



Temescal

SuperSweep64

Instruction Manual

contains

Addendum A: Error Codes

Instruction Manual 0101-8287-0A

September 8, 2005

Power Up Error Codes For Supersweep 64

The following are the error codes that may show when the SuperSweep is first powered up. Some of these codes can indicate a serious problem with the operation of the SuperSweep as described below.

- ERR 001** RAM Test tests a section of external RAM by writing and reading back patterns. It will show ER 001 if the test fails.
- ERR 002** PLD Test reads the model and revision from the PLD and verifies that the model number is in the valid range (1 to 15). It will show ERR 002 if the test fails
- ERR 003** Flash RAM Test reads and verifies the manufacturer code from both Flash modules. It will show ERR 003 if the test fails.
- ERR 004** Front Panel Test reads the Button state register and verifies that no buttons are stuck down. It will show ERR 004 if the test fails.
- ERR 005** Analog Test configures the D to A output zero volts on the Lat and Long channels and a small positive value on the emission channel. The test reads the A to D values from the feedbacks and checks for a match. It then applies a small offset to the Lat and Long positions and reads the offset back from the A to D. It will show ERR 005 if the test fails. This test will also fail if the coil outputs are disconnected from the SuperSweep 64 or if one or both of the sweep coils are defective (open or shorted).



SuperSweep™ 64

Instruction Manual

PN 0101-8287-0

Final

June 6, 2002

Temescal
Part of the BOC Coating Technology
A member of The BOC Group, Inc.
2700 Maxwell Way, Fairfield, CA 94533-0252
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November 2001

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In the event that factory testing or field testing does not demonstrate compliance with the specifications, Purchaser's sole and exclusive remedy under the above warranty is limited to, at Seller's option, repair or replacement of defective parts or components or return to Purchaser of the purchase price of the apparatus. In the event that Seller elects to refund the purchase price, the apparatus shall be the property of Seller.

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Safety Instructions for Operating and Service Personnel

Operators and service personnel should always wear safety glasses. Operators shall not enter areas intended for service access only. Only experienced service personnel should enter such areas, and only after taking the preliminary precautions described in paragraphs 1 through 6 below.

DANGER: Potentially lethal voltages may exist within this system, even with the main power switched off. Service should only be attempted by qualified personnel. Failure to observe all safety precautions can result in personal injury.

Observe the precautions described below when servicing this system, especially when servicing components where high voltages might be present.

1. Before servicing or operating this equipment, read all the component manuals supplied with the system, paying special attention to safety instructions.
2. Post HIGH VOLTAGE WARNING signs in conspicuous locations within the service area.
3. Remove rings, watches, bracelets, and any other metal jewelry before working around high voltage.
4. DO NOT WORK ALONE! Work in a “buddy system” when doing preventative maintenance work.
5. Be sure that all equipment is connected to a power receptacle having the correct polarity and grounding, as prescribed by the local electrical codes. Refer to the power supply portion of the documentation to determine the proper electrical ground for high-voltage components.
6. Before servicing any high-voltage component, switch off the electrical power at the component’s main power switch. This switch must have a lockout feature. Lock the power off and keep the key with you while you are working on the equipment.
7. Certain electrical parts (e.g., electrolytic capacitors) hold a lethal voltage even after the power is switched off. Before entering any service area, use a grounding hook to discharge such parts. Be sure that these parts are discharged before starting any repairs.
8. DO NOT touch high-voltage leads unless power is off and a grounding hook is connected to the parts to be serviced.
9. The high-voltage components of the system should be equipped with electrical interlocks to protect personnel from injury.
10. Electro/mechanical components of the system should be equipped with electrical interlocks to protect personnel from injury. DO NOT ATTEMPT TO DEFEAT, OVERRIDE, OR BYPASS THESE PROTECTIVE DEVICES!
11. Never leave loose ends on high-voltage connections.
12. Observe the following warning if the system employs Radio Frequency (RF) power.

DANGER

RF radiation-even at modest power levels-can cause serious injury. If any of the RF components (e.g., the RF power supply, the RF matching network, or the RF electrodes or shielding inside the product chamber) are moved or changed in any way, the RF energy may be radiated outside the equipment. Monitor the equipment to assure that external RF radiation is below the levels prescribed by any and all applicable safety codes.

Special Amendment for United Kingdom Users

All Electrical Power Sources: Safety Precautions

Only authorized personnel should be permitted to carry out work on this system.

Prior to any servicing, grounding hooks should be used to short out all high-voltage parts and conductors in both the vacuum system and the high-voltage power supply. Screens protecting extra-high-voltage conductors should be removed only if appropriate action has been taken to ensure that extra-high-voltage conductors are dead and cannot be reenergized inadvertently.

In addition, all personnel should be aware of:

1. The Electricity (Factories Act) Special Regulations (1908 and 1944), in particular, Regulations 18(d) and 28 of the 1980 Regulations, as amended; and
2. The employer's responsibility to set up suitable systems to safeguard the health and safety of employees, according to the Health & Safety at Work etc. Act (1974).

User Responsibility

This equipment will perform in accordance with the instructions and information contained in the user's manual and its referenced documents when such equipment is installed, operated, and maintained in compliance with such instructions. The equipment must be checked periodically. Defective equipment shall not be used. Parts that are broken, missing, plainly worn, distorted, or contaminated, shall be replaced immediately. Should such repair or replacement become necessary, a telephonic or written request for service should be made to Temescal.

The equipment, or any of its parts, shall not be altered without the prior written approval of Temescal/BOC Coating Technology. The user and/or purchaser of this equipment shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, damage, improper repair, or alteration by any party other than Temescal.

Health Hazard

The condensates deposited on the tank walls of a vacuum system are generally in the form of extremely fine particles. The nature, as well as the form, of the materials pose the following potential health hazards:

- a) Inhaling fine particles (powder) may cause damage to the lungs. To help prevent this, wear a protective respirator mask with fine filter that has been approved by the National Institute for Occupational Safety and Health (NIOSH) and the federal Mine Safety and Health Administration (MSHA).
- b) Some substances are toxic and inhaling them should be avoided. Take steps to ascertain whether or not the material being deposited is a known toxic substance. Refer to the Material Safety Data Sheet(s) covering the evaporant(s) in question.
- c) Certain powders (titanium, for instance) can cause flash fires when exposed to oxygen or other oxidizers. Therefore, when opening the chamber door after a deposition cycle, exercise extreme caution and allow time for the coating surface to oxidize. Breakage of some of the more reactive condensates may be hazardous, even when the above precautions are observed. In this situation, fire-protective clothing should be worn.

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Overview

The Temescal SuperSweep64 (SS64) provides a range of programmable sweep controls for an electromagnetically deflected electron beam source. The SuperSweep64 can store up to 64 pre-defined wave pattern recipes. You can define or modify the recipes on-line using the Handheld unit, or off-line on a computer using the SS64 software program. Controls include wave pattern selection, amplitude and frequency adjustments, offset and position adjustments, and emission current.

The enhancements include:

- 16 bit microprocessor control
- PC Recipe Menu control
- 64 sweep programs or recipes (unlimited on PC)
- user-defined arbitrary waveform
- hand-held remote control
- updatable firmware

A hardware device (the SS64) controls the intensity and pattern of the e-beam emission from an e-beam gun. The SS64 can store up to 64 wave pattern *recipes*. Your PC can hold more.

Each SS64 contains four predefined *waveforms* that are provided for both lateral (or horizontal x-axis) and longitudinal (or vertical y-axis) directions.

- sine
- triangle
- saw tooth
- clipped

A total of 16 (4 x 4) waveform combinations can be used to define a *wave pattern*, for example, combinations such as sine (x) and sine (y), sine (x) and triangle (y), and so on.

In addition, a fifth output option allows the creation of an *arbitrary* waveform. This is a user-defined option in which you define the shape of the wave pattern.

Furthermore, you can determine the amplitude, frequency, and position of the waveform along x- and y-axes.

SuperSweep Components

The following SuperSweep components:

- SS64 Box
- Hand-Held Remote
- PC Menu

are discussed in brief below.

SS64 Box

To create a desired sweep pattern, use the controls located on the front panel of the SuperSweep box to adjust current amplitude, frequency, and position in x- and y-axes. When the desired pattern is set, the user can prevent further modification by disconnecting the box's hand-held remote.

Front Panel

Use the Front Panel to turn the E-beam sweep on or off, configure the unit control source, select and load a wave pattern recipe from a memory location in the unit, and save any changes you make to the recipe via the handheld.

The Front Panel has the following six controls: Sweep Enable, Mode, Program Up/Down, Program Load, and Program Save.

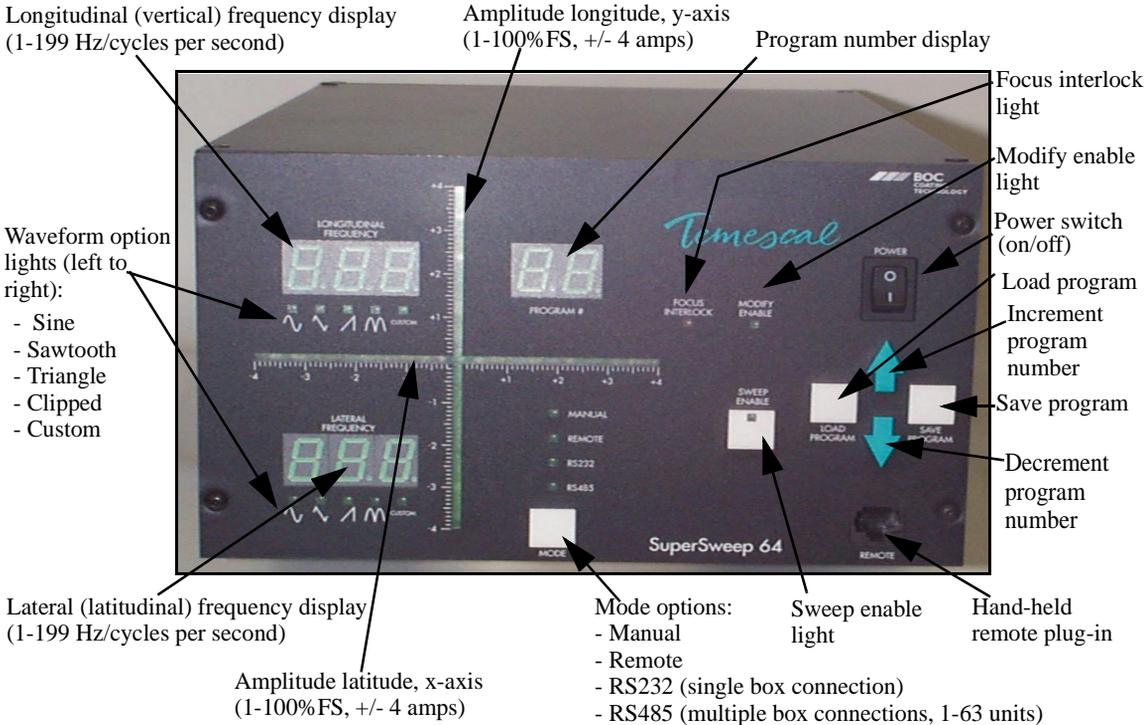


Figure 1-1. SS64 Front Panel

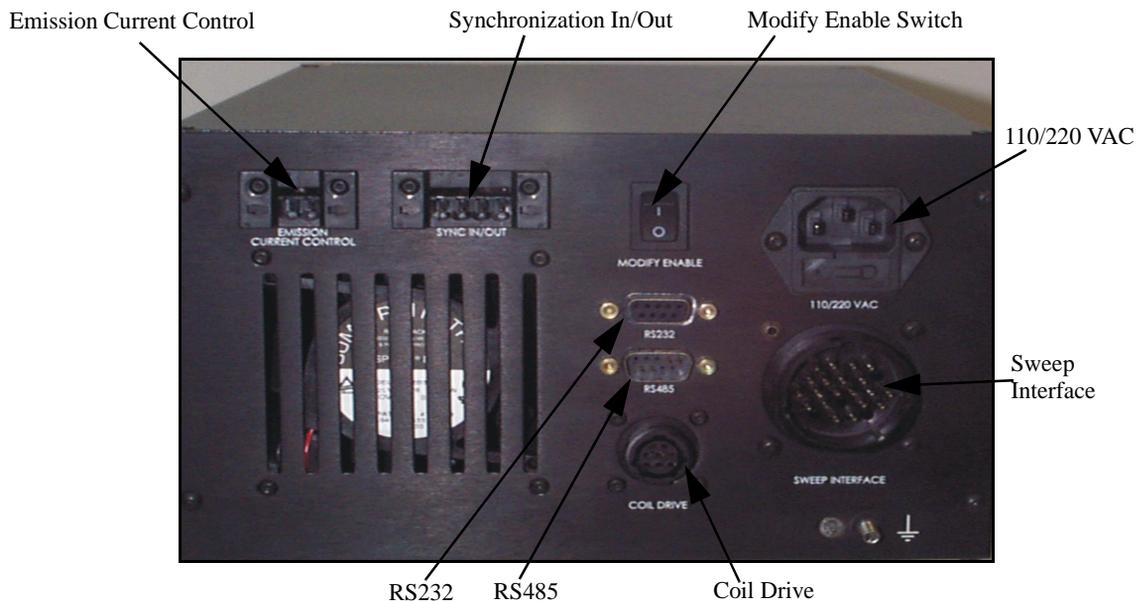


Figure 1-2. SS64 Back Panel

Hand-Held Remote

The Handheld Remote is a remote controller that allows you to create a new recipe or modify an existing recipe's attributes.

The Handheld Remote has the following six controls: Emission, Waveform, Latitude/Longitude, Position, Amplitude, and Frequency.

To create a new recipe or modify an existing recipe, select the desired option and adjust the value using the dial control. To save changes, press *Program Save* located on the front panel of the SS64 box.

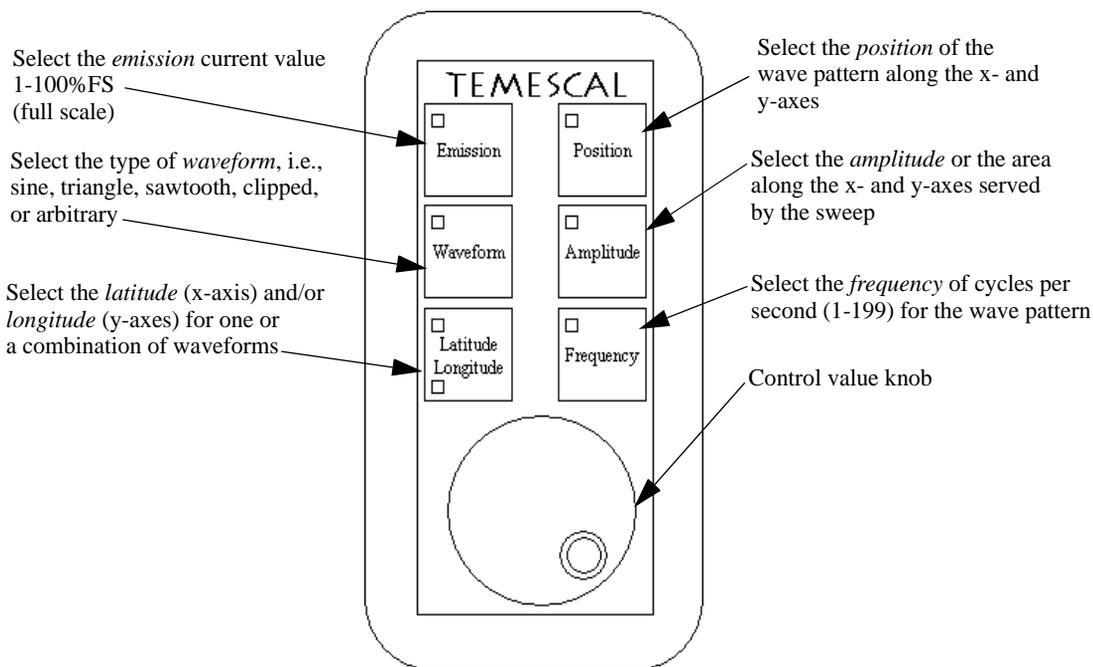


Figure 1-3. SS64 Remote

E-Beam Gun

The SuperSweep 64 controls the movement of the electron beam from an E-beam gun by dividing this movement into latitudinal (x-axis) and longitudinal (y-axis) components. The combination of these components determines the position of the beam at any time.

PC Menu

The SS64 program includes a software component that allows you to:

- create and simulate wave-pattern recipes off-line
- modify existing recipes (off-line or on-line)
- send a recipe from the PC or laptop to a SuperSweep 64
- get a recipe from the SS64
- control a SuperSweep 64 unit remotely through a serial cable connection (RS232/RS485)

Recipe Window

The Recipe window displays when you open the program. Use this window when working off-line to create or import new recipes, view and modify existing recipes, and save recipe files to disk or to the SuperSweep 64 EEPROM.

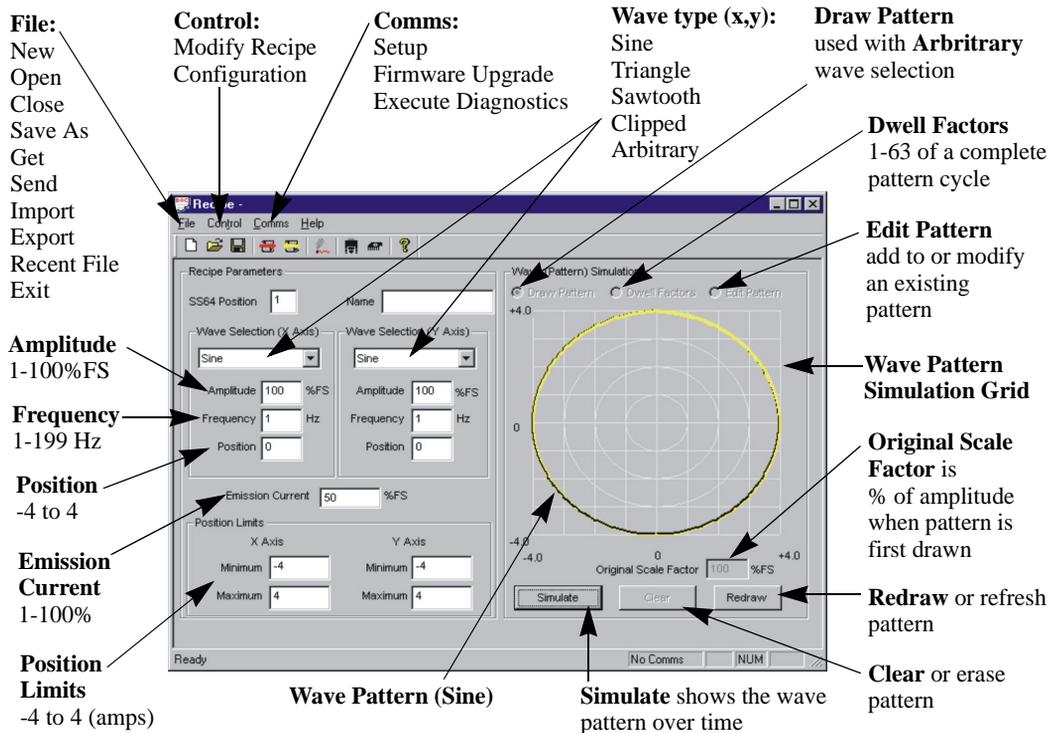


Figure 1-4. Recipe Window

SuperSweep Operation

The programmable sweep produces beam sweep patterns by varying the current in the coils of the e-beam source.

The SS64 is a hardware device that controls the intensity and pattern of the e-beam, which is created by an e-beam gun. The SS64 EEPROM can store up to 64 wave pattern recipes. The following options allow you to modify values of the wave pattern (along the x- and y-axes):

- wave selection
- amplitude
- frequency
- position
- emission current

Also, the SS64 system includes a PC software component that allows you to create and modify wave pattern recipes and to control the SS64 unit remotely. Further discussion on this will follow.

Definitions

The following SS64 system features and functions are identified and defined below.

Amplitude

Amplitude refers to the maximum latitudinal or longitudinal position of the waveform. It is displayed as a percent of Full Scale.

Arbitrary Wave

For an Arbitrary wave pattern, there is one value for Amplitude that represents the largest of either the latitudinal (x) or the longitudinal (y) dimension.

Standard Wave

For a Standard wave selection, the latitudinal and longitudinal values are independent; therefore, there is a value for the Amplitude of the waveform in the x direction and a second independent value for the Amplitude in the y direction. The combination of points from both axes creates the pattern.

Arbitrary Wave

In addition to the Standard waveforms, the SS64 includes the ability to draw an Arbitrary or random pattern. Select *Arbitrary Wave* then use the mouse to draw the pattern on the *Wave Pattern Simulation* grid.

After drawing, select Redraw to normalize the pattern. The program will calculate 1,024 pairs of latitudinal and longitudinal points (x, y) that define the wave pattern.

You can change the size of the wave pattern by varying the Amplitude.

You can change the number of times the E-beam sweeps the pattern in one second by varying the Frequency and by adding or changing Dwell Factors.

You can view the movement of the E-beam over time by selecting Simulate.

Dwell Factors

Arbitrary Waveform

Dwell Factors only apply to Arbitrary waveforms. A Dwell Factor refers to a point on the wave pattern where the E-beam holds its position for a specified period of time. A single Dwell Factor can range from 1/1,024 to 63/1,024 of a complete pattern cycle and the system allows up to 63 Dwell Factors per pattern. Dwell factor times are pattern cycle frequency dependent.

If you have not specified a Dwell Factor, the E-beam travels the waveform pattern at a constant rate of speed.

The Dwell Factor window shows the Row and Column designation for the dwell factor. Row 0 and Column 0 correspond to the lower left corner of the grid (-4, -4).

EEPROM

The Erasable Electronic Programmable Read-Only Memory (EEPROM) is a non-volatile memory component of the SuperSweep 64 that provides 64 memory locations for storing waveform recipes. Each location corresponds to a number from 1 to 64. This location number uniquely identifies the recipe.

Emission Current

Emission current refers to the intensity of the E-beam and is displayed as a percent of maximum (or Full Scale).

Frequency

Arbitrary Wave

For an Arbitrary wave pattern, Frequency is the number of times the beam sweeps through the pattern in one second.

Standard Wave

For a Standard wave selection, there is a value for the Frequency in the latitudinal direction and a second, independent value in the longitudinal direction. Therefore, Frequency refers to the number of times the E-beam sweeps through the pattern on the specified axis in one second.

Full-Scale

Full Scale refers to the percent of maximum Amplitude.

On the *Wave Pattern Simulation* grid, the maximum latitude (x-value) is +4 amps and the maximum longitude (y-value) is +4 amps. Therefore, the value +4 corresponds to 100% Full Scale and 0 corresponds to 50% Full Scale.

Off-Line

Use the PC program independently from the SuperSweep 64 to work off-line. In this mode, there is no interaction with the active recipe in the SS64.

When you launch the PC program, the *Recipe* window displays. Use this window to work off-line. You can create, view, and modify waveform recipes. You can store recipes to PC disk or to a location in the SS64.

In off-line mode, the *Save* action saves the recipe to the PC disk. The *Send* action saves the recipe to a location on the SS64 EEPROM.

Offset Position

Set the sweep *position* by selecting a position range from 1 to 255, laterally and/or longitudinally.

The center of the *Wave Pattern Simulation* grid (as shown on the PC Recipe menu screen) is defined as the intersection point (128, 128) of the x and y axes. Changing the x- or y-coordinate *offsets* the center of the wave pattern and the new coordinates reposition the wave pattern.

On-Line

You are working on-line when you are using the PC program to control the SS64.

If you select *Control/Modify Recipe*, the SuperSweep *Commands* window displays. Use this window to work on-line.

You can load a recipe into the SS64, making it the active recipe. You can then adjust the PC controls the same way that you would adjust controls using the front panel or the handheld.

In on-line mode, the *Save* action saves any modifications to the active recipe to the SS64 EEPROM. The system does not save the modifications to a file stored on the PC.

See *Controlling the SS64 Remotely* and *Modifying the Active Recipe*.

Original Scale Factor

Arbitrary Wave

The *Original Scale Factor* is only relevant for Arbitrary waveforms. Original Scale Factor is the percentage of Full Scale, or Amplitude, at the time the pattern is first drawn. (For Standard waveforms, the Original Scale Factor is always 100.)

The Original Scale Factor displays under the *Wave Pattern Simulation* grid in the Recipe window. If you modify Amplitude then return to the original value, type the Original Scale Factor into the Amplitude field under Wave Selection (Latitude).

Position Limits

Position Limits for each axis of the *Wave Pattern Simulation* grid define the working area of the grid. The program displays (and the E-beam moves along) only that portion of the pattern that lies within the minimum and maximum Position Limits.

For example, if you want to use only the lower half of a pattern, set the maximum *Longitudinal Position Limit* equal to 0.

Recipe

A recipe is a set of properties that define the intensity and position of the e-beam over time. The system executes a recipe to create a wave pattern.

When you launch the PC program, the *Recipe* window displays. Use this window to create, modify, and store recipes off-line, and send recipes to and retrieve recipes from the SS64.

The *active recipe* is the recipe that is currently loaded in the SS64. You can work on-line to adjust a recipe while it is active in the SS64, either via the PC program or using the SS64 hardware controls.

Properties

You can adjust various properties or parameters of the waveform recipe.

Emission Current controls the intensity of the e-beam while the remaining properties define the position of the e-beam over time.

- *Position Name* - the Recipe property, SS64 Position, uniquely identifies the waveform recipe to the PC program and specifies its memory location in the SS64; *name* is an optional field for recipe identification in the PC program only
- *Wave Selection* - choose a *Standard* or an *Arbitrary* waveform that is the basis for the e-beam's pattern of movement. Adjust

the pattern by modifying *amplitude, frequency, offset position, and position limits*.

- *Amplitude* - adjust the height and width of the waveform as a percentage of full scale
- *Frequency* - specify the number of times the beam sweeps or cycles through x- and y-axes (*Standard* wave selection) or pattern (*Arbitrary* wave selection) per second
- *Offset Position* - specify the center position of the wave pattern
- *Position Limits* - define the relevant area of the *Wave Pattern Simulation* grid

Active Versus Current Recipe

The *Active Recipe* is the Recipe that is currently loaded into the SS64. To modify the Active Recipe, you must work in On-Line mode.

The *Current Recipe* is the Recipe that is displayed in the Recipe window of the PC program. To modify the Current Recipe, you must work in Off-Line mode.

Standard Wave

Waveforms

The SuperSweep 64 includes four Standard waveforms: *Sine, Triangle, Sawtooth, and Clipped*. From the Recipe screen, you can select one of these waveforms for the latitudinal (x) direction and one for the longitudinal (y) direction. This results in 16 possible standard-wave combinations.

Wave Pattern Simulation

After you have selected the latitudinal and longitudinal waveforms, the program generates a static representation of the pattern and displays it on the *Wave Pattern Simulation* grid.

The program generates 1,024 independent x- and y-coordinates based on the chosen waveforms. The program then pairs these x- and y-coordinates according to the remaining recipe parameters to form the shape of the completed wave pattern.

Redraw

You can adjust the waveform properties then view the changes using *Redraw*. The Redraw function recomputes the x- and y-coordinates according to the current parameters. Because Redraw is a static representation, it does not incorporate Frequency. To view the pattern with the Frequency parameter included, use *Simulate*.

Note: If the Wave Selection is the same in both the latitudinal and the longitudinal directions, the combined wave pattern is a diagonal line where $x = y$. To create a more useful wave pattern when the Wave Selection and the Frequency properties are equal, the program offsets the longitudinal waveform by 90 degrees.

Simulate

To view the waveform pattern as it changes over time, select *simulate*. The Simulate function incorporates both *Frequency* and *Dwell Factors*. If Frequency in both the latitudinal and longitudinal directions is the same, then the waveform appears the same in both the Redraw and Simulate modes.

Wave Selection

Standard Wave

If you choose to use Standard waveforms, you must select a waveform for the X-axis and an independent waveform for the Y-axis. The program will combine the two waveforms to create the Wave Pattern. The program displays the new wave pattern on the *Wave Pattern Simulation* grid.

Arbitrary Wave

To draw an Arbitrary, or random, wave pattern, select the *Arbitrary Wave Selection*, then use the mouse to draw the shape on the *Wave Pattern Simulation* grid. See *Create an Arbitrary Pattern*.

Latitude and Longitude

From the PC Recipe screen, select one of these waveforms for latitude, x-axis, and one for the longitudinal, y-axis. This results in 16 possible standard wave combinations.

After selecting the x and y waveforms, a waveform is displayed on the Wave Pattern Simulation grid. Independent 1,024 x- and y-coordinates are based on the selected waveforms. The x- and y-coordinates are paired together according to the selected amplitude and position, and form the shape of the completed wave pattern.

To change the wave pattern, vary the amplitude and position of the waveform on either axis.

Use the *Simulate* function to see the movement of the e-beam over time.

Note: If the same wave form, amplitude, and position are selected for both the x- and y-axis, the y-coordinate is offset by 90 degrees to form a usable pattern.

Arbitrary Wave

In addition to the *Standard* waveforms, the SS64 includes the ability to draw a user-defined or *Arbitrary* pattern. From the PC Recipe screen, select the *Arbitrary Wave* option under *Wave Selection Latitude* (x-axis) drop down box. Draw a freehand pattern on the Wave Pattern Simulation grid.

Note: Note the number value in the *Amplitude* field. If needed, you can re-enter it later to return to the original value.

After drawing the pattern, select *Redraw* to *normalize* the pattern. Normalizing *smoothes out* the pattern by calculating 1,024 pairs of (x, y) points.

Change the size of the wave pattern by varying the *amplitude*.

Change the number of times the e-beam sweeps the pattern in one second by varying the *frequency* and *dwell factors*.

Selecting *Dwell Factors* allows you to specify a point or points on the pattern where you want the e-beam to pause or dwell for a period of time. A dwell factor ranges from 1/1,024 to 63/1,024 of a pattern.

View the movement of the e-beam by selecting *Simulate*.

Return to the original value of amplitude or when the pattern was first drawn by entering the original scale factor into the Amplitude field.

Specifications

The following is a list of specifications for the SS64 box unit and hand-held remote.

Maximum amplitude: -/+ 4 amperes on x- and y-axes

Frequency range: 1 to 199 Hz/cycles per second, both axes

Power requirements: 100-240 VAC, 50-440 Hz

The next chapter discusses the installation and configuration of the SS64 box and software.

Installation

This section provides hardware and software installation and configuration instructions for the SS64. The standard hardware installation procedures pertain to cabling, setting position interlock limits, and rack mounting the SS64 unit. The hardware configuration instructions concern the following operational options:

- The unit automatically compensates for changes in the input power. No changes are necessary whether 120-, 220-, 230- or 240V AC is supplied at 50- or 60-Hz.
- Program selection and the Modify Enable and Sweep Enable functions can be controlled by a host computer or some other customer-supplied remote switching device. The unit is factory-configured to accept contact-closure inputs from such devices. It can be configured to accept +24-VDC inputs.

Objectives for this chapter allow you to:

- Connect the coil-drive cable (See “Connect the Coil-Drive Cable” on Page 18.)
- Make remote I/O connections via the interface cable (See “Remote Inputs and Outputs” on Page 21.)
- Reconfigure for +24 VDC remote control inputs (See “Reconfiguring for +24-Volt Remote Control Inputs” on Page 25.)
- Set the limits for the position interlock output (See “Setting the Position Interlock Limits” on Page 28.)
- Rack mount the unit (See “Rack Mounting the SS64” on Page 30.)
- Install and configure the software (See “Installing and Configuring the Software” on Page 31.)

Connect the Coil-Drive Cable

Refer to Figure 2-1 and follow the procedure described below in connecting the beam position cable (PN 0040-3740-0 for 20-ft. cable, PN 0040-3740-1 for 40-ft. cable) to the coil current feedthrough and to rear panel connector J2.

1. If necessary, make a hole for the cable in the vacuum cabinet wall near the coil current feedthrough. The hole should be large enough to hold a standard electrical box connector or another device that will secure the cable and protect it from chafing against the edges of the hole.
2. Strip 1/4 inch of insulation off the ends of all four exposed wires.
3. Attach the spade lugs provided with the cables to each stripped wire. Hollingsworth crimping tool H-7B is recommended for this operation.
4. Attach the electrical box connector or other securing device loosely to the cable and remove the nut from the connector.
5. Insert the cable and connector through the hole in the vacuum cabinet wall, screw the nut back onto the connector securely, and tighten the connector's retainer around the cable until it is tight enough to prevent the cable from moving through the connector.

Caution: *Do not* overtighten this retainer; doing so could short the position control circuits.

6. Attach the lugs on the ends of the green-white wire pair to the feedthrough terminals for the longitudinal position coil. (See Table 1 for polarity.)

Table 1. Coil Wiring Position

Color	Polarity	Function
Green	Negative (-)	Longitudinal Position Coil
White	Positive (+)	
Red	Positive (+)	Lateral
Black	Negative (-)	Position Coil

Note: The white wire must be connected to the positive (+) terminal for the longitudinal coil, and the green wire *must* be connected to the negative (-) terminal for the longitudinal coil.

7. Attach the lugs on the ends of the red-black wire pair to the feedthrough terminals for the lateral position coil.
8. Plug the other end of the cable into rear panel connector J2 on the programmable sweep chassis and tighten the twistlock.

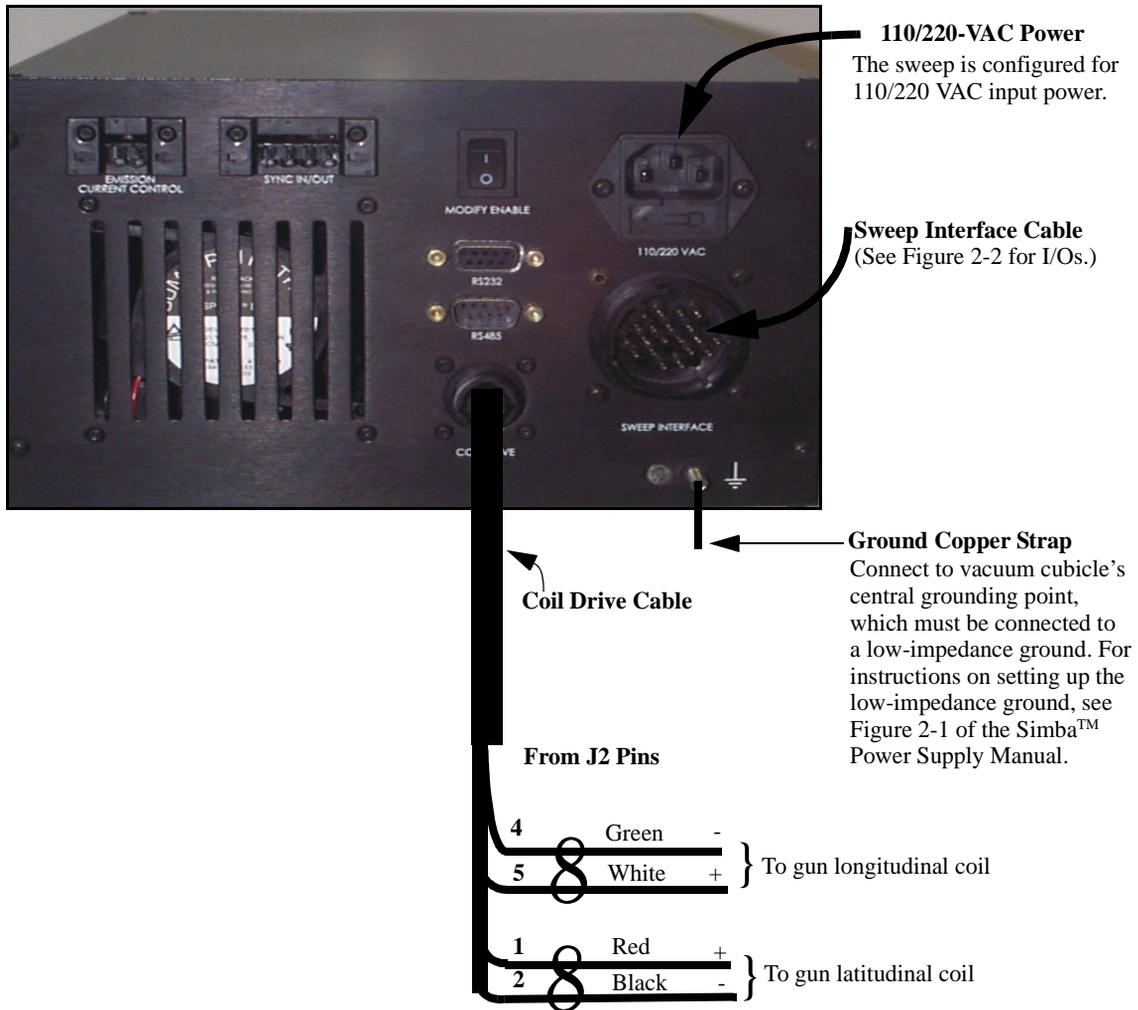


Figure 2-1. Rear Panel Connections

Remote Inputs and Outputs

This subsection provides instructions for making connections to remote devices via the Sweep Interface cable (PN 0040-4972-0), which plugs into rear panel connector J1. Figure 2-2 shows the color coding and the pinouts for the wires in this cable and provides specifications for the inputs and outputs.

Except for the Position Interlock output, which is required by most electron beam power supplies, these remote I/Os are optional. However, if no remote Modify Enable input is provided, the red-black wire pair provided for this function must be jumpered, or the operator will not be able to modify sweep programs with the hand-held controller.

In addition, the yellow-black wire pair for the Sweep Enable input must be jumpered if other remote control functions--but not remote Sweep Enable--are implemented.

If the Sweep Enable loop is not closed, either by remote input or by jumpering of the yellow/black wire pair, the beam will not sweep when the rear panel Local/Remote Switch is set to Remote.

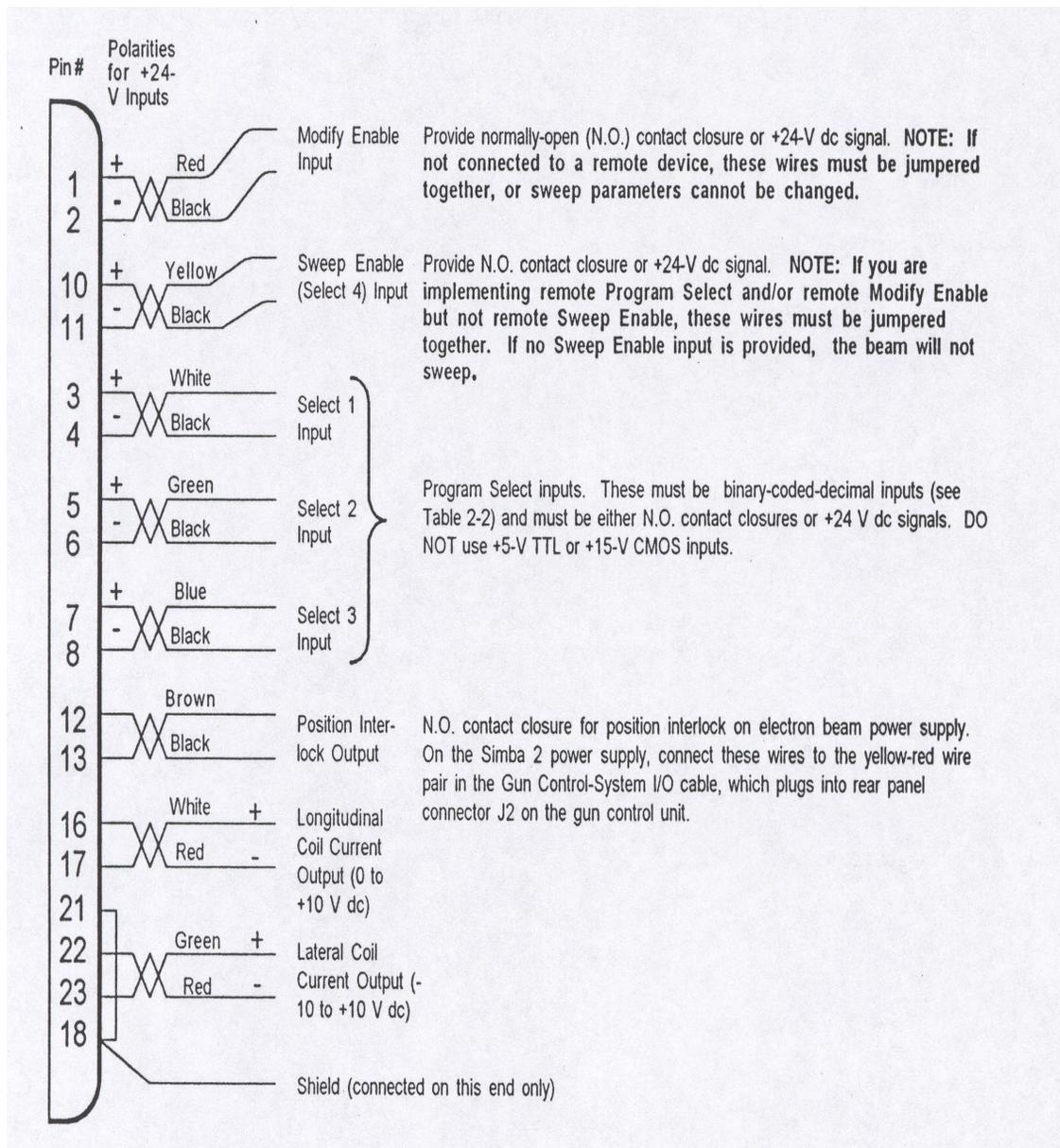


Figure 2-2. Remote I/Os Via the Sweep Interface Cable

Functional Description of Remote I/Os

Table 2. Remote I/Os

Input/Output	Description
Modify Enable	<p>If this loop is not closed, the hand-held controller is disabled. This function can be enabled by contact closure or a +24 VDC signal from a host computer or some other customer-supplied switching device. Such a device can then be used to prevent undesired modification of the sweep programs.</p> <p style="text-align: center;">NOTE</p> <p>If no remote input is provided, the red-black wire pair for this line MUST be jumpered together, or programs cannot be modified.</p>
Sweep Enable	<p>A normally-open contact closure or a +24 VDC signal can be used to enable the beam sweep. When this line is not enabled, the beam is controlled only by the position parameters of the beam sweep program currently selected.</p> <p style="text-align: center;">NOTE</p> <p>If you are not implementing this function but are implementing other remote control functions, the yellow-black wire pair for this line MUST be jumpered together. If this loop is not closed--either by remote input or by the jumpering of these wires--the beam does not sweep.</p>
Select 1, Select 2, Select 3	<p>These input lines allow the user to implement remote program selection. The inputs must be either normally-open contact closures or +24 VDC signals, and they must be coded according to the binary-coded-decimal scheme. See <i>Coding for Program Selection Inputs</i>, following this table.</p>
Position Interlock Output	<p>This normally-open contact closure signals the system's electron beam power supply that the longitudinal coil current is within the set limits (see subsection 2.5). If the power supply is a Simba 2, connect these wires to the yellow-red wire pair in the Gun Control-System I/O cable, which plugs into rear panel connector J2 on the Simba gun control unit.</p> <p style="text-align: center;">CAUTION</p> <p>If you are supplying this output to a Simba 2 power supply, it is also necessary to remove the position PC board for the gun controlled by this sweeper from the Simba gun interface. Failure to do so may result in the power supply receiving a false interlock signal and consequent damage to the electron beam gun.</p>

Table 2. Remote I/Os

Input/Output	Description
Longitudinal Coil Current Output	This 0 to +10 VDC signal tracks the +/- 4 A current that the sweep provides to drive the electron beam gun's longitudinal coil. This output allows a remote device to monitor and/or display the lateral coil current.
Lateral Coil Current Output	This -10 to +10 VDC signal tracks the +/- 4 A current that the sweeper provides to drive the electron beam gun's lateral deflection coil. This output allows a remote device to monitor and/or display the lateral coil current.

Coding for Program Selection Inputs

Program Number	Select 3 Signal	Select 2 Signal	Select 1 Signal
1	0	0	0
2	0	0	1
3	0	1	0
4	0	1	1
5	1	0	0
6	1	0	1
7	1	1	0
8	1	1	1

Connecting I/O Lines to Remote Devices

Follow the procedure described below in connecting the remote I/O lines.

1. Plug the Sweep Interface cable into rear panel connector J1 and tighten the twistlock.
2. Referring to the descriptions above, determine which remote functions you wish to implement.
3. Refer to Figure 2-2 to determine which wires to connect for the desired function.
4. Connect the appropriate wires to the appropriate device(s).

5. If one or more of the control inputs is to be +24 VDC, follow the procedure described in subsection 2.3 to reconfigure control PC board #1 for the +24 V input(s). Note the polarities for +24 V inputs indicated in Figure 2-2.
6. If you are not implementing remote Modify Enable, jumper the ends of the red-black wire pair together.

Note: If no input is provided and these wires are not jumpered, sweep programs cannot be modified.

7. If you are implementing remote program selection and/or remote Modify Enable, but not remote Sweep Enable, jumper the ends of the yellow-black wire pair together.

Note: If no input is provided and these wires are not jumpered, the beam does not sweep.

Reconfiguring for +24-Volt Remote Control Inputs

Any of the remote control inputs described previously can be either a contact closure or a +24 VDC signal. For each 24V signal supplied, a jumper block on the main PCB must be reconfigured. Upon removing the chassis top cover, locate the jumper blocks in question toward the rear on the left side in front of the DB37 connector, J2. See the following figure. The jumper blocks are arranged as follows: J7, J8, J10, J9, J11, with J7 nearest the PCB edge. Jumper blocks J8, J10, and J9 are for program selection lines Select 1, Select 2, and Select 3, respectively. J7 is for the Modify Enable line, and J11 is for the Sweep Enable line (shown as Select 4 on the schematics).

To reconfigure a given jumper block:

- Remove the chassis top cover, if you have not already done so.
- Find the correct jumper block for the signal in question.

- Remove the three jumpers connecting pins 1 and 2, 3 and 4, and 5 and 6.
- Replace two of the jumpers so that they connect pin 2 to pin 3 and pin 4 to pin 5.

Refer as needed to the SuperSweep assembly drawing and the Main PCB schematic Sheet 6.

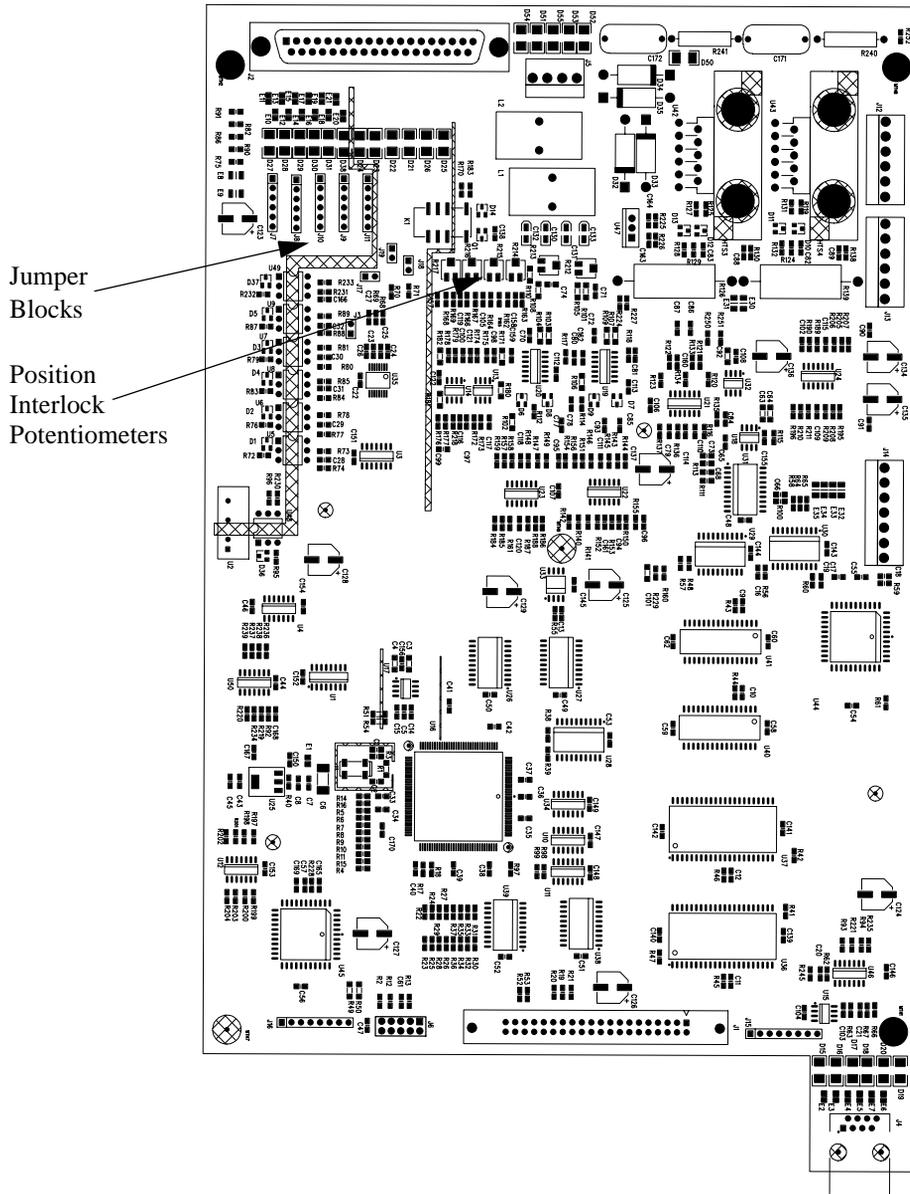


Figure 2-3. SS64 Printed Circuit Board

Setting the Position Interlock Limits

Follow the procedure described below in setting the upper and lower limits for the position interlock contact closure, which must be output to the electron beam power supply for the source controlled by this SuperSweep unit. All appropriate installation configuration procedures outlined in the preceding section must be completed before this procedure is performed. The SuperSweep Position Interlock Limits have been factory set to limit the beam position to +/-4 amperes on both axes. Potentiometers R214 through R217 provide these limit adjustments. There are also software position limits discussed later in this manual.

Caution: Before beginning this procedure, make sure that the position interlock signal is interfaced to the correct power supply. If the source is powered by a Simba 2 power supply, make sure that:

1. the position interlock output is provided to the gun control unit for the source whose beam is controlled by the SuperSweep unit
 2. the position PCB is removed from the gun interface chassis
1. Make sure that the hand-held remote is plugged into the RJ-85 connector on the front panel of the SuperSweep.
 2. Remove the unit's top cover, if you have not already done so. Refer to the preceding figure for potentiometer R214 through R217 locations.
 3. Plug in the SuperSweep's power cord and turn on the Power switch on the front panel. The displays illuminate, and the Amplitude bar-graph displays show the position of the beam and any sweep activity. If there is sweep activity occurring, press the Sweep Enable button to stop the sweep. The green indicator light on the button dims when the sweep is disabled.
 4. Using the hand held remote, press the Latitude/Longitude select button so that the Longitude indicator light displays.

5. Press the Position button, and turn the Adjust knob to move the Longitude bar-graph display indicator to the Zero position.
6. Press the Latitude/Longitude button again to select Latitude, and then center the Latitude display as done previously for the Longitude.
7. Note that the Position Interlock indicator on the front panel is not illuminated.
8. Find the gun control for the source controlled by the SuperSweep and set the Filament Request to 0 amperes.
9. Switch on the high voltage and the emission current for this source. If you look at the source through a viewport, you should see the filament glowing and possibly a faint beam. If you cannot see a beam, slowly increase the filament current request until a beam is barely visible.

Caution: Damage to the source or to other equipment inside the vacuum chamber is likely if any more than minimum power is used to obtain a visible beam for this procedure.

10. Rotate the Adjust knob clockwise and note the lateral movement of the beam in the positive current direction. Move the beam up to the edge of the pocket and then turn off the emission current and high voltage. Note the current reading on the SuperSweep front panel.
11. Using a small potentiometer adjusting tool, rotate potentiometer R214 counterclockwise until the Position Interlock indicator just comes on. Slowly turn the Adjust knob counterclockwise until the Position Interlock indicator dims, then turn it back clockwise until the Position Interlock displays. Note that the current reading on the SuperSweep panel matches the previously noted value. If not, slightly adjust R214 so that the Position Interlock illumination point coincides with the current value.
12. Once set, reset the current back to zero.
13. Switch on the high voltage and emission current for this source again, repeating Step 9.

14. Rotate the Adjust knob counterclockwise and note the lateral movement of the beam in the negative current direction. Move the beam up to the edge of the pocket and then turn off the emission current and high voltage. Note the current reading on the SuperSweep front panel.
15. Using a small potentiometer adjusting tool, rotate potentiometer R215 clockwise until the Position Interlock indicator just comes on. Slowly turn the Adjust knob clockwise until the Position Interlock indicator dims, then turn it back counterclockwise until the Position Interlock re-displays. Note that the current reading on the SuperSweep panel matches the previously noted value. If not, slightly adjust R215 so that the Position Interlock illumination point coincides with the current value.
16. Once set, return the current back to zero.
17. Press the Latitude/Longitude button to select Longitude.
18. Repeat the above procedure (Steps 9 through 16) for the longitudinal beam position setpoints, adjusting potentiometer R216 for the positive current direction, and potentiometer R217 for the negative current direction.
19. Replace the SuperSweep top cover. The unit is now ready for mechanical installation and software based configuration.

Rack Mounting the SS64

Follow the procedure described below in mounting the SS64 in a standard 19-inch rack. If your installation requires access to the unit's PC boards, rack mount the unit as the final step in the installation.

1. Unplug the unit's power cable.
2. Disconnect the coil drive cable and the sweep interface cable from their rear panel connectors.
3. Disconnect the hand-held controller's cord from the front panel jack.

4. Set the sweeper into the rack and secure it in place with mounting screws.
5. Reconnect the hand-held controller's cord, the sweep interface cable, and the coil drive cable.
6. Connect the rear-panel GND lug to the central grounding point in the vacuum cubicle with a length of 1/2-inch-wide copper strap. The central grounding point **MUST** be properly connected to a low-impedance ground (for instructions see Figure 2-1 in the instruction manual for the Simba™ 2 Power Supply).

Note: The SS64 may fail to operate properly if the low-impedance ground is not established correctly, particularly in systems that generate relatively large amounts of RF noise.

7. Plug in the unit's power cable.

The SS64 is now ready for initial operation.

Installing and Configuring the Software

Install the SS64 software from the CD.

Centering the SS64 E-Beam

Before performing a sweep operation, you *must* first position the e-beam over the *center* of the crucible using the *Recipe Menu* window.

Note: Use the *Recipe Menu* window (computer interface to the SS64 box) to set the position values for the e-beam. (You may also use the handheld remote to set the e-beam values but the coils need to be connected first before the front panel values can be displayed [not recommended].)

Set the e-beam position to the following values:

- latitude position, x-axis: 0 (0.0 amps)
- longitude position, y-axis -1.1(-1.1 amps)

Set the position limits to the following values

- latitude, x-axis, minimum: -1.80
- latitude, x-axis, maximum: 1.80
- longitude, y-axis, minimum:1.80
- longitude, y-axis, maximum:0.0

Caution: Do not exceed *0.0* on *maximum*. Damage to e-gun and crucible may occur.

Features and Functions

This section provides you with a discussion of the features and functions of the SS64 box control/display and software. The SS64 box control and display functions and software are identified and defined. Furthermore, the following tasks and procedures provide examples on how to use the SS64 features and functions to perform specific sweep tasks. Objectives for this chapter allow you to:

- Identify and define SS64 features and functions (See “SS64 Box Unit and Remote Control, Features and Functions” on Page 35.)
- Identify and define PC menu features and functions (See “PC Menu Features and Functions” on Page 40.)
 - ↗ See program information (See “View the Program Version Information” on Page 41.)
 - ↗ Set up communications (See “Set Up Communications” on Page 41.)
 - ↗ Close the PC menu (See “Close the PC Program” on Page 48.)
 - ↗ Center SS64 e-beam (See “Centering the SS64 E-Beam” on Page 48.)
 - ↗ Create a new recipe (See “Create a New Recipe” on Page 49.)
 - ↗ Create a standard pattern (See “Create a Standard Pattern” on Page 49.)
 - ↗ Create an arbitrary pattern (See “Create an Arbitrary Pattern” on Page 51.)
 - ↗ Edit an arbitrary pattern (See “Edit an Arbitrary Pattern” on Page 52.)

- ↗ Redraw a recipe wave pattern (See “Redraw a Recipe Wave Pattern” on Page 53.)
- ↗ Simulate a wave pattern (See “Simulate a Wave Pattern” on Page 55.)
- ↗ Set dwell factors (See “Set Dwell Factors” on Page 56.)
- ↗ Import/export an arbitrary pattern (See “Import/Export an Arbitrary Pattern” on Page 57.)
- ↗ Save a recipe (See “Save a Recipe” on Page 61.)
- ↗ Open a recipe file (See “Open a Recipe File” on Page 62.)
- ↗ Modify a recipe (See “Modify a Recipe” on Page 62.)
- ↗ Send a recipe to the SS64 (See “Send a Recipe to the SuperSweep 64” on Page 63.)
- ↗ Get a recipe from the SS64 (See “Get a Recipe from the SuperSweep 64” on Page 63.)
- ↗ Control the SS64 remotely (See “Control the SS64 Remotely” on Page 64.)
- ↗ Install a firmware upgrade (See “Install a Firmware Upgrade” on Page 69.)

Features and Functions

This section identifies and defines the SS64 box and software features.

SS64 Box Unit and Remote Control, Features and Functions

The SS64 box unit and remote control allow you to:

- Load and save a program (recipe)
- Modify and save a program
- Select manual or remote modes of operation
- Connect one or more computers to the SS64 (through an RS232 or RS485 connection)
- Select predefined and user-defined (arbitrary) waveforms
- Select latitudinal and longitudinal amplitude, frequency, and position
- Adjust emission current for each waveform

SS64 Front Panel

A waveform and its values, e.g., x- and y-axes amplitude, frequency, and/or position value, determines the wave pattern characteristics. For example, you can select a sine waveform for both x- and y-axes with the values of 100% of full scale (FS) amplitude with 10 cycles per second frequency at a position offset at - 0.5 amperes on the x-axis and + .25 amperes on the y-axis.

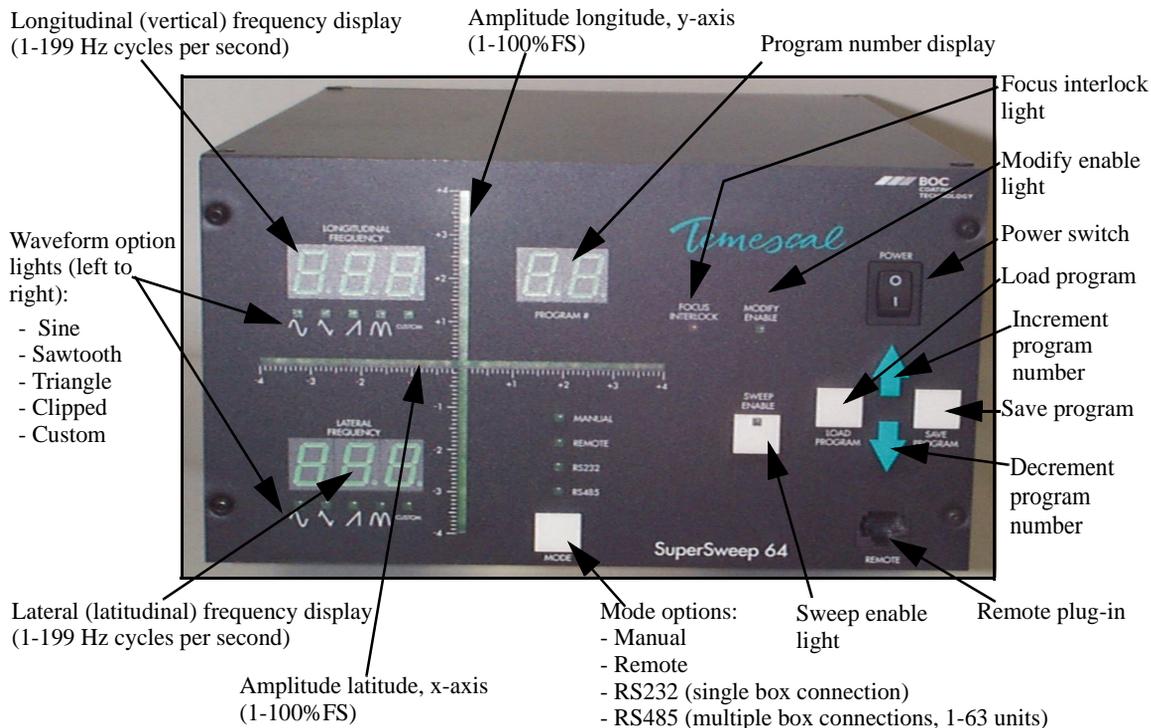


Figure 3-1. SS64 Box, Front Panel

Recipes or programs can be loaded, modified, or created to perform specific types of sweeps. Load a recipe by using the SS64 *load program* option, modify a recipe using the remote options, or create a new recipe by using the recipe menu on your PC.

You can load and modify a recipe using the SS64 box and remote. Select one of the stored recipes in the SS64 box by pressing the up or down arrow on the box's front panel and then select *load program*. The recipe or program number appears in the *program number* display. The amplitude and frequency values appear on the *x-* and *y-axes* and *lateral (latitudinal)* and *longitudinal frequency* displays.

Table 1. SS64 Front Panel Features and Functions

Feature	Function
Power Switch	This is the on and off switch for the SS64 box.
Focus Interlock	The Focus Interlock light is displayed once the e-beam focus or emission current has been set. Bending the electron beam so that it strikes the material to be evaporated is the function of the focus circuits. The focus interlock prevents the application of filament power and high voltage unless the longitudinal focus current is within the desired limits.
Modify Enable	The Modify Enable light is displayed once the Modify Enable Switch is enabled on the the SS64 back panel. When enabled, this feature allows a recipe to be modified by either the Handheld Remote or the PC Recipe Menu.
Sweep Enable	The Sweep Enable button toggles the e-beam sweep on or off.
Increment Program/Recipe	The <i>up arrow</i> allows you to increment or navigate up a series of increasing recipe numbers.
Decrement Program/Recipe	The <i>down arrow</i> allows you to decrement or navigate down a series of decreasing page numbers.
Load Program	Once a recipe number is selected, you can press the Load Program button to load the recipe.
Save Program	After a recipe's settings are modified on the Handheld Remote or PC Recipe Menu, you can save the recipe by pressing the Save Program button.
Program Number	This display shows the number of the current recipe in operation.
Remote (Plug-In)	Connect your Handheld Remote to the Remote plug-in. You can modify a program or recipe by using the Handheld Remote or the PC Recipe Menu.
Mode	<p>Mode options allow you to run the SS64 in the following modes:</p> <ul style="list-style-type: none"> • manual - control through the front panel • remote - remote control through legacy connector located on back panel • RS232 (single SS64 connection) - control by PC through RS232 serial connection • RS485 (multiple SS64 connections, 1-63) - control by PC through RS485 serial connection
Longitudinal Frequency	The Longitudinal Frequency display shows the vertical frequency value (1-199 Hz cycles per second) that was selected on the Handheld Remote or PC Recipe Menu.
Latitudinal Frequency	The Latitudinal Frequency display shows the horizontal frequency value (1-199 Hz cycles per second) that was selected on the Handheld Remote or PC Recipe Menu.
Waveform Options	The type of waveform light displays depending on the type of waveform selected (i.e., Sine, Sawtooth, Triangle, Clipped, or Custom/Arbitrary) on the Handheld Remote or PC Recipe Menu.

Table 1. SS64 Front Panel Features and Functions

Feature	Function
Amplitude Longitude, Y-axis	This vertical bar displays the amplitude value (1-100% of full scale) that was selected on the Handheld Remote or PC Recipe Menu.
Amplitude Latitude, X-axis	This horizontal bar displays the amplitude value (1-100% of full scale) that was selected on the Handheld Remote or PC Recipe Menu.
Position Limits	The x- and y-axis coordinates are displayed on the horizontal and vertical bar displays. These coordinates were selected using the Position and Position Limits features on the Handheld Remote or PC Recipe Menu. The combination of x- and y-axis position coordinates determines the shape of the wave pattern.

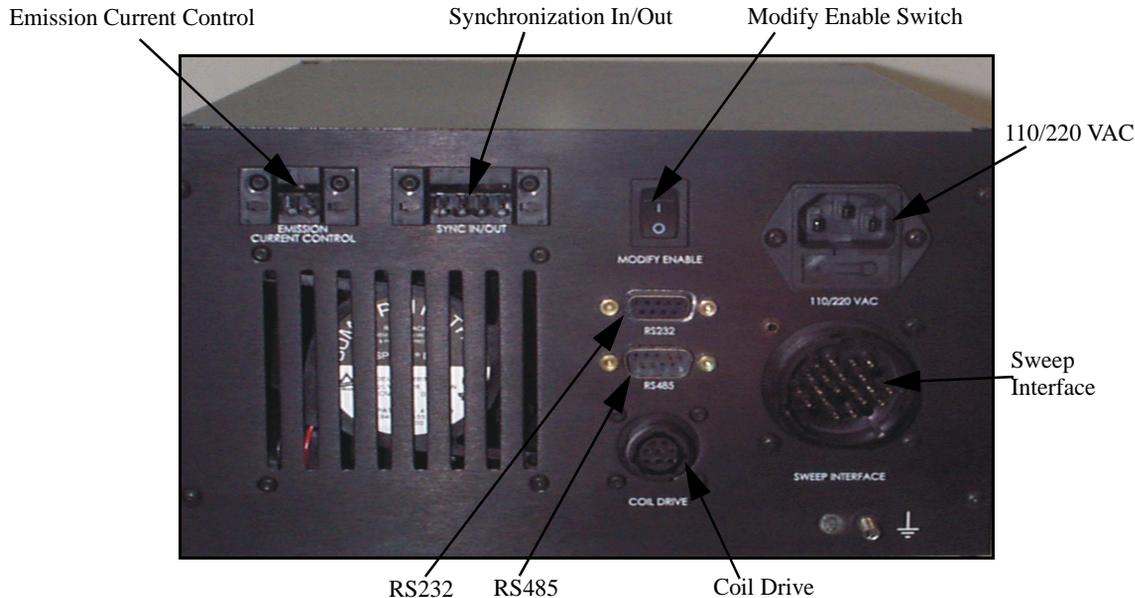


Figure 3-2. SS64 Box, Back Panel

Handheld Remote

A remote control is used to select a specific waveform’s amplitude, frequency, and/or position value for the x- and y-axes. Select the desired waveform attribute and adjust the attribute value by using the

Dial Control. These values can be saved as a new recipe or program by pressing *Save Program* located on the SS64 front panel. The remote can access 8 of the SS64's recipes at a time.

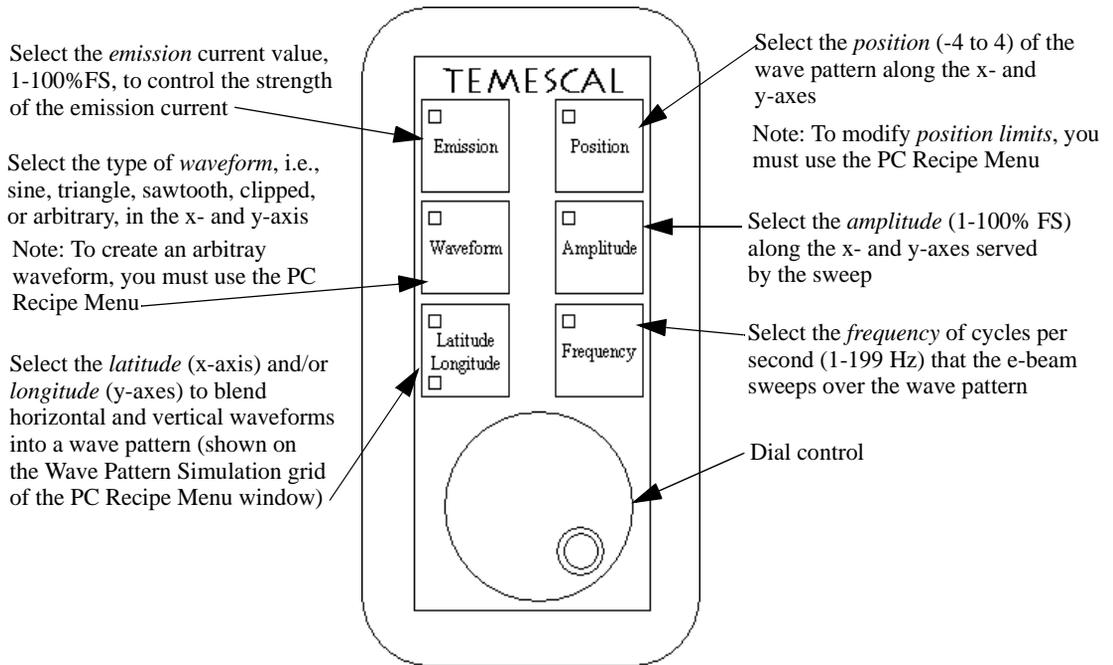


Figure 3-3. SS64 Handheld Remote

E-Beam Gun

The SS64 controls the movement of the e-beam gun by dividing this movement into horizontal (latitudinal or x-axis) and vertical (longitudinal or y-axis) components. The combination of these components determines the position of the beam at any time.

PC Menu Features and Functions

The PC or *recipe* menu also allows you to load, modify, create, and save a recipe or program from your PC. You can store an almost unlimited amount of recipes on your PC.

The SuperSweep Recipe Menu screen allows you to:

- View the program version information
- Set up communications
- Connect a single SS64
- Connect a network of SS64 units
- Create a recipe
- Open a recipe
- Modify and save a recipe
- Send a recipe to and get a recipe from the SS64
- Control the SS64 remotely
- Install a firmware upgrade

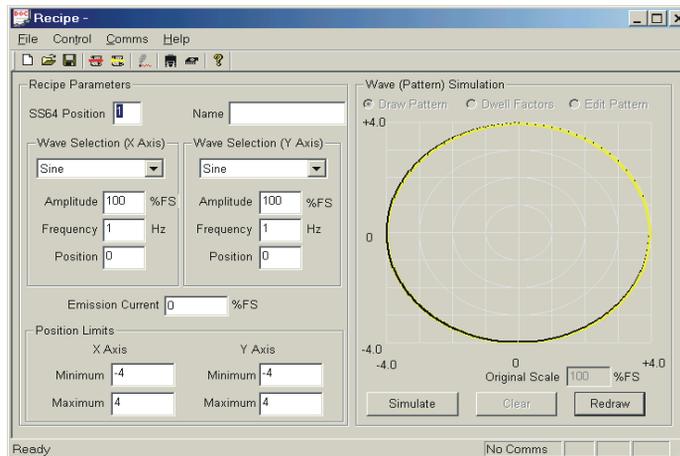


Figure 3-4. Recipe Menu

View the Program Version Information

To find out what version of the PC program you are running:

1. From the *Help* menu select *About*. The *About SuperSweep 64* window displays.
2. Select OK to close the window.

Set Up Communications

The SuperSweep 64 has two serial ports: a RS-232 port (female) for connecting directly to a PC, and a RS-485 port (male) for connecting multiple units in a daisy-chain configuration.

The following topics describe how to set up communications between your PC and one or more SuperSweep 64 units:

- PC to a single SS64
- PC to a network of SS64 units

Data Transfer Specifications

- Port Selection - COM1, COM2, COM3, or COM4)
- Baud Rate - 9600
- Parity - None
- Data Bits - 8
- Stop Bits - 0
- Receive Buffer Size - static 512 Bytes
- Transmit Buffer Size - static 512 Bytes

See *SS64 Hardware* and *Resolve Connection Problem* sections.

Connect a Single SS64

The following topic describes how to set up communications between your PC and a single SuperSweep 64.

Hardware Connection

1. On the SS64, set the Mode to RS-232.

- Using a 9-pin serial cable, connect a COM port on your PC to the RS-232 port (female) on the SuperSweep 64.

PC Settings

After connecting the PC to the SuperSweep 64, you must configure the PC program communications settings to coincide with your hardware connection.

To configure the PC communications settings:

- From the *Comms* menu, select *Setup*. The following dialog displays:



Figure 3-5. Setup Serial Port

- From the *PC Com Port* drop-down box, select the port to which your RS-232 cable is connected.
- After verifying that your PC is connected to the SS64, select the RS232 radio button. The program attempts to connect to the SS64.
- If the connection is successful, a dialog box similar to the one below displays.

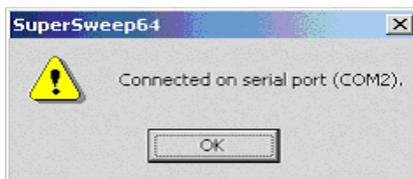


Figure 3-6. Confirm Serial Port Connection

5. Select *OK*, then select *Close*.

See *Network of SS64 Units* and *Resolve Connection Problem* sections.

Connect a Network of SS64 Units

It is possible to network several SS64 units in a daisy-chain configuration using RS485 protocol. You will then be able to control these units, one at a time, from a single PC.

Assigning Addresses (Slave IDs)

The first step is to connect the PC to a SS64 and assign that unit a unique address. You must repeat this procedure for each SS64 to be connected.

1. On the SS64, set the *Mode to RS232*.
2. Using a 9-pin serial cable, connect a COM port on your PC to the RS232 port (female) on the SS64.
3. Open the SS64 PC program. From the *Comms* menu, select *Setup*.

The following dialog displays.



Figure 3-7. Setup Serial Port

4. From the *PC Com Port* drop-down box, select the port to which your RS-232 cable is connected.
5. After verifying that your PC is connected to the SS64, select the RS232 radio button.

The program attempts to connect to the SS64.

6. If the connection is successful, a dialog box similar to the one below displays.

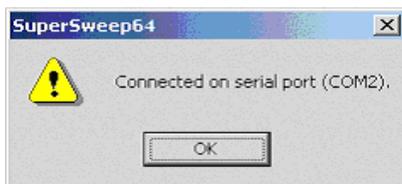


Figure 3-8. Serial Port Connection Confirmation

7. Select *OK*.
8. Select *Assign 485 Address...*

The following dialog box displays.



Figure 3-9. Set RS485 Address

9. Enter an Address (also known as Slave ID). Addresses can be any number from 2 to 64.
10. Enter a *Description*.
11. Select *OK*. The program sets the address.
12. Disconnect the SS64. Repeat the entire process (Steps 1 through 12) for each SS64 that you plan to connect.

Configuring the Network

After assigning an address for each SS64, you are ready to configure the network. For this step, you will need a RS485 converter and RS485 cable.

1. Connect the RS485 converter directly to a Com port on the PC.

2. Use RS485 cable to connect the converter to the RS485 port (male) of the SS64 units in a serial, daisy-chain configuration. (The RS485 port is located below the RS232 port.)
3. Turn on each SS64 in the network and set the Mode to RS485.

Using the Network

You can now use the PC to control any SS64 in the network. However, you can only communicate with one unit at a time. You must tell the program which unit you wish to communicate with.

1. Open the SS64 PC program. From the *Comms* menu, select *Setup*.

The following dialog displays.



Figure 3-10. Setup Serial Port

2. From the *PC Com Port* drop-down box, select the port to which your RS485 converter is connected.
3. After verifying that your PC is properly connected to the RS485 network, select the RS485 radio button. The program connects.
4. If the connection is successful, a dialog box similar to the one below displays.



Figure 3-11. Serial Connection Confirmation

5. Select *OK*.
6. Choose the *Select 485 Address* button.

The program presents a drop-down list of the Slave IDs (Addresses) for each SS64 on the network.

7. Select a Slave ID.

The program makes the connection with the selected SS64. You can now communicate with this unit using the PC controls.

See *Single SS64* and *Resolve Connection Problems* sections.

Resolve Connection Problems

For instructions on how to set up the connection between the PC and one or more SS64 units, see *Setup Communications*.

If the program is unable to connect to the SS64, the following dialog box displays.



Figure 3-12. Unable to Connect Message

If you do not need to connect to the SS64, select *OK* then select *Close*.

If you do need to connect to the SS64, you must resolve the connection problem.

Connection to One SuperSweep 64 (RS232)

To resolve a connection problem, verify that:

1. You are using a RS232 cable and that it is connected to the RS232 port (female) on the SS64.

2. The COM port you have selected coincides with the actual hardware connection.
3. The Mode selector on the SS64 is set to RS232.
4. After resolving the connection problem, re-select the R-232 radio button. A dialog box similar to the one below should display.

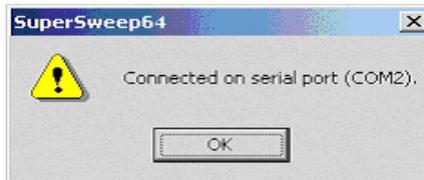


Figure 3-13. Serial Connection Confirmation

5. Select *OK*, then select *Close*.

Connection to Multiple SuperSweep 64 Units (RS485)

To resolve a connection problem, verify that:

1. The RS485 converter is connected to a PC COM port and that you have selected this COM port in the PC communications Setup window.
2. The RS485 cable is connected to the RS485 port (male) on each SS64.
3. The Mode selector on the SS64 units is set to RS485.
4. Each SS64 in the network has a unique address (Slave ID).
5. After resolving the connection problem, re-select the RS485 radio button. A dialog box similar to the one below should display.

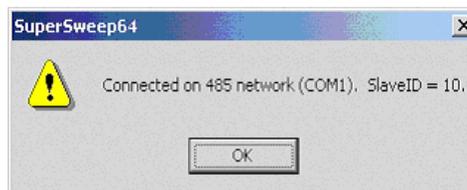


Figure 3-14. Serial Connection Confirmed

6. Select *OK*, then select *Close*.

See *Setting Up Communications, Connecting a Single SS64, and Connecting Multiple SS64 Units.*

Close the PC Program

To close the PC program:

- From the *File* menu select either *Close* or *Exit*. Alternately, click the *X* in the upper right corner of the screen.

Centering the SS64 E-Beam

Before performing a sweep operation, you *must* first position the e-beam over the *center* of the crucible using the *Recipe Menu* window to prevent the beam from over-sweeping the standard temescal pocket. (An ampere of 0 positions the beam at the rear of the pocket.)

Note: Use the *Recipe Menu* window (computer interface to the SS64 box) to set the position values for the e-beam. (You may also use the handheld remote to set the e-beam values but the coils need to be connected first before the front panel values can be displayed. This method is not recommended.)

Set the e-beam position to the following values:

- latitude position, x-axis: 0 (0.0 amps)
- longitude position, y-axis -1.1(-1.1 amps)

Set the position limits to the following values

- latitude, x-axis, minimum: -1.80
- latitude, x-axis, maximum: 1.80
- longitude, y-axis, minimum: 1.80
- longitude, y-axis, maximum: 0.0

Caution: Do not exceed 0.0 on *maximum*. Damage to e-gun and crucible may occur.

Create a New Recipe

Off-Line

When you launch the SS64 PC program, the Recipe window displays. Use this window to create, import, view, or modify Recipes off-line.

To create a new recipe off-line:

1. From the *File* menu, select *New*.
2. Enter the SS64 Position. The SS64 Position identifies the Recipe to the SS64 and specifies its location in memory.
3. Enter a *Name*, if desired. This field is optional.
4. Choose a Wave Selection for the latitudinal (x) and the longitudinal (y) directions.
5. Enter the properties of the desired waveform.
 - If you choose Standard waveforms, a static representation displays on the Wave Pattern Simulation grid.
 - If you choose an Arbitrary waveform, you must draw the wave on the grid using the mouse, then select *Redraw* to set the x and y coordinates for the pattern.
6. Select *Simulate* to view the E-beam in motion.

On-Line

You cannot create a new Recipe on-line; however, you can modify Recipes that are already stored in the SS64.

Create a Standard Pattern

The SuperSweep 64 includes four Standard waveforms: Sine, Triangle, Sawtooth, and Clipped. To create a wave pattern, select a waveform for both the latitudinal and the longitudinal directions. This results in 16 possible standard-wave combinations. You can adjust the individual waveform properties to create the desired wave pattern.

To create a wave pattern from the Standard waveforms:

1. From the *File* menu, select *New*. The *Recipe* screen displays.
2. Enter the SS64 Position.
3. Enter a *Name*, if desired.
4. From the *Wave Selection (Latitude)* list box, select any waveform except *Arbitrary*.
5. From the *Wave Selection (Longitude)* list box, select any waveform.
6. Adjust the following waveform properties as desired for both the Latitudinal and Longitudinal directions:
 - amplitude
 - frequency
 - position
 - emission current
 - position limits
7. Select *Redraw* or press *Enter* to effect the changes.

The resulting static wave pattern displays on the Wave Pattern Simulation grid. To see the effect of Frequency, select *Simulate*.

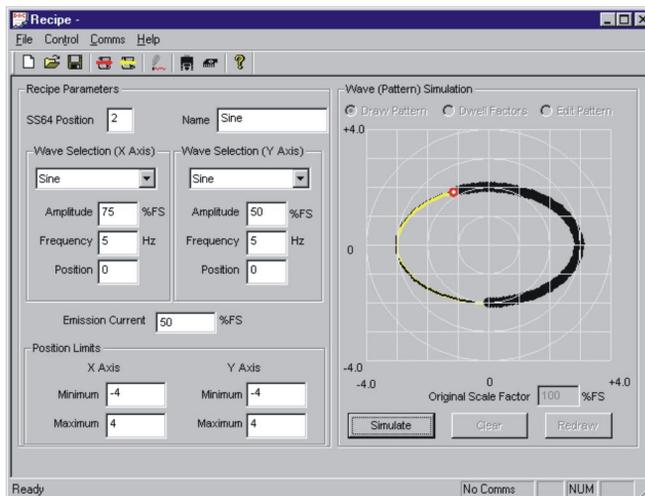


Figure 3-15. Standard Pattern - Sine

Note: If the Wave Selection is the same in both the latitudinal and longitudinal directions, the combined wave pattern is a diagonal line where $x = y$. In order to create a more useful pattern when the Wave Selection and the Frequency properties are equal, the program offsets the longitudinal waveform by 90 degrees.

Create an Arbitrary Pattern

In addition to the four Standard waveforms, the SS64 provides the capability to draw or import a random or Arbitrary wave pattern.

To create an Arbitrary wave pattern:

1. From the *File* menu, select *New*. The *Recipe* screen displays.
2. Enter the SS64 Position.
3. Enter a *Name*, if desired.
4. From the *Wave Selection (Latitude)* list box, select *Arbitrary*.

The *Wave Selection (Longitude)* list box and the Amplitude and Frequency fields become unavailable. The *Draw Pattern* radio button on the *Wave Pattern Simulation* grid is selected.

5. Using the mouse, draw a pattern on the Wave Pattern Simulation grid. If you wish, you may edit the pattern.
6. Select *Redraw* to set the (x, y) points that define the pattern.
7. Adjust the following properties as desired:
 - amplitude
 - frequency
 - position
 - emission current
 - position limits
8. Select *Redraw* after editing to effect the changes.

9. The resulting static wave pattern displays on th Wave Pattern Simulation grid. The static waveform properties are Waveform, Amplitude, Offset Position, and Position Limits.

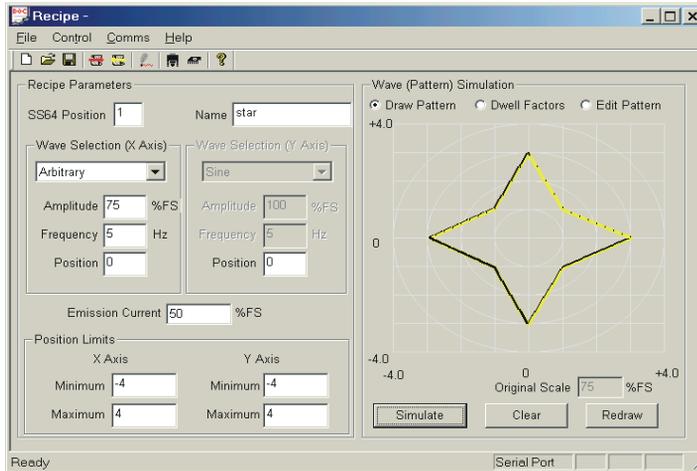


Figure 3-16. Arbitrary Wave Pattern

10. Set Dwell Factors if desired.
11. Select *Simulate* to view the E-beam motion. The Simulate function incorporates both Frequency and Dwell Factors.
12. Select *Clear* if you wish to delete the drawing and reset the wave properties to their default values.

Edit an Arbitrary Pattern

To edit a previously drawn Arbitrary wave pattern:

1. Locate the Arbitrary wave pattern that you wish to edit.

2. Select the *Edit Pattern* radio button to enable edit mode. The following warning message displays.

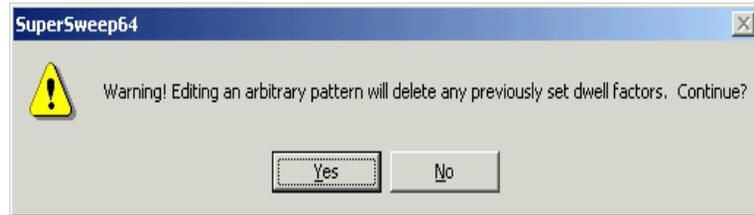


Figure 3-17. Edit Pattern Warning

If you wish to set dwell factors for this pattern, do so after completing your edits.

3. Select *Yes*.
4. Use the mouse to edit the pattern. The edit must have a start point (mouse-down) and end point (mouse-up) located on the original pattern.
5. Select the *Redraw* button.

The software calculates the points on the original pattern closest to the start and end points, removes all points in between, inserts the newly drawn points, and recalculates the waveform's 1,024 points. Any previously existing dwell factors are removed.

6. If you wish to make multiple edits, repeat Steps 2 through 5 for each mouse-down/mouse-up event.
7. After all changes are complete, re-enter dwell factors if desired.

Redraw a Recipe Wave Pattern

What is Redraw

The Redraw function recomputes the x- and y-coordinates for a wave pattern using the current wave properties. Because Redraw is a static representation, it does not incorporate time factors such as Frequency or Dwell Factors. To view the pattern with these time parameters included, use Simulate.

Arbitrary Wave

When initially creating an Arbitrary wave, you must first draw the pattern then select *Redraw* to set the points that define the pattern.

For more information, see Create an Arbitrary Pattern.

Arbitrary and Standard Wave

Once you have created a Wave Pattern, you can alter the wave properties then use Redraw to recreate the pattern using the current properties.

Using Redraw

To use the Redraw function:

1. Create a new Recipe or retrieve an existing Recipe.
2. Alter one or more of the waveform properties.
3. Select *Redraw* (or press *Enter*).
4. The adjusted wave pattern displays on the Wave Pattern Simulation grid.

Note 1: If the Wave Selection is the same in both the latitudinal and longitudinal directions, the combined Wave Pattern will be a diagonal line where $x = y$. In order to create a more useful Wave Pattern when both the Wave Selection and the Frequency properties are equal, the software offsets the longitudinal waveform by 90 degrees. For example, a Sine, Sine combination yields a circle instead of a diagonal line.

Note 2: If the Frequency is the same in both the latitudinal and longitudinal directions, the Wave Pattern displayed in both the Redraw and Simulate modes is the same.

Simulate a Wave Pattern

What is Simulate

The Wave Pattern Simulation grid displays a static representation of the wave pattern. The Simulate function displays the movement of the E-beam over time.

Note: If the Frequency in both the latitudinal and longitudinal directions is the same, then the wave appears the same in both the Redraw and Simulate modes.

Using Simulate

To Simulate the E-beam motion:

1. Create a new Recipe or retrieve an existing Recipe.
2. In the *Recipe* window under the Wave Pattern Simulation grid, select *Simulate*.
3. The E-beam displays on the Wave Pattern Simulation grid as a red circle tracing a black path along the pattern.

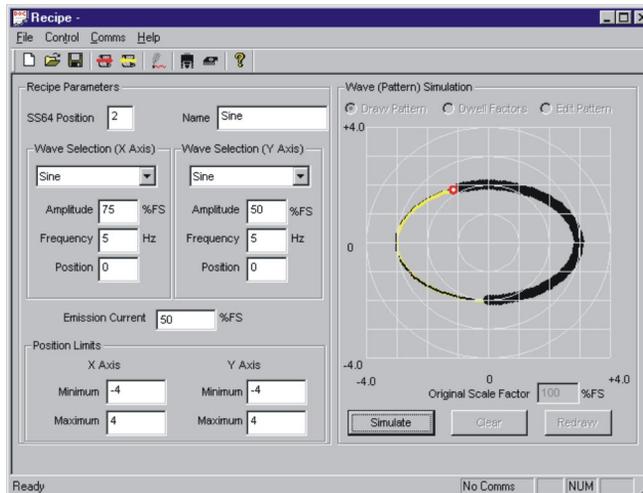


Figure 3-18. E-Beam Simulation

4. To end the simulation, select *Simulate* again.

Set Dwell Factors

Arbitrary Wave

Dwell Factors only apply to Arbitrary waveforms. A Dwell Factor is a point on the wave pattern where the E-beam holds its position for a specified period of time. A single Dwell Factor can range from $1/1024$ to $63/1024$ of the pattern cycle time. You can enter a maximum of 63 Dwell Factors.

To set Dwell Factors:

1. Create a new or retrieve an existing Recipe. The Recipe must use the Arbitrary Wave Selection.
2. In the Recipe window above the Wave Pattern Simulation grid, select *Set Dwell Factors*.

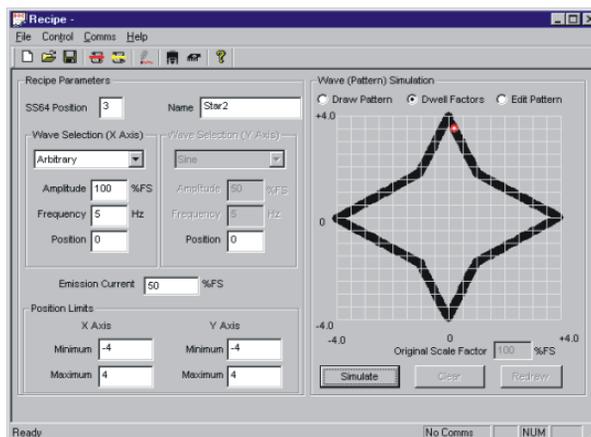


Figure 3-19. Set Dwell Factors

3. Double-click a location on the pattern. The Dwell Factor window displays.

If the message, "There are no points on the curve within this region" displays, select *OK* and retry.

- Enter a Dwell Factor. Since the standard dwell time is 1 (1/1024 of a pattern cycle time), enter a number from 2 to 63.

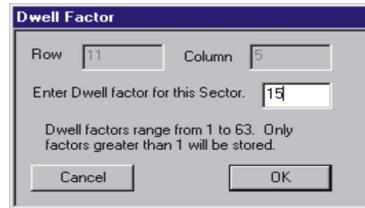


Figure 3-20. Dwell Factor

- Select *OK*. A red square displays to indicate the presence of a Dwell Factor.

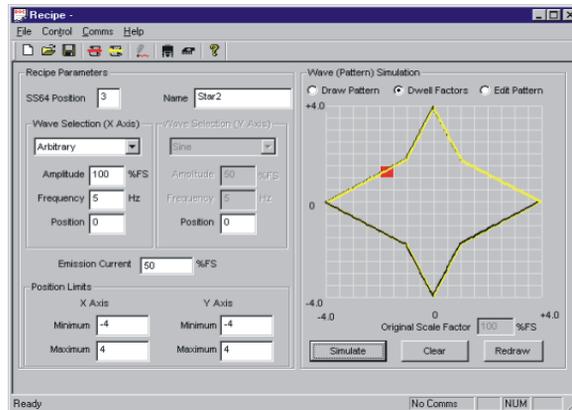


Figure 3-21. Dwell Point

- Select *Simulate* if you wish to view the E-beam moving along the pattern

Import/Export an Arbitrary Pattern

After creating an Arbitrary waveform, you may wish to precisely edit the points that define the pattern. With the Import/Export feature, you can export the pattern as a text file (*.txt), open the file in any text editor and edit the values, then import the file and view the revised waveform.

Note: The import/export feature is available only for Arbitrary waveforms, and is best used without dwell factors.

How It Works

When you Export the wave pattern, the program writes the pattern data to a text file (*.txt). The file consists of 1,024 pairs of x (latitudinal) and y (longitudinal) coordinates with values ranging from -4.000 to + 4.000. Any existing dwell factors are converted to simple x,y values. For example:

Let's say that you have a dwell factor of 50 located at the point $x=2$, $y=1$. When you export the file, the program still exports 1,024 points but the dwell factors are removed and you see 50 pairs of $x=2$, $y=1$. When you import the file, there are no dwell factors.

After exporting the pattern, you can open the file using any program (such as Notepad or Excel) that can read *.txt files. You are able to edit the x, y values as desired.

When you import the edited pattern, you can run the Simulator to verify your changes. The program does not recalculate your point values upon import. However, if you use Edit Pattern, Redraw, or add Dwell Factors, the program recalculates values.

Note: Important! The program removes all Dwell Factors during the import/export process. Do not add dwell factors after importing your edited wave pattern; the program regenerates a new set of 1,024 points and your edits are lost. If you need to use dwell factors, add them before exporting.

Export

To export an Arbitrary wave pattern:

1. Select or create an Arbitrary wave pattern.

- From the *File* menu, select *Export*. The Open window displays with the name of the current Recipe file in the File name field.

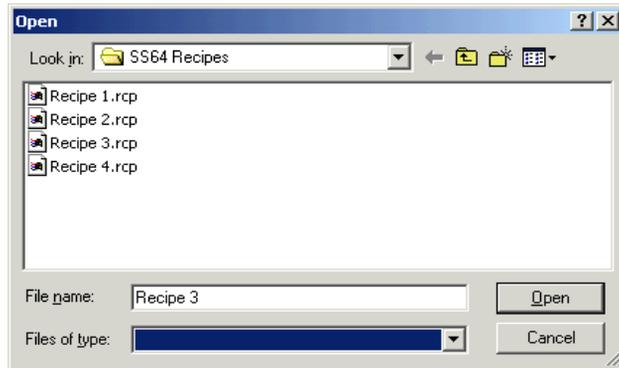


Figure 3-22. File Menu

- Select *Open*. The program exports the recipe as a text file.

Editing a Text File

To edit your exported text file:

- Open a program, such as Notepad or Excel, that can read *.txt files.
- Open the text file you previously exported. The file looks something like this, containing 1,024 pairs of x and y values:

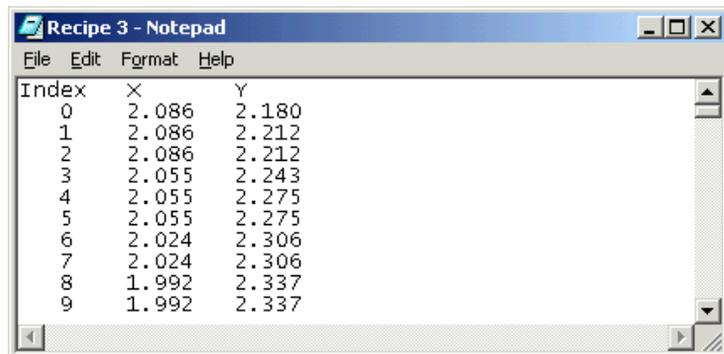


Figure 3-23. Text File Sample

3. Edit the x, y values as desired. Remember that these values can range from -4.000 to +4.000. Do not change the Index values.
4. Save your changes and close the file.

Import

To import a text file of an arbitrary wave pattern, the file must be in the format described above.

1. In the SuperSweep 64 PC program from the *File* menu, select *Import*. An Open window displays.

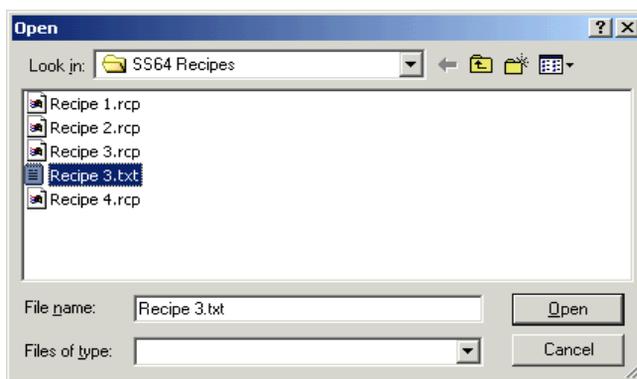


Figure 3-24. File Menu

2. Highlight the text file that you wish to import and select *Open*.

The imported recipe displays in the SS64 PC program.

3. To verify that the recipe is correct, select *Simulate*. The program does not recalculate point values upon import.

Note: If you use Edit Pattern, Redraw, or add Dwell Factors, the program regenerates the x,y values and your edits are lost.

Dwell Factors

The program removes all dwell factors during the import/export process. Do not add dwell factors after importing your edited wave pattern; the program will regenerate a new set of 1,024 points and your

edits are lost. If you need to use dwell factors, add them before exporting. See *How It Works* for more information.

Save a Recipe

Save a New Recipe to a PC File

The *Save* and *Save As* functions save a new Recipe to a PC file location. If the recipe file does not yet exist, the *Save* function displays the *Save As* window.

To save the current Recipe to a file on your PC:

1. From the File menu, select *Save* or *Save As*.
2. A *Save As* window displays.
3. Enter the desired PC file location in the *Save In* field.
4. Type a file name in the *File Name* field. Recipe files are saved in the format *.rcp.
5. Select *Save*.
6. The Recipe is saved on the PC in the specified location.

Save Modifications to a Recipe to a PC File

To save changes to an existing Recipe file:

From the *File* menu, select *Save*. The program saves the changes to the existing Recipe file on the PC in the previously specified location.

Save a Recipe to the SuperSweep 64 (Send)

The *Send* function saves the current Recipe from the PC to the SS64 EEPROM.

Note: Before attempting to send a Recipe to the SS64, verify that your PC is properly connected to the SS64.

To save the current Recipe to a location in the SS64:

1. From the *File* menu, select *Send*. A confirmation dialog box displays.
2. Select *Yes* to send the Recipe. The Recipe is stored in the SS64 EEPROM in the SS64 Position specified in the Recipe.
3. If the message, "Failed to Send Recipe. (Communication Timeout.)" displays, check hardware connections and retry.

Open a Recipe File

To open a Recipe file that has been stored on the PC:

1. From the *File* menu select *Open*. The Open dialog box displays.
2. Locate and highlight the desired file.
3. Select *Open*. The program opens the file and displays the Recipe parameters on the Recipe screen.

Modify a Recipe

Off-Line

You can modify Recipe files stored on the PC while working off-line.

To modify a Recipe off-line:

1. Retrieve an existing Recipe file.
2. Alter one or more of the waveform properties.
3. Select *Redraw* (or press *Enter*). The adjusted wave pattern displays on the Wave Pattern Simulation grid.
4. If desired, select *Simulate* to view the E-beam in motion.
5. From the *File* menu, select *Save*. The program saves the modifications to the existing Recipe file.
6. If you want to store the modified recipe in the SS64, from the *File* menu, select *Send*.

On-Line

You can modify the Recipe that is currently active in the SS64 while working on-line. To perform on-line modifications, see *Control the SS64 Remotely*.

Send a Recipe to the SuperSweep 64

The Send function sends the currently displayed recipe to the SS64.

Note: Before attempting to send a Recipe to the SS64, verify that it is properly connected to the PC.

To send the current Recipe to a location in the SS64:

1. From the *File* menu, select *Send*. A confirmation dialog box displays.
2. Select *Yes* to send the Recipe. The Recipe is stored in the SS64 EEPROM in the SS64 Position location specified in the Recipe.
3. If the message, "Failed to Send Recipe. (Communication Timeout.)" displays, check hardware connections and retry.

Get a Recipe from the SuperSweep 64

The Get function retrieves a Recipe from the SS64 and makes it the current Recipe in the PC program.

Note: Before attempting to retrieve a Recipe from the SS64, verify that it is properly connected to the PC.

To retrieve a Recipe from a location in the SS64:

1. From the *File* menu, select *Get*. A selection dialog box displays.
2. Enter the SS64 Position for the Recipe you wish to retrieve.
3. Select *OK*. The Recipe is copied from the SS64 EEPROM and displayed in the Recipe window.
4. If the message, "Cannot get select recipe. (Communication Timeout.)" displays, check hardware connections and retry.

Control the SS64 Remotely

Controlling the SuperSweep 64 with the PC

The SS64 PC program allows you to load, control, and modify a recipe remotely. The PC controls mimic the controls on both the Front Panel and the Handheld unit. You can load a Recipe into the unit, view the current settings, enable the Sweep, modify the sweep, and save the modifications as changes to the Recipe.

Note: Before attempting remote control of the SS64, verify that:

- your PC is properly connected to the SS64
- the Mode control on the Front Panel is set correctly (RS232 for a single connection or RS485 for a network)

Accessing the PC Controls

The software provides PC Front Panel Controls, PC Handheld Controls, and a Current Settings display.

To access the PC controls:

From the *Control* menu, choose *Modify Recipe*. The *Modify/View Current Recipe* window displays.

Front Panel Controls (PC)

The PC program provides Load Recipe, Save Current Recipe, and Sweep Disable/Enable functions that mimic these controls on the Front Panel of the SS64.

Note: Before attempting remote control of the SS64, verify that:

- your PC is properly connected to the SS64
- the Mode control on the Front Panel is set correctly (RS232 for a single connection or RS485 for a network of SS64 units)

To access the PC Front Panel control functions:

From the *Control* menu, choose *Modify Recipe*. The *Modify/View Current Recipe* window displays. The Front Panel controls are located on the left.

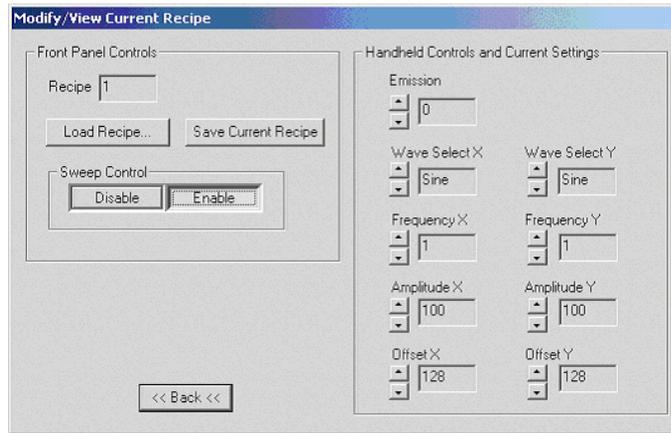


Figure 3-25. Modify/View Current Recipe

Load Recipe

To use the PC control functions, you must first load a Recipe into the SS64.

To load a Recipe using the PC:

1. From the *Control* menu, choose *Modify Recipe*.
2. In the *Modify/View Current Recipe* window under *Front Panel Controls*, select *Load Recipe*. The Load Recipe Control window displays.
3. Type a recipe location ID (SS64 Position) and select *OK*. The Recipe stored in the selected location becomes the active Recipe in the SS64.

Sweep Disable/Enable

When you load a recipe, the Sweep is enabled. If you wish to control the SS64, remain in the Sweep Enable mode. If you choose to disable the Sweep, you can still modify the loaded Recipe and/or view the Current Settings.

To disable/enable the Sweep using the PC:

1. From the *Control* menu, choose *Modify Recipe*.
2. In the Front Panel Controls under Sweep Control, select either the *Disable* or the *Enable* option. The SuperSweep 64 sweep is either disabled or enabled.

Save Current Recipe

You can modify the currently loaded recipe using the PC Handheld Controls then save these changes to the EEPROM memory in the SS64.

To save modifications:

1. From the *Control* menu, choose *Modify Recipe*. The Modify/View Current Recipe window displays.
2. Modify the Recipe as desired.
3. Under Front Panel Controls, select *Save Current Recipe*. The system saves the changes to the current Recipe in the proper memory location in the SS64 EEPROM.

Handheld Controls

The PC program provides Emission, Wave Select, Frequency, Amplitude, and Offset functions that mimic the controls on the Handheld unit.

Emission

Adjusts the strength of the Emission Current up or down.

Wave Select X, Wave Select Y

Toggles through the Standard wave selection choices in the latitudinal (x) and longitudinal (y) directions.

You cannot select an Arbitrary waveform using the Handheld Controls. To create an Arbitrary waveform, use the *Create Recipe* function in the PC program.

If an Arbitrary waveform has been loaded, you are not able to change the waveform selection. If you wish to activate the waveform selection control, you must load a Standard waveform into the SS64.

In addition, when a waveform has been loaded, you cannot change the waveform type. That is, you cannot change from Arbitrary to Standard, or from Standard to Arbitrary.

Frequency X, Frequency Y

Adjusts the Frequency in hertz in the latitudinal (x) and longitudinal (y) directions. If you have loaded an Arbitrary waveform, a change to Frequency x or Frequency y applies to both axes.

Amplitude X, Amplitude Y

Adjusts the Amplitude in percent of full scale in the latitudinal (x) and longitudinal (y) directions.

If you have loaded an Arbitrary waveform, a change to Amplitude x or Amplitude y applies to both axes.

Offset X, Offset Y

Adjusts the center position in the latitudinal (x) and longitudinal (y) directions. (Functions the same as the Position control in the Recipe window.)

To Use the PC Handheld Controls

Before attempting remote control of the SS64, verify that:

- your PC is properly connected to the SS64
- the Mode control on the Front Panel is set correctly (RS232 for a single connection or RS485 for a network of SS64 units)

To use the PC Handheld Controls:

1. From the *Control* menu, choose *Modify Recipe*. The *Modify/View Current Recipe* window displays. The Handheld Controls are located on the right side of the screen.

2. Load a Recipe. TheSweep is enabled upon loading the Recipe. You can disable/enable the sweep as desired.
3. Adjust the parameters up or down as desired.

View the Current Settings

To view the settings for the currently loaded Recipe:

1. From the *Control* menu, choose *Modify Recipe*. The *Modify/View Current Recipe* window displays.
2. Select *View Current Settings*. The current settings display. If you modify the current Recipe, the system displays your changes.

Modify the Active Recipe Using the PC Controls

You can modify the settings of the Active, or currently loaded, Recipe with or without the Sweep enabled. Your changes display under Current Settings.

To modify the currently loaded Recipe using the PC:

1. From the *Control* menu, choose *Modify Recipe*.
2. Load a Recipe into the SS64. When a Recipe is loaded, the Sweep is enabled. You may disable the Sweep if desired.
3. Adjust the waveform parameters using the PC Handheld Controls. The changes display under the Current Settings. If the Sweep is enabled, the changes are reflected in the movement of the E-beam.
4. If you wish to save the modifications, select *Save Current Recipe*. The system saves the changes to the current Recipe in the proper memory location in the SS64 EEPROM.
5. To save the changes to PC disk, see *Get a Recipe* from the SS64.

Install a Firmware Upgrade

1. From the *Comms* menu, select *Firmware Upgrade*. The File Open dialog box displays.
2. Find and highlight the program file. The upgrade file has the extension *.s19.
3. Select *Open*. The SS64 PC program downloads the new Firmware and updates your system.

Theory of Operation

The electron beam gun filament is placed out of the line-of-sight of the source crucible to prevent ion bombardment and contamination. Bending the electron beam so that it strikes the material to be evaporated is the function of the focus circuits. The magnetic fields necessary for positioning the beam are provided by controlled currents in the longitudinal and lateral focus coils as well as by one or more permanent magnets in the electron beam gun. The *longitudinal focus current* also controls an electron gun controller interlock. This prevents the application of filament power and high voltage unless the longitudinal focus current is within the desired limits.

The Sweep Control System

The beam control system controls the position and sweep of the electron beam in both the lateral (x) and longitudinal (y) directions. In any given sweep pattern, there are seven parameters of concern:

- lateral position
- longitudinal position
- lateral sweep frequency
- longitudinal sweep frequency
- lateral sweep amplitude
- longitudinal sweep amplitude
- amplitude of emission current

The SS64 sweep control stores a maximum of 64 sweep programs and the seven parameters can each have independent values in each of the 64 programs. Part of the function of the sweep controls is to keep these parameters separately stored in a non-volatile memory; they are stored on power down.

The sweep control consists of a control section that drives a firmware and software controlled waveform generator and two power amps. One power amp drives the lateral coil, the other drives the longitudinal coil.

The control section has a microprocessor and support circuitry that includes FLASH RAM, SRAM, decoding circuits, and buffers. The firmware in the control system determines the operating mode of the electron beam sweep control based on the external control inputs or computer control. The inputs in the remote (non-computer) mode select the program number, sweep on or off, and Modify Enable mode. Each input is optically isolated and buffered before reaching the control section.

The handheld controller provides parameter adjustments. The Modify knob turns a digital pot. The digital pot has no stop in either the clockwise or counterclockwise direction. As the pot is rotated, it puts out a pair of signals (in quadrature). The phase relationship of these two signals tells the control system in which direction the pot is being turned. The pot modifies a particular sweep parameter -- stored in RAM -- if the Modify Enable external input mode is selected. If the system is not in Modify Enable mode, the pot does not have any effect.

The display section of the sweep control is driven by the control system. Sweep programs #1 through #64 can be displayed. In addition, the longitudinal and lateral sweep frequencies are displayed (0 to 199 Hz).

The control system is disabled under the condition that the 5 volt power supply is not at the proper value, i.e., above 4.8 volts DC. A 5 volt monitor circuit performs this function.

The heart of the SS64 is a 16 bit Motorola MC68HC16 microprocessor (U16). The microprocessor provides all of the control functionality in conjunction with a Programmable Logic Device (PLD) U44. This PLD operates as a state machine to select and control the various internal and external functions of the SS64.

Firmware that generates the microprocessor program is contained in FLASH RAMs.

U36 contains the executable program code, and U37 is used to retain the program and parameter settings for each of the 64 program recipes available to the SS64 operator. SRAMs U40 and 41 are used to provide dynamic memory for normal operation. A 16 bit wide data architecture is used throughout the SS64, with the low byte (data bits 0-7) used for the waveform data information that drives the output quad DAC U31. The high byte is used for all of the control functions within the SS64.

On initial turn-on of the SS64, a system reset is generated by U25. The microprocessor then sends a \sim CSBOOT command and loads the firmware program from U36. A self check diagnostic routine is performed, and error codes (if any) are displayed on the front panel display. After the diagnostic check is performed, the SS64 parameters that were present at the last power-down are loaded into the system from U37. The SS64 then starts normal operation.

In normal operation, octal bus interface chips U26,27,28,29,30,38, and U39 perform data bus switching and transfer from commands received from the microprocessor and state machine. Front panel display and control functions are accessed and controlled using the high byte data lines (8 through 15) and address lines 0 through 4.

External data entry is accomplished through control of the bus and connection with the external interface points. The external interface points include the *sweeper interface* connector on the rear panel, the *hand-held* remote controller, and two serial ports (RS-232 and RS485). U29 provides the interface for the rear panel *sweeper interface* digital control inputs. U30 provides the interface for the hand-held remote controller. Quad 2 to 1 line multiplexer U1 selects either the RS-232 transceiver U35 or the RS-485 Transceiver U3 to provide external communications with a PC.

The output section consists of both digital and analog components. Quad DAC U31 generates three analog outputs, Latitude Sweep Drive, Longitude Sweep Drive, and Emission Current Drive. The Latitude and Longitude Sweep Drive signals are sent to bias offset

amplifiers U21A and B. U21 generates a negative offset to the analog drive voltages to offset the 0-10V signal generated by DAC U31. This offset allows the DAC to drive the sweep output amplifiers U42 and U43 with a bipolar signal with adjustable offset. U42 and U43 are commercial audio amplifier circuits with 68-watt output capability, and are operated at a maximum output of 32 watts at full deflection. In addition to driving the output amplifiers, the DAC sweep outputs are used to generate analog signals for the Peak Lateral and Longitudinal Current monitor circuits comprised of Op-Amps U19 and U20.

Current viewing resistors R121 and R139 are used to generate feedback to provide signals to several circuits. One circuit is the Lateral and Longitudinal Upper and Lower interlocks that provides an interlock that opens when either output current exceeds a preset level to prevent damage to an electron gun crucible if the electron beam strikes anything other than the pocket. This circuit is comprised of Op-Amp U23 and voltage comparators U13 and U14. U13 and 14 have open collector outputs and all four sections are in a wired OR configuration so that if any one section is activated, Transistor Q1 is turned off, thus opening relay K1 and opening the interlock.

The second use of the feedback signals is to drive A to D converters on the display PCB, which in turn provide the LED Sweep Position display indication.

Quad DAC U31 also provides a 0 to 10V signal to drive a suitable external Emission Request input on a typical E-Gun power supply system.

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