INSTALLATION, OPERATION AND TROUBLESHOOTING

MM14330 - CRUISECOMMAND USER MANUAL

MARINE PROPULSION SYSTEMS

Released by After Sales dept.

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

Table of Contents

Installation, Operation and Troubleshooting Manual
MM14330
SW13867.1F

List of Figures

List of Tables

Revisions List

Rev	Date	Revision Description
A	9/01	Replaced Appendix B SER-165.
B	11/01	Updated formatting, Revised Sections 3.7, 5.7, 6.3, (4.1 to 4.0), 6.3.4, 7.5, 9.1, Revised TRAIN-156
C	2/02	Changes made per ELR 637, ECN 2556, 2574. Revised Section 9.1, Revised Appendix A Parts List, Revised Appendix B SER-165. Changes made per ELR 707 Revised Section 5.4.1, Revised Appendix B TRAIN-156 Changes made per ELR 694. Revised Section 4.1
D	5/02	Revised Section 4.1, Section 5.2.2, 5.2.3, 6.3.18, Revised Appendix A - Deutsch Manufacturers sheet and S-214 APS, Revised Appendix B - SER-165
E	12/02	Added Warm-up Mode Operations Section, Revised Section 5.2.2, Revised Appendix A All forms. Added F-253, Appendix B Troubleshooting: Revised TRAIN-156 and SER-165. Removed TRAIN-157 and TRAIN-158, replacing with MM13927.
F	5/03	SOFTWARE REVISED TO .1, Revised per NCAR 1034
F	11/03	Manual revised to Current Forms. NOTE NEW ADDRESS AND PHONE NUMBERS.
G	3/05	Manual revised to New Company Name, Format, Current Forms, etc.
H	5/06	Updated formatting, ELR 719, ELR 1296, Added Parameter A4 - Neutral Indication Tone, Default Function Values updated per DVP .1ESW
H.1	4/08	Updated all external documents with current revision level
H.2	6/08	Added Appendix D - Addendum with software SW 13867.1F change': Throttle Rate Control (function codes), Speed Boost (function codes), Fixed Neutral Delay Additional Synchronization Options for Function Code E7.
H.3	1/09	Updated all external documents with current revision level
H.4	4/09	Updated all external documents with current revision level
H.5	06/11	Reformatted to FrameMaker9, Updated Software number, Revised preface per ELR00113 and ELR00070, updated all external documents with current revision levels
H.6	02/12	Revised per ELR00157, Added Appendix C per Quality Manager request
H.7	01/13	Name change to ZF Marine Propulsion Systems Miramar, LLC

Preface

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

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 Propulsion Systems Miramar CruiseCommand Control System and it options.

CruiseCommand Processor List

The processors for the systems listed below have software which includes several featured options. Information about these options is contained in this manual, along with all standard instructions for 785CE Processors.

Processor Part Number	Electronic Engine	Solenoid Clutch	Solenoid Troll
785CE	Yes	Yes	Yes

Conventional Symbols Used in the Manual

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

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

CAUTION: Damage to equipment may occur if this message is disregarded.

IMPORTANT: Contains essential Information about a topic.

NOTE: Contains noteworthy information that may help to clarify a topic.

Important Information

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

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

How to Use the Manual

This manual is written describing all possible options available for this processor. Your vessel may not require all of these options. Refer only to the sections that apply to your vessel. If you wish to use one of the available options listed, please contact a technician from ZF Marine Propulsion Systems Miramar Sales & Service Organization (SSO). For more information on an SSO in your area, please see section 12: Appendix B - Sales and Service Information.

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

1 Introduction

This manual is written to document every possible system option. Your system may not include every available option for single or multi-screw reverse reduction gear applications. Only those sections that apply to your specific installation are relevant to your vessel.

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

1.1 Basic Theory of Operation

The CruiseCommand Marine Propulsion Control System will hereafter be referred to as CruiseCommand 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 CruiseCommand commands the vessel's throttle and shift using a single Control Head lever.

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

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

- electronic engine governors
- solenoid activated clutches or clutch/troll

1.2 System Features

1.2.1 Standard Processor Features

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

- Sequencing of Clutch and Engine Speed.
- Station-in-Command indication.
- Up to four Remote Stations.
- Command of up to five screws.
- Single Control Head lever command of speed and direction.
- Integrated Solenoid Trolling Valve Control.
- Start Interlock.
- Push Button Station Transfer.
- Emergency Reversal Protection.
- Warm-up Mode.
- High/Low Idle Selection.
- Engine Synchronization.
- One Lever Mode.

Further information regarding the following features can be found in Section 5 Set Up Procedure.

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

Further information regarding the following feature can be found in section 10 Troubleshooting, 10.4 Troubleshooting Diagnostic Menu.

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

Further information regarding the following features can be found in section 10 Troubleshooting, 10.5 Troubleshooting Audible Tones.

- Audible system diagnostics and status indications.

1.2.2 Optional Processor Features

Further information regarding each optional feature can be found in Section 2 Operation, “Optional Features”.

- System failure external alarm contact.
- Backup Control System
- Clutch pressure interlock.
- Multiple Screw installations.
- Station Expander (SE).

2 Operation

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

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

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.
- Troll:
  - Solenoid: The trolling valve solenoids are commanding lock-up.

2.2 Taking Command

The CruiseCommand Processor has four (4) Remote Station connectors available for pluggable Remote Station Control Head connection. If more Remote Stations are required, refer to section 8.4: Station Expander (SE) - Optional.

To take command at any one of the Remote Stations:

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

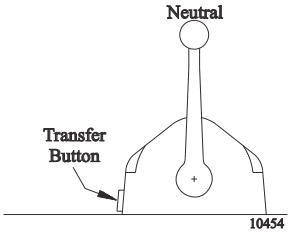


Figure 2-1: Station taking Command

- Depress the transfer button for 1/2 second.

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

	**NOTE: If Start Interlock is used: Once a Station is in command the Start Interlock relay contact will close, allowing the engine to start.**
	**NOTE: Only one Station can have command at a time.**

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

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

2.3 Basic Operation

2.3.1 Normal Operating Mode

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

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

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

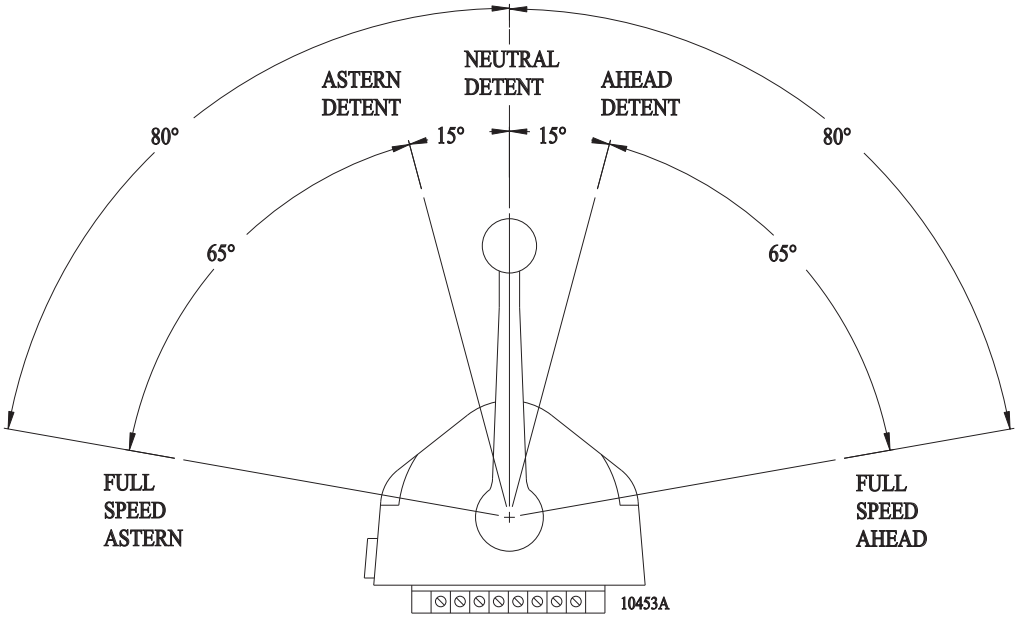


Figure 2-2: Control Head Detents

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

2.3.2 Trolling Valve (optional)

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

This Control System is able to control electric Trolling Valves that utilize single or dual solenoids.

This System has two Modes of Operation when a Troll Valve Type of command has been set up: Troll and Non-Troll.

The Troll Mode option is selected during Set Up. When Troll Mode has been set up, the Control System will initially power up in Non-Troll Mode.

2.3.2.1 Operation in Non-Troll Mode

During Non-Troll Mode the Trolling valve will remain locked up, or at maximum oil pressure position. The System will work in Normal Operating Mode.

2.3.2.2 Operation in Troll Mode

2.3.2.2.1 Turn Troll ON

- Position the Control Head lever (s) in the Neutral, Ahead, or Astern detent.

NOTE: If System is set for Twin Screw or more operation, ensure all Control Head levers are in the same detent.

- Press and hold the transfer button for two (2) seconds.
    - The solid red indicator light on the Control Head will begin blinking rapidly, indicating the system is now in Troll Mode.

2.3.2.2.2 Operation

- Once in Troll Mode, movement of the Control Head's lever(s) to the Ahead or Astern detent, will begin to rotate the propeller at approximately 30% of Idle lock-up RPM.
    - Transmission commands Ahead or Astern;
    - Throttle remains in Idle;
    - Control Head red LED flashing.
- Continued Control Head lever movement through the Troll Range:
    - Will increase the propeller RPM from 30% shaft RPM to approximately 70% shaft RPM;
    - Throttle remains at Idle (or can be adjusted using L4 to increase up to 20% of maximum throttle within this Troll Range).
    - Control Head red LED becomes a steady light when the Control Head lever reaches the end of the Troll Range.
- The remaining movement of the Control Head lever beyond the Troll Range:
    - Clutch locks up;
    - Engine speed increases up to maximum throttle.

2.3.2.2.3 Turn Troll OFF

- Place the Station-in-Command Control Head lever in the Neutral, Ahead, or Astern detent.
- Press and hold the transfer button until the red indicator light on the Control Head changes (approximately 2 seconds) then release the button:
    - When the red indicator light is a steady solid red, the Control system has Troll Mode OFF.
    - Clutch is locked-up.

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.

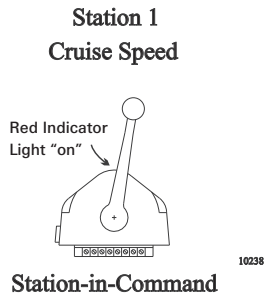
2.5 Station Transfer

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

Command can be transferred as follows:

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

B Place the Control Head's lever(s) of the receiving Station in the Neutral/Idle detent position (refer to Figure 2-3: Remote Stations Before Transfer of Command)



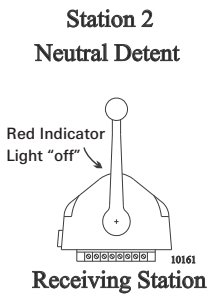
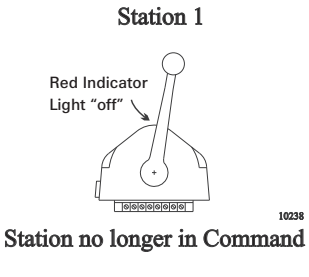


Figure 2-3: Remote Stations Before Transfer of Command



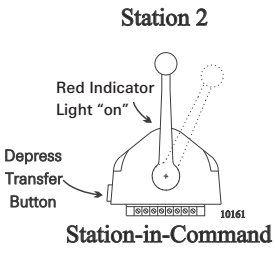


Figure 2-4: Remote Station Transfer after Transfer of Command

C At the Station taking command (Receiving Station), depress and hold the transfer button for 1/2 second (refer to Figure 2-4: Remote Station Transfer after Transfer of Command).

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

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

2.6 Warm-up Mode (Throttle Only Mode)

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

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

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

A At the Station-in-Command, ensure that the Control Head's lever is in the Neutral detent position (refer to Figure 2-5: Control head Warm-Up Mode).

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.

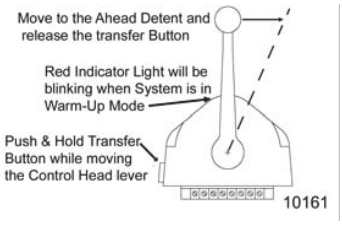


Figure 2-5: Control head Warm-Up Mode

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

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

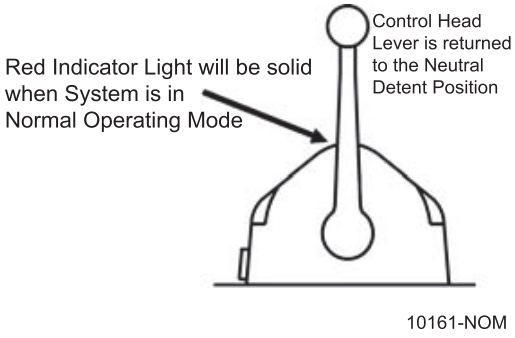


Figure 2-6: Control Head Normal Operating Mode

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

2.7 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.

2.7.1 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.

2.7.2 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.

2.7.3 Selecting Between High and Low Idle

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

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

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

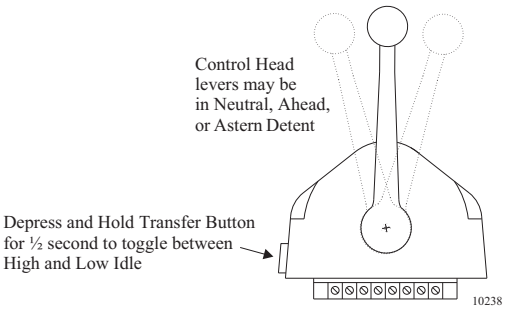


Figure 2-7: High/Low Idle Mode Selection

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

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

2.8 Engine Synchronization

This Feature is not available for Single Screw Applications.

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

The Control System will always power-up with synchronization ON.

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.

2.8.1 Criteria

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

- Both Control Heads must be commanding 5% or greater of the throttle range.
- The commanded throttles are within a 10% window of one another.
- Both Control Head levers are commanding Ahead clutch engagement.

2.8.2 Types

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

2.8.2.1 Equal Throttle Electronic Synchronization (default)

Equal Throttle synchronization simply has the Processors send the same or an equal throttle command signal to the engines when the criteria has been met.

With Equal Throttle Synchronization the Processors do not receive Tachometer signals representative of the Engine's RPM's.

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

2.8.2.2 Active

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

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

2.8.3 Indications

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

- When the green LED is lit steady, the engines are synchronized.
- When the green LED is not lit, the engines are not synchronized and the Control System is not attempting to do so.
- The green LED blinks when the Control system is working toward synchronization.

2.8.4 Turning Synchronization OFF/ON when Criteria is Met

2.8.4.1 Turning OFF:

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

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

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

C Synchronization is now OFF.

2.8.4.2 Turning ON:

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

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

B At the Station-in-Command, press and hold the transfer button until the green LED lights (approximately 2 seconds).

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

2.9 One Lever Mode (Multi Screw)

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

NOTE: The Green LED will always be lit while in One Lever Operation, no matter which 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

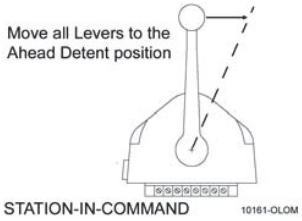


Figure 2-8: (Step A) One Lever Operation Mode

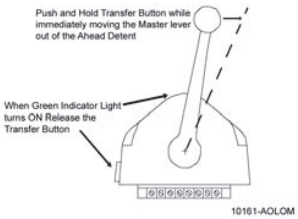


Figure 2-9: (Step B) One Lever Operation Mode

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.

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

2.9.2 Turning OFF One Lever Operation

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

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

A Place the Master lever into the Neutral detent.

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

- Whenever an inactive lever(s) is moved to the Neutral detent, One Lever Operation is turned OFF 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.

2.9.3 Throttle Rate Control

The CruiseCommand Throttle Rate Control applies rate control to the Throttle Command Output. Function Codes are provided to allow the installer to control how fast the Throttle Command Output increases and decreases.

2.9.4 Speed Boost

Speed Boost is a transient increase in the Speed Command output signal from the Processor during clutch engagement. Its purpose is to decrease the possibility of stalling the engine upon clutch engagement or a reversal in direction (e.g. Ahead to Astern). Speed Boost is rarely required and its necessity should be assessed during sea trials.

2.9.5 Fixed Neutral Delay

Fixed Neutral Delay is the amount of time the Processor will command Neutral on every shift from Ahead to Astern or vice versa. This delay is in addition to any Proportional Pause that has accrued. Function Code C8 is used to adjust the duration in seconds of the Fixed Neutral Delay.

2.10 Optional Features

2.10.1 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 - CONTROL OPTIONS.

2.10.2 Auxiliary Backup Control System

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

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

2.10.3 Clutch Pressure Interlock

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

2.10.4 Multiple Screw Installations

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

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

2.10.5 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 Propulsion Systems Miramar Representative for further information.

2.10.6 Additional Synchronization Options

This revision provides the installer additional options for the engine synchronization Function Code E7.

3 Plan the Installation

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

3.1 System Requirements

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

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

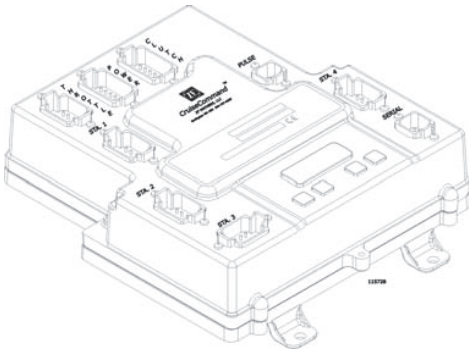


Figure 3-1: 785CE Processor

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/gear sequencing, etc., are all stored on memory within the Processor.

Only when the locations and lengths of wiring/harnesses have been determined, should you start the actual installation. The following sections describe the requirements for installing the components and selecting mounting locations.

3.1.1 Processor(s)

Processors required per engine:

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

Mounting Hardware is installer supplied.

Installation/Troubleshooting Manual is included with the Processor.

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

- The Processor is spray proof, but not water proof. Therefore, an area must be selected that typically stays dry.
- The engine room is the preferred location for mounting the Processor. If the engine room is too small, locate in any area where it is easily accessible, as long as all of the criteria listed are met.
- Bulkhead mounting is the preferred method due to ease of access for wiring and adjustments. However, the Processor can be mounted in any attitude as long as the Display LED window and push buttons are accessible.
- Locate the Processor(s) away from sources of high heat, such as engine exhaust manifolds or turbochargers. Allow 4 feet (1,2m) of clearance or more.

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

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

- Grounding (Bonding) is required for maximum electromagnetic compatibility (EMC) performance. A threaded hole is provided for connection to the vessel's grounding system.

3.1.2 Wire Harnesses

For further information regarding Wire Harness requirements, contact a ZF Marine Propulsion Systems Miramar Representative.

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

Table 3-1: Processor Harness Connector Locations is a general list of Wire Harnesses available for CruiseCommand. Not all of the harnesses may be used on every system. The use of the harness depends on the features being used on the vessel. All Harnesses are available from ZF Marine Propulsion Systems Miramar, LLC.

Station 2, Station 3, Station 4, Pulse, and Serial connectors on the Processor are sealed with plugs at the factory. If the connectors are to be used, remove and discard these plugs. Every connector should either have a Wire Harness or plug. Do not leave a connector empty.

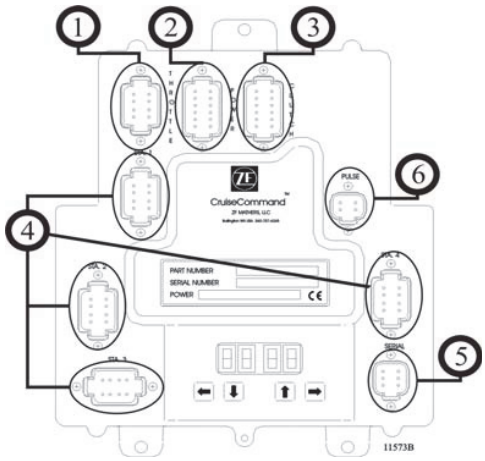


Table 3-1: Processor Harness Connector Locations

No.	Description
1	Throttle Harness
2	Power/Start Interlock/Clutch Pressure (optional)/Alarm Circuit (optional) Harness
3	Clutch Wire Harness or Clutch/Troll Wire Harness (or optional MAN with Troll or MAN without Troll Wire Harness)
4	Control Head Wire Harness
5	Serial Communication Wire Harness (Multi Screw)
6	(Pulse) Tachometer Sensor Wire Harness (Multi Screw using Active Synchronization only)

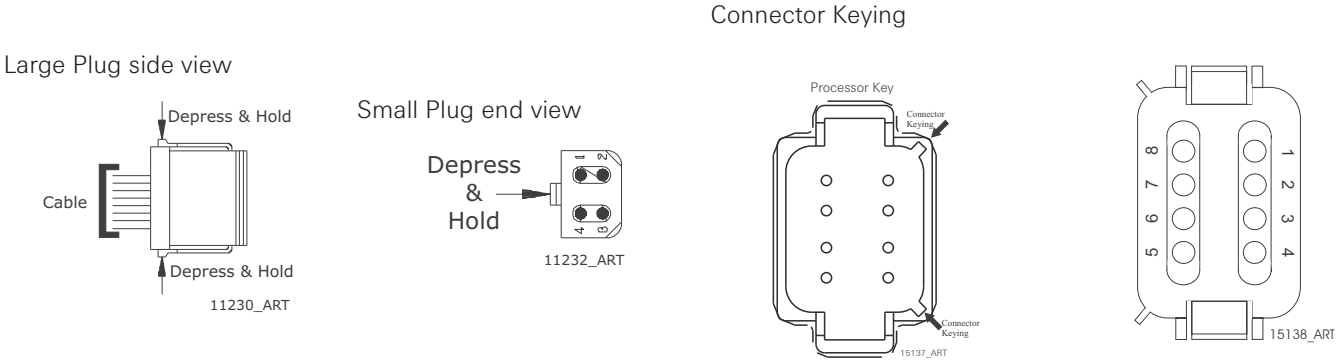


Figure 3-2: Deutsch Plug Connectors

The Harnesses use one or both of the plug connector types detailed in Figure 3-2: Deutsch Plug Connectors.

When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected.

Ensure the harness plug connector is in the appropriate orientation, using the keying on the connectors, before connecting to the Processor.

Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

3.1.3 Control Head Harnesses

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

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

- One Harness required per Processor Power, Start Interlock, Clutch Pressure Switch, Alarm Pigtail.
- The Harness is plugged at the Processor Pigtail end only.
- In addition to the required DC power and Start Interlock, the Harness has options for Clutch Oil Pressure Switch and External Alarm Circuit that are available.
- All of the cables in the Harness are the same length, therefore, order a length that will reach all of the previously mentioned items, if required.
- The Harness is available in lengths up to 30 feet (9,14m) for 12 VDC systems, and up to 60 feet (18,2m) for 24 VDC systems.

3.1.4.1 Serial Communication Harness

The Serial Communication Harness is only required in:

- Multi Screw applications,

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)

3.1.5 Additional Harnesses

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

3.1.5.1 Clutch Harness

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

3.1.5.2 Clutch/Troll Harness

One Harness required per Processor. The Harness consists of:

- 2 two-conductor cables for Ahead and Astern Clutch Solenoids.
- 2 two-conductor cables for Troll ON/OFF and Troll Proportional Solenoids.

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

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

3.1.5.3 Throttle Harness

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

3.1.5.4 Tach Sensor Harness

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

1. An AC Coupled Sensor Harness, which is designed for inputs from items such as Mechanical Senders, Magnetic Pickup Sensors, the Alternator AC Stator Terminal or the negative Coil Terminal.
2. A Harness designed for Active Sensors with an Open Collector output, such as Hall Effect Sensors.

This Harness is only required when Active Synchronization is required.

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

3.2 Tachometer Sensors (optional)

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

3.2.1 AC Coupled Sensors

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

3.2.2 Alternator

- The pre-rectified stator AC terminal may be used as the tach source.
- The signal is inputted to the AC Coupled Sensor input.
- The signal must meet the same criteria as any AC Coupled Sensor Signal (refer to section 3.2.1: AC Coupled Sensors).

3.2.3 Point side of the Coil

- When the signal is sourced from the coil or an electronically produced tach signal (used on some gasoline engines) the signal is connected to the AC Coupled Sensor input.
- The signal must meet the same criteria as any AC Coupled Sensor Signal (refer to section 3.2.1: AC Coupled Sensors).

3.2.4 Active Sensors (Open Collector Output)

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

3.3 Installer Supplied Tools And Parts

3.3.1 Required Tools

Screwdriver – medium Phillips, #2.

Wire cutter, stripper & crimper (Thomas & Betts model WT-2000 or equivalent).

Saw with blade suitable for Console Top Panel.

Drill Motor with 9/32 inch and 7/32 inch drill bits.

Hole saw - 1 inch (25,4mm)

3.3.2 Optional Tools

Calibrated Digital Multimeter (Fluke 80 Series or equivalent).

Service Field Test Unit (P/N 13927, available through ZF Marine Propulsion Systems Miramar)

Field Test Control Head - Dual (P/N 14000)

3.3.3 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.

3.4 DC Power Source

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

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

When using ZF Marine Propulsion Systems Miramar supplied 14 gauge power cable, and in accordance with ABYC Standard E-11, the distance from a 12 volt power source (battery or DC Distribution Panel) shall not exceed 30 feet (9,1m). In 24 volt systems, the maximum cable length is 60 feet (18,2m).

ZF Marine Propulsion Systems Miramar highly recommends using an Automatic Power Selector (APS) and a second power source (battery) to supply power to each Processor. Refer to S-214 Automatic Power Selector Model: 13505 in section 11: Appendix A - System Components and Specifications for examples of power supplies.

Processor Power

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

- The Processor requires a battery source of 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%. Refer to S-214 Automatic Power Selector Model: 13505 in section 11: Appendix A - System Components and Specifications.

  Contact a ZF Marine Propulsion Systems Miramar representative for the Processor's power cable(s) maximum lengths. Refer to S-214 Automatic Power Selector Model: 13505 in section 11: Appendix A - System Components and Specifications for examples of the various wiring options. Ultimately, it is the boat builder or installer's responsibility to ensure that the vessel's wiring meets the requirements of American Boating & Yachting Council standard E-11, for AC and DC Electrical Systems on Boats.

3.4.1 Clutch Power

The power for the Clutch Solenoids may come from the same or different power source as Processor power if isolation is required. The Clutch Power Supply cable and the Processor DC Power Supply cables may come from the same 10 amp circuit breaker or in the case of isolated power, from two separate 5 amp circuit breakers. Refer to section 14: Appendix D - System Drawings for actual requirements.

4 Installation

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

	NOTE: When connecting the plugs, ensure that the release buttons are depressed and held until plug is fully connected. To disconnect the plugs, the release buttons MUST be held depressed until plug is disconnected.

	NOTE: When installing the harness cable, support the cables using clamps or straps not more than 18 inches (0,5m) apart, unless contained in a conduit. Install each cable so it is protected from physical damage. Refer to ABYC Standard.

4.1 Processor

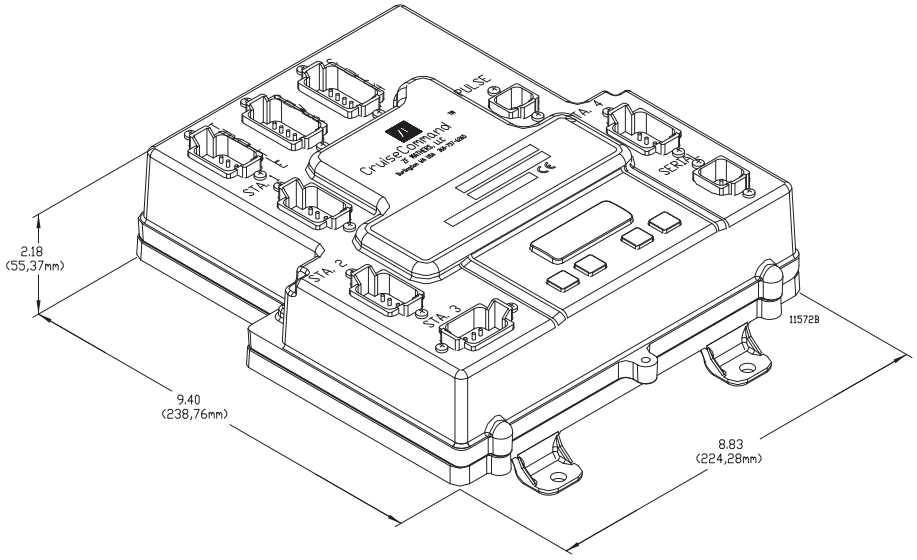


Figure 4-1: 785CE Processor Dimensions

A Place the Processor on the mounting surface and mark the three (3) screw holes.

B Remove Processor and drill the screw holes.

C Secure the Processor to the mounting surface with three 1/4 inch or M6 fasteners.

D Connect the Processor to the Hull or Grounding Bus by running a 12 AWG or larger wire between the Processor's threaded grounding hole and the Grounding Bus. (The Processor is grounded if mounted directly to a metallic surface that is connected to a metal hull) (Refer to MMC-287 Grounding (Bonding))

4.2 Control Head(s)

4.2.1 400, MC2000 and 700 Series Control Heads

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

NOTE: The one connector Control Head harness requires a modification at the Control Head connections. Refer to section 11: Appendix A - System Components and Specifications - Control Head Sheet's 7-conductor Control Head connections.

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

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

4.3.1 Harness Plug Insertion and Extraction

A Prior to inserting the Harness plug, pay close attention to the number of pins and the keying of the plug. The plug is designed to be inserted one way only into the connector, but can be incorrectly forced together in the opposite orientation.

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

4.3.2 Control Head Harnesses

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

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

IMPORTANT: The distance of the Control Head from the Processor is limited to the length of an UNINTERRUPTED Harness. This cable should NEVER be spliced.

NOTE: Multi Screw, Control Heads must be connected to the same numbered Station on all Processors.

4.3.2.1 Control Head Harness with Two Connectors

A At the Port Processor, insert the plug into the **STATION 1** connector.

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

C Insert the Harness 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 the rest of the Remote Stations.

NOTE: 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.

4.3.2.2 Control Head Harness with One Plug

A At the Port Processor, insert the plug into the **STATION 1** connector.
B Run the cable to the Port side of the Control Head located at Station 1.
C Connect the conductors to the Control Head as described in the appropriate Control Head Dimensions and Variations Service Sheet in section 11: Appendix A - System Components and Specifications.
D Provide a strain relief in close proximity to the Control Head's terminal block.
E Repeat Steps A) thru D) for the Starboard Processor.
F Repeat steps A) thru E) with the rest of the Remote Stations.

NOTE: When Stations 3, 4 and 5 are to be installed, they each require the removal of the watertight seal located on the Processor enclosure in the Station cable entry holes.

4.3.3 Standard Power / Start Interlock / Alarm (optional) / Clutch Pressure Switch (optional) 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).

This Harness has one plug, which is inserted in the Processor's **POWER** connector.

CAUTION: The most common source of trouble is loose wiring connections.

- **Verify wiring connectors are properly crimped and cannot be pulled out.**
- **Crimps and connections must be made to conductor wire, NOT to the wire insulation.**
- **Verify all screwed wire connections are secure.**

Continue with the following Sections that apply to this application.

4.3.3.1 DC Power Cable

WARNING: When connecting the Power Harness to the Processor, be sure the power is OFF

It is critical to design and wire the Control system in a manner which provides the cleanest power source possible. This can be accomplished by providing two power sources, along with an APS. The preferred system is a dedicated circuit with no other accessories or functions. (Refer to S-214 Automatic Power Selector Model: 13505 in section 11: Appendix A - System Components and Specifications)

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

4.3.3.2 Start Interlock Cable

CAUTION: The Processor is designed for a maximum of 5 amperes, maximum 50 volt, start signal current. Greater current will damage the interlock circuit.

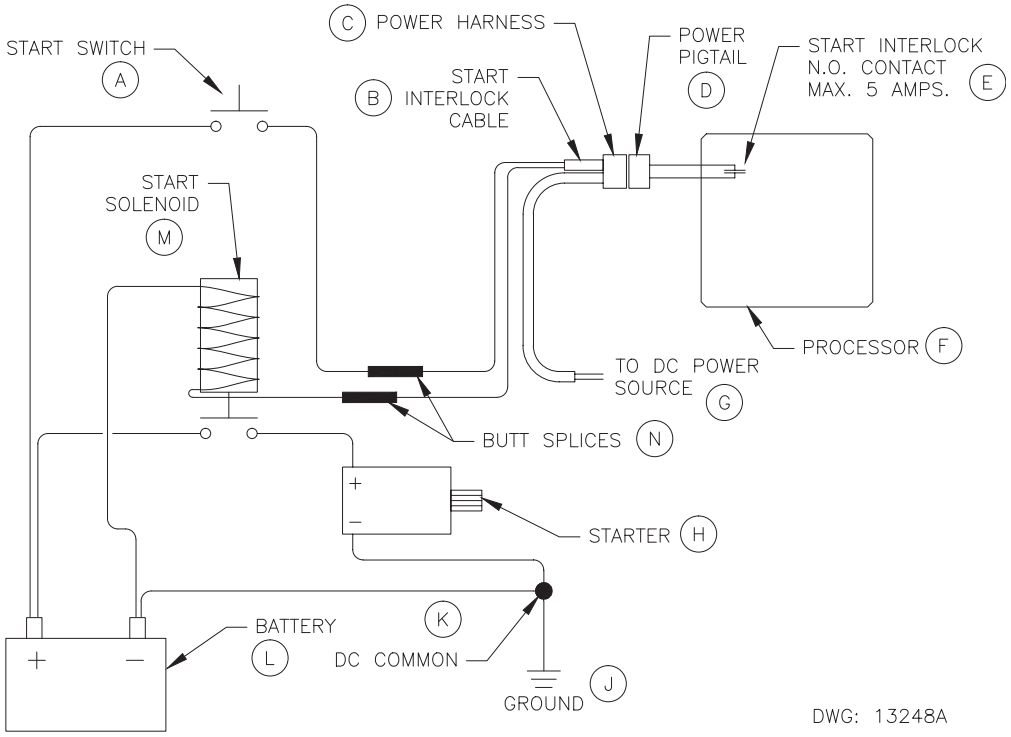


Figure 4-2: Start Interlock Connections

A Run the cable labeled **START INTERLOCK** 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.

4.3.3.3 External Alarm Circuit (optional)

Refer to section 8: Control Options for installation information.

4.3.3.4 Clutch Pressure Switch (optional)

Refer to section 8: Control Options for installation information.

4.3.4 Serial Communication Harness (Multi Screw)

Not required for Single Screw applications.

The CruiseCommand System's default method of synchronization is "Equal Throttle". With this type of synchronization the Processors ensure that the SAME or an EQUAL Throttle Command Signal is applied to both governors when the Synchronization Criteria has been met. Though this is not "true" Synchronization, in most cases it is very effective.

If “true” Synchronization is required, or requested, “Active” Synchronization would need to be selected during SET UP. “Active” Synchronization requires a tachometer signal representative of each engines’ RPM. The frequency of these signals are measured and changes to the Processor’s throttle command signal outputs are made until all engines are running at the same RPM.

4.3.4.1 Twin Screw Serial Communication (Required for both Synchronization Types)

A At the Processors, remove the watertight plug-in cap from the **SERIAL** connector and discard.
B At the Port Processor, insert the Serial harness’s plug into the **SERIAL** connector.
C Run the harness to the Starboard Processor.
D Insert the plug into the Starboard Processor’s **SERIAL** connector.
E Secure the Serial Harness at least every 18 in. (45,72 cm).

4.3.4.2 Tachometer Sensor (Required for Active Synchronization Only)

A At the Processors, remove the watertight plug-in cap from the **PULSE** connector and discard.
B At the Port Processor, insert the Tach Sensor harness’s plug into the **PULSE** connector.
C Run the Port Tach Sensor Harness cable to the Tach signal source of the Port engine.
D Connect the conductors to the Port Tach source as indicated by the Engine Manufacturer’s documentation. Keep in mind that some sources are polarity sensitive. (black wire - negative, red wire - positive)
E Repeat B) through D) for the Starboard side.

4.3.5 Additional Harnesses

4.3.5.1 Throttle Harness

IMPORTANT: Ensure all Processors are using the same kind of Wire Harness and that it matches the Engine Selection to be applied in Section 5 - SET UP PROCEDURES.

The Processor connects directly to the engine interface using a Throttle Wire Harness.

A Connect the plug end of the Harness into the **THROTTLE** connector at the Processor.
B Run the cable to the appropriate engine interface. (Example: Port to Port, etc.)
C Refer to the engine documentation for termination points at the engine interface.
D Repeat steps A) thru C) on all Processors.

4.3.5.2 Clutch Harness

The Clutch Harness is supplied with three (3) or four (4) cables extending from the plug. One cable is supplied for each of the following:

- Ahead Clutch solenoid
- Astern Clutch solenoid
- Power
- Neutral Clutch solenoid (optional)

A Insert the Clutch Harness plug into the **CLUTCH** connector on the Processor. (Example: Port to Port, etc.)
B Run all the cables, except the one labeled **POWER,** to the appropriate transmission.
C Refer to the Transmission documentation for termination at the solenoids.

4.3.5.3 Clutch/Troll Harness

The Clutch/Troll Harness is supplied with three (3) or more of the following cables:

- Ahead Clutch solenoid (Refer to section 10.11.1.4: Clutch Wire Harnesses)
- Astern Clutch solenoid (Refer to section 10.11.1.4: Clutch Wire Harnesses)
- Power (Refer to section 10.11.1.4: Clutch Wire Harnesses)

- Neutral Clutch solenoid (optional) (Refer to section 10.11.1.4: Clutch Wire Harnesses)
- Troll Command solenoid
- Troll ON/OFF solenoid

A Insert the Clutch/Troll Harness plug into the **CLUTCH** connector on the Processor.

B Run all the cables, except the one labeled **POWER,** to the appropriate transmission.

C Refer to the Transmission documentation for termination at the solenoids.

4.4 Engine Stop Switches

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

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

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

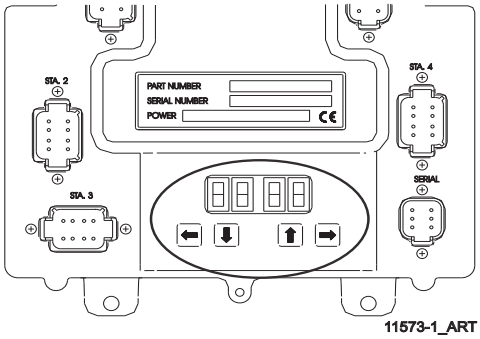


Figure 5-1: Processor Display LED and Arrow Push Buttons

Each Processor has a Display LED and Arrow Push Buttons located on the front cover. (Figure 5-1: Processor Display LED and Arrow Push Buttons)

- The Display LED is to view the Function Codes and Values. It consists of four 7-segment display pads.
- The Arrow Push Buttons are used to scroll through and select the Function Codes, and set the Values.

5.1.1 Processor Display LED

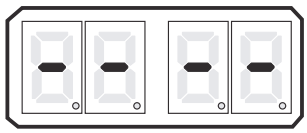


Figure 5-2: Display LED at Normal Operation

- The Processor's Display LED has four 7-segment LED's, which light up to show either letters or numbers.
- The Display LED during Normal operation has running red center dash lines (Figure 5-2: Display LED at Normal Operation)
- The first two digit Display LED's to the left, indicate the Function Code, which is alphanumeric.

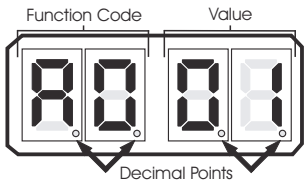


Figure 5-3: Display LED Designations

- The second two digit Display LED's indicate the numeric Value that is currently programmed into the Processor for the Function Code displayed to the left.
- A decimal point indicator is located on the bottom right corner of each Display LED. (Figure 5-3: Display LED Designations)

5.1.2 Push Buttons

There are four Push Buttons with arrows located below the Display LED on the Processor cover. These push buttons are used to scroll through, select, and store the Functions and Values. The direction of the arrow indicates “Left”, “Down”, “Up”, and “Right”. See Figure 5-1: Processor Display LED and Arrow Push Buttons.

5.1.2.1 “Up” and “Down” Push Buttons

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

- Stops Normal Operation Display (running red center dash lines) and activates the Function Menu.
- While in the Function Menu, scrolls through the Function Codes one at a time.
- When in Set Up Mode, increases (Up) or decreases (Down) the Function Value one digit at a time.
- When an Error Code is displayed, scrolls through the error messages one at a time.

NOTE: Refer to section 10.7: Troubleshooting Error Codes for steps to be taken for Error Messages.

5.1.2.2 “Left” and “Right” Push Buttons

Pressing and *holding* the “Left” and “Right” Push Buttons *at the same time* has the following functions:

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

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 Function Value stored in memory. (Operator must *hold* the button down until function code stops blinking, then *release*.) The previously saved Function Value will then be displayed.

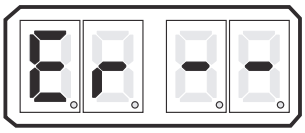


Figure 5-4: Error Menu Example

- 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 function:

- While in the Error Menu, clears inactive errors. (Active errors blink, inactive do not)

Pressing and *holding* the "Right" Push Button has the following function:

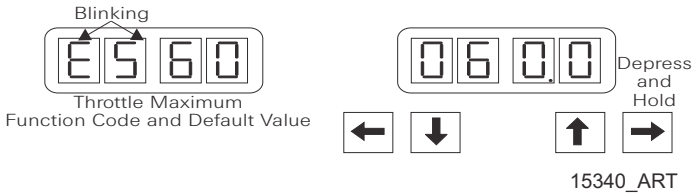


Figure 5-5: Display LED Four Digit Value

- While in Set Up Mode, or Function Menu, allows the Function Value of the current Function Code to be displayed with all four Display LEDs.

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" Arrow Push Button *once*. 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 running red center dash lines.

B Depressing either the "Up" or "Down" Arrow Push Button will ACTIVATE the Function Menu.

C Depressing the "Up" or "Down" Arrow Push Button will SCROLL through the Function Menu Function Codes, one at a time.

D Once the desired Function Code is visible on the Display LED, press and *hold* the "Left" and "Right" Arrow Push Buttons *at the same time*, until the Function Code begins to blink. This will activate Set Up Mode.

E Depressing the "Up" Arrow Push Button will INCREASE the Value of the Function, while pressing the "Down" Arrow Push Button will DECREASE the Value of the Function. (Pressing and *holding* the "Up" or "Down" Arrow Push Button will INCREASE or DECREASE the Function 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 "Left" and "Right" Arrow push buttons 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" Arrow Push Button until the next required Function Code is reached.

C Reactivate Set Up Mode. Refer to section 5.2: Activating Set Up Mode.

NOTE: If no Push Buttons are pressed for five (5) minutes, the selected Mode of operation is automatically exited and the System returns to Normal Operating Mode. If no Push Buttons are pressed for five (5) minutes while in Set Up Mode, it will be exited without the changes stored to memory

5.4 Function Codes And Values

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

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

Once these parameters are set, either cycle power to the Processors or wait five (5) minutes, before continuing set up.

CAUTION: If ZF Hurth Gears are used, set the L1 parameter as the next setting AFTER the A1 and A0 parameters have been set.

NOTE: Once these parameters are set, either cycle power to the Processors or wait five (5) minutes, before continuing set up.

Table 5-1: Processor Function Codes

Function Code	Function Name	Default Value	Value Range or Options
A0	Processor Identification	01	01, 02, 03, 04, 05
SET FUNCTION A0 AFTER THE A1 FUNCTION CODE HAS BEEN SET. Each Processor MUST have a unique Processor ID #.			
A1	Number of Engines	01	01, 02, 03, 04, 05
MULTI SCREW: The A1 Function Code is the FIRST (1ST) Parameter Set. Then set A0.			
	**IMPORTANT: If ZF Hurth Gears are used, set the L1 parameter after A1 and A0.**		
A2	One Lever Operation	00	00 - Disabled; 01 - Enabled
A3	Station Expander	00	00 - Disabled; 01 - Enabled
A4	Neutral Indication Tone	00	00 - No Tone 01 - Tone upon Control Head engaging Neutral 02 - Tone upon Transmission shifting to Neutral

Table 5-2: Electric Throttle Function Codes

Function Code	Function Name	Default Value	Value Range or Options
E0	Engine Throttle Profile	06	01 - Caterpillar (PWM) (8 to 92%) 02 - Cummins Centry (Voltage)(0.9 to 4.5 VDC) 03 - Cummins Quantum (Voltage)(0.9 to 1.2- 4.0 VDC) 04 - Detroit Diesel (Voltage) (0.64 to 4.65 VDC) 05 - MTU or MAN (Current) (4.0 to 20.0 mA) 06 - Scania (Voltage) (0.42 to 2.95 VDC) 07 - John Deere (Voltage) (0.5 to 4.5 VDC) 08 - Volvo (Voltage) (0.6 to 3.6 VDC) 09 - Detroit Diesel 1800 (Frequency)(120.64 to 360.9 Hz) 10 - Detroit Diesel 2300 (Frequency) (120.64 to 463.5 Hz)
** DEFAULT BASED ON THROTTLE PROFILE SELECTED.			
E1	Throttle in Neutral	**	01.0% to 25.0% of Throttle Range [Throttle Range = Throttle Max (E3) - Throttle Min (E2)
E2	Throttle Minimum	**	1.0% to 97.0% Must be 3% or more below Throttle Maximum (E3)
E3	Throttle Maximum	**	04.0% to 100.0% of Maximum Throttle Allowable. Must be 3% or more above Throttle Minimum (E2)
E4	Throttle Maximum Astern	100.0	01.0 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 Maximum (E3).
E7	Active Synchronization	00.	00 – Disabled 01 - Enabled

Table 5-3: Clutch Function Codes

Function Code	Function Name	Default Value	Value Range or Options
C0	Clutch Pressure Interlock	00	00 – Not Installed 01 – Installed 02 – Throttle Clutch Pressure Interlock Mode
C1	Clutch Interlock Delay	01.0	00.5 to 10.0 Seconds
C2	Proportional (Reversal) Pause	00	00 – In-Gear; 01 – Neutral
C3	Proportional (Reversal) Pause Time	03	00 to 99 Seconds
C4	Proportional (Reversal) Pause Ratio	00	00 – 2:1 Ahead to Astern vs. Astern to Ahead 01 – 1:1 Ahead to Astern vs. Astern to Ahead
C8	Fixed Neutral Delay	00.0	00.0 to 6.0 Seconds (In addition to any Proportional Delay)

Table 5-4: Trolling Valve Function Codes

Function Code	Function Name	Default Value	Value Range or Options
L0	Troll Enable and Control Head Troll Lever Range	00	00 – No Troll 01 – 20 Degrees- Type 1 02 – 35 Degrees- Type 2 03 – 45 Degrees- Type 3 (Throttle limited to 75% of Throttle Range)
The following L1 parameter MUST be the THIRD Function set if ZF Hurth Gears are used.			
L1	Troll Valve Function (solenoid)	00	00 - Normal, (No Current when at Lock-up) 01 - Inverse (No Current when at Lock-up) 02 - Normal (Maximum Current when at Lock-up) Preset for ZF220-550, 12VDC Systems. 03 - Normal (No Current when at Lock-up) Preset for ZF220-550, 24VDC Systems. 04 - Normal (No Current when at Lock-up) Preset for ZF2000, 24 VDC Systems. 05 - Inverse (No Current when at Lock-up) Preset for ZF600, 1900 and 2500, 24VDC Systems. 06 - Preset for 12VDC ZF Hurth Systems with two (2) proportional solenoids. 07 - Preset for 24VDC ZF Hurth Systems with two (2) proportional solenoids
L2	Troll Minimum Pressure	10.0	01.0 to 99.0% Must be at least 1% more or less Troll Maximum (L3) [DEPENDING on whether Normal or Inverse is selected].
L3	Troll Maximum Pressure	10.0	02.0% to 100.0% Must be at least 1% more or less than Troll Minimum. (L2) [DEPENDING on whether Normal or Inverse is selected].
L4	Troll Throttle Limit	00	00 to 20% of Troll Maximum (L3)
L5	Troll Pulse Duration	00	00.0 to 09.9 Seconds.
L6	Troll Pulse Percentage	25.0	00.0 to 100.0%
L7	Lock Up Percentage (Hurth Only)	45 (L106) 60 (L107)	00.0 to 100.0% Used only when L106 or L107 is selected.

Table 5-5: Troubleshooting Function Codes

Function Code	Function Name	Default Value	Value Range or Options
H0	Diagnostic	none	Input Voltage (+/- 0.5VDC) Tachometer Sensor Frequency Lever A/D, Stations 1, 2, 3, & 4 Transfer Button, Stations 1, 2, 3, & 4 Software Revision Level
H1	Erase EPROM	none	Return to Factory Defaults (For Authorized Personnel Only)

Table 5-5: Troubleshooting Function Codes

Function Code	Function Name	Default Value	Value Range or Options
H2	Driver Fault Detection Enable	Allows the Processor to monitor the clutch or clutch/troll solenoids.	H2

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

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

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

Table 5-6: Electric Throttle Functions requiring Field Service Test Unit and Multimeter

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

Table 5-7: Solenoid Trolling Functions requiring Field Service Test Unit and Multimeter

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

5.6 System Programming And Adjustments

NOTE: <u>SINGLE SCREW APPLICATIONS</u>: The Function Values may be entered and stored in any order.
<u>TWIN SCREW APPLICATIONS:</u> 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.
<u>IF ZF HURTH GEARS ARE USED</u>: Set L1 Function after the A1 and A0 Functions are set.

Once the above Functions are set, either cycle power to the Processors or wait five (5) minutes, before continuing Set Up Procedures.

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 five (5) minutes to become ACTIVE. The Functions affected by this are the functions that rely on Serial Communication, such as A0, A1, A2, A3, E7, and L0. Cycling power OFF, then ON, expedites these features making the Functions available immediately.

5.6.1 (A) Processor Functions

5.6.1.1 (A1) Number of Engines)

	NOTE: If Processors are not connected by a serial communication cable, leave the A1 Function Code at Default Value 01.

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

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

The available Values for this Function are:

01 Single Screw (Default Value)

02 Twin Screw

03 Triple Screw (if required, contact a ZF Marine Propulsion Systems Miramar Technician.)

04 Quad Screw (if required, contact a ZF Marine Propulsion Systems Miramar Technician.)

05 Quint Screw (if required, contact a ZF Marine Propulsion Systems Miramar Technician).

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

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

A Scroll to Function Code A1.

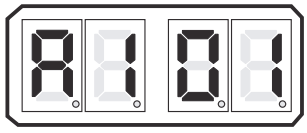


Figure 5-6: Display LED A1

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

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

5.6.1.2 (A0) Processor Identification

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

The available Values for this Function are:

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

A Scroll to Function Code A0.

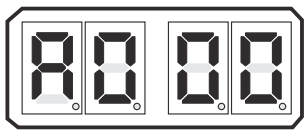


Figure 5-7: Display LED A0

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.
D Store the Value to memory.
E Repeat on all Processors BEFORE proceeding to the next Function.

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

NOTE: If ZF Hurth Gears are used, set the L1 parameter next.

5.6.1.3 (A2) One Lever Operation

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

In Multi Screw applications, the System has the ability to command all engines and transmissions to the same speed and direction with a single Control Head lever. This Function allows this Feature to be enabled or disabled. (Refer to section 2: Operation for operating instructions)

The available Values for this Function are:

00 Disabled

01 Enabled (Default Value)

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

A Scroll to Function Code A2.

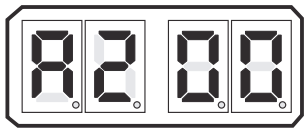


Figure 5-8: Display LED Function A2

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

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

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

The SE is a separate unit, which gives the System the ability to increase the number of Remote Stations, if more than five Remote Stations are required. (Refer to MMC-343 Station Expander User Instructions for further information)
The available Values for this Function are:

00 Disabled (Default Value)

01 Enabled

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

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

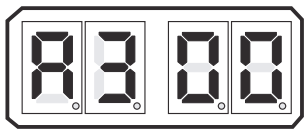


Figure 5-9: Display LED Function A3 Set Up Activated

5.6.1.5 Function Code A4 – Neutral Indication Tone

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

The available Values for this Function are:

00 Disabled (Default Value)

01 Tone sounds when the Control Head's lever reaches Neutral.

02 Tone sounds when the Processor commands the Transmission to Neutral.

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

A Scroll to Function Code A4.

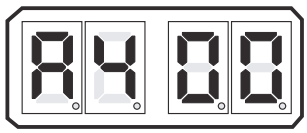


Figure 5-10: Display LED Function A4

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

5.6.2 Throttle Functions

The following Throttle Functions are set up in Section 6 - DOCK TRIALS:

Table 5-8: Throttle Functions Performed during Dock Trials

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

5.6.2.1 (E0) Electric Engine Throttle Profile

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

01 - Caterpillar (PWM) (8 to 92%)

02 - Cummins Centry (Voltage) (0.9 to 4.5 VDC)

03 - Cummins Quantum (Voltage) (0.9 to 1.2 - 4.0 VDC)

04 - Detroit Diesel (Voltage) (0.64 to 4.65 VDC)

05 - MTU or MAN (Current) (4.0 to 20.0 mA)

06 - Scania (Voltage (0.42 to 2.95 VDC) (DEFAULT)

07 - John Deere (Voltage) (0.5 to 4.5 VDC)

08 - Volvo (Voltage) (0.6 to 3.6 VDC)

09 - Detroit Diesel (Frequency) (120.64 to 360.9 Hz)

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

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

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

A Scroll to Function Code E0.

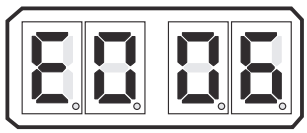


Figure 5-11: Display LED E0 - Electronic

B Activate Set Up Mode.

C Scroll Up or Down until the desired Value is displayed.

D Store the Value to memory.

Function Code E7 – Active Synchronization

This Function Code selects the type of Synchronization. The types are described in section 2: Operation.

The available Values for this Function are:

00 Disabled (DEFAULT)

01 Enabled

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

A Scroll to Function Code E7.

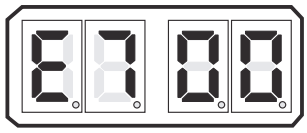


Figure 5-12: Display LED Function E7

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

5.6.3 Clutch Functions

The following Clutch Functions are set up in section 7: Sea Trials:

Table 5-9: Basic Clutch Functions Performed during Sea Trials

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

5.6.3.1 (C0) Clutch Pressure Interlock

IMPORTANT: 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: Control Options, for detailed information.

The available Values for this Function are:

00 Not Installed (Default Value)

01 Installed

02 Throttle Clutch Pressure Interlock Mode

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

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

A Scroll to Function Code C0.

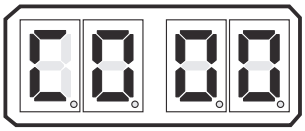


Figure 5-13: Display LED C0

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

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

5.6.3.2 (C1) Clutch Interlock Delay

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

This Function works together with Function Code C0. Refer to section 8: Control Options, for further information.

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

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

A Scroll to Function Code C1.

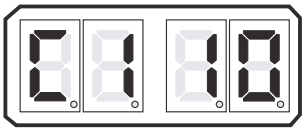


Figure 5-14: Display LED C1

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

5.6.3.3 Function Code C4 – Proportional Pause Ratio

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

00 - 2:1 Ratio

- This is the default setting. This function determines how the value set during Sea Trials for C3 - Proportional Pause Time, is applied.
- The number of seconds selected is for an Ahead to Astern maneuver only. An Astern to Ahead maneuver will be one-half of the C3 -Proportional 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 during Sea Trials for C3 - Proportional Pause Time is the same for both Ahead to Astern, as with Astern to Ahead maneuvers.
- This may be selected when the vessel reaches the same water speed in both directions, as would be the case with a Double Ended Ferry. Another application where this option may be selected would be the control of a Bow or Stern Thruster.

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

A Scroll to Function Code C4.

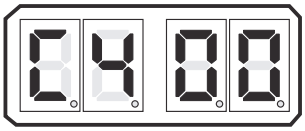


Figure 5-15: Display LED Function C4

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

5.6.4 Troll Functions

The following Troll Function is set up during Dock Trials for ZF Hurth Transmissions only. Refer to section 6: Dock Trials:

Table 5-10: Troll Function Performed during Dock Trials

Code	Function Name
L7	Lock Up Percentage (ZF Hurth Only)

The following Troll Functions are set up during Sea Trials. Refer to section 7: Sea Trials:

Table 5-11: Troll Functions Performed during Sea Trials

Code	Function Name		Code	Function Name
L2	Troll Minimum Pressure		L5	Troll Pulse Duration
L3	Troll Maximum Pressure		L6	Troll Pulse Percentage
L4	Troll Throttle Limit			

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

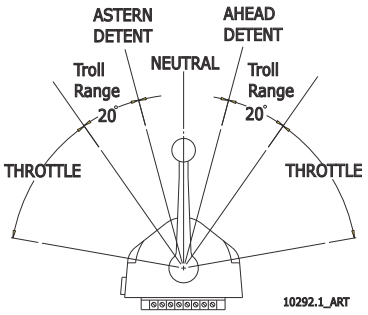
5.6.4.1 (L0) Troll Enable and Control Head Lever Troll Range

There are three types which can be used to control any trolling valve. The available Values are:

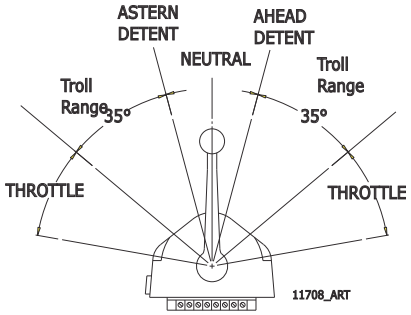
00 = No Trolling Valve (Normal Operating Mode) DEFAULT
01 = Type 1 20 degrees Troll Range
02 = Type 2 35 degrees Troll Range
03 = Type 3 45 degrees Troll Range

NOTE: When Troll Type 3 is selected, maximum throttle is limited to 75%

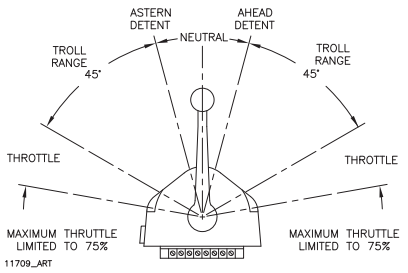
20 Degree Troll Range - Type 1



35 Degree Troll Range - Type 2



45 Degree Troll Range - Type 3



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

A Scroll to Function Code L0.

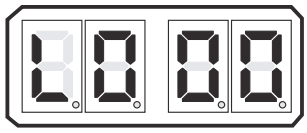


Figure 5-16: Display LED L0

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory

5.6.4.2 (L1) Solenoid Troll Valve Function

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

Refer to Table 5-12: (L1) Solenoid Trolling Valve Type Selection to select the correct set up for the trolling valve used with this application. The manner in which the current signal to the Proportional Valve behaves, is determined with this function.

provide satisfactory operation may differ slightly from those listed.

Table 5-12: (L1) Solenoid Trolling Valve Type Selection

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

Table 5-12: (L1) Solenoid Trolling Valve Type Selection

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

Table 5-13: Troll Valve Typical Current/Pressure Requirements for some ZF Gears

Model #	Current (Min)	Current (Max)	Pressure (Min)	Pressure (Max)	Comments
ZF 25- 80 [Old Style with two (2) proportional solenoids]	12VDC - 900 mA. 24VDC - 450 mA	12VDC - 1260 mA. 24VDC - 630 mA.	1 Bar (15 PSI)	8 Bar (116 PSI)	Main shift control valve is proportional. The Min & Max Troll currents listed are at lock-up. Exceeding the Max current may damage the solenoid. Current below the Min listed may damage the clutch pack when the engine rpm exceeds 1000.
ZF 25- 80 [New Style with two (2) On/Off and one (1) proportional solenoid]	12VDC - 200 mA. 24VDC - 100 mA.	12VDC - 300 mA. 24VDC - 150 mA.	1 Bar (15 PSI)	8 Bar (116 PSI)	One variable current control valve in addition to Ahead & Astern solenoids. Increased current equals increased pressure
ZF90- 110TS, 220- 311, 220A, 325, 350, 550 & 665	200 mA.	300 mA.	1 Bar (15 PSI)	4 Bar (58 PSI)	One variable current control valve in addition to Ahead & Astern solenoids. Increased current equals increased pressure.
ZF600, 1900	160 mA.	350 mA	1 Bar (15 PSI)	6 Bar (87 PSI)	Two Solenoids in addition to Ahead & Astern solenoids; one On/ Off, one variable current control valve. Increased current equals decreased pressure. The ZF1900 Gear may also be ordered with Autotroll, which is supported by System 9000 Series Processors. Contact your ZF Representative for information.
ZF2000	150 mA	300 mA.	1 Bar (15 PSI)	4 Bar (58 PSI)	Two Solenoids in addition to Ahead & Astern solenoids; one On/ Off, one variable current control valve. Increased current equals increased pressure
ZF2500	175 mA	350 mA	1 Bar (15 PSI)	6 Bar (87 PSI)	Two Solenoids in addition to Ahead & Astern solenoids; one On/ Off, one variable current control valve. Increased current equals decreased pressure. The ZF2500 Gear may also be ordered with Autotroll, which is supported by System 9000 Series Processors. Contact your ZF Representative for information.
ZF4500- 7500	n/a	n/a	n/a	n/a	These series of Gears are available with Autotroll only and are supported by System 9000 Series Processors. Contact your ZF Representative for information.

To change the Value (Refer to section Table 5-2:: Electric Throttle Function Codes and section Table 5-3:: Clutch Function Codes):

The default value is 00.

A Scroll to Function Code L1.

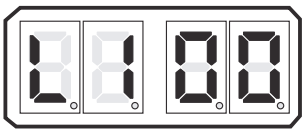


Figure 5-17: Display LED Function L1

B Activate Set Up Mode.

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

D Store the Value to memory

5.6.5 Troubleshooting Functions

5.6.5.1 (H0) Diagnostics

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

5.6.5.2 (H1) Return to Factory Defaults

This Function may be used during troubleshooting.

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

5.6.5.3 Solenoid Troubleshooting Functions

5.6.5.3.1 (H2) Driver Fault Detection Enable

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

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

Table 5-14: Solenoid Error Status Enable lists the required value that needs to be entered for Function Code H2, to monitor the Ahead, Astern, Neutral clutch solenoids and the Troll Command and Troll On/Off.

Table 5-14: Solenoid Error Status Enable

Value	Ahead	Astern	Neutral (optional)	Troll Command	Troll On/Off	Value	Ahead	Astern	Neutral (optional)	Troll Command	Troll On/Off
00	off	off	off	off	off	16	off	off	off	off	ON
01	ON	off	off	off	off	17	ON	off	off	off	ON
02	off	ON	off	off	off	18	off	ON	off	off	ON
03	ON	ON	off	off	off	19	ON	ON	off	off	ON
04	off	off	ON	off	off	20	off	off	ON	off	ON
05	ON	off	ON	off	off	21	ON	off	ON	off	ON
06	off	ON	ON	off	off	22	off	ON	ON	off	ON
07	ON	ON	ON	off	off	23	ON	ON	ON	off	ON
08	off	off	off	ON	off	24	off	off	off	ON	ON
09	ON	off	off	ON	off	25	ON	off	off	ON	ON

Table 5-14: Solenoid Error Status Enable

Value	Ahead	Astern	Neutral (optional)	Troll Command	Troll On/Off	Value	Ahead	Astern	Neutral (optional)	Troll Command	Troll On/Off
10	off	ON	off	ON	off	26	off	ON	off	ON	ON
11	ON	ON	off	ON	off	27	ON	ON	off	ON	ON
12	off	off	ON	ON	off	28	off	off	ON	ON	ON
13	ON	off	ON	ON	off	29	ON	off	ON	ON	ON
14	off	ON	ON	ON	off	30	off	ON	ON	ON	ON
15	ON	ON	ON	ON	off	31	ON	ON	ON	ON	ON

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

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.

NOTE: On multiple screw applications, the following tests must be performed on all Processors. If any of the following tests fail, consult section 10: Troubleshooting.

6.1 Control Heads (Engines Stopped)

A Turn power ON to the Control System.

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

C Take command at a Remote Station.

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

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

If the red indicator light BLINKS, continue with the testing. If the red indicator light DOES NOT BLINK, check connections as stated in the appropriate Control Head Service Sheet found in section 11: Appendix A - System Components and Specifications.

6.2 Start Interlock (Engines Stopped)

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

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

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

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

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

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

6.3 Throttle Dock Settings (Engines Stopped)

6.3.1 E2 - Throttle Minimum and E3 - Throttle Maximum Signal

IMPORTANT: ADJUSTMENTS MAY NOT BE REQUIRED.

Verify the existing Throttle Minimum and Maximum values, prior to adjusting them.

NOTE: Synchronization is dependent on the Throttle Minimum and Maximum adjustments being equal on each Processor.

NOTE: Prior to adjustments, the correct Engine Signal Selection should have been made during Section 5 - SET UP PROCEDURES.

Throttle Minimum (E2)

This function allows the installer the ability to adjust the Processor's Throttle signal at Idle, above and beyond the profile set in E0 Engine Throttle Profile. This value is adjustable anywhere between 1% to 97% of the maximum throttle output capability of the driver. The value must be at least 3% less than E3 Throttle Maximum setting.

Throttle Maximum (E3)

This function allows the installer the ability to adjust the Processor's Throttle signal at full throttle, above and beyond the profile set in E0 Engine Throttle Profile. This value is adjustable anywhere between 4% to 100% of the maximum throttle output capability of the driver. The value must be at least 3% greater than the E2 Throttle Minimum setting.

6.3.1.1 Processor Throttle Signal Check

Use the Service Field Test Unit and a Multimeter:

A Disconnect the Throttle Wire Harness from the Processor.

B Connect the 8-Pin connector of the Service Field Test Unit to the Processor Throttle connector and to the Throttle Wire Harness. Refer to MM13927 Field Service Test Unit.

C Depending on the type of signal required, follow the appropriate column of Table 6-1: Throttle Output Adjustments

Table 6-1: Throttle Output Adjustments

PWM (Duty Cycle)	VOLTAGE (VDC)	Current (mA)	Frequency (Hz)
Set Multimeter to Duty Cycle Setting. _____ %	Set Multimeter to Voltage Setting _____VDC	Set the Multimeter up as an Amp Meter _____ mA	Set Multimeter to Frequency setting. _____ Hz
On the Multimeter attach the black Lead to COM and the red Lead to V.	On the Multimeter attach the black Lead to COM and the red Lead to V.	On the Multimeter attach the black Lead to COM and the red Lead to mA.	On the Multimeter attach the black Lead to COM and the red Lead to V.
Attach the Multimeter black Lead to the negative (-) and the red LED to the PWM.	Attach the Multimeter black Lead to the negative (-) and the red LED to the VDC.	Attach the Multimeter black Lead to the negative (-) and the red LED to the mA	Attach the Multimeter black Lead to the negative (-) and the red LED to the Frequency.

D Turn ON power to the Engine's ECM. Ensure power is ON to the Processor.

E Scroll to Function Code to be checked (E2 or E3). The Multimeter will read the output signal for Throttle Minimum (E2) or Throttle Maximum (E3).

NOTE: To read Current, the mA Push Button on the Service Field Test Unit MUST be depressed.

NOTE: Synchronization is dependent on the Throttle Minimum and Maximum adjustments being equal on each Processor.

6.3.1.2 Throttle Adjustment

If E2 Throttle Minimum or E3 Throttle Maximum require adjustment, perform the following on the appropriate Processor.

NOTE: When in Set Up Mode to show values that have more than two digits (EXAMPLE: 010.5) DEPRESS AND HOLD the RIGHT ARROW. The Function Code will disappear and be replaced with the three or four digit Value. The Decimal Indicator will light if the number has a decimal value. Releasing the RIGHT ARROW returns the Display to the Normal blinking Function Code and two digit value.

A Leave the Service Field Test Unit connected to the Processor.
B Activate Set Up Mode.
C Scroll either Up or Down to change the value of the parameter to be changed. (E2 Throttle Minimum, E3 Throttle Maximum

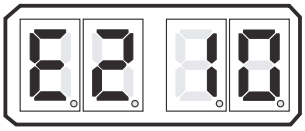


Figure 6-1: Display LED Function E2

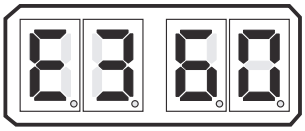


Figure 6-2: Display LED Function E3

D Store the Value to memory.
E Remove the Service Field Test Unit and reconnect the Throttle Wire Harness to the Processor.

6.4 E4 - Throttle Maximum Astern (Engines Stopped)

This value determines the percentage of Throttle Maximum that is allowed in Astern. This is adjustable anywhere between 1% to 100%.

The values of this Function are 1.0% to 100.0%. Throttle defaults are based on Throttle Profile selected.

A Disconnect the Throttle Wire Harness from the CruiseCommand Processor.
B Connect the 8-Pin connector of the Service Field Test Unit to the Processor THROTTLE connector and to the Throttle Wire Harness. Refer to MM13927 Field Service Test Unit.
C Turn ON power to the Engine's ECM. Ensure Power is ON to the Processor.
D Scroll to Function Code E4.

- The Multimeter will read the output signal for Throttle Maximum Astern.

NOTE: To read current, the mA Push Button on the Service Field Test Unit must be depressed.

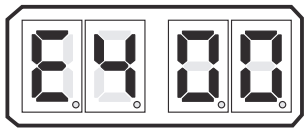


Figure 6-3: Display LED Function E4

E Activate Set Up Mode.
F Scroll Up or Down to the desired Value.
G Store the Value to memory.
H
I Remove the Service Field Test Unit and reconnect the Throttle Wire Harness to the Processor.

6.5 Engine Stop Switches (Engines Running)

Start the engine(s) and verify that the Stop switches (normally push buttons) function correctly at all Remote Stations. Refer to the information supplied by the engine manufacturer or switch supplier for set up and adjustments.

CAUTION: An Engine Stop Switch at each station is an absolute requirement. Refer to CFR46, 62.35-5 and ABYC P-24.5.8.

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

6.6 Control Head Command Checks (Engines Running)

A Start the engine(s) and let them run at Neutral/Idle.
B Place one Control Head lever at a time into the Ahead detent, the Astern detent and then Neutral.
- SOLENOID SHIFT: Confirm that the movement of the vessel is in the correct direction. If incorrect, reverse the electric cable connections at the shift solenoids.

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

6.7 E1 - Throttle in Neutral (Cummins-Quantum Engines Only) (Engines Running)

NOTE: This Function is used ONLY when the E0 Select Engine Throttle Profile is set for 03 - Cummins Quantum.

The Cummins-Quantum Engine requires different throttle command signals in Neutral than when In-Gear. These engines require a voltage throttle signal of 0.9 VDC when unloaded at Neutral. When a load is placed upon the engine by engaging the clutch, the throttle command signal increases to 1.2 VDC.

The Throttle in Neutral Function allows the installer the ability to adjust the throttle signal level at Neutral/Idle and also adjust a second throttle signal level for when the clutch is engaged. The Neutral value may be adjusted anywhere between 1 to 20% of the maximum throttle output capability of the voltage circuit. For example; if the circuit has the ability to drive 0 to 5.00 VDC and the value entered is 10, the output at Neutral would be 0.50 VDC.

The values of this Function are 01.0% to 50.0%. Throttle defaults are based on the Throttle Profile selected.

A Disconnect the Throttle Wire Harness from the Processor.
B Connect the 8-Pin connector of the Service Field Test Unit to the Processor THROTTLE connector and to the Throttle Wire Harness. Refer to MM13927 Field Service Test Unit.
C Turn ON power to the Engine's ECM. Ensure Power is ON to the Processor.
D Scroll to Function Code E1.

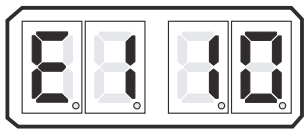


Figure 6-4: Display LED Function E1

E Activate Set Up Mode.
F Scroll Up or Down to the desired Value.
G Store the Value to memory.
H Remove the Service Field Test Unit and reconnect the Throttle Wire Harness to the Processor

6.8 E5 - Throttle Pause Following Shift (Engines Running)

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

A Move the Station in command's lever to the Ahead detent, while monitoring the Shaft.
- ELECTRIC THROTTLE: Start the stop-watch while monitoring the Shaft.

B When the Shaft begins to rotate, stop the stop-watch.
C Record the time expired on the stop-watch.

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

To change the Value (Refer to Table 5-2: Electric Throttle Function Codes and Table 5-3: Clutch Function Codes):

A Scroll to Function Code E5.

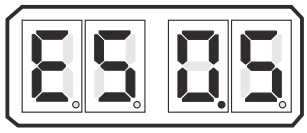


Figure 6-5: Display LED Function E5

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

6.9 E6 - High Idle (Engines Running)

This function allows the operator the option of having a second elevated Idle speed. This second elevated Idle can be adjusted from 0 to 20% of full throttle. If 0 is selected, High Idle will be the same as normal or Low Idle, which is the default value.

When power is first applied to the system, the commanded throttle is low. In order to increase the RPM to the High Idle command, the Transfer Button must be depressed for 1/2 second then released. This can be done with the Control Head lever in either the Ahead, Neutral, or Astern Detent.

The values of this Function are 0% to 20% of Throttle Maximum. Default Value is set to 00.

A Disconnect the Throttle Wire Harness from the Processor.
B Connect the 8-Pin connector of the Service Field Test Unit to the Processor Throttle connector and to the Throttle Wire Harness. Refer to MM13927 Field Service Test Unit.
C Turn ON power to the Engine's ECM. Ensure Power is ON to the Processor.
D Scroll to Function Code E6.
- The Multimeter will read the output signal for Idle.

NOTE: To read current, the mA Push Button on the Service Field Test Unit must be depressed.

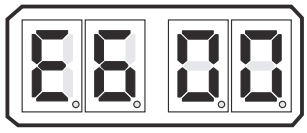


Figure 6-6: Display LED Function E6

E Activate Set Up Mode.
F Scroll Up or Down to the desired Value.
G Store the Value to memory.
H Remove the Service Field Test Unit and reconnect the Throttle Wire Harness to the Processor.

6.10 L7 - Lock Up Percentage (Hurth Transmissions Only) (Engines Running)

This function controls the amount of current while the gear is locked up and troll is turned OFF. Refer to the Gear Manual for maximum current setting

Factory calculated preset values are set if L106 or L107 are used.

Function Range: 0.0 - 100.0%

Preset Values:L106 (12 VDC)45.0

L107 (24 VDC)60.0

If the preset values need to be altered, a multimeter must be set to measure the current. Refer to MM13927 Field Service Test Unit.

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

A Scroll to Function Code L7.

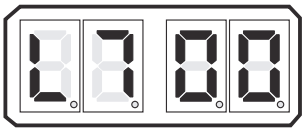


Figure 6-7: Display LED Function L7

B Activate Set Up Mode.
C Scroll Up or Down to the desired Value.
D Store the Value to memory
E Remove the Service Field Test Unit and multimeter, replacing any unplugged wire harnesses.

7 Sea Trials

WARNING: It is imperative that the information provided in the previous Sections has been read and followed precisely, prior to attempting a Sea Trial. If any of the following tests fail, discontinue the Sea Trial immediately and return to the dock. Consult Section 10 Troubleshooting or a ZF Facility prior to resuming the Sea Trial.

NOTE: In Multi Screw Applications, the following tests must be performed on all engines/transmissions. During the course of the Dock Trial and Sea Trials, fill out F-253 CruiseCommand System Trial Report. Retain this information for future use.

7.1 Full Speed Setting

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

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

C If synchronization is installed, disable synchronization as explained in Section 2 Operation.

- ELECTRIC THROTTLE: If the engine RPM is low, refer to MM13927 Field Service Test Unit on how to check electric setting.
- If the engine RPM is high, decrease by using Function Code E3 - Throttle Maximum, as explained in Section 6 Dock Trials.

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

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

7.2 C2 - Proportional (Reversal) 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 C4 - Proportional (Reversal) Pause Ratio for the C2 Function is stored during Set Up. Refer to section 5: Set Up Procedure.

The sequence of events, are as follows for the different Reversal Pause types:

7.2.1 In-Gear Delay [C200]

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

7.2.2 Neutral Delay [C201]

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

7.2.3 Store C2 - Proportional Pause Value

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

A Scroll to Function Code C2.

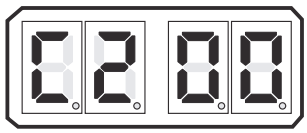


Figure 7-1: Display LED Function C2

B Activate Set Up Mode.

C Scroll Up or Down to the desired Value.

D Store the Value to memory.

7.3 C3 - Proportional (Reversal) Pause Time

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 (Reversal) 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 (Reversal) Pause Ratio.

7.3.1 Determine C3 Pause Requirement

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

The amount of pause required is determined as follows:

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

B Leave the Control Head lever(s) at this position for whichever of the following 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 to the time expired on the stop-watch.

7.3.2 Program Function Code C3

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

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

A Scroll to Function Code C3.

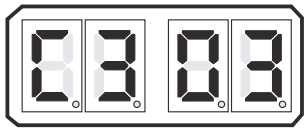


Figure 7-2: Display LED Function C3

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

7.3.3 Testing Proportional (Reversal) Pause Time

CAUTION: It is critical that the Proportional (Reversal) Pause is tested as outlined below, to ensure that is 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 following the steps in the previous Section. 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 (1) 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 section 10: Troubleshooting.

7.5 L2 - Trolling Minimum and L3 - Trolling Maximum Adjustments

Troll Minimum Pressure (L2)

The amount of current delivered to the Proportional Valve when Minimum Pressure is desired, is set with this function. This is adjustable anywhere between 01.0% to 99.0% of the total current output capability of the circuit. The value set must be at least 1% less or more (depending on whether non-inverted or inverted is selected) than Troll Maximum. The Default Value is 10.0%.

Troll Maximum Pressure (L3)

The amount of current delivered to the Proportional Valve when Maximum Pressure is desired, is set with this function. This is adjustable anywhere between 02.0% to 100.0% of the total current output capability of the circuit. The value set must be at least 1% more or less (depending on whether non-inverted or inverted is selected) than Troll Minimum. The Default Value is 25.0%.

When the transmission has reached operating temperature, measure and record in Table 7-1: Record Propeller Shaft RPM at Idle Ahead.

Table 7-1: Record Propeller Shaft RPM at Idle Ahead

Propeller Shaft RPM (when engines have reached operating temperature)

Use the Field Service Test Unit and a Multimeter: (Reference MM13927 Field Service Test Unit manual for set up.)

A Disconnect the Clutch/Troll Wire Harness from the Processor.
B Connect the 12-Pin connector of the Service Field Test Unit to the Processor Clutch connector and to the Clutch/Troll Wire Harness.
C Set Multimeter to Current (mA) setting.
D On the Multimeter, attach the Black Lead to COM and the Red Lead to mA.
E Turn ON power to the Clutch Power Supply. Ensure Power is ON to the Processor.
F Position the Control Head lever to the Ahead Detent and turn Troll Mode ON.
G Activate the Function Menu.

7.5.1 L2 - Troll Minimum Set Up

A Scroll to the Function Code.
- The Multimeter will read the output signal for Troll Minimum when the Troll Command Switch on the Test Unit is flipped away from “Troll Command”.

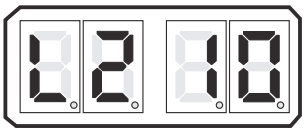


Figure 7-3: Display LED Function L2

B Activate Set Up Mode.

C Scroll Up or Down to the appropriate Value.

NOTE: When the trolling valve is in the minimum oil pressure position, Propeller Shaft RPM should be 30% of the engaged RPM noted in Table 7-1: Record Propeller Shaft RPM at Idle Ahead.

D Record Propeller Shaft RPM on Table 7-2: Record L2 - Minimum Trolling Pressure

Table 7-2: Record L2 - Minimum Trolling Pressure

SINGLE SCREW Propeller Shaft RPM at minimum Trolling Pressure (Approx. 30 - 50% of Table 7-1:)			
	Shaft RPM	Current (mA)	Function %
TWIN SCREW Propeller Shaft RPM at minimum Trolling Pressure (Approx. 30 - 50% of Table 7-1:)			
	Shaft RPM	Current (mA)	Function %
PORT			
STARBOARD			

E Store the Value to memory

7.5.1.1 L3 - Troll Maximum Set Up

A Position the Control Head lever through the selected Troll Lever Range to the Troll Maximum position.

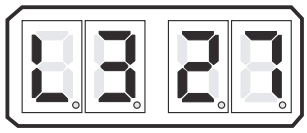


Figure 7-4: Display LED Function L2

NOTE: It is difficult to use a slipping clutch to control shaft RPM between 70% and 100% of normal shaft RPM. However, it may be desirable to set the Maximum Trolling Pressure position higher than the 70% RPM, so that added oil pressure is available when maneuvering.

B Scroll to the Function Code.

- The Multimeter will read the output signal for Troll Maximum when the Troll Command Switch on the Test Unit is flipped away from “Troll Command”.

C Activate Set Up Mode.

D Scroll Up or Down to the appropriate Value.

E Record Propeller Shaft RPM on Table 7-3: Record L3-Maximum Trolling Pressure

Table 7-3: Record L3-Maximum Trolling Pressure

SINGLE SCREW Propeller Shaft RPM at maximum Trolling Pressure (Approx. 70% of Table 7-1: Record Propeller Shaft RPM at Idle Ahead)			
	Shaft RPM	Current (mA)	Function %

Table 7-3: Record L3-Maximum Trolling Pressure

SINGLE SCREW Propeller Shaft RPM at maximum Trolling Pressure (Approx. 70% of Table 7-1: Record Propeller Shaft RPM at Idle Ahead)			
TWIN SCREW Propeller Shaft RPM at maximum Trolling Pressure (Approx. 70% of Table 7-1: Record Propeller Shaft RPM at Idle Ahead)			
	Shaft RPM	Current (mA)	Function %
PORT			
STARBOARD			

F Store the Value to memory

G Position the Control Head lever into the Neutral/Idle position.

H Remove the Service Field Test Unit and reconnect the Clutch/Troll Wire Harness to the Processor.

7.6 L4 - Troll Throttle Limit

CAUTION: Consult the Trolling Valve's Installation Manual prior to programming any increased throttle above Idle, while slipping the Clutch. Failure to adhere to the Transmission manufactures directives may permanently damage the Clutch Pack and void the warranty.

- The Value programmed for Function Code L4 is a percentage of the throttle range. The Throttle Range is the difference between Throttle Maximum (E3) and Throttle Minimum (E2).
- The maximum percentage of the Throttle Range which the Value can be set to is 20% of Full Throttle.
- The adjustment of this Function Code is a matter of personal preference. There is no set procedure which determines when increased throttle should be used and what percentage of the range it should be set to, but never exceed transmission manufacturers recommendation.
- The values of this Function are 00% to 20% of Throttle Maximum. Default Value is set to 00.

A Disconnect the Throttle Wire Harness from the Processor.

B Connect the 8-Pin connector of the Service Field Test Unit to the Processor Throttle connector and to the Throttle Wire Harness. Refer to MM13927 Field Service Test Unit manual for set up.)

C Turn ON power to the Engine's ECM. Ensure Power is ON to the Processor.

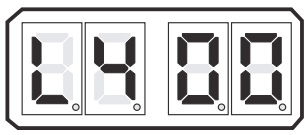


Figure 7-5: Display LED Function L4

D Activate the Function Menu.

E Scroll to the Function Code.

- The Multimeter will read the Troll Throttle Limit output signal

NOTE: To read current, the mA Push Button on the Service Field Test Unit must be depressed.

F Activate Set Up Mode.

G Change the Value of the Function.

H When the value required is displayed, store the value.

I Remove the Service Field Test Unit and reconnect the Throttle Wire Harness to the Processor.

7.7 L5 - Troll Pulse Duration

This function sets the time in seconds that the Proportional Valve will command L6 - Troll Pulse Percentage. This function gives a pressure boost to the Clutch plate in order to get the Propeller Shaft rotating prior to dropping to the level programmed in L2 - Troll Minimum.

The values of this Function are 0.0 to 9.9 Seconds. Default Value is set at 0.6 seconds.

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

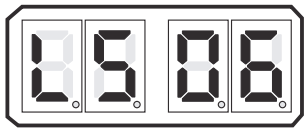


Figure 7-6: Display LED Function L5

A Activate the Function Menu.
B Scroll to the Function Code.
C Activate Set Up Mode.
D Change the Value of the Function.
E When the value required is displayed, store the value.

7.8 L6 - Troll Pulse Percentage

This function sets the percentage of L3 - Troll Maximum that the Proportional Valve will be commanded when first entering Troll Mode. This function determines the amount of pressure boost to the Clutch plate in order to get the Propeller Shaft rotating prior to dropping to the level programmed in L2 - Troll Minimum.

The values of this Function are 0.0% to 100.0%. Default Value is set at 25%.

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

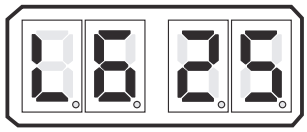


Figure 7-7: Display LED Function L6

A Activate the Function Menu.
B Scroll to the Function Code.
C Activate Set Up Mode.
D Change the Value of the Function.
E When the value required is displayed, store the value.

7.9 Sea Trial Report - See F-253 CruiseCommand System Trial Report.

CruiseCommand System 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 CruiseCommand Propulsion Control System. Please enter ALL information. We recommend a copy of this completed form remain aboard the vessel, and require that you fax a copy to 425-493-1569.

Your Name:		Date:	
Contact Name:		Telephone:	
Vessel Owner:		Vessel name:	
Builder:		Hull #:	
Engine Manufacturer		Model:	
HP:		RPM:	
Transmission Manufacturer		Model:	
Ratio:		No. of Screws:	
No. of Stations (max 4):			
Sta. 1 Location		Sta. 2 Location	
Sta. 3 Location		Sta. 4 Location	

Table F-253-1: Processor Information

Processor Information	Port		Stbd	
Processor Serial Numbers				
Is the Processor subject to excessive heat? (Above 70 degrees C)	Yes ☐	No ☐	Yes ☐	No ☐
At least 4 feet (1,2m) from strong magnetic fields?	Yes ☐	No ☐	Yes ☐	No ☐
Accessible for checkout, adjustments, and maintenance?	Yes ☐	No ☐	Yes ☐	No ☐
Are the Processors bonded (grounded)?	Yes ☐	No ☐	Yes ☐	No ☐
Are all Electric Cables supported every 18 inches (45,72cm)?	Yes ☐	No ☐	Yes ☐	No ☐
Are the electrical cable connections tight at the Processors and Control Heads?	Yes ☐	No ☐	Yes ☐	No ☐
Is the Processor's Start Interlock Circuit being used? If not, what type of start interlock is being used?	Yes ☐	No ☐	Yes ☐	No ☐
Is there an Engine Stop Switch installed at each Remote Station?	Yes ☐	No ☐	Yes ☐	No ☐
What is the length of the Control Head Harness?	Sta. 1	Sta. 2	Sta. 1	Sta. 2
	Sta. 3	Sta. 4	Sta. 3	Sta. 4

Table F-253-2: Power Supply

Processor Information	Port		Stbd	
What is the source of Processor power and how is it charged?				
Is there a backup power supply? APS or other, explain.	Yes ☐	No ☐	Yes ☐	No ☐

Table F-253-2: Power Supply

Processor Information	Port		Stbd	
Are the power cables protected by 10 Ampere Circuit Breakers?	Yes ☐	No ☐	Yes ☐	No ☐
What is the Voltage when not being charged?	Battery	Processor	Battery	Processor
What is the Voltage when connected to Shore Power?	Battery	Processor	Battery	Processor
What is the Voltage when the engines are running?	Battery	Processor	Battery	Processor

Table F-253-3: Dock Trials

Processor Information	Port		Stbd	
Does the engine start remotely when the Control System is turned OFF?	Yes ☐	No ☐	Yes ☐	No ☐
Does the Engine Stop Switch function at all Stations, regardless of RPM?	Yes ☐	No ☐	Yes ☐	No ☐
Can all Remote Stations take command?	Yes ☐	No ☐	Yes ☐	No ☐
Does the Warm-up Indicator Light blink in Ahead?	Yes ☐	No ☐	Yes ☐	No ☐
What is the Low Idle RPM?		RPM		RPM
High Idle RPM (optional)		RPM		RPM
Does the vessel surge forward with Control Head lever in the Ahead Detent?	Yes ☐	No ☐	Yes ☐	No ☐

Table F-253-4: Record at Dock

Processor Information		Port	Stbd
Throttle in Neutral (Cummins Quantum only)	VDC, mA., Hz. or %		
Throttle Minimum	VDC, mA., Hz. or %		
Throttle Maximum	VDC, mA., Hz. or %		
Troll Minimum (signal)	mA		
Troll Maximum (signal)	mA		

Table F-253-5: Sea Trials

Processor Information	Port		Stbd	
Do the Dual Control Head levers match position and RPM throughout the speed range?	Yes ☐	No ☐	Yes ☐	No ☐
Is Synchronization operational?	Yes ☐	No ☐	Yes ☐	No ☐

Table F-253-6: Record during Sea Trial

Processor Information	Port	Stbd
Engine Idle RPM		
Shaft Idle RPM (Calculate the Shaft Idle RPM as follows: Engine Idle RPM/Gear Ratio)		
Full Throttle RPM		
Troll Minimum (Shaft RPM) RPM (Actual) (The desired Troll Minimum can be calculated as follows: Shaft Idle RPM x 0.3)		
Troll Maximum (Shaft RPM) RPM (Actual) (The desired Troll Maximum can be calculated as follows: Shaft Idle RPM x 0.7)		

Table F-253-7: RECORD PARAMETERS:

Record the following only after all information has been recorded on the previous sections. Refer to the Manual for parameter default values and ranges.

Function Code	Function Name	Port	Stbd
A0	Processor Identification		
A1	Number of Engines		
A2	One Lever Operation		
A4	Neutral Indication Tone		
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	Active Synchronization		
E9	Throttle Rate Increase		
EA	Throttle Rate Decrease		
C0	Clutch Interlock		
C1	Clutch Interlock Delay		
C2	Reversal Pause		
C3	Reversal Pause Time		
C4	Reversal Pause Ratio		
C8	Neutral Delay		
L0	Troll Lever Range		
L1	Troll Valve Function		
L2	Troll Minimum Pressure		
L3	Troll Maximum Pressure		
L4	Troll Throttle Limit		
L5	Troll Pulse Duration		
L6	Troll Pulse Percentage		
L7	Lock Up Percentage		
F0	Boost Percent		
F1	Boost Duration		
F2	Boost Start Delay		
F3	Boost Bypass Clutch Delay		
H2	High Side Driver Fault Detection Enable		

NOTE: The Field Service Test Unit (Breakout Box p/n 13927) should be used for the following measurements.

Comments (Please use additional paper as necessary):
General Installation Condition:
Any Irregularities:

Is the Installation and Troubleshooting Manual on board?	Yes ☐	No ☐	If No, request copy?	Yes ☐	No ☐
Is the Operator Card on board?				Yes ☐	No ☐
Is a copy of this completed report aboard?				Yes ☐	No ☐
Is a copy of this completed report faxed?				Yes ☐	No ☐

Inspector: _____ Date: _____

Company: _____ Contact info: _____

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

8 Control Options

8.1 External Alarm Capability

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

NOTE: The following information applies to CruiseCommand Processors with a Processor Serial Number of ZE01320 or HIGHER. If your Processor has a lower Serial Number and you will be using this option, contact ZF Marine Propulsion Systems Miramar for guidance.

The Alarm Output of the Processor can be used to connect to an external alarm system supplied by others. The use of this output by the customer is optional.

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.

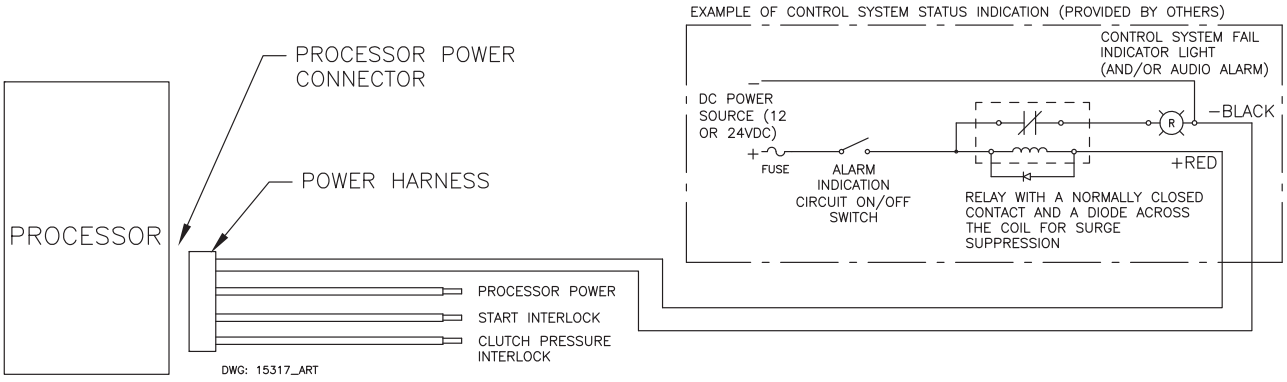


Figure 8-1: Example of Control System Status Indication

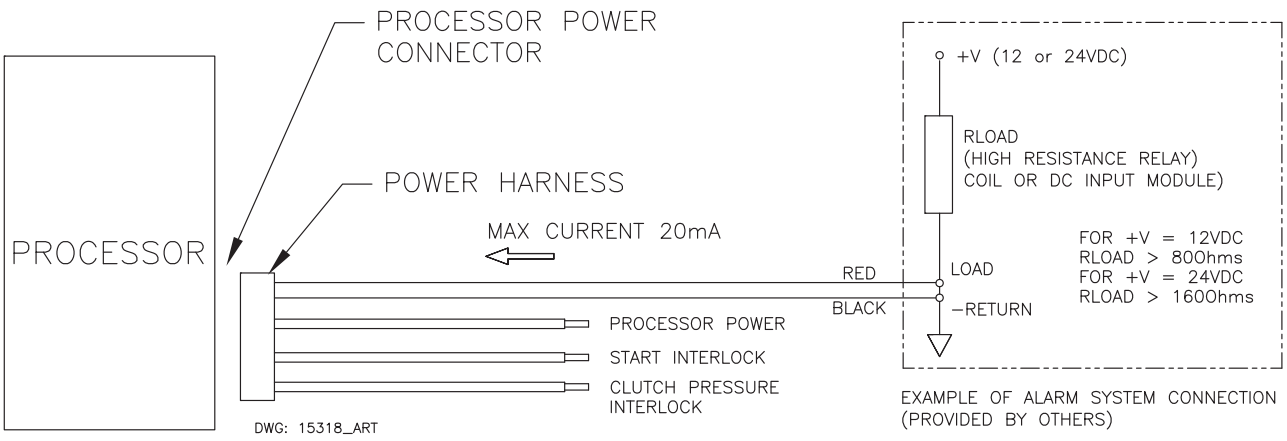


Figure 8-2: Example of External Alarm Connection Requirements

8.1.1 Installation

The following items should be considered when designing and installing the Status Indication Panel:

- A Power Wire Harness with Alarm Output must be used if an External Alarm is required.
- 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: Example of Control System Status Indication and Figure 8-1: Example of Control System Status Indication are an example of a suitable circuit, but not necessarily the only circuit configuration acceptable.

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

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: Example of Control System Status Indication and Figure 8-1: Example of Control System Status Indication.

8.2 Auxiliary (Backup) Control System

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

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

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

8.3 Clutch Pressure Interlock

NOTE: The Clutch Pressure Interlock C0 must be set to be used. Refer to the section 5.6.3.1: (C0) Clutch Pressure Interlock for more information.

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

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

8.3.1 C0 - Clutch Pressure Interlock Methods of Operation

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

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

8.3.1.2 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.

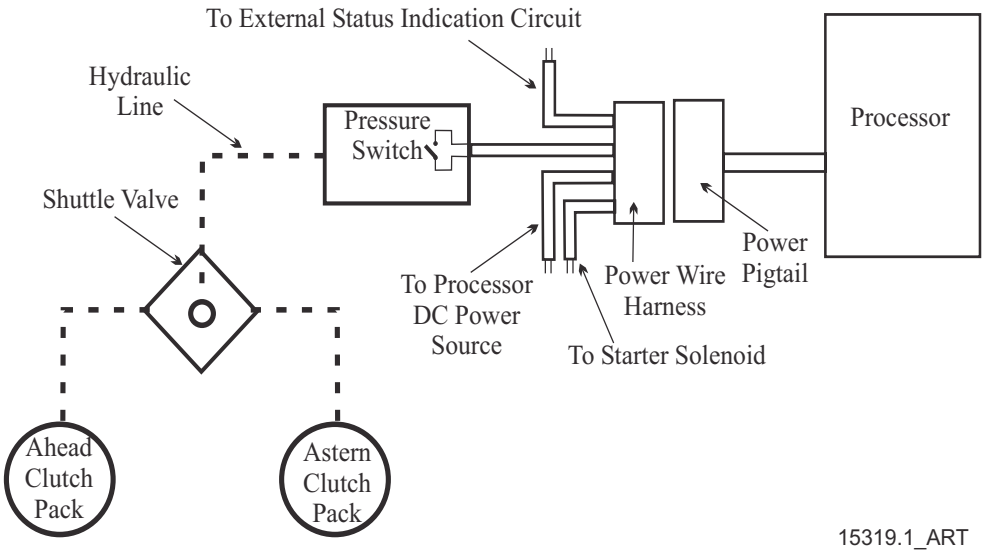


Figure 8-3: Clutch Pressure Switch with Processor Harness Diagram

8.3.2 Installation

The installation of the Clutch Pressure Switch is the same for both methods of operation. (Refer to the above Figures.)

A Install a Shuttle Valve on or near the Transmission.

B Connect hydraulic line from the Ahead and Astern Clutches.

C Connect a hydraulic line that is no longer than 5 feet (1,524m)and at approximately the same height between the Shuttle Valve and the Pressure Switch.

D Connect the Power Wire Harness's Clutch Pressure Interlock cable to the Pressure Switch's normally open contact.

E Calibrate the Pressure Switch to close when adequate Clutch Pressure is reached. (Refer to the Transmission Manufacturers Installation Manual)

8.4 Station Expander (SE) - Optional

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

For detailed information on the operation, installation and adjustment of the SE, refer to MMC-343 Station Expander User Instructions

9 Periodic Checks & Maintenance

The items listed below should be checked on an annual basis, or more frequently where noted:

9.1 Control Heads

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

9.2 Processor

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

9.3 Power

- Check all of the connections from the battery to the DC Distribution Panel to the APS for loose or corroded connections.
- Measure the voltage at the battery and at the Processor while the Clutch or Throttle is driving. There should be no more than 10% difference between these two points. If so, check all devices and connections for excessive voltage drop

NOTE: If an APS is used in the circuit to supply power to the Processor, account for the 0.7V drop across the APS. Example: 12.6V @ battery – 1.26V (10% drop) – 0.7V (APS drop) = 10.64V (Minimum allowable voltage)

10 Troubleshooting

10.1 General Troubleshooting

The ZF Marine Propulsion Systems Miramar Control System consists of one Processor per engine, typically mounted in the engine room, and one to four Control Heads located at the vessel's Remote Stations.

In the event that a malfunction occurs, review the appropriate System Diagram and become familiar with the various components, their functions and locations on the vessel.

The following Sections are a list of the main components that make up a typical system, along with a brief description of their functions:

10.1.1 Control System Examples

10.1.1.1 785CE (Throttle Electronic, Clutch Solenoid or Clutch/Troll Solenoid, up to Four pluggable Stations) Processor

The 785CE is designed to precisely control speed and direction on vessels equipped with electronic Throttle, solenoid Clutch or Clutch/Troll selection.

10.1.2 Typical System Main Components

10.1.2.1 Control Head

The primary function of the Control Head is to send out a variable DC voltage to the Processor. This DC voltage is representative of the Control Head's present lever position. In addition to the primary function, the Control Head also has audible (Sound Transducer) and visual (LED) status indications, along with a Transfer Button for taking command and performing other system functions.

10.1.2.2 Processor

The Processor receives the variable DC voltage from the Control Head(s) and converts these inputs to the appropriate electronic or electric outputs at the correct time and sequence to the Governor and Gear Box. The information regarding throttle type, throttle/ clutch sequencing, etc., are all stored on memory within the Processor.

10.1.2.3 Power Source

All electronic equipment must have power in order to operate. Ensuring a properly charged reliable power source is available and crucial.

The Processor requires a 12 or 24 VDC power system.

The minimum voltage at which the Processor will continue to operate is 8.00 VDC. The maximum allowable voltage is 30 VDC. Exceeding these limits will not damage the Processor, but will render it unusable temporarily. The power supply must be capable of delivering 10 amperes to each Processor on a continual basis and current surges up to 20 amperes.

All cable calculations should be based on a 10 ampere draw with no more than 10% voltage drop.

10.1.2.4 Electrical Cables and Harnesses

The function of the Electrical Cables and Harnesses are to move electrical information from one point to another. The ZF Marine Propulsion Systems Miramar' System has pluggable Harnesses. These Harnesses may have plugs on one end or both, depending on its purpose.

There are Harnesses available for Control Head Interface, DC Power, Start Interlock, Clutch Oil Pressure Interlock and External System Status Indication Circuit.

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

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

Prior to attempting to troubleshoot the System, get as much information as possible from the owner or operator. Inspect the System for signs of mis-adjustments, loose connections, physical damage or water incursion. Pay special attention to the following items:

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

10.2 Troubleshooting Questions

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

A Is the System installed on a Single, Twin or Multiple Screw vessel?
- If the System is installed on a Single Screw vessel, this question does not have much value in narrowing down the source of the problem.
- If the System is installed on a Twin or more Screw application, this question is quite useful, if you ask the following question.
    - Does the problem or symptom occur on the Port, Starboard or both sides?
        - If the problem or symptom occurs on one side only, you have effectively eliminated 50% of the possible causes. For example, the symptom only occurs on the Port side. All of the components on the Starboard side have been eliminated as potential causes.
        - If the problem occurs on both the Port and Starboard sides, you must ask yourself: What do both sides have in common? Most likely answer to your question would be the DC Power source.

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

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

D Are any tones generated when the problem occurs?

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

The following basic tones can be produced on all Systems (refer to section 10.5: Troubleshooting Audible Tones):

- Slow Repetitive Tone
- One Long- Three Short Tones
- Steady Tone
- Three Second Steady Tone

The following tone can be produced on all Systems using Solenoid Clutches (refer to section 10.5: Troubleshooting Audible Tones):

- One Long - One Short Tone

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

In addition to generating a tone, at any time the system detects a malfunction or fault, an error message will be displayed at the Processor. Refer to Table 10-8: Basic Error Codes for an explanation of the errors.

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

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

Lit Steady

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

Not Lit

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

Blinking Slowly

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

Blinking Rapidly

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

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

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

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

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

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

10.3 Troubleshooting Problem Resolution

If the problem could not be resolved by asking the questions in the previous section, a careful inspection of the Control System may be the next step. Even in situations where the problem was found and corrected, it is good practice to always perform a careful inspection of the entire Control System each and every time you are asked aboard a boat.

Always verify that the installation of the System is in compliance with the Installation Manual by carefully inspecting the following:

10.3.1 DC Power

A Ensure that the Processor(s) is connected to a properly charged 24 VDC battery through a 10 Ampere circuit breaker.

B To ensure reliable power to the Processors an APS (Automatic Power Selector) is strongly recommended. The APS take inputs from two separate power sources. Whichever power source is at the higher voltage level, will be automatically switched through.

C Refer to Automatic Power Selector information in S-214 Automatic Power Selector Model: 13505.

10.3.2 Component Location

10.3.2.1 Control Heads

There are virtually no restrictions regarding the location of the 400 Series and the MC2000 Series Control Heads, as long as the bottom is protected from the environment. The 500 Series Control Heads must be mounted to a console and the 700 Series are waterproof from top to bottom.

Refer to section 11: Appendix A - System Components and Specifications for Installation requirements.

10.3.2.2 Processors

The Processors are typically mounted in the engine room, while maintaining a minium distance of 4 feet (1,22m) from sources of high heat and EMI (Electro Magnetic Interference) or RFI (Radio Frequency Interference). Refer to section 3: Plan the Installation for requirements. Inspect the Processor for any signs of physical damage.

10.3.3 Component Condition

10.3.3.1 Control Heads

Inspect for any signs of corrosion due to water incursion. If hard-wired, ensure that all the fork connectors are properly secured to the terminal. Verify all wires are fully crimped and do not pull loose.

10.3.3.2 Processors

Inspect the Processor for any signs of physical damage.

10.3.4 Interconnecting Wiring and Harnesses

A Inspect the wire terminations for loose connections, corrosion or wire strands.

B Inspect the Harness's pins and sockets for bent pins, torn boots or any signs of corrosion.

The first step in troubleshooting a problem with the Propulsion System is to determine if the problem is with the Control System or something external to the System. In all cases a Control System malfunction will alert the operator of the potential problem. This is accomplished through the audible tone emitted at all Remote Stations. When an audible tone is emitted, it will be accompanied by an Error Message at the Processor. Also, in many cases, the Control System will alert the operator to a problem external to the Control System.

The following are examples of components both internal and external to the Control System which could be a source of trouble:

Table 10-1: Examples of Internal/External Components

Internal	External
Processor	DC Power Source
Control Head	Engine
Interconnecting Wiring (Harnesses)	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.

10.4 Troubleshooting Diagnostic Menu

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

- Applied Battery Voltage
- Tachometer Sender Frequency
- Stations 1- 4 A/D's
- Stations 1- 4 Transfer Button Status
- 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 a running dash pattern moving from left to right while the program is running in Normal Operation.

B Depress the Up or Down Push Button to activate the Function Code List. The characters A001 will be shown on the Display like Figure 10-1: Display Function Code

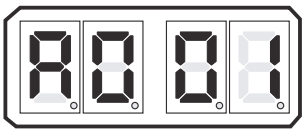


Figure 10-1: Display Function Code

C Depress the Up or Down Push Button repeatedly until H000 is displayed like Figure 10-2: Display Troubleshooting Function.

D Depress and hold the Left and Right Push Buttons simultaneously until the H0 begins to blink. (Figure 10-3: Display Function Blinking) Release the Push Buttons; the applied battery voltage will now be displayed:

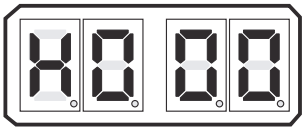


Figure 10-2: Display Troubleshooting Function

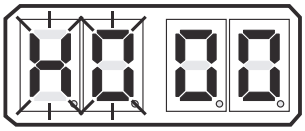


Figure 10-3: Display Function Blinking

- The displayed value is in "real time" and provides a rough estimate of the DC voltage applied to the Processor. The reading is accurate to within 0.50 DC. Refer to Figure 10-4: Example Display of Applied Battery Voltage

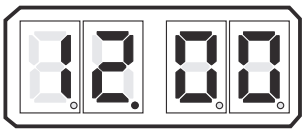


Figure 10-4: Example Display of Applied Battery Voltage

E In addition to the applied battery voltage, scrolling through the Diagnostics Menu by pressing the Up or Down Push Button can also show the Tachometer Sender Frequency (Figure 10-5: Example Display of Tach Sensor Frequency):

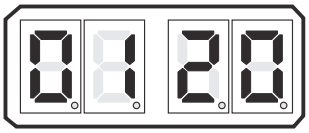
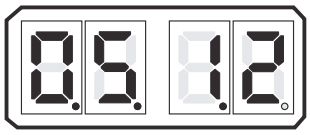
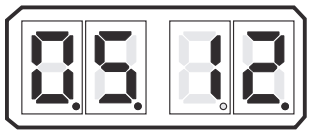
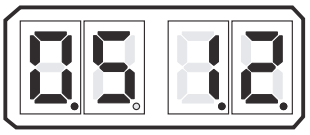
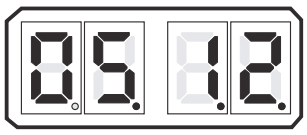


Figure 10-5: Example Display of Tach Sensor Frequency

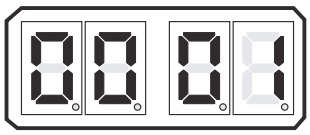
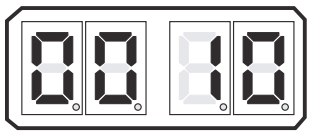
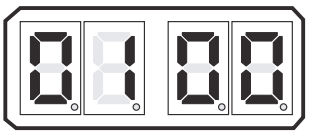
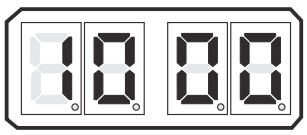
- The information shown is the actual frequency output by the Tachometer Sender. This signal is utilized in “Closed Loop” Synchronization or “Closed Loop” Troll (future) systems
- The Control Head’s lever position, and the resulting output of the Station’s Control Heads can always be monitored. This is regardless of whether that Station is in command or not. Note the placement of the decimal points in the following examples, which show all Stations with the lever positioned at the Neutral/Idle position. This will be covered in further detail later.

Table 10-2: Example Display Control Head Lever Current Positions

Station 1	Station 2	Station 3	Station 4
			

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.

Table 10-3: Example Display Control Head Transfer Button Status View

Station 1	Station 2	Station 3	Station 4
			

G Depressing the Up or Down Push Button one more time will show the current revision level of the software. This feature will provide invaluable information in the years to come. Determining the characteristics or capabilities of a certain Processor will be as simple as selecting this feature.

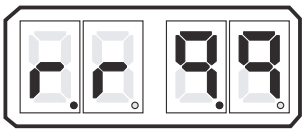


Figure 10-6: Example Display of Software Revision Level View

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

I The Diagnostic Menu can be exited two ways:

- Do not touch any Push Buttons for 5 minutes. The system will automatically exit.
- Depress the Left Push Button until H000 appears. You may now scroll through the Set Up Menu.

10.5 Troubleshooting Audible Tones

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

10.5.1 Basic Control System Tones

These basic tones are as follows:

10.5.1.1 Slow Repetitive Tone

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

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

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

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

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

A Check the Display on the Processor for Error Messages. Error Message 55 may appear indicating Under Voltage. One or more of Error Messages 37 through 53 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 Section 10.4 Troubleshooting Diagnostic Menu until the Applied Battery Voltage is displayed. Take note of the applied voltage.

C Go to the battery or Main Distribution Panel which is feeding power to the Processor. With a DC Voltmeter, measure the voltage at this power source. The battery voltage should be greater than 12.4 Volts in 12 VDC systems and 24.8 Volts in 24 VDC systems. If not, the battery or it's charging system needs servicing.

D The voltage differential between the power source and the Processor should not exceed 1.2 Volts in 12 VDC systems and 2.4 Volts in 24 VDC systems. If so, there is high resistance somewhere between the battery and Processor.

NOTE: If an APS is being utilized in the power circuit, take into account the 0.7 VDC forward voltage drop of the diodes. This would increase the permissible differential between power source and Processor from 1.2 to 1.9 VDC in 12 VDC circuits and 2.4 to 3.1 VDC in 24 VDC circuits.

E High resistance, resulting in a differential voltage of 1.2 Volts (12 VDC Systems) or 2.4 Volts (24 VDC Systems) or greater, may be the result of corroded or tarnished connections, dirty or pitted relay contacts or an improperly sized power cable.

F If the voltage differential is less than 1.2 Volts (12 VDC Systems) or 2.4 Volts (24 VDC Systems), which is what you would typically expect, a loose connection may exist between the power source and the Processor. The vibration experienced while the vessel is underway may intermittently cause the circuit to open. Check all the connections between the power source and the Processor for loose bolts, nuts, etc.

10.5.1.2 One Long - Three Short Tones

This tone indicates that there is an invalid command signal at the Station-in-Command. The Processor expects a DC voltage, representative of the Control Head's present lever position.

This voltage is referred to as the "Command Signal". In normally functioning Control Heads, the command signal is between approximately 0.5VDC at Full Astern to 4.40 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 or exceeds this range, the tone will be generated.

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

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

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

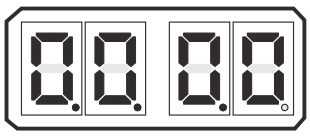
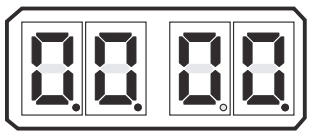
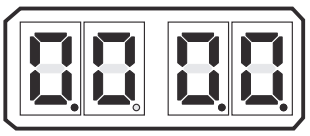
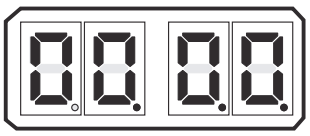
A Check the Processor's Display for error messages. Most likely, one of error messages 13 thru 28 will be shown. The exact number shown depends on which remote station is experiencing the problem and whether the command signal was too high or too low.

B Enter the Diagnostic Menu as outlined in Section 10.4 Troubleshooting Diagnostic Menu.

C Depress the Up or Down (Scroll) Push Button until the appropriate Remote Station is displayed.

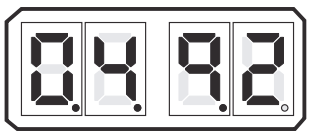
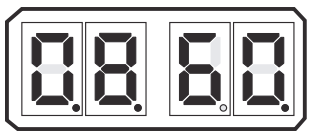
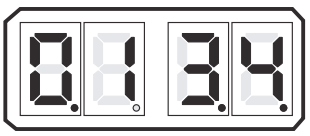
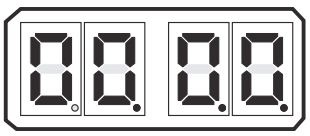
- The Remote Station are identified by the position of the decimal points.
- Station 1 has no decimal point after the first digit to the far right. The remaining three digits all have decimal points.
- If the digit to the far left had no decimal point following it, but the remaining three do, this would represent Station 4.

Table 10-4: Display Examples of Remote Stations

Station 1	Station 2	Station 3	Station 4
			

D The examples above 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 following examples:

Table 10-5: Display Examples of Remote Stations A/D Values

Station 1 Neutral Commanded	Station 2 Full Ahead Commanded	Station 3 Full Astern Commanded	Station 4 No Control Head Connected
			

E An A/D value is 900 or greater, one of Error Codes 13 to 20 will be shown.

- If the A/D value is greater than 900, 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, one of the following may be the cause.
  1. JUMPER between pins 3 and 5 (Right hand) Control Heads or pins 3 and 7 (Left Hand) Control Heads is disconnected.

2. If the LED is not lit and no audible tone is heard, the red wire connected between pin 3 of the Control Head and pin 5 of the Processor is open.

F If the A/D value is 100 or less, one of Error Codes 21- 28 will be shown.

- If the A/D value is less than 100, but greater than 75, the following may be the cause:
  1. The Control Head's potentiometer is out of calibration.
  2. The potentiometer is defective.
  3. A high resistance connection exists on pin 6 (green wire) between the Control Head and Processor.
- If the A/D value is less than 75:
  1. There is an open wire between pin 6 (green wire) of the Control Head and the Processor.
  2. There is an open wire between pin 7 (blue wire) of a right hand Control Head and the Processor.
  3. There is an open wire between pin 5 (blue wire) of a left hand Control Head and pin 7 (blue wire) of the Processor.

10.5.1.3 Steady Tone

The Steady Tone is an indication to the operator that something has gone wrong within the Control System. The Steady Tone will typically be accompanied by an Error Message on the Processor's Display. If the tone is heard, the Processor's Display must be referred to in order to further diagnosis the problem.

If 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 (shorted) Station until the problem is rectified.

10.5.1.4 Three Second Steady Tone

This tone is generated when a fault is detected with the Troll ON/OFF Solenoid or Troll Proportional Solenoid. The tone will also be accompanied with one or more of Error Messages 7 - 10. The System's program/memory must be told of the existence of these solenoids in order to activate this feature.

This tone is also generated with a stuck Control Head transfer button. Refer to section 10.6.5: Stuck Transfer Button.

10.5.2 Clutch Solenoid Control System Tones

10.5.2.1 One Long - One Short Tone

This tone indicates that there is some type of malfunction with one or more of the Clutch or Neutral Solenoid Circuits. The exact nature of the malfunction can be further isolated as indicated by the Error Message on the Processor Display.

There are six (6) different Error Messages, which one or more will be displayed in conjunction with this tone depending on which solenoid and whether an Open or a short is detected. Error Messages 1 - 6 will be shown.

The System's program/memory must be told of the existence of these solenoids in order to activate this feature. Refer to section 5: Set Up Procedure for Function H2.

10.6 Troubleshooting Remote Stations

10.6.1 Transfer

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

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

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

10.6.2 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 0.60 VDC).
- When the lever is positioned fully Ahead, a larger portion is tapped off and the voltage is at its highest point (approximately 4.40 VDC).

10.6.3 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 Signal with the lever at the Neutral/Idle position is 48 - 50% of the Reference Voltage or 491 - 511 A/D's (2.40 - 2.50VDC).
- The Command Signal at Full Ahead is 83 - 85% of the Reference Voltage or 849 - 869 A/D's (4.15 - 4.25VDC).
- The Command Signal at Full Astern is 12 - 14% of the Reference Voltage or 123 - 143 A/D's (-.60 - 0.70VDC).

10.6.4 Remote Station Select

The second required item for taking command is "Station Select" or depressing of the Transfer Button. The Transfer Button can be tested by entering the Diagnostic Menu H0.

A Depress the Up or Down (scroll) Push Button until four zeroes are displayed without decimal points as shown in Figure 10-7: Display Station A/D's No Station Transfer Button Depressed.

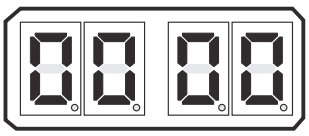


Figure 10-7: Display Station A/D's No Station Transfer Button Depressed

B For Stations 1 - 4 when the Transfer Button is depressed, the 0 which represents that remote station, will change to a 1 as shown in Figure 10-8: Example Display Station A/D's Transfer Button Depressed for Stations 1 - 4.

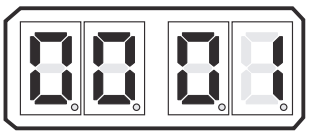


Figure 10-8: Example Display Station A/D's Transfer Button Depressed for Stations 1 - 4

Whenever command cannot be gained at a particular remote station, the Station Select and Command Signals are the first to be investigated. If either the Command Signal is out of range or the Station Select is inoperable, command will not be accepted at that remote station

10.6.5 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 29 - 32, 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 B6-4 - "Remote Station Select".

- An Error Code 29 - 32 will be shown on the Display, depending on which Station is experiencing the problem.

10.7 Troubleshooting 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.

Table 10-6: Solenoid Clutch Error Codes

Error #	Title	Description
1	Clutch Astern Shorted	The Astern Clutch Solenoid is requiring more current than expected.
3	Clutch Neutral Shorted	The Neutral Clutch Solenoid is requiring more current than expected.
5	Clutch Ahead Shorted	The Ahead Clutch Solenoid is requiring more current than expected.

Table 10-7: Solenoid Troll Error Codes

Error #	Title	Description
7	Troll ON/OFF Shorted	The Troll ON/OFF Solenoid is requiring more current than expected.
9	Troll Command Shorted	The Troll Proportional Solenoid is requiring more current than expected.
10	Troll Command Open	The Troll Proportional Solenoid should be drawing current but is not.

Table 10-8: Basic Error Codes

Error #	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.

Table 10-8: Basic Error Codes

Error #	Title	Description
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.1 Faulted Low	Station No.1 Control Head's lever position is out of range. The input appears to be too low.
22	Station No.2 Faulted Low	Station No.2 Control Head's lever position is out of range. The input appears to be too low.
23	Station No.3 Faulted Low	Station No.3 Control Head's lever position is out of range. The input appears to be too low.
24	Station No.4 Faulted Low	Station No.4 Control Head's lever position is out of range. The input appears to be too low.
25	Station No.5 Faulted Low	Station No.5 Control Head's lever position is out of range. The input appears to be too low.
26	Station No.6 Faulted Low	Station No.6 Control Head's lever position is out of range. The input appears to be too low.
27	Station No.7 Faulted Low	Station No.7 Control Head's lever position is out of range. The input appears to be too low.
28	Station No.8 Faulted Low	Station No.8 Control Head's lever position is out of range. The input appears to be too low.
29	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.
30	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.
31	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.
32	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.
33	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.
34	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.
35	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.
36	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.
37	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.

Table 10-8: Basic Error Codes

Error #	Title	Description
38	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.
39	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.
40	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.
41	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.
42	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.
43	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.
44	Comm. Error Time-out System 1	Communication with System has been too long without a Refresh message
45	Comm. Error Time-out System 2	Communication with System has been too long without a Refresh message
46	Comm. Error Time-out System 3	Communication with System has been too long without a Refresh message
47	Comm. Error Time-out System 4	Communication with System has been too long without a Refresh message
48	Comm. Error Time-out System 5	Communication with System has been too long without a Refresh message
49	Station Expander Comm. Error Time-out System 6	Communication with Station Expander has been too long without a Refresh message.
50	Station Expander Comm. Error Time-out System 7	Communication with Station Expander has been too long without a Refresh message.
51	Station Expander Comm. Error Time-out System 8	Communication with Station Expander has been too long without a Refresh message.
52	Station Expander Comm. Error Time-out System 9	Communication with Station Expander has been too long without a Refresh message.
53	Station Expander Comm. Error Time-out System 10	Communication with Station Expander has been too long without a Refresh message.
54	Over Voltage Fault	The applied battery voltage is above the expected limits for greater than two (2) seconds
55	Under Voltage Fault	The applied battery voltage is below the expected limits for greater than two (2) seconds
56	Reset Due to Software Watchdog	The system has had an unexpected Reset, due to a software problem.
57	Reset Due to Software Fault	The system has had an unexpected Reset, due to a software problem.
58	Reset Due to Hardware Watchdog	The system has had an unexpected Reset, due to a hardware problem.
59	Oscillator Watchdog	The system Oscillator has experienced a malfunction.

10.8 Troubleshooting Basic Problem Cases 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.

Table 10-9: Solenoid Clutch Problem Causes and Solutions

Error #	Cause		Solution	
1	a	The Astern Clutch Solenoid is defective.	a	Replace the Astern Clutch Solenoid.
	b	The Clutch Harness is incorrectly wired at the Gear Box.	b	Properly connect the Clutch Harness to the Astern Solenoid.
2	a	The Astern Clutch Solenoid circuit is Open.	a	Properly connect the Astern Clutch Solenoid.
	b	The Astern Clutch Solenoid is defective.	b	Replace the Astern Clutch Solenoid.
3	a	The Neutral Solenoid is defective.	a	Replace the Neutral Solenoid.
	b	The Neutral Solenoid is incorrectly wired at the Gear Box.	b	Properly connect the Neutral Solenoid.
4	a	The Neutral Solenoid circuit is Open.	a	Properly connect the Neutral Solenoid.
	b	The Neutral Solenoid is defective.	b	Replace the Neutral Solenoid.
5	a	The Ahead Clutch Solenoid Circuit is incorrectly wired at the Gear Box.	a	Properly connect the Ahead Clutch Solenoid.
	b	The Ahead Clutch Solenoid is defective.	b	Replace the Ahead Clutch Solenoid.
6	a	The Ahead Clutch Solenoid Circuit is Open.	a	Properly connect the Ahead Clutch Solenoid.
	b	The Ahead Clutch Solenoid is defective.	b	Replace the Ahead Clutch Solenoid.

Table 10-10: Solenoid Troll Problem Causes and Solutions

Error #	Cause		Solution	
7	a	The Troll On/ Off Solenoid is defective.	a	Properly connect the Troll On/ Off Solenoid.
	b	The Troll On/ Off Solenoid is incorrectly wired at the Gear Box.	b	Replace the Troll On/ Off Solenoid.
8	a	The Troll On/ Off Solenoid circuit is Open.	a	Properly connect the Troll On/ Off Solenoid.
	b	The Troll On/ Off Solenoid is defective.	b	Replace the Troll On/ Off Solenoid.
9	a	The Troll Command Solenoid is defective.	a	Properly connect the Troll Command Solenoid.
	b	The Troll Command Solenoid is incorrectly wired at the Gear Box.	b	Replace the Troll Command Solenoid.
10	a	The Troll On/ Off Solenoid circuit is Open.	a	Properly connect the Troll On/ Off Solenoid.
	b	The Troll On/ Off Solenoid is defective.	b	Replace the Troll On/ Off Solenoid.

Table 10-11: Basic Control System Problem Causes and Solutions

Error #	Cause		Solution	
13	a.	The Station No.1 Control Head is defective.	a.	Replace Station No.1 Control Head.
14	a.	The Station No.2 Control Head is defective.	a.	Replace Station No.2 Control Head.
15	a.	The Station No.3 Control Head is defective.	a.	Replace Station No.3 Control Head.
16	a.	The Station No.4 Control Head is defective.	a.	Replace Station No.4 Control Head.
17	a.	The Station No.5 Control Head is defective.	a.	Replace Station No.5 Control Head.
18	a.	The Station No.6 Control Head is defective.	a.	Replace Station No.6 Control Head.

Table 10-11: Basic Control System Problem Causes and Solutions

Error #	Cause		Solution	
19	a.	The Station No.7 Control Head is defective.	a.	Replace Station No.7 Control Head.
20	a.	The Station No.8 Control Head is defective.	a.	Replace Station No.8 Control Head.
21	a.	The Station No.1 Control Head is not properly connected.	a	Properly connect the Station No.1 Control Head.
	b.	The Station No.1 Control Head is defective.	b	Replace Station No.1 Control Head.
22	a.	The Station No.2 Control Head is not properly connected.	a	Properly connect the Station No.2 Control Head.
	b.	The Station No.2 Control Head is defective.	b	Replace Station No.2 Control Head.
23	a.	The Station No.3 Control Head is not properly connected.	a	Properly connect the Station No.3 Control Head.
	b.	The Station No.3 Control Head is defective.	b	Replace Station No.3 Control Head.
24	a.	The Station No.4 Control Head is not properly connected.	a	Properly connect the Station No.4 Control Head.
	b.	The Station No.4 Control Head is defective.	b	Replace Station No.4 Control Head.
25	a.	The Station No.5 Control Head is not properly connected.	a	Properly connect the Station No.5 Control Head.
	b.	The Station No.5 Control Head is defective.	b	Replace Station No.5 Control Head.
26	a.	The Station No.6 Control Head is not properly connected.	a	Properly connect the Station No.6 Control Head.
	b	The Station No.6 Control Head is defective.	b	Replace Station No.6 Control Head.
27	a.	The Station No.7 Control Head is not properly connected.	a	Properly connect the Station No.7 Control Head.
	b.	The Station No.7 Control Head is defective.	b	Replace Station No.7 Control Head.
28	a.	The Station No.8 Control Head is not properly connected.	a	Properly connect the Station No.8 Control Head.
	b.	The Station No.8 Control Head is defective.	b	Replace Station No.8 Control Head.
29	a.	The Station No.1 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.1 Control Head is improperly wired.	b.	Properly connect Control Head
30	a.	The Station No.2 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.2 Control Head is improperly wired.	b.	Properly connect Control Head
31	a.	The Station No.3 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.3 Control Head is improperly wired.	b.	Properly connect Control Head
32	a.	The Station No.4 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.4 Control Head is improperly wired.	b.	Properly connect Control Head
33	a.	The Station No.5 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.5 Control Head is improperly wired.	b.	Properly connect Control Head
34	a.	The Station No.6 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.6 Control Head is improperly wired.	b.	Properly connect Control Head

Table 10-11: Basic Control System Problem Causes and Solutions

Error #	Cause		Solution	
35	a.	The Station No.7 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.7 Control Head is improperly wired.	b.	Properly connect Control Head
36	a.	The Station No.8 Control Head transfer button is defective	a.	Replace the Control Head
	b.	The Station No.8 Control Head is improperly wired.	b.	Properly connect Control Head
37	a.	The Serial Harness is in excess of 130 feet (40m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
38	a.	The Serial Harness is in excess of 130 feet (40m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
39	a.	The Serial Harness is not connected at one or more Processors.	a.	Ensure that the Serial Harness is properly seated at all Processors.
	b.	The Serial Harness is incorrectly wired.	b.	Refer to section 10.11: Troubleshooting Wire Harnesses Correct or replace the Harness.
	c.	Loss of power to one of the Processor.	c.	Restore Power to the Processor.
40	a.	The Serial Harness is in excess of 130 feet (40m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
41	a.	The Serial Harness is in excess of 130 feet (40m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated	c.	Ensure that the shield is terminated and the termination is at one side only.
42	a.	The Serial Harness is in excess of 130 feet (40m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
43	a.	The Serial Harness is in excess of 130 feet (40m).	a.	Reposition the Processor(s) so that the Serial Harness is less than 120 feet (37m).
	b.	The Processor is defective.	b.	Replace the faulty Processor.
	c.	The Serial Harness's shield is not properly terminated.	c.	Ensure that the shield is terminated and the termination is at one side only.
44	a.	The Serial Harness is not connected at Processor ID No.1.	a.	Connect the Serial Harness into Processor ID No.1.
	b.	None of the Processors has ID No. 1 selected.	b.	Identify one of the Processors as ID No.1 with the A0 function.
	c.	Loss of power to Processor ID No.1.	c.	Restore power to Processor ID No.1.

Table 10-11: Basic Control System Problem Causes and Solutions

Error #	Cause		Solution	
45	a.	The Serial Harness is not connected at Processor ID No.2.	a.	Connect the Serial Harness into Processor ID No.2.
	b.	None of the Processors has ID No.2 selected.	b.	Identify one of the Processors as ID No.2 with the A0 function.
	c.	Loss of power to Processor ID No.2	c.	Restore power to Processor ID No.2.
	d.	Twin Screw System: One Processor has A1 set 01 (single screw) selected and the other Processor has A1 set 02 (twin screw).	d.	Set Up A1 to 02 (twin screw) on both Processors.
46	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.
47	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.
48	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.
49	a.	The Station Expander Serial Harness is not connected to ID #6, although it has been selected.	a.	Connect the Station Expander serial Harness into ID #6.
	b.	If six items had been selected, ID #6 has not been identified.	b.	Identify one item as ID #6 with the A0 Function.
	c.	Loss of power to ID#6.	c.	Restore power to ID#6.
50	a.	The Station Expander Serial Harness is not connected to ID #7, although it has been selected.	a.	Connect the Station Expander serial Harness into ID #7.
	b.	If six items had been selected, ID #7 has not been identified.	b.	Identify one item as ID #7 with the A0 Function.
	c.	Loss of power to ID#7	c.	Restore power to ID#7.
51	a.	The Station Expander Serial Harness is not connected to ID #8, although it has been selected.	a.	Connect the Station Expander serial Harness into ID #8.
	b.	If six items had been selected, ID #8 has not been identified.	b.	Identify one item as ID #8 with the A0 Function.
	c.	Loss of power to ID#8.	c.	Restore power to ID#8.
52	a.	The Station Expander Serial Harness is not connected to ID #9, although it has been selected.	a.	Connect the Station Expander serial Harness into ID #9.
	b.	If six items had been selected, ID #9 has not been identified.	b.	Identify one item as ID #9 with the A0 Function.
	c.	Loss of power to ID#9.	c.	Restore power to ID#9.

Table 10-11: Basic Control System Problem Causes and Solutions

Error #	Cause		Solution	
53	a.	The Station Expander Serial Harness is not connected to ID #10, although it has been selected.	a.	Connect the Station Expander serial Harness into ID #10.
	b.	If six items had been selected, ID #10 has not been identified.	b.	Identify one item as ID #10 with the A0 Function.
	c.	Loss of power to ID#10.	c.	Restore power to ID#10.
54	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.
55	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
56		An unexpected software or hardware reset has occurred.		Replace the Processor.
57		An unexpected software reset has occurred.		Replace the Processor.
58		An unexpected software or hardware reset has occurred.		Replace the Processor.
59		External Interference, such as a lightning strike.		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.

10.9 Troubleshooting 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:

Table 10-12: Basic without Error Codes

Symptom	Cause		Solution	
No audible tones heard at one Control Station when power is first applied to the Processor. All other features function normally.	a	Incorrectly wired Station Harness/ Cable.	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.
The Control Head's red LED doesn't light when in command, but otherwise functions properly	a	Incorrectly wired Station Harness/ Cable.	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 Head. 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.
The engine begins to turn-over while starting and then stops. A slow repetitive tone is heard from all Remote Stations	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 than 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.

Table 10-12: Basic without Error Codes

Symptom	Cause		Solution	
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.	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.
Active Synchronization is inoperable.	a	There is no Tachometer Sensor signal at the Port or Starboard Processor.	a	The Tachometer Sensor frequency can be seen on the Processor's Display by accessing the Diagnostic Menu H0. If the frequency is not measured, check the Tachometer Sensor and the wiring.
	b	Loss of Serial Communication between the Processors.	b	If Active Synchronization is inoperative due to a lack of Serial Communications, one or more Error Codes will be displayed indicating the loss of communication.
	c	The Processor's Identification number(s) have not been set properly.	c	All Processors must have a unique identification number as set with Function Code A0. Refer to section 5: Set Up Procedure.
	d	The correct number of engines has not been set.	d	All Processor must have the same number of engines selected as programmed with Function Code A1. Refer to section 5: Set Up Procedure.
When transferring command from one Station to another, command transfers to one side only. No Error Messages are displayed.		The Control Head Harnesses are plugged into two different Station connectors on a Processor with the Software Revision .0		Set the correct Throttle Profile with Function Code E0. Refer to section 5: Set Up Procedure.Plug the Control Head Harnesses into the same numbered Station connector on the Port and Starboard Processors
When transferring command from one Station to another, the transfer does not take place. The red LED does not light, even temporarily. No Error Messages are displayed.	a.	The Control Head Harnesses are plugged into two different Station connectors on a Processor with the Software Revision .1	a.	Set the correct Throttle Profile with Function Code E0. Refer to section 5: Set Up Procedure.
	b.	The Transfer Button is defective.	b.	Verify a defective Transfer Button by accessing the H0 Diagnostic Menu. If the 0 does not change to a 1 while the Transfer Button is depressed, replace the Control Head.

Table 10-13: Solenoid Clutch Without Error Codes

Symptom	Cause	Solution
Cannot obtain Warm-up Mode while moving the Control Head lever in the Ahead direction, only in the Astern direction.	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.

Table 10-14: Electronic Throttle Without Error Codes

Symptom	Cause		Solution	
The engine RPM's vary, without moving the Control Head lever (synchronization disabled).	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 in section 10.6.1: Transfer. 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.
The engine's Idle and Full Throttle RPM's are too high or too low.	a.	The incorrect Throttle Profile has been set.	a.	Set the correct Throttle Profile with Function Code E0. Refer to section 5: Set Up Procedure.
	b.	The Idle (Function Code E2 Throttle Minimum) and Full Throttle (Function Code E3 Throttle Maximum) are incorrectly set.	b.	Adjust Throttle Minimum E2 and Throttle Maximum E3 as specified in Section 6 - DOCK TRIALS.
	c.	The Governor or its Control Module is incorrectly adjusted or faulty.	c.	After Causes a. and b. have been eliminated, contact a certified engine mechanic to properly adjust.

10.10 Synchronization Troubleshooting

If you encounter a problem with Synchronization, it will more than likely one of the following; failure to attempt to synchronize, synchronizing at different RPM's or RPM variations of one or both engines while synchronized. Each problem is distinct and the cause may differ depending on the type of Synch. Therefore, each type is discussed individually.

10.10.1 Equal Throttle Synchronization

Table 10-15: Basic Troubleshooting

Symptom	Cause		Solution	
Will not synchronize.	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	Plug the Serial Communication Harness into both Processors.
	d	The Port and Starboard Processors have the same ID number.	d	On the Port Processor, scroll to Function A0 and enter a Value of 01. On the Starboard Processor, scroll to Function A0 and enter a Value of 02.

10.10.2 Active Synchronization

Table 10-16: Basic Troubleshooting

Symptom	Cause		Solution	
The green LED is lit solid, though the Engine RPM's differ by a significant amount.	The Tach Sender signal has been lost by one or both Processors.		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.	
Will not synchronize.	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.

Table 10-17: Electronic Throttle

Symptom	Cause		Solution	
The green LED is lit solid, though the Engine RPM's differ by a significant amount.	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.
One or both of the engines continually changes RPM (hunts). Will not synchronize properly	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, or is 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

Table 10-17: Electronic Throttle

Symptom	Cause		Solution	
Synchronization does not function. The Control Head's green LED does not light.	a.	The Processors think Astern is being commanded when the Control Head lever is positioned to the Ahead Detent.	a.	Place both the Port and Starboard Processor into Warm-up Mode by pressing the Transfer Button while moving the Control Head levers to the Ahead detent. Both Control Head's red LEDs should be blinking. If not, the 7-conductor's connections at pins 5 and 7 are reversed.
	b.	The Serial Communication Harness is not properly installed.	b.	Ensure the Serial Harness' plugs are fully inserted into the Port and Starboard Processor's Pigtails.
	c.	The Processors are not programmed for twin screw.	c.	Scroll to Function Code A1 on both Processors and verify that the Value of both is set to 02.
	d.	Both Processors are set to the same ID number.	d.	Scroll to Function Code A0 and verify that the Port and Starboard Processors have different ID numbers.
	e.	Function Code E7 Value is set to 02.	e.	Depending on the installation, change the Value of E7 to 00, 01, or 03.
	f.	Function Code E7 is set to 03 and no Tach Signal is present.	f.	Determine why there is no Tach Signal present.

10.11 Troubleshooting Wire Harnesses

The following Sections list the various Harnesses manufactured for use with the Processor. These tables are invaluable when troubleshooting a suspected interface problem or when manufacturing your own Harnesses.

The Wire Harness Plug figures below indicators:

- SOLID BLACK circles wire termination
- WHITE circles indicate no wire termination.

10.11.1 Basic Control System Harnesses

10.11.1.1 Serial Wire Harnesses

Table 10-18: Wire Harness - Serial Communication (p/n 13316-XX)

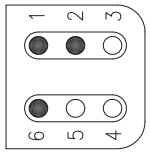
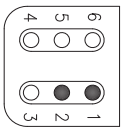
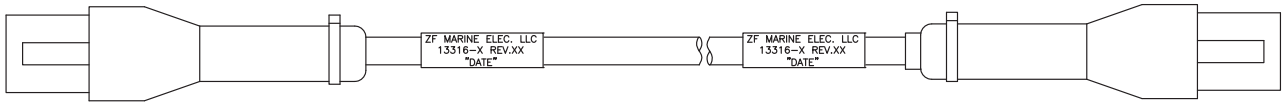
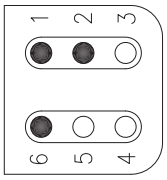
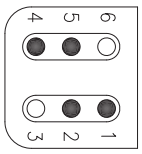
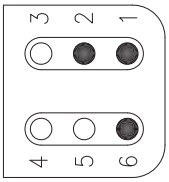
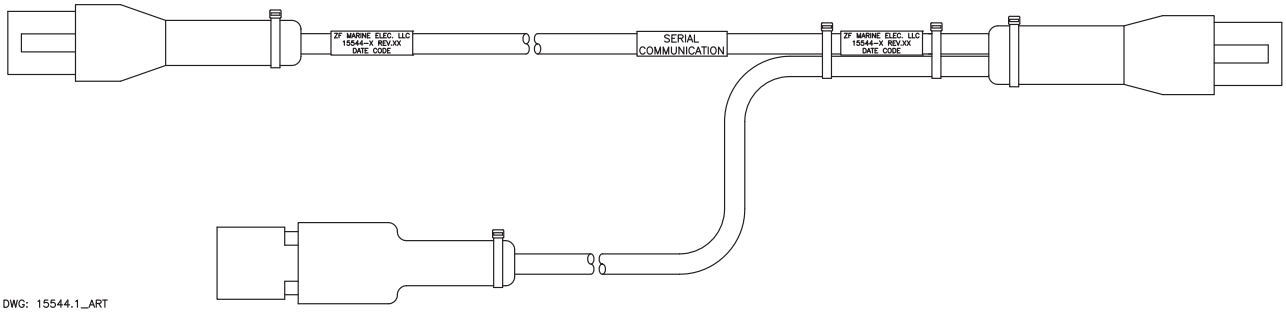
Termination A	Termination B
 PIN 1: BLUE (CAN LOW) PIN 2: WHITE (CAN HIGH) PIN 6: DRAIN WIRE AND SOCKET OR GRN/YEL (DRAIN) OPTION DWG: 13316.2_ART	 PIN 1: BLUE (CAN LOW) PIN 2: WHITE (CAN HIGH) DWG: 13316.2_ART
 DWG: 13316.1_ART	

Table 10-19: Wire Harness - Serial Communication Multi-Screw (p/n 15544-XX)

Termination A	Termination B
 PIN 1: BLUE (CAN LOW) PIN 2: WHITE (CAN HIGH) PIN 6: DRAIN WIRE (SHIELD) DWG: 15544.2_ART	 CABLE 1 – PIN 1: BLUE (CAN LOW) CABLE 1 – PIN 2: WHITE (CAN HIGH) CABLE 2 – PIN 5: BLUE (CAN LOW) CABLE 2 – PIN 4: WHITE (CAN HIGH) DWG: 15544.4_ART
 PIN 1: BLUE (CAN LOW) PIN 2: WHITE (CAN HIGH) PIN 6: DRAIN WIRE (SHIELD) DWG: 15544.3_ART	
	

10.11.1.2 Throttle Wire Harnesses

Table 10-20: Wire Harness - Throttle, Voltage (IVECO, Cummins) (p/n 13432-XX)

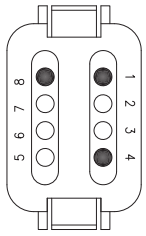
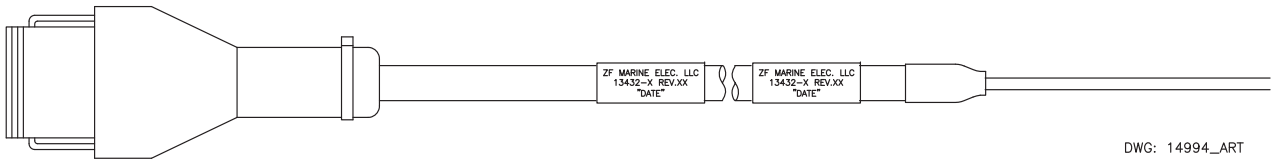
Termination A	Termination B
 PIN 1: BLACK (DC RETURN) PIN 4: RED (+) (VDC) PIN 8: GREEN/YELLOW (SHIELD) DWG: 14993_ART	
 DWG: 14994_ART	

Table 10-21: Wire Harness- Throttle, Current (MAN, MTU) (p/n 13494-XX)

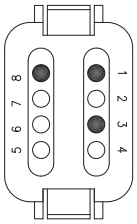
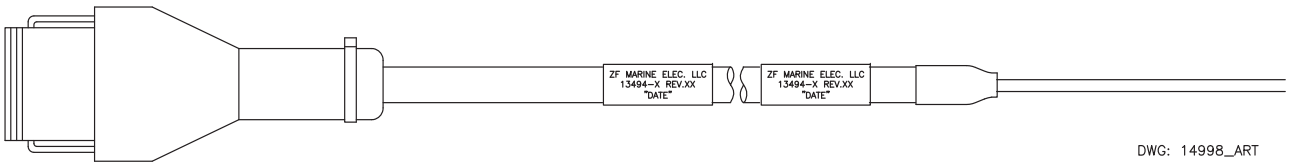
Termination A	Termination B
 PIN 1: BLACK (DC RETURN) PIN 3: RED (+ mA) PIN 8: GREEN/YELLOW (SHIELD) DWG: 14997_ART	
 DWG: 14998_ART	

Table 10-22: Wire Harness - Throttle, Voltage (Cummins Plug), (p/n 13565-XX)

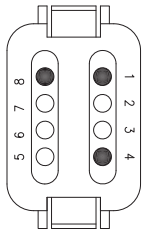
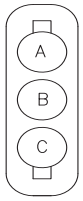
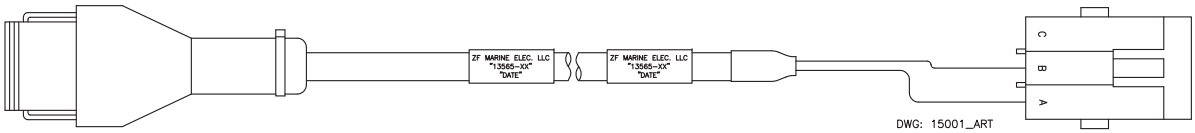
Termination A	Termination B
 PIN 1: BLACK (DC RETURN) PIN 4: RED (+ VDC) PIN 8: GREEN/YELLOW (SHIELD) DWG: 14999_ART	 PIN A: BLACK (DC RETURN) PIN B: RED (+ VDC) DWG: 15000_ART
	

Table 10-23: Voltage Throttle Harness Pin-Out (p/n 14148-XX)

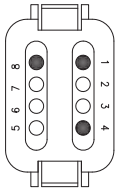
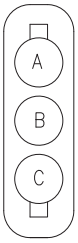
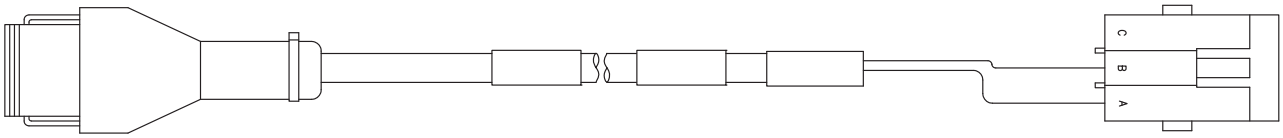
Termination A	Termination B
 PIN 1: BLACK PIN 4: RED PIN 8: GREEN/YELLOW (SHIELD) OR OPTIONAL SHIELD AND SOCKET DWG: 14148.2_ART	 PIN A: BLACK PIN B: RED DWG: 14148.3_ART
 DWG: 14148.1_ART	

Table 10-24: Wire Harness - Throttle (Pulse width modulation [PWM]), (p/n 13533-XX)

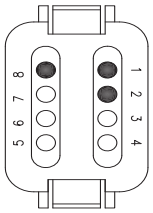
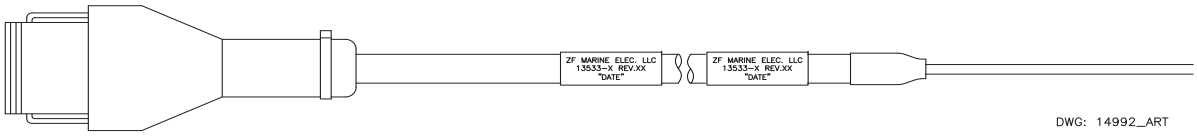
Termination A	Termination B
 PIN 1: BLACK (DC RETURN) PIN 2: RED (+ ECM) PIN 8: GREEN/YELLOW (SHIELD) DWG: 14991_ART	
 DWG: 14992_ART	

Table 10-25: Voltage Throttle Harness Pin-Out (p/n 71262-XX)

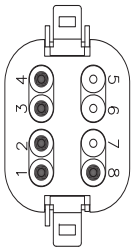
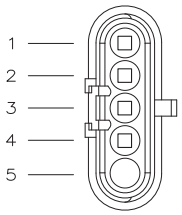
Termination A	Termination B
 PIN 1: GREEN (– ISOLATED RETURN) PIN 2: WHITE (+ THROTTLE V OUT 2) PIN 3: BLACK (– ISOLATED RETURN) PIN 4: RED (+ THROTTLE V OUT 1) PIN 8: SHIELD DWG: 71262.2_ART	 PIN 1: RED W/ JUMPER TO PIN 2 PIN 2: JUMPER PIN 1 TO PIN 2 PIN 3: BLACK W/ JUMPER TO PIN 4 PIN 4: JUMPER PIN 3 TO PIN 4 DWG: 71262.3_ART
 DWG: 71262.1_ART	

Table 10-26: Cable,throttle,man Edc (p/n 14421-XX)

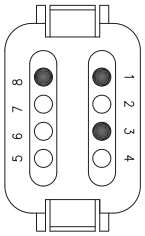
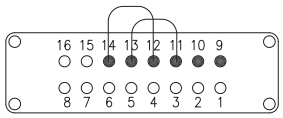
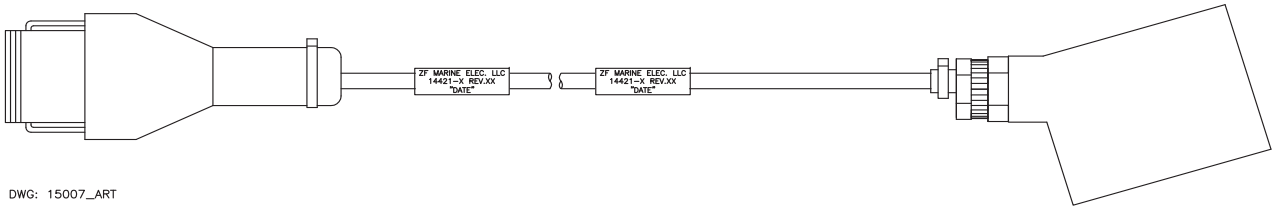
Termination A	Termination B
 PIN 1: BLACK (DC RETURN) PIN 3: RED (mA +) PIN 8: GREEN/YELLOW (SHIELD) DWG: 15005_ART	 DWG: 15006_ART PIN 9: RED (mA) PIN 10: BLACK (DC RETURN)
 DWG: 15007_ART	

Table 10-27: Wire Harness - Throttle Current w/ Mag Pickup, Man (Non-Common Rail) (p/n 14363-XX)

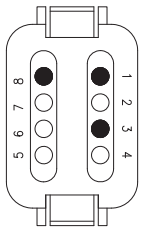
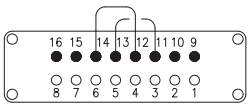
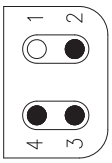
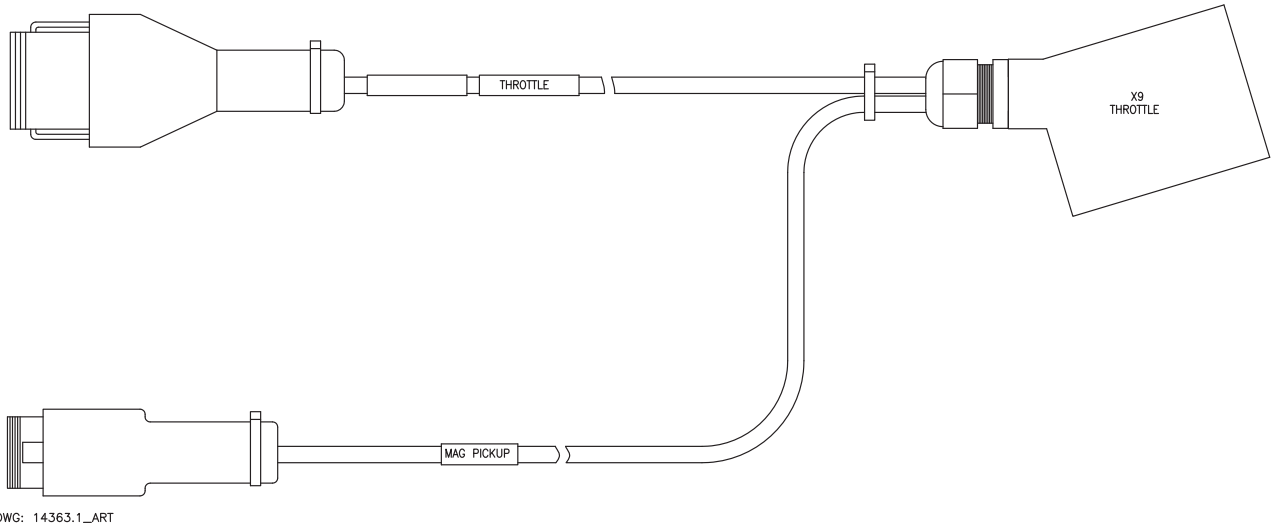
Termination A	Termination B
 PIN 1: BLACK PIN 3: RED PIN 8: GREEN/YELLOW (SHIELD) DWG: 14363.2_ART	 DWG: 14363.3_ART PIN 9: RED (THROTTLE) PIN 10: BLACK PIN 11: JUMPER (P/N: 1557-2) TO PIN 13. PIN 12: JUMPER (P/N: 1557-2) TO PIN 14. PIN 13: JUMPER TO PIN 11 PIN 14: JUMPER TO PIN 12 PIN 15: BLACK (MAG PICKUP) PIN 16: RED (MAG PICKUP)
 PIN 2: RED PIN 3: BLACK PIN 4: GREEN/YELLOW (SHIELD) DWG: 14363.4_ART	
 DWG: 14363.1_ART	

Table 10-28: Wire Harness- Man,common Rail,throttle/clutch/mag (p/n 70013-XX)

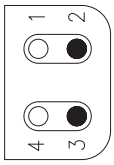
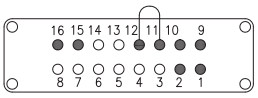
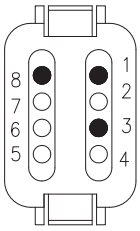
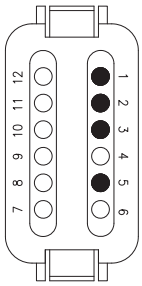
Termination A	Termination B
 PIN 2: WHITE (MAG PICKUP) PIN 3: GREEN (MAG PICKUP) DWG: 70013.2_ART	 DWG: 70013.5_ART PIN 1: RED (AHEAD) PIN 2: BLACK (ASTERN) PIN 9: RED (THROTTLE) PIN 10: BLACK (THROTTLE) PIN 11: BLACK JUMPER TO PIN 12 PIN 12: BLACK JUMPER TO PIN 11 PIN 15: GREEN (MAG PICKUP) PIN 16: WHITE (MAG PICKUP)
 PIN 1: BLACK (THROTTLE) PIN 3: RED (THROTTLE) PIN 8: GREEN/YELLOW (SHIELD) DWG: 70013.3_ART	
 PIN 1: RED (CLUTCH/PWR) PIN 2: BLACK (CLUTCH/PWR) PIN 3: RED (AHEAD) PIN 5: BLACK (ASTERN) DWG: 70013.4_ART	

Table 10-28: Wire Harness- Man,common Rail,throttle/clutch/mag (p/n 70013-XX)

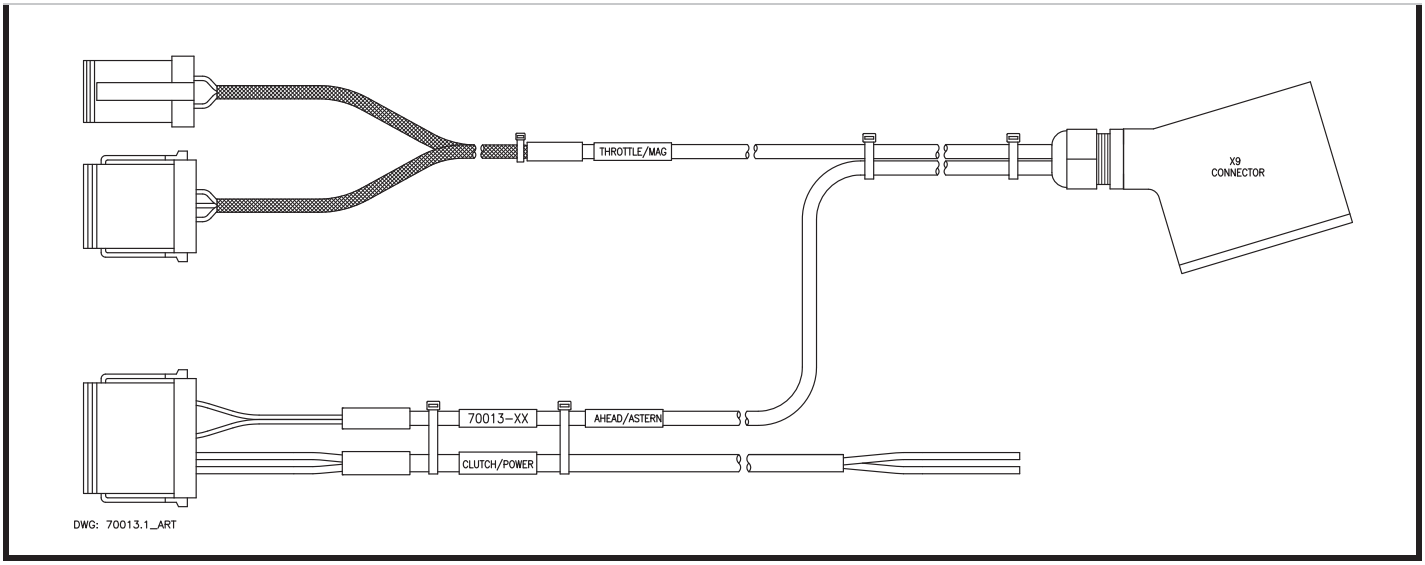
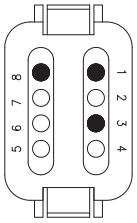
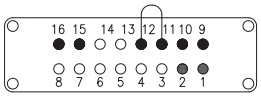
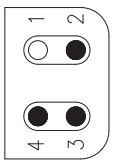
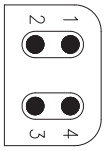
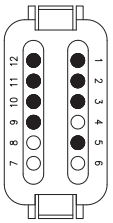
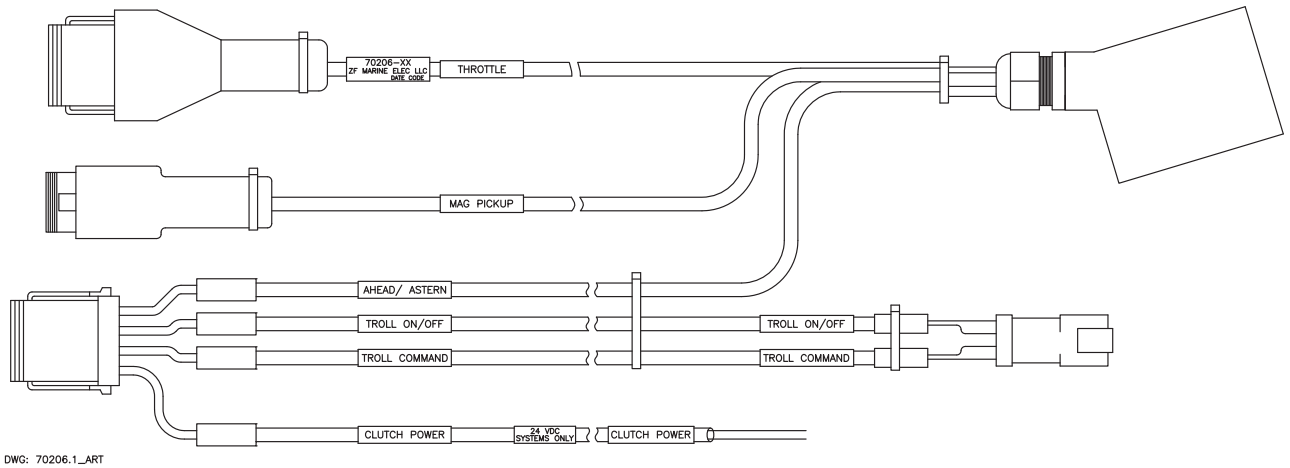
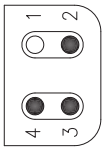
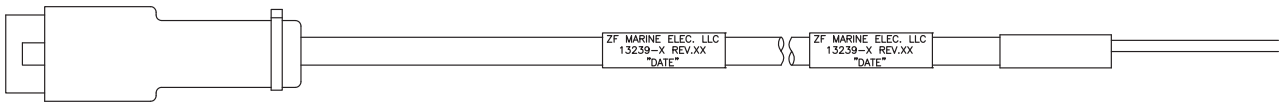


Table 10-29: Wire Harness- Man, Common Rail, Throttle/clutch/mag (p/n 70206-XX)

Termination A	Termination B
 PIN 1: BLACK PIN 3: RED PIN 8: GREEN/YELLOW (SHIELD) DWG: 70206.2_ART	 PIN 1: RED (AHEAD) PIN 2: BLACK (ASTERN) PIN 9: RED (THROTTLE) PIN 10: BLACK (THROTTLE) PIN 11: BLACK JUMPER TO PIN 12 PIN 12: BLACK JUMPER TO PIN 11 PIN 15: BLACK (MAG PICKUP) PIN 16: RED (MAG PICKUP) DWG: 70206.6_ART
 PIN 2: RED PIN 3: BLACK PIN 4: GREEN/YELLOW (SHIELD) DWG: 70206.3_ART	 PIN 1: RED (TROLL ON/OFF +) PIN 2: BLACK (TROLL ON/OFF −) PIN 3: RED (TROLL COMMAND +) PIN 4: BLACK (TROLL COMMAND −) DWG: 70206.5_ART
 PIN 1: CABLE #6: RED (+ CLUTCH POWER) PIN 2: CABLE #6: BLACK (− CLUTCH POWER) PIN 3: CABLE #3: RED (AHEAD) PIN 5: CABLE #3: BLACK (ASTERN) PIN 9: CABLE #4: RED (+ TROLL ON/OFF) PIN 10: CABLE #4: BLACK (− TROLL ON/OFF) PIN 11: CABLE #5: RED (+ TROLL COMMAND) PIN 12: CABLE #5: BLACK (− TROLL COMMAND) DWG: 70206.4_ART	
 DWG: 70206.1_ART	

10.11.1.3 Tachometer Wire Harnesses

Table 10-30: Wire Harness - Tachometer Sensor Harness Pin-Out (p/n 13239-XX)

Termination A	Termination B
 PIN 2: RED PIN 3: BLACK PIN 4: GREEN/YELLOW (SHIELD) OR OPTION SHIELD AND SOCKET DWG: 13239.2_ART	
 DWG: 13239.1_ART	

10.11.1.4 Clutch Wire Harnesses

Table 10-31: Wire Harness - Clutch Ahead, Astern (p/n 13322-XX)

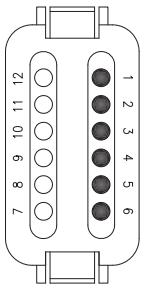
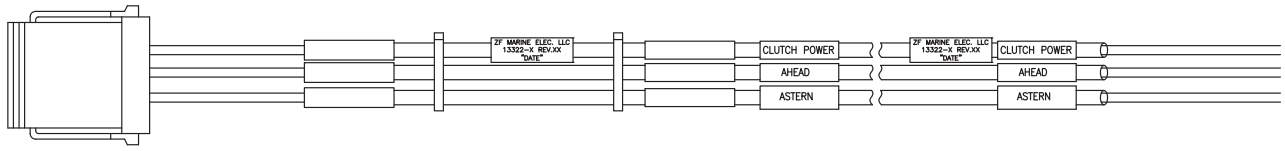
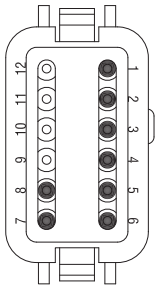
Termination A	Termination B
 PIN 1: RED (CLUTCH POWER) PIN 2: BLACK (CLUTCH POWER) PIN 3: RED (AHEAD) PIN 4: BLACK (AHEAD) PIN 5: RED (ASTERN) PIN 6: BLACK (ASTERN) DWG: 13322.2_ART	
 DWG: 13322.1_ART	

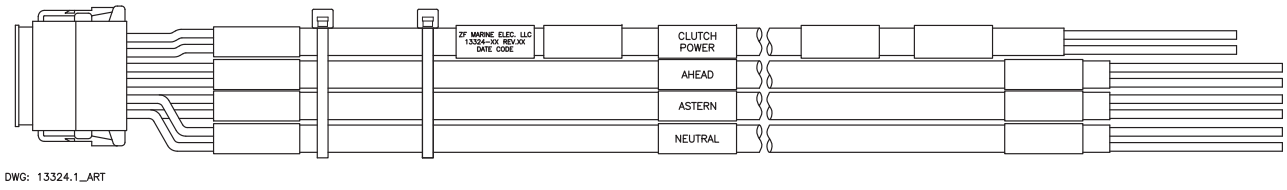
Table 10-32: Wire Harness - Ahead, Neutral, and Astern Clutch Harness Pin-Out (p/n 13324-XX)

Termination A	Termination B



PIN 1: CLUTCH POWER: RED
PIN 2: CLUTCH POWER: BLACK
PIN 3: AHEAD: RED
PIN 4: AHEAD: BLACK
PIN 5: ASTERN: RED
PIN 6: ASTERN: BLACK
PIN 7: NEUTRAL: RED
PIN 8: NEUTRAL: BLACK

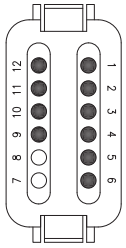
DWG: 13324.2_ART



DWG: 13324.1_ART

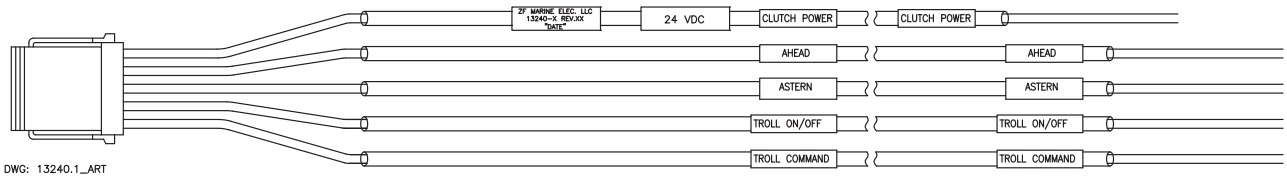
Table 10-33: Wire Harness - Clutch, Ahead, Astern, Troll, Troll Command (p/n 13240-XX)

Termination A	Termination B



PIN 1: RED (CLUTCH POWER)
PIN 2: BLACK (CLUTCH POWER)
PIN 3: RED (AHEAD)
PIN 4: BLACK (AHEAD)
PIN 5: RED (ASTERN)
PIN 6: BLACK (ASTERN)
PIN 9: RED (TROLL ON/OFF)
PIN 10: BLACK (TROLL ON/OFF)
PIN 11: RED (TROLL COMMAND)
PIN 12: BLACK (TROLL COMMAND)

DWG: 13240.2_ART



DWG: 13240.1_ART

Table 10-34: Wire Harness - Clutch, Ahead, Astern, Troll Command(p/n 14310-XX)

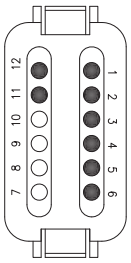
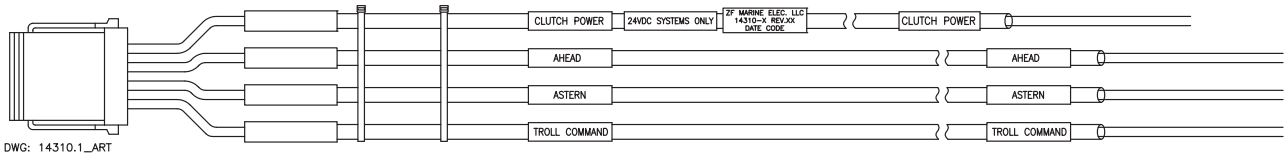
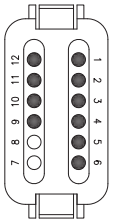
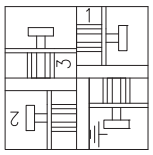
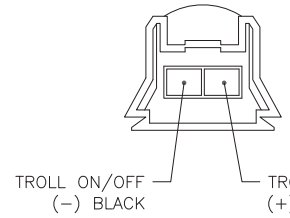
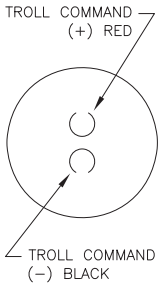
Termination A	Termination B
 PIN 1: RED (CLUTCH POWER) PIN 2: BLACK (CLUTCH POWER) PIN 3: RED (AHEAD) PIN 4: BLACK (AHEAD) PIN 5: RED (ASTERN) PIN 6: BLACK (ASTERN) PIN 11: RED (TROLL COMMAND) PIN 12: BLACK (TROLL COMMAND) DWG: 14310.2_ART	
 DWG: 14310.1_ART	

Table 10-35: Clutch Ahead, Astern, Troll, Troll Command (ZF2000) (p/n 15414-XX)

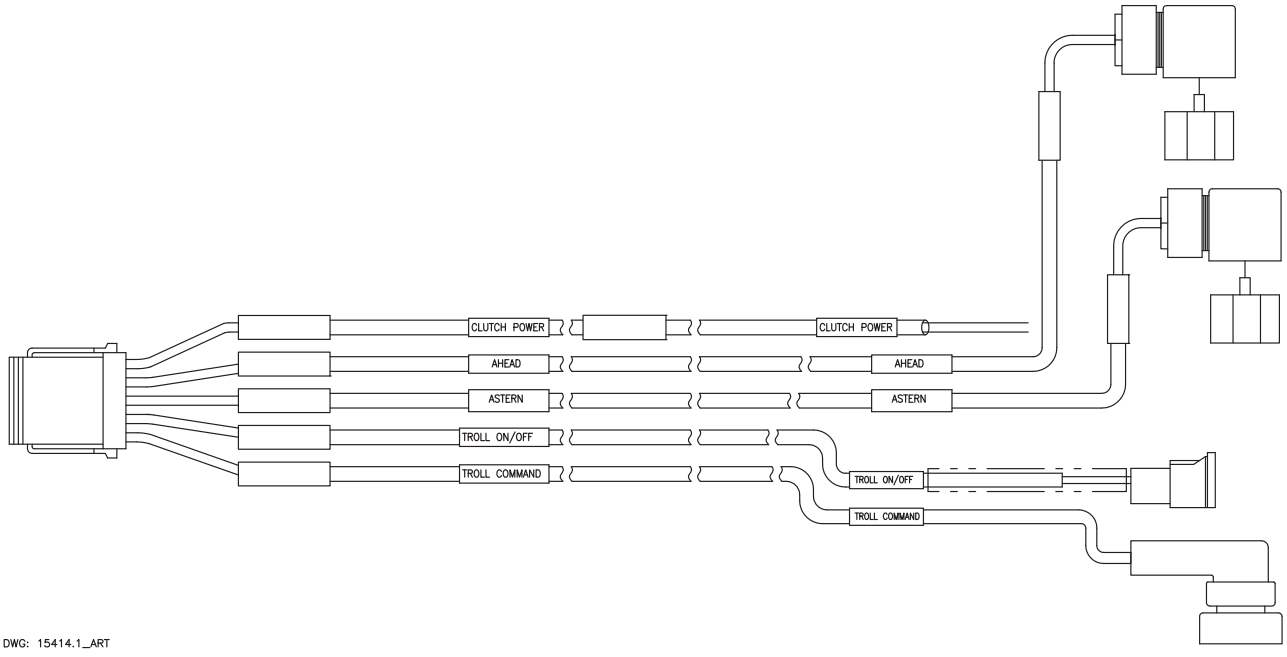
Termination A	Termination B
 PIN 1: CABLE #1: RED (CLUTCH POWER) PIN 2: CABLE #1: BLACK (CLUTCH POWER) PIN 3: CABLE #2: RED (AHEAD) PIN 4: CABLE #2: BLACK (AHEAD) PIN 5: CABLE #3: RED (ASTERN) PIN 6: CABLE #3: BLACK (ASTERN) PIN 9: CABLE #4: RED (TROLL ON/OFF) PIN 10: CABLE #4: BLACK (TROLL ON/OFF) PIN 11: CABLE #5: RED (TROLL COMMAND) PIN 12: CABLE #5: BLACK (TROLL COMMAND) DWG: 15414.2_ART	 PIN 1: RED PIN 2: BLACK DWG: 15414.3_ART



DWG: 15414.4_ART

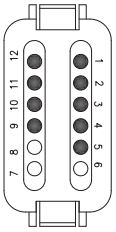
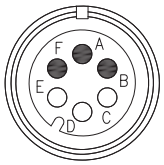
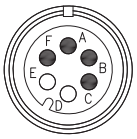
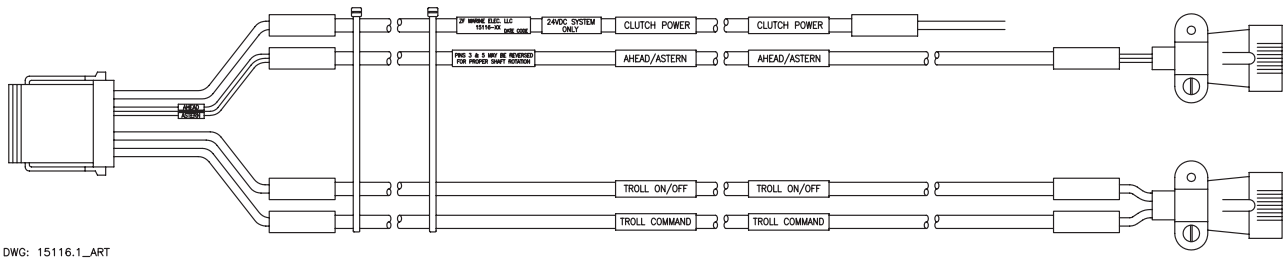


DWG: 15414.5_ART



DWG: 15414.1_ART

Table 10-36: Wire Harness - Clutch, Ahead, Astern, Troll, Troll Command (ZFF 4600 Gears) (p/n 15116-XX)

Termination A	Termination B
 PIN 1: RED (+) (CLUTCH POWER CABLE) PIN 2: BLACK (–) (CLUTCH POWER CABLE) PIN 3: RED (+) (AHEAD CABLE) PIN 4: BLACK (–) (AHEAD CABLE) PIN 5: RED (+) (ASTERN CABLE) PIN 9: RED (+) (TROLL ON/OFF CABLE) PIN 10: BLACK (–) (TROLL ON/OFF CABLE) PIN 11: RED (+) (TROLL COMMAND CABLE) PIN 12: BLACK (–) (TROLL COMMAND CABLE) DWG: 15116.2_ART	 PIN A: RED (+) (AHEAD) PIN B: RED (+) (ASTERN) PIN F: BLACK (–) (AHEAD) DWG: 15116.3_ART
 PIN A: RED (+) (TROLL COMMAND) PIN B: RED (+) (TROLL ON/OFF) PIN C: BLACK (–) (TROLL ON/OFF) PIN F: BLACK (–) (TROLL COMMAND) DWG: 15116.5_ART	
 DWG: 15116.1_ART	

10.11.1.5 Power Wire Harnesses

Table 10-37: Power, Start Interlock Harness Pin-Out (p/n 13756-XX)

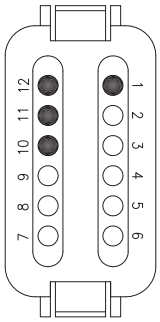
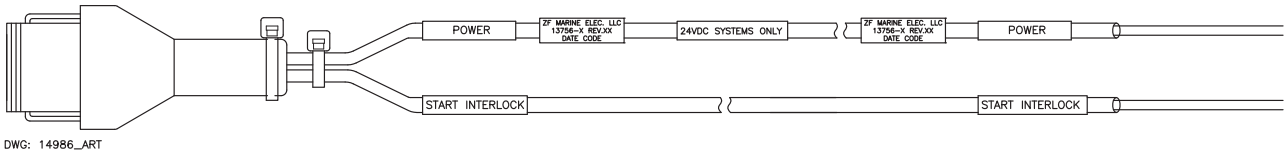
Termination A	Termination B
 PIN 11: BLACK (POWER) PIN 10: RED (POWER) PIN 1: YELLOW W/RED (START INTERLOCK) PIN 12: YELLOW W/RED (START INTERLOCK) DWG: 14985_ART	
 DWG: 14986_ART	

Table 10-38: Wire Harness - Power, SI & Clutch Pressure Switch (p/n 13552-XX)

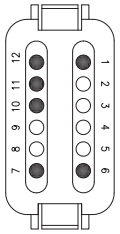
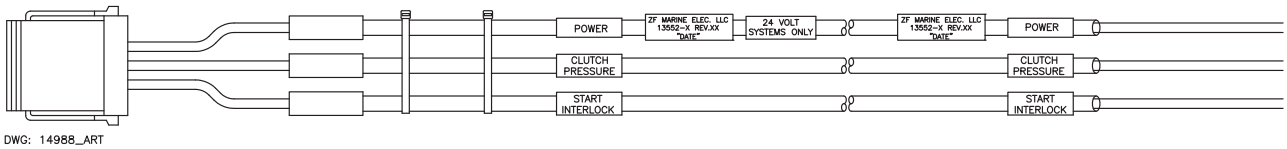
Termination A	Termination B
 PIN 1: YELLOW W/RED (START INTERLOCK) PIN 6: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 7: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 10: RED (POWER) PIN 11: BLACK (POWER) PIN 12: YELLOW W/RED (START INTERLOCK) DWG: 14987_ART	
 DWG: 14988_ART	

Table 10-39: Wire Harness - Power, SI, Clutch Pressure Switch & Alarm (p/n 13631-XX)

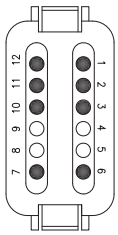
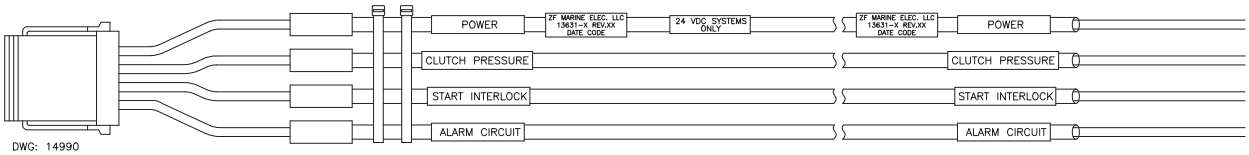
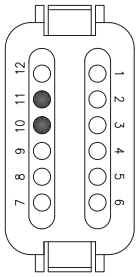
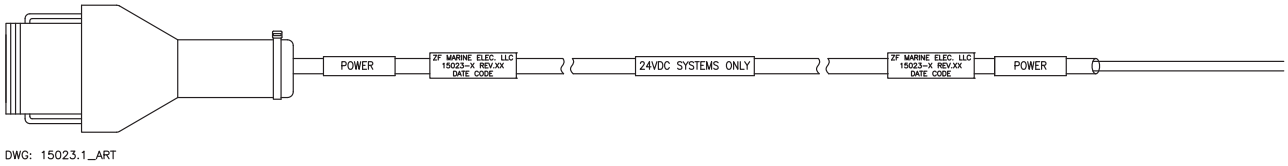
Termination A	Termination B	
 PIN 1: YELLOW W/RED (START INTERLOCK) PIN 2: RED (ALARM CIRCUIT) PIN 3: BLACK (ALARM CIRCUIT) PIN 6: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 7: LIGHT BLUE (CLUTCH OIL PRESSURE) PIN 10: RED (POWER) PIN 11: BLACK (POWER) PIN 12: YELLOW W/RED (START INTERLOCK) DWG: 14989_ART		
 DWG: 14990		

Table 10-40: Wire Harness- Power Use W/existing St Intlk Only (p/n 15023-XX)

Termination A	Termination B
 PIN 10: RED PIN 11: BLACK DWG: 15023.2_ART	
 DWG: 15023.1_ART	

10.11.1.6 Control Head Wire Harnesses

Table 10-41: Wire Harness - Control Head One Connector (p/n 13557-XX)

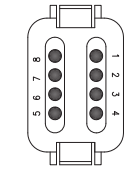
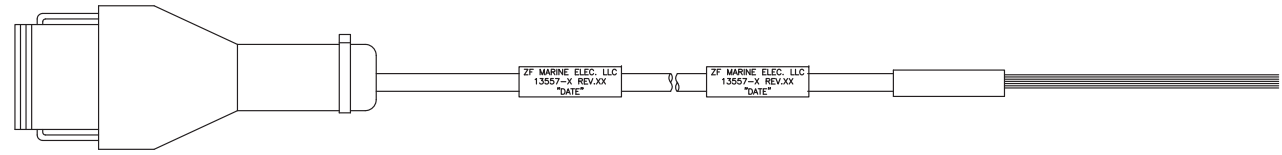
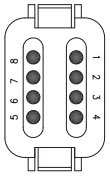
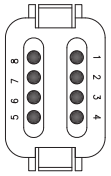
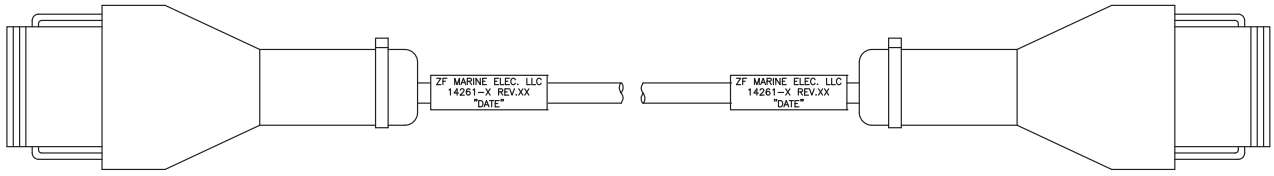
Termination A	Termination B
 DWG: 13557.2_ART PIN 1: GREEN/YELLOW (SHIELD) OR OPTIONAL SHIELD TO SOCKET PIN 2: BROWN RED LED (+) PIN 3: VIOLET GREEN LED (–) (SYNC) PIN 4: ORANGE TRANSFER BUTTON (+) PIN 5: RED GROUND PIN 6: GREEN LEVER COMMAND SIGNAL PIN 7: BLUE VREF (+5VDC) PIN 8: BLACK TONE (+)	
 DWG: 13557.1_ART	

Table 10-42: Wire Harness - Control Head Two Connectors (p/n 14261-XX)

Termination A	Termination B
 DWG: 14261.2_ART PIN 1: GREEN/YELLOW (SHIELD) OR OPTIONAL SHIELD TO SOCKET PIN 2: BROWN RED LED (+) PIN 3: VIOLET GREEN LED (–) (SYNC) PIN 4: ORANGE TRANSFER BUTTON (+) PIN 5: RED GROUND PIN 6: GREEN LEVER COMMAND SIGNAL PIN 7: BLUE VREF (+5VDC) PIN 8: BLACK TONE (+)	 DWG: 14261.2_ART PIN 1: GREEN/YELLOW (SHIELD) OR OPTIONAL SHIELD TO SOCKET PIN 2: BROWN RED LED (+) PIN 3: VIOLET GREEN LED (–) (SYNC) PIN 4: ORANGE TRANSFER BUTTON (+) PIN 5: RED GROUND PIN 6: GREEN LEVER COMMAND SIGNAL PIN 7: BLUE VREF (+5VDC) PIN 8: BLACK TONE (+)
 DWG: 14261.1_ART	

NOTE: (P/N 14261) Starboard Side of Control Head - Jumper Pins 3 to 5;
Port Side of Control Head - Jumper Pins 3 to 7

11 Appendix A - System Components and Specifications

400 Series Control Head Variations

Table MMC-280-1: Revision List

Rev	Date	Description
- to N.1	07/10	Previous date unavailable
N.2	02/15/12	Added compass distance note

This Service Sheet reflects all current variations of the standard 3-detent ZF 400 Series Control Heads.

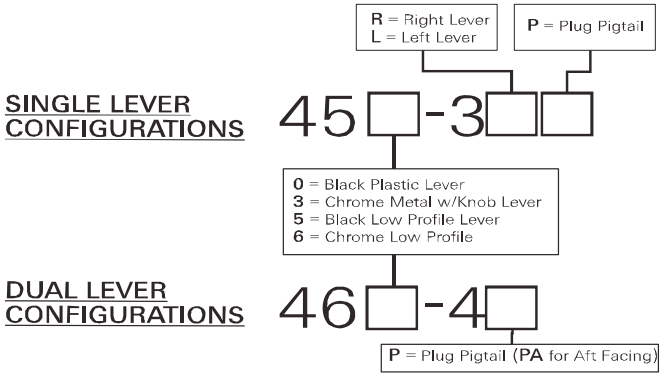


Figure MMC-280-1: Part Numbering Configurations

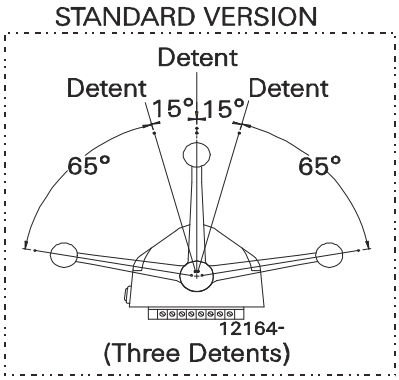


Figure MMC-280-2: Detents Available

1. Requirements:

   MicroCommander/ClearCommand: one (1) 8-Conductor Cable per Control Head lever.

   Pluggable MicroCommander/ClearCommand: one (1) Control Head Harness per Control Head lever.

   CruiseCommand: one (1) Control Head Harness per Control Head lever.

   Included with the Control Head:

   - Gasket
   - Mounting screws and washers
   - Terminals (For 8-Conductor or 1-Connector Harnesses)
   - Watertight cable grip for the cable entrance on the Processor (For 8-Conductor)

   When the Control Head is properly mounted on a console, it is spray proof from the top only. An adhesive gasket must be used to seal it to the mounting surface. However, below the mounting surface it needs protection from water or spray. Consider using a Weather Mount Enclosure, which is available from ZF.

2. Mounting And Installation:
   - A Select the desired mounting locations and make cutouts per template. Refer to Figure MMC-280-3: Dimensions.
   - B Check that the four mounting screws will start into the Control Head. Remove the Control Head from the cutout.
   - C Remove the backing from the adhesive gasket and apply the gasket adhesive side to the console around the cutout.
   - D Run cable/harnesses between Processor and Control Head. Label both ends with the Station ID. (EXAMPLE: Port, Center, or Starboard; Port Thrust, Port Throttle; etc.)

   There are two types of Control Head connections available: Plug or Terminal Connected. Both types may be used with MicroCommander, ClearCommand, or CruiseCommand using the appropriate cable or harness. Follow the appropriate steps for the Control Head that has been supplied for your system.

WARNING: Do not mount control head less than 100mm from Compass.
Mounting control head too close to compass can cause the compass to malfunction.

3. Type 1 - Pluggable

   Plug Control Head cable into the pigtail at the Control Head. (Ensure the correct Processor Cable is being plugged into the corresponding Control Head lever pigtail).

   When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected. Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

4. Type 2 - Hard-wired
   - A Strip back the PVC cover on the shielded cable approximately 2-1/2" (63,5mm) at the Control Head.
   - B At the Control Head end of the cable strip and cut off the shielding and drain wire flush with the end of the PVC cover (the drain wire at the Control Head is not connected to ground).
   - C Strip 3/8" (9,5mm) insulation off each wire.
   - D Twist the individual strands of the wires to minimize fraying.
   - E Crimp a locking fork terminal (included with each Control Head) to each of the conductors.
   - F Make connections to the Control Head as indicated in the following TERMINAL CONNECTIONS diagrams.

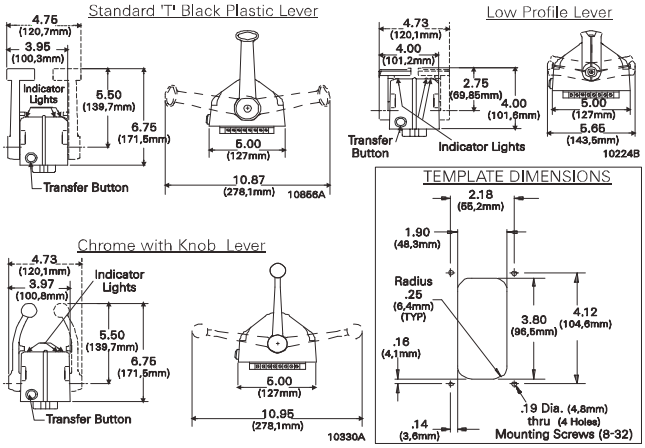


Figure MMC-280-3: Dimensions

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

When cable connections are complete, MOUNT Control Head to the console using the four (4) mounting screws and washers supplied with the Control Head.

5. CABLE/HARNESS CONNECTIONS:

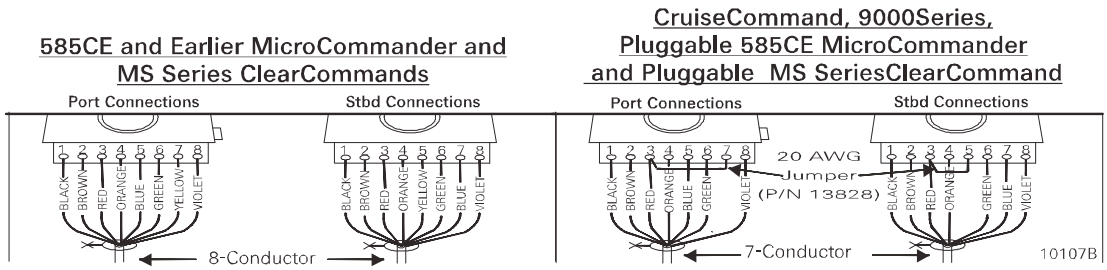


Figure MMC-280-4: Terminal Connections

Cable/Jumper connections 5 and 7 at the Port and Starboard terminal block are direction sensitive.

MicroCommander/ClearCommand			
Port Lever:		Starboard Lever:	
Terminal 3	Red	Terminal 3	Red
Terminal 5	Blue	Terminal 5	Yellow
Terminal 7	Yellow	Terminal 7	Blue

CruiseCommand/9000 Series			
Port Lever:		Starboard Lever:	
Terminal 3	Red & JUMPER	Terminal 3	Red & JUMPER
Terminal 5	Blue	Terminal 5	JUMPER
Terminal 7	JUMPER	Terminal 7	Blue

6. Pluggable Connections
   Pluggable Control Heads are supplied with a harness pigtail for each lever. When disconnecting/connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully disconnected or connected. Disconnecting/connecting plugs without depressing and holding the release button or buttons WILL damage the plug.

7. AFT FACING CONTROL HEADS

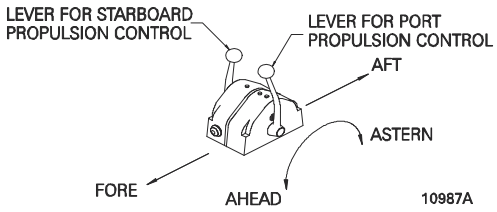
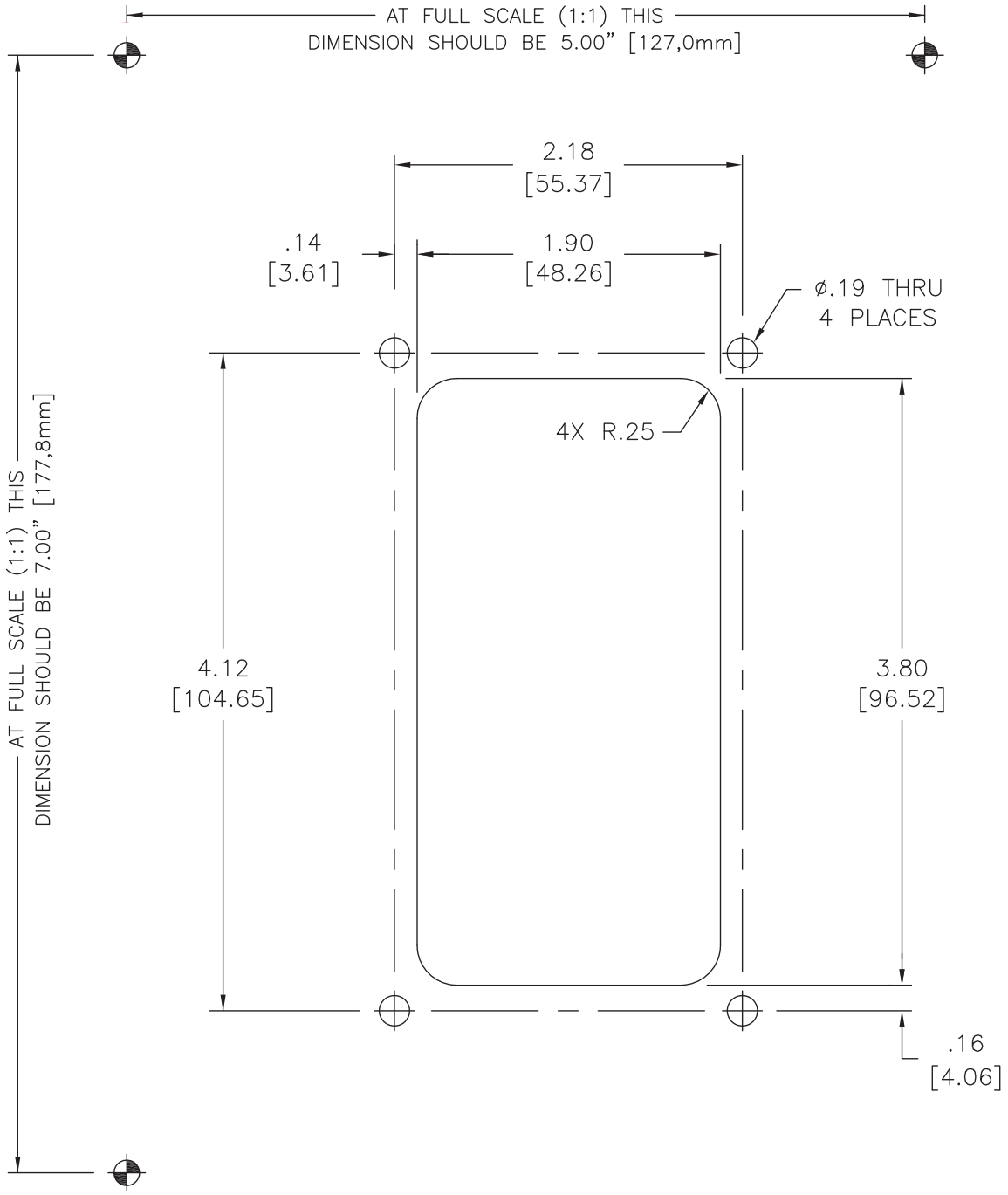


Figure MMC-280-5: AFT Facing Control Head

For dual lever Control Head Stations that have the user facing aft: Reverse connections 5 and 7.

For single lever Control Head Stations that have the user facing aft and the one Control Head lever on the user's right, reverse connections 5 and 7.

Handheld Control is a Station option. Contact your ZF Dealer for further information on Handheld requirements and options.



	**WARNING: Do not mount control head less than 100mm from Compass.** **Mounting control head too close to compass can cause the compass to malfunction.**

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

MC2000 Series Standard Control Head Variations

Table MMC-329-1: Revision List

Rev	Date	Description
- to E.1	03/11	Previous date unavailable
E.2	02/15/12	Added compass distance note

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

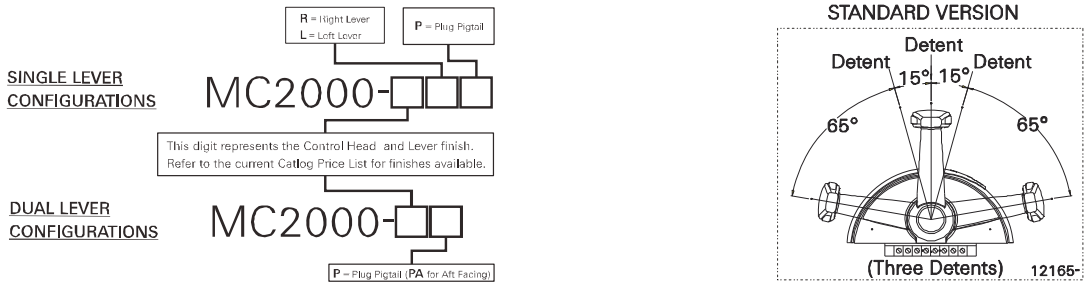


Figure MMC-329-1: Part Numbering Configurations Detents Available

REQUIREMENTS:

MicroCommander/ClearCommand: one (1) 8-Conductor Cable per Control Head lever.

Pluggable MicroCommander/ClearCommand: one (1) Control Head Harness per Control Head lever.

CruiseCommand: one (1) Control Head Harness per Control Head lever.

Included with the Control Head:

- Mounting screws
- Terminals (For 8-Conductor or 1-Connector Harnesses)
- Watertight cable grip for the cable entrance on the Processor (For 8-Conductor)

When the Control Head is properly mounted on a console, it is spray proof from the top only. An adhesive gasket is mounted on the bottom of the Control Head to seal it to the mounting surface. However, below the mounting surface it needs protection from water or spray. Consider using a Weather Mount Enclosure, which is available from ZF.

MOUNTING AND INSTALLATION:

A Select the desired mounting locations and make cutouts per template. Refer to Figure MMC-329-2: Dimensions.

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

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

WARNING: Do not mount control head less than 250mm from Compass.
Mounting control head too close to compass can cause the compass to malfunction.

Dimensions

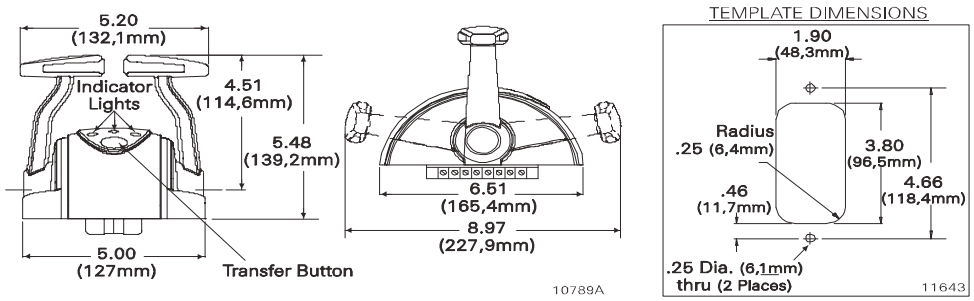


Figure MMC-329-2: Dimensions

There are two types of Control Head connections available: Plug or Terminal Connected. Both types may be used with MicroCommander, ClearCommand, or CruiseCommand using the appropriate cable or harness. Follow the appropriate steps for the Control Head that has been supplied for your system.

Pluggable

A Plug Control Head cable into the pigtail at the Control Head. (Ensure the correct Processor Cable is being plugged into the corresponding Control Head lever pigtail).

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

C Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

Standard Cable

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

B At the Control Head end of the cable strip and cut off the shielding and drain wire flush with the end of the PVC cover (the drain wire at the Control Head is not connected to ground).

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

D Twist the individual strands of the wires to minimize fraying.

E Crimp a locking fork terminal (included with each Control Head) to each of the conductors.

F Make connections to the Control Head as indicated in the following TERMINAL CONNECTIONS diagrams.

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

When cable connections are complete, MOUNT Control Head to the console using the two (2) mounting screws and washers supplied with the Control Head.

CABLE/HARNESS CONNECTIONS:

Dual Control Head Connections

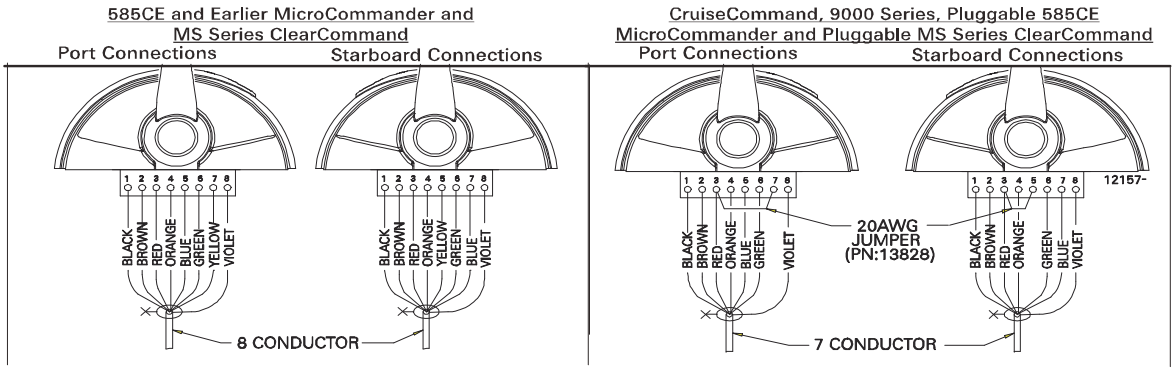


Figure MMC-329-3: Terminal Connections

Cable/Jumper connections 5 and 7 at the Port and Starboard terminal block are direction sensitive.

MicroCommander/ClearCommand		CruiseCommand/9000 Series	
Port Lever:	Starboard Lever:	Port Lever:	Starboard Lever:
Terminal 3 Red	Terminal 3 Red	Terminal 3 Red & JUMPER	Terminal 3 Red & JUMPER
Terminal 5 Blue	Terminal 5 Yellow	Terminal 5 Blue	Terminal 5 JUMPER
Terminal 7 Yellow	Terminal 7 Blue	Terminal 7 JUMPER	Terminal 7 Blue

Pluggable Connections

Pluggable Control Heads are supplied with a harness pigtail for each lever. When disconnecting/connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully disconnected or connected. Disconnecting/connecting plugs without depressing and holding the release button or buttons WILL damage the plug.

Aft Facing Control Heads

For dual lever Control Head Stations that have the user facing aft: Reverse connections 5 and 7.

For single lever Control Head Stations that have the user facing aft and the one Control Head lever on the user's right, reverse connections 5 and 7.

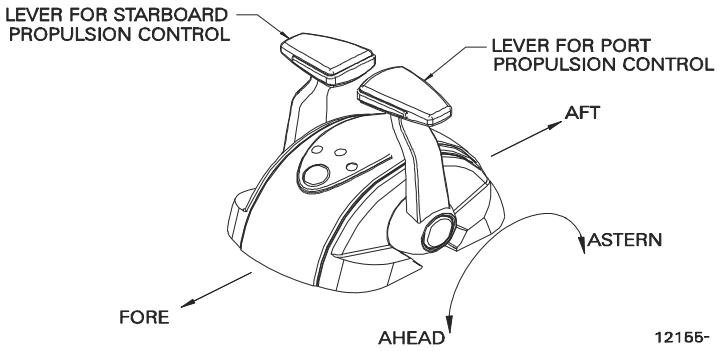
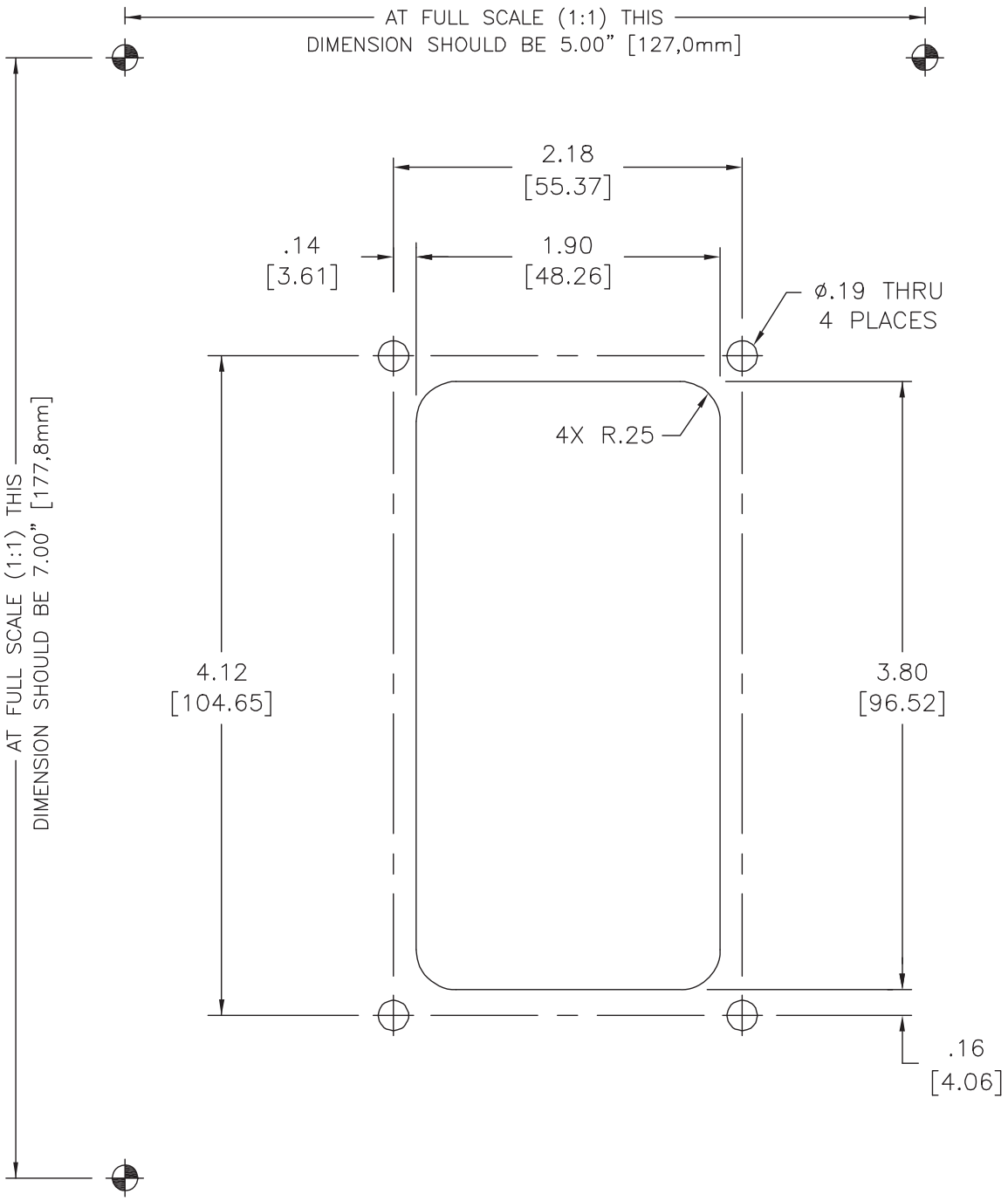


Figure MMC-329-4: AFT Facing Control Head

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



	**WARNING: Do not mount control head less than 250mm from Compass.** **Mounting control head too close to compass can cause the compass to malfunction.**

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

700 Series Standard Control Head Variations

This Service Sheet reflects all current variations of the standard 3-detent ZF Marine Electronics 700 Series Control Heads.

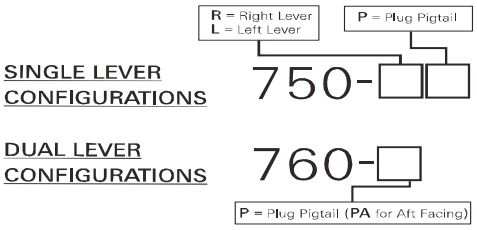


Figure MMC-307-1: Part Numbering Configurations

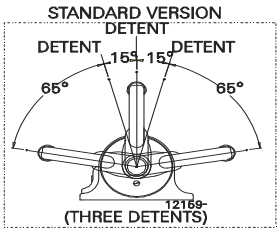


Figure MMC-307-2: Detents Available

1. REQUIREMENTS:

   MicroCommander/ClearCommand: one (1) 8-Conductor Cable per Control Head lever.

   Pluggable MicroCommander/ClearCommand: one (1) Control Head Harness per Control Head lever.

   CruiseCommand: one (1) Control Head Harness per Control Head lever.

   Included with the Control Head:

   - (4) Flat-washer - Stainless Steel, 1/4 inch
   - (4) Screw - Stainless Steel, Philip Pan Head, 1/4 inch-20 x 1-3/4 inch
   - (4) Nut - Stainless Steel, 1/4 inch-20
   - (14) Terminal - Flanged For, #6
   - (2) Liquid Tight Connector (in addition to those installed at the factory)

   When the Control Head is properly mounted on a console, the Control Head is watertight.

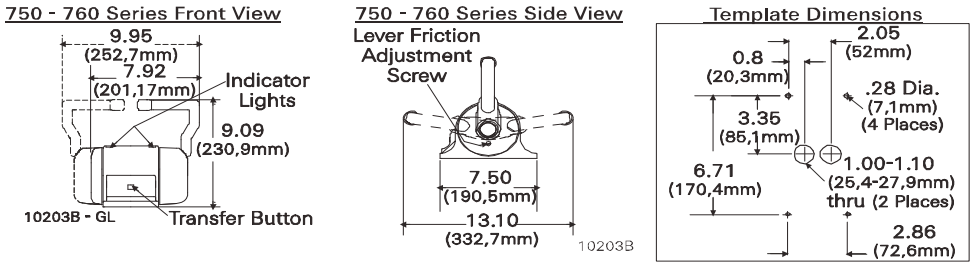


Figure MMC-307-3: Dimensions

2. MOUNTING AND INSTALLATION:

   Select the desired mounting locations and drill screw and cable holes as indicated on the template diagram. Refer to the Dimensions Diagram on the next page.

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

   There are two types of Control Head connections available: Plug or Terminal Connected. Both types may be used with MicroCommander, ClearCommand, or CruiseCommand using the appropriate cable or harness. Follow the appropriate steps for the Control Head that has been supplied for your system.

3. Standard Cable
   - A Remove the six screws holding the bottom cover of the Control Head housings and set aside.
   - B Insert cable through the correct cable grip in the bottom cover.
   - C Strip back the PVC cover on the shielded cable approximately 2-1/2" (63,5mm) at the Control Head.
   - D At the Control Head end of the cable strip and cut off the shielding and drain wire flush with the end of the PVC cover (the drain wire at the Control Head is not connected to ground).
   - E Strip 3/8" (9,5mm) insulation off each wire.
   - F Twist the individual strands of the wires to minimize fraying.
   - G Crimp a locking fork terminal (included with each Control Head) to each of the conductors.

   Make connections to the Control Head as indicated in the following TERMINAL CONNECTIONS diagrams.

4. Pluggable
   - A Plug Control Head cable into the pigtail at the Control Head. (Ensure the correct Processor Cable is being plugged into the corresponding Control Head lever pigtail).
   - B When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected. Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

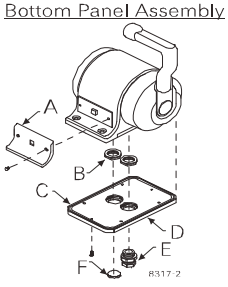
   ALWAYS REFER TO THE MANUAL THAT IS SUPPLIED WITH THE CONTROL SYSTEM FOR ANY UNIQUE CONTROL HEAD CONNECTIONS FOR YOUR SYSTEM.

   When cable connections are complete:

   - A Replace Control Head bottom cover using the six (6) mounting screws removed earlier. Ensure seal is in place.
   - B Tighten watertight cable grip(s).
   - C Remove front cover from the Control Head
   - D Mount Control Head with supplied hardware.
   - E Replace front cover when mounting is complete.

5. Bottom Panel Assembly Designations
   - A Front Cover
   - B Cable Grip Nut
   - C Seal
   - D Bottom Cover
   - E 750-R = Plug; 750-L & 760 = Watertight Cable Grip (Cable O.D..275 -.393 [7mm - 10mm)
   - F 750-L = Plug; 750-R & 760 = Watertight Cable Grip (Cable O.D..275 -.393 [7mm - 10mm)

Bottom Panel Assembly



6. CABLE/HARNESS CONNECTIONS:

MicroCommander/ClearCommand			
Port Lever:		**Starboard Lever:**	
Terminal 3	Red	Terminal 3	Red
Terminal 5	Blue	Terminal 5	Yellow
Terminal 7	Yellow	Terminal 7	Blue

CruiseCommand/9000 Series			
Port Lever:		**Starboard Lever:**	
Terminal 3	Red & JUMPER	Terminal 3	Red & JUMPER
Terminal 5	Blue	Terminal 5	JUMPER
Terminal 7	JUMPER	Terminal 7	Blue

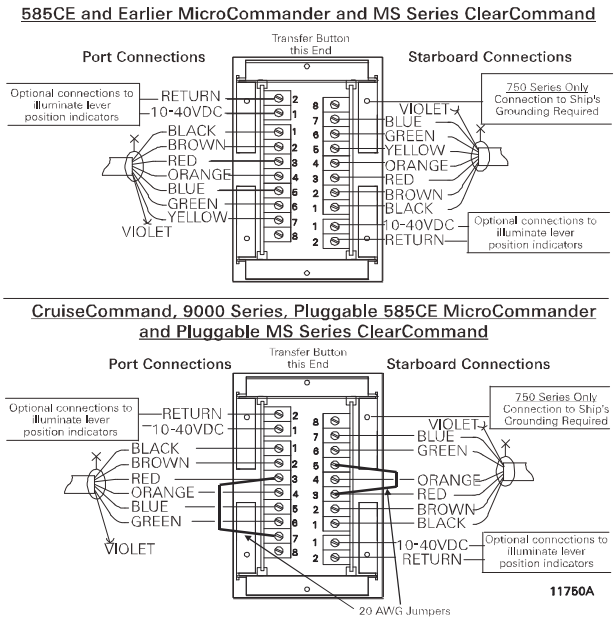


Figure MMC-307-4: Dual Control Head Connections

7. Pluggable Connections

Pluggable Control Heads are supplied with a harness pigtail for each lever. When disconnecting/connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully disconnected or connected. Disconnecting/connecting plugs without depressing and holding the release button or buttons WILL damage the plug.

8. Aft Facing Control Head

For dual lever Control Head Stations that have the user facing aft: Reverse connections 5 and 7.

For single lever Control Head Stations that have the user facing aft and the one Control Head lever on the user's right, reverse connections 5 and 7.

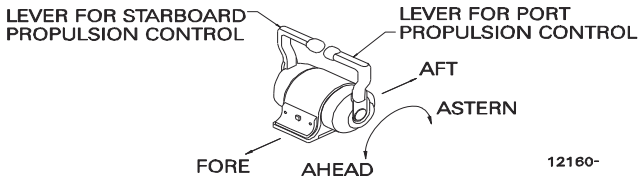
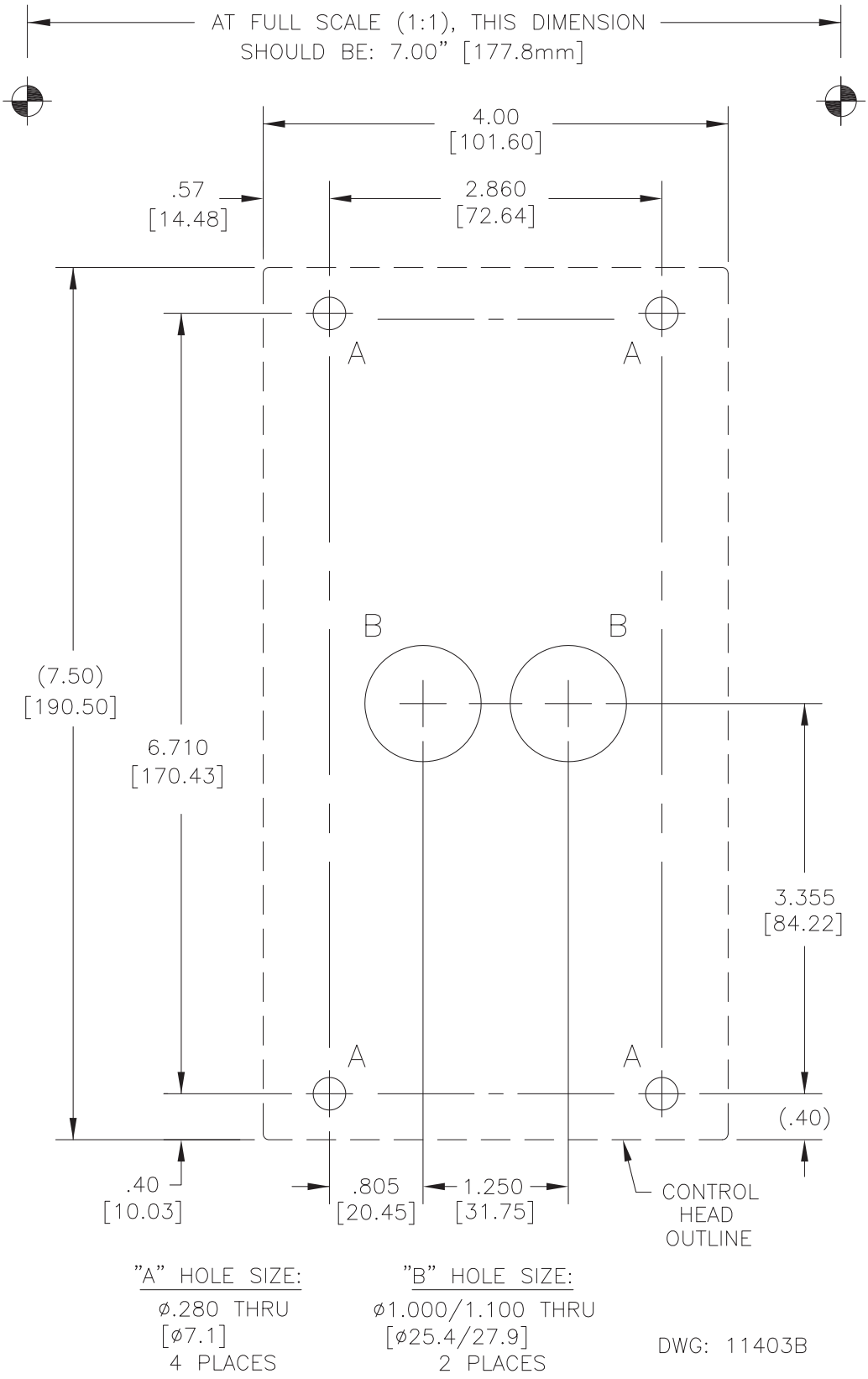


Figure MMC-307-5: Aft Facing Control Head

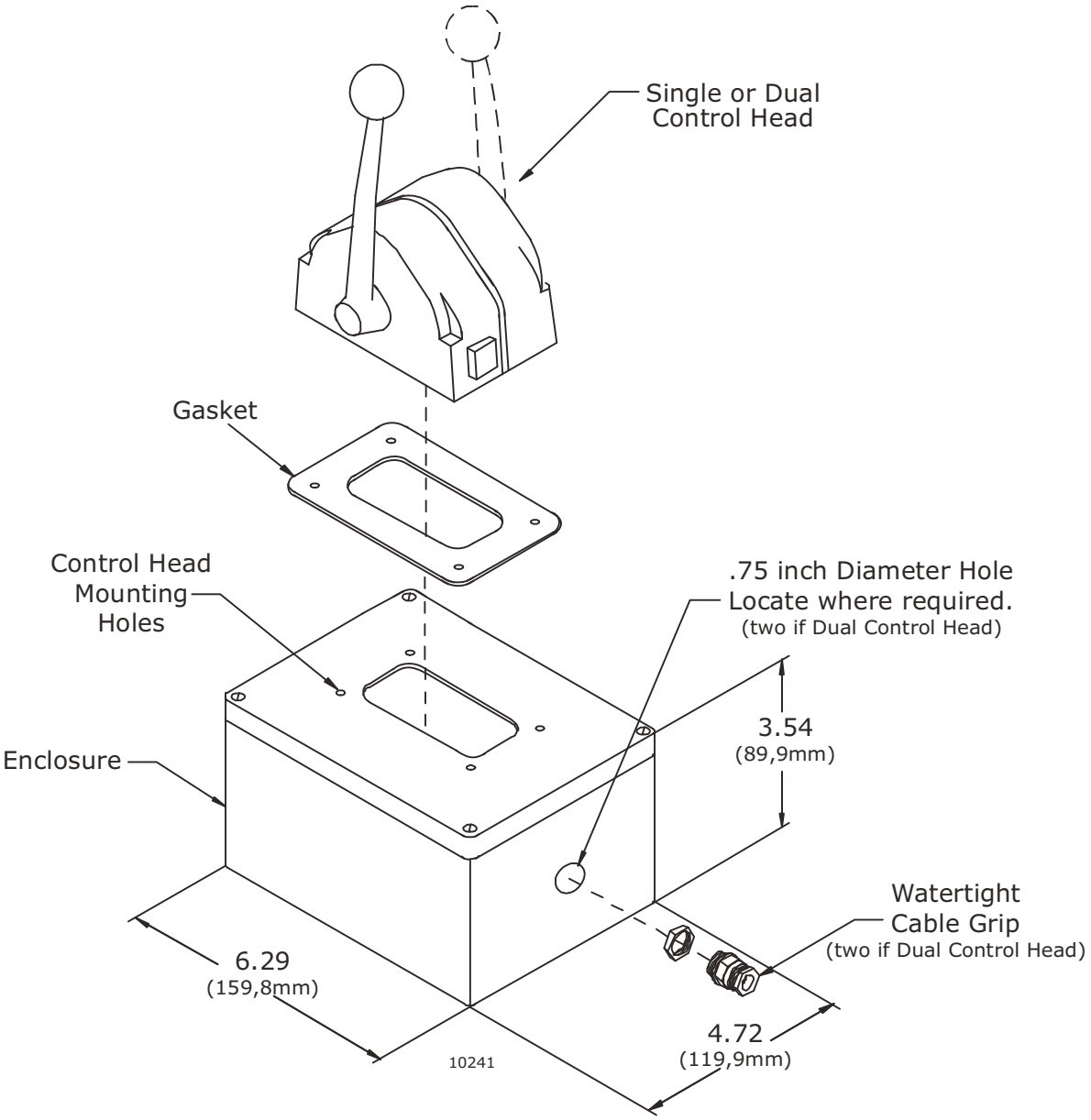
Handheld Control is a Station option. Contact your ZF Marine Electronics Dealer for further information on Handheld requirements and options.



WARNING: Do not mount control head less than 600mm from Compass. Mounting control head too close to compass can cause the compass to malfunction.

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

400 Series Weather Mount Enclosure



Deck Mount or Exposed Mount

Ideal for outside Weather Mount

To prevent internal condensation and moisture build up the mount is drilled to allow air circulation.

Part No. 12110

DT Type

Step 1: Contact Removal

1. Remove wedgelock using needlenose pliers or a hook shaped wire. Pull wedge straight out.

2. To remove the contacts, gently pull wire backwards, while at the same time releasing the locking finger by moving it away from the contact with a screwdriver.

3. Hold the rear seal in place, as removing the contact may displace the seal.

Step 2: Wire Stripping

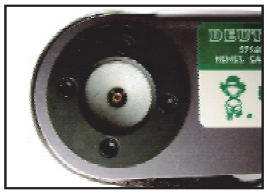
Solid Contacts

Contact Part Number	Wire Gauge Range	Strip Length (inches)
0460-202-20141 0462-201-20141	20 AWG 20 AWG	.156-.218 .156-.218
0460-202-16141 0462-201-16141	16, 18 & 20 AWG 16, 18 & 20 AWG	.250-.312 .250-.312
0460-215-16141 0462-209-16141	14 AWG 14 AWG	.250-.312 .250-.312
0460-204-12141 0462-203-12141	12 & 14 AWG 12 & 14 AWG	.222-.284 .222-.284
0460-204-08141 0462-203-08141	8 & 10 AWG 8 & 10 AWG	.430-.492 .430-.492
0460-204-0490 0462-203-04141	6 AWG 6 AWG	.430-.492 .430-.492

Step 3: Contact Crimping

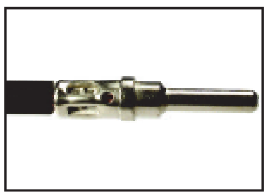
Use Crimp Tool #HDT48-00

1. Strip insulation from wire. (See Step 2).
2. Raise selector knob and rotate until arrow is aligned with wire size to be crimped.
3. Loosen locknut, turn adjusting screw in until it stops.



4. Insert contact with barrel up. Turn adjusting screw counter–clockwise until contact is flush with indentor cover. Tighten locknut.

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

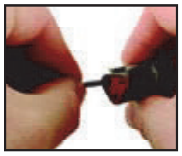


7. Inspect terminal to ensure that all strands are in crimp barrel.**NOTE:** Tool must be readjusted for each type/size of contact. Use HDT04-08 for size 8 and 4 contacts.

Step 4: Contact Insertion

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

2. Hold connector with rear grommet facing you.



3. Push contact straight into connector grommet until a click is felt. A slight tug will confirm that contact is properly locked in place.

4. Once all contacts are in place, insert wedgelock with arrow pointing toward exterior locking mechanism. The wedgelock will snap into place. Rectangular wedges are not oriented. They may go in either way.
NOTE: The receptacle is shown –use the same procedure for plug.

DEUTSCH INDUSTRIAL PRODUCTS DIVISION

LADD Exclusive Authorized U.S. Distributor

(800) 223-1236

Automatic Power Selector (APS) Model: 13505

ATTACHMENTS: DC POWER SOURCE DWG 11488

A GENERAL INFORMATION

The APS, Model 13505, provides a simple, solid state solution to the need for routing redundant DC power sources for vital electronic equipment while maintaining isolation of the DC power sources.

Two independent batteries rated at the same nominal voltage are wired to separate terminals on the APS and internal diodes maintain total isolation between them. A single output terminal is wired to the ZF Marine Propulsion Control System.

The APS is rated for loads of up to 70 Amps on 12-24VDC systems. The unit is ruggedly constructed with heavy-duty wiring studs and epoxy-potted components in an anodized aluminum case.

B APS SPECIFICATIONS

Model: 13505

Maximum Load Current: 70 amps

Operating Temperature: - 40 degrees C to +80 degrees C; derate linearly from 100% @ 50 degrees C to 70% @ 80 degrees C

Voltage Drop: 0.7 VDC @ 50% load; 0.9 VDC @ full load

Dimensions: 3.25" x 4.5" x 3.1" (8,3 x 11,4 x 7,9 cm)

C MATERIALS PROVIDED

The single APS is supplied with a hardware packet containing (6) hex nuts, (3) lock washers, (4) self-tapping mounting screws, (1) instructions diagram.

NOTE: Not all of the hardware will be used in the installation; some spares are provided. Nut size is M-6.

The twin APS is supplied with (2) single APS hardware packets.

D INSTALLATION

Refer to Drawing 11488 DC Power Source Kit.

1. Shut off all charging sources and disconnect the negative (ground) side of each battery which will be wired to the APS.
2. Mount the APS(s) in a suitable location which will keep wire runs to a minimum length, and is (preferably) ventilated, for cooler operation. The case of the APS is electrically isolated from the internal diodes, so mounting on either a metal or non-metal surface is acceptable.
3. Complete the wiring as indicated.
4. Reconnect the negative battery posts.

E IMPORTANT NOTE ABOUT BATTERY SOURCES

Whenever the load is turned on, it can be drawing power from the batteries. Therefore, if the batteries are not simultaneously being recharged, or if charging will not be available for an extended period, it is recommended that the load be shut off to prevent complete discharge of batteries.

NOTES: UNLESS OTHERWISE SPECIFIED

1. WIRE SIZE (REF ABYC E 11.16.1.2.9, TABLE X 3%).

12VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET	[METRIC]	WIRE GAUGE AWG	[METRIC EQUIV.]
0–15 FT.	[0–4,6M]	12 AWG	[#4]
15–25 FT.	[4,6M–7,6M]	10 AWG	[#6]
25–40 FT.	[7,6M–12,2M]	8 AWG	[#10]
40–70 FT.	[12,2–21,3M]	6 AWG	[#16]

24VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET	[METRIC]	WIRE GAUGE AWG	[METRIC EQUIV.]
0–20 FT.	[0–6,1M]	14 AWG	[#2,5]
20–30 FT.	[6,1M–9,1M]	12 AWG	[#4]
30–50 FT.	[9,1M–15,2M]	10 AWG	[#6]
50–80 FT.	[15,2–24,3M]	8 AWG	[#10]

2. WIRE SIZE (RECOMMENDED: TWISTED PAIR)

12VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET	[METRIC]	WIRE GAUGE AWG	[METRIC EQUIV.]
0–20 FT.	[0–6,1M]	14 AWG	[#2,5]
20–30 FT.	[6,1M–9,1M]	12 AWG	[#6]

24VDC POWER SYSTEMS

WIRE HARNESS LENGTHS FEET	[METRIC]	WIRE GAUGE AWG	[METRIC EQUIV.]
0–40 FT.	[0–12,2M]	14 AWG	[#2,5]
40–65 FT.	[12,2M–19,8M]	12 AWG	[#4]

3. AUTOMATIC POWER SELECTOR (APS) OUTPUT IS STRICTLY FOR ZF MARINE ELECTRONIC CONTROLS.

4. POWER SOURCES MAY BE 12VDC OR 24VDC.

5. PART NUMBER: 13983 (SINGLE SCREW KIT MATERIAL LIST)
   SEE SHEET 3 FOR BOM AND WIRING

   PART NUMBER: 13984 (TWIN SCREW KIT MATERIAL LISTS)
   SEE SHEETS 4 FOR BOM AND WIRING

6. MAXIMUM WIRE SIZE ALLOWED IN FUSEHOLDER IS 12 AWG. IF A LARGER WIRE SIZE IS REQUIRED FOR INSTALLATION, THE CUSTOMER SHALL PROVIDE AN APPROPRIATE FUSE AND FUSE HOLDER. (SUGGESTED MANUFACTURER BLUE SEA SYSTEMS, MAXI FUSE BLOCK SERIES).

7. IF THIS CONFIGURATION IS USED WITH AN ELECTRONIC ENGINE, THE THE CIRCUIT BREAKER MUST BE TURNED ON PRIOR TO APPLYING POWER TO THE REMOTE SWITCH.

8. FOR SUGGESTED HARDWARE STACKING FOR SYSTEMS UTILIZING MULTIPLE OUTPUTS FROM THE APS, SEE SHEET 2.

REVISION

ZONE	REV	DESCRIPTION	INC. BY	ENG. APR	QC/CE APR
	A	REVISED WIRING TO APS	JC 6–01	–	–
	B	ADDED FLAGNOTES 6 AND 7	TJ 7–02	–	–
	C	ADDED FLAGNOTE 8, REVISED FLAGNOTE 6.	TJ 3–03	–	–
	D	REVISED FLAGNOTES 1 AND 2.	MW 4–03	–	–
	E	MOVED DRAWING TO NEW FORMAT AND UPDATED. ADDED NEW SHEET 2, CREATING 4 SHEETS.	D.MONTZ 10/05/06	C.ESTES 10/11/06	RBH 10/12/06
	F	SHEET 2, ADDED SCHEMATIC DIAGRAM. SHEETS 3 AND 4: ADDED DIODES TO APS 93 PLACES) PER SHEET 2 SCHEMATIC. REVISED PER ECN 5141.	RAC 12/15/08	RSA 12/15/08	RBH 12/15/08
	G	SHEET 3: ADDED "FOR TWIN SCREW APPLICATION ONLY" REVISED WITHOUT ECN.	GJG 07/20/10	AHN 07/20/10	JDS 07/20/10
	H	EXTENSIVE CHANGES TO ALL SHEETS. UPDATED APS, CIRCUIT BREAKER AND REMOTE SWITCH SCHEMATIC TO NEW ZF WIRING DIAGRAM DRAWING STANDARDS. SEE ECN ARCHIVES FOR PREVIOUS CONFIGURATION. REVISED PER ECN 5787.	RAC 08/11/12	AHN 08/18/12	RBH 08/18/12

SHEET INDEX

UNLESS OTHERWISE SPECIFIED TOLERANCES

FRAC. = ±1/64 IN.
.X = ±.05
.XX = ±.01
.XXX = ±.005
ANGLE = ±2°

DIMENSIONS ARE IN INCHES [mm]
INTERPRET PER ANSI Y14.5M–1982
DIMENSIONS APPLY PRIOR TO FINISH
BREAK ALL SHARP EDGES
DO NOT SCALE DRAWING

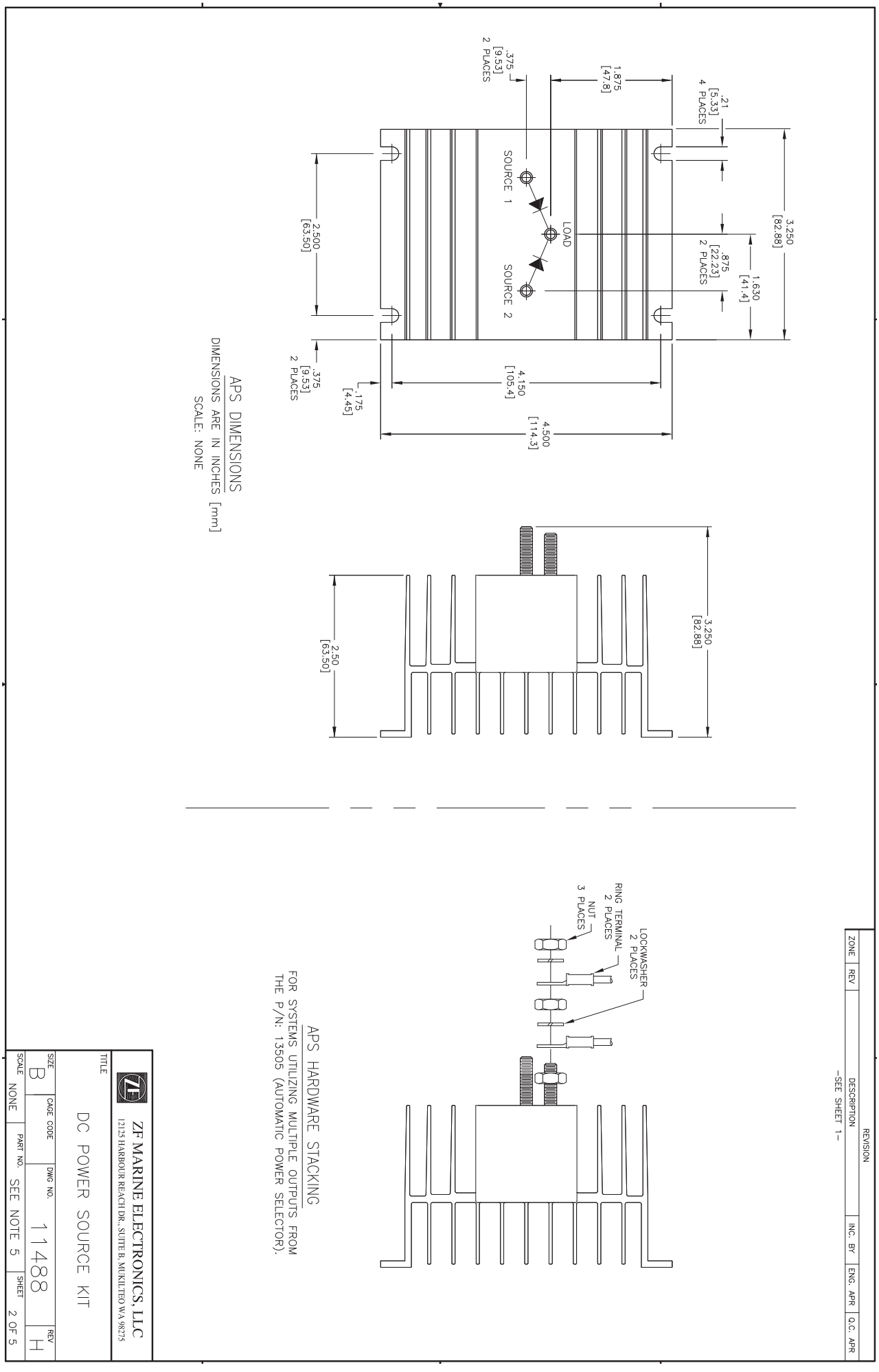
	APPROVAL	DATE
DRN	M.WILSON	1–30–01
ENG	JHC	1–30–01
CHK	–	–
QC	–	–
MFG	–	–

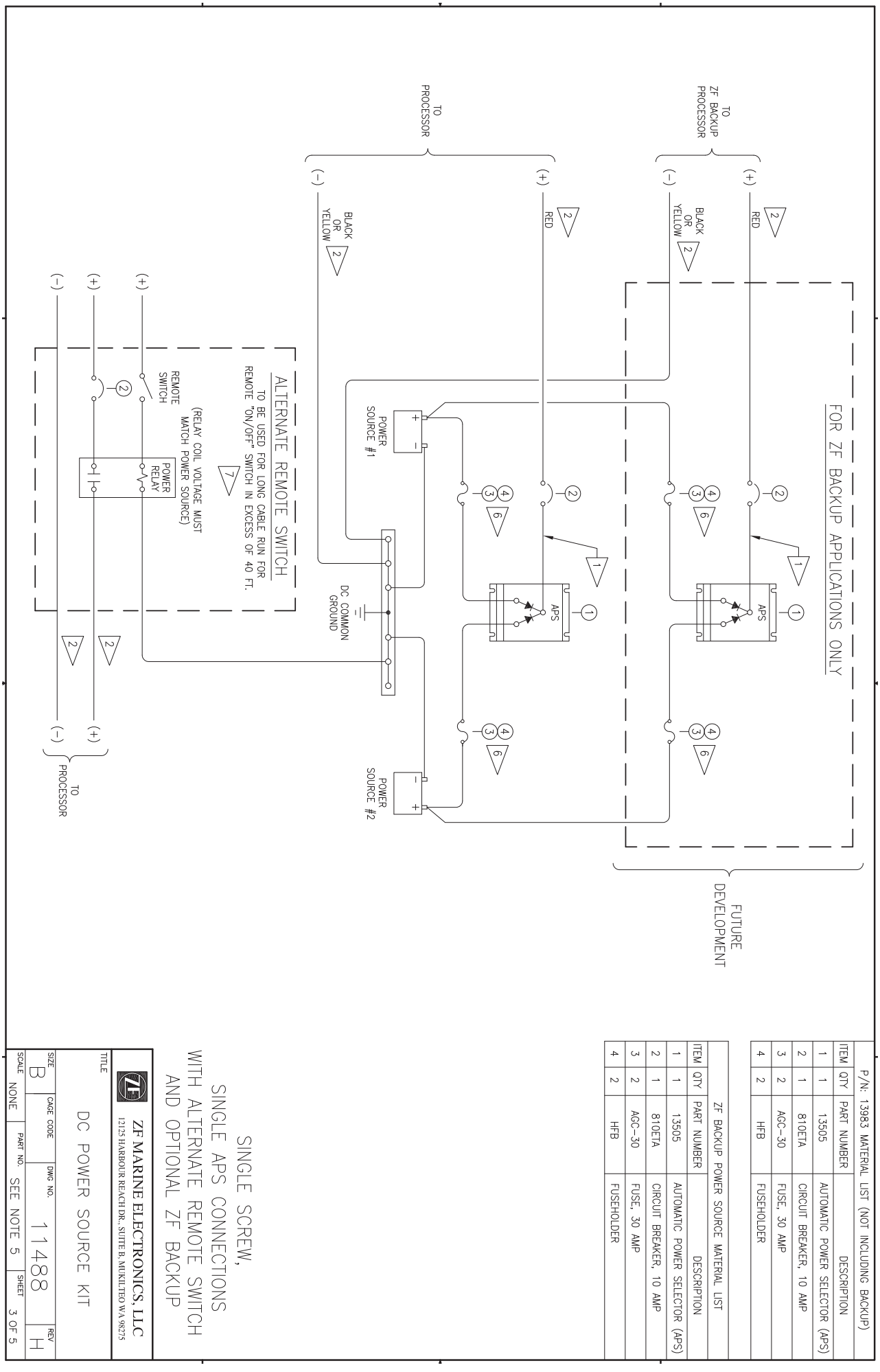
ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE
DC POWER SOURCE KIT

SIZE	CAGE CODE	DWG NO.	REV
B		11488	H

SCALE	PART NO.	SHEET
NONE	SEE NOTE 5	1 OF 5


.375 [9.53] 2 PLACES
1.875 [47.8]
.21 [5.33] 4 PLACES
SOURCE 1
LOAD
SOURCE 2
.875 [22.23] 2 PLACES
1.630 [41.4]
3.250 [82.88]
2.500 [63.50]
.375 [9.53] 2 PLACES
.175 [4.45]
4.150 [105.4]
4.500 [114.3]
APS DIMENSIONS
DIMENSIONS ARE IN INCHES [mm]
SCALE: NONE
2.50 [63.50]
3.250 [82.88]
LOCKWASHER 2 PLACES
RING TERMINAL 2 PLACES
NUT 3 PLACES
APS HARDWARE STACKING
FOR SYSTEMS UTILIZING MULTIPLE OUTPUTS FROM THE P/N: 13505 (AUTOMATIC POWER SELECTOR).
ZONE
REV.
DESCRIPTION
REVISION
-SEE SHEET 1-
INC. BY
ENG. APR
Q.C. APR
ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275
TITLE
DC POWER SOURCE KIT
SIZE
B
CAGE CODE
DWG NO.
11488
REV
H
SCALE
NONE
PART NO.
SEE NOTE 5
SHEET
2 OF 5



P/N: 13983 MATERIAL LIST (NOT INCLUDING BACKUP)

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC–30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

ZF BACKUP POWER SOURCE MATERIAL LIST

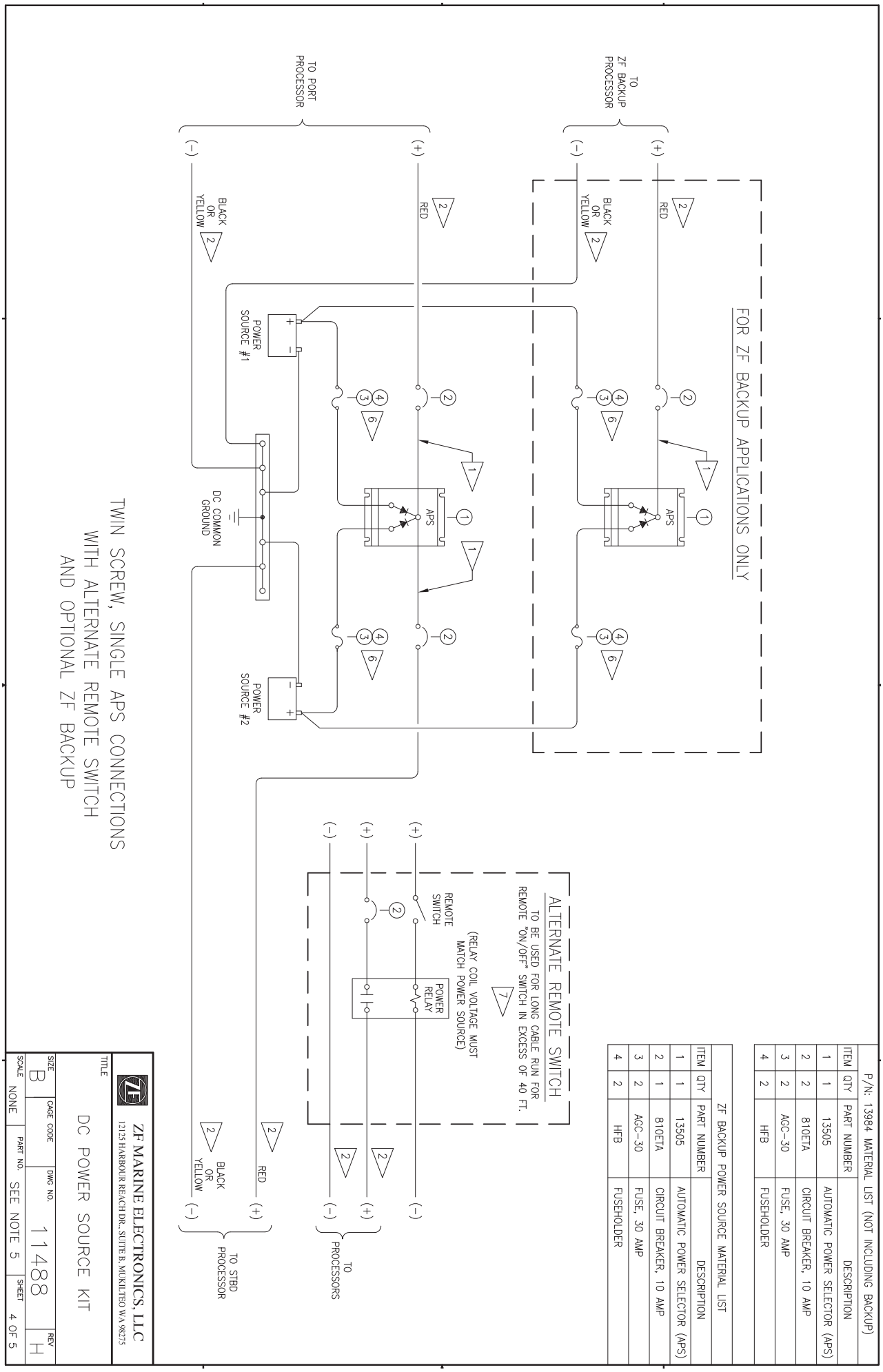
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC–30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

SINGLE SCREW,
SINGLE APS CONNECTIONS
WITH ALTERNATE REMOTE SWITCH
AND OPTIONAL ZF BACKUP

ZF MARINE ELECTRONICS, LLC
12125 HARBOUR REACH DR., SUITE B, MUKILTEO WA 98275

TITLE
DC POWER SOURCE KIT

SIZE	CAGE CODE	DWG NO.	REV
B		11488	H
SCALE	PART NO.	SHEET	
NONE	SEE NOTE 5	3 OF 5	

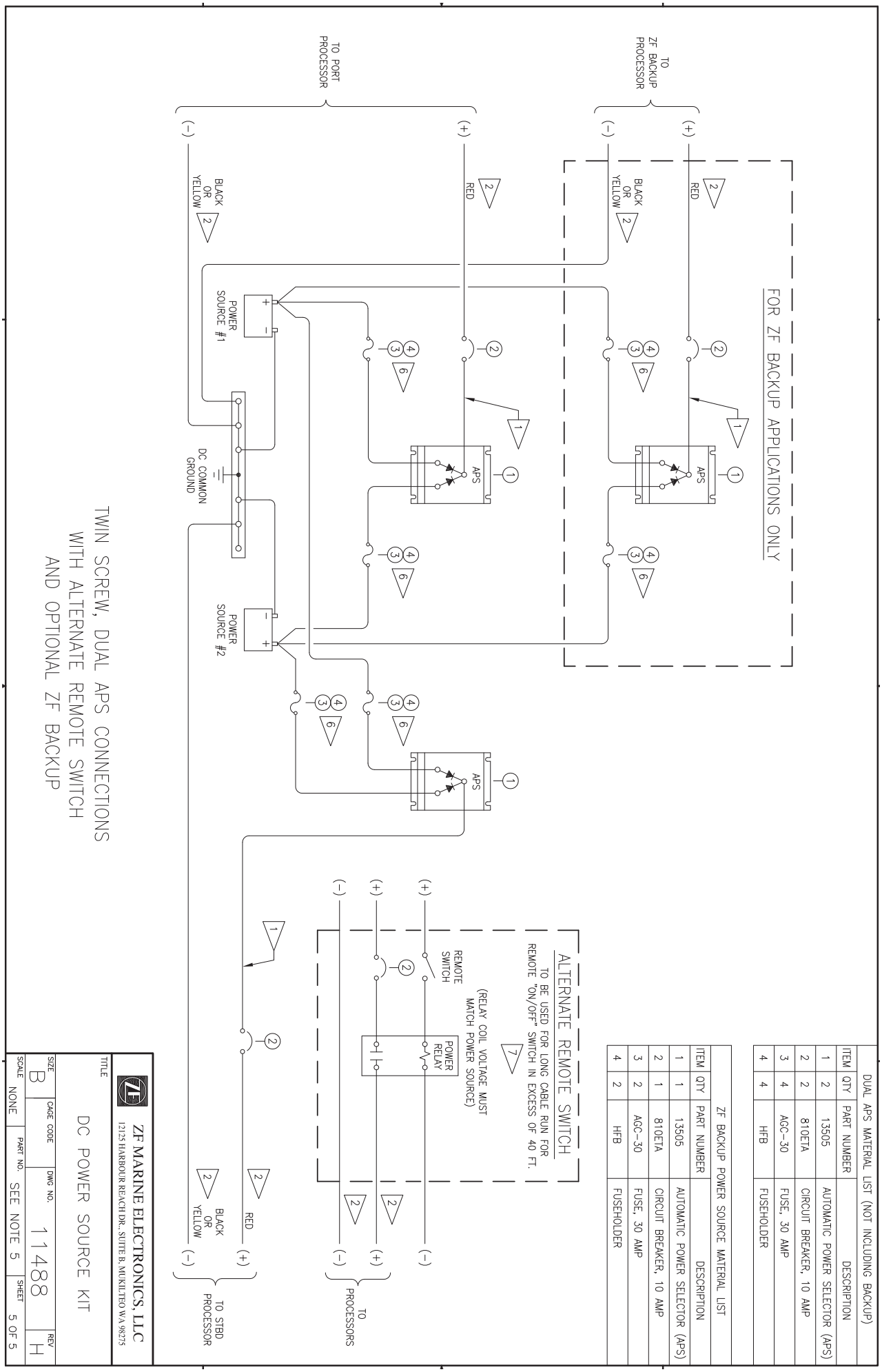


P/N: 13984 MATERIAL LIST (NOT INCLUDING BACKUP)

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	2	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

ZF BACKUP POWER SOURCE MATERIAL LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER



DUAL APS MATERIAL LIST (NOT INCLUDING BACKUP)

ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	13505	AUTOMATIC POWER SELECTOR (APS)
2	2	810ETA	CIRCUIT BREAKER, 10 AMP
3	4	AGC-30	FUSE, 30 AMP
4	4	HFB	FUSEHOLDER

ZF BACKUP POWER SOURCE MATERIAL LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	13505	AUTOMATIC POWER SELECTOR (APS)
2	1	810ETA	CIRCUIT BREAKER, 10 AMP
3	2	AGC-30	FUSE, 30 AMP
4	2	HFB	FUSEHOLDER

Grounding (Bonding)

Grounding (Bonding) - 46 CFR 111.05 and ABYC Section E-11: July 2012

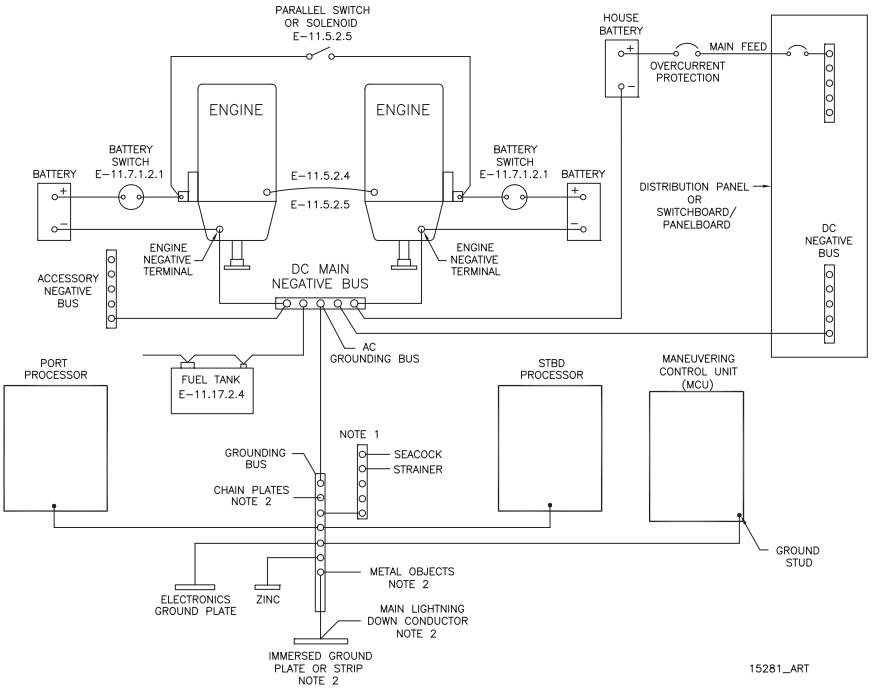
Grounding (Bonding) should be done according to ABYC Section E-11 and Code of Federal Regulations 46 CFR 111.05.

Each grounded system must have only one point of connection to ground regardless of the number of power sources operating in parallel in the system

A vessel's hull must not carry current as a conductor. A metallic hull, or the bonding and DC grounding systems, shall not be used as a return conductor.

There are some limited exceptions: (1) Impressed current cathodic protection systems. (2) Limited and locally grounded systems, such as a battery system for engine starting that has a one-wire system and the ground lead connected to the engine. (3) Insulation level monitoring devices if the circulation current does not exceed 30 milliamperes under the most unfavorable conditions. (4) Welding systems with hull return except vessels subject to 46 CFR Subchapter D.

Grounding conductors should be identified via a green or green with a yellow stripe jacket, and shall not be used as a return. Where grounding conductors are attached to Processors or other CE marked devices – a tinned copper braid is the preferred grounding method - per References: CFR Sec. 111.05-11, Sec. 111.05-13 and ABYC E-11 sect. 11.4.



[a] Grounding diagram is used courtesy of American Boat and Yacht Council.
All parts of figure except processors and processor connection ©
2003 American Boat and Yacht Council

Metal - Hull Vessels

The hull of a metal hull vessel may serve as the common grounding conductor. If it is desirable for the item being installed to be bonded to the vessel grounding system, and the installation or mounting method does not provide the desired path, a separate grounding conductor may be required.

References and Parts Sources

References

A American Boat & Yacht Council (ABYC)
3069 Solomons Island Road
Edgewater, MD 21037-1416
- E-3 Wiring Identification on Boats
- E-11 AC and DC Electrical Systems on Boats
- H-2.4e or 32.4g Ambient Temp. 50 degrees C
- P-24 Electric/Electronic Propulsion Controls

B Code of Federal Regulations
33 CFR 183 Subpart I - Electrical Systems
33 CFR 183.410 Ignition protection
33 CFR 183.415 Grounding
33 CFR 183.425 Conductors: General
33 CFR 183.430 Conductors in circuit of less than 50 Volts
33 CFR 183.445 Conductors: Protection
33 CFR 183.455 Over-current and Protection: General
46 CFR 111.01 - 15(b) Ambient Temp. Machinery Spaces 50 degrees C
46 CFR 111.05- System Grounds

C Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096
- J1171 External Ignition Protection
- J1428 Marine Circuit Breakers
- J378 Marine Engine Wiring

D National Marine Manufacturers Association
401 North Michigan Avenue
Chicago, IL 60611

E Underwriters Laboratories

Parts Source

Anti-Static Wrist Strap - - - - - - - - - P/N 517 [Thomas & Betts (P/N AWCC)]
Automatic Power Selector - - - - - - - P/N 13505
Circuit Breaker- UL Approved - - - - - - P/N 810 [E-T-A (P/N 41-2-514-LN2-10)]
Fuse- P/N 1030 [Bussman (P/N. GDC-1A)]
Relay 12 VDC - - - - - - - - - - - - - - P/N 1114 [Potter-Brumfield (P/N KRPA5D6-12)]
Relay 24 VDC - - - - - - - - - - - - - - P/N 1122 [Potter-Brumfield (P/N KRPA5D6-24)]
Service Field Test Unit (Break-out Box) - P/N 13927
WAGO Tool - - - - - - - - - - - - - - - - P/N 397 [WAGO (P/N 236-332)]
Field Test Control Head - Dual - - - - - P/N 14000

Station Expander User Instructions

Table of Contents

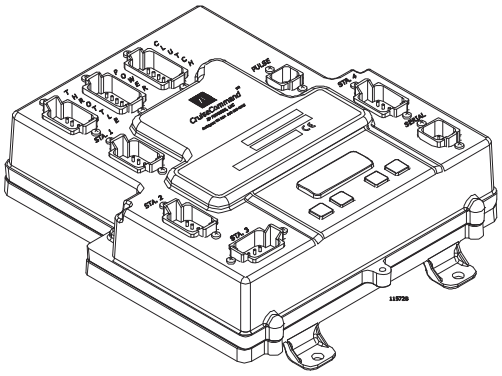


Figure MMC-343-1: Station Expander

The station expander (SE) is designed to be an addition to the 9000 Series / CruiseCommand Processors. The station expander allows the user to install more than the maximum allowed control heads (up to four).

1 Features

- Station-in-Command Indication
- Audible and Visual Indicators
- Key-Pad Set Up
- Plug-in Cable Connections
- Built-in Diagnostics
- Addition of One to Four Remote Stations

The Station Expander receives the variable DC voltage from the Control Head(s) and serially communicates these inputs to the Processor.

2 Required Parts

- One Station Expander required per Processor.
- Mounting Hardware is installer supplied.
- System Operation Manual included with the Processor.

3 Location

NOTE: Read the MMC-165 Warranty in section 12: Appendix B - Sales and Service Information. Improper mounting location may cancel warranty.

- Expanders are spray proof, but must not be immersed.
- An engine room location of the Expanders is preferred.
    - If the engine room is too small, locate in any area where it is accessible for electrical connections.

Bulkhead mounting preferred for ease of access for wiring and adjustments.

The Expander can be mounted in any attitude as long as the LED on the front cover is readable.

Do not mount the Expander on the engine, on the transmission, or in any location that will subject it to excessive vibration.

Refer to Figure MMC-343-4: Station Expander Dimensions, for Expander dimensions.

Locate Expander(s) away from heat sources, such as engine exhaust manifolds turbochargers. Allow 4 feet (1,2m) of clearance, or more, between the Expander(s) and such heat sources.

CAUTION: Electro-magnetic fields can influence the Station Expander's electronic circuits.

Do not mount close to gas engine ignition systems, alternators, or electric motors. Allow 4 feet (1,2m) of clearance between the Expander and alternators or electric motors.

A threaded hole is provided for connection to the vessel's bonding system.

4 Station Expander Power

The Station Expander requires:

- A battery source of 12 or 24 volts DC
- A 10 ampere circuit breaker with manual reset
- Automatic Power Selector (refer to S-214 Automatic Power Selector Model: 13505)

NOTE: The Processor and the Station Expander may use the same Automatic Power Selector, but the Station Expander MUST have a separate circuit breaker.

The power source should be the same as the processors power source which can be either 12 or 24 volts DC. It is important to keep the length of power cable short to reduce voltage drop.

CAUTION: It is important that the wire size from the battery to the circuit breaker panel is large enough to keep voltage drop due to current flow, to less than 3% of 7 amps. The DC return to the battery must be large enough to supply all current requirements with a voltage drop of less than 3%. Refer to ABYC E-9.

It is recommended by ZF Marine Propulsion Systems Miramar that an Automatic Power Selector (APS) and a second power source be used. Refer to S-214 Automatic Power Selector Model: 13505 and Section 7.2 Power Cable.

5 Harnesses

Below is a general list of Wire Harnesses available to Station Expander. A complete harness list and part numbers are located in section 13 Parts List.

Stations 2-4 connectors on the Station Expander are sealed with plugs at the factory. Every connector should either have inserted a Wire Harness or plug. Do not leave a connector empty.

- **(2) Power Wire Harness** (Station Expander to Power connections)
- **(4) Control Head Wire Harness** (Station Expander to Control Head)
- **(5) Serial Communication Wire Harness** (Processor to Station Expander to 2nd (etc.) Processor)

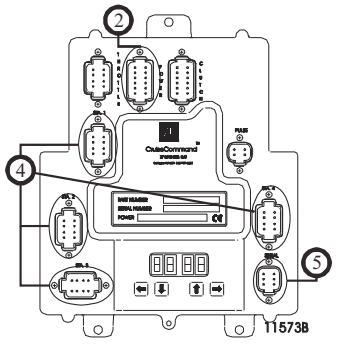


Figure MMC-343-2: Station Expander Harness Connector Locations

The Harnesses use one or both of the plug connector types detailed in Figure MMC-343-3: Harness Plug Connectors. When connecting the plugs, ensure that the release button or buttons are depressed and held until plug is fully connected or disconnected. Connecting or disconnecting plugs without depressing and holding the release button or buttons will damage the plug.

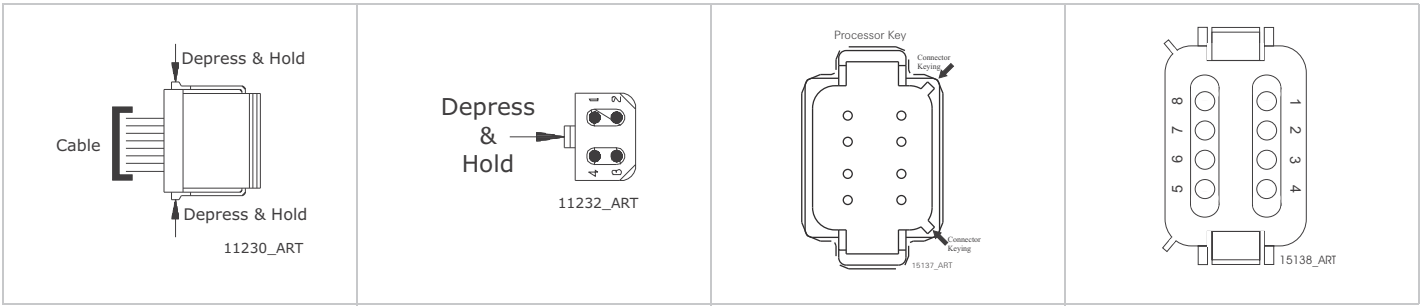


Figure MMC-343-3: Harness Plug Connectors

Ensure that the harness cable lengths are long enough to make one complete run from the Station Expander to:

- the power supply
- the remote station.
- the Port and Starboard Processor

6 Tools For Installation

6.1 Required

- Screwdriver – med. Phillips #2
- Hole saw -- 1 inch (25,4mm)
- Drills -- 9/32 inch (7,2mm) and 7/32 inch (5,6mm)
- Saw (appropriate type of saw for cutting material Control Head will be mounted on)

6.2 Optional

Wire cutter, stripper, crimper (Recommend Thomas & Betts WT-2000) (if using single terminated harnesses)

7 Installation

Before starting the actual installation of the Station Expander, make sure you have the correct parts and tools. See section 6 Tools For Installation. Read ALL the instructions pertinent to each part before beginning the installation of that part

	NOTE: When connecting the plugs, ensure that the release buttons are depressed and held until plug is fully connected. To disconnect the plugs, the release buttons MUST be held depressed until plug is disconnected.

	NOTE: When installing the harness cable, support the cables using clamps or straps not more than 18 inches (0,5m) apart, unless contained in a conduit. Install each cable so it is protected from physical damage. Refer to ABYC Standard E-9.

7.1 Station Expander

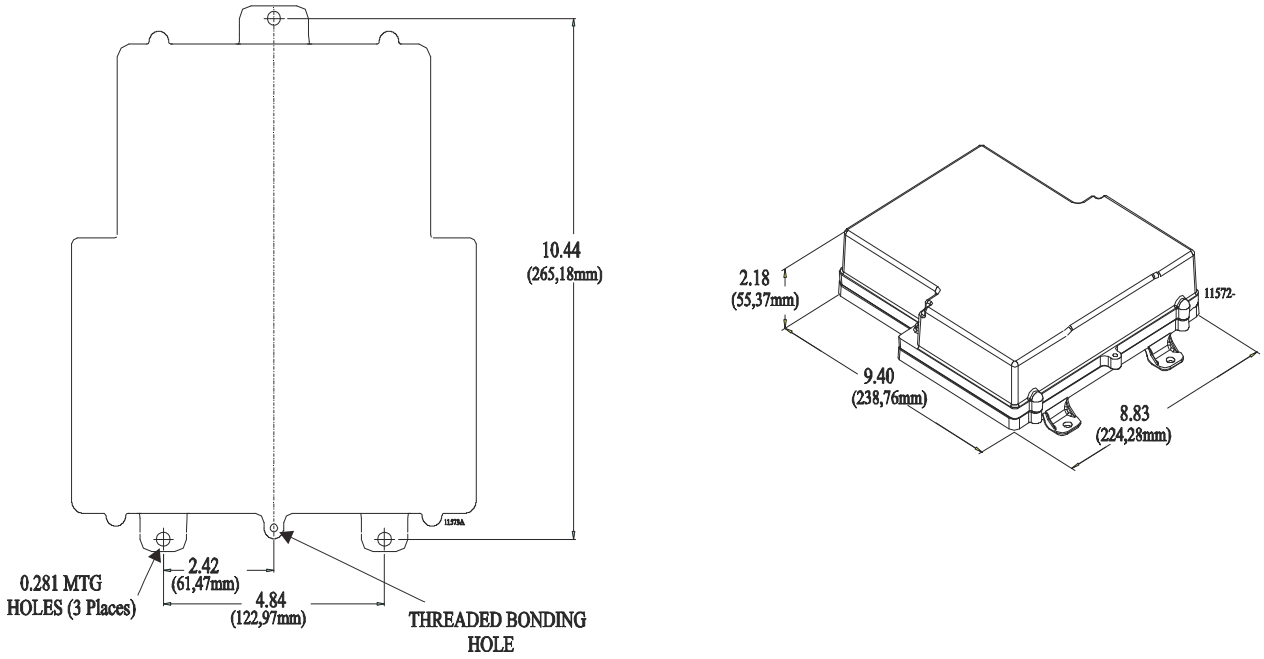


Figure MMC-343-4: Station Expander Dimensions

A Place the Station Expander on the mounting surface and mark the three screw holes.
B Remove the Expander and drill the screw holes.
C Secure the Expander using 1/4 inch or M6 fasteners.
D Connect to the Bonding System.

	WARNING: When connecting the Power Harness to the Station Expander be sure the power is OFF.

A Insert the Wire Harness plug into the **POWER** connector on the Station Expander.
B Continue with the following Sections that apply to this application.

7.2 Power Cable

It is critical to design and wire the Control System in a manner where the chance of losing power to the Control System is kept to a minimum.

ZF Marine Propulsion Systems Miramar recommends that two power sources are utilized along with the APS see document S-214 Automatic Power Selector Model: 13505 for more information.

A Install the Power cable from the Station Expander to the DC Power Source.
- Install each cable so it is protected from physical damage.

B Review the DC Power Supply documents to confirm termination points for power connection.

NOTE: Repeat for all Station Expanders.

7.3 Control Head Harnesses

There are two choices of Control Head Harnesses depending on the type of Control Head being used with this application.

- Plug at Station Expander end of harness only. (terminal connection Control Heads)
- Plug at Station Expander and Control Head ends. (Plug connection Control Heads)

The distance of the Control Head from the Station Expander is limited to the length of an uninterrupted 7-conductor harness. This cable may never be spliced.

A Install the Control Head Wire Harness between each Control Head and the appropriate Station Expander.

B **Label** each harness at **both ends** with the station it connects, and Port, Center, or Starboard for Multi Screw applications.

CAUTION: Ensure that each Control Head is plugged into the same Numbered Station Connector on each Station Expander.
EXAMPLE: Station 1 Control Head will plug into the Station 1 connector on the Port Station Expander and the Station 1 connector on the Starboard Station Expander. Failure to do this will result in incorrect Station Transfer.

Install each harness so it is protected from physical damage.

When installing the cable, support using clamps or straps not more than 18 inches (0,5m) apart, unless contained in a conduit. Refer to the ABYC Standard E-9.

7.4 Engine Stop Switch

The Installer supplies the Stop Switches. Refer to the information supplied with the Stop Switches for installation.

WARNING: Each Station must have some method to stop the engine, refer to CFR 46, SEC. 62.35-5 and ABYC P-24.5.8.

7.5 Control Heads

Refer only to the following Sections that relate to the Control Heads used.

- Mounting
  - 400 Series Control Head:
    - A Use the template supplied inMMC-280 400 Series Control Head Variations and drill the screw holes and the corner cutout holes.
    - B Saw between the corner cutout holes.
    - C Check that the four mounting screws will start into the Control Head.
    - D Remove the Control Head.
    - E Strip the adhesive cover from the gasket and apply the adhesive side to the console.
  - 700 Series Control Head:
    - A Use the template supplied inMMC-307 700 Series Standard Control Head Variations and drill the screw holes and the corner cutout holes.
    - B Drill the screw holes and the cable holes.
  - MC2000 Series Control Head:
    - A Use the template supplied inMMC-329 MC2000 Series Standard Control Head Variations and drill the screw holes and the corner cutout holes.
    - B Saw between the corner cutout holes.
  - Check that the two mounting screws will start into the Control Head 500 Series Control Head Assembly:

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

8 Set Up Procedures

NOTE: Main Processor function should be set to A3-01 to enable station expander.

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

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

8.1 Station Expander Components Used In Set Up

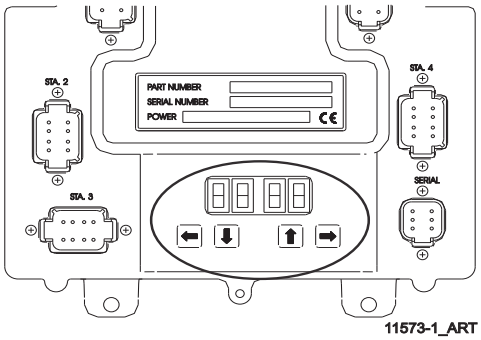


Figure MMC-343-5: Station Expander Display LED and Arrow Push Buttons

Each Station Expander has a Display LED and Arrow Push Buttons located on the front cover. (Figure MMC-343-5: Station Expander Display LED and Arrow Push Buttons)

- The Display LED is to view the Function Codes and Values. It consists of four 7-segment display pads.
- The Arrow Push Buttons are used to scroll through and select the Function Codes, and set the Values.

8.2 Station Expander Display LED

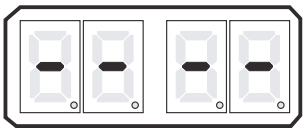


Figure MMC-343-6: Display LED at Normal Operation

- The Station Expander's Display LED has four 7-segment LED's, which light up to show either letters or numbers.
- The Display LED during Normal operation has running red center dash lines (Figure MMC-343-6: Display LED at Normal Operation)
- The first two digit Display LED's to the left, indicate the Function Code, which is alphanumeric.

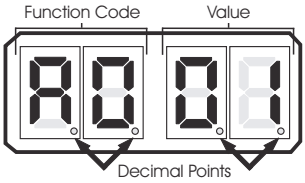


Figure MMC-343-7: Display LED Designations

- The second two digit Display LED's indicate the numeric Value that is currently programmed into the Station Expander for the Function Code displayed to the left.
- A decimal point indicator is located on the bottom right corner of each Display LED. (Figure MMC-343-7: Display LED Designations)

8.3 Push Buttons

There are four Push Buttons with arrows located below the Display LED on the Station Expander cover. These push buttons are used to scroll through, select, and store the Functions and Values. The direction of the arrow indicates "Left", "Down", "Up", and "Right". See Figure MMC-343-5: Station Expander Display LED and Arrow Push Buttons.

- "Up" and "Down" Push Buttons

  Pressing the "Up" or "Down" Push Buttons *once* has the following functions:
  - Stops Normal Operation Display (running red center dash lines) and activates the Function Menu.
  - While in the Function Menu, scrolls through the Function Codes one at a time.
  - When in Set Up Mode, increases (Up) or decreases (Down) the Function Value one digit at a time.
  - When an Error Code is displayed, scrolls through the error messages one at a time.

	NOTE: Refer to Troubleshooting section of the processor manual for steps to be taken for Error Messages.

- "Left" and "Right" Push Buttons

  Pressing and *holding* the "Left" and "Right" Push Buttons *at the same time* has the following functions:

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

- "Left "Push Button Only

  Pressing the "Left" Push Button *once* has the following functions:

  - Deactivates Set Up Mode WITHOUT any changes to the Function Value stored in memory. (Operator must *hold* the button down until function code stops blinking, then *release*.) The previously saved Function Value will then be displayed.

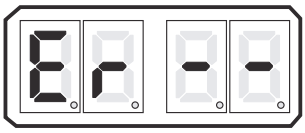


Figure MMC-343-8: Error Menu Example

  - While in Function Menu, changes the Display LED to the Error Menu, if any errors are present. (has no effect if there are no errors stored)
  - While in the Error Menu, changes the Display LED back to the Function Menu.

- "Right" Push Button Only

  Pressing the "Right" Push Button *once* has the following function:

  - While in the Error Menu, clears inactive errors. (Active errors blink, inactive do not)

  Pressing and *holding* the "Right" Push Button has the following function:

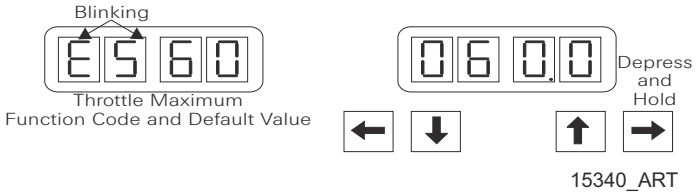


Figure MMC-343-9: Display LED Four Digit Value

  - While in Set Up Mode, or Function Menu, allows the Function Value of the current Function Code to be displayed with all four Display LEDs.

9 Activating Set Up Mode and Storing a Value

	NOTE: To escape from the set up procedure at any time without saving the changed value. Depress the LEFT Arrow Push Button. The Function Code will stop flashing and the Function will be saved with the original value.

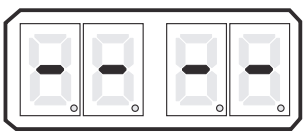


Figure MMC-343-10: Display Normal Operating Condition

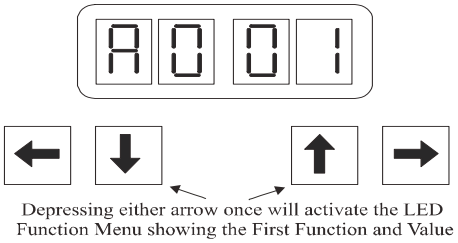


Figure MMC-343-11: Display Function Menu Activated

A The Display is in Normal Operating condition with red running center dash lines.

B Depressing either the Up or Down Arrow Push Button will activate the Function Menu. (refer to Figure MMC-343-11: Display Function Menu Activated)

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

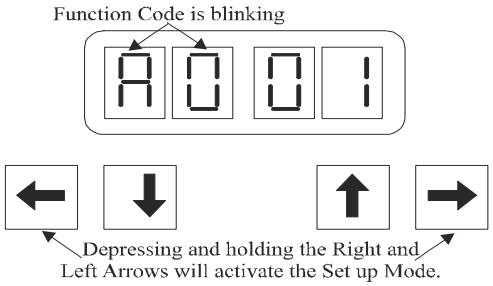


Figure MMC-343-12: Display with Set up Activated

D Once the desired Function Code is visible on the Display, **depressing** and **holding** the Left and Right Arrow Push Buttons at the same time will activate Set Up. The left two Display pads will begin to blink, indicating that the value is ready to be changed. Refer to Figure MMC-343-12: Display with Set up Activated

E Depressing either the Up or Down arrow push buttons will change the Value of the Function. Holding down either the Up or Down arrow push buttons will scroll quickly through the values.

F When the value required is displayed, depress and hold the Right and Left Arrow push buttons until the Display Function Code stops blinking and becomes solid. The new Value is now set into memory.

G Depressing either the Up or Down arrow push buttons will now scroll through the Function Codes.

10 Set Up Functions & Values

The following table lists the various Function Codes, the Function's Name, Default Value and Range. Each Function will be explained in one of the following Sections.

Table MMC-343-1: Functions List

Function Code	Function Name	Default Value	Value Range or Options
STATION EXPANDER FUNCTIONS			
A0	Station Expander Identification	01	01, 02, 03, 04, 05 (Must match Processor Identification set in the 9000 Series / CruiseCommand Processor the Expander is connected to.)

Table MMC-343-2: Troubleshooting Functions

Function Code	Function Name	Default Value	Value Range or Options
H0	Diagnostic	00	Input Voltage (+/- 0.5VDC)
			Tachometer Sensor Frequency
			Station 1 Lever A/D
			Station 2 Lever A/D
			Station 3 Lever A/D
			Station 4 Lever A/D
			Transfer Button, Stations 1, 2, 3 & 4
			Software Revision Level
H1	Erase EPROM	00	Store to Erase (For Authorized Personnel Only)

10.1 A0 - Station Expander Identification

CAUTION: This feature MUST be the SAME value as set in the 9000 Series / CruiseCommand Processor the Expander is connected to.

In applications where there is more than one screw, the system must have some way of determining which Station Expander is where. Every Station Expander must have it's own identifying unique number that corresponds to the Processor it is connected to. At no time can two Station Expanders be identified by the same Station Expander Identification Number.

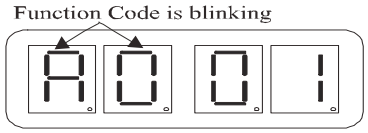


Figure MMC-343-13: Display with A0 - Station Expander Identification Set Up Activated

The values of this Function are **01** (Default Value), **02**, **03**, **04**, and **05.**

To change the value:

A Depress any Arrow Push-Button to stop running center dash lines.
B This is the first code on the Function Menu List and the Function Code for Station Expander Identification.
C Activate Set Up Mode. Refer to section 9: Activating Set Up Mode and Storing a Value.
D Depress either the Up or Down arrows to change the Value of the Function.
E When the value required is displayed, store the value. Refer to section 9: Activating Set Up Mode and Storing a Value.

10.2 H0 - Diagnostic

This Function is used during Troubleshooting. Refer to the 9000 Series / CruiseCommand Manual supplied with the Control System for information on this Function.

10.3 H1 - Erase EPROM

This Function is used during Adjustments or Troubleshooting. **(For Authorized Personnel Use ONLY)**

11 Dock Trials

Ensure 9000 Series / CruiseCommand System has been installed, adjusted, and tested before performing the following tests for the Station Expander.

11.1 Control Head (Engines Stopped)

A Turn the power ON to the control system.

WARNING: Turn OFF the control system power before disconnecting from the batteries. Do not disconnect battery terminals when engine is operating.

B The Control Head at each station will produce an intermittent tone.

C Take command at a remote station.

D Perform each of the following steps on all Control Heads.

- Move each Control Head lever full Ahead and full Astern. Ensure correct 9000 Series / CruiseCommand Processor and Station Expander reacts to lever movement.

NOTE: This will check that the Control Head is operating. * On Twin Screw or more applications ensure the Port Control Head lever operates the Port Processor and the Starboard Control Head lever operates the Starboard Processor, etc. *

- Place the Control Head levers in the Neutral detent position.
- Depress and hold the station transfer button.
- Move the Control Head levers to the Ahead detent position before releasing the transfer button.
- The red indicator light on the Control Head should blink, indicating 9000 Series / CruiseCommand has been placed in Warm-up Mode. Warm-up Mode only operates in the Ahead direction.
    - If the red indicator light blinks, continue with Control Head testing
    - If the red indicator light does not blink, check connections as stated in Section 7.5 Control Heads.

11.2 Engine Stop Switches Test (Engines Running)

A Start engine(s).

B Verify that all Engine Stop Switches function correctly at all stations.

Refer to information supplied by engine manufacturer or switch supplier for set up and adjustments.

CAUTION: An Engine Stop Switch at each station is an absolute requirement. Refer to CFR46, SEC. 62.35-5 and ABYC P-24.5.8.

WARNING: Do not attempt to continue tests until Engine Stop Switches function correctly.

12 Periodic Checks and Maintenance

12.1 Station Expander

Check all terminal connections for signs of corrosion or loose connections.

12.2 Control Head

Verify once a year that Control Head terminals are secure and free of corrosion. Apply a light coating of Teflon grease, or corrosion block, to the contacts.

13 Parts List

Part No. Description

13.1 Control Heads

A Single Screw

450-3L or 3RLeft or Right Control Head, 'T' Lever
453-3L or 3RLeft or Right Control Head, Chrome Knob Lever
455-3L or 3RLeft or Right Control Head, Black Low Profile Lever
456-3L or 3R Left or Right Control Head, Chrome Low Profile Lever
456-3LP or 3R PLeft or Right Control Head, Chrome Low Profile Lever, Pluggable
521-4 Control Head, Single Lever Tournament Style - Aluminum
521-5 Control Head, Single Lever Tournament Style - Chrome
750-L or –RLeft or Right Control Head, Heavy Duty
MC2000-1L or 1RLeft or Right Black Control Head, Black Lever
MC2000-2L or 2RLeft or Right Chrome Control Head, Chrome Lever
MC2000-4L or 4RLeft or Right Black Control Head, Chrome Lever
MC2000-4LP or 4RPLeft or Right Black Control Head, Chrome Lever, Pluggable
MC2000-5L or 5RLeft or Right Black Control Head, Gold Lever

B Twin Screw (Synchronization Indication)

460-4 Control Head, 'T' Lever
460-4P Control Head, 'T' Lever, Pluggable
463-4 Control Head, Chrome Knob Lever
463-4P Control Head, Chrome Knob Lever, Pluggable
464-4 Control Heads, Split, with Single Levers, Chrome Knobs (pair)
465-4 Control Head, Black Low Profile Lever
466-4 Control Head, Chrome Low Profile Lever
522-4 Control Head, Dual Lever Tournament Style - Aluminum
522-5 Control Head, Dual Lever Tournament Style - Chrome
760 Control Head, Heavy Duty
760P Control Head, Heavy Duty, Pluggable
MC2000-1 Black Head, Black Levers
MC2000-1PBlack Head, Black Levers, Pluggable
MC2000-2 Chrome Head, Chrome Levers
MC2000-2PChrome Head, Chrome Levers, Pluggable
MC2000-3 Gold Head, Gold Levers
MC2000-4 Black Head, Chrome Levers
MC2000-4PBlack Head, Chrome Levers, Pluggable
MC2000-5 Black Head, Gold Levers

13.2 Cable (Electric)

180	8-Cond. Shielded CablePer/ft.
350	8-Cond. Shielded Cable500' Spool
11811	8-Cond. Shielded Cable1000' Spool
212	2-Cond. Power CablePer/ft.
349	2-Cond. Power Cable250' Spool
183	2-Cond. Start Interlock CablePer/ft.
355	2-Cond. Start Interlock Cable250' Spool

13.3 Wire Harness (Plug)

Replace the # after the Part Number with the length of harness required. EXAMPLE: 13316-10; 13316-20; 13316-30

13316-#	Serial Communication (Twin Screw)
13408-#	Serial Communication (Multiple Screw)
15544-#	Serial Communication - CruiseCommand (Multiple Screw)
13432-#	Throttle, Voltage
13494-#	Throttle, Current
13533-#	Throttle, PWM
14363-#	Throttle, MAN
15027-#	Throttle, Frequency
13322-#	Clutch – Ahead/Astern/Clutch Power
13324-#	Clutch – Ahead/Astern/Neutral/Clutch Power
13240-#	Clutch – Ahead/Astern/Troll/Troll CMD/Clutch Power
14310-#	Clutch – Ahead/Astern/Troll CMD/Clutch Power
14925-#	MAN with Troll
14542-#	MAN without Troll
13239-#	Magnetic Pickup or Pulse Transmitter
13422-#	ZF Autotroll (MS70-13231 only)
15364-	ZF Autotroll (MS570-15382 Cannon Connector only)
15208-	ZF Autotroll (MS570-15382 Harting Connector only)
13552-#	Power/Start Interlock/Clutch Pressure
13756-#	Power/Start Interlock
15023-#	Power
13557-#	Control Head - 1 Connector
14261-#	Control Head - 2 Connectors

13.4 Test Unit

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

12 Appendix B - Sales and Service Information

Electronic Propulsion Control Systems Limited Warranty

A Limited Warranty: Your ZF product was designed and manufactured by experienced engineers and craftsmen. ZF Marine Propulsion Systems Miramar, LLC warrants for the period indicated below, each product manufactured by ZF Marine Propulsion Systems Miramar, LLC to be free from defects in materials and workmanship. If during the applicable warranty period a product is determined by ZF Marine Propulsion Systems Miramar, LLC to be in breach of this limited warranty, ZF Marine Propulsion Systems Miramar, LLC, at its option, will repair or replace the defective product.

B Warranty Exclusions: This warranty covers only failures due to defects in materials or workmanship that occurs during normal use. This warranty does not cover damage that occurs in shipment, failures that are caused by products not supplied by ZF Marine Propulsion Systems Miramar, LLC, failures that result from installation that is not in compliance with ZF specifications, accident, misuse, abuse, neglect, water damage, mishandling, misapplication, setup adjustments, improper maintenance, alterations, modification or service by anyone other than a ZF Authorized Service Center, damage that is attributable to acts of God or other causes unrelated to defects in materials and workmanship.

C Warranty Period: The length of the applicable warranty period will depend on the use of your vessel. For Commercial Craft the standard warranty period is for 24 months from the date of original shipment by ZF or 12 months after commissioning of the craft, whichever occurs first. A commercial craft is defined as any vessel used for any commercial purpose including but not limited to any use as a workboat, passenger vessel, charter or rental fleet.

D For Pleasure Craft the warranty period is 36 months from the date of original shipment by ZFME or 24 months after commissioning of the craft, whichever occurs first. A Pleasure Craft is any vessel that is or has not been used for any commercial purpose including but not limited to any use as a workboat, passenger vessel, charter or rental fleet.

E Repair or replacement parts provided under this Warranty will not be covered by the remainder of the unexpired warranty in effect on the complete unit.

F No Coverage Under Warranty: The exclusive remedy under this warranty is the repair or replacement of the defective component and this warranty specifically does not provide coverage for:

1. Towing or transportation of the vessel, or travel to and from the job site or vessel.
2. Original installation charges or start-up costs.
3. Loss of use or income from the vessel and/or rental of equipment during the performance of warranty repairs.

G To Obtain Warranty Service: Please go to www.zf.com or call 1-425-583-1900 or (U.S. only) 1-800-546-5455 for the nearest ZF Factory or Authorized Service Center.

1. The Service Center will contact ZF Service Department for a Service Return Authorization (SRA) number. Return the product freight prepaid, marked clearly with the SRA number, and with a description of the malfunction included.
2. If there are defects covered by this warranty, ZF will, at its option, either repair or replace the defective part or product. If after inspection, ZF determines that the product is not defective, ZF will charge a testing fee and return the product to the sender, freight collect.
3. Repair or replacement during the warranty period will not extend the warranty period.
4. All SRA claims must be requested and submitted within 30 days from the date of repair service.
5. Claims for over 3 hours labor must be pre-approved by the ZF Service Department.

This warranty is expressly in lieu of all other warranties, express or implied. Except to the extent prohibited by applicable law, ZF hereby disclaims all other implied or express warranties of any kind, including warranties of merchantability and fitness for a particular purpose. Under no circumstances shall ZF be liable for any incidental or consequential damages sustained in connection with the product or its use, including any costs or damages that result from loss of use of the product or any engine or boat with which it is used. ZF does not authorize any representative or agent to assume for it any obligation or liability other than those expressly set forth above. Some States and other jurisdictions do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of consequential damages, so above limitations may not apply to you. All implied warranties, if any, are limited to the duration of this express warranty. This warranty gives you legal rights, and you may have other rights that may vary from State to State.

Warranty Registration

Processor, Serial #			Serial #		
Number of Remote Stations					
Purchase Date					
Dealer's Name					
Installer's Name					
Phone Number			Cell Number		
E-Mail Address			Fax Number		
Purchaser's Name					
Street Address					
City		State		Zip	
Phone					
YOUR VESSEL:					
Engine, Make & Model					
Length					
Manufacturer					

ZF Marine Propulsion Systems Miramar, LLC. Product First Seen At:

Boat Show	Dealer	Magazine	Friend

Factory Authorized Sales & Service - North America

USA

Alabama

Company:	Gulf Coast Air & Hydraulics
Contact:	Chuck Moorehead, Mike Ellis
Address:	PO Box 161134
	Mobile, AL 36613
Shipping:	3415 Halls Mills Road
	Mobile, AL 33693
Phone:	251-666-6683
Fax:	251-666-6684
Email:	cmoore41984@aol.com
Website:	www.wegetstuffdone.com

California

Company:	TDC Equipment
Contact:	Terry Brown
Address:	15886 Manufacture Lane
	Huntington Beach, CA 92649
Phone:	714-373-8099
Fax:	714-898-1996
Email:	tbrown@tdcequipment.com
Website:	www.tdcequipment.com

Company:	Trans Pacific Distributors
Contact:	Henry Bramhall
Address:	1941 Walters Court
	Fairfield, CA 94533
Phone:	707-426-6670
Fax:	707-426-0206
Email:	sales@marinegate.com

Florida

Company:	Control Masters
Contact:	Ed Raffaniello
Address:	14603 Beach Blvd Ste 600
	Jacksonville, FL 32250
Phone:	904-260-9756
Fax:	904-260-9727
Email:	edr@controlmastersinc.com
Website:	www.controlmastersinc.com

Company:	D.S. Hull Company, Inc.
Contact:	Lou Moran
Address:	3320 SW Third Ave
	Ft Lauderdale, FL 32258
Phone:	954-463-4307
Fax:	954-527-4173
Email:	loudshull@yahoo.com

Company:	H & H Marine Sales & Service
Contact:	John Fox, Andy Glen
Address:	10220 San Martin Blvd. N
	St Petersburg, FL 33702
Phone:	727-576-0923
Fax:	727-576-9727
Email:	hhmarine@ij.net

Company:	Yacht Equipment & Parts
Contact:	Jim Monroe, Lee Moore
Address:	3355 SW 2nd Ave
	Ft Lauderdale, FL 33315
Phone:	954-463-7222
Phone:	800-349-9224
Fax:	954-463-9009
Email:	jmonroe@bowboat.com

Company:	ZF Marine Propulsion Systems Miramar – US Headquarters
Contact:	A.J. Halavacs
Address:	15351 SW 29th Street, Ste 300
	Miramar, FL 33027
Phone:	954-441-4040
Fax:	954-441-4140
Email:	aj.halavacs@zf.com
Website:	www.zf-marine.com

Louisiana

Company:	Donovan Marine, Inc.
Contact:	Steve Garver, Richard McConnell
Address:	6316 Humphreys Street
	Harahan, LA 70123
Phone:	504-488-5731
Phone:	800-347-4464
Fax:	504-486-3258
Email:	rbenton@donovanmarine.com

Company:	ZFI Marine – Gulf Coast
Contact:	Mike Gauthreaux, Laura Heckler
Address:	161 James Drive West, Suite 120
	St Rose, LA 70087
Phone:	504-443-0501
Fax:	504-443-0504
Email:	mike.gauthreaux@zf.com
Website:	www.zf-marine.com

Michigan

Company:	Marysville Marine North
Contact:	Randy Hall, John Dillon
Address:	1551 Michigan Ave
	Marysville, MI 48040
Phone:	810-364-7653
Phone:	800-367-0987
Fax:	810-364-4112
Email:	rhall@marysvillemarine.com
Website:	www.marysvillemarine.com

New Jersey

Company:	Airline Hydraulics Corporation
Contact:	Bernie Keppel
Address:	428 Woodbine-Ocean View Road
	Ocean View, NJ 08230
Phone:	609-624-3700
Fax:	909-624-0863
Email:	sales@airlinehyd.com
Website:	www.airlinehyd.com

Ohio

Company:	Marysville Marine - Ohio
Contact:	Jeff Mechan
Address:	1470 South Danbury Rd
	Port Clinton, OH 43452
Phone:	419-734-3104
Fax:	coming soon
Email:	jmechan@marysvillemarine.com
Website:	www.marysvillemarine.com

Tennessee

Company:	Marysville Marine South
Contact:	Randy Hall
Address:	127 Industrial Drive
	White House, TN 37188
Phone:	615-672-1142
Fax:	615-851-9465
Email:	rhall@marysvillemarine.com
Website:	www.marysvillemarine.com

Texas

Company:	Donovan Marine, Inc.
Contact:	Trey Grant
Address:	4757 South Loop East
	Houston, TX 77033
Phone:	713-734-4171
Phone:	800-669-8392
Fax:	713-734-167
Email:	treygrant@donovanmarine.com

Virginia

Company:	Engines 1
Contact:	Tim Walters
Address:	PO Box 7788
	Portsmouth, VA 23707
Shipping:	3504 Shipwright Street
	Portsmouth, VA 23703
Phone:	757-673-7200
Phone:	800-548-6252
Fax:	757-673-7211
Email:	info@engines1.com
Website:	www.engines1.com

Washington

Company:	Fisheries Supply Co
Contact:	Mike Gibbons
Address:	1900 N. Northlake Way
	Seattle, WA 98103
Phone:	206-632-4462
Phone:	800-426-6930
Fax:	206-634-4600
Email:	mail@fisheriessupply.com
Website:	www.fisheriessupply.com

Company:	Pinnacle Marine Services
Company:	Dave Hanson
Address:	160 Cascade Place, #229
	Burlington, WA 98233
Phone:	360-404-2063
Fax:	360-404-2064
Email:	pinnmar@aol.com

Company:	PPC – Systems, Inc
Contact:	Bill Mol
Address:	12147 Bayhill Road
	Burlington, WA 98233
Phone:	360-336-9698
Fax:	360-757-8747
Cell:	206-915-0712
Email:	ppcsystemsinc@verizon.net

Company:	ZFI Marine – West Coast
Contact:	Bud Bloom, Kevin Zwicker
Address:	12125 Harbour Reach Dr Ste B
	Mukilteo, WA 98275
Phone:	425-583-1900
Fax:	425-493-1579
Email:	bud.bloom@zf.com; kevin.zwicker@zf.com
Website:	www.zf-maine.com

Wisconsin

Company:	Marysville Marine West
Contact:	Brian Hunter
Address:	282 Progress Way
	Sun Prairies, WI 53590
Phone:	608-825-3875
Phone:	800-992-3878
Fax:	608-825-2790
Email:	bhunter@marysvillemarine.com
Website:	www.marysvillemarine.com

CANADA

Eastern Canada

Company:	CMC Electronics
Contact:	Mark Newcomb
Address:	40 Thornhill Drive, Unit 6
	Dartmouth, Nova Scotia
	Canada B3B 1S1
Phone:	902-468-8480
Fax:	902-468-8484
Email:	mark.newcomb@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Brian Sibley
Address:	8 Brown Street / PO Box 5
	Yarmouth, Nova Scotia
	Canada B5A 1N1
Phone:	902-742-3423
Fax:	902-742-5593
Email:	brian.sibley@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Bill Taaffe, Dave Duff
Address:	29 Hallett Cresent
	St John's, Newfoundland
	Canada A1B 3T2
Phone:	709-726-2422
Fax:	709-726-2428
Email:	bill.taaffe@cmcelectronics.ca; dave.duff@cmcelectronics.ca

Central Canada

Company:	CMC Electronics
Contact:	Graham Taylor
Address:	3600 B Laird Road Unit 12
	Mississauga, Ontario
	Canada L5L 6A7
Phone:	905-607- 4262
Fax:	905-607-1576
Email:	graham.taylor@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Michel Roy
Address:	566 Duphare Street East
	Mantane, Quebec
	Canada G4W 3P6
Phone:	418-562-6637
Fax:	418-562-5335
Email:	michel.roy@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Walter Timmerman
Address:	600 Dr Frederik Phillips Blvd
	Ville St Laurent, Quebec
	Canada H4M 2S9
Phone:	514-748-3000, ext 4800
Fax:	514-748-3006
Email:	walter.timmerman@cmcelectronics.ca

Western Canada

Company:	Western Marine
Contact:	Bill Falk, Alan Stovell
Address:	1494 Powell Street
	Vancouver, British Columbia
	Canada V5L 5B5
Phone:	604--253-7721
Phone:	800-663-0600
Fax:	604-253-2656
Email:	astovell@westernmarine.com

Company:	CMC Electronics
Contact:	Jeff Bailey
Address:	3839 Still Creek Ave
	Burnaby, British Columbia
	Canada V5C 4E2
Phone:	604-435-1455
Fax:	604-435-2231
Email:	Jeffrey.Bailey@cmcelectronics.ca

Company:	CMC Electronics
Contact:	Brad Funk, Jim Goodfellow
Address:	6680 Mirah Road
	Saanichton, British Columbia
	Canada V8M 1Z4
Phone:	250-544-1561
Fax:	250-544-2061
Email:	brad.funk@cmcelectronics.ca; jim.goodfellow@cmcelectronics.ca

Factory Authorized Service Centers - North America

USA

Alaska

Company:	Alaska Professional Marine
Contact:	Keith Stephens
Address:	PO Box 32083
	Juneau, AK 99803
Shipping:	1900 Fritz Cove Road
	Juneau, AK 99803
Phone:	907-780-3960
Fax:	907-789-0054

Company:	Brick's Electronics
Contact:	Brick Lobaugh
Address:	1035 Mendenhall Pennisula Road
	Juneau, AK 99801
Phone:	907-789-2787
Fax:	907-789-4778
Email:	bricks@gci.neet

Company:	Kodiak DC Electric
Contact:	Dennis McCuster
Address:	2561 Beaver lake Drive
	Kodiak, AK 99615
Phone:	907-486-5323
Email:	debmccusker@yahoo.com

Company:	Kodiak Service
Contact:	Fred Lentz
Address:	PO Box 1018
	Kodiak, AK 99615
Phone:	907-486-6556
Fax:	907-486-6022
Email:	ksci@worldnethtt.net

Company:	Rainbow Glacier Company
Contact:	Karl Johnson
Address:	PO Box 821
	Haines, AK 99827
Phone:	907-766-2218
Fax:	907-766-2585

Company:	Redden Marine Supply Formerly - Kachemak Gear Shed
Contact:	John and Butch
Address:	3625 East End Road
	Homer, AK 99603
Phone:	907-235-7993
Fax:	907-235-7233

Company:	Spaulding Sports Supply
Contact:	Steve Spaulding
Address:	2017 Badger Road
	North Pole, AK 99708
Phone:	907-488-6998
Phone:	907-488-5242
Fax:	907-488-6385

Company:	The Bay Company
Contact:	Chet Powell, Mike Ottesen
Address:	431 Front Street
	Wrangell, AK 99929
Phone:	907-874-3340
Fax:	907-874-2592

Company:	Timber & Marine
Contact:	Ken Perry
Address:	2547 Tongass Avenue
	Ketchikan, AK 99001
Phone:	907-225-6644
Fax:	907-225-0644

Company:	Wikan Enterprises
Contact:	Sheri and John Wikan
Address:	PO Box 929
	Petersburg, AK 99833
Shipping:	103 Dock Street
	Petersburg, AK 99833
Phone:	907-772-4155
Fax:	907-772-4153
Email:	wikanent@alaska.com

Arizona

Company:	Aramark / Lake Powell Resorts & Marinas
Contact:	Mark Suttie
Address:	PO Box 1597
	Page, AZ 86040
Phone:	928-645-1186
Fax:	928-645-1101
Email:	suttee-mark@aramark.com

Company:	Desert Recreation, Inc.
Contact:	Jim Ronnie
Address:	315 Long Ave.
	Bull head, City, AZ 86429
Phone:	928-754-4391
Fax:	928-754-3335
Email:	desrec@ctaz.com

Company:	Donn's Boat Shop, Inc.
Contact:	Donn DeVore
Address:	PO box 3826
	Page, AZ 86040
Shipping:	486 Haul Road
	Page, AZ 86040
Phone:	928-645-0313
Fax:	928-645-0323
Email:	boatfxr@donnsboatshop.com

Company:	Mobile Marine Repair, Inc.
Contact:	Steve Ringleman
Address:	PO Box 2988
	Page, AZ 86040
Phone:	928-645-1406
Fax:	928-645-1406

Company:	Old West Marine Service
Contact:	Len Cook, Jason Giffen
Address:	PO Box 4798
	Page, AZ 86040
Shipping:	1002 Vista
	Page, AZ 86040
Phone:	928-645-2705
Fax:	928-645-2542
Email:	oldwest@oldwestmarine.com

Company:	Skipperliner
Contact:	Jay Phelps, Jerry Apalategui
Address:	PO Box 3058
	Page, AZ 86040
Shipping:	550 Haul Road
	Page, AZ 86040
Phone:	928-645-2444
Fax:	928-645-5753

Company:	Skipperliner – Lake Pleasant
Contact:	Mike Montgomery, Glenn Carson
Address:	40202 N. 87th Ave
	Peoria, AZ 85382
Phone:	928-501-2444
Fax:	928-501-2443
Email:	phelpsjy@skipperliner.com

Company:	Tony's Dri-Dock & Marine
Contact:	Tony Ferrando
Address:	PO Box 897
	Page, AZ 86040
Shipping:	902 Hemlock
	Page, AZ 86040
Phone:	928-645-2732
Fax:	928-645-5237

Arkansas

Company:	Dreamchaser Houseboats
Contact:	Tiny Joe
Address:	PO Box 356
	Mt Ida, AR 71957
Shipping:	60 Marina Drive
	Mt Ida, AR 71957
Phone:	870-867-3480
Fax:	870-867-2665

California

Company:	Bayside Marine Electric
Contact:	Mike Vihel
Address:	PO BOX 685
	Bayside, CA 95524
Phone:	707-498-9999

Company:	Fishing Boats Unlimited
Contact:	Tony Greyshock, Jason Greyshock
Address:	624 Terminal Way
	Costa Mesa, CA 92627
Phone:	949-642-0882
Fax:	949-642-0419
Email:	crew@fishingboatsunlimited.com
Website:	www.fishingboatsunlilmited.com

Company:	Channel Coast Marine
Contact:	Marc Hermann
Address:	2949 W. 5th Street
	Oxnard, CA 93030
Phone:	805-985-0220
Fax:	805-985-7707

Company:	Chris Marine
Contact:	Chris Schjoth
Address:	14265 Holiday Road
	Redding, CA 96003
Phone:	530-275-3097
Fax:	530-275-3096

Company:	Dependable Marine
Contact:	Ernie Monroe, Syd Arnold
Address:	3134 Main Street
	San Diego, CA 92113
Phone:	619-226-2015
Fax:	619-226-0027
Email:	erniedepmar@aol.com

Company:	Easley Consulting
Contact:	Ron Easley
Address:	1048 Irvine Ave #315
	Newport Beach, CA 92660
Phone:	949-287-1619
Email:	roneasley93@yahoo.com

Company:	Fish Head Marine
Contact:	Robert Johnson (RJ)
Address:	603 Seagaze Dr Ste 162
	Oceanside, CA 92054
Phone:	760-271-0829
Email:	fishheadmarine@gmail.com

Company:	Hoffman Yacht Management
Contact:	Soren Megling
Address:	2330 172 Shelter Is Dr
	San Diego, CA 92106
Phone:	619-990-1409
Email:	steve@hoffmanyachtmgt.com

Company:	John Gumb Yacht Management, LLC
Contact:	Charles (Boomer) Walling
Address:	2330 Shelter Is Dr Ste 160
	San Diego, CA 92106
Phone:	619-247-6697
Fax:	619-437-4324
Email:	dgum@pacbell.net

Company:	Johnson Hicks Marine, Inc.
Contact:	Joe Donatini, Mark Egon, Larry Scroggins
Address:	333 C Lake Ave
	Santa Cruz, CA 95062
Phone:	831-475-3383
Fax:	831-475-1498
Email:	jhme6@cs.com

Company:	Jones Valley & Shasta Lake Resorts
Contact:	Mike Han, Kip Fatout
Address:	22300 Jones Valley Marina Road
	Redding, CA 96003
Phone:	530-275-7950
Fax:	530-275-3523

Company:	Outbound Yacht Service
Contact:	Kevin Ryan
Address:	34241 Pacific Coast Hwy #105
	Dana Point, CA 92629
Phone:	949-488-0652
Fax:	949-489-0704
Email:	kevin@outboundyachtservices.com

Company:	Reliable Marine Electronics
Contact:	Roger Nunez
Address:	1925 Lafeyette Street
	Alameda, CA 94501
Phone:	510-885-0525
Fax:	510-885-0526
Email:	radarrog@aol.com

Company:	Ron's Marine Service
Address:	5449 Maricopa Dr
	Simi Valley, CA 93063
Phone:	310-508-2228
Email:	ronsmarine@sbcglobal.net

Company:	Scoles Marine Services
Contact:	Brian Scoles
Address:	615 LeHarve Avenue
	Lake Elsimore, CA 92530-5386
Phone:	909-678-6171
Fax:	909-678-7807

Company:	Sherrill's Marine Service
Contact:	Robert Sherrill, Caleb Linn
Address:	PO Box 2112eet
	Avalon, CA 90704
Phone:	310-510-1610
Fax:	310-510-1352

Company:	Ship Shape Marine
Contact:	Tony Travis
Address:	909 Marina Village Pkwy, #186
	Alameda, CA 94501
Phone:	510-206-0420
Email:	Shipshapemarine@gmail.com

Connecticut

Company:	Mystic River Marina
Contact:	Greg Schroder
Address:	36 Quarry Road
	Mystic, CT 06355
Phone:	860-536-3936

Delaware

Company:	Hinckley Yacht Service
Contact:	Tom Turner
Address:	PO Box 369
	Oxford, MD 21654
Shipping:	Bank Street
	Oxford, MD 21654
Phone:	410-226-5113
	Covers Delaware & Maryland

Florida

Company:	ATM Marine, Inc.
Contact:	Mike Handschmann
Address:	18730 Lenaire Drive
	Miami, FL 33157
Phone:	305-251-7547
Cell:	786-429-7068
Fax:	305-926-3813
Email:	atmmarine1@bellsouth.net

Company:	Dave Gillen Diesel
Contact:	Dave Gillen
Address:	811 N.E. 3RD Street
	Dania Beach, FL 33004
Phone:	954-927-6500
Fax:	954-927-6090
Email:	Gillenda@GillenDiesel.net
Website:	www.Gillendiesel.net

Company:	Mega Yacht Service
Contact:	Dave Laschomb
Address:	408 SE STREAMLET AVE
	Port St. Lucy, FL 34983
Phone:	772-284-9638
Email:	megayacht@bellsouth.net

Company:	Naval Electrical Systems
Contact:	Alain Lauchy
Address:	14681 SW 124th Pl
	Miami, FL 33186
Phone:	305-962-7104
Email:	lauchy33@yahoo.com

Company:	Sea Wiz
Contact:	Melody Dodamead
Address:	PO Box 501396
	Marathon, FL 33050
Shipping:	8025 Gulf Stream Blvd
	Marathon, FL 33050
Phone:	305-289-4044
Cell:	305-289-3090
Fax:	305-481-0449

Company:	Yacht Electric Corporation
Contact:	Enrique Giner
Address:	7770 NW 53rd Street
	Miami, FL 33166
Phone:	404-376-8599
Fax:	770-979-4872

Georgia

Company:	J & W Marine Services
Contact:	Jerry Sumrel
Address:	3292 McEver Road, Suite 103
	Buford, GA 30518
Phone:	404-376-8599
Fax:	770-979-4872

Company:	Mobile Marine
Contact:	Painter Stevenson
Address:	4603 Countryside Drive
	Flowery Branch, GA 30542
Phone:	770-480-3805
Fax:	770-965-1864
Email:	sst3485@aol.com

Company:	On Site Marine Service
Contact:	Tim McNeil
Address:	2835 Still Meadows Way
	Buford, GA 30519
Shipping:	6109 Holiday Road
	Buford, GA 30518
Phone:	770-614-0106
Fax:	770-271-1909
Cell:	404-867-1235

Hawaii

Company:	Uhane Enterprises, LLC
Contact:	Jack Womack
Address:	74-425 Kealakehe Parkway #11
	Kailua-Kona, HI 96740
Phone:	808-557-9622
Fax:	808-329-4157
Email:	kalani444@aol.com

Iowa

Company:	S & S Rentals, Inc.
Contact:	Greg Stirn
Address:	PO Box 389
	Lansing, IA 52151
Shipping:	990 South Front Street
	Lansing, IA 51251
Phone:	563-538-4135
Fax:	563-538-4454

Kentucky

Company:	Monticello Mobile Marine
Contact:	Mark Tucker, Pam Tucker
Address:	PO BOX 1090
	Monticello, KY 42633
Shipping:	472 Barleson Sub Rd
	Monticello, KY 42633
Phone:	606-307-7077
Fax:	606-348-3587
Email:	mark@monticellomobilemarine.com
Website:	www.monticellomobilemarine.com

Company:	Pluckebaum Custom Boats, Inc.
Contact:	Jamie Donahue
Address:	1231 State Road 1793
	Prospect, KY 40059
Phone:	502-228-0111
Fax:	502-228-4767

Company:	The Boat Doctor
Contact:	Ancil Shelton
Address:	950 Duncan Valley Rd
	Monticello, KY 42633
Phone:	606-348-3484
Fax:	606-307-4960

Louisiana

Company:	Total Electric Service of Arcadiana
Contact:	Barry LaGrange
Address:	200 Rue Degravelle
	New Iberia, LA 70563
Phone:	337-367-6756
Fax:	337-367-6765

Maryland

Company:	Hinckley Yachts Services
Contact:	Tom Turner
Address:	PO Box 369
	Oxford, MD 51654
Shipping:	Bank Street
	Oxford, MD 51654
Phone:	410-226-5113
Fax:	410-226-5602
	Covers Delaware & Maryland

Company:	Middle River Electronics
Contact:	John Weaver, Darren Weaver
Address:	233 C Nanticoke Road
	Baltimore, MD 21221
Phone:	410-687-6474
Fax:	410-687-3353

Massachusetts

Company:	Niemiec Marine
Contact:	Martin Niemiec
Address:	173 Popes Island
	New Bedford, MA 02740
Phone:	508-997-7390
Fax:	508-997-8978

Nevada

Company:	A & M Marine
Contact:	Jim Bell, Scott Wall
Address:	1630 Foothill Drive
	Boulder City, NV 89005
Phone:	702-293-1321
Fax:	702-293-5896
Cell:	609-517-5595
Email:	anmmarine@aol.com

Company:	Callville Bay Resort & Marina
Contact:	Carl Ward
Address:	HCR 30 Box 100
	Las Vegas, NV 89124
Phone:	702-565-4813
Fax:	702-566-9899

New Jersey

Company:	Authority Marine Service
Contact:	Scott Self
Address:	1 Marine Bay Ct
	Highland, NJ 07732
Phone:	732-291-0012
Email:	authoritymarineservice@verizon.net

Company:	Martek Electronics
Contact:	Charles Hewitt
Address:	47 South Shore Road
	Marmora, NJ 08223
Phone:	609-390-3355
Fax:	609-369-0849
Cell:	609-517-5595

New York

Company:	Den-Mac Sales
Contact:	Dennis McGowen
Address:	8 Ramick Drive West
	Amityville, NY 11701
Phone:	631-842-8967
Fax:	631-842-5274

Company:	Montauk Marine Basin, Inc
Contact:	Mark Jarboe
Address:	PO Box 610
	Montauk, NY 11954
Shipping:	426 Westlake Drive
	Montauk, NY 11954
Phone:	631-668-5900
Fax:	631-668-5659
	Covers 60 miles west only

North Carolina

Company:	Demann Marine Power
Contact:	Tom Demann
Address:	107 Bryan Road
	Wilmington, NC 28412
Phone:	910-791-6222
Fax:	910-791-7056

Company:	Griffin Marine, Inc.
Contact:	Don Griffin, Don Griffin Jr., Casey Carr
Address:	PO Box 458
	Wanachese, NC 27981
Shipping:	898 Harbor Road
	Wanachese, NC 27981
Phone:	252-473-1422
Fax:	252-473-4654
Email:	griffinmarine@mindspring.com

Company:	Marine Control Systems
Contact:	Gary Sorenson
Address:	76 May Apple Lane
	Franklyn, NC 28734
Phone:	828-508-4201
Fax:	828-369-7572

Oregon

Company:	Cook Engine & Co.
Contact:	Jeff Dykes
Address:	503 NE Tomahawk Island Drive
	Portland, OR 97217
Phone:	503-289-8466
Fax:	503-286-2836
Email:	sales@cookengine.com

Company:	Curry Marine
Contact:	Terry Wheeler, Scot Graf, Laurie Wheeler
Address:	PO Box 610
	Newport, OR 97365
Shipping:	1211 SE Bay Blvd
	Newport, OR 97365
Phone:	541-265-7655
Fax:	541-265-4226

Company:	George's Marine Electric
Contact:	Bill Elderkin, Paul Kepford
Address:	PO Box 5530
	Charleston, OR 97420
Phone:	541-888-5209
Fax:	541-888-9557

Company:	Sells Marine
Contact:	Paul Wilson
Address:	1111 NE Marine Drive
	Portland, OR 97211
Phone:	503-285-3838

Puerto Rico

Company:	Yacht Specialty
Contact:	David Davila
Address:	RR #2 Box 693
	San Juan, PR 00926
Phone:	787-755-4406
Fax:	787-755-4406
Cell:	787-397-7518

South Carolina

Company:	MacKay Communications
Contact:	Tony Smircic
Address:	1369 B Ashley River Road
	Charleston, SC 29407
Phone:	865-966-8481
Fax:	843-571-5301

Company:	Tidal Marine Electronics Ltd.
Contact:	Jeff Sechrest
Address:	1643 B Savannah Hwy, Suite 340
	Charleston, SC 29407
Phone:	843-763-8553
Fax:	843-763-8554
Email:	tidalmarineelec@aol.com

Tennessee

Company:	Simpson Marine Electronics
Contact:	R.S. Simpson
Address:	PO Box 22213
	Knoxville, TN 37933
Shipping:	665 Chapel Point Lane
	Knoxville, TN 37922
Phone:	865-966-8481
Fax:	865-966-9707

Texas

Company:	Lakewood Yacht Service
Contact:	Dennis Osborne, Danny Baldwin
Address:	POBox 536
	Seabrook, TX 37933
Shipping:	2301 Nasa Road 1
	Seabrook, TX 77586
Phone:	281-474-2885
Fax:	281-474-2885
Email:	jjohnston@lakewoodyachtservice.com

Utah

Company:	Aramark – Halls Crossing
Contact:	Mark Grahn
Address:	PO Box 5101
	Lake Powell, UT 84533
Phone:	435-684-7019
Fax:	281-474-2885

Company:	Bullfrog Boat Shop
Contact:	Tami Luckson
Address:	PO Box 4055
	Lake Powell, UT 84533
Phone:	435-684-3018
Fax:	435-684-3005

Company:	Offshore Marina, Inc.
Contact:	Daryl Hickson, Chris Pear
Address:	PO Box 330330
	Lake Powell, UT 84533
Shipping:	Hwy 276, Mile Marker 30
	Lake Powell, UT 84533
Phone:	435-788-2303
Fax:	offshoremarinaLP@aol.com
Email:	435-788-2303

Virginia

Company:	Bluewater Yacht Sales
Contact:	Craig Messick
Address:	26 Marina Yacht Charters
	Hampton, VA 23702
Phone:	757-723-0793
Fax:	757-723-3320

Washington

Company:	Anacortes Yacht Charters
Contact:	Sandy
Address:	2415 T Avenue, #112
	Anacortes, WA 98221
Phone:	360-293-4555
Fax:	360-293-6683

Company:	Complete Controls
Contact:	Jim Palmer
Address:	9306 NE 7th Street
	Vancouver, WA 98664
Phone:	360-904-7525
Fax:	360-254-7846
Email:	palmer.jim@comcast.net

Company:	Islands Marine Center, Inc
Contact:	Ron Meng
Address:	PO Box 88
	Lopez Island, WA 98261
Shipping:	Fisherman's Bay Road
	Lopez Island, WA 98261
Phone:	360-468-3377
Fax:	360-468-2283

Company:	Marine Service Center, Inc. – ANA
Contact:	Skip Dassler
Address:	2417 T Avenue
	Anacortes, WA 98221
Phone:	360-293-8200
Fax:	360-293-9648

Company:	Maritime Fabrications / LaConner Maritime
Contact:	Tony Ford, Joe Franett
Address:	PO Box 816
	LaConner, WA 98257
Shipping:	920 W. Pearle Jensen Way
	LaConner, WA 98257
Phone:	360-466-3629
Fax:	360-466-3632

Company:	North Harbor Diesel, Inc.
Contact:	Dave Williams, Mike Curran
Address:	720 30th Street
	Anacortes, WA 98221
Phone:	360-293-5551
Fax:	360-293-0728
Email:	nharbor@fidalgo.net

Company:	Ocean Alexander Marine Center
Contact:	Scott Morris
Address:	1115 N. Northlake Way
	Seattle, WA 98103
Phone:	206-547-1395
Fax:	206-547-3789

Company:	Puget Sound Yacht Service
Contact:	Paul Waits
Address:	9611 146th Place SE
	Snohomish, WA 98296
Phone:	206-660-3630
Fax:	206-483-0710
Email:	psyachtservice@aol.com

Company:	Radar Marine Electronics
Contact:	Bill Pulse
Address:	16 Squallicum Mall Blvd
	Bellingham, WA 98225
Phone:	360-733-2012
Fax:	360-733-2383

Company:	Reliance Marine Electronics
Contact:	Randy Widen
Address:	2436 NW 61st
	Seattle, WA 98107
Phone:	206-781-1105
Fax:	206-789-9775
Email:	randy@wolfenet.com
Works in Alaska – May & June Only - Call:907-842-3917	

Company:	Roberts Maritime
Contact:	Bill Roberts
Address:	PO BOX 1592
	Coupeville, WA 98239
Phone:	360-678-4235
Fax:	360-678-5576
Email:	boatzz@comcast.net

Company:	Yacht Care, Inc
Contact:	Jim Brown
Address:	26010 West Marina Place, Suite K
	Seattle, WA 98199
Phone:	206-285-2600
Fax:	206-285-2610
Cell:	360-914-0256

Factory Authorized Sales & Service Centers - International

Argentina

Company:	Transmsiones Marinas S.A.
Contact:	Ing. Daniel Canoura
Address:	Hernandarias 3656
	B7603GNH Mar Del Plata
	Argentina
Phone:	54-223- 410 7975
Fax:	54-223- 480 7174
Email:	TM@tmgroup.com.ar; tmventas@tmgroup.com.ar
Website:	www.tmgroup.com

Company:	Trimer S.A.
Contact:	Carlos Dorian Freidlander
Address:	Attn: Mariano Castroverde
	PO Box 772
	1000 Buenos Aires, Argentina
Shipping:	Fray J.S.M. de Oro 2030-40
	1425 Buenos Aires, Argentina
Phone:	54-11-4580-0444
Fax:	54-11-4580-0440
Email:	trimer@trimer.com.ar

Australia

Company:	ZF Services Australia Pty, Ltd.
Contact:	Gary Bain, Rodney Lean
Address:	Locked Bag 6305
	Blacktown BC NSW 2148
	Australia
Shipping:	14 Lidco Street
	Arndell Park, NSW 2148
	Australia
Phone:	61- (0)2-9679-5555
Fax:	61-(0)2-9679-5500
Email:	gary.bain@zf.com.au or oesales@zf.com
Website:	www.zf.com.au

Brazil

Company:	ZF do Brazil S.A.
Contact:	Richard Bergamini
Address:	Avenida Conda Zepplin, 1935
	CEP 18103-0000 Sorocaba, Brazil
Phone:	5515-235-2301
Fax:	5515-235-2233
Email:	richard.bergamini@zf.com
Website:	www.zf.com

Chili

Company:	Equipamiento Marino Ltda
Contact:	Christian Rogers Nickelmann
Address:	Rafael Correa 1268 Vitacura
	Santiago, Chili
Phone:	(56-2) 4158737
Fax:	(56-2) 9-9975059
Email:	info@equipamientomarino.cl

China

Company:	Foilborne Engineering, Ltd.
Contact:	Paul Chow
Address:	Unit A 7-9, 13/F Veristrong
	34-36 Au Pui Wan Street / FO-Tan
	Shatin, N.T.
	Hong Kong, China
Phone:	852-2687-2988
Fax:	852-2687-1996
Email:	paulchow@foilborne.biz.com.hk

Company:	Renford Marine Equipment *(China)* Ltd.
Contact:	Anthony Yuen
Address:	501 Laws Commercial Plaza
	788 Cheung Sha Wan Road
	Hong Kong, China
Phone:	852-27427111
Fax:	852-27427171
Email:	anthony.yuen@renford.com

Company:	Renford Marine Equipment *(Shanghai)* Ltd.
Contact:	Anthony Yuen
Address:	811 Jiaxing Building
	877 Dong Fang Road, Pudong
	Shanghai, China 200122
Phone:	8621-50589000
Fax:	8621-505880007
Email:	anthony.yuen@renford.com

Company:	ZF Shanghai Rep. Office
Contact:	Tang Zhou Qing, Gong Lan
Address:	Room 2504, Jiangnan Building
	No. 600 Luban Road
	Shanghai, 200023, PR China
Phone:	0086-21-6301-4338
Fax:	0086-21-6301-6449
Email:	qiwei.yao@zf.com
Website:	www.zf-marine.com

Denmark

Company:	ZF Danmark APS
Contact:	Michael Johansson, Frank Kiessling
Address:	Taastrupgaardsvej 8-10
	Taastrup, DK-2630, Denmark
Phone:	45-7022-6243
Fax:	45-7022-2643
Email:	frank.kiessling@zf.com; michael.johansson@zf.com
Website:	www.zf-marine.com

Ecuador

Company:	ZF Marine's Consulting
Contact:	Pedro Aspiazu
Address:	Urdesa Central 1A #13184 Costanera
	Guaaquil – Guayas, Ecuador
Phone:	(593-4) 238-9306
Fax:	(593-4) 238-4010
Email:	zfmarineconsulting@yahoo.com

Finland

Company:	Atoy Oy
Contact:	Antti Hiidenheim
Address:	PO Box 137
	FIN-00101, Helsinki
	Finland
Phone:	35-8968271
Fax:	35-896827305
Email:	anttihiidenheimo@atoy.fi

France

Company:	ZF France
Contact:	Ronald Gamere
Address:	3, rue Henri Poincare'
	92167 ANTONY CEDEX, France
Phone:	+33 (01) 40 96 42 74
Fax:	+33 (01) 40 96 42 74
Email:	Ronald.Gamere@zf.com
Website:	www.zf.com/sso/fr

Germany

Company:	Otto Piening Propeller GMBH
Contact:	Mathias Pien
Address:	AM Altendeich 83
	D25348 Glückstadt
	Germany
Phone:	49-4124-916812
Fax:	49-171-4853376
Email:	pein@piening-propeller.de
Website:	www.piening-propeller.de

Greece

Company:	Amaltheia Marine, Ltd
Contact:	Demetris Kyriazis
Address:	13 Papaflessa Str.
	143 43 N. Halkidona
	Athens, Greece
Phone:	30210-25-88-985
Fax:	30210-25-89-986
Email:	amalmar@otenet.gr

Iceland

Company:	Maras ehf
Address:	Gudmundur Bragasson
	Akralind 2
	201 Kopavogur
	Iceland
Phone:	354-555-6444
Fax:	354-565-7230
Email:	Gummi@maras.is

Ireland

Company:	ZF Services Great Britain, Ltd
Contact:	Adi License
Address:	Abbeyfield Road, Lenton
	Nottingham, United Kingdom
	NG7 2SX, England
Phone:	44-115-986-9211
Fax:	44-115-986-9261
Email:	adi.license@zf.com
Website:	www.zf-marine.com

Italy

Company:	Saim SPA
Contact:	Antonio Renzetti, Alessandro Busetto
Address:	Via Donizetti, 9/11
	20090 Assago (MI)
	Italy
Phone:	39-02-488-521
Fax:	39-02-45703070
Email:	alessandro.busetto@saim-group.com; antonio.renzetti@saim-group.com
Website:	www.saim-group.com

Japan

Company:	ZF Marine Japan Co. Ltd
Contact:	Y. Ikeda, Nobora Kasajima
Address:	Fujikoshi Bldg. 1-10-11 Iriya taito-ku
	Tokyo, 110-0013
	Japan
Phone:	81-03-5808-4521
Fax:	81-03-5808-4531
Email:	mikio.sato@zf.com
Website:	www.zf-marine.com

Korea

Company:	SE Jung Engineering Co.
Contact:	M.G. Song
Address:	#35-4 Namhangdong-1KA
	Yeongdogu
	Pusan, Korea
Phone:	82-51-415-0591
Fax:	82-51-412-6361
Email:	sjeng88@kornet.net

Mexico

Company:	Baja Naval, s.a. de c.v.
Contact:	Jaime Hernandez, Alfredo Soqui, Mario Herrera
Address:	Av. de le Marina, 10
	Ensenada,
	Baja California Norte 22800
Phone:	011 52 646 174 0020
Fax:	011 52 646 174 0028
Email:	diego@bajanaval.com

Company:	RAL LINE, S.A. DE C.V.
Contact:	Ing. Ernesto Cadavid
Address:	Av. Gran Via Tropical #8
	Fraccionamiento Las Playas
	Acapulco, Gro. Mexico
Phone:	744-482-6365
Fax:	744-482-6365
Email:	ecadavid@ralline.com.mx

New Zealand

Company:	ZF Services Australia Pty, Ltd
Contact:	Gary Bain, Rodney Lean
Address:	Locked Bag 6305
	Blacktown BC
	NSW, Australia 2148
Shipping:	14 Lidco Street
	Arndell Park, NSW
	Australia 2148
Phone:	61-02-9679-5555
Fax:	61-02-9679-5500
Email:	gary.bain@zf.com.au or oesales@zf.com

Norway

Company:	KGK Norge AS
Contact:	Bjorn Reiersen
Address:	Casper Storms Vei 19
	N-0064 Oslo
	Norway
Phone:	47-22-884-680
Fax:	47-22-720-902
Email:	bjorn.reiersen@zf-group.com

Peru

Company:	PGO International S.A.C
Contact:	Pedro Gonzalez – Orbegoso
Address:	AV. Arequipa 2450 of 1108
	Lima 14, Peru
Phone:	(51-1) 421-6055
Fax:	(51-1) 421-6664
Email:	pgorbegoso@perusat.net.pe

Russia

Company:	ZF Russia
Contact:	Anastassia Selverstova
Address:	71, Marata Street Ste 313
	St Petersburg
	Russia 191119
Phone:	7-812-324-54-72
Fax:	7-812-140-18-15
Email:	anastassia.selverstova@zf.sp.ru

Scotland

Company:	ZF Services Great Britain, Ltd
Contact:	Adi License
Address:	Abbeyfield Road, Lenton
	Nottingham, United Kingdom
	NG7 2SX England
Phone:	44-115-986-9211
Fax:	44-115-986-9261
Email:	adi.license@zf.com
Website:	www.zf-marine.com

Singapore

Company:	Mammoth Enterprises Pte, Ltd
Contact:	Steven Wee
Address:	PO Box 283
	Siglap Post Office
	Singapore 914503
Shipping:	6-A Waringin Park
	Singapore 416320
Phone:	65-6-44-88266
Fax:	65-6-44-89800
Email:	mament@singnet.com.sg

Company:	ZF South East Asia
Contact:	Sharon Ho
Address:	11, Tuas Drive 1
	Singapore
Phone:	6861-0177
Fax:	6861-9173
Email:	sharon.ho@zf-seasia

South Africa

Company:	ZF South Africa Pty, Ltd
Contact:	Heather Hermann
Address:	PO Box 2098
	Kempton Park, 1620 South
	Africa
Shipping:	C/O Barlows Power Systems
	Cnr Peter Barlow and Kasselss Vlei Rd
Phone:	27-11-453-1818
Fax:	27-11-453-7506
Email:	heather@zfsa.za

Spain

Company:	ZF Espana S.A.
Contact:	Maria Valladolid
Address:	Avda. Fuentemar, 11
	Coslada (Madrid) 28820
	Spain
Phone:	34 (0) 91485-2695
Fax:	34 (0) 91485-0036
Email:	maria.valladolid@zf.com
Website:	www.zf-marine.com

Sweden

Company:	KG Knutsson AB
Contact:	Karl-Henry Pragsten
Address:	Tansmissions Divisionen
	Hammarbracken 8
	S-191 81 Sollentuna
	Sweden
Phone:	46-08-923-312
Fax:	46-08-929-599
Email:	zf-marine@kgk.se
Website:	www.kgk.se

Switzerland

Company:	Marine Parts Technic
Contact:	Fabian Kraemer
Address:	Pfaffikerstrasse 6
	CH-8604 Volketswil
	Zurich, Switzerland
Phone:	41-1997-4090
Fax:	41-1997-4094
Email:	info@marineparts.ch; fabian.kraemer@marineparts.ch
Website:	www.marineparts.ch

Taiwan

Company:	Asia Diesel electric Corp
Contact:	Mike Ou
Address:	8F-1, No. 34, Min Chuan 1s. Road
	Kaohsiung, Taiwan. #80205
Phone:	886-7-3331191
Fax:	886-7-3346808
Email:	ade.taiwan@msa.hinet.net
Website:	www.asiadiesel.com.tw

Thailand

Company:	ZF Thailand Co. Ltd
Contact:	Reungpoj V
Address:	159/33 Soi Vipawasee 64
	Vipawasee-Rangsit Road
	Laksi, Bangkok 10210 Thailand
Phone:	66-2-521-6520
Fax:	66-2-521-6523
Email:	tanapath@bkk.loxinfo.th

The Netherlands (Holland)

Company:	ADS/van Stigt
Contact:	Ton Hekman, Rob van der Linde
Address:	Avelingen – West 30
	NL-4202 MS Gorinchem
	The Netherlands
Phone:	31-0-183-650000
Fax:	31-0—183-650001
Email:	Ton.Hekman@vanstigt.com
Website:	info@vanstigt.com

U.A.E.

Company:	ZF Middle East, LLC
Contact:	M. Narasimhan (Narsi), A.T. Moorthy
Address:	PO Box 26093
	Sharjah, U.A.E.
Shipping:	#502 Golden Tower Building
	Sharjah, U.A.E.
Phone:	971-6-5747074
Fax:	971-6-5747174
Email:	thiru.moorthy@zf-marine.com; narasimhan.manian@zf-marine.com
Website:	www.zf.com

United Kingdom

Company:	Atlantis Marine Power, Ltd
Contact:	Peter Middleton, Paul Lakey
Address:	Western wood Way
	Language Science Park
	Plymouth, Devon, PL7 5BG
	5BG England
Phone:	44-1752-208810
Fax:	44-1752-208811
Email:	paul.lakey@atlantismarine.co.uk; peter@atlantismarine.com
Website:	www.atlantismarine.co.uk

USA

Company:	ZF Marine Propulsion Systems Miramar – US Headquarters
Contact:	A.J. Halavacs
Address:	15351 SW 29th Street, Ste 300
	Miramar, FL 33027
Phone:	954-441-4040
Fax:	954-441-4140
Email:	aj.halavacs@zf.com
Website:	www.zf.com

Company:	ZF Marine Propulsion Systems Miramar, LLC – Gulf Coast
Contact:	Mike Gauthreaux
Address:	161 James Drive West
	Suite 120
	St Rose, LA 70087
Phone:	504-443-0501
Fax:	504-443-0504
Email:	mike.gauthreaux@zf.com
Website:	www.zf.com

Company:	ZF Marine Propulsion Systems Miramar –West Coast
Contact:	Kevin Zwicker
Address:	12125 Harbour Reach Drive Ste B
	Mukilteo,WA 98275
Phone:	425-583-1900
Fax:	425-493-1569
Email:	kevin.zwicker@zf.com
Website:	www.zf.com

Venezuela

Company:	Sistemas de Propulsion C.A.
Address:	AV 67a Entre 149By 150
	2 Etapa Zona Industrial
	Maracaibo, Venezuela
Phone:	58-261-736-0747
Fax:	58-261-736-0746
Email:	spd@sistemaspropulsion.com

REFERENCE MANUAL

MM13927 - Field Service Test Unit

MARINE PROPULSION SYSTEMS

Released by After Sales dept.

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

Revisions List

Rev	Date	Revision Description
A	11/02	Revised Section 1.0 Table 1
B	2/03	Revised manual to current ZF Marine Propulsion Systems Miramar manual standards. Revised Section 3.0
C	4/03	Deleted Section 2.1.6
D	10/03	Revising to add 9000 Series and 2-Speed information
E	06/07	Brought Entire Manual up to current ZF Standards. Software revised to SW70203.3 adding Joystick display. ELR 1401: Table 1, 2, 3, and 4 Item #3 changed from 13316-XX to 70422-xx Made CANtrak consistent throughout manual. Renamed Figures without CANtrak
E.1	07/10	Reformatted, updated inserted images
E.2	01/13	Name change to ZF Marine Propulsion Systems Miramar, LLC

1 Introduction

Refer to Bulletin 02-008 for Service Field Test Unit (Part No. 13927) recommendations. Refer to Figure MM13927-1: .Service Field Test Unit (Break-out Box) for an example of the Test Unit and a Multimeter

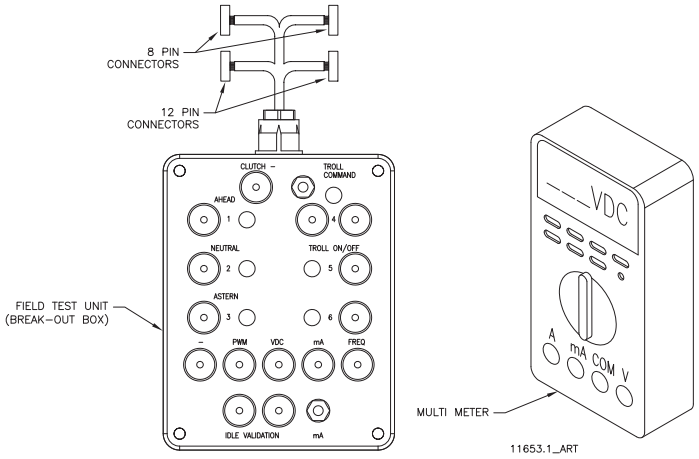


Figure MM13927-1: .Service Field Test Unit (Break-out Box)

The Service Field Test Unit, hereafter referred to as the "Break-out Box", is recommended for use with all CruiseCommand Processors (Part No. 785CE) and with ClearCommand Processors (Part No. 9XXX Series) that have pluggable (Pigtail) Throttle, Clutch or Troll Connections.

The procedures for testing the various outputs of the ClearCommand and CruiseCommand Processors are similar, with the exception of where they connect to the respective Processor. Figure MM13927-2: CruiseCommand Connector Locations indicates the location of the connectors on the CruiseCommand Processor and Figure MM13927-3: Example of CLEARCommand Pigtail Locations the typical pigtail plugs on a 9000 Series ClearCommand Processor.

	NOTE: Not all ClearCommand Processors have all of the pigtails shown in Figure MM13927-3: Example of CLEARCommand Pigtail Locations. Only the pigtails that are required for a specific application are installed in a ClearCommand Processor.

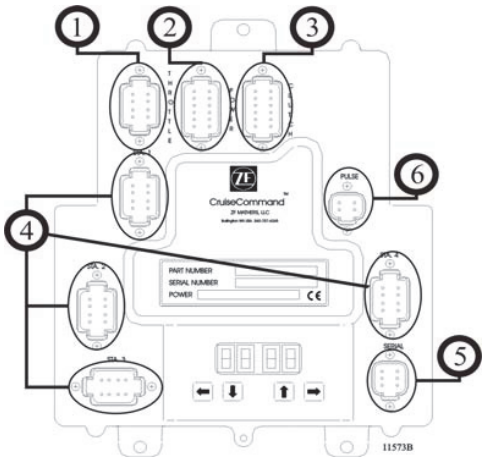


Figure MM13927-2: CruiseCommand Connector Locations

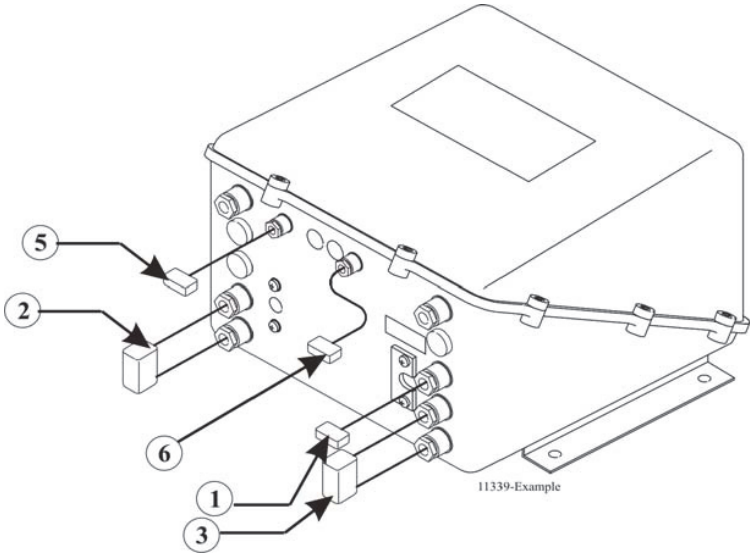


Figure MM13927-3: Example of CLEARCommand Pigtail Locations

Designation #	Description	Harness Type	Harness Use
1	Black 8 Pin	Throttle Connector/Pigtail	The throttle signal is output from this connector/pigtail. The signal may be in the form of Pulse Width Modulation (PWM), Voltage, Current, or Frequency.
2	Black 12 Pin	Power Connector/Pigtail	This connector/pigtail contains the inputs and outputs for Main Processor Power, Start Interlock, Clutch Oil Pressure Interlock, and External Alarm Circuit.
3	Gray 12 Pin	Clutch Connector/Pigtail	The external connections for Clutch Power, Ahead, Astern, and Neutral Solenoids, Troll On/ Off, and Proportional Solenoids are made at this connector/pigtail.
4	Gray 8 Pin	Control Head Connector	All the required connections for the Remote Control Stations are made at these connectors.
5	Gray 6 Pin	Serial Communication Connector/Pigtail	The Serial Communication connections between multiple Processors in applications with more than one Processor at this connector/pigtail.
6	Gray 4 Pin	Tachometer Sensor Connector/ Pigtail	The input signal from a Tachometer or Shaft Speed Sensor connects to this connector/pigtail.

The actual procedures for using the Break-out Box are the same for CruiseCommand and ClearCommand Processors. However, the adjustment within the Processor to obtain the correct output may differ. The appropriate Installation Manual must be referred to when making the adjustments.

2 Procedure

2.1 Throttle Signal Testing

Depending on which Processor is being tested, it may have the capability of sourcing one or all of the following: DC Voltage, Current, PWM (Pulse Width Modulation) or Frequency.

NOTE: The following procedures and drawings pertain to both the CruiseCommand and ClearCommand Processors.

2.1.1 DC Voltage

A Ensure that power is removed from the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-4: Throttle Connection (DC Voltage).

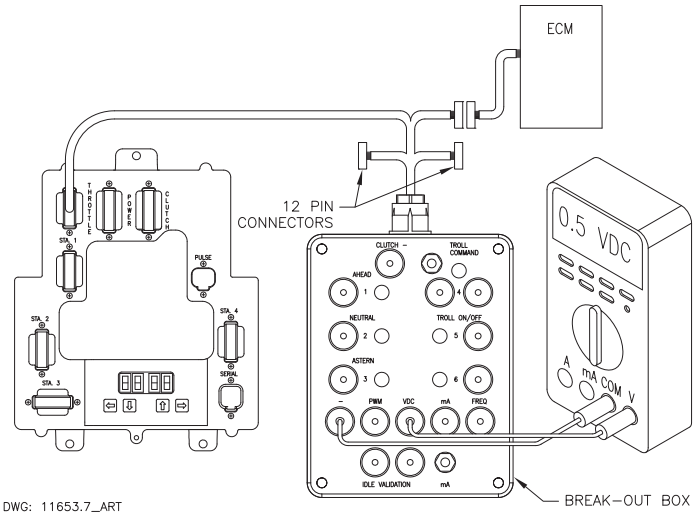


Figure MM13927-4: Throttle Connection (DC Voltage)

D Set up the Multimeter to measure DC Volts and plug the black lead into the Break-out Box black socket labeled "-" and the red lead into the socket labeled "VDC".

E Turn power 'On' to the Processor and take command at any Remote Station.

F The appropriate Idle Voltage for the application should be measured at this time.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

H The appropriate Full Throttle Voltage for the application should be measured at this time.

2.1.2 Current (mA)

A Ensure power is removed from both the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-5: Throttle Connection (Current mA).

D Set up the Multimeter to measure current (mA.) and plug the black lead into the Break-out Box black socket labeled "-" and the red lead into the socket labeled "mA".

E Turn power 'On' to the Processor and take command at any Remote Station.

F Depress and hold the Push-button Switch labeled "mA." The appropriate Current (mA.) for the application should be measured.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

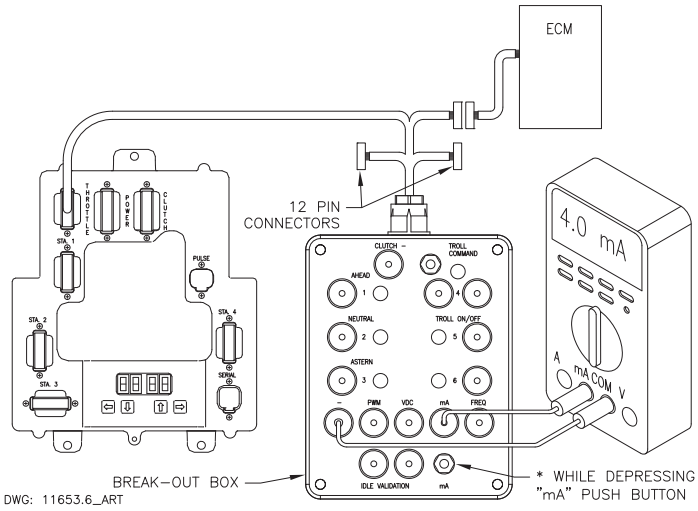


Figure MM13927-5: Throttle Connection (Current mA)

H Depress and hold the “mA.” Push-button. The appropriate Full Throttle Current (mA.) for the application should be measured at this time.

2.1.3 PWM (Pulse Width Modulation) with DC Voltmeter

A Ensure power is removed from both the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-6: Throttle Connection (PWM with DC Voltmeter) labeled “-” and the red lead into the socket labeled “PWM”.

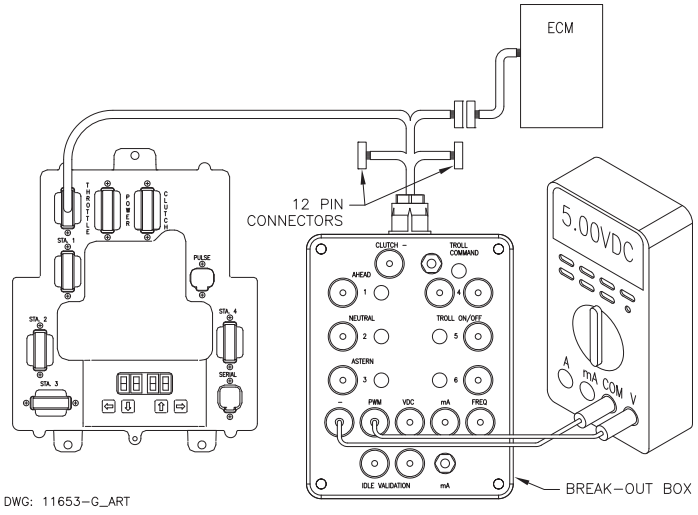


Figure MM13927-6: Throttle Connection (PWM with DC Voltmeter)

D Turn power ‘On’ to the Caterpillar ECM (Electronic Control Module) **Only**. **Do Not** apply power to the Processor at this time.

E Depending on the type of Caterpillar ECM (PEEC or ADEMS), the measurement should be approximately 5.00 or 12.00 VDC. Record the measurement as shown in Drawing Figure MM13927-6: Throttle Connection (PWM with DC Voltmeter).

F Set up the Multimeter to DC Volts and plug the black lead into the Break-out Box black socket Turn power 'On' to the Processor and take command at any Remote Station.

G Record the DC Voltage at this time. The measurement should be 7- 9% of the voltage measured in step F).

H Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

I The measurement should be 91- 93% of the voltage measured in step F) [e.g. Idle = 8% of 12 VDC reference or 0.96 VDC; Full Throttle = 92% of 12 VDC reference or 11.04 VDC.

2.1.4 PWM (Pulse Width Modulation) with Duty Cycle Meter

A Ensure power is removed from both the Engine electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-7: Throttle connection (PWM with Duty Cycle Meter).

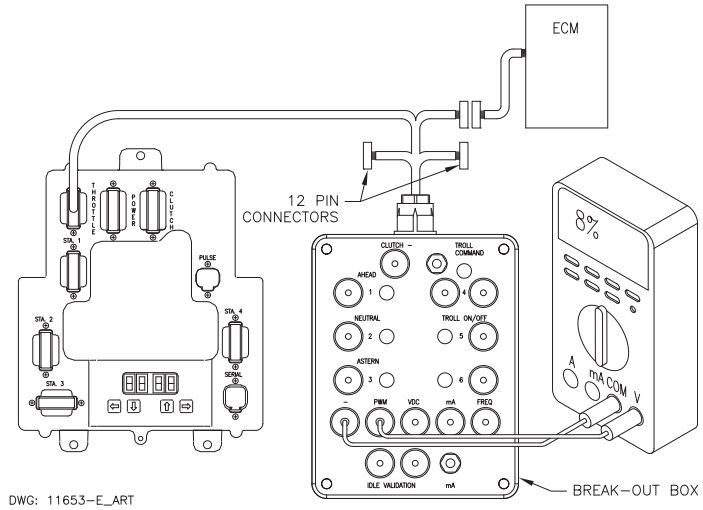


Figure MM13927-7: Throttle connection (PWM with Duty Cycle Meter)

D Set up the Multimeter to measure Duty Cycle and plug the black lead into the Break-out Box black socket labeled "-" and the red lead into the socket labeled "PWM".

E Turn power 'On' to the Caterpillar ECM (Electronic Control Module) and to the Processor.

F The measurement should be approximately 8% duty Cycle.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

H The measurement will increase from 8% to 91- 93%.

2.1.5 Frequency (Hz.)

A Ensure power is removed from both the Engine Electronics and the Processor.

B Disconnect the Throttle Harness from the number **1** Processor connector/pigtail.

C Insert the Break-out Box between the number **1** Processor connector/pigtail and the Throttle Harness as shown in Figure MM13927-8: Throttle Connection (Frequency Hz).

D Set up the Multimeter to measure Frequency and plug the black lead into the Break-out Box black socket labeled “-” and the red lead into the socket labeled “FREQ”.

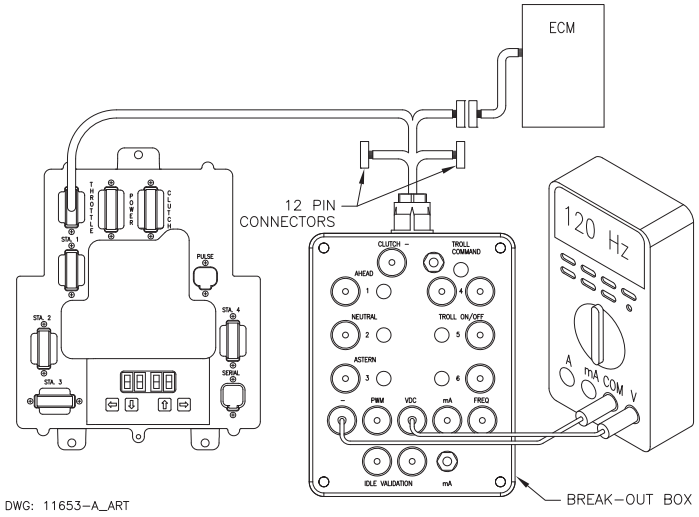


Figure MM13927-8: Throttle Connection (Frequency Hz)

E Turn power ‘On’ to the Processor and take command at any Remote Station.

F The appropriate Idle Frequency for the application should be measured at this time.

G Move the Control Head lever to the Full Throttle position while depressing the Transfer Button (Throttle Only Mode).

H The appropriate Full Throttle Frequency for the application should be measured at this time.

2.2 Clutch Testing

2.2.1 Neutral Solenoid Testing

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-9: Clutch Connections Neutral Solenoid.

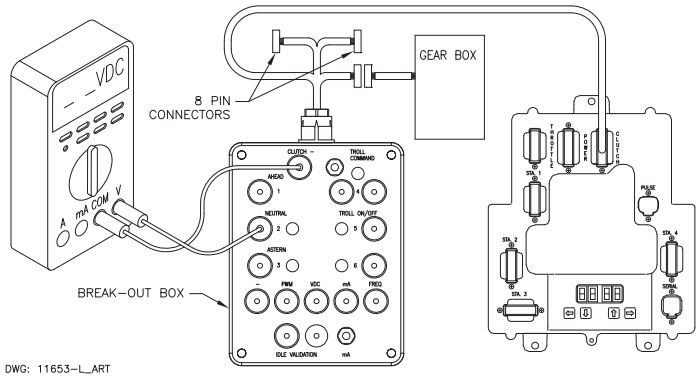


Figure MM13927-9: Clutch Connections Neutral Solenoid

D Turn power ‘On’ to the Processor and take command at any Remote Station with the Control Head lever in the Neutral/Idle position.

E The measurement on the Neutral Test Point should be 12 or 24 VDC, depending on the Solenoid’s rating and the LED adjacent to the socket should be illuminated.

F Move the Control Head lever to the Ahead Detent position. The voltage should drop to 0 VDC in CruiseCommand systems and remain at 12 or 24 VDC in ClearCommand systems.

The adjacent LED should go out in CruiseCommand systems and stay on in ClearCommand systems.

2.2.2 Ahead Solenoid Testing

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-10: Clutch Connections Ahead Solenoid.

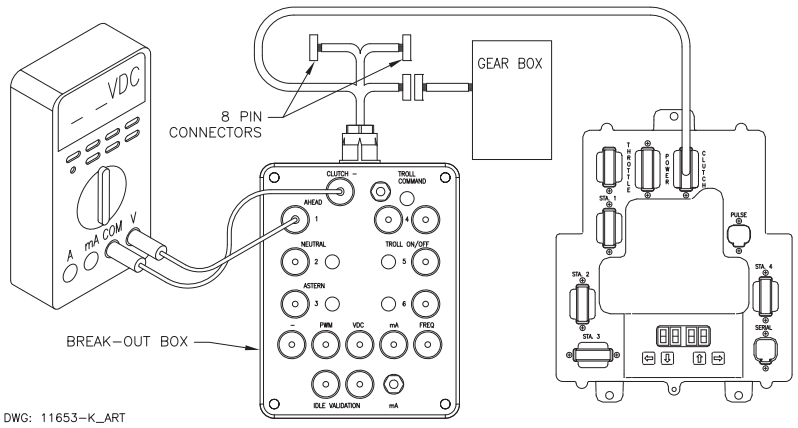


Figure MM13927-10: Clutch Connections Ahead Solenoid

D Set up the Multimeter to measure DC Volts and plug the black lead into the Break-out Box socket labeled “CLUTCH -” and the red lead into the socket labeled “AHEAD”.

E Turn power ‘On’ to the Processor and take command at any Remote Station with the lever in the Neutral/Idle position.

F The measurement should be 0 VDC and the adjacent LED should not be lit.

G Position the Control Head lever into the Ahead detent. The measurement should be 12 or 24 VDC depending on the Ahead Solenoid’s rating. The LED adjacent to the Ahead plug on the Break-out Box should be lit.

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

2.2.3 Astern Solenoid Testing

A Ensure power is removed from both the Processor and the Clutch Supply Power.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-11: Clutch Connections Astern Solenoid.

D Set up the Multimeter to measure DC Volts and plug the black lead into the Break-out Box socket labeled “CLUTCH -” and the red lead into the socket labeled “ASTERN”.

E Turn power ‘On’ to the Processor and take command at any Remote Station with the Control Head lever in the Neutral/Idle position.

F The measurement should be 0 VDC and the adjacent LED should not be lit.

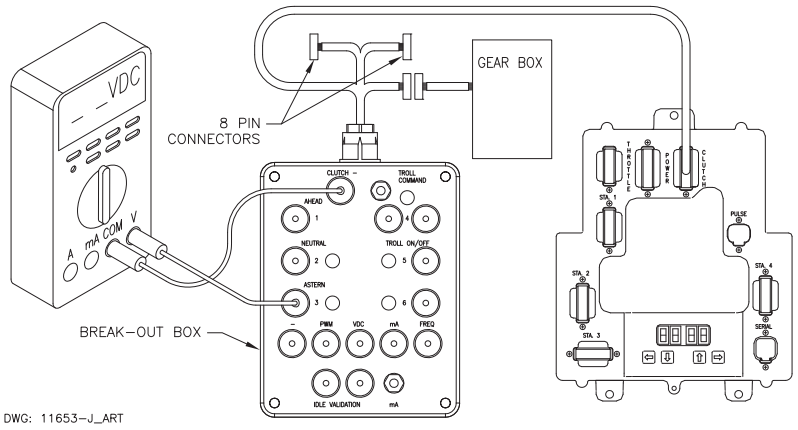


Figure MM13927-11: Clutch Connections Astern Solenoid

G Position the Control Head lever into the Astern detent. The measurement should be 12 or 24 VDC depending on the Astern Solenoid's rating. The LED adjacent to the Astern plug on the Break-out Box should be lit. Return the Control Head lever to the Neutral/Idle position.

2.3 Troll Testing

2.3.1 Troll On/Off Solenoid

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-12: Troll Connections Troll On/Off Solenoid.

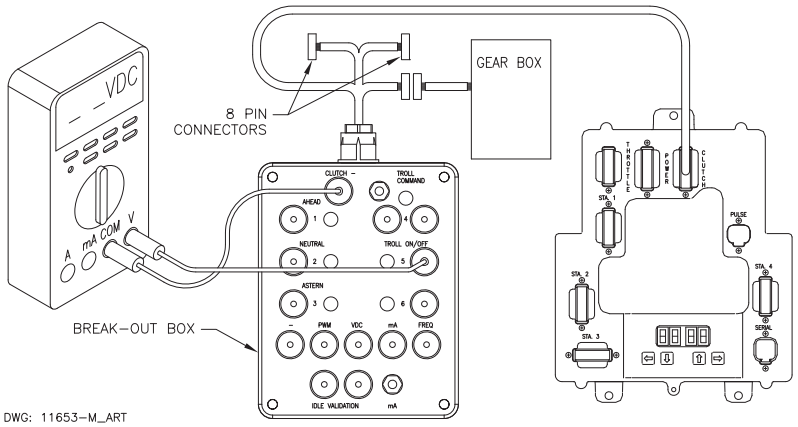


Figure MM13927-12: Troll Connections Troll On/Off Solenoid

D Set up the Multimeter to measure DC Volts and connect the black lead to the socket labeled "CLUTCH –" and the red lead to the socket labeled "TROLL ON/OFF" as shown in Figure MM13927-12: Troll Connections Troll On/Off Solenoid.

E Turn power 'On' to the Processor and the Clutch Power Supply and take command at a Remote Station with the Control Head lever in the Neutral/Idle position.

F Depress the Transfer Button again for approximately 2 seconds until the red LED begins blinking at a fast rate (Troll Mode Indication).

G The measurement should be 0 VDC.

H Position the Control Head lever to the Ahead detent. The measurement should now be 12 or 24 VDC, depending on the Solenoid's rating.

I Position the Control Head lever further forward while monitoring the DC Voltmeter. The measurement should go from 12 or 24 VDC to 0 VDC at the same time the red LED on the Control Head becomes lit solid.

2.3.2 Troll Command (Proportional Solenoid) Testing with Amp Meter

A Ensure power is removed from both the Processor and the Clutch Power Supply.

B Disconnect the Clutch Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch Harness as shown in Figure MM13927-13: Troll Connections (Proportional Solenoid).

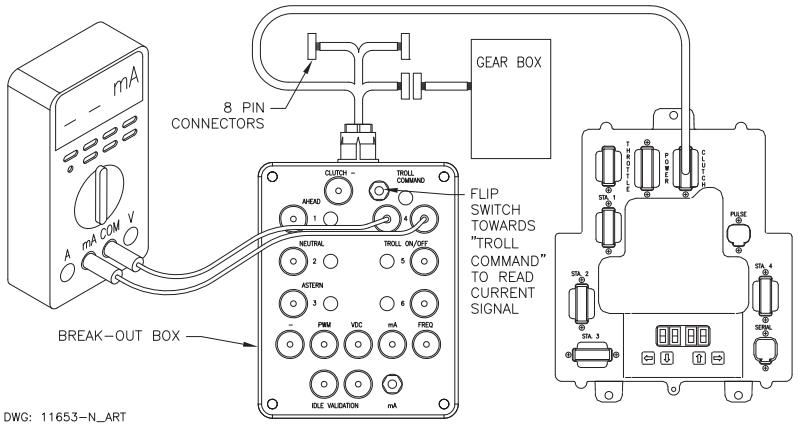


Figure MM13927-13: Troll Connections (Proportional Solenoid)

D Set up the Multimeter to measure (mA.) and connect the black lead to black socket and the red lead to the red socket labeled "TROLL COMMAND" as shown in Figure MM13927-13: Troll Connections (Proportional Solenoid).

E Turn power 'On' to the Processor and the Clutch Power Supply and take command at a Remote Station with the Control Head lever in the Neutral/Idle position.

F Depress the Transfer Button again for approximately 2 seconds until the red LED on the Control Head begins blinking at a fast rate (Troll Mode Indication).

G Flip switch away from "Troll Command" to read current through meter.

H Move the Control Head lever to the Ahead detent. The current measurement should be the correct value for minimum clutch pressure (shaft rotations). This value varies depending on the type of Marine Gear. Refer to the Literature provided with the Trolling Valve and the Processor for specifics.

I Slowly advance the Control Head lever while monitoring the current. The current should increase or decrease, depending on the Gear type, in proportion with the Control Head lever movement. Once again, refer to the Literature provided with the Trolling Valve and the Processor for specific values.

J Continue to move the Control Head lever forward until the red LED stops blinking (lit steady). The current should drop to 0 mA.

2.4 2-Speed Testing

2.4.1 2nd Gear Disengaged

A Ensure power is removed from the Processor.

B Disconnect the Clutch/2-Speed Harness from the number **3** Processor connector/pigtail.

C Insert the Break-out Box between the number **3** Processor connector/pigtail and the Clutch/ 2-Speed Harness as shown in Figure MM13927-14: 2-Speed Connections.1653

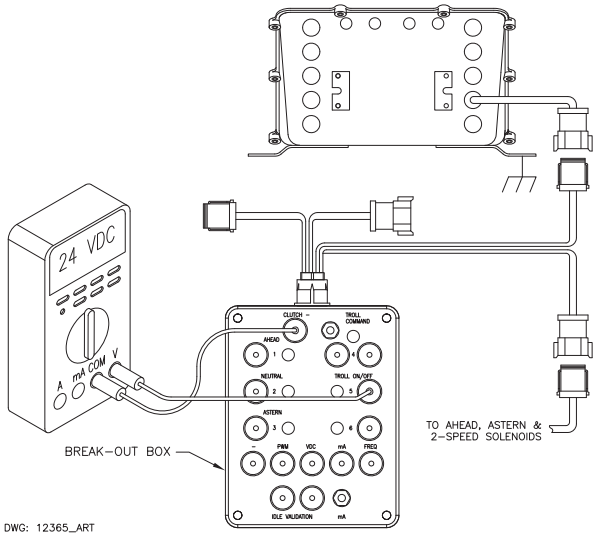


Figure MM13927-14: 2-Speed Connections

D Set up the Multimeter to measure DC Volts and connect the black lead to the socket labeled "CLUTCH - " and the red lead to the socket labeled "TROLL ON/OFF" as shown in Figure MM13927-14: 2-Speed Connections.

E Turn power 'On' to the Processor and take command at any Remote Station.

F The voltage measurement should be approximate 0 VDC.

2.4.2 2nd Gear Engaged

A Leave the Break-out Box and Multimeter in the same position as left in 2nd Gear Disengaged.

B Start the engine(s).

C Depress the Transfer Button while moving the lever(s) into the Ahead detent (red LED should be blinking, indicating Warm-up Mode).

D Continue to move both Control Head lever(s) forward until the RPM programmed for Function Code **U1** has been reached.

E The voltage measurement at the Multimeter should now be 12 or 24 VDC, depending on the Solenoid's rating.

F Return the Control Head levers to the Neutral/Idle position and shut down the engines.

G Turn power Off to the Processor(s).

H Unplug the Break-out Box from the Pigtail and Harness plugs and reconnect the Harness to the Pigtail.

2.5 Parts List

ZF Marine Propulsion Systems Miramar Part No.	Part Name
13927	Service Field Test unit (Break-out Box)
MM13927	Technical Manual
	Multimeter
14000	Test Control Head - Dual

13 Appendix C - QFA & DVTP

(Qualitative Failure Analysis & Design Verification Test Procedure)

785CE Qualitative Failure Analysis & Design Verification Test Procedure and Periodic Safety Test

1 785CE System Description

1.1 Power

Each enclosure requires its own separate 12 or 24VDC, 7-amp max power supply. Backup or alternate power supplies required by regulatory bodies must be established before connecting to the 785CE.

Control Head (Stationary)

The 785CE must have at least one, but may have up to four remote stations. Single screw control head applications will have one LED to indicate when the station has command, a push button to take command, an audible alarm and a lever for controlling the engine and gear. Twin screw applications will have two alarms, two red station in command LEDs, a lever for each engine and gear and only one push button at each Control Head.

Handheld Remote

The 785CE can have up to four remote stations, of which three can be Handheld Remotes. Each Handheld Remote has a push button to take command, a LED to indicate which station has command, and engine stop switch, a safety lanyard, and a knob for controlling engine and gear. Twin screw applications will have two LED's and knobs, and only one engine stop switch and lanyard.

Single Lever Control

Single lever command allows one lever to control both the engine and the gear. The system sequences the operation of speed and shift in order to prevent mishandling of the engine or transmission.

Plug in Connections

All connections made to the enclosure are made with connectors on the front of the enclosure.

Station Transfer

Control can be transferred to a different station by moving the receiving station's levers to Neutral and pressing the transfer button until the red LED light on the Control Head. The operator then has 1 second to move the levers to the desired position, if necessary, before command is transferred.

Keypad Setup

Adjustable parameters are set using a 4-button keypad on the outside of the enclosure.

Start Interlock

Normally open contacts are available to allow starting of the engines only when the control system is powered up, the gear is in Neutral and a station is in control.

Clutch Oil Pressure Switch

A clutch oil pressure switch option is available to confirm that the clutch is fully engaged before increasing the throttle above Idle.

Alarm Interface

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.

System Errors

The Control Heads provide audible tones and the enclosure has four 7-segment LED displays that indicate system faults.

2 Qualitative Failure Analysis For 785CE

ITEM NUMBER	FAILED COMPONENT	ALARM STATUS	INITIAL RESULT	FINAL OUTCOME
1	ZF Marine Propulsion Systems Miramar Control Head	Audible Tone will sound at Control Head	Throttle resets to Idle	No Increast 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 Increast in Engine RPM
			Clutch Shifts to Neutral	No Increase in Shaft Speed

3 Design Verification Test Procedure

The 785CE Propulsion Control System is designed to meet the environmental design standards in 46 CFR 62.25-30. Test written for twin screw application.

3.1 Control Head Potentiometer Failure (minimum of two stationary Control Heads)

A Purpose: Show results of a Control Head potentiometer failure, item 1 of the Qualitative Failure Analysis.

B Test Results: The Processor tested will command Idle throttle and shift to Neutral.

C System:

1. Number of Stations: Minimum of 2 stations.
2. Equipment Status: Power ON, no active errors.
3. Safety Precautions: Vessel will go from 50% Ahead to Neutral.

D Test Procedure

1. Take command at station 1.
2. Move levers to 50% Ahead.
3. Remove Station 1 connector from Port 785CE Processor.
4. The Port Processor will command Idle throttle.
5. The Port Processor will shift to Neutral.
6. The Port Control Heads at other stations will give a 1 long and 3 short alarm tone indicating a faulty potentiometer.
7. The Port Processor will show error ‘Er 21’, indicating that station 1 has failed.
8. Move the Port and Starboard Control Head levers back to Neutral.

9. Reconnect the station 1 connector at the 785CE Processor.
10. Repeat for Starboard side.

3.2 Control Head Potentiometer Failure (One stationary Control Head)

A Purpose: Show results of a Control Head potentiometer failure, item 2 of the Qualitative Failure Analysis.

B Test Results: The Processor tested will command Idle throttle and shift to Neutral.

C System:

1. Number of Stations: One stationary Control Head (Station 1).
2. Equipment Status: Power ON, no active errors.
3. Safety Precautions: Vessel will go from 50% Ahead to Neutral/Idle on one side.

D Test Procedure

1. Take command at the stationary Control Head (Station 1).
2. Move levers to 50% Ahead.
3. Remove the green wire from pin 6 of the Port Control Head's terminal block.
4. The Port Processor will command Idle throttle.
5. The Port Processor will shift to Neutral.
6. The Port side of the stationary Control Head will give a 1 long and 3 short alarm tone, indicating a faulty potentiometer.
7. The Port Processor will show error '**Er 21**', indicating that Station 1 has failed.
8. Move the Port and Starboard Control Head levers back to Neutral.
9. Reconnect the green wire to pin 6 on the Port side of the stationary Control Head.
10. Repeat Steps 1) through 9) for the Starboard side.

3.3 Power Failure to 785CE

A Purpose: Show results of Qualitative Failure Analysis Item 2, a Power Failure to 785CE. A power failure to the 785CE circuit board will have the same results as a failed microprocessor.

B Test Results:

1. Engine will go to Idle throttle.
2. Gear will shift to Neutral.
3. LED at Control Heads will not be lit.
4. Opposite engine still under power has full control.
5. Opposite Processor will give an audible alarm and show error 'Er 39'.

C System:

1. Number of Stations: Minimum of 1 station.
2. Equipment Status: Power ON, no active errors.
3. Safety Precautions: Vessel will go from 50% Ahead to Neutral.

D Test Procedure

1. Take command at station 1.
2. Move levers to 50% Ahead.
3. Turn power OFF to the Port Processor only.
4. The Port Processor will command Idle throttle.
5. The Port Processor will shift to Neutral.
6. LED on the Port side of the Control Head in command will go OFF.
7. The Starboard Control Head will still have full command of the Starboard engine and gear.
8. The Starboard Processor will give a 3 second audible tone indicating an error condition.
9. The Starboard Processor will show error 'Er 39'.
10. Move the Port and Starboard Control Head levers back to Neutral.
11. Turn power ON to the Port Processor. Take command of the Port side.
12. The Port Control Head will operate as usual utilizing Non-volatile memory.
13. Repeat for Starboard side.

4 Periodic Safety Test

4.1 Clutch Test

A Purpose: Test Ahead, Neutral and Astern clutch actuation.
B Test Results: The Processor tested will command Ahead, Neutral and Astern.
C System:
    1. Number of Stations: Minimum of 1 station.
    2. Equipment Status: Power ON, no active errors.
    3. Safety Precautions: Vessel will shift into Ahead and Astern.
D Test Procedure
    1. Take command at station 1.
    2. Move Port lever into the Ahead detent.
    3. Verify that the Port Ahead clutch has engaged.
    4. Move Port lever into the Neutral detent.
    5. Verify that the Port Ahead clutch has disengaged.
    6. Move Port lever into the Astern detent.
    7. Verify that the Port Astern clutch has engaged.
    8. Move Port lever into the Neutral detent.
    9. Verify that the Port Astern clutch has disengaged.
    10. Repeat for Starboard side.

4.2 Throttle Test.

A Purpose: Test engine control.
B Test Results: The engine tested will command Idle to full throttle.
C System:
    1. Number of Stations: Minimum of 1 station.
    2. Equipment Status: Power ON, no active errors.
    3. Safety Precautions: Vessel will increase to full throttle, while in gear.
D Test Procedure
    1. Take command at station 1.
    2. Move Port lever into the Ahead detent.
    3. Verify that the Port Ahead clutch has engaged.
    4. Move Port lever to full Ahead.
    5. Verify that the Port engine has increased to full throttle.
    6. Move the Port lever to the Ahead detent.
    7. Verify that the Port engine goes to Idle.
    8. Move Port lever into the Astern detent.
    9. Verify that the Port Astern clutch has engaged.
    10. Move Port lever into the Neutral detent.
    11. Verify that the Port Astern clutch has disengaged.
    12. Repeat for Starboard side.

4.3 Start Interlock Test

A Purpose: Test functionality of the start interlock option.

B Test Results: The engine will only start when the 785CE is powered up, a station has command, and the clutch is in Neutral.

C System

1. Number of Stations: Minimum of 1 station.
2. Equipment Status: Power ON & OFF, no active errors, start interlock must be connected, and engines must be OFF.
3. Safety Precautions: Engine(s) will start.

D Test Procedure

1. Turn power OFF to control system.
2. Attempt to start engines.
3. Verify that the engines do not start.
4. Turn power ON to the control system.
5. Take command at a station.
6. Move the Control Head levers to the Ahead detent.
7. Verify that the engines do not start.
8. Move the Control Head levers to the Neutral detent.
9. Verify that the engines start.

4.4 Station Transfer Test

A Purpose: Test functionality of station transfer.

B Test Results: Station transfer is only available when the receiving station is in Neutral.

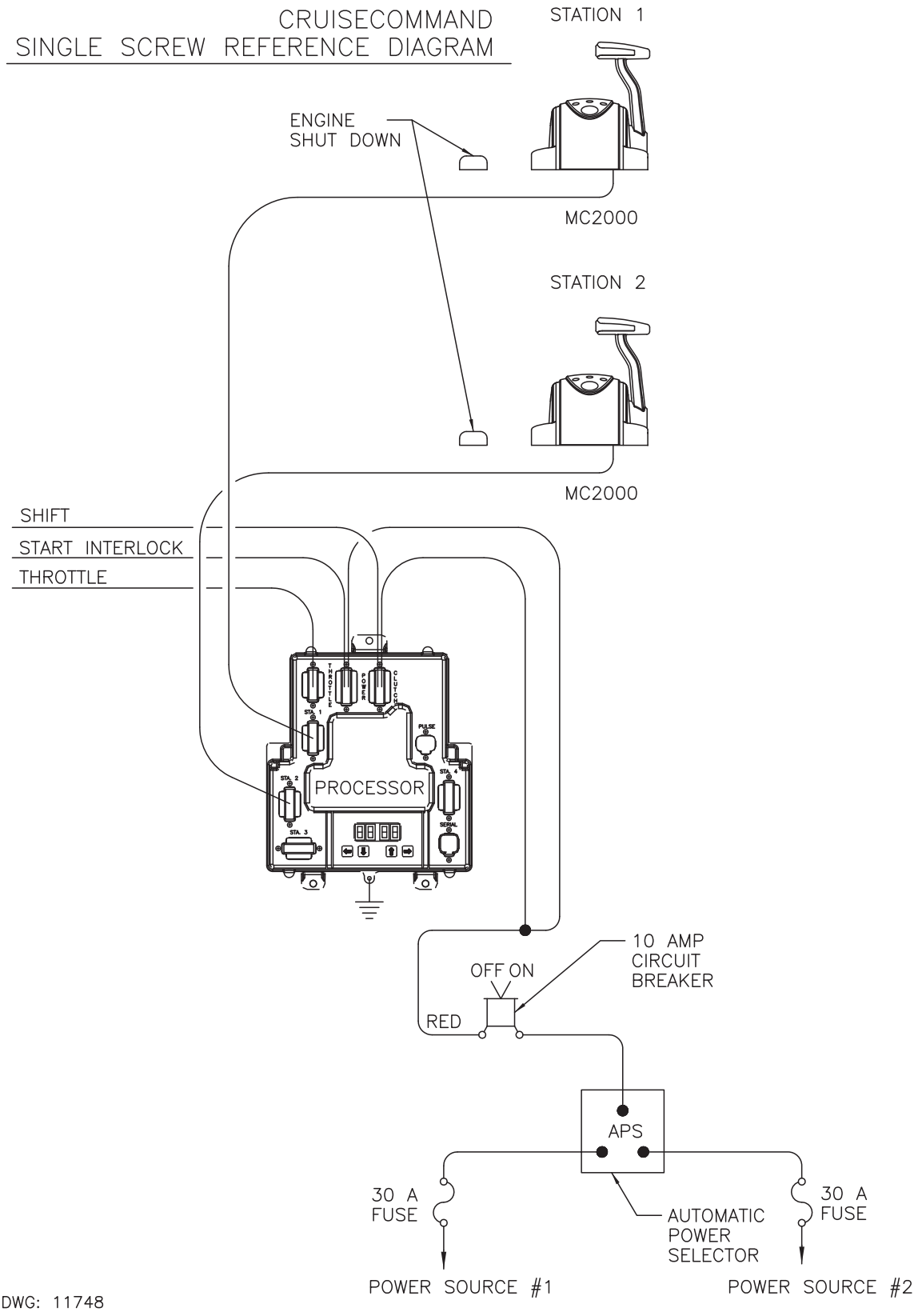
C System

1. Number of Stations: Minimum of 2 stations.
2. Equipment Status: Power ON, no active errors.
3. Safety Precautions: Engine command may change with station transfer.

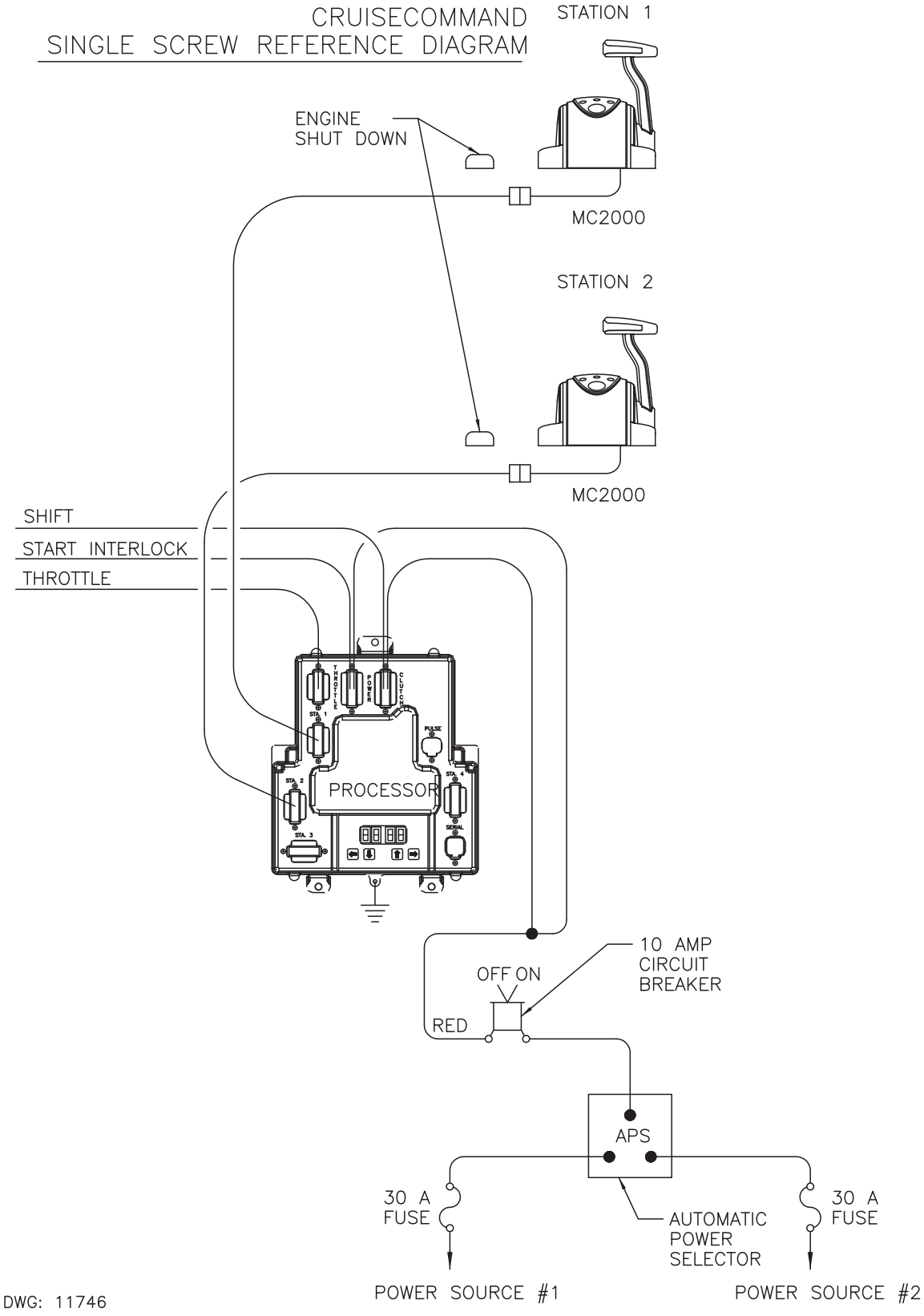
D Test Procedure

1. Take command at station 1.
2. Move levers to Neutral.
3. Go to station 2, and move levers to Neutral.
4. Press transfer button at station 2.
5. Verify command has transferred, LED’s are lit, and Control Head levers are active.
6. Move levers to the Neutral detent.
7. Go to station 1 and move the levers to the Ahead detent.
8. Press the transfer button at station 1.
9. Verify that command has not transferred to station 1, Control Head LED’s are not lit.

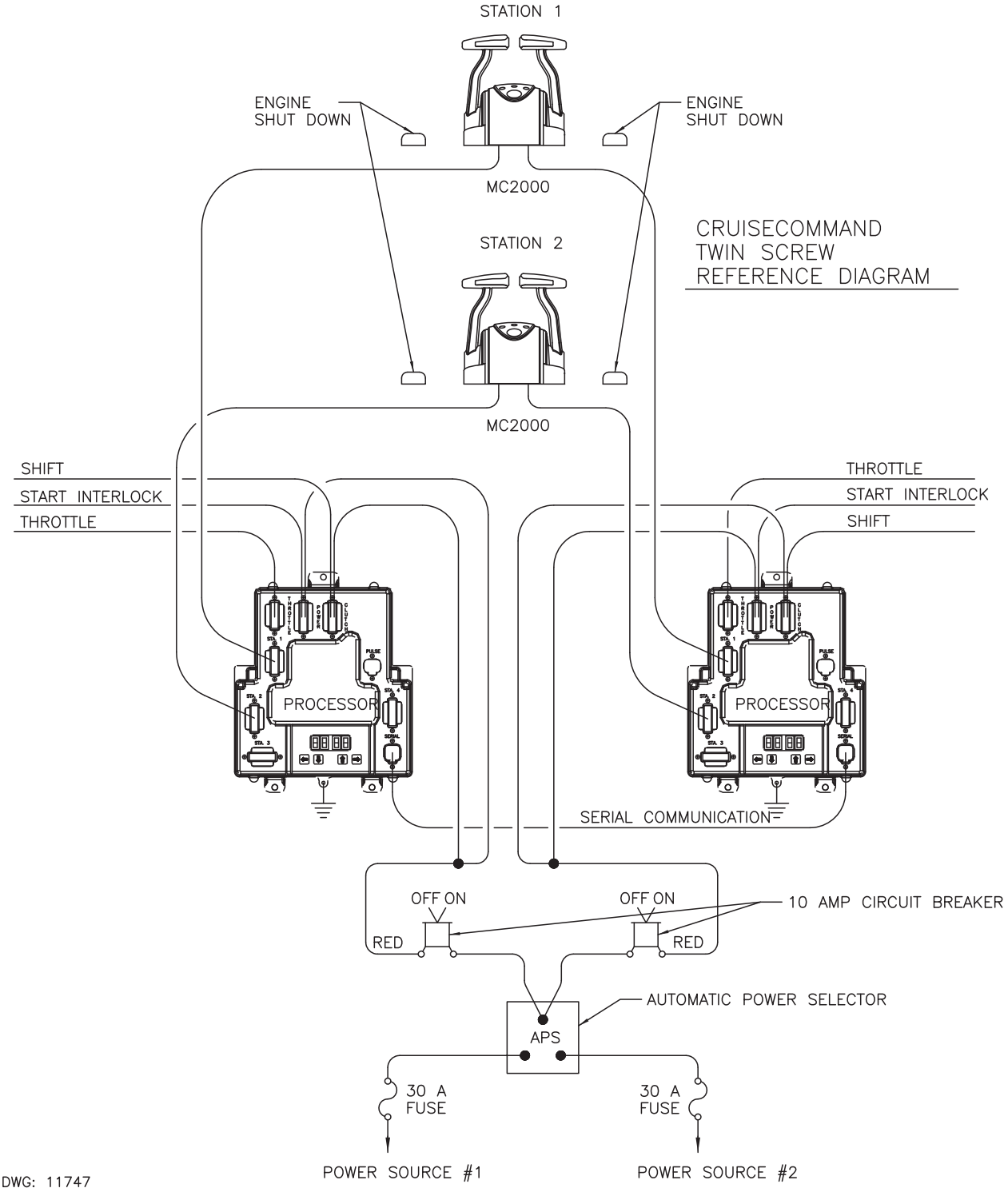
14 Appendix D - System Drawings



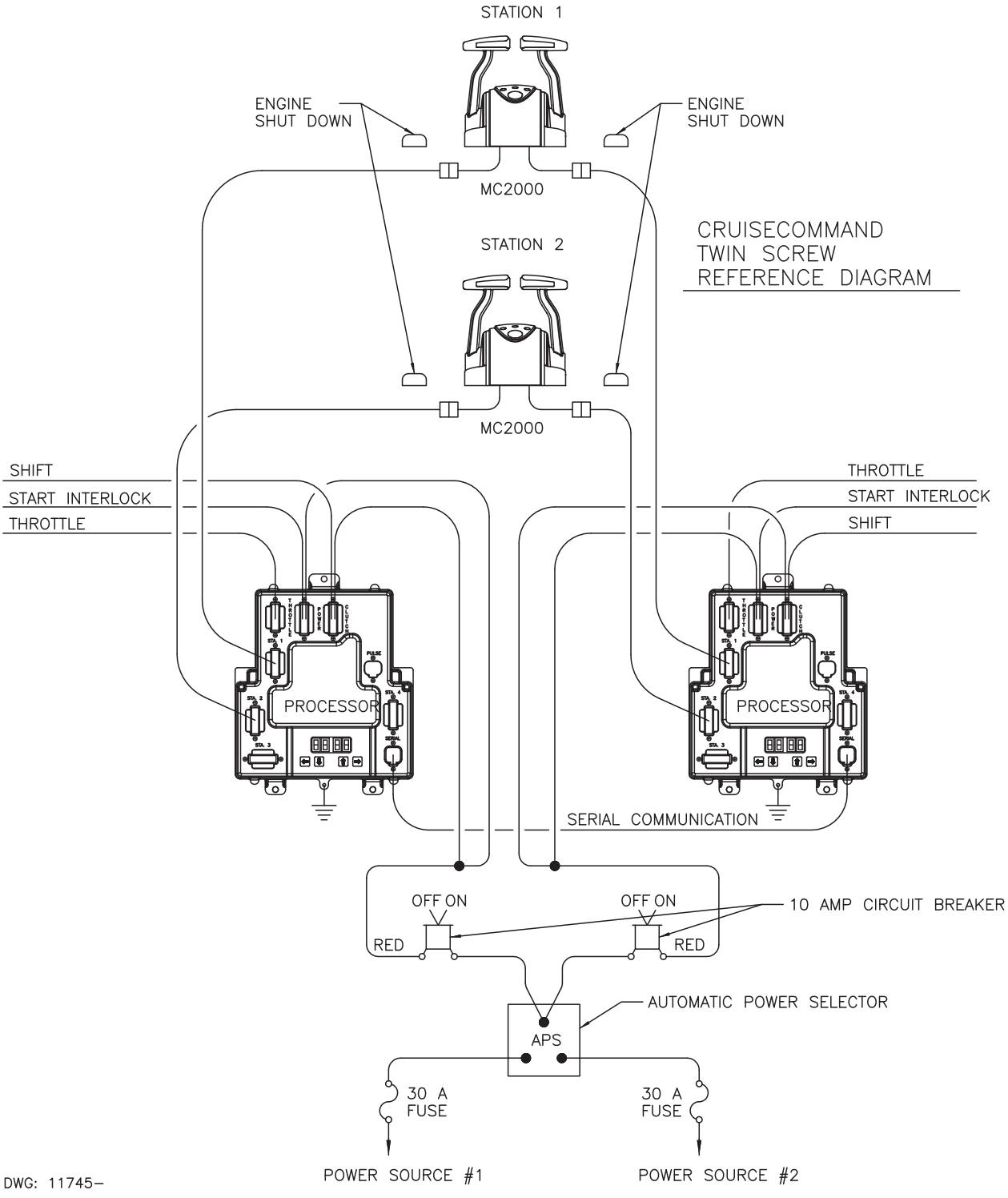
Drawing 11748 CruiseCommand Single Screw Reference Diagram



Drawing 11746 CruiseCommand Single Screw Reference Diagram



Drawing 11747 CruiseCommand Twin Screw Reference Diagram



Drawing 11745 CruiseCommand Twin Screw Reference Diagram

ZF Padova S.r.l.
Via Penghe, 48
I - 35030 Caselle di Selvazzano (PD)
ITALY
Phone +39 049 8299 311
Fax +39 049 8299 550
www.zf.com

EN 3340.758.004 a - 2014-10