

Table of Contents

Table of Contents	1
1.0 OPERATION - - - - -	3
Figure 1: Basic System Diagram	3
1.1 Features	3
1.2 Options	4
1.3 Operation	4
Figure 2: Control Head Detents	4
1.4 Initialization	4
Figure 3: Control Head Transfer Button	4
1.5 Station Transfer	5
Figure 4: Station Transfer	5
1.6 Control Head Tones	5
1.7 High Idle	6
Figure 5: High / Low Idle Selection	6
1.8 Neutral Warm-up Mode	6
Figure 6: Neutral Warm-up Mode Selection	6
1.10 Clutch Oil Pressure Interlock (Option)	7
1.11 Alarm Capability (Option)	7
1.12 Synchronization Mode (Option)	7
1.9 Neutral-only Start Interlock	7
Figure 7: Neutral-Only Start Interlock	7
1.13 Troll Mode (Option)	8
2.0 PLAN THE INSTALLATION - - - - -	9
2.1 Required Parts from your Dealer	9
2.1.1 Actuator	9
Figure 8: Actuator Dimensions	9
2.1.2 Control Head	10
2.1.3 Electric Cable	10
2.2 Required Tools and Parts from your Installer	10
2.2.1 Push-Pull Cables and Cable Connection Kits	10
2.2.2 Tools	11
2.2.3 DC Power Source	11
Figure 9: DC Power Sources	11
2.2.4 Engine STOP Switch	12
3.0 INSTALLATION - - - - -	12
3.1 Eight-Conductor Cable	12
3.2 Actuator	12
Figure 10: Plug Removal and Cable Grip Installation	12
3.2.1 Two-Conductor Power Cable Connection	13
3.2.2 Two-Conductor Start Interlock Cable Connection	13

3.2.3 Eight-Conductor Cable Connection	14
Figure 11: Terminal Connections	14
3.3 Control Head	15
3.3.1 Eight-Conductor Cable Connection	15
Figure 12: Control Head Connections	16
Figure 13: Control Head Connections for Stations Facing Aft	16
3.4 Engine STOP Switches	17
3.5 Push-Pull Cable Connections	17
3.5.1 Actuator	17
Figure 14: Actuator Push-Pull Cable Connections	17
3.5.2 Engine and Transmission	18
4.0 ADJUSTMENTS AND TESTS - - - - -	18
4.1 Initialization Test (Engines Stopped)	18
4.2 Control Head And Station Transfer (Engines Stopped)	18
4.3 Engine and Transmission Push-Pull Cable	19
4.3.1 Direction Shunt Configuration (Engines Stopped).	19
4.3.2 SHIFT Cable Adjustment (Engines Stopped)	19
4.3.3 THROTTLE Cable Adjustment (Engines Running)	20
4.4 Throttle Pause	21
4.5 High Idle	21
4.5.1 Selection.	21
4.5.2 Setting (Engines Running)	22
4.6 Adjustments To Check At the Dock	22
4.6.1 Start Interlock.	23
4.6.2 Stop Switches	23
4.6.3 Push-Pull Cables	23
4.6.4 Control Head	23
4.7 Adjustments To Check Underway	23
4.7.1 Full-Speed Setting	23
4.7.2 Proportional Pause Upon Direction Change	24
Table 1: SW1 Switch: Full-Speed Pause Timing Chart.....	24
5.0 CONTROL OPTIONS - - - - -	24
5.1 Alarm Capability	24
5.2 Clutch Oil Pressure Interlock Switch	25
5.2.1 Interlock Switch Used.	25
5.2.2 Switch Not Used	26
6.0 MAINTENANCE - - - - -	27
6.1 Actuator	27
6.2 Control Heads	27
MMC-165 Rev.C 10/00.....	29
Electronic Propulsion Control Systems Three Year Limited Warranty	

F-226 Rev.A 11/00 31
 Sea Trial Report

Appendix A.1

PARTS LIST 1

MMC-280 Rev.G 6/01 3
400 & MC2000 Control Head Variations

MMC-307 Rev.C 6-01 7
700 Series Control Head Sheet

MMC-279 Rev.A 11/00 9
400 Series Watertight Enclosure

S-214 Rev.A 6/01..... 11
Automatic Power Selector (APS) Model: 13505
 Figure 1: 12
 Figure 2: 12

MMC-287 Rev.B 7-01 13
Bonding - A.B.Y.C. E-9 46 CFR 111.05

MMC-288 Rev.C 7/01..... 15
References and Parts Source

MMC-289 Rev.- 6/01 17
Morse Clutch and Throttle Kit Selection

MMC-290 Rev.- 6/01 19
Universal Mounting Kit
 Figure 1: Universal Mounting Kit 19

Appendix B.1

1.0 General - - - - - 1

**2.0 SYMPTOM - Cannot acknowledge command at one remote station
 (both Port and Starboard for Twin Screw) when the system is first
 turned On. - - - - - 2**

**3.0 SYMPTOM - On a Twin Screw Application, one Control Head lever of
 a Dual Control Head will accept command while the other lever will
 not. - - - - - 2**

**4.0 SYMPTOM - The red light blinks when the Station Transfer Button is
 depressed, and continues to blink after it is released (Control Head
 lever is in Neutral/Idle position). Cannot transfer to this Remote
 Station if another Remote STation was previously in command. 2**

**5.0 SYMPTOM - The engine RPM varies, without moving the Control
 Head lever (synchronization disabled). - - - - - 3**

- 6.0 SYMPTOM - The engine RPM drops to Idle, transmission to Neutral, the Control Head red indicator light turns Off, and a slow repetitive tone is heard at all Remote Stations after repositioning the Control Head lever. - - - - - 3
- 7.0 SYMPTOM - No tones or indicator lights at the Control Head, and no LEDs lit on the Circuit Board. - - - - - 3
- 8.0 SYMPTOM - No audible tone at a Control Head when power is first turned On, but otherwise works perfectly. - - - - - 4
- 9.0 SYMPTOM - The Control Head red indicator light does not light when in command, but everything else works perfectly. - - - - - 4
- 10.0 SYMPTOM - The engine starter will not engage. - - - - - 4
- 11.0 SYMPTOM - Cannot obtain Neutral Warm-up Mode while moving the Control Head lever in the Ahead direction, only in the Astern direction. - - - - - 5
- 12.0 SYMPTOM - Rapid tone at all Remote Stations. - - - - - 5
- 13.0 SYMPTOM - Steady tone is heard from all Remote Stations. Cannot gain command at any remote station. - - - - - 6
- 14.0 SYMPTOM - The engine starts to turn over while starting, and then stops. A slow repetitive tone is heard from all Remote Stations. 6
- 15.0 SYMPTOM - One long, one short tone from all Remote Stations. 6
- 16.0 SYMPTOM - One long, two short tones from all Remote Stations 6
- 17.0 SYMPTOM - One long, three short tones from all Remote Stations. 6

Appendix C.1

Typical Actuator Connections	3
Single Engine	5
Two Engines with No Synchronization	7

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

NOTE: Contains Helpful Information

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

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

ATTENTION

It is important to KEEP the 585CE Manual in a safe place for future reference. This manual contains answers to questions that may arise during user operation or installation of MicroCommander Options.

CAUTION: On MicroCommander Systems utilizing more than one 585 or 585CE Actuator, ZF Mathers highly recommends that software in ALL UNITS be upgraded to the same revision level at the same time.

If planning to use the High/Low Idle, Clutch Oil Pressure Interlock options, or adding Synchronization or Trolling, DO NOT attempt to operate a 585 or 585CE Actuator with this software upgrade in conjunction with a 585 or 585CE Actuator using any other software versions.

1.0 OPERATION

The design of the MicroCommander Marine Propulsion Control System (hereafter referred to as MicroCommander or System) is for pleasure and light commercial marine applications on vessels up to approximately 100 feet (30m) in length. The System is electronic, requiring a 12 to 32 VDC power Source, one Actuator required per engine, and one Control Head per remote station. The MicroCommander commands the vessel's throttle and shift using a single Control Head lever.

The Actuator is located in the engine room area and connected mechanically to the vessel's main engine throttle for speed command and to the transmission for shift command.

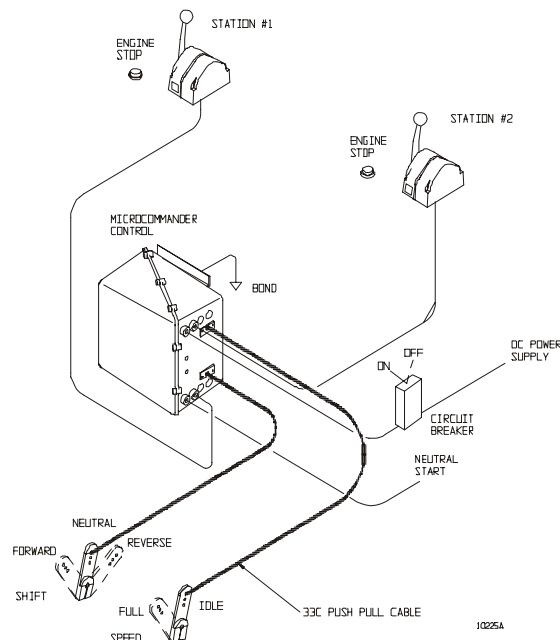


Figure 1: Basic System Diagram

Eight-conductor shielded cable connects the Control Head(s) at the remote station(s) to the Actuator(s). Only one remote station will have command at any time. Station transfer is by push button acknowledgment with Station-in-Command indicated by a red light located on the Control Head.

1.1 FEATURES

- Easily configured to vessel control requirements (Section 1.2)
- Single lever control of speed and direction (Section 1.3)
- Station-in-Command indication (Section 1.4)
- Push button station transfer (Section 1.5)
- Audible system diagnostics and status indication (Section 1.6)
- Low / High Idle selection (Section 1.7)
- Neutral Warm-up Mode (Section 1.8)
- Neutral-Only Start Interlock (Section 1.9)
- Clutch Oil Pressure Interlock (optional) (Section 1.10)
- System failure alarm contact (optional) (Section 1.11)
- Proportional pause on through-Neutral shifts (Section 4.4)

- Mechanical interface to most engine / transmission combinations (Figure 1:)
- One to five remote stations (Appendix C Drawing)

1.2 OPTIONS

- Automatic engine synchronization (Section 1.12 and MM11410 Synchronization Installation Manual)
- Integrated trolling valve control (Section 1.13 and MM11411 813CE Trolling Installation Manual)
- Hand Held Remote Control (MM12822 Hand Held Installation Manual)

1.3 OPERATION

The Control Head has three detents; Astern, Neutral, and Ahead. (refer to Figure 2:) With the Control Head lever(s) positioned in the Neutral (vertical) detent the System will command Neutral and Idle RPM. Control Head lever movement of 15 degrees to the Ahead or Astern detent will command Ahead or Astern clutch engagement while the engine remains at Idle RPM. Further movement of the Control Head lever will increase the engine RPM in proportion to the Control Head lever position.

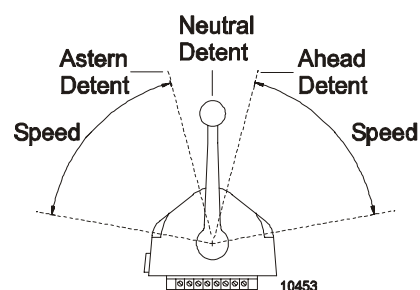


Figure 2: Control Head Detents

1.4 INITIALIZATION

When DC power is supplied to the MicroCommander, the Actuator initializes by positioning the engine throttle lever to Idle and the transmission lever to Neutral. A low repetition tone occurs at all remote stations, indicating the System has initialized and that no remote station has taken command.

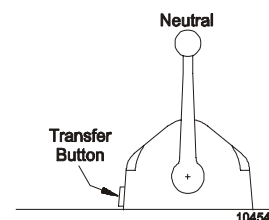


Figure 3: Control Head Transfer Button

Accept command at any remote station by positioning the Control Head lever(s) into the Neutral position and depressing the station transfer button. (refer to Figure 3:) The red light (s) on the Control Head will become solid red and the low repetition tone will cease, indicating this remote station is in command.

1.5 STATION TRANSFER

Each remote station is independent, making only one station able to have command at a time. Solid red light(s) on the Control Head housing indicate Station-in-Command. To transfer command to another remote station while in transit, leave the Station-in-Command's Control Head lever(s) at the last commanded position. At the receiving remote station, move the Control Head lever(s) into the Neutral detent position and press the station transfer button. (refer to Figure 4:) The operator has one second after the red light(s) becomes solid to position the Control Head lever(s) to the approximate position the previous remote station's lever(s) were set. A smooth transfer of command has been accomplished without interruption of speed.

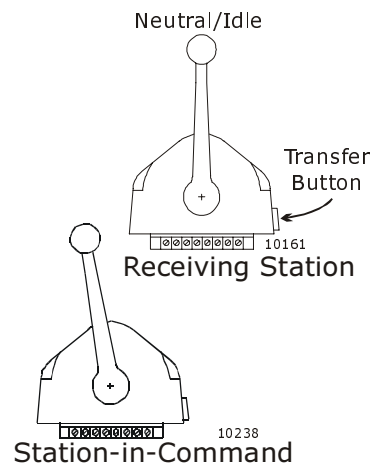


Figure 4: Station Transfer

1.6 CONTROL HEAD TONES

There are six patterns of Control Head tone:

Low Repetition Tone is normal when DC power is first applied to the System. This tone indicates that the System initialization has occurred and the operator can accept command at any remote station.

High Repetition Rate Tone signals a jam condition of either the Shift or Throttle cable. The Actuator has stopped when this tone occurs. Moving the Control Head lever away from the position at which the tone began will usually stop this tone; however, the cause of the excessive push-pull cable load must be found. Refer to Appendix B Trouble Shooting Section for recommendations.

Steady Tone signals a voltage problem or that a component has failed. Depress the Station Transfer Button; if the tone continues, the Actuator or circuit board may require service. Refer to Appendix B Trouble Shooting Section for recommendations.

Repetitive Signal - One Long, One Short Tone signals a Shift position feedback error. Refer to Appendix B Trouble Shooting Section.

Repetitive Signal - One Long, Two Short Tones signals a Throttle position feedback error. Refer to Appendix B Trouble Shooting Section.

Repetitive Signal - One Long, Three Short Tones signals a Control Head failure of the remote station that was in command at the time tone started. Refer to Appendix B Trouble Shooting Section.

1.7 HIGH IDLE

MicroCommander features an option for two engine Idle settings. The system will be in Low Idle Mode at initial power up. High Idle may be selected with the transfer button.

The normal Low Idle RPM is set mechanically by the Low Idle stop at the engine throttle. A secondary High Idle RPM may be set within the Actuator at a RPM desirable for maneuvering.

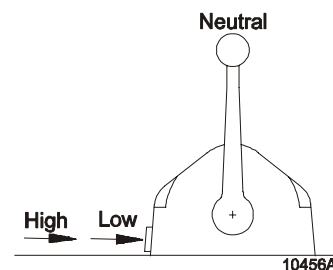


Figure 5: High / Low Idle Selection

Selection of High or Low Idle is by alternately depressing the remote station transfer button while the Control Head lever(s) is in the Neutral position. (refer to Figure 5:)

When using the High Idle option, Station 5 cannot be used.

1.8 NEUTRAL WARM-UP MODE

This feature allows adjustment for engine start and warm-up of the desired engine throttle RPM with the transmission held in Neutral. System is in High Idle Mode when Neutral Warm-up Mode is selected.

To achieve Neutral Warm-up Mode, position the Control Head lever(s) in the Neutral detent. Depress and hold the station transfer button while moving the Control Head lever(s) to the Ahead detent. (Refer to Figure 6:)

Continue to hold the transfer button until the red light on the Control Head housing begins to blink slowly. Release the transfer button. The transmission will remain in Neutral. Further movement of the Control Head lever(s) will increase engine RPM to the desired level. When the desired engine RPM has been achieved, return the Control Head lever(s) to the Neutral detent, the red light will become steady to indicate standard command has returned.

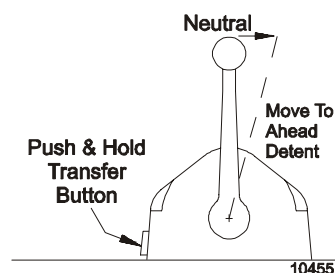


Figure 6: Neutral Warm-up Mode Selection

Synchronization Mode will automatically start when Port and Starboard Control Head levers are:

- commanding Ahead,
- commanding at least 5% speed,
- and within 15% of each other.

The Starboard Actuator receives a signal from both Lead and Follow engines representing engine RPM. The Starboard Actuator compares the engine signals, then makes the needed adjustments to the Follow engine throttle to match the Lead engine RPM.

The green synchronization light on the Starboard Control Head will blink as the engines are being compared and adjusted. When the green light becomes a steady green, synchronization has completed and the engines are now synchronized.

Synchronization Mode automatically deactivates when one Control Head lever moves beyond the 15% window of the other. The green synchronization light turns Off, indicating the System is not in Synchronization Mode.

The operator has the option to disable/re-enable automatic synchronization while in Synchronization Mode.

Refer to MM11410 585CE Synchronization Installation Manual supplied with the Lead and Follow Auxiliary Boards.

1.13 TROLL MODE (OPTION)

By adding an 813CE Actuator to the System, MicroCommander offers integrated trolling valve control. The MicroCommander 585CE System must be completely installed and thoroughly tested before installing this option.

The 813CE Actuator connects electrically with the Port and Starboard 585CE Actuators, linking by push-pull cable with the trolling valve lever on the reverse reduction gear.

For further information on Trolling Valve operation, refer to MM14411 813CE Installation Manual supplied with the 813CE Actuator.

2.0 PLAN THE INSTALLATION

2.1 REQUIRED PARTS FROM YOUR DEALER

NOTE: Refer to Appendix A - Parts List for component Part Numbers.

2.1.1 Actuator

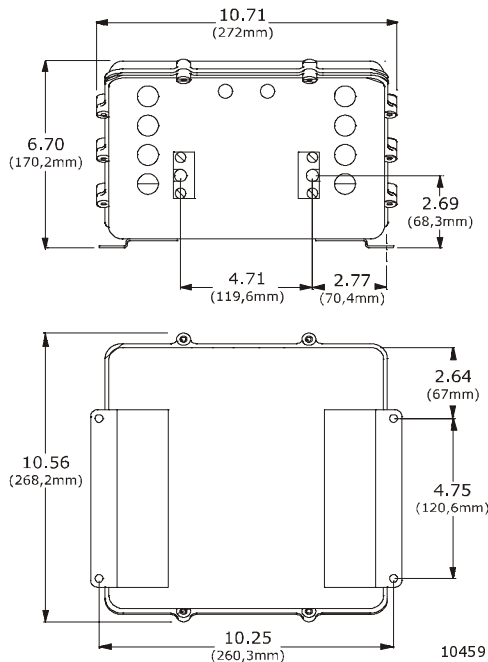


Figure 8: Actuator Dimensions

One Actuator required per engine.

Actuators are spray proof, but must not be immersed.

Refer to Figure 8: for Actuator dimensions.

Usually an engine room location of the Actuator is preferred. If the engine room is too small, locate in any area where it is accessible for electrical and push-pull cable connections.

Bulkhead mounting preferred for ease of access for wiring and adjustments, but the Actuator can be mounted in any attitude. If the clutch cable is connected to an I/O drive outside the hull, the Actuator must be two feet (0,6m) above waterline. Do not mount the Actuator to the engine, to the transmission, or in any location that will subject it to excessive vibration.

MicroCommander's electronic circuits can be influenced by static charges. Do not mount close to gas engine ignition systems, alternators, or electric motors. Allow two feet (0,6m) of clearance, or more, between the Actuator(s) and such devices.

Power source must be bonded to the hull in metal-hulled vessels, or to the bonding buss in non-metal vessels. Refer to Appendix A Bonding for specific information.

Locate each Actuator such that the push-pull cables from it to the engine have large radius bends, with the least total degrees of bend and moderate length. **EXAMPLE:** The minimum bend radius of 10 inches (254mm) for total degrees of bends of less than 270 degrees. Push-pull cable lengths should not exceed 20 feet (6m).

Locate Actuator(s) away from heat sources, such as engine exhaust manifolds. Allow four feet (1,2m) of clearance, or more, between the Actuator(s) and such heat sources.

2.1.2 Control Head

Refer to Appendix A Control Head Sheets for specific information on the correct Control Head style.

The Control Heads are in single or dual lever configurations.

One Control Head required per remote station. ZF Mathers offers an option of a Hand Held Control as an added remote station. See your Micro-Commander Dealer for further information.

When mounting a Control Head that may be weather exposed from the underside, consider using a Watertight Enclosure. Reference Appendix A Watertight Enclosure for specific information.

Retrofit applications may require planning for an adapter pad to cover the old Control Head cut-out. A variety of adapter and cover pads are available from ZF Mathers, LLC.

2.1.3 Electric Cable

Eight-Conductor cable will connect the Control Head(s) with the Actuator(s). One eight-conductor cable required per Control Head lever.

Two-Conductor power cable will connect the Actuator(s) to the vessel's power distribution panel. It is important to keep the length of power cable short to reduce voltage drop. The 14 gauge twisted pair power cable, should not exceed 20 feet (6m). If individual wires are used for supply (+) and return (-) then the total wire length should not exceed 40 feet (12m)

Two-Conductor start interlock cable will connect the Actuator to the starter solenoid or relay. Refer to Section 3.2.2 for further information.

CAUTION: When more than one Actuator is used, all Actuators must connect to power sources that have a common DC return (-).

2.2 REQUIRED TOOLS AND PARTS FROM YOUR INSTALLER

2.2.1 Push-Pull Cables and Cable Connection Kits

Two Type 33C push-pull cables needed per engine. The cable length is measured from end of thread to end of thread. Cables are usually stocked in one foot (0,3m) increments.

NOTE: Engine and transmission lever load should not exceed 30 pounds (13,6kg).

Many engine, transmission, and inboard/outboard (I/O) drives are delivered with factory mounted kits. If factory mounting kit not included, contact the engine dealer for a Factory Cable Connection Kit. Appendix A shows other connection options.

2.2.2 Tools

- Anti-static wrist strap (Included with Actuator)
- Wire cutter, stripper, crimper (Thomas & Betts WT-2000 or equal)
- 7/16-inch Socket and medium extension
- 5/16-inch Wrench - open end
- Screwdriver - medium Phillips head #2
- Screwdriver - medium straight slot
- Screwdriver - small straight slot
- Hole saw - 1-inch (25,4mm)
- Saw: blade suitable for Console Top Panel
- Drills - 9/32-inch (7,2mm) & 7/32-inch (5,6mm)

2.2.3 DC Power Source

The Actuator requires a battery source (12, 24, or 32 volts DC) protected by a 10 ampere circuit breaker. Power should come from the vessel's DC power distribution panel. Do not use engine starting batteries on a 12 volt system, because the cranking voltage may be too low. Refer to Figure 9:

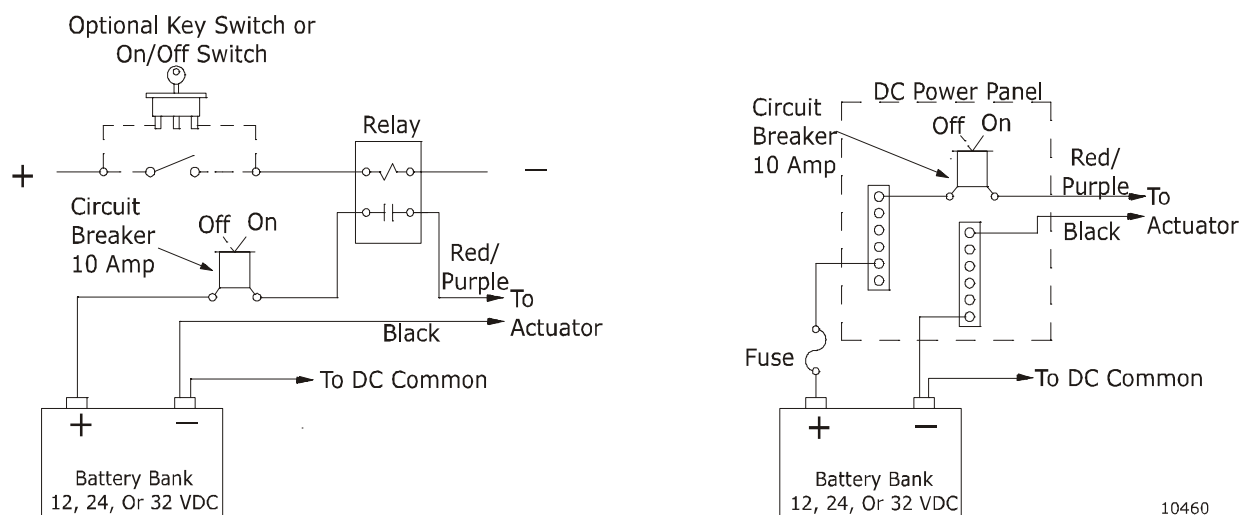


Figure 9: DC Power Sources

NOTE: 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%. The DC return to the battery must be large enough to supply all current requirements with a voltage drop of less than 3%. (See References, Appendix A.)

2.2.4 Engine STOP Switch

An engine STOP switch MUST be located at each remote station.

3.0 INSTALLATION

NOTE: Before starting the actual installation of MicroCommander, make sure you have the correct parts and tools on hand. See Section 2.0. Read ALL the instructions pertinent to each part before beginning the installation of that part.

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

3.1 EIGHT-CONDUCTOR CABLE

Install the eight-conductor electric cable between each Control Head location and the appropriate Actuator location. Support the cables using clamps or straps not more than 18 inches (0,5m) apart if not contained in a conduit. Verify cable location protects the cable from physical damage.

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

3.2 ACTUATOR

- A) Secure the Actuator using 1/4 inch or M6 fasteners.
- B) Remove the Actuator cover. When not working on the Actuator, keep the cover in place to prevent damage to circuits.
- C) Connect the wrist strap to your person, and the ground connector to the Actuator frame.
- D) Bond each Actuator to the hull or bonding bus. (Refer to Bonding in Appendix A).

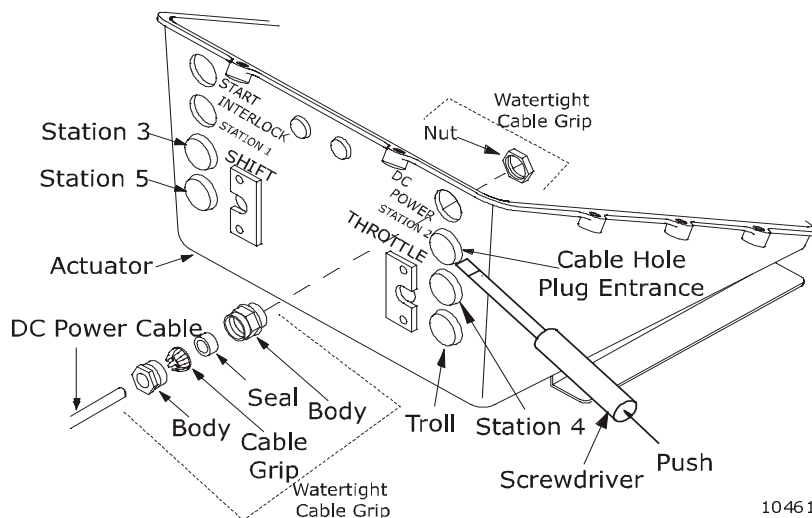


Figure 10: Plug Removal and Cable Grip Installation

10461

- E) Remove only the Hole Plugs needed for remote station cable entry as shown in Figure 10:.
- F) Install the watertight cable grips into the open entry holes of the Actuator. Refer to Figure 10: for cable grip installation.

3.2.1 Two-Conductor Power Cable Connection

NOTE: When connecting the DC power cable to the Actuator be sure the power is Off.

- A) Run the length of two-conductor power cable between the DC Power Source and the Actuator.
- B) Make the connections at the vessel's DC Power Source.
- C) Install a watertight cable grip into the DC POWER entry hole. Refer to Figure 10: for cable grip installation.
- D) Run the two-conductor power cable through the watertight cable grip.
- E) Strip each wire 3/8-inch (9,5mm), then install crimp terminals.
- F) Connect the two-conductor cable as indicated on the Drawing - Appendix C.
- G) Feed through a little slack cable and tighten the cable grip.
- H) Tie wrap the power cable to the Actuator frame.

3.2.2 Two-Conductor Start Interlock Cable Connection

CAUTION: The design of the circuit board is for a maximum of 30 amperes start signal current. Greater current will damage the interlock circuit.

Run the length of two-conductor start interlock cable between the Starter Solenoid and the Actuator.

CONNECTIONS AT STARTER SOLENOID

- A) Remove the remote start switch lead from the Starter Solenoid.
- B) Strip and connect one start interlock cable wire to this lead.
- C) Strip and connect the second start interlock cable wire to the Starter Solenoid

CONNECTIONS AT ACTUATOR

- A) Install a watertight cable grip into the START INTERLOCK entry hole. Refer to Figure 10: for cable grip installation.

- B) Run the two-conductor start interlock cable through the watertight cable grip.
- C) Strip each wire 3/8-inch (9,5mm), then install crimp terminals.
- D) Connect the two-conductor cable as indicated on the Drawing - Appendix C.
- E) Feed through a little slack cable and tighten the cable grip.
- F) Tie wrap the start interlock cable to the Actuator frame.

3.2.3 Eight-Conductor Cable Connection

- A) Run the eight-conductor cable for each remote station through the corresponding watertight cable grip on the Actuator. Do not tighten cable grip at this time.
- B) Strip the PVC jacket and shielding back approximately 2 inches (50,8mm) on the STATION 1 eight-conductor cable.
- C) Bend the Violet wire out of the wire bundle and wrap, or otherwise compact it at the cover; secure with tape for possible use in optional wiring.
- D) Stagger the remaining wire lead lengths to match the STA 1 terminal strip. Wire leads must not touch frame.
- E) Strip the wire 3/8 inch (9,5mm) on each lead.

NOTE: On the Actuator circuit board, all station terminal strips have a jumper between terminals 5 and 6. Remove the jumper only on used terminal strips. Do not remove the jumper on unused terminal strips.

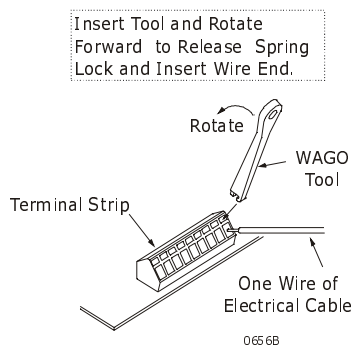


Figure 11: Terminal Connections

- F) A WAGO Tool is taped to the relay on the circuit board in each Actuator. Use this tool to depress the spring lock for the individual wire connection to the terminal strip. (See Figure 11:) Connect the wire colors to the terminal strip as shown on the Drawing in Appendix C.
- G) Connect the bare shielding drain wire to Terminal 8 on the terminal strip. The shielding drain wire MUST NOT touch any other components.
- H) Feed through a little slack cable, and tighten the cable grip on the eight-conductor cable.

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

NOTE: Verify all unused station terminal strips have a jumper between terminals 5 and 6.

- J) Secure the eight-conductor cables to each other and the Actuator frame, using the tie wraps provided.

3.3 CONTROL HEAD

- A) Refer to Appendix A - Control Head Dimensions and Variations for the cutout and mounting hole information.
- B) Drill the screw holes and the corner cutout holes at the chosen location. Using a Saw, complete the rectangular opening for the Control Head terminal block.
- C) The Number 8-32 x 1-inch mounting screws are for a 3/4 inch (19,1mm) maximum thick mounting surface. Verify that the four mounting screws will penetrate the mounting surface and start into the Control Head.
- D) Strip the cover from the adhesive side of the Control Head gasket. Apply the adhesive side to the console.

3.3.1 Eight-Conductor Cable Connection

- A) Run the eight-conductor cable through the Control Head opening of the console to the Control Head.
- B) Strip back the PVC cover on the eight-conductor cable approximately 2-1/2 inches (63,5mm).
- C) Cut off the shielding and drain wire flush with the end of the PVC cover. Do not connect the drain wire at the Control Head to ground.
- D) Bend the Violet wire out of the wire bundle and wrap at the cover. Secure with tape for possible use as a spare or in optional wiring.
- E) Strip 3/8 inch (9,5mm) insulation off each wire, and install crimp connectors.
- F) Make the connections to the Control Head terminal block(s) as indicated on the Drawing in Appendix C.
- G) Connections 5 and 7 at the terminal block are direction sensitive. The connections must be as follows:

Port Lever:	Starboard Lever:
Terminal 5 Blue	Terminal 5 Yellow
Terminal 7 Yellow	Terminal 7 Blue

Figure 12: depicts a twin-screw remote station with the Control Head lever for the Port engine on the user's left and the Control Head lever for the Starboard engine on the user's right. Figure 12: also depicts a single-screw remote station with the Control Head lever on the user's left.

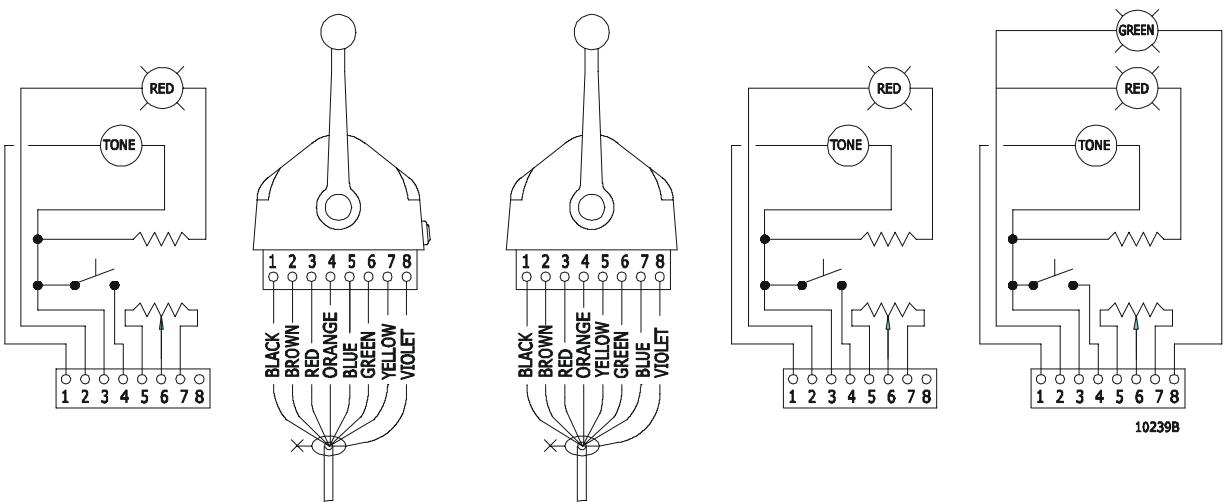


Figure 12: Control Head Connections

Refer to Figure 13: For dual lever Control Head remote stations that have the user facing aft:

- Reverse connections 5 and 7.
- If the synchronization option is being used, ensure the violet wire is connected on the Control Head side that is commanding the Starboard Processor.

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

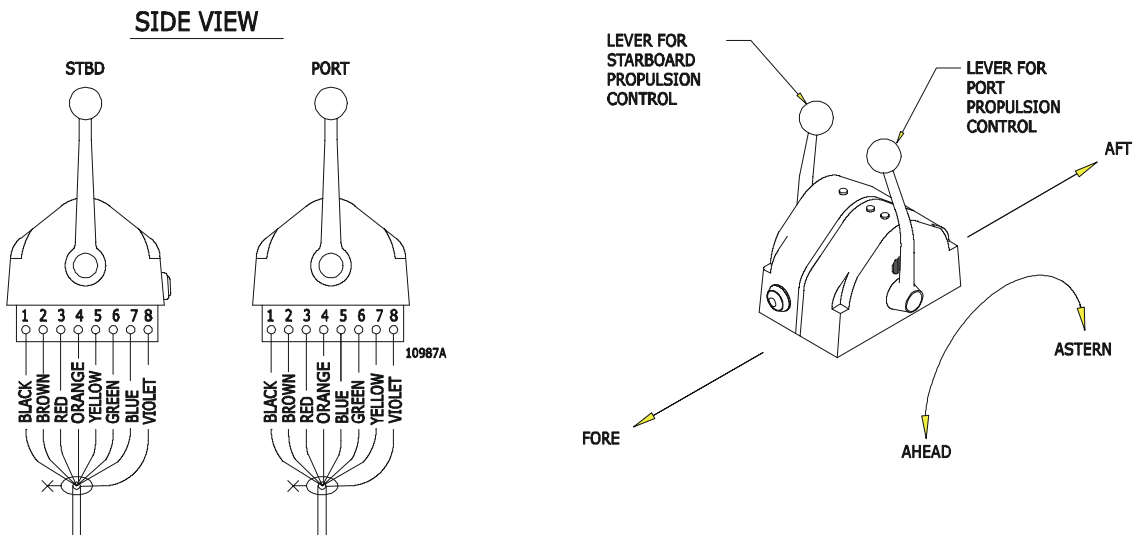


Figure 13: Control Head Connections for Stations Facing Aft

3.4 ENGINE STOP SWITCHES

Required at all Control Head stations are engine STOP switches. Refer to the installation instructions supplied with the switches for manufacturer recommended installation.

3.5 PUSH-PULL CABLE CONNECTIONS

3.5.1 Actuator

Refer to Figure 14:.

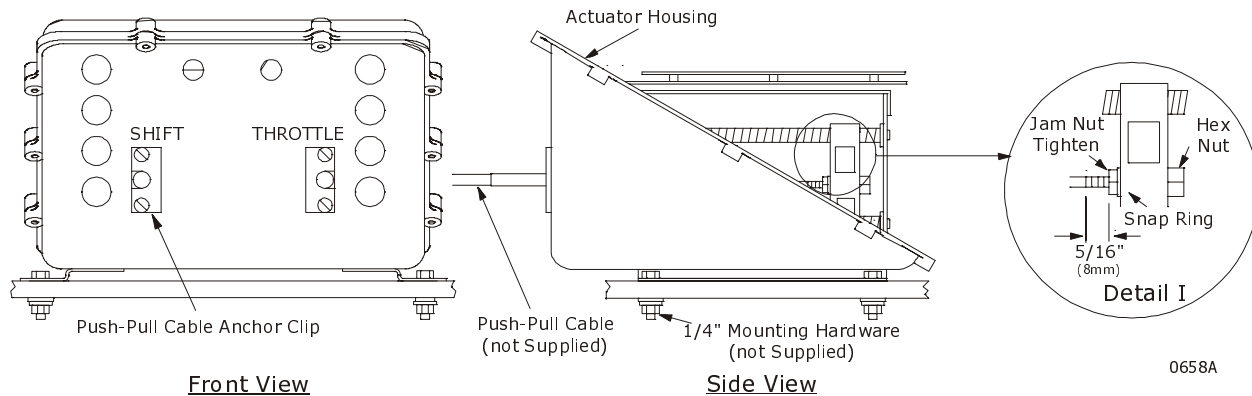


Figure 14: Actuator Push-Pull Cable Connections

- A) Remove the #10-32 jam nut and the two rubber seals from the end of each push-pull cable that is to connect to the Actuator(s) only; discard the seals
- B) Remove one screw from each Cable Anchor Clip and loosen the other screw. Swing the two Clips clear.
- C) Insert the SHIFT push-pull cable and THROTTLE push-pull cable according to the labels on the Actuator.
- D) When the push-pull cable end is visible within the Actuator interior, reinstall the #10-32 jam nut.
- E) Connect the push-pull cables to the hex nuts (See Figure 14:; Detail I). Use a 7/16 inch socket to turn the hex nut onto the cable rod end until there is approximately 5/16 inch (7,9mm) of thread showing beyond the jam nut.
- F) Use a 7/16-inch socket wrench and a 5/16-inch open end wrench to tighten the jam nuts.
- G) Position the Cable Anchor Clips to secure the cables to the Actuator housing.
- H) Install the screws removed in step B). Tighten all Cable Anchor Clip screws.

3.5.2 Engine and Transmission

- A) Check on the engine and transmission if push-pull cable anchor brackets installed. If the brackets are not on the engine or the transmission, select from Morse Standard Kits (Appendix A) or fabricate brackets as shown in Universal Mounting Kit (Appendix A).
- B) Use the jam nuts supplied with the cables to secure the cable rod ends in the ball joints.
- C) Do not remove the two rubber seals from this end of the cable.

CAUTION: Do NOT connect push-pull cables to the engine or transmission at this time.

4.0 ADJUSTMENTS AND TESTS

4.1 INITIALIZATION TEST (ENGINES STOPPED)

- A) Apply DC power to the MicroCommander Propulsion Control System.
- B) The Control Head at each remote station will produce an intermittent tone.
- C) Verify that Control Head lever(s) is at Neutral.
- D) Depress the Station Transfer Button. The red indicator light on the Control Head should light, showing this station has command. (Note that both red indicator lights must be lighted on dual Control Heads.)
- E) Move the Control Head lever(s) full-Ahead and full-Astern. This will check that the controls are operating.

NOTE: On remote stations that have the user facing aft, ensure Control Head lever direction is correct.

WARNING: Keep hands and tools clear of the Actuator when power is On. Turn Off the control system power before disconnecting from the batteries. Do not disconnect battery terminals when engine is operating.

4.2 CONTROL HEAD AND STATION TRANSFER (ENGINES STOPPED)

At each remote station, move the Control Head lever(s) to the Neutral detent position, then press the Station Transfer Button. The indicator light on the Control Head will confirm that station transfer has taken place. Control Head levers are direction-sensitive; to prove that the Control Head wiring connections are correct:

- A) Move the Control Head lever(s) to the Neutral detent position.
- B) Depress and hold the Station Transfer Button, then move the Control Head lever(s) to Ahead detent position. This will put the System in Neutral Warm-up Mode with the red indicator light on the Control Head blinking. The blinking red light indicates that the clutch is in Neutral and that the Control Head lever(s) will position the throttle only.
- C) Depress and hold the Station Transfer Button, then move the Control Head lever(s) to Astern detent position. The red indicator light on the Control Head should now remain steadily On.

Neutral Warm-up Mode must operate only in the Ahead direction. If the red indicator light is On in Ahead and blinks in Astern, see Section 3.3 and reverse connections 5 and 7 on the Control Head terminal block.

4.3 ENGINE AND TRANSMISSION PUSH-PULL CABLE

Verify push-pull cable anchor brackets installed on the engine and transmission, and that cable ball joints are disconnected.

CAUTION: Misadjusted shift and throttle cables cause Actuator servo motor failure. Ensure adjustments are made correctly and completely.

4.3.1 Direction Shunt Configuration (Engines Stopped)

- A) Refer to Typical Actuator Connections in Appendix C.
- B) As shipped from the factory, Clutch Direction - JMPR 4 is at OFF position and, therefore, the push-pull cable will pull on the transmission shift lever for Ahead. If this is wrong, move the Clutch Direction JMPR 4 to ON, and the push-pull cable will push the transmission shift lever for Ahead.
- C) As shipped from the factory, Throttle Direction - JMPR 3 is at OFF position and, therefore, the push-pull cable will push the throttle lever for full-speed. If this is wrong, move the Throttle Direction JMPR 3 to ON, and the push-pull cable will pull on the throttle lever for full-speed.

4.3.2 SHIFT Cable Adjustment (Engines Stopped)

- A) Position the Control Head lever(s) to the Neutral detent and turn the System On.
- B) With the SHIFT cable disconnected, adjust the SHIFT cable ball joint at the transmission to align with the clutch selector lever in Neutral. The push-pull cable should form a right angle (90

degrees) to the clutch selector lever with the Control Head lever in the Neutral position.

- C) Leave the SHIFT Cable disconnected.
- D) Move the Control Head lever to the Ahead detent. The Actuator can be adjusted for a total clutch movement of 2-inches (51mm) to 3-inches (76mm). Actuators are shipped with switches set for minimum movement
- E) Measure the clutch selector lever movement from Ahead detent to Astern detent. The lever movement must be within the adjustment range of 2-inches (51mm) to 3-inches (76mm).
- F) DIP Switch SW1 (refer to Typical Actuator Connections in Appendix C) will increase the SHIFT cable movement in each direction from Neutral by moving the switches from ON to OFF.
 - Switch 1:1/4-inch (6,4mm)
 - Switch 2:1/8-inch (3,2mm) Approximate Dimensions
 - Switch 3:1/16-inch(1,6mm)
- G) Select the combination of switches to obtain the required additional movement, then check the Astern direction.
- H) Recheck with the SHIFT cable disconnected: Ahead; Neutral; and Astern. Verify that the Actuator will not jam the clutch selector lever against its stops and that Neutral is correct.
- I) Connect SHIFT cable to the clutch selector lever. Ensure that the push-pull cable and clutch selector lever connection point form a 90 degree angle. If the connection is not a 90 degree angle, there will be unequal Ahead and Astern travel.

4.3.3 THROTTLE Cable Adjustment (Engines Running)

- A) Refer to Typical Actuator Connections in Appendix C.
- B) Check that potentiometers R7 and R8 are in the fully counterclockwise ↺ position, as shipped from the factory.

CAUTION: Potentiometers can be damaged by turning too hard against the stop.

- C) Leave the THROTTLE cable disconnected at this time.
- D) Measure the throttle movement at the engine from Idle to Full. It must be within the Actuator range

of 1-inch (25,4mm) to 2-7/8-inches (73mm). If the throttle movement is less than 1-inch (25,4mm) or greater than 2-7/8-inches (73mm), change the lever radius to be within range. If possible, throttle movement should be 2-1/2-inches (64mm) Idle to Full.

- E) Place Control Head lever(s) in Neutral, start the engine and run at Idle.
- F) Adjust the ball joint on the THROTTLE cable to match the throttle lever at Idle position.
- G) Stop the engine.
- H) Move the Control Head lever to the Full Ahead position. Manually move the engine throttle lever to the full-speed stop.
- I) Gradually turn potentiometer R7 on the circuit board clockwise ↻ until the push-pull cable ball joint, when connected, will exert a slight amount of pressure against the full-speed throttle stop.
- J) Recheck Idle and Full.
- K) Connect ball joint to throttle lever.
- L) Throttle adjustment is complete.

4.4 THROTTLE PAUSE

Refer to Typical Actuator Connections in Appendix C.

Hydraulic-actuated clutches typically require 1/2 second or longer following clutch selector lever movement before there is clutch plate contact. Accordingly, Dip Switch SW1-7 in the OFF position allows 1/2 second Idle throttle pause after the Actuator has completed clutch selector movement.

Dog and cone clutches used on some inboard/outboard and outboard drives typically do not require a throttle pause following clutch shift. Accordingly, SW1-7 should be in ON position.

Some clutches may build clutch pressure more slowly; this could mean high engine RPM before clutch engagement. Clutch Oil Pressure Interlock minimizes this possibility. Refer to Section 5.2.

4.5 HIGH IDLE

4.5.1 Selection

Refer to Typical Actuator Connections in Appendix C.

Make the following circuit board adjustments, to select the High Idle feature:

- Move JMPR 1 from pins 2 and 3 to pins 1 and 2.
- Move JMPR 2 from one pin to both pins.

4.5.2 Setting (Engines Running)

Refer to Typical Actuator Connections in Appendix C.

Set High Idle with potentiometer R8; when turned fully counterclockwise ↶ High Idle is minimum, and is the same as Low Idle. R8 is set this way at the factory.

To adjust High Idle:

- A) Turn power On to MicroCommander.
- B) Accept command at any remote station by positioning the Control Head lever(s) into the Neutral position and depressing the station transfer button.

NOTE: Through the entire High Idle adjustment procedure the Control Head lever(s) remains in the Neutral Idle position.

- C) At the Actuator, rotate potentiometer R8 clockwise ↷ 1/4 turn. The servo should not move as MicroCommander is in Low Idle Mode at initial power up.
- D) Turn on Engine.
- E) To change to High Idle Mode, depress the station transfer button. The servo should move slightly and the Idle should increase, indicating MicroCommander is in High Idle Mode.
- F) Rotate potentiometer R8 clockwise ↷ until desired High Idle RPM is achieved.
- G) Depress station transfer button to change to Low Idle Mode. The servo should move to the Low Idle position. Test High and Low Idle by alternately depressing the station transfer button and observing the Actuator servo movement.

NOTE: On a twin screw vessel, if High and Low Idle are out of phase, place both engines in the Neutral Warm-up Mode. Return the Control Head levers into the Neutral Idle position. The system has just reset to Low Idle Mode.

4.6 ADJUSTMENTS TO CHECK AT THE DOCK

WARNING: Do not attempt to operate the controls away from the dock with any system abnormality.

Perform the following tests with the vessel moored to the dock. Do all the tests ensuring operation is correct. Only then is the vessel ready to leave the dock.

4.6.1 Start Interlock

Verify proper operation of Start Interlock:

- A) Turn DC power to MicroCommander Off; verify that engine(s) can NOT be started.
- B) Turn DC power to MicroCommander On and acknowledge command. Position the Control Head lever(s) to the Ahead detent and verify that engine(s) can NOT be started.
- C) Position the Control Head lever(s) in the Neutral detent and verify that engine(s) CAN now be started.

4.6.2 Stop Switches

Start engine(s) and verify that engine Stop switches (normally, push buttons) function correctly at all remote stations. Refer to Sect. 3.4 if any problems occur.

4.6.3 Push-Pull Cables

- A) Check that all push-pull cable connecting fasteners are tightened securely.
- B) Refer to Figure 14:, Detail I. In the Actuator(s) check that the push-pull cable Hex Nuts are securely tightened to the Jam Nuts. A loose Hex Nut can back off the push-pull cable threaded end and effectively change the cable length.

4.6.4 Control Head

- A) Idle the engine(s) and place one Control Head lever at a time in the Ahead detent and then the Astern detent. Do this at each station to confirm direction command.
- B) Operate Control Head lever(s) to Ahead and Astern detents and verify that push-pull cable direction is correct.
- C) Operate Control Head lever(s) from Idle to Full-Ahead and check push-pull cable movement is correct.
- D) Use Neutral Warm-up Mode on each engine at each station, one engine at a time, to confirm speed control.

4.7 ADJUSTMENTS TO CHECK UNDERWAY

4.7.1 Full-Speed Setting

Warm-up the engine and in open water gradually move the Control Head lever to full-speed.

If the engine RPM is low, check whether the engine throttle lever is against the full-speed stop. Other possibilities are incorrectly set full-speed stops or too great of a propeller load.

If the engine RPM is high, refer to Sect. 4.5.2 and turn potentiometer R7 counterclockwise ↶ to obtain desired full speed. For twin screw applications, check that matching Idle, Mid-range, and Full-speed Control Head lever positions cause equal RPM in both engines.

4.7.2 Proportional Pause Upon Direction Change

The Proportional Pause feature provides engine deceleration when making a direction change.

- throttle position drops to Idle;
- transmission remains engaged Ahead;
- the pause that follows is in proportion to:
 1. The Control Head lever position prior to the reversal.
 2. How long the Control Head lever had been in that position prior to the reversal.

Refer to Timing Chart, Table 1;; to configure the Proportional Pause to meet the vessel’s requirements. Factory settings at the time of shipment are 4 seconds from full speed.

NOTE: The pause in gear on a through-shift is proportional to the speed commanded and time at that speed. The times listed in Table 1: are maximum. Shifting from Idle Ahead to Idle Astern, the pause is ZERO. The time required to build to the maximum pause is 6 times the pause listed in Table 1:. The pause from full-Astern to Ahead is half that listed in Table 1: for full-Ahead to Astern.

Table 1: SW1 Switch: Full-Speed Pause Timing Chart

Switch SW1-4	OFF	OFF	OFF	OFF	ON	ON	ON	ON
Switch SW1-5	OFF	OFF	ON	ON	OFF	OFF	ON	ON
Switch SW1-6	OFF	ON	OFF	ON	OFF	ON	OFF	ON
Seconds:	0	2	4	5	7	9	10	12

After pause has expired, the clutch is positioned to Neutral (or Ahead or Astern) depending on the final Control Head position.

5.0 CONTROL OPTIONS

5.1 ALARM CAPABILITY

ClearCommand offers a single alarm connection that OPENS with a system power failure or circuit malfunction.

The Processor's alarm connection point is a single connection block on each Processor Circuit Board. The alarm circuit in the Processor operates an alarm system supplied by others.

The control failure alarm is rated for a maximum of 200 mA. Do not exceed this rating. Normal operation is 21 ohms to DC return, high impedance indicates Alarm Condition.

It is the Shipyard's responsibility to utilize the alarm connection in an appropriate alarm circuit that has the same common mode voltage.

5.2 CLUTCH OIL PRESSURE INTERLOCK SWITCH

NOTE: A Jumper is installed in place of the Pressure Switch connections. If Clutch Oil Pressure Switch is used, remove this Jumper. Refer to Appendix C Drawing Notes for details on Jumper.

The purpose of the Clutch Oil Pressure Interlock is to prevent high engine RPM when the clutch is not fully engaged. The interlock will block a speed signal to the engine until the hydraulic clutch pressure has reached a value recommended by the transmission manufacturer that ensures clutch engagement.

- The pressure switch is Installer supplied.
- The requirement is a N.O. (Normally Open) pressure switch with a trip point adjustable to match the transmission manufacturers recommended setting.
- The hydraulic clutch pressure of either the Ahead or Astern clutch must operate the pressure switch.
- When contacts close, this indicates to the Actuator when the clutch is sufficiently engaged to allow a speed command above Idle speed. It is a safety feature that protects the clutch and its use is recommended.

If the clutch pressure should fall below the pressure switch setting, the engine speed will drop to Idle RPM.

The Factory places a jumper between the two clutch oil pressure switch connections on the Actuator before shipment. Remove this jumper when connecting the clutch oil pressure switch. Refer to Appendix C Drawing for specific details.

5.2.1 Interlock Switch Used

Refer to the information supplied by the switch manufacturer for switch installation. The pressure switch must be installed so the hydraulic clutch pressure of both the Ahead or Astern clutch will operate the pressure switch.

- A) Run a two-conductor cable from the Clutch Oil Pressure Interlock Switch to the Actuator.

- B) Connect at the pressure switch as recommended by the manufacturer.
- C) Remove a Hole Plug from an unused entry hole on the START INTERLOCK side of the Actuator. Refer to Figure 10: for Hole Plug removal.
- D) Install a watertight cable grip into the entry hole. Refer to Figure 10: for cable grip installation.
- E) Run the two-conductor cable through the watertight cable grip.
- F) Strip each wire 3/8-inch (9,5mm), then install crimp terminals.
- G) Connect the two-conductor cable as indicated on the Single Engine Drawing in Appendix C.
- H) Feed through a little slack cable and tighten the cable grip.
- I) Tie wrap the two-conductor cable to the Actuator frame.

The pressure switch set point must be set at the value recommended by the transmission manufacturer that ensures clutch engagement. The hydraulic clutch pressure of both the Ahead or Astern clutch must operate the pressure switch.

The clutch pressure may rise to pressure switch set point slowly, and therefore, limit throttle response immediately after clutch engagement.

- When Dip Switch SW1-7 is in the Off position, there is a 5 second delay before the Clutch Oil Pressure Interlock becomes active.
- When Dip Switch SW1-7 is in the On position, clutch oil pressure must be greater than switch set point before throttle will increase above Idle.

5.2.2 Switch Not Used

To disable this feature for outboard engines and engines with mechanical clutches, a single insulated wire must be connected to the two clutch oil pressure interlock switch connection points within the Actuator. Refer to Appendix C for reference to these two connection points.

6.0 MAINTENANCE

6.1 ACTUATOR

The MicroCommander Actuator requires the following annual checks:

- Check all terminal connections for signs of corrosion or loose connections.
- Check mechanical connections within the Actuator, and at the throttle and transmission selector lever.
- Check mechanical movement of the throttle lever from Idle to Full. Ensure that the cable does not jam while positioning the throttle at Idle or Full speed.
- Check mechanical movement of the transmission selector lever from Neutral to Ahead, and Neutral to Astern. Ensure that the cable does not jam while positioning the transmission selector lever at the Ahead or Astern stops.
- Cycle the Actuator and if lead screws are noisy, apply a light coating of silicone grease to the stainless steel lead screw.

6.2 CONTROL HEADS

Check the Control Heads annually to insure that the terminals are secure and free of corrosion.



MMC-165 Rev.C 10/00

ZF Mathers, LLC
1415 Pacific Drive
Burlington WA 98233-3103 U.S.A.
800-546-5455 / 360-757-6265
Fax: 360-757-2500



Electronic Propulsion Control Systems **Three Year Limited Warranty**

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

A) Coverage Under Warranty

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

Year One

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

Year Two and Three

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

B) No Coverage Under Warranty

The following will not be covered under warranty.

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

C) Warranty Service

Call 1-800-546-5455 or 1-360-757-6265 for your nearest ZF Mathers Factory Authorized Dealer.

1. Prior to returning any product to the factory, you must contact ZF Mathers Service Department for a Material Return Authorization (MRA) number. Return the product freight prepaid, marked clearly with the MRA number and a description of the malfunction.
2. If there is a defect covered by warranty, ZF Mathers will, at its option, either repair or replace the defective part or product. If after inspection, ZF Mathers determines that the product is not defective, it will return the product to the sender, freight collect.
3. Repair or replacement during the warranty period will not extend the warranty period.

This Warranty is expressly in lieu of all other Warranties, express or implied. Except to the extent prohibited by applicable law, ZF Mathers 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 Mathers be liable for any consequential damages sustained in connection with the product or its use, including any costs or damages which result from loss of use of the product or any engine or boat with which it is used. ZF Mathers does not authorize any representative or agent to assume for it any obligation or liability other than those expressly set forth above. Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you. All implied warranties, if any, are limited to the duration of this express warranty. This warranty gives you legal rights, and you may have other rights which may vary from State to State.



F-226 Rev.A 11/00

ZF Mathers, LLC
1415 Pacific Drive
Burlington WA 98233-3103 U.S.A.
800-546-5455 / 360-757-6265
Fax: 360-757-2500

Sea Trial Report

Vessel Name: Trial Date: SSN:
Owners Name:
Address:
Tel/Fax/e-mail:
Contact Name:

APPLICATION:

A: Boat Builder Model Size Year
Original Equipment Retrofit Type of Controls Replaced
B: Single or Twin Screw
Engine Make Model
Horsepower RPM Engine Hours
Reduction Gear/Drive Model/Ratio Trolling? Yes No
Type of Service (Pleasure, Fishing, Rental, Etc.)
C: Number of Remote Stations

Actuator/Control Processor: Port Model Starboard Model
Port SN: Starboard SN:

Before Running Engine:

Port Stbd
1. Voltage at the Battery Terminals. VDC VDC
2. Voltage at the Actuator/Control Processor. VDC VDC
3. Warm-up Indicator Light blinks in 'Ahead'. All Stations. Yes No Yes No
4. Electric Cables are supported every 18 inches (45,72cm) Yes No Yes No
5. Cable connections are tight at the Actuator/Control Processor and Control Heads. Yes No Yes No
6. Engine Stop Switches at EACH Remote Station are operational. Yes No Yes No
7. Check push-pull cable match. Disconnect push-pull cables at the clutch and throttle. Check that cables travel in the correct direction. Check the cable movement, insure that it matches clutch and throttle. Yes No Yes No

Dock Side Tests (Running):

1. Voltage at the Battery Terminals. VDC VDC
2. Does Engine 'Start' when Controls are OFF? Yes No Yes No
3. Low Idle RPM. RPM RPM
4. High Idle RPM (optional). RPM RPM
5. Check Warm-Up Mode. Yes No Yes No
6. Check shift in both directions. Yes No Yes No

Sea Trials:

1. Check that Twin Screw Control Head levers match position and RPM through speed range.
 Yes ___ No___ Yes___ No___
2. Set maximum engine RPM as required.
 _____RPM _____RPM
3. Adjust Full Speed Reversal Delay
 _____SEC _____SEC
4. Is Synchronization operational? Yes ___ No___ Yes___ No___
5. Is Trolling Valve operational? Yes ___ No___ Yes___ No___

SW1 Switch Settings:

PORT							STBD						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
ON							ON						
OFF							OFF						

PORT JMPR 3 ___ ___
 PUSH ← → PULL

JMPR 4 ___ ___
 PUSH ← → PULL

STBD JMPR 3 ___ ___
 PUSH ← → PULL

JMPR 4 ___ ___
 PUSH ← → PULL

Comments (Please use additional paper as necessary):

General Installation Condition:

Any Irregularities:

ARE THE MANUALS ON BOARD? Yes___ No___

IS THE OPERATOR CARD ON BOARD? Yes___ No___

INSPECTOR_____ DATE_____

MAIL COMPLETED COPY TO:

**ZF Mathers, LLC
 1415 Pacific Drive
 Burlington, WA 98233**

OR FAX TO: 360-757-2500

APPENDIX A.1



PARTS LIST

PART NO.

DESCRIPTION

ACTUATORS

585CE	Actuator	(Shift & Speed)	Multi-voltage
813CE	Actuator	(Trolling)	Multi-voltage

CONTROL HEADS

SINGLE SCREW

450-3L or 3R	Left or Right Control Head, 'T' Lever
453-3L or 3R	Left or Right Control Head, Chrome Knob Lever
455-3L or 3R	Left or Right Control Head, Black Low Profile Lever
456-3L or 3R	Left or Right Control Head, Chrome Low Profile Lever
750-L or -R	Left or Right Control Head, Heavy Duty

TWIN SCREW (Synchronization Indication)

460-4	Control Head, 'T' Lever
463-4	Control Head, Chrome Knob Lever
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
760	Control Head, Heavy Duty
MC2000-1	Black Head, Black Levers
MC2000-2	Chrome Head, Chrome Levers
MC2000-3	Gold Head, Gold Levers
MC2000-4	Black Head, Chrome Levers
MC2000-5	Black Head, Gold Levers

CABLE (Electric)

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

585CE AUXILIARY CIRCUIT BOARDS FOR OPTIONAL SYNC OR TROLL

1133	Auxiliary Circuit Board	Lead Actuator
1135	Auxiliary Circuit Board	(Mag. Pickup ONLY) Follow Actuator
1135-1	Auxiliary Circuit Board	Follow Actuator

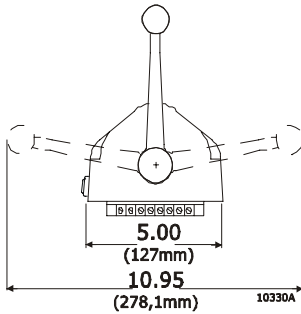
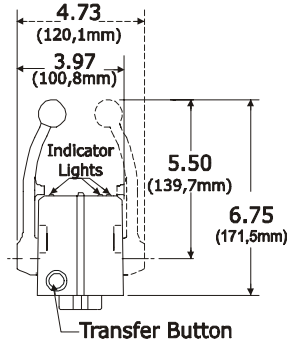
585CE ADDITIONAL PARTS FOR OPTIONAL SYNC

11124	Tachometer Sender Signal (Dual)
2241	Tachometer Wire - Shielded
8912	Magnetic Pickup 3/4 x 16

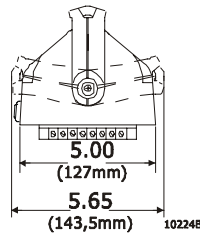
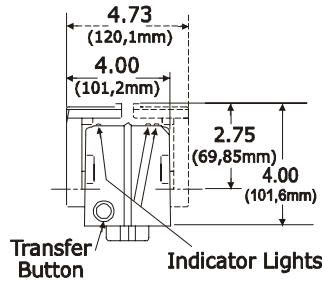
400 & MC2000 Control Head Variations

450 - 460 Series

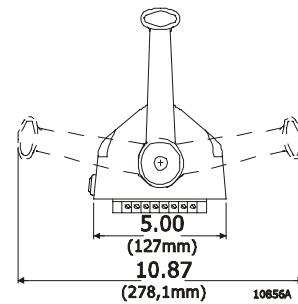
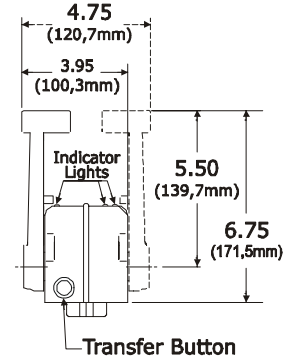
Chrome Lever with Knob



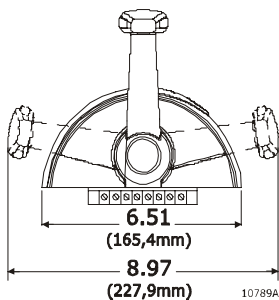
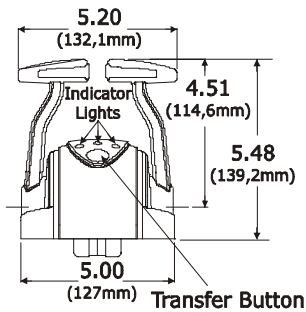
Low Profile Lever



Standard 'T' Handle

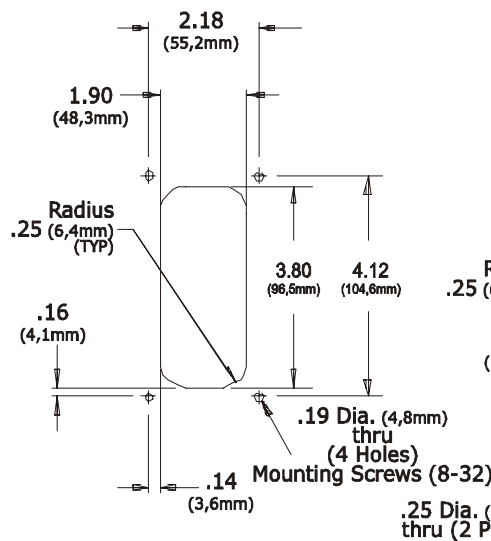


MC2000 Series

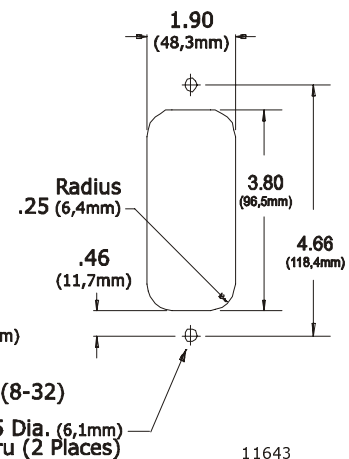


TEMPLATES

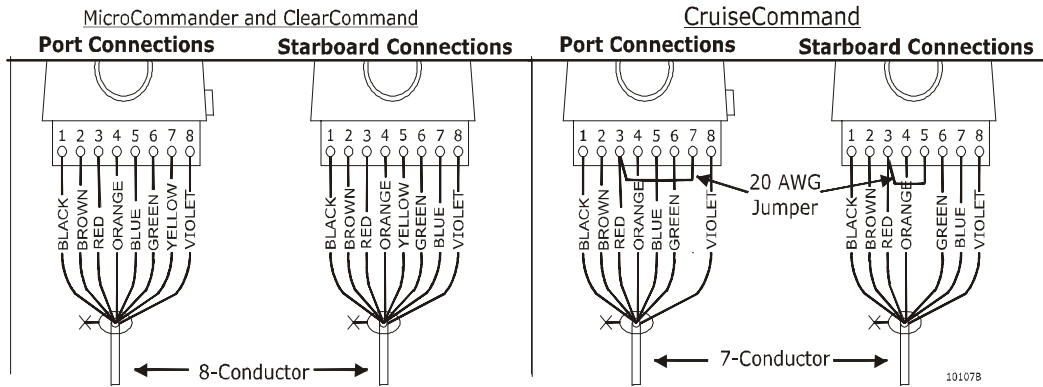
450 - 460 Series



MC2000 Series



400 and MC2000 Series



Standard Cable Connections

Select the desired mounting locations and drill holes per template.

Run cables between Actuator/Processor and Control Head.

At the Control Head, strip back the PVC cover on the shielded cable approximately 2" (50mm).

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

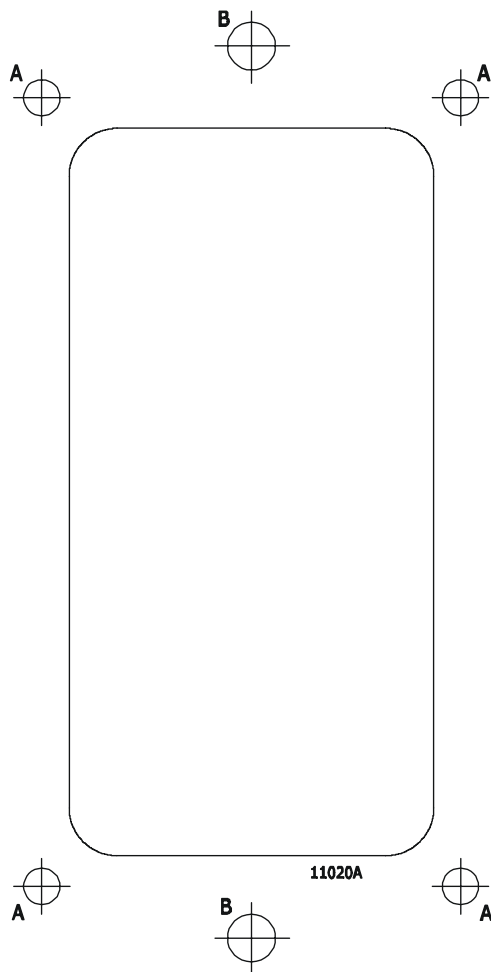
Strip 3/8" (9,5mm) insulation off each wire.

Twist the individual strands of the wires to minimize fraying.

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

Make connections to the Control Head as shown above for MicroCommander, ClearCommand, and CruiseCommand Systems.

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



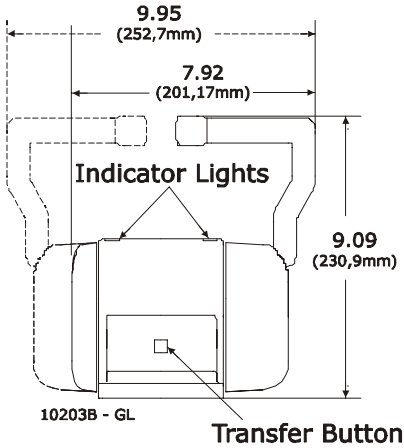
"A" HOLES 450 - 460 SERIES: ϕ .19

"B" HOLES MC2000 SERIES: ϕ .25

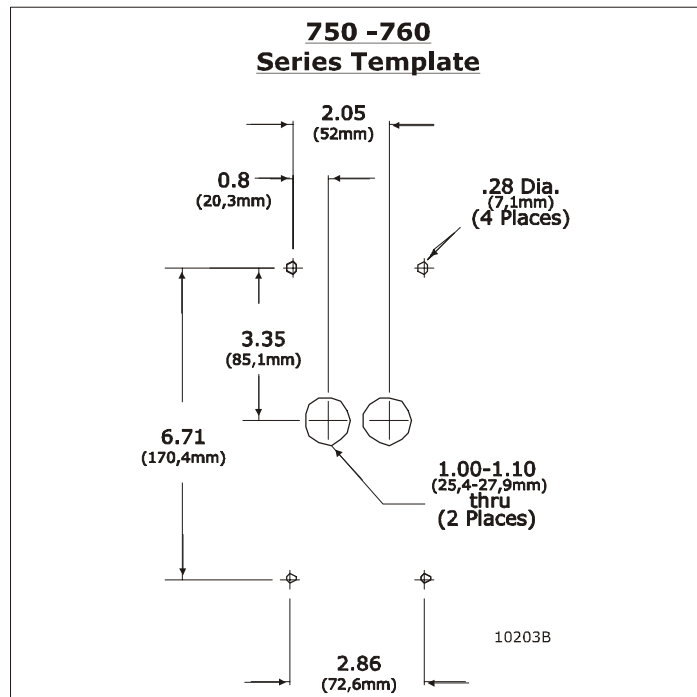
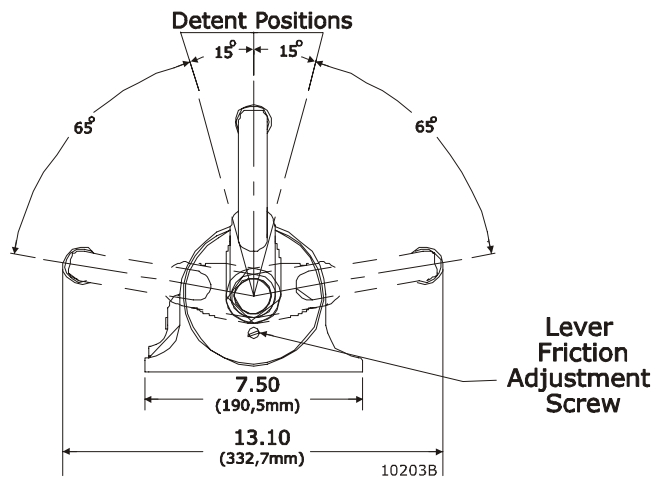


700 Series Control Head Sheet

750 - 760 Series Front View



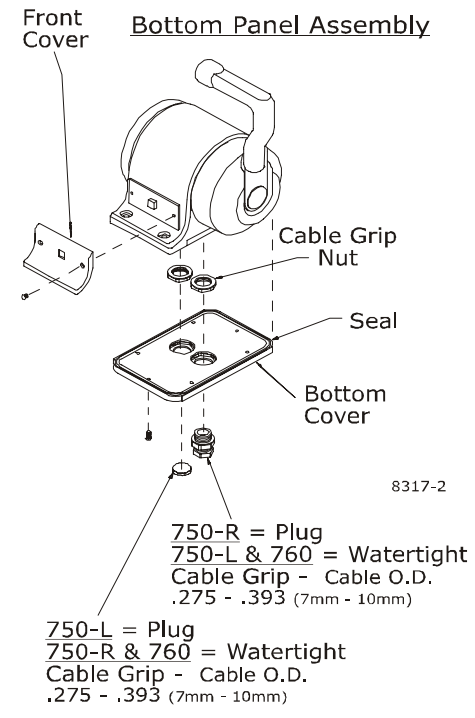
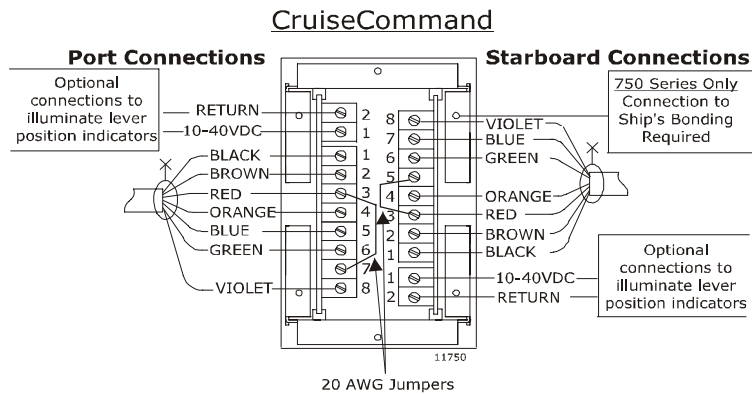
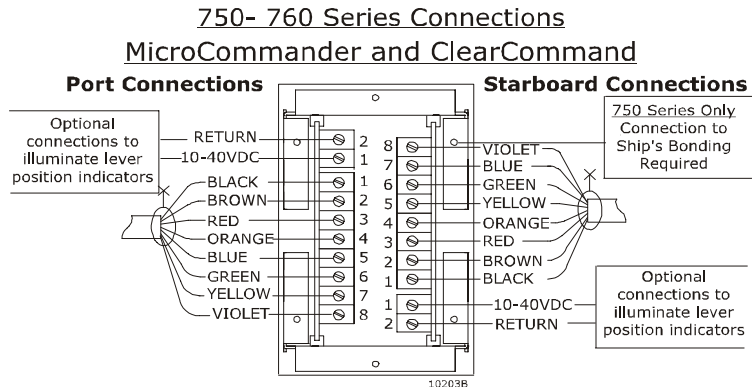
750 - 760 Series Side View



Standard Cable Connections

- A) Remove the bottom cover from the Control Head.
- B) Insert electrical cable through watertight cable grip(s) in Control Head bottom cover.
- C) Strip back the PVC cover on the shielded cable approximately 2" (50mm).

- D) 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.
- H) Make connections to the Control Head as shown below for Micro-Commander, ClearCommand, and CruiseCommand Systems.



- I) When connections are complete, replace the bottom cover to the bottom of the Control Head housing.

NOTE: On 750 Series Control Heads use one of the bottom cover screws to connect to the ship's bonding system.

- J) Tighten watertight cable grip(s).

Mounting

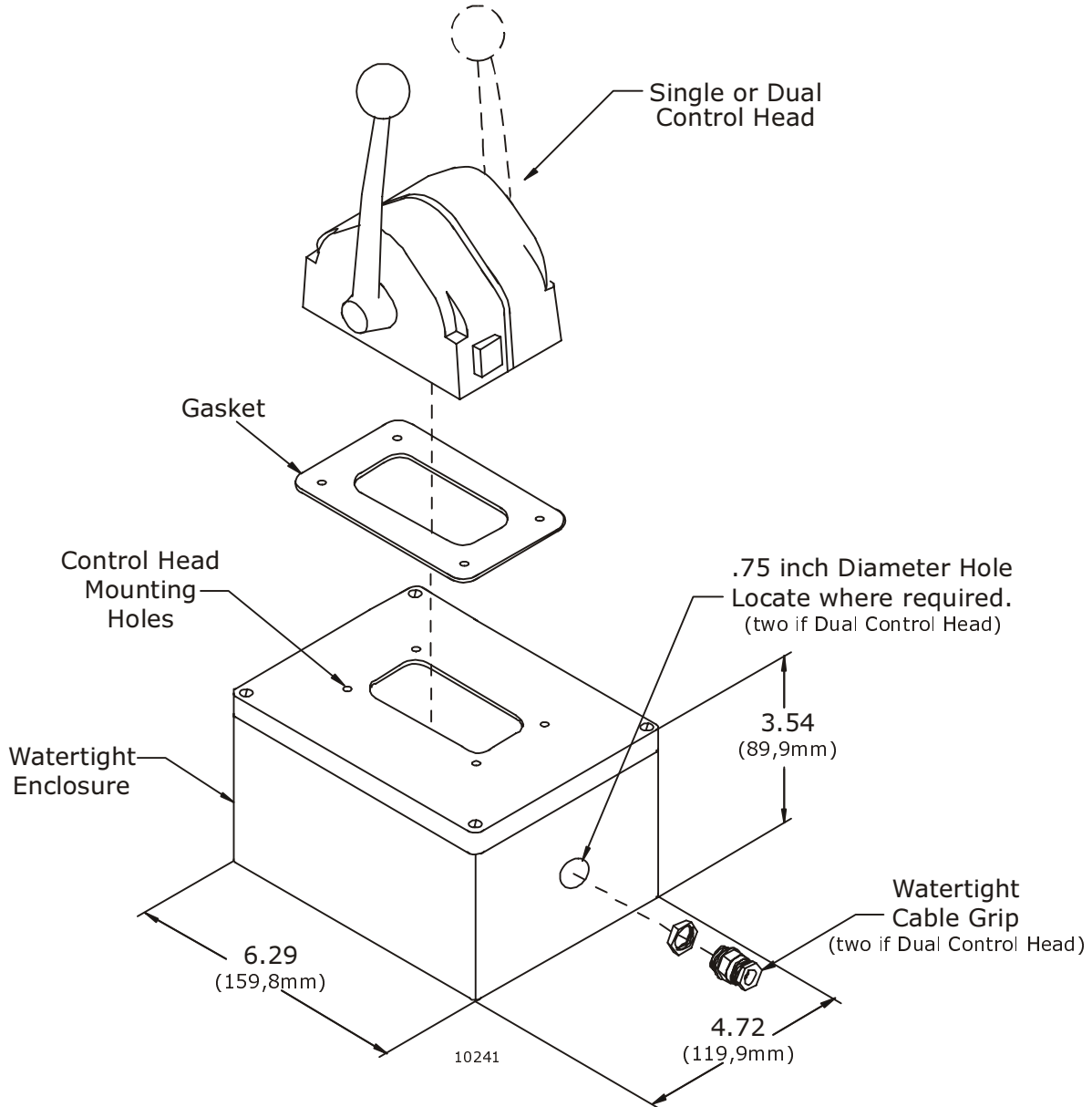
- A) Select mounting location and drill mounting holes as shown in the template on the front page.
- B) Remove front cover from the Control Head
- C) Mount Control Head with supplied hardware.
- D) Replace front cover when mounting is complete.



MMC-279 Rev.A 11/00

ZF Mathers, LLC
1415 Pacific Drive
Burlington WA 98233-3103 U.S.A.
800-546-5455 / 360-757-6265
Fax: 360-757-2500

400 Series Watertight 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



S-214 Rev.A 6/01

ZF Mathers, LLC
1415 Pacific Drive
Burlington WA 98233-3103 U.S.A.
800-546-5455 / 360-757-6265
Fax: 360-757-2500



Automatic Power Selector (APS) Model: 13505

A) GENERAL INFORMATION

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

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

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

B) APS SPECIFICATIONS

Model: 13505

Maximum Load Current: 70 amps

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

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

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

C) MATERIALS PROVIDED

The APS is supplied with a hardware packet containing (8) hex nuts, (4) lock washers, (6) 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.

D) INSTALLATION

Refer to the installation diagram Figure 1:.

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 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. Complete the wiring as shown on Page 2.
3. 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.

F) INSTALLATION DIAGRAM

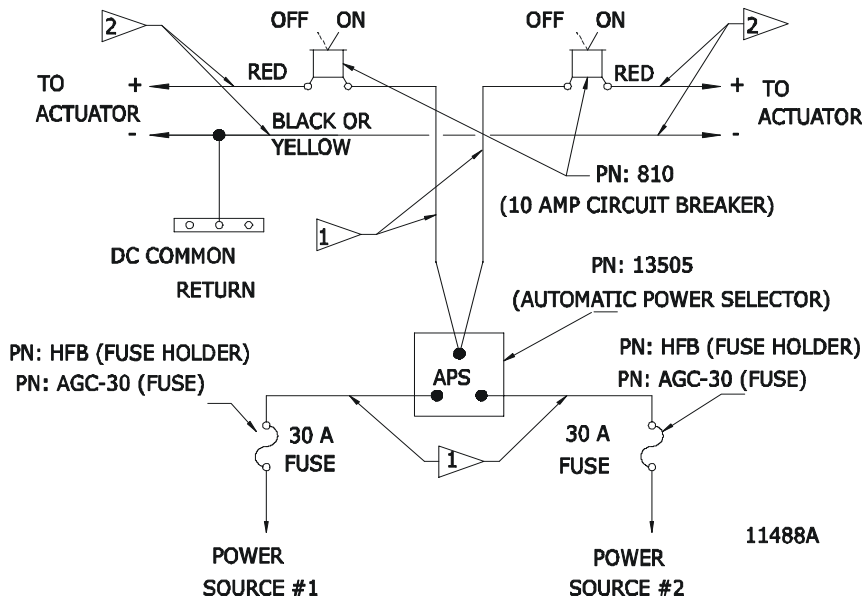


Figure 1:

Flag 1: Wire Size (Ref ABYC E9.15.9 10%)

0-15'	12 AWG (#3 Metric Equivalent)
15'-30'	10 AWG (#5 Metric Equivalent)
30'-60'	8 AWG (#8 Metric Equivalent)

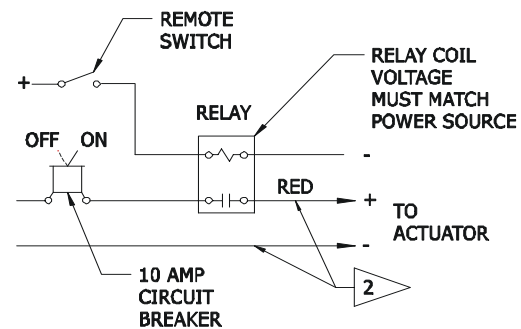
Flag 2: Wire Size (Recommended Twisted Pair)

0-20'	14 AWG (#2 Metric Equivalent)
20'-40'	12 AWG (#3 Metric Equivalent)

Note:

1. APS output is strictly for ZF Mathers Controls
2. Power Sources may be 12 or 24 volts DC

A.P.S. (Auto Power Selector) Kits			
<u>Twin Screw</u>	<u>Single Screw</u>	Include the following:	
13983	13984		
<u>Quantity</u>		<u>Description</u>	<u>Part Number</u>
1	1	A.P.S. Unit	13505
2	1	10 amp Switch Circuit Breaker	810
2	2	Fuse Holder In-Line	HFB
2	2	30 Amp Fuse	AGC-30



ALTERNATE: TO BE USED FOR LONG CABLE RUN FOR REMOTE 'ON' 'OFF' SWITCH (IN EXCESS OF 40')

Figure 2:

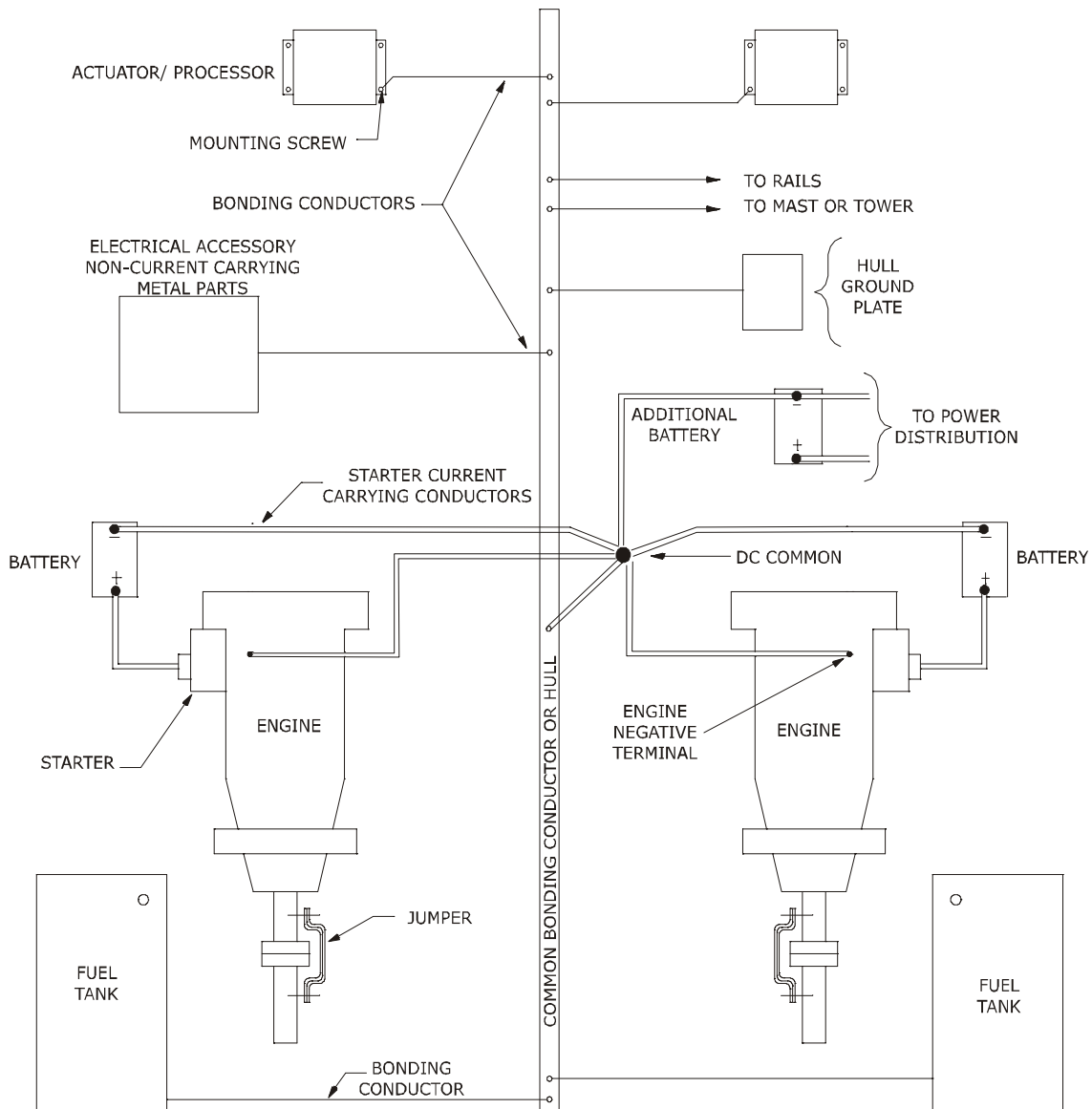


Bonding - A.B.Y.C. E-9 46 CFR 111.05

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

Metal - Hull Vessels

The hull of a metal - hull vessel may serve as the common bonding conductor. Any item to be bonded not in contact with the hull requires a bonding conductor to the hull.





MMC-288 Rev.C 7/01

ZF Mathers, LLC
1415 Pacific Drive
Burlington WA 98233-3103 U.S.A.
800-546-5455 / 360-757-6265
Fax: 360-757-2500



References and Parts Source

A) REFERENCES

1. American Boat & Yacht Council (ABYC)
3069 Solomons Island Road
Edgewater, MD 21037-1416
E-3 Wiring Identification on Boats
E-9 DC Electrical Systems on Boats
H-2.4e or 32.4g Ambient Temp. 50 degrees C
P-24 Electric/Electronic Propulsion Controls
2. Code of Federal Regulations
33 CFR 183 Subpart I - Electrical Systems
33 CFR 183, 410 Ignition protection
33 CFR 183, 415 Grounding
33 CFR 183, 425 Conductors: General
33 CFR 183, 430 Conductors in circuit of less than 50 Volts
33 CFR 183, 445 Conductors: Protection
33 CFR 183, 455 Over-current and Protection: General
46 CFR 111.01 - 15(b) Ambient Temp. Machinery Spaces 50 degrees C
46 CFR 111.05- System Grounds
3. Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096
J1171 External Ignition Protection
J1428 Marine Circuit Breakers
J378 Marine Engine Wiring
4. National Marine Manufacturers Association
401 North Michigan Avenue
Chicago, IL 60611
5. Underwriters Laboratories

B)PARTS SOURCE

Anti-Static Wrist Strap	P/N 517	[Thomas & Betts (P/N AWCC)]
Automatic Power Selector	P/N 13505	
Circuit Breaker- UL Approved	P/N 810	[E-T-A (P/N 41-2-514-LN2-10)]
Fuse	P/N 1030	[Bussman (P/N. GDC-1A)]
Relay 12 VDC	P/N 1114	[Potter-Brumfield (P/N KRPA5D6-12)]
Relay 24 VDC	P/N 1122	[Potter-Brumfield (P/N KRPA5D6-24)]
Service Field Test Unit (Break-out Box)	P/N 13927	
WAGO Tool	P/N 397	[WAGO (P/N 236-332)]

Morse Clutch and Throttle Kit Selection

Pre-Engineered Throttle Connection Kits

MAKE	ENGINE MODEL	KIT NO.
Caterpillar	3208NA	300172
	3208TA	305403
	334, 3304, 3306	36680
	3406 & 343	36680
	3408	36680
Cummins	A11 w/MVSGOV AFC Fuel Pump	36680
	V504M, V555M, V903M, VT903M, VTA903M, NT855M, VT1710M, VTA1710M, KT & KTA 1150M, KT & KTA 2300M, 1975 and later	300580
General Motors	3, 4, & 6-71 w/var.sp.gov.	41736
	6, 8, 12 V-71 & 6, 8 V-92 w/var.sp.gov.	41736
	6-71 inclined	36680
	2, 3, 4-53 w/left hand gov.	36680
	Right hand gov.	36680
	6V-53 Rear entry	36680
	6V-53 Front entry	36680
	6, 8V-71 Front entry 12, 16V-149	36680
Perkins	4, 236M	48931
	6, 3544M; T6, 3544M; ST6, 3544M; SST6, 3544M	302026
	4, 108 W/shut off	303878

Pre-Engineered Clutch Connection Kits

MAKE	TRANSMISSION MODEL	KIT NO.
Allison	M & MH	41482
Borg Worner	70, 71, 72 In line w/red gear rear entry	301474
Capital	12400	36680
	2, 3, & 4 HD & HE	36680
MerCruiser	Inboard w/o Warner red gear	62355
Paragon	HF-7	36680
Twin Disc	MG508, 509, 510, 510A, 512, 514C, 514CHP, 518, 521, 527, 530, 540	42577
	MG502, 506, 507, W/x9994, xA7022, A7048 Valves	63696
Twin Disc Trolling Valve	MG509, 510A, 511A, 514C	307171

Outboard and I/O Cable Connection Kits

ENGINE MAKE	KIT NO.
Chrysler 1975 & later	300465
Evinrude/Johnson 55-235 H.P. 1978 to date	301729
Mercury 40-300 H.P.	301901
Mercruiser I/O	302123
OMC Sterndrive I/O	300557
Volvo I/O	Engine and out drive brackets are provided by Volvo



Universal Mounting Kit

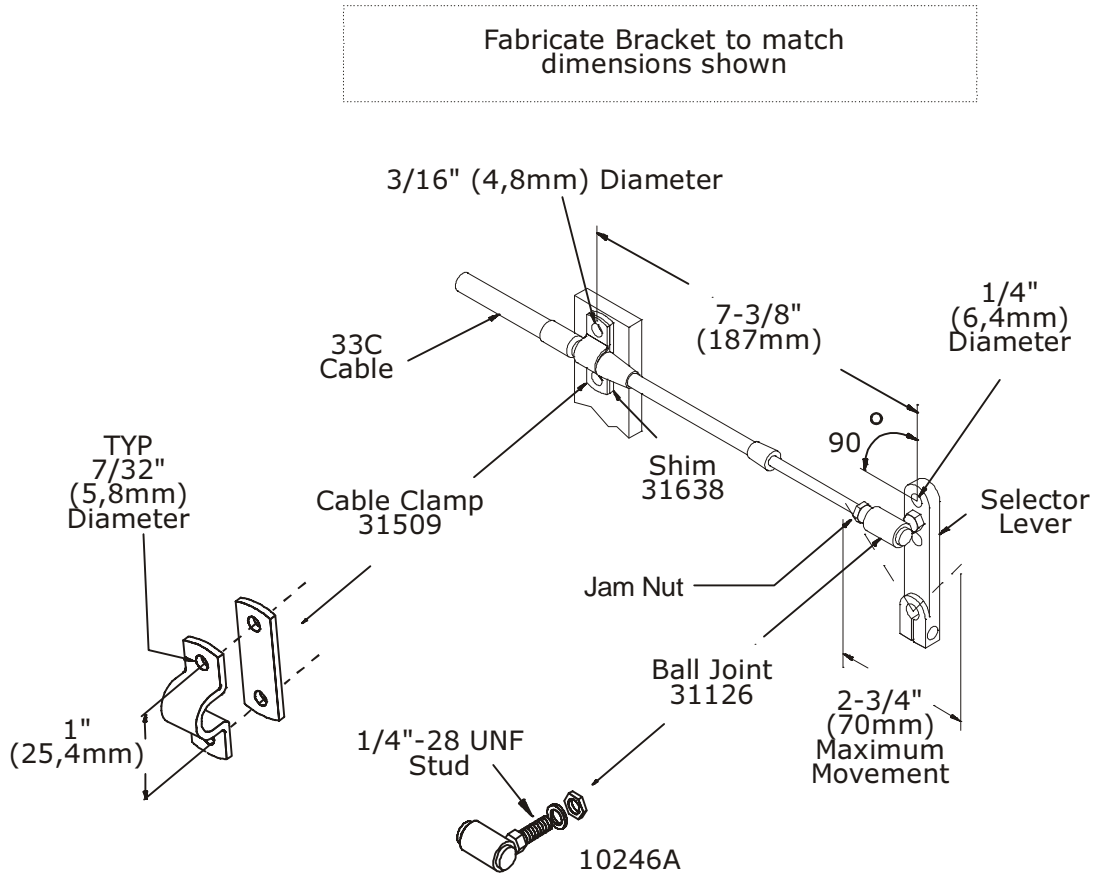


Figure 1: Universal Mounting Kit

APPENDIX B.1



1.0 General

The MicroCommander Control System consists of one to five Control Heads located at the vessel's remote stations, connected to one or two Actuators located in the engine room area. The Actuator(s) may be configured for main engine speed and transmission direction only, or configured for automatic engine synchronization and trolling valve control.

Before beginning troubleshooting, review the Drawings in Appendix C. Become familiar with the component configuration on your vessel.

Carefully inspect the following:

- DC Power Source
- Component Location
- Component Condition
- Interconnecting Wiring
- Wire Termination's
- Mechanical Connections at the Throttle and Transmission
- Pulse Signal (Synchronization Applications)
- Mechanical Connections at the Trolling Valve

A key in troubleshooting the MicroCommander System is identifying the problem as:

- DC Power Source
- Interconnection wiring or termination
- Mechanical Interface
- Component Calibration
- Component Failure

The MicroCommander System has Station-in-Command indicator lights on each Control Head, as well as audible tone indicators. These indicators will assist in troubleshooting and control system status.

When contacting an authorized MicroCommander servicing dealer, or ZF Mathers Service Department, please be ready with the Actuator Part Number and Serial Number.

CAUTION: Static electricity can destroy electronic components. Any time the Actuator cover is off, wear the wrist strap provided and connect it to the Actuator frame. This will drain any static charge you may have on your person.

NOTE: Always check the other remote stations, to see if the symptom can be repeated

2.0 **SYMPTOM** - Cannot acknowledge command at one remote station (both Port and Starboard for Twin Screw) when the system is first turned On.

<u>CAUSE</u>	<u>REMEDY</u>
A) A bad electrical connection.	A) Check the crimps and insure that all the screws are tight at the Control Head. Check the STATION connections at the Actuator. Tighten or re-crimp as necessary.
B) Incorrectly wired eight-conductor cable.	B) Check wire termination's at both the Control Head and the Actuator for correct terminal connections. Refer to Drawings in Appendix C.

3.0 **SYMPTOM** - On a Twin Screw Application, one Control Head lever of a Dual Control Head will accept command while the other lever will not.

During initial power up, the MicroCommander System has initialized, although you are unable to acknowledge command, the low repetition tone is present and the red indicator light is not lit.

<u>CAUSE</u>	<u>REMEDY</u>
A) Incorrect or poor wire connections at the Control Head or Actuator.	A) Check wire termination's at the Control Head and the Actuator. Refer to Drawings in Appendix C.
B) Faulty Control Head.	B) Replace Control Head or rebuild with Overhaul Kit.
C) Port and Starboard power sources do not have a common ground (only the starboard would be unable to acknowledge command).	C) The negative terminals of both batteries must be connected to a common point. If not, connect both to a common point.
D) Incorrectly wired eight-conductor cable.	D) Wire the cable connections as shown in Appendix C.

4.0 **SYMPTOM** - The red light blinks when the Station Transfer Button is depressed, and continues to blink after it is released (Control Head lever is in Neutral/Idle position). Cannot transfer to this Remote Station if another Remote STation was previously in command.

<u>CAUSE</u>	<u>REMEDY</u>
A) The Control Head potentiometer is not centered.	A) Replace the Control Head or install a Control Head Repair Kit.

5.0 **SYMPTOM** - The engine RPM varies, without moving the Control Head lever (synchronization disabled).

CAUSE	REMEDY
A) Problem with the governor or carburetor.	A) Watch the push-pull cable at the governor or carburetor; if the push-pull cable is moving, go to step B). If not, contact a certified mechanic.
B) Erratic command signal.	B) At the Actuator, measure the DC voltage at the yellow and green wires (pins 5 and 6) of the Station-in-Command; the reading should be a stable voltage (no variations). If not, check for a loose connection between the Actuator and the Control Head. If the connections are tight, and no corrosion is present, replace the Control Head or install a Control Head Repair Kit.

6.0 **SYMPTOM** - The engine RPM drops to Idle, transmission to Neutral, the Control Head red indicator light turns Off, and a slow repetitive tone is heard at all Remote Stations after repositioning the Control Head lever.

CAUSE	REMEDY
A) A drop in battery voltage (12 volt systems only) at the Actuator.	A) Measure the voltage at the battery without the engine or charger running; the reading should be a minimum of 12.4 volts. If not, the battery needs charging or possibly replacing. Measure the voltage at the Actuator(s) BATT+ and BATT- terminals; this reading should be no less than 0.20 volt below the measured battery voltage.
B) Defective Control Head.	B) Replace the Control Head or install a Control Head Repair Kit if the voltage at the Actuator tested good.

7.0 **SYMPTOM** - No tones or indicator lights at the Control Head, and no LEDs lit on the Circuit Board.

CAUSE	REMEDY
A) No power to the Actuator.	A) Check the power source to the Actuator.
B) Polarity of the battery voltage reversed.	B) Connect the red/purple wire to the Actuator terminal labeled BATT+ and the black wire to the terminal labeled BATT-.
C) Fuse (Part No. GDC-1A) on the circuit board blown.	C) Measure the battery voltage at the Actuator. If the voltage exceeds 40 volts, the power source must be corrected. Replace the fuse with the spare, which is taped to the relay on the circuit board. If the fuse again blows, the circuit board needs to be serviced or replaced with a Circuit Board Kit.

8.0 **SYMPTOM** - No audible tone at a Control Head when power is first turned On, but otherwise works perfectly.

<u>CAUSE</u>	<u>REMEDY</u>
A) Incorrectly wired eight-conductor cable.	A) Verify that the black wire is connected to pin 1 in the Actuator, and to pin 1 at the Control Head. The brown wire must be connected to pin 2 in the Actuator, and to pin 2 at the Control Head. In addition, the LED will not light if the brown wire is loose or connected incorrectly. Check for loose or corroded connections.
B) Defective sound transducer.	B) Measure the voltage at Control Head at pins 1 and 2 (do not depress the Station Transfer Button); the voltage should fluctuate at a steady rate. If an unsteady fluctuating voltage is measured, replace the Control Head or install a Control Head Repair Kit.

9.0 **SYMPTOM** - The Control Head red indicator light does not light when in command, but everything else works perfectly.

<u>CAUSE</u>	<u>REMEDY</u>
A) Incorrectly wired eight-conductor cable.	A) Verify that the brown wire is connected to pin 2 of the Actuator and to pin 2 of the Control Head.
B) Defective LED	B) Measure the DC voltage between pins 2 and 3 at the Control Head; the reading will be 1.00 to 2.00 volts in normal operation. If 4.00 volts is measured, the LED is open. Replace the Control Head or install a Control Head Repair Kit.

10.0 **SYMPTOM** - The engine starter will not engage.

<u>CAUSE</u>	<u>REMEDY</u>
A) The MicroCommander System is not turned On.	A) Turn power On to the MicroCommander System.
B) The Control Head lever(s) are not at the Neutral position.	B) Place the Control Head lever(s) in the Neutral position and depress the Station Transfer Button.
C) Low battery voltage.	C) Check the battery voltage. If the voltage is low, charge or replace the battery.
D) Faulty start interlock circuit in the Actuator.	D) Temporarily connect the two start interlock wires (yellow with red stripe) at the Actuator to the same START INTERLOCK terminal. If the engine can now be started, the Actuator needs to be serviced.

11.0 SYMPTOM - Cannot obtain Neutral Warm-up Mode while moving the Control Head lever in the Ahead direction, only in the Astern direction.

CAUSE	REMEDY
A) The Actuator is sensing Control Head lever movement in the Astern direction.	<p>A) Depress the Station Transfer Button while moving the Control Head lever to the Astern detent. If the LED now blinks, the Actuator is incorrectly set up. This will be corrected by performing the following:</p> <ul style="list-style-type: none"> • Check the eight-conductor wiring. • For right-hand Control Heads, the yellow wire should go to pin 5 at both the Actuator and Control Head. • For right-hand Control Heads, the blue wire should go to pin 7 at both the Actuator and Control Head. • For left-hand Control Heads, the yellow wire should go to pin 7 at the Control Head and pin 5 at the Actuator. • For left-hand Control Heads, the blue wire should go to pin 5 at the Control Head and pin 7 at the Actuator.

If any changes to the wiring are necessary, the shunt at JMPR 4 may need to be changed to the opposite two pins. Check all Stations for Ahead and Astern operation.

12.0 SYMPTOM - Rapid tone at all Remote Stations.

CAUSE	REMEDY
<p>A) Incorrectly adjusted push-pull cable.</p> <p>B) Defective push-pull cable.</p> <p>C) Low battery voltage at the Actuator (12 volt systems).</p> <p>D) Defective servo unit in the Actuator.</p>	<p>A) Disconnect the push-pull cable from the shift lever at the transmission. Disconnect the push-pull cable from the throttle lever at the carburetor or governor. Operate the Control Head(s). If the rapid tone is no longer present, follow the Push-Pull Cable Adjustment and Tests Section.</p> <p>B) One-by-one, remove the push-pull cables from the Actuator and operate the Control Head(s). If the rapid tone is no longer present, replace the defective push-pull cable.</p> <p>C) Measure the battery voltage at the Actuator. If the measured voltage is 8 to 12 volts, the power source needs to be checked.</p> <p>D) If A), B), and C) tested good, the entire Actuator needs to be repaired or replaced.</p>

13.0 SYMPTOM - Steady tone is heard from all Remote Stations. Cannot gain command at any remote station.

CAUSE	REMEDY
A) Low battery voltage at the Actuator.	A) Check the battery voltage at the Actuator. If the measurement is less than 8 volts, the battery needs to be replaced or the source of the voltage drop needs to be corrected.
B) Component failure on the circuit board.	B) If the voltage tested good, the circuit board needs to be repaired or replaced. The Actuator may require service by an authorized ZF Mathers Service Center.

14.0 SYMPTOM - The engine starts to turn over while starting, and then stops. A slow repetitive tone is heard from all Remote Stations.

CAUSE	REMEDY
A) The voltage to the Actuator has dropped too low, due to the starter's current requirements.	A) Supply power to the Actuator from a battery other than the starting battery.
B) Battery charge is low.	B) Recharge or replace the battery.

15.0 SYMPTOM - One long, one short tone from all Remote Stations.

CAUSE	REMEDY
A) Shift position feedback error.	A) Depress the Station Transfer Button twice. The Actuator will need to be serviced at the first opportunity.

16.0 SYMPTOM - One long, two short tones from all Remote Stations

CAUSE	REMEDY
A) Throttle position feedback error.	A) Depress the Station Transfer Button twice. The Actuator will need to be serviced at the first opportunity.

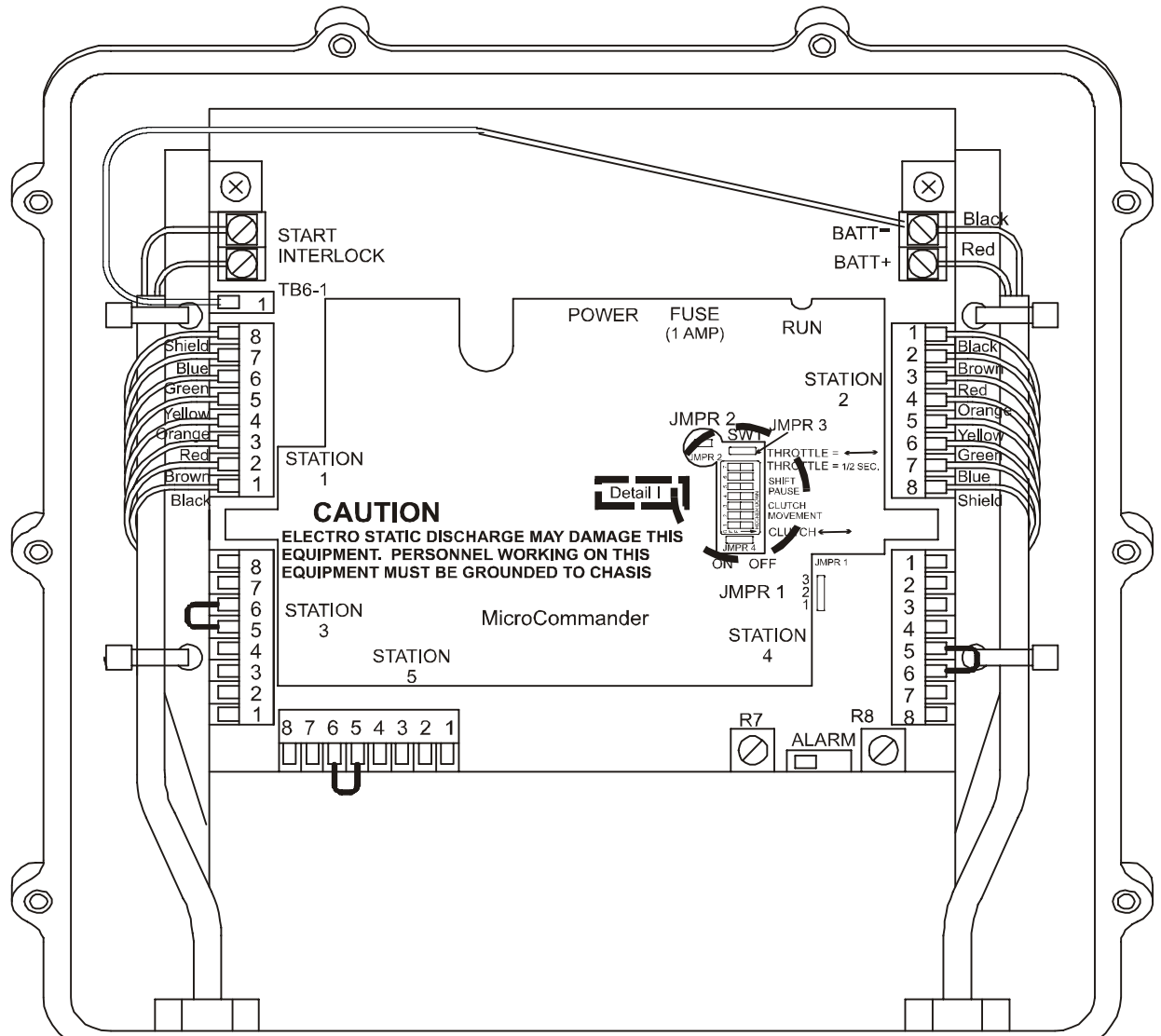
17.0 SYMPTOM - One long, three short tones from all Remote Stations.

CAUSE	REMEDY
A) Defective Control Head.	B) Depress the Station Transfer Button twice. Change Stations if possible. Have Control Head serviced at the first opportunity.

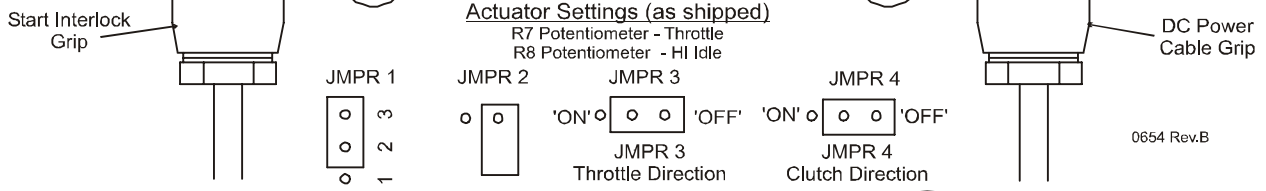
APPENDIX C.1



Typical Actuator Connections



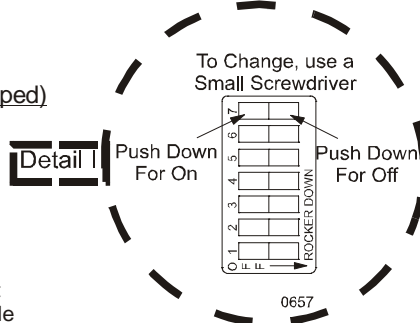
CAUTION
ELECTRO STATIC DISCHARGE MAY DAMAGE THIS EQUIPMENT. PERSONNEL WORKING ON THIS EQUIPMENT MUST BE GROUNDED TO CHASSIS



0654 Rev.B

Dip Switch SW1 Settings (as shipped)

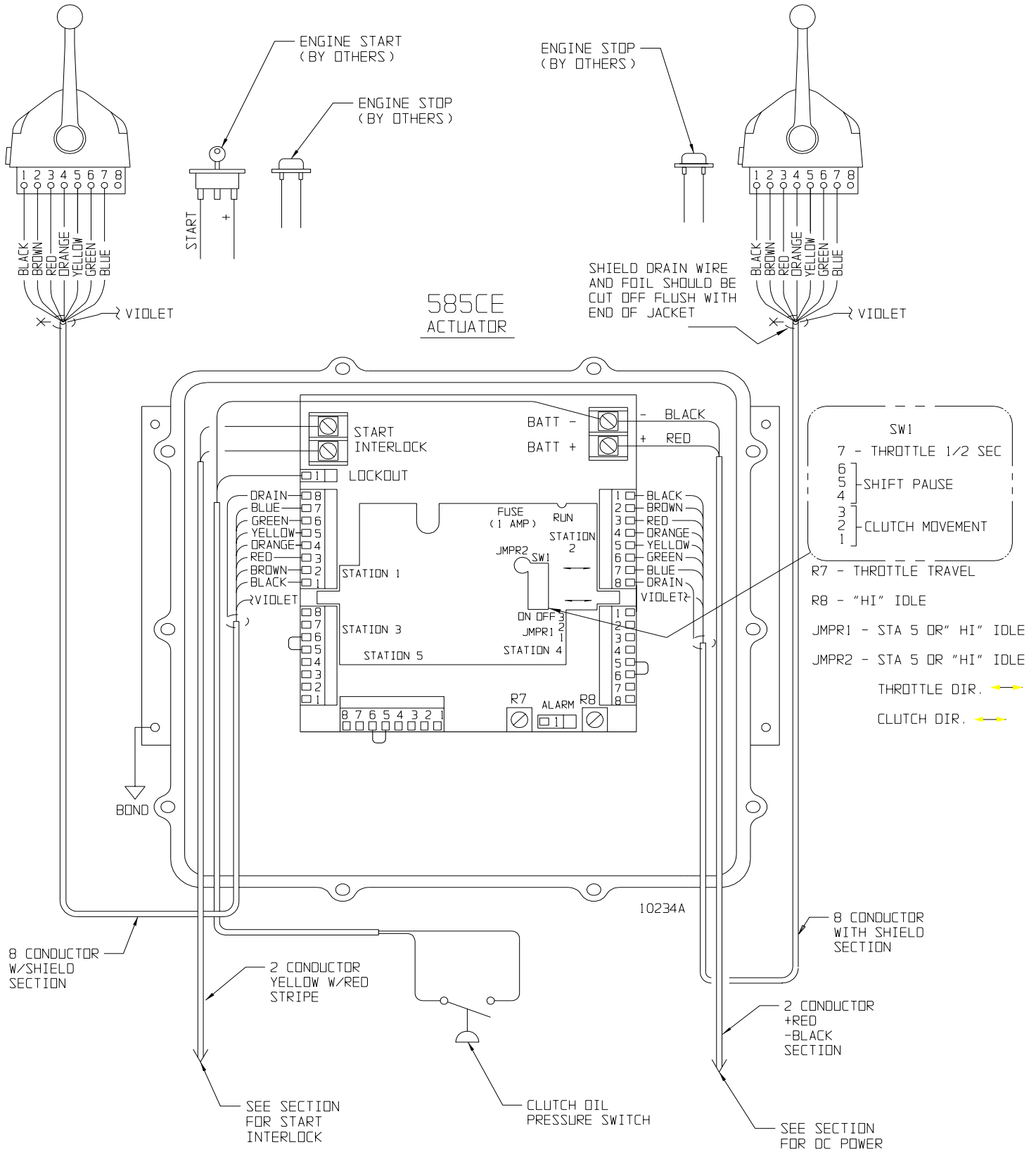
- Off (7) Throttle Pause
- Off (6) Clutch Pause - see Timing Chart, Sect. 4.8.2
- On (5) Figure 7
- Off (4) Figure 7
- On (3) 1/16 inch (1,6mm) Shift
- On (2) 1/8 inch (3,2mm) Cable
- On (1) 1/4 inch (6,4mm) Movement



Single Engine

STATION NO. 1

TYPICAL OF STATION 2 THRU 5



Two Engines with No Synchronization

