T150, 150G, T400 and 400G Autopilot Course Computers Service Manual

Document Number: 83156-1
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Course Computer core packs

(including compass and rudder reference)

E12054, T150 core pack

E12055, T400 core pack

E12091, 150G core pack

E12092, 400G core pack

Course Computer only

E15013, T150 Course Computer

E15014, T400 Course Computer

E15015, 150G Course Computer

E15016, 400G Course Computer

WARNING:

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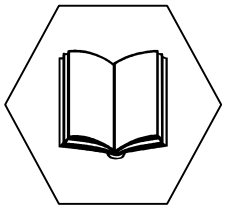

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Chapter 1: Introduction

This manual explains the service and maintenance procedures for the Raymarine Type 150, 150G, 400 and 400G autopilot Course Computers.

1.1. General description

The Course Computer processes information from the sensors in the autopilot system (e.g. rudder position and heading data) so it can steer the boat using the drive unit. The Course Computer assembly consists of a plastic case, a printed circuit board (PCB) and a metal heat-sink base. The PCB carries a microprocessor, electronic circuitry to control the drive unit, a power amplifier for the drive motor and a connector block for all inputs and outputs.

1.2. Variants

There are 4 variants of the Course Computer:

Version	Part number	Supply voltage	Drive unit compatibility	Built-in GyroPlus yaw sensor?
Type 150	E15013 (E12054 core pack)	12 V	All Raymarine Type 1 12 V drives and pumps (including 12 V Constant Running pump).	No
Type 150G	E15015 (E12091 core pack)	12 V	All Raymarine Type 1 12 V drives and pumps (including 12 V Constant Running pump).	Yes
Type 400	E15014 (E12055 core pack)	12 V or 24 V	All Raymarine 12 V and 24 V Type 1, Type 2 and Type 3 drives and pumps. Drive voltage must be matched to boat's supply voltage.	No
Type 400G	E15016 (E12092 core pack)	12 V or 24 V	All Raymarine 12 V and 24 V Type 1, Type 2 and Type 3 drives and pumps. Drive voltage must be matched to boat's supply voltage.	Yes

The main visual differences between the four variants are:

- version label on main cover (150, 150G, 400 or 400G)
- Types 150G and 400G have a GyroPlus yaw sensor on the underside of PCB, with its plug connected to socket on top left hand edge of PCB
- Type 400/400G versions have:
  - 40 A fuse for power supply (30 A for Type 150/150G)
  - extra terminals on left end of connector strip
  - expansion slot on left of PCB
  - additional capacitors and chokes on top right of PCB (and a choke on the underside of PCB)
  - 3 additional power devices and 2 additional FET clamps on right of PCB

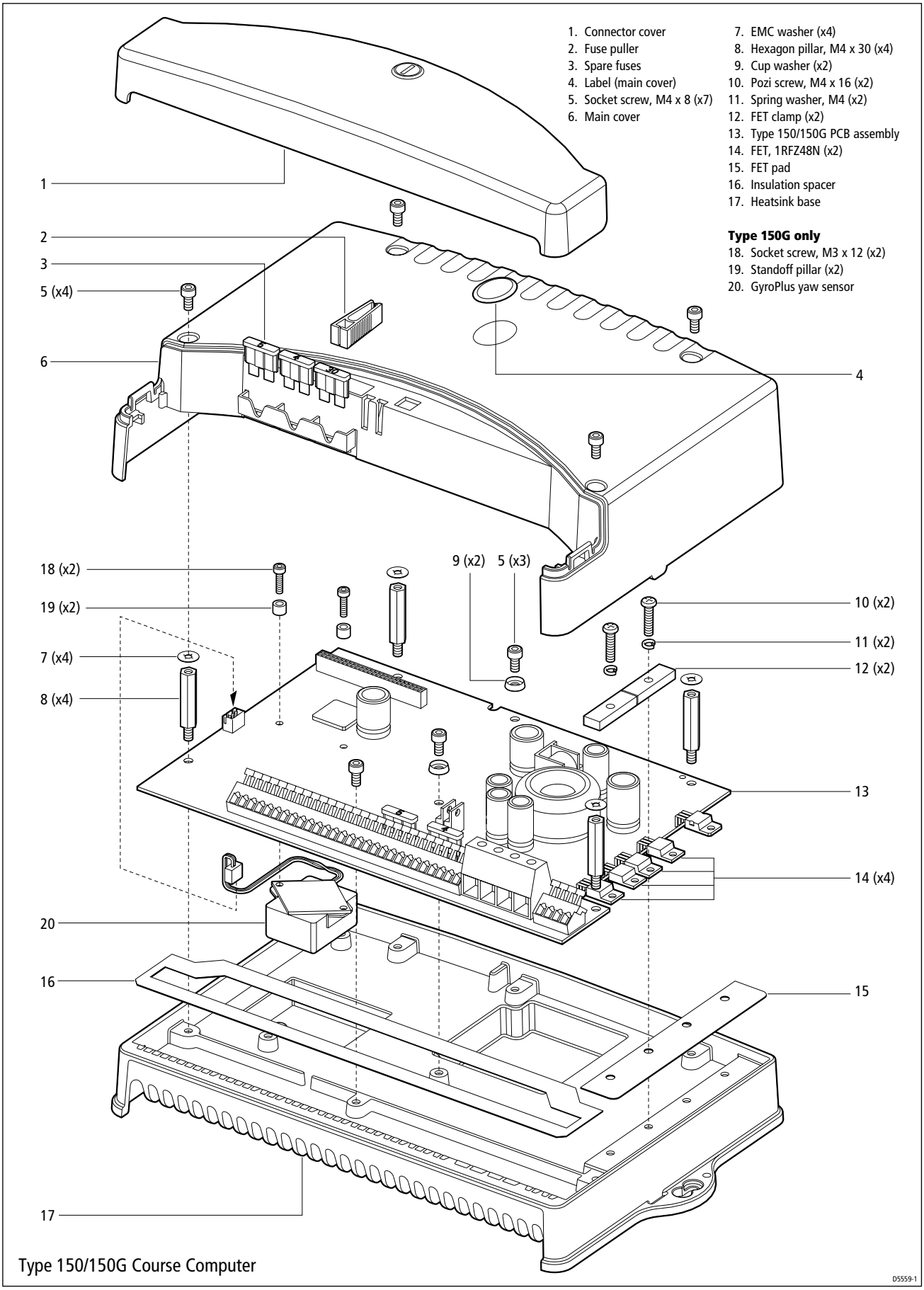
Chapter 2: Main Parts and Spares

Refer to the following exploded views for information about the main parts of the Type 150/150G and Type 400/400G Course Computers.

2.1. Type 150/150G spares

Item	Spare/Accessory	Part No.	Comments
Connector cover assembly		A18064	
1	Connector cover assembly		Fastener stud and receptacle assembled
150/400 Fuse pack		A18065	
2	Fuse puller		
3	Fuses: 4, 5, 30 and 40 amp		
Main cover kit		A18063	
4	Labels: 150, 150G, 400 and 400G		
5	Socket screw, M4 x 8 (x4)		
6	Main cover		
7	EMC washer (x4)		
150/400 PCB fittings kit pack		A18068	
5	Socket screw, M4 x 8 (x3)		
8	Hexagon pillar, M4 x 30 (x4)		
9	Cup washer (x2)		
10	Pozi screw, M4x16 (x4)		
11	Spring washer, M4 (x2)		
12	FET clamp (x4)		
15	FET pad		
16	Insulation spacer		
150 PCB assembly pack		A18066	
9	Cup washer (x2)		
13	150 PCB sub assembly		
15	FET pad		
16	Insulation spacer		
150 FET pack		A18070	
14	FETs, IRFZ48N (x4)		
15	FET pad		
16	Insulation spacer		
150/400 Rate Gyro pack		A18069	
7	EMC washer (x4)		
15	FET pad		
16	Insulation spacer		
18	Socket screw, M3 x 12 (x2)		
19	Standoff pillar (x2)		
20	GyroPlus yaw sensor		Has attached insulator
150/400 Cable clamp pack		A18072	
-	Cable clamp		Not illustrated with exploded unit
-	Re-usable cable tie		Not illustrated with exploded unit

2.2. Type 150/150G exploded view

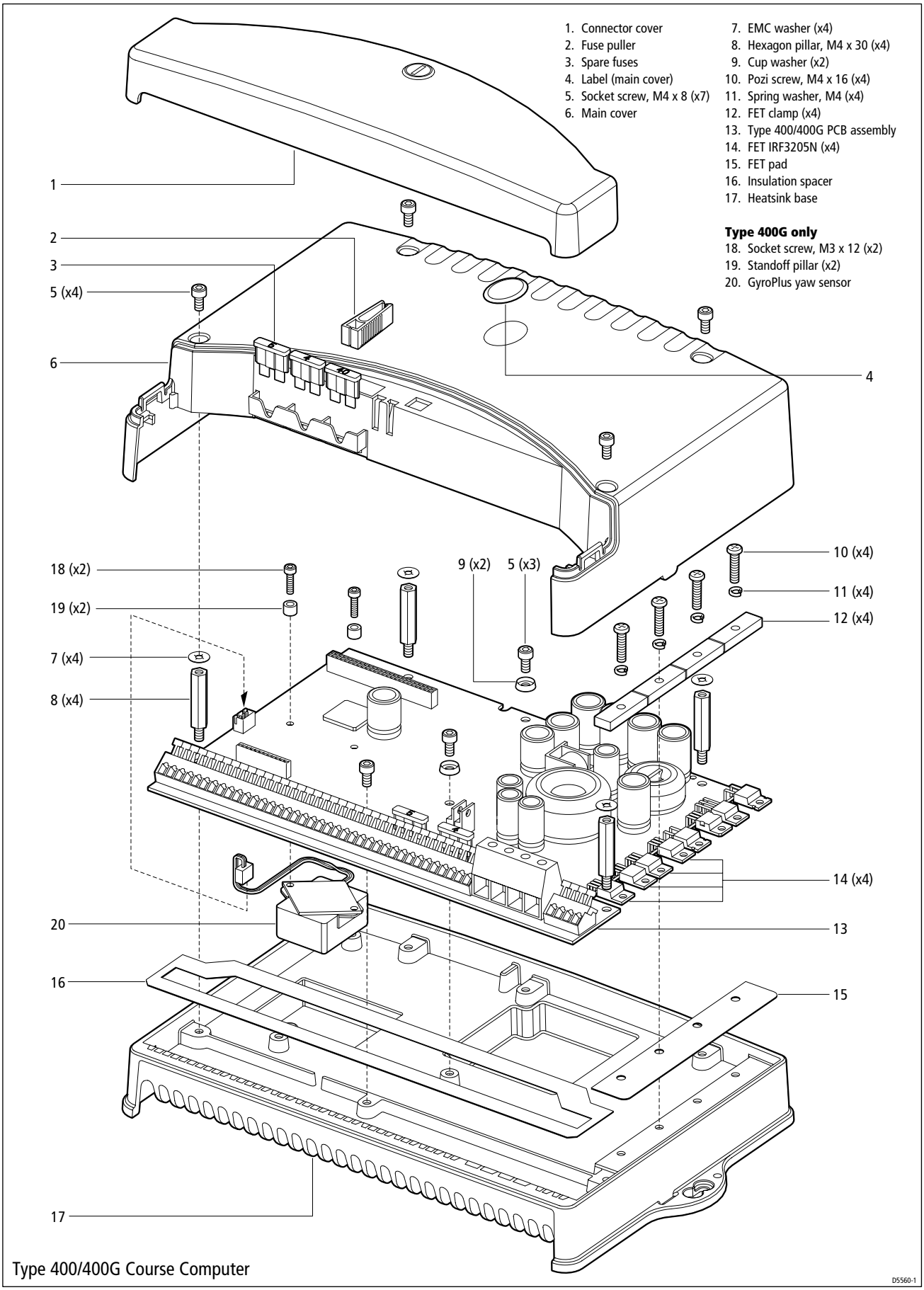


Type 150/150G Course Computer

2.3. Type 400/400G spares

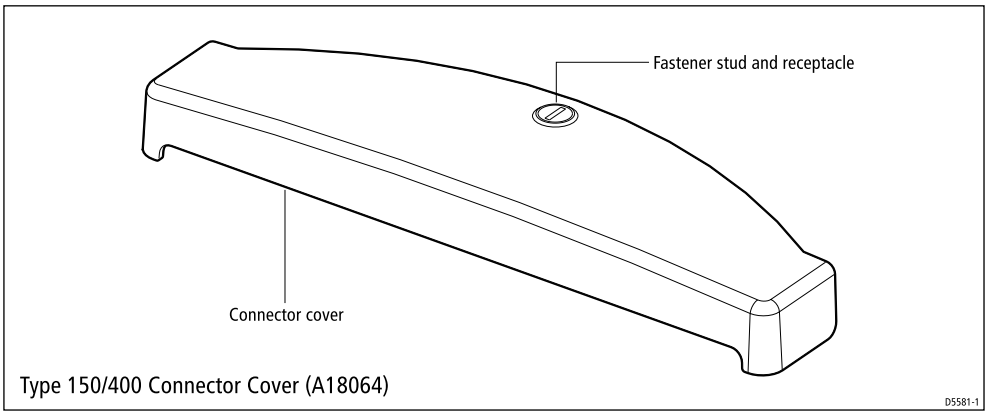
Item	Spare/Accessory	Part No.	Comments
Connector cover assembly		A18064	
1	Connector cover assembly		Fastener stud and receptacle assembled
150/400 Fuse pack		A18065	
2	Fuse puller		
3	Fuses: 4, 5, 30 and 40 amp		
Main cover kit		A18063	
4	Labels: 150, 150G, 400 and 400G		
5	Socket screw, M4 x 8 (x4)		
6	Main cover		
7	EMC washer (x4)		
150/400 PCB fittings kit pack		A18068	
5	Socket screw, M4 x 8 (x3)		
8	Hexagon pillar, M4 x 30 (x4)		
9	Cup washer (x2)		
10	Pozi screw, M4x16 (x4)		
11	Spring washer, M4 (x2)		
12	FET clamp (x4)		
15	FET pad		
16	Insulation spacer		
400 PCB assembly pack		A18067	
9	Cup washer (x2)		
13	400 PCB sub assembly		
15	FET pad		
16	Insulation spacer		
400 FET pack		A18071	
14	FETs, IRF3205 (x4)		
15	FET pad		
16	Insulation spacer		
150/400 Rate Gyro pack		A18069	
7	EMC washer (x4)		
15	FET pad		
16	Insulation spacer		
18	Socket screw, M3 x 12 (x2)		
19	Standoff pillar (x2)		
20	GyroPlus yaw sensor		Has attached insulator
150/400 Cable clamp pack		A18072	
-	Cable clamp		Not illustrated with exploded unit
-	Re-usable cable tie		Not illustrated with exploded unit

2.4. Type 400/400G exploded view

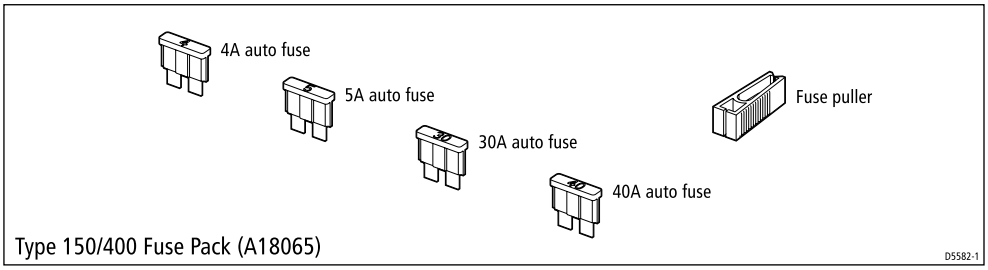


Type 400/400G Course Computer

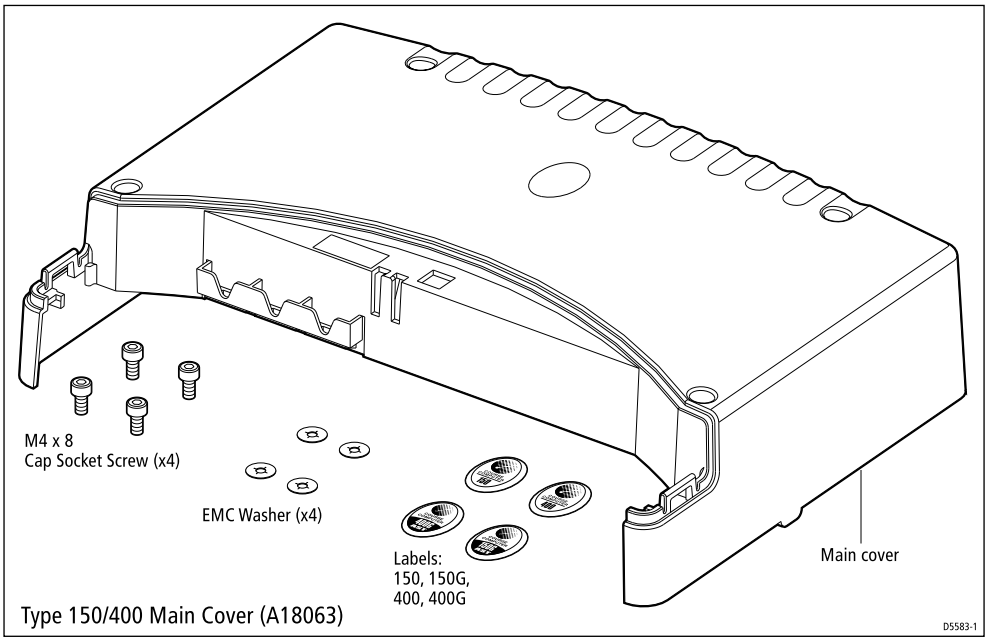
2.5. Spares packs for 150/150G/400/400G



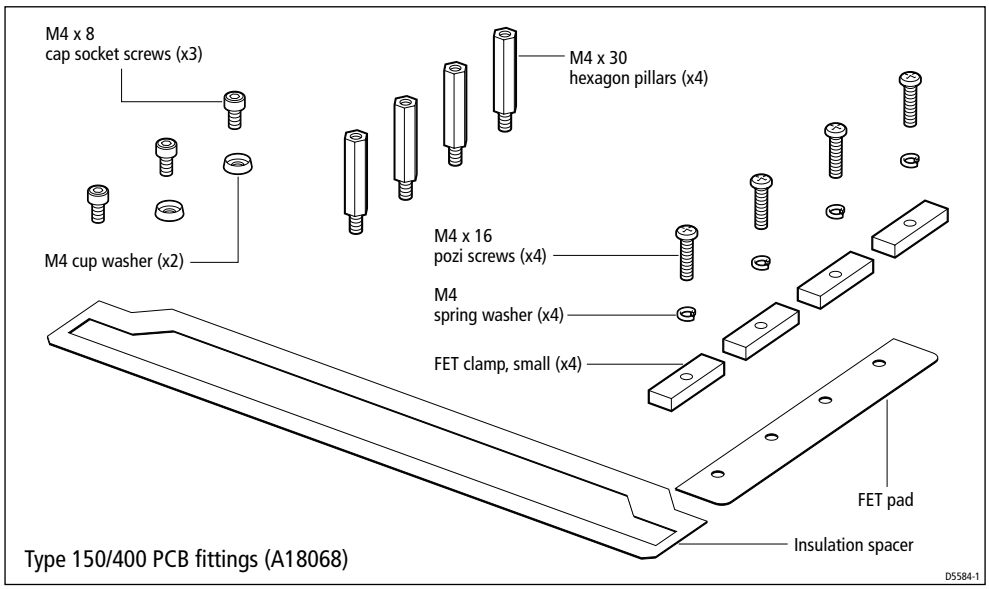
Type 150/400 Connector Cover (A18064)



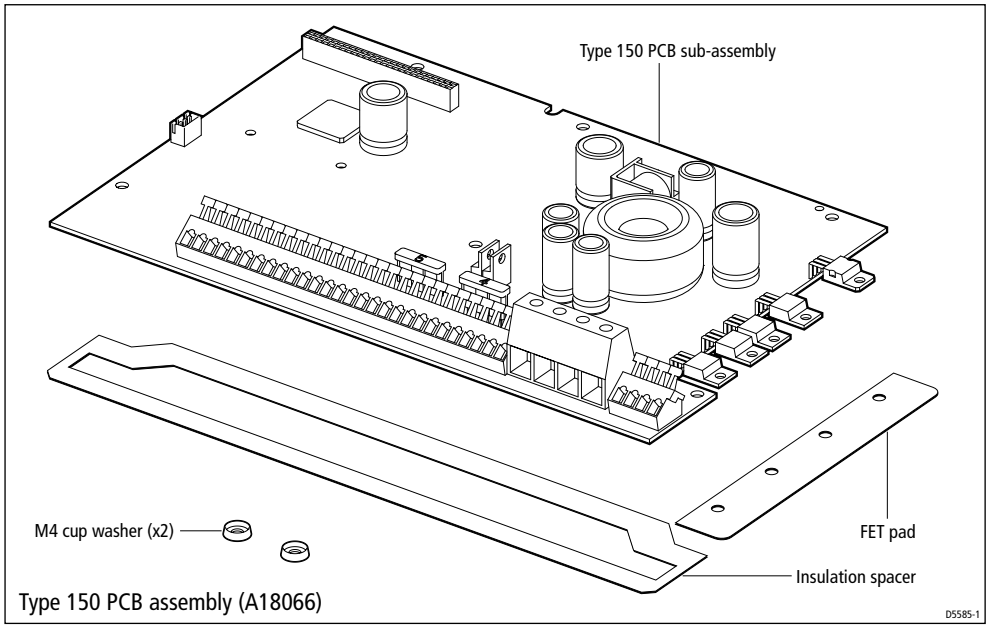
Type 150/400 Fuse Pack (A18065)



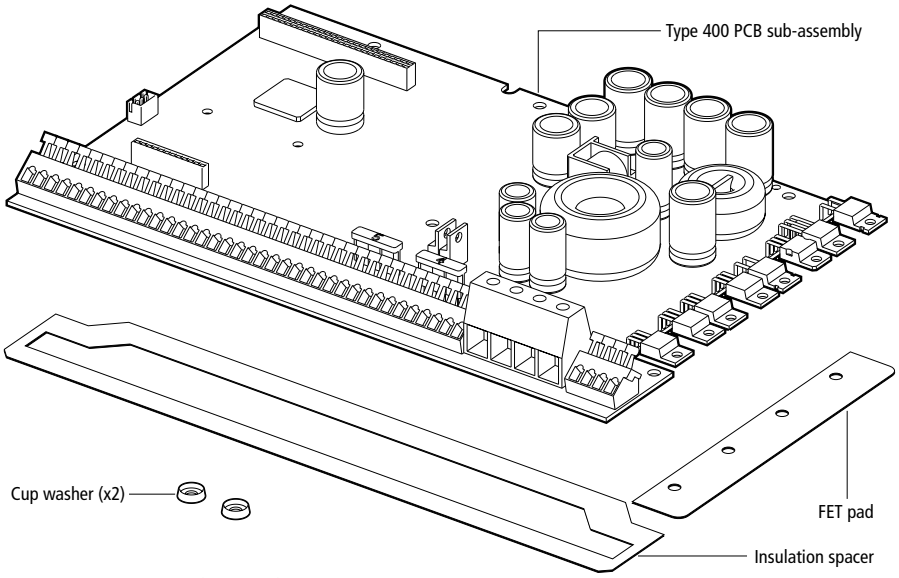
Type 150/400 Main Cover (A18063)



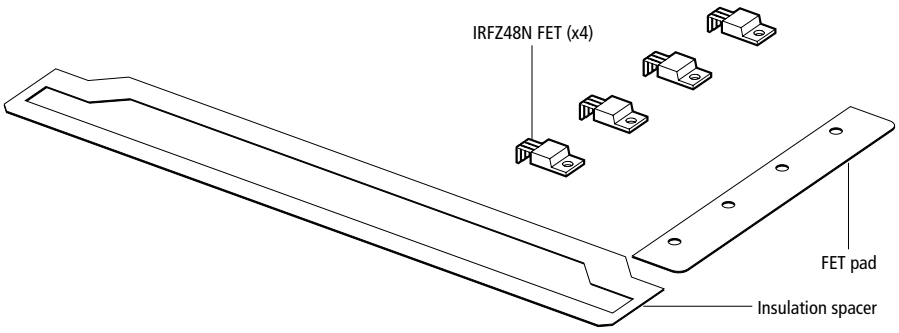
Type 150/400 PCB fittings (A18068)



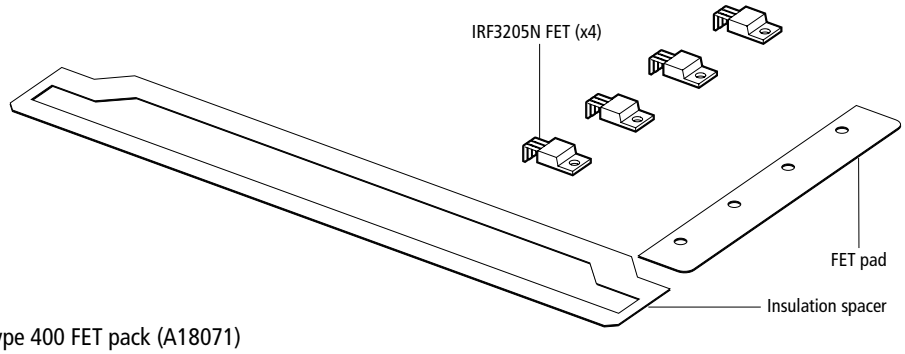
Type 150 PCB assembly (A18066)



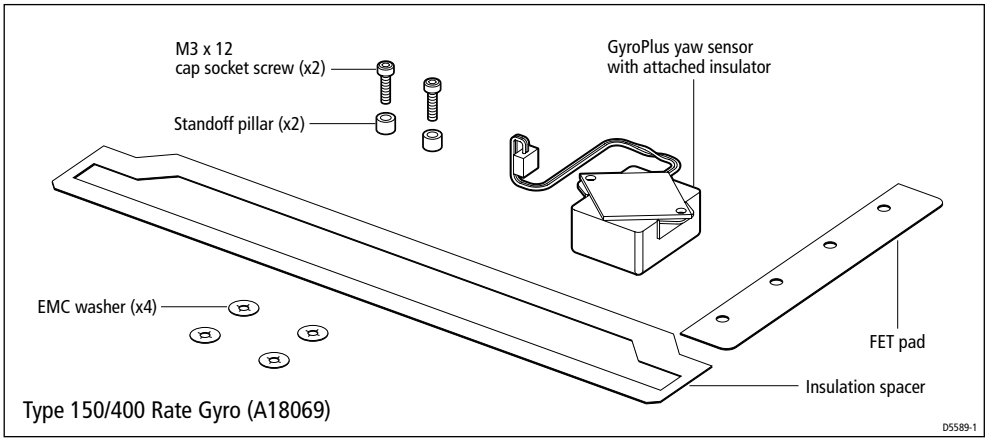
Type 400 PCB assembly (A18067)



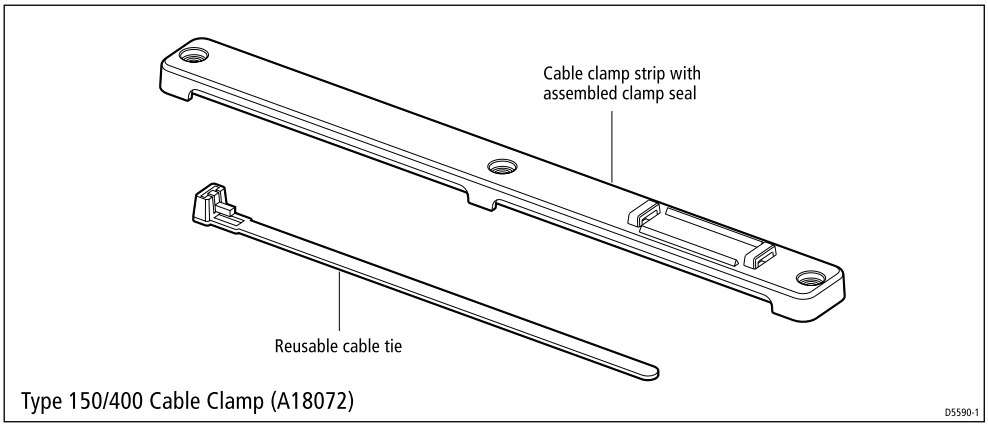
Type 150 FET pack (A18070)



Type 400 FET pack (A18071)



Type 150/400 Rate Gyro (A18069)



Type 150/400 Cable Clamp (A18072)

Chapter 3: Functional Tests

3.1. Introduction

This section describes how to complete basic functional tests on the Course Computer aiding fault diagnosis.

Equipment and Tools You Will Need

- Raymarine ST6001 or ST7001 Control Head
- Raymarine Rudder Reference
- Raymarine Fluxgate Compass
- Any Raymarine Pathfinder Display
- Digital Volt Meter
- DC Power Supply which can supply 12V and 24V (if T400's are to be tested) at 5A (to cope with inrush currents when motors are started during testing)
- A 12V Mabutshi motor
- A Raymarine type 1 motor can be used for this purpose, but will require a larger PSU (10A) to cope with the inrush during start up.
- A conventional 330 Ohm resistor, rated at 1 Watt, to use as a clutch load. R66 can be removed from a scrap Course Computer PCB and used for this purpose.
- A 3mm Allen Key to remove the Course Computer cover

3.2. Initial Inspection Checks

Before applying power to the Course Computer carry out following visual inspections:

Remove the top cover of the Course Computer, ensuring that the EMC gaskets on the underside do not fall onto the PCB.

Visually inspect the PCB for any obvious signs of component damage or blackening, paying particular attention to the FETs and main power components.

Using a DVM set to Ohms, check that there are no short circuits between the metal tabs of the power devices and the heatsink.

Check that the three fuses, FS1 (30A/40A), FS2 (5A), FS3 (4A) are of the correct rating, and are not blown.

Ensure that FS3 is set to the 12V setting.

Current Sense Resistors

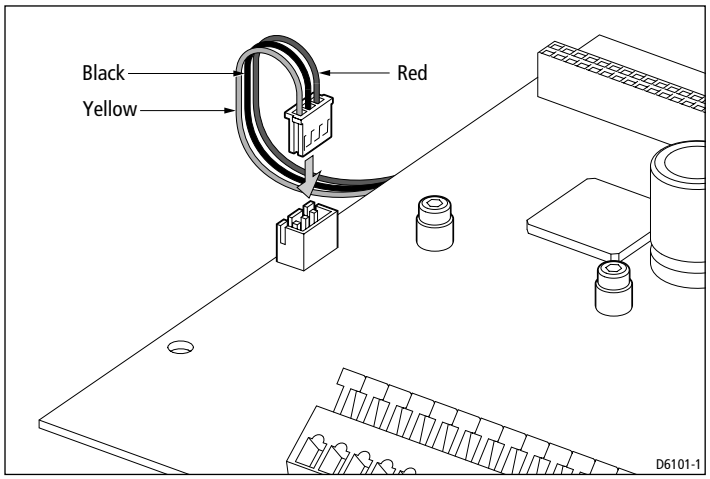
Using a DVM set to Ohms, measure the resistance of resistors R167 and R133.

These are 10mΩ resistors. Unless the DVM is extremely sensitive, it will be difficult to measure this accurately. For the purposes of this test follow the steps below to determine whether they are intact:

1. Set the DVM to measure Ohms.
2. Touch the two probes together and make a note of the resistance measured. This should be close to 0
3. Measure across the resistor R167
4. The measured value should be virtually the same as that measured in step 2
5. Repeat for resistor R133

Check Rate Gyro Connection

The plug is designed to fit one way into the socket. Ensure that the keyed side of the plug faces the outermost side of the PCB when inserted. There are matching slots in the socket to accommodate this.



Relay Visual Checks

(The relay (RL1) on the Course Computer PCB can carry up to 40A, but if for any reason, it does not close, this will cause DX to fail.)

- Check for dirt or flux residue around the relay contacts
- Check for signs of blackening or burnt out track around diode D4 and resistor R323

FET SIL Pad

The SIL pad is a thermally conductive but electrically isolative strip of material, which sits between the metal tabs of the power devices and the metal heatsink. The material ensures that there is good thermal conductivity between the power devices and the metal heatsink, but also provides a high level of electrical isolation between the tabs and the heatsink. If

the SIL pad is punctured the power devices are likely to be blown. This test is to check whether the SIL pad is intact.

- Using a DVM set to Ohms, touch one probe on the metal tab of the power device and the other on the heatsink.
- Check that the resistance measured is >500K
- Repeat for all power devices along the right hand side of the PCB.

3.3. Detailed Diagnosis

Before starting testing ensure that the following are connected to the Course Computer:

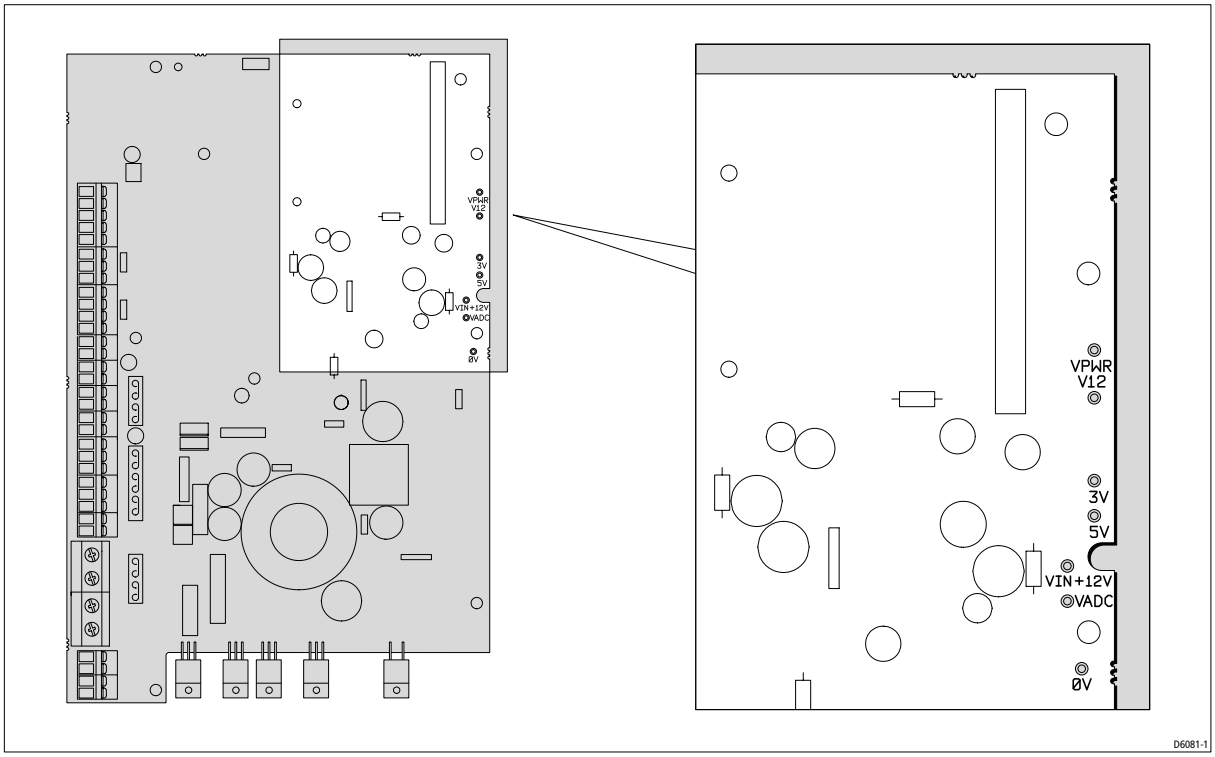
- Fluxgate compass
- Rudder reference
- Control Head
- 330Ohm resistive load to the clutch terminals
- Pathfinder Display connected via **NMEA 1** (do not connect the Pathfinder unit via SeaTalk)

Unless otherwise stated, the following tests should be carried out with 12V applied to the Course Computer

Step 1 - Power Checks

- Check the voltages at the following locations are correct:

Testpoint	Measured Voltage	
	Type 150	Type 400
V_{PWR}	12V	12V
V12	12V	12V
3V	3.3V	3.3V
5V	4.9V – 5.2V	4.9 – 5.2V
VIN+12V	22.5 – 25V	22.5 – 25V
VADC	?	?



For Type 400 Course Computers Only

- Apply 24V to the Course Computer
- Check that the following voltages are correct:

Testpoint	Measured Voltage
	Type 400
V_{PWR}	24V
V12	13V
3V	3.3V
5V	4.9V – 5.2V
VIN+12V	35-36V
VADC	?

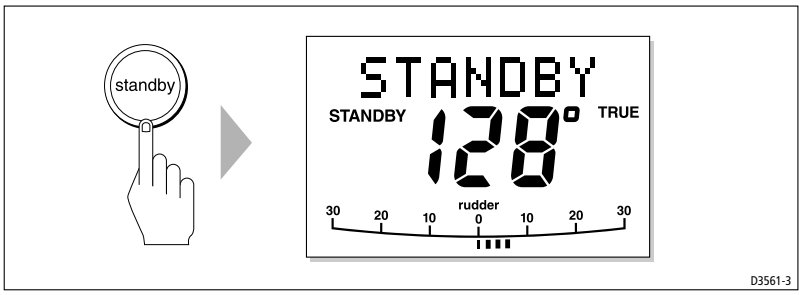
✓ If all the voltages are correct, proceed to **Step 2**

✖ If any of these voltages are incorrect, return the Course Computer to your nearest Raymarine Service Center with the results of these tests.

Step 2 - System Checks

- Check that the display shows a compass heading (the actual heading displayed is unimportant at this stage) and that a rudder angle bar is displayed.

  Note: *With a rudder reference fitted, the rudder bar will read full scale in one direction due to the internal spring mechanism.*



✓ If both of these are present, this confirms that the Seatalk communications are functioning correctly. Proceed to **Step 3**

✖ If these are not correct, return the Course Computer to your nearest Raymarine Service Center.

Step 3 – Rate Gyro (if fitted)

If you are testing a T150G or T400G, it is necessary to test whether the internal rate gyro is functioning correctly.

- Using a Digital Voltmeter set to measure DC, measure the voltage at the rate gyro terminals on the front connector strip. If the rate gyro is serviceable, the reading should be between 2.1V and 2.9V.

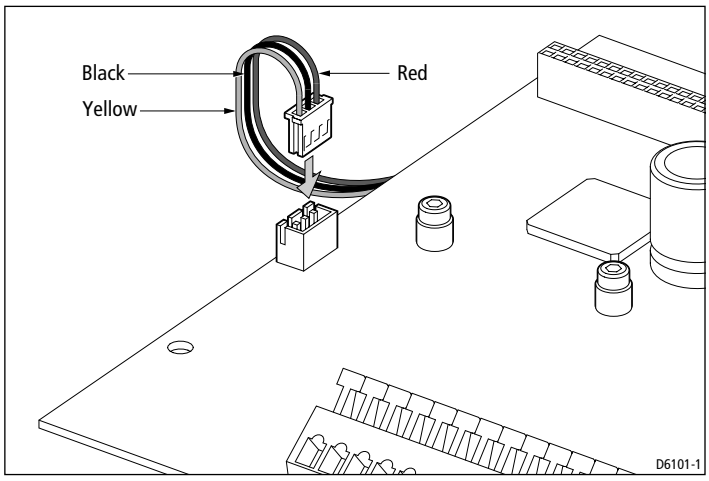
✓ If the voltage is within these limits, proceed

✖ If the compass display does not match the change in orientation of the compass, return the Course Computer to your nearest Raymarine Service Center.

- With the multimeter still connected, turn the Course Computer slowly, first clockwise, then anticlockwise.

  If the rate gyro unit is functioning correctly, the voltage should increase (from 2.5V) as the Course Computer is turned in one direction and decrease (from 2.5V) as it is turned in the opposite direction.

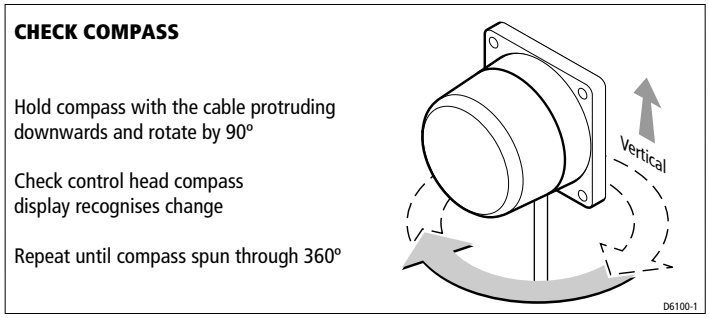
✓ If the voltage changes as described, disconnect the rate gyro from the PCB (see diagram) and proceed to **Step 4**



✖ If the compass display does not match the change in orientation of the compass, return the Course Computer to your nearest Raymarine Service Center.

Step 4 – Compass

- With the compass unit connected to the Course Computer, rotate the compass through 90º as shown below.



Note: *Ensure that you hold the compass with the cable protruding downwards.*

- Slowly rotate the compass clockwise through 360º. As the compass is turned, check that the displayed heading increases with no sharp changes in the reading.

✓ If the compass display changes in accordance with the rotating of the compass, proceed to **Step 5.**

✖ If the compass display does not match the change in orientation of the compass, return the Course Computer to your nearest Raymarine Service Center.

Step 5 – Rudder Reference

- Check that the rudder offset in the set up is set to zero. To adjust, use the Dealer Calibration screens.
- Move the rudder reference into the central position.
- Check that the rudder bar on the display is in the central position.
- Move the rudder reference to the left and check that the rudder position bar on the display moves to the left.
- Move the rudder reference to the right and check that the rudder position bar on the display moves to the right.

✓ If the rudder bar moves the right way, proceed to **Step 6.**

✖ If the rudder bar display moves the wrong way:

- turn off the power
- reverse the red and green wires connected to the RUDDER inputs on the Course Computer
- switch on the power and re-check

✖ If the rudder bar is still not working correctly, return the Course Computer and Rudder Reference Unit to your nearest Raymarine Service Center.

Step 6 – Clutch (Auto)

- Ensure that the rudder reference is in the central position.
- Press **AUTO**
- Measure voltage at clutch terminals

✓ If the voltage is within limits, proceed to **Step 7**

✖ If the voltage exceeds limits then return the Course Computer to your nearest Raymarine Service Center.

Step 7– Clutch (Standby)

- Press **STANDBY**
- Measure voltage at clutch terminals

✓ If the voltage is 0V, proceed to **Step 8**

✖ Otherwise return the Course Computer to your nearest Raymarine Service Center.

Step 8– H-Bridge

- Press **AUTO**
- Press **+10** twice
    - The motor should spin
- Press **STANDBY**
    - The motor should stop
- Press **AUTO**
- Press **-10** twice
    - The motor should spin in the opposite direction
- Press **–10** three times
- Measure V_{IN+12V} whilst the motor is running. Check this against the table in Step 1

✓ If the motor behaves as described and the voltage is correct, proceed to **Step 9**

✖ Otherwise return the Course Computer to your nearest Raymarine Service Center.

Step 9 – NMEA

Receive

- Enter a new waypoint into the Pathfinder unit.
- Perform a "Goto Waypoint" command on the Pathfinder Unit
- Verify that the waypoint information has been sent to the Course Computer by viewing the XTE, DTW and BTW data pages on the Control Unit.

Transmit

- Check that the heading displayed on the Pathfinder Unit matches that of the Autopilot.

Move the pathfinder connection to NMEA 2 and repeat the above tests.

✓ If data is being sent across both NMEA interfaces correctly, proceed to **Step 10**

✖ Otherwise return the Course Computer to your nearest Raymarine Service Center.

Step 10 – Kill Switch

- Place a short circuit across terminals TBx and x.

  The Course Computer should shut down.

- Remove the shorting link.

  The Course Computer should power up again.

✓ If the Course Computer behaves as described, proceed to **Step 11**

✖ Otherwise return the Course Computer to your nearest Raymarine Service Center.

Step 11 – EEPROM Test

This test checks that the calibration settings are being stored correctly.

- Using the calibration screens, change the Drive Type to another value and make a note of this new value.
- Save the setting and exit calibration.
- Cycle the power to the unit.
- Verify that the drive type has not changed from the value set above.

Repeat the above

✓ If the Course Computer retains the settings as described then these tests are complete. If you are still experiencing problems, please contact your nearest Raymarine Service Center with a complete description of your setup, observations and measurements.

✖ If the Course Computer does not respond as described, return the Course Computer your nearest Raymarine Service Center.

Chapter 4: Disassembly and Reassembly

CAUTION: Electrostatic Discharge (ESD)

This product contains components that can be damaged by electrostatic discharge.

If the cover is removed, any work on the product must be carried out at a properly equipped anti-static station by personnel wearing anti-static straps.

Note: *The numbered parts in the following instructions refer to the annotations on the exploded views.*

4.1. Tools required

To assemble/disassemble the Course Computer you will need:

- 3 mm Allen key
- pozi-drive (cross-head) screwdriver
- 7 mm socket spanner (or adjustable spanner)
- 2 mm Allen key (to remove or fit the GyroPlus yaw sensor)

4.2. Disassembly

1. Unscrew and remove the 4 main cover screws (5).
2. Remove the main cover (6) and connector cover (1). Make sure that the 4 EMC washers (7) are retained on the underside of the main cover.
3. Unscrew the FET clamp screws (10), and then remove the screws, washers (11) and FET clamps (12). Note: Type 150/150G PCBs have 2 FET clamps/screws/washers; Type 400/400G PCBs have 4 FET clamps/screws/washers.
4. To remove the PCB:
   - unscrew and remove the 4 hexagon pillars (8)
   - unscrew and remove the 3 PCB screws (5), then remove the screws and 2 cup washers (9)
   - lift the PCB (13) out of the base casting (17)

4.3. Reassembly

Note: *If you have removed the PCB, we recommend fitting a replacement FET pad and insulation spacer in case the originals have been damaged. Replacements are supplied with the relevant spares packs.*

1. Fit the replacement FET pad (15) and insulation spacer (16) onto the base casting (17).
2. Place the PCB (13) into position on the base casting (17).
3. To secure the PCB:
   - fit the 3 PCB screws (5) and 2 washers (9), and tighten the screws
   - fit and tighten the 4 hexagon pillars (8)

4. Fit the FET clamps (12), washers (11) and screws (10), then tighten the screws.
5. Check that the EMC washers (7) are still retained on the underside of the main cover (6), then fit the main cover over the PCB. Insert and tighten the main cover screws (5).
6. Fit the terminal cover (1) (if necessary).

4.4. Removing/fitting GyroPlus yaw sensor

Removing the GyroPlus yaw sensor

1. Disassemble the Course Computer and remove the PCB (13).
2. Unplug the GyroPlus connector from the socket on the left of the PCB.
3. Unscrew and remove the 2 GyroPlus screws (18) and standoff pillars (19).
4. Remove the GyroPlus yaw sensor (20) and attached insulation pad.

Fitting the GyroPlus yaw sensor

1. Position the GyroPlus yaw sensor (20) under the PCB (13).
2. Fit the 2 standoff pillars (19) and GyroPlus screws (18), and tighten the screws to secure the sensor to the PCB.
3. Plug the GyroPlus connector into the socket on the PCB.
4. Fit the PCB and reassemble the Course Computer.

After installing a GyroPlus yaw sensor

Course Computer re-calibration

After installing a GyroPlus you MUST re-calibrate the autopilot. If you have an ST6001+ or ST7001+ control unit you will be able to use the AutoLearn steering calibration function.

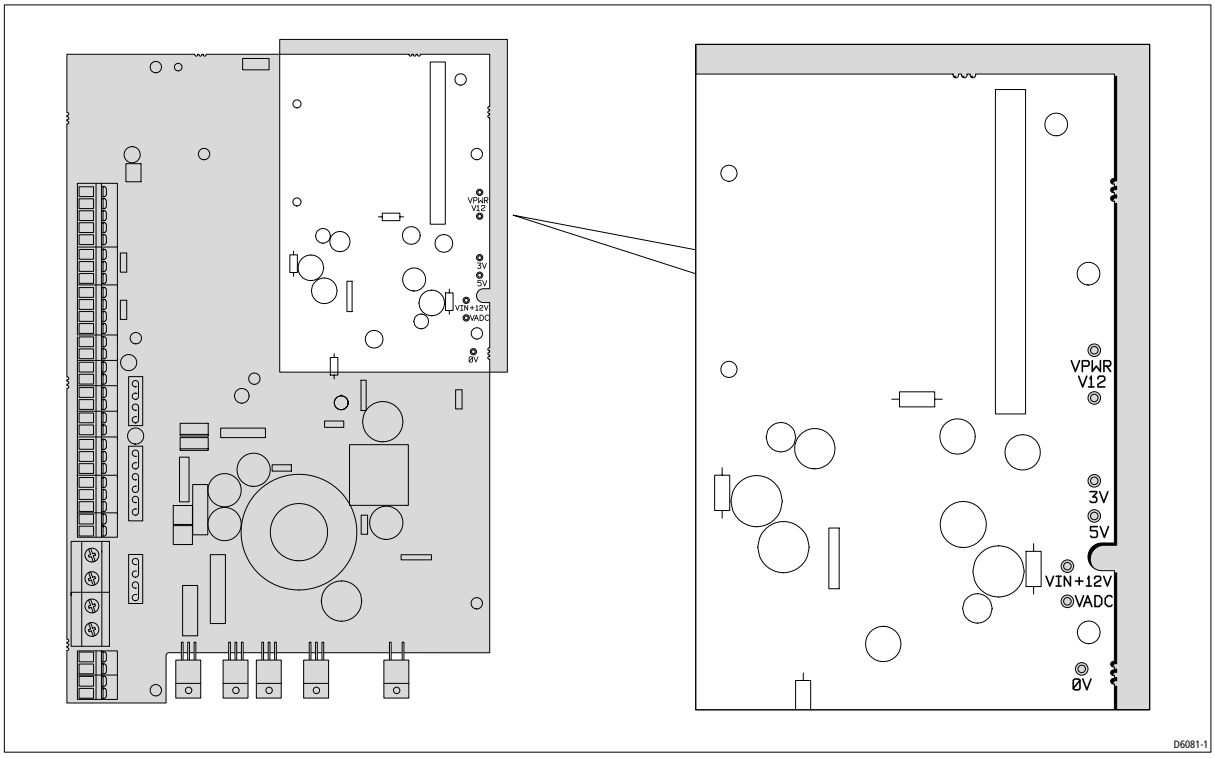
Refer to the control unit owner's handbook for more information about calibrating the Course Computer.

Chapter 5: Functional Circuit Description

5.1. Test points on PCB

There are seven test points available on the Course Computer PCB. These are:

- **VPWR**
  Incoming Supply Voltage (12V or 24V)
- **V12**
  12V Systems – Incoming Supply
  24V Systems - Regulated to 12V DC
- **3V**
  3.3V DC Rail Voltage (Used by Microprocessor)
- **5V**
  5V DC Rail Voltage
- **VIN+12V**
  Approx 12V above VPWR (for high-side FET drives)
- **VADC**
  Regulated 6.9V DC (for ADC conversion in fluxgate circuit)
- **0V**
  Ground



5.2. Main functional parts of circuit

Power Supply

The Type 150 Course Computer is a nominal 12 Volt only product where as the Type 400 can run from a nominal 12 or 24 Volt supply.

The incoming power is protected by fuse FS1 and is protected against reverse polarity connection by the components controlling relay RLY1. The Type 150 Course Computer is further protected against connection to supplies in excess of 18V by the circuit connected to Zener diode ZD16.

The heavy-duty power supply can be forced into an off state by shorting the TB2 terminals. This generates a logic zero signal /KILL to signal this has happened.

The incoming supply is fed directly into the H-Bridge circuit.

VIN+12V is a rail that is nominally 12 Volts greater than the incoming power supply that is required to control high side FETs TR18, TR34, TR8 and TR56. This rail is produced using a charge pump circuit formed by FETs TR14 and TR15 and capacitors C31 and C32.

Link LK2 is fitted on the Type 150 Course Computers only, and connects the incoming supply directly to rail V12.

The following switch mode regulator components are not fitted on Type 150 Course Computers:

- Inductors L43 and L1
- Diodes D7 and D9
- Switch Mode Regulator IC3
- Capacitors C121, C122, C123, C13, C18 and C21
- FET TR8.

On Type 400 Course Computers, the feed to V12 is switched via FET TR8 from either the incoming supply or the output of the nominal 12 Volt switching regulator provided by IC3. Comparator IC5c monitors the incoming supply voltage and switches TR8 depending on the magnitude of the voltage. When the supply is less than 17 Volts, the supply is connected directly to V12. When the supply is more than 17 Volts, V12 is fed from the regulator output.

V12 is further regulated down to provide the other required voltage rails.

Transistor TR81 is configured as a simple series pass linear regulator to provide a voltage limited rail VREG. This ensures that no more than 15 Volts is ever applied to the gates of FETs TR24 and TR27.

5V-STABLE is a 5 Volt supply provided by linear regulator IC23 to power critical circuit elements that must stabilise quickly at power-up.

IC21 is also a linear regulator and provides rail 7.8V, which is used by the microcontroller during the Flash memory download (re-programming) process.

Another switching regulator IC6, provides the main 5 Volt requirement, 5V-REG. A filtered version of this, 5V-DIG supplies all the 5 Volt digital circuitry on the PCB. 5V-DIG is further regulated down by linear regulator IC16. This generates the 3.3 Volt rail (3VDD) required by the microcontroller IC15.

Drive Output

The main motor drive circuit consists of the H-Bridge formed by the FETs TR18, TR24, TR34 and TR27. These four power devices control the current delivered to any drive unit connected to terminals MOTOR1 and MOTOR2. Each FET is controlled by buffer circuits which switch the gate terminals between ground and the appropriate drive potential (VREG for TR24 and TR27 and VIN+12V for TR18 and TR34).

The buffer circuits are themselves controlled from four logic signals (HIGH-LEFT, LOW-LEFT, LOW-RIGHT and HIGH-RIGHT), which emanate from logic chips IC11 and IC8 in response to signals from the micro controller (PORT-D, STBD-D and PWM).

Comparator circuits IC5a and IC5b monitor the current flowing through the H-Bridge and shut down the drive in the event of an over-current situation.

The H-Bridge can also be shut down in response to the WATCHDOG, RESET or KILL signals going low. The buffers in IC24 and transistors TR80, TR49 and TR50 control this. The H-Bridge provides direction and speed control of the motor. Speed control is achieved by modulating the drive voltage at 20KHz for various duty cycle settings.

Spool Valve Control

Both the Type 150 and 400 Course Computers have dedicated ground connections for use with solenoid valve drives. These connections provide a current limited ground return by monitoring the current flow in sense resistor R133. When this current exceeds 2 Amps, comparator IC10a changes state and shuts down the drive provided by H-Bridge high side FETs TR18 and TR34.

Clutch Drive

The clutch output (TB11) is controlled by FET, TR56. The output voltage is normally a nominal 12 Volts but can be connected direct to the incoming power rail by moving the position of output fuse FS3. In the case of a 24 Volt power supply, this enables you to drive a 24 Volt clutch if required.

In a similar manner to the Spool Valve drive, the clutch output current is sensed across resistor R167 and compared against a fixed threshold by comparator IC10c. The comparator output shuts down TR56 if the clutch current exceeds 4 Amps.

Fluxgate Compass

The compass is driven at 8 KHz by the buffer circuit consisting of TR36 and TR37. The drive signal originates from the micro controller and the current amplified output is a.c. coupled via capacitor C53 to the fluxgate drive (Blue) terminal.

Sine and Cosine fluxgate output signals are measured between the Yellow & Red and Green & Red fluxgate terminals respectively. The Red terminal is biased at 2.5 Volts. The micro controller selects the input signals using multiplex chip IC8. These are then presented to the input of the dual slope integrator (IC9a and capacitor C61) for measurement. IC9b is a comparator that generates a micro controller interrupt (ADC-INT) at the end of the integrator discharge cycle.

Rate Gyro

The Type 150 and 400 Course Computers can be fitted with a Rate Gyro (yaw sensor) either externally (via connector block TB8) or internally (via connector CON1).

In either case, the signal is biased around 2.5 Volts (zero yaw condition) and changes by ±22mV (sign is dependent on direction of turn) for every 1°/sec of turn rate. The output signal has a total operating range of 0 to +5 Volts.

External Gyro

12 Volt power is supplied from VBUS via a current limit circuit built around transistor TR45, to the Red gyro connection. The rate signal returns to the Course Computer via the Yellow terminal.

Internal Gyro

The internal Rate Gyro option is powered directly from 5V-ANA. The output and external gyro are connected to the same part of the circuit. This makes the output of the internal gyro available for direct measurement (for diagnostic purposes) at the Yellow terminal of the external gyro connector block.

In either case (external or internal gyro) the signal is buffered by voltage follower amplifier IC13d. The difference between this signal and a 2.5 Volt bias voltage is amplified by differential amplifier IC13c (gain = 3.9). The raw gyro signal (RATE-GYRO) and the amplified signal (RATE-GYRO x3) are presented to two channels of the built in Analogue to Digital Converter (ADC) inputs of the microcontroller IC15.

Rudder Reference

The rudder transducer connects to connector block TB12 on the Course Computer. Transistors TR57a and TR57b current limit the 5 Volt supply to the Red terminal. The transducer output signal enters the Course Computer on the Blue terminal and is buffered by voltage follower IC22a. The output of this unity gain follower (RUDDER-REF) is fed to one of the ADC inputs of the microcontroller.

Differential amplifier IC13b, amplifies the difference between signal RUDDER-REF and a 2.5 Volt bias. The gain of this amplifier is 1.5 and it's output signal (RUDDER-REF x1.5) feeds into another ADC channel of the microcontroller.

RUDDER-REF x1.5 is further amplified by differential amplifier IC13a. Once again, this amplifies the difference between RUDDER-REF x1.5 and a 2.5 Volt bias. The gain of this

amplifier is 3.3 and the output signal RUDDER-REF x3, feeds into yet another microcontroller ADC channel.

NMEA Inputs

The Type 150 and 400 Course Computers have two NMEA input channels, NMEA (in) 1 and NMEA (in) 2. These channels are very similar except NMEA 1 has been tuned to work at higher baud rates for connection to P.C. RS232 serial ports (for diagnostic and software download purposes).

Both NMEA inputs opto-isolate the incoming signal (using opto-couplers IC12 & IC14 respectively) before connecting the incoming signals to UARTs in the microcontroller.

NMEA Output

Like the NMEA inputs, there are two NMEA outputs in the Course Computers, NMEA (out) 1 and NMEA (out) 2. Once again although very similar, NMEA 1 is tuned to work at higher baud rates for connection to P.C. RS232 serial ports (for diagnostic purposes).

Serial data from the microcontroller's UARTs is fed to these output circuits, which are effectively current limited buffer stages that provide the necessary drive levels to comply with NMEA 0183 requirements.

SeaTalk

The SeaTalk circuit is a complex bi-directional buffer stage which provides level shifting and drive capability for both transmit and receive. This is in addition to isolation capability in the event of fault conditions.

FET TR68 prevents the Course Computer being "back" powered from an external voltage on the SeaTalk (Red) bus. Fuse FS2 limits the current (5 Amps) that can be supplied to power other equipment connected to the SeaTalk bus.

When the Course Computer is not powered-up, FET TR47 isolates the transmit buffer circuit from the SeaTalk Yellow data line. This prevents the circuit from pulling down the data line thus preventing other equipment from communicating with each other.

FETs TR76 and TR77 provide a switching capability that enables the Course Computer to selectively shut down either of the two SeaTalk channels in the event of a bus communication failure, enabling the other channel to continue to function independently.

Microcontroller

The microcontroller IC15, used in the Course Computers is a NEC V850 IA1 "Phoenix" device. This is a 32-bit architecture product with built-in Flash ROM, RAM, ADC, Timers, UARTs and PWM outputs. The device is clocked from a 3.6864MHz crystal, which is internally multiplied up by a factor of 10.

Watchdog

Transistors TR67a and TR67b monitor the "health" of the microcontroller IC15. Drive pulses from the microcontroller on signal line WATCHDOG-DRIVE keep capacitor C67 charged up which maintains the output signal (WATCHDOG) in a high logic state. If the microcontroller crashes, the input signal WATCHDOG-DRIVE will cease, causing the output signal WATCHDOG to go low. This Output signal is fed into the H-Bridge control logic to shut it down in the event of any problem occurring. Link LK3 (normally not fitted) connects capacitor C67 to the 5V-DIG power rail, keeping it charged at all times. This is used for diagnostic purposes only.

Flash Memory Programming

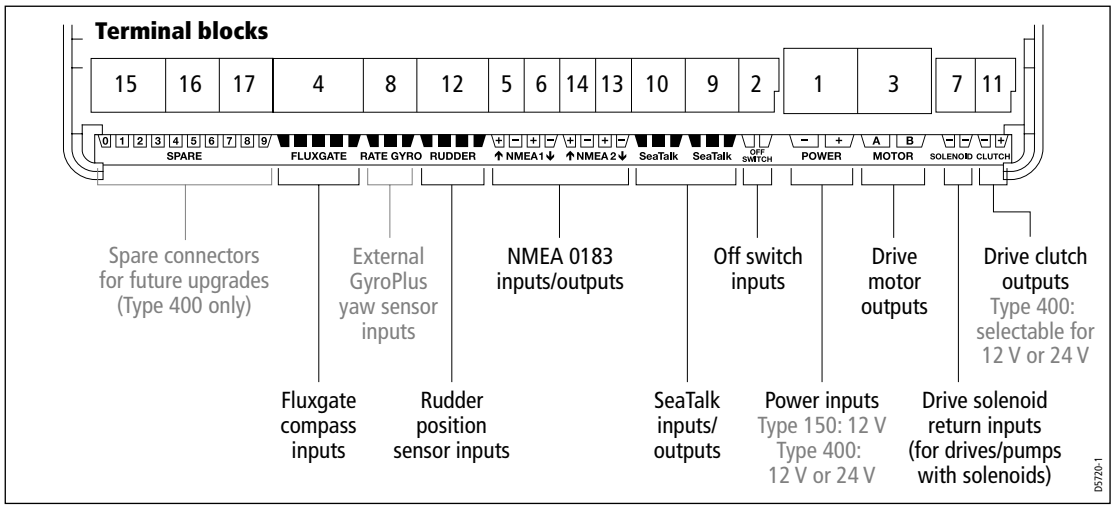
FET TR72 is used to connect the VPP (programming voltage) pin of the microcontroller to the 7.8V power rail during Flash memory programming.

Non-Volatile Memory

Calibration data, hours spent in Auto modes etc. is stored in EEPROM memory IC17. This chip also has a secondary function of providing the reset signal to the microcontroller and the H-Bridge shut down circuit.

Chapter 6: PCB Details

6.1. Inputs and outputs



Terminal block	Color/label	Signal	Direction
1	POWER +	Nominal +12 V or +24 V DC	IN
	POWER –	0 V	IN
2	OFF SWITCH	Switch contact 1	IN
	OFF SWITCH	Switch contact 2	IN
3	MOTOR A	Motor A	OUT
	MOTOR B	Motor B	OUT
4	FLUXGATE gray	Compass drive 2	OUT
	FLUXGATE red	VRESET	OUT
	FLUXGATE green	Compass output F/GA	IN
	FLUXGATE yellow	Compass output F/GB	IN
	FLUXGATE blue	Compass drive 1	OUT
5	NMEA 1 +	NMEA 1 In +	IN
	NMEA 1 –	NMEA 1 In –	IN
6	NMEA 1 +	NMEA 1 Out +	OUT
	NMEA 1 –	NMEA 1 Out –	OUT
7	SOLENOID –	Ground return 1	IN
	SOLENOID –	Ground return 2	IN
8	RATE GYRO red	Nominal +12 V DC	IN
	RATE GYRO gray	0 V	IN
	RATE GYRO yellow	Gyro Signal 0-5 V	IN
9	SeaTalk gray	0 V	OUT
	SeaTalk red	+12 V	OUT
	SeaTalk yellow	SeaTalk data	IN/OUT
10	SeaTalk gray	0 V	OUT
	SeaTalk red	+12 V	OUT
	SeaTalk yellow	SeaTalk data	IN/OUT
11	CLUTCH –	Clutch –	OUT
	CLUTCH +	Clutch +	OUT
12	RUDDER gray	0 V	IN
	RUDDER red	+5 V	IN
	RUDDER green	0 V	IN

Terminal block	Color/label	Signal	Direction
	RUDDER blue	Rudder position sensor output	IN
13	NMEA 2 +	NMEA 2 Out +	IN
	NMEA 2 –	NMEA 2 Out –	IN
14	NMEA 2 +	NMEA 2 In +	OUT
	NMEA 2 –	NMEA 2 In –	OUT
15 (400/400G only)	SPARE 0	Not currently used	TBA
	SPARE 1	Not currently used	TBA
	SPARE 2	Not currently used	TBA
	SPARE 3	Not currently used	TBA
16 (400/400G only)	SPARE 4	Not currently used	TBA
	SPARE 5	Not currently used	TBA
	SPARE 6	Not currently used	TBA
17 (400/400G only)	SPARE 7	Not currently used	TBA
	SPARE 8	Not currently used	TBA
	SPARE 9	Not currently used	TBA

6.2. Circuit diagram and PCB layout

Refer to the Appendix for circuit diagrams and PCB layouts.

6.3. PCB components

Type 150, 150G, 400 and 400G surface mount

Part number	Description	Qty	Reference on PCB layout
91010R0	ZERO OHM LINK, 0603 PACKAGE	3	R192, R341, R338
910210K	RESISTOR 10K+-5% 0805 0.1W	30	R103, R104, R112, R113, R131, R145, R147, R154, R159, R164, R178, R180, R186, R202, R211, R225, R240, R242, R250, R258, R263, R266, R267, R311, R313, R37, R38, R53, R79, R86
910215K	RESISTOR 15K+-5% 0805 0.1W	12	R135, R140, R160, R170, R173, R25, R27, R309, R310, R4, R226, R227
9102180R	RESISTOR 180R+-5% 0805 0.1W	1	R245
91021K	RESISTOR 1K+-5% 0805 0.1W	15	R100, R11, R110, R117, R136, R141, R203, R218, R219, R229, R275, R290, R3, R301, R99
9102270R	RESISTOR 270R, 0850	8	R111, R280, R284, R318, R50, R84, R97, R98
910327K	RESISTOR 27K, 1206	5	R316, R317, R32, R49, R85
91061R0	RESISTOR 1R0, 1206 0.25W	3	R305, R306, R91
910622R	RESISTOR 22 OHM 1206	9	R139, R172, R40, R41, R43, R44, R8, R335, R336
9106470R	RESISTOR 470R, 1206	5	R16, R33, R34, R58, R74
910647R	RESISTOR 47R, 1206	2	R127, R182
91068R2	RESISTOR 8R2, 1206	7	R150, R212, R22, R31, R89, R9, R90
9108VC260540	TRANSGUARD	3	V3, V4, V5
911210K	RES. NETWORK - 10K	1	RN15
91121K	RES. NETWORK 1K(MNR14)	1	RN26
91122K2	RES. NETWORK 2K2(MNR34)	2	RN22, RN25
91124K7	RESISTOR NETWORK	6	RN10, RN17, RN21, RN24, RN27, RN28
91AAAXX100K	RES. 100K, 1%, 0.063W, 0603	5	R118, R138, R222, R65, R67
91AAAXX100R	RES. 100R, 1%, 0.063W, 0603	9	R15, R174, R247, R256, R271, R277, R279, R303, R45
91AAAXX390R	RES. 390R, 1%, 0.063W, 0603	1	R156
91AAAXX470K	RESISTOR – 470K 1% 0603	3	R253, R261, R29
91AAAXX470R	RESISTOR 470R, 1% 0.063W 0603	2	R243, R244
91AAAXX680R	RESISTOR – 680 OHMS 1% 0603	1	R228
91AAAXX820K	RESISTOR – 820K 1% 0603	1	R114
91AAAXXX10R	RES. 10R, 1% 0.063W, 0603	4	R281, R285, R276, R278
91AAAXXX1K2	RESISTOR - 1K2 1% 0603	7	R107, R17, R21, R223, R224, R343, R344
91AAAXXX1K5	RESISTOR 1.5K, 1% 0.063W 0603	14	R129, R165, R171, R184, R2, R215, R26, R299, R300, R5, R92, R93, R94, R96
91AAAXXX22K	RES. 22K, 1%, 0.063W, 0603	9	R134, R158, R168, R18, R19, R230, R291, R292, R304
91AAAXXX2K2	RESISTOR 2.2K, 1% 0.063W 0603	7	R115, R151, R152, R153, R157, R56, R77
91AAAXXX33K	RESISTOR 33K, 0.063W, 0603	7	R105, R179, R181, R195, R198, R274, R95
91AAAXXX39K	RESISTOR 39K, 1% 0.063W 0603	10	R14, R146, R148, R155, R161, R163, R213, R214, R63, R69
91AAAXXX47K	RESISTOR 47K, 1% 0.063W 0603	12	R268, R324, R325, R326, R327, R328, R329, R330, R331, R332, R333, R334
91AAAXXX4K7	RESISTOR 4.7K, 1% 0.063W 0603	33	R116, R13, R132, R162, R210, R216, R217, R220, R221, R232, R233, R234, R235, R241, R246, R255, R272, R283, R286, R288, R289, R312, R314, R315, R319, R320, R321, R322, R35, R36, R342, R339, R194
91AAAXXX5K6	RESISTOR - 5K6 1% 0603	4	R106, R196, R197, R273

Part number	Description	Qty	Reference on PCB layout
91AAAXXX68K	RESISTOR 68K, 1% 0.063W 0603	11	R101, R102, R109, R149, R166, R251, R259, R262, R270, R39, R42
91AAAXXX82R	RESISTOR - 82 OHMS 1% 0603	1	R108
91AAAXXXX1M	RESISTOR 1M,1% 0.063W 0603	7	R137, R169, R175, R252, R260, R64, R68
91ZCAXXX47K	RESISTOR PACK, 47K OHM	4	RN11, RN12, RN13, RN14
9200BAS19	DIODE SOT23 BAS19	18	D1, D10, D14, D18, D2, D20, D21, D22, D30, D31, D36, D37, D38, D42, D43, D44, D5, D8
9200BAT54S	DIODE - SCHOTTKY BARRIER	1	D45
9200BAV99	BAV99 DIODE	4	D19, D25, D27, D29
9200BAW56	BAW56LT1 DIODE	1	D35
9200RB160L	SCHOTTKY-RECTIFIER DIODE	1	D41
9203BZX12V	12V ZENER DIODE	2	ZD14, ZD15
9203BZX15V	ZENER DIODE BZX84-C15	14	ZD12, ZD13, ZD18, ZD19, ZD21, ZD22, ZD24, ZD25, ZD3, ZD5, ZD6, ZD7, ZD8, ZD9
9203BZX18V	BZX84C18 ZENER DIODE	1	ZD16
9203BZX39V	39V DIODE	1	ZD4
9203BZX84C5V1	5V1 ZENER	9	D33, D39, D40, ZD1, ZD10, ZD11, ZD17, ZD20, ZD23
9203BZXC7V5	ZENER DIODE - BZX7V5-ZDSOT23	1	ZD2
9204D1F10	DIODE RECTIFIER 1A / 100V	7	D12, D13, D23, D24, D28, D4, D6
9301470P	CAPACITOR 470pf 100v +-5% 0805	8	C124, C125, C126, C127, C154, C76, C173, C174
93040U01	CAPACITOR 0.01uF, X7R	2	C167, C7
93070U1	CAPACITOR .1uF, 1206	34	C135, C140, C141, C142, C143, C146, C149, C152, C165, C175, C179, C19, C25, C34, C35, C42, C43, C47, C48, C54, C56, C57, C58, C62, C63, C64, C65, C66, C68, C73, C82, C87, C91, NAL, C180
93091U	CAPACITOR 1uF, TANT	2	C16, C17
93102U2	CAPACITOR 2.2uF	1	C53
931122U	CAPACITOR 22U, 6V3 TANT	3	C156, C72, C83
9324100U	CAPACITOR 100uF ELECT. 6.3VDC	3	C102, C112, C55
932410U	CAPACITOR 10uF, 16VDC ELECT	13	C118, C136, C137, C138, C139, C166, C20, C46, C67, C9, C93, C95, C96
93ACHAXX100P	CAP. SM, 100pF, 50V, 5%, 0603	15	C117, C153, C155, C36, C37, C44, C45, C59, C60, C71, C74, C75, C80, C81, C88
93ACHAXXX12P	CAP. SM, 12pF, 50V, 5%, 0603	2	C100, C99
93ADHBXX10N	CAP. 10nF XR7	3	C103, C158, C79
93ADHBXX1N	CAPACITOR 1nF 0603	29	C101, C113, C114, C115, C116, C144, C145, C147, C148, C150, C151, C39, C41, C49, C50, C51, C52, C61, C69, C77, C78, C84, C85, C86, C89, C90, C92, C94, C133
93BDHXXX4N7	CAP. 4n7, 0805 CERAMIC	3	C176, C177, C178
93ZGFGXX220P	CAPACITOR 220pF 25V -20/+50%	1	FLTR1
940024022	RESET CONTROLLER S24O22 +2KMEM	1	IC17
940074HC00	QUAD 2 INPUT NAND	1	IC18
940074HC08	QUAD AND GATE - SN74HC08D R	1	IC11
940074HC14ST	SCHMITT TRIGGER IC	2	IC24, IC7
940074HC4051	IC 74HC4051	1	IC8
9400HP0701	OPTO SWITCH - HCPL-0701	2	IC12, IC14
9400IRF7406	MOSFET (IRF7406TR) - POWER FET	1	IC2
9400LM1117	LIN.REGULATOR - LM1117MPX-3.3	1	IC16
9400LM324	QUAD OP-AMP LM324	2	IC13, IC22
9400LM339	QUAD OP AMP	2	IC10, IC5
9400PC357D	OPTO-COUPLER, GRADE D	1	IC4

Part number	Description	Qty	Reference on PCB layout
9400TLC27M2C	TLC27M2CD	1	IC9
9400UPD70F3116	FLASH 32bit MICRO UPD70F3116	1	IC15
9401LM2674M	SWITCH MODE REGULATOR IC	1	IC6
9401LM317	VOLT. REG. - LM317MDT	2	IC21, IC23
95002N7002	2N7002 MOSFET	5	TR14, TR15, TR47, TR76, TR77
95002SK3065	SWITCHING MOSFET(N-CHANNEL)	1	TR72
9500BC807	BC807	7	TR16, TR22, TR28, TR33, TR36, TR40, TR59
9500BC817	BC817	18	TR37, TR41, TR42, TR55, TR60, TR61, TR65, TR66, TR70, TR71, TR73, TR78, TR80, TR81, TR82, TR83, TR84, TR85
9500IMT1	DUAL TRANSISTOR ARRAY	2	TR45, TR57
9500IMX1	DIGITAL TRANSISTOR ARRAY	18	TR1, TR10, TR12, TR19, TR2, TR21, TR26, TR31, TR43, TR48, TR49, TR50, TR53, TR67, TR69, TR7, TR74, TR75
9500IMZ1	DUAL TRANSISTOR ARRAY	1	TR51
9600CHIPIND3	CHIP FILTER - BLM41P800S	1	L49
9600CHOKE2	INDUCTOR 5A COMMON MODE	1	L3
9600CR36864M	CRYSTAL, 3.6864MHz	1	XL1
9600FER2012	CHIP FERRITE BEAD BLM21 SERIES	10	L50, L53, L54, L55, L56, L57, L59, L60, L61, L64
9600L1	CHIP INDUCTOR	29	L10, L11, L12, L13, L14, L15, L16, L17, L18, L19, L20, L23, L24, L25, L26, L27, L29, L34, L42, L46, L47, L5, L52, L6, L66, L67, L7, L8, L9

Type 150/150G conventional mount

Part number	Description	Qty	Reference on PCB layout
01208	RESISTOR 0.1 OHM, 1 WATT	2	R133, R167
01244	VARISTOR V33ZA5	2	V1, V2
01245	RES. 330R (ROX3S 330R)	1	R66
01246	RES. 51R (PHILIPS 343-651)	1	R323
03031	100uF 35V 10MMDIA ELEC CAP	4	C23, C30, C32, C168
03046	CAP. 10uF 63V RAD ELEC.	1	C157
03060	CAP ELECT 470uF 25V RADIAL	1	C172
03072	CAP 10UF 20% 25V	2	C24, C31
03082	CAP. 100NF 100V	6	C12, C169, C170, C22, C5, C6
03132	CAP. 680uF, 50V RADIAL	2	C21, C26
03146	CAP 1uF 63V PEST	1	C171
03153	CAPACITOR 220uF ELECT 50V 20%	4	C160, C161, C3, C4
03174	CAPACITOR 33uF 50V, AL. ELECT.	1	C28
03175	CAPACITOR 82uF 35V, AL. ELECT.	1	C29
03177	CAP. AL. ELECT. 1000uF 50V	1	C33
03179	CAPACITOR 4700nF, 50V, POLY.	2	C1, C2
05007	TRANSISTOR TIP31A	1	TR3
05040	FET IRFZ48N, TO220 PACKAGE	6	TR18, TR24, TR27, TR34, TR56, TR68
07375	TERMINAL BLOCK (28)	1	TBA
07392	2 x 25 WAY HEADER - AMP	1	HD1
07397	PCB TERMINAL BLOCK	2	TB1, TB3
07399	PCB CONNECTOR (DBC 2 2.5 3 T)	1	COM1
07403	TERMINAL BLOCK (4)	1	TBC
13024	24 SWG WIRE LINKS BANDLIER	3	LK2, LK4, LK6
15157	RELAY ZC114012	1	RLY1
15185	RADIAL CHOKE 100uH	2	L44, L48
15375	INDUCTOR - EC24-100K	3	L2, L45, L63
15376	AUTOMOTIVE FUSE - 4 AMP	1	FS3
15377	AUTOMOTIVE FUSE - 5 AMP	1	FS2
15378	AUTOMOTIVE FUSE - 30 AMP	1	FS1
15380	AUTOMOTIVE FUSE CLIP	7	FS1a, FS1b, FS2a, FS2b, FS3a, FS3b, FS3c
15390	FERRITE (294666631)	3	L51, L58, L62
15394	INDUCTOR - EC24-101K	1	L4
3030-255-C	COMM. MODE CHOKE (40AMP)	1	L65

Type 400/400G conventional mount

Part number	Description	Qty	Reference on PCB layout
01208	RESISTOR 0.1 OHM, 1 WATT	2	R133, R167
01226	RES. 22 OHM, 2W, 350V	1	R231
01244	VARISTOR V33ZA5	2	V1, V2
01245	RES. 330R (ROX3S 330R)	1	R66
01246	RES. 51R (PHILIPS 343-651)	1	R323
02042	DIODE SCHOTTKY PBYR 1645	2	D7, D9
03031	100uF 35V 10MMDIA ELEC CAP	4	C23, C30, C32, C168
03046	CAP. 10uF 63V RAD ELEC.	1	C157
03060	CAP ELECT 470uF 25V RADIAL	1	C172
03071	CAP 2.2UF 20% 25V	1	C15
03072	CAP 10UF 20% 25V	2	C24, C31
03082	CAP. 100NF 100V	9	C12, C14, C162, C169, C170, C22, C5, C6, C134
03122	CAP. 4.7nF 400V POLYESTER	1	C128
03132	CAP. 680uF, 50V RADIAL	3	C18, C21, C26
03146	CAP 1uF 63V PEST	1	C171
03153	CAPACITOR 220uF ELECT 50V 20%	4	C160, C161, C3, C4
03174	CAPACITOR 33uF 50V, AL. ELECT.	1	C28
03175	CAPACITOR 82uF 35V, AL. ELECT.	1	C29
03176	CAP. POLY. 10nF 63V	2	C129, C130
03177	CAP. AL. ELECT. 1000uF 50V	5	C121, C122, C123, C13, C33
03178	CAPACITOR 470pF, 100V, POLY.	2	C119, C120
03179	CAPACITOR 4700nF, 50V, POLY.	3	C159, C1, C2
04080	REGULATOR (LT1270ACT) - FLOW 06	1	IC3
05007	TRANSISTOR TIP31A	1	TR3
05040	FET IRFZ48N, TO220 PACKAGE	2	TR56, TR68
05060	MOSFET (IRF3205) - POWER FET	5	TR18, TR24, TR27, TR34, TR8
07376	TERMINAL BLOCK (38)	1	TBB
07391	1 x 12 WAY HEADER - AMP	1	HD2
07392	2 x 25 WAY HEADER - AMP	1	HD1
07395	PCB TERMINAL BLOCK	2	TB1, TB3
07399	PCB CONNECTOR (DBC 2 2.5 3 T)	1	COM1
07403	TERMINAL BLOCK (4)	1	TBC
15157	RELAY ZC114012	1	RLY1
15185	RADIAL CHOKE 100uH	2	L44, L48
15375	INDUCTOR - EC24-100K	3	L2, L45, L63
15376	AUTOMOTIVE FUSE - 4 AMP	1	FS3
15377	AUTOMOTIVE FUSE - 5 AMP	1	FS2
15379	AUTOMOTIVE FUSE - 40 AMP	1	FS1
15380	AUTOMOTIVE FUSE CLIP	7	FS1a, FS1b, FS2a, FS2b, FS3a, FS3b, FS3c
15390	FERRITE (294666631)	3	L51, L58, L62
15394	INDUCTOR - EC24-101K	1	L4
3030-250-B	INDUCTOR-10AMP TOROID	1	L1
3030-255-C	COMM. MODE CHOKE (40AMP)	1	L65
3030-256-A	COMM. MODE CHOKE (10AMP)	1	L43

Chapter 7: Software Upgrade

7.1. Introduction

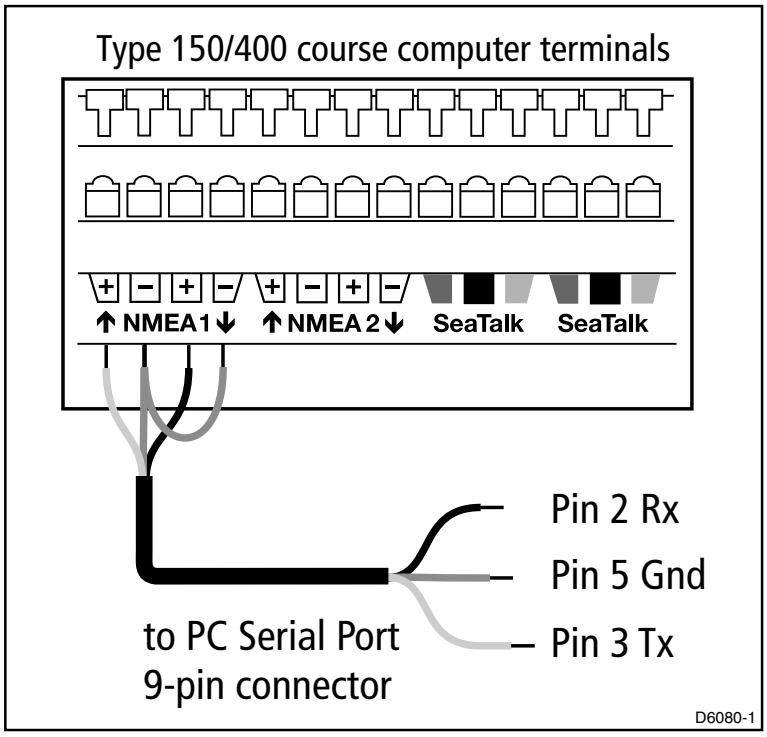
The Type 150/400 Course Computer has the ability to implement software upgrades via their NMEA port connected to a PC running Windows 9x or NT 4.0. This chapter describes the upgrade procedure.

7.2. Minimum Requirements

- PC with an Intel 486 CPU and 16650 UART (refer to your PC's handbook)
- The three program files should be installed on a local hard disk.

7.3. Connecting the Course Computer to the PC

Power off the Course Computer and connect a cable as shown to the PC's serial port. The connection of both NMEA –ve ports to ground is essential.



7.4. Upgrade procedure

1. At the PC run the program **SWDL 4 WINDOWS.EXE**.
2. Select **FILE** from the top menu, then **OPEN**.
3. A new dialog box will appear and you will need to select a file based on the COM port you are using.
   - For COM1 use **CC115K1.INI**
   - For COM2 use **CC115K2.INI**

   The dialog box should open in the correct folder. If not, these files can be found in the C:\Program Files\Raymarine\Course Computer\ directory.
4. The screen should be displaying "TX: CMD :null" every few seconds.
5. Power Up the Course Computer.
6. You should now see red "ACK" and black "TX: CMD :null" messages scrolling down the screen.

7. Make sure that every other line is a red "ACK" as shown above. If it is not, power off the Course Computer and then power it on again.
8. Select **DOWNLOAD** from the top menu and click on **DOWNLOAD APPLICATION**.
9. A new dialog box will appear and you will need to select the appropriate *.BIN file to be used.
10. DO NOT SWITCH OFF POWER TO THE COURSE COMPUTER DURING THE FILE DOWNLOAD!

    It is very important that during the actual file transfer that power is not removed from the Course Computer. If power is lost, only a partial transfer will take place and this will render the unit inoperable. In this occurs, the unit will have to be returned to Raymarine Limited.
11. The download will take approximately 1 minute. As the download is underway the screen will not update. After a time a number of "TX…" and "ACK…" messages will be displayed.
12. **Only when the text "Download Successful" is displayed is the process complete.**
13. Exit the **SWDL 4 WINDOWS** application.
14. Power OFF the Course Computer and disconnect the download cable.
15. The software upgrade is now complete and the unit is ready for normal operation.

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