A Control System for Laser Trimming Thick Film Resistors and the Reliability Effects

by

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Abstract

Since the development of thick film hybrid microelectronic processing, there has been a need for methods to adjust for tighter tolerances for electrical components through a trimming process. Components/elements, as produced, show a tolerance of the order of ±10% due to the variability of the screen printing process associated with film curing conditions. The methods that have arisen from this need encompass a variety of technologies and techniques. The usefulness of each method is based on its operation, flexibility, repeatability, and post-trim effects on the resistor's reliability.

The work in this thesis concerns the laser trimming of resistor components to a tight tolerance. It is the objective of this thesis to address the performance of an Nd:YAG laser operation and interface with a computer. The first task involves a computer hardware system to be interfaced to the laser control system, this task includes both design and implementation. The second task consists of a software operating environment to be flowcharted, written, and tested. The third task involves the computer interface driving the laser in the process of trimming resistor components using different types of cuts. The trimmed resistor performance is evaluated as part of the study.

Acknowledgements

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I could not have done this thesis without the enduring help and love that I received from my wife, Paige Walters, during the entire, gruesome adventure. It is because of these things and so many others that I dedicate this thesis to her. I wish that her presence in this project could be made more prevalent.

Table of Contents

	Page
Abstract	**iii**
Acknowledgments	**iii**
Table of Contents	**iv**
List of Figures	**ix**
Chapter 1 Introduction	**1**
1.1 Introduction	1
1.2 Objectives	2
1.3 Proposed Process and Tests	2
1.4 Thesis Structure	3
Chapter 2 Literature Review	**4**
2.1 Methods of Resistor Trimming	4
2.2 Techniques of Resistor Trimming	5
2.2.1 The Single Straight Cut	5
2.2.2 The L Cut	7
2.2.3 The Multiple Straight Cut	8
2.3 Development of Applications	8
2.4 Conclusion	11
Chapter 3 Hardware System	**12**
3.1 System Requirements	12
3.2 Possible Interface Designs	12
3.2.1 IBM XT with DOS and Available I/O Boards	12
3.2.2 IBM XT with DOS and a Constructed I/O Board	13

3.2.3 IBM AT with DOS 13

3.2.4 IBM AT with OS/2 14

3.2.5 Additional Line Conversion Box 14

3.3 Evaluation of Possible Interface Designs 15

3.4 Design Description 15

3.4.1 The I/O Boards 16

3.4.2 The Line Conversion Box 21

3.5 Diagnostics 25

Chapter 4 Software / Programming 26

4.1 System Requirements 26

4.2 Component Description of Internal Laser Controls 26

4.3 Prototype Description 34

4.3.1 Laser System Register Control 34

4.3.2 Linear Motor Manipulation with Joystick Control 35

4.3.3 Resistance Measurements 37

4.4 Principles of Operation 38

4.4.1 LASER Program Operation 39

4.4.1.1 Single Operations 40

4.4.1.1.1 Move Distance 40

4.4.1.1.2 Scribe 42

4.4.1.1.3 Cut a Circle 42

4.4.1.1.4 Index 43

4.4.1.1.5 Hardware Test 43

4.4.1.2 Pattern Cut Menu Options 43

4.4.1.2.1 Create a File 43

4.4.1.2.2 Analyze / Print a File 46
4.4.1.2.3 Edit a File 47
4.4.1.2.4 Run a file 48
4.4.1.3 Resistor Trimming 49
4.4.1.3.1 Resistance Value Acquisition 51
4.4.1.3.2 Single Straight Cut 51
4.4.1.3.3 Double Cut 51
4.4.1.3.4 L Cut 52
4.4.1.3.5 Multiple Straight Cuts 52
4.4.1.3.6 Measurement Test Routines 53
4.4.1.3.7 Trimming Defaults 53
4.4.2 FILEMAKE Program Operations 53
4.5 Conclusion 57
Chapter 5 Resistor Trimming and Aging Experimental Realization 58
5.1 Overview 58
5.1.1 Objectives 58
5.1.2 Testing Configuration 59
5.1.3 Thermal Aging Procedure 59
5.1.4 Testing Results 61
5.2 Analysis of Types of Cut, System Power, and Resistor Tolerances 61
5.2.1 The Single Straight Cut 61
5.2.2 The L Cut with the Elbow at 60% 64
5.2.3 The L Cut with the Elbow at 70% 64
5.2.4 The L Cut with the Elbow at 80% 73
5.2.5 The Double Cut 73

5.2.6 The Serpentine Cut 82

5.2.7 Discussion 82

5.3 Analysis of Resistor Geometry, Types of Cuts, and Resistor Tolerances 91

5.3.1 The Single Straight Cut 94

5.3.2 The L Cut with the Elbow at 60% 94

5.3.3 The L Cut with the Elbow at 70% 94

5.3.4 The L Cut with the Elbow at 80% 95

5.3.5 The Double Cut 95

5.3.6 The Serpentine Cut 95

5.3.7 Discussion 96

5.4 Thermal Aging Results 103

Chapter 6 Conclusions and Recommendations 119

6.1 Conclusions 119

6.2 Recommendations 120

References 121

APPENDIX I ENDPRO Source Code 125

APPENDIX II STARTPRO Source Code 127

APPENDIX III JOYMOVE Source Code 129

APPENDIX IV VELTEST Source Code 131

APPENDIX V LASER Software Flowchart 134

APPENDIX VI LASER Source Code 165

APPENDIX VII LASER / FILEMAKE Include Files 268

APPENDIX VIII FILEMAKE Software Flowchart 272

APPENDIX IX FILEMAKE Source Code 291

APPENDIX X Laser System User's Manual 320

List of Figures

	Page
2.1 The Single Straight Cut	6
2.2 The L Cut	6
2.3 The Double Cut	9
2.4 The Double-Reverse Cut	9
2.5 The Serpentine Cut	10
3.1a BMB A	18
3.1b BMB C	18
3.2a BAC A	19
3.2b BAC B	19
3.2c BAC C	19
3.3a AC A	20
3.3b AC B	20
3.3c AC C	20
3.4 BAC Convertor Board	22
3.5 BMB Convertor Board	23
3.6 AC Convertor Board	24
4.1 Function Groups and IOP Break-up	28
4.2 PC Accumulator Usage	29
4.3 Laser Accumulator Usage	30
4.4 Comparator Flag/Laser Control	31
4.5 Bridge Range/Measuring System	31
4.6 Scanner Position and Channel	32

4.7 Display and Sorting 32

4.8 Overload Readout 33

4.9 Handler Information 33

4.10 The Main Menu 41

4.11 The Pattern Cut Menu 44

4.12 The Create a File Menu 45

4.13 The Resistor Trimming Menu 50

4.14 The Main Measurement Test Menu 54

4.15 The Measurement Test Value Selection Menu 55

4.16 The Trimming Defaults Menu 56

5.1 The Substrate 60

5.2 The Final Tolerances for the Straight Cut 62

5.3 The Breakup of Tolerances for the Straight Cut 63

5.4 The Tolerances of the First Cut of a L Cut with the Elbow at 60% 65

5.5 The Breakup of Tolerances of the First Cut of a L Cut with the Elbow at 60% 66

5.6 The Final Tolerances of a L Cut with the Elbow at 60% 67

5.7 The Breakup of the Final Tolerances of a L Cut with the Elbow at 60% 68

5.8 The Tolerances of the First Cut of a L Cut with the Elbow at 70% 69

5.9 The Breakup of Tolerances of the First Cut of a L Cut with the Elbow at 70% 70

5.10 The Final Tolerances of a L Cut
with the Elbow at 70% 71
5.11 The Breakup of the Final Tolerances of a L Cut with
the Elbow at 70% 72
5.12 The Tolerances of the First Cut of a L Cut
with the Elbow at 80% 74
5.13 The Breakup of Tolerances of the First Cut of a L Cut
with the Elbow at 80% 75
5.14 The Final Tolerances of a L Cut
with the Elbow at 80% 76
5.15 The Breakup of the Final Tolerances of a L Cut
with the Elbow at 80% 77
5.16 The Tolerances of the First Cut of a Double Cut 78
5.17 The Breakup of Tolerances of the First Cut of a Double Cut 79
5.18 The Final Tolerances of a Double Cut 80
5.19 The Breakup of the Final Tolerances of a Double Cut 81
5.20 The Tolerances of the First Cut of a Serpentine Cut 83
5.21 The Breakup of Tolerances of the First Cut of a Serpentine Cut 84
5.22 The Tolerances of the Second Cut of a Serpentine Cut 85
5.23 The Breakup of Tolerances of the Second Cut of a Serpentine Cut 86
5.24 The Tolerances of the Third Cut of a Serpentine Cut 87
5.25 The Breakup of Tolerances of the Third Cut of a Serpentine Cut 88
5.26 The Final Tolerances of a Serpentine Cut 89
5.27 The Breakup of the Final Tolerances of a Serpentine Cut 90
5.28 The Resistor Dimensions 92

5.29 The Numbering Format for the Resistors 93

5.30 The Single Straight Cut 97

5.31 The L Cut with the Elbow at 60% 98

5.32 The L Cut with the Elbow at 70% 99

5.33 The L Cut with the Elbow at 80% 100

5.34 The Double Cut 101

5.35 The Serpentine Cut 102

5.36 The Tolerances for the Control Substrate
after Thermal Aging 105

5.37 The Breakup of Tolerances for the Control Substrate
after Thermal Aging 106

5.38 The Tolerances for the Single Straight Cut
after Thermal Aging 107

5.39 The Breakup of Tolerances for the Single Straight Cut
after Thermal Aging 108

5.40 The Tolerances for the L Cut at 60%
after Thermal Aging 109

5.41 The Breakup of Tolerances for the L Cut at 60%
after Thermal Aging 110

5.42 The Tolerances for the L Cut at 70%
after Thermal Aging 111

5.43 The Breakup of Tolerances for the L Cut at 70%
after Thermal Aging 112

5.44 The Tolerances for the L Cut at 80%
after Thermal Aging 113

5.45 The Breakup of Tolerances for the L Cut at 80%
after Thermal Aging **114**

5.46 The Tolerances for the Double Cut
after Thermal Aging **115**

5.47 The Breakup of Tolerances for the Double Cut
after Thermal Aging **116**

5.48 The Tolerances for the Serpentine Cut
after Thermal Aging **117**

5.49 The Breakup of Tolerances for the Serpentine Cut
after Thermal Aging **118**

Chapter 1

Introduction

1.1 Introduction

With its usefulness, diversity, and size, thick film processing has many applications. Along with this processing technique comes the inherent difficulties of obtaining and maintaining low tolerance components. This fact is particularly true for thick film resistors. Although their geometry can be quite accurate, the screen printing process associated with film curing conditions leads to limited control of the tolerance value. To alleviate this problem, various methods such as abrasive trimming [1,2], radio frequency trimming [3], and laser trimming [4-29] are used to adjust the resistance value to a tighter tolerance. Various standard techniques are applicable for all of the methods that can increase the resistance to a very fine tolerance. The actual tolerance range is a function of both the method and the technique. The trimming process requires that the resistor be designed for less than its final intended value.

The process of trimming a resistor is highly dependent on the capabilities and limitations of the method as well as the techniques used. Each method that can be used involves a control mechanism and a trimming mechanism; each is an essential part of operation. The techniques, such as the L cut and the serpentine cut, are standard for all methods but are better realized in some methods than in others. An abrasive trimmer, for instance, may not be able to make an accurate 90 degree turn that is required for the L cut. A laser system, on the other hand, can make sudden turns and keep the same travelling velocity.

1.2 Objectives

The main objective of this thesis is to design a new control interface and mechanism to connect a standard ESI Model 25 acousto-optic Q-switched Nd:YAG laser trimming system to an IBM XT. This entire system should be able to easily and accurately trim resistors using different techniques. The hardware interface is designed from the component level schematics of the ESI Model 25 laser system and from the requirements of the chosen Input/Output board for the IBM XT computer. When the hardware is completed, the software operating environment is designed for ease of use and for flexible operating options. With a completed control system, resistors are trimmed using different techniques. Both the trimmed as well as untrimmed resistors are then thermally aged for further component evaluation.

1.3 Proposed Process and Tests

The important aspect in the control system is that the computer must be able to control all of the parameters required in laser trimming. The hardware interface and software hand-shaking must be able to address all of the laser's control system functions whether all of the functions are required at one time or not. The software operating environment must provide the user with options to the available parameters as well as to routines for different techniques. The reliability of the resistors is tested by measuring the current leakage during and after thermal cycling has occurred.

1.4 Thesis Structure

This thesis consists of seven chapters. This chapter, Chapter 1, is a general introduction. Chapter 2 presents a literature survey of previously published work related to resistor trimming. In Chapter 3, an evaluation is made of possible hardware interface designs and a discussion is presented about requirements for the laser control system. The software is described in Chapter 4. This involves an understanding of the software system requirements, the discussion of constructed prototypes, and the presentation of the principles of operation of the completed software operating environment. Chapter 5 previews the resistor trimming configuration and the thermal aging procedure. Also in Chapter 5, the results are displayed and evaluated by power and frequency, by resistor geometry, and by post thermal aging stability. Chapter 6 concludes this thesis and provides recommendations for future research.

Chapter 2

Literature Review

2.1 Methods of Resistor Trimming

Due mainly to the limitations of technology and the price of the method, the original methods for resistor trimming were based on abrasive techniques that were similar to a fine streamed sand-blaster [1]. Through the advancement of technology, reliable and relatively inexpensive laser systems were constructed. The two laser systems that were put into production for use as laser trimmers were Carbon Dioxide (CO_2) lasers [2-4] and the acouto-optic, Q-switched Neodymium doped Yttrium Aluminum Garnet (Nd:YAG) lasers [3-4, 12-19, 22, 23-30]. The main difference between the laser systems is that the Nd:YAG laser has a ten times smaller line cutting width than the CO_2. Though the laser systems have far surpassed the accuracy and reliability of the abrasive systems, there is still some debate as to which system performs better under certain specific applications [5]. Most recently, other alternatives such as an electro-optic, Q-switched Nd:YAG systems [6], a radio frequency (RF) technique [7], and an ultrasonic trimming [8] have emerged. All of these methods are based on cutting into a resistor with as small of a straight line width as possible. Even though the obtainable accuracies are within the same range, there has always been discussion about the 'best' type of system [3-6] to obtain a stable performance over a period of time for a certain range of frequencies with minimum parasitics.

2.2 Techniques of Resistor Trimming

It is generally accepted [9-11] that there are three types of popular trimming techniques: the single straight cut, the L cut, and the multiple straight cut. These techniques are relevant for all of the trimming methods since all of the techniques involve straight line cuts into the resistor element.

2.2.1 The Single Straight Cut

The single straight cut (see Figure 2.1) is the simplest and fastest type of cut, but by far gives the least precision of the three techniques. The single straight cut starts at one edge of the resistor and cuts into the resistor perpendicular to the current flow. It is clear that as the cut proceeds further across the resistor, the change in the resistor value will increase more rapidly. The action makes it more difficult to stop the cut at the desired value because, during the time in between the measurement of the resistor's value, the resistance value will have greatly increased. By the time the control system has stopped the trimmer, the resistance will have already passed the desired value. Although this may hypothetically be bypassed by a very slow trim, other effects such as heating and width expansion play a major part in slow trims by adversely effecting the measurement of the resistance value as well as the future operating reliability.

Figure 2.1 The Single Straight Cut

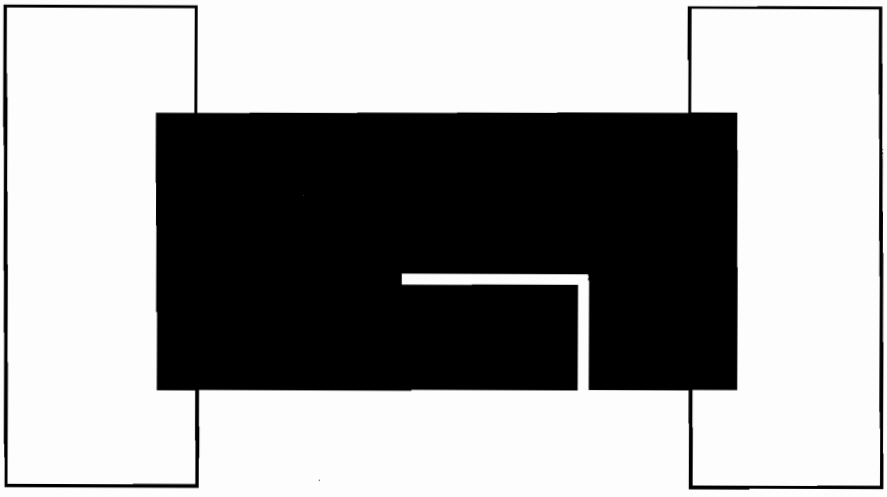

Figure 2.2 The L Cut

2.2.2 The L Cut

The L cut (see Figure 2.2) is much more effective than the single straight cut and does not require much more time. The principle behind the L cut is that once the change in resistance value begins to rapidly increase as the trimmer is cutting perpendicular to the current flow, the trimmer changes direction and cuts serial to the current flow. This change in cutting direction significantly decreases the change in resistance per distance. This allows the trimming control system more time to shut the trimmer off while the resistor value is within tolerance and not have the trimmer cut the resistor out of tolerance while the control system is in the process of shutting the trimmer off. The decision about when the change in direction should be made can be based on a number of different criteria. First, the control system could be made to monitor the change in resistance as well as the resistance value. Once the change in resistance was, for example, three times what it was when the trim was first started, the direction would change. Another way would be to have the direction change when the trimmer was one third of the way through the resistor. A third way would be to do a straight cut to a percentage of the desired resistance value and then to change direction. The L cut offers more options than the single straight cut. The disadvantage is that the L cut can be ineffective on resistors that have a longer length (resistor distance across the conductive pad) than width (resistor distance on free sides between the pads). In these cases, the L cut may reach the end of the resistor and start cutting into the pad while still not being within the desired tolerance range.

2.2.3 The Multiple Straight Cut

The third type of cut is the multiple straight cut. The multiple straight cut is based on the single straight cut but uses multiple cuts to bypass the problem of cutting too deep on any one cut and making tolerance acquisition difficult. There are three standard types of multiple straight cuts. The first is the double straight cut (see Figure 2.3). This cut type uses two cuts, each originating on the same side of the resistor. The second is the double-reverse cut (see Figure 2.4). This is similar to the regular double cut except that the cuts begin from opposite sides of the resistor. The third type of cut is the serpentine cut (see Figure 2.5). This cut uses a number of cuts that alternate origination sides. Although the serpentine cut may seem to give the best results of all of the techniques, a capacitive effect arises due to the configuration of the cuts that can be damaging in high frequency operation. When using multiple cuts, care must be taken so that the spacing between the trims does not violate the rigid power capability of the resistor [10].

2.3 Development of Applications

Focusing on the acousto-optic, Q-switched, Nd:YAG laser in this thesis, there has been a lot of research dealing with specific applications. Aside from using the laser as a scribing tool [12], the Nd:YAG laser is quite a flexible tool. With regard to research dealing with the effects of resistor trimming of specific compositions of resistors, studies have been completed regarding the characteristics of Tantalum Nitride resistors on Silver [13] and the trimming effects on Birox and 1100 series thick film compositions [14]. These studies are accompanied by the laser trimming effects on polymer thick film

Figure 2.3 The Double Cut

Figure 2.4 The Double-Reverse Cut

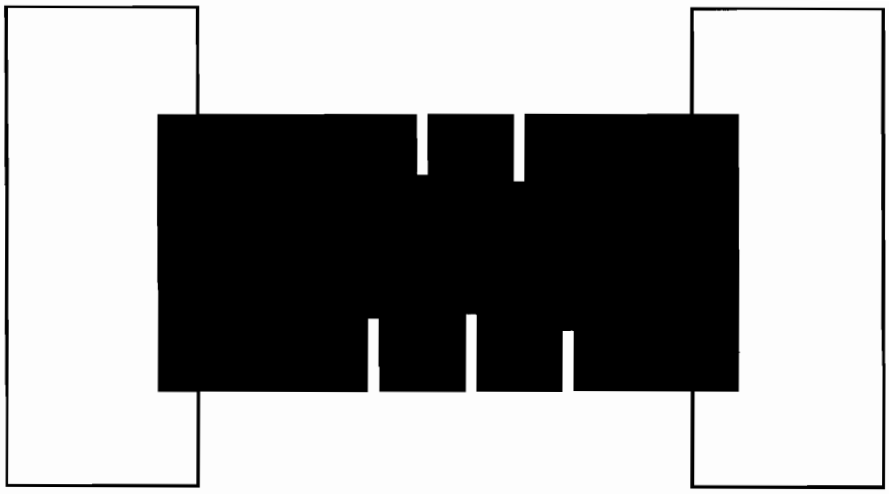

Figure 2.5 The Serpentine Cut

resistors [15] and thermistors that require high accuracy [16-17]. The Nd:YAG provides the flexibility required for the trimming of different types of material. The documented research involved analyzing different power settings for their laser, not whether or not the Nd:YAG would actually cut their material. In measuring the accuracy and reliability of laser trimmed resistors, it is useful to measure against a relatively high standard such as the standard which is required for military applications [18]. The beam size of the Nd:YAG and the possible computer configurations allow for the precision and accuracy required for stringent standards.

2.4 Conclusion

The use of the Nd:YAG laser as a functional tool is well documented. Of the many possible methods to trim thick film resistors, the Nd:YAG laser has been a strong competitor with its precision and accuracy. A set of popular trimming techniques exist that allow for some flexibility in how a particular resistor may be trimmed. The straight cut is simple but not very accurate. The L cut is accurate but may be ineffective on certain types of resistor geometries. This geometry limitation also exists for the multiple straight cuts. The multiple straight cuts provide the tightest tolerance but may add unwanted capacitance at high frequency.

Chapter 3

Hardware System

3.1 System Requirements

The objective of this system is to be as precise and reliable in the full usage of the laser control system while allowing the user full capability to change all available system parameters. The laser control system is asynchronous; therefore, the interface must handle all of the required hand-shaking. The laser control system has three cables of 40 lines through which communication must be maintained. The interface should minimally use the data lines as well as the skip test line to control the laser system. An interrupt line is available but may not be required depending upon whether the interface is polled or interrupt driven.

3.2 Possible Interface Designs

To design the control system interface, all possible PC methodologies are examined. Each system is analyzed using a need, cost, and availability analysis. The following sections detail the different possible interface designs.

3.2.1 IBM XT with DOS and Available I/O Boards

The IBM XT is an 8 bit, 8 Megahertz, 8088 machine. Since a single laser operation requires a 24 bit command followed by an 8 bit input or output, it would take

the IBM XT three machine cycles to produce a single operation. Since DOS is a single tasking operating system, a full hand-shaking scheme can be implemented with either polled or interrupt driven I/O. This is because the computer can wait for the laser to respond to the last task set to it. Since DOS can not perform any other tasks until the laser responds, all of the response methods will perform the same. There are a variety of I/O boards available for the XT that can reasonably perform the desired functions. To fully interface with the laser, the XT requires three I/O Boards; although, not all of the I/O lines will be used. Due to the asynchronous nature of the laser and the logic that it is implemented in, some buffering capability will be required.

3.2.2 IBM XT with DOS and a Constructed I/O Board

Although very similar to the previous option, constructing new boards can conserve a lot of space as well as streamline the hand-shaking both in hardware and in software. The construction of a new board can eliminate ambiguities that occur in the previous system, due to being able to choose how many I/O lines to construct. This new construction can fit on one board. The need for buffering can also be put right on the I/O board. This process requires about four months to design, simulate, wire-wrap, and test.

3.2.3 IBM AT with DOS

The IBM AT is a 16 bit, 12 Megahertz, 80286 machine. This can provide a much faster processing speed because the AT has a faster clock, moves twice as many bits per cycle, and has a much more efficient processor. Because the AT has a 16 bit data bus, the range of available I/O boards fully supports the interface system's need for multiple

I/O lines and for full buffering. An I/O board for the AT will provide all necessary lines on a single board. This board would come at a much higher price. With DOS as the operating system, the interface can work as either polled or interrupt driven without any performance difference.

3.2.4 IBM AT with OS/2

This is equivalent to the previous option except for the major difference in operating conditions due to using OS/2 as an operating system. OS/2 has the capability to multi-task computer events. Using an interrupt driven interface, the user can run a laser program and then immediately afterwards be able to work on building a different laser program or even to switch to any other computer application. This can save the user time when a laser program needs to be run while other computer tasks also need immediate attention. The limitation is that to build the required software support for OS/2 will require an additional four months over DOS. The extra time is also due to the requirement that the system be interrupt driven.

3.2.5 Additional Line Conversion Box

In addition to all of the previous options, a line conversion box can be useful to change the 40 pin laser cable into whatever format the I/O board uses. In essence, the line conversion box will convert the pin-out of the laser control system to the pin-out of the interface system. For those options that do not have the buffering and pull-up capabilities, this will be an ideal place to build those capabilities into the system.

3.3 Evaluation of Possible Interface Designs

Comparing cost, time required, and added advantages, the options are quickly evaluated. Even though the IBM AT system with OS/2 seems almost ideal, the time required to develop the necessary software out-weighs the possible time advantages that OS/2 allows. Since the computer system will be a dedicated machine, the cost of using an AT can not be justified even though the AT would be much faster. The two remaining options involve the IBM XT. Although the construction of a new I/O board may use the computer ports and the number of available lines more effectively, there is no reason for these things to be a factor since the XT will be dedicated to the laser system. The time and cost involved in the construction of the new I/O board is much less efficient than purchasing available boards. Available boards will require the use of a constructed line conversion box for changing the pinouts of the laser to the interface and to add buffering and pull-up capabilities required for the system. Although there is a sacrifice in speed between the AT and the XT, the XT provides sufficient speed for a much better time and cost value.

3.4 Design Description

The hardware interface is made up of three 24-bit serial I/O boards, six cables, and one line conversion box. This interface goes together with the control software to send the right codes at the right time to the laser. There are also two sets of three cables. Each set contains the following cables: BAC, BMB, and AC. The first set of cables goes from the laser to the line conversion box. These cables are D-submarine 37 pin lines. A

second set of cables goes from the line conversion box to the laser. These are 40 pin straight connector lines.

To better understand the process of communicating with the laser, this description will assume that the coding of a function into a function number, an IOP number, and accumulator usage has already been done in the control software. The software translated code is sent to the I/O boards, which will be the first topic of discussion. From the I/O boards, the code goes through the first set of cables to the line conversion box. Here, the individual lines are rearranged into the form that the laser expects to see them. The line conversion box will be the second topic of discussion.

3.4.1 The I/O Boards

The key to the information exchange between the two systems is to organize the interface in a manner that both the PC and the laser can understand. There are a number of difficulties that arise due to the differences between the PC and the laser code usage. Since the laser was originally designed for use with a PDP/8e, the codes are made up of octal numbers (sets of three bits). With the BMB line, three of the binary digits are required in their complement form. The laser, on the other hand, does not independently produce complements of any line and communicates in hexidecimal (sets of four bits). This leads to a need to create a conversion standard that allows each system to operate in its regular environment. Note that the address and the IOP numbers for the laser are read from the charts as octal numbers (sets of three bits). The PC and I/O boards deal in hexidecimal code (sets of four bits).

The three 24-bit serial digital I/O interface boards are inside the PC and are given addresses 300H, 304H, and 308H for the BMB, AC, and BAC lines, respectively. The

I/O boards chosen are Omega Engineering, Inc.'s Model PI012, 24 Bit Parallel Digital I/O Interface Boards. Each of the I/O boards is broken up into 3 sets of 8-bit ports. Each port is given a letter from A to C. This requires that there be a correspondence between each laser cable and each bit coming into/out of the I/O boards. For better troubleshooting and understanding, each I/O board corresponds to one of the laser cables. Therefore, each board is labeled by the corresponding line. The BMB line carries the function address in six bits as well as three of the six address bits in their complement form. The BMB I/O board divides the bits up according to Figure 3.1a-b. The BAC line (Figure 3.2a-c) carries the PC accumulator of 12 bits, the IOP of 3 bits, and an initialization bit. The AC line (Figure 3.3a-c) carries the laser accumulator of 12 bits, an interrupt request bit, and a skip test bit. Listed with the laser line name is its internal, laser connector number.

The address is formed by taking the "10's" digit of the address, breaking it up into an octal number, and putting it into BMB03-BMB05 with BMB03 being the most significant bit(msb). After putting the complement of BMB03-BMB05 (i.e. BMB03'-BMB05') into its place, take the "1's" digit of the address, break it up into an octal number, and put it into BMB06-BMB08. To form a code, the address is loaded on the BMB line (and data into the PC accumulator on the BAC line if the particular function needs data). A '1' is loaded in the correct IOP number's bit and then a '0' placed into that bit. This has the effect of a pulse. If the function does not use the PC accumulator but does use the laser accumulator or the skip line, a '1' is loaded into the correct IOP line, and the data is received from the AC line. After the data has been received, the IOP line is dropped to '0'. The data on the AC line only remains valid while the correct IOP line is high.

A7	A6	A5	A4	A3	A2	A1	A0
0	0	BMB03 J1	BMB04 M1	BMB05 S1	BMB06 E2	BMB07 K2	BMB08 P2

Figure 3.1a BMB A

C7	C6	C5	C4	C3	C2	C1	C0
0	0	0	0	0	BMB03' H1	BMB04' L1	BMB05' P1

Figure 3.1b BMB C

Figure 3.1 The BMB Line

A7	A6	A5	A4	A3	A2	A1	A0
BAC00 B1	BAC01 D1	BAC02 E1	BAC03 H1	BAC04 J1	BAC05 L1	BAC06 M1	BAC07 P1

Figure 3.2a BAC A

B7	B6	B5	B4	B3	B2	B1	B0
0	0	0	0	AC08 S1	AC09 D2	AC10 E2	AC11 H2

Figure 3.2b BAC B

C7	C6	C5	C4	C3	C2	C1	C0
0	0	0	0	BINT V2	IOP4 P2	IOP2 M2	IOP1 K2

Figure 3.2c BAC C

Figure 3.2 The BAC Line

A7	A6	A5	A4	A3	A2	A1	A0
AC00 B1	AC01 D1	AC02 E1	AC03 E1	AC04 J1	AC05 L1	AC06 M1	AC07 P1

Figure 3.3a AC A

B7	B6	B5	B4	B3	B2	B1	B0
0	0	0	0	AC08 S1	AC09 D2	AC10 E2	AC11 H2

Figure 3.3b AC B

C7	C6	C5	C4	C3	C2	C1	C0
0	0	0	0	0	0	SKIP K2	INTR M2

Figure 3.3c AC C

Figure 3.3 The AC Line

3.4.2 The Line Conversion Box

The line conversion box basically converts the 37 pin cable to the 40 pin cable. Those lines that transfer information from the PC to the laser (i.e. BMB and BAC) are also buffered so that they can supply the laser's DTL transistors with enough current to operate. The AC lines have pull up resistors on them because the laser transistor logic goes tri-state when the lines are not in use.

Once the code is placed on the I/O board's ports, the signal needs to be transferred to the laser. As noted before, the individual line order that the laser and the PC use the are very different. The line conversion box is made of three perforated boards, one for each line. The BAC and BMB boards each have a 74LS244N buffer chip. The AC board has a pull-up resistor for each one of its data lines. Figure 3.4 displays the BAC board pin configuration with the line numbers from the PC cable, the board position of the individual lines from the PC, the pin and chip that line is connected to, the pin that line is buffered out to, the board position that the laser cable is connected to that takes that line, and the line number of each line on the laser cable. Figure 3.5 displays the BMB board pin configuration with the line numbers from the PC cable, the board position of the individual lines from the PC, the pin and chip that line is connected to, the pin that line is buffered out to, the board position that the laser cable is connected to that takes that line, and the line number of each line on the laser cable. Finally, Figure 3.6 shows the line number of each line from the laser's AC cable and the corresponding line number of each line on the PC's AC cable.

PC Line Number	PC Board Position	Pin from PC	Chip	Pin to Laser	Laser Board Position	Laser Line Number
BAC00-22	12	2	U1	18	21	4
BAC01-24	13	4	U1	16	19	8
BAC02-26	14	6	U1	14	17	12
BAC03-28	15	8	U1	12	15	16
BAC04-30	16	11	U1	9	13	20
BAC05-32	17	13	U1	7	11	24
BAC06-34	18	15	U1	5	9	28
BAC07-36	19	17	U1	3	7	32
BAC08-13	1	2	U2	18	2	36
BAC09-15	2	4	U2	16	20	6
BAC10-21	3	6	U2	14	18	10
BAC11-19	4	8	U2	12	16	14
BIOP1-20	9	11	U2	9	14	18
BIOP2-18	8	13	U2	7	12	22
BIOP4-16	7	15	U2	5	10	26
BINT-14	6	17	U2	3	1	38

Figure 3.4 BAC Convertor Board

PC Line Number	PC Board Position	Pin from PC	Chip	Pin to Laser	Laser Board Position	Laser Line Number
BMB03-26	14	2	U1	18	7	32
BMB04-28	15	4	U1	16	11	24
BMB05-28	16	6	U1	14	15	16
BMB06-28	17	8	U1	12	10	26
BMB07-28	18	11	U1	9	14	18
BMB08-28	19	13	U1	7	18	10
BMB03'-28	7	15	U1	5	5	36
BMB04'-28	8	17	U1	3	9	28
BMB05'-28	9	2	U2	18	13	20

Figure 3.5 BMB Convertor Board

Laser Line Number	PC Line Number
AC00-4	36
AC01-8	34
AC02-12	32
AC03-16	30
AC04-20	28
AC05-24	26
AC06-28	24
AC07-32	22
AC08-36	19
AC09-6	17
AC10-10	15
AC11-14	13
INTR	20
SKIP	18

Figure 3.6 AC Convertor Board

3.5 Diagnostics

In order for the interface to be diagnosed for trouble-shooting purposes, VELTEST was written to test the data process from the PC to the laser. By monitoring either output of the linear motor's velocity digital-to-analog convertors on an oscilloscope, a diagnosis can be made about the accuracy of the BMB and the BAC lines. VELTEST simply ramps each of the motors velocities from a digital -125 to 125. This gives an analog output ramping from -0.67 Volts to +0.67 Volts. If the ramp function is not seen, there is a problem with the BMB line. If the ramp function is not continuous, there is a problem with the BAC line. To figure out which bit line is in error, LINETEST can be used to set and clear all of the bit lines on both the BAC and the BMB lines. The source code for VELTEST is found in Appendix X.

Once the input lines are secure, the AC line can be tested. This can be quickly seen from running the LASER program. When the laser control system is initializing, the laser head should be sent to its home position. If the returned "current position" is not (0,0), there is a problem with the AC line. To find the bit line in error, only the pull-up resistor values must be checked.

Chapter 4

Software / Programming

4.1 System Requirements

A completed interface will provide laser system register control, linear motor manipulation, and resistor trimming. Laser system register control involves sending values to specific registers and recognizing them. This will confirm that the register is being properly addressed and that the input lines to the laser system are operating. This will be witnessed by selecting the register that controls the laser's control panel lights. Linear motor manipulation requires the use of the previously established register selecting capability and an additional register output acquisition. This register output acquisition will be satisfied by the receipt and decoding of the linear motor position. The ability to trim resistors will be available once the linear motor manipulation is completed, but the resistor trimming requires high speed and high accuracy with motor movement and with data acquisition. The errors involved in resistor trimming are easily monitorable and upon system completion, will ensure a secure interface. All of the functions are included in one final operating environment that also includes an initialization sequence.

4.2 Component Description of Internal Laser Controls

For the Model 25 System, there are three lines through which communication takes place: BMB, BAC, and AC. Each line is unidirectional. The BMB and BAC lines

send information from the PC to the laser, while the AC line returns information from the laser to the PC.

All of the possible functions that the current Model 25 laser can accomplish are shown in Figure 4.1. Each function group has a unique address and consists of three functions. The individual functions are selected by pulsing the respective IOP line. The laser accumulator (AC lines) contains information that the laser has for the PC to read. The PC accumulator (BAC lines) has information that the PC has for the laser to read.

Knowing what laser function needs to be executed is only the beginning of the communication process. Figure 4.1 shows the function group in the left column and the tri- IOP function break-up in the right column. Figure 4.2 displays the PC accumulator usage, while Figure 4.3 shows the laser accumulator usage. Note that the meanings of some of the bits for certain accumulator usage are detailed in Figures 4.4 to 4.9.

The first step in accessing a function is to look it up in Figure 4.1 and record its address and its IOP number. If that function uses the PC accumulator, the required bits are needed from Figure 4.2 to do the function properly and must be obtained. If that function uses the laser accumulator, a note should be made about how the information is sent back to the PC through the laser accumulator so that it can be processed correctly. This information is available from Figure 4.3.

A complete operation to have the laser perform a particular function requires the following:

1. Load the address on the BMB line.
2. Load the PC accumulator on the BAC line.
3. Pulse the correct IOP line on the BAC line.

At this point, the laser knows what function is selected and acts on it.

Function	Address	IOP1	IOP2	IOP4
Programmable Time Delay	13	Skip on end of Delay	Load Delay, Start, Clear Flag	Send Probe Down
Comparator Flag/ Laser Control	15	Skip on "0" Crossing	Clear and Disable "0" Crossing Flag	Load Laser Control and Enable "0" Flag
Convertor Control/ Preamp Gain	16	Start Convertor & Clr Overload Flag	Load Gain	
Comparator Limit	16			Load Comparator
Convertor Readout	17	Skip on End Conversion	AC Clear	Read Convertor
Bridge Range	30		Load Range	Load Function
Generator Voltage	31		Load Generator Voltage	
Detector Gain	31			Load Detector Gain
Conductance Standard	32	Skip on Strobe Done	Load Standard	Measurement System Strobe
Axis Select/Rest Test	40	Select the X-axis	Select the Y-axis	Skip on Rest
Table Position	41	Clear Counter	Read the MSB	Read the LSB
Distance to Go	42	Load the MSB and Set Low Power	Load the LSB	Skip if No Count
Velocity & Accel/ Home Latch	43	Load Velocity & Acceleration	Clear the Home Latch	Skip on the Home Latch
Overtravel, Overshoot, Joystick	44	Skip on Interrupt	Clear Interrupt	Read Overtravel, Overshoot, Joystick
Overload Readout	52	Clear Overload Flag	Clear AC	Read Overload Status
Scanner, Position, and Channel	53	Skip if Ready	Load Position	Load Channel and Probe Number
Display and Sorting	56	Clear Manual Functions	Load Display and Sorting	
Handler Information	56			Read the Manual Functions

Fguure 4.1 Function Groups and IOP Break-up

Function	Address	BAC											
Programmable Time Delay	13	2048	1024	512	256	128	64	32	16	8	4	2	1
Comparator Flag/ Laser Control	15	X									X	X	X
Convertor Control/ Preamp Gain	16												1=8x 0=1x
Comparator Limit	16	-	MSB	←								→	LSB
Bridge Range/ Measurement System	30												
Generator Voltage	31	1= + 0= -	8	4	2	1	0.5	0.25	0.125				
Detector Gain	31	256	128	64	32	16	8	4	2	1	0.5	0.25	0.125
Conductance Standard	32												
Distance to Go Upper	42									MSB	←		→
Lower	42	←										→	LSB
Velocity & Accel/ Home Latch	43	1= - 0= +	64	32	16	8	4	2	1	0.5	0.25	16x	HI G
Scanner, Position, and Channel	53	MSB	LSB					MSB	←			→	LSB
Display/ Sorting	56	X	X	X								X	X

Figure 4.2 PC Accumulator Usage

Convertor Readout	17	MSB	←									→	LSB
Table Position Upper	41									MSB	←		→
Lower	41		←									→	LSB
Overload, Overshoot, and Joystick	44	+OT	-OT	OS	0 = +OT	0 = -OT	0 = -Vel				0 = Scan	+ Dir	
Overload Readout	52	X	X			X	X	X	X	X	X	X	X
Handler Information	56	X	X	X	X	X							X

Figure 4.3 Laser Accumulator Usage

AC Bit	Function
0	Limit Crossing Detector (0=normal (+to-), 1=reverse (-to+))
9	Laser On Unconditionally
10	Auxiliary Limit Crossing Selection (Else the Bridge Comparator is selected)
11	Laser On if Limit Crossing Flag is '1'

Figure 4.4 Comparator Flag / Laser Control

Bridge Range	AC00	AC01	AC02	AC03
1.	0	0	1	0
2.	0	1	0	0
3.	0	1	1	0
4.	1	0	0	0
5.	1	0	1	0
6.	1	1	0	0
7.	1	1	1	0
8.	X	X	0	1
9.	X	X	1	1

System Function	AC04	AC05	AC06	AC07
Resistance	X	0	0	0
Voltage	X	1	0	0

Figure 4.5 Bridge Range / Measuring System

Channel	AC00	AC01	AC06 to AC11
A (C1, P1)	0	1	Probe number (0-63)
B (C2, P2)	1	0	Probe number (0-63)

Figure 4.6 Scanner Position and Channel

AC Bit	Function
00	Handler Advance
01	Initial Reject
02	Final Reject
10	Process Complete
11	In Process

Figure 4.7 Display and Sorting

AC Bit	Overload Function
00	Integrating Converter Overload (+)
01	Peak Overload (Any one or all bits 4-11)
04	Guard Overload (+)
05	Guard Overload (-)
06	Detector Preamp (+)
07	Detector Preamp (-)
08	Bridge (+)
09	Bridge (-)
10	Bridge Power (+)
11	Bridge Power (-)

Figure 4.8 Overload Readout

AC Bit	Function
00	Emergency Stop
01	Single Step
02	Load Position
03	Index
04	Start Sequence
11	Resistance Only

Figure 4.9 Handler Information

A complete operation to read the status of a particular register requires the following:

1. Load the address for that register on the BMB line.
2. Pull the correct IOP line high on the BAC line.
3. Read in the laser accumulator data from the AC line.
4. Drop the IOP line to its ground state.

4.3 Prototype Description

Before the operating environment can be constructed, a series of test codes must be written to confirm the hardware construction, to verify laser control sequences, and to build a base for more complex function accessing. A detailed description follows on the accomplishment of each of the three benchmarks: laser system register control, linear motor manipulation, and resistor trimming.

4.3.1 Laser System Register Control

Controlling the laser system's registers is a basic step, but a step that requires that the hardware output functions are operating as well as an understanding of the laser function encoding process. The goal of this benchmark is to turn on and off the laser's control panel lights. In particular, the "In Process" and the "Process Complete" lights are used. From Figure 4.4, the address for loading data into the display-and-sorting is an octal 56 with a pulse on IOP 2. From Figure 4.7, the bit responsible for the "In Process" light is bit 11, and the "Process Complete" light is bit 10. A value of 1 in this register turns on the light, and a value of 0 turns off the light. Toggling between the two lights

was accomplished by using the ENDPRO and STARTPRO programs. ENDPRO turned on the "Process Complete" light and turned off the "In Process" light. STARTPRO turned on the "In Process" light and turned off the "Process Complete" light. The source code for ENDPRO and STARTPRO are located in Appendix I and II, respectively.

4.3.2 Linear Motor Manipulation with Joystick Control

Linear motor manipulation is accomplished through dialogue between the laser and the interface. Along with sending codes to the laser, the hardware and software must accept and decode data from the laser. The test program will involve using the joystick on the laser control panel to signal a direction and speed. The interface will recognize this request and send the appropriate function calls back to the laser. When the joystick is in its upright position, i.e. when no direction and speed are selected, the interface reads the current laser position. With this benchmark completed, the stability of the hardware and the process in which laser function encoding and decoding takes place are completely tested and verified. Information that the interface sends to the laser includes an axis select (octal address 40 and IOP 1 or 2), a velocity/acceleration setting (octal address 43 and IOP 1), the lower 12 bits of the distance to go (octal address 42 and IOP 2), and the upper 4 bits of the distance to go (octal address 42 and IOP 1). The data that the interface will receive from the laser includes a reading of the lowest 12 bits of the table position (octal address 41 and IOP 4), a reading of the highest 4 bits of the table position (octal address 41 and IOP 2), and a reading of the joystick position (octal address 44 and IOP 4).

The JOYMOVE program successfully completes the linear motor movement using the joystick. The program continuously polls both the x-axis and the y-axis

joystick registers to check for any movement. The laser treats the joystick as two separate joysticks, one for each direction. Therefore, there are two joystick registers. The joystick, itself, also has the capability to sense if it is at an angle greater than 45 degrees from its normal upright position. If it is at an angle greater than 45 degrees, it sets the appropriate flag in the appropriate joystick register where that the angle occurs. The steep angle of the joystick is used to reflect a faster speed of travel. When the joystick is in its upright position, the computer reads the current position of the laser. When the joystick is moved, the respective register(s) will reflect whether the joystick is angled in a positive or negative direction and whether that angle is greater than 45 degrees from its normal upright position. The computer recognizes the joystick movement on the next polling. The joystick registers are then decoded. The computer immediately encodes and sends a signal to the laser to move in the appropriate directions. On a slow move, the computer sends a velocity of 2 decimeters per second, while on a fast move it sends a velocity of 6 decimeters per second.

The table position that the laser sends back to the computer is incorrect until the linear motors are both moved across their origins. This is a laser initialization process, not an interface problem. At this point, this inconsistency is of no concern because the based on distances, not positions. Eventually, the initialization of the laser will be required for proper laser control system operation. In the final operating environment, an initialization sequence includes sending both motors to their origins.

4.3.3 Resistance Measurements

The final task only accounts for those functions that have not already been utilized. The remaining functions are those involved with resistor measurement. The only major difference between resistor measurement and resistor trimming is the continuous measurements with the laser on during a resistor trim. There are also other minor differences due to having a better first approximation of the nominal value of the unknown resistor with the resistor trim. This saves time during a trim and allows the latest measurement to better reflect the actual value of the resistor as it is being trimmed. It is sufficient to show for this task that the measurement process is properly accessed.

The laser uses a Wheatstone Bridge to calculate the resistance difference from a configurable comparison value. The measurement system in the laser returns the difference between the comparison value and the unknown resistance value. The first step in a measurement is to define a comparison value. In the measurement of an unknown resistance value, the comparison value will begin at the relatively low value of 500 ohms. The feedback that the computer receives from the laser measurement system after a measure includes a flag that represents if the comparison value is out of the measurable range. While the comparison value is out of range, the comparison value is multiplied by 2. This multiplication factor is small enough that it will not step the value over the measurable range of an unknown resistance value. When the value steps in range, it is stepped back out and then in again at a rate of 1.25 until the value is within the detectable difference range. The detectable difference range is only about half the size of the measurable range. Once the comparison value is within the detectable difference range, the computer decodes the difference and calculates the new comparison value. A new difference is recorded, and the comparison value is again recalculated. This

recalculation is required because it is possible to increase the gain when the comparison value is close to the actual value in order to achieve a much greater resolution. It only takes the computer two or three recalculation periods before the tightest resolution is achieved.

4.4 Principles of Operation

This section goes in-depth into the operating environment and the accessing of all available laser functions from the original code. For more information about the conceptualization of the environment, the illustrating flowcharts are provided in Appendix V and Appendix VIII. A by-product of this operating environment is a laser system user's manual that is included in Appendix X.

The original code was written and compiled in the Microsoft C 5.1 environment. There are two executable files: LASER and FILEMAKE. Some of the functions used in both LASER and FILEMAKE are from a separate library from the C TOOLS PLUS software package. In order to keep the terminology serial, a description of words to be used follows. A **program** is a C code file (with a .C extension) like LASER.C and SAVING.C. An **executable program** is a file with an .EXE extension that can be run. These are the LASER.EXE and FILEMAKE.EXE files. A **function** is a name inside a program that represents a set of commands and/or other functions. A **module** is the set of commands and/or functions that defines a function and is followed by (). In other words, a function is defined by a module that contains commands and/or other functions.

This code has been streamlined to reduce the size and confusion caused by hefty code. A difficulty that arises from this is that a lot of the functions are called by several other modules that will each do something different with the information provided.

Sometimes the reason that a module will perform a process that makes no sense with respect to a certain way that it is called makes perfect sense with respect to a different way. In the particular case of the 'set_up_a_loop()' module, the module is itself recursive. This means that under certain circumstances, the module will call itself. The header at the beginning of the module lists the users and modules called.

4.4.1 LASER Program Operation

The LASER program is the main file that processes the complete set of all laser functions. The LASER program is made up of five separate files: LASER.C, SAVING.C, NEWSTUFF.C, MEASINCD.C, and MOVEINCD.C. These are put together by the program list LASER.MAK. The program list has the proper library calls, including MT5_M5M.LIB from C TOOLS PLUS that defines certain external functions. For the LASER program, there is also a set of include files to allow for inter-program function calling. These include files are BWINDOW.H, GLOBLVAR.H, EXTRNVAR.H, MOVEINCD.H, MEASINCD.H, NEWSTUFF.H, LASER.H, SAVEINCD.H. The source code listings for LASER.C, SAVING.C, NEWSTUFF.C, MEASINCD.C, and MOVEINCD.C are included in Appendix VI, while the listing of the include files for LASER are in Appendix VII.

As the names of the four programs of the compiled LASER program suggest, each program contains the majority of a certain type of operations. The LASER.C program mainly coordinates the entire effort with the Main Menu as well as the single, individual operations such as the scribe, the circle cut, and the move option. The SAVING.C program contains all of the Pattern Cut Menu with pattern sequence options like creating, editing, and running patterns. The NEWSTUFF.C program incorporates all

of the resistor trimming menu systems and operations involved in the break-up of the a complete measurement system operation into sub-modules. The MOVEINCD.C program contains all of the code sequences that translates the intention to move, to turn laser on, etc. into number sequences that the laser understands. The MEASINCD.C program translates all of the resistor trimming intentions into correct number sequences for the laser. By subdividing the entire system and compiling it with a program list, any program or set of programs can be edited without having to re-compile the entire system. This saves time during testing, compiling, and future additions.

The executable program begins in the LASER program. The first function that LASER operates initializes all the laser systems registers as well as sends the laser to its home position. Once this initialization has been achieved, the laser system will not need to be initialized again until after the entire system has been shut down. At this point in the LASER program, the operation of the system is in the hands of the user. The main menu, Figure 4.10, is displayed, and the user is prompted to select an option. All of the screen display functions are from the C TOOL PLUS software package. Depending on the option chosen, the system will operate the particular sequence that may encompass all of the four programs. Listed below are the paths in which each option will go.

4.4.1.1 Single Operations

4.4.1.1.1 Move Distance

This option will perform a move of the users choice; with the joystick or with a distance entered by the user. The computer will then prompt for a further move. When all moving has been completed, the main menu is redisplayed.

```
Laser Operating System

What would you like to do?

1. Move distance
2. Scribe
3. Pattern cut
4. Cut a circle
5. Index
6. Resistor trinming
7. Hardware test
8. Test measurenent system
9. Exit

Option:

System Status
Current Position: 0, 0
```

Figure 4.10 The Main Menu

4.4.1.1.2 Scribe

In a scribe, the user will define the endpoints by using either the joystick or distances, as well as define the cutting speed and the number of repetitions that the laser will make over the object. Once all of the scribes have been completed, the main menu is redisplayed.

4.4.1.1.3 Cut a Circle

This option takes advantage of a circle cutting module that is used for pattern cutting, but does not in itself cut the circle. It is responsible for getting the necessary information in order to run the other module. The two modules are not together because there are other modules that also need circles to be cut, but already have the necessary information that this main menu option does not have. As discussed before, the actual circle cutting module is one of modules that is called by many modules with different needs. The path to this cutting module requires that the user enter the necessary information as opposed to already having the information in a file. The necessary information consists of finding the origin of the circle, defining the radius, and determining whether or not the circle needs to be saved. After all of the information has been entered, the circle is actually cut.

4.4.1.1.4 Index

Indexing means the laser is sent back to its internal (0,0) position. This is accomplished by reading the internal position and moving the opposite directional distance.

4.4.1.1.5 Hardware Test

This is not a test of the laser hardware but of the interface hardware between the laser and the computer. This test is completed by simply indexing laser. If the laser will not index, something is wrong with the interface.

4.4.1.2 Pattern Cut Menu Options

This option has its own menu, the pattern cut menu. The pattern cut menu appears on the screen as it is shown in Figure 4.11. Depending on the users choice, one of the following will be done.

4.4.1.2.1 Create a File

After the user enters the name of the file to be created, the computer will check if that file already exists. If the file does already exist, the user is alerted, and the pattern cut menu is redisplayed. If the file does not already exist, the user is prompted for the velocity at which the laser will travel when the laser is ON. With this information stored, the create-a-file menu appears (see Figure 4.12). The user will enter the pattern

```
Laser Operating System

What would you like to do?

1. Create a file
2. Analyze / print a file
3. Edit a file
4. Run a file
5. Main menu

Option:

System Status
Current Position: 0, 0
```

Figure 4.11 The Pattern Cut Menu

```
Laser Operating System

What would you like to do?

   1. Move to a position
   2. Distance move
   3. laser On
   4. Laser off
   5. Circle cut
   6. Start a loop
   7. Repeat a loop

   9. Exit

        Option:
```

```
System Status
Current Position: 0, 0
```

Figure 4.12 The Create a File Menu

sequence that he wants. The computer treats each single operation as an action with possible parameters. Each action is given a number. Depending on the user's next step, the computer stores that particular action number in the file and then prompts for the parameters of that step if any exist. For instance, the "distance move" will have two parameters, x and y distance, while the "laser on" will have no parameters. Since the parameters are obtained from the user as ASCII characters, the parameters must be transformed into numbers. The parameters are stored in the file right after the action number. Once the user has completed entering his sequence and selects the exit option, an "end of file" action number is saved in the file, and the file is closed. Control goes back to the pattern cut menu.

4.4.1.2.2 Analyze / Print a File

After the user enters the name of the file to be analyzed, the computer will check if that file already exists. If the file does not already exist, the user is alerted and the pattern cut menu is redisplayed. If the file does exist, the computer will ask the user if the file should be printed and analyzed. If the user wants the file printed, the user must turn on the printer. The computer will read the file line by line and keep track of each of the individual actions and their parameters. The circles, laser ons, laser offs, loops started, and loops completed are counted, and the final laser position would be are saved. If the file is to be printed, the computer reads each line and it sends a line to the printer that displays the action, its parameters, the instantaneous position of the laser, and the velocity of the laser. Nested loops are handled as a general case of looping with a single loop as the special case. The program keeps accurate tabs on the effects of loops by storing the number of times that each loop is to be completed along with the difference in

position between the start of the loop and the end of one repetition of that loop. This way, the number of times that each counted action is performed, as well as the final position, can be multiplied by the proper factor to represent all iterations of the nested loops. All of the final counts and the final position are displayed on the screen and sent to the printer if the user wanted the file sent there. Control is then passed back to the pattern cut menu.

4.4.1.2.3 Edit a File

After the user enters the name of the file to be edited, the computer will check if that file already exists. If the file does not already exist, the user is alerted, and the pattern cut menu is redisplayed. If the file does exist, the computer will create a back up of the file. After creating or overwriting a file with the same filename but with an '.old' extension, the computer copies each action, one at a time, with their parameters to the backup. When this task is completed, the backup is used as a source file and editing (inserting, deleting, or changing) is performed by confirming each action as the backup is copied back to the filename with the '.new' extension. Starting with the cutting velocity, each action is displayed one at a time on the screen, and the user is asked if that line is correct. If the user says that the line is correct, the next action will be displayed. If the user does not want the particular action, whether it is because it should not be there, something should be before it, or that the parameters are incorrect, the computer will prompt for the wanted changes. The first question asked is if other actions (commands) need to be inserted. If they do, the create-a-file menu (Figure 4.4.1.2.1) is displayed, and the user can enter as many other actions as needed that will precede the action that was in question. These other actions are stored in the '.new' file. Once this is done or if nothing

was to be inserted, the next question is to decide whether or not to delete the action in question. If the user responds to the deletion, the action is not transferred back to the '.new' extension, and the next action is displayed. If the user keeps the action and if the action has parameters, the user is asked if the parameter need to be changed. If so, the computer will prompt for the new parameters. Otherwise, the next action is displayed. Another option from the original prompt is 'q' for quit. This option will transfer the remaining actions from the backup file to the '.new' file.

4.4.1.2.4 Run a file

After the user enters the name of the file to be run, the computer will check if that file already exists. If the file does not already exist, the user is alerted and the pattern cut menu is redisplayed. If the file does exist, the computer processes the file by reading one action (with its parameters) and sending the appropriate command to the laser. If a loop is encountered, some fancy processing is required. This is accomplished by setting up an array that can hold all of the actions and their parameters that make up that loop. Nested loops are taken care of by calling a module recursively. This only adds another dimension to the array while allowing for multiple loops. This option processes the actions in the same way as editing is performed but it gets the actions and their parameters from the array as opposed to straight from the file. When the file has been completely processed, the final position as well as the number of circles, laser ons, laser offs, and loops are displayed. After this action is completed, the pattern cut menu is displayed.

4.4.1.3 Resistor Trimming

This option has its own menu, the resistor trimming menu. The resistor trimming menu appears on the screen as it is shown in Figure 4.13. All of the options under this menu except for the changing of the trimming defaults (Figure 4.16) require resistor probes to be in place on the laser and entered into the computer. Each option will request the probe numbers if no probes were previously entered; otherwise, a confirmation of the probes numbers will occur. Since there is no way that the computer can compare probe location with resistor location, the computer assumes that the user knows which resistor corresponds to the selected probes. The user is also responsible for making sure that the power supply is operating and that there are no open interlocks when a trim is to take place. If there is any problem during a laser trim or if the trim hit its final destination without trimming the resistor within tolerance, the user can strike the STOP button on the laser control to regain computer control and to turn off the laser.

The actual laser trim is a complicated process by which the computer carefully monitors the resistance value of a resistor as it is being cut. When the resistor is within the tolerance level, the laser is turned off and the trimming is completed. Laser_trim() is the module that coordinates this effort. When the user is ready, the laser is turned on and moves into the resistor. The first test is for a resistance that with large enough amplification is within the measuring range. When this is true, the computer compares the actual resistor value with the resistance value to be obtained. When the difference between the numbers is within the smallest tolerance, the trimming is completed.

Depending on the users choice, one of the functions discribed in sections 4.4.1.3.1 to 4.4.1.3.7 will be processed.

```
Laser Operating System

What would you like to do?

1. Get current resistance
2. Straight-cut trim
3. Double-cut trim
4. L-cut trim
5. Multiple-line-cut trim (serpentine)
6. Test routines for the measurement system
7. Imbedded resistor (not in use)
8. Change trimming defaults
9. Exit

Option:

System Status

Current Position: 0, 0
```

Figure 4.13 The Resistor Trimming Menu

4.4.1.3.1 Resistance Value Acquisition

After requesting or confirming which probes straddle the resistor, the computer calculates the resistance across the selected probes and displays the value in the bottom window.

4.4.1.3.2 Single Straight Cut

A straight cut is performed by acquiring a laser head position on each side of the resistor from the user. Once these points are entered by the user and the user confirms that everything is ready, the laser will start trimming from the first point and will move in the direction of the second point. When the resistance is within the accepted tolerance range, the laser will stop trimming and the user regains control.

4.4.1.3.3 Double Cut

For a double cut, three laser head positions are required. The first will be the starting position. The second position represents the direction in which the first cut will take place. The third position allows the computer to calculate the area of the resistor that is available for the starting and ending positions for the second cut. The laser trimming is accomplished by starting to trim from the first position towards the second position. When the resistance is within the tolerance of a percentage of the final resistance, the laser is turned off and the moves to the second starting position. This second starting position is based on a percentage of the available resistor area. The percentage of the final resistance and the percentage of available area that the computer

uses are parameters that can be changed from the change trimming defaults option (see Figure 4.16). The laser then starts to trim from this position in the same direction as the first cut until the resistance is within the tolerance of the final resistance value.

4.4.1.3.4 L Cut

As with a double cut, the L cut also requires three laser head positions. The first will be the starting position. The second position represents the direction in which the first cut will take place. The third position allows the computer to calculate the direction in which the laser will turn for the second cut. The laser trimming is accomplished by starting to trim from the first position toward the second position. When the resistance value is within the tolerance of a percentage of the final resistance value, the laser direction changes to that of the direction between the second position and the third position. The percentage of the final resistance that the computer uses is a parameter that can be changed from the change trimming defaults option (see Figure 4.16). The laser trims along this diagonal direction until the resistance is within the tolerance of the final resistance value.

4.4.1.3.5 Multiple Straight Cuts

A multiple straight cut follows the same principles as the double cut except that there can be more than two cuts and that the cuts alternate sides. The distance between cuts and the intermediate resistance values are calculated by the computer based on the number of cuts. The number of cuts is a trimming parameter that can be changed.

4.4.1.3.6 Measurement Test Routines

There are a lot of parts that make up the measurement system. For the most part, they are not completely independent of each other and can be integrated together. The possibility also exists that individual control might be wanted. All of these options are included in the measurement system test. The available options for the measurement system include setting the resistor value to test against, the generator voltage, the detector gain, and the pre-amp gain. Although the comparator value and a delay time are also listed, it is not taken into account in the program. Figure 4.14 displays the main measurement test menu with options to obtain feedback from the laser measurement system. The option to change the parameters is displayed in the measurement test value selection menu as seen in Figure 4.15.

4.4.1.3.7 Trimming Defaults

The trimming defaults menu, Figure 4.16, allows the user to change parameters that effect the different trims. These parameters include the percentages for L and double cut turns, the percentage of distance for the second double cut, and the number of multiple cuts.

4.4.2 FILEMAKE Program Operations

The FILEMAKE program is a subset of the LASER program that only does pattern sequence functions: creating, saving, editing, printing, and a test run. The FILEMAKE program is made up of only one program: FILEMAKE.C. There is a

```
Laser Operating System

1. Define test values
                    A Probe                        999
                    B Probe                        999
                    Test Resistance Value        0
                    Range                          0
                    Standard                0.000000000000
                    Generator Voltage            +0.000
                    Detectors Voltage            0.000
                    Pre-amp gain (1 or 8)          0
                    Comparator value               0
                    Delay                          0
2. Strobe the measurement system
3. Clear the overload flag
4. Find the unknown resistance
          9. Return to Main Menu

         Option:
```

```
System Status
Convertor  0                End Delay      :  Ready
Overload  0                 Ready Flag     :  Ready
End Convertion :  Ready     Strobe Done    :  Ready
```

Figure 4.14 The Main Measurement Test Menu

```
Laser Operating System

Define test values
      1. Change A Probe
      2. Change B Probe
      3. Change Test Resistance Value
                Range
                Standard
      4. Change Generator Voltage
      5. Change Detectors Voltage
      6. Change Pre-amp gain (1 or 8)
      7. Change Comparator value
      8. Change Delay
Strobe the neasurement system
Clear the overload flag
Find the unknown resistance
       9. Exit test value definitions

      Option:
```

```
System Status

Convertor  0                End Delay      :  Ready
Overload  0                 Ready Flag     :  Ready
End Convertion :  Ready     Strobe Done    :  Ready
```

Figure 4.15 The Measurement Test Value Selection Menu

```
Laser Operating System

1. Trim speed                                        0.125000
2. Double-cut or L-cut turn percentage                  80
3. Second cut (Double-cut) percentage distance          20
4. Perpendicular cuts - abort distance                  50
5. Adjacent (parallel) cuts - abort distance            50
6. Number of serpentine cuts                             5
7. Restore defaults

9. Return to Laser Menu

        Option:

System Status
Current position: 0, 0
```

Figure 4.16 The Trimming Defaults Menu

program list, FILEMAKE.MAK, that supplements this file in order to include the appropriate libraries, including MT5_M5M.LIB from C TOOLS PLUS. FILEMAKE requires the include files BWINDOW.H and GLOBLVAR.H. These include files for FILEMAKE are the same as for LASER and can, therefore, be found with the LASER include listings in Appendix VII. The source code listing for FILEMAKE.C is located in Appendix VIII.

The FILEMAKE executable program is made up of only one program, FILEMAKE.C. This program is an offshoot of SAVING.C, but has no laser oriented functions. FILEMAKE.C only contains information and abilities to create, edit, and screen run a pattern file. This program is almost an exact replica of SAVING.C, except that nothing is ever sent to or received from the laser. The operation of FILEMAKE.C is understood from the pattern cut menu options.

4.5 Conclusion

Once the prototypes were constructed and tested, the operating environment was constructed by type of operation. When the LASER program is run, the laser is initialized so that the laser control system will communicate properly with the PC. The main menu provides access to individual operations and to the pattern cut and resistor trimming menus. The pattern cut menu allows the user to create, edit, analyze, and run patterns. The resistor trimming menu provides the user with access to the various types of resistor trims as well as to a measurement testing menu. From the measurement testing menu, the laser's internal measurement system can be manipulated. A second program, FILEMAKE, allows users access to create, edit, and analyze patterns without having to be at the laser.

Chapter 5

Resistor Trimming and Aging Experimental Realization

5.1 Overview

This chapter is broken up into four sections. Section 5.1 discusses the testing objectives, the configuration and setup, and the preliminary testing results. By the end of section 5.1, an understanding of the process in which the resistors were trimmed and thermally aged will be known. The analysis of the results compared by the type of cut and the laser power applied is discussed in section 5.2. Section 5.3 evaluates the results by the type of cut and the resistor geometry. The results of the thermal aging are compiled in section 5.4.

5.1.1 Objectives

The objectives of the testing were to evaluate the types of cuts at two different levels. The first set of tests involved the best type of cut for the particular resistor geometry and the laser power applied. These same trimmed resistors were then tested for deterioration due to thermal aging. The resistor paste used was DuPont BIROX Series-1900 Paste number 1939.

5.1.2 Testing Configuration

The testing incorporated six sets of cuts and one set of control resistors. Four different system power configurations for a total of 24 groups of cuts and two groups of control resistors were used in the experimentation. Each group was made up of 9 different resistor geometries which consisted of the combinations of three different aspect ratios and three different surface areas. The six cuts used were a straight cut, an L cut with the elbow at 60%, an L cut with the elbow at 70%, an L cut with the elbow at 80%, a double cut with the shift at 70%, and a 4 cut serpentine cut. The four system power configurations included the combinations of a total output power of either 1.5 Watts or 2.0 Watts, and of a Q-switching frequency of either 3kHz or 6kHz. An attempt was made to use 10kHz instead of 6kHz, but the 10kHz beam could not completely burn through the resistor. The configuration of the substrate is shown in Figure 5.1. The resistors were trimmed to 1.4 times their printed resistance. This means that this evaluation is valid for resistors originally designed for approximately 70% of its intended value.

5.1.3 Thermal Aging Procedure

Each set of resistors underwent a thermal aging process that involved ramping up to 175 degrees C and then ramping back down to room temperature. A Fischer Programmable Ashing Furnace Model 497 was used. This furnace has the capability of ramping up to three temperatures. The furnace has a hold time at each temperature level before it continues to ramp to the next temperature. When the value set as the maximum temperature is reached, the temperature is held constant for a pre-programmed hold time. When the hold time is over, the furnace ramps back down to three temperatures.

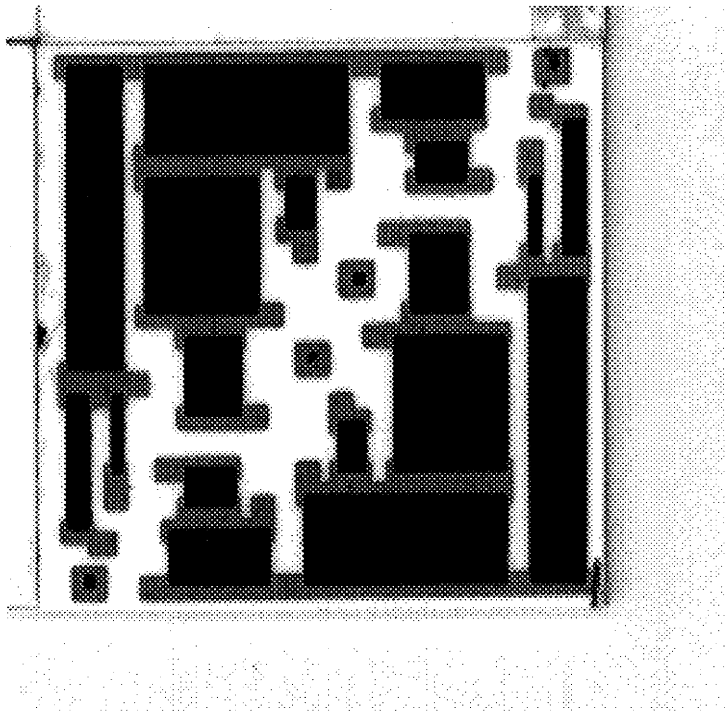

Figure 5.1 The Substrate

For this thesis, all of the ramps were set at 10 degrees per minute and there were no intermediate hold times. In ramping up, the first temperature was 59 degrees C, the second temperature was 118 degrees C, and the third (maximum) temperature was 175 degrees C. This temperature was held for one hour. During the down ramping, the first temperature was 118 degrees C, the second temperature was 59 degrees C, and the last temperature was 32 degrees C (room temperature).

5.1.4 Testing Results

There were very little problems encountered during the trimming process. Of the 216 resistors that were trimmed, only four resistors were trimmed to an infinite resistance. Three of these were due to software data manipulation errors. The software was immediately fixed and the resistors were re-trimmed without any problems. The fourth resistor was due to a user error from the selection of a resistor other than the one that the probes were across. There were no data transfer errors. In general, all of the cuts were trimmed to a tolerance of less than 4%. The average tolerance for all of the trimmed resistors was about 0.9%.

5.2 Analysis of Types of Cut, System Power, and Resistor Tolerances

5.2.1 The Single Straight Cut

Since the straight cut involves only one cut, the results for this cut are based on one set of results. All other cuts can be reflected back to the straight cut since all of the cuts first trim into the resistor. Figure 5.2 shows the results of the straight cut. From a

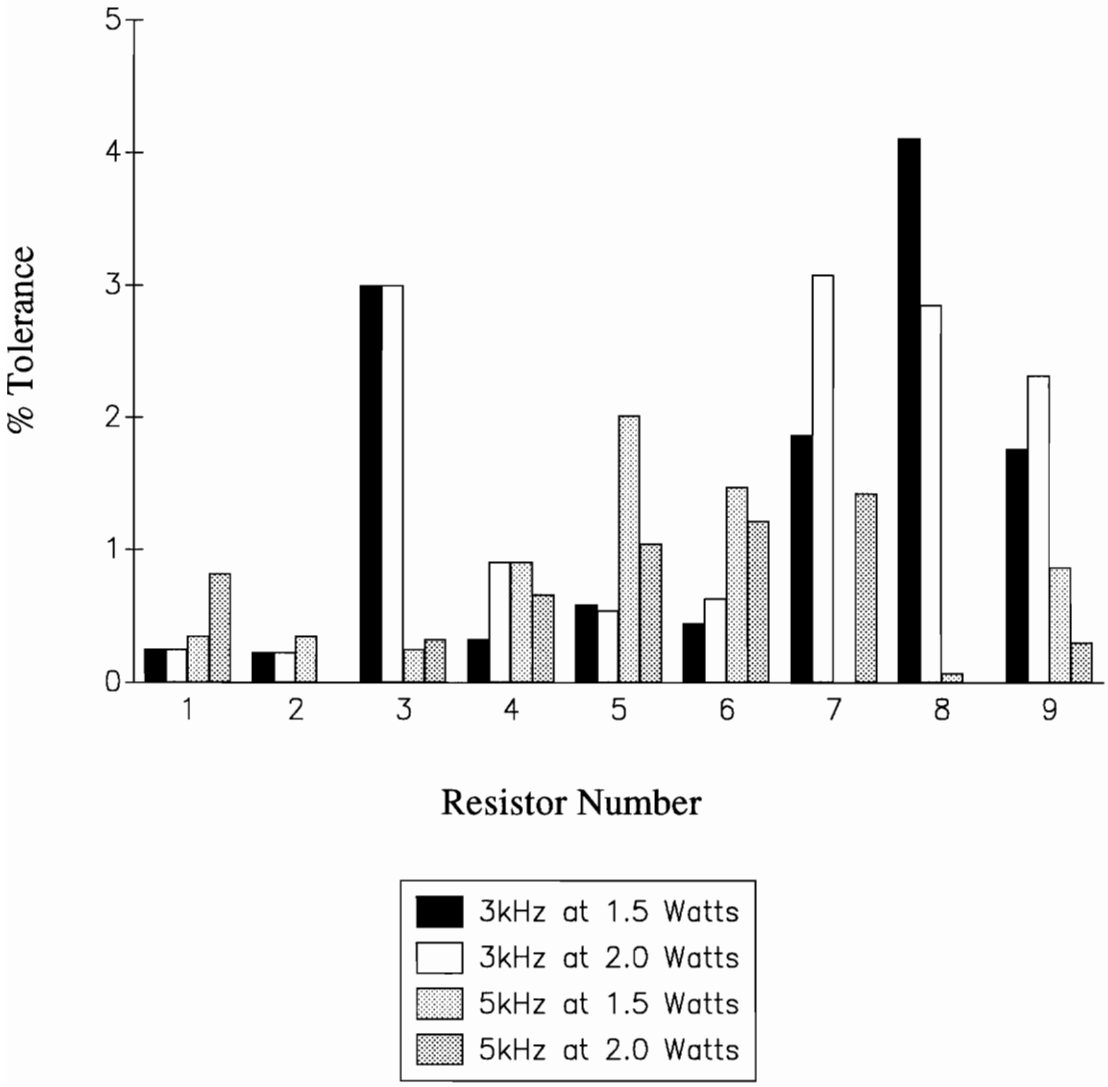

Figure 5.2
The Final Tolerances for the Straight Cut

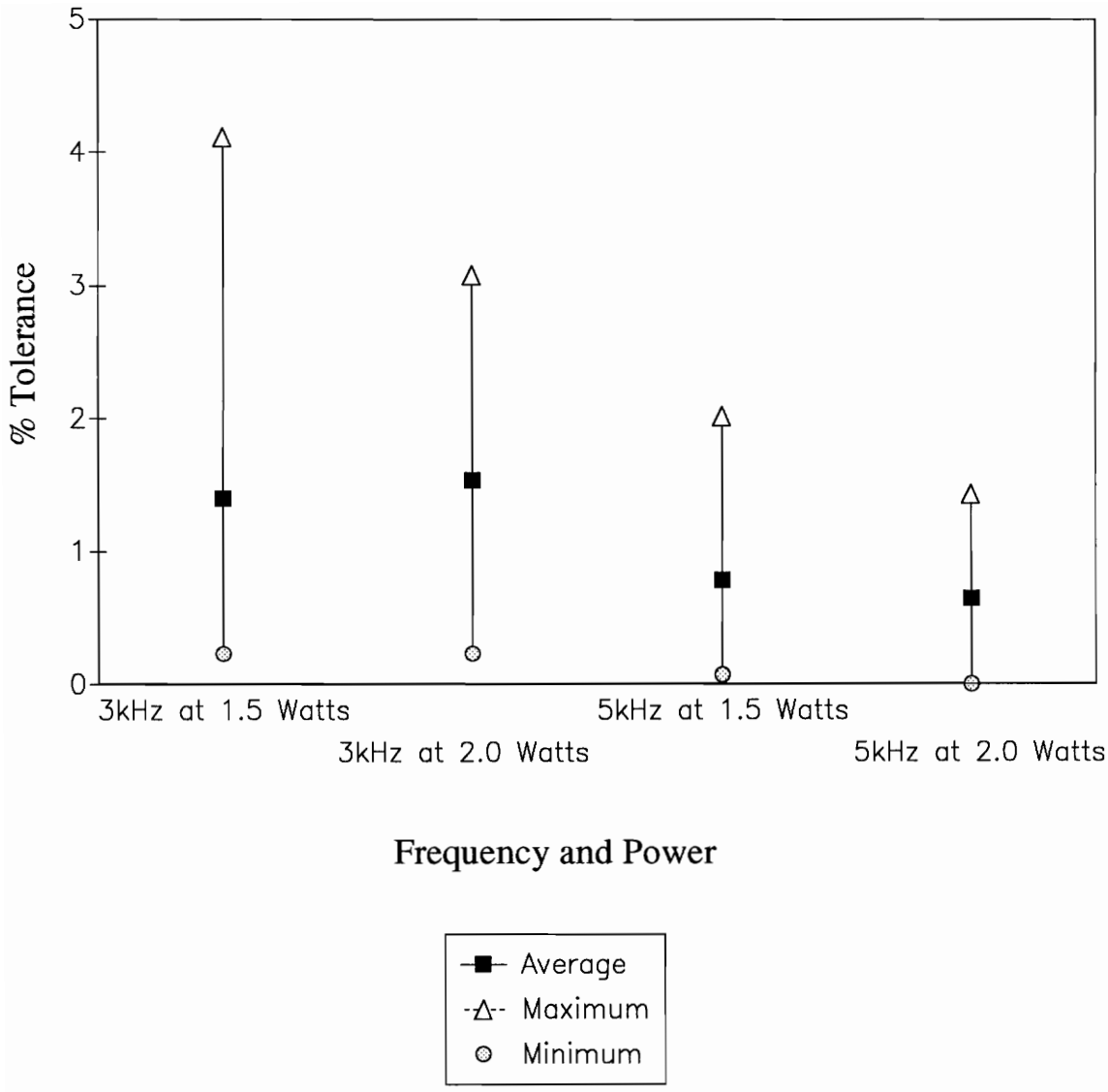

Figure 5.3
The Breakup of Final Tolerances
for the Straight Cut

close inspection, both of the 3kHz trims caused less than optimal tolerances for almost half of the resistors. From Figure 5.3, this difference is noticed in both the average and the maximum tolerances. There is no other noticeable correlation between the tolerances and the applied power and frequency.

5.2.2 The L Cut with the Elbow at 60%

The L cut is made up of an initial straight cut with a 90 degree turn and a second, perpendicular cut. Figures 5.4 and 5.5 present the results of the first straight cut. There are no outstanding features about these cuts, although it is expected that the results would match those found from the single straight cut. The results from this first cut are in no way uniform or very accurate. The results from the second, perpendicular cut are much more uniform. The results from the first three resistors for all of the power and frequency combinations were not obtainable because this type of cut was ineffective. This will be explained later by the resistor geometry. Even though the obtained tolerances for the second cut were not all below 1%, the spread of the maximum and minimum values were close to the average tolerance. This is seen from Figures 5.6 and 5.7.

5.2.3 The L Cut with the Elbow at 70%

The first cut for this L cut produced relatively uniform distributions without any of the power and frequency combinations performing differently from the others. The distribution shown in Figure 5.8 shows this more than the general data in Figure 5.9. The average values for this first cut are quite close. The 3kHz trims yielded the noticeably

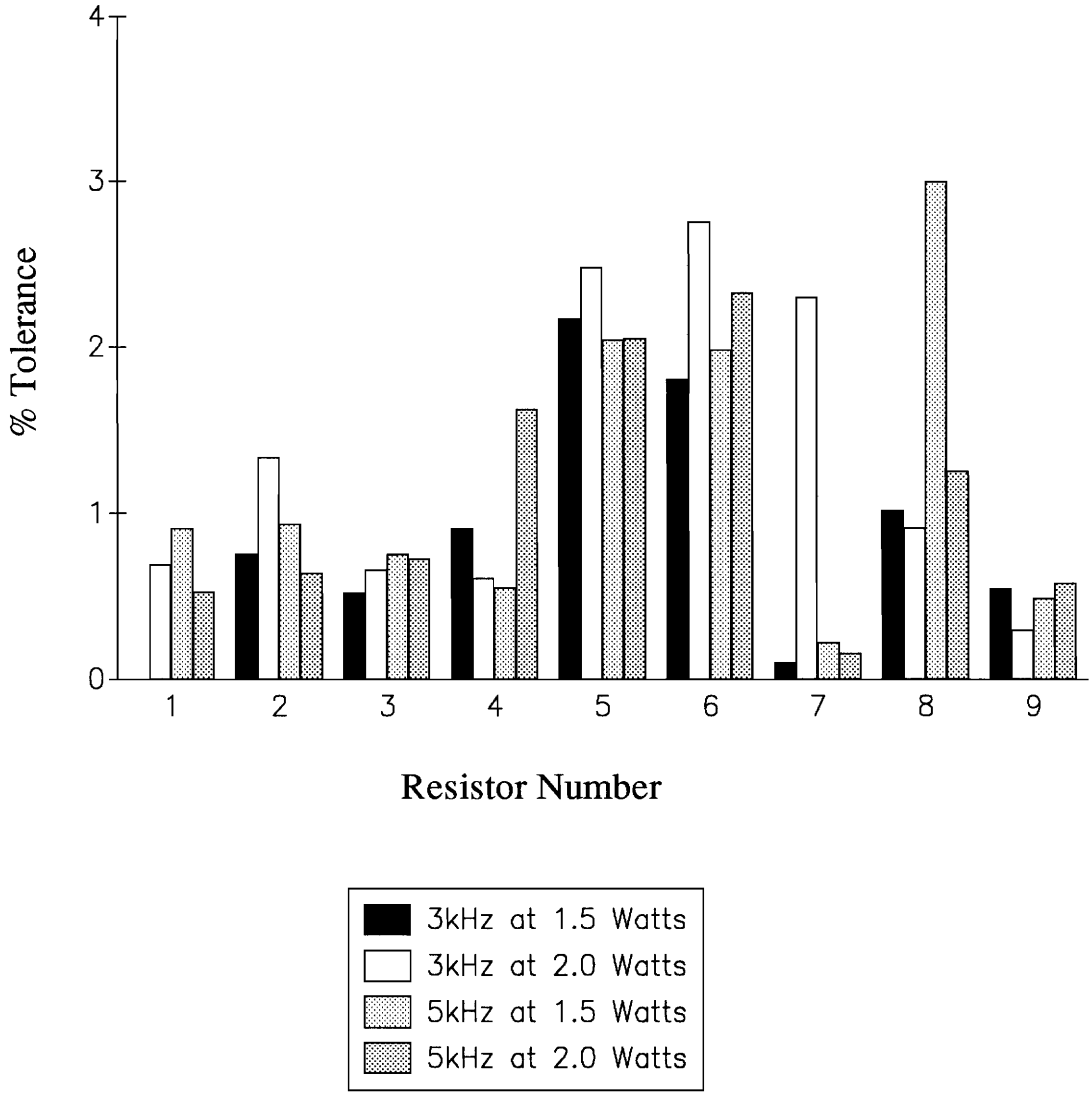

Figure 5.4
The Tolerances for the First Cut
of a L Cut with the Elbow at 60%

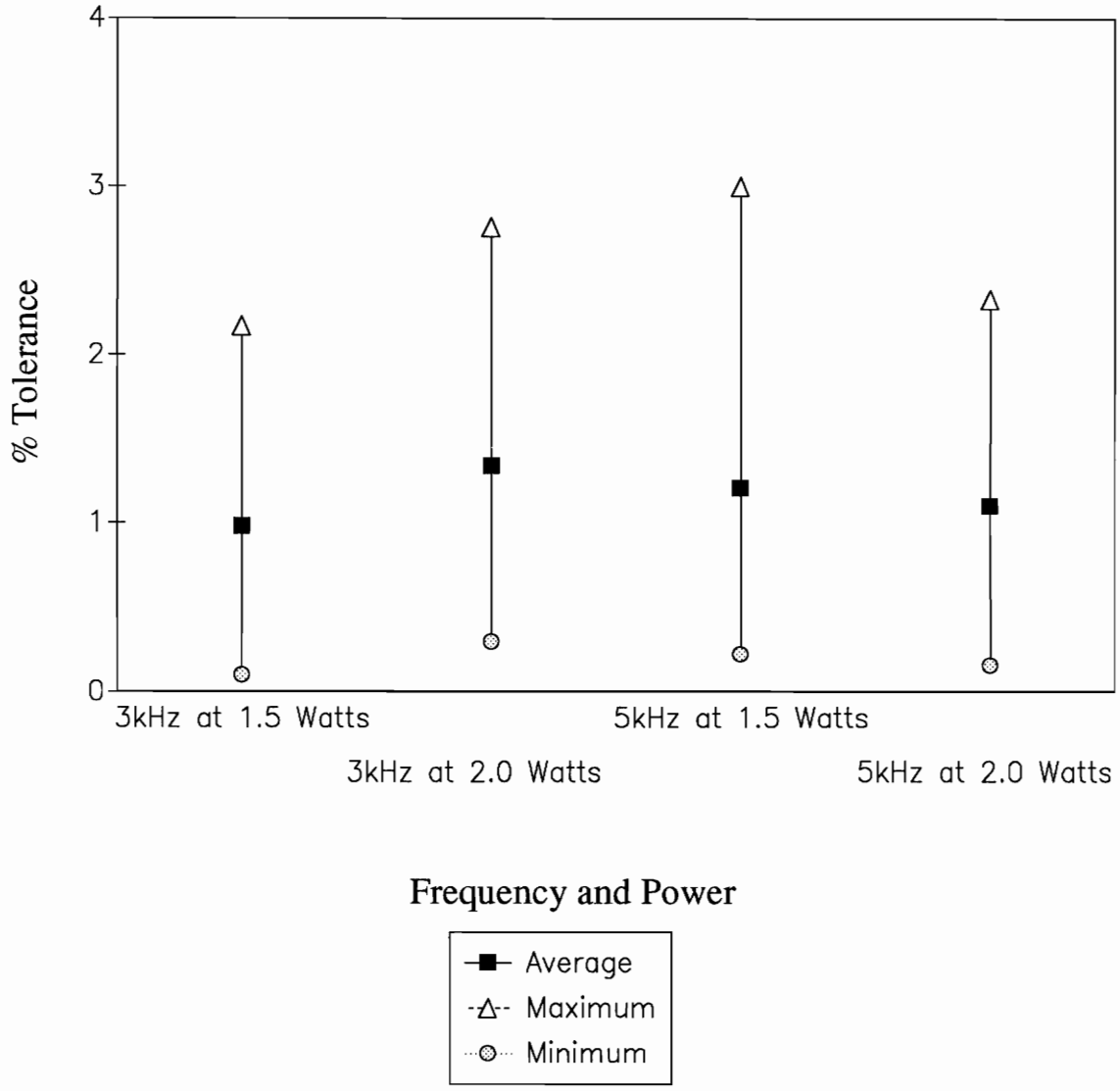

Figure 5.5
The Breakup of Tolerances for the First Cut
of a L Cut with the Elbow at 60%

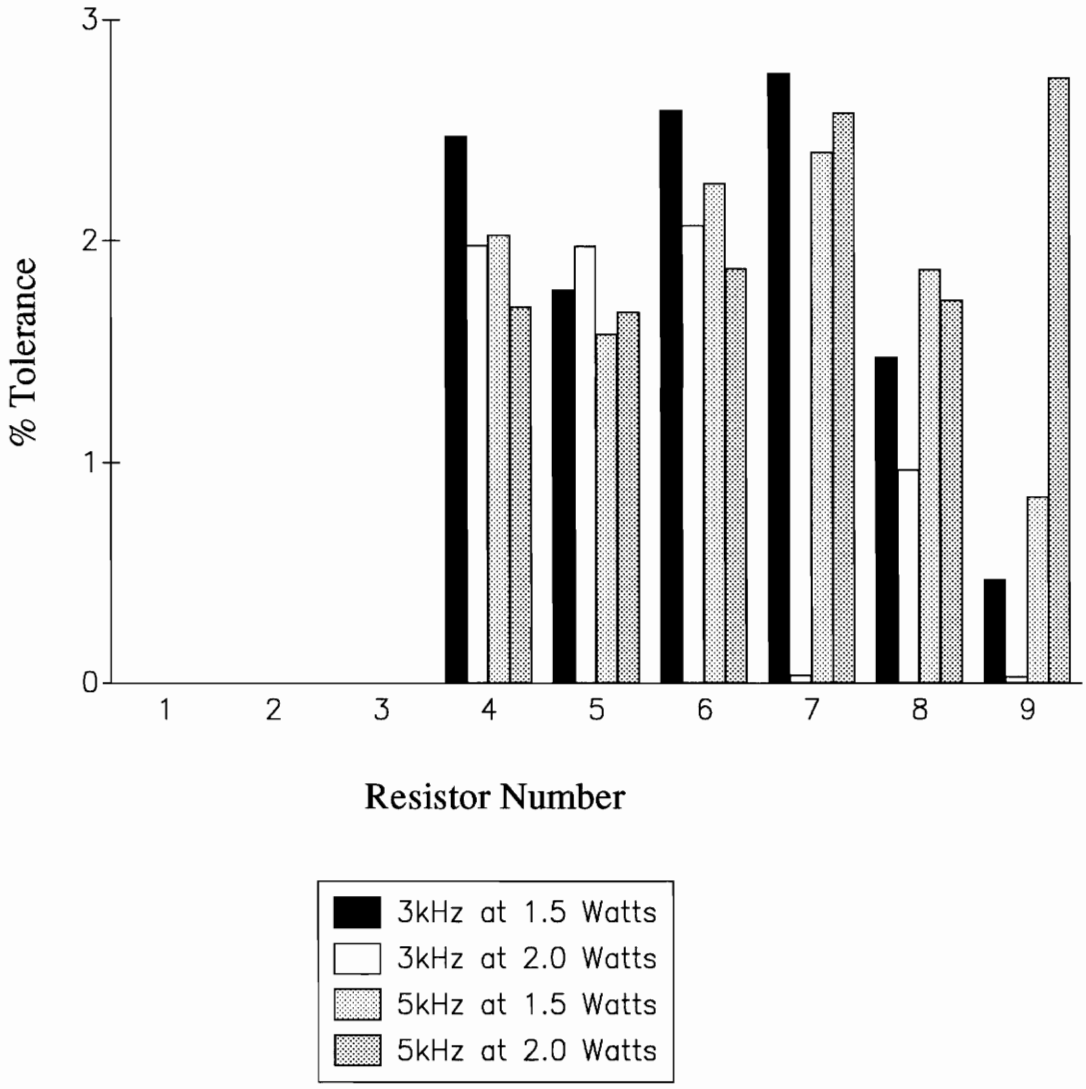

Figure 5.6
The Final Tolerances
of a L Cut with the Elbow at 60%

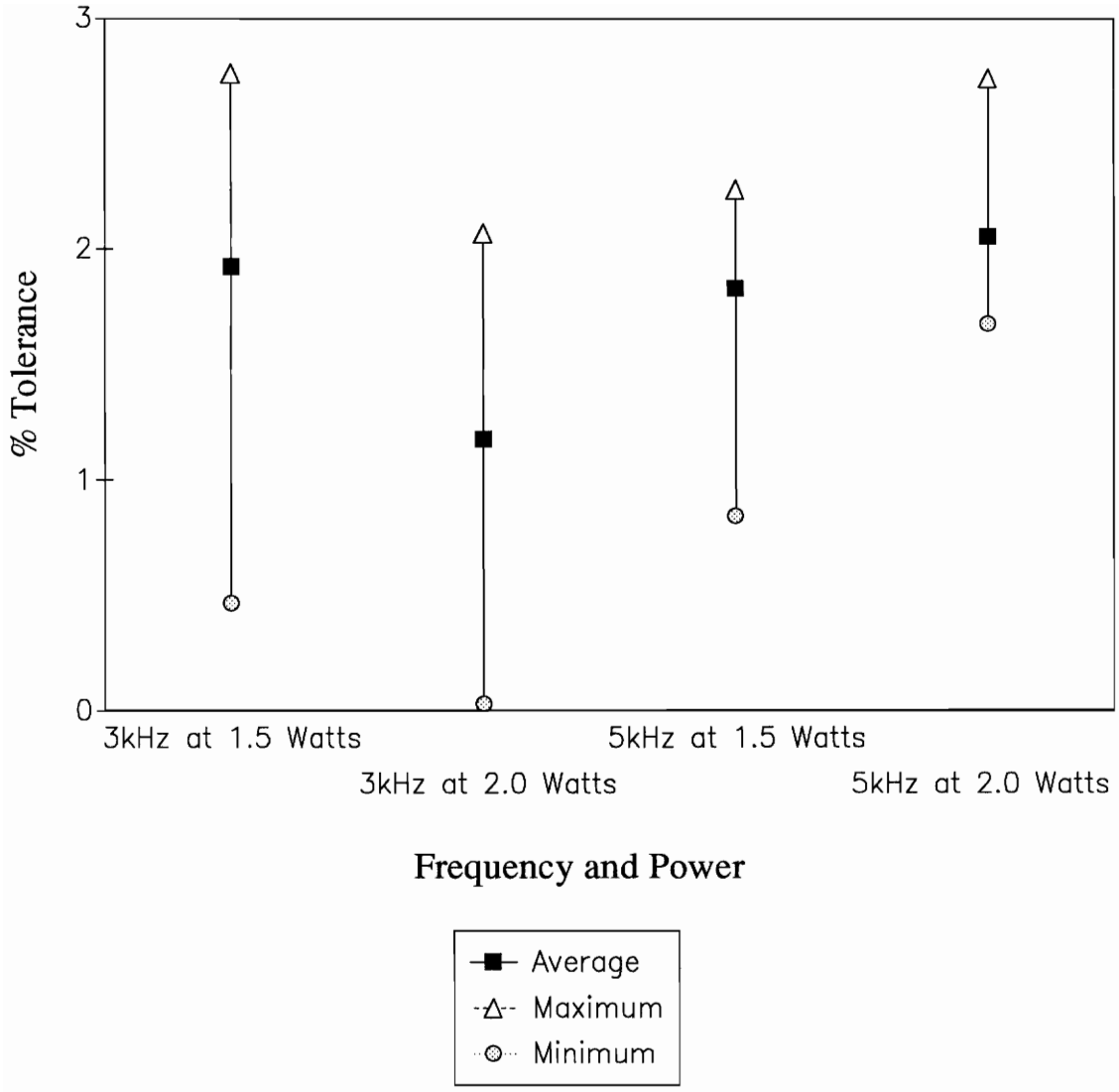

Figure 5.7
The Breakup of the Final Tolerances
of a L Cut with the Elbow at 60%

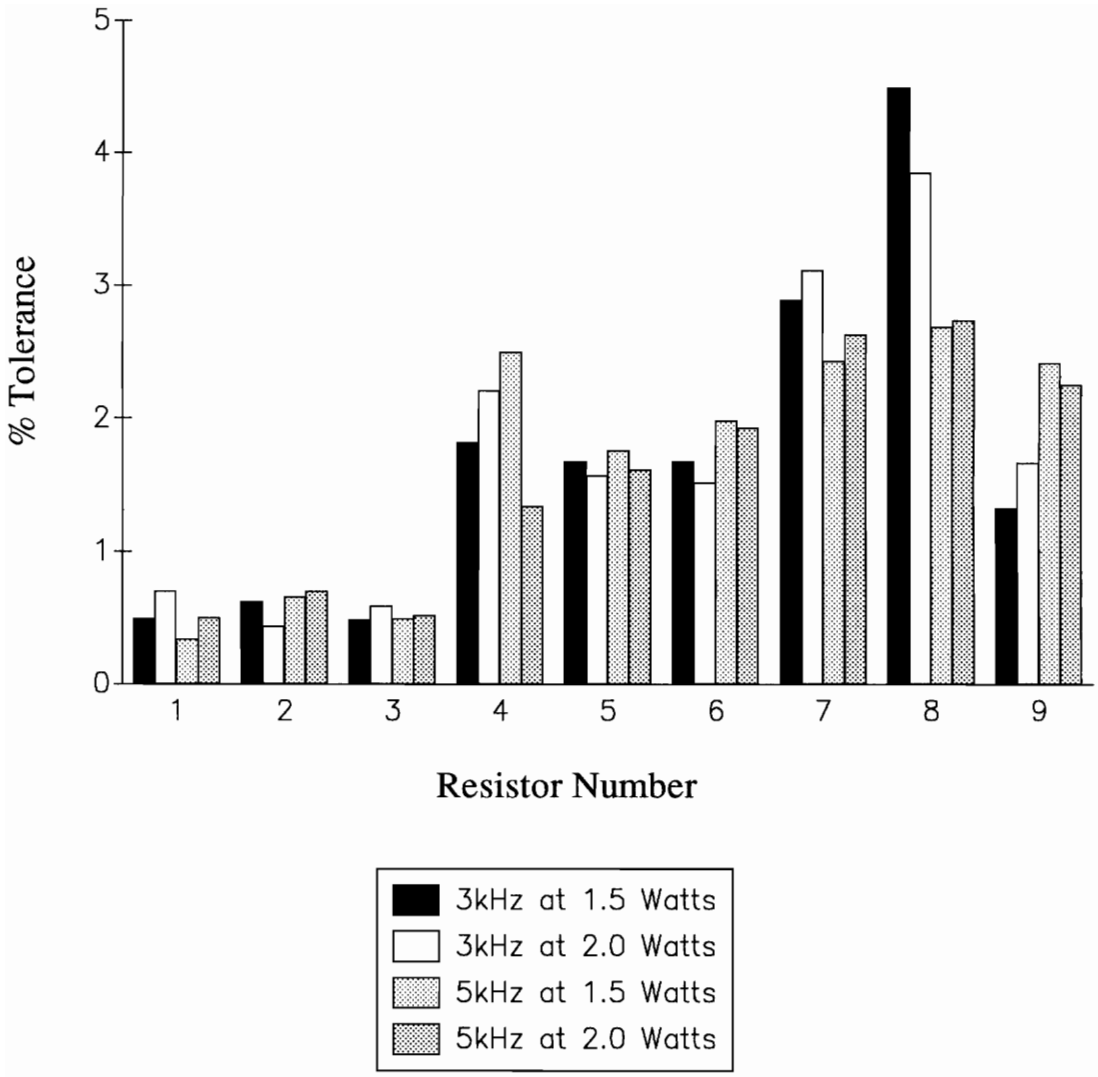

Figure 5.8
The Tolerances for the First Cut
of a L Cut with the Elbow at 70%

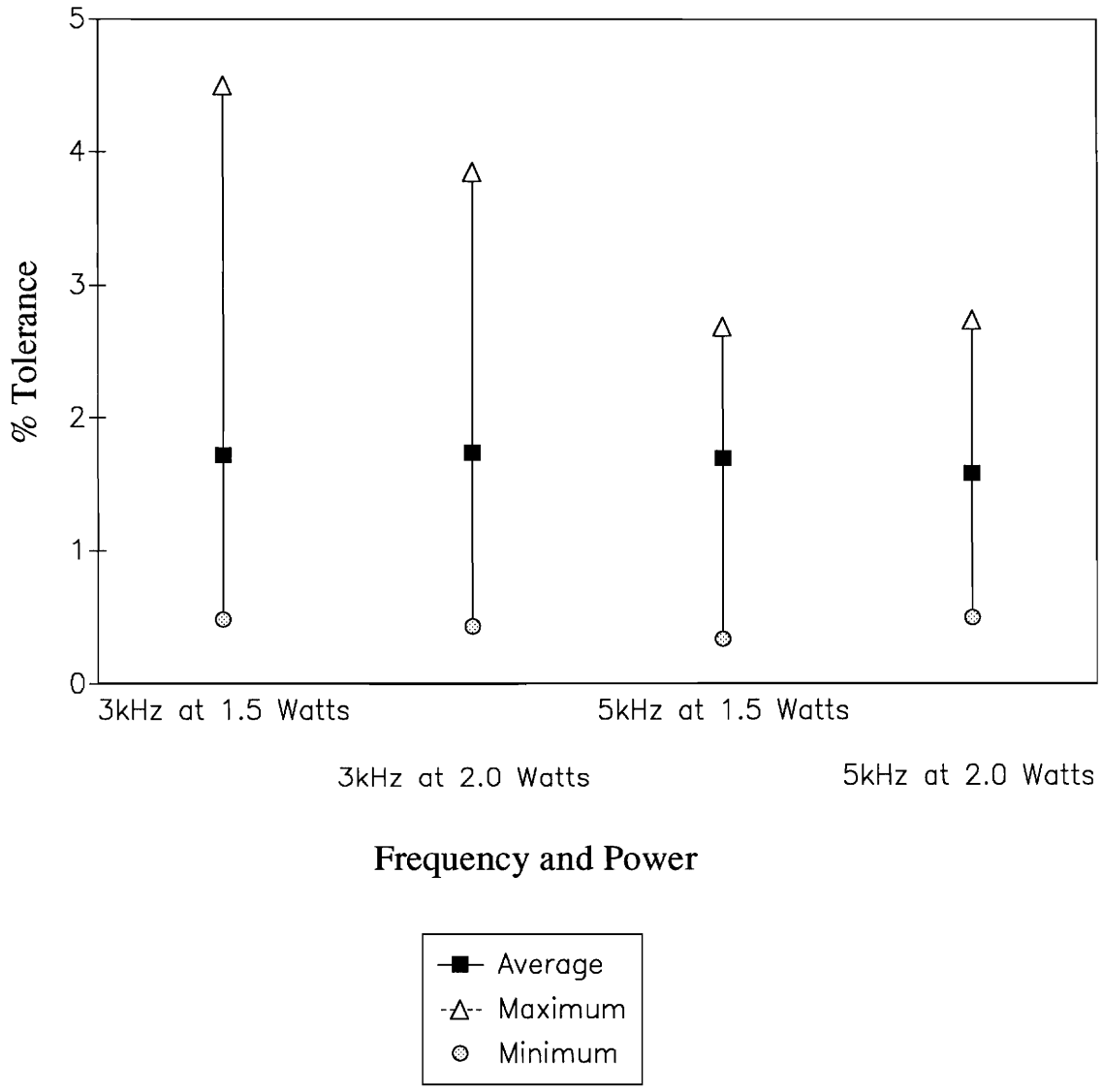

Figure 5.9
The Breakup of Tolerances for the First Cut
of a L Cut with the Elbow at 70%

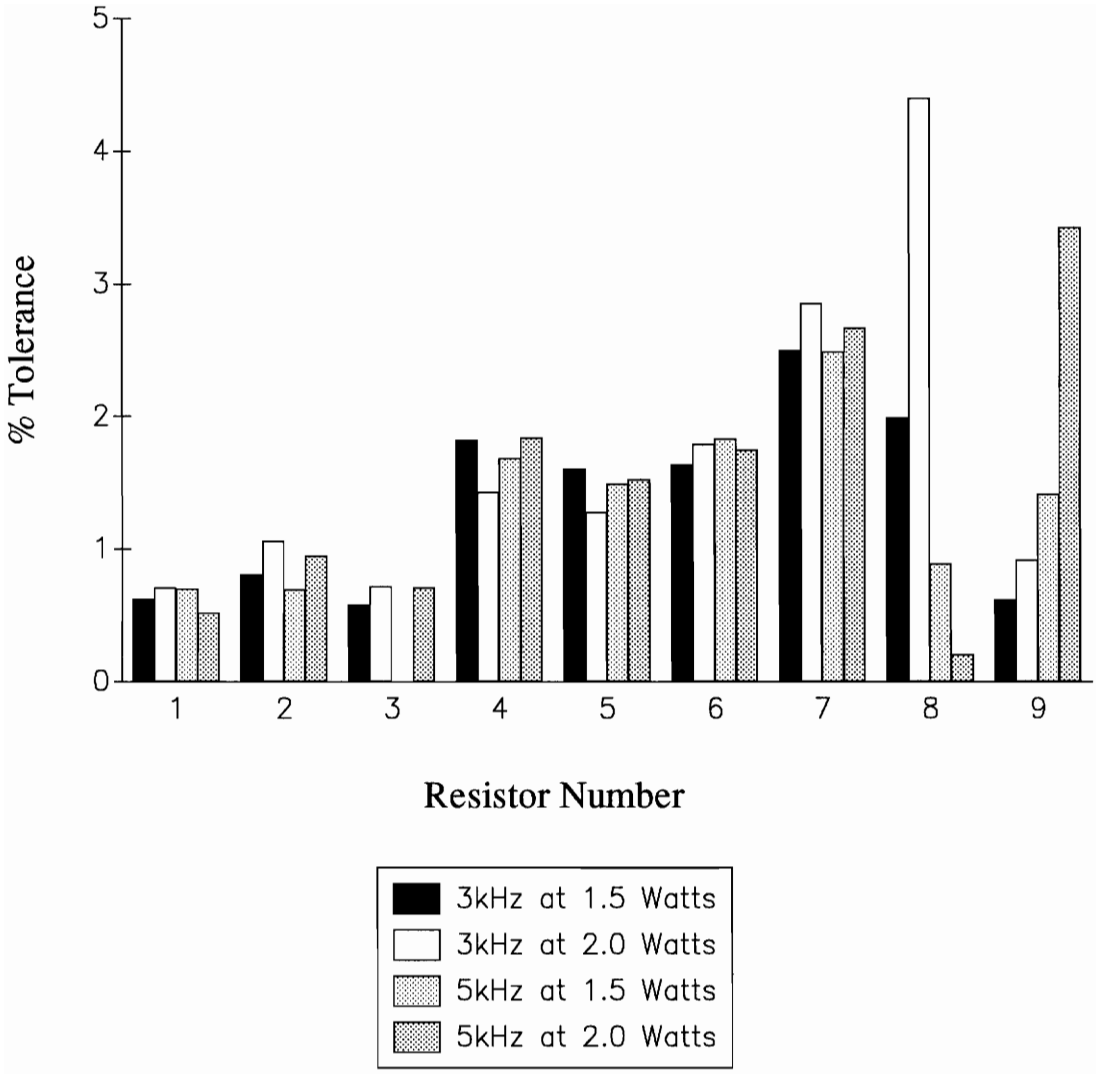

Figure 5.10
The Final Tolerances
of a L Cut with the Elbow at 70%

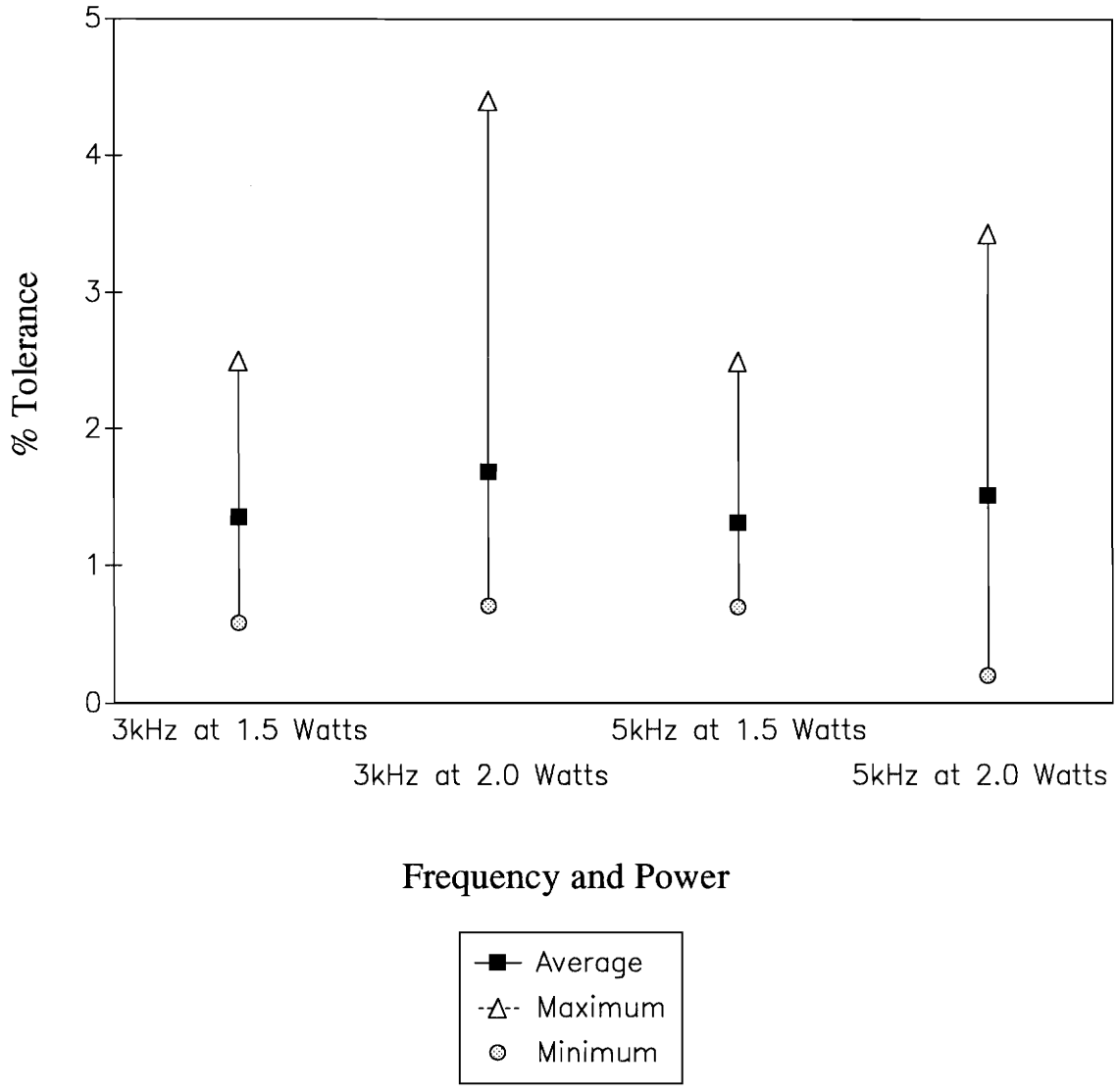

Figure 5.11
The Breakup of the Final Tolerances
of a L Cut with the Elbow at 70%

worse maximum tolerance values. The final results have a better tolerance than the first cut but, the uniformity was lost with resistors 8 and 9. Figure 5.10 shows how the power and frequency behaved completely differently. The average tolerance in Figure 5.11 remained relatively constant as was seen from the first cut. The worse maximum values and slightly higher averages were seen with the 2.0 Watt cuts as compared with the 3kHz cuts from before.

5.2.4 The L Cut with the Elbow at 80%

Aside from the close average tolerances, as seen in Figure 5.13, there was no continuity between the trimming performances. Figure 5.12 displays how the tolerance varies differently between the resistors. An interesting note is that the 3kHz cuts follow each other relatively closely across the resistors. This is also true for the two 5kHz groups of trims. The final tolerance followed closely with the results from the first cut. Once again, the tolerances showed no correlation other than that the 3kHz trims vary radically for the different resistors. Figures 5.14 and 5.15 show this in detail.

5.2.5 The Double Cut

The performances of the 3kHz trims for the first cut are seen in Figure 5.15 to be quite good. For the double cut, the 5kHz trims behave most nonuniformly. This is seen in both the higher average and the maximum values in Figure 5.17. This pattern, though, did not continue with the second straight cut. The results for the final tolerance have the best average tolerances. Even though the 3kHz cuts had higher maximum tolerances, all of the tolerances were below 1.6%, and all of the averages were below 0.8%.

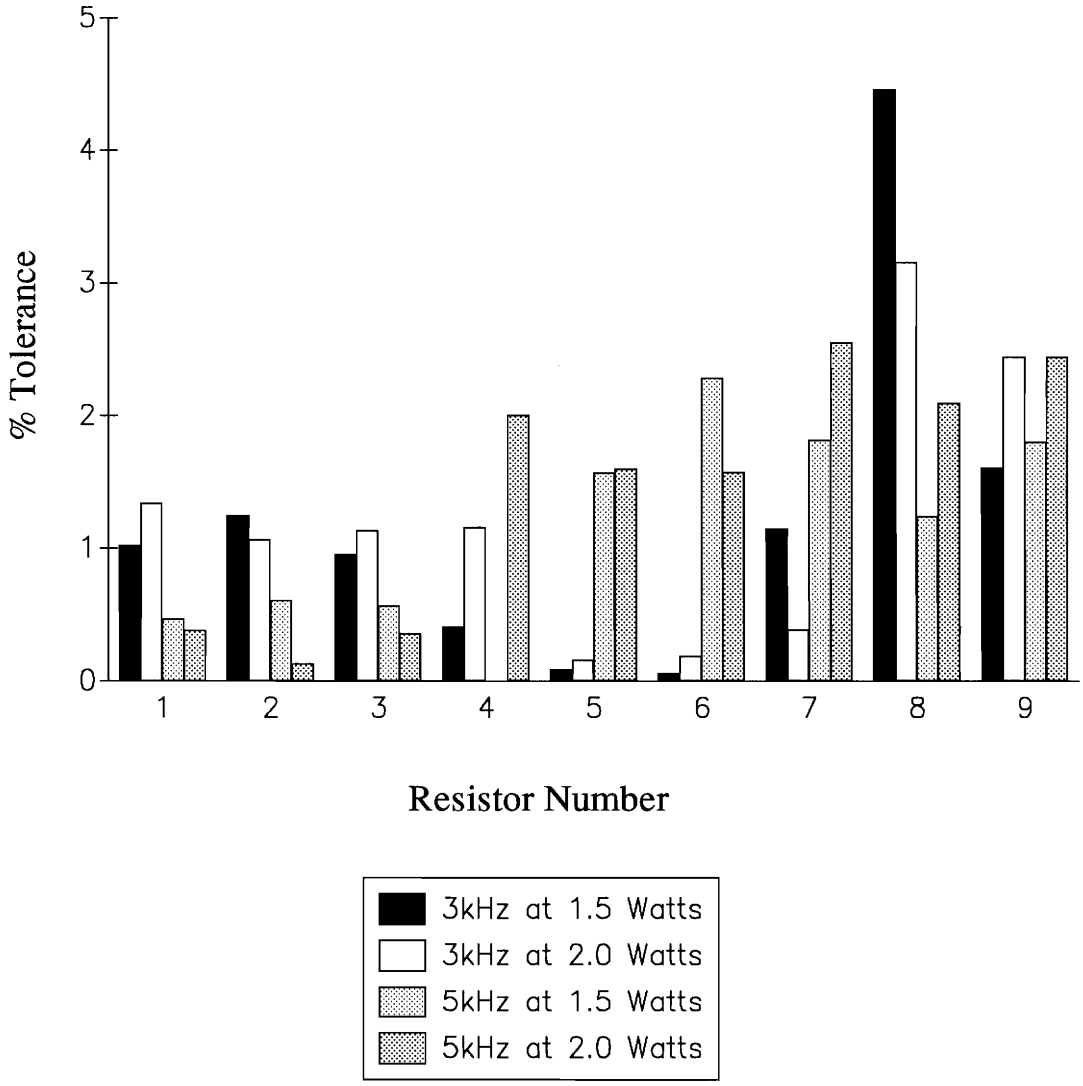

Figure 5.12
The Tolerances for the First Cut
of a L Cut with the Elbow at 80%

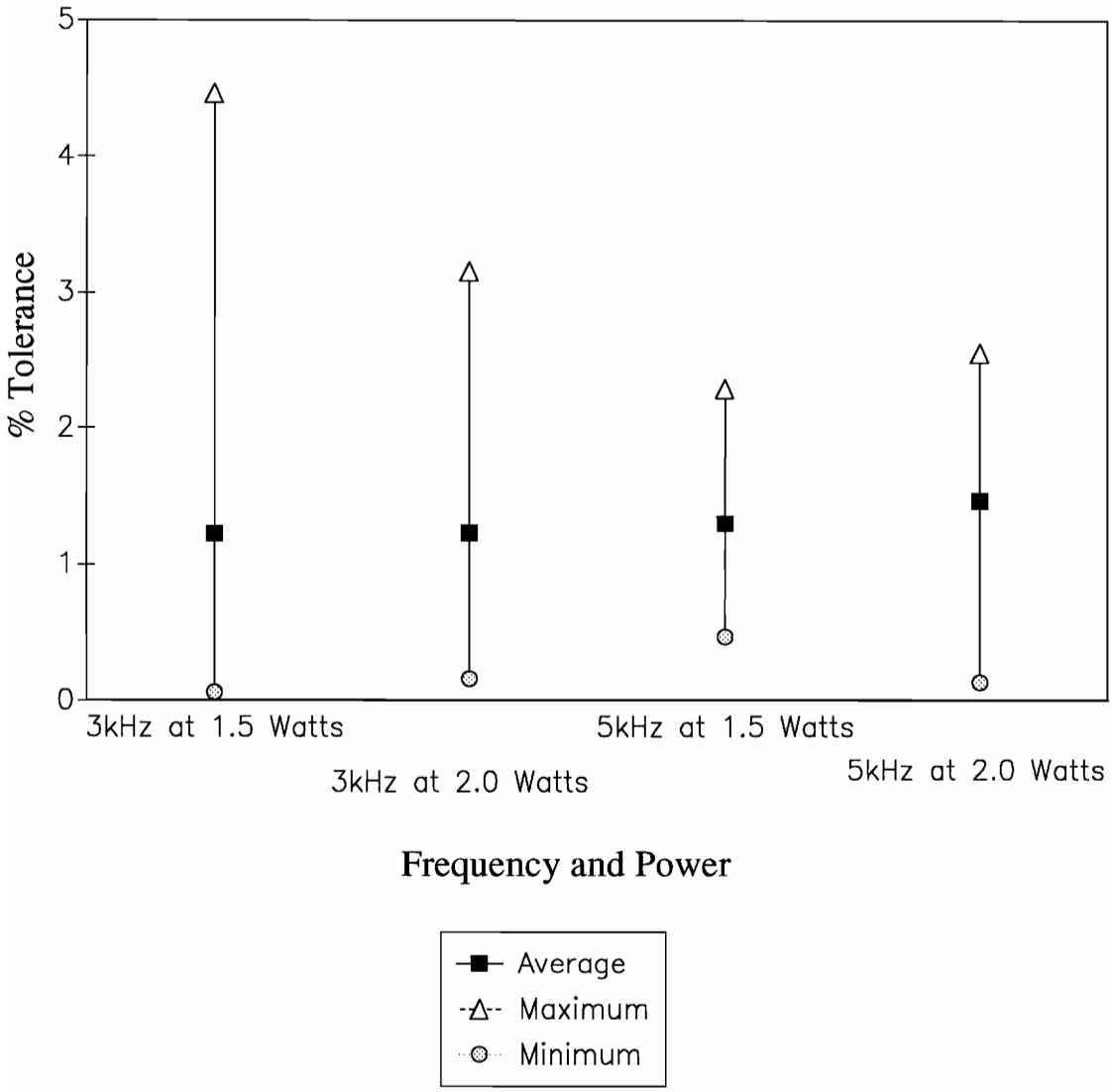

Figure 5.13
The Breakup of Tolerances for the First Cut
of a L Cut with the Elbow at 80%

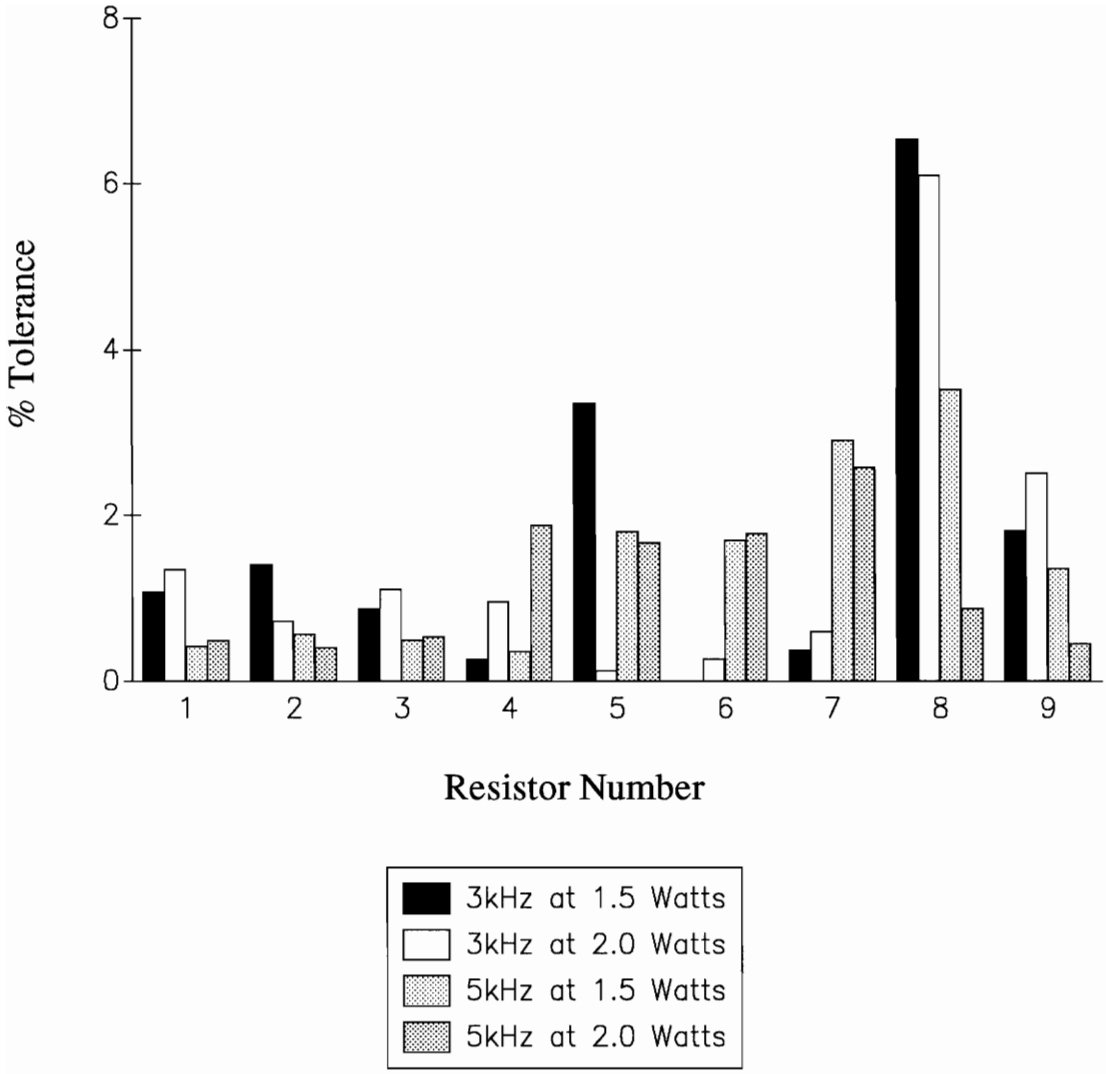

Figure 5.14
The Final Tolerances
of a L Cut with the Elbow at 80%

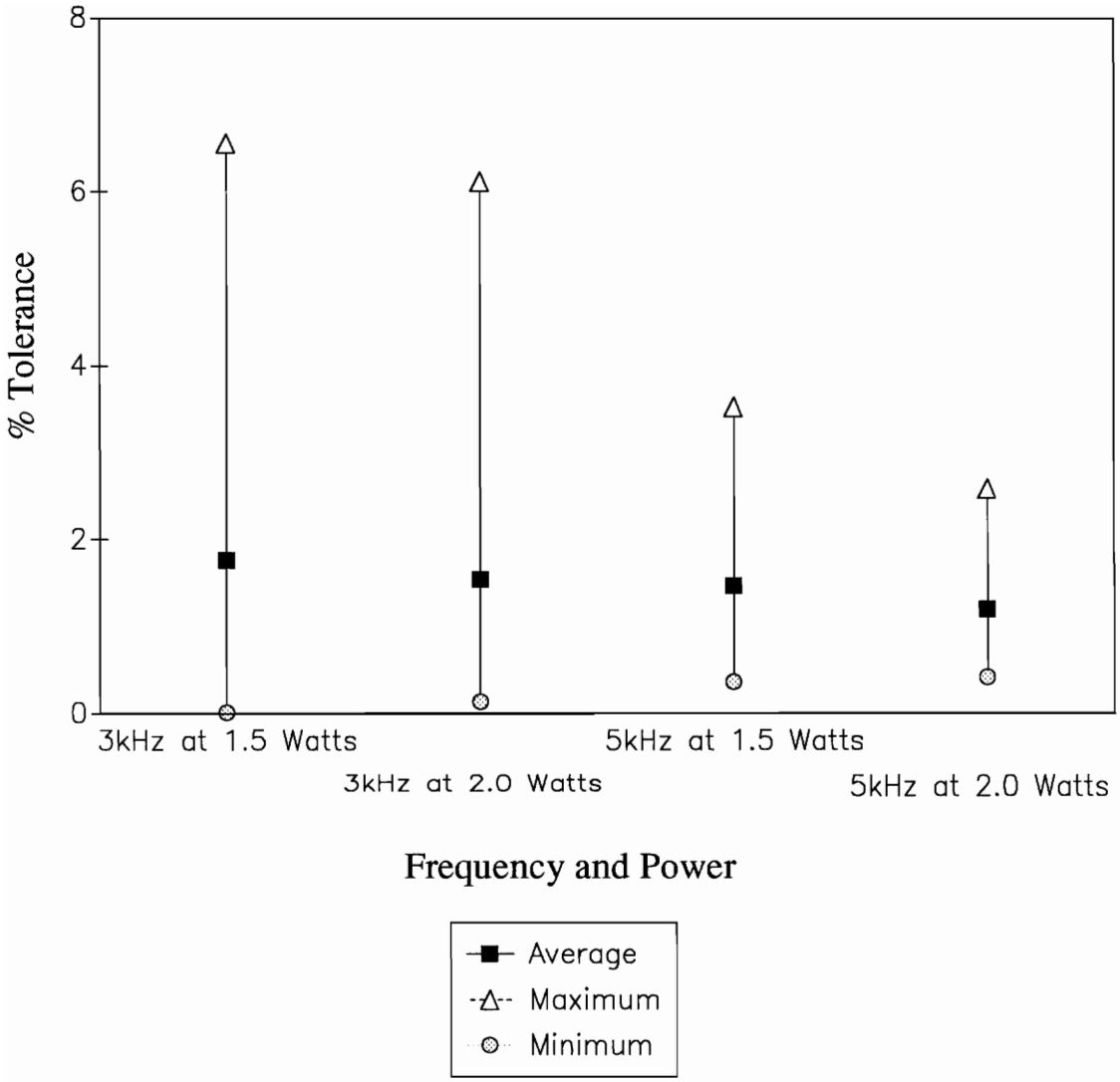

Figure 5.15
The Breakup of the Final Tolerances
of a L Cut with the Elbow at 80%

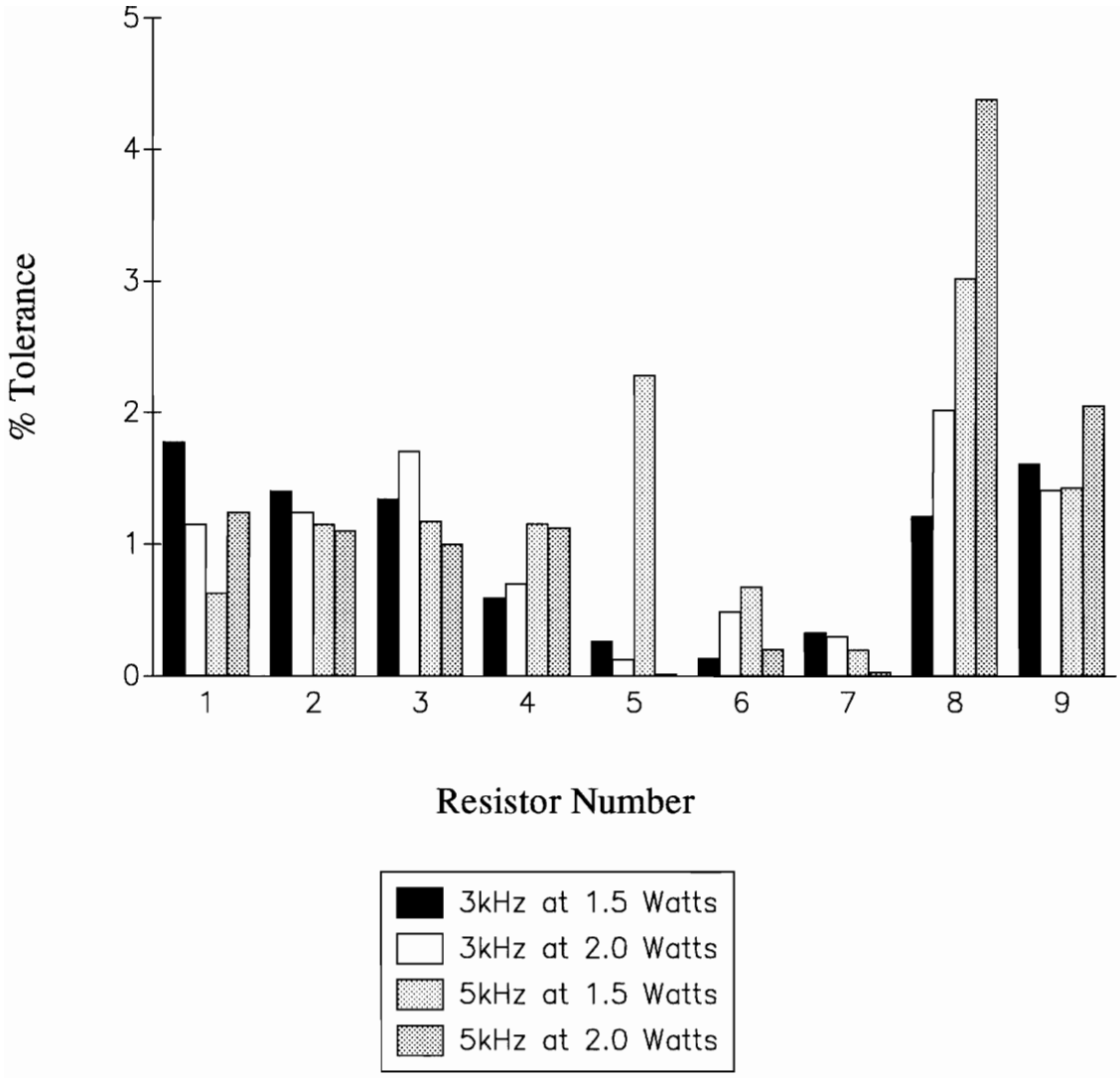

Figure 5.16
The Tolerances for the First Cut
of a Double Cut

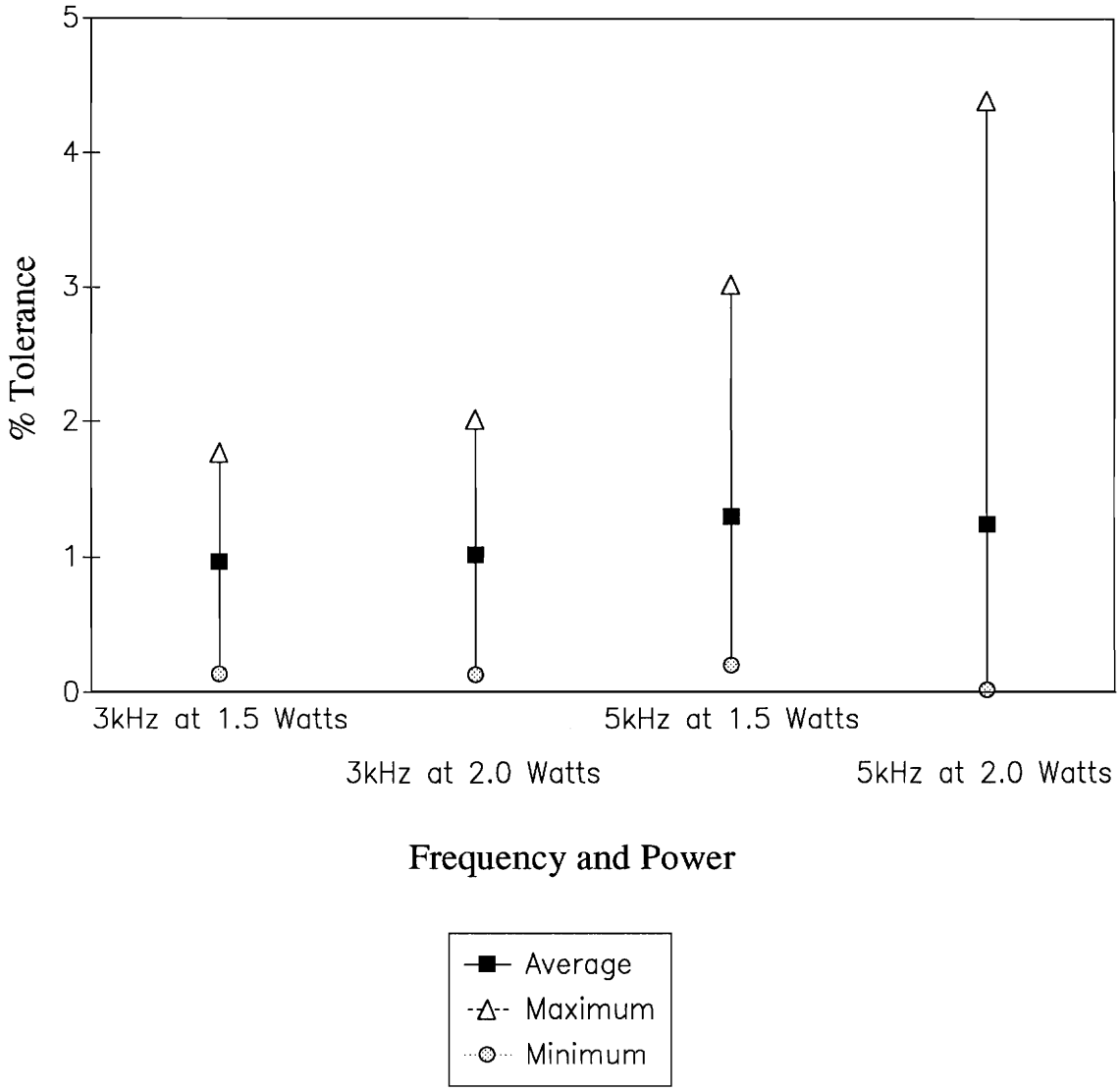

Figure 5.17
The Breakup of Tolerances for the First Cut
of a Double Cut

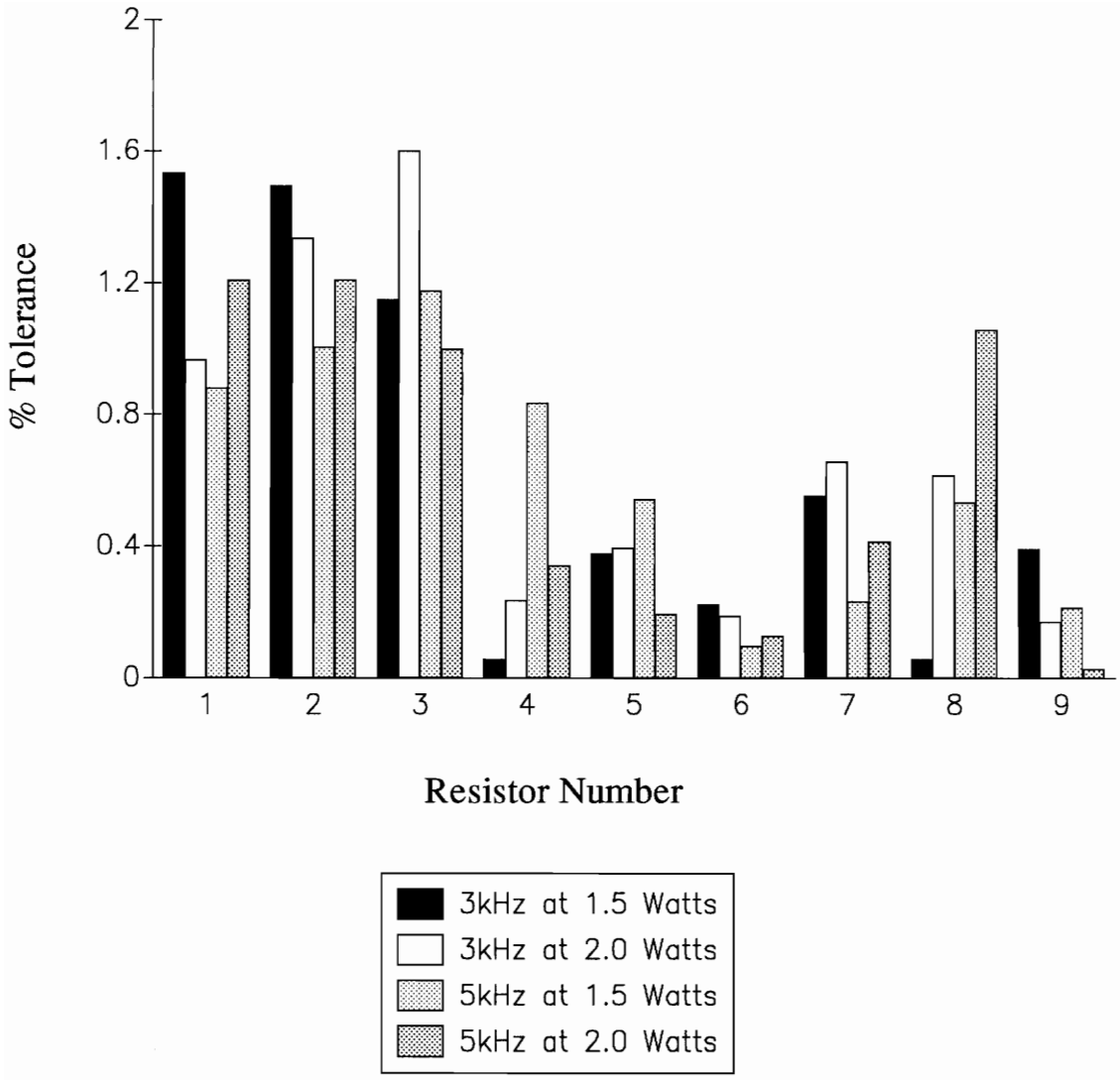

Figure 5.18
The Final Tolerances
of a Double Cut

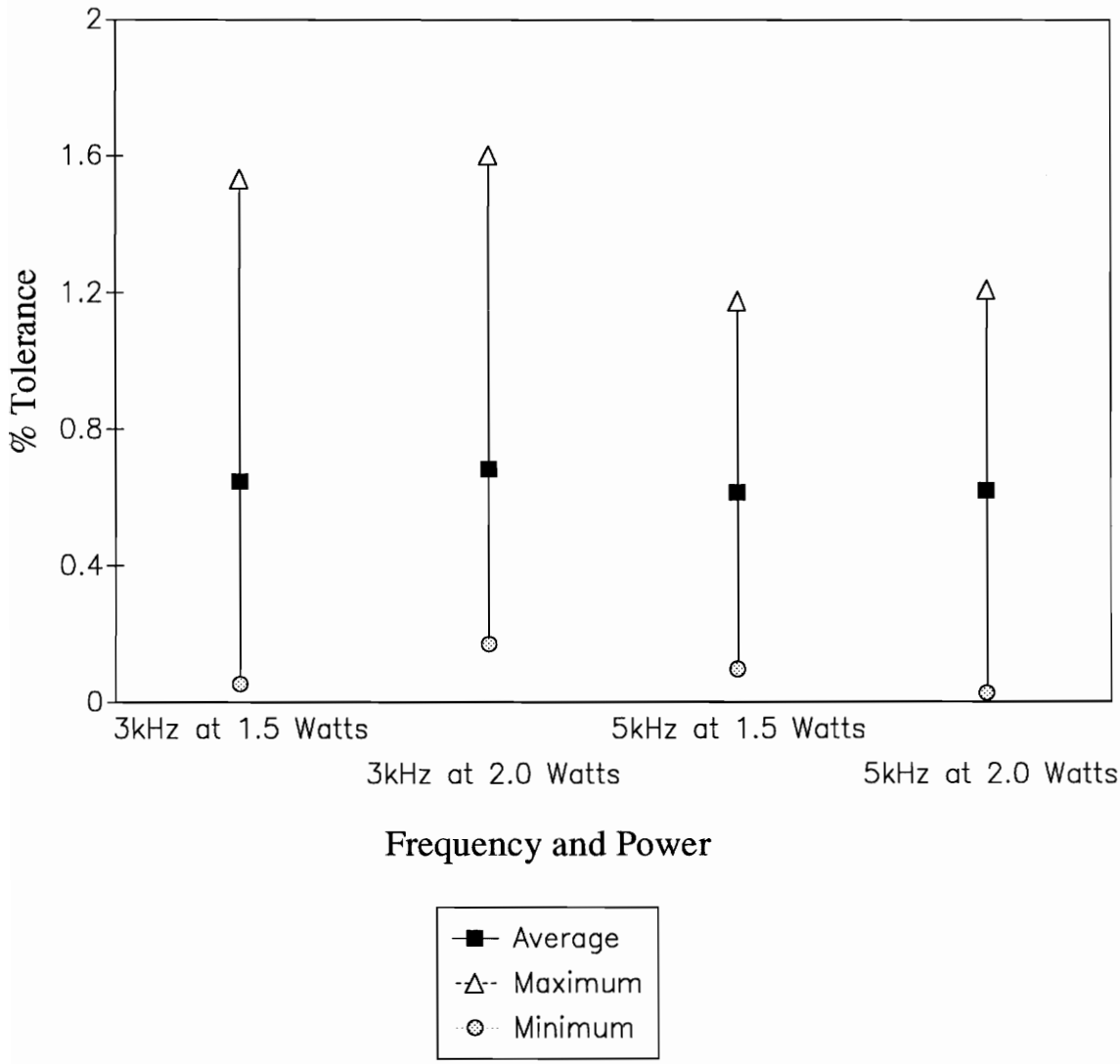

Figure 5.19
The Breakup of the Final Tolerances
of a Double Cut

5.2.6 The Serpentine Cut

This serpentine cut was performed with four cuts. This is similar to doing two of the previous double cuts except that the cuts alternate sides of the resistor. The results of the first three cuts are displayed in Figures 5.20 to 5.25. The results are good for all of the cuts except for a few particular results that are inconsistent with the rest of the data. From Figures 5.26 and 5.27, it is evident that trims were quite accurate, but that some very odd inconsistencies occurred with resistors 5 and 7. Other than the outstanding data, the uniformity is evident.

5.2.7 Discussion

The most outstanding common factors among all of the cuts are with the average tolerance. All of the averages were less than 2% and they were all relatively even for each type of cut. The 3kHz cuts have the largest maximum value throughout the final tolerances. The uniformity of power and frequency combinations are seen strongly with the L Cuts. It is interesting to note, though, that the tightest tolerances were found particularly with the L Cuts with the elbow at 60%, the Double Cuts, and the Serpentine Cuts. This is discluding the invalid data for the Serpentine Cuts. The 5kHz at 1.5 Watt trims are the only trims that consistently had low average tolerances and low maximum tolerances. The lowest average tolerances were obtained from the Double Cuts and the Serpentine Cuts.

The most powerful of the cuts was the 3kHz at 2.0 Watt cuts. The least powerful was the 5kHz at 1.5 Watt cuts. It is surprising that the strongest of the cuts would not have prevailed more in the intricate cuts as it might have been expected to perform. A

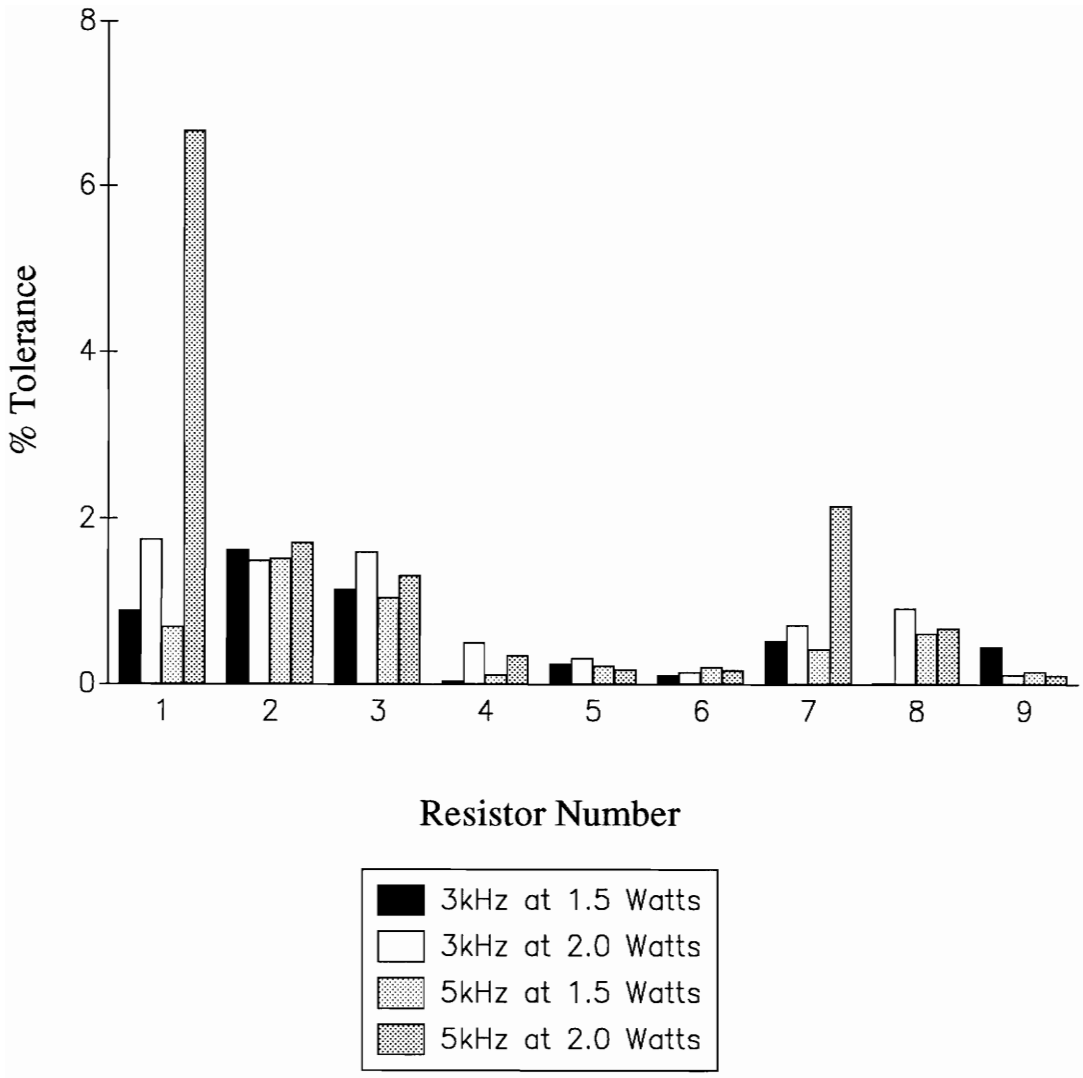

Figure 5.20
The Tolerances for the First Cut
of a Serpentine Cut

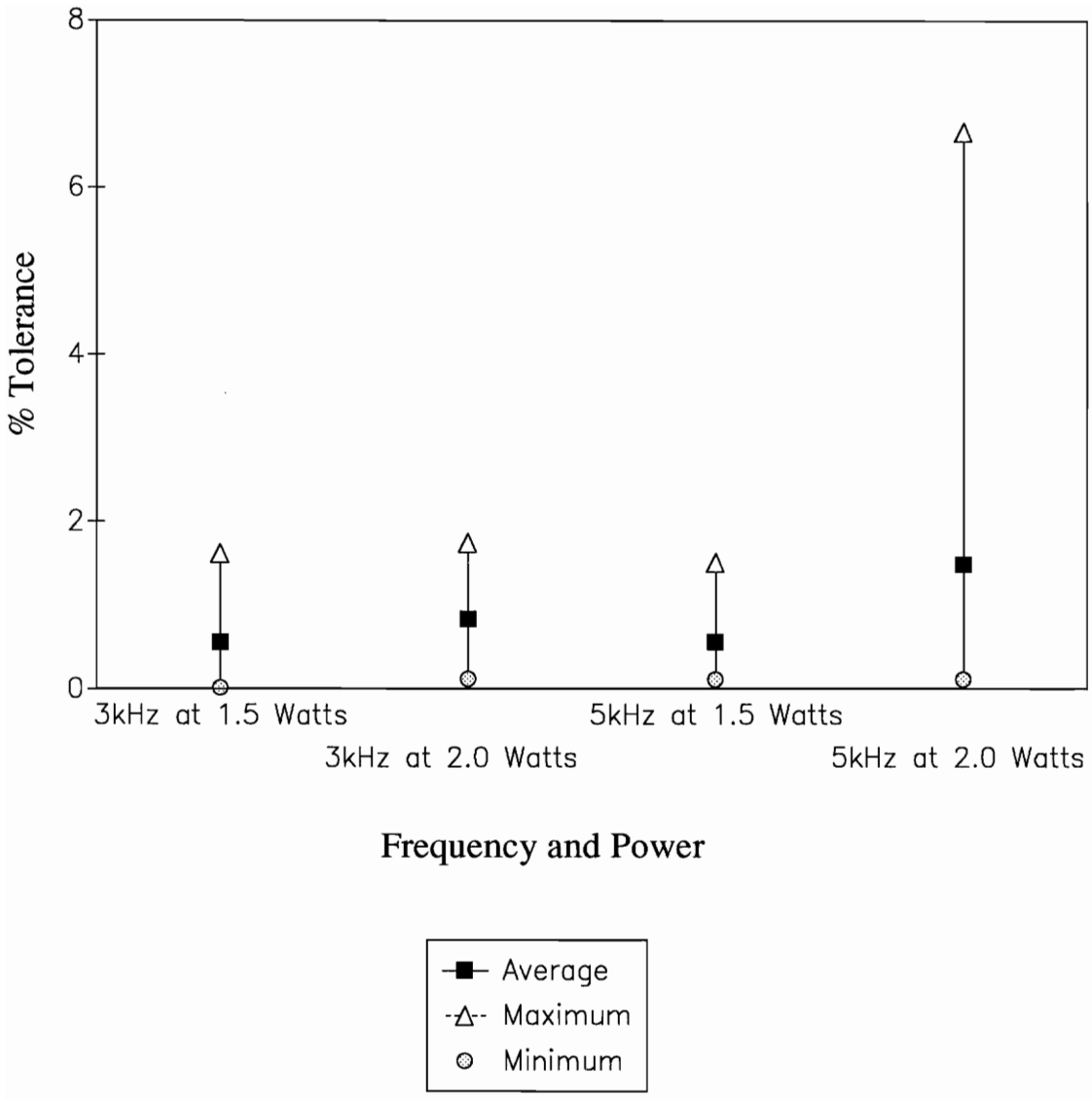

Figure 5.21
The Breakup of Tolerances for the First Cut
of a Serpentine Cut

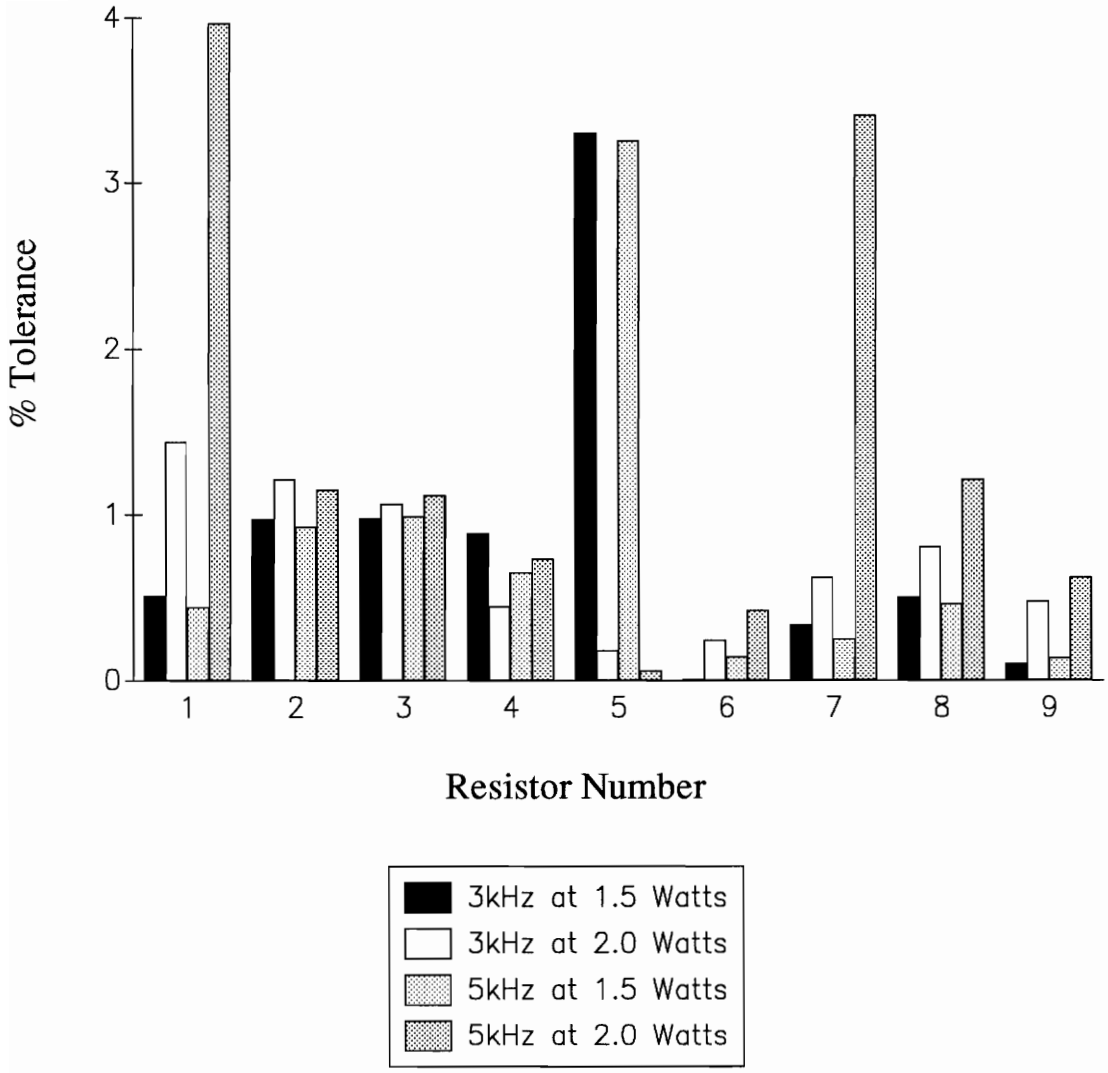

Figure 5.22
The Tolerances for the Second Cut
of a Serpentine Cut

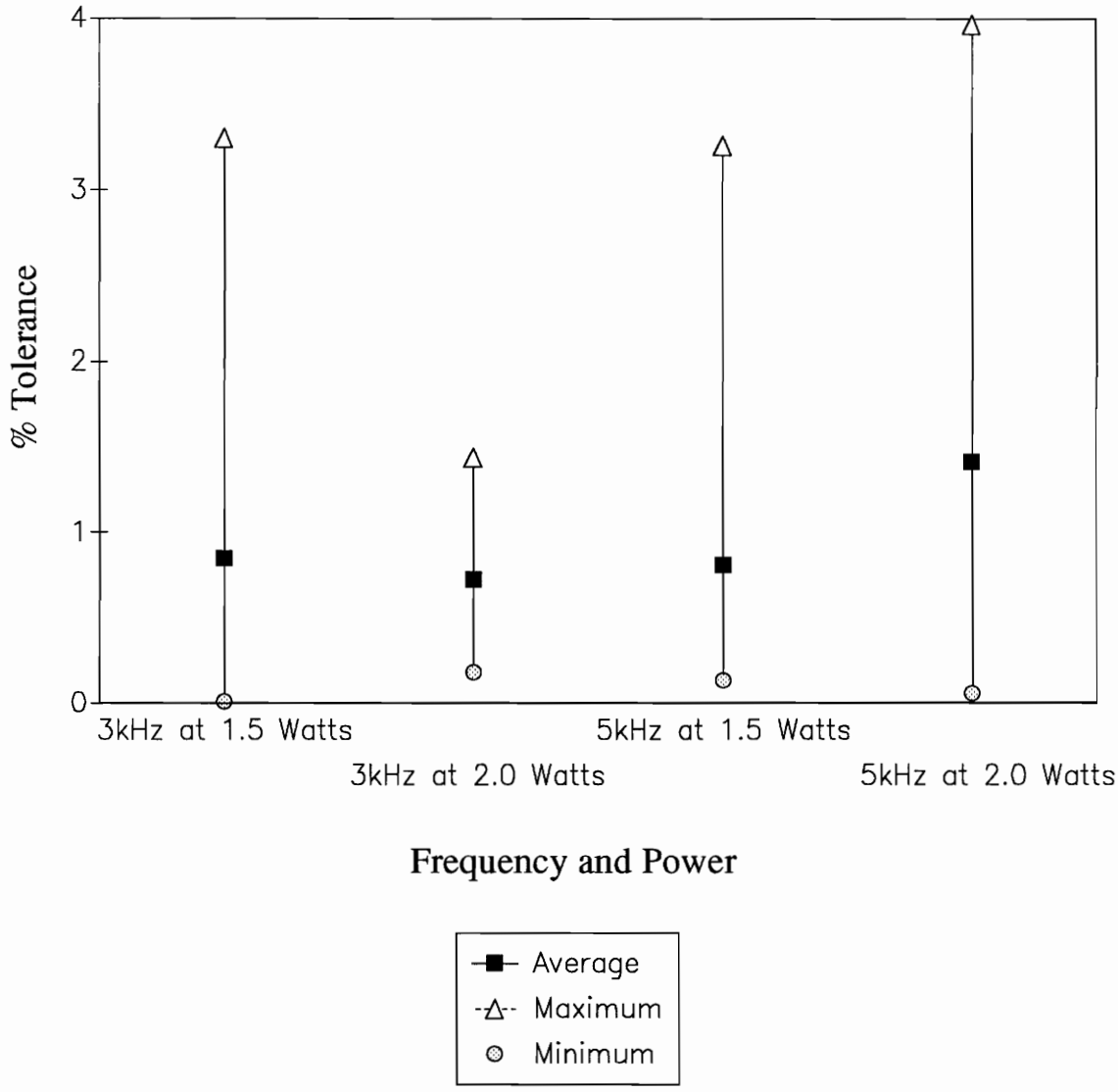

Figure 5.23
The Breakup of Tolerances for the Second Cut
of a Serpentine Cut

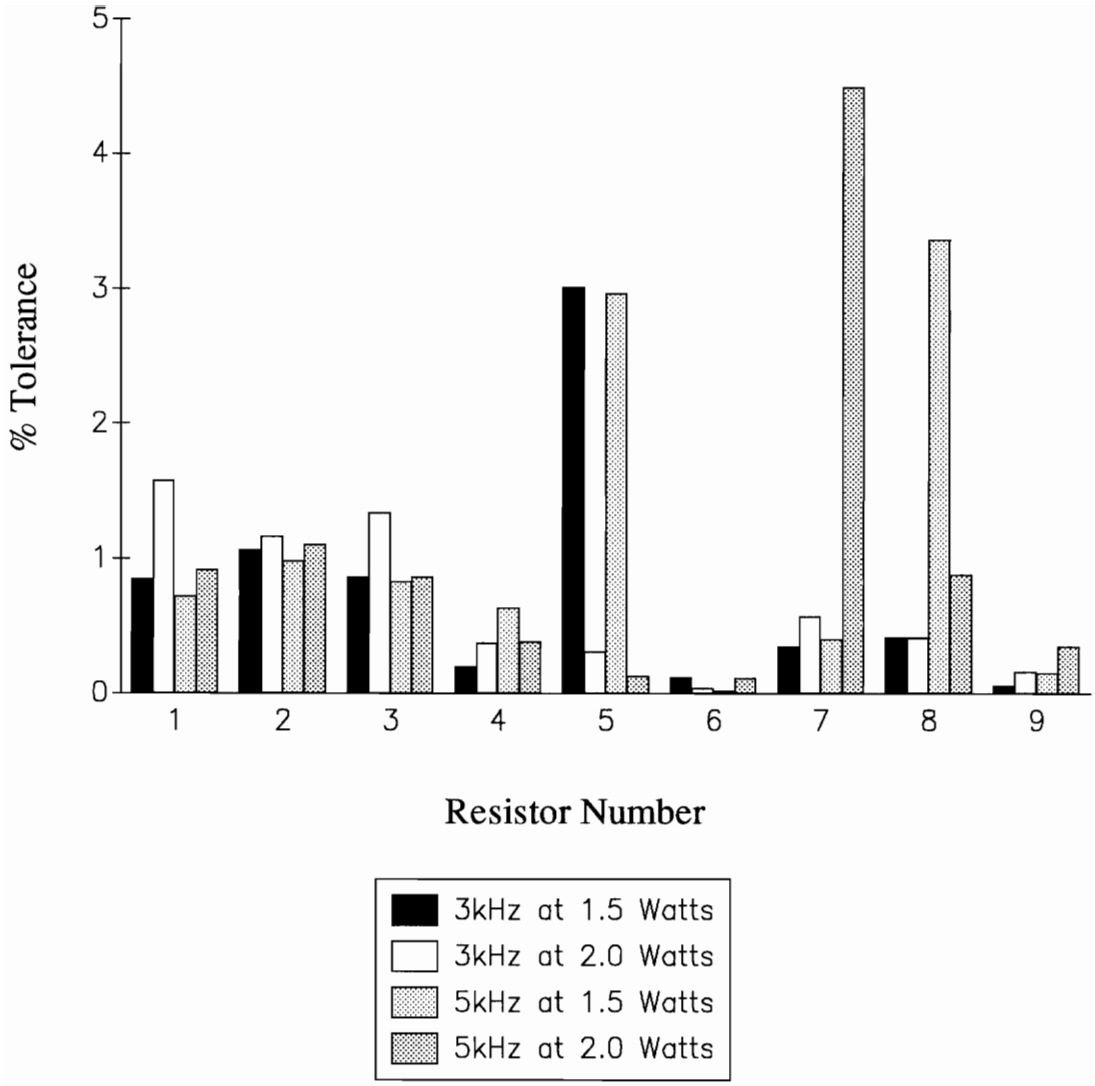

Figure 5.24
The Tolerances for the Third Cut
of a Serpentine Cut

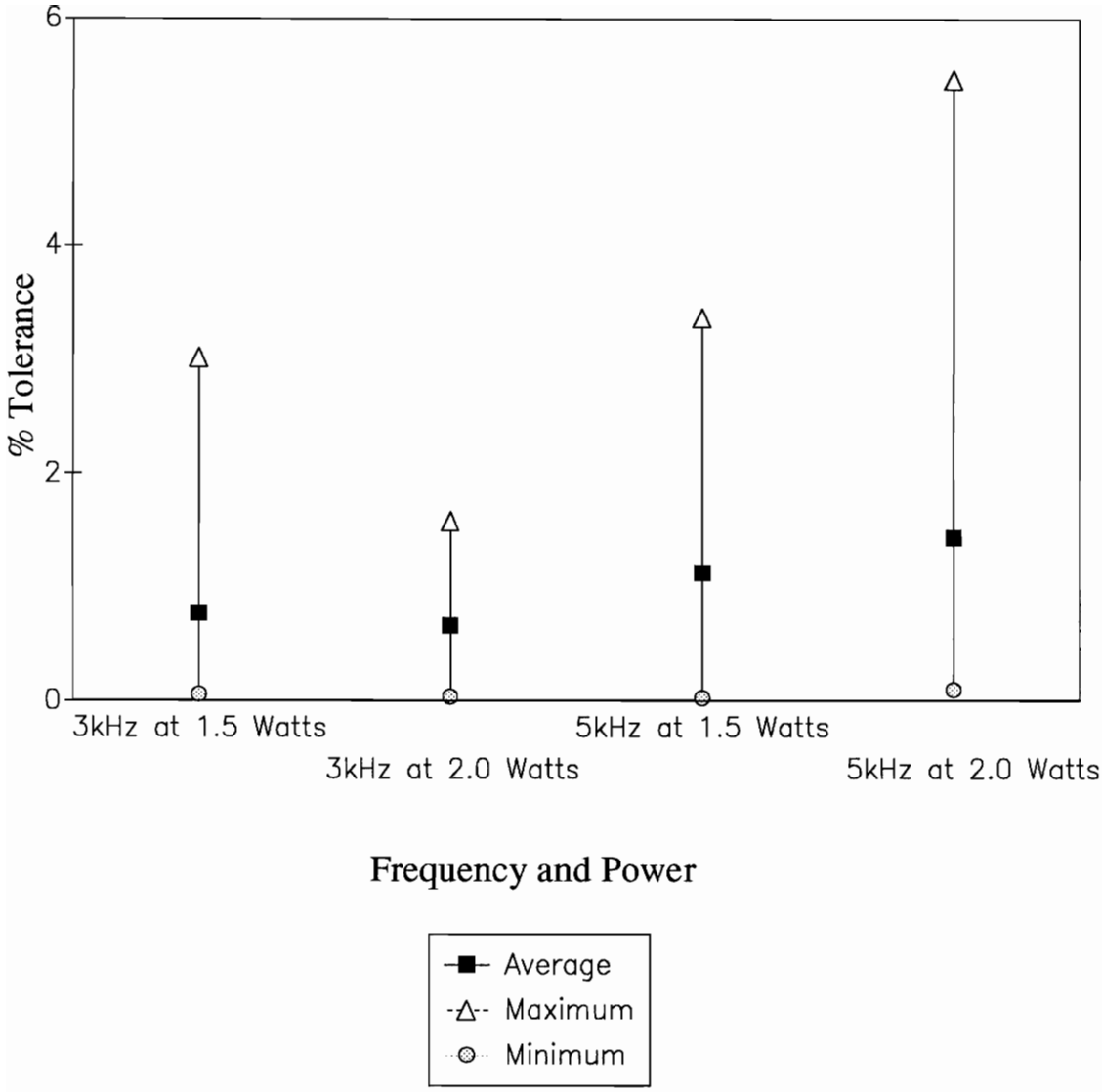

Figure 5.25
The Breakup of Tolerances for the Third Cut
of a Serpentine Cut

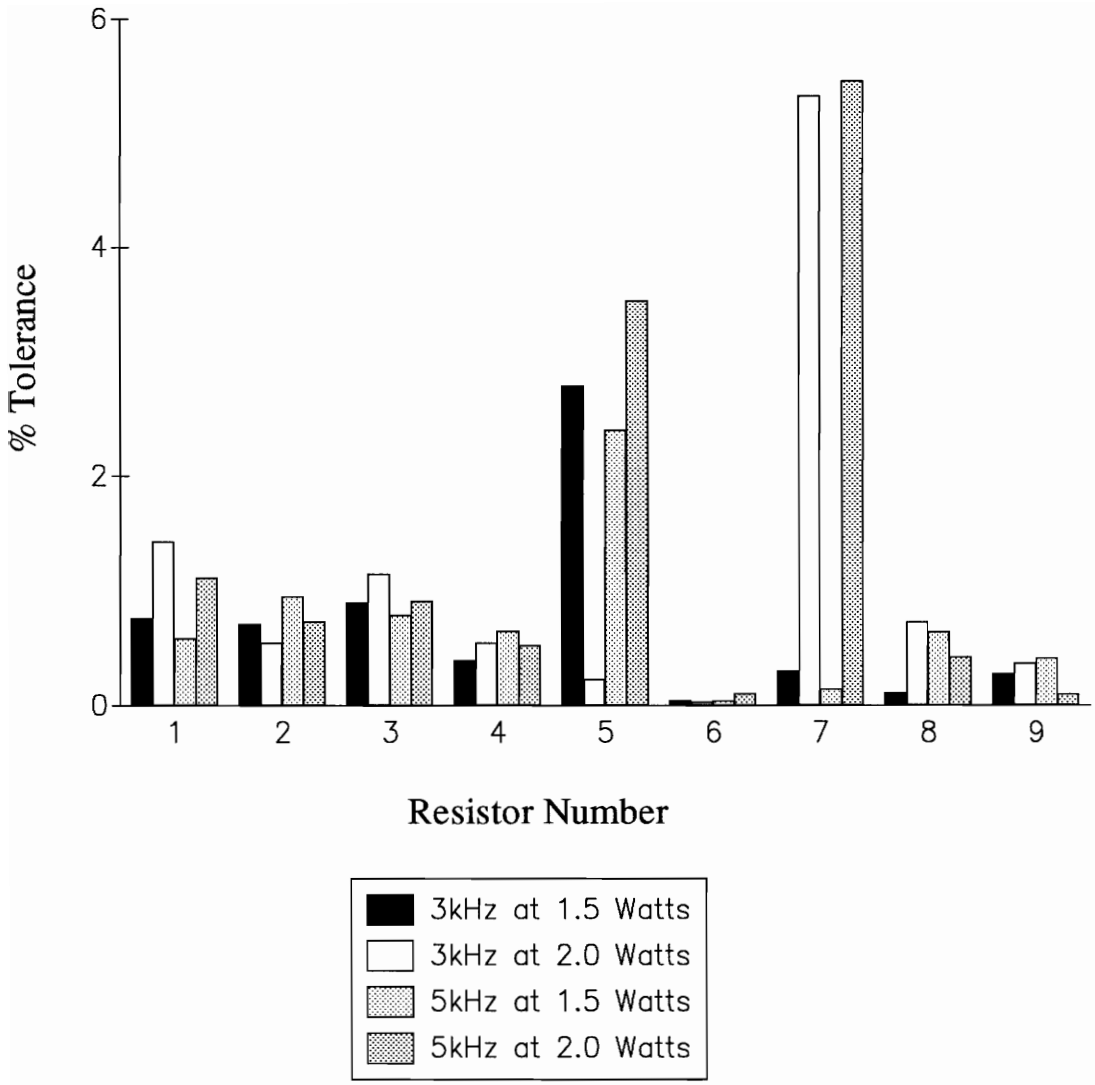

Figure 5.26
The Final Tolerances
of a Serpentine Cut

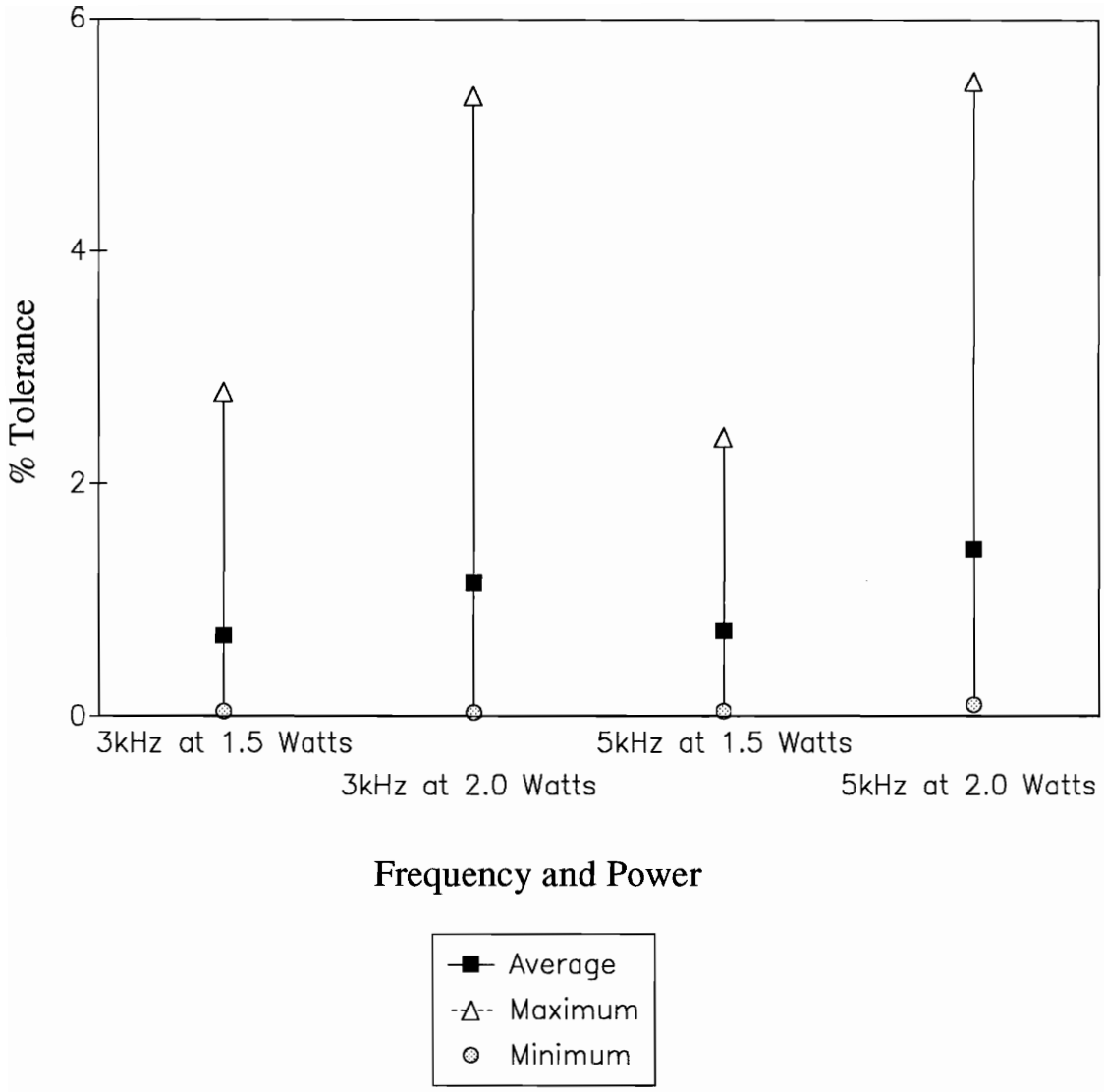

Figure 5.27
The Breakup of the Final Tolerances
of a Serpentine Cut

possible explanation for this effect is that the stronger cuts effectively heated the resistor so that the measured resistance was not the normal operating resistance. When the trim was completed and the resistor cooled down, the resistance increased away from the original desired resistance. Another surprising result is that the best uniformity and average tolerances were obtained from the Double Cuts and the Serpentine Cuts. It was originally assumed that the L Cuts would have the best performance. Since the Double Cuts and the Serpentine Cuts can be evaluated as a series of straight cuts, it could be hypothesized that the quality would be the same as the Single Straight Cut. These multiple straight cuts performed better than the L Cuts because the percentage of resistance that was trimmed on the latter straight cuts was not as large as a Single Straight Cut. They also did not require the laser to trim as deep into the resistor. The L Cut, on the other hand, was already deep in the resistor when it turned to do its perpendicular cut and was trimming the resistor in an area that the resistance changed fast with respect to the measuring speed.

5.3 Analysis of Resistor Geometry, Types of Cuts, and Resistor Tolerances

The following evaluations are based on the aspect ratios of the trimmed resistors as seen in Figure 5.28. The correlation between the resistor's number and the resistor is shown in Figure 5.29. Resistors 1 to 3 have a low aspect ratio of 1:3, resistors 4 to 6 are square with an aspect ratio of 1:1, and resistors 7 to 9 have a high aspect ratio of 5:1.

Surface Area \ Aspect Ratio	5:1	1:1	1:3
Large	R7	R5	R3
Medium	R9	R6	R2
Small	R8	R4	R1

Figure 5.28 The Resistor Dimensions

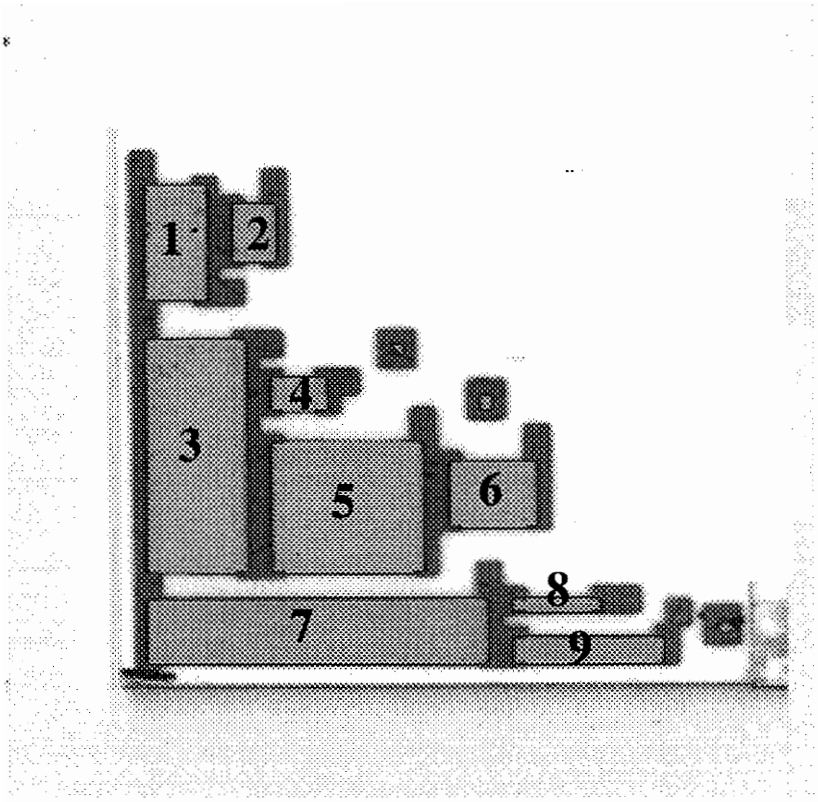

Figure 5.29 The Numbering Format for the Resistors

5.3.1 The Single Straight Cut

The Straight Cut worked most effectively with the low aspect ratio resistors (R1 to R3) at 5kHz which is shown in Figure 5.2. The square resistors (R4 to R6) took the Straight Cut well, but not with the same low tolerance as the low aspect ratio resistors. The high aspect ratio resistors (R7 to R9) turned out less than satisfactory.

5.3.2 The L Cut with the Elbow at 60%

The L Cuts with the elbow at 60% did not work on the low aspect ratio resistors because the second cut of the L Cut could not get the requested resistance without trimming into the resistor pad. The other two resistor aspect ratios had a very good response to this cut. The tolerances and uniformity are outstanding for the square and the high aspect ratio resistors. The tolerances on the first cut were not very good, but that is the basic advantage of the L Cut.

5.3.3 The L Cut with the Elbow at 70%

The L Cuts with the elbow at 70% were not as accurate as the elbow at 60%. In fact, this L Cut performed better on the low aspect ratio resistors than either the square or the high aspect ratio resistors. This was due to the laser trimming deeper into the resistor and trimming its second cut in an area that was still a high resistance change per resistance measurement. This did not happen to the low aspect ratio resistors because there was still a good amount of width remaining on the resistor when the second cut was begun. This data was extrapolated from Figures 5.8 to 5.10.

5.3.4 The L Cut with the Elbow at 80%

This type of cut followed very closely with the straight cut. The turn at 80% of the final value was very close to the stopping point of the final value of the straight cut. By comparing Figures 5.2 and 5.14, it is noticed that turning at 80% did not give any benefit and that there was no advantage between these cuts and the Single Straight Cuts.

5.3.5 The Double Cut

The Double Cut was programmed to turn at 70% of the final value. Surprisingly, the first cut of the Double Cuts and the first cut of the L Cuts with the elbow at 70% did not match very well by comparing Figure 5.8 and 5.16. The final values of the Double Cut had tolerances under 1% for the square and the high aspect ratio resistors. The low aspect ratio resistor did not perform well because the second cut was not far from the first cut.

5.3.6 The Serpentine Cut

The Serpentine Cut did very well, except for the two resistors with the longest length (resistors 5 and 7) as seen in Figure 5.26. Other than those two resistors, the tolerances and uniformity were excellent for the Serpentine Cuts. The square and the high aspect ratio resistors both performed well compared to the low aspect ratio resistors.

5.3.7 Discussion

It is commonly known that the Single Straight Cut is the least optimal type of cut. Although the Double Cuts and the Serpentine Cuts were clearly better than the Single Straight Cuts, the performance of the L Cuts were not so evident and were based strongly on the elbow percentage with respect to the resistor dimensions. The elbow at 60% worked well for the square and the high aspect ratio resistors, but the low aspect ratio resistors needed an elbow greater than that. The elbow at 70% and 80% worked well for the low aspect ratio resistors, but were not as effective on the square and the high aspect ratio resistors. Another interesting note is that the Serpentine Cuts worked well on the low aspect ratio resistors while the Double Cuts did not. This was due to the fact that the Serpentine Cut was accomplished by alternating cutting sides.

The results of the trims are most quickly seen by looking at the trimmed resistor. Figures 5.30 to 5.35 show images of the cuts on the square resistor 5. Figure 5.30 displays the Straight Cut as it was conceptualized in Figure 2.1. Figures 5.31 to 5.33 show the different L Cuts. It is quickly noticed how the elbow at 60% in Figure 5.31 has a longer second trim than the elbow at 70% and at 80%. The 70% and the 80% elbows differ only slightly in the length of the second cut due to the change in resistance per resistance measuring time. The Double Cut in Figure 5.34 and the Serpentine Cut in Figure 5.35 both show that by dividing up the final resistance among several cuts, no one cut went too deep into the resistor.

Figure 5.30 The Straight Cut

Figure 5.31 The L Cut with the Elbow at 60%

Figure 5.32 The L Cut with the Elbow at 70%

Figure 5.33 The L Cut with the Elbow at 80%

Figure 5.34 The Double Cut

Figure 5.35 The Serpentine Cut

5.4 Thermal Aging Results

The evaluation of the thermal aging results was based on resistor cracking along the trimmed line over time. The acquired results were quite diverse. The response of the control substrate that had no trims is shown in Figures 5.36 and 5.37. These results corresponded quite well to the specifications of the resistive paste that was used [31]. The Straight Cuts responded well, except for the 5kHz at 1.5 Watt trims (Figure 5.38). These went to an average of 5% from their original value (Figure 5.39). The other three groups averaged less than 1%. All of the low aspect ratio resistors that had L Cuts (Figures 5.40 to 5.45) held up well, also. The high aspect ratio resistors that had L Cuts were greatly affected by the thermal aging. The square resistors of the L Cuts with the elbow at 80% responded reasonably, but the high aspect ratio resistors reacted very poorly. The resistors trimmed with a L Cut with the elbow at 70% and at 3kHz with 1.5 Watts on power reacted five times worse than the other cuts on the average. The Double Cut (Figure 5.46 and 5.47) reacted the same way at 3kHz with 1.5 Watts of power. This was an interesting match because both of these cuts have had there turn/shift at 70%. These were the only power, frequency, and type of cut combinations that showed any distinct pattern. Even with the spikes from the 3kHz cuts, the average tolerance for all of the Double Cuts was below 1%. The most tolerant and uniform distribution came from the Serpentine Cuts seen in Figures 5.48 and 5.49. The average tolerances were around 0.5% and all of the maximums and minimums varied by less than 1%. This type of cut was most related to the response of the control resistors.

In relating all of the types of cuts, the L Cuts seemed to be the most damaged from the aging process. This was probably due to the configuration of the L Cut. By having cuts in perpendicular directions, the L cut is susceptible to cracks in all directions.

Cracks that occurred off of the perpendicular cut will act like straight cuts that went directly into the current path. The response of the Serpentine Cuts was not surprising because no one cut penetrated deep into the resistor. Even though cracking may occur, the cracks would not disturb the current flow to any great extent.

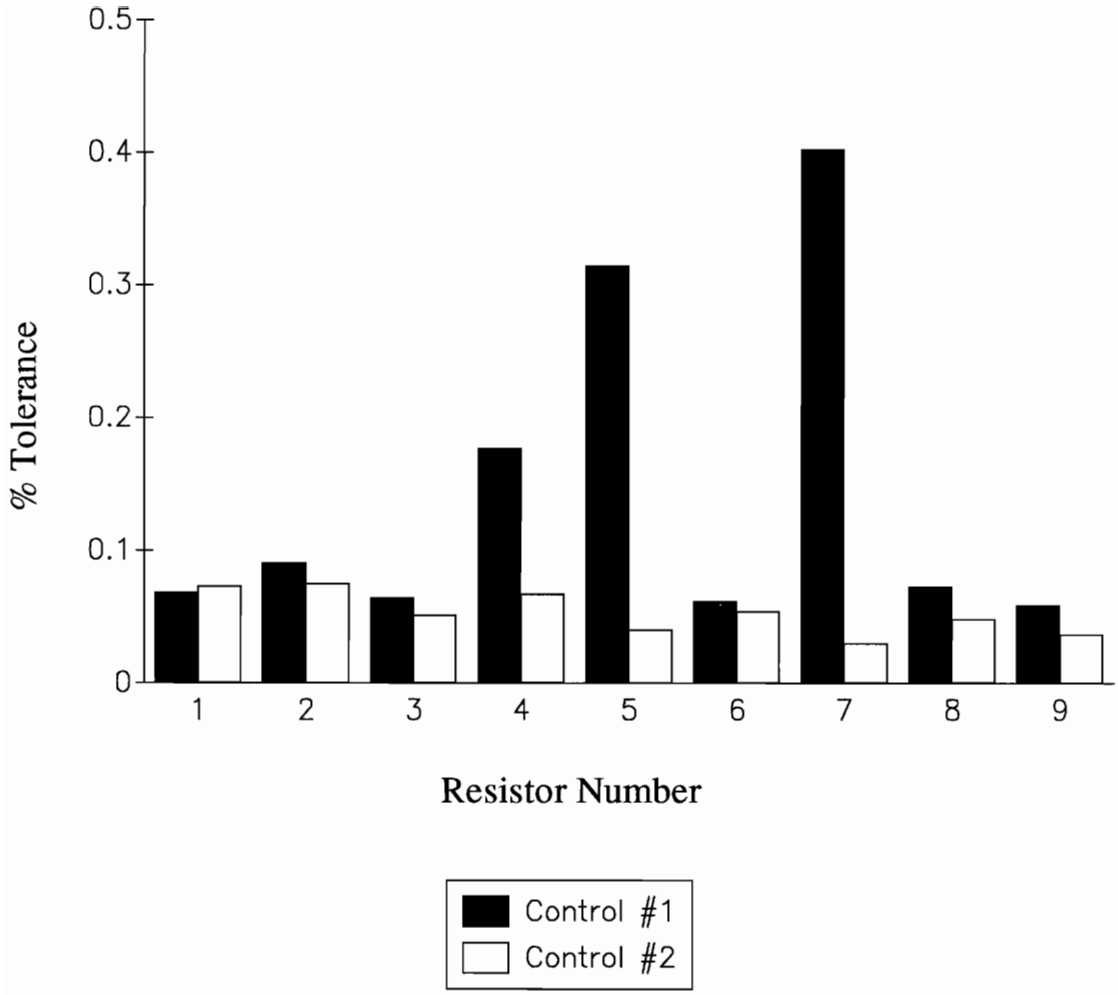

Figure 5.36
The Tolerances for the Control Substrate
after Thermal Aging

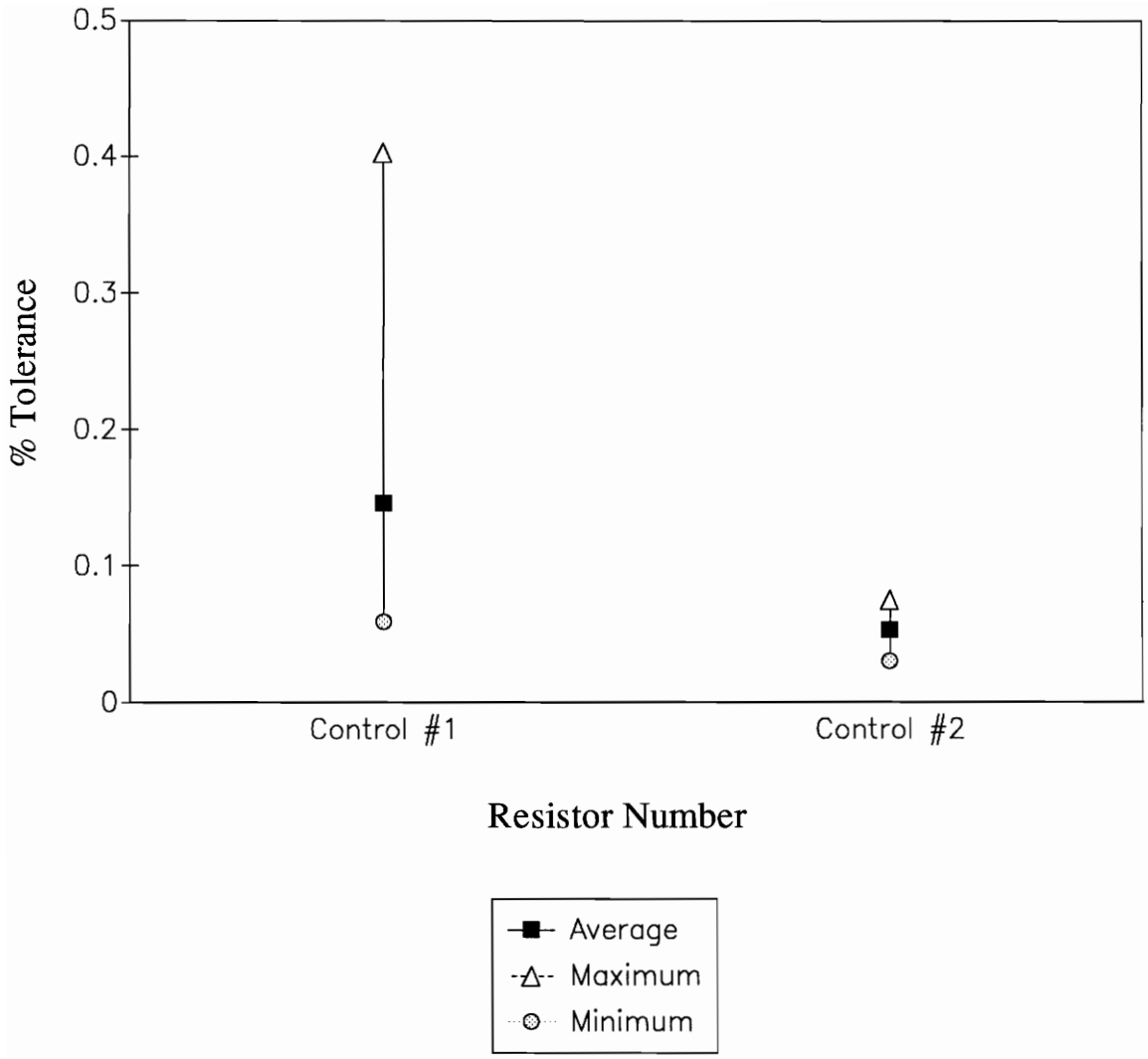

Figure 5.37
The Breakup of Tolerances for
the Control Substrate after Thermal Aging

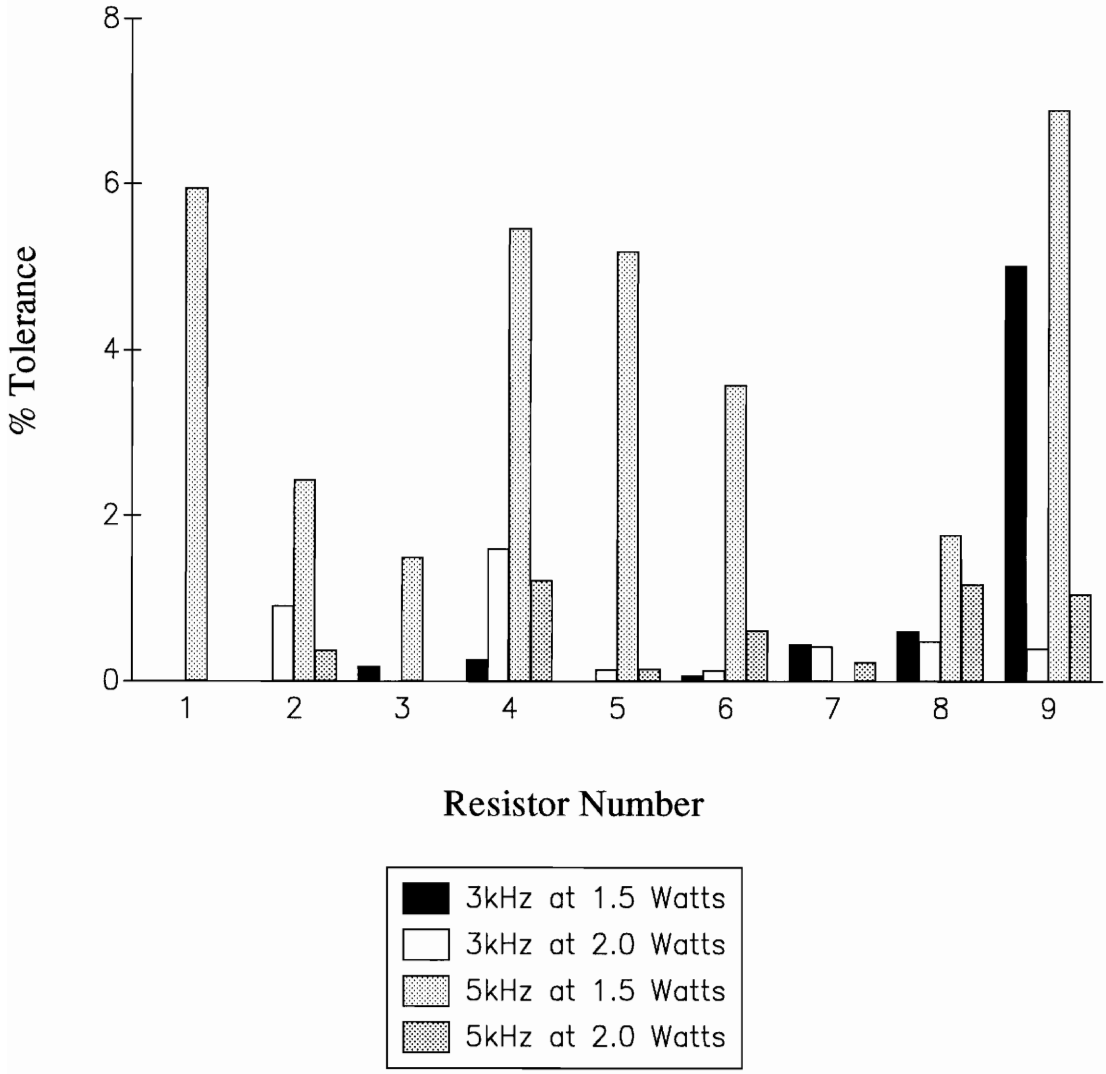

Figure 5.38
The Tolerances for the Single Straight Cut
after Thermal Aging

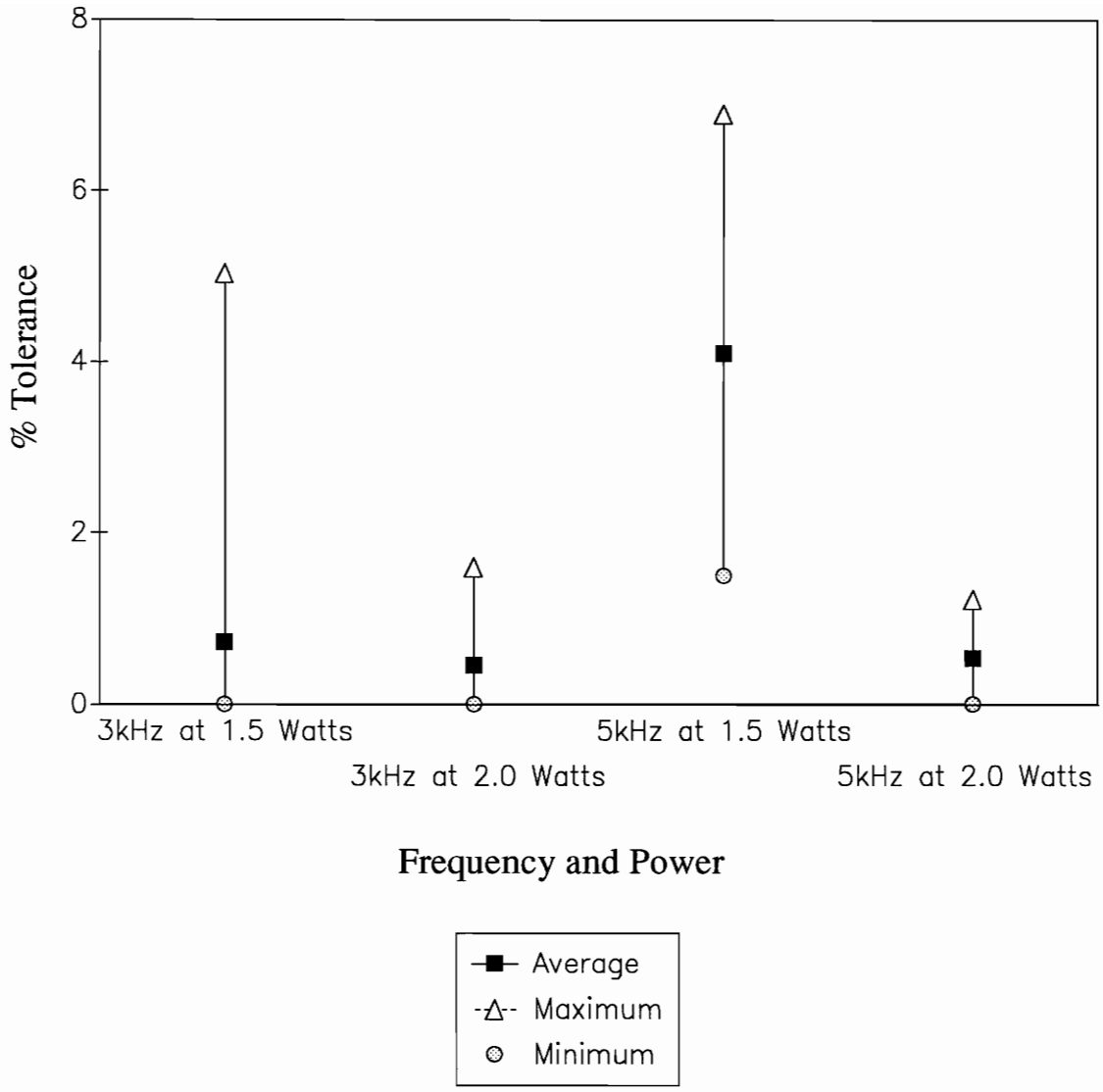

Figure 5.39
The Breakup of Tolerances for
the Single Straight Cut after Thermal Aging

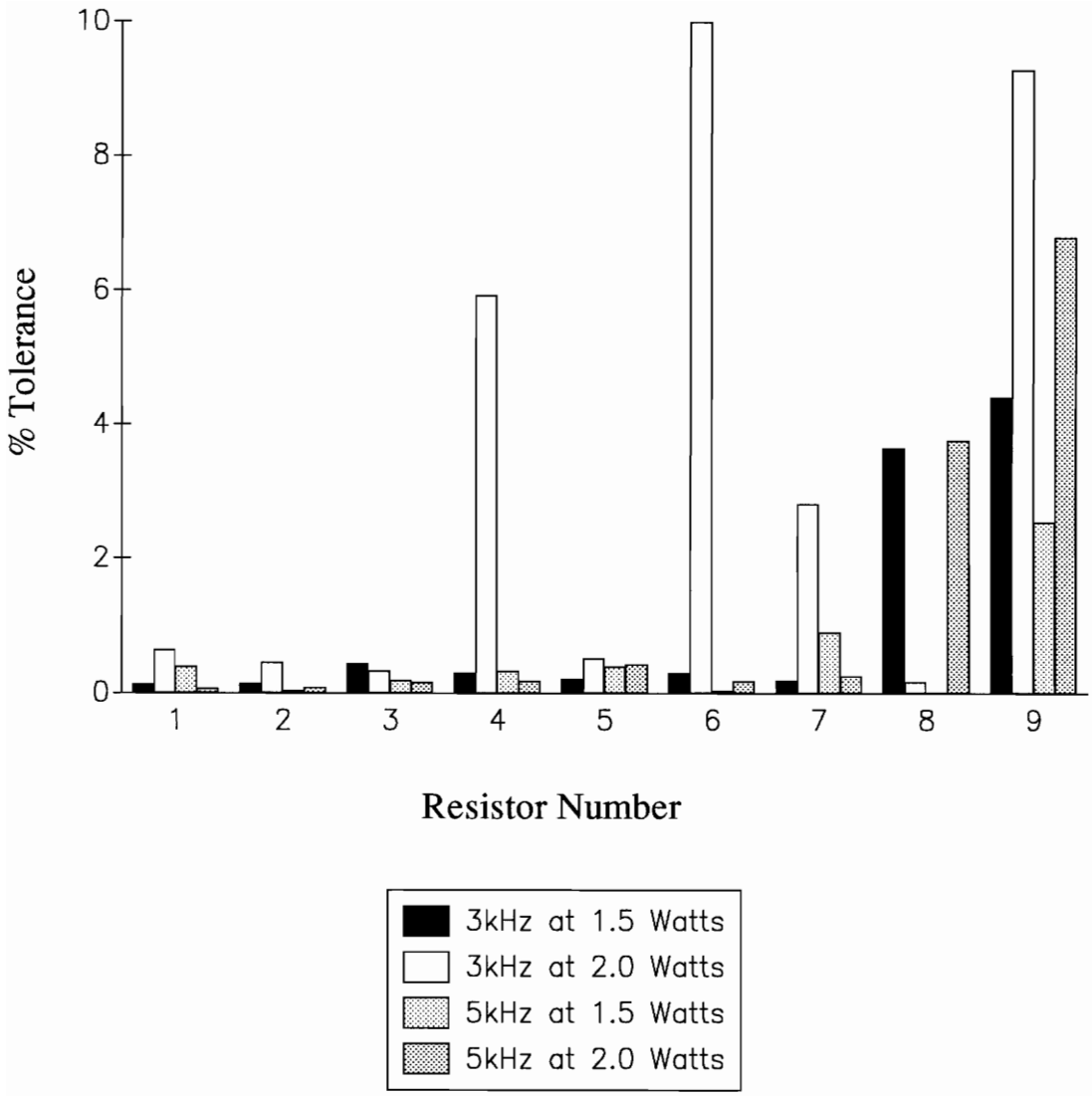

Figure 5.40
The Tolerances for a L Cut
with the Elbow at 60% after Thermal Aging

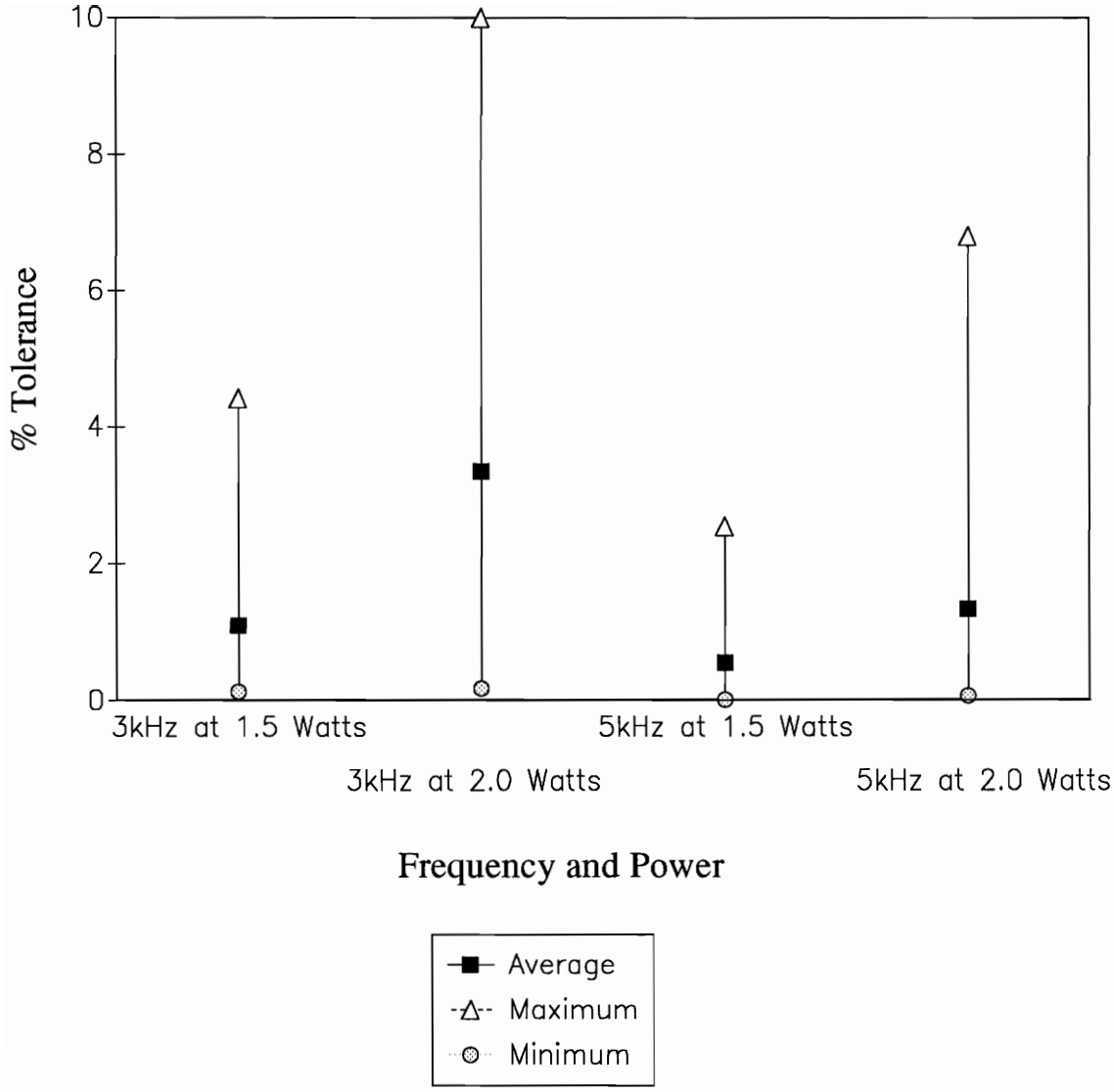

Figure 5.41
The Breakup of Tolerances for a L Cut
with the Elbow at 60% after Thermal Aging

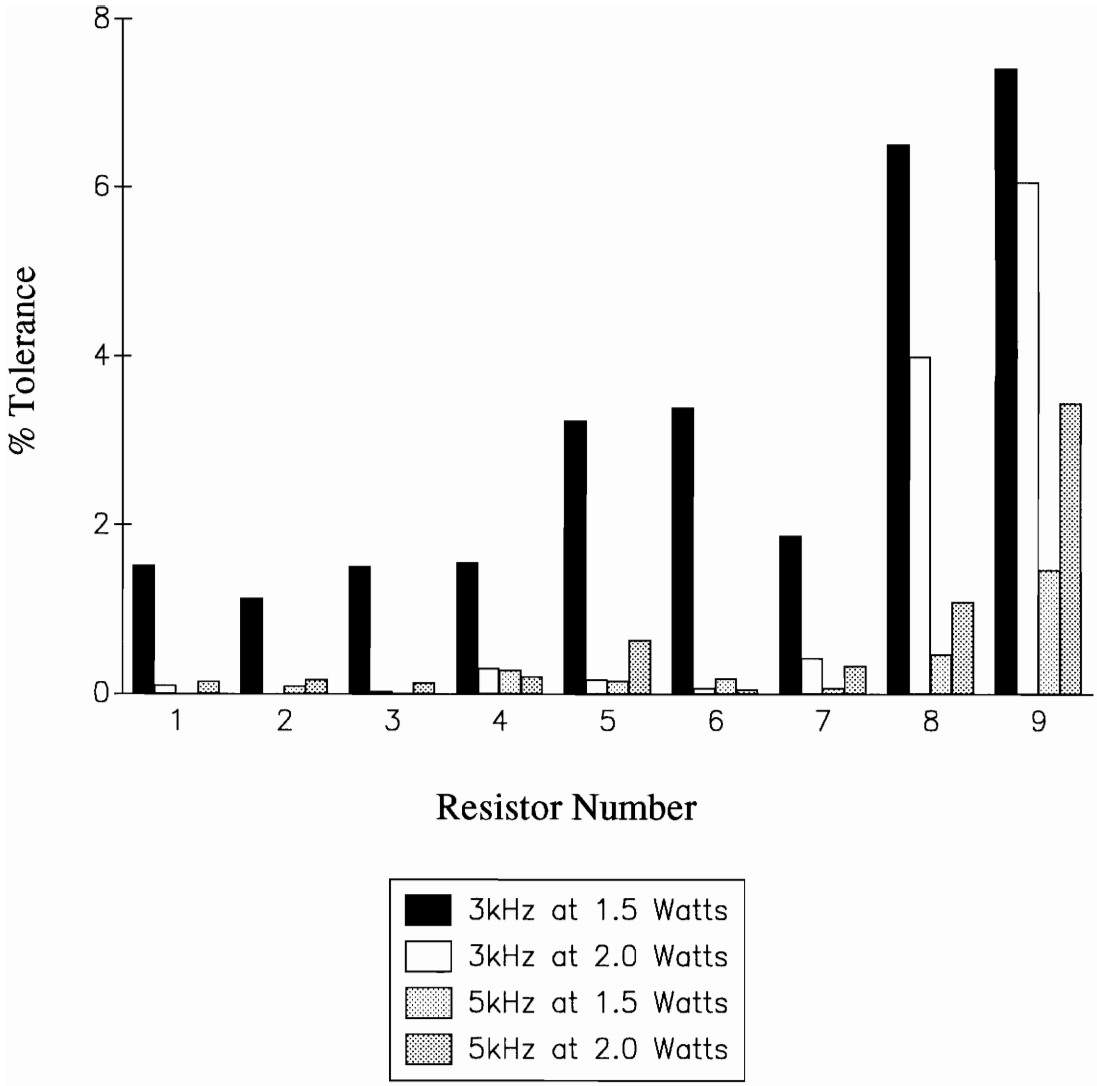

Figure 5.42
The Tolerances for a L Cut
with the Elbow at 70% after Thermal Aging

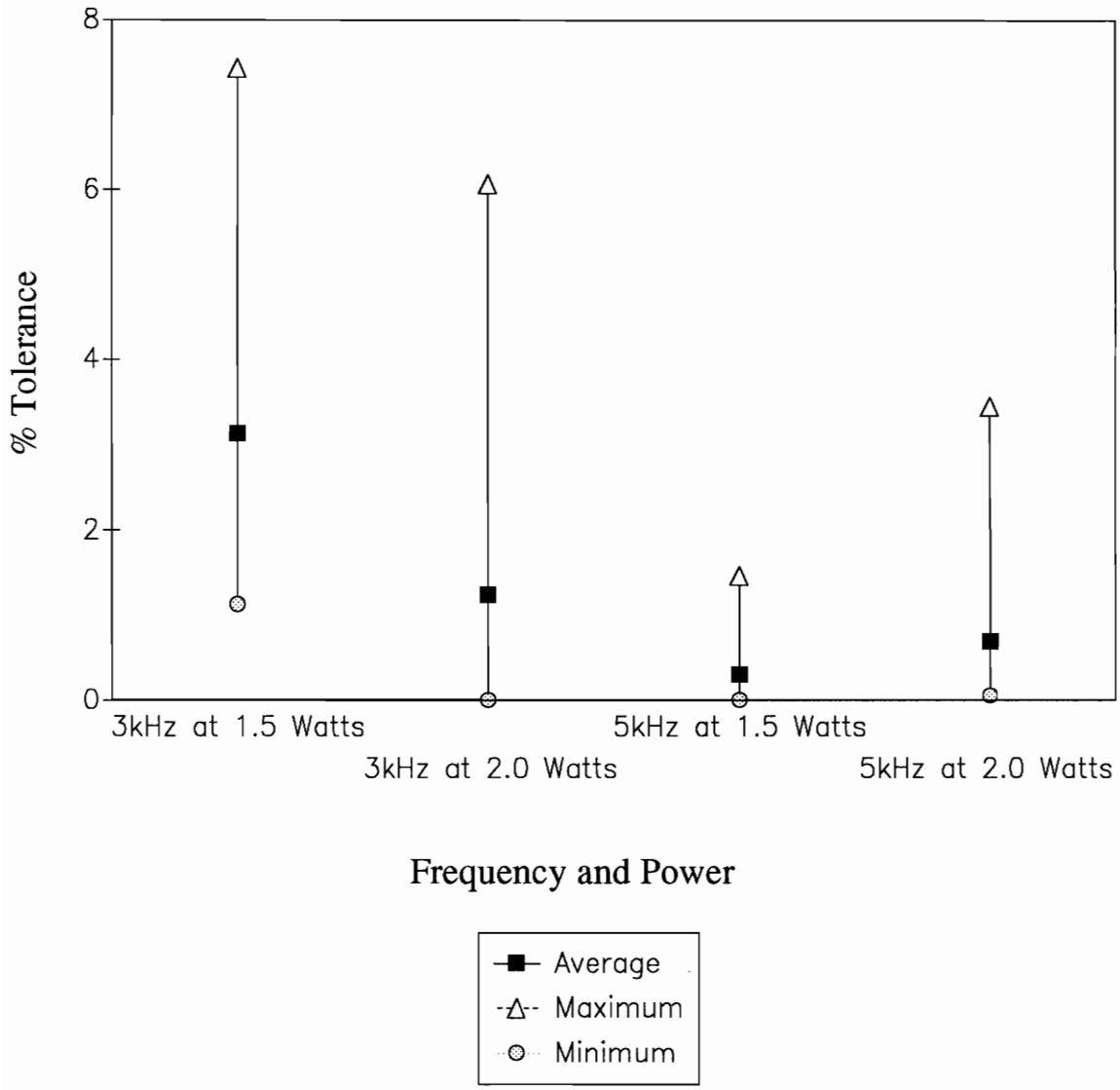

Figure 5.43
The Breakup of Tolerances for a L Cut
with the Elbow at 70% after Thermal Aging

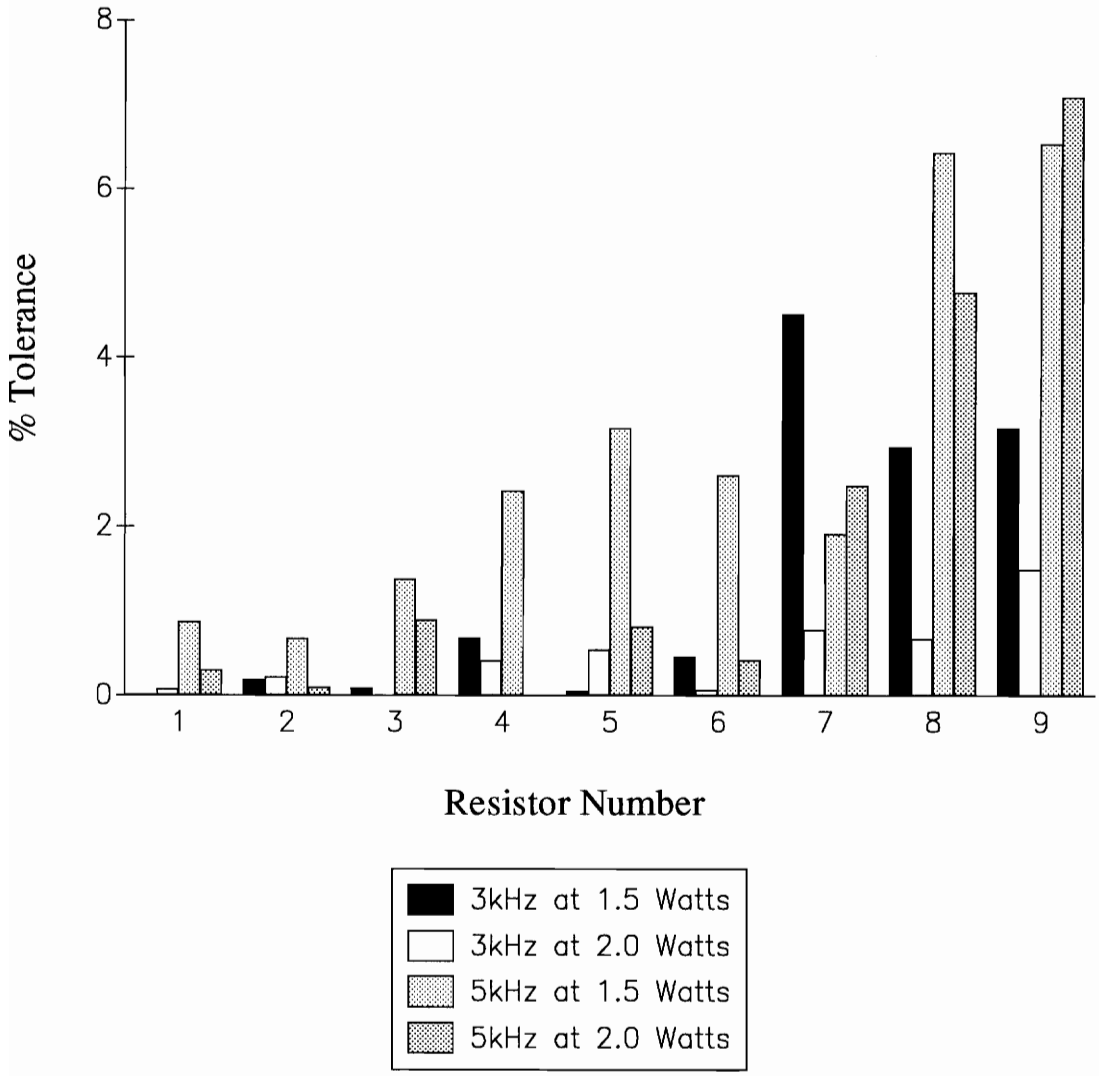

Figure 5.44
The Tolerances for a L Cut
with the Elbow at 80% after Thermal Aging

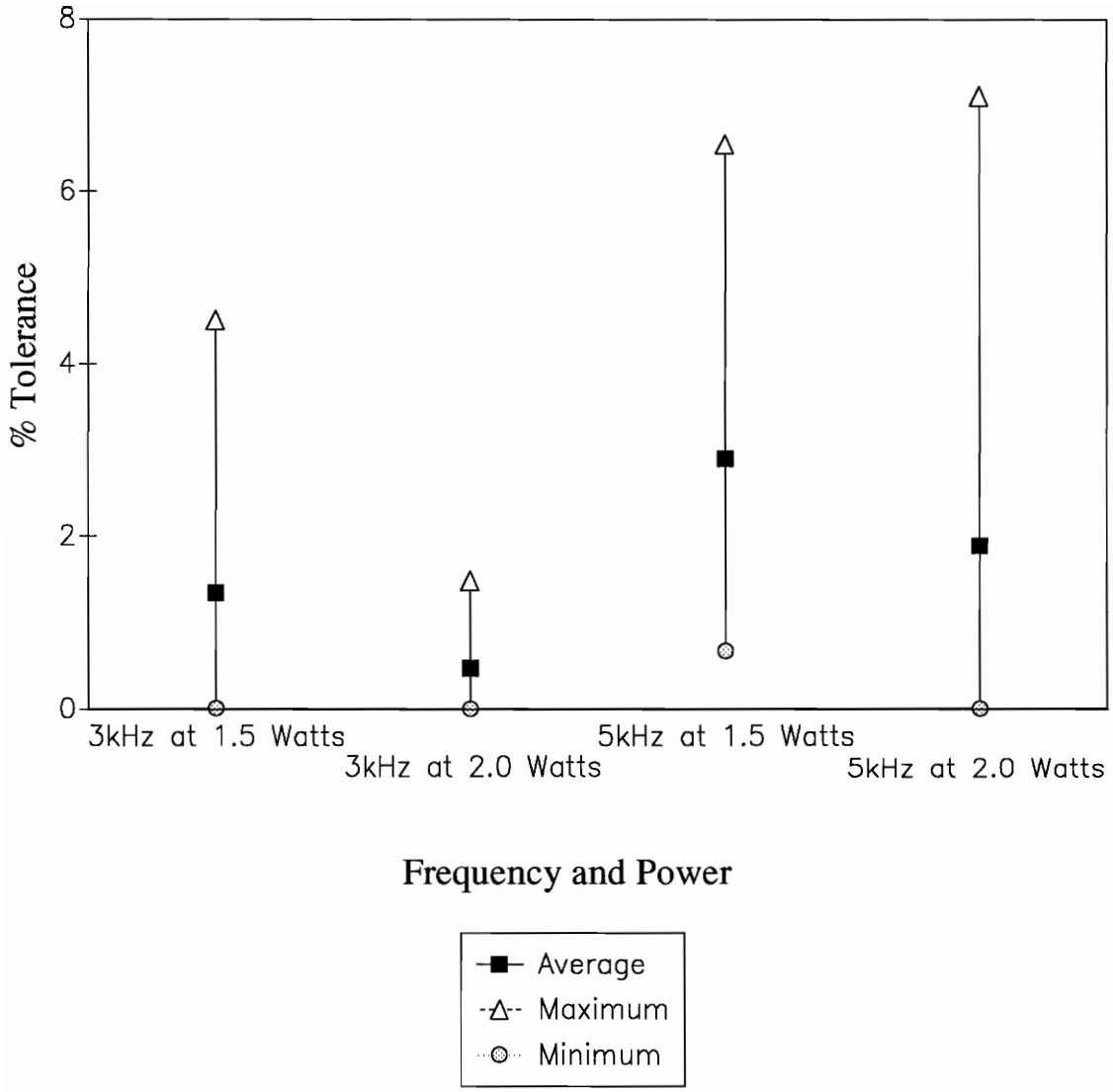

Figure 5.45
The Breakup of Tolerances for a L Cut
with the Elbow at 80% after Thermal Aging

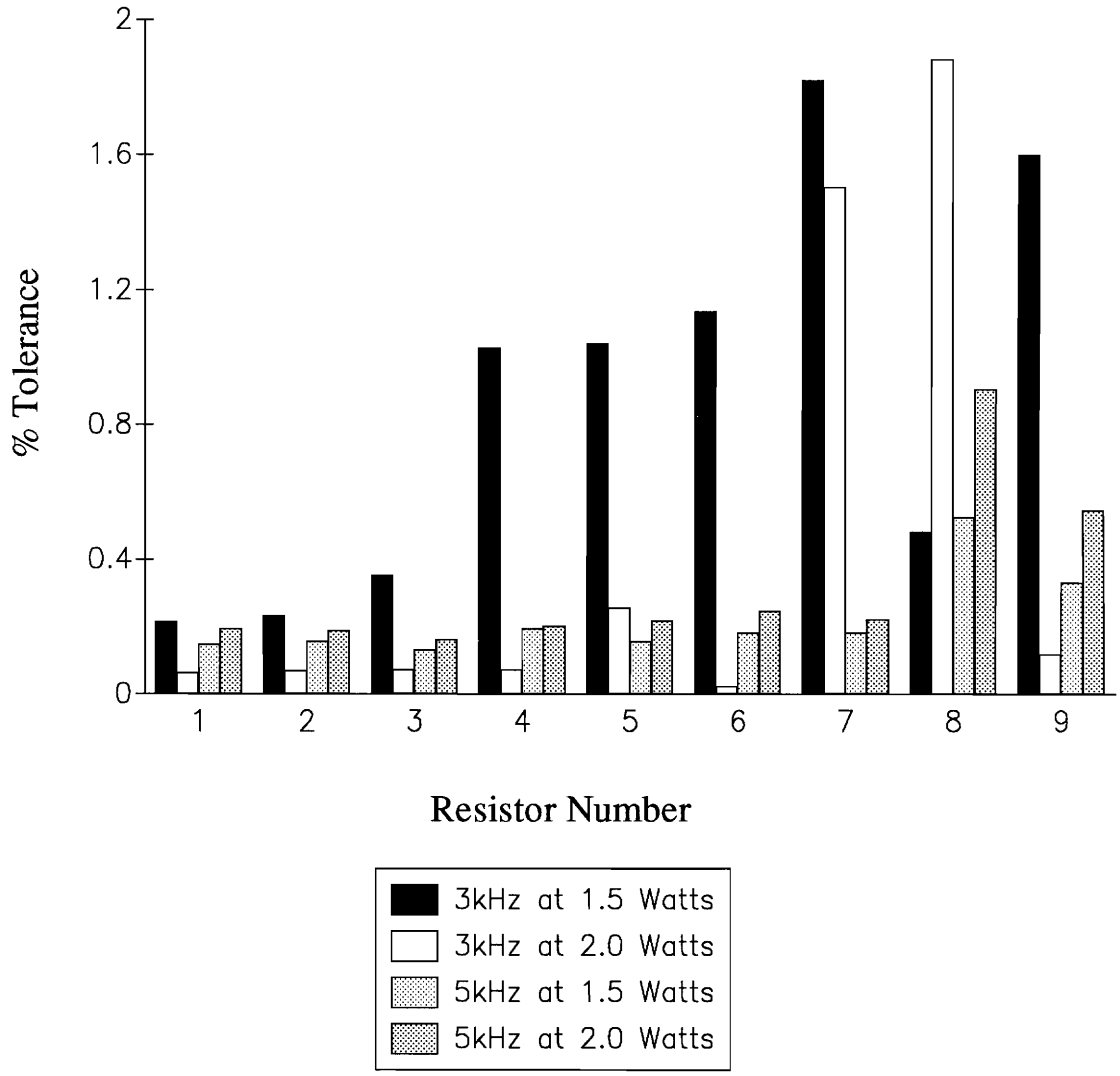

Figure 5.46
The Tolerances for a
Double Cut after Thermal Aging

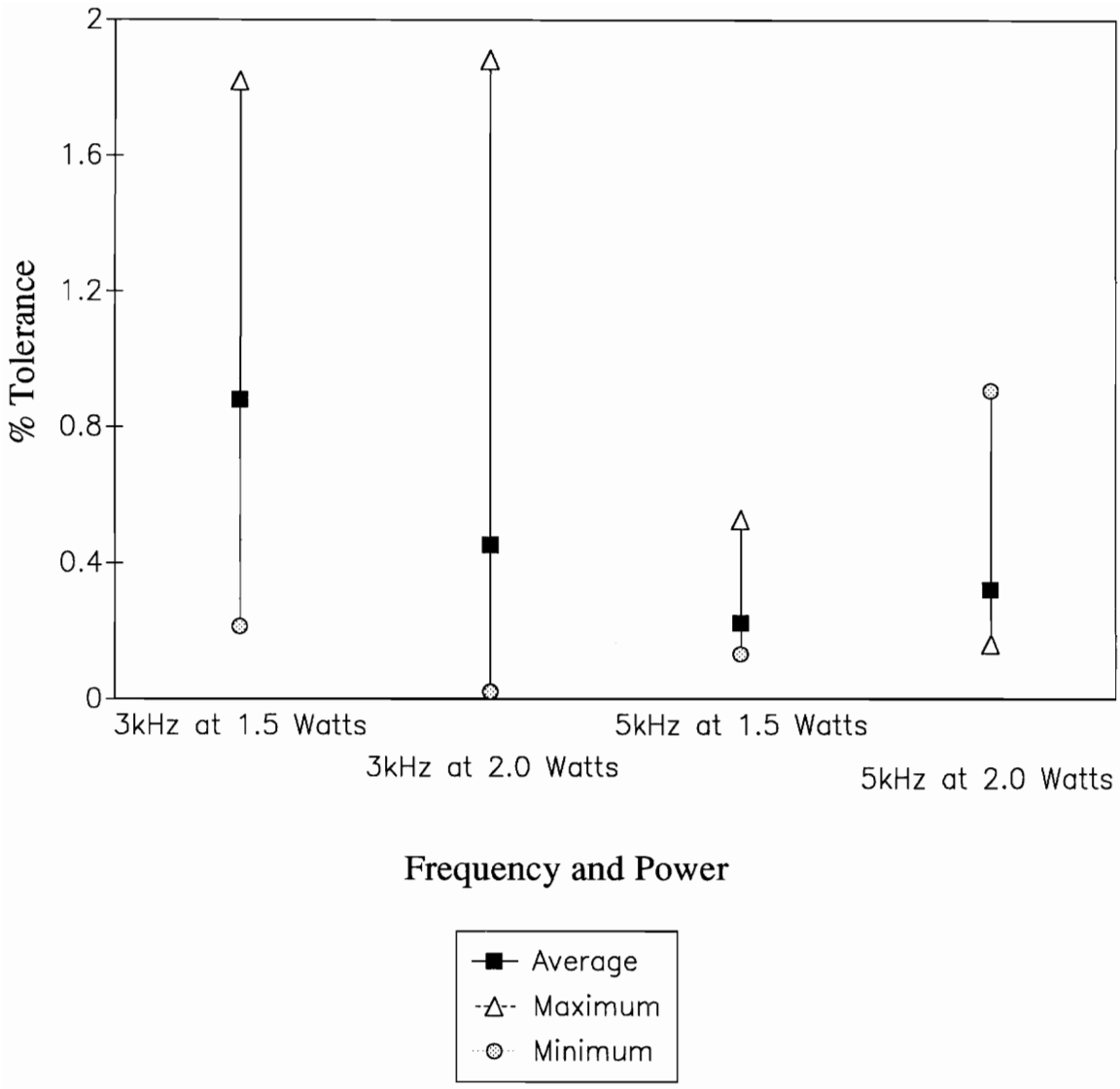

Figure 5.47
The Breakup of Tolerances for a
Double Cut after Thermal Aging

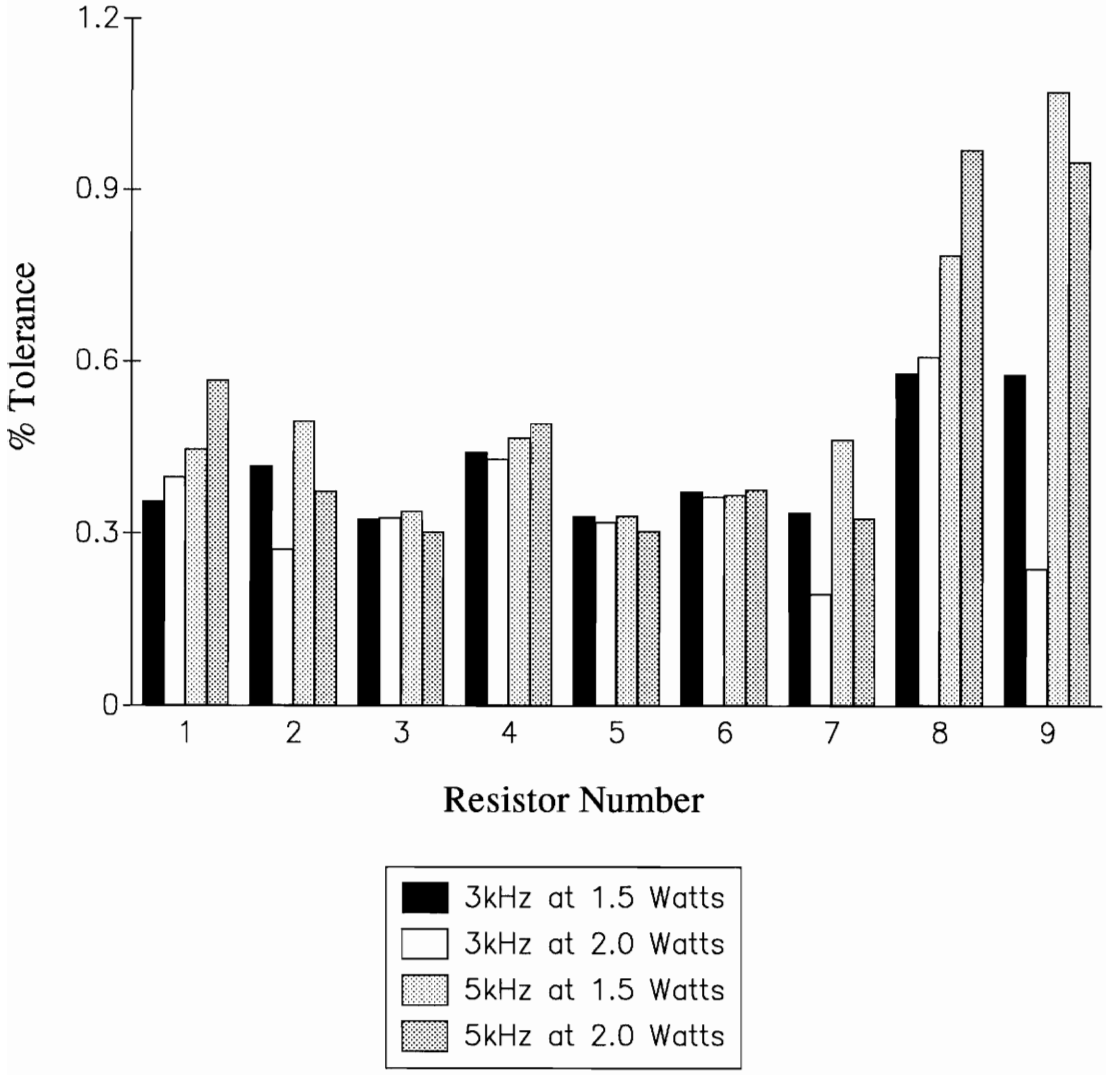

Figure 5.48
The Tolerances for a
Serpentine Cut after Thermal Aging

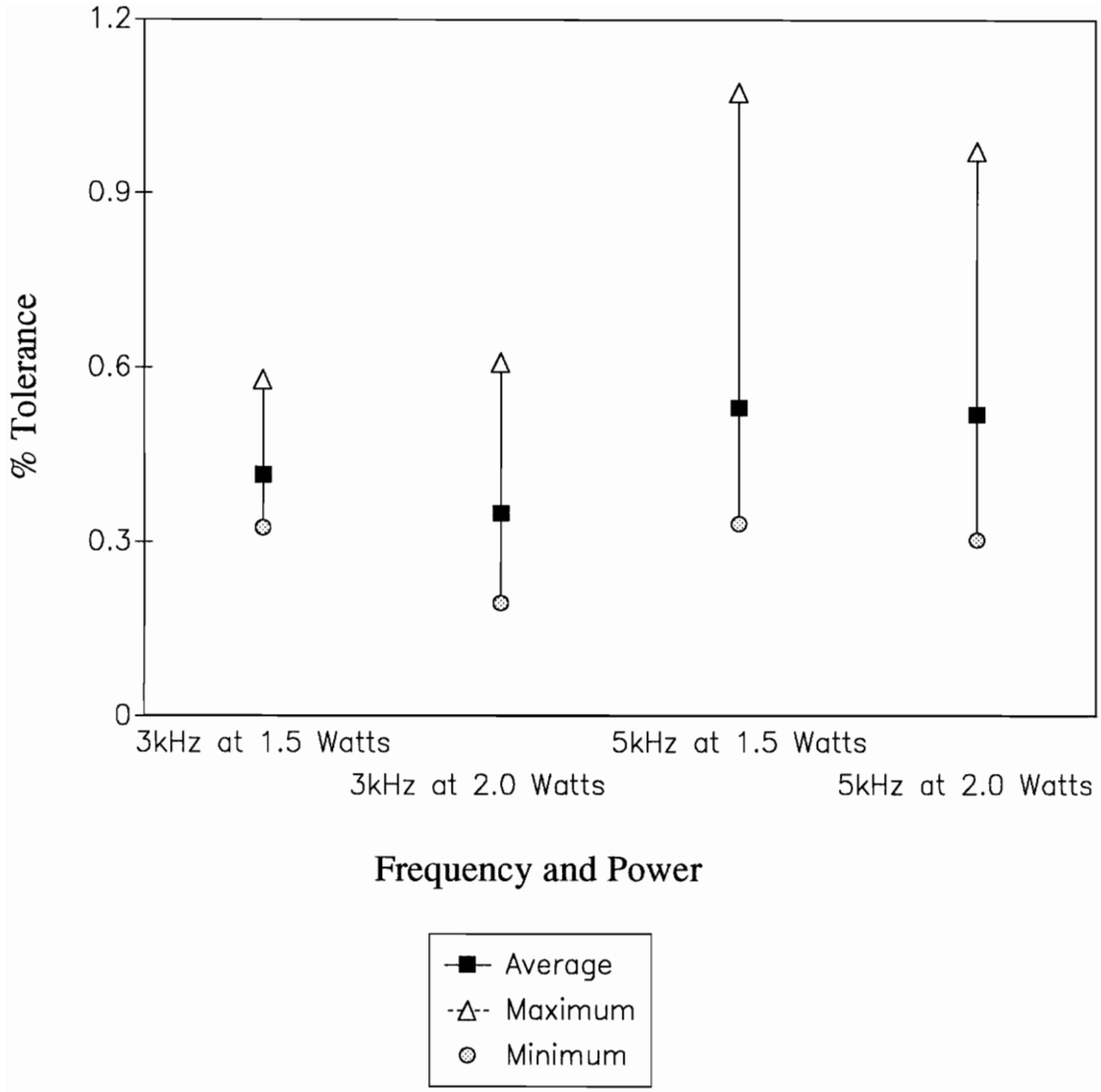

Figure 5.49
The Breakup of Tolerances for a
Serpentine Cut after Thermal Aging

Chapter 6

Conclusions and Recommendations

6.1 Conclusions

Laser trimming of thick film resistors is a very useful tool. The constructed laser control system interface effectively operates the laser systems functions through hardware and software. The hardware handles the line conversion, the correct buffering, and a means to communicate with the laser control system. The software takes responsibility for initializing the laser correctly, but allows the user the full realm of laser operations and parameters in an integrated operating environment. The operating environment includes a pattern storage structure that allows for sequences of patterns to be stored for later use, as well as being analyzed and printed.

The stability and effects of laser trimming are important to understand. Although the laser is a precise method of resistor trimming, the process in which the trimming is performed is important. Depending on the configuration of the resistor, a type of cut along with the power and frequency is selected. These are also a function of a necessary or suggested tolerance level and the long term stability requirements. The Serpentine Cut is the most effective type of cut for resistors without much length between the conductor pads. The Double Cut are shown to be stable for square and high aspect ratio resistors, but not for low aspect ratio resistors. The L Cuts are accurate, but require planning for the correct percentage of final resistance at which to turn. The stability of the L Cuts is

not very impressive. The Straight Cuts have relatively random results and are not suggested for use.

6.2 Recommendations

The current interface is limited for use by an XT. Future revisions may include upgrading the hardware to make use of faster machines and architectures. This will provide a more accurate resistor trimming function due to the polled nature of the interface. Additions to the current interface may also include adding diode banks to the communication lines for an easier diagnosis of line communication problems.

Further resistor trimming research may include cutting some Double-Reverse Cuts that will help in evaluating the difference between the Double Cut and the Serpentine Cut on low aspect ratio resistors. With the construction of a faster interface system, a second set of tests can evaluate the differences in actual performance.

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APPENDIX I

ENDPRO SOURCE CODE

```
#include <conio.h>
#include <dos.h>
                                        /* Initialize the addresses
*/
#define  bmba     0x300
#define  bmbc     0x302
#define  bmbcom   0x303
#define  baca     0x304
#define  bacb     0x305
#define  bacc     0x306
#define  baccom   0x307
#define  accom    0x30B
#define  addr56A   0x2E
#define  addr56C   0x02
                                        /* Initialize the control bytes
*/
#define  outcbt   0x80                  /*   Command config code for output all ports
*/
#define  incbt    0x9B                  /*   Command config code for input all ports
*/
#define  iop2     0x02
#define  clearIop 0x00


/*****************************************************************************************
**
 *
 *      PROGRAM:  Endpro.c
 *
 *     PURPOSE:  To test the laser register accessing by turning off the In Process light
 *                                     and turning on the Process Complete light.
 *
 *    PARAMETERS:
 *                      GLOBL: NONE
 *
 *                      LOCAL: NONE
 *
 *                      CALLS: NONE
 *
 *     RETURNS:  NONE
 *
 *        DATE:  10 February 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *

*****************************************************************************************
*/


main()
{
                                        /*** Initialize the I/O cards ***/
```

```
    outp(bmbcom, outcbt);                /* INIT BMB FOR OUTPUT
*/
    outp(baccom, outcbt);                /* INIT BAC FOR OUTPUT
*/
    outp(accom, incbt);                  /* INIT AC  FOR INPUT
*/



  /*** Turn on the process complete light and turn off the in process light ***/

    outp(bmba, addr56A);
    outp(bmbc, addr56C);

    outp(baca, 0x00);
    outp(bacb, 0x02);

    outp(bacc, iop2);
    outp(bacc, clearіop);

}
```

APPENDIX II

STARTPRO SOURCE CODE

```
#include <conio.h>
#include <dos.h>
                                        /* Initialize the addresses
*/
#define  bmba     0x300
#define  bmbc     0x302
#define  bmbcom   0x303
#define  baca     0x304
#define  bacb     0x305
#define  bacc     0x306
#define  baccom   0x307
#define  accom    0x30B
#define  addr56A   0x2E
#define  addr56C   0x02
                                        /* Initialize the control bytes
*/
#define  outcbt   0x80                  /*   Command config code for output all ports
*/
#define  incbt    0x9B                  /*   Command config code for input all ports
*/
#define  iop2     0x02
#define  cleariop 0x00


/*****************************************************************************************
**
 *
 *      PROGRAM:  Startpro.c
 *
 *     PURPOSE:  To test the laser register accessing by turning on the In Process light
 *                                     and turning off the Process Complete light.
 *
 *    PARAMETERS:
 *                      GLOBL: NONE
 *
 *                      LOCAL: NONE
 *
 *                      CALLS: NONE
 *
 *     RETURNS:  NONE
 *
 *        DATE:  10 February 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                     MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *

*****************************************************************************************
*/


main()
{
                                        /*** Initialize the I/O cards ***/
```

```
    outp(bmbcom, outcbt);                /* INIT BMB FOR OUTPUT
*/
    outp(baccom, outcbt);                /* INIT BAC FOR OUTPUT
*/
    outp(accom, incbt);                  /* INIT AC  FOR INPUT
*/



  /*** Turn off the process complete light and turn on the in process light ***/

    outp(bmba, addr56A);
    outp(bmbc, addr56C);

    outp(baca, 0x00);
    outp(bacb, 0x01);

    outp(bacc, iop2);
    outp(bacc, clearIop);

}
```

APPENDIX III

JOYMOVE SOURCE CODE

```
#include <defntion.h>
#include <conio.h>
#include <dos.h>
#include <moveincd.h>
#include <globlva1.h>
#include <moveincd.c>


/*****************************************************************************
 *
 *     PROGRAM:  Joymove.c
 *
 *     PURPOSE:  Allow access to the full capabilities of the control panel's joystick
 *
 *  PARAMETERS:        GLOBL: None
 *
 *                     LOCAL: x_velo            - X axis velocity
 *                            y_velo            - Y axis velocity
 *                            x_dist            - X axis distance
 *                            y_dist            - Y axis distance
 *                            xd                - Temp X axis distance
 *                            yd                - Temp Y axis distance
 *                            xv                - Temp X axis velocity
 *                            yv                - Temp Y axis velocity
 *                            finish            - Counter
 *
 *                     CALLS: outp               rdjoy
 *                            move_norest
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

main()
{
     int   xd=0, yd=0, x_dist, y_dist, finish;
     float xv=0, yv=0 ,x_velo, y_velo;

   /***init I/O cards***/

       outp(bmbcom, outcbt);     /*INIT BMB FOR OUTPUT*/
       outp(baccom, outcbt);     /*INIT BAC FOR OUTPUT*/
       outp(accom, incbt);       /*INIT AC  FOR INPUT*/

  printf("\n Hit 's' for stop when you have finished playing with the joystick");

  finish = 1;
  while( finish == 1){
       rdjoy();

       if(xjoy == 1 )
          {
          move_norest(0,yd,0,yv);
          xd = 0;
          xv = 0;
          }
       if(yjoy == 1)
```

```
        {
        move_norest(xd,0,xv,0);
        yd = 0;
        yv = 0;
        }
    if(xjoy != 1)              /* test for motion in x */
        {
        xd = 32001;
        if(xjoy < 4)
          {
          xv = 2;
          }
        else
          {
          xv = 10;
          }
        if(xjoy == 2 || xjoy == 6)
          {
          xd = -1*xd;
          }
        move_norest(xd, yd, xv, yv);
        }
    if( yjoy != 1)
        {
        yd = 32001;
        if(yjoy < 4 )
          {
          yv = 2;
          }
        else
          {
          yv = 10;
          }
        if(yjoy == 2 || yjoy == 6)
          {
          yd = -1*yd;
          }
        move_norest(xd, yd, xv, yv);
        }


    if(kbhit() != 0)
      {
      finish = 0;
      move_norest(0,0,0,0);
      }

    }

    finish = 1;


}
```

APPENDIX IV

VELTEST SOURCE CODE

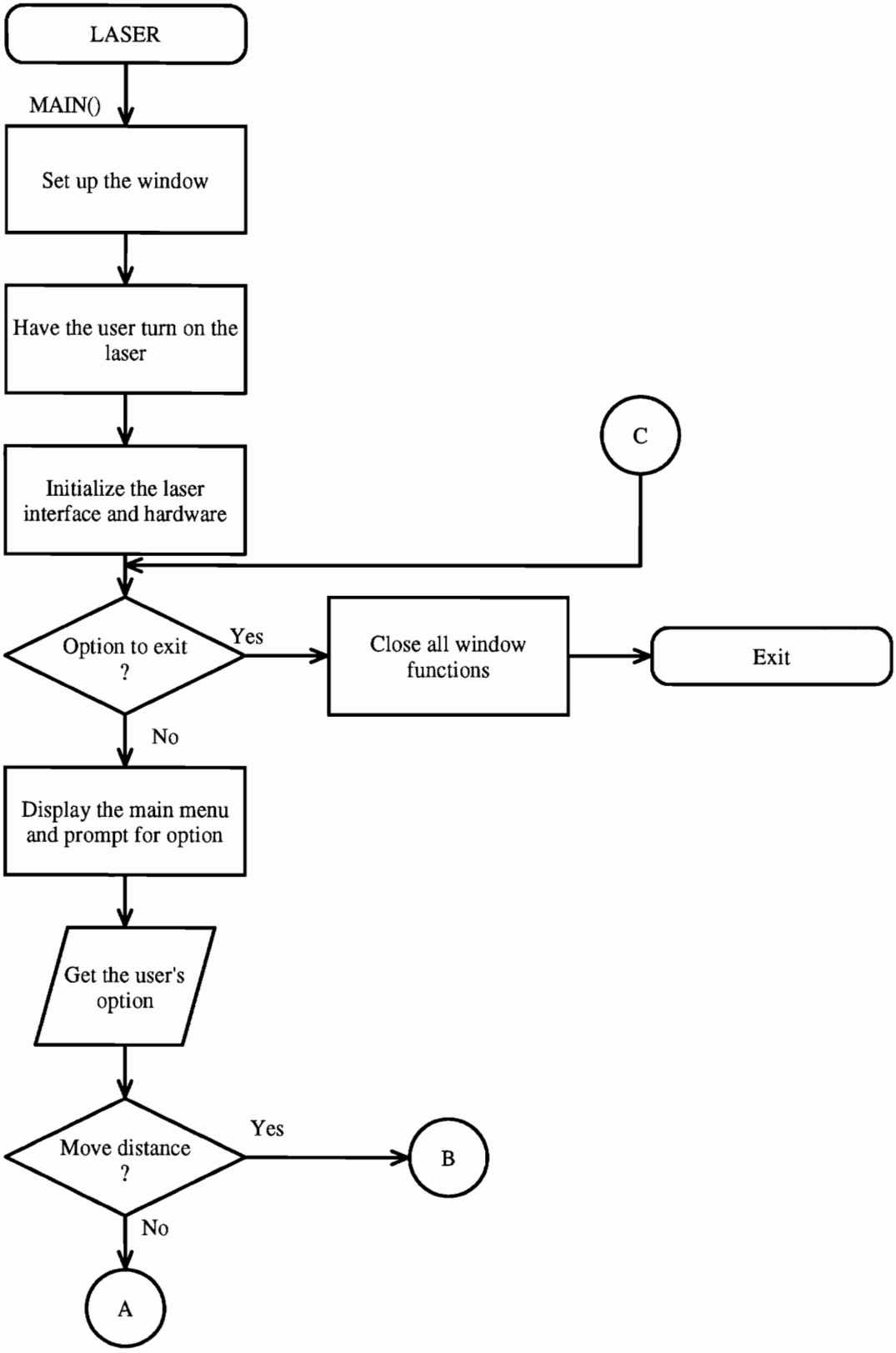
```
#include <conio.h>
#include <dos.h>
#include <defntion.h>
#include <globlva1.h>
#include <moveincd.h>
#include <moveincd.c>


/*****************************************************************************
 *
 *     PROGRAM:  Veltest.c
 *
 *     PURPOSE:  To send a ramping velocity to the D to A boards on the linear motors
 *
 *  PARAMETERS:        GLOBL: xpos                ypos
 *
 *                     LOCAL: x_velo             - X axis velocity
 *                            y_velo             - Y axis velocity
 *                            finish             - Counter
 *                            i, j               - Counters
 *
 *                     CALLS: outp                inp
 *                            encode              send_vel
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

main()
{
     float x_velo, y_velo;
     int i, j, finish;

                                        /***init I/O cards***/

  outp(bmbcom, outcbt);     /*INIT BMB FOR OUTPUT*/
  outp(baccom, outcbt);     /*INIT BAC FOR OUTPUT*/
  outp(accom, incbt);       /*INIT AC  FOR INPUT*/

  finish = 1;

  while(finish == 1)
       {

       x_velo = 0;
       y_velo = 0;

              /*** read in position ***/

       printf("\nstill going");

       for(i=0;i<1000;i++)
         {
         printf("\n%i",i);
```

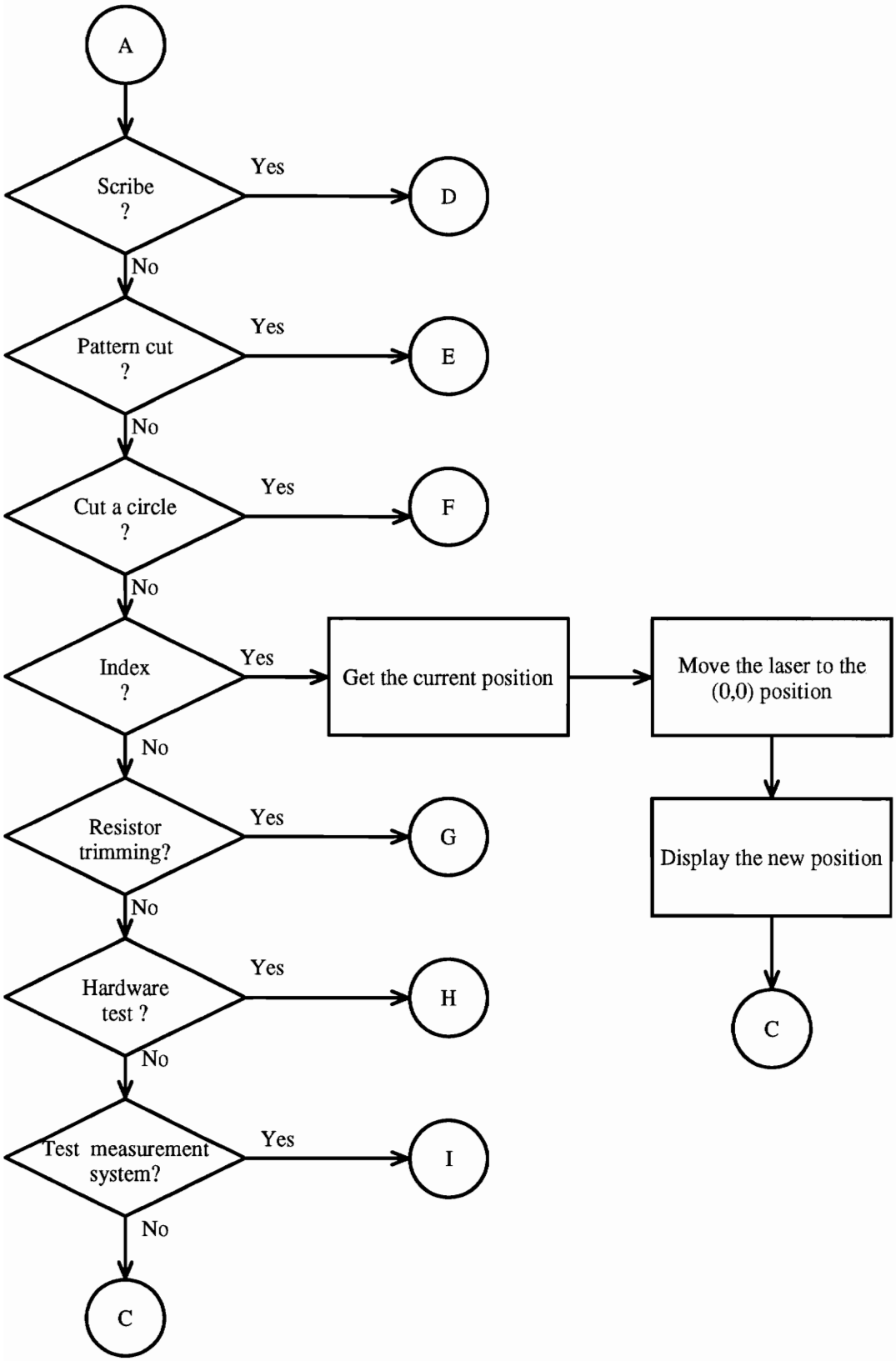
```
        for(j=127;j>0;j--)
          {
          encode( -1, -1, j, j);
          send_vel();
          }
        for(j=0;j<127;j++)
          {
          encode( 1, 1, j, j);
          send_vel();
          }

        }

      }

}


/*****************************************************************************
 *
 *      MODULE:  send_vel
 *
 *     PURPOSE:  To send the sequence to get the laser to move
 *
 *  PARAMETERS:        GLOBL: hlsbx              hlsby
 *                            llsbx              llsby
 *                            msbx               msby
 *                            vhlsbx             vhlsby
 *                            vllsbx             vllsby
 *
 *                     USERS: move_dist          move_norest
 *
 *                     CALLS:  outp
 *
 *     RETURNS: None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

void send_vel()
{

     /***axis select  x axis  ***/

       outp(bmba, addr40A);     /*set addr 40 on a and c*/
       outp(bmbc, addr40C);
       outp(bacc, iop1);     /*pulse iop 1 for x axis select*/
       outp(bacc, clearіop);


              /*** load velocity and acceleration ***/

              outp(bmba, addr43A);     /*set addr 43 on a and c*/
              outp(bmbc, addr43C);
                        /* SET VELOCITY AT 1/4 MAX */
              outp(baca, vhlsbx);          /*send hlsb (ac 0 - 7)*/
              outp(bacb, vllsbx);          /*send llsb (ac 8 - 11)*/
              outp(bacc, iop1);     /*pulse iop 1 for load velocity */
              outp(bacc, clearіop);


     /*** axis select y axis  ***/

       outp(bmba, addr40A);     /*set addr 40 on a and c*/
       outp(bmbc, addr40C);
       outp(bacc, iop2);     /*pulse iop 2 for y axis select*/
       outp(bacc, clearіop);
```

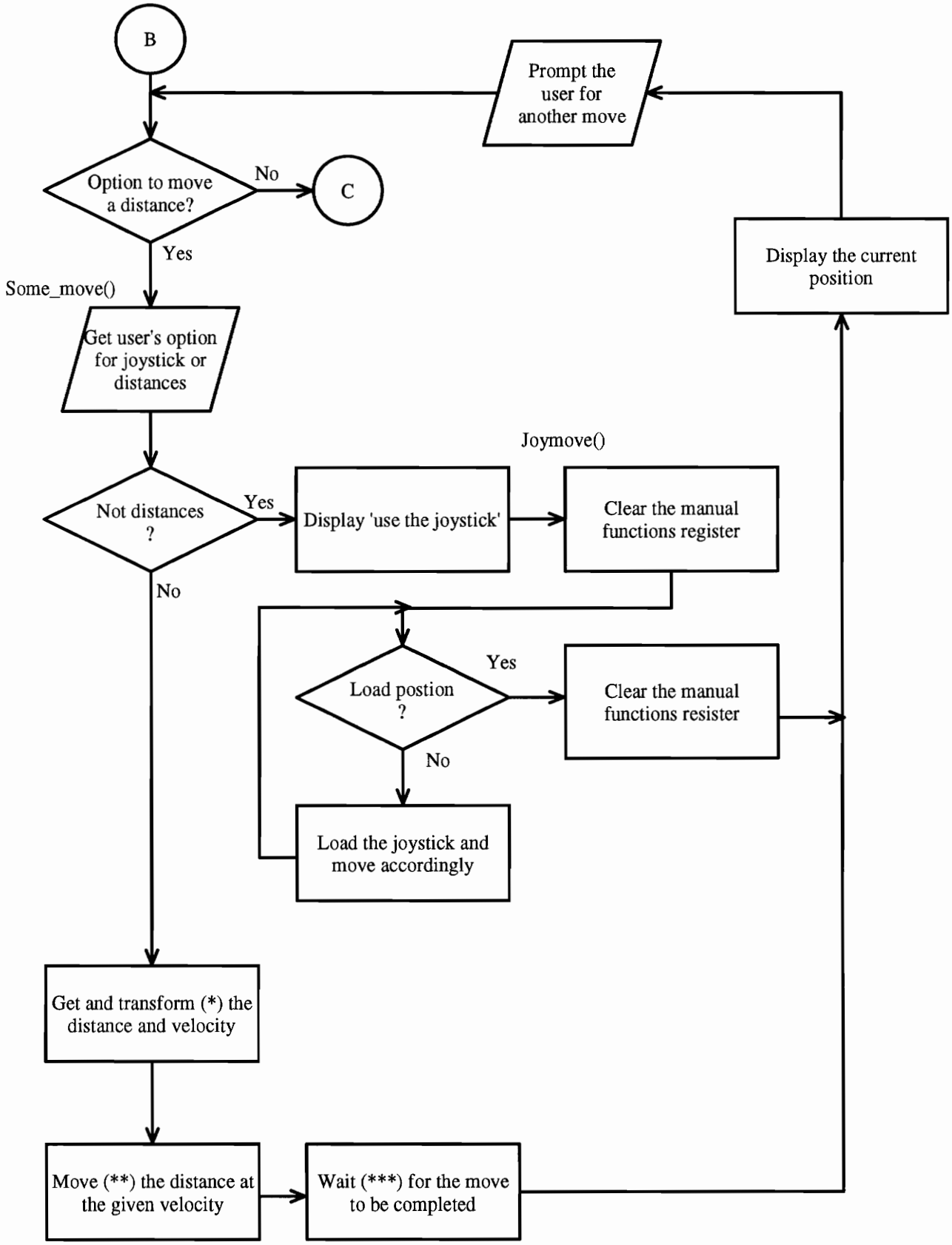
```
        /*** load velocity and acceleration ***/

        outp(bmba, addr43A);     /*set addr 43 on a and c*/
        outp(bmbc, addr43C);
        outp(baca, vhlsby);          /*send hlsb (ac 0 - 7)*/
        outp(bacb, vllsby);          /*send llsb (ac 8 - 11)*/
        outp(bacc, iop1);     /*pulse iop 1 for load velocity */
        outp(bacc, clearIop);

}
```

APPENDIX V

LASER SOFTWARE FLOWCHART


LASER
MAIN()
Set up the window
Have the user turn on the laser
Initialize the laser interface and hardware
C
Option to exit ?
Yes
Close all window functions
Exit
No
Display the main menu and prompt for option
Get the user's option
Move distance ?
Yes
B
No
A

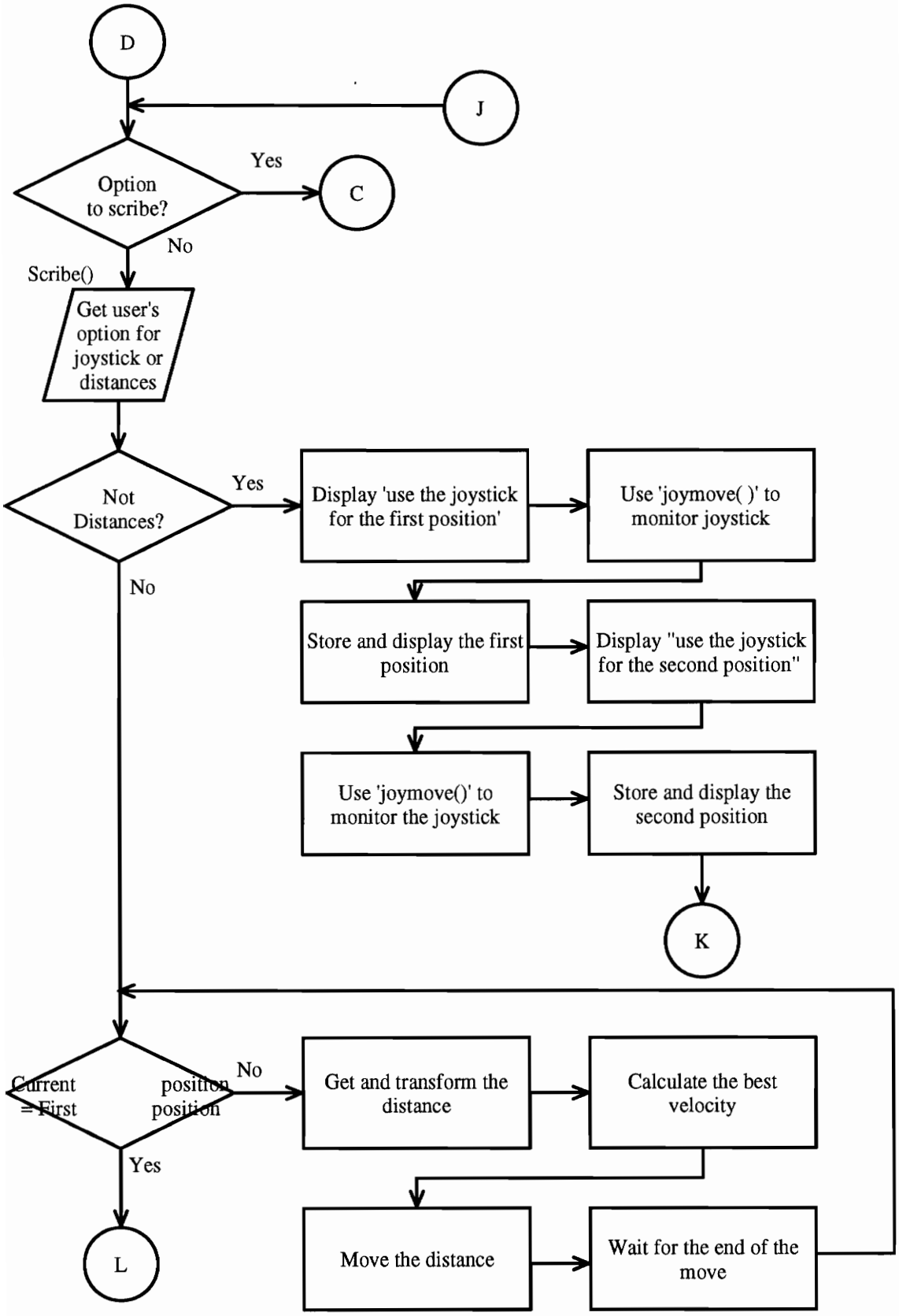

A
Scribe ?
Yes
D
No
Pattern cut ?
Yes
E
No
Cut a circle ?
Yes
F
No
Index ?
Yes
Get the current position
Move the laser to the (0,0) position
Display the new position
C
No
Resistor trimming?
Yes
G
No
Hardware test ?
Yes
H
No
Test measurement system?
Yes
I
No
C

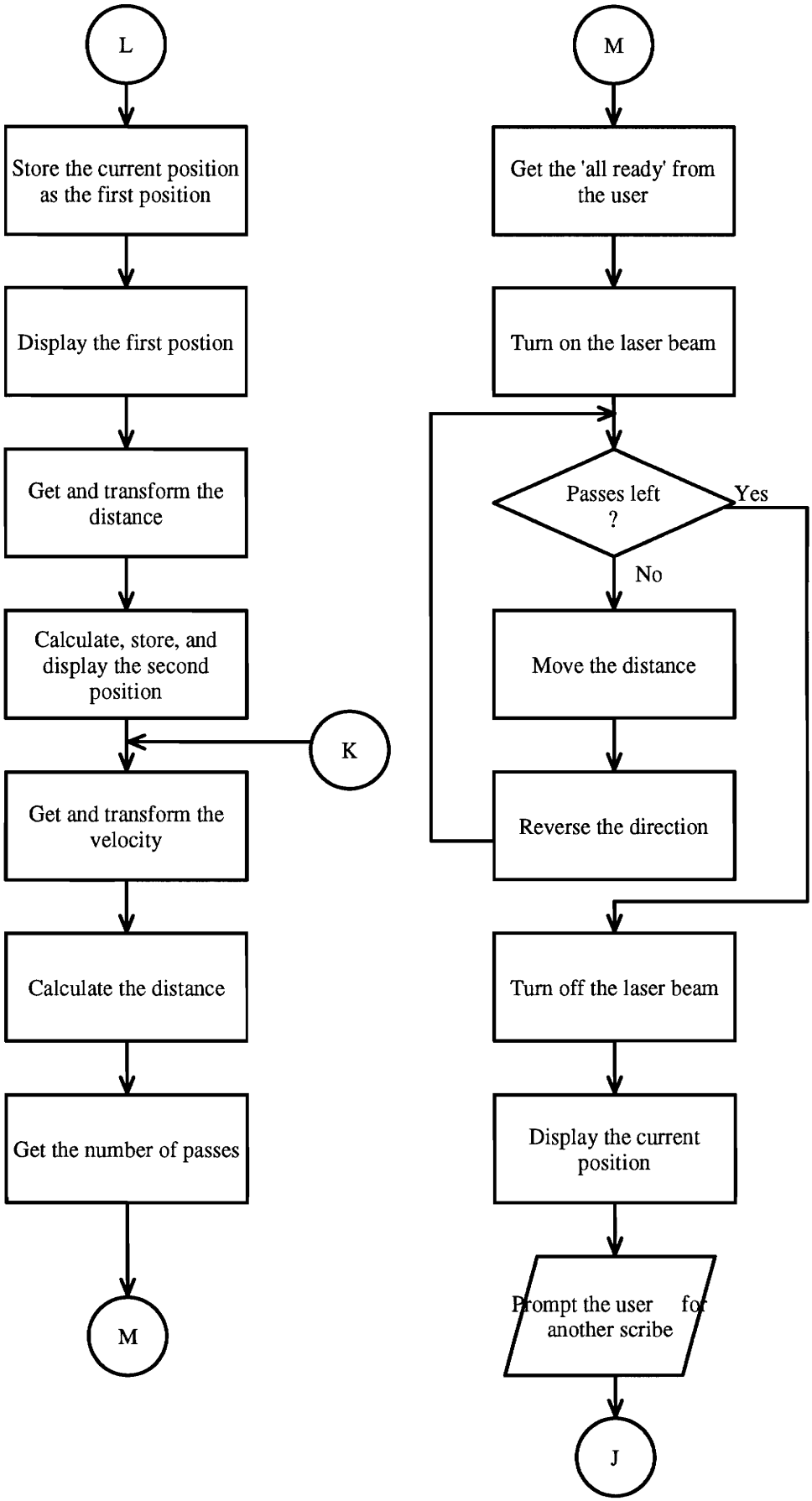


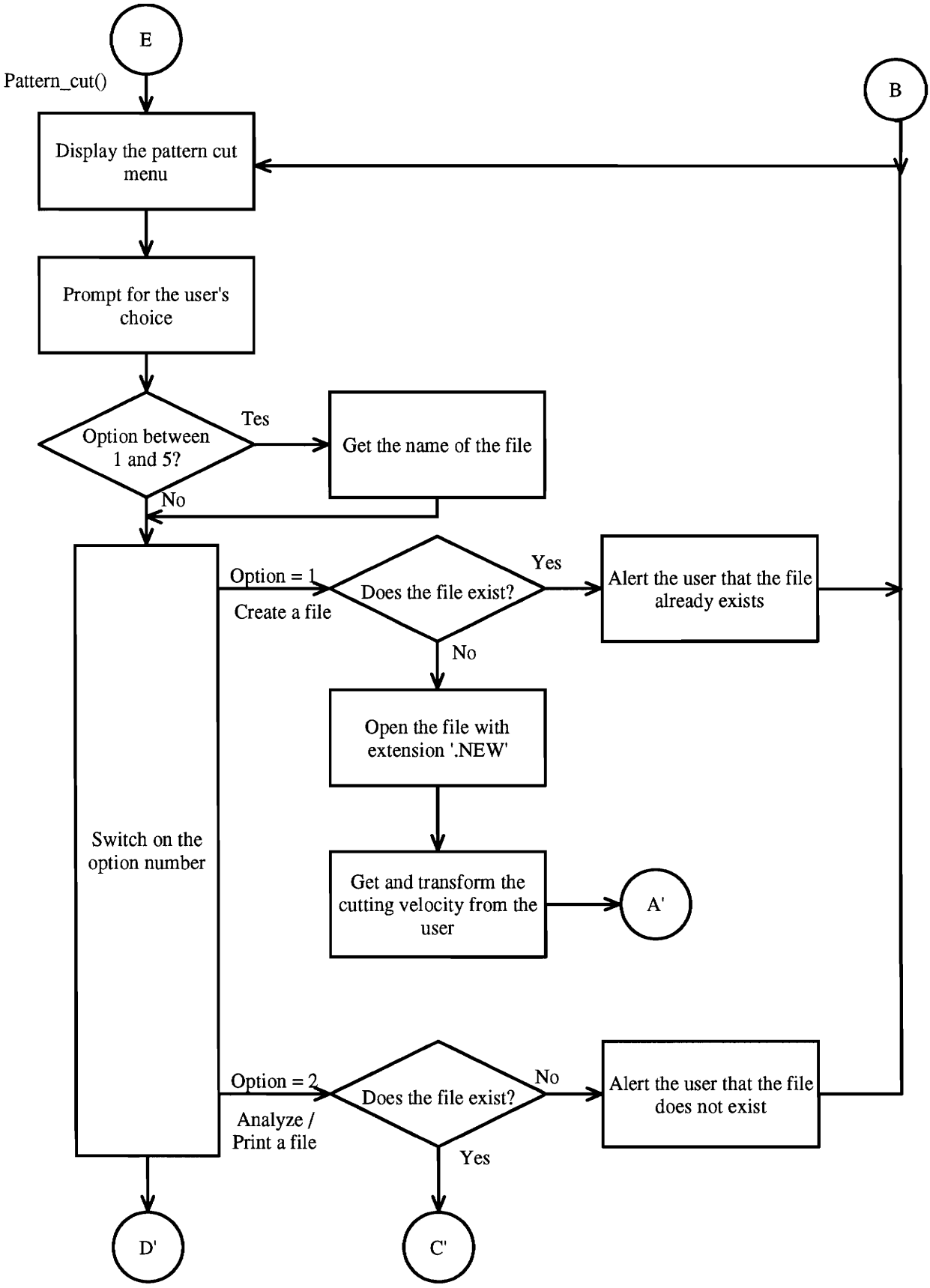
* All numbers are entered as individual characters. They must be transformed into a number.

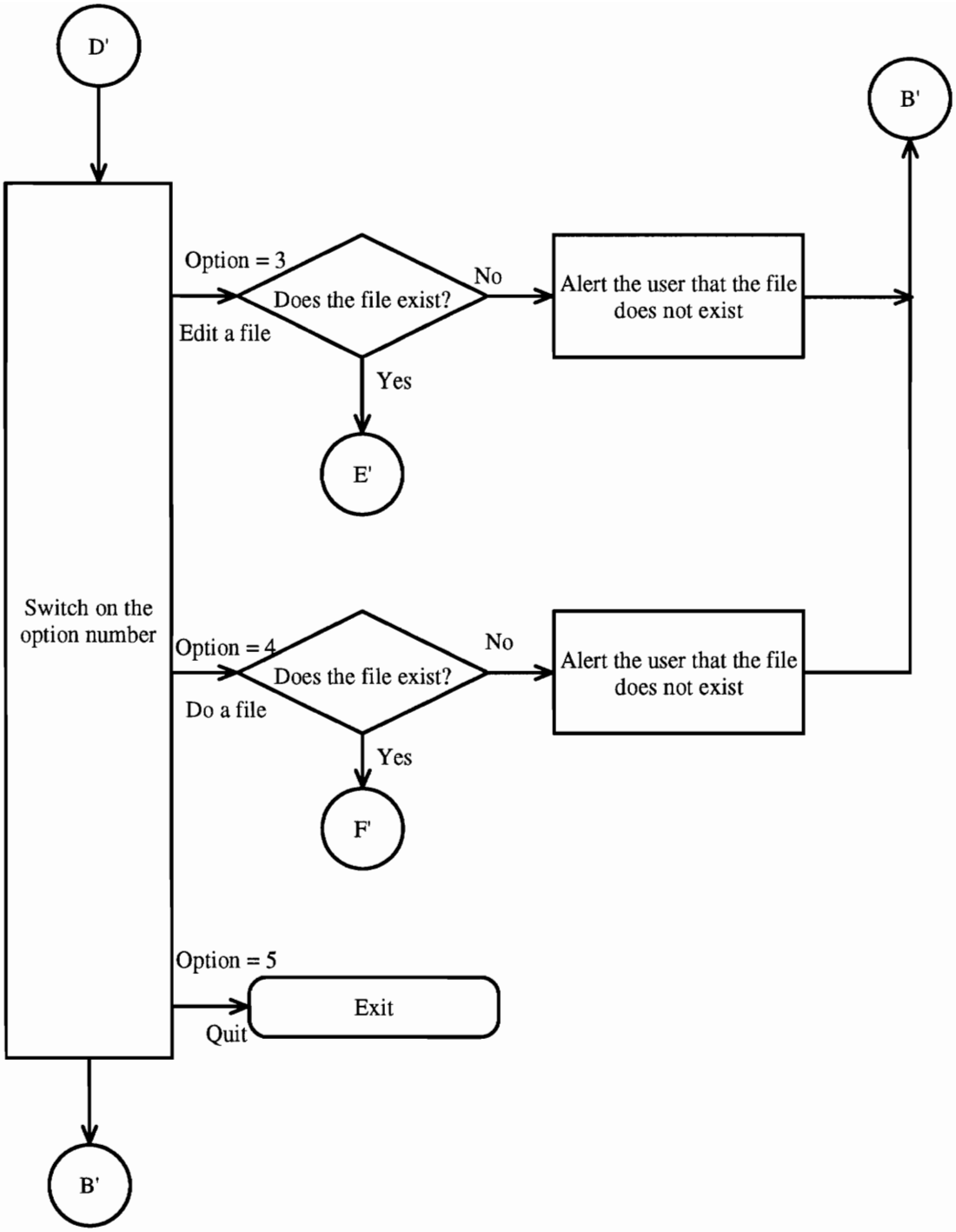
** All moves must be encoded in a way that the laser can understand.

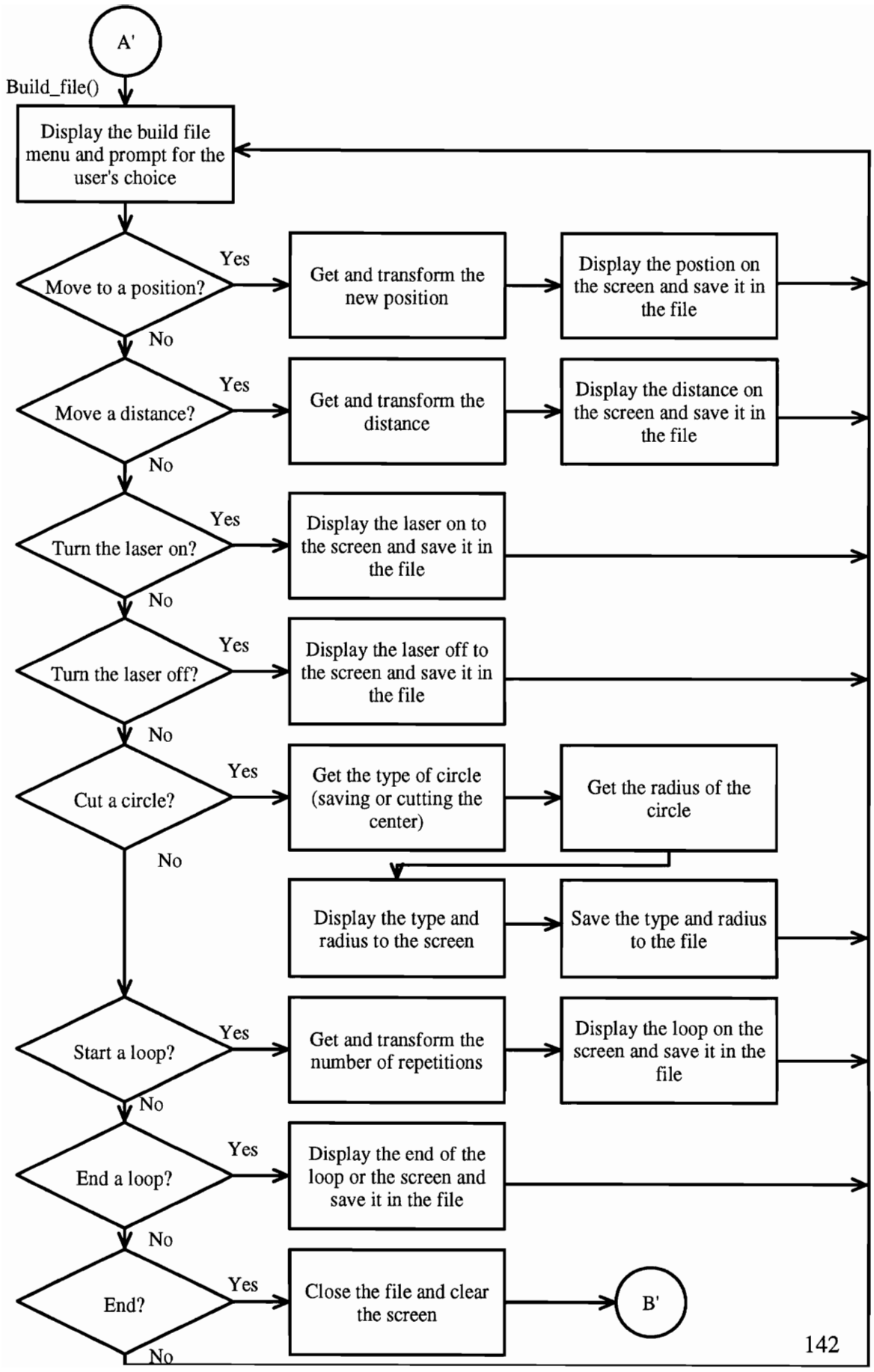
*** Once a move is invoked, control returns to the caller. In order to be sure the move is finished, a check must be made.

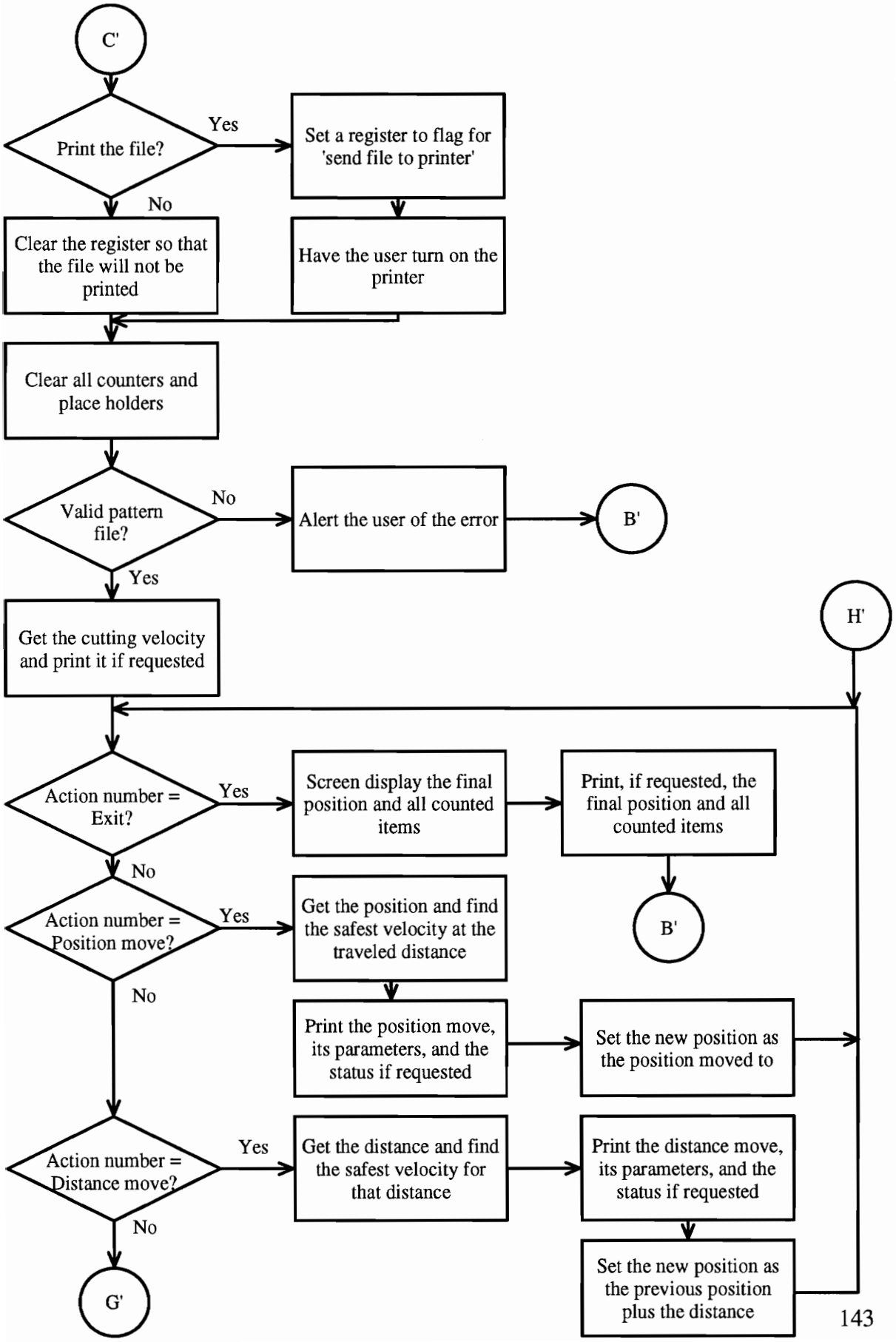

D
J
Option to scribe?
Yes
C
No
Scribe()
Get user's option for joystick or distances
Not Distances?
Yes
Display 'use the joystick for the first position'
Use 'joymove( )' to monitor joystick
No
Store and display the first position
Display "use the joystick for the second position"
Use 'joymove()' to monitor the joystick
Store and display the second position
K
Current position = First position
No
Get and transform the distance
Calculate the best velocity
Yes
L
Move the distance
Wait for the end of the move

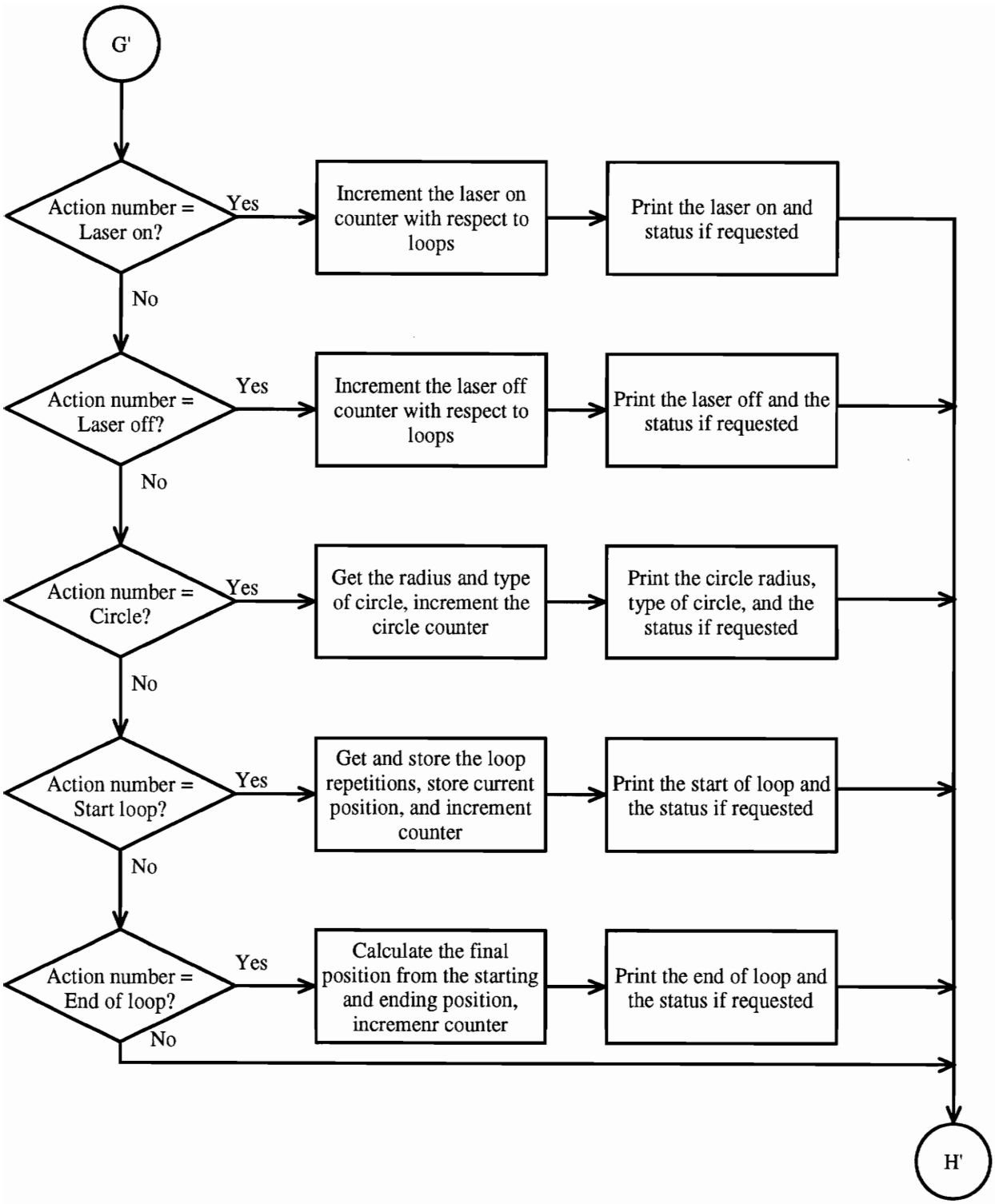

L
Store the current position as the first position
Display the first postion
Get and transform the distance
Calculate, store, and display the second position
K
Get and transform the velocity
Calculate the distance
Get the number of passes
M
M
Get the 'all ready' from the user
Turn on the laser beam
Passes left ?
Yes
No
Move the distance
Reverse the direction
Turn off the laser beam
Display the current position
Prompt the user for another scribe
J

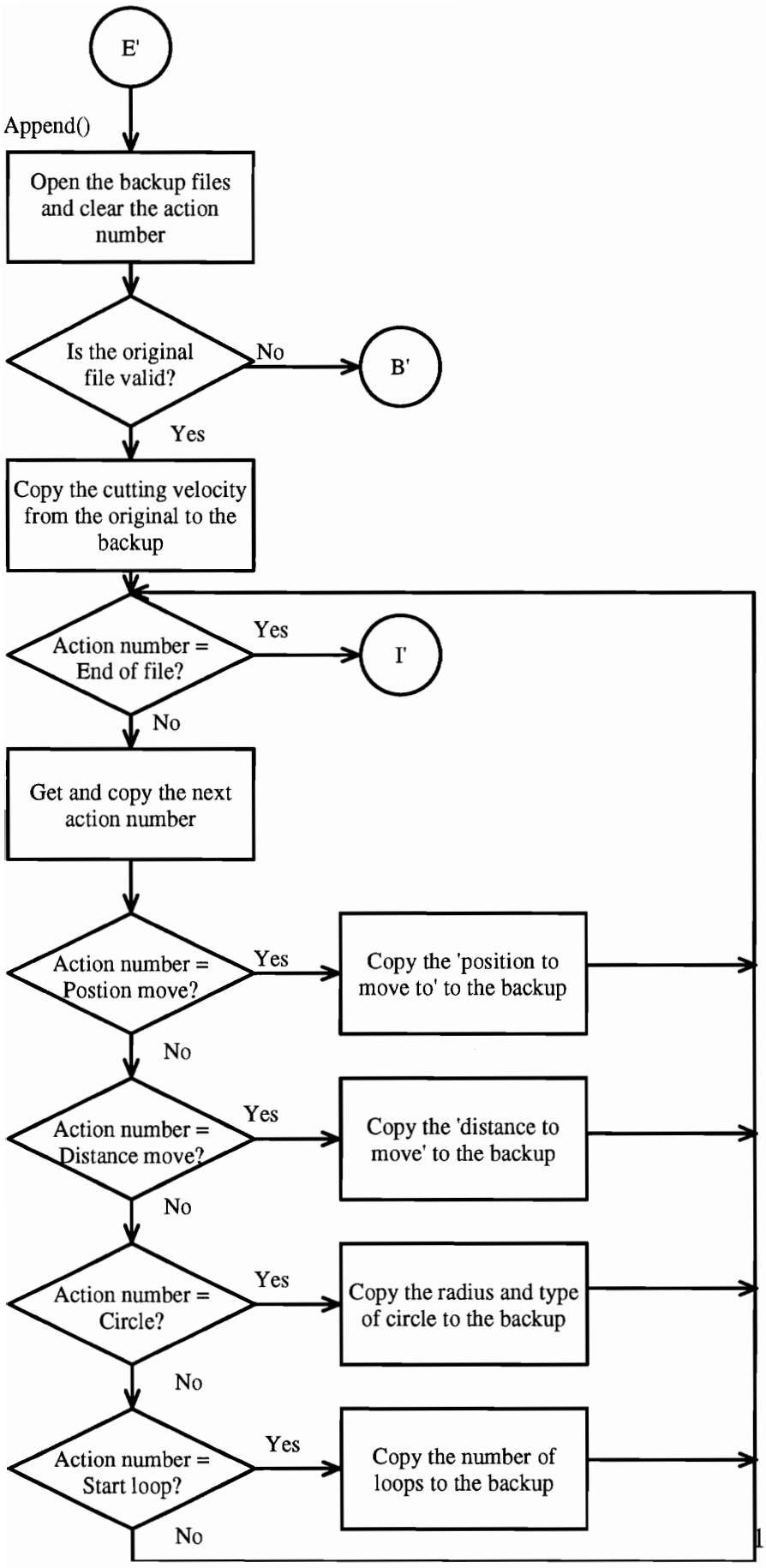

E
Pattern_cut()
B
Display the pattern cut menu
Prompt for the user's choice
Option between 1 and 5?
Tes
Get the name of the file
No
Switch on the option number
Option = 1
Create a file
Does the file exist?
Yes
Alert the user that the file already exists
No
Open the file with extension '.NEW'
Get and transform the cutting velocity from the user
A'
Option = 2
Analyze / Print a file
Does the file exist?
No
Alert the user that the file does not exist
Yes
D'
C'

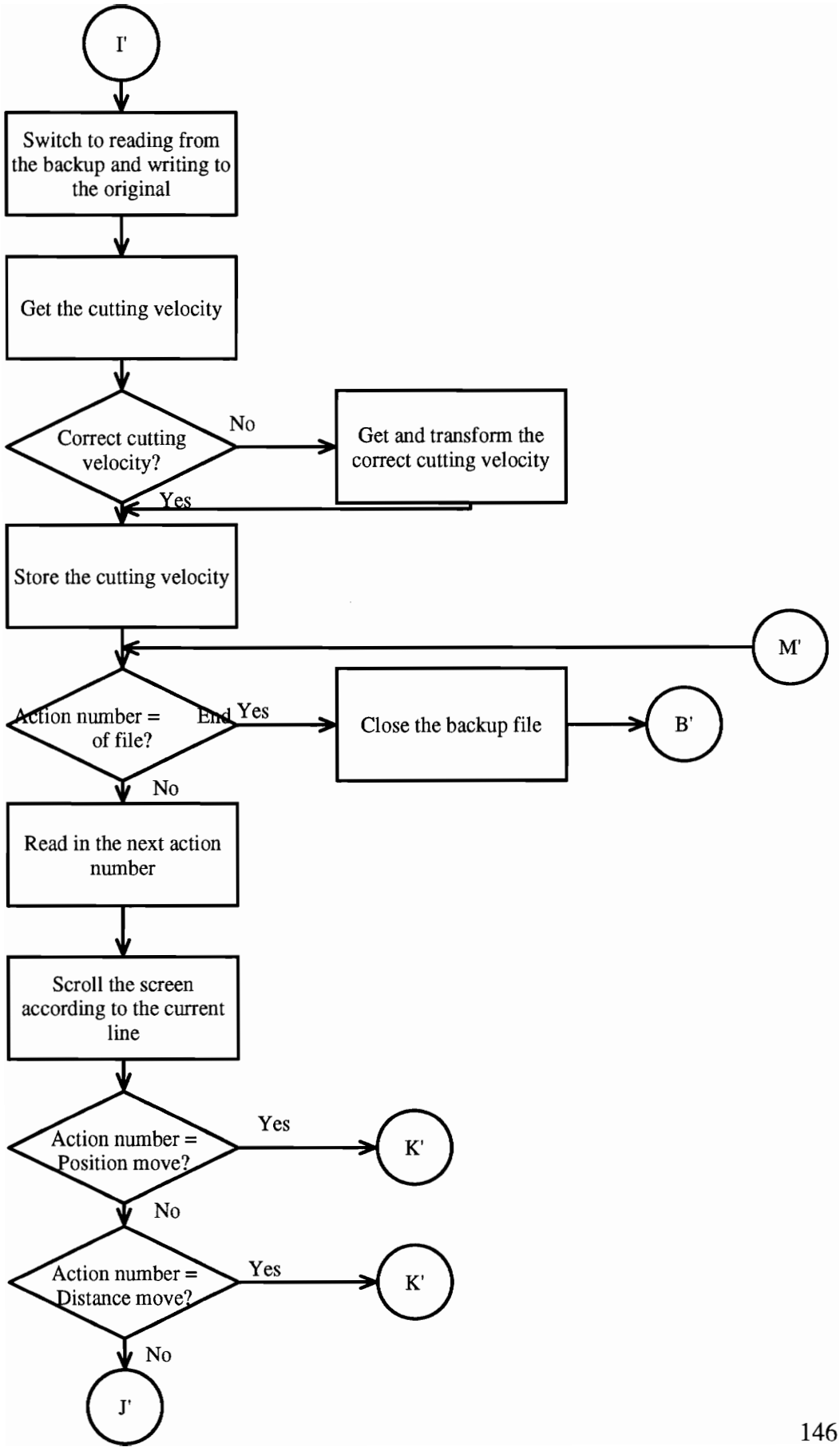

D'
B'
Switch on the option number
Option = 3
Does the file exist?
No
Alert the user that the file does not exist
Edit a file
Yes
E'
Option = 4
Does the file exist?
No
Alert the user that the file does not exist
Do a file
Yes
F'
Option = 5
Exit
Quit
B'

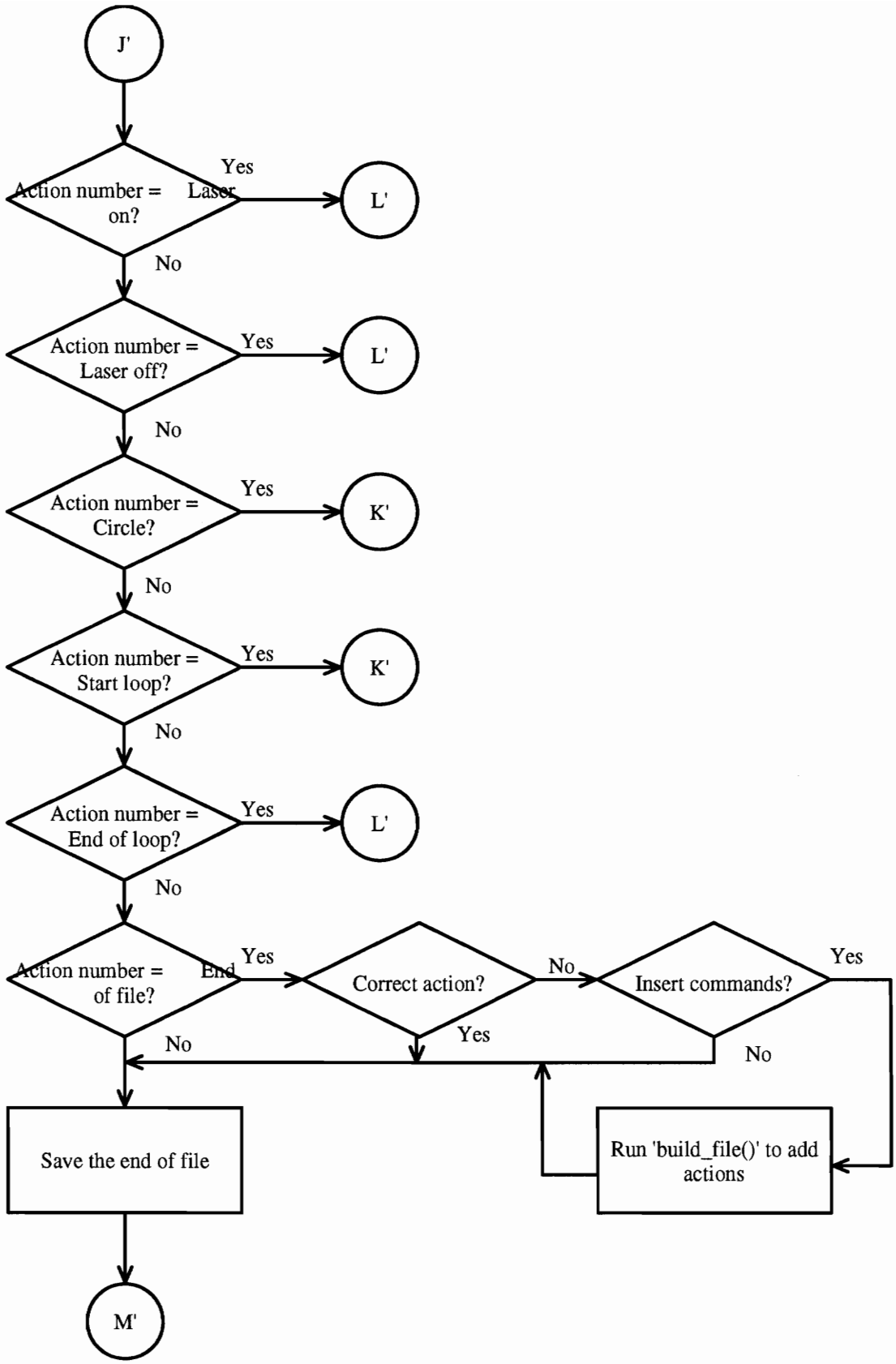

A'
Build_file()
Display the build file menu and prompt for the user's choice
Move to a position?
Yes
Get and transform the new position
Display the postion on the screen and save it in the file
No
Move a distance?
Yes
Get and transform the distance
Display the distance on the screen and save it in the file
No
Turn the laser on?
Yes
Display the laser on to the screen and save it in the file
No
Turn the laser off?
Yes
Display the laser off to the screen and save it in the file
No
Cut a circle?
Yes
Get the type of circle (saving or cutting the center)
Get the radius of the circle
No
Display the type and radius to the screen
Save the type and radius to the file
Start a loop?
Yes
Get and transform the number of repetitions
Display the loop on the screen and save it in the file
No
End a loop?
Yes
Display the end of the loop or the screen and save it in the file
No
End?
Yes
Close the file and clear the screen
B'
No

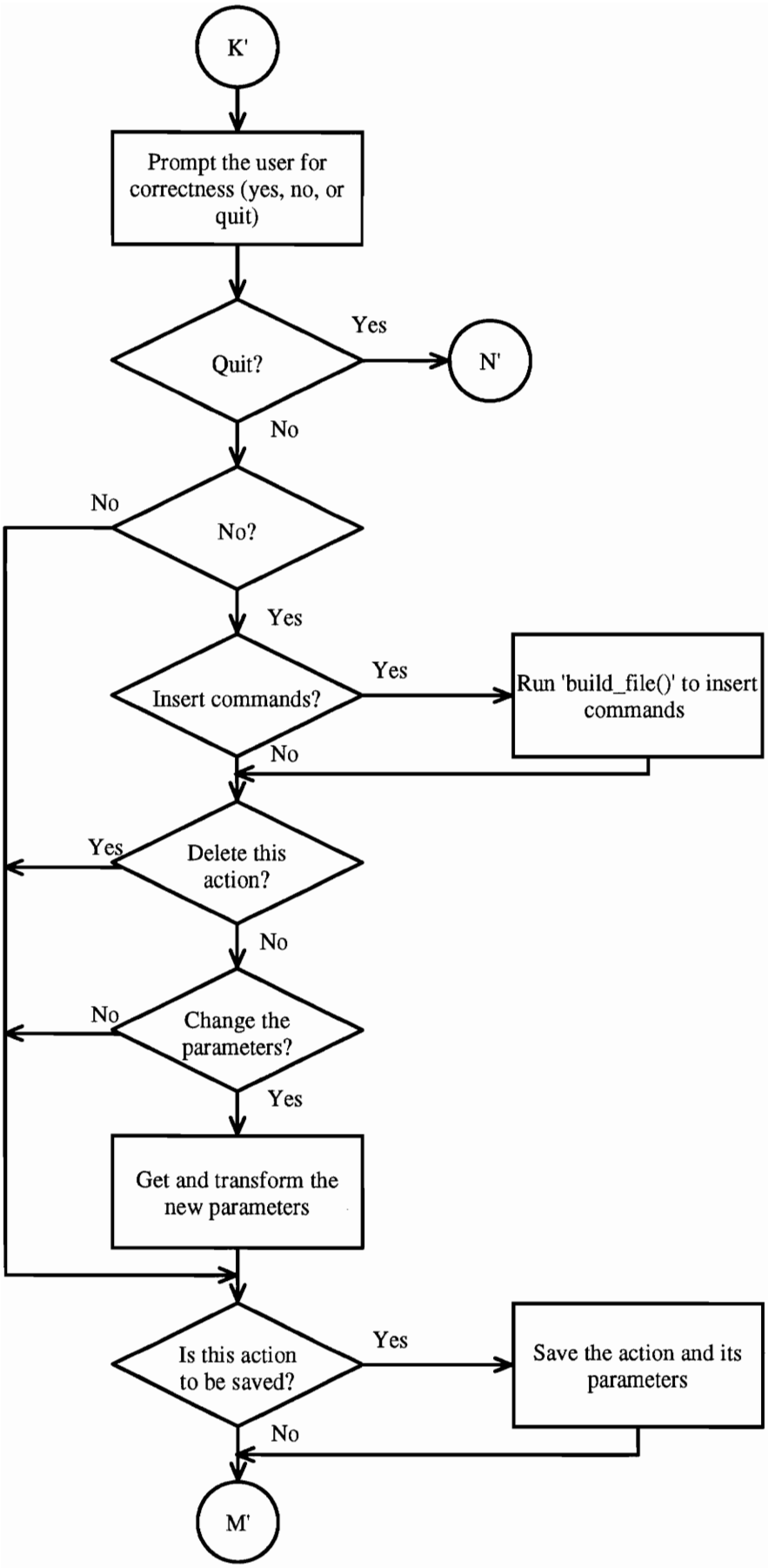

C'
Print the file?
Yes
Set a register to flag for 'send file to printer'
No
Clear the register so that the file will not be printed
Have the user turn on the printer
Clear all counters and place holders
Valid pattern file?
No
Alert the user of the error
B'
Yes
Get the cutting velocity and print it if requested
H'
Action number = Exit?
Yes
Screen display the final position and all counted items
Print, if requested, the final position and all counted items
B'
No
Action number = Position move?
Yes
Get the position and find the safest velocity at the traveled distance
Print the position move, its parameters, and the status if requested
Set the new position as the position moved to
No
Action number = Distance move?
Yes
Get the distance and find the safest velocity for that distance
Print the distance move, its parameters, and the status if requested
Set the new position as the previous position plus the distance
No
G'

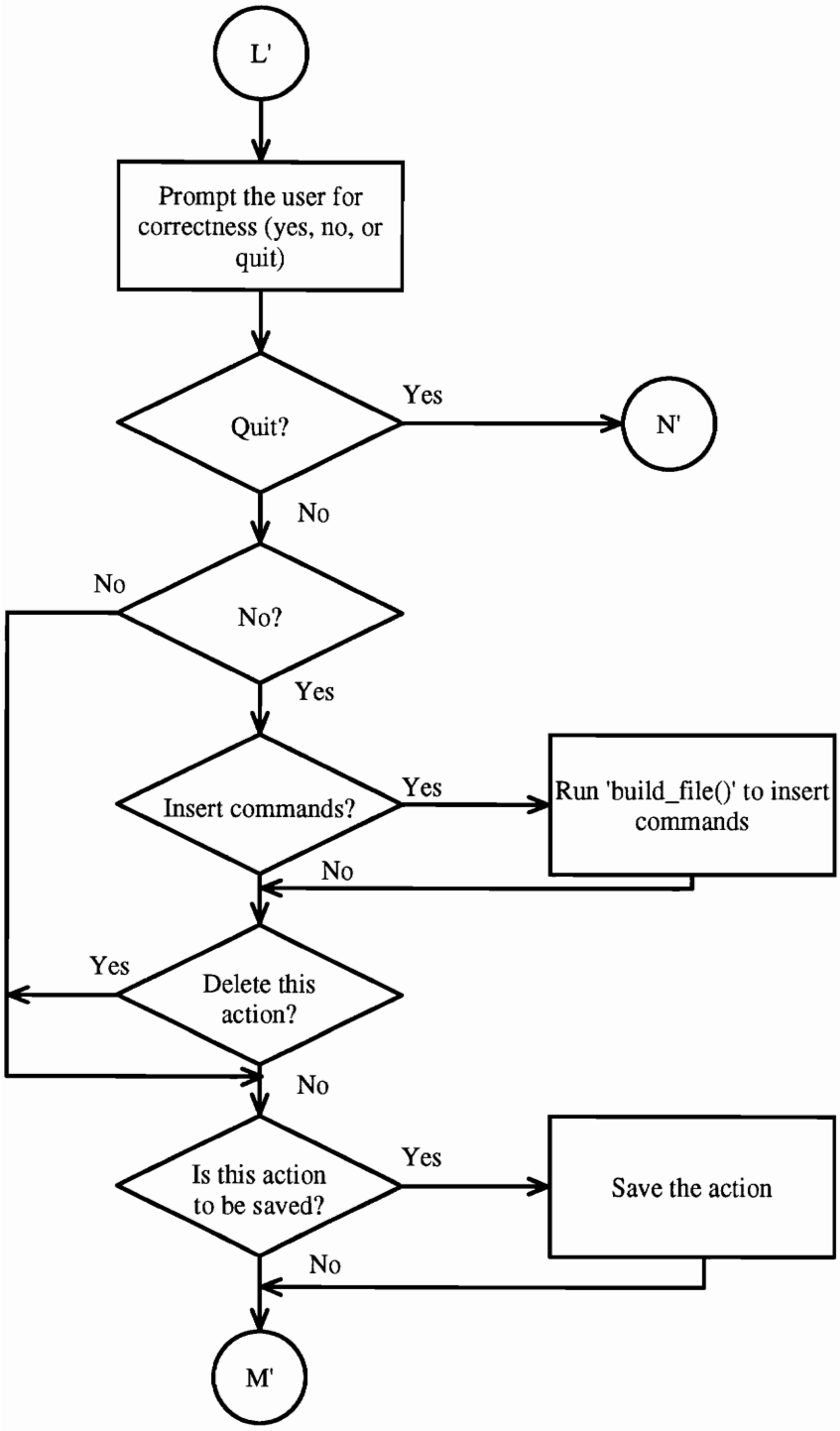

G'
Action number = Laser on?
Yes
Increment the laser on counter with respect to loops
Print the laser on and status if requested
No
Action number = Laser off?
Yes
Increment the laser off counter with respect to loops
Print the laser off and the status if requested
No
Action number = Circle?
Yes
Get the radius and type of circle, increment the circle counter
Print the circle radius, type of circle, and the status if requested
No
Action number = Start loop?
Yes
Get and store the loop repetitions, store current position, and increment counter
Print the start of loop and the status if requested
No
Action number = End of loop?
Yes
Calculate the final position from the starting and ending position, incremenr counter
Print the end of loop and the status if requested
No
H'

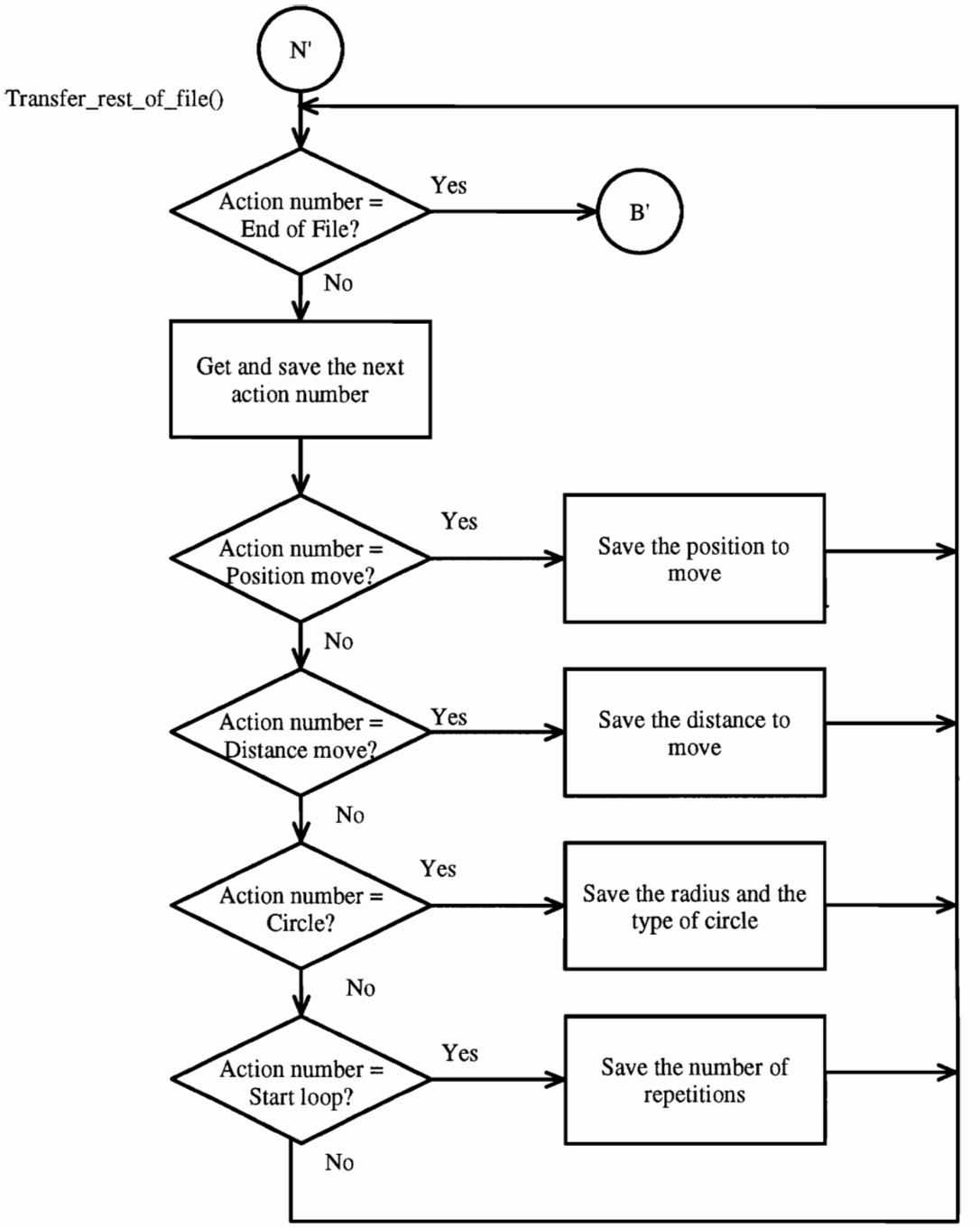

E'
Append()
Open the backup files and clear the action number
Is the original file valid?
No
B'
Yes
Copy the cutting velocity from the original to the backup
Action number = End of file?
Yes
I'
No
Get and copy the next action number
Action number = Postion move?
Yes
Copy the 'position to move to' to the backup
No
Action number = Distance move?
Yes
Copy the 'distance to move' to the backup
No
Action number = Circle?
Yes
Copy the radius and type of circle to the backup
No
Action number = Start loop?
Yes
Copy the number of loops to the backup
No

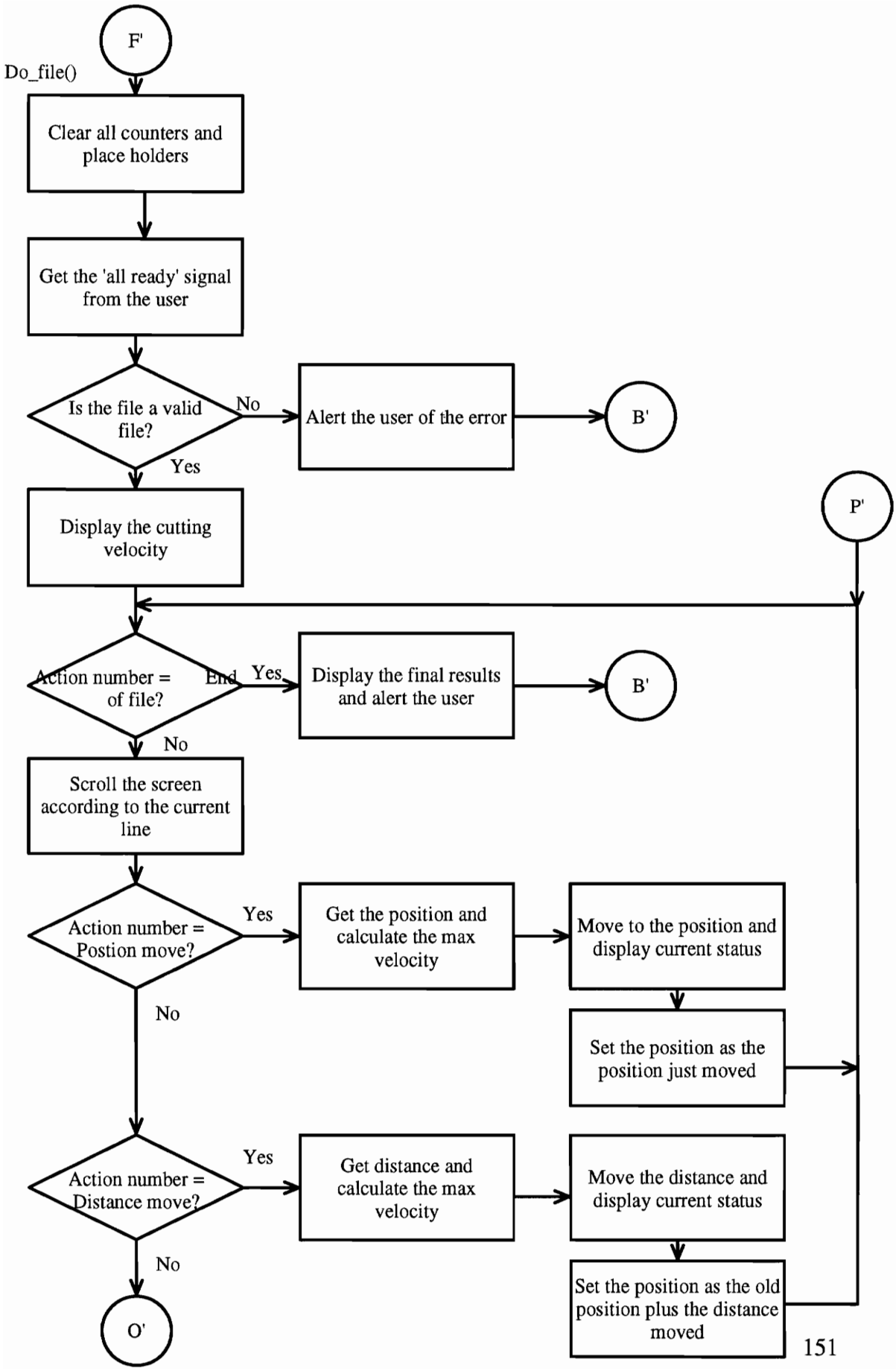

I'
Switch to reading from the backup and writing to the original
Get the cutting velocity
Correct cutting velocity?
No
Get and transform the correct cutting velocity
Yes
Store the cutting velocity
M'
Action number = End of file?
Yes
Close the backup file
B'
No
Read in the next action number
Scroll the screen according to the current line
Action number = Position move?
Yes
K'
No
Action number = Distance move?
Yes
K'
No
J'

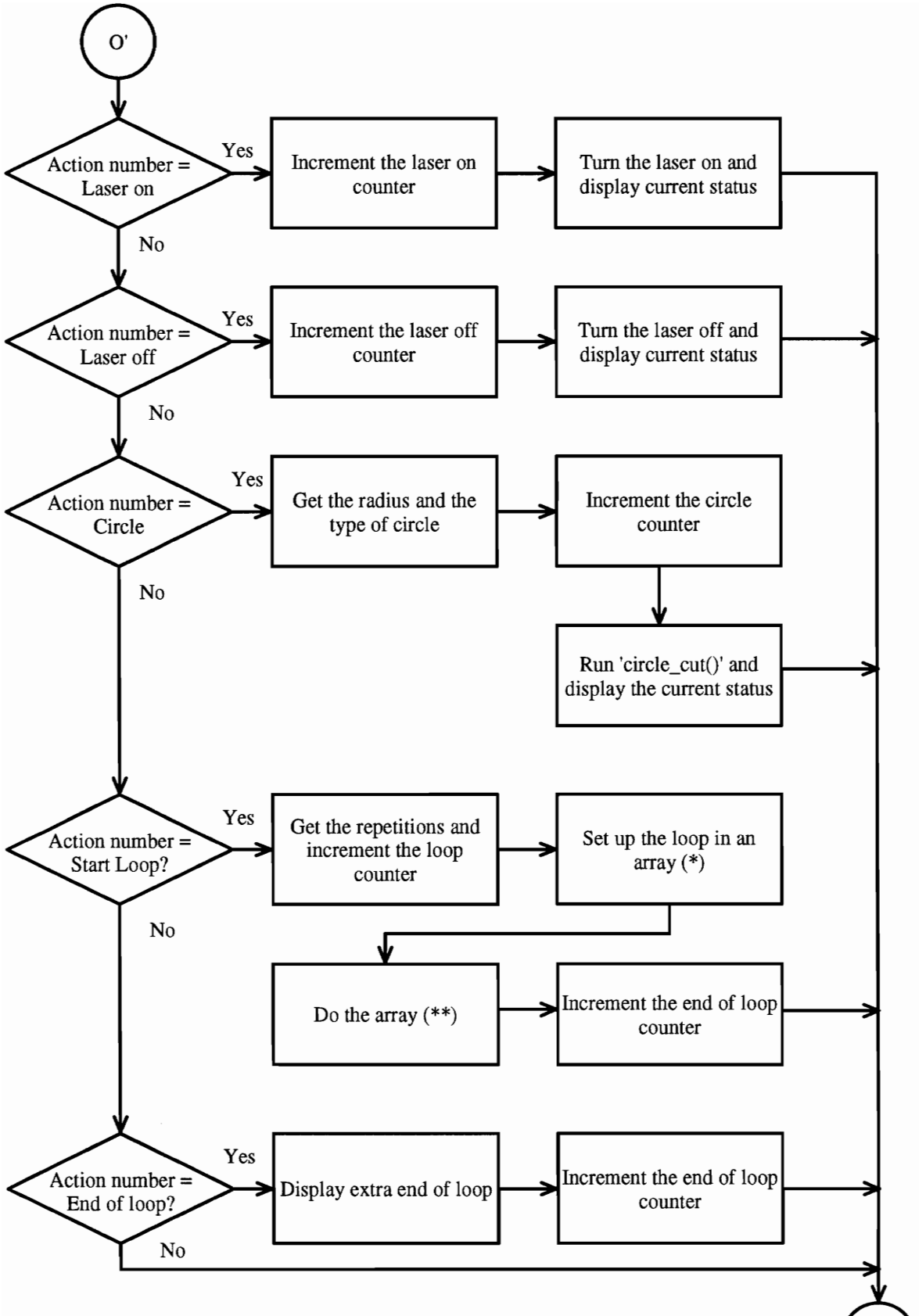

J'
Action number = Laser on?
Yes
L'
No
Action number = Laser off?
Yes
L'
No
Action number = Circle?
Yes
K'
No
Action number = Start loop?
Yes
K'
No
Action number = End of loop?
Yes
L'
No
Action number = End of file?
Yes
Correct action?
No
Insert commands?
Yes
Yes
No
No
Save the end of file
Run 'build_file()' to add actions
M'


K'
Prompt the user for correctness (yes, no, or quit)
Quit?
Yes
N'
No
No?
No
Yes
Insert commands?
Yes
Run 'build_file()' to insert commands
No
Delete this action?
Yes
No
Change the parameters?
No
Yes
Get and transform the new parameters
Is this action to be saved?
Yes
Save the action and its parameters
No
M'


L'
Prompt the user for correctness (yes, no, or quit)
Quit?
Yes
N'
No
No?
No
Yes
Insert commands?
Yes
Run 'build_file()' to insert commands
No
Delete this action?
Yes
No
Is this action to be saved?
Yes
Save the action
No
M'

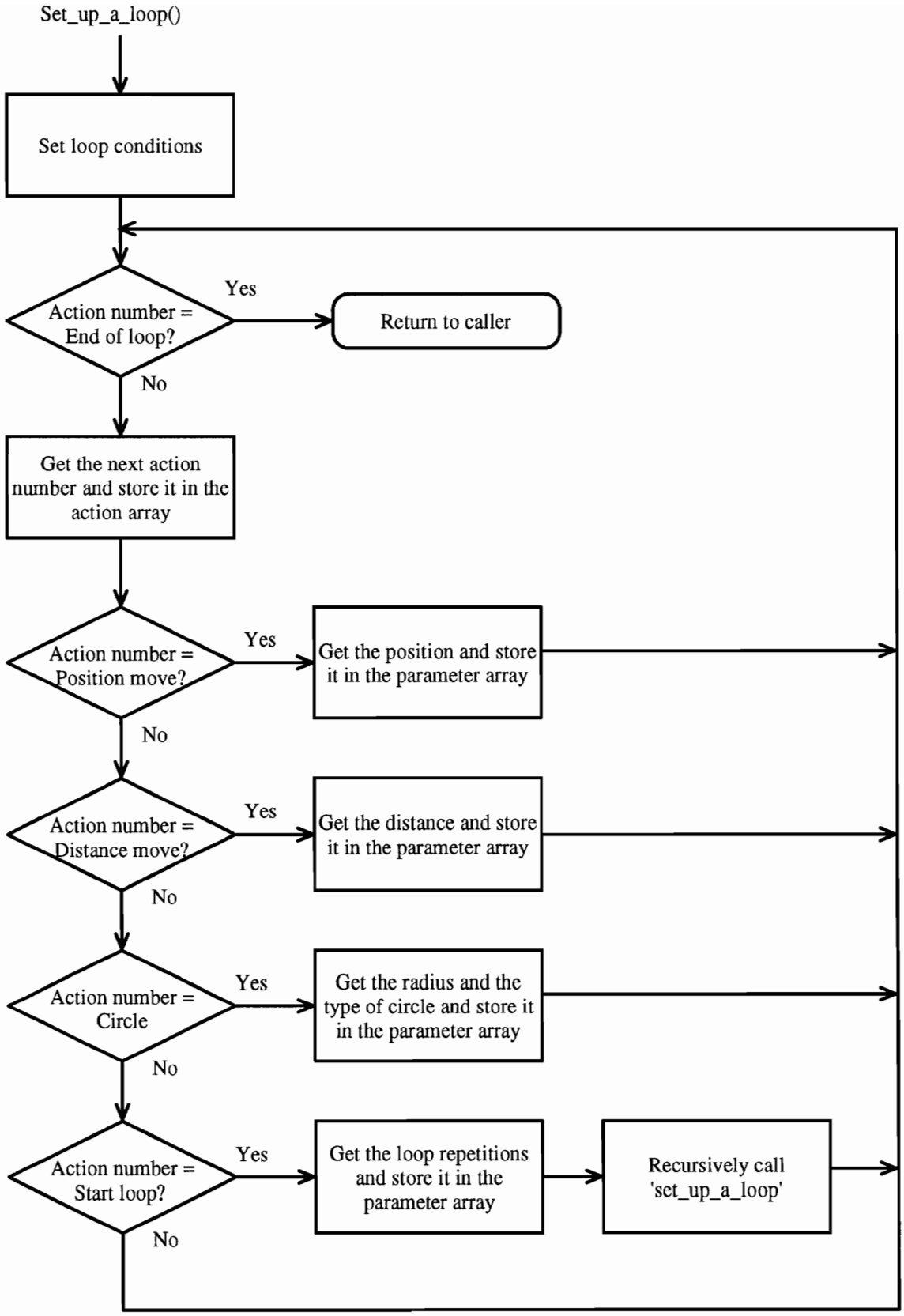

N'
Transfer_rest_of_file()
Action number = End of File?
Yes
B'
No
Get and save the next action number
Action number = Position move?
Yes
Save the position to move
No
Action number = Distance move?
Yes
Save the distance to move
No
Action number = Circle?
Yes
Save the radius and the type of circle
No
Action number = Start loop?
Yes
Save the number of repetitions
No

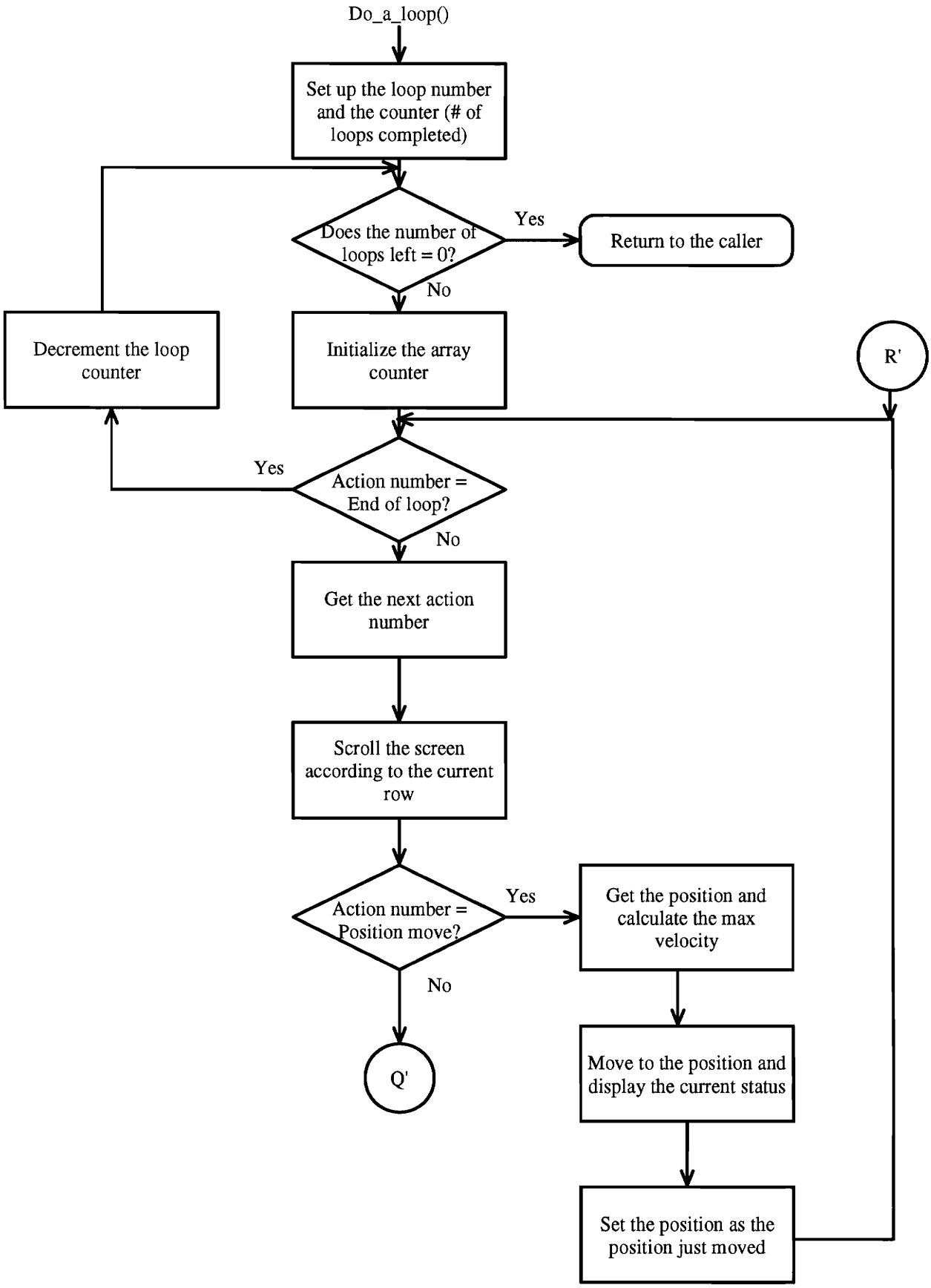

F'
Do_file()
Clear all counters and place holders
Get the 'all ready' signal from the user
Is the file a valid file?
No
Alert the user of the error
B'
Yes
Display the cutting velocity
P'
Action number = End of file?
Yes
Display the final results and alert the user
B'
No
Scroll the screen according to the current line
Action number = Postion move?
Yes
Get the position and calculate the max velocity
Move to the position and display current status
Set the position as the position just moved
No
Action number = Distance move?
Yes
Get distance and calculate the max velocity
Move the distance and display current status
Set the position as the old position plus the distance moved
No
O'

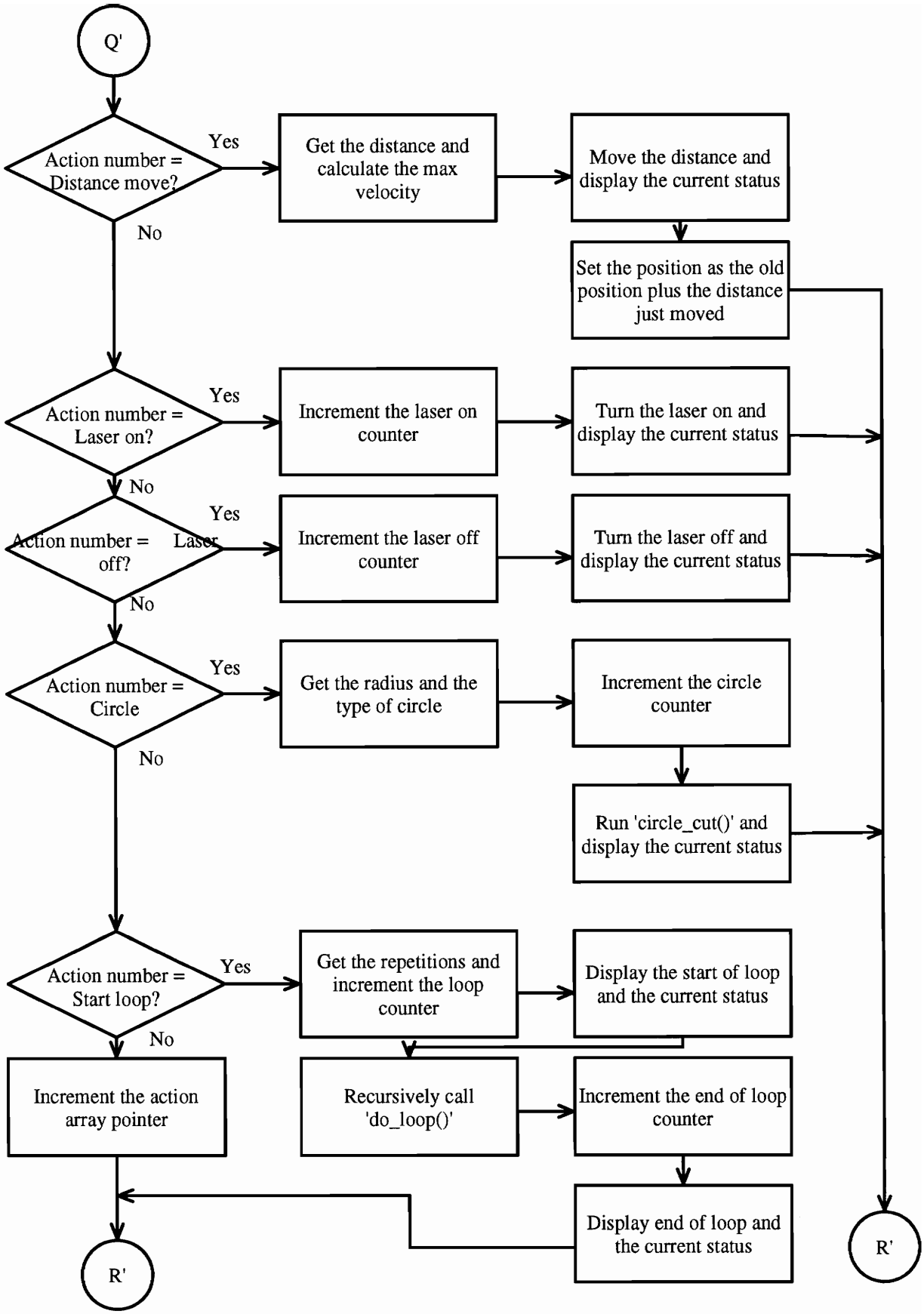


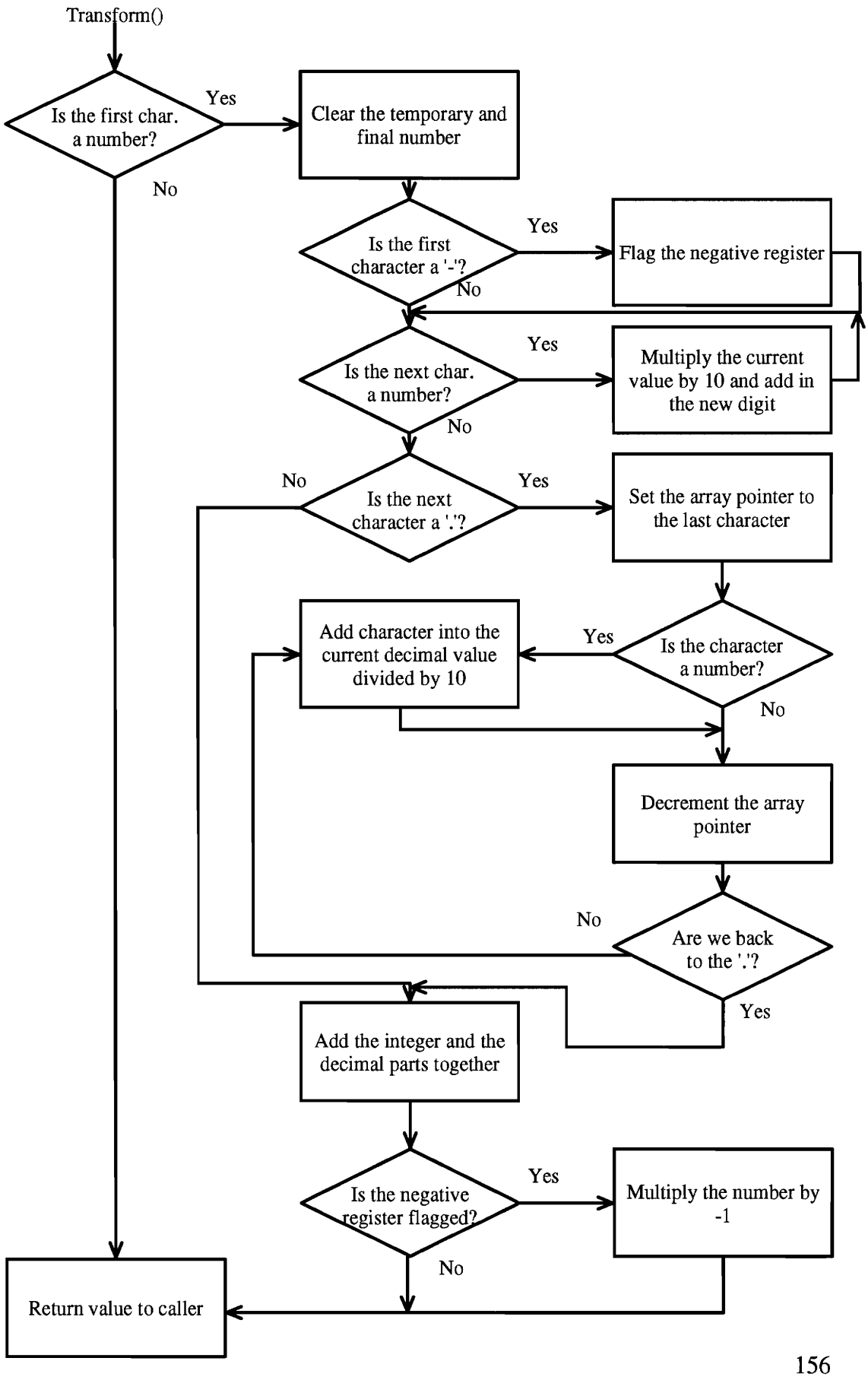
* All loops are put in an array format by set_up_a_loop()

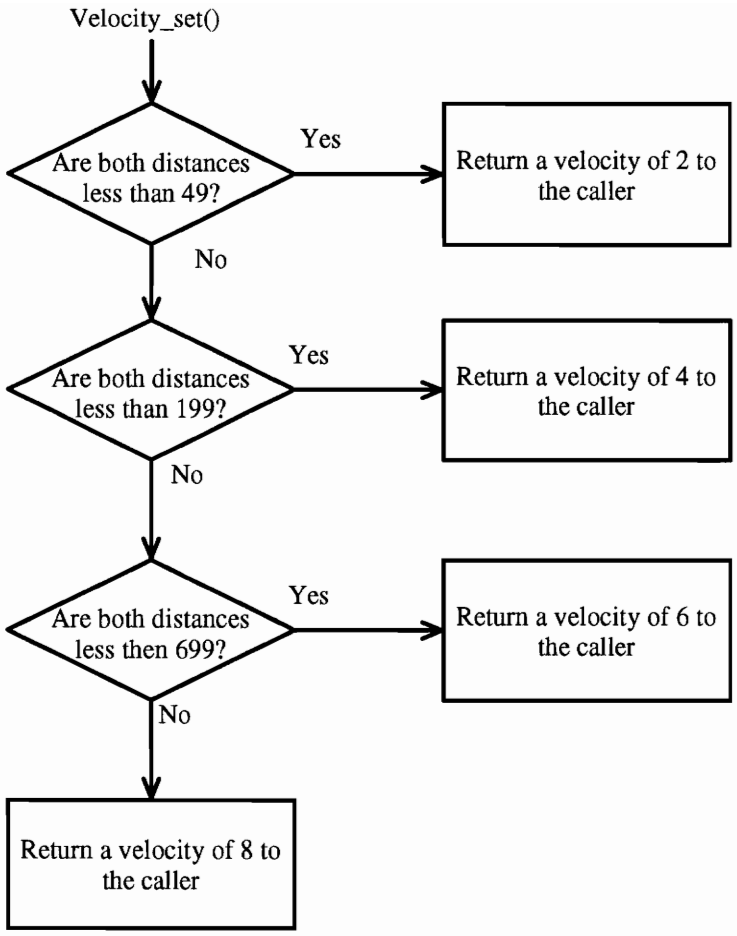
** All arrays are processed by do_a_loop().

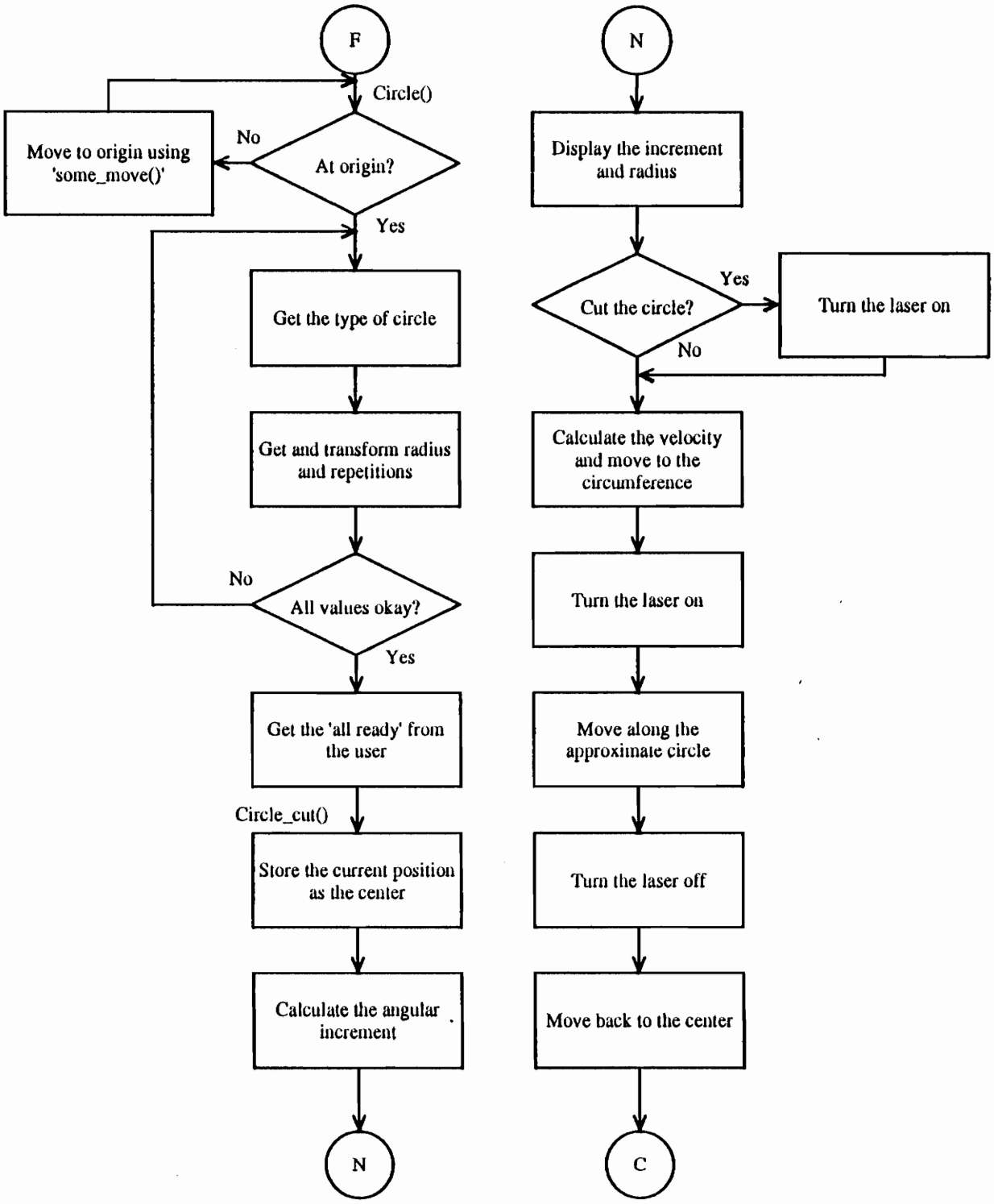

Set_up_a_loop()
Set loop conditions
Action number = End of loop?
Yes
Return to caller
No
Get the next action number and store it in the action array
Action number = Position move?
Yes
Get the position and store it in the parameter array
No
Action number = Distance move?
Yes
Get the distance and store it in the parameter array
No
Action number = Circle
Yes
Get the radius and the type of circle and store it in the parameter array
No
Action number = Start loop?
Yes
Get the loop repetitions and store it in the parameter array
Recursively call 'set_up_a_loop'
No

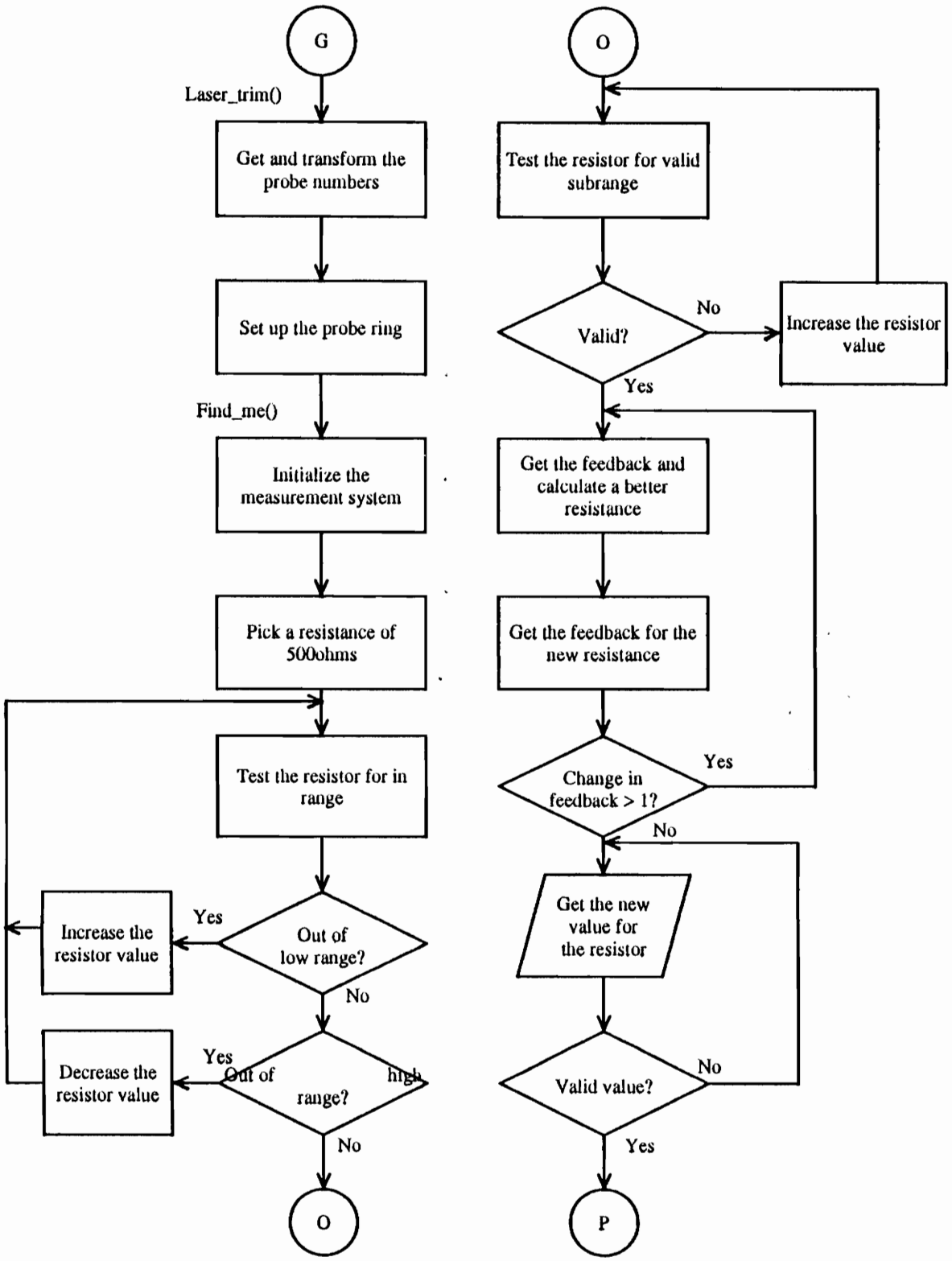

Do_a_loop()
Set up the loop number and the counter (# of loops completed)
Does the number of loops left = 0?
Yes
Return to the caller
No
Decrement the loop counter
Initialize the array counter
R'
Yes
Action number = End of loop?
No
Get the next action number
Scroll the screen according to the current row
Action number = Position move?
Yes
Get the position and calculate the max velocity
No
Q'
Move to the position and display the current status
Set the position as the position just moved

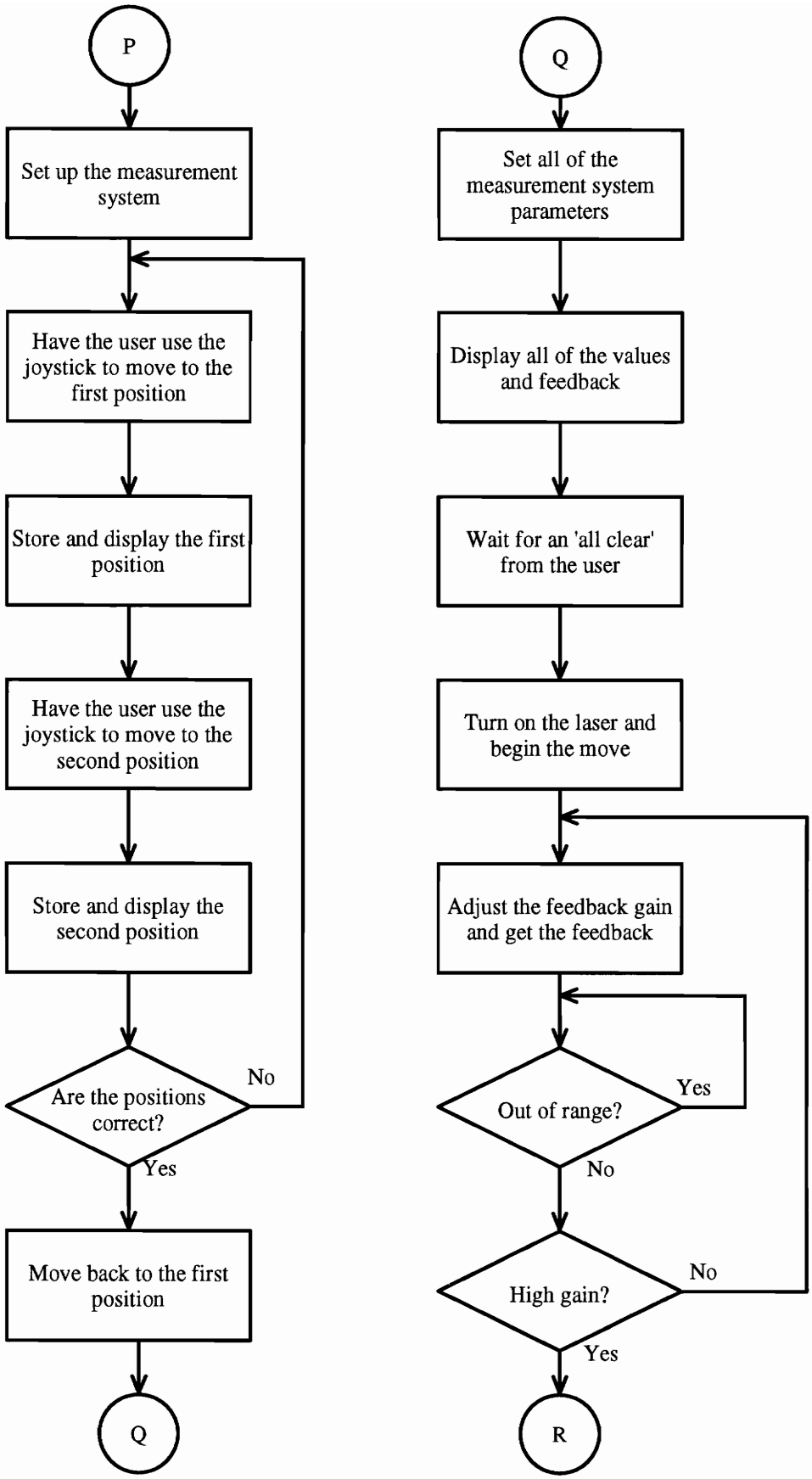

Q'
Action number = Distance move?
Yes
No
Get the distance and calculate the max velocity
Move the distance and display the current status
Set the position as the old position plus the distance just moved
Action number = Laser on?
Yes
No
Increment the laser on counter
Turn the laser on and display the current status
Action number = Laser off?
Yes
No
Increment the laser off counter
Turn the laser off and display the current status
Action number = Circle
Yes
No
Get the radius and the type of circle
Increment the circle counter
Run 'circle_cut()' and display the current status
Action number = Start loop?
Yes
No
Get the repetitions and increment the loop counter
Display the start of loop and the current status
Increment the action array pointer
Recursively call 'do_loop()'
Increment the end of loop counter
Display end of loop and the current status
R'
R'

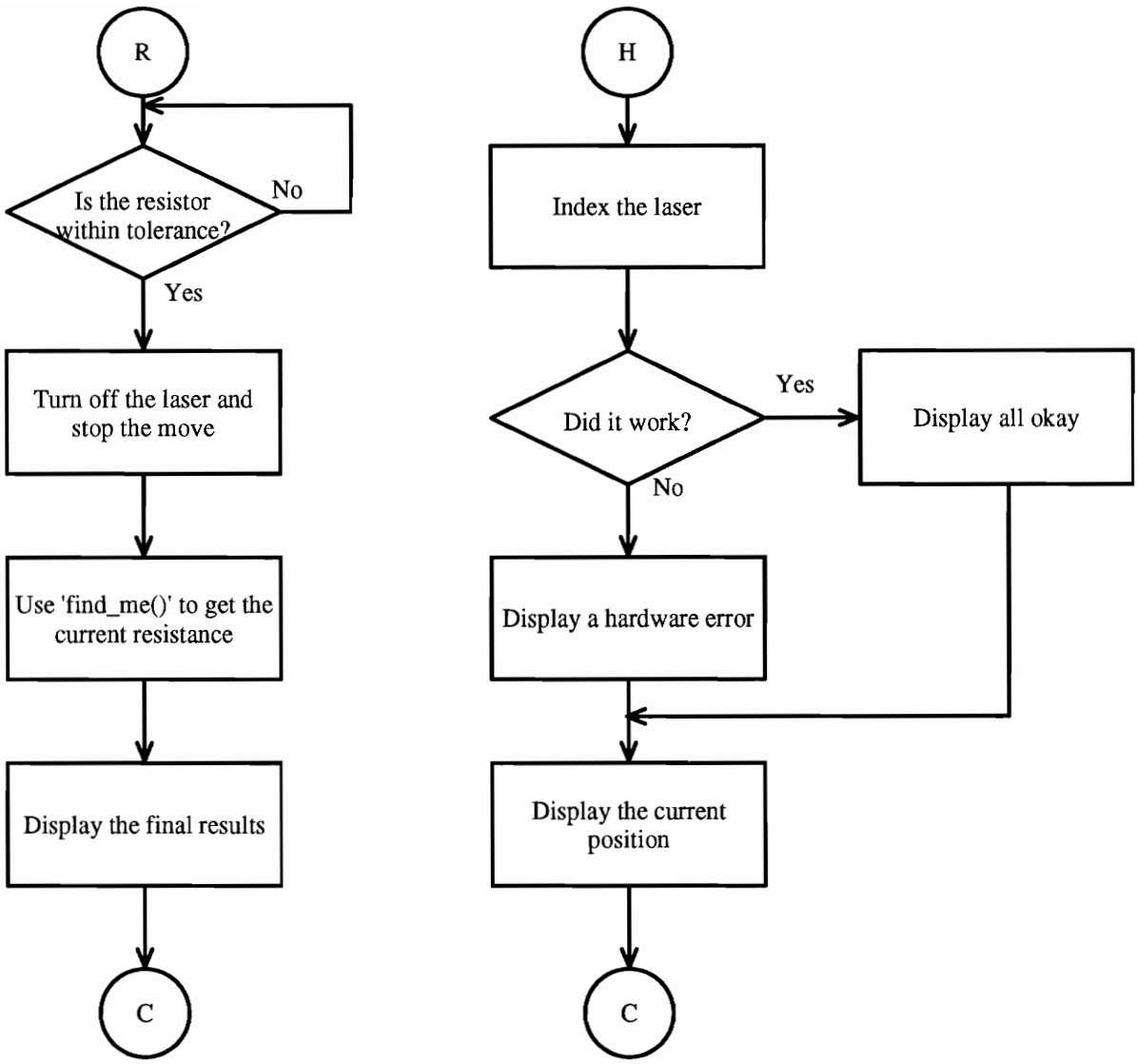

Transform()
Is the first char. a number?
Yes
No
Clear the temporary and final number
Is the first character a '-'?
Yes
No
Flag the negative register
Is the next char. a number?
Yes
No
Multiply the current value by 10 and add in the new digit
Is the next character a '.'?
No
Yes
Set the array pointer to the last character
Is the character a number?
Yes
No
Add character into the current decimal value divided by 10
Decrement the array pointer
Are we back to the '.'?
No
Yes
Add the integer and the decimal parts together
Is the negative register flagged?
Yes
No
Multiply the number by -1
Return value to caller

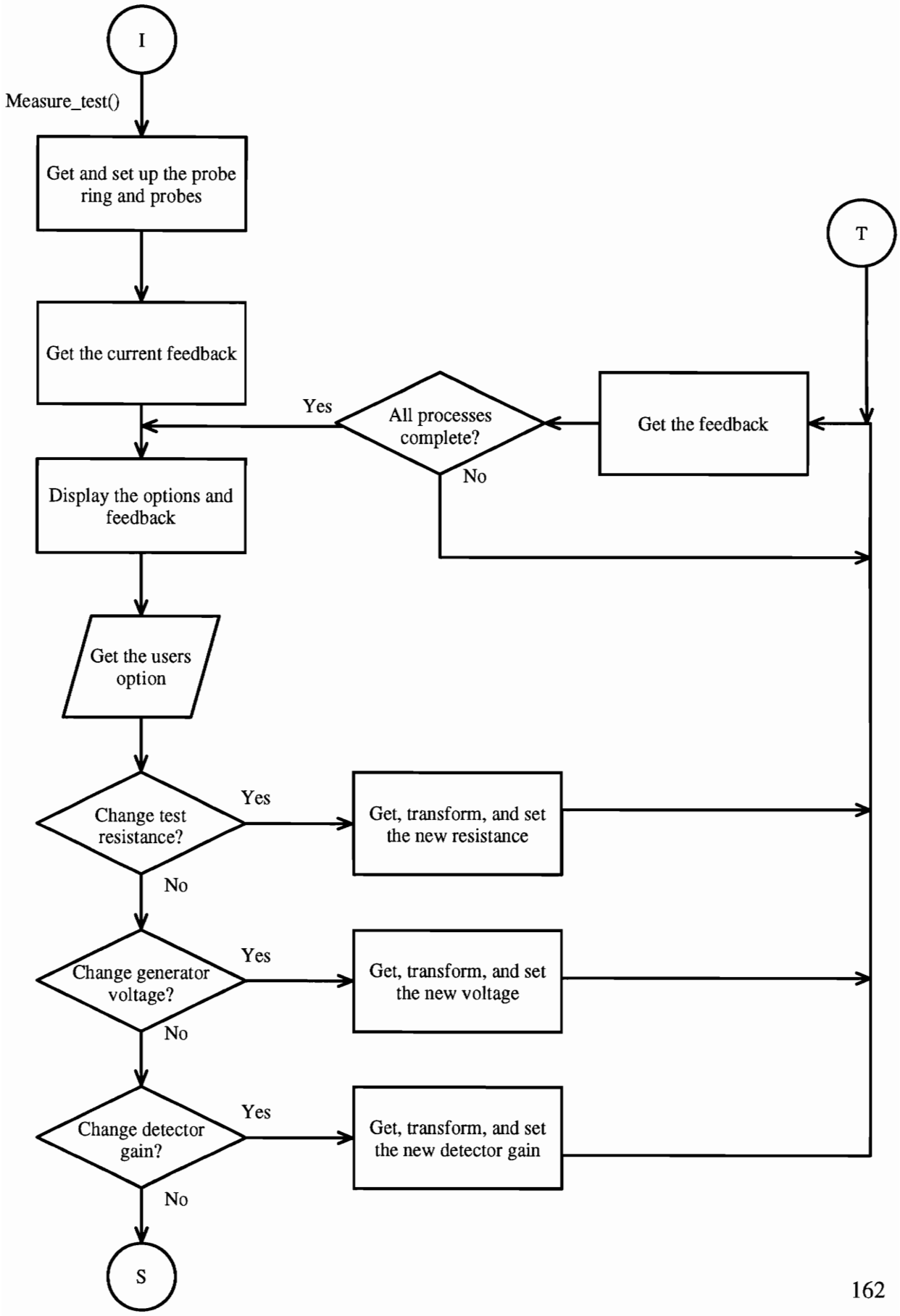

Velocity_set()
Are both distances less than 49?
Yes
Return a velocity of 2 to the caller
No
Are both distances less than 199?
Yes
Return a velocity of 4 to the caller
No
Are both distances less then 699?
Yes
Return a velocity of 6 to the caller
No
Return a velocity of 8 to the caller

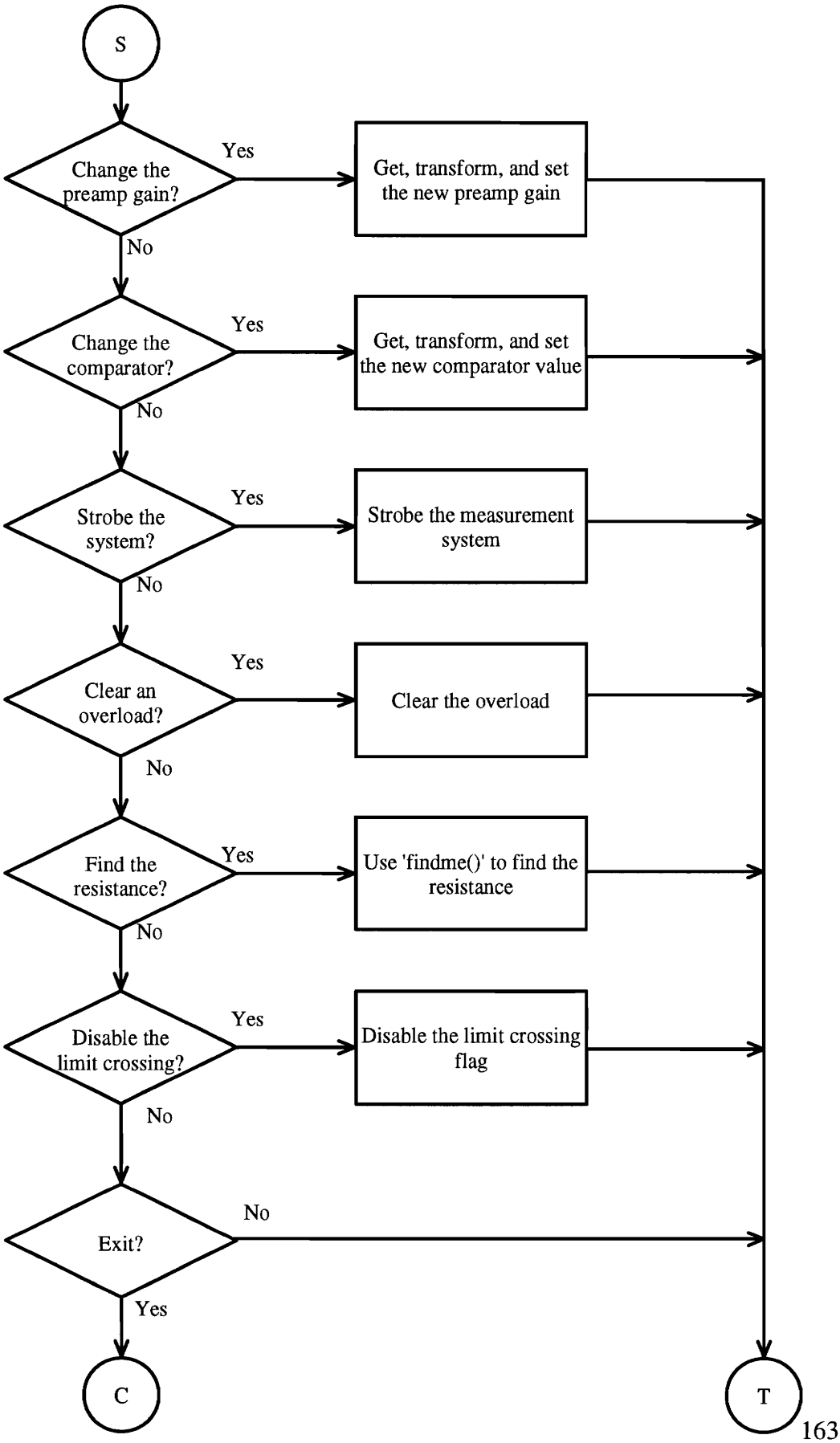

F
Circle()
Move to origin using 'some_move()'
No
At origin?
Yes
Get the type of circle
Get and transform radius and repetitions
No
All values okay?
Yes
Get the 'all ready' from the user
Circle_cut()
Store the current position as the center
Calculate the angular increment
N
N
Display the increment and radius
Cut the circle?
Yes
Turn the laser on
No
Calculate the velocity and move to the circumference
Turn the laser on
Move along the approximate circle
Turn the laser off
Move back to the center
C


G
Laser_trim()
Get and transform the probe numbers
Set up the probe ring
Find_me()
Initialize the measurement system
Pick a resistance of 500ohms
Test the resistor for in range
Out of low range?
Yes
Increase the resistor value
No
Out of high range?
Yes
Decrease the resistor value
No
O
O
Test the resistor for valid subrange
Valid?
No
Increase the resistor value
Yes
Get the feedback and calculate a better resistance
Get the feedback for the new resistance
Change in feedback > 1?
Yes
No
Get the new value for the resistor
Valid value?
No
Yes
P


P
Set up the measurement system
Have the user use the joystick to move to the first position
Store and display the first position
Have the user use the joystick to move to the second position
Store and display the second position
Are the positions correct?
No
Yes
Move back to the first position
Q
Q
Set all of the measurement system parameters
Display all of the values and feedback
Wait for an 'all clear' from the user
Turn on the laser and begin the move
Adjust the feedback gain and get the feedback
Out of range?
Yes
No
High gain?
No
Yes
R

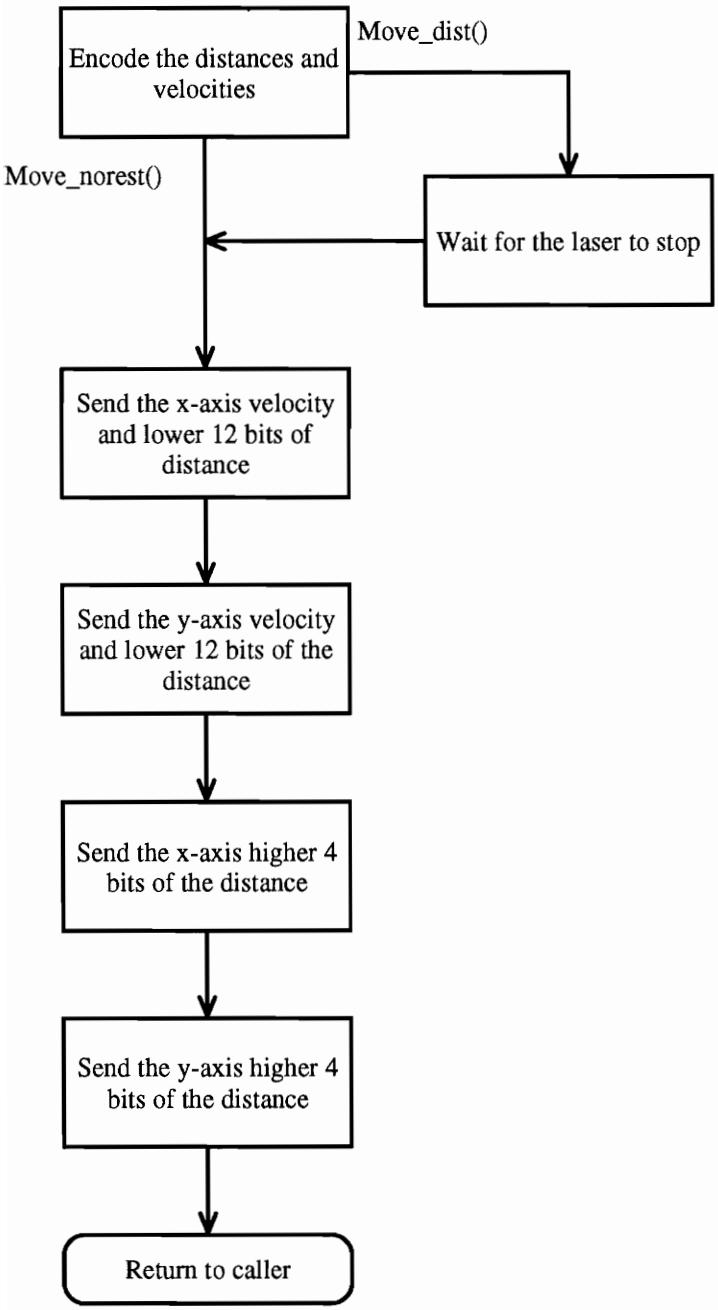

R
Is the resistor within tolerance?
No
Yes
Turn off the laser and stop the move
Use 'find_me()' to get the current resistance
Display the final results
C
H
Index the laser
Did it work?
Yes
Display all okay
No
Display a hardware error
Display the current position
C


I
Measure_test()
Get and set up the probe ring and probes
Get the current feedback
Display the options and feedback
Get the users option
Change test resistance?
Yes
No
Get, transform, and set the new resistance
Change generator voltage?
Yes
No
Get, transform, and set the new voltage
Change detector gain?
Yes
No
Get, transform, and set the new detector gain
S
T
Get the feedback
All processes complete?
Yes
No

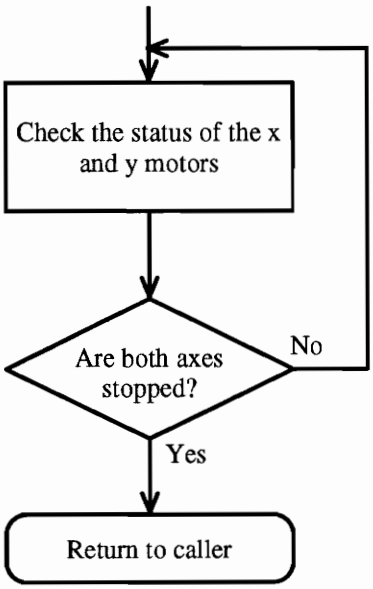

S
Change the preamp gain?
Yes
Get, transform, and set the new preamp gain
No
Change the comparator?
Yes
Get, transform, and set the new comparator value
No
Strobe the system?
Yes
Strobe the measurement system
No
Clear an overload?
Yes
Clear the overload
No
Find the resistance?
Yes
Use 'findme()' to find the resistance
No
Disable the limit crossing?
Yes
Disable the limit crossing flag
No
Exit?
No
Yes
C
T

Distance Moving

Move_dist() and Move_norest()



Wait_for_rest()



APPENDIX VI

LASER SOURCE CODE

```
/*****************************************************************************************
 *
                              LASER.C
 *
 *****************************************************************************************/

#include <bwindow.h>
#include <moveincd.h>
#include <measincd.h>
#include <newstuff.h>
#include <stdio.h>
#include <globlvar.h>
#include <defntion.h>
#include <math.h>
#include <float.h>
#include <main.h>

/*****************************************************************************
 *                                                                           *
 *    GLOBAL PARAMETERS:
 *
 * DEFIN: aca                acb          - Port addresses for info transfer from
 *        acc                accom            laser to pc (ac port)
 *        baca               bacb         - Port addresses for info transfer from
 *        bacc               baccom           laser to pc (bac port)
 *        bmba               bmbc         - Port addresses for function call from
 *        bmbcom                              laser to pc (bmb port)
 *        iop1               iop2         - Bmb value number for function load
 *        iop4               clearIop
 *        outcbt             incbt        - I/O board definition values for input
 *                                                          vs. output
 *        addr13A            addr13C      - Address value sets for each function
 *        addr15A            addr15C
 *        addr16A            addr16C
 *        addr17A            addr17C
 *        addr30A            addr30C
 *        addr31A            addr31C
 *        addr32A            addr32C
 *        addr40A            addr40C
 *        addr41A            addr41C
 *        addr42A            addr42C
 *        addr43A            addr43C
 *        addr44A            addr44C
 *        addr52A            addr52C
 *        addr53A            addr53C
 *        addr54A            addr54C
 *        addr55A            addr55C
 *        addr56A            addr56C
 *        ON                 OFF          - Status of laser beam on/off
 *
 * GLOBL: BWINDOW   - Window defined type cast for window pointer name
 *        aprobe    - The 'a' probe number
 *        bprobe    - The 'b' probe number
 *        circles   - The count of number of circles that are in the current file
 *        compare   - The comparator number sent to the laser in high speed trimming
 *        convertor - The value returned from the laser in response to a resistor measure
 *        current   - The file that is currently being processed
 *        delay     - The delay value for the measurement bridge before it takes a reading
 *        end_conv  - The laser control skip bit for convertor done converting
 *        end_delay - The laser control skip bit for the delay being over
 *        end_loops - The count of the number of ended loops in the current file
 *        file_name - The file name that the user types in  - with no extension
 *        gain      - Gain for the measurement system before being sent to the pc
 *        gen_volt  - The generator voltage value for the measurement bridge
```

```
*        hcompare  - The high byte of the sent comp. word    - used for software checking
*        hdelay    - The high byte of the sent delay word    -   '   '     '         '
*        hgain     - The high byte of the sent gain word     -   '   '     '         '
*        hgen_volt - The high byte of the sent generator voltage word -   '   '     '   '
*        hpre_amp  - The high byte of the sent preamplifier word -   '   '     '         '
*        hrange    - The high byte of the sent range word        -   '   '     '         '
*        hstandard - The high byte if the sent standard word     -   '   '     '         '
*        lcompare  - The low byte of the sent comp. word   - used for software checking
*        ldelay    - The low byte of the sent delay word   -   '   '     '         '
*        lgain     - The low byte of the sent gain word    -   '   '     '         '
*        lgen_volt - The low byte of the sent generator voltage word - '  '     '         '
*        lpre_amp  - The low byte of the sent preamplifier word -   '   '     '         '
*        lrange    - The low byte of the sent range word        -   '   '     '         '
*        lstandard - The low byte if the sent standard word     -   '   '     '         '
*        hlsbx     - The upper byte of the second x distance word after being encoded
*        hlsby     - The upper byte of the second y distance word after being encoded
*        llsbx     - The lower byte of the second x distance word after being encoded
*        llsby     - The lower byte of the second y distance word after being encoded
*        msbx      - The only byte of the first x distance word after being encoded
*        msby      - The only byte of the first y distance word after being encoded
*        laser_status  - Current status of the laser beam on/off
*        loops         - The number of loops in the current file
*        nested_loops  - Array for all nested loops of the current file that is being run
*        new_file  - The name of the user file with .new extension - the current file
*        num_loops - Counter as to which of the nested loops is currently being looped
*        off       - Number of times that the current file turns the laser off
*        on        - Number of times that the current file turns the laser on
*        old_file  - The user file with .old extension - the backup of the last file
*        old       - The file being backed up due to a revision in the current file
*        overload  - The measurement system overload readout
*        plist     - The name of the lower window - used for parameter viewing
*        posx      - The x positions that are used for differnece in distances
*        posy      - The y positions that are used for differnece in distances
*        pre_amp   - The value of the pre-amp which sets the bridge up for a measure
*        print     - The file that is written to for future printing
*        prn_file  - The user file with .prn extension - the printable function listing
*        probeahigh- The high byte of the 'a' probe byte
*        probealow - The low byte of the 'a' probe byte
*        probebhigh- The high byte of the 'b' probe byte
*        probeblow - The low byte of the 'b' probe byte
*        pwin      - The name of the main (upper) window
*        r1        - The global version of the current resistance
*        radius    - The radius of the circle to be cut
*        range     - The value number of which range the current resistor is in
*        ready     - The laser control skip bit for if the laser measurement is ready
*        resistor  - The user inputed value for the resistor value to be trimmed to
*        resting   - The control bit for if the linear motors ( laser head ) are moving
*        selection - The character string (2 char) that stores user responses
*        scan      - The dummy variable that holds the end character of user input
*        speed     - The type of a circle (with diagonal cut or with center unscaithed)
*        standard  - The ratio of the user inputed resistance and the range resistor
*        strobe_done  - The skip bit for if the pre-measuring strobe is completed
*        units_of_step  - The counter for which step number of the current nested loop
*        values    - The parameters for nested loops during the running of a program
*        vel       - The velocity that the laser is set to move at
*        vhlsbx    - The high bit of the x direction of the velocity after being encoded
*        vhlsby    - The high bit of the y direction of the velocity after being encoded
*        vllsbx    - The low bit of the x direction of the velocity after being encoded
*        vllsbx    - The low bit of the y direction of the velocity after being encoded
*        x_axis    - The x axis distance to move
*        y_axis    - The y axis distance to move
*        x_displace- The difference distance between two points in the x direction
*        y_displace- The difference distance between two points in the y direction
*        x_position- The current x position for evaluation
*        y_position- The current y position for evaluation
*        x_travel  - The x position or distance that is being read from/written to
*        y_travel  - The y position or distance that is being read from/written to
*        xhome     - The laser control bit for the x direction home position latch
*        yhome     - The laser control bit for the y direction home position latch
*        xjoy      - The laser control bit for the joystick movement in the x direction
*        yjoy      - The laser control bit for the joystick movement in the y direction
*        xotos     - The movement error value for the x linear motor
*        yotos     - The movement error value for the y linear motor
*        xpos      - The current x position
*        ypos      - The current y position
*
```

```
 *
 ***********************************************************************/


/*****************************************************************************
 *
 *      MODULE:   main
 *
 *     PURPOSE:   Laser system  operating system
 *
 *    PARAMETERS:
 *              GLOBL: plist              pwin
 *                     scan               radius
 *                     xpos               ypos
 *                     selection
 *
 *              LOCAL: act_page          - Active page number
 *                     choice            - Numeric value of user response to main menu
 *                     col               - Current column position of the cursor
 *                     columns           - Number of columns in the window
 *                     high              - Pointer for cursor high scan
 *                     i                 - Counter variable
 *                     low               - Pointer for cursor low scan
 *                     mode              - Current mode of the window
 *                     reps              - Number of times to cut a circle
 *                     row               - Current row of the cursor
 *                     yeah              - Converted user input for loop control
 *
 *
 *              CALLS: wncreate           scmode
 *                     sccurst            wndsplay
 *                     wnselect           wncursor
 *                     wncurmov           wnprintf
 *                     wnquery            outp
 *                     probe_select       laser_off
 *                     rdpositn           wnscroll
 *                     scribe             laser_trim
 *                     cut_a_pattern      some_move
 *                     index_pos          wait_for_rest
 *                     measure_test       move_dist
 *                     transform          circle_cut
 *                     wnremove           sccurset
 *                     scpgcur            wndstroy
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***********************************************************************/

void main()
{
    BORDER  bord;
    WHERE   location;
    int     mode,columns,act_page;
    int     row,col,high,low,choice;
    int     reps, yeah, i;


    plist = wncreate(3,78,WHITE);      /*  Dimensions of window data area.              */

    pwin = wncreate(18,78,CYAN);

    bord.type = BBRD_DDDD | BBRD_TCT;  /*  Box drawn with single                        */
                                       /*    lines, having a top centered               */
                                       /*    title.                                     */
    bord.attr    = MAGENTA;            /*  Border will be magenta on black.             */
    location.dev       = scmode(&mode,&columns,&act_page);
    location.page      = act_page;
    location.corner.col = 1;
    location.corner.row = 21;
```

```
    bord.ttattr  = REVERSE;            /*  Title will be black on white.                 */
    bord.pttitle = " System Status ";  /*  Text of the title.                            */

    if (NIL == wndsplay(plist,&location,&bord))
      return;                          /*  Quit if failure.                              */

    location.corner.row = 1;
    bord.pttitle = " Laser Operating System ";  /*  Text of the title.                   */
     if (NIL == wndsplay(pwin,&location,&bord))
      return;                          /*  Quit if failure.                              */

    wnselect(pwin);                    /*  Display turn on laser in top window           */
    wncursor(pwin);
    wncurmov(8,10);
    wnprintf("Turn on the Laser.  (Press ENTER to continue) ");

    wnquery(selection, 1, &scan);      /*  Wait for the user to respond                  */

    wncurmov(8,10);
    wnprintf("Laser initialization sequence is in process.  ");

                  /***init I/O cards***/

      outp(bmbcom, outcbt);            /*  INIT BMB FOR OUTPUT                           */
      outp(baccom, outcbt);            /*  INIT BAC FOR OUTPUT                           */
      outp(accom, incbt);              /*  INIT AC  FOR INPUT                            */


    outp(bacc,0x08);                   /*  Reset the system with a pulse on Bint line    */
   for(i=0;i<1000;i++);
    outp(bacc,0x00);

   probe_select();                     /* Set the multiplexer to acknowledge pc use    */

    laser_off();                        /* Turn off the laser                           */

                  /***clear manual functions***/

    outp(bmba, addr56A);                /* Set addr 56 on a and c                        */
    outp(bmbc, addr56C);
    outp(bacc, iop1);                   /* Pulse iop 1 for clear manual functions        */
    outp(bacc, clearlop);

    index_pos();                        /* Send the laser to its internal home position */
    wait_for_rest();
    clrintr();                          /* Clear all internal interrupts                 */

    wnselect(plist);                    /* Display the current position - bottom window */
    wncurmov(0,2);
    rdpositn();
    wnprintf("Current Position: %6li, %6li     ",xpos,ypos);

    choice = 0;

while(choice != 9)                      /* While the choice is not an exit               */
    {
    wnselect(pwin);
    wnscroll(0,-1,-1,0);                /* Clear the upper screen                        */
                                        /* Display the main menu                         */
    wncurmov(2,22);
    wnprintf("What would you like to do?");
    wncurmov(4,20);
    wnprintf(" 1. Move distance ");
    wncurmov(5,20);
    wnprintf(" 2. Scribe        ");
    wncurmov(6,20);
    wnprintf(" 3. Pattern cut ");
    wncurmov(7,20);
    wnprintf(" 4. Cut a circle");
    wncurmov(8,20);
    wnprintf(" 5. Index");
    wncurmov(9,20);
    wnprintf(" 6. Resistor trimming ");
    wncurmov(10,20);
    wnprintf(" 7. Hardware test");
    wncurmov(11,20);
```

```
wnprintf(" 8. Test measurement system ");
wncurmov(12,20);
wnprintf(" 9. Exit");
wncurmov(14,20);
wnprintf("Option:");

wnquery(selection, 2, &scan);        /*  Get the users selection                    */
                                     /*  Translate the possibilities into one number */
if(*selection == 'm'|| *selection == 'M' || *selection == 49)
   choice = 1;

if(*selection == 's'|| *selection == 'S' || *selection == 50)
   choice = 2;

if(*selection == 'p'|| *selection == 'P' || *selection == 51)
   choice = 3;

if(*selection == 'c'|| *selection == 'C' || *selection == 52)
   choice = 4;

if(*selection == 'i'|| *selection == 'I' || *selection == 53)
   choice = 5;

if(*selection == 'r'|| *selection == 'R' || *selection == 54)
   choice = 6;

if(*selection == 'h'|| *selection == 'H' || *selection == 55)
   choice = 7;

if(*selection == 't'|| *selection == 'T' || *selection == 56)
   choice = 8;

if(*selection == 'e'|| *selection == 'E' || *selection == 57)
   choice = 9;

switch(choice)                       /* Jump to the correct set of commands          */
  {
  case 1:                            /* Option to move a distance                    */
 while(choice == 1)              /* While the user still wants a distance move   */
    {
    wnscroll(0,-1,-1,0);         /* Clear the screen                             */
    some_move();                 /* Do a distance move                           */
    wncurmov(13,8);
    wnprintf("Is this the final point? (y/n)");
                                     /* See if the user wants another move           */
    wnquery(selection,2,&scan);
    if(*selection == 'y' || *selection == 'Y')
    choice = 0;
    }
  break;                             /* When all is done, go back to the main menu   */

  case 2:                            /* Option to scribe                             */
 while(choice == 2)              /* While the user still wants to scribe         */
    {
    wnscroll(0,-1,-1,0);         /* Clear the screen                             */
    scribe();                    /* Do the scribing                              */
    wnselect(plist);             /* Display the current position                 */
    wncurmov(0,2);
    rdpositn();
    wnprintf("Current position: %6li, %6li      ",xpos,ypos);

    wnselect(pwin);
    wncurmov(14,15);             /* See if the user wants another scribe         */
    wnprintf("Do you want to do another scribe? (y or n) ");

    wnquery(selection, 2, &scan);

    if(*selection != 'y'&& *selection != 'Y' )
     choice = 0;
    }
 break;                          /* When all is done, go back the main menu      */

  case 3:                            /* Option to cut a pattern                      */
 wnscroll(0,-1,-1,0);            /* Clear the screen                             */
 cut_a_pattern();                /* Go to the cut a pattern menu                 */
 break;                          /* When all is done, go back to the main menu   */
```

```
 case 4:                          /* Option to cut a circle                    */
wnscroll(0,-1,-1,0);            /* Clear the screen                          */
circle();                       /* Do a circle cutting                       */
break;                          /* When all is done, go back to the main menu */

 case 5:                          /* Option to index the laser                 */
wnscroll(0,-1,-1,0);            /* Clear the screen                          */
rdpositn();                     /* Move to the 0,0 position                  */
move_dist(-1*xpos,-1*ypos,10,10);
wait_for_rest();

for(i=0;i<1000;i++);            /* Pause for a while                         */

rdpositn();                     /* Make sure that we are at 0,0              */
if(xpos != 0 && ypos != 0)
    move_dist(-1*xpos,-1*ypos,1,1);
wnselect(plist);
wncurmov(0,2);
wait_for_rest();

for(i=0;i<1000;i++);            /* Pause just a tad bit more                 */
rdpositn();                     /* Display the current position              */
wnprintf("Current position: %6li, %6li        ",xpos,ypos);
wnselect(pwin);
break;                          /* When all is done, go back to the main menu */

 case 6:                          /* Option to do a laser resistor trim        */
   wnscroll(0,-1,-1,0);           /* Clear the screen                          */
laser_menu();                   /* Do a resistor trim                        */
   wnselect(plist);               /* Display the current position              */
   wnscroll(0,-1,-1,0);           /* Clear the screen                          */
   wncurmov(0,2);
rdpositn();
wnprintf("Current position: %6li, %6li      ",xpos,ypos);

   wnselect(pwin);
break;                          /* When all is done, go back to the main menu */

 case 7:                          /* Option to check the hardware              */
wnscroll(0,-1,-1,0);            /* Clear the screen                          */
index_pos();                    /* Index the laser position                  */

wait_for_rest();

for(i=0;i<1000;i++);            /* Pause just a little while                 */
rdpositn();
wncurmov(5,5);
rdpositn();
if(xpos != 0 || ypos != 0)      /* If the index did not get us home, alert user */
    {
    wnprintf("There is a problem with the hardware");
    wncurmov(6,5);
    wnprintf("Current position: %6li, %6li       ",xpos,ypos);
    }
else                            /* If we made it home, all is okay           */
    wnprintf("Everything with the hardware is correct");
wncurmov(8,5);                  /* Let the user absorb all the info          */
wnprintf("(Press ENTER to continue) ");
wnquery(selection, 1, &scan);
wnselect(plist);                /* Display the current position              */
wncurmov(0,2);
rdpositn();
wnprintf("Current position: %6li, %6li        ",xpos,ypos);
wnselect(pwin);
break;                          /* When all is done, go back to the main menu */

 case 8:                          /* Option to test out the measurement system */
wnscroll(0,-1,-1,0);            /* Clear the screen                          */
measure_test();                 /* Do a measurement sustem test              */
break;                          /* When all is done, go back to the main menu */
 }                                /* No other options!!                        */

}                                 /* Go back to test for an exit or for main menu */
```

```
          /*  Remove the window & restore the screen and cursor.          */

    wnremove(pwin);
    wnremove(plist);
    wndstroy(pwin);                     /* Clean up data structures.                    */
    wndstroy(plist);                    /* Clean up data structures.                    */
}



/*************************************************************************
 *
 *      MODULE:  wait_for_rest
 *
 *     PURPOSE:  To wait for the laser to stop moving
 *
 *    PARAMETERS:      GLOBL: resting             laser_status
 *
 *              USERS: main                 scribe
 *                     circle_cut           some_move
 *                     move_dist            index_pos
 *
 *              CALLS: skip_on_rest
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ************************************************************************/


void wait_for_rest(void)
{
   resting = 0;                         /* Let's assume that we are moving              */
   while(resting == 0)                  /* Keep testing until we are not moving         */
      skip_on_rest();

}



/*************************************************************************
 *
 *      MODULE:  wait_for_rest2
 *
 *     PURPOSE:  To wait for the laser to stop moving, but also testing to see if the STOP
 *                     button has been pressed
 *
 *    PARAMETERS:      GLOBL: resting             laser_status
 *
 *              USERS: main                 scribe
 *                     circle_cut           some_move
 *                     move_dist            index_pos
 *
 *              CALLS: skip_on_rest         laser_off
 *                     check_for_rest       move_dist
 *
 *     RETURNS:  1 - If STOP
 *               0 - If okay to continue
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *   12/90          RRW          Add check_for_stop to stop in middle of a move
 ************************************************************************/
```

```
int wait_for_rest2()
{
   resting = 0;                          /* Let's assume that we are moving              */
   while(resting == 0)                   /* Wait for laser to stop, or STOP button to int*/
      {
      if(check_for_stop() == 1)          /* Check the stop button                        */
           {                             /* If STOP button, turn off the laser, stop     */
           laser_off();                  /*   moving, reset laser status flag, and       */
           move_norest(0,0,0,0);
           laser_status = OFF;           /*   return with an error flag.                 */
           return(1);
           }
      skip_on_rest();                    /* No STOP, keep checking for stopped moving    */
      }
   return(0);                            /* Stopped regularly, return with okay flag     */
}


/*****************************************************************************
 *
 *      MODULE:  circle
 *
 *     PURPOSE:  To set up a circle cut from the main menu
 *
 *    PARAMETERS:      GLOBL: resting          radius
 *                      scan             selection
 *
 *              LOCAL: numbers         - Character buffer for numeric input (radius)
 *                     reps            - Number of times to do the circle
 *                     yeah            - Prompt variable for another circle
 *                     type            - Type of circle (cutting or saving the circle)
 *
 *              USERS: main
 *
 *              CALLS: wncurmov           wnprintf
 *                     wnquery            circle_cut
 *                     some_move          transform
 *                     wnscroll
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***************************************************************************/

void circle()
{
  int reps, yeah, type;
  char numbers[5];

  yeah = 1;                              /* Assume that we are not at the origin         */

  while(yeah == 1)                       /* While we are not sure if we are at the origin*/
           {
           wnscroll(0,-1,-1,0);          /* Clear the screen                             */
           wncurmov(5,5);
           wnprintf("Is this the origin? (y/n)");  /* Ask the user if we are there yet */
           wnquery(selection,2,&scan);
           if(*selection == 'y' || *selection == 'Y')
                                         /* If we are there, then we can continue        */
              yeah = 0;
           else                          /* If we are not there, do a distance move      */
              {
              wnscroll(0,-1,-1,0);       /* Clear the screen                             */
              some_move();
              }
           }                             /* Check if we are sure about the origin        */
```

```
  wnscroll(0,-1,-1,0);                    /* Clear the screen                              */
  wncurmov(5,5);
  wnprintf("Do you want to keep the center? (y/n)");
                                          /* Ask the user if he wants to keep the center  */
  wnquery(selection,2,&scan);
  if(*selection == 'n' || *selection == 'N')  /* If not, flag a cut the circle            */
        type = 1;
  else                                    /* If so, flag a save the circle                 */
        type = 0;

  yeah = 1;                               /* Assume that some vaule will be wrong          */

  while(yeah == 1)                        /* While we are not sure if the values are right*/
          {
          wncurmov(8,8);                  /* Get the radius                                */
          wnprintf("What is the radius in integer values of .01mm?");
          wnquery(numbers,5,&scan);
          radius = (int)transform(numbers);
                                          /* Transform the radius from an ASCII string     */
          wncurmov(9,8);                  /* Get the repetitions                           */
          wnprintf("How many repetitions?");
          wnquery(numbers,3,&scan);
          reps = (int)transform(numbers);
                                          /* Transform the repetions from ASCII            */
          wncurmov(11,8);                 /* Check if the user is happy yet                */
          wnprintf("Is radius = %4d  correct? (y/n)", radius);
          wnquery(selection,2,&scan);
          if(*selection == 'y' || *selection == 'Y')
                                          /* If so, all is well and we can continue        */
               yeah = 0;
          }                               /* Check to see if all is okay with the values   */

  wncurmov(13,8);                         /* Let the user give an all clear                */
  wnprintf("Press START when you are ready");
  wait_for_start();

  while(reps != 0)                        /* While there are still reps to do              */
        {
        circle_cut(type);                 /* Do a circle cut of the wanted type            */
    reps--;                           /* Subtract one from the reps                    */
    wait_for_rest();
    }                                 /* Check if we are done yet                      */
}


/*****************************************************************************
 *
 *      MODULE:  scribe
 *
 *     PURPOSE:  Do a single operation scribe
 *
 *    PARAMETERS:      GLOBL: plist              posx
 *                     posy                pwin
 *                     vel                 xpos
 *                     ypos                r1
 *                     selection           scan
 *                     x_displace          y_displace
 *                     x_position          y_position
 *                     vel
 *
 *              LOCAL: passes             - Number of times to do the scribe
 *
 *              USERS: main
 *
 *              CALLS: wncurmov            wnprintf
 *                     wnquery             joymove
 *                     rdpositn            wnselect
 *                     wnscroll            wait_for_rest
 *                     transform           laser_on
 *                     move_dist           laser_off
 *                     wait_for_rest2      move_norest
 *
 *     RETURNS:  NONE
 *
```

```
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***********************************************************************/

void scribe()
{
 char passes, numbers[7];

    wncurmov(5,5);                      /* Figure out if it will be with joy or dist    */
    wnprintf("Would you like to use the Joystick or Distances? (j/d)");
    wnquery(selection,2,&scan);

      if(*selection != 'd' && *selection != 'D')
                                        /* If it is not with distances, yes joystick    */
            {
            wncurmov(5,5);              /* Tell the user to use the joy to move to pos 1*/
       wnprintf(" Use the joystick to move to the first position and to align the base.");
            wncurmov(10,8);
            wnprintf(" (Use the laser panel button to load the position.)");

            joymove();                  /* Let the user use the joystick                */

            rdpositn();                 /* Store the current position as the 1st pos.   */
            posx[0] = xpos;
            posy[0] = ypos;

            wnselect(plist);            /* Display the current position                 */
            wncurmov(1,2);
            wnprintf("Position #1: %6li, %6li", posx[0], posy[0]);

            wnselect(pwin);             /* Tell the user to use the joy to move to pos 2*/
            wncurmov(5,5);
      wnprintf(" Use the joystick to move to the second position.                        ");

            joymove();                  /* Let the user use the joystick                */

            rdpositn();                 /* Store the current position as the 2nd pos.   */
            posx[1] = xpos;
            posy[1] = ypos;

            wnselect(plist);            /* Display the second position                  */
            wncurmov(2,2);
            wnprintf("Position #2: %6li, %6li", posx[1], posy[1]);

            }
      else                              /* If the user wants to use distances           */
            {
            wnscroll(0,-1,-1,0);        /* Clear the screen                             */
            wncurmov(5,5);              /* Ask the user if current pos is the 1st pos.  */
            wnprintf("Is the current position the first position? (y/n)");
            wnquery(selection,2,&scan);
            wnprintf("                                                    ");
            while(*selection != 'y' && *selection != 'Y')
                                        /* If current pos. is not the first position    */
                  {
                  wncurmov(8,8);        /*    Get the x distance                        */
                  wnprintf("Enter the x distance (less than +/-6000)");
                  wnquery(numbers,6,&scan);
                  x_displace = (int)transform(numbers);
                                        /*    Transform the x distance                  */
                  wncurmov(10,8);       /*    Get the y distance                        */
                  wnprintf("Enter the y distance (less than +/-6000)");
                  wnquery(numbers,6,&scan);
                  y_displace = (int)transform(numbers);
                                        /*    Transform the y distance                  */

                  vel = velocity_set(x_displace, y_displace);
                                        /*    Calculate the best velocity to travel at  */

                  move_dist(x_displace, y_displace, vel, vel);
```

```
                                /*    Move that distance                          */
            wait_for_rest();

            wnscroll(0,-1,-1,0);  /* Clear the screen                            */
            wncurmov(1,5);        /* Ask the user if he is happy now             */
            wnprintf("Is the current position the first position? (y/n)");
            wnquery(selection,2,&scan);
            wnprintf("                                                  ");
            }                     /* Repeat if the user isn't happy              */

      rdpositn();                 /* If all is okay, store current pos as 1st pos.*/
      posx[1] = xpos;
      posy[1] = ypos;

      wnselect(plist);            /* Display the first position                  */
      wncurmov(1,2);
      wnprintf("Position #1: %6li, %6li", posx[1], posy[1]);

      wnselect(pwin);             /* Tell the user to enter the distance to cut  */
      wnscroll(0,-1,-1,0);        /* Clear the screen                            */
      wncurmov(5,5);
      wnprintf(" Enter the distance to move with respect to the current position.");
      wncurmov(8,8);              /* Get the x distance                          */
      wnprintf("Enter the x distance (less than +/-6000)");
      wnquery(numbers,6,&scan);
      x_position = (int)transform(numbers);
                                  /* Transform the x distance                    */
      wncurmov(9,8);              /* Get the y distance                          */
      wnprintf("Enter the y distance (less than +/-6000)");
      wnquery(numbers,6,&scan);
      y_position = (int)transform(numbers);
                                  /* Transform the y distance                    */
      posx[0] = posx[1] + x_position;
                                 /* Calculate the second position               */
      posy[0] = posy[1] + y_position;

      wnselect(plist);            /* Display the second position                 */
      wncurmov(2,2);
      wnprintf("Position #2: %6li, %6li", posx[0], posy[0]);
      }

wnselect(pwin);
wnscroll(0,-1,-1,0);              /* Clear the screen                            */
wncurmov(3,8);                    /* Get the velocity to travel at               */
wnprintf("Enter the velocity (127.75 to .25): ");
wnquery(numbers,7,&scan);
vel = transform(numbers);         /* Transform the velocity                      */

x_displace = (int)(posx[0] - posx[1]);  /* Figure out the distance               */
y_displace = (int)(posy[0] - posy[1]);

wncurmov(3,5);                    /* Get the number of passes                    */
wnprintf("How many passes would you like to make? (max of 9)");
wnquery(numbers, 2, &scan);

passes = *numbers - 48;           /* Tranform the passes                         */

if(passes <= 0 || passes > 9)     /* Don't let the user enter an invalid number  */
     return;

wncurmov(8,9);                    /* Wait for an all okay from the user          */
wnprintf("Press START when you are ready.");
wait_for_start();

laser_on();                       /* Turn on the laser                           */

while((passes != 0) && wait_for_rest2() != 1)
                                  /* While there are still passes to do and      */
   {                              /*no STOP button                               */
   passes--;                      /* Subtract one from the passes                */

   move_norest(x_displace, y_displace, vel, vel);  /* Move the distance          */

   x_displace = -1 * x_displace;  /* Get the distance ready to move backwards    */
   y_displace = -1 * y_displace;
```

```
        }                               /* See if all is okay to continue or if finished*/

      wait_for_rest2();                 /* Wait for the laser to stop                   */

      laser_off();                      /* Turn off the laser                           */

}


/*****************************************************************************
 *
 *      MODULE:  circle_cut
 *
 *     PURPOSE:  To cut a circle (either cutting or saving the circle)
 *
 *    PARAMETERS:      GLOBL: plist              pwin
 *                     vel                 xpos
 *                     ypos                radius
 *                     scan                selection
 *                     x_travel            y_travel
 *
 *              PARAM: type                - Type of circle ( cutting or saving the circle)
 *
 *              LOCAL: angle               - Angle that the circle is cutting to
 *                     increment           - Increment at which to increase the angle
 *                     negradius           - Distance to circumference in the -x direction
 *                     origx               - Current x position
 *                     origy               - Current y position
 *                     xax                 - Next x position after incrementing the angle
 *                     yax                 - Next y position after incrementing the angle
 *
 *              USERS: circle              do_file
 *                     do_a_loop
 *
 *              CALLS: wait_for_rest       laser_off
 *                     rdpositn            wnselect
 *                     asin                wncurmov
 *                     wnprintf            move_dist
 *                     laser_on            sin
 *                     cos                 wait_for_rest2
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *    12/90         RRW         Modify for stop during movement(wait_for_rest2)
 *
 ***************************************************************************/


void circle_cut(int type)
{
 int origx, origy, negradius;
 int xax, yax;
 double angle, increment;


 laser_off();                           /* Turn off the laser                           */

 rdpositn();                            /* Read and store the current pos as the center */
 x_travel = xpos;
 y_travel = ypos;
 wnselect(plist);

 angle = 0;                             /* Initialize the angle                         */
 increment = 2*(asin(.5/(double)radius));     /* Calculate the angular increment step   */
 wncurmov(0,40);                        /* Display the radius and increment             */
 wnprintf("The increment is %lf",increment);
 wncurmov(2,40);
 wnprintf("The radius is %3d", radius);
 negradius = -1 * radius;               /* Set the first comparison values              */
```

```
 origx = radius;
 origy = 0;

 vel = velocity_set(radius,radius);     /* Set the velocity to travel the edge          */

 if(type == 1)
                                        /* If option to cut the circle,                 */
    laser_on();                         /*   turn on the laser                          */

 move_dist(negradius, 0, vel, 0);       /* Move to the circumference                    */

 if(wait_for_rest2() == 0)              /* While there has not been a STOP button       */
      {
      laser_on();                       /* Turn on the laser regardless of option       */

      while((angle < 6.2831853) && (wait_for_rest2() != 1))
                                        /* While no STOP and not a complete circle      */
            {
            angle = angle + increment;  /* Find the new angle                           */
            yax = (int)(radius*(sin(angle)));    /* Compute the components              */
            xax = (int)(radius*(cos(angle)));
            if(origx != xax || origy != yax)     /* Check if movement is needed         */
                  {
                  move_norest( origx - xax, yax - origy, 2, 2);   /*  If so, move it!  */
                  origx = xax;          /*  Change the location to the new location     */
                  origy = yax;
                  }
            }                           /* Check if we are done                         */

      wait_for_rest();                  /* Make sure that the laser has finished moving */
      laser_off();                      /* Turn off the laser                           */
      }

 rdpositn();                            /* Find out where we are                        */
 move_dist(x_travel - xpos, y_travel - ypos, vel, vel);  /* Move back to the center     */

 wncurmov(0,40);                        /* Clear the lower screen of all circle info    */
 wnprintf("                              ");
 wncurmov(1,40);
 wnprintf("                              ");
 wncurmov(2,40);
 wnprintf("                              ");
 wnselect(pwin);

}


/*****************************************************************************
 *
 *      MODULE:  some_move
 *
 *     PURPOSE:  To move a distance either by the joystick or by distances
 *
 *    PARAMETERS:      GLOBL: plist              pwin
 *                     vel                 xpos
 *                     ypos                selection
 *                     scan                x_displace
 *                     y_displace
 *
 *              LOCAL: numbers            - Character buffer for numeric input (distances)
 *
 *              USERS: main                 do_file
 *
 *              CALLS: wncurmov             wnprintf
 *                     wnquery              joymove
 *                     transform            move_dist
 *                     wait_for_rest2       wnselect
 *                     rdpositn             wnscroll
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
```

```
 *
 *     DATE       INITIALS                    MODIFICATION
 *  ---------     --------  ------------------------------------------------
 *
 ***********************************************************************/

void some_move()
{
    char numbers[7];

    wncurmov(5,5);                      /* Ask if user wants to use the joy or dist     */
    wnprintf("Would you like to use the Joystick or Distances? (j/d)");
    wnquery(selection,2,&scan);

      if(*selection != 'd'&& *selection != 'D')  /* If its not dist, its going to be joy*/
          {
          wncurmov(5,5);                /*   Tell the user to use the joy               */
          wnprintf("     Use the joystick to move and load position to finish");
          joymove();                    /*   Let the user use the joystick              */
          }
      else                              /* If he wants to use distances                 */
          {
          wncurmov(8,8);                /*   Get the x distance                         */
          wnprintf("Enter the x distance (less than +/-6000)");
          wnquery(numbers,6,&scan);
          x_displace = (int)transform(numbers);  /*   Transform the x distance          */
          wncurmov(9,8);                /*   Get the y distance                         */
          wnprintf("Enter the y distance (less than +/-6000)");
          wnquery(numbers,6,&scan);
          y_displace = (int)transform(numbers);  /*   Transform the y distance          */
          wncurmov(10,8);               /*   Get the velocity                           */
          wnprintf("Enter the velocity (127.75 to .25)");
          wnquery(numbers,7,&scan);
          vel = transform(numbers);     /*   Transform the velocity                     */

          move_dist(x_displace, y_displace, vel, vel);   /*   Move the distance         */

          wait_for_rest2();             /*   Wait for the laser to stop moving          */
          }

      wnselect(plist);                  /* Get and display the current position         */
      wncurmov(0,2);
      rdpositn();
      wnprintf("Current position: %6li, %6li        ",xpos,ypos);

      wnselect(pwin);

}


/*****************************************************************************
 *
 *      MODULE:  transform
 *
 *     PURPOSE:  To change a character buffer array into a numeric number
 *
 *    PARAMETERS:      PARAM: buffer            - Character buffer to change
 *
 *              LOCAL: j                  - Loop variable
 *                     m                  - Loop variable
 *                     n                  - Loop variable
 *                     v1                 - decimal part of the number
 *                     value              - integer part of the number
 *
 *              USERS: cut_a_pattern       build_file
 *                     main                append
 *                     scribe              some_move
 *                     measure_test
 *
 *     RETURNS:  Number in float form
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
```

```
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *                                                                            *
 ***************************************************************************/

float transform(char *buffer)
{
   float value, v1;
   int n,j,m;


   if((buffer[0] <48 || buffer[0] > 57) && buffer[0] != 45 && buffer[0] != 46);
                                        /*  If the first character is not valid, quit   */
   else
                                        /* If the first character is valid              */
      {
      n=0;                              /*   Initialize the counters                    */
      value = 0;
      v1 = 0;
      if(buffer[0] == 45)               /*   If the first character is negative,        */
              n=1;                      /*Flag it                                       */
      for(j=n; buffer[j] >= 48 && buffer[j] <= 57; j++)  /*   For each integer number   */
          value = (value * 10) + buffer[j]-'0';  /*      Add it in and shift            */
      if(buffer[j] == 46)               /*   If, after the integers there is a period,  */
          {
          for(m=6; m != j; --m)         /*   For each possible other character          */
            {
            if( buffer[m] >= 48 && buffer[m] <= 57)    /* If the character is a number  */
               v1 = (v1 + buffer[m]-'0')/10;     /*      Add it in and shift            */
            }                           /*   Do for all other characters                */
          }
      value = value + v1;               /*   Add the decimal and integer numbers        */
      if(n==1)                          /* If the number is negative,                   */
          value = (-1)*value;           /*   Make the number negative                   */
      }
  return value;                         /* Return the number                            */

}



/*****************************************************************************
 *
 *      MODULE:  vel_set
 *
 *     PURPOSE:  Calculate the fastest velocity that the laser can safely move
 *
 *    PARAMETERS:      PARAM: x_dist     - The x distance to travel
 *                            y_dist     - The y distance to travel
 *
 *              USERS: cut_a_pattern      build_file
 *                     main               append
 *                     scribe             some_move
 *                     measure_test
 *
 *     RETURNS:  Number (velocity) in int form
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *                                                                            *
 ***************************************************************************/

int velocity_set(int x_dist, int y_dist)
{
  if(abs(x_dist) < 49 && abs(y_dist) <49)
     return(2);

  if(abs(x_dist) < 199 && abs(y_dist) < 199)
     return(4);
```

```
  if(abs(x_dist) < 699 && abs(y_dist) < 699)
     return(6);

  return(8);

}
```

```
/*****************************************************************************************
 *
                              NEWSTUFF.C
 *
 *****************************************************************************************/
#include <stdlib.h>
#include <conio.h>
#include <dos.h>
#include <stdio.h>
#include <string.h>
#include <float.h>
#include <math.h>
#include <bwindow.h>
#include <measincd.h>
#include <newstuff.h>
#include <moveincd.h>
#include <extrnvar.h>
#include <defntion.h>
#include <main.h>


/*****************************************************************************************
 *
 *      MODULE:  laser_menu
 *
 *     PURPOSE:  To figure out what kind of trimming the user wants
 *
 *    PARAMETERS:      GLOBL: aprobe              bprobe
 *                            convertor           end_conv
 *                            gain                gen_volt
 *                            overload            plist
 *                            posx                posy
 *                            pre_amp             pwin
 *                            range               resistor
 *                            scan                standard
 *                            xpos                ypos
 *                            r1                  selection
 *                            x_displace          y_displace
 *
 *                      LOCAL: okay               - Prompt variable for another trim
 *                            numbers             - Character buffer for numeric input
 *
 *                      USERS: main
 *
 *                      CALLS: wncurmov           wnprintf
 *                            wnquery             channela
 *                            channelb            findme
 *                            wnscroll            scanf
 *                            arange              strobe
 *                            clrol               rdconvert
 *                            rdoverload          joymove
 *                            rdpositn            wnselect
 *                            move_dist           pre_gain
 *                            agen_volt           detect_gain
 *                            skend_conv          disable_lim_cro
 *                            laser_on            move_norest
 *                            laser_off
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void laser_menu(void)
{
  double r2;
  float resistor_value[9], initial_resistor;
  int serp_loops, choice;
  int double_cut_pos2dist_x, double_cut_pos2dist_y,
```

```
    serp_cut_pos2dist_x, serp_cut_pos2dist_y;

wnselect(pwin);

aprobe = 999;
bprobe = 999;

choice = 0;

while(choice != 9)                    /* While the choice is not an exit              */
  {
  wnscroll(0,-1,-1,0);                /* Clear the upper screen                       */
                                      /* Display the main menu                        */
  wncurmov(2,22);
  wnprintf("What would you like to do?");
  wncurmov(4,20);
  wnprintf(" 1. Get current resistance ");
  wncurmov(5,20);
  wnprintf(" 2. Straight-cut trim      ");
  wncurmov(6,20);
  wnprintf(" 3. Double-cut trim        ");
  wncurmov(7,20);
  wnprintf(" 4. L-cut trim             ");
  wncurmov(8,20);
  wnprintf(" 5. Multiple-line-cut trim (serpentine)");
  wncurmov(9,20);
  wnprintf(" 6. Test routines for the measurement system");
  wncurmov(10,20);
  wnprintf(" 7. Imbedded resistor (not in use)");
  wncurmov(11,20);
  wnprintf(" 8. Change trimming defaults");
  wncurmov(12,20);
  wnprintf(" 9. Exit");
  wncurmov(14,20);
  wnprintf("Option:");

  wnquery(selection, 2, &scan);       /*  Get the users selection                     */
                                      /*  Translate the possibilities into one number */
  if(*selection == 'g'|| *selection == 'G' || *selection == 49)
     choice = 1;

  if(*selection == 's'|| *selection == 'S' || *selection == 50)
     choice = 2;

  if(*selection == 'd'|| *selection == 'D' || *selection == 51)
     choice = 3;

  if(*selection == 'l'|| *selection == 'L' || *selection == 52)
     choice = 4;

  if(*selection == 'm'|| *selection == 'M' || *selection == 53)
     choice = 5;

  if(*selection == 't'|| *selection == 'T' || *selection == 54)
     choice = 6;

  if(*selection == 'i'|| *selection == 'I' || *selection == 55)
     choice = 7;

  if(*selection == 'c'|| *selection == 'C' || *selection == 56)
     choice = 8;

  if(*selection == 'e'|| *selection == 'E' || *selection == 57)
     choice = 9;

  stop = 0;

  if(choice > 0 && choice < 6)
    {
    if (aprobe == 999 || bprobe == 999)
    probe_request();
    else
    confirm_probes();

    switch(choice)                    /* Jump to the correct set of commands          */
      {
```

```
case 1:                         /* Option to find a resistance                  */
  while(choice == 1)
    {
    wnscroll(0,-1,-1,0);        /* Clear the upper window                       */
    wnselect(plist);
    wnscroll(0,-1,-1,0);        /* Clear the lower window                       */
    current_resistor();         /* Get the current resistance                   */
    wncurmov(14,15);            /* See if the user wants to find another resist */
    wnprintf("Do you want to find another resistance? (y/n) ");

    wnquery(selection, 2, &scan);

    if(*selection != 'n'&& *selection != 'N' )
    probe_request();
    else
    choice = 0;
    }
  break;                        /* When all is done, go back to the main menu   */

case 2:                         /* Option to laser trim a straight cut          */
  while(choice == 2)            /* While the user still wants to laser trim     */
        {
    wnscroll(0,-1,-1,0);        /* Clear the upper window                       */
    wnselect(plist);
    wnscroll(0,-1,-1,0);        /* Clear the lower window                       */
    current_resistor();         /* Get the current resistance                   */
    resistor_corners();         /* Find out where the resistor is               */
    get_wanted_resistor();      /* Figure out what resistance the user wants    */
    wnselect(pwin);
    wnscroll(0,-1,-1,0);        /* Clear the upper window                       */
    wncurmov(10,15);            /* Get the all ready from the user              */
    wnprintf("Press START when you are ready.");
    wnselect(plist);
    wait_for_start();

        laser_trim();               /* Do the scribing                              */
        wnselect(plist);            /* Display the current position                 */
        wncurmov(0,2);
        rdpositn();
        wnprintf("Current position: %6li, %6li      ",xpos,ypos);

        wnselect(pwin);
    wncurmov(12,15);
    wnprintf("The final resistance was %12.0f ", resistor);
    wncurmov(14,15);            /* See if the user wants another straight cut   */
        wnprintf("Do you want to do another straight-cut trim? (y/n) ");

        wnquery(selection, 2, &scan);

        if(*selection != 'y'&& *selection != 'Y' )
            choice = 0;
    else
    probe_request();
    }
  break;                        /* When all is done, go back the main menu      */

case 3:                         /* Option to laser trim a double cut            */
  while(choice == 3)            /* While the user still wants to laser trim     */
        {
    wnscroll(0,-1,-1,0);        /* Clear the upper window                       */
    wnselect(plist);
    wnscroll(0,-1,-1,0);        /* Clear the lower window                       */
    current_resistor();         /* Get the current resistance                   */
    initial_resistor = resistor;
    resistor_corners();         /* Find out where the resistor is               */
    get_wanted_resistor();      /* Figure out what resistance the user wants    */
        r2 = r1;
    r1 = (r2 * (double)turn_after / 100) + ((double)initial_resistor
         * (100 - (double)turn_after)/100);
    resistor = (float)r1;
    wnselect(pwin);
    wnscroll(0,-1,-1,0);        /* Clear the upper window                       */
    wncurmov(10,15);            /* Get the all ready from the user              */
    wnprintf("Press START when you are ready.");
    wnselect(plist);
    wait_for_start();
```

```
        laser_trim();                /* Do the scribing                                  */
        resistor_value[0] = resistor;
        r1 = r2;
        resistor = (float)r1;
        rdpositn();
        double_cut_pos2dist_x = (int)((int)starting_corner_x - (int)xpos +
            (((int)opp_starting_corner_x - (int)adj_starting_corner_x) *
double_cut_ratio/100));
        double_cut_pos2dist_y = (int)((int)starting_corner_y - (int)ypos +
            (((int)opp_starting_corner_y - (int)adj_starting_corner_y) *
double_cut_ratio/100));
        wncurmov(0,2);
        move_norest(double_cut_pos2dist_x, double_cut_pos2dist_y, 4,4);
            wait_for_rest();
        wncurmov(1,2);
        if(stop != 1)
           {
           laser_trim();
           resistor_value[1] = resistor;
           }
            wnselect(plist);             /* Display the current position                 */
            wncurmov(0,2);
            rdpositn();
            wnprintf("Current position: %6li, %6li      ",xpos,ypos);

            wnselect(pwin);
        wncurmov(11,15);
        wnprintf("The first resistance was %12.0f ", resistor_value[0]);
        wncurmov(12,15);
        wnprintf("The final resistance was %12.0f ", resistor_value[1]);
            wncurmov(14,15);             /* See if the user wants another scribe         */
            wnprintf("Do you want to do another double-cut trim? (y/n) ");

            wnquery(selection, 2, &scan);

            if(*selection != 'y'&& *selection != 'Y' )
                choice = 0;
        else
        probe_request();
            }
      break;                         /* When all is done, go back the main menu      */

        case 4:                          /* Option to cut a circle                       */
      while(choice == 4)             /* While the user still wants to scribe         */
            {
        wnscroll(0,-1,-1,0);         /* Clear the upper window                       */
        wnselect(plist);
        wnscroll(0,-1,-1,0);         /* Clear the lower window                       */
        current_resistor();          /* Get the current resistance                   */
        initial_resistor = resistor;
        resistor_corners();          /* Find out where the resistor is               */
        get_wanted_resistor();       /* Figure out what resistance the user wants    */
            r2 = r1;
        r1 = (r2 * (double)turn_after / 100) +
         ((double)initial_resistor * (100 - (double)turn_after)/100);
        resistor = (float)r1;
        wnselect(pwin);
        wnscroll(0,-1,-1,0);         /* Clear the upper window                       */
        wncurmov(10,15);             /* Get the all ready from the user              */
        wnprintf("Press START when you are ready.");
        wnselect(plist);
        wait_for_start();

        laser_trim();                /* Do the scribing                                  */
        resistor_value[0] = resistor;
        r1 = r2;
        resistor = (float)r1;
            x_displace = (int)(opp_starting_corner_x - adj_starting_corner_x);
            y_displace = (int)(opp_starting_corner_y - adj_starting_corner_y);
        if(stop != 1)
        {
        laser_trim();
        resistor_value[1] = resistor;
        }
            wnselect(plist);             /* Display the current position                 */
```

```
        wncurmov(0,2);
        rdpositn();
        wnprintf("Current position: %6li, %6li      ",xpos,ypos);

        wnselect(pwin);
    wncurmov(11,15);
    wnprintf("The first resistance was %12.0f ", resistor_value[0]);
    wncurmov(12,15);
    wnprintf("The final resistance was %12.0f ", resistor_value[1]);
        wncurmov(14,15);            /* See if the user wants another scribe         */
        wnprintf("Do you want to do another L-cut trim? (y/n) ");

        wnquery(selection, 2, &scan);

        if(*selection != 'y'&& *selection != 'Y' )
            choice = 0;
    else
    probe_request();
        }
  break;                        /* When all is done, go back the main menu      */

case 5:                         /* Option to do a serpentine cut                */
  while(choice == 5)            /* While the user still wants to laser trim     */
        {
    wnscroll(0,-1,-1,0);        /* Clear the upper window                       */
    wnselect(plist);
    wnscroll(0,-1,-1,0);        /* Clear the lower window                       */
    current_resistor();         /* Get the current resistance                   */
    initial_resistor = resistor;
    resistor_corners();         /* Find out where the resistor is               */
    get_wanted_resistor();      /* Figure out what resistance the user wants    */
        r2 = r1;
    r1 = (double)((r2 - (double)initial_resistor) / (double)(number_of_serp_cuts))
                + (double)initial_resistor;
    resistor = (float)r1;
    wnselect(pwin);
    wnscroll(0,-1,-1,0);        /* Clear the upper window                       */
    wncurmov(10,15);            /* Get the all ready from the user              */
    wnprintf("Press START when you are ready.");
    wnselect(plist);
    wait_for_start();

    laser_trim();               /* Do the scribing                              */
    resistor_value[0] = resistor;
        wncurmov(0,2);
        rdpositn();
        wnprintf("Current position: %6li, %6li      ",xpos,ypos);
    for( serp_loops = 2; serp_loops != number_of_serp_cuts + 1; serp_loops++)
          {
    r1 = ((r2-(double)initial_resistor) * (double)serp_loops /
         (double)number_of_serp_cuts) + (double)initial_resistor;
    rdpositn();
    resistor = (float)r1;
    rdpositn();
    if(pow(-1,(double)(serp_loops)) == 1)
                {
        serp_cut_pos2dist_x = (int)((int)adj_starting_corner_x - (int)xpos +
               (int)((int)(opp_starting_corner_x - adj_starting_corner_x) *
                          serp_loops / number_of_serp_cuts));
        serp_cut_pos2dist_y = (int)(adj_starting_corner_y - ypos) +
               (int)((int)(opp_starting_corner_y - adj_starting_corner_y) *
                          serp_loops / number_of_serp_cuts);
        }
            else
                {
        serp_cut_pos2dist_x = (int)((int)starting_corner_x - (int)xpos +
               (int)((int)(opp_starting_corner_x - adj_starting_corner_x) *
                          serp_loops / number_of_serp_cuts));
        serp_cut_pos2dist_y = (int)(starting_corner_y - ypos) +
               (int)((int)(opp_starting_corner_y - adj_starting_corner_y) *
                          serp_loops / number_of_serp_cuts);
        }
    move_norest(serp_cut_pos2dist_x, 0, 4,0);
    wait_for_rest();
    move_norest(0, serp_cut_pos2dist_y, 0,4);
            wait_for_rest();
```

```
                x_displace = -1 * x_displace;
                y_displace = -1 * y_displace;
        if(stop != 1)
             laser_trim();
        resistor_value[serp_loops - 1] = resistor;
                }
            wnselect(pwin);
        for(serp_loops = 0; serp_loops != number_of_serp_cuts; serp_loops++)
        {
        wncurmov(13 - number_of_serp_cuts + serp_loops,15);
        wnprintf("The resistance at turn %i was %12.0f ",
                    serp_loops, resistor_value[serp_loops]);
        }
        wncurmov(14,15);            /* See if the user wants another laser trim     */
            wnprintf("Do you want to do another serpentine cut? (y/n) ");

            wnquery(selection, 2, &scan);

            if(*selection != 'y'&& *selection != 'Y' )
                choice = 0;
        else
        probe_request();
            }
      break;                        /* When all is done, go back the main menu      */

    case 6:                         /* Option to do test the measurement system     */
      measure_test_screen();
      measure_test();
      break;

    case 7:                         /* Option to do trim an imbedded resistor       */
      break;
        }
      }

    if (choice == 8)
        change_defaults();
    }
}


/*****************************************************************************************
 *
 *      MODULE:  change_defaults
 *
 *     PURPOSE:  To change the defaults for the different kinds of trims
 *
 *    PARAMETERS:      GLOBL: plist
 *
 *                     LOCAL: okay              - Prompt variable for another trim
 *
 *                     USERS: main
 *
 *                     CALLS: wncurmov           wnprintf
 *
 *     RETURNS:  NONE
 *
 *        DATE:  26 October 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void change_defaults(void)
{
  int choice;
  char numbers[6];

    wnselect(pwin);
    wnscroll(0,-1,-1,0);                /* Clear the upper screen                       */
                                        /* Display the main menu                        */
```

```
wncurmov(2,10);
wnprintf(" 1. Trim speed                                    ");
wncurmov(3,10);
wnprintf(" 2. Double-cut or L-cut turn percentage           ");
wncurmov(4,10);
wnprintf(" 3. Second cut (Double-cut) percentage distance   ");
wncurmov(5,10);
wnprintf(" 4. Perpendicular cuts - abort distance           ");
wncurmov(6,10);
wnprintf(" 5. Adjacent (parallel) cuts - abort distance     ");
wncurmov(7,10);
wnprintf(" 6. Number of serpentine cuts                     ");
wncurmov(8,10);
wnprintf(" 7. Restore defaults                              ");
wncurmov(10,10);
wnprintf(" 9. Return to Laser Menu");

choice = 0;
while(choice != 9)
{
wncurmov(2,60);
wnprintf("%4f", trim_speed);
wncurmov(3,62);
wnprintf("%3i", turn_after);
wncurmov(4,62);
wnprintf("%3i", double_cut_ratio);
wncurmov(5,60);
wnprintf("%5i", abort_dist_straight);
wncurmov(6,60);
wnprintf("%5i", abort_dist_lcut);
wncurmov(7,63);
wnprintf("%2i", number_of_serp_cuts);

wncurmov(12,20);
wnprintf("Option:  ");
wncurmov(12,28);
wnquery(selection, 2, &scan);        /*  Get the users selection                    */
                                     /*  Translate the possibilities into one number */
if(*selection == 't'|| *selection == 'T' || *selection == 49)
    choice = 1;

if(*selection == 'd'|| *selection == 'D' || *selection == 50)
    choice = 2;

if(*selection == 's'|| *selection == 'S' || *selection == 51)
    choice = 3;

if(*selection == 'p'|| *selection == 'P' || *selection == 52)
    choice = 4;

if(*selection == 'a'|| *selection == 'A' || *selection == 53)
    choice = 5;

if(*selection == 'n'|| *selection == 'N' || *selection == 54)
    choice = 6;

if(*selection == 'r'|| *selection == 'R' || *selection == 55)
    choice = 7;

if(*selection == 'e'|| *selection == 'E' || *selection == 57)
    choice = 9;

 switch(choice)                      /* Jump to the correct set of commands          */
    {
case 1:                          /* Option to move a distance                    */
   trim_speed = 100;
   while( trim_speed < 0 || trim_speed > 4)
       {
       wncurmov(15,10);          /* Get the first probe number                   */
       wnprintf("Enter the trimming speed (between .125 and 4): ");
       wnquery(numbers,5,&scan);
       trim_speed = transform(numbers);   /* Transform the first probe number    */
       }
   wncurmov(2,60);
   wnprintf("%4f",trim_speed);
   wncurmov(15,10);              /* Clear out the question area                  */
```

```
   wnprintf("                                                                  ");
   break;                        /* When all is done, go back to the main menu   */

case 2:                          /* Option to move a distance                    */
   turn_after = 999;
   while( turn_after < 20 || turn_after > 100)
      {
      wncurmov(15,10);           /* Get the first probe number                   */
      wnprintf("Enter the percentage of final value ");
      wncurmov(16,10);
      wnprintf("  to turn at (between 20 and 100): ");
      wnquery(numbers,4,&scan);
      turn_after = (int)(transform(numbers));  /* Transform the 1st probe number */
      }
   wncurmov(3,62);
   wnprintf("%3i",turn_after);
   wncurmov(15,10);              /* Clear out the question area                  */
   wnprintf("                                                                  ");
   wncurmov(16,10);              /* Clear out the question area                  */
   wnprintf("                                                                  ");
   break;                        /* When all is done, go back to the main menu   */

case 3:                          /* Option to move a distance                    */
   double_cut_ratio = 999;
   while( double_cut_ratio < 0 || double_cut_ratio > 100)
      {
      wncurmov(15,10);           /* Get the first probe number                   */
      wnprintf("    Enter the percentage of distance ");
      wncurmov(16,10);
      wnprintf("to turn for 2nd cut (between 0 and 100): ");
      wnquery(numbers,4,&scan);
      double_cut_ratio = (int)(transform(numbers));
      }
   wncurmov(4,62);
   wnprintf("%3i",double_cut_ratio);
   wncurmov(15,10);              /* Clear out the question area                  */
   wnprintf("                                                                  ");
   wncurmov(16,10);              /* Clear out the question area                  */
   wnprintf("                                                                  ");
   break;                        /* When all is done, go back to the main menu   */

case 4:                          /* Option to move a distance                    */
   abort_dist_straight = 0;
   while( abort_dist_straight < 1)
      {
      wncurmov(15,10);           /* Get the first probe number                   */
      wnprintf("Enter the abort distance from approaching side: ");
      wnquery(numbers,6,&scan);
      abort_dist_straight = (int)(transform(numbers));
                        /* Transform the first probe number             */
      }
   wncurmov(5,60);
   wnprintf("%5i",abort_dist_straight);
   wncurmov(15,10);              /* Clear out the question area                  */
   wnprintf("                                                                  ");
   break;                        /* When all is done, go back to the main menu   */

case 5:                          /* Option to move a distance                    */
   abort_dist_lcut = 0;
   while( abort_dist_lcut < 1)
      {
      wncurmov(15,10);           /* Get the first probe number                   */
      wnprintf("Enter the abort distance from approaching resistor pad: ");
      wnquery(numbers,6,&scan);
      abort_dist_lcut = (int)(transform(numbers));
                        /* Transform the first probe number             */
      }
   wncurmov(6,60);
   wnprintf("%5i",abort_dist_lcut);
   wncurmov(15,10);              /* Clear out the question area                  */
   wnprintf("                                                                  ");
   break;                        /* When all is done, go back to the main menu   */

case 6:                          /* Option to move a distance                    */
   number_of_serp_cuts = 999;
   while( number_of_serp_cuts < 1 || number_of_serp_cuts > 20)
```

```
        {
        wncurmov(15,10);            /* Get the first probe number                    */
        wnprintf("Enter the number of serpentine cuts (between 1 and 20): ");
        wnquery(numbers,3,&scan);
        number_of_serp_cuts = (int)(transform(numbers));
                                /* Transform the first probe number             */
        }
      wncurmov(7,63);
      wnprintf("%2i", number_of_serp_cuts);
      wncurmov(15,10);              /* Clear out the question area                   */
      wnprintf("                                                                    ");
      break;                        /* When all is done, go back to the main menu    */

       case 7:
      number_of_serp_cuts = 5;
      abort_dist_lcut = 50;
      abort_dist_straight = 50;
      double_cut_ratio = 20;
      turn_after = 80;
      trim_speed = 0.125;
      break;
       }
    }
}



/*****************************************************************************************
 *
 *      MODULE:  measure_test_screen
 *
 *     PURPOSE:  To make the basic screen for testing with the measurement system
 *
 *    PARAMETERS:      GLOBL: plist
 *
 *                     LOCAL: okay              - Prompt variable for another trim
 *
 *                     USERS: main
 *
 *                     CALLS: wncurmov           wnprintf
 *
 *     RETURNS:  NONE
 *
 *        DATE:  26 October 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void measure_test_screen(void)
{
    wnselect(pwin);
    wnscroll(0,-1,-1,0);                /* Clear the upper screen                        */
                                        /* Display the main menu                         */
    wncurmov(1,10);
    wnprintf(" 1. Define test values");
    wncurmov(2,10);
    wnprintf("                    A Probe                 ");
    wncurmov(3,10);
    wnprintf("                    B Probe                 ");
    wncurmov(4,10);
    wnprintf("                    Test Resistance Value   ");
    wncurmov(5,10);
    wnprintf("                    Range                   ");
    wncurmov(6,10);
    wnprintf("                    Standard                ");
    wncurmov(7,10);
    wnprintf("                    Generator Voltage       ");
    wncurmov(8,10);
    wnprintf("                    Detectors Voltage       ");
    wncurmov(9,10);
```

```
    wnprintf("                    Pre-amp gain (1 or 8)   ");
    wncurmov(10,10);
    wnprintf("                    Comparator value        ");
    wncurmov(11,10);
    wnprintf("                    Delay                   ");
    wncurmov(12,10);
    wnprintf(" 2. Strobe the measurement system");
    wncurmov(13,10);
    wnprintf(" 3. Clear the overload flag");
    wncurmov(14,10);
    wnprintf(" 4. Find the unknown resistance");
    wncurmov(15,20);
    wnprintf(" 9. Return to Main Menu");
    wncurmov(17,20);
    wnprintf("Option:  ");
    wncurmov(17,28);

}



/*****************************************************************************************
 *
 *      MODULE:  measure_test
 *
 *     PURPOSE:  To play with the measurement system
 *
 *    PARAMETERS:      GLOBL: aprobe              bprobe
 *                            convertor           end_conv
 *                            gain                gen_volt
 *                            overload            plist
 *                            posx                posy
 *                            pre_amp             pwin
 *                            range               resistor
 *                            scan                standard
 *                            xpos                ypos
 *                            r1                  selection
 *                            x_displace          y_displace
 *
 *                      LOCAL: okay               - Prompt variable for another trim
 *                            numbers             - Character buffer for numeric input
 *
 *                      USERS: main
 *
 *                      CALLS: wncurmov           wnprintf
 *                            wnquery             channela
 *                            channelb            findme
 *                            wnscroll            scanf
 *                            arange              strobe
 *                            clrol               rdconvert
 *                            rdoverload          joymove
 *                            rdpositn            wnselect
 *                            move_dist           pre_gain
 *                            agen_volt           detect_gain
 *                            skend_conv          disable_lim_cro
 *                            laser_on            move_norest
 *                            laser_off
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void measure_test(void)
{
  int okay, choice;
  char numbers[14];
```

```
    choice = 0;
    while(choice != 9)
    {
    measure_test_screen();
    display_feedback();
    wncurmov(17,20);
    wnprintf("Option:  ");
    wncurmov(17,28);
    wnquery(selection, 2, &scan);        /*  Get the users selection                    */
                                         /*  Translate the possibilities into one number */
    if(*selection == 'd'|| *selection == 'D' || *selection == 49)
        choice = 1;

    if(*selection == 's'|| *selection == 'S' || *selection == 50)
        choice = 2;

    if(*selection == 'c'|| *selection == 'C' || *selection == 51)
        choice = 3;

    if(*selection == 'f'|| *selection == 'F' || *selection == 52)
        choice = 4;

    if(*selection == 'e'|| *selection == 'E' || *selection == 57)
        choice = 9;

    if(choice > 0 && choice < 5)
      {
      if (aprobe == 999 || bprobe == 999)
    probe_request();
      else
    confirm_probes();

      switch(choice)                     /* Jump to the correct set of commands          */
        {
        case 1:                          /* Option to move a distance                    */
       measure_test_screen();
       change_measure_test_values();
       break;                        /* When all is done, go back to the main menu   */

        case 2:                          /* Option to move a distance                    */
       strobe();
       break;                        /* When all is done, go back to the main menu   */

        case 3:                          /* Option to move a distance                    */
       clrol();
       break;                        /* When all is done, go back to the main menu   */

        case 4:                          /* Option to move a distance                    */
       findme();
       r1 = resistor;
       arange();
       break;                        /* When all is done, go back to the main menu   */
        }
      }
    }

    wnselect(plist);
    wnscroll(0,-1,-1,0);                 /* Clear the lower window                       */
    wnselect(pwin);

}




/*****************************************************************************************
 *
 *      MODULE:  change_measure_test_values
 *
 *     PURPOSE:  To play with the measurement system
 *
 *    PARAMETERS:      GLOBL: aprobe              bprobe
 *                            convertor            end_conv
 *                            gain                 gen_volt
```

```
 *                          overload          plist
 *                          posx              posy
 *                          pre_amp           pwin
 *                          range             resistor
 *                          scan              standard
 *                          xpos              ypos
 *                          r1                selection
 *                          x_displace        y_displace
 *
 *                    LOCAL: okay             - Prompt variable for another trim
 *                           numbers          - Character buffer for numeric input
 *
 *                    USERS: main
 *
 *                    CALLS: wncurmov          wnprintf
 *                           wnquery           channela
 *                           channelb          findme
 *                           wnscroll          scanf
 *                           arange            strobe
 *                           clrol             rdconvert
 *                           rdoverload        joymove
 *                           rdpositn          wnselect
 *                           move_dist         pre_gain
 *                           agen_volt         detect_gain
 *                           skend_conv        disable_lim_cro
 *                           laser_on          move_norest
 *                           laser_off
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 ******************************************************************************************/

void change_measure_test_values(void)
{
  int  okay, choice;
  char numbers[14];


    wncurmov(1,10);
    wnprintf("    ");
    wncurmov(2,10);
    wnprintf("          1. Change");
    wncurmov(3,10);
    wnprintf("          2. Change");
    wncurmov(4,10);
    wnprintf("          3. Change");
    wncurmov(7,10);
    wnprintf("          4. Change");
    wncurmov(8,10);
    wnprintf("          5. Change");
    wncurmov(9,10);
    wnprintf("          6. Change");
    wncurmov(10,10);
    wnprintf("          7. Change");
    wncurmov(11,10);
    wnprintf("          8. Change");
    wncurmov(12,10);
    wnprintf("    ");
    wncurmov(13,10);
    wnprintf("    ");
    wncurmov(14,10);
    wnprintf("    ");
    wncurmov(15,20);
    wnprintf(" 9. Exit test value definitions");
                                        /*  Translate the possibilities into one number */
    while(choice != 9)
    {
    wncurmov(17,20);
```

```
wnprintf("Option:  ");
wncurmov(17,28);
wnquery(selection, 2, &scan);        /*  Get the users selection                    */
                                     /*  Translate the possibilities into one number */
if(*selection == 'g'|| *selection == 'G' || *selection == 49)
    choice = 1;

if(*selection == 's'|| *selection == 'S' || *selection == 50)
    choice = 2;

if(*selection == 'd'|| *selection == 'D' || *selection == 51)
    choice = 3;

if(*selection == 'l'|| *selection == 'L' || *selection == 52)
    choice = 4;

if(*selection == 'm'|| *selection == 'M' || *selection == 53)
    choice = 5;

if(*selection == 't'|| *selection == 'T' || *selection == 54)
    choice = 6;

if(*selection == 'i'|| *selection == 'I' || *selection == 55)
    choice = 7;

if(*selection == 'c'|| *selection == 'C' || *selection == 56)
    choice = 8;

if(*selection == 'e'|| *selection == 'E' || *selection == 57)
    choice = 9;

if(choice > 0 && choice < 8)
  {
  switch(choice)                     /* Jump to the correct set of commands          */
    {
    case 1:                          /* Option to move a distance                    */
    aprobe = 999;
    while( aprobe < 0 || aprobe > 40)
        {
    wncurmov(17,10);             /* Get the first probe number                   */
    wnprintf("Enter the A probe number (between 1 and 40): ");
        wnquery(numbers,3,&scan);
        aprobe = (int)(transform(numbers));
                                     /* Transform the first probe number             */
        }
    channela();
wncurmov(3,60);
    wnprintf("%2i",aprobe);
wncurmov(17,10);             /* Get the first probe number                   */
wnprintf("                                                                  ");
    break;                           /* When all is done, go back to the main menu   */

    case 2:                          /* Option to move a distance                    */
    bprobe = 999;
    while( bprobe < 0 || bprobe > 40)
        {
    wncurmov(17,10);             /* Get the first probe number                   */
        wnprintf("Enter the B probe number (between 1 and 40)");
        wnquery(numbers,3,&scan);
        bprobe = (int)(transform(numbers));
                                     /* Transform the first probe number             */
        }
    channelb();
wncurmov(4,60);
    wnprintf("%2i",bprobe);
wncurmov(17,10);             /* Get the first probe number                   */
wnprintf("                                                                  ");
    break;                           /* When all is done, go back to the main menu   */

    case 3:                          /* Option to move a distance                    */
resistor = 0;
while( resistor == 0 )
        {
    wncurmov(17,10);             /* Get the first probe number                   */
        wnprintf("Enter the Resistor value to compare against");
        wnquery(numbers,14,&scan);
```

```
        resistor = transform(numbers);
                                    /* Transform the first probe number              */
        }
    r1 = resistor;
    arange;
wncurmov(5,59);
    wnprintf("%-12.0f",resistor);
wncurmov(6,61);
    wnprintf("%1i",range);
    wncurmov(7,54);
    wnprintf("%13.12f",standard);
wncurmov(17,10);            /* Get the first probe number                    */
wnprintf("                                                          ");
    break;                          /* When all is done, go back to the main menu   */

    case 4:                         /* Option to move a distance                    */
gen_volt = 100;
    while( gen_volt > 8 || gen_volt < -8 )
        {
    wncurmov(17,8);             /* Get the first probe number                   */
        wnprintf("Enter the Generator voltage (+/- .125, .25, .5, 1, ..., 8) ");
        wnquery(numbers,7,&scan);
        gen_volt = transform(numbers);
                                    /* Transform the first probe number              */
        }
    agen_volt();
wncurmov(8,57);
    wnprintf("%+7.3f",gen_volt);
wncurmov(17,10);            /* Get the first probe number                    */
wnprintf("                                                          ");
    break;                          /* When all is done, go back to the main menu   */

    case 5:                         /* Option to move a distance                    */
gain = 513;
    while( gain < 0 || gain > 512 )
        {
    wncurmov(17,10);            /* Get the first probe number                   */
        wnprintf("Enter the detector gain (0 to 511.875)");
        wnquery(numbers,7,&scan);
        gain = transform(numbers);  /* Transform the first probe number              */
        }
    detect_gain();
wncurmov(9,57);
    wnprintf("%7.3f",gain);
wncurmov(17,10);            /* Get the first probe number                    */
wnprintf("                                                          ");
    break;                          /* When all is done, go back to the main menu   */

    case 6:                         /* Option to move a distance                    */
pre_amp = 9;
    while( pre_amp != 1 || pre_amp != 8)
        {
    wncurmov(17,10);            /* Get the first probe number                   */
    wnprintf("Enter the Pre-amp gain ( 1 or 8 )");
        wnquery(numbers,2,&scan);
        pre_amp = (int)(transform(numbers));
                                    /* Transform the first probe number              */
        }
    pre_gain();
wncurmov(10,61);
    wnprintf("%1i",pre_amp);
wncurmov(17,10);            /* Get the first probe number                    */
wnprintf("                                                          ");
    break;                          /* When all is done, go back to the main menu   */

    case 7:                         /* Option to move a distance                    */
    compare = -1;
    while( compare < 0 || compare > 4095)
        {
    wncurmov(17,10);            /* Get the first probe number                   */
        wnprintf("Enter the Comparator value ( 0 to 4095)");
        wnquery(numbers,5,&scan);
        compare = (int)(transform(numbers));
                                    /* Transform the first probe number              */
        }
    acomparator();
```

```
    wncurmov(11,58);
        wnprintf("%4u",compare);
    wncurmov(17,10);            /* Get the first probe number                    */
    wnprintf("                                                              ");
        break;                          /* When all is done, go back to the main menu   */

        case 8:                         /* Option to move a distance                    */
        delay = -1;
        while( delay < 0 )
            {
        wncurmov(17,10);            /* Get the first probe number                    */
            wnprintf("Enter the measurement delay time");
            wnquery(numbers,5,&scan);
            delay = (int)(transform(numbers));
                                        /* Transform the first probe number             */
            }
    wncurmov(12,58);
        wnprintf("%4u",delay);
    wncurmov(17,10);            /* Get the first probe number                    */
    wnprintf("                                                              ");
        break;                          /* When all is done, go back to the main menu   */
        }
      display_feedback();
      }
    }
}



/*****************************************************************************************
 *
 *      MODULE:  display_feedback
 *
 *     PURPOSE:  To display the measurement system feedback in the bottom window
 *
 *    PARAMETERS:      GLOBL: aprobe            bprobe
 *                            convertor         end_conv
 *                            gain              gen_volt
 *                            overload          plist
 *                            posx              posy
 *                            pre_amp           pwin
 *                            range             resistor
 *                            scan              standard
 *                            xpos              ypos
 *                            r1                selection
 *                            x_displace        y_displace
 *
 *                     LOCAL: okay              - Prompt variable for another trim
 *                            numbers           - Character buffer for numeric input
 *
 *                     USERS: main
 *
 *                     CALLS: wncurmov          wnprintf
 *                            wnquery           channela
 *                            channelb          findme
 *                            wnscroll          scanf
 *                            arange            strobe
 *                            clrol             rdconvert
 *                            rdoverload        joymove
 *                            rdpositn          wnselect
 *                            move_dist         pre_gain
 *                            agen_volt         detect_gain
 *                            skend_conv        disable_lim_cro
 *                            laser_on          move_norest
 *                            laser_off
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
```

```
 *
 ****************************************************************************************/

void display_feedback(void)
{
  int  okay;

  wncurmov(2,60);
  wnprintf("%2i",aprobe);
  wncurmov(3,60);
  wnprintf("%2i",bprobe);
  wncurmov(4,59);
  wnprintf("%-12.0f",resistor);
  wncurmov(5,61);
  wnprintf("%1i",range);
  wncurmov(6,54);
  wnprintf("%13.12f",standard);
  wncurmov(7,57);
  wnprintf("%+7.3f",gen_volt);
  wncurmov(8,57);
  wnprintf("%7.3f",gain);
  wncurmov(9,61);
  wnprintf("%1i",pre_amp);
  wncurmov(10,58);
  wnprintf("%4u",compare);
  wncurmov(11,58);
  wnprintf("%4u",delay);

  okay = 0;
  wnselect(plist);
  wnscroll(0,-1,-1,0);                    /* Clear the lower window                    */
  while(okay == 0)
    {
    okay =1;

    rdconvert();
    wncurmov(0,5);
    wnprintf("Convertor  %i",convertor);

   rdoverload();
    wncurmov(1,5);
    wnprintf("Overload  %i",overload);

    skend_conv();
    wncurmov(2,5);
    wnprintf("End Convertion : ");
    if(end_conv != 0)
        {
        wnprintf(" WAIT ");
        okay = 0;
        }
    else
        wnprintf(" Ready ");

    skend_delay();
    wncurmov(0,35);
    wnprintf("End Delay      : ");
    if(end_delay != 0)
        {
        wnprintf(" WAIT ");
        okay = 0;
        }
    else
        wnprintf(" Ready ");

    skready();
    wncurmov(1,35);
    wnprintf("Ready Flag     : ");
    if(ready != 0)
        {
        wnprintf(" WAIT ");
        okay = 0;
        }
    else
        wnprintf(" Ready ");
```

```
    skstrobe();
    wncurmov(2,35);
    wnprintf("Strobe Done    : ");
    if(strobe_done != 0)
        {
        wnprintf(" WAIT ");
        okay = 0;
        }
    else
        wnprintf(" Ready ");
    }
  wnselect(pwin);

}



/*****************************************************************************************
 *
 *      MODULE:  laser_trim
 *
 *     PURPOSE:  To perform a resistor trim
 *
 *    PARAMETERS:      GLOBL: aprobe              bprobe
 *                            convertor           end_conv
 *                            gain                gen_volt
 *                            overload            plist
 *                            posx                posy
 *                            pre_amp             pwin
 *                            range               resistor
 *                            scan                standard
 *                            xpos                ypos
 *                            r1                  selection
 *                            x_displace          y_displace
 *
 *                      LOCAL: okay               - Prompt variable for another trim
 *                            numbers             - Character buffer for numeric input
 *
 *                      USERS: main
 *
 *                      CALLS: wncurmov           wnprintf
 *                            wnquery             channela
 *                            channelb            findme
 *                            wnscroll            scanf
 *                            arange              strobe
 *                            clrol               rdconvert
 *                            rdoverload          joymove
 *                            rdpositn            wnselect
 *                            move_dist           pre_gain
 *                            agen_volt           detect_gain
 *                            skend_conv          disable_lim_cro
 *                            laser_on            move_norest
 *                            laser_off
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void laser_trim(void)
{
  int  okay;
  char numbers[14];

  stop = 0;
  r1 = resistor;                        /* Store the value to trim to                  */
  arange();                             /* Send the value to the laser                 */
  strobe();                             /* Strobe and clear the system for setup       */
```

```
  clrol();
  rdconvert();                          /* Get the measurement system feedback          */
  rdoverload();

  pre_amp = 1;                          /* Set and send the pre-amp gain value (1 or 8) */
  pre_gain();
  gain = 1;                             /* Set and send the detector gain               */
  detect_gain();
  gen_volt = 8;                         /* Set and send the generator voltage           */
  agen_volt();
  strobe();                             /* Strobe and clear the system for setup       */
  clrol();

  skend_conv();                         /* Wait for the measurement system to finish    */
  while(end_conv != 0 )
    {
    skend_conv();
    }

 rdconvert();                           /* Get the measurement system feedback          */
 rdoverload();

/* wnselect(plist);                       /* Display the current values and feedback      */
/* wncurmov(1,25);
 wnprintf("Resistor=%10.0f Range=%i Stand=%.8f",r1,range,standard);
 wncurmov(2,25);
 wnprintf("Generator volt=%2.0f Gain=%3.0f",gen_volt,gain);
 wncurmov(3,25);
 wnprintf("Convert=%i Overload=%x",convertor,overload);
*/

 gain = .5;

 disable_lim_cro();                     /* Disable the comparator laser interupt        */
 laser_on();                            /* Turn on the laser                            */

 move_norest(x_displace, y_displace, trim_speed, trim_speed);
/* Start moving into the resistor                */

 while(gain != 4 && stop != 1)          /* While we are not in range with a high gain   */
   {
   if(check_for_stop() == 1)            /* Check the stop button                        */
      {                                 /* If STOP button, turn off the laser, stop     */
      laser_off();                      /*   moving, reset laser status flag, and       */
      move_norest(0,0,0,0);
      stop = 1;                         /*   return with an error flag.                 */
      }
   gain = gain * 2;                     /*  Adjust and send the gain                    */
   detect_gain();
   strobe();                            /*  Strobe and clear the system for setup       */
   clrol();
   skend_conv();                        /* Wait for the measurement system to finish    */
   while(end_conv != 0 )
      skend_conv();
   rdoverload();                        /* Get the measurement system feedback          */
   rdconvert();
   while(overload != 0x8ff)             /* While we are out of range                    */
     {
     clrol();
                                        /*                                              */
     skend_conv();                      /* Wait for the measurement system to finish    */
     while(end_conv != 0 )
     skend_conv();
     rdoverload();                      /* Get the measurement system feedback          */
     rdconvert();
     if(check_for_stop() == 1)          /* Check the stop button                        */
    {                               /* If STOP button, turn off the laser, stop     */
    laser_off();                    /*   moving, reset laser status flag, and       */
    move_norest(0,0,0,0);
    stop = 1;                       /*   return with an error flag.                 */
    overload = 0x8ff;
    }
     }                                  /* See if we are in range yet                   */
   }                                    /* See if we are at a high gain                 */

 clrol();                               /* Clear the system overload                    */
```

```
 if(stop == 0)
     {
     skend_conv();                        /* Wait for the measurement system to finish    */
     while(end_conv != 0 )
    skend_conv();
     rdconvert();                         /* Get the measurement system feedback          */
     }
 else
     convertor = 0;

 while(convertor < -300)                  /* While we are not within tolerance            */
     {
     clrol();                             /* Clear the system overload                    */
     skend_conv();                        /* Wait for the measurement system to finish    */
     while(end_conv != 0)
     skend_conv();
     rdconvert();                         /* Get the measurement system feedback          */
     if(check_for_stop() == 1)            /* Check the stop button                        */
    {                                 /* If STOP button,                              */
    stop = 1;                         /*   return with an error flag.                 */
    convertor = 0;
    }
     }                                    /* See if we are within tolerance               */

 laser_off();                             /* Turn off the laser                          */

 move_norest(0,0,0,0);                    /* STOP MOVING                                  */

 findme();                                /* Get the current resistance                   */
 }


/*****************************************************************************************
 *
 *      MODULE:  probe_request
 *
 *     PURPOSE:  To set the probes that the resistor is across
 *
 *    PARAMETERS:      GLOBL: aprobe            bprobe
 *                            scan
 *
 *                     LOCAL: numbers          - Character buffer for numeric input
 *
 *                     USERS: laser_menu
 *
 *                     CALLS: wncurmov          wnprintf
 *                            wnquery           channela
 *                            channelb          transform
 *                            wnscroll
 *
 *     RETURNS:  NONE
 *
 *        DATE:  18 September 1991
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 4.1
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void probe_request(void)
{
  char numbers[14];

  wnscroll(0,-1,-1,0);                    /* Clear the upper screen                       */
  wncurmov(8,15);                         /* Get the first probe number                   */
  wnprintf("Enter the A probe number:");
  wnquery(numbers,3,&scan);

  aprobe = (int)(transform(numbers));     /* Transform the first probe number             */

  wncurmov(10,15);                         /* Get the second probe number                 */
```

```
  wnprintf("Enter the B probe number:");
  wnquery(numbers,3,&scan);

  bprobe = (int)(transform(numbers));   /* Transform the second probe number          */

  channela();                           /* Send the numbers to the system             */
  channelb();

 wnselect(plist);                       /* Display the current values and feedback    */
 wncurmov(0,5);
 wnprintf("Probe A: %i",aprobe);
 wncurmov(1,5);
 wnprintf("Probe B: %i",bprobe);

 wnselect(pwin);
}


/*****************************************************************************************
 *
 *      MODULE:  confirm_probes
 *
 *     PURPOSE:  Check that the right probes are being tested
 *
 *    PARAMETERS:      GLOBL: aprobe              bprobe
 *                            scan               selection
 *
 *                     LOCAL: okay              - Loop until user is happy with the probes
 *
 *                     USERS: laser_menu
 *
 *                     CALLS: wncurmov            wnprintf
 *                            wnquery             wnscroll
 *                            probe_request
 *
 *     RETURNS:  NONE
 *
 *        DATE:  18 September 1991
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 4.1
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void confirm_probes(void)
{
 int okay;

 okay = 0;

 while(okay == 0)
    {
    wnscroll(0,-1,-1,0);                /* Clear the upper window                     */
    wncurmov(3,22);
    wnprintf("The probes are currently set at:");
    wncurmov(8,35);
    wnprintf("Probe A: %i", aprobe);
    wncurmov(9,35);
    wnprintf("Probe B: %i", bprobe);
    wncurmov(13,15);
    wnprintf("Are you sure that these are the right probes? (y/n)");

    wnquery(selection, 2, &scan);       /*  Get the users selection                   */

    if(*selection != 'y'&& *selection != 'Y' )
     probe_request();
    else
     okay = 1;
    }
}
```

```
/*****************************************************************************************
 *
 *      MODULE:  current_resistor
 *
 *     PURPOSE:  Check that the right probes are being tested
 *
 *    PARAMETERS:      GLOBL: r1                  resistor
 *
 *                     LOCAL: NONE
 *
 *                     USERS: laser_menu
 *
 *                     CALLS: wncurmov            wnprintf
 *                            wnselect            findme
 *
 *     RETURNS:  NONE
 *
 *        DATE:  18 September 1991
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 4.1
 *
 *     DATE      INITIALS                     MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void current_resistor(void)
{
  findme();                              /* Get the resistors current value              */
  r1 = resistor;

  wnselect(plist);
  wncurmov(2,5);                         /* Display the current resistance               */
  wnprintf("The current resistance is %.0f",r1);
  wnselect(pwin);

}
```

```
/*****************************************************************************************
 *
 *      MODULE:  resistor_corners
 *
 *     PURPOSE:  Check that the right probes are being tested
 *
 *    PARAMETERS:      GLOBL: starting_corner(x,y)      opp_starting_corner(x,y)
 *                            adj_starting_corner(x,y)  selection
 *                            scan
 *
 *                     LOCAL: okay              - Prompt variable for another trim
 *
 *                     USERS: laser_menu
 *
 *                     CALLS: wncurmov            wnprintf
 *                            wnselect            wnscroll
 *                            joymove             rdpositn
 *                            abs                 wnquery
 *                            move_dist
 *
 *
 *     RETURNS:  NONE
 *
 *        DATE:  18 September 1991
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 4.1
 *
 *     DATE      INITIALS                     MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
```

```
 *
 ****************************************************************************************/

void resistor_corners(void)
{
 int okay, scan;
 char selection[2];

 okay = 0;
 while(okay == 0)
    {
    wnselect(pwin);
    wnscroll(0, -1, -1, 0);
    wncurmov(5,15);                        /* Tell the user to use the joy to go to pos 1  */
    wnprintf("       Use the joystick to move to the corner     ");
    wncurmov(6,15);
    wnprintf("        you want the laser to first cut into.     ");
    wncurmov(8,15);
    wnprintf(" Use the laser panel button to load the position. ");
    wncurmov(12,15);
    wnprintf(" You will have a chance to change wrong positions ");
    wncurmov(13,15);
    wnprintf("         after all have been entered.             ");

    joymove();                             /* Let the user use the joystick                */

    rdpositn();                            /* Store the current position as pos 1.         */
    starting_corner_x = xpos;
    starting_corner_y = ypos;

    wnselect(plist);                       /* Display the first position.                  */
    wncurmov(0,40);
    wnprintf("    Position #1: %6li, %6li", starting_corner_x, starting_corner_y);

    wnselect(pwin);                        /* Tell the user to use the joy to go to pos 2. */
    wncurmov(5,15);
    wnprintf("     Use the joystick to move to the position     ");
    wncurmov(6,15);
    wnprintf("           directly across the resistor.          ");

    joymove();                             /* Let the user use the joystick                */

    rdpositn();                            /* Store the current position as pos 2          */
    adj_starting_corner_x = xpos;
    adj_starting_corner_y = ypos;

    wnselect(plist);                       /* Display the first position.                  */
    wncurmov(1,40);
    wnprintf("    Position #2: %6li, %6li", adj_starting_corner_x, adj_starting_corner_y);

    x_displace = (int)(adj_starting_corner_x - starting_corner_x);
                                           /* Check if the positions are okay              */
    y_displace = (int)(adj_starting_corner_y - starting_corner_y);

    wnselect(pwin);                        /* Tell the user to use the joy to go to pos 2. */

    if(abs(x_displace) > 10 && abs(y_displace) > 10)
      {
      wnscroll(0,-1,-1,0);                 /* Clear the upper window                       */
      wncurmov(8,15);
      wnprintf("  Adjust the base so that the cutting direction ");
      wncurmov(9,15);
      wnprintf("        is either horizontal or vertical.       ");
      wncurmov(12,15);
      wnprintf("  Press ENTER when the base has been adjusted   ");
      wnquery(selection,2,&scan);
      }
   else
      {
      wncurmov(5,15);
      wnprintf("    Use the joystick to move to the position    ");
      wncurmov(6,15);
      wnprintf("        catty-corner to the first corner.       ");

      joymove();                           /* Let the user use the joystick                */
```

```
      rdpositn();                        /* Store the current position as pos 2          */
      opp_starting_corner_x = xpos;
      opp_starting_corner_y = ypos;

      wnselect(plist);                   /* Display the first position.                  */
      wncurmov(2,40);
      wnprintf("    Position #3: %6li, %6li",
               opp_starting_corner_x, opp_starting_corner_y);

      wnselect(pwin);                    /* Ask the user if the positions are okay       */
      wnscroll(0,-1,-1,0);               /* Clear the upper window                       */
      wncurmov(5,5);
      wnprintf("Are these positions correct? (y/n)");

      wnquery(selection,2,&scan);

      if(*selection == 'y'|| *selection == 'Y')   /* If user says okay, set the flag    */
         okay = 1;
      }
    }


                                         /* Move back to the first position              */
 move_dist(-1*(int)(opp_starting_corner_x - starting_corner_x),
       -1*(int)(opp_starting_corner_y - starting_corner_y), 8, 8);

}




/*****************************************************************************************
 *
 *      MODULE:  get_wanted_resistor
 *
 *     PURPOSE:  Get the value that the user wats the resistor trimmed to
 *
 *    PARAMETERS:      GLOBL: r1                 resistor
 *
 *                     LOCAL: NONE
 *
 *                     USERS: laser_menu
 *
 *                     CALLS: wncurmov           wnprintf
 *                            wnselect           findme
 *
 *     RETURNS:  NONE
 *
 *        DATE:  18 September 1991
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 4.1
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------------------
 *
 *****************************************************************************************/

void get_wanted_resistor(void)
{
  int okay;
  char numbers[14];

  findme();                              /* Get the resistors current value              */
  r1 = resistor;

  okay = 0;                              /* Asumme that the inputted value is incorrect  */
  while(okay == 0)                       /* While the value is incorrect                 */
    {
     wnselect(pwin);
     wnscroll(0,-1,-1,0);                /* Clear the upper window                       */
     wncurmov(5,5);                      /* Display the current resistance               */
     wnprintf("The current resistance is %.0f",r1);
     wncurmov(8,8);                      /* Tell the user to value to trim to            */
     wnprintf("What resistance would you like it to be?");
```

```
    wnquery(numbers,14,&scan);
    resistor = transform(numbers);      /* Transform the resistance to a number         */
    if( resistor < r1)                  /* If the resistor is greater than the value    */
      {                                 /*   that the user wants to trim to.            */
      wncurmov(10,5);                   /*   Tell the user that it isn't possible       */
      wnprintf("You can not get that resistance from this resistor!!!");
      wncurmov(11,6);
      wnprintf("Press ENTER to continue");
      wnquery(selection,2,&scan);
      }
    else                                /* Otherwise all the values are okay            */
      okay = 1;
   }                                    /* Check to see if all the values are correct   */

r1 = (double)resistor;

}
```

```
/*****************************************************************************************
 *
                        MEASINCD.C
 *
 *****************************************************************************************/

#include <stdlib.h>
#include <conio.h>
#include <dos.h>
#include <stdio.h>                  /* Include Standard I/O for testing*/
#include <string.h>                    /* Include string manipulation  */
#include <float.h>
#include <math.h>
#include <bwindow.h>
#include <measincd.h>
#include <moveincd.h>
#include <newstuff.h>
#include <extrnvar.h>
#include <defntion.h>
#include <main.h>


/*****************************************************************************
 *
 *      MODULE:  FINDME
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: convertor          end_conv
 *                            gain               gen_volt
 *                            hstandard          lstandard
 *                            overload           pre_amp
 *                            r1                 resistor
 *                            standard
 *
 *                      LOCAL: bottom1           - Place holder for the current resistor
 *                            resistor_incr      - Increment change for correct resistance
 *                            conv_old           - Old convertor value
 *                            det_incr           - Detector increment
 *                            s_hex              - New standard value
 *                            s_hex_old          - Old standard value
 *
 *                      USERS: laser_trim         measure_test
 *
 *                      CALLS: arange             pre_gain
 *                            agen_volt          detect_gain
 *                            strobe             clrol
 *                            skend_conv         rdoverload
 *                            rdconvert          abs
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ***********************************************************************/

void findme()
{ unsigned int s_hex, s_hex_old;
  float        resistor_incr, det_incr, bottom1;
  int          conv_old;

  resistor = 500;                                    /* Set and send an initial resistance
*/
  arange();
  pre_amp = 1;                                       /* Set and send an initial preamp gain
*/
  pre_gain();
  gain = 1;                                          /* Set and send an initial detector
gain        */
  detect_gain();
```

```
  gen_volt = 8;                                        /* Set and send an initial generator
voltage    */
  agen_volt();
  strobe();                              /* Strobe and clear the system for set-up       */
  clrol();
  skend_conv();                          /* Wait for the measurement system to finish    */
  while(end_conv != 0)
    skend_conv();
  rdoverload();                          /* Get the system feed back                     */
  rdconvert();
  resistor_incr = 2;                                   /* Set the initial resistor
incrementation      */

  while(overload != 0x8FF)               /* While we are still out of range              */
   {
   resistor = (long int)(resistor*resistor_incr);  /* Increment the resistance          */
   arange();                             /* Send the new resistance                      */
   strobe();                             /* Strobe and clear the system for set-up       */
   clrol();
   skend_conv();                         /* Wait for the measurement system to finish    */
   while(end_conv != 0)
     skend_conv();
   rdoverload();                         /* Get the system feed back                     */
   rdconvert();
   if((overload&0x800) != 0x800)         /* If we passed it,                             */
      {
      resistor_incr = .97;               /*   Reset the incrementation                   */
      }
   }                                     /* See if we are in range yet                   */

  resistor_incr =  1.25;                 /* Reset the incrementation                     */
  conv_old = 2047;                       /* Assume that we are at the far end of close   */

  while(conv_old == convertor)           /* While we are still not within guessing range */
   {
   resistor = (long int)(resistor*resistor_incr);  /*   Increment the resistance        */
   arange();                             /*   Send that resistance                       */
   strobe();                             /* Strobe and clear the system for set-up       */
   clrol();
   skend_conv();                         /* Wait for the measurement system to finish    */
   while(end_conv != 0)
      skend_conv();
   rdconvert();                          /* Get the system feed back                     */
   }                                     /* Check if we are close enough to guess        */


  det_incr = 2;                                        /* Set the detector gain increment
*/
  s_hex_old = 0;                                       /* Set the initial difference in
values         */
  s_hex = (hstandard*16)+lstandard;
  gain = 1;                              /* Initialize the gain                          */

  while(abs(s_hex - s_hex_old) > 0x001 )/* While our last value put us closer to home   */
   {
   gain = (int)(gain*det_incr);          /*   Increment the gain                         */
   detect_gain();                        /*   Send the new gain                          */
   bottom1 = (convertor/(1024*gain*gen_volt));  /*   Make a new educated guess          */
   resistor = 1 + (long int)(r1*(bottom1 + standard ));
   arange();                             /*   Send the new guess                         */

   strobe();                             /* Strobe and clear the system for set-up       */
   clrol();
   skend_conv();                         /* Wait for the measurement system to finish    */
   while(end_conv != 0)
      skend_conv();
   rdoverload();                         /* Get the system feed back                     */
   rdconvert();

   s_hex_old = s_hex;                    /*   Figure out the new feedback values         */
   s_hex = (hstandard*16)||lstandard;
   }                                     /* Are we there yet                             */
}
```

```
/*****************************************************************************
 *
 *      MODULE:  ASTANDARD
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: hstandard          lstandard
 *                            standard
 *
 *                     LOCAL: high              - High byte of the standard
 *                            low               - Low byte of the standard
 *                            s1                - Temp value of standard
 *
 *                     USERS: arange
 *
 *                     CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                     MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ***********************************************************************/

void astandard()
{
   int high = 0, low = 0;
   float s1;

   s1 = standard;                        /* Put the value into a place holder          */
   standard = 0;
                                         /* Figure out the right code to send          */
   if(s1 > .5)
     {
     s1 = s1 - .5;
     standard = .5;
     high = 0x80;
     }

   if(s1 > .25)
     {
     s1 = s1 - .25;
     standard = standard + .25;
     high = high|0x40;
     }

   if(s1 > .125)
     {
     s1 = s1 - .125;
     standard = standard + .125;
     high = high|0x20;
     }

   if(s1 > .0625)
     {
     s1 = s1 - .0625;
     standard = standard + .0625;
     high = high|0x10;
     }

   if(s1 > .03125)
     {
     s1 = s1 - .03125;
     standard = standard + .03125;
     high = high|0x08;
     }

   if(s1 > .015625)
     {
     s1 = s1 - .015625;
```

```
      standard = standard + .015625;
      high = high|0x04;
      }

    if(s1 > .0078125)
      {
      s1 = s1 - .0078125;
      standard = standard + .0078125;
      high = high|0x02;
      }

    if(s1 > .00390625)
      {
      s1 = s1 - .00390625;
      standard = standard + .00390625;
      high = high|0x01;
      }

    if(s1 > .001953125)
      {
      s1 = s1 - .001953125;
      standard = standard + .001953125;
      low = low|0x08;
      }

    if(s1 > .0009765625)
      {
      s1 = s1 - .0009765625;
      standard = standard + .0009765625;
      low = low|0x04;
      }

    if(s1 > .00048828125)
      {
      s1 = s1 - .00048828125;
      standard = standard + .00048828125;
      low = low|0x02;
      }

    if(s1 > .000244140625)
      {
      s1 = s1 - .000244140625;
      standard = standard + .000244140625;
      low = low|0x01;
      }

                    /*** Send out the standard ***/

     outp(bmba, addr32A);                /* Set addr 32 on a and c                    */
     outp(bmbc, addr32C);
     outp(baca, high);                   /* Set HSB AC(0-7)                           */
     outp(bacb, low);                    /* Set LSB AC(8-11)                          */
     outp(bacc, iop2);                  /* Pulse  iop 2 for load                      */
     outp(bacc, clearIop);

     hstandard = high;
     lstandard = low;
}



/*****************************************************************************
 *
 *      MODULE:  arange
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: hrange              lrange
 *                            r1                   range
 *                            resistor             standard
 *
 *                     LOCAL: high               - High byte of the range
 *
 *                     USERS: findme              laser_trim
 *                            measure_test
```

```
 *
 *                    CALLS: pow                astandard
 *                           outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ****************************************************************************/


void arange()
{
   int high;

   range = 0;                          /* Initialize the place holders                  */
   r1 = 0;
   while( r1 < resistor )              /* Find out what range we are in                 */
     {
     range++;
     r1 = pow(2,(3+(3*range)));
     }

   standard = resistor/((float)r1);    /* Compute the ratio of resistor to range        */

   astandard();                        /* Send that to the system                       */

   if(range < 8)                       /* If the range is less than eight, adjust it    */
     {
     high = range;
     high <<= 5;
     }
   if(range == 8)                      /* If the range is eight, set its proper value   */
     high = 0x10;

   if(range == 9)                      /* If the range is nine, set its proper value    */
     high = 0x30;


                  /*** Send out the range number ***/

    outp(bmba, addr30A);               /* Set addr 30 on a and c                        */
    outp(bmbc, addr30C);
    outp(baca, high);                  /* Set HSB AC(0-7)                               */
    outp(bacb, 0x00);                  /* Set LSB AC(8-11)                              */
    outp(bacc, iop2);                  /* Pulse iop 2 for load                          */
    outp(bacc, cleariop);


    /*** Send out the function ***/

    outp(bmba, addr30A);     /*set addr 30 on a and c                        */
    outp(bmbc, addr30C);
    outp(baca, 0x00);                  /* Set HSB AC(0-7)                              */
    outp(bacb, 0x00);                  /* Set LSB AC(8-11)                              */
    outp(bacc, iop4);                  /* Pulse iop 4 for load                          */
    outp(bacc, cleariop);

    hrange = high;
    lrange = 0x00;

}



/****************************************************************************
 *
 *      MODULE:  agen_volt
```

```
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: gen_volt           hgen_volt
 *                            lgen_volt
 *
 *                     LOCAL: g1                - Temporary value of the gneerator voltage
 *                            high              - High byte of the genrator voltage
 *
 *                     USERS: findme             laser_trim
 *                            measure_test
 *
 *                     CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ******************************************************************************/

void agen_volt()
{  int high = 0;
   float g1;

   g1 = gen_volt;
                                        /* Figure out the right code to send          */

   if (g1 > 0 )
      high = 0x10;
   else
      g1 = g1*(-1);

   high = high|(int)g1;
   high <<= 1;
   if(g1 >= (int)g1 +.5)
     {
     high = high|0x01;
     g1 = g1 - .5;
     }

   high <<= 1;
   if(g1 >= (int)g1 +.25)
     {
     high = high|0x01;
     g1 = g1 - .25;
     }

   high <<= 1;
   if(g1 > (int)g1)
     {
     high = high|0x01;
     }


    /*** Send out the generator voltage ***/

    outp(bmba, addr31A);                /* Set addr 15 on a and c                     */
    outp(bmbc, addr31C);
    outp(baca, high);                   /* Set HSB AC(0-7)                           */
    outp(bacb, 0x00);                   /* Set LSB AC(8-11)                           */
    outp(bacc, iop2);                   /* Pulse iop 2 for load                       */
    outp(bacc, cleariop);

   lgen_volt = 0x00;
   hgen_volt = high;


}
```

```
/*****************************************************************************
 *
 *      MODULE:  detect_gain
 *
 *     PURPOSE:  detector gain
 *
 *    PARAMETERS:      GLOBL: gain                hgain
 *                            lgain
 *
 *                     LOCAL: g1                 - Temporary value of the gain
 *                            high               - High byte of the gain
 *                            low                - Low byte of the gain
 *
 *                     USERS: findme              laser_trim
 *                            measure_test
 *
 *                     CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 *****************************************************************************/

void detect_gain()
{  int high = 0, low = 0;
   float g1;

   if(gain > 511)                        /* Truncate the to the max gain                */
      gain = 511;

   g1 = gain;                            /* Figure out the right code to send           */

   high = (int)g1;
   high >>= 1;

   if(g1 != (2*(int)(g1/2)))
     {
     low = 0x01;
     }

   low <<= 1;
   if(g1 >= (int)g1 +.5)
     {
     low = low|0x01;
     g1 = g1 - .5;
     }

   low <<= 1;
   if(g1 >= (int)g1 +.25)
     {
     low = low|0x01;
     g1 = g1 - .25;
     }

   low <<= 1;
   if(g1 > (int)g1)
     {
     low = low|0x01;
     }


    /*** Send out the detector g1 ***/

    outp(bmba, addr31A);                 /* Set addr 15 on a and c                      */
    outp(bmbc, addr31C);
    outp(baca, high);                    /* Set HSB AC(0-7)                             */
    outp(bacb, low);                     /* Set LSB AC(8-11)                            */
```

```
    outp(bacc, iop4);                   /* Pulse iop 4 for load                        */
    outp(bacc, cleariop);

    hgain = high;
    lgain = low;
}



/*****************************************************************************
 *
 *      MODULE:  pre_gain
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: hpre_amp           lpre_amp
 *                            pre_amp
 *
 *                     LOCAL: high              - High byte of the pre_amp
 *
 *                     USERS: findme             laser_trim
 *                            measure_test
 *
 *                     CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 *****************************************************************************/

void pre_gain()
{  int high = 0;

   if(pre_amp == 8)                     /* If the value is eight, set that code        */
      high = 0x01;
   else                                 /* Otherwise, set the code for one (1)         */
      high = 0x00;

    /*** Send out the generator voltage ***/

    outp(bmba, addr16A);                /* Set addr 16 on a and c                      */
    outp(bmbc, addr16C);
    outp(baca, 0x00);                   /* Set HSB AC(0-7)                             */
    outp(bacb, high);                   /* Set LSB AC(8-11)                            */
    outp(bacc, iop2);                   /* Pulse iop 2 for load                        */
    outp(bacc, cleariop);

   hpre_amp = 0x00;
   lpre_amp = high;

}



/*****************************************************************************
 *
 *      MODULE:  acomparator
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: compare            hcompare
 *                            lcompare
 *
 *                     LOCAL: high              - High byte of the comparator
 *                            high1             - Temporary byte holder
 *                            low               - Low byte of the comparator
 *
```

```
 *                    USERS: measure_test
 *
 *                    CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ****************************************************************************/

void acomparator()
{  int high = 0, high1 = 0, low = 0;

   high = compare;
                                        /* Figure out the right code to send          */
   high >>= 4;
   high1 = high;

   high1 <<= 4;
   low = compare - high1;


    /*** Send out the comparator ***/

    outp(bmba, addr16A);                /* Set addr 16 on a and c                     */
    outp(bmbc, addr16C);
    outp(baca, high);                   /* Set HSB AC(0-7)                            */
    outp(bacb, low);                    /* Set LSB AC(8-11)                           */
    outp(bacc, iop4);                   /* Pulse iop 4 for load                       */
    outp(bacc, cleariop);

   lcompare = low;
   hcompare = high;

}



/****************************************************************************
 *
 *      MODULE:  adelay
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: delay              hdelay
 *                            ldelay
 *
 *                     LOCAL: high              - High byte of the delay
 *                            high1             - Temporary holder
 *                            low               - Low byte of the delay
 *
 *                     CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ****************************************************************************/

void adelay()
{  int high = 0, high1 = 0, low = 0;

   high = delay;
```

```
                                        /* Figure out the right code to send          */
   high >>= 4;
   high1 = high;

   high1 <<= 4;
   low = delay - high1;


    /*** Send out the delay ***/

    outp(bmba, addr13A);                /* Set addr 16 on a and c                     */
    outp(bmbc, addr13C);
    outp(baca, high);                   /* Set HSB AC(0-7)                            */
    outp(bacb, low);                    /* Set LSB AC(8-11)                           */
    outp(bacc, iop2);                   /* Pulse iop 4 for load                       */
    outp(bacc, cleariop);

   ldelay = low;
   hdelay = high;

}



/*****************************************************************************
 *
 *      MODULE:  clrol
 *
 *     PURPOSE:  Clear overload and go.
 *
 *    PARAMETERS:  None
 *
 *                     USERS: findme             laser_trim
 *                            measure_test
 *
 *                     CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 *****************************************************************************/

void clrol()
{

    /*** Send out the comparator ***/

    outp(bmba, addr16A);                /* Set addr 16 on a and c                     */
    outp(bmbc, addr16C);
    outp(baca, 0x00);                   /* Set HSB AC(0-7)                            */
    outp(bacb, 0x00);                   /* Set LSB AC(8-11)                           */
    outp(bacc, iop1);                   /* Pulse iop 1 for load                       */
    outp(bacc, cleariop);



}



/*****************************************************************************
 *
 *      MODULE:  skstrobe
 *
 *     PURPOSE:  skip on a strobe done
 *
 *    PARAMETERS:      GLOBL: strobe_done
```

```
 *
 *                    USERS: strobe              measure_test
 *                           rdconvert
 *
 *                    CALLS: outp                inp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ****************************************************************************/

void skstrobe()
{

    /*** Send out the comparator ***/

    outp(bmba, addr32A);                /* Set addr 16 on a and c                    */
    outp(bmbc, addr32C);
    outp(bacc, iop1);                   /* Pulse iop 1 for load                      */

    strobe_done = inp(acc);
    strobe_done = strobe_done&0x02;

    outp(bacc, cleariop);


}



/****************************************************************************
 *
 *      MODULE:  strobe
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: strobe_done
 *
 *                     LOCAL: i                 - Wait loop variable
 *
 *                     USERS: findme              laser_trim
 *                            measure_test
 *
 *                     CALLS: outp                skstrobe
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ****************************************************************************/
void strobe()
{
  int i;

    /*** Measure System Strobe ***/

    outp(bmba, addr32A);                /* Set addr 32 on a and c                    */
    outp(bmbc, addr32C);
    outp(bacc, iop4);                   /* Pulse iop 4 for load                      */

    for(i=0;i<1000;i++);                /* Wait for a while                          */
```

```
    outp(bacc, clearIop);

    skstrobe();
    while(strobe_done != 0)             /* Wait for the system to finish                */
      skstrobe();

}



/*****************************************************************************
 *
 *     MODULE:  clraccon
 *
 *     PURPOSE:  Clear the accumulator for the convertor.
 *
 *    PARAMETERS:  None
 *
 *                      CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 *****************************************************************************/

void clraccon()
  {

  /***  clear ac convertor ***/

  outp(bmba, addr17A);                  /* Set addr 17 on a and c                       */
  outp(bmbc, addr17C);
  outp(bacc, iop2);                     /* Pulse iop 2 for CLEAR ac convertor           */
  outp(bacc, clearIop);


 }



/*****************************************************************************
 *
 *      MODULE:  clracov
 *
 *     PURPOSE:  Clear the accumulator for the overload.
 *
 *    PARAMETERS:  None
 *
 *                      CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 *****************************************************************************/

void clracov()
 {

  /***  clear ac overload ***/
```

```
  outp(bmba, addr52A);                    /* Set addr 52 on a and c                    */
  outp(bmbc, addr52C);
  outp(bacc, iop2);                       /* Pulse iop 2 for CLEAR ac overload         */
  outp(bacc, clearlop);


 }



/*****************************************************************************
 *
 *      MODULE:  skend_delay
 *
 *     PURPOSE:  skip on a strobe done
 *
 *    PARAMETERS:      GLOBL: end_delay
 *
 *                     CALLS: outp              inp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 *****************************************************************************/

void skend_delay()
{

    /*** Send out the comparator ***/

    outp(bmba, addr13A);                  /* Set addr 16 on a and c                    */
    outp(bmbc, addr13C);
    outp(bacc, iop1);                     /* Pulse iop 1 for load                      */

    end_delay = inp(acc);
    end_delay = end_delay&0x02;

    outp(bacc, clearlop);


}



/*****************************************************************************
 *
 *      MODULE:  skready
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:       GLOBL: ready
 *
 *                     USERS: measure_test       channelb
 *                            channela
 *
 *                     CALLS: outp              inp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
```

```
 ****************************************************************************/

void skready()
{

    /*** Send out the comparator ***/

    outp(bmba, addr53A);                /* Set addr 16 on a and c                    */
    outp(bmbc, addr53C);
    outp(bacc, iop1);                   /* Pulse iop 1 for load                      */

    ready = inp(acc);
    ready = ready&0x02;

    outp(bacc, cleariop);


}



/****************************************************************************
 *
 *      MODULE:  skendcov
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: end_conv
 *
 *                     USERS: findme              laser_trim
 *                            measure_test        rdconvert
 *
 *                     CALLS: outp                inp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                     MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ****************************************************************************/

void skend_conv()
{

    /*** Send out the comparator ***/

    outp(bmba, addr17A);                /* Set addr 16 on a and c                    */
    outp(bmbc, addr17C);
    outp(bacc, iop1);                   /* Pulse iop 1 for load                      */

    end_conv = inp(acc);
    end_conv = end_conv&0x02;

    outp(bacc, cleariop);


}



/****************************************************************************
 *
 *      MODULE:  rdoverload
 *
 *     PURPOSE:  Main control system routines.
 *
 *    PARAMETERS:      GLOBL: overload
 *
 *                     LOCAL: high              - High byte of the overload
```

```
 *                              low                - Low byte of the overload
 *
 *                      USERS: findme              laser_trim
 *                             measure_test
 *
 *                      CALLS: outp                inp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ****************************************************************************/

void rdoverload()
{ int  high=0, low=0;


    /*** Measure System Strobe ***/

    outp(bmba, addr52A);                /* Set addr 52 on a and c                    */
    outp(bmbc, addr52C);
    outp(bacc, iop4);                   /* Pulse iop 4 for load                      */

    high = inp(aca);
    low = inp(acb);
    low = low&0x0f;

    outp(bacc, cleariop);

    overload = high;                    /* Compute the overload in order to display  */
    overload <<= 4;
    overload = overload + low;
    overload = overload&0xcff;

}



/****************************************************************************
 *
 *      MODULE:  rdconvert
 *
 *     PURPOSE:  read the converter
 *
 *    PARAMETERS:       GLOBL: convertor           end_conv
 *                             strobe_done
 *
 *                      LOCAL: high                - High byte of the convertor
 *                             low                 - Low byte of the convertor
 *
 *                      USERS: findme              laser_trim
 *                             measure_test
 *
 *                      CALLS: outp                inp
 *                             skend_conv          skstrobe
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ****************************************************************************/

void rdconvert()
```

```
{ int high=0, low=0;

    /*** Measure System Strobe ***/

    outp(bmba, addr17A);                /* Set addr 17 on a and c                    */
    outp(bmbc, addr17C);
    outp(bacc, iop4);                   /* Pulse iop 4 for load                      */

    high = inp(aca);
    low = inp(acb);
    low = low&0x0f;

    outp(bacc, cleariop);

    convertor = high;                   /* Calculate the conv. in order to display   */
    convertor <<= 4;
    convertor = convertor + low;
    if(convertor > 2047)
       convertor = convertor - 4096;

    end_conv = 2;
    while( end_conv != 0)               /* Wait for the conversion to finish         */
       skend_conv();

    strobe_done = 2;
    while( strobe_done != 0)            /* Wait for the system to be ready           */
       skstrobe();

}



/*****************************************************************************
 *
 *      MODULE:  channelb
 *
 *     PURPOSE:  Set CHANNEL B position.
 *
 *    PARAMETERS:      GLOBL: bprobe            probebhigh
 *                            probeblow         ready
 *
 *                     LOCAL: high             - High byte for channel B
 *                            low              - Low byte for chennel B
 *
 *                     USERS: laser_trim        measure_test
 *
 *                     CALLS: outp              skready
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 *****************************************************************************/

void channelb()
{ unsigned int high,low;

    low = bprobe&0x0f;                  /* Compute the right code                    */
    high = bprobe&0xff0;
    high >>= 4;
    high = high|0x80;

    /*** Send out the generator voltage ***/

    outp(bmba, addr53A);                /* Set addr 15 on a and c                    */
    outp(bmbc, addr53C);
    outp(baca, high);                   /* Set HSB AC(0-7)                           */
    outp(bacb, low);                    /* Set LSB AC(8-11)                          */
```

```
    outp(bacc, 0x06);                   /* Pulse iop 2 for load                        */
    outp(bacc, cleariop);

    probebhigh = high;
    probeblow = low;

    skready();
    while(ready != 0)                   /* Wait for the system to recover              */
      skready();

}



/*****************************************************************************
 *
 *      MODULE:  channela
 *
 *     PURPOSE:  Set CHANNEL A position.
 *
 *    PARAMETERS:      GLOBL: aprobe            probeahigh
 *                            probealow         ready
 *
 *                     LOCAL: high             - High byte for channel A
 *                            low              - Low byte for channel A
 *
 *                     USERS: laser_trim        measure_test
 *
 *                     CALLS: outp              skready
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 *****************************************************************************/

void channela()
{ unsigned int high,low;

    low = aprobe&0x0f;                  /* Compute the right code to send              */
    high = aprobe&0xff0;
    high >>= 4;
    high = high|0x40;

    /*** Send out the generator voltage ***/

    outp(bmba, addr53A);                /* Set addr 15 on a and c                      */
    outp(bmbc, addr53C);
    outp(baca, high);                   /* Set HSB AC(0-7)                             */
    outp(bacb, low );                   /* Set LSB AC(8-11)                            */
    outp(bacc, 0x06);                   /* Pulse iop 2 for load                        */
    outp(bacc, cleariop);

    probeahigh = high;
    probealow = low;

    skready();
    while(ready != 0)               /* Wait for the system to recover              */
      skready();

}



/*****************************************************************************
 *
 *      MODULE:  probe_select
 *
```

```
 *     PURPOSE:  Select the right multiplexed probes
 *
 *    PARAMETERS:  None
 *
 *                     USERS: main
 *
 *                     CALLS: outp
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE       INITIALS                    MODIFICATION
 *  ---------     --------  ------------------------------------------------
 *
 ******************************************************************************/

void probe_select()
{

    outp(bmba, addr55A);                /*set addr 15 on a and c                        */
    outp(bmbc, addr55C);
    outp(baca, 0x00);                   /* Set HSB AC(0-7)                              */
    outp(bacb, 0x00);                   /* Set LSB AC(8-11)                             */
    outp(bacc, 0x04);                   /* Pulse iop 2 for load                         */
    outp(bacc, clearIop);

}
```

```
/*****************************************************************************************
 *
                          MOVEINCD.C
 *
 *****************************************************************************************/

#include <stdlib.h>
#include <conio.h>
#include <stdio.h>
#include <dos.h>
#include <bwindow.h>
#include <moveincd.h>
#include <measincd.h>
#include <newstuff.h>
#include <extrnvar.h>
#include <defntion.h>
#include <main.h>
#include <float.h>
#include <math.h>


/*****************************************************************************
 *
 *      MODULE:  skip_on_rest
 *
 *     PURPOSE:  Skip test for if the laser is moving (resting) or not
 *
 *  PARAMETERS:        GLOBL: resting
 *
 *                     LOCAL: restx             - Control byte for x direction
 *                            resty             - Contolr byte for y direction
 *
 *                     USERS: main               move_dist
 *                            scribe             circle_cut
 *                            some_move          do_file
 *                            do_a_loop
 *
 *                     CALLS: outp               inp
 *
 *     RETURNS: None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

void skip_on_rest()
{
  int restx, resty;

                  /*** skip on rest ***/

                  /** x - axis select **/

    outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
    outp(bmbc, addr40C);
    outp(bacc, iop1);                   /* Pulse iop1 for x-axis                     */
    outp(bacc, cleariop);

                  /***  skip on rest  ***/

    outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
    outp(bmbc, addr40C);
    outp(bacc, iop4);                   /* Pulse iop 4 for read msb                  */

    restx = inp(acc);                   /* Control bits; clear ac, interrupt, skip   */
    restx = restx & 0x02;

    outp(bacc, cleariop);
```

```
                    /** y - axis select **/

    outp(bmba, addr40A);                /* Set addr 40 on a and c                      */
    outp(bmbc, addr40C);
    outp(bacc, iop2);                   /* Pulse iop2 for y-axis                       */
    outp(bacc, clearіop);

                    /***  skip on rest  ***/

    outp(bmba, addr40A);                /* Set addr 40 on a and c                      */
    outp(bmbc, addr40C);
    outp(bacc, iop4);                   /* Pulse iop 4 for read msb                    */

    resty = inp(acc);                   /* Control bits; clear ac, interrupt, skip     */
    resty = resty & 0x02;

    outp(bacc, clearіop);

                    /*** check if end of move ***/

    if( restx == 0 )
       if( resty == 0 )
          resting = 1;             /*** set flag for end of last move ***/

}



/*****************************************************************************
 *
 *      MODULE:  encode
 *
 *     PURPOSE:  Tranform the distance into octal code
 *
 *  PARAMETERS:        GLOBL: hlsbx              hlsby
 *                            llsbx              llsby
 *                            msbx               msby
 *                            vhlsbx             vhlsby
 *                            vllsbx             vllsby
 *
 *                     PARAM: x_dist            - X distance to transform
 *                            x_velo            - X velocity to transform
 *                            y_dist            - Y distance to transform
 *                            y_velo            - Y veloctiy to transform
 *
 *                     LOCAL: temp              - Temporary value holder
 *
 *                     USERS: move_norest        move_dist
 *
 *                     CALLS: abs
 *
 *     RETURNS:
 *
 *        DATE:
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

void encode(int x_dist,int y_dist, float x_velo, float y_velo)
{
  int temp = 0x0000;


    if(x_dist < 0 )
       x_velo = 128 - x_velo;

    if(y_dist < 0)
       y_velo = 128 - y_velo;
```

```
                /*** encode numbers ***/

                /*** velocity ***/

                /*** x-axis ***/

vhlsbx = 0x00;
vllsbx = 0x00;

vhlsbx = abs((int)x_velo);

if(x_dist < 0 ){
   vhlsbx = 0x80|vhlsbx;
   x_dist = x_dist * (-1);
   }

if(x_velo > (int)x_velo + .25){
   vllsbx = 0x08;
   x_velo = x_velo-.5;
   };

if(x_velo > (int)x_velo){
   vllsbx = vllsbx|0x04;
   };

               /*** y-axis ***/

vhlsby = 0x00;
vllsby = 0x00;

vhlsby = abs((int)y_velo);

if(y_dist < 0 ){
   vhlsby = 0x80|vhlsby;
   y_dist = y_dist * (-1);
   }

if(y_velo > (int)y_velo + .25){
   vllsby = 0x08;
   y_velo = y_velo-.5;
   };

if(y_velo > (int)y_velo){
   vllsby = vllsby|0x04;
   };

                /*** position ***/

                /*** x-axis ***/

msbx  = 0x00;
hlsbx = 0x00;
llsbx = 0x00;

temp = x_dist & 0xF000;
temp >>= 12;                        /* Shift right 12 to right align                */
msbx = temp;

temp = x_dist & 0x0FF0;
temp >>= 4;
hlsbx = temp;

llsbx = x_dist & 0x000F;


                /*** y axis ***/

msby  = 0x00;
hlsby = 0x00;
llsby = 0x00;

temp = y_dist & 0xF000;
temp >>= 12;                        /* Shift right 12 to right align                */
msby = temp;

temp = y_dist & 0x0FF0;
```

```
    temp >>= 4;
    hlsby = temp;

    llsby = y_dist & 0x000F;

}



/*****************************************************************************
 *
 *      MODULE:  move_no_rest
 *
 *     PURPOSE:  Distance move with no initial wait for laser to not be moving
 *
 *  PARAMETERS:        PARAM: x_dist            - X distance to move
 *                            x_velo            - X velocity to move
 *                            y_dist            - Y distance to move
 *                            y_velo            - Y velocity to move
 *
 *                     USERS: laser_trim         index_pos
 *                            joymove
 *
 *                     CALLS: encode             move_it
 *
 *     RETURNS: None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ---------------------------------------------------
 *
 *****************************************************************************/

void move_norest(int x_dist, int y_dist, float x_velo, float y_velo)
{
  double angle;

      if(x_velo == 0 || y_velo == 0 || x_dist == 0 || y_dist ==0);
      else
    if(x_velo == y_velo)
       {
       angle = atan((double)(abs(y_dist)/abs(x_dist)));
       x_velo = x_velo * (float)(cos(angle));
       y_velo = y_velo * (float)(sin(angle));
       }

      encode(x_dist,  y_dist,  x_velo,  y_velo);
      move_it();

}



/*****************************************************************************
 *
 *      MODULE:  move_dist
 *
 *     PURPOSE:  To move a distance after the laser has stopped moving
 *
 *  PARAMETERS:        PARAM: x_dist            - X distance to move
 *                            x_velo            - X velocity to move
 *                            y_dist            - Y distance to move
 *                            y_velo            - Y velocity to move
 *
 *                     USERS: main               scribe
 *                            laser_trim         circle_cut
 *                            some_move          index_pos
 *                            do_file            do_a_loop
 *
 *                     CALLS: encode             wait_for_rest
```

```
 *                            move_it            wait_for_rest2
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void move_dist(int x_dist, int y_dist, float x_velo, float y_velo)
{
  double angle;

      if(x_velo == 0 || y_velo == 0 || x_dist == 0 || y_dist ==0);
      else
    if(x_velo == y_velo)
       {
       angle = atan((double)(abs(y_dist)/abs(x_dist)));
       x_velo = x_velo * (float)(cos(angle));
       y_velo = y_velo * (float)(sin(angle));
       }

      encode(x_dist,  y_dist,  x_velo,  y_velo);
      wait_for_rest();
      move_it();

}



/****************************************************************************
 *
 *      MODULE:  move_it
 *
 *     PURPOSE:  To send the sequence to get the laser to move
 *
 *  PARAMETERS:        GLOBL: hlsbx              hlsby
 *                            llsbx              llsby
 *                            msbx               msby
 *                            vhlsbx             vhlsby
 *                            vllsbx             vllsby
 *
 *                     USERS: move_dist          move_norest
 *
 *                     CALLS:  outp
 *
 *     RETURNS: None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void move_it()
{

                  /***axis select  x axis  ***/

    outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
    outp(bmbc, addr40C);
    outp(bacc, iop1);                   /* Pulse iop 1 for x axis select             */
    outp(bacc, cleariop);


                  /***  load location as distance to go  ***/
```

```
            /*** load velocity and acceleration ***/

    outp(bmba, addr43A);            /* Set addr 43 on a and c                    */
    outp(bmbc, addr43C);
                                    /* SET VELOCITY AT 1/4 MAX                   */
    outp(baca, vhlsbx);             /* Send hlsb (ac 0 - 7)                      */
    outp(bacb, vllsbx);             /* Send llsb (ac 8 - 11)                     */
    outp(bacc, iop1);               /* Pulse iop 1 for load velocity             */
    outp(bacc, cleariop);

            /***  distance to go - send lsb  ***/

    outp(bmba, addr42A);            /* Set addr 42 on a and c                    */
    outp(bmbc, addr42C);
    outp(baca, hlsbx );             /* Send hlsb (ac 0 - 7)                      */
    outp(bacb, llsbx );             /* Send llsb (ac 8 - 11)                     */
    outp(bacc, iop2);               /* Pulse iop 2 for load lsb                  */
    outp(bacc, cleariop);

            /*** axis select y axis  ***/

outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
outp(bmbc, addr40C);
outp(bacc, iop2);                   /* Pulse iop 2 for y axis select             */
outp(bacc, cleariop);


            /***  load location as distance to go  ***/

            /*** load velocity and acceleration ***/

    outp(bmba, addr43A);            /* Set addr 43 on a and c                    */
    outp(bmbc, addr43C);
                                    /* SET VELOCITY AT 1/4 MAX                   */
    outp(baca, vhlsby);             /* Send hlsb (ac 0 - 7)                      */
    outp(bacb, vllsby);             /* Send llsb (ac 8 - 11)                     */
    outp(bacc, iop1);               /* Pulse iop 1 for load velocity             */
    outp(bacc, cleariop);

            /***  distance to go - send lsb  ***/

    outp(bmba, addr42A);            /* Set addr 42 on a and c                    */
    outp(bmbc, addr42C);
    outp(baca, hlsby);              /* Send hlsb (ac 0 - 7)                      */
    outp(bacb, llsby);              /* Send llsb (ac 8 - 11)                     */
    outp(bacc, iop2);               /* Pulse iop 2 for load lsb                  */
    outp(bacc, cleariop);

            /*** axis select  x axis  ***/

outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
outp(bmbc, addr40C);
outp(bacc, iop1);                   /* Pulse iop 1 for x axis select*/
outp(bacc, cleariop);

            /***  distance to go - send msb  ***/

    outp(bmba, addr42A);            /* Set addr 42 on a and c                    */
    outp(bmbc, addr42C);
    outp(bacb, msbx );              /* Put msb on ac                             */
    outp(bacc, iop1);               /* Pulse iop 1 for load msb                  */
    outp(bacc, cleariop);

            /*** axis select y axis  ***/

outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
outp(bmbc, addr40C);
outp(bacc, iop2);                   /* Pulse iop 2 for y axis select*/
outp(bacc, cleariop);


            /***  distance to go - send msb  ***/

    outp(bmba, addr42A);            /* Set addr 42 on a and c                    */
    outp(bmbc, addr42C);
```

```
        outp(bacb, msby );              /* Put msb on ac                                */
        outp(bacc, iop1);               /* Pulse iop 1 for load msb                     */
        outp(bacc, cleariop);

}



/*****************************************************************************
 *
 *      MODULE:  clrhome
 *
 *     PURPOSE:  Clear the home latches
 *
 *  PARAMETERS:  None
 *
 *                     USERS: index_pos
 *
 *                     CALLS: outp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

void clrhome()
{

                  /** x - axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                       */
  outp(bmbc, addr40C);
  outp(bacc, iop1);                     /* Pulse iop1 for the x-axis                    */
  outp(bacc, cleariop);

                  /***  clear home latch  ***/

  outp(bmba, addr43A);                  /* Set addr 43 on a and c                       */
  outp(bmbc, addr43C);
  outp(bacc, iop2);                     /* Pulse iop 2 for CLEAR HOME LATCH             */
  outp(bacc, cleariop);

                  /** y - axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                       */
  outp(bmbc, addr40C);
  outp(bacc, iop2);                     /* Pulse iop2 for the y-axis                    */
  outp(bacc, cleariop);

                  /***  clear home latch  ***/

  outp(bmba, addr43A);                  /* Set addr 43 on a and c                       */
  outp(bmbc, addr43C);
  outp(bacc, iop2);                     /* Pulse iop 4 for CLEAR HOME LATCH             */
  outp(bacc, cleariop);

 }



/*****************************************************************************
 *
 *      MODULE:  rdjoy
 *
 *     PURPOSE:  Read the joystick values
 *
 *  PARAMETERS:        GLOBL: xjoy              yjoy
```

```
 *
 *                    USERS: joymove
 *
 *                    CALLS: outp              inp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void rdjoy()
{

                  /** x-axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                    */
  outp(bmbc, addr40C);
  outp(bacc, iop1);                     /* Pulse iop1 for the x-axis                 */
  outp(bacc, cleariop);

                  /***  read overtravel and overshoot  ***/

  outp(bmba, addr44A);                  /* Set addr 44 on a and c                    */
  outp(bmbc, addr44C);
  outp(bacc, iop4);                     /* Pulse iop 4 for read otosjoy              */

    xjoy = inp(acb);
    xjoy = xjoy & 0x07;

 outp(bacc, cleariop);


                  /** y-axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                    */
  outp(bmbc, addr40C);
  outp(bacc, iop2);                     /* Pulse iop2 for the y-axis                 */
  outp(bacc, cleariop);

                  /***  read overtravel and overshoot  ***/

  outp(bmba, addr44A);                  /* Set addr 44 on a and c                    */
  outp(bmbc, addr44C);
  outp(bacc, iop4);                     /* Pulse iop 4 for read otosjoy              */

    yjoy = inp(acb);
    yjoy = yjoy & 0x07;

 outp(bacc, cleariop);

 }



/****************************************************************************
 *
 *      MODULE:  laser_on
 *
 *     PURPOSE:  Turn the laser on
 *
 *  PARAMETERS:  None
 *
 *                    USERS: scribe            laser_trim
 *                           circle_cut        do_file
 *                           do_a_loop
 *
 *                    CALLS: outp
 *
```

```
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void laser_on()
{

                    /** Turn on the laser **/

    outp(bmba, addr15A);                /* Set addr 15 on a and c                    */
    outp(bmbc, addr15C);
    outp(baca, 0x00);                   /* Set HSB AC(0-7)                           */
    outp(bacb, 0x04);                   /* Set LSB AC(8-11)                          */
    outp(bacc, iop4);                   /* Pulse iop 4 for load                      */
    outp(bacc, clearIop);

                    /** Disable the compartator **/

    outp(bmba, addr15A);                /* Set addr 15 on a and c                    */
    outp(bmbc, addr15C);
    outp(bacc, iop2);                   /* Pulse iop2 for load                       */
    outp(bacc, clearIop);

 }



/****************************************************************************
 *
 *      MODULE:  disable_lim_cro
 *
 *     PURPOSE:  Disable the limit crossing flag
 *
 *  PARAMETERS:  None
 *
 *                     USERS: laser_trim     measure_test
 *
 *                     CALLS: outp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void disable_lim_cro()
{
                    /** Disable the compartator **/

    outp(bmba, addr15A);                /* Set addr 15 on a and c                    */
    outp(bmbc, addr15C);
    outp(bacc, iop2);                   /* Pulse iop2 for load                       */
    outp(bacc, clearIop);

 }



/****************************************************************************
 *
```

```
 *      MODULE:  laser_off
 *
 *     PURPOSE:  To turn the laser off
 *
 *  PARAMETERS:  None
 *
 *                    USERS: main              scribe
 *                           laser_trim        circle_cut
 *                           do_file           do_a_loop
 *
 *                    CALLS: outp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void laser_off()
{

                  /** Turn off the laser **/

    outp(bmba, addr15A);                /* Set addr 15 on a and c                    */
    outp(bmbc, addr15C);
    outp(baca, 0x00);                   /* Set HSB AC(0-7)                           */
    outp(bacb, 0x00);                   /* Set LSB AC(8-11)                          */
    outp(bacc, iop4);                   /* Pulse iop 4 for load                      */
    outp(bacc, clearIop);
 }



/****************************************************************************
 *
 *      MODULE:  rdpositn
 *
 *     PURPOSE:  To read the position
 *
 *  PARAMETERS:        GLOBL: xpos              ypos
 *
 *                     LOCAL: llsb             - Low byte of lsb
 *                            hlsb             - High byte of lsb
 *                            msb              - Most significant byte
 *                            total            - Compiled value
 *
 *                     USERS: main              scribe
 *                            laser_trim        circle_cut
 *                            some_move         index_pos
 *                            measure_test      do_file
 *                            do_a_loop
 *
 *                     CALLS: outp              inp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void rdpositn()
{
long int  total;
```

```
int       msb, hlsb, llsb;

                /*** axis select  x axis  ***/

    outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
    outp(bmbc, addr40C);
    outp(bacc, iop1);                   /* Pulse iop 1 for x axis select             */
    outp(bacc, clearIop);


                /*** read location ***/

                /*** table pos - read msb ***/

    outp(bmba, addr41A);                /* Set addr 41 on a and c                    */
    outp(bmbc, addr41C);
    outp(bacc, iop2);                   /* Pulse iop 2 for read msb                  */

    msb = inp(acb);                     /* MSB (ac 8-11)                             */
    msb = msb & 0x0F  ;                 /* Clean out the input                       */

    outp(bacc, clearIop);

                /*** table pos - read lsb ***/

    outp(bmba, addr41A);                /* Set addr 41 on a and c                    */
    outp(bmbc, addr41C);
    outp(bacc, iop4);                   /* Pulse iop 4 for read lsb                  */

    hlsb = inp(aca);                    /* HLSB (ac 0 - 7)                           */
    llsb = inp(acb);                    /* LLSB (ac 8 - 11)                          */
    llsb = llsb & 0x0F;                 /* Clean out the input                       */

    outp(bacc, clearIop);

                /*** put together number ***/

    total = 0x00000000;                 /* Clear out the number                      */
    total = msb;
    total <<= 8;                        /* Make room for HLSB                        */
    total &= 0xFFFFFF00;                /*    clear the space just in case           */
    total |= hlsb;                      /*    OR it in                               */
    total <<= 4;                        /* Make room for LLSB                        */
    total &= 0xFFFFFFF0;                /*    clear the space just in case           */
    total |= llsb;
    total = 32767 - total;
    xpos = total;


                /*** axis select  y axis ***/

    outp(bmba, addr40A);                /* Set addr 40 on a and c                    */
    outp(bmbc, addr40C);
    outp(bacc, iop2);                   /* Pulse iop 2 for y axis select             */
    outp(bacc, clearIop);


                /*** read location ***/

                /*** table pos - read msb ***/

    outp(bmba, addr41A);                /* Set addr 41 on a and c                    */
    outp(bmbc, addr41C);
    outp(bacc, iop2);                   /* Pulse iop 2 for read msb                  */

    msb = inp(acb);                     /* MSB (ac 8-11)                             */
    msb = msb & 0x0F  ;                 /* Clean up the input                        */

    outp(bacc, clearIop);


                /*** table pos - read lsb ***/

    outp(bmba, addr41A);                /* Set addr 41 on a and c                    */
    outp(bmbc, addr41C);
```

```
    outp(bacc, iop4);                   /* Pulse iop 4 for read lsb                    */

    hlsb = inp(aca);                    /* HLSB (ac 0 - 7)                             */
    llsb = inp(acb);                    /* LLSB (ac 8 - 11)                            */
    llsb = llsb & 0x0F;                 /* Clean up the input                          */

    outp(bacc, cleariop);

                    /*** put together number ***/

    total = 0x00000000;                 /* Clear out number                            */
    total = msb;
    total <<= 8;                        /* Make room for hlsb                          */
    total &= 0xFFFFFF00;                /*   clear the space just in case              */
    total |= hlsb;                      /*   OR it in                                  */
    total <<= 4;                        /* Make room for llsb                          */
    total &= 0xFFFFFFF0;                /*   clear the space just in case              */
    total |= llsb;
    total = 32767 - total;
    ypos = total;


 }



/*****************************************************************************
 *
 *      MODULE:  power
 *
 *     PURPOSE:  Change the auxilary power settings
 *
 *  PARAMETERS:        PARAM: pwr             - New power setting (0 - 8)
 *                            rep             - New rep rate (0 - 8)
 *
 *                     CALLS: outp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

void power(int pwr, int rep)
{

                    /** Set the power level and rep. **/

    outp(bmba, addr54A);                /* Set addr 54 on a and c                      */
    outp(bmbc, addr54C);
    outp(baca, pwr);                    /* Set power                                   */
    outp(bacb, rep);                    /* Set reps                                    */
    outp(bacc, iop1);                   /* Pulse iop1 to load power                    */
    outp(bacc, cleariop);

}



/*****************************************************************************
 *
 *      MODULE:  rdotos
 *
 *     PURPOSE:  To read the overtravel and overshoot latches
 *
 *  PARAMETERS:        GLOBL: xotos              yotos
 *
 *                     USERS: index_pos
```

```
 *
 *                    CALLS: outp              inp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ******************************************************************************/

void rdotos()
{

                  /** x-axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                        */
  outp(bmbc, addr40C);
  outp(bacc, iop1);                     /* Pulse iop1 for the x-axis                     */
  outp(bacc, cleariop);

                  /***  read overtravel and overshoot  ***/

  outp(bmba, addr44A);                  /* Set addr 44 on a and c                        */
  outp(bmbc, addr44C);
  outp(bacc, iop4);                     /* Pulse iop 4 for read msb                      */

    xotos = inp(aca);

 outp(bacc, cleariop);


                  /** y-axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                        */
  outp(bmbc, addr40C);
  outp(bacc, iop2);                     /* Pulse iop2 for the y-axis                     */
  outp(bacc, cleariop);

                  /***  read overtravel and overshoot  ***/

  outp(bmba, addr44A);                  /* Set addr 44 on a and c                        */
  outp(bmbc, addr44C);
  outp(bacc, iop4);                     /* Pulse iop 4 for read msb                      */

    yotos = inp(aca);

 outp(bacc, cleariop);

 }



/******************************************************************************
 *
 *      MODULE:  skhome
 *
 *     PURPOSE:  Skip test for the home latches
 *
 *  PARAMETERS:        GLOBL: xhome             yhome
 *
 *                     USERS: index_pos
 *
 *                     CALLS: outp              inp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
```

```
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void skhome()
{

                    /** x - axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                    */
  outp(bmbc, addr40C);
  outp(bacc, iop1);                     /* Pulse iop1 for the x-axis                 */
  outp(bacc, cleariop);

                    /***  skip on home latch  ***/

  outp(bmba, addr43A);                  /* Set addr 43 on a and c                    */
  outp(bmbc, addr43C);
  outp(bacc, iop4);                     /* Pulse iop 4 for read msb                  */

    xhome =  inp(acc);                  /* Control bits; clear ac, interrupt, skip   */
    xhome = xhome & 0x02;

 outp(bacc, cleariop);

                    /** y - axis select **/

  outp(bmba, addr40A);                  /* Set addr 40 on a and c                    */
  outp(bmbc, addr40C);
  outp(bacc, iop2);                     /* Pulse iop2 for the y-axis                 */
  outp(bacc, cleariop);

                    /***  skip on home latch  ***/

  outp(bmba, addr43A);                  /* Set addr 43 on a and c                    */
  outp(bmbc, addr43C);
  outp(bacc, iop4);                     /* Pulse iop 4 for read msb                  */

    yhome = inp(acc);                   /* Control bits; clear ac, interrupt, skip   */
    yhome = yhome & 0x02;

 outp(bacc, cleariop);


 }



/****************************************************************************
 *
 *      MODULE:  clrintr
 *
 *     PURPOSE:  To clear the interrupts
 *
 *  PARAMETERS:  None
 *
 *                     USERS: index_pos
 *
 *                     CALLS: outp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 ****************************************************************************/

void clrintr()
```

```
{
                    /** x - axis select **/

   outp(bmba, addr40A);                  /* Set addr 40 on a and c                    */
   outp(bmbc, addr40C);
   outp(bacc, iop1);                     /* Pulse iop1 for x-axis                     */
   outp(bacc, clearіop);


                    /** Clear an interrupt **/

    outp(bmba, addr44A);                 /* Set addr 44 on a and c                    */
    outp(bmbc, addr44C);
    outp(bacc, iop2);                    /* Pulse iop 2 for load                      */
    outp(bacc, clearіop);

                    /** y - axis select **/

   outp(bmba, addr40A);                  /* Set addr 40 on a and c                    */
   outp(bmbc, addr40C);
   outp(bacc, iop2);                     /* Pulse iop2 for y-axis                     */
   outp(bacc, clearіop);


                    /** Clear an interrupt **/

    outp(bmba, addr44A);                 /* Set addr 44 on a and c                    */
    outp(bmbc, addr44C);
    outp(bacc, iop2);                    /* Pulse iop 2 for load                      */
    outp(bacc, clearіop);

 }



/*****************************************************************************
 *
 *      MODULE:  index_pos
 *
 *     PURPOSE:  To index the laser position ( home position )
 *
 *  PARAMETERS:        GLOBL: xhome              xotos
 *                            xpos               yhome
 *                            yotos              ypos
 *
 *                     LOCAL: x_dtemp           - X distance to travel to cause a latch
 *                            y_dtemp           - Y distance to travel to cause a latch
 *
 *                     USERS: main
 *
 *                     CALLS: clrintr            rdotos
 *                            move_norest        clrhome
 *                            skhome             rdpositn
 *                            move_dist          wait_for_rest
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ---------------------------------------------------
 *
 *****************************************************************************/

void index_pos()
{
 int  x_dtemp, y_dtemp;

  clrhome();                             /* Clear the home latch and the interupt reg.   */
  clrintr();
```

```
  x_dtemp = 6767;                        /* Set some very large distance to travel       */
  y_dtemp = 6767;

  move_norest(x_dtemp, y_dtemp, 7, 7);  /* Start to move that distance                  */
  while ( x_dtemp != 0 || y_dtemp != 0) /* While our axial flags are not set            */
     {
     rdotos();                          /*   See if we have any overtravel              */
     skhome();                          /*   See if we have passed home                 */
     if( (xhome == 0 || (xotos&0x80) == 0) && x_dtemp != 0)
                                        /*   If the x axis passed home or hit the edge, */
         {                              /*     but we haven't already done something    */
         x_dtemp = 0;                   /*     Flag the x axis flag                     */
         move_norest(0, y_dtemp, 0, 7); /*     Stop x direction but keep current y      */
         }
     if( (yhome == 0 || (yotos&0x80) == 0) && y_dtemp != 0)
                                        /*   If the y axis passed home or hit the edge, */
         {                              /*     but we haven't already done something    */
         y_dtemp = 0;                   /*     Flag the y axis flag                     */
         move_norest(x_dtemp, 0, 7, 0); /*     Stop y direction but keep current x      */
         }
     }                                  /* Check if both flags have been hit            */

  clrintr();                            /* Clear the interupts                          */

  if(xhome != 0)                        /* If the x axis wasn't a home flag             */
    x_dtemp = -6767;                    /*  Set a backwards direction                   */

  if(yhome != 0)                        /* If the y axis wasn't a home flag             */
    y_dtemp = -6767;                    /*  Set a backwards direction                   */

  move_norest(x_dtemp, y_dtemp, 7, 7);  /* Move according to the home flags             */
  while ( x_dtemp != 0 || y_dtemp != 0) /* While both flags aren't home flagged         */
     {
     skhome();                          /*   Check the home status                      */
     if( xhome == 0  && x_dtemp != 0)   /*   If x home and haven't already flagged it   */
         {
         x_dtemp = 0;                   /*      Set the flag                            */
         move_norest(0, y_dtemp, 0, 7); /*      Stop x movement but keep y              */
         }
     if( yhome == 0  && y_dtemp != 0)   /*   If y home and haven't already flagged it   */
         {
         y_dtemp = 0;                   /*      Set the flag                            */
         move_norest(x_dtemp, 0, 7, 0); /*      Stop y movement but keep x              */
         }
     }                                  /* Check the flags                              */

  rdpositn();                           /* Find out where we are                        */
  move_dist(-xpos, -ypos, 3, 3);        /* Move to pos 0,0                              */

  wait_for_rest();                      /* Wait for laser to stop                       */

  rdpositn();                           /* Find out where we are                        */
  move_dist(-xpos, -ypos, .25, .25);    /* Move to pos 0,0 if we aren't already there   */

  wait_for_rest();                      /* Wait for the laser to stop                   */
}


/*****************************************************************************
 *
 *      MODULE:  joymove
 *
 *     PURPOSE:  Joystick movement
 *
 *  PARAMETERS:        GLOBL: xjoy              yjoy
 *
 *                     LOCAL: finish            - Loop variable for load position button
 *                            msb               - Most significant byte
 *                            xd                - X distance to travel
 *                            xv                - X velocity to travel
 *                            yd                - Y distance to travel
 *                            yv                - Y velocity to travel
 *
 *                     USERS: scribe            laser_trim
```

```
 *                              some_move
 *
 *                       CALLS: outp                rdjoy
 *                              move_norest         inp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE     INITIALS                      MODIFICATION
 *  ---------  --------  ---------------------------------------------------
 *
 ******************************************************************************/

void joymove()
{
     int msb, xd=0, yd=0, finish;
     float  xv=0, yv=0;


                    /*** clear manual functions ***/

  outp(bmba, addr56A);                  /* Set addr 56 on a and c                      */
  outp(bmbc, addr56C);
  outp(bacc, iop1);                     /* Pulse iop 1 for clear manual functions      */
  outp(bacc, cleariop);

  finish = 1;                           /* Assume that there will be some movement     */
  while( finish == 1)                   /* While we are going to have movement         */
    {
    rdjoy();                            /*   Read the joystick                         */

    if(xjoy == 1 )                      /*   If the x axis is not angled               */
       {
       move_norest(0,yd,0,yv);          /*     Stop all movement in the x direction    */
       xd = 0;                          /*     Reset the x distance and velocity       */
       xv = 0;
       }
    if(yjoy == 1)                       /*   If the y axis is not angled               */
       {
       move_norest(xd,0,xv,0);          /*     Stop all movement in the y direction    */
       yd = 0;                          /*     Reset the y distance and velocity       */
       yv = 0;
       }
                                        /*   Test for motion in the x direction        */
    if(xjoy != 1)                       /*   If the x axis is angled                   */
       {
       xd = 32001;                      /*     Set some big distance                   */
       if(xjoy < 4)                     /*     If the angle is small, set a slow vel.  */
         {
         xv = 2;
         }
       else                             /*     Else(big angle), set a fast velocity    */
         {
         xv = 10;
         }
       if(xjoy == 2 || xjoy == 6)       /*     If angle to left, set distance a negative*/
         {
         xd = -1*xd;
         }
       move_norest(xd, yd, xv, yv);     /*     Move!!                                  */
       }
    if( yjoy != 1)                      /*   If the y axis is angled                   */
       {
       yd = 32001;                      /*     Set some big distance                   */
       if(yjoy < 4 )                    /*     If the angle is small, set a slow vel.  */
         {
         yv = 2;
         }
       else                             /*     Else(big angle), set a fast velocity    */
         {
         yv = 10;
         }
```

```
      if(yjoy == 2 || yjoy == 6)        /*     If angle is down, set distance as neg.   */
        {
        yd = -1*yd;
        }
      move_norest(xd, yd, xv, yv);      /*     Move!!                                   */
      }


                  /*** read manual functions ***/

    outp(bmba, addr56A);                /* Set addr 56 on a and c                       */
    outp(bmbc, addr56C);
    outp(bacc, iop4);                   /* Pulse iop 1 for clear manual functions       */

       msb = inp(aca)&0xf8;

    outp(bacc, cleariop);

    if((msb&0x20) == 0)                 /* If the load position button is pressed       */
      {
      move_norest(0,0,0,0);             /*   Stop all moving                            */
      finish = 0;                       /*   Flag a get out of here                     */
      }

    }                                   /* Check for a get out of here                  */

                  /*** clear manual functions ***/

  outp(bmba, addr56A);                  /* Set addr 56 on a and c                       */
  outp(bmbc, addr56C);
  outp(bacc, iop1);                     /* Pulse iop 1 for clear manual functions       */
  outp(bacc, cleariop);

}



/*****************************************************************************
 *
 *      MODULE:  wait_for_start
 *
 *     PURPOSE:  To wait until the start button has been pressed
 *
 *  PARAMETERS:        LOCAL: msb               - Most significant byte
 *
 *                     USERS: scribe             do_file
 *
 *                     CALLS: outp               inp
 *
 *     RETURNS:  None
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

void wait_for_start()
{
 int msb;


 msb =  0xff;

                  /*** read manual functions ***/

 outp(bmba, addr56A);                   /* Set addr 56 on a and c                       */
 outp(bmbc, addr56C);

 while((msb&0x08) != 0)                 /* While no START button                        */
    {
```

```
    outp(bacc, iop4);                   /* Pulse iop 4 for read manual functions        */
    msb = inp(aca)&0xf8;                /*  Check that START button!!                   */
    outp(bacc, cleariop);
    }                                   /* Did we get it??                              */

                    /*** clear manual functions ***/

  outp(bmba, addr56A);                  /* Set addr 56 on a and c                       */
  outp(bmbc, addr56C);
  outp(bacc, iop1);                     /* Pulse iop 1 for clear manual functions       */
  outp(bacc, cleariop);

}



/*****************************************************************************
 *
 *      MODULE:  check_for_stop
 *
 *     PURPOSE:  To check if the stop button has been pressed
 *
 *  PARAMETERS:        LOCAL: msb              - Most significant byte
 *
 *                     USERS: scribe             do_file
 *                            do_a_loop
 *
 *                     CALLS: outp               inp
 *
 *     RETURNS: 0 - Keep going (no stop)
 *              1 - STOP!!
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE    INITIALS                    MODIFICATION
 *  ---------  --------  ------------------------------------------------
 *
 *****************************************************************************/

int  check_for_stop()
{
 int msb;


 msb =  0xff;

                    /*** read manual functions ***/

 outp(bmba, addr56A);                   /* Set addr 56 on a and c                       */
 outp(bmbc, addr56C);
 outp(bacc, iop4);                      /* Pulse iop 1 for clear manual functions       */
    msb = inp(aca)&0xf8;
 outp(bacc, cleariop);

                    /*** clear manual functions ***/

  outp(bmba, addr56A);                  /* Set addr 56 on a and c                       */
  outp(bmbc, addr56C);
  outp(bacc, iop1);                     /* Pulse iop 1 for clear manual functions       */
  outp(bacc, cleariop);

 if((msb&0x80) == 0)                    /* We've been snagged by a stop                 */
   return(1);                           /*   Return a STOP for the rest of the system   */

 return(0);                             /* Otherwise, send a no stop                    */
}
```

```
/*****************************************************************************************
 *
                              SAVING.C
 *
 *****************************************************************************************/

#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <math.h>
#include <float.h>
#include <bwindow.h>
#include <extrnvar.h>
#include <defntion.h>
#include <main.h>
#include <moveincd.h>
#include <saveincd.h>


/*****************************************************************************
 *
 *      MODULE:  cut_a_pattern
 *
 *     PURPOSE:  Main menu system for building, analyzing, editting, and test running.
 *
 *    PARAMETERS:
 *                      GLOBL: NULL                 current
 *                             file_name            new_file
 *                             old_file             vel_cut
 *                             scan                 selection
 *                             x_travel             y_travel
 *
 *                      LOCAL: action              - Laser action variable
 *                             numbers             - Character buffer for numeric input
 *                             true                - Loop conditional (loop until 5.Exit)
 *                             option              - Menu variable (create, analyze,...)
 *
 *
 *                      USERS: main
 *
 *                      CALLS: wnscroll             wncurmov
 *                             wnprintf             wnquery
 *                             strncpy              strcat
 *                             fopen                append
 *                             fclose               fprintf
 *                             transform            build_file
 *                             pattern_check        do_file
 *                             kbplace              kbgetkey
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                     MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *    12/90        RRW          Add previous used file as the next file to use
 *
 ***************************************************************************/

void cut_a_pattern()
{
int true, action, option;
char numbers[10];

true = 1;                                /* Defining variables.                        */
while(true = 1)
    {
    wnscroll(0,-1,-1,0);

    wncurmov(3,26);
    wnprintf("What would you like to do?");  /* Print                                  */
    wncurmov(5,22);
    wnprintf(" 1. Create a file");           /* Print                                  */
```

```
  wncurmov(6,22);
  wnprintf(" 2. Analyze / print a file "); /* Print                                  */
  wncurmov(7,22);
  wnprintf(" 3. Edit a file ");            /* Print                                  */
  wncurmov(8,22);
  wnprintf(" 4. Run a file ");
  wncurmov(9,22);
  wnprintf(" 5. Main menu");
  wncurmov(12,26);
  wnprintf("Option:");

  wnquery(selection, 2, &scan);

  if(*selection == 'c'|| *selection == 'C' || *selection == '1')
     option = 1;

  if(*selection == 'a'|| *selection == 'A'|| *selection == '2')
     option = 2;

  if(*selection == 'e'|| *selection == 'E' || *selection == '3')
     option = 3;

  if(*selection == 'r'|| *selection == 'R' || *selection == '4')
     option = 4;

  if(*selection == 'm'|| *selection == 'M' || *selection == '5')
     option = 5;

if(option > 0 && option < 5)        /* If it is one of the first four options.      */
  {
  if(file_name == "" || option == 1)
      {
      wncurmov(14,20);                /* Move cursor.                                 */
      wnprintf("Enter the name of the file: "); /* Print                              */
      wnquery(file_name, 9, &scan);   /* Find next selection.                         */

      strncpy(old_file,file_name,9);  /* Store the backup file.                       */
      strncpy(new_file,file_name,9);
      strcat(old_file,".old");
      strcat(new_file,".new");
      }
  else
      {
      wncurmov(14,20);                /* Move cursor.                                 */
      wnprintf("Enter the name of the file: %s",file_name); /* Print                  */
      if((new_file[0] = kbgetkey(&scan)) != 13)
          {
          wncurmov(14,48);
          wnprintf("                  ");   /* Print                                  */
          wncurmov(14,48);                  /* Move cursor                            */
          kbplace(1,new_file[0],scan);
          wnquery(file_name, 9, &scan);     /* Get next request.                      */
          strncpy(new_file,file_name,9);
          strncpy(old_file,file_name,9);    /* Store the backup.                      */
          strcat(old_file,".old");
          strcat(new_file,".new");
          }
      else
          {
          strncpy(old_file,file_name,9);
          strncpy(new_file,file_name,9);
          strcat(old_file,".old");          /* Store the backup with .old extension.  */
          strcat(new_file,".new");
          }
      }
  }

  switch(option)
    {
 case 1:
  if ((current = fopen(new_file,"r")) != NULL)  /* If the new file exists.            */
      {
      wnscroll(0,-1,-1,0);            /* Scroll window                                */
      wncurmov(5,5);
      wnprintf("This file already exists. ");  /*Print                               */
      wncurmov(7,5);                           /* Move cursor.                        */
```

```
    wnprintf("(Press ENTER to continue)");
    wnquery(selection, 1, &scan);            /* Get the next selection.            */
    }
 else
    {
    fclose(current);                 /* Close the current file.                    */
    current = fopen(new_file,"w");
    action = 8;                      /* If action is a resistor trim.              */
    fprintf(current,"\n%i\n",action);        /*Print                               */
    wnscroll(0,-1,-1,0);                     /* Scroll window                      */
    wncurmov(5,5);
    wnprintf("What cutting velocity would you like to set? (0 - 20.625) "); /* Print*/
    wnquery(numbers, sizeof(numbers), &scan);     /* Get the next selection.       */
    vel_cut = transform(numbers);
    fprintf(current, "%.3f\n", vel_cut);          /* Print                         */
    build_file();                                 /* Do module.                    */
    fprintf(current,"\n9\n");
    fclose(current);                              /* Close file.                   */
    }
 break;

case 2:
 if ((current = fopen(new_file,"r")) == NULL)     /* If the file doesn't exist.    */
    {
    wnscroll(0,-1,-1,0);
    wncurmov(5,5);                                /* Move cursor.                  */
    wnprintf("This file does not exist. ");       /* Print                         */
    wncurmov(7,5);
    wnprintf("(Press ENTER to continue)");
    wnquery(selection, sizeof(selection), &scan);
    fclose(current);
    break;
    }
 wnscroll(0,-1,-1,0);                              /* Move cursor.                  */
 wncurmov(6,10);
 wnprintf("Do you want the file sent to the printer? (y/n)");  /* Print            */
 wnquery(selection,2,&scan);
 if(*selection == 'y' || *selection == 'Y')        /* Selection is a yes.           */
    {
    wncurmov(8,10);
    wnprintf("Turn on the printer and press ENTER.");   /* Print                   */
    wnquery(selection,1,&scan);                       /* Find next selection.      */
    pattern_check(1);
    }
 else
    pattern_check(0);                /* Do module.                                 */

 wnscroll(0,-1,-1,0);                /* Scroll window.                             */
 wncurmov(5,0);
 wnprintf("              The final position is %6i, %6i.", x_position, y_position);
 wnprintf("\n              There were %i loops started.",loops);
 wnprintf("\n              There were %i loops ended.",end_loops);
 wnprintf("\n              The laser was turned on %i times.",on);
 wnprintf("\n              The laser was turned off %i times.",off);
 wnprintf("\n              There were %i circles.",circles);

 wnprintf("\n\n                 (Press ENTER to continue)");
 wnquery(selection,1,&scan);          /* Get next selection.                        */

 fclose(current);                     /* Close the file.                            */
 break;

case 3:
 if ((current = fopen(new_file,"r")) == NULL)
    {
    wnscroll(0,-1,-1,0);              /* Scroll window.                             */
    wncurmov(5,5);
    wnprintf("This file does not exist. ");  /* Print                               */
    wncurmov(7,5);
    wnprintf("(Press ENTER to continue)");
    wnquery(selection, 1, &scan);            /* Get next selection.                */
    fclose(current);
    break;
    }
 wnscroll(0,-1,-1,0);                 /* Move cursor                                */
 append();
```

```
    fclose(current);                    /* Close file.                                  */
    break;

   case 4:
    if ((current = fopen(new_file,"r")) == NULL)  /* If new file doesn't exist          */
        {
        wnscroll(0,-1,-1,0);            /* Scroll window.                               */
        wncurmov(5,5);
        wnprintf("This file does not exist. ");     /* Print                            */
        wncurmov(7,5);
        wnprintf("(Press ENTER to continue)");      /* Print                            */
        wnquery(selection, sizeof(selection), &scan);
        fclose(current);
        break;
        }
    wnscroll(0,-1,-1,0);                /* Scroll window.                               */
    do_file();                          /* Do module.                                   */
    fclose(current);
    break;

   case 5:
    return;

      }
   }
}



/*****************************************************************************
 *
 *      MODULE:  build_file
 *
 *     PURPOSE:  Create menu system - create a file from scratch
 *
 *    PARAMETERS:
 *                      GLOBL: current            scan
 *                             selection          x_displace
 *                             y_displace
 *
 *                      LOCAL: numbers           - Character buffer for numeric input
 *                             times             - Number of times to process a loop
 *                             rad               - Radius of a circle
 *                             type              - Type of circle (cutting/saving center)
 *
 *                      USERS: cut_a_pattern      append
 *
 *                      CALLS: wnscroll           wncurmov
 *                             wnprintf           wnquery
 *                             fprintf            transform
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 *****************************************************************************/

void build_file()
{
int  times, rad, type;                  /* Define variables.                            */
char numbers[10];

*selection = 'a';
rdpositn();                             /* Do module.                                   */

while(*selection != 'e' && *selection != 'E' && *selection != '9')
                                        /* While selection is not an exit.              */
    {
    wnscroll(0,-1,-1,0);
```

```
wncurmov(1,26);                        /* Move cursor                                  */
wnprintf("What would you like to do?");    /* Print                                    */
wncurmov(3,28);                        /* Move cursor.                                 */
wnprintf(" 1. Move to a position");
wncurmov(4,28);
wnprintf(" 2. Distance move ");
wncurmov(5,28);
wnprintf(" 3. laser On ");
wncurmov(6,28);
wnprintf(" 4. Laser off");
wncurmov(7,28);
wnprintf(" 5. Circle cut ");
wncurmov(8,28);
wnprintf(" 6. Start a loop");
wncurmov(9,28);
wnprintf(" 7. Repeat a loop");
wncurmov(11,28);
wnprintf(" 9. Exit");
wncurmov(13,34);
wnprintf("Option:");

wnquery(selection, 2, &scan);

if(*selection == 'm' || *selection == 'M' || *selection == '1')
   {
   fprintf(current,"\n1\n");        /* Print                                          */
   wncurmov( 13,20);
   wnprintf("To what position would you like to move?");    /* Print.                 */
   wncurmov(15,20);
   wnprintf("          X direction:");
   wnquery(numbers, 10, &scan);
   x_displace = (int)transform(numbers);   /* Calculate x displacement.               */
   wncurmov(16,20);                        /* Move cursor                             */
   wnprintf("          Y direction:");
   wnquery(numbers, 10, &scan);            /* Get next selection                      */
   y_displace = (int)transform(numbers);
   fprintf(current, " %i\n", x_displace);
   fprintf(current, " %i\n", y_displace);  /* Print.                                  */
   wnselect(plist);
   wnscroll(1,-1,-1,0);                    /* Scroll one line.                        */
   wncurmov(2,40);
   wnprintf("  Position    %5i, %5i", x_displace, y_displace);
   }

if(*selection == 'd' || *selection == 'D'|| *selection == '2')
                                       /* If it is the second selection.               */
   {
   fprintf(current,"\n2\n");        /* Print.                                         */
   wncurmov( 13,20);                /* Print                                          */
   wnprintf("What distance would you like to move?");
   wncurmov(15,20);
   wnprintf("          X direction:"); /* Print                                       */
   wnquery(numbers, 10, &scan);
   x_displace = (int)transform(numbers);  /* New x distance.                          */
   wncurmov(16,20);
   wnprintf("          Y direction:");
   wnquery(numbers, 10, &scan);           /* Get next selection.                      */
   y_displace = (int)transform(numbers);
   fprintf(current, " %i\n", x_displace);   /* Print                                  */
   fprintf(current, " %i\n", y_displace);
   wnselect(plist);                          /* Lower window.                         */
   wnscroll(1,-1,-1,0);
   wncurmov(2,40);                           /* Select lower window.                  */
   wnprintf("  Distance    %5i, %5i", x_displace, y_displace);  /* Print              */
   }

if(*selection == 'o' || *selection == 'O'|| *selection == '3')
   {
   fprintf(current,"\n3\n");        /* Print                                          */
   wnselect(plist);
   wnscroll(1,-1,-1,0);             /* Scroll one line.                               */
   wncurmov(2,40);
   wnprintf("  Laser on                  ");   /* Print                               */
   }
```

```
    if(*selection == 'f' || *selection == 'F' || *selection == '4')
       {
       fprintf(current,"\n4\n");        /* Print                                    */
       wnselect(plist);                 /* Select lower window.                     */
       wnscroll(1,-1,-1,0);
       wncurmov(2,40);                  /* Move cursor.                             */
       wnprintf("  Laser off                 ");  /* Print                          */
       }

    if(*selection == 'c' || *selection == 'C' || *selection == '5')
       {
       fprintf(current,"\n5\n");
       wncurmov( 13,12);                /* Move cursor.                             */
       wnprintf("Do you want to save the center? (y/n) ");  /* Print                 */
       wnquery(numbers, 2, &scan);
       if(*numbers == 'y' || *numbers == 'Y')
          type = 0;
       else
          type = 1;                          /* If it is a circle with a center.   */
       wncurmov( 15,12);
       wnprintf("What radius would you like the circle? (in .01mm) ");  /* Print   */
       wnquery(numbers, 10, &scan);     /* Get the next selection.                  */
       rad = (int)transform(numbers);
       fprintf(current, "%i\n", rad);
       fprintf(current, "%i\n", type);  /* Print                                    */
       wnselect(plist);
       wnscroll(1,-1,-1,0);
       wncurmov(2,40);                  /* Move cursor.                             */
       if(type == 1)
          wnprintf("  Circle w/o cntr %4i", rad);  /* Print                         */
       else
          wnprintf("  Circle w/ center%4i", rad);
       }


    if(*selection == 's' || *selection == 'S' || *selection == '6')
       {
       fprintf(current,"\n6\n");        /* Print                                    */
       wncurmov( 13,20);
       wnprintf("How many times would you like to loop? ");
       wnquery(numbers, 10, &scan);
       times = (int)transform(numbers); /* Calculate the number of loops.           */
       fprintf(current, "%i\n", times); /* Print                                    */
       wnselect(plist);
       wnscroll(1,-1,-1,0);             /* Scroll one line.                         */
       wncurmov(2,40);
       wnprintf("  Start loop     %2i times", times);   /* Print                    */
       }

    if(*selection == 'r' || *selection == 'R' || *selection == '7')
       {
       fprintf(current,"\n7\n");        /* Print                                    */
       wnselect(plist);                 /* Select lower window.                     */
       wnscroll(1,-1,-1,0);
       wncurmov(2,40);
       wnprintf("  Repeat a loop              ");  /* Print                         */
       }

    wnselect(plist);
    wncurmov(0,2);
    wnprintf("Current Position: %6li, %6li     ",xpos,ypos);   /* Print            */
    wnselect(pwin);
    }

 *selection = ' ';
 wnselect(plist);
 wnscroll(3,-1,-1,0);                   /* Scroll three lines.                      */
 wncurmov(0,2);
 wnprintf("Current Position: %6li, %6li     ",xpos,ypos);   /* Print               */
 wnselect(pwin);                        /* Select upper window                      */
}


/*****************************************************************************
```

```
 *
 *      MODULE:   append                                                    *
 *
 *     PURPOSE:  Edit the file
 *
 *    PARAMETERS:      GLOBL: current            new_file
 *                            old                old_file
 *                            scan               radius
 *                            x_travel           y_travel
 *                            vel_cut            speed
 *
 *                     LOCAL: action            - Laser action variable
 *                            choice            - User choice character variable
 *                            choice1           - User choice character variable
 *                            numbers           - Character buffer for numeric input
 *                            times             - Number of times to process a loop
 *                            row               - Row number of the screen
 *
 *                     USERS: cut_a_pattern
 *
 *                     CALLS: fopen              fscanf
 *                            fprintf            wnscroll
 *                            wncurmov           wnprintf
 *                            wnquery            fclose
 *                            transform          build_file
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ***********************************************************************/

void append()
{
int row, action, times;
char choice[2], choice1[2], numbers[10];


old = fopen(old_file,"w");              /* Open extension file.                    */

action = 0;

fscanf(current, "%1i", &action);        /* Scan file for selection.                */
fprintf(old,"\n%1i\n",action);          /* Print                                   */
if(action != 8)
  {
  wnscroll(0,-1,-1,0);
  wncurmov(10,10);                      /* Move cursor.                            */
  wnprintf("There is an error in this program!!!");     /* Print                   */
  wnquery(choice,2,&scan);
  fclose(old);                          /* Close extention file                    */
  return;
  }
fscanf(current, "%f", &vel_cut);
fprintf(old, "%.3f\n", vel_cut);        /* Print                                   */

while(action != 9)                      /* As long as it is not an exit.           */
      {
      fscanf(current, "%1i", &action);
      fprintf(old,"\n%1i\n",action);    /* Print                                   */

      if(action == 1)                   /* If it is a move position.               */
         {
         fscanf(current, "%i", &x_travel);
         fscanf(current, "%i", &y_travel);  /* Scan file for the y travel distance. */
         fprintf(old, "%i\n", x_travel);    /* Print                               */
         fprintf(old, "%i\n", y_travel);
         }

      if(action == 2)                   /* If it is a move distance.               */
```

```
        {
        fscanf(current, "%i", &x_travel);
        fscanf(current, "%i", &y_travel);  /* Scan file for the y travel distance.     */
        fprintf(old, "%i\n", x_travel);    /* Print                                    */
        fprintf(old, "%i\n", y_travel);    /* Print                                    */
        }

     if(action == 5)                   /* If it is a circle set                       */
        {
        fscanf(current, "%i", &radius);    /* Scan file for the radius.                */
        fscanf(current, "%i", &speed);
        fprintf(old, "%i\n", radius);      /* Print                                    */
        fprintf(old, "%i\n", speed);
        }

     if(action == 6)                   /* If it is a loop set                         */
        {
        fscanf(current, "%i", &times);
        fprintf(old, "%i\n", times);       /* Print                                    */
        }
     }
fclose(old);
fclose(current);                       /* Close file.                                 */

current = fopen(new_file,"w");
old = fopen(old_file,"r");             /* Opening back up file.                       */

row = 3;
fscanf(old, "%1i", &action);           /* Scan file for the action.                   */
fscanf(old, "%f", &vel_cut);
wnscroll(0,-1,-1,0);                   /* Scroll window.                              */
wncurmov(row,1);
wnprintf("  Cutting Velocity %.3f", vel_cut);  /* Print                               */
wnprintf("                    Is this correct? (y/n)");
wnquery(choice,2,&scan);               /* Find the next selection.                    */
wncurmov(row,40);
wnprintf("                             ");     /* Print                              */
if(*choice == 'n' || *choice == 'N')
  {
  wncurmov(++row,1);
  wnprintf("            What cutting velocity do you want? (0 - 20.625)");  /* Print  */
  wnquery(numbers,10,&scan);
  vel_cut = transform(numbers);        /* Find the cutting velocity                   */
  }
fprintf(current,"\n%1i\n",action);     /* Print.                                      */
fprintf(current,"%.3f\n", vel_cut);

while(action != 9)                     /* As long as it is not an exit.               */
      {
      fscanf(old, "%1i", &action);
      if( ++row > 13)                  /* If the number of rows is more than 13       */
         {
         wnscroll(5,-1,-1,0);               /* Scroll 5 lines.                         */
         row = row - 5;
         }
      wncurmov(row,1);

  if(action == 1)                      /* If it is a move                             */
     {
     *choice1 = 'n';
     fscanf(old, "%i", &x_travel);
     fscanf(old, "%i", &y_travel);     /* Scan backup for the y travel distance.       */
     wnprintf("  Position    %5i, %5i", x_travel, y_travel);   /* Print               */
     wnprintf("              Is this correct? (y/n/q)");
     wnquery(choice,2,&scan);          /* Find the next selection.                     */
     wncurmov(row,40);
     wnprintf("                                 ");
     if(*choice == 'q' || *choice == 'Q')    /* If choice is a quit.                   */
         {
         fprintf(current,"\n%1i\n",action);   /* Print                                 */
         fprintf(current, "%i\n", x_travel);
         fprintf(current, "%i\n", y_travel);
         transfer_rest_of_file();             /* Do module.                            */
         return;
         }
     if(*choice == 'n' || *choice == 'N')
```

```
        {
        wncurmov(row,35);
        wnprintf("Do you want to insert commands? (y/n)");   /* Print                    */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                        ");    /* Print                 */
        if(*choice1 == 'y' || *choice1 == 'Y')
           {
           build_file();                          /* Do module.                          */

           wnscroll(0,-1,-1,0);                /* Scroll window.                          */
           row = 1;
           wncurmov(++row,1);                     /* Move cursor.                        */
           wnprintf("  Position    %5i, %5i", x_travel, y_travel);    /* Print          */
           }
        wncurmov(row,35);
        wnprintf("Delete this position move? (y/n)");   /* Print                          */
        wnquery(choice1,2,&scan);      /* Get the next selection.                         */
        wncurmov(row,35);
        wnprintf("                                    ");     /* Print                    */
        if(*choice1 != 'y' && *choice1 != 'Y')          /* If choice is a yes.            */
           {
           wncurmov(row,35);
           wnprintf("Keep the position the same? (y/n)");    /* Print                     */
           wnquery(choice,2,&scan);       /* Get next selection.                           */
           wncurmov(row,35);
           wnprintf("                                        ");
           if(*choice == 'n' || *choice == 'N')
              {
              wncurmov(++row,1);
              wnprintf("             What position would you like to move to? ");
              wncurmov(++row,1);
              wnprintf("                          X direction:");   /* Print              */
              wnquery(numbers,10,&scan);
              x_travel = (int)transform(numbers);
              wncurmov(++row,1);
              wnprintf("                          Y direction:");   /* Print              */
              wnquery(numbers,10,&scan);
              y_travel = (int)transform(numbers);
              }
           }
        }
    if(*choice1 != 'y' && *choice1 != 'Y')    /* If choice is a yes.                      */
        {
        fprintf(current,"\n%1i\n",action);
        fprintf(current, "%i\n", x_travel);
        fprintf(current, "%i\n", y_travel);   /* Print                                    */
        }
    }

if(action == 2)                        /* If it is a move distance.                       */
    {
    *choice1 = 'n';
    fscanf(old, "%i", &x_travel);      /* Scan backup file for the x travel distance.     */
    fscanf(old, "%i", &y_travel);
    wnprintf("  Distance    %5i, %5i", x_travel, y_travel);    /* Print                  */
    wnprintf("             Is this correct? (y/n/q)");
    wnquery(choice,2,&scan);           /* Find the next selection.                        */
    wncurmov(row,40);
    wnprintf("                                 ");     /* Print                          */
    if(*choice == 'q' || *choice == 'Q')
        {
        fprintf(current,"\n%1i\n",action);
        fprintf(current, "%i\n", x_travel);          /* Print                             */
        fprintf(current, "%i\n", y_travel);
        transfer_rest_of_file();
        return;
        }
    if(*choice == 'n' || *choice == 'N')             /* Choice is a no.                   */
        {
        wncurmov(row,35);              /* Move cursor                                     */
        wnprintf("Do you want to insert commands? (y/n)");    /* Print                    */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                        ");   /* Print                  */
        if(*choice1 == 'y' || *choice1 == 'Y')
```

```
        {
        build_file();                  /* Do module.                                  */
        wnscroll(0,-1,-1,0);
        row = 1;                       /* Define the row.                             */
        wncurmov(++row,1);
        wnprintf("  Distance    %5i, %5i", x_travel, y_travel);  /* Print            */
        }
      wncurmov(row,35);              /* Move cursor.                                 */
      wnprintf("Delete this distance move? (y/n)");   /* Print                        */
      wnquery(choice1,2,&scan);
      wncurmov(row,35);
      wnprintf("                                    ");    /* Print                   */
      if(*choice1 != 'y' && *choice1 != 'Y')
        {
        wncurmov(row,35);
        wnprintf(" Keep the distance the same? (y/n)");    /* Print                   */
        wnquery(choice,2,&scan);       /* Get the next selection                      */
        wncurmov(row,35);
        wnprintf("                                        ");    /* Print             */
        if(*choice == 'n' || *choice == 'N')
          {
          wncurmov(++row,1);          /* Move cursor.                                */
          wnprintf("             What distance would you like to move? ");
          wncurmov(++row,1);
          wnprintf("                          X direction:");   /* Print             */
          wnquery(numbers,10,&scan);
          x_travel = (int)transform(numbers);      /* Fine the x travel distance.    */
          wncurmov(++row,1);
          wnprintf("                          Y direction:");   /* Print             */
          wnquery(numbers,10,&scan);      /* Get the next selection.                 */
          y_travel = (int)transform(numbers);
          }
        }
      }
    if(*choice1 != 'y' && *choice1 != 'Y')   /* If the choice is a yes.               */
      {
      fprintf(current,"\n%1i\n",action);
      fprintf(current, "%i\n", x_travel);  /* Print                                   */
      fprintf(current, "%i\n", y_travel);
      }
    }

  if(action == 3)                      /* If it is a velocity set                     */
    {
    *choice1 = 'n';
    wnprintf("  Laser on                                Is this correct? (y/n/q)");
                                       /* Print                                       */
    wnquery(choice,2,&scan);           /* Get the next selection.                     */
    wncurmov(row,40);
    wnprintf("                                  ");   /* Print                        */
    if(*choice == 'q' || *choice == 'Q')           /* Choice is a quit.               */
      {
      fprintf(current,"\n%1i\n",action);
      transfer_rest_of_file();
      return;
      }
    if(*choice == 'n' || *choice == 'N')
      {
      wncurmov(row,35);
      wnprintf("Do you want to insert commands? (y/n)");   /* Print                    */
      wnquery(choice1,2,&scan);      /* Get the next selection.                       */
      wncurmov(row,35);
      wnprintf("                                        ");    /* Print               */
      if(*choice1 == 'y' || *choice1 == 'Y')
        {
        build_file();                  /* Do module.                                  */
        wnscroll(0,-1,-1,0);
        row = 1;                       /* Define row.                                 */
        wncurmov(++row,1);
        wnprintf("  Laser on      ");   /* Print                                      */
        }
      wncurmov(row,35);
      wnprintf("Delete this laser on? (y/n)");      /* Print                          */
      wnquery(choice1,2,&scan);      /* Find the next selection.                      */
      wncurmov(row,35);
      wnprintf("                                ");    /* Print                      */
```

```
        }
    if(*choice1 != 'y' && *choice1 != 'Y')
        fprintf(current,"\n%1i\n",action);      /* Print                                   */
    }

if(action == 4)                         /* If it is a laser off.                           */
    {
    *choice1 = 'n';
    wnprintf("  Laser off                                   Is this correct? (y/n/q)");
                                        /* Print                                           */
    wnquery(choice,2,&scan);            /* Get the next selection.                         */
    wncurmov(row,40);
    wnprintf("                                  ");     /* Print                           */
    if(*choice == 'q' || *choice == 'Q')     /* If the choice is a quit                    */
        {
        fprintf(current,"\n%1i\n",action);   /* Print                                      */
        transfer_rest_of_file();        /* Do module.                                      */
        return;
        }
    if(*choice == 'n' || *choice == 'N')
        {
        wncurmov(row,35);
        wnprintf("Do you want to insert commands? (y/n)");   /* Print                       */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);               /* Move cursor.                                    */
        wnprintf("                                          ");   /* Print                 */
        if(*choice1 == 'y' || *choice1 == 'Y')
            {
            build_file();                   /* Do module.                                  */
            wnscroll(0,-1,-1,0);
            row = 1;
            wncurmov(++row,1);              /* Do module.                                  */
            wnprintf("  Laser off     ");   /* Print                                       */
            }
        wncurmov(row,35);
        wnprintf("Delete this laser off? (y/n)");     /* Print                             */
        wnquery(choice1,2,&scan);       /* Get the next selection.                         */
        wncurmov(row,35);
        wnprintf("                                  ");    /* Print                        */
        }
    if(*choice1 != 'y' && *choice1 != 'Y')    /* Choice is no.                             */
        fprintf(current,"\n%1i\n",action);    /* Print                                     */
    }

if(action == 5)                         /* If it is a circle set                           */
    {
    *choice1 = 'n';
    fscanf(old, "%i", &radius);
    fscanf(old, "%i", &speed);
    if(speed == 1)
         wnprintf("  Circle w/o cntr %4i", radius);     /* Print                           */
    else
         wnprintf("  Circle w/ center%4i", radius);
    wnprintf("                  Is this correct? (y/n/q)");  /* Print                       */
    wnquery(choice,2,&scan);
    wncurmov(row,40);
    wnprintf("                                  ");    /* Print                            */
    if(*choice == 'q' || *choice == 'Q')    /* Choice is a quit.                           */
        {
        fprintf(current,"\n%1i\n",action);     /* Print                                    */
        fprintf(current, "%i\n", radius);
        fprintf(current, "%i\n", speed);
        transfer_rest_of_file();        /* Do the module.                                  */
        return;
        }
    if(*choice == 'n' || *choice == 'N')
        {
        wncurmov(row,35);               /* Do the module.                                  */
        wnprintf("Do you want to insert commands? (y/n)");    /* Print                     */
        wnquery(choice1,2,&scan);       /* Get the next selection.                         */
        wncurmov(row,35);
        wnprintf("                                          ");    /* Print                 */
        if(*choice1 == 'y' || *choice1 == 'Y')        /* Choice is a yes.                  */
            {
            build_file();
            wnscroll(0,-1,-1,0);            /* Scroll window.                              */
```

```
            row = 1;
            wncurmov(++row,1);
            if(speed == 1)
               wnprintf("  Circle w/o cntr %4i", radius);
             else
               wnprintf("  Circle w/ center%4i", radius);    /* Print                    */
            }
         wncurmov(row,35);
         wnprintf("Delete this circle? (y/n)");     /* Print                              */
         wnquery(choice1,2,&scan);      /* Get the next selection.                        */
         wncurmov(row,35);
         wnprintf("                                ");       /* Print                    */
         if(*choice1 != 'y' && *choice1 != 'Y')
            {
            wncurmov(row,35);
            wnprintf(" Keep the same circle and radius? (y/n)",radius);    /* Print     */
            wnquery(choice,2,&scan);       /* Get the next selection.                    */
            wncurmov(row,35);
            wnprintf("                                                  ");      /* Print       */
            if(*choice == 'n' || *choice == 'N')
               {
               wncurmov(++row,1);
               wnprintf("             What radius do you want? (in .01mm)");   /* Print */
               wnquery(numbers,10,&scan);
               radius = (int)transform(numbers);       /* Calculate the radius.          */
               wncurmov(++row,1);
               wnprintf("             Do you want to save the center? (y/n)"); /* Print */
               wnquery(numbers,2,&scan);
               if(*numbers == 'n' || *numbers == 'N')
                  speed = 1;
               else
                  speed = 0;               /* If it is a circle with a center.           */
               }
            }
         }
      if(*choice1 != 'y' && *choice1 != 'Y')   /* Choice is a yes.                       */
         {
         fprintf(current,"\n%1i\n",action);
         fprintf(current, "%i\n", radius);   /* Print                                     */
         fprintf(current, "%i\n", speed);
         }
      }

   if(action == 6)                        /* If it is a loop                             */
      {
      *choice1 = 'n';
      fscanf(old, "%i", &times);
      wnprintf("  Start loop     %2i times", times);    /* Print                          */
      wnprintf("              Is this correct? (y/n/q)");
      wnquery(choice,2,&scan);                          /* Get the next selection.        */
      wncurmov(row,40);
      wnprintf("                                ");     /* Print                         */
      if(*choice == 'q' || *choice == 'Q')     /* If it is a quit.                        */
         {
         fprintf(current,"\n%1i\n",action);     /* Print                                 */
         fprintf(current, "%i\n", times);
         transfer_rest_of_file();              /* Do the module.                          */
         return;
         }
      if(*choice == 'n' || *choice == 'N')     /* Choice is a no.                         */
         {
         wncurmov(row,35);
         wnprintf("Do you want to insert commands? (y/n)");  /* Print                     */
         wnquery(choice1,2,&scan);            /* Get the next selection.                 */
         wncurmov(row,35);
         wnprintf("                                          ");  /* Print               */
         if(*choice1 == 'y' || *choice1 == 'Y')       /* Choice is a yes.                */
            {
            build_file();
            wnscroll(0,-1,-1,0);
            row = 1;
            wncurmov(++row,1);
            wnprintf("  Start loop     %2i times", times);     /* Print                  */
            }
         wncurmov(row,35);
         wnprintf("Delete this start of a loop? (y/n)");     /* Print                     */
```

```
        wnquery(choice1,2,&scan);      /* Get the next selection.                    */
        wncurmov(row,35);
        wnprintf("                                    ");   /* Print                 */
        if(*choice1 != 'y' && *choice1 != 'Y')
           {
           wncurmov(row,35);
           wnprintf(" Keep the %2i loop repetitions? (y/n)", times);   /* Print     */
           wnquery(choice,2,&scan);
           wncurmov(row,35);              /* Move cursor.                           */
           wnprintf("                                          ");
           if(*choice == 'n' || *choice == 'N')
              {
              wncurmov(++row,1);
              wnprintf("             How many times do you want? ");   /* Print    */
              wnquery(numbers,10,&scan);       /* Get the next selection.           */
              times = (int)transform(numbers);        /* Calculate the number of loops.*/
              }
           }
        }
    if(*choice1 != 'y' && *choice1 != 'Y')
        {
        fprintf(current,"\n%1i\n",action);     /* Print                             */
        fprintf(current, "%i\n", times);
        }
    }

if(action == 7)                        /* If it is a repeat loop                    */
    {
    *choice1 = 'n';
    wnprintf("  End loop                              Is this correct? (y/n/q)");
    wnquery(choice,2,&scan);           /* Get the next selection.                   */
    wncurmov(row,40);
    wnprintf("                              ");      /* Print                      */
    if(*choice == 'q' || *choice == 'Q')              /* Choice is a quit.          */
        {
        fprintf(current,"\n%1i\n",action);            /* Print                      */
        transfer_rest_of_file();                      /* Do module.                 */
        return;
        }
    if(*choice == 'n' || *choice == 'N')              /* Choice is a no.            */
        {
        wncurmov(row,35);
        wnprintf("Do you want to insert commands? (y/n)");    /* Print              */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                        ");  /* Print             */
        if(*choice1 == 'y' || *choice1 == 'Y')
           {
           build_file();                   /* Do module.                            */
           wnscroll(0,-1,-1,0);            /* Scroll window.                        */
           row = 1;
           wncurmov(++row,1);
           wnprintf("  End loop                              ");   /* Print        */
           }
        wncurmov(row,35);              /* Move cursor.                              */
        wnprintf(" Delete this loop repetition? (y/n)");      /* Print              */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                          ");  /* Print           */
        }
    if(*choice1 != 'y' && *choice1 != 'Y')                     /* If choice is a no. */
        fprintf(current,"\n%1i\n",action);                     /* Print             */
    }

if(action == 9)                        /* If it is a exit                           */
    {
    *choice1 = 'n';
    wnprintf("  End of file                           Is this correct? (y/n)");
    wnquery(choice,2,&scan);           /* Find the next selection.                  */
    wncurmov(row,40);
    wnprintf("                              ");                /* Print            */
    if(*choice == 'n' || *choice == 'N')
        {
        wncurmov(row,35); /* Move the cursor. */
        wnprintf("Do you want to insert commands? (y/n)");      /* Print            */
        wnquery(choice1,2,&scan);
```

```
        wncurmov(row,35);
        wnprintf("                                        ");    /* Print                  */
        if(*choice1 == 'y' || *choice1 == 'Y')                   /* Choice is a yes.       */
       {
       build_file();                    /* Do module.                                      */
       wnscroll(0,-1,-1,0);
       row = 1;
       }
        }
     fprintf(current,"\n%1i\n",action);                           /* Print                  */
     }
   }
fclose(old);
}



/*****************************************************************************
 *
 *      MODULE:   transfer_rest_of_file
 *
 *     PURPOSE:   Copy the rest of file to disk (from a quit in the edit)
 *
 *    PARAMETERS:      GLOBL: current            old
 *                            speed              radius
 *                            x_travel           y_travel
 *
 *                     LOCAL: action            - Laser action variable
 *                            times             - Number of times to process a loop
 *
 *                     USERS: append
 *
 *                     CALLS: fprintf            fscanf
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ***********************************************************************/

void transfer_rest_of_file()
{
int action, times;


while(action != 9)                  /* As long as it isn't an exit.                    */
  {
  fscanf(old, "%1i", &action);
  fprintf(current,"\n%1i\n",action);   /* Print                                    */

  if(action == 1)                   /* If it is a move                                 */
     {
     fscanf(old, "%i", &x_travel);  /* Scan backup for the x travel distance.          */
     fscanf(old, "%i", &y_travel);
     fprintf(current, "%i\n", x_travel);
     fprintf(current, "%i\n", y_travel);
     }

  if(action == 2)                   /* If it is a move                                 */
     {
     fscanf(old, "%i", &x_travel);  /* Scan file for the x travel distance.            */
     fscanf(old, "%i", &y_travel);
     fprintf(current, "%i\n", x_travel);      /* Print                                  */
     fprintf(current, "%i\n", y_travel);
     }

  if(action == 5)                   /* If it is a circle set                           */
     {
     fscanf(old, "%i", &radius);    /* Scan file for the radius.                       */
```

```
    fscanf(old, "%i", &speed);
    fprintf(current, "%i\n", radius);                    /* Print                    */
    fprintf(current, "%i\n", speed);
    }

  if(action == 6)                        /* If it is a loop                          */
    {
    fscanf(old, "%i", &times);           /* Scan file for the number of loops.       */
    fprintf(current, "%i\n", times);                     /* Print                    */
    }
     }
}



/*****************************************************************************
 *
 *      MODULE:  pattern_check
 *
 *     PURPOSE: Analyze and optionally print the file
 *
 *    PARAMETERS:      GLOBL: current            print
 *                            prn_file           radius
 *                            scan               selection
 *                            x_position         y_position
 *                            x_travel           y_travel
 *                            speed              laser_status
 *                            vel                vel_cut
 *
 *                     PARAM: print_it          - Option to send the file to the printer
 *
 *                     LOCAL: action            - Laser action variable
 *                            count             - Array counter
 *                            i                 - Loop counter
 *                            k                 - Loop counter
 *                            loop_times        - Array for the # of times a loop is done
 *                            looping           - Array counter for loop to keep track of
 *                            nested_x          - Array for the x posit. during the loops
 *                            nested_y          - Array for the y posit. during the loops
 *                            times             - Number of times to pracess a loop
 *                            row               - Row number of the screen
 *
 *                     USERS: cut_a_pattern
 *
 *                     CALLS: fopen              fprintf
 *                            fscanf             wnscroll
 *                            wncurmov           wnprintf
 *                            wnquery            fclose
 *                            velocity_set
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***********************************************************************/

void pattern_check(int print_it)
{
int i, k, row, count;
int action, times[5];
int nested_x[5], nested_y[5], loop_times[5], looping;


laser_status = OFF;                      /* Defining initial values.                 */
count = 0;
for(k=0;k!=5;k++)
  {
  times[k] = 0;
  nested_x[k] = 0;
```

```
  nested_y[k] = 0;
  loop_times[k] = 0;
  }
x_position = 0;
y_position = 0;
circles = 0;
loops = 0;
end_loops = 0;
on = 0;
off = 0;
looping = 0;
row = 1;

if(print_it == 1)
   fprintf(stdprn," \r\n\n#    Action      Parameters         Position      Velocity\n");
                                        /* Print                                          */

action = 0;

fscanf(current, "%1i", &action);        /* Scan file for the action.                      */
if(action != 8)                         /* If it isn't a resistor trim                    */
  {
  wnscroll(0,-1,-1,0);                                  /* Scroll window.                 */
  wncurmov(10,10);
  wnprintf("There is an error in this program!!!");     /* Print                          */
  wnquery(selection,2,&scan);
  fclose(current);
  return;                                               /* Return                         */
  }
fscanf(current, "%f", &vel_cut);
if(print_it == 1)
     fprintf(stdprn," \r\n%1i   Cutting Vel.  %7.3f            0,    0        0.000\n",
                          action, vel_cut);

while(action != 9)                      /* While action isn't exit.                       */
  {
  fscanf(current, "%1i", &action);      /* Scan file for the action.                      */

  if(action == 1)                       /* If it is a move                                */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for the x travel distance            */
     fscanf(current, "%i", &y_travel);
     if(laser_status == ON)             /* If laser is on                                 */
        vel = vel_cut;
     else
        vel = velocity_set(x_travel-x_position, y_travel-y_position);
                                        /* Find the safe velocity                         */
     if(print_it == 1)
        fprintf(stdprn," \r%1i   Position   %5i,%5i       %5i,%5i      %7.3f\n",
                          action, x_travel, y_travel, x_position, y_position, vel);
     x_position = x_travel;             /* Calculate the x position.                      */
     y_position = y_travel;
     }

  if(action == 2)                       /* If it is a move                                */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for the x travel distance.           */
     fscanf(current, "%i", &y_travel);
     if(laser_status == ON)
        vel = vel_cut;                  /* Calculate the cutting velocity                 */
     else
        vel = velocity_set(x_travel, y_travel);
     if(print_it == 1)
         fprintf(stdprn," \r%1i   Distance   %5i,%5i       %5i,%5i      %7.3f\n",
                           action, x_travel, y_travel, x_position, y_position, vel);
     x_position = x_travel + x_position;            /* Calculate the x position.          */
     y_position = y_travel + y_position;
     }

  if(action == 3)                       /* If it is a laser on                            */
     {
     k = 1;
     if(looping != 0)
        {
        for(i=1; i != looping + 1; i++)       /* Increment the number of loops.           */
           {
```

```
        k = k * loop_times[i];              /* keep track of the number of loops.     */
        }
      }
   on = on + k;            /* Keep track of the number of times the laser has been on. */
   if(print_it == 1)
       fprintf(stdprn," \r%1i   Laser on                    %5i,%5i      %7.3f\n",
                          action, x_position, y_position, vel);
                                        /* Print.                                     */
   laser_status = ON;
   }

if(action == 4)                         /* If it is a laser off                       */
   {
   k = 1;                               /* Number of times laser has been on.         */

   if(looping != 0)
      {
      for(i=1; i != looping + 1; i++)   /* Keeping track of the number of loops.      */

         {
         k = k * loop_times[i];
         }
      }
   off = off + k;      /* Keeping track of the number of times the laser has been off. */
   if(print_it == 1)
       fprintf(stdprn," \r%1i   Laser off                   %5i,%5i      %7.3f\n",
                          action, x_position, y_position, vel);
   laser_status = OFF;                  /* Turning laser off.                         */

   }

if(action == 5)                         /* If it is a circle set                      */
   {
   fscanf(current, "%i", &radius);      /* Scan file for the radius                   */

   fscanf(current, "%i", &speed);
   k = 1;                               /* Number of circles                          */

   if(looping != 0)
      {
      for(i=1; i != looping + 1; i++)  /* Keeping track of the number of times        */
                                       /*          circle has been done.              */

         {
         k = k * loop_times[i];
         }
      }
   circles = circles + k;               /* Number of circles.                         */
   if(print_it == 1)
      {
      if(speed == 1)                    /* If it is a circle with a center.           */
       fprintf(stdprn," \r%1i   Circle w/o cntr%5i         %5i,%5i        2.000\n",
                          action, radius, x_position, y_position, vel);
      else
       fprintf(stdprn," \r%1i   Circle w/center%5i         %5i,%5i        1.000\n",
                          action, radius, x_position, y_position, vel);
      }
   }

if(action == 6)                         /* If it is a start loop                      */
   {
   fscanf(current, "%i", &times[count]);    /* Scan file for the number of loops.     */
   nested_x[count] = x_position;
   nested_y[count] = y_position;
   looping++;                           /* Increment                                  */
   loop_times[looping] = times[count];  /* Calculate the number of loops.             */
   loops++;
   if(print_it == 1)
       fprintf(stdprn," \r%1i   Start Loop   %3i times       %5i,%5i      %7.3f\n",
                          action, times[count], x_position, y_position, vel);
   count++;                             /* Increment                                  */
   }

 if(action == 7)                         /* If it is an end loop                       */
   {
   if(count != 0)                       /* If is isn't the first loop                 */
```

```
        {
        count--;
        x_position = nested_x[count] + times[count]*(x_position - nested_x[count]);
                                        /* Calculate the x position.                    */
        y_position = nested_y[count] + times[count]*(y_position - nested_y[count]);
        end_loops++;
        if(print_it == 1)               /* If it is to be sent to the printer.          */
             {
             fprintf(stdprn," \r-     Loop repetition \n");
             fprintf(stdprn," \r%1i   End loop                    %5i,%5i      %7.3f\n",
                              action, x_position, y_position, vel);
             }
        looping--;                      /* Decrement the number of loops                */
        }
     else
        {
        end_loops++;                    /* Keep track of the number of loops completed  */
        if(print_it == 1)
           fprintf(stdprn," \r%1i   EXTRA END LOOP              %5i,%5i      %7.3f\n",
                             action, x_position, y_position, vel);
        }
     }
   }

if(print_it == 1)
    fprintf(stdprn," \r\n%1i   End of File                  %5i,%5i      %7.3f\n",
                          action, x_position, y_position, vel);
                                        /* Print                                        */

if(print_it == 1)                       /* If it is to be sent to the printer.          */
    {
    fprintf(stdprn," \r\n\nThe final position is %6i, %6i.", x_position, y_position);
                                        /* Send the following messages to the printer.  */
    fprintf(stdprn," \r\nThere were %i loops started.",loops);
    fprintf(stdprn," \r\nThere were %i loops ended.",end_loops);
    fprintf(stdprn," \r\nThe laser was turned on %i times.",on);
    fprintf(stdprn," \r\nThe laser was turned off %i times.",off);
    fprintf(stdprn," \r\nThere were %i circles.",circles);
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
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    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    }

}



/*****************************************************************************
 *
 *      MODULE:  do_file
 *
 *     PURPOSE:  Base loop execution (internal loops are processed separately)
 *
 *    PARAMETERS:      GLOBL: circles            current
 *                            end_loops         loops
 *                            num_loops         off
 *                            on                plist
 *                            pwin              resting
```

```
 *                              vel                 x_displace
 *                              x_position          xpos
 *                              y_displace          y_position
 *                              ypos                radius
 *                              scan                selection
 *                              x_travel            y_travel
 *                              speed               vel_cut
 *
 *                       LOCAL: action              - Laser action variable
 *                              choice              - User character input choice
 *                              col                 - Dumby variable for screen column
 *                              row                 - Row value of the screen
 *                              times               - Number of times to process a loop
 *                              bits                - Value of the port that controls speaker
 *                              i                   - Loop variable for the beep
 *                              j                   - Loop variable for the beep
 *                              vel_cut             - Cutting velocity of the laser
 *
 *                       USERS: cut_a_pattern
 *
 *                       CALLS: wnscroll            wncurmov
 *                              wnprintf            wnquery
 *                              some_move           rdpositn
 *                              fscanf              fclose
 *                              move_dist           skip_on_rest
 *                              laser_on            laser_off
 *                              circle_cut          set_up_a_loop
 *                              do_a_loop           wncurpos
 *                              wnselect            wait_for_rest
 *                              wait_for_rest2      check_for_stop
 *                              velocity_set
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***********************************************************************/

void do_file()
{
int i, j, bits, times, row, col, action;


pattern_check(0);

if((loops != end_loops) || (on != off) || (x_position != 0) || (y_position != 0))
  {
  wnscroll(0,-1,-1,0);                  /* Scroll window                          */
  wncurmov(7,10);
  wnprintf("This file is not operationaly correct!!");         /* Print           */
  wncurmov(9,10);
  wnprintf("Do you want to run the program anyway? (y/n)");    /* Print           */
  wnquery(selection,2,&scan);
  }
if(*selection == 'n' || *selection == 'N')          /* If selection is no.         */
  return;

fclose(current);

current = fopen(new_file,"r");          /* Open new file.                          */

laser_off();                            /* Laser off.                              */
laser_status = OFF;                     /* Defining variables.                     */
loops = 0;
end_loops = 0;
x_position = 0;
y_position = 0;
circles = 0;
on = 0;
off = 0;
```

```
wnscroll(0,-1,-1,0);                    /* Scroll window                          */
wncurmov(7,10);
wnprintf("Is the current position the origin? (y/n)");     /* Print                 */
wnquery(selection,2,&scan);
if(*selection == 'n' || *selection == 'N')      /* Selection is no.                 */
   some_move();                                 /* Module.                          */
rdpositn();
x_displace = xpos;                      /* New x position.                          */
y_displace = ypos;

wnscroll(0,-1,-1,0);
wncurmov(7,10);                         /* Move cursor.                             */
wnprintf("Press START when you are ready.            ");        /* Print             */
wait_for_start();                       /* Module                                   */
action = 0;

wnscroll(0,-1,-1,0);                    /* Scroll window                            */
wncurmov(1,1);
wnprintf("#    Action      Parameters         Position      Velocity");  /* Print*/
fscanf(current, "%1i", &action);
if(action != 8)
  {
  wnscroll(0,-1,-1,0);                  /* Scroll window                            */
  wncurmov(10,10);
  wnprintf("There is an error in this program!!!");     /* Print                    */
  wnquery(selection,2,&scan);
  fclose(current);
  return;
  }
fscanf(current, "%f", &vel_cut);
row = 2;
wncurmov(++row,1);
wnprintf("%1i   Cutting Vel.  %7.3f            0,    0        0.000\n",action, vel_cut);


while(action != 9)                      /* If it is an exit                         */
 {
 if(wait_for_rest2() == 1)
    {
    move_dist(0,0,0,0);                 /* Don't move                               */
    laser_off();                        /* Laser off                                */
    laser_status = OFF;
    rdpositn();                         /* Module                                   */
    vel = velocity_set( -xpos + x_displace,  -ypos + y_displace);
    move_dist( -xpos + x_displace, -ypos + y_displace, vel, vel);   /* Move distance.   */
    break;
    }
 fscanf(current, "%1i", &action);
 if( ++row > 17)
    {
    wnscroll(5,-1,-1,0);                /* Scroll five lines.                       */
    row = row - 5;
    }
      wncurmov(row,1);

  if(action == 1)                       /* If it is a move                          */
     {
     fscanf(current, "%i", &x_travel);    /* Scan file.                             */
     fscanf(current, "%i", &y_travel);
     rdpositn();
     if(laser_status == ON)
        vel = vel_cut;
     else
        vel = velocity_set(x_travel - xpos + x_displace,
                           y_travel - ypos + y_displace);
     move_dist(x_travel - xpos + x_displace,
               y_travel - ypos + y_displace, vel, vel);
                                        /* Move distance.                           */
     wnprintf("%1i   Position   %5i,%5i       %5i,%5i      %7.3f\n",
               action, x_travel, y_travel, x_position, y_position, vel);
     x_position = x_travel;
     y_position = y_travel;
     }

  if(action == 2)                       /* If it is a move                          */
```

```
   {
   fscanf(current, "%i", &x_travel);
   fscanf(current, "%i", &y_travel);  /* Scan file.                                  */
   if(laser_status == ON)
      vel = vel_cut;                  /* Set cutting velocity.                       */
   else
      vel = velocity_set(x_travel, y_travel);
   move_dist(x_travel, y_travel, vel, vel);         /* Move distance.               */
   wnprintf("%1i   Distance   %5i,%5i       %5i,%5i      %7.3f\n",
            action, x_travel, y_travel, x_position, y_position, vel);
   x_position = x_travel + x_position;              /* New x position.              */
   y_position = y_travel + y_position;
   }

if(action == 3)                       /* If it is a laser on                         */
   {
   on++;
   wnprintf("%1i   Laser on                    %5i,%5i      %7.3f\n",
            action, x_position, y_position, vel);
                                      /* Print                                       */
   wnselect(plist);
   wncurmov(0,2);                     /* Move cursor                                 */
   rdpositn();                        /* Do module                                   */
   wnprintf("Current Position: %6li, %6li      ",xpos, ypos);

   wnselect(pwin);
   laser_on();                        /* Do module                                   */
   laser_status = ON;
   }

if(action == 4)                       /* If it is a laser off                        */
   {
   off++;
   wnprintf("%1i   Laser off                   %5i,%5i      %7.3f\n",
            action, x_position, y_position, vel);
                                      /* Print                                       */
   laser_off();
   wnselect(plist);                   /* Lower window.                               */
   wncurmov(0,2);
   rdpositn();
   wnprintf("Current Position: %6li, %6li      ",xpos, ypos);  /* Print              */

   wnselect(pwin);
   laser_status = OFF;
   }

if(action == 5)                       /* If it is a circle set                       */
   {
   fscanf(current, "%i", &radius);    /* Scan file.                                  */
   circles++;
   laser_off();
   fscanf(current, "%i", &speed);     /* Scan file.                                  */
   if(speed == 1)
        {
        wnprintf("%1i   Circle w/o cntr%5i         %5i,%5i        2.000\n",
                 action, radius, x_position, y_position);
                                      /* Scan file.                                  */
        circle_cut(1);
        }
   else
        {
        wnprintf("%1i   Circle w/center%5i         %5i,%5i        2.000\n",
                 action, radius, x_position, y_position);
                                     /* Scan file.                                   */
        circle_cut(0);
        }
   wnselect(plist);                  /* Lower window.                                */
   wncurmov(0,2);
   rdpositn();
   wnprintf("Current Position: %6li, %6li      ",xpos, ypos);  /* Print              */

   wnselect(pwin);                   /* Upper window.                                */
   wait_for_rest();
   if(laser_status == ON)
         laser_on();
   }
```

```
  if(action == 6)                        /* If it is a start loop                        */
     {
     fscanf(current, "%i", &times);
     wnprintf("%1i   Start Loop 0  %3i times      %5i,%5i      %7.3f\n",
              action, times, x_position, y_position, vel);
     loops++;
     num_loops = 0;
     set_up_a_loop();
     num_loops = 0;
     if(do_a_loop(times) == 1)
        {
        move_dist(0,0,0,0);              /* Don't move.                                  */
        laser_off();                     /* Do module.                                   */
        laser_status = OFF;              /* Laser is off.                                */
        vel = velocity_set( -xpos + x_displace,  -ypos + y_displace);  /* New velocity. */
        move_dist( -xpos + x_displace, -ypos + y_displace, vel, vel);
        break;
        }
     wait_for_rest();
     wnprintf("8   End Loop 0                    %5i,%5i      %7.3f\n",
                                        x_position, y_position, vel);
                                        /* Print                                        */
     end_loops += 1;
     wncurpos(&row,&col);                /* Move cursor.                                 */
     }

  if(action == 7)                        /* If it is an repeat loop                      */
     {
     wnprintf(  "-     Extra end of repetition ");      /* Print                         */
     wnprintf("%1i   End loop                     %5i,%5i      %7.3f\n",
              action, x_position, y_position, vel);
     end_loops++;                        /* Increment number of endloops.                */
     return;
     }
  }

wncurmov(++row,1);
wnprintf("\a\a%1i   End of File                  %5i,%5i      %7.3f\n",action, x_position,
y_position, vel);
                                        /* Print                                        */

wnscroll(8,-1,-1,0);                    /* Scroll 8 lines.                              */
wncurmov(9,1);
wnprintf("              The final position is %6i, %6i.", x_position, y_position);
                                        /* Print                                        */
wnprintf("\n              There were %i loops started.",loops);  /* Print               */
wnprintf("\n              There were %i loops ended.",end_loops);
wnprintf("\n              The laser was turned on %i times.",on);
wnprintf("\n              The laser was turned off %i times.",off);
wnprintf("\n              There were %i circles.",circles);

wnselect(plist);                        /* Select lower window.                         */
wncurmov(0,2);
rdpositn();                             /* Do module.                                   */
wnprintf("Current Position: %6li, %6li     ",xpos,ypos);     /* Print                   */

laser_off();                            /* Do module.                                   */

wnselect(pwin);                         /* Lower window.                                */
wnprintf("\n\n                  (Press ENTER to continue)");      /* Print              */
wnquery(selection,2,&scan);

fclose(current);                        /* Close file.                                  */
}



/*****************************************************************************
 *
 *      MODULE:  set_up_a_loop
 *
 *     PURPOSE: To store in memory the (nested) loops of the file
 *
 *    PARAMETERS:      GLOBL: current            nested_loops
```

```
 *                              num_loops          speed
 *                              values             radius
 *                              x_travel           y_travel
 *
 *                       LOCAL: action            - Laser action variable
 *                              loop_number       - Current loop that is being processed
 *                              velo_cut          - Cutting velocity of the laser
 *                              times             - Number of times to process a loop
 *                              units_of_step     - Single operation pointer in a loop
 *
 *                       USERS: do_file            set_up_a_loop
 *
 *                       CALLS: fscanf             set_up_a_loop
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                     MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***********************************************************************/

void set_up_a_loop()
{
int action, times, loop_number, units_of_step;
float velo_set;


action = 0;                             /* Set initial value.                          */
loop_number = num_loops;
num_loops++;
units_of_step = 0;

while(action != 7)                      /* As long as it is not a 7                    */

      {
      fscanf(current, "%1i", &action);  /* Scan file.                                  */
      nested_loops[loop_number][units_of_step] = action;     /* Calculate nested loops. */

  if(action == 1)                       /* If it is a move                             */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for x travel distance.            */
     fscanf(current, "%i", &y_travel);
     values[loop_number][units_of_step][0] = x_travel;
     values[loop_number][units_of_step][1] = y_travel;    /* Find location for pointer. */
     }

  if(action == 2)                       /* If it is a move                             */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for x travel distance.            */
     fscanf(current, "%i", &y_travel);
     values[loop_number][units_of_step][0] = x_travel;    /* Find location for pointer. */
     values[loop_number][units_of_step][1] = y_travel;
     }

  if(action == 5)                       /* If it is a circle set                       */
     {
     fscanf(current, "%i", &radius);    /* Find radius.                                */
     fscanf(current, "%i", &speed );    /* Find type.                                  */
     values[loop_number][units_of_step][0] = radius;
     values[loop_number][units_of_step][1] = speed;
     }

  if(action == 6)                       /* If it is a start loop                       */
     {
     fscanf(current, "%i", &times);     /* Find number of times to do loop.            */
     values[loop_number][units_of_step][0] = times;
     set_up_a_loop();                   /* Do module.                                  */
     }
      units_of_step += 1;
      }
```

```
return;
}



/*****************************************************************************
 *
 *      MODULE: do_a_loop
 *
 *     PURPOSE: To process the internal (nested) loops
 *
 *    PARAMETERS:      GLOBL: circles            loops
 *                            nested_loops      num_loops
 *                            off               on
 *                            resting           speed
 *                            values            vel
 *                            x_displace        x_position
 *                            xpos              y_displace
 *                            y_position        ypos
 *                            radius            x_travel
 *                            y_travel          vel_cut
 *
 *                      PARAM: count            - Number of times to process this loop
 *
 *                      LOCAL: action           - Laser action variable
 *                            times             - Number of times to process the next loop
 *                            col               - Dumby variable for the column position
 *                            counter           - Loop counter
 *                            loop_number       - Which loop is being processed
 *                            row               - Row position on the screen
 *                            units_of_step     - Single operation pointer in a loop
 *                            vel_cut           - Cutting velocity of the laser
 *
 *                      USERS: do_file            do_a_loop
 *
 *                      CALLS: wncurpos           wnscroll
 *                            wncurmov          wnprintf
 *                            rdpositn          move_dist
 *                            skip_on_rest      laser_on
 *                            laser_off         circle_cut
 *                            do_a_loop         wait_for_rest
 *                            velocity_set      wait_for_rest2
 *
 *     RETURNS:  0 - Okay to keep going
 *               1 - STOP!!
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***************************************************************************/

int do_a_loop(int count)
{
int row, col, times, counter, loop_number, action, units_of_step;


loop_number = num_loops;
wncurpos(&row,&col);

for(counter = 0; counter < count; counter++)
  {
  num_loops = loop_number;
  units_of_step = 0;
  action = 0;
  while(action != 7)                    /* As long as it isn't a resistor trim.        */
      {
      if(wait_for_rest2() == 1)
         return(1);
      action = nested_loops[loop_number][units_of_step];
      if( ++row > 13)                   /* If the number of rows is more than 13       */
```

```
      {
      wnscroll(5,-1,-1,0);            /* Scroll window five lines.                    */
      row = row - 5;                  /* Calculate new row for window.                */
      }
    wncurmov(row,1);                  /* Move cursor.                                 */

if(action == 1)                       /* If it is a move                              */
   {
   x_travel = values[loop_number][units_of_step][0];  /* Calculate new x position.   */
   y_travel = values[loop_number][units_of_step][1];
   rdpositn();                        /* Do module.                                   */
   if(laser_status == ON)
      vel = vel_cut;                  /* Find new velocity.                           */
   else
      vel = velocity_set(x_travel - xpos + x_displace,
                         y_travel - ypos + y_displace);
   move_dist(x_travel - xpos + x_displace,
             y_travel - ypos + y_displace, vel, vel);
                                     /* Find the distance to move.                   */
   wnprintf("%1i   Position   %5i,%5i       %5i,%5i      %7.3f\n",
             action, x_travel, y_travel, x_position, y_position, vel);
                                     /* Print.                                       */
   x_position = x_travel;
   y_position = y_travel;             /* Find new y position.                         */
   }

if(action == 2)                       /* If it is a move                              */
   {
   x_travel = values[loop_number][units_of_step][0];   /* Find new x travel distance. */
   y_travel = values[loop_number][units_of_step][1];
   if(laser_status == ON)
      vel = vel_cut;                  /* Find new velocity.                           */
   else
      vel = velocity_set(x_travel, y_travel);   /* Find new velocity                  */
   move_dist(x_travel, y_travel, vel, vel);
   wnprintf("%1i   Distance   %5i,%5i       %5i,%5i      %7.3f\n",
             action, x_travel, y_travel, x_position, y_position, vel);
                                     /* Print                                        */
   x_position = x_travel + x_position;     /* Find new x position.                   */
   y_position = y_travel + y_position;
   }

if(action == 3)                       /* If it is a laser on                          */
   {
   on++;
   wnprintf("%1i   Laser on                    %5i,%5i      %7.3f\n",
             action, x_position, y_position, vel);
                                     /* Print                                        */
   wnselect(plist);                   /* Select lower window.                         */
   wncurmov(0,2);
   rdpositn();
   wnprintf("Current Position: %6li, %6li      ",xpos, ypos);
                                     /* Print                                        */

   wnselect(pwin);                    /* Select upper window.                         */
   laser_on();
   laser_status = ON;                 /* Change laser status to on.                   */
   }

if(action == 4)                       /* If it is a laser off                         */
   {
   off++;
   wnprintf("%1i   Laser off                   %5i,%5i      %7.3f\n",
             action, x_position, y_position, vel);
                                     /* Print.                                       */
   laser_off();
   wnselect(plist);
   wncurmov(0,2);
   rdpositn();                        /* Do module.                                   */
   wnprintf("Current Position: %6li, %6li      ",xpos, ypos);

   wnselect(pwin);                    /* Select lower window.                         */
   laser_status = OFF;
   }

if(action == 5)                       /* If it is a circle set                        */
```

```
    {
    radius = values[loop_number][units_of_step][0];
    speed  = values[loop_number][units_of_step][1];     /* Find type of circle.        */
    circles++;
    laser_off();                        /* Turn the laser off.                         */
    if(speed == 1)
         {
         wnprintf("%1i   Circle w/o cntr%5i         %5i,%5i        2.000\n",
                   action, radius, x_position, y_position);
                                        /* Print.                                      */
         circle_cut(1);                 /* Do module.                                  */
         }
    else
         {
         wnprintf("%1i   Circle w/center%5i         %5i,%5i        2.000\n",
                   action, radius, x_position, y_position);
                                        /* Print.                                      */
         circle_cut(0);                 /* Do module.                                  */
         }
    wnselect(plist);                    /* Select lower window                         */
    wncurmov(0,2);
    rdpositn();                         /* Do module.                                  */
    wnprintf("Current Position: %6li, %6li      ",xpos, ypos);
                                        /* Print.                                      */

    wnselect(pwin);                     /* Select lower window.                        */
    wait_for_rest();
    if(laser_status == ON)              /* If laser is on.                             */
          laser_on();
    }

  if(action == 6)                       /* If it is a start loop                       */
    {
    times = values[loop_number][units_of_step][0];       /* Calculate number of times. */
    num_loops++;
    wnprintf("%1i   Start Loop %i  %3i times      %5i,%5i      %7.3f\n",
              action, loop_number + 1, times, x_position, y_position, vel);
                                        /* Print.                                      */
    loops++;
    if(do_a_loop(times) == 1)           /* If it is the first loop.                    */
      return(1);
    wnprintf("8   End Loop %i                   %5i,%5i      %7.3f\n",
                           loop_number + 1, x_position, y_position, vel);
                                        /* Print                                       */
    end_loops += 1;                     /* Increment the number of endloops.           */
    wncurpos(&row,&col);                /* Move cursor.                                */
    }

     units_of_step++;
     }
   }
return(0);
}
```

APPENDIX VII

LASER/FILEMAKE INCLUDE FILES

```
/* main.h */

void  main(void);
void  scribe(void);
void  some_move(void);
void  circle_cut(int);
float transform(char *);
void  wait_for_rest(void);
int   wait_for_rest2(void);
void  circle(void);
int   velocity_set(int, int);

/*  */
```

```
/* moveincd.h */

void skip_on_rest(void);
void encode(int, int, float, float);
void move_norest(int, int, float, float);
void move_dist(int, int, float, float);
void move_it(void);
void clrhome(void);
void rdjoy(void);
void laser_on(void);
void disable_lim_cro(void);
void laser_off(void);
void rdpositn(void);
void power(int, int);
void rdotos(void);
void skhome(void);
void clrintr(void);
void index_pos(void);
void joymove(void);
void wait_for_start(void);
int  check_for_stop(void);

/*  */
```

```
/* savincd.h */

void cdecl cut_a_pattern(void);
void cdecl build_file(void);
void cdecl append(void);
void cdecl pattern_check(int);
void cdecl do_file(void);
int cdecl do_a_loop(int);
void cdecl set_up_a_loop(void);
void cdecl transfer_rest_of_file(void);

/*  */
```

```
/* measincd.h */

void astandard(void);
void arange(void);
void agen_volt(void);
void detect_gain(void);
void pre_gain(void);
void acomparator(void);
void adelay(void);
void clrol(void);
void skstrobe(void);
void strobe(void);
void clraccon(void);
void clracov(void);
void skend_delay(void);
void skready(void);
void skend_conv(void);
void rdoverload(void);
void rdconvert(void);
void channelb(void);
void channela(void);
void probe_select(void);
void findme(void);

/*  */


/* newstuff.h */

void laser_menu(void);
void change_defaults(void);
void measure_test_screen(void);
void measure_test(void);
void change_measure_test_values(void);
void display_feedback(void);
void laser_trim(void);
void probe_request(void);
void confirm_probes(void);
void current_resistor(void);
void resistor_corners(void);
void get_wanted_resistor(void);

/*  */


/* globlvar.h */

unsigned int resting, xjoy, yjoy, xotos, yotos, xhome, yhome;
int x_axis, y_axis, msbx, hlsbx, llsbx, vhlsbx, vllsbx;
int msby, hlsby, llsby, vhlsby, vllsby;
long int xpos, ypos;
float vel;

unsigned int strobe_done, ready, end_conv, end_delay, bprobe, aprobe, range;
unsigned int pre_amp, compare, delay, overload;
unsigned int probeahigh, probealow, probebhigh, probeblow, hdelay, ldelay;
unsigned int hrange, lrange, hstandard, lstandard, hgen_volt, lgen_volt;
unsigned int hgain, lgain, hpre_amp, lpre_amp, hcompare, lcompare;
int convertor;
float resistor, standard, gen_volt, gain;

long int posx[2] = {0}, posy[2] = {0};
BWINDOW *pwin, *plist;

int radius, scan, x_travel, y_travel;
char selection[3];

char file_name[9];
char old_file[12];
char new_file[12];
char prn_file[12];

FILE *old, *current, *print;
```

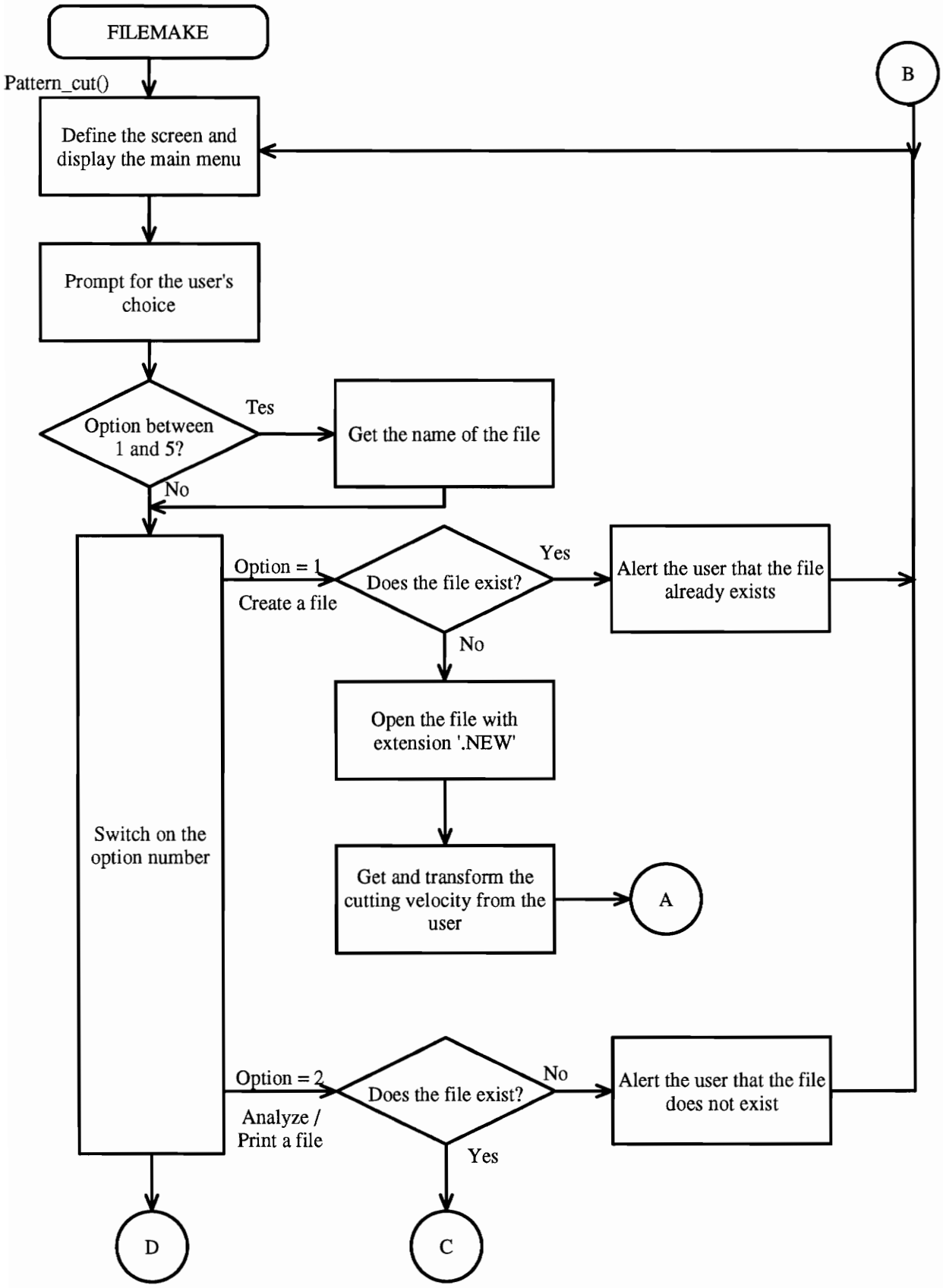
```
/* measincd.h */

void astandard(void);
void arange(void);
void agen_volt(void);
void detect_gain(void);
void pre_gain(void);
void acomparator(void);
void adelay(void);
void clrol(void);
void skstrobe(void);
void strobe(void);
void clraccon(void);
void clracov(void);
void skend_delay(void);
void skready(void);
void skend_conv(void);
void rdoverload(void);
void rdconvert(void);
void channelb(void);
void channela(void);
void probe_select(void);
void findme(void);

/*  */


/* newstuff.h */

void laser_menu(void);
void change_defaults(void);
void measure_test_screen(void);
void measure_test(void);
void change_measure_test_values(void);
void display_feedback(void);
void laser_trim(void);
void probe_request(void);
void confirm_probes(void);
void current_resistor(void);
void resistor_corners(void);
void get_wanted_resistor(void);

/*  */


/* globlvar.h */

unsigned int resting, xjoy, yjoy, xotos, yotos, xhome, yhome;
int x_axis, y_axis, msbx, hlsbx, llsbx, vhlsbx, vllsbx;
int msby, hlsby, llsby, vhlsby, vllsby;
long int xpos, ypos;
float vel;

unsigned int strobe_done, ready, end_conv, end_delay, bprobe, aprobe, range;
unsigned int pre_amp, compare, delay, overload;
unsigned int probeahigh, probealow, probebhigh, probeblow, hdelay, ldelay;
unsigned int hrange, lrange, hstandard, lstandard, hgen_volt, lgen_volt;
unsigned int hgain, lgain, hpre_amp, lpre_amp, hcompare, lcompare;
int convertor;
float resistor, standard, gen_volt, gain;

long int posx[2] = {0}, posy[2] = {0};
BWINDOW *pwin, *plist;

int radius, scan, x_travel, y_travel;
char selection[3];

char file_name[9];
char old_file[12];
char new_file[12];
char prn_file[12];

FILE *old, *current, *print;
```

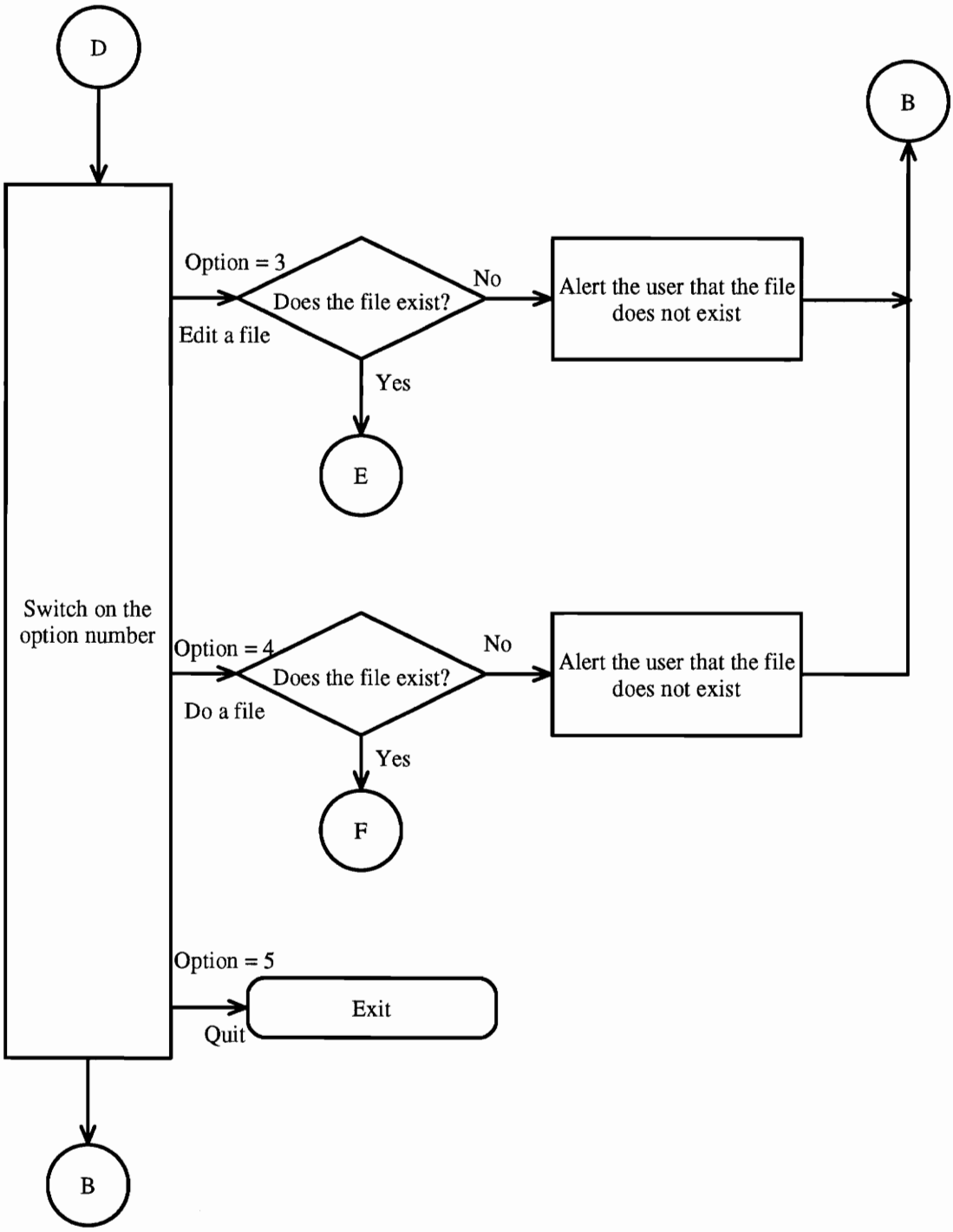
```
float vel, vel_cut;
int loops, end_loops, on, off, x_position, y_position, circles;
int nested_loops[30][200];
int values[30][200][2];
int x_displace, y_displace, num_loops, units_of_step;

double r1;

int stop, laser_status, speed;

long int starting_corner_x, starting_corner_y,
     adj_starting_corner_x, adj_starting_corner_y,
     opp_starting_corner_x, opp_starting_corner_y;

int number_of_serp_cuts = 5, abort_dist_lcut = 50, abort_dist_straight = 50;
int double_cut_ratio = 20, turn_after = 80;
float trim_speed = 0.125;

/*  */



/* extrnvar.h */

extern unsigned int resting, xjoy, yjoy, xotos, yotos, xhome, yhome;
extern int x_axis, y_axis, msbx, hlsbx, llsbx, vhlsbx, vllsbx;
extern int msby, hlsby, llsby, vhlsby, vllsby;
extern long int xpos, ypos;
extern float vel;

extern unsigned int strobe_done, ready, end_conv, end_delay, bprobe, aprobe, range;
extern unsigned int pre_amp, compare, delay, overload;
extern unsigned int probeahigh, probealow, probebhigh, probeblow, hdelay, ldelay;
extern unsigned int hrange, lrange, hstandard, lstandard, hgen_volt, lgen_volt;
extern unsigned int hgain, lgain, hpre_amp, lpre_amp, hcompare, lcompare;
extern int convertor;
extern float resistor, standard, gen_volt, gain;

extern long int posx[2], posy[2];
extern BWINDOW *pwin, *plist;

extern int radius, scan, x_travel, y_travel;
extern char selection[3];

extern char file_name[9];
extern char old_file[12];
extern char new_file[12];
extern char prn_file[12];

extern FILE *old, *current, *print;

extern float vel, vel_cut;
extern int loops, end_loops, on, off, x_position, y_position, circles;
extern int nested_loops[30][200];
extern int values[30][200][2];
extern int x_displace, y_displace, num_loops, units_of_step;

extern double r1;

extern int stop, laser_status, speed;

extern long int starting_corner_x, starting_corner_y,
          adj_starting_corner_x, adj_starting_corner_y,
          opp_starting_corner_x, opp_starting_corner_y;

extern int number_of_serp_cuts, abort_dist_lcut, abort_dist_straight;
extern int double_cut_ratio, turn_after;
extern float trim_speed;

/*  */
```

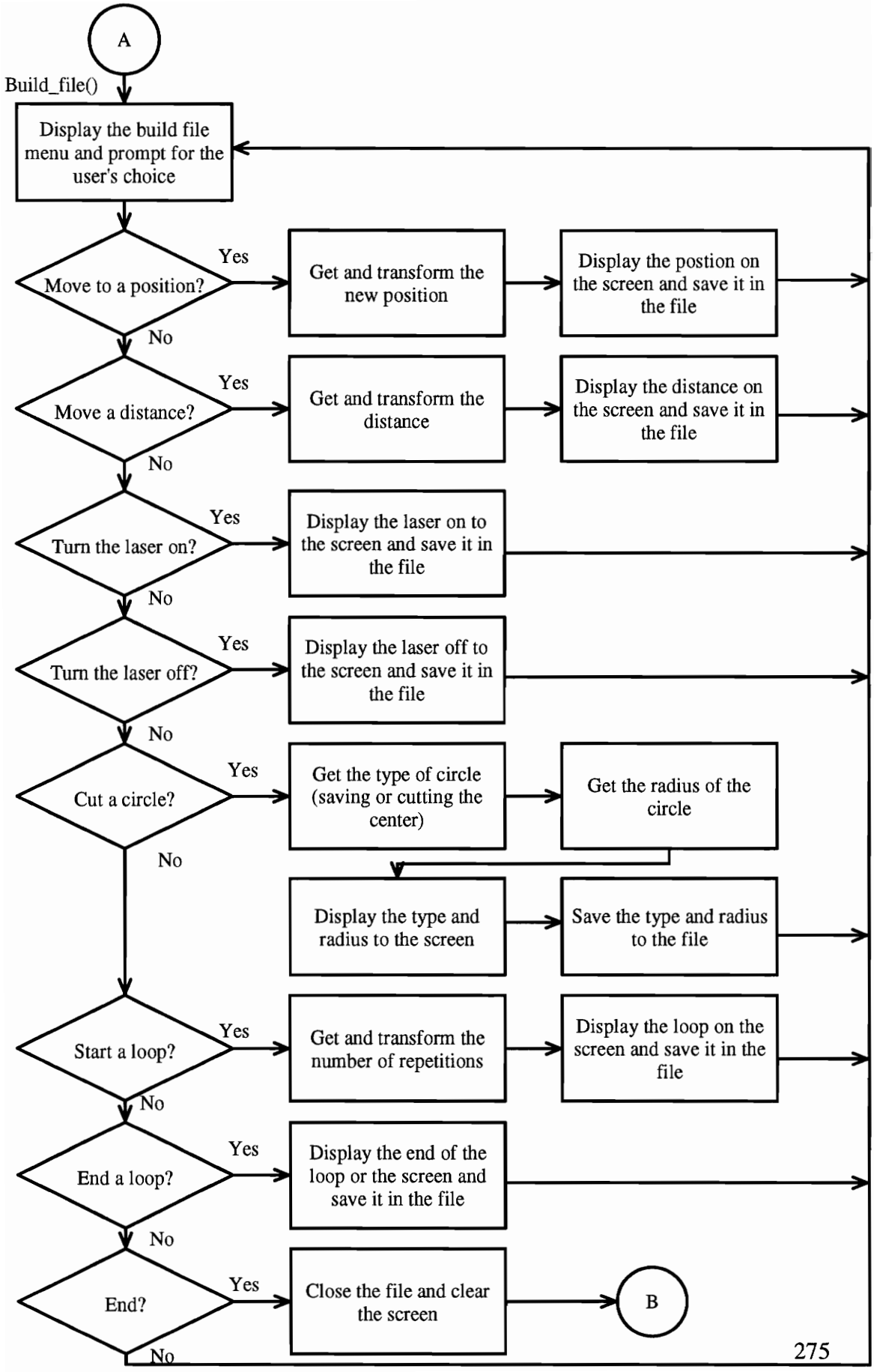
```
/* defntion.h */

#define  bmba      0x300
#define  bmbc      0x302
#define  bmbcom    0x303
#define  baca      0x304
#define  bacb      0x305
#define  bacc      0x306
#define  baccom    0x307
#define  aca       0x308
#define  acb       0x309
#define  acc       0x30A
#define  accom     0x30B
#define  outcbt    0x80      /*command config code for output all ports*/
#define  incbt     0x9B      /*command config code for input all ports*/

#define  addr13A    0x0B
#define  addr13C    0x06
#define  addr15A    0x0D
#define  addr15C    0x06
#define  addr16A    0x0E
#define  addr16C    0x06
#define  addr17A    0x0F
#define  addr17C    0x06
#define  addr30A    0x18
#define  addr30C    0x04
#define  addr31A    0x19
#define  addr31C    0x04
#define  addr32A    0x1A
#define  addr32C    0x04
#define  addr40A    0x20
#define  addr40C    0x03
#define  addr41A    0x21
#define  addr41C    0x03
#define  addr42A    0x22
#define  addr42C    0x03
#define  addr43A    0x23
#define  addr43C    0x03
#define  addr44A    0x24
#define  addr44C    0x03
#define  addr52A    0x2A
#define  addr52C    0x02
#define  addr53A    0x2B
#define  addr53C    0x02
#define  addr54A    0x2C
#define  addr54C    0x02
#define  addr55A    0x2D
#define  addr55C    0x02
#define  addr56A    0x2E
#define  addr56C    0x02

#define  iop1      0x01
#define  iop2      0x02
#define  iop4      0x04
#define  cleariop  0x00

#define  ON        1
#define  OFF       0

/*  */
```

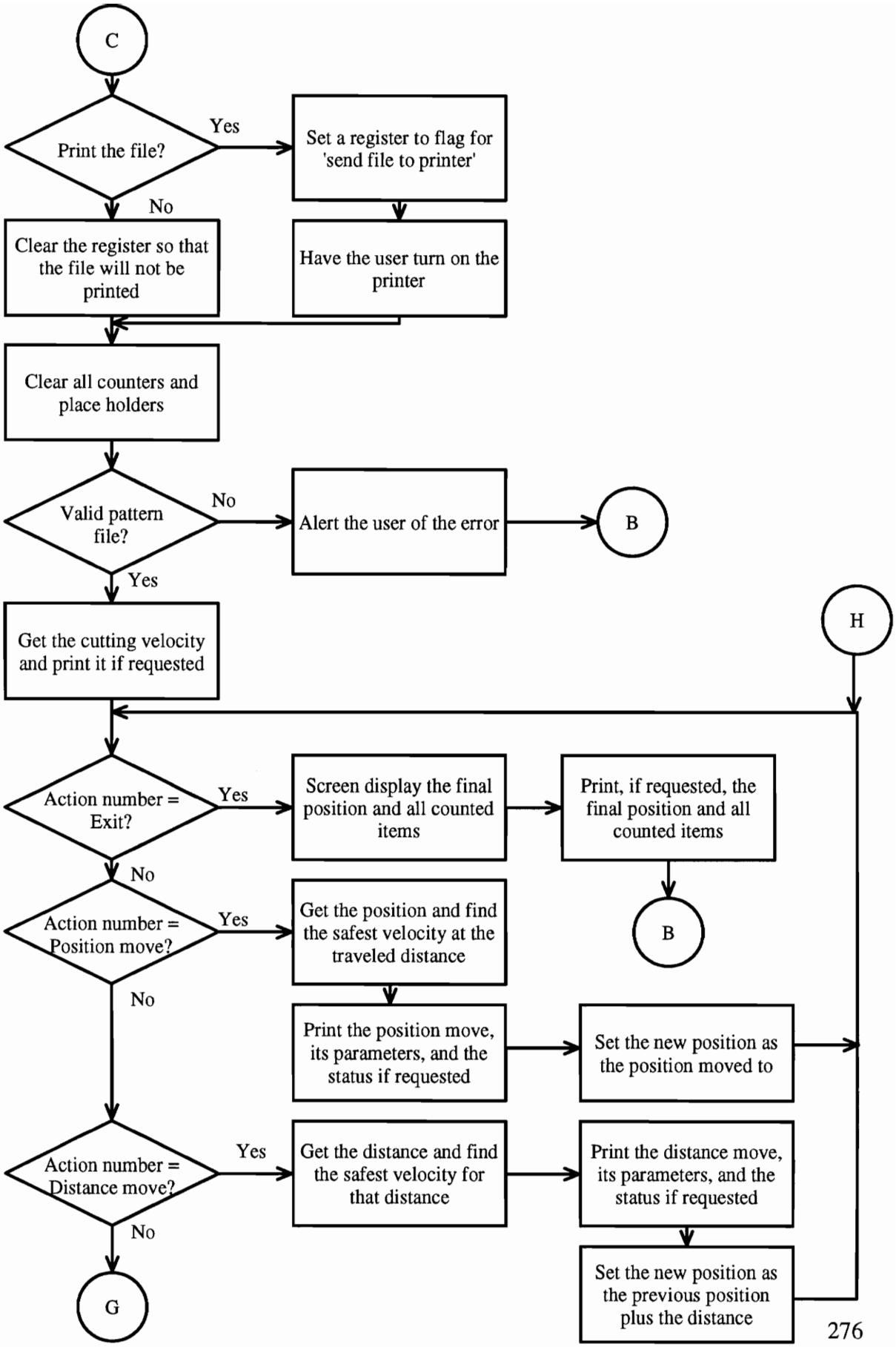
APPENDIX VIII

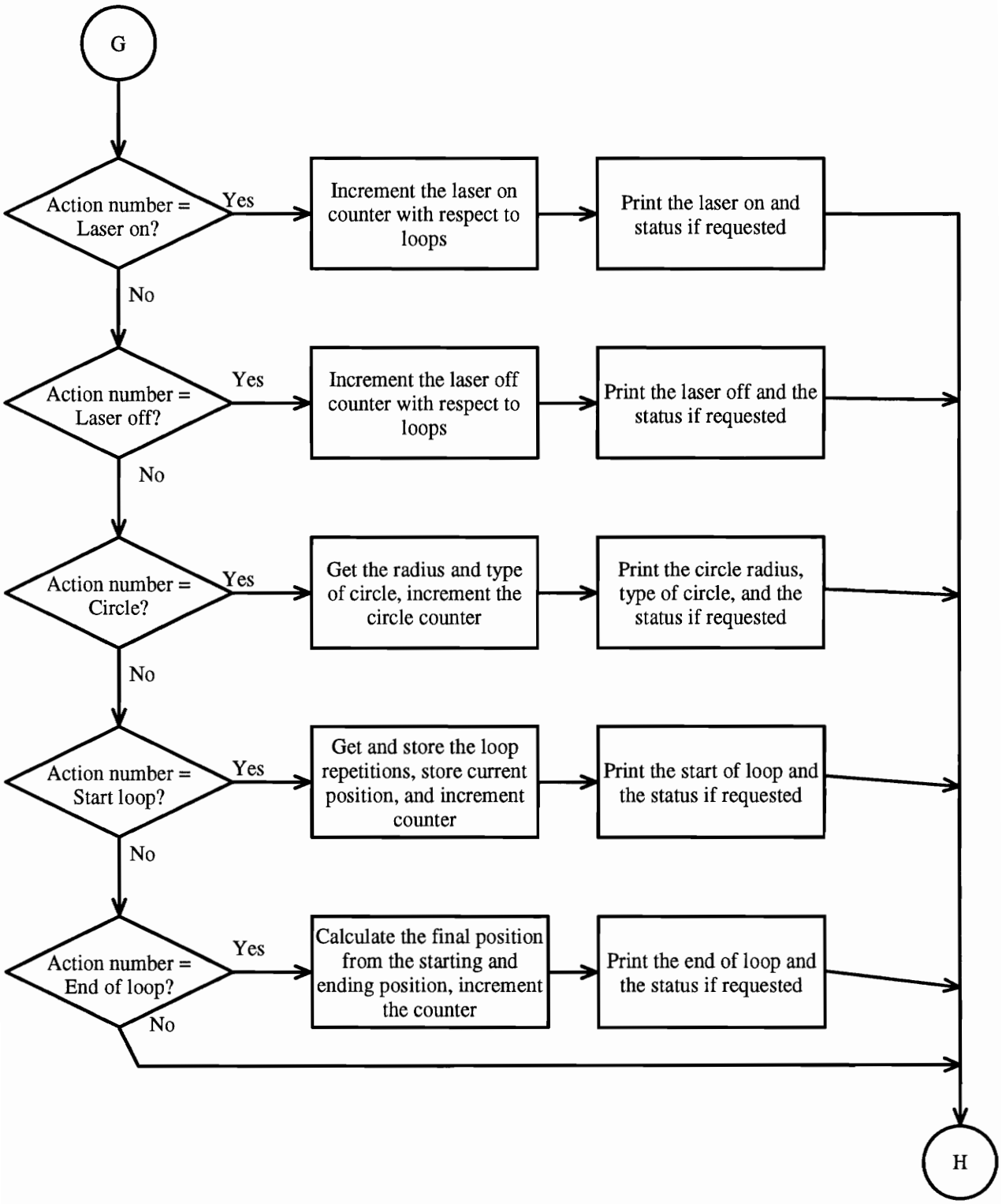
FILEMAKE SOFTWARE FLOWCHART

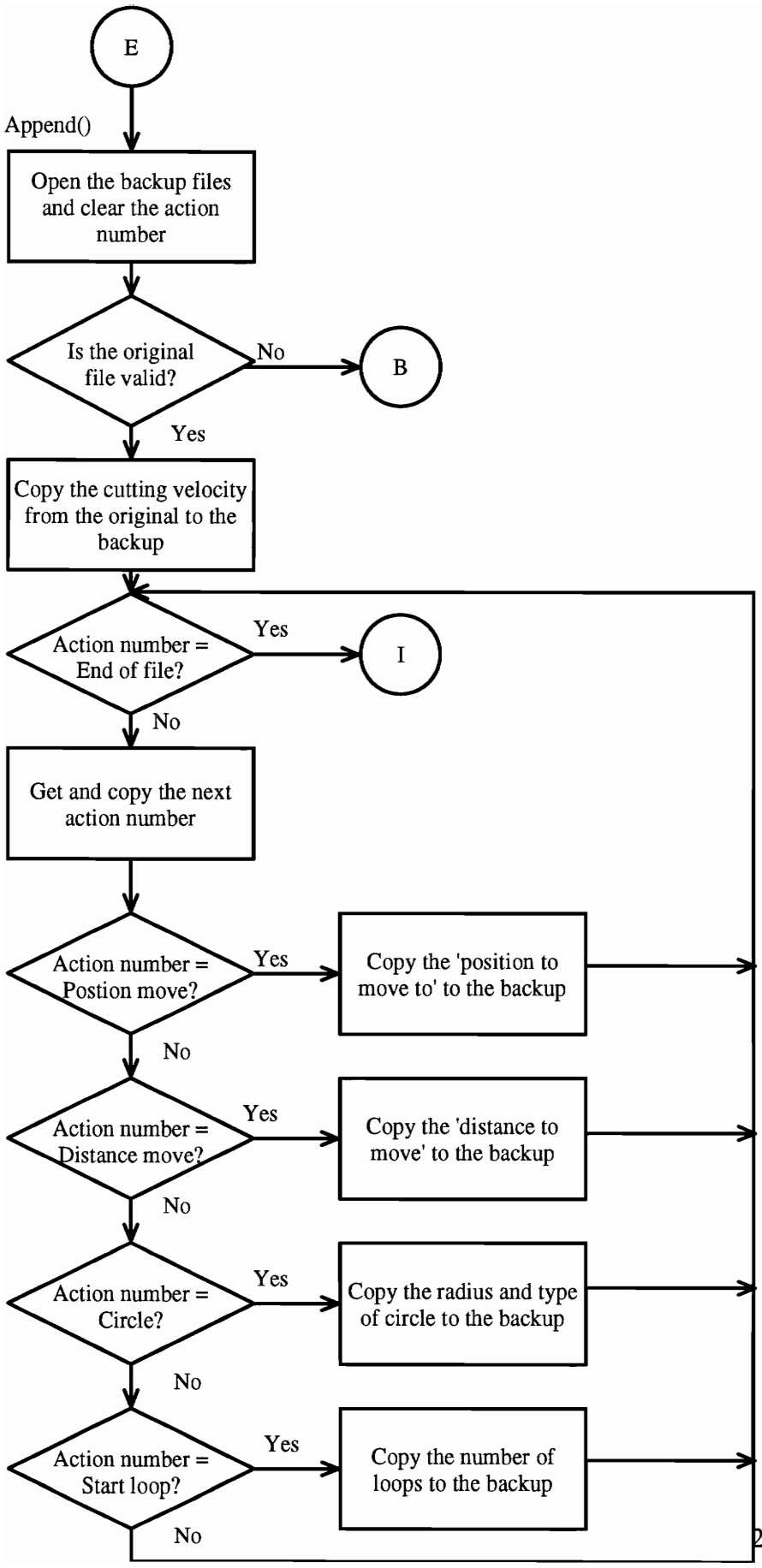

FILEMAKE
Pattern_cut()
B
Define the screen and display the main menu
Prompt for the user's choice
Option between 1 and 5?
Tes
Get the name of the file
No
Switch on the option number
Option = 1
Create a file
Does the file exist?
Yes
Alert the user that the file already exists
No
Open the file with extension '.NEW'
Get and transform the cutting velocity from the user
A
Option = 2
Analyze / Print a file
Does the file exist?
No
Alert the user that the file does not exist
Yes
D
C

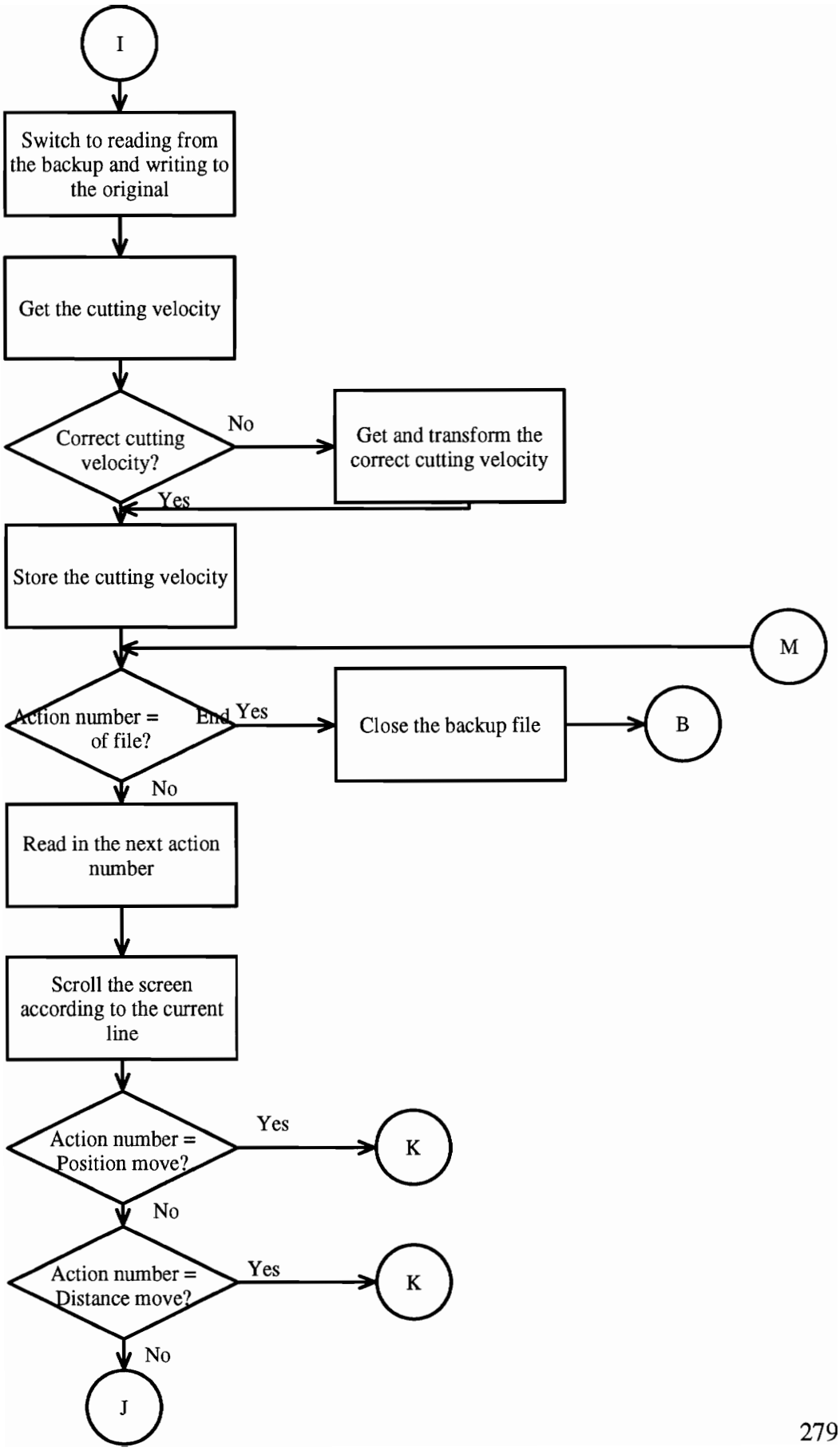

D
B
Switch on the option number
Option = 3
Does the file exist?
No
Alert the user that the file does not exist
Edit a file
Yes
E
Option = 4
Does the file exist?
No
Alert the user that the file does not exist
Do a file
Yes
F
Option = 5
Exit
Quit
B

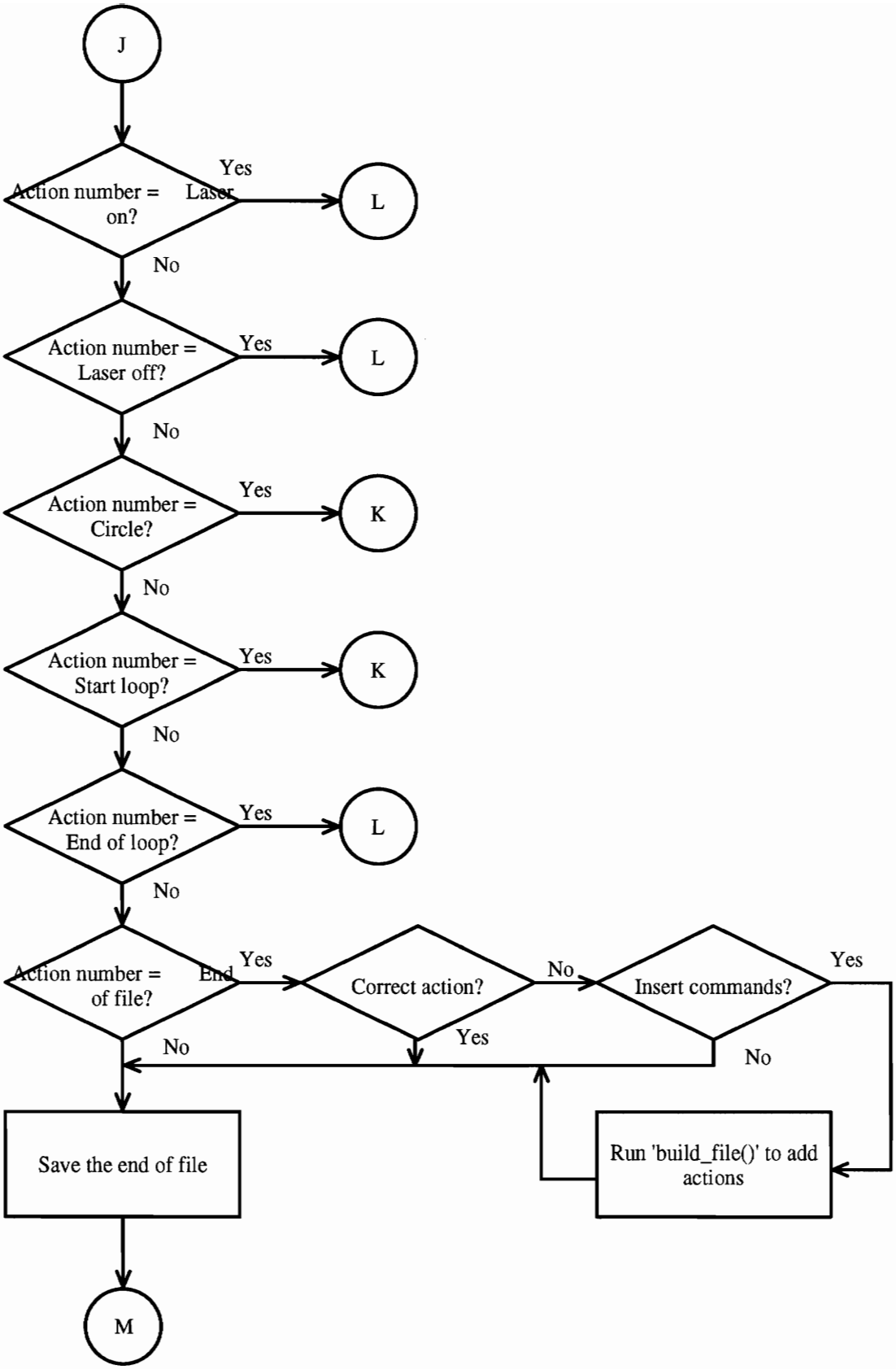

A
Build_file()
Display the build file menu and prompt for the user's choice
Move to a position?
Yes
Get and transform the new position
Display the postion on the screen and save it in the file
No
Move a distance?
Yes
Get and transform the distance
Display the distance on the screen and save it in the file
No
Turn the laser on?
Yes
Display the laser on to the screen and save it in the file
No
Turn the laser off?
Yes
Display the laser off to the screen and save it in the file
No
Cut a circle?
Yes
Get the type of circle (saving or cutting the center)
Get the radius of the circle
No
Display the type and radius to the screen
Save the type and radius to the file
Start a loop?
Yes
Get and transform the number of repetitions
Display the loop on the screen and save it in the file
No
End a loop?
Yes
Display the end of the loop or the screen and save it in the file
No
End?
Yes
Close the file and clear the screen
B
No

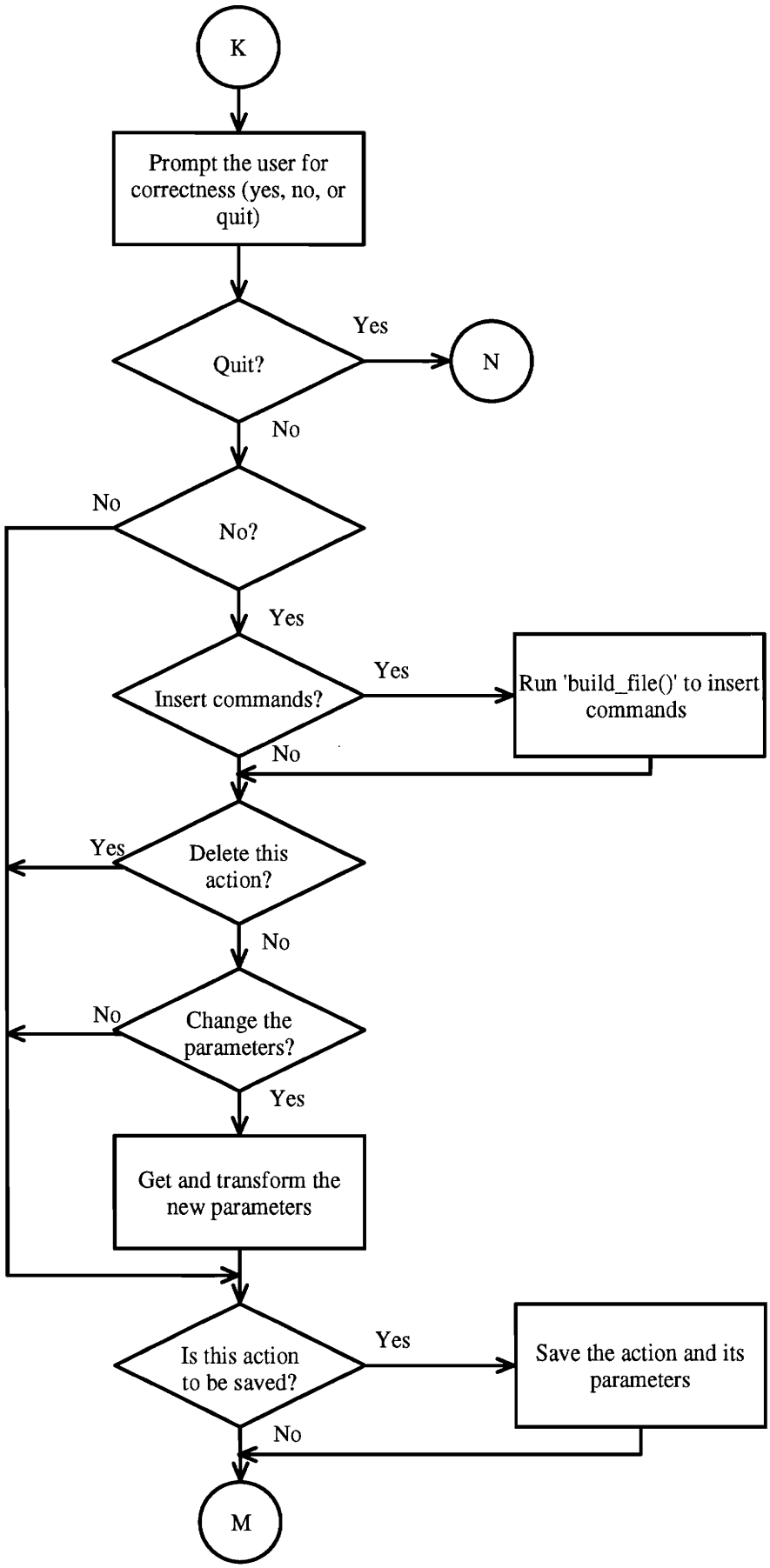

C
Print the file?
Yes
Set a register to flag for 'send file to printer'
No
Clear the register so that the file will not be printed
Have the user turn on the printer
Clear all counters and place holders
Valid pattern file?
No
Alert the user of the error
B
Yes
Get the cutting velocity and print it if requested
H
Action number = Exit?
Yes
Screen display the final position and all counted items
Print, if requested, the final position and all counted items
B
No
Action number = Position move?
Yes
Get the position and find the safest velocity at the traveled distance
Print the position move, its parameters, and the status if requested
Set the new position as the position moved to
No
Action number = Distance move?
Yes
Get the distance and find the safest velocity for that distance
Print the distance move, its parameters, and the status if requested
Set the new position as the previous position plus the distance
No
G

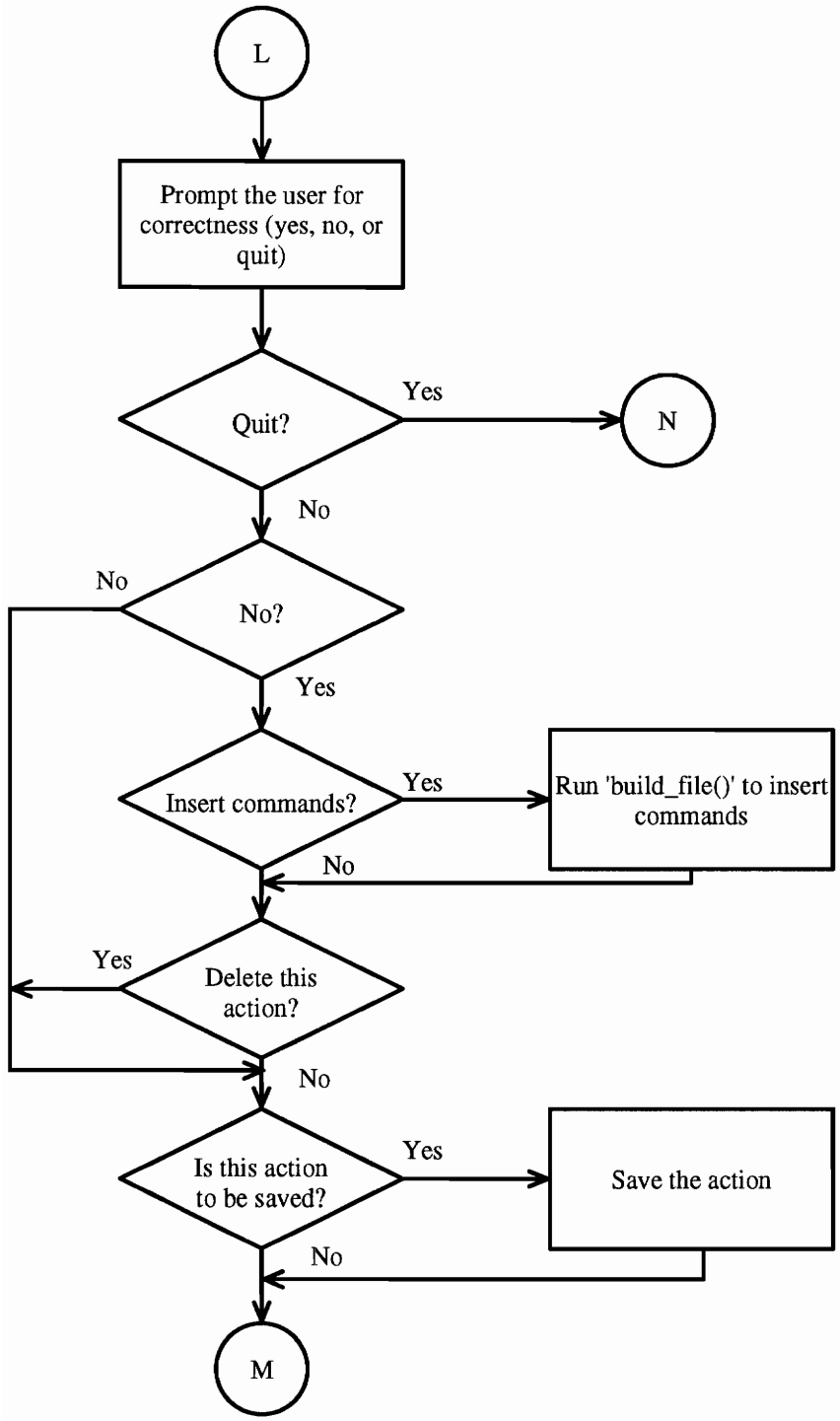

G
Action number = Laser on?
Yes
Increment the laser on counter with respect to loops
Print the laser on and status if requested
No
Action number = Laser off?
Yes
Increment the laser off counter with respect to loops
Print the laser off and the status if requested
No
Action number = Circle?
Yes
Get the radius and type of circle, increment the circle counter
Print the circle radius, type of circle, and the status if requested
No
Action number = Start loop?
Yes
Get and store the loop repetitions, store current position, and increment counter
Print the start of loop and the status if requested
No
Action number = End of loop?
Yes
Calculate the final position from the starting and ending position, increment the counter
Print the end of loop and the status if requested
No
H

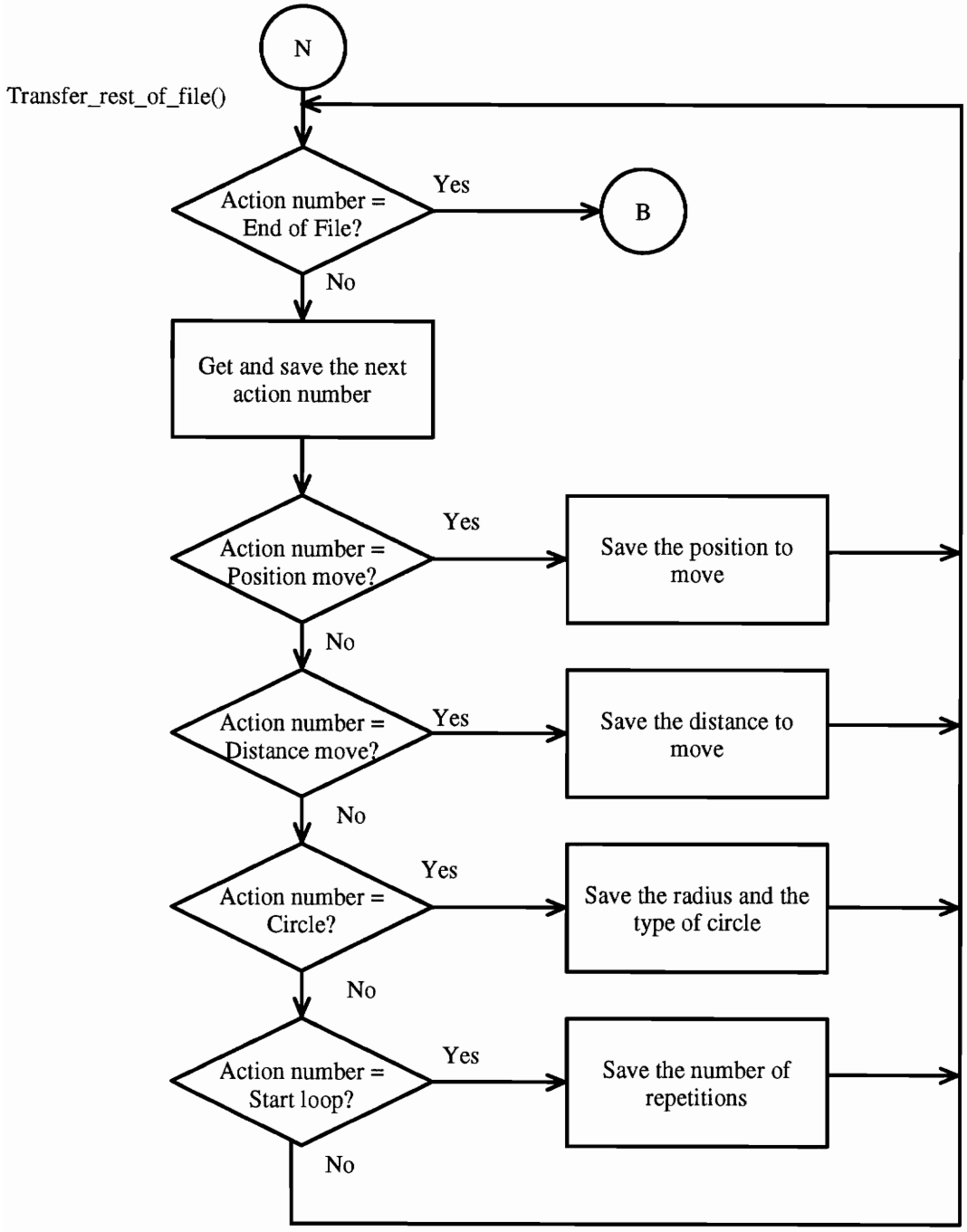

E
Append()
Open the backup files and clear the action number
Is the original file valid?
No
B
Yes
Copy the cutting velocity from the original to the backup
Action number = End of file?
Yes
I
No
Get and copy the next action number
Action number = Postion move?
Yes
Copy the 'position to move to' to the backup
No
Action number = Distance move?
Yes
Copy the 'distance to move' to the backup
No
Action number = Circle?
Yes
Copy the radius and type of circle to the backup
No
Action number = Start loop?
Yes
Copy the number of loops to the backup
No

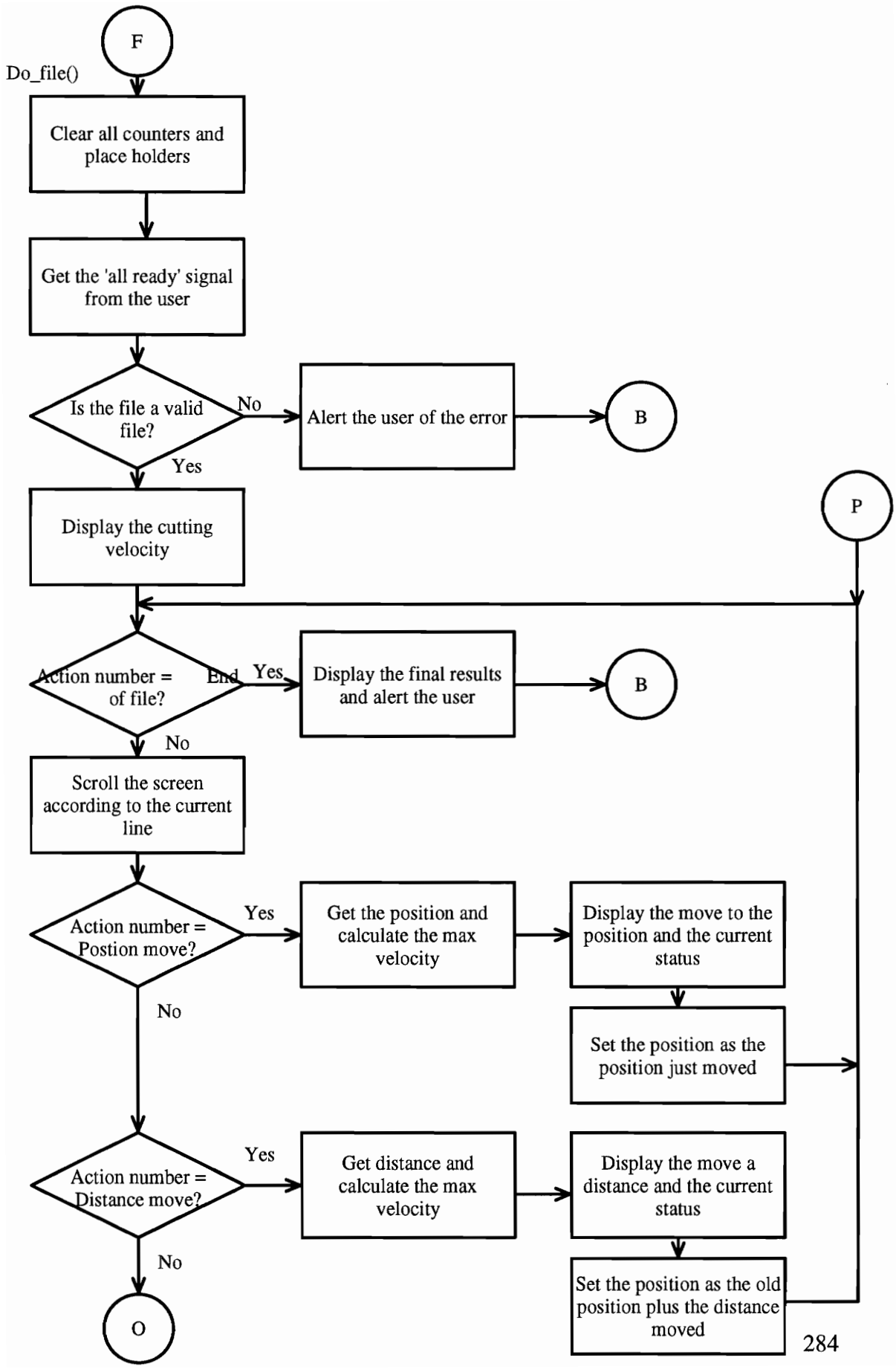

I
Switch to reading from the backup and writing to the original
Get the cutting velocity
Correct cutting velocity?
No
Get and transform the correct cutting velocity
Yes
Store the cutting velocity
M
Action number = End of file?
Yes
Close the backup file
B
No
Read in the next action number
Scroll the screen according to the current line
Action number = Position move?
Yes
K
No
Action number = Distance move?
Yes
K
No
J

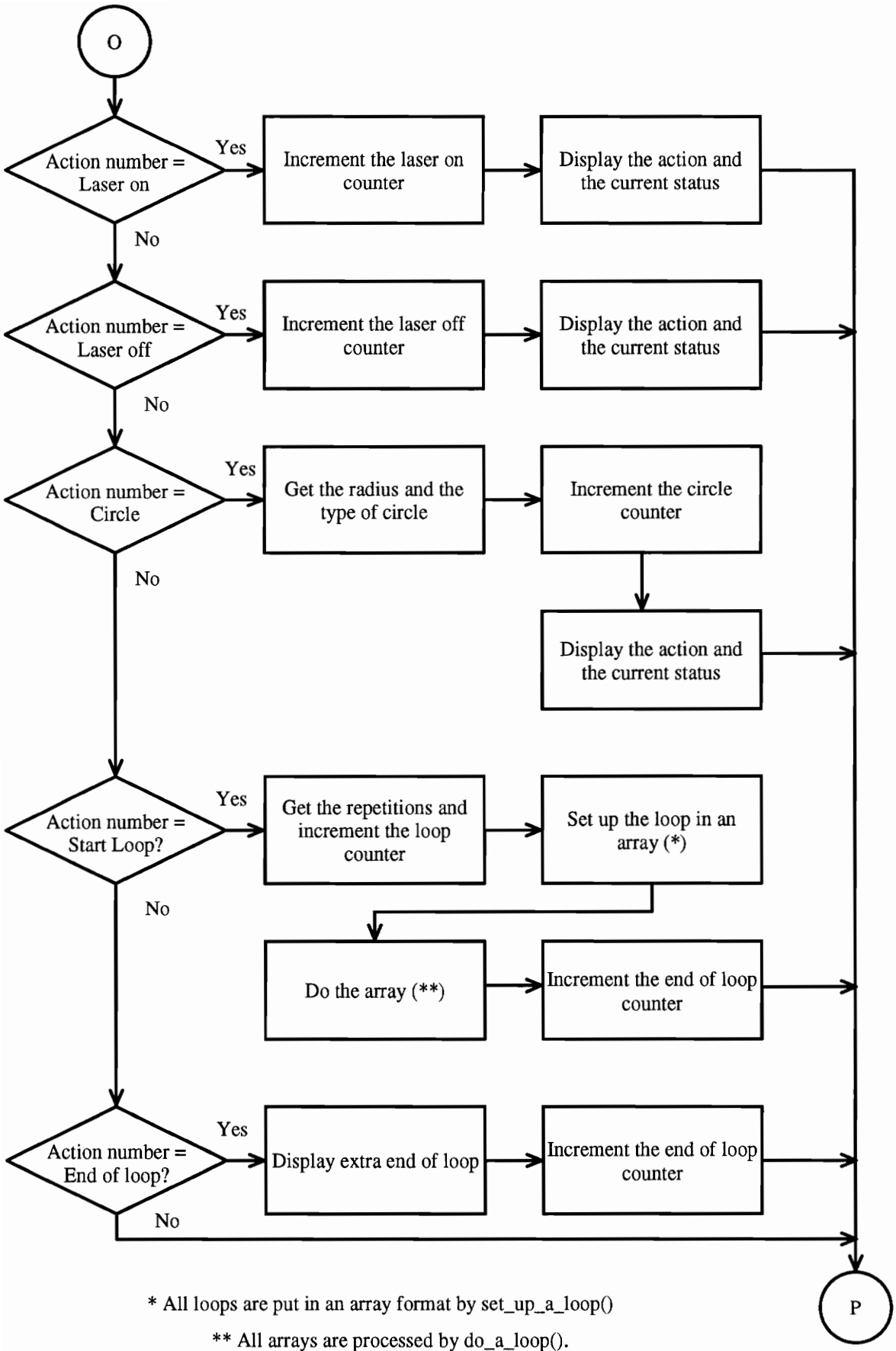

J
Action number = Laser on?
Yes
L
No
Action number = Laser off?
Yes
L
No
Action number = Circle?
Yes
K
No
Action number = Start loop?
Yes
K
No
Action number = End of loop?
Yes
L
No
Action number = End of file?
Yes
Correct action?
No
Insert commands?
Yes
Yes
No
No
Save the end of file
Run 'build_file()' to add actions
M


K
Prompt the user for correctness (yes, no, or quit)
Quit?
Yes
N
No
No?
No
Yes
Insert commands?
Yes
Run 'build_file()' to insert commands
No
Delete this action?
Yes
No
Change the parameters?
No
Yes
Get and transform the new parameters
Is this action to be saved?
Yes
Save the action and its parameters
No
M


L
Prompt the user for correctness (yes, no, or quit)
Quit?
Yes
N
No
No?
No
Yes
Insert commands?
Yes
Run 'build_file()' to insert commands
No
Delete this action?
Yes
No
Is this action to be saved?
Yes
Save the action
No
M

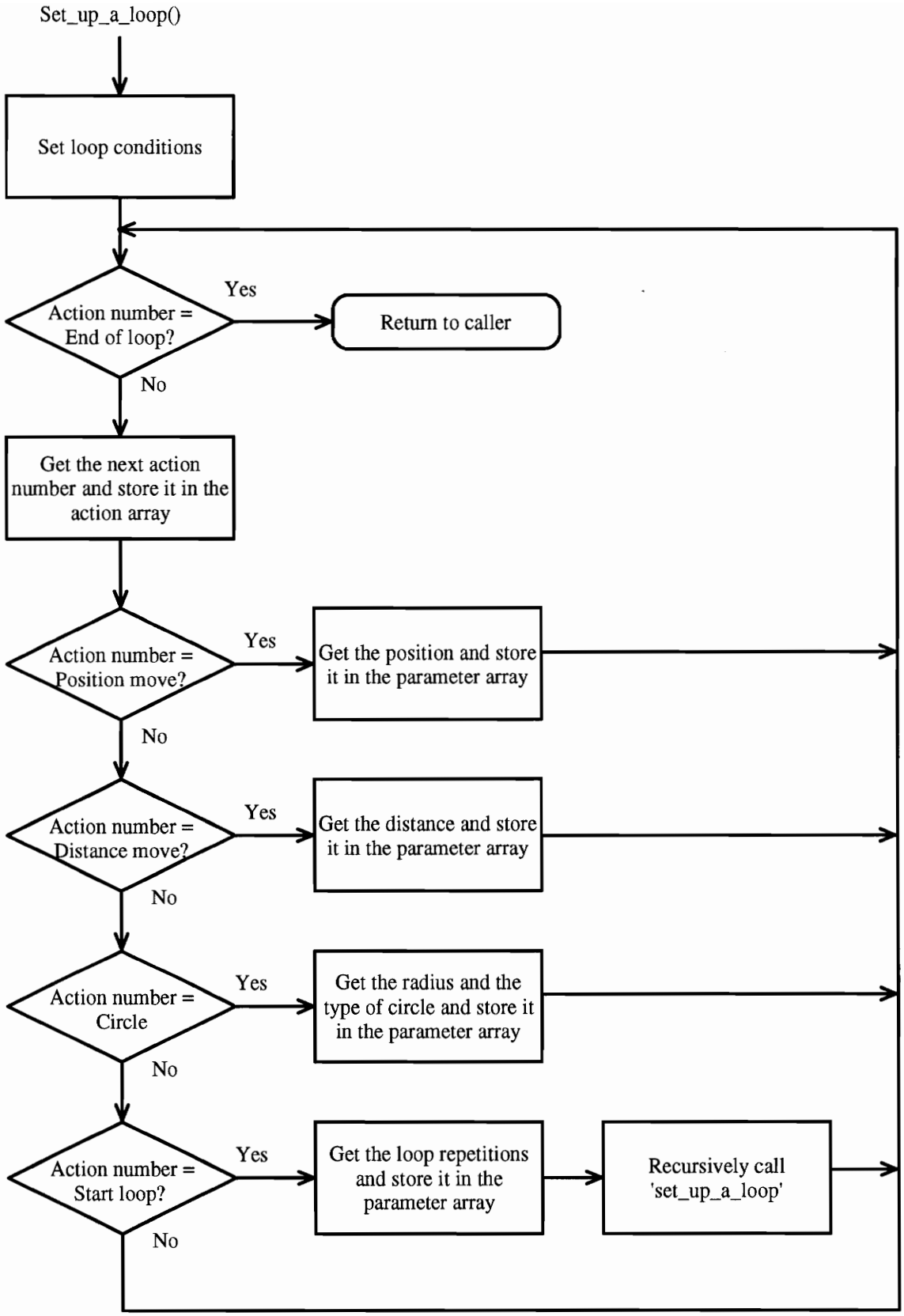

Transfer_rest_of_file()
N
Action number = End of File?
Yes
B
No
Get and save the next action number
Action number = Position move?
Yes
Save the position to move
No
Action number = Distance move?
Yes
Save the distance to move
No
Action number = Circle?
Yes
Save the radius and the type of circle
No
Action number = Start loop?
Yes
Save the number of repetitions
No

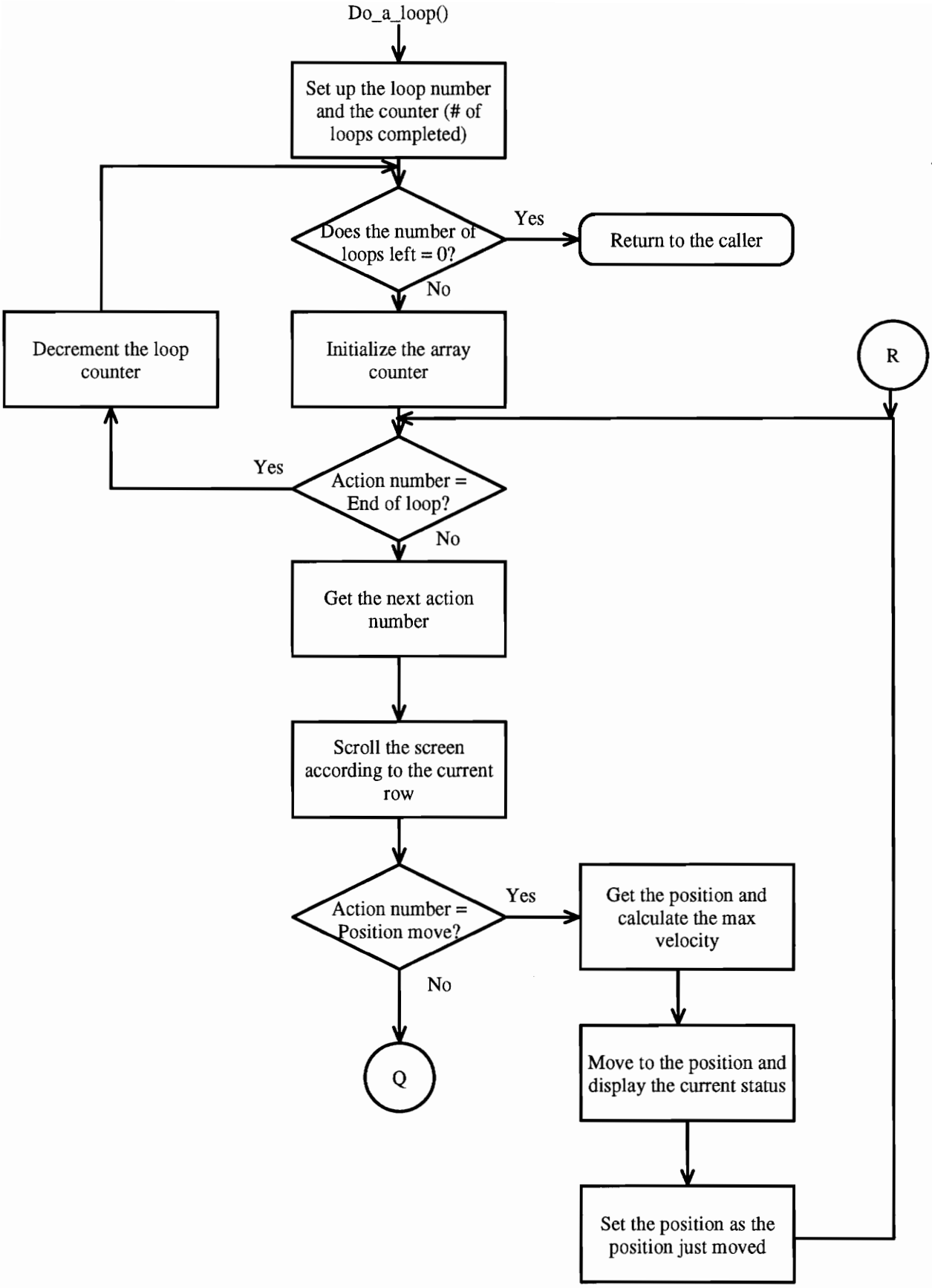

F
Do_file()
Clear all counters and place holders
Get the 'all ready' signal from the user
Is the file a valid file?
No
Alert the user of the error
B
Yes
Display the cutting velocity
P
Action number = End of file?
Yes
Display the final results and alert the user
B
No
Scroll the screen according to the current line
Action number = Postion move?
Yes
Get the position and calculate the max velocity
Display the move to the position and the current status
Set the position as the position just moved
No
Action number = Distance move?
Yes
Get distance and calculate the max velocity
Display the move a distance and the current status
Set the position as the old position plus the distance moved
No
O

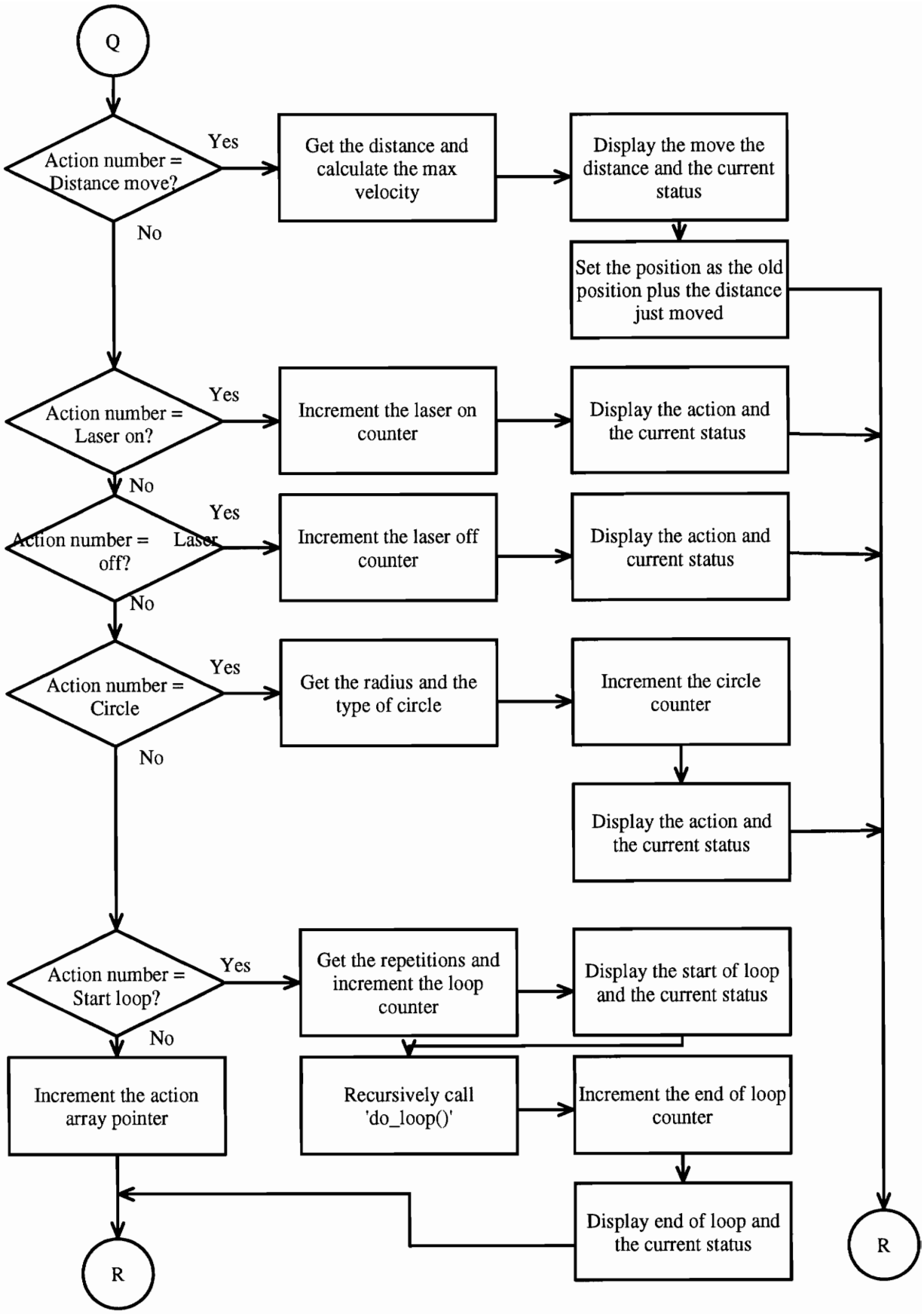


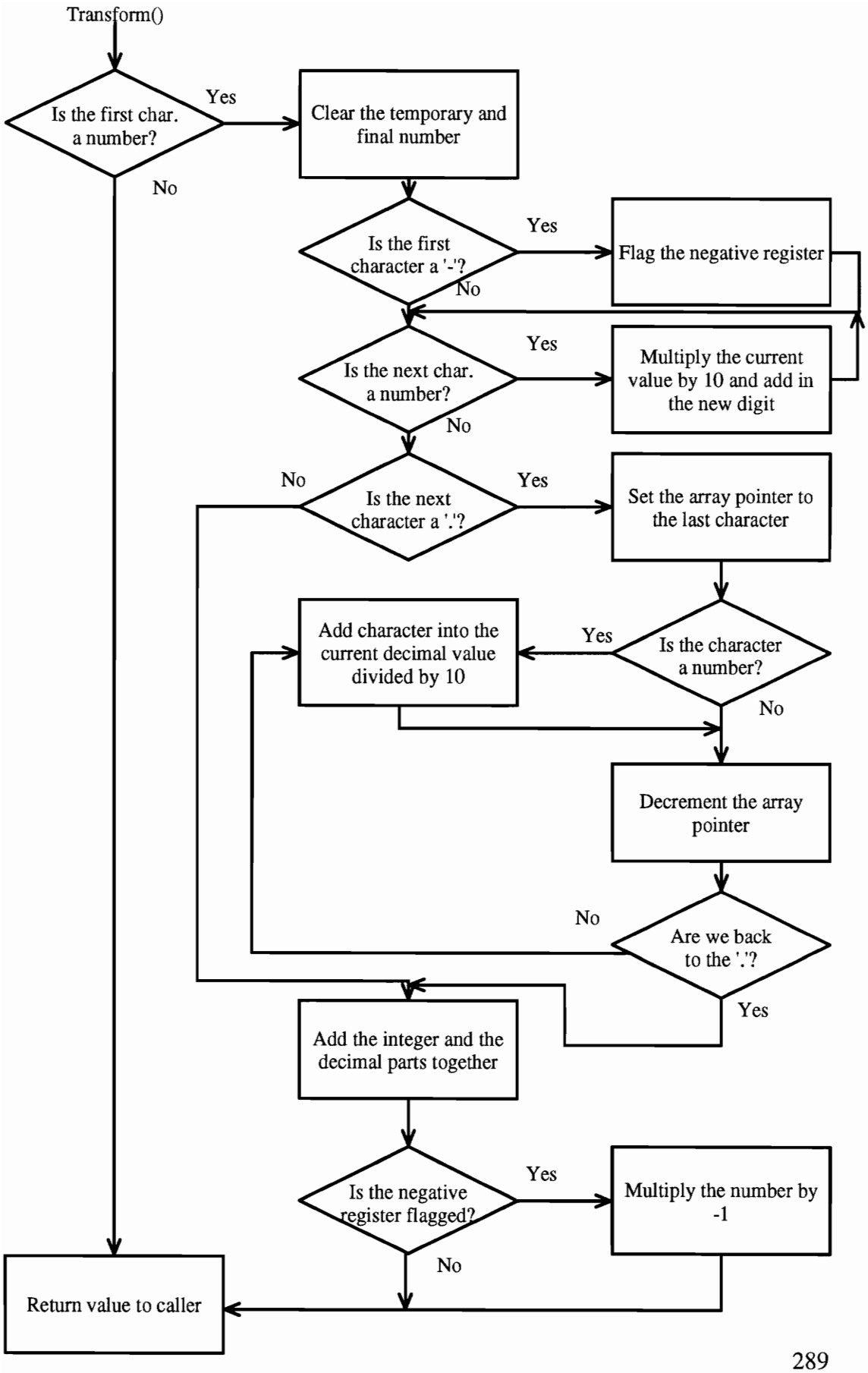
* All loops are put in an array format by set_up_a_loop()

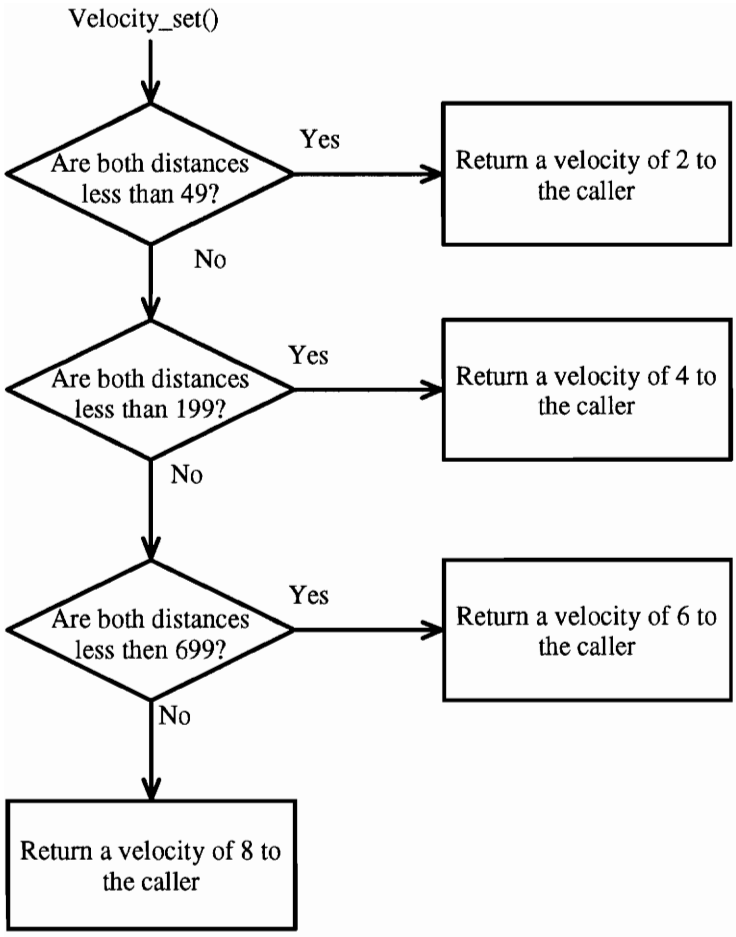
** All arrays are processed by do_a_loop().


Set_up_a_loop()
Set loop conditions
Action number = End of loop?
Yes
Return to caller
No
Get the next action number and store it in the action array
Action number = Position move?
Yes
Get the position and store it in the parameter array
No
Action number = Distance move?
Yes
Get the distance and store it in the parameter array
No
Action number = Circle
Yes
Get the radius and the type of circle and store it in the parameter array
No
Action number = Start loop?
Yes
Get the loop repetitions and store it in the parameter array
Recursively call 'set_up_a_loop'
No


Do_a_loop()
Set up the loop number and the counter (# of loops completed)
Does the number of loops left = 0?
Yes
Return to the caller
No
Decrement the loop counter
Initialize the array counter
R
Yes
Action number = End of loop?
No
Get the next action number
Scroll the screen according to the current row
Action number = Position move?
Yes
Get the position and calculate the max velocity
No
Q
Move to the position and display the current status
Set the position as the position just moved


Q
Action number = Distance move?
Yes
No
Get the distance and calculate the max velocity
Display the move the distance and the current status
Set the position as the old position plus the distance just moved
Action number = Laser on?
Yes
No
Increment the laser on counter
Display the action and the current status
Action number = Laser off?
Yes
No
Increment the laser off counter
Display the action and current status
Action number = Circle
Yes
No
Get the radius and the type of circle
Increment the circle counter
Display the action and the current status
Action number = Start loop?
Yes
No
Get the repetitions and increment the loop counter
Display the start of loop and the current status
Increment the action array pointer
Recursively call 'do_loop()'
Increment the end of loop counter
Display end of loop and the current status
R
R


Transform()
Is the first char. a number?
Yes
No
Clear the temporary and final number
Is the first character a '-'?
Yes
No
Flag the negative register
Is the next char. a number?
Yes
No
Multiply the current value by 10 and add in the new digit
Is the next character a '.'?
No
Yes
Set the array pointer to the last character
Is the character a number?
Yes
No
Add character into the current decimal value divided by 10
Decrement the array pointer
Are we back to the '.'?
No
Yes
Add the integer and the decimal parts together
Is the negative register flagged?
Yes
No
Multiply the number by -1
Return value to caller


Velocity_set()
Are both distances less than 49?
Yes
Return a velocity of 2 to the caller
No
Are both distances less than 199?
Yes
Return a velocity of 4 to the caller
No
Are both distances less then 699?
Yes
Return a velocity of 6 to the caller
No
Return a velocity of 8 to the caller

APPENDIX IX

FILEMAKE SOURCE CODE

```
/*****************************************************************************************
 *
                              FILEMAKE.C
 *
 *****************************************************************************************/

#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <math.h>
#include <float.h>
#include <bwindow.h>
#include <globlvar.h>
#include <defntion.h>

void cdecl pattern_cut(void);
void cdecl build_file(void);
void cdecl append(void);
void cdecl pattern_check(int);
void cdecl do_file(void);
int cdecl do_a_loop(int);
void cdecl set_up_a_loop(void);
void cdecl transfer_rest_of_file(void);
float transform(char *);
int velocity_set(int, int);


/*****************************************************************************
 *                                                                           *
 *    GLOBAL PARAMETERS:
 *
 * DEFIN: aca                acb          - Port addresses for info transfer from
 *        acc                accom            laser to pc (ac port)
 *        baca               bacb         - Port addresses for info transfer from
 *        bacc               baccom           laser to pc (bac port)
 *        bmba               bmbc         - Port addresses for function call from
 *        bmbcom                              laser to pc (bmb port)
 *        iop1               iop2         - Bmb value number for function load
 *        iop4               clearlop
 *        outcbt             incbt        - I/O board definition values for input
 *                                                      vs. output
 *        addr13A            addr13C      - Address value sets for each function
 *        addr15A            addr15C
 *        addr16A            addr16C
 *        addr17A            addr17C
 *        addr30A            addr30C
 *        addr31A            addr31C
 *        addr32A            addr32C
 *        addr40A            addr40C
 *        addr41A            addr41C
 *        addr42A            addr42C
 *        addr43A            addr43C
 *        addr44A            addr44C
 *        addr52A            addr52C
 *        addr53A            addr53C
 *        addr54A            addr54C
 *        addr55A            addr55C
 *        addr56A            addr56C
 *        ON                 OFF          - Status of laser beam on/off
 *
 * GLOBL: BWINDOW    - Window defined type cast for window pointer name
 *        aprobe     - The 'a' probe number
 *        bprobe     - The 'b' probe number
```

```
*       circles    - The count of number of circles that are in the current file
*       compare    - The comparator number sent to the laser in high speed trimming
*       convertor  - The value returned from the laser in response to a resistor measure
*       current    - The file that is currently being processed
*       delay      - The delay value for the measurement bridge before it takes a reading
*       end_conv   - The laser control skip bit for convertor done converting
*       end_delay  - The laser control skip bit for the delay being over
*       end_loops  - The count of the number of ended loops in the current file
*       file_name  - The file name that the user types in  - with no extension
*       gain       - Gain for the measurement system before being sent to the pc
*       gen_volt   - The generator voltage value for the measurement bridge
*       hcompare   - The high byte of the sent comp. word    - used for software checking
*       hdelay     - The high byte of the sent delay word    -   '   '     '         '
*       hgain      - The high byte of the sent gain word     -   '   '     '         '
*       hgen_volt  - The high byte of the sent generator voltage word -   '   '     '   '
*       hpre_amp   - The high byte of the sent preamplifier word -   '   '     '         '
*       hrange     - The high byte of the sent range word        -   '   '     '         '
*       hstandard  - The high byte if the sent standard word     -   '   '     '         '
*       lcompare   - The low byte of the sent comp. word   - used for software checking
*       ldelay     - The low byte of the sent delay word   -   '   '     '         '
*       lgain      - The low byte of the sent gain word    -   '   '     '         '
*       lgen_volt  - The low byte of the sent generator voltage word - '   '     '         '
*       lpre_amp   - The low byte of the sent preamplifier word -   '   '     '         '
*       lrange     - The low byte of the sent range word        -   '   '     '         '
*       lstandard  - The low byte if the sent standard word     -   '   '     '         '
*       hlsbx      - The upper byte of the second x distance word after being encoded
*       hlsby      - The upper byte of the second y distance word after being encoded
*       llsbx      - The lower byte of the second x distance word after being encoded
*       llsby      - The lower byte of the second y distance word after being encoded
*       msbx       - The only byte of the first x distance word after being encoded
*       msby       - The only byte of the first y distance word after being encoded
*       laser_status  - Current status of the laser beam on/off
*       loops         - The number of loops in the current file
*       nested_loops  - Array for all nested loops of the current file that is being run
*       new_file   - The name of the user file with .new extension - the current file
*       num_loops  - Counter as to which of the nested loops is currently being looped
*       off        - Number of times that the current file turns the laser off
*       on         - Number of times that the current file turns the laser on
*       old_file   - The user file with .old extension - the backup of the last file
*       old        - The file being backed up due to a revision in the current file
*       overload   - The measurement system overload readout
*       plist      - The name of the lower window - used for parameter viewing
*       posx       - The x positions that are used for differnece in distances
*       posy       - The y positions that are used for differnece in distances
*       pre_amp    - The value of the pre-amp which sets the bridge up for a measure
*       print      - The file that is written to for future printing
*       prn_file   - The user file with .prn extension - the printable function listing
*       probeahigh- The high byte of the 'a' probe byte
*       probealow  - The low byte of the 'a' probe byte
*       probebhigh- The high byte of the 'b' probe byte
*       probeblow  - The low byte of the 'b' probe byte
*       pwin       - The name of the main (upper) window
*       r1         - The global version of the current resistance
*       radius     - The radius of the circle to be cut
*       range      - The value number of which range the current resistor is in
*       ready      - The laser control skip bit for if the laser measurement is ready
*       resistor   - The user inputed value for the resistor value to be trimmed to
*       resting    - The control bit for if the linear motors ( laser head ) are moving
*       selection  - The character string (2 char) that stores user responses
*       scan       - The dummy variable that holds the end character of user input
*       speed      - The type of a circle (with diagonal cut or with center unscaithed)
*       standard   - The ratio of the user inputed resistance and the range resistor
*       strobe_done  - The skip bit for if the pre-measuring strobe is completed
*       units_of_step  - The counter for which step number of the current nested loop
*       values     - The parameters for nested loops during the running of a program
*       vel        - The velocity that the laser is set to move at
*       x_axis     - The x axis distance to move
*       y_axis     - The y axis distance to move
*       x_displace- The difference distance between two points in the x direction
*       y_displace- The difference distance between two points in the y direction
*       x_position- The current x position for evaluation
*       y_position- The current y position for evaluation
*       x_travel   - The x position or distance that is being read from/written to
*       y_travel   - The y position or distance that is being read from/written to
*       xhome      - The laser control bit for the x direction home position latch
*       yhome      - The laser control bit for the y direction home position latch
```

```
 *        xjoy      - The laser control bit for the joystick movement in the x direction
 *        yjoy      - The laser control bit for the joystick movement in the y direction
 *        xotos     - The movement error value for the x linear motor
 *        yotos     - The movement error value for the y linear motor
 *        xpos      - The current x position
 *        ypos      - The current y position
 *
 *
 ***********************************************************************/



/*****************************************************************************
 *
 *      MODULE:   main
 *
 *     PURPOSE:   File making operating system
 *
 *    PARAMETERS:
 *                      GLOBL: plist              pwin
 *                             scan               radius
 *                             xpos               ypos
 *                             selection
 *
 *                      LOCAL: act_page          - Active page number
 *                             choice            - Numeric value of user response
 *                             col               - Current column position of the cursor
 *                             columns           - Number of columns in the window
 *                             high              - Pointer for cursor high scan
 *                             i                 - Counter variable
 *                             low               - Pointer for cursor low scan
 *                             mode              - Current mode of the window
 *                             reps              - Number of times to cut a circle
 *                             row               - Current row of the cursor
 *                             yeah              - Converted user input for loop control
 *
 *
 *                      CALLS: wncreate           scmode
 *                             sccurst            wndsplay
 *                             wnselect           wncursor
 *                             wncurmov           wnprintf
 *                             wnquery            outp
 *                             probe_select       scpgcur
 *                             wnscroll           wndstroy
 *                             cut_a_pattern      some_move
 *                             transform          circle_cut
 *                             wnremove           sccurset
 *                             scpgcur
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 ***********************************************************************/


void main()
{
    BORDER  bord;
    WHERE   location;
    int     mode,columns,act_page;
    int     row,col,high,low,choice;
    int     reps, yeah, i;


    plist = wncreate(3,78,WHITE);       /* Dimensions of window data area.              */

    pwin = wncreate(18,78,CYAN);

    bord.type = BBRD_DDDD | BBRD_TCT;   /* Box drawn with single lines, having a top    */
                                        /*   centered title.                            */
```

```
    bord.attr     = MAGENTA;              /* Border will be magenta on black.              */
    location.dev        = scmode(&mode,&columns,&act_page);
    location.page       = act_page;
    location.corner.col = 1;
    location.corner.row = 21;
    bord.ttattr  = REVERSE;               /* Title will be black on white.                 */
    bord.pttitle = " System Status ";     /* Text of the title.                            */

    if (NIL == wndsplay(plist,&location,&bord))
    return;                               /* Quit if failure.                              */

    location.corner.row = 1;
    bord.pttitle = " Laser Operating System ";    /* Text of the title.                    */

    if (NIL == wndsplay(pwin,&location,&bord))
    return;                                       /* Quit if failure.                      */

    pattern_cut();

                  /* Remove the window & restore the screen and cursor.  */

    wnremove(pwin);
    wnremove(plist);
    wndstroy(pwin);                       /* Clean up data structures.                     */
    wndstroy(plist);                      /* Clean up data structures.                     */
}



/*****************************************************************************
 *
 *      MODULE:  pattern_cut
 *
 *     PURPOSE:  Main menu system for building, analyzing, editting, and test running.
 *
 *    PARAMETERS:
 *                      GLOBL: NULL                 current
 *                             file_name            new_file
 *                             old_file             vel_cut
 *                             scan                 selection
 *                             x_travel             y_travel
 *
 *                      LOCAL: action              - Laser action variable
 *                             numbers             - Character buffer for numeric input
 *                             true                - Loop conditional (loop until 5.Exit)
 *                             option              - Menu variable (create, analyze,...)
 *
 *
 *                      USERS: main
 *
 *                      CALLS: wnscroll             wncurmov
 *                             wnprintf             wnquery
 *                             strncpy              strcat
 *                             fopen                append
 *                             fclose               fprintf
 *                             transform            build_file
 *                             pattern_check        do_file
 *                             kbplace              kbgetkey
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *    12/90        RRW          Add previous used file as the next file to use
 *
 ***************************************************************************/

void pattern_cut()
{
int true, action, option;
```

```
char numbers[10];

true = 1;                                /* Defining variables.                          */
while(true = 1)
    {
    wnscroll(0,-1,-1,0);

    wncurmov(3,26);
    wnprintf("What would you like to do?");  /* Print                                    */
    wncurmov(5,22);
    wnprintf(" 1. Create a file");           /* Print                                    */
    wncurmov(6,22);
    wnprintf(" 2. Analyze / print a file "); /* Print                                    */
    wncurmov(7,22);
    wnprintf(" 3. Edit a file ");            /* Print                                    */
    wncurmov(8,22);
    wnprintf(" 4. Run a file (test the sequence)");
    wncurmov(9,22);
    wnprintf(" 5. Exit to DOS");
    wncurmov(12,26);
    wnprintf("Option:");

    wnquery(selection, 2, &scan);

    if(*selection == 'c'|| *selection == 'C' || *selection == '1')
       option = 1;

    if(*selection == 'a'|| *selection == 'A'|| *selection == '2')
       option = 2;

    if(*selection == 'e'|| *selection == 'E' || *selection == '3')
       option = 3;

    if(*selection == 'r'|| *selection == 'R' || *selection == '4')
       option = 4;

    if(*selection == 'm'|| *selection == 'M' || *selection == '5')
       option = 5;

  if(option > 0 && option < 5)        /* If it is one of the first four options.      */
    {
    if(file_name == "" || option == 1)
        {
        wncurmov(14,20);                 /* Move cursor.                                 */
        wnprintf("Enter the name of the file: "); /* Print                               */
        wnquery(file_name, 9, &scan);    /* Find next selection.                         */

        strncpy(old_file,file_name,9);   /* Store the backup file.                       */
        strncpy(new_file,file_name,9);
        strcat(old_file,".old");
        strcat(new_file,".new");
        }
    else
        {
        wncurmov(14,20);                 /* Move cursor.                                 */
        wnprintf("Enter the name of the file: %s",file_name); /* Print                   */
        if((new_file[0] = kbgetkey(&scan)) != 13)
            {
            wncurmov(14,48);
            wnprintf("                  ");   /* Print                                   */
            wncurmov(14,48);                  /* Move cursor                             */
            kbplace(1,new_file[0],scan);
            wnquery(file_name, 9, &scan);     /* Get next request.                       */
            strncpy(new_file,file_name,9);
            strncpy(old_file,file_name,9);    /* Store the backup.                       */
            strcat(old_file,".old");
            strcat(new_file,".new");
            }
        else
            {
            strncpy(old_file,file_name,9);
            strncpy(new_file,file_name,9);
            strcat(old_file,".old");          /* Store the backup with .old extension.   */
            strcat(new_file,".new");
            }
        }
```

```
 }

 switch(option)
   {
case 1:
 if ((current = fopen(new_file,"r")) != NULL)  /* If the new file exists.            */
     {
     wnscroll(0,-1,-1,0);            /* Scroll window                                */
     wncurmov(5,5);
     wnprintf("This file already exists. ");  /*Print                                */
     wncurmov(7,5);                           /* Move cursor.                        */
     wnprintf("(Press ENTER to continue)");
     wnquery(selection, 1, &scan);            /* Get the next selection.             */
     }
 else
     {
     fclose(current);                /* Close the current file.                      */
     current = fopen(new_file,"w");
     action = 8;                     /* If action is a resistor trim.                */
     fprintf(current,"\n%i\n",action);        /*Print                               */
     wnscroll(0,-1,-1,0);                     /* Scroll window                       */
     wncurmov(5,5);
     wnprintf("What cutting velocity would you like to set? (0 - 20.625) "); /* Print*/
     wnquery(numbers, sizeof(numbers), &scan);     /* Get the next selection.        */
     vel_cut = transform(numbers);
     fprintf(current, "%.3f\n", vel_cut);          /* Print                          */
     build_file();                                 /* Do module.                     */
     fprintf(current,"\n9\n");
     fclose(current);                              /* Close file.                    */
     }
 break;

case 2:
 if ((current = fopen(new_file,"r")) == NULL)      /* If the file doesn't exist.     */
     {
     wnscroll(0,-1,-1,0);
     wncurmov(5,5);                                /* Move cursor.                   */
     wnprintf("This file does not exist. ");       /* Print                          */
     wncurmov(7,5);
     wnprintf("(Press ENTER to continue)");
     wnquery(selection, sizeof(selection), &scan);
     fclose(current);
     break;
     }
 wnscroll(0,-1,-1,0);                               /* Move cursor.                  */
 wncurmov(6,10);
 wnprintf("Do you want the file sent to the printer? (y/n)");  /* Print             */
 wnquery(selection,2,&scan);
 if(*selection == 'y' || *selection == 'Y')         /* Selection is a yes.           */
     {
     wncurmov(8,10);
     wnprintf("Turn on the printer and press ENTER.");   /* Print                    */
     wnquery(selection,1,&scan);                    /* Find next selection.          */
     pattern_check(1);
     }
 else
     pattern_check(0);               /* Do module.                                   */

 wnscroll(0,-1,-1,0);                /* Scroll window.                               */
 wncurmov(5,0);
 wnprintf("              The final position is %6i, %6i.", x_position, y_position);
 wnprintf("\n              There were %i loops started.",loops);
 wnprintf("\n              There were %i loops ended.",end_loops);
 wnprintf("\n              The laser was turned on %i times.",on);
 wnprintf("\n              The laser was turned off %i times.",off);
 wnprintf("\n              There were %i circles.",circles);

 wnprintf("\n\n                 (Press ENTER to continue)");
 wnquery(selection,1,&scan);         /* Get next selection.                          */

 fclose(current);                    /* Close the file.                              */
 break;

case 3:
 if ((current = fopen(new_file,"r")) == NULL)
     {
```

```
        wnscroll(0,-1,-1,0);            /* Scroll window.                          */
        wncurmov(5,5);
        wnprintf("This file does not exist. ");  /* Print                          */
        wncurmov(7,5);
        wnprintf("(Press ENTER to continue)");
        wnquery(selection, 1, &scan);            /* Get next selection.            */
        fclose(current);
        break;
        }
    wnscroll(0,-1,-1,0);                /* Move cursor                             */
    append();
    fclose(current);                    /* Close file.                             */
    break;

   case 4:
    if ((current = fopen(new_file,"r")) == NULL)  /* If new file doesn't exist     */
        {
        wnscroll(0,-1,-1,0);            /* Scroll window.                          */
        wncurmov(5,5);
        wnprintf("This file does not exist. ");     /* Print                       */
        wncurmov(7,5);
        wnprintf("(Press ENTER to continue)");      /* Print                       */
        wnquery(selection, sizeof(selection), &scan);
        fclose(current);
        break;
        }
    wnscroll(0,-1,-1,0);                /* Scroll window.                          */
    do_file();                          /* Do module.                              */
    fclose(current);
    break;

   case 5:
    return;

      }
   }
}



/*****************************************************************************
 *
 *      MODULE:  build_file
 *
 *     PURPOSE:  Create menu system - create a file from scratch
 *
 *    PARAMETERS:
 *                     GLOBL: current            scan
 *                            selection          x_displace
 *                            y_displace
 *
 *                     LOCAL: numbers           - Character buffer for numeric input
 *                            times             - Number of times to process a loop
 *                            rad               - Radius of a circle
 *                            type              - Type of circle (cutting/saving center)
 *
 *                     USERS: cut_a_pattern      append
 *
 *                     CALLS: wnscroll           wncurmov
 *                            wnprintf           wnquery
 *                            fprintf            transform
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 *****************************************************************************/

void build_file()
```

```
{
int  times, rad, type;                    /* Define variables.                                  */
char numbers[10];

*selection = 'a';

while(*selection != 'e' && *selection != 'E' && *selection != '9')
                                          /* While selection is not an exit.                    */
    {
    wnscroll(0,-1,-1,0);

    wncurmov(1,26);                       /* Move cursor                                        */
    wnprintf("What would you like to do?");    /* Print                                         */
    wncurmov(3,28);                       /* Move cursor.                                       */
    wnprintf(" 1. Move to a position");
    wncurmov(4,28);
    wnprintf(" 2. Distance move ");
    wncurmov(5,28);
    wnprintf(" 3. laser On ");
    wncurmov(6,28);
    wnprintf(" 4. Laser off");
    wncurmov(7,28);
    wnprintf(" 5. Circle cut ");
    wncurmov(8,28);
    wnprintf(" 6. Start a loop");
    wncurmov(9,28);
    wnprintf(" 7. Repeat a loop");
    wncurmov(11,28);
    wnprintf(" 9. Exit");
    wncurmov(13,34);
    wnprintf("Option:");

    wnquery(selection, 2, &scan);

    if(*selection == 'm' || *selection == 'M' || *selection == '1')
       {
       fprintf(current,"\n1\n");          /* Print                                              */
       wncurmov( 13,20);
       wnprintf("To what position would you like to move?");    /* Print.                        */
       wncurmov(15,20);
       wnprintf("          X direction:");
       wnquery(numbers, 10, &scan);
       x_displace = (int)transform(numbers);   /* Calculate x displacement.                     */
       wncurmov(16,20);                        /* Move cursor                                   */
       wnprintf("          Y direction:");
       wnquery(numbers, 10, &scan);            /* Get next selection                            */
       y_displace = (int)transform(numbers);
       fprintf(current, " %i\n", x_displace);
       fprintf(current, " %i\n", y_displace);  /* Print.                                        */
       wnselect(plist);
       wnscroll(1,-1,-1,0);                    /* Scroll one line.                              */
       wncurmov(2,40);
       wnprintf("  Position    %5i, %5i", x_displace, y_displace);
       }

    if(*selection == 'd' || *selection == 'D'|| *selection == '2')
                                          /* If it is the second selection.                     */
       {
       fprintf(current,"\n2\n");          /* Print.                                             */
       wncurmov( 13,20);                  /* Print                                              */
       wnprintf("What distance would you like to move?");
       wncurmov(15,20);
       wnprintf("          X direction:"); /* Print                                             */
       wnquery(numbers, 10, &scan);
       x_displace = (int)transform(numbers);  /* New x distance.                                 */
       wncurmov(16,20);
       wnprintf("          Y direction:");
       wnquery(numbers, 10, &scan);           /* Get next selection.                             */
       y_displace = (int)transform(numbers);
       fprintf(current, " %i\n", x_displace);   /* Print                                         */
       fprintf(current, " %i\n", y_displace);
       wnselect(plist);                         /* Lower window.                                 */
       wnscroll(1,-1,-1,0);
       wncurmov(2,40);                          /* Select lower window.                          */
       wnprintf("  Distance    %5i, %5i", x_displace, y_displace);  /* Print                    */
       }
```

```
   if(*selection == 'o' || *selection == 'O'|| *selection == '3')
      {
      fprintf(current,"\n3\n");        /* Print                                    */
      wnselect(plist);
      wnscroll(1,-1,-1,0);             /* Scroll one line.                         */
      wncurmov(2,40);
      wnprintf("  Laser on                    ");   /* Print                       */
      }

   if(*selection == 'f' || *selection == 'F' || *selection == '4')
      {
      fprintf(current,"\n4\n");        /* Print                                    */
      wnselect(plist);                 /* Select lower window.                     */
      wnscroll(1,-1,-1,0);
      wncurmov(2,40);                  /* Move cursor.                             */
      wnprintf("  Laser off                   ");  /* Print                        */
      }

   if(*selection == 'c' || *selection == 'C' || *selection == '5')
      {
      fprintf(current,"\n5\n");
      wncurmov( 13,12);                /* Move cursor.                             */
      wnprintf("Do you want to save the center? (y/n) ");  /* Print                 */
      wnquery(numbers, 2, &scan);
      if(*numbers == 'y' || *numbers == 'Y')
         type = 0;
      else
         type = 1;                          /* If it is a circle with a center.   */
      wncurmov( 15,12);
      wnprintf("What radius would you like the circle? (in .01mm) ");  /* Print   */
      wnquery(numbers, 10, &scan);     /* Get the next selection.                  */
      rad = (int)transform(numbers);
      fprintf(current, "%i\n", rad);
      fprintf(current, "%i\n", type);  /* Print                                    */
      wnselect(plist);
      wnscroll(1,-1,-1,0);
      wncurmov(2,40);                  /* Move cursor.                             */
      if(type == 1)
         wnprintf("  Circle w/o cntr %4i", rad);  /* Print                         */
      else
         wnprintf("  Circle w/ center%4i", rad);
      }


   if(*selection == 's' || *selection == 'S' || *selection == '6')
      {
      fprintf(current,"\n6\n");        /* Print                                    */
      wncurmov( 13,20);
      wnprintf("How many times would you like to loop? ");
      wnquery(numbers, 10, &scan);
      times = (int)transform(numbers); /* Calculate the number of loops.           */
      fprintf(current, "%i\n", times); /* Print                                    */
      wnselect(plist);
      wnscroll(1,-1,-1,0);             /* Scroll one line.                         */
      wncurmov(2,40);
      wnprintf("  Start loop     %2i times", times);   /* Print                    */
      }

   if(*selection == 'r' || *selection == 'R' || *selection == '7')
      {
      fprintf(current,"\n7\n");        /* Print                                    */
      wnselect(plist);                 /* Select lower window.                     */
      wnscroll(1,-1,-1,0);
      wncurmov(2,40);
      wnprintf("  Repeat a loop               ");  /* Print                        */
      }

   wnselect(plist);
   wncurmov(0,2);
   wnprintf("Current Position: %6li, %6li     ",xpos,ypos);   /* Print            */
   wnselect(pwin);
   }

*selection = ' ';
wnselect(plist);
```

```
 wnscroll(3,-1,-1,0);                    /* Scroll three lines.                          */
 wncurmov(0,2);
 wnprintf("Current Position: %6li, %6li     ",xpos,ypos);   /* Print                    */
 wnselect(pwin);                         /* Select upper window                          */
}



/*****************************************************************************
 *
 *      MODULE:   append                                                                 *
 *
 *     PURPOSE:  Edit the file
 *
 *    PARAMETERS:      GLOBL: current            new_file
 *                            old                old_file
 *                            scan               radius
 *                            x_travel           y_travel
 *                            vel_cut            speed
 *
 *                     LOCAL: action            - Laser action variable
 *                            choice            - User choice character variable
 *                            choice1           - User choice character variable
 *                            numbers           - Character buffer for numeric input
 *                            times             - Number of times to process a loop
 *                            row               - Row number of the screen
 *
 *                     USERS: cut_a_pattern
 *
 *                     CALLS: fopen              fscanf
 *                            fprintf            wnscroll
 *                            wncurmov           wnprintf
 *                            wnquery            fclose
 *                            transform          build_file
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***************************************************************************/

void append()
{
int row, action, times;
char choice[2], choice1[2], numbers[10];


old = fopen(old_file,"w");               /* Open extension file.                         */

action = 0;

fscanf(current, "%1i", &action);         /* Scan file for selection.                     */
fprintf(old,"\n%1i\n",action);           /* Print                                        */
if(action != 8)
  {
  wnscroll(0,-1,-1,0);
  wncurmov(10,10);                       /* Move cursor.                                 */
  wnprintf("There is an error in this program!!!");     /* Print                          */
  wnquery(choice,2,&scan);
  fclose(old);                           /* Close extention file                         */
  return;
  }
fscanf(current, "%f", &vel_cut);
fprintf(old, "%.3f\n", vel_cut);         /* Print                                        */

while(action != 9)                       /* As long as it is not an exit.                */
      {
      fscanf(current, "%1i", &action);
      fprintf(old,"\n%1i\n",action);     /* Print                                        */
```

```
      if(action == 1)                    /* If it is a move position.                    */
         {
         fscanf(current, "%i", &x_travel);
         fscanf(current, "%i", &y_travel);  /* Scan file for the y travel distance.     */
         fprintf(old, "%i\n", x_travel);    /* Print                                    */
         fprintf(old, "%i\n", y_travel);
         }

      if(action == 2)                    /* If it is a move distance.                    */
         {
         fscanf(current, "%i", &x_travel);
         fscanf(current, "%i", &y_travel);  /* Scan file for the y travel distance.     */
         fprintf(old, "%i\n", x_travel);    /* Print                                    */
         fprintf(old, "%i\n", y_travel);    /* Print                                    */
         }

      if(action == 5)                    /* If it is a circle set                        */
         {
         fscanf(current, "%i", &radius);    /* Scan file for the radius.                */
         fscanf(current, "%i", &speed);
         fprintf(old, "%i\n", radius);      /* Print                                    */
         fprintf(old, "%i\n", speed);
         }

      if(action == 6)                    /* If it is a loop set                          */
         {
         fscanf(current, "%i", &times);
         fprintf(old, "%i\n", times);       /* Print                                    */
         }
      }
fclose(old);
fclose(current);                         /* Close file.                                  */

current = fopen(new_file,"w");
old = fopen(old_file,"r");               /* Opening back up file.                        */

row = 3;
fscanf(old, "%1i", &action);             /* Scan file for the action.                    */
fscanf(old, "%f", &vel_cut);
wnscroll(0,-1,-1,0);                     /* Scroll window.                               */
wncurmov(row,1);
wnprintf("  Cutting Velocity %.3f", vel_cut);  /* Print                                  */
wnprintf("                    Is this correct? (y/n)");
wnquery(choice,2,&scan);                 /* Find the next selection.                     */
wncurmov(row,40);
wnprintf("                               ");     /* Print                               */
if(*choice == 'n' || *choice == 'N')
  {
  wncurmov(++row,1);
  wnprintf("            What cutting velocity do you want? (0 - 20.625)");  /* Print    */
  wnquery(numbers,10,&scan);
  vel_cut = transform(numbers);          /* Find the cutting velocity                    */
  }
fprintf(current,"\n%1i\n",action);       /* Print.                                       */
fprintf(current,"%.3f\n", vel_cut);

while(action != 9)                       /* As long as it is not an exit.                */
      {
      fscanf(old, "%1i", &action);
      if( ++row > 13)                    /* If the number of rows is more than 13        */
         {
         wnscroll(5,-1,-1,0);                /* Scroll 5 lines.                           */
         row = row - 5;
         }
      wncurmov(row,1);

  if(action == 1)                        /* If it is a move                              */
     {
     *choice1 = 'n';
     fscanf(old, "%i", &x_travel);
     fscanf(old, "%i", &y_travel);       /* Scan backup for the y travel distance.       */
     wnprintf("  Position    %5i, %5i", x_travel, y_travel);   /* Print                  */
     wnprintf("              Is this correct? (y/n/q)");
     wnquery(choice,2,&scan);            /* Find the next selection.                     */
     wncurmov(row,40);
```

```
    wnprintf("                                  ");
    if(*choice == 'q' || *choice == 'Q')    /* If choice is a quit.                    */
        {
        fprintf(current,"\n%1i\n",action);   /* Print                                   */
        fprintf(current, "%i\n", x_travel);
        fprintf(current, "%i\n", y_travel);
        transfer_rest_of_file();             /* Do module.                              */
        return;
        }
    if(*choice == 'n' || *choice == 'N')
        {
        wncurmov(row,35);
        wnprintf("Do you want to insert commands? (y/n)");   /* Print                   */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                          ");    /* Print             */
        if(*choice1 == 'y' || *choice1 == 'Y')
           {
           build_file();                        /* Do module.                          */

           wnscroll(0,-1,-1,0);              /* Scroll window.                         */
           row = 1;
           wncurmov(++row,1);                   /* Move cursor.                        */
           wnprintf("  Position    %5i, %5i", x_travel, y_travel);    /* Print        */
           }
        wncurmov(row,35);
        wnprintf("Delete this position move? (y/n)");   /* Print                        */
        wnquery(choice1,2,&scan);      /* Get the next selection.                      */
        wncurmov(row,35);
        wnprintf("                                    ");     /* Print                 */
        if(*choice1 != 'y' && *choice1 != 'Y')         /* If choice is a yes.          */
           {
           wncurmov(row,35);
           wnprintf("Keep the position the same? (y/n)");    /* Print                   */
           wnquery(choice,2,&scan);       /* Get next selection.                        */
           wncurmov(row,35);
           wnprintf("                                  ");
           if(*choice == 'n' || *choice == 'N')
              {
              wncurmov(++row,1);
              wnprintf("            What position would you like to move to? ");
              wncurmov(++row,1);
              wnprintf("                       X direction:");   /* Print              */
              wnquery(numbers,10,&scan);
              x_travel = (int)transform(numbers);
              wncurmov(++row,1);
              wnprintf("                       Y direction:");   /* Print              */
              wnquery(numbers,10,&scan);
              y_travel = (int)transform(numbers);
              }
           }
        }
    if(*choice1 != 'y' && *choice1 != 'Y')    /* If choice is a yes.                   */
        {
        fprintf(current,"\n%1i\n",action);
        fprintf(current, "%i\n", x_travel);
        fprintf(current, "%i\n", y_travel);   /* Print                                   */
        }
    }

if(action == 2)                        /* If it is a move distance.                    */
    {
    *choice1 = 'n';
    fscanf(old, "%i", &x_travel);      /* Scan backup file for the x travel distance.  */
    fscanf(old, "%i", &y_travel);
    wnprintf("  Distance    %5i, %5i", x_travel, y_travel);    /* Print                 */
    wnprintf("              Is this correct? (y/n/q)");
    wnquery(choice,2,&scan);           /* Find the next selection.                     */
    wncurmov(row,40);
    wnprintf("                                  ");     /* Print                       */
    if(*choice == 'q' || *choice == 'Q')
        {
        fprintf(current,"\n%1i\n",action);
        fprintf(current, "%i\n", x_travel);          /* Print                           */
        fprintf(current, "%i\n", y_travel);
        transfer_rest_of_file();
```

```
        return;
        }
    if(*choice == 'n' || *choice == 'N')             /* Choice is a no.                    */
        {
        wncurmov(row,35);              /* Move cursor                                      */
        wnprintf("Do you want to insert commands? (y/n)");    /* Print                     */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                    ");   /* Print                       */
        if(*choice1 == 'y' || *choice1 == 'Y')
           {
           build_file();                 /* Do module.                                    */
           wnscroll(0,-1,-1,0);
           row = 1;                      /* Define the row.                               */
           wncurmov(++row,1);
           wnprintf("  Distance    %5i, %5i", x_travel, y_travel);  /* Print              */
           }
        wncurmov(row,35);              /* Move cursor.                                     */
        wnprintf("Delete this distance move? (y/n)");   /* Print                           */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                 ");    /* Print                         */
        if(*choice1 != 'y' && *choice1 != 'Y')
           {
           wncurmov(row,35);
           wnprintf(" Keep the distance the same? (y/n)");    /* Print                     */
           wnquery(choice,2,&scan);       /* Get the next selection                        */
           wncurmov(row,35);
           wnprintf("                                    ");    /* Print                   */
           if(*choice == 'n' || *choice == 'N')
              {
              wncurmov(++row,1);          /* Move cursor.                                  */
              wnprintf("              What distance would you like to move? ");
              wncurmov(++row,1);
              wnprintf("                          X direction:");   /* Print               */
              wnquery(numbers,10,&scan);
              x_travel = (int)transform(numbers);      /* Fine the x travel distance.     */
              wncurmov(++row,1);
              wnprintf("                          Y direction:");   /* Print               */
              wnquery(numbers,10,&scan);      /* Get the next selection.                  */
              y_travel = (int)transform(numbers);
              }
           }
        }
    if(*choice1 != 'y' && *choice1 != 'Y')   /* If the choice is a yes.                  */
        {
        fprintf(current,"\n%1i\n",action);
        fprintf(current, "%i\n", x_travel);  /* Print                                      */
        fprintf(current, "%i\n", y_travel);
        }
    }

if(action == 3)                        /* If it is a velocity set                          */
    {
    *choice1 = 'n';
    wnprintf("  Laser on                                Is this correct? (y/n/q)");
                                       /* Print                                            */
    wnquery(choice,2,&scan);           /* Get the next selection.                          */
    wncurmov(row,40);
    wnprintf("                                 ");   /* Print                             */
    if(*choice == 'q' || *choice == 'Q')            /* Choice is a quit.                   */
        {
        fprintf(current,"\n%1i\n",action);
        transfer_rest_of_file();
        return;
        }
    if(*choice == 'n' || *choice == 'N')
        {
        wncurmov(row,35);
        wnprintf("Do you want to insert commands? (y/n)");   /* Print                       */
        wnquery(choice1,2,&scan);      /* Get the next selection.                          */
        wncurmov(row,35);
        wnprintf("                                    ");    /* Print                      */
        if(*choice1 == 'y' || *choice1 == 'Y')
           {
           build_file();                    /* Do module.                                  */
```

```
            wnscroll(0,-1,-1,0);
            row = 1;                        /* Define row.                          */
            wncurmov(++row,1);
            wnprintf("  Laser on      ");   /* Print                                */
            }
        wncurmov(row,35);
        wnprintf("Delete this laser on? (y/n)");      /* Print                      */
        wnquery(choice1,2,&scan);      /* Find the next selection.                  */
        wncurmov(row,35);
        wnprintf("                                ");    /* Print                  */
        }
    if(*choice1 != 'y' && *choice1 != 'Y')
        fprintf(current,"\n%1i\n",action);      /* Print                            */
    }

if(action == 4)                        /* If it is a laser off.                    */
    {
    *choice1 = 'n';
    wnprintf("  Laser off                                 Is this correct? (y/n/q)");
                                       /* Print                                    */
    wnquery(choice,2,&scan);           /* Get the next selection.                  */
    wncurmov(row,40);
    wnprintf("                                  ");     /* Print                   */
    if(*choice == 'q' || *choice == 'Q')     /* If the choice is a quit             */
        {
        fprintf(current,"\n%1i\n",action);   /* Print                               */
        transfer_rest_of_file();       /* Do module.                                */
        return;
        }
    if(*choice == 'n' || *choice == 'N')
        {
        wncurmov(row,35);
        wnprintf("Do you want to insert commands? (y/n)");   /* Print               */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);              /* Move cursor.                              */
        wnprintf("                                          ");   /* Print          */
        if(*choice1 == 'y' || *choice1 == 'Y')
            {
            build_file();                  /* Do module.                            */
            wnscroll(0,-1,-1,0);
            row = 1;
            wncurmov(++row,1);             /* Do module.                            */
            wnprintf("  Laser off     ");   /* Print                               */
            }
        wncurmov(row,35);
        wnprintf("Delete this laser off? (y/n)");     /* Print                      */
        wnquery(choice1,2,&scan);      /* Get the next selection.                   */
        wncurmov(row,35);
        wnprintf("                                ");    /* Print                  */
        }
    if(*choice1 != 'y' && *choice1 != 'Y')    /* Choice is no.                     */
        fprintf(current,"\n%1i\n",action);    /* Print                             */
    }

if(action == 5)                        /* If it is a circle set                    */
    {
    *choice1 = 'n';
    fscanf(old, "%i", &radius);
    fscanf(old, "%i", &speed);
    if(speed == 1)
         wnprintf("  Circle w/o cntr %4i", radius);     /* Print                   */
    else
         wnprintf("  Circle w/ center%4i", radius);
    wnprintf("                 Is this correct? (y/n/q)");  /* Print               */
    wnquery(choice,2,&scan);
    wncurmov(row,40);
    wnprintf("                                  ");    /* Print                    */
    if(*choice == 'q' || *choice == 'Q')    /* Choice is a quit.                   */
        {
        fprintf(current,"\n%1i\n",action);     /* Print                            */
        fprintf(current, "%i\n", radius);
        fprintf(current, "%i\n", speed);
        transfer_rest_of_file();       /* Do the module.                            */
        return;
        }
    if(*choice == 'n' || *choice == 'N')
```

```
      {
      wncurmov(row,35);              /* Do the module.                          */
      wnprintf("Do you want to insert commands? (y/n)");    /* Print            */
      wnquery(choice1,2,&scan);      /* Get the next selection.                 */
      wncurmov(row,35);
      wnprintf("                                        ");    /* Print         */
      if(*choice1 == 'y' || *choice1 == 'Y')        /* Choice is a yes.        */
         {
         build_file();
         wnscroll(0,-1,-1,0);            /* Scroll window.                     */
         row = 1;
         wncurmov(++row,1);
         if(speed == 1)
            wnprintf("  Circle w/o cntr %4i", radius);
          else
            wnprintf("  Circle w/ center%4i", radius);    /* Print             */
         }
      wncurmov(row,35);
      wnprintf("Delete this circle? (y/n)");     /* Print                       */
      wnquery(choice1,2,&scan);      /* Get the next selection.                 */
      wncurmov(row,35);
      wnprintf("                              ");       /* Print              */
      if(*choice1 != 'y' && *choice1 != 'Y')
         {
         wncurmov(row,35);
         wnprintf(" Keep the same circle and radius? (y/n)",radius);    /* Print    */
         wnquery(choice,2,&scan);       /* Get the next selection.              */
         wncurmov(row,35);
         wnprintf("                                            ");      /* Print      */
         if(*choice == 'n' || *choice == 'N')
            {
            wncurmov(++row,1);
            wnprintf("              What radius do you want? (in .01mm)");   /* Print */
            wnquery(numbers,10,&scan);
            radius = (int)transform(numbers);       /* Calculate the radius.    */
            wncurmov(++row,1);
            wnprintf("              Do you want to save the center? (y/n)"); /* Print */
            wnquery(numbers,2,&scan);
            if(*numbers == 'n' || *numbers == 'N')
               speed = 1;
            else
               speed = 0;               /* If it is a circle with a center.     */
            }
         }
      }
   if(*choice1 != 'y' && *choice1 != 'Y')   /* Choice is a yes.                 */
      {
      fprintf(current,"\n%1i\n",action);
      fprintf(current, "%i\n", radius);   /* Print                              */
      fprintf(current, "%i\n", speed);
      }
   }

if(action == 6)                       /* If it is a loop                        */
   {
   *choice1 = 'n';
   fscanf(old, "%i", &times);
   wnprintf("  Start loop     %2i times", times);    /* Print                   */
   wnprintf("              Is this correct? (y/n/q)");
   wnquery(choice,2,&scan);                          /* Get the next selection. */
   wncurmov(row,40);
   wnprintf("                              ");     /* Print                    */
   if(*choice == 'q' || *choice == 'Q')     /* If it is a quit.                 */
      {
      fprintf(current,"\n%1i\n",action);     /* Print                           */
      fprintf(current, "%i\n", times);
      transfer_rest_of_file();              /* Do the module.                   */
      return;
      }
   if(*choice == 'n' || *choice == 'N')     /* Choice is a no.                  */
      {
      wncurmov(row,35);
      wnprintf("Do you want to insert commands? (y/n)");  /* Print              */
      wnquery(choice1,2,&scan);            /* Get the next selection.           */
      wncurmov(row,35);
      wnprintf("                                        ");  /* Print          */
```

```
      if(*choice1 == 'y' || *choice1 == 'Y')       /* Choice is a yes.                */
         {
         build_file();
         wnscroll(0,-1,-1,0);
         row = 1;
         wncurmov(++row,1);
         wnprintf("  Start loop     %2i times", times);     /* Print                 */
         }
      wncurmov(row,35);
      wnprintf("Delete this start of a loop? (y/n)");     /* Print                    */
      wnquery(choice1,2,&scan);      /* Get the next selection.                       */
      wncurmov(row,35);
      wnprintf("                                    ");   /* Print                   */
      if(*choice1 != 'y' && *choice1 != 'Y')
         {
         wncurmov(row,35);
         wnprintf(" Keep the %2i loop repetitions? (y/n)", times);   /* Print        */
         wnquery(choice,2,&scan);
         wncurmov(row,35);              /* Move cursor.                               */
         wnprintf("                                          ");
         if(*choice == 'n' || *choice == 'N')
            {
            wncurmov(++row,1);
            wnprintf("             How many times do you want? ");   /* Print        */
            wnquery(numbers,10,&scan);       /* Get the next selection.               */
            times = (int)transform(numbers);        /* Calculate the number of loops.*/
            }
         }
      }
   if(*choice1 != 'y' && *choice1 != 'Y')
      {
      fprintf(current,"\n%1i\n",action);     /* Print                                 */
      fprintf(current, "%i\n", times);
      }
   }

if(action == 7)                       /* If it is a repeat loop                       */
   {
   *choice1 = 'n';
   wnprintf("  End loop                              Is this correct? (y/n/q)");
   wnquery(choice,2,&scan);           /* Get the next selection.                       */
   wncurmov(row,40);
   wnprintf("                              ");      /* Print                         */
   if(*choice == 'q' || *choice == 'Q')              /* Choice is a quit.             */
      {
      fprintf(current,"\n%1i\n",action);             /* Print                         */
      transfer_rest_of_file();                       /* Do module.                    */
      return;
      }
   if(*choice == 'n' || *choice == 'N')              /* Choice is a no.               */
      {
      wncurmov(row,35);
      wnprintf("Do you want to insert commands? (y/n)");    /* Print                 */
      wnquery(choice1,2,&scan);
      wncurmov(row,35);
      wnprintf("                                      ");  /* Print                  */
      if(*choice1 == 'y' || *choice1 == 'Y')
         {
         build_file();                    /* Do module.                              */
         wnscroll(0,-1,-1,0);             /* Scroll window.                          */
         row = 1;
         wncurmov(++row,1);
         wnprintf("  End loop                              ");   /* Print            */
         }
      wncurmov(row,35);              /* Move cursor.                                 */
      wnprintf(" Delete this loop repetition? (y/n)");      /* Print                 */
      wnquery(choice1,2,&scan);
      wncurmov(row,35);
      wnprintf("                                        ");  /* Print               */
      }
   if(*choice1 != 'y' && *choice1 != 'Y')                  /* If choice is a no.    */
      fprintf(current,"\n%1i\n",action);                   /* Print                 */
   }

if(action == 9)                       /* If it is a exit                              */
   {
```

```
    *choice1 = 'n';
    wnprintf("  End of file                          Is this correct? (y/n)");
    wnquery(choice,2,&scan);          /* Find the next selection.                    */
    wncurmov(row,40);
    wnprintf("                                 ");                /* Print              */
    if(*choice == 'n' || *choice == 'N')
        {
        wncurmov(row,35); /* Move the cursor. */
        wnprintf("Do you want to insert commands? (y/n)");      /* Print              */
        wnquery(choice1,2,&scan);
        wncurmov(row,35);
        wnprintf("                                        ");    /* Print              */
        if(*choice1 == 'y' || *choice1 == 'Y')                  /* Choice is a yes.   */
       {
       build_file();                  /* Do module.                                  */
       wnscroll(0,-1,-1,0);
       row = 1;
       }
        }
    fprintf(current,"\n%1i\n",action);                           /* Print              */
    }
  }
fclose(old);
}



/*****************************************************************************
 *
 *      MODULE:   transfer_rest_of_file
 *
 *     PURPOSE:   Copy the rest of file to disk (from a quit in the edit)
 *
 *    PARAMETERS:      GLOBL: current            old
 *                            speed              radius
 *                            x_travel           y_travel
 *
 *                     LOCAL: action            - Laser action variable
 *                            times             - Number of times to process a loop
 *
 *                     USERS: append
 *
 *                     CALLS: fprintf            fscanf
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ------------------------------------------------
 *
 ***********************************************************************/

void transfer_rest_of_file()
{
int action, times;


while(action != 9)                    /* As long as it isn't an exit.                */
  {
  fscanf(old, "%1i", &action);
  fprintf(current,"\n%1i\n",action);   /* Print                                    */

  if(action == 1)                     /* If it is a move                             */
     {
     fscanf(old, "%i", &x_travel);    /* Scan backup for the x travel distance.      */
     fscanf(old, "%i", &y_travel);
     fprintf(current, "%i\n", x_travel);
     fprintf(current, "%i\n", y_travel);
     }

  if(action == 2)                     /* If it is a move                             */
```

```
     {
     fscanf(old, "%i", &x_travel);      /* Scan file for the x travel distance.        */
     fscanf(old, "%i", &y_travel);
     fprintf(current, "%i\n", x_travel);      /* Print                                 */
     fprintf(current, "%i\n", y_travel);
     }

  if(action == 5)                       /* If it is a circle set                       */
     {
     fscanf(old, "%i", &radius);        /* Scan file for the radius.                   */
     fscanf(old, "%i", &speed);
     fprintf(current, "%i\n", radius);                      /* Print                   */
     fprintf(current, "%i\n", speed);
     }

  if(action == 6)                       /* If it is a loop                             */
     {
     fscanf(old, "%i", &times);         /* Scan file for the number of loops.          */
     fprintf(current, "%i\n", times);                       /* Print                   */
     }
      }
}



/*****************************************************************************
 *
 *      MODULE:  pattern_check
 *
 *     PURPOSE: Analyze and optionally print the file
 *
 *    PARAMETERS:      GLOBL: current            print
 *                            prn_file           radius
 *                            scan               selection
 *                            x_position         y_position
 *                            x_travel           y_travel
 *                            speed              laser_status
 *                            vel                vel_cut
 *
 *                     PARAM: print_it          - Option to send the file to the printer
 *
 *                     LOCAL: action            - Laser action variable
 *                            count             - Array counter
 *                            i                 - Loop counter
 *                            k                 - Loop counter
 *                            loop_times        - Array for the # of times a loop is done
 *                            looping           - Array counter for loop to keep track of
 *                            nested_x          - Array for the x posit. during the loops
 *                            nested_y          - Array for the y posit. during the loops
 *                            times             - Number of times to pracess a loop
 *                            row               - Row number of the screen
 *
 *                     USERS: cut_a_pattern
 *
 *                     CALLS: fopen              fprintf
 *                            fscanf             wnscroll
 *                            wncurmov           wnprintf
 *                            wnquery            fclose
 *                            velocity_set
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***************************************************************************/

void pattern_check(int print_it)
{
int i, k, row, count;
```

```
int action, times[5];
int nested_x[5], nested_y[5], loop_times[5], looping;


laser_status = OFF;                     /* Defining initial values.                    */
count = 0;
for(k=0;k!=5;k++)
  {
  times[k] = 0;
  nested_x[k] = 0;
  nested_y[k] = 0;
  loop_times[k] = 0;
  }
x_position = 0;
y_position = 0;
circles = 0;
loops = 0;
end_loops = 0;
on = 0;
off = 0;
looping = 0;
row = 1;

if(print_it == 1)
   fprintf(stdprn," \r\n\n#    Action      Parameters         Position      Velocity\n");
                                        /* Print                                       */

action = 0;

fscanf(current, "%1i", &action);        /* Scan file for the action.                   */
if(action != 8)                         /* If it isn't a resistor trim                 */
  {
  wnscroll(0,-1,-1,0);                                  /* Scroll window.              */
  wncurmov(10,10);
  wnprintf("There is an error in this program!!!");     /* Print                       */
  wnquery(selection,2,&scan);
  fclose(current);
  return;                                               /* Return                      */
  }
fscanf(current, "%f", &vel_cut);
if(print_it == 1)
     fprintf(stdprn," \r\n%1i   Cutting Vel.  %7.3f            0,    0        0.000\n",
                          action, vel_cut);

while(action != 9)                      /* While action isn't exit.                    */
  {
  fscanf(current, "%1i", &action);      /* Scan file for the action.                   */

  if(action == 1)                       /* If it is a move                             */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for the x travel distance         */
     fscanf(current, "%i", &y_travel);
     if(laser_status == ON)             /* If laser is on                              */
        vel = vel_cut;
     else
        vel = velocity_set(x_travel-x_position, y_travel-y_position);
                                        /* Find the safe velocity                      */
     if(print_it == 1)
        fprintf(stdprn," \r%1i   Position   %5i,%5i       %5i,%5i      %7.3f\n",
                          action, x_travel, y_travel, x_position, y_position, vel);
     x_position = x_travel;             /* Calculate the x position.                   */
     y_position = y_travel;
     }

  if(action == 2)                       /* If it is a move                             */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for the x travel distance.        */
     fscanf(current, "%i", &y_travel);
     if(laser_status == ON)
        vel = vel_cut;                  /* Calculate the cutting velocity              */
     else
        vel = velocity_set(x_travel, y_travel);
     if(print_it == 1)
         fprintf(stdprn," \r%1i   Distance   %5i,%5i       %5i,%5i      %7.3f\n",
                          action, x_travel, y_travel, x_position, y_position, vel);
     x_position = x_travel + x_position;            /* Calculate the x position.       */
```

```
   y_position = y_travel + y_position;
   }

if(action == 3)                        /* If it is a laser on                        */
   {
   k = 1;
   if(looping != 0)
      {
      for(i=1; i != looping + 1; i++)       /* Increment the number of loops.         */
         {
         k = k * loop_times[i];             /* keep track of the number of loops.     */
         }
      }
   on = on + k;            /* Keep track of the number of times the laser has been on. */
   if(print_it == 1)
       fprintf(stdprn," \r%1i   Laser on                    %5i,%5i      %7.3f\n",
                           action, x_position, y_position, vel);
                                          /* Print.                                  */
   laser_status = ON;
   }

if(action == 4)                        /* If it is a laser off                       */
   {
   k = 1;                              /* Number of times laser has been on.          */

   if(looping != 0)
      {
      for(i=1; i != looping + 1; i++)   /* Keeping track of the number of loops.      */

         {
         k = k * loop_times[i];
         }
      }
   off = off + k;     /* Keeping track of the number of times the laser has been off. */
   if(print_it == 1)
       fprintf(stdprn," \r%1i   Laser off                   %5i,%5i      %7.3f\n",
                           action, x_position, y_position, vel);
   laser_status = OFF;                 /* Turning laser off.                          */

   }

if(action == 5)                        /* If it is a circle set                      */
   {
   fscanf(current, "%i", &radius);     /* Scan file for the radius                   */

   fscanf(current, "%i", &speed);
   k = 1;                              /* Number of circles                          */

   if(looping != 0)
      {
      for(i=1; i != looping + 1; i++)  /* Keeping track of the number of times       */
                                       /*          circle has been done.             */

         {
         k = k * loop_times[i];
         }
      }
   circles = circles + k;              /* Number of circles.                         */
   if(print_it == 1)
      {
      if(speed == 1)                   /* If it is a circle with a center.           */
       fprintf(stdprn," \r%1i   Circle w/o cntr%5i         %5i,%5i        2.000\n",
                           action, radius, x_position, y_position, vel);
      else
       fprintf(stdprn," \r%1i   Circle w/center%5i         %5i,%5i        1.000\n",
                           action, radius, x_position, y_position, vel);
      }
   }

if(action == 6)                        /* If it is a start loop                      */
   {
   fscanf(current, "%i", &times[count]);    /* Scan file for the number of loops.     */
   nested_x[count] = x_position;
   nested_y[count] = y_position;
   looping++;                              /* Increment                              */
   loop_times[looping] = times[count];     /* Calculate the number of loops.         */
```

```
      loops++;
      if(print_it == 1)
          fprintf(stdprn," \r%1i   Start Loop   %3i times       %5i,%5i      %7.3f\n",
                          action, times[count], x_position, y_position, vel);
      count++;                          /* Increment                                        */
      }

    if(action == 7)                      /* If it is an end loop                            */
      {
      if(count != 0)                    /* If is isn't the first loop                       */
         {
         count--;
         x_position = nested_x[count] + times[count]*(x_position - nested_x[count]);
                                        /* Calculate the x position.                        */
         y_position = nested_y[count] + times[count]*(y_position - nested_y[count]);
         end_loops++;
         if(print_it == 1)              /* If it is to be sent to the printer.              */
              {
              fprintf(stdprn," \r-     Loop repetition \n");
              fprintf(stdprn," \r%1i   End loop                    %5i,%5i      %7.3f\n",
                              action, x_position, y_position, vel);
              }
         looping--;                     /* Decrement the number of loops                    */
         }
      else
         {
         end_loops++;                   /* Keep track of the number of loops completed  */
         if(print_it == 1)
            fprintf(stdprn," \r%1i   EXTRA END LOOP              %5i,%5i      %7.3f\n",
                            action, x_position, y_position, vel);
         }
      }
    }

if(print_it == 1)
    fprintf(stdprn," \r\n%1i   End of File                  %5i,%5i      %7.3f\n",
                        action, x_position, y_position, vel);
                                        /* Print                                            */

if(print_it == 1)                       /* If it is to be sent to the printer.              */
    {
    fprintf(stdprn," \r\n\nThe final position is %6i, %6i.", x_position, y_position);
                                        /* Send the following messages to the printer.  */
    fprintf(stdprn," \r\nThere were %i loops started.",loops);
    fprintf(stdprn," \r\nThere were %i loops ended.",end_loops);
    fprintf(stdprn," \r\nThe laser was turned on %i times.",on);
    fprintf(stdprn," \r\nThe laser was turned off %i times.",off);
    fprintf(stdprn," \r\nThere were %i circles.",circles);
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    fprintf(stdprn,"
");
    }

}



/*****************************************************************************
```

```
 *
 *      MODULE:  do_file
 *
 *     PURPOSE:  Base loop execution (internal loops are processed separately)
 *
 *    PARAMETERS:      GLOBL: circles            current
 *                            end_loops         loops
 *                            num_loops         off
 *                            on                plist
 *                            pwin              resting
 *                            vel               x_displace
 *                            x_position        xpos
 *                            y_displace        y_position
 *                            ypos              radius
 *                            scan              selection
 *                            x_travel          y_travel
 *                            speed             vel_cut
 *
 *                      LOCAL: action            - Laser action variable
 *                            choice            - User character input choice
 *                            col               - Dumby variable for screen column
 *                            row               - Row value of the screen
 *                            times             - Number of times to process a loop
 *                            bits              - Value of the port that controls speaker
 *                            i                 - Loop variable for the beep
 *                            j                 - Loop variable for the beep
 *                            vel_cut           - Cutting velocity of the laser
 *
 *                      USERS: cut_a_pattern
 *
 *                      CALLS: wnscroll          wncurmov
 *                            wnprintf          wnquery
 *                            some_move         velocity_set
 *                            fscanf            fclose
 *                            wnselect          set_up_a_loop
 *                            wncurpos          do_a_loop
 *                            circle_cut
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***********************************************************************/

void do_file()
{
int i, j, bits, times, row, col, action;


pattern_check(0);

if((loops != end_loops) || (on != off) || (x_position != 0) || (y_position != 0))
  {
  wnscroll(0,-1,-1,0);                  /* Scroll window                          */
  wncurmov(7,10);
  wnprintf("This file is not operationaly correct!!");         /* Print          */
  wncurmov(9,10);
  wnprintf("Do you want to run the program anyway? (y/n)");    /* Print          */
  wnquery(selection,2,&scan);
  }
if(*selection == 'n' || *selection == 'N')          /* If selection is no.        */
  return;

fclose(current);

current = fopen(new_file,"r");          /* Open new file.                         */

laser_status = OFF;                     /* Defining variables.                    */
loops = 0;
end_loops = 0;
```

```
x_position = 0;
y_position = 0;
circles = 0;
on = 0;
off = 0;

wnscroll(0,-1,-1,0);
wncurmov(7,10);                          /* Move cursor.                                  */
wnprintf("Press ENTER when you are ready.            ");        /* Print                 */
wnquery(selection,2,&scan);
action = 0;

wnscroll(0,-1,-1,0);                     /* Scroll window                                 */
wncurmov(1,1);
wnprintf("#    Action      Parameters         Position      Velocity");  /* Print*/
fscanf(current, "%1i", &action);
if(action != 8)
  {
  wnscroll(0,-1,-1,0);                   /* Scroll window                                 */
  wncurmov(10,10);
  wnprintf("There is an error in this program!!!");     /* Print                          */
  wnquery(selection,2,&scan);
  fclose(current);
  return;
  }
fscanf(current, "%f", &vel_cut);
row = 2;
wncurmov(++row,1);
wnprintf("%1i   Cutting Vel.  %7.3f            0,    0        0.000\n",action, vel_cut);


while(action != 9)                       /* If it is an exit                              */
 {
 fscanf(current, "%1i", &action);
 if( ++row > 17)
    {
    wnscroll(5,-1,-1,0);                 /* Scroll five lines.                            */
    row = row - 5;
    }
 wncurmov(row,1);

 if(action == 1)                         /* If it is a move                               */
     {
     fscanf(current, "%i", &x_travel);    /* Scan file.                                    */
     fscanf(current, "%i", &y_travel);
     if(laser_status == ON)
        vel = vel_cut;
     else
        vel = velocity_set(x_travel - xpos + x_displace,
                           y_travel - ypos + y_displace);
     wnprintf("%1i   Position   %5i,%5i       %5i,%5i      %7.3f\n",
              action, x_travel, y_travel, x_position, y_position, vel);
     x_position = x_travel;
     y_position = y_travel;
     wnquery(selection,2,&scan);
     }

  if(action == 2)                        /* If it is a move                               */
     {
     fscanf(current, "%i", &x_travel);
     fscanf(current, "%i", &y_travel);  /* Scan file.                                    */
     if(laser_status == ON)
        vel = vel_cut;                   /* Set cutting velocity.                         */
     else
        vel = velocity_set(x_travel, y_travel);
     wnprintf("%1i   Distance   %5i,%5i       %5i,%5i      %7.3f\n",
              action, x_travel, y_travel, x_position, y_position, vel);
     x_position = x_travel + x_position;              /* New x position.                 */
     y_position = y_travel + y_position;
     wnquery(selection,2,&scan);
     }

  if(action == 3)                        /* If it is a laser on                           */
     {
     on++;
     wnprintf("%1i   Laser on                     %5i,%5i      %7.3f\n",
```

```
            action, x_position, y_position, vel);
      laser_status = ON;
      wnquery(selection,2,&scan);
      }

   if(action == 4)                        /* If it is a laser off                          */
      {
      off++;
      wnprintf("%1i   Laser off                    %5i,%5i      %7.3f\n",
            action, x_position, y_position, vel);
      laser_status = OFF;
      wnquery(selection,2,&scan);
      }

   if(action == 5)                        /* If it is a circle set                         */
      {
      fscanf(current, "%i", &radius);     /* Scan file.                                    */
      circles++;
      fscanf(current, "%i", &speed);      /* Scan file.                                    */
      if(speed == 1)
           wnprintf("%1i   Circle w/o cntr%5i         %5i,%5i        2.000\n",
                     action, radius, x_position, y_position);
                                          /* Scan file.                                    */
      else
           wnprintf("%1i   Circle w/center%5i         %5i,%5i        2.000\n",
                     action, radius, x_position, y_position);
                                         /* Scan file.                                     */
      wnquery(selection,2,&scan);
      }

   if(action == 6)                        /* If it is a start loop                         */
      {
      fscanf(current, "%i", &times);
      wnprintf("%1i   Start Loop 0  %3i times      %5i,%5i      %7.3f\n",
            action, times, x_position, y_position, vel);
      loops++;
      num_loops = 0;
      set_up_a_loop();
      num_loops = 0;
      if(do_a_loop(times) == 1)
         {
         laser_status = OFF;              /* Laser is off.                                 */
         break;
         }
      wnprintf("8   End Loop 0                   %5i,%5i      %7.3f\n",
                                          x_position, y_position, vel);
                                          /* Print                                         */
      end_loops += 1;
      wncurpos(&row,&col);                /* Move cursor.                                  */
      wnquery(selection,2,&scan);
      }

   if(action == 7)                        /* If it is an repeat loop                       */
      {
      wnprintf(  "-     Extra end of repetition ");      /* Print                          */
      wnprintf("%1i   End loop                     %5i,%5i      %7.3f\n",
            action, x_position, y_position, vel);
      end_loops++;                         /* Increment number of endloops.                 */
      wnquery(selection,2,&scan);
      return;
      }
   }

wncurmov(++row,1);
wnprintf("\a\a%1i   End of File                  %5i,%5i      %7.3f\n",
          action, x_position, y_position, vel);
wnscroll(8,-1,-1,0);                      /* Scroll 8 lines.                               */
wncurmov(9,1);
wnprintf("              The final position is %6i, %6i.", x_position, y_position);
wnprintf("\n              There were %i loops started.",loops);  /* Print                 */
wnprintf("\n              There were %i loops ended.",end_loops);
wnprintf("\n              The laser was turned on %i times.",on);
wnprintf("\n              The laser was turned off %i times.",off);
wnprintf("\n              There were %i circles.",circles);

wnprintf("\n\n                 (Press ENTER to continue)");      /* Print                 */
```

```
wnquery(selection,2,&scan);

fclose(current);                        /* Close file.                                  */
}



/*****************************************************************************
 *
 *      MODULE:  set_up_a_loop
 *
 *     PURPOSE: To store in memory the (nested) loops of the file
 *
 *    PARAMETERS:      GLOBL: current            nested_loops
 *                            num_loops          speed
 *                            values             radius
 *                            x_travel           y_travel
 *
 *                     LOCAL: action            - Laser action variable
 *                            loop_number       - Current loop that is being processed
 *                            velo_cut          - Cutting velocity of the laser
 *                            times             - Number of times to process a loop
 *                            units_of_step     - Single operation pointer in a loop
 *
 *                     USERS: do_file            set_up_a_loop
 *
 *                     CALLS: fscanf             set_up_a_loop
 *
 *     RETURNS:  NONE
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***********************************************************************/

void set_up_a_loop()
{
int action, times, loop_number, units_of_step;
float velo_set;


action = 0;                             /* Set initial value.                           */
loop_number = num_loops;
num_loops++;
units_of_step = 0;

while(action != 7)                      /* As long as it is not a 7                     */

      {
      fscanf(current, "%1i", &action);  /* Scan file.                                   */
      nested_loops[loop_number][units_of_step] = action;     /* Calculate nested loops. */

  if(action == 1)                       /* If it is a move                              */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for x travel distance.             */
     fscanf(current, "%i", &y_travel);
     values[loop_number][units_of_step][0] = x_travel;
     values[loop_number][units_of_step][1] = y_travel;    /* Find location for pointer. */
     }

  if(action == 2)                       /* If it is a move                              */
     {
     fscanf(current, "%i", &x_travel);  /* Scan file for x travel distance.             */
     fscanf(current, "%i", &y_travel);
     values[loop_number][units_of_step][0] = x_travel;    /* Find location for pointer. */
     values[loop_number][units_of_step][1] = y_travel;
     }

  if(action == 5)                       /* If it is a circle set                        */
     {
```

```
     fscanf(current, "%i", &radius);     /* Find radius.                                  */
     fscanf(current, "%i", &speed );     /* Find type.                                    */
     values[loop_number][units_of_step][0] = radius;
     values[loop_number][units_of_step][1] = speed;
     }

  if(action == 6)                        /* If it is a start loop                         */
     {
     fscanf(current, "%i", &times);      /* Find number of times to do loop.              */
     values[loop_number][units_of_step][0] = times;
     set_up_a_loop();                    /* Do module.                                    */
     }
      units_of_step += 1;
      }

return;
}



/*****************************************************************************
 *
 *      MODULE: do_a_loop
 *
 *     PURPOSE: To process the internal (nested) loops
 *
 *    PARAMETERS:      GLOBL: circles            loops
 *                            nested_loops      num_loops
 *                            off               on
 *                            resting           speed
 *                            values            vel
 *                            x_displace        x_position
 *                            xpos              y_displace
 *                            y_position        ypos
 *                            radius            x_travel
 *                            y_travel          vel_cut
 *
 *                      PARAM: count            - Number of times to process this loop
 *
 *                      LOCAL: action           - Laser action variable
 *                            times             - Number of times to process the next loop
 *                            col               - Dumby variable for the column position
 *                            counter           - Loop counter
 *                            loop_number       - Which loop is being processed
 *                            row               - Row position on the screen
 *                            units_of_step     - Single operation pointer in a loop
 *                            vel_cut           - Cutting velocity of the laser
 *
 *                      USERS: do_file            do_a_loop
 *
 *                      CALLS: wncurpos           wnscroll
 *                            wncurmov          wnprintf
 *                            do_a_loop         circle_cut
 *
 *     RETURNS:  0 - Okay to keep going
 *               1 - STOP!!
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *
 ***************************************************************************/

int do_a_loop(int count)
{
int row, col, times, counter, loop_number, action, units_of_step;


loop_number = num_loops;
wncurpos(&row,&col);
```

```
for(counter = 0; counter < count; counter++)
  {
  num_loops = loop_number;
  units_of_step = 0;
  action = 0;
  while(action != 7)                    /* As long as it isn't a resistor trim.        */
      {
      action = nested_loops[loop_number][units_of_step];
      if( ++row > 13)                   /* If the number of rows is more than 13       */
         {
         wnscroll(5,-1,-1,0);           /* Scroll window five lines.                   */
         row = row - 5;                 /* Calculate new row for window.               */
         }
      wncurmov(row,1);                  /* Move cursor.                                */

  if(action == 1)                       /* If it is a move                             */
     {
     x_travel = values[loop_number][units_of_step][0];  /* Calculate new x position.   */
     y_travel = values[loop_number][units_of_step][1];
     if(laser_status == ON)
        vel = vel_cut;                  /* Find new velocity.                          */
     else
        vel = velocity_set(x_travel - xpos + x_displace,
                           y_travel - ypos + y_displace);
     wnprintf("%1i   Position   %5i,%5i       %5i,%5i       %7.3f\n",
              action, x_travel, y_travel, x_position, y_position, vel);
                                        /* Print.                                      */
     x_position = x_travel;
     y_position = y_travel;             /* Find new y position.                        */
     wnquery(selection,2,&scan);
     }

  if(action == 2)                       /* If it is a move                             */
     {
     x_travel = values[loop_number][units_of_step][0];   /* Find new x travel distance. */
     y_travel = values[loop_number][units_of_step][1];
     if(laser_status == ON)
        vel = vel_cut;                  /* Find new velocity.                          */
     else
        vel = velocity_set(x_travel, y_travel);   /* Find new velocity                 */
     wnprintf("%1i   Distance   %5i,%5i       %5i,%5i       %7.3f\n",
              action, x_travel, y_travel, x_position, y_position, vel);
                                        /* Print                                       */
     x_position = x_travel + x_position;     /* Find new x position.                   */
     y_position = y_travel + y_position;
     wnquery(selection,2,&scan);
     }

  if(action == 3)                       /* If it is a laser on                         */
     {
     on++;
     wnprintf("%1i   Laser on                    %5i,%5i       %7.3f\n",
              action, x_position, y_position, vel);
                                        /* Print                                       */
     laser_status = ON;                 /* Change laser status to on.                  */
     wnquery(selection,2,&scan);
     }

  if(action == 4)                       /* If it is a laser off                        */
     {
     off++;
     wnprintf("%1i   Laser off                   %5i,%5i       %7.3f\n",
              action, x_position, y_position, vel);
                                        /* Print.                                      */
     laser_status = OFF;
     wnquery(selection,2,&scan);
     }

  if(action == 5)                       /* If it is a circle set                       */
     {
     radius = values[loop_number][units_of_step][0];
     speed  = values[loop_number][units_of_step][1];     /* Find type of circle.       */
     circles++;
     if(speed == 1)
          wnprintf("%1i   Circle w/o cntr%5i         %5i,%5i        2.000\n",
                   action, radius, x_position, y_position);
```

```
    else
         wnprintf("%1i   Circle w/center%5i         %5i,%5i        2.000\n",
                    action, radius, x_position, y_position);
    wnquery(selection,2,&scan);
    }

  if(action == 6)                        /* If it is a start loop                        */
    {
    times = values[loop_number][units_of_step][0];       /* Calculate number of times. */
    num_loops++;
    wnprintf("%1i   Start Loop %i  %3i times      %5i,%5i      %7.3f\n",
              action, loop_number + 1, times, x_position, y_position, vel);
                                         /* Print.                                       */
    loops++;
    if(do_a_loop(times) == 1)            /* If it is the first loop.                     */
      return(1);
    wnprintf("8   End Loop %i                    %5i,%5i      %7.3f\n",
                           loop_number + 1, x_position, y_position, vel);
                                         /* Print                                        */
    end_loops += 1;                      /* Increment the number of endloops.            */
    wncurpos(&row,&col);                 /* Move cursor.                                 */
    }

     units_of_step++;
     }
   }
return(0);
}



/*****************************************************************************
 *
 *      MODULE:  transform
 *
 *     PURPOSE:  To change a character buffer array into a numeric number
 *
 *    PARAMETERS:      PARAM: buffer            - Character buffer to change
 *
 *              LOCAL: j                 - Loop variable
 *                     m                 - Loop variable
 *                     n                 - Loop variable
 *                     v1                - decimal part of the number
 *                     value             - integer part of the number
 *
 *              USERS: cut_a_pattern      build_file
 *
 *     RETURNS:  Number in float form
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *                                                                            *
 ****************************************************************************/

float transform(char *buffer)
{
   float value, v1;
   int n,j,m;


   if((buffer[0] <48 || buffer[0] > 57) && buffer[0] != 45 && buffer[0] != 46);
                                         /*  If the first character is not valid, quit   */
   else
                                         /* If the first character is valid              */
      {
      n=0;                               /*   Initialize the counters                    */
      value = 0;
      v1 = 0;
      if(buffer[0] == 45)                /*   If the first character is negative,        */
             n=1;                        /*Flag it                                       */
```

```
      for(j=n; buffer[j] >= 48 && buffer[j] <= 57; j++)  /*   For each integer number   */
          value = (value * 10) + buffer[j]-'0';  /*      Add it in and shift            */
      if(buffer[j] == 46)                /*   If, after the integers there is a period,  */
          {
          for(m=6; m != j; --m)          /*   For each possible other character          */
            {
            if( buffer[m] >= 48 && buffer[m] <= 57)    /* If the character is a number  */
               v1 = (v1 + buffer[m]-'0')/10;     /*      Add it in and shift            */
            }                            /*   Do for all other characters                */
          }
      value = value + v1;                /*   Add the decimal and integer numbers        */
      if(n==1)                           /* If the number is negative,                   */
          value = (-1)*value;            /*   Make the number negative                   */
      }
  return value;                          /* Return the number                            */

}



/*************************************************************************
 *
 *      MODULE:  vel_set
 *
 *     PURPOSE:  Calculate the fastest velocity that the laser can safely move
 *
 *    PARAMETERS:      PARAM: x_dist     - The x distance to travel
 *                            y_dist     - The y distance to travel
 *
 *              USERS: cut_a_pattern      build_file
 *
 *     RETURNS:  Number (velocity) in int form
 *
 *        DATE:  24 June 1990
 *  PROGRAMMER:  Ryp Walters
 *    LANGUAGE:  Microsoft C Version 5.1
 *          OS:  MS-DOS Version 3.3
 *
 *     DATE      INITIALS                    MODIFICATION
 *  ---------    --------  ---------------------------------------------------
 *                                                                            *
 ***********************************************************************/

int velocity_set(int x_dist, int y_dist)
{
  if(abs(x_dist) < 49 && abs(y_dist) <49)
     return(2);

  if(abs(x_dist) < 199 && abs(y_dist) < 199)
     return(4);

  if(abs(x_dist) < 699 && abs(y_dist) < 699)
     return(6);

  return(8);

}
```

APPENDIX X

LASER SYSTEM USER'S MANUAL

10/16/90

Revised 2/25/91

Prepared by

Ryp Walters

Introduction

This system is designed so that anyone can operate the ESI Model 25 Laser System through the controlling IBM XT. Although the system is simple to use, the laser operator needs to be trained in the hardware of the entire system prior to operation. Correct operation of the system hardware, in particular with the laser power supply, is critical for equipment performance as well as proper care of the equipment. It is necessary to understand both the hardware and software characteristics in operating the laser, as covered in the user's manual.

Table of Contents

	Page
Introduction	**321**
Table of Contents	**322**
Table of Figures	**324**
Chapter 1. Laser Software	**325**
1.1 The Main Menu	325
1.1.1 Move Distance	325
1.1.2 Scribe	327
1.1.3 Pattern Cut	328
1.1.4 Cut a Circle	328
1.1.5 Index	329
1.1.6 Resistor Trimming	329
1.1.7-8 Hardware and Measurement System Test	330
1.1.9 Exit	330
1.2 Pattern Cut Menu	330
1.2.1 Create a File	330
1.2.1.1 Position Movement	333
1.2.1.2 Distance Movement	333
1.2.1.3 Laser On	333
1.2.1.4 Laser Off	333
1.2.1.5 Circle	334
1.2.1.6 Start A Loop	334
1.2.1.7 Repeat Loop	334

1.2.1.8 Exit 334

1.2.2 Edit 335

1.2.3 Analyze / Print a File 336

1.2.4 Run A File 337

1.2.5. Main Menu 337

Chapter 2. Filemake 338

Chapter 3. Hardware 339

Table of Figures

Page

Figure 1. Main Menu **326**

Figure 2. Pattern Cut Menu **331**

Figure 3. Create a File Menu **332**

Figure 4. The Hardware Diagram **340**

Chapter 1. Laser Software

1.1 The Main Menu

This software is completely menu driven. All single-action operations are accessed through the Main Menu, while all pattern cutting operations (repeated operations) are contained in a sub-menu. The program is started by calling the executable file LASER from DOS. Upon entering the program, a prompt will appear to turn the laser system ON. This only refers to the laser machinery, not to the laser power supply. After the laser has been turned on and ENTER has been pressed, the laser initialization sequence will occur. When this is completed, the Main Menu will appear as shown in Figure 1.

The screen is divided into two windows. The upper window is the active user window which displays the user's current options. The lower window is the parameter window that displays the current laser position as well as other information dealing with the user's previous choices.

A description of the Main Menu options is as follows:

1.1.1 Move Distance

Move Distance allows the user to actively change the current position of the laser system. This can be done by either using the joystick on the laser keypad or by entering the distance to move into the PC. Both techniques are very useful. The joystick method is most applicable when an exact position is not necessary. The move is completed by pressing the load position button on the laser keypad. Examples of the joystick's use include retrieving a magnification of the material by viewing it on the monitor or finding certain

```
Laser Operating System

What would you like to do?

1. Move distance
2. Scribe
3. Pattern cut
4. Cut a circle
5. Index
6. Resistor trinming
7. Hardware test
8. Test measurenent system
9. Exit

Option:

System Status
Current Position: 0, 0
```

Figure 1. The Main Menu

characteristics of the material such as corners, sides, or figures. The numeric distance method is best suited for precise distance requirements, like the half-way point between two known objects. If either the distance or velocity is 0, no change will result.

A combination of the two methods might also be required. This is seen when a 2" X 2" substrate needs to be scribed into two 1" X 2" pieces. The joystick can be used to place the position at a particular corner. A distance of 2540 motor steps (1") in the appropriate axial direction will then yield the correct initial position for the scribe. One motor step equals .01 mm (2.54 mil).

It is important to remember with any type of move that the laser system has position limits. It is very easy to forget about the location of the current position. This may result in trying to move to a position that is out of the laser's range. The joystick method will recover from a limit bump, but a circuit breaker in the upper left corner of the left front cabinet may be tripped. This is solved by moving the laser arm by hand to its center and resetting the circuit breaker. The distance method will not allow movements that would move out of range. Upon entering an out of range distance, the computer will alert the user of the error and will request a valid distance.

1.1.2 Scribe

Scribe is the single-scribe routine. The computer will prompt for the way in which the scribing end points will be entered: by joystick or by distances. Most applications of this routine will use the joystick, which prompts the user for both the initial and the final points. The points are entered by pressing the LOAD POSITION button on the laser keypad. Some applications may require the use of specific distances. The program currently assumes that the user is already at the initial point for a distance scribe. The computer only needs the distance to the final point. After loading the positions with either the joystick or the distance

to travel, the computer will ask for the number of times that the complete distance should be scribed. A reply of zero will cancel the routine. The user should note that after scribing, the final position may not be at the same initial position. After the scribe has been completed, the computer will ask if more scribing needs to be done. A response of NO will return control to the Main Menu.

1.1.3 Pattern Cut

Pattern Cut is a separate menu system that allows for sequences of actions to be created, printed/analyzed, edited, and run. Discussion of this option is left until 1.2.

1.1.4 Cut a Circle

Cut a Circle is a routine that cuts a complete circle of a given radius. Valid radii are from 1 to 3000 motor steps. It starts by asking if the current position is the origin of the circle. A response of NO will allow movement to that position using the techniques described in the move distance routine. When the origin is set, the user is asked what kind of circle he wants: saving-the-circle or cutting-the-circle.

Both types of circles will travel at the same speed without any pause as they circumscribe the circle. The only difference is that the saving-the-circle option turns the laser on after it has moved to the circumference but before it starts to move along it. The cutting-the-circle option turns the laser on at the center of the circle and cuts a radial line as the laser moves form the center to the circumference. It then proceeds around the circumference leaving the circle radially scribed. The saving-the-circle option is good for most applications, but it occasionally has an unwanted effect on small radius circles. This is due to the fact that when the laser is turned on, it pulses with a greater intensity than when it normally operates. This produces a hole of about 2 motor steps (1 mil) in diameter. With

circles that have radii greater than about twenty motor steps, this fringing is negligible due to the curvature of the circle. For circles with relatively large radii, the saving-the-circle option is reliable to use without complications. Circles with radii less than about twenty motor steps are most efficiently created using the cut-the-circle option, assuming that the inner portion of the circle does not need to be saved. With the cut-the-circle option, the continuity of the circumference is preserved. After the circle has been completed, the computer will ask if another circle needs to be cut. A response of YES will allow for a change in the origin and/or a change in the radius. A response of NO will return control to the Main Menu.

1.1.5 Index

Index is a quick way to move the laser to its home position (0,0).

1.1.6 Resistor Trimming

Resistor Trimming is the routine that performs a resistor trim. After entering the probe positions, the current value of the resistor that is connected across those probes is displayed. The computer will ask for the (higher) resistance to which the resistor is to be trimmed. After using the joystick to enter positions on both sides of the resistor, the start button must be pressed to begin the trim. Note that the computer has no way of checking the relation between the position that was loaded and where the resistor really is located. Incorrect positions can lead to computer lock-up. After the trim has been completed, the computer will ask if another resistor trim needs to be done. Only one resistor can be trimmed at a time. A response of NO will return control to the Main Menu.

1.1.7-8 Hardware and Measurement System Test

Hardware and Measurement System Test are test routines for the purpose of maintenance and trouble-shooting and should only be used by the laser system supervisor.

1.1.9 Exit

Exit will return the system to DOS.

1.2 Pattern Cut Menu

The third choice of the Main Menu is for a pattern cut. The pattern cut menu (Figure 2) includes all file oriented functions. These functions are to create a file, analyze/print a file, edit a file, and run a file. No other choices from the Main Menu include any file oriented functions. When a file needs to be constructed and/or tested, the program "Filemake" should be run instead of "Laser". The "Filemake" program does not require the use of the laser and can be run on any system. (Remember that the "Laser" program requires that the laser machinery be running.) Further information on filemake is in the next section. A synopsis of the pattern cut menu functions is as follows:

1.2.1 Create a File

Create a File is a function that builds a new file. The origin is assumed that wherever the laser is located when the file is to be run. Therefore, the file assumes a starting position (0,0). The computer will then prompt for an eight character filename without any extension. Once the file has been opened, the cutting velocity of the pattern

```
Laser Operating System

What would you like to do?

1. Create a file
2. Analyze / print a file
3. Edit a file
4. Run a file
5. Main menu

Option:

System Status
Current Position: 0, 0
```

Figure 2. The Pattern Cut Menu

```
Laser Operating System

What would you like to do?

   1. Move to a position
   2. Distance move
   3. laser On
   4. Laser off
   5. Circle cut
   6. Start a loop
   7. Repeat a loop

   9. Exit

        Option:
```

```
System Status
Current Position: 0, 0
```

Figure 3. The Create a File Menu

will be requested. This is not the travelling velocity, but the cutting velocity that the laser will have whenever the laser is on. See Chapter 4 for good velocities for the material that is to be cut. The laser operation list (Figure 3) will then appear.

An explanation of these operations is as follows:

1.2.1.1 Position Movement

Position Movement will prompt for the desired position. The program assumes that it will start at position (0,0). This position is not the internal laser position, but an arbitrary starting point. This is acceptable because when the file is running, the user is prompted to move to the starting point. This starting point will then be defined as (0,0) and the file will run with respect to it.

1.2.1.2 Distance Movement

Distance Movement will prompt for the distance to move from the current position.

1.2.1.3 Laser On

Laser On will turn the laser on at that point in the file. If the laser was previously turned on, it will remain on.

1.2.1.4 Laser Off

Laser Off will turn the laser off at that point in the file. If the laser was previously turned off, it will remain off.

1.2.1.5 Circle

Circle is a routine that cuts a circle of any radius. Regardless of whether the laser is ON or OFF, the laser will be ON when the circle is cut. The circle velocities are preset and unchangeable. There are two types of cuts, cutting-the-circle and saving-the-circle. The difference between the two methods was described in the Cut a circle operation from the Main Menu.

1.2.1.6 Start A Loop

Start a Loop is the open marker for a loop sequence. The computer will ask for the number of times the loop is to be processed.

1.2.1.7 Repeat Loop

Repeat a Loop is the close marker for a loop sequence. All loops that have been started MUST have a repeat or else the file will not be processed correctly and the computer will lock up.

1.2.1.8 Exit

Exit will close the file and return to the pattern cut menu.

Once a file has been created, it is a very good idea to analyze it so that it can be checked for errors. It is also good practice to do a distance move as the last step on all files. This allows for greatest gain in the use of an analysis.

On an exit, the file is automatically saved. There is no need to "save" the file. It is advisable to keep backups of your files by copying the filename with a ".new" extension onto a backup disk. In order to use a file, it must be in the same directory as the Laser Program.

No change of directory or drive is allowed. Once a file has been created, the user MUST fill out a file information sheet so that other people will know that the file exists, what it does, and who uses it. This sheet will also be good for keeping track of changes and for writing comments for next time the file will be used. A printout of the file should also be kept along with this information sheet.

1.2.2 Edit

Edit is a function that steps the user through a file line by line. The cutting velocity will be displayed first and the prompt will say "Is this correct? (y/n)". Entering 'n' will allow a new cutting velocity to be entered. A 'y' will continue to the next operation. The prompt will now say "Is this correct? (y/n/q)". Entering 'q' will quit the editor and save all previous changes. If the operation is correct, press 'y' and ENTER. Simply pressing ENTER will assume a 'y' reply. With this, the next operation will appear with the "Is this correct? (y/n/q)" prompt.

If the operation is not correct, press 'n' and ENTER. An incorrect operation means one or more of the following:

- commands need to be inserted before this operation,
- the operation should be deleted (skipped),
- the parameters are incorrect (wrong distance, radius,...).

After pressing 'n' and ENTER, the prompt "Do you want to insert commands? (y/n)" will appear. If commands do need to be inserted, enter 'y'. This will take the user to the create a file menu discussed above. Select option "9. Exit" when all required commands are inserted. This will return the user to the edit.

The next prompt is to delete (skip) the operation. A 'yes' response for the delete skips to the next operation and deletes the previous operation from the file. A 'no' response for the delete leads to a prompt for if the current parameters are correct. Those operations that do not have parameters (laser on, off, end loop) will skip this prompt and go on to the next operation. For those operations that do have parameters, this is the time to change them if they are incorrect.

To change the parameters, enter 'n'. The editor will then prompt for the correct parameters. After changing the parameters or selecting not to, the operation is stored in the file and the next operation is listed.

This process can be continued until the file has been completely stepped through or until 'q' is pressed. This quit will save all changes made to the file during the edit and will then quit the editor.

1.2.3 Analyze / Print a File

Analyze / Print a File will keep track of the position, as well as the number of laser ON times, laser OFF times, loops started, loops repeated, and circles. This allows for a checking sequence between what the file is expected to do and what it will really do when it is run. As described previously with creating a file, it is a good practice to do a distance move (not a position move) back to the origin as the final operation before exiting the creation of a file. This way, when the final analysis is shown, if the final position is not (0,0), it will be obvious that an error exists. Doing a position move to (0,0) as the final operation will not give this insight because the computer will tell the laser to move whatever distance is required to get back to (0,0), whether it was the intended distance or some other distance. This function also prompts for whether the file and analysis should be sent to the printer.

The printed file contains the operation name, all of the operation's parameters, the position the laser would be at BEFORE the operation is processed, and the velocity that the operation would be processed at. This gives the position of the laser as it will be when it is running which can be checked with the original diagram. The final analysis is also printed. This is ideal for debugging as well as including with the file information sheet to show the exact values and parameters. It is also very important to keep written reports of the files.

1.2.4 Run A File

Run A File is the actual function that sends the file to the laser for processing. It starts out by asking if the current position of the laser is the position to be stored as the origin for the file. If the current position is not the origin, the joystick and/or distances may be used to get to the origin as described in the Move distance option (1.1.1) of the Main Menu. The final prompt is to hit the START button on the laser keypad when everything is ready. Once this button is pressed, the file will be acted upon, so be sure that the power is set, that the status is ON, and that the interlocks are closed. To break the file before completion, the STOP button on the keypad may be pressed. This will break the file, turn the laser off, and return to the origin of the file. The file may be run again without any problems.

1.2.5. Main Menu

The option returns to the main menu.

Chapter 2. Filemake

This is a stand alone version of the Pattern Cut Menu found in the laser program. The main use of this program is to allow the creation and analysis of files without having to be in the laser environment. The laser system is required to be ON when the "LASER" program is used. The "FILEMAKE" program can be used on any computer. This is very important during times in which the laser is needed for many different projects. With this program, the laser operator for each project can have his own place to make and analyze files other than on the computer dedicated to the laser. This should cut down on the amount of actual system time required by any one project.

This program is exactly like the Pattern Cut Menu except that the Main Menu option is an exit to DOS option and the run option will only run the file on the screen. With the run option, pressing ENTER after each operation will cause the next operation to appear. This option can be useful in the debugging process. Specific information on the other options of this program can be found in the Pattern Cut Menu description.

The created file is saved in whichever drive and directory that this program is running. To use the file on the laser, use the DOS copy command to copy the filename with the ".new" extension to a floppy and then copy it onto the laser system computer's hard drive. If the filename was "Test", the DOS command to copy the file from a floppy to the hard drive would be "Copy a:Test.new d:\Laser".

Chapter 3. Hardware

The laser system is made up of three different units; the IBM computer, the laser machinery, and the laser power supply. To fully operate the system, all three units need to be operating. The computer has its own power switches on its side and on the monitor. As seen in Figure 4, the laser is turned ON by switching the middle toggle switch (B) on the power box down to local mode. Both off and remote modes are OFF. It is a very good practice to keep the line power circuit breaker (A) OFF when the system is not in use. This must be turned ON before the middle switch will turn on the laser machinery. The laser system and laser power circuit breakers can always be left on.

The laser power supply will only turn ON if the laser machinery is ON. At this point, it is mandatory to turn ON the water by completely opening the water valve located near the wall behind the power supply. The air should also be turned ON at this point. With the machinery ON, the power supply can be turned ON by inserting the key (a), turning it a quarter turn clockwise, and pushing up the switch (b). The power supply panel should have its switches set according to Figure 4 with the start button(c) lit. After the start button is brightly lit, press it. This should cause the ammeter (d) to go from 0 to approximately 13 amps. If the ammeter returns to 0 (and the start button lights up), wait until the light is completely lit and press the start button(c) again.

The sequence of remaining set-up events is very important. The switches must be set as in figure 4 before proceeding.

* First, adjust the ammeter with the knob (e) to the required number of amps for the material that is to be cut. This can be found on the materials chart in Chapter 4.

* Second, turn the mode selector(f) to GATE ON. This will allow the viewing of frequency setting on the wattmeter/frequency gage (g).

* Turn the gage selector (h) to FREQ and vary the frequency using the internal FREQ adjust screw (i) and the x1/x10 switch(j). The frequency is read by the lower scale of the gage (g) in Khz. When this is set (according to the material to be cut and as listed in Chapter 4), switch the mode (f) back to EXTERN GATED.

* With one of the laser interlocks open (usually the stage cover), switch the laser status switch(k) from ST BY (stand-by) to ON. At this point, the power supply is ready for action.

To change the frequency or number of amps after the supply has been configured, open a laser interlock (stage cover), switch the laser status to ST BY(k), do the adjustments(e,f,g,h,i,j), switch the laser status to ON(k), and continue the processing.

The laser machinery does not have any configuration, but it is very important to realize that the x and y motors that move the laser optics do have upper, lower, right, and left limits. It is VERY important not to get carried away when using the joystick with a move. Not being careful can result in hitting one of the limits. The computer will not lock up, but damage can occur to the motors and a circuit breaker may be tripped.

The keypad is mainly used through prompting by the laser program. The STOP button, though, is useful for breaking a file that is running. There are two platforms available for use on the laser: one for Green Tape(TM) and one for any relatively thin substrate

(stainless steel, aluminum nitride,...). The platforms can be switched by pressing the air controlled pedal located on the floor in front of the laser and spinning the arm on which the platforms are connected.

Curriculum Vitae

Ryp Richard Walters was born on June 24, 1991 at the Walter Reed Hospital in Washington, D.C. As a Boy Scout, Ryp achieved the rank of Eagle Scout and earned his fifth year Pipestone. In the Fall of 1987, Ryp began attending Virginia Polytechnic Institute and State University. On the 9th day of March in 1988, Ryp fell head over heels for Paige E. Curtis. Determined as ever, he proposed to her on December 9, 1989 and they married each other on June 9, 1990. Ryp completed his undergraduate degree of a Bachelor of Science in Electrical Engineering in December of 1990. That same Fall, he started his Master's Degree in Electrical Engineering while completing his undergraduate degree through the Dual Status Program.

Nothing that Ryp accomplished was done without the support of his twin flame Paige. Together they make an undefeatable pair.

Ryp R. Walters