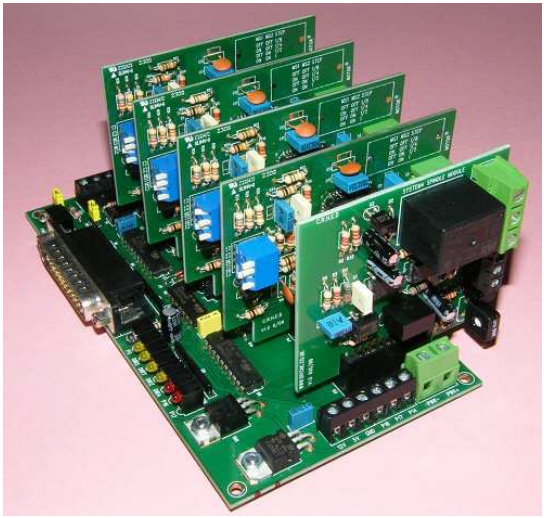
SYSTEM 4

C R H Electronics Design



SYSTEM 4

All in one modular 4 axis CNC drive board

By C R Harding

Specifications

Main PCB

- Available with up to 4 Axis X, Y, Z, A outputs.
- Standard 25 way PC Parallel port connection
- LED indicator display of Direction for each axis plus Enable, Main power , Power Save mode and relays.
- Un-pluggable stepper boards for easy replacement
- Buffered optical isolated inputs with configurable pull-ups.
- Socket for Optional Spindle control/relay board
- Available populated with 2/3 or 4 driver boards
- Power save feature to reduce current when not active.
- X and A axis can be common for dual X axis drive system
- Built in charge pump circuit connected to all output drivers and relays.
- On board 5V & 12V regulators with spare output connections.
- Uses single power supply line (24V -30V DC regulated supply recommended)
- Fused power rail with over voltage protection.
- Motherboard size 105 X 165 mm. FR4, silk screen legend, immersion gold, 1oz copper, RoHS compliant.

DRV25mod

- Step increment and current settings for each motor
- Two phase PWM operation.
- Drive boards have thermal shutdown, UVLO and crossover current protection.
- 1/8, 1/4, 1/2 or full Step selectable with 1, 1.5, 2 & 2.5Amp switch selectable max stepper current.
- Maximum 30V @ 2.5A per phase motor outputs.
- Kit comes with ready soldered surface mount driver chips
- FR4, silk screen legend, immersion gold, 2oz copper, RoHS compliant.
- Board can be populated either surface mount or conventional components.

Spindlemod

- Stepper pulse to analogue voltage convertor
- 10V maximum output
- Can be voltage trimmed on board or via software.
- 10A 240V AC 2 way relay for motor reverse or on/off
- Fully isolated on board power convertor.

Extmod

- Step, Direction, Enable, 5V+, Gnd and Power signals to feed external driver boards like the DRV50 or other third party manufactures driver boards.

Manual V1.0 Sep 09
Hardware V1.0 Aug 09

Motherboard overview

Power Input

Maximum input voltage 30V, recommended regulated voltage 24-30V.
If using an unregulated power supply, check peak voltage across output before connecting the System4 board. A 25V unregulated supply can have 35V peak unloaded output. It may be necessary to place a load resistor permanently across the output to reduce the peak voltage as when the board is not enabled the power consumption is quite low.
Power is supplied to the board via a separate 20A terminal block.
A separate smaller connector provides a 5V &12V regulated supply that can be used to power sensors etc.

Signal Inputs

The board has five inputs that are optically isolated from the main board and PC via the parallel port. There is a group of three inputs 1, 2 &3 which have configurable jumpers so that you may use internal power to provide logic switching without an external voltage. Ideal for e-stop buttons or limit switches etc. The two independent inputs 4&5 will need an external voltage to trigger them.
See fig1 for configuration jumpers

Signal Outputs

The board has three spare output connections which are buffered and capable of driving up to 30mA drive current. These outputs are only enabled with the charge pump signal and are all located at the side of the board. These pins can also be used for driving external relay boards.
Note: Pins 16&17 are shared with the spindle control board when fitted; only pin14 is independent.

Module connectors.

The System4 main board has 5 module connectors. Four of these provide power and drive signals for stepper drive boards and the fifth is for a Spindle control board. When using external driver boards with the System4 motherboard you may run the driver board from a different power rail than that used by the System4 main board. This would also be necessary if you needed to draw higher currents for the external driver boards as there is a limit of 2.5A on the current available.

Power Save

The System4 board has a power save system that sends a signal to all four axis. If there are any signals present on any of the four axis step lines the power save mode will be disabled ie; while running a program. When the signals are absent and the program is complete the power save will re activate reducing the current through the motors and driver chips saving energy and helping to keep everything cool. This function can be disabled by removing link L4

Led display

The board has several led's. There are four yellow direction led's on the XYZA axis, two red signal led's on pins 16&17. A green power save led a red enable line led and a blue power led. Unlike the system 3 we have removed the step Led's as the step pulses are so small there is hardly any noticeable indication of what is happening.

Axis configuration

There is a pair of jumper pads between the X&Y axis connectors that may be configured so that you can have two motor drivers on the X axis, as sometimes needed on wide bed routers. See fig2

Power Outputs

5V+: Power output from the onboard regulator. This can be used to work other circuit boards, sensors, relays etc. **Maximum external load must not exceed 100mA.**

12V+: Power output from the onboard regulator used to drive fans and relays. **Maximum external load must not exceed 200mA**

Charge Pump Circuit

The System4 board uses a 12 KHz charge pump signal from the controlling software to operate the enable line on all four driver circuits. This signal uses pin1 from the parallel port for its input and must be setup in your software configuration. When the signal is present the red enable light will illuminate showing that the board is active. If your software does not support this function you may override this signal with the L1 jumper link making the board permanently enabled.

The following table shows a typical parallel software set-up

Parallel Port Pin	System 4 signal	Input / Output
1	Charge pump signal	Enable
2	X Direction	X Axis
3	X Step	X Axis
4	Y Direction	Y Axis
5	Y Step	Y Axis
6	Z Direction	Z Axis
7	Z Step	Z Axis
8	A Direction	A Axis
9	A Step	A Axis
10	Input 1	Input pin
11	Input 2	Input pin
12	Input 3	Input pin
13	Input 4	Input pin
14	Output signal	Output pin
15	Input 5	Input pin
16	Spindle pulse	Output pin
17	Relay 1	Output pin
18-25	Ground	GND

Pins 8 & 9 are normally used for the fourth axis but can also be used for spindle control. The step signal becomes the speed signal and the direction becomes on/off or backwards/forwards.

If you are using Mach2/3 software, set up each axis as shown above and leave the, low/step box unchecked. You can check or uncheck the direction box to reverse the stepper motor direction as required.

Basic connection diagram of 4 axis system with e-stop and limit switches. By using the power and ground links there is no need for external power or pull-up resistors to operate the button and micro switches. The switches are arranged in series using the normaly closed contacts.

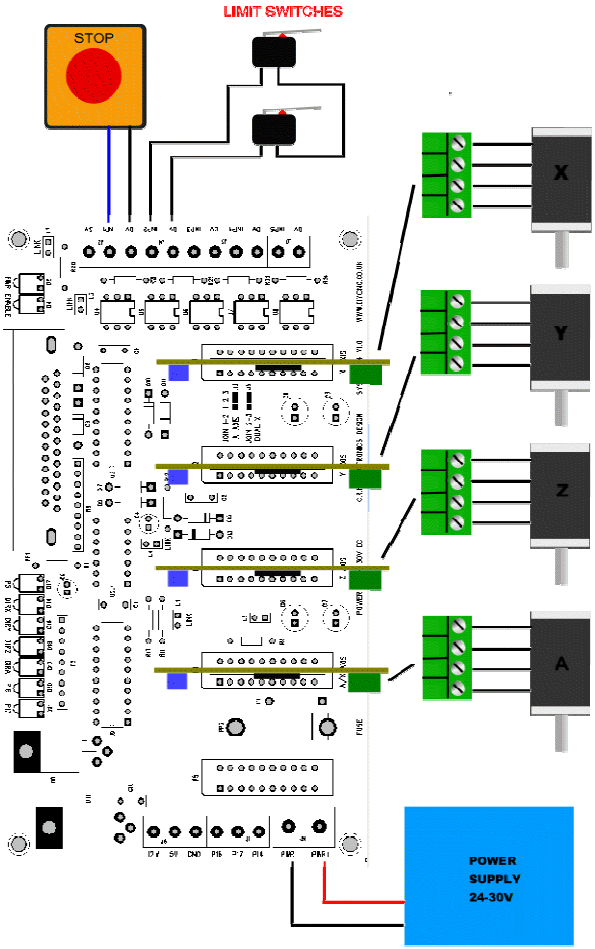


Fig1 Input jumper configuration

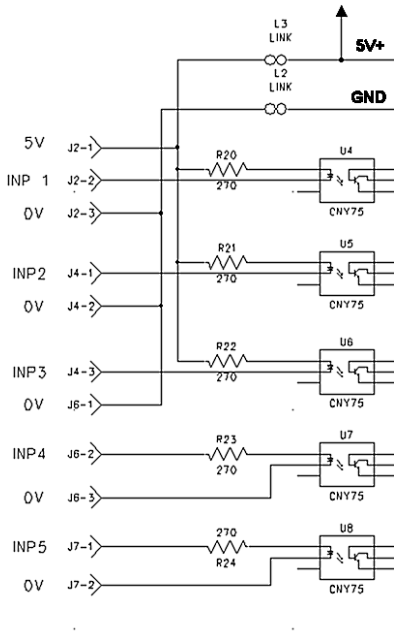
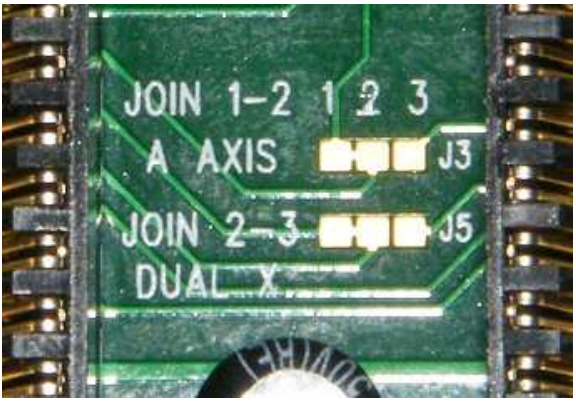
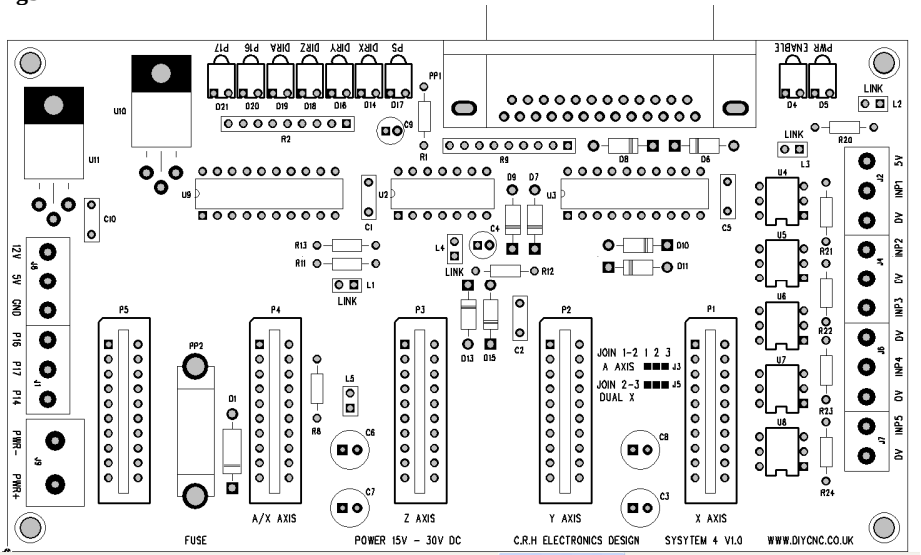


Fig2 Axis jumper



To change the jumper setting you will need a Stanley knife to cut through the existing link between pins 1&2 and then solder blob pins 2&3 together.

Fig3



System 4 General layout

Four of the slots P1 –P4 allow for connection to external driver boards and the DRV25MOD boards to individual requirements. The A axis can also become a second X axis for systems large router tables that may need twin X axis motors. The fifth slot P5 is used for a optional spindle control board.

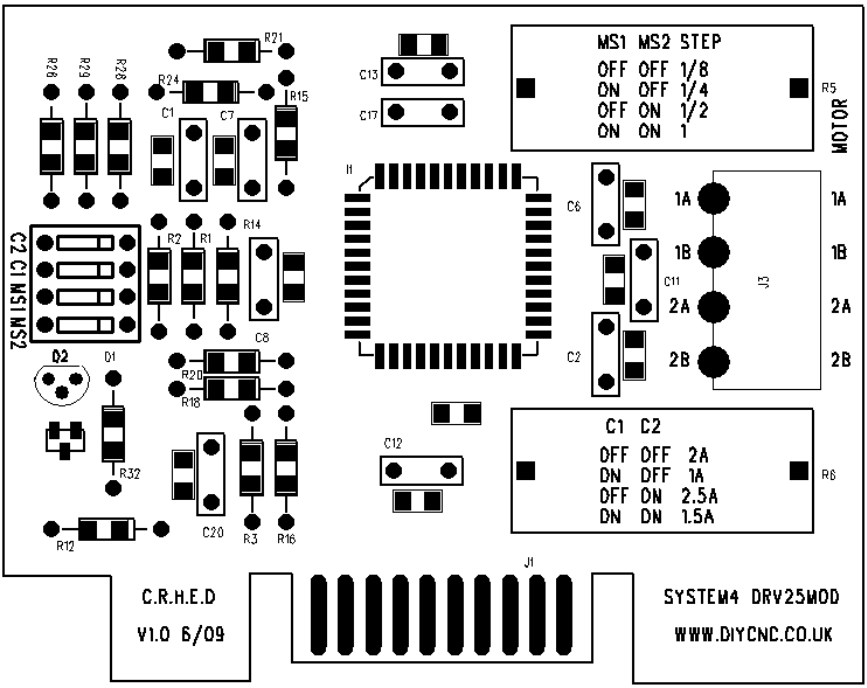
DRV25mod

The driver module board is based on the Allegro 2.5A bipolar stepper driver chip as used on the System3 and DRV25ps boards. The board has been designed to handle conventional through hole and surface mount components. The board simply slots into any of the four axis slots on the motherboard and there is a standard 4 way motor connector at the rear and a four way dip switch on the front edge.

Amendment

Some early DRV25MOD boards have an error in the silk screen printing for C1 & C2 motor current selection which are reversed by the dipswitch. Fig 4 shows the correct position.

Fig4



Dip switch settings for each Axis

MS2 & MS1 Adjust Step rate.
(MS2 on MS1 on) Full Step
(MS2 on MS1 off) ½ Step
(MS2 off MS1 on) ¼ Step
(MS2 off MS1 off) 1/8 Step

C1 & C2 Control maximum stepper current
(C1 on C2 off) 1A
(C1 on C2 on) 1.5A
(C1 off C2 off) 2A
(C1 off C2 on) 2.5A

Stepper motor connections

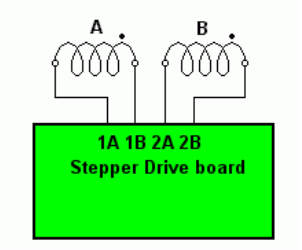
The following diagrams show typical connections for a range of different motors.

If your motor rating is in excess of the 2.5A maximum current limit then you should use the windings in serial connection for maximum efficiency.

4 leads - Bipolar Drive

4 Leads
The standard connection for a four lead motor.

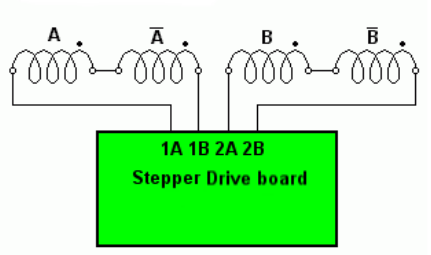
This is the standard connection for a bipolar drive. There are still four windings and, depending on motor type, they are in series or parallel. Most manufacturers makes two models with the same winding, but one time connected is series and one time in parallel.



Bipolar Drive - Serial Connection

6 Leads
The windings are connected in serial. Since most 6 lead motors are wound bifilar - link -, so the inductance will be quadruple of the single winding value.

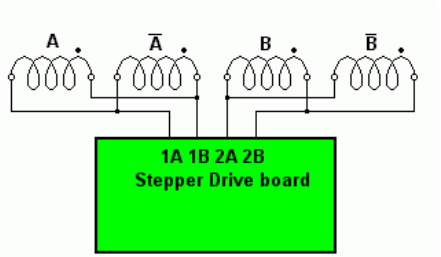
8 Leads
The windings are connected in serial. Since most 8 lead motors are wound monofilar - link -, then the inductance will be double. If the motor was wound bifilar - link -,the inductance will be quadruple .



Bipolar Drive- 8 leads - Windings Parallel

8 Leads
This is the standard high speed connection for an eight lead motor.

With the windings in parallel, the motor current can be higher whilt the inductance is lower. This is a typical connection for a motor that need to run at a high speed..



IMPORTANT:
Double check that connections are correct before applying power to the board, windings connected out of phase may cause damage to the board. Do not connect or disconnect wires with the power on. It is a good idea to adjust the current switch settings to the minimum setting if you are in any doubt of the connections. It should be noted that some six wire motors are three phase operation and are unsuitable for this board.

The PCB Stepper outputs on the DRV25mod board are marked 1A &1B this represents one winding. Outputs 2A & 2B are the other winding.

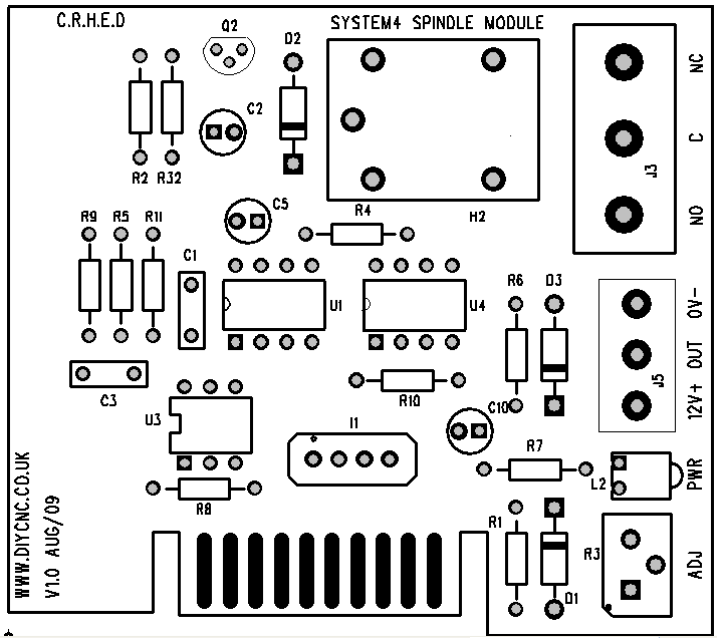
Spindlemod

The board is able to take step signals to drive a spindle motor board that normally uses a potentiometer to control spindle speed. This is achieved by converting stepper pulses on pin 16 of the parallel port into a voltage level suitable for the spindle drive board. There is also a relay with contacts rated at 2400 Watts or 240V AC at 10 Amps suitable for switching power to the motor that is controlled by the forward, backward signal on pin 17. Some motor control boards allow full reverse features, others are single direction only. The board has Opto isolation and an isolated dc/dc convertor for power to the analogue side of the board making external power unnecessary.

WARNING

It should be noted that some motor controller boards have no mains isolation and instead rely on being self contained systems. Connecting other circuits to these boards present a possibility of hazardous voltage levels which may result in electrocution or severe damage to circuit boards. We strongly recommend isolating all spindle motor power while handling this board as full mains potentials are possible between various parts of the circuit.

Fig5

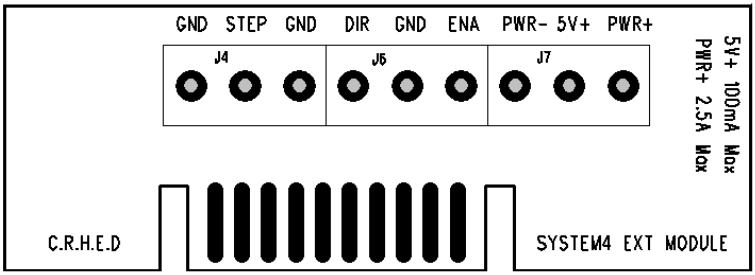


When using the spindle board to control an existing manual system only two connections are required between the Spindle module and the spindle drive motor board. A ground or bottom of the variable potentiometer to the 0V- pin and the centre pin or variable connection of the pot to the OUT connection. You must remove the existing potentiometer connections to prevent it loading the circuit.

Extmod

The small board used for connecting external stepper driver boards.
Although there is a main power rail provided on the board this is optional and a totally separate power supply may feed the external drivers which may need higher current and voltage requirements.

Fig6



KIT CONSTRUCTION

Building the System 4 motherboard kit should take about one hour and half an hour for a each of the drv25mod boards. You will need a good soldering iron; preferably temperature controlled and set to 400-450 degrees. The solder provided is lead free with a mild active flux. This helps it to flow easily but you need an extra 50 degrees higher temperature compared to lead solders. You will notice this particularly when soldering component leads to ground connections.
As the driver chips are surface mount devices the PCB's are supplied with them ready mounted into position. The individual DRV25MOD driver boards can be surface mount or through hole components. The kits are supplied with conventional components. With reference to the board layout diagram Fig2, start by placing the components with the longest leads that will need cropping after soldering. I find that the best way is to push the component through the holes until it is in contact with the board and then bending the leads at 45 degrees on the underside to stop the component moving while soldering. Using this technique you can place several components before soldering. After soldering and cropping the long leaded components next place the small capacitors which have fairly short leads. The board has LED's that are mounted at right angles with the plastic housings provided. Slide the LED legs through the housing before bending the legs at 90 degrees. The longer of the two leads on the LED's is the anode or positive and goes to the square pad. Solder one leg first and then position square with the board before soldering the other leg. The 7805 & 7812 regulators need the centre leg bending slightly forward before bending all the legs back and fitting a bolt though the metal tag to secure. There are three IC's and several diodes to fit and jumpers for charge pump, power save and input circuits. The black connector blocks are manufactured in either a three or two terminals but there is an interlocking system built into their sides for multiplying the amount of terminals needed. Make sure that they are slid together before fitting to the PCB. If available you

could clean up the flux residue with a proprietary flux cleaner when complete. I have found the SERVISOL DE-FLUX 160 flux remover / PCB cleaner is very effective.
Notes:

- Resistor arrays have a dot at the end which is common and goes to the square pad.
- Electrolytic capacitors, the longer lead is positive and goes to square pad.

Component parts list for SYSTEM4

Capacitors

C1	**10nF**	**100V**
C2, C5, C10	**0.1uF**	**100V**
C3, C6, C7, C8	**100uF**	**50V**
C4	**1uF**	**50V**
C9	**100uF**	**25V**

Semiconductors

U4, U5, U6, U7, U8	**CNY75**
U2	**74HC04**
U3, U9	**74HC244**
U10	**7805**
U11	**7812**
D1	**33V clap diode 500W**
D6, D7, D8, D9, D10, D11, D13, D15	**1N4148 diode**
D14, D16, D18, D19	**Yellow LED**
D4, D20, D21	**Red LED**
D5	**Blue LED**
D17	**Green LED**

Resistors	**All 1/4watt unless specified**		
R1		**470**	**5%**
R2	**8 resistor network**	**470**	**Array**
R8, R12		**10k**	**5%**
R9	**8 resistor network**	**2.2k**	**Array**
R11		**100k**	**5%**
R13		**10M**	**5%**
R20, R21, R22, R23, R24		**270**	**5%**

Connectors

P1, P2, P3, P4, P5	**20 way**	**0.1” pitch pcb**
J1, J2, J4, J6, J8	**3 way**	**terminal block**
J7	**2 way**	**terminal block**
J9	**2 way**	**20 Amp green block**
PP1	**25 way D type male**	

L2, L3 jumper yellow
L1, L4 jumper black

Component parts list for DRV25MOD

Capacitors

C1	**0.1uF**	**100V**
C2, C6, C11, C17	**0.22uF**	**63/100V**
C7, C8	**1nF**	**100V**
C12, C13, C20	**0.1uF**	**100V ceramic**

Semiconductors

I1	**A3977**	**PLCC44**
Q2	**BC182**	**TO92**

Resistors **All 1/4watt unless specified**

R1, R3, R16, R18, R20, R24, R32	**RES**	**10k**	**5%**
R21	**RES**	**15k**	**5%**
R14, R15	**RES**	**22k**	**5%**
R2, R12	**RES**	**1k**	**5%**
R26	**RES**	**5.6k**	**5%**
R28	**RES**	**12k**	**5%**
R29	**RES**	**4.7k**	**5%**

Connectors

J3 4 way male Connector (supplied with matching 4 way right angle terminal connector)

D1 DIPSW4

Component parts list for Spindle module

Capacitors

C1	**1nF**	**100V**
C2, C5	**1uF**	**50V**
C3	**0.1uF**	**100V**
C10	**10uF**	**25V**

Semiconductors

D1, D2	**1N400X diode**
D3	**13V zener**
I1	**IL1212S convertor**
Q2	**BC182**
U1	**LM2917**
U3	**CNY75**
U4	**LM358**
L2	**Red LED**

Resistors

R1	**220K**	**5%**
R2, R5, R7, R32	**2.2K**	**5%**
R3	**22k VRES**	

R4	**470**	**5%**
R6	**10k**	**5%**
R8	**250**	**5%**
R9	**1k**	**5%**
R11	**10K**	**1%**
R10	**20k**	**1%**

Connectors

J3	**3 way 20 amp green blocks**	
J5	**3 way terminal blocks**	
H2	**2 way 10 amp relay**	**HSR4**

Component parts list for EXT MOD

J4, J5, J7	**3 way terminal blocks**

Contact Details

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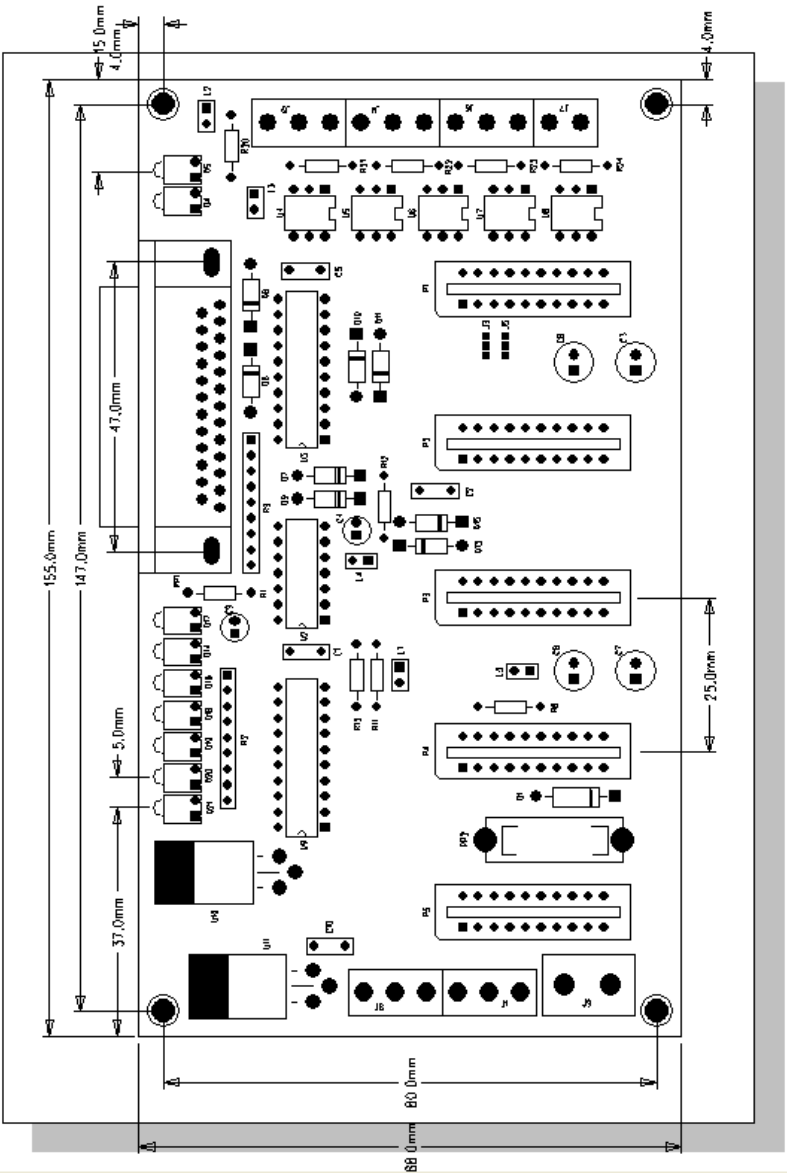

Dimensions for board and fixings. Hole diameters are 3.2mm for M3 bolts