

# *DIVISIONMASTER*

## *CONSTRUCTION GUIDE*



*KIT SUPPLIED BY THE MODEL ENGINEERS DIGITAL WORKSHOP*

<http://medw.co.uk/wiki/index.php?page=DivisionMaster>

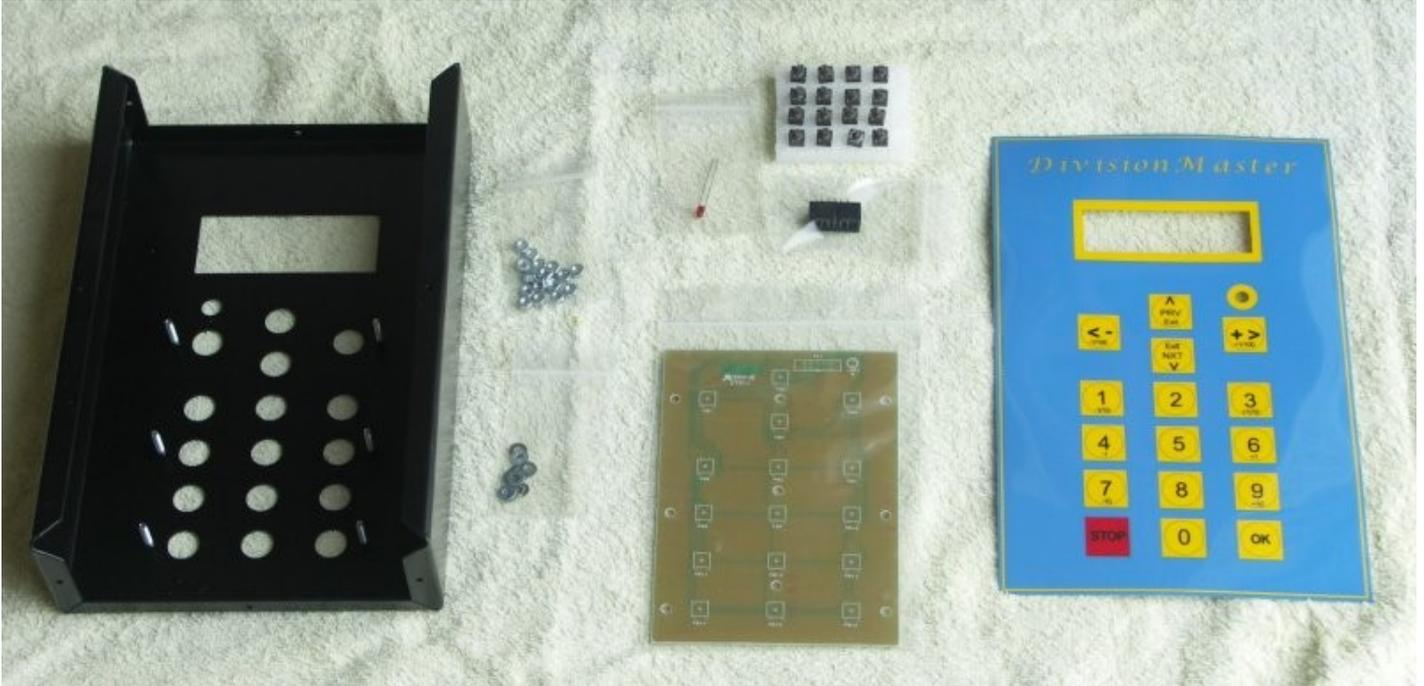
The DivisionMaster controller schematics, circuit layout, firmware, and mechanical design are copyright (C) Tony Jeffree, 2004.  
All rights reserved.



# INTRODUCTION

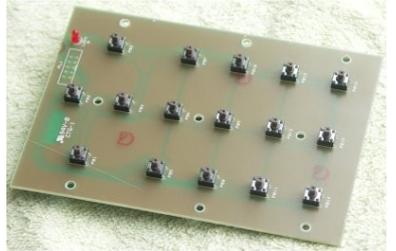
The DivisionMaster controller consists of a number of sub-components that are combined to provide the finished controller. The LCD display and ribbon cable elements are supplied as finished modules, and the steel case has a number of studs already mounted to provide accurate alignment, but the push button panel and the main drive printed circuit board still require assembly prior to installation in the case.

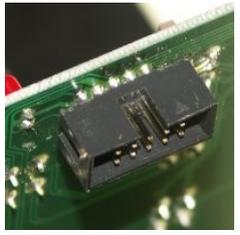
# FRONT PANEL



The front panel push button assembly is an easy place to start since it only consists of 18 components.

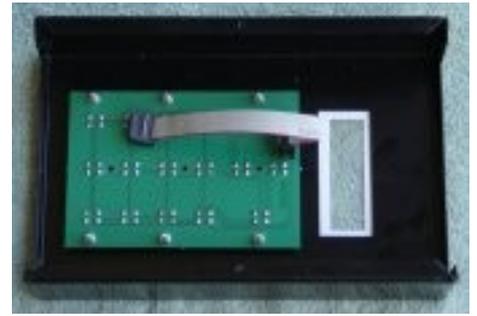
## PUSH BUTTON PRINTED CIRCUIT BOARD

The 16 push buttons clip into the board and retain themselves allowing for a tidy alignment of the buttons. The buttons should be checked for a level top to all the buttons prior to soldering into the board. The LED can be fitted and solder tight against the printer circuit board, with the long lead in the hole marked with a '+'.  


The only tricky part is mounting the the ribbon cable header which has to be fitted to the track side of the board. You will find that this has it's holes drilled undersize, so that the header will push fit, but not go tight against the board. As a result of being fitted on the reverse of the board, the polarity slot needs to be close to the edge of the board and not as shown on the silk screen. Once positioned, the board can be stood on one end and solder applied carefully to each pin. A small long tip to the soldering iron is a help here, directed to the track and pin junction and apply solder to the track side of the iron.  


## *FRONT PANEL ASSEMBLY*

The front panel has 6 studs already fitted onto which the switch printed circuit board mounts. You may need to adjust these studs slightly so that they exactly fit the pcb holes as they tend to be a little out of vertical once inserted. Once you are happy that the board is an easy fit over the studs, some spacer elements are required to keep the board the right distance behind the front holes. Two M3 nuts screwed down tight to the case provide a base, and I find a single M3 washer just places the panel so that the tip of the switches are just in line with the surface of the box, allowing easy activation through the overlay. You may find you need an extra spacer, or you do not need to fit any to get a clean operation of the switches. 12 M3 washers are included in the kit. If you find problems with the switches later simply adjust the height of the board. Once happy with the height of the board, secure it to the front panel with the remaining M3 nuts.



At this point, the overlay can be attached to the front of the box, or you may wish to wait until you have finished assembly to prevent any accidental damage to it. It is probably useful to attach the overlay with masking tape, so that you know which button is which later, and not finally fix the overlay until it can be aligned with the LCD screen. The overlay has a protective layer over it, which should only be removed once you have finished and tested the controller.



## MAIN DRIVE PRINTED CIRCUIT BOARD

While this may seem to be a little complex, there is little that need to be worried about while assembling it. In keeping with all the MEDW kits, assembly can be carried out and tested in several stages, starting with the power supply. Then the processor section, which will be connected to the LCD display at this point in order to test the processor and display section, and finally the stepper motor drive, which can be hooked temporarily to the stepper motor to check operation prior to assembly into the rear case.



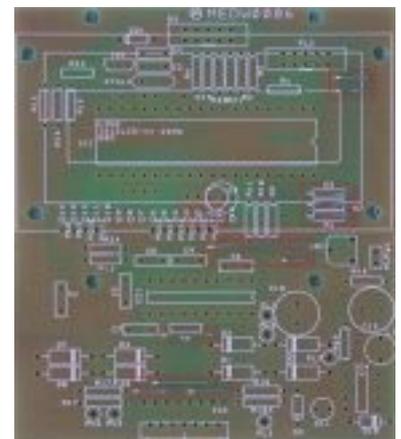
### STAGES OF BUILDING

#### INITIAL ASSEMBLY - WIRE LINKS

As the boards are both single sided, some links are required on the main board to complete the circuit. There are a total of nine links required, and in addition, R5,6 and 7 are also wire links. Eight of the nine links are quite obvious with a single line between two pads. The ninth, is be just below C3. This provides power to the LCD.

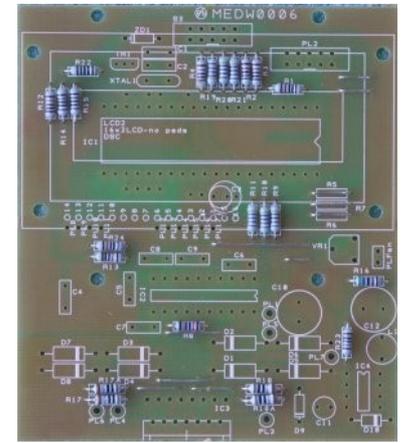
#### ADD THE POWER SUPPLY AND CHECK

Traditionally we build the power supply first and test that, but it makes things more difficult to assemble due to the big capacitors, so nowadays it makes more sense to assemble the components in order of size.



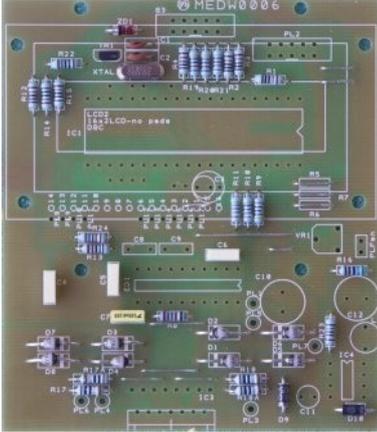
## LOAD ALL THE RESISTORS

Once you have a working power supply, the rest of the discrete components can be added. The remaining twenty one resistors can be placed first, and soldered in place.



## OTHER DISCRETE COMPONENTS

The processor support components, C1, C2, XTAL, TR1, and ZD1 in the top section of the board. D1 to D8 are mounted across the bottom of the board, with the remaining box capacitors above them. Also useful to fit at this time is VR1 so that we can get a display on the LCD shortly. And finally the remaining two diodes that supply power to the board.



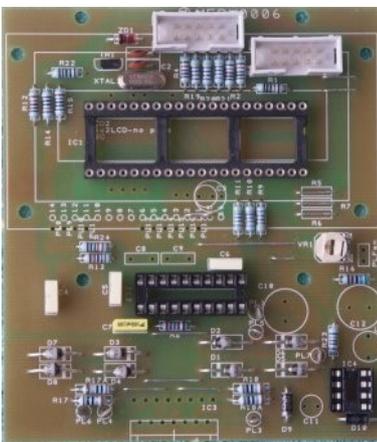
## ADD THE SOCKETS

The forty pin socket can now be fitted, with its ident notch to the right. Also the sockets for the stepper controller and power supply. The processor, which is already programmed, can also be fitted along with the 8 pin power supply IC.



## MOUNT THE CONNECTORS

The two ten pin headers and the spade terminals for the other connections can be mounted now. Rather than soldering the power and stepper motor cables direct to the board, 0.11" spade terminals are now used so that the cables can be removed easily.



## REMAINING TALL COMPONENTS

C3 fits just below the processor socket, with its long lead to the right, in the smaller outline circle. The other three large capacitors fit to the right, following the orientation in the picture. Adjacent to the LCD pot we have added a two pin connector to power the fan which is fitted with its guide towards the middle of the board. The final component at this stage is the power supply inductor.





### *POWER IC*

The final part to complete the power supply is the IC itself. This is fitted with its notch towards the inductor. Take care that all the legs are in the socket, which can be a little difficult with the proximity of the taller components.

### *POWER CABLE ASSEMBLY*

It is convenient at this point to assemble the power connector so that 24V can be applied to the board for test purposes. One of the round ferrite cores is used to provide EMC filtering. The red and black wires are passed through the core, and then looped round and passed through again. The earth tag is also passed through the core but does not need to loop. The earth wire and black wires are twisted together, and soldered to the middle terminal of the power connector. The red wire is then soldered to the right hand terminal (connected to the inner pin of the connector). Use two pieces of heatsink over the joints. Once assembled, the wires are pulled back through the connector so that the core fits tight against socket. Take care not to strip the insulation off the wires as they rub against the sharp edges.

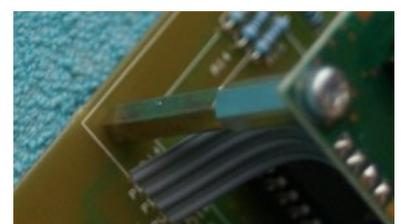
The connector can be mounted in the case later as it is fitted from the back of the panel.

The red and black wires connect to pads PL1 and 7, using spade terminals. These smaller terminals are only available uninsulated, so a piece of heat shrink sleeve is fitted to insulate the metal part. It may be necessary to squash the spade end a little to provide a tighter fit to the terminal on the board as the spacing seems a little variable. Once fitted, power can be applied, and +5V can be checked between short link above C10 and the second link from the top.



### *MOUNT THE DISPLAY*

The long pillars are added to the PCB with two M3 screws with nylon washer insulators, and the display mounted to the top with nylon washers either side of the display PCB to insulate the adjacent tracks. The link ribbons should be fitted before securing the top screws, allowing two empty pads to the right, and four pads between them. The ribbon will bend slightly as it is longer than the spacers, and once positioned below the LCD, the pads both side can be soldered up.



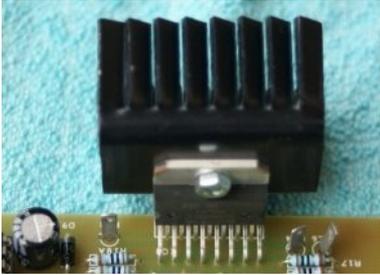
### CHECK PROCESSOR AND DISPLAY

At this point, power can be applied and the display should come on with the start up message. "DivisionMaster" should appear followed by "Parameter set = 0". The contrast may need adjusting on the display, using VR1, so that text is visible, if a single row of blocks appears, then the display is working, but the processor is not starting up.

S3 and PL2 can be added now, and will allow the keyboard to be connected so that the processor can be controlled. The key way for the connectors are located away from the board edge, and care is needed to ease the adjacent components away to allow the headers to fit tight to the board.

A quick test of the keyboard can be made by changing the selected number in the "Parameter set = 0" number position.

### COMPLETING THE STEPPER MOTOR DRIVER



IC2 and 3 can now be fitted to the board, along with the four wires for the output connector. The Heatsink needs to be fitted to IC3 now in order that it can be protected from overheating. Mounting this horizontally to maximise the flow of air over the fins from the fan

PL6 - Red, PL4 - Yellow, PL5 - Green and PL3 - Blue

These will be connected to the 4-pin XLR socket and the use of spade terminals to connect to the board allows final assembly within the box later.

The earth connection is a little redundant, since the body should be connected to the case via it's mounting screws, but the inclusion just ensures that the plastic coating does not prevent this link.



Leaving the green and blue wires 5cm longer than the red and yellow allows the cables to be neatly coiled once fitted to the board, as the longer pair go to the opposite side of the board.

## CABLE ASSEMBLY

The XLR connector pinout used in the metal case version of DivisionMaster is shown in Figure 11 the pin numbering shown is as seen from the solder side of the XLR plug, or the external view of the XLR socket.

The metal shield of the XLR socket is connected to the unit's 0V (GND); and shielded cabling is recommended between the plug and the motor, then the shield should be connected to the metal shroud of the plug to improve noise suppression. Solder the 4 motor wires into the solder buckets of the XLR socket; Red to pin 1, yellow to pin 2, green to pin 3, blue to pin 4.

Check out the assembly information on the MEDW web site for more details on adding cables to the various stepper motors.

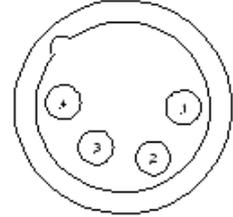


Figure 11. XLR connector pinout

## *INITIAL TESTING*

In order to test the main board, the keyboard panel needs to be connected using the appropriate ribbon cable. This is fitted to the right hand 10 way header on the main board, loops out underneath the LCD panel.

The following sequence should give a reasonable confidence test:

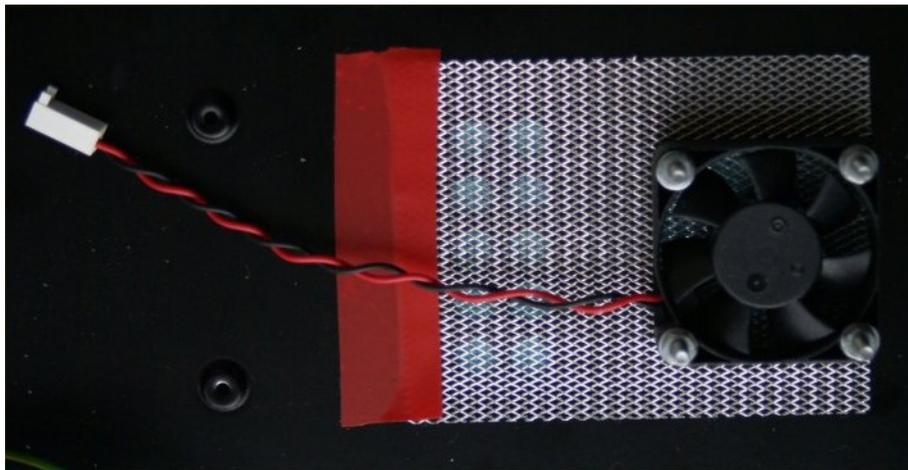
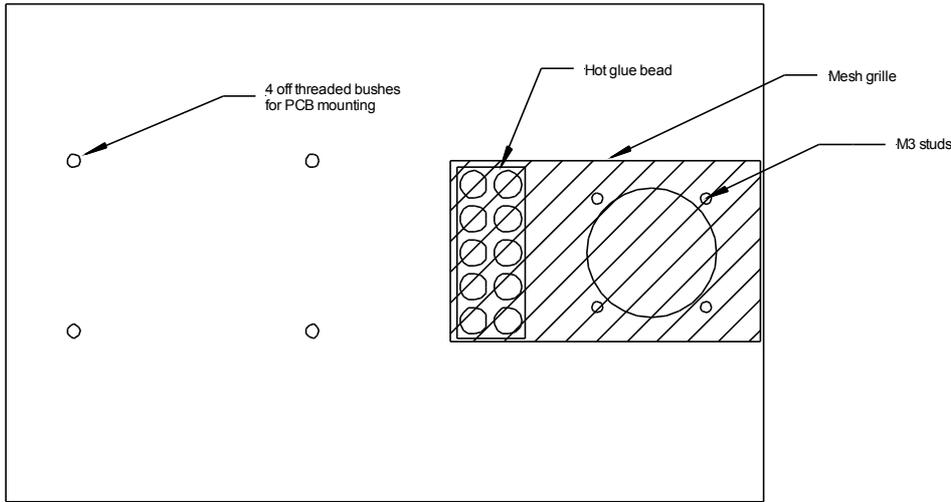
- a. Power up the controller by plugging in its power supply. The display should briefly show “DivisionMaster” plus software version and date; current version/date is V2.02 16 JAN 2004. The display will then change to show “Parameter set = 0”. Pressing “OK” will cause the display to show “JOG mode”.
- b. Press the up arrow key; the display will show “SETUP paramSet 0”. Press the OK button.
- c. The screen should now show “Parameter set = 0” and the cursor will be flashing over the number. Press all of the number keys in turn to check the operation of the keyboard; the corresponding number should appear under the cursor.
- d. Press the 1 key, then the key marked “PRV”, to display “Factory Settings?”. Press OK. Press the PRV button twice to display “Save and exit?”. Press OK.
- e. Connect a motor to the XLR socket. Press “PRV” twice to display “CONTINUOUS mode”. Press OK.
- f. Press the “+ >” button and release. The motor should rotate. Press the “NXT” button. The motor should slow down & stop.
- g. Press the “< -“ button. The motor should rotate in the opposite direction to before. Press the “STOP” button. The motor should stop immediately.
- h. Disconnect the power, then disconnect the motor.

# CASE ASSEMBLY

## FAN AND COOLING

While not required when running smaller stepper motors, the cooling fan keeps the case cool and allows larger motors to be run without any overheating problems. It is used in conjunction with the heat sink on the driver integrated circuit, and keeps that i.c. well within it's operating temperature. The fan is now connected to a two a pin socket the main printed circuit board, while early builds had it soldered directly to the PCB.

First, a piece of aluminum mesh grille is fitted on the inside of the box base using a bead of hot melt glue around the 10 vent holes, in the position shown in the diagram below. This grill will need to be punctured to fit over the 4 fan mounting studs – a small screwdriver works well! Fan is mounted label side to grille, i.e., it blows out through the grille. Four M3 nuts, shake-proof washer and plain washers secure the fan in position.



## *MOUNTING CONNECTORS*

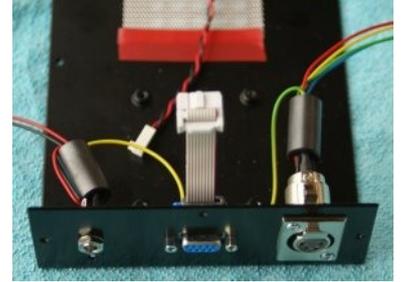
There are three connectors that need to be mounted onto the case.

The 9 way 'D' connector is supplied ready assembled to the ribbon cable and is secured using a pair of lock nuts with the suppression core mounted upwards so that the ribbon header is aligned correctly with the printed circuit board.



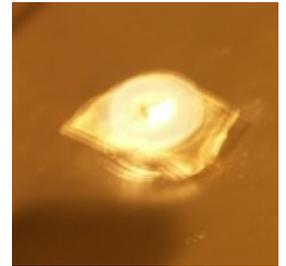
The power connector can be fitted without removing the wires as it fits from the back of the case, and has its lock nut fitted to the outside of the box.

The XLR socket used for the stepper motor will need to be removed from the wires so that it can be fitted from the outside of the box, using two self tapping screws. The wires will be replaced once the printed circuit board has been mounted in the case.



## *MOUNTING MAIN PRINTED CIRCUIT BOARD*

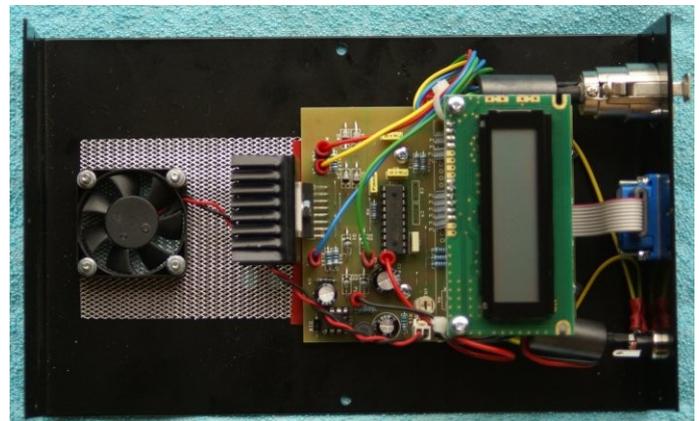
Four nylon washers need to be stuck to the top of the nutsert pillars to provide insulation from the back of the board. Double sided tape provides a convenient means of holding them. The board can then be mounted using four M3 bolts.



The ribbon connector for the 9 way 'D' can now be plugged into the PCB.

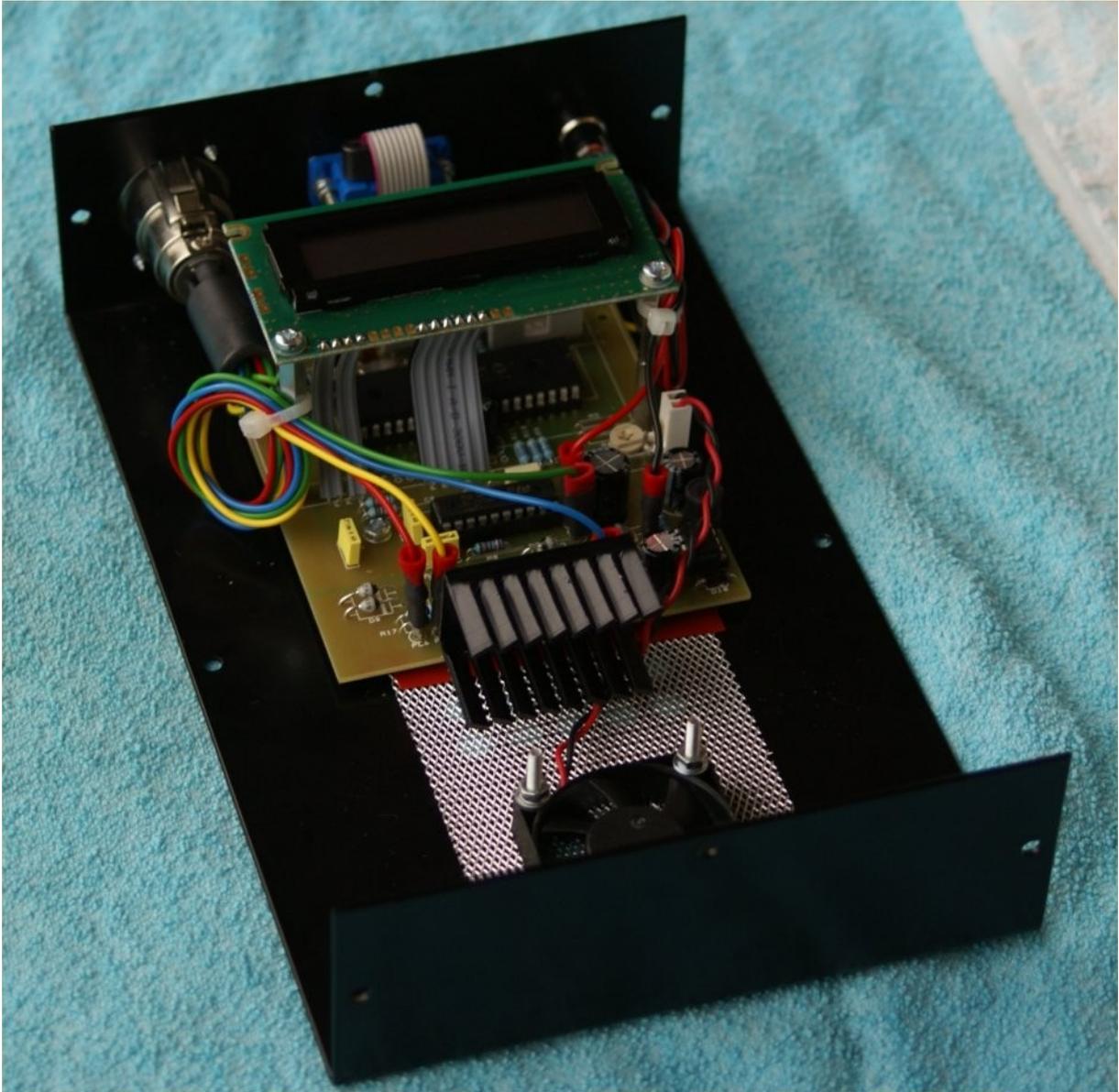
The four wires for the motor drive are dressed to the cannon connector side of the board, and secured with a cable tie, then passed through one of the round Ferrite cores before re-soldering to the connector. The core can then be moved up to be as close to the connector as possible. A piece of insulation tape wrapped round the connector pins provides a buffer to push the core against before cable tying into position. A third cable tie secures the cable loop to the LCD pillar.

The power connector has already been assembled, and can now be installed in the case. It may be appropriate to reduce the length of the wires, by removing them from the printed circuit board and reassembling with a shorter loop. A single cable tie secures any remaining spare cable to the adjacent LCD pillar.



The final step is to refit the ribbon cable to the keyboard, and allow the two halves of the case to be fitted together. At this point, operation of the unit can be tested again.

## *ASSEMBLED CASE*



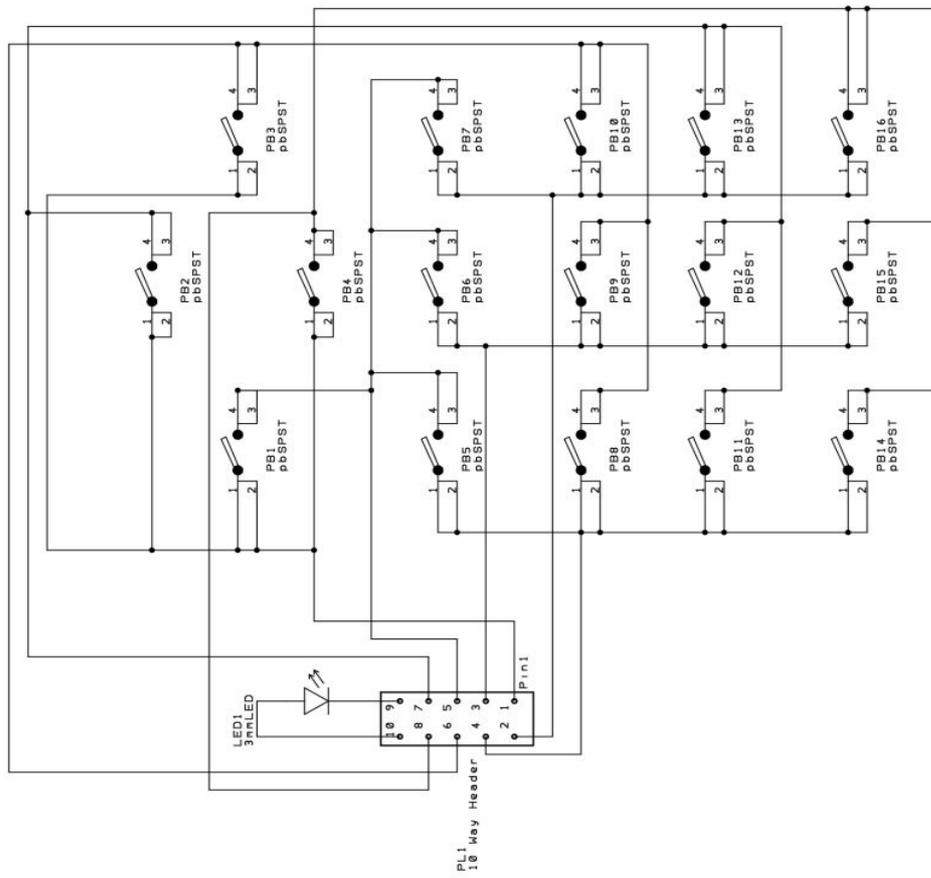
## *FINISHING*

Once happy that you have a finished working unit the final step is to secure the two halves of the case together using the remaining self tapping screws. Fit the four rubber feet to the corners of the back. The protective plastic on the overlay can be removed and you have a unit ready to use.

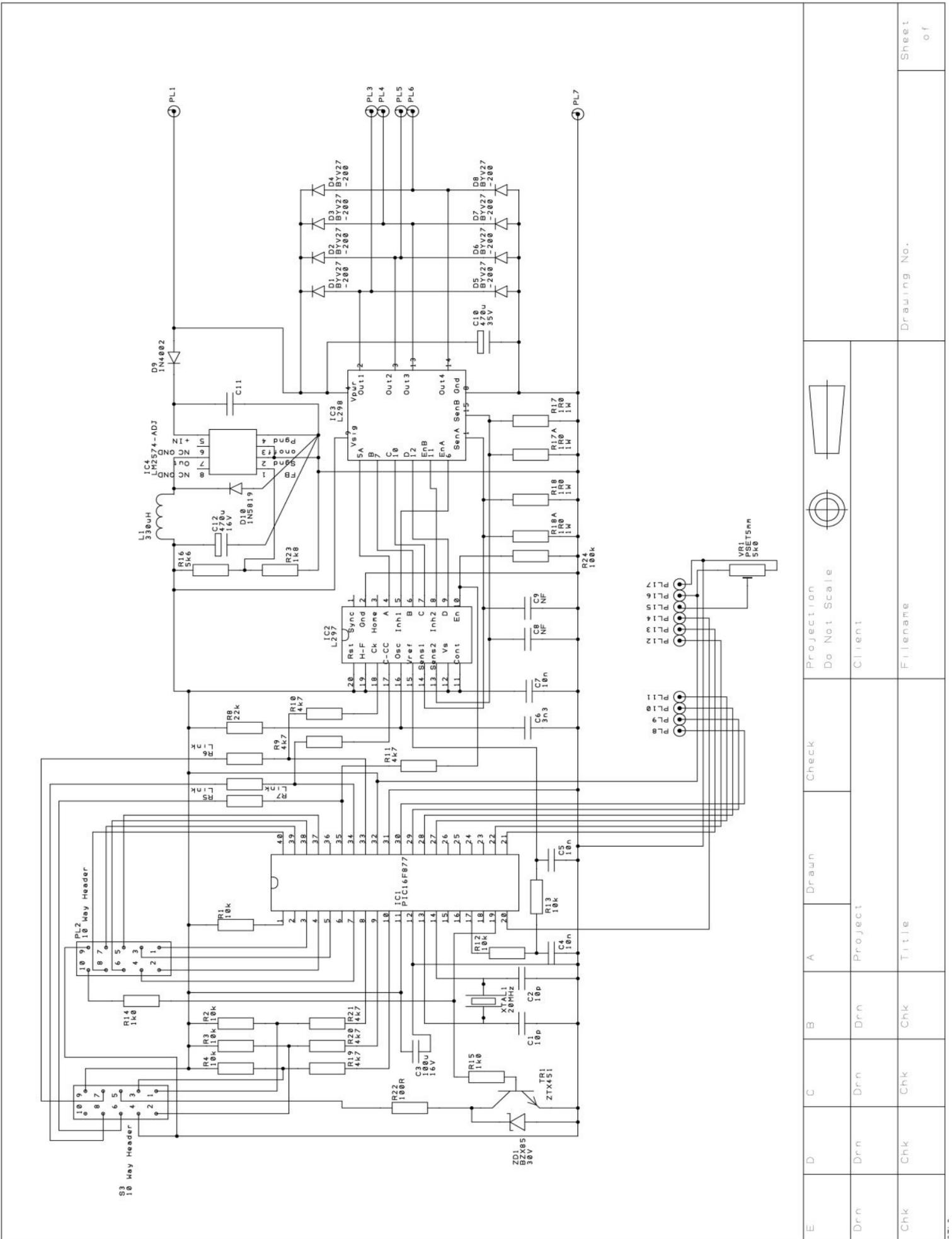
And now you can read the users manual and find out how to use it.

## *FAULT FINDING*

1. **Display fails to show any text.** PIC chip not programmed, or possibly not correctly inserted into socket.
2. **Keyboard functions don't work.** Keyboard cable not fitted, or not correctly fitted.
3. **Individual keys don't operate as expected.** Faulty keyboard and/or key switches or ribbon cable incorrectly fitted.
4. **Motor fails to rotate.** Incorrect wiring to the XLR socket, or possibly faulty L298/faulty main board.
5. **Motor buzzes & fails to rotate.** Happens if only one motor coil is being energised – again, wiring fault or board-level fault on main board.



E	D	C	B	A	Drawn	Check	Projection Do Not Scale	Sheet of
Drn	Drn	Drn	Drn	Project		Client		
Chk	Chk	Chk	Chk	Title	Filename	Drawing No.		



E	D	C	B	A	Drawn	Check	Projection Do Not Scale			Drawing No.	Sheet of
Drn	Drn	Drn	Project	Client	Filename						
Chk	Chk	Chk	Title								

## EXTERNAL CONNECTIONS

The “D”-type socket on the rear panel of the case is used to connect DivisionMaster to external devices, if so desired. Figure shows the pin numbering of the 9 pins on the connector, as viewed from the rear of the unit.

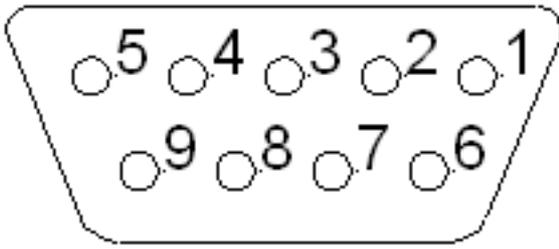


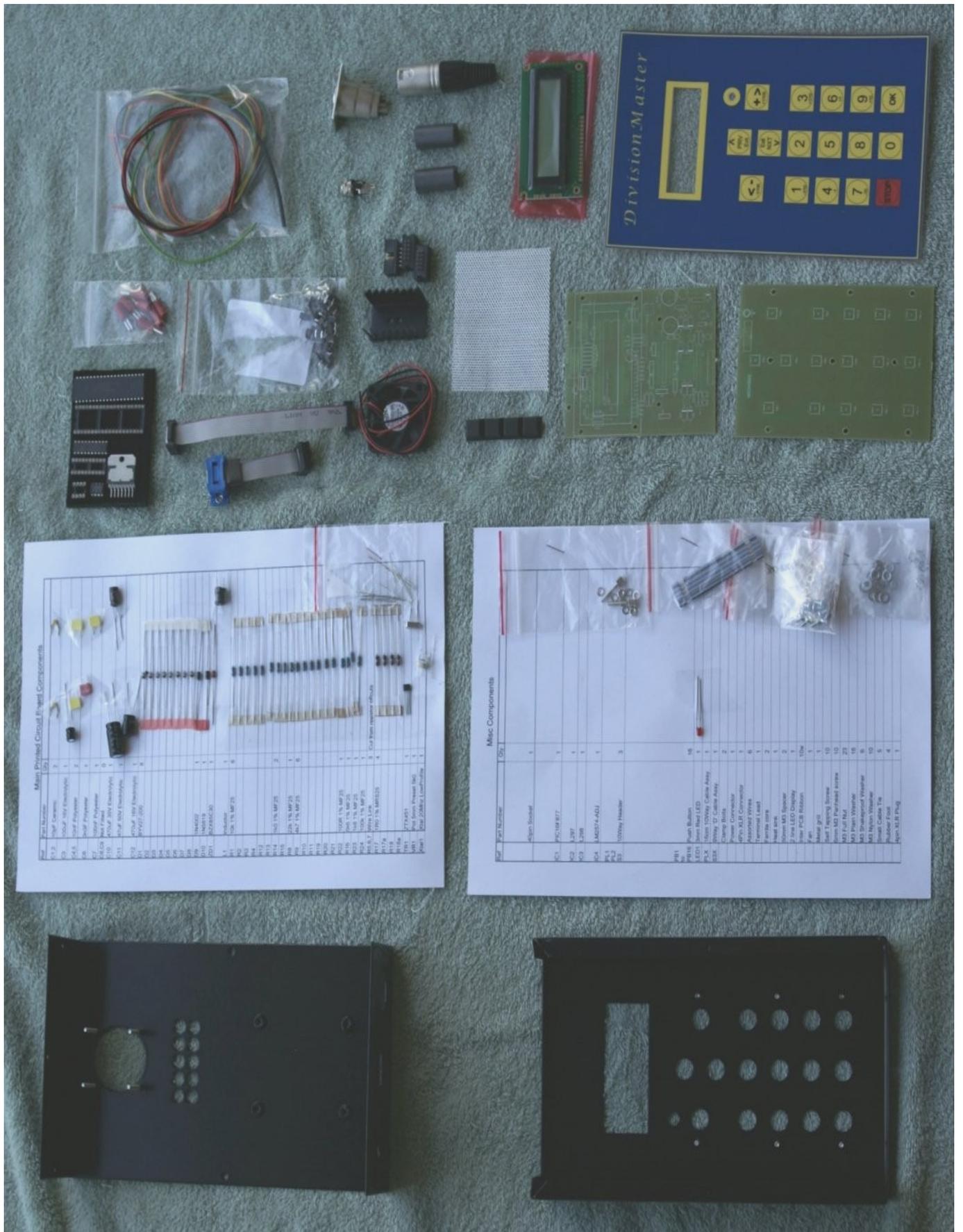
Figure 12. “D”-type socket pinout

The uses that these pins are put to are shown in Table .

TABLE 1. D-Type pin allocations

<i>Pin number</i>	<i>DivisionMaster connection</i>
1	<- key contact input**
2	STOP key contact input**
3	Active/Inactive output
4	Step input/output**
5	+5V reference
6	+> key contact input**
7	0V (GND) reference
8	Enable input/output**
9	Direction input/output**

\*\*CAUTION: VOLTAGES OUTSIDE THE TTL RANGE OF 0-5V APPLIED TO THESE PINS WILL PERMANENTLY DAMAGE THE UNIT.



The DivisionMaster controller schematics, circuit layout, firmware, and mechanical design are copyright (C) Tony Jeffree, 2004. All rights reserved.

The DivisionMaster kit templates are copyright (C) Lester Caine, 2006. All rights reserved.