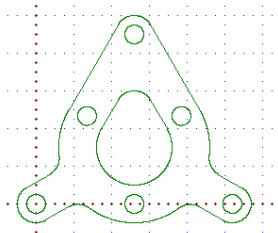


E.D.M. Stepper Motor Controller Design & Documentation On: 03-May-93 By: Kenneth Y. Maxon

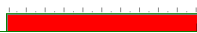
Written by: Kenneth Y. Maxon



- 0) List gerber files
- 1) Load gerber file
- 2) Process the file
- 3) Position Cutting Head
- 4) Change resolution
- 5) Review Gerber file
- 6) Change cutting size
- 7) Set cutting voltage
- 8) New Cut
- 9) Exit

Please choose (1..9) -->

Cut# 40 v,Critical= 5
0 50 100v



Introduction

This manual is designed in two basic parts as a general overview to the operation of the stepper motor controller. The first part is this text which will guide you through the operation of the "STEPPER.EXE" software provided with the controller. The second part of this manual are a series of graphics frames that have with this most recent release, been included within the text of the document itself.

The software is very straight foreword, and all of the commands can be accessed directly from the graphical main menu, that will remain the same throughout the duration of operations.

Graphical frames found at the end of this document are the technical description of the hardware within the stepper controller itself. These frames are provided for reference purposes only and should be consulted only if hardware problems arise. Otherwise, skip these frames and well get started. (for future reference don't throw away frames #1 - #5 they may come in handy some day!)

Considerable time went into the design of this software. I have tried to take into account some events/situations that may arise in certain cutting situations. If you have any questions refer here to the appropriate section of this manual for answers! If all else fails first scream, second pull your hair out, third contact me.

Call me superstitious, but there are a generous number of **Warnings** spread through out this manual. Please do not take them lightly. I'm not harping, but these are the settings which can cause you grief, and can destroy your equipment. It is worth your time to read these warnings, as they are easy to spot as follows:

NOTE: PAY ATTENTION TO ANYTHING IN THESE BOXES OR ELSE!

Introduction (Cont.)

As with any program, the STEPPER.EXE program has been built with quite a bit of flexibility. Don't hesitate to mess about, not around. In other words, think twice about what you are asking the program to do. If you tell it to rapid traverse through a chunk of steel, IT WILL, without hesitation or remorse. The specifications written into the software will direct it to carry out any reasonable 'standard' Gerber formatted command file. (for a listing, see Menu Option #5)

The tolerances built into the program will keep linear, circular, and arc commands on task to the tune of one half of one thousands of an inch. (1/2 mil) This tolerance is hard coded into the STEPPER.EXE program, and should not attempt to be overcome by increasing thread / inch in gearing, or by obtaining stepper motors with a step rate of more than 200 steps to the linear inch.

Voltage protection has been built in, to withstand 400v peak spikes, and inverse spikes to 400v as well. ~~I do not recommend reversing the cutting voltage, as the computer will stop cutting until the voltage becomes positive again.~~ (Taken care of release v2.0) The heads will automatically be flushed, by the redundant backup built into the software. (More under low voltage.)

Considerable time and effort on the part of myself, designer and programmer, has been put into this product. As such, I will keep my requests of you the consumer simple. Please do not distribute this manual or software to anyone. Feel free to demonstrate it, but do not give it away! Secondly, Most problems have a logical solution. Try to think them through.

Designer,

Kenneth Y. Maxon

Getting Started

The program 'STEPPER.EXE' resides in a folder / sub directory called EDM on your C: hard drive. To execute this program at any time, from the DOS prompt type 'STEPPER' and press enter as follows:

```
C:\BOBCAD\> STEPPER
```

As the above example shows it is not necessary to be in the EDM sub directory, to run the STEPPER program. This may prove to be a handy option later, such that you can run the program in the same sub directory that your data files reside in.

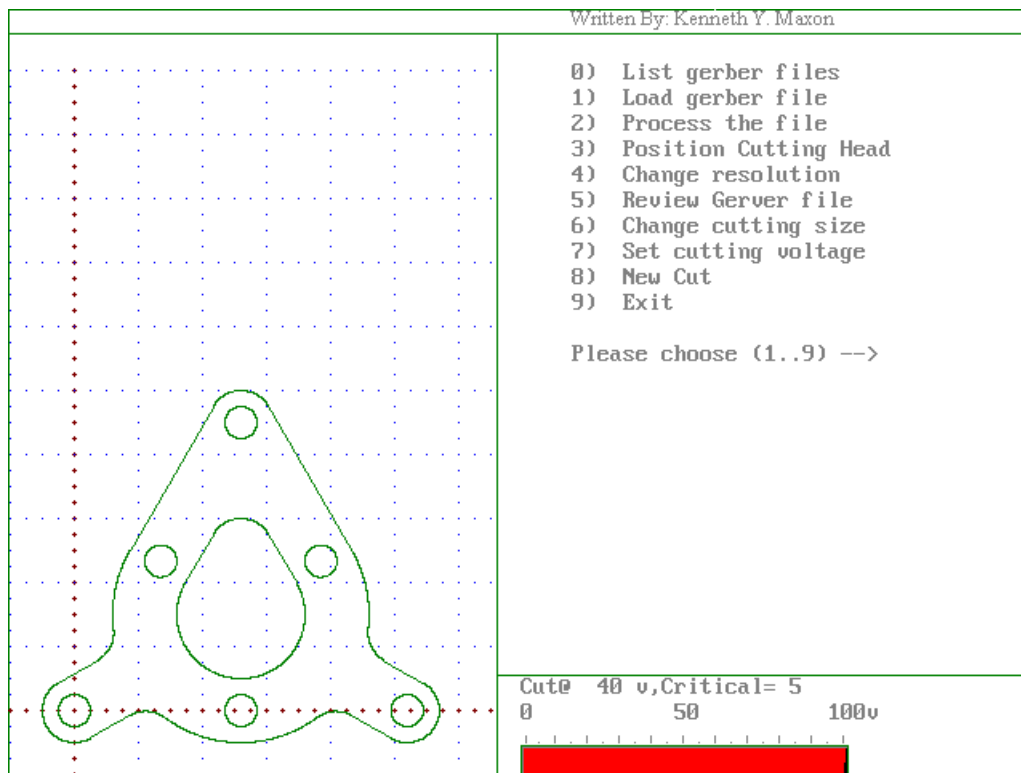
<p>NOTE: POWER TO THE DRIVER MODULE SHOULD ONLY BE TURNED ON AFTER THE STEPPER.EXE PROGRAM IS RUNNING, AND SHOULD BE TURNED OFF BEFORE QUITTING..</p>
--

First Running / Main Menu

When you first run STEPPER.EXE the program will initialize the graphics screen and draw the default workspace as well as the Main Menu. At this point every option provided by the program is available to you, and no additional setup is required. Each menu item is accessed by simply typing the number associated with it. (See the following page)

<p>NOTE: FEEL FREE TO PLAY AROUND ALL YOU WANT, AS LONG AS YOU REMEMBER ONE KEY POINT! WHEN PLAYING, <u>NEVER HAVE THE CUTTING TIP DOWN</u>, WHERE IT CAN COME INTO YOUR WORKPIECE AND <u>KEEP THE VOLTAGE TURNED ON WHEN CUTTING</u>. IF THE CUTTING TIP IS TURNED OFF AND THE SAFETY CUTTING VOLTAGES ARE SET WRONG, <u>THE DRIVERS CAN CRUSH THE CUTTING TIP!</u> (MORE LATER)</p>

The Main Menu



Now let's get down to some serious playing! You may find it beneficial to read the rest of this manual, before attempting to actually use your E.D.M. system. Then you can refer back, in a reference manner should questions arise. I intend to walk through the items listed in the main menu one at a time giving a brief functional overview and listing the possible options for each selection. Again, if there is something you don't understand, try it and see what happens.

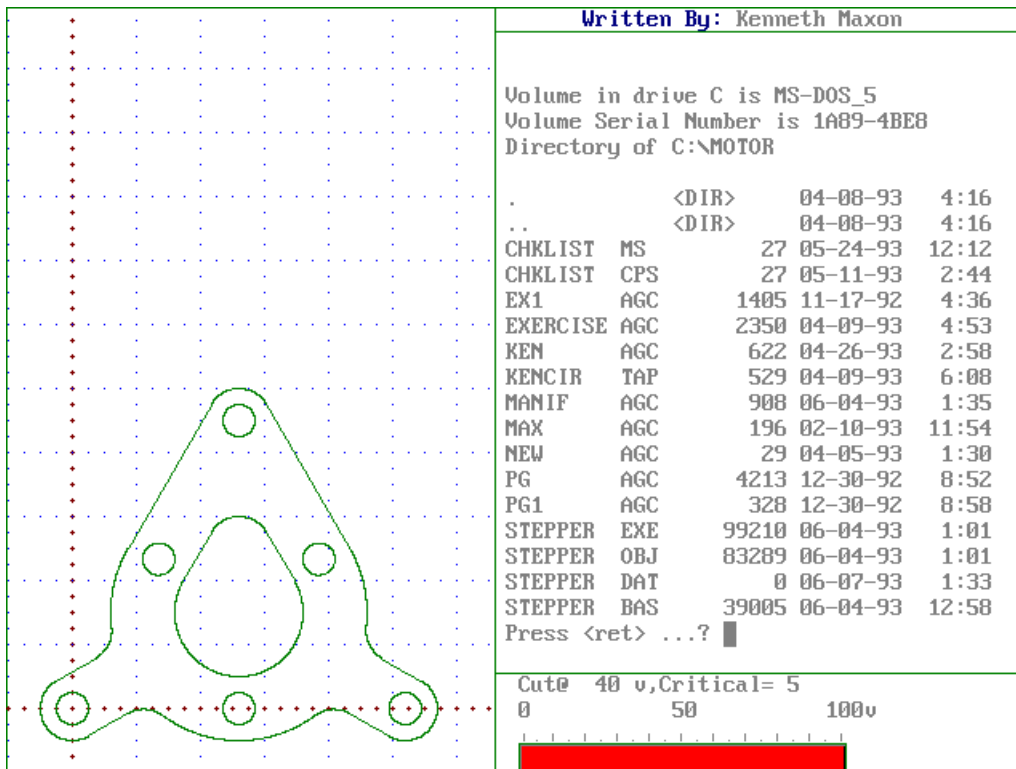
Option: 0

Menu choice '0', (List Gerber files) has two basic parts. The first part will ask you what directory or sub directory you wish to look in. (see figure) If you wish to look at the files in the directory you were currently in when you ran the STEPPER.EXE program then simply press return at the prompt and the program

will list the Gerber files available. (with the most recent release of this program, all files are listed in the current directory to include .AGC & .TAP) If you want to look into another directory or into another drive, you can type any of the standard DOS path names as follows. If you are in the C:\EDM sub directory and wish to look at files in the C:\MOTOR sub directory, at the prompt simply type C:\MOTOR. (see figure) If you wish to look at files on the D: drive at the prompt simply type D:\ followed by the name of the sub directory to look into!

After you have told the computer where to look simply press the <Return/Enter> key on your keyboard and the screen will change to look like the figure below displaying all available files. If the list is longer than the screen you will see a prompt to press return at the bottom. When the display is done, it will return to the main menu automatically.

Listing of Files:



```

Written By: Kenneth Maxon

Volume in drive C is MS-DOS_5
Volume Serial Number is 1A89-4BE8
Directory of C:\MOTOR

.           <DIR>      04-08-93   4:16
..          <DIR>      04-08-93   4:16
CHKLIST    MS          27 05-24-93 12:12
CHKLIST    CPS          27 05-11-93  2:44
EX1        AGC        1405 11-17-92  4:36
EXERCISE   AGC        2350 04-09-93   4:53
KEN        AGC         622 04-26-93   2:58
KENCIR     TAP         529 04-09-93   6:08
MANIF      AGC         908 06-04-93   1:35
MAX        AGC         196 02-10-93  11:54
NEW        AGC          29 04-05-93   1:30
PG         AGC        4213 12-30-92   8:52
PG1        AGC         328 12-30-92   8:58
STEPPER    EXE       99210 06-04-93   1:01
STEPPER    OBJ       83289 06-04-93   1:01
STEPPER    DAT          0 06-07-93   1:33
STEPPER    BAS       39005 06-04-93  12:58
Press <ret> ...? █

Cut@ 40 v,Critical= 5
0           50          100v
  
```

Option: 1

Option #1 from the main menu (Load a Gerber file) does exactly what the name implies. It moves a file from the hard disk into memory where you can work with it. Normally this will be the first option to choose upon entering the program. Once you have chosen this option the computer will prompt you for the name of the file to load. Again the computer follows the standard DOS file naming conventions. If the file is in the same sub directory that the STEPPER.EXE program was run from, simply type the name of the file and the extension then press Return.

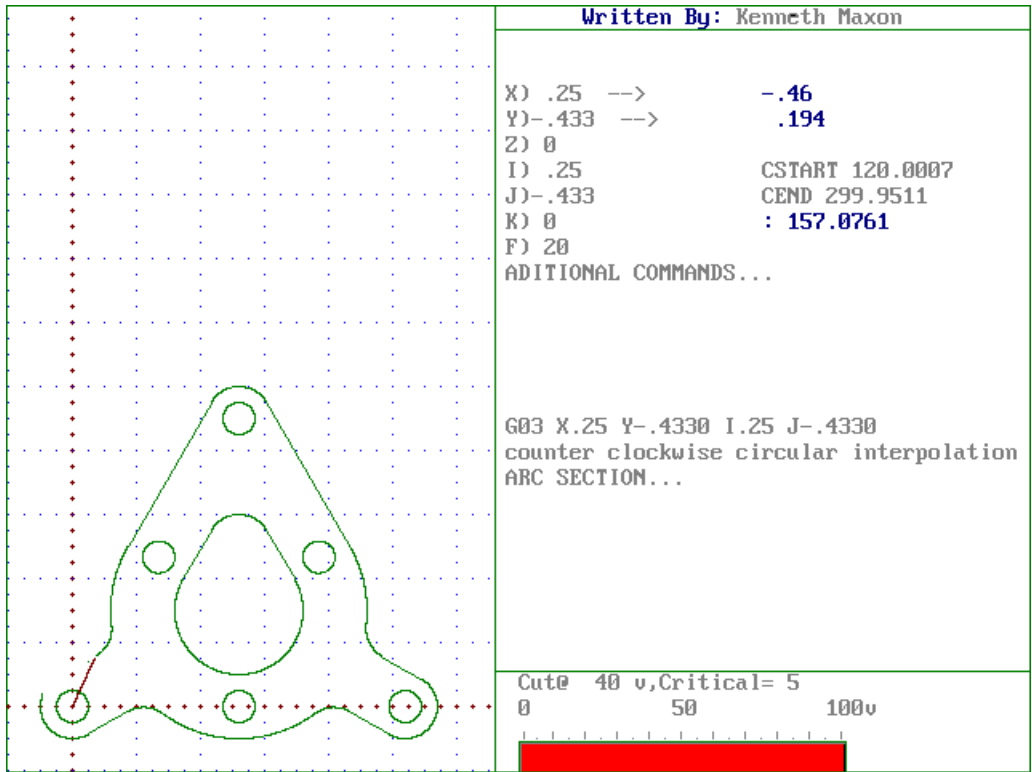
NOTE: THE NAME OF THE FILE MUST INCLUDE THE THREE DIGIT EXTENSION REQUIRED BY ALL DOS FILES. FOR EXAMPLE TO LOAD THE FILE EXERCISE, **YOU MUST TYPE EXERCISE.AGC OR EXERCISE.TAP**, DEPENDING ON THE TYPE OF FILE.

You will know if the computer was successful as your file will automatically be drawn in the work space to the right! If the computer can not find your file, it will display an error message asking you to press Return and then return you to the main menu. Do not panic if this happens, simply try again, watching out for typo's and double checking the sub directories and file extensions. If you are loading a file from another sub directory other than the one that you are in, you should type the full path name. I.E. you are in C:\EDM and want to load a file from D:\BOBCAD. This is done simply! When the computer prompts you for the file name, you respond by typing D:\BOBCAD\TEST.AGC filling in the name of the file you want for TEST.AGC. If you are unsure of the actual name of the file you want or can not remember if it is in a particular sub directory refer to Main Menu option #0 discussed previously to look for it.

Option: 2

Menu Option #2 is for telling the computer to actually process the Gerber file to the stepper motor controller equipment. This is the part you want to be a little bit careful about playing with! Several things need to be checked before you start, have you turned on the cutting voltage of the E.D.M., and is it set properly. You can check this by looking at the red voltage thermometer at the bottom of each screen. The scale is in volts. Next, you need to check the cutting voltage and the critical voltage. Both of these are displayed in the same box right above the voltage thermometer. (see figure below) A quick visual check of the cutting path shown in the work space should tell you whether the file is being processed the way, that you feel it should be. If it doesn't look right in the workspace, it will not be cut right, now is the time to quit and fix it, before you tell the computer to start cutting!

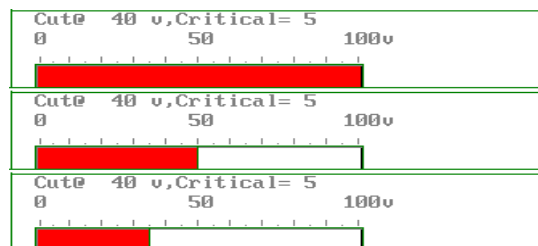
Actual File Processing:



-
-
- Check List:**
- 1.) MAKE SURE FILE IS LOADED AND LOOKS OKAY (OPTION #1)
 - 2.) SET CUTTING VOLTAGE (OPTION #7)
 - 3.) SET CRITICAL VOLTAGE (OPTION #7)
 - 4.) MAKE SURE E.D.M. IS TURNED ON AND AT PROPER VOLTAGE
 - 5.) POSITION CUTTING HEAD (OPTION #3)
-
-

If you can go through each step above, and everything seems to be okay, then fire away! As the STEPPER.EXE program processes each line in the Gerber file it will be displayed to the right of the screen, as well as several other pieces of information. (see figure above) Some of the more important information to keep an eye on are the blue numbers changing at the top. These tell you where the cutting head is exactly in contrast to the white numbers which tell you where the cutting tip is going. You can also tell quite a bit by keeping an eye on the graphics screen. The traverse path is originally drawn in green, and as the computer moves the cutting tip over the path, it will turn white. You will also notice any area skipped during the cutting process or while the cutting tip was raised will be drawn in red to let you know visually that, that portion was not cut! (see Figures)

**Watch That Thermometer:
Before Cutting, During Cutting, Waiting During A cut.**



There are two or three basic problems that can occur when cutting. These are a drop in voltage, a drop in voltage due to a direct short, and the need for the user to stop the cut for some reason. I'll explain how the program deals with each of these in turn.

LOW VOLTAGE:

Since the cutting is controlled by positive feedback due to voltage fluctuations it is reasonable to assume that the voltage must remain reasonably constant during the cut. As a matter of fact, it must remain above the voltage cutting level that you specify in Menu setting #7. If the voltage falls below this cutting voltage no harm is done, the STEPPER program will simply wait for the voltage to come back up again before it tries to advance again. (It will not wait indefinitely however, read on to find out why.)

LOW VOLTAGE (SHORT CONDITION):

What happens when the low voltage is caused by a short, or particulate matter that is not flushing into the oil bath properly? Simple, the computer will only wait so long before it realizes that the problem is not going to cure itself. The STEPPER program will do two things to rectify the situation, after it has waited for the voltage to come back up on its own and recognizes this failure, it leaps to action. First the program will back off the cutting head about 2.5mm. This should cause the Voltage to rise again, by allowing the oil to flush the head. If the voltage does come back up, the head will advance again, and cutting continues. *(This works even when cutting around corners and complex curves)* If the particle does not flush after backing up the cutting head, the computer will beep and ask you the operator what to do? (Do you want to stop cutting?) While waiting for your reply if the problem fixes itself, the STEPPER program will again advance the head and continue cutting and processing the Gerber file. You can choose to stop the cutting. If you do you will be prompted with several questions as follows:

User Interrupts Cutting:

This the third type of error that can happen when you are processing a Gerber file through the cutting procedure. There are two ways this can occur. A. you tell the computer that you do not want to continue after a low voltage situation

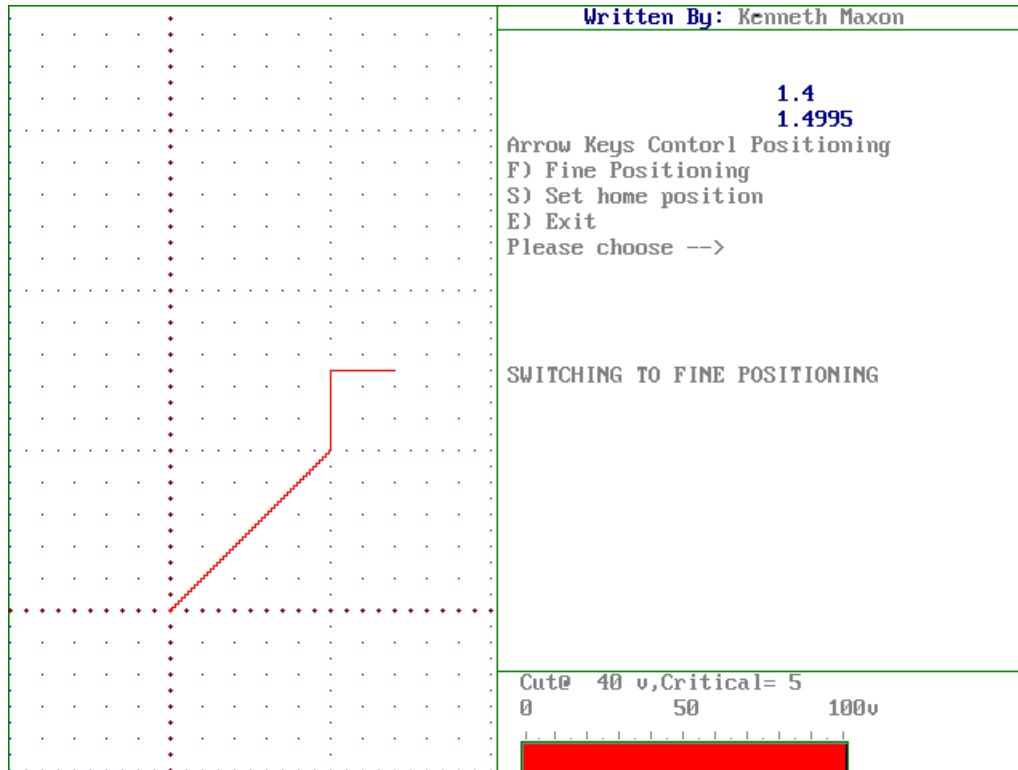
as above. B. simply press any key on the keyboard while the computer is processing and the program will ask you if you want to continue processing the file. If you answer NO to this question the program will ask you to raise the cutting head out of the cut and press return. Next it will ask you if you want to return to the home position. This is giving you the option to move the cutting tip back to the exact location where you started this cutting session. This is helpful if you want to try to reprocess the cutting file without having to line everything up again!

No matter what happens when the machine is done processing the Gerber file, whether completed or interrupted it will return you back to the main menu. Where you can simply tell it to cut again, or proceed on to other options.

Option: 3

Menu Option #3 (Position cutting head) is used to align the tip with the metal before a cut is started. (see figure) The arrow keys on the numeric keypad are used to move manually the cutting tip. There are eight movement directions corresponding to the main compass directions at 45 and 90 degrees. There are two modes of movement, coarse and fine. Coarse moves the cutting tip one half inch at a time and fine moves it by 10 thousands of an inch at a time. The absolute coordinates of the cutting tip are displayed on the screen as it moves. When positioning is completed simply choose E) Exit from the menu to return to the Main Menu. Upon returning to the menu, the position of the cutting head becomes the absolute home position, referenced by the coordinate point (0,0) and all Gerber files will be processed around this point.

Positioning Cutting Tip:



The voltage sensing mechanism is turned on during the positioning and if allowed to will control the head to perform an actual cut although this would be much better accomplished with menu option #8. During the times that one would find themselves working on an expensive piece, weather costly material, or great time investment, take heed to the following words. It may be better to leave the cutting tip centered on the motor platform and manually move the piece into position, using the edge sense feature of your E.D.M. Centering is another point, to mention, in conjunction with positioning. The STEPPER.EXE program has no way to know when the motors have reached the end of their travel on the driving linkage. Try to leave the cutting tip centered before you start to process a file. In other words, don't start a three inch cut with only two inches of thread left in that direction. Upon reaching the end of the thread, the stepper motors will travel gratefully on binding the motors tight!

Option: 4

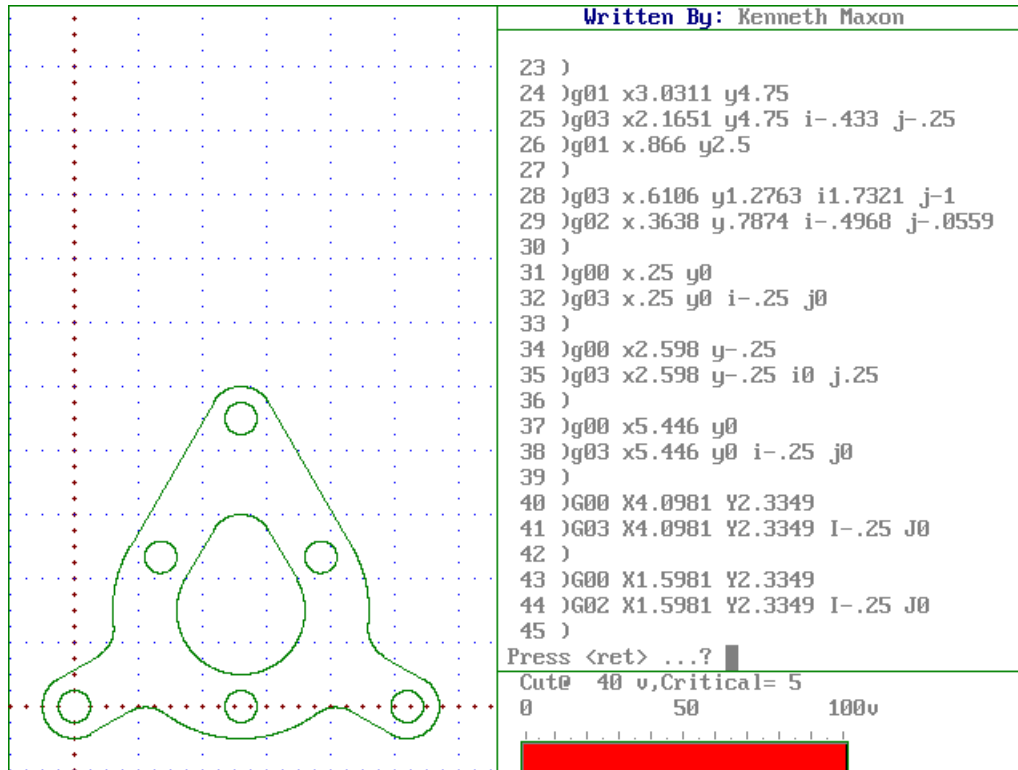
Menu Option #4 is one that will not normally need to be changed. **These settings are based on the hardware hooked up to the E.D.M. stepper motor controller, and should not be changed without first consulting the programmer!** The options are specific to the makeup of the mechanical linkage between the motors and the cutting head. The first is the number of electronic steps needed to make the motor turn one complete revolution. Do not get this confused with half stepping. This number is set to (200) as a default and should not be changed! The second option is related to the number of turns per inch on the worm screw used to position the cutting head. The default is (10) threads to the linear inch, and again should not be changed. Half stepping can be achieved by this program and driver board at the cost of torque to the motors. These motors running at half torque are not enough to break free a stiff worm gear, so I have left access to this aspect of the program unavailable to the end user.

NOTE: IF THE ABOVE SETTINGS ARE CHANGED THE COMPUTER WILL NOT ACCURATELY BE ABLE TO TRACK THE POSITION OF THE CUTTING HEAD OVER ANY DISTANCE. IF THE PROGRAM LOOSES THE ABSOLUTE POSITION OF THE CUTTING HEAD FOR ANY REASON, RESULTS CAN BE ERRATIC RANGING FROM YOUR CUT NOT LOOKING LIKE WHAT YOU ASKED FOR TO THE MOTOR CONTROLLER CRUSHING THE CUTTING HEAD INTO THE SIDE OF THE STEEL.

Option: 5

Menu Option #5 (List Gerber File) will bring up the ASCII Gerber file definition so that you may review it. (see figure) This can be helpful when trying to track down errors in the Gerber definition file. Use this in conjunction with the dry run technique presented in Option #7 and this can be a powerful tool to finding Gerber errors. There are many Generic CAD programs out there on the market, and as an aside I heartily recommend using one. Furthermore, if the particular CAD program that you use supports coordinate modifiers, such as tangent, perpendicular, center, midpoint, orthogonal, etc. please by all means use them. In the long run, they will save you time and headaches! The computer will only list the currently loaded file one screen at a time, asking you to press return at the end of each screen. When it is done, the screen will clear and the Main Menu will reappear.

Listing of Gerber Files:



Gerber files can contain many different types of Gerber codes specific to the nature of the piece being produced. The STEPPER.EXE program is designed to handle most of the standard codes, while some will not be processed. Below is a table of Gerber format codes that this program supports, and processes. An * in any column means that the program can handle the processing of this G-Code. If the program can handle a particular code, or acknowledges it, but does not support it, then the code will simply be skipped when the command line processor comes across it. This may cause some files to be processed incorrectly! Always look at the graphical display screen when the file is loaded to make sure the commands supported are moving the cutting head where desired. One of the biggest problems that can arise relate to the rapid traverse command. Make sure to include a Z-axis rapid traverse, both before and after an X-Y traverse. In plain English, you must lift the cutting blade before moving across your work. Even if you are moving across a section that has already been cut. The reasons behind this

lie in the fact that mathematically the shortest distance between two points as far as rough calculations are concerned is not a straight line.

In addition to the standard formats, the command parser in the STEPPER.EXE program has the ability to handle most standard ASCII commands and parameters. The Gerber format may separate commands with ',' ';' 'space' or any other standard DOS delimiter. Lines and comments set off with a set of '*' or ';' will be ignored, such as comment lines. Line numbers at the beginning of lines will also be ignored, including those prefixed by a alphanumeric such as '10)' or 'N15)'. Numeric processing has been expanded to handle numbers to **eight decimal places**, however only four are needed or recommended to reach the one half of one mill resolution provided by the package.

Table of supported Gerber Codes:

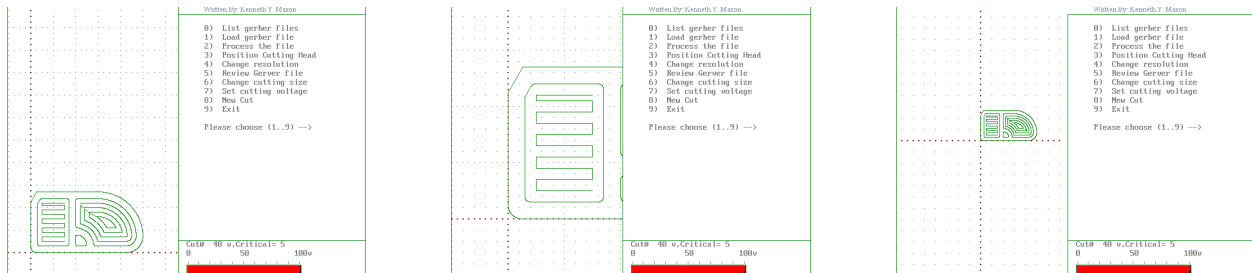
Code	Description	Ack	Support
G00	Rapid Traverse	*	*
G01	Linear Interpolation	*	*
G02	Clockwise Circular Interpolation	*	*
G03	Counter Clockwise Circular Interpolation	*	*
G28	Return to Reference Point	*	-
G39	G39 Code	*	-
G40	Cancel Cutter Diameter Compensation	*	-
G41	Cutter Diameter Compensation to Left of Work-piece	*	-
G42	Cutter Diameter Compensation to Right of Work-piece	*	-
G73	High Speed Peck Drill	*	-
G74	Cancel Multi-Quadrant Circular Interpolation	*	-
G75	Set Multi-Quadrant Circular Interpolation	*	-
G80	Cancel Canned Cycle	*	-
G81	Start Canned Drilling Cycle	*	*
G83	Peck Drill Cycle	*	-
G90	Absolute Mode Command	*	*
G91	Incremental Mode Command	*	*
G92	Assign Absolute Reference Point	*	-
XYZ	Individual motion Parameters	*	*
F	Feed Rate Parameters	*	*
Line#	Line numbers including those preceded by alpha-numeric	*	*

There may be other Gerber codes that you wish to see implemented, or supported, but the less than half the codes listed above are really required to complete any particular job. Most CAD programs with Gerber code output support will run quite fine with the list provided.

Option: 6

Menu Option #6 (Change cutting size) allows you to change the scale of the workspace on the screen image to the left of the menu. (see figures) Changing the scale of the workspace to either enlarge or shrink an image is useful when working on different size cuts. It is best to always blow or scale up your work to the largest size that fits on the screen. There are four preset options and re-choosing Menu Option #6 will cycle through them automatically. Don't worry if your work becomes too big to fit, just choose a smaller scale until it does. The STEPPER.EXE program can cut parts that do not however show on the screen. It is a good idea to have the entire file visible however, in case a problem does arise making it easier to track down.

Affects of three separate scale Factors



A Note on Unit markers:

The workspace screen is broken up into sections by various grid lines. The major axis, is represented by two rows of large red dots. The intersection of these two represents the point (0,0) on the screen. Positive values are measured in the Upwards and Right directions from this point. The blue divisions represent inch markings of which there are two types. In the small scales, there are major and minor divisions, each major division representing one inch of actual cutting

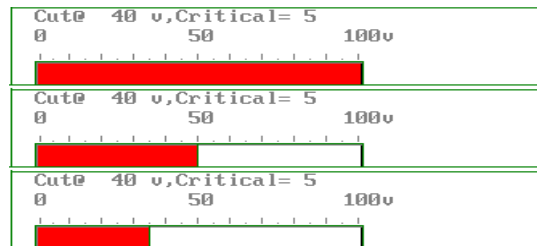
distance. In the large cutting scales the blue divisions are evenly spaced and each grid point represents one inch.

When your Gerber file is displayed, take a moment to look it over. Everything on the screen is drawn true to scale, such that one inch on the screen scale equals one inch on the E.D.M. cutter. It is helpful to use menu option #5 to display the Gerber file on the right half of the screen in order to compare it to the graphic representation on the left.

Option: 7

Menu Option #7 (Set cutting voltage) is used to specify the parameters used in the positive feedback system to control cutting head movement. The settings are for those of Cutting Voltage, Critical Voltage, and Cutting Delay time. I'll describe each of these again below due to their importance. (see figures)

Watch That Thermometer: Before Cutting, During Cutting, Waiting During A cut.



There are three basic problems that can occur when cutting. These are a drop in voltage, a drop in voltage due to a direct short, and the need for the user to stop the cut for some reason. I'll explain how the program deals with each of these in turn.

LOW VOLTAGE:

Since the cutting is controlled by positive feedback due to voltage fluctuations it is reasonable to assume that the voltage must remain reasonably constant during the cut. As a matter of fact, it must remain above the voltage cutting level that you specify in Menu setting #7. If the voltage falls below this cutting voltage no harm is done, the STEPPER program will simply wait for the voltage to come back up again before it tries to advance again.

When used in an alternating polarity mode, most E.D.M.'s are capable of reversing the polarity between the cutting tip and the piece of steel that they are cutting. As the cutting voltage crosses the zero point and begins to go negative (DC Biased) with respect to previous polarity, the computer will also read this as low voltage, but only momentarily. Circuitry has been added to rectify this wave form, and feed only the magnitude of the voltage potential to the differential inputs of the positive feedback mechanism.

LOW VOLTAGE (SHORT CONDITION):

What happens when the low voltage is caused by a short, or particulate matter that is not flushing into the oil bath properly? Simple, the computer will only wait so long before it realizes that the problem is not going to cure itself. The STEPPER program will do two things to rectify the situation, after it has waited for the voltage to come back up on its own and recognizes this failure, it leaps to action. First the program will back off the cutting head about 2.5mm. This should cause the Voltage to rise again, by allowing the oil to flush the head. If the voltage does come back up, the head will advance again, and cutting continues. *(This works even when cutting around corners and complex curves)* If the particle does not flush after backing up the cutting head, the computer will beep and ask you the operator what to do? (Do you want to stop cutting?) While waiting for your reply if the problem fixes itself, the STEPPER program will again advance

the head and continue cutting and processing the Gerber file. You can choose to stop the cutting. If you do you will be prompted with several questions as follows:

User Interrupts Cutting:

This the third type of error that can happen when you are processing a Gerber file through the cutting procedure. There are two ways this can occur. A. you tell the computer that you do not want to continue after a low voltage situation as above. B. simply press any key on the keyboard while the computer is processing and the program will ask you if you want to continue processing the file. If you answer NO to this question the program will ask you to raise the cutting head out of the cut and press return. Next it will ask you if you want to return to the home position. This is giving you the option to move the cutting tip back to the exact location where you started this cutting session. This is helpful if you want to try to reprocess the cutting file without having to line everything up again!

Voltage Waiting Time:

This option tells how many multiples of the standard time constant the STEPPER.EXE program is to wait before it decides that there is an error of some sort due to low voltage. Values for this range from (1), the default, to (100)

Varying the cutting voltage, critical voltage, and Waiting time will have a direct effect on the type of cut carried out by your E.D.M. The maximum cutting voltage and current supplied by your E.D.M. are of course going to affect the parameters set critical voltage, cutting voltage,..... Not only will these parameters affect the speed with which your machine cuts, but also the finish on the material being processed.

Dry Run (Checkout):

When testing this software, I had to have some way to run without actually having the hardware hooked up. This is accomplished by setting both the Cutting voltage and the Critical Voltage to a negative value. (say -5 or -10)

NOTE: THIS IS THE MOST DANGEROUS OF THE COMMANDS OR SETTINGS THAT ONE CAN ISSUE TO THE PROGRAM! IF YOU DO NOT HAVE THE CUTTING HEAD RETRACTED ALL OF THE WAY, THE STEPPER MOTORS WILL DO THEIR BEST TO SNAP IT OFF. ALTHOUGH THIS COMMAND IS USEFUL. **MAKE SURE TO SET THESE VALUES BACK BEFORE YOU PROCESS A REAL CUT WITH THE HEAD DOWN!**

In telling the STEPPER.EXE program that a negative voltage is the only limiting factor, it will run at its maximum speed. This is great, if you want to see the computer traverse the Gerber file without actually having to cut anything! If you turn on the controller box, the motors will traverse the cut, but make sure to keep the cutting tip turned off! You might try attaching a felt tip pen in place of the electrode. This will tell you exactly how the final cut will be made, no questions about it.

Option: 8

Menu Option #8 (New Cut) Allows a quick and easy way to enter just one cut directly from the keyboard. This is not intended as a major form of usage, and is actually left over from testing, but can be handy, after positioning the cutting head with option #3 you can give exact numbers in X and Y to the STEPPER.EXE program to cut. This mode only supports straight lines for the time being. The program will ask for two inputs, an X and Y offset from the current position of the cutting head. All responses should be given in inches. When done this command asks for the X and Y coordinates of the next cut. Remember, Negative values are

to the left and Down, and Positive values are to the Right and Upwards. These values are in relative coordinates. This means that they are intended to be an offset 'relative' to the current position. After each cut, the absolute position of the cutting tip becomes the Absolute Zero position, much like the Menu Option #3 Screen. There are currently no plans to add absolute mode cutting commands to the immediate cut sub menu. To quit back to the Main Menu, simply enter (0) for both answers, or just press Return twice.

Option: 9

What could I possibly tell you about a Menu Choice labeled Quit. Well, surprisingly enough this is a very important consideration. Never exit the program by any means other than quit. (I.E. no CTRL-BRK or CTRL-ALT-DEL) The program needs to shut off the current driver boards, so please exit properly. If for some reason, you do end up back in DOS without quitting the program, you must do one of two things. Either A.) Turn off the motor control unit, or B.) Re-run the STEPPER.EXE program immediately.

<p>NOTE: POWER TO THE DRIVER MODULE SHOULD ONLY BE TURNED ON AFTER THE STEPPER.EXE PROGRAM IS RUNNING, AND SHOULD BE TURNED OFF BEFORE QUITTING..</p>
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Reaching Me:

In the event of an earth-shattering / melt-down situation, you can reach me by message at the address following. Write it down, and leave it somewhere that you won't find it until you have had time to ponder the nature of the particular problem you are having.

Kenneth Y. Maxon
1245 Dewey Dr.
College Pl. Wa. 99324

Errors?

If you shudder when you read the title to this page, then your not alone. The fact of the matter is that errors can occur, not that I the programmer / designer have ever personally made one. What does an error look like? Well to be straight foreword, you should never see one, but there are some extraneous cases which might cause one. If an error occurs, the STEPPER.EXE program will probably catch it before you do. Most of these will be in the definition of the Gerber file. Any garbage in the file format is flagged as such and skipped, this will show up on the graphics work place, if it was something that you expected to see.

Errors show up quite well in the program. One of two things will happen. The program will stop and say '*An Error Has Occurred, Press Ret to Continue*'. If you see this, it is probably something you have done, that the machine did not like! (I.E. typed the path name wrong.) The other type of Error shows up in bright white right across the Screen something like:

AN ERROR OF TYPE 123 HAS OCCURRED

If you see this, PANIC. Not many situations can cause this to happen. There are three that I know of they are as follows:

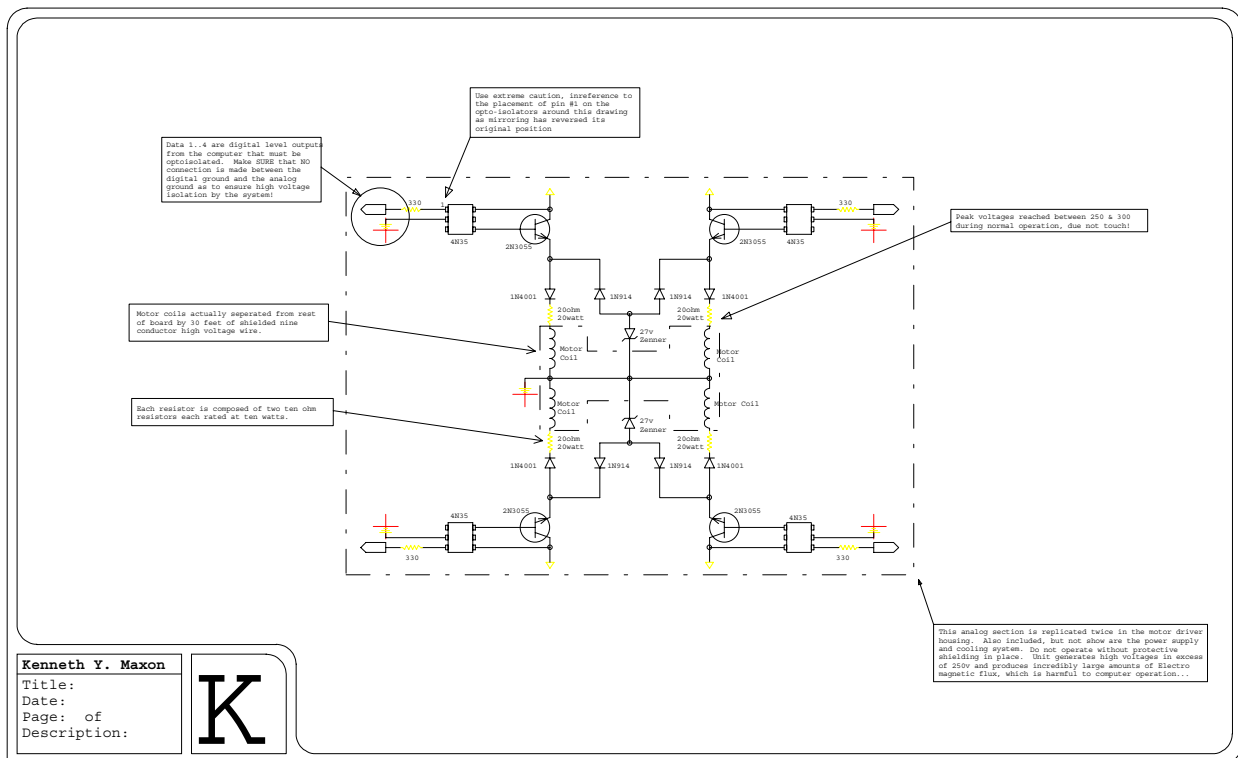
-
-
- 1.) Radius of arc incredibly shallow (possible).
 - 2.) No Coprocessor installed.
 - 3.) Program can not get cutting tip aligned to file.
-
-

In any case, write down the Number on the error message and contact me with the specific situation so that I can take care of it!

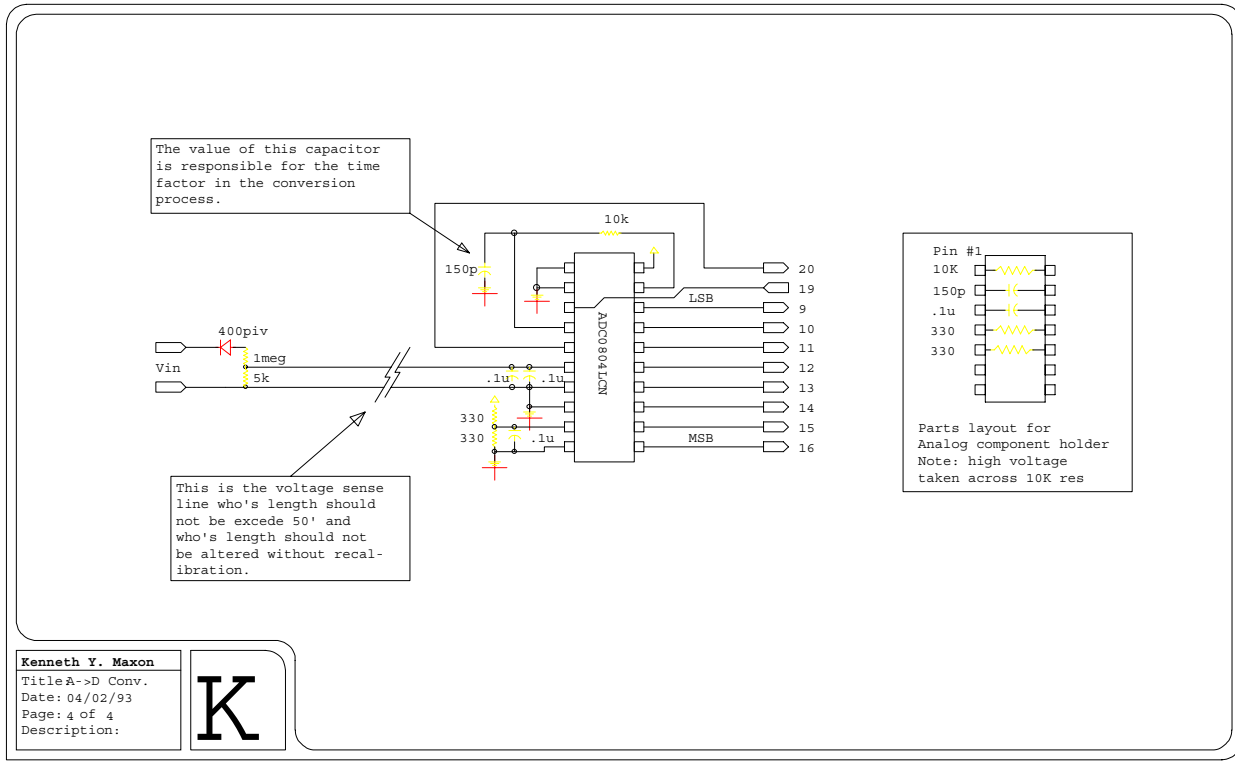
Technical Drawings:

The following pages are included as a courtesy to the purchaser of the complete Stepper Motor Control package. These drawings are provided as a means to aid the purchaser in the even that future problems should arise, please do not distribute them!

This is the Analog driver board. The circuitry found here is duplicated twice in the motor controller hardware, once for each motor.



This is the analog to digital conversion portion of the driver board. Some small changes have been made to prototype here for voltage protection. During initial testing, this unit simple as it may look was the result of many frustrated hours re- designing, building, testing.



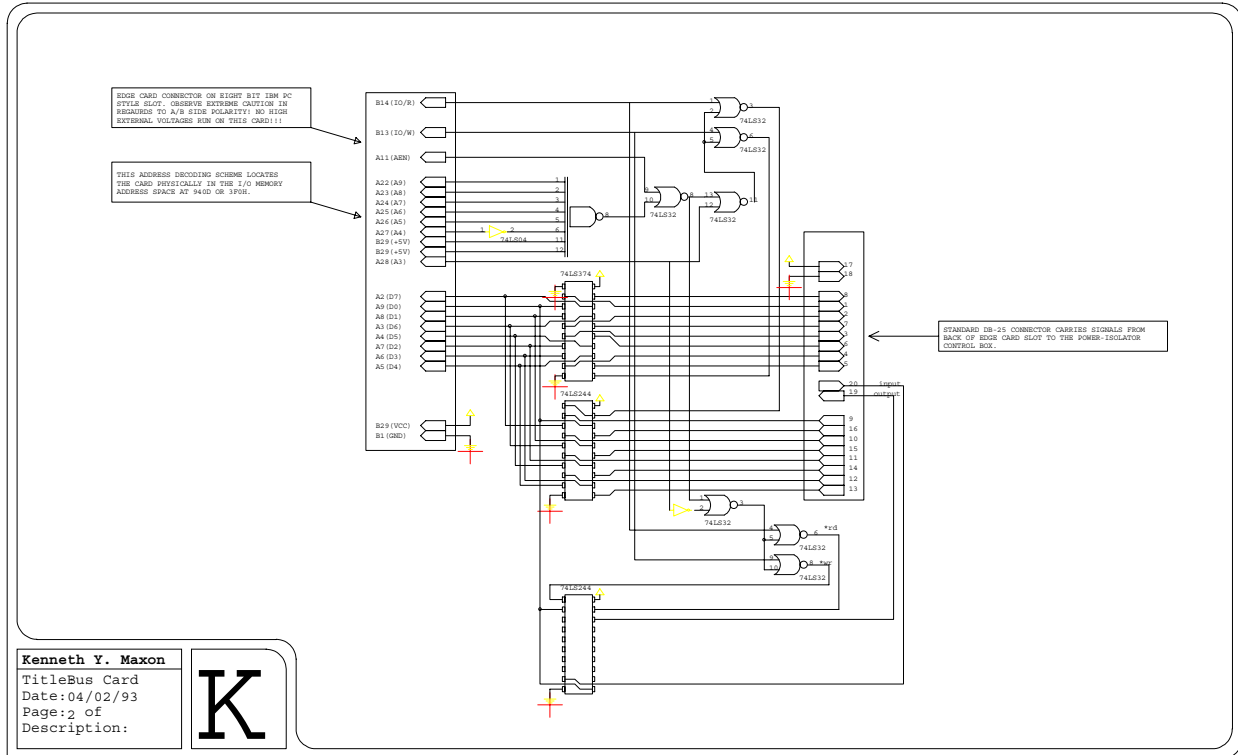
This is design specification for project completion. Included to give an idea of the overall scope of this project.

<p>ANALOG DRIVER BOARD</p> <ul style="list-style-type: none"> 8 -4N35 (IC) 8 -2N3055 POWER TRAN. 8 -330 OHM RESISTORS 8 -1N4001 BARRIER DIODE 8 -1N914 SIGNAL DIODE 4 -27V ZENNER DIODE 8 -10 OHM 10 WATT RES 8 -10 OHM 2 WATT RES 2 -30FT MOTOR CABLES 1 -PC BOARD 1 -25PIN IDC CONN. 6 -SCREW TERMINALS 1 -250 WATT SWITCHING POWER SUPPLY 1 -120V AC SWITCH 1 -POWER LED 1 -1000UF 25V CAPACITOR 1 -250 OHM RESISTOR 1 -CASE 1 -POWER CORD 2 -SLO-SYN STEPPER MOTORS 1 -COOLING FAN MISCELLANEOUS -SCREWS -WIRE -SOLDER -FLUX -MOUNDING HARDWARE <p>SEE PAGE #4</p>	<p>THE LARGEST SINGLE PART IN THIS PROJECT CAME IN THE FORM OF TIME REQUIRED TO COMPLETE THE JOB, AS FOLLOWS:</p> <ul style="list-style-type: none"> 4.5-DESIGN, CONSTRUCTION, TESTING, REDESIGN, MODIFICATION OF THE ANALOG DRIVER BOARD 5.5-RESEARCH, DESIGN, CONSTRUCTION OF THE BUS INTERFACE BOARD 8 -DESIGN, TESTING, BUS MODIFICATIONS. OF A->D BOARD 60-DESIGN, TEST, DEBUGGING PC BASED DRIVER SOFTWARE 5 -CONCEPTUAL DESIGN, ADDITIONAL RESEARCH & LAYOUT.
<p>BUS INTERFACE BOARD</p> <ul style="list-style-type: none"> 2 -74LS244 (IC) 1 -74LS374 (IC) 2 -74LS32 (IC) 1 -74LS04 (IC) 1 -PROTOTYPING CARD 1 -DB25 HOOD CONN. 7 -IC WW SOCKETS 1 -62 PIN IDC CONN. <p>SEE PAGE #2</p>	<p>A->D BOARD</p> <ul style="list-style-type: none"> 2 -10K OHM RESISTORS 1 -50 OHM RESISTOR 2 -330 OHM RESISTORS 2 -.1UF CAPACITORS 1 -150PF CAPACITOR 1 -ADC0804LCN (IC) 1 -PC BOARD 1 -30FT ANALOG CABLE 1 -25PIN IDC CONN. 1 -NEC555 TIMER 1 -74LS04 HEX INVERTER 1 -5VREED RELAY 3 -IC WW SOCKETS 1 -400piv Geranium Dio 1 -10k Pot 8 -Molex connectors <p>SEE PAGE #4</p>

Kenneth Y. Maxon
 Title:
 Date:
 Page: of
 Description:

K

This is the layout for the bus card plugged inside the computer. Extreme caution should be made when working with this board, as I had the wonderful pleasure of Cooking a 386DX mother board due to a wiring error!



The preceding Drawings were rendered in Auto CAD release v11.0, and imported into Microsoft Word using the DXF file translator. Minor Discrepancies concerning the Ground symbol block arose during this process, however all other information remained in tacked while converting.

That's All Folks...