Gamma Vacuum

Digitel MPC Technician's Manual

Part Number: 500000**, Revision: J**

Gamma Vacuum, LLC

I. Contents

II. Figures

III. Tables

I. Introduction

The manual is divided into five sections. Section 1 contains a brief description and specifications of the DIGITEL™ Multiple Pump Control (MPC). Sections 2 (page 10) and 3 (page 15) explain the installation and operation procedures, respectively. Section 4 (page 52) provides information for servicing the unit.

Description

The DIGITEL™ MPC is a pump power supply and system control. It is designed to operate up to two ion pumps and a titanium sublimation pump (TSP) or non-evaporable getter (NEG) pump, all independently and simultaneously. The MPC can accommodate pump sizes from 10 l/s and up to 1200 l/s. It operates on 115 or 230 VAC, 50 or 60 Hz.

The MPC (Figure I-1) is a programmable, microprocessor-based unit. It contains a metering circuit, 8 process setpoints, communications interface RS-232/422/485, and up to two independent high voltage modules. The front panel display provides direct readout of the ion pump voltage, current, or pressure. Ranging is automatic within the selected display mode.

Figure I-1. Photograph of the Digitel MPC.

MPC Configurations

The DIGITEL MPC comes in the following configurations:

- **635941**   base unit plus one medium HV module (200W, 100mA)
- **635942**   base unit plus one large HV module (1000W, 500mA)
- **635943**   base unit plus two medium HV modules
- **635944**   base unit plus two large HV modules
- **635945**   base unit plus one medium and one large HV module

RS-232/422/485 Serial Interface

The DIGITEL MPC can be interfaced and remotely controlled by a computer. All commands entered from the keypad can be performed from the computer.

Set Points

Eight programmable setpoints, four relay and four TTL (transistor-transistor logic), can be configured to either supply. Hysteresis and control values can be programmed through the computer interface or keypad. Nonvolatile memory is used to store setpoint data for up to 10 years without power applied to the unit. Bakeout control is designed into the software and setpoints.

High Voltage Modules

The DIGITEL MPC is available with two high-voltage (HV) modules:

- The medium HV module has a starting capacity of 200W, 100 mA. It is intended to fully operate pumps from 10 l/s to 200 l/s and can be used on larger pumps if they are well roughed or if under high vacuum.

- The large HV module has a starting capacity of 1000W, 500 mA. It is intended for pumps from 160 l/s to 1200 l/s.

HV modules are based on transformer design with low noise, high reliability, and overload protection. Each HV module has a standard output of 7000 VDC. The output voltage can be configured to ±7000 or ±5600 VDC for operating different pumps or systems. The modules come with one standard SHV-10 HV connection. For economical operation of more than one pump, an optional 2nd high-voltage output can be added.

Analog Outputs

Four buffered analog outputs are provided independently from each HV module to connect the controller to data-acquisition devices. Two of these outputs provide a 0 to 10 volt signal with a scale factor of 1 volt per 1000V output voltage (V_{MON}). The other 2 outputs are programmable.

SAFE-CONN™ High-Voltage interlock

When operated with SAFE-CONN safety interlocked pumps and cables, the will DIGITEL MPC automatically shut off high voltage when the high voltage cable is disconnected at either the pump or controller end. This provides additional protection from possible shock hazard.

AUTORUN™

AUTORUN determines optimum starting and operating conditions based the pump size entered and then starts and monitors the pump down without assistance. In start mode, because an ion pump can draw high currents, the DIGITEL MPC goes through a protected-start process, monitoring current, voltage, power, and time. If the pump starts properly, the MPC automatically goes into run protection mode. If the pump does not start properly — the DIGITEL MPC goes into a cool-down mode. If the pump does not start properly after three tries, it displays PUMP ERROR. The specific error code that identifies the cause of an error can be found in the *Menu* mode.

The DIGITEL MPC continuously protects the ion pump during start-up and normal operation. Ion pump parameters are monitored continuously by the microprocessor. If there is a vacuum failure, the MPC shuts down high voltage preventing serious damage. It can also detect power failures and be configured to automatically restart high voltage after a power loss, if desired.

Remote TSP/NEG Control Option

The remote TSP/NEG option allows you to control a TSP (titanium sublimation pump) or NEG (non-evaporable getter). All commands to operate the Remote TSP/NEG Control can be entered using the DIGITEL MPC keypad or a host computer. It can operate in current or power control mode and can be cycled based on time and pressure. In TSP operation the ranges are 0 to 999 seconds for on time and 0 to 999 minutes for off time.

The option consists of:

- Remote TSP/NEG Control unit

- harness inside the DIGITEL MPC

- control cable from the DIGITEL MPC to the Remote TSP/NEG Control

- high-current cable from the Remote TSP/NEG Control to the TSP/NEG

- an AC input power cable
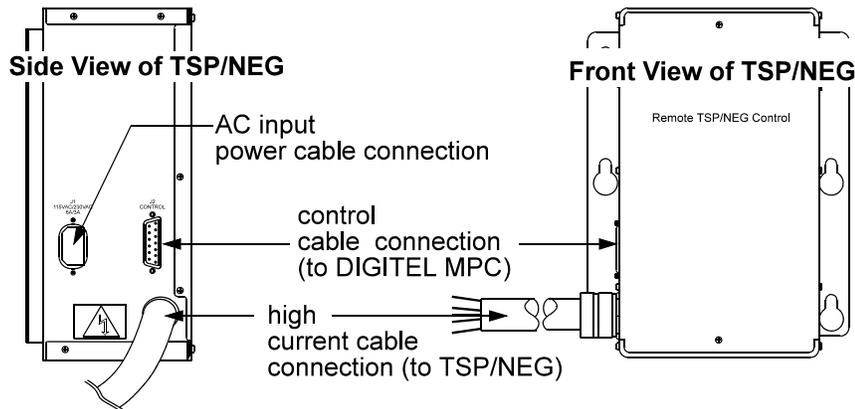
Figure I-2. Remote TSP/NEG Control Option.

High-Voltage/TSP Filament Interlock Option

The remote interlock allows disabling of either the high voltage outputs or TSP filament firing. The interlock is installed at **J506** (on the back panel of the MPC) if the option is installed. A loopback plug is shipped with the option along with a connector kit for custom configuration by the user.

Specifications

Table I-1. Specifications DIGITEL MPC.

Parameter	Specification
Operating temperature	0 to 40°C.
Operating humidity	0 to 80% RH (non-condensing).
Storage temperature	-20 to 70°C.

Dimensions:
    DIGITEL MPC
    Remote TSP/NEG
	
	WxHxD: 483 mm (19") x 133mm (5.25") x 476 mm (18.75").
	WxHxD: 138 mm (5.4") x 292 mm (11.5") x 219 mm (8.6").

Input power	115 VAC, 230 VAC, or 208 VAC selectable.

Serial interface:
    Baud Rate
    number of start bits
    number of stop bits
    parity
    number of data bits
	
	9600
	one.
	one.
	none.
	eight.

Set points (8):	
Type	Set points 1 - 4 are relay; Set points 5 - 8 are TTL.
Electrical characteristics	Relay: 500 mA, 28V each, maximum. TTL: 15 mA each, maximum.
response time	All MCP parameters are measured at least every 320 milliseconds. Assuming a set point decision is handled right after measurement is made, response time is 320 milliseconds. Assuming a set point decision is made on the next time through the standard loop response time is 640 milliseconds. Relays take a few milliseconds to operate, so this increases response time slightly.
Line frequency	48 to 62 Hz. No adjustment necessary.
High voltage output: short circuit	+7000 VDC output standard; ±5600 and -7000 VDC selectable. Medium HV module: 200W, 100 mA. Large HV module: 1000W, 500 mA.
Polarity	Positive or negative (selectable).
Analog outputs:	0 to 10V
Voltage Current (outputs are jumper selectable) Operating Load	1V = 1000V. 1V = 100mA or 100µA on 500mA HV modules; 1V = 20mA or 20µA on 100mA HV modules Lowest resistance = 2kΩ.
Pump size	Selectable from the keypad (Menu key).
Filament power ramp-up	5 amps per second.

II. Installation

This section details the installation requirements for the DIGITEL™ Multiple Pump Control (MPC).

WARNING: Gamma Vacuum, LLCs' products are designed and manufactured to provide protection against electrical and mechanical hazards for the operator and the area surrounding the product. The procedures provided in Sections 2 and 5 of this manual and in other Gamma Vacuum, LLC product manuals must be followed to ensure that these protections are not impaired in any way.

WARNING: Installation procedures are for use by qualified and authorized personnel who have experience working with voltages greater than 50 volts. To avoid personal injury, do not perform any installation or service procedures unless qualified to do so.

Voltages up to 7000V are present. An interlock is provided to shut off power when the top cover is removed. Do not defeat this interlock.

Do not disconnect the high-voltage cable with power on. After turning power off, allow at least one minute before disconnecting electrical equipment

Do not operate the control without a proper electrical ground or near water. The control may be damaged and its safety reduced, if it is operated outside of its specifications.

Inspection for Damage

NOTE: It is the customer's responsibility to inspect and report any obvious shipping damage to the carrier, typically within 30 days. Before installing Gamma Vacuum, LLC equipment, inspect it for damage that may have occurred during shipment.

Installing the DIGITEL MPC

The DIGITEL MPC can be mounted in a standard 19 in. (48.3 cm) rack or used as a free-standing unit. Make sure to provide clearance for air flow into top cover vent holes and out rear mounted fan. Installation should be in such a manner as to make the rear power cord accessible.

NOTE: This unit can radiate radio frequency energy. Be sure that you install it according to instructions or interference could result.

The unit protects against interference in a commercial environment. If operation in a residential area causes interference, it is the user's responsibility to correct this problem.

Required items

You need the following items to install the MPC:

1. 3-wire, detachable AC input power cable (included with DIGITEL)

2. high voltage (HV) cable for each pump (ordered separately)

3. safety ground cable for each pump (ordered separately)

Procedure

Perform the following procedure to install the MPC:

1. Place the unit in its location and secure as necessary.

2. Connect the safety ground cable between the pump and safety ground stud at the DIGITEL rear panel (Figure II-1).

3. Connect the high voltage cable to the ion pump and to the appropriate high voltage jack on the DIGITEL rear panel. See Figure II-1 and Table II-1.

4. If you have the optional SAFE-CONN feature, an additional connector is part of the HV connector. Connect it to the appropriate SAFE CONN jack. See Figure II-1 and Table II-1.

5. Verify correct input voltage requirements. Connect the AC input power cable to input power receptacle on the DIGITEL rear panel.

6. Switch on the DIGITEL and set correct pump size.
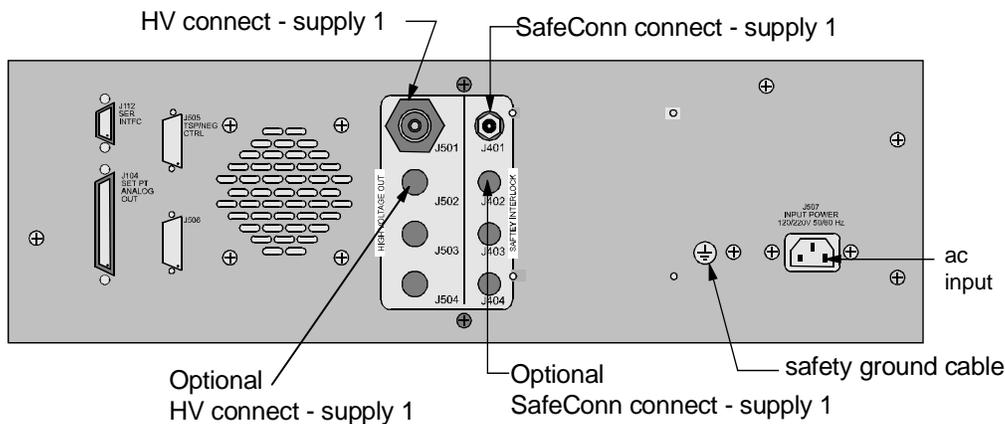
Figure II-1. MPC Rear Panel HV and SAFECONN Connectors.

Table II-1. High Voltage and SAFE-CONN Connectors.

HV Connector	SAFE-CONN Connector	Description
J501	J401	HV & SafeConn Connect, Supply 1
J502	J402	Optional Connect, Supply 1
J503	J403	HV & SafeConn Connect, Supply 2
J504	J404	Optional Connect, Supply 2

Installing the Remote TSP/NEG Control Option

DANGER: Voltages up to 7000V are present in the DIGITEL MPC. Turn off power and disconnect AC input power cable before installing the Remote TSP/NEG Control option.

Figure II-2 shows an overview of the Remote TSP/NEG Control connections in the system.
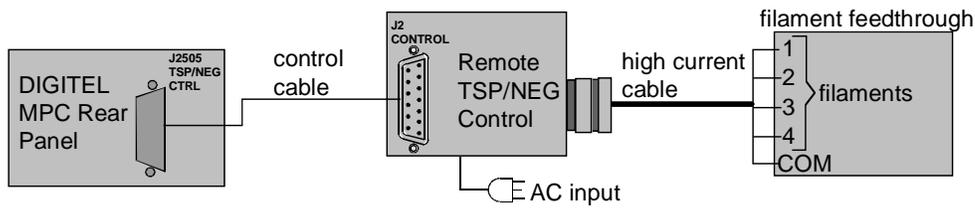
Figure II-2. Remote TSP/NEG Control Connections.

To install the Remote TSP/NEG Control, use the following procedure. Figure II-3 provides an installation diagram.

Required Items

You need the following components to install the Remote TSP/NEG Control:

1. control cable
2. Remote TSP/NEG Control unit
3. high current cable
4. AC input power cable

Procedure

1. Mount the Remote TSP/NEG Control unit using the holes provided on the mounting bracket (see Figure II-3).
2. Turn off power to the DIGITEL MPC and disconnect its AC input power cable.
3. Connect the control cable to **J505 TSP/NEG CTRL** on the rear panel of the DIGITEL MPC. Connect the other end to **J2 Control** on the Remote TSP/NEG Control unit.
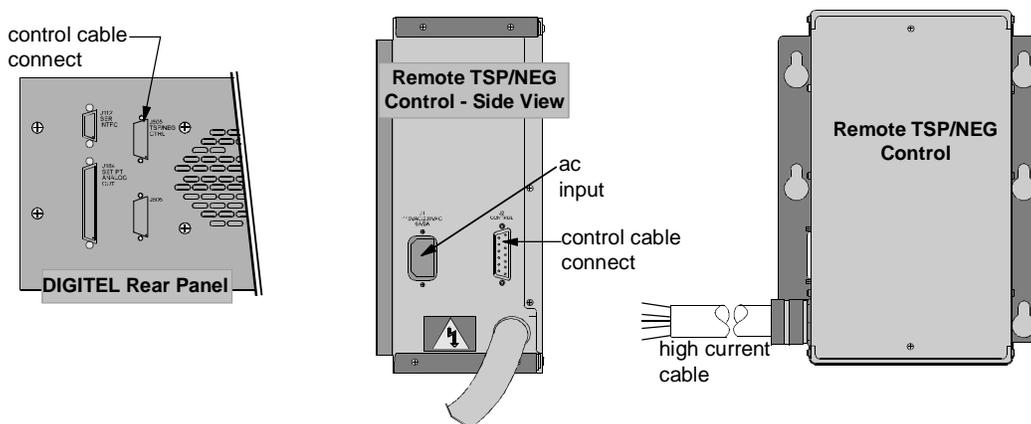
Figure II-3. Diagram of Remote TSP/NEG Control.

CAUTION: Step 4 is a high current connection. Make sure that you have a secure connection, or heating will occur.

4. Connect the high current cable to the filament feedthrough. Filament wires are labeled as shown in Figure II-4.
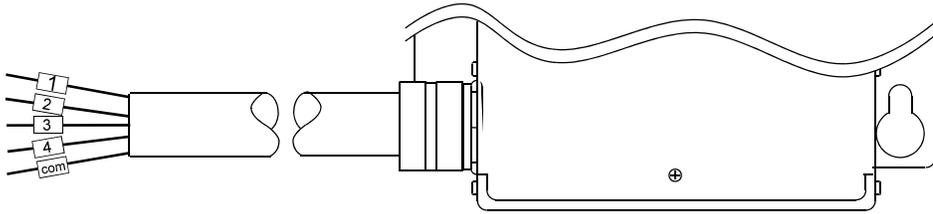
Figure II-4. High Current Cable.

5. Connect the AC input power cable to the Remote TSP/NEG Control unit.

6. Reconnect the AC input power cable to the DIGITEL MPC.

NOTE: If you need to connect a high current cable to the TSP/NEG unit, see Section 4, Connecting a High Current Cable to TSP/NEG.

SAFE-CONN™ Installation on an Ion Pump

Use the following procedure to install a SAFE-CONN on the high-voltage feedthrough (HVFT) of your ion pump.

Required Items

1. Parts:

   1.1. a PEEK (Poly-Ether-Ether-Ketone) cylinder

   1.2. two SS rings

2. Tools:

   2.1. two flat-head screwdrivers

   2.2. an SS installation tool and a plastic cylinder

Procedure

1. Place SS ring #1 on the 10 kV HVFT (Figure II-5).

2. Install the PEEK cylinder over the 10 kV HVFT with its inner diameter groove facing away from the pump (Figure II-5). The inner diameter groove will locate/lock onto the 10 kV HVFT tabs.
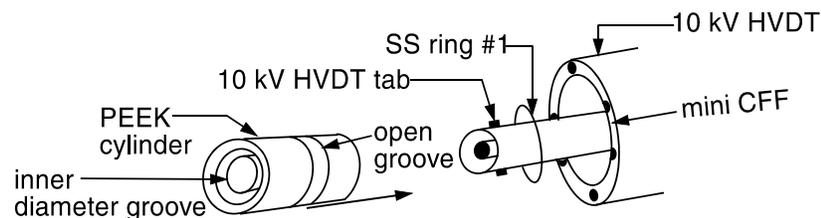
Figure II-5. SAFECONN Installation Diagram #1.

3. Use the two flat-headed screwdrivers prying against the mini-CFF, pry SS ring #1 over the PEEK cylinder and into the open groove (Figure II-6).

4. Using the SS installation tool and plastic cylinder, install SS ring #2 on the PEEK cylinder.

   4.1. Place the SS ring on the nose/ramp of the SS installation tool.
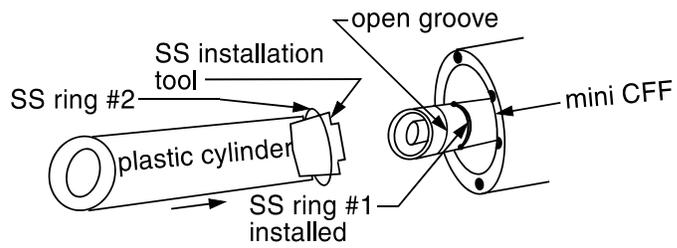
Figure II-6. SAFECONN Installation Diagram #2.

4.2. Using the plastic cylinder, keep a constant steady pressure on the SS ring, while keeping the installation tool, SS ring, and plastic cylinder assembly together.

4.3. Raise the assembly to the HVFT, and with a light tap on the plastic cylinder, slide SS ring #2 into the open groove of the PEEK cylinder.

III. Operation

Operation of the DIGITEL™ Multiple Pump Control (MPC) can be controlled by the operator through the system computer software. Refer to the system operator's guide for specific operating procedures.

Section 3 (page 15), Operation, contains the following information for manual control of the DIGITEL MPC.

- Front Panel Description identifies and describes the front panel controls and indicators.

- Rear Panel Description identifies and provides signal pinouts for the rear panel connectors.

- Operating the Ion Pump explains how to evacuate and start an ion pump.

- Using the Keypad provides a detailed explanation of keypad operation and its associated display information.

- Display Messages gives a description in a table format of the status messages that can appear on the display.

- Analog Outputs describes the monitor outputs for voltage and current.

- Serial Interface provides detailed information concerning the computer communication interface.

- Menu Structure provides detailed flow chart on the menu structure.

Front Panel Description

Figure III-1 identifies the front panel controls and indicators on the DIGITEL™ MPC, which are described in Table III-1.
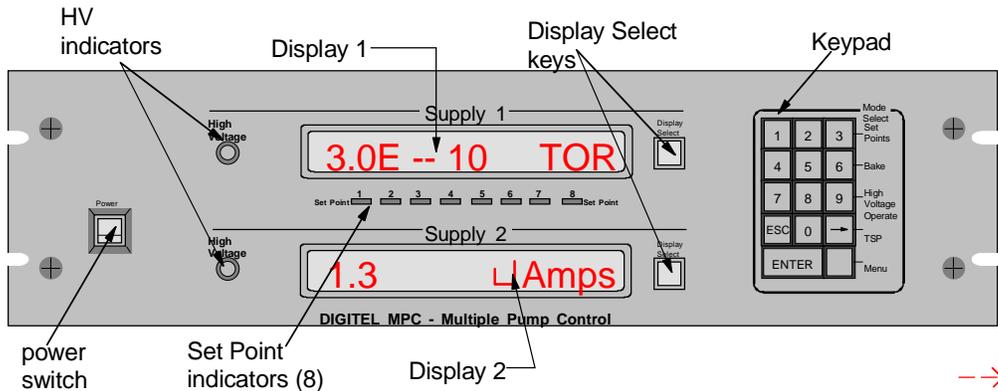
Figure III-1. Front Panel Controls and Indicators.

Table III-1. Front Panel Controls and Indicators.

Control	Description
Main Power switch	Turns main power on and off (1 = ON; 0 = OFF).
High Voltage indicators (2)	When high voltage (HV) is enabled to supply 1 or supply 2, the associated indicator on the front panel lights. To enable HV manually, use the **9** key on the front panel keypad to select **High Voltage Operate**. Press the **Display Select** key for the appropriate power supply and press **ENTER**. Note: If SAFE-CONN interlock is not intact, high voltage will not turn on.
Supply 1, Supply 2 displays	During normal mode, displays 1 & 2 show voltage, current, or pressure status information, as well as error codes. When in program mode, they display corresponding data.
Display Select (2) keys	During normal mode, press this key to select voltage, current, or pressure for display. During program or menu mode — when an arrow on the display points to a **Display Select** key, it is active. When active, press it to cycle through setup options.
Set Point indicators (8)	A set point indicator LED lights when its associated output is energized. Set points 1 through 4 are relay. Set points 5 through 8 are TTL.
Control	Description
Keypad:	Used as the primary method for manual control of the MPC.
0 key (disable)	To disable the keypad, press **0** four times in succession during normal mode. All keys except the **Display Select** keys are disabled.
1 key (enable)	To re-enable keypad operation, press **1** four times in succession.
3, **6**, **9** or ← key selects one of the following four program modes:	
Set Points	During normal mode, press **3** to select the *Set Points* program mode. The *Set Points* section following Table III-2, provides detailed information on this key.
Bake	During normal mode, press **6** to select the *Bake* program mode. The *Bake* section following Table III-2, provides detailed information on this key.
High Voltage Operate	During normal mode, press **9** to select *High Voltage Operate*, to allow the high voltage on/off function. The *High Voltage Operate* section following Table III-2, provides detailed information on this key.
TSP	During normal mode, press the ←(backspace) key to select the *TSP* program mode. The TSP section following this Table III-2, provides detailed information on this key.
Menu (blank key)	During normal mode, press the blank key to select the menu mode, which is a hierarchical system for setting unit parameters and preferences. When in the menu mode, use it to scroll through the menu options. Refer to Table III-3.
0 through **9** keys	When you select one of the program modes or the menu mode, use the numerical keys to enter the desired data. Press **ENTER** to save or **ESC** to exit without saving. Refer to Table III-2 and Table III-3.
← key	When in program or menu mode, use the ← (backspace) key to correct errors when keying in data.
ESC key	While in menu or program mode, use this key to escape without saving changes. When in a submenu, use it to move back up a level in the menu structure.
ENTER key	Press this key to save setup data. It is also used in menu mode to step down to the submenu.

Rear Panel Description

Figure III-2 identifies the rear panel connectors on the DIGITEL™ MPC. Connector pinouts are given in the tables below.
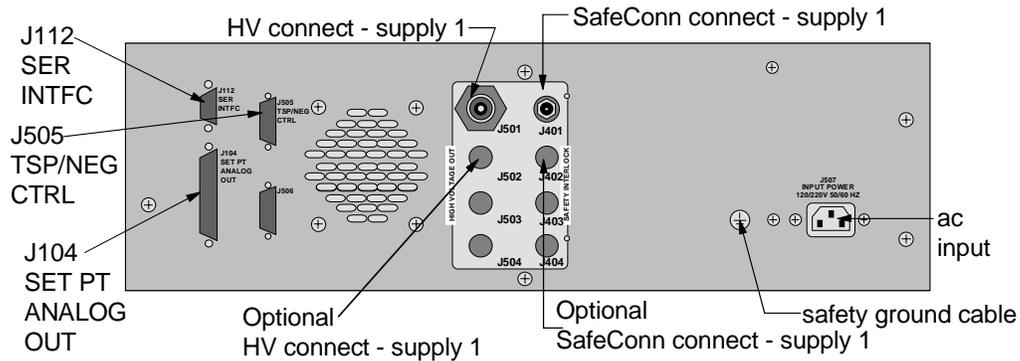
Figure III-2. Rear Panel Connectors.

J104 SET PT ANALOG OUT (a 37-pin, female Sub-D connector) provides 8 set point signals, and 4 voltage/current analog output signals.

Pin	Setpoint Signal			Pin	Analog Output Signal
1	Set Point 1 (Relay)	Common		20 … 28	Unused
2	500 mA, 28V, max.	NC		29	GND2
3		NO		30	Analog HV Supply 1 Output
4	Set Point 2 (Relay)	Common		31	GND2
5	500 mA, 28V, max.	NC		32	Analog Current Output 1*
6		NO		33	GND2
7	Set Point 3 (Relay)	Common		34	Analog Current Output 2*
8	500 mA, 28V, max.	NC		35	GND2
9		NO		36	Analog HV Supply 2 Output
10	Set Point 4 (Relay)	Common		* Can be configured for Supply 1 or Supply 2	
11	500 mA, 28V, max.	NC		current (I) output – See Analog Outputs.	
12		NO			
13, 14, 16, 18	GND1				
15	Set Point 5 (TTL), 15 mA max.				
17	Set Point 6 (TTL), 15 mA max.				
19	Set Point 7 (TTL), 15 mA max.				
37	Set Point 8 (TTL), 15 mA max.				

J505 TSP/NEG CTRL (a 15-pin, female Sub-D connector) provides the control signals for the Remote TSP/NEG Control.

Pin	Signal	Pin	Signal	Pin	Signal
1	Current Sense COM	6	SCR Trig Out	11	K2 Coil
2	SCR Trig Pull-up	7	K3 Coil	12	Not Used
3	K4 Coil	8	+15V Return	13	Current XFMR +
4	+15V to TSP	9	Current XFMR –	14	Sync Signal GND
5	Voltage Sense	10	Sync Signal from TSP	15	K1 Coil

J112 SER INTFC (a 9-pin, female Sub-D connector) routes the serial interface signals for the four serial interface protocols – RS-232, PHI (Physical Electronics), RS-485, and RS-422.

RS-232 Operation		PHI Operation		RS-485 Operation		RS-422 Operation	
DCD	1	+TX	2	+TX	2	+RX	3
RXD	2	–TX	8	–TX	8	–RX	7
TXD	3	GND	5	GND	5	GND	5
GND	5	+RX	3				
DSR	6	–RX	7				
RTS	7						
CTS	8						

Operating the Ion Pump

Ensure that the pump has been installed according to instructions supplied with it. Install the DIGITEL MPC according to its instructions.

- The DIGITEL MPC and pump must be grounded and have a safety ground strap connecting them to each other.

- The high voltage cable must be attached to the MPC and the pump.

- The proper pump size must be selected from the menu mode.

- The MPC must have the correct output polarity/voltage for the pump.

Note: More power and current are required to start larger ion pumps or pumps started at higher pressures. Use the full extent of your rough pumping before starting a pump to reduce pump wear and time to UHV, to improve system ultimate pressure, and to give the most accurate readings.

To Evacuate the Pump

Before you run an ion pump, it must be evacuated to a minimum vacuum of 1×10^{-3} Torr. Details are best obtained from the pump manual, but in general, use the following procedure.

1. Rough pump down to 1×10^{-3} Torr or less (the lower the better).

2. Ensure that contaminants do not backstream into the ion pump. If you use a mechanical pump, it must be well trapped to prevent oil back-streaming from the mechanical pump to the ion pump.

3. If an ion pump is used or has been at atmospheric pressure, it may be necessary to bakeout the pump into the roughing pump to achieve the best pressure. This is done by heating the ion pump (<300°C with magnets) for a period of several hours until heat soaked.

To Start the Pump

Use the following procedure to start the pump. If your DIGITEL MPC is configured for *POWER-LOSS restart*, high voltage starts automatically when your turn on the DIGITEL.

1. Turn on main power to the DIGITEL MPC. If in POWER-LOSS restart, go to Step 4. If in manual restart, go to Step 2.

2. Press **9** to select **High Voltage Operate**.

   2.1. To turn supply 1 on (or off), press the top **Display Select** key to toggle to the desired value.

2.2. To turn supply 2 on (or off), press the bottom **Display Select** key to toggle to the desired value.

3. Press the **ENTER** key.

NOTE: If you turn a supply ON and have not set the pump size for that supply, the display automatically goes to PUMP SIZE menu to allow you to set the value.

4. When voltage starts to rise above 700V, the pump starts. The roughing pump should be valved off at this point. If the pump starts to stall when the roughing pump is valved off (as indicated by a decrease in voltage), the roughing pump should be valved back into the system. After voltage has increased above 3000V, the display may be switched to current or pressure display (when starting the pump, the voltage display mode is more sensitive to pressure changes).

Using the Controls

Display Selection

During normal mode, Supply 1 and Supply 2 displays show either voltage, current, or pressure. Press the **Display Select** key (Figure III-3) next to each supply to cycle through these choices. Voltage is the default upon power-up, but you can change it in the Preferences menu. Refer to the pump display information in section 3, *Setting Preferences* (page 31).
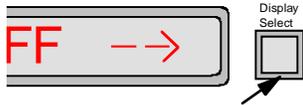
Figure III-3. DISPLAY SELECT key

Disable and Enable

If you want to disable the keypad, press the **0** key four times in succession during normal mode. All keys except the **Display Select** keys are disabled. Press the **1** key four times in succession to re-enable operation.

Keypad

The keypad (Figure III-4) consists of the following keys and are labeled:

0-9

←(backspace)

ESC

ENTER

The **3** (**Set Points**), **6** (**Bake**), **9** (**High Voltage Operate**), and ← (**TSP**) keys have program modes (Table III-2).

The **0** key four times within two seconds disables keypad operation.

The **1** key four times within two seconds enables keypad operation.

The blank key is the **Menu** mode key (Figure III-5 and Table III-3).
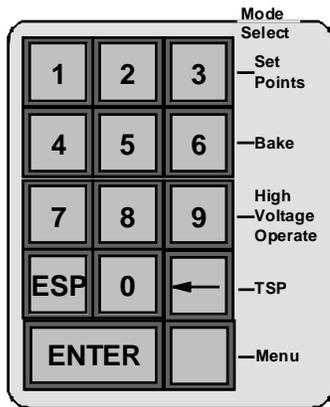
Figure III-4. Keypad.

The **Menu** key (Figure III-5 and Table III-3), which is the blank key, is a hierarchical system for setting unit parameters and preferences. Refer to section 3, *Menu Key* (page 29) for information on how to use these keys.
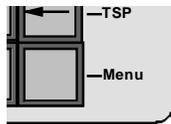
Figure III-5. Menu key.

Program Mode Keys

During normal operation, you can press the **3**, **6**, **9**, or ← key to select their program mode (**Set Points**, **Bake**, **High Voltage Operate**, and **TSP**, respectively). Press the **ESC** key anytime you want to exit a program mode without saving changes, or press **ENTER** to save the changes.
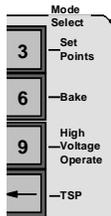
Figure III-6. Program Mode Select keys.

Table III-2. Program Mode Select Keys.

Mode	Description
Press the **3** key to select *Set Points*	With this key, you select several parameters — the set point number, what supply it should monitor (whether it should monitor a bakeout), and the on/off pressure values. With each set point parameter, if the set point has been used before, the present values are displayed. The *Set Points* section (page 22) following this table, provides detailed information on this key.
Press the **6** key to select *Bake*	With this key, you can set up your bakeout, find out how long the heaters for a current bakeout have been on, and disable a current bake. The *Bake* section (page 23) following this table, provides detailed information on this key.
Press the **9** key to select *High Voltage Operate*	This key turns high voltage to Supply 1 or Supply 2, ON or OFF using the **Display Select** key. The *High Voltage Operate* section (page 24) following this table, provides detailed information on this key.
Press the ←key to select TSP *Press ← to select TSP*, following this table, provides detailed information on this key.	Use the *Menu* key to cycle through modes of operation and parameters. **Four modes of operation**: TIMED sets the time between cycles, the number of cycles, and pressure above which the TSP operates. CONTINUOUS turns on the TSP and leaves it on, until you manually turn it off. OFF turns off the TSP and disables all modes. DEGAS is a maintenance tool. Use it to outgas your filaments if they are new or have been brought up to atmosphere. **Five setup parameters**: ACTIVE has two functions. As an information tool, the display indicates the filament number and the total amount of logged time on that filament. As a setup tool for TIMED and CONTINUOUS modes of operation, it allows you to select which filament you want to use. CLR FILMNT allows you to reset the logged time of all filaments to zero. You can do this if you DEGAS or replace a filament. This command also resets ACTIVE to the number one filament. ON TIME allows you to specify the firing time of a filament for TIMED and DEGAS operating modes. SUB LEVEL allows you to select current or power control of the TSP and specify its value. AUTO--ADVNC, if enabled, automatically switches to the next filament if an open one is detected.

Set Points

With this feature, you can establish set point parameters: the set point number, what supply it should monitor (whether it should monitor a bakeout), and the on/off pressure values. With each set point parameter, if the set point has been used before, the present values are displayed.

Procedure

1. Press **Set Points** (the **3** key). The bottom display shows 1 – 8 followed by a flashing sign to indicate that you may use the numerical keys to enter the desired set point.

2. Key in the set point number and press **ENTER**.
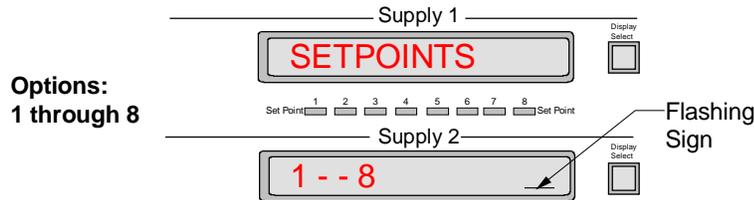
Options:
1 through 8

3. The next parameter is SPT SUPPLY. An arrow points to the bottom **Display Select** key to show it is active. Press it to cycle through the options — DISABLED, SUPPLY 1, SUPPLY 2, BAKE S1, and BAKE S2.
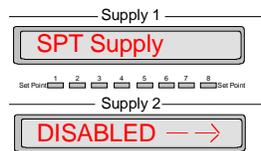
4. When you reach the desired option, press **ENTER**.

5. The next parameter is SETPT ON. The bottom display shows the current ON pressure with the number flashing to indicate that you can use the numerical keys to enter a new value (e.g. 2.0E-5 Torr).
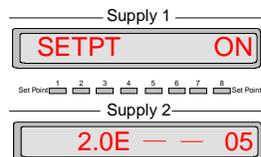
6. Key in the desired ON pressure value and press **ENTER**.

*NOTE: If you change the ON pressure, OFF pressure default is reset to: ON pressure * 1.2 (20% hysteresis)*

7. The next parameter is SETPT OFF. Key in the desired OFF pressure value and press **ENTER**. Or press ENTER for 20% hysteresis.
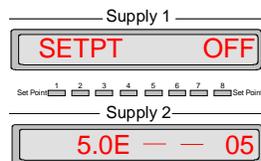
8. When the display asks you to CONFIRM, press **ENTER** to save your set point parameters or **ESC** to exit without saving changes.

After you have finished

Once the set point parameters have been saved, they are immediately applied. When pressure goes below the specified set point pressure, the set point is energized lighting the associated front panel LED. If it is above the pressure, the set point is de-energized (LED off).

To disable a set point

If you want to disable a set point,

1. press the **Set Points** key.

2. Key in the set point number, press **ENTER**,

3. press the **Display Select** key to toggle to DISABLED,

4. press **ENTER**, and press **ENTER** again to confirm.

Bake

Is the set point established?

Before you setup the bake, make sure that your set point parameters for the bakeout have been established. Once established, they are retained in memory and do not need to be re-entered.

Using the **Set Points** (**3** key), select the set point number (1-8), what supply it should monitor (BAKE S1 [supply 1] or BAKE S2 [supply 2]), and the on/off pressure values. For more information, refer to *Set Points*.

Procedure

1. Press **Bake** (the **6** key).

2. Press the lower (Supply 2) **Display Select** key to toggle between ENABLE, DISABLE, and TIME LOG. Select ENABLE and press **ENTER**.
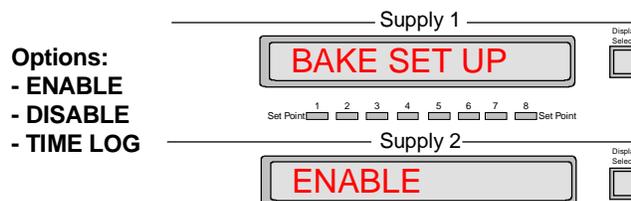
3. The next parameter is LENGTH. The bottom display shows HOURS 0, followed by a flashing sign to indicate that you may set the duration of the bake (between 0 and 255 hours). First use the backspace (←) key to overwrite, and then enter the desired duration with the numerical keys.
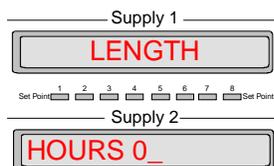
4. Press **ENTER**.

5. The next parameter is START TIME. At this point you can start the bake immediately when you press **ENTER**. Or you can change the start time, just key in all four numbers and press the **ENTER** key.

```
┌──────── Supply 1 ────────┐
│ START TIME               │
└──────────────────────────┘
Set Point 1  2  3  4  5  6  7  8  Set Point
┌──────── Supply 2 ────────┐
│        11    30          │
└──────────────────────────┘
```
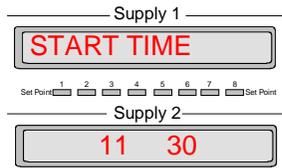
6. When the display asks you to CONFIRM, press **ENTER** to save your bake parameters or **ESC** to exit without saving changes.

After you have finished

Once the delayed bake is enabled, the display flashes "BAKE OK" for 1 second every 5 seconds. Once the bake is started, the display flashes "BAKE nn.nH" where nn.nH indicates how many hours are left in the bake. When pressure is exceeded, the bake is suspended.

How long have the heaters been on? Once your bake has started, the actual on time for the heaters is logged and can be retrieved at any time. To do this,

1. press the **Bake** key,

2. select TIME LOG with the **Display Select** key, and

3. press **ENTER**. The bottom display shows the actual on time for the heaters.

To cancel the bake

Once your bake has been enabled, if you want to cancel it,

1. press the **Bake** key,

2. press the **Display Select** key to toggle to DISABLE,

3. press **ENTER**, and press **ENTER** again to confirm.

High Voltage Operate

If the MPC is in manual restart, **High Voltage Operate** (the **9** key) allows you to enable high voltage to one or both supplies.

To apply high voltage

To apply high voltage, the following steps must be performed:

Note: If the DIGITEL MPC is in POWER-LOSS RESTART mode, do not perform Steps 3, 4, and 5.

1. Ensure that the high voltage cable is connected to both the pump and the MPC. Press the front panel main **Power** switch to 1 (1=ON).

2. If the MPC is in manual restart, press **9** to select **High Voltage Operate**. The top display shows the state of HV 1 (ON or OFF), and the bottom display shows the state of HV 2.

3. Ensure that the pump size (refer to Section 3, Setting Pump Size) has been specified.

Options:
- HV1 OFF
- HV1 ON
- HV2 OFF
- HV2 ON

```
┌──────── Supply 1 ────────┐
│ HV   1  OFF   -→         │     Display Select    Top key toggles between
└──────────────────────────┘                       ON and OFF for Supply 1.
Set Point 1  2  3  4  5  6  7  8  Set Point
┌──────── Supply 2 ────────┐
│ HV   2  OFF   -→         │     Display Select    Bottom key toggles between
└──────────────────────────┘                       ON and OFF for Supply 2.
```
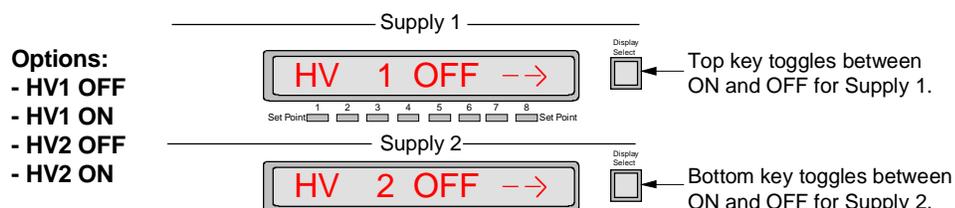
4. To turn supply 1 on (or off), press the top **Display Select** key to toggle to the desired value. To turn supply 2 on (or off), press the bottom **Display Select** key to toggle to the desired value.

5. Press the **ENTER** key.

NOTE: If you turn a supply ON and have not set the pump size for that supply, the display automatically goes to PUMP SIZE menu to allow you to set the value.

When you are finished

The **High Voltage Enable** indicator on the front panel lights when high voltage is applied for the corresponding supply.

TSP

When you press the **TSP (←)** key, TSP SETUP provides:

- Four operation modes

- Three CONFIG (setup parameters)

Use the **Menu** key to cycle through the following options.

Operation Modes

TIMED	TIMED is the main operating mode. You can set the amount of time between cycles, duration of each fire, number of cycles, and minimum pressure value for operation.
CONTINUOUS	CONTINUOUS turns the TSP on and leaves it on. Use caution when selecting this operating mode, it could blow a fuse in the Remote TSP/NEG Control unit.
ALL STOP	OFF mode turns the TSP off. It is the default operating mode when the MPC powers up.
DEGAS	DEGAS is a maintenance tool. If your filaments are new or have been brought up to air, the DEGAS operating mode conditions them.

CONFIG (Setup Parameters)

SUBLEVEL	With this parameter, you can select current or power and specify its value.
FILAMENT	Contains a submenu of options for filament operation including: SET MODE, SET ACTIVE, and CLEAR DATA which control the filament advance mode, active filament (1-4), and the filament history log reset, respectively.
DATE/TIME	Sets the date and time on the TSP controller board from the MPC date and time.

Operation Modes:

TIMED

TIMED is the main operating mode. This mode controls the amount of time between cycles, the number of cycles, and the minimum pressure value. To operate in TIMED mode, press the **TSP (←)** key. It is the first display in TSP SETUP.
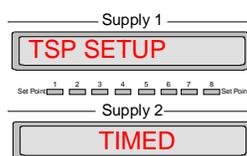
1. Before enabling TIMED mode, make sure these parameters are setup.

1.1. ACTIVE: Go to setup parameter 1 to specify the filament you want to fire first.

1.2. ON TIME. Go to setup parameter 3 to specify amounts of time the TSP fires.

1.3. SUBLEVEL. Go to setup parameter 4 to select watts/amps and specify its value.

2. Once parameters are setup, press **Menu** to cycle to TIMED. Press **ENTER** to display MINUTS, followed by a cursor to indicate that you may enter the number of minutes.

Supply 1
CYCLE EVRY
Set Point 1 2 3 4 5 6 7 8 Set Point
Supply 2
30 --
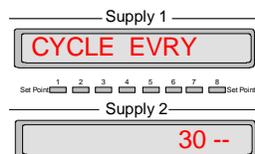
3. Use the backspace (←) key to overwrite, and enter the desired number of minutes with the numerical keys.

4. Press **ENTER** to display CYCLES. Key in the number of cycles

Supply 1
DEGAS FIL 4
Set Point 1 2 3 4 5 6 7 8 Set Point
Supply 2
25A   14.7V
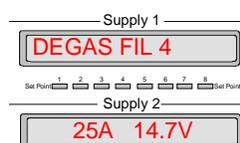
5. Press **ENTER** to display the TSP interlock pressure, the first number will flash. Key in the desired value, the TSP will operate in the TIMED mode when the ion pump pressure is above this value.

Supply 1
Display Select
IF   PRESS   >
Set Point 1 2 3 4 5 6 7 8 Set Point
Supply 2
Display Select
0.1E -- 09

Number flashes
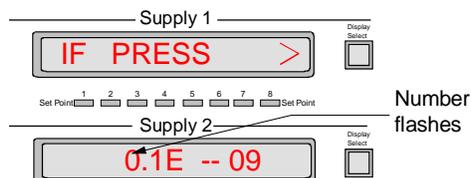
6. Press **ENTER** to enable TIMED mode.

An example of timed mode operation

If TIMED is set at 3 minutes, 8 cycles, and a minimum pressure. If SUBLEVEL is 50 amps, ON TIME is 30 sec, and ACTIVE specifies filament 2 — then FIL 2 fires immediately for 30 sec, and then fires every 3 minutes thereafter for 7 additional times, but only if pressure is above the setup value.

CONTINUOUS

CONTINUOUS mode turns the TSP on and leaves it on, until you manually turn it off. When in TSP SETUP, press **Menu** to cycle to CONTINUOUS. Press **ENTER** to display TSP ON, and press **ENTER** again to enable this mode.

Supply 1
TSP SETUP
Set Point 1 2 3 4 5 6 7 8 Set Point
Supply 2
CONTINUOUS
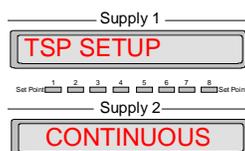
If TIMED mode is enabled and you press the **TSP** (←) key, the bottom display reads ARMED, indicating the TSP is ON. A number follows to indicate the number of cycles left. For example,

if the display reads ARMED 4, there are four cycles left and once a cycle is completed, the number decreases to three.

To turn the TSP OFF, press **Menu** to cycle to OFF. Then press **ENTER**.

```
———— Supply 1 ————
| TSP SETUP            |
Set Point 1  2  3  4  5  6  7  8  Set Point
————— Supply 2—————
|       OFF            |
```
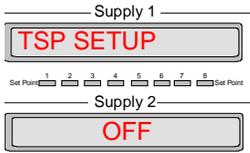
DEGAS

Use DEGAS to outgas filaments that are new or have been brought up to atmosphere.

During DEGAS mode, each filament is fired once. It uses the specified ON TIME and SUBLEVEL setup parameters, but starts firing at half the value.

For example, if current is specified at 50 amps and time at 30 seconds, then the TSP (when enabled) ramps up to 25A for the first 15 sec and then ramps up to 50A for the remaining 15-sec.

```
———— Supply 1 ————
| TSP SETUP            |
Set Point 1  2  3  4  5  6  7  8  Set Point
————— Supply 2—————
|      DEGAS           |
```
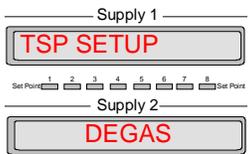
When in TSP SETUP, press **Menu** to cycle to DEGAS and press **ENTER** to enable degassing.

ATTENTION: Degas pressure should be less than 1 x 10^{-2} Torr.

While in degas mode, the display shows which filament is degassing and at what value. When DEGAS is complete, the display returns to TSP SETUP. You need to reset the filament-logged time to zero. Go to setup parameter 2, CLR FILMNT.

```
———— Supply 1 ————
| DEGAS FIL 4          |
Set Point 1  2  3  4  5  6  7  8  Set Point
————— Supply 2—————
|    25A   14.7V       |
```
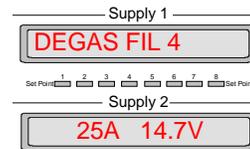
Setup parameters:

ACTIVE

The ACTIVE parameter provides two functions:

- As an information tool, the display indicates the filament number and the total amount of operating logged time.

- As a setup tool, it allows you to select which filament you want to use.

When in TSP SETUP, press **Menu** to cycle to ACTIVE.

1. Press **ENTER** to display the filament number and its total logged time.

Options:
- F1 ACTIVE
- F2 ACTIVE
- F3 ACTIVE
- F4 ACTIVE

```
———————— Supply 1 ————————              Display
                                        Select
|       F2 ACTIVE            |            □
Set Point 1  2  3  4  5  6  7  8  Set Point   arrow shows
———————— Supply 2————————              bottom key is active
                                        Display
                                        Select
|    14  MIN      – —>       |            □    press to toggle
                                              between options
```
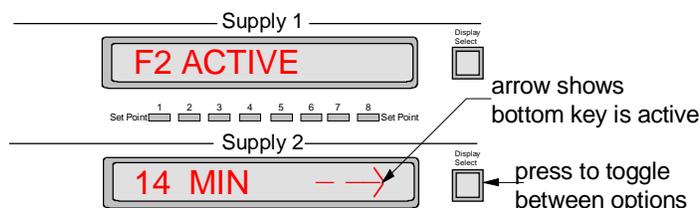
2. An arrow points to the bottom **Display Select** key to show it is active. Press it to cycle through the options: F1 ACTIVE, F2 ACTIVE, F3 ACTIVE, F4 ACTIVE.

3. When you reach the desired filament, press **ENTER** to save your selection or press **ESC** to exit without saving changes.

CLR FILMNT

If you degas filaments or install new ones, use CLR FILMNT to reset their status to OK (not open) and their operating logged time to zero. Entering 0 resets all four filaments.

When in TSP SETUP, press **Menu** to cycle to CLR FILMNT.

Press **ENTER**. When the display asks you to confirm, press **ENTER** to clear the filaments or press **ESC** to exit without clearing filaments.

```
──────── Supply 1 ────────
TSP SETUP
Set Point ▭ ▭ ▭ ▭ ▭ ▭ ▭ ▭ Set Point
         1  2  3  4  5  6  7  8
──────── Supply 2 ────────
CLR  FILMNT
```
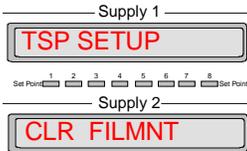
ON TIME

This parameter specifies the on firing time of a filament for TIMED and DEGAS operating modes. For example, if you specify 30 sec ON TIME (in TIMED mode), then the TSP operates for 30 sec before it shuts off.

```
──────── Supply 1 ────────
TSP SETUP
Set Point ▭ ▭ ▭ ▭ ▭ ▭ ▭ ▭ Set Point
         1  2  3  4  5  6  7  8
──────── Supply 2 ────────
ON TIME
```
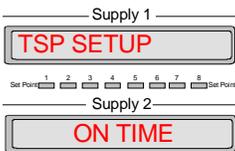
When in TSP SETUP, press **Menu** to cycle to ON TIME.

1. Press **ENTER**. The bottom display shows the on time in seconds followed by a flashing sign.

Options:
0 through 999 sec

```
──────── Supply 1 ──────── Display Select
TSP SETUP                    ▢
Set Point ▭ ▭ ▭ ▭ ▭ ▭ ▭ ▭ Set Point  ─ flashing
         1  2  3  4  5  6  7  8          sign
──────── Supply 2 ──────── Display Select
SEC  ON   50 ∠               ▢
```
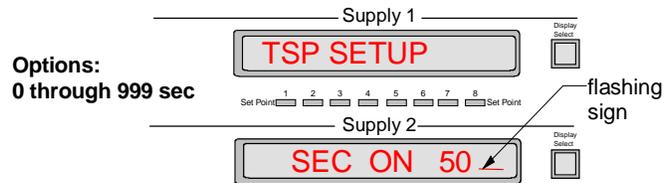
2. Use the backspace (←) key to overwrite, and enter the desired value (0-999) with the numerical keys. Press **ENTER** to save the changes.

SUB LEVEL

For TSP control, you need to select constant current (amps) or constant power (watts) and specify its value.

```
──────── Supply 1 ────────
TSP SETUP
Set Point ▭ ▭ ▭ ▭ ▭ ▭ ▭ ▭ Set Point
         1  2  3  4  5  6  7  8
──────── Supply 2 ────────
SUBLEVEL
```
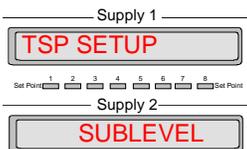
When in TSP SETUP, press the **Menu** key to cycle to SUB LEVEL.

1. Press **ENTER**. An arrow points to the top **Display Select** key to show it is active. Press it to toggle between AMPS and WATTS.

Options:
- AMPS
- WATTS

Supply 1 — AMPS — →

Display Select — press to toggle between options

arrow shows bottom key is active

Supply 2 — SUBLEVEL
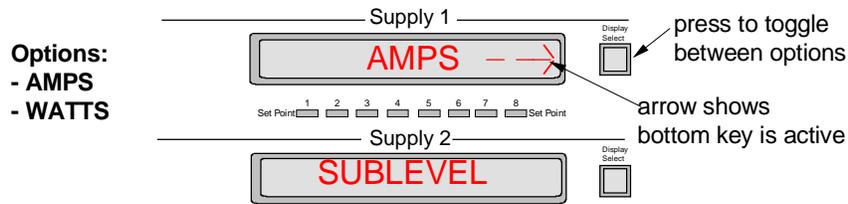
2. When you reach the desired option, press **ENTER**.

3. The bottom display shows the value followed by a flashing sign. Use the backspace (←) key to overwrite, and enter the desired value (0-75 for amps or 0-500 for watts) with the numerical keys.

Options:
- 0 to 75 amps
- 0 to 500 watts

Supply 1 — TSP AMPS

Supply 2 — 50 _

flashing sign
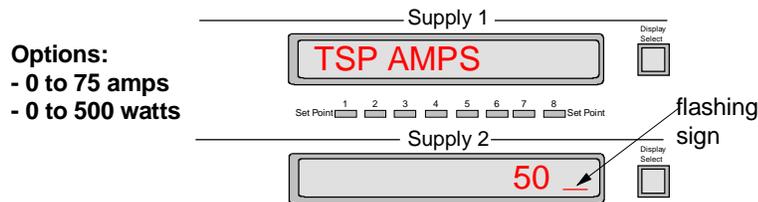
4. Press **ENTER** to save your changes.

AUTO--ADVNC

AUTO--ADVNC, when set to YES, automatically switches to the next filament if an open filament is detected.

Supply 1 — TSP SETUP

Supply 2 — AUTO--ADVNC
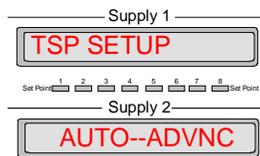
When in TSP SETUP, press the Menu key to cycle to AUTO--ADVNC.

1. Press **ENTER**. An arrow points to the bottom **Display Select** key to show it is active.

Options:
- YES
- NO

Supply 1 — AUTO--ADVANCE

arrow shows bottom key is active

Supply 2 — YES — →

press to toggle between options
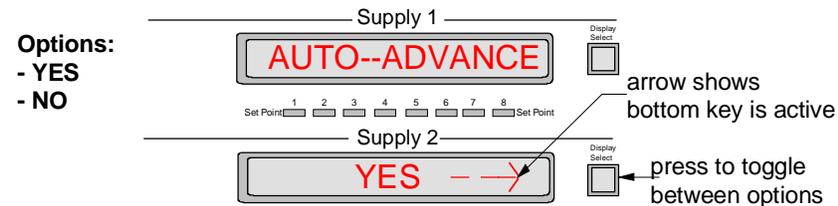
2. Press it to toggle between YES and NO.

3. When you reach the desired option, press **ENTER**.

Menu Key

The **Menu** key (blank key) is a hierarchical system (Table III-3) for setting unit parameters. After you press **Menu**, the top display shows the first menu selection.
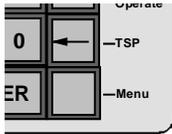
1. Press **Menu** to step through each top menu selection.

2. Use the **ENTER** key to step to a sub menu.

3. Then use **Menu** to step through each submenu selection.

4. Press **ESC** to step back up to the top menu.

Table III-3. Menu Hierarchical System.

Menu Structure	Description
PUMP1 SIZE PUMP2 SIZE	Specifies pump size in liters per second that is connected to each supply. This value must be either 0 (no pump connected) or between 10 and 1200. Default is 0.
PREFRENCES:	The following sub-menus are available in the PREFRENCES menu.
PRES UNITS	Selects pressure units to use: Torr, mBar, or Pascal. Default is Torr.
PUMP DSPLY	Selects voltage, current or pressure for each display. Default is voltage.
ANALOG 1 OUT MODE	Selects analog current/pressure output mode for supply 1.
ANALOG 2 OUT MODE	Selects analog current/pressure output mode for supply 2.
CONFIG:	The following sub-menus are available in the CONFIG menu.
FAN ON/OFF	You can set the fan to off or full speed.
POWER LOSS	If yes is chosen, both pumps start up automatically upon power up.
SERIAL ADR	Specifies which serial address to use for the Physical Electronics Serial Communications Protocol. Default is 5.
BAUD RATE	Baud rate of 9600 is available.
SET CLOCK	Allows you to set the time and date of the real time clock.
SPLY1 SIZE SPLY2 SIZE	Indicates what supply option is installed for supply 1 and supply 2: medium, large, or none.
PUMP 1 CAL PUMP 2 CAL	Pumps have a calibration factor that is multiplied by pressure to increase or decrease it. Acceptable factors are between 0.00 and 9.99. Default, 1.00.
SUPPLY1 KV SUPPLY2 KV	Indicates what output voltage the high voltage transformer is set to (for supply 1 and 2), 5600 or 7000.
PRM FACTOR	Informs the firmware of line voltage setting, 120 or 240.
DIAGNOSTCS:	Most of the following diagnostics can be used in the field.
REVISION	Displays the current firmware revision.
ERROR CODE	Display 1 shows last error code for pump 1 and display 2, pump 2.
DISPLY/KEY	Tests all displays, LEDs, and keys.
CALIBRATION	A self-calibration of the current offset for both supplies.
RST DFLTS	Resets most options to their default values.
LINE FREQ	Indicates the present line frequency.

Setting Pump Size

In order to start the pump, you need to specify the pump size (between 10 and 1200 in liters per second). Use the following procedure

Note: If an attempt is made to start a pump and the pump size is not specified, this menu option is automatically brought up and displayed. You must then set the pump size in order to start the pump.

1. After you press **Menu**, the top display shows PUMP1 SIZE.

2. Press the **ENTER** key.   The bottom display shows the current pump size in liters per second (l/s), followed by a flashing sign to indicate that you may use the numerical keys to enter the pump size.

3. First use the backspace (←) key to overwrite, and then enter the desired pump size with the numerical keys.

4. Press **ENTER** to save the changes.

5. Press the **Menu** key to select PUMP2 SIZE.

6. Repeat Steps 2, 3, and 4.
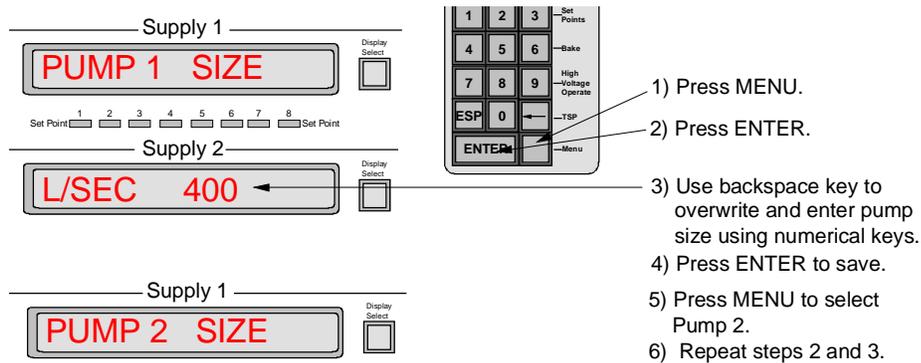
Figure III-7. Setting pump size.

Setting Preferences

Overview

Press the **Menu** key to cycle through the top menu selections until you reach PREFRENCES. Press **ENTER** to step to its submenu. Press the **Menu** key to cycle through the following submenu selections:

- PRES UNITS

- PUMP DSPLY DFAULT VAL

Press **ESC** to exit the submenu and return to PREFRENCES.
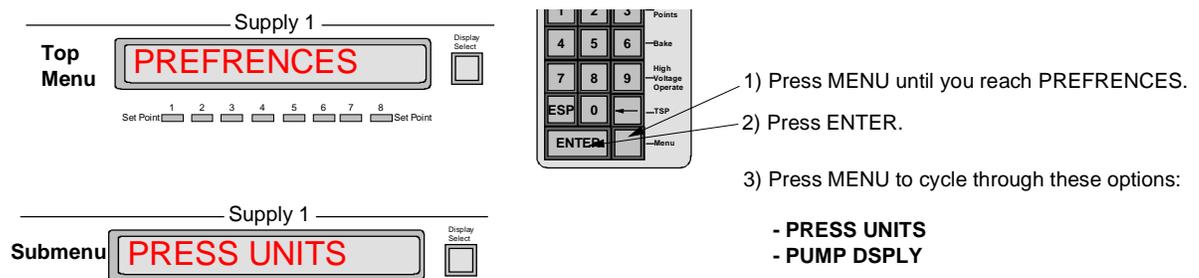
Figure III-8. Reaching PREFRENCES Submenu.

PRES UNITS

You can specify the default pressure units to display: Torr, mbar, or Pascal. The bottom display shows the units presently in use.

NOTE: This procedure does not change set point or TSP pressure values. For example, if you have 1.5 mbar and change to Torr, then you have 1.5 Torr.

1. Press the **Menu** key to cycle through the menu until you reach PREFRENCES.

2. Press **ENTER** to step to the submenu selection PRES UNITS.

3. Press **ENTER** again to display the units.

4. An arrow points to the bottom **Display Select** key to show it is active. Press it to cycle through the unit options — TORR, MBAR, and PASCAL.
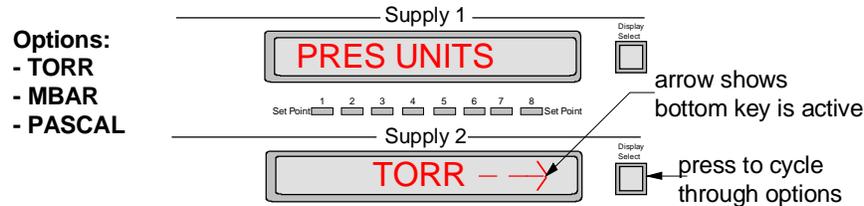
5. When you reach the desired option, press **ENTER** to save your selection.

PUMP DSPLY - DFAULT VAL

You can specify the default display in voltage, current or pressure for Supply 1 and Supply 2 displays.

1. Press the **Menu** key to cycle through the menu until you reach PREFRENCES.

2. Press **ENTER** to step to the submenu, and press the Menu key to cycle to PUMP DSPLY.

3. Press **ENTER**.

4. An arrow points to the bottom **Display Select** key to show it is active. Press it to cycle through the unit options — VOLTAGE, CURRENT, and PRESSURE.
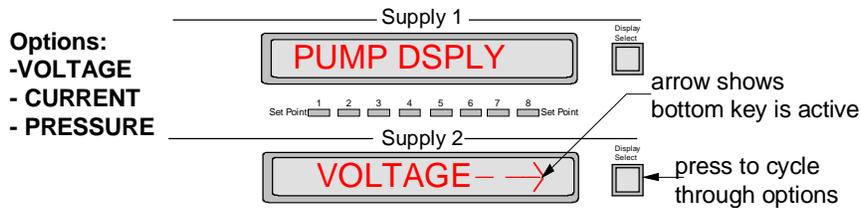
5. When you reach the desired option, press **ENTER** to save your selection.

Setting Configurations

Overview

Press the **Menu** key to cycle through the top menu selections until you reach CONFIG. Press **ENTER** to step to its submenu. Press the **Menu** key to cycle through the following 12 submenu selections:

- FAN ON/OFF

- POWER-LOSS RESTART

- SERIAL ADR

- BAUD RATE

- SET CLOCK

- SPLY1 SIZE

- SPLY2 SIZE

- PUMP1 CAL FACTOR

- PUMP2 CAL FACTOR

- SUPPLY1 KV

- SUPPLY2 KV

- PRM FACTOR

Press **ESC** to exit the submenu and return to CONFIG.
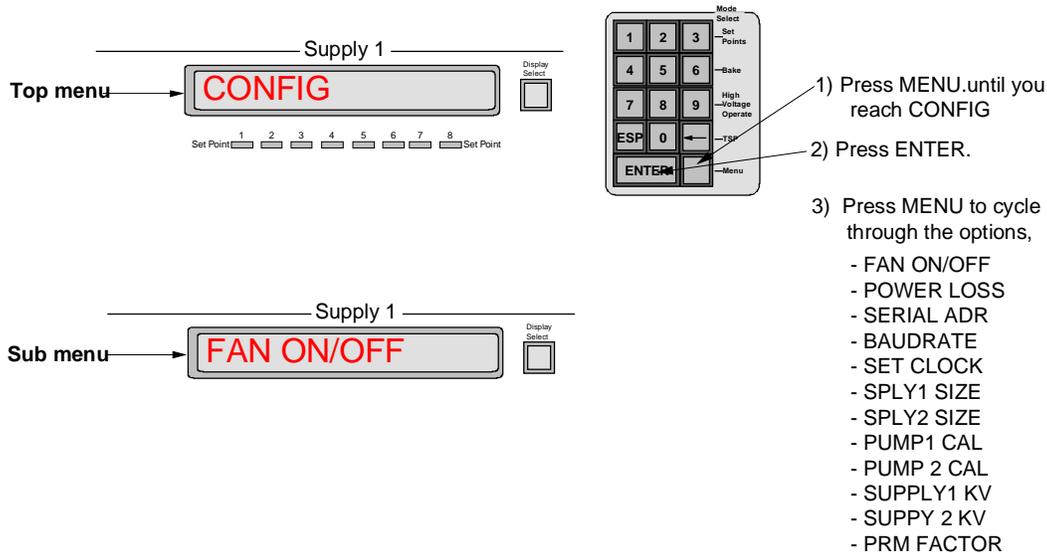
Figure III-9. Reaching the Configuration Submenu.

FAN ON/OFF

Use the following procedure to set the fan to off or full speed. If you set the fan to off, the next pump start-up sequence turns it back on. If the pump draws high current, the fan automatically restarts.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu selection FAN ON/OFF.

3. Press **ENTER** again.

4. An arrow points to the bottom **Display Select** key to show it is active. Press it to toggle between ON and OFF.
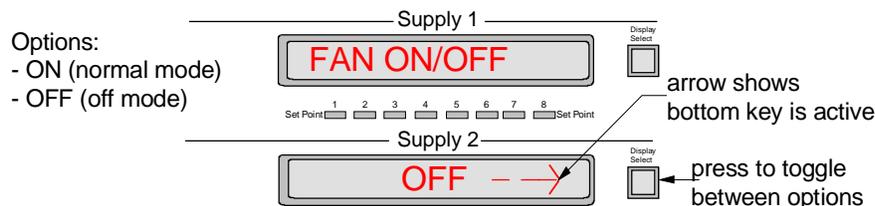
5. When you reach the desired option, press **ENTER** to save your selection.

POWER-LOSS RESTART

You can choose yes or no to have both pumps start automatically after a power loss.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the **Menu** key to cycle to POWER-LOSS.

3. Press **ENTER**.

4. An arrow points to the bottom **Display Select** key to show it is active. Press it to toggle between Yes and No.
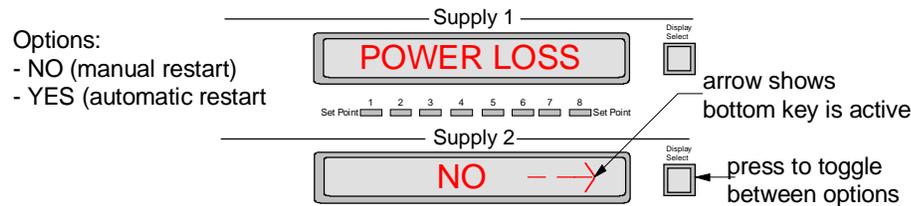
5. When you reach the desired option, press ENTER to save your selection.

SERIAL ADR

You can choose which serial address to use for serial communications. Default is 5.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the **Menu** key to cycle to SERIAL ADR.

3. Press **ENTER**. The bottom display shows the current address followed by a flashing sign to indicate that you may key in a new address (0 – 255).
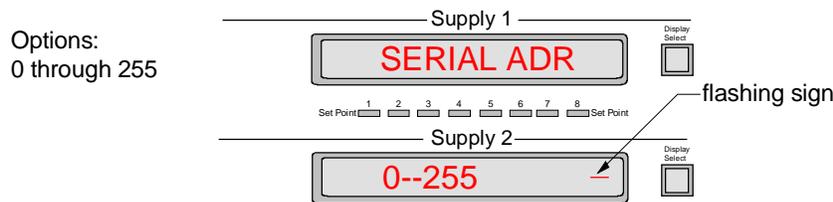
4. First use the backspace (←) key to overwrite, and then enter the desired address with the numerical keys.

5. Press **ENTER** to save the changes.

BAUD RATE

You can select the baud rate to use: 9600, 4800, 2400, 1200, or 300. The default is 9600. Baud rate can be decreased to allow communication through longer serial cables.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the **Menu** key to cycle to BAUD RATE.

3. Press **ENTER** again to display the rate.

4. An arrow points to the bottom **Display Select** key to show it is active. Press it to cycle through the baud rate options — 9600, 4800, 2400, 1200, or 300.

Options:
- 9600
- 4800
- 2400
- 1200
- 300
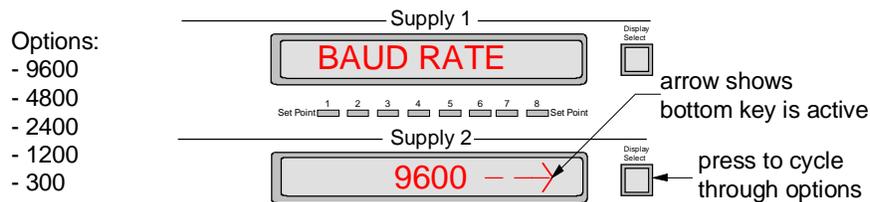
5. When you reach the desired option, press **ENTER** to save your selection.

SET CLOCK

You can set the time and date of the clock. The values must be stepped through one at a time: hours, minutes, day, and date. For each value, the current data is displayed along with a flashing sign. Press **ENTER** to accept these values, or use the backspace (←) and numerical keys to key in a new value and then press **ENTER**.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the Menu key to cycle to SET CLOCK.

NOTE: When you press ENTER in step 3 the display will momentarily flash the battery status.

3. Press **ENTER**. The bottom display shows the hour setting followed by a flashing sign to indicate that you may enter the desired hour (0-23) using the backspace and numerical keys.

4. Press **ENTER** to save the hour value. The bottom display now shows the current minute setting.
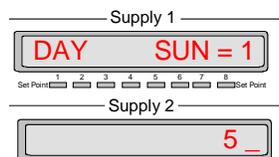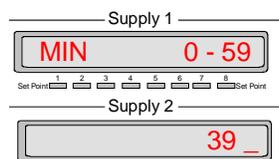
5. Use the backspace and numerical keys to enter the minute value (0-59).

6. Press **ENTER** to save the minute value. The bottom display now shows the current day setting.

7. Key in the day: 1 through 7 where Sunday=1, Monday =2, and so on. Press **ENTER** to save.

8. You can now set the correct date:

   8.1. Key in the day of the month and press **ENTER** to save.

   8.2. Key in the month and press **ENTER** to save.

   8.3. Key in the year and press **ENTER** to save.

9. Press the top **Display Select** key (YES) to save changes, or the bottom **Display Select** (NO) to exit without saving changes.

SPLY1 SIZE / SPLY2 SIZE

To display the supply option installed (large, medium or none) for supply 1 and supply 2, use the following procedure.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the **Menu** key to cycle to SPLY1 SIZE.

3. Press the **ENTER** key. The bottom display shows the pump option installed for supply 1.

Options:
- LARGE
- MEDIUM
- NONE
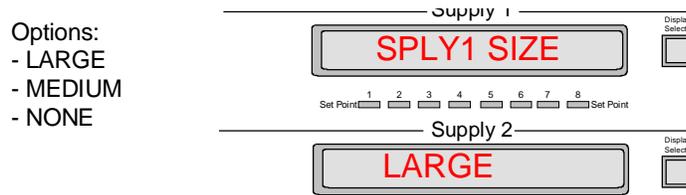
4. Press the **Menu** key twice to select SPLY2 SIZE, and press **ENTER**. The bottom display shows the pump option installed for supply 2.

PUMP 1 CAL FACTOR / PUMP 2 CAL FACTOR

Each pump has a calibration factor. This factor is multiplied by pressure to increase or decrease it. You need to specify an acceptable factor between 0.00 and 9.99. Use the following procedure.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the **Menu** key to cycle to PUMP 1 CAL FACTOR.

3. Press the **ENTER** key. The bottom display shows the calibration factor with the first number flashing.

Number flashes.
Enter cal using
the keypad.
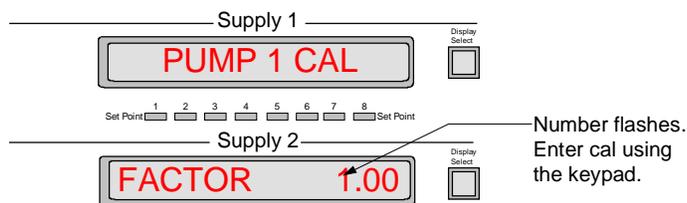
4. Key in a new value and press **ENTER** to save the changes.

5. Press the **Menu** key to select PUMP 2 CAL FACTOR.

6. Repeat Steps 3 and 4.

SUPPLY1 KV / SUPPLY2 KV

To display what voltage is strapped to the high voltage transformer for supply 1 and 2 (5600 or 7000), use the following procedure.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the **Menu** key to cycle to SUPPLY1 KV.

3. Press the **ENTER** key. The bottom display shows the voltage strapped to supply 1.

4. Press the **Menu** key twice to select SUPPLY2 KV, and press **ENTER**. The bottom display shows the voltage strapped to supply 2.

PRM FACTOR

To display what line voltage the DIGITEL MPC is set to, you need to specify it — 120 or 240. Use the following procedure.

ATTENTION: Setting the PRM FACTOR merely informs the software how the MPC is configured, it does not configure it.

1. Press the **Menu** key to cycle through the menu until you reach CONFIG.

2. Press **ENTER** to step to the submenu and press the **Menu** key to cycle to PRM FACTOR.

3. Press the **ENTER** key.

4. An arrow points to the bottom Display Select key to show it is active. Press it to toggle between 120 and 240.
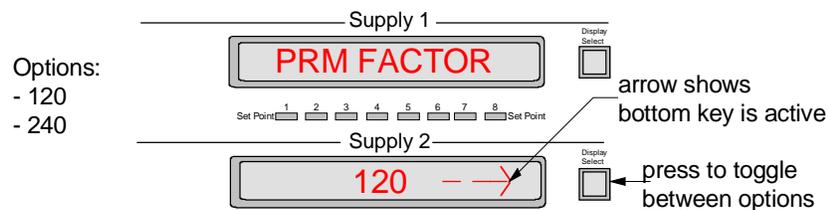
5. When you reach the desired option, press **ENTER** to save your selection.

Running Diagnostics

Overview

Press the **Menu** key to cycle through the top menu selections until you reach DIAGNOSTCS. Press **ENTER** to step to its submenu. Press the **Menu** key to cycle through the following 6 submenu selections:

- REVISION

- ERROR CODE

- DISPLY/KEY

- CALIBRATION

- RST DFLTS

- LINE FREQ

Press **ESC** to exit the submenu and return to DIAGNOSTCS.
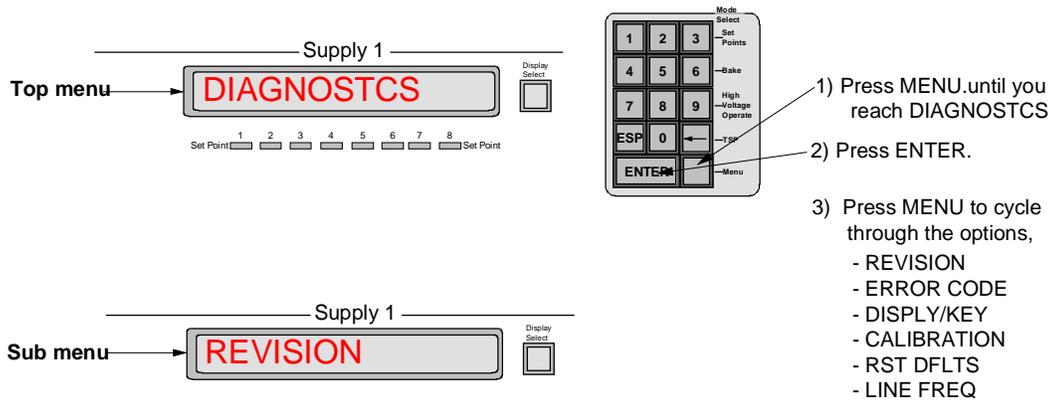
Figure III-10. Reaching the DIAGNOSTCS Submenu.

REVISION

The first diagnostic submenu item is REVISION. Press **ENTER**, the bottom display shows the revision level of the firmware/software.
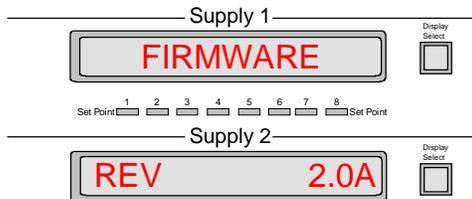
ERROR CODE

Table III-4 provides a list of error codes and their meanings. Here is how you get there.

1. From DIAGNOSTCS, press **ENTER** to step to its submenu.

2. Press the **Menu** key to cycle to ERROR CODE.

3. Press **ENTER**.

Display 1 shows the last error code for pump 1.

Display 2 shows the last error code for pump 2.

Table III-4. Error Codes.

Error	Description
00	No errors.
01	Too many cool down cycles. The MPC makes three attempts to start a pump. Cool down can be reached for various reasons. See codes 05, 06, and 07.
02	Running pressure too high. Pressure of a started pump climbed above 1.0 E-04 Torr for more than 1 second.
03	Running primary current too high. Current of a started pump climbed to a level that was too high for either the pump or the supply.
04	Running pressure too high. Pump pressure that is in the process of starting, climbed above 1.0 E-04 Torr.
While in cool down, the code will be 05, 06, or 07 to let you know the reason for cool down.	
05	Pump power. Cool down was entered because pump power exceeded a safe value.
06	Supply current. Cool down was entered because the current from the supply exceeded a safe value.
07	Short circuit. Cool down was entered because the supply output was a short circuit.
08	Supply malfunction. Possibly a blown fuse.
09	Voltage too low. HV was shut down because HV dropped below 1200V.
10	Arc detect circuit determined an over current condition occurred.

DISPLY/KEY

This submenu selection allows you to test the display, keypad, and LEDs.

1. From DIAGNOSTCS, press **ENTER** to step to its submenu.
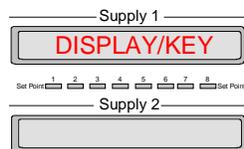
2. Press **Menu** to cycle to DISPLY/KEY.

3. Press **ENTER** to test the display. Both displays show alpha-numeric characters. Press **ENTER** again to test the remaining characters.
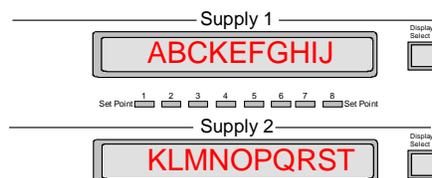
4. Press **ENTER** to test the keypad.

KEY TEST

Display Select

Set Point 1 2 3 4 5 6 7 8 Set Point

Supply 2

ESC LAST

Display Select
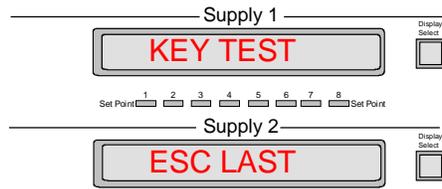
5. As you press each key to test it (press the **ESC** key last), the key is displayed on the bottom display. Some keys are displayed as they are. Other keys (the **ENTER** key for example) are displayed as symbols. The keys are displayed as follows:

Keys	Displayed As
1, 2, 3, 4, 5, 6, 7, 8, 9, 0	1, 2, 3, 4, 5, 6, 7, 8, 9, 0
Backspace (←) key	←
ENTER	→
Menu (blank) key	M
Display Select 1 key	A
Display Select 2 key	B

6. Press **ESC** to exit the keypad test and enter the LED test. The MPC first tests the ODD LEDs.

Leds flash as they are tested.

Set Point 1 2 3 4 5 6 7 8 Set Point

7. Press **ENTER** again test ALL LEDs.

8. Press **ENTER** again test EVEN LEDs.

9. Press **ESC** to return to the DISPLY/KEY submenu. Press **ESC** again to step up to DIAGNOSTICS.

CALIBRATION

For the calibration procedure remove the HV cables from the rear panel of the DIGITEL MPC.

1. From DIAGNOSTCS, press **ENTER** to step to its submenu. Press **Menu** to cycle to CALIBRATION.

2. Press **ENTER** to start calibrating the MPC. A momentary message "TURNING SUPLYS OFF" appears to let you know that the MPC is turning off the supplies.

3. Press **ENTER** to display the first instruction, which reminds you to remove the HV cables.

4. Press **ENTER** to display next instruction.

Options:
- CAL YES
- CAL NO

Supply 1

CAL YES →

Display Select

Set Point 1 2 3 4 5 6 7 8 Set Point

Supply 2

CAL NO →
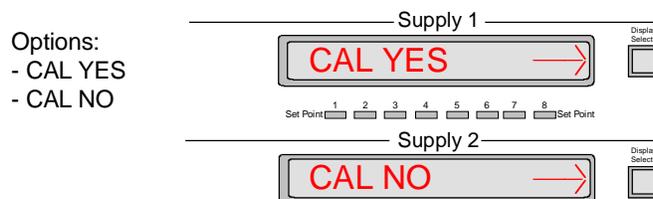
Display Select

5. Press the top **Display Select** key to calibrate the MPC. If you don't wish to calibrate at this time, press the bottom **Display Select** key to exit.

RST DFLTS

RST DFLTS allows you to clear supply calibration, disable all setpoints, and reset pump cal factor to zero.

1. From DIAGNOSTCS, press **ENTER** to step to its submenu.

2. Press **Menu** to cycle to RST DFLTS.

3. Press **ENTER** to display RESET DEFAULTS.

4. Press **ENTER** again.

5. Press **ENTER** a third time to confirm, or **ESC** to exit without resetting defaults.

LINE FREQ

1. From DIAGNOSTCS, press **ENTER** to step to its submenu. Press **Menu** to cycle to LINE FREQ. Press **ENTER** to display the line frequency.

Display Messages

Status messages that appear on a display assist you in the operation of the DIGITEL MPC. Most of these messages occur immediately after a function key is pressed. Table III-5 provides a description these messages.

Table III-5. Display Messages.

Status	Description
STANDBY	STBY command received from computer interface or keypad (**High Voltage Operate** key) was placed into standby by the remote STBY input on the set point option. High voltage is shut off.
SAFE-CONN	The SAFE-CON cable is not connected properly.
COOL DOWN	The DIGITEL MPC has entered cool-down mode. As long as it is in cool-down, this message remains on the display. After 3 cool-downs, the DIGITEL goes into STANDBY.
PUMP ERROR	The pump has shut down. Go to the DIAGNOSTCs submenu, ERROR CODE.

Event Log

General Description

The Event Log will store information in the CPU Board external FLASH whenever a significant "event" occurs. These events are mostly errors, such as supply over-current, short circuit detection, or cool down cycles. The log is setup as a circular buffer containing up to 2048 events. When the buffer is full, the earliest 256 events are erased to make room for new events. Events can be read via the front panel display or via the serial port. An event contains the following information:

1. The pump the error occurred on.

2. The type of error that occurred.

3. The date and time the event occurred.

4. The supply voltage and current at the time of the event.

5. The supply size and specified pump size.

6. The number of over-current cycles and number of cool down cycles.

Front Panel Display of Events

Each event is displayed in five parts (Table III-6). Each part files the dual 10 character display.

Table III-6. The Five Parts of the Event Record.

Part	Format		Description
1.	EVNT n	>	e is the event number
	PMP n ee	<	n is the effected pump, and ee is the error code (see section ERROR CODE on page 39)
2.	mm/dd/yy	>	mm is month, dd is day, yy is year that the event occurred
	hh mm ss	<	hh is hour, mm is minute, ss is second that the event occurred
3.	nnnn V	>	nnnn is the high voltage when the event occurred
	n.nn –ee A	<	current when the event occurred
4.	xxx nn	>	xxx is either LRG or MED for supply size, nn is pump size in liters per second
	n c	<	n is number of arcs, c is number of cool down cycles
5.	n 0	>	is the pump state, 0 is data reserved for future use
	0 0	<	*for future use*

Serial Port Output of Events

The serial port merely combines both display lines into a single line, and puts out 5 lines.

Analog Outputs

Two analog outputs (voltage and current/pressure) from each high voltage (HV) supply are provided at **J104 SET PT ANALOG OUT**, a 37-pin SUB-D connector on the rear panel of the DIGITEL MPC.

Voltage measuring

HV supply outputs 1 and 2 provide 0 to 10 volt signals with a scale factor of 1V/1000V output voltage. To obtain ion pump voltage, measure voltage at **J104** located on the rear panel of the DIGITEL MPC. Use the following table.

HV Supply Outputs 1 and 2

Measure Pins	Output	Scale Factor
+30, 29 (Gnd) at **J104**	HV Supply 1	1V/1000V
+36, 35 (Gnd) at **J104**	HV Supply 2	1V/1000V

Current measuring

Analog current/pressure outputs 1 and 2 are computer controlled for maximum flexibility. These outputs provide signals that are proportional to pump current or pressure. The computer allows selection of eight output modes via the front panel keypad (PREFERENCES menu) or through serial port commands. Jumpers on the internal CPU board assembly allow selecting positive or negative outputs. Connector **J13** configures current/pressure analog output 1 and connector **J8** configures output 2. Jumper pins 3 to 4 and 5 to 6 for positive output or 1 to 2 and 4 to 6 for negative output. The following tables summarize these outputs.

Current and Pressure Outputs 1 and 2

Measure Pins	Output
+32, 31 (Gnd) at **J104**	Supply 1
+34, 33 (Gnd) at **J104**	Supply 2

Analog Current Output Modes

Mode	Range	Scale Factor	
Press Log	1E-4 – 1E-10	Logarithmic	Volts out = log(pressure) + 10.0V
Curr Log	0 – 1 Amp	Logarithmic	Volts out = log(current) + 8.0V
Curr 1uA	0 – 10uA	1uA per Volt	
Curr 10uA	0 – 100uA	10uA per Volt	
Curr 100uA	0 – 1mA	100uA per Volt	
Curr 1mA	0 – 10mA	1mA per Volt	
Curr 10mA	0 – 100mA	10mA per Volt	
Curr 50mA	0 – 500mA	50mA per Volt	
Note: All modes are 0 – 10Vdc out.			
Note: Pressure units are the same as selected for the display.			

High Voltage/TSP Filament Interlock Option

The remote interlock allows disabling of the high voltage outputs or TSP filament firing (if TSP option is installed). The interlock is installed at **J506** (on the back panel of the MPC) if the option is installed.
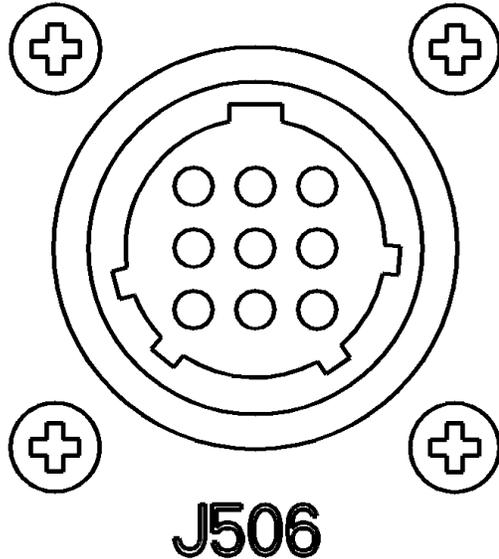
Figure III-11. Line drawing of the optional interlock connector J506.

The interlock is configured to enable both high voltage outputs when the loopback plug (PN 380082) is attached. The user may install external interlock switches using the extra connector kit provided with the interlock option. To enable high voltage: short pins 1 to 3 and 7 to 9 for output one and output two (if available) respectively. To enable the TSP (if installed): short pins 2 to 4 and 6 to 8.

Serial Interface

TIA/EIA RS-232/422/485 are electrical standards specifying hardware requirements for a serial communications interfaces. The standard specifies a bi-directional (half duplex), multi-point interface, allowing multiple devices to be connected to the same serial port on a computer. The standard does not set up or address any software protocols. A carefully planned protocol for use between the remote devices and the controlling computer allows devices manufactured by different companies to function on the same port, even if they do not use the same protocol. This section lays out a standard protocol for use on any future PHI (Physical Electronics) instruments that use the standard, and makes recommendations regarding hardware design in areas where software performance may be affected.

Standard

The interface consists of a differential (balanced) twisted wire pair that is connected to all devices on that serial port. This makes the interface fairly immune to electrical and RF (radio frequency) noise generated in the vicinity. All units on the same port must be configured for the same baud rate.

Devices cannot send data until they have been addressed by the controlling computer. A typical command exchange for a device would be:

1. The computer sends a command.

2. Devices read the address.

3. When a device recognizes its address, it decodes the message and returns an acknowledgement to the computer, along with any data that was requested.

Specifics

The serial communications port settings such as number of data/start/stop bits, parity, etc. are defined in (Table I-1. Specifications DIGITEL MPC.). Every communications exchange between the controlling computer and a PHI unit using the standard interface consists of a command packet (sent by the controlling computer), and a response packet (returned by the remote unit). All characters in these packets are ASCII. All fields are separated by a space (not required between the checksum and terminator). Hexadecimal numbers can be represented in either upper or lower case.

Cabling

The MPC functions as DTE (Data Terminal Equipment). When the MPC will be connected to another DTE (such as a personal computer), a null modem serial cable is required to connect the devices. The null modem cable swaps the signal and control lines so that receive and transmit are properly connected. The MPC is equipped with a nine-pin female (DCE) D-sub connector (Table IV-8, page 61) protruding from the chassis rear.

RS-485 allows communications over greater distances but most personal computers are equipped with 9 or 25 pin RS-232 serial connectors. RS-485 cables can be as long 1220 meters (4000 ft.) while RS-232 lines are typically limited to between 15 and 30 meters (50 - 100 ft.). RS-422 is possible for Apple's Macintosh computers which utilizes this protocol. Protocol configuration is accomplished by DIP switch settings according to Table IV-9 (page 63).

Maximum operating baud rate is determined by cable length and the environment near the cable. External noise sources and line loss degrade the signal. Twisted-pair cable should be used with signal wires twisted with ground wires. Shielded cables also decrease the maximum transmission length but may be required for (electrically) noisy environments. The baud rate should be adjusted (BAUD RATE, page 34) on the MPC to ensure viable communication.

Command packet

The command packet (Table III-7) is made up of at least five fields and contains information needed for a remote unit to perform a command. The minimum command packet (single command with no data) is 11 bytes long and consists of the following fields.

\<START CHAR\>	\<space\>	\<ADDRESS\>	\<space\>	\<COMMAND\>	\<space\>	\<CHECKSUM\>	\<TERMINATOR\>
1 byte	1 byte	2 byte	1 byte	2 byte	1 byte	2 byte	1 byte

Table III-7. Serial Command Packet Description.

Field	Size	Comment
1. START character	1 character (byte)	ASCII character is '~' (TILDA)
Start is the first byte in the command packet and tells remote units to start decoding a message. It should be implemented as a #define, so that it can be changed if necessary. As a #define, the character is rarely changed because it is hard coded into PHI remote units.		
<SPACE>		
2. ADDRESS	2 hex characters	Range 00 through FF
This field should be filled in with the hexadecimal representation of the integer address of the unit. The range provides 255 unique addresses for PHI controls. Only 32 devices may reside on the same serial port due to hardware loading limitations.		
<SPACE>		
3. COMMAND CODE	2 hex characters	Range 00 through FF
This field is one of 255 possible hexadecimal numbers, which is typically an index into a table of functions on the remote unit. Commands should be implemented as #defines with integers between 0 and 255. The integer value must be converted into ASCII hex before placement into the command packet character array. The command code must be two hex digits, even if the first is a zero. See Table III-8.		
<SPACE>		
4. DATA field(s), optional	as needed	ASCII printable characters only
Data field(s) are for any commands that have a data value. For instance, a command to set a beam voltage in some unit would probably consist of a command to set the beam voltage, along with a value of beam voltage. If the command had more than one data value associated with it, such as setting an X and a Y value in a unit, the command field could be followed by two data fields (X and Y) separated by a space between them. All data must be sent in ASCII printable format (no binary or "control" characters). There is no limit on the number or size of data fields. It is up to the remote unit designer to keep practicality in mind when determining these fields. A data field is not required for all commands.		
<SPACE>		
5. CHECKSUM	2 hex characters	Computed checksum of packet
The calculated checksum must have its value in ASCII hexadecimal notation. It is calculated by adding the decimal value of all characters in the packet (excluding start, checksum, and terminator), and then dividing the result by 256. The integer remainder converted to two ASCII hex digits is the checksum. When a remote device receives a packet, the passed checksum is compared with a computed checksum and if they do not match, the device discards the packet.		
6. Terminator character	2 hex characters	ASCII carriage return
This field is an ASCII carriage return placed at the end of a command packet. This character is not the newline character "\n", but can be used in string assign statements as "\r". There is not a space between the checksum and terminator field.		

Decoding the command packet

A PHI remote unit operates in one of three modes. Receipt of data is interrupt driven or otherwise multiplexed so that other tasks are performed by the unit's microprocessor. When the unit receives a command packet, it continues monitoring for new commands while the current one is carried out.

1. MONITOR. The PHI unit monitors serial data traffic. When a PHI "start" character is detected, the PHI unit changes to the RECEIVE MODE.

2. RECEIVE. After receiving start, the unit tests subsequent characters for a valid PHI command packet. This mode must have a count down timer associated with it, which is a predetermined time for a valid command packet to be received. Furthermore if another PHI start character is received while in this mode, (i.e. the first PHI start character was actually part of a command packet for a non-PHI device) the unit responds by going back to the beginning of the RECEIVE mode, with a fresh timer setting. If a command packet is not received within the allowed time frame or if the checksum does not match, the timer is disabled, the packet is discarded, and the mode

is reset back to MONITOR. Once a command packet is received, the mode changes to RESPOND. The only way the unit can get to a RESPOND is by receiving

    2.1. a valid PHI start character followed by a space,

    2.2. a 2-byte hex value matching the unit's address followed by a space,

    2.3. at least one 2-character hex value command followed by a space,

    2.4. a 2-byte hex checksum matching the command packet's actual checksum,

    2.5. and a carriage return terminator.

3. RESPOND. The controlling computer is in count-down timer mode waiting for a response from the PHI unit. All PHI units must respond within 500 milliseconds once a valid command has been received. A valid response could be an error code indicating that the unit is BUSY with a previous command or an acknowledging response packet. After returning a response packet, the unit returns to MONITOR and executes the command. If the controlling computer needs to verify that the last command was successful, it sends a command to the unit requesting status feedback.

Response packet

The response packet is made up of at least five fields, and contains information to let the controlling computer know that the command requested was either recognized and accepted (STATUS = "OK"), or an error condition occurred (STATUS = "ER"). The minimum packet also contains a RESPONSE CODE that is used either to pass an error code (if STATUS = "ER"), or is available for each unit to use as needed for a STATUS return of "OK". The minimum response packet (simple acknowledgment with no data) would consist of the following fields, and would be 12 bytes long.

< ADDRESS >	<space>	<STATUS>	<space>	<RESPONSE CODE>	<space>	<CHECKSUM>	<TERMINATOR>
2 byte	1 byte	2 byte	1 byte	2 byte	1 byte	2 byte	1 byte

NOTE: When a device responds to the controlling computer, that response has been requested and is expected by the computer. For this reason, a specific "start" character is not required in the response packet. The address of the responding unit is included in the packet so the controlling computer can verify it to make the data exchange easier to view on an ASCII terminal.

Table III-8. Serial Response Packet Description.

Field	Size	Comment
1. ADDRESS of unit	2 hex characters	Range 00 through FF
This field is filled in with the hexadecimal representation of the integer address of the unit. The range provides 255 unique addresses for PHI controls. The controlling computer will use this field to determine that the correct remote unit is responding.		
<SPACE>		
2. STATUS MNEMONIC	2 ASCII characters	Either OK or ER
This field is made up of two ASCII characters and is either OK or ER. OK indicates success in recognizing the command. ER indicates an error condition which can mean that the command is invalid, or that the remote unit received the command but is still busy with a previous command. Specific information about ER is reported in the RESPONSE CODE field.		
<SPACE>		
3. RESPONSE CODE	2 hex characters	Range 00 through FF
For an error condition with an incoming command, this field returns an error number to the controlling computer. For non-error conditions, this field returns a status byte/word to the controlling computer, which is definable by the PHI unit, and can vary with the needs of individual commands within a unit, as well as varying from unit to unit. Data must be in ASCII printable format.		
<SPACE>		
4. DATA field(s), optional	as needed	ASCII printable characters only
Data field(s) are used to respond to commands requesting data. For example, a command requesting the current voltage setting in a unit would have the reading placed in a data field. Data must be in ASCII printable format. There is no limit on the number or size of data fields. Data is not required for all responses.		
<SPACE>		
5. CHECKSUM	2 hex characters	Computed checksum of packet
Checksum contains a simple computed checksum of the command packet. The value must be in ASCII hexadecimal notation. The checksum is calculated by adding the decimal value of all characters in this packet (including the space before the checksum field) and then dividing the result by 256 (base 10). The integer remainder converted to two ASCII hex digits is the packet checksum. When the controlling computer receives a response packet, the passed checksum is converted from the hex value to a binary integer and compared with a computed checksum. If they are not the same, considers it an error, and repeats the last command. When qualified technicians are testing the remote unit using a dumb terminal this returned checksum value can be ignored.		
6. Terminator character	2 hex characters	ASCII carriage return
This field is an ASCII carriage return placed at the end of a packet. This character is not the newline character "\n" which is actually an ASCII linefeed, but can be assigned using the "\r" designation in a string. There is not a space between the checksum and terminator field.		

Table III-9. RS-232/422/485 Commands — PHI Standard Serial Interface.

Hex Cmd	Description
01	MODEL NUMBER. A description of the unit. Response: *DIGITEL MPC.*
02	VERSION. Firmware revision level. Response: *FIRMWARE X.X.n* where X.X is the numerical revision level for major changes and n is an alpha character for minor changes.
0A	READ CURRENT. Reads pump current. Parameters: 1 or 2*. Response: *X.XE-X AMPS.*
0B	READ PRESSURE. Reads pump pressure. Parameters: 1 or 2*. Response: *X.XE-XX UUU* where UUU is pressure units (Torr, MBR, or PA).
0C	READ VOLTAGE. Reads pump voltage. Parameters: 1 or 2*. Response: *XXXX* in volts.
0D	GET SUPPLY STATUS. Reads present status of the specified supply. Parameters: 1 or 2*. Status response: *WAITING TO START, STANDBY, SAFE-CONN XX, RUNNING XX, COOL DOWN XX, PUMP ERROR XX,* or *INTERLOCK XX, SHUT DOWN XX, CALIBRATION XX,* where XX is the pump error code.
0E	SET PRESS UNITS. Specifies the default pressure units. Parameters: UUU where UUU is pressure units — Torr, MBR, or PA.
0F	GET DATE/TIME. Reads the date and time. Response: *w dd/yy hh:mm*, where *w* is day of the week (1=Sunday); *dd* is date; *mm* is month; *yy* is year; *hh* is hour, and *mm* is minute.
10	SET DATE/TIME. Sets the date and time. Response: *w dd/yy hh:mm*, where *w* is day of the week (1=Sunday); *dd* is date; *mm* is month; *yy* is year; *hh* is hour, and *mm* is minute.
11	GET PUMP SIZE. Reads pump size in liters per second. Parameters: 1 or 2[1]. Response: *ssss L/S*, where *ssss* is pump size.
12	SET PUMP SIZE. Parameters: 1, size or 2*, size. Response: *ssss L/S*. Size = 0 or 10 – 1200.
1C	GET SUPPLY SIZE. Parameters: 1 or 2*. Response: "LARGE" or "MEDIUM".
1D	GET CAL FACTOR. Reads the calibration factor that modifies pressure. Parameters: 1 or 2*. Response: n.nn. n.nn is 0.00 – 9.99.
1E	SET CAL FACTOR. Sets calibration factor. Parameters: 1, n.nn or 2*, n.nn. n.nn is 0.00 – 9.99.
20	GET HV STRAPPING. Reads the supplies' high voltage strapping. Parameters: 1 or 2[1]. Response: *5600* or *7000*.
22	GET PARM FACTOR. Reads the line voltage that the unit is strapped for. Response: *120* or *240*.
23	TELL PARM FACTOR. Informs the computer which line voltage the unit is strapped for. NOTE: This does NOT change the input voltage strapping! Parameter: *120* or *240*.
24	GET LINE FREQUENCY. Reads the line frequency. Response: *50HZ* or *60HZ*.
25	SET DISPLAY. Changes the display parameter. Parameters: 1, parameter or 2*, parameter. Parameter is VOLTS, CURRENT, or PRESSURE. Note: only the first character of each parameter is actually required.
27	TSP TIMED. Sets TSP mode of operation to TIMED. Cycles TSP once every X minutes, for Y seconds, Z number of cycles, but only if pressure is above specified amount. Parameters: XXX (000 – 999), YYY (000 – 999), ZZZ (000 – 999), and X.XE-XX is specified pressure units (Torr, MBar, or PA).
28	TSP OFF. Disables the TSP. Sets values: ZZZ = 0, X.XE-XX = 0.1E-9.
29	FILAMENT ACTIVE. Sets which filament is active during TSP Timed. Parameters: N (filament number).
2A	TSP STATUS. Reports how many cycles left and minutes each filament has been used. Response: CCC, N- MMMM, N- MMMM, N- MMMM, and N- MMMM. CCC (number of cycles left to execute), N (filament number), and MMMM (total amount of logged time in minutes that the filament has been used).
2B	FILAMENT CLEAR. Executed after degassing. Resets logged time of all filaments to zero.
2C	FILAMENT AUTO. Automatically advances to the next filament if the one being used is open. Parameters: YES or NO.
2D	TSP CONTINUOUS. Sets the TSP mode of operation to continuous.
2E	SUBLIMATION LEVEL. For TSP Timed mode of operation, sets the TSP controlling parameter (watts or amps) and its value. Parameters: XXX,P, N. XXX = value; P = W for watts or A for amps; N = number of seconds of on time (0 - 255).

2F	DEGAS. A maintenance tool. that conditions your filaments. Each filament is fired once. DEGAS uses the specified ON TIME and SUBLEVEL setup parameters, but starts its firing at half the value. For example, if current is specified at 50 amps and time at 30 seconds, then the TSP fires at 25A for the first 15 sec and then steps up to 50A for the remaining 15 sec.
32	CONTROL FAN. Parameters: ON or OFF.
33	SET AUTO-RESTART. Sets pump to automatically restart on power up. Parameters: YES or NO.
34	GET AUTO RESTART. Response: YES or NO.
37	START PUMP. Starts specified pump. Parameters: 1 or 2*.
38	STOP PUMP. Stops specified pump. Parameters: 1 or 2*.
3C	GET SETPOINT. Reads configuration of specified set point. Response: *n*, *s*, *X.XE-XX*, *Y.YE-YY*, *ST*. *n* = set point number (1-8); *s* = supply driving it; *X.XE-XX* = on pressure; *Y.YE-YY* = off pressure, *ST* indicates current setpoint state, 1 = ON, 0 = OFF.
3D	SET SETPOINT. Configures a specified set point. Parameters: n, s, X.XE-XX, Y.YE-YY. n = set point number (1-8); s = supply driving it (0=inactive, 1=supply 1, 2=supply 2, 3=bake supply 1, and 4=bake supply 2); X.XE-XX = on pressure; Y.YE-YY = off pressure.
3E	SETUP BAKE. Arms the bake. Parameters: hhh, HH:MM. hhh is bake duration (0 –255 hours); HH:MM is the start time in hours and minutes.
3F	BAKE TIME LOG. Response: *nnn.nH*. *nnn.nH* is the total time the set points have been on.
40	DISABLE BAKE.
44	LOCK KEYPAD.
45	UNLOCK KEYPAD.
50	GET ANALOG OUTPUT MODE. Gets the current/pressure analog output mode for each supply. Parameters 1 or 2*. Response: "0 Logarithmic pressure", or "1 Logarithmic current", or "2 Volts per 1.0uA", or "3 Volts per 10.0uA", or "4 Volts per 100.0uA", or "5 Volts per 1.0mA", or "6 Volts per 10.0mA", or "7 Volts per 50.0mA".
51	SET ANALOG OUTPUT MODE. Sets the current/pressure analog output mode for each supply. Parameters 1 or 2*, n. Where n = 0 – 7. 0 = Logarithmic pressure, 1 = Logarithmic current, 2 = 1uA, 3 = 10uA, 4 = 100uA, 5 = 1mA, 6 = 10mA, 7 = 50mA.
C6	READ EVENT LOG. Reads event data from the event log. Parameter: 0 – 2048. Events are numbered 1 – 2048. 0 will return just the latest event. Response: n string where n is the event number string is the following format pump# error code time & date Voltage current pump size supply size # of arcs # of cool down cycles 0 0 0 0 (data reserved for future)
* Parameters 1 or 2 allow you to select which supply.	

CRC Checksum Error

The following is an example of the CRC checksum calculation.

1. The response from the DIGITEL MPC to command 01 is:

00 OK 00 DIGITEL MPC DC

2. Table III-8 gives the values of the response.

3. Add all values in Table III-10 to get 4DCh[1].

4. Divide by 100h (256d). 4DCh ÷ 100h = 4h with a remainder of DCh.

5. The remainder, DCh, is the CRC.

Table III-10. CRC Checksum Calculation.

Response	Value (hex)
0	30
0	30
space	20
O	4F
K	4B
space	20
0	30
0	30
space	20
D	44
I	49
G	47
I	49
T	54
E	45
L	4C
space	20
M	4D
P	50
C	43
space	20

---

[1] *h* indicates a hexadecimal (base 16) value while *d* indicates a decimal (base 10) value.

IV. Service

If the DIGITEL™ Multiple Pump Control (MPC) fails to perform specified functions, either seek the services of qualified personnel or contact customer service as follows:

By mail:

 Gamma Vacuum, LLC

 12912 Ventura Court No. 28

 Shakopee, MN 55379

 USA

By e-mail:

 service@gammavacuum.com

By telephone:

 1-952-445-7597

By fax:

 1-952-445-7615

WARNING: Performing any service tasks other than those described in this section without the assistance of Gamma Vacuum, LLC Customer Service could result in serious injury, could damage equipment, and may nullify applicable equipment warranties.

WARNING: Service procedures are for use by qualified and authorized personnel who have experience working with voltages greater than 50 volts. To avoid personal injury, do not perform any installation or service procedures unless qualified to do so.

WARNING: Voltages up to 7000V are present. An interlock is provided to shut off power when the cover is removed. Do not defeat this interlock.

WARNING: Do not disconnect the high voltage cable with power on. After turning power off, allow at least one minute before disconnecting electrical equipment.

Do not operate the control without a proper electrical ground or near water. The control may be damaged and its safety reduced, if operated outside of its specifications.

Circuit boards may be destroyed by a small static discharge. To avoid damaging the boards, use the following precautions:

- **Handle boards at approved ESD workstation.**

- **Do not touch any electrical contacts.**

- **Do not rub boards against any insulator that may build up a static charge.**

- **When shipping boards, use approved ESD containers and packaging.**
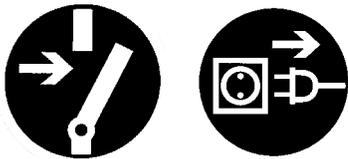
WARNING: Voltages up to 7000V are present in the DIGITEL MPC. Turn off power and disconnect power cord before performing any service procedures in this section.

MPC Components

The location of MPC components are found in Figure IV-1. Table IV-1 provides their part numbers.
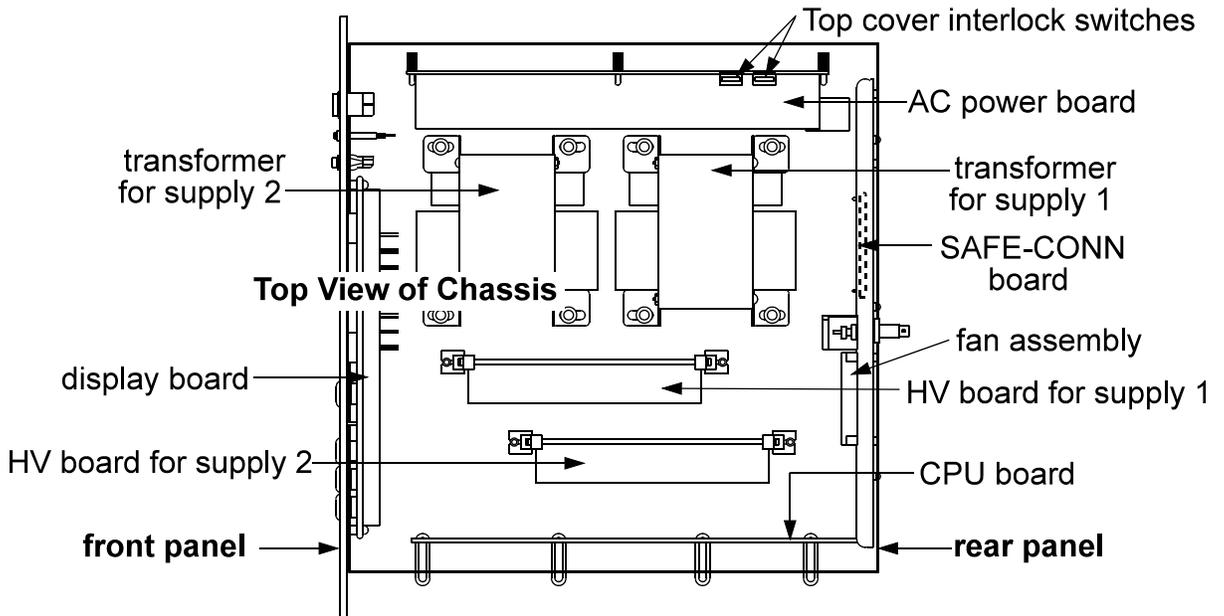
Figure IV-1. Location of MPC Components.

Table IV-1. MPC Component Parts List.

Component	Part Number	Component	Part Number
Display Board	635347	100 mA transformer	635452
HV amber lamps	611716	500 mA transformer	635451
Rear Panel Assembly	638757	100 mA HV Board	640574
SAFECONN Board	640728	500 mA HV Board	635465
Fan Filter	622775	**Cable Assemblies**	**Part Number**
Fan	635932	SAFECONN to CPU	636051
AC Power Board	640690	CPU to HV Board	636052
Fuses	see Table IV-3	AC Power to Display and CPU	636053
Interlock Switches	635805	SAFECONN to AC Power	636054
CPU Board	641539	CPU to Display	635934
		CPU to Rear Panel (TSP Opt)	635931

Maintenance Procedures

Table IV-2 lists maintenance procedures that need to be performed on the MPC.
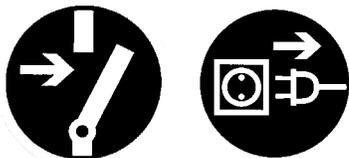
WARNING: Voltages up to 7000V are present in the DIGITEL MPC. Turn off power and disconnect power cord before performing any maintenance procedures.

Table IV-2. Routine Maintenance Schedule.

Maintenance	Period
Clean the chassis interior	every six months
Clean the air filter	every six months
Replace lamps	as necessary
Replace fuses	as necessary

Removing the Top Cover

Turn off power and disconnect power cord from the DIGITEL MPC. To gain access to the unit interior, remove the nine screws securing the top cover to the chassis.

Cleaning the Chassis

1. Turn off power and disconnect power cord from the DIGITEL MPC.

2. Remove the top cover.

3. Clean the interior of the chassis with clean, oil-free, compressed air at 345 kPa (50 psi) maximum.

4. Clean all high voltage wiring and connections; they are susceptible to arcing.

5. Inspect the HV insulation for cracks. If you find any, contact your service representative.

Cleaning the Fan Filter

The fan filter is located on the rear panel.

1. To remove the filter, gently compress it and pull the filter out of the frame.

2. Clean filter with warm water to remove dust and dirt that restricts air flow.

3. After the filter is completely dry, gently compress and insert it into the frame.

NOTE: If the fan filter is worn, replace it (part number 622775).

Replacing Fuses

MPC fuses are located on the AC Power board (Figure IV-2). Replace the fuses according to Table IV-3.
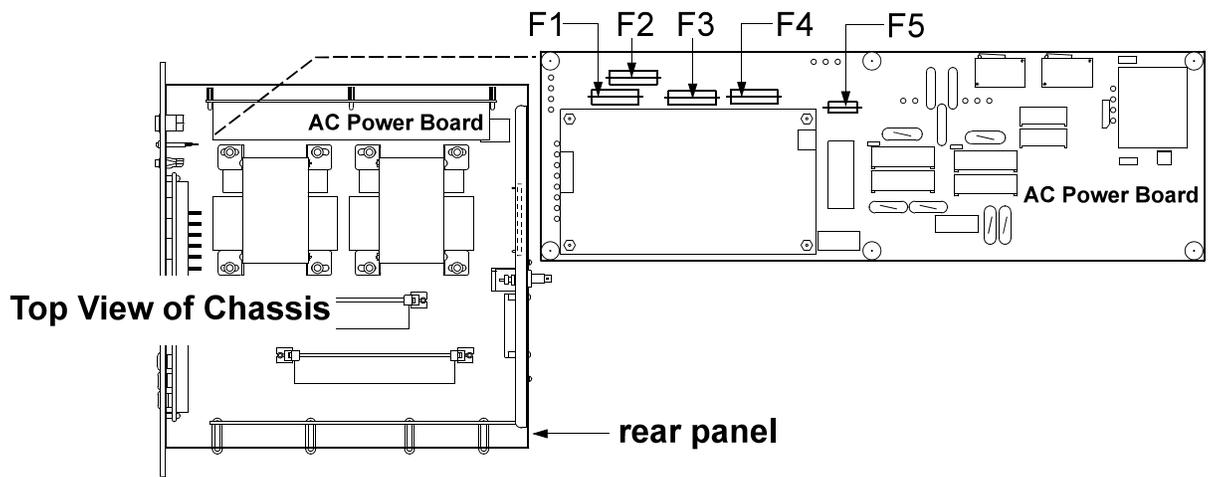
Figure IV-2. Location of Fuses on the AC Power Board.

Table IV-3. Part Numbers (p/n) — Fuses on the AC Power Board.

|		F3 – Supply 1 F4 – Supply 2	F1 and F2 – Main Power	F5 – Aux Power
100 mA HV Card	100/120 VAC	2.5A, 250V, slo-blo, IEC, sheet 5 p/n 639627	10A, 250V, slo-blo	2.5A, 250V, slo-blo
	200/240 VAC	1.25A, 250V, slo-blo, IEC, sheet 5 p/n 636475	sheet 5, IEC	pigtail
500 mA HV Card	100/120 VAC	6.3A, 250V, slo-blo, IEC, sheet 5 p/n 636477	p/n 636478	p/n 639638
	200/240 VAC	4.0A, 250V, slo-blo, IEC, sheet 5 p/n 639623		
Fuse cover for F1 through F4 is p/n 638170				

Input and Output Voltage Selection

Use the following Input Voltage Selection Procedure to change input voltage to 115 or 230 VAC. The voltage shown on the rear panel indicates the present configuration. Use the Output Voltage Selection Procedure to change output voltage to 7000 or 5600 VDC.
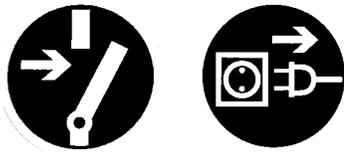
WARNING: Voltages up to 7000V are present in the DIGITEL MPC. Turn off power and disconnect the power cord before servicing the unit.
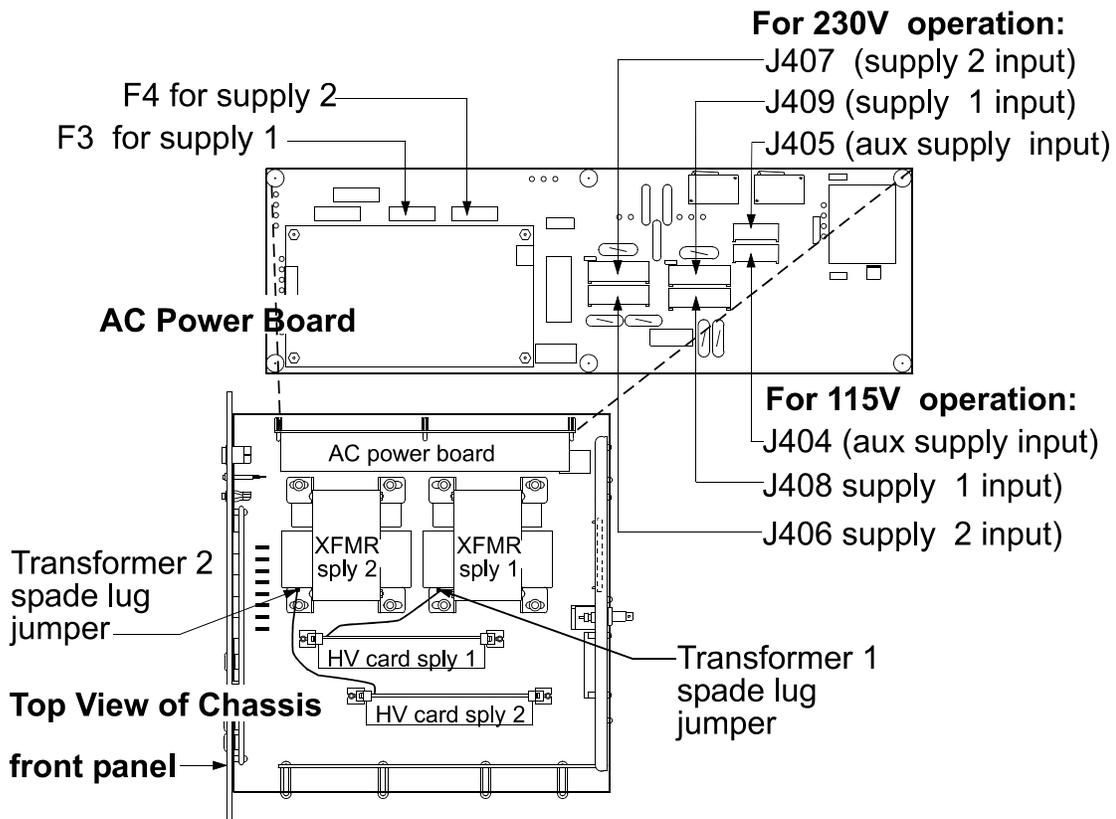
Figure IV-3. Input and Output Voltage Conversion — Location of Components.

Input Voltage Selection Procedure

1. Disconnect power and remove the top cover.

2. On the AC Power board (Figure IV-3), remove the cover from the two fuses (F3 for supply 1 and F4 for supply 2) and replace the fuses according to the Table IV-4.

Table IV-4. Input Voltage Conversion Fuse Values for the DIGITEL MPC.

	F3/F4 — 100/120 V	F3/F4 — 200/240 V
100 mA HV Card	2.5A, 250V, slo-blo, IEC p/n 639627	1.25A, 250V, slo-blo, IEC p/n 636475
500 mA HV Card	6.3A, 250V, slo-blo, IEC p/n 636477	4.0A, 250V, slo-blo, IEC p/n 639623

3. Replace the cover on each fuse.

4. On the AC Power board (Figure IV-3), pull out the input voltage connectors and reconnect them to appropriate voltage according to the Table IV-5.

Table IV-5. Input Voltage Conversion Connectors for the DIGITEL MPC.

	100/120 V	200/240 V
supply 2 input	J406	J407
supply 1 input	J408	J409
aux supply input	J404	J405

5. Replace the top cover of the MPC and reconnect power.

Output Voltage Selection Procedure

1. Disconnect power and remove the top cover.

2. Move the spade lug jumper (Figure IV-3) located on the secondary tap of the high voltage transformer to appropriate connection.

   2.1. 5600 VDC for the upper connection

   2.2. 7000 VDC for the lower connection

3. Replace the top cover and plug in the DIGITEL.

4. Remove the high voltage cables.

5. Turn on the DIGITEL.

6. Go to the DIAGNOSTICS menu and select CALIBRATION to calibrate the unit.

NOTE: Calibration calibrates the output current and automatically informs the DIGITEL what output voltage the high voltage transformer is set to (for supply 1 and 2).

Voltage Polarity Configuration

The DIGITEL MPC can be configured for positive or negative voltage polarity. Use the following procedure to change the voltage polarity.
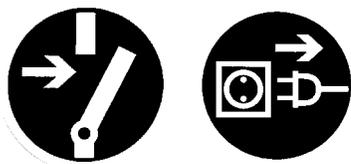
WARNING: Voltages up to 7000V are present in the DIGITEL MPC. Turn off power and disconnect power cord before performing any service procedures.

1. Turn off power to the MPC and remove its power cord.

2. Remove the chassis top cover.

3. Disconnect any cables connected to the High Voltage (HV) board and remove it from its slot.

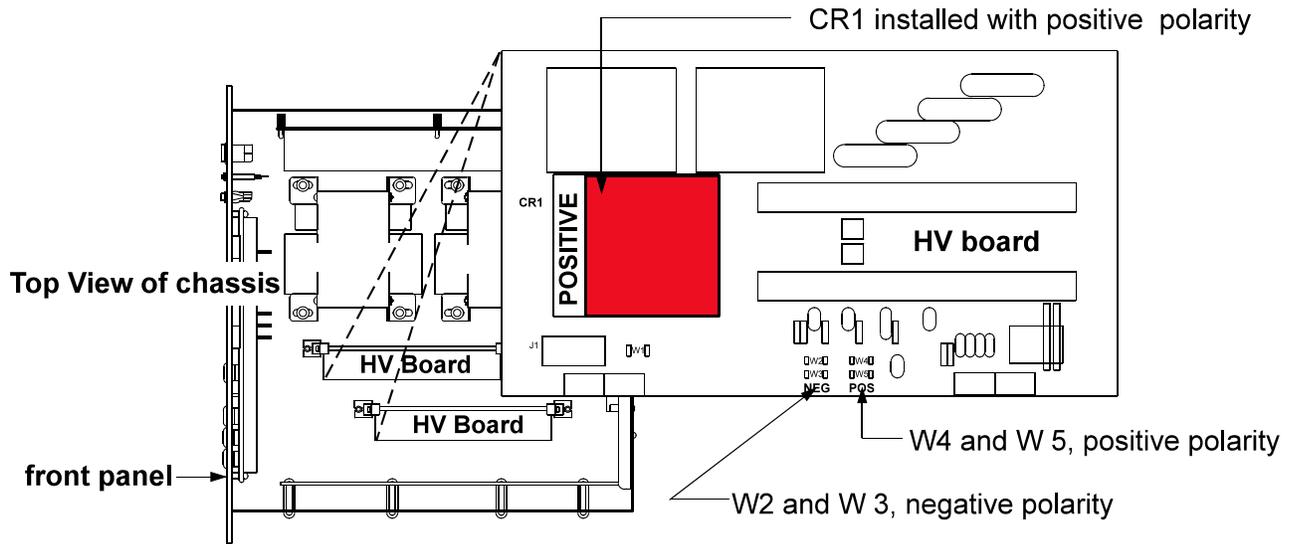*NOTE: Each HV board can be independently configured for positive or negative polarity.*

Figure IV-4. Voltage Polarity — Location of Components.

4. Locate component CR1 (the diode bridge). Along one side, CR1 will read:

   4.1. If the MPC is configured for positive polarity, the word POSITIVE is shown to the left of CR1 as shown in Figure IV-4.

   4.2. If configured for negative polarity, the word NEGATIVE is shown to the right of CR1.

5. If a polarity change is desired, unsolder the four pins of CR1.

6. Rotate CR1 180° and shift it to the next series of holes so that CR1 exposes the desired polarity.

7. Re-solder CR1 at the desired location.

8. Next, unsolder the two polarity jumpers on the bottom-center of the HV board (Figure IV-4), and re-solder the jumpers according to the table below.

W4 and W5	configures positive polarity
W2 and W3	configures negative polarity

9. Reinstall the HV board and reconnect the cables.

10. Replace the MPC top cover and reconnect power.

11. Re-calibrate the unit. See Section 3, Running Diagnostics (page 37), the CALIBRATION (page 40) portion.

PROM Change Procedure

The CPU board, located inside the DIGITEL MPC chassis, houses the PROM (Programmable Read Only Memory), which contains the programmable commands for the DIGITEL MPC. Figure IV-5 shows the PROM's location.

If you need to update the revision level of the MPC, you need to change this PROM. Use the following procedure.
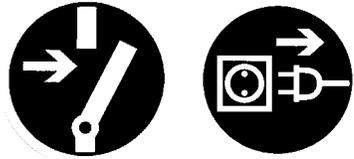
WARNING: Voltages up to 7000V are present in the DIGITEL MPC. Turn off power and disconnect power cord before performing any service procedures.

1. Make sure that you have an ESD grounding strap on your wrist.

2. Turn off power to the MPC and remove its power cord.

3. Remove the chassis top cover.

4. Disconnect any cables connected to the CPU board and remove the CPU board from its slot.

5. Remove the old PROM.

NOTE: Each PROM contains a label indicating its revision level. Do not use this label to position the new PROM (the label does not always face the same direction).

Make sure the groove is facing towards the rear panel.

Figure IV-5. CPU Board — Location of PROM.

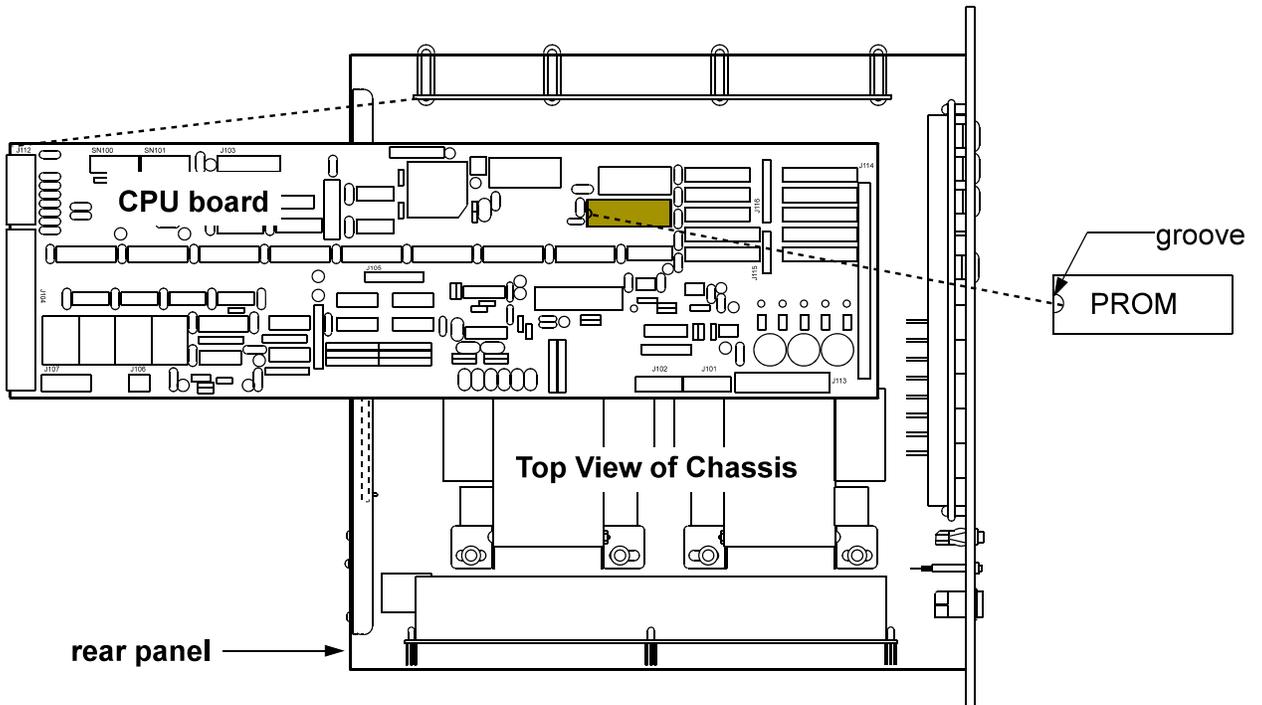6. Carefully insert the new PROM, making sure the small groove on the PROM (denoting pin 1) is positioned correctly. See Figure IV-5.

7. Reinstall the CPU board and reconnect the cables.

8. Replace the MPC top cover and plug in the power cable.

Rear Panel Connector Pinouts

The location of the rear panel connectors on the DIGITEL MPC are shown in the Figure IV-6.
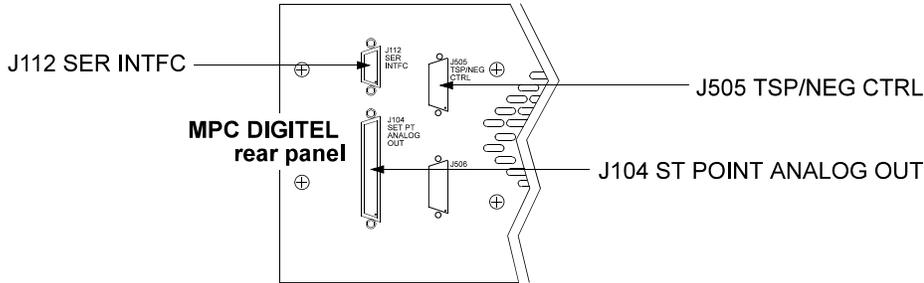
Figure IV-6. Rear Panel Connectors.

Connector pinouts and signal designations are provided in the following tables:

- **J104 SET PT ANALOG OUT** — Table IV-6

- **J505 TSP/NEG CTRL** — Table IV-7

- **J112 SER INTFC** — Table IV-8.

Connector J104 — Set Point and Analog Output Signals

J104 SET PT ANALOG OUT (a 37-pin, female Sub-D connector) provides 8 set point signals, and 4 voltage/current analog output signals.

Table IV-6. Connector J104 Pinouts.

Pin	Setpoint Signal			Pin	Analog Output Signal
1	Set Point 1 (Relay)	Common		20 … 28	Unused
2		NC		29	GND2
3		NO		30	Analog HV Supply 1 Output
4	Set Point 2 (Relay)	Common		31	GND2
5		NC		32	Analog Current Output 1*
6		NO		33	GND2
7	Set Point 3 (Relay)	Common		34	Analog Current Output 2*
8		NC		35	GND2
9		NO		36	Analog HV Supply 2 Output
10	Set Point 4 (Relay)	Common			
11		NC		* Can be configured for Supply 1 or	
12		NO		Supply 2 current (I) output - See Analog Outputs.	
13, 14, 16, 18	GND1				
15	Set Point 5 (TTL)				
17	Set Point 6 (TTL)				
19	Set Point 7 (TTL)				
37	Set Point 8 (TTL)				

Connector J505 — Remote TSP/NEG Control Signals

J505 TSP/NEG CTRL (a 15-pin, female Sub-D connector) provides the control signals for the Remote TSP/NEG Control.

Table IV-7. Connector J505 Pinouts.

Pin	Signal	Pin	Signal	Pin	Signal
1	Current Sense COM	6	SCR Trig Out	11	K2 Coil
2	SCR Trig Pull-up	7	K3 Coil	12	Not Used
3	K4 Coil	8	+15V Return	13	Current XFMR +
4	+15V to TSP	9	Current XFMR –	14	Sync Signal GND
5	Voltage Sense	10	Sync Signal from TSP	15	K1 Coil

Connector J112 — Serial Interface Signals

J112 SER INTFC (a 9-pin, female Sub-D connector) routes the serial interface signals for the four serial interface protocols – RS-232, PHI, RS-485, and RS-422.

Table IV-8. Connector J112 Pinouts.

RS-232 Operation		PHI Operation		RS-485 Operation		RS-422 Operation	
DCD	1	+TX	2	+TX	2	+RX	3
RXD	2	–TX	8	–TX	8	–RX	7
TXD	3	GND	5	GND	5	GND	5
GND	5	+RX	3				
DSR	6	–RX	7				
RTS	7						
CTS	8						

Serial Communication Protocol Selection

Four serial interface protocols are available on the MPC — RS-232 Operation, RS-485 Operation, RS-422 Operation, and PHI Operation. Set DIP switches SW1 and SW2 on the CPU board (Figure IV-7) to select a serial interface. Table IV-9 shows the DIP switch settings.
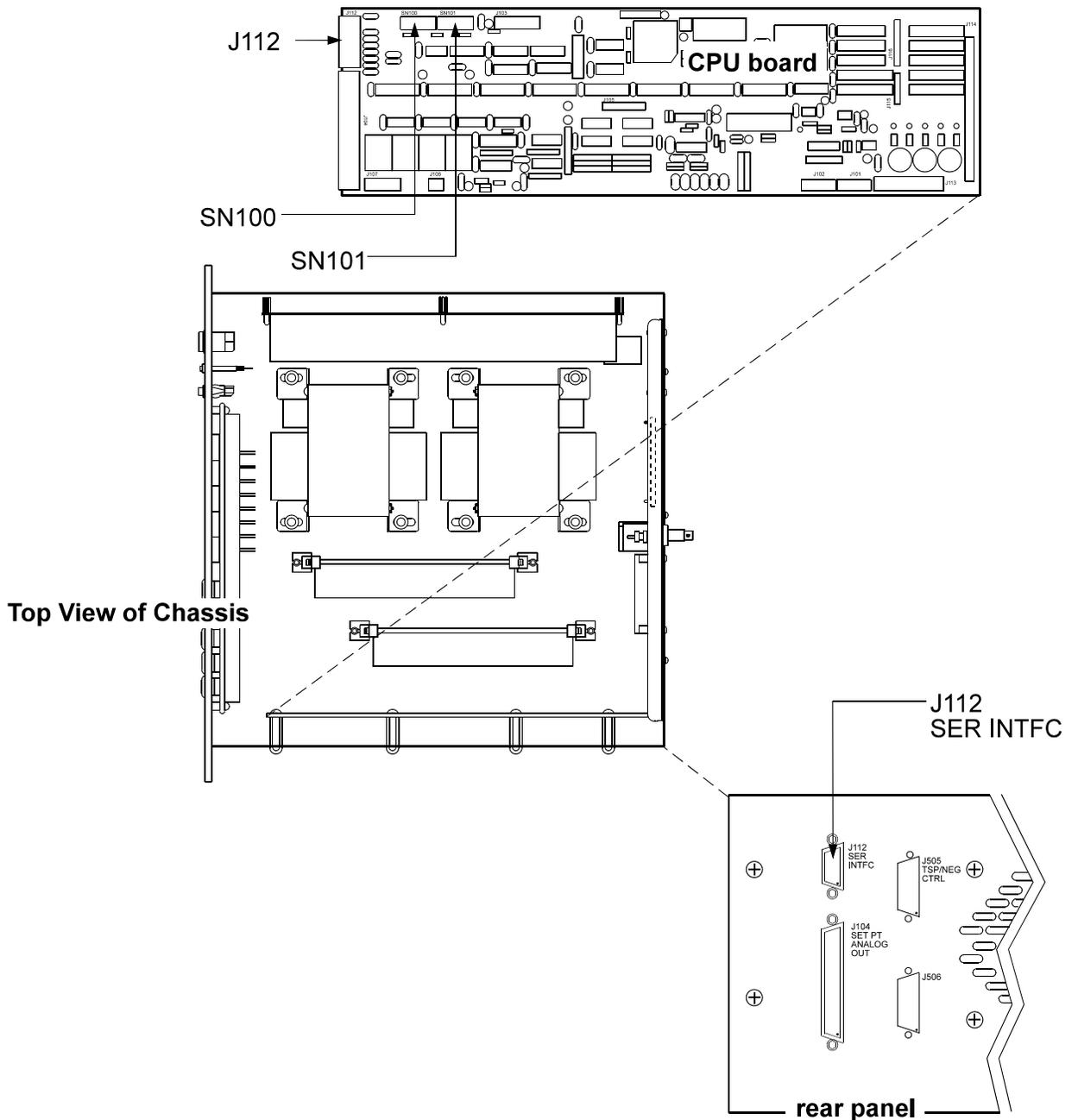

Figure IV-7. Selecting the Serial Interface Protocol.

Table IV-9. Serial Interface DIP Switch Setting.

RS-232

SW1	SW2	J112 SER INTFC			
		Signal	**Pin No.**	**Signal**	**Pin No.**
Close 5 thru 8	Close 6				
Open 1 thru 4	Open all others	DCD	1	DSR	6
		RXD	2	RTS	7
		TXD	3	CTS	8
		GND	5		

RS-485

SW1	SW2	J112 SER INTFC			
		Signal	**Pin No.**	**Signal**	**Pin No.**
Close 1, 2, and 4					
Open all others	Open all	+ TX	2	+ RX	3
For terminator close 7.		−TX	8	−RX	7
		GND	5		

RS-422

SW1	SW2	J112 SER INTFC	
		Signal	**Pin No.**
Close 1, 3, and 4	Close 1 and 2		
Open all others	Open all others	+ RX	3
For terminator close 8.		−RX	7
		GND	5

PHI

SW1	SW2	J112 SER INTFC			
		Signal	**Pin No.**	**Signal**	**Pin No.**
Close 1, 3, and 4	Close 1 and 2				
Open all others	Open all others	+ TX	2	+ RX	3
For terminator close 8.		−TX	8	−RX	7
		GND	5		

Remote TSP/NEG Control Option
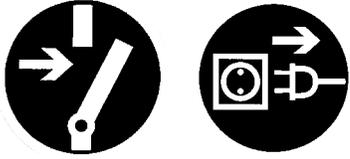
WARNING: High voltages are present in the Remote TSP/NEG Control and DIGITEL. Turn off power and disconnect power cords from both units before servicing.
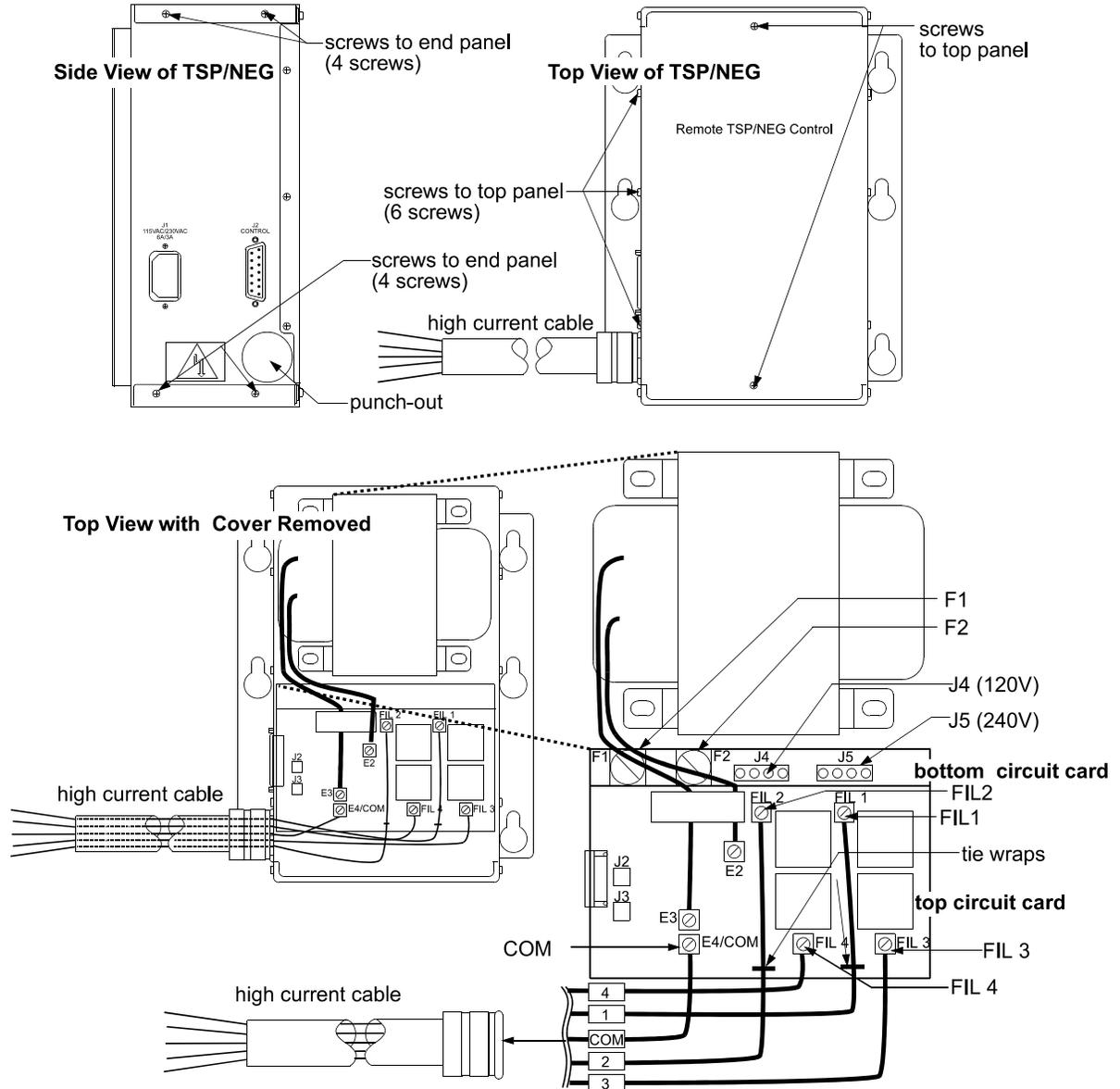

Figure IV-8. Remote TSP/NEG Control — Location of Components.

Removing the Panels of the Remote TSP/NEG Control

The Remote TSP/NEG Control has a top panel and two end panels

1. Remove the top panel:

  1.1. Remove the eight screws (two on the front and three on each side) from the top panel and pull it away from the unit.

2. Remove the end panels:

    2.1. Remove the four screws (two on each side) from the end panel and pull it away from the unit.

Input Voltage Selection of the Remote TSP/NEG Control

To change input voltage on the Remote TSP/NEG, you need to access the bottom circuit card inside the unit. Refer to Figure IV-8 for its location.

1. Turn off power and disconnect the power cord from the unit.

2. Remove the top panel.

3. On the bottom circuit card (Figure IV-8), pull out the input voltage connector and reconnect it to appropriate voltage:

    3.1. For 120 VAC, connect to J4

    3.2. For 240 VAC, connect to J5

4. Replace the panel and install the appropriate power cord.

Connecting a High Current Cable to the Remote TSP/NEG Control

1. Remove the top panel and end panel.

2. Tap the punch-out on the end panel to make a hole for the high current cable connector (Figure IV-8). Install the cable connector.

3. On the top circuit card, connect high current cable wires 1 and 2 to FIL 1 and FIL 2, respectively. Install tie wraps to these wires. See Figure IV-8.

ATTENTION: This is a high current connection. Make sure that you have a secure connection, or heating will occur.

4. Connect wires 3, 4, and COM to FIL 3, FIL 4, and COM, respectively.

5. Replace the panels.

Accessory Equipment

Table IV-10. Optional Accessory Equipment.

Order No.	High Voltage Modules
640574	medium HV module (200W, 100mA), transformer, and fuse.
635465	large HV module (1000W, 500mA), transformer, and fuse.
Remote TSP/NEG Control Unit	
640697	Remote TSP. (Order TSP control and power cables separately.)
Ion Pump High Voltage Cables for use with 3-Million Series Captorr Pumps	
642453	3 m bakeable (200°), SAFE-CONN ion pump HV cable.
642454	6 m bakeable (200°), SAFE-CONN ion pump HV cable.
642455	10 m bakeable (200°), SAFE-CONN ion pump HV cable.
642456	15 m bakeable (200°), SAFE-CONN ion pump HV cable.
642457	20 m bakeable (200°), SAFE-CONN ion pump HV.
642458	30 m bakeable (200°), SAFE-CONN ion pump HV.
643506	40 m bakeable (200°), SAFE-CONN ion pump HV.
643507	50 m bakeable (200°), SAFE-CONN ion pump HV.
643508	75 m bakeable (200°), SAFE-CONN ion pump HV.
643509	100 m bakeable (200°), SAFE-CONN ion pump HV.
Ion Pump High Voltage Cables for use with 2-Million Series and older Pumps	
1001514	10' bakeable (200°) ion pump HV cable .
1000438	15' bakeable (200°) ion pump HV cable .
1001515	20' bakeable (200°) ion pump HV cable .
1001516	30' bakeable (200°) ion pump HV cable .
1001518	50' bakeable (200°) ion pump HV cable .
1001517	75' bakeable (200°) ion pump HV cable .
1006169	100' bakeable (200°) ion pump HV cable .
TSP Control Cables (MPC to Remote TSP Unit)	
638108	3 m (10') TSP control cable (MPC to remote TSP unit).
638109	6 m (20') TSP control cable (MPC to remote TSP unit).
638110	10 m (30') TSP control cable (MPC to remote TSP unit).
638111	15 m (50') TSP control cable (MPC to remote TSP unit).
638112	20 m (65') TSP control cable (MPC to remote TSP unit).
High Current Cables (Remote TSP/NEG Unit to TSP or NEG)	
638106	1.5 m (5') bakeable (250°) cable (remote TSP unit to TSP/NEG).
638107	3 m (10') bakeable (200°) cable (remote TSP unit to TSP/NEG).
Main AC Power Cable (MPC Base Unit, TSP/NEG Remote Units)	
639643	Power Cord, IEC / Stripped 230V, 2m
1004936	Power Cord, IEC / US 110V, 2m
633150	Power Cord, IEC / US 220V, 2.5m
638644	Power Cord, IEC / UK 240V, 10A, 2.5m
638645	Power Cord, IEC / EC 230V, 2.5m
2nd High Voltage Output Options	
641784	DIGITEL MPC high voltage output

V. Appendix A

This appendix contains drawings/parts lists and schematics for the DIGITEL™ Multiple Pump Control (MPC) to assist qualified and authorized service technicians with on-site troubleshooting. Table V-1 lists assembly drawings (each drawing is followed by its parts list). Table V-2 lists schematics.

Table V-1. Drawings and Parts Lists.

Order of Appearance	Part Number	Description
1	643325	top level assembly drawing followed by parts lists.
2	643181	CPU circuit card drawing followed by parts lists.
3	640690	AC Power circuit card drawing followed by parts lists.
4	641458	HV (100 mA) circuit card drawing followed by parts lists.
5	641459	HV (500 mA) circuit card drawing followed by parts lists.
6	635464	High Voltage PCB drawing.
7	635347	Display circuit card drawing followed by parts lists.
8	640728	SAFECONN circuit card drawing followed by parts lists.
9	640697	TSP Control assembly drawing followed by parts lists.
10	635460	Remote TSP circuit card drawing followed by parts lists.

Table V-2. Schematics.

Order of Appearance	Part Number	Description
1	635344	CPU circuit card
2	640691	AC Power circuit card
3	635466	HV (500 mA) circuit card
4	635348	Display circuit card
5	640729	SAFECONN circuit card
6	635461	TSP/NEG Control assembly

Menu Flowcharts

Flowcharts printed on the next five pages.