The examples in Figure B5-3: 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 B5-4: 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.

B5-1.3 Steady Tone

Figure B5-5: 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.

B5-1.4 Three Second Steady Tone

Figure B5-6: Three Second 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.

B5-1.5 Three Second Steady Tone, followed by a Slow Repetitive Tone

Figure B5-7: Three Second 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.

B5-1.6 Five Seconds On, Five Seconds Off - High Repetitive Rate Tone

Figure B5-8: 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.

B5-1.7 Five Second Steady Tone

Figure B5-9: Five Second Steady Tone

Loss of Serial Communication.

B5-2 Clutch Solenoid Control System Tones

B5-2.1 One Long - One Short Tone

Figure B5-10: 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

B6 TROUBLESHOOTING STATION TRANSFER

In order to transfer command from one Remote Station to another, the following must occur:

- There must be a valid "Command Signal" at the Station being transferred to.
- The "Command Signal" must indicate that the Control Head's lever(s) is at the Neutral/Idle position.
- The Transfer Button must be depressed which takes the "Station Select" signal from 5.00 VDC to 0.00 VDC.

If a transfer from one Remote Station to another is requested, but does not take place; the items required for successful transfer can be tested as follows:

B6-1 *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).

B6-2 *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 B6-1:, page B6-2.

- 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 VDC 1023 A/D Counts
Command Voltage 2.45 VDC 501 A/D Counts

Example 2

Reference Voltage 4.80 VDC 1023 A/D Counts
Command Voltage 2.35 VDC 501 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 B4.

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 B6-1: 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
Ahead Shift Point	537
Full Ahead	821 - 841
Lever Out of Range High	910

B6-3 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**.

Figure B6-1: Display Station A/D's No Station Transfer Button Depressed

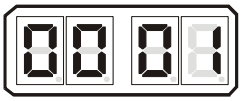


Figure B6-2: Example Display Station A/D's Transfer Button Depressed for Stations 1 - 4

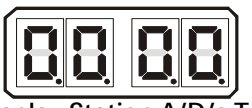


Figure B6-3: Display Station A/D/s Transfer Button Depressed for Station 5

A) Depress the Up or Down (scroll) Push Button until four zeroes are displayed without decimal points as shown in Figure B6-1:.

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 B6-2:. For Station 5 when the Transfer Button is depressed, all four decimal points will light as shown in Figure B6-3:

- 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.

B5 TROUBLESHOOTING STUCK TRANSFER BUTTON

The Transfer Button is a normally open, momentary switch. The only time the switch should close is when it is depressed to take command or when entering or departing various other functions. In the event that the Transfer Button became stuck in the closed position, the following will occur:

- The Transfer Button would have to be closed for 15 seconds or more.
- The throttle and clutch are not affected.
- A solid tone is heard from all remote stations, until the button's contact opens or transfer to another remote station has taken place.

If a Control Head that is not in command has a stuck transfer button, the following will happen:

- If Control Head levers are positioned at Neutral/Idle, a solid tone is heard from all remote stations.
- If Control Head levers are positioned other than Neutral/Idle, a three (3) second tone is heard from all remote stations.
- Error Code **33 - 42**, depending on which remote station, will be shown on the Processor Display.
- Command can be taken at any other operational remote station.
- After one (1) second command can be regained at the remote station with the stuck button as long as the problem has been corrected by depressing the transfer button.

If a stuck Transfer Button is suspected, this can be verified by looking at the Station Select status (**1** or **0**) as outlined in Section B6-3, page B6-2.

- An Error Code **33 - 42** will be shown on the Display, depending on which Station is experiencing the problem.

B8 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.

B8-1 Basic Control System Error Codes

Table B8-1: Basic Control System Error Codes

Error No.	Title	Description
13	Station No.1 Faulted High	Station No.1 Control Head's lever position is out of range. The input appears to be too high.
14	Station No.2 Faulted High	Station No.2 Control Head's lever position is out of range. The input appears to be too high.
15	Station No.3 Faulted High	Station No.3 Control Head's lever position is out of range. The input appears to be too high.
16	Station No.4 Faulted High	Station No.4 Control Head's lever position is out of range. The input appears to be too high.
17	Station No.5 Faulted High	Station No.5 Control Head's lever position is out of range. The input appears to be too high.
18	Station No.6 Faulted High	Station No.6 Control Head's lever position is out of range. The input appears to be too high.
19	Station No.7 Faulted High	Station No.7 Control Head's lever position is out of range. The input appears to be too high.
20	Station No.8 Faulted High	Station No.8 Control Head's lever position is out of range. The input appears to be too high.
21	Station No.9 Faulted High	Station No.9 Control Head's lever position is out of range. The input appears to be too high.
22	Station No.10 Faulted High	Station No.10 Control Head's lever position is out of range. The input appears to be too high.
23	Station No.1 Faulted Low	Station No.1 Control Head's lever position is out of range. The input appears to be too low.
24	Station No.2 Faulted Low	Station No.2 Control Head's lever position is out of range. The input appears to be too low.
25	Station No.3 Faulted Low	Station No.3 Control Head's lever position is out of range. The input appears to be too low.
26	Station No.4 Faulted Low	Station No.4 Control Head's lever position is out of range. The input appears to be too low.
27	Station No.5 Faulted Low	Station No.5 Control Head's lever position is out of range. The input appears to be too low.
28	Station No.6 Faulted Low	Station No.6 Control Head's lever position is out of range. The input appears to be too low.
29	Station No.7 Faulted Low	Station No.7 Control Head's lever position is out of range. The input appears to be too low.
30	Station No.8 Faulted Low	Station No.8 Control Head's lever position is out of range. The input appears to be too low.
31	Station No.9 Faulted Low	Station No.9 Control Head's lever position is out of range. The input appears to be too low.
32	Station No.10 Faulted Low	Station No.10 Control Head's lever position is out of range. The input appears to be too low.
33	Station No.1 Button Stuck Closed	Station No.1 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
34	Station No.2 Button Stuck Closed	Station No.2 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
35	Station No.3 Button Stuck Closed	Station No.3 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
36	Station No.4 Button Stuck Closed	Station No.4 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
37	Station No.5 Button Stuck Closed	Station No.5 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
38	Station No.6 Button Stuck Closed	Station No.6 Control Head's Transfer Button has either been closed too long or has been closed since power-up.

Table B8-1: Basic Control System Error Codes

Error No.	Title	Description
39	Station No.7 Button Stuck Closed	Station No.7 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
40	Station No.8 Button Stuck Closed	Station No.8 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
41	Station No.9 Button Stuck Closed	Station No.9 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
42	Station No.10 Button Stuck Closed	Station No.10 Control Head's Transfer Button has either been closed too long or has been closed since power-up.
43	CAN Communication Stuffing Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a stuffing error.
44	CAN Communication Form Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a form error.
45	CAN Communication Acknowledge Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is an acknowledge error.
46	CAN Communication Bit 1 Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a Bit 1 error.
47	CAN Communication Bit 0 Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a Bit 0 error.
48	CAN Communication CRC Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a CRC error.
49	CAN Communication Bus Error	The Control-Area-Network protocol has detected an error in communication with other devices on the network. The error type is a Bus failure error. The error cannot be recovered from without cycling power to the Processor.
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.

B8-1 Clutch Solenoid Error Codes

Table B8-2: 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.

B9 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.

B9-1 Basic Control System Problem Causes and Solutions

Table B9-1: Basic Control System Problem Causes and Solutions

Error No.	Causes	Solutions
13	a. Station No.1 Control Head is defective. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.1 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.2 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. c. Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
15	a. The Station No.3 Control Head is defective. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.3 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.4 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.5 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.6 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.7 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.8 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. c. Install a jumper from pin 3 to 5 on right hand and 3 to 7 on left hand Control Heads.
21	a. The Station No.9 Control Head is defective. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.9 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 5's of the Control Head Harness connectors. c. Control Head jumper (pin 3 to 5 or 7) is missing.	a. Replace Station No.10 Control Head. b. Ensure that the red conductor is properly crimped to pin 5 at both connectors. 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. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.1 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. c. Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.

Table B9-1: Basic Control System Problem Causes and Solutions

Error No.	Causes	Solutions
24	a. The Station No.2 Control Head is defective. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.2 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. 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. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.3 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. c. Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
26	a. The Station No.4 Control Head is defective. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.4 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. 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. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.5 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. 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. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.6 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. 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. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.7 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. 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. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.8 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. c. Ensure that the blue conductor is properly crimped to pin 7 at both connectors and there is continuity.
31	a. The Station No.9 Control Head is defective. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.9 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. 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. b. No continuity between pin 6's of the Control Head Harness connectors. c. No continuity between pin 7's of the Control Head Harness connectors.	a. Replace Station No.10 Control Head. b. Ensure that the green conductor is properly crimped to pin 6 at both connectors and there is continuity. 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 b. The Station No.1 Control Head transfer button is defective c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory b. Replace the Control Head 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. Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. In addition, ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
34	a. The Station No.2 transfer button was held down for 15 seconds or longer. b. The Station No.2 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. 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 B9-1: Basic Control System Problem Causes and Solutions

Error No.	Causes	Solutions
35	a. The Station No.3 transfer button was held down for 15 seconds or longer. b. The Station No.3 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. 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. b. The Station No.4 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
37	a. The Station No.5 transfer button was held down for 15 seconds or longer. b. The Station No.5 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. 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. b. The Station No.6 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. 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. b. The Station No.7 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
40	a. The Station No.8 transfer button was held down for 15 seconds or longer. b. The Station No.8 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. 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 B9-1: Basic Control System Problem Causes and Solutions

Error No.	Causes	Solutions
41	a. The Station No.9 transfer button was held down for 15 seconds or longer. b. The Station No.9 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. 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. b. The Station No.10 Control Head transfer button is defective. c. The Control Head Harness is miswired. d. The Control Head's Pigtail is miswired.	a. Clear the Error Code from memory. b. Replace the Control Head. 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. Ensure that the orange conductor is crimped to pin 4 of the connector and connected to pin 4 of the Control Head's terminal block. Ensure that the red conductor is crimped to pin 5 of the connector and connected to pin 3 of the Control Head's terminal block.
43	a. The Serial Harness is in excess of 120 feet (37m). b. The Processor is defective. c. The Serial Harness's shield is not properly terminated.	a. Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m). b. Replace the faulty Processor. 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). b. The Processor is defective. c. The Serial Harness's shield is not properly terminated.	a. Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m). b. Replace the faulty Processor. 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. b. The Serial Harness is incorrectly wired. c. Loss of power to one of the Processors.	a. Ensure that the Serial Harness is properly seated at all Processors. b. Refer to the Serial Plug pin-out in Appendix B. Correct or replace the Harness. c. Restore Power to the Processor.
46	a. The Serial Harness is in excess of 120 feet (37m). b. The Processor is defective. c. The Serial Harness's shield is not properly terminated.	a. Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m). b. Replace the faulty Processor. 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). b. The Processor is defective. c. The Serial Harness's shield is not properly terminated.	a. Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m). b. Replace the faulty Processor. 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). b. The Processor is defective. c. The Serial Harness's shield is not properly terminated.	a. Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m). b. Replace the faulty Processor. c. Ensure that the shield is terminated and the termination is at one side only.
49	a. The Serial Harness is in excess of 120 feet (37m). b. The Processor is defective. c. The Serial Harness's shield is not properly terminated.	a. Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m). b. Replace the faulty Processor. 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. b. None of the Processors has ID No. 1 selected. c. Loss of power to Processor ID No.1.	a. Connect the Serial Harness into Processor ID No.1. b. Identify one of the Processors as ID No.1 with the A0 function. c. Restore power to Processor ID No.1.
51	a. The Serial Harness is not connected at Processor ID No.2. b. None of the Processors has ID No.2 selected. c. Loss of power to Processor ID No.2	a. Connect the Serial Harness into Processor ID No.2. b. Identify one of the Processors as ID No.2 with the A0 function. c. Restore power to Processor ID No.2.

Table B9-1: Basic Control System Problem Causes and Solutions

Error No.	Causes	Solutions
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.
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.

B10 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:

B10-1 Basic Control System Problems Without Error Codes

A) **SYMPTOM:** No audible tones heard at one Control Station when power is first applied to the Processor. All other features function normally.

Cause	Remedy
a. Incorrectly wired Station Harness/ Cable or Pigtail.	a. Verify that the black wire is properly connected to pin 1 on the Control Head and Pin 8 at the Processor.
b. The Control Head's Sound Transducer is defective.	b. Measure the AC voltage at pins 1 & 3 of the Control Head. If 20- 25 VAC is present, replace the Control Head.

B) **SYMPTOM:** The Control Head's red LED doesn't light when in command, but otherwise functions properly.

Cause	Remedy
a. Incorrectly wired Station Harness/ Cable or Pigtail.	a. Verify that the brown wire is properly connected to pin 2 on the Control head and pin 2 at the Processor.
b. The Control Head's red LED or circuit is open.	b. Measure the DC voltage at pins 2 & 3 at the Control. The measurement will be approximately 2.20 VDC when the red LED is lit. If 4.00 VDC is measured, the red LED or its circuit is open. Replace the Control Head.

C) **SYMPTOM:** When power is turned ON to the Processor, there are no tones from any of the Remote Stations, the Control Head red LED does not light when the Transfer Button is pressed, and the Display is not lit at the Processor**.**

Cause	Remedy
a. No power to the Processor.	a. Disconnect the Power Harness from the Processor. Measure the DC voltage at pins 10 (+) and 11 (-) of the Harness plug. If 12 or 24 VDC is not present, check the circuit breakers, switches and cables feeding power to the Processor. Correct the power source as required.
b. The battery's polarity is reversed at the Processor.	b. Disconnect the Power Harness from the Processor. Connect a voltmeter's red lead to pin 10 and the black lead to pin 11 of the Harness's plug. If negative voltage is measured, reverse the wires.
c. Defective Processor.	c. If Causes a. and b. were not the fault, replace the Processor.

D) **SYMPTOM:** The engine begins to turn-over while starting and then stops. A slow repetitive tone is heard from all Remote Stations.

Cause	Remedy
a. The voltage available at the Processor has dropped too low, due to the starter's current requirement	a. Supply power to the Processor from a battery other that the starting battery or supply power from two sources through an APS (Automatic Power Selector)
b. Battery charge is too low	b. Recharge/ replace the battery or supply battery power from two sources through an APS.

E) **SYMPTOM:** Active Synchronization is inoperable.

Cause	Remedy
a. There is no Tachometer Sensor signal at the Port or Starboard Processor.	a. The Tachometer Sensor frequency can be seen on the Processor's Display by accessing the Diagnostic Menu H0. If the frequency is not measured, check the Tachometer Sensor and the wiring.
b. Loss of Serial Communication between the Processors.	b. If Active Synchronization is inoperative due to a lack of Serial Communications, one or more Error Codes will be displayed indicating the loss of communication.
c. The Processor's Identification number(s) have not been set properly.	c. All Processors must have a unique identification number as set with Function Code A0. Refer to Section 5-5.0.1., page 5-7.
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 5-5.0.2., page 5-7.

B10-2 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.

Cause	Remedy
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.

B10-3 Electronic Throttle Control System Problems Without Error Codes

A) **SYMPTOM:** The engine RPM's vary, without moving the Control Head lever (synchronization disabled).

Cause	Remedy
a. Problem with the Governor.	a. Connect the Break-out Box (p/n 13927) as shown in the Throttle Testing Section of the Service Field Test Unit Manual. If variations are seen, proceed to Step B). If no variations are seen, contact a certified engine mechanic.
b. Erratic Command Signal.	b. Refer to Command Signal testing. If variations of the A/D counts occur, connect the Control Head to another Station (if available) on the Processor. If variations persist, replace the Control Head.

B) **SYMPTOM:** The engine's Idle is too high.

Cause	Remedy
a. Idle was not adjusted mechanically correct at the Idle stop.	a. Adjust the Throttle Push-Pull cable as specified in Section 5-6.2.2.1., page 5-12.
b. Function Code E2 Throttle Minimum is incorrectly set.	b. Adjust Throttle Minimum as specified in Section 5-6.2.2.2, page 5-13.
c. The Governor or Carburetor is incorrectly adjusted.	c. After Causes a. and b. have been eliminated, contact a certified engine mechanic to properly adjust.

B11 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.

B11-1 Equal Throttle Synchronization

B11-1.1 Basic Troubleshooting

B11-1.1.1 SYMPTOM: Will not synchronize.

Causes	Solutions
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**.

B11-2 Active Synchronization

B11-2.1 Basic Troubleshooting

B11-2.1.1 SYMPTOM: The green LED is lit solid, though the Engine RPM's differ by a significant amount.

Causes	Solutions
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.

B11-2.1.2 SYMPTOM: Will not synchronize.

Causes	Solutions
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.

B11-2.2 Electronic Throttle

B11-2.2.1 SYMPTOM: The green LED is lit solid, though the Engine RPM's differ by a significant amount.

Causes	Solutions
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.

B11-2.2.2 SYMPTOM: One or both of the engines continually changes RPM (hunts). Will not synchronize properly

Causes	Solutions
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

B11-2.2.3 SYMPTOM: Synchronization does not function. The Control Head's green LED does not light.

Causes	Solutions
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.

B12 TROUBLESHOOTING CABLE 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.

B12-1 Basic Control System Harnesses

Table B12-1: Power, Start Interlock Harness Pin-Out

PROCESSOR PIGTAIL		ENGINE and BATTERY	
Termination A	Conductor Color	Termination B	Description
Pin 1	Yellow w/ Red Trace	Starter Solenoid	Closed contact when In-command and at Neutral.
Pin 10	Red	Battery (+)	+12 or 24VDC.
Pin 11	Black	Battery (-)	- DC Return
Pin 12	Yellow w/ Red Trace	Starter Switch Wire at the Starter Solenoid	Closed contact when In-command and at Neutral.

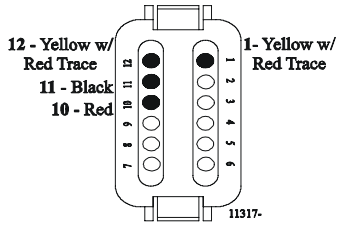


Table B12-2: Power, Start Interlock, and Pressure Switch Harness Pin-Out

PROCESSOR PIGTAIL		ENGINE and BATTERY	
Termination A	Conductor Color	Termination B	Description
Pin 1	Yellow w/ Red Trace	Starter Solenoid	Closed contact when In-command and at Neutral.
Pin 6	Light Blue	Clutch Pressure Switch	Normally Open contact that closes when transmission manufacturer's minimum safe operating pressure is reached.
Pin 7	Light Blue	Clutch Pressure Switch	Normally Open contact that closes when transmission manufacturer's minimum safe operating pressure is reached.
Pin 10	Red	Battery (+)	+12 or 24VDC.
Pin 11	Black	Battery (-)	- DC Return
Pin 12	Yellow w/ Red Trace	Starter Switch Wire at the Starter Solenoid	Closed contact when In-command and at Neutral.

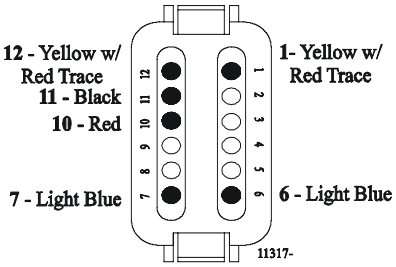


Table B12-3: Power, Start Interlock, Pressure Switch, and Alarm Harness Pin-Out

PROCESSOR PIGTAIL		ENGINE and BATTERY	
Termination A	Conductor Color	Termination B	Description
Pin 1	Yellow w/ Red Trace	Starter Solenoid	Closed contact when In-command and at Neutral.
Pin 2	Red	External Alarm Circuit	Normally Open contact opens with fault or loss of power.
Pin 3	Black	External Alarm Circuit	Normally Open contact opens with fault or loss of power.
Pin 6	Light Blue	Clutch Pressure Switch	Normally Open contact that closes when transmission manufacturer's minimum safe operating pressure is reached.
Pin 10	Red	Battery (+)	+12 or 24VDC.
Pin 11	Black	Battery (-)	- DC Return
Pin 12	Yellow w/ Red Trace	Starter Switch Wire at the Starter Solenoid	Closed contact when In-command and at Neutral.

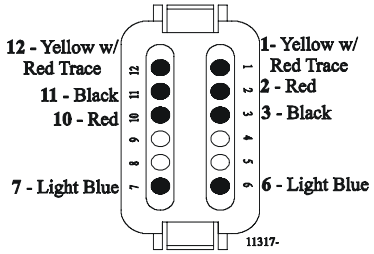


Table B12-4: Serial Communication Harness Pin-Out

PROCESSOR PIGTAIL		PROCESSOR	
Termination A	Conductor Color	Termination B	Description
Pin 1	Black	Pin 1	CAN Low
Pin 2	Red	Pin 2	CAN High
Pin 6	Yellow/ Green	N/C	Shield

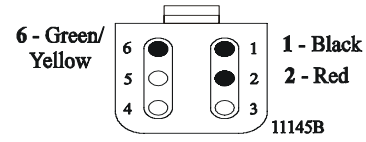
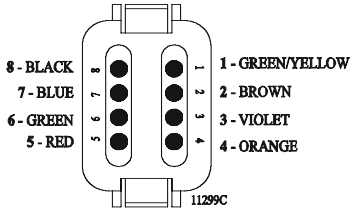


Table B12-5: Control Head Harness Pin-Out and Hard-Wire

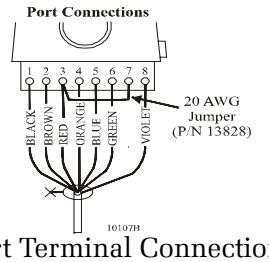
PROCESSOR PIGTAIL		CONTROL HEAD PIGTAIL (14261-X)	
Termination A	Conductor Color	Termination B	Description
Pin 1	Green/ Yellow	Pin 1	Shield
Pin 2	Brown	Pin 2	Red LED (+)
Pin 3	Violet	Pin 3	Green LED (-)
Pin 4	Orange	Pin 4	Transfer Button (+)
Pin 5	Red	Pin 5	Ground
Pin 6	Green	Pin 6	Lever Command Signal
Pin 7	Blue	Pin 7	VREF (+5VDC)
Pin 8	Black	Pin 8	Tone (+)



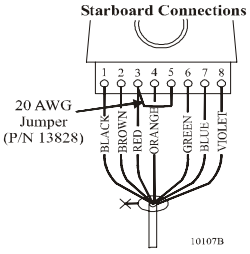
Harness Plug Pin- Out

PROCESSOR PIGTAIL		CONTROL HEAD TERMINAL STRIP (13557-X)	
Termination A	Conductor Color	Termination B	Description
Pin 1	Green/ Yellow	N/C	Shield
Pin 2	Brown	Pin 2	Red LED (+)
Pin 3	Violet	Pin 8	Green LED (-)
Pin 4	Orange	Pin 4	Transfer Button (+)
Pin 5	Red	Pin 3	Ground
Pin 6	Green	Pin 6	Lever Command Signal
Pin 7	Blue	Pin 5- Port Pin 7- Stbd	VREF (+5VDC)
Pin 8	Black	Pin 1	Tone (+)

NOTE: STARBOARD- Jumper Pins 3 to 5
PORT- Jumper Pins 3 to 7



Port Terminal Connections



Stbd Terminal Connections

Table B12-6: Tachometer Sensor Harness Pin-Out

PROCESSOR PIGTAIL		TACHOMETER SENSOR	
Termination A	Conductor Color	Termination B	Description
Pin 2	Red	Pin B	Tachometer (+)
Pin 3	Black	Pin C	Tachometer (-)
Pin 4	Green/Yellow	N/C	Shield

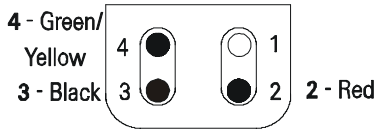
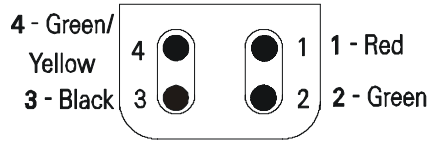


Table B12-7: Tachometer Sensor Harness with Power Pin-Out

PROCESSOR PIGTAIL		TACHOMETER SENSOR	
Termination A	Conductor Color	Termination B	Description
Pin 1	Red	As Required	Sensor Supply (+9VDC)
Pin 2	Green	As Required	Tachometer (+)
Pin 3	Black	As Required	Tachometer (-)
Pin 4	Green/Yellow	N/C	Shield

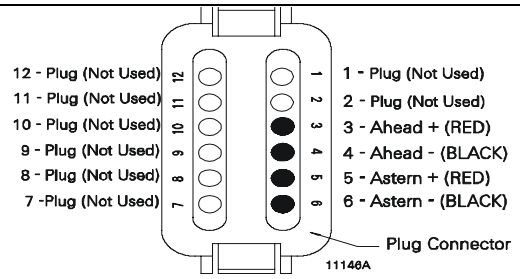


B12-2 Clutch Harnesses

B12-2.1 Ahead/Astern

Table B12-8: Ahead/Astern Clutch Harness Pin-Out

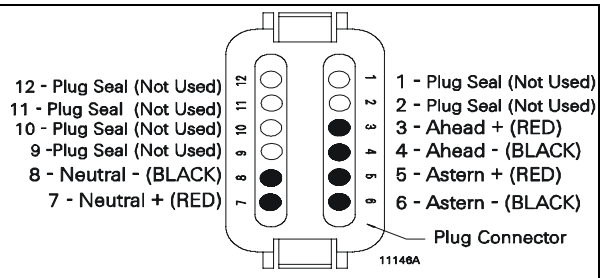
PROCESSOR PIGTAIL		GEAR BOX	
Termination A	Conductor Color	Termination B	Description
Pin 3	Red	Ahead Solenoid	+ 24 VDC when Ahead Clutch Selected
Pin 4	Black	Ahead Solenoid	- VDC Return for Ahead Clutch
Pin 5	Red	Astern Solenoid	+ 24 VDC when Astern Clutch Selected
Pin 6	Black	Astern Solenoid	- VDC Return for Astern Clutch



B12-2.1 Ahead/Neutral/Astern

Table B12-9: Ahead/Neutral/Astern Clutch Harness Pin-Out

PROCESSOR PIGTAIL		GEAR BOX	
Termination A	Conductor Color	Termination B	Description
Pin 3	Red	Ahead Solenoid	+24 VDC when Ahead Clutch Selected
Pin 4	Black	Ahead Solenoid	-VDC Return Ahead Clutch
Pin 5	Red	Astern Solenoid	+24 VDC when Astern Clutch Selected
Pin 6	Black	Astern Solenoid	-VDC Return Astern Clutch
Pin 7	Red	Neutral Solenoid	+24 VDC at all times
Pin 8	Black	Neutral Solenoid	-VDC Return for Neutral Solenoid

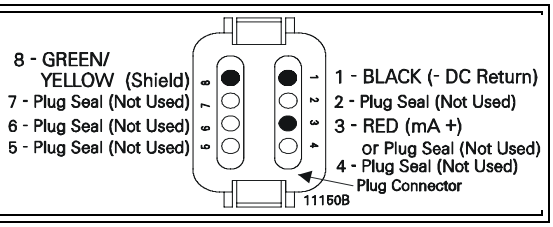


B12-3 Throttle Harnesses

B12-3.1 Current, MAN

Table B12-10: Current, MAN, Throttle Harness Pin-Out

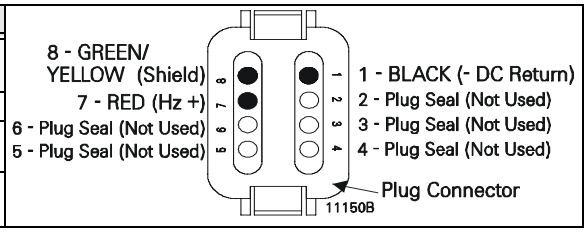
PROCESSOR PIGTAIL		ENGINE	
Termination A	Conductor Color	Termination B	Description
Pin 1	Black	Engine DC-Bus	Throttle Signal Return
Pin 3	Red	ECM	0.00- 21.0 mA. Throttle Signal
Pin 8	Green/ Yellow	N/C	N/A



B12-3.1 Frequency

Table B12-11: Frequency Throttle Harness Pin-Out

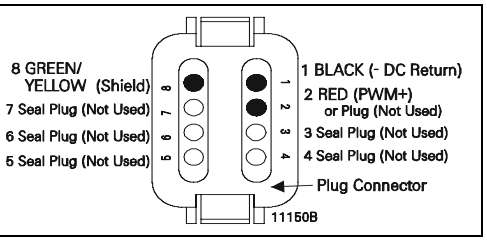
PROCESSOR PIGTAIL		ENGINE	
Termination A	Conductor Color	Termination B	Description
Pin 1	Black	Engine DC- Bus	Throttle Signal Return
Pin 7	Red	ECM	120.64- 463.50 Hz. Throttle Signal
Pin 8	Green/ Yellow	N/C	N/A



B12-3.1 PWM

Table B12-12: PWM Throttle Harness Pin-Out

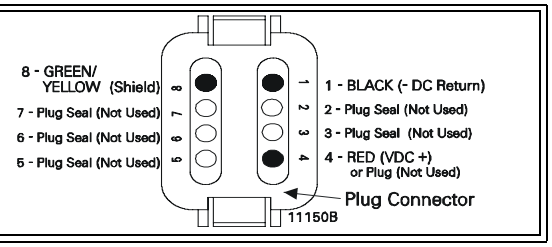
PROCESSOR PIGTAIL		ENGINE	
Termination A	Conductor Color	Termination B	Description
Pin 1	Black	Engine DC- Bus	Throttle Signal Return
Pin 2	Red	ECM	PWM Throttle Signal - 0- 100% Duty Cycle @ 500Hz.
Pin 8	Green / Yellow	N/C	N/A



B12-3.1 Voltage

Table B12-13: Voltage Throttle Harness Pin-Out

PROCESSOR PIGTAILS		ENGINE	
Termination A	Conductor Color	Termination B	Description
Pin 1	Black	Engine DC- Bus	Throttle Signal Return
Pin 2	Red	ECM	0.00- 5.00 VDC Throttle Signal
Pin 8	Green/ Yellow	N/C	N/A



B13 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 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.

B13-1 Basic Processor Pigtails

Table B13-1: Power/Start Interlock/Clutch Oil Pressure Switch/Alarm Pigtail Pin-Out

CIRCUIT BOARD		PLUG	
Termination A	Conductor Color	Termination B	Description
PB2-2	Yellow	Pin 1	Start Interlock
TB6-6	Brown	Pin 2	Alarm (N.O.)
TB6-5	Black	Pin 3	Alarm (Common)
TB6-2	Orange	Pin 4	Back-up Ctrl (Ground)
TB6-1	White	Pin 5	Back-up Ctrl Input
TB6-3	Blue	Pin 6	Clutch Pressure Switch
TB6-4	Green	Pin 7	Clutch Pressure Switch (Ground)
PB1 (+)	Red	Pin 10	DC Power (+)
PB1 (-)	Black	Pin 11	DC Power (-)
PB2-1	Red	Pin 12	Start Interlock

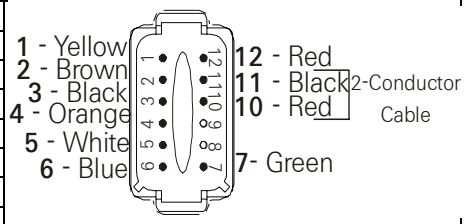


Table B13-2: Serial Communication Pigtail Pin-Out

CIRCUIT BOARD		PLUG	
Termination A	Conductor Color	Termination B	Description
TB7-6	White	Pin 2	CAN High
TB7-7	Green	Pin 1	CAN Low
TB7-8	Black	Pin 4	CAN High
TB7-9	Red	Pin 5	CAN Low
TB7-10	Black	Pin 6	Shield

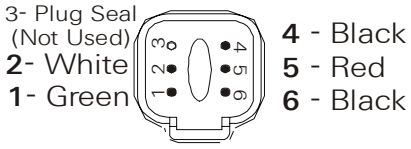
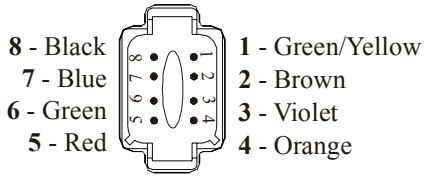


Table B13-3: Control Head Pigtail Pin-Out (Up to 5 Stations)

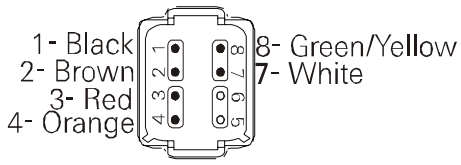
CIRCUIT BOARD		PLUG	
Termination A	Conductor Color	Termination B	Description
Frame	Non-insulated to Green/Yellow	Pin 1	Shield
TB1 thru 5-2	Brown	Pin 2	Red LED (+)
TB1 thru 5-8	Violet	Pin 3	Green LED (-)
TB1 thru 5-4	Orange	Pin 4	Transfer Button
TB1 thru 5-3	Red	Pin 5	Ground
TB1 thru 5-7	Blue	Pin 7	VREF (+5VDC)
TB1 thru 5-6	Green	Pin 6	Lever Command Signal
TB1 thru 5-1	Black	Pin 8	Tone (+)



B13-2 Throttle Pigtail

Table B13-4: Throttle Pigtail Pin-Out

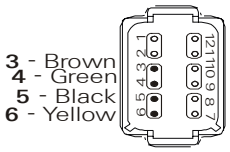
CIRCUIT BOARD		PLUG	
Termination A	Conductor Color	Termination B	Description
TB8-3	Brown	Pin 2	PWM (+)
TB8-4	Red	Pin 3	Current (+)
TB8-5	Orange	Pin 4	VDC (+)
TB8-6	White	Pin 7	Frequency (+)
TB8-7	Black	Pin 1	Signal Ground
P-Clamp to Frame	Green/Yellow	Pin 8	Shield



B13-3 Clutch Pigtail

Table B13-5: Clutch Pigtail Pin-Out

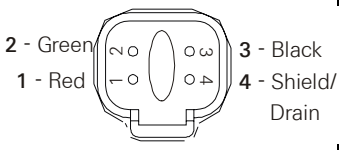
CIRCUIT BOARD		PLUG	
Termination A	Conductor Color	Termination B	Description
TB11-1	Black	Pin 5	Astern Clutch (+)
TB11-2	Brown	Pin 3	Ahead Clutch (+)
TB11-5	Yellow	Pin 6	Astern clutch (-)
TB11-6	Green	Pin 4	Ahead Clutch (-)



B13-4 Tachometer Sensor Pigtail

Table B13-6: Tachometer Sensor Pigtail Pin-Out

CIRCUIT BOARD		PLUG	
Termination A	Conductor Color	Termination B	Description
TB9- 1	Red	Pin 1	Sensor Supply (+9VDC)
TB9- 2	Green	Pin 2	AC Type Tach Input
TB9- 3	N/C	Open Collector Tach Input (the green wire is moved from TB9-2 to TB9-3 when an Open Collector Tach is used)	
TB9- 4	Black	Pin 3	Return for Tach Input
Grounding Screw	Drain	Pin 4	Shield



ZF Marine Electronics, LLC
Mukilteo Plant

ClearCommand 9000 Series Electronic Throttle – Solenoid Clutch

Qualitative Failure Analysis & Design Verification

Test Procedure

Version: 1.0

Document #	AUTHOR	CHECKED	APPROVED	DATE
ENG-143	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:

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.
   1) 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.

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 overspeed 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 Electronics 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 Electronics provides audible tones at the Control Head locations to indicate system faults.

ITEM #	FAILED COMPONENT	ALARM STATUS	INITIAL RESULT	FINAL OUTCOME
1	ZF Marine Electronics 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 Shifts To Neutral	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) **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

i) Turn power on to both Port and Starboard Processors. Take command at a Control Head.

ii) Move the Port and Starboard Control Head levers to approximately ½ Ahead.

iii) 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.

1) The Port Processor will shift to Neutral and throttle will go to Idle.

2) The Port Control Head will give an alarm tone indicating a faulty potentiometer.

iv) Move the Port and Starboard Control Head levers back to Neutral. Reconnect the green wire.

v) Repeat for Starboard side.

2) **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

i) Throttle signal to Idle and shift to Neutral.

ii) LED at Control Heads will not be lit.

iii) Opposite engine still under power has full control.

b) Test Procedure.

i) Turn power on to both Port and Starboard Processors. Take command at a Control Head.

ii) Move the Port and Starboard Control Head levers to approximately ½ Ahead.

iii) Turn power off to the Port side only.

1) Port side will go to Neutral Idle.

2) LED on the Port side of the Control Head in command will go off.

3) The Port Control Head will no longer have command of the engine and gear.

4) The Starboard Control Head will still have full command of the Starboard engine and gear.

iv Turn power on to the Port Processor. Take command of the Port side.

1) The Port Control Head will operate as usual-(Non-volatile memory)

v) Repeat test for Starboard Processor.

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Service Field Test Unit
Reference Manual

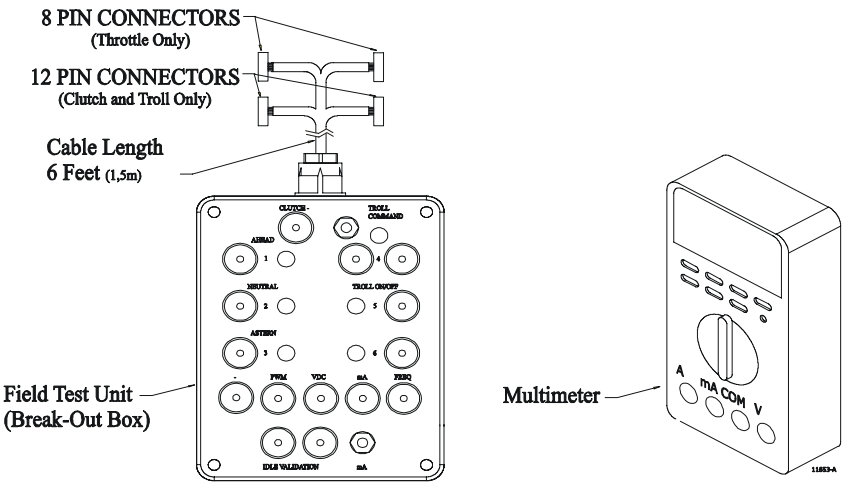
MM13927 Rev.D 10/03

MM13927 Table of Contents

Revision List

Rev	Date	Revision Description
A	11/02	Revised Section 1.0 Table 1
B	2/03	Revised manual to current ZF Marine Electronics 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

1 INTRODUCTION



Refer to Bulletin 02-008 for Service Field Test Unit (Part No. 13927) recommendations. Refer to Figure 1-1:for an example of the Test Unit and a Multimeter.

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.

Figure 1-1: Service Field Test Unit (Break-out Box)

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 1-2: indicates the location of the connectors on the CruiseCommand Processor and Figure 1-3: the typical pigtail plugs on a 9000 Series ClearCommand Processor.

NOTE: Not all ClearCommand Processors have all of the pigtails shown in Figure 3. Only the pigtails that are required for a specific application are installed in a ClearCommand Processor.

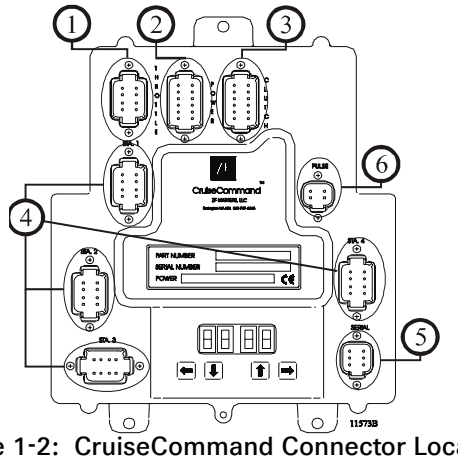


Figure 1-2: CruiseCommand Connector Locations

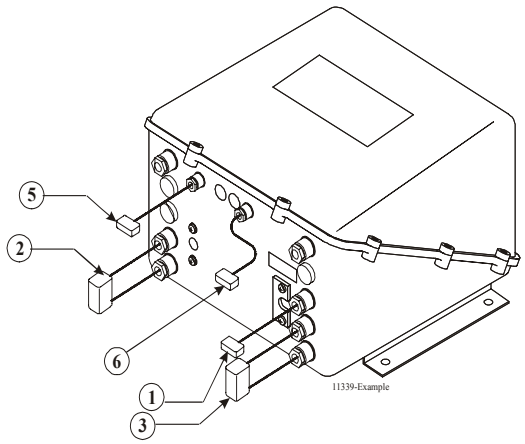


Figure 1-3: Example of ClearCommand Pigtail Locations

#	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.

Table 1-1: Connector/Pigtail Descriptions

2 PROCEDURE

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.

2-1 Throttle Signal Testing

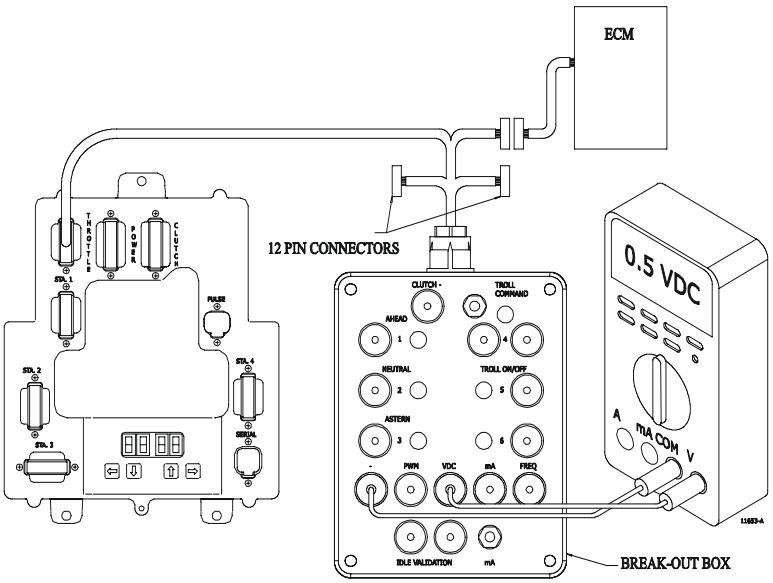
Depending on which Processor is being tested, it may have the capability of sourcing one or all of the following: DC Voltage, Current, PWM (Pulse Width Modulation) or Frequency.

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 2-4:.

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).

Figure 2-4: Throttle Connection (DC Voltage)

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 2-5:.

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.

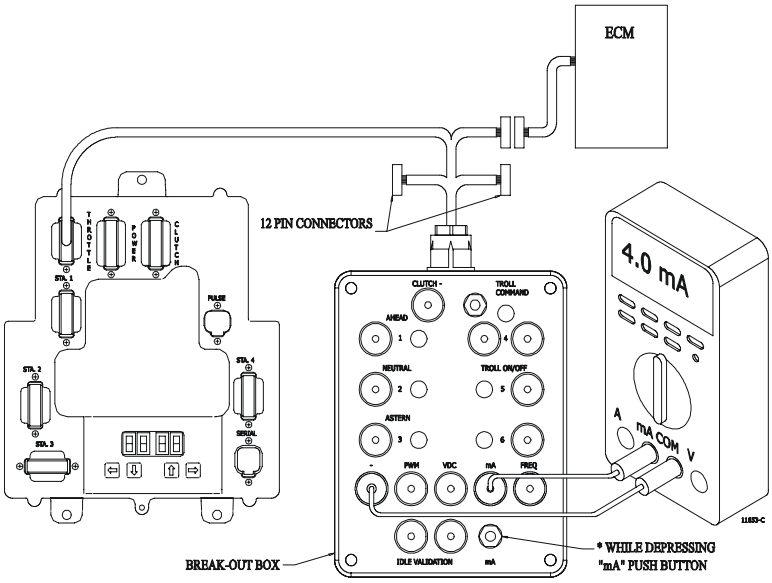


Figure 2-5: Throttle Connection (Current mA)

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).

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.

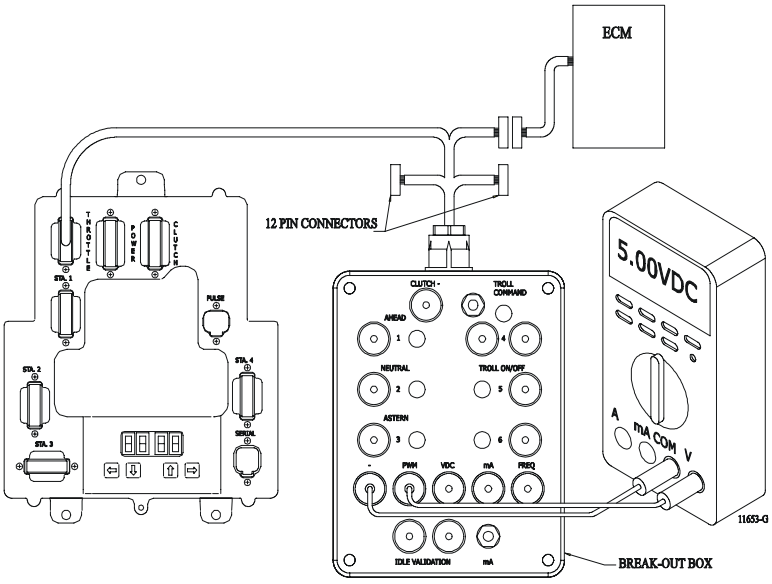


Figure 2-6: Throttle Connection (PWM with DC Voltmeter)

C) Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure 2-6:

D) labeled “-“ and the red lead into the socket labeled “PWM”.

E) Turn power ‘On’ to the Caterpillar ECM (Electronic Control Module) Only. Do Not apply power to the Processor at this time.

F) 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 2-6:.

G) 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.

H) Record the DC Voltage at this time. The measurement should be 7-9% of the voltage measured in step f).

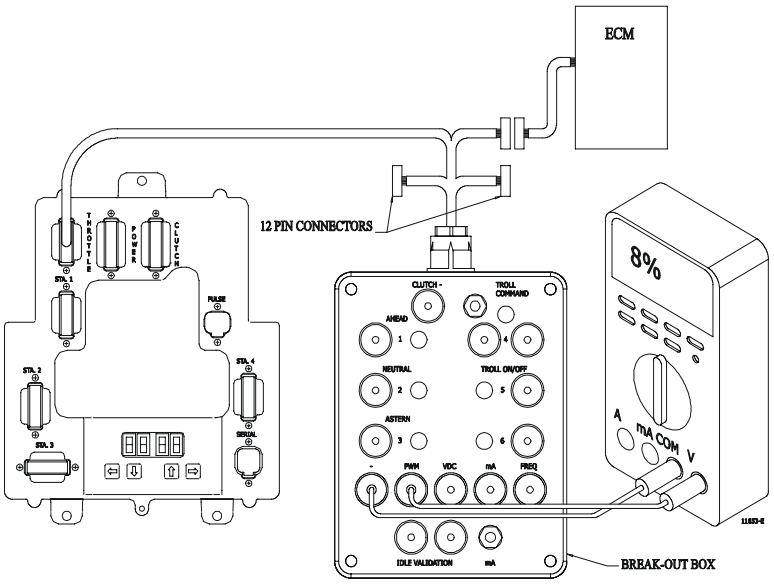
I) Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

J) 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 2-7:

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).

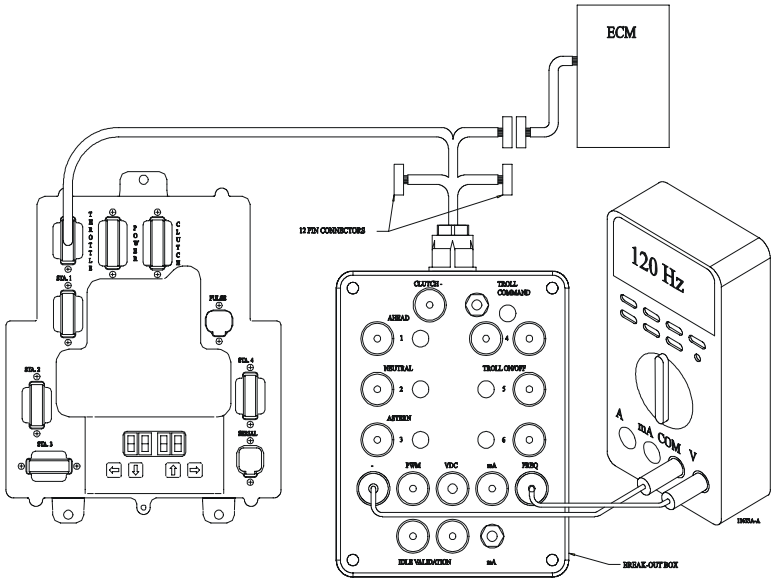
Figure 2-7: Throttle Connection (PWM with Duty Cycle Meter)

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 2-8:

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".

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).

Figure 2-8: Throttle Connection (Frequency Hz)

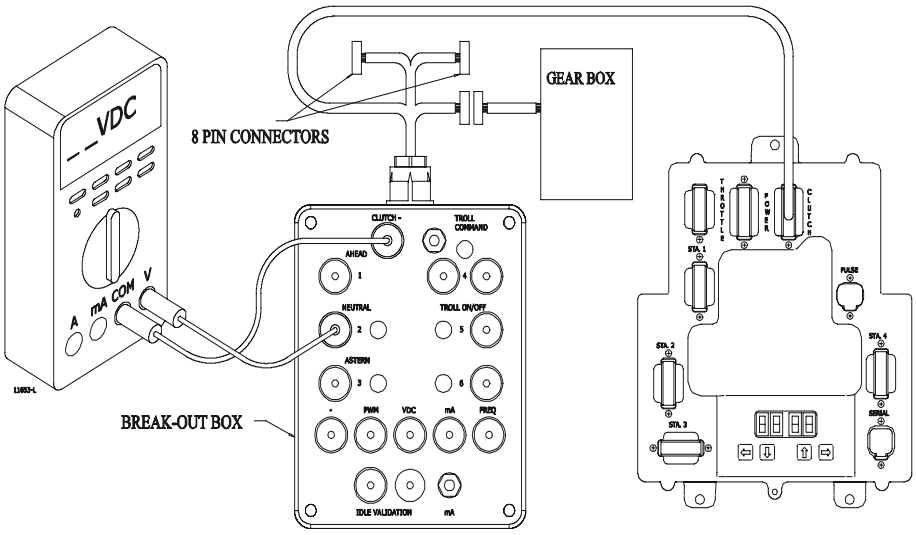
H) The appropriate Full Throttle Frequency for the application should be measured at this time.

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 2-9:.

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.

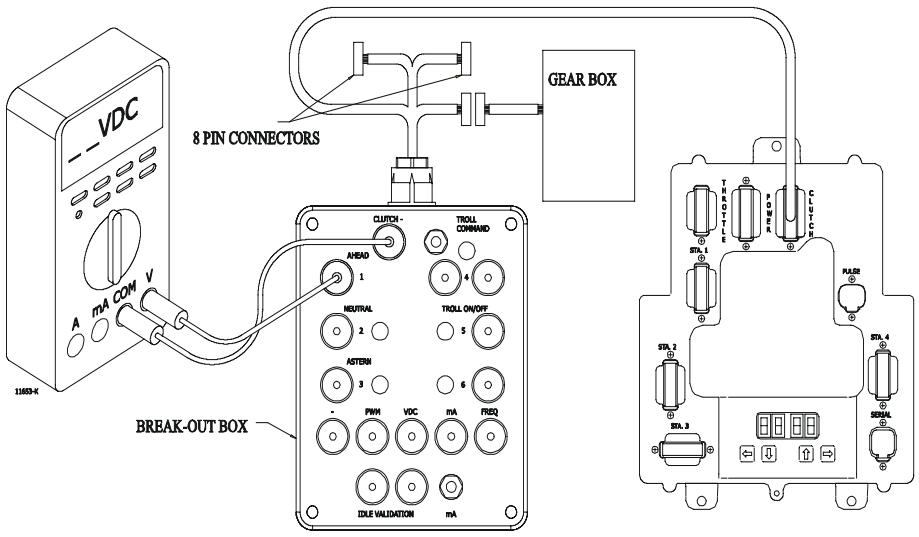
Figure 2-9: Clutch Connection (Neutral Solenoid)

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 2-10:.

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.

Figure 2-10: Clutch Connection (Ahead Solenoid)

F) The measurement should be 0 VDC and the adjacent LED should not be lit.

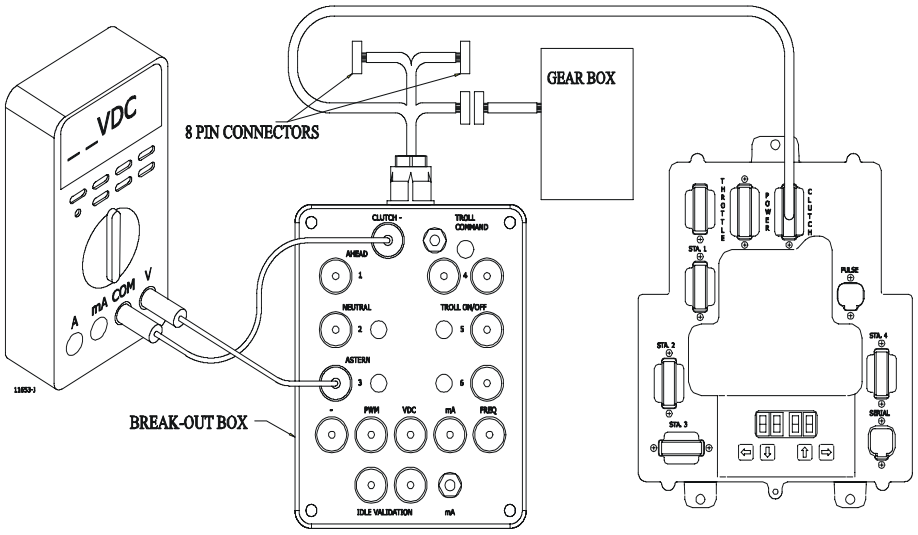
G) Position the Control Head lever into the Ahead detent. The measurement should be 12 or 24 VDC depending on the Ahead Solenoid's rating. The LED adjacent to the Ahead plug on the Break-out Box should be lit.

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 2-11:.

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.

Figure 2-11: Clutch Connection (Astern Solenoid)

F) The measurement should be 0 VDC and the adjacent LED should not be lit.

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.

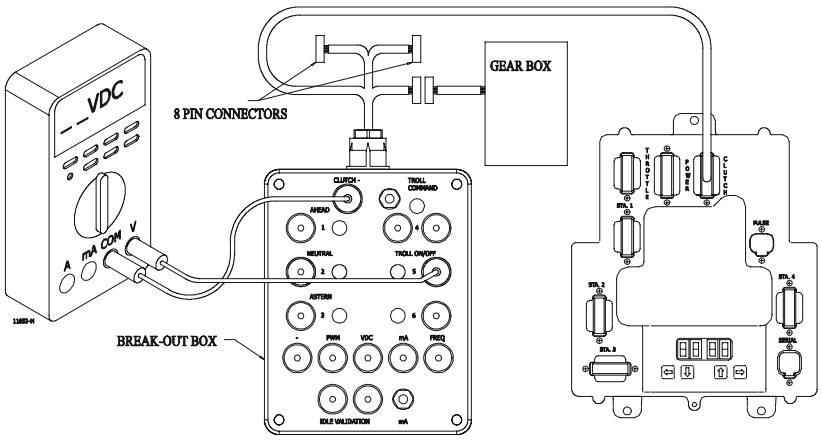
H) Return the Control Head lever to the Neutral/Idle position.

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 2-12:.

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 2-12:.

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.

Figure 2-12: Troll Connection (ON/OFF Solenoid)

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.

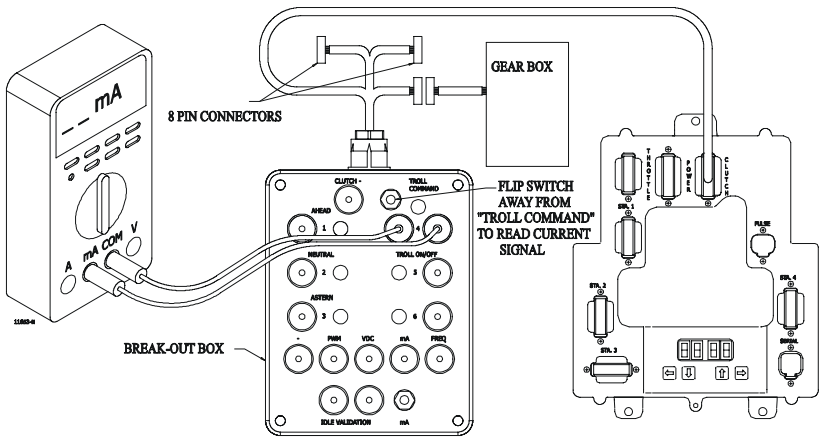
H) Position the Control Head lever to the Ahead detent. The measurement should now be 12 or 24 VDC, depending on the Solenoid's rating.

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 2-13:.

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 2-13:.

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.

Figure 2-13: Troll Connection (Proportional Solenoid with Amp Meter)

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.

3 PARTS LIST

Table 3-2: Parts List

Part Name	ZF Marine Electronics Part No.
Service Field Test Unit	13927
Technical Manual	MM13927
Multimeter	
Test Control Head - Dual	14000

APPENDIX C

Drawing 13068A-1 Notes Page

– 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 CHECKOUT, 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 RATED FOR A MAXIMUM OF 0.5A, MAXIMUM CONTACT DRY RATING OF 100V. DO NOT EXCEED THIS RATING. IT IS THE SHIPYARDS 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 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.
11. THE CONTROL PROCESSOR'S MOUNTING FEET MUST BE CONNECTED TO THE VESSELS BONDING 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.
14. REFER TO THE CONTROL SYSTEM MANUAL FOR ADDITIONAL INFORMATION.
15. NOT USED.
16. INSURE 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. INSURE THAT DRAIN WIRE ON SHIELDED CABLE IS CONNECTED ONLY WHERE INDICATED INSIDE HOUSING AND THAT DRAIN WIRE DOES NOT TOUCH ANY OTHER CONDUCTIVE SURFACE. FOR PROCESSORS WITH A SERIAL COMMUNICATION PIGTAIL, SHIELD TERMINATION IS DONE AT THE FACTORY. REFER TO THE INSTALLATION MANUAL FOR ADDITIONAL INFORMATION.
18. THIS CONNECTOR PROVIDES THE FOLLOWING FUNCTIONS: POWER INPUT, START INTERLOCK OUTPUT, CLUTCH PRESSURE INPUT, ALARM OUTPUT. THE EXTERNAL WIRE HARNESS ATTACHED TO THIS CONNECTOR DETERMINES WHICH FUNCTIONS ARE USED. POWER AND START INTER–LOCK ARE REQUIRED, CLUTCH PRESSURE AND ALARM MAYBE OPTIONAL BASED ON CUSTOMER OR REGULATORY REQUIREMENTS.

MATERIAL LIST

✓	ITEM	QTY	PART NUMBER	DESCRIPTION
	1	2	96202	CONTROL PROCESSOR
	2	1	MC2000–2P	CONTROL HEAD
	3	2	14261–XX	CONTROL HEAD CABLE, DOUBLE ENDED
	4	BY OTHERS	13756–XX	WIRE HARNESS – POWER/START INTERLOCK
	5	2	13533–XX	WIRE HARNESS – THROTTLE, PWM
	6	2	13322–XX	WIRE HARNESS – AHEAD/ASTERN CLUTCHES
	7	1	13316–XX	WIRE HARNESS – SERIAL COMMUNICATION
	8	2	810	CIRCUIT BREAKER, 10 AMP
	9	BY OTHERS	13505	AUTOMATIC POWER SELECTOR

INDEX

ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	Q.C. APR
	A	RENAMED DWG & EXT. REVISED; ADDED SH 3 & 4	V. CLAUS 08/25/05	CME 08/25/05	RBH 08/25/05

REVISION

APPROVAL		DATE
DRN	LLN	2–05
ENG	BA	2–05
CHK	JRT	2–05
QC		
MFG		

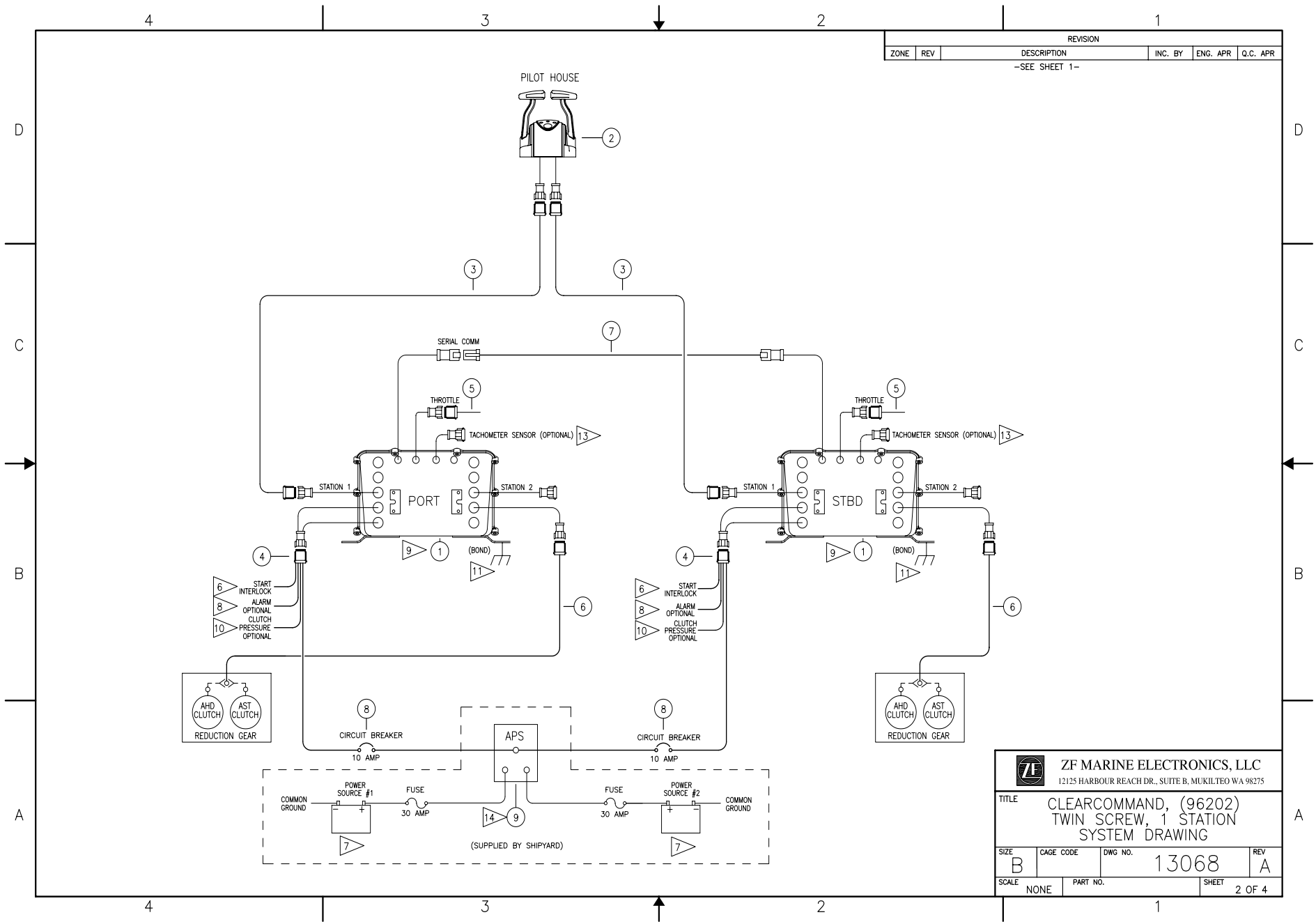
ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE: CLEARCOMMAND, (96202) TWIN SCREW, 1 STATION SYSTEM DRAWING

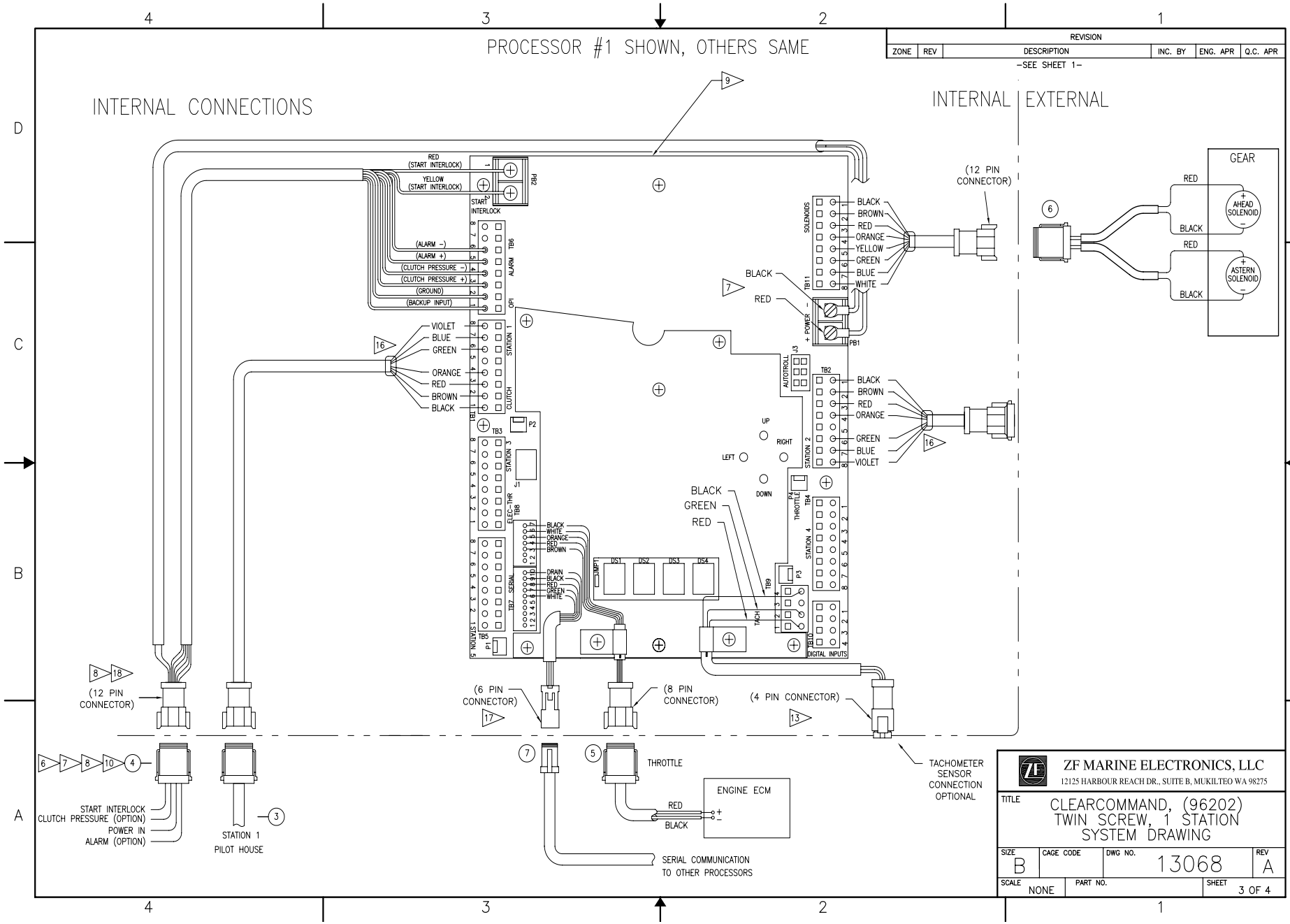
SIZE	CAGE CODE	DWG NO.	REV
B		13068	A

SCALE	PART NO.	SHEET
NONE	–	1 OF 4

Drawing 13068A-2 System Diagram



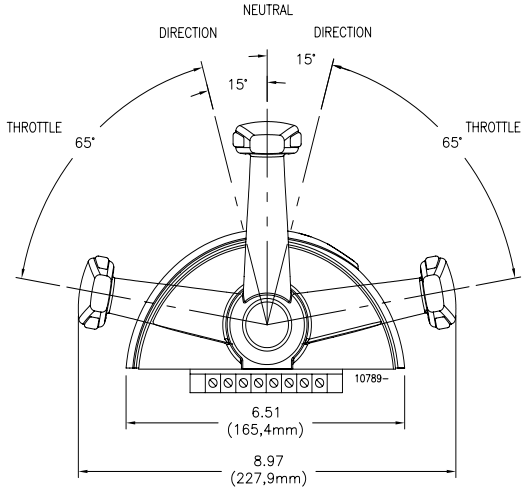
Drawing 13068A-3 Processor Connections



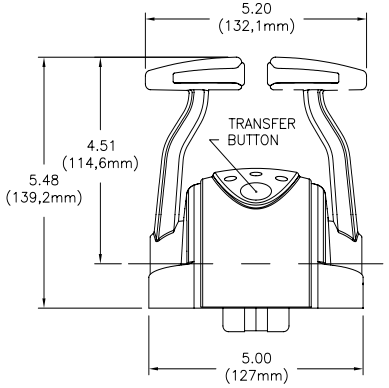
Drawing 13068A-4 Control Head Connections

REVISION					
ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	Q.C. APR
		–SEE SHEET 1–			

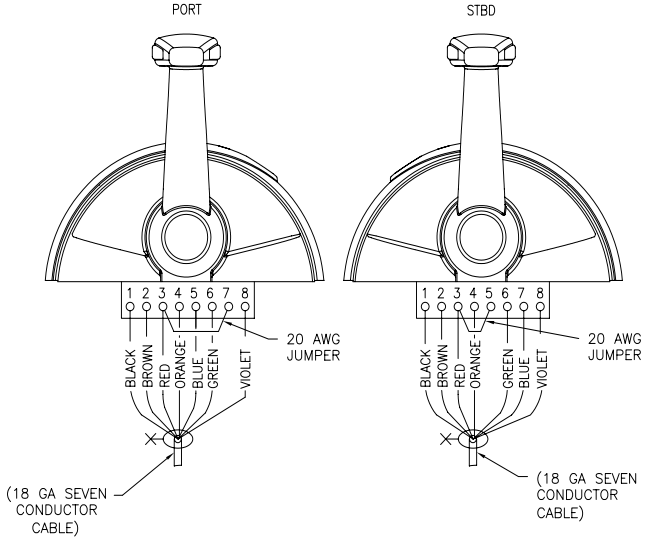
PART NUMBER MC2000–2P
REFERENCE INFORMATION



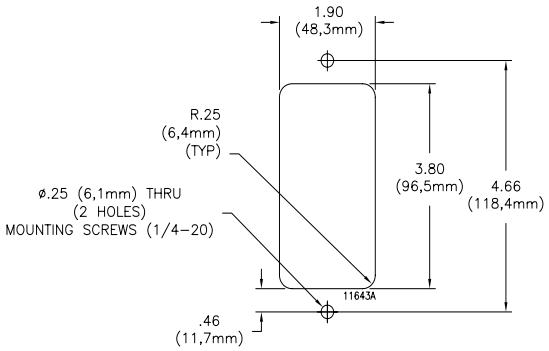
OUTLINE DIMENSIONS



SIDE VIEW



PART NUMBER MC2000–2P CONTROL
HEAD CONNECTIONS



PANEL CUT DIMENSIONS

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE			
CLEARCOMMAND, (96202) TWIN SCREW, 1 STATION SYSTEM DRAWING			
SIZE: B	CAGE CODE	DWG NO.: 13068	REV: A
SCALE: NONE	PART NO.	SHEET: 4 OF 4	