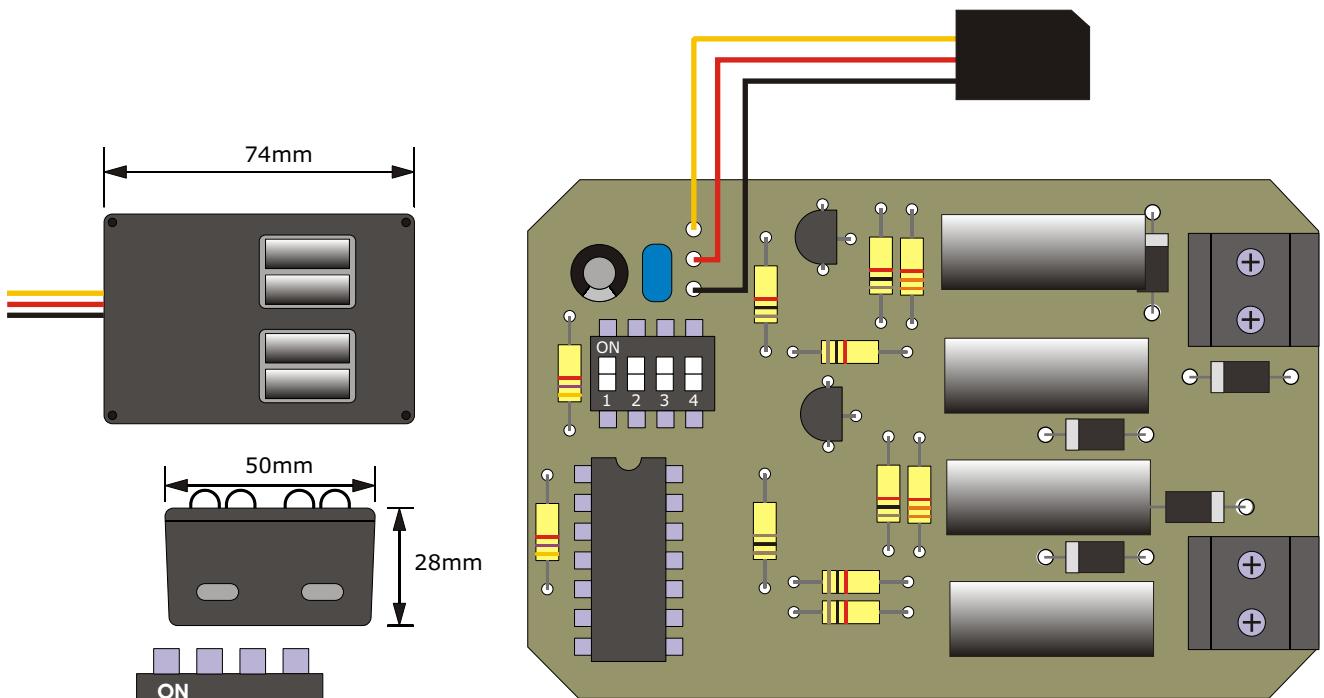# P93 HIGH POWER MULTI CONTROLLER

The P93 Multi-controller is a multiple function module designed as an all-purpose building block for model boats. The system uses a bridge arrangement of high-power, low-resistance MOSFETs giving the maximum efficiency. P93 will drive 10A continuously with the standard heat-sinks. If the heat-sinks are upgraded or water cooled the system will drive up to 20A continuously. The system will cope with the in-rush (stall) current for most of the motors likely to be used for scale model boats. The P93 includes a fail-safe: if the signal from the receiver is lost, the output of the P93 is shut down until signal is regained.
The basic functions of the P93 are:

ESC - Conventional ESC mode, giving fully proportional forward/reversing operation. The user can select full output, 50% output or 25% output. This allows the output to be tailored to the model either by slowing an over-enthusiastic motor or by allowing the use of a lower voltage on a higher voltage supply (for example 12V motor on a 24V supply)

Thruster - Drives a thruster or winch. The motor is driven when the stick is at full throw. The output is settable for commercial thrusters with either a 6V or 7.2V output, on either a 12V or 24V supply. If the voltage rating of the motor is greater or equal to the battery voltage then use the full supply voltage setting (Mode 4).

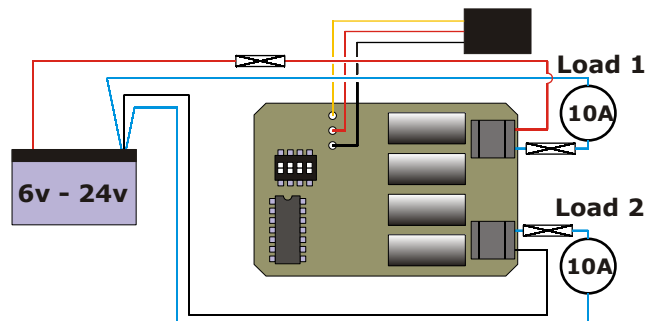Switcher - Conventional single or twin-load switcher operation in either latching or non-latching modes. For use as a switch for winches, deck lifts etc a special Limit Switch Module (P93M) is available.

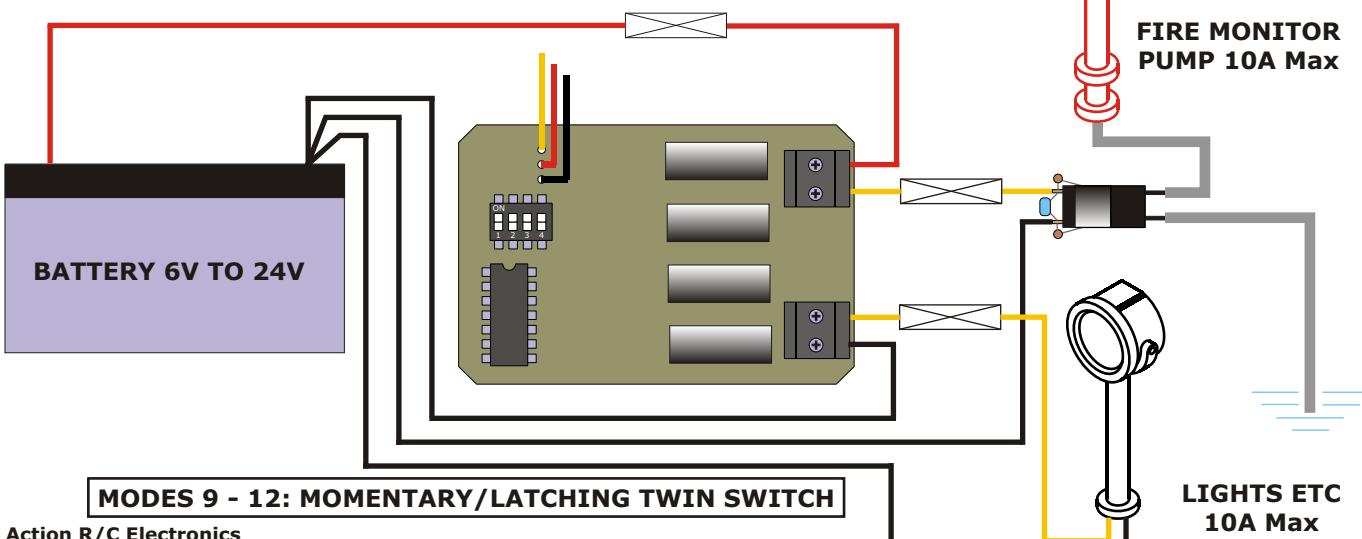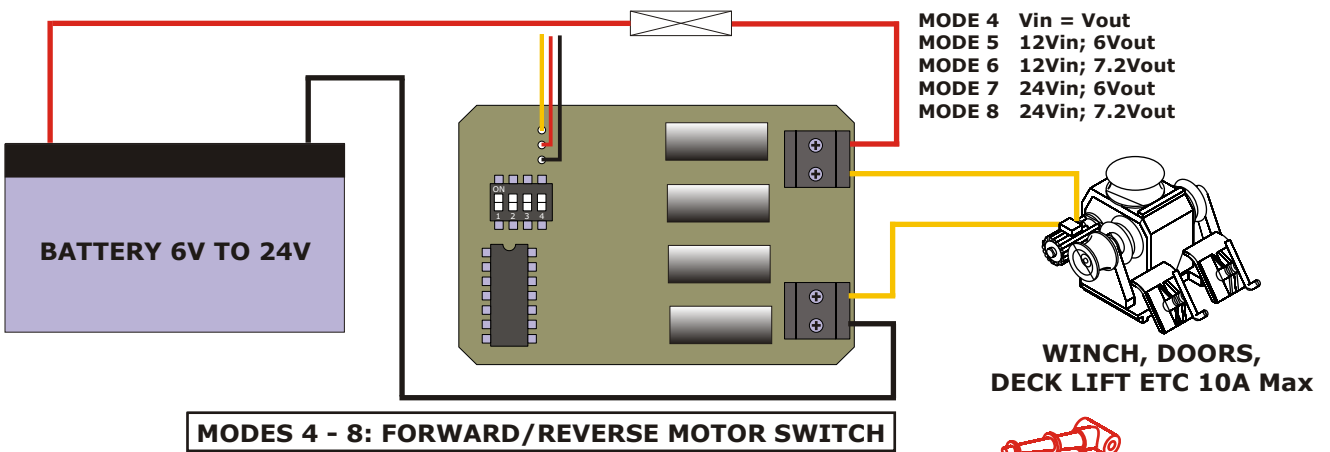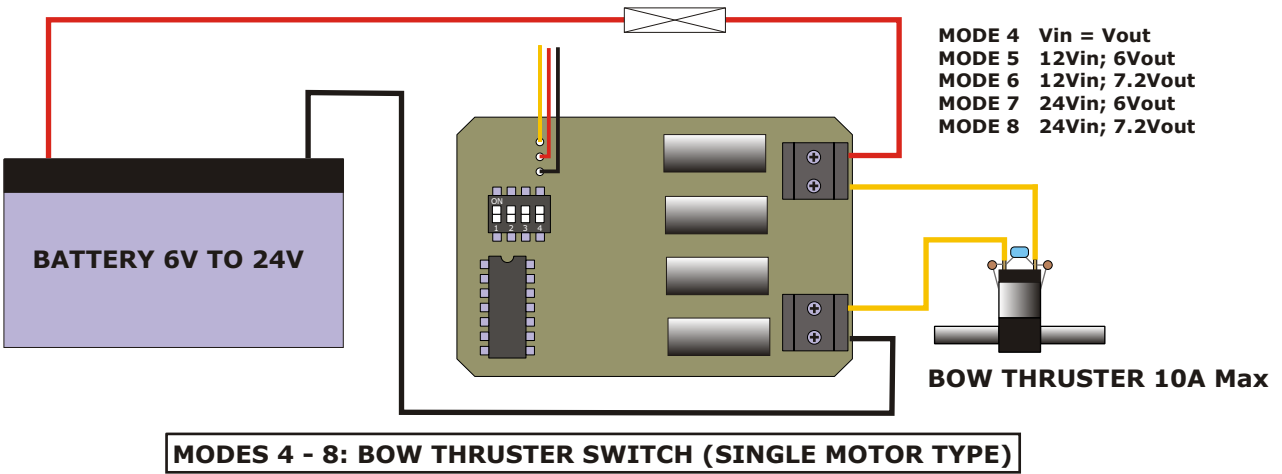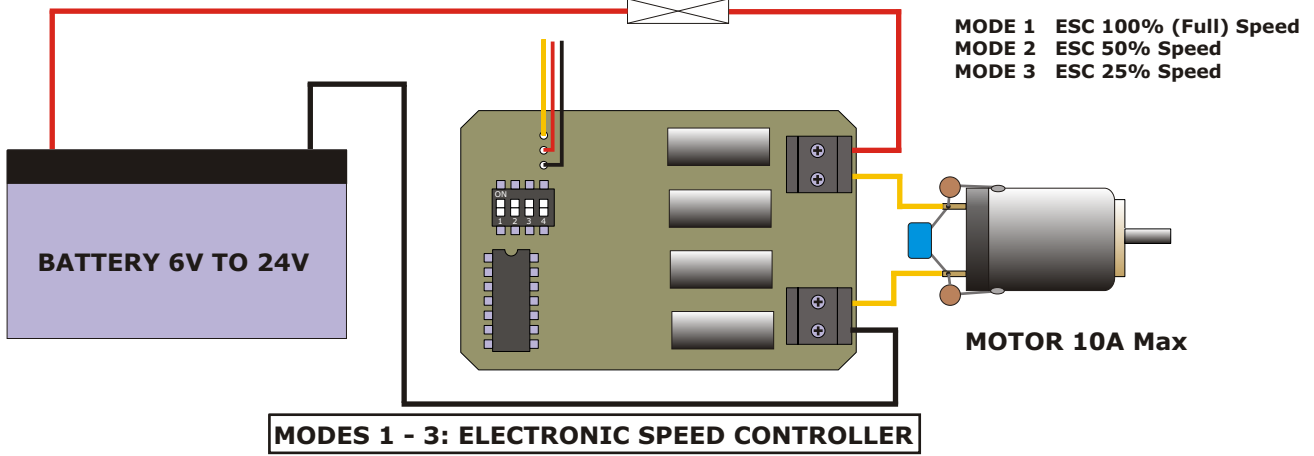Mode selection by on-board switches.
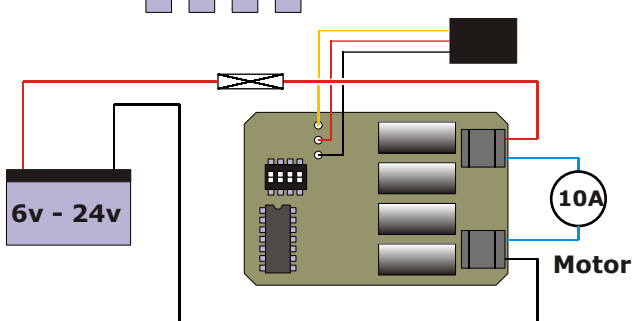
MODES 1 to 8 = Speed Controller or
Single Motor Forward/Reverse switch

MODES 9 to 12 = 10A Twin Switch;
Latching or Momentary selectable

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0843 2898528 or 0782 5511877 (Mobile)

www.action-electronics.co.uk

MODE 1   ESC 100% (Full) Speed
MODE 2   ESC 50% Speed
MODE 3   ESC 25% Speed

BATTERY 6V TO 24V

MOTOR 10A Max

MODES 1 - 3: ELECTRONIC SPEED CONTROLLER

MODE 4   Vin = Vout
MODE 5   12Vin; 6Vout
MODE 6   12Vin; 7.2Vout
MODE 7   24Vin; 6Vout
MODE 8   24Vin; 7.2Vout

BATTERY 6V TO 24V

BOW THRUSTER 10A Max

MODES 4 - 8: BOW THRUSTER SWITCH (SINGLE MOTOR TYPE)

MODE 4   Vin = Vout
MODE 5   12Vin; 6Vout
MODE 6   12Vin; 7.2Vout
MODE 7   24Vin; 6Vout
MODE 8   24Vin; 7.2Vout

BATTERY 6V TO 24V

WINCH, DOORS, DECK LIFT ETC 10A Max

MODES 4 - 8: FORWARD/REVERSE MOTOR SWITCH

FIRE MONITOR PUMP 10A Max

BATTERY 6V TO 24V

LIGHTS ETC 10A Max

MODES 9 - 12: MOMENTARY/LATCHING TWIN SWITCH

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P93 — HIGH-POWER MULTI CONTROLLER

ACTion R/C ELECTRONICS

The P93 Multi-controller is a multiple function module designed as an all-purpose building block for model boats. The system uses a bridge arrangement of switching MOSFETs to drive the system. These are high-power, low-resistance devices giving the maximum efficiency. The system will drive 10A continuously with the standard heat-sinks. If the heat-sinks are upgraded or water-cooled the system will drive up to 20A continuously. *NB: The heat-sinks on Q3 and Q5 heat-sinks should NEVER be allowed to short together; it's the equivalent of a direct short across the controller's output terminals and will certainly destroy the MOSFETs in pretty quick time!* If you are fitting additional heat-sinks or water-cooling then make sure that these two are electrically insulated from each other. The system will cope with short term currents up to 50A for up to 1 second. This will cope with the inrush (stall) current for most of the motors likely to be used for scale model boats. The P93 includes a fail-safe. If the signal from the receiver is lost, the output of the P93 is shut down until signal is regained. NB: Most 2.4GHz radios require the failsafe position to be programmed into the transmitter.

The basic functions of the P93 are:

ESC Conventional ESC mode, giving fully proportional forward/reversing operation. The user can select full output, 50% output or 25% output. This allows the output to be tailored to the model either by slowing an over-enthusiastic motor or by allowing the use of a lower voltage motor on a higher voltage supply (for example 12V motor on a 24V supply)

Thruster   Drives a thruster, winch, deck lift, cargo doors etc. The motor is driven in either direction when the stick is at full. The output is adjustable for commercial thrusters with either a 6V or 7.2V output, on either a 12V or 24V supply. If the voltage rating of the motor is greater or equal to the battery voltage then use the full supply voltage setting (Mode 4).

Switcher Conventional single or twin-load switcher operation in either latching or non-latching modes. A separate module (P93M) is available which provides connections to two small microswitches. These are fitted in a suitable position on the model to stop the driven motor at each end of its required travel. The 4-way DIL switch is removed and the module simply plugs into the same 8-pin socket. Full instructions are provided with the P93M unit.

Setting the switches to suit the required mode of operation

The operating mode is set using the four switches on SW1 as indicated in the table below. **The mode switches should only be changed when the system is powered off.**

SW1 Position

Mode	1	2	3	4	Operating Function
1	On	On	On	On	Conventional ESC Full Stick = Full Output Voltage
2	On	On	On	Off	Conventional ESC Full Stick = 50% Output Voltage
3	On	On	Off	On	Conventional ESC Full Stick = 25% Output Voltage
4	On	On	Off	Off	Bow Thruster/Winch Mode Output = Full supply voltage
5	On	Off	On	On	Bow Thruster/Winch Mode 12V input, 6V Output (Robbe Thruster)
6	On	Off	On	Off	Bow Thruster/Winch Mode 12V input, 7.2V Output (Graupner or Raboesch)
7	On	Off	Off	On	Bow Thruster/Winch Mode 24V input, 6V Output (Robbe Thruster)
8	On	Off	Off	Off	Bow Thruster/Winch Mode 24V input, 7.2V Output (Graupner or Raboesch)
9	Off	On	On	On	Switcher Mode Ch1 Momentary, Ch2 Momentary
10	Off	On	On	Off	Switcher Mode Ch 1 Latching, Ch2 Momentary
11	Off	On	Off	On	Switcher Mode C1 Momentary, Ch2 Latching
12	Off	On	Off	Off	Switcher Mode Ch1 Latching , Ch1 Latching
13	Off	Off	On	On	Undefined Do not use
14	Off	Off	On	Off	Undefined Do not use
15	Off	Off	Off	On	Undefined Do not use
16	Off	Off	Off	Off	Undefined Do not use

Connecting the P93
BEFORE CONNECTING POWER TO THE P93, ENSURE THE BATTERY IS CORRECTLY CONNECTED. CHECK TWICE BEFORE SWITCHING ON ONCE! IF YOU REVERSE-CONNECT THE P93 AND POWER IT UP, YOU WILL <u>CERTAINLY</u> DESTROY ALL SIX OF THE SEMICONDUCTORS. THIS IS VERY SPECTACULAR TO WATCH BUT ALSO VERY EXPENSIVE TO REPAIR!
The P93 must always be connected to the battery by a suitable rated fuse. For operating modes 1 to 8, it is recommended that a 10A fuse is used. For operating modes 9 to 12, a fuse of up to 20A can be used, though if a fuse of greater than 10A is used, the two outputs should be fused individually with 10A fuses. <u>Do NOT use a 5-cell rechargeable pack or a 6v lead-acid battery for the receiver power supply</u>; these will have a fully-charged voltage which can exceed the maximum permissible for the microprocessor fitted to P93. Ring ACTion for further information.
If the P93 is operating in modes 1 to 8, <u>the load must not have parallel flywheel diodes connected across it</u> as they will short out the unit and may damage it. The motors should have suppression capacitors across them; ACTion can supply an inexpensive kit of components specially selected for the job see latest lists under "RFI Kit". If extra filtering is required, connect 220nF 50v directly across the output terminals of the P93.
If the P93 is being used as a switcher, it provides two channels. These should be used to drive independent loads. These can be connected to either the positive or negative supply. If the load is connected between the output channel and negative, the channel operates as a normally open contact, so it activates when the stick is on the limit. If it is connected between the output channel and positive, the channel operates as a normally closed contact with the load being deactivated when the stick is at the limit. Note that the wiring from each load to the battery negative terminal should be separate. Alternatively you could use an ACTion P92 5-way Power Distribution Board which will supply suitable connections to one battery and also takes care of the fusing for the system.

This latest version of P93 has Autoset software installed. When the unit is switched on it will listen to the signal from the receiver and then automatically set its centre (neutral) position to align with the position of the transmitter stick. This process takes about five seconds from when the transmitter and receiver have been switched on and any signal binding procedures have finished (e.g. With 2.4GHz radios(. It is important not to move the transmitter stick until Autoset has finished so we would advise you to leave the stick alone for at least 10 seconds after switching on.

Using modes 1 to 3, the system runs as a conventional ESC. The receiver socket should be connected to the required channel on the receiver.
If the system is driving a bow thruster using modes 4 to 8, it should be connected to the rudder channel using a suitable "Y" lead so the thruster is activated on full rudder. If the thruster is operating independently of the rudder on its own channel it is better to use one of the ESC modes 1 to 3, unless you require "bang bang" operation i.e. with the thruster activating on full power only when the stick is at the limit. For the switcher modes (modes 9 to 12) the system should have a receiver channel dedicated to it. NOTE: Channels which are operated by a two-position ON/OFF switch on the transmitter cannot be used to operate the P93 as a selective switch. These switches are typically fitted for aircraft or helicopter use and are signed "Retract", "Flaps", "Idle Up" or similar. If you want to use one of these channels for switching then contact ACTion for further information.

Do NOT use a 5-cell rechargeable pack to power the receiver _directly;_ it may fatally damage the P93.

Power _via_ a regulated 5v or 6v supply such as a separate BEC or ACTion power board will be fine.

RECOVERY SERVICE
A recovery or repairs service ensures that you will not be left with a dead unit for any reason.
Because of the very high cost of the MOSFET devices in P93, the price of any repair which involves replacing these is £19.50 including parts (also includes return shipping cost in the UK).
All returns should include full Credit Card details (Name & Address of Cardholder, Card Account Number, Expiry Date, Card Security Number)

ACTION R/C ELECTRONICS, 1 Llwyn Bleddyn, Llanllechid, Bangor LL57 3EF, United Kingdom
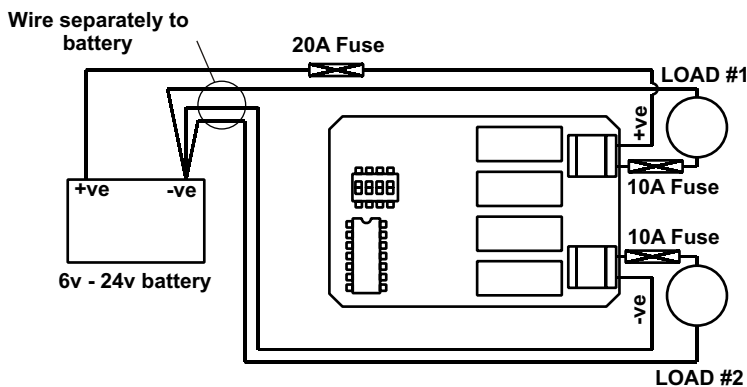
The small print……….
ACTion R/C Electronics guarantee all products to be free from manufacturing defects for 12 months from date of purchase. This does not cover suitability for specific applications; components worn or damaged by use, tampering or incorrect connection; alteration to original components; damage to batteries or other equipment through use; misuse, or shipping damage. Where goods are found to be faulty, the customer shall return them to ACTion R/C Electronics in their original condition and with their original instructions, packaging etc. Our liability is limited to repairing or replacing goods to their original specification and will not exceed the cost of the goods. By using the product the user accepts all liability. Where a fixed repair charge is applicable, ACTion R/C Electronics shall undertake repairs to the extent that they are judged economically viable. Where such is not the case then the customer will be offered the option of crediting the repair charge towards the cost of a new unit or having the faulty unit returned and the charge refunded (less the cost of return carriage). We reserve the right to modify this guarantee without notice.
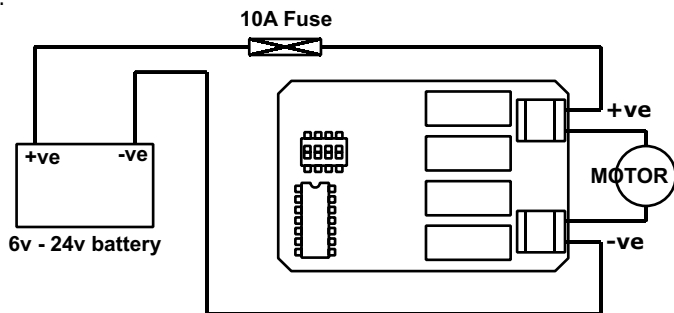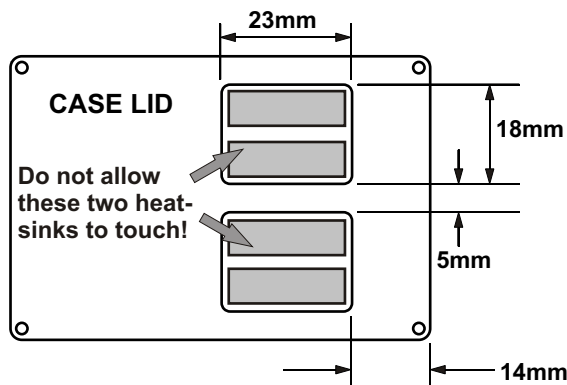

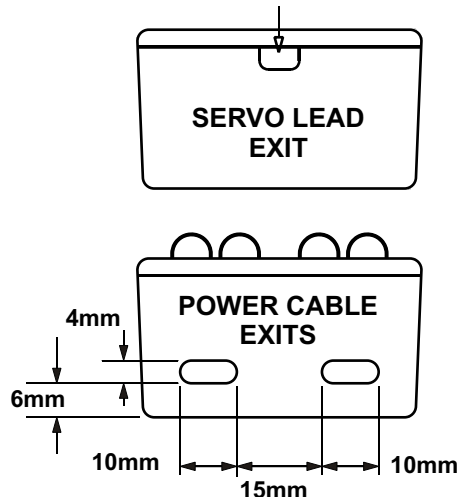**SINGLE-MOTOR OPERATION
MODES 1 TO 8**

File slot approx 7mm x 4mm for Rx lead

SERVO LEAD EXIT

Loads may be either motors, lights, sound units or any combination, up to 10A current per load.

**MULTI-LOAD OPERATION
MODES 9 TO 12**

POWER CABLE EXITS

CASE CUT-OUT DETAILS

Ⓒ **Action R/C Electronics**

ACTion
R/C ELECTRONICS

P93 Ver3 HIGH-POWER MULTI CONTROLLER
Instructions for Kit version

Wires to servo plug

WHITE
RED
BLACK

Components layout

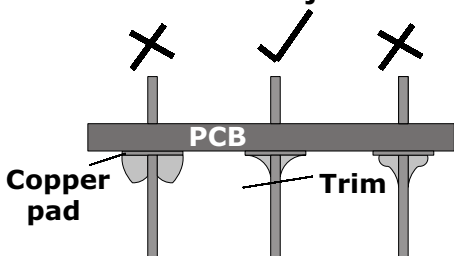C2 · C1 · + · - · R3 · Q2 · R1 · R2 · Q1 · D4 · TB1 + · R11 · ON · SW1 · 1 2 3 4 · R4 · Q3 · D3 · R10 · U1 · Q4 · D1 · R5 · R6 · Q5 · D5 · R7 · D2 · R8 · R9 · Q6 · TB2 −
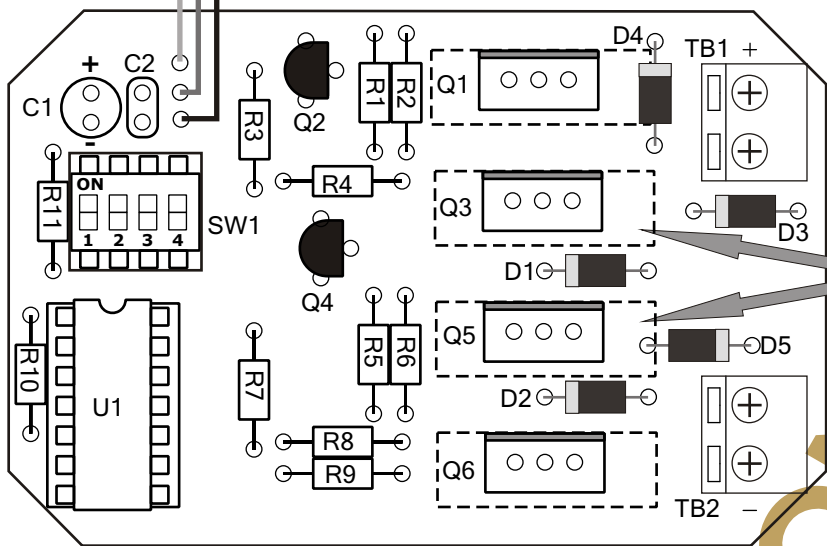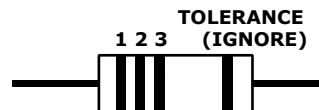
IMPORTANT!!!
DO NOT ALLOW THESE TWO HEAT-SINKS TO TOUCH EACH OTHER WHEN POWER IS APPLIED!!

Re-solder ✗   Good joint ✓   Re-solder ✗

PCB

Copper pad   Trim

Soldering Tips

TOLERANCE
1 2 3   (IGNORE)

Resistor Colour Bands

SW1

Diodes   Resistors   C2   Q2 & Q4   C1   U1

-ve +ve
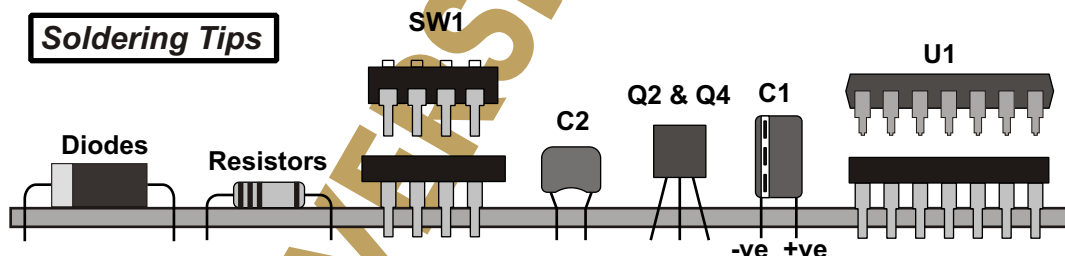
Component mounting details

PARTS LIST

Ref	Value
R13, 4, 5, 8, 9	1K (BROWN/BLACK/RED)
R2, 6	3K3 (ORANGE/ORANGE/RED)
R7	100R (BROWN/BLACK/BROWN)*
R10, 11	4K7 (YELLOW/VIOLET/RED)
C1	2u2 ELECTYROLYTIC 50V
C2	0.1uF CERAMIC (104 BLUE)
D1-D5	1N4001
Q1, 3	SUP75P03-07 & HEAT-SINK
Q3, 6	NDP6060L & HEAT-SINK
Q2, 4	2N7000
U1	PIC16F684 PROGRAMMED & 14W DIL SOCKET
SW1	4W DIL SWITCH & 8W DIL SOCKET
TB1, 2	16A STD PROFILE
PCB	P93 VER3
CASE	RX 2010 & SCREWS
LEAD	22AWG 3-WIRE WITH PLUG

*R7 for 20A Darke Horse Special = 0R
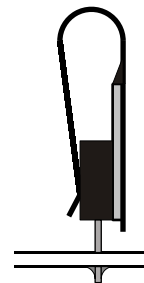
Fitting heat-sinks to
Q1, Q3, Q5 & Q6

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P93 KIT INSTRUCTIONS

PCB

The PCB has an insulated (Component Side) and a tinned track side. Components are mounted on the insulated side and soldered on the track side. The PCB for this Project is fully prepared and requires no additional work. Look carefully at the area of the PCB you are working on when soldering to ensure that you do not apply an extra connection with a splash of solder.

TOOLS

For construction you will require a soldering iron with a fine pointed bit and flux cored solder (22 SWG recommended); a small pair of wire cutters, a screwdriver to make connections and, of course, a good level of light.

PARTS - <u>DO NOT HANDLE ITEMS IN BLACK CONDUCTIVE FOAM UNTIL INSTRUCTED. (MOS DEVICES)</u>

- The short, creamy-coloured cylinders with coloured bands and a wire at each end are resistors R1 to R11. Their values are shown in the Parts List below, along with their respective coloured bands. The other band, which is usually gold, signifies the tolerance and can be ignored.
- The tubular electrolytic capacitor (C1) is marked with the value 2u2F and working voltage; it also has a band down one side of the plastic sleeve with (-) Negative sign on it which signifies which leg goes to the negative. The opposite leg of the capacitor, of course, goes to the positive. Capacitor polarity (+ and -) are clearly shown on the drawing.
- The small blue or brown component with two wires is a monolithic capacitors C2. It can be fitted either way round.
- The black cylindrical components with a flat on one side and three wire leads are MOSFETs Q1 and Q2. They are static-sensitive and should be handled in accordance with the note below. They must be fitted as shown, with the flat face towards the screw terminals.
- The cylindrical black plastic components with a lead at each end and a silver-coloured bar are the diodes D1-D5. They are polarity-sensitive and should be fitted as shown, with the silver bar towards the screw terminals.
- The 14-pin PIC device (U1) is marked with its type code; see the drawing together with the Parts list. It is delivered in conductive foam and should be left in the foam until you are about to fit it. Being a MOS device, it can be damaged by static electricity and care must be exercised when handling. It is supplied with a socket. This will enable the builder to solder in the socket during construction, then fit the IC at the end of construction.
- The MOSFETs Q3- Q6 have three legs and a black plastic body with a silver metal tab on one side. Note that there are two different types, which must be identified by the legend on the component and fitted correctly. These are MOS devices and care must be taken in handling. They must also be fitted as shown, with the metal tabs all facing the top edge of the PCB when viewed with the screw terminals on the right, and the heat-sink tabs pushed onto the body as shown in the drawing.
- The eight-pin switch SW1 is used to select the operating mode according to the table on the attached sheet. It should be fitted as shown, plugged into its own 8-way socket.
- The 2-way screw connectors are TB1 and TB2, and are rated for 16A current. Make sure you fit them with the openings for the cable towards the outside edge of the board…………..it has been known for folk to do this wrong!

CONSTRUCTION

<u>NOTES ON CMOS DEVICE HANDLING</u>**.** <u>USE A SHEET OF ALUMINIUM OR TIN TO WORK ON; AN OLD METAL BISCUIT-TIN LID OR METAL COOKING FOIL WILL DO.</u>

Place it on the work surface. Place the PCB, solder side down on it. Place the black conductive foam on it, touch the metal with the soldering iron tip and then rest your hands on it, holding them there while you read through this part of the instructions. The PCB, any tools, the MOS IC and you are now all at the same potential, i.e. static-neutralised.

I would suggest that you fit the resistors first, followed by the sockets for U1 and SW1. Note the small notch at one end of the plastic moulding and ensure that it is fitted as shown in the drawing, soldering all pins carefully.

The monolithic capacitor C2 can be fitted either way round, but C1 (2.2 uF electrolytic) must be fitted with care. The negative marking on the sleeve faces the outside edge of the PCB. Fit the diodes D1-D5 next, with the silver bands aligned as shown.

Fit the MOSFETS NDP6060L next (Q3 and Q6), followed by the high-end MOSFETs SUP75P03-07 (Q1 and Q5). The components' legs should be pushed right into the PCB up to the point where they widen to prevent the component from going any further in. Push the metal heat-sinks into place, making sure that the tab fits up against the little stop inside the heat-sink. Q2 and Q4 are fitted with their bodies about 2.5mm above the PCB.

Strip about 6mm of insulation from the end of each wire on your chosen receiver connector lead; twist the individual strands or each separate wire together and tin them with solder. Clip off the end at about 45 degrees then push them into their respective holes in the PCB and solder. MAKE SURE YOU FIT THEM IN THE RIGHT ORDER OR YOUR SWITCH WON'T WORK. The 14-pin IC and 8-pin switch should be plugged into the IC socket as the last operation of construction. Clip off all surplus component leads from underneath the board.

**WARNING** - DO NOT use the black foam as a packing foam in the finished unit, it is **CONDUCTIVE.**

The rear of the board can now be cleaned with something like an old toothbrush and some spirit cleaner. Meths will do but Isopropyl is very much better. Then check all over the soldered side of the board for good joints and no solder bridges between tracks or round pads. That's the PCB construction completed.

CASE

Refer to the dimensioned drawing. File out a narrow section at the top edge of one end of the case (not the flat part with the screw-holes, which is the lid, but the deeper box part) so that the receiver connector wires can exit the case after the lid has been screwed down. Mark and cut out the holes for the heat-sink in the lid and the main power connections in the base. This is easiest if you stick masking tape to the case first and use a sharp pencil to mark out. Drill a series of small holes e.g. about 3mm diameter, just around the inside of the marked line; snip the web between the holes with your side-cutters and push out the waste material. Using a fine warding file, file back the ABS to the marked line; remove the tape and de-burr the edges of the holes with a sharp blade.
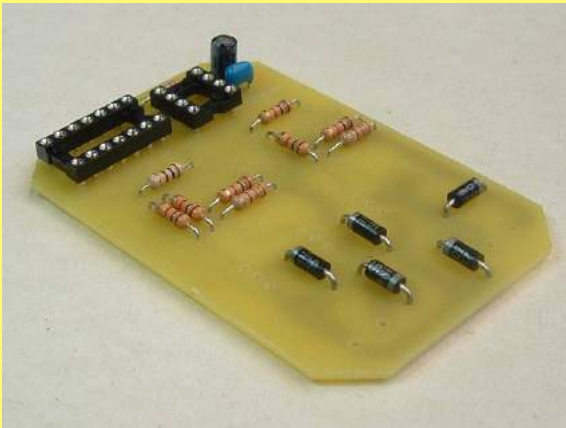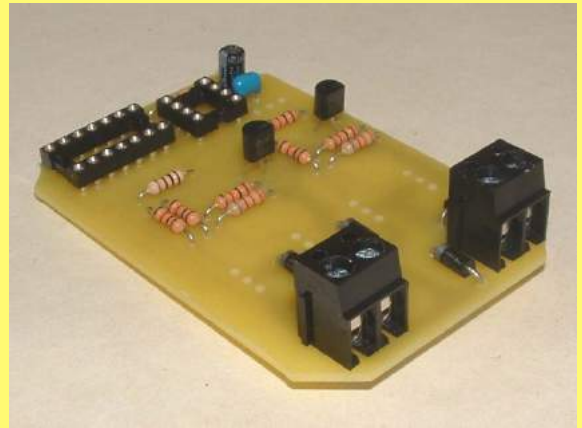
P93 HI-POWER MULTI CONTROLLER
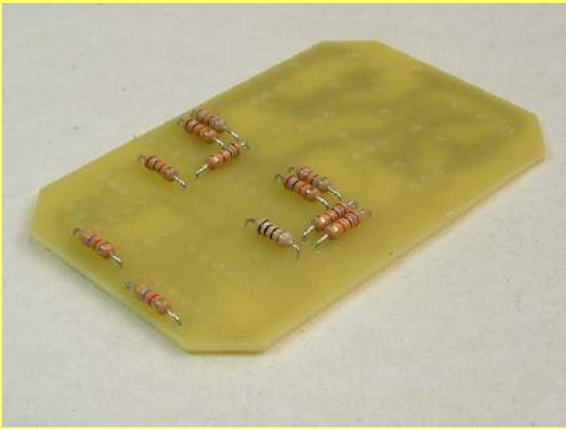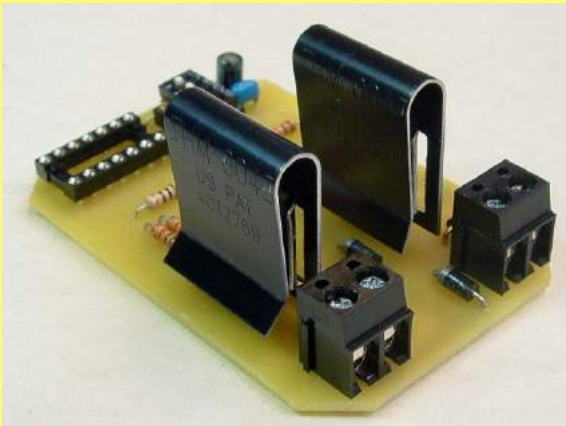
PICTURE 1: Resistors fitted to PCB
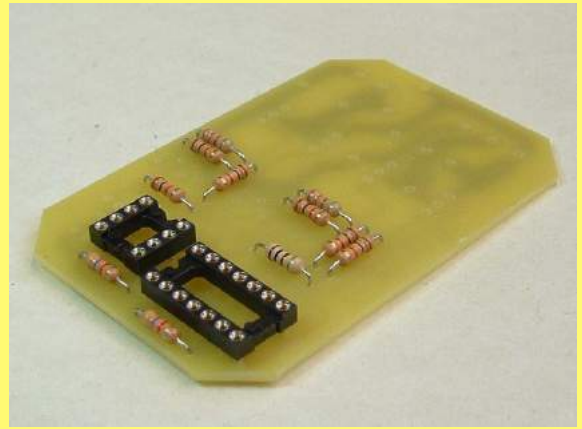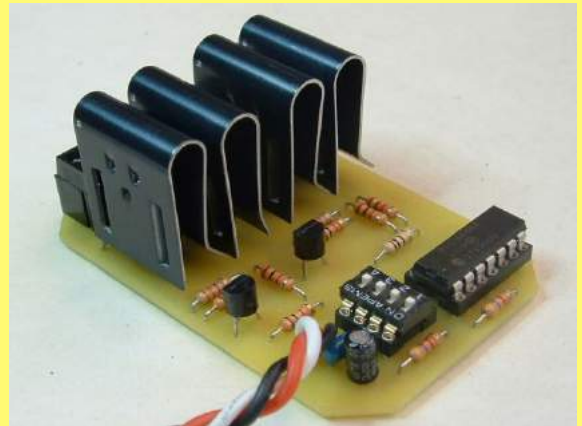
PICTURE 2: I/C sockets added

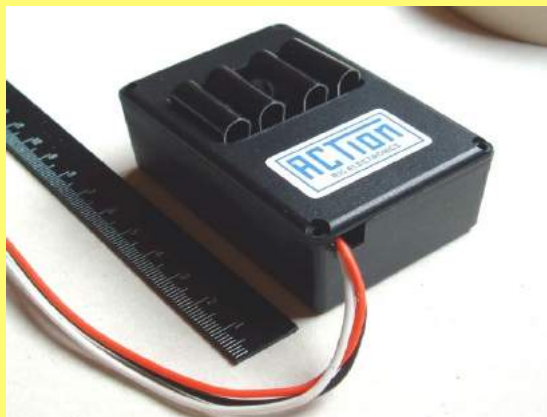**PICTURE 3: Fit capacitors and diodes**

PICTURE 4: Switch, screw terminals & transistors added

PICTURE 5: NDP6060L MOSFETs fitted

PICTURE 6: Remaining MOSFETs, PIC & lead fitted. NB: ANTI-STATIC PRECAUTIONS REQUIRED!

PICTURE 7: Finished unit, showing cut-outs for heat sinks and slot for Rx lead