Brewer Science, Inc., Rolla, MO
Cee® Division - Manufacturing Group
Originator - Dave Wilson, Tech Doc Coordinator
Approved By: Tom Edington, Mfg Mgr.

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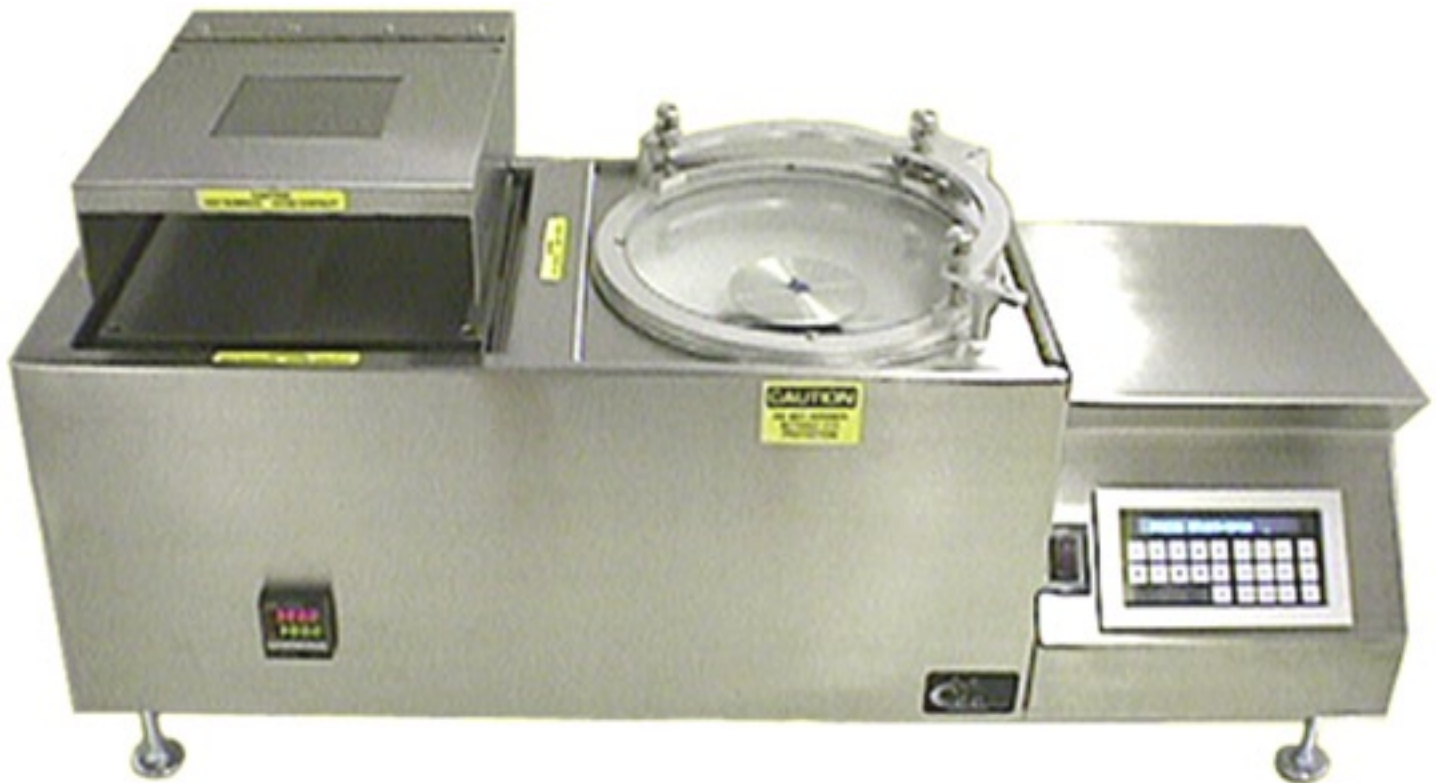Effective Date: 09 Feb 00
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Cee® Model 100CB

OPERATORS' MANUAL

Brewer Science, Inc., Rolla, MO
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CEE®
Cost Effective Equipment

Model 100CB

SECTION 0

<div style="border:1px solid black">

SYSTEM DESCRIPTION

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Originator - Dave Wilson, Tech Doc Coordinator
Approved By: Tom Edington, Mfg Mgr.

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Section 0.
SYSTEM DESCRIPTION:

SPECIFICATIONS

MODEL:	Cee (Cost Effective Equipment) Model 100CB Hotplate/Spinner.
TEMPERATURE CONTROL:	PID (Proportional Integral Derivative) Microprocessor controlled to a maximum temperature of 300° C (400° C optional) with 1.0°-C resolution (0.1° C optional with platinum RTD sensor).
SPIN CONTROL:	PID (Proportional Integral Derivative) Microprocessor controlled to a maximum speed of 6000 RPM (+/- 5RPM) with an acceleration of 30,000 RPM/s.
SUBSTRATE SIZE:	Standard capacities of 0.5 to 8 inches depending on model and/or retrofit. Custom chuck configurations also available.
EXHAUST COVER:	Cee open-faced single-lip exhaust cover supplied as standard equipment on all hotplates.
USER PROGRAM STORAGE:	Lithium battery, life expectancy of 33 years.
POWER SUPPLY:	120 Volts AC (240 Volts AC, optional), 1500 Watts.
UTILITIES:	Nitrogen: 35 psi minimum. Vacuum: 25" Hg Drain: 3/4" O.D. Spinner exhaust: 1" O.D. Hot chuck exhaust: 2" O.D.
DIMENSIONS:	13" height x 38" length x 13" depth
WEIGHT:	79 lb

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Section 0.
SYSTEM DESCRIPTION:

FEATURES

- The battery-backed memory stores up to ten user programs containing preset values for bake temperature, bake time, and bake method while the machine is operating in the hotplate mode. A bake program contains up to three consecutive bake methods. The spinner mode of operation also contains ten user programs with ten individual steps for setting spin speed, acceleration and time which allows for very precise spinning.

- The Model 100CB Hotplate/Spinner supports three bake methods: proximity, soft-contact, and hard-contact (For more information, see bake methods in Section 10). These bake methods provide maximum control of substrate warmup, solvent drying, and resin curing characteristics.

- A separate microprocessor allows greater control of temperature critical processes. The Model 100CB Hotplate/Spinner is capable of bake temperatures to a maximum of 300° C with a resolution of 1.0° C (400° C and/or 0.1° C, respectively, optional).

- A benchtop unit, the 100CB Hotplate/Spinner occupies less than four square feet and requires only common utilities: 120 Volts AC (240 VAC optional), exhaust, drain, nitrogen gas or clean dry air (CDA) and vacuum connections.

- Built-in diagnostic firmware aids in system installation and testing.

- Single-step operating mode allows substrate baking without prior programming setup for quick processing of one or two substrates.

- Information on various options will be distributed as they become available.

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SECTION 1

UNPACKING INSTRUCTIONS

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Section 1.
UNPACKING INSTRUCTIONS

Your Model 100CB Hotplate/Spinner has been packed using urethane foam and a protective covering of plastic wrap to reduce the possibility of damage to the unit during shipment.

UNPACKING THE UNIT

1. Remove all packing material from the shipping container. Remove manuals, cables and/or any accessories that were packed with the unit.

2. Lift the unit out of the carton by grasping the ends of the machine only. Do not lift it by the top covers or protrusions. Do not turn the machine onto its' side or ends. Remove the protective plastic wrap.

3. On the rear of the unit you will find two, 1/4" NPT pipe fittings: NITROGEN(N2) and VACUUM(VAC). Connect these to a nitrogen source of at least 35 psi and a vacuum source of 25" Hg.

4. Also on the rear of the unit, you will find three utility connections. Connect the drain (3/4" O.D.) to the house chemical drain facilities. Connect the spinner exhaust (1" O.D.) and the hot chuck exhaust (2" O.D.) to the house exhaust system.

5. Plug the power cord into an appropriately grounded 110 volt AC outlet. Verify correct operation by pushing the power switch to the ON position. The keypad display should read "**CEE ---100CB SPINNER**". Pressing the "**OPT.**" key will switch the keypad display and system firmware to the hotplate display and operating system. The display should now read "**CEE --- 100CB HOTPLATE**".

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Section 1.
UNPACKING INSTRUCTIONS

UNPACKING THE UNIT *continued*

Hot Surface: The chuck surface is hot and should not be touched. The substrates should not be touched after the baking process until sufficient time for cooling has elapsed.

6. Press the "**DIAG**" key to enter the hot plate *Diagnostic* mode. Press the "**1**" key to activate the nitrogen (or CDA) feed to the proximity cushion on the hot chuck. This will allow you to proceed with the next step, the precise leveling of the unit.

7. Place a wafer of correct size on the chuck. Adjust the leveling legs until the wafer does not move appreciably toward the left or right side of the chuck - but does tend to float toward the rear of the hotchuck into the centering (stop) pins.

8. Press the "**RESET**" key to turn off the nitrogen flow to the proximity cushion on the hot chuck.

9. Pressing the "OPT" key a second time will return you to the Spinner portion of the system firmware and the keypad display will return to the "**CEE --- 100CB SPINNER**" message.

* * * * *

This completes the setup procedure.

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SECTION 1

SYSTEM CONTROL

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Section 1.
SYSTEM CONTROL:

 System operation for both the hotplate and spinner sections is accomplished through one keyboard. This is made possible by multi-tasking the operating system of each section. Switching between operating systems is accomplished by simply pressing the "OPT." (option) key. Upon power-up the system will revert to the spinner display

By pressing the "OPT." key control is switched over to the hotplate operating system.

Control can be switched at anytime in either the hotplate or spinner modes.

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SECTION 2

HOTPLATE SYSTEM OPERATION

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Section 2.
HOTPLATE SYSTEM OPERATION:

KEYBOARD FUNCTIONS

The Model 100CB Hotplate/Spinner has two independent microprocessors; one for the system firmware and one for the temperature controller.

The keyboard shown below controls the system firmware. All programming and system functions of the machine originate here.

The second keypad is used for programming the temperature control microprocessor. However, during normal operations, the system firmware controller automatically and directly instructs the temperature controller.

SYSTEM KEYBOARD FUNCTIONS:
Hot plate operation:

> 0-9 number Selects a program to modify or to run, as well as, encoding numerical data.

> PROGram   Places the system in program mode.

> RUN Places the system in run mode. Allows selection of desired program to execute.

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Section 2.
HOTPLATE SYSTEM OPERATION:

KEYBOARD FUNCTIONS *continued*

DIAGnostics	Starts diagnostic routines. These manually operate chuck nitrogen and vacuum and are primarily used for system checkout.
START	Begins execution of a user bake program when requested through the display. In the event of an error, this key instructs the system to continue from the point at which the error occurred.
STOP	Ends the bake cycle--immediately--at any time during operation.
RESET	Resets the system completely. All operations halt, and the system returns to the model number display shown above. *An important note: the controller will not remember a substrate on the chuck after a reset. Remove the substrate manually.*
ENTER	Signifies acceptance of the currently displayed choice during data entry and program selection. This key and the CLEAR key function very much like a calculator/computer keyboard

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Section 2.
HOTPLATE SYSTEM OPERATION:

KEYBOARD FUNCTIONS *continued*

CLEAR	Clears unwanted or invalid information during data entry. This key also selects the no bake (NOBKE) option when setting up a user program.
CONFiguration	Configures system parameters and allows selection (in percent) of a usable bake temperature range.
OPTions	Switches control between hotplate and spinner operating systems.
PROXimity	Selects proximity bake during system programming.
CONTact	Selects soft-contact bake during system programming.
VACuum	Selects hard-contact (vacuum) bake during system programming.

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Section 2.
HOTPLATE SYSTEM OPERATION:

KEYBOARD FUNCTIONS *continued*

Menu Access Key
Used to enter or exit the menu system, index to the next menu and enter the Security Level menu

Raise Key
Used to Increase values. (Hold for fast-step progression)

Lower Key
Used to decrease (Hold to fast-step progression)

Mode / Enter Key
Used to enter Parameter selections, access operating modes, release latched alarms & index through menu items.

Except under specified circumstances, the user does not manipulate the temperature-control keyboard on the Model 100CB Hotplate. The system controller instructs the temperature controller during normal functions rendering operator intervention unnecessary.

The display provides information about the current temperature set point, as well as, the current chuck temperature. By manipulating the keyboard, the display reveals information related to output power and tuning.

The temperature controller incorporates a red and green LED display. Display of the current chuck temperature occurs at all times. The red LED display shows the current temperature. The green LED display shows the set point.

A small red LED next to 01 indicates if the chuck heater is activated.

The temperature for the Model 100CB Hotplate standard package ranges from 30° to 300° C; therefore, the controller will not allow input beyond this range. The 400°-C option permits input to this higher range.

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SECTION 3

HOTPLATE SYSTEM CONFIGURATION

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Section 3.
HOTPLATE SYSTEM CONFIGURATION:

This section presents the system configuration for the Model 100CB hotplate section.

The system configuration procedure initiates the system parameters in regards to loading and unloading substrates and also substrate size.

In addition, this procedure instructs the system as to the maximum temperature error (in percent) acceptable before baking a substrate.

NOTE--The default values provided represent examples; values may be different in a given machine.

PROCEDURE

1.   From the model number display (CEE ----100CB HOTPLATE), press the CONF key. This enters the configuration mode.

CEE --- 100CB HOTPLATE
PRESS CONF KEY

The display now reads "SYS. OPTIONS -". Following is a list of the keys used for selecting the system options.

SYSTEM OPTIONS:

1   Enables single step function.

5   Changes substrate size on hot chuck.

6   Enters standard system configuration.

9   Enables/Disables serial communications between system controller and temperature controller

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Section 3.
HOTPLATE SYSTEM CONFIGURATION:

OPTION 1:

The single step function enables the operator to bake wafers without prior system programming. As a result, five or ten substrates may be baked with different methods and different bake times without having to preset ten user programs.

All options are accessible from the model number display (CEE ----- 100CB HOTPLATE). Option 1 contains the single step function.

To enable this function, press the 1 key. The display reads "SYS. OPTIONS - SSTEP." The system waits for input from the user.

| SYS. OPTIONS - |
| PRESS "1" |

Press ENTER; this engages the single step function which remains in effect until pressing the RESET key.

| OPTION-- SSTEP |
| (ENTER) |

Next, press the RUN key to enter run mode as detailed in Section 5.

| CEE --- 100CB HOTPLATE |
| PRESS RUN KEY |

The display reads "RUN PROG# ? _   SSTEP" indicating that the selected program will be run in single step mode.

| RUN PROG# ?_ SSTEP |
| ENTER PROGRAM # |

The system uses the bake temperature from the preset program.

When the temperature falls within range or override occurs, the operator chooses the bake method. Choose a method "PROX," "CONT," or "VAC" and press "ENTER".

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Section 3.
HOTPLATE SYSTEM CONFIGURATION:

OPTION 1 *continued*

PGM # SSTEP
ENTER NEW METHOD
(PROX, CONT, or VAC-ENTER)

The substrate loads onto the chuck and bakes as usual except for the display counting up from 0 in seconds.

After reaching the desired bake time, press the STOP key. The substrate can then be unloaded from the chuck.

Processing continues in this fashion until pressing the RESET key which restores the normal operating mode.

OPTION 5:
This option allows the user to change substrate size on the chuck. If the machine has the multi-substrate option installed refer to the appendix for details.

OPTION 6:
Option 6 initiates the system parameters in regards to loading and unloading substrates.

In addition, this procedure instructs the system as to the maximum temperature error (in percent) acceptable before baking a substrate.

NOTE--The default values provided represent examples; values may be different in a given machine.

PROCEDURE
1. From the model number display (CEE ----100CB HOTPLATE), press the CONF key.

CEE --- 100CB HOTPLATE
PRESS CONF KEY

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Section 3.
HOTPLATE SYSTEM CONFIGURATION:

PROCEDURE *continued*

The display now reads "SYS. OPTIONS". Press "6" to enter the configuration loop.

Next, the display reads "CHK LOADING TIME   2," where "2" indicates that a 2-second gas-pillow settling time exists when loading a substrate.

CHK LOADING TIME 2
ENTER ENTRY TIME
(ENTER)

When a number or the cursor flashes on the display, the system waits for input from the operator. At this point, pressing ENTER leaves the value unchanged; CLEAR facilitates the changing of input by entering the desired number, then pressing ENTER.

CHK LOADING TIME 2
ENTER ENTRY TIME
(CLEAR-4-ENTER

2. After configuring the entry type, configure the exit type. The display will read "CHK UNLOADING TIME   2", where "2" indicates that a 2-second gas-pillow settling time exists when loading a substrate. Retain or replace this value in the same manner as the entry time.

3. At this point, the display reads "TEMP ERROR PRCNT   3.0," where 3.0% equals the maximum error tolerated before actually baking wafers. Retain or replace this value in the same manner as for the entry time.

TEMP ERROR PRCNT 3.0
ENTER ERROR PERCENT
(CLEAR - 4 - 0 - ENTER)

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HOTPLATE SYSTEM CONFIGURATION:

PROCEDURE *continued*

With the value of 3.0% and a setpoint of 100° C, the system would not bake a wafer unless the chuck temperature equals at least 97° C, but not greater than 103° C. Acceptable values range from 0.1% to 9.9%.

Note: Setting the error range to 0.0% effectively shuts off the temperature checking function. Turn off this function if operations can tolerate unusually large temperature variations.

4. Up to this point, a temporary buffer stores any changes; no modifications occur to the system configuration. To make the changes permanent, enter "1" by pressing the "1" key followed by ENTER.

STORE DATA 1/0
ENTER # 1
(1-ENTER)

Before initiating permanent changes, if uncertainty about any changes exists, or the operator desires to review the default settings, enter "0" to return to the first display "CHK LOADING TIME 2."

STORE DATA 1/0
ENTER # 1
(0-ENTER)

5. After storing all changes, the system returns to the model number display.

To quit the configuration mode, press RESET at any time. The system returns to the model number display without storing any changes to the system configuration.

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Section 3.
HOTPLATE SYSTEM CONFIGURATION:

PROCEDURE *continued*

OPTION 9:

Option 9 is used to enable or disable the communications link between the system controller and the temperature controller. During normal operating conditions the communications link should not be terminated. All units are shipped with the communications enabled.

1. From the model number display (CEE ----100CB HOTPLATE), press the CONF key.

CEE --- 100CB HOTPLATE
PRESS CONF KEY

The display now reads "SYS. OPTIONS". Pressing the "9" key will disable the serial communications. The display will momentarilly show "SER. COMM. OFF", and then will revert back to the model number display.

SYS. OPTIONS
(9)

2. To reenable communications repeat step one

* * * * *

This completes the system configuration procedure.

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SECTION 4

HOTPLATE PROGRAMMING

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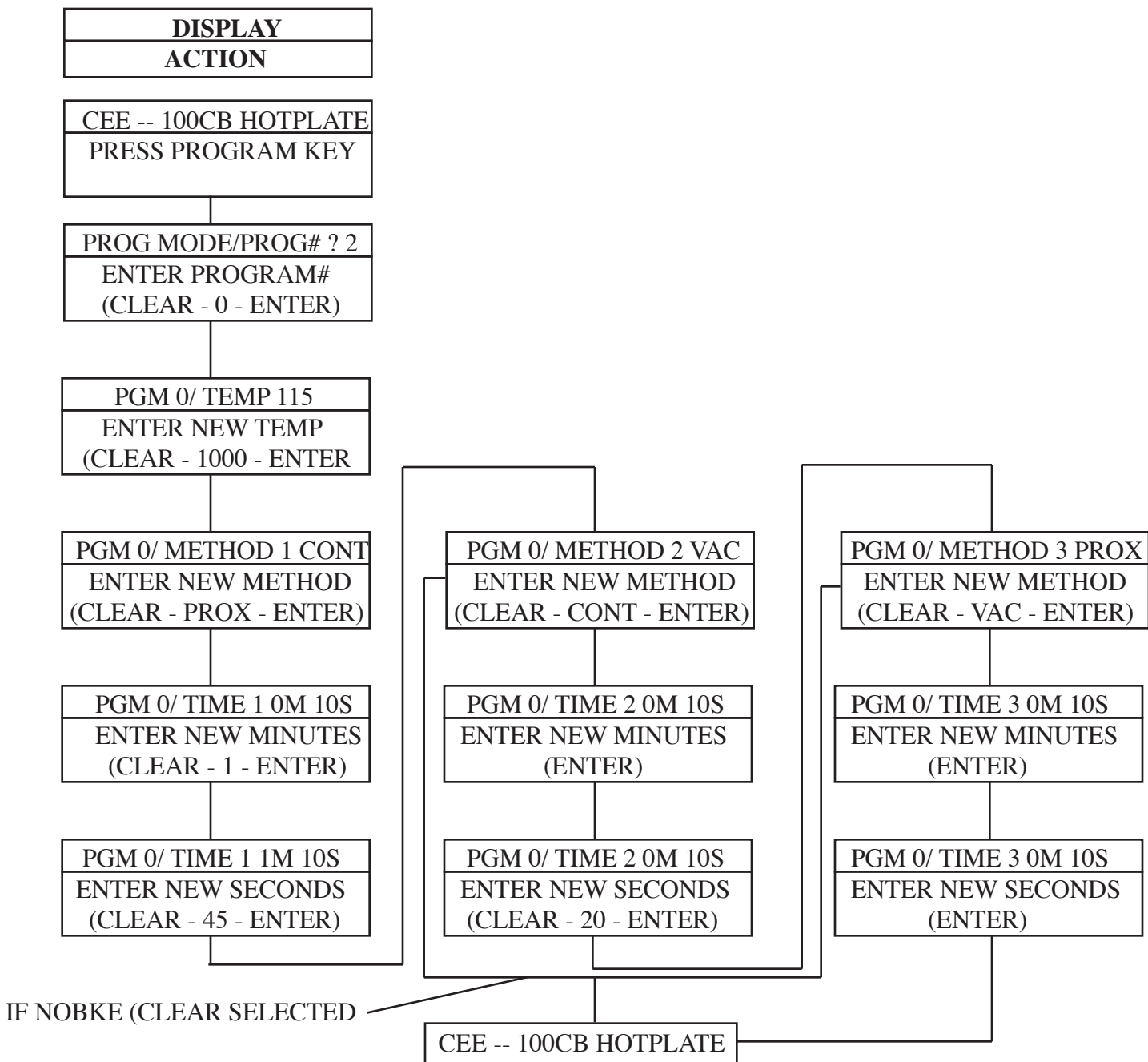
Section 4.
HOTPLATE PROGRAMMING:

The Model 100CB Hotplate section stores ten user programs in battery-backed memory. Programs contain information such as bake temperature, up to three bake methods, and bake times. Programs, numbered zero to nine, are individually modified or reviewed.

NOTE--Default values are examples and may be different in a given machine.

FLOW CHART SYSTEM PROGRAMMING

DISPLAY
ACTION

CEE -- 100CB HOTPLATE
PRESS PROGRAM KEY

PROG MODE/PROG# ? 2
ENTER PROGRAM#
(CLEAR - 0 - ENTER)

PGM 0/ TEMP 115
ENTER NEW TEMP
(CLEAR - 1000 - ENTER

PGM 0/ METHOD 1 CONT	PGM 0/ METHOD 2 VAC	PGM 0/ METHOD 3 PROX
ENTER NEW METHOD	ENTER NEW METHOD	ENTER NEW METHOD
(CLEAR - PROX - ENTER)	(CLEAR - CONT - ENTER)	(CLEAR - VAC - ENTER)

PGM 0/ TIME 1 0M 10S	PGM 0/ TIME 2 0M 10S	PGM 0/ TIME 3 0M 10S
ENTER NEW MINUTES	ENTER NEW MINUTES	ENTER NEW MINUTES
(CLEAR - 1 - ENTER)	(ENTER)	(ENTER)

PGM 0/ TIME 1 1M 10S	PGM 0/ TIME 2 0M 10S	PGM 0/ TIME 3 0M 10S
ENTER NEW SECONDS	ENTER NEW SECONDS	ENTER NEW SECONDS
(CLEAR - 45 - ENTER)	(CLEAR - 20 - ENTER)	(ENTER)

IF NOBKE (CLEAR SELECTED

CEE -- 100CB HOTPLATE

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Section 4.
HOTPLATE PROGRAMMING:

PROCEDURE

1. The preceding page details the Flow Chart System Programming.

DISPLAY
ACTION

From the model number display (CEE ----100CB HOTPLATE), press the PROG key to enter the program mode.

CEE --- 100CB HOTPLATE
PRESS PROGRAM
KEY

The display reads "PROG MODE/PROG #? 2," where "2" represents the most recently used program (default value). To work with program number 0 instead of number 2 press CLEAR, followed by "0," then ENTER.

PROG MODE/PROG #? 2
ENTER PROGRAM #
(CLEAR-0-ENTER)

2.   At this point, the display presents "PGM 0/ TEMP 115", where "115" indicates the current temperature setting ("TEMP") for program number 0 ("PGM 0"). To alter this value press CLEAR, followed by "1", "4", "5," then ENTER. This sets the temperature of program number 0 to 145° C.

PGM 0/ TEMP 115
ENTER NEW TEMP
(CLEAR-145-ENTER)

3.   Next, the display presents "PGM 0/ METHOD 1 CONT" to program the first of three possible bake methods as indicated by "1."

PGM 0/METHOD 1 CONT
ENTER NEW METHOD

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Section 4.
HOTPLATE PROGRAMMING:

PROCEDURE *continued*

In this example, the contact ("CONT") bake method is currently selected. To change to the proximity bake method, press CLEAR, followed by PROX, then ENTER.

```
PGM 0/METHOD 1 CONT
ENTER NEW METHOD
(CLEAR-PROX-ENTER)
```

4.   As currently shown by the display, "PGM 0/ TIME 1 0M 10S," the bake time ("TIME") for method 1 ("1") is 0 minutes ("0M") and 10 seconds ("10S").

```
PGM 0/TIME 1 0M 10 S
ENTER NEW MINUTES
(CLEAR-1-ENTER)
```

First, accept or change the bake time minutes value. To program minutes in the bake time to 1, press CLEAR, followed by "1," then ENTER.

```
PGM 0/TIME 1 0M 10 S
ENTER NEW MINUTES
(CLEAR-1-ENTER)
```

Next, accept or change the bake time seconds value. To program seconds in the bake time to 45, press CLEAR, followed by "45," then ENTER.

```
PGM 0/TIME 1 1M 10 S
ENTER NEW SECONDS
(CLEAR-45-ENTER)
```
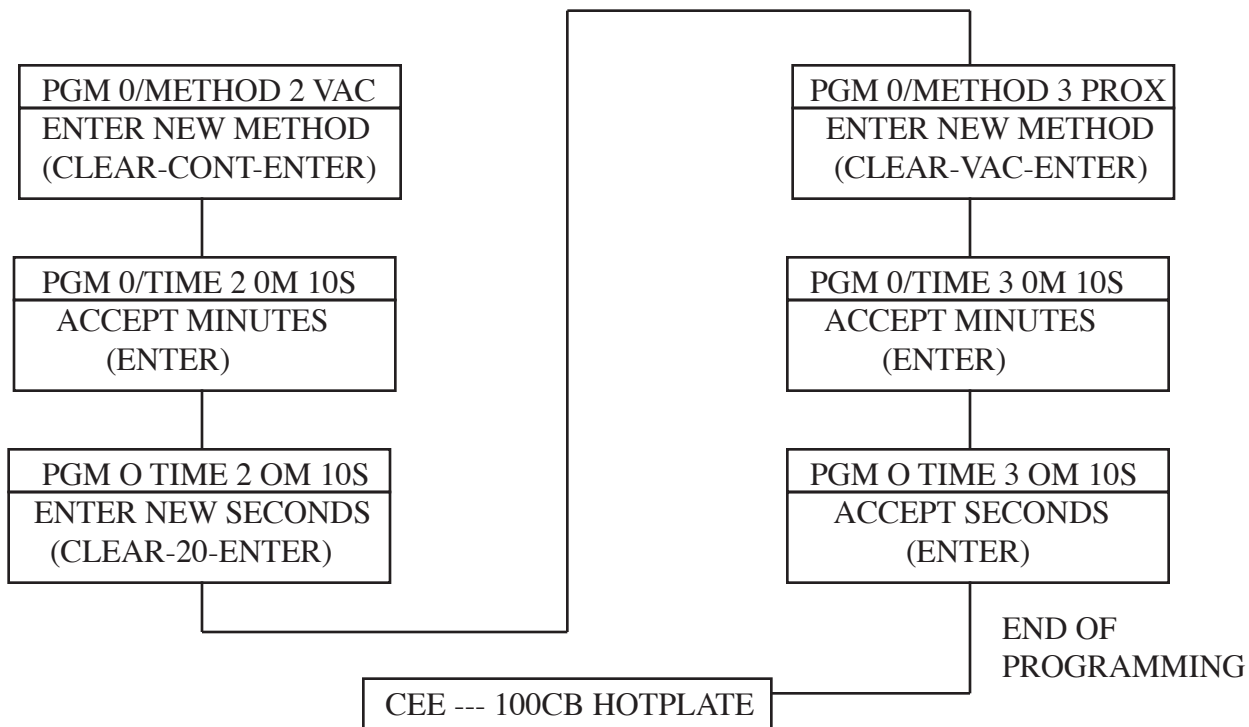
As a result, total bake time for the first bake, method 1, equals 1 minute and 45 seconds.

Acceptable values for bake times range from 0 to 9 minutes and 0 to 59 seconds.
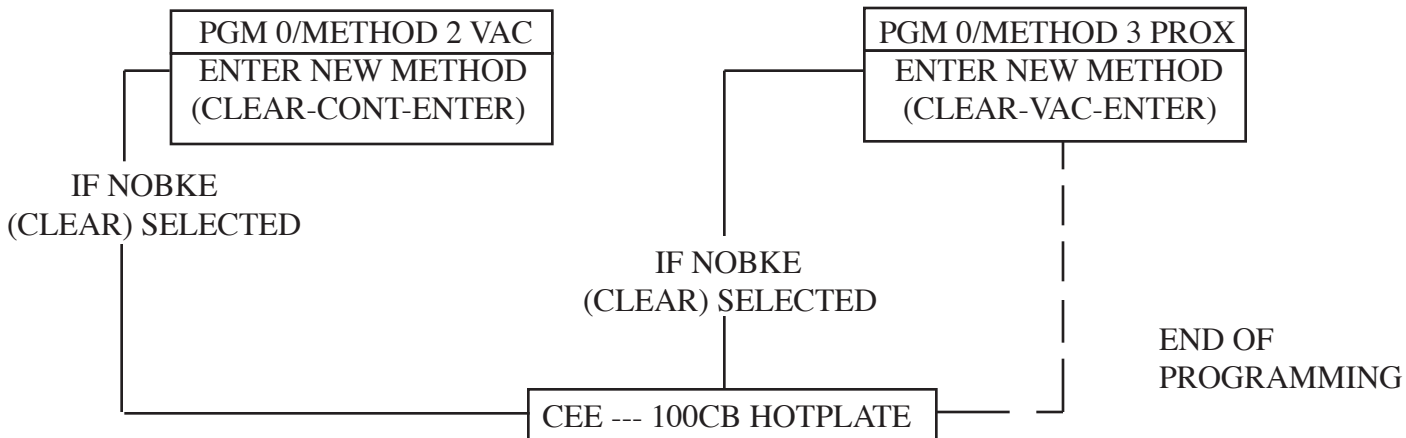
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Section 4.
HOTPLATE PROGRAMMING:

PROCEDURE *continued*

5. At this point, the operator may continue programming for multiple bakes. The same procedure applies to the second and third methods and bake times.

```
┌──────────────────────────┐          ┌──────────────────────────┐
│ PGM 0/METHOD 2 VAC       │          │ PGM 0/METHOD 3 PROX      │
│ ENTER NEW METHOD         │          │ ENTER NEW METHOD         │
│ (CLEAR-CONT-ENTER)       │          │ (CLEAR-VAC-ENTER)        │
└──────────────────────────┘          └──────────────────────────┘

┌──────────────────────────┐          ┌──────────────────────────┐
│ PGM 0/TIME 2 0M 10S      │          │ PGM 0/TIME 3 0M 10S      │
│ ACCEPT MINUTES           │          │ ACCEPT MINUTES           │
│ (ENTER)                  │          │ (ENTER)                  │
└──────────────────────────┘          └──────────────────────────┘

┌──────────────────────────┐          ┌──────────────────────────┐
│ PGM O TIME 2 OM 10S      │          │ PGM O TIME 3 OM 10S      │
│ ENTER NEW SECONDS        │          │ ACCEPT SECONDS           │
│ (CLEAR-20-ENTER)         │          │ (ENTER)                  │
└──────────────────────────┘          └──────────────────────────┘

                                                        END OF
                                                        PROGRAMMING

          ┌──────────────────────────────┐
          │ CEE --- 100CB HOTPLATE       │
          └──────────────────────────────┘
```

If a multistage bake is unnecessary, press CLEAR for the second bake method. The display will read "NOBKE" indicating no additional bake methods.

```
┌──────────────────────────┐          ┌──────────────────────────┐
│ PGM 0/METHOD 2 VAC       │          │ PGM 0/METHOD 3 PROX      │
│ ENTER NEW METHOD         │          │ ENTER NEW METHOD         │
│ (CLEAR-CONT-ENTER)       │          │ (CLEAR-VAC-ENTER)        │
└──────────────────────────┘          └──────────────────────────┘

 IF NOBKE                              IF NOBKE
(CLEAR) SELECTED                      (CLEAR) SELECTED
                                                        END OF
                                                        PROGRAMMING
          ┌──────────────────────────────┐
          │ CEE --- 100CB HOTPLATE       │
          └──────────────────────────────┘
```

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Section 4.
HOTPLATE PROGRAMMING:

PROCEDURE *continued*

To end the program at this point, press the ENTER key. To program dual method bakes, enter NOBKE for the third method.

6. After programming the third bake method and time or selecting a NOBKE, the system stores all program data in memory.

Note: The current program in memory is not replaced until completing the program. If at any time during programming the operator is unsure of the values selected or would prefer to use the default values, press RESET, and no changes occur to the original program. Press PROG again to start over from the beginning.

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SECTION 5

HOTPLATE PROGRAM RUNNING

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Section 5.
HOTPLATE PROGRAM RUNNING:

Running user programs on the Model 100CB Hotplate is not difficult. The hotplate system itself handles most of the work; the user need only supply substrates and instruct the system as to which program to run.

Hot Surface: The chuck surface is hot and should not be touched. The substrates should not be touched after the baking process until sufficient time for cooling has elapsed.

PROCEDURE

1.   From the model number display (CEE -----100CB HOTPLATE), press the RUN key. This initiates the run mode.

```
CEE --- 100CB HOTPLATE

     PRESS RUN KEY
```

2.   The display reads "RUN PROG#? _" where the flashing cursor indicates that the system waits for input from the operator.

```
     RUN PROG #?_
   ENTER PROGRAM #
```

No default value exists in this display.

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HOTPLATE PROGRAM RUNNING:

PROCEDURE *continued*

Hot Surface: The chuck surface is hot and should not be touched. The substrates should not be touched after the baking process until sufficient time for cooling has elapsed.

To enter a user program, press the appropriate numerical key "2", then ENTER.

RUN PROG #?_
ENTER PROGRAM #
(2-ENTER)

2.   The system controller instructs the temperature controller as to the temperature set point of the current program.

In addition, the system controller compares the chuck temperature to the error bounds established in the configuration procedure (see Section 3 for more information).

3. If the chuck temperature falls under the acceptable temperature range, specified in the system configuration, the display reads "UNDER TEMP / OVERRIDE _." This indicates that the chuck temperature is currently below the normal operating range; at this point, the system allows the operator to override the error.

UNDER TEMP/OVERRIDE
ENTER START TO OVERRIDE
(START)

Pressing START at this point overrides the system and begins baking wafers.

Similarly if the current chuck temperature is too high, the display reads "OVER TEMP / OVERRIDE_," indicating that the current chuck temperature falls out of range. At this point, the system allows the operator to override the error.

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Section 5.
HOTPLATE PROGRAM RUNNING:

PROCEDURE *continued*

Hot Surface: The chuck surface is hot and should not be touched. The substrates should not be touched after the baking process until sufficient time for cooling has elapsed.

Pressing START at this point overrides the system and begins baking wafers.

```
UNDER TEMP/OVERRIDE_
ENTER START TO OVERRIDE
(START)
```

To institute a global override, during the configuration procedure set the allowed percent error to 0% (see Section 3 for more information). When the temperature has fallen within specifications or has been overridden, the system begins the program.

4.   At this point, the display reads "READY PRESS START." Press START to initiate the program.

```
READY PRESS START
PRESS START TO BEGIN
(START)
```

5.   Next, the display reads "PLEASE LOAD CHUCK."

```
PLEASE LOAD CHUCK

LOAD CHUCK
```

The chuck gas pillow will turn on for the settle time allowed in the configuration routine (see Section 3 for more information)

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HOTPLATE PROGRAM RUNNING:

PROCEDURE *continued*

 Hot Surface: The chuck surface is hot and should not be touched. The substrates should not be touched after the baking process until sufficient time for cooling has elapsed.

During the settle time, place a substrate on the chuck against the centering pins. After settling on the chuck, the substrate bakes according to the selected program.

Upon completing the bake cycle, the display reads "PLEASE UNLOAD CHUCK." The gas pillow turns on for the time alotted in the system configuration . After unloading, the system reverts back to step 4. This continues until completion of all substrates.

PLEASE UNLOAD CHUCK
UNLOAD CHUCK

READY PRESS START
PRESS START TO CONTINUE
(START)

7.   To stop processing in the middle of a bake cycle, press the "STOP" key. The system halts the bake cycle and goes immediately to the unloading procedure. After unloading, the system reverts to step 4 and continues as before To stop processing and exit the run mode, press the RESET key. If a reset is performed anytime other than during a stopped or idle system, clear any substrates from the chuck. No memory of the substrates will exist; the substrates will not bake accurately.

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SECTION 6

SPINNER SYSTEM OPERATION

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Section 6.
SPINNER SYSTEM OPERATION:

KEYBOARD FUNCTIONS

System operation for the spinner section of the CEE Model 100CB is very similar to the hotplate section.

The keyboard shown below guides the system controller. All programming and functioning of the machine operate through here.

SYSTEM KEYBOARD FUNCTIONS:
Spinner operation:

    0-9 number Selects a program to modify or to run, as well as encoding numerical data.

    PROGram   Places the system in program mode.

    RUN Places the system in run mode. Allows selection of desired program to execute.

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Section 6.
SPINNER SYSTEM OPERATION:

KEYBOARD FUNCTIONS *continued*

DIAGnostics	Starts diagnostic routines. These manually operate spin chuck vacuum and motion, and are primarily used for system checkout.
START	Begins execution of a user-spin program when requested through the display. In the event of an error, this key instructs the system to continue from the point at which the error occurred.
STOP	Ends the spin cycle--immediately--at any time during operation.
RESET	Resets the system completely. All operations halt, and the system returns to the model number display shown above. An important note: the controller will not remember a substrate on the spin chuck after a reset. Remove the substrate manually.
ENTER	Signifies acceptance of the currently displayed choice during data entry and program selection. This key and the CLEAR key function very much like a calculator/computer keyboard.

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SPINNER SYSTEM OPERATION:

KEYBOARD FUNCTIONS *cotinued*

CLEAR	Clears unwanted or invalid information during data entry. This key also endsa user program at the end of each step.
CONFiguration	Configures motor control system parameters.
OPTions	Switches control between hotplate and spinner operating systems.
PROXimity	Not used.
CONTact	Not used.
VACuum	Not used.

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SECTION 7

SPINNER PROGRAMMING

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Section 7.
SPINNER PROGRAMMING:

The Model 100CB Spinner section stores ten user programs in battery-backed memory. Programs contain information such as spin speed, ramp rate, and spin duration. Programs, numbered zero to nine, are individually modified or reviewed.

NOTE--Default values are examples and may be different in a given machine.

FLOW CHART SYSTEM PROGRAMMING

DISPLAY
ACTION

CEE -- 100CB SPINNER
PRESS PROGRAM KEY

PROG MODE/PROG#? 2
ENTER PROGRAM#
(CLEAR - 5 - ENTER)

PG/5 VEL/0 3755RPM
ENTER SPIN SPEED
(CLEAR - 2500 - ENTER

PG/5 RMP/0 15375 R/S
ENTER RAMP RATE
(13900 - ENTER)

PG/5 TIME/0 17 SEC
ENTER SPIN DURATION
(43 - ENTER)

PG/5 VEL/1 1000 RPM
END PROGRAM
(CLEAR - ENTER)

CEE -- 100CB SPINNER

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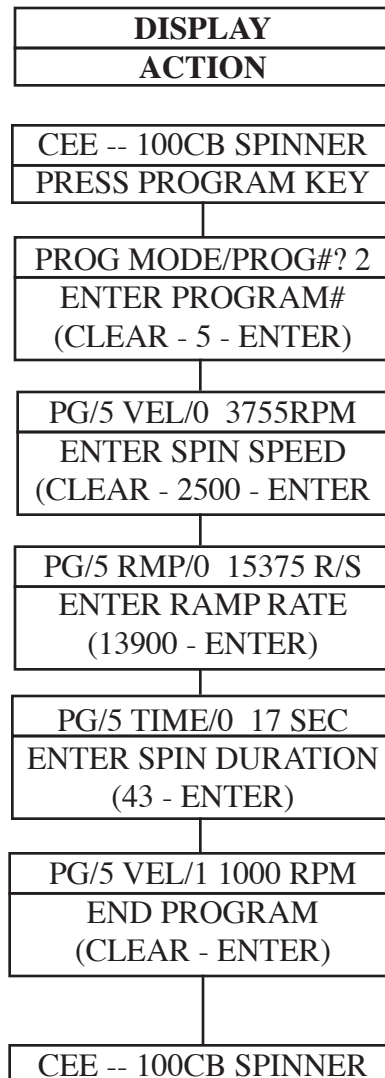
Section 7.
SPINNER PROGRAMMING:

The Cee Series 100 spinners store up to 10 user programs numbered 0 to 9. Each program contains up to ten spin steps to allow ramped and multistep processing.

PROCEDURE:

From the model number display (CEE----100CB SPINNER), press the "PROG" key to enter program mode.

CEE --- 100CB SPINNER
PRESS PROGRAM
KEY

The display now reads "PROG MODE/PROG# ? 2". This indicates that we are now in program mode. The most recently accessed program number will appear as a default, in this case program number 2. To edit program number five; press "5" and then "ENTER".

PROG MODE/PROG# ? 2
ENTER PROGRAM #
(5-ENTER)

Values from 0 to 9 are accepted as program numbers.

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Section 7.
SPINNER PROGRAMMING:

PROCEDURE: *continued*

The display reads "PG/5 VEL/0 3755 RPM". This display indicates that we are accessing program number five. The parameter being edited is the velocity for step number zero and the current value is 3755 rpm. To change the spin speed press "2500" and "ENTER".

```
PG/5 VEL/0   3755 RPM
  ENTER SPIN SPEED
    (2500-ENTER)
```

Values from 0 to 6000 rpm are acceptable spin speeds. If a mistake is made at any time simply press the clear key and enter the correct value.

The display now reads "PG/5 RMP/0   15375 R/S". The parameter being edited is the accelleration (ramp rate) for step number zero. The current value is 15375 rpm/second. To change the accelleration press "13900" and "ENTER".

```
PG/5 RMP/0  15375 R/S
  ENTER RAMP RATE
    (13900-ENTER)
```

Values from 0 to 30000 rpm/second are acceptable ramp rates. The ramp rate for this step is now changed to 13900 rpm/second.

The display now reads "PG/5 TIME/0   17 SEC". The parameter being edited is the spin duration. This display shows that step zero for program 5 will last for 17 seconds. To change this value to 43 seconds, press "43" and "ENTER".

```
 PG/5 TIME/0    17 SEC
ENTER SPIN DURATION
    (43-ENTER)
```

Values from 0 to 999 seconds are acceptable values.

The display now reads "PG/5 VEL/1   1000 RPM". The "1" after "VEL" is the current step number. This process continues with successive step numbers until the end of step number 9 is reached or until the program is ended. To force the process program to terminate at the end of

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Section 7.
SPINNER PROGRAMMING:

PROCEDURE: *continued*

a given step, leave the velocity value empty by pressing "CLEAR" for the next step. This will cause the previous step to be the last one in the program.

PG/5 VEL/1   1000 RPM
END PROGRAM
(CLEAR-ENTER)

No changes are saved until the program is ended and the system reverts back to the model number display. To exit program mode without saving changes simply press "RESET". The display will revert to the model number display but no changes will be saved.

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SECTION 8

SPINNER SYSTEM CONFIGURATION

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Section 8.
SPINNER SYSTEM CONFIGURATION:

Configuration mode allows access to a set of parameters that control the operation of the spin motor. These parameters are global and are not affected by individual program values. By adjusting these parameters it is possible to tune the motor control system for optimum performance with a variety of substrate shapes, sizes, and thicknesses.

Note: The values shown in this example may not necessarily match those on a given machine.

There are four parameters that affect motor operation on the Cee Series 100 spinners.

1. The Proportional coefficient.

2. The Integral coefficient.

3. The Derivative coefficient.

4. The Integration Limit.

Together, these control the tuning for the digital PID (proportion, integral, derivative) motor control loop. A discussion of these coefficients is presented at the end of this section.

PROCEDURE:

From the model number display "CEE ---- 100CB SPINNER", press "CONF".

CEE --- 100CB SPINNER
PRESS CONF KEY

The display will read "PROP COEFF.   100". This display indicates that we are accessing the proportional coefficient of the control system. To change this value press "10" and "ENTER".
PROP COEFF.   100

ENTER PROPORTIONAL
COEFFICIENT
(10-ENTER)

Values from 0 to 32511 are acceptable values. If a mistake is made at any time simply press the clear key and enter the correct value.

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SPINNER SYSTEM CONFIGURATION:

PROCEDURE: *continued*

The display will now read "INTG COEFF.   10". The display is showing the integral coefficient of the system. To change this value press "100" then "ENTER".

INTG COEFF.   10
ENTER INTEGRAL COEFFICIENT
(100-ENTER)

Values from 0 to 32511 are acceptable values. Mistakes may be corrected by pressing the clear key and entering the correct value. The integral coefficient is now changed to 100 and the display shows the next coefficient to be edited.

The display now reads "DERV COEFF.   1000". The display indicates that we are accessing the derivative coefficient of the control system. To change this value press "20000" and "ENTER".

DERV COEFF.   10
ENTER DERIVATIVE COEFFICIENT
(20000-ENTER)

Values from 0 to 32511 are acceptable. Mistakes may be corrected by pressing the clear key and entering the correct value. The derivative coefficient is now changed to 20000 and the display shows the next coefficient to be edited.

The display now reads "INTGR. LIMIT   10".

This display indicates that we are accessing the integration limit of the control system. To change this value press "100" and "ENTER".

INTGR. LIMIT   10
ENTER INTEGRATION LIMIT
100-ENTER)

Values from 0 to 32511 are acceptable. If a mistake is made at any time simply press the clear key and enter the correct value. The integration limit is now changed to 100 and the system reverts to the model number display (CEE-----100CB   SPINNER).

Section 8.
SPINNER SYSTEM CONFIGURATION:

FILTER COEFFICIENTS

THE PROPORTIONAL COEFFICIENT:

The *proportional coefficient* adjusts the power applied to the motor by comparing the target speed with the actual speed during operation. This difference or error signal is multiplied by the proportional coefficient and applied to the motor power circuits. The power applied to the motor is directly proportional to the error signal. Used alone this control loop would not produce the desired performance.

Proportional loops tend to show a constant droop when used alone. The actual motor speed would always be somewhat lower than the target speed.

This can be overcome by increasing the *proportional coefficient* but this causes instability and the motor speed will then oscillate above and below the target speed sometimes quite dramatically.

INTEGRAL COEFFICIENT:

The *integral coefficient* operates a different control loop. The integral control loop uses the error signal to generate a time integral of the error. In other words a sum of the error signal is built up over time. This running sum is multiplied by the integration coefficient and applied along with the proportional power signal to the motor power circuits.

Used in conjunction with the proportional loop, the integral loop can compensate for the droop left by the proportion control. However, the integral loop can also add to the instability of the system by over compensating and causing oscillation.

DERIVATIVE COEFFICIENT:

The *derivative* control loop acts as a stabilizer for the proportional and integral loops. This loop calculates the derivative of the error signal and uses this derivative to predict the motor speed. This ability to predict allows the system to begin adjusting power well before overshoot or undershoot occurs. The derivative of the error signal is multiplied by the derivative coefficient and added to the proportional and integral control signals to compensate for any instabilities created in the other loops.

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Section 8.
SPINNER SYSTEM CONFIGURATION:

FILTER COEFFICIENTS

INTEGRATION LIMIT:

The last coeffient used on the Cee Series 100 spinner is the *integration limit*. This coefficient limits the integral control signal to a maximum value. This allows the use of a larger integral coefficient than would otherwise be possible thus giving maximum accuracy with minimal instability.

When these four parameters are well chosen the spinner can operate over its full range of speeds with high precision and accuracy.

Example configuration parameters for silicon wafers:

Wafer Size	Proportional Coefficient	Integral Coefficient	Derivative Coefficient	integration Limit
75mm	8	100	10000	80
100mm	8	100	10000	80
125mm	8	100	10000	80
150mm	8	100	10000	80

Generally, the parameters shown for the 150mm substrates will give satisfactory operation for all sizes however, the chart is provided as a starting point for those who wish to fine tune the system.

NOTE: Overshoot of the target speed by larger substrates is sometimes caused by a large acclleration (ramp rate) setting within the process program. The ramp rate can be set up to 30,000 rpm/second for the smaller substrates. Large or heavy substrates require a lower ramp rate for precise control of speed.
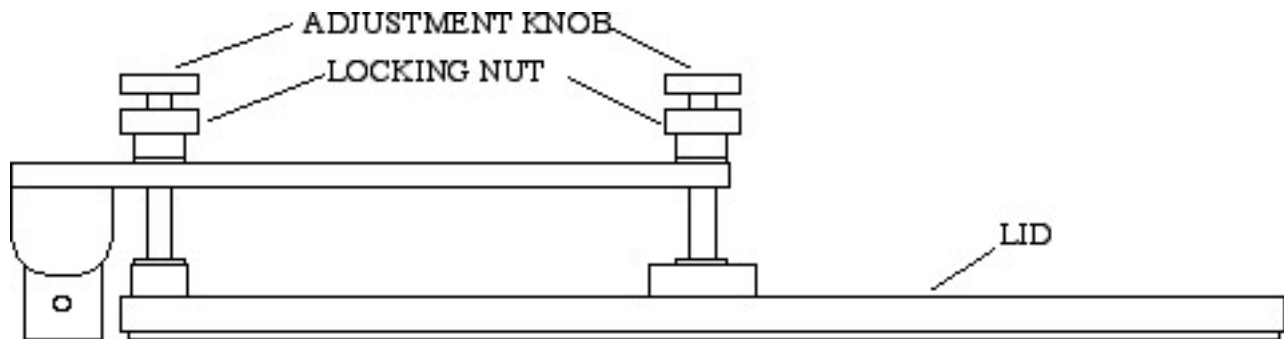
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Section 8.
SPINNER SYSTEM CONFIGURATION:

LID ADJUSTMENT:

The spinner section of the CEE Model 100CB is furnished with an adjustable exhaust lid. This lid allows the operator to regulate the exhaust flow through the bowl region. To adjust the lid height loosen all locking knuts on the adjustment knobs. The lid is raised by rotating the adjustment knobs counterclockwise and lowered by rotating them clockwise. Three adjustment knobs are used to raise and lower the lid. For best results it is recommended that each knob be adjusted in sequence and not more than one turn per sequence.

Each rotation equals approximately 0.05". To raise the lid 0.25" rotate the adjustment knobs a total of five times counterclockwise from the lowest lid position. Refer to the pictorial below for adjustment knob locations.

SPIN EXHAUST LID

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SECTION 9

SPINNER PROGRAM RUNNING

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Section 9.
SPINNER PROGRAM RUNNING:

Running user spin programs on the Model 100CB Hotplate/Spinner is not difficult. The spinner system itself handles most of the work; the user need only supply substrates and instruct the system as to which program to run.

Warning: Safety goggles must be worn during operation of the spinner system to prevent risk of injury.

PROCEDURE

1. From the model number display (CEE -----100CB SPINNER), press the RUN key. This initiates the run mode. The display reads "RUN PROG#? _" where the flashing cursor indicates that the system is waiting for input from the operator.

CEE --- 100CB SPINNER
PRESS RUN KEY

2. To enter a user program, press the appropriate numerical key "2," then ENTER.

RUN PROG #?_
ENTER PROGRAM #
(2-ENTER)

3. At this point the display will show "READY/ PRESS START".

READY/PRESS START
LOAD WAFER
(START)

Load a wafer onto the spin chuck as near to center as possible, close the exhaust lid and press start.

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Section 9.
SPINNER PROGRAM RUNNING:
PROCEDURE: *continued*

Warning: Safety goggles must be worn during operation of the spinner system to prevent risk of injury.

4. The display will show the following message and the motor will run at about 100rpm for 2 seconds to verify centering. At this point it should be obvious if the wafer is not centered.

<div align="center">

TESTING CENTERING

</div>

5. At the end of the centering test the display will read as follows:

<div align="center">

0 TO RETEST / START

</div>

If the wafer is not properly centered, it may be adjusted now. Press the "0" key to retest for centering. When the substrate is centered, close the lid and press "START".

6. The spin process will continue automatically from here. The display is constantly updated in the following format.

<div align="center">

RPM 1369 TIME 153

</div>

Indicating that the current speed is 1369 revolutions per minute and that there are 153 seconds remaining in this step.

7. This display is updated throughout all of the steps in a spin program. When finished, the display will look like this. An alarm will sound until the wafer has been removed.

<div align="center">

UNLOAD SPIN CHUCK

</div>

Note: To abort a spin program in progress simply press the "STOP" key.

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Section 11.
ERRORS AND THEIR RECOVERY:

The Model 100CB Hotplate/Spinner contains extensive error checking routines. These minimize problems while in use as well as point out potential problems before they become serious.

The following lists possible error messages ("display messages"), their cause, and the corrective actions necessary.

ERROR:	CAUSE:	ACTION:
Temperature controller communication error ("Temp contr com error")	Error in communication to temperature controller	Turn system off; wait 5 secconds; turn back on; Check for loose cables.
Temperature controller disabled ("Temp contr disabled')	Temperature controller not able to comply with command	Enable remote communication, see section 2. Temperature controller.
Vauum error on spinner (Error - poor vacuum)	Insufficient vacuum on spin chuck to proceed with spin process	Check utility connections Verify presence of vacuum of at least 25"Hg
(Motor command error)	Internal system error	Usually occurs in diagnostics mode only. Press RESET
System dead, no lights on temperature controller	No power to outlet	Check electrical outlet for presence of 120 Volts, AC.
System dead, no lights	Blown fuse	Replace fuse (located at the back of unit).
Nitrogen and/or vacuum not functional	Blockage in tubing	Check connections to the unit for possible kinks or obstructions.

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Cost Effective Equipment

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