Chapter 3

Motor Drive and Connections

3.1 Introduction

RS hybrid stepping motor was used. It has a rated voltage up to 12V and a rated current of 0.6A. The stepper motor has a step angle of 1.8 degree and it has 8 wires.

The stepper motor was connected to 4-phase unipolar stepper motor drive board. The board drives up to 2A and 30V DC per phase. The external control inputs are C-MOS and open controller TTL logic compatible (level '0'- 0V and level '1'- 12V). Frequency range to the clock is (1Hz to 25KHz) and the minimum pulse width is 10μs.

The following components were also used to conducts tests and experiments: Ps 5010 programmable power supply DM 5110 programmable DMM, FG 5010 programmable function generator and four channel digitizing oscilloscope.

The following website is recommending for basics of stepper motors:

http://www.euclidres.com/apps/stepper_motor/stepper.html

3.2 Stepper motor testing, and verification of wiring.

3.2.a Correcting the sequence at which the motor terminals are attached to the drive board.

Pulses will be sent to the motor board where they are going to be translated to higher voltage signals used to energize the stepper motor coils in a specified sequence that will result in rotating the motor shaft in a specific manner. The electrical signals are sent from

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the motor drive pins. An experiment was held to find which pins are set high (+5 volts) and which pins are set low (0 volts). Pulses will be sent to the clock pin from the function generator. Using a Digital MultiMeter (DMM), the voltage on the motor drive pins will be observed at every motor step.

<u>Objective:</u>

It is to find the correct order at which the stepper motor terminals should be attached to the drive board pins.

<u>Procedure:</u>

- Some connections should be made initially so that the test can be conducted. The correct wiring sequence was obtained from the motor drive manual. Pin 1 on the board is attached to pin 28 and is connected to +12 volts source from the power supply. Pin 1 is also connected to the black/white, red/white, green/white and yellow/white terminals from the stepper motor. The voltage source ground is connected to pins 29, 30, 31, 32. The function generation is connected to the clock, pin 23.

Unipolar stepper motor drive board connections

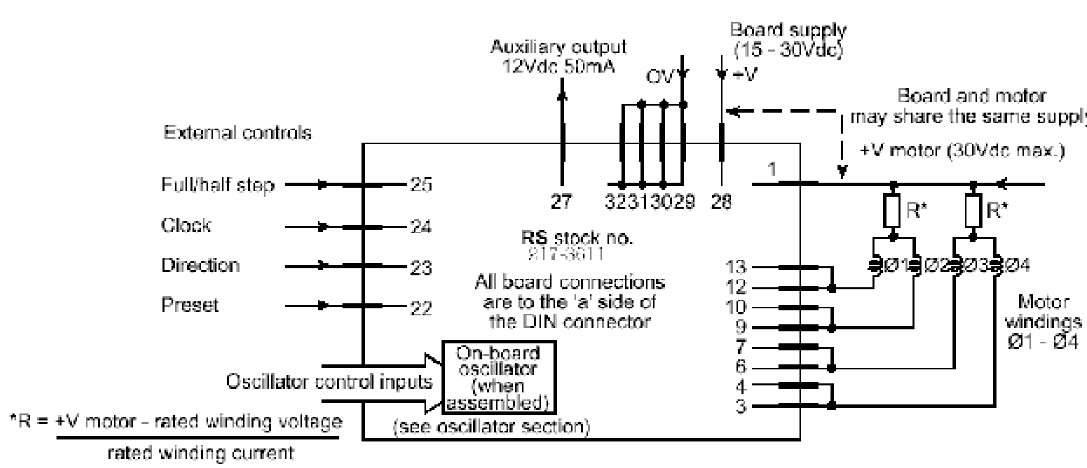

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Fig 3.1: Correct wiring sequence provided by the manual.

- The black wire was connected to pins 3 and 4, red wire was connected to pins 6 and 7, green wire was connected to pins 9 and 10, and yellow wire was connected to pins 12 and 13.Pulses were sent to the clock pin, from the function generator. The function generator was set to send a square signal with 0.5 Hz frequency.

- The voltage is observed on pins 3, 4, 6, 7, 9, 10, 12 and 13 on the drive board using a Digital Multimeter (DMM). This is repeated once every step moved by the motor. High and low pins are recorded at every step.

- Results are compared to coils energizing sequence defined in the motor manual, table 3.1. The correct wire order was predicted. The motor terminals should be connected to the board according to the figure 3.2 taken from the motor drive manual.

Step / pins	A	B	A'	B'
1	On	On	Off	Off
2	Off	On	On	Off
3	Off	Off	On	On
4	On	Off	Off	On

Tables3.1: Manual drive table.

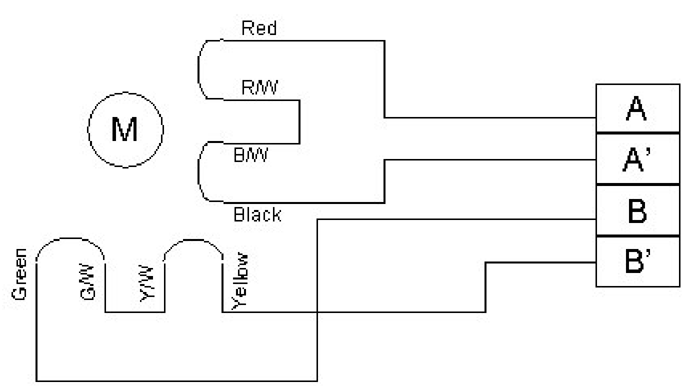

Figure 3.2: Correct wiring sequence provided by the manual.

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Results and Discussion:

The energizing sequence as found from voltage observations was found as shown in table 3.2:

Step / pins	**3-4**	**6-7**	**9-10**	**12-13**
1	On	Off	Off	On
2	Off	On	Off	On
3	Off	On	On	Off
4	On	Off	On	Off

Table 3.2: Experiment table

Comparing table 2.1 to 2.2, we find that A refers to pins 3 and 4, B refers to pins 12 and 13, A' refers to pins 6 and 7, B' refers to pins 9 and 10. Now, referring to figure 3.1, the motor terminals should be connected to the board as follows:

Red wire to pins 3 and 4, black wire to pins 6 and 7, yellow wire to pins 9 and 10, green wire to pins 12 and 13 as shown in figure 3.3. The rest of the initial connections are also shown on the figure.

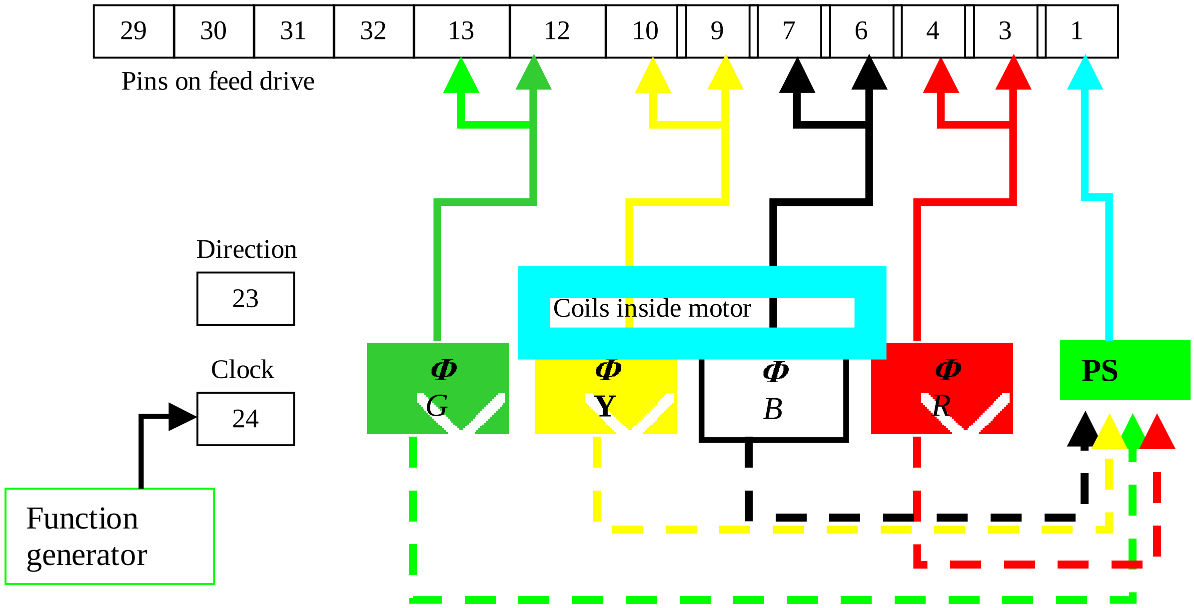

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Figure 3.3: Wiring diagram after correction

3.2.b Testing the stepper motor shaft RPM.

The angular displacement of the motor shaft can be captured using an encoder. The encoder is a non-contacting rotary to digital position feedback device designed to easily mount to an existing shaft. The encoder is reading the rotational position of the motor and is capable of converting these rotational positions into pulses. The MULTIQ terminal board with the software (MATLAB, Simulink and winlib) will convert the pulses from the encoder to continuous signal which proportional to the angle rotated.

Objective:

To test the motor RPM by plotting its actual speed computed by the encoder against speed values computed directly from the input frequency

Procedure:

- +12 volts source was attached to both the stepper motor and the drive board.
- Frequency is input to the clock on the drive board from the function generator.
- Both actual and desired motor velocities (rev/min) were plotted against the input frequency.
- The encoder was mounted and assembled to the motor shaft.
- MATLAB program was used in reading the continuous signal from the terminal board that sent +5 volts to encoder.
- Wincon program can be used to plot the displacement, velocity, and acceleration vs. time graphs. The following MATLAB Simulink block diagram, shown in figure 3.4,

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was used in obtaining the velocity and acceleration signals from the captured position signal as shown in figure 3.4.

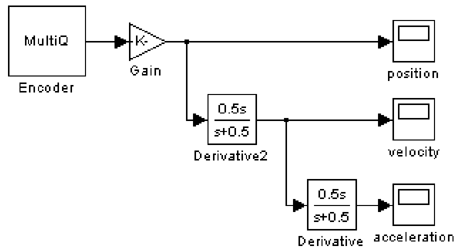

Fig 3.4: Simulink block diagram

Results and Discussion:

The actual velocity is found from the velocity graph generated by wincon. While the velocity computed directly from the input frequency is

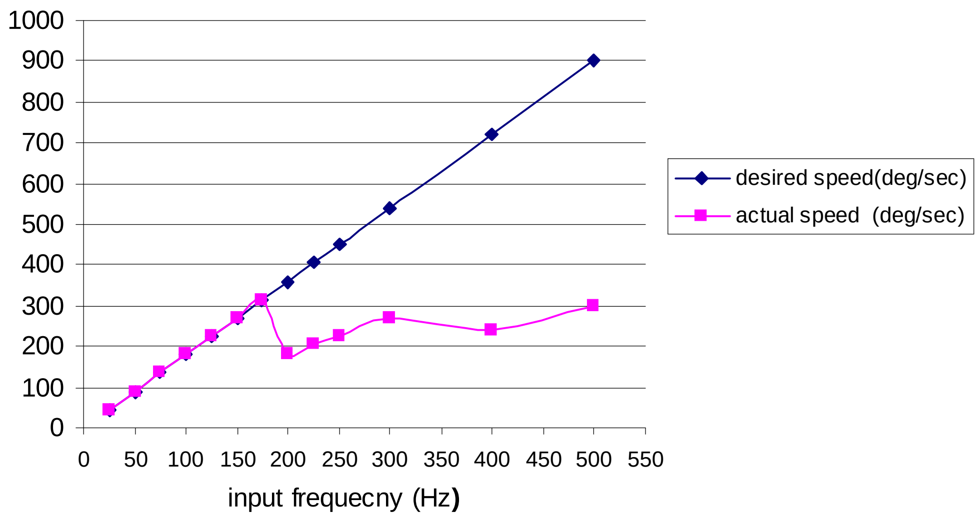

Fig.3.6: Motor RPM vs. input frequency actual and desired

$$RPM_d = 1.8f_i \qquad (3.1)$$

Where f_i is the input frequency from the function generator.

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Figure 3.6 shows the actual and desired motor RPM against several values of input frequency between 25 to 500 Hz. While the velocity of the motor should increase linearly as the input frequency increases, we notice that the motor is not exhibiting the required performance, as the speed decreases at 175 Hz input frequency, instead of following the desired speed line. The input frequency to the motor should be limited to a maximum value of 175 Hz.

3.3 Design and building of electrical circuits.

3.2c Design and build the plotter holder circuit:

The objective is to design and build the circuit that amplifies +5 volts sent by the computer to +12 volts required to energize the solenoid coil. The component of the solenoid circuit are: solenoid - relay and +12 volts power supply. +5 volts will be sent to the relay through the printer parallel port to allow passing of +12 volts current to energize the solenoid. Relay

the pulses were stopped the circuit will be opened and the pen will be released.

The relay has 5 pins, see figure3.7. Pin 1 is connected to the computer ground, pin 2 is connected to the power supply ground, pin 3 is connected to 9 on the printer port. Pin 4 was connected to the solenoid ground. The +12 volts was connected to the solenoid directly. See figure3.7.

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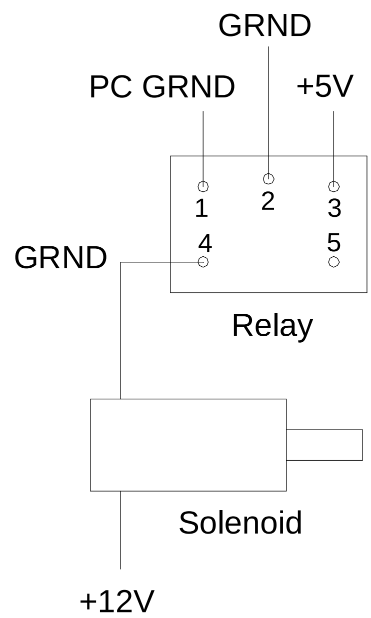

Figure 3.7: Solenoid circuit

The current passing between pins 3 and 1, will close the +12V circuit. By connecting pin 2 to pin 4. If pin 3 was grounded, pin 2 will be connected to pen 5 instead, opening the 12+ circuit.

3.2d Switch Limit Circuit:

Two limit switches taken from a computer mouse were used to send pulses to the status port of parallel port indicating the minimum lengths of the actuators in the return 2 datum system discussed in section 4. A switch limit has three pins: Pin 1 is attached to +5 volts from the power supply. Pin 2 is attached to the power supply ground and pin 3 is attached to the input pins on the parallel port. Normally, the switch limit circuit is opened and no pulses are sent to the computer (figure3.8.a). When the switch limit is pushed. The circuit will be closed and pulses will be sent to the computer (see figure3.8.B).

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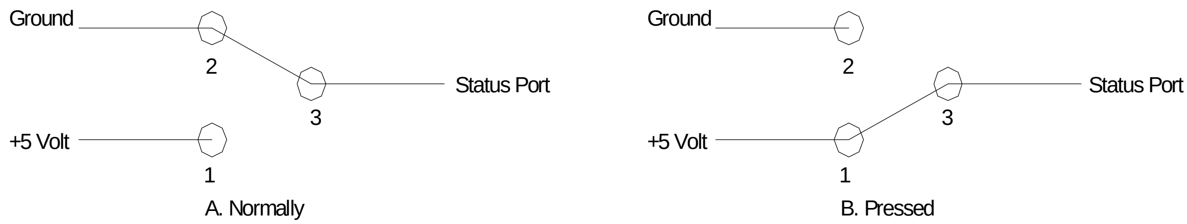

Figure 3.8: switch limit circuit

3.2f Circuit Connection Box:

The connection box contains: three 32-way drive board connectors, three 9-pin female sockets, 25-pin female socket, relay and on/off switch see figure3.9. The switch is connected to the power supply. These components were used as follows:

- Three 32-way connectors are connected to the drive board.
- Three 9-pins female sockets are connected to the three motors by using long male-to-male cables. Socket 1 and 2 are attached to the limit switches through motors 1 and 2 cables.
- The 25-pins female socket is connected to the printer parallel port using long male to male cables.

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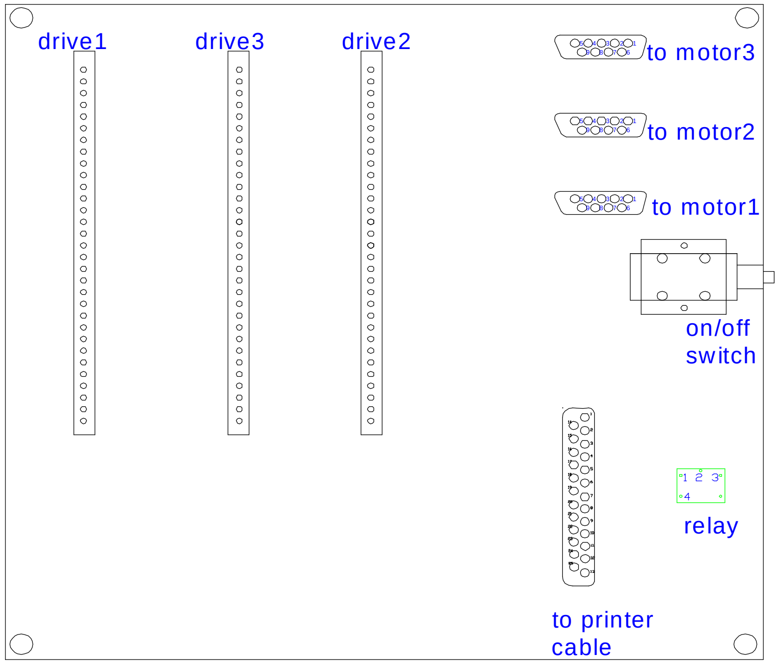

Fig.3.9: circuit connection box component

The wiring between the components of the connection box are domenstrated in figure 3.10:

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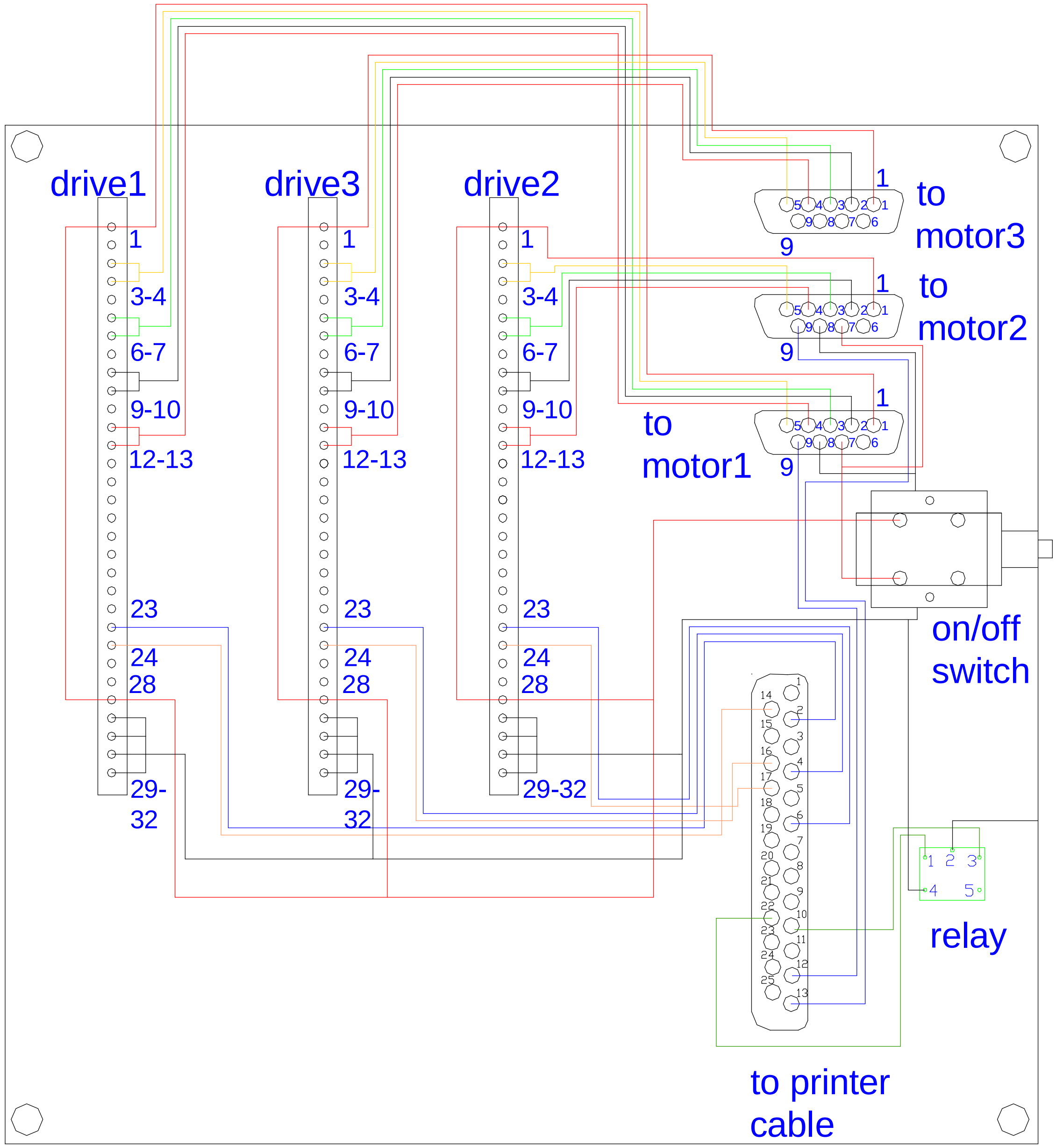

Fig.3.10: circuit connection box

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