Model 1100 Wafer Dicing Saw

OPERATION MANUAL

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TABLE OF CONTENTS

LIST OF FIGURES

INSTALLATION:

1) Remove metal clips from front of crate.

2) Remove front of crate from crate.

   NOTE: SAW IS MOUNTED ON WOODEN SKIDS.

3) Slide remainder of crate off 1100 saw and mounting skids.

4) Check contents of crate against contents listed on packing list.

   NOTE: IF ANY CONTENTS ARE MISSING OR DAMAGED, REPORT PROBLEM TO CARRIER.

5) Remove strapping.

   NOTE: FIND A FLAT LEVEL PLACE TO POSITION SAW. THERE ARE ADJUSTABLE LEVELLING ASSEMBLIES ON BOTTOM OF BASE CASTING AND TABLE WHICH CAN BE USED TO LEVEL SAW.

   NOTE: ALL REFERENCES IN THIS INSTALLATION PROCEDURE ARE TO DRAWINGS, FIGURES AND TASKS IN THE 1100 MAINTENANCE MANUAL. YOU SHOULD HAVE A COPY OF THE 1100 MAINTENANCE MANUAL BEFORE YOU BEGIN.

   NOTE: BEFORE INSTALLING SAW, MAKE SURE YOU HAVE THE REQUIRED UTILITIES ON HAND. SEE SPECIFICATIONS, PAGE 1-12.

   NOTE: IT IS RECOMMENDED THAT YOU USE DIONIZED WATER. REGULAR USE OF CITY WATER QUICKLY BUILDS UP CORROSION .

6) Remove three screws and front access panel from base casting. See dwg., page 7-10 (item 12).

   NOTE: FOR STEPS 7-9 SEE DWG., PAGE 7-9 (ITEM 31, DETAIL "C").

7) Remove three screws, washers and shipping bracket from X axis pillow-block and X drive pin.

8) Flip shipping bracket over so that narrow end points away from X leadscrew and wide end lines up with two screw holes in X axis pillow-block.

9) Install shipping bracket with two washers and screws to X axis pillow-block.

10) Loosen two screws and lift top cover.

    NOTE: FOR STEPS 11-12 SEE DWG., PAGE 7-6 (ITEM 45).

11) Remove two screws, splitlock washers, washers and ball holder from shipping bracket at rear of Y slide assembly.

12) Remove four screws, washers and bracket from rear of Y slide assembly.

    NOTE: FOR STEPS 13-16 SEE DWG., PAGE 7-29.

13) Grease Y leadscrew finger with Lubriplate.

14) Compress Y leadscrew finger and install ball holder in top of Y leadscrew doublenut.

15) Move Y slide to align slots in ball holder with holes in Y flag holder.

16) Install ball holder to Y flag holder with two screws and washers.

17) Install spindle control PCB in guides and jack J4 on mother board power supply. See dwg., page 7-5 (item 68).

NOTE: FOR STEPS 18-20 SEE DWG., PAGE 7-18 AND/OR FIGURE 4, PAGE 3-0.1.

18) Install tubing from SPINDLE COOLING OUT to shop drain.

19) Install tubing from VACUUM IN to shop vacuum supply.

20) Install tubing from vacuum drain (white plastic fitting below VACUUM IN) to shop drain.

21) Install elbow fittings and plastic tubing to two drain outlets and route to shop drain.

NOTE: FOR STEPS 22-23 SEE DWG., PAGE 7-13 AND/OR FIGURE 6, PAGE 4-0.1.

22) Hook up shop air to barbed fitting at end of air regulator on service unit (item 10).

23) Hook up shop water supply to barbed fitting at end of water pressure regulator on service unit (item 36).

NOTE: FOR STEPS 24-25 SEE DWG., PAGE 7-10.

24) Install monitor in monitor support bracket.

25) Install support wedge and screw under monitor support bracket.

26) If required for access, lift card cage tabs and remove X-Theta CPU and Y-Z CPU from slots two and three on mother/logic board.

27) Install monitor plug P18 to mother/logic board jack J18. See dwg., page 7-8 (item 20).

28) If required, install X-Theta CPU and Y-Z CPU in slots two and three on mother/logic board and push down card cage tabs.

NOTE: FOR STEPS 29-31 SEE DWG., PAGE 7-64 (100X ME2), PAGE 7-67 (100X)AND/OR FIGURE 14, PAGE 4-9.

NOTE: WHEN INSTALLING TUBING TO OPTICS BODY, USE SPECIAL SCREWS AND WASHERS PROVIDED IN PLASTIC BAG.

29) Install two (one for 100X ME2) branches of orange tubing, with fitting, to holes in lower backside surface of optics body (item 1).

30) Install yellow tubing, with fitting, to hole in top backside surface of optics body.

31) Install camera support and camera to camera support mount with three washers and screws (item 44).

32) Install camera plug P1 to mother board camera harness connector J1.

33) Install green tube at left front corner of base casting to barbed fitting on blade removal tube.

34) Install power plug to rear panel and power outlet.

35) Perform chuck flatness adjustment (see maintenance manual, task 4.21).

36) Perform camera angular position adjustment (see maintenance manual, task 4.39).

37) If required, install front access panel, and three screws to base casting.

1.3 SAFETY

All operators should read and understand these safety procedures before working with the system.

WARNING and **CAUTION** instructions must be observed during operation or servicing of the system. These instructions appear in the manual text and on labels attached to the equipment. They are defined as follows:

WARNING: Given when failure to observe its instruction can result in injury to the operator.

CAUTION: Given when failure to observe its instruction can result in permanent damage to the equipment.

NOTES: Given when failure to observe its instruction can result in improper operaton of saw.

Micro Automation Inc. cannot control the use of the equipment or be responsible for personal injury or damage resulting from its use. Observe all **WARNINGS, CAUTIONS,** and **NOTES.** Consult local, state, and federal agencies regarding specific requirements and regulations.

1.3.1 WARNINGS

WARNING: Application of the incorrect power input voltage can cause an explosion, fire, or electrical shock that can injure the operator and damage the equipment irreparably. Ensure that the power outlet has the voltage and power ratings specified for the equipment.

WARNING: DO NOT assume that power is removed from the equipment when the power switch is off. Some portions of the circuit are HOT whenever the unit is connected to the power main. Always switch the power off and disconnect the power cable from the receptacle before removing covers exposing current carrying parts.

1.3.2 CAUTIONS

CAUTION: Use replacement fuses with the required current rating and specifications. Makeshift fuses and the short-circuiting of fuse holders may cause fire or damage to the equipment.

CAUTION: Electrical transients created by disconnecting cables or printed circuit boards can severely damage the equipment components. Always switch the power off before connecting or disconnecting any components or cables.

CAUTION: To prevent damage to the printed circuit boards, do not place a board near anything that can create an electrostatic charge and destroy components on the board. Certain components (CMOS chips) are extremely sensitive to static electricity. Before handling the boards the operator should touch a grounded metal object such as the chassis of the saw.

1.3.3 INTERLOCK

The saw is equiped with a top cover actuated safety switch. This switch disconnects all power to the saw by interrupting both the hot line and the neutral line when the cover is removed.

1.4 SPECIFICATIONS

Physical Characteristics	
Dimensions:	Length: 33" (83.8 cm) Height: 32" (81.2 cm) Depth: 30" (76.2 cm)
Weight:	330 lb (150 kg)
Weight with table:	675 lb (297 kg)
Power Requirements	
Voltage:	110/220 Vac + 10%
Power:	Nominal: 900 W Maximum: 1500 W
Frequency:	50/60 Hz
Fuses:	2 8A, 2 2A
Air Requirement	65 PSI Minimum, 6 CFM
Vacuum Requirement	20" HG Minimum, 2 CFM
Water Requirement	
Blade Coolant:	1/2 to 1 GPM
Blade Coolant Pressure:	30 PSIG Minimum
Spindle Coolant:	6 GPH
Spindle Coolant Pressure:	30 PSIG
Drain Requirement	90 GPH
Environment	
Operating Temperature:	Nominal: 25°C
Maximum Humidity:	80% (Noncondensing)
Wafer Dimensions	
Round:	Diameter: Maximum: 6" Minimum: 2"
Rectangular:	Sides Maximum: 6"
Wafer Thickness	Maximum: 500 mils Minimum: 1 mil
Spindle Speed:	15,000 RPM to 40,000 rpm
Program Storage Capacity:	60 standard programs

SECTION 2

SYSTEM OPERATION

2.1 INTRODUCTION

The model 1100 saw consists of the following major components:

- o The vacuum chuck,
- o The spindle and cutting wheel,
- o The split-image TV camera and monitor,
- o The program panel, and
- o The control panel.

The chuck holds the wafer securely by vacuum while cutting. Several concentric and four radial grooves are cut into the chuck's face to distribute the vacuum on its surface.

The vacuum reaches the surface of the chuck at points of intersection of the smallest concentric groove and the four radial grooves. Figure 2-1 shows the top of the chuck for unmounted wafers/substrates; other chucks are available for film frames and rings. All wafer shapes and sizes from 2-inch to 6-inch are accepted without modification. The chuck moves right and left to move the wafer under the blade. It also rotates and moves up and down. All movements can be programmed or affected by operator controls. Section Four of the manual describes all programming and operating steps in detail.

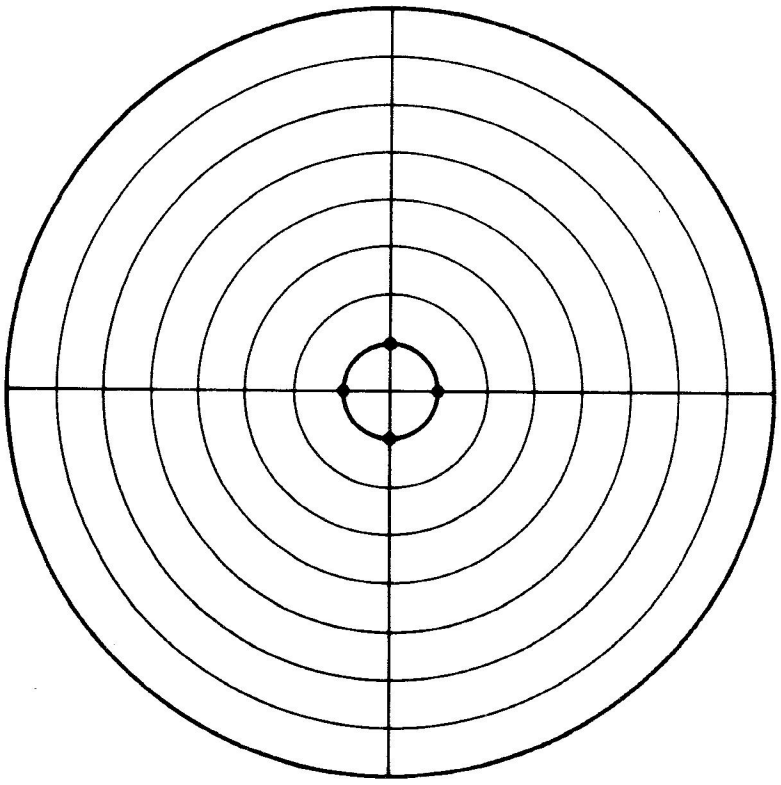


Figure 2-1: Vacuum Chuck

2.2 AXIS DEFINITION

Four motor-driven assemblies control the relative motion between the chuck (and the wafer on it) and the saw blade.

The assemblies are refered to as the X, Y, Z, and Theta axes. All four axes can be controlled from the control panel, and can be programmed for automatic operation. The relationship between the axes is shown in Figure 2-2, and explained below.

- o X axis. This assembly moves the chuck in the left-right directions. Speed and amount of travel is controlled by the operator.
- o Y axis. This assembly moves the spindle and the blade in the front-to-back directions, and controls the distance between each cut.
- o Z axis. This assembly moves the chuck up and down, and determines how deep the saw blade will cut into the wafer.
- o Theta axis. This assembly rotates the chuck. After cuts are made in one direction, the Theta axis is turned and cuts are made in the other direction.

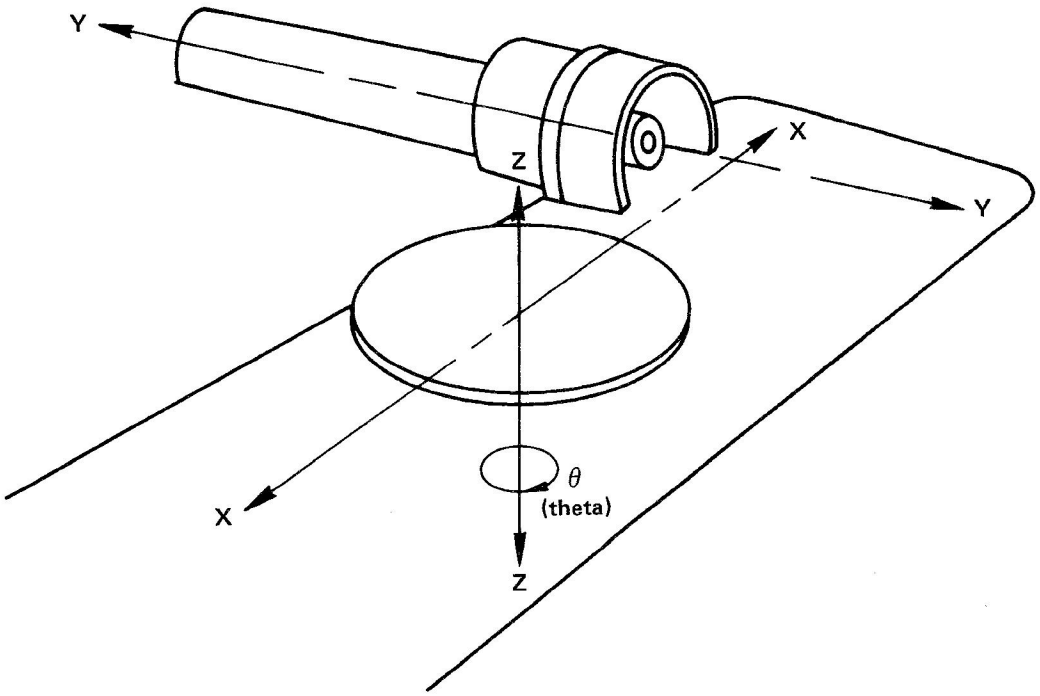


Figure 2-2: Axis Definition

2.3 SWITCHES AND CONTROLS

The main power control is the ON/OFF switch. It is the red button on the top right corner of the control panel to the right of the spindle. To turn the saw on, turn the ON/OFF switch clockwise until a clicking sound is heard. To turn it off, press down on the switch.

CAUTION

Do not turn off main power when the spindle is running, except in an emergency.

All operating controls are pressure sensitive keys, and are grouped on the control panel. They are used to operate the saw manually.

The programming controls, also pressure sensitive keys, are to the left of the spindle, on the program panel. They are used to enter values for programmed (automatic) operation. The use of these keys is explained in Section 4 of the manual.

CAUTION

The keys can be damaged if they are pushed with metal objects, tools, pencils, etc. Use only the tip of the finger.

2.4 GENERAL OPERATION

The basic steps for any sawing operation are as follows:

- o Program the saw.
- o Turn on spindle.
- o Perform CHUCK ZERO function.
- o Put the wafer on the chuck.
- o Turn on the vacuum to hold the wafer firmly on the chuck.
- o Move the chuck so that the wafer is under the TV camera.
- o Align the wafer to the saw blade.
- o Press AUTO CUT.

2.5 DICING

One of the two basic methods of cutting wafers is dicing. Figure 2-3 shows the relative movement between the cutting wheel and the wafer while dicing. The sequence is as follows:

- o The wafer is raised to the programmed height.
- o The chuck moves from left to right, making the first cut.
- o The chuck is lowered, then moved back to the left.
- o At the same time the Y axis is moved toward the rear of the saw. It moves a programmed distance so that it is in position to make a cut in the next street.
- o The above actions are repeated until all cuts are made in one direction.
- o The chuck rotates through a programmed angle and cuts are made in the other direction.

Note that when a circular wafer is cut, the chuck moves only as far as necessary to make the cuts.

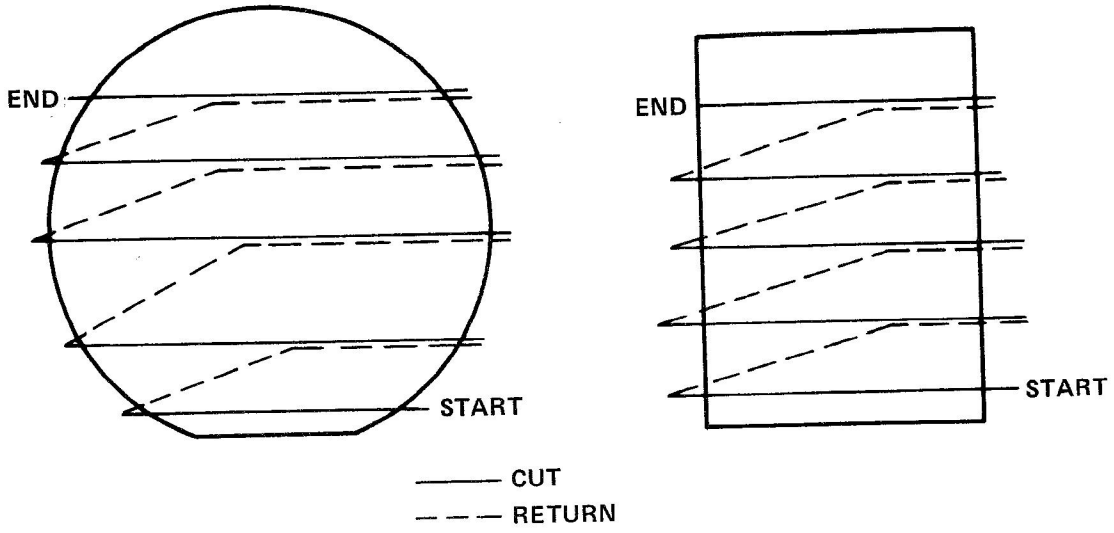


Figure 2-3:Cutting Path, Dicing

2.6 SCRIBING

Scribing is similar to dicing, except that the saw cuts in both directions. Figure 2-4 shows the chuck movement during scribing.

Scribing is frequently faster than dicing, but other factors, such as chipping and blade cooling, must be taken into consideration.

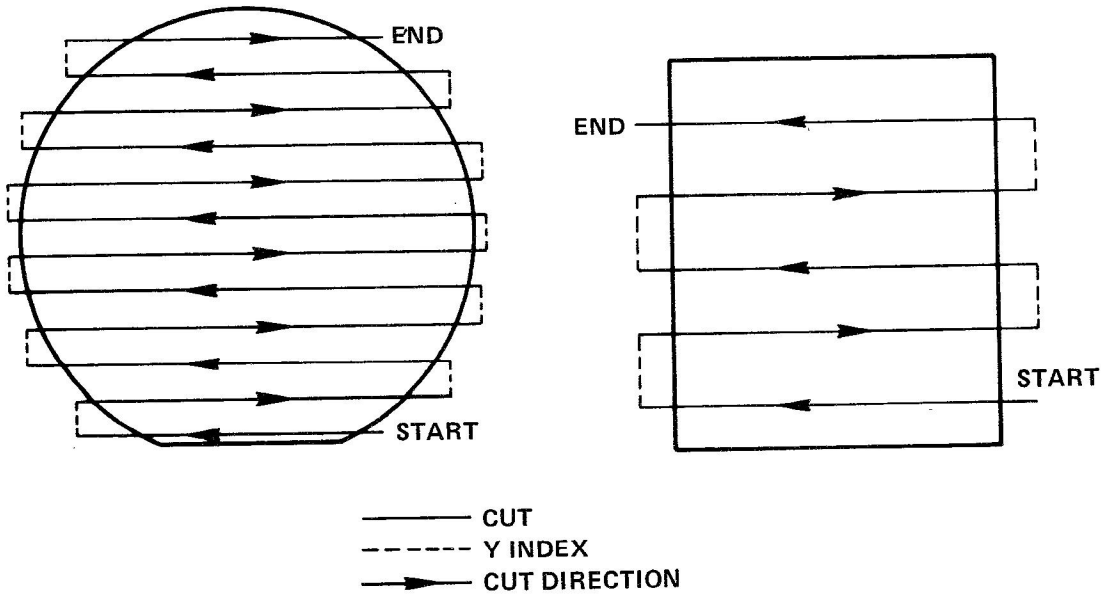


Figure 2-4: Cutting Path, Scribing

SECTION 3

BLADES

3.1 INTRODUCTION

This section provides information on how to select the right blade for a cutting operation, and how to install both hubless and mounted blades on the spindle. By using these guide lines you will be able to select a blade which will give the best quality of cut together with long blade life and high production rates.

NOTE

Blades are also called "wheels" and "cutting wheels". The terms are interchangeable.

3.2 BLADE TYPES

The two basic types of blades are mounted and unmounted (Hubless) blades. Figure 3-1 shows both types of blades.

Mounted blades are made by directly plating a nickel alloy with diamond chips on a hub. Some characteris tics of mounted blades are:

- Rugged. There is less chance of damage in handling.
- Good cooling by heat transfer from cutting edge to hub, which means less chipping and kerf loss.
- Less kerf loss due to reduced vibration.
- More consistent performance from one manufacturer's lot to another.

Unmounted blades are made by compressing (usually under heat) abrasive material with some bonding material to form a flat cutting disc. Most unmounted blades are of two types:

- Resinoid. These are sometimes called "wear blades". These are mostly used to cut very hard material.
- Sintered. Sintered blades are made by compressing a paste-like mixture of abrasives under heat. Sintered blades are used for cutting silicon.

The characteristics of unmounted blades are:

- Very delicate. There is a high risk of damage during handling.
- Blades require mounting hubs or adapters to hold them on the spindle.
- The heat transfer between the blade and the hub is less efficient.
- By using progressively smaller mounting adapters, blade life can be extended.

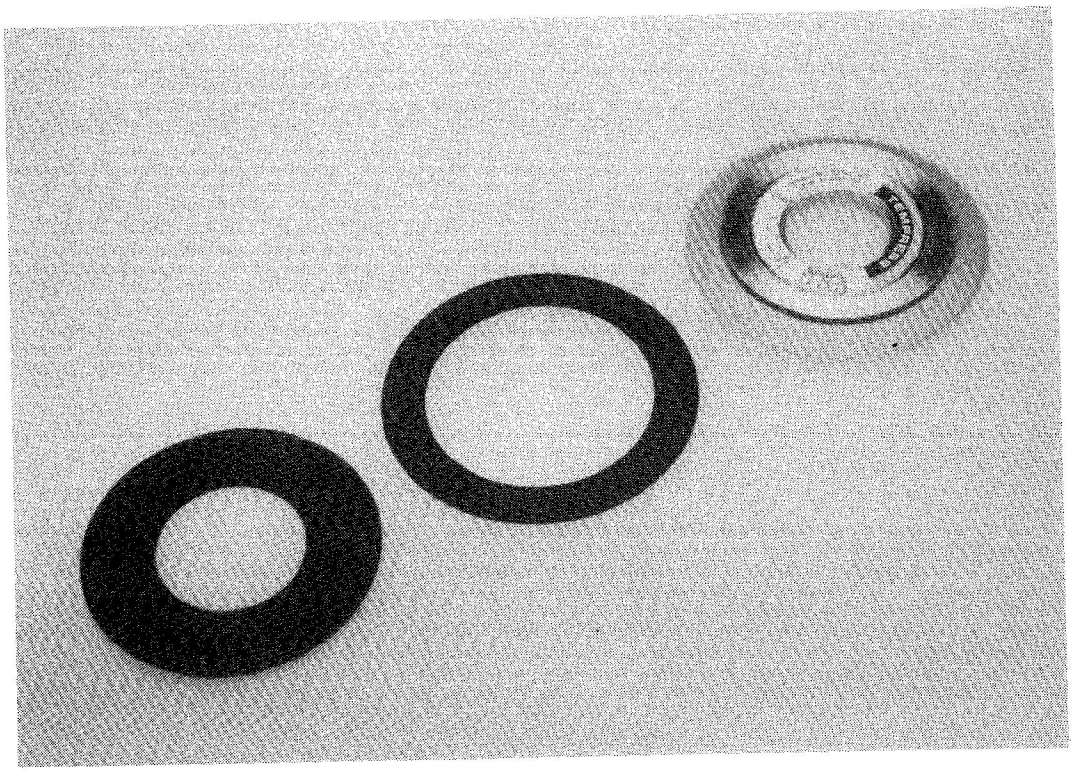


Figure 3-1: Blades

3.3 BLADE SELECTION

o Blade Thickness (Width)

The thinner the blade is, the narrower the kerf will be; but the wider the blade, the longer it will last. Choose the widest blade possible that will still give an acceptable kerf width. As a rule of thumb, kerf width will be about 1.3 times the blade thickness.

o Blade Exposure (Length)

Blade exposure determines the deepest cut that can be made with that blade. Ideally, about 80% of the blade should be in the cut. At this depth, the walls of the cut help support the blade and keep it straight, and there is not much loading on the blade. To find the ideal exposure, multiply the depth of the cut by 1.25.

o Cutting Speed

Production rate should be considered when selecting a wheel, and high cutting speed means high production. Figure 3-4 is a graph showing cutting speed versus depth of cut for a typical one mil thick blade.

o Aggregate (Grit) Size

The best grit size to use depends on the material being cut, the allowable kerf loss and chipping, and the speed and depth of cut. Table 3-1 gives recommended grit sizes for materials commonly cut. Larger grit tends to cut faster, and reduce loading of the blade. It is usually best to select the largest grit that can be used without excessive chipping.

Table 3-1: Recommended Diamond Grit Size

Particle Size (Microns)	Recommended for Cutting
2-5	Lithium Niobate
3	Gallium Arsenate
5-15	Silicon
30	Lithium Niobate, Barium Titanate, Ferrite, Glass
45	Quartz, Glass, Saphire, Garnet, Ruby, Ferrite
70	Quartz, Glass, Saphire, Ruby, Carbides

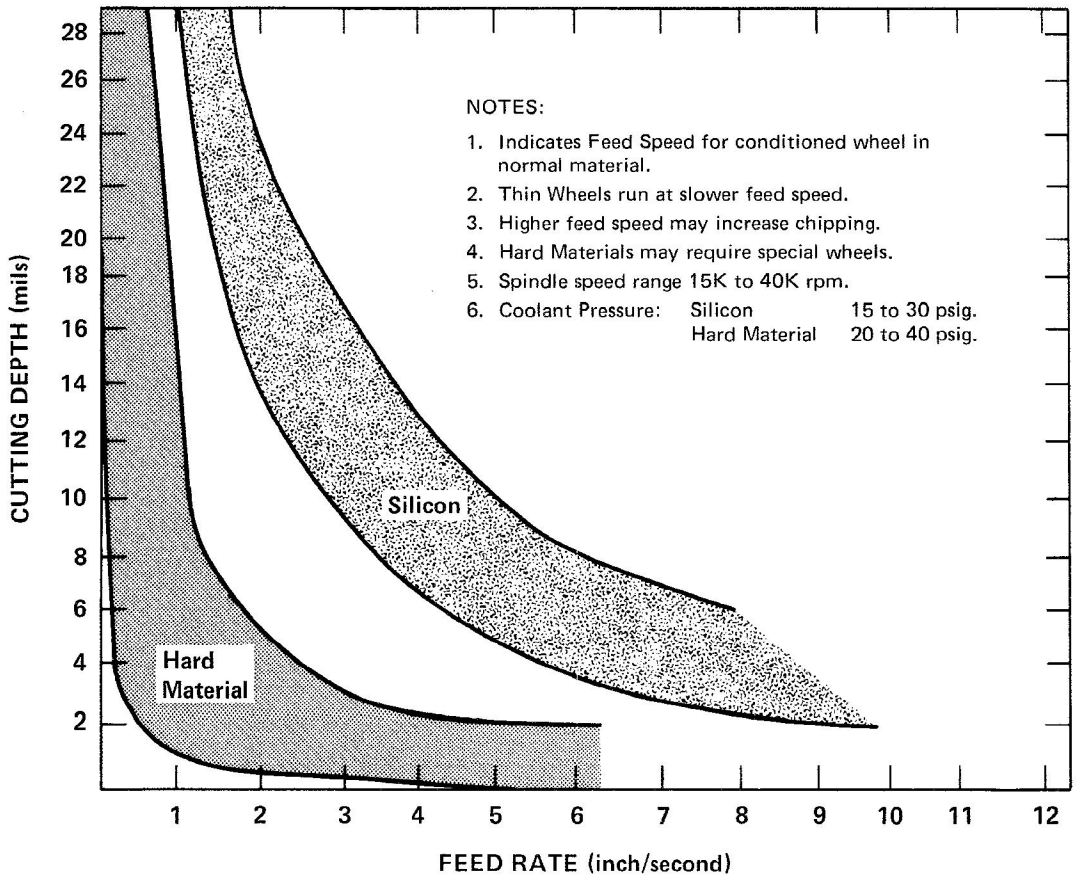


Figure 3-2: Depth of Cut vs. Speed

3.4 BLADE MOUNTING

This section describes how to mount hubless blades in adapters and how to remove them.

CAUTION

Never touch the cutting edge of a blade. Even the slightest touch can bend it. A bent blade results in excessive kerf and a shortened blade life.

The disassembly tool for 1 inch blade adapters is a Model RT25, Micro Automation part number 11007480.

1 inch ID Hubless Blades

Figure 3-3 shows a disassembled blade holder, a 1 inch ID (inside diameter) unmounted blade, and the disassembly tool for the adapter. Blade exposure is one-half the difference between the blade OD (outside diameter) and the OD of the adapter.

By choosing the proper adapter, the desired exposure can be determined. For information on adapter sizes call Micro Automation marketing division.

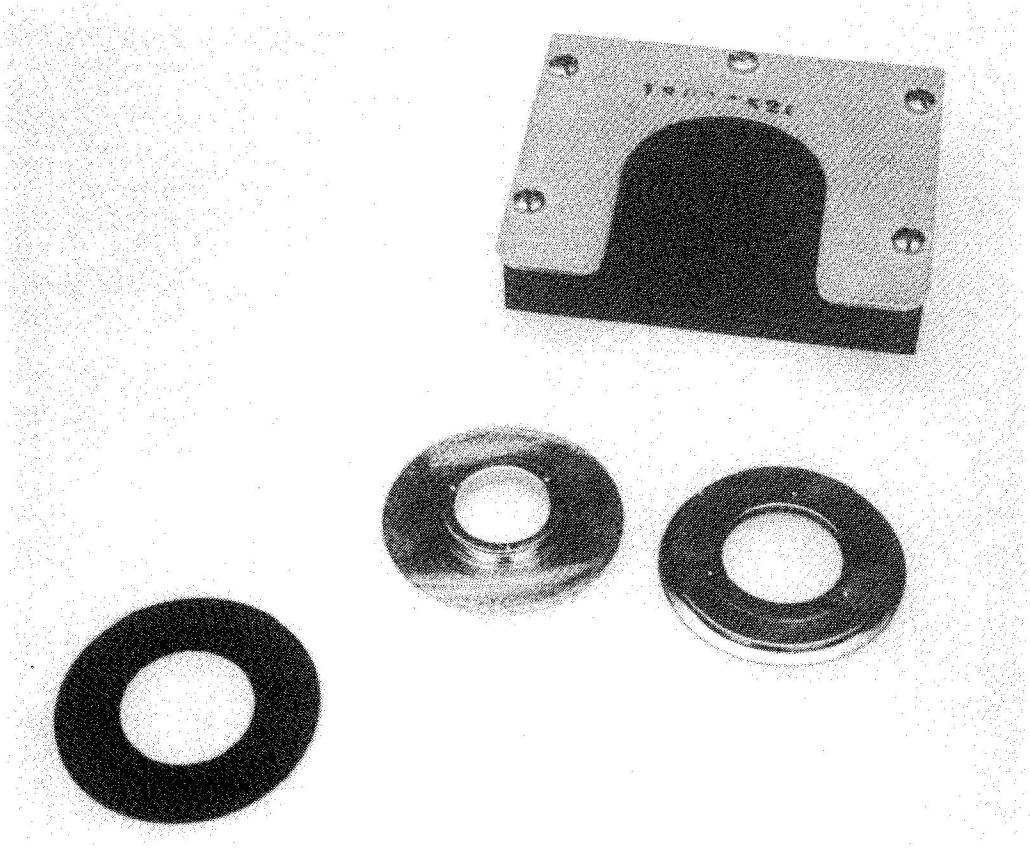


Figure 3-3: One-inch ID Blade with Adapter and Disassembly Tool

To mount the blade in the adapter, perform the following steps:

- Wipe the hub and the retainer clean with a cloth or tissue.
- Place the hub on a clean surface with the flat side down. (Refer to Figure 3-3.)
- Place the blade on the hub. Center it on the raised shoulder on the hub.
- Place the retainer over the hub. The large diameter should be facing down.
- Push down evenly on the retainer until it snaps into place.

To remove the blade from the adapter, perform the following steps:

- Place the blade and adapter in the disassembly tool. (Refer to Figure 3-4.)
- Push firmly and evenly on the inside hub. The retainer and blade will snap out of the hub and drop to the bottom of the tool.

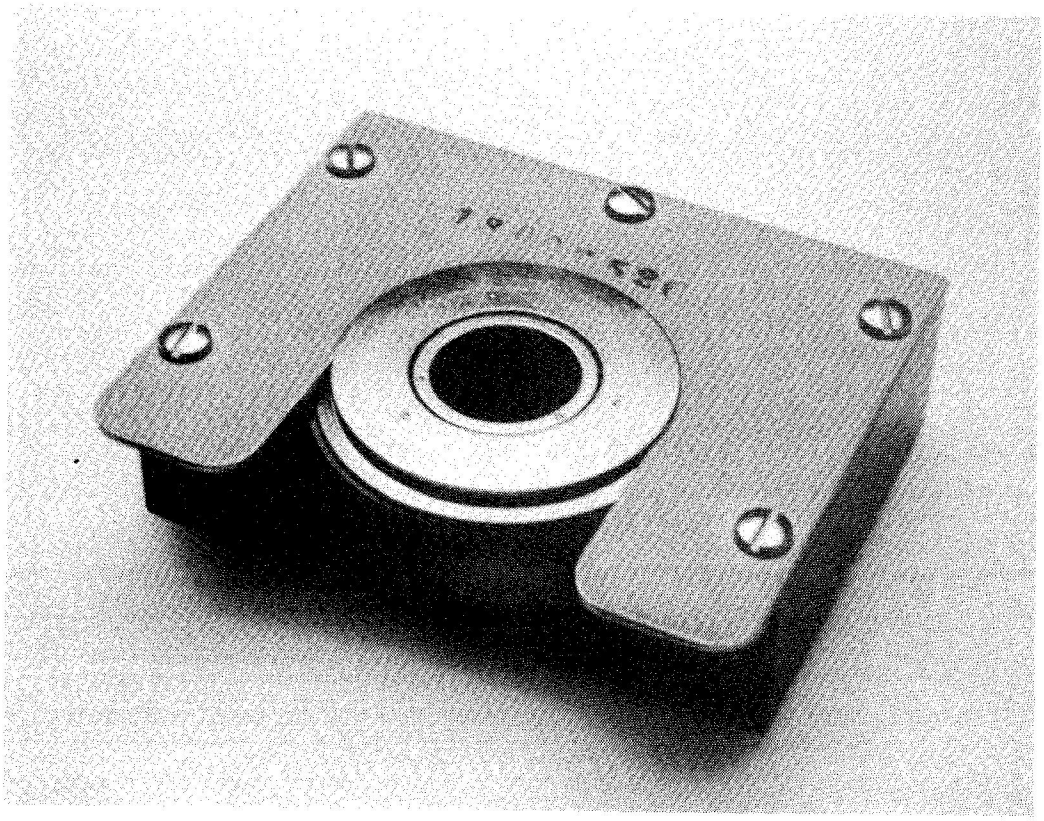


Figure 3-4: Blade and Adapter in Disassembly Tool

40-Millimeter ID Hubless Blades

Mounting 40-mm blades is similar to mounting one-inch blades. However, a different tool is needed for these blades. Figure 3-5 shows a disassembled adapter and blade, and the disassembly tool. The disassembly tool for 40-mm ID adapters is a Model RT40, Micro Automation part number 11007480.

For hub and adaptor size information call Micro Automation marketing division.

To mount the blade in the adapter, perform the following steps:

- Wipe hub and retainer clean with cloth or tissue.
- Place the hub on a clean, flat surface with the flat side down, as shown in Figure 3-5.
- Place the blade on the hub. Center it on the raised shoulder on the hub.
- Place the retainer over the hub with the largest diameter down.
- Push down evenly on the retainer until it snaps into place.

To remove the blade from the adapter, perform the following steps:

- The three pins on the disassembly tool fit into the three holes in the assembled adapter. Refer to Figure 3-6.
- With the base tool resting on a firm, flat surface, push the inside of the hub down. It will snap out of the retainer.

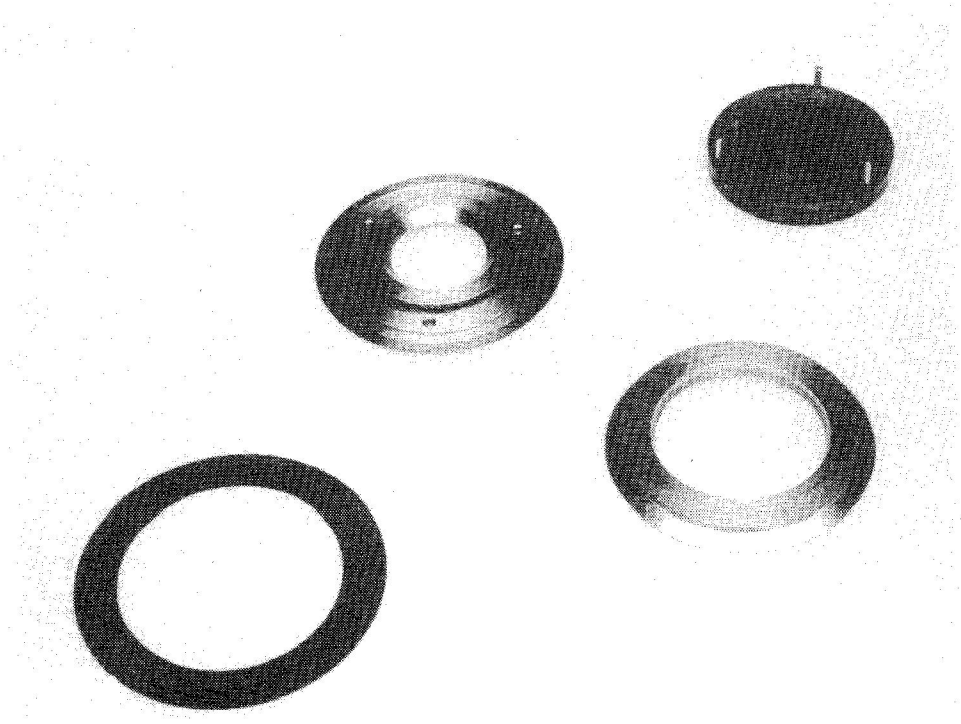


Figure 3-5: 40-mm ID Hubless Blade, with Adapter and Disassembly Tool

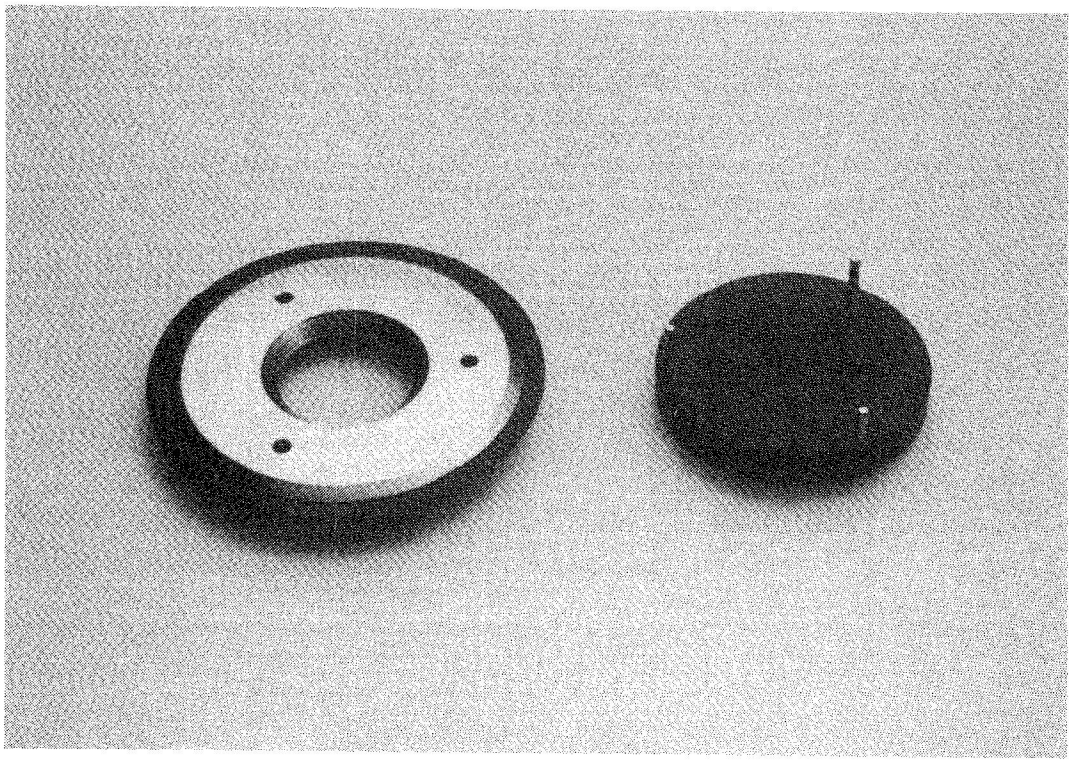


Figure 3-6: Blade in Adapter with Disassembly Tool

3.5 BLADE INSTALLATION

Two tools are provided with the saw to help install the blade on the spindle: the wheel-mounting chuck and the wheel-installation/removal tool.

The wheel-mounting chuck is an accessory which aids in wheel mounting and unmounting. It is attached to the saw via a vacuum tube at the front left side of the saw. The vacuum for the tool is turned on by a toggle key called BLADE TOOL, located below the ON/OFF switch on the control panel.

NOTE

The vacuum blade holder is free to move up and down on the blade centering shaft.

The wheel-installation/removal tool consists of a knurled spanner wrench and an Allen wrench.

The Allen wrench fits into an Allen screw in the end of the spindle to allow the spanner wrench to tighten the spindle nut.

Figure 3-7 shows the blade mounting chuck with a blade already picked up out of its plastic container.

CAUTION

Do NOT remove the plastic blade guard while the spindle is running.

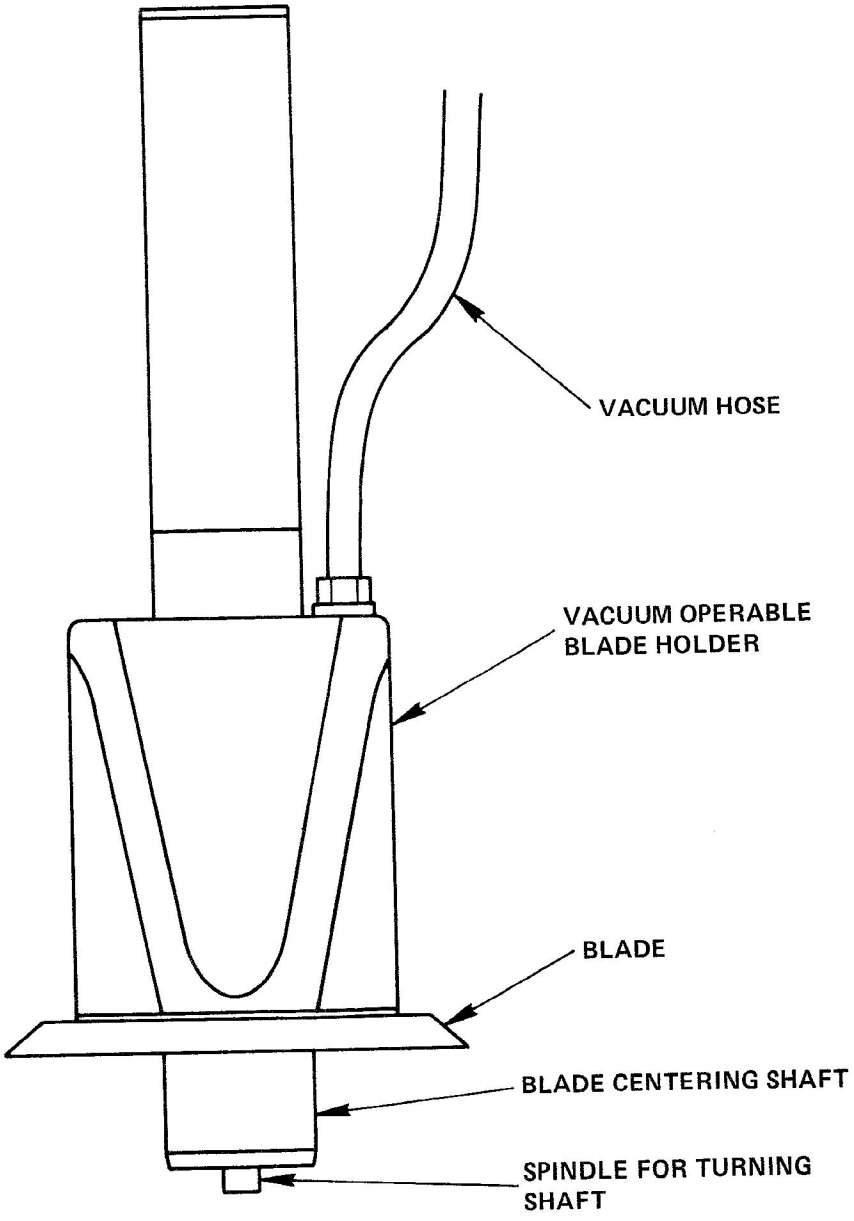


Figure 3-7: Blade-mounting Chuck with blade in position

To use the tool to install a mounted blade on the saw, follow the steps below:

- Remove blade housing.
- Wipe off spindle and spindle face with a clean cloth or tissue.
- Place the mounted blade in its plastic container on a flat surface.
- Pull the blade holder toward the knurled handle of the tool, exposing the centering shaft.
- Insert the centering shaft in the blade's hub while holding the vacuum holder back.
- Turn on the vacuum by pressing the BLADE TOOL key on the control panel.
- Gently lower the vacuum holder until it contacts the wheel. The vacuum will hold the wheel on the holder.
- Pull the vacuum holder back. This will lift the blade.
- Hold vacuum holder and blade at a 30° angle to prevent accidental dropping.
- With the vacuum holder and blade still retracted, insert the spindle centering shaft into the Allen screw hole in the front of the spindle.
- Push the vacuum holder and the blade all the way onto the spindle shaft until the blade is against the spindle face.
- Turn off the vacuum by pressing the BLADE TOOL key again.
- Carefully pull the vacuum holder back, leaving the blade in place.
- Remove the mounting tool from the spindle.
- Place the pressure washer and the nut on the spindle. The order of assembly of the blade, pressure washer, and nut are shown in Figure 3-8.

NOTE

The pressure washer must be placed so that the raised face contacts the blade. See Figure 3-9.

- Use the installation/removal tool to tighten the nut (Figure 3.10). Hold the Allen wrench handle to keep the spindle from turning while tightening the nut CCW with the spanner.
- Reinstall blade housing.

CAUTION

Spindle must NEVER be turned on without blade housing in place.

- The blade is removed by reversing the above procedure.

Sometimes the blade cannot be removed with the vacuum tool. When this happens, heat the blade slightly with a heat gun. This lossens the blade so that it can be removed easily.

The procedure for installing hubless blades with adapters is the same as described above, except that there is no plastic container. The adapters must go on the spindle with the hub part of the adapter contacting the spindle face.

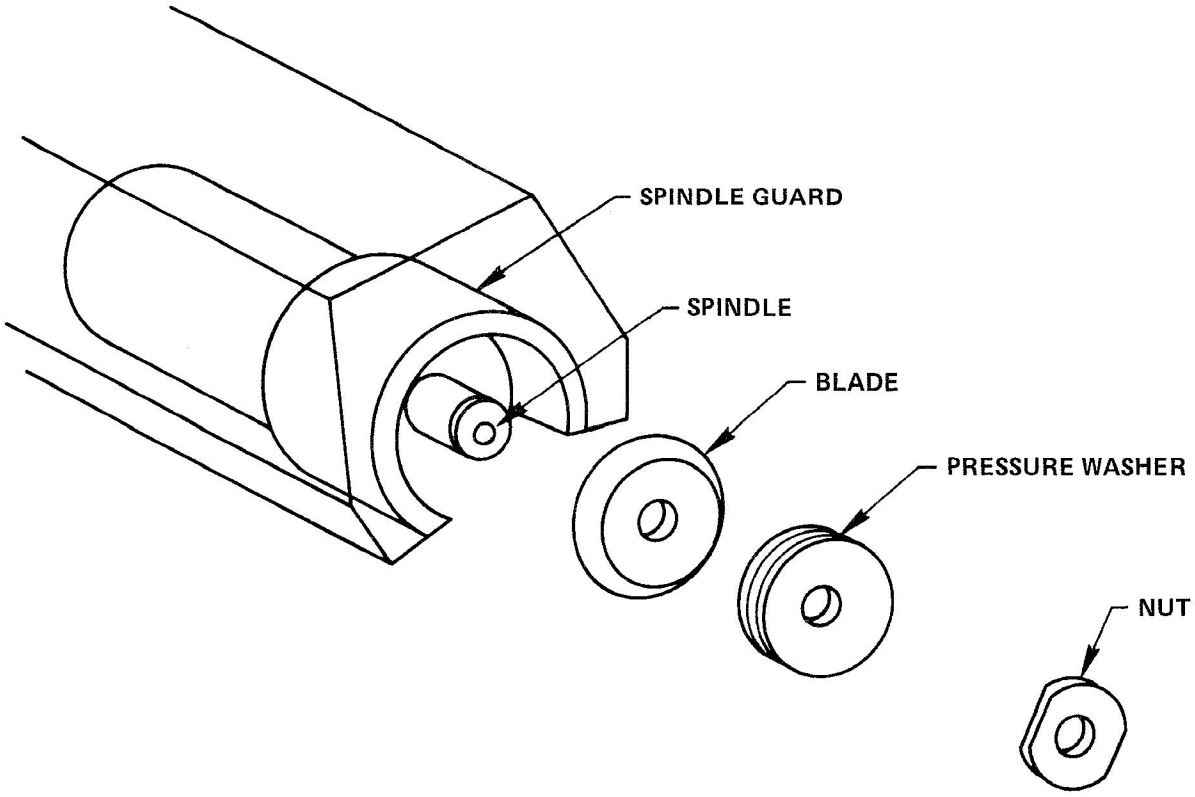


Figure 3-8: Assembly of Blade, Pressure Washer, and Nut.
(Front blade cover not shown)

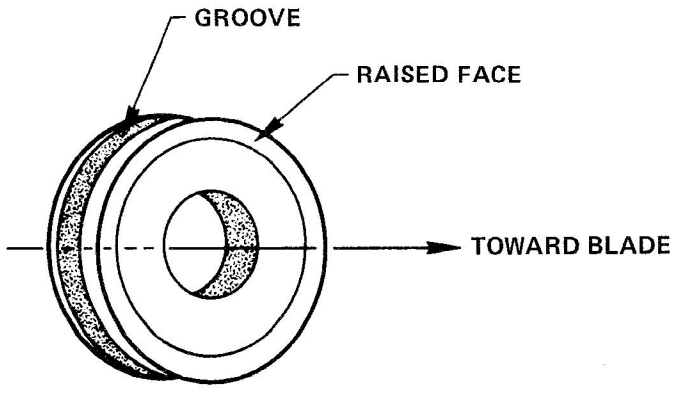


Figure 3-9: Pressure Washer

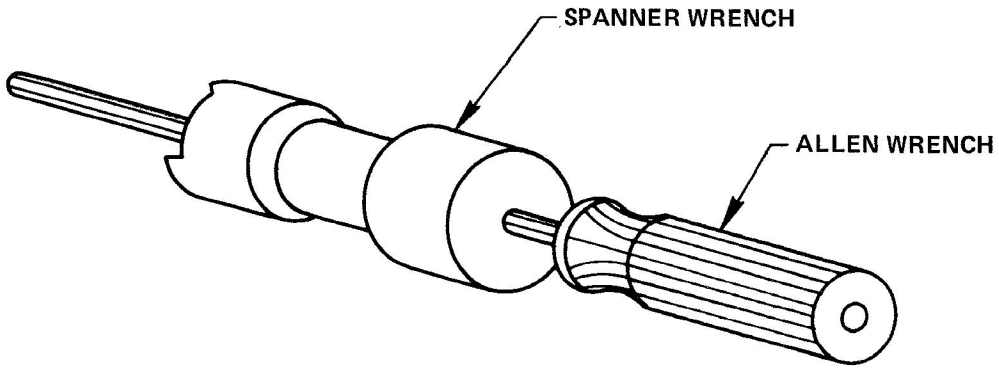


Figure 3-10: Installation/Removal Tool

SECTION 4

PROGRAMMING AND OPERATING

4.1 INTRODUCTION

Programming means entering a set of instructions and numbers into the saw memory, which is divided into working memory and storage memory. Working memory is the one being currently accessed and contains one program only. Storage memory contains all other programs, which can be copied into the working memory one at a time. Once the instructions are in the working memory, the saw will perform all the programmed steps automatically. This section gives the general rules for programming, explains the functions of each control, introduces fault and error codes, and explains the flow chart format used in the manual.

4.2 GENERAL RULES

The following statements apply to all programming operations:

- Once programming has been initiated, all program parameters must be completed. This means that a value must be entered into the memory for each saw parameter, if the value does not already reside in memory.
- A number other than zero must be entered for each parameter.
- Numbers are entered into the memory when the ENTER key is pressed.
- If a wrong number was selected by mistake, press CLEAR and enter the correct number.
- The saw can be programmed in any operating mode except AUTO CUT.
- When the PROG lamp is lit, the saw is in programming mode. The saw cannot be operated unless the PROG light is out.
- The numbers entered and displayed in the CUT INC, INDEX, DIM, HEIGHT, and THICKNESS modes are in mils (0.001 inch), or mm, depending on the ENG/MET switch selection.
- When the saw is started up, the program used in the last operation is in the working memory.

4.3 PROGRAMMING CONTROLS

The program panel is to the left of the spindle (Figure 4-1). There are four parts to this panel: the teach keys, the programming keys, the LED, alpha-numeric display, and the numeric keyboard with the ENTER key.

The teach key functions are explained later in this section.

Table 4-1 lists the keys of the programming panel and explains their functions. It also lists the largest and the smallest values the saw accepts for its parameters.

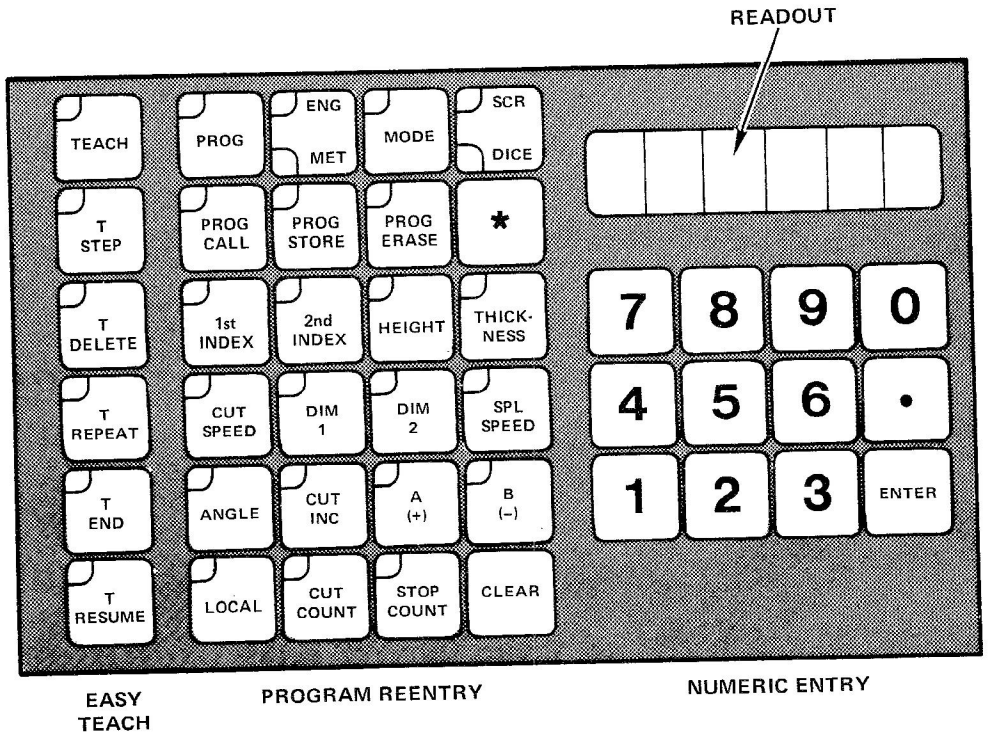


Figure 4-1: Program Panel

Table 4-1: Programming Controls and Functions

Name	Function/Explanation
PROG	This key sets the saw into, and takes it out of, the programming mode. This key acts as a toggle switch. Pressing the key lights the PROG lamp and sets the saw in the programming mode; pressing the key again takes it out of the programming mode and the lamp goes out. The saw cannot be operated while the PROG lamp is lit. In this mode the program in the working memory is displayed on the TV monitor. To program the saw, press PROG, enter each parameter by pressing the appropriate key, enter the values on the numerical keyboard, and press the ENTER key after each parameter. Continue until all parameters have a value.
ENG/MET	The saw can be programmed in either English or metric units. This key is also a toggle. The lamp on top of the key, when lit, indicates ENG mode; the bottom lamp indicates the MET mode. In ENG mode the numbers are set in mils (1 mil = 0.001 inches). In the MET mode, the units are millimeters, mm. One mm = 0.03937 inches.
MODE	This key selects the mode of cutting, which is determined by the type of wafer to be diced/scribed. Wafer refers to the shape of material to be sawn, which is round. Wafer also implies silicon, but could be ceramic or some other "hard material." To select a mode, press the MODE key, key in the mode number on the numeric keyboard, and then press the ENTER key. Cutting modes are listed below.

Mode No.	Description
10	Round wafers. Alignment required for each pass.
11	Round wafers. No alignment required for second pass. (Wafers without patterns prior to sawing.)
20	Round wafers, hexagonal die. Alignment required for each pass. (Triple alignment option; patterned wafers.)
21	Round wafers, hexagonal die. No alignment required for any pass. (Wafers without patterns prior to sawing.)

Table 4-1: Programming Controls and Functions (Continued)

Mode No.	Description
22	Round wafers, hexagonal die. No alignment required for passes one or two. Pass three alignment is made to an intersection of cuts one and two. (Wafers without patterns prior to sawing.)
30	Rectangular substrates. Alignment required for each pass. (Patterned wafers.)
31	Rectangular substrates. No alignment required for second pass. (Wafers without patterns prior to sawing.)
60	Same as mode no. 10 except for progressive depth cuts.
61	Same as mode no. 11 except for progressive depth cuts. (Blank wafers.)
70	Same as mode no. 30 except for progressive depth cuts.
71	Same as mode no. 31 except for progressive depth cuts. (Blank wafers.)
815	TV illumination intensity (lamp) adjustment mode.
816	Y axis linearity mode.
817	This mode displays the following sensor readouts: 60V, 10V, air pressure, and vacuum.
9XX	Test mode. Any two digit mode number when prefixed with 9 becomes a test mode with all the characteristics of the two digit mode except that the water is not turned on and the vacuum and water sensors are not checked. For example, 910 is test mode version of mode 10.

Table 4-1: Programming Controls and Functions (Continued)

Name	Function/Explanation
SCR/DICE	This key selects scribing or dicing operation modes. (Dicing and scribing operations are described in Section 1 of this manual).
PROG CALL	When PROG CALL key is pressed, the TV monitor and the LED display show the ID number of the program last recalled or stored. To enter a different program into the working memory, press PROG CALL, enter its ID number, and press the ENTER key.
PROG STORE	The PROG STORE key is used to transfer a program from the working memory into the storage memory. To store the program last created, press PROG STORE, assign a program ID number (1 through 999) to it by entering this number on the numeric keyboard, and press ENTER. This program can then be recalled into working memory at any time via the PROG CALL key.
PROG ERASE	Pressing the PROG ERASE key deletes a program. To delete a specific program, press PROG ERASE, enter the program's ID number, and press the ENTER key.
* (Asterisk)	To display program ID numbers, press PROG CALL, and then press the * key once for each subsequent program ID number. ID numbers are shown in ascending order.
1st INDEX	The 1st INDEX key allows the user to define the distance between cuts (Y axis movements) via the numeric keyboard. This is the street-to-street dimension for the first cut (pass 1). The smallest programmable index is 0.1 mil. The largest number that can be programmed is 4000 mils (4 inches). In metric operation this is 0.0032 mm to 101.6 mm. (Programmable in increments accurate to the third decimal place.)
2nd INDEX	The 2nd INDEX key sets the street-to-street dimensions for the second cut. It is also programmable from 0.1 mil to 4000 mils (0.0032 mm to 101.6 mm). (Increments accurate to the third decimal place.)

Table 4-1: Programming Controls and Functions (Continued)

Name	Function/Explanation
HEIGHT	The HEIGHT key allows the user to define the distance from the top of the chuck to the bottom of the cut. The smallest height that can be programmed is 0.1 mils; the largest is 1024 mils (0.0064 mm to 24 mm). (Increments accurate to the third decimal place.)
THICKNESS	This key defines the thickness of the material to be sawn, that is, the distance from the chuck surface to upper surface of material to be sawn. Thickness is programmable from 0.1 mil to 1024 mils (0.0025 mm to 24 mm). NOTE: When sawing material mounted on film or host wafers, thickness is the material thickness plus the film or host thickness. Typical film thickness is 3 mils. (Increments accurate to the third decimal place.)
CUT SPEED	The CUT SPEED key sets the speed of X axis travel, which is the wafer cutting speed. CUT SPEED is programmable from 5 mils per second to 19.999 inches per second (1.27 mm/sec to 508 mm/sec).
DIM 1	DIM 1 defines the wafer diameter. It is programmable from 0.1 mil to 6000 mils (0.0025 mm to 152 mm). In rectangular substrate cutting DIM 1 is used to program the dimension of the wafer width for pass 1. (Increments accurate to the third decimal place.)
DIM 2	DIM 2 is used in rectangular wafer cutting to program the dimension of the wafer length for pass 2. It is programmable from 0.1 mil to 6000 mils (0.0025 mm to 152 mm). (Increments accurate to the third decimal place.)
SPL SPEED	The SPL SPEED key is used to program the speed of rotation of the saw spindle. The spindle speed is programmable from 15,000 to 40,000 rpm, in 100 rpm increments.
ANGLE	This key defines the angle the chuck will turn (Theta axis) between passes. The angle can be set between 1° and 121°, except when in "Hex" cutting mode. In the "Hex" cutting mode the largest number that can be entered is 60.1°.
CUT INC	This key defines the incremental depth for progressive cutting of materials. It can be programmed from 0.1 mil to 1000 mils (0.0025 mm to 25.4 mm). (Increments accurate to the third decimal place.)

Table 4-1: Programming Controls and Functions (Continued)

Name	Function/Explanation
A (+)	This key is used in the teach mode.
B (-)	This key is used in the teach mode.
LOCAL	The LOCAL key selects the point of control of the saw. When the LOCAL key lamp is lit, the saw is controlled from its control panel. To transfer control of the saw to external control, as is the case when the saw is one module of a wafer dicing system, press the LOCAL key to turn off its indicator lamp. This key is also a toggle.
CUT COUNT	The CUT COUNT key is used to count the number of cuts made with a blade. It can be initialized from zero to 999,999. When a new blade is installed cut count is usually initialized at zero.
STOP COUNT	The STOP COUNT key is used to enter the number of cuts after which the saw will automatically stop. It is programmable from 1 to 999 cuts. When the saw is turned on, STOP COUNT is automatically set to 999.
CLEAR	Pressing CLEAR deletes the numbers from the alpha-numeric display during programming, and clears the display of error and fault codes.
0(zero) to 9	Number keys for entering numbers into the numeric keyboard during programming.
. (decimal point)	Used to set fractional numbers during programming.
ENTER	The ENTER key transfers program data such as numbers from the numeric keyboard into the working memory.

4.4 OPERATING CONTROLS

The operating controls are located on the Control Panel, to the right of the spindle (Figure 4-2). The main ON/OFF power switch is the red push-button/knob at the top right corner of the Control Panel. It controls the power to all elements of the saw.

To turn the saw on, rotate the ON/OFF knob clockwise until a "clicking" sound is heard. To turn off the saw, press down on the ON/OFF switch.

Table 4-2 lists the operating control keys and their functions.

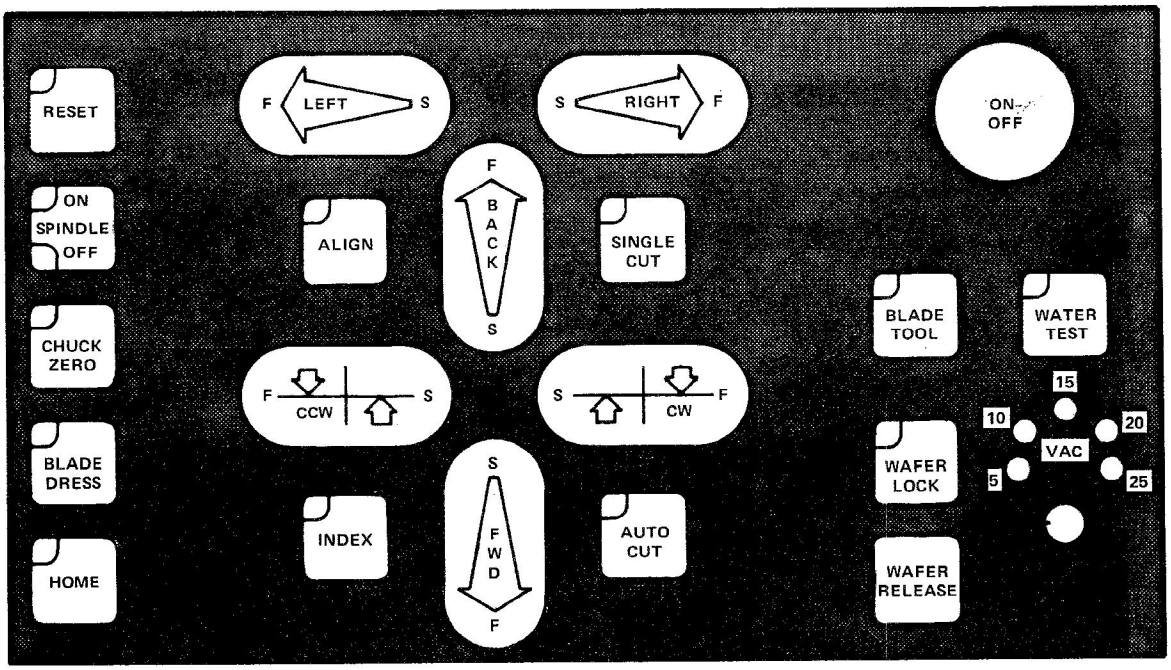


Figure 4-2: Control Panel

Table 4-2: Operating Controls and Functions

Name	Function/Explanation
RESET	Pressing RESET immediately sends all axes to the home position. After pressing RESET the chuck zero is lost. The indicator lamp on the RESET key blinks until all home positions are reached, then stays lit.
SPINDLE ON/OFF	SPINDLE ON/OFF is a toggle switch. NOTE: The spindle cannot be turned on when the PROG key lamp is lit.
CHUCK ZERO	Pressing the CHUCK ZERO key initiates an automatic chuck zero sequence: the chuck is moved under the dicing blade on the spindle; it is raised until the chuck zero circuit detects "contact" and chuck zero is established; it is lowered to the programmed height, then returns home. The indicator lamp of the CHUCK ZERO key blinks during this process, then stays lit when the chuck zero sequence is completed.
BLADE DRESS	This key initiates a built-in automatic blade dress routine. Refer to flow chart 6 for a detailed description.
HOME	When the HOME key is pressed, all axes except the Z axis return to the home position. The spindle, if turned on, stays on.
ALIGN	Pressing ALIGN moves the chuck into position under the optics and enables the Street and Theta Keys. If ALIGN is pressed while the saw is cutting, the saw finishes the cut, stops cutting, and returns to the ALIGN position.
INDEX	Pressing INDEX also moves the chuck under the optics and enables the Street and Theta keys. If INDEX is pressed while the saw is cutting, the saw will finish the cut, then position the last cut under the optics.
SINGLE CUT	The SINGLE CUT key is enabled only in the ALIGN or INDEX mode. When this key is pressed, the saw will make one cut and position that cut under the optics.

Table 4-2: Operating Controls and Functions (Continued)

Name	Function/Explanation
AUTO CUT	The AUTO CUT key starts the programmed automatic cutting sequence. If this key is pressed while the saw is in the INDEX mode, the saw will make a cut one street back from its last cut. If the key is pressed while the saw is in the ALIGN mode, the saw will start to cut at the front of the wafer (close to the operator).
BLADE TOOL	This key provides vacuum to the blade installation tool. This key is a toggle.
WATER TEST	This key is used to test the presence of the blade cooling water.
WAFER LOCK	Pressing the WAFER LOCK key applies vacuum to the chuck to hold down the material being cut. This key is only operational after chuck zero has been performed.
WAFER RELEASE	Pressing the WAFER RELEASE key fills the vacuum lines of the chuck with air to release the wafer.

Table 4-2: Operating Controls and Functions (Continued)

Name	Function/Explanation

The following group of controls is called the "Planar Joystick." Alignment of the material mounted on the chuck to the saw blade is accomplished with the Planar Joystick alignment controls. Each axis (X, Y, and Theta) is manually moved via a continuous seven segment switch. This allows the operator to control the speed of axis motion by pressing on the appropriate location along the length of the "slide switch." The broad end of each direciton arrow provides (F) fast motion, and the narrow end provides (S) slow motion. The saw must be in INDEX or ALIGN mode to operate the Planar Joystick controls.

(Chuck) LEFT	When LEFT is pressed, the X axis moves to the left.
(Chuck) RIGHT	When RIGHT is pressed, the X axis moves to the right.
(Blade) BACK	When BACK is pressed, the spindle moves toward the back of the saw (away from the operator). In the ALIGN mode, the spindle moves as long as BACK is pressed. In the INDEX mode, the spindle moves in steps, the distance programmed as 1st or 2nd index.
(Blade) FWD	When FWD is pressed, the spindle moves forward (toward the operator). In the ALIGN mode the spindle moves as long as FWD is pressed. In the INDEX mode, the spindle moves in steps, the distance programmed as 1st or 2nd index.
(Theta) CCW	When CCW is pressed, the chuck rotates counterclockwise. In the ALIGN mode the chuck turns as long as the key is pressed. In the INDEX mode the chuck turns through the programmed angle.
(Theta) CW	When CW is pressed, the chuck rotates clockwise. In the ALIGN mode the chuck turns as long as the key is pressed. In the INDEX mode the chuck turns through the programmed angle.

In addition, the Vacuum Gauge and the Wafer Lift-off Controls are located to the right of the WAFER RELEASE key.

The Vacuum Gauge indicates inches of mercury in five-inch increments, from 5 through 25 inches.

The Wafer Lift-off Control adjusts the amount of air pressure introduced into the vacuum line of the wafer to facilitate removal of the material being sawn. Turning this control clockwise increases the air pressure, which increases the rate of lift-off.

4.5 ERROR AND FAULT CODES

Error codes and fault codes are displayed in the apha-numeric panel whenever the self-checking circuits of the saw detect a malfunction or mistake in programming. They are also displayed on the CRT with a brief explanation of the problem. In addition, fault and error codes are listed in the Appendix of the manual. Error codes that may occur during programming are explained with the instructions.

4.5.1 Error Codes

Error codes are usually an indication that an incorrect operation was performed, such as trying to insert a parameter out of range or omitting some required operation.

Error codes are displayed as an "E" followed by three digits. They may also be displayed as a warning. Error codes are usually correctable by the operator.

They are cleared by pressing CLEAR, and then correcting the programming or operation error.

Error code E002 can occur at any time during programming. It is described here to prevent its repetition in each programming instruction, and applies to all flowcharts.

E002 means that an attempt was made to operate the saw in a improper manner (that is, the key just pressed doesn't make sense to the saw logic). The usual cause for this error code is an attempt to operate the saw while in PROG mode.

If the indicator lamp on the PROG key is lit, make sure all programming is completed; then press the PROG key to turn off the indicator lamp.

4.5.2 Fault Codes

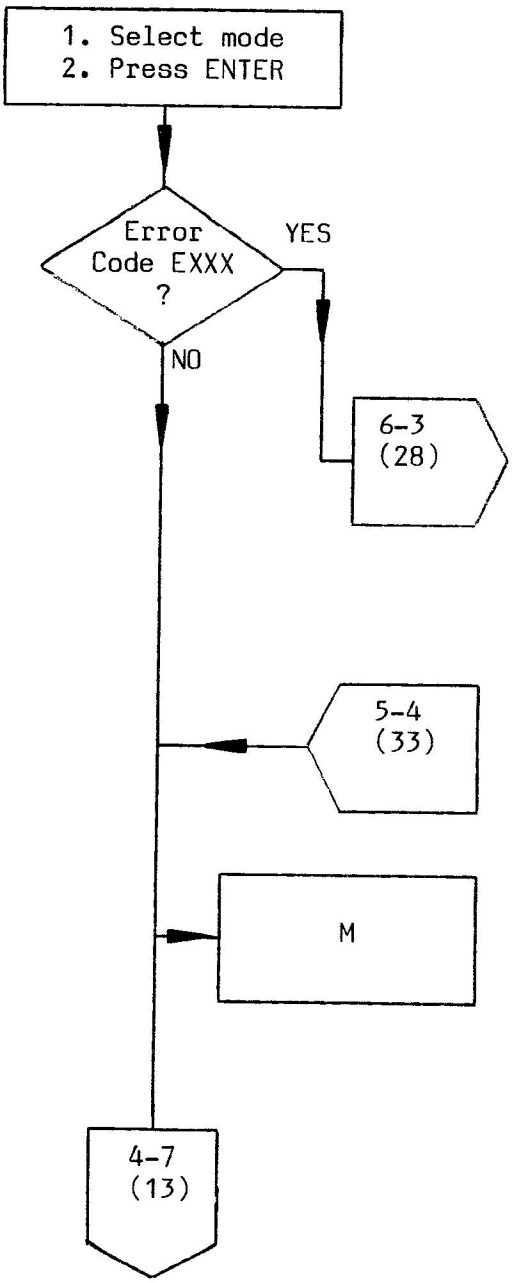
Fault Codes are displayed as an "F" followed by three digits. They indicate a mechanical or electrical malfunction. When a fault code is displayed a maintenance technician should be called.

4.6 OPERATING INSTRUCTIONS

The rest of this section consists of instructions for performing specific dicing or scribing operations. Most of the instructions are given in flow chart form. "FC" is used as an abbreviation for flow chart.

To use a flow chart, start at the top of the first page and follow the arrows to the end. The shape of the blocks used in the charts indicate the actions to be taken. The Flowchart Example on the following page shows the functions of each block.

Flowchart Example



A rectangle gives directions for actions to be performed.

The diamond shaped box contains questions, and the answers to these questions give directions to the proper path to follow.

This is called a connector. It directs the operator from one part of the flow chart to another, or from one flow chart to another flow chart. This example means: go to incomming connector, FC 6-3, on page 4-28.

This is an incomming connector. Enter here from connector on FC 5-4, page 4-33.

A rectangle with a capital "M" means that a maintenance technician should be called.

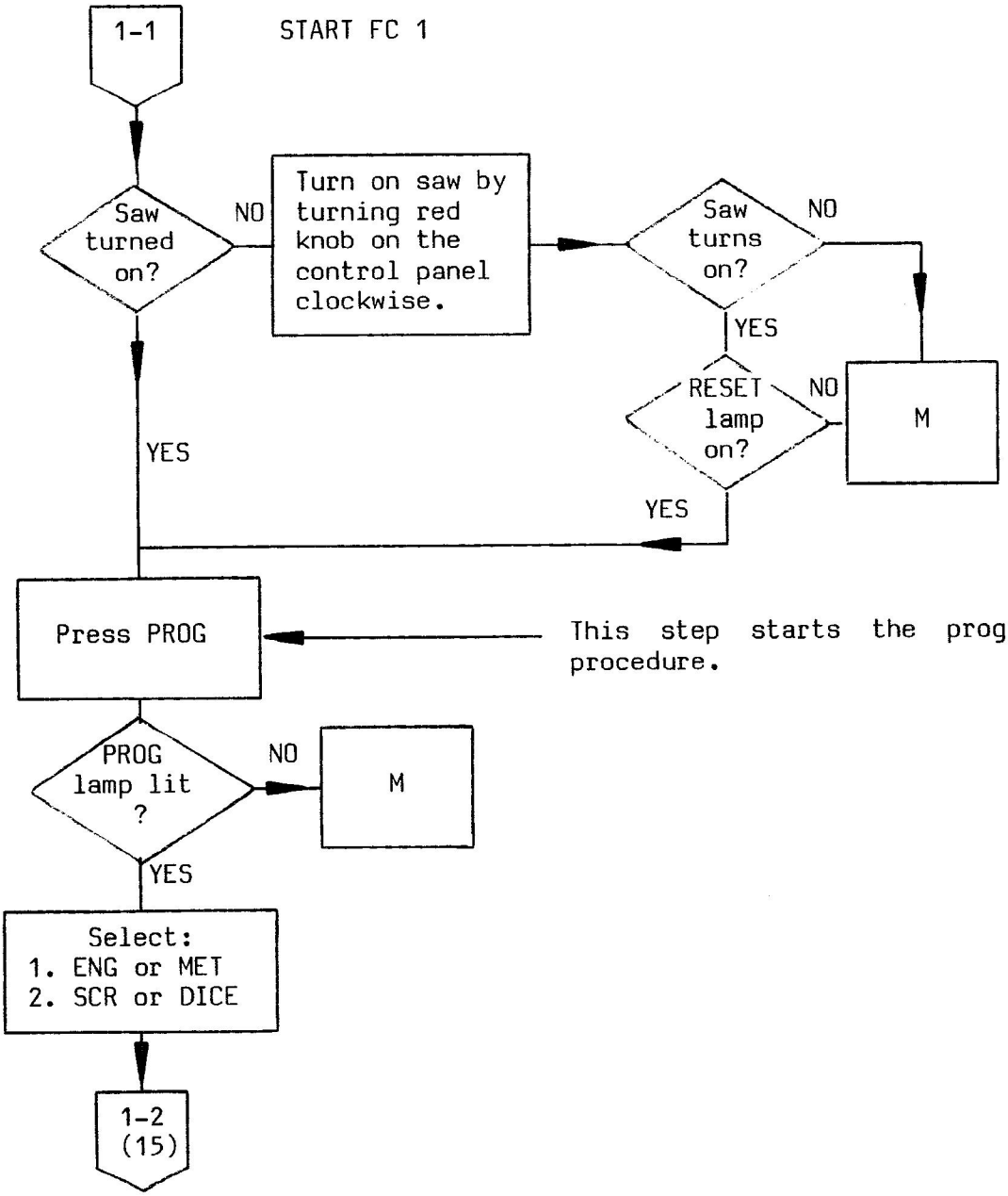
Go to FC 4, connector 7, on page 4-13.

4.6.1 Flow Chart 1.
Turn-on and Basic Programming.

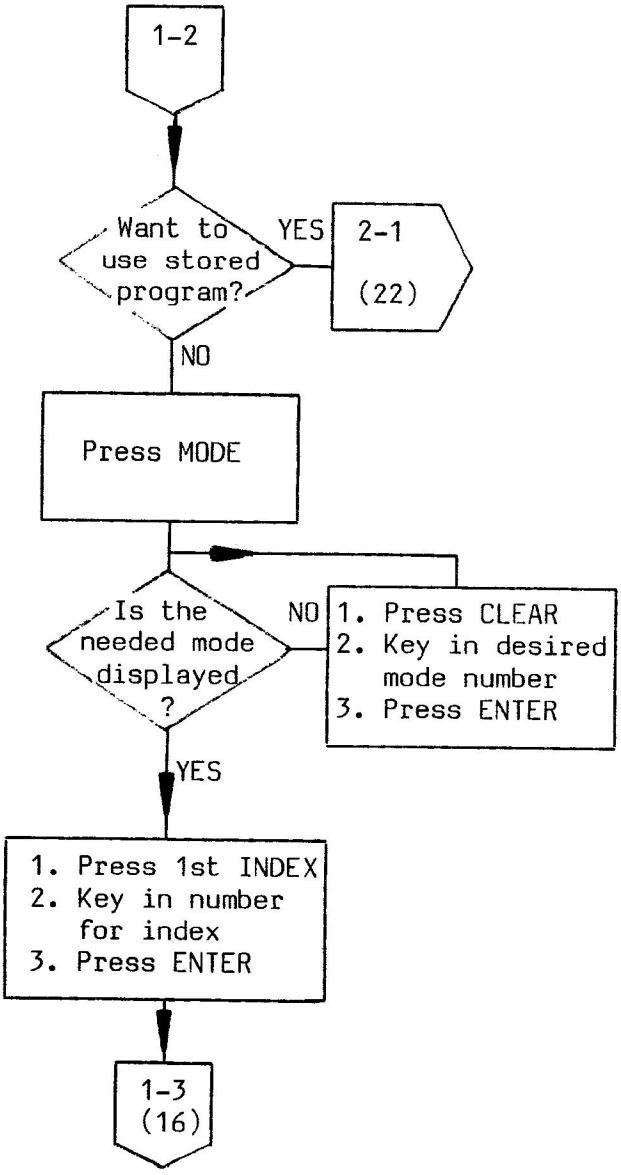
This flow chart shows how to turn on the saw, enter a program into the saw's working memory, and perform a chuck zero operation. All the programming operations, along with the values entered are displayed on the TV monitor.

When all the operations in this flow chart are completed, the saw is ready for blade dressing, optical system alignment, or production sawing.

This flow chart also refers the user to other flow charts or instructions for specific tasks.



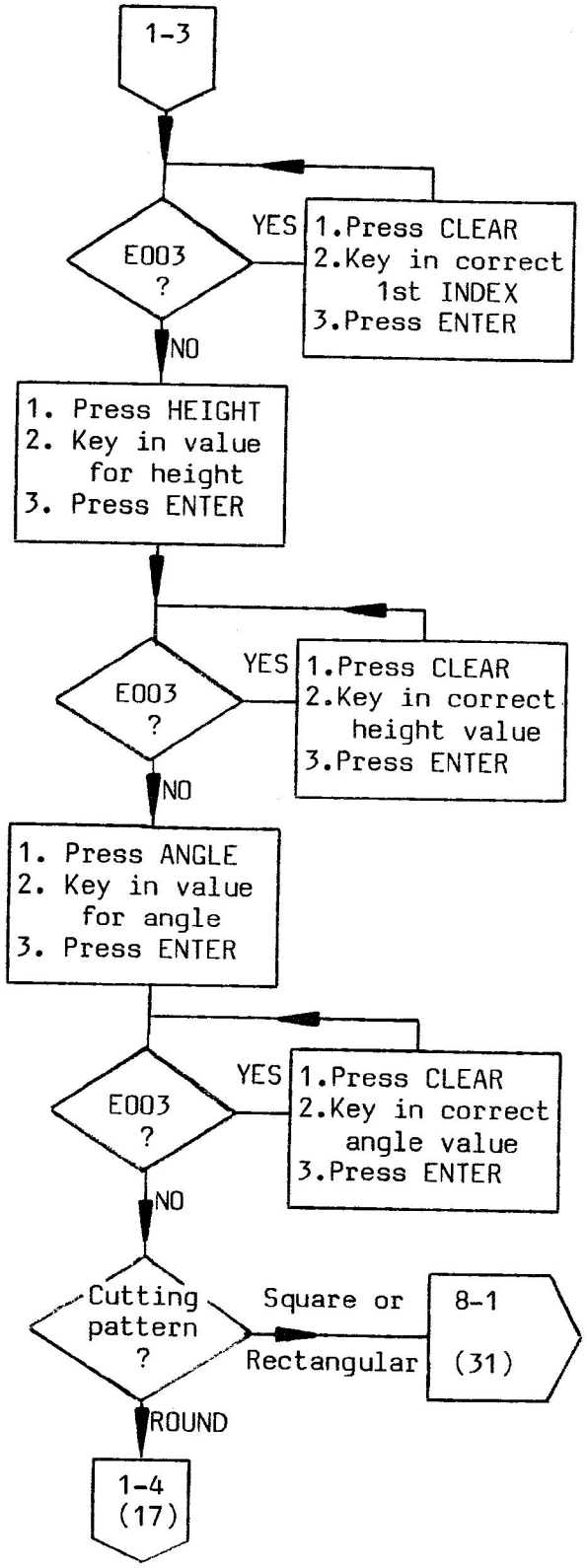
FC 1 - Continued



Frequently used programs may be transfered to and reside in storage memory for future use. FC 2 shows how previously stored programs are put into the working memory.

First INDEX is the Y axis distance between streets for the first pass.

FC 1 - Continued



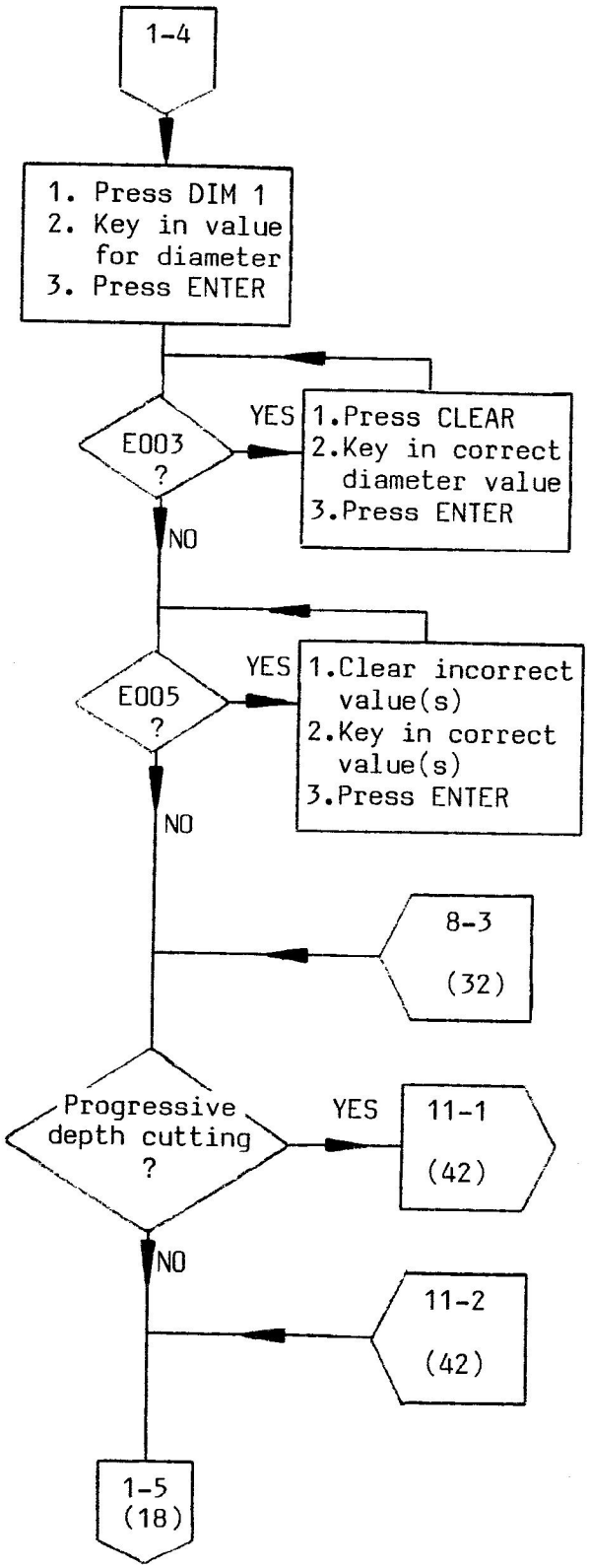
E003: value entered is outside the limits allowed for that parameter. Index must be between 0.1 and 4000 mils (0.003 and 101.6 mm).

Height = Thickness - depth of cut. (Amount of material that will be left after cutting.)

E003: value out of acceptable range. Must be between 0.1 and 1024 mils (0.006 - 13 mm).

E003: number out of range. Angle must be between 1° and 121° for all modes other than hex. In hex mode, angle must be between 1° and 60.5°.

FC 1 - Continued



DIM 1 is the diameter of round wafers, or dimension of rectangular substrates.

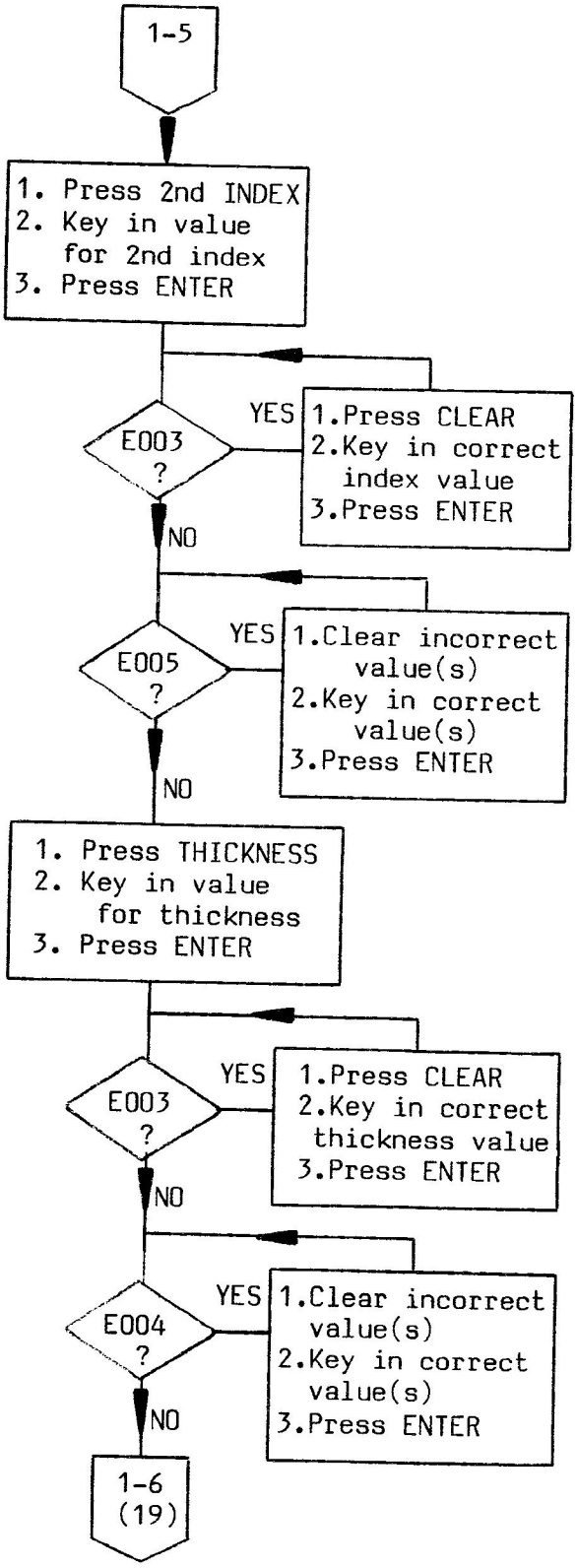
E003: value out of range. Wafer diameter must be between 0.1 and 6000 mils (0.006 and 152 mm).

E005: the value that was inserted for the 1st index, in a previous step, is too large for the wafer diameter just entered.

Reenter this flow chart here after programming for rectangular substrates.

Reenter this flow chart here after programming for progressive depth cutting.

FC 1 - Continued



E003: value out of range. 2nd index must be between 0.1 and 4000 mils (0.003 and 102 mm).

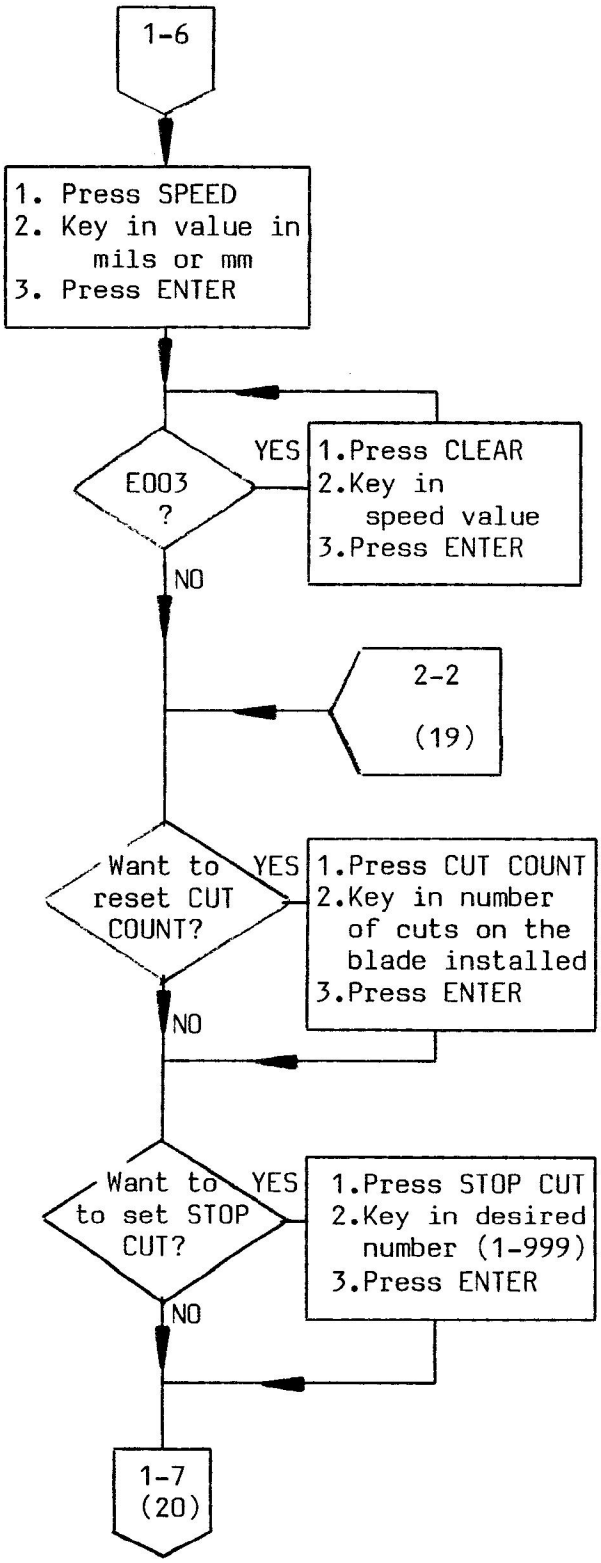
E005: the value inserted for the 2nd index is too large for the wafer diameter, or length of the rectangular wafer.

Thickness value must include thickness of film or host wafer plus wafer thickness.

E003: value out of range. Thickness value must be between 0.1 and 1024 mils (0.006 and 13 mm).

E004: the value inserted for thickness is less than the value inserted for height.

FC 1 - Continued



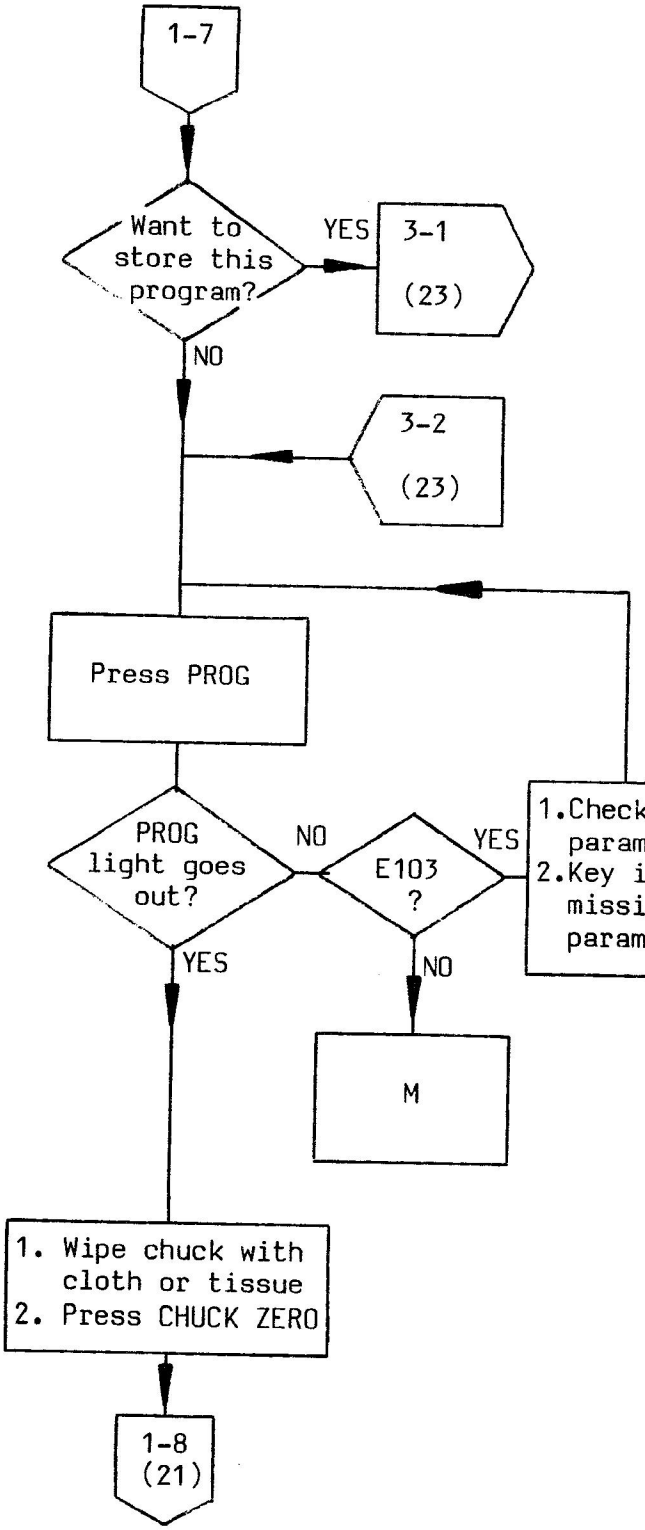
E003: value out of range. Speed must be between 5 and 19,999 mils per second (1.27 and 508 mm per second).

This is the point to reenter this flow chart when a stored program is used.

Cut count is usually set at zero when a new blade is installed. When a used blade is installed, cut count can be set to pick up the previous count. CUT COUNT can be set from zero to 999,999.

STOP CUT can be set to stop the saw after the programmed number of cuts have been made. STOP CUT is automatically reset each time AUTO CUT is pressed. When the saw is turned off, STOP CUT goes to 999.

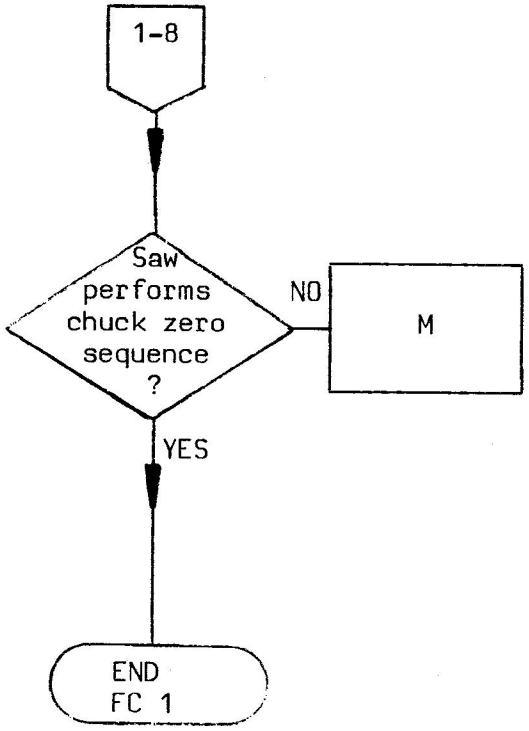
FC 1 - Continued



Performing steps of FC 3 will store the parameters just entered. This program can can be recalled when needed.

At this point a complete cutting program has been put into the saw working file.

E103: an attempt was made to operate the saw with one or more parameters missing When cutting rectangular substrates, also check DIM 2.



Chuck zero sequence:

1. Chuck lowers
2. Chuck moves to position under blade
3. Chuck rises until the chuck zero circuit detects the blade
4. Chuck lowers
5. Chuck moves left
6. Chuck raises
7. CHUCK ZERO lamp comes on.

When the steps in this FC are completed, the saw is ready for sawing.

NOTE:

Before production cutting starts, it may be necessary to dress the blade or to align the optical system. See the Flow Charts listed below for these procedures.

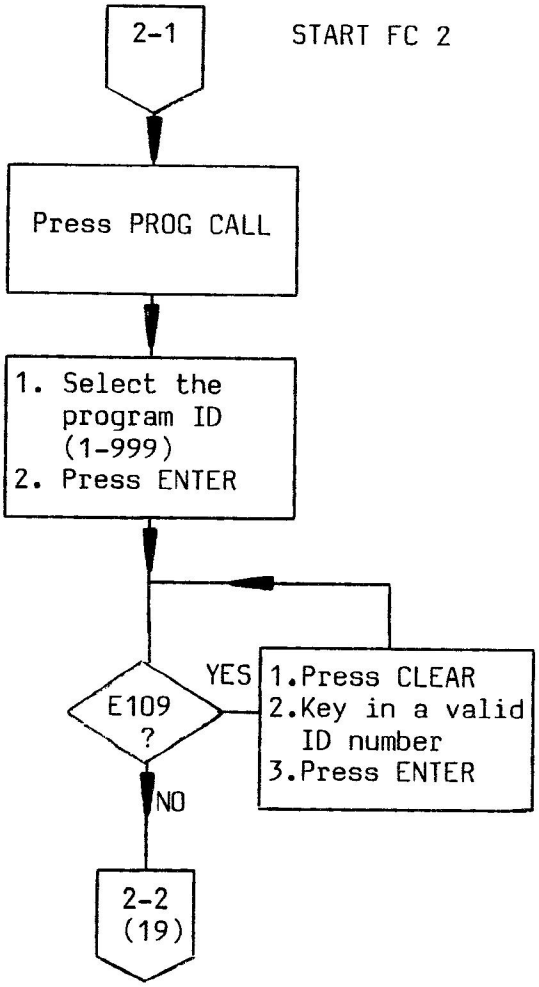
Blade dressing: FC 6 (p.4-26).

Optics Alignment: FC 7 (p.4-29).

4.6.2 Flow Chart 2. Loading a Stored Program into the working File.

If there are programs stored in the saw's storage memory, one of these programs can be transfered to the working memory by following FC 2, below.

Using pre-stored programs is faster than reprogramming step-by-step, and eliminates operator errors.



Enter this Flow Chart from FC 1.

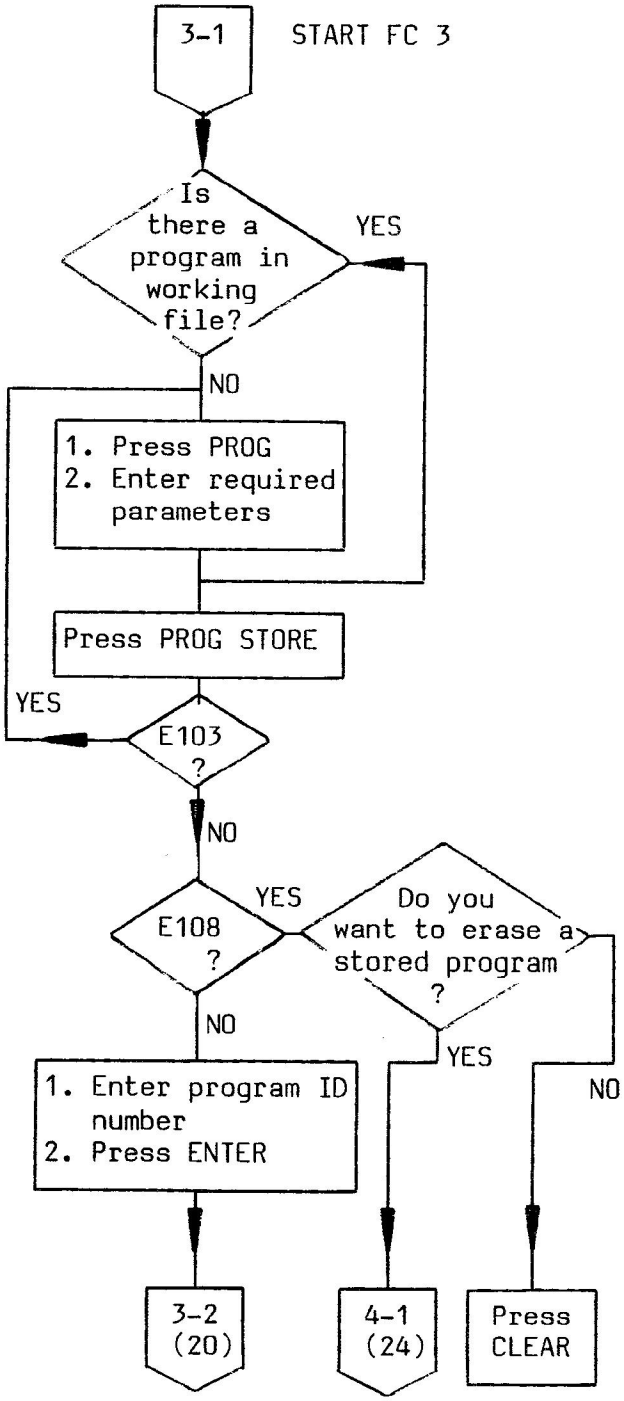
Programs are stored under program ID numbers from 1 to 999.

E109: there is no program stored under the number just used.

Program has been transfered from storage memory to the working memory. Reenter FC 1.

4.6.3 Flow Chart 3. Storing a Program for Future Use.

Following this flow chart transfers a program from the working memory into storage memory for future use.



This FC may be entered from FC 1, or may be used on its own.

To enter the desired cutting parameters, see FC 1, pages 4-13 to 4-20.

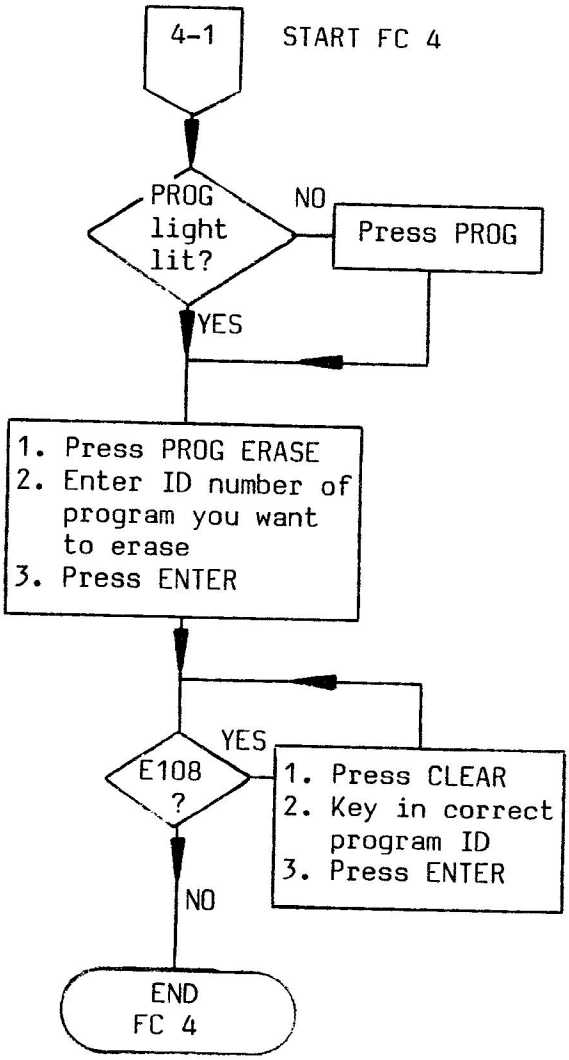
E103: missing parameter(s). Go back and insert any missing parameters.

E108: all memory slots are filled. To store this program, a program already stored must be erased. Go to FC 4, page 4-24, if you want to erase a stored program.

Any number from 1 to 999 can be assigned to this program as a program ID, as long as that number has not already been used for another program. To find out which numbers have already been used, go to FC 5, page 4-25.

Pressing CLEAR aborts this sequence without changing the working file.

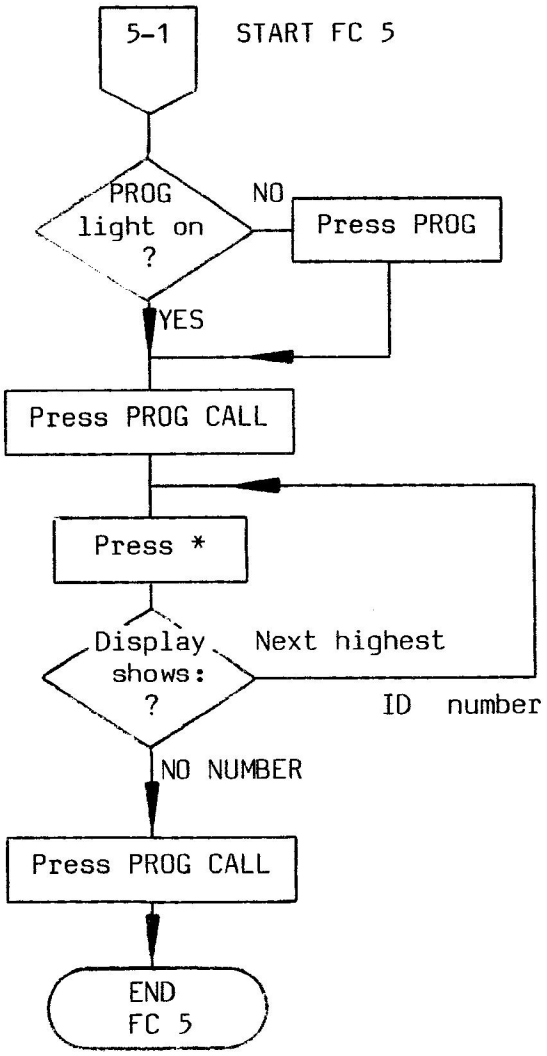
4.6.4 Flow Chart 4. Erasing a Stored Program from Storage Memory.



E108: there is no program stored under the program ID entered.

The program stored under the ID number selected has now been erased.

4.6.5 Flow Chart 5. Displaying Stored Programs.



Display shows program ID in working file. CRT also shows parameters of this program.

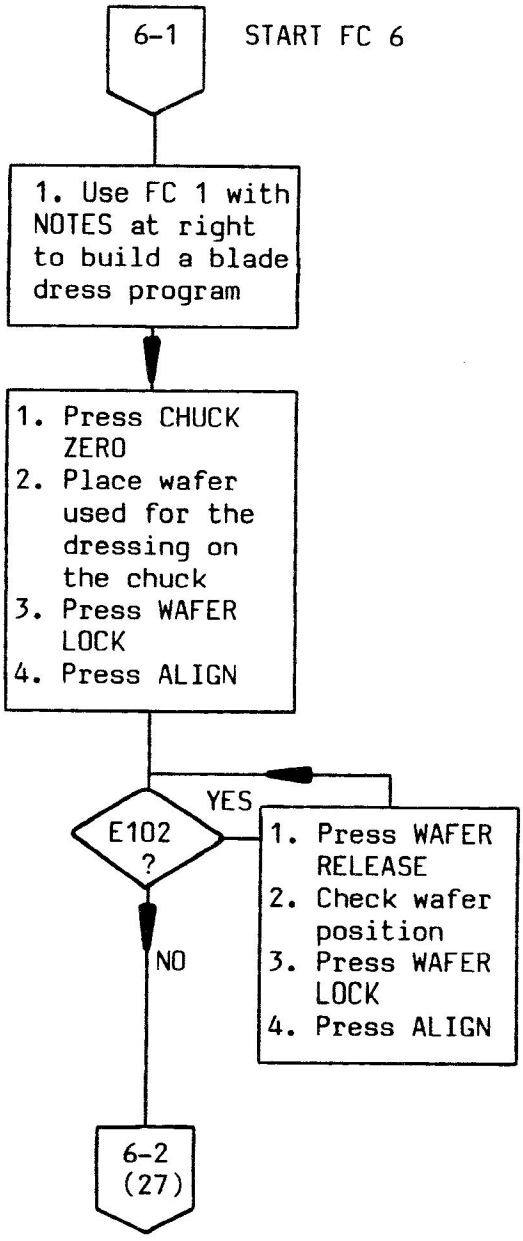
After all program ID numbers have been displayed, the display starts from the beginning.

4.6.6 Flow Chart 6. Automatic Blade Dressing in Silicon.

The saw has a built-in blade dressing program. This program is to be used for dressing blades in silicon only.

CAUTION

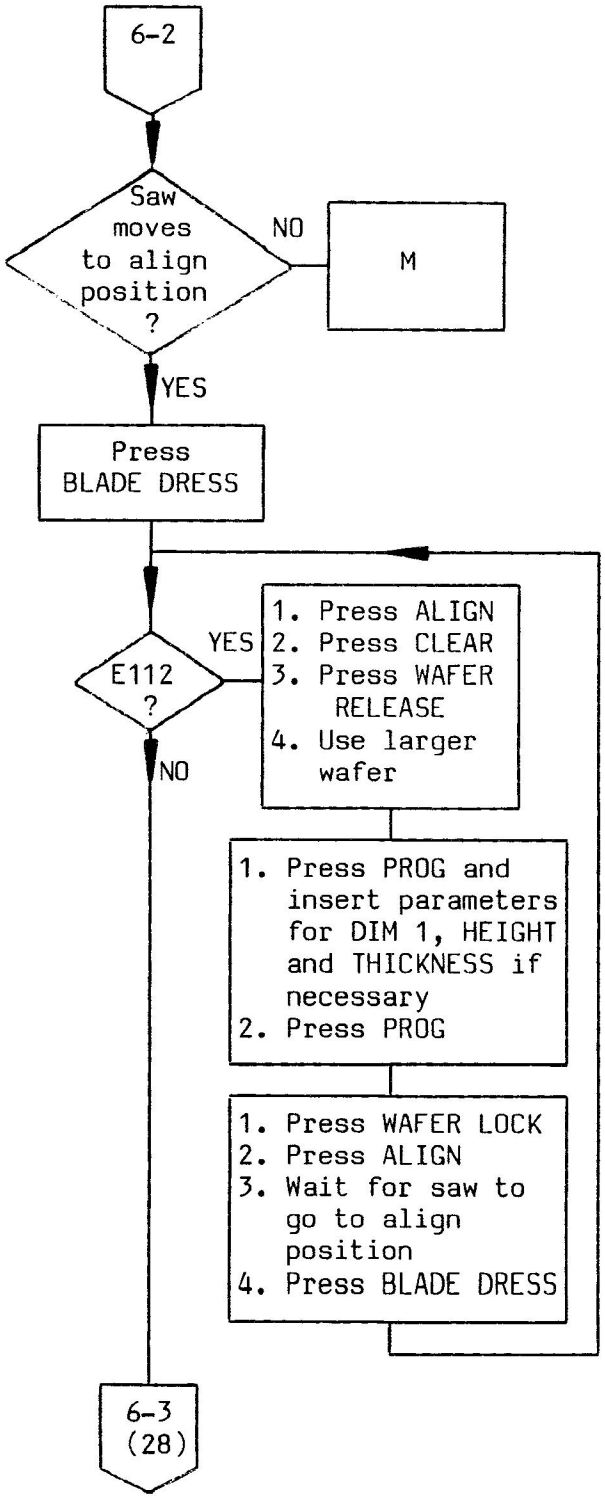
Using this program to dress blades in carbide dressing blocks will result in excessive blade wear.



NOTES:

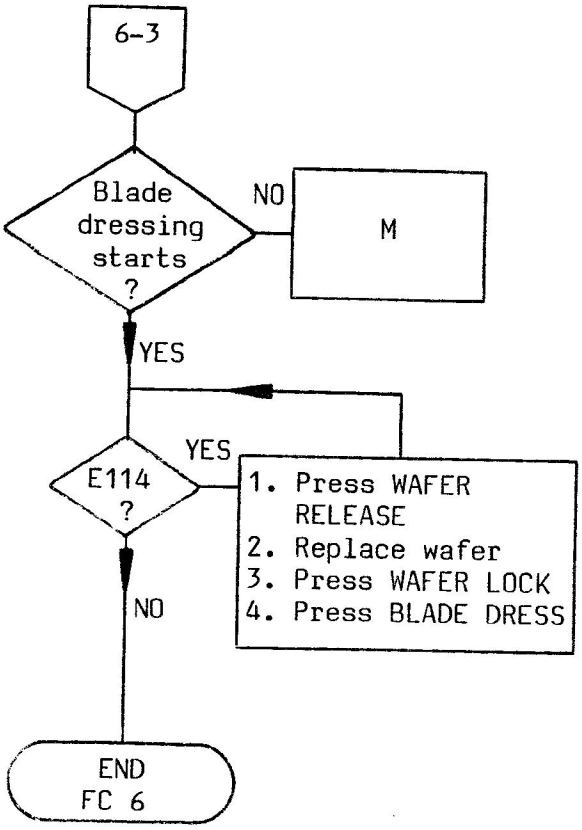
1. Enter typical values for each parameter in order to exit from the program mode.
2. Use the thickness and diameter of the dressing wafer (length and width if rectangular wafer is used).
3. Set HEIGHT (thickness minus depth of cut) so that the blade penetrates to the same depth that it will penetrate in production cutting.
4. Set CUT SPEED to the production cutting speed.
5. Set ANGLE to a value greater than 30°. The recommended angle is 90°.
6. 1st and 2nd INDEX are overridden by the dressing program, but they must be entered.

FC 6 - Continued



Align position means that the chuck moves under the optics and blade is centered front to back.

E112: the number entered into the program for wafer diameter is less than 1.9 inches (or the width, in case of rectangular substrate, is less than 1.9 inches), the minimum dimension for the wafer dress routine.



The blade dressing program starts cutting at 50 mils per second, then gradually increases the speed until the speed set in the program is reached. The display shows the speed that the saw is cutting at any moment.

E114: the dressing wafer has been "used up". The saw returns to the home position.

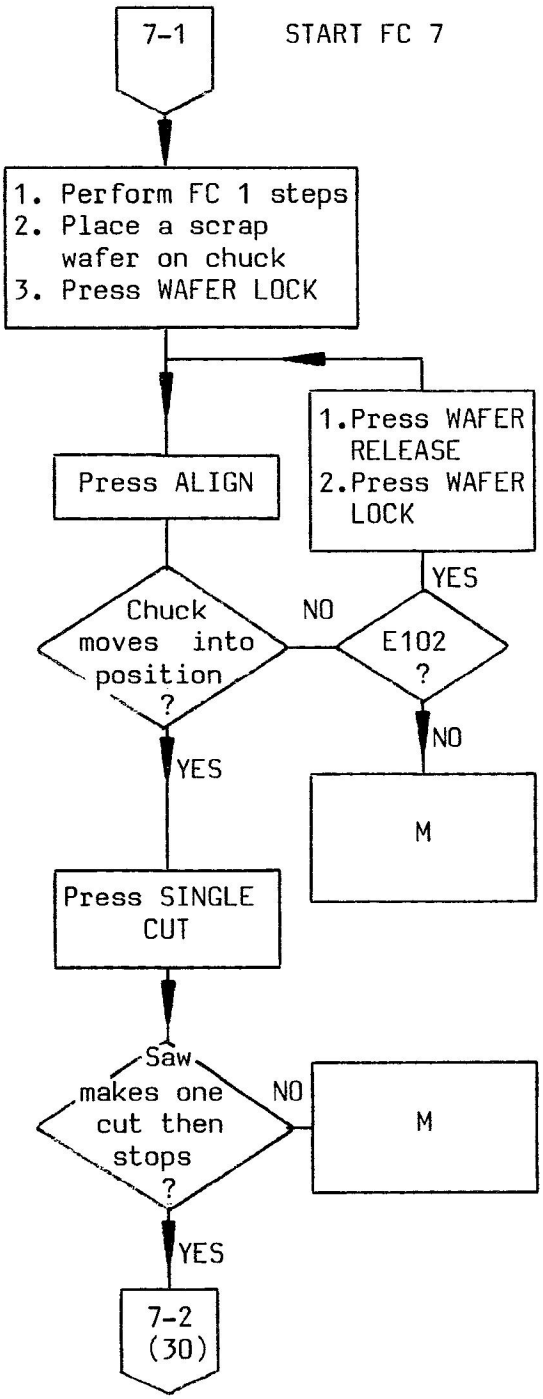
When blade dressing is complete, a signal is sounded.

NOTE

After each blade dress sequence the saw requires that a chuck zero operation be performed before it can be operated. This is necessary because the dressing may have reduced the diameter of the blade slightly. E104 will be displayed if an attempt is made to operate the saw without a new chuck zero.

4.6.7 Flow Chart 7. Alignment of Optics to Blade.

Following the steps in this flow chart will align the closed circuit TV split-field optics to the plane of the blade.



This will ensure that the saw will position the cut exactly through the center of the street that was aligned to the reticle.

Refer to FC 13 (Wafer Alignment) for additional alignment procedures.

Program the saw for the desired cutting pattern, except set CUT SPEED to 500 mil/sec (13 mm/sec).

Chuck moves so that the wafer is under the optics.

E102 shows that wafer was not locked.

Saw will make a single cut and then stop in the align position.

7-2

Optics Y alignment

1. Refer to Figure 4-3
2. Adjust the Focus Control at top rear of the camera
3. Adjust reticle, using a 8-32 hex wrench in Y Adjust screw until reticle is centered on the cut.

   For fine adjustment of the reticle position, use the SPREAD/CONVERGE, RETICLE COLOR, and UP/DOWN controls on the monitor (Refer to Figure 4-4).

Opptics Theta alignment

4. Adjust Theta alignment with Theta Adjust lever at the bottom front of the camera until cut appears to be continuous accross screen.

END
FC 7

The vertical line joining the right and left fields of the split image can be adjusted with two 4-40 hex screws located on the bottom of the camera.

For additional adjustments of the video system see: Micro Automation Video Alignment Procedure"
Part # 24031440-001.

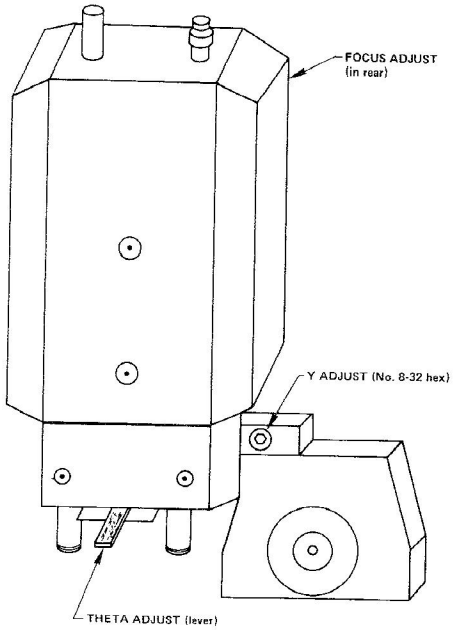


Figure 4-3 Split-image Camera

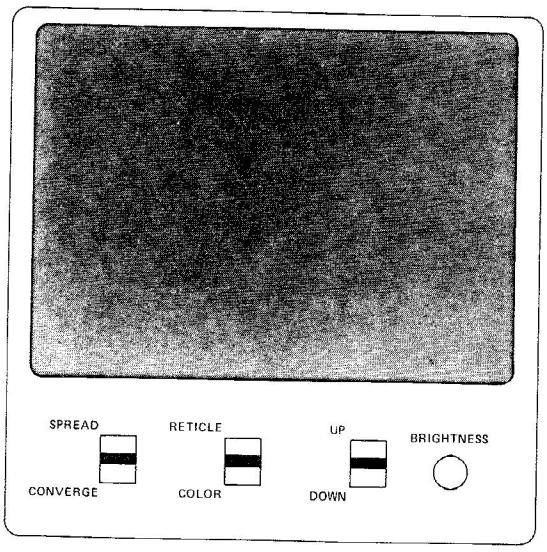
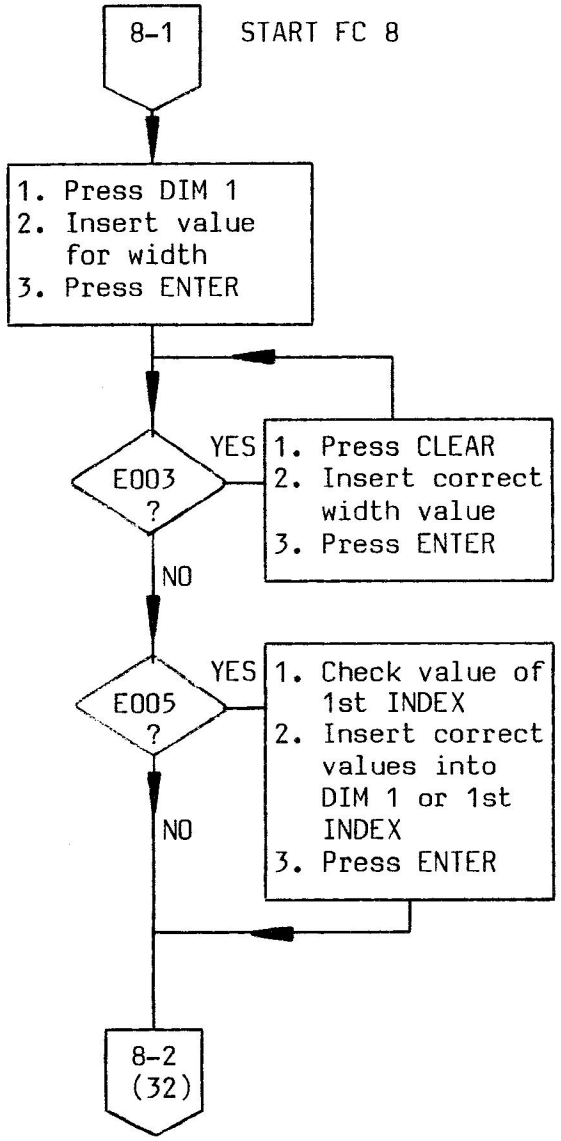


Figure 4-4 Monitor Controls

4.6.8 Flow Chart 8. Cutting Rectangular Substrates.

Cutting rectangular substrates requires that two dimensions be entered: width and length. DIM 1 is used to enter width (pass one), and DIM 2 is used to enter length (pass two).

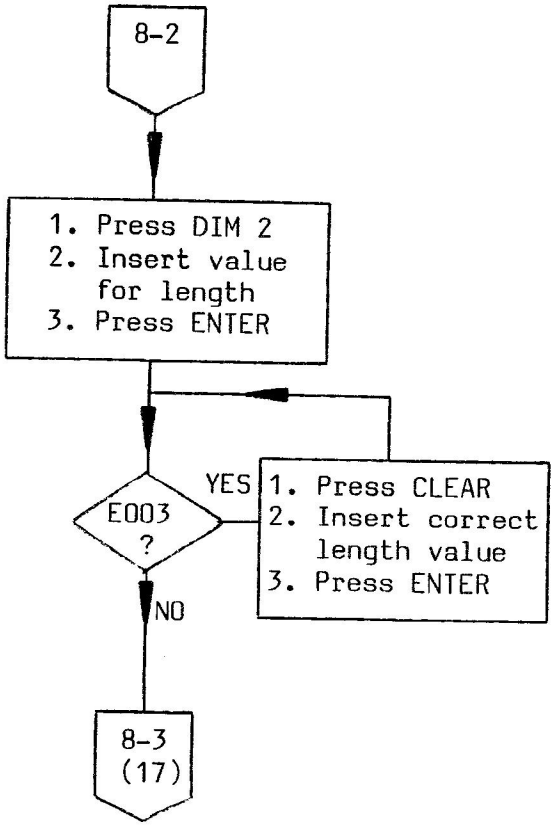


This FC is entered from FC 1.

Width is defined as the dimension from right to left (the cutting stroke on the first pass).

E003: value is out of range. Width must be between 0.1 and 6000 mils (0.0025 to 152 mm).

E005: value inserted for the 1st INDEX in FC 1 is too large for the value just entered for width.



This value is for the second pass of the saw. Entering DIM 2 also indicates that a rectangular substrate is being cut.

E003: value out of range. Length must be between 0.1 and 6000 mils (0.0025 and 152 mm).

Reenter FC 1.

4.6.9 Flow Chart 9. Basic Dicing and Scribing Procedures for Round Wafers.

This flow chart shows the steps to perform in aligning and sawing round wafers.

During these operations the saw can be stopped by pressing the ON/OFF switch, or the RESET, ALIGN, HOME, or INDEX keys.

The ON/OFF switch should only be used in case of an emergency. It is a "panic button"; it shuts down everything.

When the RESET key is pressed, all axes return to their home position, and chuck zero is lost, but the program in the working file is not affected.

When ALIGN is pressed, the saw finishes the cut in progress and then returns to the ALIGN position. Chuck zero is retained. If AUTO CUT is pressed next, sawing starts at the front of the wafer.

When INDEX is pressed, the saw finishes the cut in progress, then positions the last cut under the optics. Chuck zero is retained. If AUTO CUT is pressed next, the sawing starts at street following the one just completed.

If SINGLE CUT is pressed, after pressing ALIGN or INDEX, only X and Z axes move, and the cut is made in the position the wafer is in.

Three methods of wafer alignment are described on the following pages. They are: single pass, dual pass, and no pattern alignment.

This flow chart does not cover cutting wafers with hexagonal dies or progressive cutting. See the appropriate flow charts for these operations.

o SINGLE PASS ALIGNMENT: (Mode 10)

The operator aligns the streets to the blade using the monitor, and then presses AUTO CUT. The saw makes all the cuts for the first pass, rotates the wafer through the programmed angle, returns the wafer to the align position, and sounds a signal. The operator aligns the wafer for the second pass and again presses AUTO CUT. The saw then cuts the second pass and goes to the home position. Again an audible signal is sounded to indicate that dicing or scribing is complete.

o DUAL PASS ALIGNMENT: (Mode 10)

In this operation, the operator aligns the wafer for the first pass, and then rotates the wafer and aligns the streets for the second pass. When AUTO CUT is pressed, the saw cuts both passes without operator intervention. At the end of the dicing or scribing operation a signal is sounded.

o NO PATTERN ALIGNMENT: (Mode 11)

This method of cutting is used for blank wafers. In this mode the saw chuck rotates through the programmed angle after cutting the first pass and makes the second pass without pausing for alignment. This is not the same as dual pass alignment, since there is no provision for alignment on the second pass.

Figure 4-5, on the following page, shows the starting points of the first cuts when AUTO CUT or SINGLE CUT is pressed.

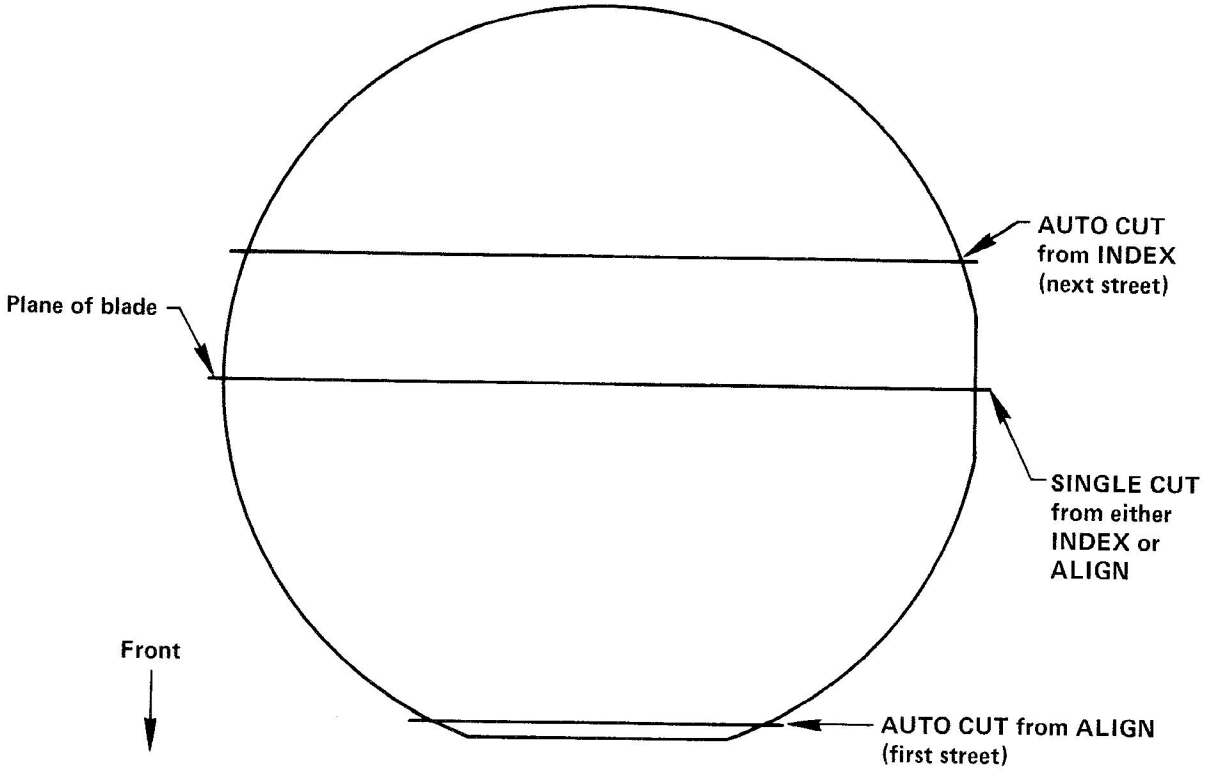
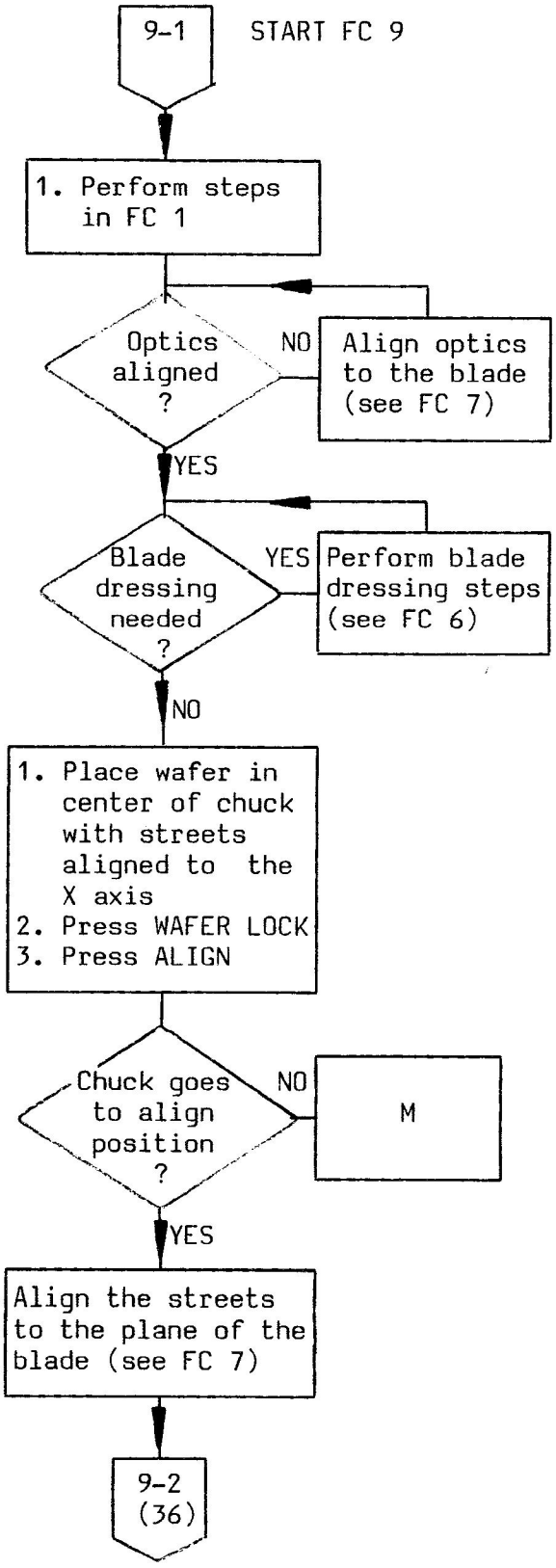


Figure 4-5: Starting Point of First Cut



The status of the saw should be:

Spindle running

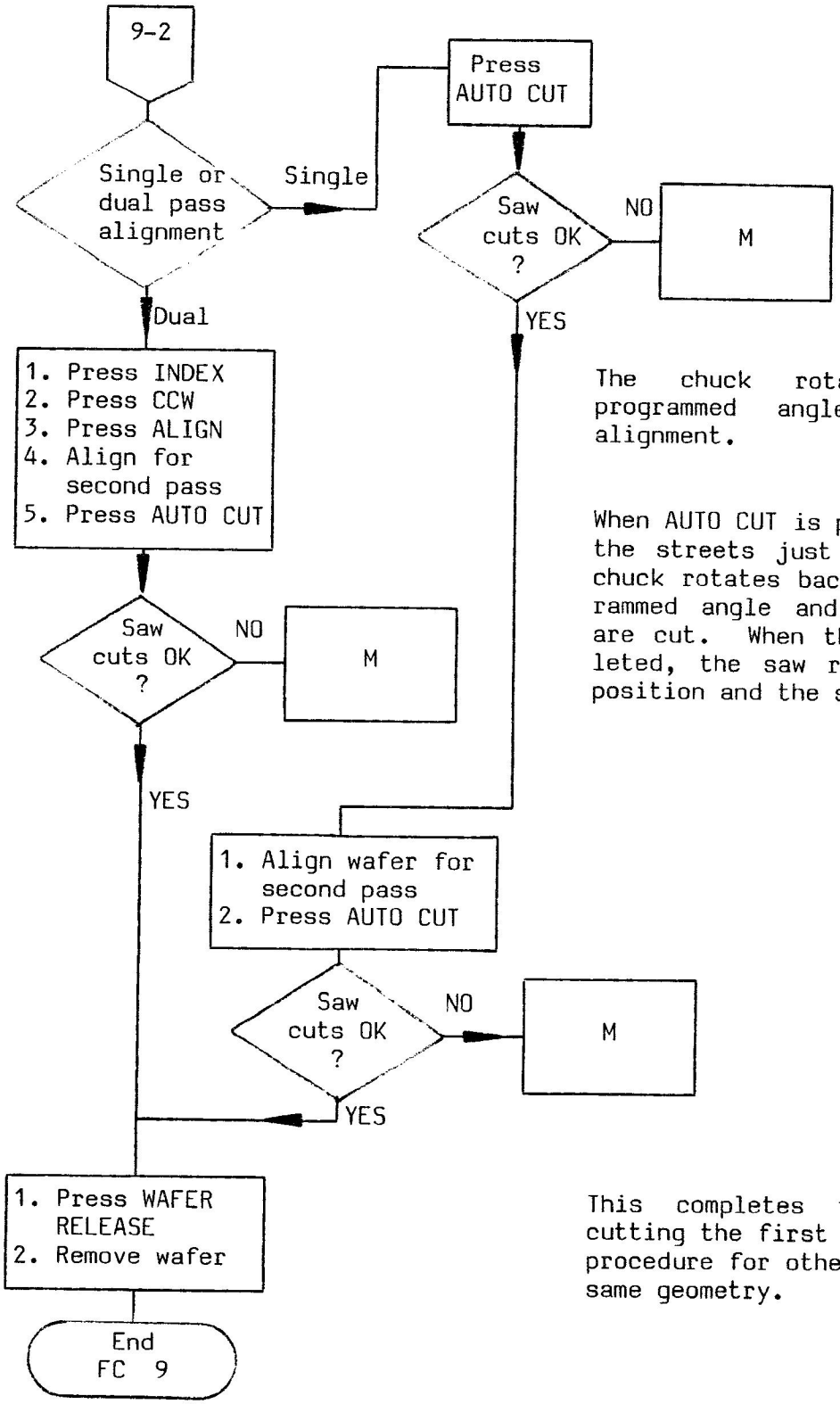
Chuck zero performed (CHUCK ZERO light lit)

Chuck should be in home position

If wafers are mounted on film frames, place the frame so that it engages the pins on the film frame adapter. This will align and center the wafer.

Align position means that the wafer moves under the optics.

FC 9 - Continued



The chuck rotates through the programmed angle and stops for alignment.

When AUTO CUT is pressed the saw cuts the streets just aligned. Then the chuck rotates back through the programmed angle and the cross streets are cut. When the cutting is completed, the saw returns to the home position and the signal is sounded.

This completes the procedure for cutting the first wafer. Repeat this procedure for other wafers having the same geometry.

4.6.10 Flow Chart 10. Cutting Hexagonal Dies.

Cutting hexagonal dies requires three passes, each separated from the last pass by a 60° angle. Three operating modes are available for this purpose: manual, automatic, and semi-automatic.

Manual Mode (Mode 20, Patterned Wafers)

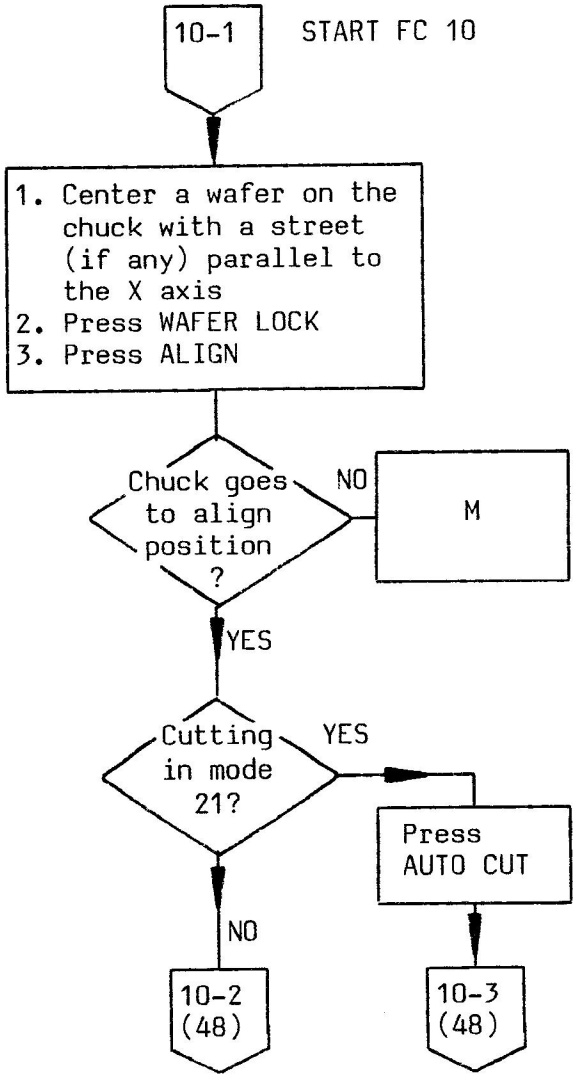
Manual alignment of all three axes one at a time, or triple alignment, can be made where all three passes are aligned before cutting begins.

Automatic Mode (Mode 21, Blank Wafers)

No pattern alignment.

Semi-automatic Mode (Mode 22, Blank Wafers)

No alignment required for passes 1 and 2, and pass 3 aligned to the intersection of 1 and 2. To cut unpatterned wafers, cut the first wafer in this mode and then all subsequent wafers in mode 21.



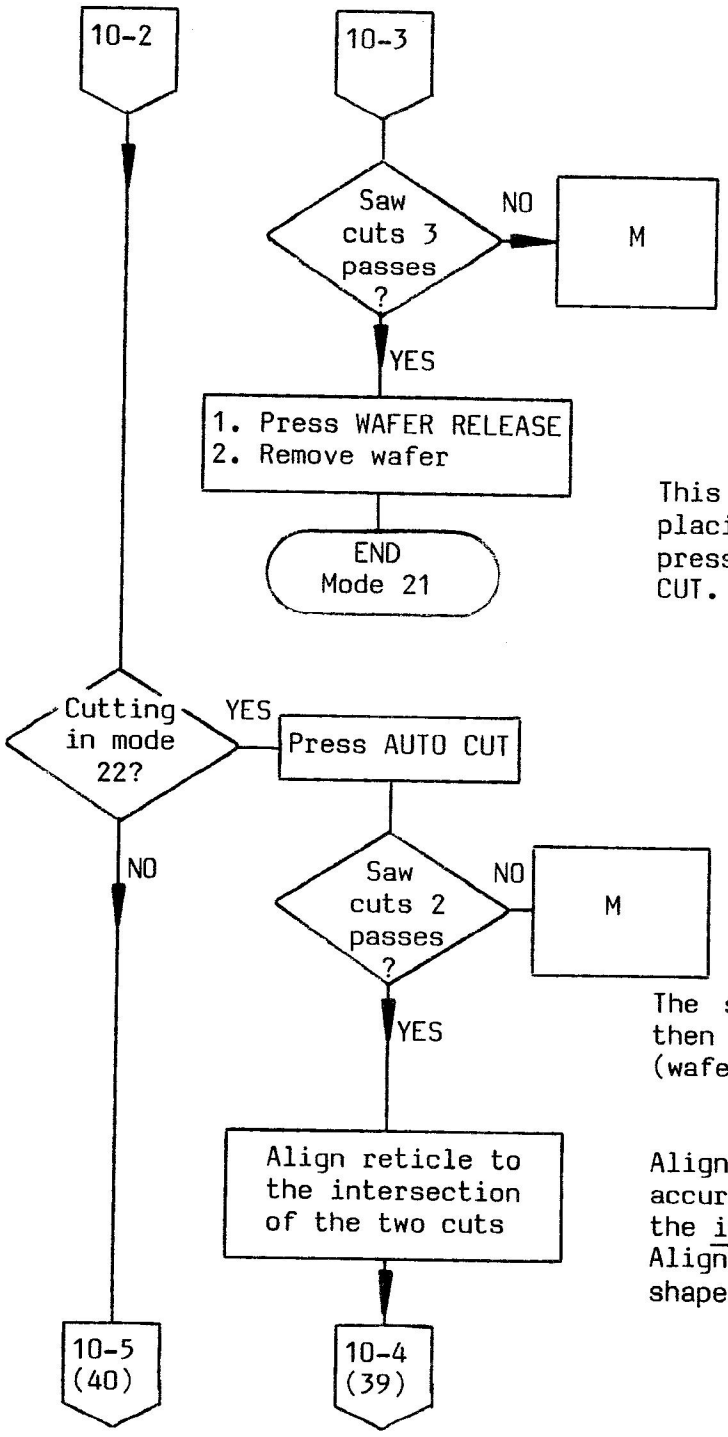
The status of the saw should be:

Spindle running.
Chuck zero performed (CHUCK ZERO light lit).
Chuck in home position.
Optics aligned.
A dressed blade should be mounted.
A hex cutting program should be in the working file.

If wafers are mounted on film frames, placing the frame so that it engages the pins on the film frame adapter will align and center the wafer.

The saw cuts the first pass. Then the chuck rotates 60° CCW and cuts the second pass. The chuck rotates another 60° and cuts the third pass. The saw then returns to the home position.

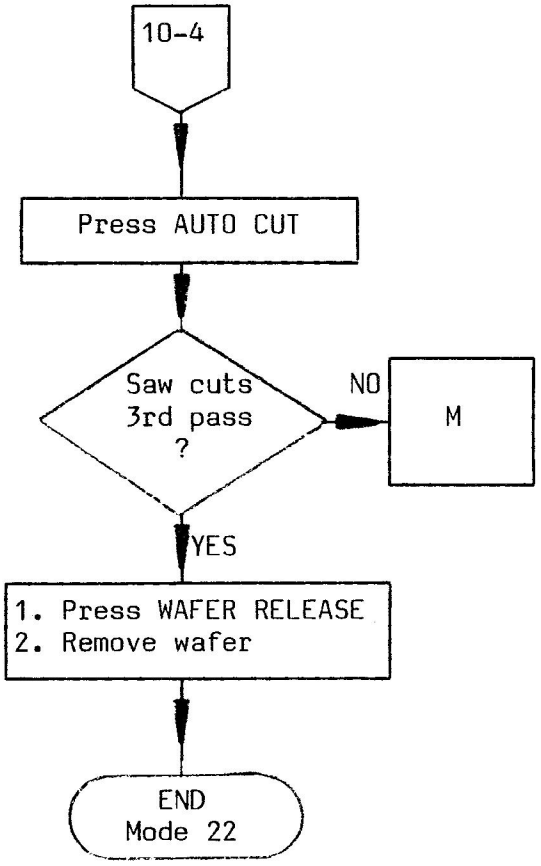
FC 10 - Continued



This process may be repeated by placing another wafer on the chuck, pressing WAFER LOCK, ALIGN, then AUTO CUT.

The saw cuts two passes 60° apart, then returns to the align position (wafer under optics).

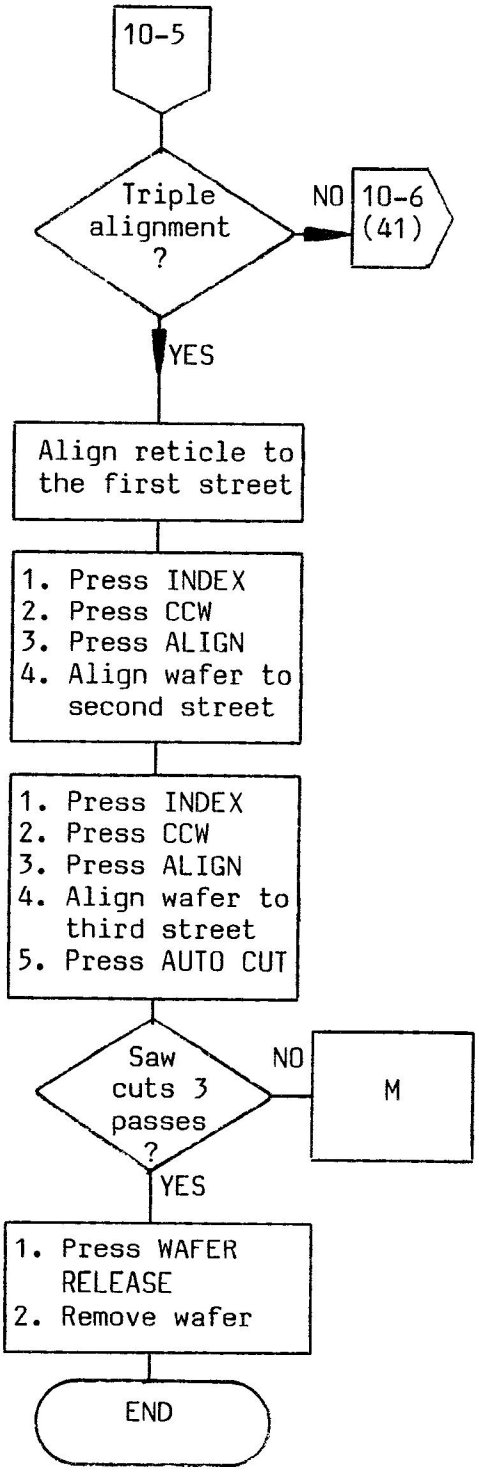
Aligning the reticle increases the accuracy of the third cut. Align to the intersection of any two cuts. Alignment to any other part produces shapes that are not hexagons.



The saw cuts the third pass. The change put in Y in the last step will be remembered by the program. After the pass, the saw returns to the home position.

Now that the Y correction is in the memory, subsequent wafers can be cut in the full automatic mode 21.

Change to mode 21 and repeat the steps above to cut more wafers to this pattern.

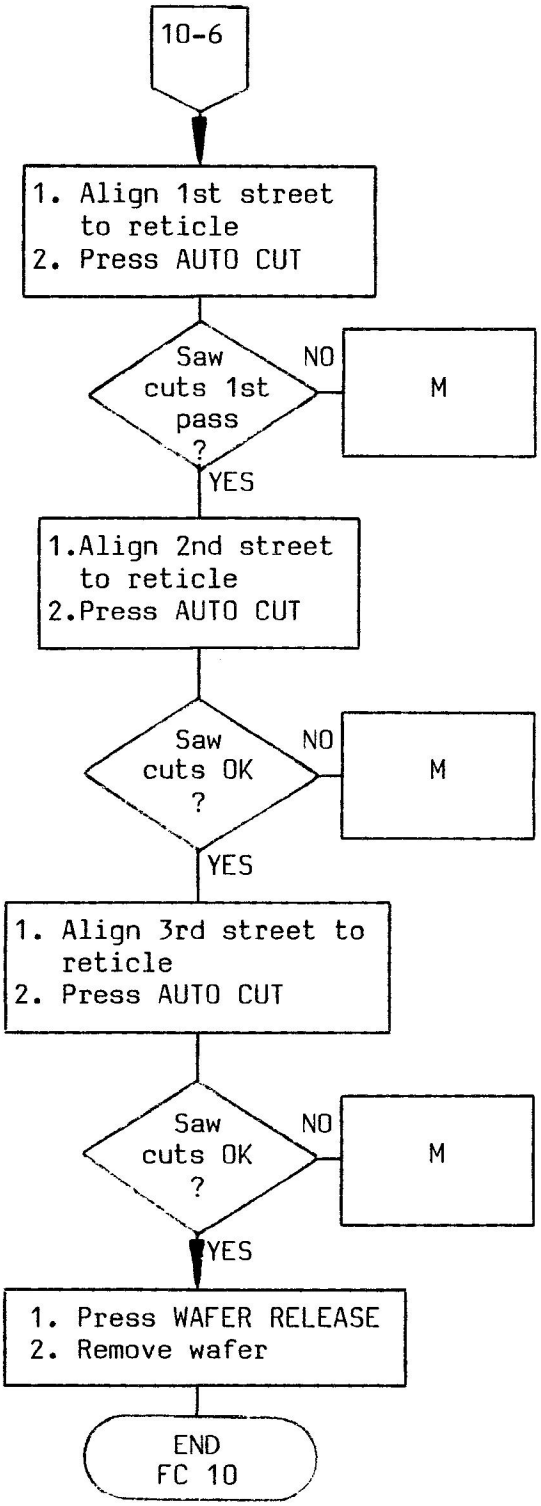


The chuck rotates 60° for alignment to the second street.

This aligns the chuck for the third pass. This alignment is saved in the program, as well as the previous one, and the saw automatically cuts all three passes.

The saw cuts all three passes and then returns to the home position.

This completes the procedure for cutting hexagonal wafers with triple automatic alignment.



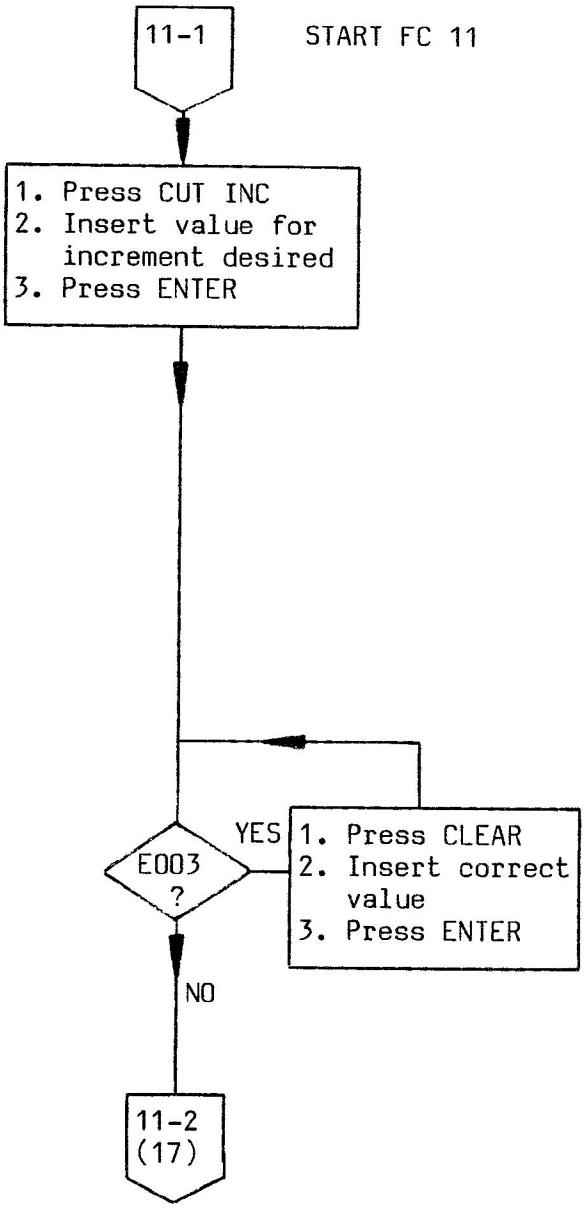
This starts the manual (mode 20) cutting procedure. As in cutting round or rectangular wafers, all passes must be aligned before cutting, or the alignment can be made before each pass.

The saw cuts the first pass, rotates 60°, and returns to the align position.

4.6.11 Flow Chart 11. Progressive Depth Cutting.

In this mode the saw makes a series of progressively deeper cuts on the same street before moving on to the next street.

The total depth of cut is programmed in the usual way (height = thickness - depth). The incremental depth is programmed in by following the flow chart below.



This flow chart is entered from FC 1.

The saw should be in the following condition:

PROG light lit.

A progressive cut mode should be programmed into the working file. Progressive modes are:

Mode 60 - round wafers, alignment before each pass.

Mode 61 - round wafers, no pattern alignment.

Mode 70 - rectangular wafers, alignment before each pass.

Mode 71 - rectangular wafers, no pattern alignment.

E003: The value entered for the incremental depth is out of range. Incremental depth values must be between 0.1 mil and 1000 mils (2.54 and 25.4 mm).

Reenter FC 1.

4.6.12 Wafer Alignment.

The model 1100 saw is equipped with split-field TV optics. With this system, images of the left and right sides of the wafer are presented on a split-image monitor. To align a wafer, follow the steps below.

- o Make sure that the saw is programmed for the geometry of the wafer to be diced or scribed.

- o The saw should be in a reset condition, that is:

  Spindle running,
  Chuck zero performed,
  All axes in home position.

- o Place wafer in the center of the chuck with the streets approximately aligned to the X axis. If the wafer is mounted on a film frame, engage the alignment pins of the frame on the chuck adapter.

- o Press WAFER LOCK

- o Press ALIGN

- o The saw places the wafer under the TV lenses so that the left and right sides of the wafer are displayed on the monitor.

- o Use the FWD, BACK, CW, and CCW controls to align the wafer to the reticle. Figures 4-6 through 4-9 show a wafer as seen on the monitor. When aligned, the streets appear continuous across the screen and centered over the reticle.

Refer to FC 7 (Alignment of Optics to the Blade) for additional alignment procedures.

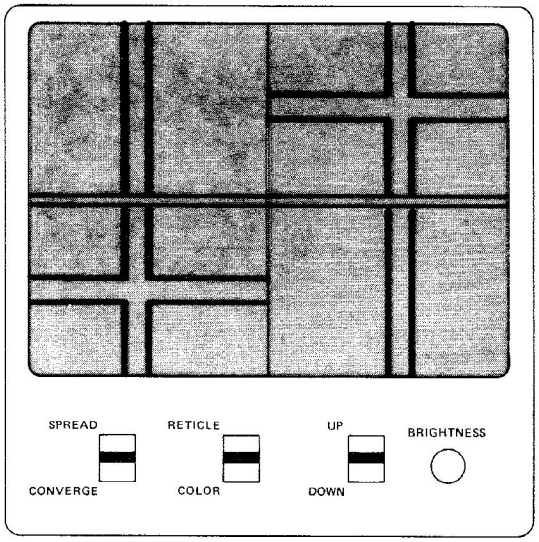


Figure 4-6: Unaligned Wafer

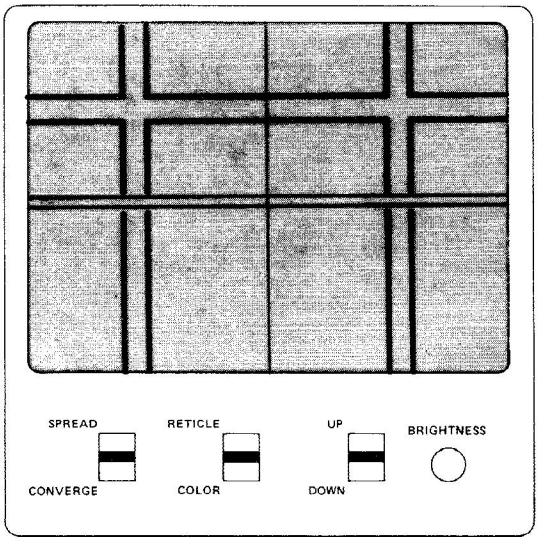


Figure 4-7:
Wafer with Theta Aligned

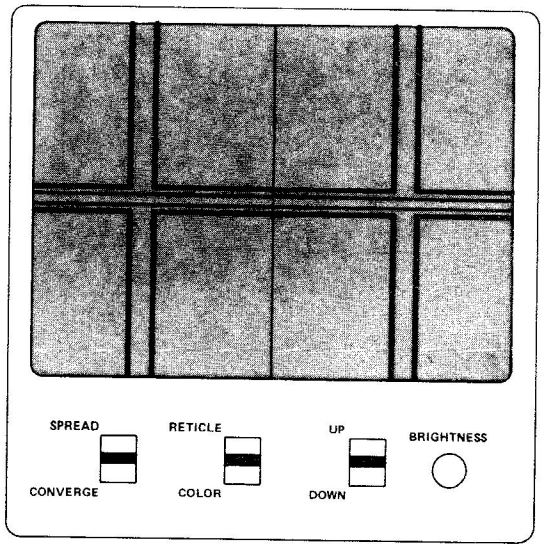


Figure 4-8:
Wafer with Theta and Y Aligned

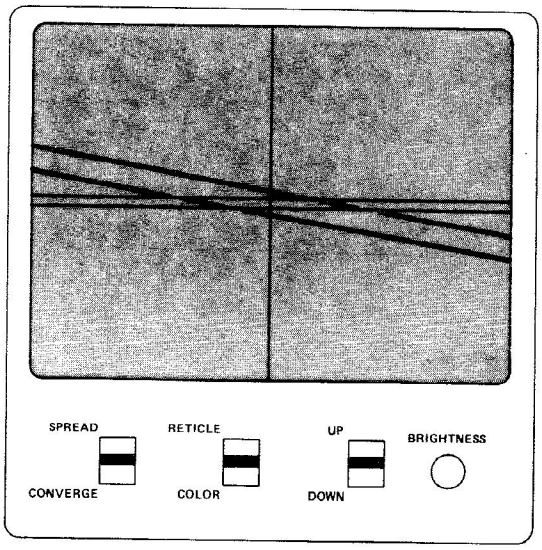


Figure 4-9:
Improper Camera Alignment

EASY TEACH

NOTE: YOU SHOULD BE FAMILIAR WITH THE BASIC PRINCIPLES OF SAW OPERATION AND PROGRAMMING BEFORE ATTEMPTING TO USE THIS ADVANCED OPERATING FEATURE OF THE 1100 SAW.

DESCRIPTION

Easy Teach is a feature of the 1100 saw that enables saw program parameters to vary during operation. Anything that can be done by the saw under normal program operation can be combined in unique combinations in a teach program. Some of the most common uses for Easy Teach are progressive depth cutting of hard and/or thick materials, multi-angle cuts, variable indexing and variable cut speeds. While these are a few of the more common applications, many other potential applications exist, limited only by the capabilities of the saw and the imagination of the operator.

Only after an initial set of regular, non-teach program parameters is recalled or generated can a teach program be written. Each set of teach instructions is linked to the specific saw program in memory when the teach instructions are generated. As a result, the teach program is stored and called up along with the regular saw program in which it was written.

NOTE: ON AVERAGE, TEACH PROGRAMS ARE LIMITED TO ABOUT 20 STEPS BEFORE RUNNING OUT OF MEMORY.

Once teach programming is begun, (by pressing TEACH), only the yellow colored keys and numeric keys on the program panel can be used. Also, the ALIGN, INDEX, SINGLE CUT, AUTO CUT keys, and the Y and Theta joysticks on the control panel may be used.

When the teach program is started, use the operable teach functions to program a series of saw movements that you desire. Program functions that you input will be listed in numerical order on the monitor. A cursor will appear next to the most recently addressed step. To edit a teach program, use the T STEP and T DELETE keys (see below). To nest a series of repeated steps, use the T REPEAT and T END keys (see below).

Once the teach program is complete, press the TEACH key to toggle out of the teach mode. Your teach program is now ready to run as part of the non-teach program. Those parameters entered as part of teach will override existing parameters in the non-teach program. Non-teach program parameters for which no teach value exists, will default to that value in the non-teach program.

KEY DEFINITIONS FOR TEACH MODE

TEACH

Toggles into and out of the teach program. When TEACH indicator light is lit, programming or modifications of a teach program can be made.

NOTE: T STEP AND T DELETE ARE USED TO EDIT EXISTING TEACH PROGRAMS.

T STEP

Used to place cursor next to a step to be deleted or next to a step under which a step can be added. To move cursor down one to the next step in a teach program, press T STEP. To move cursor anywhere in a teach program, press the step number you want to go to, then press T STEP.

T DELETE

To delete a teach program step, move cursor to the step you want deleted and press T DELETE.

T REPEAT

This teach program feature allows you to repeat a specified program operation or set of operations up to 255 times. It also allows you to nest a T REPEAT series of operations within another T REPEAT operation. Up to three nestings are available on the 1100 saw. Each T REPEAT function is indented from the previous step on the monitor program listing, even if the previous step was another T REPEAT function. The first repeat loop to be performed can then be easily identified by the most indented part of the teach program listing on the monitor display. T REPEAT must be accompanied by a T END at the end of the repeat loop.

T END

Signifies the end of a T REPEAT set of operations. T END must end a repeat loop or a programming error will occur. After the T END, steps listed on the monitor display will loose one indentation.

T RESUME

This key causes a teach program to continue after an ALIGN or INDEX function. It also causes a teach program to run from the beginning.

All other yellow program keys except for A(-) and B(+) function the same way for inputing teach program parameters as they do for inputing non-teach program parameters.

A(+)

This key is used to positively increment a program parameter by the specified amount. If used as part of a T REPEAT function, the program parameter will be positively incremented for each iteration of the repeat loop.

B(-)

This key is used to negatively increment a program parameter by the specified amount. If used as part of a T REPEAT function, the program parameter will be negatively incremented for each iteration of the repeat loop.

NOTE: DURING TEACH MODE, SOME OF THE FUNCTIONS ON THE CONTROL PANEL CHANGE.

Y and Theta joysticks

During teach mode, the Y and Theta joysticks no longer cause continuous movements of the Y and Theta axis. Activation of any part of these switches causes a discrete movement by the value of the index parameter (Y joystick) or the value of the angle parameter (Theta joystick).

ALIGN

During teach programming, ALIGN will bring the wafer to the align position, where the saw will pause. T RESUME must be pressed for the teach program to continue. If either SINGLE CUT or AUTO CUT is pressed next, the wafer will saw from the first street of the wafer.

INDEX

During teach programming, INDEX will bring you to the same point as when entered during regular operation and the saw will pause. T RESUME must be pressed for the

teach program to continue. When SINGLE CUT is pressed after ALIGN in a teach program, a cut is made at the current position of the chuck. During regular operation, the cut would be made at the first street on the wafer.

SOME NOTES ABOUT PROGRAMMING EASY TEACH

If you have had experience programming a computer, programming in easy teach works much like BASIC programming language. Program flow is sequential, that is the steps in your teach program are performed in numerical order. If a teach program utilizes the T REPEAT and T END commands, all steps bracketed by the T REPEAT and T END statements will be repeated the designated number of times before any steps outside the T REPEAT and T END. When T REPEAT/T END loops are nested within other T REPEAT/T END loops, the inner most loop must be completed before an outer loop is incremented.

Initially, all program parameter values are those listed in the regular saw program. Whenever a program parameter value is defined by a step in the teach program, the new value will be operable from the step in the teach program where it is redefined, to the remainder of the teach program. When the teach program is run again, all program parameter values are reset to the original values from the non-teach program. During pauses or at the end of the teach program, joystick controls can be operated in the normal manual manner.

If at any time you wish to view the working value of a program parameter value, press the program key for the parameter you wish to interrogate and the working value will be displayed on the program panel.

The following is a listing of three sample programs which demonstrate some of the more common applications of easy teach and the flexibility and power of teach programming.

REGULAR (NON-EASY TEACH) PROGRAM

PROGRAM ID:	0
MODE:	10
DIMENSION 1:	2000.00 MILS
DIMENSION 2:	0 MILS
INDEX 1:	100.000 MILS
INDEX 2:	100.000 MILS
HEIGHT:	50.000 MILS
THICKNESS:	150.000 MILS
ANGLE:	90.000 DEGREES
CUTTING SPEED;	100.000 MILS/SEC
CUT INCREMENT:	0 MILS
SPINDLE SPEED:	30000.0 RPM
STOP COUNT:	999
CUT COUNT:	33041

PROGRAM FOR PROGRESSIVE DEPTH CUTTING

```
 1 ALIGN
 2  REPEAT FOLLOWING 255 TIMES
 3  HEIGHT:            100.000 MILS
 4  SINGLE CUT
 5  HEIGHT:             75.000 MILS
 6  SINGLE CUT
 7  HEIGHT:             60.000 MILS
 8  SINGLE CUT
 9  HEIGHT:             50.000 MILS
10  SINGLE CUT
11  MOVE BACK ONE INDEX
12  END OF REPEAT
13 ROTATE CHUCK COUNTER-CLOCKWISE
```

EXPLANATION

This program is an example of how a repeat loop can be used for progressive depth cutting of hard or thick materials. The difference between the four values of height indicate the actual amount of material that is removed on each single cut. Note that in the original program the thickness is set at 150.000 MILS. Since the height programmed for the first step is 100.000 MILS, this indicates that 50.000 MILS will be removed in step 4. Subsequently, 25.000 MILS, 15.000 MILS, and 10.000 MILS will be removed in steps 6, 8 and 10 respectively. These four single cuts are made in the same street.

Once the street is completely cut, the chuck moves one index to the next street in step 11 and is instructed to go back to step two and repeat the process. If the process has repeated 255 times, step 12 will allow program flow to pass to step 13 where the chuck is rotated by the angle in the program (90 degrees).

Note that the final height is the height listed on the original non-teach program. More material is removed in the initial shallow cuts because deeper cuts are harder to clear of cut material and are more prone to side friction of the cut on the blade. Progressive depth cutting helps eliminate blade wear, excessive kerf and chipping.

PROGRAM FOR ANGLE DECREMENTING

```
1 ALIGN
2 AUTO CUT
3 ROTATE CHUCK COUNTER-CLOCKWISE
4 ALIGN
5 AUTO CUT
6 ANGLE:              -30.000 DEGREES
7 ROTATE CHUCK CLOCKWISE
8 ALIGN
9 AUTO CUT
```

EXPLANATION

The above program shows how the teach feature may be used to program for a non-standard cutting angle. During steps 1 and 2, a normal pass of cuts is made on the wafer. Step 3 will rotate the chuck 90 degrees, using the angle value in the original non-teach program, and steps 4 and 5 will cut the second pass in the wafer. The B(-) key is used to increment the existing angle parameter by -30.000 degrees in step 6. This causes the chuck to rotate back 60 degrees (90-30) so that the series of cuts made in steps 8 and 9 will be 30 degrees from the cuts made on the first pass.

BLADE COMPENSATION PROGRAM

```
1 ALIGN
2  REPEAT FOLLOWING 255 TIMES
3   REPEAT FOLLOWING 5 TIMES
4   SINGLE CUT
5   MOVE BACK ONE INDEX
6   END OF REPEAT
7  HEIGHT:              -.0500 MILS
8  END OF REPEAT
9 ROTATE CHUCK COUNTER-CLOCKWISE
```

EXPLANATION

The above program is used to illustrate how one might compensate for normal blade wear. The idea is to raise the chuck up by the amount the blade is being worn down. Cut speed, depth and material are all factors affecting the kind of blade compensation you may want to employ.

The above program makes 5 single cuts (steps 3-6) between each compensation. Compensation is made by negatively incrementing the height programming parameter -.0500 MILS, which causes the chuck to raise up .0500 MILS. 255 compensations are made (steps 2 and 8) before the chuck is rotated and the whole process starts over.

APPENDIX

ERROR CODES/FAULT CODES

This appendix lists, in alphanumeric order, error an fault codes, the meaning of each code, and the probable cause(s) and remedies.

ERROR CODES

Error codes are displayed as an E followed by three digits. Error codes generally mean that the operator has made a mistake while programming or operating the saw. Error codes can usually be cleared by pressing CLEAR and then returning to proper procedures.

If proper operating and programming procedures are followed and an error code persists, hardware problem may be involved and a maintenance technician should be called.

FAULT CODES

Fault codes are displayed as an F followed by three digits. They generally indicate that there is a mechanical or electrical failure.

ERROR/FAULT CODES

Code	Definition	Cause/Corrective Action
E002	Operator tried to operate the machine while in PROG mode.	See if the PROGRAM light is lit. Press PROG key to exit mode.
E003	Number out of range	An attempt was made to enter a numerical parameter which is outside the design capability of the equipment. Press CLEAR and enter an acceptable value.
E004	The dimension entered for height is greater than the dimension for wafer thickness. This would result in no dicing or scribing of the wafer.	Press CLEAR. Enter correct dimensions.
E005	Dimension entered for index is greater than dimension entered for wafer size.	Press CLEAR. Enter correct dimensions.
E007	A Theta angle of more than 60.5° was programmed while the saw was in hex mode (Mode 20, 21, or 22).	Press CLEAR. Program an angle less than 60.5°.
E008	Information not complete.	Make sure all programming and operating information is complete.
E109	Program storage empty.	
E010	Loop count must be within 0 and 255.	
E011	Load entry not allowed in this mode.	An attempt was made to change MODE after ALIGN or INDEX was pressed.

Code	Definition	Cause/Corrective Action
E102	An attempt has been made to operate the saw without the wafer locked.	Press WAFER LOCK, then proceed. If condition persists call a maintenance technician.
E103	An attempt has been made to operate the saw with one or more parameters missing.	Make sure all parameters have been programmed correctly.
E104	Chuck zero required.	Perform chuck zero.
E105	Spindle not up to speed.	Wait until spindle is up to speed.
E108	Program storage is full.	This indicates that all memory spaces are filled. A new program can only be stored if an existing program is erased.
E109	An attempt was made to retrieve a program from memory that does not exist.	Check program ID number requested.
E110	A program is already stored in memory under the ID number selected.	Attempts to store new program under this ID number will erase the existing program. If this is desired, press ENTER, otherwise press CLEAR and assign different ID number to this program.
E112	An attempt was was made to use the blade dress program on a wafer with a diameter less than 1.9 inches.	Use a wafer with a diameter over 1.9 inches.
E114	During automatic blade dress program the blade dressing material was used up.	Replace dressing material.
E116	Working program is bad.	
E118	Motor or spindle circuit card is missing.	

Code	Definition	Cause/Corrective Action
F201	Chuck zero circuit open.	
F202	Chuck zero circuit shorted.	Water shorting the spindle to the casting is a common cause of this problem.
F214	Vacuum service missing.	Check vacuum hoses, connections, and sensor.
F215	Water pressure missing or low.	Check water supply.
F216	Air pressure missing or low.	Check air hoses, connections, and sensor.
F220	The X axis of the saw is at the left limit.	The CPU has sensed that the X axis is at the left limit when it should not be.
F221	The X axis of the saw is at the right limit.	The CPU has sensed that the X axis is at the right limit when it should not be.
F222	The Y axis of the saw is at the the rear limit.	The CPU has sensed that the Y axis is at the rear limit when it should not be.
F223	The Y axis of the saw is at the front limit.	The CPU has sensed that the Y axis is at the front limit when it should not be.
F224	The Theta axis of the saw is at the CCW limit.	The CPU has sensed that the Theta axis is at the CCW limit when it should not be.
F225	The Theta axis of the saw is at the CW limit.	The CPU has sensed that the Theta axis is at the CW limit when it should not be.
F226	The Z axis of the saw is at the lower limit.	The CPU has detected that the Z axis is at the lower limit when it should not be.

Code	Definition	Cause/Corrective Action
F230	Saw has run the maximum distance without detecting the X axis left sensor.	The CPU has detected a number of pulses from the X axis motor sensor without the X axis limit being encoutered. This problem generally means that the motor was turning but the X axis was not moving, or the flag is bent.
F232	Saw has run the maximum distance without detecting the Y axis rear sensor.	The CPU has detected a number of pulses from the Y axis motor sensor without the Y axis limit being encountered.
F234	Saw has run the maximum distance without detecting the Theta axis CW sensor.	The CPU has detected a number of pulses from the Theta axis motor without the Theta axis limit being encountered.
F236	Saw has run the maximum distance without detecting the Z axis lower sensor.	The CPU has detected a number of pulsess from the Z axis motor sensor without the Z axis limit being encountered.
F240	The X axis has not moved from the left limit.	The X axis has been commanded to move a number of steps but the CPU has not detected that the axis has moved out of the left llimit.
F242	The Y axis has not moved from the rear limit.	The Y axis has been commanded to move a number of steps but the CPU has not detected that the axis has moved out of the rear limit.
F244	The Theta axis has not moved from the CW limit.	The Theta axis has been commanded to move a number of steps but the CPU has not detected that the axis has moved out of the CW limit.
F246	The Z axis has not moved from the lower limit.	The Z axis has been commaded to move a number of steps but the CPU has not detected that the axis has moved out of the lower limit.
F250	Input voltage is out of operating range.	
F255	Chuck CCW sensor malfunction.	Chuck CCW limit has failed to switch.

Code	Definition	Cause/Corrective Action
F256	Chuck CW sensor malfunction	Chuck CW limit has failed to switch.
F301	Card No. 1 failure.	Press ENTER again.
F302	Card No. 2 failure.	Press ENTER again.
F303	Card No. 3 failure.	Press ENTER again.
F304	Card No. 4 failure.	Press ENTER again.
F305	Card No. 5 failure.	Press ENTER again.
F306	Card No. 6 failure.	Press ENTER again.
F310	EPROM failure.	Indicates a potential EPROM failure.
F311	RAM failure.	Indicates a potential RAM failure.
F322	Card No. 2 missing.	
F323	Card No. 3 missing.	
F324	Card No. 4 missing.	
F325	Card No. 5 missing.	
F326	Card No. 6 missing.	
F330	CMOS failure.	Indicates a potential CMOS memory failure.
F331	Spindle speed failure.	Verify air pressure and water pressure. Air pressure should be 80 psi.
F332	10v supply out of range.	Check line voltage.
F333	60v supply out of range.	Check line voltage.

APPENDIX

GLOSSARY

GLOSSARY

AGGREGATE - Abrasive (usually diamond) chips in the saw blade.

BLADE WIDTH - The nominal thickness of a blade.

CHIPPING - The action that occurs when particles (chips) of the material being sawn break away from the edge of the cut.

CUT COUNT - The total number of cutting strokes accumulated on a blade.

DICING - A basic method of cutting silicon wafers and other hard material. When dicing, the saw cuts in one direction of only.

DRESSING - A new blade is dressed by making cuts at progressively higher speeds until the blade is conditioned for the material to be cut.

EASY TEACH - A mode of programming the saw that allows the input and storage of a sequence of various instructions to be used with the standard program to expand the capabilities of the saw. It is also called TEACH function.

EXPOSURE - The distance that the blade protrudes from the hub. Also called blade length. It is measured in mils.

GRIT - Another name for aggregate.

HARD MATERIAL - Any material other than silicon, even though it may be softer than silicon.

INDEX - The distance between cuts (Y axis movement). Also the moving of the chuck under the optics.

KERF - The width of the saw cut in the material. Kerf is always larger than the blade width.

KERF LOSS - The width of a saw cut minus the width of the blade that made it, (theoretically, the loss of material due to sawing abberations).

LOADING - The accumulation of foreign matter between protruding diamond chip edges while the blade is cutting.

LUBRICANT - Solution or chemicals other than water used to improve cutting.

PENETRATION - The depth that a blade cuts into the material. It is measured in mils.

SCRIBING - Scribing is similar to dicing, except that the saw cuts in both directions of the X axis.

SLURRY - Material suspended in the coolant (or lubricant). It consists of particles of the material being cut and small amounts of blade wear products.

STREET - The space between individual integrated circuits on a wafer.

SUBSTRATE - A base material upon which circuitry or other materials may be attached.

WAFER - Generally, wafer refers to round silicon material containing a number of individual integrated circuits, or dies.

WHEEL - Another name for blade, also called cutting wheel.