

**N13310**

**High Voltage DC Power Supply**

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# SECTION 1

## Introduction

The Nova Research N13310 High Voltage Power supply was specifically designed to drive electrostatic chuck wafer clamping devices. The output is variable from 30 volts through 2500 volts DC with dynamic output voltage tracking and user defined current limit. The specification list is shown in Appendix A.

The 13310 can store up to ten user programs that direct the clamping and declamping operation. Each program can be up to 32 steps long. During remote mode configuration, the unit may be directed to execute any one of the stored programs, giving the user maximum flexibility in both the setup phase when testing clamp reliability, and in operation when clamping different types of substrates.

A local operation mode that executes any specified program gives the user the means of testing new programs without interfering with proven programs in use by a production operation. A full featured command set allows the user to poll for status, setpoint values and current readings in addition to commands for configuring timers and output parameters gives the user great flexibility in designing a successful clamping algorithm.

Serial RS232, DeviceNet (4Q '00), isolated digital, and analog control modes are available, and programs may use the default parameters for the operation mode or may override them internal to the program at the user's option. Two optically isolated digital outputs are available to allow the power supply to mimic the older mechanical clamping mechanisms (Clamp is Up, Clamp is Down). Additionally, an isolated Alarm output is provided that is set whenever a fault condition arises.

## **SECTION 2**

### **Installation**

The 13310 is meant for tabletop operation or rack-mount installation. Power is supplied to the unit via the IEC 320 receptacle in the rear of the case, and should be 120VAC (nominal, see Appendix A) at 1/2 Amp. The unit is internally fused for protection, and the high voltage output is impedance limited for protection in case of a load short circuit.

The power supply output is via the two TNC high voltage connectors at the top, rear of the case. The outer ring of these connectors is unconnected in the power supply and the user may leave the cable set floating or ground the cable shield at his option.

The DB9 female connector in the center, bottom of the rear of the case is for RS232 communication. The connector is wired as DCE with no modem lines (CTS, RTS, etc.) The communications specifications are: 9600 baud, no parity, eight data bits, one stop bit, 100 milliseconds line to line delay. The connector pinout and a repeat of these parameters are shown in Appendix B.

The remaining DB15 female connector on the rear of the case is used for the rest of the user interface functionality. The remote HV Go On, the analog setpoint, and the Clamp Is Up, Clamp Is Down, and Alarm outputs are contained in this connector. The connector pinout is shown in Appendix C.

## SECTION 3

### Operation

This section concerns itself with the proper operation of the 13310 High Voltage power supply. These units are designed specifically to operate electrostatic chucks and so contain many features not normally associated with a power supply. These features allow the user to reliably clamp a substrate, and just as reliably release it.

#### 3.1 Setting the Operating Mode

The 13310 has a local operating mode and four remote operating modes. The LOCAL mode is typically used for testing new control programs, where flexibility is important, while the remote modes are normally used in a production process where repeatability is of paramount importance.

In any of the operating modes, the 13310 attempts to drive the final output terminals to the setpoint voltage, independent of the load attached to the power supply. If the load impedance is too low, the current trip point will be exceeded, an "OVERLOAD" error message will appear in the display, the ALARM output will be set, and the Overcurrent Fault bit in the status word will be set. If the trip current value is set quite high and the setpoint voltage is also set high, the power supply output will not be able to reach the setpoint value, the "OVERLOAD" message will again appear in the display, the ALARM output will be set, and the Voltage Compliance fault bit in the status word will be set.

After voltage compliance is reached, the output will not turn off on loss of voltage compliance due to a lowering impedance of the attached chuck. If the current trip point is set below 1024uA, the 13310 will still shut down when that current is reached. If the trip current is set high, the output voltage will rise to a maximum and hold there. That maximum voltage is dependant on the load impedance.

Whenever an overload condition is detected, or a board failure is detected, the output is turned off. The location of the fault and failure bits in the status word are detailed in the **RS** command. The ALARM output is automatically reset when the fault condition causing it is cleared.

##### 3.1.1 The Local Operating Mode

The local mode is entered by setting the **LOCAL/REMOTE** switch on the front panel to LOCAL. If the **HV ON** switch is ON when the mode is set to LOCAL, the ALARM output will be set and the display will show a 'HV SWITCH ON' error. The high voltage will not be turned on until the switch is first turned off.

The default output voltage used during the HV ON cycle in LOCAL mode is displayed and may be changed via the **+/-** switch on the front panel. The default voltage may not be set less than zero nor more than 2500 volts. The trip current cannot be set in this mode. See Section 3.1.2.

When the HV ON switch is pressed, the power supply executes stored program zero. This is the only program that may be executed in local mode. As with any other program, the execution of the program may change the output voltage from the default. If the exclusive use of the default voltage is desired, make sure that stored program zero contains no **SV** or **SO** commands.

An overload fault in local mode is cleared when the HV ON switch is toggled OFF.

### 3.1.2 The RS232 Remote Operating Mode

The RS232 remote operating mode is entered by flipping the **LOCAL/REMOTE** switch on the front panel to REMOTE and pressing the +/- switch until 'RS232' is shown in the MODE area of the display. The **HV ON** switch is ignored when in any of the remote modes, so its setting is unimportant.

The default output voltage used during the HV ON cycle is displayed and may be changed via the **SV** command. The default voltage may not be set less than zero nor more than 1024 volts. The command set is covered in section 3.2.

When the HV ON command is given, the power supply executes the selected stored program. As with any other program, the execution of the program may change the output voltage from the default. If the exclusive use of the default voltage is desired, make sure that the selected stored program contains no **SV** or **SO** commands.

The RS232 remote operating mode is one of the two modes wherein one may configure the default settings of the unit. The voltage and current settings set using the **SV** command will apply to all of the remote operating modes, and the **SI** command sets the current trip point for all of the operating modes, including local mode.

An overload fault in RS232 Remote Operating mode is cleared when the next command is successfully executed. This means that an RS command should be issued preceding each command to the unit to ensure that the voltage is still on, or that an exception must be processed.

### 3.1.3 The Digital Remote Operating Mode

The Digital Remote operating mode is entered by flipping the **LOCAL/REMOTE** switch on the front panel to REMOTE and pressing the +/- switch until 'DigRem' is shown in the MODE area of the display. The **HV ON** switch is ignored when in any of the remote modes, so its setting is unimportant.

The default output voltage used during the HV ON cycle is displayed and may not be changed while in this operating mode. See Section 3.1.2. The HV ON command is given in this mode via the DB15 control connector in the rear of the unit.

When the HV ON command is given, the power supply executes the selected stored program. As with any other program, the execution of the program may change the output voltage from the default. If the exclusive use of the default voltage is desired, make sure that the selected stored program contains no **SV** or **SO** commands.

An overload fault in Digital Remote operating mode is cleared when the HV ON command is removed.

### 3.1.4 The Analog Remote Operating Mode

The Analog Remote operating mode is entered by flipping the **LOCAL/REMOTE** switch on the front panel to REMOTE and pressing the +/- switch until 'AlgRem' is shown in the MODE area of the display. The **HV ON** switch is ignored when in any of the remote modes, so its setting is unimportant.

The default output voltage used during the HV ON cycle is displayed and is obtained from the DB15 control connector in the rear of the unit. The output voltage does not track the analog

input. The analog input is sampled only when the HV ON command is given. The HV ON command is given in this mode via the DB15 control connector in the rear of the unit.

When the HV ON command is given, the power supply executes the selected stored program. As with any other program, the execution of the program may change the output voltage from the default. If the exclusive use of the default voltage is desired, make sure that the selected stored program contains no **SV** or **SO** commands.

An overload fault in Analog Remote operating mode is cleared when the HV ON command is removed.

### 3.1.5 The DeviceNet Operating Mode

The DeviceNet remote operating mode is entered by flipping the **LOCAL/REMOTE** switch on the front panel to REMOTE and pressing the **+/-** switch until 'DevNet' is shown in the MODE area of the display. The **HV ON** switch is ignored when in any of the remote modes, so its setting is unimportant.

The default output voltage used during the HV ON cycle is displayed and may be changed via the **SV** command. The default voltage may not be set less than zero nor more than 2500 volts. The command set is covered in section 3.2.

When the HV ON command is given, the power supply executes the selected stored program. As with any other program, the execution of the program may change the output voltage from the default. If the exclusive use of the default voltage is desired, make sure that the selected stored program contains no **SV** or **SO** commands.

The DeviceNet remote operating mode is one of the two modes wherein one may configure the default settings of the unit. The voltage and current settings set using the **SV** command will apply to all of the remote operating modes, and the **SI** command sets the current trip point for all of the operating modes, including local mode.

An overload fault in DeviceNet remote operating mode is cleared when the next command is successfully executed. This means that an RS command should be issued preceding each command to the unit to ensure that the voltage is still on, or that an exception must be processed.

## 3.2 The 13310 Command Set

The command set of the 13310 has been designed to afford the user maximum control over the functionality of the unit's behavior. In addition to the expected on and off commands, there are a wide variety of reporting, configuration, and control commands. The unit has two user accessible timers and two controllable optically isolated outputs.

Status requests (**RS** command) are honored independent of operating mode, but all other commands require that the unit be placed in Remote RS232 mode. Commands are entered as: <command> <ENTER>, where <ENTER> means to press the ENTER key. If the command is not recognized, or is invalid in the current operating mode, the 13310 will respond with the '?' character.

### 3.2.1 The Immediate (Stopped) Command Set

These commands may be used when the user program is not running.

**(nn) Store program step 'nn' (01-32):** >0 01 SO 0900

User programs may be up to 32 steps long. When entering or editing a given program, the new line entered is stored according to the line number.

**(Pn) Select program 'n' (0-9):** >0 P1

The 13310 supports up to 10 user programs. Program zero is run when HV ON is activated in LOCAL mode. Program zero may also be selected for remote mode operation with the 'P0' command.

**(OF) HV go off:** >0 OF

This command turns off the high voltage output.

**(ON) HV go on:** >0 ON

This command turns on the high voltage output.

**(CU) Clear clamp is up:** >0 CU

This command turns the user controlled 'Clamp Is Up' output off. This is an active pull down output, so the output pin in the DB15 control connector will be left floating.

**(SU) Set clamp is up:** >0 SU

This command turns the user controlled 'Clamp Is Up' output on. This is an active pull down output, so the output pin in the DB15 control connector will be pulled low with respect to the Digital Common pin.

**(CD) Clear clamp is down:** >0 CD

This command turns the user controlled 'Clamp Is Up' output off. This is an active pull down output, so the output pin in the DB15 control connector will be left floating.

**(SD) Set clamp is down:** >0 SD

This command turns the user controlled 'Clamp Is Up' output on. This is an active pull down output, so the output pin in the DB15 control connector will be pulled low with respect to the Digital Common pin.

**(ID) Return software version:** >0 ID

This command returns the build version of the software operating in the 13310.

### 3.2.1 The Immediate (Stopped) Command Set (Continued)

**(RS) Return hardware status:**

**>0 RS**

This command returns the contents of the status register. The status register contents are returned as four ASCII HEX nybbles. The bit definitions of the returned word are:

D15	LCD failure	Set = failed initialization
D14	Front Panel PCB (10223) failure	Set = failed POST
D13	CPU PCB (10226) failure	Set = failed POST
D12	HV PCB (10227) failure	Set = failed POST
D11	reserved	
D10	reserved	
D9	Overcurrent fault	Set = Overcurrent
D8	Voltage compliance fault	Set = HV could not lock in
D7	Mode Bit	*
D6	Mode Bit	*
D5	Local/Remote switch setting	Set = Remote
D4	HV status	Set = HV is ON
D3	Polarity	Set = positive polarity
D2	Program status	Set = program is running
D1	Clamp Is Down status	Set = ON
D0	Clamp Is Up status	Set = ON

\* The remote operating mode may be decoded from bits D6 and D7:

D7	D6	Operating Mode
0	0	RS232
1	0	Digital Remote
0	1	Analog Remote
1	1	DeviceNet

**(RP) Return program status:**

**>0 RP**

This command returns the number of the selected program, the program step number that is currently executing (if any), and the activity of the program (running or stopped).

**(MV) Measure volts at terminals:**

**>0 MV**

This command returns the immediate value of the voltage at the 13310 output terminals. The voltage value is expressed in volts.

**(MI) Measure current at terminals:**

**>0 MI**

This command returns the immediate value of the 13310 output current. The current value is expressed in microamps.

**(RI) Return overcurrent trip point (I):**

**>0 RI**

This command returns the setting of the overcurrent trip value.

**(RV) Return voltage setpoint (V):**

**>0 RV**

This command sets the default setpoint voltage used in all of the REMOTE operating modes.

**(CP) Clear current program (clears all steps):**

**>0 CP**

This command erases all steps of the current program.

**(CA) Clears all programs (prompts Y-N):**

**>0 CA**

This command clears all of the user's stored programs. The response from the command is to prompt the user for a Yes/No response to ensure that erasing all of the stored programs is really desired.

### 3.2.1 The Immediate (Stopped) Command Set (Continued)

**(LP) List current program:** >0 LP  
Sends a listing of the currently selected program to the terminal port. The output format includes line numbers so that it may be immediately uploaded into another 13310.

**(ST) Set timer 1 (user time delay):** >0 ST 0105  
This command sets a time-out value into the user's general purpose timer and starts the timer running.

**(C1) Clear timer 1:** >0 C1  
This command clears the user's general purpose time and stops it.

**(RT) Reload and start timer 1:** >0 RT  
This command reloads the user's general purpose timer with the value previously specified by the **ST** command and restarts the timer.

**(R1) Read timer 1 (user time delay):** >0 R1  
This command reads back time remaining in the user's general purpose timer.

**(R2) Read timer 2 (HV on time):** >0 R2  
The 13310 keeps track of the time that the high voltage output is ON. This command returns the contents of the manufacturer's timer. This timer may be reset by the user and can be used to track customer use of the unit.

**(C2) Clear timer 2 (HV on time):** >0 C2  
This command clears the HV ON time totalizer. It would normally be used by the manufacturer to determine how long the high voltage was ON during a period of use by a customer.

**(R3) Read timer 3 (OEM odometer):** >0 R3  
The 13310 keeps track of the time that the high voltage output is ON. This command returns the contents of the OEM timer. This timer may not be reset by the user.

**(SV) Set REMOTE mode high voltage setpoint:** >0 SV 0750  
This command sets the default value of the high voltage output used whenever the HV ON command is issued while in any of the remote modes of operation. The value is overridden by **SV** or **SO** commands contained within programs executed by the user.

The high voltage setpoint is measured as volts, and is limited to  $0 \leq SV < 2500$ .

**(SI) Set overcurrent trip point:** >0 SI 0500  
This command sets the value of the overcurrent trip point used in all operating modes. The 13310 shuts off the high voltage output when the overcurrent trip point is reached. When this occurs, the ALARM output is set and the display flashes an 'OVERLOAD' message. The ALARM condition is cleared by the next command.

The overcurrent trip point is measured in microamps, and is limited to  $0 \leq SI < 1024$ . Setting the overcurrent trip point to 1024 disables the trip point.

**(SH) Shunt HV output:** >0 SH  
This command causes the power supply to short circuit the output terminals through the internal control bridge. This command is beneficial in removing any residual charge left on the substrate after processing.

### 3.2.1 The Immediate (Stopped) Command Set (Continued)

**(PP) Set Positive output polarity:** >0 PP  
This command sets the output polarity of the power supply to positive. This polarity will be assumed on the next **HV ON** command.

**(NP) Set Negative output polarity:** >0 NP  
This command sets the output polarity of the power supply to negative. This polarity will be assumed on the next **HV ON** command.

**(TP) Toggle polarity:** >0 TP  
This command causes the output voltage polarity to reverse. If the high voltage is already on, the output will turn off and then back on with the reverse polarity. If the high voltage is not on, the polarity will reverse with the next **HV ON** command. The value of the setpoint voltage in the display does not display polarity.

**(XP) Execute current program:** >0 XP  
This command causes the currently selected program to begin execution.

**(SB) Reset the high voltage output to the default:** >0 SB  
This command reloads the default output voltage. It is typically used with the **SO** command to gradually raise the output voltage into an unknown load to the default level.

**(RC) Return the Voltage Compliance value (V):** >0 RC  
This command returns the setting of the output voltage compliance value.

**(CN) Compliance ON:** >0 CN  
This command turns on the high voltage output compliance testing. If the high voltage output cannot be raised to the setpoint value within three seconds when turned on the 13310 shuts off the high voltage and registers an **OVERLOAD** fault.

**(CF) Compliance OFF:** >0 CF  
This command turns off the high voltage output compliance testing. The 13310 will attempt to raise the high voltage output to the setpoint value within three seconds when turned on, but will not register an **OVERLOAD** fault if it cannot.

**(SC) Set Compliance (V):** >0 SC 99  
This command sets the high voltage output compliance level. The high voltage compliance is measured as volts, and is limited to  $0 \leq SC < 100$ .

**(??) Print HELP List:** >0 ??  
This command prints the list of commands that are valid for the 13310. The list contains all commands, independent of operating mode.

**(#V) Set Maximum Voltage (V):** >0 #V 2200  
This command sets the maximum high voltage output. The units are volts, and is limited to  $0 \leq V < 4096$ .

### 3.2.2 The Immediate (Running) Command Set

These commands may be used when the user program is running.

**(ID) Return software version:**

**>0 ID**

This command returns the build version of the software operating in the 13310.

**(RS) Return hardware status:**

**>0 RS**

This command returns the contents of the status register. The status register contents are returned as four ASCII HEX nybbles. The bit definitions of the returned word are:

D15	LCD failure	Set = failed initialization
D14	Front Panel PCB (10223) failure	Set = failed POST
D13	CPU PCB (10226) failure	Set = failed POST
D12	HV PCB (10227) failure	Set = failed POST
D11	reserved	
D10	reserved	
D9	Overcurrent fault	Set = Overcurrent
D8	Voltage compliance fault	Set = HV could not lock in
D7	Mode Bit	*
D6	Mode Bit	*
D5	Local/Remote switch setting	Set = Remote
D4	HV status	Set = HV is ON
D3	Polarity	Set = positive polarity
D2	Program status	Set = program is running
D1	Clamp Is Down status	Set = ON
D0	Clamp Is Up status	Set = ON

\* The remote operating mode may be decoded from bits D6 and D7:

D7	D6	Operating Mode
0	0	RS232
1	0	Digital Remote
0	1	Analog Remote
1	1	DeviceNet

**(RP) Return program status:**

**>0 RP**

This command returns the number of the selected program, the program step number that is currently executing (if any), and the activity of the program (running or stopped).

**(MV) Measure volts at terminals:**

**>0 MV**

This command returns the immediate value of the voltage at the 13310 output terminals. The voltage value is expressed in volts.

**(MI) Measure current at terminals:**

**>0 MI**

This command returns the immediate value of the 13310 output current. The current value is expressed in microamps.

**(RI) Return overcurrent trip point (I):**

**>0 RI**

This command returns the setting of the overcurrent trip value.

**(RV) Return voltage setpoint (V):**

**>0 RV**

This command sets the default setpoint voltage used in all of the REMOTE operating modes.

**(R1) Read timer 1 (user time delay):**

**>0 R1**

This command reads back time remaining in the user's general purpose timer.

**(R2) Read timer 2 (HV on time):** **>0 R2**

The 13310 keeps track of the time that the high voltage output is ON. This command returns the contents of the manufacturer's timer. This timer may be reset by the user and can be used to track customer use of the unit.

**(AB) Abort the current program:** **>0 AB**

This command stops the operation of the current program.

**(RC) Return the Voltage Compliance value (V):** **>0 RC**

This command returns the setting of the output voltage compliance value.

### 3.2.3 The Program Command Set

These commands may be used in a user program.

**(OF) HV go off:** **>0 OF**  
This command turns off the high voltage output.

**(ON) HV go on:** **>0 ON**  
This command turns on the high voltage output.

**(CU) Clear clamp is up:** **>0 CU**  
This command turns the user controlled 'Clamp Is Up' output off. This is an active pull down output, so the output pin in the DB15 control connector will be left floating.

**(SU) Set clamp is up:** **>0 SU**  
This command turns the user controlled 'Clamp Is Up' output on. This is an active pull down output, so the output pin in the DB15 control connector will be pulled low with respect to the Digital Common pin.

**(CD) Clear clamp is down:** **>0 CD**  
This command turns the user controlled 'Clamp Is Up' output off. This is an active pull down output, so the output pin in the DB15 control connector will be left floating.

**(SD) Set clamp is down:** **>0 SD**  
This command turns the user controlled 'Clamp Is Up' output on. This is an active pull down output, so the output pin in the DB15 control connector will be pulled low with respect to the Digital Common pin.

**(ST) Set timer 1 (user time delay):** **>0 ST 0105**  
This command sets a timeout value into the user's general purpose timer and starts the timer running.

**(C1) Clear timer 1:** **>0 C1**  
This command clears the user's general purpose time and stops it.

**(SH) Shunt HV output:** **>0 SH**  
This command causes the power supply to short circuit the output terminals through the internal control bridge. This command is beneficial in removing any residual charge left on the substrate after processing.

**(C2) Clear timer 2 (HV on time):** **>0 C2**  
This command clears the HV ON time totalizer. It would normally be used by the manufacturer to determine how long the high voltage was ON during a period of use by a customer.

**(RT) Reload and start timer 1:** **>0 RT**  
This command reloads the user's general purpose timer with the value previously specified by the **ST** command and restarts the timer.

**(SO) Set high voltage output level:** **>0 SO 0650**  
This command sets the immediate output voltage from within a program. This command does not change the default setpoint value for the remote mode output voltage.

The high voltage setpoint is measured as volts, and is limited to  $0 \leq SO < 1024$ .

### 3.2.3 The Program Command Set (Continued)

**(SV) Set high voltage setpoint: >0 SV 0750**

This command sets the default value of the high voltage output used whenever the HV ON command is issued while in any of the remote modes of operation. The value is overridden by **SV** or **SO** commands contained within programs executed by the user.

The high voltage setpoint is measured as volts, and is limited to  $0 \leq SV < 2500$ .

**(SI) Set overcurrent trip point: >0 SI 0500**

This command sets the value of the overcurrent trip point used in all operating modes. The 13310 shuts off the high voltage output when the overcurrent trip point is reached. When this occurs, the ALARM output is set and the display flashes an 'OVERLOAD' message. The ALARM condition is cleared by the next command.

The overcurrent trip point is measured in microamps, and is limited to  $0 < SI < 1024$ . Setting the overcurrent trip point to 1024 disables the trip point.

**(PP) Set Positive output polarity: >0 PP**

This command sets the output polarity of the power supply to positive. This polarity will be assumed on the next **HV ON** command.

**(NP) Set Negative output polarity: >0 NP**

This command sets the output polarity of the power supply to negative. This polarity will be assumed on the next **HV ON** command.

**(TP) Toggle polarity: >0 TP**

This command causes the output voltage polarity to reverse. If the high voltage is already on, the output will turn off and then back on with the reverse polarity. If the high voltage is not on, the polarity will reverse with the next HV ON command. The value of the setpoint voltage in the display does not display polarity.

**(WF) Wait for HV off: >0 WF**

This command causes a program to wait with the high voltage output on until an HV OFF command is received. The format of the HV OFF command is read according to the operating mode, that is, LOCAL mode waits for the front panel switch, RS232 and DeviceNet modes wait for a serial OFF command, and Analog Remote and Digital Remote modes wait for the HV ON command to be removed from the DB15 control connector.

If the HV ON command is already removed from the DB15 control connector when the WF command is encountered, program operation immediately continues.

**(WT) Wait for timer 1: >0 WT**

This command causes a program to pause until timer one expires.

**(SB) Reset the high voltage output to the default: >0 SB**

This command reloads the default output voltage. It is typically used with the SO command to gradually raise the output voltage into an unknown load to the default level.

**(CN) Compliance ON: >0 CN**

This command turns on the high voltage output compliance testing. If the high voltage output cannot be raised to the setpoint value within three seconds when turned on the 13310 shuts off the high voltage and registers an OVERLOAD fault.

**(CF) Compliance OFF:**

**>0 CF**

This command turns off the high voltage output compliance testing. The 13310 will attempt to raise the high voltage output to the setpoint value within three seconds when turned on, but will not register an OVERLOAD fault if it cannot.

**(SC) Set Compliance (V):**

**>0 SC 99**

This command sets the high voltage output compliance level. The high voltage compliance is measured as volts, and is limited to  $0 \leq SC < 99$ .

### 3.2.4 Command Syntax

All serial commands are preceded by an attention symbol, '>', and the unit number '0'. Commands requiring data (such as the **SV** and **SO** commands) require one to four digits of data. Examples are:

>0 SV 500	sets the remote mode default output voltage to 500V
>0 ST 105	sets timer one to 1 minute and five seconds
>0 P5	sets the operating program to number five

### 3.2.5 Sample Programs

The following program is equivalent to the Semco power supply operation:

01 ON	turn on the high voltage
03 WF	wait for the OFF command
05 TP	toggle polarity
07 ON	turn on the high voltage
09 ST 1	set up a one second time delay
11 RT	reload and start the timer
13 WT	wait for the timer to expire
15 OF	turn off the high voltage

A slightly different program ramps the start voltage without compliance to ensure a clamp is achieved, and then rings the output to release the wafer:

01 CF	turn off compliance
02 ON	turn on the high voltage
03 SO 500	set it to 500 volts to start
04 ST 5	wait five seconds
05 WT	
06 SB	go to the default voltage
07 WF	wait for OFF signal
08 TP	toggle polarity
09 CN	turn compliance back on
10 ON	turn on the high voltage
11 SO 400	set output to 400V
12 ST 5	set five second wait
13 WT	wait for timer to expire
14 TP	toggle polarity
15 SO 200	set output to 200V
18 RT	reload and start the timer
19 WT	wait for timer to expire
29 OF	turn high voltage off

## 3.2.6 Timers

The three system timers in the 13310 are intended for very different uses. Timer 1 may be set and monitored by the user with the ST, RT, and WT commands. This timer is intended to be used for timing the application of voltage during the clamping and declamping operations.

Timer 2 runs whenever the high voltage output is turned on, and the user may clear it and report its current value. It is designed to be used to monitor the life of the attached electrostatic chuck.

The user may only examine the current value of Timer 3. It is designed to be used to monitor the total HV ON time of the 13310 for maintenance scheduling.

### 3.2.6.1 The ST Command

The ST command is used to set the time value of timer 1 and to start its countdown. The data format is flexible, and may be seconds only, or minutes and seconds. The basic rules are: 1) if the data is less than 100, it represents seconds only, 2) if the data is greater than 100, the hundreds value represents minutes. Some examples are:

```
>0 ST 5      ;sets timer one to count out five seconds
>0 ST 90     ;sets timer one to count out 90 seconds
>0 ST 105    ;sets timer one to count out one minute five seconds
>0 ST 6729   ;sets timer one to 67 minutes and 29 seconds
```

## 3.2.7 Clamp Output Bits

The Clamp Is Up and Clamp Is Down output bits are included so that an electrostatic chuck may be easily retrofit into an older mechanically clamped system using the 13310 as both its power supply and system interface. Both bits are included in the interface so that a full emulation of a mechanical system with limits at both ends of travel may be performed.

Clamp Is Up generally indicates that the wafer has been released by the clamp and may be retrieved, or that the chamber is ready to receive a wafer. Clamp Is Down is generally used to indicate that a wafer is currently clamped and may not be retrieved.

Utilization of these bits is entirely at the discretion of the user. The default setting when the 13310 powers up is Clamp Is Up is set and Clamp Is Down is cleared. The Semco program with clamping operations would look like:

```
01 CU      clear Clamp Is Up
03 ON      turn on the high voltage
05 SD      set Clamp Is Down
07 WF      wait for the OFF command
09 TP      toggle polarity
11 ON      turn on the high voltage
13 ST 1    set up a one second time delay
15 RT      reload and start the timer
17 WT      wait for the timer to expire
19 OF      turn off the high voltage
21 CD      clear Clamp Is Down
23 SU      set Clamp Is Up
```

## SECTION 4

### Troubleshooting

This section deals with troubleshooting the 13310 power supply in the event that it is not performing properly. The front panel display provides all of the data necessary to determine whether the unit is functioning properly.

#### 4.1 High Voltage does not turn on:

Verify that the unit is properly powered and that the display is presenting data. If the unit has detected an internal fault, it will identify the board causing the fault. If the unit could not achieve voltage compliance, or had a current trip, the display will show an 'OVERLOAD' message.

If a board fault is displayed, or if the display is garbled or blank, the unit must be returned for factory repair. If the 'OVERLOAD' message is displayed, the load may be drawing too much current. Disconnect the unit from the load and turn on the high voltage manually. If the high voltage comes on, the unit is performing normally and the load impedance is too low for the programmed settings.

Try using the **SI** command to raise the current limit, or the **SV** command to reduce the output voltage and turn the high voltage back on. Note that a program may contain internal voltage settings, so ideally these tests should be conducted using the RS232 remote mode.

If the unit continues to display the OVERLOAD message when isolated from the load, it has experienced an internal failure and must be returned for factory repair.

#### 4.2 ALARM output is set:

The ALARM output is set whenever an OVERLOAD occurs. This may be caused by too low of a current trip point setting, or by too high an output voltage setpoint. Set the unit to RS232 remote mode and use the **SV** command to lower the setpoint voltage, or use the **SI** command to raise the trip current, then use the ON command to turn on the high voltage.

Watch the display to see the instantaneous voltage and current readings. If the voltage reading does not reach the setpoint, the load on the output has too low an impedance and the unit cannot achieve voltage compliance.

If the displayed current reaches the setpoint level the unit will automatically turn off the high voltage output. In this way the user may set a lower limit on the impedance of the load.

## **SECTION 5**

### **COMPONENT REPLACEMENT**

**There are no user serviceable components in the unit. The unit should be sent to Nova Research for any repairs.**

# Appendix A

## Equipment Specifications

### Power Specification:

Power Required: 95-265VAC @ 500 milliAmp

Power Connection: IEC 320 Female Power Connector

Output: 100 to 1000 VDC limited by series resistance

### Controls:

Local Mode: Output voltage may be default local mode voltage or altered by program. Runs last program selected.

Remote modes: RS232, DeviceNet (4Q '00), Analog Remote, Digital Remote  
Selected by front panel switch. Output voltage may be default remote mode voltage or altered by program. Program may be selected from zero through nine.

### Environmental:

Storage: -40°F - 140°F

Operation: 0°F - 120°F

# Appendix B

## RS232 Connector Pinout Specifications

<b>Pin</b>	<b>Function</b>
2	Transmit Data (from 13310)
3	Receive Data (to 13310)
5	Common

# Appendix C

## Control Connector Pinout Specifications

Pin	Function	Direction
1	HV Go ON (-)	Input
2	HV Analog Setpoint (0-5V Scale = 0-1000VDC)	Input
3	HV Go ON (+)	Input
4	+12VDC (low current)	Output
5	Analog Common	Input
6	HV Output (0-5V Scale = 0-1000VDC)	Output
7	Clamp Is Active (DOWN)      LOW TRUE to Digital Common	Output
8	Clamp Is Inactive (UP)      LOW TRUE to Digital Common	Output
9	ALARM Output      LOW TRUE to Digital Common	Output
10	Digital Common	Input
11	Address Bit Common	
12	Address Bit 0	
13	Address Bit 1	
14	Address Bit 2	
15	Address Bit 3	

The address bits on pins 12 through 15 are pulled up internally and not designed to be driven, but to be jumpered to the Address Bit Common provided on pin 11. If no jumpers are set, the device address is 0.

Pins 1 and 3 are optically isolated and can be driven as :  
pin 1 tied to common and pin 3 at +24V for HV on  
or  
pin1 driven low and pin 3 tied to +24V for HV on

Pins 5 and 10 are not tied together internally.