OPTION D APPLICATIONS NOTE

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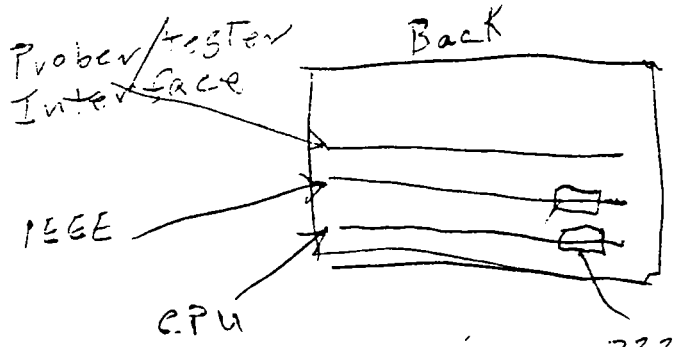

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I. UNDERSTANDING AND MODIFYING THE RS232 INTERFACE.

The RS232 serial interface is one of the most non-standard standards in the world. It is also one of the most common interfaces in use today,because it takes relatively few wires to implement and has fairly good noise immunity. Unfortunately,the standard was defined to implement communications between a terminal (DTE) and a modem telephone interface (DCE). The word "computer" does not appear in the EIA standard,thus its implementation in a computer to computer environment is pretty much left up to the designer of the interface. Figure 1 shows the major signals defined by the EIA standard. The ground and signal return lines have been omitted from the diagram. The pin numbers shown are those on the standard 25 pin D-shell connector most commonly used for RS232.

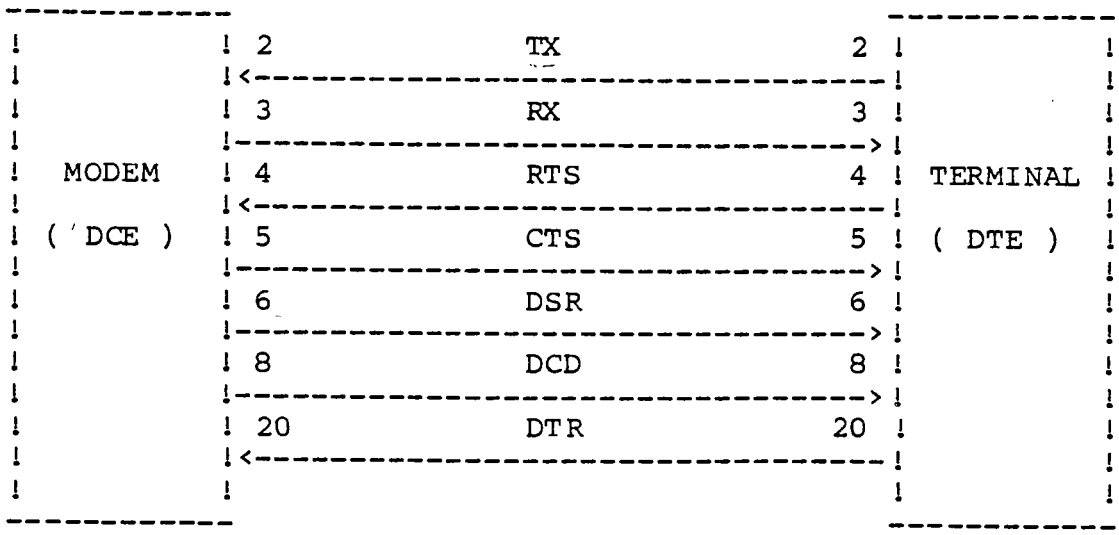

FIGURE 1. EIA RS-232-C STANDARD CONFIGURATION.

The first thing that has to be understood about the interface is that all signal names and directions are defined from the terminal's point of view. Thus,the terminal transmits over line TX,and receives over RX. Serial communication is bi-directional,but it takes two wires to go both directions,as shown in figure 1. Once this is understood,it is easy to see that the modem (DCE) must transmit over line RX,and receive over line TX.

The other signals are used for handshaking and status indication. DCD is a mnemonic for Data Carrier Detect,but is called out in the standard as RLSD (Received Line Signal Detect). Signal DCD is a status line,and indicates to the terminal that the modem is receiving a "carrier" signal from the modem at the other end of the telephone line. If DCD is not active,the terminal will not "listen" to it's receive line (RX). This is because DCD is defined to mean that the link is complete and any data seen by the terminal is valid data. Without this line active,the terminal's receiver

shuts off,since any data it receives,by definition,is not valid and is probably just noise. This helps to keep the terminal from displaying "garbage" when the link is not active. Signal DSR is another status line,and indicates to the terminal that the modem is connected to the telephone line and is generally ready to talk to the modem at the other end of the phone line,whenever that modem is ready. In this use,DSR would,in effect,tell the terminal that the communication link is ready at this end of the telephone line and DCD would tell the terminal that the link has been completed at both ends of the phone line and transmission/reception may begin.

The handshake line DTR tells the modem that the terminal is connected,turned on and generally ready to transmit/receive. DTR is a mnemonic for "Data Terminal Ready". This signal will often be "hard wired" active inside the terminal,and it will be left to the user to be sure he is ready to go before initiating communications. Handshake lines RTS and CTS are used to control transmission from the terminal. It is usually assumed that if DTR is active,the terminal is ready to receive,thus only transmission need be regulated. The transmission handshake is as follows: When the terminal wishes to transmit (i.e.; the user has pressed a key on the keyboard),it sets line RTS active. RTS is a mnemonic for "Request To Send". When the modem is ready for the terminal's data,it sets line CTS (Clear To Send) active. When the terminal sees CTS active,it transmits the data typed by the user. When the terminal has finished sending,it will set RTS inactive, and the modem,seeing RTS inactive,will set CTS inactive.

Figure 2 shows the interface when the modem is replaced by a computer. Note that the computer must "look like" a modem,since the terminal has not changed. Also,status lines DCD and DSR are not implemented,since they are primarily concerned with the telephone communications link,which does not exist in this configuration. These signals will usually be "hard wired" active inside the terminal. This allows the terminal to see the signals it wants,and allows two wires to be removed from the interconnecting cable. In many cases,the RTS,CTS and DTR handshake lines will also not be implemented,and a software handshake called "XON/XOFF" will be used instead. This allows the cable to consist of only three wires - TX,RX and ground.

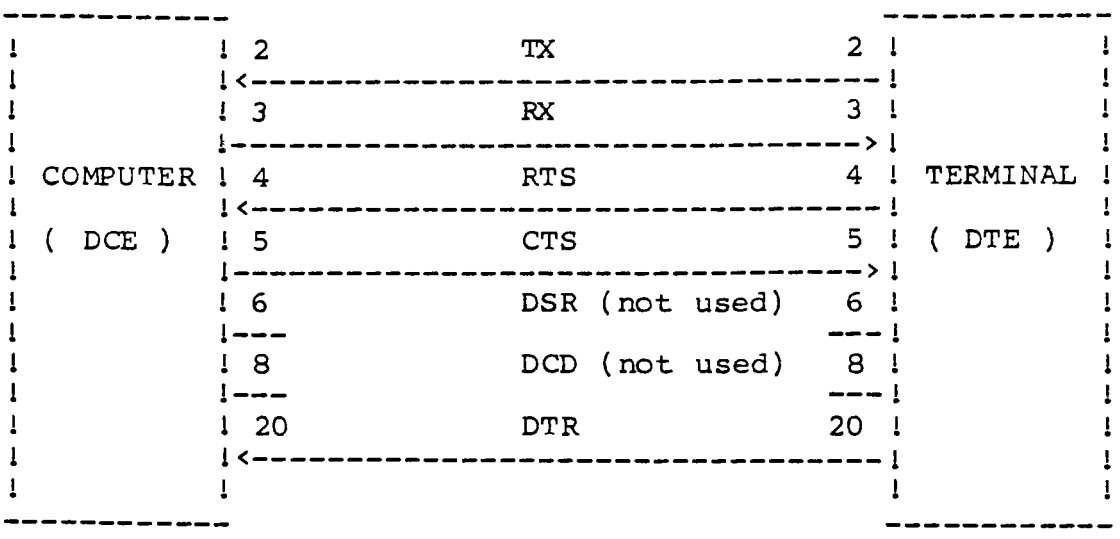

FIGURE 2. TYPICAL COMPUTER/TERMINAL CONFIGURATION.

Figure 3 shows the option D as it is shipped from the factory. All signal names and directions are from the option D's point of view. Compare this diagram to figure 2. You will notice that from the computer's point of view,all of the signals are going in the wrong direction. In addition,signal DCD is used,which is not implemented in the computer to terminal interface.

This configuration was chosen because it would interface with the Lear Siegler ADM3 dumb terminal. One of the design goals was that the option D be able to interface with a dumb terminal. Because of this requirement,plus the limitations of the MC6850 serial interface chip on the option D's CPU board,this configuration was implemented.

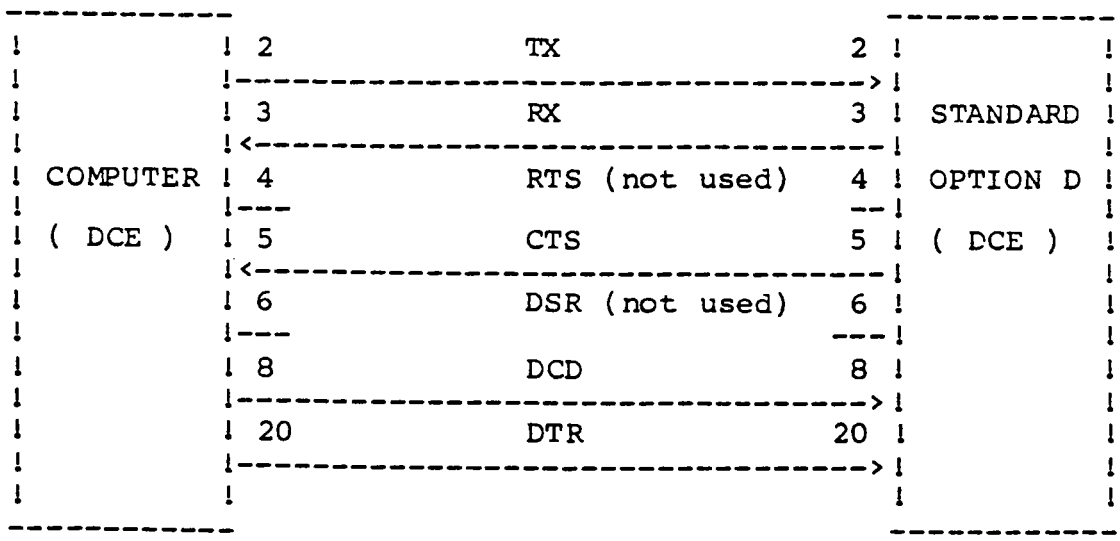

FIGURE 3. COMPUTER / OPTION D CONFIGURATION.

It should be noted that this diagram does not agree with the signal input/output description given on page 29 of the option D manual (pg. 20 for revision E and earlier manuals). The manual calls out DCD as Received Line Signal Detect,which is the other name for this signal,but it also specifies it as an output,not an input. This is because this signal is "hard wired" active inside the option D in such a way that the active level is output over this line. See the next section for details. In addition,the manual calls out signal DSR as an output,but it is shown as "not used" in figure 3. This signal is also hard wired active inside the option D. It performs no handshake function,but may be used as an indication that the option D is connected and turned on,if desired.

Figure 4 shows an interface configuration that can be obtained by modifying the option D. The modifications required are simply moving jumpers on the Motorola M68MM19 CPU board,no trace cutting or jumpering is neccessary. Before we discuss the modifications,however,an understanding of the MC6850 serial interface IC is required.

The 6850 only implements a partial set of the RS232 handshake / status lines. These are the RTS output and the CTS and DCD inputs. These IC functions match their names - CTS must be active before the IC will transmit and DCD must be active or the IC will not receive. The RTS output does not automatically perform its function,it must be set active or inactive by the software in the option D.

Lets examine how these IC functions are handled in the option D. Remember,we are talking about the 6850 IC's input/output pins, not neccessarily the RS232 signal lines of the same names.

The DCD input is tied active within the option D,thus the option D is always able to receive. This makes sense since the RS232 link generally has only 1 device on each end of the cable and there is no reason to inhibit reception at either end,as there would be if it was a buss structure.

The CTS input allows the 6850's transmitter section to operate. If this pin is inactive,the option D will not be able to transmit to the host computer. Note that the software inside the option D monitors this line when it wishes to transmit. If this pin is tied inactive,the option D will "hang" in an endless loop,waiting for CTS to go active.

The RTS output,as noted before,performs no automatic enabling or disabling function within the 6850,as the CTS and DCD inputs do. This output is completely software controlled. The software uses this line to perform the DTR function - that is, this output is active when the host computer may transmit to the option D. Thus,although Motorola named this pin "RTS",the option D uses it to perform the "DTR" function.

Now,let's look at the connections between the 6850 IC and the "outside world" RS232 signal lines. The 6850 RTS output runs the RS232 signal line CTS, and the RS232 signal line DTR is connected to the 6850's CTS input. The 6850's DCD input is connected to the RS232 signal line DCD. This pin,however,is also "hard wired" active inside the option D. The result of this is that the option D actually outputs an active level (+12 V) on RS232 signal line DCD. This is true for the standard option D and for the modifications that we will make. The ramifications of this are: (1) You do not have to connect a wire to this signal in your cable, and (2) If you do connect a wire to this signal,your computer must not fight the +12V level on this line. The upshot of all this is that the best thing to do with the DCD signal in your cable is simply not connect it.

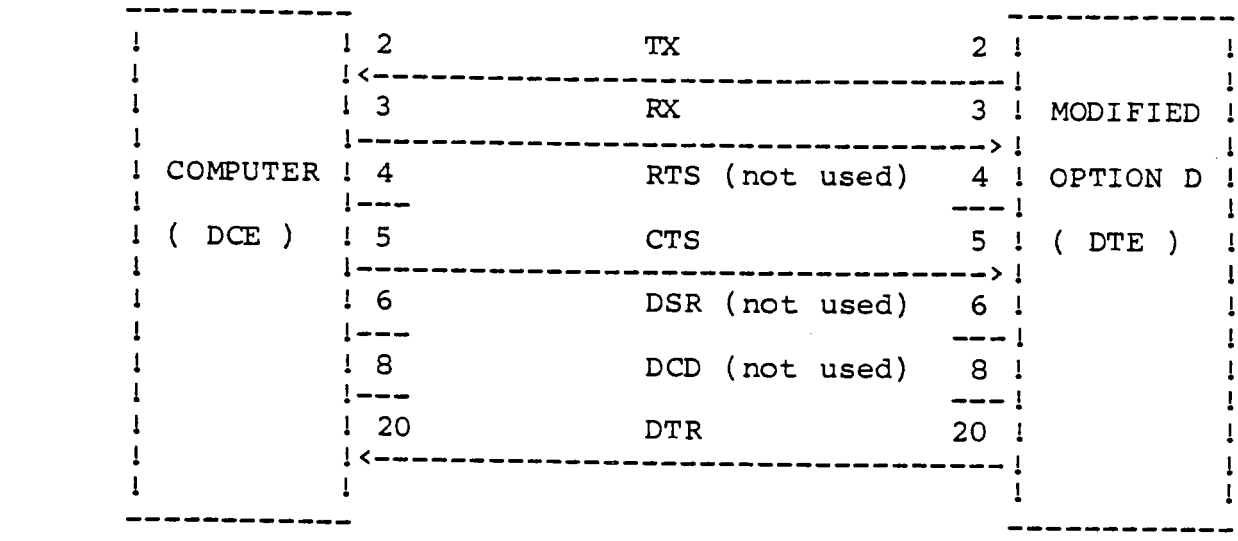

FIGURE 4. COMPUTER / MODIFIED OPTION D CONFIGURATION.

Now,for the modifications. On the M68MM19 CPU board is a patchpanel,with pin names KA,KB, KC and KD. This area configures the RS232 interface and is the area we need to change. To connect the 6850 IC's CTS input to the RS232 CTS signal line, move jumper KC11 to KC7. Now,the host computer may inhibit the option D's transmission by taking RS232 signal line CTS inactive.

Since the option D software considers the 6850's RTS output to be running a function equivalent to the RS232 DTR,let's move that output. Move jumper KA7 to KA11,and the RS232 signal line DTR now performs its assigned function.

To swap the transmit (TX) and receive (RX) lines,move jumper KA3 to KA1,and move KC1 to KC3. With both of these jumpers moved,the option D transmits over line TX and receives on line RX,the normal terminal configuration.

There is no way to get the option D to run the RTS function. However,we can hard wire that line active. If

your computer requires that RTS be active before it will listen to information coming from the option D,then you should add a jumper at position KD5.

Now that we have gone about as far as we can in getting the handshaking functions to work,lets examine another option. We can completely disable the handshaking by hard wiring the 6850's CTS input active and by not connecting its RTS output to the outside world. What this yields is the "3-wire" system shown in figure 5. The required ground wire is not shown,but it is the third wire.

Examining the advantages and disadvantages of the 3 wire system and the partial handshake system yields some interesting results. The partial handshake requires that the CTS line either be set active by the host computer to simply allow the option D to talk anytime it wishes,or that the host manipulate the CTS line in order to regulate the option D's transmission. In either case,the option D will attempt to talk whenever it has anything to say. Thus,the host has to either catch data from the option D at asynchronous intervals,or define specific times to activate CTS and listen for data. If the host can't catch data asynchronously,then it has to use the CTS line to regulate the option D. This will usually slow down the probing operation. If the host can catch data asynchronously,then there is no need to have CTS implemented,and it would save programming effort to simply tie it active inside the option D and not worry about it.

To disable the CTS input,first remove any and all of these jumpers: KC5,KC7,KC9,KC11. Then connect KC7 and KD7. The CTS input to the 6850 is now tied active. You may also remove the 6850's RTS output from the outside world by disconnecting any and all of jumpers KC5,KD5,KB5 and KA5.

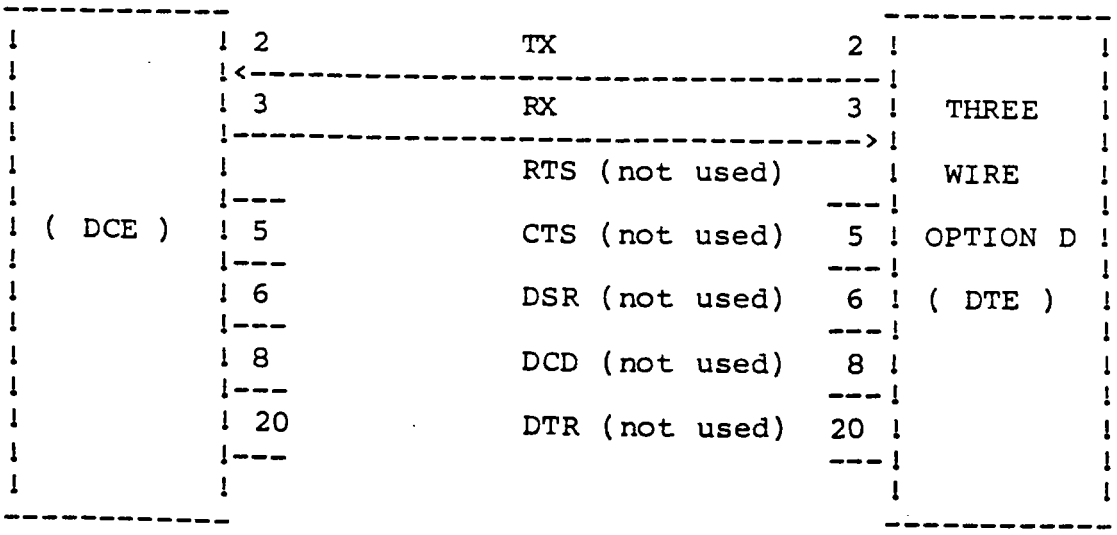

FIGURE 5. COMPUTER / OPTION D 3-WIRE CONFIGURATION.

The option D responds to every command with the angle bracket (>) prompt. Since most commands elicit no other response,handling this prompt should prove no problem. However,the query commands and the move command do require the option D to talk back,and it is necessary to know the sequence. The three query commands (?S,?P,?H) return the requested information,and then transmit the angle bracket. The move command,however,returns the angle bracket first,and then the "MC" move complete message. This must be taken into account when writing control software for the option D.

II. STARTING IN OTHER THAN QUADRANT II.

It is possible to begin probing in other than quadrant II (the top left corner) of a wafer. This is done by using negative numbers in the die size (DS) command. A negative number for the die x size inverts the x coordinate system,and a negative y size inverts the y coordinate system. Negating both x and y inverts the entire coordinate system. The following list provides the die size specifications required for starting in each quadrant. A 100 mil by 100 mil die is used for the examples. Spaces have been added within the commands for clarity.

```
QUADRANT I   : DSX -1000 Y  1000
QUADRANT II  : DSX  1000 Y  1000
QUADRANT III : DSX  1000 Y -1000
QUADRANT IV  : DSX -1000 Y -1000
```

There are some things to watch out for when using negative die sizes. As has been stated,this inverts one or both axes of the coordinate system. All move commands and position reports will be affected by this. For example,if both x and y die sizes are positive,the command: "MOX50Y20" will cause the positioner to move to the left and up. (Up is towards the back of the prober.) If,however,a negative x die size was specified,the same move command would cause the positioner to move to the right and up. In the same fashion,if a negative y was specified,the positioner would move down (toward the front of the prober).

No matter which quadrant probing begins in,the option D will automatically begin probing in the correct direction. This direction is towards positive increasing x coordinates and positive increasing y coordinates.

A useful side effect results from beginning probing in quadrant III - the option D will report die locations in cartesian coodinates. Cartesian coodinates have the x axis negative to the left of center, and positive x is to the right of center. Positive y is reported in the top half of the wafer,and negative y in the bottom half. By doing this,the reported x-y coordinates can be very simply translated into x-y coordinates for wafer mapping on a CRT or printer,by using an x and y offset. (The offset is required

since CRT coordinates usually place the 0,0 point at the lower left or upper left corner of the screen, rather than in the center.)

The option D will report in cartesian coordinates,but it is up to the test programmer to see that it reports the correct coordinates. The programmer will need to inspect the wafer and count the die positions to the left and bottom of the wafer from the center. These values would then be used in the preset (PRXnYn) command. For instance,if the wafer has 30 die in the x direction (at the center row of the wafer) and 40 die in the y direction,a preset of PRX-15Y-20 would be close. In actuality,you must count the die to find the correct x and y offsets to preset.

III. USING THE AUTOPROBE MODES.

The 5 autoprobe modes the option D provides gives you very powerful automatic control over your probing sequence. These autoprobe mode commands and their functions are:

AP0 - exits an autoprobe mode.
AP1 - standard edgesense probe.
AP2 - square pattern probe.
AP3 - circular probe.
AP4 - random access probe.

1. AP0 - EXIT AUTO PROBE MODE.

When the option D receives the "AP0" command,whatever probe mode it is in is terminated. The chuck does not move,and the option D is left in auto mode.

2. AP1 - STANDARD EDGESENSE PROBE.

This is the same probe mode as the 1034X prober performs without an option D connected. You can,of course,enable the wafer mapping function (WM1) or use the "?P" command to get the die coordinates for mapping your data. Also,by using negative die sizes as explained in section II,you can begin probing in other than quadrant II.

3. AP2 - SQUARE PATTERN PROBE.

Square pattern probing was designed for probing large hybrid assemblies and is not particularly useful for wafer probing.

4. AP3 - CIRCULAR PROBING.

In this mode,the edge sensor is used only to stop the Z-stage rise. Instead of using the edge sensor to determine if the prober is on or off the wafer,it calculates where the next die in the pattern is by using trigonometry. When the last die in a row is tested,the prober moves automatically to the first die in the next row. Thus,one benefit of circular probing is getting rid of the "turnaround" time that you have to live with when using the edgesense mode.

In order for circular mode to work,you need to give the option D more information than you normally do for edgesense mode. First,it needs to know the diameter of the wafer so that it can calculate where the end of the rows are. This information is given to the option D via the "pattern parameter" command. The format of this command is "PPDnnnnn",where "nnnnn" is the diameter of the wafer in either 0.1 mil or 1 micron units,depending on whether the prober is setup for english or metric units. Please note that the units used here (and in all other commands) should match the prober's english/metric switch setting.

Another parameter the option D needs is the "reference" die location. The reference die is a die that is a known distance from the starting die. This is usually a test die site since it is easy to align to. The option D assumes that the prober is at the reference die when you press the auto button. The reference die is designated by using the "RFXnnnYnnn" command. The "nnn"'s are the number of die to be moved to get to the preset point. For example,RFX5Y3 tells the option D to move 5 die in x and 3 die in y to get from the reference die to the starting point. Assuming that you have used positive die sizes and are starting in quadrant II,the chuck will move right 5 die and down 3 die. This is effectively moving left on the wafer and up on the wafer. (Observe this carefully - motions are confusing on the prober, since the die movement is always opposite the chuck movement.)

The last parameter needed (other than the die size,of course) is the preset. This is the "PRXnnnYnnn" command used in all modes. Operation is different in circular mode,however. In edgesense mode,the preset position is assigned to the die under the probes when the preset command is received. In circular mode,the die under the probes is assumed to be the reference die,and the chuck will move to the preset die location before beginning to probe.

An example is in order. Refer to figure 6 to see the results of the following command list. It should be noted that the order of the commands can be important. The order illustrated in the example is the order that should be used for circular probing.

```
DSX1000Y1000     (DIE SIZE IS 100 MILS BY 100 MILS)
PPD40000         (WAFER IS 4 INCHES IN DIAMETER)
RFX5Y3           (MOVE 5 X AND 3 Y TO GET TO PRESET DIE)
PRX10Y10         (STARTING DIE IS CALLED 10,10)
WM1              (ENABLE WAFER MAPPING)
AP3              (SELECT CIRCULAR PROBE MODE)
```

The operator should align the wafer so that the test die site (the reference die,marked "RF" in figure 6) is the die under the probes. When the prober is aligned,the option D "auto" button should be pressed. When it is,the chuck

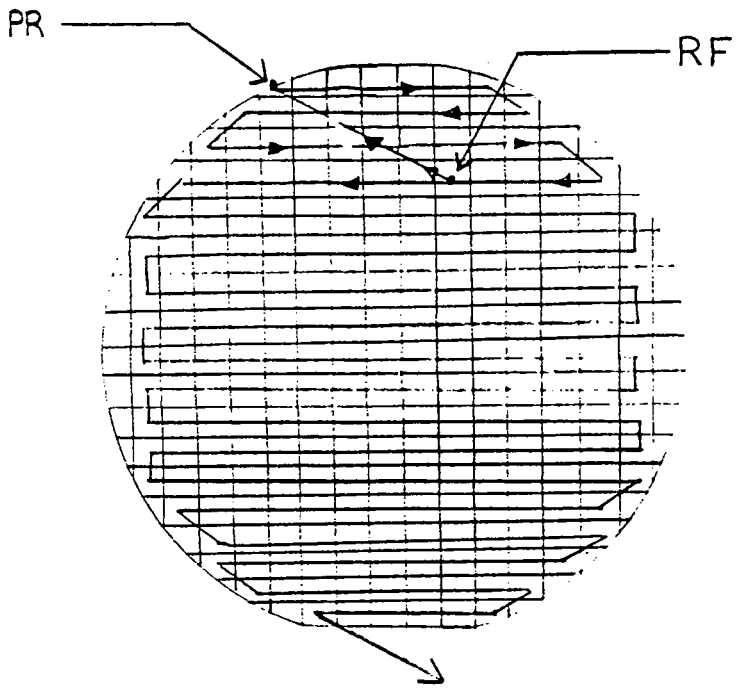

FIGURE 6. CIRCULAR PROBE OPERATION

will immediately move so that the preset die (marked "PR" in figure 6) is under the probes. The Z-stage will raise and the option D will output the message "TSDX10Y10" to the host computer. The x and y position windows on the option D front panel will also be displaying the numbers x 10 and y 10. When the test complete signal is received from the tester,the prober will move to the die to the right of the die just tested and the option D will issue the message "TSDX11Y10". This sequence will continue until the last die in the row is reached. After that die is tested,and the test complete signal received,the option D will step the prober directly to the first die in the row under the row tested previously.

The option D and prober will continue in this fashion until all die on the wafer have been probed. When the last die has been tested,and the test complete signal received,the option D will issue "PC" to the host,indicating the pattern complete condition. The stage will go to the harbor position,and the option D will switch itself into manual mode and issue the "MA" (manual) message to the host.

In practice,you will find that the option D will end up probing partial (edge) die,and will often step off of the wafer to the left or the right. The programmer needs to test his "RF" specification on the wafer before putting his program into production. Rarely should the "RF" position be the first whole die in the top row of the wafer. It will usually be a few die to the left of that first whole die. By trial and error,the test programmer can determine what "RF" spec is needed to keep the prober on the wafer most of the time. This will usually result in partial or non-existent die being probed on the top and bottom rows,but the option D will then step correctly through the main body of

the wafer (i.e.;not stepping 2 or 4 die to the right of the wafer edge).

5. AP4 - RANDOM ACCESS PROBE.

There are two main uses for the random access probe mode. The first is to test only the test die sites on a wafer,and the second is for sample probing. In addition,random access probe can be used to test just the test die sites on a wafer,and then go into one of the other autoprobe modes if the test die sites indicate the wafer is worth testing.

There is a set of commands the option D recognizes that relates only to random access probing. These commands are:

RS : RESET (CLEAR) THE LIST OF POINTS.
AD : ADD A POINT TO THE LIST.
DE : DELETE A POINT FROM THE LIST/.

The format of the "RS" (reset) command is just those two letters,there are no parameters. The list should always be cleared before you add new points to it or you will end up probing some strange locations - whatever points are left in the list or some "random" locations caused by the list being scrambled by power-up.

The "AD" (add) command is in the format "ADXnnnYnnn". Up to 128 points may be added at one time,this is the length of the list. Points are added in a backwards fashion. That is,the first point entered will be the last point probed,and the last point entered will be the first point probed.

The "DE" (delete) command format is "DEXnnnYnnn". This command will delete a point from the list. If there are two (or more) points in the list with the same coordinates,the delete command will only delete the first point from the list. For example,if there are two "X10Y5" points in the list (placed there by two separate "ADX10Y5" commands) the command "DEX10Y5" will only delete the first occurence in the list,the second "X10Y5" point will still be there until a second "DEX10Y5" command is sent.

The "PRXnnYnn" command is used to specify the starting point for the probe mode. This is,in effect,the 129th point in the learn list. When "AP4" is received and the option D is placed in auto mode,the die under the probes (at location PRXnnYnn) will be tested. The chuck will raise and the test start message will be issued. When the test complete message is received via the communication link or over the tester interface,the chuck will step to the die coordinates specified by the last entry in the list,and test it. Testing will continue in this fashion until the first die in the list is tested. When test complete is received for this die,the chuck will go to the home position and the option D will issue the "PC" (pattern complete) and "MA" (manual) messages,and go into the manual mode.

Let's examine the application described earlier - testing the ecm sites using random access probe,and then testing (or not testing) the rest of the wafer based on the results of the ecm tests.

Assume there are 5 ecm sites on the wafer. That means we need to add 4 points to the list,since our preset (PRXnYn) point will also be tested. However,we need to keep the option D from sending the positioner to the home position after the last die,since the option D will switch to manual mode at that point and we will lose control of it. This is done by adding an extra "dummy" point to the list, whose coordinates we know and can test for. Since we will possibly want to test the whole wafer at this point, let's make this dummy point the first die that we'll test if we test the whole wafer.

Since the option D is going to go through the list in a backwards fashion, we need to specify the points in reverse order,as shown in the example on the next page. This example assumes that the operator has positioned to the top left ecm die before the following command sequence is executed. If this is not convenient (i.e.;the operator can't signal this fact to the host) ,then modify the sequence so that the "PRX" and "AP4" commands are issued after the host receives the "AU" message from the option D.

T COMMAND	OPTION D RESPONSE	COMMENTS
DAD		
SX1000Y1000		SET DIE SIZE
RS		ALWAYS CLEAR THE LIST FIRST !
DX-5Y-4		DUMMY POINT,FIRST DIE ON WAFER
DX15Y17		BOTTOM RIGHT ECM DIE
ADX0Y17		BOTTOM LEFT ECM DIE
DX7Y10		CENTER ECM DIE
DX15,0		TOP RIGTHT ECM DIE
RX0Y0		PRESET,TOP LEFT ECM DIE
WM1		ENABLE POSITION REPORTING
P4		ENTER RANDOM ACCESS PROBE.

** OPERATOR NOW PRESSES 'AUTO' BUTTON ON OPTION D.

	AU	AUTO MODE REPORT
	TSDX0Y0	TEST START
(TEST...)		
C	TC0	HOST SENDS TC,OPT.D ECHOES
	TSDX15Y0	STEPS TO TOP RIGHT ECM DIE
(TEST...)		
C	TC0	
	TSDX7Y10	STEPS TO CENTER ECM DIE
(TEST...)		
TC	TC0	
	TSDX0Y17	STEPS TO BOTTOM LEFT ECM DIE.
(TEST...)		
TC	TC0	
	TSDX15Y17	STEPS TO BOTTOM RIGHT ECM DIE.
(TEST...)		
TC	TC0	
	TSDX-5Y-4	STEPS TO FIRST DIE OF WAFER

** HOST NOW DECIDES WHETHER TO TEST THE REST OF THE WAFER OR NOT. IF THE WAFER IS NOT TO BE TESTED,SEND THE "HO" COMMAND. THE OPTION D WILL GO HOME,SWITCH TO MANUAL MODE AND SEND THE "MA" MESSAGE. IF THE WAFER IS TO BE TESTED,PERFORM THE FOLLOWING:

P0		EXIT RANDOM ACCESS PROBE.
P1	TSDX-5Y-4	NOW IN EDGESENSE MODE.
(TEST...)		

Operation will now continue in the standard edgesense pattern. To test the next wafer,you don't need to send all of those commands again,just send the "PRX" and "AP4". The random access list is maintained until it is reset or power to the option D is removed.

IV. EXTERNAL MOTION CONTROL.

Direct control of the prober's motion is simple using the option D. Using the "MOXnYn" (move) command,you can step the prober directly to any position desired. The programmer does not need to control or worry about the

Z-stage, since the option D will lower the chuck prior to motion and raise it when motion is complete,if the chuck was up prior to the move. Thus,one "ZU" (z up) command may be issued before starting the move sequences,and the option D will handle all Z-stage motion during the actual x-y motion.

Motion can only be commanded while the option D is in auto mode. All move commands will be ignored while it is in manual mode. Also,an "AP0" (autoprobe off) command should be issued before the option D is placed in auto mode. That way,if the option D was in an autoprobe mode earlier,it won't take off in that probe mode when switched to auto mode.

The usual sequence is to download the die size (DS) and mode (MD) information first,then wait for the operator to align the wafer and press the "auto" button on the option D. When the "AU" message is received,the host should transmit the preset (PRXnYn) command. This sets the reference point for all subsequent motion. For example,if the command PRX0Y0 is sent,the command "MOX3Y1" would cause the positioner to step 3 die to the right and 1 die below the preset position,to location 3,1. Note that this assumes that absolute die positioning is used,as set by the "MDAD" command. If you preset to position 10,15 by sending PRX10Y15,you would mocve to the same die mentioned above by the command MOX13Y16.

It is not necessary to use absolute positioning. If the command "MDID" is sent,the option D will enter the "incremental die" positioning mode. This is a relative positioning mode,that is,the move commands specify a distance to move from the current position. In the examples above,the command "MOX3Y1" caused the positioner to step to location 3,1. In incremental mode,this command would cause the positioner to step 3 die to the right and 1 die down. If a preset position has been set via a "PRX" command,the option D will report it's location in absolute coordinates,even though it is moving incrementally. Thus,if you preset to 0,0 and then issue 3 "MOX5Y1" commands,the option D will report it's position as 15,3.

V. SAMPLE PROGRAMS.

The following programs are included to help demonstrate to systems and test programmers how to talk to the option D. They are written on an HP85 computer in BASIC. Most programmers will have no problems understanding what the programs are doing,but a few explanations are in order.

Statements that begin with "REM" or "!" are comments,and are not executed. Also,anytime an exclamation point (!) is seen (other than inside quotes ("")),all information to the right of the ! is treated as a comment. The "@" symbol is used to separate statements on a line. The statements "ENTER D;" and "OUTPUT D;" perform the IEEE-488 input and output functions.

All of the programs are quite similar,differing mainly in the operator prompts and in the commands sent to the option D. The first program,demonstrating the edge sense autoprobe mode, is commented more than the others in the areas pertaining to input and output details specific to the HP85 computer. This program should be examined by anyone who needs to write software for the option D,no matter what autoprobe mode is needed.

```
00 !
10 ! OPTION D SAMPLE PROGRAM
20 ! IEEE-488 VERSION
30 !
40 ! AUTOPROBE MODE=AP1,
50 ! EDGE SENSE MODE
60 !
70 ! WRITTEN FOR HP85 COMPUTER
80 !
90 ! BY JEFF HENSHAW,
00 ! ELECTROGLAS.
10 ! (408) 727-4482
20 ! 16 AUGUST 1982
30 !
40 CLEAR
50 DIM D$[100]
60 REM IF OPTION D SRQ FUNCTION IS ENABLED,VARIBLE 'S1' MUST BE 1
70 REM IF SRQ IS NOT ENABLED,VARIABLE 'S1' MUST BE 0
80 S1=1 ! SRQ IS ENABLED.
90 REM DEFINE IEEE488 INTERFACE ADDRESS
00 REM INTERFACE=7,OPTION D IS
10 REM DEVICE ADDRESS 1
20 D=701
30 REM IS OPTION D IN AUTO OR MANUAL MODE?
40 OUTPUT D ;"?S"
50 GOSUB 560
60 A$=D$[7,7] ! EXTRACT AUTO/MANUAL STATUS FROM RESPONSE
   IF A$="0" THEN GOTO 440
80 REM OPTION D IN AUTO
90 DISP "PRESS OPTION D'S 'MANUAL' BUTTON !!" @ BEEP @ D$=""
00 REM WAIT FOR MANUAL MODE
10 GOSUB 560
20 IF D$="MA" THEN 440
30 CLEAR @ GOTO 390
40 CLEAR
50 REM PROMPT OPERATOR
60 DISP "LOAD AND ALIGN WAFER."
70 DISP "ALIGN TO THE FIRST FULL DIE"
80 DISP "IN THE TOP LEFT SECTION OF"
90 DISP "THE WAFER."
00 DISP "PRESS THE 'AUTO' BUTTON ON THE"
10 DISP "OPTION D TO BEGIN PROBING!"
20 BEEP
30 GOSUB 560
40 IF D$="AU" THEN 630
50 GOTO 440
60 REM INPUT FROM OPTION D.
61 ! LINE 570 CHECKS TO SEE IF THE OPTION D SRQ FUNCTION IS
62 ! ENABLED. IF IT IS NOT,IT JUMPS TO LINE 610 TO ENTER THE
63 ! DATA FROM THE OPTION D. IF SRQ IS ENABLED,IT FALLS INTO
64 ! LINES 580-600 WHICH HANDLE THE SRQ.
70 IF S1=0 THEN 610
71 ! LINE 580 TESTS IEEE488 INTERFACE FOR SRQ ACTIVE
   ! IF SRQ NOT ACTIVE, LOOP ON LINE 580 - IN EFFECT,AN
73 ! ENDLESS LOOP UNTIL SRQ GOES ACTIVE.
74 ! LINE 590 PERFORMS THE IEEE488 SERIAL POLL FUNCTION.
```

```
75 ! IF SERIAL POLL RESPONSE IS NOT 64,THEN OPTION D IS NOT
   ! REQUESTING SERVICE AND PROGRAM STOPS.
   STATUS 7,2 ; S9@ IF BINAND(S9,32)=0 THEN 580
)0 S9=SPOLL(D)
)0 IF S9<>64 THEN DISP "ERROR-UNDEFINED GPIB DEVICE!" @ STOP
610 ENTER D ; D$
620 RETURN
30 REM PROBER IS NOW POSITIONED AT THE STARTING DIE
640 REM OPTION D IS IN AUTO MODE.
650 REM DOWNLOAD PARAMETERS AND BEGIN PROBING.
60 REM SET ABSOLUTE DIE POSITIONING MODE
70 OUTPUT D ;"MDAD"
680 REM DEFINE CURRENT DIE TO BE X=0,Y=0
90 OUTPUT D ;"PRX0Y0"
)0 REM SET DIE SIZE TO X=100 MILS,Y=100 MILS
710 OUTPUT D ;"DSX1000Y1000"
720 REM DISABLE WAFER MAPPING,WE DON'T NEED IT.
30 OUTPUT D ;"WM0"
740 REM
750 REM BEGIN PROBING
60 REM SET EDGESENSE MODE
70 D$=""
780 OUTPUT D ;"AP1"
790 REM WAIT FOR TEST START FROM OPTION D.
)0 GOSUB 560
810 IF D$[1,2]="PC" THEN 920 ! EXIT TEST LOOP IF PROBING COMPLETE
820 IF D$[1,2]="TS" THEN 860
   DISP "ERROR - UNEXPECTED MESSAGE!" @ BEEP
   DISP "MESSAGE=";D$
850 DISP "PROGRAM ABORTED!" @ STOP
60 REM CALL TEST SUBROUTINE
70 GOSUB 1100
880 REM TEST COMPLETE,WAIT FOR "TCn" MESSAGE
890 GOSUB 560
)0 IF D$[1,2]<>"TC" THEN 830
)0 GOTO 790 ! CONTINUE TEST LOOP
920 REM PROBING IS COMPLETE.
30 REM RECEIVE THE "MA"
:0 REM MESSAGE FROM THE
950 REM OPTION D.
60 GOSUB 560
'0 REM DISABLE AUTOPROBE MODE
980 OUTPUT 701 ;"AP0"
990 REM PROMPT OPERATOR
)00 CLEAR
)10 DISP "PROBING COMPLETE!"
1020 DISP
)30 DISP "REMOVE WAFER FROM CHUCK."
)40 DISP
1050 DISP "PRESS THE 'k1' KEY UNDER THE"
1060 DISP "CRT TO PROBE ANOTHER WAFER."
)70 ON KEY# 1,"TEST" GOTO 330
1080 KEY LABEL @ BEEP
1   GOTO 1090
.00 REM ** TEST SUBROUTINE **
..10 REM INSERT TEST ROUTINE BETWEEN LINES 1100 AND 9998.
```

LISTING 1 - EDGESENSE PROBE.

```
120 REM SINCE THIS IS A DEMO,
  0 REM THIS PROGRAM WILL
140 REM JUST WAIT FOR 50
150 REM MILLISECONDS AND THEN
160 REM SEND "TC" OVER THE
170 REM LINK TO THE OPTION D.
180 REM
190 WAIT 50
200 OUTPUT D ;"TC"
210 RETURN
999 END
```

LISTING 1 - EDGESENSE PROBE.

```
100 !
110 ! OPTION D SAMPLE PROGRAM
120 ! IEEE-488 VERSION
130 !
140 ! AUTOPROBE MODE=AP2,
150 ! SQUARE PATTERN MODE
160 !
170 ! WRITTEN FOR HP85 COMPUTER
180 !
190 ! BY JEFF HENSHAW,
200 ! ELECTROGLAS.
210 ! (408) 727-4482
220 ! 16 AUGUST 1982
230 !
240 CLEAR
250 DIM D$[100]
260 REM IF OPTION D SRQ FUNCTION IS ENABLED,VARIBLE 'S1' MUST BE 1
270 REM IF SRQ IS NOT ENABLED,VARIABLE 'S1' MUST BE 0
280 S1=1 ! SRQ IS ENABLED.
290 REM DEFINE IEEE488 INTERFACE ADDRESS
300 REM INTERFACE=7,OPTION D IS
310 REM DEVICE ADDRESS 1
320 D=701
330 REM IS OPTION D IN AUTO OR MANUAL MODE?
340 OUTPUT D ;"?S"
350 GOSUB 560
360 A$=D$[7,7] ! EXTRACT AUTO/MANUAL STATUS FROM RESPONSE
370 IF A$="0" THEN GOTO 440
380 REM OPTION D IN AUTO
390 DISP "PRESS OPTION D'S 'MANUAL' BUTTON !!" @ BEEP @ D$=""
400 REM WAIT FOR MANUAL MODE
410 GOSUB 560
420 IF D$="MA" THEN 440
430 CLEAR @ GOTO 390
440 CLEAR
450 REM PROMPT OPERATOR
460 DISP "LOAD AND ALIGN WAFER."
470 DISP "ALIGN TO THE FIRST DIE"
480 DISP "IN THE TOP LEFT SECTION OF"
490 DISP "THE AREA TO BE PROBED."
500 DISP "PRESS THE 'AUTO' BUTTON ON THE"
510 DISP "OPTION D TO BEGIN PROBING!"
520 BEEP
530 GOSUB 560
540 IF D$="AU" THEN 630
550 GOTO 440
560 REM INPUT FROM OPTION D.
570 IF S1=0 THEN 610
580 STATUS 7,2 ; S9@ IF BINAND(S9,32)=0 THEN 580
590 S9=SPOLL(D)
600 IF S9<>64 THEN DISP "ERROR-UNDEFINED GPIB DEVICE!" @ STOP
610 ENTER D ; D$
620 RETURN
630 REM PROBER IS NOW POSITIONED AT THE STARTING DIE
640 REM OPTION D IS IN AUTO MODE.
650 REM DOWNLOAD PARAMETERS AND BEGIN PROBING.
```

```
650 REM SET ABSOLUTE DIE POSITIONING MODE
660 OUTPUT D ;"MDAD"
670 REM DEFINE CURRENT DIE TO BE X=0,Y=0
680 OUTPUT D ;"PRX0Y0"
690 REM SET DIE SIZE TO X=100 MILS,Y=100 MILS
710 OUTPUT D ;"DSX1000Y1000"
720 REM SET SQUARE PATTERN LIMITS:5 IN X AND 10 IN Y
730 OUTPUT D ;"PPX5Y10"
740 REM DISABLE WAFER MAPPING,WE DON'T NEED IT.
750 OUTPUT D ;"WM0"
760 REM
770 REM BEGIN PROBING
780 REM SET SQUARE MODE
790 D$=""
800 OUTPUT D ;"AP2"
810 REM WAIT FOR TEST START FROM OPTION D.
820 GOSUB 560
830 IF D$[1,2]="PC" THEN 940 ! EXIT TEST LOOP IF PROBING COMPLETE
840 IF D$[1,2]="TS" THEN 880
850 DISP "ERROR - UNEXPECTED MESSAGE!" @ BEEP
860 DISP "MESSAGE=";D$
870 DISP "PROGRAM ABORTED!" @ STOP
880 REM CALL TEST SUBROUTINE
890 GOSUB 1120
900 REM TEST COMPLETE,WAIT FOR "TCn" MESSAGE
910 GOSUB 560
920 IF D$[1,2]<>"TC" THEN 850
930 GOTO 810 ! CONTINUE TEST LOOP
940 REM PROBING IS COMPLETE.
950 REM RECEIVE THE "MA"
960 REM MESSAGE FROM THE
970 REM OPTION D.
980 GOSUB 560
990 REM DISABLE AUTOPROBE MODE
1000 OUTPUT 701 ;"AP0"
1010 REM PROMPT OPERATOR
1020 CLEAR
1030 DISP "PROBING COMPLETE!"
1040 DISP
1050 DISP "REMOVE WAFER FROM CHUCK."
1060 DISP
1070 DISP "PRESS THE 'k1' KEY UNDER THE"
1080 DISP "CRT TO PROBE ANOTHER WAFER."
1090 ON KEY# 1,"TEST" GOTO 330
1100 KEY LABEL @ BEEP
1110 GOTO 1110
1120 REM ** TEST SUBROUTINE **
1130 REM INSERT TEST ROUTINE BETWEEN LINES 1120 AND 9998.
1140 REM SINCE THIS IS A DEMO,
1150 REM THIS PROGRAM WILL
1160 REM JUST WAIT FOR 50
1170 REM MILLISECONDS AND THEN
1180 REM SEND "TC" OVER THE
1190 REM LINK TO THE OPTION D.
1200 REM
1210 WAIT 50
```

```
220 OUTPUT D ;"TC"
230 RETURN
  9 END
```

LISTING 2 - SQUARE PATTERN.

```
100 !
110 ! OPTION D SAMPLE PROGRAM
120 ! IEEE-488 VERSION
130 !
140 ! AUTOPROBE MODE=AP3,
150 ! CIRCULAR MODE
160 !
170 ! WRITTEN FOR HP85 COMPUTER
180 !
190 ! BY JEFF HENSHAW,
200 ! ELECTROGLAS.
210 ! (408) 727-4482
220 ! 16 AUGUST 1982
230 !
240 CLEAR
250 DIM D$[100]
260 REM IF OPTION D SRQ FUNCTION IS ENABLED,VARIBLE 'S1' MUST BE 1
270 REM IF SRQ IS NOT ENABLED,VARIABLE 'S1' MUST BE 0
280 S1=1 ! SRQ IS ENABLED.
290 REM DEFINE IEEE488 INTERFACE ADDRESS
300 REM INTERFACE=7,OPTION D IS
310 REM DEVICE ADDRESS 1
320 D=701
330 REM IS OPTION D IN AUTO OR MANUAL MODE?
340 OUTPUT D ;"?S"
350 GOSUB 560
360 A$=D$[7,7] ! EXTRACT AUTO/MANUAL STATUS FROM RESPONSE
370 IF A$="0" THEN GOTO 440
380 REM OPTION D IN AUTO
390 DISP "PRESS OPTION D'S 'MANUAL' BUTTON !!" @ BEEP @ D$=""
400 REM WAIT FOR MANUAL MODE
410 GOSUB 560
420 IF D$="MA" THEN 440
430 CLEAR @ GOTO 390
440 CLEAR
450 REM PROMPT OPERATOR
460 DISP "LOAD AND ALIGN WAFER."
470 DISP "ALIGN TO THE REFERENCE DIE"
480 DISP "IN THE TOP LEFT SECTION OF"
490 DISP "THE AREA TO BE PROBED."
500 DISP "PRESS THE 'AUTO' BUTTON ON THE"
510 DISP "OPTION D TO BEGIN PROBING!"
520 BEEP
530 GOSUB 560
540 IF D$="AU" THEN 630
550 GOTO 440
560 REM INPUT FROM OPTION D.
570 IF S1=0 THEN 610
580 STATUS 7,2 ; S9@ IF BINAND(S9,32)=0 THEN 580
590 S9=SPOLL(D)
600 IF S9<>64 THEN DISP "ERROR-UNDEFINED GPIB DEVICE!" @ STOP
610 ENTER D ; D$
620 RETURN
630 REM PROBER IS NOW POSITIONED AT THE REFERENCE DIE
640 REM OPTION D IS IN AUTO MODE.
650 REM DOWNLOAD PARAMETERS AND BEGIN PROBING.
```

LISTING 3 - CIRCULAR PROBE.

```
50 REM SET ABSOLUTE DIE POSITIONING MODE
70 OUTPUT D ;"MDAD"
   REM SET DIE SIZE TO X=100 MILS,Y=100 MILS
10 OUTPUT D ;"DSX1000Y1000"
20 REM SET WAFER DIAMETER TO 3 INCHES
730 OUTPUT D ;"PPD30000"
732 REM DEFINE REFERENCE DIE TO BE 3X,5Y AWAY FROM 1ST DIE TO TEST
35 OUTPUT D ;"RFX3Y5"
737 REM DEFINE STARTING DIE TO BE X=0,Y=0
738 OUTPUT D ;"PRX0Y0"
40 REM DISABLE WAFER MAPPING,WE DON'T NEED IT.
50 OUTPUT D ;"WM0"
760 REM
770 REM BEGIN PROBING
80 REM SET CIRCULAR MODE
790 D$=""
800 OUTPUT D ;"AP3"
10 REM WAIT FOR TEST START FROM OPTION D.
820 GOSUB 560
830 IF D$[1,2]="PC" THEN 940 ! EXIT TEST LOOP IF PROBING COMPLETE
40 IF D$[1,2]="TS" THEN 880
50 DISP "ERROR - UNEXPECTED MESSAGE!" @ BEEP
860 DISP "MESSAGE=";D$
870 DISP "PROGRAM ABORTED!" @ STOP
80 REM CALL TEST SUBROUTINE
890 GOSUB 1120
900 REM TEST COMPLETE,WAIT FOR "TCn" MESSAGE
   GOSUB 560
   IF D$[1,2]<>"TC" THEN 850
930 GOTO 810 ! CONTINUE TEST LOOP
40 REM PROBING IS COMPLETE.
50 REM RECEIVE THE "MA"
960 REM MESSAGE FROM THE
970 REM OPTION D.
80 GOSUB 560
90 REM DISABLE AUTOPROBE MODE
1000 OUTPUT 701 ;"AP0"
010 REM PROMPT OPERATOR
020 CLEAR
1030 DISP "PROBING COMPLETE!"
040 DISP
050 DISP "REMOVE WAFER FROM CHUCK."
060 DISP
1070 DISP "PRESS THE 'k1' KEY UNDER THE"
090 ON KEY# 1,"TEST" GOTO 330
100 KEY LABEL @ BEEP
1110 GOTO 1110
120 REM ** TEST SUBROUTINE **
130 REM INSERT TEST ROUTINE BETWEEN LINES 1120 AND 9998.
1140 REM SINCE THIS IS A DEMO,
150 REM THIS PROGRAM WILL
160 REM JUST WAIT FOR 50
170 REM MILLISECONDS AND THEN
1   REM SEND "TC" OVER THE
190 REM LINK TO THE OPTION D.
200 REM
```

LISTING 3 - CIRCULAR PROBE.

```
210 WAIT 50
220 OUTPUT D ;"TC"
230 RETURN
299 END
```

LISTING 3 - CIRCULAR PROBE.

```
100 !
110 ! OPTION D SAMPLE PROGRAM
120 ! IEEE-488 VERSION
130 !
140 ! AUTOPROBE MODE=AP4,
150 ! RANDOM ACCESS MODE
160 !
170 ! WRITTEN FOR HP85 COMPUTER
180 !
190 ! BY JEFF HENSHAW,
200 ! ELECTROGLAS.
210 ! (408) 727-4482
220 ! 16 AUGUST 1982
230 !
240 CLEAR
250 DIM D$[100]
260 REM IF OPTION D SRQ FUNCTION IS ENABLED,VARIBLE 'S1' MUST BE 1
270 REM IF SRQ IS NOT ENABLED,VARIABLE 'S1' MUST BE 0
280 S1=1 ! SRQ IS ENABLED.
290 REM DEFINE IEEE488 INTERFACE ADDRESS
300 REM INTERFACE=7,OPTION D IS
310 REM DEVICE ADDRESS 1
320 D=701
330 REM IS OPTION D IN AUTO OR MANUAL MODE?
340 OUTPUT D ;"?S"
350 GOSUB 560
360 A$=D$[7,7] ! EXTRACT AUTO/MANUAL STATUS FROM RESPONSE
370 IF A$="0" THEN GOTO 440
380 REM OPTION D IN AUTO
390 DISP "PRESS OPTION D'S 'MANUAL' BUTTON !!" @ BEEP @ D$=""
400 REM WAIT FOR MANUAL MODE
410 GOSUB 560
420 IF D$="MA" THEN 440
430 CLEAR @ GOTO 390
440 CLEAR
450 REM PROMPT OPERATOR
460 DISP "LOAD AND ALIGN WAFER."
470 DISP "ALIGN TO THE TEST DIE"
480 DISP "IN THE TOP LEFT CORNER OF"
490 DISP "THE WAFER,THEN"
500 DISP "PRESS THE 'AUTO' BUTTON ON THE"
510 DISP "OPTION D TO BEGIN PROBING!"
520 BEEP
530 GOSUB 560
540 IF D$="AU" THEN 630
550 GOTO 440
560 REM INPUT FROM OPTION D.
570 IF S1=0 THEN 610
580 STATUS 7,2 ; S9@ IF BINAND(S9,32)=0 THEN 580
590 S9=SPOLL(D)
600 IF S9<>64 THEN DISP "ERROR-UNDEFINED GPIB DEVICE!" @ STOP
610 ENTER D ; D$
620 RETURN
630 REM PROBER IS NOW POSITIONED AT THE 1ST TEST DIE
640 REM OPTION D IS IN AUTO MODE.
650 REM DOWNLOAD PARAMETERS AND BEGIN PROBING.
```

```
 60 REM SET ABSOLUTE DIE POSITIONING MODE
    OUTPUT D ;"MDAD"
600 REM DEFINE STARTING DIE TO BE X=0,Y=0
 90 OUTPUT D ;"PRX0Y0"
 00 REM SET DIE SIZE TO X=100 MILS,Y=100 MILS
710 OUTPUT D ;"DSX1000Y1000"
 20 REM CLEAR THE OPTION D'S LIST
 30 OUTPUT D ;"RS"
740 REM DOWNLOAD THE OTHER 4 TEST DIE SITE LOCATIONS.
750 OUTPUT D ;"ADX16Y16"
 60 OUTPUT D ;"ADX0Y16"
 70 OUTPUT D ;"ADX8Y8"
780 OUTPUT D ;"ADX16Y0"
 90 REM DISABLE WAFER MAPPING,WE DON'T NEED IT.
 00 OUTPUT D ;"WM0"
810 REM
 20 REM BEGIN PROBING
 30 REM SET RANDOM ACCESS MODE
840 D$=""
850 OUTPUT D ;"AP4"
 60 REM WAIT FOR TEST START FROM OPTION D.
870 GOSUB 560
880 IF D$[1,2]="PC" THEN 990 ! EXIT TEST LOOP IF PROBING COMPLETE
 90 IF D$[1,2]="TS" THEN 930
 00 DISP "ERROR - UNEXPECTED MESSAGE!" @ BEEP
910 DISP "MESSAGE=";D$
920 DISP "PROGRAM ABORTED!" @ STOP
    REM CALL TEST SUBROUTINE
940 GOSUB 1170
950 REM TEST COMPLETE,WAIT FOR "TCn" MESSAGE
 60 GOSUB 560
 70 IF D$[1,2]<>"TC" THEN 900
980 GOTO 860 ! CONTINUE TEST LOOP
 90 REM PROBING IS COMPLETE.
 00 REM SEND THE POSITIONER
1010 REM TO THE HOME POSITION.
1020 OUTPUT D ;"HO"
 030 GOSUB 560 ! GET "MA" MESSAGE
1040 REM DISABLE AUTOPROBE MODE
1050 OUTPUT 701 ;"AP0"
 060 REM PROMPT OPERATOR
 070 CLEAR
1080 DISP "PROBING COMPLETE!"
1100 DISP "REMOVE WAFER FROM CHUCK."
 110 DISP
1120 DISP "PRESS THE 'k1' KEY UNDER THE"
1130 DISP "CRT TO PROBE ANOTHER WAFER."
 140 ON KEY# 1,"TEST" GOTO 330
 150 KEY LABEL @ BEEP
1160 GOTO 1160
 170 REM ** TEST SUBROUTINE **
 180 REM INSERT TEST ROUTINE BETWEEN LINES 1170 AND 9998.
1190 REM SINCE THIS IS A DEMO,
1200 REM THIS PROGRAM WILL
 210 REM JUST WAIT FOR 50
1220 REM MILLISECONDS AND THEN
```

LISTING 4 - RANDOM ACCESS PROBE.

```
 230 REM SEND "TC" OVER THE
 240 REM LINK TO THE OPTION D.
 250 REM
 260 WAIT 50
 270 OUTPUT D ;"TC"
1280 RETURN
9999 END
```

LISTING 4 - RANDOM ACCESS PROBE.