


TECHNICIAN'S
DIGITEL SPC
(Small Pump Control)
Component Manual

Part No. 647988 Rev. B

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Eden Prairie, MN 55344

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PHI Safety Notices

Physical Electronics' (PHI's) products are designed and manufactured in compliance with accepted worldwide practices and standards to provide protection against electrical and mechanical hazards for the operator and the area surrounding the product. All PHI products are designed and intended for professional use only, by skilled "**operators**" for their intended purpose and according to all of the instructions, safety notices, and warnings provide by PHI.

Those instructions, notices, and warnings assume that an "operator" will not employ any tool when using PHI products. They further assume that all operators clearly understand that use of PHI products in any manner not specified by PHI may impair the protection provided by the products and expose them to hazards.

A "**technician**" is a qualified servicing individual who:

- Has received training to work with voltages above 50 V,
- Has read and understood the PHI technician's manual for the equipment,
- Observes and understands all safety notices on PHI equipment.

The safety symbols that PHI uses are defined on the following page.* To reduce or eliminate hazards, technicians and operators of this equipment must fully understand these symbols.

PHI's products are installed with international-style or **ANSI**[†]-style safety notices, according to site requirements. International notices are symbols within triangles (alerts) or circles (mandatory actions). PHI's ANSI-style safety notices contain:

- One of three signal words (in all capitals) preceded by the general danger symbol (Δ);
- One of PHI's safety symbols along with a brief description of the hazard and the risk or injury that could occur;
- Short message that observes ANSI's Hazard Alert Trilogy Rule by identifying the hazard, the possible result of ignoring the notice, and how to avoid the hazard.

The three signal words are defined as follows:

- **DANGER**—imminently hazardous situation that, if not avoided, will result in death or serious injury;
- **WARNING**—potentially hazardous situation that, if not

avoided, could result in death or serious injury;

- **CAUTION**—potentially hazardous situation or unsafe practice that, if not avoided, may result in minor or moderate injury or damage to equipment.

SEMI[‡] standards require identification of type 3, 4, and 5 electrical maintenance tasks in equipment manuals:

- **Type 3** electrical maintenance tasks involve energized equipment, exposed live circuits, and possible accidental contact; potential exposures are less than 30 V RMS, 42.2 V peak, 240 V-A, and 20 J.
- **Type 4** is the same but potential exposures are greater than 30 V RMS, 42.2 V peak, 240 V-A, and 20 J or radio frequency is present.
- **Type 5** tasks involve energized equipment and measurements and adjustment require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes.

Only experienced, trained technicians should attempt to perform type 3, 4, or 5 electrical maintenance tasks.

* Many of PHI's safety symbols are provided and copyrighted by Hazard Communication Systems, Inc., Milford, PA.

* American National Standards Institute, 1430 Broadway, New York, NY 10018.

‡ Semiconductor Equipment and Materials International, 805 E. Middlefield Rd., Mountain View, CA 94043-4080.

PHI Safety Notices



Voltages may be present that could cause death or personal injury.



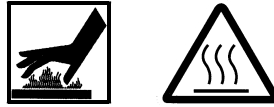
Visible or invisible radiation may be present that could cause personal injury.



A potentially dangerous magnetic field may be present.



A risk of death, personal injury, and/or damage to equipment exists (and a more specific label is not available).



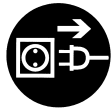
Hot surfaces may be present that could cause personal injury.



Wearing protective gloves is mandatory.



Wearing eye protection is mandatory.



Pulling the plug from its power source before servicing is mandatory.



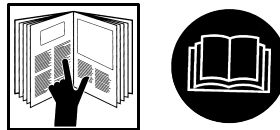
Turning off the power switch before servicing is mandatory.



Wearing foot protection is mandatory.



A pinching point is present that could cause personal injury.



Refer to the manual(s) before proceeding.



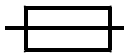
This is the location of the protective grounding conductor terminal.



A risk of explosion or implosion may be present that could cause personal injury.



Contents are under pressure.



This is the location of the fuse.



A harmful or irritant material may be present that could cause personal injury.



This is the location of an earth (ground) terminal.



Lifting with assistance or equipment could cause personal injury.



Extremely low temperatures may be present that could cause personal injury.

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Limited Warranty

Except as otherwise provided herein, the Seller warrants to Buyer that the equipment sold hereunder, whether it is new equipment or remanufactured (reconditioned) equipment, is, at the time of shipment to Buyer from Seller, free from defects in material and workmanship. As Buyer's sole exclusive remedy under this warranty Seller agrees either to repair or replace, at Seller's sole option and free of part charge to Buyer, any part or parts of such equipment which, under proper and normal conditions of use prove to be defective within 12 months from the date of receipt by the Buyer. Warranty period for equipment requiring installation by Seller will commence on completion of standard installation services. If customer delays installation beyond 45 days after delivery, the warranty period will commence to run 45 days after delivery. After installation, any realignment, readjustment, recleaning or recalibration, provided it does not relate to a proven defect in material or workmanship, shall be performed only at Seller's then current rates for service.

Exclusions and Limitations

It is recognized that some parts by their nature (expendable items) may not function for one full year; therefore, excluded from the foregoing warranty are filaments, anodes, cathodes, multipliers, retard grids, special ceramics, ionizers, along with other such parts mentioned in the applicable operating manual.

The foregoing warranty excludes certain major items or accessories specifically indicated on applicable price lists or quotations, as to which Seller passes to Buyer whatever warranty is provided to Seller by the manufacturer or the specific warranty indicated by the price list or quotation.

This warranty does not cover loss, damage, or defects resulting from transportation to the Buyer's facility, improper or inadequate maintenance by Buyer, buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the equipment or improper site preparation and maintenance.

Product Service

All claims must be brought to the attention of Seller within 30 days of the failure to perform.

Seller at his option may require the product to be returned to the factory, transportation prepaid, for repair.

Refund of Purchase Price

In lieu of the foregoing, Seller may at any time elect, in its sole discretion, to discharge its warranty by accepting the return of such equipment and refunding any portion of the purchase price paid by Buyer.

Software and Firmware Products

The sole exclusive warranty applicable to software and firmware products provided by Seller for use with a processor will be as follows: Seller warrants that such software and firmware will conform to Seller's program manuals current at the time of shipment to Buyer when properly installed on that processor. Seller does not warrant that the operation of the processor software or firmware will be uninterrupted or error free.

No other warranty is expressed or implied. Seller expressly disclaims the implied warranties of merchantability and fitness for a particular purpose.

Section 1: General Information

The manual is divided into nine sections. Section 1 contains a brief introduction and a description of the units features. Section 2 explains the installation procedure while Section 3 describes operation of the DIGITEL SPC. Section 4 details the unit's serial protocol and Section 5 discusses the optional PC configuration software tool. Section 6 describes all input and output connections. Section 7 details the unit's advanced settings and Section 8 reviews general information on servicing the SPC. Section 9 contains a listing of all accessories for the SPC.

Introduction

The DIGITEL SPC-1 is an ion pump power supply. It requires a 24V DC power supply, and an external mains adapter is available to permit operation from 85 to 260V AC, 50 or 60Hz.

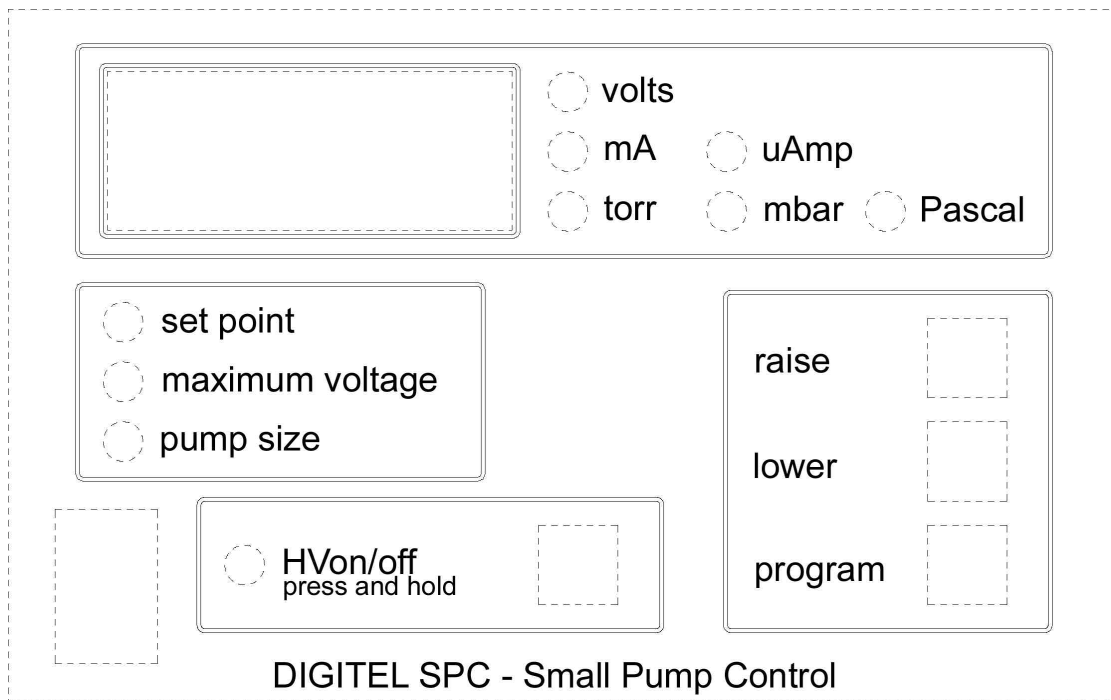


Figure 1-1. Diagram of the DIGITEL SPC Front Panel.

The SPC is an 'intelligent' programmable power supply. It can be controlled from the front panel (refer to Figure 1-1) or remotely through a serial communication interface. The serial interface is compatible with RS-232, RS-422 and RS-485 hardware and uses an industry standard communication protocol.

Features

Soft Configuration

Most aspects of the operation and calibration of the SPC power supply are controlled using software. These can be changed by the user from the front-panel or using a PC-based application program. There are no hardware links or internal adjustments.

Serial Port

The serial port allows the SPC to be configured and controlled remotely from a computer. A PC application is available which allows the user to fully calibrate and configure the operation of the SPC power supply through the serial port. The serial interface hardware is itself fully software configurable, so that the SPC may be programmed to communicate using any one of RS-232, RS-422 or RS-485 serial standards. The serial protocol used is described in Section 8 of this manual.

Ion Pump Output

The EHT output is a 20W, 15mA supply. It is generated using proven switch mode design technology for high reliability. The desired output voltage may be programmed to be in the range 3500 to 7000 volts to match the ion pump. The output connector is a standard Kings SHV-10kV and includes a SAFE-CONN interlock.

SAFE-CONN

A SAFE-CONN interlock connector is provided, the SPC will automatically turn off the EHT output if this interlock is removed.

Set Point

A programmable process control relay is available, this is controlled by the pressure read-back from the ion pump. Both normally-open and normally-closed contacts are available from the relay. This relay is energized when the pressure is below a value set by the user.

Pump Protection

The SPC supply continuously monitors the ion pump current, voltage, power and pressure during both start-up and continuous operation. If a problem occurs the SPC power-supply will act to prevent damage, for example in the event of a vacuum failure the SPC power-supply will immediately shut down the EHT to protect the pump. In the event of power failures the SPC supply can be configured to automatically restart the ion pump, if required.

Analog Outputs

Two buffered analog outputs (0 ... 10V) are provided: one reports ion-pump current and the other reports ion-pump voltage. These can be scaled within the configuration tool software.

Remote Control

A digital input is provided which can be used to remotely turn the SPC power-supply on or off. This input can be fully configured from software, it can be ignored or inverted, and it can separately be allowed to enable or disable the SPC power-supply.

A digital output is provided which reports the state of the SPC supply. This is driven when the EHT output is active.

Specifications

Table 1-1. Listing of the DIGITEL Small Pump Control Specifications.

Parameter:	Specification:
EHT output voltage	3,500 to 7,000 VDC
EHT output current	15mA
EHT output power	20W
EHT polarity	SPC positive, SPC-N negative.
Set Point Controller Output	Floating Relay contacts, NO and NC.
Set Point Range	1e-4 down to 1e-9 or OFF.
Analogue Output – Voltage monitor	Default 1V per 1kV, can be configured by user.
Analogue Output – Current monitor	Default 1V per 1mA, can be configured by user.
Storage Temperature	-20 to 65°C
Operating Temperature	0 to 40°C
Humidity	0 to 80% RH, non-condensing.
Dimensions mm (in.) W x H x D	140mm x 89mm x 250mm 5.6 Inches x 3.5 Inches x 9.9 Inches
Pump Size	Complete control of pumps up to 50l/s. Can be used with pumps up to 640l/s at low pressure.

Approvals

SPC was tested as supplied and was shown to meet the intent of Directive 89/336/EEC for Electromagnetic Compatibility and Low-Voltage Directive 73/23/EEC for product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

- **EN 50081-1 Emissions**
 - EN 55011 Class A radiated and Conducted Emissions
- **EN 50082-1 Immunity**
 - IEC 801-2 Electrostatic Discharge Immunity
 - IEC 801-3 RF Electromagnetic Field Immunity
 - IEC 801-4 Electrical Fast Transient/Burst Immunity
- **Low Voltage Directive 73/23/EEC**
 - EN 61010-1 Safety requirements for electrical equipment for measurement, control and laboratory use

Section 2: Installation

This section details the installation requirements for the DIGITEL SPC ion pump power supply.



WARNING: *Physical Electronics' (PHI's) 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 this manual and in other PHI 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.*



WARNING: *The SPC may become active as soon as power is supplied to the unit. Since it is possible to configure the SPC to automatically start driving the ion pump as soon as power is applied care must be taken when connecting the SPC to any external power supply.*

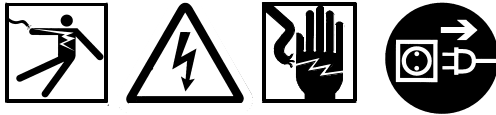
Inspection for Damage

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

Tools Required

Tools are to be used on equipment by technicians only, not by operators.* The only tool required in this procedure is a Phillips screwdriver for installing the front panel screws when the DIGITEL SPC is rack mounted.

Additional Precautions



WARNING: Do not disconnect the high-voltage cable with power on. After disconnecting the SPC supply from input power, allow at least one minute before disconnecting the ion pump.



Do not operate the SPC power-supply without an electrical ground connection.

Do not operate the SPC power-supply near any conducting fluid.

There are no serviceable parts inside the SPC power-supply, and voltages up to 7,500V (7.5kV) are present. Do not open the supply case under any circumstances. In the event that the power-supply requires attention, return it to the factory (refer to Section 8: Service).

* “PHI Safety Notices” at the beginning of this document describes who is an operator and who is a technician.

Connecting the SPC

The SPC supply can be used as a free-standing unit or mounted in a standard 19-Inch rack. A rack-mounting kit is available which can be used to mount up to three SPC units side-by-side.

The following items are required to install the SPC supply:

- 24V supply cable or AC to 24V universal mains adapter.
- One of these will be supplied with the SPC PSU.
- High voltage cable to connect to the ion pump.
- Safety ground cable.

Use the following procedure to install the SPC:

1. Locate the SPC and secure as required.
2. Connect the safety ground cable between the stud on the SPC power-supply rear panel and the ion pump.
3. Connect the MISCellaneous I/O cable and/or Serial I/O cables, if required.
4. Connect the high voltage (HV) cable to the ion pump and to the EHT connector on the SPC power-supply rear panel.
5. If fitted to the cable, also connect the SafeConn connector on the cable to the SafeConn connector on the SPC rear panel. If the cable does not have a SafeConn connector, then a dummy SafeConn cable must be used to connect the SafeConn connector on the SPC rear panel to the safety ground stud on the SPC rear panel. Contact your distributor for details.
6. Connect the SPC supply to a 24V DC supply.
7. At this point the SPC supply should be active and the correct pump size must be set before using the power-supply.

Section 3: Operation

The operation of this component is controlled by the operator through the system computer software. Refer to the system operator's guide for specific operating procedures.

The SPC power-supply can be controlled by an operator using the front panel controls, or controlled remotely through the serial port using a host computer.

Front Panel Operation

Figure 3-1 below shows the DIGITEL SPC front panel controls and displays.

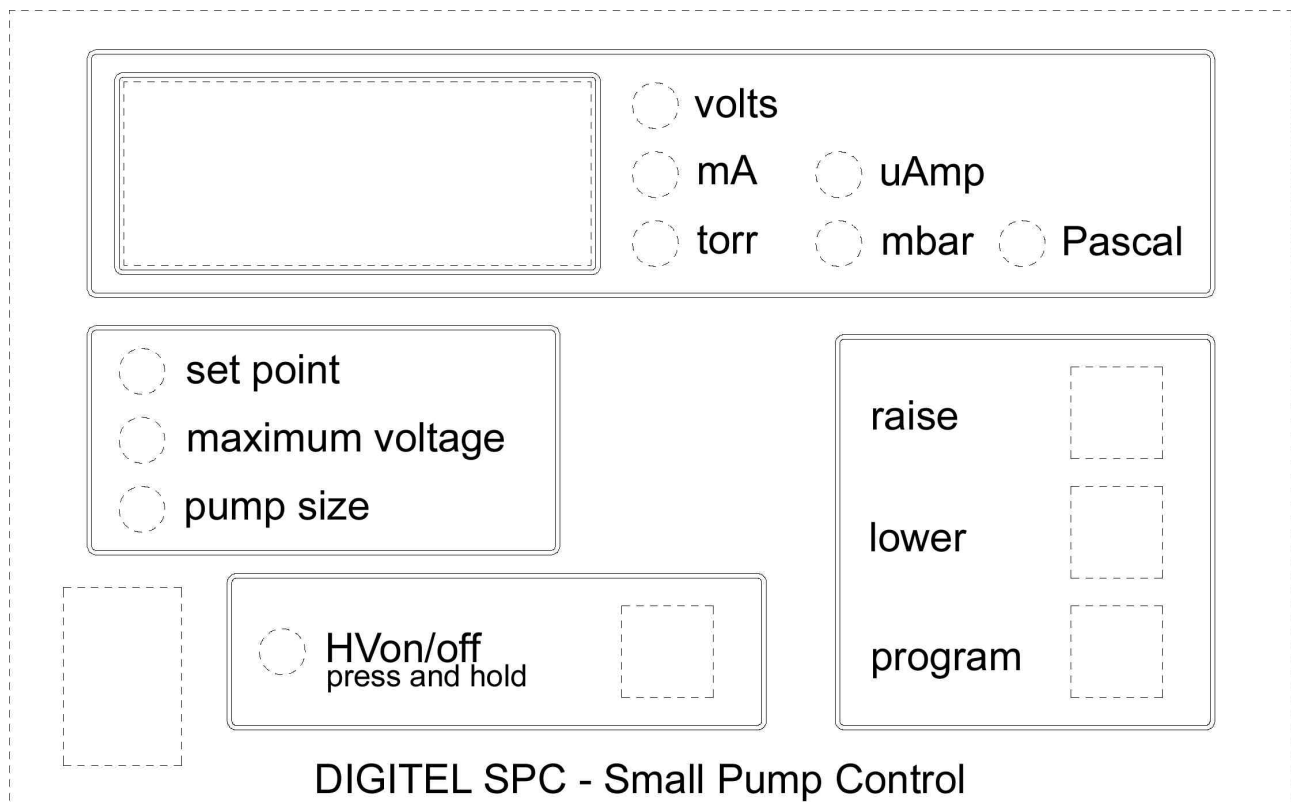


Figure 3-1. Diagram of the Front Panel Controls and Indicators for the DIGITEL SPC.

Indicators

The “HV” indicator is lit whenever the high-voltage output to the pump is driven.

During normal operation the “Volts”, “mA”, “uAmp”, “torr”, “mbar” and “Pascal” indicators are used to show what parameter the display is currently showing.

During setup the “set point”, “maximum Voltage” and “pump size” indicators are used to show which parameter is currently being changed.

The SPC unit calculates pressure readings from the output voltage and output current. Since this is not accurate for low voltages it will not display pressure readings until the voltage output to the ion pump exceeds a minimum value, by default this is 2kV. This limit can be altered using the PC configuration tool (refer to Section 5 for further information).

Switches

The power switch in the bottom-left corner of the front panel allows the user to completely disable the SPC by physically disconnecting the 24V input to the unit.

(It is worth noting that the other four switches may be disabled by a serial command if the serial port is connected to a computer or terminal).

The “HV on/off” switch allows the operator to control the high voltage output to the pump. To turn the HV on this switch must be pressed and held for approximately two seconds. If the HV is on, touching this switch will turn it off immediately.

The “program” switch is used to change between normal operation and setup mode.

In normal operation the “raise” and “lower” switches select the display mode, they switch between voltage, current or pressure display. Which parameter is being displayed is shown by the indicator lights.

In setup mode the “raise” and “lower” switches are used to change the value of the parameter being modified.

Setup Mode

Setup mode is used to set some essential operating parameters for the SPC power supply and the ion pump. These are the maximum voltage, the pump size, the set point pressure and the units used for the pressure display.

The setup procedure is as follows:

1. Press the “program” switch once. The display will flash showing the name of the currently selected pressure unit.

3: Operation

2. Use the “raise” and/or “lower” keys until the display shows the name of the desired pressure units.
3. Press the “program” switch once. This moves on to editing the next parameter, in this case the set point pressure.
4. Use the “raise” and/or “lower” keys until the display shows the required set point pressure. If set point operation is not required use the “lower” key until the display shows “off”. This disables the set point relay.
5. Press the “program” switch once. This moves on to editing the next parameter, in this case the maximum voltage.
6. Use the “raise” and/or “lower” keys until the display shows the required maximum voltage.
7. Press the “program” switch once. This moves on to editing the final parameter, the ion pump size.
8. Use the “raise” and/or “lower” keys until the display shows the required ion pump size.
9. Press the “program” switch once. This finishes editing the parameters and returns the unit to normal operation.

These parameter values are stored permanently and remain set until they are edited again by the operator.

Normal Operation

During normal operation, the only interaction between an operator and the SPC supply will be to enable/disable the high voltage and to change the display mode to show the required parameter – pump voltage, pump current or calculated pressure. These operations are performed as follows:

HV Control

By default, the HV output to the pump will be disabled when the SPC is powered up and will remain disabled until the operator requests it, either using the front panel switch or through the serial port. However, by using the serial configuration software, it is possible to configure the SPC to start up with the HV enabled, or to allow external HV control through the misc. I/O port.

To turn the HV on from the front panel, the “HV on/off” switch should be pressed and held for approximately two seconds. The SPC supply will then illuminate the “HV” indicator and attempt to start the ion pump.

To turn the HV off from the front panel, the “HV on/off” switch should be pressed and not held for more than two seconds. As soon as the switch is pressed, the HV will be disabled. The operator should be aware that it is possible

3: Operation

for the HV to be re-enabled by an external controller using the serial link or the misc. I/O port.

In every case, the “HV” indicator light will be illuminated whenever the HV output is active.

Display Mode Selection

The front panel display can be used to show the output voltage, the output current or the calculated pressure.

By pressing the “raise” or “lower” keys it is possible to change which of these parameters is being displayed. The indicator lights to the right of the numeric display show which parameter is currently being displayed.

Set Point Display

The “set point” indicator will be illuminated whenever the set-point relay is driven, this indicates that the calculated ion-pump pressure is lower than the set point pressure.

Error Reporting

During operation the SPC power supply may detect and report a number of possible error conditions. For example, the SafeConn connector may become disconnected, the vacuum may fail or the ion-pump may have a problem. These errors are reported by the following messages on the numeric display:

Table 3-1. *Error Messages and Descriptions.*

SAFE	This indicates that the SafeConn connector is not connected. While this is displayed the SPC will not generate any high-voltages.
Err1	This indicates that the SPC power supply has tried and failed to start the ion pump three times. This error message will be continue to be displayed and the SPC power supply will not try again until the operator intervenes, usually by pressing the “HV on/off” switch.
Err2	This indicates that the ion pump pressure has slowly risen to above 1e-4 Torr and remained higher than this for more than 10 minutes.
Err3	This indicates that the SPC output current has exceeded the specification.
Err4	This indicates that the pressure has risen above 1e-4 Torr during the startup process. The SPC supply will attempt to restart the pump after a delay.
Err5	The power that the SPC has supplied to the ion pump has exceeded the power dissipation limit for the ion pump. The SPC supply will attempt to restart the pump after a delay to allow the pump to cool down.
Err6	The SPC output current has exceeded the specification. The SPC supply will attempt to restart the pump after a delay.
Err7	The output voltage has been pulled below 400V, this usually represents a short-circuit in the ion pump. The SPC supply will attempt to restart the pump after a delay.
ErrC	This indicates that the software controlling the SPC has detected a checksum error in the stored program, please consult your distributor.

3: Operation

It should be noted that all the constants mentioned above, i.e., 400V, 1e-4, 10 minutes, etc., can be changed using the SPC PC configuration application.

Serial Operation

The SPC power supply can be controlled remotely using the serial port. The serial port setup and protocol is detailed in Section 4.

Table 3-2 below lists all of the serial commands recognized by the SPC power supply and the fixed-length responses returned by the unit (with 'x' replaced by an appropriate digit).

Table 3-2. List of Serial Commands and Corresponding SPC Responses.

Hex Command:	Description:	SPC Parameter or Response:
01	MODEL Number.	No parameter, replies "SPC1 "
02	VERSION	No parameter, replies "FIRMWARE x.xx "
0A	Read Current	No parameter, replies "x.xE-x AMPS "
0B	Read Pressure	No parameter, replies "x.xE-x Torr "
0C	Read Voltage	No parameter, replies "xxxx "
0D	Read Status	No parameter, replies "SAFE-CONN " or "STANDBY " or "STARTING " or "RUNNING " or "COOL DOWN 0x " or "PUMP ERROR 0x "
0E	Set Pressure Units	One text parameter - the first letter is checked for "T", "M" or "P" and anything extra is ignored. Null reply.
11	Get Pump Size	No parameter, replies "xxx.x ", i.e. "040.0 " = 40l/s
12	Set Pump Size	One floating point parameter, i.e. "40 " or "0.2 ". Null reply.
33	Set Auto-Restart	One text parameter – the first letter is checked for "y" or "n" and anything extra is ignored. Null reply.
34	Get Auto-Restart	"yes " or "no "
37	START Pump	No parameter, null reply.
38	STOP Pump	No parameter, null reply.
3C	Get Setpoint	No parameter, replies "x.xE-x, y.yE-y "
3D	Set Setpoint	1 floating point parameter, i.e. "1.0e-7 ". Null reply.
44	Lock Keypad	No parameter, null reply.
45	Unlock Keypad	No parameter, null reply.
51	Set Maximum Voltage	1 Floating point parameter, e.g. "5000 ". Null reply.
FF	RESET SPC	No parameter and no reply. This completely resets the SPC.

These commands should be fully compatible with the PHI protocol, except for the Get/Set Pump Size commands, which use floating point numbers to allow pump sizes to be specified down to 0.1 l/s, and the Get/Set Setpoint commands.

3: Operation

The Get Setpoint command returns the set and release pressures only, there are no other values. The Set Setpoint command accepts only one number which is set pressure. The SPC calculates the release pressure by multiplying the set pressure by 1.2, based on a hysteresis value of 20%. This value can be changed using the PC configuration utility.

Note that the SPC is fairly flexible wherever a floating point parameter is required. The following are examples of numbers the SPC would find acceptable:

1, 1.2, 1.2e-3, 10, 0.0001, 1e-2, 1e+2, etc..

It is also worth noting that the SPC can return floating point values in various forms, including numbers with leading zeros – i.e. “040.0” and this (rarely) includes exponential notation with a first digit of 0, for example “0.9e-9”, “0.5e-6”, etc.

(There are also some extra commands specific to the PC configuration utility which are not documented here).

The serial port hardware can be configured to drive RS-232, RS-422 or RS-485 lines. The baud-rate, etc., can be selected using the PC configuration application.

Remote Hardware Operation

The SPC supply can be controlled to a limited extent from hardware using the misc. I/O port. (Refer to Table 6-2 on page 6-3).

HV Control

Pin 8 on the misc. I/O connector can be configured using the PC application to allow a logic signal to either switch the HV on, switch the HV off, or both. The active state of this signal can be selected. This pin is internally pulled down (to 0V through a 10K resistor) and it can be driven from a logic level, or through a switch to either the +5V or any of the +14V pins on the same connector.

HV Monitoring

Pin 13 on the misc. I/O connector can be used to determine if the HV is enabled. It is designed to drive a relay, or logic signals as required.

When the HV is enabled, pin 13 is pulled down to 0V and can sink 100mA. When the HV is disabled, pin 13 is pulled up to +14V through a 4K7 resistor.

Output Voltage Monitor

Pin 14 on the misc. I/O connector is a buffered voltage output which is proportional to the HV output voltage and which can be used to monitor the HV voltage. The scaling factor defaults to 1V per 1KV out, though this is soft configurable and can be set using the PC configuration tool.

Output Current Monitor

Pin 12 on the misc. I/O connector is a buffered voltage output which is proportional to the HV output current and which can be used to monitor the HV current. The scaling factor defaults to 1V per 1mA out, though this is soft configurable and can be set using the PC configuration tool.

Setpoint Relay

The setpoint relay is driven while the following conditions are all true:

1. The SPC unit is powered up.
2. The HV is enabled.
3. The output voltage is high enough for a valid pressure to be read. By default this is greater than 2kV.
4. The calculated pressure is lower than the user-selected setpoint pressure.

Note that there is a delay after turning the HV until the SPC considers the calculated pressure reading to be valid, this can take up to one minute. The setpoint relay will not be driven during this period.

Pin 1 is the relay common, pin 2 is the normally closed and pin 9 is the normally open contact.

Pin 11 is a TTL logic level output (with a 1K resistor in series for protection) which mimics the set point relay state. It is high whenever the set point relay is driven.

Power Supplies

The following power supply pins are available on the misc. I/O connector. These power supplies are not protected and should be used with care. Do not attempt to power the SPC by connecting external power supplies to these pins.

Pin 5 is connected to (approximately) -14V .

Pin 10, pin 6 and pin 15 are connected to (approximately) $+14\text{V}$.

Pin 7 is connected to (approximately) $+5\text{V}$.

Pin 3 and pin 4 are connected to 0V .

The $+14\text{V}$ and -14V supplies are regulated, but not calibrated. In practice, they may vary over the range 12V to 15V or so. No more than 50mA should be drawn from any of these supplies, and significant levels of noise should not be injected into them.

The $+5\text{V}$ supply may range from $+4.9\text{V}$ to $+5.1\text{V}$. Do not draw more than 100mA from this supply.

Section 4:

Serial Protocol

Overview

RS-232, RS-422 and RS-485 are all electrical standards which specify the hardware requirements for a serial link, but not the software protocol used to convey meaningful information across this serial link.

The SPC power-supply can be configured in software to use any of the above hardware standards, and the SPC supports many variations of these 'standards' to increase the range of devices with which it is compatible.

The easiest way to configure the SPC serial port is to use the PC configuration tool (refer to Section 5 of this manual for further information).

Equally important for serial communication is the use of a common software protocol. To this end the SPC power supply supports a number of serial protocols including, for compatibility, a super-set of a 'standard' protocol used by some other ion pump power supplies.

Protocol Details

The serial protocol consists of command packets sent from a host computer to the SPC power supply, and response packets sent back from the SPC power supply back to the host computer.

To permit a host computer to control more than one device on the same serial line each packet contains a device address number and each device has a unique address. Only the device corresponding to the address in the command packet responds to the command.

To help ensure reliable communications both the command and the response packets contain checksum information.

Refer to Table 4-1 through 4-4 below for a list of the commands supported by the SPC power supply.

The serial port settings would normally be set to 9600 baud, 8 data bits, no parity, and 1 stop bit. Normally the handshaking should be set to 'none', though the SPC can be configured to support XON/XOFF software handshaking and/or CTS/RTS hardware handshaking.

The SPC baud rate can be configured using the PC configuration utility from 2400 to 57600 baud, but by default it is set to 9600 baud.

4: Serial Protocol

The SPC unit ID is set to one by default, this can also be configured using the PC configuration utility. The SPC baud rate and unit ID can also be set manually, see the Advanced Settings chapter below.

The command packet may or may not contain additional information as a data field, hence there are two possible formats for the command packet.

The format of the command packet (without optional data) is as follows in the table below.

Table 4-1. *Table of the Command Packet w/o Optional Data.*

Field:	Field Size:	Characters:
Start Character	1 byte	“~”(7Eh)
<space>	1 byte	“ ” (20h)
Device address	2 bytes	“xx” two hex digits
<space>	1 byte	“ ” (20h)
Command	2 bytes	“xx” two hex digits
<space>	1 byte	“ ” (20h)
Checksum	2 bytes	“xx” two hex digits
Terminator	1 byte	0Dh

The format of the command packet (with optional data) is as follows in the table below.

Table 4-2. *Table of Command Packet with Optional Data.*

Field:	Field size:	Characters:
Start Character	1 byte	“~”(7Eh)
<space>	1 byte	“ ” (20h)
Device address	2 bytes	“xx” two hex digits
<space>	1 byte	“ ” (20h)
Command	2 bytes	“xx” two hex digits
<space>	1 byte	“ ” (20h)
Data field	Unknown	ASCII characters
<space>	1 byte	“ ” (20h)
Checksum	2 bytes	“xx” two hex digits
Terminator	1 byte	0Dh

4: Serial Protocol

The checksum is calculated by summing all the characters sent after the Start character and before the Checksum field.

After a valid command packet has been received it is the responsibility of the device to react and respond to the command within 500mS. The SPC power supply has one exception to this rule, which is the RESET command. This immediately resets the SPC unit so it is unable to send a response packet. This command is intended to be used by the PC configuration utility and should only be used with care by other software.

The response packet is similar, but does not include the start character field. It also may or may not contain additional information as a data field, hence there are two possible formats for the response packet.

The format of the response packet (without optional data) is as follows:

Table 4-3. *Table of Response Packet without Optional Data.*

Field Name:	Field Size:	Characters:
Device address	2 bytes	"xx" two hex digits
<space>	1 byte	" " (20h)
Status	2 bytes	"OK" or "ER"
<space>	1 byte	" " (20h)
Response Code	2 bytes	"xx" two hex digits
<space>	1 byte	" " (20h)
Checksum	2 bytes	"xx" two hex digits
Terminator	1 byte	0Dh

The format of the response packet (with optional data) is as follows:

Table 4-4. *Table of Response Packet with Optional Data.*

Field Name:	Field Size:	Characters:
Device address	2 bytes	"xx" two hex digits
<space>	1 byte	" " (20h)
Status	2 bytes	"OK" or "ER"
<space>	1 byte	" " (20h)
Response Code	2 bytes	"xx" two hex digits
<space>	1 byte	" " (20h)
Data field	Unknown	ASCII characters
<space>	1 byte	" " (20h)
Checksum	2 bytes	"xx" two hex digits
Terminator	1 byte	0Dh

4: Serial Protocol

The checksum is calculated by summing all the characters sent including the Device address up to but not including the Checksum field.

The SPC power supply will only recognize and respond to serial commands after the following events have occurred:

- The SPC has received a “~” start character.
- The Device address field matched the SPC’s internally set address.
- There was a valid 2 hex digit command field.
- The calculated checksum matched the received checksum field.
- There was a carriage return terminator.

Once a valid serial command has been recognized, it will be acted upon and a response packet returned within 500mS.

Provided messages don't exceed 32 bytes in length, the SPC will handle them correctly, even when sent without pause at 57600 baud.

Messages longer than 32 bytes but shorter than the maximum allowed message length of 64 bytes will also normally be handled correctly at up to and including 57600 baud, but this may not be true if the SPC is very busy, for example, performing consecutive EEROM write cycles in the program mode.

Messages longer than 64 bytes are not supported and will be ignored.

The SPC does not send reply messages longer than 30 bytes.

Typically, no handshaking is required between the SPC and the external controller, but where the controller is unable to keep up with the SPC, the SPC can be configured to support XON/XOFF or any combination of the RTS, CTS, DSR, and DCD hardware handshaking lines.

When using XON/XOFF, the remote controller can send an XOFF character (\$13) to stop the SPC, then send an XON character (\$11) to restart the SPC transmission. The SPC is fast enough to keep up with incoming data at any speed up to and including 57600 baud, so it will never send either XON or XOFF.

Serial Command Examples

For example, the following strings represent valid commands and checksums, and could be sent by simply typing them into a terminal. Do not type the “” quotes, and the spaces are significant. These assume the unit ID of the SPC is set to 1:

Command 01, GET MODEL NUMBER

Send “~ 01 01 22” + a carriage return

If the SPC is connected correctly it should respond with a message containing it’s model name. Currently this is as follows:

SPC replies “01 OK 00 SPC1 F2” + a carriage return.

Command 02, GET VERSION

Send “~ 01 02 23” + a carriage return

If the SPC is connected correctly it should respond with a message containing it’s software version number. Currently this is as follows:

SPC replies “01 OK 00 FIRMWARE 1.01 18” + a carriage return.

Section 5:

PC Configuration Tool

A freeware PC windows application program is available which allows the user to calibrate and/or configure the SPC power supply. This application is available from your distributor or can be downloaded from the Scanwel web-site (currently at www.scanwel.co.uk).

Although this application is not necessary for normal use of the SPC power supply, it does extend the functionality of the SPC by allowing the user to calibrate the SPC power supply, provided that they have the required tools and expertise. This includes the ability to alter the current to pressure scale factor used to calculate the vacuum pressure from the ion pump voltage and current.

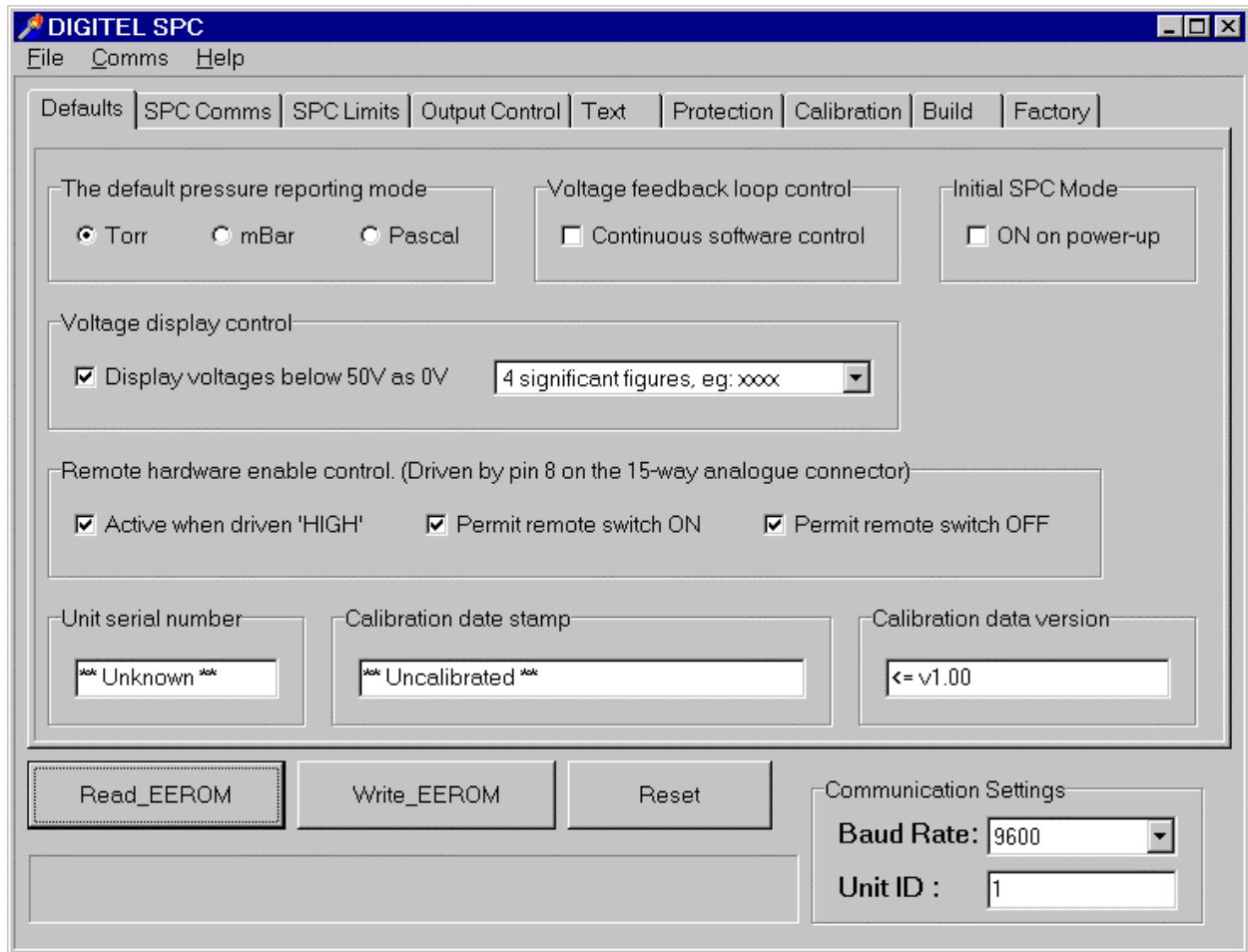


Figure 5-1. The DIGITEL SPC Configuration Tool: Defaults Tabbed Page.

5: PC Configuration Tool

The PC Configuration Tool can be used to customize the range of voltages, currents, and ion pump sizes that the SPC reports to the user, as well as setting the scale-factors for the current and voltage monitoring outputs as shown below.

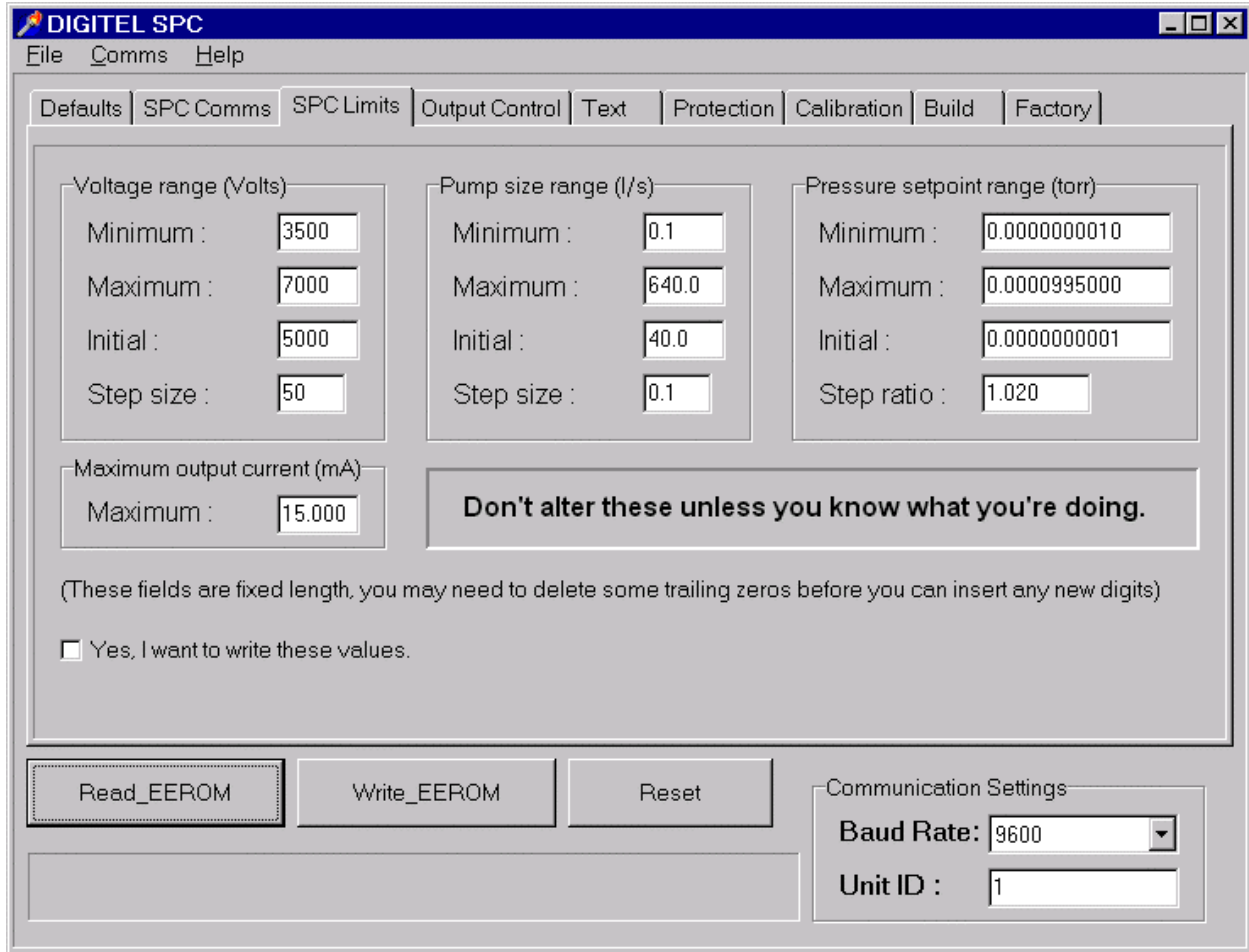


Figure 5-2. The DIGITEL SPC Configuration Tool: SPC Limits Tabbed Page.

5: PC Configuration Tool

It can also be used to customize the protection limits for the ion pump and SPC supply, and also to configure some cosmetic features of the SPC, for example, the number of digits and rounding mode of the numeric display.

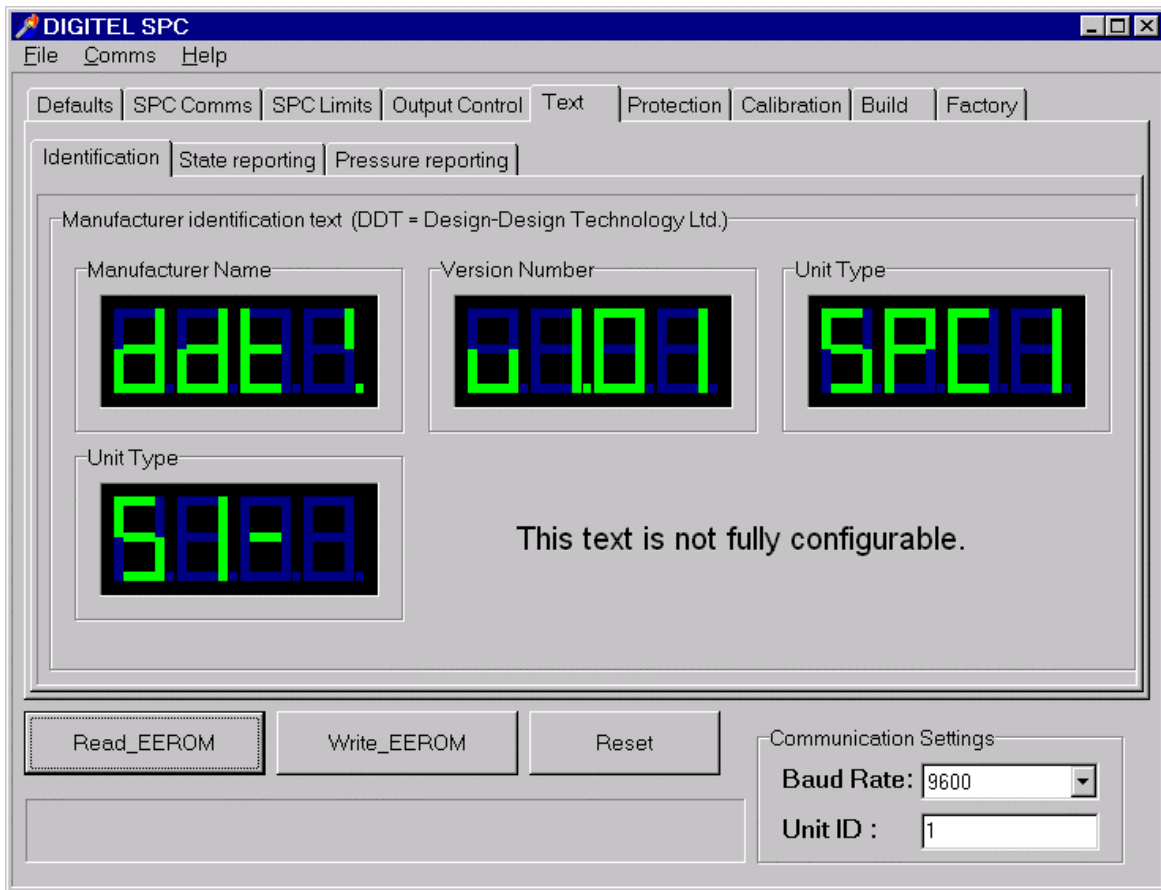


Figure 5-3. An Example of the Text Tabbed Page within the SPC Configuration Tool.

Downloading, Installing the Software

To download and install the freeware software, perform the following steps.

1. Go to the Scanwel web-site at www.scanwel.co.uk.
2. Select the link to **Custom Systems** and then select the category for **Downloads**.
3. Select the **ion_psu.zip** icon and save to a local hard drive on your PC. After downloading the file, unzip (decompress) the file and select the executable file (ion_psu.exe).



ion_psu.zip
Size: 190K

Configuration software for the SPC

Section 6: Inputs and Outputs

All input and output connectors are mounted on the rear panel of the SPC power supply. Refer to Figure 6-1 below.

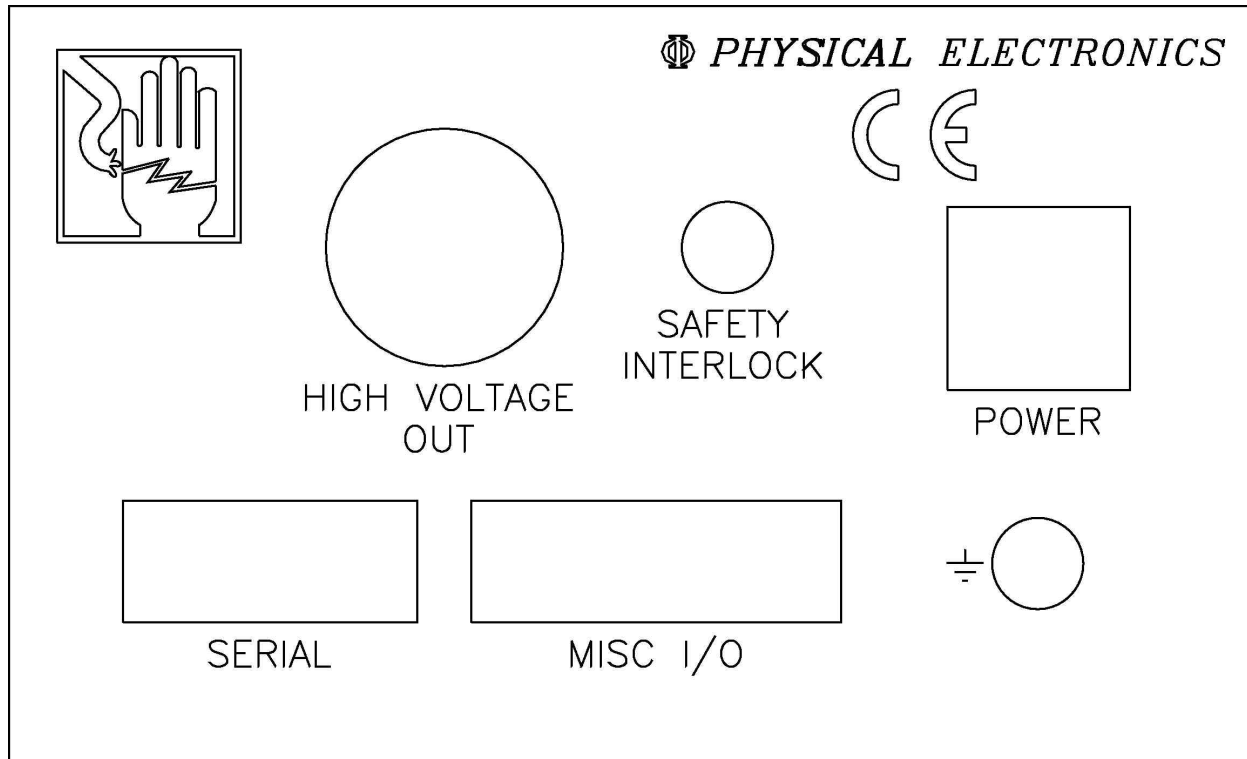


Figure 6-1. Diagram of the back panel of the SPC.

Connectors

HIGH VOLTAGE OUT

This is a Kings SHV-10kV connector and connects directly to the ion pump.

SAFETY INTERLOCK

This is an SMB jack socket. This connector must be shorted to ground to enable the HV generator. Usually, this is accomplished by using a connector attached to the HV cable so that it automatically disconnects if the HV cable is removed.

6: Input and Output

POWER

This is a trident 6-pin connector. A suitable cable will have been supplied with the SPC unit, usually as part of a universal AC-to-DC converter.

SERIAL

This is a 9-pin Sub-D connection. The function and pin-out of this connector is determined by software running in the SPC power supply. This can be configured using the PC configuration tool software. This configuration tool will also display the currently defined pin-out for the serial port.

The default pin-outs for some of the possible serial interfaces are shown below in Table 6-1.

By default the SPC power supply will use 3-wire RS-232 with the pin-outs shown in the RS-232 column below, although these can be overridden using the PC configuration tool. By default, the SPC does not support any of the RS-232 control lines. If these are required, they can be enabled using the PC configuration tool.

Do not connect to any pin other than the ones appropriate for the serial mode selected. Some of the pins not used by the current mode may still be driven even though they are not used.

Table 6-1. *Serial Port Pin Connectors and Corresponding Assignments.*

Serial Port Pin:	RS-232:	RS-422:	RS-485:	PHI/DD-485:
1				
2	RxD	TXA(+)	A(+)	TXA(+)
3	TxD	RXA(+)		RXA(+)
4				
5	GND	GND	GND	GND
6				
7		RXB(-)		RXB(-)
8		TXB(-)	B(-)	TXB(-)
9				

Refer to page 3-5 in Section 3 for information regarding the use of this serial connector.

6: Input and Output

MISC I/O

The pin-out of the Miscellaneous I/O port is shown in the table below.

Table 6-2. Misc. I/O Pin Connections and Corresponding Functions.

MISC(ellaneous) I/O Port Pin Number:	Function:
1	Set point relay common
2	Set point relay NC
3	GND
4	GND
5	-14V
6	+14V
7	+5V
8	Remote HV Enable
9	Set point relay NO
10	+14V
11	Set point logic output
12	Output Current Monitor
13	HV Enable Monitor
14	Output Voltage Monitor
15	+14V

Refer to page 3-7 in Section 3 for information regarding the use of this connector.

Section 7:

Advanced Settings

General Information

The SPC contains a small amount of memory (called EEROM) which stores information permanently, even when the power is disconnected, until the information is changed by the user. This memory is where the SPC ‘remembers’ what size pump is connected, what serial baud rate to use, etc.

This information is stored in a form which is easy for the SPC to understand, but which is fairly meaningless to the user. If changing any of these settings, either use the front-panel when the change is trivial, such as setting a new pump size, or use the PC configuration utility for more obscure settings. The only time the user may need to directly edit this information is if the SPC has not been set up to talk to the PC, or if a PC or the PC configuration tool software is not available.

The following information will allow the user to manually restore the power supply to the state it was in when it left the factory, or to set some of the serial port settings. This will usually be enough to allow the unit to communicate with the PC application which can then be used to make more complicated changes.

Before making any changes, it is necessary to put the SPC into the configuration mode. This will be described first. The SPC can be returned to normal operating mode by simply switching it off and on again. The SPC has to be put into configuration mode manually every time it is switched on, as required.

Once the SPC is in this mode, it is possible to manually change the values stored in the SPC memory, but be careful to only change the settings EXACTLY as explained here. Changing any other values could make the SPC behave dangerously. For example, it could output an excessively high voltage or operate the pump outside its permitted parameters.

If confused while following any of these procedures, it is probably safest to turn off the SPC without trying to continue and restart the procedure from scratch. If you suspect you have changed any settings incorrectly, always use the “restore factory defaults” procedure to reset the SPC back to the state it was in when it left the factory. In most cases, this will return the SPC back to normal operation, however, if the unit is restored back to the factory defaults, any calibration or other changes made since it left the factory will be lost. Normally this should not be a problem, but if advice is required, feel free to contact the factory. An e-mail contact address and phone numbers are given in the Section 8: Service.

Setting the SPC into Configuration Mode

Before making any changes, the SPC must be placed into the configuration mode. To do this, you must do the following:

1. First, switch the SPC off using the front panel switch. The display will go blank.
2. While the SPC is still off, press and hold the "Raise", "Lower" and "Program" buttons simultaneously.
3. While still holding all three buttons pressed, switch the SPC on. Do NOT release the buttons yet.
4. The unit will go through the normal start-up sequence, you must keep holding all three buttons pressed while it does so.
5. When the start-up sequence is finished, after about 7 seconds, you should see the following displayed : "A-00", this indicates that the unit is ready to be configured.
6. Release all three buttons now.
7. If you do not get this display, turn off the unit and try again. Failure usually means that you did not hold all of the buttons down for the entire time. This is deliberately made awkward so that the unit cannot be accidentally set into the configuration mode.
8. At this point the display should be showing "A-00", if it is not turn it off and try the above process again until it is.
9. The SPC is now in configuration mode, at this point you can make changes to the EEROM or simply turn it off and the SPC will revert back to normal operation when you turn it back on again.

Resetting back to the Factory Defaults

The following steps are required to restore the factory default settings.

1. If you have not already done so, place the SPC power supply into the configuration mode as described above.
2. The SPC display should now be showing "A-00". If it is not, turn it off and try the "Setting the SPC into configuration mode" process again until it is.
3. Now, press the "Program" button once. The display will change to "d-00". If it does not, try pressing "Program" again, or switch off and try the whole process again.

7: Advanced Settings

4. Now, repeatedly press the "Lower" button until the display steps round to "d-A0". You can press and hold the button to make it auto-repeat. If you 'miss' the value "d-A0" and overshoot, use the "Raise" button to move backwards.
5. When the display shows "d-A0", press the "Program" button once. The display will return to showing "A-00". Now, press the "HV on/off" button and the unit will reset, then start up in the state it was in when it left the factory.

The process is complete. The unit should now behave exactly as it did when it was first shipped. This process can be repeated as many times as desired.

Simple 3-wire RS-232 Setup

Use this procedure to get the SPC to talk to the PC configuration tool, or for any application that requires 3-wire (GND, RxD and TxD) RS-232 mode.

1. Before starting, decide what unit ID number to assign to the SPC. Under nearly all circumstances, this will be "1".
2. This procedure will set the SPC to use 3-wire RS-232, 9600 baud, 8 data bits, no parity and 1 stop bit. It also sets the unit ID to any given value in the range 1 to 32.
3. If you have not already done so, place the SPC power supply into the configuration mode, as described above.
4. The SPC display should now be showing "A-00". If it is not, turn it off and try the "Setting the SPC into configuration mode" process again until it is.
5. Now press the "program" button once and the display will change to "d-00".
6. If the display did not change to "d-00", try pressing the "program" button again. The "program" button switches between editing the address (shown as "A-") and editing the data at that address (shown as "d-").
7. If the display changes to "d-xx", where "xx" is not "00", this means that the SPC you are trying to configure is one of the first fifteen units which do not support this operation. In this case, try changing the unit ID and serial mode separately using the procedures described in the following sections below.
8. With the display now showing "d-00", use the "raise" and "lower" buttons to change this to whichever unit ID is required. If not comfortable with hexadecimal numbers, this may seem awkward, but the table below (Table 7-1, page 7-4) shows all valid settings for this location.
9. For example, to select 3-wire RS-232 and unit ID "1", you only need to press the "Raise" button once to make the SPC display "d-01".

7: Advanced Settings

10. Once the display is showing the appropriate setting, press the “program” button once. This will configure the SPC as selected and the display will revert to showing “A-00”. Note that if the “program” button is pressed again, the display will not show the setting just selected, but instead will revert back to showing “d-00” to indicate that it is ready to accept another setting.
11. Now, press the "HV on/off" button, and the unit will reset and start up with the new serial mode and user ID.

This process can be repeated as many times as desired.

Table 7-1.

Simple 3-wire RS-232 Settings.

Required SPC Unit ID:	SPC Display	Required SPC Unit ID:	SPC Display
1(default)	“d-01”	17	“d-11”
2	“d-02”	18	“d-12”
3	“d-03”	19	“d-13”
4	“d-04”	20	“d-14”
5	“d-05”	21	“d-15”
6	“d-06”	22	“d-16”
7	“d-07”	23	“d-17”
8	“d-08”	24	“d-18”
9	“d-09”	25	“d-19”
10	“d-0A”	26	“d-1A”
11	“d-0B”	27	“d-1B”
12	“d-0C”	28	“d-1C”
13	“d-0D”	29	“d-1D”
14	“d-0E”	30	“d-1E”
15	“d-0F”	31	“d-1F”
16	“d-10”	32	“d-20”

Do not use any value not shown in the table above. Other values do not select different unit ID’s, but are instead interpreted by the SPC as configuration commands. If selecting a unit ID which is not shown in the table, use the specific unit ID selection process described below.

Changing the Unit ID Setting Only

If you have not already done so, place the SPC power supply into the configuration mode, as previously described.

1. The SPC display should now show "A-00". If it is not, turn it off and try the "Setting the SPC into configuration mode" process again until it is.
2. What "A-00" *means* is that the SPC is ready to change the value stored at address 00 in memory. The "A" stands for Address. When the "A-" is shown, this changes the address of the information which the user is going to change, not the information itself. Each piece of information has a unique address, for the SPC the address has two hexadecimal digits, from "00" to "FF". Do not worry if you do not understand this, you do not need too to follow these procedures. Insure that the display is set to exactly what is given here and it should work.
3. Press and hold the "raise" button until the display is showing "A-22". Hold the "raise" key pressed in to repeat. If the display is overshoot, use the "lower" button to move back to "A-22". It does not matter if using repeats or overshoots as long as the display shows "A-22".
4. Now press the "program" button once and the display will change to "d-xx". Note that there won't actually be the two "x" characters. What will actually be displayed will be two hex digits which represent the value of the current unit ID. For example, if the unit ID is currently set to 1, the user will see "d-01". If the unit ID is set to 2, the user will see "d-02", etc.
5. If the display didn't change to "d-", try pressing the "program" button again. What the "program" button does is switch between editing the address (shown as "A-") and editing the data at that address (shown as "d-").
6. Now that you have the display showing the data ("d-xx") you can use the "raise" and "lower" buttons to change this data to what you require. If you're not comfortable with hexadecimal numbers this may seem awkward, but the table below (Table 7-2) has the settings for the first few unit ID values.
7. Note that these data values ("d-") obviously only apply if the address ("A-") value is currently set to 22 ("A-22").
8. Once the right data has been set for the required Unit ID, (for example, if the Unit ID desired is 1, set the display to be "d-01"), then press the "program" key. This writes the new value into memory and then changes the display back to the address mode ("A-xx") to allow for selection of another address, if required. Writing the memory takes very little time and any delay while this happens will not be detected.
9. You can repeatedly switch between address and data mode by pressing the "program" key to check that you have actually changed the data.

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When finished, either press the “HV on/off” key, or switch the power off and then on again. When in the configuration mode the “HV” key doesn’t turn the HV on, it just returns the SPC from configuration mode back to normal operation.

Table 7-2. List of the SPC Unit IDs and Corresponding Data Values.

Required SPC Unit ID:	Data Value for Address (“A-22”):
1	01 (“d-01”)
2	02 (“d-02”)
3	03 (“d-03”)
4	04 (“d-04”)
5	05 (“d-05”)
6	06 (“d-06”)
7	07 (“d-07”)
8	08 (“d-08”)
9	09 (“d-09”)
10	0A (“d-0A”)
11	0B (“d-0B”)
12	0C (“d-0C”)
13	0D (“d-0D”)
14	0E (“d-0E”)
15	0F (“d-0F”)
16	10 (“d-10”)
17	11 (“d-11”)
18, etc	12 (“d-12”) etc

Number values above 18 need to be converted into hexadecimal numbers. Number values up to 255 are legal.

Resetting the SPC Serial Port back to 3-Wire RS232

This procedure changes the serial mode to 3-wire RS-232, but leaves the unit ID unchanged. A simpler procedure outlined previously in this section might be easier to use for unit ID values below 32.

1. If you have not already done so, place the SPC power supply into the configuration mode, as described above.

7: Advanced Settings

2. The SPC display should be showing "A-00". If not, turn it off and try the "Setting the SPC into configuration mode" process again until it is.
3. What "A-00" *means* is that the SPC is ready to change the value stored at address 00 in memory. The "A" stands for Address, and whenever the "A-" is shown you are changing the address of the information which you are going to change, not the information itself. Each piece of information has a unique address, for the SPC the address has two hexadecimal digits, from "00" to "FF". Do not worry if you do not understand this, you do not need to follow these procedures. Insure that the display has been set to exactly what is given here and it should work.
4. Press and hold the "raise" button until the display is showing "A-23". While you hold the "raise" key pressed it will repeat, and if you overshoot you can use the "lower" button to move back to "A-23". It does not matter if you use repeats or overshoot as long as you get the display to show "A-23".
5. Now press the "program" button once and the display will change to "d-xx". Note that there won't actually be the two "x" characters, what you'll actually see will be two hex digits which may have any value.
6. If the display didn't change to "d-" try pressing the "program" button again. What the "program" button does is switch between editing the address (shown as "A-") and editing the data at that address (shown as "d-").
7. Now that you have the display showing the data ("d-xx") you can use the "raise" and "lower" buttons to change this data to "d-70". If you're not comfortable with hexadecimal numbers, this may seem awkward, but simply keep using the "raise" and "lower" buttons until the display shows this value.
8. Once the right data has been set, press the "program" key. This writes the new value into memory and then changes the display back to the address mode ("A-xx") to allow the user to select the next address, if required. Writing to the memory takes very little time. The user will not notice any delay while this takes place.
9. You can repeatedly switch between address and data mode by pressing the "program" key to check that the data has actually changed.
10. Now change the address to "A-24" and change the data there to "d-FF" using the "program", "raise" and "lower" keys as above. Press "program" to save this value.
11. Now change the address to "A-25" and change the data there to "d-10" using the "program", "raise" and "lower" keys as above. Press "program" to save this value.
12. Now change the address to "A-29" and change the data there to "d-98" using the "program", "raise" and "lower" keys as above. Press "program" to save this value.

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13. Now change the address to “A-2A” and change the data there to “d-33” using the “program”, “raise” and “lower” keys as above. Press “program” to save this value.
14. When all these values have been changed, either press the “HV on/off” key, or switch the power off and then on again. When in the configuration mode, the “HV” key does not turn the HV on. It merely returns the SPC from configuration mode back to normal operation.

If you make those changes correctly this will set the unit to conventional RS-232 at 9600 Baud. This procedure DOES NOT change the unit ID, so if unsure of the SPC’s unit ID, change it to 1 either by using the procedure outlined on page 7-5 or by simply setting location A-22 to the value d-01 at the same time as the other five locations above are set.

Section 8: Service

The SPC power supply does not require routine service or maintenance. Under no circumstances should the SPC power supply be opened. There are no user serviceable components inside.

If the unit fails to perform specified functions, either seek the services of qualified personnel or contact PHI Customer Service as follows:

By mail:

Physical Electronics, Inc.
PHI Vacuum Customer Service, M/S G11
6509 Flying Cloud Drive
Eden Prairie, MN 55344
USA

By e-mail:

vacuum@phi.com

By telephone or fax:

Region	Telephone	Fax
U.S.	1-800-237-3603	1-952-828-6325
Outside U.S.	1-952-828-5831	1-952-828-6325
Japan	81-46-785-6522	81-46-785-4411
Europe	49-89-96275-0	49-89-96275-50



WARNING: Physical Electronics' (PHI's) 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 this manual and in other PHI 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.

Cleaning Instructions

Normal maintenance does not require cleaning. A cloth slightly moistened with water may, however, be used on the outside only, if desired.

Removal of the Component for Servicing

Removal for servicing is to be performed by PHI Customer Service personnel only, according to PHI Customer Service procedures.

Equipment Required

Tools are to be used on equipment by technicians only, not by operators.

Section 9: Accessories

The following parts and accessories are available for the DIGITEL SPC (Small Pump Control).

Table 9-1. *Listing of DIGITEL SPC Accessories.*

Part No.:	Part/Accessory:
E-647586	DIGITEL SPC-1 Power Supply
E-647585	24V DC converter, includes 1m SPC-1 connection cable (24V)
E-CICON3F240	3m ferrite IEC/CE222 power cord (compatible with 110 or 240V operation)
E-CIECPIECS2M	IEC Plug to IEC Socket, 2m
E-CIECPIECS3M	IEC Plug to IEC Socket, 3m
E-CIECSUKMP2M	IEC Socket to UK Mains Plug, 2m
642453	3m HV Cable with SAFE-CONN connector