

MATHERS CONTROLS INC.

Technical Manual



**Mathers ClearCommand MS558-12351
System Serial Number
2591**

for

Halter Marine

**Mathers Controls Inc.
Technical Manual
September 1997**

Vessel General Information:

Customer:	Donovan Marine
Builder:	Halter Marine
Vessel:	Supply Vessel Bow Thruster
Power:	Single Screw Caterpillar 3412 670 HP @ 1800 RPM
Transmission:	Reintjes WAF 243
Stations:	Pilothouse Aft Pilothouse

ClearCommand General Information:

Control Processor	MS558-12351
System Serial Number:	2591
Sales Order Number	54813
Drawing Number	10445, 4 pages

TABLE OF CONTENTS

1. THEORY OF OPERATION.....	1
2. OPERATOR INSTRUCTIONS.....	1
2.1 DC Power On.....	1
2.2 Engine Start.....	1
2.3 Station Transfer.....	2
2.4 Dynamic Positioning System.....	2
2.4.1 Station Transfer to Dynamic Positioning (DP) / Joystick System.....	2
3. REQUIRED PARTS AND TOOLS.....	2
3.1 Control Head.....	2
3.2 Electric Cable.....	2
3.3 Tools Required For Installation.....	3
3.4 Push-Pull Cable.....	3
3.5 Engine Stop Switch.....	3
3.6 Control System Power.....	3
4. PLAN THE INSTALLATION.....	3
4.1 Processor(s) Location.....	3
4.2 Remote Control Head Location.....	4
4.3 DC Power Source.....	4
5. INSTALLATION.....	4
5.1 Eight-Conductor Cable.....	4
5.2 Control Processor.....	5
5.2.1 Eight-Conductor Cable.....	5
5.2.2 Two-Conductor Power Cable.....	5
5.2.3 DP System to Processor(s).....	6
5.3 Control Head.....	6
5.3.1 Eight-Conductor Cable.....	6
5.4 Start Interlock.....	6
5.5 Engine Stop Switch.....	7
5.6 Bonding.....	7
5.7 Push-Pull Cables.....	7
6. ADJUSTMENTS AND TESTS (SECURED TO DOCK).....	8
6.1 Control Head and Station Transfer Test (Engines Stopped).....	8
6.2 Start Interlock Test and Adjustments (Engines Stopped).....	9
6.3 Clutch Cable Adjustment (Engines Stopped).....	9
6.4 Engine Stop Switches Test (Engines Running).....	10
6.5 Engine Governor Push-Pull Cable Adjustment (engine running).....	10
6.6 Dockside Test - DP Control.....	11

7. ADJUSTMENTS UNDERWAY	11
7.1 Full-Speed Setting - Engine RPM	11
7.2 Proportional Pause On Direction Change.....	11
8. CONTROL OPTIONS	11
8.1 Alarm Capability.....	11
8.2 Clutch Oil Pressure Interlock	12
9. MAINTENANCE.....	12
9.1 Control Processor	12
9.2 Control Head.....	12
10. TROUBLE SHOOTING.....	13
11.1 Symptom - When DC Power is turned On, operator cannot take command at one station (both Port and Starboard for twin screw).	13
11.2 Symptom - The engine starts to turn over while starting and then stops. A slow repetitive audible tone from all Control Head stations.....	13
11.3 Symptom - The Control Head red indicator light does not light when in command, but everything else works perfectly.	13
11.4 Symptom - The engine RPM reduces to IDLE, transmission to NEUTRAL, the Control Head indicator light turns Off, and a slow repetitive tone emitted at all stations after repositioning the Control Head lever.....	14
11.5 Symptom - No audible tone at a Control Head when system is first turned On, but otherwise works perfectly.....	14
11.6 Symptom - No tones or lighted indicator lights at the Control Head, and no lighted indicator lights on the Processor circuit board.	15
11.7 Symptom - The engine will not start.....	15
11.8 Symptom - The engine RPM varies, without moving the Control Head Lever.....	15
11.9 Symptom - High repetition rate tone at all remote stations.....	16
11.10 Symptom - Audible steady tone from all remote stations. Cannot gain command at any station.....	16
11.11 Symptom - One long - Two short tones from all Control Head stations....	16
11.12 Symptom - One long - One short tone from all Control Head stations.....	16
11. REFERENCES	17
11.1 American Boat & Yacht Council.....	17
11.2 Code of Federal Regulations	17
11.3 Society of Automotive Engineers	17
11.4 National Marine Manufacturers Association	17
11.5 Underwriters Laboratories	17
11.6 Parts Source	17

Appendix A

Drawing. No. 10445, 4 pages

1. THEORY OF OPERATION

This ClearCommand Control Processor (hereafter referred to as Processor) is designed specifically for interfacing with a Simrad Dynamic Positioning System, controlling engines that require mechanical throttle selection and transmissions with mechanical clutch selection.

A single lever at the Station-in-Command Control Head will select clutch direction and engine RPM. The operator may transfer command to any other station by leaving the Station-in-Command Control Head lever in any position. At another station ensure the Control Head levers are in the NEUTRAL position before depressing the station transfer button. After depressing the station transfer button, the new Station-in-Command Control Head red indicator light will light, indicating the operator has taken command. The operator has a one second pause after the indicator light is lit to match the previous speed setting. Only one station is in command at a time.

This system includes the following features:

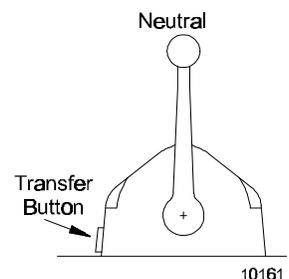
- Sequencing of Clutch Selection and Engine Speed
- Proportional Pause on through Neutral Shifts
- Station-in-Command Indication
- One to Four Remote Stations
- ClearCommand System Fault Indication
- ClearCommand Failure Alarm Contact
- Dynamic Positioning (DP) System Interface
- Clutch Oil Pressure Interlock
- Neutral Start Interlock

A detailed System Drawing that is specific to this application is included in Appendix A. Refer to this drawing for technical details, and wiring arrangements. During installation and testing, take special care to verify all wiring is to specifications, termination's are correct, and that all Notes on the System Drawing are followed.

2. OPERATOR INSTRUCTIONS

2.1 DC POWER ON

When control system DC power is turned On, the Processor will move to NEUTRAL IDLE position. An intermittent tone will sound at all remote stations, indicating that no station has command. To take command at a station, the operator must depress the station transfer button. The tone will stop at all stations and the red indicator light will be lit at the Station-in-Command. Only one station has command at a time.



2.2 ENGINE START

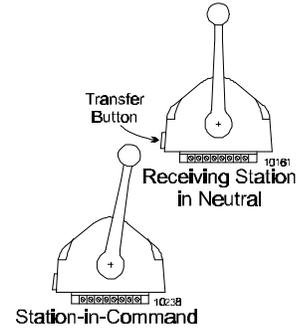
There are two features related to main engine start:

- Start Interlock to block the engine start signal if the DC power has not been turned On.

- Start Interlock to block the engine start signal if clutch engaged.

2.3 STATION TRANSFER

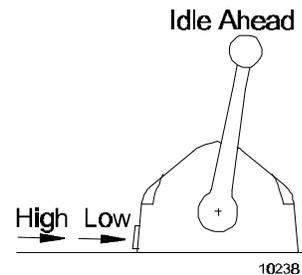
When transferring command from one remote station to another, the Control Head lever of the Station-in-Command may be left in any position. The station taking command must be in the NEUTRAL position. Depress the station transfer button at the station taking command. The red indicator light will light indicating the station has taken command. The Control System will remain unchanged for one second after that to allow the operator time to move the Control Head lever to a position approximately matching the last speed setting.



2.4 DYNAMIC POSITIONING SYSTEM

Refer to the information supplied with the Dynamic Positioning System (hereafter referred to as DP Mode) for operation.

The ClearCommand System and the DP System cannot be in command at the same time.



2.4.1 Station Transfer to Dynamic Positioning (DP) / Joystick System

While ClearCommand is in remote control, the DP / Joystick Mode may be selected by depressing the DP / Joystick ready switch, which is included in the DP System.

The red LED on the Control Head will not be lit. The engine and transmission are now under control of the DP / Joystick System.

To regain ClearCommand control, depress any remote station transfer button.

To regain DP Mode, the operator must reset the DP ready switches.

3. REQUIRED PARTS AND TOOLS

3.1 CONTROL HEAD

- A Control Head is required at each Station
- Included are gasket, terminals, mounting screws, and watertight cable grip for the cable entrance on the Processor.

3.2 ELECTRIC CABLE

Eight-Conductor Cable (Control Head to Control Processor)
 Shielded 20 AWG, 300V, PVC Insulated: -20 degrees C to +80 degrees C.
 UL VW-1 PVC Jacket.
 Color Coded.

Two Conductor Power Cable
 14 AWG, 300V, PVC Insulated: -20 degrees C to +105 degrees C
 UL VW-1 PVC Jacket.
 Red with purple stripe and black.

Two Conductor Cable Start Interlock Cable
 16 AWG, 300 V, PVC Insulated: -20 degrees C to +105 degrees C
 UL VW-1 PVC Jacket.
 Yellow with red stripe.

3.3 TOOLS REQUIRED FOR INSTALLATION

- | | |
|--|---|
| Anti-static Wrist Strap | Screwdriver -- medium Phillips #2 |
| Wire cutter (Recommend Thomas & Betts WT-2000) | Screwdriver -- medium straight slot |
| Wire stripper (Recommend Thomas & Betts WT-2000) | Screwdriver -- small straight slot |
| Wire crimper (Recommend Thomas & Betts WT-2000) | Hole saw -- 1 inch (25,4mm) |
| | Drills -- 9/32 inch (7,2mm) and 7/32 inch (5,6mm) |

3.4 PUSH-PULL CABLE

Use Type 33C push-pull cable to the transmission clutch selector lever and the engine governor. When measuring cable length, measure cable from end of thread to end of thread. Cables stocked in one foot (0,3m) increments.

Many engines are delivered with factory push-pull cable mounting kits. If factory mounting kit is not included, contact the engine dealer for a Factory Cable Connection Kit or refer to Fig. 4 for Universal Mounting.

3.5 ENGINE STOP SWITCH

It is mandatory for an Engine Stop Switch to be located at each remote station.

WARNING: An Engine Stop Switch at each station is an absolute requirement, and will cancel warranty if not installed.

3.6 CONTROL SYSTEM POWER

(Reference Fig. 1) The power for the Control System should come from the same power distribution panel as the other required engine functions. (Refer to the References Section)

4. PLAN THE INSTALLATION

4.1 PROCESSOR(S) LOCATION

Considerations:

- The Processor is spray proof but cannot be immersed.
- Bulkhead mount preferred for ease of access for wiring and adjustments. Mount the Processor in any attitude easily accessible for electric connections. (See System Drawing for mounting dimensions.)
- Do not mount to the engine, or transmission, or any location that will allow excessive vibration.

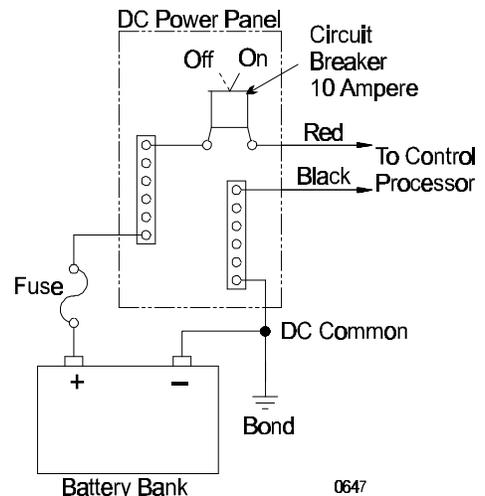


Fig. 1
Power Source

- ClearCommand uses electronic circuits that can be influenced by strong magnetic fields, and static charges. Allow 4 feet (1,2m) of clearance between the Processor and alternators or electric motors.
- Locate away from heat sources, such as engine exhaust manifolds.
- Mounting Hardware is installer supplied.
- Locate the Processor such that the push-pull cables from it to the transmission and the engine governor have large radius bends, with the least total degrees of bend and moderate length. **EXAMPLE:** Minimum bend radius 10-inches (254mm) for total degrees of bends of less than 270 degrees. Push-pull cable lengths should not exceed 20 feet (6m).

CAUTION: *It is mandatory the Processor power source be bonded (connected) to the hull. See Section on Bonding.*

4.2 REMOTE CONTROL HEAD LOCATION

Considerations:

- When properly mounted on a console, the Control Head is watertight from the top. Protect the Control Head from water or spray from inside or below the console.
- It mounts flush to the console, with a cutout for wiring and mounting screws. (See System Drawing for mounting dimensions)
- Secure with Number 8-32 x 1 inch screws, from the bottom side of the panel.

4.3 DC POWER SOURCE

The Processor requires a battery source of 12 or 24 volts DC, protected by a 10 ampere circuit breaker with manual reset. (See **Fig. 1**) 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).

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 percent. The DC return to the battery must be large enough to supply all current requirements with a voltage drop of less than 3 percent.*

5. INSTALLATION

NOTE: *Before starting the actual installation of ClearCommand, make sure you have the correct parts and tools on hand. See Sect. 2.4 -- REQUIRED PARTS AND TOOLS. Read ALL the instructions pertinent to each part before beginning the installation of that part.*

WARNING: *Static electricity can destroy electronic components. Anytime the Processor cover is off, use the wrist strap provided and connect it to the Processor frame. This will drain any static charge you may have on your person.*

5.1 EIGHT-CONDUCTOR CABLE

Install the eight-conductor electric cable between each Control Head and the appropriate Processor. Label each eight-conductor cable at both ends with the station it connects, and Port or Starboard.

When installing the eight-conductor 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.

5.2 CONTROL PROCESSOR

- A) Secure the Processor using 1/4 inch or M6 fasteners.
- B) Remove the Processor cover.
- C) Connect the wrist strap to your person, and the ground connector to the Processor frame. When not working on the Processor, keep the cover in place to prevent damage to circuits.
- D) Install the watertight cable grip, included with the Control Head. See System Drawing Notes for information regarding cable hole penetration of the Processor.

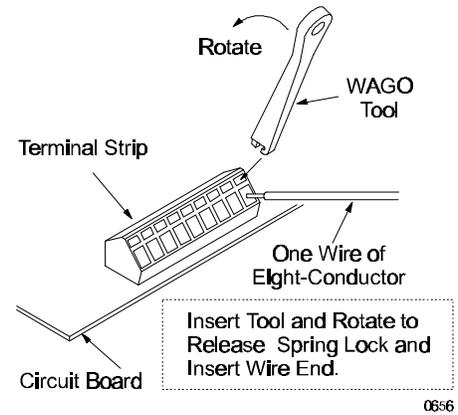


Fig. 2
Terminal Connection

5.2.1 Eight-Conductor Cable

- A) Strip the PVC jacket and shielding back approximately 3 inches (75mm). Stagger wire lead length to match the Station 1 terminal strip. Wire leads must not touch frame. Strip the wire 3/8 inch (9,5mm) on each lead.
- B) Connect colors as shown on System Drawing. A WAGO Tool is taped to the relay on the circuit board in each Processor. Use this tool to depress the spring lock for the individual wire connection to the terminal strip. (See Fig. 2)
- C) Connect the shielding drain wire (bare wire) to Terminal 8 on the terminal strip. The shielding drain wire **MUST NOT** touch any other components.
- D) Feed through a little slack cable, and tighten the cable grip on the eight-conductor cable.
- E) Bring the other station's eight-conductor cables in the same way, and connect to the appropriate Terminals. (See System Drawing)
- F) Secure the cable to each other using the tie wraps provided.

NOTE: A jumper is required between terminals 5 and 6 on all unused stations on the circuit board. See System Drawing.

5.2.2 Two-Conductor Power Cable

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

- A) Run the length of two-conductor power cable between the DC Power Supply and the Processor.
- B) Connect the two-conductor cable as indicated on the System Drawing - Appendix A.

5.2.3 DP System to Processor(s)

- A) Install a watertight cable grip in the Processor enclosure for electric cable entry.
- B) Refer to the System Drawing in Appendix A for cable connection information.
- C) After wire connections have been made at the Processor. Feed through a little slack cable, and tighten the cable grip on the electric cable.
- D) Secure the wiring using tie wraps.

5.3 CONTROL HEAD

- A) See System Drawing for location of cutout and mounting holes.
- B) Drill the screw holes and the corner cutout holes. The Number 8-32 x 1 inch mounting screws are for a 3/4 inch (19,1mm) maximum thick mounting surface.
- C) Check that the four mounting screws will start into the Control Head.
- D) Remove the Control Head and strip the adhesive cover from the gasket. Apply the adhesive side to the console.
- E) At the Control Head, strip back the PVC cover on the eight-conductor cable approximately 2-1/2 inches (63,5mm).

5.3.1 Eight-Conductor Cable

- A) Strip and 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.
- B) The installer must strip 3/8 inch (9,5mm) insulation off each wire, and crimp connectors.

5.4 START INTERLOCK

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

The Processor provides a start interlock that requires the controls to be On and clutch in NEUTRAL. Refer to System Drawing Notes for voltage and amperage.

Install the start interlock grip in the Processor enclosure.

The start interlock cable is two wires, yellow with a red stripe. Remove the key start lead at the start relay or solenoid (see System Drawing). Connect one yellow with red striped wire to this lead, and the other yellow with red striped wire to the starter solenoid. Run the cable to the Processor through the cable grip to the start interlock connections on the Processor circuit board (see System Drawing).

NOTE: *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 the wire, not to the wire insulation. Verify all screwed wire connections are secure.*

5.5 ENGINE STOP SWITCH

A requirement is that Engine Stop Switches are at all remote stations. The Stop Switches are installer supplied.

WARNING: *Each control station must have some method to stop the engine. Warranty canceled if requirement not followed.*

5.6 BONDING

Reference Fig. 3

All boats equipped with a permanently installed electrical system shall 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 Hulled Vessels

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

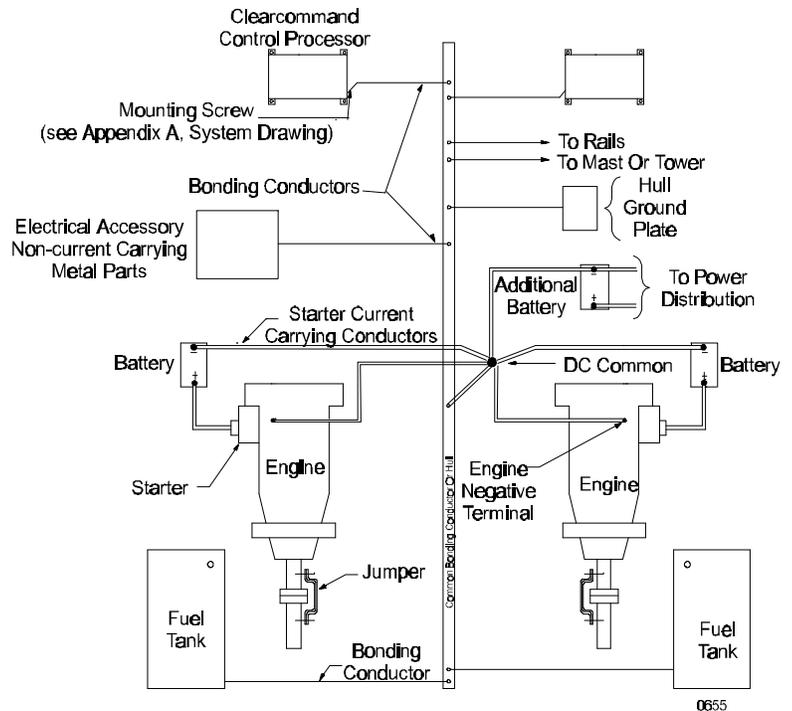


Fig. 3
Bonding

5.7 PUSH-PULL CABLES

The Processor interconnects with the transmission by push-pull cable to operate the clutch selector lever, and the engine governor by push-pull cable to operate throttle. The nominal load rating is 30 pounds force and 3 inches maximum movement of the push-pull cable.

WARNING: *The design of ClearCommand is to protect the transmission and engine from damage. Take care to verify that push-pull cable installation is correct, as misadjusted cables may cause damage.*

- A) Verify installation of push-pull cable brackets on the transmission and engine governor. If the brackets are not on the transmission or governor, fabricate brackets as shown in Fig. 4

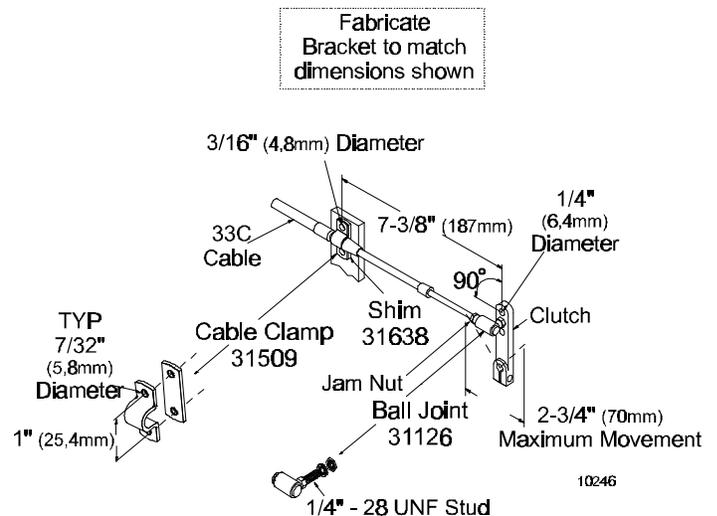


Fig. 4
Universal Mounting

- B) Verify jumper settings for Clutch direction are correct. (See System Drawing Notes)
- C) Remove the Number 10-32 jam nut and the two rubber seals from the push-pull cable end that is to connect to the Processor.
- D) On the Processor housing, remove one screw from each cable retainer clip. Loosen the remaining screws and swing the cable retainer clips away from the entry holes.
- E) Enter the push-pull cables through the correct entry holes. Refer to the System Drawing in Appendix A.

F) When the push-pull cable end is visible within the Processor interior, reinstall the Number 10-32 jam nut.

G) Connect the push-pull cable to the hex nut (See Fig. 5, 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.

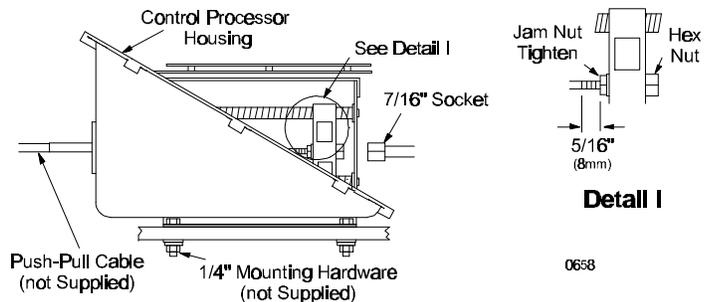


Fig. 5
Push-Pull Cable Connection

- H) Tighten the jam nut to the hex nut.
- I) Reinstall the cable anchor clips to secure the push-pull cables to the Processor housing.

6. ADJUSTMENTS AND TESTS (SECURED TO DOCK)

6.1 CONTROL HEAD AND STATION TRANSFER TEST (ENGINES STOPPED)

- A) Turn the power On to the control system.

WARNING: *Keep hands and tools clear of the Processor when power is On. 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.

NOTE: *Control Head Tones*

- **Low Repetition Tone** *is normal when DC power is first applied to ClearCommand. This tone indicates ClearCommand is in NEUTRAL and IDLE, and the operator can take command by depressing a station transfer button.*
- **Steady Tone:** *A steady tone signals a voltage problem or a component has failed. Confirm the voltage is steady between 12 and 24 volts DC, and that there is not a momentary voltage drop. If tone continues, refer to the Trouble Shooting Section.*
- **High Repetition Rate Tone** *is used to signal a jam condition of either the clutch or throttle push-pull cable. The Processor has stopped when this tone is heard. Moving the Control Head lever away from the position that the tone was encountered, will usually stop this tone. The cause of the excessive push-pull cable load MUST be found. Refer to Trouble Shooting Section.*

- ***Repetitive Signal - One Long, One Short Tone*** is used to show a clutch position feedback error. Refer to Trouble Shooting Section.
- ***Repetitive Signal - One long - Two Short Tones*** is used to show a throttle position feedback error. Refer to the Trouble Shooting Section.

C) Depress one station transfer button (Control Head lever in NEUTRAL). The red indicator light at the station taking command will light. (On dual Control Heads to indicate station has command, both red indicator lights must be lit.)

NOTE: *If the operator places the Control Head lever to the AHEAD position before depressing the transfer button, Neutral Fast Idle Mode will be made active and indicated by a blinking red indicator light. The transmission will remain in NEUTRAL. Return Control Head lever to the NEUTRAL position and continue with test.*

D) Move the Control Head lever full-ahead and full-astern. This will check that the Control Head is operating.

E) Test that the Control Head wiring connections are correct by placing the Control Head levers in the NEUTRAL position. Depress and hold the station transfer button. Move the Control Head lever to the AHEAD detent position before releasing the transfer button.

F) The red indicator light on the Control Head should blink, indicating ClearCommand has been placed in Neutral Fast Idle Mode. Neutral Fast Idle Mode only operates in the AHEAD direction. If the red indicator light does not blink, verify Control Head connections are correct. Refer to Appendix A System Drawing for Control Head connections.

6.2 START INTERLOCK TEST AND ADJUSTMENTS (ENGINES STOPPED)

NOTE: *If any of the following tests fail, verify Start Interlock Installation (Paragraph 5.4 Start Interlock Cable) and Start Interlock connections as shown on the System Drawing.*

A) Turn the ClearCommand DC power Off, and verify that the engine(s) will not start. Control Stations Off; interlock check.

B) Turn the ClearCommand DC power On, and accept command. Place the Control Head Lever(s) to 50% throttle, and verify engine(s) will not start.

C) Place Control Head Lever(s) in the IDLE position. Verify engine(s) will start in this position.

6.3 CLUTCH CABLE ADJUSTMENT (ENGINES STOPPED)

NOTE: *Throttle Pause*

- ***Hydraulic actuated clutches require 1/2 second, or longer, following lever movement before there is clutch plate contact. Switch SW1-7 on the Auxiliary Board adjusts the Throttle Pause. (See System Drawing Notes for Switch Settings)***
- ***Some clutches may build clutch pressure more slowly. This could mean high engine RPM before clutch engagement. The optional Clutch Oil Pressure Switch (refer to Paragraph 8.2) will check actual clutch oil pressure, before allowing speed to governor.***

A) Move the clutch selector lever on the transmission from the AHEAD position to the ASTERN position. Measure the length of cable travel required. The total cable travel must be within 2 inches (51mm) to 3 inches (76mm).

- B) Transfer command to the remote station you will be working from. Leave the Control Head lever in the NEUTRAL position.
- C) Adjust the clutch cable ball joint at the transmission to match the clutch selector lever in NEUTRAL. The push-pull cable should form a right angle (90 degrees) with the clutch selector lever in the NEUTRAL position. Leave the clutch cable disconnected.
- D) Move the Control Head lever to the AHEAD detent.
- E) Before the Processor(s) are shipped, the dip switches are set for minimum cable movement. See System Drawing Notes for dip switch settings to achieve required clutch cable adjustment range.
- F) When you have achieved the required travel for AHEAD, then verify ASTERN.
- G) Verify all three positions; AHEAD; NEUTRAL; and ASTERN. If cable travel is correct at all three positions, continue to step H). If cable travel is incorrect, review steps A) through F), making the necessary adjustments.
- H) Connect the clutch cable. Confirm that the Processor does not jam the clutch selector lever against its stops, and that NEUTRAL is correct. If the Processor jams the clutch selector lever against its stops, disconnect the clutch cable and review steps A) through G), making the necessary adjustments.

6.4 ENGINE STOP SWITCHES TEST (ENGINES RUNNING)

Start engine(s) and verify that all Engine Stop Switches (normally a push button) function correctly at all stations.

WARNING: *Do not attempt to continue tests until Engine Stop Switches function correctly. Refer to information supplied by engine manufacturer or supplier for set-up and adjustments. Warranty canceled if requirement of Engine Stop Switches at all remote stations are not installed.*

6.5 ENGINE GOVERNOR PUSH-PULL CABLE ADJUSTMENT (ENGINE RUNNING)

- A) Verify potentiometer R7 is fully in the counterclockwise  position, as shipped from the factory.

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

- B) Leave the throttle push-pull cable disconnected at this time.
- C) Measure the throttle movement at the engine from Idle to full speed. It must be within the Processor 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), the lever radius must be changed to be within range. If possible, throttle movement should be 2-1/2 inches (64mm) from Idle to full speed.
- D) Stop the engine.
- E) Move the Control Head lever to the full speed position.
- F) Manually move the engine throttle lever to the full speed stop.

- G) 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.
- H) Recheck from Idle to full speed.
- I) If incorrect, repeat step G) and step H) until correct.
- J) Connect ball joint to the throttle lever.

6.6 DOCKSIDE TEST - DP CONTROL

- A) Place Control Head levers in the Neutral (vertical) position.
- B) Select DP Mode by pressing the DP ready switch provided with the DP control system.

NOTE: The LED light is not lit.

- C) The control system is now under the command of the DP control system.
- D) Command may be transferred from DP Mode by depressing the station transfer button or by selecting DP Off at the DP control console.

7. ADJUSTMENTS UNDERWAY

WARNING: Verify that all the above tests are completed and are correct. Only then is the vessel ready to leave the dock. DO NOT attempt to operate ClearCommand away from the dock with any system abnormality.

CAUTION: Start slowly and learn to appreciate that the ClearCommand System provides a light touch, that is fast and accurate.

7.1 FULL-SPEED SETTING - ENGINE RPM

In open water gradually move the Throttle Lever to full-speed. Engine(s) should be running at full rated RPM. Consult the engine operator's manual for additional RPM adjustments.

7.2 PROPORTIONAL PAUSE ON DIRECTION CHANGE

This feature allows for engine deceleration and vessel speed to decrease on a High Speed Reversal. The throttle setting drops to Idle and the transmission remains engaged during this pause. See System Drawing Notes for Dip Switch Settings to adjust the proportional pause.

NOTE: The pause is in proportion to Control Head lever position, and how long the Control Head lever had been in that position before the High Speed Reversal. The times listed in the System Drawing Notes are maximum. Shifting from Idle Port to Idle Starboard, the pause is zero. The time required to build to the maximum pause is six times the pause listed in the System Drawing Notes.

8. CONTROL OPTIONS

8.1 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 a relay in an alarm system supplied by others. See System Drawing Notes for details.

8.2 CLUTCH OIL PRESSURE INTERLOCK

NOTE: *If no pressure switch used, refer to the System Drawing Notes in Appendix A for Jumper connection.*

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.

Pressure switch supplied by others. 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. See System Drawing Notes for details.

When in operation, if for any reason the clutch pressure should fall below the pressure switch setting, the engine speed will drop to IDLE RPM.

9. MAINTENANCE

9.1 CONTROL PROCESSOR

The Processor(s) does not require scheduled maintenance.

9.2 CONTROL HEAD

Verify once a year Control Head terminals are secure and free of corrosion. Apply a light coating of Teflon grease, or corrosion block, to the contacts.

10. TROUBLE SHOOTING

Note: *Always check other Remote Stations, to see if the symptom can be repeated.*

11.1 Symptom - When DC Power is turned On, operator cannot take command at one station (both Port and Starboard for twin screw).

Cause:

- a) A corroded or loose electrical connection.
- b) Incorrectly wired eight-conductor cable or transfer button
- c) Defective transfer button.

Remedy:

- a) At the Control Head verify crimps and screws are tight. Verify the station connections at the Processor. Tighten or re-crimp as necessary.
- b) Rewire the cable connections as shown on System Drawing. Correct as necessary.
- c) Verify the voltage between the red and orange wires (Terminals 3 and 4). The reading should be 4.80 to 5.00 volts DC. Verify the voltage at Terminals 3 and 4 while depressing the transfer button. The voltage reading should be less than 0.50 volts DC. If the voltage remains near 5.00 volts, the Control Head needs repair.

11.2 Symptom - The engine starts to turn over while starting and then stops. A slow repetitive audible tone from all Control Head stations.

Cause:

- a) The voltage to the Processor has dropped too low, due to the starters current requirements.
- b) Battery charge is low.

Remedy:

- a) Supply power to the Processor from a battery other than the starting battery.
- b) Recharge or replace the battery.

11.3 Symptom - The Control Head red indicator light does not light when in command, but everything else works perfectly.

Cause:

- a) Incorrectly wired eight-conductor cable.
- b) Defective red indicator light

Remedy:

- a) Verify brown wire connection to Terminal 2 of the Processor and the Control Head.
- b) Measure the DC voltage between Terminals 2 and 3 at the Control Head. The reading will be 1.00 to 2.00 volts in normal operation. A measurement of 4.00 volts means the indicator light is OPEN. Replace the Control Head or install a Control Head Repair Kit.

11.4 Symptom - The engine RPM reduces to IDLE, transmission to NEUTRAL, the Control Head indicator light turns Off, and a slow repetitive tone emitted at all stations after repositioning the Control Head lever.

Cause:

- a) A drop in battery voltage at the Processor.
- b) Defective Control Head.

Remedy:

- a) Measure the voltage at the battery without the engine or charger running. The reading should be a minimum of 24.6 volts. If not, the battery needs charging or possibly replacing. Measure the voltage at the Processor. This reading should be not more than 0.20 volt below the measured battery voltage.
- b) If the voltage at the Processor passed, replace the Control Head or install a Control Head Repair Kit.

11.5 Symptom - No audible tone at a Control Head when system is first turned On, but otherwise works perfectly.

Cause:

- a) Incorrectly wired eight-conductor cable.
- b) Defective sound transducer.

Remedy:

- a) Verify connection of the black wire to Terminal 1 in the Processor and Terminal 1 at the Control Head. Verify connection of the red wire to Terminal 3 in the Processor and Terminal 3 at the Control Head. In addition, the red indicator light would not work if the red wire was loose or incorrectly wired. Check for loose or corroded connections.
- b) Measure the voltage at Terminals 1 and 2 of the Control Head (do not depress the transfer button). The voltage should fluctuate at a steady rate. If a fluctuating voltage is not measured, replace the Control Head, or install a Control Head Repair Kit.

11.6 Symptom - No tones or lighted indicator lights at the Control Head, and no lighted indicator lights on the Processor circuit board.

Cause:

- a) No power to the Processor.
- b) Polarity of the battery voltage reversed.
- c) Fuse on the Processor circuit board blown.

Remedy:

- a) Verify the power source to the Processor.
- b) Connect the red wire to the terminal labeled ' + ' and the black wire to the terminal labeled ' - '.
- c) Measure the battery voltage at the Processor. It is MANDATORY to correct power source if voltage can exceed 40 volts under any condition. Replace the fuse with the spare, which is taped to the relay on the Processor circuit board. If the fuse again blows, the circuit board needs repair or replaced with a Circuit Board Kit.

11.7 Symptom - The engine will not start.

Cause:

- a) ClearCommand does not have power turned On.
- b) The Control Heads are not at the NEUTRAL position.
- c) Low battery voltage.
- d) Faulty start interlock circuit in the Processor.
- e) Faulty wire or component in the starting system.

Remedy:

- a) Turn power On to the Clear-Command System.
- b) Place the Control Head lever into the NEUTRAL position and depress the station transfer button.
- c) Check the battery voltage. If the voltage is low, charge or replace the battery.
- d) Connect the two start interlock wires (yellow with red stripe) at the Processor to the same terminal. If the engine starts, have the Processor repaired.

11.8 Symptom - The engine RPM varies, without moving the Control Head Lever.

Cause:

- a) Erratic command signal.

Remedy:

- a) At the Processor, measure the DC voltage at the yellow and green wires (Terminals 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 Processor 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.

11.9 Symptom - High repetition rate tone at all remote stations.

Cause:

- a) Incorrectly adjusted push-pull cable.
- b) Defective push-pull cable.
- c) Low battery voltage at the Processor (12 volt systems).
- d) Defective servo unit in the Processor.

Remedy:

- a) Disconnect the push-pull cable from the clutch selector lever at the transmission. Disconnect the push-pull cable from the throttle lever at the governor. Operate ClearCommand. If the rapid tone is no longer present, follow the Push-Pull Cable Installation section in the Manual.
- b) Remove the push-pull cables from the Processor one by one. Operate ClearCommand. If the rapid tone is no longer present, replace the defective push-pull cable.
- c) Measure the battery voltage at the Processor. If the measured voltage is 8 to 12 volts, check the power source.
- d) If a), b), and c) tested good, the entire Processor needs repair or replacement.

11.10 Symptom - Audible steady tone from all remote stations. Cannot gain command at any station.

Cause:

- a) Low battery voltage at the Processor.
- b) Component failure on the Processor circuit board.

Remedy:

- a) Check the battery voltage at the Processor. If the measurement is less than 8 volts, replace battery or correct source of voltage drop.
- b) If the voltage tested good, the circuit board needs repair or a Circuit Board Kit needs to be installed.

11.11 Symptom - One long - Two short tones from all Control Head stations.

Cause:

- a) Throttle feedback error.

Remedy:

- a) Depress the transfer button twice. Have Processor repaired at the first opportunity.

11.12 Symptom - One long - One short tone from all Control Head stations.

Cause:

- a) Clutch position feedback error.

Remedy:

- a) Depress the station transfer button twice. Have Processor repaired at the first opportunity.

11. REFERENCES

11.1 AMERICAN BOAT & YACHT COUNCIL (ABYC)

Box 806
Amityville, NY 11701

E-1 Bonding of Direct Current Systems
E-3 Wiring Identification on Boats
E-9 DC Electrical Systems on Boats
H-2.4e or 32.4g Ambient Temp. 50
degrees C

11.2 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

11.3 SOCIETY OF AUTOMOTIVE ENGINEERS

400 Commonwealth Drive
Warrendale, PA 15096

J1171 External Ignition Protection
J1428 Marine Circuit Breakers
J378 Marine Engine Wiring

11.4 NATIONAL MARINE MANUFACTURERS ASSOCIATION

401 North Michigan Avenue
Chicago, IL 60611

11.5 UNDERWRITERS LABORATORIES

11.6 PARTS SOURCE

Anti-Static Wrist Strap

Fuse

WAGO Tool

Part No. 517

Part No. 1030

Part No. 397

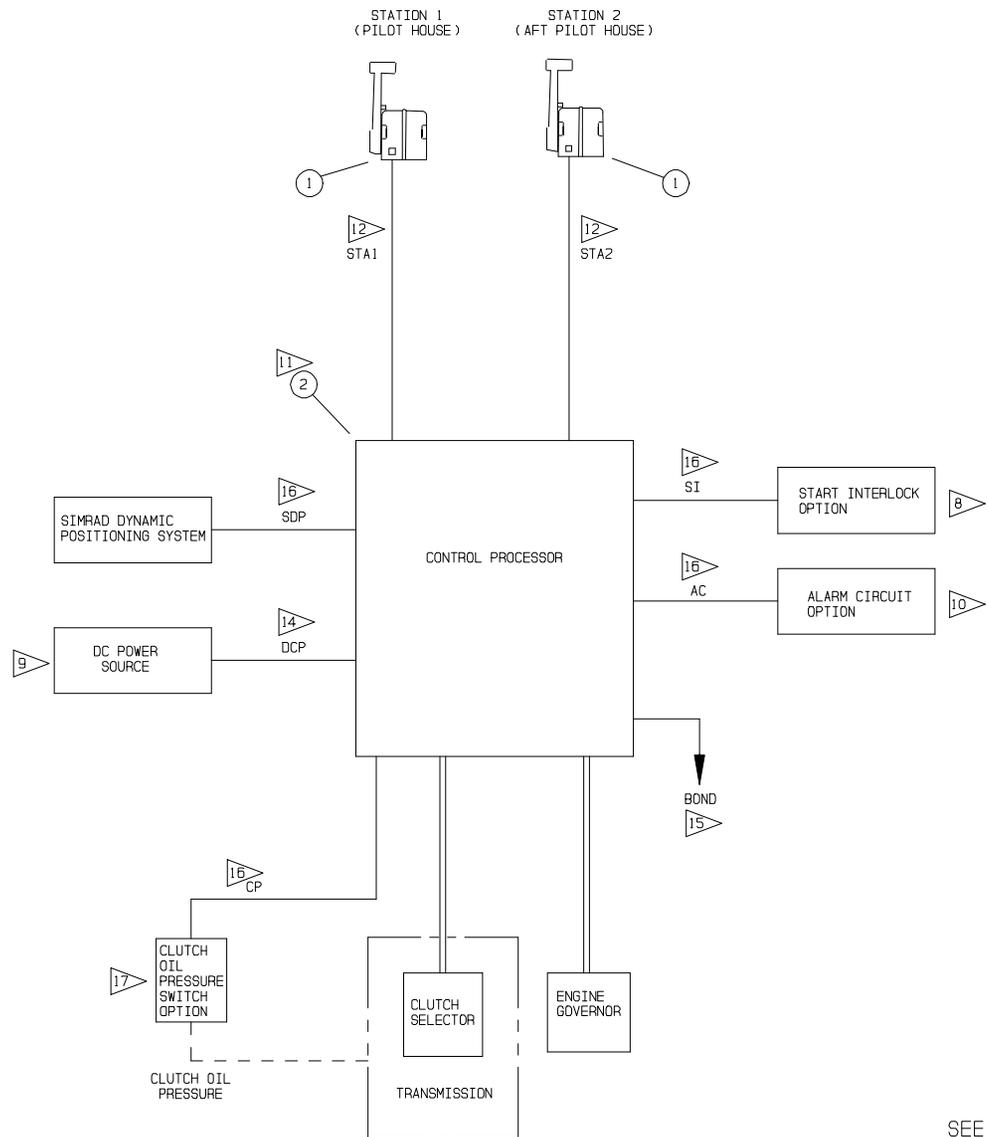
[Thomas & Betts (Part No. AWCC)]

[Bussman (Part No. GDC-1A)]

[WAGO (Part No. 236-332)]

APPENDIX A

System Drawing



MATERIAL LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	2	450-3L	CONTROL HEAD
2	1	M8558-12351	CONTROL PROCESSOR

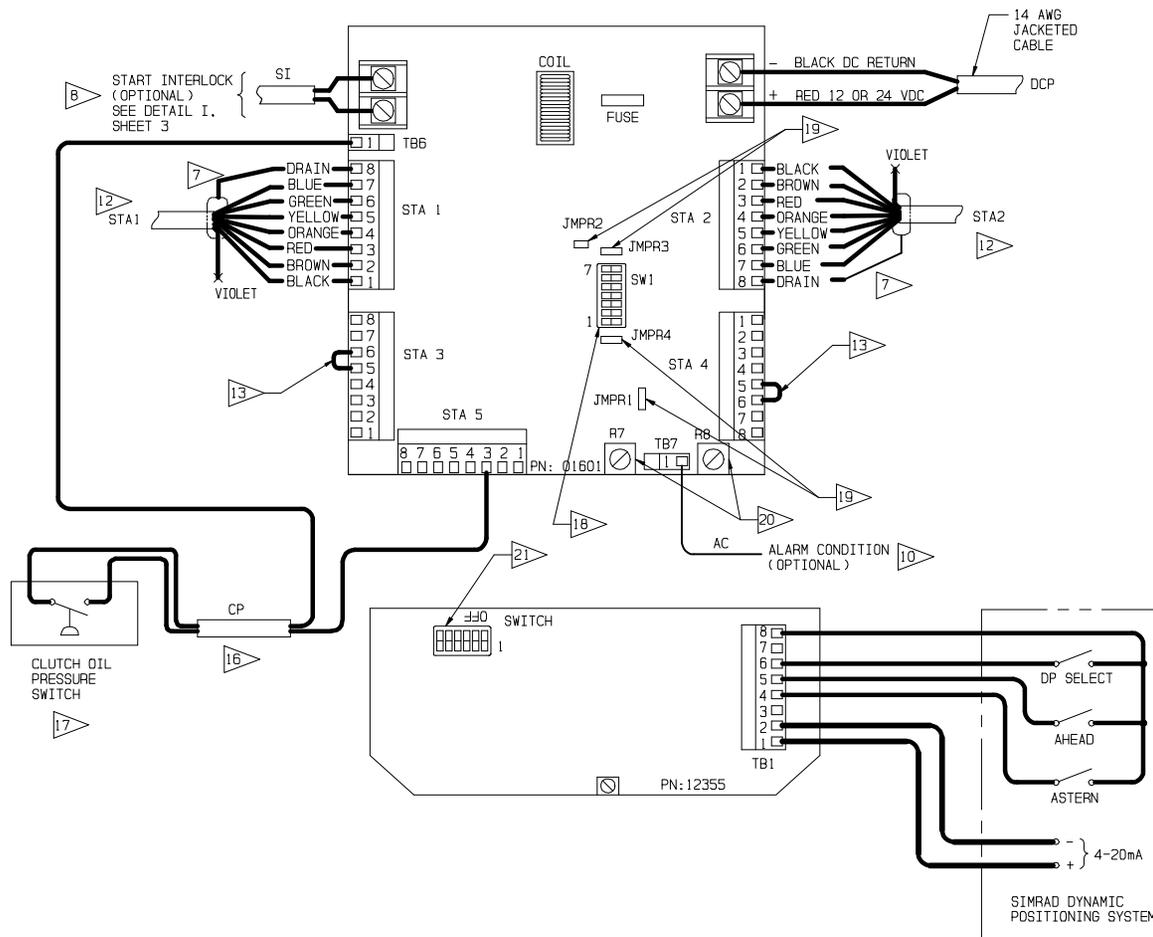
- LEGEND -
 _____ ELECTRICAL CABLE
 - - - - - HYDRAULIC LINE
 == == == PUSH PULL CABLE



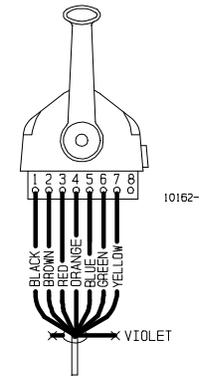
SEE SHEET 4 FOR NOTES

MATHERS CONTROLS INC.			
675 PEASE ROAD BURLINGTON WA. 98233			
CLEARCOMMAND M8558, SINGLE SCREW, TWO STATION, CAT ENGINES			
ENG. C.J.M.	DWN. M.WILSON	DATE 10-3-97	
CKD. T.L.		SHT. 1 OF 4	
SCALE: NONE		SIZE B	
DWG. NO. 10445			

PART NUMBER MS558-12351 CONNECTIONS



SIDE VIEW



450-3L CONTROL HEAD CONNECTIONS

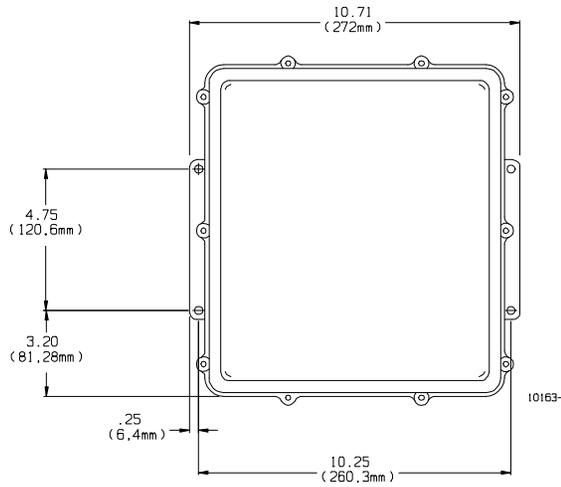
SEE SHEET 4 FOR NOTES



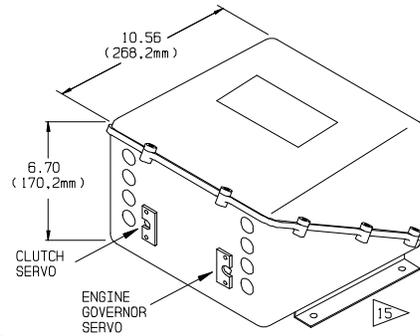
MATHERS CONTROLS INC.
675 PEASE ROAD BURLINGTON WA. 98233
CLEARCOMMAND MS558, SINGLE SCREW,
TWO STATION, CAT ENGINES

ENG. C.J.M.	DWN. M. WILSON
CRD. T.L.	DATE 10-3-97
SCALE: NONE	SHT. 2 OF 4
	SIZE B

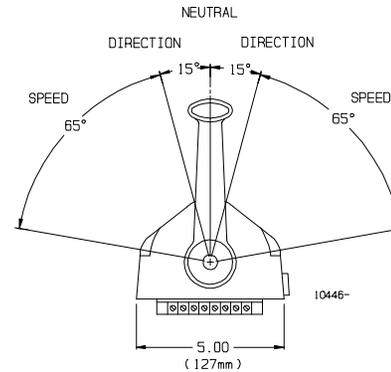
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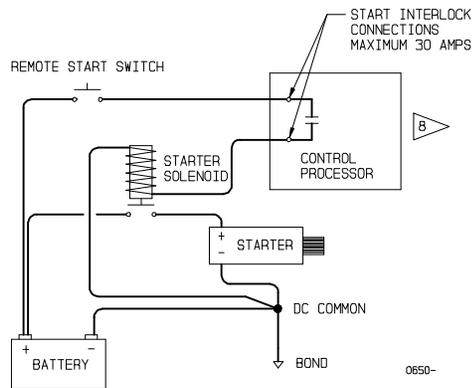
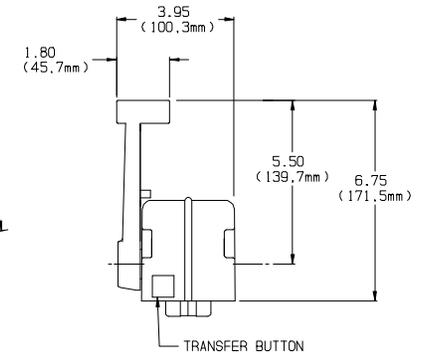
PART NUMBER MS558-12351 TOP VIEW
MOUNTING DIMENSIONS



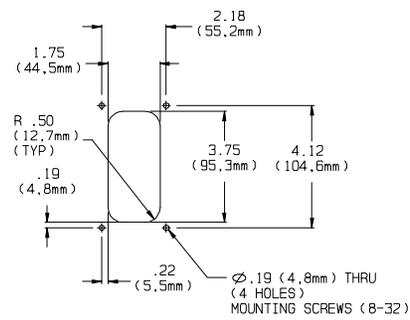
PART NUMBER MS558-12351
OUTLINE DIMENSIONS
(WEIGHT: 8.00 POUNDS
3.63 KILOGRAMS)



PART NUMBER 450-3L
OUTLINE DIMENSIONS AND DETENTS
(WEIGHT: .94 POUNDS
.43 KILOGRAMS)



DETAIL I
START INTERLOCK OPTION



PANEL CUT-OUT FOR
PART NUMBER 450-3L
MOUNTING DIMENSIONS

SEE SHEET 4 FOR NOTES



MATHERS CONTROLS INC.			
675 PEASE ROAD BURLINGTON MA. 98233			
CLEARCOMMAND MS558, SINGLE SCREW TWO STATION, CAT ENGINES			
ENG. C.J.M.	DWN. M. WILSON	CKD. T.L.	DATE 10-3-97
SCALE: NONE	SHT. 3 OF 4	SIZE B	
			DWG. NO. 10445

