Interface Manual for the

- **TRAK® A.G.E. 2 CAD/CAM**
- **TRAK® A.G.E. 3 CAD/CAM & DNC**
- **TRAK® QMV CAD/CAM & DNC**

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Contents

1.0 Introduction

Sections 1 through 7 cover the basics of setting up the TRAK A.G.E. 2, A.G.E. 3 and QMV to communicate with a computer via RS232, and the troubleshooting steps if the procedure does not work. We suggest that you follow these steps to ensure that the computer and the A.G.E. 2, A.G.E. 3 or QMV are communicating before using the CAD/CAM and DNC Sections.

The TRAK A.G.E. 2, A.G.E. 3 and QMV are capable of using an IBM compatible or Apple Macintosh computer for storage and retrieval of programs. These programs may be written at a TRAK A.G.E. 2, A.G.E. 3 or QMV and transferred by RS232 or floppy diskette to a computer for later retrieval. They may also be written on a computer with the TRAK A.G.E. Offline program and stored at the computer for later retrieval by the TRAK A.G.E. 2, A.G.E. 3 or QMV.

The TRAK A.G.E. 2, A.G.E. 3 and QMV are also capable of accepting programs for 2 or 2 1/2 axis parts from a CAD/CAM system. In this case, the part is drawn on the CAD/CAM system and sent to the TRAK A.G.E. 2, A.G.E. 3 or QMV via a post processor which converts the data to a format that is usable by the TRAK A.G.E. 2, A.G.E. 3 or QMV. The A.G.E. 2 requires a Fanuc 6M post processor. The TRAK A.G.E. 3 and QMV require the same post processor as the ProtoTRAK MX3. The DNC option requires a separate post processor. 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 TRAK A.G.E. 2, A.G.E. 3 or QMV via the RS232 port, or saved on a 3.5", 1.44MB or 720KB floppy disk for later retrieval directly through the floppy disk drive.

Two-and-one-half axis is defined as simultaneous movement in X and Y axes with Z-axis stationary, or movement in the Z axis with both X and Y axes stationary. If simultaneous three-axis movement is required, see the DNC Option.

NOTE: Since the TRAK A.G.E. 2, A.G.E. 3 and QMV limits error checking when reading files with the extensions .MX2 and .MX3, 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., . MX2 or .MX3 programs) format and sending them to the TRAK A.G.E. 2, A.G.E. 3 or QMV.*

2. *Modifying programs from the TRAK A.G.E. 2, A.G.E. 3 or QMV at the computer and sending them back to the TRAK A.G.E. 2, A.G.E. 3 or QMV.*

The TRAK A.G.E. 3 and QMV are also capable of communication with the computer in a DNC format. Direct Numerical Control (DNC) means that the control can receive programs from the computer that are normally too large for the memory capacity of the control. In this mode the control will receive a section of the program, run some portion of this section, and then receive an additional section. This will continue until the entire program is received by the control and executed.

Summary

The TRAK A.G.E. 2, A.G.E. 3 and QMV communicate with a computer in the following ways:

1. Programs written at the TRAK A.G.E. 2, A.G.E. 3 and QMV can be sent via RS232 or by floppy disk to a computer for storage, and can be retrieved via RS232 or floppy disk.

2. Programs written at a computer with a CAD/CAM package can be sent to the TRAK A.G.E. 2, A.G.E. 3 and QMV via RS232 or floppy disk. Each program must not be larger than the memory capacity of the TRAK A.G.E. 2, A.G.E. 3 and QMV (A.G.E. 2 =maximum 500 events; A.G.E. and QMV 3=maximum 2356 events). A special post processor is needed.

3. For the DNC option, programs written at the computer with a CAD/CAM package can be sent to the TRAK A.G.E. 3 and QMV via RS232 or floppy disk. Programs being sent via floppy disk are only limited by the capacity of the floppy disk. Programs being sent via RS232 are not limited in size. A special post processor is needed which is different from the one referred to in 2 above for the A.G.E. 3 and QMV.

2.0 Glossary of Terms

RS232 - The chief means by which auxiliary computer equipment communicates with a computer. The RS232 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 that is part of the CAD/CAM package, and which arranges the data output from the CAD/CAM into a specific format for use on a specific CNC machine.

CONRAD - A TRAK-generated arc connecting two mill and/or arc events.

File Name - The TRAK A.G.E. 2, A.G.E. 3 and QMV requires that each program have a name consisting of numbers up to eight digits long. The file name from CAD/CAM programs should have the extension .CAM and should be retrieved at the TRAK A.G.E. 2, A.G.E. 3 or QMV by using the "RETRVE CAM" key.

The filename for DNC programs should have the extension .DNC.

All programs saved at the TRAK A.G.E. 2, A.G.E. 3 and QMV have the extension .MX2 or .MX3 after the file name and should be retrieved from a remote computer using the "RETRVE MX2" or "RETRVE MX3" key at the TRAK A.G.E. 2, A.G.E. 3 or QMV.

DNC - Direct Numerical Control

3.0 RS232 Specifications

Baud Rate	Fixed 4800 (for regular TRAK A.G.E. 2, A.G.E. and QMV 3 mode) Selectable 2400/4800/9600/19200 (for DNC mode)
Stop Bits	1
Data Bits	7
Parity	Even
Duplex	Full

3.1 RS232 Pin Out at TRAK A.G.E. 2, A.G.E. 3 and QMV

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

4.0 Setting up the TRAK A.G.E. 2, A.G.E. 3, QMV & Computer to Communicate Via RS232

Requirements

- RS232 cable (50 ft. or less recommended), see Figure 1
- IBM compatible or Apple Macintosh computer
- TRAK A.G.E. 2, A.G.E. 3 or QMV system

Step 1: Connect the RS232 cable to the 25 male pin connector on the rear panel of the TRAK A.G.E. 2, A.G.E. 3 or QMV pendant display.

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

a. Do not confuse the connector with the 25 female pin 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. A Mac-to-Hayes cable is required to convert the Macintosh connector to a 25-pin connector.

Step 3: Configure the communication port, for example, if Communication Port 1 is to be used on IBM compatible 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: COM1 might be COM2, COM3 or COM4.

Wiring Diagram

DB25 Connector
With Female Pins

DB 25 Connector
With Female Pins

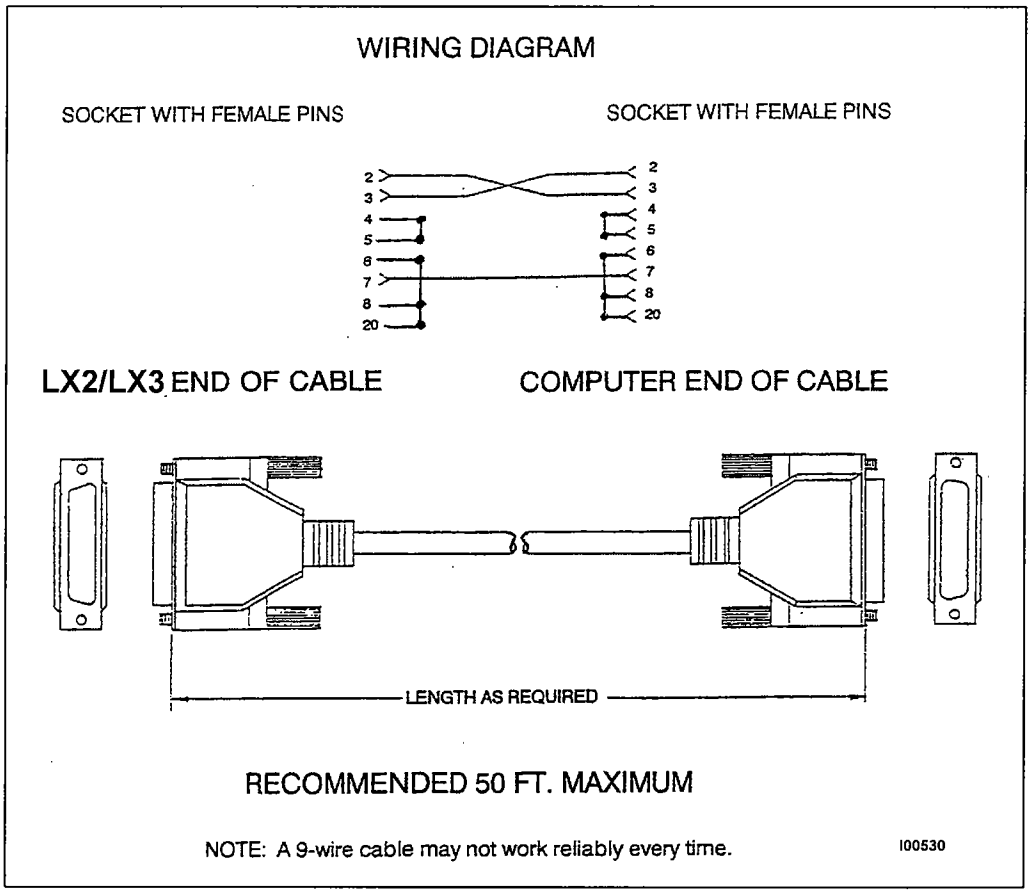


FIGURE 1

5.0 SENDING A PROGRAM TO THE COMPUTER FROM THE TRAK A.G.E. 2, A.G.E. 3 & QMV

Step 1: Set up the computer to receive the program from the TRAK A.G.E. 2, A.G.E. 3 or QMV 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 compatibles, 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 TRAK A.G.E. 2, A.G.E. 3 or QMV 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 TRAK A.G.E. 2, A.G.E. 3 or QMV 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 TRAK A.G.E. 2, A.G.E. 3 and QMV ". If the program was not received, see "Troubleshooting the RS232," Section 7.

6.0 RECEIVING A PROGRAM AT THE TRAK A.G.E. 2 , A.G.E. 3 or QMV

Step 1: Save any program in memory on the TRAK A.G.E. 2, A.G.E. 3, or QMV if needed. At the completion of Step 2, any program in current memory will be lost.

Step 2: Set the TRAK A.G.E. 2, A.G.E. 3, or QMV 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 .MX2 or .MX3; the TRAK A.G.E. 2, A.G.E. 3, or QMV is now waiting to receive the data from the computer, and will flash "ready"
until it starts to receive a program.

> *NOTE: The RETRVE CAM key on the TRAK A.G.E. 2, A.G.E. 3 and QMV are used if the program has been generated by a CAD/CAM system. The RETRVE MX2 or .MX3 key is used to retrieve a program that was originally saved from the TRAK A.G.E. 2, A.G.E. 3, or QMV and has the extension MX2 or .MX3 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 TRAK A.G.E. 2, A.G.E. 3, or QMV programs are stored:

Step 4: On IBM compatible computers type COPY "FILENAME" COM1: and press ENTER to send the program to the TRAK A.G.E. 2, A.G.E. 3., or QMV

Step 5: Draw the tool path of the part on the TRAK A.G.E. 2, A.G.E. 3 or QMV with the following steps:

a. Press SET-UP key (Press REF POSN key, and set Z retract for A.G.E. 2, A.G.E. 3 or QMV
b. Press RETURN, press TOOL DATA and ensure that the tool diameter is entered.
c. Press RETURN, press TOOL PATH, select the required view
d. Press and hold down the start key for two seconds

Step 6: If the part is drawn, the TRAK A.G.E. 2, A.G.E. 3, or QMV 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

7.1 Requirements

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

If programs cannot be transmitted between the computer and the TRAK A.G.E. 2, A.G.E. 3, or QMV via the RS232, follow these steps in the order presented:

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

7.3 Checking the TRAK A.G.E. 2, A.G.E. 3, or QMV

Step 1: Unplug the RS232 cable from the TRAK A.G.E. 2, A.G.E. 3 or QMV pendant display.

Step 2: Plug the RS232 mini-tester only into the TRAK A.G.E. 2, A.G.E. 3, or QMV pendant display.

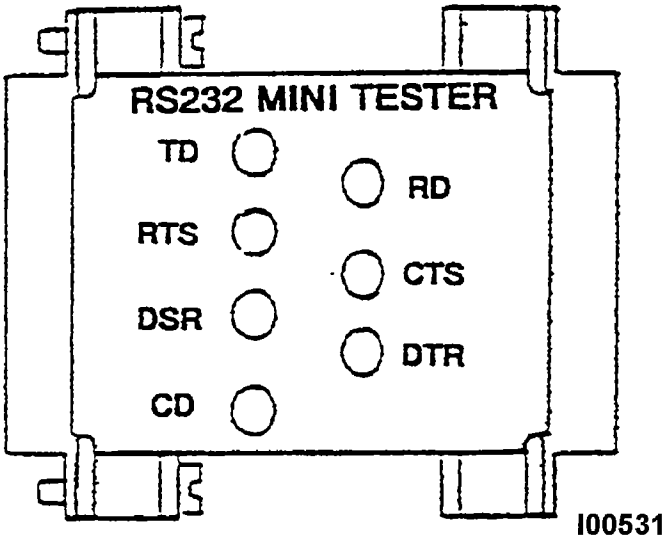
Result:

TD = ON
RTS = ON
DTR = ON

If these results are not obtained, replace the computer module.

If these results are obtained, continue with Step 3.

Step 3: Retrieve the sample program 99999999.MX2 or 99999999.MX3 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 TRAK A.G.E. 2, A.G.E. 3 and QMV 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.

7.4 Checking the IBM Compatible Computer & 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: With the RS232 mini-tester still plugged into the computer, plug the RS232 cable into the RS232 mini-tester with the TRAK A.G.E. 2, A.G.E. 3, or QMV 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 TRAK A.G.E. 2, A.G.E. 3, or QMV 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 TRAK A.G.E. 2, A.G.E. 3, or QMV 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 TRAK A.G.E. 2, A.G.E. 3, or QMV, 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.

7.5 Checking the Macintosh Computer and the RS232 Cable

If a problem is encountered in transferring programs between the Macintosh computer and the TRAK A.G.E. 2, A.G.E. 3 and QMV, 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 TRAK A.G.E. 2, A.G.E. 3, or QMV.

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 TRAK A.G.E. 2, A.G.E. 3, or QMV 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 TRAK A.G.E. 2, A.G.E. 3, or QMV 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 TRAK A.G.E. 2, A.G.E. 3, or QMV.

Step 5: Set the TRAK A.G.E. 2, A.G.E. 3, or QMV to receive a program from the Macintosh with the following procedure:

a. Erase any program in the memory of the TRAK A.G.E. 2, A.G.E. 3. or QMV.

b. Select PROG IN/OUT.

c. Select RS232.

d. Enter the part number to be received.

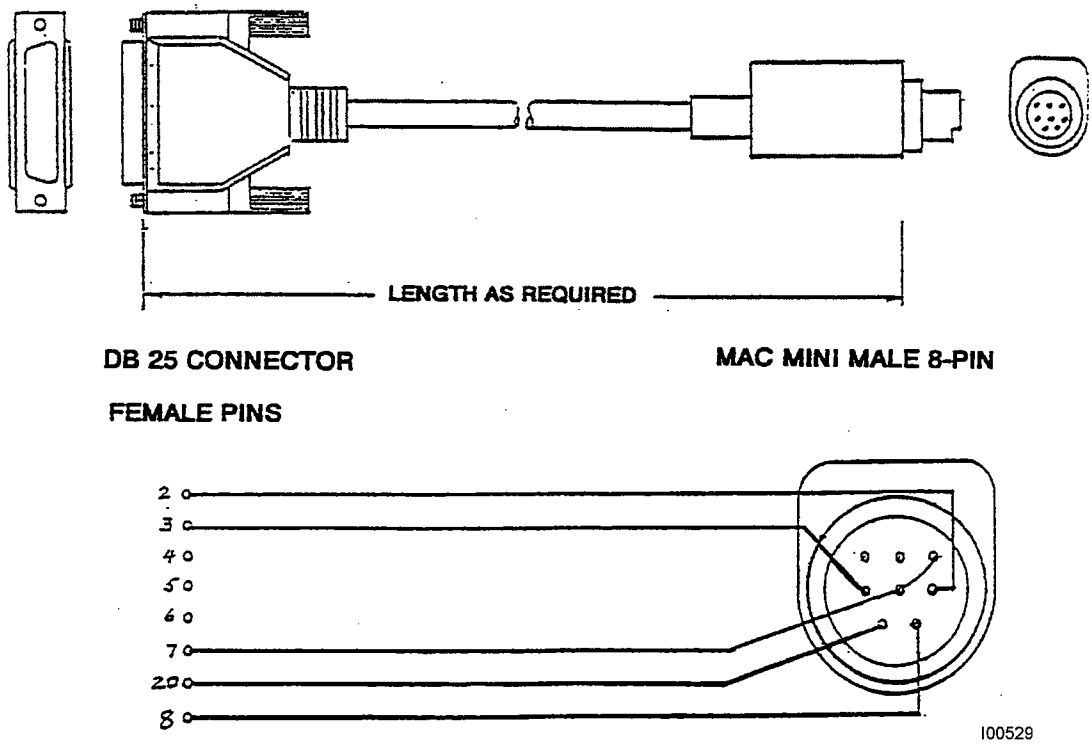
e. Select RETRVE MX2 or RETRVE MX3.

Step 6: Using a communications program at the Macintosh, send any program to the TRAK A.G.E. 2, A.G.E. 3, or QMV.

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.



TRAK A.G.E. 2 and A.G.E. 3 to Macintosh Computer Cable

FIGURE 3

8.0 CAD/CAM - TRAK A.G.E. 2

This Section of the manual deals with communications with a CAD/CAM system. The CAD/CAM system requires a post processor to arrange the output data in a format that is acceptable to the TRAK A.G.E. 2. The TRAK A.G.E. 2 will accept the data formats from the following post processors:

a. A standard Fanuc 6M post processor

b. A Fanuc 6M post processor modified for the ProtoTRAK Plus

c. A special post processor written for the ProtoTRAK Plus

The TRAK A.G.E. 2 is a 2-axis controller that has the ability to convert G Codes that were intended for a 3-axis machining center into its normal position, mill and arc events. The TRAK A.G.E. 2 uses the Z data from the 3-axis machining center to decide if the XY movements in consecutive events should be connected. If the Z data changes, XY movements are assumed to be not connected and the TRAK A.G.E. 2 will prompt the operator to check the tool before it continues. If the Z data does not change between consecutive events, the TRAK A.G.E. 2 will assume that the events are connected and will insert a CONTINUE=YES in the first event.

8.1 Miscellaneous

The TRAK A.G.E. 2 accepts the standard RS274 G Code format, but outputs special G Codes. G Code data is converted into events so line numbers will not necessarily convert into corresponding event numbers. The following is a list of RS274 G Codes and addresses supported by the A.G.E. 2. (See G Code formats in A.G.E. 3 section.)

Addresses	RS274 G Codes	
(	G0	G40
)	G1	G41
N	G2	G42
T	G3	
X		G90
Y	*G17	G91
*Z	*G18	
I	*G19	
J	G20	
*K	G21	
F		
S		

*These are only used by the A.G.E. 2 to determine if events are connected.

8.2 Conrad

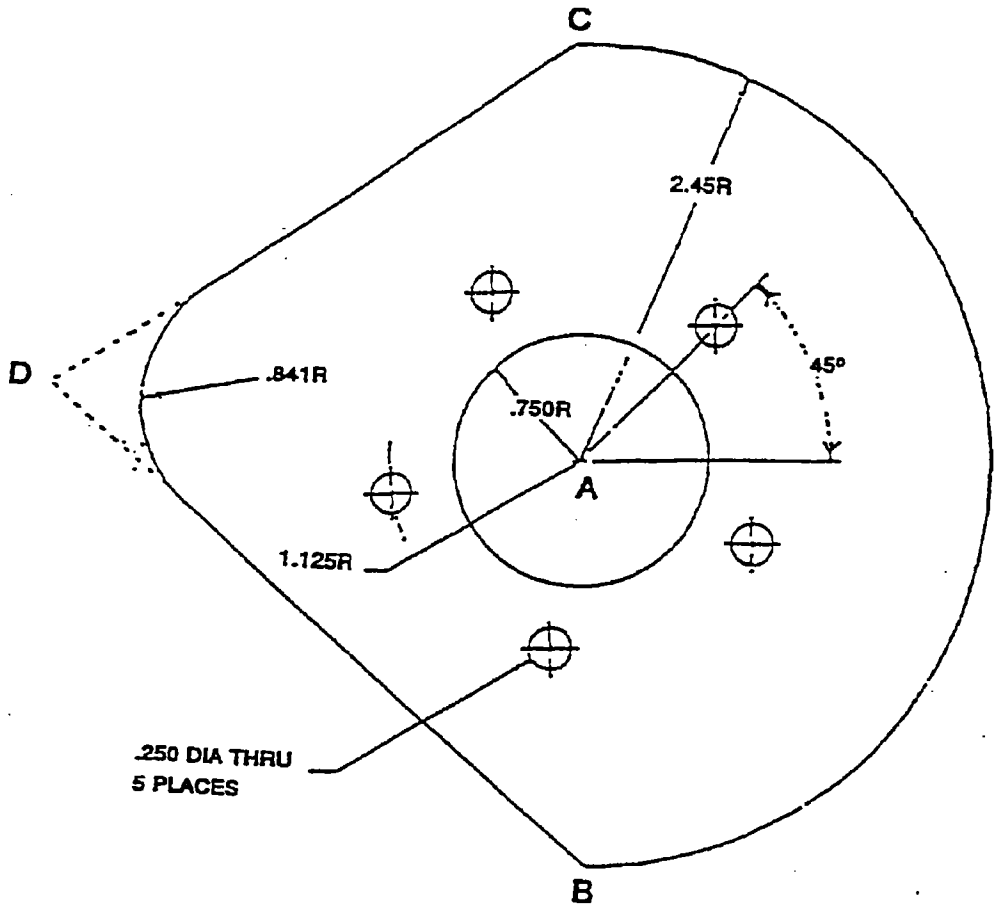
Negative values of Conrad are used to indicate that the present event is not connected to the next event. Positive values or zero indicate that the present event is connected to the next event.

8.3 Circles

When setting the tool path for a circle on a CAD/CAM system, break the tool path around the circle into two 1/2 circles. If the tool path is not broken into two 1/2 circles, the ProtoTRAK M2 will see the beginning and end points of the circle tool path as the same point and will not machine the circle.

8.4 Sample Programs

Following are two sample parts which were drawn on a CAD/CAM system and processed with a standard Fanuc 6 post processor. The programs were then saved onto a floppy disk with the .CAM extension on the part number, and read into the TRAK. Shown also is a listing of each program in the special G Code format as output by the TRAK.



	X	Y
A	0	0
B	0	-2.45
C	0	2.45
D	-3.064	.5045

i00633

Figure 4

8.5 TRAK A.G.E. 2 Output *(see Figure 4)*

```
PN111291 G20;
N1 G100 X0.0000A Y0.0000A T01 DO.0;
N2 G101 XB0.0000A YB0.0000A XE0.0000A YE0.2500A TCO F10.0 DO.0 CR0.0000 T01;
N3 G103 XB0.0000I YB0.0000I XE0.0000A YE-0.2500A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N4 G103 XB0.0000I YB0.0000I XE0.0000A YE0.2500A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N5 G101 XB0.0000I YB0.0000I XE0.0000A YE0.5000A TC0 F10.0 D0.0 CR0.0000 T01;
N6 G103 XB0.0000I YB0.0000I XE0.0000A YE-0.5000A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N7 G103 XB0.0000I YB0.0000I XE0.0000A YE0.5000A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR- T01;
N8 G100 X0.7955A Y0.7955A T01 D0.0;
N9 G100 X-0.5107A Y1.0024A T01 D0.0;
N10 G100 X-1.1112A Y-0.1760A T01 D0.0;
N11 G100 X-0.1760A Y-1.1112A T01 D0.0;
N12 G100 X1.0024A Y-0.5107A T01 D0.0;
N13 G100 X0.7955A Y0.7955A T01 D0.0;
N14 G100 X-0.5107A Y1.0024A T01 D0.0;
N15 G100 X-1.1112A Y-0.1760A T01 D0.0;
N16 G100 X-0.1760A Y-1.1112A T01 D0.0;
N17 G100 X1.0024A Y-0.5107A T01 D0.0;
N18 G102 XB0.0000A YB2.7000A XE0.0000A YE-2.7000A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N19 G102 XB0.0000I YB0.0000I XE-0.1735A YE-2.6300A XC0.0000A YC-2.4500A F10.0 TCO D0.0 CR0.0000 T01;
N20 G101 XB0.0000I YB0.0000I XE-2.4678A YE-0.4177A TC0 F10.0 D0.0 CR0.0000 T01;
N21 G102 XB0.0000I YB0.0000I XE-2.2953A YE1.2887A XC-1.7105A YC0.3677A F10.0 TC0 D0.0 CR0.0000 T01;
N22 G101 XB0.0000I YB0.0000I XE-0.1340A YE2.6611A TC0 F10.0 D0.0 CR0.0000 T01;
N23 G102 XB0.0000I YB0.0000I XE0.0000A YE2.7000A XC0.0000A YC2.4501A F10.0 TC0 D0.0 CR- T01;
%
```

8.6 CAD/CAM Output

```
K%:111291.TXT
N2G00G90G92X0Y0Z0
N3T1M16
N4X0Y0S4000M03
N5G45H1Z0.05T1
N6G01Z0F5.0
N7Y0.25F10.0
N8G03X0Y-0.25I0J-0.25
N9X0Y0.25I0J0.25
N10G01Y0.5
N11G03X0Y-0.5I0J-0.5
N12X0Y0.5I0J0.5
N13G00Z0.05
N14X0.7955Y0.7955
N15Z0
N16G81R0Z0F5.0
N17G80
N18G00X-0.5107Y1.0024
N19G81R0Z0F5.0
N20G80
N21G00X-1.1112Y-0.176
N22G81R0Z0F5.0
N23G80
N24G00X-0.176Y-1.1112
N25G81R0Z0F5.0
N26G80
N27G00X1.0024Y-0.5107
N28G81R0Z0F5.0
N29G80
N30G00Z0
N31X0.7955Y0.7955
N32G81R0Z0F5.0
N33G80
N34G00X-0.5107Y1.0024
N35G81R0Z0F5.0
N36G80
N37G00X-1.1112Y-0.176
N38G81R0Z0F5.0
N39G80
N40G00X-0.176Y-1.1112
N41G81R0Z0F5.0
N42G80
N43G00X1.0024Y-0.5107
N44G81R0Z0F5.0
N45G80
N46M09
N47G28Z15.0
N48M06
N49G00X0Y2.7S4000M03
```

8.6 CAD/CAM Output *(Continued)*

```
N50G45H2Z0T1
N51G02X0Y-2.7I0J-2.7F10.0
N52X-0.1735Y-2.63I0J0.25
N53G01X-2.4678Y-0.4177Z0
N54G02X-2.2953Y1.2887I0.7573J0.7854
N55G01X-0.134Y2.6611
N56G02X0Y2.7I0.134J-0.211
N57M09
N58M06
N59M30
%
```

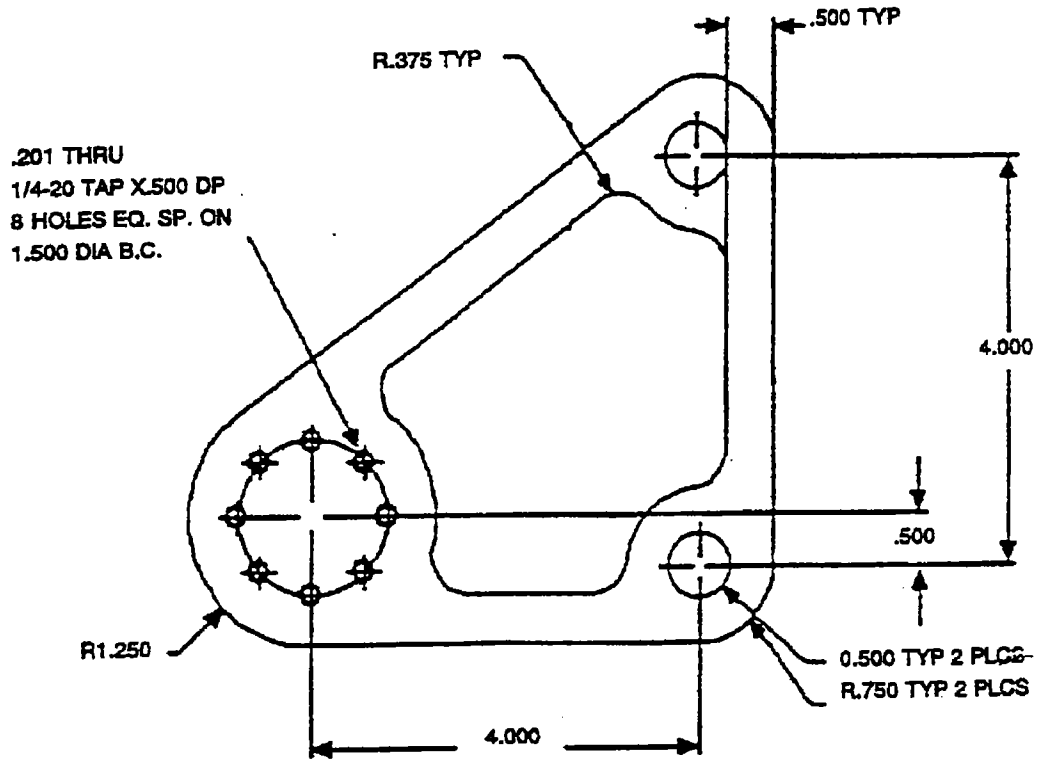

.500 TYP
R.375 TYP
.201 THRU
1/4-20 TAP X.500 DP
8 HOLES EQ. SP. ON
1.500 DIA B.C.
4.000
.500
R1.250
0.500 TYP 2 PLCS
R.750 TYP 2 PLCS
4.000
i00634

Figure 5

8.7 TRAK A.G.E. 2 Output *(see Figure 5)*

```
PN4 G20;
N1 G100 X0.0000A Y0.0000A T01 D0.0;
N2 G101 XB-0.8918A YB1.2371A XE3.4006A YE4.3315A TC0 F10.0 D0.0 CR0.0000 T01;
N3 G102 XB0.0000I YB0.0000I XE5.0250A YE3.5000A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N4 G101 XB0.0000I YB0.0000I XE5.0250A YE-0.5000A TC0 F10.0 D0.0 CR0.0000 T01;
N5 G102 XB0.0000I YB0.0000I XE4.0000A YE-1.5250A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N6 G101 XB0.0000I YB0.0000I XE0.0000A YE-1.5250A TC0 F10.0 D0.0 CR0.0000 T01;
N7 G102 XB0.0000I YB0.0000I XE-0.8918A YE1.2371A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR- T01;
N8 G101 XB-0.8772A YB1.2168A XE3.4152A YE4.3112A TC0 F10.0 D0.0 CR0.0000 T01;
N9 G102 XB0.0000I YB0.0000I XE5.0000A YE3.5000A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N10 G101 XB0.0000I YB0.0000I XE5.0000A YE-0.5000A TC0 F10.0 D0.0 CR0.0000 T01;
N11 G102 XB0.0000I YB0.0000I XE4.0000A YE-1.5000A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N12 G101 XB0.0000I YB0.0000I XE0.0000A YE-1.5000A TC0 F10.0 D0.0 CR0.0000 T01;
N13 G102 XB0.0000I YB0.0000I XE-0.8772A YE1.2168A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR- T01;
N14 G101 XB2.4524A YB0.9785A XE2.4288A YE0.8553A TC0 F10.0 D0.0 CR0.0000 T01;
N15 G102 XB0.0000I YB0.0000I XE2.9250A YE1.2748A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N16 G101 XB0.0000I YB0.0000I XE2.9250A YE1.3998A TC0 F10.0 D0.0 CR0.0000 T01;
N17 G101 XB0.0000I YB0.0000I XE2.3723A YE1.0014A TC0 F10.0 D0.0 CR0.0000 T01;
N18 G102 XB0.0000I YB0.0000I XE2.4288A YE0.8553A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N19 G101 XB0.0000I YB0.0000I XE2.2136A YE0.2250A TC0 F10.0 D0.0 CR0.0000 T01;
N20 G101 XB0.0000I YB0.0000I XE2.4348A YE0.2250A TC0 F10.0 D0.0 CR0.0000 T01;
N21 G102 XB0.0000I YB0.0000I XE3.2750A YE1.0652A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N22 G101 XB0.0000I YB0.0000I XE3.2750A YE1.9348A TC0 F10.0 D0.0 CR0.0000 T01;
N23 G102 XB0.0000I YB0.0000I XE3.1543A YE1.9966A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N24 G101 XB0.0000I YB0.0000I XE1.9272A YE1.1120A TC0 F10.0 D0.0 CR0.0000 T01;
N25 G102 XB0.0000I YB0.0000I XE2.2136A YE0.2250A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N26 G101 XB0.0000I YB0.0000I XE1.8708A YE-0.1250A TC0 F10.0 D0.0 CR0.0000 T01;
N27 G101 XB0.0000I YB0.0000I XE2.6771A YE-0.1250A TC0 F10.0 D0.0 CR0.0000 T01;
N28 G102 XB0.0000I YB0.0000I XE3.6250A YE0.8229A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N29 G101 XB0.0000I YB0.0000I XE3.6250A YE2.1771A TC0 F10.0 D0.0 CR0.0000 T01;
N30 G102 XB0.0000I YB0.0000I XE3.1462A YE2.4222A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N31 G101 XB0.0000I YB0.0000I XE1.4445A YE1.1954A TC0 F10.0 D0.0 CR0.0000 T01;
N32 G102 XB0.0000I YB0.0000I XE1.8708A YE-0.1250A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N33 G101 XB0.0000I YB0.0000I XE1.5811A YE-0.4750A TC0 F10.0 D0.0 CR0.0000 T01;
N34 G101 XB0.0000I YB0.0000I XE2.8820A YE-0.4750A TC0 F10.0 D0.0 CR0.0000 T01;
N35 G103 XB0.0000I YB0.0000I XE2.9813A YE-0.3861A XC2.8820A YC-0.3750A F10.0 TC0 D0.0 CR0.0000 T01;
N36 G102 XB0.0000I YB0.0000I XE3.8861A YE0.5187A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N37 G103 XB0.0000I YB0.0000I XE3.9750A YE0.6180A XC3.8750A YC0.6181A F10.0 TC0 D0.0 CR0.0000 T01;
N38 G101 XB0.0000I YB0.0000I XE3.9750A YE2.3820A TC0 F10.0 D0.0 CR0.0000 T01;
N39 G103 XB0.0000I YB0.0000I XE3.8861A YE2.4813A XC3.8750A YC2.3820A F10.0 TC0 D0.0 CR0.0000 T01;
N40 G102 XB0.0000I YB0.0000I XE3.2403A YE2.8119A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N41 G103 XB0.0000I YB0.0000I XE3.1077A YE2.8259A XC3.1662A YC2.7448A F10.0 TC0 D0.0 CR0.0000 T01;
N42 G101 XB0.0000I YB0.0000I XE1.0048A YE1.3099A TC0 F10.0 D0.0 CR0.0000 T01;
N43 G103 XB0.0000I YB0.0000I XE0.9979A YE1.1532A XC1.0633A YC1.2288A F10.0 TC0 D0.0 CR0.0000 T01;
N44 G102 XB0.0000I YB0.0000I XE1.4838A YE-0.3519A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N45 G103 XB0.0000I YB0.0000I XE1.5811A YE-0.4750A XC1.5811A YC-0.3750A F10.0 TC0 D0.0 CR- T01;
N46 G101 XB2.4524A YB0.9785A XE2.4194A YE0.8055A TC0 F10.0 D0.0 CR0.0000 T01;
N47 G102 XB0.0000I YB0.0000I XE2.9500A YE1.2607A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N48 G101 XB0.0000I YB0.0000I XE2.9500A YE1.4486A TC0 F10.0 D0.0 CR0.0000 T01;
N49 G101 XB0.0000I YB0.0000I XE2.3415A YE1.0100A TC0 F10.0 D0.0 CR0.0000 T01;
```

8.7 TRAK A.G.E. 2 Output *(Continued; see Figure 5)*

```
N50 G102 XB0.0000I YB0.0000I XE2.4194A YE0.8055A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.000 T01;
N51 G101 XB0.0000I YB0.0000I XE2.1909A YE0.2000A TC0 F10.0 D0.0 CR0.0000 T01;
N52 G101 XB0.0000I YB0.0000I XE2.4508A YE0.2000A TC0 F10.0 D0.0 CR0.0000 T01;
N53 G102 XB0.0000I YB0.0000I XE3.3000A YE1.0492A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N54 G101 XB0.0000I YB0.0000I XE3.3000A YE1.9508A TC0 F10.0 D0.0 CR0.0000 T01;
N55 G102 XB0.0000I YB0.0000I XE3.1527A YE2.0262A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N56 G101 XB0.0000I YB0.0000I XE1.8942A YE1.1190A TC0 F10.0 D0.0 CR0.0000 T01;
N57 G102 XB0.0000I YB0.0000I XE2.1909A YE0.2000A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N58 G101 XB0.0000I YB0.0000I XE1.8439A YE-0.1500A TC0 F10.0 D0.0 CR0.0000 T01;
N59 G101 XB0.0000I YB0.0000I XE2.6962A YE-0.1500A TC0 F10.0 D0.0 CR0.0000 T01;
N60 G102 XB0.0000I YB0.0000I XE3.6500A YE0.8038A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N61 G101 XB0.0000I YB0.0000I XE3.6500A YE2.1962A TC0 F10.0 D0.0 CR0.0000 T01;
N62 G102 XB0.0000I YB0.0000I XE3.1470A YE2.4536A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N63 G101 XB0.0000I YB0.0000I XE1.4080A YE1.2000A TC0 F10.0 D0.0 CR0.0000 T01;
N64 G102 XB0.0000I YB0.0000I XE1.8439A YE-0.1500A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N65 G101 XB0.0000I YB0.0000I XE1.5811A YE-0.5000A TC0 F10.0 D0.0 CR0.0000 T01;
N66 G101 XB0.0000I YB0.0000I XE2.8820A YE-0.5000A TC0 F10.0 D0.0 CR0.0000 T01;
N67 G103 XB0.0000I YB0.0000I XE3.0062A YE-0.3889A XC2.8820A YC-0.3750A F10.0 TC0 D0.0 CR0.0000 T01;
N68 G102 XB0.0000I YB0.0000I XE3.8889A YE0.4938A XC4.0000A YC-0.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N69 G103 XB0.0000I YB0.0000I XE4.0000A YE0.6180A XC3.8750A YC0.6180A F10.0 TC0 D0.0 CR0.0000 T01;
N70 G101 XB0.0000I YB0.0000I XE4.0000A YE2.3820A TC0 F10.0 D0.0 CR0.0000 T01;
N71 G103 XB0.0000I YB0.0000I XE3.8889A YE2.5062A XC3.8750A YC2.3820A F10.0 TC0 D0.0 CR0.0000 T01;
N72 G102 XB0.00008 YB0.0000I XE3.2588A YE2.8287A XC4.0000A YC3.5000A F10.0 TC0 D0.0 CR0.0000 T01;
N73 G103 XB0.00008 YB0.0000I XE3.0931A YE2.8462A XC3.1662A YC2.7448A F10.0 TC0 D0.0 CR0.0000 T01;
N74 G101 XB0.00008 YB0.0000I XE0.9902A YE1.3302A TC0 F10.0 D0.0 CR0.0000 T01;
N75 G103 XB0.0000I YB0.0000I XE0.9815A YE1.1343A XC1.0633A YC1.2288A F10.0 TC0 D0.0 CR0.0000 T01;
N76 G102 XB0.0000I YB0.0000I XE1.4595A YE-0.3462A XC0.0000A YC0.0000A F10.0 TC0 D0.0 CR0.0000 T01;
N77 G103 XB0.0000I YB0.0000I XE1.5811A YE-0.5000A XC1.5811A YC-0.3750A F10.0 TC0 D0.0 CR- T01;
N78 G100 X4.0000A Y3.5000A T01 D0.0;
N79 G100 X4.0000A Y-0.5000A T01 D0.0;
N80 G100 X4.0000A Y3.5000A T01 D0.0;
N81 G100 X4.0000A Y-0.5000A T01 D0.0;
N82 G100 X4.0000A Y3.5000A T01 D0.0;
N83 G100 X4.0000A Y-0.5000A T01 D0.0;
N84 G100 X0.0000A Y0.7500A T01 D0.0;
N85 G100 X-0.5303A Y0.5303A T01 D0.0;
N86 G100 X-0.7500A Y0.0000A T01 D0.0;
N87 G100 X-0.5303A Y-0.5303A T01 D0.0;
N88 G100 X0.0000A Y-0.7500A T01 D0.0;
N89 G100 X0.5303A Y-0.5303A T01 D0.0;
N90 G100 X0.7500A Y0.0000A T01 D0.0;
N91 G100 X0.5303A Y0.5303A T01 D0.0;
N92 G100 X0.00001 Y0.7500A T01 D0.0;
N93 G100 X-0.5303A Y0.5303A T01 D0.0;
N94 G100 X-0.7500A Y0.0000A T01 D0.0;
N95 G100 X-0.5303A Y-0.5303A T01 D0.0;
N96 G100 X0.0000A Y-0.7500A T01 D0.0;
N97 G100 X0.5303A Y-0.5303A T01 D0.0;
N98 G100 X0.7500A Y0.0000A T01 D0.0;
N99 G100 X0.5303A Y0.5303A T01 D0.0;
```

8.8 CAD/CAM Output *(see Figure 5)*

```
N100 G100 X0.0000A Y0.0000A T01 D0.0;
%
%:PN4.TXT
N1G00G90G92X0Y0Z0
N2T1M16
N3X-0.8918Y1.2371S3000M03
N4G45H1Z0T1
N5M08
N6G01X3.4006Y4.3315F10.0
N7G02X5.025Y3.5I0.5994J-0.8315
N8G01Y-0.5
N9G02X4.0Y-1.525I-1.025J0
N10G01X0
N11G02X-0.8918Y1.2371I0J1.525
N12G00Z0
N13X-0.8772Y1.2168
N14G01X3.4152Y4.3112F10.0
N15G02X5.0Y3.5I0.5848J-0.8112
N16G01Y-0.5
N17G02X4.0Y-1.5I-1.0J0
N18G01X0
N19G02X-0.8772Y1.2168I0J1.5
N20G00Z0
N21X2.4524Y0.9785
N22G01X2.4288Y0.8553F10.0
N23G02X2.925Y1.2748I1.5712J-1.3553
N24G01Y1.3998
N25X2.3723Y1.0014
N26G02X2.4288Y0.8553I-2.3723J-1.0014
N27G01X2.2136Y0.225
N28X2.4348
N29G02X3.275Y1.0652I1.5652J-0.725
N30G01Y1.9348
N31G02X3.1543Y1.9966I0.725J1.5652
N32G01X1.9272Y1.112
N33G02X2.2136Y0.225I-1.9272J-1.112
N34G01X1.8708Y-0.125
N35X2.6771
N36G02X3.625Y0.8229I1.3229J-0.375
N37G01Y2.1771
N38G02X3.1462Y2.4222I0.375J1.3229
N39G01X1.445Y1.1954
N40G02X1.8708Y-0.125I-1.4445J-1.1954
N41G01X1.5811Y-0.475
N42X2.882
N43G03X2.9813Y-0.3861I0J0.1
N44G02X3.8861Y0.5187I1.0187J-0.1139
N45G03X3.975Y0.618I-0.0111J0.0994
N46G01Y2.382
N47G03X3.8861Y2.4813I-0.1J0
```

8.8 CAD/CAM Output *(Continued; see Figure 5)*

```
N48G02X3.2403Y2.8119I0.1139J1.0187
N49G03X3.1077Y2.8259I-0.0741J-0.0671
N50G01X1.0048Y1.3099
N51G03X0.9979Y1.1532I0.0585J-0.0811
N52G02X1.4838Y-0.3519I-0.9979J-1.1532
N53G03X1.5811Y-0.475I0.0973J-0.0231
N54G00Z0
N55X2.4524Y0.9785
N56G01X2.4194Y0.8055F10.0
N57G02X2.95Y1.2607I1.5806J-1.3055
N58G01Y1.4486
N59X2.3415Y1.01
N60G02X2.4194Y0.8055I-2.3415J-1.01
N61G01X2.1909Y0.2
N62X2.4508
N63G02X3.3Y1.0492I1.5492J-0.7
N64G01Y1.9508
N65G02X3.1527Y2.0262I0.7J1.5492
N66G01X1.8942Y1.119
N67G02X2.1909Y0.2I-1.8942J-1.119
N68G01X1.8439Y-0.15
N69X2.6962
N70G02X3.65Y0.8038I1.3038J-0.35
N71G01Y2.1962
N72G02X3.147Y2.4536I0.35J1.3038
N73G01X1.408Y1.2
N74G02X1.8439Y-0.15I-1.408J-1.2
N75G01X1.5811Y-0.5
N76X2.882
N77G03X3.0062Y-0.3889I0J0.125
N78G02X3.8889Y0.4938I0.9938J-0.1111
N79G03X4.0Y0.618I-0.0139J0.1242
N80G01Y2.382
N81G03X3.8889Y2.5062I-0.125J0
N82G02X3.2588Y2.8287I0.1111J0.9938
N83G03X3.0931Y2.8462I-0.0926J-0.0839
N84G01X0.9902Y1.3303
N85G03X0.9815Y1.1343I0.0731J-0.1014
N86G02X1.4595Y-0.3462I-0.9815J-1.1343
N87G03X1.5811Y-0.5I0.1216J-0.0288
N88M09
N89G28Z0
N90M06
N91G00X4.0Y3.5S3000M03
N92G45H2Z0T1
N93M08
N94G82R0Z0P0F5.0
N95Y-0.5
N96G80
N97M09
N98G28Z0
```

8.8 CAD/CAM Output *(Continued; see Figure 5)*

```
N99M06
N100G00X4.0Y3.5S3000M03
N101G45H3Z0T1
N102M08
N103G81R0Z0F5.0
N104Y-0.5
N105Y.3
N106Y-0.5
N107G80
N108M09
N109G28Z0
N110M06
N111G00X0Y0.75S3000M03
N112G45H4Z0T1
N113M08
N114G81R0Z0F5.0
N115G80
N116G00X-0.5303Y0.5303
N117G81R0Z0F5.0
N118G80
N119G00X-0.75Y0
N120G81R0Z0F5.0
N121G80
N122G00X-0.5303Y-0.5303
N123G81R0Z0F5.0
N124G80
N125G00X0Y-0.75
N126G81R0Z0F5.0
N127G80
N128G00X0.5303Y-0.5303
N129G81R0Z0F5.0
N130G80
N131G00X0.75Y0
N132G81R0Z0F5.0
N133G80
N134G00X0.5303Y0.5303
N135G81R0Z0F5.0
N136G80
N137G00Z0
N138X0Y0.75
N139G84R0Z0F5.0
N140G80
N141G00X-0.5303Y0.5303
N142G84R0Z0F5.0
N143G80
N144G00X-0.75Y0
N145G84R0Z0F5.0
N146G80
N147G00X-0.5303Y-0.5303
N148G84R0Z0F5.0
```

8.8 CAD/CAM Output *(Continued; see Figure 5)*

```
N149G80
N150G00X0Y-0.75
N151G84R0Z0F5.0
N152G80
N153G00X0.5303Y-0.5303
N154G84R0Z0F5.0
N155G80
N156G00X0.75Y0
N157G84R0Z0F5.0
N158G80
N159G00X0.5303Y0.5303
N160G84R0Z0F5.0
N161G80
N162M09
N163G28Z0
N164G28X0Y0M05
N165M06
N166M30
%
```

9.0 CAD/CAM - TRAK A.G.E. 3 and QMV

This Section of the manual deals with communications with a CAD/CAM system. The CAD/CAM system requires a post processor to arrange the output data in a format that is acceptable to the TRAK A.G.E. 3 and QMV.

Normally, the TRAK A.G.E. 3 and QMV acts like a 2 1/2 axis system when programs are sent to it via the RS232 serial port. In order to use the RS232 capability of the TRAK A.G.E. 3 and QMV with a CAD/CAM package, a special post processor must be written by the manufacturer of the CAD/CAM package.

Two-and-a-half-axis is defined as simultaneous movement in the X and Y axes with Z axis stationary, or movement in the Z axis with both X and Y axes stationary.

The information provided in this section of the manual will be used by your CAD/CAM manufacturer to design the required post processor for the TRAK A.G.E. 3 and QMV.

NOTE: See the DNC section of this manual for information on using the TRAK A.G.E. 3 and QMV as 3-axis controller.

The RS274 G Code format has been divided into three categories of commands:
1. Acceptable and convertible G Code commands
2. Not acceptable and not convertible G Code commands
3. Ignored G Code commands

When the TRAK A.G.E. 3 and QMV receives the first category of commands from a CAD/CAM package, it will accept the program and convert the G Codes into TRAK A.G.E. 3 and QMV format.

When the second category of codes are received, the TRAK A.G.E. 3 and QMV will generate an error report and will display the lines in which the unacceptable codes are located. The program will then be erased from the TRAK A.G.E. 3 and QMV memory.

The third category of codes will be accepted by the TRAK A.G.E. 3 and QMV, but will not be used in the program. They will have no effect on the program.

9.1 Accepted G Codes

G CODE	FUNCTION
G00	Positioning
G01	Linear interpolation
G02	Circular interpolation CW XY plane
G03	Circular interpolation CCW XY plane
G20	Input in inch
G21	Input in metric
G40	Cutter compensation cancel
G41	Cutter compensation left
G42	Cutter compensation right
G73	Peck drilling cycle
G80	Canned cycle cancel
G81	Drilling cycle, spot boring
G82	Drilling cycle, counter boring
G83	Peck drilling cycle
G85	Boring cycle
G89	Boring cycle, dwell at bottom
G90	Absolute programming
G91	Incremental programming
G98	Return to initial point in canned cycle
G99	Return to R point in canned cycle

NOTE: DO NOT mix standard RS274 format G Codes with the special SWI G Codes in the same program.

9.2 Format of Accepted G Codes

G CODE	ACCEPTABLE FORMAT
G00	X<SCOORD> Y<SCOORD>
G01 (2 Axis)	X<SCOORD> Y<SCOORD> F<FRATE>
G01 (3 Axis)	X<SCOORD> Y<SCOORD> Z<SCOORD> F<FRATE>

G CODE	ACCEPTABLE FORMAT

NOTES:

1. *In G01, if no F code is specified, the minimum TRAK A.G.E. 3 and QMV feedrate will be used.*
2. *We suggest that G01 (3 Axis) be used only for ramping into pockets. The TRAK A.G.E. 3 and QMV do not support 3D motion for surface machining with this interface. The system has a separate interface that handles this type of machining.*

G02/G03

X<SCOORD> Y<SCOORD> I<SCOORD>
J<SCOORD> F<FRATE>

NOTES:

1. *Arcs are in the XY plane only.*
2. *In incremental mode X and Y are relative to the start point of the arc.*
3. *I & J are always incremental from the starting point of the arc.*
4. *I & J both must be included even if one is incremental.*
5. *The radius-specified form of the arc is not accepted.*

G20 or G21

G20; or G21;

This must be in a block by itself at the start of the program.

G40

This must be in the same block as G00, G01, G02 or G03.

G41 or G42

D<OFSTNUM>

NOTES:

1. *This must be in the same block as G00, G01, G02 or G03.*
2. *The radius of the current tool number is used as the <OFSTNUM> on the TRAK A.G.E. 3 and QMV.*
3. *<OFSTNUM> sent to the TRAK A.G.E. 3 and QMV from the CAD/CAM system will be ignored.*

G73

X<SCOORD> Y<SCOORD> Z<SCOORD>
Q<COORD> R<SCOORD> F<FRATE>
Q = Depth of each peck

G80

G80;

G CODE	ACCEPTABLE FORMAT
	NOTE: If, while in any other canned cycle mode, a G00, G01, G02 or G03 is commanded, the TRAK A.G.E. 3 and QMV will be taken out of the canned cycle mode as if a G80 were commanded.
G81	X<SCOORD> Y<SCOORD> Z<SCOORD> R<SCOORD> F<FRATE>
G82	X<SCOORD> Y<SCOORD> Z<SCOORD> R<SCOORD> P<SEQ-NUMBER> F<FRATE>
	NOTE: The dwell is specified in milliseconds, and gets rounded to the nearest .1 second.
G83	X<SCOORD> Y<SCOORD> Z<SCOORD> Q<COORD> R<SCOORD> F<FRATE> Q = Depth of Peck
G85	X<SCOORD> Y<SCOORD> Z<SCOORD> R<SCOORD> F<FRATE>
G89	X<SCOORD> Y<SCOORD> Z<SCOORD> R<SCOORD> P<SEQ-NUMBER> F<FRATE>
	NOTE: The dwell time is specified in milliseconds, and gets rounded to the nearest .1 second.
G90	G90
G91	G91
G98	G98
G99	G99

9.3 Format Terms and Definitions

I. Number Formats

A. Preparatory Function Number, denoted <prep-func>
1. format : dd
2. leading 0 suppression
3. range: 0 to 99

B. Sequence or Line Number, denoted <seq-number>
   1. format (independent of units) : dddd
   2. leading 0 suppression
   3. range: 1 to 9999

C. Unsigned Coordinate Word, denoted <coord>
   1. format :
      a. metric : ddddd.ddd
      b. English : dddd.dddd
   2. the "+" sign is implied and therefore may be omitted.
   3. leading 0 suppression
   4. if no decimal point is given, the supplied number will be interpreted as an integer (i.e., whole number).
   5. fractional portion is optional
   6. range :
      a. metric: 0 to 99999.999
      b. English: 0 to 9999.9999

D. Signed Coordinate Word, denoted <scoord>
   1. format :
      a. negative number : -<coord>
      b. positive number : +<coord> or <coord>
   2. range :
      a. metric: -99999.999 to 99999.999
      b. English: -9999.9999 to 9999.9999

E. Tool Function, denoted <tool>

   1. format : dd

      NOTE: the 2-digit dd format is the only format that SWI can handle; the 4 digit format is not supported.

   2. leading 0 suppression
   3. range: 1 to 99

F. Miscellaneous or M Codes function number, denoted <prep-func>

   1. format : dd
   2. leading 0 suppression
   3. range: 0 to 99

G. Feedrate values, denoted <frate>

   1. format :
      a. metric : ddddd
      b. English : ddd.dd

2. leading 0 suppression
3. decimal point not required
4. fractional portion is optional
5. range:
   a. metric: 1 to 2540 mm/min
   b. English: 0.1 to 99.9 inches/min

H. Offset numbers, denoted <ofstnum>
1. format : dd
2. leading 0 suppression
3. range: 0 to 64

I. Offset amounts, denoted <offset-amount>

1. Format :
   a. metric: -999.999 to +999.999, no sign implies +
   b. English: -99.9999 to +99.9999, no sign implies +

J. RPM Command (QMV)

1. Format :
   S1000 = 1000 RPM

II. Acceptable Addresses

D, M, N, G, T, X, Y, Z, H, I, J, K, L, F, P, Q, R.

9.4 Ignored G Codes

G Codes that are ignored by the TRAK A.G.E. 3 and QMV neither generates errors nor do they get converted into TRAK A.G.E. 3 and QMV codes

G CODE	FUNCTION
G04	Dwell
G09	Exact stop check
G10	Offset value setting
G17	XY plane selection
G22	Stored stroke limit on
G23	Stored stroke limit off
G43	Tool length compensation + direction
G44	Tool length compensation - direction
G49	Z Tool length offset cancel
G60	Single direction positioning
G61	Exact stop mode
G64	Cutting Mode
G94	Feed per minute

9.5 G Codes That Generate Errors

G CODE	FUNCTION
G02/G03	CW/CCW arcs in XZ or YZ planes
G02/G03	CW/CCW helix
G18	XZ plane selection
G19	YZ plane selection
G27	Reference point return check
G28	Return to reference point
G29	Return from reference point
G30	Return to 2nd reference point
G31	Skip function
G33	Thread cutting
G37	Tool length automatic measurement
G38	Cutter radius compensation vector change
G39	Cutter radius compensation corner rounding
G45	Tool offset increase
G46	Tool offset decrease
G47	Tool offset double increase
G48	Tool offset double decrease
G54	Work coordinate system 1 selection
G55	Work coordinate system 2 selection
G56	Work coordinate system 3 selection
G57	Work coordinate system 4 selection
G58	Work coordinate system 5 selection
G59	Work coordinate system 6 selection
G62	Automatic corner override mode
G63	Tapping mode
G65	User macro simple call
G66	User macro modal call
G67	User macro modal call cancel
G74	Counter tapping cycle
G76	Fine boring
G84	Tapping cycle
G86	Boring cycle
G87	Back boring cycle
G88	Boring cycle
G92	Programming of absolute zero point
G95	Feed per revolution

9.6 Accepted M Codes

The TRAK A.G.E. 3 and QMV recognize the following M codes in the following way.

M CODE	FUNCTION
M00	A pause is generated. The axes will not move, but the motors will be engaged. The spindle motor will not turn off.
M02	Executed automatically at the end of all programs. Turns off the servo motors and all auxiliary functions. The auxiliary function box must be present for this function to work.
M05	Stops the spindle at the end of the current event. The auxiliary function box must be present for this function to work.
M06	Tool change. The M06 is ignored, as the tool change on the TRAK A.G.E. 3 and QMV is accomplished by changing the tool number.
M07	Flood coolant on. This will turn on the auxiliary box A/C outlet before the event.
M08	Mist coolant on. This will turn on the air supply from the auxiliary box, before the event.
M09	Coolant off. This will turn off the auxiliary box A/C outlet and air supply after the event.
M12 & M20	Send a pulse to the Haas indexer and wait for an "in position" response.
All other M codes will be ignored.	

NOTES:
1. *Place M Codes on same line as movement G Code.*
2. *One M Code per block.*

9.7 Miscellaneous Information

1. End-of-file is the (%) character and must be placed at the end of each program being sent via RS232 to the TRAK A.G.E. 3 and QMV.

2. End-of-block is the carriage return (ASCII 13) and the linefeed (ASCII 10) characters. Both of these characters must be at the end of each line of G codes. Unexpected results can occur if they are not both provided.

3. The semicolon is not recognized.

4. Error checking must be done by the post processor. The TRAK A.G.E. 3 and QMV do only limited error checking.

5. Programs from a CAD/CAM system can be sent to the TRAK A.G.E. 3 and QMV in two formats:

   Format 1 - The tool path can be generated by the CAD/CAM system using the bottom center of the tool, and the tool's diameter. This information can then be sent to the TRAK A.G.E. 3 and QMV.

   If Format 1 is used, input a tool diameter of zero (0) in the TRAK A.G.E. 3 and QMV. The effect of inputting a tool diameter other than zero (0) is that the tool position tangent to the programmed geometry will be incorrect when Z axis movements are involved.

   Format 2 - If the CAD/CAM system has a custom post processor that can output a file in the A.G.E. 3 and QMV format, this can also be sent to the A.G.E. 3 and QMV control. The file will have extension .MX3, which can be read directly into the A.G.E. 3 and QMV.

9.8 TRAK A.G.E. 3 Output - Sample Program 111291.MX3

```
PN111291 G20;
G130 X0.0000 Y0.0000;
G131 Z0.0000 XM0.0000 XN0.0000 YM0.0000 YN0.0000 ST=00000;
N1 G116 X+0.7955A Y+0.7955A ZR+0.0500A ZE-0.1250A NP01 FZ10.0 DB1 D0.0000 DW0.0 T01;
N2 G116 X-0.5107A Y+1.0024A ZR+0.0500A ZE-0.1250A NP01 FZ10.0 DB1 D0.0000 DW0.0 T01;
N3 G116 X-1.1112A Y-0.1760A ZR+0.0500A ZE-0.1250A NP01 FZ10.0 DB1 D0.0000 DW0.0 T01;
N4 G116 X-0.1760A Y-1.1112A ZR+0.0500A ZE-0.1250A NP01 FZ10.0 DB1 D0.0000 DW0.0 T01;
N5 G116 X+1.0024A Y-0.5107A ZR+0.0500A ZE-0.1250A NP01 FZ10.0 DB1 D0.0000 DW0.0 T01;
N6 G116 X+0.7955A Y+0.7955A ZR+0.0500A ZE-0.4000A NP01 FZ10.0 DB1 D0.0000 DW0.0 T02;
N7 G116 X-0.5107A Y+1.0024A ZR+0.0500A ZE-0.4000A NP01 FZ10.0 DB1 D0.0000 DW0.0 T02;
N8 G116 X-1.1112A Y-0.1760A ZR+0.0500A ZE-0.4000A NP01 FZ10.0 DB1 D0.0000 DW0.0 T02;
N9 G116 X-0.1760A Y-1.1112A ZR+0.0500A ZE-0.4000A NP01 FZ10.0 DB1 D0.0000 DW0.0 T02;
N10 G116 X+1.0024A Y-0.5107A ZR+0.0500A ZE-0.4000A NP01 FZ10.0 DB1 D0.0000 DW0.0 T02;
N11 G101 XB+0.0000A YB+0.0000A ZR+0.0500A ZB+0.0500A XE+0.0000A YE+0.0000A ZE-0.4000A
        TC0 F10.0 FZ10.0 D0.0000 CR0.0000 T03;
N12 G101 XB+0.0000I YB+0.0000I ZR-0.4000A ZB-0.4000A XE+0.1250A YE+0.0000A ZE-0.4000A TC0
        F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N13 G103 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE-0.1250A YE+0.0000A ZE-0.4000A
        XC+0.0000A YC+0.0000A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N14 G103 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE+0.1250A YE+0.0000A ZE-0.4000A
        XC+0.0000A YC+0.0000A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N15 G101 XB+0.0000I YB+0.0000I ZR-0.4000A ZB-0.4000A XE+0.5000A YE+0.0000A ZE-0.4000A TC0
        F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N16 G103 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE-0.5000A YE+0.0000A ZE-0.4000A
        XC+0.0000A YC+0.0000A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N17 G103 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE+0.5000A YE+0.0000A ZE-0.4000A
        XC+0.0000A YC+0.0000A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N18 G100 X+0.5000A Y+0.0000A ZR+0.0500A D0.0000 T03;
N19 G101 XB+0.0000A YB+2.7000A ZR+0.0500A ZB+0.0500A XE+0.0000A YE+2.7000A ZE-0.4000A
        TC0 F10.0 FZ10.0 D0.0000 CR0.0000 T03;
N20 G102 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE+0.0000A YE-2.7000A ZE-0.4000A
        XC+0.0000A YC+0.0000A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N21 G102 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE-0.1735A YE-2.6300A ZE-0.4000A
        XC+0.0000A YC-2.4500A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N22 G101 XB+0.0000I YB+0.0000I ZR-0.4000A ZB-0.4000A XE-2.4678A YE-0.4177A ZE-0.4000A TC0
        F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N23 G102 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE-2.2953A YE+1.2887A ZE-0.4000A
        XC-1.7105A YC+0.3677A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N24 G101 XB+0.0000I YB+0.0000I ZR-0.4000A ZB-0.4000A XE-0.1340A YE+2.6611A ZE-0.4000A TC0
        F15.0 FZ15.0 D0.0000 CR0.0000 T03;
N25 G102 XB+0.0000I YB+0.0000I ZR+0.0000I ZB-0.4000A XE+0.0000A YE+2.7000A ZE-0.4000A
        XC+0.0000A YC+2.4501A ZC-0.4000A TC0 F15.0 FZ15.0 D0.0000 CR0.0000 T03;
%
```

9.9 CAD/CAM Output for TRAK A.G.E. 3- Sample Program 111291.CAM

```
%P111291
N2G00G90
N3T1M6
N4X0.7955Y0.7955
N5Z0.05
N6G81R0.05Z-0.125F10.0
N7G80
N8G00X-0.5107Y1.0024
N9G81R0.05Z-0.125F10.0
N10G80
N11G00X-1.1112Y-0.176
N12G81R0.05Z-0.125F10.0
N13G80
N14G00X-0.176Y-1.1112
N15G81R0.05Z-0.125F10.0
N16G80
N17G00X1.0024Y-0.5107
N18G81R0.05Z-0.125F10.0
N19G80
N20T2M06
N21G00X0.7955Y0.7955
N22Z0.05
N23G83R0.05Z-0.4Q0F10.0
N24G80
N25G00X-0.5107Y1.0024
N26G83R0.05Z-0.4Q0F10.0
N27G80
N28G00X-1.1112Y-0.176
N29G83R0.05Z-0.4Q0F10.0
N30G80
N31G00X-0.176Y-1.1112
N32G83R0.05Z-0.4Q0F10.0
N33G80
N34G00X1.0024Y-0.5107
N35G83R0.05Z-0.4Q0F10.0
N36G80
N37T3M06
N38G00X0Y0
N39Z0.05
N40G01Z-0.4F10.0
N41X0.125F15.0
N42G03X-0.125Y0I-0.125J0
N43X0.125Y0I0.125J0
N44G01X0.5
N45G03X-0.5Y0I-0.5J0
N46X0.5Y0I0.5J0
N47G00Z0.05
N48X0Y2.7
N49G01Z-0.4F10.0
N50G02X0Y-2.7I0J-2.7F15.0
N51X-0.1735Y-2.63I0J0.25
N52G01X-2.4678Y-0.4177
N53G02X-2.2953Y1.2887I0.7573J0.7854
N54G01X-0.134Y2.6611
N55G02X0Y2.7I0.134J-0.211
N56M02
%
```

9.10 CAD/CAM Output for QMV - Sample Program 111291.CAM

You will notice that the only difference between the CAD/CAM output for the TRAK A.G.E. 3 and the TRAK QMV is the S with a number after it (as highlighted below). This designates the programmable spindle speed for all events following it up until the next change in spindle speed in the program. This principle is consistent with outputs with .DNC and .MX3 extensions as well.

%PN111291
N1G90G40
N2T1**S1800**M06
N3G00X0.7955Y0.7955
N4Z0.01
N5G81R0.01Z-0.1F5.0
N6G80
N7G00X-0.5107Y1.0024
N8G81R0.01Z-0.1F5.0
N9G80
N10G00X-1.1111Y-0.176
N11G81R0.01Z-0.1F5.0
N12G80
N13G00X-0.176Y-1.1111
N14G81R0.01Z-0.1F5.0
N15G80
N16G00X1.0024Y-0.5107
N17G81R0.01Z-0.1F5.0
N18G80
N19T2M06
N20G00X0.7955Y0.7955
N21Z0.01
N22G81R0.01Z-0.3F5.0
N23G80
N24G00X-0.5107Y1.0024
N25G81R0.01Z-0.3F5.0
N26G80
N27G00X-1.1111Y-0.176
N28G81R0.01Z-0.3F5.0
N29G80
N30G00X-0.176Y-1.1111
N31G81R0.01Z-0.3F5.0
N32G80
N33G00X1.0024Y-0.5107
N34G81R0.01Z-0.3F5.0
N35G80
N36M02
N37G00
N38T3**S1500**M6
N39X0Y0
N40Z0.01
N41G01Z-0.2F2.0
N42X0.2F10.0
N43G03X-0.2Y0I-0.2J0
N44X0.2Y0I0.2J0
N45G01X0.5
N46G03X-0.5Y0I-0.5J0
N47X0.5Y0I0.5J0
N48G00
N49Z0.01
N50X0Y-2.7
N51G01Z-0.26F2.0
N52G03X0Y2.7I0J2.7F10.0
N53X-0.134Y2.6611I0J-0.25
N54G01X-2.2953Y1.2887
N55G03X-2.4678Y-0.4177I0.5848J-0.921
N56G01X-0.1735Y-2.63
N57G03X0Y-2.7I0.1735J0.18
N58G00Z0.01
%

10.0 DNC - TRAK A.G.E. 3 and QMV

This section of the manual deals with communication between the TRAK A.G.E. 3 and QMV and the computer in Direct Numerical Control (DNC) Mode.

In DNC mode, the TRAK A.G.E. 3 and QMV will receive a section of a program from the computer, execute some portion of this program, and then receive an additional section of the program from the computer. This will continue until the entire program is received and executed.

The TRAK A.G.E. 3 and QMV can receive DNC programs either from the RS232 serial port or a floppy disk. Normally, the RS232 port is used because programs can be of unlimited size, but using the floppy disk is valuable because of its simplicity, since it does not require a RS232 cable, telecommunications program and nearby computer. However, the largest program that fits on a floppy disk is approximately 50,000 events. Several limitations have been imposed, but they should not cause problems in most cases, i.e., no tool comping (G41, G42), no tool length offsets (G43, G44), and no canned cycles (G81, etc.).

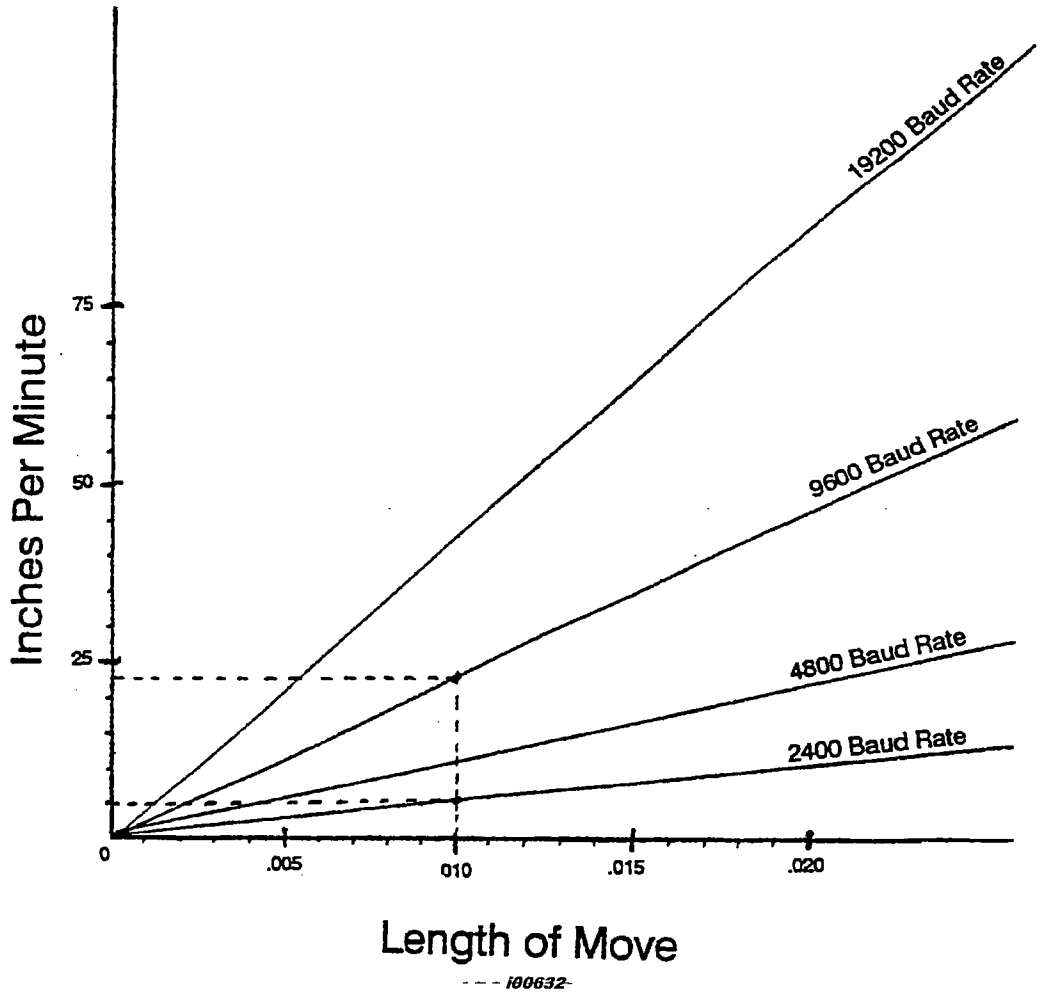
When machining in DNC mode the TRAK A.G.E. 3 and QMV could pause and wait for additional data from the remote computer if the rate of machining, i.e., the feedrate is too fast. The factors affecting the feedrate are:

1. The baud rate
2. The length of each move

For example, in the graph below if the size of each move is .010", then at a baud rate of 2400, the maximum feedrate at which the TRAK A.G.E. 3 and QMV will operate satisfactorily is 5 ipm. If the baud rate is increased to 9600, then the maximum feedrate will increase to 23 ipm. Increasing the size of each move to .020" with the baud rate remaining at 2400, increases the maximum feedrate to 12 ipm.

Therefore, if it is necessary to machine a part (e.g., plastic) at a very high feedrate, either increase the length of each move, or increase the baud rate. This would suggest that setting the baud rate permanently to the maximum of 19200 would be best. However, the transmission of data gets less reliable as the baud rate is increased, and a slower baud rate is adequate for most applications.

The TRAK A.G.E. 3 and QMV will not make linear moves that are less than .0002". If a move of less than .0002" is received by the TRAK A.G.E. 3 and QMV, it will generate an error and the TRAK A.G.E. 3 and QMV will not run the program. If your program has these short moves, either delete them or reconfigure your CAD/CAM system to increase the length of these moves.



10.1 Who Needs DNC?

Mold makers who do complex parts and design them on a CAD/CAM system will find this option invaluable when using the TRAK A.G.E. 3 and QMV. Other types of manufacturers that use a CAD/CAM system to design parts that result in a long program, will also find this option invaluable.

The outstanding features for these manufacturers are:

- The ability to run programs of infinite length.
- The ability to operate the control in full three-axis mode.

10.2 DNC Requirements

- TRAK A.G.E. 3 and QMV - with DNC option
- IBM compatible or Macintosh computer
- CAD/CAM system - with correct post-processor (See Command Format Section 9.12)
- Communication software if not included with CAD/CAM

10.3 DNC Option Kit

The DNC option kit consists of:

- A floppy disk to replace the system disk in the TRAK A.G.E. 3 and QMV .
- A floppy disk containing sample programs.
- A hardware key to be plugged into the parallel port on the TRAK A.G.E. 3 and QMV.
- A 50 foot cable.
- A CAD/CAM & DNC interface manual.
- TRAK A.G.E. 3 and QMV programming, operating and care manual.

10.4 Setup

Step 1: Turn the power off on the TRAK A.G.E. 3 and QMV.

Step 2: Plug the hardware key into the parallel port on the computer cabinet of the TRAK A.G.E. 3 and QMV (refer to TRAK A.G.E. 3 and QMV Programming, Operating and Care Manual, Section 2, Figure 3).

Step 3: Replace the system disk in the TRAK A.G.E. 3 and QMV with the one provided in the DNC kit.

Step 4: Turn power on at the TRAK A.G.E. 3 and QMV.

Step 5: Set up the TRAK A.G.E. 3 and QMV and the computer to communicate via RS232 (see Sections 3-7.)

10.5 Preparing to Run a DNC Program

Several steps must be performed before running a DNC program:

- The Z retract position and home position must be defined. This step is necessary for the same reasons as it is for regular, non-DNC TRAK A.G.E. 3 and QMV operation.
- The tool lengths must be set so that tool-length compensation may be automatically performed. The tool numbers that will be utilized in the program must be known *prior* to beginning the actual Run operation.
- The part's absolute zero must be set in DRO mode.
- The baud rate must be set using Service Code 37 in the TRAK A.G.E. 3 and QMV. Service Code 37 works in both standard operating mode and DNC mode, but selecting a DNC baud rate does not affect the .CAM baud rate which is always 4800. After Code 37, pressing one of the 2400, 4800, 9600, or 19200 soft keys selects a new baud rate for DNC only. The TRAK A.G.E. 3 and QMV remembers the last DNC baud rate chosen even if power is turned off.
- Set the computer to have the same baud rate, even parity, 7 data bits and 1 stop bit.
- Xon/Xoff software handshaking must be enabled in the sending computer's software.

10.6 Running A Program from Floppy Disk

Press the following keys and follow the instructions on the screen, to run a program from the disk containing the sample programs.

a. MODE — While in DNC mode, the MODE key will always return the user to the DNC operation menu. DNC OFF key is used to return to the TRAK A.G.E. 3 and QMV Select Mode menu.

b.	PROG IN/OUT	
c.	DNC	If DNC is missing from the menu, then the hardware key is not attached, is broken, or the computer is defective.
d.	DRO	Set X,Y and Z absolute 0 positions now. The DRO soft key works the same in DNC mode as described in the TRAK A.G.E. 3 and QMV Programming, Operating and Care Manual, Section 4.0.
e.	RSTR	
f.	SET-UP	
g.	TOOL DATA	Place each tool in the spindle and set its length. In DNC mode tool data is not supplied by the part program, so it must be entered before pressing the RUN key. Tool offsets for up to 99 tools can be entered.
h.	RETURN	
i.	REF POSNS	Set Z retract position now. Set X and Y home position now. Set XY and Z limits now.
j.	MODE	
k.	RUN	Place the floppy disk with the sample programs in the TRAK A.G.E. 3 and QMV.
l.	FROM FLOPPY	Enter the numbers 111291. now. Only programs with .DNC filename extensions can be loaded. NOTE: The DRO display does not update while the TRAK A.G.E. 3 and QMV is accessing the diskette. This results in lengthy pauses in the coordinate display.
m.	RUN IT	The TRAK A.G.E. 3 and QMV will begin to run the program.

10.7 Running a Program Via RS232

Step 1: Prepare the computer to send the program to the TRAK A.G.E. 3 and QMV.

a. Use a telecommunications program such as CROSSTALK. Set the baud rate (e.g., 9600,e,7,1) and read the sample program 111291.dnc from the disk with sample programs

b. Enable Xon/Xoff in the telecommunications software.

Step 2: Prepare the TRAK A.G.E. 3 and QMV to receive the program by pressing the following keys:

a. Repeat the keystrokes as in Section 9.6 (a) to (j).

b. RUN

c. FROM RS232 - The TRAK A.G.E. 3 and QMV will now flash "ready."

In addition to the initial conditions of the coordinates, feedrate and feedrate override, the display shows how much of the DNC part program has been loaded. As the part program runs, the current memory empties and is refilled by loading more of the part program from the remote computer, and the buffer % display changes to reflect the percent of current memory filled. The Block number display shows the G Code block about to be executed.

Step 3: Send the program in ASCII from the computer to the TRAK A.G.E. 3 and QMV.

Step 4: Press GO when the TRAK A.G.E. 3 and QMV prompts to do so.

10.7.1 Running a Program Directly from CAD/CAM

Follow the steps in the section 9.7 above. Use the CAD/CAM system as the telecommunications software and send the G Codes representing the drawing, directly from the CAD/CAM system to the TRAK A.G.E. 3 and QMV.

10.8 Troubleshooting

The troubleshooting procedures described here are intended to isolate problems into one of the following areas:

- The TRAK A.G.E. 3 and QMV
- The part program
- The remote computer
- The telecommunications program
- The RS232 cable

If a problem develops while operating the TRAK A.G.E. 3 and QMV in DNC mode, first eliminate the TRAK A.G.E. 3 and QMV as the cause of the problem by placing the disk with the sample parts in the TRAK A.G.E. 3 and QMV and retrieving the program with the .MX3 extension.

Depending on the nature of the problem being experienced, it may be necessary to make the part and check the dimensions which are shown on the drawing manual, or it may only be necessary to draw the part on the screen to check if the TRAK A.G.E. 3 and QMV is functional. Call for service if the TRAK A.G.E. 3 and QMV is defective.

If the TRAK A.G.E. 3 and QMV pass the functionality test above, then run the .DNC part program from the same disk to check if the DNC option is functioning correctly. Call for service if the TRAK A.G.E. 3 and QMV will not run the DNC program.

Now that we are sure the TRAK A.G.E. 3 is functioning correctly, check the remote computer and the RS232 cable. See Section 7.0 of this manual.

Next, test the telecommunications program being used by sending the DNC program from the sample parts disk, from the remote computer to the TRAK A.G.E. 3 and QMV, in DNC mode.

If the above results are as expected, the problem should be in your program on the CAD/CAM system. Refer the problem to your CAD/CAM manufacturer along with this manual so that they can make the necessary adjustment, or contact us for more information.

10.9 Sample Program 111291.DNC *(see Fig. 4 for drawing)*

DNC Format

```
%
N1(111291.DNC)
N2(REV A)
N3G20
N4M6T1(#5 C'DRILL)
N5G90M7
N6G0X0.884Y0.884
N7Z0.05
N8G1Z-0.05F30.
N9G0Z0.05
N10X-0.567Y1.114
N11G1Z-0.05
N12G0Z0.05
N13X-1.235Y-0.196
N14G1Z-0.05
N15G0Z0.05
N16X-0.196Y-1.235
N17G1Z-0.05
N18G0Z0.05
N19X1.114Y-0.567
N20G1Z-0.05
N21M9
N22M5
N23M6T2(1/4 DRILL)
N24M7
N25G0X0.884Y0.884
N26Z0.05
N27G1Z-0.35F17.
N28G0Z0.05
N29X-0.567Y1.114
N30G1Z-0.35
N31G0Z0.05
N32X-1.235Y-0.196
N33G1Z-0.35
N34G0Z0.05
N35X-0.196Y-1.235
N36G1Z-0.35
N37G0Z0.05
N38X1.114Y-0.567
N39G1Z-0.35
N40M9
N41M5
N42M6T3(.5 ENDMILL)
N43M7
N44G0X0Y0
N45Z0.05
N46G1Z-0.2F25.
N47G1X0.2F40.
N48G3I-0.2
N49G1X0.4
N50G3I-0.4
N51G1X0.5F40.
N52G3I-0.5
N53G0Z0.05
N54X-0.103Y-2.698
N55G1Z-0.25F25.
N56G3X-0.074Y2.699J2.698I0.103
N57G1X-2.295Y1.289
N58G3X-2.4678Y-0.4177I0.5848J-0.921
N59G1X-0.103Y-2.698
N60M9
N61M2
%
```

10.10 Accepted G Codes

1. G0 - rapid linear move
   Example: G0X0.Y1.Z2.

2. G1 - linear move at feedrate
   Example: G1X1.25Y-1.5F25.

3. G2 - arc CW (XY only)
   Example: G1X1.Y0.Z0.10
   G2X2.Y1,I1.J0.

4. G3 - arc CCW (XY only)
   Example: G1X1.Y0.Z0.10
   G3X0.Y1.I-1.J0.

5. G4 - dwell (non-modal)
   Example: G0X1.Y0.Z.05
   G1Z-.5G4P1000F5.
   G1Z.05

6. G9 - exact stop mode (one shot): applies to G1, G2, and G3 only

7. G20 - inch programming: all dimensions in inches, feedrate in inches/minute
   Example: % (first line of the program)
   G20
   ...

8. G21 - Metric programming: all dimensions in mm, feedrate in mm/minute
   Example: % (first line of the program)
   G21
   ...

9. G61 - exact stop mode (modal until G64): applies to G1, G2, and G3 only

10. G64 - cutting mode (turns off exact stop mode)

11. G90/91 - Absolute/incremental programming
    Example: G90G1X1.Y-1.Z0.F10.
    G91Z-1.
    Z1.05

12. **All other G codes are ignored.**

10.11 Accepted M Codes (the auxiliary function box option is required for all M Codes)

1. M0, M1 - program stop
   a. Turn off the spindle and coolant functions, hold axes where they are; prompt user to press GO.

2. M2 - end of program
   a. Return to home position
   b. Turn off spindle and coolant functions

3. M5 - turn off spindle

4. M6 - tool change
   a. Example: T02M6
   b. Sequence of events:
      turn off spindle and coolant functions
      return spindle to Z retract position
      return to (X,Y) home position
      turn off the Z axis motor
      prompt for tool specified in the T word; wait for GO
      return to Z retract position
      allow spindle to be turned on

5. M7 - turn on the air solenoid in the aux box.

6. M8 - turn on the A/C switch on the aux box.

7. M9 - turn off the air solenoid and the A/C switch.

8. M12 & M20 - give a pulse for the Haas indexer and wait for an "in position" response

9. M99 - give the line number (not the block number Nxxx) at which execution should start (in the P word)

   a. Note: This command ***is not*** very forgiving and ***must*** be used with extreme care when starting in the middle of a program. Count the program's line ***very*** carefully. For example:

      %
      T1M6 (line is counted: part data/part comment)
      M99P11 (this is line #3: begin run at line #11)
      G90G0X1.Y1. (line #4: not executed)
      Z.05 (line #5: not executed)
      (line #6: this line is counted even if there's no data)

G1Z-.5F10. (line #7: not executed)
Z.05 (line #8: not executed)
Z-1. (line #9: not executed)
Z.05 (line #10: not executed)
G0X2.G4P1000 (line #11: begin execution here)
G1Z-.5F10.
Z.05
Z-1.
Z.05
M2
%

10. **All other M codes are ignored.**

10.12 Command Format

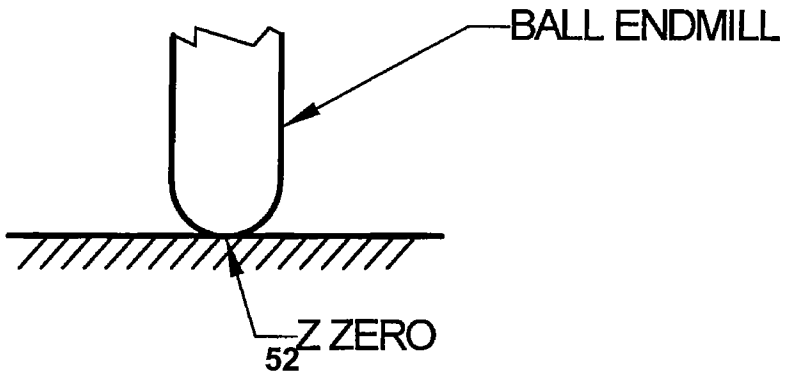
1. Commands are expected in a restricted Fanuc-like format. Only those commands described above are supported. The required post processor is a Fanuc 6M or Fanuc 10M. This post processor must be modified so that it only outputs the G and M Codes shown in Sections 9.10 and 9.11 All other G and M Codes should be turned off.

2. The first % in this RS274 data must be on the first line of data. Any % in the data that is not on the first line will be interpreted as the end of the data. Any data that exists after the ending % will be ignored. In other words, the output of the post processor should look like the following:

   %
   ...
   (your program data goes here)
   ...
   %

3. Comments must be surrounded by parentheses.

4. The DNC program must be written for the bottom center of a ball endmill.



Southwestern Industries, Inc.

Trav-A-Dial & TRAK

Warranty Statement

Trav-A-Dial and TRAK products are warranted to the original purchaser to be free from defects in workmanship and materials for the following periods:

Product	Warranty Period	
	Materials	Factory Labor
New Trav-A-Dial	1 Year	1 Year
New TRAK	1 Year	1 Year
Any Exchange Unit	90 Days	90 Days

The warranty period starts on the date of the invoice to the original purchaser from Southwestern Industries, Inc. (Southwestern Industries, Inc.) or its authorized distributor.

If a unit under warranty proves to be defective in workmanship or materials, it will be repaired or exchanged at our option for a properly functioning unit in similar or better condition. Such repairs or exchanges will be made FOB Factory/Los Angeles.

Disclaimers of Warranties

- This warranty is expressly in lieu of any other warranties, express or implied, including any implied warranty of merchantability or fitness for a particular purpose, and of any other obligation or liability on the part of SWI (or any producing entity, if different).
- Warranty repairs/exchanges do not cover incidental costs such as installation, labor, freight, etc.
- SWI is not responsible for consequential damages from use or misuse of any of its products, even if SWI has been notified of the possibility of such damages.
- Trav-A-Dial/TRAK products are precision mechanical/electromechanical measurement systems and must be given the reasonable care that these types of instruments require:
    - ◊ Proper shop facilities are the responsibility of the customer. This warranty does not apply if the facilities, e.g., flooring or electricity, are not adequate for the installation and use of the products.
    - ◊ Proper use of shop equipment such as air hoses. Consequently, the warranty does not apply if the customer uses poor machine shop practices and blows chips into machine gibs, glass scale, and TRAK Sensor or control instruments.
    - ◊ Proper maintenance and lubrication as directed in the product manual is the responsibility of the customer. This warranty does not apply if the customer does not properly maintain the unit.
- Accidental damage, beyond the control of SWI, is not covered by the warranty. Thus, the warranty does not apply if an instrument has been abused, dropped, hit, disassembled or opened.
- Improper use or installation by or at the direction of the customer in such a way that the product consequently fails is considered to be beyond the control of the manufacturer and outside the scope of the warranty.

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