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OPTIMUS EPS
BY SEASTAR

BAYSTAR[™]

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INSTALLATION MANUAL

ELECTRONIC POWER STEERING (EPS)

www.seastarsolutions.com



OPTIMUS EPS
BY SEASTAR

Electronic Power Steering for Sterndrive
and Small Inboard Powered Vessels



*Before you do it your way,
please try it our way*

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**California
Proposition 65 Warning**

Battery posts, terminals, and related accessories contain lead and lead compounds, chemicals known to the state of California to cause cancer and reproductive harm.

Wash hands after handling.


Thank you for choosing an Optimus™ Electronic Power Steering (EPS) System. You have chosen a state of the art steering system that will provide years of effortless and trouble free steering performance.

About this Book

This book will show you how to install the base Optimus EPS steering system to a vessel powered by inboard or inboard/outboard (sterndrive) engines. Use it in conjunction with the Optimus Setup and Configuration Guide (Book 65).

Deliver this book to the customer when the installation is complete.

Notice to the Installer

Throughout this publication, Dangers, Warnings and Cautions (accompanied by the International Hazard Symbol ) are used to alert the user to special instructions concerning a particular service or operation that may be hazardous if ignored or performed incorrectly or carelessly. **Observe Them Carefully!**

These safety alerts alone cannot eliminate the hazards that they signal. Strict compliance with these special instructions during installation, operation, and maintenance, plus common sense operation, are important measures to prevent accidents.

DANGER

IMMEDIATE HAZARDS WHICH, IF NOT ACTED UPON, WILL RESULT IN SEVERE PERSONAL INJURY OR DEATH.

WARNING

HAZARDS OR UNSAFE PRACTICES WHICH, IF NOT ACTED UPON, COULD RESULT IN SEVERE PERSONAL INJURY OR DEATH.

CAUTION

Hazards or unsafe practices which COULD result in minor injury or product or property damage.

NOTICE

Information which is important to proper use or maintenance, but is not hazard-related.

ABBREVIATIONS

The following abbreviations are used in this manual:

ABYC	American Boat & Yacht Council
ACR	Automatic Charging Relay
AUX	Auxiliary
BAT	Battery
CAN	Controller Area Network
CAN Bus	Controller Area Network (data) bus. (A harness of wires that carry digital signals and power between electronic modules)
ENG	Engine
EPS	Electronic Power Steering
FT-LB	Foot Pounds
GND	Ground
HI	High
IN-LB	Inch Pounds
LED	Light Emitting Diode
LO	Low
MPH	Miles Per Hour
NA	Not Applicable or Not Available
N/C	No Connection
Nm	Newton Meters
NMEA	National Marine Electronics Association
NMEA 2000®	A protocol for digital communication on a CAN Bus
PCM	Pump Control Module
RFU	Rudder feedback unit. This is the position sensor on the SmartCylinder. Sometimes called a rudder reference unit.
RPM	Revolutions Per Minute
STBD	Starboard (right when facing forward)
SW	Switch
WOT	Wide Open Throttle

Note: Some abbreviations not listed here may be found in their respective sections.

INDEX

Abbreviations	iv
1.0 Safety Information	1-1
2.0 System Overview	2-1
2.1 System Description	2-1
2.2 Optimus EPS System Diagrams	2-2
3.0 Installation Overview	3-1
3.1 Important Information/Technical Support Contact	3-1
3.2 Installation Summary	3-1
4.0 Planning.....	4-1
4.1 Required Parts	4-2
4.2 Plan Your Component Placement	4-3
4.2.1 <i>Electronic Helm(s)</i>	4-3
4.2.2 <i>CANtrak Display</i>	4-5
4.2.3 <i>Pump Control Module (PCM)</i>	4-8
4.2.4 <i>Power steering pump</i>	4-10
4.2.5 <i>SmartCylinders</i>	4-11
4.2.6 <i>Steering Service Valves</i>	4-12
4.2.7 <i>Circuit Breakers</i>	4-12
4.3 Plan Your Connections	4-13
4.3.1 <i>Hydraulic Hoses</i>	4-13
4.3.2 <i>Power Connections</i>	4-14
4.3.3 <i>Ignition Connection</i>	4-16
4.3.4 <i>Engine RPM Source Connection</i>	4-16
4.3.5 <i>Autopilot Connection (Optional)</i>	4-16
4.4 Diagram.....	4-17
5.0 Component Installation.....	5-1
5.1 Helm(s).....	5-1
5.1.1 <i>EPS Front Mount Helm (EH1510)</i>	5-2
5.1.2 <i>EPS Sport Plus Tilt Helm (EH1530)</i>	5-3
5.1.3 <i>EPS Classic Tilt Helm (EH1550)</i>	5-4
5.1.4 <i>EPS Rear Mount Helm (EH1570)</i>	5-5
5.2 CANtrak Display	5-6
5.3 PCM and Power Steering Pumps.....	5-7
5.3.1 <i>PCM Recommended Mount Hardware</i>	5-7
5.3.2 <i>PCM Mounting Considerations</i>	5-8
5.3.3 <i>Power Steering Pump Mounting Considerations</i>	5-9
5.3.4 <i>Power Steering Pump Mounting Hardware</i>	5-11
5.3.5 <i>Integrated Steering Service Valve</i>	5-11
5.4 SmartCylinder Installation	5-12
5.4.1 <i>EC5360 Sterndrive Cylinder</i>	5-12
5.4.2 <i>EC5380 Inboard Cylinder</i>	5-13
5.5 Plumbing the System	5-15
5.5.1 <i>Hose Labels</i>	5-16
5.5.2 <i>Hose Installation</i>	5-17
5.5.3 <i>Hose Fitting Reorientation (if required)</i>	5-19
5.6 Connecting the SmartCylinder	5-20

6.0 Networks and Wiring	6-1
6.1 Network Diagrams	6-1
6.2 Harness Connections	6-3
6.2.1 <i>Connecting the Helm</i>	6-3
6.2.2 <i>Connecting a Second Station</i>	6-5
6.2.3 <i>Connecting the CANtrak</i>	6-6
6.3 Power Wiring	6-7
6.3.1 <i>PCM Wiring</i>	6-7
6.3.2 <i>PCM Wiring Strain Relief</i>	6-9
6.4 Ignition Sensing	6-10
6.4.1 <i>Ignition Splicing</i>	6-11
6.5 Engine RPM Source	6-12
6.5.1 <i>NMEA 2000 CAN Bus</i>	6-12
6.5.2 <i>Analog Tachometer</i>	6-13
6.6 Autopilot Connection (Optional).....	6-13
6.7 Buzzer Kit (Optional)	6-14
7.0 System Setup and Configuration.....	7-1
Appendix A – Mounting Templates	A-1
A.1 Helm Templates	A-1
A.1.1 <i>Front Mount Helm (EH1510/EH1512)</i>	A-1
A.1.2 <i>Sport Plus Tilt Helm (EH1530/EH1532)</i>	A-3
A.1.3 <i>Classic Tilt Helm (EH1550/EH1552)</i>	A-5
A.1.4 <i>Rear Mount Helm (EH1570/EH1572)</i>	A-7
A.2 CANtrak Display Template	A-9
A.3 PCM Mounting Dimensions	A-11
A.4 Power Steering Pump Mounting Dimensions	A-12
Appendix B – CAN Network.....	B-1
B.1 Basic Network.....	B-1
B.1.1 <i>CAN Bus Connectors</i>	B-2
B.1.2 <i>CAN Bus Connectivity</i>	B-3
B.1.3 <i>Electrical Harness</i>	B-3
B.1.4 <i>Powering the Bus</i>	B-4
B.1.5 <i>CAN Bus Power</i>	B-4
Appendix C - Bolt Torque Specifications	C-1

1.0 SAFETY INFORMATION

⚠ WARNING

THE SAFETY INFORMATION PROVIDED HERE IS INTENDED TO INFORM YOU OF THE DANGERS THAT MAY BE PRESENT BEFORE, DURING, AND AFTER INSTALLATION. IT IS CRITICAL THAT YOU READ AND UNDERSTAND THIS INFORMATION.

Safe operation of the steering system depends upon proper installation and maintenance of the system, and the common sense, safe judgment, knowledge, and expertise of the operator. Every installer and operator of the steering system should know the following requirements before installing or operating the steering system. If you have any questions regarding any of these warnings, contact SeaStar Solutions.

Before installation

1. Read and understand all installation and user's manuals provided with the steering components.
2. Ensure that all components required to complete the installation are on hand (including hoses, fittings, oil, and the proper tools).
3. SeaStar and Optimus components are highly engineered and safety tested to ensure system integrity. **DO NOT** substitute any component. Substitution with non-SeaStar or non-Optimus components may compromise system safety, performance, and reliability.
4. **DO NOT** use a wheel-mounted, coiled cord trim switch. The cord can wrap tight around the steering wheel shaft and inhibit steering.

During Installation

1. Install system components as directed in this manual. Some component parts and kits (such as hoses and fitting kits) are supplied with additional installation instructions—refer also to these instructions.
2. SeaStar and Optimus components are highly engineered and safety tested to ensure system integrity. **DO NOT** substitute any component. Substitution with non-SeaStar or non-Optimus components may compromise system safety, performance, and reliability.
3. If an instruction is unclear, contradictory, or you are otherwise uncertain how to proceed, do not guess. Call SeaStar Solutions technical support.

After Installation

1. Check that there is no interference between the steering cylinder(s), transom, hull, tiller, tie bar (if applicable) or any other component over the full stroke of the cylinder(s). Steer slowly while performing these checks.
2. Check that the steering cylinder can be fully stroked in both directions, without stretching, chafing rubbing, or kinking of the hydraulic hoses and electrical harnesses.
3. Check that only SeaStar Pro steering hose (1500psi rating) has been used to plumb the system.

Prior to every use

Perform a system inspection as outlined below. Refer to Section 8 in Book 65 for further details.

1. Check steering fluid level in all steering pumps.
2. Verify immediate steering response when turning steering wheel(s).
3. Inspect all steering hoses, fittings, mechanical cables, and electrical harnesses for wear, kinks, or leaks.
4. Check for binding, loose, worn or leaking steering or shift/throttle control components.
5. Verify proper shift and throttle response for all control handles.
6. Verify that no alarms or warnings are shown on the CANtrak display.

⚠ WARNING

DO NOT OPERATE BOAT IF ANY COMPONENT IS NOT IN PROPER WORKING CONDITION.

During use

1. WEAR A COAST GUARD-APPROVED PERSONAL FLOTATION DEVICE (PFD).
2. ATTACH ENGINE SHUT-OFF CORD (LANYARD) TO YOUR PFD.
3. Never allow anyone who is not familiar with the operation of the steering system to operate the boat at any time.
4. If boat is equipped with multiple helms, ensure that only one is used at a time.
5. Know and adhere to all applicable federal, state, and municipal laws and regulations that govern boating in your area.

⚠ WARNING

DO NOT OPERATE BOAT IF ANY COMPONENT IS NOT IN PROPER WORKING CONDITION.

After use

If the SmartCylinder(s) have been exposed to salt water, rinse them thoroughly using only fresh, clean water.

DO NOT rinse the PCM, pumps, actuators, or any other component of the Optimus system.

DO NOT use acetone, or cleaners containing ammonia, acids, or any other corrosive ingredients on any Optimus components.

⚠ WARNING

Failure to comply with any warning, notice or caution may lead to loss of steering control resulting in a collision and/or ejection from the boat leading to property damage, personal injury and/or death.

2.0 SYSTEM OVERVIEW

2.1 System Description

Optimus EPS is a steer-by-wire system that replaces a traditional hydraulic helm with electronic components that communicate over a serial data network. This state-of-the-art system incorporates many advanced features to make it safe and reliable. These features include redundant sensors, fault-tolerant communications, extensive self-monitoring, and fault communications to notify and advise the operator in case of a system fault.

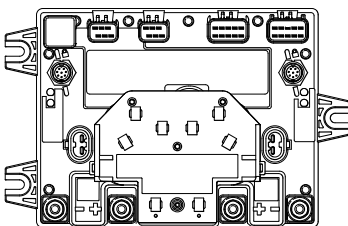
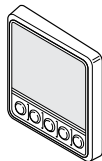
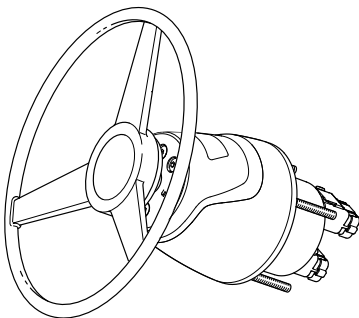
The Optimus EPS system consists of several major components, listed below. Refer to figure 2-1 through figure 2-3 to see these components in a schematic system diagram.

CAN Networks

CAN (controller area network) is a serial network protocol that is widely used in marine and automotive control systems. Each device (node) on the network can send and receive data using specially formatted messages. The ability to reliably communicate data between devices is what enables the steer-by-wire functionality of Optimus EPS. Optimus EPS uses up to three independent CAN networks, designated CAN1, CAN2, and CAN3.

- CAN1 is a low-speed, fault-tolerant network with redundant power wiring. It is used for safety-critical communications.
- CAN2 is a high-speed network that is well-suited for non-critical tasks such as passing data to and from the CANtrak display.
- CAN3 is a public network using the NMEA 2000 protocol. The Optimus system broadcasts public messages onto this network, and can also monitor the network for engine RPM. Use of this network is optional.

More information about CAN may be found in Appendix B.



Electronic helm

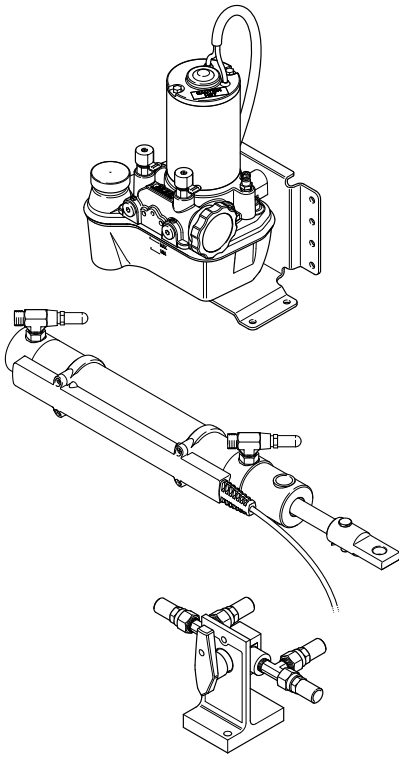
The helm converts steering wheel movement into digital messages that are sent over CAN1 to the pump control module (PCM). A system of friction plates in the helm allow the steering effort to be adjusted according to a setpoint received from the PCM. (A steering wheel is not included with the Optimus EPS system.)

CANtrak display

The CANtrak display is a small color LCD that displays system status and fault information to the operator. It is also used to make changes to user-adjustable steering settings. Authorized installers have access to additional menus with system setup and calibration tools.

Pump control module (PCM)

The PCM receives wheel movement messages from the helm(s) and operates the hydraulic steering pumps to steer the vessel as required. The PCM uses position feedback from the SmartCylinders for precise steering control and fault detection. The PCM can also respond to inputs from a certified autopilot system.



Power steering pumps

The power steering pumps supply pressurized fluid to the SmartCylinders in order to steer the boat. The PCM controls a 12V DC motor that drives a small gear pump. The pump assembly has an integral fluid reservoir and pressure relief valves.

The steering pumps have an integral service valve that can be opened to bypass the pumps and allow the engines to be manually repositioned. They are used for service or in the case of an emergency.

SmartCylinders

The SmartCylinder is a hydraulic steering cylinder fitted with a magnet and a position sensor (RFU). A SmartCylinder can steer a single outdrive or up to two rudders connected with a tiebar (not supplied by SeaStar).

Remote-mounted steering service valves (optional)

When the service valves on the power steering pumps are not easily accessible these optional remote-mounted valves can be installed in a convenient location.

2.2 Optimus EPS System Diagrams

The system diagrams shown on the following pages are meant for illustrative purposes only. Not all system configurations can be shown, and in some diagrams a different cylinder type is used. Do not use these diagrams as installation schematics.

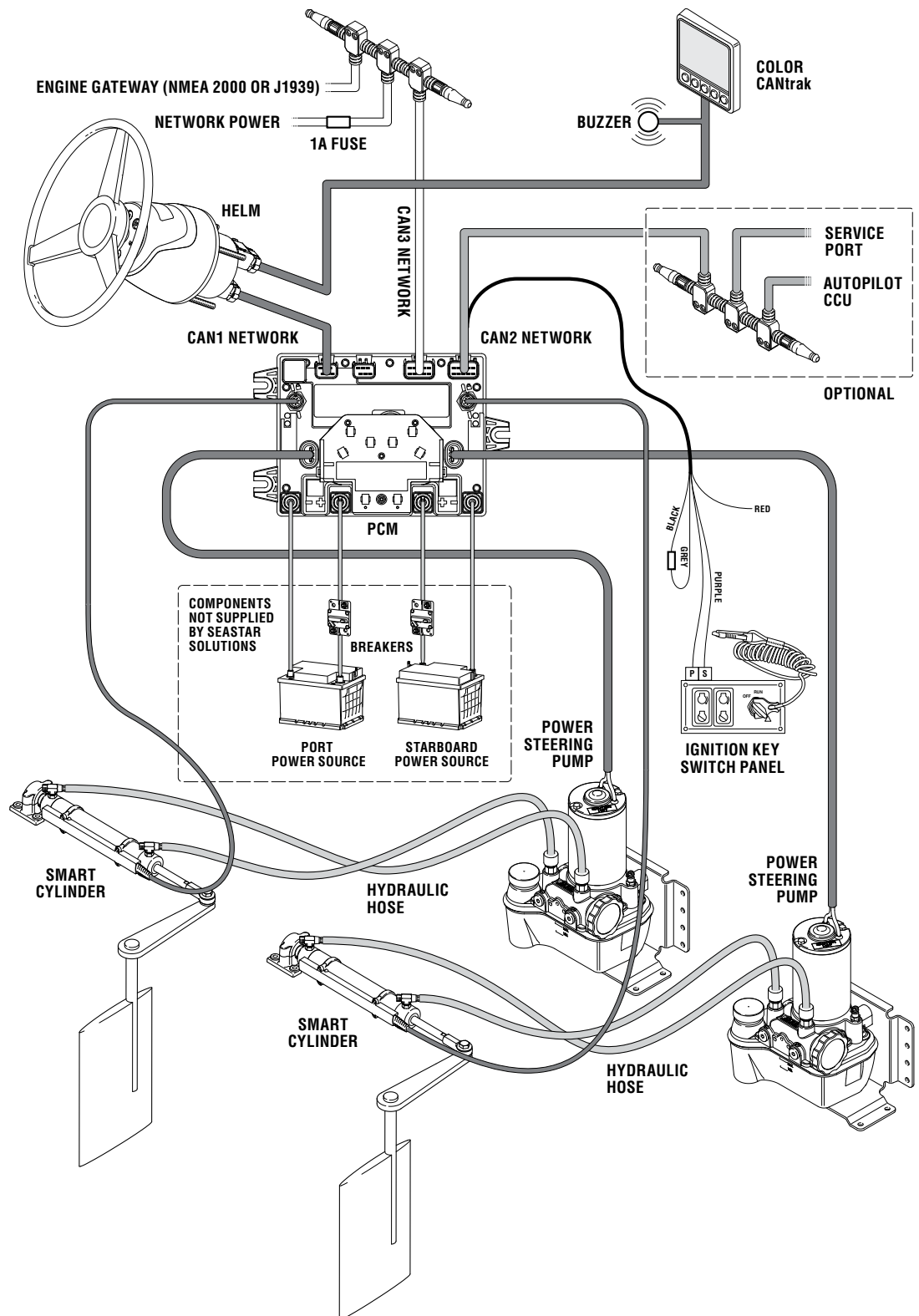


Figure 2-1. Optimus EPS system diagram, single station, twin cylinder.

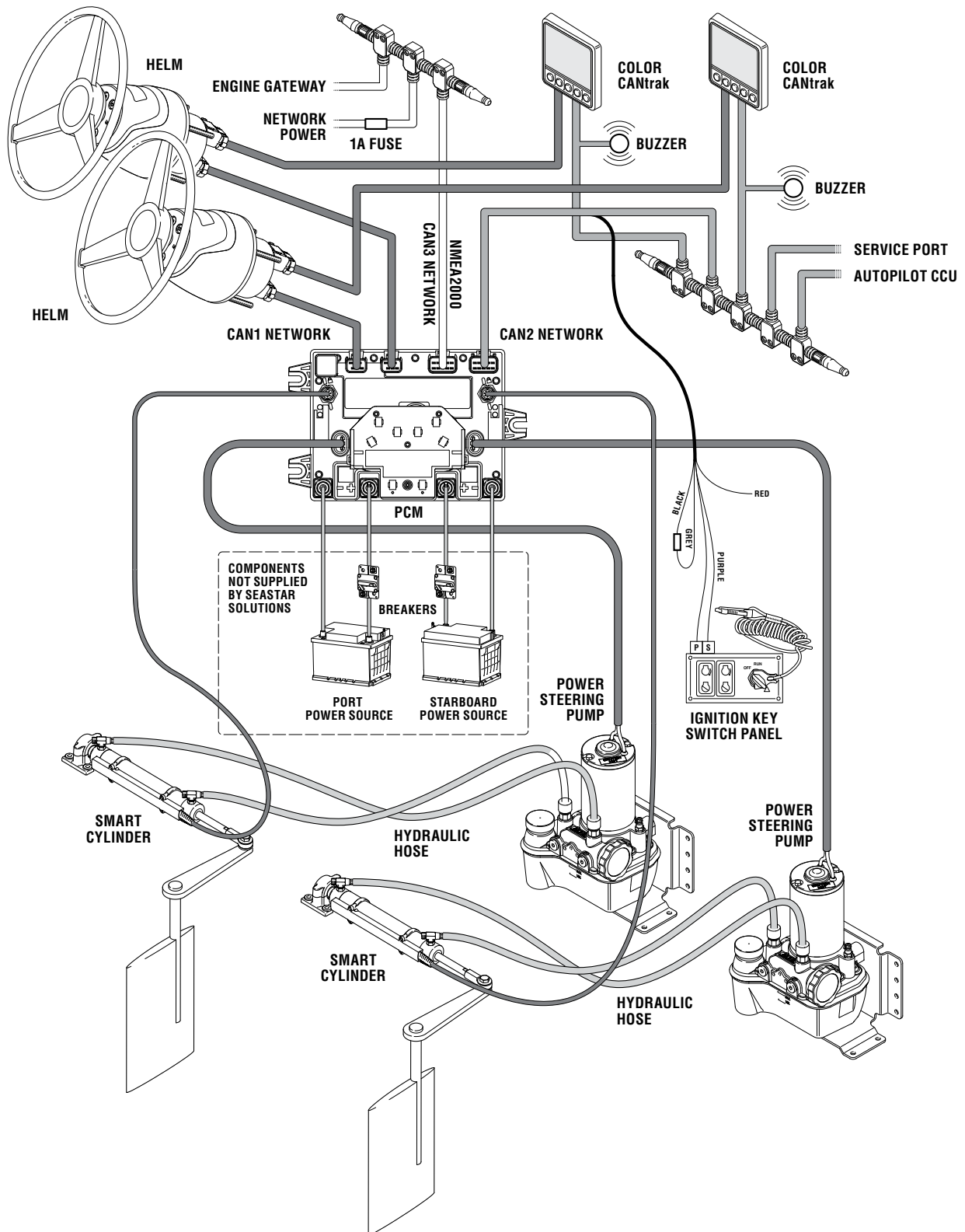


Figure 2-2. Optimus EPS system diagram, dual station, twin cylinder.

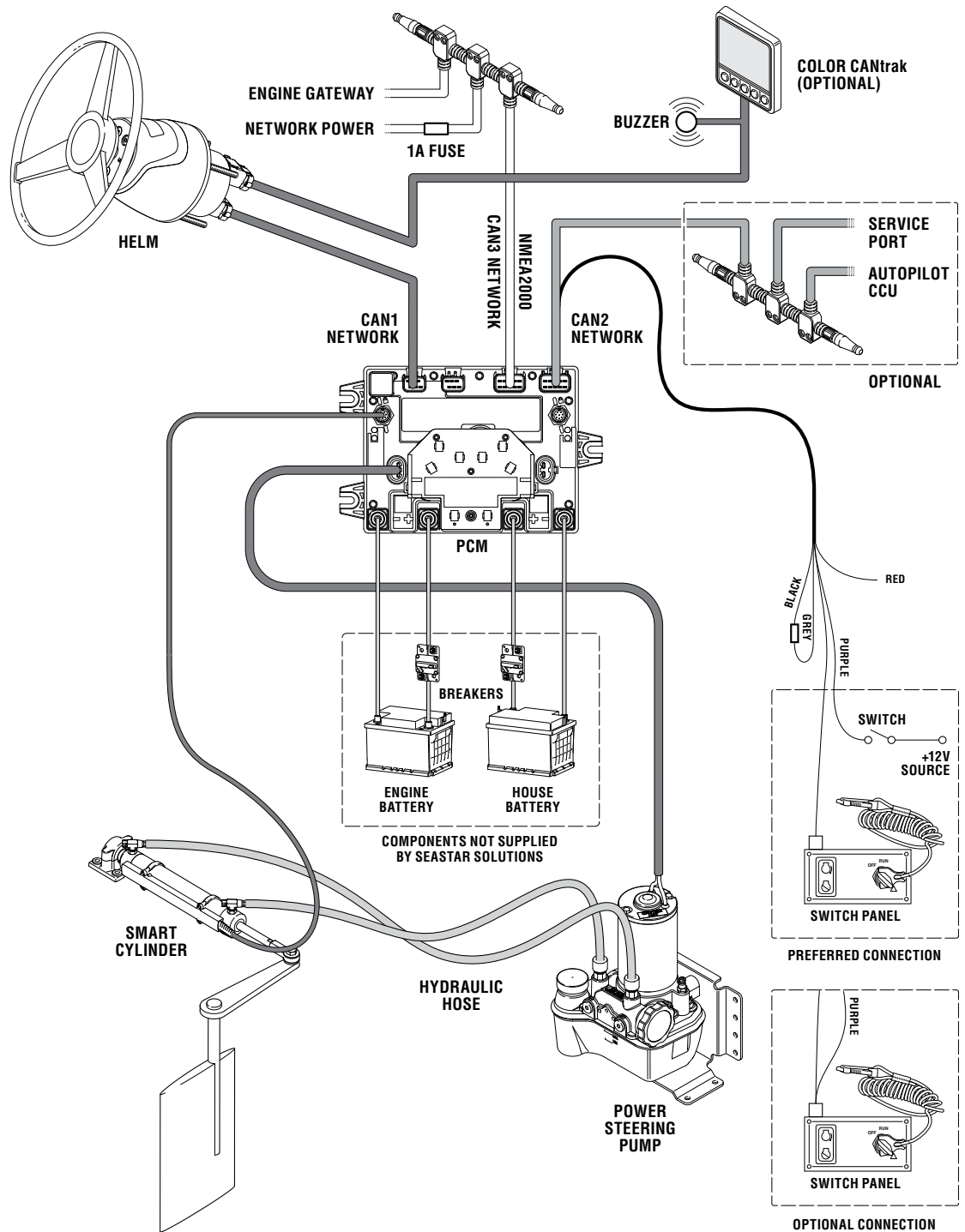


Figure 2-3. Optimus EPS system diagram, single station, single cylinder.

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3.0 INSTALLATION OVERVIEW

3.1 Important Information/Technical Support Contact

To ensure proper installation and maintenance of this steering system, please note the following:

- Installation must be performed by a SeaStar Solutions authorized installer.
- Read and understand all installation instructions provided with the system and its components before starting the installation.
- Read and understand all the safety information noted in this manual and all other installation instructions..

If you need technical assistance, or wish to report an error in our documentation, please contact SeaStar Solutions technical support:

Technical Support

Web: www.seastarsolutions.com

E-mail: seastar@@seastarsolutions.com

Phone: 604.248.3858

Fax: 604.279.2202

3.2 Installation Summary

There are several stages in the installation of the Optimus EPS system, listed below. By reviewing this summary you will better understand each step in the context of the entire installation.

Planning (Section 4)

- Acquire a general understanding of the system and its various components.
- Check that the equipment supplied is available and correct.
- Establish suitable locations for each component.
- Plan the cabling and the hose connections.
- Consider the power connections to the battery and the breaker location. All wiring should be done to ABYC standards.
- Consider where the ignition and tach sources will come from.
- Verify that you have a dealer setup kit for purge & calibration.
- Make a diagram of the system as it pertains to the particular boat installation.

Component Installation (Section 5)

- Mount the helm.
- Mount the CANtrak.
- Mount the pump control module (PCM) and the power steering pumps.
- Install the SmartCylinders.
- Install the remote service valves (if necessary).
- Install the hoses.

Networks and Wiring (Section 6)

- Review network diagrams
- Install network tees.
- Connect network harnesses.
- Install circuit breakers and run the power wires.
- Connect ignition wires.
- Connect engine RPM source.
- Connect autopilot if required.

This concludes all the physical installation steps up to the point when the system is powered on. The setup and commissioning of the Optimus EPS system is covered in the Setup and Configuration Guide (Book 65).

4.0 PLANNING

Proper planning is critical to a successful installation. This section will step you through the key planning activities:

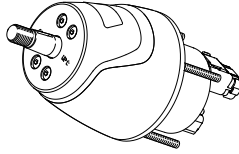
- Review each of the major components and consider where to place them, keeping in mind the various mounting restrictions.
- Check that the harness connections can be made without violating any of the cabling restrictions. Determine if the available harnesses are sufficient or if it is necessary to order any additional harnesses or cabling components.
- Ensure that you understand the CAN network requirements and have the required components available. Review Appendix B for important information about planning the CAN network.
- Plan the location of the breakers and the connections to the batteries, keeping in mind the ABYC requirements. Confirm the required breakers are at hand. Make sure that sufficient wire of the correct gauge is available with the correct termination hardware and tie straps.
- Review the required hoses and fittings and check that all are available.
- Document the information on the system diagram in section 4.4.

NOTICE

It is highly recommended that a complete review of Section 4 is done in order to assemble the appropriate materials and ensure that proper installation techniques are understood.

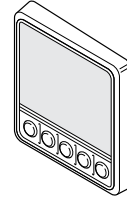
4.1 Required Parts

Check that following parts are available for the installation:



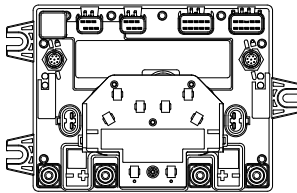
Helm

One per helm station



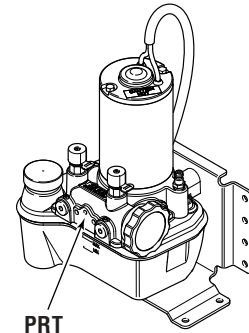
CANtrak Display

One per helm station



Pump Control Module (PCM)

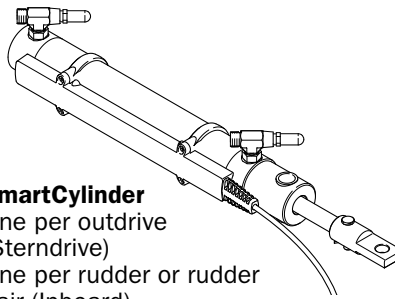
One PCM is required



PRT

Power steering pump

One per steering cylinder.
Check that the pump is marked
PRT in the location shown.
If it isn't marked it is the wrong
pump for this application.



SmartCylinder

One per outdrive
(Sterndrive)
One per rudder or rudder
pair (Inboard)

Figure 4-1.

Other parts required (not shown):

- SeaStar Pro Steering Hoses
- SeaStar Electronic Power Steering Fluid (Green/blue color)
- Dealer Installation Kit and Purge Hose
- Electrical harnesses and wire(s) (some wire[s] not supplied by SeaStar Solutions)
- Circuit breakers (not supplied by SeaStar Solutions)
- Steering wheel (not supplied by SeaStar Solutions)

4.2 Plan Your Component Placement

Review the detailed information for each of the following components and determine where they will be located on the boat. Pay particular attention to the harness length information, as this may impact the choice of component locations. During this process, confirm that the correct harness lengths are available.

4.2.1 Electronic Helm(s)

The helm is an electronic unit and send signals to the Pump Control Module (PCM) via an electrical harness supplied with the system. One helm is required at each station.

There are four helm styles available. On multiple helm station boats, different style helms may be used at different stations.

Mounting templates can be found in Appendix A.

⚠ CAUTION

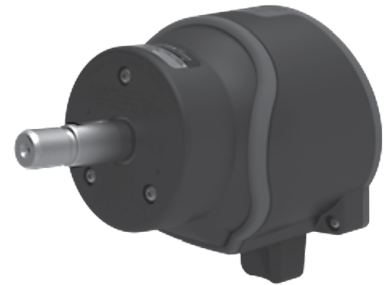
The helm may effect a ship's or the autopilot's compass. For less than one degree of effect keep the EPS helm and the compass a minimum of 24 inches (61 cm) apart.

NOTICE

The helms listed here are suitable for 12V systems only. Consult with SeaStar if you are planning a 24V system.



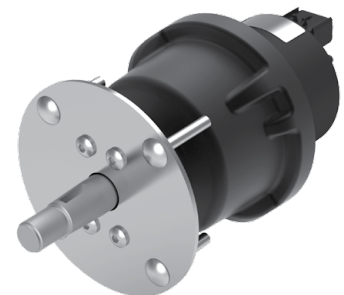
EPS Front Mount Helm
Part No. EH1510



EPS Sport Plus Tilt Helm
Part No. EH1530



EPS Classic Tilt Helm
Part No. EH1550



EPS Rear Mount Helm
Part No. EH1570

Figure 4-2.

⚠ CAUTION

Total harness length CANNOT exceed 120 feet. Do not use more than three harnesses between devices.

The harness length from the PCM to the farthest helm may not exceed 120 total feet. Harnesses are available in 6-foot increments up to 36 feet, with an available 36 foot extension. Under no circumstances should you use more than two extensions (for a total of three harnesses) between consecutive devices.

CAN1 HARNESS – HELM TO PCM		
One harness is required for single helm station, two are required for multiple helm stations.		
DESCRIPTION	LENGTH, FT (m)	PART No.
Harness, EPS, H4, 6 PIN FCI	6 (1.8)	CM20406
	12 (3.6)	CM20412
	18 (5.5)	CM20418
	24 (7.3)	CM20424
	30 (9.1)	CM20430
	36 (11)	CM20436
Harness, EPS, FTCAN Extension M-F	36 (11)	CM22036
Harness, Wye	2 (0.6)	CM21702

Table 4-1.

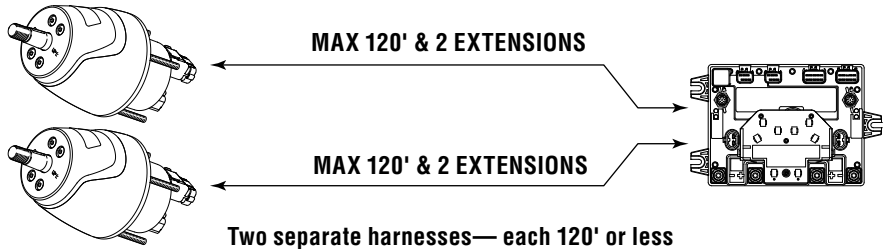
NOTICE

Every harness connection is a potential failure point. Try to minimize the number of connections in your system and always locate them in dry and protected areas.

Single Helm



Multiple Helm (Preferred Arrangement)



Multiple Helm (Optional Arrangement)

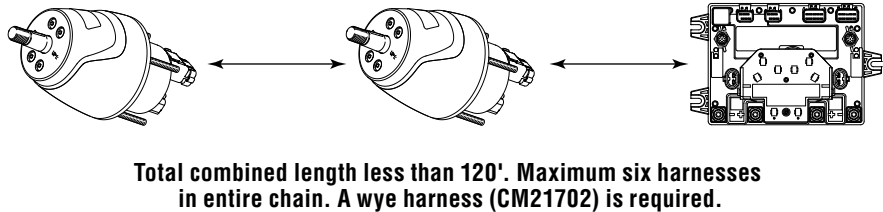


Figure 4-3.

4.2.2 CANtrak Display

NOTICE

A CANtrak display is required at the main helm station, but is optional at secondary control station(s).

There are two color CANtrak displays available, as shown in table 4-2.

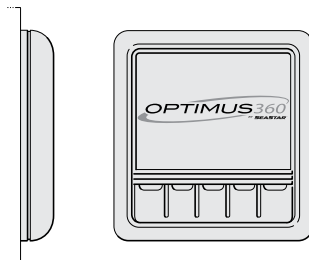
DISPLAY PART NO.	FOR USE WITH:	NOTES
ED1700	Twin sterndrive Inboard vessel with two independent rudders	Comes with harness CM21504 for connection to both CAN1 and CAN2 networks
ED1800	Single sterndrive Inboard vessel with a single rudder Inboard vessel with two rudders steered by a single cylinder	Comes with harness CM20030 for connection to CAN1 only

Table 4-2.

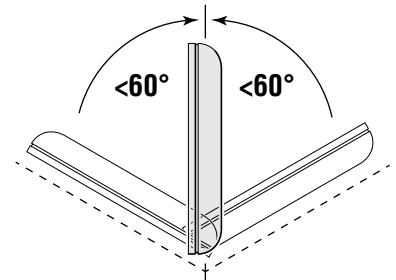
All CANtrak Displays are identical and can be used at any station. The display must be easily visible from the helm station. The display may be located in any position but if it is exposed to weather it should be installed on a sloped surface so water does not collect on the screen.

A mounting template can be found in Appendix A.

DO

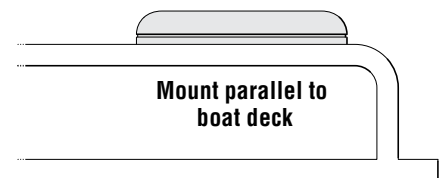


Mount vertical to hull or wall



Mount at an angle less than 60°

DO NOT



Mount parallel to boat deck

Figure 4-4.

Figure 4-5 and figure 4-6 show the required CAN2 harness connections when using the ED1700 display. The ED1800 display does not use these connections.

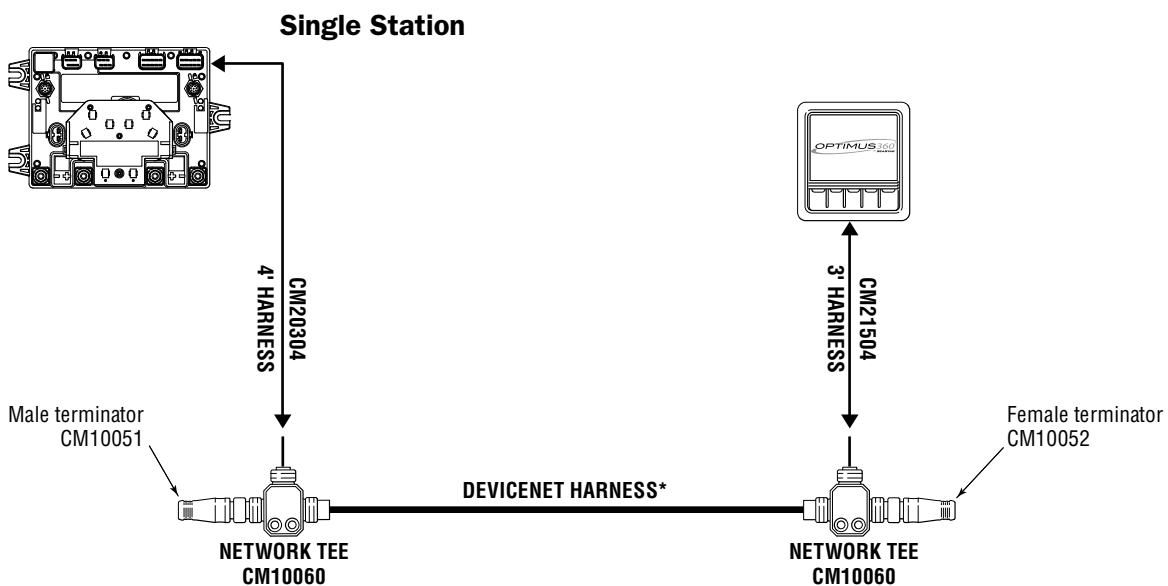


Figure 4-5.

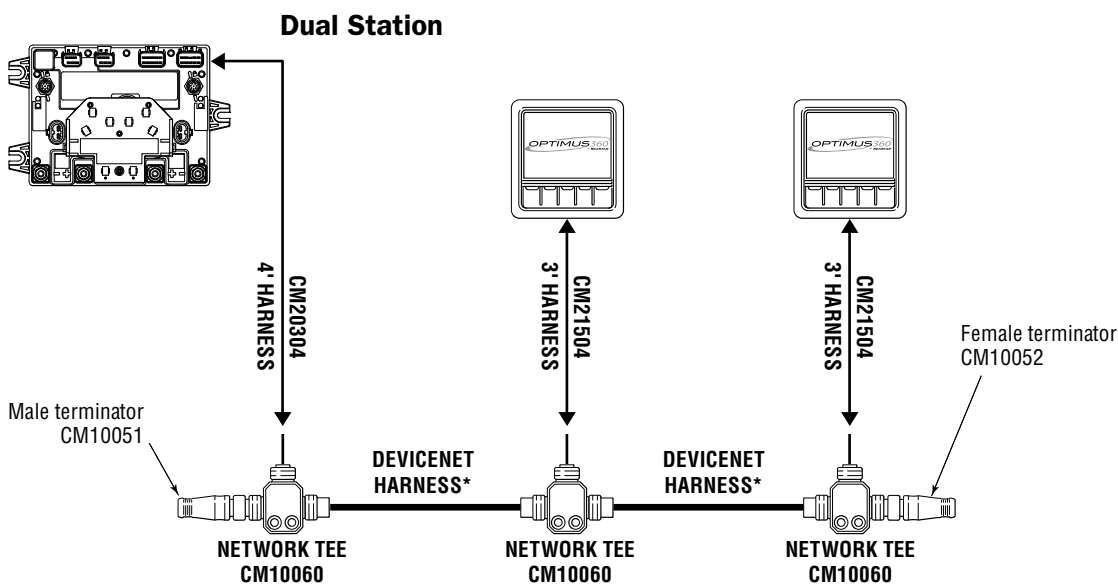


Figure 4-6.

* Note: see next page for harness information.

DeviceNet Extension Harnesses

Available DeviceNet extension harnesses are listed in table 4-3. If you need a harness longer than 30 feet (9.1m) you may chain up to three harnesses together for a maximum total length of 90 feet (27.3m).

Every harness connection is a potential failure point. Try to minimize the number of connections in your system and always locate them in dry and protected areas. Use tie wraps or other methods to ensure that nothing is pulling the connection apart.

MICRO-C DEVICENET HARNESS		
DESCRIPTION	LENGTH, FT (m)	PART No.
Micro-C Extension, Male/Female	1 (0.3)	CM10001
	3 (0.9)	CM10003
	6 (1.8)	CM10006
	9 (2.7)	CM10009
	12 (3.6)	CM10012
	16 (4.9)	CM10016
	20 (6.1)	CM10020
	30 (9.1)	CM10030

Table 4-3.

⚠ CAUTION

Do not cut or splice DeviceNet harnesses.

⚠ CAUTION

Do not connect anything other than SeaStar Optimus components, or SeaStar approved autopilots, to the CAN2 network.

⚠ CAUTION

If your system voltage is 24V the CAN2 network voltage will also be 24V, which could damage some third-party components.

4.2.3 Pump Control Module (PCM)

The PCM should be mounted in a cool, dry area and must be mounted in such a way that the three foot harness supplied with the power steering pumps reach the PCM. The harness *must not* be extended. Do a dry fit, with the leads properly run through the strain relief plate to verify the harness will reach.

Each PCM has two independent power feeds, each of which must be connected to a power source. See section 4.3.2 for more information.

Mounting dimensions can be found in Appendix A.

⚠ CAUTION

Do not use Automatic Power Selectors (APS) or selector diodes of any kind on the PCM power or ignition wires. This functionality is already built into the PCM.

⚠ WARNING

ALL ELECTRICAL CONNECTIONS AND HARNESS MUST COMPLY WITH ABYC WIRING STANDARDS, BE RATED FOR 105°C (221°F), AND COMPLIANT WITH SAEJ1128.

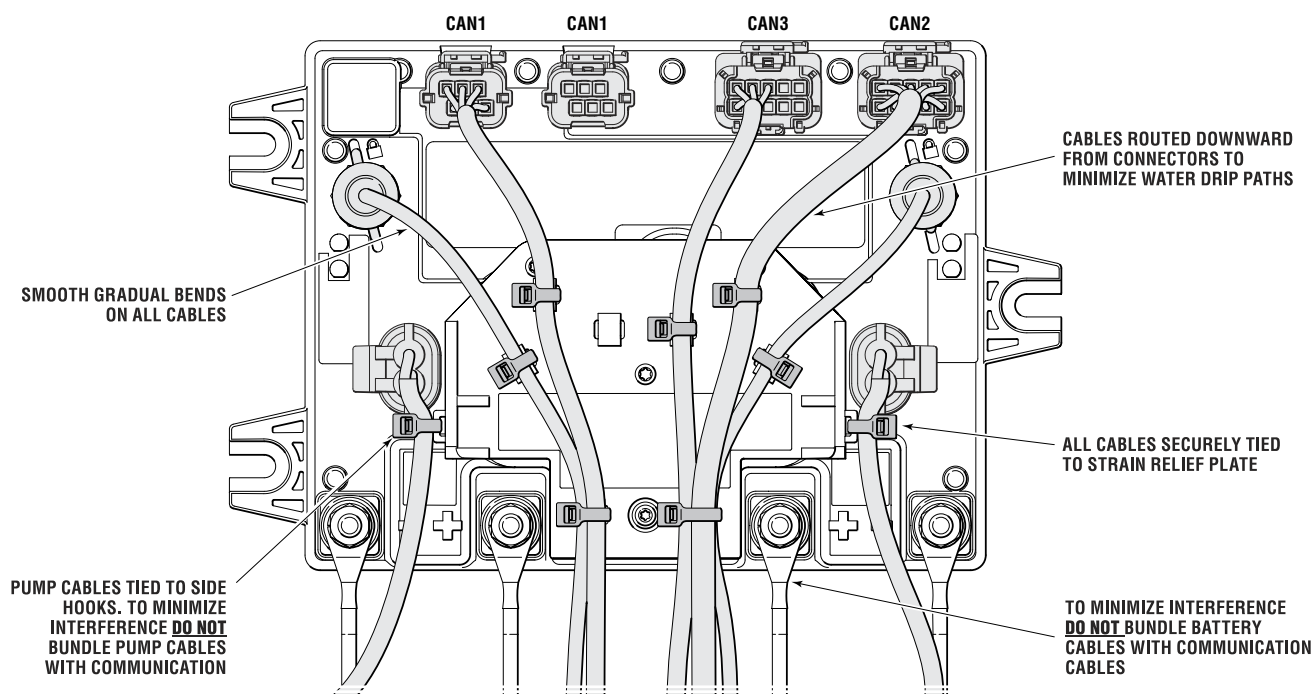
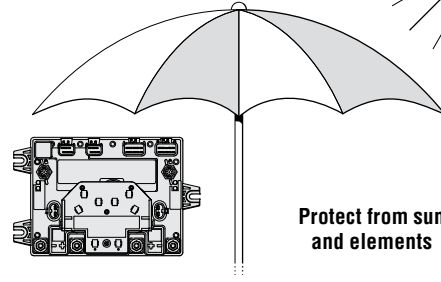
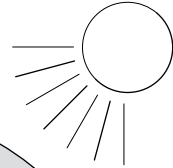


Figure 4-7. Pump Control Module.

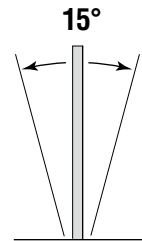
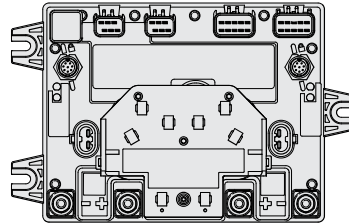
⚠ WARNING

Make sure that all unused ports have sealing plugs.

DO

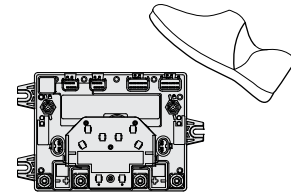
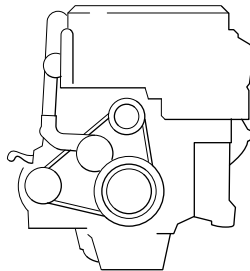


Protect from sun and elements

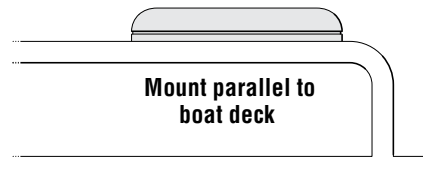


Mount vertical (parallel) to hull or wall, plus or minus 15°

DO NOT



Expose to vibration, shocks or excessive heat



Mount parallel to boat deck

Figure 4-8.

4.2.4 Power Steering Pump

The power steering pumps provide the fluid flow to move the SmartCylinders. The pumps can be mounted to the floor, a vertical wall or to the transom. The pumps should be in a dry location and must be able to connect to the PCM with the three foot harness supplied with the pump. Do a dry fit, with the leads properly run through the PCM strain relief plate to verify the harness will reach before permanently mounting the pumps.

⚠ CAUTION

This harness must not be extended.

The power steering pump makes a moderate amount of noise when operational. Select a location that will minimize the noise in the passenger area.

Typical locations for the power steering pumps and the PCM are behind the helm area on center console boats, in the rear compartment of cruisers, or in the base of the seating area. The location of the pump will have the most impact on the overall ease of installation and long term system maintenance so take time deciding on the best location. Mounting dimensions can be found in Appendix A.

Some considerations:

- It is easier to run communications harnesses than hydraulic hoses and heavy power wires.
- The operator will need to check the steering fluid level in the power steering pumps on a regular basis.
- The steering service valves *must* be accessible to the operator in case of emergency. If you can't locate the pumps in a way that makes the valves accessible, use the remote service valve kit, HA5480, as shown in section 4.2.6.
- Service and maintenance operations will be performed for the life of the boat. The installation is performed once.

NOTICE

Hose fittings can be relocated to plugged ports if required. (See figure 4-9, item 1 and 2.) Torque hose fittings to 18 ft-lb (24 Nm) and plugs to 50 in-lb (6 Nm).

You can also install 90° fittings (Kit # HF6004) for additional hose routing flexibility.

NOTICE

Due to material variability, fitting installation torque differs between the power steering pump and the steering cylinder. Be sure to use the correct installation torque to avoid irreparable damage to the pump housing or cylinder body when installing an ORB fitting.

NOTICE

Check that the pump is marked "PRT" in the location indicated in figure 4-9. Do not use the pump if it isn't marked.

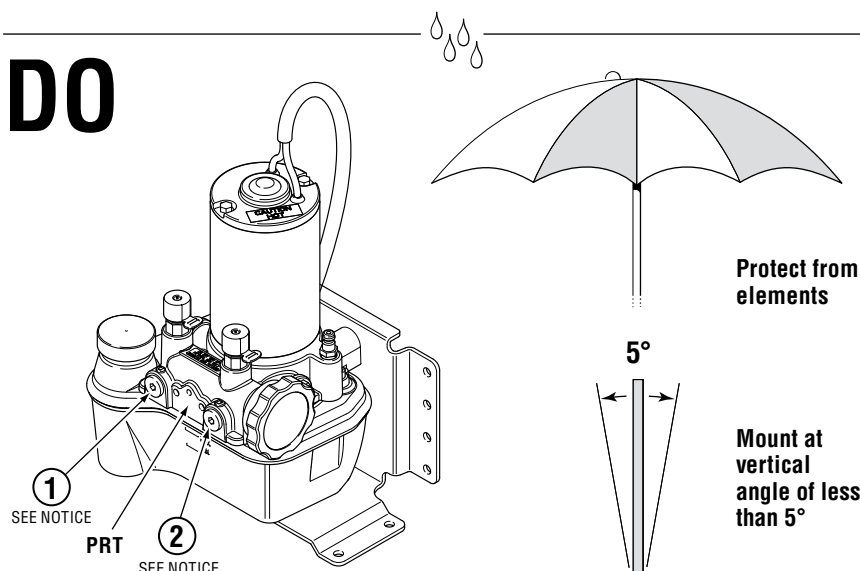


Figure 4-9.

4.2.5 SmartCylinders

The SmartCylinders move the tillers and supply a feedback signal that tells the PCM where the outdrives/rudders are positioned. Each SmartCylinder connects to a power steering pump by means of two hoses, and connects to the PCM by means of an electrical harness. It is very important that the hydraulic hoses and harness from each SmartCylinder are installed in such a way that gives the cylinder full travel without kinking or snagging on an obstruction.

⚠ CAUTION

Ensure that there are no pumps, motors, or other magnetic fields, too close to the cylinder because they may affect the position feedback signal. The minimum recommended distance is 12" (30cm).

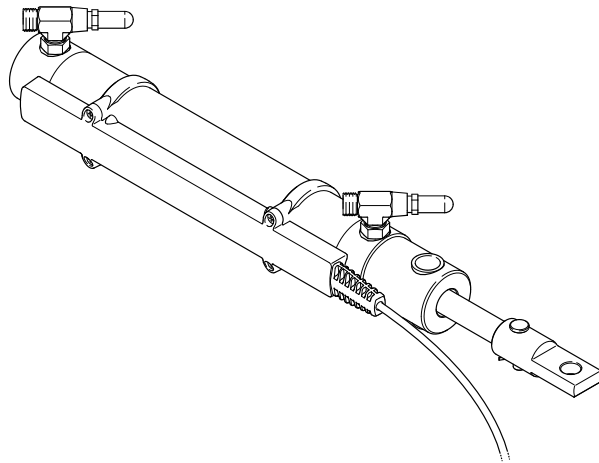


Figure 4-10.

The SmartCylinder comes with an 18 foot (5.5 m) electrical harness which connects to the PCM. There are three lengths of extension harness available, if required. Up to two extension harnesses may be added to each SmartCylinder. Take care to locate the harness connections in dry areas (or a junction box) and provide strain relief on either side of each connection.

DESCRIPTION	LENGTH, FT (m)	PART NO.
SmartCylinder Harness Ext. EPS, H9	6 (1.8)	CM20906
	12 (3.6)	CM20912
	18 (5.5)	CM20918

Table 4-4.

⚠ CAUTION

A maximum of two extension harnesses are permitted per SmartCylinder.

⚠ WARNING

THE SMARTCYLINDER ELECTRICAL HARNESS MUST BE PROPERLY SECURED. SEE SECTION 5.6.

4.2.6 Steering Service Valves

The steering service valves are integrated with the power steering pumps. When open they allow the engines to be manually repositioned, and are used for maintenance or in case of emergency. The pumps must be installed so that the valves are accessible and visible to the operator. The supplied decal (figure 5-13) must be applied in a visible location near the service valve.

If you can't install the pumps in such a way that the valves are accessible, use the remote-mounted service valve kit HA5480 (one per steering cylinder). These service valves can be mounted in a convenient location. You will require an additional pair of hydraulic hoses for each remote service valve.

Turn the knob fully counterclockwise (about 3 turns) to open the service valve, and clockwise to close. Turn just until you feel a firm stop – do not use tools or overtighten.

⚠ WARNING

DO NOT OPEN THE SERVICE VALVE WITH THE ENGINE(S) RUNNING.

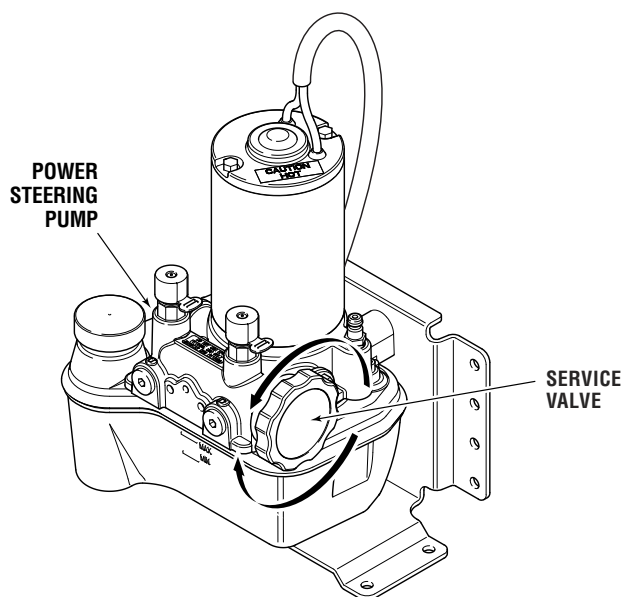


Figure 4-11. Service valve location.

4.2.7 Circuit Breakers

A circuit breaker must be provided by the installer for each of the two PCM power feeds. See section 4.3.2 for the required circuit breaker rating.

Use only circuit breakers designed for marine use, and with corrosion-resistant, stainless steel connection hardware.

Refer to ABYC wiring standards for all wiring best practices.

4.3 Plan Your Connections

At this point of the planning process the location of all major components should be established. Now it is time to review and plan your hydraulic and electrical connections.

4.3.1 Hydraulic Hoses

⚠ WARNING

**THE OPTIMUS EPS SYSTEM
REQUIRES THE USE OF
KEVLAR REINFORCED HOSES
ONLY. DO NOT USE EXTRUDED
NYLON TUBING OR STANDARD
SEASTAR (1000PSI) HOSE.**

SeaStar Pro steering hoses are available in kits containing two equal length hoses. Determine the length of the required hoses from each pump to its associated SmartCylinder, and check that you have the proper hoses available.

If you are using remote-mounted service valves (HA5480) you will need two sets of hoses for each cylinder: one pair from the pump to the service valve and a second pair from the service valve to the cylinder.

Consider the following when planning your hose routing and determining the required lengths:

- The cylinder body moves slightly as it steers. Ensure there is enough slack in the hose routing to avoid any binding, chafing, rubbing, or kinking.
- Minimum bend radius on the hose is 3.5". Never route the hoses in such a way that they can kink.
- Hoses should be secured along their routing path whenever possible, and should not be allowed to hang free in any area where they may become a safety hazard. SeaStar Solutions recommends the use of a rigging tube, PVC piping, or conduit for the safe installation and protection of the steering hoses.
- Do not install hoses in such a way that they may become exposed to hot engine components, such as manifolds or exhaust components.
- Do not install hoses where they may be exposed to corrosive acids, such as those that may be found at battery connection points, or where they may be exposed to battery fumes.

Table 4-5 shows the available hose kits. Each kit comes with two hoses. You can choose from brass or stainless steel hose end fittings.

KIT PART No.	DESCRIPTION	FITTINGS
H057XX	SeaStar Pro hose kit	Brass
H057XXSS	SeaStar Pro hose kit, SS	Stainless Steel

*XX denotes hose length in feet, with a leading zero for lengths below 10 feet.
Available lengths:*

- 2 to 7 feet in 1 foot increments (e.g. for a 3 foot hose kit, order H05703)
- 8 to 30 feet in 2 foot increments

Table 4-5.

4.3.2 Power Connections

All system wiring and power connections must be made to ABYC standards. See *ABYC E-11 AC and DC Electrical Systems on Boats*.

The Optimus EPS system requires a 12V or 24V DC power source, and can draw a peak current of approximately 40 Amps (20A with 24V source) when the steering is in heavy use. It is important that the power supply wires are correctly sized for the load.

Single Cylinder Applications:

Connect power to both sides of the PCM as shown in this section. This provides redundant power to the PCM.

If the boat has only a single battery you will need to get a second.

Connect the engine battery to the port side terminals of the PCM and the house battery to the starboard side. The system will only draw power from the house battery if the engine battery is low.

Typical Source Connections

- Direct to the batteries.
- To battery switches. *Never* switch the negative wire.
- To a bus bar or power distribution panel. Ensure that the wire size from the bus to the batteries is sufficient to handle the peak current of *all* accessories connected to the bus. Many boats have a positive and/or negative bus behind the helm or in the center console. These are typically supplied to handle light accessory loads and usually do not have sufficient wire size to supply the EPS system. In general, buses that supply power to vessel electronics such as radar and GPS are usually not acceptable power sources for the EPS system.

ABYC standards require that all wires carrying positive voltage must have a circuit protection device within 7" of the power source. Use a circuit breaker designed for marine use, with the rating shown in Table 4-6.

In some installations the circuit breaker may need to be located more than 7" from the power source. In this case an additional protection device (breaker or fuse) must be located within 7" of the battery to protect the intervening wire. The device must be rated based on wire size, and is usually of a slightly higher current rating than the breaker. Be sure to factor in the entire wire length from PCM to source when selecting wire size. Refer to ABYC E-11 for more details.

See figure 4-12 for source connection examples.

Wire Type and Sizing

Use wire with red insulation for the positive connections, and wire with black or yellow insulation for the negative connections.

The positive and negative power wires are frequently routed along different paths. For each wire, determine the length required to connect from the PCM to the power source or ground, then select the correct wire size from table 4-6.

WIRE LENGTH FROM PCM TO POWER SOURCE		AWG (mm ²)	
		12V	24V
< 9.8 feet	< 3.0 meters	6 (16)	10 (6)
< 14.7 feet	< 4.5 meters	4 (25)	10 (6)
< 24.6 feet	< 7.5 meters	2 (35)	8 (10)
CIRCUIT BREAKER RATING		60A	30A

Table 4-6.

NOTICE

ABYC standards require that the negative terminals of all batteries on the vessel be connected together. See ABYC E-11 for more information.

Examples

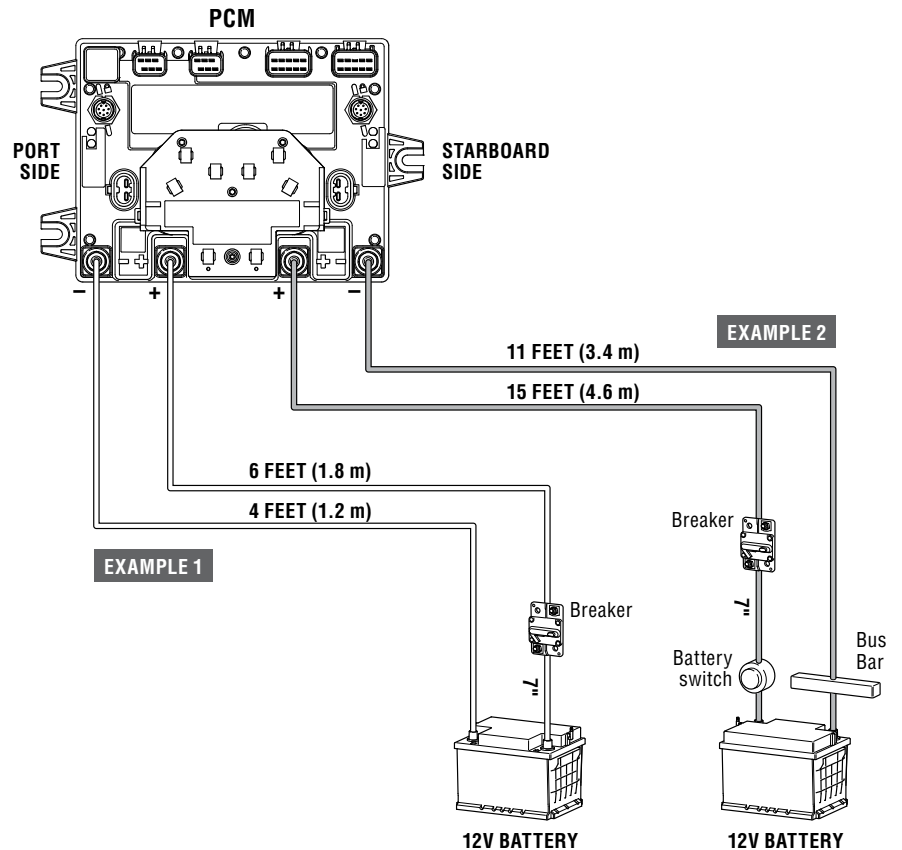


Figure 4-12. Examples.

Example 1

The negative cable is 4' (1.2 m) and according to the table you can use 6 AWG (16 mm²) wire. The positive cable is 6' (1.8 m) and requires a circuit protection device within 7" (18 cm) of the power source. The total length is still below 9.8' (3 m) so again 6 AWG (16 mm²) wire can be used.

Example 2

The negative wire is going from the PCM to a good ground bus. The negative wire is 11' (3.4 m) long and the table indicates that 4 AWG (25 mm²) wire is required. The positive wire is 15' (4.6 m) long and goes from the breaker to the PCM. The 7" (18 cm) run from the battery switch to the breaker must be added, resulting in a total length of 15' 7" (4.8 m). Checking the table results in a 2 AWG (35 mm²) wire for this connection.

4.3.3 Ignition Connection

The EPS system requires an ignition signal at the PCM to “wake up” the steering system. Review the instructions in section 6.4 and:

- plan how you will make the connection and where you need to install wire splices.
- determine the parts (e.g. butt splices) and tools you will require.

4.3.4 Engine RPM Source Connection

The EPS system requires an engine RPM input to support the speed-sensitive functionality of the system. Engine RPM can come from two sources: an NMEA2000 network, or an analog tachometer. Review the instructions in section 6.5 and:

- determine which source you will use.
- if using an existing NMEA2000 network, determine if you need an additional tee (CM10060) and/or extension harness (section 4.2.2).
- if creating a dedicated NMEA2000 network, be sure that you have the kit (HA5492) and an engine gateway.
- if using an analog tachometer, determine the parts and tools you require.

4.3.5 Autopilot Connection (Optional)

The Optimus EPS system can take steering commands from compatible autopilot units through a simple CAN2 network connection. No additional hydraulic pumps or connections are required. Refer to www.seastarsolutions.com for compatible autopilot systems.

An additional network tee on the CAN2 network will be required (CM10060)*. You may also need a DeviceNet extension harness to extend either the CAN2 backbone or the autopilot harness. Extension harnesses are listed in section 4.2.2.

Refer to section 6.6 and the autopilot installation instructions for additional information.

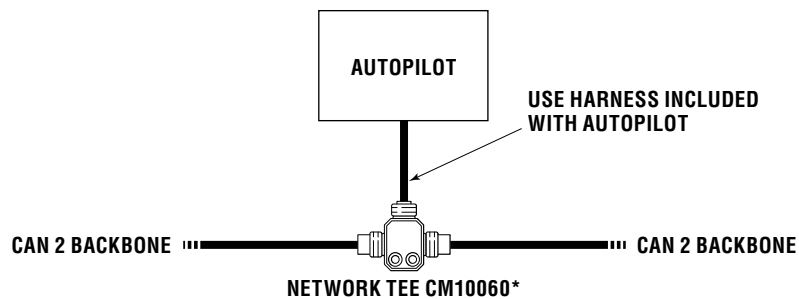


Figure 4-13. Autopilot connection to CAN 2 network.

* **Important Note:** If you are using a Simrad SG05 autopilot you must use a power isolating tee such as a Navico 000-12259-001 or a Garmin 010-11580-00.

4.4 Diagram

Use this page to make a complete diagram of the installation. The diagram should be similar to the one in Section 2.2, with the locations and correct harness and hose lengths indicated.

Helm area:

PCM/Pump area:

SmartCylinder area:

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5.0 COMPONENT INSTALLATION

NOTICE

Refer to Section 4 – Planning, before proceeding with any part of the installation. This will speed the installation and avoid problems that could occur due to lack of up-front planning.

5.1 Helm(s)

Find the installation diagram for your helm(s) in the following pages. Before beginning the installation, carefully unpack the helm from the box and check that you have all the required hardware shown in the diagram.

Mounting templates for each helm type can be found in Appendix A. Make sure you are using the correct template before drilling or cutting the dash.

A ground strap is provided with each helm. It is critical that this ground strap be installed as described below each installation diagram. If the ground strap is not installed the steering sensor may be damaged by static electricity discharge. This can lead to a failure of the steering system.

We recommend that you note the type and serial number of each helm in the table below. In a multi-station system the serial number will be required during the system setup. The helm type may be useful to the owner in the future.

STATION	HELM TYPE	SERIAL No.
Main	<input type="checkbox"/> Front Mount <input type="checkbox"/> Sport Plus Tilt <input type="checkbox"/> Classic Tilt <input type="checkbox"/> Rear Mount	
Second	<input type="checkbox"/> Front Mount <input type="checkbox"/> Sport Plus Tilt <input type="checkbox"/> Classic Tilt <input type="checkbox"/> Rear Mount	

Table 5-1.

⚠ WARNING

ALL HELMS MUST HAVE A GROUND CONNECTION TO THE GROUND, NEGATIVE BUS BAR, OR THE NEGATIVE SIDE OF THE BATTERY TO PREVENT DAMAGE FROM STATIC ELECTRICITY. A GROUND STRAP AND HARDWARE IS PROVIDED WITH EACH HELM.

FAILURE TO DO SO MAY RESULT IN LOSS OF STEERING CONTROL, POSSIBLY RESULTING IN PROPERTY DAMAGE, INJURY OR DEATH.

5.1.1 EPS Front Mount Helm (EH1510)

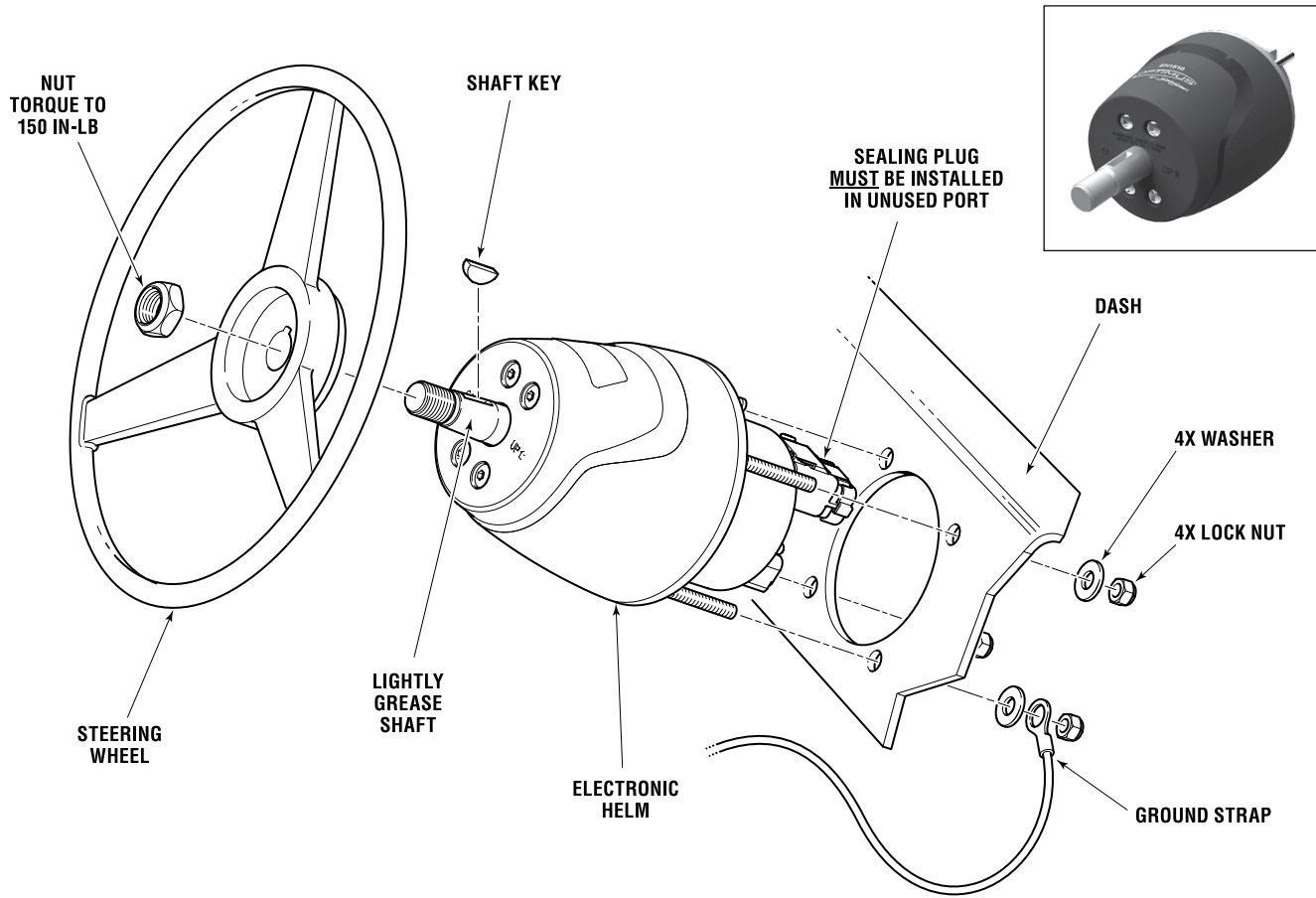


Figure 5-1.

Install the ground strap – install one end of the ground strap between the nut and washer on the helm’s mounting stud. Connect the other end to ground or negative bus bar or to the battery negative terminal.

⚠ WARNING

USE ONLY THE SELF-LOCKING FASTENERS PROVIDED! SUBSTITUTING NON-SELF-LOCKING FASTENERS CAN RESULT IN LOOSENING OR SEPARATION OF EQUIPMENT, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND OR DEATH. DO NOT EXCEED 110 IN-LB, (12NM) TORQUE ON HELM NUTS AND BOLTS.

5.1.2 EPS Sport Plus Tilt Helm (EH1530)

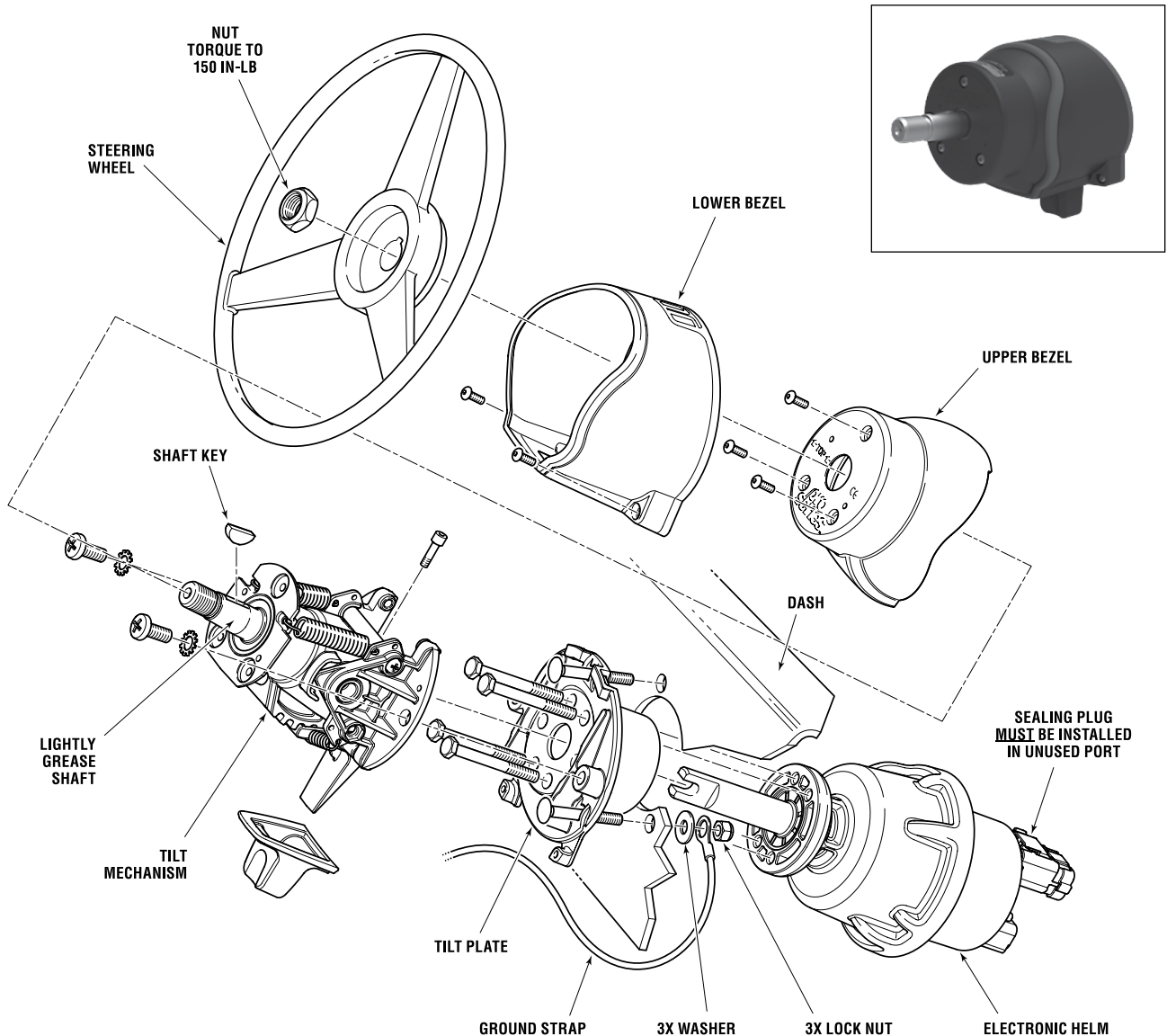


Figure 5-2.

Install the ground strap – install one end of the ground strap between the nut and washer of one of the carriage bolts holding the adapter plate to the dash. Connect the other end to ground or negative bus bar or to the battery negative terminal.

⚠ WARNING

USE ONLY THE SELF-LOCKING FASTENERS PROVIDED! SUBSTITUTING NON-SELF-LOCKING FASTENERS CAN RESULT IN LOOSENING OR SEPARATION OF EQUIPMENT, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND OR DEATH. DO NOT EXCEED 110 IN-LB, (12NM) TORQUE ON HELM NUTS AND BOLTS.

5.1.3 EPS Classic Tilt Helm (EH1550)

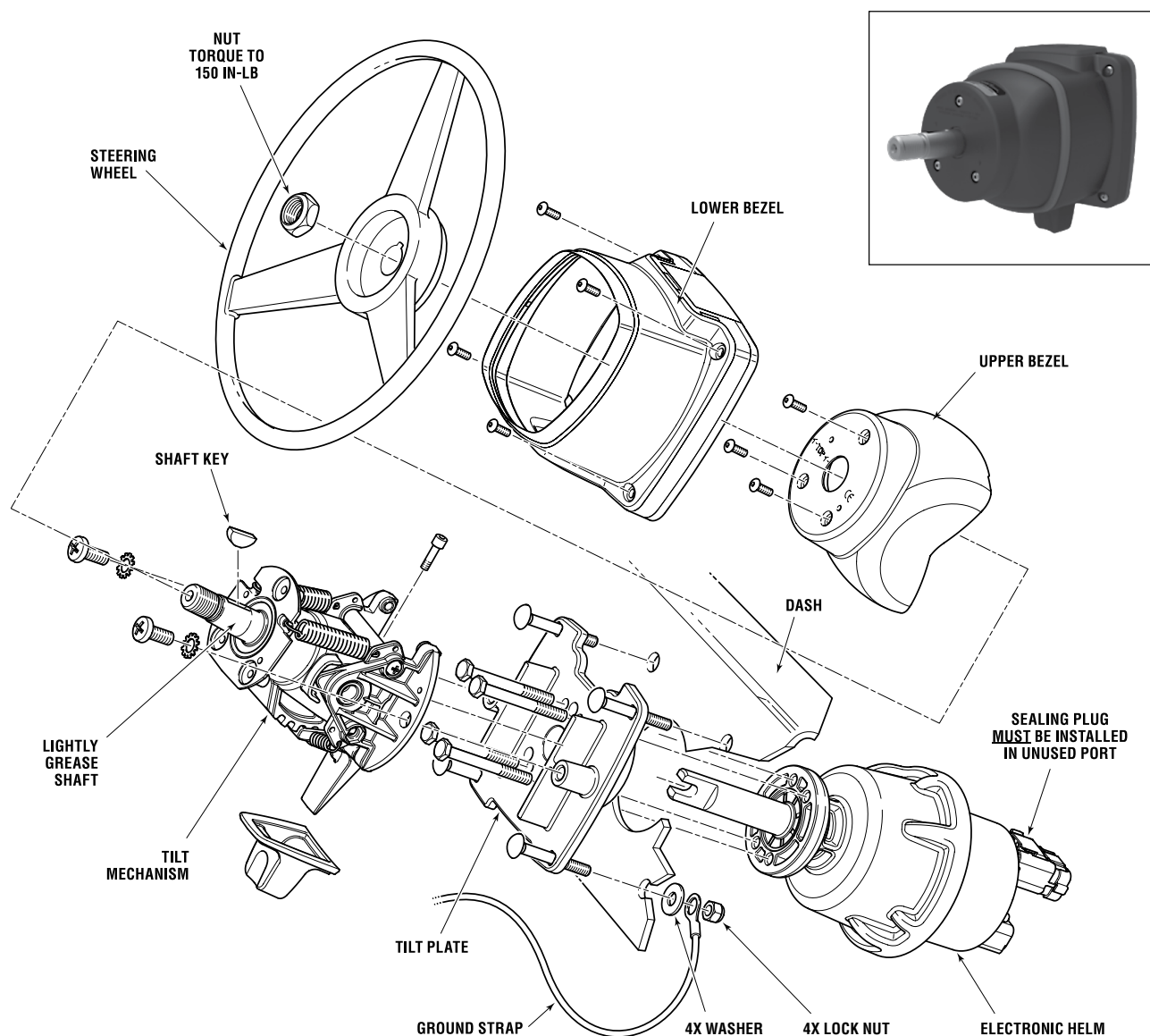


Figure 5-3.

Install the ground strap – install one end of the ground strap between the nut and washer of one of the carriage bolts holding the adapter plate to the dash. Connect the other end to ground or negative bus bar or to the battery negative terminal.

⚠ WARNING

USE ONLY THE SELF-LOCKING FASTENERS PROVIDED! SUBSTITUTING NON-SELF-LOCKING FASTENERS CAN RESULT IN LOOSENING OR SEPARATION OF EQUIPMENT, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND OR DEATH. DO NOT EXCEED 110 IN-LB, (12NM) TORQUE ON HELM NUTS AND BOLTS.

5.1.4 EPS Rear Mount Helm (EH1570)

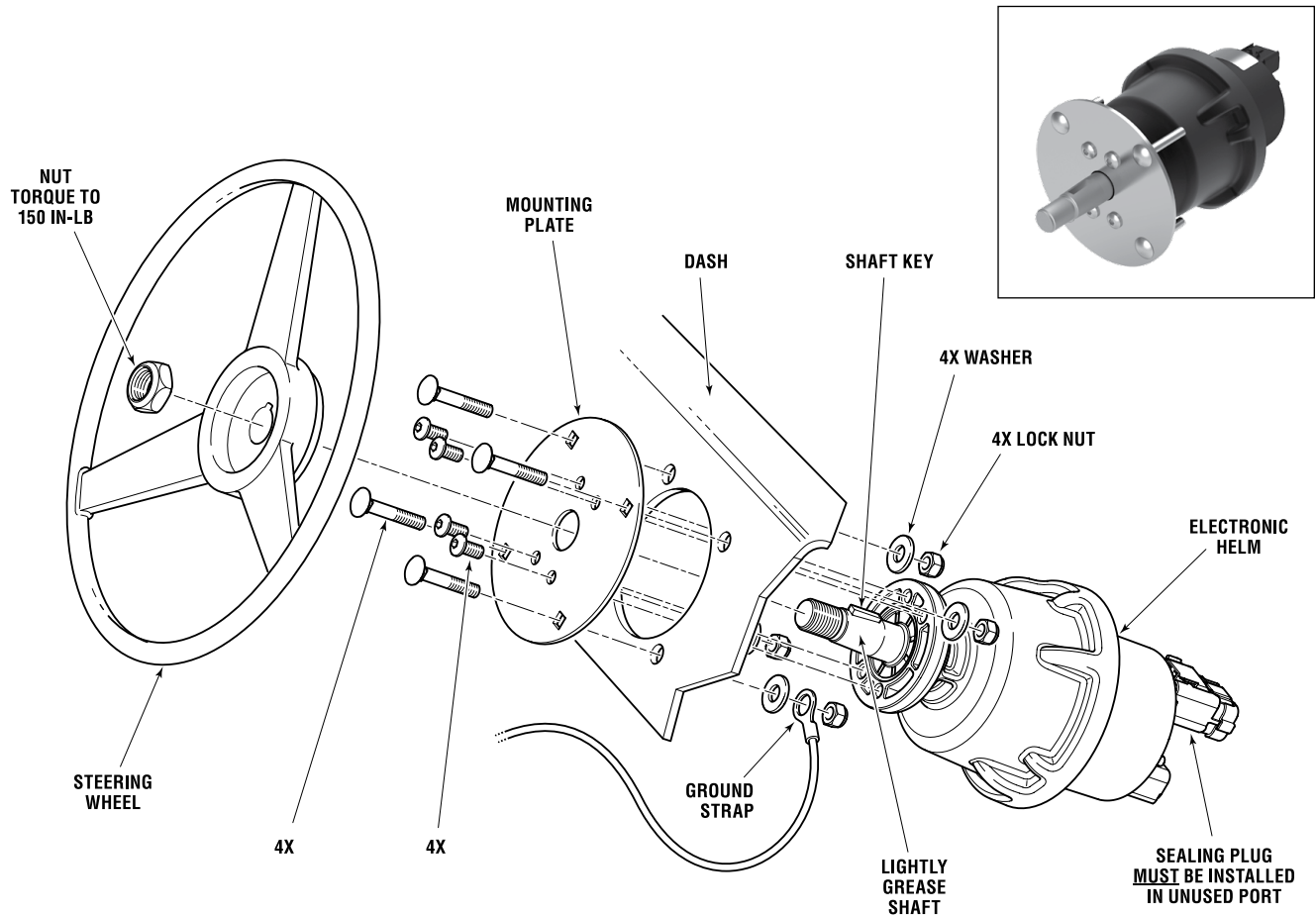


Figure 5-4.

Install the ground strap – install one end of the ground strap between the nut and washer on one of the carriage bolts holding the polished plate to the dash. Connect the other end to ground or negative bus bar or to the battery negative terminal.

⚠ WARNING

USE ONLY THE SELF-LOCKING FASTENERS PROVIDED! SUBSTITUTING NON-SELF-LOCKING FASTENERS CAN RESULT IN LOOSENING OR SEPARATION OF EQUIPMENT, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND OR DEATH.. DO NOT EXCEED 110 IN-LB, (12NM) TORQUE ON HELM NUTS AND BOLTS.

5.2 CANtrak Display

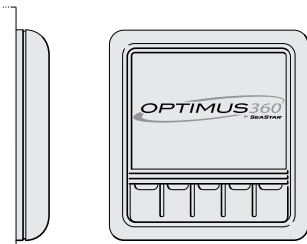
Mount the CANtrak display where it is easily visible from the helm station. A mounting template can be found in Appendix A.

NOTICE

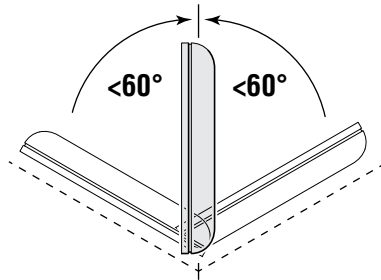
On a dual station vessel the CANtrak is optional at the second station. If you don't install a CANtrak at the second station you must install a buzzer kit (HA5493).

- Mount the display vertically, or within 60 degrees of vertical.
- Ensure adequate ventilation around the unit.
- Ensure that you are able to get to the rear of the unit for harness connections.
- **DO NOT** mount parallel to the boat deck, unless the helm is in a completely enclosed wheelhouse where no water can accumulate on the face of the CANtrak.

DO

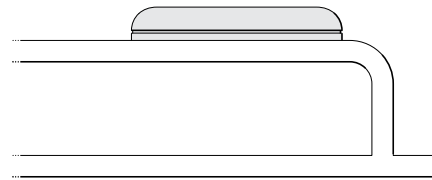


Mount vertical to hull or wall



Mount at an angle less than 60°

DO NOT



Mount parallel to boat deck

Figure 5-5.

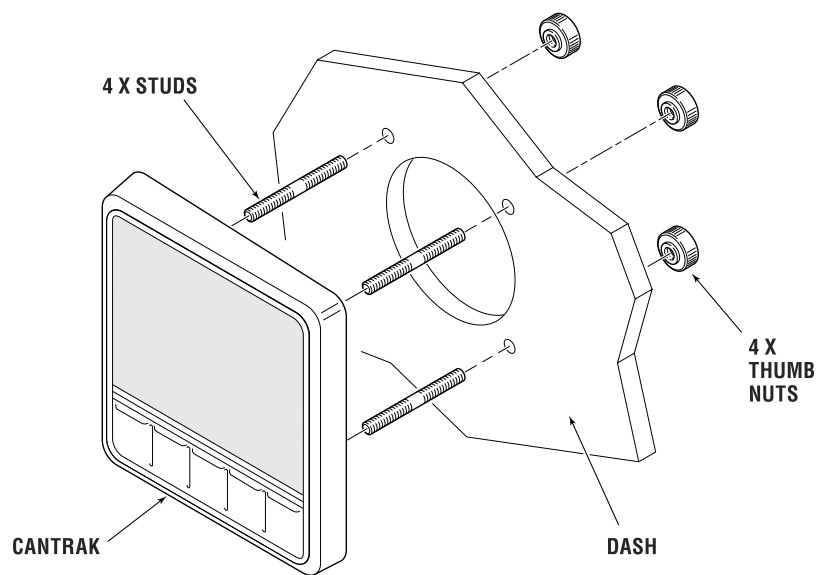


Figure 5-6.

5.3 PCM and Power Steering Pumps

PCM and the power steering pumps must be mounted in close proximity. The three foot harnesses on the pumps need to reach the appropriate connectors on the PCM without strain, and they cannot be extended.

Single Cylinder Applications:
The power steering pump *must* be plugged in to the port pump connection (M1).

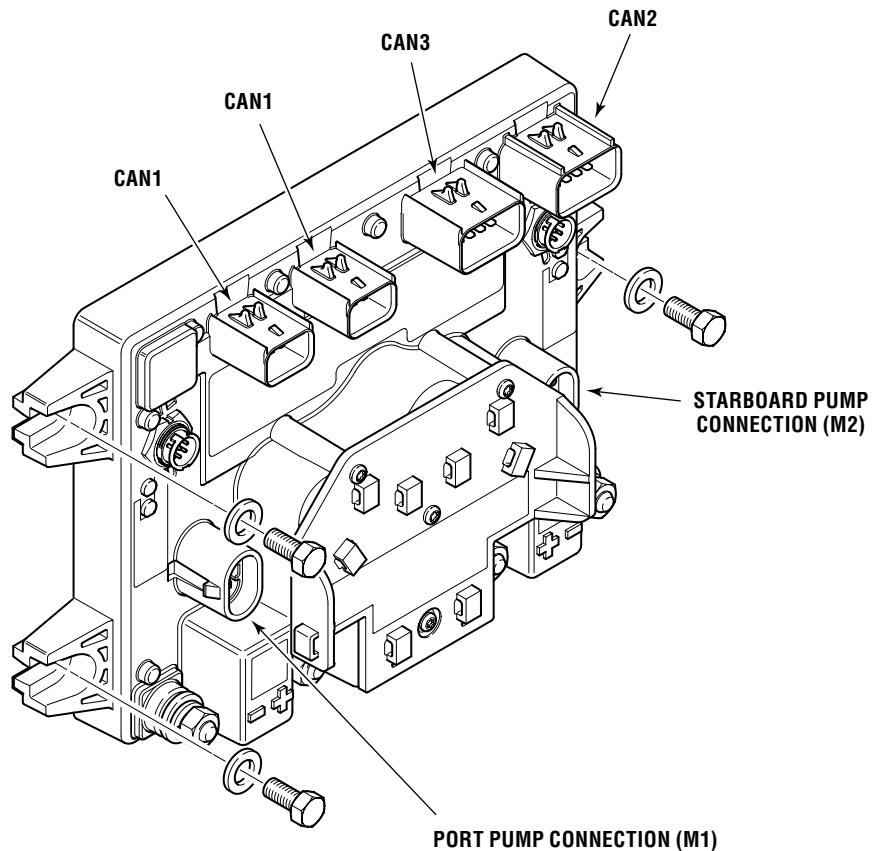


Figure 5-7.

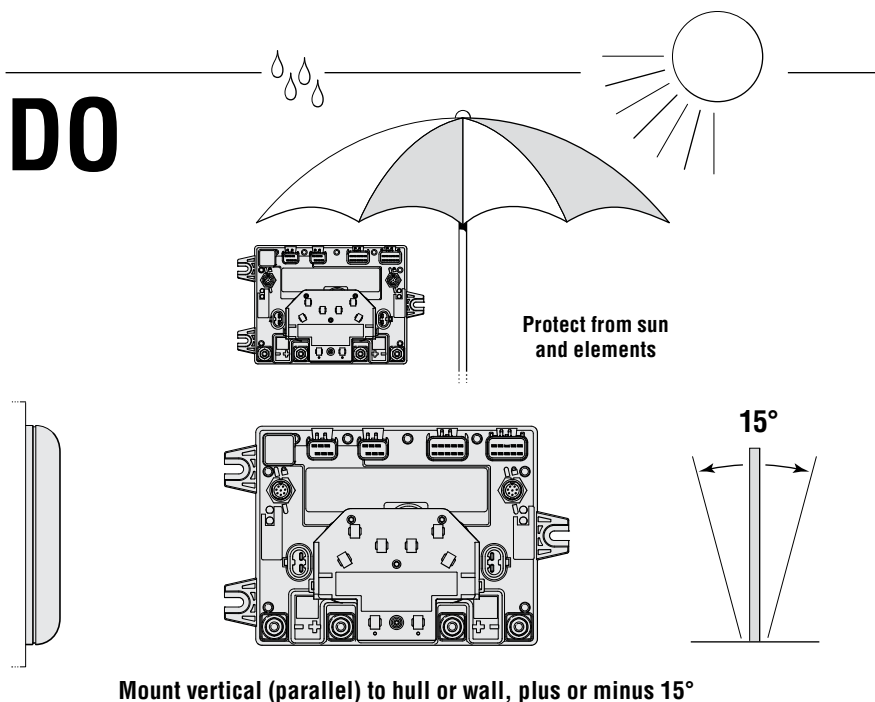
5.3.1 PCM Recommended Mounting Hardware

We recommend that you use only stainless steel mounting hardware.

- Fasten at all three mounting points.
- The PCM is designed to fit 1/4" or M6 cap screws or machine screws. Use washers between the screw head and the PCM.
- Through-bolt with nuts and washers on the back the side, or drill and tap into a metal mounting surface.
- You can also use a #14 wood screw and washer.

5.3.2 PCM Mounting Considerations

- Mount the PCM to a flat, vertical surface parallel to the wall or hull. It may be mounted no more than 15 degrees from vertical.
- The PCM must be mounted in a cool, dry location.
- Any unused connectors must have a sealing plug installed.



DO NOT

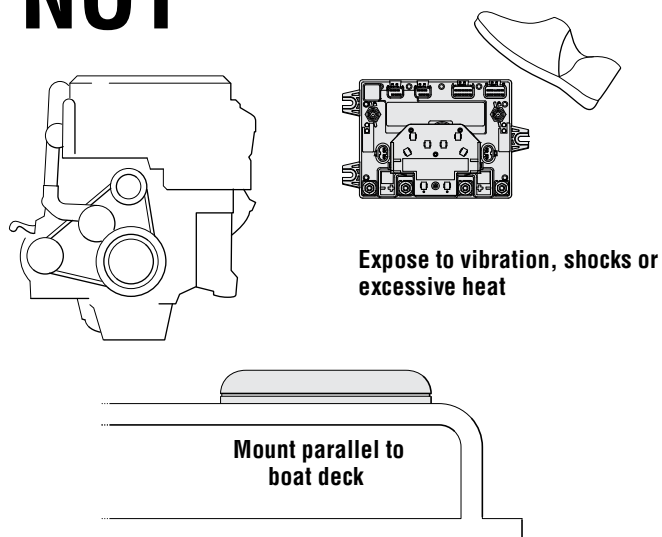


Figure 5-8.

5.3.3 Power Steering Pump Mounting Considerations

- Pumps should be mounted in a cool, dry, well ventilated location.
- Pump harnesses are 3' long and must not be extended. Choose pump and PCM mounting locations accordingly.
- Pumps can be wall or floor mounted. See Appendix A for mounting dimensions.
- Pumps must be mounted so that the oil level indicators and the reservoir are visible and accessible to the operator.
- The service valve knob must be easily accessible. Ensure there is room around the knob for a user to grasp it and turn it.
- Pump ports are color coded from the factory to indicate the appropriate cylinder fitting connection.
- Pump ports and corresponding cylinder ports are also marked with "U" and "D."

NOTICE

Hose fittings can be relocated to plugged ports if required. (See figure 4-9, item 1 and 2.) Torque hose fittings to 18 ft-lb (24 Nm) and plugs to 50 in-lb (6 Nm).

You can also install 90° fittings (Kit # HF6004) for additional hose routing flexibility.

NOTICE

Due to material variability, fitting installation torque differs between the power steering pump and the steering cylinder. Be sure to use the correct installation torque to avoid irreparable damage to the pump housing or cylinder body when installing an ORB fitting.

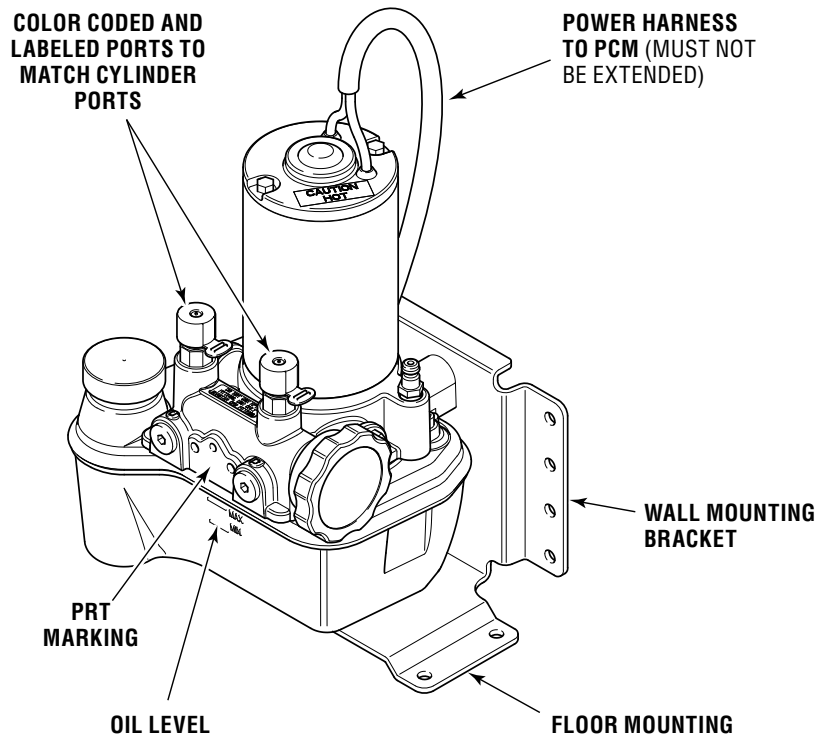


Figure 5-9.

⚠ WARNING

THE PUMP MOTOR MAY BE HOT TO THE TOUCH DURING OPERATION. DO NOT MOUNT PUMPS IN AN AREA WHERE FABRICS AND/OR OTHER FLAMMABLE MATERIAL MAY COME IN CONTACT WITH THE PUMP MOTOR. DO NOT COVER.

DO

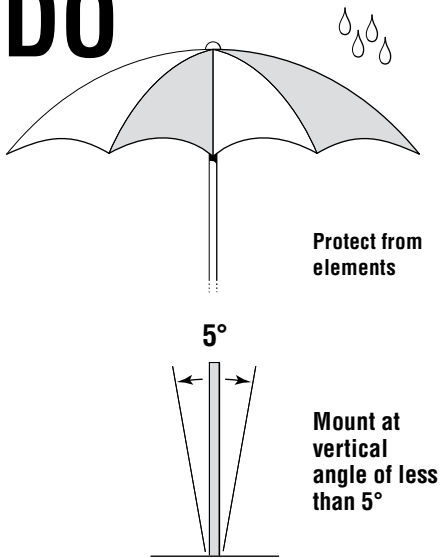


Figure 5-10.

Wall-mounting the power steering pump:

- Pumps must be mounted upright to facilitate oil fill and purge.
- If mounting to an angled wall, use shims to mount the pump upright.

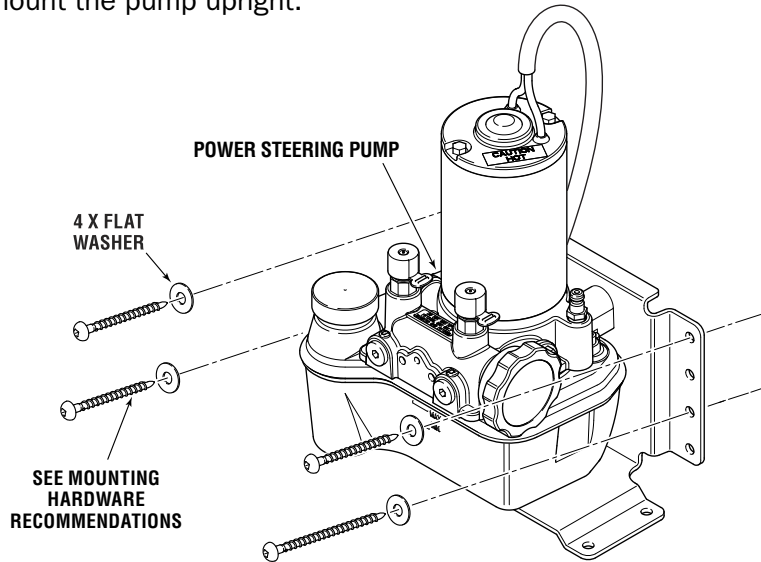


Figure 5-11.

Floor-mounting the power steering pump:

- Pumps must be mounted upright to facilitate oil fill and purge.

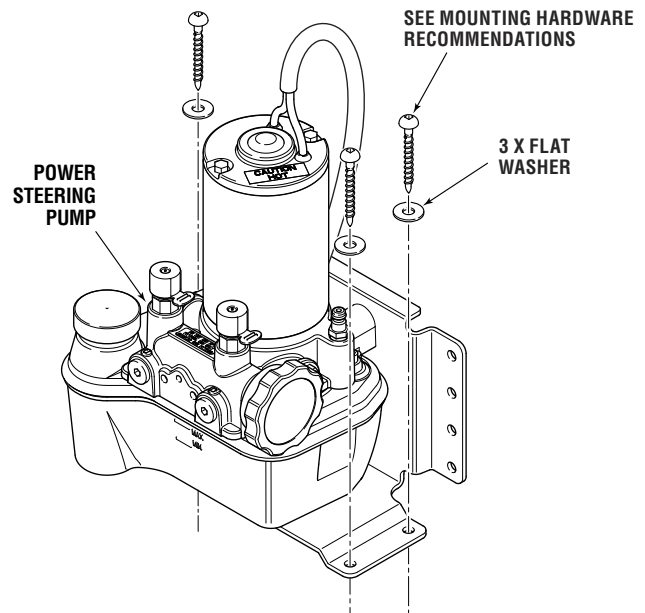


Figure 5-12.

5.3.4 Power Steering Pump Mounting Hardware

We recommend that you use only stainless steel mounting hardware.

- M6 cap or machine screw and washer.
- 1/4" cap or machine screw and washer.
- #14 wood screw and washer (flat bearing surface under screw head only).

5.3.5 Integrated Steering Service Valve

The power steering pump has an integrated service valve for maintenance and emergency use. It must be accessible to the operator. If it isn't accessible, you will need to use the remote-mount service valve kit, HA5480.

There is an instruction label on the pump motor. If it is not visible, you must install the label shown in figure 5-13 in a visible location.

This decal MUST be visible!



Figure 5-13.

5.4 SmartCylinder Installation

NOTICE

Before beginning installation make sure that all mounting hardware is available and the tiller arm is clean and free from rust or burrs.

5.4.1 EC5360 Sterndrive Cylinder

Refer to figure 5-14 for an illustration of a typical sterndrive cylinder installation.

Installation Procedure

1. Install steering cylinder (item 1) onto transom bracket using the mounting hardware provided with your transom bracket. Liberally grease all pivot surfaces with a quality marine grease.
Note: If the transom bracket uses 1/2" trunnion pins, use the adapter bushings provided with the cylinder.
2. Ensure the supplied cylinder clevis (item 2) is installed onto the end of the steering cylinder and the cotter pin (item 3) is installed with the prongs bent to avoid separation.
3. Connect steering cylinder to the outdrive tiller using the supplied clevis pin (item 4) and cotter pin (item 5). Bend cotter pin ends to prevent separation. Liberally grease all pivot surfaces with a quality marine grease.

- Note:** Both 1/2" and 3/8" tiller pins are provided. When using the 3/8" tiller pin place the associated adapter bushing in the clevis.
4. Remove caps from cylinder hose fittings and swing the tiller(s) back and forth and confirm there is free sterndrive movement. Ensure there is no interference with the SmartCylinder. Ensure the SmartStick does not come close to any hot engine components.

⚠ WARNING

FAILURE TO ENSURE PROPER INSTALLATION OF THE COTTER PIN MAY LEAD TO SEPARATION OF COMPONENTS RESULTING IN LOSS OF VESSEL CONTROL.

⚠ CAUTION

Take particular care with hose routing when rigging a Yanmar engine. Keep the hoses and harness as far from the turbo-charger as possible.

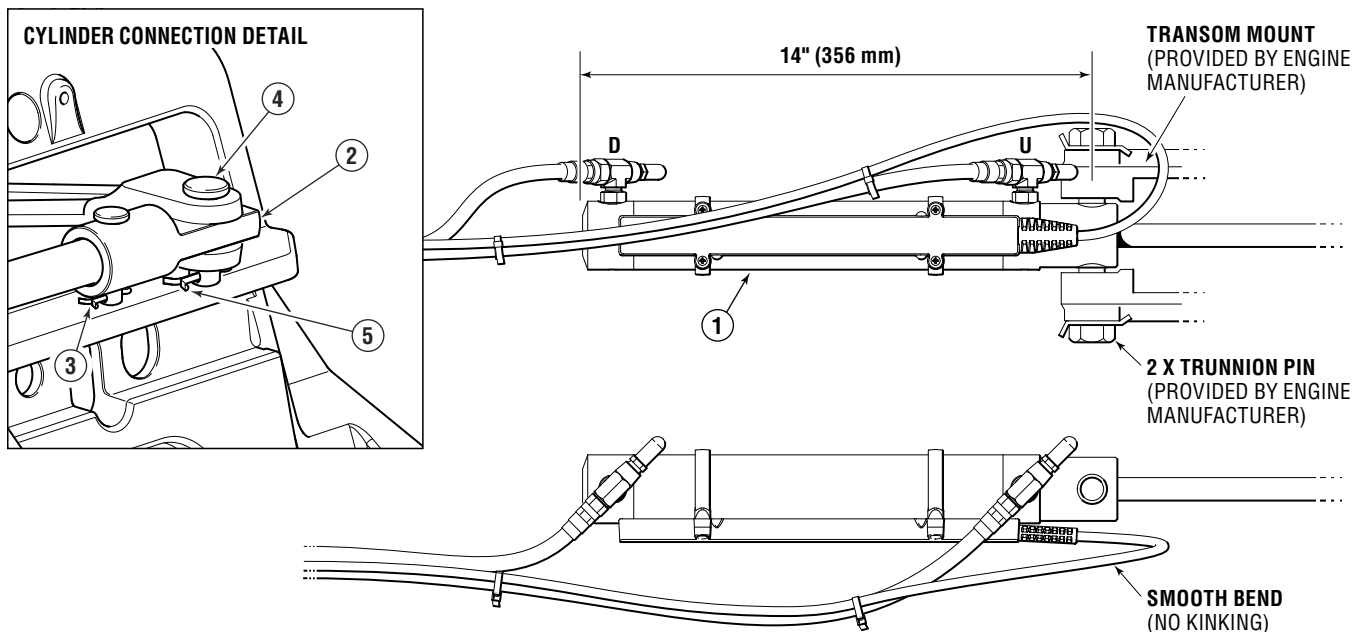


Figure 5-14.

5.4.2 EC5380 Inboard Cylinder

Proper cylinder mounting is critical to the successful operation of your hydraulic steering system; misalignment will lead to rapid seal and bearing wear, as well as non-repairable damage.

Figure 5-15 illustrates the correct cylinder alignment, with the cylinder centerline defined by an imaginary line drawn through the tiller arm hole at both hard over positions. Use table 5-2 to determine the required tiller arm length (dimension 'A') for the application, based on required rudder torque and steering angle. Not all possible cylinder mounting configurations are shown, but all share the same key dimensions.

⚠ CAUTION

If installing rudder stops, ensure that the cylinder(s) reach end of stroke BEFORE rudder stops are engaged.

⚠ WARNING

WHERE APPLICABLE, CYLINDERS SHOULD BE SECURED WITH THROUGH BOLTS, NOT WITH LAG SCREWS. FAILURE TO DO SO MAY RESULT IN LOSS OF STEERING CONTROL CAUSING PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.

⚠ CAUTION

The cylinder bleed fittings must be installed so that they are above the cylinder. If this isn't possible you will need to dismantle the cylinder during the purge procedure so that the fittings can be oriented upright. Once the air is removed the cylinder can be reinstalled. Leaving air in the system will drastically affect performance of your steering system.

Protect cylinder shafts from nicks and scratches. A damaged cylinder shaft can not be repaired and a new cylinder will need to be purchased.

Installation Procedure

1. Determine the tiller arm length (dimension 'A') and foot bracket location (dimension 'B') from table 5-2. If the tiller arm length is already set, use figure 5-15 to locate the cylinder, keeping angles X and Y equal over the 7" stroke of the cylinder.
2. Secure rod end to tiller arm using the supplied hardware as shown in figure 5-16. Torque the nut to 43 ft-lb (58.3 Nm).
3. Place mounting foot in location indicated in figure 5-16 and table 5-2 for desired steering angle.

NOTICE

In order to obtain a correct push and pull angle between the tiller arm and cylinder, or tiebar and cylinder, the cylinder should be parallel to the transom, tiebar or the keel line (depending on your mounting configuration) when cylinder rod is fully extended (out) or fully retracted (in).

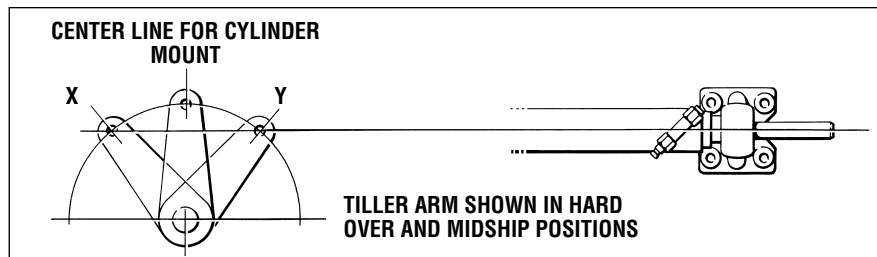


Figure 5-15.

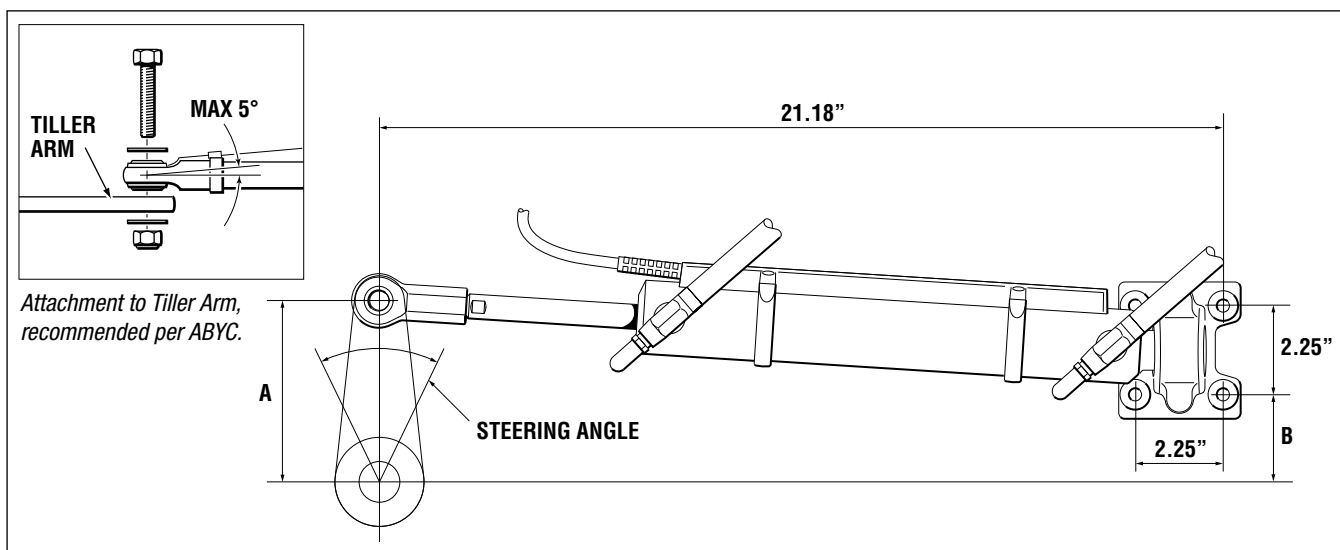


Figure 5-16.

Model	Steering Angle							
	50°		60°		70°		80°	
	A	B	A	B	A	B	A	B
EC5380	8.33"	6.43"	7.04"	4.98"	6.14"	3.91"	5.48"	3.07"
	11,004 in-lbs		8887 in-lbs		7328 in-lbs		6115 in-lbs	

Table 5-2.

⚠ CAUTION

There is no adjustment for centering the cylinder after installation. Correct mounting is critical at this time. Total cylinder travel is 7" (178 mm).

NOTICE

For twin rudders, the cylinder may be mounted directly to the tiebar or to one of the tiller arms. Ensure all measurements remain the same as if mounting to a rudder arm.

- Secure the mounting foot to transom or mounting bracket using four 5/16" (8 mm) bolts (304 or 316 stainless steel) and self-locking nuts. Orient the fasteners such that if the nut were to vibrate loose the fastener would not fall out.
- Remove caps from cylinder hose fittings.

6. Before making the hose connections, swing the rudder(s) back and forth and confirm there is free movement of the cylinder and that there is no binding of the rod end ball joint. Ensure SmartStick does not come close to any magnetic material or electric motors such as a bilge pump.

⚠ WARNING

ANY BINDING AND OR INTERFERENCE MUST BE CORRECTED PRIOR TO USE. FAILURE TO DO SO MAY LEAD TO SEPARATION OF COMPONENTS AND/OR PREVENTION OF STEERING CONTROL. SEPARATION OF COMPONENTS OR LOSS OF STEERING CONTROL MAY LEAD TO UNPREDICTABLE BOAT BEHAVIOR AND/OR A COLLISION WITH AN OBSTACLE AND/OR EJECTION FROM VESSEL RESULTING IN PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.

⚠ CAUTION

The cylinder ball mount allows up to **15 degrees** of movement **MAX**. Any movement beyond **15 degrees** will result in premature seal and/or bearing wear.

5.5 Plumbing the System

⚠ WARNING

THE OPTIMUS EPS SYSTEM REQUIRES THE USE OF SEASTAR PRO (1500 PSI) KEVLAR REINFORCED HOSES ONLY.

⚠ WARNING

DO NOT CUT SEASTAR PRO STEERING HOSE. THERE IS NO MEANS IN THE FIELD TO INSTALL A SWAGE FITTING TO THE HOSE END.

⚠ CAUTION

Substituting brass fittings into the steering cylinder may result in galvanic corrosion and irreparable damage to the cylinder, as well as affect system integrity.

NOTICE

Individual items (i.e. swage fitting, bulkhead plate, hose, etc.) cannot be ordered as a single part. If replacement parts are required an entire new length of hose will need to be purchased.

Before installing the steering hoses, please read and understand the important DOs and DON'Ts below.

DO:

- ✓ Use only SeaStar Pro hose. Extruded nylon tubing is not acceptable.
- ✓ Protect the hose from chafing, rubbing, and contact with assembly screws or sharp edges of any type.

- ✓ Route hoses through a protective PVC tube if possible. If not possible, attempt to route the hoses so that they can be periodically inspected for wear or damage.
- ✓ Secure exposed sections of hoses every 12" (30cm) or less.
- ✓ Provide sufficient hose length to allow for cylinder movement throughout the turning arc.

DON'T:

- ✗ Install pipe sealant onto the hose side of a fitting.
- ✗ Remove the protective end caps until the hoses have been routed and are ready to be connected to the pump or cylinder.
- ✗ Install hoses in an area where they will be exposed to high temperatures. Areas to avoid are near engine manifolds and in engine compartments.
- ✗ Install hoses such that they contact electrical connections or are exposed to battery acid or fumes from batteries.
- ✗ Bend hoses tighter than a 3.5" (90mm) radius.
- ✗ Allow hoses to hang free in an area where they could become a safety hazard.

⚠ WARNING

CONTINUOUS KINKING, RUBBING, CHAFING OR TWISTING OF A STEERING HOSE MAY EVENTUALLY WEAKEN THE HOSE(S) TO A POINT WHERE IT COULD RUPTURE, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND OR DEATH.

5.5.1 Hose Labels

When plumbing the Optimus EPS system it is extremely important to get all of the connections in the correct place. When the hoses are being pulled through the boat it is easy to lose track of which hoses are which. To assure proper connections each kit is supplied with a sheet of labels to identify each hose end. Attach the labels to the hoses *before* routing the hoses in the boat.

The sheet also contains labels to identify the port and starboard power steering pumps, service valves (if remote valves are used), and SmartCylinder cables. Place all labels so they can be easily read after the installation is complete as they are a great help when servicing the system. See figure 5-17.

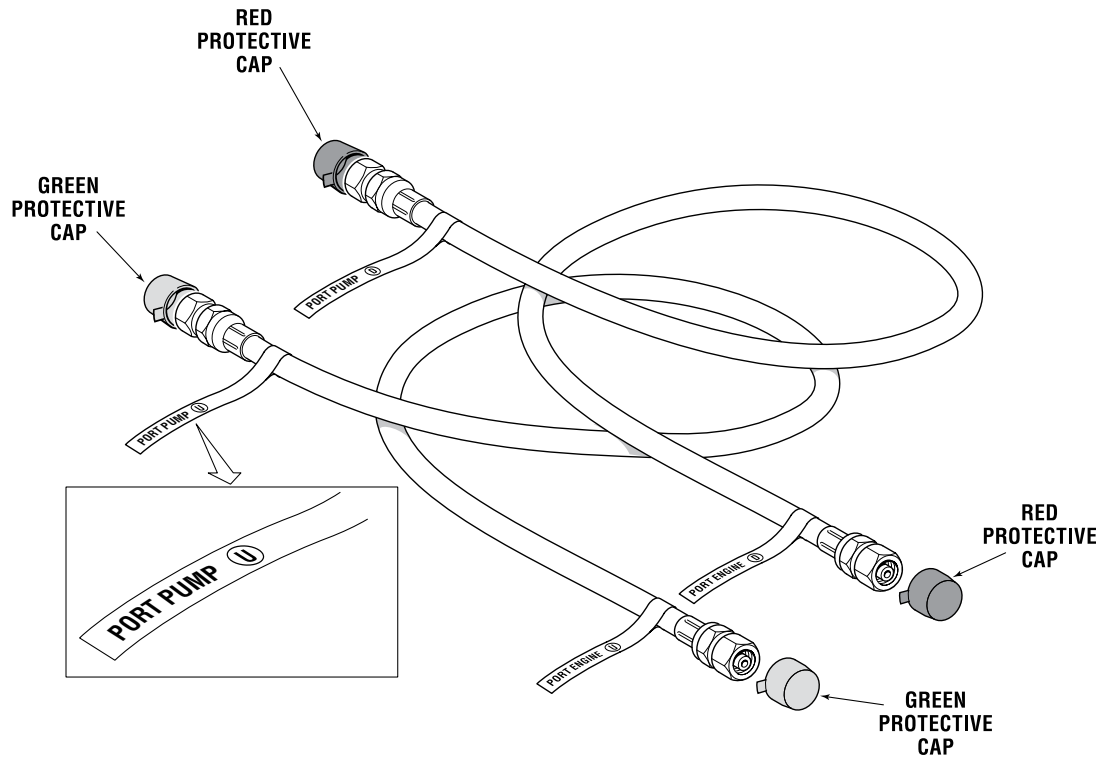


Figure 5-17.

5.5.2 Hose Installation

Figure 5-18 shows the general plumbing diagram for the Optimus EPS system. It is critical that the connections are made correctly, so be sure to pay attention to the port identifiers and the color coded protective caps. Standard hoses are shown for clarity, but the connections are the same for bulkhead hoses.

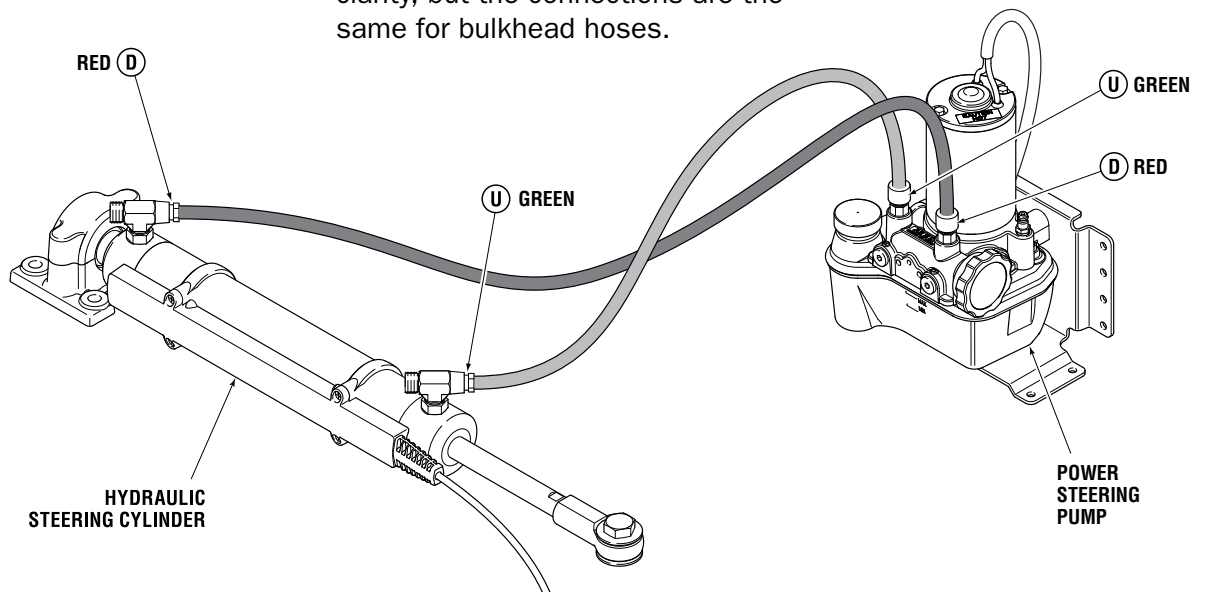


Figure 5-18. Hydraulic connections.

⚠ WARNING

ENSURE THE STARBOARD CYLINDER IS CONNECTED TO THE STARBOARD PUMP, AND THE PORT CYLINDER IS CONNECTED TO THE PORT PUMP. INCORRECT PLUMBING MAY LEAD TO PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.

⚠ CAUTION

Do not remove the protective end caps until connections are ready to be made.

NOTICE

- *Be sure to mark all hoses using the supplied labels to insure correct installation.*
- *We recommend you plumb and connect hoses for each engine separately to avoid confusion.*

Installation Procedure

1. Apply hose labels as instructed in section 5.5.1
2. Attach the hydraulic hoses to the SmartCylinder and slide the bend restrictor over the fitting as shown in figure 5-19. Torque fitting to 15 ft-lb. (20 Nm). If necessary, you can reposition the fitting on the cylinder. See section 5.5.3.
3. Route the hoses along the gunwale or inside a protective PVC pipe to the power steering pumps. Connect the hoses to the appropriate pump ports and tighten to 15 ft-lb. (20 Nm) The cylinder 'U' and 'D' ports must be connected to the corresponding pump 'U' and 'D' ports.

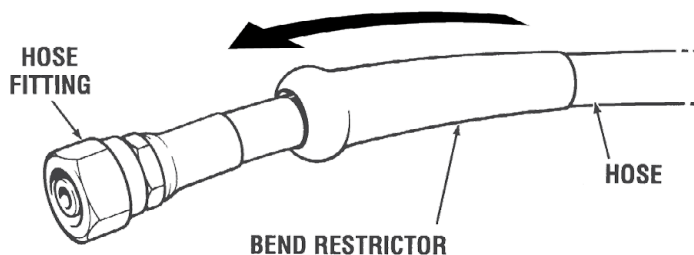


Figure 5-19.

5.5.3 Hose Fitting Reorientation (if required)

1. Back off lock nut (item 1 in figure 5-20) counter-clockwise, until it stops.
2. Thread fitting into the cylinder port until the fitting washer (item 2) contacts the face of the cylinder port. Tighten hand tight. **DO NOT USE A WRENCH.**
3. Re-position fitting to desired orientation by turning it counter-clockwise to a *maximum* of 1 full turn.
4. While holding the fitting body securely with a wrench, torque the locknut to 40–43ft-lb. Note that this torque is appropriate for the cylinder only. For fittings installed into the pump see section 5.3.3 for torque specification.

⚠ WARNING

FAILURE TO PROPERLY TIGHTEN THE LOCKNUT MAY LEAD TO LOSS OF STEERING CONTROL. LOSS OF STEERING CONTROL MAY RESULT IN UNPREDICTABLE BOAT BEHAVIOR, COLLISION WITH AN OBSTACLE AND/OR EJECTION FROM VESSEL, LEADING TO PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.

NOTICE

Due to material variability, fitting installation torque differs between the power steering pump and the steering cylinder. Be sure to use the correct installation torque to avoid irreparable damage to the pump housing or cylinder body when installing an ORB fitting.

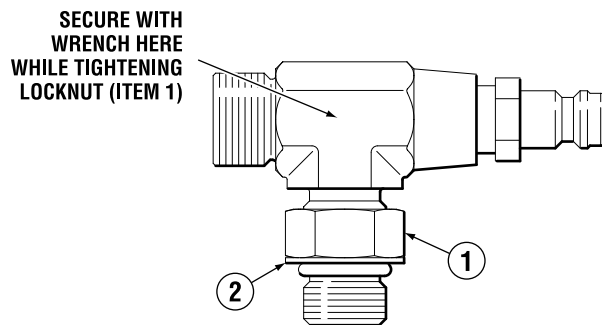


Figure 5-20. Re-orientable hose fitting.

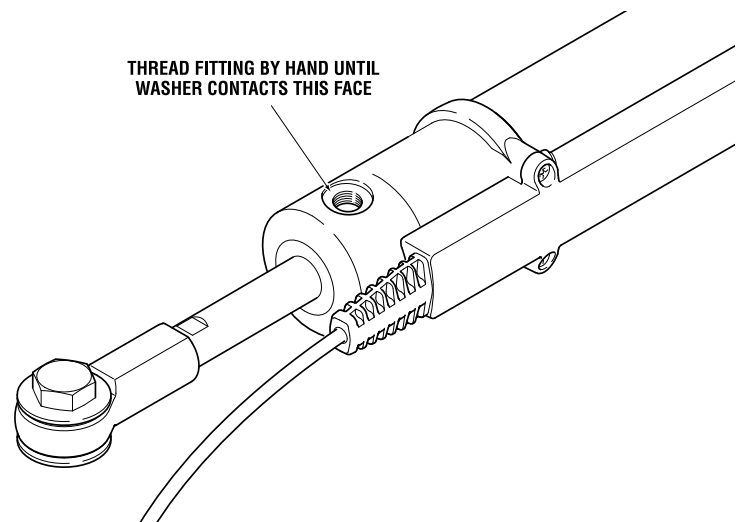


Figure 5-21.

5.6 Connecting the SmartCylinder

NOTICE

Be sure to mark all hoses using the supplied labels to insure correct installation. See Section 5.5.1.

Each SmartCylinder is supplied with an 18 foot (5.5 m) harness. Route the harness for each SmartCylinder as shown below. Sensor (RFU) harness *must* be secured to the hydraulic hoses every six inches (15 cm). Harness ends *must* be marked PORT or STARBOARD (on single cylinder applications mark the harness PORT, as you will be connecting it to the port side of the PCM). Do not mix up RFU harness connections at PCM. Identification labels are provided with the kit.

If additional harness length is required to reach the PCM, extension harnesses are available (see Section 4.2.5).

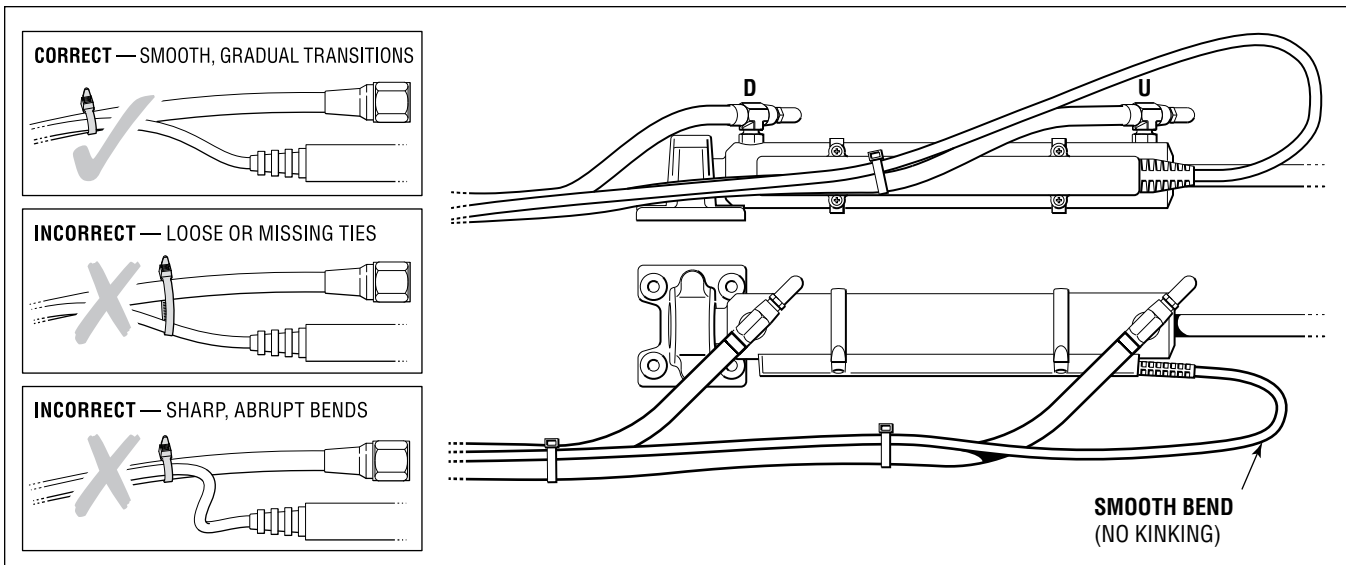


Figure 5-22.

⚠ WARNING

FAILURE TO SECURE HARNESS MAY RESULT IN HARNESS WEAR, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND OR DEATH.

⚠ CAUTION

Take particular care with hose and RFU harness routing when rigging a Yanmar engine. Keep the hoses and harness as far from the turbocharger as possible.

Connection at PCM

Apply a thin layer of dielectric grease (P/N 051700, included in your document package) to the top of the pins within the RFU connectors, as shown in figure 5-23. Insert the SmartCylinder harness plugs and turn the locking rings clockwise until they click into place. The locking ring should be aligned with the marks on PCM as shown in figure 5-24.

Single Engine Applications:
Plug the RFU harness into the port SmartCylinder connection (RFU1). Apply dielectric grease only to the port RFU connection.

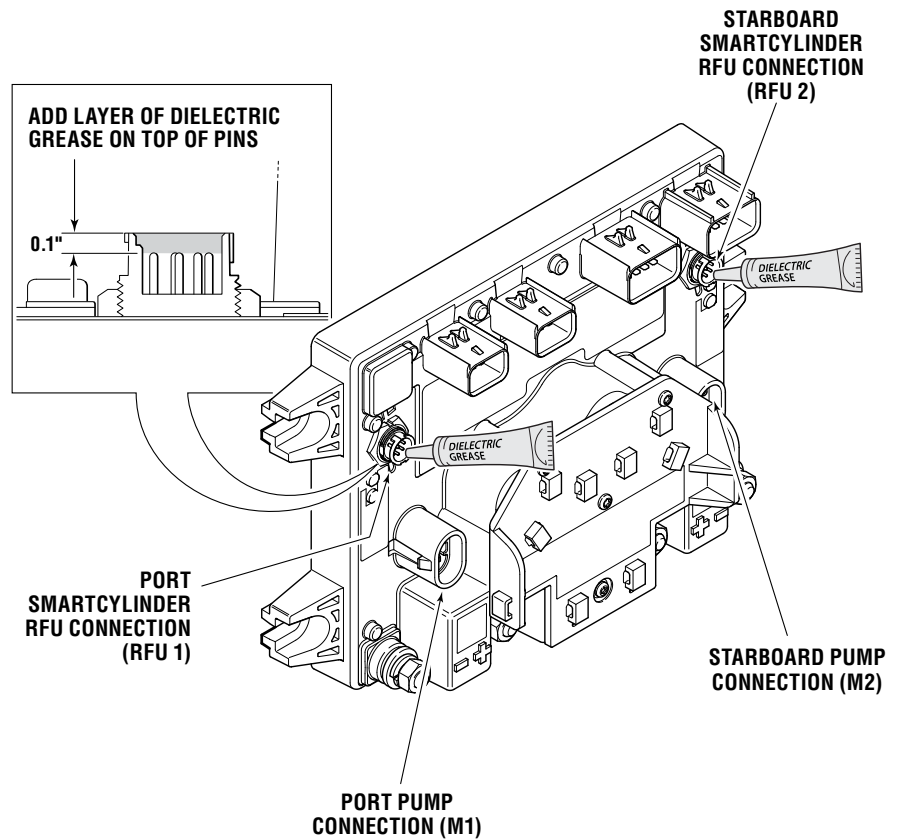


Figure 5-23. PCM showing RFU connector locations.

NOTICE

If you are using SmartCylinder (RFU) extension harnesses, apply the dielectric grease to the extension connections as well.

NOTICE

Dielectric grease should only be applied to SmartCylinder harness connection points. Do not apply to any other connectors in the system.

⚠ CAUTION

Do not force the locking ring past the alignment marks.

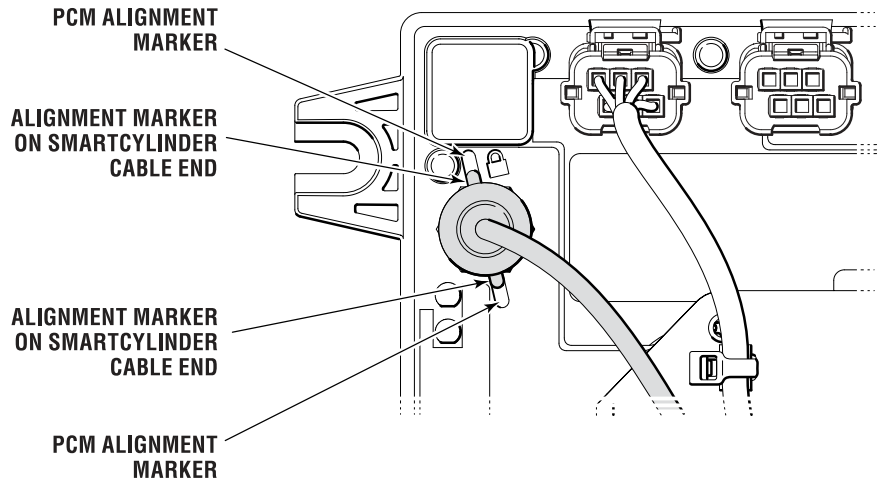


Figure 5-24.

NOTICE

RFU Extension harnesses should also be strain relieved on either side of each connection.

Proper Strain Relief of RFU Harness

The RFU harness should be strain relieved in a manner that does not compromise the seal of the connector. The harness should extend vertically by approximately 2.5" from the base of the connector to the tallest point on the cable. Furthermore, the harness should be secured to the strain relief plate such that the primary zap strap is located between the warning and barcode labels on the harness. This configuration is shown in figure 5-25.

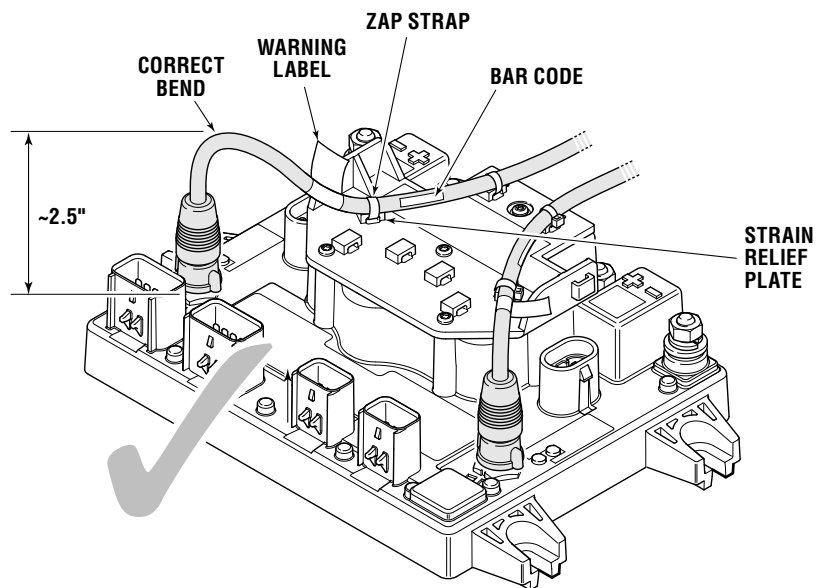
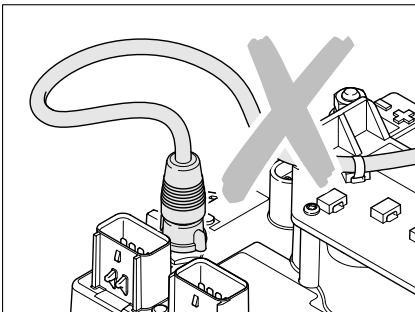
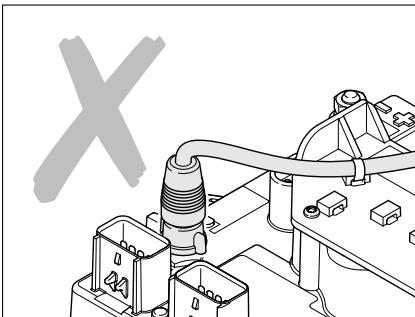


Figure 5-25.

6.0 NETWORKS AND WIRING

6.1 Network Diagrams

The following schematics illustrate the CAN1 and CAN2 network connections for single and dual station installations on sterndrive and inboard vessels. (Not all possible configurations are shown.) Connections are made with simple harness connections, as shown in section 6.2.

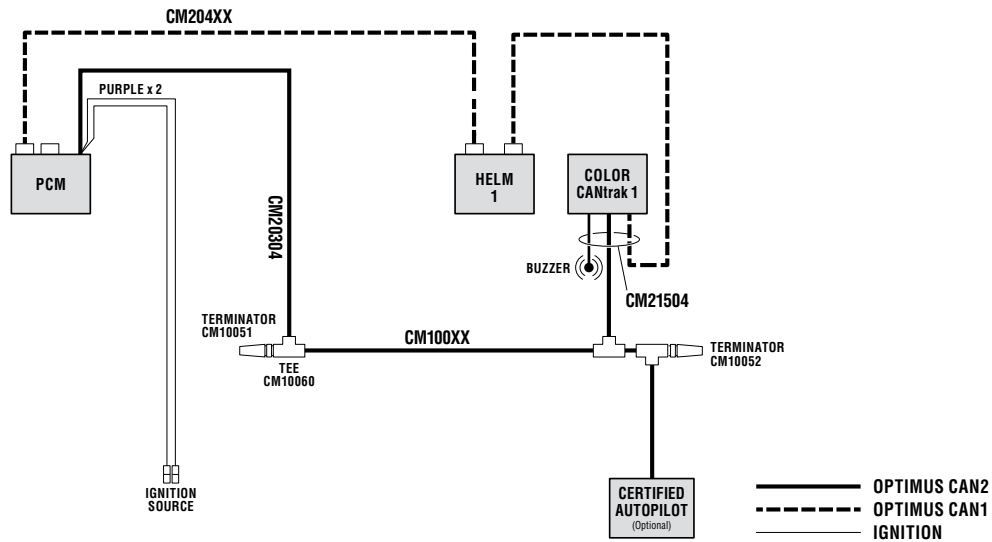


Figure 6-1. Network diagram — single station, twin sterndrive or inboard with twin independent rudder.

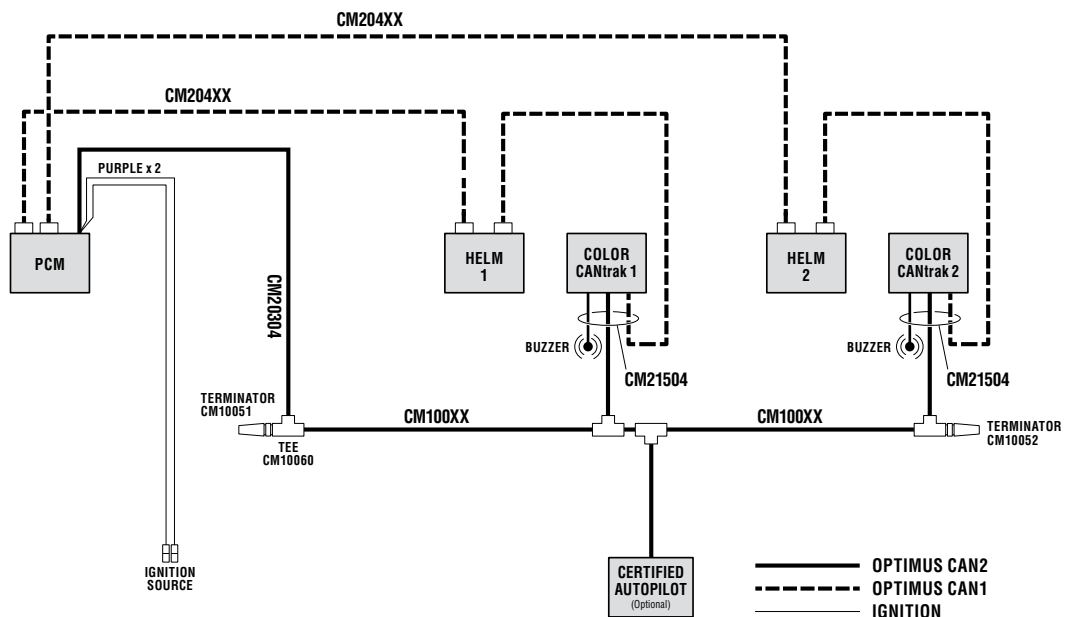


Figure 6-2. Network diagram — dual station, twin sterndrive or inboard with twin independent rudder.

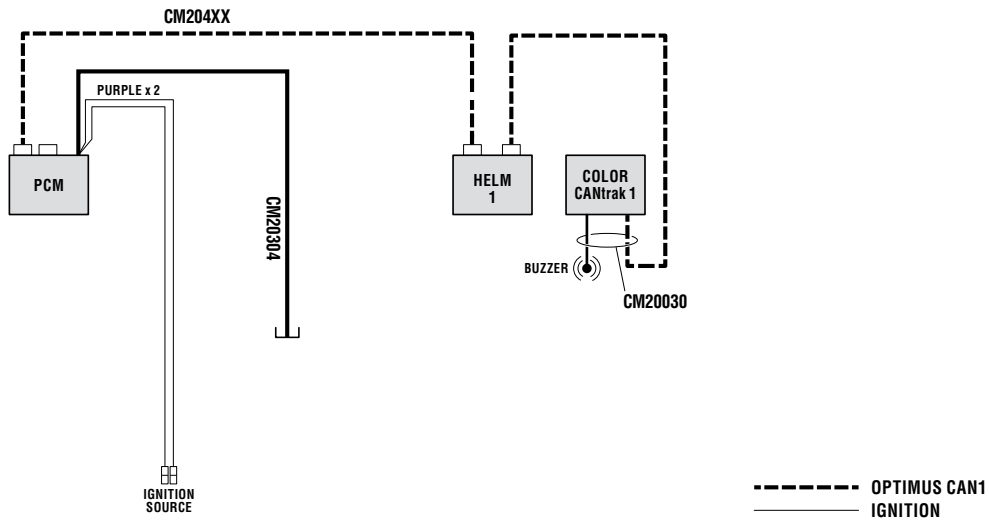


Figure 6-3. Network diagram — single station, single sterndrive or inboard with single steering cylinder.

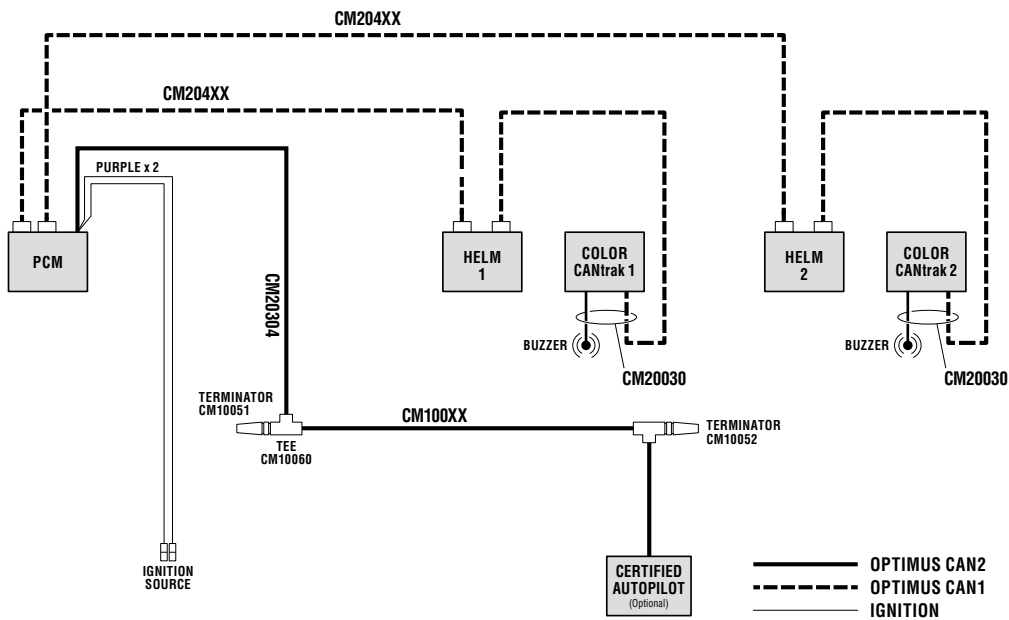


Figure 6-4. Network diagram — dual station, single sterndrive or inboard with single steering cylinder, with optional CAN2 for autopilot.

6.2 Harness Connections

6.2.1 Connecting the Helm

Connect the Helm to the PCM CAN1, Port 1, using harness CM204XX. See section 4.2.1 for available harness lengths. Use cable ties to strain-relieve the harness as shown below.

Note: See the figure on the next page for proper installation of the helm connector.

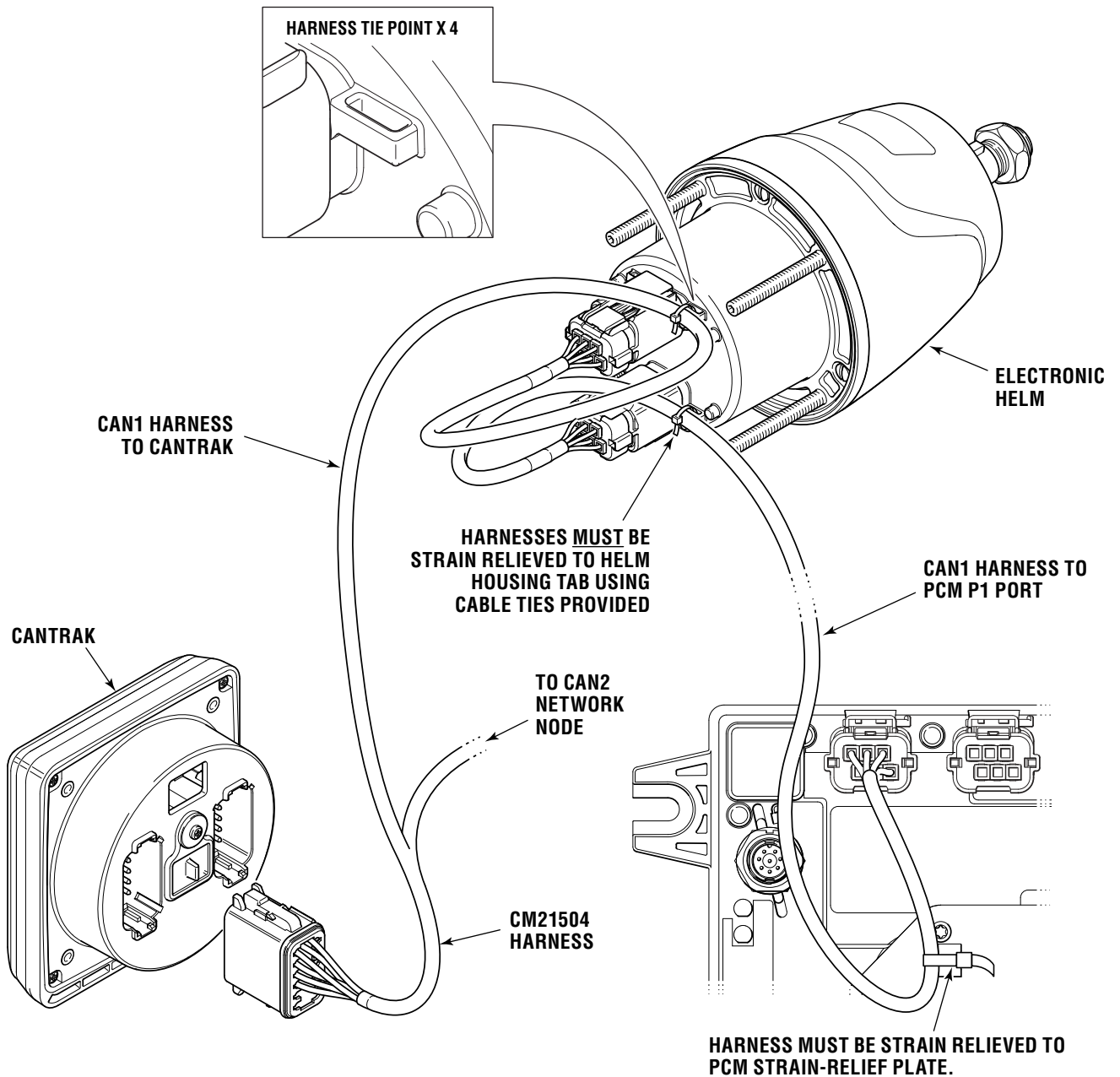


Figure 6-5.

⚠ WARNING

A SEALING PLUG MUST BE INSTALLED IN ANY UNUSED PORTS.

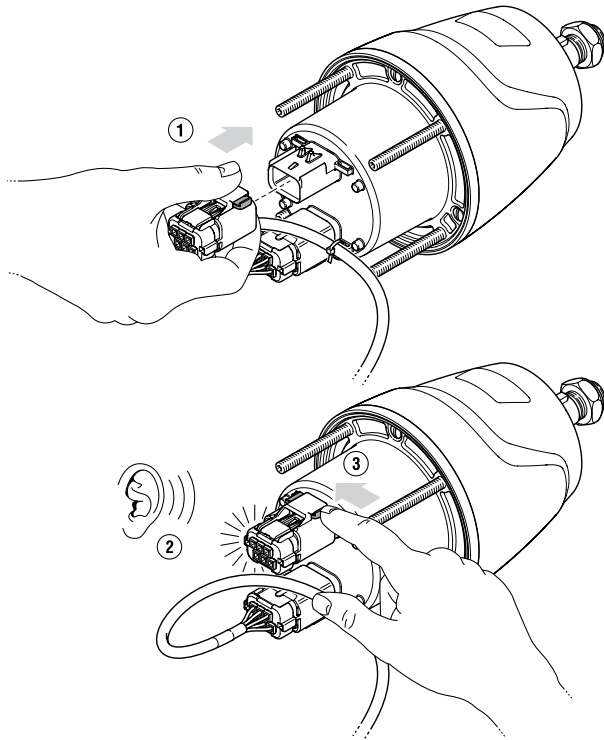
⚠ WARNING

FAILURE TO SECURE HARNESS MAY RESULT IN HARNESS WEAR, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.

To properly install connector, push into the socket, listen for it to click, then push the lock over, as shown below.

TO LOCK:

- 1. PRESS THE CONNECTOR FIRMLY ONTO THE RECEPTACLE**
- 2. LISTEN FOR THE "CLICK" AS THE CONNECTOR LOCKS**
- 3. PUSH TO ENGAGE THE SECONDARY LOCK**



TO UNLOCK:

- 1. PUSH TO DISENGAGE THE SECONDARY LOCK**
- 2. SQUEEZE TO UNLATCH THE CONNECTOR**
- 3. PULL TO REMOVE**

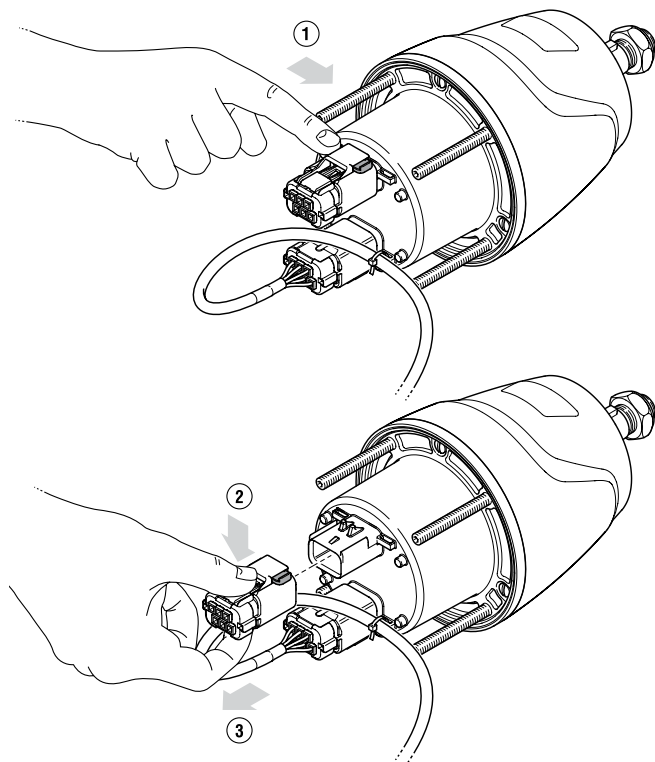


Figure 6-6.

6.2.2 Connecting a Second Station

Figure 6-7 shows the acceptable CAN1 connections when adding a second station. If harness lengths allow (see Section 4.2.1), connect the second helm to the second CAN1 port as shown in a). This parallel configuration makes it less likely that both helms would be lost if a wiring harness is damaged.

In some cases the control station layout will require a series connection as shown in b). This is allowable provided the total harness length is within the limits shown in section 4.2.1. This configuration requires a wye harness (CM21702) in order to have enough CAN1 ports available at the main station.

If more than two helms are required then a combination of these connections will be required.

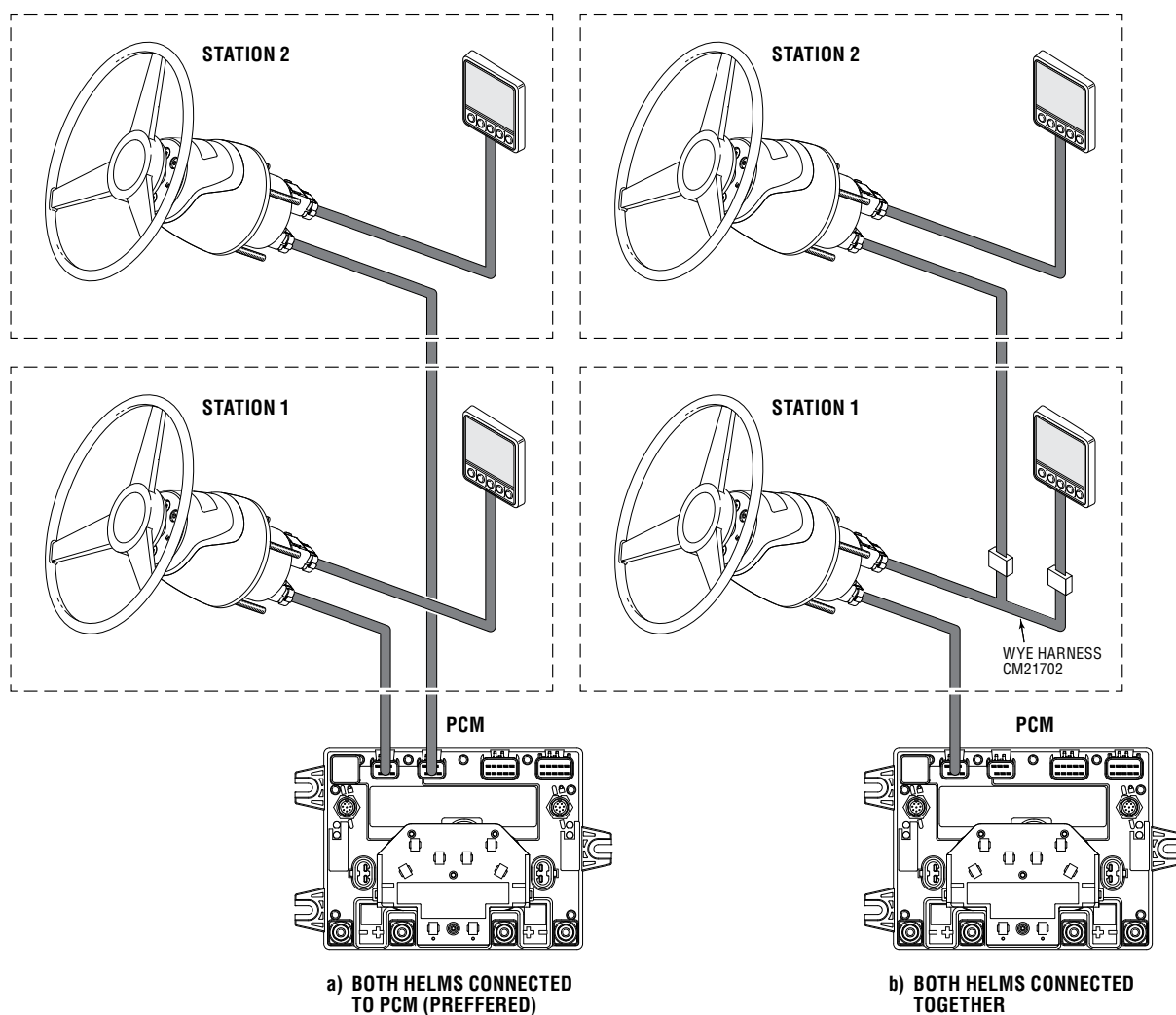
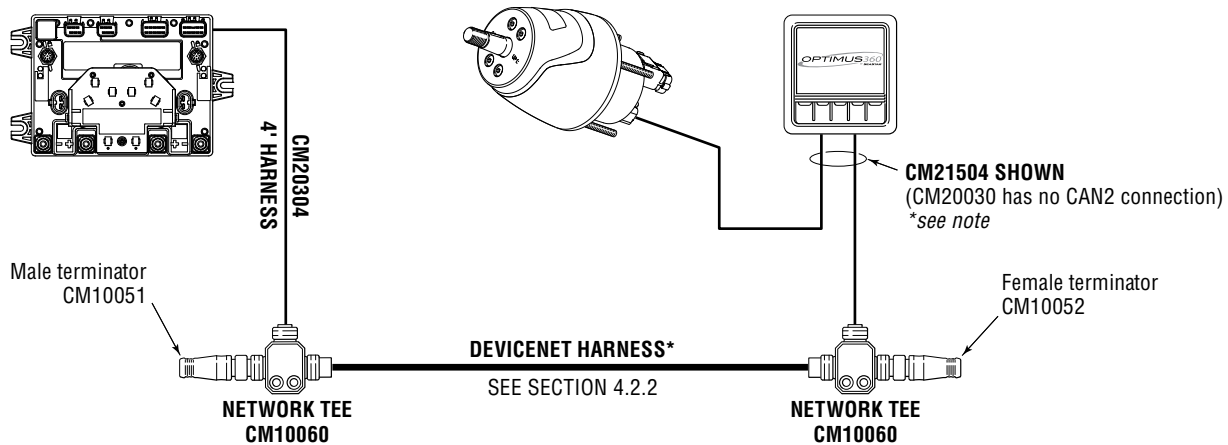


Figure 6-7. Alternate helm connections in dual-station applications.

6.2.3 Connecting the CANtrak

Plug the harness supplied with your CANtrak into the back of the display. The connector is keyed so that it will only go one way. Plug the rectangular CAN1 connector into the helm port and the round DeviceNet connector (ED1700 display only) into a CAN2 tee. Hand tighten all DeviceNet connections. Do not use tools.



*Note: the CAN1 harness connection to the helm may be extended using union harness CM22401 and an extension harness from table 4-1.

Figure 6-8. CANtrak connections. Multi-engine application shown.

⚠ CAUTION

All network Tees **MUST** be mounted securely using screws through both mounting holes.

⚠ CAUTION

Do not connect anything other than SeaStar Optimus components, or SeaStar approved autopilots, to the CAN2 network.

⚠ CAUTION

The CAN2 network operates at system voltage. If system voltage is 24V the CAN2 network may damage non-approved components that are plugged into it.

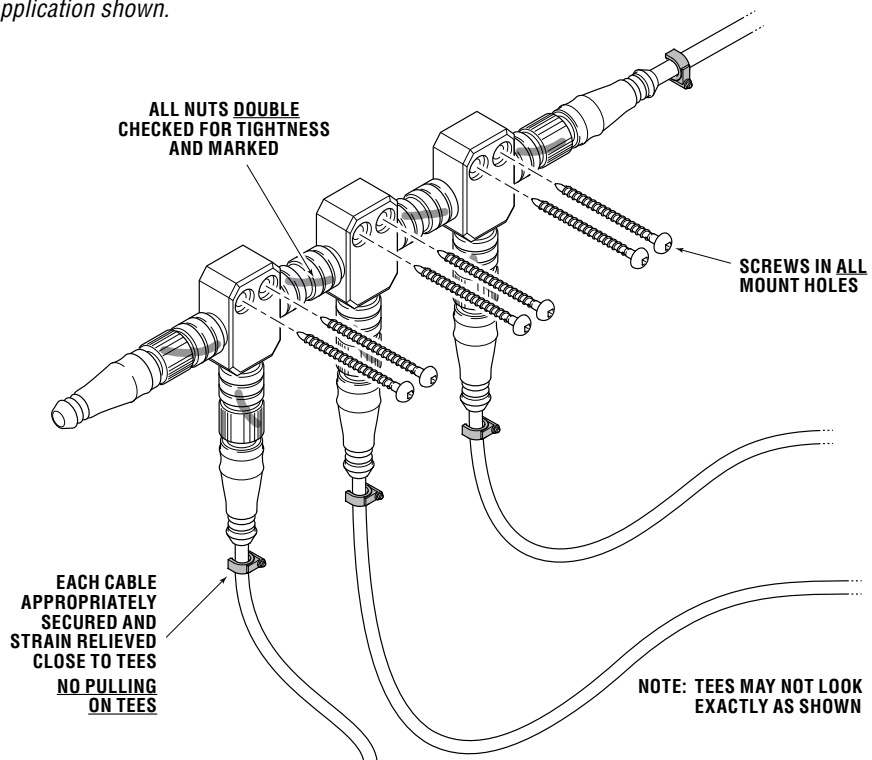


Figure 6-9.

When the installation is complete, Use a permanent marker to draw a line across all of the DeviceNet connections. If one of the connections becomes loose, it will be evident.

6.3 Power Wiring

⚠ WARNING

ALL ELECTRICAL CONNECTIONS AND HARNESS MUST COMPLY WITH ABYC WIRING STANDARDS, BE RATED FOR 105° C (221° F), AND COMPLIANT WITH SAEJ1128.

6.3.1 PCM Wiring

The proper wire gauge and circuit breaker rating must be used. See Section 4.3.2 for selection.

Use wire with red insulation for the positive connections and wire with black or yellow insulation for the negative connections.

1. Mount two circuit breakers, one for the port and one for the starboard power feed to each PCM within 7 inches from the power source. Use only circuit breakers designed for marine use, and with corrosion-resistant, stainless steel connection hardware.

ABYC Standards require the breakers be placed close to the batteries to protect the wires in case they are shorted. See the E-11 standard for complete details about the allowable wire length and placement of the breakers as they vary depending on how the batteries are located and protected.

⚠ CAUTION

Crimped and soldered connector lugs must be used on all PCM power connections.

⚠ CAUTION

Do not use Automatic Power Selectors (APS) or selector diodes of any kind on the PCM power or ignition wires. This functionality is already built into the PCM.

⚠ WARNING

NO ADDITIONAL DEVICES OR LOADS SHOULD BE CONNECTED TO THE PCM POWER AND GROUND POSTS. THE CIRCUIT BREAKER COULD TRIP, WHICH COULD RESULT IN LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.

NOTICE

ABYC standards require that the negative terminals of all batteries on the vessel be connected together. See ABYC E-11 for more information.

2. Run a wire from the negative terminal of the port battery to the negative terminal of the PCM port side. Run a separate wire from the negative terminal of the starboard battery to the negative terminal of the PCM starboard side.
3. Run the positive wires as shown in the diagram.
4. Tighten the PCM terminals to a maximum of 30 in-lb (3.5 Nm). Do not overtighten, as you may damage the terminals.

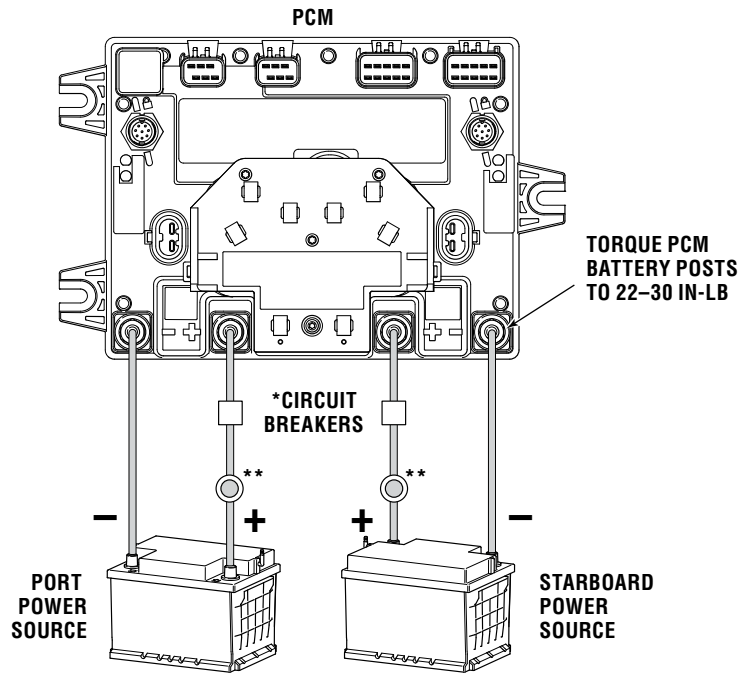


Figure 6-10.

- *Breakers are not supplied as part of the SeaStar Solutions Kit.
- ** Battery Switch (PCM power may be connected directly to the battery or to the battery switch).

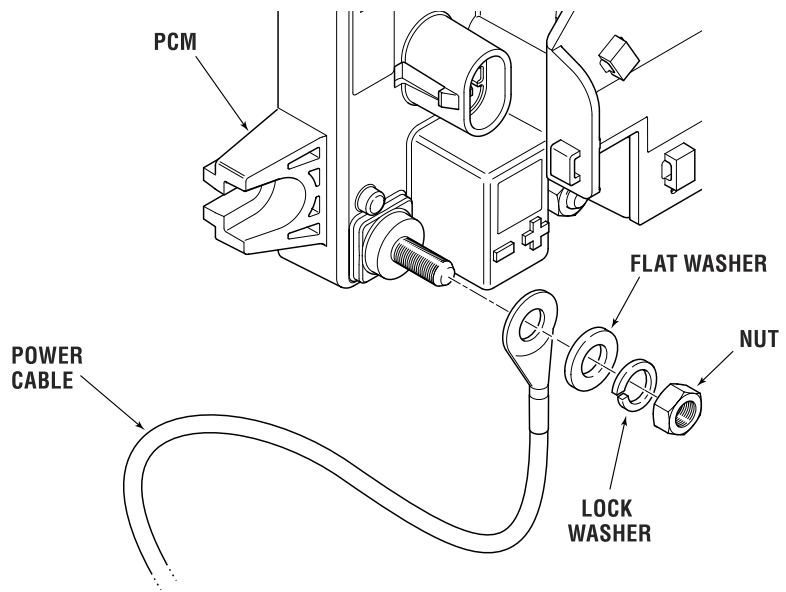


Figure 6-11.

6.3.2 PCM Wiring Strain Relief

- When all connections are made, strain relieve the wires as shown below. Be sure to properly strain relieve the wires at the power source as well.
- All unused ports must have sealing caps.

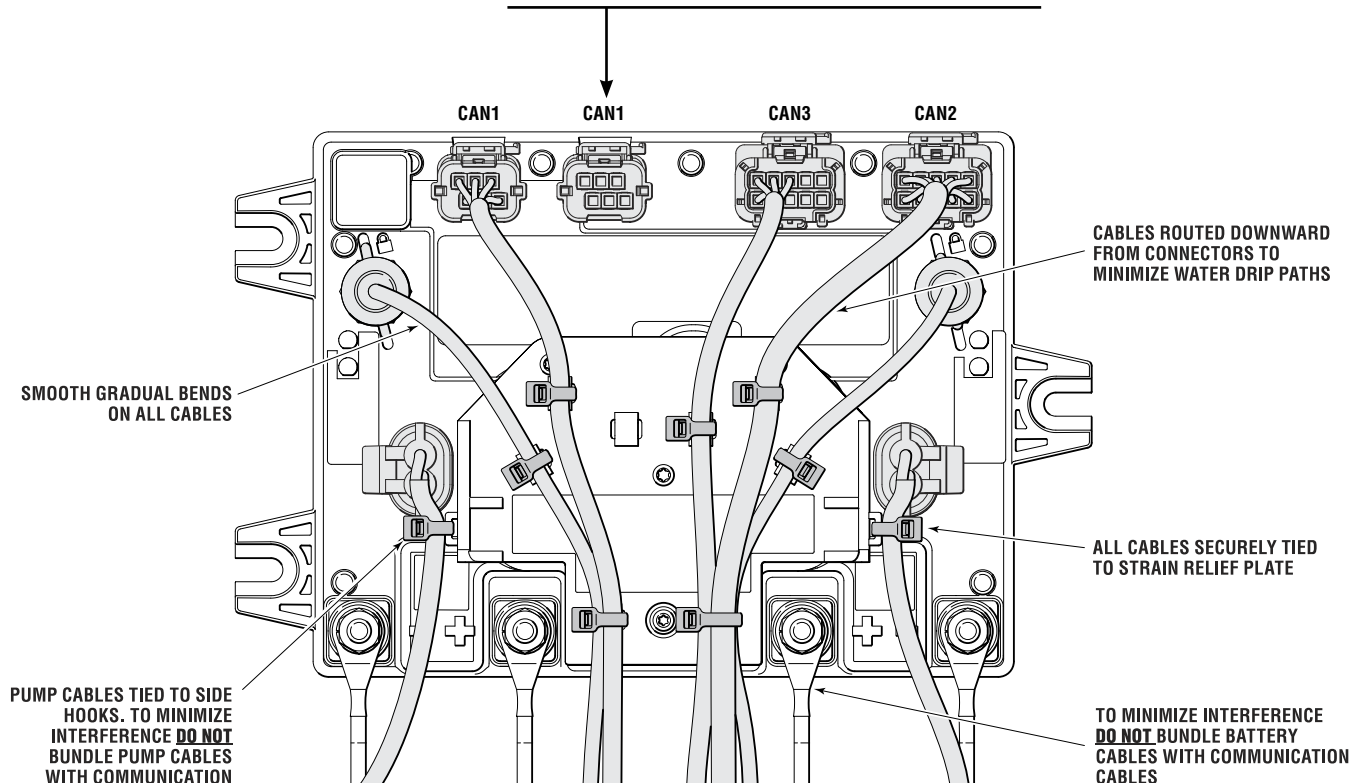


Figure 6-12.

⚠ WARNING

FAILURE TO SECURE HARNESS, AS SHOWN, MAY RESULT IN HARNESS WEAR, CAUSING LOSS OF STEERING CONTROL, PROPERTY DAMAGE, PERSONAL INJURY AND/OR DEATH.

⚠ WARNING

ALL UNUSED CONNECTORS REQUIRE SEALING PLUGS. THEY WILL LIKELY BE REQUIRED ON PCM AND THE HELM.

6.4 Ignition Sensing

The CM20304 harness connects through the CAN2 port on the PCM. It has two violet ignition sensing wires that must be connected to an ignition source (has system voltage when ignition is on). See section 6.4.1 for important ignition splicing instructions.

Twin-engine applications: Connect one sensing wire to the starboard ignition and the other to the port ignition.

Single engine applications: Connect one sensing wire to the engine ignition. Connect the second sensing wire to either a separately switched voltage source (preferred) or the same source. NEVER leave the second sensing wire unconnected. These connection options are illustrated in figure 2-3.

⚠ DANGER

THE INTEGRITY OF THE IGNITION SENSING CIRCUIT IS CRITICAL TO THE SAFE OPERATION OF THE STEERING SYSTEM. ALWAYS CONNECT BOTH SENSING LEADS AND ENSURE THAT WIRING AND SPLICES ARE PROPERLY STRAIN- RELIEVED AND PROTECTED FROM DAMAGE, WATER, OR OTHER HAZARDS.

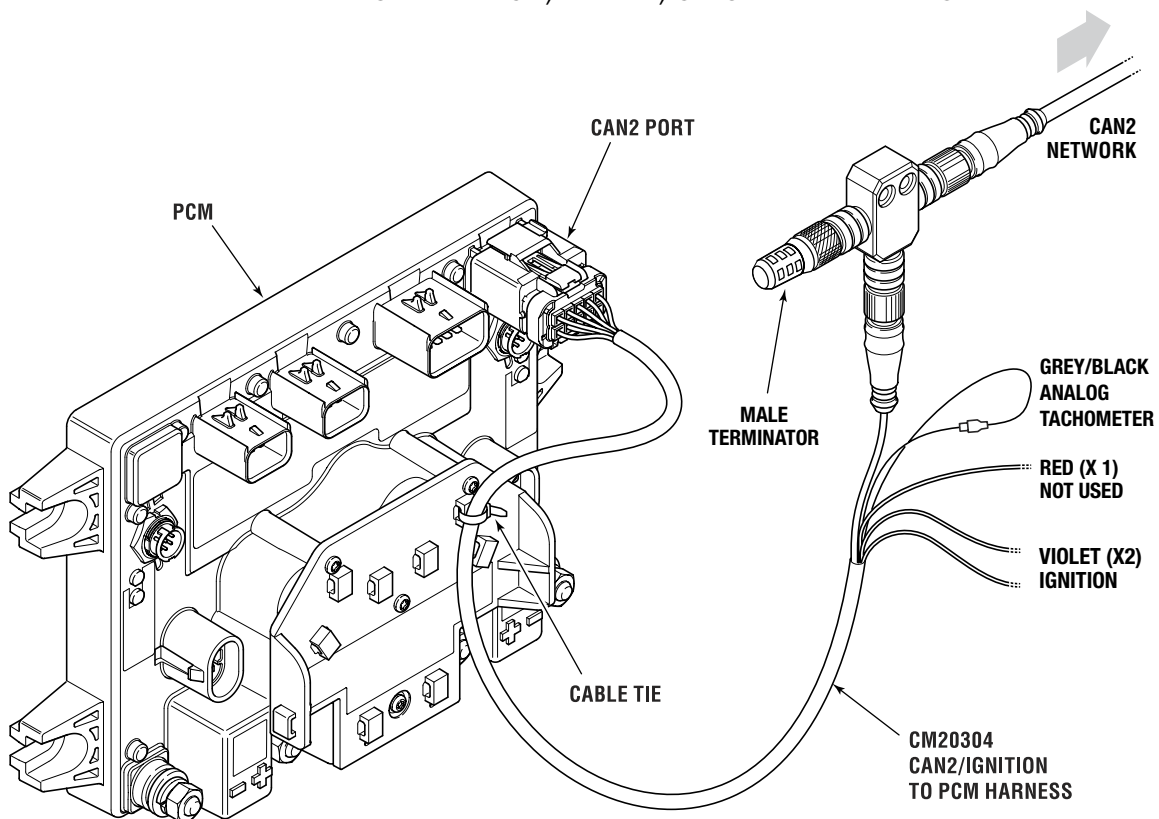


Figure 6-13.

6.4.1 Ignition Splicing

The integrity of the ignition connection is critical to the safe operation of the Optimus EPS steering system. Please note the following:

- Whenever possible, make your splice connections in dry areas of the vessel. If you must splice in a potentially wet area, always secure the wires in a way that keeps the splice out of pooling water.
- Use sealed, heat-shrink butt splices, such as Molex Perma-Seal, or a soldered connection with heat-shrink tubing. Always follow the manufacturer's installation instructions.
- Secure the wiring on both sides of the splice so that there is no strain on the splice connection.
- Choose a route for the wires that minimizes exposure to water, high temperatures, and mechanical damage.

On most vessels you will have one of two options for an ignition source: a single ignition source wire, or you will have to splice into an existing ignition wire.

Option 1 – single ignition source

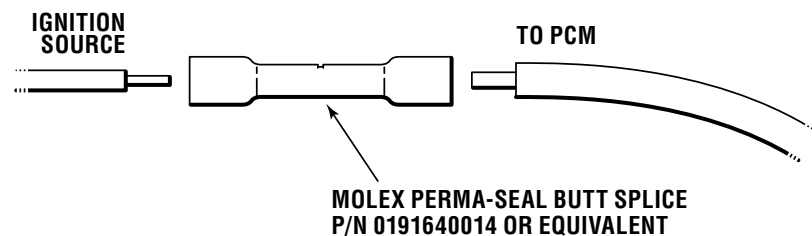


Figure 6-14

Option 2 – splice into an existing engine ignition wire

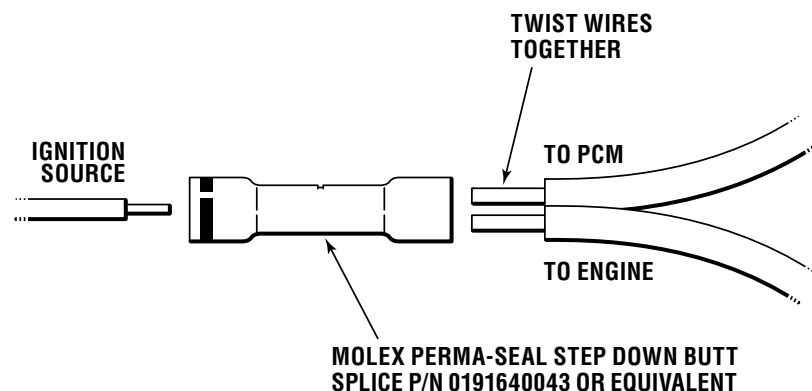


Figure 6-15.

6.5 Engine RPM Source

6.5.1 NMEA 2000 CAN Bus

There are two options for getting your engine speed source from an NMEA 2000 network.

Option 1 – Use existing bus: If an RPM signal is present on the NMEA 2000 bus you can connect the optional NMEA 2000 harness CM20503 to an available DeviceNet tee on the bus. If no tee is available, you will need to add one (CM10060). You may also require an extension harness to extend CM20503 to reach the tee.

Option 2 – Create new bus: You can create a basic NMEA2000 bus using kit HA5492. In addition to the kit you will need a gateway device that connects between the engine bus and the NMEA2000 bus, supplied by the engine manufacturer.

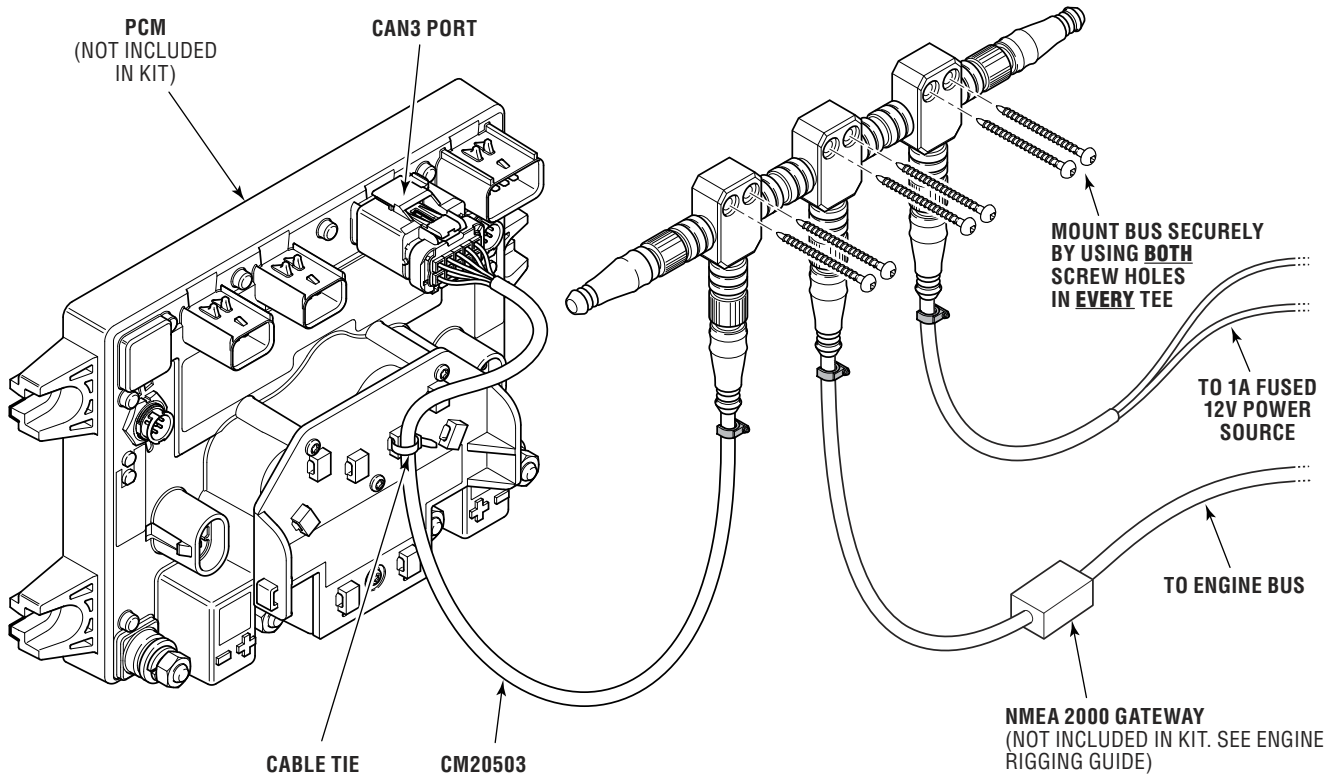


Figure 6-16. Creating an NMEA 2000 network with kit HA5492.

NOTICE

When using NMEA 2000 CAN Bus for engine RPMs ensure that the black and gray analog tachometer inputs from the CM20304 CAN2 Harness are connected together.

6.5.2 Analog Tachometer

If you are using analog tachometers as your engine speed source, you will need to connect the gray and black tachometer leads on harness CM20304 (see figure 6-13). Connect the gray wire to the port engine analog tach input, and the black (with gray stripe) wire to the starboard analog tach input. In a single-engine application connect only the gray tachometer wire.

The leads are fitted with Molex Perma-Seal bullet connectors. The male connector is Molex P/N 191640040 and the female connector is 191640054. Crimp and seal the mating connectors (not supplied by SeaStar) onto your tachometer leads, per the manufacturer's instructions, and push together to connect.

If you are getting your input source from an NMEA 2000 network (section 6.5.1) then you need to leave the gray and black wires connected to each other as shown in figure 6-13.

6.6 Autopilot Connection (Optional)

Autopilots certified by SeaStar as compliant with the EPS system will simply connect to an available CAN2 network tee*. The connection harness is supplied by the autopilot manufacturer. Refer to the manufacturer's instructions for additional information.

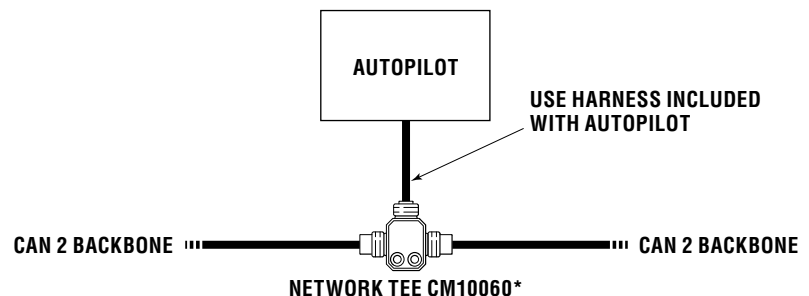


Figure 6-17. Autopilot connection to CAN 2 network.

* **Important Note:** If you are using a Simrad SG05 autopilot you must use a power isolating tee such as a Navico 000-12259-001 or a Garmin 010-11580-00.

6.7 Buzzer Kit (Optional)

Dual station boats do not require a CANtrak display at the second station. However, you must install a buzzer kit to notify the operator that the steering system has a fault and needs attention.

Locate the buzzer under the second station dash, near the helm. A warning label is included in the buzzer kit and must be applied to the dash in a visible location near the helm.

Connect the positive (yellow) and negative (pink) leads of the buzzer to the positive (yellow) and negative (pink) flying leads on the CANtrak harness at the main station.

Secure the wires adjacent to the splice for strain relief.

Crimp connections as follows:

- Strip the wires 7.6 mm (.3") from the end and insert into the barrel of the butt splices provided (Molex 0191640043) observing the correct orientation shown below:

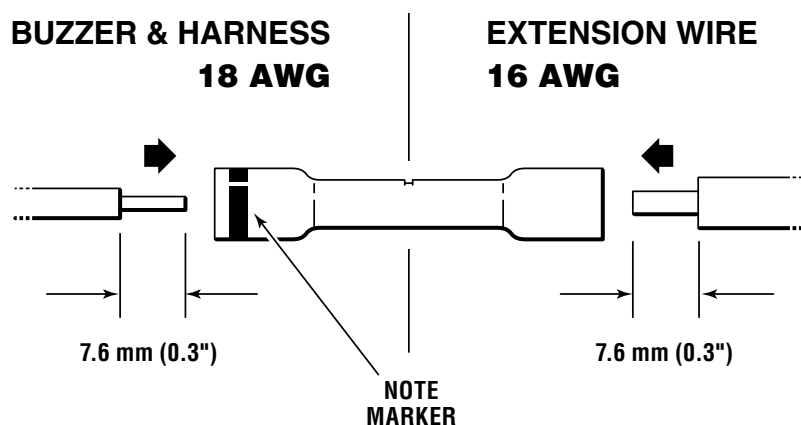


Figure 6-18.

- Making sure the wire end is properly seated, make the crimp connection using the recommended tool (Molex 0640014500, not included).
- Apply heat directly to the splice, working from the center out to the edges, using a hot air gun or other heat source, until the tubing shrinks and the adhesive flows.
- Allow to cool before inspecting splice and checking the integrity.

⚠ CAUTION

Reversing the polarity of the buzzer may result in damage to the CANtrak harness and/or CANtrak display. 16AWG wire has been included in the kit to power the buzzer and comply with ABYC E-11. Refer to the ABYC E-11 for required gauge if longer wire runs are required.

7.0 SYSTEM SETUP AND CONFIGURATION

At this point in the installation you are ready to turn the ignition on and set up your system. Refer to Book 65 – Setup and Configuration Guide for instructions.



Figure 7-1. Book 65.

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APPENDIX A MOUNTING TEMPLATES

A.1 Helm Templates

A.1.1 Front Mount Helm (EH1510/EH1512)

NOTICE

If this template has been downloaded electronically or copied from another document, please verify all template dimensions prior to cutting. Print/copy reproductions may be scaled differently.

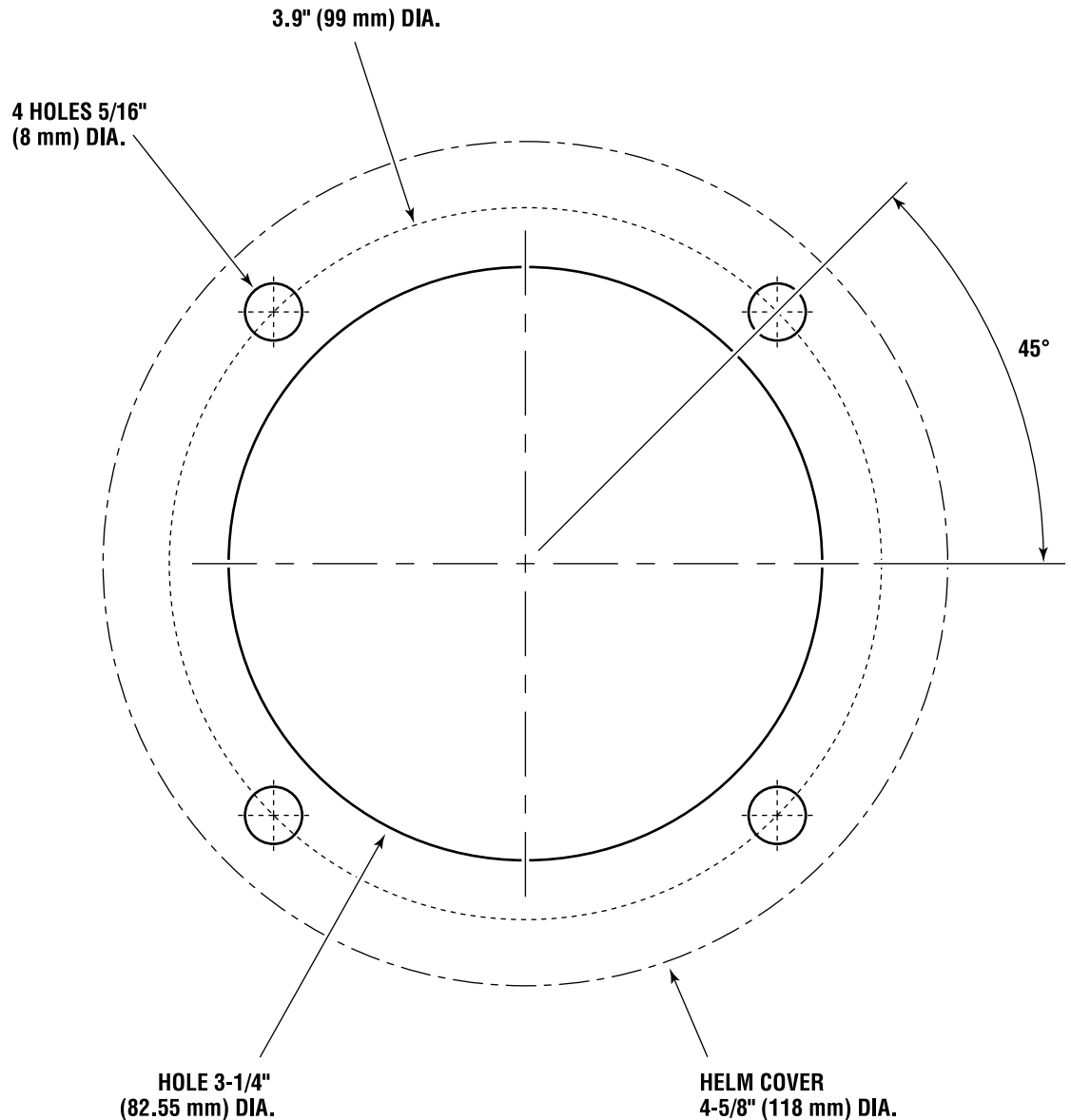


Figure A-1.

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A.1.2 Sport Plus Tilt Helm (EH1530/EH1532)

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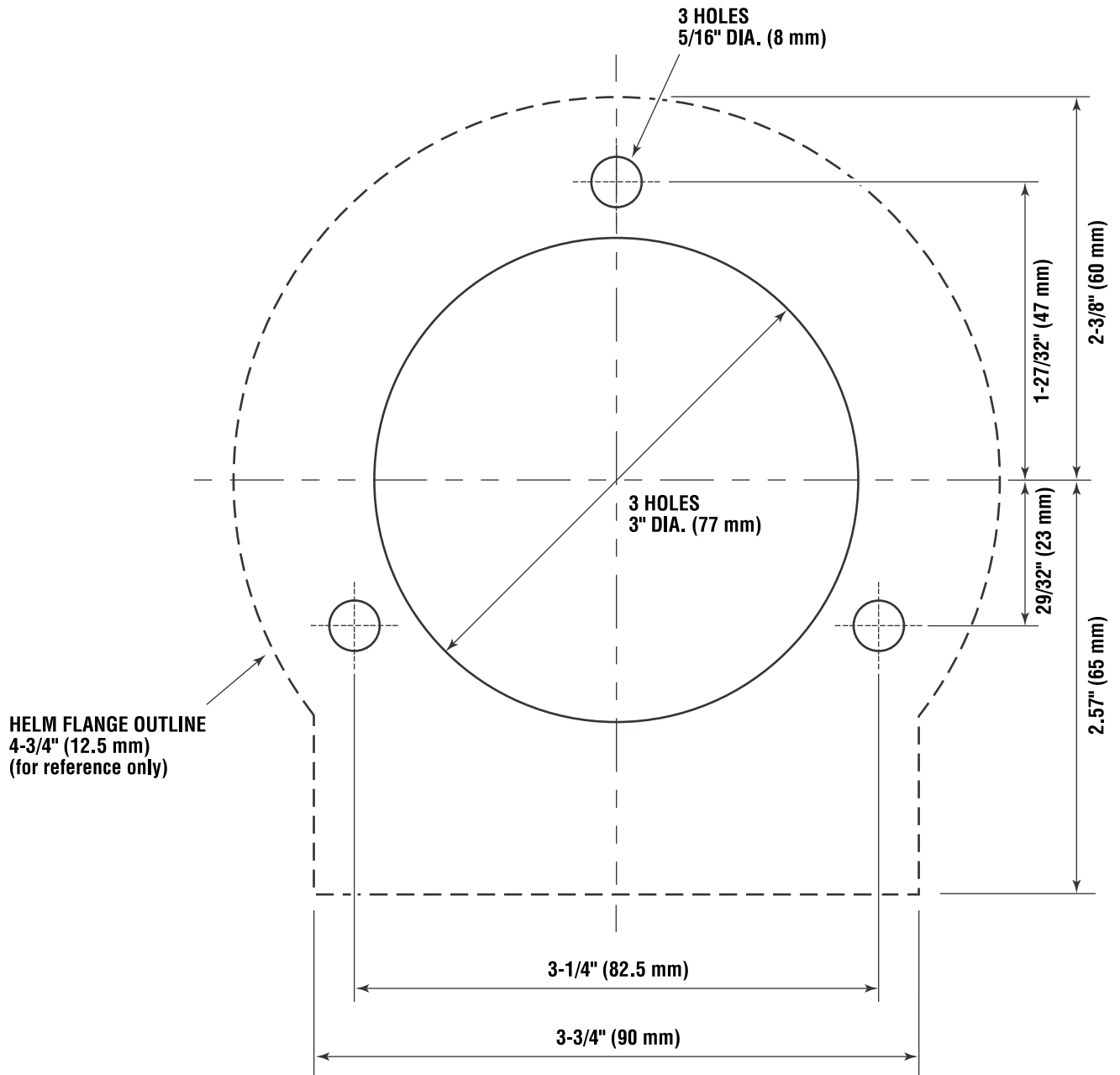


Figure A-2.

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A.1.3 Classic Tilt Helm (EH1550/EH1552)

NOTICE

If this template has been downloaded electronically or copied from another document, please verify all template dimensions prior to cutting. Print/copy reproductions may be scaled differently.

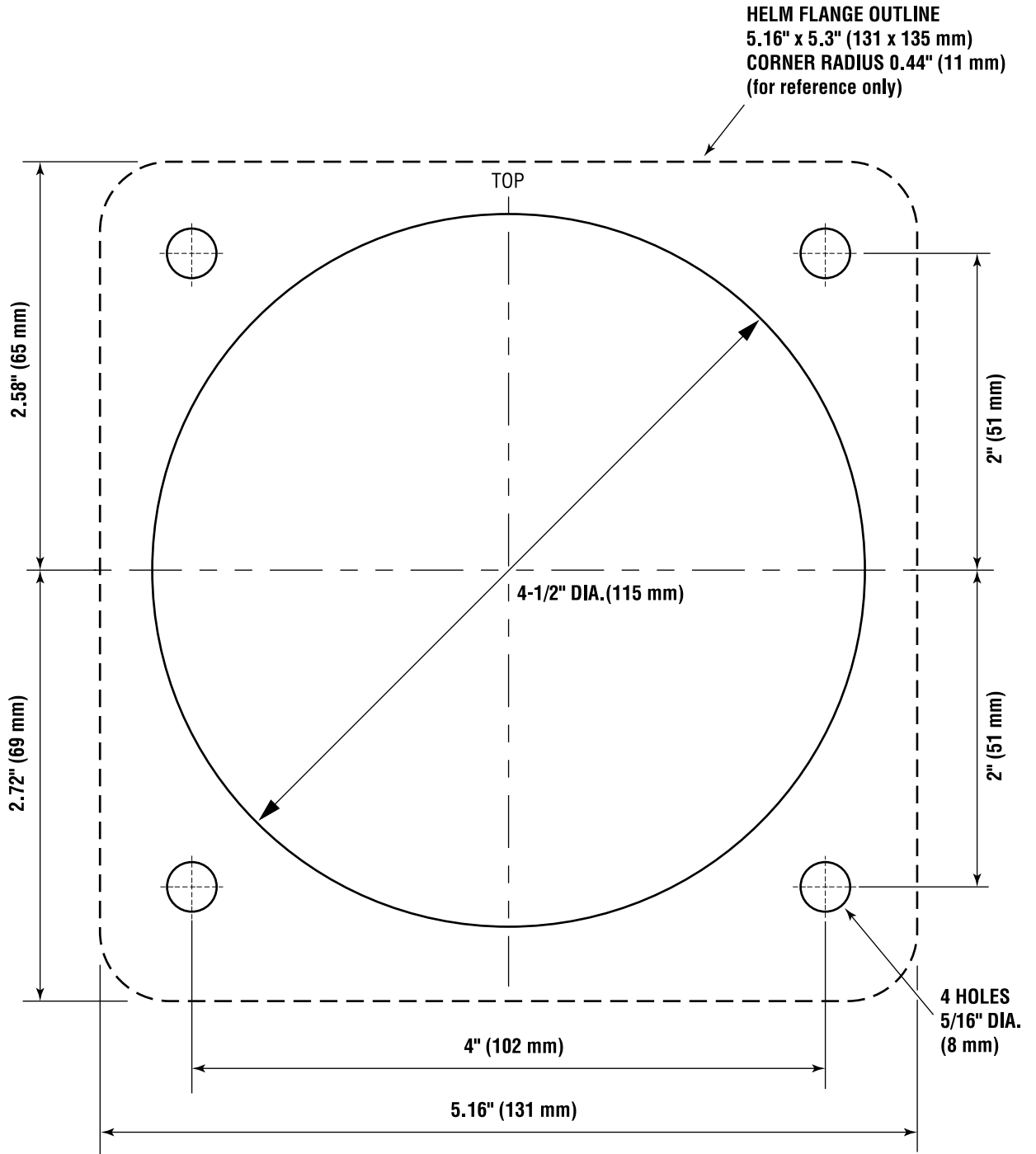


Figure A-3.

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A.1.4 Rear Mount Helm (EH1570/EH1572)

NOTICE

If this template has been downloaded electronically or copied from another document, please verify all template dimensions prior to cutting. Print/copy reproductions may be scaled differently.

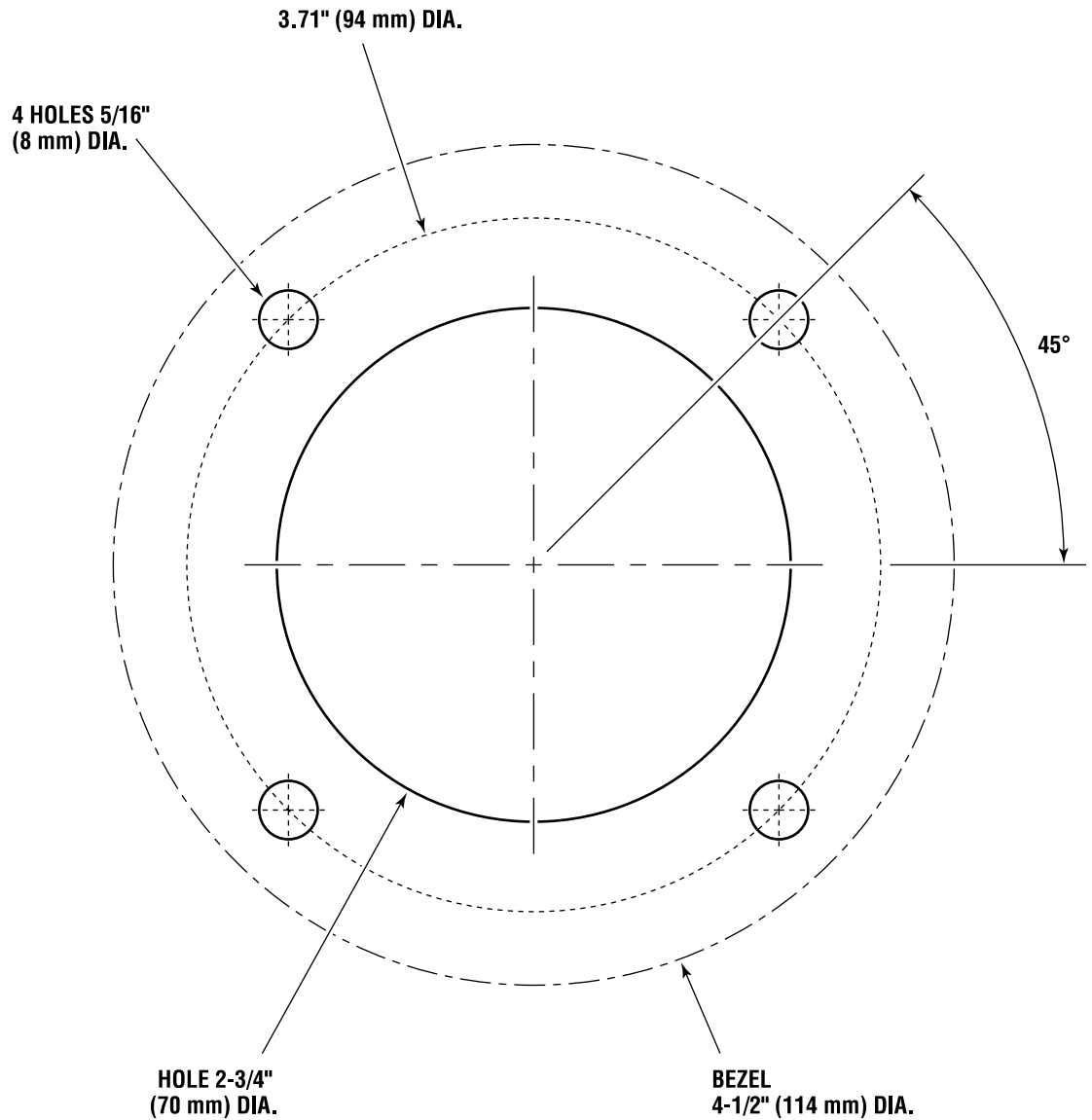


Figure A-4.

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A.2 CANtrak Display Template

NOTICE

If this template has been downloaded electronically or copied from another document, please verify all template dimensions prior to cutting. Print/copy reproductions may be scaled differently.

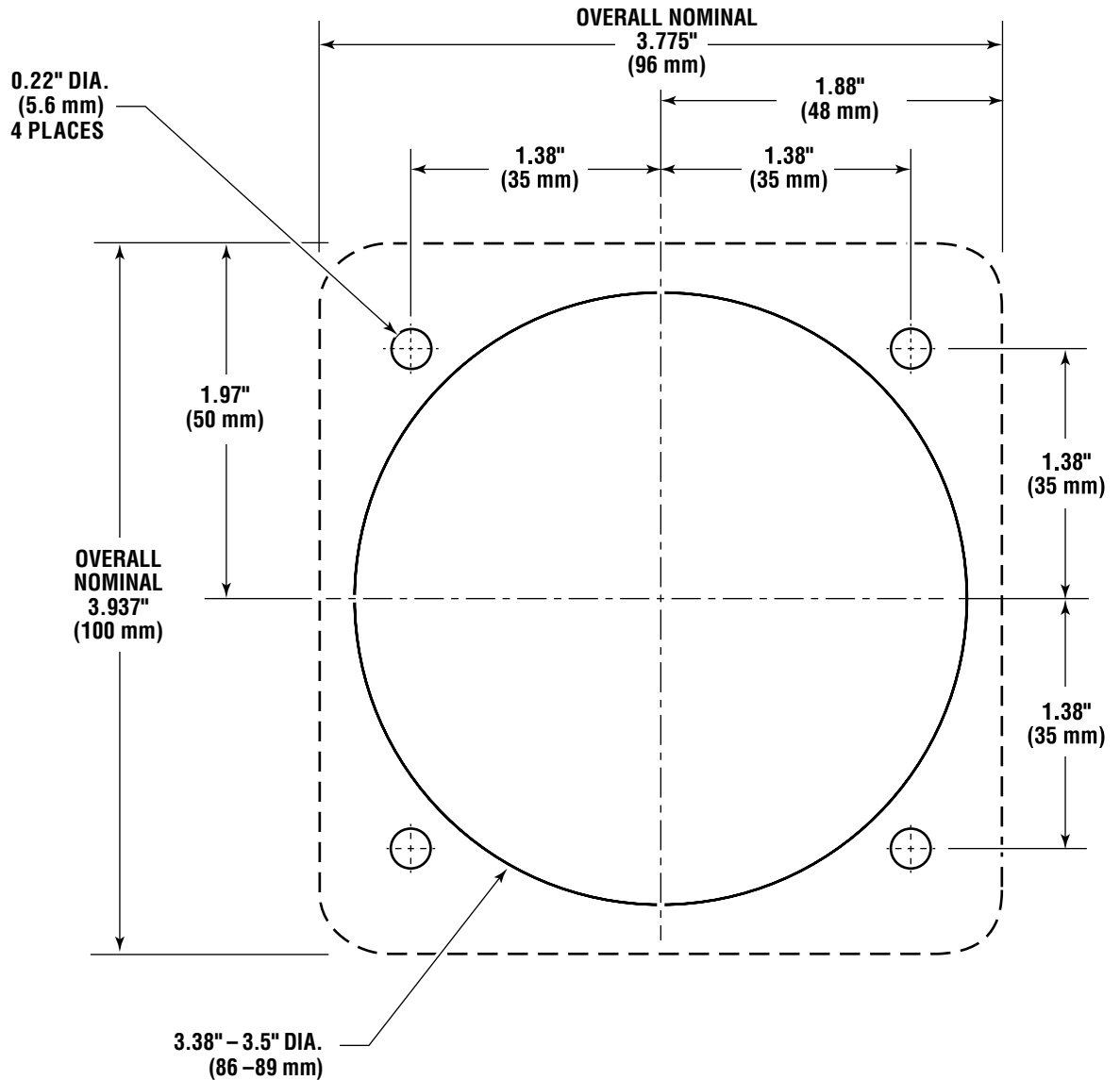


Figure A-5. Color CANtrak Display Mounting Template.

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A.3 PCM Mounting Dimensions

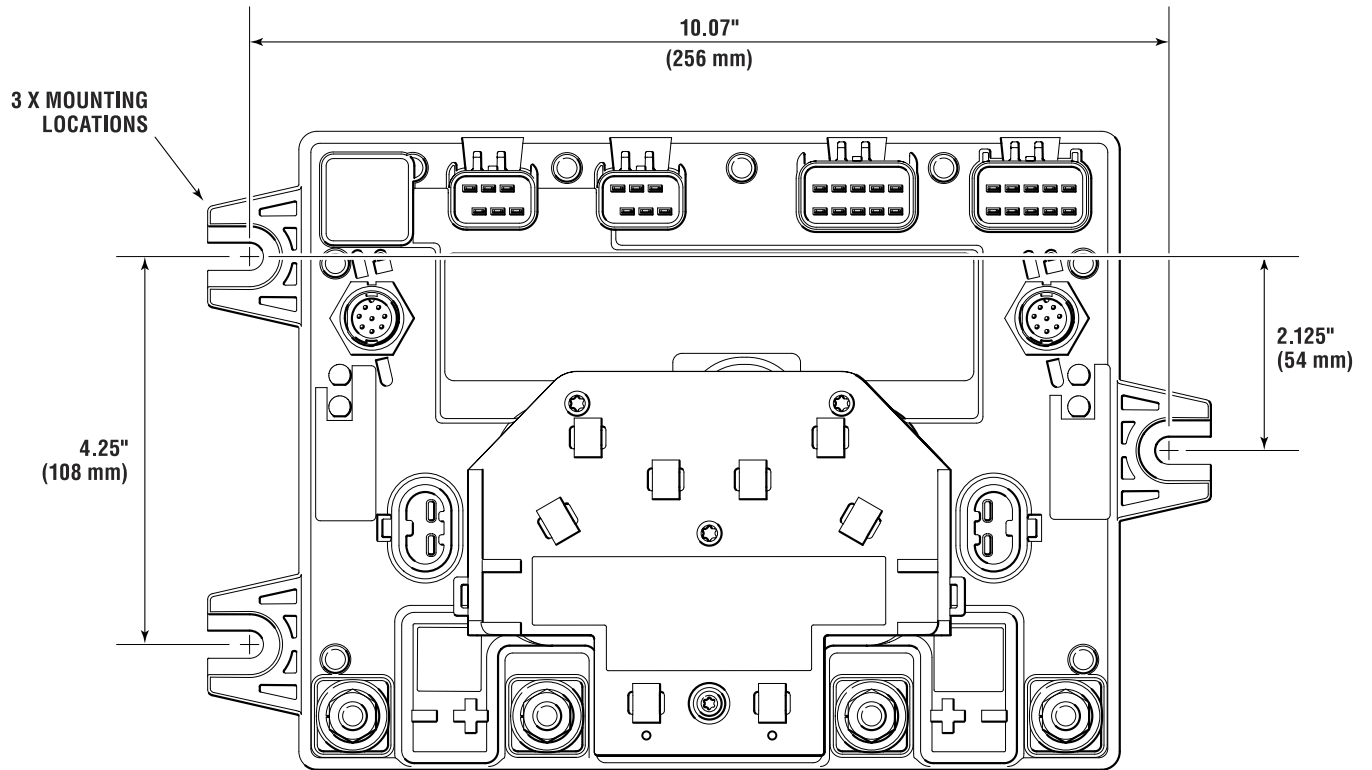


Figure A-6.

A.4 Power Steering Pump Mounting Dimensions

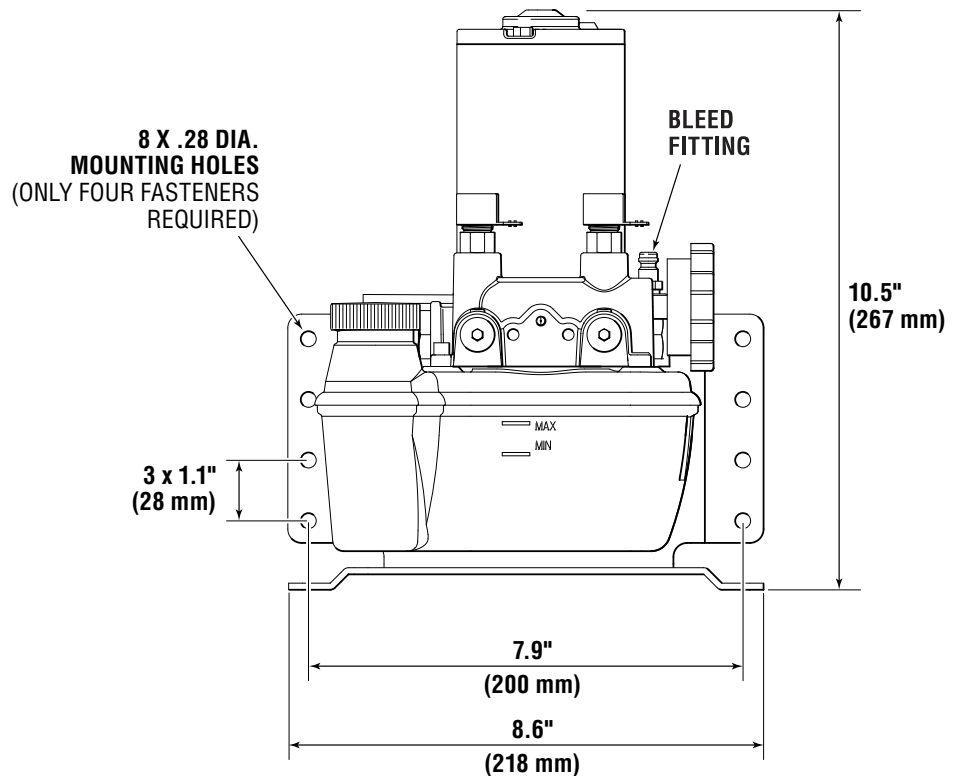
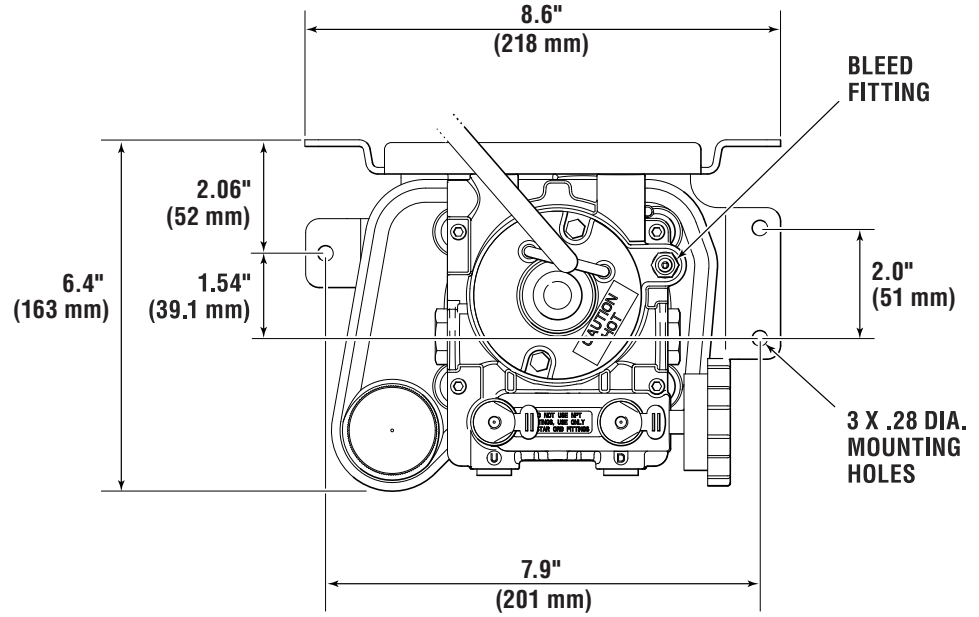


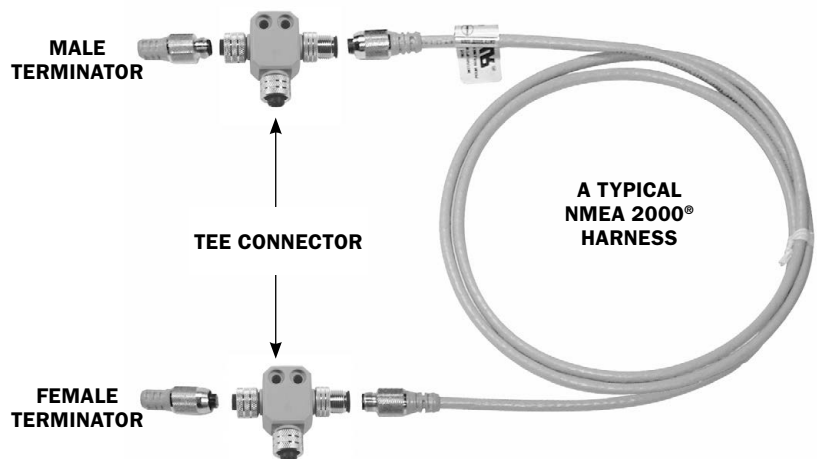
Figure A-7.

APPENDIX B CAN NETWORK

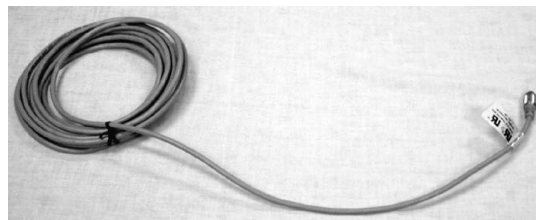
B.1 Basic Network

The NMEA 2000® protocol allows several types of harness. The one shown in this document is the smaller type used in pleasure boats and small vessels. The larger harness is used in shipboard applications. Any manufacturer may use their own harness but to adhere to the standard they must have an adaptor harness that allows easy connection to the approved harness. All SEASTAR SOLUTIONS CAN Bus harness meet the NMEA 2000® standard and will work with any other suppliers' harness that meet the NMEA 2000® standard.

While the NMEA 2000® standard allows separate wires and terminals all CAN Bus harness use the connectors shown in this manual. They are easy to install and result in a high quality, rugged, waterproof installation. The harness should never be cut and spliced.



CM100XX: A typical NMEA 2000® harness

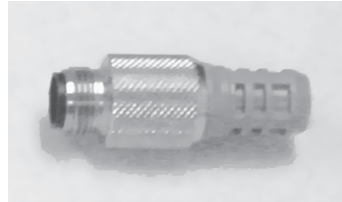


**CM100XX WHERE "XX" EQUALS THE LENGTH OF FEET.
SEE 4.2.2 FOR PART NUMBERS**

Figure B-1.

B.1.1 CAN Bus Connectors

CM10051: MALE TERMINATOR



CM10052: FEMALE TERMINATOR

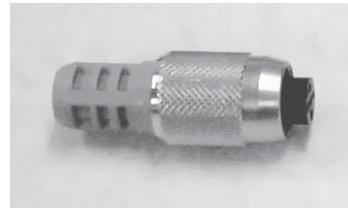


Figure B-2.

Tee Connectors:

Supplied by several vendors. Appearance may vary - parts are interchangeable.

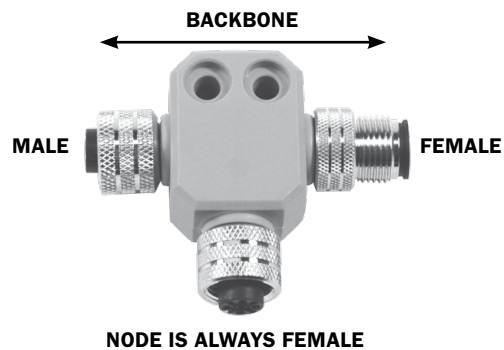


Figure B-3. CM10060: Single tee connector.

Note regarding connectivity of tee connectors:

- When connecting a tee connector to a component always install via the middle connection ("NODE").
- When connecting a tee connector to a CAN Bus harness to connect components that are far from each other, always install via the male/female end of the connector (whichever applies).
- Hand-tighten after the connection is made. **DO NOT** tightly tie down the tee connectors, as this will create stress.

B.1.2 CAN Bus Connectivity

The Network must consist of a single harness run to which devices are connected by means of a tee connector. All products must connect onto the node part of the tee connector. Each end of the harness must have a terminator. It is essential there be a total of two, and ONLY two, terminators - one located at each end of the backbone.

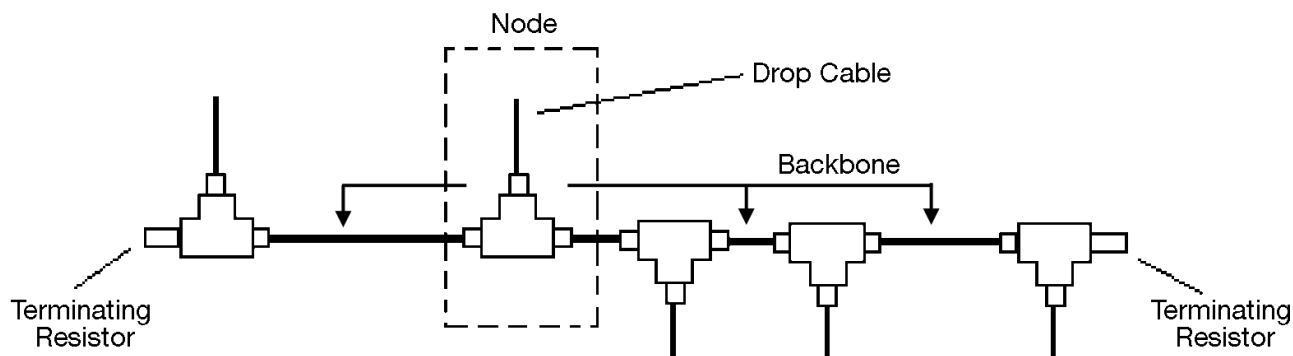


Figure B-4.

Note- a tee connector with nothing attached to its node is OK and will not effect the network. NEVER use a terminator to cap the node of an unused tee connector.

B.1.3 Electrical Harness

NOTICE

The electrical harness must not be cut or spliced. Replace worn or frayed harness.

When securing the harness and especially when tying down a number of direct connected tees never pull them down so tight as to cause strain or put a curve in the tees as this may cause a failure.

The cabling that is used conforms to the DeviceNet standard and was developed for Industrial applications. In general the harness are molded and the connection area is sealed with o-ring gaskets to provide a good seal from the environment. The harness are available in a variety of lengths.

When installing a NMEA 2000® CAN Bus system there are several things to keep in mind:

- The harness ends are male and female. To avoid a mismatch it is best to work from one end toward the other. If you must work from both ends toward the middle assure that the mating point will be a male/female connection.

-
- It is wise to plan for expansion. With so many new NMEA 2000® products entering the market and the ability to connect on to the bus for testing it is sometimes wise to use two harness where one would suffice. The connection of the two harness can later be separated so additional tees can be inserted to add another product or test equipment.
 - On 24 volt systems, a DC to DC converter or separate 12 volt battery is required.

B.1.4 Powering the Bus

The CAN Bus requires DC power. The voltage range is 9 to 16 volts. The power may be supplied by one or more of the products on the Data Bus or from a separate source. Most equipment manufacturers strongly recommends that at least two independent sources are used to supply the data bus power.

B.1.5 CAN Bus Power

The CAN Bus is used to supply power to all the items that are connected on the bus. For items drawing less than one amp, not having any other power connection, or another path back to ground the entire power for the item may be pulled from the CAN Bus. This requires the CAN Bus to have adequate sources of power. Note that the private CAN2 network is powered from the PCM. Only the public CAN3 network requires external power.

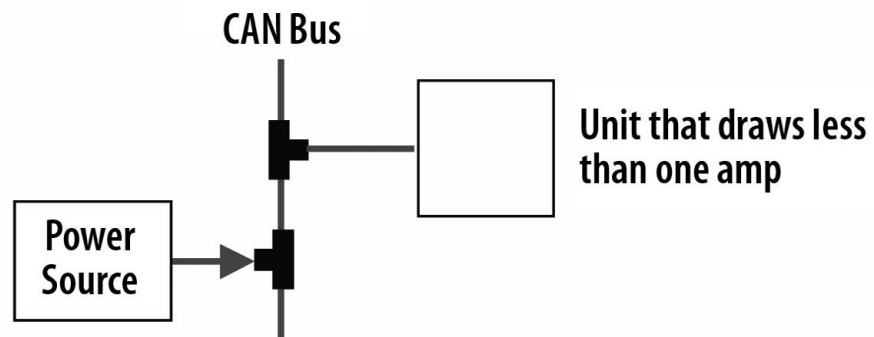


Figure B-5.

APPENDIX C BOLT TORQUE SPECIFICATIONS

These are the recommended maximum torque values for reusable dry bolts. Bolts should be torqued to this value +0% - 20%. For lubricated bolts, multiply the dry bolt torque values by 0.75.

Values are stated in: ft/lbs (N.m)								
Bolt Size	18-8SS	Brass	Bolt Size	18-8SS	Brass	Bolt Size	18-8SS	Brass
2-56	2.5 (.282)	2.0 (.226)	6-32	9.6 (1.08)	4.9 (.554)	5/16"-18	132.0 (14.91)	107.0 (12.10)
2-64	3.0 (.338)	2.5 (.282)	6-40	12.0 (1.35)	9.9 (1.12)	5/16"-24	142.0 (16.04)	116.0 (13.11)
3-48	3.9 (.440)	3.2 (.361)	8-32	20.0 (2.25)	16.0 (1.81)	3/8"-16	236.0 (26.66)	192.0 (21.71)
3-56	4.4 (.497)	3.6 (.407)	8-36	22.0 (2.48)	18.0 (2.03)	3/8"-24	259.0 (29.20)	212.0 (23.97)
4-40	5.2 (.587)	4.3 (.486)	10-24	23.0 (2.59)	19.0 (2.14)			
4-48	6.6 (.740)	5.4 (.610)	10-32	32.0 (3.61)	26.0 (2.94)			
5-40	7.7 (.869)	6.3 (.712)	1/4"-20	75.0 (8.47)	62.0 (7.01)			
5-44	9.4 (1.06)	7.7 (.869)	1/4"-28	94.0 (10.6)	77.0 (8.70)			
Values are stated in: ft/lbs (N.m)								
Bolt Size	18-8SS	Brass	Bolt Size	18-8SS	Brass	Bolt Size	18-8SS	Brass
7/16"-14	31.0 (42.00)	26.0 (35.25)	5/8"-11	93.0 (126.09)	76.0 (103.04)	1"-8	287.0 (389.12)	235.0 (318.62)
7/16"-20	33.0 (44.74)	27.0 (36.61)	5/8"-18	104.0 (141.00)	85.0 (115.24)	1"-14	259.0 (351.16)	212.0 (287.43)
1/2"-13	43.0 (58.30)	35.0 (47.45)	3/4"-10	128.0 (173.55)	104.0 (141.00)			
1/2"-20	45.0 (61.01)	37.0 (50.17)	3/4"-16	124.0 (168.12)	102.0 (138.29)			
9/16"-12	57.0 (77.28)	47.0 (63.72)	7/8"-9	194.0 (236.03)	159.0 (215.58)			
9/16"-18	63.0 (85.42)	51.0 (69.15)	7/8"-14	193.0 (261.67)	158.0 (214.22)			

Notes

WARRANTY

Statement of Limited Warranty

We warrant to the original retail purchaser that **Marine Canada Acquisition Inc. DBA SEASTAR SOLUTIONS** (herein forward referred to as **SeaStar Solutions**) products have been manufactured free from defects in materials and workmanship. This warranty is effective for two years from date of purchase, excepting that where **SeaStar Solutions** products are used commercially or in any rental or income producing activity, then this warranty is limited to one year from the date of purchase.

We will provide replacement product without charge, for any **SeaStar Solutions** product meeting this warranty, which is returned (freight prepaid) within the warranty period to the dealer from whom such product were purchased, or to us at the appropriate address. In such a case **SeaStar Solutions** products found to be defective and covered by this warranty, will be replaced at **SeaStar Solutions'** option, and returned to the customer.

The above quoted statement is an extract from the complete **SeaStar Solutions** products warranty statement. A complete warranty policy is available in our **SeaStar Solutions** products catalogue.

Return Goods Procedure

Prior to returning product to **SEASTAR SOLUTIONS** under warranty, please obtain a *Return Goods Authorization number* (claim number).

Be sure to label the goods with:

- a) the name and address of the sender, and
- b) the return goods authorization number (claim number)

Please address the returned goods as follows:

From U.S.A.

RGA # ?
SeaStar Solutions
c/o UPS-SCS
19308 70th Ave S.
Kent, WA 98032

From Canada

RGA # ?
SeaStar Solutions
3831 No.6 Road
Richmond, B.C.
Canada V6V 1P6

Technical Support

Phone: 604-248-3858

email: seastar@seastarsolutions.com

Hours: Monday to Friday 05:00 – 15:30 PST

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