



TEKdrive™

Technical & Operations Manual

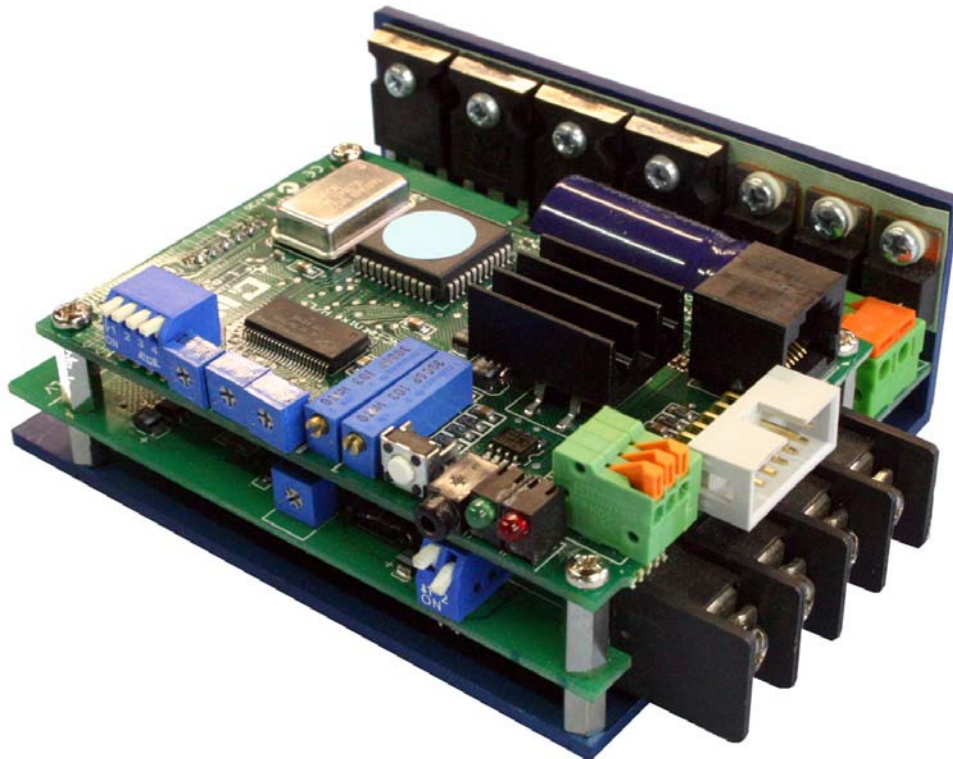


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Preface

Thank you for purchasing one of our CNC Servo Drivers, we trust that this installation will be an easy procedure for you and that your machine will be up and running your very quickly. Please visit our web site, www.cncteknix.com email our support team technical@cncteknix.com or call us on 61 2 4257411 if you experience difficulties.

Parts Supplied

Upon opening your CNC carton, please ensure that all the following parts are present and undamaged.

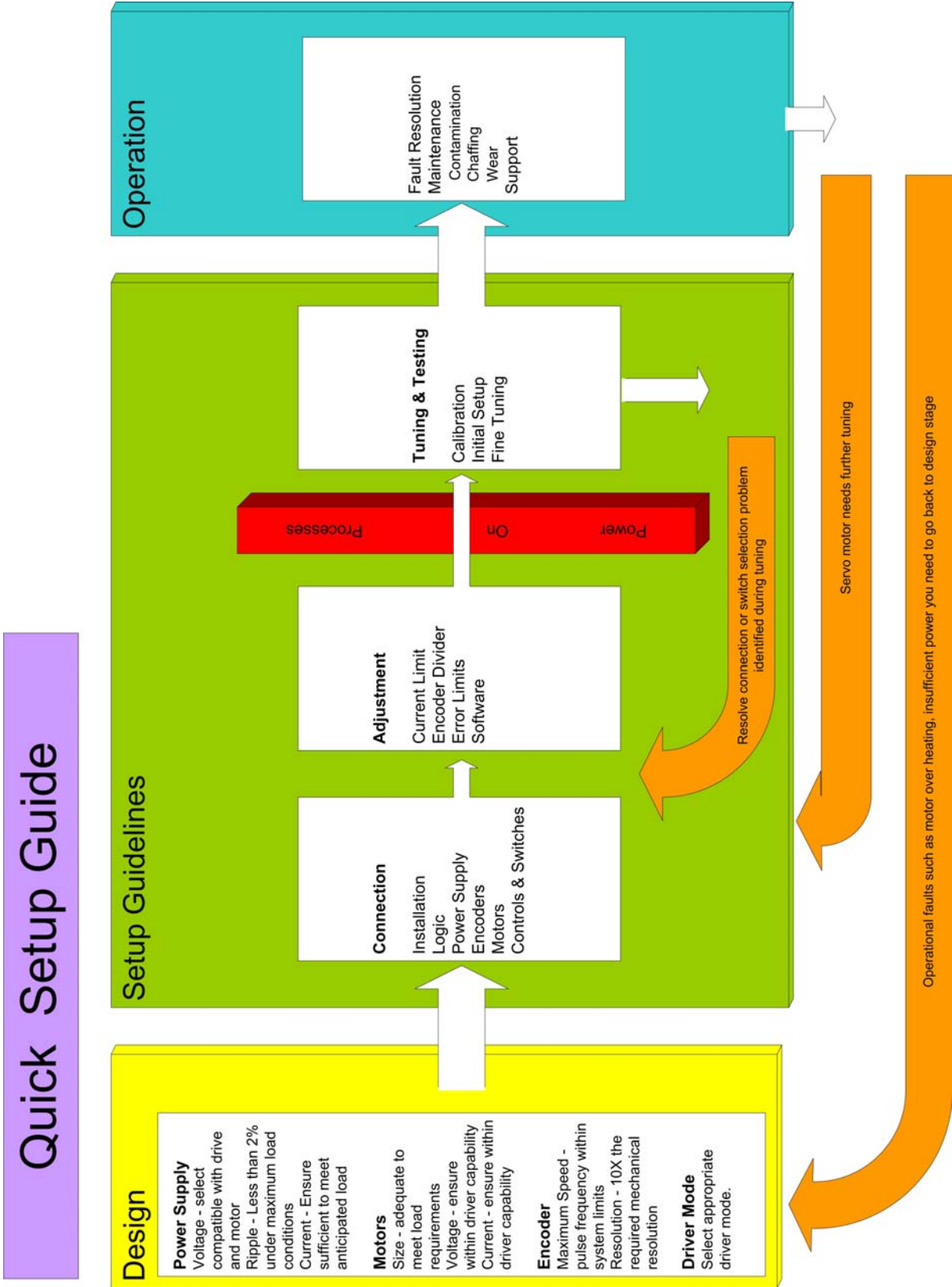
- CNC Servo Driver
- Technical and Operations Manual?

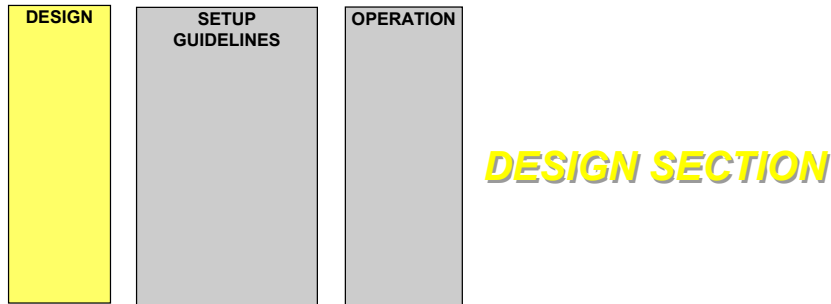
If you have ordered any other parts with your driver please ensure they are also enclosed. Contact CNC Teknix **immediately** if parts are missing or appear damaged.

CAUTION!

Your CNC Driver has been pre-tested at the workshop prior to shipping, so it should be pre-set with the basic settings. Please read this manual carefully to ensure it is hooked up correctly before powering it up for the first time.

QUICK SETUP GUIDE





D1. Introduction

The design of a CNC control system must accommodate many factors. This section of the manual aims to highlight some of the main considerations and outline possible solutions. There are also many resources available on the web which might be helpful during the design phase. In particular the CNCZone.com web site has many links and forums which will assist you in designing your CNC system.

The design phase should (ideally) begin before you purchase anything. In practice you often have some pieces of equipment before you start a CNC conversion. You may have the machine and lead screws or the motors. One purpose of the design phase is to determine how the various pieces will come together in order to build a working system. You may need to go around this loop several times to get it all together. If you determine that bigger motors will be required this may mean a larger power supply etc. If you calculate that you need 325PPR encoders and then find you can only buy 300 or 400 PPR encoders that is fine. You want things in the ball park. The detailed setup of the machine will enable you to fit the as purchased hardware to the controlling software and fine tune the details.

Design is about getting the broad scale of things together. Some experimentation and changes may be required along the way.

D2. Power Supply

To provide power for the motors, connect a power supply with a DC voltage suitable for the motors you are using, and a current output sufficient to power all the motors. The best power supplies for motors include a basic transformer with rectifier and capacitor, switch mode supplies are not always suitable due to the fast switching demand of the motor drives.

If you have also purchased your power supply from us it will be correct and ready to connect to the terminals on the side of the driver. If you are planning to build your own the following formulas may prove useful:

D2.1 Transformer Voltage Rating

The transformer should have a secondary output voltage 0.717 times lower than the DC voltage required for the motors, ie. If your motors require 65VDC your transformer secondary voltage should be no more than $65 * 0.717$ or 46.6VAC.

D2.2 Transformer Current Rating

The current rating should be large enough to handle all motors running at full power simultaneously. If you have a 3 axis system with each motor drawing a maximum average current of 10A, then the transformer secondary should be capable of delivering at least 30A. Note that the servo driver has an adjustable peak current limit. Average continuous current will be 20 to 60% below this value depending on your motor, torque and acceleration setup. Conversion of AC to DC does lower this current, as it also raises the voltage, but with a large filter capacitor it should still be sufficient. If in doubt it is better to get bigger rather than smaller.

D2.3 Rectifier

Rectification can, in most cases, be a standard bridge rectifier, so long as the current rating is not exceeded. If the total current draw is in excess of 25A then it is much better to make up a rectifier using large stud diodes. If you do not have any experience in electronics then it is advisable to seek help in making up this rectifier.

D2.4 Capacitance

The power supply needs enough capacitance to control the ripple voltage to under 2% at maximum load. A capacitance (C1) value of this should be such that it provides at least 1,000uF (2,000uF recommended) of capacity for every 1 Amp of current draw, so if your motors draw a total of 25A then you will need a capacitance of at least 25,000uF. This can be one large capacitor or 2 or more smaller capacitors connected in parallel. Mount the capacitance, power supply, as close to the drivers as possible.

D2.5 Circuit Breaker

The power supply connects directly to the mains thus it is required ,for safety reasons, that you have a circuit breaker in the circuit. You will need one on the input mains supply and, if you want extra security, another on the output to the driver. Remember to specify to your supplier the DC current rating needed.

WARNING!

The power supply should be connected to the two terminals on the right side of the driver.

ENSURE CORRECT POLARITY.
Severe damage will result if it is connected incorrectly.

CAUTION!

Ensure the negative line is the same potential as the logic negative supply.

D3. Motors

D3.1 Size

The motors must be able to generate sufficient torque to overcome friction in turning the lead screw. The cutting load will apply additional torque requirements to the lead screw. The exact load depends on the lead and design of the nut. Torque available above these requirements is required to accelerate the motor and overcome inertia of the lead screw and attached mass. Torque must be greater than the load at all speeds below maximum. Excess torque above the load is available for acceleration. The higher the excess torque the greater the acceleration available. Reduction gearing decreases the motor torque requirements and inertia ratio. Exact calculation of the torque requirement is a specialised activity beyond the scope of this manual..

D3.2 Torque

Estimating the torque requirement can be achieved by using either a small torque wrench attached to the lead screw to determine the starting torque required to begin rotation. A lever and weight can also be used to determine the starting torque. Keep in mind that much of the inertia in a typical machine is from the ROTATING mass of the ballscrew, coupling, bearings, and the armature of the motor itself. The sliding (linear) mass has inertia too, but you'll probably find that the rotating (polar moment) inertia is the big factor. The rotating masses, including the motor armature, act like a flywheel which takes significant energy to accelerate and decelerate. The largest load however is the friction of the moving components, the friction of the sliding mass is usually the greatest but its effect is significantly reduced due to the reducing or gearing action of the screw that moves it. Consequently the major friction component to deal with is the screw. Rolled threads or Acme screws have large sliding surfaces, the friction between these surfaces increases with the load it is driving, Ballscrews however have minimal friction, due to the rolling action of the bearings, which does not increase significantly with the load. The use of ballscrews in CNC design are highly recommended as they reduce the torque requirements and the size of motor required.

D3.3 Power

The motor must also be able to handle the average power input with out overloading thermally. As some part programs may take several hours to complete the thermal load on the motor will cause excessive heating if the motor is not able to dissipate the heat. Check the continuous power rating of the motor is not exceeded. The continuous power output of the Servo driver is approximately equal to the motor drive voltage by 75% of the peak current limit (in watts).

A higher power motor may draw more current than the servo driver can supply under certain load conditions. Peak current for a brushed DC motor occurs when the motor is locked. A 300W, 24 Volt motor may be rated at 12.5Amps continuous but may draw 30 plus Amps with the motor locked. This condition may occur at start up depending on the acceleration settings and inertia of the drive system. Check the stalled motor current limit.

D4. Encoders

D1. Resolution & PPR:

The driver requires quadrature encoder feedback to control the servo motor. Encoders have two channels and are available with different resolutions. On a quadrature encoder each channel generates a given number of PPR (Pulses Per Revolution). The TEKdrive counts each transition of each of the channels, so the effective resolution is four times the given resolution. Select an encoder with the appropriate PPR for your system. The PPR count effects the resolution and speed of the system. Resolution can be calculated as follows:

$$\text{Linear Resolution} = \text{pitch lead screw} / ((\text{PPR} * 4) * \text{Drive Ratio})$$

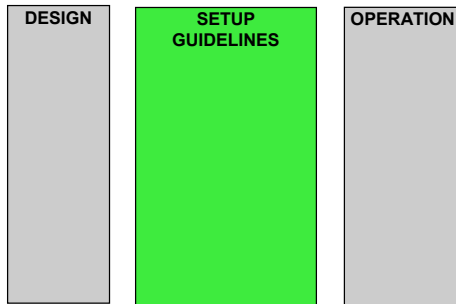
For example if you had 5mm per turn lead screws, 1200PPR encoders and 3:1 drive ratio the resolution would be:

$$\text{Linear Resolution} = 5/((1200*4)*3) = 0.000347\text{mm/step}$$

As a general rule, a resolution of 0.00035mm will deliver an effective resolution of 10 times larger. So this system would perform to a working resolution of approximately 0.003mm or 0.00012 thousands of an inch.

The resolution of the encoder also affects the maximum speed of the motor. The servo driver must be able to read the encoder pulses and the driver must be able to generate enough STEP pulses. Using the above example, 1200 PPR encoder at 600RPM requires a pulse rate of 48Khz. giving a linear velocity of 3000mm per minute. (Encoder resolution * 4 * RPM). For most PC based drivers this would be the maximum pulse rate. The TEKdrive can accept pulses at over 2Mhz giving a maximum speed for this motor of 25,000RPM and this configuration a linear velocity of 125M per minute!. (See Driver Specification-appendix 1 for details) Used in conjunction with the DeskCNC control system (as used in our MultiTEK controllers) with a maximum output of 125,000 steps/sec this would equate to a maximum speed for this configuration of 2.6Metres/min. Higher pulse frequencies sustain high maximum speeds and higher resolution.

The driver can also divide the encoder pulses coming from the encoder by factors of 2, 4 or 8. So a high resolution encoder can be used at lower resolution by using this divide function. So you can err on the side of a higher resolution encoder and divide it later if it turns out to be too high.



SETUP GUIDELINES

S1. Connection

S1.1: Installation

Before connecting any wires to the driver please ensure that the mounting position will dissipate the required amount of heat from the driver for your application. See technical specification at enclosure 1. Also ensure that it is not in a place where it can get splashed by coolant or covered in shavings from the machine.

S1.2: Logic

The servo driver can operate in two modes. The normal mode for axis control uses STEP and DIRection pulses to control the motor. Each step moves the axis a specific small increment as defined by the encoder resolution, gear ratio and screw lead. The driver has an optional alternate mode (VMODE) which drives the servo as a motor using the encoder as a tachometer only. VMODE can be selected during operation so that the motor can move from a spindle function to precise servo control to perform certain operations such as threading or tapping. VMODE should be considered if you require precise control of the spindle of your machine. Further description of VMODE operations can be found in the Driver Technical Specification. Hook up for VMODE is described in the Setup Section of this manual. Use of VMODE will require an encoder with an index signal or the use of a separate index signal connected into the controller as an encoder index pulse.

S1.3 Power Supply

In the design section, you determined the appropriate power supply that would need to operate all the servo motors you are connecting to the driver. Connect the power supply ensuring that the polarity of the connection is correct. Ensure the power supply is appropriately positioned to be clear of swarf and coolant contamination. Position the power supply as close as possible to the driver.

S1.4: Encoders

Either single ended or differential encoders can be used with the TEKdrive, differential encoders being recommended due to their increased resistance to noise. The Encoders are connected via the large RJ45 connector and accepts a standard computer network style connector, any standard computer patch cable can be used, which makes connection to the drive very simple.

The pinout of the connector is detailed later in this document, but if a standard computer patch cable is used there are connector adaptors available for connecting the other end of the patch cable to the encoder, these include:

- RJ45 – IDC10 For Differential encoders
- RJ45 – IDC5 For Single ended encoders
- RJ45 – IDC5 w/RS485 Converts single encoders to differential and connects to the cable

It is important that the polarity of the 5V and Gnd terminals are connected correctly, however the ChA and ChB can be reversed without any adverse effects.

WARNING!
Do not connect the encoder shield to the motor shield.

S1.5: Motors

DC Servomotors have two leads for connecting the power, these are usually coloured red and black, but the colour is not very important. If these are connected the wrong way no damage will result, the motor will just travel in the wrong direction. The cable you use to connect the motor to the driver should be shielded and large enough to carry the current needed by the motor. At the motor end the shield in the cable should be connected to the motor case, and at the driver end it should be connected the chassis ground and the power inlet ground in the driver and is used to ensure all motors remain at the same electrical potential as the driver.

S1.6: Controls & Switches

Limit and emergency stop switches should be connected from the machine to the controller or PC. Limit and/or emergency stop signals could be used by the controller logic to disable the driver under conditions where further motor rotation would cause damage or potential injury. The RUN signal from the driver can be used by the controller to detect driver faults caused by position error or current over limits. If a single driver faults then the controller should command an emergency stop to halt all motion, as further motion of the remaining axis could cause damage to the machine or job.

S2. Adjustments:

S2.1: Current Trip Limit

The current adjust trim pot allows the user to set a current output level at which the drive will trip out. The trim pot gives an adjustment from 0.5A – to one third of the maximum driver current limit (depending on driver model). See enclosed technical specification. This pot sets the maximum current which, if exceeded, will cause the drive will trip out. The two adjacent switches each add another one third of the current output range to the adjustment ie. On a TEK10 with all switches off the pot has an adjustment of 0 – 10A, one switch on adds another 10A to make it 0 - 20A, all switches on gives 0 - 30A.

The four switches at the bottom of the drive allow for the selection of different modes of operation. They are read by the drive processors as the drive is enabled, once enabled they have no further effect (with the exception of SW2 described in the fine tuning section below.) The functions of these switches are:

S2.2: Encoder Dividers

The SW4 switch divides the encoder input by 2, this is useful if the encoder is of a greater resolution than required for this application. Decreasing the encoder resolution allows the motor to run at twice the speed for the same input step pulse frequency

The SW3 switch divides the encoder resolution by 4, this has the same effect as the description above but divides by four instead of two. If both switches are on then the total encoder division is 8.

S2.3: Error Limits

The SW2 switch allows selection of eight or twelve bit error. With the switch in the OFF position the drive will trip if the error between set point and actual positions is greater than +/- 128 encoder steps. (Remember that the encoder step, or resolution, is four times the resolution stated on the encoder, so a 500ppr encoder gives 2000 steps/revolution). With the switch in the ON position the drive uses a twelve bit error limit, or +/- 1024 encoder steps. This setting is most useful if you have a high inertial load and wish to allow a greater initial error while accelerating or decelerating, or if the encoder resolution is particularly high. If you have a motor with a 1000ppr encoder it will have 4000 encoder steps per revolution. In 8 bit error mode the drive will trip if the shaft is $((360/4000) * 128)$ or +/- 11.5 deg. out of position. In 12 bit error mode this increases to $((360/4000) * 1024)$ or +/- 92 deg. out of position.(NB: SW1 is reserved for future use.)

S2.4 Software:

S2.4.1 Setting up Controller Software

The servo driver is one element of a CNC Machine control system. The pulse train that commands the servo driver to rotate the servo motors must be generated and co-ordinated for each axis by a controller. The servo drivers can be used with a large number of CNC controllers. Reviews and links to many of the available controllers can be found at CNCZone.com. The controller software generally runs on a PC under and may control the driver directly via the parallel port or via a break out board. Some controllers, such as DeskCNC run the control program on an embedded microcontroller board. In this case a program on the PC is used to provide the user interface to the controller. The embedded controllers have the advantage of providing high pulse frequencies to the drivers. DeskCNC is used as the controller in the CNCTekix MultiTEK Controller box.

Once you have selected a controller application, install it on your PC as per the controller documentation. Determine which output pins will be used to control the driver on each axis and how the controller will interface with emergency stop and limit switches. Controller documentation should explain the particular requirements and functionality of the controller..

S2.4.5 Axes Setup

In this section indicate the specific resolutions and speeds for the axis. Starting with the X axis, enter the number of steps/MM for the XD axis. If this is an unknown at this point you can make an approximation using the following formula:

$$\frac{\text{Encoder resolution} * 4}{\text{Distance travelled}}$$

Where Distance travelled is the movement of the axis with one rotation of the motor shaft.

As an example, a motor with a 1000ppr encoder direct driving a 5mm pitch ball screw would be:

$$(1000 * 4) / 5 = 800 \text{ steps/mm}$$

Finally specify the maximum speed of the motor (Max Vel - SPS), or the speed limit you would like to impose on the axis. This can also be approximated from the last equation by taking the steps/revolution (encoder * 4) this is the number of pulses for one rotation of the motor shaft, therefore the number pulses to generate a speed of 1 RPS, or 60RPM. If you have an encoder of 500ppr, then it takes 2000 steps for one rotation, therefore 20,000 steps/sec would make it turn 10 times/sec. (* 60 seconds = 600RPM).

If you prefer to calculate the linear speed of the axis instead, take the Steps/mm figure you entered in the box above and multiply it by the number of mm travel per second you want it to move. For example, using the above encoder at 800steps/mm, for 100mm/sec travel (6M/min) 100 * 800 = 80,000 steps/sec.

You should also be able to set the acceleration for each axis. Some controllers have a single acceleration setting and others have a more comprehensive acceleration profile system. Acceleration settings will be important during the tuning phase of the setup. Reviewing your controller setup documentation before powering up the servo driver will assist you in setting up and tuning the servo driver. Particularly knowing how to save the setting you have entered to ensure you capture them for later operation of the machine.

POWER ON PROCESSES

WARNING!

Use of high voltage DC power supplies can pose a potentially lethal danger. Ensure all power leads are correctly insulated and firmly connect.

Confirm power connections are correct:

1. Polarities of all connections are correct.
2. Check polarity of any electrolytic capacitors you have used to control ripple.
3. No connections or wiring can short to each other or ground
4. Earth connections are made from the power socket to chassis and machine.
5. The correct fuse and/or circuit breakers are in place.
6. Once you have confirmed that the wiring of the machine and driver is correct you can get ready to power it up.

You will need to run up your controller software to provide the enable input to the drives. Once the enable signal is active the green run light will illuminate.

CAUTION!

Incorrect connection of power supplies can cause serious damage to the servo driver.

S3.Tuning & Testing

Firstly you need to determine if the axes are moving in the right direction. To visualise which is the right direction, imagine the table as a piece of graph paper with the zero point of the X and Y in the bottom left corner. As with any standard graph the Y axis increases as it goes up the page and the X increases as it goes to the right. To draw a line on the paper the pen (tool) has to move across the paper, for an increase in X the pen moves to the right (or the table to the left).

Turn on the power supply. It is normal for the servo motor to hiss slightly when everything is hooked up correctly. The motor is dithering at high speed between adjacent encoder counts. The integral function in a PID loop has infinite DC gain over time and will amplify even the smallest position error. Because quadrature encoder feedback only occurs on the edge of a line, no count is encountered until the servo moves enough for an edge to pass the sensor. The drive then reverses the motor direction until another edge is found dithering the motor between the two edges. If the motor jumps slightly and the FAULT light comes on.(either position or current limit indication), then probably either the motor or the encoder are wired backwards. Swap the motor lead polarity and power on again.

To check the direction of your axes first press the X+ jog button, focusing on the tool it should move across the table as if to draw an X+ line on the table, travelling to the right. Pressing the Y+ jog button should move the tool towards the back of the table, The Z axis should move up on a Z+ jog and down on a Z- jog. If any of these jogs move the table in the wrong direction it can be corrected by changing the sign of the steps/mm in the 'axis setup' section of the machine settings for your controller. ie. If the Y moves the wrong way and the resolution is set to 400 steps/mm, change it to -400 and press Save. The direction should now have changed.

Finally you will need to check the calibration, or the accuracy of movement. A dial indicator is very useful for this but reasonable results can be achieved with a good ruler. To do this you need to zero the axis for calibration at close to one end of its travel and make a mark at that point. Then move the axis to a point a fixed distance close to the other end of the travel and make another mark. If there is any difference between the displayed and the measured distance you will need to change the steps/mm setting in the 'axis setup'. To calculate the correct value, use the following equation:

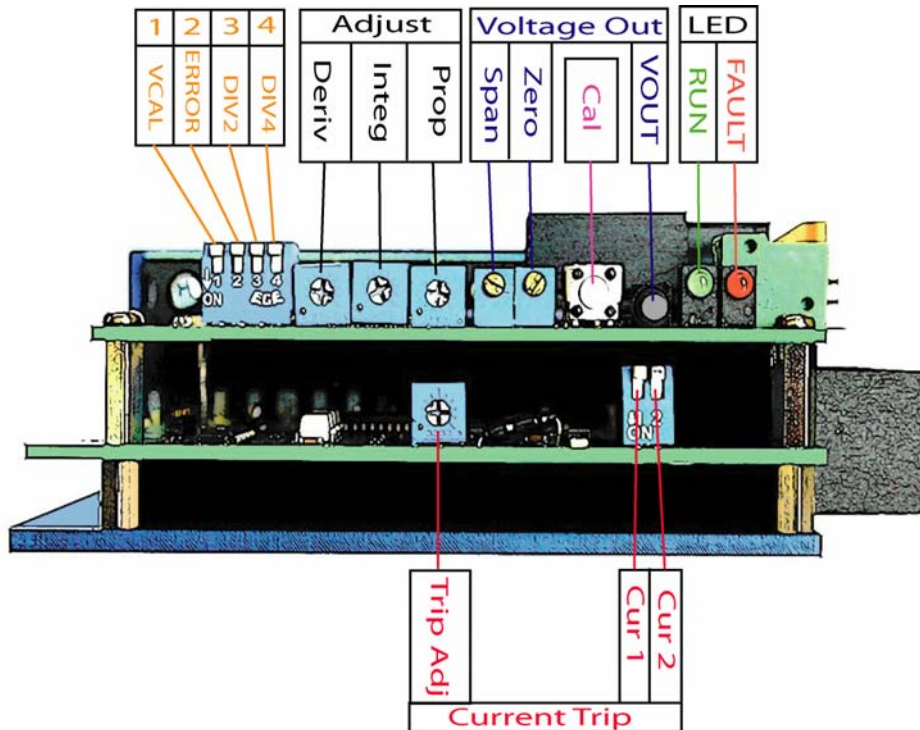
$$\frac{\text{Displayed Distance}}{\text{Measured Distance}} * \text{present Steps/mm setting}$$

As an example, with a steps/mm setting of 400, if the X axis is moved 90mm according to the screen display, and the measured move is 100mm, then the correct setting is $(90/100)*400 = 0.9 * 400 = 360\text{steps/mm}$.

You should now have your machine running accurately with the axis directions correct. There are many more settings that can be adjusted or tweaked to better the performance of the machine, but these will not be described here as they are specific to your particular controller software. Please review your controller documentation to set items such as axis acceleration and maximum velocity.

S3.1 Calibrating your Drives

For each axis there are several trim pots used to adjust the various settings. The front panel display around each drive labels each item as to its function.



These functions are:

- | | |
|-------------|--|
| Red LED | A red LED to indicate a fault condition |
| Green LED | A green LED to indicate drive running |
| V-Out | A 2.5mm Jack socket for a +/- V output for advanced calibration. |
| Zero | An adjustment to Zero the V-Out signal |
| Span | An adjustment to set the gain of the V-Out signal |
| PRO | To adjust the Proportional gain |
| INT | To adjust the Integral Gain |
| DER | To adjust the Derivative gain |
| SW 4 | Divide the encoder input by 2 |
| SW 3 | Divide the encoder resolution by 4 |
| SW 2 | Set 8bit/12bit mode operation |
| SW 1 | Reserved |
| Trip | Adjustment for the overcurrent trip point |
| Cur1 & Cur2 | Either switch adds 10A to the current limit range |

The three main trim pots are labelled P, I & D, which stand for Proportional, Integral and Derivative. Their functions are:

Proportional: This is the amount of power, relative to the error, that the drive will output. The analogy here is a comparison to the accelerator in a car, if you are travelling at 60Km/H and you want to travel at 80Km/H, the P controls how much more the accelerator needs to be pushed to get the right speed. If the P is set too low it will accelerate very slowly, too high and it will likely speed up too quickly and overshoot 80Km/H, causing it to have to decelerate again. This can cause the drive to oscillate, and, if set too high, will cause ever increasing oscillations until the drive trips out.

Integral: This is often called the steady state error. If there is a small error, not enough to cause the P control to correct, but present for a period of time, the I adds up all these errors over a time period and causes the drive to adjust slightly to reduce this error.

Derivative: This is the adjustment for the 'rate of change' error, such as when a sudden acceleration or deceleration is called for, or the load quickly changes. It works by adding or subtracting power to assist the correction for any sudden changes. Back to the car analogy, if the car was to suddenly reach an incline and the speed starts to decrease it looks at how fast the car is slowing down and adds a burst of power to correct for it. As it acts faster than the proportional control it is also helpful in decreasing the oscillations caused by too much proportional control.

S3.1.1 Indicator LEDs

There are two LEDs at the top of the drive which indicate the present state of the drive. The Green LED is for normal operation and the Red for a Fault condition. If the drive is not engaged both the LEDs will be off. The Red or Fault LED has two states, steady or flashing. A steady Red Led indicates a positional fault, or the drive error is too great (see SW2 description below), whereas a flashing Red Led indicates an Over current, or the output current exceeded the limit set on the trimpot.

S3.2.2 Initial Setup

To get your drives operational prior to fine tuning you can follow this guide.

7. Set the current limit, to avoid overloading the motor set this trimpot and switch selection to the max current allowed by your motor, this figure you can find in the specifications for your motor.
8. Set switches 3 and 4 to add any divisors you need for your motors, if any.
9. Set switch 2 for either 8 or 12 bit error limit.
10. Turn the I & D trim pots to the off (fully counter clockwise) positions and the proportional just slightly on from the off position.
11. Enable the drive
12. Gradually increase the P trimpot between giving the motor intermittent step pulses, do this until the drive starts to become unstable or 'bouncy', then back it off a little.
13. Increase the D trimpot until the step movements feel nice and solid. If this is adjusted too far the motors can produce a 'hissing' sound, if this occurs back it off a little.
14. While slowly hand-turning the shaft of the motor back and forward, adjust the I pot until little or no 'slop' can be felt.

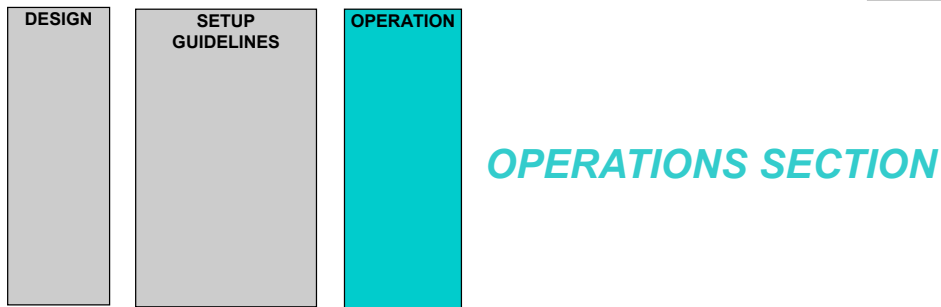
Your drive should now be adjusted fairly close to the correct settings. Operating the drive will prove if it is right or not. If during operation you find it trips out with a solid red LED, or positional error, then you might need to adjust the P or the D trimpots up a little. For this you might also consider setting 12 bit error mode, or adding a divisor into the encoder feedback with switches 3 or 4. If it trips out with a flashing red LED then reduce the P or D trimpots to reduce the power that the drive can supply. Alternatively you should adjust the acceleration settings in your controller software to ensure a slower acceleration which will not push the drive past the set points.

S3.2.3: Fine Tuning

Provision has been made on our servo drives for you to fine-tune them. To tune the motors to their peak you will need an Oscilloscope and a cable which will connect the Oscilloscope to the 2.5mm jack socket on the front of the drive (just under the indicator LEDs.) SW2 on the front panel allows you to toggle the output to display either Power output or Following error. This switch should be used to select the error mode before enabling the drive, once enabled it can be used for the output display. Following is the sequence for tuning the drives:

1. Select the correct operating modes and enable the drive.
2. Switch SW2 to the OFF position.
3. Underneath the jack socket are two trimpots labelled Zero and Span, with the drive enabled and not moving, adjust the Zero trimpot until the trace on the Oscilloscope is 0V.
4. Run a small G code program to move the selected axis backwards and forwards repeatedly over a short distance, say 10mm. You are after a step function into the motor so you can see how it responds.
5. While watching the Oscilloscope display, adjust the P trimpot until you can a series of oscillations after each direction change, then back it off a little.
6. Adjust the D trimpot to reduce the oscillations even further, you will see an increase in the 'noise' of the signal when you increase the D, try to find the happy balance between the bounce and the noise. The ideal signal should have one to two oscillations before settling to the new value. In cases where there is a high inertial load, or flex in the drive system this may not be possible, in these cases tune it to get the lowest oscillations. Reducing the acceleration in the controlling software can also help greatly in these cases.
7. Flip SW2 to the on position, this will display the 'following' error, or the difference between the set and actual positions. On each direction change you should see a sharp deviation from the zero with a steady ramp back to the line. Adjust the I pot so that the signal returns to the line relatively quickly without causing any further oscillations.
8. To see exactly how big the error really is, stop the program and turn the P trimpot back to the zero position (after remembering where it was!) to remove all power from the drive. Moving the shaft by hand until the signal deviates to the same level as you saw in the last step will show you how big the error is at its worst case.
9. Repeat this process for the rest of the drives in your driver.

Your driver should now be fully tuned and running your machine to its best ability. Should you have any problems following the tuning steps above please do not hesitate to call us and we will be glad to help you.



O1. Fault Resolution

During operation there are two faults that can occur with the drive. The drivers can trip out from either a position error or over-current error. Both of these errors are the result of the drive being unable to command the servo motor to the correct position within the set error limits. A position error fault is a direct indication of this condition. An over-current trip occurs when the drive increases the current to the motor to correct for the error and this then exceeds the current trip setting. Assuming that the drives were tuned during the initial setup of the system and the system has been operating for some time without fault indications. A fault condition could be caused by the following factors:

1. Increased cutting load due to tool wear, higher feed rate, or vibration.
2. Electrical wiring faults to motors and encoders. Loose connections, chaffed wiring.
3. Changes to the controlling software have affected the acceleration profiles of the system.
4. Change in moving mass due to large job mass, fixtures and clamps
5. Changes in lubrication or adjustment of mechanical components for the system
6. Wear in mechanical components. Such as gear boxes, ways lead screw and nut.
7. Motor performance decreased due to worn or dirty brushes.
8. Dirt or light entering encoder housing causing errors in reading

After investigating these factors and the fault continues to re-occur, return to the Set Up Guidelines – Tuning and Testing section and re tune the drives.

Other problems may only become apparent following a period of operation. Often these develop as the use of the machine is expanded and its operational envelope is explored. This could include motors over heating, or being under powered. At this point you have two choices. You can work within the limitations or go back to the design phase and modify the system. For example you may find that by changing or adding reduction gears you can trade maximum speed for more torque.

02. Maintenance

Include the following three areas in your routine machine maintenance tasks to ensure continued reliable performance of your CNC driver.

02.1: Contamination Checks

The driver may become contaminated by swarf, coolant and dust build up during normal operation. Locate the driver such that swarf does not collect on or around the unit. Shields and covers may need to be fabricated and installed to control swarf build up once in operation. Coolant should not come in contact with the driver or flow under it at any time. Steps should be taken to clean and eliminate coolant contamination if this occurs during operation of the machine. Fan forced cooling air will cause dust to build up around the driver. The driver has filters fitted to both inlet and exit cooling ports. These filters need to be removed and cleaned. The filters are located on either side of the driver. They can be removed by gentle prying the cover off on each side. Gentle wash the filters in warm soapy water and dry them before replacement. Do not use solvent based cleaners on these filters.

02.2: Lead Chaffing Checks

In many applications the motors and encoders are attached to moving parts of the machine. During operation, the motor power and encoder leads flex back and forth thousands of times. Machine vibrations during cutting can cause deterioration of cables and connections. All cables and connectors from the driver to the machine should be checked for signs of wear. Any cables with signs of wear should be replaced and alternate routing or support designs investigated.

02.3: Mechanical Wear Implications

The tuning of the drives aims to match the servo driver to the motion system, mechanical load and inertia. As the mechanical system wears, the forces may change and require adjustment of the servo driver control settings. Lubrication of the mechanical system should be applied to reduce this occurrence. Adjustment of gibs and ways should be conducted with care, and any major adjustments may require concurrent servo tuning. Many software control applications have backlash compensation to account for the measured backlash of the system. Over time, mechanical wear can change the backlash and may necessitate the adjustment of the software. Play can develop in the lead screw which will effect the accuracy of the motion system. As maintenance is done to the mechanical system be aware that it may have implications for the control system and require re-adjustment or calibration of some elements of the driver.

O3. Support

If you have any problems or questions please contact CNCTeknix using the details below. You will also find a significant amount of useful material on the Internet. Please visit the CNCTeknix web site where you will find the latest support information, down loads and links to other valuable web resources. The Web resources and forums will be invaluable in putting your CNC machine to maximum use and gaining further ideas and insights into how to derive maximum usefulness and enjoyment from your equipment.

Useful Web sites include:

CNCTeknix <http://www.cncteknix.com/>

DeskCNC: <http://www.deskcnc.com/>

CNCZone: <http://www.cnczone.com>

For Contact, Sales and Technical Information:

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