EPS200

Electrostatic Chuck DC Power Supply
Users Manual

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1. INTRODUCTION

1.1. Introduction. The Gripping Power, Inc. EPS200 high voltage DC power supply was designed to drive semiconductor wafer electrostatic chucks in all process conditions, with years of reliable performance.

1.2. Features. The EPS200 is microprocessor based and is fully programmable. One local and three remote operating modes are provided. The unit is available with either 1kV or 2.5kV true floating, bipolar outputs. The high voltage output is continuously variable, with output load voltage tracking and user defined current limiting. A back-lit LCD displays voltage, current and status information.

1.3. Local Operation. The local operation mode provides the user the means of testing programs and diagnosing hardware problems, via the EPS200 front panel, without the use of a host computer interface.

1.4. Remote Operation. Serial RS-232, digital, and analog remote control modes are provided. All electrical interfaces are isolated from the high-voltage output and are ground referenced. The high-voltage can be turned on and off via a single digital bit input. An analog input is provided for remote high voltage control. Two digital output signals are provided to minimize interface problems when replacing mechanical chuck mechanisms with electrostatic chucks. A digital alarm output signal is also provided.

1.5. Programmability. The EPS200 can store up to ten user defined programs that control the chuck and dechucking operation. Each program can be up to 32 steps long. The unit may be directed to execute any one of the ten stored programs, giving the user maximum flexibility in both the setup phase, when testing chuck reliability, and in production operation. All ten of the EPS200 programs are stored in nonvolatile RAM and can be downloaded to a host computer. The EPS200 programming command set provides the user optimum flexibility for developing sophisticated chucking algorithms for multiple process conditions.

2. INSTALLATION

2.1. Installation. The EPS200 is designed for installation in a standard 9.5 inch equipment half-rack or it can be use as a desktop instrument.

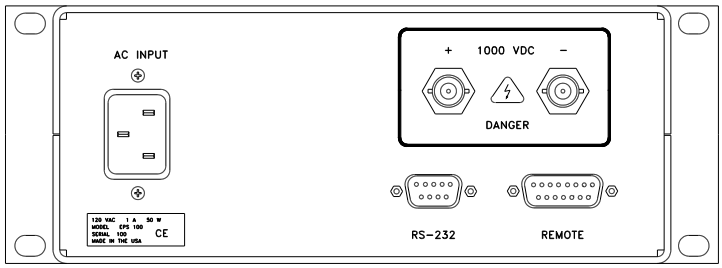

Figure 2.1 - EPS200 Rear Panel

2.2. AC Power Requirements. Power is supplied to the unit via the IEC 320 receptacle, located on the real panel. The AC power cord provided with the EPS 200 is for North American usage at 120 VAC, 60 Hz. The unit can operate from 90 to 264 VAC at a line frequency of 47 to 63 Hz and is internally fused for safety. Contact the factory for power cords and accessories for installation and operation in other areas of the world.

2.3. RS-232 Serial Interface. The RS-232 serial interface is a 9-pin, D-style subminiature female connector, located on the rear panel. The unit is configured as DCE without modem control lines such as CTS, RTS or DTR. The host terminal or computer should be configured for 9600 baud, no parity, eight data bits, one stop bit. When uploading ASCII text programming files, use a 100 millisecond line-to-line delay. Additional information detailing the communication specifications and serial interface is available in Appendix C.

2.4. Digital/Analog Remote Interface. The digital and analog interface is a 15-pin, D-style subminiature female connector, located on the rear panel. The remote high voltage go on, analog setpoint, clamp is up, clamp is down, and alarm outputs are contained in this connector. The connector definition is shown in Appendix D.

WARNING: High-voltages are produced by the EPS200. Installation and operation of the unit should be performed only by qualified and authorized personnel.

2.5. High Voltage Connections. The power supply high voltage output is via the two BNC connectors located at rear of the unit. The outer ring of these connectors is electrically isolated from ground and is not referenced to the high-voltage output. Connections to the outer conductors can be terminated at a common ground point, or left floating without affecting the performance of the EPS200.

2.6. Load Connections. For proper operation and continued reliability, the high voltage outputs of the EPS200 must be electrically isolated from extremely high DC bias voltages, high power RF fields or other sources of potential damage.

It is highly recommended that only accessories manufactured, or specifically authorized, by Gripping Power, Inc. should be used with the EPS200 when developing an electrostatic chuck application for plasma processes. Gripping Power, Inc. can provide interconnect cables, RF decouplers and other accessories to meet any specific need.

A typical electrostatic chuck application for a semiconductor plasma process is shown below. All of the components are required for proper chucking operation and protection of the EPS200 power supply.

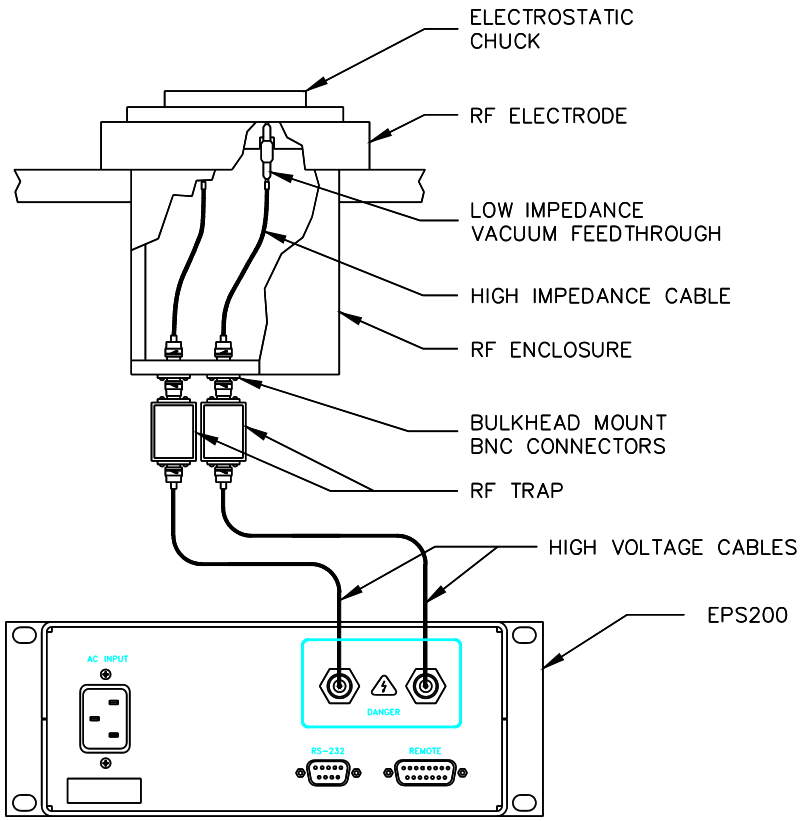

Figure 2.2 - Typical Installation

3. OPERATION

3.1. Operation. The EPS200 is specifically designed to operate electrostatic chucks and it provides many features that are not normally associated with a general purpose, high-voltage power supply.

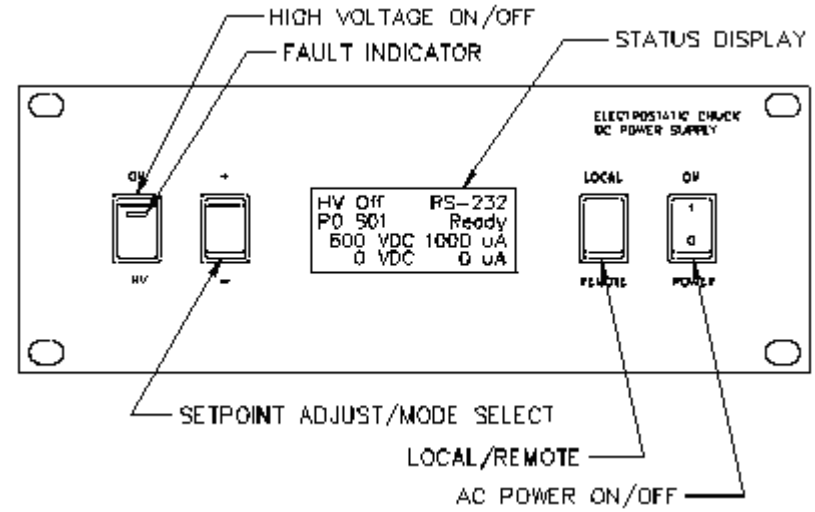

Figure 3.1 - EPS200 Front Panel

3.2. The Front Panel. The EPS200 front panel user interface is simple to operate. The operation of the various switches is explained in the following sections. The four line, backlit LCD panel provides program and status information.

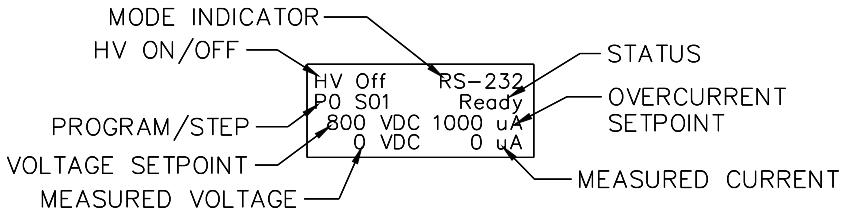

Figure 3.2 - LCD Status Display

3.3. Setting the Operating Mode. The EPS200 has a local operating mode and four remote operating modes. The local mode can be used for testing and developing new programs. The remote mode, which disables the front panel setpoint adjustment, is normally used in a production process where repeatability and automated processing is desired.

3.4. Local Operating Mode. The local mode is entered by setting the LOCAL/REMOTE switch on the front panel to the LOCAL position. The mode indicator will display 'Local' when the unit is in local mode.

If the HV ON switch is in the ON position, when the mode is set to local, the HV ON fault indicator will blink. The fault will not clear until the switch is set to the off position. When the HV ON switch is depressed, and all pending faults have been cleared, the power supply executes the currently active program, without a remote control interface required.

The high voltage output voltage setpoint can be changed via the setpoint adjust switch on the front panel. Changes made to the high voltage setpoint in the local mode will alter the remote mode high voltage setpoint as well. No provision is provided in the local mode to adjust the overcurrent trip point, or change the active program. All other parameters must be adjusted via the RS-232 remote mode.

3.5. Digital Remote Mode. The digital remote operating mode is entered by setting the LOCAL/REMOTE switch on the front panel to the REMOTE position. Press the mode select switch until 'DigRem' is displayed in the mode indicator area of the status display. Note that the HV ON switch is ignored when in digital remote mode.

The default output voltage used during the HV ON cycle is displayed and may not be changed while in this operating mode. The HV ON command is given in this mode via the 15-pin control connector in the rear of the unit. Refer to Appendix D for digital remote mode interface information.

When the HV ON signal is activated, the power supply executes the currently selected program. As with any other program, the execution of the program may change the output voltage from the stored value. If the previously stored high voltage setting is desired, the selected program should not contain a SV commands, which will alter the stored output voltage setpoint.

3.6. Analog Remote Mode. The analog remote operating mode is entered by setting the LOCAL/REMOTE switch on the front panel to the REMOTE position. Press the mode select switch until 'AlgRem' is displayed in the mode indicator area of the status display. Note that the HV ON switch is ignored when in analog remote mode.

The high voltage output setpoint used during the HV ON cycle is obtained from the 15-pin control connector, on the rear of the unit. The analog voltage is converted to a setpoint and displayed on the status display. The high voltage output will 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 15-pin control connector in the rear of the unit via the digital remote interface. Refer to Appendix D for interface information.

When the HV ON signal is activated, the power supply executes the currently selected program. As with any other program, the execution of the program may change the output voltage from the stored value. If the exclusive use of the analog input voltage setting is desired, the selected program should not contain a SV commands, which will alter the stored output voltage setpoint.

3.7. RS-232 Remote Mode. The RS-232 remote operating mode is entered by setting the LOCAL/REMOTE switch on the front panel to the REMOTE position. Press the mode select switch until 'RS-232' is displayed in the mode indicator area of the status display. Note that the HV ON switch is ignored when in RS-232 remote mode.

The host computer must be capable of supporting a 9600 baud DTE RS-232 device and have the proper software installed, to communicate with the EPS200 via the RS-232 serial port. Refer to Appendix C for RS-232 interface specifications.

A versatile command protocol has been developed for the EPS200 with the intent to make it a flexible production or development instrument designed to fit any need. Refer to sections four

and five for additional information on the EPS200 command set and program development. There are two immediate command formats used with the EPS200.

Immediate mode command only format:

```
> a [sp] cc [cr]
```

Immediate mode command with parameters format:

```
> a [sp] cc [sp] dddd [cr]
```

All messages sent to the EPS200 must start with an ASCII '>' (hex 3E) or the following fields will be ignored. The following one byte code [a] is the unique address of the target unit. This code is a hex-ASCII value ranging from 0-9 and A-F. The EPS200 currently only supports address zero (hex 32).

ASCII space characters [sp] (hex 32) act as delimiters and must be inserted as shown between fields. No space is permitted after the attention character and the address field. The following field [cc] is the command field, which contains a two byte ASCII character from the EPS200 instruction set.

The data field, if it is used, may contain up to four ASCII bytes. For example, if the desired target voltage is 850 volts, then an ASCII '850' should be in the data field.

After the complete message has been sent, a carriage return (hex 0D) must be sent to unit to indicate the end of the message. If the last byte after the command message is not a carriage return, of the command does not pass syntax checks, the data will be ignored and a '?' character will be returned. Multiple commands per line are not allowed.

Except where indicated, the EPS200 buffers the incoming data, tests for a valid command, executes or stores it. The acknowledge message will be returned to the host only after the command has been processed. The unit will not respond to further polls until the previously received command has been processed and acknowledged.

3.8. RS-232 Command Lockout. If the EPS200 is running a program the unit will only respond to a subset of commands, which provide limited control and status information only. This feature prevents conflicting or improper settings from being received by the unit.

AB	Abort the current program
MV	Measure volts at terminals
MI	Measure current at terminals
OF	High voltage off/stop program
R1	Read timer 1 (user time delay)
R2	Read timer 2 (HV on time)
R3	Read timer 3 (OEM odometer)
RC	Return compliance value
RI	Return overcurrent trip point
RM	Report maximum voltage
RP	Return program number/step/run-stop
RS	Return hardware status
RV	Return voltage setpoint
??	HELP command

Table 3.1 - Valid RS-232 Commands When a Program is Executing

Even when the EPS200 is in local mode, the host computer can still poll the unit via RS-232 to determine why the unit is not responding to configuration changes by decoding the status byte (RS command). The host computer can prompt a user to toggle the front panel mode switch to the remote position, so that processing can continue. The AB and OF commands are included as a remote safety feature.

AB	Abort the current program
OF	High voltage off
RP	Return program status
RS	Return hardware status

Table 3.2 - Valid RS-232 Commands in Local Mode

3.9. DeviceNet Mode. The DeviceNet remote operating mode is entered by setting the LOCAL/REMOTE switch on the front panel to the REMOTE position. Press the mode select switch until 'DevNet' is shown in the mode display. The EPS200 currently does not support DeviceNet and will ignore all commands until it is returned to one of the other three operating modes.

4. PROGRAM AND CONTROL COMMANDS

4.1. Introduction. The command set of the EPS200 has been designed to provide the user with outstanding process flexibility. In addition to basic on and off commands, there are a wide range of reporting, configuration, and control commands. All EPS200 commands, except SO, WF and WT can be used in immediate mode, as shown in the examples. Refer to section five for additional information on program specific commands.

In all modes, other than the RS-232 remote mode, all serial commands will be ignored, except for AB, OF, RS and RP. Unless otherwise indicated, most commands do not require numerical parameters. When entering numerical parameters, leading zeros, or fixed length fielding is not required. Current and voltage units are reported in volts and microamps.

4.2. High voltage control commands. The following commands control, and adjust parameters related to, the high voltage output.

4.2.1. (CF) Set high voltage compliance off. If the user expects the load to change significantly, such as during thermal stabilization, the EPS200 can be set to ignore compliance faults completely by sending a CF command.

```
Send:        >0 CF [CR]
Receive:     >0 CF [CR]
```

4.2.2. (CN) Set high voltage compliance on. Once the load had stabilized and voltage tracking errors are significant, a CN command will turn the voltage compliance error detection on. Voltage compliance deviations outside the compliance widow will produce an overload fault.

```
Send:        >0 CN [CR]
Receive:     >0 CN [CR]
```

4.2.3. (OF) High voltage output off. If an OF command is received, when a program is not executing, the high voltage output is immediately turned off. If a program is running, and a WF instruction was active, the program will continue normal execution.

```
Send:        >0 OF [CR]
Receive:     >0 OF [CR]
```

4.2.4. (ON) High voltage output on. If an ON command is received and a program is not executing, the high voltage output is immediately turned on. The output will remain on until another command is received that can override the high voltage on condition. If a program is running, the ON command will be ignored.

```
Send:        >0 ON [CR]
Receive:     >0 ON [CR]
```

4.2.5. (SB) Set output to default value. During a program run, the SO value can temporarily change the high voltage output from the stored setpoint value. The high voltage output can be reset back to the stored setpoint by executing a SB command.

```
Send:        >0 SB [CR]
Receive:     >0 SB [CR]
```

4.2.6. (SC) Set high voltage compliance window. Once the high voltage is on, the unit will attempt to adjust the output voltage to compensate for varying load conditions. If the high voltage output deviates outside of the compliance window, an overload error will be produced. The compliance window can be up to 99 VDC. Valid parameters are 0 up to 99.

```
Send:        >0 SC 10 [CR]
Receive:     >0 SC 10 [CR]
```

4.2.7. (SV) Set high voltage setpoint. The SV command sets the value of the high voltage output used whenever the ON command is issued directly or within a program in RS-232, digital remote, local or DeviceNet modes. This value is ignored in analog remote mode. Valid parameters are 0 up to 1000 for a 1kV unit and 2500 for a 2.5kV unit.

```
Send:        >0 SV 900 [CR]
Receive:     >0 SV 900 [CR]
```

4.2.8. (SI) Set overcurrent trip point. The SI command sets the value of the overcurrent trip point used in all operating modes. The EPS200 will turn off the high voltage output when the overcurrent trip point is reached. When this occurs, the alarm output is set and the unit displays an 'Overload' message. The alarm condition can be cleared by any user acknowledge, such as a status poll or a toggling of the REMOTE/LOCAL switch. Valid parameters are 0 up to 1000 microamps.

```
Send:        >0 SI 500 [CR]
Receive:     >0 SI 500 [CR]
```

4.2.9. (RM) Report maximum voltage. The RM command is used to indicate the maximum full scale range of the EPS200. All units have a 0 to 1000 VDC or 0 to 2500 VDC range.

```
Send:        >0 RM [CR]
Receive:     >0 1000 [CR]
```

4.2.10. (SH) Shunt HV output. The SH command will cause the power supply to short the output terminals through the internal output resistor network. This command can be beneficial in removing residual charges left on the chuck before or after processing.

```
Send:        >0 SH [CR]
Receive:     >0 SH [CR]
```

4.2.11. (TP) Toggle polarity. The TP command causes the output voltage polarity to reverse. If the high voltage is on, the output will turn off and then back on at 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 does not change. Reversing the chuck voltage polarity is typically performed to remove charge from the chuck surface when dechucking substrates.

```
Send:        >0 TP [CR]
Receive:     >0 TP [CR]
```

4.2.12. (PP) Set polarity positive. The PP command causes the output voltage polarity to be set to positive. If the high voltage is on and at the opposite polarity, the output will turn off and then turn back at the assigned polarity. If the high voltage is not on, the set polarity command will take effect with the next HV ON command. The value of the setpoint voltage does not change.

```
Send:        >0 PP [CR]
Receive:     >0 PP [CR]
```

4.2.13. (NP) Set polarity negative. The NP command causes the output voltage polarity to be set to negative. If the high voltage is on and at the opposite polarity, the output will turn off and then turn back at the assigned polarity. If the high voltage is not on, the set polarity command will take effect with the next HV ON command. The value of the setpoint voltage does not change.

```
Send:        >0 NP [CR]
Receive:     >0 NP [CR]
```

4.3. Status information commands. The following commands provide status information about the unit, operating parameters or program condition.

4.3.1. (ID) Return software version. The ID command returns the software version installed in the EPS200.

```
Send:        >0 ID [CR]
Receive:     >0 EPS200 01.30 [CR]
```

4.3.2. (RS) Return Status. The RS command will return a four byte ASCII hexadecimal value which can be decoded to determine the status of the unit. This command is valid in all operating modes, including local mode.

```
Send:        >0 RS [CR]
Receive:     >0 dddd [CR]
```

The ‘dddd’ is an ASCII hexadecimal value. Each bit represents an operating mode or condition of the unit. Bits D11 to D15 are not used and are fixed at a value of ‘0’.

D10	Voltage compliance mode (active/inactive)
D9	Overcurrent/overload fault
D8	Voltage compliance fault
D7	EPS200 mode bit (see table 4.2)
D6	EPS200 mode bit (see table 4.2)
D5	Local/Remote switch position
D4	HV is on
D3	Output polarity
D2	Program stop/run
D1	CLAMP IS DOWN bit is on
D0	CLAMP IS UP bit is on

Table 4.1 - 16 bit Status Data Bit Description

The EPS200 operating mode can be determined by decoding bits 6 and 7.

D7	D6	
0	0	RS-232 interface
1	0	Digital remote interface
0	1	Analog remote interface
1	1	DeviceNet interface

Table 4.2 - EPS200 Mode Bits in the Status Value

The Local/Remote switch bit (D5) will be set when the front panel switch is in the remote position and cleared when the switch is in the local position. The program run/stop bit (D2) will be set when a program is running and the bit will be cleared when a program is aborted or has completed.

The polarity bit (D3) is cleared when the power supply output is in a positive polarity mode and the bit will be set when the power supply output is in a negative polarity mode, whether high voltage is actually present or not. The polarity bit will be static until a PP, NP or TP command is received.

The remaining bits are set when the indicated condition is active and reset when they are inactive.

4.3.3. (RP) Return program status. The RP 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).

```
Send:       >0 RP [CR]
Receive:    >0 P0 01 S [CR]
```

In this example, the selected program is program zero (P0), the current step is step one (01) and the program is stopped (S). If a program is running, the last character will be a (R).

4.3.4. (MI) Measure current at terminals. The MI command returns the measured value of the EPS200 output current. The value is expressed in microamps. The sign will be positive (+) or negative (-).

```
Send:       >0 MI [CR]
Receive:    >0 -250 [CR]
```

4.3.5. (MV) Measure volts at terminals. The MV command returns the measured value of the voltage at the EPS200 output terminals. The voltage value is expressed in volts. The sign will be positive (+) or negative (-).

```
Send:       >0 MV [CR]
Receive:    >0 +750 [CR]
```

4.3.6. (RC) Return compliance value. The RC command returns the value of the voltage compliance window, in volts, as set by the SC command.

```
Send:       >0 MV [CR]
Receive:    >0 10 [CR]
```

4.3.7. (RI) Return overcurrent trip point. The RI command returns the setting of the overcurrent trip value, in uA, as set by the SI command.

```
Send:         >0 RI [CR]
Receive:      >0 500 [CR]
```

4.3.8. (RV) Return voltage setpoint. The RV commands returns the current value of the stored high voltage setpoint used in all of the operating modes. This value is set by the SV command.

```
Send:         >0 RV [CR]
Receive:      >0 900 [CR]
```

4.4. T1, T2 and T3 timer commands. The timer commands allow the user to reset, load, start and display the timer data. The EPS200 has three process timers: one general purpose and two high-voltage activity monitors.

Timer 1 (T1) is a user programmable timer that can be used as a countdown timer, when used in conjunction with the WT command. The resolution of T1 is one second. It has a maximum time period of 59 minutes and 59 seconds.

Timer 2 (T2) tracks the period the high voltage has been on, since timer 2 was last cleared, using the C2 command. Timer 2 can be used as a chuck or chamber preventative maintenance timer. The resolution of T2 is one second. It has a maximum time period of 59,999 hours, 59 minutes and 59 seconds.

Timer 3 (T3) is the OEM high voltage on timer. This timer cannot be reset and is used by the manufacturer for MTBF information. The resolution of T3 is one minute. It has a maximum time period of 59,999 hours and 59 minutes.

4.4.1. (C1) Clear timer 1. The C1 command resets the T1 general purpose timer to 00:00 and stops it.

```
Send:         >0 C1 [CR]
Receive:      >0 C1 [CR]
```

4.4.2. (ST) Set timer 1. The ST command loads the user defined time-out value into timer 1 and starts the timer. The minutes and seconds entry may be entered as seconds alone.

```
Send:         >0 ST mmss [CR]
Receive:      >0 ST mmss [CR]
```

4.4.3. (RT) Reload and start timer 1. The RT command reloads T1 with the value previously specified by the ST command and restarts the timer.

```
Send:         >0 RT [CR]
Receive:      >0 RT [CR]
```

4.4.4. (R1) Read timer 1. The R1 command returns the time remaining on the T1 timer.

```
Send:         >0 R1 [CR]
Receive:      >0 12m 34s [CR]
```

4.4.5. (C2) Clear timer 2. This command resets the T2 timer to 00:00. If timer 2 is reset with the high voltage in the on state, the timer will reset and continue timing until the high voltage is turned off.

```
Send:        >0 C2 [CR]
Receive:     >0 C2 [CR]
```

4.4.6. (R2) Read timer 2. The R2 command returns the time that the high voltage has been on, since the prior reset of the T2 timer. This time can be used as a chuck or chamber preventative maintenance indicator.

```
Send:        >0 R2 [CR]
Receive:     >0 5h 49m 24s [CR]
```

4.4.7. (R3) Read timer 3. The R3 command returns the contents of the OEM cumulative high voltage on period timer. This timer may not be reset by the user.

```
Send:        >0 R3 [CR]
Receive:     >0 345h 23m [CR]
```

4.5. Digital output control. The EPS200 provides the user with three digital output bits. Two of those bits are available to the user for emulating mechanical clamp interfaces. The bits are identified as “clamp is up” and “clamp is down.”

When a clamping/chuck operation is started, “clamp is up” is normally cleared and “clamp is down” is set active. When the chucking operation is completed, “clamp is up” is normally set and “clamp is down” is cleared. The user must set the bits to the preferred state throughout a program.

If an abort (AB) command is received, or a fault is cleared, the EPS200 will automatically reset the bits to the default state of “clamp is up” set and “clamp is down” cleared.

4.5.1. (CD) Clear the “clamp is down” bit. The CD command sets the “clamp is down” output bit off. The “clamp is down” output is an open-collector output and will be left floating when the bit is in the off condition

```
Send:        >0 CD [CR]
Receive:     >0 CD [CR]
```

4.5.2. (CU) Clear the “clamp is up” bit. The CU command sets the “clamp is up” output bit off. The “clamp is up” output is an open-collector output and will be left floating when the bit is in the off condition.

```
Send:        >0 CU [CR]
Receive:     >0 CU [CR]
```

4.5.3. (SD) Set the “clamp is down” bit. The SD command sets the “clamp is down” output bit on. The “clamp is down” output is an open-collector output and will be driven low, to digital common, when the bit is in the on condition.

```
Send:        >0 SD [CR]
Receive:     >0 SD [CR]
```

4.5.4. (SU) Set the "clamp is up" bit. The SU command sets the "clamp is up" output bit on. The "clamp is up" output is an open-collector output and will be driven low, to digital common, when the bit is in the on condition.

```
Send:        >0 SU [CR]
Receive:     >0 SU [CR]
```

5. PROGRAMMING

5.1. Introduction. One of the unique features of the EPS200 is its ability to allow the user to develop complex chucking algorithms using a proprietary command language. The unit can store up to ten programs that control the chucking and dechucking operation. Each program can be up to 32 steps long. The unit may be directed to execute any one of the ten stored programs, giving the user maximum flexibility in both the setup phase, when testing chuck reliability, and in production operation. All ten of the EPS200 programs are stored in nonvolatile RAM and can be downloaded to a host computer. The EPS200 programming command set provides the user optimum flexibility for developing sophisticated chucking algorithms for multiple process conditions.

5.2. Program specific commands. In addition to the general purpose commands detailed in section 4, there are additional commands that that can only be used within programs or are related to program control.

5.3. Special program commands. These commands that have unique functions and are related to program flow or have other special functions. These commands can only be used from within a program.

5.3.1. (WF) Wait for HV off. This command will cause a program to pause execution and wait for an high voltage off condition or command. If a high voltage off condition is already present when the WF instruction is encountered, program execution will continue with the next instruction

```
Instruction Format:  WF[CR]
```

In local mode, once a program has been started by pressing the high voltage switch and a WF is encountered, the EPS200 will wait for the switch to be set to the off position.

In digital or analog remote mode, once a program has been started by setting the high voltage go on bit and a WF is encountered, the EPS200 will wait for the high voltage go on bit to be reset.

In RS-232 remote mode, once a program has been started by sending a XP command, and a WF is encountered, the EPS200 will wait for an OF command. Note that changing from remote mode to local mode, while a program is executing, will have the same affect as an AB command.

5.3.2. (WT) Wait for timer 1. This command causes a program to pause until timer one expires. No arguments are required.

```
Instruction Format:  WT[CR]
```

Before the WT command can be used, the program interpreter must have encountered a RT or ST command. The RT or ST command will load and start the timer. When the program interpreter encounters the WT instruction, program execution will stop until the timer one count reaches 00:00.

5.3.3. (SO) Set high voltage output level. The SO command sets the high voltage output level from within a program. The SO command does not alter the setpoint value stored in memory, which is set with the SV command. Valid parameters are 0 up to 1000 for a 1kV unit and 2500 for a 2.5kV unit.

```
Instruction Format:  SO 825 [CR]
```

Once a program has terminated, any ON command will produce an output voltage that corresponds to the most recent SV command setting. The SO command is useful to develop sophisticated dechucking waveforms without affecting the setpoint for chucking.

5.4. Program control commands. The following commands provide the user the ability to execute, abort, list and clear programs. Once the EPS200 has begun program execution, only the AB program control command will be accepted, all others will be ignored.

5.4.1. (AB) Abort the current program. The AB command stops the operation of the current program, turns off the high voltage, resets the digital outputs, returns to program step 01 and if possible, returns to the ready state.

```
Send:        >0 AB [CR]
Receive:     >0 AB [CR]
```

5.4.2. (CP) Clear current program. The CP command erases all steps of the current program. Be cautious in the use of this command. No prompt is provided. Only the currently selected program, as indicated on the status display, is erased.

```
Send:        >0 CP [CR]
Receive:     >0 CP [CR]
```

5.4.3. (CA) Clears all programs. The CA command clears all ten of the EPS200 stored programs. The user is prompted for a Y(es) or N(o) response to confirm that erasure of all of the stored programs is desired.

```
Send:    >0 CA [CR]
Receive: Preparing to clear ALL programs. [CR]
         Are you sure (Y-N)? [CR]
```

5.4.4. (LP) List current program. The LP command sends a listing of the currently selected program to the serial port. The output format includes line numbers so that it may be uploaded into another EPS200. A simple program is shown for example.

```
Send:       >0 LP [CR]
Receive:    P0 [CR]
            01 SV 850 [CR]
            02 ON [CR]
            03 WF [CR]
```

5.4.5. (Pn) Select program. The EPS200 supports up to 10 user defined programs, stored as P0 through P9. To select a program, enter the desired program number immediately after the select program mnemonic. All operating modes use the same programs and all program locations (P0-P9) are identical in function. The last program selected remains in effect for all modes unit another select program command is processed.

```
Send:        >0 P3 [CR]
Receive:     >0 P3 [CR]
```

5.4.6. (XP) Execute current program. The XP command causes the currently selected program to begin execution. The return message indicates that the program

selected was executed. If a fault condition is active, a '?' will be returned and the program will not run until the fault has been cleared.

```
Send:         >0 XP [CR]
Receive:      >0 XP P0 [CR]
```

5.4.7. (??) Help. A brief listing of all available EPS200 commands can be displayed by sending the unit the help listing command.

```
Send:         >0 ?? [CR]
```

Entering program commands. User programs may be up to 32 steps long. Each program instruction is entered similar to the immediate mode commands, with the exception that a line number is included with the instruction. The instructions are stored and executed in sequence, based upon the instruction line number. There are two program instruction formats used with the EPS200.

Program instruction only format:

```
> a [sp] nn [sp] cc [cr]
```

Program instruction with parameters format:

```
> a [sp] nn [sp] cc [sp] dddd [cr]
```

All program instructions sent to the EPS200 must start with an ASCII '>' (hex 3E) or the following fields will be ignored. The following one byte code [a] is the unique address of the target unit. This code is a hex-ASCII value ranging from 0-9 and A-F. The EPS200 currently only supports address zero (hex 32).

ASCII space characters [sp] act as delimiters and must be inserted as shown between fields. No space is permitted after the attention character and the address field.

The following field [nn] is the line number, which can range from 01 to 32. Instruction lines can be entered in any order. Instructions are stored and listed in order, sorted by line number. Line numbers may be skipped. Empty program locations are treated as "no operation" and are skipped.

The next field [cc] is the instruction field, which contains a two byte ASCII character from the EPS200 instruction set. The program instruction can be any instruction that is valid within a program. Some instructions are not valid in programs. Refer to Table 5.1 and section four for additional information.

The data field [dddd] may contain up to four ASCII bytes. For example, if the desired target voltage is 850 volts, then an ASCII '850' should be in the data field. Leading zero are not required.

After the complete message has been sent, a carriage return (hex 0D) must be sent to unit to indicate the end of the message. If the last byte after the command message is not a carriage return or the command does not pass syntax checks, the data will be ignored and a '?' character will be returned.

Multiple program instructions per line number are not allowed.

MV	Measure volts at terminals (+/-)
MI	Measure current at terminals (+/-)
R1	Read timer 1 (user time delay)
R2	Read timer 2 (HV on time)
R3	Read timer 3 (OEM odometer)
RC	Return compliance value (V)
RI	Return overcurrent trip point (I)
RM	Report maximum voltage
RP	Return program number/step/run-stop
RS	Return hardware status
RV	Return voltage setpoint (V)
??	Help command

Table 5.1 - Instructions that may not be used in a program

6. TROUBLESHOOTING

6.1. Introduction. This section provides the user with information on methods to resolve problems that may be encountered in the event the EPS200 is not functioning properly. To determine the fault condition, refer to the LCD display. It provides information to determine whether the unit is functioning properly.

6.2. Overload Fault. An overload fault can be caused by an overcurrent trip point setting that is too low, an output voltage setpoint is beyond the capability of the EPS200, for the given load, or an electrical problem with the load.

The output overcurrent limit setpoint can be adjusted with a SI command. Increase the setting, up to 1000 uA, and restart the unit. If the load current exceeds the over current trip point, the unit will shut off the high voltage output, or abort a running program. This allows the user to set a lower limit for the expected load impedance.

If voltage compliance monitoring is activated and voltage compliance cannot be maintained, the unit will produce an overload fault,. Correct the problem by turning off voltage compliance monitoring (CN command), reset the voltage setpoint to a lower value (SV command) or inspect the load for shorts or other excessive loading.

If the unit continues to display the overload fault, disconnect the unit from the load and turn on the high voltage. If the high voltage comes on and achieves the desired voltage level, the unit is performing normally. 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.

6.3. Alarm Output. The alarm output is set whenever an overload fault occurs. The alarm output can be cleared by any user acknowledge, such as a status poll or a toggling of the REMOTE/LOCAL switch.

6.4. No Output. If the EPS200 does not produce a high voltage output, verify that the unit is properly powered and that the LCD display indicates a ready state. If the unit could not achieve voltage compliance, or a overload condition exists, an 'Overload' message will be displayed. If the unit has detected an internal fault, it will produce a coded error message.

6.5. Component replacement. There are no user serviceable components in the any of the EPS series power supplies. Any EPS unit should be returned to the factory for repair or replacement.

WARNING: Dangerous high-voltages are present inside the EPS200. Under no circumstances should the user attempt to remove the cover or repair or adjust the internal circuitry.

APPENDIX A - Programming Examples

The following program emulates basic electrostatic chuck power supply functions of chucking and dechucking. The program will set the high voltage setpoint to 800 VDC, wait for the high voltage go off command and then apply a reverse pulse of 800 VDC for two seconds to discharge the chuck and release the substrate.

```
01 TP         ; toggle the polarity
02 SV 800     ; set the output to 800 VDC
03 ON         ; turn on the high voltage
04 WF         ; wait for the high voltage off command
05 TP         ; toggle polarity
06 ON         ; turn on the high voltage
07 ST 4       ; start a four second timer
08 WT         ; wait for the timer to expire
09 OF         ; turn off the high voltage
```

This program better illustrates the flexibility of the EPS200. An oscillating voltage can be produced by the EPS200 to discharge the chuck, and more effectively release the substrate. Digital output bit commands are included as well.

```
01 TP         ; toggle polarity
02 SV 800     ; set the output to 800 VDC
03 CU         ; clear clamp is up bit
04 SD         ; set clamp is down bit
05 ON         ; turn on the high voltage
06 WF         ; wait for the high voltage off command
07 TP         ; toggle polarity
08 ON         ; turn on the high voltage
09 SV 800     ; set output to 800V
10 ST 8       ; start eight second timer
11 WT         ; wait for timer to expire
12 TP         ; toggle polarity
13 ON         ; turn on the high voltage
14 SV 400     ; set output to 400V
15 ST 6       ; start six second timer
16 WT         ; wait for timer to expire
17 TP         ; toggle polarity
18 ON         ; turn on the high voltage
19 SV 200     ; set output to 200V
20 ST 4       ; start four second timer
21 WT         ; wait for timer to expire
22 0F         ; turn high voltage off
23 SU         ; set clamp is up bit
24 CD         ; clear clamp is down bit
```

These programs are shown for example only. Some electrostatic chuck algorithms have been patented. Use of patented algorithms may be a violation of federal law.

APPENDIX B - Technical Specifications

AC Power Requirements

Input power required:	95 - 265 VAC, 47 - 63 Hz, 40 watts
Input power connection:	IEC 320, female

Environmental

Storage temperature range:	0°F - 140°F
Operation temperature range:	40°F - 120°F
Humidity:	10 - 90%, non-condensing

Physical

Dimensions (H x W x D)	3.5" x 9.5" (front panel) x 10"
Weight	3 lb. (1.3 kgs)

DC Output

EPS200-1	0 to 1,000 VDC, ±1%
EPS200-2	0 to 2,500 VDC, ±1%
Output impedance	150 kohm
Output connector	BNC (2x)
High voltage output isolation from chassis	100 meg minimum

Operating Modes and Interface Options

Operating modes	1 local, and 3 remote
Remote control interfaces	Digital, analog, RS-232

Program Specifications

Number of user defined programs	10
Number of steps per program	32

Testing Agency Approvals

The internal line-powered, low-voltage DC switching power supply and the IEC power entry module meet UL, CSA, TUV and CE requirements.

APPENDIX C - RS-232 Connector Specifications

The RS-232 serial interface connector is a female, 9 pin, D-subminiature style connector, located on the rear panel.

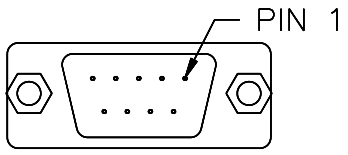

Figure C.1 - Serial Interface Connector

Pin	Description	Direction
2	Transmit Data	Output
3	Receive Data	Input
5	Common	

All serial communications meets RS-232C requirements. The baud rate is fixed at 9600 baud. No parity and one stop bit is required. Modem control lines, such as RTS and CTS, are not provided. No handshaking protocol (such as XON and XOFF) is supported. The host system must delay data transmission to avoid overflowing the EPS200 serial buffer.

APPENDIX D - Remote Control Interface Specifications

The analog and digital remote control interface connector is a female, 15 pin, D-subminiature style connector, located on the rear panel.

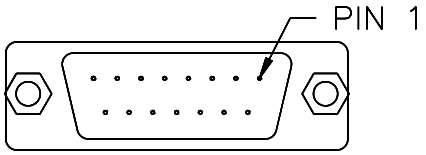

Figure D.1 - Remote Control Connector

Pin	Description	Direction
1	HV go on (-)	Input
2	HV analog setpoint (1V = 1000 VDC)	Input
3	HV go on (+)	Input
4	+12 VDC (current limited)	Output
5	Analog common	Input
6	Measured HV output (±1V = ±1000 VDC)	Output
7	Clamp is active (active low to pin 10)	Output
8	Clamp is inactive (active low to pin 10)	Output
9	Alarm output (active low to pin 10)	Output
10	Digital common	Input
11	No connection	
12	No connection	
13	No connection	
14	No connection	
15	No connection	

Analog I/O pins 2 and 6 are configured for 0-1 VDC operation. Consult the factory for applications that require a 0-10 VDC interface.

Pins 5 and 10 are not tied together internally. All digital I/O should be referenced to pin 10 and all analog I/O should be referenced to pin 5. An external common connection between pins 5 and 10 will not alter the performance of the EPS200.

Pins 1 and 3 are optically isolated from DC power and DC common. A simple remote control interface can be accomplished by connecting pins 3 and 4 together and connecting pin 1 to DC common, via a switch, to set the high voltage go on active via the digital interface.

APPENDIX E - Ordering and Service Information

Before returning defective materials for repair or replacement, contact the manufacture and obtain an RMA number. All items returned for repair must be packaged properly before shipment or the warranty will be void.

Ship to: **Gripping Power, Inc.**
11930 44th Street North, Suite B
Clearwater, Florida 33762

http://www.GrippingPower.com

Tel: (727) 572-4100
Fax: (727) 592-9894