

# *VOLVO PENTA SPEED RELAY*

A Guide to Testing & Repair



# Volvo Penta Speed Relay

## **Disclaimer**

This document provides general information about the Volvo Penta KAD series marine diesel engine. The words and other content provided in this document, and in any linked materials, are not intended and should not be construed as technical advice.

If the reader or any other person has a technical concern they should consult with appropriately qualified Volvo Penta Engineer.

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**For questions or help contact me here:**

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## **Important**

Depending on the boat's wiring, the supercharger clutch coil will remain connected to the 12V supply even when the ignition is off.

Before connecting or disconnecting any components, disconnect the battery leads or isolate using the battery isolator.

## Volvo Penta Speed Relay

### Testing for damage

Isolate battery and then disconnect the multiway connector.

Remove the speed relay from the engine and remove the cover on the speed relay.

Locate the transistor as shown bottom left in the picture.

This is the black item that is riveted into the board.


You may need to scrape the coating using a fingernail, plastic scraper or a similar soft item to expose the pins. Do not scrape the coating using a screwdriver.

The transistor has 3 legs. The left pin is pin1, middle is pin 2, right leg is pin 3.



Note: The square blue component with the brass screw adjuster is a variable resistor. This adjusts the cut-out RPM for when the supercharger will disengage.

Do not adjust this to fix the issue, this will put the box out of adjustment.


Use a digital multi-meter that has diode setting: 

Touch the black lead of the meter to pin 1 of the transistor and the red lead to pin 2, note the reading and follow the rest of the table below.

| Black lead | Red Lead | Reading      |
|------------|----------|--------------|
| 1          | 2        | -            |
| 1          | 3        | 699 (Approx) |
| 2          | 1        | -            |
| 2          | 3        | 530 (Approx) |
| 3          | 2        | -            |
| 3          | 1        | -            |

If you read '0' the transistor is internally shorted. Other values can be read if the transistor is damaged. The "-" in the table means there should be no reading.

Zener Diode measured in circuit: 699 (Approx).

This item is located immediately on the left of the transistor's pin 1 and in the picture above is red/black in colour. Colour can vary. Example: 

## Volvo Penta Speed Relay

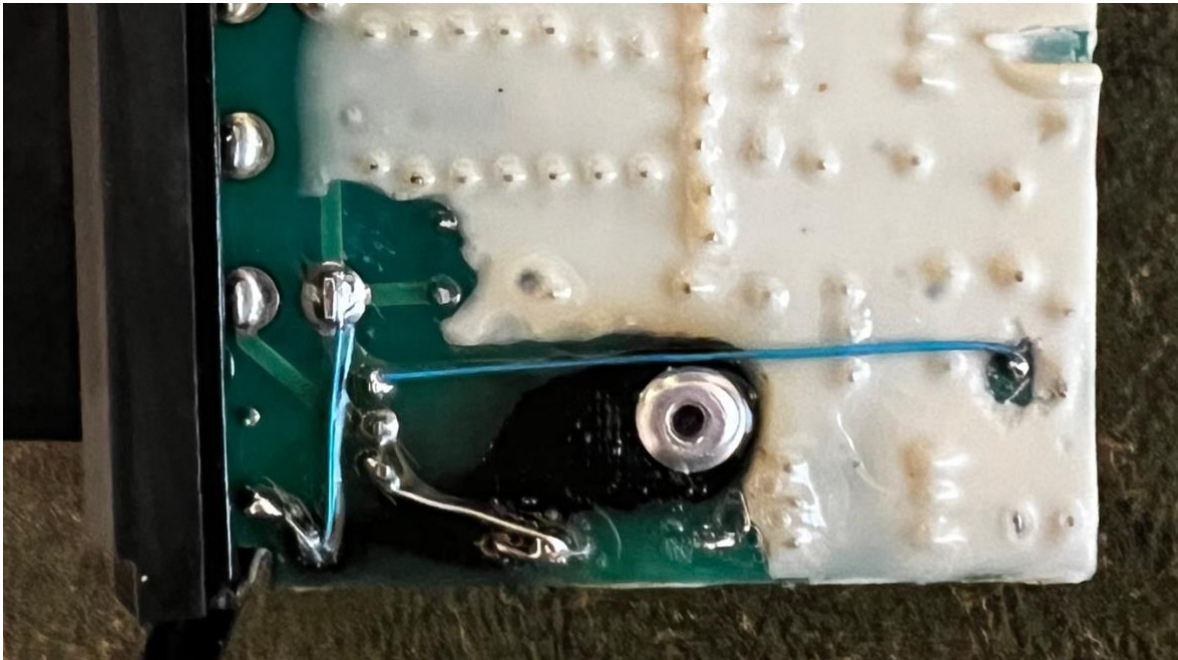
### Example of a damaged board

Whilst the board has suffered from heat damage which has also damaged some of the tracks and the pads it is still repairable, although the repair will be obvious.



The board has been repaired and a new transistor has been riveted in.

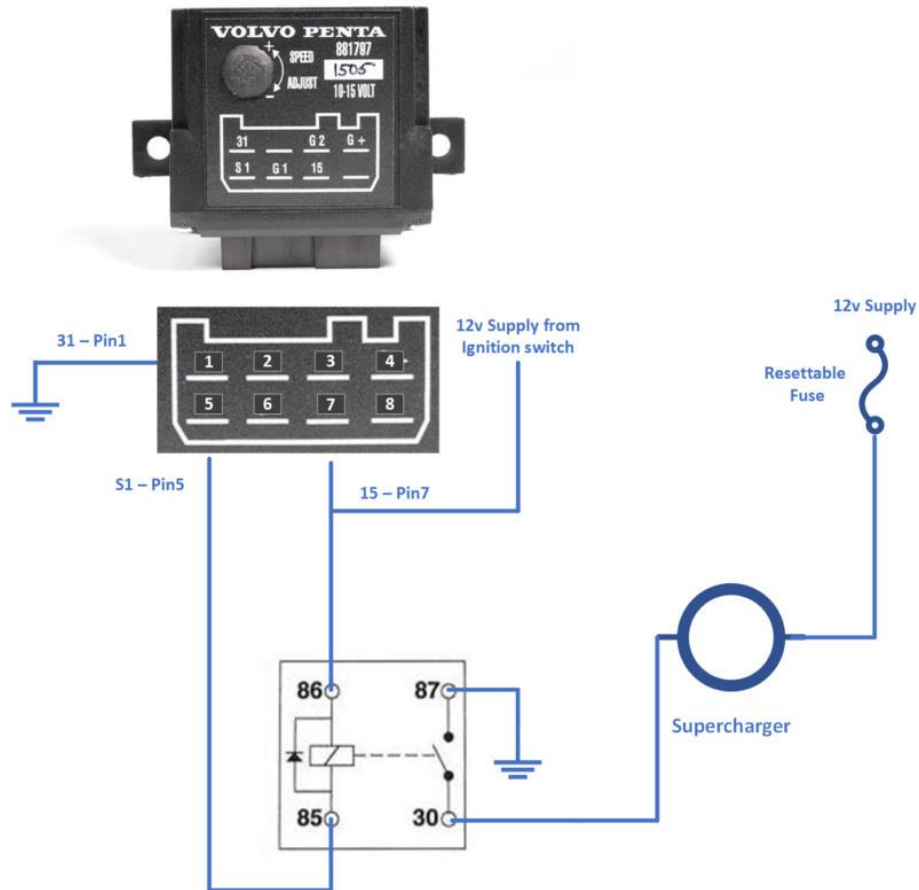
The damage destroyed about 5 tracks and 2 through holes. The heat also damaged 2 other components on the board.



## Volvo Penta Speed Relay

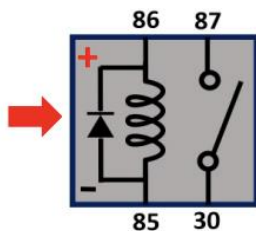
### Protecting the Speed Relay

Consider fitting a relay in between the supercharger and the Volvo speed relay. This will protect the speed relay from damage when the clutch coil fails.



Ensure the relay has a suppression diode.

The diode should be installed in the relay with the stripe on the diode body facing towards terminal 86 (reverse biased) and it is important that +12V is connected this terminal.



#### Relay with diode across coil for spike suppression

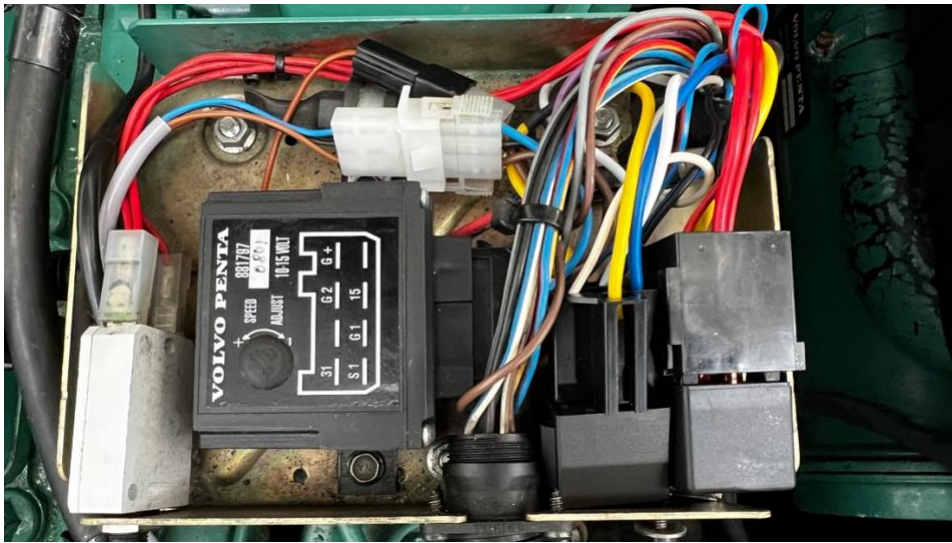
Diodes are usually installed with the band (Cathode/Negative) of the diode facing to terminal 86 (if positive reverse biased) & is critical that +12V be connected here and not to 85 to prevent diode damage and relay box damage.

Note: Some relays have the diode is reversed - please check before installing.



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Protection relay installed next to starter relay



### Cable Connections

Locate cable S1 / Pin 5 on the Volvo connector block. Do not cut this cable. Remove the connector from the connector housing using a [connector pin removal tool](#).



<<< Volvo connector



New relay socket >>>

On the new relay socket remove the existing cable for Pin 30\*\* using a pin removal tool and insert the cable removed from S1/Pin 5 into the new relay socket at Pin 30.

\*\* This removed cable is spare

On the new relay socket locate pin 85.

Using another relay socket as a donor remove the same colour cable using a pin removal tool. Cut to length and join this spare cable together with the cable on pin 85. The 'new' connector obtained from the donor relay socket will then plug into the now empty position S1/Pin5 on the Volvo connector block.

Note: If you have the correct crimp, you may attach a crimp instead of using a donor socket. Female blade terminal with locking tab. 6.3 Type using SNA-48B Crimp tool.

On the new relay socket locate pin 87. This cable should be spliced onto cable 31/Pin 1.  
On the new relay socket locate pin 86. This cable should be spliced onto cable 15/Pin 7.

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### Speed Relay Connections

| Connector | Case Identifier | Info                        |
|-----------|-----------------|-----------------------------|
| P1        | 31              | GND                         |
| P2        | -               | n/c                         |
| P3        | G2              | Signal from position sensor |
| P4        | G+              | Supply to position sensor   |
| P5        | S1              | Supercharger                |
| P6        | G1              | Engine Speed Sensor         |
| P7        | 15              | Ignition Switch (+12v)      |
| P8        | -               | n/c                         |



### Check Supercharger

Ensure Supercharger will freely rotate. It should be easy to rotate the front of the assembly using just 1 finger. If it does not rotate freely there may be a bearing issue or fouled turbines – this will cause additional load on the clutch and may damage the speed relay.

Check the oil level and condition in the supercharger.

### Check Trip

The circuit breaker / trip is the white item shown below. It will trip at 10A.

If it is tripping repeatedly then it is likely there is a fault with the supercharger coils.

**DO NOT CONTINUE TO OPERATE THE SUPERCHARGER**

Check the current draw as described in the next section: **Testing the Clutch Coil**

Check the trip is correctly wired and has not been bypassed by a previous owner.

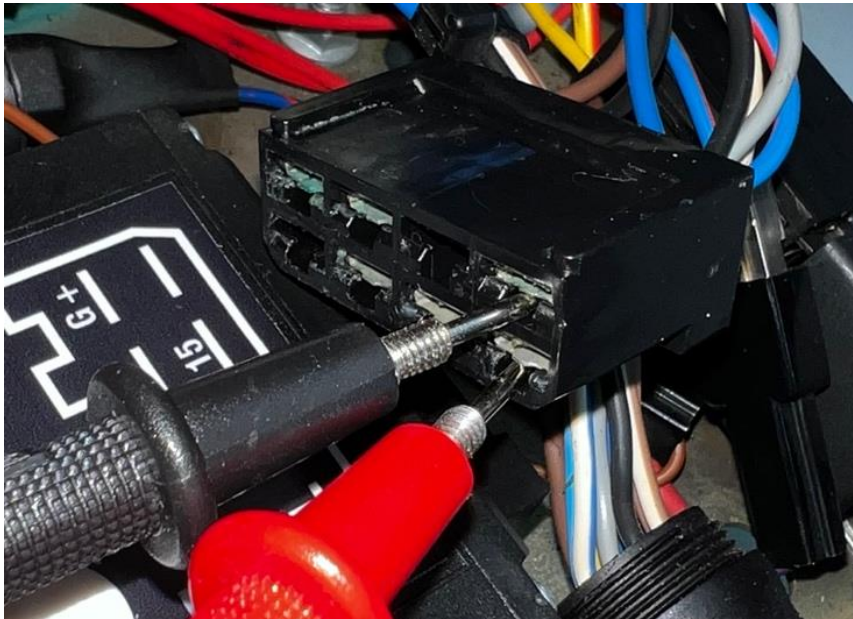


## Volvo Penta Speed Relay

### Testing the Clutch Coil

The clutch coil is the primary reason the speed control relay gets damaged. The clutch coil can be tested in situ to measure the voltage and current. Unplug the multiway connector from the speed relay.

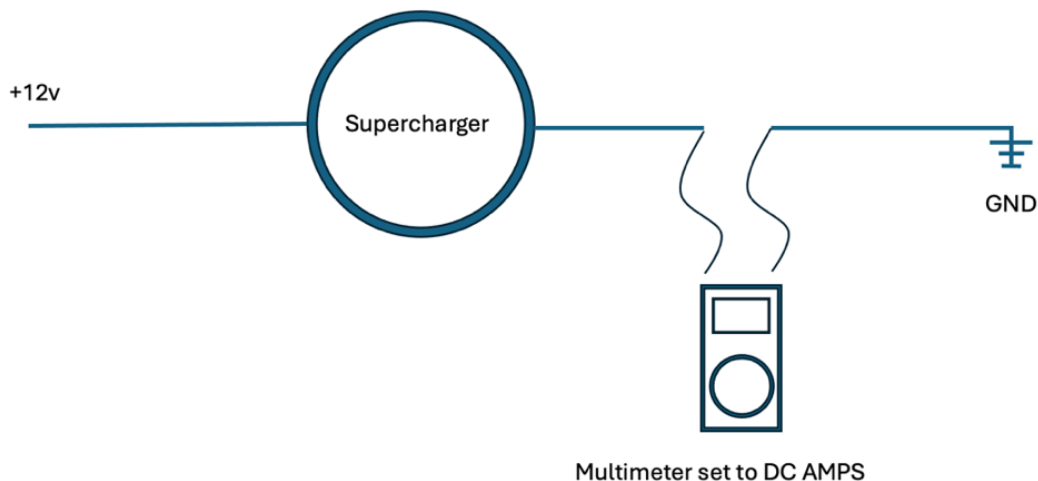
Using a multimeter set to DC volts measure the voltage between pin 1 and pin 5 on the connector (31 & S1). The reading should be at least 12v.



Disconnect the multimeter and reconfigure it for measuring DC Amps.

The multimeter must support high current, eg 10-20 Amps for a short time – this is usually on a separate fused input.

Measure the current between pin 1 and pin 5 on the connector. The reading should be circa 3.75 Amps. The clutch will make an audible clunk as the measurement is read.





## Volvo Penta Speed Relay

### Throttle position sensor

Volvo part number: 874498

Pepperl & Fuchs model number: 922FS2-B4N-V3-Z895. Part no: 451435S

Type: NPN. Normally Closed

Volvo exclusive part – not available to purchase from P&F

Possible alternative: NBB3-V3-E1 (Not verified). 3mm detection range

A faulty or bad connection on throttle position sensor can cause the supercharger to run when the engine is at idle. Temporarily disconnecting the speed sensor (Part number: 862251) and restarting the engine will confirm if this is the case. With no signal being received the clutch will not be engaged at idle.

If it is still engaged at idle with the speed sensor disconnected, then it's likely to be a different fault.

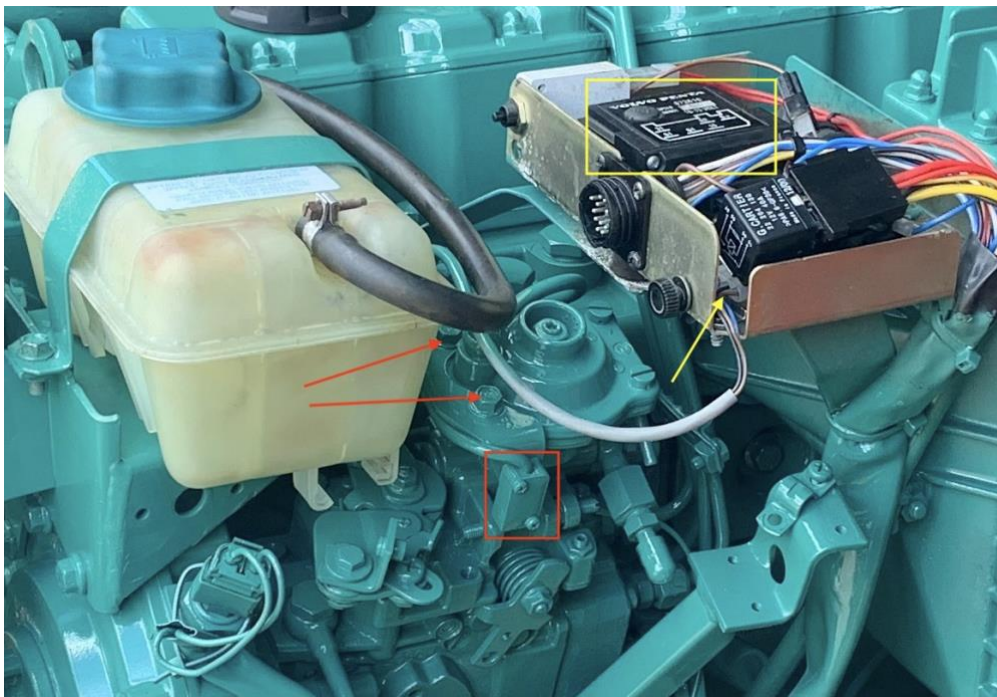
Proximity sensor connections to the relay box: Brown – P4, Black – P3, Blue – GND

### Throttle position sensor removal

Disconnect the throttle position sensor inside the control box – disconnect the 3-way connector as indicated with the yellow arrow.

Remove the Throttle position sensor and mounting bracket by removing the 2 bolts indicated with a red arrow. Leave the sensor attached to the bracket for testing.

The sensor may be tested in situ but must be disconnected.



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### Testing the throttle position sensor

The sensor must be completely disconnected from the engine by disconnecting the 3-way connector in the control box.

#### **Connect proximity sensor to power:**

Connect Brown wire on proximity sensor to power (12v)

Connect Blue wire on proximity sensor to 0v

LED (if present) on proximity sensor should be lit (May be covered with paint)

Leave the wires connected and go to next step

#### **Connect proximity sensor to multi-meter:**

With the power wires still connected, connect multi-meter as follows:

Set meter to DC Volts

Black lead on meter to Black wire on proximity sensor

Red lead on meter to brown wire on proximity sensor

Meter will read about 11.31v

Activate sensor with a metal object on the target area indicated on the sensor

Multi-meter will read 0v and the LED should go out.

Not applicable to the earlier version based on a microswitch.

### Calibrating “Speed Adjust”

Requires a signal generator and test rig.

| Frequency / Speed |        |                         |                       |                         |
|-------------------|--------|-------------------------|-----------------------|-------------------------|
| KAD32             | Engage | High Speed<br>Disengage | Kickdown<br>Disengage | Decelerate<br>Disengage |
| RPM               | 1700   | 2600                    | 3100                  | 1400                    |
| Freq Hz           | 935    | 1430                    | 1705                  | 770                     |

Note: The **KAMD** engines disengage at 2400 RPM. Check the Volvo manual for correct information and ensure the correct RPM adjustment is used.

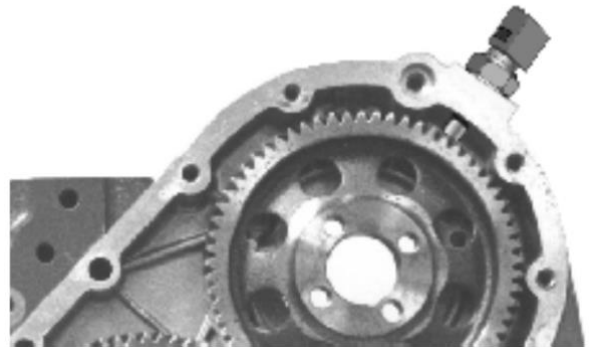
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### Inductive Speed Sensor

This item is located on the camshaft cover.

The speed relay uses this component to determine the engine speed. If it is disconnected, faulty or has a bad connection, the supercharger will not engage.

The alternator W terminal does not provide input for the supercharger.

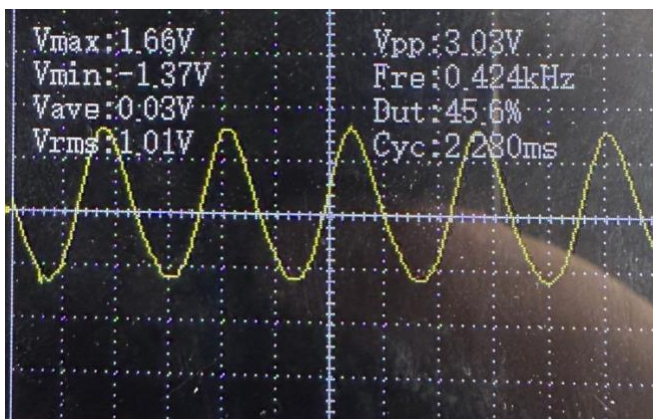


Inductive sensor (cog counter). Internal resistance  $1050 \Omega \pm 100 \Omega$ .

### Testing Inductive Speed Sensor

With the connector removed measure the resistance with a multimeter set to Ohms.  
Expected reading  $1050 \Omega \pm 100 \Omega$

With the connector re connected and the engine running, connect an oscilloscope to the speed relay: P6 / G1 – the expected signal is shown below.



Frequency shown as 0.424kHz (424Hz). Engine was running at 771RPM  
Amplitude = 3.03v p-p.

Frequency and amplitude will increase with engine speed

## Volvo Penta Speed Relay

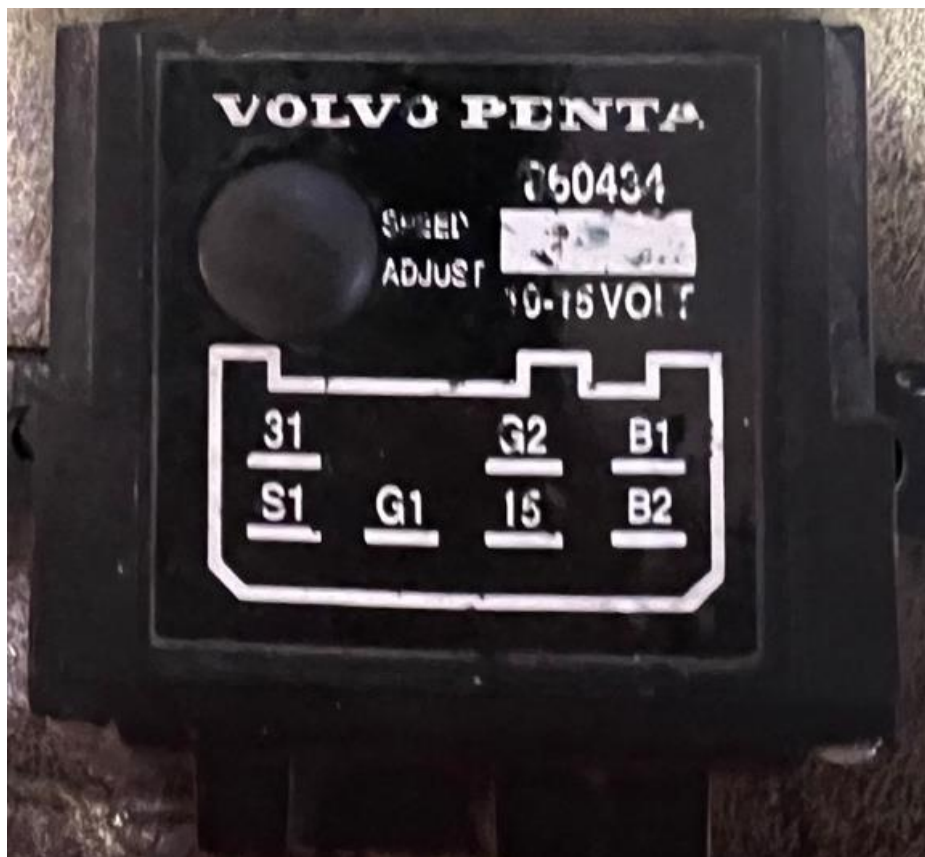
### Testing the throttle position sensor – Earlier Microswitch version

This is simply a switch with Common & NO. The wiring has 2 wires.

The switch is pressed all the time except on a full throttle condition when the switch will disengage.

Using a meter check for continuity between the 2 wires. This should be normally open and then closed when the switch is pressed.

The speed relay on earlier engines has the part number 860434.



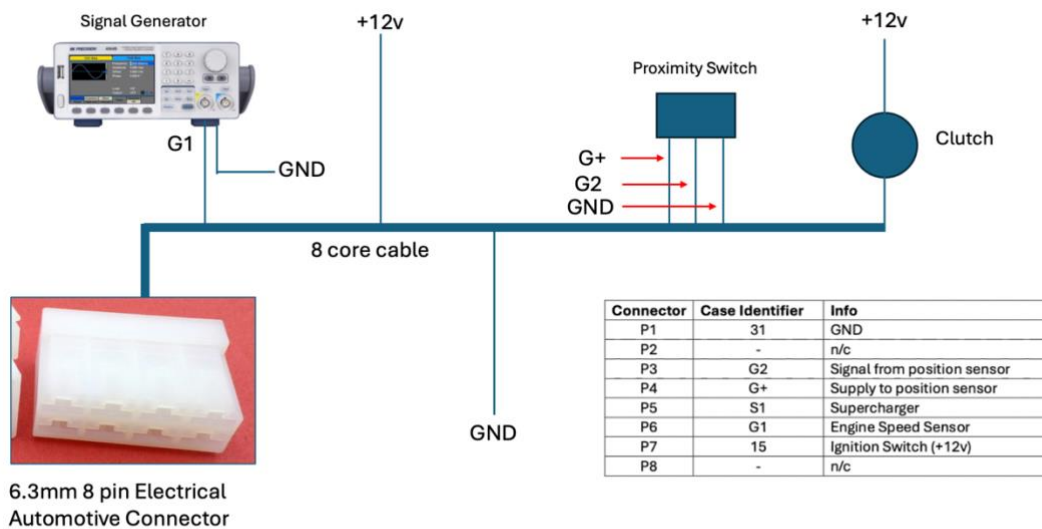
# Volvo Penta Speed Relay

## Building a test cable

### Items required

- Signal Generator to provide sine wave. 5v P-P. Range 900hz – 1800hz
- Proximity Switch. NPN Normally Closed. Ideally Volvo, but any generic will work.
- 8 core cable and suitable crimps
- Connector suitable for Volvo connector. Ideally an original Volvo Penta cable and connector, but an alternative is a 6.3mm 8 pin Electrical Automotive Connector.
- 12v power supply. 2A
- LED to represent the clutch coil.

Connect the component as shown in the diagram below.



Proximity switch is usually connected as follows:

Brown wire: P4 /G+ (Supply)

Blue wire: GND

Black wire: P3/ G2 (Signal)



# Volvo Penta Speed Relay

## **Fault Finding**

### **Supercharger running all the time**

- Faulty Proximity sensor
- Bad transistor on speed relay
  - Test throttle proximity sensor using the instructions in this document
  - Check speed relay transistor with a multimeter using the instructions in this document

### **Speed Relay keeps failing**

- Supercharger clutch coil burning out
- Seized supercharger
  - Check current draw on clutch coil using the instructions in this document
  - Check the supercharger clutch will spin easily using just your finger
  - Do not replace or repair the speed relay until you have confirmed the clutch coil is ok

### **Fuse tripping**

- Supercharger clutch coil bad
  - Check current draw on clutch coil using the instructions in this document
  - Check diode in clutch wiring
  - Check clutch wiring for damage

### **Supercharger cutting in at wrong speeds**

- Faulty Proximity sensor
- Bad wiring on proximity sensor
  - Test Proximity sensor
  - Check wiring. Look for crushed or damaged cables
  - Check engine RPM using alternate method

### **Supercharger cutting out at wrong engine RPM**

- Adjustment on speed relay is incorrect
- Rev counter incorrect / Alternator pulley incorrect size
- Poor turbo boost causing RPM to drop when supercharger disengages
  - Check it cuts in at the correct speed and then adjust the potentiometer on the speed relay
  - Check turbo boost if RPM is dropping when supercharger disengages
  - Check engine RPM using alternate method
  - Check supercharger air pipes / Connectors / Air flap

### **Supercharger does not operate**

- Seized supercharger
- Bad transistor on speed relay
- Faulty, disconnected or badly adjusted inductive pickup sensor
- No Power
  - Check the supercharger clutch will spin easily using just your finger
  - Check Inductive engine speed sensor on cam cover
  - Check wiring from Inductive engine speed sensor
  - Check resettable trip
  - Check voltage on clutch coil using instructions in this document
  - Check speed relay transistor with a multimeter using the instructions in this document
  - Check supercharger belt
  - Check Speed Relay Pin7 (15) for 12v when ignition is on
  - Check Speed Relay Pin4 (G+) for approx. 7v when ignition is on.

### **Burning Smell from Supercharger/Blackbox**

- Supercharger clutch coil burning out
- Speed Relay internal fault
- Supercharger seized
  - Isolate power
  - Disconnect speed relay
  - Do not use
  - Seek Help from a Volvo Engineer

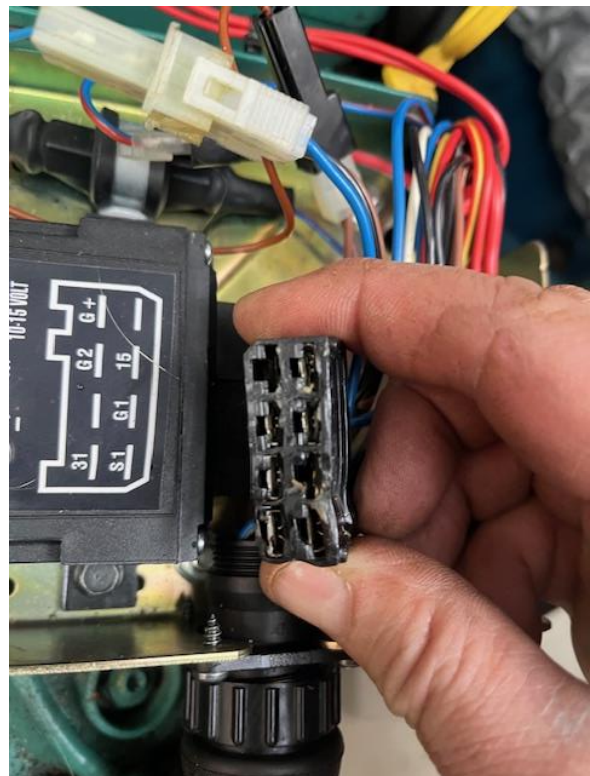
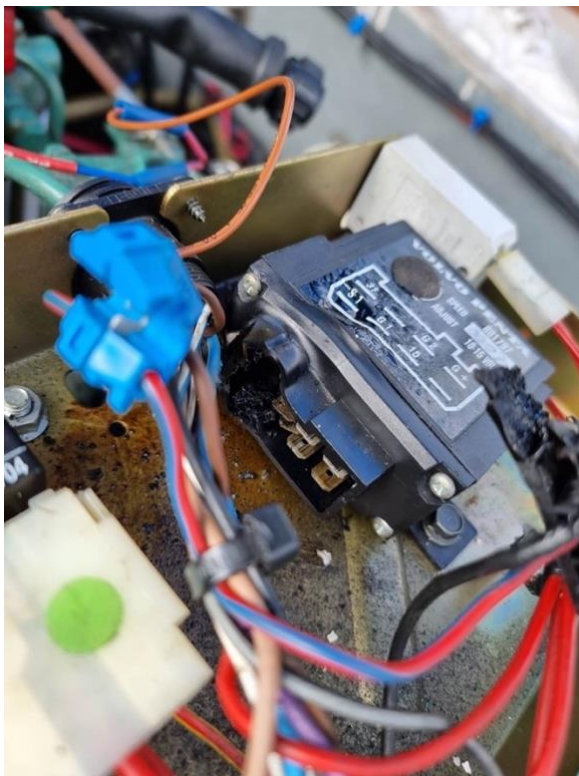
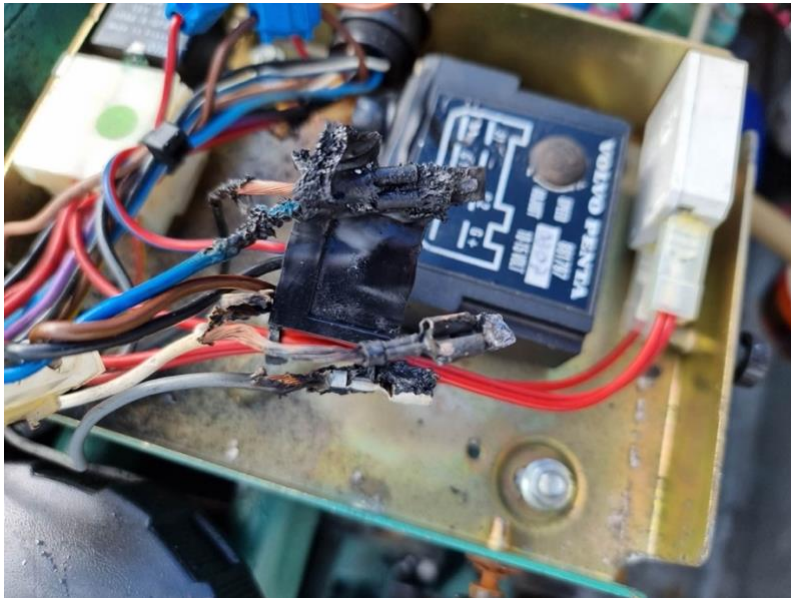
## Volvo Penta Speed Relay

### The Graveyard

Picture below shows a wiring loom damaged by a faulty clutch coil. This caused considerable damage.

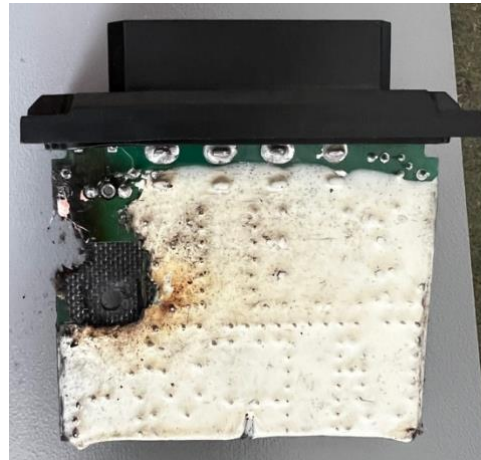
Treat any burning smell seriously and isolate power immediately.

Replacement wiring harness from Volvo: Part No: 3581477. £404.40



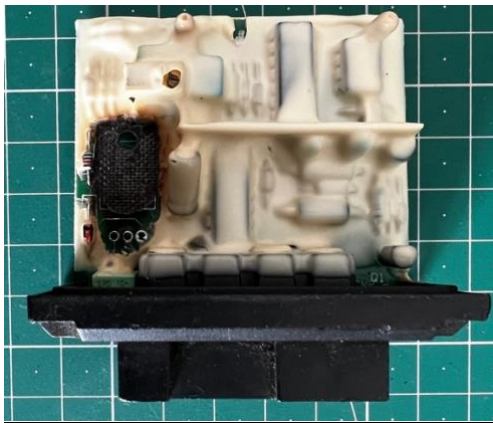
## Volvo Penta Speed Relay

Unfortunately for this owner the speed relay was beyond repair. The heat had damaged 6 components, and the main board had started to disintegrate.



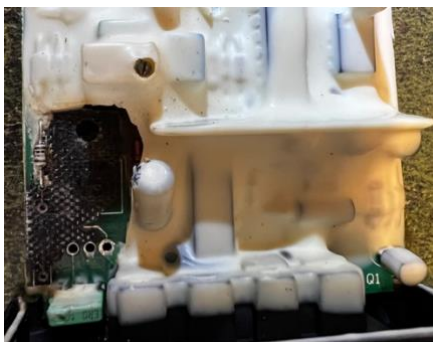
A different board and a successful repair.

This board had heat damage, but no track damage. Whilst cosmetically it does not look perfect, it is a good repair with a new transistor riveted in place.



Another board with track and component damage.

Successfully repaired with the repair covered in a conformal coating to protect it from moisture and corrosion.





## Volvo Penta Speed Relay

### **More information**

#### **Bench Testing a repaired Speed Relay:**

<https://youtu.be/xh9VkKdx4xw>

#### **Repair of Speed Relay**

<https://youtu.be/Rn4DBag-9Bw>

### **Some of my projects**

#### **Clear water covers on the KAD32 (& Others)**

<https://www.youtube.com/watch?v=1BA6v-2P758>

A nice upgrade to add clear covers on the water strainer.

These are available from Sweden Marine Part. (Author has no association)

#### **Replace domestic water display with Arduino**

<https://www.youtube.com/shorts/WlagKgHyAQc>

The analogue meter was not reliable, so developed an alternative using Arduino.

This monitors the waste & freshwater tanks, the shower sump and the hot water temperature. [GitHub](#)

#### **IPcamera on Axiom Pro**

Added an IP camera to my Raymarine Axiom Pro. This is fitted in the engine room which with additional lighting gives a clear view of the engines whilst underway.

Full write up is here: [Sealine Forum](#) and here: [GitHub](#)

#### **KAD engine data on chart plotter – NMEA2000**

Developed an interface to display various engine data on an Axiom Pro

Full write up is here: [Sealine Forum](#) and here: [GitHub](#)