

Understanding electrics: switches and relays

Pat Manley and Oliver Ballam demystify boat electrics, starting with switches and relays

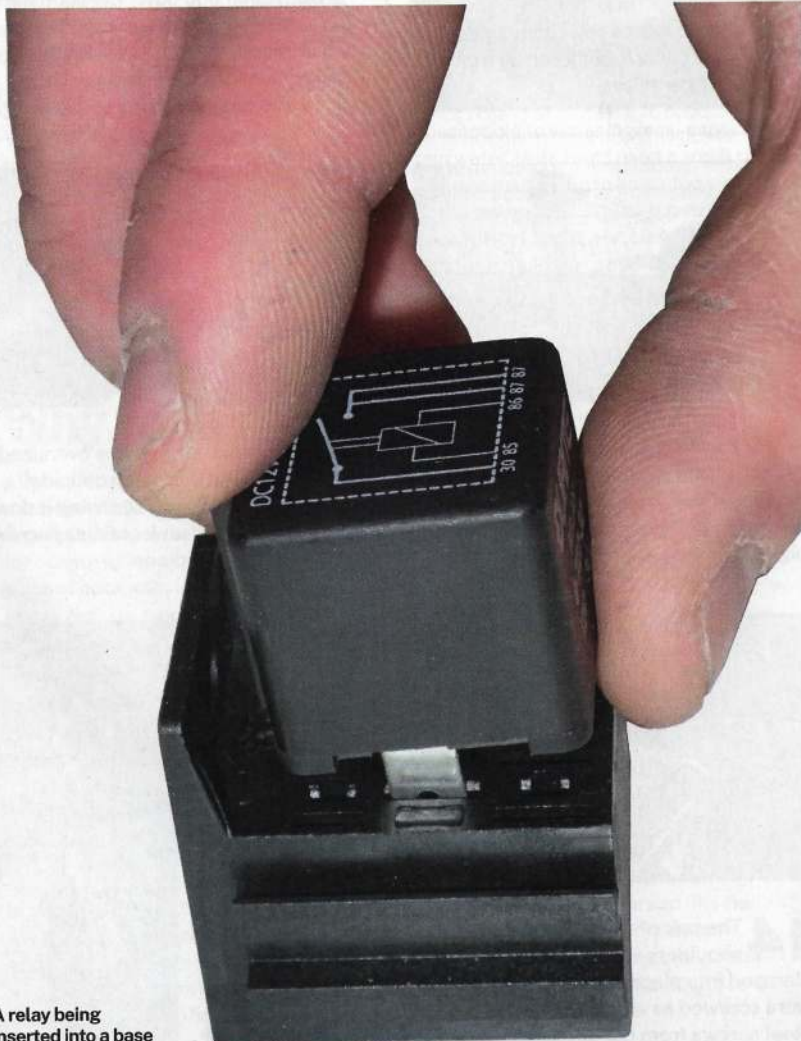
Switches allow a circuit to be 'made' or 'broken' so that a light, motor or whatever can be activated or isolated.

A switch has at least one pair of contacts that can be made or broken but it can be much more complicated. It can make or break several circuits at a time, or can be made to switch between one or more circuits, either

individually or in unison.

Obviously the DPDT (double pole, double throw) switch may also be found with a centre OFF position.

Some switches might be latching (stay where they are put - like a domestic light switch) or momentary (return to off when pressure is released - like a horn switch). You don't have to use all the terminals, so you can tailor the switch to suit your circuit.



A relay being inserted into a base

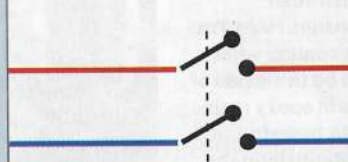
SWITCH EXAMPLES

■ Single pole, single throw (SPST), i.e. ON/OFF.



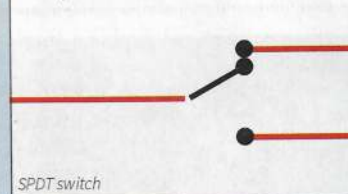
SPST switch

■ Double pole, single throw (DPST), i.e. ON/OFF for two different circuits at the same time.



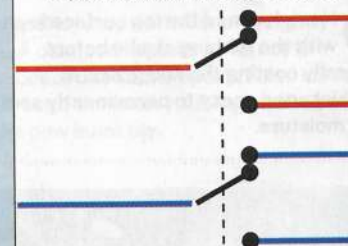
DPST switch

■ Single pole, double throw (SPDT), i.e. switches between two different inputs / outputs.



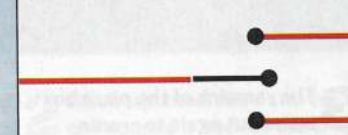
SPDT switch

■ Double pole, double throw (DPDT), i.e. switches between two different inputs / outputs for two circuits at the same time.



DPDT switch

Another variation is that double throw switches may have a centre 'OFF' position so that you may choose between OFF and either one or another circuit:



Switch with centre off

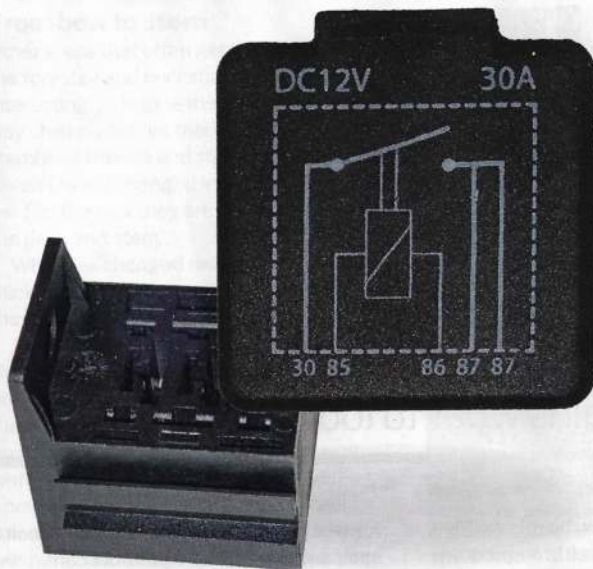
Switch 'spade' terminals install in crimp terminals

Troubleshooting
You can use a multimeter to check the resistance of the switch contacts. The resistance should be zero.

The most common switch is the SPST switch. About 90% of all switches are SPST. Sometimes you will see what is called a 'rocker' switch. When the switch is in the 'ON' position, the contacts are in contact. When the switch is in the 'OFF' position, the contacts are separated. Double pole switches have two contacts that move together.

Relays
Relays are used instead of manual switches.

RIGHT Single pole, single throw switch with a centre off position.
FAR RIGHT Double pole, double throw switch with a centre off position.



LEFT A relay with a configuration printed on its side ... and its base



RIGHT A relay...

Switches may have solder terminals or 'spade' terminals, the latter being easier to install in boat circuits as you can use crimp terminals to fit the wires.

Troubleshooting switches

You can check the operation of a switch using a multimeter – with the switch 'open' the resistance should be infinite and with the switch 'closed' the resistance should be zero.

The more wire terminals there are on the switch, the more you have to think about which terminal does what. It's sometimes easier to draw a 'mini circuit' to see what's happening. Where there are only two, that's easy. With more it gets complicated.

- When you move the switch lever (or rocker), the terminals in use are usually opposite to the direction of movement – if in doubt check with the multimeter.
- Double pole switches have their 'paired' contacts on the same side (in the plane of movement of the switch).

Relays

Relays do the same job as switches. But instead of the switch being operated manually, in a relay a current passes

through a coil of wire, which then becomes an electromagnet. When the electromagnet is energised, it moves a soft iron core inside the coil. The movement of this core or rod operates contactors so that a current can flow through the circuit.

Only a relatively small current flows through the coil, while the contactors can handle a much higher one. All the time the relay is energised, it is drawing some power from the boat's electrical system – generally 0.1-0.2A, but it can be a lot more for larger relays.

The purpose of a relay is to switch a circuit remotely. If you had a long run of cable which would have the problem of too much volt drop (or need excessively-sized cable), a relay is used near to the appliance. Then the big current only has a short path to travel. Small cables can be run all the way to where the circuit needs to be operated from, and a much smaller switch can be used as it only needs to take the coil current.

Like switches, the terminals may be of the soldered type or spades. Spade terminals are best suited for use on boats as you can use crimped terminals for your connections.

Relay connections may be 'normally open', ie they close when energised, or 'normally closed' so that they open when energised. You may even find a combination of both on the same relay.

Automotive-type relays often have their terminal configuration marked on the side of the plastic casing. If not, you'll need to use a multimeter to check which terminal is which.

- The coil terminals will have a resistance of 50-100 ohms for typical 12/24V relays.
- The contacts will have either zero resistance (closed) or infinite resistance (open).

Troubleshooting relays

- Check the coil resistance with a multimeter. If it's infinity the coil is faulty.
- Apply 12V to the coil terminals – you should hear and feel a click as the iron core or rod moves.
- Measure the resistance across the contact terminals with a multimeter. The open (infinite resistance) ones should close and have zero resistance, as the contacts change over when the coil is energised.

RIGHT Single pole switch with a single throw

FAR RIGHT Double pole switch with a double throw with centre as 'off'



ABOUT THE BOOK

The third edition of *Essential Boat Electrics* (Fernhurst Books, £16.99) is available at fernhurstbooks.com. Written by Oliver Ballam and the late Pat Manley, it's a practical guide – with simple language and clear diagrams – to allow owners to tackle electrical jobs on board. There are tutorials, from wiring a circuit, to troubleshooting electrical



faults, all using easy-to-follow photo sequences. The book also looks at tasks such as choosing solar panels and batteries and connecting navigational instruments.