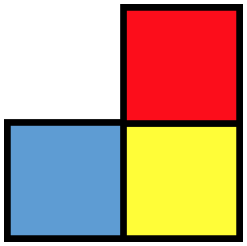
TCM-122 Thruster Control Module

Installation and Troubleshooting Guide



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Warnings / Cautions

WARNING: Before installing or troubleshooting any part of a bow / stern thruster system, locate the main battery switch that disconnects the thruster from all power sources (batteries) and ensure the thruster system is de-energized.

WARNING: The TCM-122 thruster control module is NOT an ignition protected device. It must not be installed in compartments or spaces requiring ignition protected electrical equipment.

WARNING: Never operate thrusters in close proximity to persons, animals or objects in the water. Serious injury or damage will occur if persons, animals or objects come in contact with rotating propellers.

WARNING: Do not operate the thruster unless the thruster propeller is submerged in water. Operating the thruster without mechanical resistance will allow it to spin up to dangerous RPM levels.

CAUTION: Thrusters are designed for short duration / intermittent use while docking or maneuvering. Thrusters can be operated continuously only for several minutes before overheating. Most thruster motors have a built-in thermal switch that will shut off the thruster motor ONLY IF the thermal switch is properly connected to the TCM-122 Thruster Control Module.

CAUTION: The thermal shut down feature described above can be disabled on the TCM-122 if your thruster motor is not equipped with a thermal shut-off switch. If the thermal shut off feature is disabled be sure to run the thruster motor ONLY for short periods. Overheating will cause serious damage to the motor windings.

CAUTION: The TCM-122 Thruster Control Module will protect the thruster motor against sudden reversal. The thruster can be used repeatedly to “bump” the boat in one direction, but a delay of several seconds will elapse to allow the thruster motor to coast to a stop before it can be operated in the reverse direction. Be sure to keep this in mind when using bow / stern thrusters to maneuver the boat.

CAUTION: Some thruster installations have controls in more than one location. Ensure only one directional control switch is used at the same time. If conflicting inputs are received simultaneously by the TCM-122, the thruster will not operate

CAUTION: If the thruster stops giving thrust while the thruster motor is running, there is possibly a problem in the drive system. You must immediately stop running the thruster and turn it off. Running the thruster motor for more than a few seconds without resistance from the propeller can cause serious damage.

WARNING: In addition to this manual, read and familiarize yourself with the Operating and Installation manuals for your thruster system. Be sure to comply with ALL WARNINGS and CAUTIONS that are applicable to your thruster system.

1 Introduction

This manual provides installation instructions for the TCM-122 thruster control module along with basic troubleshooting information. The TCM-122 control module is an aftermarket product that is compatible with Volvo Penta QL® BP-series bow and stern thrusters. It is a compatible replacement for P/N 41100658.

WARNING: The TCM-122 thruster control module is NOT an ignition protected device. It MUST NOT be installed in compartments requiring ignition protection.

1.1 Product Specifications:

Nominal operating voltage:	12/24 VDC
Dimensions:	138mm x 64mm x 29mm
Connector:	10-pin screw terminal (pluggable)
Directional Control Input:	SPDT switch between Switch Common and Port or Stbd Command
Directional Control Output:	V_{batt} and GND (reversible)
Over-Temp Protection:	Yes
Ignition protection:	***NO***

1.2 LED Indicators

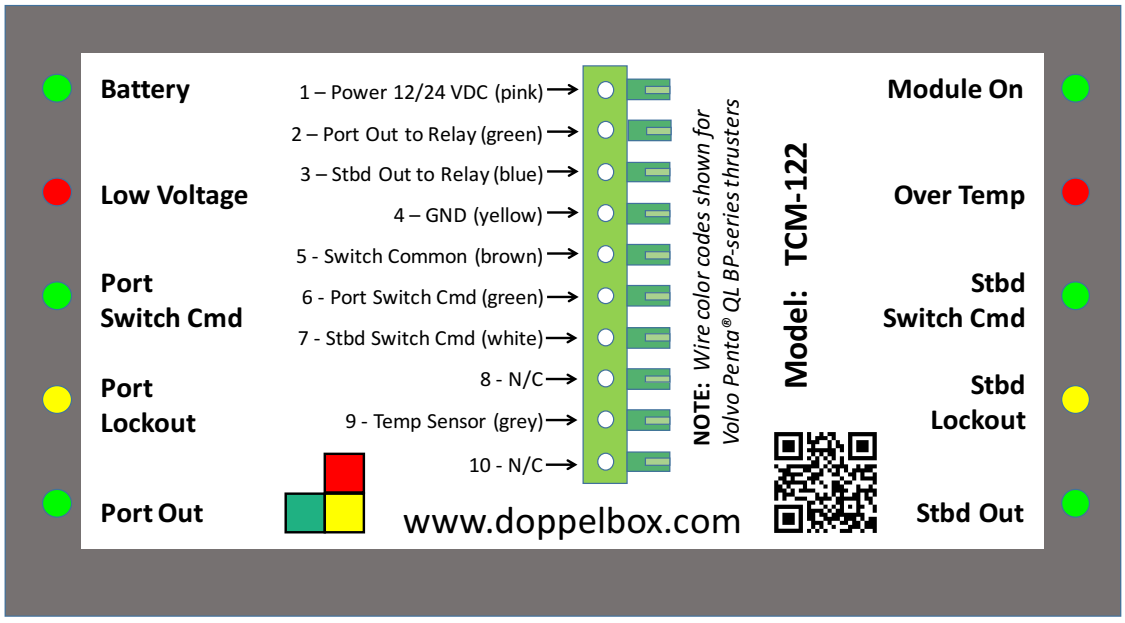

Figure 1 Front View of TCM-122 Incudes LEDs and Terminal Pin Descriptions

The TCM-122 features several LEDs to aid in installation and troubleshooting:

Battery:	Indicates module is connected to 12/24 VDC
Module On:	Module powered ON
Low Voltage:	Low battery voltage condition is detected
High Temp:	Thruster motor over-temperature condition is detected
Port Cmd:	Module is receiving PORT directional command from Directional Control Switch/Joystick
Stbd Cmd:	Module is receiving STARBOARD directional command from Directional Control Switch/Joystick
Port Lockout:	Thruster operation in PORT direction momentarily disabled
Stbd Lockout:	Thruster operation in STARBOARD direction momentarily disabled
Port Out:	Module sending signal to thruster to operate in PORT direction
Stbd Out:	Module sending signal to thruster to operate in STBD direction

NOTE: Further details on LED indicators are provided in the Installation and Troubleshooting sections below.

2 Bow/Stern Thruster Basics

Troubleshooting a malfunctioning bow or stern thruster can be daunting, but the task is more manageable once basic operation is understood. The TCM-122 Thruster Control Module is designed for use with bow and stern thruster systems with the basic layout shown in Figure 2.

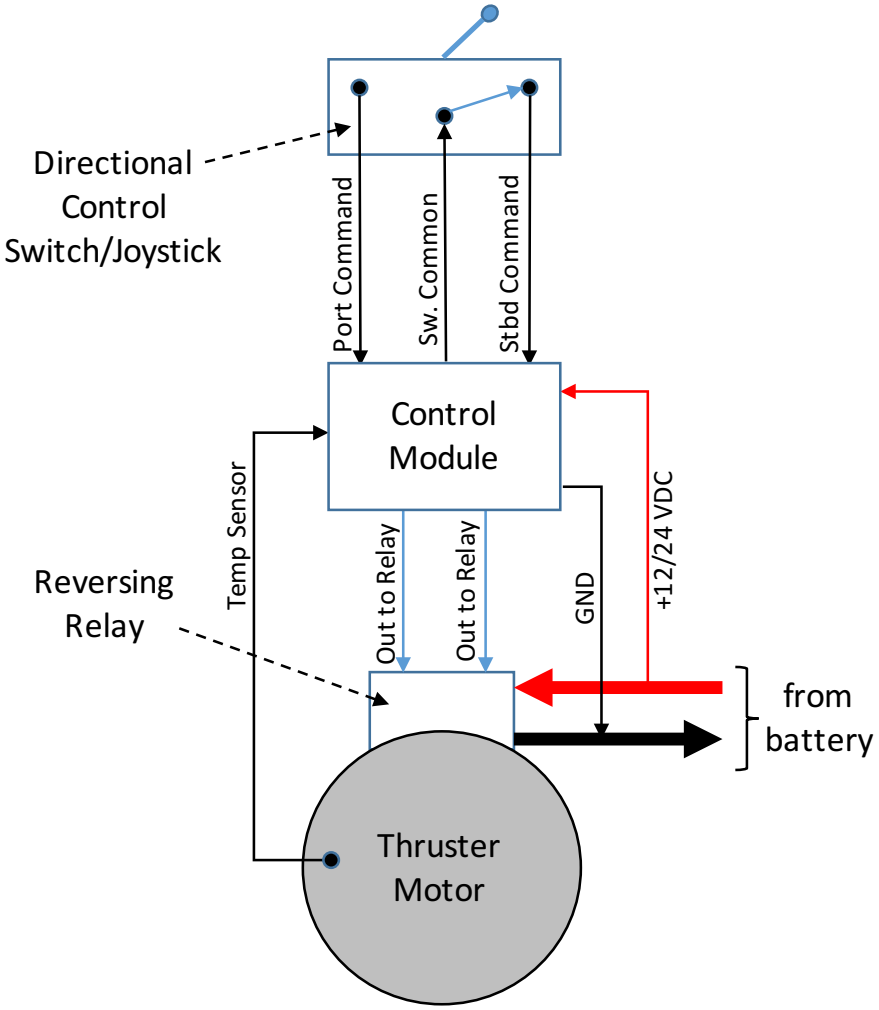

Figure 2 Basic Layout of BP/SP Series Bow/Stern Thruster

The main components are:

- Directional Control Switch/Joystick (normally located near the helm)
- Thruster control module
- Reversing relay (mounted on the side of the thruster motor)
- Thruster motor

2.1 Directional Control Switch / Joystick

The Directional Control Switch / Joystick transmits port and starboard commands to the Thruster Control Module via a simple three wire interface. It is basically a single-pole, double-throw (SPDT) switch. The switch is manually placed in the port or starboard position to operate the thruster. When released, the switch will return to the neutral position.

Most Directional Control Switches / Joysticks also have an on/off switch located on the front of the control panel. The on/off switch normally has a timer feature. In order to prevent inadvertent operation of the thruster while the vessel is underway, the thruster will operate only when the system is switched on. The timer turns the system off after several minutes. The system will remain inoperable until switched on again.

2.2 Thruster Control Module

Under normal operating conditions, the Thruster Control Module simply receives commands from the Directional Control Switch/Joystick and forwards to the Reversing Relay. However, there are operating conditions that can result in damage to the thruster electrical motor or mechanical components:

1. Rapid/sudden reversal of the thruster motor
2. Under-voltage condition
3. Over-temperature condition

The TCM-122 will prevent thruster operation when any of the conditions listed above are detected.

2.2.1 Rapid Reversal Protection

Thruster motors draw extremely high current at start up and produce very high levels of torque. As a DC motor comes up to operating speed, it develops counter electro-motive force, or CEMF. CEMF is simply a voltage which NORMALLY has OPPOSITE polarity relative to battery voltage. Counter EMF is proportional to motor speed and, under normal operating conditions, CEMF is actually results in LOWER current draw once the motor reaches operating speed. Under normal operation, motor current (I) can be calculated as shown in Equation 1:

$$I_{normal} = \frac{V_{batt} - V_{CEMF}}{R_{winding}} \qquad (1)$$

where:
I_{normal} = motor current during normal operation
V_{batt} = battery voltage
V_{CEMF} = Voltage due to counter EMF
$R_{winding}$ = resistance of motor windings

HOWEVER, when battery voltage is suddenly reversed before the motor can come to a stop, CEMF and battery voltage will momentarily have the SAME polarity, and they will ADD rather than subtract (2). This will result in extremely high motor current and torque which can severely damage the thruster.

$$I_{reverse} = \frac{V_{batt} + V_{CEMF}}{R_{winding}} \qquad (2)$$

The Thruster Control Module is designed to prevent sudden reversals. The thruster can be operated repeatedly in the SAME direction, but a delay of a few seconds will occur before the thruster can be energized in the OPPOSITE direction. This allows the thruster to coast to a stop before it will reverse direction, which will prevent thruster damage from sudden reversal.

2.2.2 Under-Voltage Protection

The TCM-122 also provides under-voltage protection. It may seem counter-intuitive, but operating a DC motor at low voltage can result in damage to the windings. If the batteries powering the thruster are not fully charged or are in need of replacement (an all-to-common occurrence), voltage provided to the thruster system can drop quickly once the motor is energized. In the absence of under-voltage protection, the motor would not come up to full operating speed. In a relatively short period of time, battery voltage would continue to drop to a point at which the motor turns very slowly or not at all.

$$I_{locked} = \frac{V_{batt} - V_{CEMF}}{R_{winding}} \qquad (3)$$

Recall that counter EMF (described above) is proportional to motor speed. In the case of a motor that is not turning at all, counter EMF would be ZERO, as shown in Equation 3. This is sometimes referred to as a "locked rotor" condition. In this situation, the entire battery voltage would be applied across the resistance of the motor windings. Motor windings are designed specifically to have low resistance. Even though battery *voltage* can fall to low levels, battery *current* can still be significant in this situation. Keep in mind that at this point, the motor is spinning very slowly or not at all. In this situation, all of the energy coming from the battery is converted to heat in the motor windings rather than mechanical energy. The result is excessive heating and possible damage to the motor windings. For this reason, the TCM-122 will prevent thruster motor operation when battery voltage drops too low.

2.2.3 Over-Temp Protection

The TCM-122 module also provides over-temperature protection for thruster motors equipped with a temperature sensor. If the wire lead from the temperature sensor is connected to the TCM-122 control module, thruster operation is prevented when an over-temperature condition is detected. If your thruster does not have a temperature sensor, this feature can be turned off

on the TCM-122 by placing a simple jumper wire from Pin 9 to Pin 8 on the TCM-122 screw terminal block as described in Section 3.2.

CAUTION: If the thermal shut off feature is disabled be sure to run the thruster motor ONLY for short periods. Overheating will cause serious damage to the motor windings.

2.3 Reversing Relay

The reversing relay is normally mounted on the side of the thruster motor. Thruster motors can draw VERY high levels of current from batteries. Wiring that provides power from batteries to thruster motors must be kept to a minimum length and maximum diameter to ensure efficient operation. It would be impractical to run wires carrying high levels of current from the batteries all the way to the helm station and back down to the thruster motor. Further, the current levels are quite high and would require a massive Directional Control Switch. Instead, wires carrying motor current are connected to the reversing relay.

The reversing relay is controlled by commands from the directional control switch/joystick (located near the helm) via the control module. This allows remote operation of the thruster while minimizing the length of wiring carrying high levels of current from batteries to the thruster motor.

2.4 Thruster Motor

The thruster motor is the heart of the system. It is a reversible DC motor that drives the thruster propeller, either directly or through a reduction gear. Thruster motors are big, expensive, and difficult to replace when damaged. That explains the need for a thruster control module that protects the thruster motor when hazardous operating conditions arise.

3 Installation

These instructions describe installation on a vessel equipped with a Volvo Penta® QL BP-series bow or SP-series stern thruster. The TCM-122 Thruster Control Module is equipped with LEDs to facilitate proper installation and troubleshooting as shown in Figure 3.

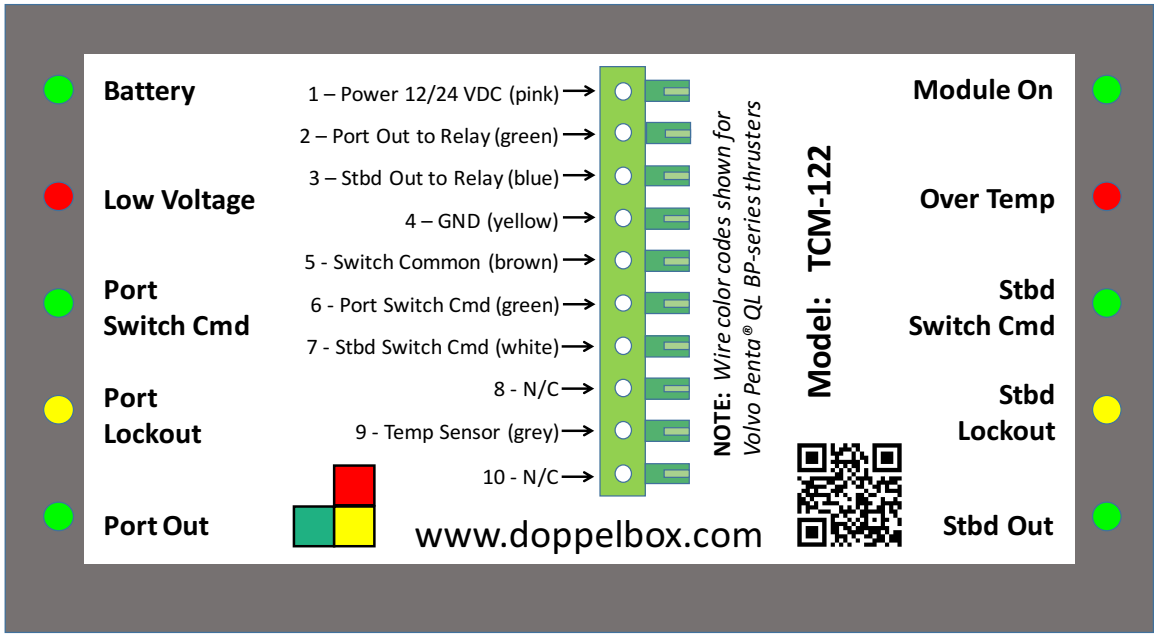

Figure 3 TCM-122 LEDs Facilitate Installation and Troubleshooting

3.1 Preparation

1.) Ensure the thruster system is completely de-energized.
   a. Locate the main battery switch that disconnects the thruster system from all sources and de-energize the system.
   b. Verify the system is de-energized with a multi-meter or other suitable instrument before commencing installation.

2.) Unplug the screw terminal block from the TCM-122.
   a. The TCM-122 Thruster Control Module is equipped with a pluggable (removable) screw terminal block.
   b. The screw terminal block can be removed from the module to facilitate wiring connections.
   c. Removal of the screw terminal block from the module is much easier by grasping one end and gently working it lose, then grasp the other end and repeating.

3.) Locate the connection numbers on the screw terminal block to ensure wires are connected in the proper order.

4.) Connecting eight separate wires is required for installation. Locate all eight wires before starting installation. Wire color codes for Volvo Penta® QL BP-series and SP-series thrusters are as follows

1 – Pink:	12/24 VDC
2 – Green:	Reversing Relay
3 – Blue:	Reversing Relay
4 – Yellow:	Ground
5 – Brown:	Control Switch Common
6 – Green:	Control Switch Direction
7 – White:	Control Switch Common
8 – NC:	
9 – Grey:	Thruster Motor Thermal Switch
10 – NC:	

3.2 Connecting Power and Configuring Thermal Protection

5.) Connect Pin 1 to 12/24VDC (pink wire) and Pin 4 to Ground (yellow wire). Plug the screw terminal block back into the TCM-122 and turn power back on. Ensure the Battery, Module On and Over Temp LED's on the front face of the TCM-122 are illuminated (refer to Figure 4).

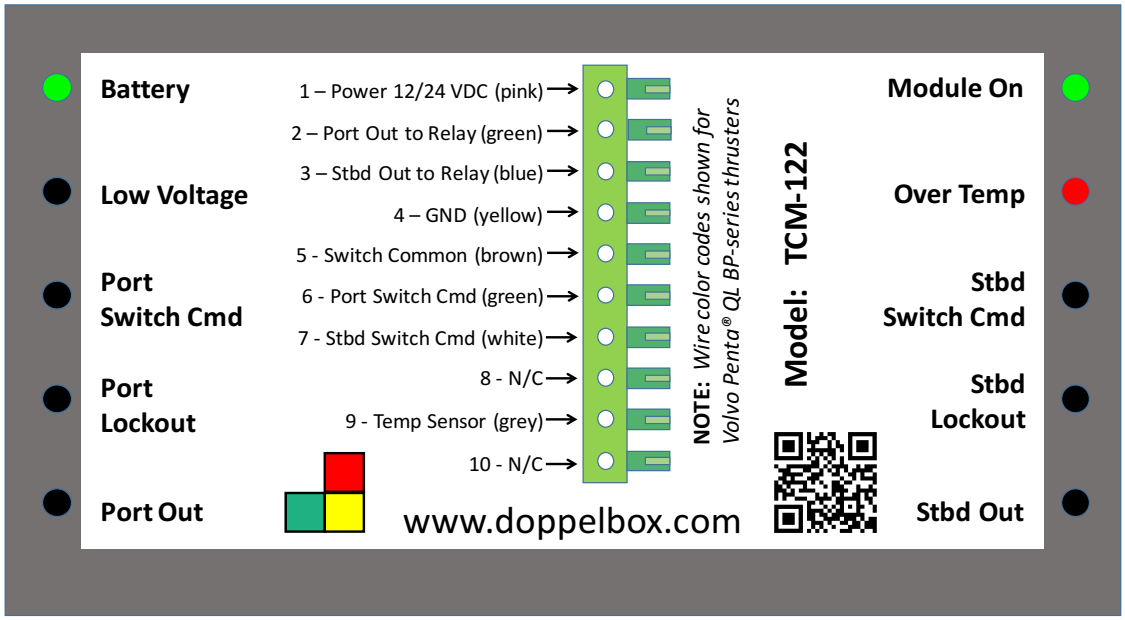

Figure 4 Power On and Over Temp LEDs will Illuminate with Pins 1 and 4 connected

6.) Turn power off and ensure the thruster system is de-energized. All LEDs should be extinguished. Unplug the screw terminal block and connect Pin 9 to the Thruster Motor Thermal Switch (grey wire). If your thruster motor is not equipped with a thermal switch, the thermal shut down feature must be disabled by connecting a small jumper wire between Pin 9 and Pin 8. Plug the screw terminal back in and turn power on. Ensure the *Battery* and *Module On* LED's are illuminated and the *Over Temp* LED is extinguished.

3.3 Connecting Directional Control Switch to TCM-122

7.) Turn power off and ensure the thruster system is de-energized. All LEDs should be extinguished. Unplug the screw terminal block and connect Pin 5 to Control Switch Common (brown), Pin 6 to Control Switch Direction (green), and Pin 7 to Control Switch Direction (white). Plug the screw terminal back in. Turn power back on and ensure the *Battery* and *Module On* LEDs are illuminated.

8.) Place the Directional Control Switch / Joystick in the Starboard position. Check the following:

a. *Stdb Cmd* LED is illuminated
b. *Port Lockout* LED is illuminated
c. *Stbd Out* LED is illuminated

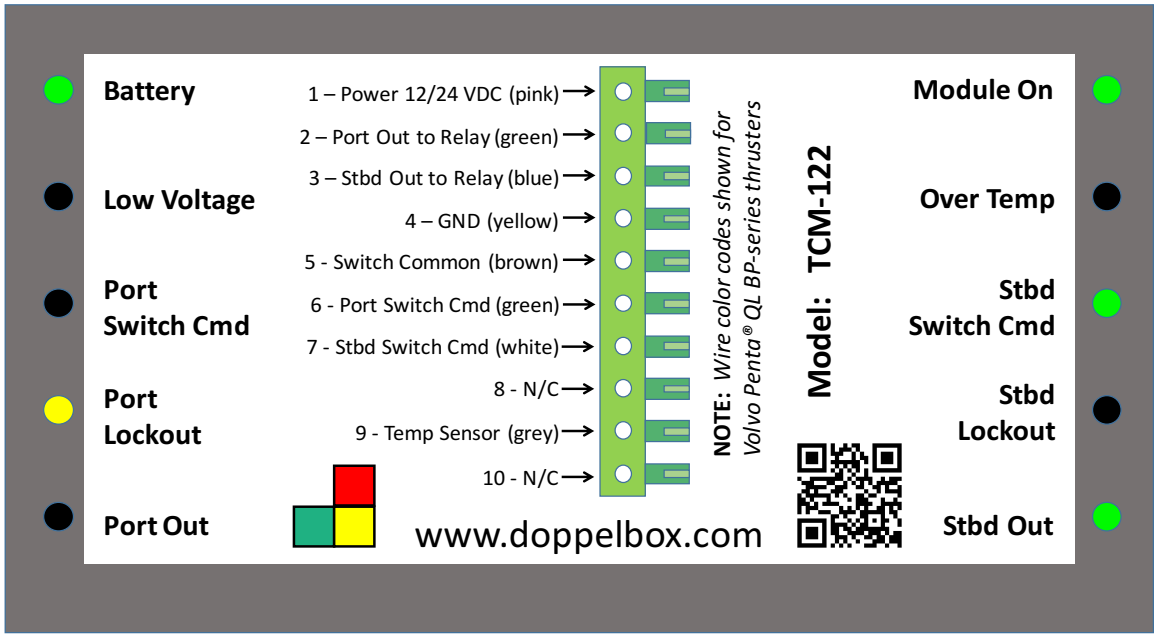

Figure 5 Port Lockout is enabled while Stbd Command is received. Port Lockout remains enabled for 3 seconds after Stbd Command is turned off.

9.) Release the Directional Control Switch. Ensure the *Stbd Cmd* and *Stbd Out* LEDs are extinguished immediately. The *Port Lockout* LED should remain illuminated for approximately 3 seconds before being extinguished.

IMPORTANT NOTE: If the *Port Cmd*, *Port Out*, and *Stbd Lockout* LEDs are illuminated when the Directional Control Switch is placed in the *STARBOARD* position, turn power off and ensure the thruster system is de-energized. All LEDs should be extinguished. Simply reverse the Green and White wires on Pins 6 and 7. Turn power back on and repeat Steps 8 and 9 above.

10.) Place the Directional Control Switch / Joystick in the Port position. Check the following:

a. *Port Cmd* LED is illuminated
b. *Stbd Lockout* LED is illuminated
c. *Port Out* LED is illuminated

11.) Release the Directional Control Switch. Ensure the *Port Cmd* and *Port Out* LEDs are extinguished immediately. The *Stbd Lockout* LED should remain illuminated for approximately 3 seconds and then be extinguished.

3.4 Connecting TCM-122 to Reversing Relay

12.) Turn power off and ensure the thruster system is de-energized. All LEDs should be extinguished. Unplug the screw terminal block and connect Pin 2 to the Green wire coming from the reversing relay and Pin 3 to Blue wire connected to the reversing relay (Blue). Turn power back on.

13.) Place the Directional Control Switch / Joystick in the STARBOARD position. Ensure the thruster turns on and provides thrust in the STARBOARD direction.

IMPORTANT NOTE: If the thruster pushes the vessel in the *PORT* direction when the Directional Control Switch is placed in the *STARBOARD* position, turn power off and ensure the thruster system is de-energized. All LEDs should be extinguished. Simply reverse the Blue and Green wires on Pins 2 and 3. Turn power back on and repeat Step 12 above.

14.) Place the Directional Control Switch / Joystick in the PORT position. Ensure the thruster turns on and provides thrust in the port direction

The TCM-122 is now installed and checked for proper operation.

4 Troubleshooting

The following paragraphs describe common problems encountered with bow / stern thrusters, diagnosing root cause, and performing simple repairs. Carefully review the Warnings and Cautions on Page 2 of this manual AND those included in the manual for the thruster system you are servicing before starting to troubleshoot a problem.

IMPORTANT: Some troubleshooting steps are easier to perform by unplugging the screw terminal block from the TCM-122. Unplugging the screw terminal block from the module is much easier by grasping one end and gently working it lose, then grasp the other end and repeat.

4.1 Some Simple Steps

If the thruster system is inoperable, check the following

1.) Ensure the thruster is turned ON at the control panel
2.) Ensure the *Battery* and *Module On* LEDs on the TCM-122 are illuminated. If not, check the circuit breakers/fuses and switches in the main power system.
3.) Ensure the *Over Temp* LED is extinguished.
    a. If the *Over Temp* LED is illuminated and the thruster has just been in use, it may be necessary for the thruster motor to cool for several minutes. If so, the Over Temp light should extinguish once the thruster motor cools.
    b. If the *Over Temp* LED is illuminated and thruster has not been in recent use, the connection to the thermal switch on Pin 9 of the TCM-122 may be loose. If the thruster doesn't have a temperature sensor, there should be a jumper wire between Pin 8 and Pin 9. Ensure it is installed and the connections are secure.
4.) If the *Low Voltage* LED is illuminated or it illuminates intermittently when the directional control switch is placed in the Port or Stbd position, the most likely cause is the batteries are not properly charged and may be in need of replacement.

4.2 General System Check Out

1.) Visual inspection
    a. Turn off power to thruster system
    b. Remove the cover from the mechanical drive and check for signs of wear or damage. Replace cover on mechanical drive unit.
    c. Remove cover from reversing relay. Ensure all connections are tight and show no sign of heat damage.
    d. Ensure all connections to the TCM-122 are secure --- no loose wires.

2.) Check voltage at the reversing relay and thruster motor
    a. Ensure system is turned on at control panel

b. Ensure *Battery* and *Module On* LEDs on the TCM-122 are illuminated
c. Ensure *Over Temp* and *Low Voltage* LEDs are extinguished on TCM-122
d. If accessible, measure voltage at main power connections on reversing relay and thruster motor.
e. Voltage should be 12-14VDC on 12 Volt systems and 24-28VDC on 24 Volt systems.
f. Turn power off and replace cover on reversing relay before proceeding to next steps

3.) Check thruster motor and reversing relay are operating properly.
a. The next sequence of steps is easier if the screw terminal block is removed from the TCM-122.
b. Ensure power to thruster system is turned off
c. Unplug the screw terminal block from TCM-122. Unplugging the screw terminal block from the module is much easier by grasping one end and gently working it lose, then grasp the other end and repeat.
d. Turn power to thruster system back on
e. Measure voltage between Pin 1 (pink) and Pin 4 (yellow). Voltage should be 12-14VDC on 12 Volt systems and 24-28VDC on 24 Volt systems
f. If supply voltage is okay, MOMENTARILY connect Pin 2 to Pin 4 by placing a jumper between these pins on the screw terminal block. The thruster should momentarily turn on.
g. MOMENTARILY connect Pin 3 to Pin 4 on the screw terminal block using the jumper wire. The thruster should operate in the **opposite** direction. If the thruster runs properly in both directions, the thruster motor and revering relay are working properly.
h. Turn off power to thruster system before plugging the screw terminal block back into the TCM-122.

4.) Check TCM-122 for proper operation
a. Ensure power to the thruster system is turned off.
b. Unplug the screw terminal block from TCM-122. Unplugging the screw terminal block from the module is much easier by grasping one end and gently working it lose, then grasp the other end and repeat.
c. Disconnect wires from Pins 5, 6, and 7. Be sure to note the color and position of each wire.
d. Replace with three short jumper wires. Each jumper should be connected at one end to Pin 5, Pin 6, or Pin 7. Ensure the unconnected ends of the jumper wires do not come in contact with each other.
e. Plug the screw terminal block back into the TCM-122.
f. Turn system power back on. Ensure POWER ON light on TCM-122 is illuminated and LOW VOLTAGE and OVER TEMP lights are extinguished.
g. MOMENTARILY connect the jumper wire on Pin 5 to the jumper wire on Pin 6. The thruster should operate in one direction.

h. Momentarily connect the jumper wire on Pin 5 to the jumper wire on Pin 7. The thruster should operate in the opposite direction.
i. Turn off power to the thruster system. Reconnect the wires from the Directional Control Switch to Pins 5, 6 and 7 in the proper order and plug the screw terminal back into the TCM-122.
j. If the thruster operates in both directions, the TCM-122 is operating properly. The problem is in the Directional Control Switch / Joystick.

5 Compatibility

The TCM-122 Thruster Control Module is an aftermarket product which has been configured for compatibility with the Volvo Penta® QL BP-series bow and stern thruster systems listed below.

Bow Thrusters	BP250
	BP300
	BP450
	BP500
	BP600
	BP800
	BP900
	BP1200
	BP1300
Stern Thrusters	SP600
	SP900
	SP1300

The TCM-122 is a compatible replacement for P/N 41100658