INSTALLATION AND OPERATION MANUAL

MESC
Mobile Electrostatic Chuck Charge Station

ELECTROGRIP

WARRANTY

LIABILITY. Although all care is taken to ensure stated, safe, and reliable performance, Electrogrip can not be held liable for any direct or consequential damages arising from the use or abuse of this equipment. Detailed descriptive, hazard and use data is provided with each unit. Proper operating and safety procedures must be followed and reasonable care must be taken by the user to avoid hazards.

GUARANTEE. Products manufactured by Electrogrip are warranted against defects in workmanship and components for 1 year after shipment from Electrogrip to the buyer. Liability under this warranty is expressly limited to replacement or repair (at Electrogrip's option) of defective parts. Electrogrip may at any time discharge its warranty as to any of its products by refunding the purchase price and taking back the products.

All warranty replacement or repair of parts shall be limited to equipment malfunctions which, in the sole opinion of Electrogrip, are due or traceable to defects in original materials or workmanship. Malfunctions caused by abuse or neglect of the equipment are expressly not covered by this warranty. One particular such abuse is accessing, attempting to read, or reading the drive unit microcode.

In-warranty repaired or replacement parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the parts which have been repaired or replaced.

After expiration of the applicable warranty period, the buyer shall be charged at Electrogrip's then current prices for parts and labour plus transportation.

Except as stated herein, Electrogrip makes no warranty, expressed or implied (either in fact or by operation of law), statutory or otherwise:

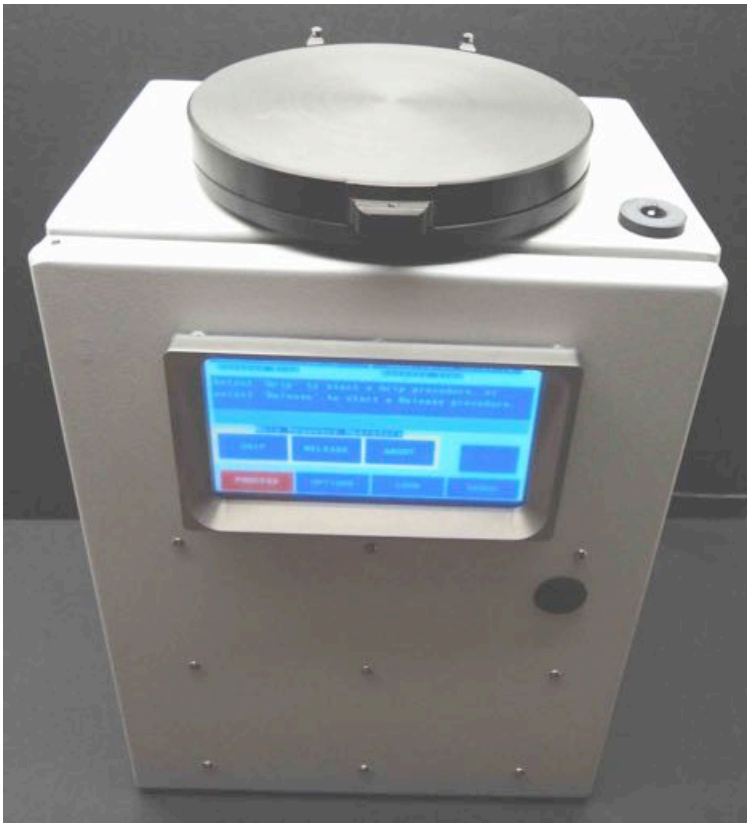
And, except as stated herein, Electrogrip shall have no liability for special or consequential damages of any kind or from any cause arising out of the sale, installation, or use of any of its products. Statements made by any person, including representatives of Electrogrip, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Electrogrip unless reduced to writing and approved by Electrogrip.

Service contracts are available for Electrogrip products.

For additional assistance, contact Electrogrip or its authorised agent.

MESC-1
Mobile Electrostatic Chuck Charge Station

This manual refers to Electrogrip Model MESC for use with a USB serial port interface



Covered by US patents 5,103,367; 5,325,261; 6,922,324; and other issued and pending patents worldwide.

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CONTENTS

OPERATIONAL SAFETY

SYMBOLS USED IN THIS MANUAL

Definitions of WARNING, CAUTION, NOTE messages:

 The WARNING sign denotes a hazard which could result in injury to personnel.

 The CAUTION sign denotes a hazard which could result in product damage.

 The NOTE sign denotes important information necessary for correct operation.

SAFETY PROCEDURES AND PRECAUTIONS

Failure to comply with the following precautions or with specific warnings elsewhere in this manual violates safety standards of the intended use of the instrument and may impair the protection provided by the equipment. Electrogrip Co. assumes no liability for the customer's failure to comply with these requirements.

 DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to Electrogrip for service and repair to ensure that all safety features are maintained.

 SERVICE BY QUALIFIED PERSONNEL ONLY

Operating personnel must not modify items inside instrument covers apart from replacement of backup batteries. Component replacement and internal adjustments must be made by qualified service personnel only.

 KEEP AWAY FROM LIVE CIRCUITS

Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

 USE CAUTION WHEN OPERATING WITH HAZARDOUS MATERIALS

If hazardous materials are used, users must take responsibility to observe the proper safety precautions, completely purge the instrument when necessary, and ensure that the material used is compatible with sealing materials.

 DO NOT OPERATE IN AN EXPLOSIVE ENVIRONMENT

Do not operate this product in an explosive environment. It is NOT certified for such use.

 KEEP THE UNIT FREE OF CONTAMINANTS

Contaminants such as corrosive gases, depositing and particle-generating gases, dust, dirt, lint, and chips may damage the unit.

 ALLOW PROPER WARM UP / INTERNAL CALIBRATION TIME

Units will only meet specifications when sufficient time is allowed for internal setup, after it has completed initialisation. This may include the first grip/release cycle, during which the DR5V internal high-voltage generator performs internal calibrations.

GENERAL INFORMATION

INTRODUCTION

The Electrogrip MESC Mobile Electrostatic Chuck Charging Station is designed for charging and discharging ElectroStatic Chuck wafers, which hold semiconductor wafers during process steps. Either bipolar or monopolar ESC wafers may be used with the Electrogrip MESC.

Figure 1. 150mm MESC front and top view

Operation:

With an electrostatic chuck on the MESC platen, the wafer to be gripped is placed on top. The MESC then forms a partial vacuum around the chuck-wafer sandwich. The wafer is gripped with high voltage in programmed stages applied at the rear of the electrostatic chuck. The MESC then retracts its high voltage contacts and releases vacuum. All pumps are dry diaphragm types.

After processing, the chuck-wafer sandwich is returned to the MESC for safe release and separation of the gripped wafer in a programmed release cycle.

The MESC includes an Electrogrip DR5V high voltage adaptive grip / release module which can attain very low residual grip levels during release, and which can provide adaptive grip, alternating polarity, or unipolar grip modes. The system is shipped in unipolar grip mode.

Connections:

The connection between the MESC and a host computer is via a rear USB-B jack. MESC datalogging output and debugging data are obtained in text file format through this USB connection. This USB jack also permits software upgrades. An internal RJ-12 jack yields monitoring of signals between the MESC control computer and the internal Electrogrip DR5V high voltage adaptive grip/release system.

Power:

Power to the MESC is via an IEC–320 power connector and is shipped for 115VAC input. A switch on the internal 24Vdc supply permits 240VAC operation if required. The MESC real-time clock has a 2032 Li-cell power retention battery that will need occasional replacement.

Environmental and Safety:

 The MESC is designed to permit wet glove control of front panel operations, with a sealed touchscreen controlling all functions. However its rear panel is not sealed against water spray and its top platen electric contacts and pumping ports are not sealed against water ingress. The MESC is not designed to be airtight and has internal pumps that use the rear panel and top platen openings for their exhaust.

 This system is NOT to be used in explosive atmospheres, due to possible spark generation when contacts close on electrostatic chucks.

Internal voltages, with the exception of the high voltage chuck wires and input mains wiring, are within IEC 60990 safety limits for human contact.

Available current from the high voltage pins attached to the DR5V outputs can be as high as 1mA. Ventricular fibrillation currents in humans are ~150mA at dc to 0.1Hz, falling to ~50mA at 20-100Hz. While DR5V current levels by themselves thus should not cause death, movement resulting from electric shock may yield severe injury and should be avoided.

 Shock hazards also arise from stored energy. The stored energy of each of the DR5V outputs is [C V^2 / 2], where C is the output capacitance (~100pF internally). With a maximum of 2kV on an output and with internal capacitances only, the stored energy of 0.2mJ is below the sensation threshold. However, with an attached load capacitance of 10nF stored energy rises to the 'possibly sensed' level of 20mJ. A load of 1000nF (1μF) yields an incapacitating 2J and possible death in weakened bodies. Death results from a 10μF load. *{Ref; Theodore Bernstein, IEEE Trans. Education **34** (3) Aug 1991 p 216-222.}*

SERVICE

The MESC may be returned to Electrogrip for repair and recalibration. Electrogrip does not require an RMA (Return Material Authorisation) before return shipment, but does require an accompanying purchase order which may be made out with a 'not to exceed' amount. The order amount should be set to the quoted repair charge (if not in warranty), plus Electrogrip's processing/shipping charges.

 The purchase order must also include or accompany the below safety warranty:

"**All returns to Electrogrip are warranted to be free of harmful materials, including but not limited to toxic, radioactive, and corrosive chemicals.**"

INSTALLATION

INTRODUCTION

This section of the manual describes initial setup and operation of the Electrogrip MESC system. Additional information useful for more detailed setup will be found in the Electrogrip DR5V manual.

UNPACKING

Upon receipt, check for defects such as cracks, dents, broken or loose parts, or other evidence of shipping damage. If such damage is found, please follow the 'SERVICE' instructions above to return the equipment.

Retain packing materials until above check is completed satisfactorily.

In your package you should find:

(i) MESC system enclosure with top platen and clamshell lid
(ii) USB-B to USB-A connection cable
(iii) IEC-320 power cable for US power
(iv) Ring magnet for holding and extracting flatted-wafer location pins
(v) Two flatted-wafer locating pins.

Follow standard procedures:

(i) Discard cardboard packaging
(ii) Remove outer plastic sheath, if present, at transfer box and discard
(iii) Wipe down then remove inner plastic covering in clean room
(iv) Final damage inspection

(v)  **No touching of connector pins with gloves due to ESD from gloves.** Connector pins are rated up to 2kV human body model contact ESD but such exposure should be limited to assure continued reliable operation. In addition, cleanroom gloves may attain a higher surface potential than the above 2kV.

INSTALLATION ITEMS

You will require the following items for installation:

(i) Host device (optional; for datalog collection)
(ii) Mobile ESC wafer and wafer to be gripped.

INSTALLATION REQUIREMENTS

(i) Atmospheric air operation at 10°C to 45°C.
(ii) No warmup time is required but at power-up an internal setup is performed.
(iii) Host computer communication if desired: eg using Hyperterminal ...
USB port serial emulation at 9600 baud, 8 bit, no parity, 1 stop bit

SETUP

The initialising screen will display at power-on and will remain until the DR5V high voltage system is set up with its default parameters. It shows startup process stages on a 4th line:

Figure 2. Typical MESC startup screen.

If internal connections to the DR5V high voltage module are broken, this screen will show and internal plugs should be checked to obtain DR5V communication to the control computer:

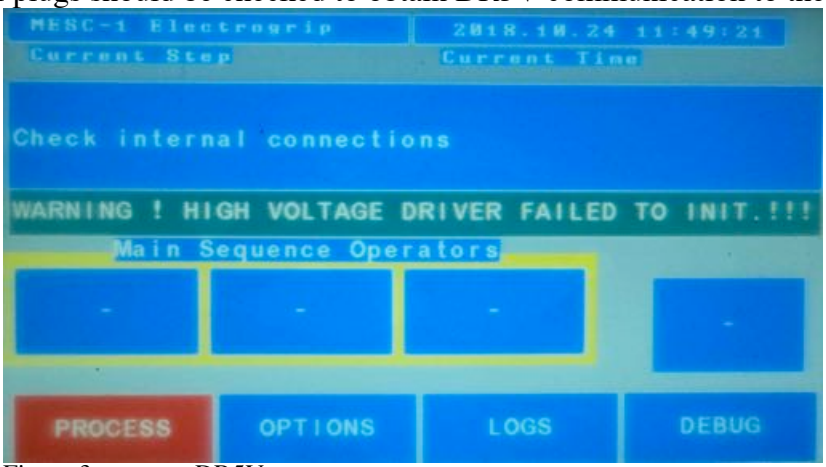

Figure 3. DR5V error message screen.

If initialisation has completed correctly, the process startup screen will display:

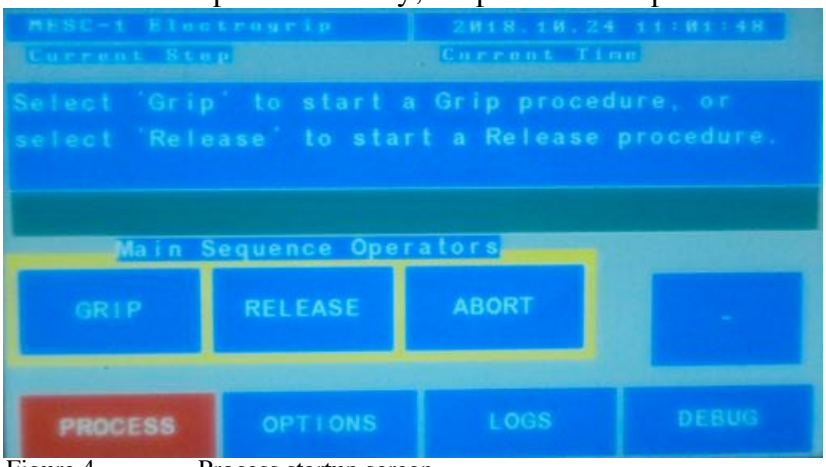

Figure 4. Process startup screen.

If the displayed time and date are wrong, press on the upper RHS time and date box, or go to the LOGS screen control; the time gets a red background, and the following screen allows time and date entry. This will be needed if the internal real-time clock battery has been changed:

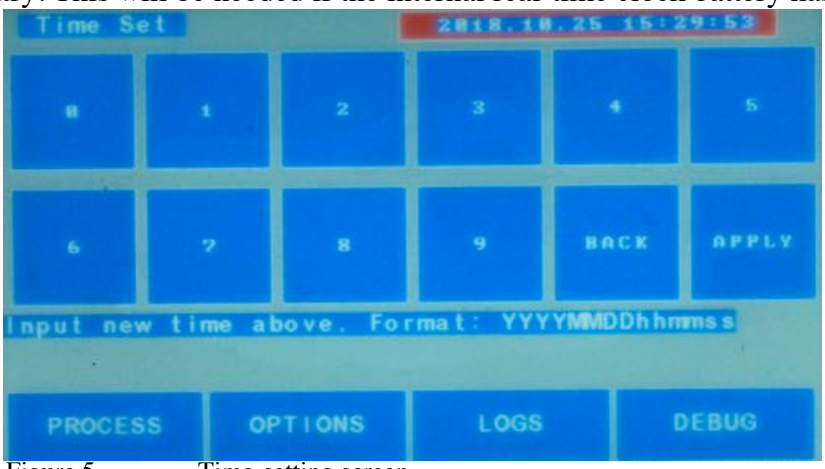

Figure 5. Time-setting screen.

If the internal real-time clock battery must be changed, open the box with a quarter-turn of the latch screw at the front panel RHS and change the 2032 Li-cell:

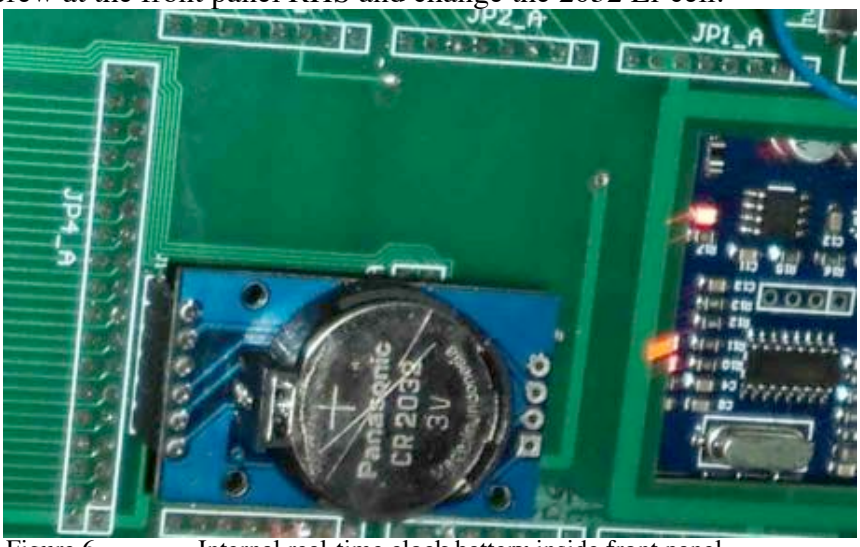

Figure 6. Internal real-time clock battery inside front panel.

Process parameters are changed using the OPTIONS screen: USE/APPLY enters a value for use; SAVE will retain the new value after power cycling for future use.

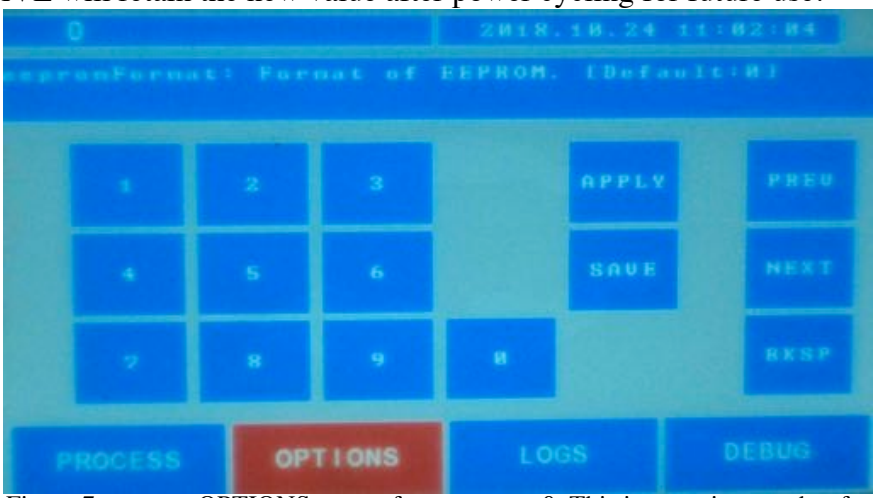

Figure 7. OPTIONS screen for parameter 0. This is a version number for factory use only.

Other parameters for factory use only are detailed below this section.

Scroll through process parameter settings by pressing the PREV / NEXT button:

Figure 8. OPTIONS screen for Grip1 voltage parameter.

Grip voltages and times may be programmed to have 4 values during the grip cycle, to enable a warped substrate to be quickly pulled down to the electrostatic chuck surface, and then to cause sufficient charge to be built up in the dielectrics present between electrodes and gripped substrate to maintain grip during later process steps.

The first voltage transient is measured in tenths of a second and is controlled inside the DR5V module. Parameter settings for this fast action are shown in the following screens:

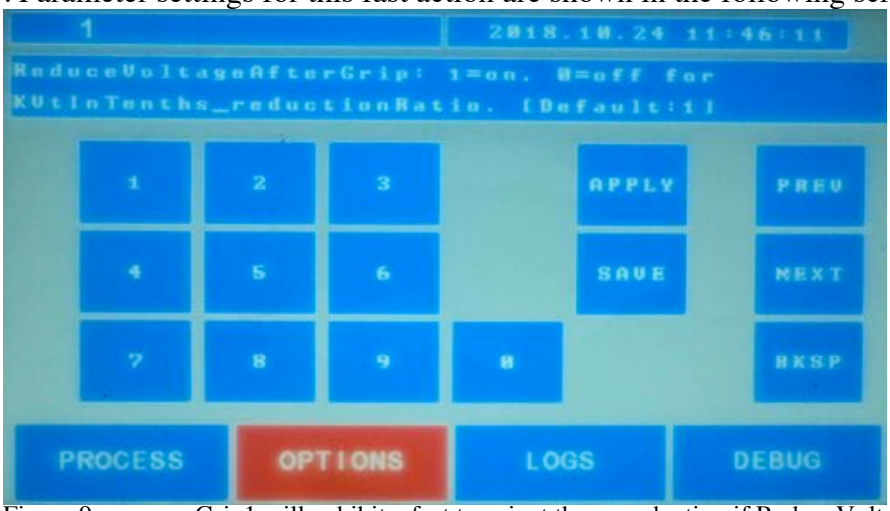

Figure 9. Grip1 will exhibit a fast transient then a reduction if ReduceVoltageAfterGrip = 1.

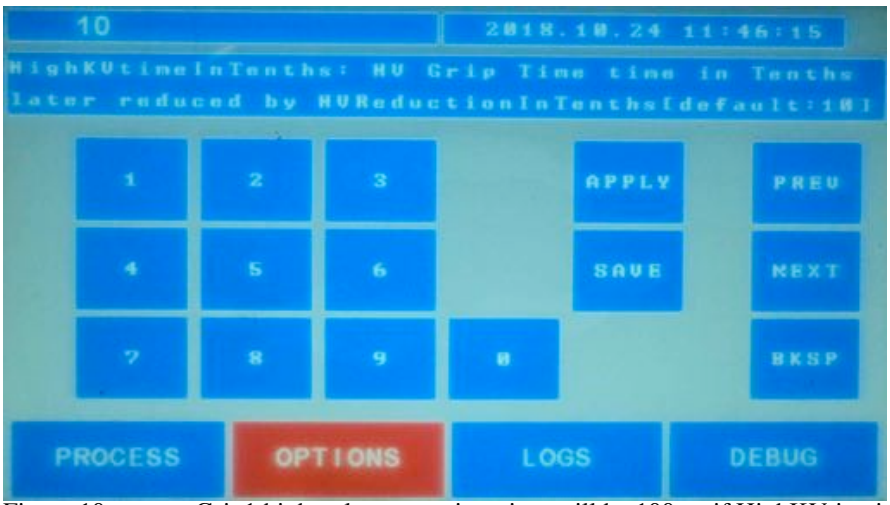

Figure 10. Grip1 high voltage transient time will be 100ms if HighKVtimeinTenths = 1.

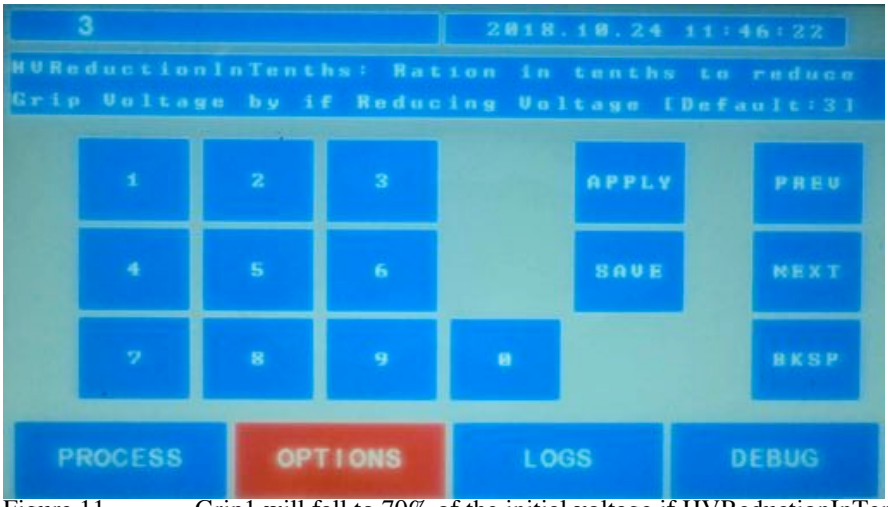

Figure 11. Grip1 will fall to 70% of the initial voltage if HVReductionInTenths is set to 3.

The 'Grip1' through 'Grip3' voltages and times are entered in volts and milliseconds and may be used to develop any kind of complex grip waveform desired after that initial fast transient is completed. The Grip1Time in seconds is the total time spent in the first grip period, and the Grip1 voltage is the peak voltage attained during that time. If a GripTime setting is zero, that Grip step is ignored:

Figure 12. Set Grip3TimeSecs = 0 to bypass Grip3.

Release Parameters control the voltage applied to the electrode pins before contact to the electrostatic chuck carrier, and the time taken for the release.

Parameters for factory use only are the above eepromFormat parameter0, Debug, Center / Clam PressureOffset / PressureGain sensor calibrations, CenterValveNC, ClamValveNC.

Other parameters are the pressure goals for moving on to the next step in a process, but are factory-set to permit tolerant processing. The factory-set pressure goals are easily met by the installed pumps if placement of the electrostatic chuck wafer is central and if the clamshell lid is well-seated on its outer seal ring.

Some DR5V high-voltage module Option parameters can be set from the OPTIONS screen; these normally will not need to be changed, apart from the 'ReduceVoltageAfterGrip' Option above. Details on all of the DR5V Options are found in the DR5V manual. Note the MESC DR5V is adjusted for low voltage operation so is internally programmed and reads back 4x the actual output voltage. This voltage factor is compensated for in the MESC software.

OPERATION

LOGS and INTERNAL DEBUG CONNECTIONS

Datalogging of process steps to the host computer occurs if the 'Log to USB' button is activated, as shown below. Log output is tab-delimited between all data fields. Time, Date, sensor outputs, and process step stages are all shown in columns, with column header fields sent whenever a process is started.

Clear Logs and Send Logs will be implemented in a later version of this equipment, if it is desired to store log files for later download to a host computer.

RAM to USB is a memory check for factory use.

DR5 to USB routes communications with the DR5V high-voltage module to the USB host port instead of the internal MESC computer to enable direct DR5V parameter and option setting. In this state, the internal computer information is not current and the screen display will have incorrect DR5V voltage and current values. At startup any manually entered settings in the DR5V using the USB port will be overridden, if they are also MESC system parameters, using the stored MESC parameters.

Date and Time can be set either with pressing the control button in the LOGS screen, or by pressing on the time/date box at the top RHS of the screen. Either action calls up the time/date alteration screen shown on p.10, fig. 5.

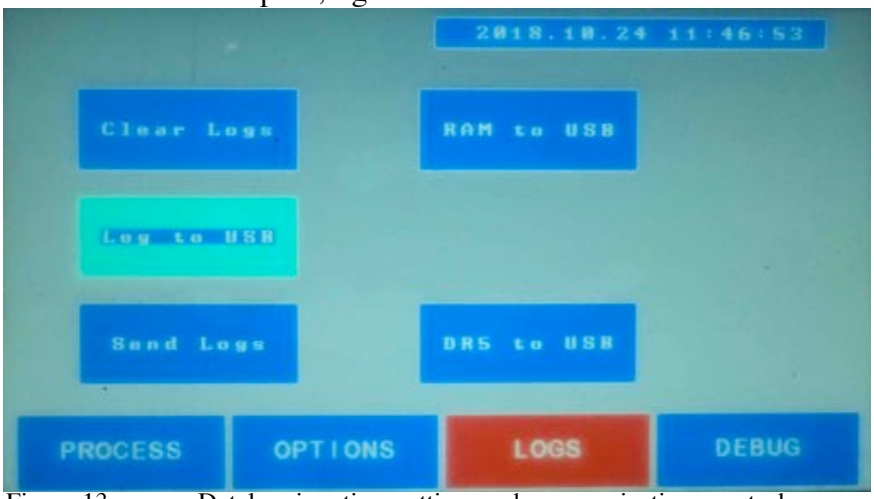

Figure 13. Datalogging, time setting, and communications control screen.

DEBUG SCREEN

The DEBUG screen may be viewed at any time. During a process the user may toggle between DEBUG and PROCESS screens to fully observe events.

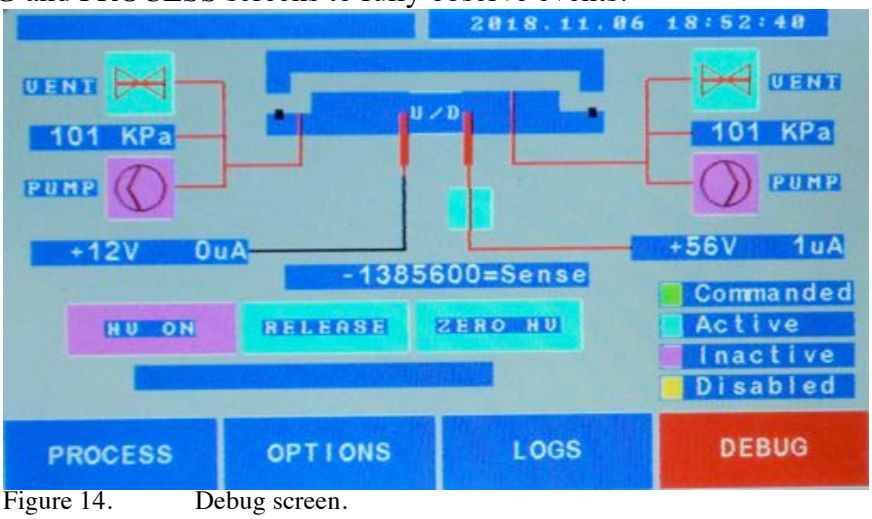

Figure 14. Debug screen.

Actuators*:*

Touching an actuator icon toggles the state of that actuator even in the middle of a process step. Contact Pin lift is in the platen center; pumps are circles; valves are joined triangles. HV ON, RELEASE, and ZERO HV are DR5V commands. HV ON turns on the DR5V high voltage outputs to the level that the prior operation requested.

For example, if the system is programmed to grip wafers with a GRIP1 voltage level that then is reduced during GRIP1 process, then if either (i) the system has come out of initialisation at startup, or (ii) the system has last been doing a GRIP process, then the HV ON command will cause a GRIP1 voltage level and subsequent drop in voltage to be executed.

Alternatively, if the system has just been doing a RELEASE process, then the HV ON command will cause the programmed voltage which is used at the start of the release process to be applied.

If the system is programmed to grip a monopolar ESC, then a single voltage output to the left-hand black contact pin wire will be applied rather than a bipolar output to both contact pins. The button in series with the red right-hand electrode wire controls that wire's switch. Monopolar chuck voltages are limited by the switch rating and is an OPTIONS parameter.

Sensors*:*

Other boxes display sensor outputs; electrode currents and voltages, wafer sense level, and pressures in the inner and outer platen regions.

100kPa pressure is atmospheric pressure; 0kPa is full vacuum. When the clamshell lid is under vacuum, it is shown lowered, touching a seal on the platen rim. It is normal, and required, that the inner pump pressure always be lower than the outer clamshell pressure during a process.

If electrode current while gripping is more than say 2μA, one must suspect leakage and chuck dielectric breakdown. Steady state chuck currents are normally much less than 1 μA.

The DR5V readout resolutions are 25V and 1μA, so readouts will fluctuate by those amounts.

The Sense level is a measure of grip strength and presence of good contact to the MESC carrier wafer. The reading is zeroed at the start of a process and at initial power-up. During a grip the reading will go more positive as the electrode capacitance rises; during a release it will go more negative. If a MESC wafer carrier is not contacting the electrodes, the sense reading will reflect that with a low reading. For example, a monopolar MESC carrier may exhibit a sense change of about 500 upon contact; a bipolar carrier a change of 10,000.

PROCESSES

The PROCESS screen default state is shown below. Three programmed sequences are available: Grip, Release, and Abort.

The voltages and timings for the Grip and Release sequences are programmed in the OPTION parameter settings as described above.

At any time ABORT may be pressed to zero the contact pin voltages, lower the contact pins, and vent evacuated spaces to air.

If monopolar ESC operation is required one of the electrode wires is turned 'OFF' either using the Debug screen; or if running automatically in a Process, by the appropriate Parameter setting in the Option screen. That Parameter setting will also be used at startup to initialise the system in that mode. The shipped default status is bipolar grip.

Monopolar gripping requires that the top gripped wafer be grounded electrically. This is achieved by connecting a thin ground plate or wires between the side ground contact and the top of the wafer in a non-patterned region.

Monopolar gripping also requires that the series switch in the right-hand red electrode wire in the Debug screen be kept within its voltage rating. This is a Parameter setting, and attempting to grip in monopolar mode at a voltage greater than that Parameter setting will result in a fault condition and then an Abort sequence.

Figure 13. Process startup screen.

During a process, the dark green box shows the current step and above it the blue text scrolls up, showing the most recent completed steps and other information notes.

GRIP PROCESS:
During a GRIP, the user must attend to three prompts:

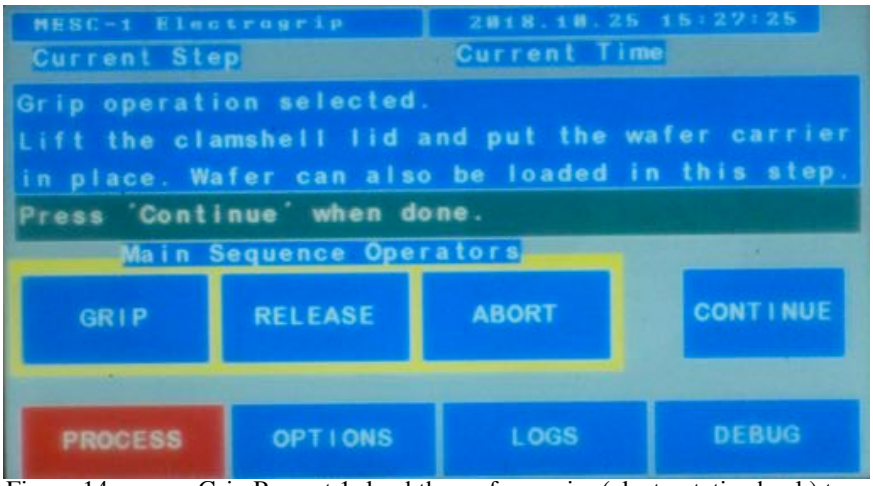

Figure 14. Grip Prompt 1; load the wafer carrier (electrostatic chuck) to pump its rearside.

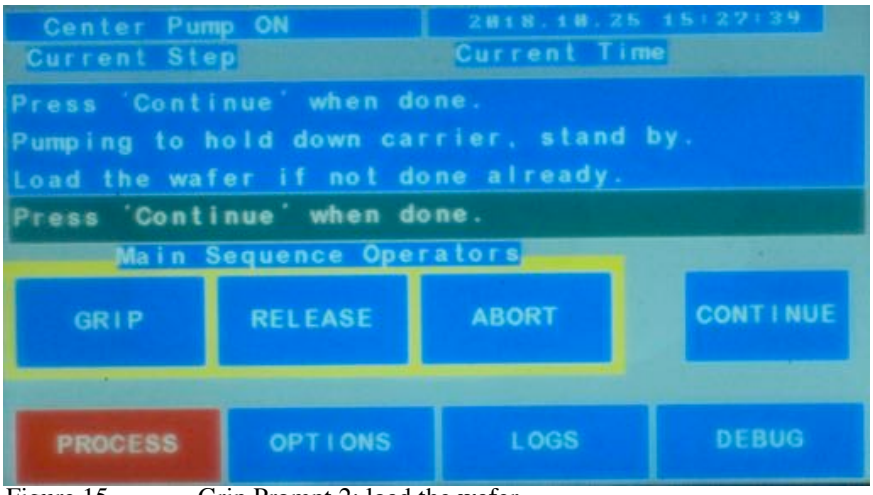

Figure 15. Grip Prompt 2; load the wafer.

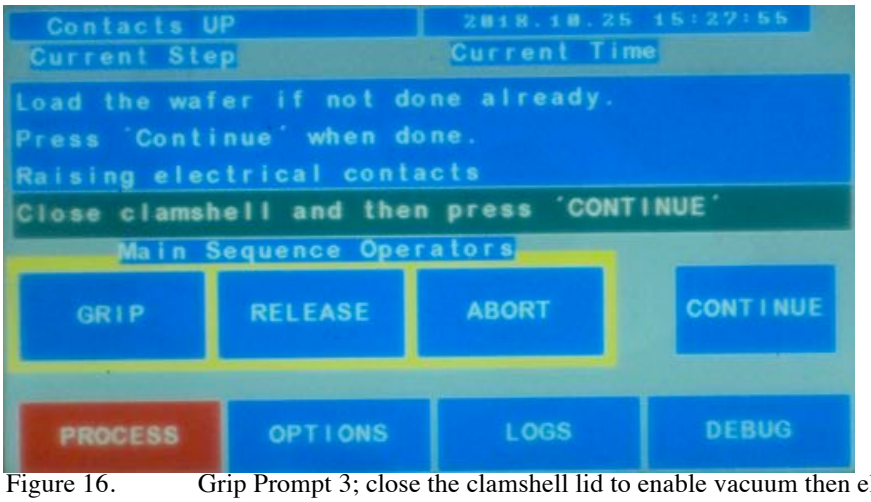

Figure 16. Grip Prompt 3; close the clamshell lid to enable vacuum then electrostatic grip.

After clamshell pumping, wafer grip to the wafer carrier electrostatic chuck is achieved when high voltage is applied:

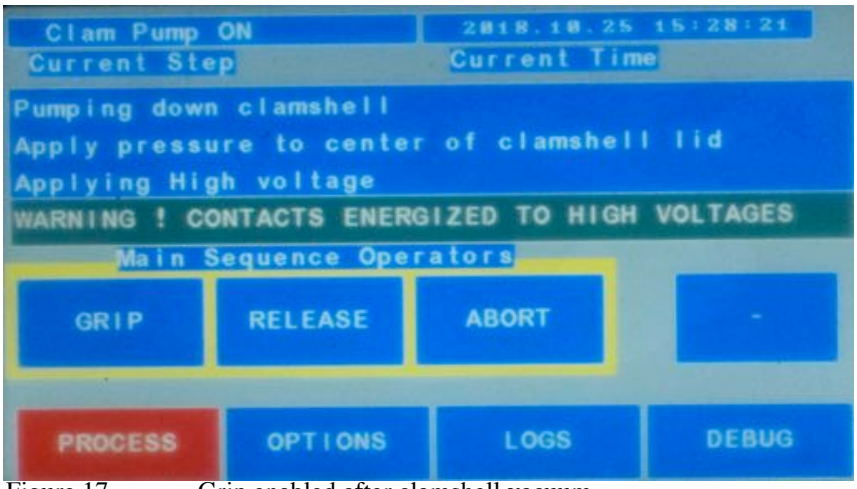

Figure 17. Grip enabled after clamshell vacuum.

During the grip process, system operation can be monitored with the log file output on a computer, or using the DEBUG screen.

Especially for a new process, it is important to observe the electrode voltages and currents, and command an ABORT whenever excess currents are observed.

A MESC carrier with high leakage current may well drain any stored charge in a short time, rendering the MESC carrier of limited usefulness. Thus high leakage currents are suspect.

Bipolar MESC carrier wafer electrode voltages should be at approximately the same absolute value, but of opposite polarity, at all times during a grip or release. Abnormally high currents, often combined with both electrodes being taken to the same polarity, indicate a faulty MESC wafer carrier.

After a successful grip sequence, the system is vented for gripped wafer sandwich removal ...

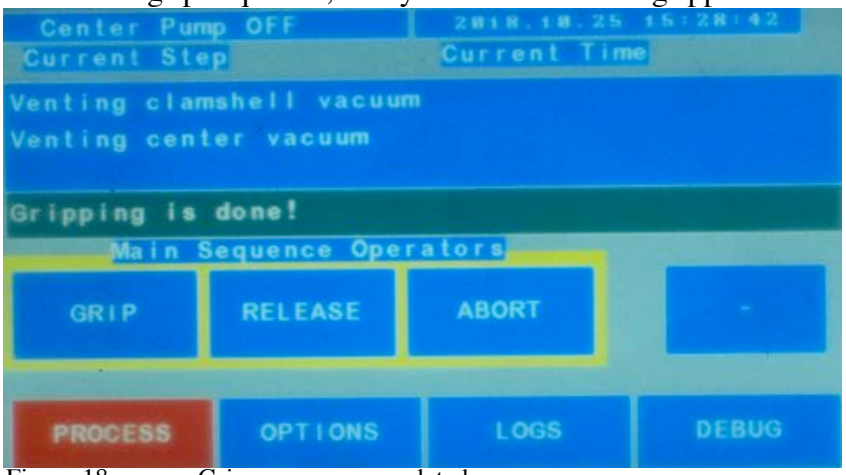

Figure 18. Grip sequence completed.

RELEASE PROCESS:
To separate a gripped wafer from its carrier esc, follow the system prompt for insertion of the wafer sandwich ...

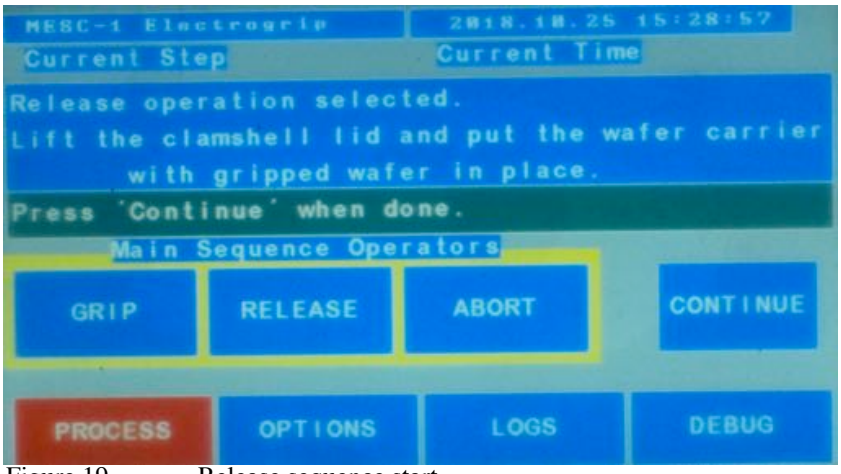

Figure 19. Release sequence start.

The carrier is pumped down and the electric contacts energised to the pre-programmed user-set release start voltage.
This voltage is set to approximate the remanent electrode voltage, thus avoiding high discharge currents and electrode pitting upon contact. This process-dependent voltage can be measured in the field. Electrogrip can provide this service.

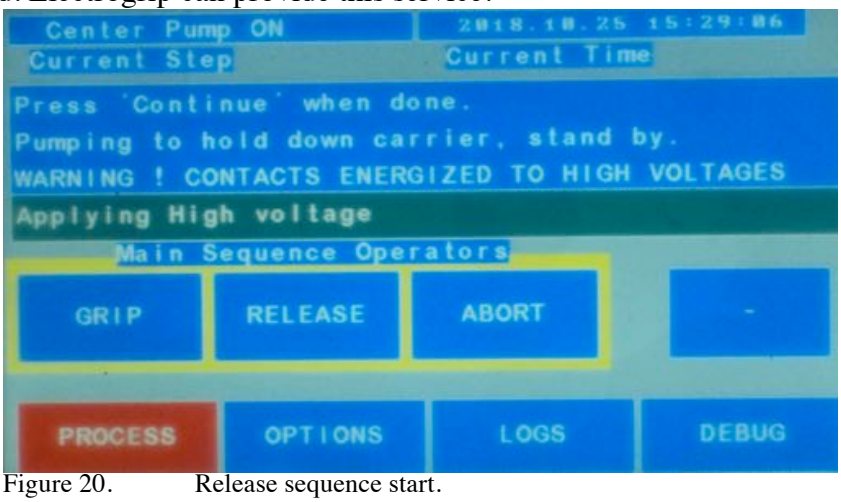

Figure 20. Release sequence start.

The electrodes are now raised to contact the wafer carrier and the release process is begun ...

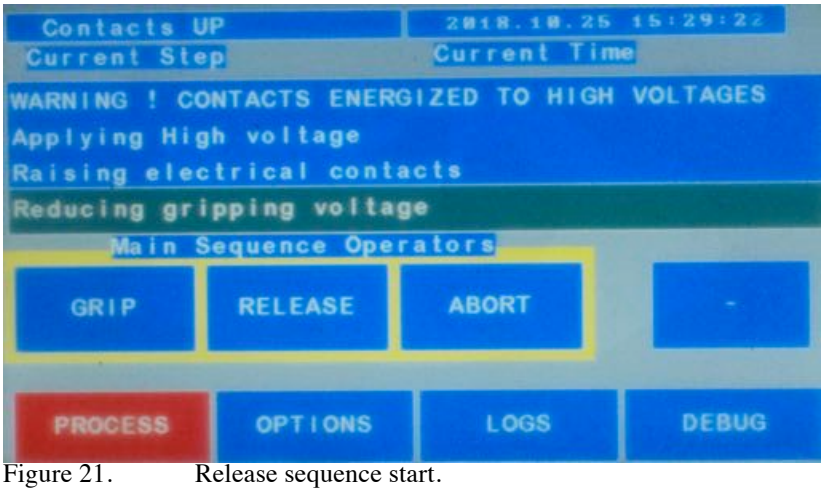

Figure 21. Release sequence start.

The electrodes are lowered after release, and the central vacuum vented ...

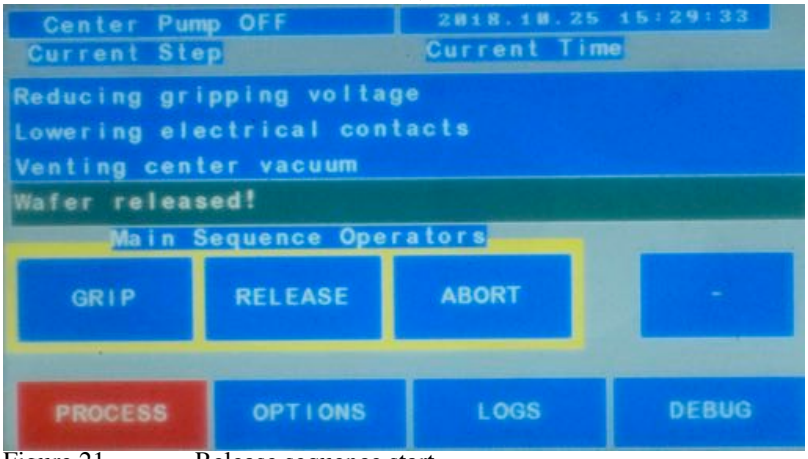

Figure 21. Release sequence start.

ABORT PROCESS:
Grip voltages lowered, pin contacts lowered, and vacuum lines are vented to abort. This can be done at any time during a grip or release process ...

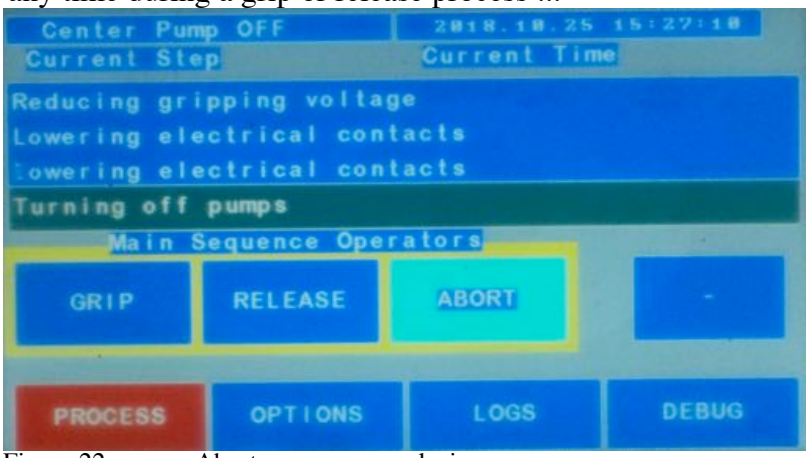

Figure 22. Abort sequence conclusion.

MAINTENANCE

The outer clamshell lid seal ring may be lightly lubricated with vacuum grease to assure easy sealing without application of pressure to the clamshell lid if desired. Otherwise, sealing requires approx. 5kg of downward force on the clamshell lid.

The internal seal rings must never be lubricated, and must be kept clean at all times, to maintain purity during device processing steps.

The clamshell lid hinges are lubricated with Molykote MoS_2 grease to prevent squeaking noises.

The Real-Time Clock battery, if dead, is changed as shown in Figure 6 and the Date/Time resetting is done via the LOGS screen control button.

PLUMBING CONNECTIONS:

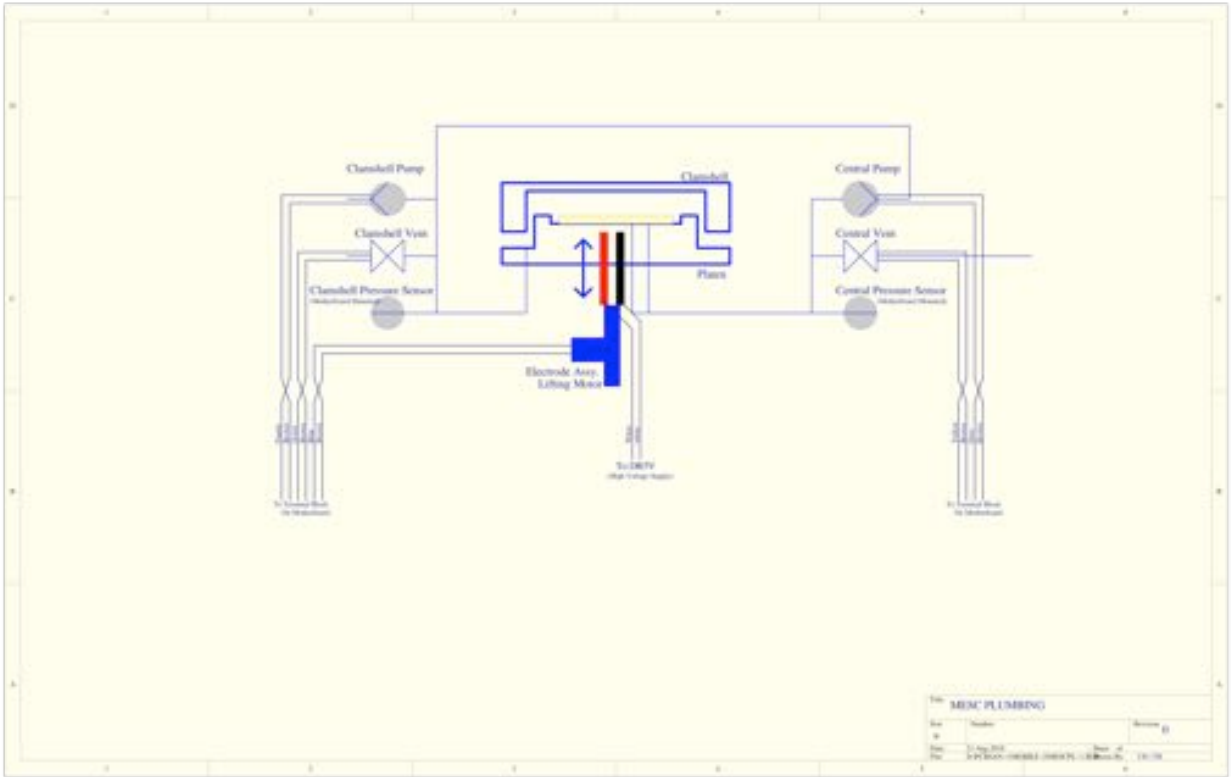

Figure 23. MESC plumbing connections.