

P/N 18695

Southwestern Industries, Inc.

LX2

CAD/CAM INTERFACE MANUAL

(VER062394)

TABLE OF CONTENTS

Section 1.0 Introduction 1

- Type of computers
- RS232 and Floppy Disk
- Don'ts

Section 2.0 Glossary of Terms 2

Section 3.0 RS232 Specifications 3

3.1 RS232 Pin-Out at ProtoTRAK LX2 3

Section 4.0 Setting Up the ProtoTRAK LX2 & Computer to Communicate via RS232 4

Section 5.0 Sending a Program to the Computer from the ProtoTRAK LX2 6

Section	6.0	Receiving a Program at the ProtoTRAK LX2	7
----------------	------------	--	---

Section	7.0	Troubleshooting the RS232	9
----------------	------------	---------------------------	---

■	Using the Mini Tester		
7.1	Computer Configuration		9
7.2	Checking the ProtoTRAK LX2		9
7.3	Checking the IBM Computer & the RS232 Cable		11
7.4	Checking the Macintosh Computer & the RS232 Cable		13

Section	8.0	CAD/CAM & Post Processors	16
----------------	------------	---------------------------	----

8.1	Description of Supported G Codes		17
8.2	Description of Special G Codes		18
8.3	Description of Unsupported G Codes		19
8.4	Sample Program and Listings		21
8.5	Summary		25

Appendixes

Appendix A	Sample Part	26
Appendix B	Sample Program - Fanuc 6T Format	27
Appendix C	Sample Program - Fanuc 6T Modified for LX2	31
Appendix D	Sample Program - SWI Format	33

1.0 INTRODUCTION

This manual will introduce the user to the ability of the ProtoTRAK LX2 system to communicate with a computer via the RS232 port.

The ProtoTRAK LX2 is capable of using an IBM compatible or Apple Macintosh computer for storage and retrieval of programs. These programs may either be written at the ProtoTRAK LX2, sent to the computer for storage, and later retrieved, or written with an offline program and stored at the computer for retrieval by the ProtoTRAK LX2 at a later date.

The ProtoTRAK LX2 is only capable of accepting programs for 2 axis parts from a CAD/CAM system. In this case, the part is drawn on the CAD/CAM system and sent to the ProtoTRAK LX2 via a post processor which converts the data to a format that is usable by the ProtoTRAK LX2. The requirements for this post processor are laid out in this manual, and should be presented to the manufacturer of your CAD/CAM system so that they can design the post processor. The data from the CAD/CAM system, can either be sent directly to the ProtoTRAK LX2 via the RS232 port, or saved on a 3.5", 1.44M or 720K floppy disk for later retrieval directly through the floppy disk drive on the ProtoTRAK LX2.

NOTE: Since the ProtoTRAK LX2 limits error checking when reading files with the extension .LX2, and there could be unexpected results if erroneous information is sent to it, we do not recommend the following:

- 1. Writing programs at the computer in SWI G codes (i.e., .LX2 programs) format and sending them to the ProtoTRAK LX2.*
- 2. Modifying programs from the ProtoTRAK LX2 at the computer and sending them back to the ProtoTRAK LX2.*

2.0 GLOSSARY OF TERMS

RS232C - The chief means by which auxiliary computer equipment communicates with a computer. The RS232C is a standard for computer communications sponsored by the Electronic Industries Association (EIA).

RS274 - The standardized data format (G codes and M codes) sponsored by the Electronic Industries Association for use in computer numerical control (CNC) machines.

Port - A connector on a computer, through which data is sent and received.

Serial Port - A port configured to handle data to be sent or received bit by bit.

Parallel Port - A port configured to handle data to be sent or received byte by byte (8 bits = 1 byte).

CAD/CAM - Computer aided design/computer aided manufacturing. A software package for drawing parts and sending the coordinates of the parts to a computer numeric controller (CNC).

Post Processor - A software program which arranges the data output by the CAD/CAM into a specific format for use on a specific CNC machine.

CONRAD - An arc connecting two mill and/or arc events.

File Name - The ProtoTRAK LX2 requires each program to have a name consisting of numbers up to eight digits long. If the program is output from a CAD/CAM package via the special post processor which is required, it should have the extension .CAM after the name, and should be retrieved by the ProtoTRAK LX2 using the key "RETRVE CAM." Programs saved from the ProtoTRAK LX2 will have the extension .LX2 after the name and should be retrieved using the key "RETRVE LX2."

3.0 RS232 SPECIFICATIONS

Baud Rate	4800
Stop Bit	1
Data Bit	7
Parity	Even
Duplex	Full

3.1 RS232 Pin Out at ProtoTRAK LX2

Pin 2	Transmit data to computer
Pin 3	Receive data from computer
Pin 7	Ground

4.0 SETTING UP THE PROTOTRAK LX2 & COMPUTER TO COMMUNICATE VIA RS232

Requirements

- RS232 cable (50 ft. or less recommended), see Figure 1
- IBM compatible or Apple Macintosh computer
- LX2 system

Step 1: Connect the RS232 cable to the 25-pin RS232 male pins connector on the rear panel of the ProtoTRAK LX2 pendant display.

Step 2: Connect the other end of the RS232 cable to the 25-pin RS232 male pin connector at the computer (this is the serial port).

- a. Do not confuse the connector with the 25-pin female pins connector which is the parallel port.
- b. On IBM AT and P/S computer systems a DB9 to DB25 adapter is required to convert the 9-pin connector on these serial ports to a 25-pin connector.
- c. On Macintosh computers connect the RS232 cable to the modem port. An adapter is required to convert the Macintosh connector to a 25-pin connector.

Step 3: Configure the communication port, e.g., if Communication Port 1 is to be used on IBM systems, type MODE COM1:4800,e,7,1 and press ENTER.

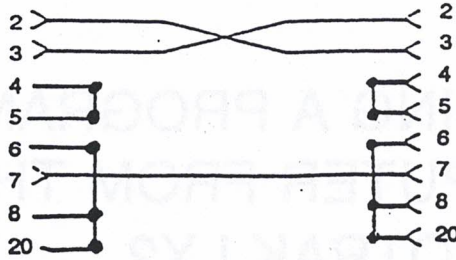
On Macintosh systems use a communications program to configure the modem port for the RS232 specification shown in Section 3.

NOTE: COM 1 might be COM 2, COM 3 or COM 4.

WIRING DIAGRAM

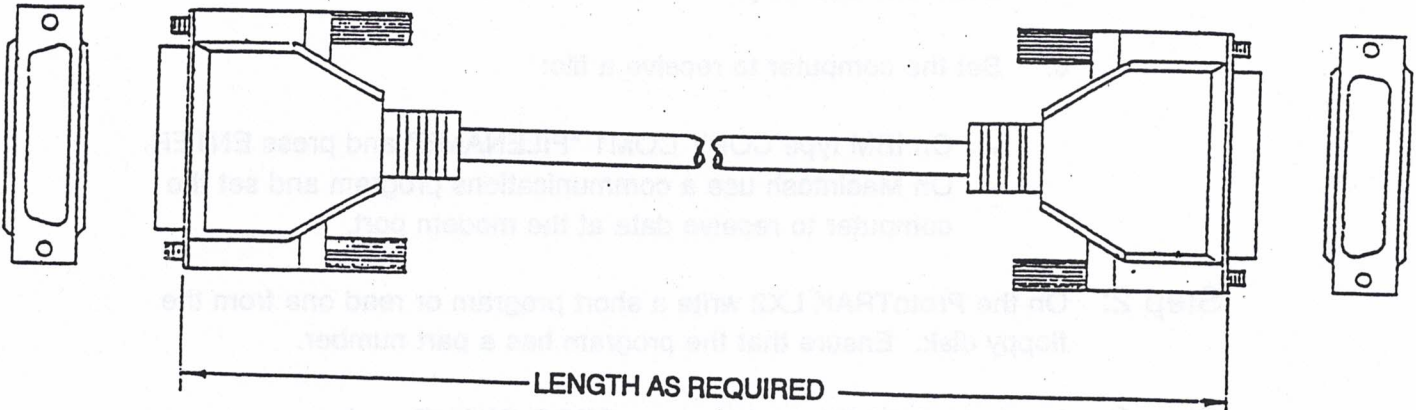
SOCKET WITH FEMALE PINS

SOCKET WITH FEMALE PINS



LX2 END OF CABLE

COMPUTER END OF CABLE



RECOMMENDED 50 FT. MAXIMUM

NOTE: A 9-wire cable may not work reliably every time.

FIGURE 1

5.0 SENDING A PROGRAM TO THE COMPUTER FROM THE PROTOTRAK LX2

Step 1: Set up the computer to receive the program from the ProtoTRAK LX2 with the following procedure:

- a. Make a directory in which programs will be stored.
- b. Enter this directory.
- c. Set the computer to receive a file:
 - On IBM type COPY COM1 "FILENAME" and press ENTER.
 - On Macintosh use a communications program and set the computer to receive data at the modem port.

Step 2: On the ProtoTRAK LX2 write a short program or read one from the floppy disk. Ensure that the program has a part number.

Step 3: Press the MODE key, then enter PROG IN/OUT mode.

Step 4: Select RS232 option.

Step 5: Select STORE option; the ProtoTRAK LX2 will send the program to the computer.

Step 6: Recall the program at the computer to check if it was received.

If the program was received at the computer, proceed to "Receiving a Program at the ProtoTRAK LX2." If the program was not received, see "Troubleshooting the RS232," Section 7.

6.0 RECEIVING A PROGRAM AT THE PROTOTRAK LX2

Step 1: If needed, save any program in memory on the ProtoTRAK LX2 because at the completion of Step 2, any program in current memory will be erased.

Step 2: Set the ProtoTRAK LX2 to receive a program from the computer with the following procedure:

- a. Enter PROG IN/OUT mode.
- b. Select RS232.
- c. Enter the part number of the program to be received.
- d. Press RETRVE LX2; the ProtoTRAK LX2 is now waiting to receive the data from the computer, and will display "RETRIEVING: part number".

NOTE: The RETRVE CAM key on the ProtoTRAK LX2 is used if the program is being sent from a CAD/CAM system. The RETRVE LX2 key is used to retrieve a program that was originally saved from the ProtoTRAK LX2 and has the extension .LX2 after the file name.

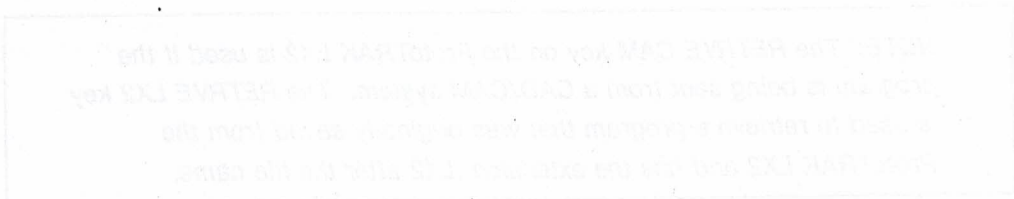
Step 3: At the computer, ensure that the port is configured as in Section 4, Step 3, then enter the directory in which the ProtoTRAK LX2 programs are stored:

Step 4: On IBM Computers type COPY "FILENAME" COM1 and press ENTER to send the program to the ProtoTRAK LX2.

Step 5: Draw the tool path of the part on the LX2 with the following steps:

- a. Press MODE key
- b. Press SET-UP key
- c. Press press TOOL PATH
- d. Press and hold down the start key for two seconds

Step 6: If the part is drawn, the ProtoTRAK LX2 and the computer are configured to communicate via the RS232 port. If the part is not drawn because there is no program in memory, see "Troubleshooting the RS232," Section 7.



7.0 TROUBLESHOOTING THE RS232

Requirements

- RS232 mini-tester (see Figure 2) is available at most computer supply stores.

If programs cannot be transmitted between the computer and the ProtoTRAK LX2 via the RS232, follow these steps in the order presented:

7.1 Ensure that the computer is configured as in Section 4, Step 3.

7.2 Checking the ProtoTRAK LX2

Step 1: Unplug the RS232 cable from the LX2 pendant display.

Step 2: Plug the RS232 mini-tester only into the ProtoTRAK LX2 pendant display.

Result:

TD = ON

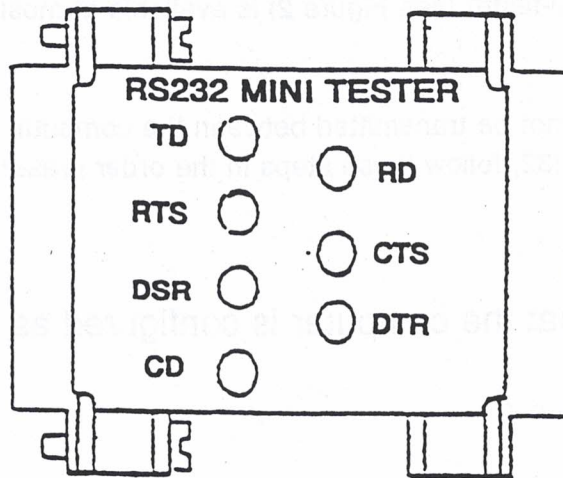
RTS = ON

DTR = ON

If these results are not obtained, the logic cable or the computer module of the ProtoTRAK LX2 is defective and should be replaced.

If these results are obtained, continue with Step 3.

Step 3: Retrieve the sample program 77777777.LX2 from the floppy disk drive (or use any other long program that is available).



The RS232 mini-tester is highly recommended in assuring the proper installation of the ProtoTRAK LX2 CAD/CAM interface. There are several manufacturers of the testers and they are readily available at local computer retailers. Most versions have seven bi-colored LED lamps that allow you to check the states of the RS232 communications. A representative version is configured as shown above.

Where:

TD or TS = Transmit
 RD or RX = Receive
 RTS = Ready to Send
 CTS = Clear to Send
 DSR = Data Set Ready
 CD = Carrier Detect
 DTR = Data Terminal Ready

FIGURE 2

Step 4: Send this program out to the RS232 port using the following procedure:

- a. Enter PROG IN/OUT mode.
- b. Select RS232
- c. Select STORE

Result:

TD = ON (different color while data is transmitting)
RTS = ON
DTR = ON

When transmission is completed, all three lights should change to the same color as in Step 2.

If these results are not obtained, the computer module is defective and should be replaced.

7.3 Checking the IBM Computer and the RS232 Cable

Step 1: Unplug the RS232 cable from the computer.

Step 2: Plug the RS232 mini-tester only into the computer.

Result:

TD = ON
RTS = ON
DTR = ON

If these results are not obtained, the computer is defective and should be checked by a qualified computer technician.

If these results are obtained, continue with Step 3.

Step 3: Plug the RS232 cable into the RS232 mini-tester with the ProtoTRAK LX2 end of the cable disconnected.

Results:

TD = ON
RTS = ON
DTR = ON
DSR = ON
CTS = ON
CD = ON
RD = No Light

If these results are not obtained, check the RS232 cable. The computer end of the RS232 cable must have a jumper between Pins 4 and 5, and another jumper between Pins 6, 8 and 20.

If the jumpers are in the correct position and the above results are not obtained, have a qualified technician check the computer.

If the above results are obtained, continue with Step 4.

Step 4: Plug the other end of the RS232 cable into the ProtoTRAK LX2 pendant display.

Result:

RD = ON

All other lights remain the same as in Step 3. If RD does not light, the cable is defective or wired improperly. See Figure 1 for RS232 cable wiring diagram. If RD = ON, continue with Step 5.

Step 5: Remove the RS232 mini-tester from the computer end of the RS232 cable and reconnect it into the ProtoTRAK LX2 end of the cable. With the cable now plugged directly into the computer, the other end plugged into the RS232 mini-tester, and the RS232 mini-tester plugged into the ProtoTRAK LX2, the following lights should be on:

TD = ON	CTS = ON
RD = ON	DSR = ON
RTS = ON	CD = ON
DTR = ON	

If RD does not light, the cable is defective or wired improperly.

Step 6: At the computer send any file out of the RS232 port by typing COPY "FILENAME.XXX" COM1 and pressing ENTER (see "Filename" in Section 2, Glossary of Terms).

Result:

TD = ON	CTS = ON
RTS = ON	CD = ON
DTR = ON	RD = ON
DSR = ON	

If the RD light does not change color while the file is being transmitted, and then change back to its original color after transmission is completed, the computer is defective and should be checked by a qualified technician.

7.4 Checking the Macintosh Computer and the RS232 Cable

If a problem is encountered in transferring programs between the Macintosh computer and the ProtoTRAK LX2, follow these steps:

- Step 1:** Plug one end of the RS232 cable into the Macintosh computer and the other end into the RS232 mini-tester.
- Step 2:** Plug the mini tester into the ProtoTRAK LX2.
- Step 3:** Set the Macintosh to receive a program through the modem (RS232) port.
- Step 4:** Send a long program out through the RS232 port of the ProtoTRAK LX2 with the following procedure:
 - a. Read the program into memory.
 - b. Select PROG IN/OUT.
 - c. Select RS232.
 - d. Select STORE.

Result:

TD = Change Color CTS = ON
RTS = ON RD = ON

If TD does not change from its original color while the program is being transmitted, and change back to its original color after transmission is completed, the LX2 computer module is defective and should be replaced.

If the above results are obtained, but the program is not received at the Macintosh, check the set up of the Macintosh, i.e., baud rate, stop bit, data bit, parity, and duplex (see Section 3).

Check the cable with an ohm meter (see Figure 3).

If this test is successful, continue this procedure with Step 5 to check transmission of data from the Macintosh to the ProtoTRAK LX2.

Step 5: Set the ProtoTRAK LX2 to receive a program from the Macintosh with the following procedure:

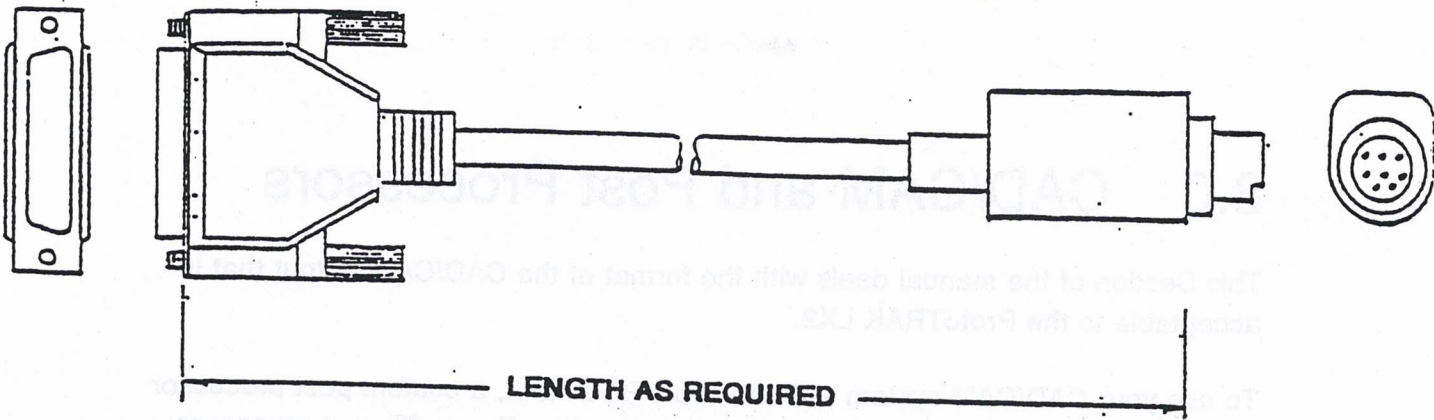
- a. Erase any program in the memory of the ProtoTRAK LX2.
- b. Select PROG IN/OUT.
- c. Select RS232.
- d. Enter the part number to be received.
- e. Select RETRVE LX2.

Step 6: Using a communications program at the Macintosh, send any program to the ProtoTRAK LX2.

Result:

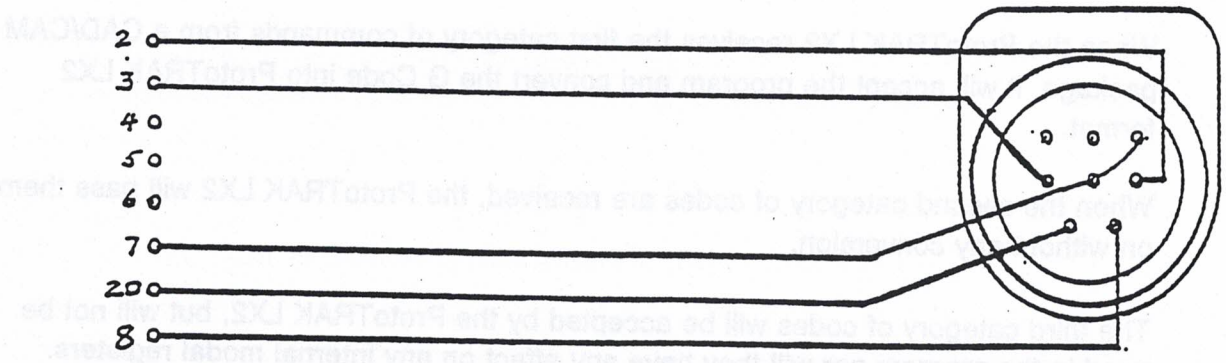
RD = Changes from its original color

If RD does not change color while the program is being transmitted, and then change back to its original color when transmission is completed, the Macintosh is not sending out the data and it should be checked by a qualified technician.



**DB 25 CONNECTOR
FEMALE PINS**

MAC MINI MALE 8-PIN



PROTOTRAK LX2 TO MACINTOSH COMPUTER CABLE

FIGURE 3

8.0 CAD/CAM and Post Processors

This Section of the manual deals with the format of the CAD/CAM output that is acceptable to the ProtoTRAK LX2.

To use your CAD/CAM system with the ProtoTRAK LX2, a custom post processor must be made. This only requires a few changes to a Fanuc 6T post processor.

The information provided in this section of the manual should be used by your CAD/CAM manufacturer to design the required post processor for the ProtoTRAK LX2.

The RS274 G Code format has been divided into three categories of commands;

1. Acceptable and convertible G Code commands.
2. Special SWI G Codes.
3. Ignored G Code commands.

When the ProtoTRAK LX2 receives the first category of commands from a CAD/CAM package, it will accept the program and convert the G Code into ProtoTRAK LX2 format.

When the second category of codes are received, the ProtoTRAK LX2 will pass them on without any conversion.

The third category of codes will be accepted by the ProtoTRAK LX2, but will not be used in the program nor will they have any effect on any internal modal registers.

Special Consideration should be given to the following ;

- Feed Rates - The LX2 is programmed in inches / minute or millimeter / minute. It does not support feed per revolution.
- Tool and Offset numbers - The format of the tool number is in the range of T1 through T50. It does not support combined tool number and offset number.
- Spindle Speed - The LX2 does not support constant surface speed.

- Threading - The LX2 requires the SWI format.
- Drilling and Tapping - The LX2 requires SWI format for canned cycle drilling and does not support tapping.
- X axis - The X axis is programmed in diameter, not the displacement of the cross slide.

8.1 Description of Supported G Codes

The following is a list of G Codes that the ProtoTRAK LX2 will receive and convert into the SWI Format.

G Code	Description
G00	Rapid Positioning
G01	Linear interpolation
G02	Circular Interpolation CW
G03	Circular Interpolation CCW
G20	Input in inch
G21	Input in metric
G40	Cutter compensation Cancel
G41	Cutter compensation Left
G42	Cutter compensation Right

8.2 Description of Special G Codes

Following are the special G Codes that are unique to the ProtoTRAK LX2. These G Codes are necessary in order to support the Drilling and Threading Events of the ProtoTRAK LX2.

8.2.1 G130 Drill Cycle Event With Pecking

The event tool motion will be to rapid in a straight line to (X = 0 Absolute) and the programmed Z Rapid position, then feed to Z Final, then rapid out to Z Rapid.

Format :

```
G130 ZB + 0.1000A ZE-1.0000I F5.0 NP04 T05;
```

Where :

ZB is the Z dimension to transition from rapid to feed.

ZE is the final Z depth of the hole.

F is the Z drilling feedrate in in/mm from .1 to 99.9 or mm/min from 5 to 2500.

NP is the number of tool withdrawal cycles (each cycle drills progressively less).

T is the tool number from 1 to 50.

A is absolute dimension reference.

I is incremental dimension reference.

8.2.2 G137 Threading Event

This event allows the LX2 to create standard I.D or O.D. threads. They may be straight or tapered, and may be single, double, or triple lead.

The event tool motion will be to rapid to the X Begin, Z Begin position, then feed to a depth equal to the total thread depth adjusted for the number of passes, then feed to X End, Z End, then rapid away from the thread, then return to X Begin, Z Begin and repeat for the total number of passes.

Format :

```
G137 XB + 0.6250A ZB + 0.1000A XE + 0.6250A ZE-1.0000A PI0.0357 NP010 A29.5 SI1 ST01 T10;
```

Where:

- XB** is the X dimension or major diameter where the thread begins (diameter).
- ZB** is the Z dimension where the thread begins.
- XE** is the X dimension or major diameter where the thread will end.
- ZE** is the Z dimension where the thread ends.
- PI** is Pitch which is defined as the distance from one thread to the next in inches or mm. It is equal to one divided by the number of thread per inch.
- NP** is Number of passes to cut the thread to its final depth.
- A** is the Plunge Angle that the tool feeds into the beginning depth. Normally this is set to 29.5 degrees.
- SI** Select whether this is an I.D. (value = 0) or O.D. (value = 1) thread.
- ST** is the number of starts. Valid values are 1,2 or 3.
- T** is Tool number from a range of 1 to 50.

8.3 Description of Unsupported G Codes

Following are the G codes that are ignored by the ProtoTRAK LX2. When the LX2 encounters these codes, it will not create any LX2 events, or set any internal register.

G Code	Description
G04	Dwell
G07	Feedrate sine curve control
G10	Offset value setting
G23	Stored stroke limit On
G27	Reference point return check
G28	Return to reference point
G29	Return from reference point
G30	Return to 2nd reference point
G31	Skip cutting
G32	Straight and taper thread cutting

G Code	Description
G34	Variable lead thread cutting
G36	Automatic tool compensation X
G37	Automatic tool compensation Z
G50	Programming of absolute zero point.
G65	User macro simple calling
G66	User macro modal calling
G67	User macro modal call cancellation
G68	Mirror image for double turrets On
G69	Mirror image for double turrets Off
G70	Finish cycle
G71	Stock removal in turning
G72	Stock removal in facing
G73	Pattern repeating
G74	Peck drilling on Z axis
G75	Grooving on X axis
G76	Thread cutting cycle
G90	Cutting cycle A
G92	Thread cutting cycle
G94	Cutting cycle B
G96	Constant surface speed control
G97	Constant surface speed cancel
G98	Per minute feed
G99	Per revolution feed

8.4 Sample Program and Listings

A sample program was created to help in the making a post processor for the ProtoTRAK LX2. The sample part is representative of a typical turning operation that is available on the ProtoTRAK LX2 control. Please read Appendix A through D before going to the next sections.

- Appendix A Detail Drawing of the Sample Part.
- Appendix B Program listing using standard Fanuc 6T post processor.
- Appendix C Program listing using an LX2 post processor (.CAM File).
- Appendix D Program listing using SWI Format (.LX2 File)

8.4.1 Making a ProtoTRAK Post Processor

Because of the wide range in types of post processors that are available, the ability to make the recommended changes will vary. We recommend that only CAD/CAM dealers or manufacturers make the changes. Use the following sequence to create a post processor for the ProtoTRAK LX2.

- Beginning of File Format

The ProtoTRAK has no special requirements for the beginning of the file. It does not need any special characters. Note that the Fanuc 6T post processor in Appendix B places the percent sign (%) on the first line. The original meaning of this character was the rewind tape command and it did not make a difference whether it appeared in the beginning or the end of the file. The LX2 and most modern day floppy or RS232 based storage devices use this character as the end of file command.

- End of File Format

The ProtoTRAK requires the percent sign (%) as the end of the file character.

- Beginning of Program

The program should declare the data as inch or metric. Usually at the beginning of the program, the post processor will output a G20 or G21. In the example in Appendix C, line number N001 is G20. This means that the data in the file is English. If G21 is found, the LX2 will switch to Metric Mode and receive the data as metric.

■ Beginning of an Operation

The ProtoTRAK LX2 requires that the Tool Number, Feedrate, and Tool Compensation appears before, or on the same line as the actual move command. The Fanuc 6T usually has a very complicated sequence. In Appendix B lines N002 through N005 are as follows;

```
N002 G50 X4. Z6. S3000      (SET ABS ZERO,SPEED = 3000)
N003 G00 T0101             (RAPID HOME,TOOL = 1,OFFSET = 1)
N004 M38                   (SET GEAR LOW RANGE)
N005 G97 S1098 M03         (CSF = OFF,SPEED = 1098,SPINDLE = FWD)
```

The above sequence is repeated for each new operation. The ProtoTRAK LX2 will ignore G50,S3000,M38,G97 and M03. The above block of code will work fine with the only exception of the tool number format. Because the tool number is T0101, the ProtoTRAK will interpret it as tool number T101. This will result in a error message during run mode. The tool number format is described below.

■ G Code Lines

The ProtoTRAK LX2 only requires a carriage return code at the end of each line. This is ASCII code hex 0d. A semi colon is optional.

■ Coordinates

The Coordinates may be formatted in inches or metric. The Coordinates Words are X,Z,I and K.

Valid Inch Range is from min -99.9999 to max +99.9999 and the valid Metric Range is from min -999.99 to max +999.99.

■ Rapid Moves

G00 Rapid moves can be modal or non - modal. Modal means that data is generated only if it is different than the last position.

■ Linear Moves

G01 Linear moves are formatted the same as the Rapid Moves.

- **Circular Moves**

G02 and G03 are in the I and K format which are acceptable for the LX2. Some post processors output circular moves in the form of radius which is not supported.

- **Tool Number and Tool Changes**

The valid format and range is T1 through T50. Tool changes are generated automatically when a different tool is generated. The LX2 will Rapid to the home position and pause while the operator manually changes to the new tool.

- **Feed Rates**

The LX2 supports feedrate in the form of inches per minute or millimeters per minute. In the example, the Fanuc 6T program, the feedrate is in the feed per revolution form, which is not supported and must be converted by the post processor. Valid Inch range is .1 to 99.9 and Metric is 3 to 2535.

- **Drilling**

The LX2 supports drilling cycles via the special SWI G Code defined in section 8.2. Some post processors give the option to use a canned cycle or emit individual moves. The ProtoTRAK only supports the automatic pecking within the special SWI G Code.

- **Threading**

The LX2 supports the Threading cycles via the special SWI G Code Described in section 8.2. In Appendix B, line N089 through N169 are the Fanuc 6T threading cycle.

(THREADING OPERATION)

N089 G00 G40 X4. Z6. T0400	(RAPID HOME, TOOL = 4, OFFSET = 0)
N090 M05	(SPINDLE STOP)
N091 M01	(OPTIONAL STOP)
N092 G50 X4. Z6. S3000	(SET ABS 0, HOME, SPEED = 3000)
N093 G00 T0505	(RAPID, TOOL = 5, OFFSET = 5)
N094 M37	(SET LOW GEAR RANGE)
N095 G97 S4 M05	(CSF = OFF, SPEED = 4)
N096 G00 X.875 Z4.1	(RAPID X,Z)

N097 X.8847	(RAPID X)
N098 G99 G32 Z2. F.125	(CSF = ON,THREAD Z@.125 /REV)
N099 G00 X.875	(RAPID X)
N100 Z4.1	(RAPID Z)
N101 X.8985	(RAPID X)
N102 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N103 G00 X.875	(RAPID X)
N104 Z4.1	(RAPID Z)
N105 X.9098	(RAPID X)
.	
.	
N166 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N167 G00 X.875	(RAPID X)
N168 Z4.1	(RAPID Z)
N169 G00 G40 X4. Z6. T0500	(RAPID,COMP = OFF,TOOL = 5)

All of the above can be replaced by one line of data in the special SWI format shown in Appendix C.

N064 G137 XB+1.0000A ZB+4.1000A XE+0.0000I ZE+2.0000A PI0.1250
NP06 A29.500 SI0 ST01 T05

The approach should be to incorporate the following format.

"G137 XBnA ZBnA XEnA ZEnA PIn NPn An SIn STn Tn"

The lower case n represents the data to be inserted between the two upper case identifier. The upper case "A" following the data is a internal flag that is used to identify the data as absolute. Some of the data required may not be available through your CAD/CAM system. Try to use the following work around if you run into that problem.

"SI" means side and is defined as 0 = inside, and 1 = outside thread. Some CAD/CAM's have the ability to create variables inside the post processor. With variables you can subtract the X beginning from the X end to calculate whether the tool is moving toward or away from the center line, hence inside or outside.

"NP" is defined as the number of passes. In the above example the sample block of code is repeated 17 times. A system variable can be created to insert this value into the SWI format.

"ST" means starts and is defined as the number of starts. The ProtoTRAK supports up to 3 starts. If this information is not available, it may be "HARD CODED" to 1 start by inserting "NP1" into the above format.

- File Name

Before the ProtoTRAK LX2 can read a file from the floppy disk, the file must have the extension ".CAM". This identifies the file as a CAD/CAM generated file.

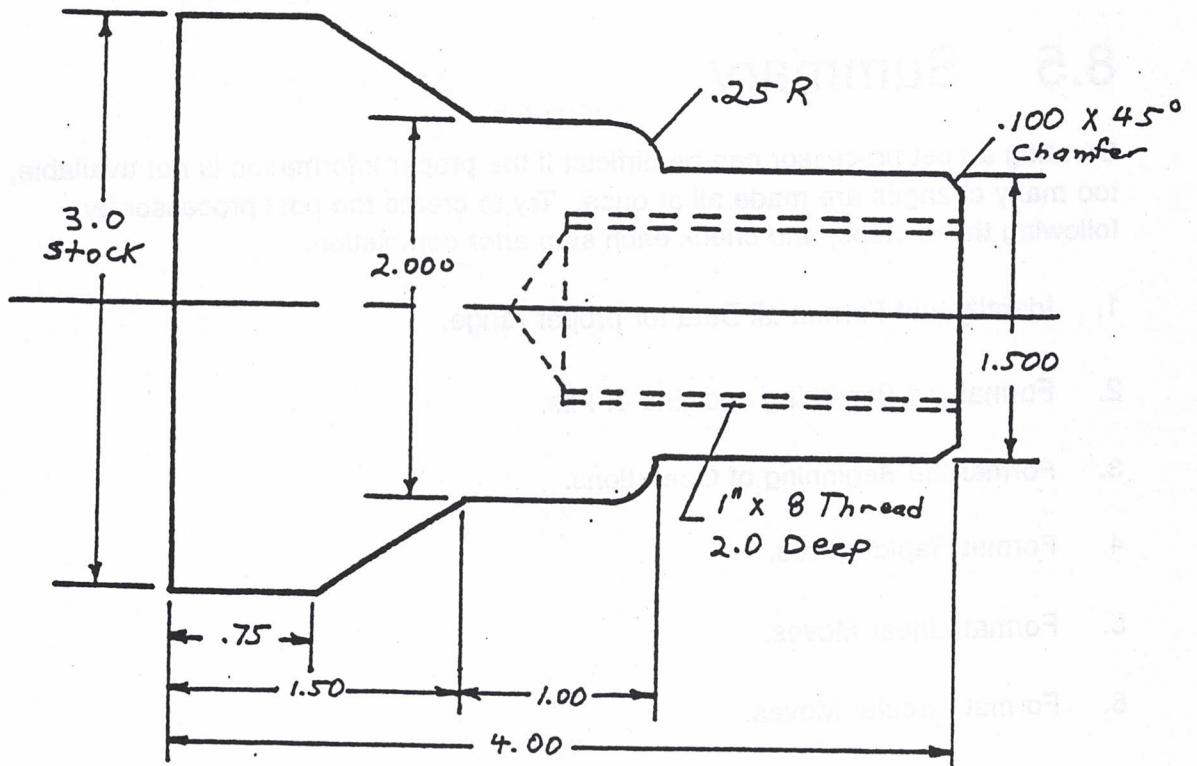
8.5 Summary

Creating a post processor can be difficult if the proper information is not available, or too many changes are made all at once. Try to create the post processor by following these steps, and check each step after completion.

1. Identify and Format all Data for proper range.
2. Format the Beginning and End of File.
3. Format the Beginning of Operations.
4. Format Rapid Moves.
5. Format Linear Moves.
6. Format Circular Moves.
7. Format Any Canned Cycles, i.e. Drilling and Threading.

APPENDIX A

Sample Part



Sample Program - Fanuc 6T Format

%	(REWIND TAPE COMMAND)
(ROUGHING CUT)	
N001 G20	(SET UNITS = ENGLISH)
N002 G50 X4. Z6. S3000	(SET ABS ZERO,HOME,SPEED)
N003 G00 T0101	(RAPID TO HOME,TOOL = 1,OFFSET = 1)
N004 M38	(SET LOW GEAR RANGE)
N005 G97 S1098 M03	(CSF = OFF,SPEED = 1098,SPINDLE FWD)
N006 G00 X2.7832 Z4.05	(RAPID X,Z)
N007 G96 S800	(CSF = ON,SPEED = 800)
N008 G42	(TOOL COMPENSATION = LEFT)
N009 G99 G01 Z1.0027 F.01	(FEED PER REV = ON,FEED Z @ .01 /REV)
N010 X3.0832 Z.7777	(FEED X,Z)
N011 X3.1032	(FEED X)
N012 G00 Z4.05	(RAPID Z)
N013 X2.4832	(RAPID X)
N014 G01 Z1.2277	(FEED Z)
N015 X2.8032 Z.9877	(FEED XZ)
N016 G00 Z4.05	(RAPID Z)
N017 X2.1832	(RAPID X)
N018 G01 Z1.4527	(FEED Z)
N019 X2.5032 Z1.2127	(FEED X,Z)
N020 G00 Z4.05	(RAPID X)
N021 X1.8832	(RAPID X)
N022 G01 Z2.4808	(FEED Z)
N023 G03 X2.1 Z2.25 I-.1916 K-.2308	(FEED ARC CCW X,Z)
N024 G01 Z1.5151	(FEED Z)
N025 X2.2032 Z1.4377	(FEED X,Z)
N026 G00 Z4.05	(RAPID Z)
N027 X1.5832	(RAPID X)
N028 G01 Z3.9291	(FEED Z)
N029 X1.6 Z3.9207	(FEED X,Z)
N030 Z2.5458	(FEED Z)
N031 G03 X1.9032 Z2.4722 I-.05 K-.2958	(FEED ARC CCW X,Z)
N032 G00 Z4.05	(RAPID Z)
N033 X1.2832	(RAPID X)
N034 G01 X1.3414	(FEED X)
N035 X1.6 Z3.9207	(FEED X,Z)
N036 Z2.5458	(FEED Z)
N037 G03 X1.6032 Z2.5455 I-.05 K-.2958	(ARC CCW X,Z)
N038 G00 Z4.05	(RAPID Z)
N039 X.9832	(RAPID X)
N040 G01 X1.3032	(FEED X)
N041 G00 X.6832	(RAPID X)
N042 G01 X1.0032	(FEED X)

N043 G00 X.3832	(RAPID X)
N044 G01 X.7032	(FEED X)
N045 G00 X.0832	(RAPID X)
N046 G01 X.4032	(FEED X)
N047 G00 X0.	(RAPID X)
N048 G01 X.1032	(FEED X)
N049 G00 X3.1632	(RAPID X)
(FINISH CUT)	
N050 G00 G40 X4. Z6. T0100	(RAPID HOME,COMP = OFF,TOOL = 1,OFFSET = 0)
N051 M01	(OPTIONAL STOP)
N052 G50 X4. Z6. S3000	(ABS ZERO,HOME,SPEED = 3000)
N053 G00 T0202	(RAPID HOME,TOOL = 2,OFFSET = 2)
N054 M39	(SET LOW GEAR RANGE)
N055 G97 S3000 M03	(CCF = OFF,SPEED = 3000,SPINDLE FWD)
N056 G00 X0. Z4.	(RAPID X,Z)
N057 G96 S1000	(CCF = ON,SPEED = 1000)
N058 G42	(TOOL COMP = LEFT)
N059 G99 G01 X1.3 F.003	(FEED/REV = ON,FEED TO X @ .003/REV)
N060 X1.5 Z3.9	(FEED X,Z)
N061 Z2.5	(FEED Z)
N062 G03 X2. Z2.25 K-.25	(FEED ARC CCW X,Z)
N063 G01 Z1.5	(FEED Z)
N064 X3. Z.75	(FEED XZ)
N065 Z0.	(FEED Z)
(DRILL .8125 HOLE)	
N066 G00 G40 X4. Z6. T0200	(RAPID HOME,COMP = OFF,TOOL = 2,OFFSET = 0)
N067 M05	(SPINDLE OFF)
N068 M01	(OPTIONAL STOP)
N069 G50 X4. Z6. S3000	(SET ABS ZERO,HOME,SPEED = 3000)
N070 G00 T0303	(RAPID HOME,TOOL = 3,OFFSET = 3)
N071 M38	(SET LOW GEAR RANGE)
N072 G97 S1910 M03	(CCF = OFF,SPEED = 1910,SPINDLE = FWD)
N073 G00 X0. Z4.1	(RAPID X Z)
N074 G00 Z 4.1	(RAPID Z)
N075 G99 G01 Z1.8 F.007	(FEED PER REV = ON,FEED Z @ .007/REV)
N076 G00 4.1	(RAPID Z)
N077 Z4.1	(RAPID Z)
(BORING OPERATION)	
N078 G00 G40 X4. Z6. T0300	(RAPID HOME,TOOL = 3,OFFSET = 0)
N079 M05	(SPINDLE STOP)
N080 M01	(OPTIONAL STOP)
N081 G50 X4. Z6. S3000	(SET ABS ZERO,HOME,SPEED = 3000)
N082 G00 T0404	(RAPID TO HOME,TOOL = 4,OFFSET = 4)
N083 M39	(SET LOW GEAR RANGE)
N084 G97 S3000 M03	(CCF = OFF,SPEED = 1910,SPINDLE = FWD)
N085 G00 X.875 Z4.1	(RAPID X,Z)
N086 G96 S1000	(CSF = OFF,SPEED = 1000)
N087 G41	(TOOL COMP = RIGHT)
N088 G99 G01 Z1.95 F.003	(CSF = ON,FEED Z @ .003/REV)
(THREADING OPERATION)	
N089 G00 G40 X4. Z6. T0400	(RAPID HOME,TOOL = 4,OFFSET = 0)

N090 M05	(SPINDLE STOP)
N091 M01	(OPTIONAL STOP)
N092 G50 X4. Z6. S3000	(SET ABS ZERO,HOME,SPEED = 3000)
N093 G00 T0505	(RAPID TO HOME,TOOL = 5,OFFSET = 5)
N094 M37	(SET LOW GEAR RANGE)
N095 G97 S1000 M03	(CSF = OFF,SPEED = 4,SPINDLE FWD)
N096 G00 X.875 Z4.1	(RAPID X,Z)
N097 X.8847	(RAPID X)
N098 G99 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N099 G00 X.875	(RAPID X)
N100 Z4.1	(RAPID Z)
N101 X.8985	(RAPID X)
N102 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N103 G00 X.875	(RAPID X)
N104 Z4.1	(RAPID Z)
N105 X.9098	(RAPID X)
N106 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N107 G00 X.875	(RAPID X)
N108 Z4.1	(RAPID Z)
N109 X.9195	(RAPID X)
N110 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N111 G00 X.875	(RAPID X)
N112 Z4.1	(RAPID Z)
N113 X.9283	(RAPID X)
N114 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N115 G00 X.875	(RAPID X)
N116 Z4.1	(RAPID Z)
N117 X.9362	(RAPID X)
N118 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N119 G00 X.875	(RAPID X)
N120 Z4.1	(RAPID Z)
N121 X.9436	(RAPID X)
N122 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N123 G00 X.875	(RAPID X)
N124 Z4.1	(RAPID Z)
N125 X.9505	(RAPID X)
N126 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N127 G00 X.875	(RAPID X)
N128 Z4.1	(RAPID Z)
N129 X.957	(RAPID X)
N130 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N131 G00 X.875	(RAPID X)
N132 Z4.1	(RAPID Z)
N133 X.9632	(RAPID X)
N134 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N135 G00 X.875	(RAPID X)
N136 Z4.1	(RAPID Z)
N137 X.9691	(RAPID X)
N138 G32 Z2. F.125	(CSF = ON,THREAD Z @.125 /REV)
N139 G00 X.875	(RAPID X)
N140 Z4.1	(RAPID Z)

N141 X.9747	(RAPID X)
N142 G32 Z2. F.125	(CSF = ON, THREAD Z @.125 /REV)
N143 G00 X.875	(RAPID X)
N144 Z4.1	(RAPID Z)
N145 X.9801	(RAPID X)
N146 G32 Z2. F.125	(CSF = ON, THREAD Z @.125 /REV)
N147 G00 X.875	(RAPID X)
N148 Z4.1	(RAPID Z)
N149 X.9853	(RAPID X)
N150 G32 Z2. F.125	(CSF = ON, THREAD Z @.125 /REV)
N151 G00 X.875	(RAPID X)
N152 Z4.1	(RAPID Z)
N153 X.9904	(RAPID X)
N154 G32 Z2. F.125	(CSF = ON, THREAD Z @.125 /REV)
N155 G00 X.875	(RAPID X)
N156 Z4.1	(RAPID Z)
N157 X.9953	(RAPID X)
N158 G32 Z2. F.125	(CSF = ON, THREAD Z @.125 /REV)
N159 G00 X.875	(RAPID X)
N160 Z4.1	(RAPID Z)
N161 X1.	(RAPID X)
N162 G32 Z2. F.125	(CSF = ON, THREAD Z @.125 /REV)
N163 G00 X.875	(RAPID X)
N164 Z4.1	(RAPID Z)
N165 X1.	(RAPID X)
N166 G32 Z2. F.125	(CSF = ON, THREAD Z @.125 /REV)
N167 G00 X.875	(RAPID X)
N168 Z4.1	(RAPID Z)
N169 G00 G40 X4. Z6. T0500	(RAPID HOME, TOOL COMP = OFF, TOOL = 5)
N170 M05	(SPINDLE STOP)
N171 M30	(END OF PROGRAM!)

APPENDIX C

Sample Program - Fanuc 6T Modified for LX2

(ROUGHING CUT)
N001 G20 (MODE = INCHES)
N002 G00 X2.7832 Z4.05 (RADID X,Z)
N003 G42 (TOOL COMP = LEFT)
N004 G01 Z1.0027 F5.0 (FEED X,Z @ 5 IN/MIN)
N005 X3.0832 Z.7777 (FEED X,Z)
N006 X3.1032 (FEED X,Z)
N007 G00 Z4.05 (RAPID Z)
N008 X2.4832 (RAPID Z)
N009 G01 Z1.2277 (FEED Z)
N010 X2.8032 Z.9877 (FEED Z)
N011 G00 Z4.05 (RAPID Z)
N012 X2.1832 (RAPID X)
N013 G01 Z1.4527 (FEED X,Z)
N014 X2.5032 Z1.2127 (FEED X,Z)
N015 G00 Z4.05 (RAPID X)
N016 X1.8832 (RAPID X)
N017 G01 Z2.4808 (FEED X,Z)
N018 G03 X2.1 Z2.25 I-.1916 K-.2308 (FEED ARC X,Z)
N019 G01 Z1.5151 (FEED Z)
N020 X2.2032 Z1.4377 (FEED X,Z)
N021 G00 Z4.05 (RAPID Z)
N022 X1.5832 (RAPID X)
N023 G01 Z3.9291 (FEED Z)
N024 X1.6 Z3.9207 (FEED X,Z)
N025 Z2.5458 (FEED Z)
N026 G03 X1.9032 Z2.4722 I-.05 K-.2958 (FEED ARC X,Z)
N027 G00 Z4.05 (RAPID Z)
N028 X1.2832 (RAPID X)
N029 G01 X1.3414 (FEED X)
N030 X1.6 Z3.9207 (FEED X,Z)
N031 Z2.5458 (FEED Z)
N032 G03 X1.6032 Z2.5455 I-.05 K-.2958 (ARC CCW X,Z)
N033 G00 Z4.05 (RAPID Z)
N034 X.9832 (RAPID X)
N035 G01 X1.3032 (FEED X)
N036 G00 X.6832 (RAPID X)
N037 G01 X1.0032 (FEED X)
N038 G00 X.3832 (RAPID X)
N039 G01 X.7032 (FEED X)
N040 G00 X.0832 (RAPID X)
N041 G01 X.4032 (FEED X)
N042 G00 X0. (RAPID X)
N043 G01 X.1032 (FEED X)
N044 G00 X3.1632 (RAPID X)

(FINISH CUT)	
N045 G00 T02	(TOOL = 2)
N046 G00 X0. Z4.	(RAPID X,Z)
N047 G42	(TOOL COMP = LEFT)
N048 G01 X1.3 F5.0	(FEED X @ 5 IN/MIN)
N049 X1.5 Z3.9	(FEED X,Z)
N050 Z2.5	(FEED Z)
N051 G03 X2. Z2.25 K-.25	(FEED ARC CCW X,Z)
N052 G01 Z1.5	(FEED Z)
N053 X3. Z.75	(FEED X)
N054 Z0.	(FEED Z)
(DRILL .8125 HOLE)	
N055 T03	(TOOL = 3)
N056 G00 X0. Z4.1	(RAPID X Z)
N057 G00 Z 4.1	(RAPID Z)
N058 G01 Z1.8 F5.0	(FEED Z @ 5 IN/MIN)
N059 G00 4.1	(RAPID Z)
N060 Z4.1	(RAPID Z)
(BORING OPERATION)	
N061 T04	(TOOL = 4)
N062 G00 X.875 Z4.1	(RAPID X,Z)
N063 G01 Z1.95 F3.0	(FEED Z @ 3 IN/MIN)
(THREADING OPERATION)	
N064 G137 XB+1.0000A ZB+4.1000A XE+0.0000I ZE+2.0000A PI0.1250 NP06 A29.500	
S10 ST01 T05	
%	(LX2'S END OF FILE CHARACTER)

Sample Program - SWI Format

PN77777777 G20;
N1 G101 XB+3.1000A ZB+4.0000A XE+0.0000A ZE+0.0000I TC1 F5.0 CR0.0 T01;
N2 G136 NP10 AP1 F5.0 T01 FC0.0200 FF5.0 FT02;
N3 G201 XB+1.3000A ZB+4.0000A XE+0.2000I ZE-0.1000I TC2 F5.0 CR0.0000 T02;
N4 G201 XB+0.0000I ZB+0.0000I XE+0.0000I ZE+2.5000A TC2 F5.0 CR0.0000 T02;
N5 G202 XB+0.0000I ZB+0.0000I XE+2.0000A ZE-0.2500I R0.2500 F5.0 TC2 CR0.0000 T02;
N6 G201 XB+0.0000I ZB+0.0000I XE+0.0000I ZE+1.5000A TC2 F5.0 CR0.0000 T02;
N7 G201 XB+0.0000I ZB+0.0000I XE+3.0000A ZE+0.7500A TC2 F5.0 CR0.0000 T02;
N8 G200 X+3.0000A Z+4.0000A CT1 T02;
N9 G200 X+1.3000A Z+4.0000A CT1 T02;
N10 G130 ZB+4.1000A ZE+1.8000A F3.0 NP05 T03;
N11 G134 X+0.8750A ZB+4.1000A ZE+1.9500A F3.0 T04;
N12 G137 XB+1.0000A ZB+4.1000A XE+0.0000I ZE+2.0000A PI0.1250 NP06 A29.500 SIO ST01 T05;
%

