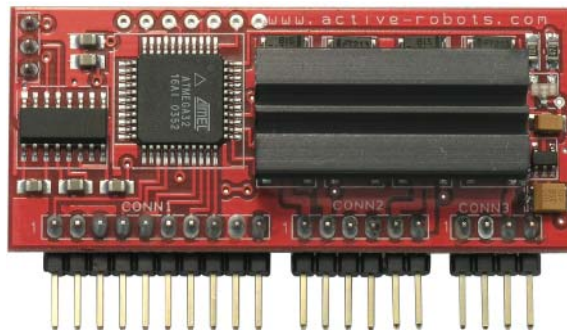


ACTIVE ROBOTS

EASY STEP™ 3000



User Guide



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1 Description

The Easy-Step™ 3000 (**ES3000**) is an advanced stepper motor drive/control system that will support unipolar stepper motors up to 35V and 3 Amps per phase. Its small physical size makes it ideal for incorporating in robots and other industrial control equipment.

1.1 Main Features

- ❑ Small footprint
- ❑ Up to 35Volts and 3 Amp per phase
- ❑ Drive **Unipolar** Stepper Motors in Full 2 Phase, Full 1 Phase and Half step
- ❑ Easy to use Command Set
- ❑ 4 Modes of Operation:
 - Direct Command Set (via PC serial comms – PC Mode)
 - Slave/Remote – Pulse Mode (Step, direction & Replay pin inputs)
 - Voltage Mode (Analogue Voltage pin input)
 - Teach Mode (via PC serial comms)
- ❑ Store and Replay Facility (Pro Version Only – via software or pin Inputs)
- ❑ Smooth Acceleration
- ❑ Selectable Pull in rate and Maximum step rate
- ❑ Adjustable ramp time to suit varying loads/motors/operating voltages
- ❑ Separate winding supplies to allow “forcing” resistors
- ❑ On board 5V regulator for logic power supply
- ❑ RS232 and TTL logic level data IN/OUT
- ❑ Built-In Demonstration Routine
- ❑ PC Based program “EASY STEP™ ISP” to allow setting up/control of motors
- ❑ 5V logic supply available for external potentiometer (10mA Max)
- ❑ Status/Mode/Power LED
- ❑ Industry standard 0.1” (2.54mm) Gold Plated Connectors
- ❑ Current position register +/- 100,000,000,000 steps
- ❑ Home and mark position registers
- ❑ Absolute and relative move commands



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1.2 Operating Modes

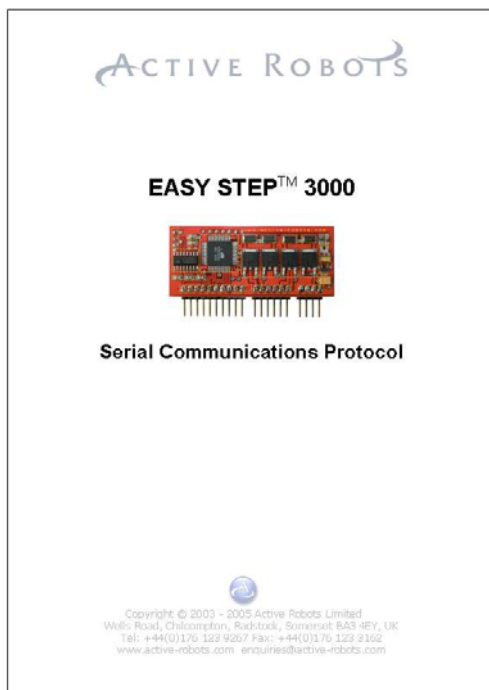
The ES3000 has 4 operating modes and with the Professional (Pro) version the ability to store and replay up to 25 sequences, each having control over direction, pull in rate, max step rate, acceleration and dwell.

The 4 basic operating modes are:

- ❑ PC mode using embedded Command Set (could also use a microcontroller)
- ❑ Slave/Remote mode (PIN control mode – using IP1, IP2, IP3 & IP4)
- ❑ Voltage Mode (IP5, 0 to +5V analogue voltage)
- ❑ Teach Mode (pro-version only,)

In PC/Micro mode, commands are issued to the ES3000 to set certain parameters such as pull in rate, max step rate, mode etc. **All modes** except Teach are remembered through a Power down/Reset.

The serial protocol for the various commands is fully covered in the document named “Easy Step™ 3000 serial communications protocol” (front cover shown below).



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1.3 Hints and tips – Common problems

1.3.1 Continuous holding torque

It's OK to leave the motor power on in the stop state for long periods. The PCB is fitted with a suitable heatsink.

1.3.2 Logic Supply Voltage

The logic Supply for the ES3000 is a minimum of 6Vdc, and no more than 20Vdc. The unit may appear to function correctly with lower voltages but several obscure problems arise if it's too low.

1.3.3 Documents

Please take some time to read this manual before launching off and plugging things together.

1.3.4 Step Rates

You may find that steps are being lost or the motor stalls, there are several reasons for this, the most common is that the step rate is too high for the motor, large stepper motors have very low step rates (Forcing resistors can be used to increase the step rate of the motor).

If you are using a very small motor (i.e. Sanyo 103-4902-0650) then you may find that the start step rate needs to be **increased**, many small motors do not function properly at slow step rates, if you need to step slowly with a small motor then try using 'half step'.

The latest version of the PC program; **Easy Step™ ISP 1V29**, has in the main splash screen, a tab that allows you to choose a motor type (Setup > Select motor type>). Six popular types are available and once selected the **default start and step rates are automatically** altered (in PC and Teach mode) to match the motor characteristics.

Maximum step rates can be manually calculated as follows:

A motor has the following characteristics: 1.8° /step (or 200 steps per revolution), 3.3 Ohm phase resistance and a phase inductance of 3.4uH. To calculate the maximum step rate, assuming we have a need for 85% motor torque and given that 2 Time constants = 85% torque

Two Time constant in ms = 2 * (3.4/3.3) = 2.06ms per step
Max step rate = 1S / 2.06ms = 485 steps per second



1.3.5 Pro-mode replay using IP3 and IP4

Both these inputs replay stored sequences (programmed in Teach mode), IP3 replays all the memory in one go, IP4 replays it one sequence at a time.

Imagine you have 10 sequences stored in memory and you have been working your way through them using the IP4 pin and you are now at sequence number 8 (with only two more to go), at this point IP3 is triggered and all ten sequences automatically replay (starting at 1 not 9), what happens when IP4 is next triggered? It will start from 1 and not carry on from 9.

With the above in mind we recommend that you use only one of the replay options on a particular application as using both together is not the design intention.

1.3.6 Industrial Interface - ES3K IND INT

An Industrial interface is available from Active Robots for the Easy Step™ this makes connecting wires easy and also adds a whole range of safety features. This allows the unit to be operated in a commercial/factory setting reliably (the spec. is on Active Robots web site).

Have a look at the industrial interface user guide, there are some useful circuit diagrams there.

1.3.7 Stepper Motor development system - ES3KDS

A stepper motor development system has been designed primarily for educational purposes but is suitable for the hobbyist too. The development system has many features (air cooling, switch mode PSU, square wave oscillator etc) it's best to have a read through the ES3KDS user guide to get an overview.

The ES3KDS also makes an ideal tool to test and determine a motors inherent characteristics. The user guide also contains several circuit diagrams, including one for a switched mode power supply.



2 EASY STEP™ 3000 Pin Out Data

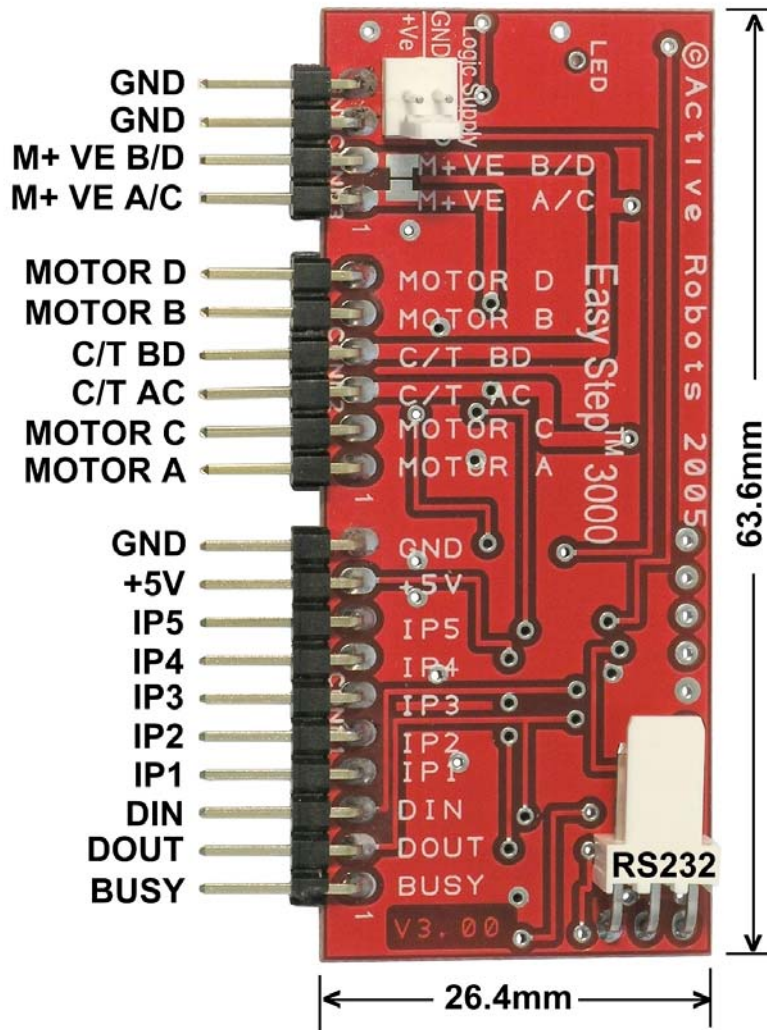


Fig. 1 Easy Step™ 3000 - PCB and Pin Names

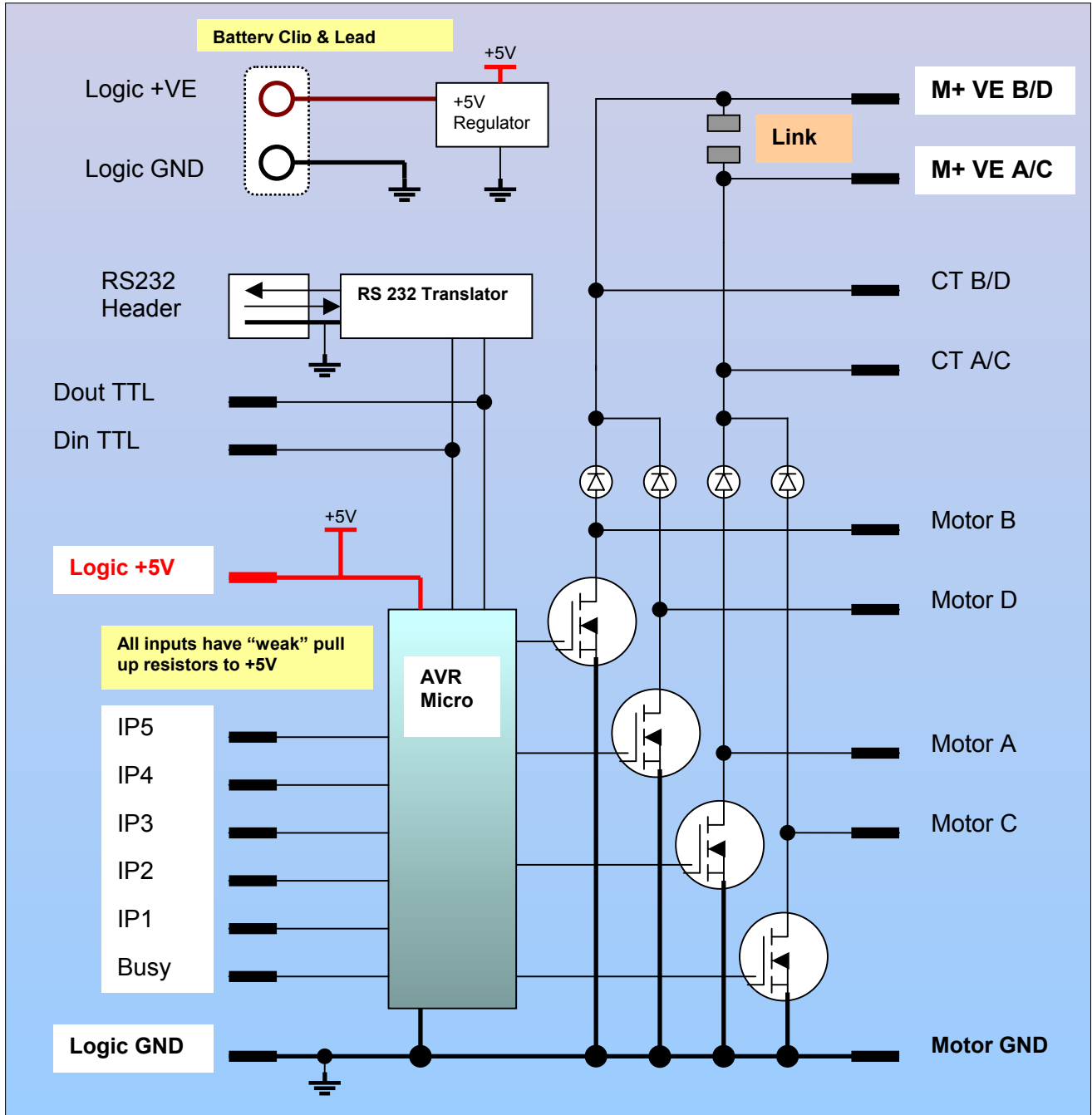


2.1 Pin Descriptions

PIN Name	Description
GND	Motor Supply Input – (Double) Common Ground Connections
M+VE B/D	Motor Supply Input - Positive B-coil
M+VE A/C	Motor Supply Input - Positive A-coil
MOTOR D	Output to Motor Phase coil D (Negative)
MOTOR B	Output to Motor Phase coil B (Negative)
C/T BD	Output to Common Phase coils BD (Positive)
C/T AC	Output to Common Phase coils AC (Positive)
MOTOR C	Output to Motor Phase coil C (Negative)
MOTOR A	Output to Motor Phase coil A (Negative)
GND	Logic Supply – Common Ground Connection
+5V	Logic Supply +5V Output for Potentiometer
IP5	Analogue Voltage Input (0 to 5V). This input has a “weak” pull-up resistor to +5V
IP4	Digital Input, Replay one sequence at a time (logic1-0-1) in Slave mode.
IP3	Digital Input, Replay all sequences (Logic 1-0-1) in Slave mode.
IP2	Digital Input - Direction select Control, in “Remote/Slave” mode (used in conjunction with IP1- clock input) Logic “0” = Counter Clockwise, “1” = Clockwise Select.
IP1	Digital Input - Step Input. Each “1” to “0” transition causes the motor to rotate by 1 step (or ½ step in Half Step mode)
DIN	Serial Comms Data Input (TTL)
DOUT	Serial Comms Data Out (TTL)
BUSY	Digital Output signal, ES3000 busy status; 1= Ready, 0=Busy

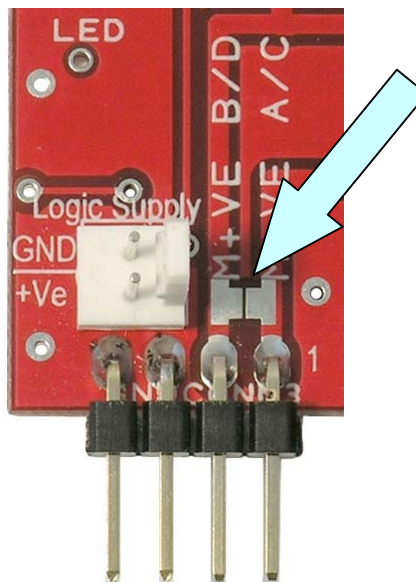


2.2 ES3000 Block Diagram



3 Getting Started

If you are using a single **motor** power supply, link the 2 pads just above the power supply pins marked M+VE B/D and M+VE A/C as shown below:



3.1 Easy Step™ ISP

EASY STEP ISP is a PC based program that allows the ES3000 to be controlled and configured (via a serial comms link), the program is intuitive to use and most buttons and boxes have tooltips (text boxes that flash up when the mouse is over an area of interest) to tell you what they do.

You should take the time to read the *EASY STEP™ 3000 Serial Communications Protocol* document, this explains all the functionality of the ES3000 command set.

3.2 Software Revision Guidelines

EASY STEP ISP is issued with a version number (it's on the splash screen when first run) and this must be compatible with your ES3000 PCB. The Document control information at the start of this document, advises on the compatibility of this document for use with different software issue versions.

Check software compatibility on the Active Robots website forum should you be in doubt.

3.3 Connecting a motor

We will use as an example the [Sanyo Denki H546](#) stepper motor, the colours indicated in Fig.2 are for this motor. You can purchase the Motor from Active Robots with a pre-wired connector suitable for use with the ES3000 motor pin connections (available on request).

The supply voltage for this motor is around 5VDC (You could power it from a 4*AA Ni-MH battery pack, which will give about one hours continuous use).



ES3000 Connection Diagram

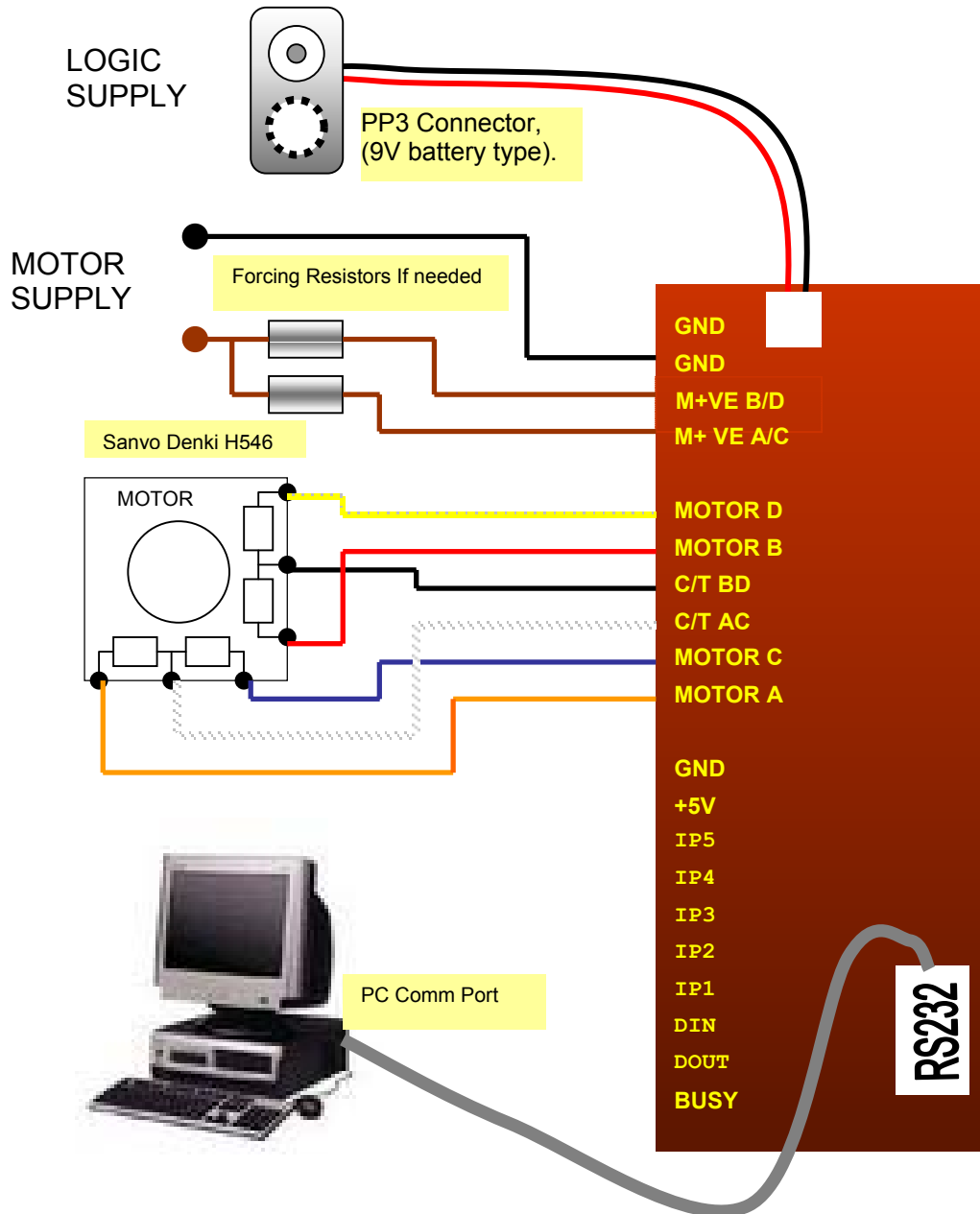


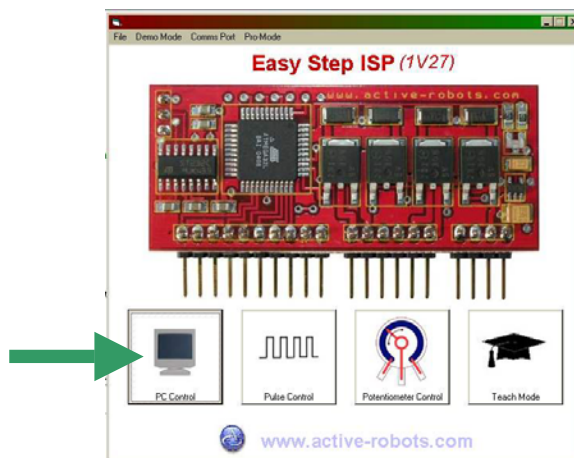
Fig.2 ES3000 PSU and Motor Connection Diagram



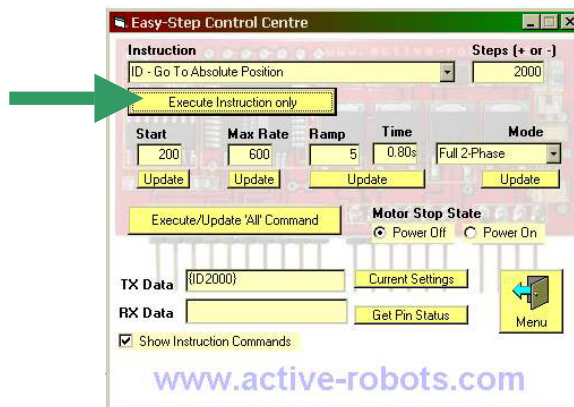
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1. Install the program; "EASY STEP™ ISP" on any PC running Windows 98 to XP.
2. Connect the RS232 cable to a COM port (1=default) on the PC and the ES3000 PCB.
3. Run EASY STEP™ ISP.
4. Apply power (DO NOT EXCEED 35V) to the ES3000 board (ENSURE CORRECT POLARITY).

The on board indicator LED should now be Green.



5. Click on the 'PC Control' Button



6. Then Click on '**Execute Instruction only**', and the motor should rotate 5 times in the clockwise direction. If you click again the motor will not move as this is the 'go to Absolute position'. Try selecting go to relative position and the '**Execute/Update All Command**' button.



4 Stepper Motor Basics

In order to understand the operation of the ES3000 you need to know the basics of stepper motors. This section is a useful reference.

4.1 Step Angle

Motor Data sheets state the 'Step Angle' of a motor, our example motor has a step angle of 1.8° / Step. This means to achieve one rotation would require;

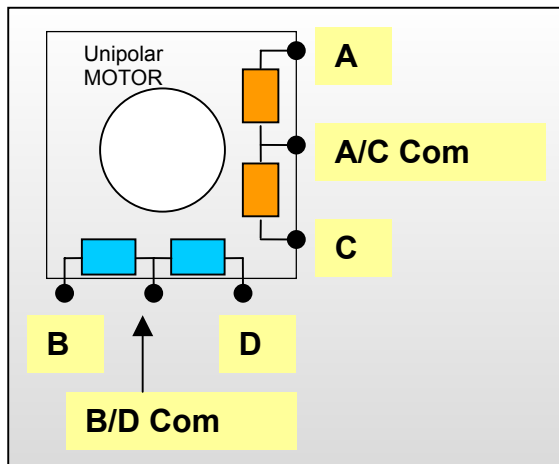
$$360^\circ / 1.8^\circ = 200 \text{ steps}$$

4.2 Step Rate

If we had a Step Rate of 600 then for our motor (1.8° step angle) this would mean;
 $600 / 200 = 3$ revolutions per second

4.3 Step Sequence

The ES3000 is designed to drive Unipolar motors, these have 4 coils. The coils are grouped in pairs, often referred to as 'A' and 'B', thus they are commonly called - 2 Phase Motors.



However if we were to look at terminals 'A' and 'A/C Com' these are also referred to as a phase coil – although in fact they are half the total winding.

Where a motor spec. sheet says for example 3.3Ohm and 3.4uH (for our motor) this is regarding this coil section only i.e. A to A/C Com and not from A to C.

To make a stepper motor rotate these coils have to be powered in a set sequence.

There are several sequences available for a Unipolar motor and these are; **Full step 2-phase**, **Full step 1-phase** (sometimes called *Wave mode*) and **Half step**. As the names suggest Full step means stepping at the specified Step Angle (see 4.1), Half step means stepping at half the Step angle, or for our motor this means 400 steps per revolution (that means a doubling the stepping resolution).

It is possible to 'Micro step' this means multiplying the motor resolution by some factor (typically of 128 or more), thus phenomenal rotational positional accuracy is possible, however micro-stepping is not available on the ES3000 product, but is available on higher models.



4.3.1 Full Step 2 Phase, Sequence (CW- Clock Wise motion)

Sequence Number	A	B	C	D
1	1	1	0	0
2	0	1	1	0
3	0	0	1	1
4	1	0	0	1

4.3.2 Full Step 1 Phase (Wave Mode), Sequence (CW- Clock Wise motion)

Sequence Number	A	B	C	D
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

4.3.3 Half Step, sequence (CW – Clock wise)

Sequence Number	A	B	C	D
1	1	0	0	0
2	1	1	0	0
3	0	1	0	0
4	0	1	1	0
5	0	0	1	0
6	0	0	1	1
7	0	0	0	1
8	1	0	0	1

4.3.4 Counter Clockwise (CCW)

If the step sequence of the above truth tables are reversed (i.e. starting from 4 [or 8 in half step] running down to 1) then the motor will run in reverse – or counter clockwise (viewed from the front of the motor).



4.4 Holding Torque

Holding torque (or static torque) is the torque with the motor at rest **being supplied with the rated** current (our example motor has a holding torque of 0.37Nm at 1.2A phase current).

4.5 Detent Torque

Is the torque with the motor at rest but with **no** current flowing.

4.6 Pull-in torque Curve

This is the speed (step rate) a motor can start, stop or reverse and still stay in synchronisation with motor drive pulses with a given load, greater loads require lower start step rates. Motor manufacturers may supply a graph of this property.

If synchronisation is lost then the motor will not be able reach its assigned position, and there will be no way to know how far it has rotated without using some form of rotational sensing feedback (i.e. limit switches).

4.7 Start Stop region

This is the region under the Pull-in Torque curve where a motor can be started/stopped or reversed at will. Even so there are certain small areas where the motor is unstartable/unrotatable – the motor manufacturer will highlight these in their Torque-Speed curve charts.

4.8 Pull-out Torque

This is the boundary for motors maximum speed for a given load. Beyond this and the motor will stall or loose synchronisation.

4.9 Slew-range

This is the area between Pull-in and Pull-out torque, where the motor must be ramped up slowly. Typically a motor is started in the 'Start Stop region' and then ramped up to near the 'Pull-out' torque limit.

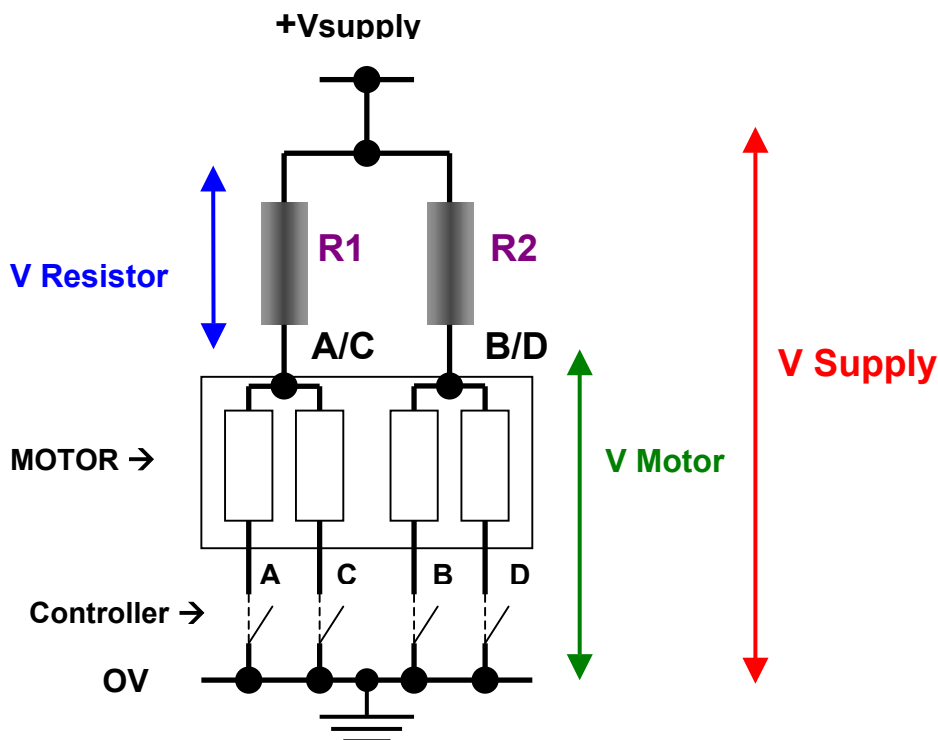
If the motor is ramped too quickly then inertia may cause loss of synchronisation.



4.10 Forcing Resistors

Are used to increase the maximum available step rate for a given motor.

Below is an example of how to calculate the value resistor you need for a **12V Supply**, we will use our example **1.2A/Phase 3.3Ohms/Phase** (The ES3000 has separate power supply inputs unipolar phase coils, so two forcing resistors will be needed)



- Calculate motor Voltage; **V Motor** = $1.2A * 3.3Ohms = \underline{4V}$
- Calculate **V across R1** = **V Supply** - **V Motor** = **8V**
- Calculate **R1** = $(12V - 4V) / 1.2A = \underline{6.6 Ohms}$
- Calculate **R2** = R1 = **6.6 Ohms**
- Calculate Wattage for R1 = $(8V * 1.2) / 2 = \underline{4.8 Watts}$ (also same for R2)
- Practical Value 6.8 Ohms (6R8). Actually a motor can be driven to 140% of its rated current so you could go as low as 4 Ohms. Active robots supply a 5R4 resistor for this motor.



4.11 Torque Speed curve graph example

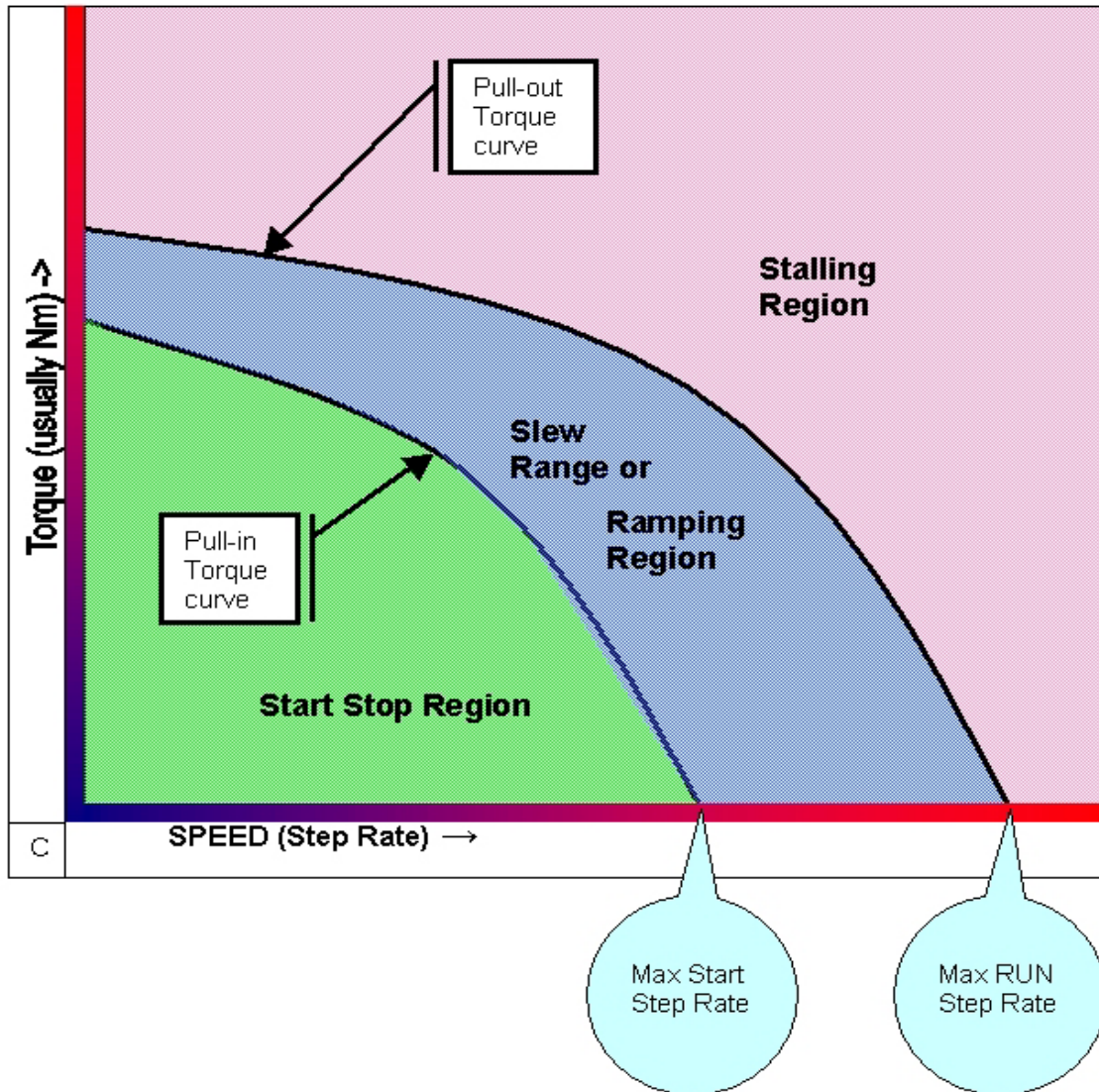


Fig.3 Speed Torque Curves





5 Easy Step™ ISP - Terminology Summary

5.1 Absolute Position

When the ES3000 is first switched on the resting state of the motor becomes the absolute position zero. Absolute position zero is the Home position. Move Absolute will move to a position that is the number of steps specified from the home position.

The ES3000 remembers every step made and keeps adding or subtracting as necessary from its internal counter - Current position register +/- 100,000,000,000 steps.

It is possible to read this register if needed, by issuing a {CU} command –see ES3000 command and protocol document.

5.2 Home Position

When you change the home position after the motor has moved, then this becomes the new home position also absolute position zero changes too. In fact goto absolute position zero and goto home position do the same thing.

5.3 Mark Position

This works like a second home position. There is no relationship between the absolute position counter and mark position.

5.4 Inputs as Stops

This refers to hardware input pins IP1 and IP2, these are 'weak' pulled to +5V (technically referred to as; Normally High), if you connect them to GND (through a switch for example) then the onboard microcontroller on the ES3000 will see this and action it (there are 5 pin command actions available on the ES3000).



6 Easy Step™ 3000 – Basic Operation

6.1 Move Absolute

Move Absolute will move to a position that is the number of steps specified from the home position, this move instruction can be issued with or without stops based on pin conditions.

6.2 Move Relative

Move Relative, always moves the specified number of steps relative to the **current** position, but maintains the position register allowing Absolute, Home and Mark position moves to be accurate and consistent.

6.3 Mark Position

The ability to set a mark position allows 2 'end' positions to be set which can be moved to by the issuing of a single command, all Absolute move commands operate on the Home position even if the last move you made was to the Mark position; Relative move will always just be relative to your current position.

6.4 Full to Half step positional Integrity

Changing modes from Full Step 2-phase to Full Step 1-phase mode will have no effect on the position registers, however, if you change from full to half or back again, in order to maintain positional accuracy, the software will double the number of steps from the home location when changing to half step mode as twice as many steps are now required to return to the home position. When changing back to full step mode the reverse is carried out and the current position register halved, before changing modes, to maintain positional accuracy completely, it is necessary to ensure the number of steps is an even number or else one half step will be lost (0.9 degrees with a 200 step motor).

It's best to decide what mode you are going to use (half or full), and stick to that.

6.5 Move Commands & Acceleration

The Pull in Rate, Max Step Rate and Ramp Factors are constantly used values, unless you change them, previously stored rates will be applied to all move commands.

If the number of steps to allow full acceleration/deceleration to take place are not available then at the mid point of the move instruction the acceleration will change to deceleration, the motor stopping at the correct location.



6.5 Move Commands – affect of Pin inputs

If using the pin commands in **PC mode**, where movement is stopped by taking one of the **hardware control pins low** (IP1 and IP2 are used for pin control in PC mode only), then, when the pin goes low, the motor will start decelerating, so it is important if setting the home or mark positions to keep the pull in rate, max step rate and acceleration time low to allow the motor to stop quickly.

i.e. in the 'start stop' region – see the green part of the speed/torque graph in figure three, Page19.

6.6 Ramp Factor

The ramp factor is one of the variable factors within a formula that is used to calculate acceleration and deceleration of the motor. The higher the number the longer the acceleration/deceleration times will be. *Start Step Rate* and *Step Speed* settings are also factors that affect timings.

Start Speed	Step Speed	Ramp Factor	Acceleration Time (Secs)
100	500	0	2s
100	500	1	2.8s
100	500	5	5.5s
100	500	10	9s
200	600	0	0.5s
200	600	10	2.5s
200	600	50	10s
200	600	100	18s

Ramp Factor chart

It should be noted that a high ramp factor causes very slow acceleration, this can cause the number of steps to "run out" before full speed is reached and thus the motor will slow down again without reaching full speed.

Say for example you only wanted to move two hundred steps (1 rotation with 1.8° motor) but the ramp factor meant an acceleration/deceleration time of 20seconds then the motor would hardly increase above the start step rate.

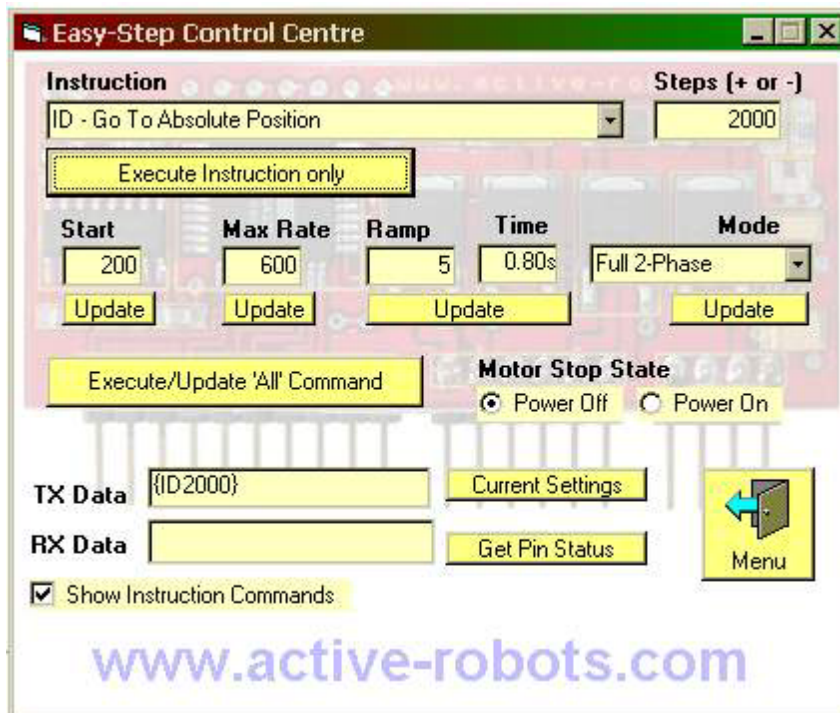
The 'Easy Step 3000 ISP™', program displays the **deceleration time** in a box next to the Ramp Factor entry box.



6.7 Motor Stop State

If the motor is not loaded in its stop position, it is always better to stop with the motor power off option selected. This will turn off power to the motor when the current operation has finished.

The default motor stop state is [off](#).



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7 PC Mode/Pin Controls

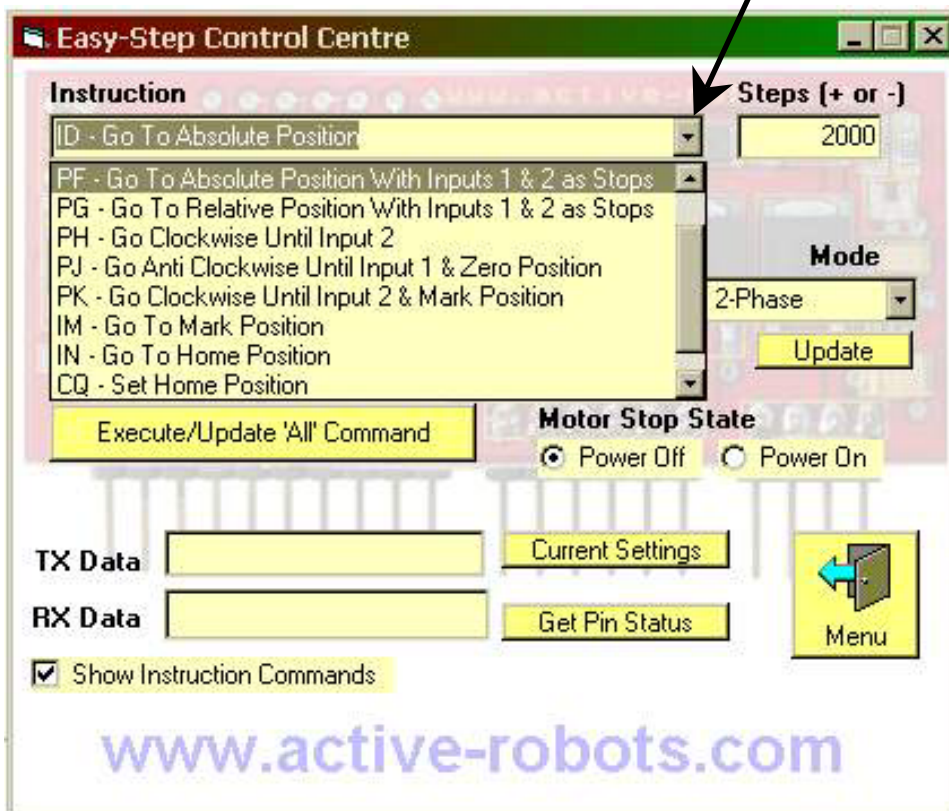
Pin control is used in conjunction with the serial interface control program 'ES3000 ISP'. You can run this program on your PC and issue the Pin Commands (you need to have the ES3000 connected to a serial port on your computer and be in PC mode. The program has options to change the comms port if Comm-1 is not available.

First Click on the PC Mode Control



The Easy-Step Control Centre then opens.

Click on this drop down options box to reveal the Inputs options, the (Px) commands



7.1 Pin Control Options

Five options are available, these are;

1. {PF} Goto Absolute Position with inputs 1 and 2 as stops
2. {PG} Goto Relative Position with inputs 1 and 2 as stops
3. {PH} Go Clockwise until Input 2
4. {PJ} Go Anti-clockwise until Input 1 and Zero Position Counter
5. {PK} Go Clockwise until Input 2 and mark position

7.2 Pin Control Example

By way of example, try using no.4 - {PJ} *Go Anti-clockwise until Input 1 and Zero Position Counter.*

You will need to connect a flying wire to the common ground (any of the GND pins).

Go in to the easy step control centre screen and select the option **PJ...**, then click on the 'execute/Update all commands' button.

At this point the motor should start and continue rotating CCW (counter clockwise).

Now take the flying wire and touch **IP1** and the motor should stop. Also note that the home position has changed, so this new position has now become the new 'absolute position zero' or home position.



8 Remote/Slave Mode

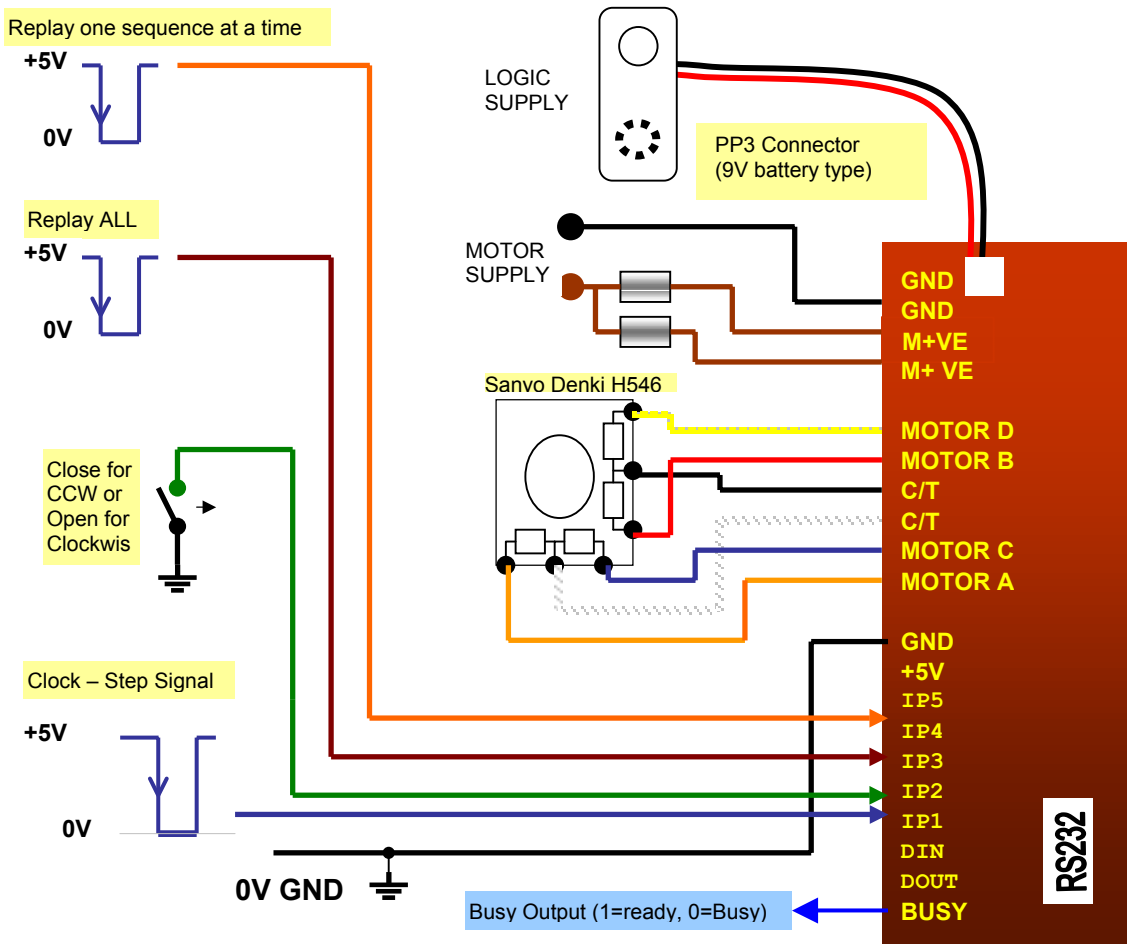


Fig. 4 Remote/Slave or Pulse Mode Connection diagram

This mode is selected by clicking on



In **remote/slave mode** the ES3000 accepts commands on the IP1 IP2 IP3 and IP4 pins. Once selected this mode is remembered through a power down/Reset.



8.1 Comms during Slave mode

It is also possible to still send serial information, however, transmitting serial information when stepping (depending on step rate and length of instruction) may cause the Easy Step to delay a step. Under normal operating circumstances, it is best to only issue exit remote/slave mode commands.

The **busy** signal output pin could be monitored to determine when the ES3000 has finished moving the motor, the convention is; 1= Ready, 0=Busy (where 1=5V and 0=0V)

8.2 Slave mode IP1 & IP2 - Clock-step waveform

Applying a pulse (1-0-1, where 1=5V and 0=0V) to IP1 will cause the easy Step to increment the position counter and step the motor **once**, clockwise if IP2 is High, Counter clockwise if low. This mode is very useful if you want to control the stepper motor from another Micro allowing a simple single pulse to step the motor.

In order for the pulses to be detected they must be at least 100uS (or 10KHz square wave) and symmetrical. Non symmetrical waveforms are acceptable as long as the times between negative edges are at least 100uS. In practice stepper motors are limited to about 1KHz which is well within the limits of the ES3000.

NOTE

IP1 and IP2 can also be used as pin controls when replaying (using IP3 and IP4), for example you could replay the stored command 'Go Clockwise Until IP2', IP2 will now work as a stop when pulled low, it will then return to its normal function (CW/CCW control).

8.3 Slave Mode IP1 & IP2 - Motor stop state

The LED on the ES3000 board will be Red when in remote/slave mode.

8.4 Slave Mode IP3 & IP4 – Replay Stored teach mode commands

When the ES3000 has learnt sequences in teach mode then these sequences can be replayed by software command or by toggling (logic 1-0-1; the 1-0 edge triggers the action) input pins IP3 and IP4.

IP3 replays the entire replay memory (up to 25 stored command sequences).

IP4 replays the sequences one at a time, the time between each is determined by how often IP4 is toggled.

Both IP3 and IP4 use a wrap around system, so that once the last command is reached then the process repeats again – starting with the first stored command again.

We recommend that you only use one of these (IP3/4) controls in your application [see section 1.3.5](#)



9 Voltage Mode

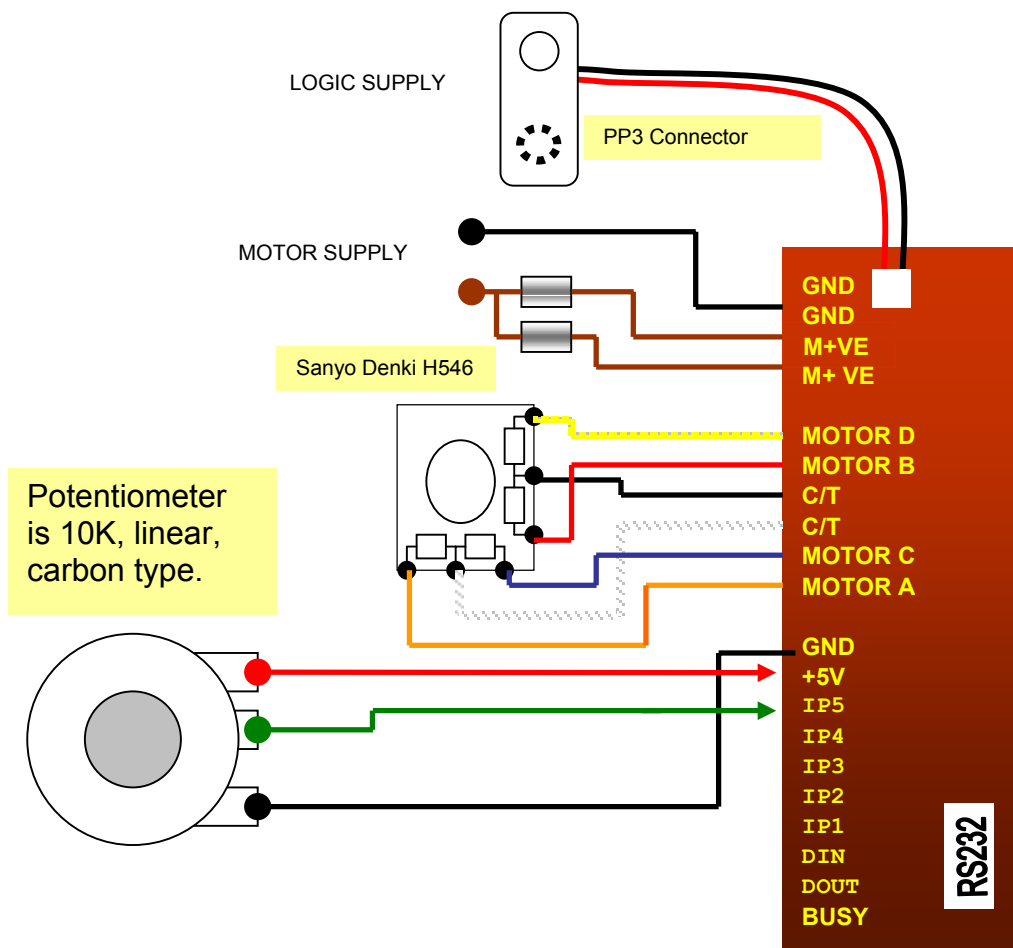


Fig.5 Potentiometer control connection diagram

To select Voltage mode click on this button



In voltage mode, the input voltage on IP5 is measured. If you are going to supply a voltage via your own circuit it is important **not to exceed** the Logic Supply (+5V) as permanent damage may occur to the ES3000.



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9.1 Voltage Modes

There are 3 voltage modes which can be selected in ES3000 ISP.

Mode 1

The analogue voltage is used to mimic a potentiometer movement, i.e. the motor will turn through approximately 270 degrees following the movement of a potentiometer connected to IP5, +VE and ground (assuming a standard potentiometer is used).

Mode 2

The motor will mimic the movements of a potentiometer but with much greater movement, the rotation of the pot will be amplified allowing about 3 turns of the motor for 270 degrees of pot movement.

Mode 3

Allows for continuous rotation of the motor in either direction with a **centre off** point. If the pot is in mid track the motor will be stationary, moving away from the centre point will cause the motor to start turning, the further from the centre point the greater the motor speed.

5V = maximum CCW speed

2.5V = at rest

0V = maximum CW speed

Notes on ES3000 Reset

All Voltage type modes will use the 'Maximum Step rate' and motor 'stop state' setup in PC mode; **however** after a Power up/down cycle the ES3000 will **revert back** to factory default settings, the motor stop state will be '**power off**' and the maximum step speed will be **400** (this was chosen to give accurate tracking of a standard potentiometer being rotated manually).

General Advice

Rotating a pot quickly with a heavily loaded motor attached and a high maximum step rate may cause loss of position.

If long leads are being used to connect the ES3000 to your potentiometer you may find a 10V 22uF capacitor between GND and the centre wiper will help reduce interference.



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10 Teach Mode

Teach mode is used to program the ES3000 with a sequence of commands that can then be 'replayed'. *Only the Pro version has the capability of teach mode.* Teach mode is not remembered through a power down/Reset; after a reset (in teach mode) the unit will assume PC Mode.

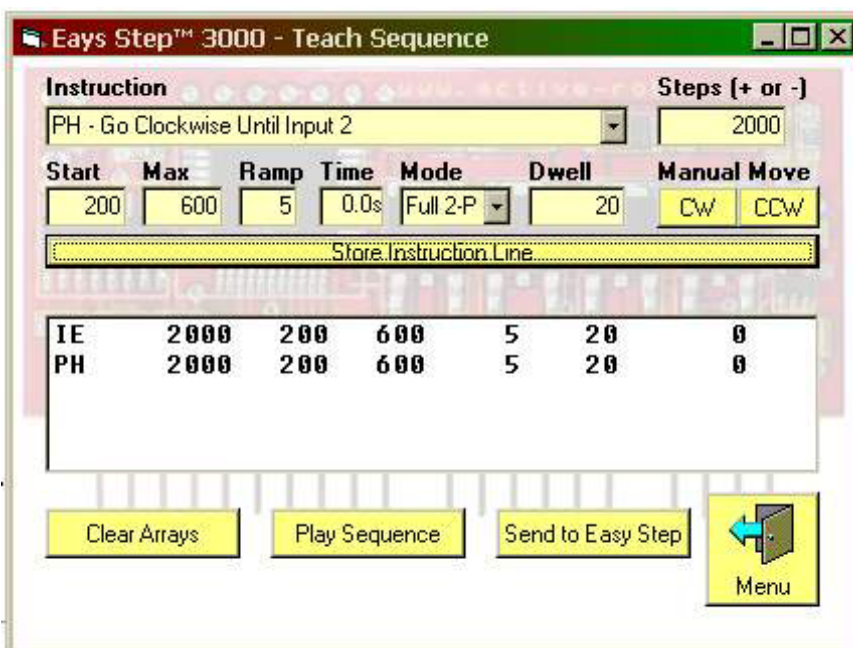
To Enter Teach Mode click on this button



The ES3000 can be programmed with up to 25 sequences, a sequence is any of the commands that are available in the protocol. There is one extra feature, and that is the addition of a dwell time. The dwell time allows pauses between the commands.

These features make the Easy Step 3000 a uniquely versatile device allowing it run autonomously for indefinite periods of time while carrying out complex routines.

The best way to get to know about 'teach mode' is to actually try it out, using the ES3000 ISP program. The teach mode screen is shown below.



Note You can also replay using IP3 and IP4 see section 8.



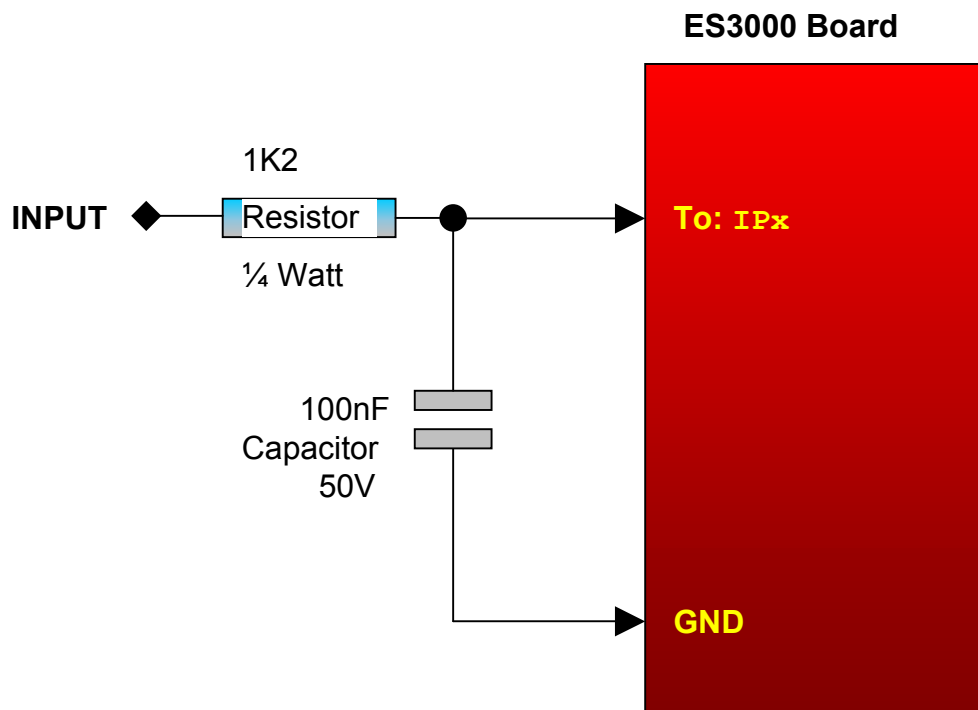
11 Mode Summary Table

MODE	Description	Mode Remembered through a Reset	Demo mode possible
PC Mode/ Pin Control See Sect. 7 Page 24/25	Serial commands (RS232) are used to control the unit. Some commands such as ' <i>Go Clockwise Until IP2</i> ' work in conjunction with the hardware input pins	Yes	Yes
Slave Mode See Sect. 8 Page 26/27	Clock and Direction inputs active (Clock=IP1 Direction=IP2). Previously stored commands can also be replayed (using IP3/4) While replaying using IP3/4, the other inputs; IP1/2 can have an alternate function i.e. ' <i>Go Clockwise Until IP2</i> ' will use IP2 as a stop pin, as soon as the command has finished it will revert back to it CW/CCW direction control function.	Yes	No
Pot/Voltage Mode See Sect. 9 Page 28/29	Selectable 270 or 720 degree potentiometers used as a control. In voltage mode 2.5V = still <2.4 - 0V = CW >2.6 - 5V = CCW	Yes	No
Teach Mode See Sect.10 Page 30	Pro-version ONLY UP 25 PC Mode Serial commands can be stored. These are replayed in Slave mode (IP3 & IP4). They can also be replayed in teach mode via software commands.	No	No



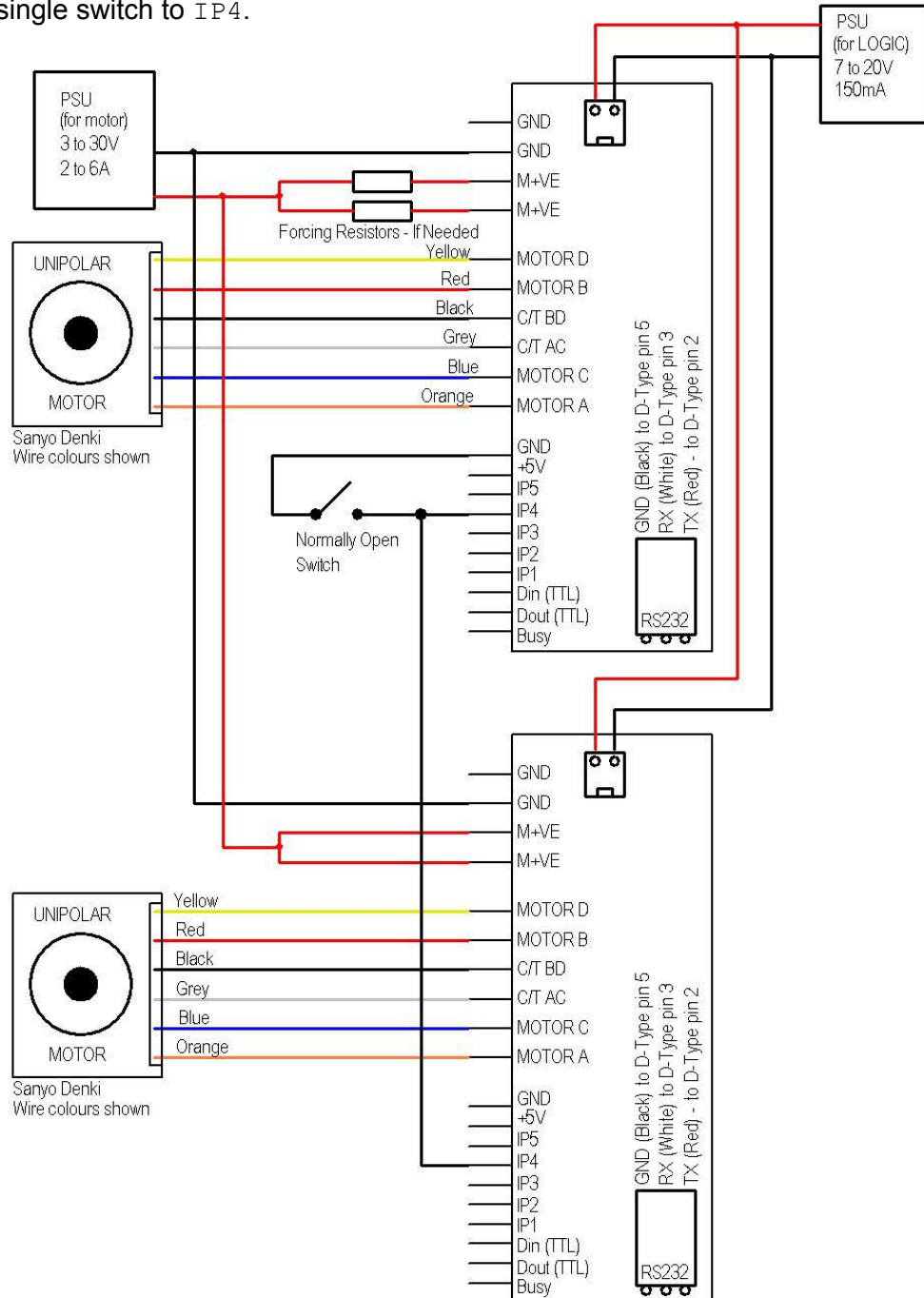
12 Circuit – Input protection and filter

Below is shown a simple protection circuit for use with IP1 through to IP5 and the Busy O/P. Although simple it does give good protection against the human error that occurs when connecting up circuit boards! One circuit is shown, duplicate as needed.



13 Circuit – Multiple Modules

This circuit shows two modules in an application where they share a power supply and are both triggered with a single switch to IP4.



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NOTES

END OF DOCUMENT.



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