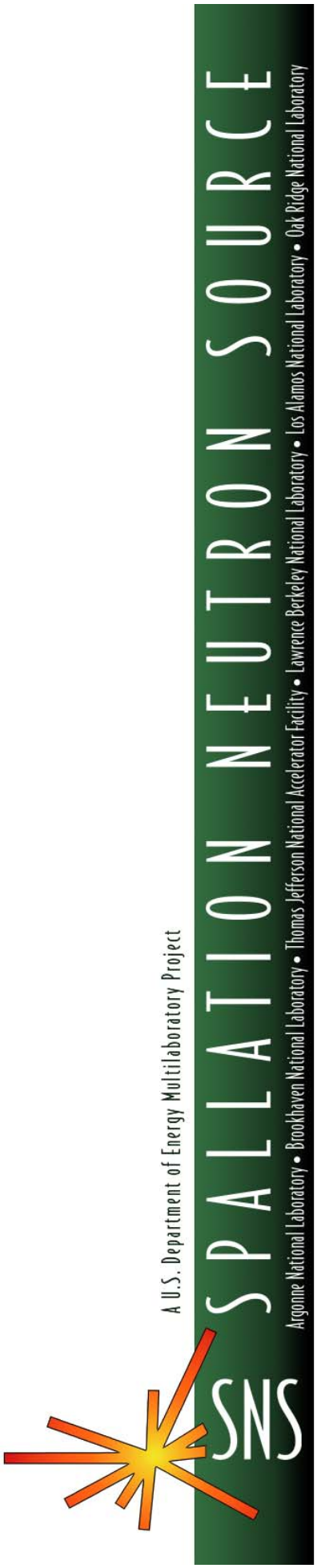
SNS 104000000-ST0001-R00

SNS Magnet Power Supply Standards Manual



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SNS MAGNET POWER SUPPLY STANDARDS MANUAL

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1. MAGNET POWER SUPPLY SPECIFICATION STANDARDS FOR SNS

1. All Power Supplies shall meet IEC 61000 part 3-2/4 (harmonics) part 3-3/5 (voltage fluctuation and flicker), part 6-2/4(EMC immunity and emission) and UL standards.
2. Power Supply vendors shall be ISO9000-4 compliant, or demonstrate a presence of an ISO equivalent QA program at their facilities.
3. Power Supply enclosures shall be minimum IP43 or NEMA12 for free standing power supplies, and rack mounted power supplies shall have metal front panel and minimum IP20 for the part embedded in the equipment rack.
4. Power Supply AC and DC terminals shall be part of the above enclosure or of separate removable terminal enclosure(s) protecting against accidental contact, EMI shielded if a source of pulsed energy.
5. All power supplies shall be in compliance with SNS Hazardous Energy Control Manual, i.e., lockable switch, circuit breaker, cord plug or other lockable disconnecting means galvanically separating incoming source of energy from the power supply.
6. ON/START and OFF/STOP push buttons and indications. ON or START being of GREEN color, OFF or STOP being of RED color. ON and OFF toggle switches for small power supplies shall be permitted if there is no ambiguity about the ON/OFF state of the supply (light, LED or other LC multiple display).
7. All Magnet Power Supplies rated higher than 5kW shall have PERSONAL PROTECTION SYSTEM (PPS) enable/disable interlock capability. All Magnet Power Supplies rated higher than 5kW shall therefore be equipped with a 9-pin PPS connector as specified in the "General Interface Requirements for SNS Power Supplies" attachment to this document. In case of small rack mounted power supplies, where PPS required modification would not be financially justified, clustering of same types of power supplies being governed by a PPS contactor panel shall be permitted. The PPS contactor panel PPS interface shall have the same PPS connector as described in the "General Interface Requirements for SNS Power Supplies" attachment. Soft turn off of large power supplies shall be permitted.
8. All Magnet Power Supplies regardless of their output shall have a 4-pin connector as described in the "General Interface Requirements for SNS Power Supplies" attachment, section 4.0 Machine Protection System (MPS) Interface. In addition to this MPS interface, selected magnets shall have DC output current monitor hardwired to MPS system. These selected magnet power supplies are: Linac Dump magnet power supply for magnets LDUMP:QH1, :QV2, :QH3, :QH4, :QV5, :QV6; Linac to RING Dump HEBT:DH11, :DH12; Injection Dump IDUMP:Q1 Extraction Dump to Target RTBT:DH13 (RTBT:DH14); Extraction Dump EXTDUMP:QH1, :QV2, and Target RTBT:QH26, :QV27, :QH28, :QV29, :QH30. Required trip read back accuracy 1%. The adjustable shunts for QUADRUPOLE magnet power supplies in the LINAC do not require individual MPS interface.
9. All rack mounted Magnet Power Supplies shall be selected to have most parameters identical by type of magnets they are powering and specifications shall take into consideration grouping by output and other relevant parameters.
10. All rack mounted Magnet Power Supplies shall be mounted on L brackets. Rack profile design shall call for heavier and water-cooled power supplies to be mounted on the bottom of the equipment racks.
11. Power Supplies of identical types shall have same front panel color, indications and readouts.
12. All Power Supplies shall have the following front panel instrumentation and indications:

- Main switch or circuit breaker.
- ON/START and OFF/STOP push buttons for input (AC) and output (DC) power. Exception 2
- REMOTE/LOCAL CONTROL switch. This switch shall do what it says, i.e., REMOTE CONTROL shall disable LOCAL CONTROL and LOCAL CONTROL shall disable the REMOTE CONTROL. In both cases the status indication shall not be affected. Both LOCAL and REMOTE status read outs **must not** be disabled in any position of the switch.
- Over current, ground fault, over heat, internal and external fault indications, if so equipped.
- PPS permit OK indication.
- Volt/Ampere meters or equivalent LC multiple display.
- Local power supply setting. (V/I)

Remote features shall be capable of accommodating SNS standard Power Supply Interface. See "General Interface Requirements for SNS Power Supplies" attachment.

Commands:

- ON/OFF
- STANDBAY
- RESET
- POLARITY
- Remote V/I setting as described in PSI standard proposal (see attachment)

Status:

- ON/OFF
- LOCAL/REMOTE
- STANDBY
- Remote V/I readback as described in PSI standard proposal (see attachment)
- Out of Regulation
- Over current
- Over voltage
- Over temperature
- Ground fault
- Air flow
- Water flow if applicable
- Water mat if applicable
- Internal interlock
- External interlock (PPS interlock)
- RIPPLE FAULT
- PHASE LOSS

13. Magnet power supply enclosure or front panel shall be of beige color:

    `SNS Color Pale Yellow Beige, Federal Standard No.37886, Chip No.25, Page 595B`

14. Reliability. Expected lifetime shall be ten years, assuming 99.9% availability for accelerator operation 6000 hours a year.
15. Documentation shall consist of two complete sets manufacturer as built for each delivered power supply (type and system), operation manual, maintenance manual, block diagram, installation drawings and technical description of the power supply and the system where the power supply is used. Warranty of the power supply shall be negotiated for two years from the date of shipment.

APPENDIX A

GENERAL INTERFACE REQUIREMENTS FOR SNS POWER SUPPLIES

CONTENTS

1. SCOPE

This document describes the interface to the SNS Power Supplies. It describes how the Control, Machine Protection System (MPS), Personal Protection System (PPS), and External Interlock System are connected to the power supplies.

Some of this document is applicable to the manufacture of the power supplies. Other parts are included to assist in the installation of the equipment.

2. CONTROL INTERFACE

2.1 OVERVIEW

The control interface consists of two elements, a Power Supply Controller (PSC) that resides in the control VME crate, and a Power Supply Interface (PSI) that resides in or near the power supply. These two elements are connected by a pair of fiber optic cables. The PSC can control up to six PSIs. This system is shown in Figure 1.

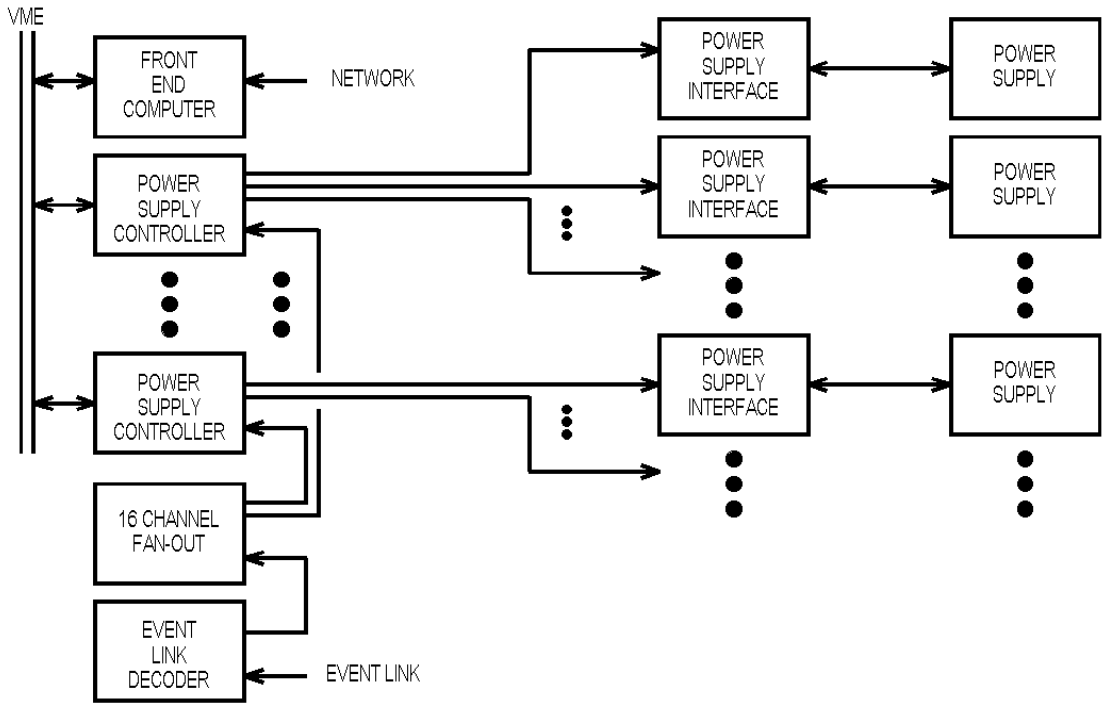

Fig. 1. Control interface.

2.2 THE PSI TO POWER SUPPLY CONNECTION

The power supply is connected to the PSI with two cables. One is for analog signals, the other for digital signals. The power supply manufacturer will typically supply these cables, but it is important that even the power supply end is as described here. Then, if a cable fails, it can be replaced with a standard spare.

2.2.1 Analog Cable

a. Analog Output - There is one analog output from the PSI to the power supply. This is typically used for the current set point. Depending on a jumper setting on the PSI, this may be either bipolar (±10V) or unipolar (10V). It is designed to be received differentially, and will drive loads whose resistance is 2KΩ or greater.

b. Analog Inputs - There are four analog inputs to the PSI from the power supply. These are typically used for current set point, measured current, measured voltage, and measured current. These are always bipolar (±10V). They are received differentially, with a load whose resistance is 2K Ω or greater.

c. Connectors - All connectors are nine pin standard D connectors, with gender as follows:

- On PSI: Male
- On PSI end of Cable: Female
- On Power Supply end of Cable: Female
- On Power Supply: Male

Connectors on both ends of the cable are to be supplied with strain relief back shells.

d. Pin Designations - The pin designations are given in Table 1, and the general arrangement is given in Figure 2.

e. Cable - An assembly of two separate cables, as seen in Figure 2, joins the connectors. One is a shielded twisted pair, and the other is a shielded twisted five conductor cable.

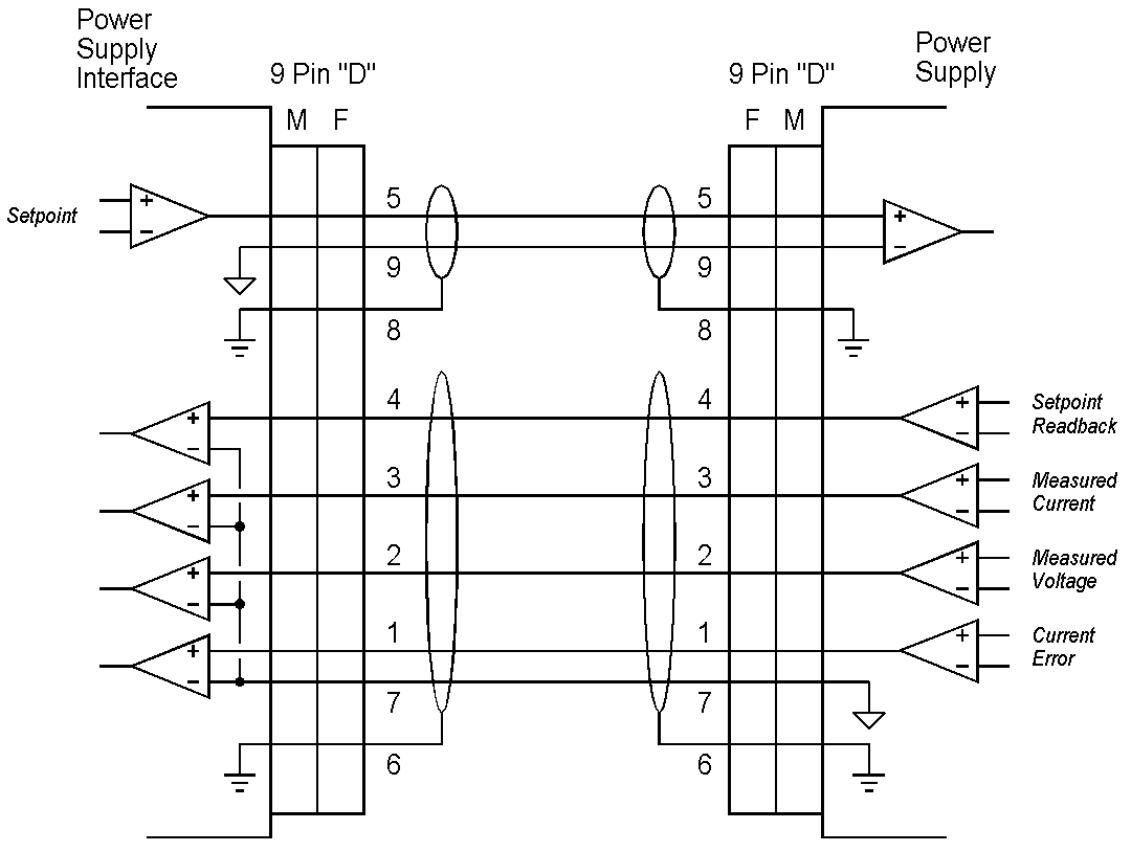

Fig. 2. Analog cable—general arrangement.

Table 1. Analog cable pin designation

Pin	Function
1	Current Error Analog Input
2	Measured Voltage Analog Input
3	Measured Current Analog Input
4	Current Set Point Analog Input
5	Set Point Analog Output
6	Input Shield
7	Input Return
8	Set Point Shield
9	Set Point Return

2.2.2 Digital Cable

a. Digital Outputs - There are sixteen digital outputs from the PSI to the power supply. They are designed to provide standard five volt TTL logic levels when terminated in the power supply by a 1KΩ resistor to digital ground. The power supply must provide these terminating resistors to digital ground. All outputs are TRUE high (TTL logical 1), except for OFF, which is TRUE low (TTL logical 0). This will cause the power supply to shutoff if the PSI loses power.

b. Digital Inputs - There are sixteen digital inputs to the PSI from the power supply. They are designed to accept standard five volt TTL logic levels, and each will be terminated in the PSI by a 1KΩ resistor to digital ground. All outputs are TRUE high (TTL logical 1).

c. Connectors - All connectors are 37 pin standard D connectors, with gender as follows:

- On PSI: Female
- On PSI end of Cable: Male
- On Power Supply end of Cable: Male
- On Power Supply: Female

Connectors on both ends of the cable are to be supplied with strain relief back shells.

d. Pin Designations - The pin designations are given in Table 2. The interpretation of these signals may change as a function of power supply type, but the designations as input or output will not.

e. Cable - A shielded twisted 37 conductor cable joins the connectors.

Table 2. Digital cable pin designation

Pin	Function	Pin	Function
1	On Command	20	Off Command
2	Standby Command	21	Reset Command
3	Negative Polarity Command	22	Spare Command #1
4	Spare Command #2	23	Spare Command #3
5	Spare Command #4	24	Spare Command #5
6	Spare Command #6	25	Spare Command #7
7	Spare Command #8	26	Spare Command #9
8	Spare Command #10	27	Spare Command #11
9	Digital Ground	28	Digital Ground
10	Digital Ground	29	Digital Ground
11	Digital Ground	30	On Status
12	Off Status	31	Standby Status
13	Negative Status	32	Fault Summary
14	Overvoltage	33	Overcurrent
15	Out of Regulation	34	Fan Fault
16	Overtemp	35	Water Flow Fault
17	Water Mat Fault	36	Security Interlock
18	Ground Fault	37	Ripple Fault
19	Phase Fault		

2.3 THE PSC TO PSI CONNECTION

The PSC is connected to the PSI with a pair of fibers terminated in duplex connectors. Figure 3 shows the required materials, and the kit required to install the connectors on the fiber.

This connection is not normally done at the power supply manufacturer, but is made as part of installation. Pre-assembled cables are available to use for testing at the power supply manufacturer.

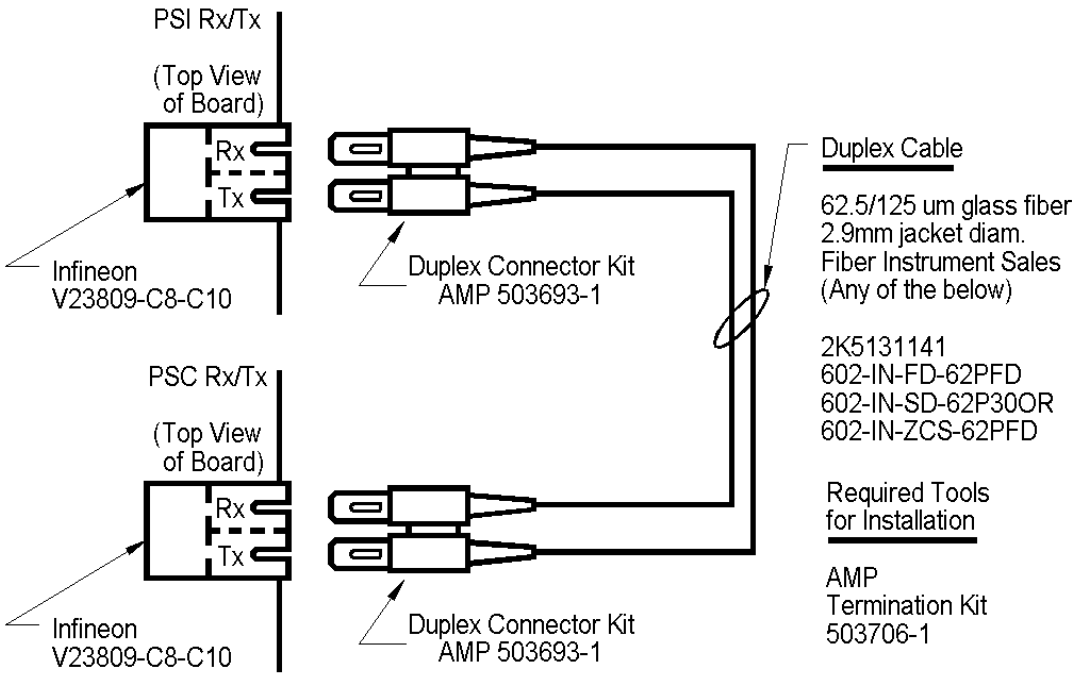

Fig. 3. PSC to PSI connection.

2.4 PSC CONNECTIONS

The PSC is normally used within a VME chassis. VME interfacing is not covered in this document. But, aside from the VME interface and the fiber connections described in section 2.3, there are additional connections to the PSC. First, there are a pair of trigger inputs for timing, and an RS-232 input.

2.4.1 Timing Inputs

a. Function - There are two timing inputs, one to initiate a read, and one to initiate a write. They have identical hardware requirements.

b. Isolation - The PSC provides isolation for the timing pulses, with a TLP2530 opto-isolator. The load seen by the timing pulses is the input LED of that device in series with 180Ω.

c. Connector - The right angle printed circuit card receptacle on the PSC is Lemo part number EPL.00.250.NTN. The cable used to interface with the PSC will typically be an RG316 coaxial cable terminated with a LEMO P/N FFC.00.250.NTCC27 connector.

2.4.2 RS232 Input

The RS232 input is used in place of the VME interface for testing purposes, when a VME based system is not available.

a. Signals - RS232 signal thresholds. 38400 baud, 8 data bits, 1 start bit, 1 stop bit, no parity.

b. Connector - Standard nine pin D connector.

c. Software - BNL will provide software will be provided to users of the PSC. The serial port protocol and memory mapping is not covered in this document.

3. PERSONNEL PROTECTION SYSTEM (PPS) INTERFACE

3.1 OVERVIEW

The function of the PPS interface to the power supplies is to have the ability to drop out (de-energize) the main contactor of the power supply in a fail-safe manner. Positive indication of this de-energized state is sent back to the PPS by means of auxiliary contacts from the power contactor.

Power supplies whose output power rating is less than 5KW, shall not require the PPS interlock circuitry described in the other paragraphs of this section.

3.2 INTERFACE DETAILS

The elements of the PPS interface are shown in Figure 4.

3.2.1 Connector

The PPS interface connector on the power supply is Amphenol P/N 97-4102A-18-19S. This is a box mounted receptacle with ten female crimp pins. The pin designations for this connector are shown in Table 3.

3.2.2 Test Plug

A test plug, to permit operation of the power supply without the PPS, shall consist of a mating male nine pin “D” connector with pins 1 and 2 shorted and pins 3 and 4 shorted, and a backshell to assist handling. These test plug assemblies will be supplied with the power supplies in the quantities listed in the power supply specification.

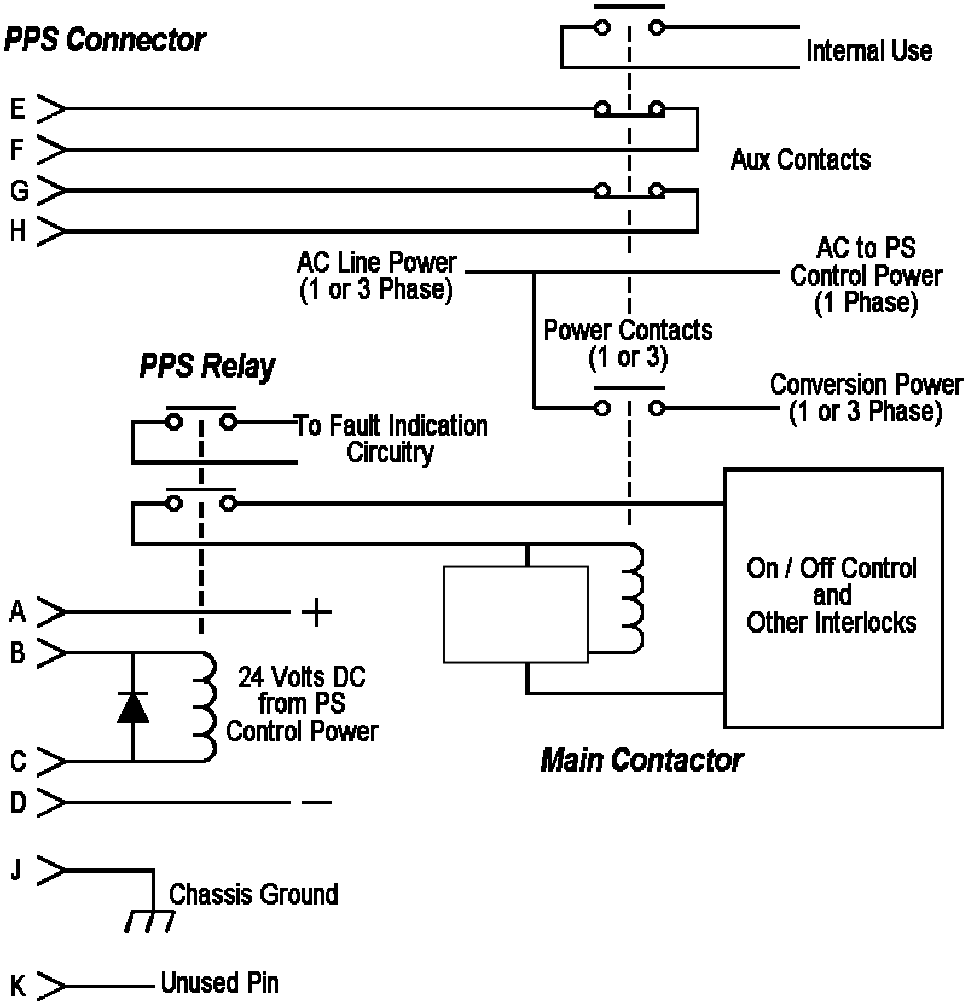

Fig. 4. PPS interface elements.

Table 3. PPS connector pin designation

Pin	Function
A	+24 VDC
B	Contactor Coil: +24 VDC Side
C	Contactor Coil: +24 VDC Return Side
D	+24 VDC Return
E	Aux Contact 1 - Pin 1
F	Aux Contact 1 - Pin 2
G	Aux Contact 2 - Pin 1
H	Aux Contact 2 - Pin 2
J	Chassis Ground
K	Not Used

3.2.3 PPS Delay Circuit for Soft Shutoff

Magnet power supplies rated 20kW and higher shall have PPS delay for soft shutoff. This circuit is very similar to one in the figure 4, but a delay relay has been added. In this circuit, the PPS Relay removes power from the Delay Relay at the same time the circuit is opened to the gate inhibit input to the SCR firing card. After a delay of about 100 mSec (adjustable from the passive RC timing components), the Delay Relay opens the circuit powering the Main Contactor. As before, the PPS status readback is from the Main Contactor.

This circuit remains fail-safe. The timing is performed by passive components that cannot maintain the Delay Relay in an energized state by themselves. The use two contacts from each relay is to guard against the case where one set of contacts were welded shut and may be required for the magnet power supplies that have 20kW and higher.

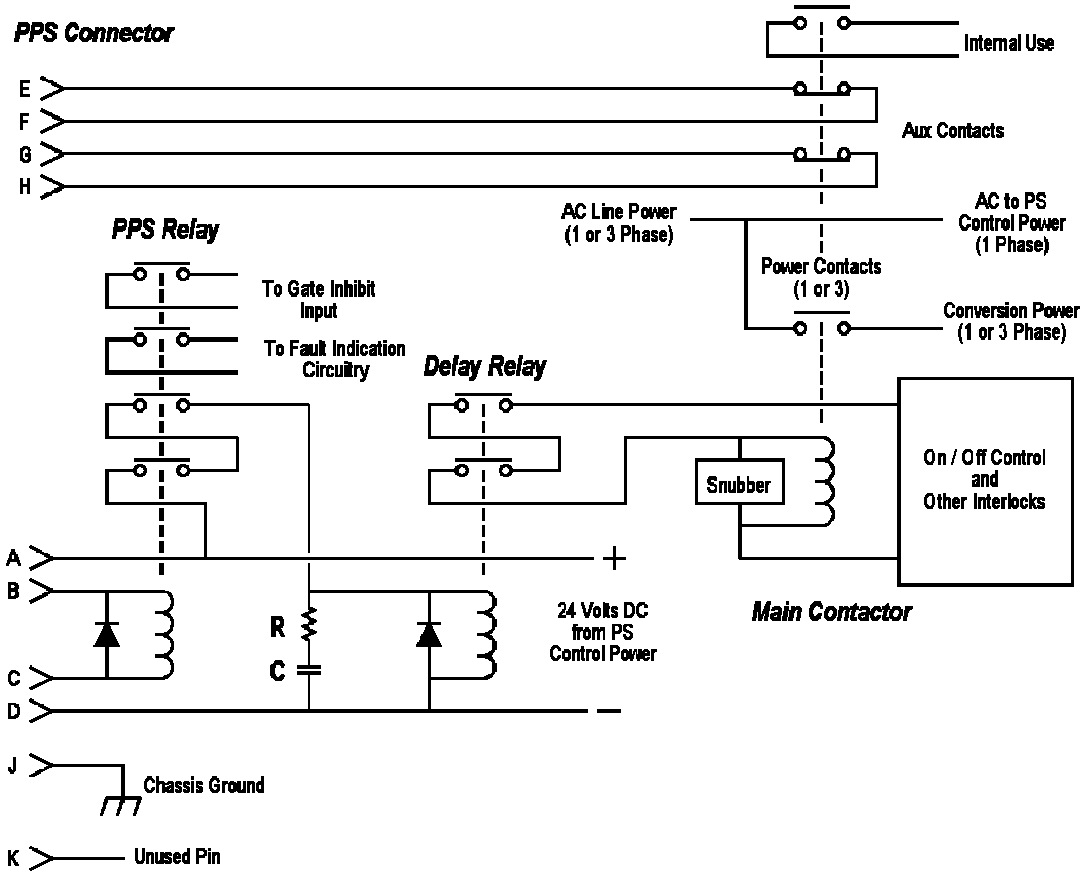

Fig. 4A. PPS elements for soft shutoff.

4. MACHINE PROTECTION SYSTEM (MPS) INTERFACE

4.1 OVERVIEW

The function of the MPS interface described in this section, is to indicate when the power supplies has power to it's output leads. This will be derived from sensing the state of the DC output power contactor or gate inhibit in case of soft shutoff power supplies.

4.2 INTERFACE DETAILS

The elements of the MPS interface are shown in Figure 5. Other implementations to effect this same function may be acceptable.

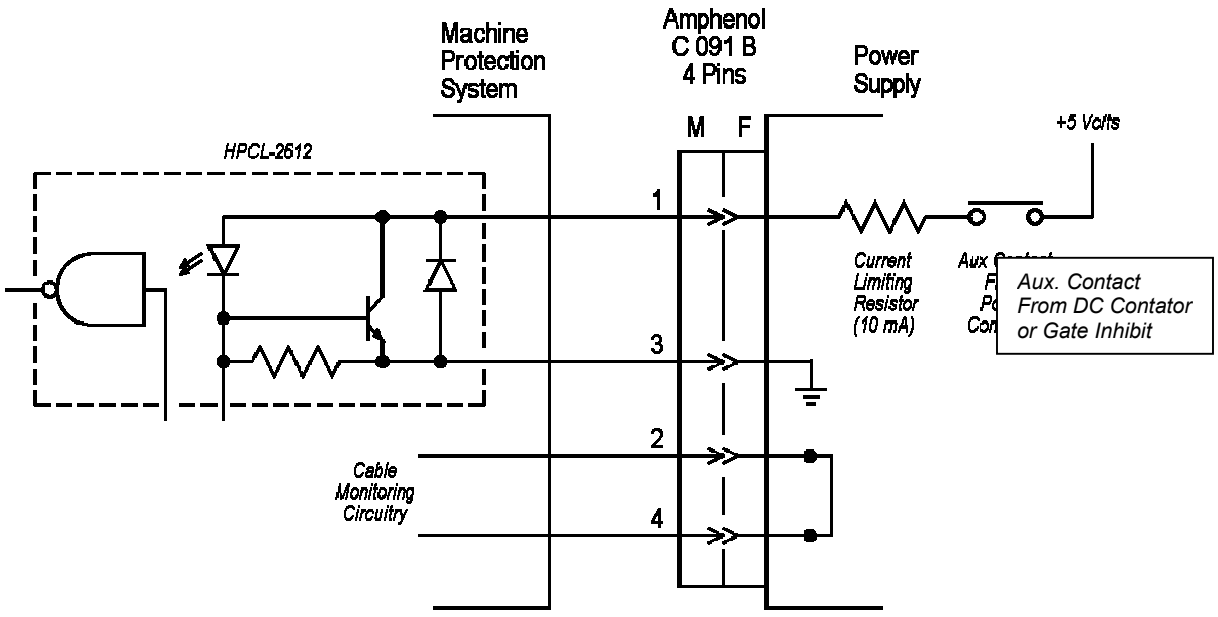

Fig. 5. MPS interface elements.

4.2.1 Connector

The MPS interface connector on the power supply is an Amphenol C 091 B 4 (four) pin connector, with IEC contact arrangement 130-9 with female gold plated crimp contacts.

4.2.2 Signal Levels

A TTL level HIGH signal capable of driving an HPCL2612 optocoupler (10 mA) is the input to the MPS, indicating that the supply is in the ON state.

5. INTERLOCK / FAN CONTROL INTERFACE

5.1 OVERVIEW

A terminal block shall be provided on the power supply to accommodate wires for two purposes. The first of these is to accept interlock signals, such as magnet overtemp and magnet waterflow, that can shut down the power supply to protect itself and the equipment that is connected to the power supply.

The second function (for rack mountable power supplies) is to control the fan in the rack enclosure. If the power supply is not in the OFF mode, this control will energize the fan. In the case of multiple power supplies in a rack, these outputs may be put in parallel such that if any supply in the rack is not in the OFF mode, the fan will be energized. This case is shown in Figure 6.

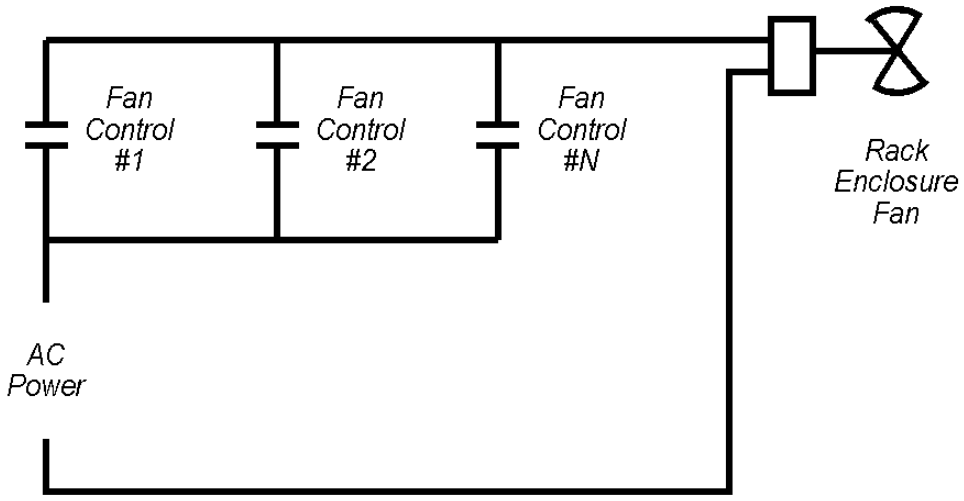

Fig. 6. Fan control with multiple supplies.

5.2 INTERFACE DETAILS

The terminal block arrangement is shown in Table 4.

Table 4. Interlock/fan control terminal block numbering

Pin	Function
1	Magnet Overtemp
2	Magnet Overtemp
3	Rack Airflow
4	Rack Airflow
5	Magnet Water Flow
6	Magnet Water Flow
7	Other External Interlock
8	Other External Interlock
9	Fan Control
10	Fan Control

5.2.1 Terminal Block

a. Dead Front - The terminal block selected shall not present a shock hazard from accidental contact.

b. Shipping / Testing Jumpers - The power supply will be shipped with all interlock connections shorted with a jumper. These will be removed after installation.

c. Wire Range - The terminal block shall be able to accommodate wires in the range of AWG #22 to AWG #16.

5.2.2 Interlock Inputs

a. Operation - The interlock inputs will be connected to a normally closed dry contact. When this contact opens, it will cause the power supply to go into the FAULT mode as described in the power supply specification.

b. Signal Levels - The contacts for these inputs are typically 1,000 feet away from the power supply. The voltage that appears on an open contact shall not be more than 30 Volts, but not less than 15 Volts. The current through a closed contact shall not be more than 100 mA, nor less than 10 mA.

5.2.3 Fan Control Outputs

a. Operation - The fan control contacts will be open if the power supply is in the OFF mode. The fan control contacts will be closed in any other mode.

b. Contact Rating - The contacts will be rated for 120 VAC, 15 Amps.