

OPERATING AND SERVICE MANUAL

MQ SERIES

DC POWER SUPPLIES



MAGNA-POWER ELECTRONICS, INC.
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December 19, 2002

SAFETY NOTICE

Before applying power to the system, verify that the unit is configured properly for the user's particular application.

Analog control inputs and outputs, connector JO2 on the rear panel, are referenced to the negative output of the power supply. Grounding the positive output of the power supply or biasing the output of the supply above chassis potential will cause these inputs and outputs to have a potentially hazardous offset voltage. Exercise caution under these conditions. Under no circumstances should the output of the power supply be biased more than 600 V from chassis ground.

Installation and service must be performed only by properly trained and qualified personnel who are aware of dealing with electrical hazards. Ensure that the ac power line ground is properly connected to the power supply chassis. Furthermore, other power grounds, including those connected to application maintenance equipment, must be grounded for both personnel and equipment safety.

Always ensure that facility ac input power is de-energized prior to connecting or disconnecting the input and output power cables.



Caution: Lethal voltages may be present inside the power supply even when the ac input voltage is disconnected. Only properly trained and qualified personnel should remove covers and access the inside of the power supply.

During normal operation, the operator does not have access to hazardous voltages within the cabinet. Depending on the user's application configuration, high voltages hazardous to human safety may be generated normally on the output terminals. Ensure that the output power cables are properly labeled as to the safety hazards and that any inadvertent contact with hazardous voltages is eliminated.

This power supply is designed to be permanently connected to the power source requiring a readily accessible disconnect device incorporated in the fixed wiring.

These operating instructions form an integral part of the equipment and must be available to the operating personnel at all times. All the safety instructions and advice notes are to be followed.

Neither Magna-Power Electronics, Inc. nor any of the associated sales organizations can accept responsibility for personal injury, consequential injury, loss, or damage that results from improper use of the equipment and accessories.

LIMITED WARRANTY

The following is made in lieu of all warranties expressed or implied.

Magna-Power Electronics, Inc. warrants its products to be free of manufacturing defects for a period of one (1) year from date of original shipment from its factory. Magna-Power Electronics, Inc. will repair or replace at its discretion, any part exclusive of labor to diagnose, remove and install, which upon examination by Magna-Power Electronics, Inc., is determined to be defective in material or workmanship, providing such claimed defective material is returned upon written authorization of Magna-Power Electronics, Inc., freight prepaid. All warranty items are F.O.B. factory.

All electrical, commercial supply parts and items not manufactured by Magna-Power Electronics, Inc. shall carry the warranty of the original manufacturer and no more, but under no circumstances to exceed the "limited warranty."

Replacement parts shall be warranted for a period of 90 days.

Warranty labor shall only apply if the machine, assembly, or part is returned to the factory freight prepaid and insured.

Magna-Power Electronics, Inc. assumes no responsibility for losses of material, labor, production time, any injury, loss or damage, direct or consequential resulting from the operation of, or use, or the inability to use the product other than specifically covered in this warranty.

Damage or breakage through misuse or while in transit is not covered by this warranty.

All claims against the warranty shall be the final determination of Magna-Power Electronics, Inc.

CLAIM FOR DAMAGE IN SHIPMENT

This instrument received comprehensive mechanical and electrical inspections before shipment. Immediately upon receipt from the carrier, and before operation, this instrument should be inspected visually for damage caused in shipment. If such inspection reveals internal or external damage in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. When referring to this equipment, always include the model and serial numbers.

RETURNING EQUIPMENT

Before returning any equipment to the factory, the following steps should be taken:

1. Contact our technical service department. Give a full description of the difficulty and include the model and serial number of the unit. On receipt of this information, we will give you service information or shipping instructions.
2. Equipment returned to us must be properly packed and insured if the unit is to be returned for service. You must request a "Return Authorization Number." No returns will be accepted without a preauthorized RA.
3. For non-warranty repairs, we will submit a cost estimate for your approval before proceeding.

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1.0 GENERAL INFORMATION

1.1 Description

This manual contains operation and maintenance instructions for Magna-Power Electronics' MQ Series, medium frequency link power supplies. These power supplies are constant voltage/constant current sources suitable for a wide range of applications.

1.2 Features

Magna-Power Electronics' MQ Series power supplies set a new standard for high-powered dc supplies. A combination of high and medium frequency power processing technologies improves response, shrinks package size, and reduces cost. MQ Series power supplies are current fed. Compared with conventional switching power supplies, these supplies can easily tolerate the punishment of the most rigorous applications.

MQ Series power supplies are fully programmable via resistance, voltage, current, or optional IEEE-488/RS232. While other supplies can remotely control only output voltage and current, MQ Series units also allow programming of over voltage and over current protection. Program lines are constantly monitored for range of operation. If a line should open or if a programmable input is set beyond that anticipated, the unit safely shuts down protecting the load.

MQ Series power supplies can operate as a voltage source or current source depending on the control settings and load conditions. If the power supply is operating as a voltage source and the load increases to a point beyond the current command setting, the power supply automatically crosses over to current mode control and operates as a current source at that setting.

Differential amplifiers permit remote sensing at any distance from the load. Additional differential amplifiers are provided for master/slave series or parallel operation.

Diagnostic functions are contained directly within the supply's control loop. Exclusive circuitry eliminates guesswork about which function has control -- voltage, current, or a fault condition. If the fault condition requires user attention, main power is disconnected and the diagnostic condition is latched into memory. Pressing the reset switch clears the memory. All diagnostic functions are monitored with optical isolators that can be paralleled for master/slave operation. Furthermore, control functions can also be set through optical isolators to allow simultaneous control of one or more MQ Series units. Programming switches in the rear of the supply enable internal operation of controls, external operation, or both.

MQ Series supplies have three levels of over voltage/current protection: shutdown of controlling insulated gate bipolar transistors (IGBT's), disconnect of main power, and optional SCR crowbar. After an over voltage/current condition, the supply must be reset. Pressing the reset switch causes the over voltage/current settings to be displayed on the front meters.

MQ Series power supplies have push button start/stop controls. These controls are electrically integrated to a mechanical contactor which operates with the electronic switches to break the ac mains when stop is commanded. Unlike competing products, an off means both an electrical and mechanical break in the power circuit — not a break in an electronic switch. Safety comes first at Magna-Power Electronics.

1.3 IEC Symbols Used in Manual

The following IEC symbols are used in this manual.



Caution, risk of electric shock



Caution, risk of danger



Protective conductor terminal



Three-phase alternating current

1.4 Installation

The power supply is ready for operation when shipped. Electrical connections are made through the rear access panel. Power and control cables must be totally separated. Cables should run in independent conduits and feed through dedicated holes punched in the access panel. The unit should be operated in the upright position.

1.4.1 Cooling

Each power supply enclosure is cooled by suitable blowers exhausting warm air to the top of the cabinet. Fresh air intake is from the bottom and front. Blocking ventilation will cause the power supply to overheat.



Caution: blocking ventilation will cause the power supply to overheat.

1.4.2 AC Input Connections



Caution: disconnect AC power from the mains before attempting any installation procedure.



Caution: a safety ground wire must be connected to the unit as indicated by the protective ground symbol at the rear of the power supply.

AC power is wired to the power supply by attaching three cables plus ground. The cables feed through the rear access panel through a hole punched by the installer. The manufacture recommends cables, as specified in Tables 1.1 or 1.2, be crimped to ring terminals and securely fastened to the four studs at the rear of the power supply. After connections are made, secure the rear access panel to the back of the cabinet.

This power supply is designed to be permanently connected to the power source requiring a readily accessible disconnect device incorporated into the fixed wiring.

Table 1.1 SUGGESTED AMPACITIES OF 4-CONDUCTOR TYPE S OR SO CABLE

Wire Size (AWG)	Maximum Current (A)	Wire Size (AWG)	Maximum Current (A)
18	7	8	35
16	10	6	45
14	15	4	60
12	20	2	80
10	25		

Table 1.2 SUGGESTED AMPACITIES OF CONDUCTORS AS RECOMMENDED BY THE NATIONAL ELECTRICAL CODE

Size	Temperature Rating of Copper Conductor			
	60 °C	75°C	85°C	90°C
	Types	Types	Types	Types
Wire Size (AWG)	RUW, T, TW	FEPW, RH, RHW, RUH, THW, THWN, XHHW, ZW	V, MI	TA, TBS, SA, AVB, SIS, FEP, FEPB, RHH, THHN, XHHW
14	25	30	30	35
12	30	35	40	40
10	40	50	55	55
8	60	70	75	80
6	80	95	100	105
4	105	125	135	140
3	120	145	160	165
2	140	170	185	190
1	165	195	215	220
1/0	195	230	250	260
2/0	225	265	290	300
3/0	260	310	335	350
4/0	300	360	390	405
250 MCM	340	405	440	455
300 MCM	375	445	485	505
350 MCM	420	505	550	570

Single conductors in free air, based on ambient temperature of 30°C

1.4.3 DC Output Connections



Caution: disconnect AC power from the mains before attempting any installation procedure.

DC power is wired to the power supply by attaching cables to the output bus bars. Four holes are provided on each bus bar permitting parallel connections for high current loads. The manufacture recommends cables, as specified in Tables 1.2 or 1.3, be crimped to ring terminals and securely fastened to the bus bars using 3/8" bolts, lock washers, and mating nuts. After the connections are made, secure the protective shield to the back of the cabinet.



Caution: Make sure connections are tight to avoid overheating of the bus bars.

Table1.3 SUGGESTED AMPACITIES OF WELDING CABLE

Wire Size (AWG)	Maximum Current (A)	Wire Size (AWG)	Maximum Current (A)
6	85	1/0	200
4	110	2/0	235
3	130	3/0	275
2	150	4/0	315
1	170	*	315+

* Contact factory for assistance

1.4.4 Interfacing the Optional SBC488A

The optional SBC488A is a single board computer that incorporates a variety of input and output capabilities including two communication interfaces. The SBC488A provides the interface between the power supply and computer and may be installed internal or external to the power supply. Before installing this optional equipment, the manufacturer recommends that you first commission the system using the manual controls on the front panel of the power supply.

To connect the SBC488A to the MQ Series power supply, proceed as follows:

1. Set all positions of dip switch S2 on the power supply to 0. Figure 2.2 illustrates the default positions.
2. Connect a standard, straight-through, 25 conductor, serial extension cable between connector JS1 of the power supply and connector JQ1 of the SBC488A. Connect a second standard, straight-through, 25 conductor, serial extension cable between connector JO2 of the power supply and connector JQ2 of the SBC488A. These cables are supplied with the SBC488A.
3. Connect a #20 wire between terminal 4 of connector JS2 on the rear of the power supply to the positive terminal of the output. Connect a second #20 wire between terminal 3 of connector JS2 to the negative terminal of the output. This configuration, shown in figure 2.6, allows the SBC488A to read the output voltage.
4. For RS-232 communications, connect the straight-through, 9 conductor, serial extension cable supplied with the SBC488A between connector JP4 of the SPC488A to a serial port on a computer. Set dip switch S1 on the SBC488A to address 31 to enable RS-232 communications.
5. For IEEE488 communications, connect an IEEE488 cable between connector JP1 of the

SBC488A and an IEEE488 port on a computer. Set the dip switch S1 on the SBC488A to address 0-30 to enable IEEE488 communications.

1.5 Power Requirements

MQ power supplies are manufactured to operate on 208/240 V mains, 380/415 V mains, or 440/480 V 50 to 60 Hz mains.

The standard operating voltage is 208 V, 3 ϕ , 50 to 60 Hz unless otherwise specified at time of order. For conversion from 208 V to 240 V operation, two internal wiring changes must be made to each power module. The locations are not accessible to the user and the power supply must be returned to the factory for modification.

MQ power supplies are optionally available to operate on 380 V or 480 V, 3 ϕ , 50 to 60 Hz mains. For conversion from 380 V to 415 V or from 480 V to 440 V operation, two internal wiring changes must be made to each power module. The locations are not accessible to the user and the power supply must be returned to the factory for modification.

1.6 Specifications

The following specifications describe the published operational characteristics of the MQ Series power supplies.

Input voltage: 208/240 Vac, 50-60 Hz, 3 ϕ standard; 380/415 Vac or 440/480 Vac, 50-60 Hz, 3 ϕ optional.

Regulation line and load combined: 0.10 %.

Stability: 0.10 % for 8 hours after 30 minute warm up.

Transient response: 10.0 ms to recover within 2 % of regulated output with a 30 % step load change.

Programming resistors: 1 K Ω full scale for output voltage, output current, over voltage shutdown, and over current shutdown.

Ambient Temperature: 0 to 50°C.

Storage Temperature: -25 to +85°C.

Temperature coefficient: 0.04 %/°C of maximum output current.

Agency Approvals: CE-marked units meet the following standards (note: optional EMI filter must be installed to meet EMC requirements)

EN61010-1:2001-02 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

EN61326-1:1997 Electrical Equipment for Measurement, Control, and Laboratory Use EMC Requirements

- EN55022:1998 Radiated, Class A, Group 1
- EN55022:1998 Conducted, Class A, Group 1
- EN61000-4-2:1999 Electrostatic Discharge
- EN61000-4-3:1999 Radiated Susceptibility
- EN61000-4-6:1999 Conducted Susceptibility

Table 1.4 SIZE AND WEIGHT MATRIX

POWER kW	SIZE H”xW”xD”	WEIGHT LBS
20	38½x22x29	280
30	38½x22x29	395
40	38½x22x29	510
50	49x22x29	645
60	49x22x29	760

Table 1.5 20 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
MQ16-1200	16	1200	40	86	72	36
MQ32-600	32	600	30	86	72	36
MQ50-400	50	400	40	87	72	36
MQ80-250	80	250	50	87	72	36
MQ125-160	125	160	60	87	70	35
MQ200-100	200	100	80	87	70	35
MQ250-80	250	80	90	88	70	35
MQ375-54	375	54	100	88	70	35
MQ500-40	500	40	130	88	70	35
MQ600-32	600	32	150	88	70	35

Notes:

- 1) Rating specified at 208 and 440 V input.
- 2) Specifications subject to change without notice.

Table 1.6 30 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
MQ16-1800	16	1800	40	86	108	54
MQ32-900	32	900	30	86	108	54
MQ50-600	50	600	40	87	108	54
MQ80-375	80	375	50	87	108	54
MQ125-240	125	240	60	87	105	52
MQ200-150	200	150	80	87	105	52
MQ250-120	250	120	90	88	105	52
MQ375-81	375	81	100	88	105	52
MQ500-60	500	60	130	88	105	52
MQ600-48	600	48	150	88	105	52

Notes:

- 1) Rating specified at 208 and 440 V input.
- 2) Specifications subject to change without notice.

Table 1.7 40 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
MQ16-2400	16	2400	40	86	144	72
MQ32-1200	32	1200	30	86	144	72
MQ50-800	50	800	40	87	144	72
MQ80-500	80	500	50	87	144	72
MQ125-320	125	320	60	87	140	70
MQ200-200	200	200	80	87	140	70
MQ250-160	250	160	90	88	140	70
MQ375-108	375	108	100	88	140	70
MQ500-80	500	80	130	88	140	70
MQ600-64	600	64	150	88	140	70

Notes:

- 1) Rating specified at 208 and 440 V input.
- 2) Specifications subject to change without notice.

Table 1.8 50 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
MQ16-3000	16	3000	40	86	180	90
MQ32-1500	32	1500	30	86	180	90
MQ50-1000	50	1000	40	87	180	90
MQ80-625	80	625	50	87	180	90
MQ125-400	125	400	60	87	175	88
MQ200-250	200	250	80	87	175	88
MQ250-200	250	200	90	88	175	88
MQ375-135	375	135	100	88	175	88
MQ500-100	500	100	130	88	175	88
MQ600-80	600	80	150	88	175	88

Notes:

- 1) Rating specified at 208 and 440 V input.
- 2) Specifications subject to change without notice.

Table 1.9 60 KW MODELS AND RATINGS

MODEL	VOLTS Vdc	AMPS Adc	RIPPLE mVrms	EFF. %	INPUT CURRENT (Aac)	
					208/240 V MODELS	440/480 V MODELS
MQ16-3600	16	3600	40	86	216	108
MQ32-1800	32	1800	30	86	216	108
MQ50-1200	50	1200	40	87	216	108
MQ80-750	80	750	50	87	216	108
MQ125-480	125	480	60	87	210	105
MQ200-300	200	300	80	87	210	105
MQ250-240	250	240	90	88	210	105
MQ375-162	375	162	100	88	210	105
MQ500-120	500	120	130	88	210	105
MQ600-96	600	96	150	88	210	105

Notes:

- 1) Rating specified at 208 and 440 V input.
- 2) Specifications subject to change without notice.

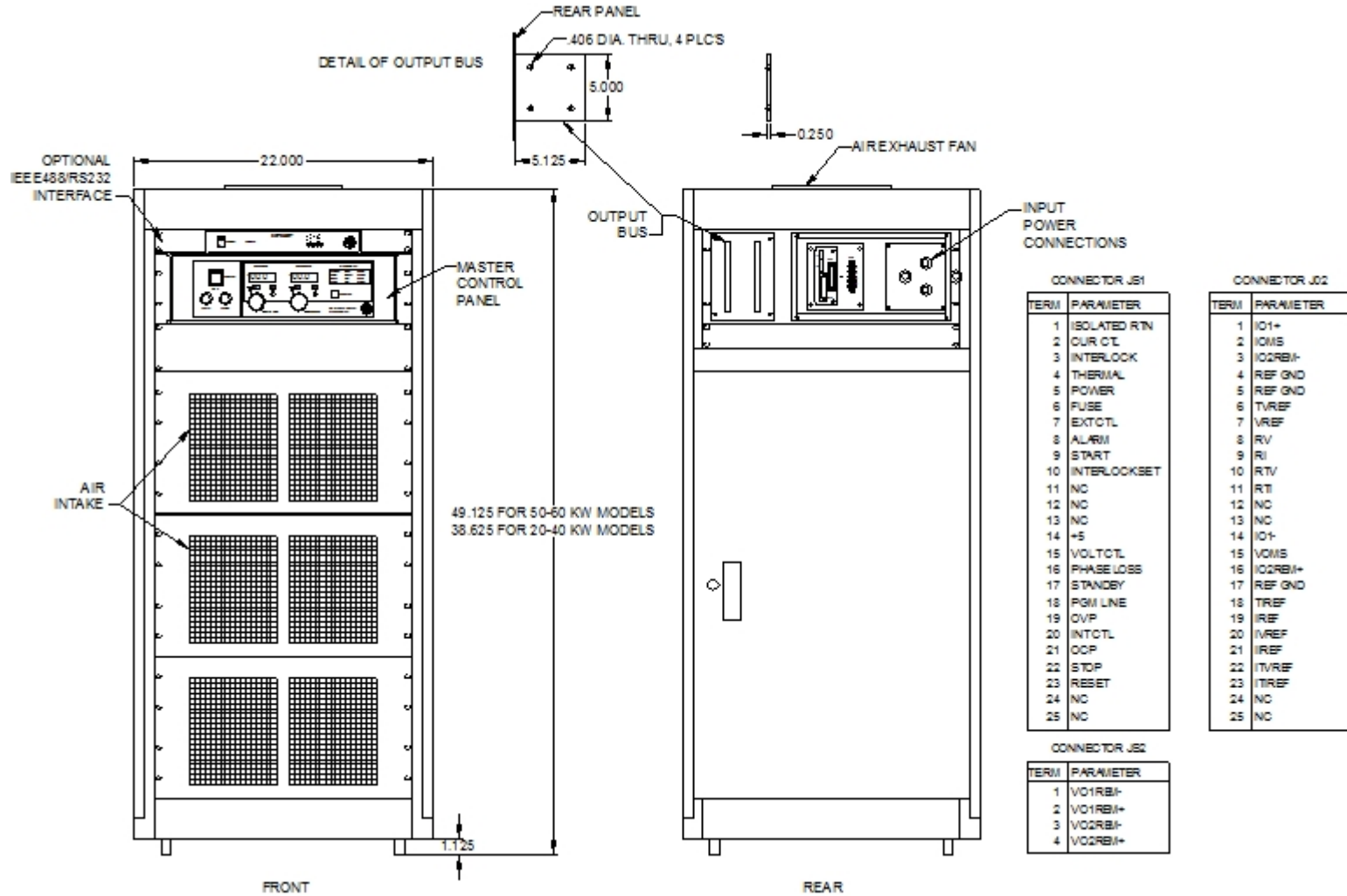


Figure 1.1 MQ Series package drawing

2.0 OPERATING INSTRUCTIONS

2.1 General Operation

As shipped, the power supply is configured for local sensing, internal programming, and 208 V, 3 ϕ input. The front panel voltage and current controls set the boundary limits for output voltage and current, respectively. The impedance of the load determines whether the unit is voltage or current controlled and the illumination of the respective mode indicator light indicates the state. If either control is set to maximum counter clockwise rotation, the other control will have little or no effect. Each control must be set to the appropriate position for proper operation.

2.2 Controls and Indicators

The controls and indicators are illustrated in figure 2.1.

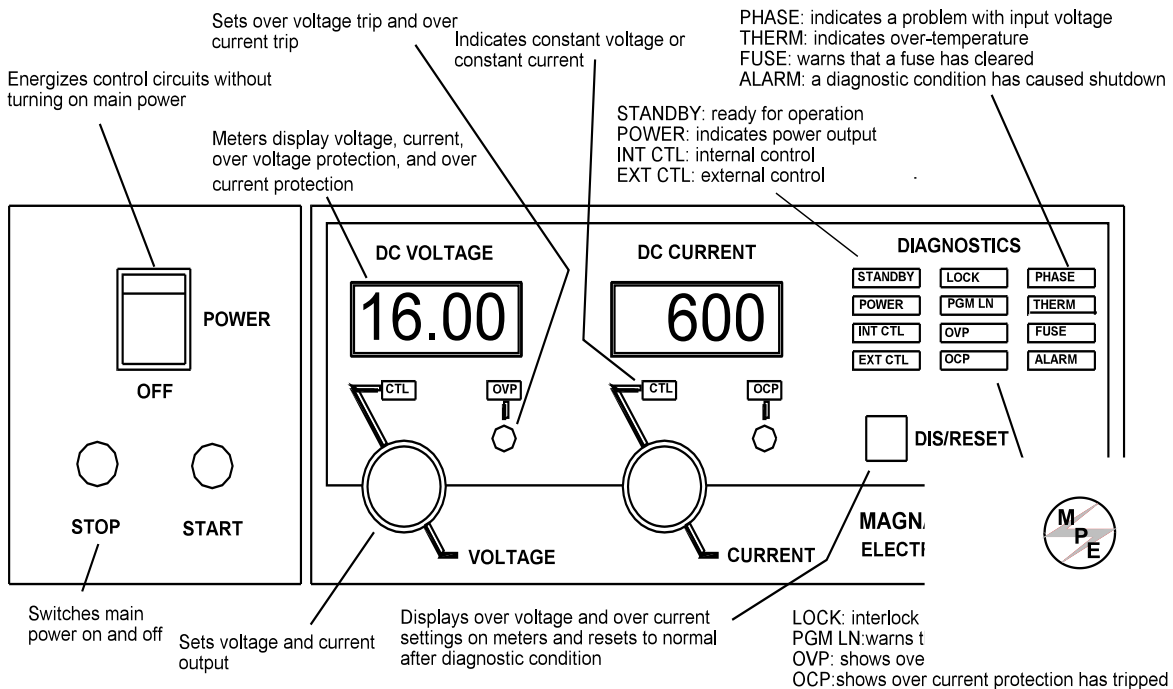


Figure 2.1 Controls and indicators

2.3 Preparation for Use

2.3.1 Unpacking

Carefully unpack the power supply saving all packing materials and included enclosures. Inspect power supply for possible shipping damage. Check that there are no broken knobs or connectors,

the external surface is not scratched or dented, the meter faces are not damaged, and all controls move freely. Any external damage may be an indication of internal damage.

2.3.2 Electrical Check

Check that switches S1 and S2, located at the rear of the supply, are set to position 1, the default switch positions. As shown in figure 2.2, switch positions depict normal local sense and programming configurations. It is recommended that the following brief electrical check be made shortly after unpacking the supply.

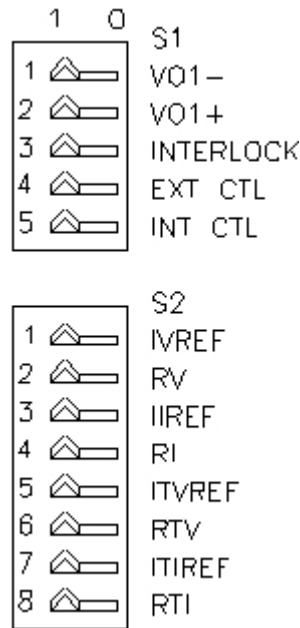


Figure 2.2 Default switch positions for S1 and S2 (on is state 1 and off is state 0)

Set voltage and current controls full counterclockwise, turn the power switch off and connect a short circuit to the power output studs on the rear panel. Connect the power supply to a suitable source of ac voltage. For this test, only 50% of rated ac current is required.

Turn the power switch on. The standby, internal control (int ctl), and external control (ext ctl) lights should come on. Press the start switch and advance the voltage control one turn clockwise. The standby light should extinguish and the power and current control lights should come on. Press the display/reset switch and adjust the over current trip to maximum current by means of the screw driver adjustment potentiometer. Increase the current setting to maximum and then to minimum. Dc current should increase smoothly from minimum to maximum to minimum as indicated on the meter. Return the current control full counterclockwise.

Press the display/reset switch and adjust the over current trip to half-rated current. Slowly increase the current setting. Over current trip should operate at the over current trip setting, the over current

light should come on, and the supply should shut down. Press the display/reset switch and adjust the over current trip to maximum current. Adjust the current control full counterclockwise and restart the supply. The supply should operate normally

With the power supply off, disconnect the output short circuit. Turn the power switch on. Press the start switch and advance the current control one turn clockwise. The standby light should extinguish and the power and voltage control lights should come on. Press the display/reset switch and adjust the over voltage trip to maximum voltage by means of the screw driver adjustment potentiometer. Increase the voltage setting to maximum and then to minimum. Dc voltage should increase smoothly from minimum to maximum to minimum as indicated on the meter. Return the voltage control full counterclockwise.

Press the display/reset switch and adjust the over voltage trip to half-rated voltage. Slowly increase the voltage setting. Over voltage trip should operate at the over voltage trip setting, the over voltage light should come on, and the supply should shut down. Press the display/reset switch and adjust the over voltage trip to maximum voltage. Adjust the voltage control full counterclockwise and restart the supply. The supply should operate normally.

If any of these events do not occur, the supply is defective and should not be operated. Depending on the circumstances, either warranty service or trouble shooting as described in Section 4.2 is required.

2.4 Modes of Operation

2.4.1 Normal Mode

MQ Series power supplies are normally shipped with its switch settings arranged for constant voltage/constant current, local sensing, and local programming. This is set by the programming switches, S1 and S2, located at the rear of the supply. As illustrated in figure 2.2, all of the programming switches should be set to position 1. The operator selects either a constant voltage or a constant current output using the front panel controls (local programming, no switch changes are necessary).

2.4.2 Constant Voltage

To select a constant voltage output, proceed as follows:

With the supply off, set all controls to full counterclockwise and advance current control one turn clockwise. Turn on the power supply and adjust the voltage trip to 110% of desired output voltage. Advance the voltage control for the desired output voltage with the output terminals open.

Turn the supply off and short the output terminals. Turn on the supply and adjust the current control for the maximum output current allowable as determined by load conditions. If a load change causes

the current limit to be exceeded, the power supply will automatically crossover to constant current output at the preset current limit and the output voltage will drop proportionately. In setting the current limit, allowance must be made for high peak currents which can cause unwanted crossover (see section 2.13).

Turn off the power supply, remove the short on the output terminals, and connect the load. The unit is now ready for operation.

2.4.3 Constant Current

To select a constant current output, proceed as follows:

With the supply off, short the output terminals, set all controls to full counterclockwise, and advance the voltage control one turn clockwise. Turn on the power supply and adjust the current trip to 110% of desired output current. Advance the current control for the desired output current with the output terminals shorted.

Turn off the supply and remove the short on the output terminals. Turn on the power supply and adjust the voltage control for maximum output voltage allowable as determined by load conditions. If a load change causes the voltage limit to be exceeded, the power supply will automatically crossover to constant voltage output at the preset voltage limit and the output current will drop proportionately.

Turn off the power supply and connect the load. The unit is now ready for operation.

2.5 Remote Sensing

Remote sensing is used to improve the degradation of regulation which will occur at the load when the voltage drop in the connecting wires is appreciable. This is done by setting switch positions 1 and 2 of S1 to 0. Using a pair of #20 AWG wires, connect terminal 2 of JS2 to the positive terminal of the load and connect terminal 1 of JS2 to the negative terminal of the load.

Figure 2.3 illustrates standard output sensing and remote output sensing.

2.6 Standard Programming

The standard programming configuration, illustrated in figure 2.4, shows that references for voltage, current, voltage trip, and current trip are established by internal 2 mA current sources producing voltages across potentiometers RV, RI, RTV, and RTI. These potentiometers are the front panel controls for voltage, current, voltage trip, and current trip, respectively.

Resistors placed in series with the voltage and current trip potentiometers allow settings above the maximum voltage and current of the power supply.

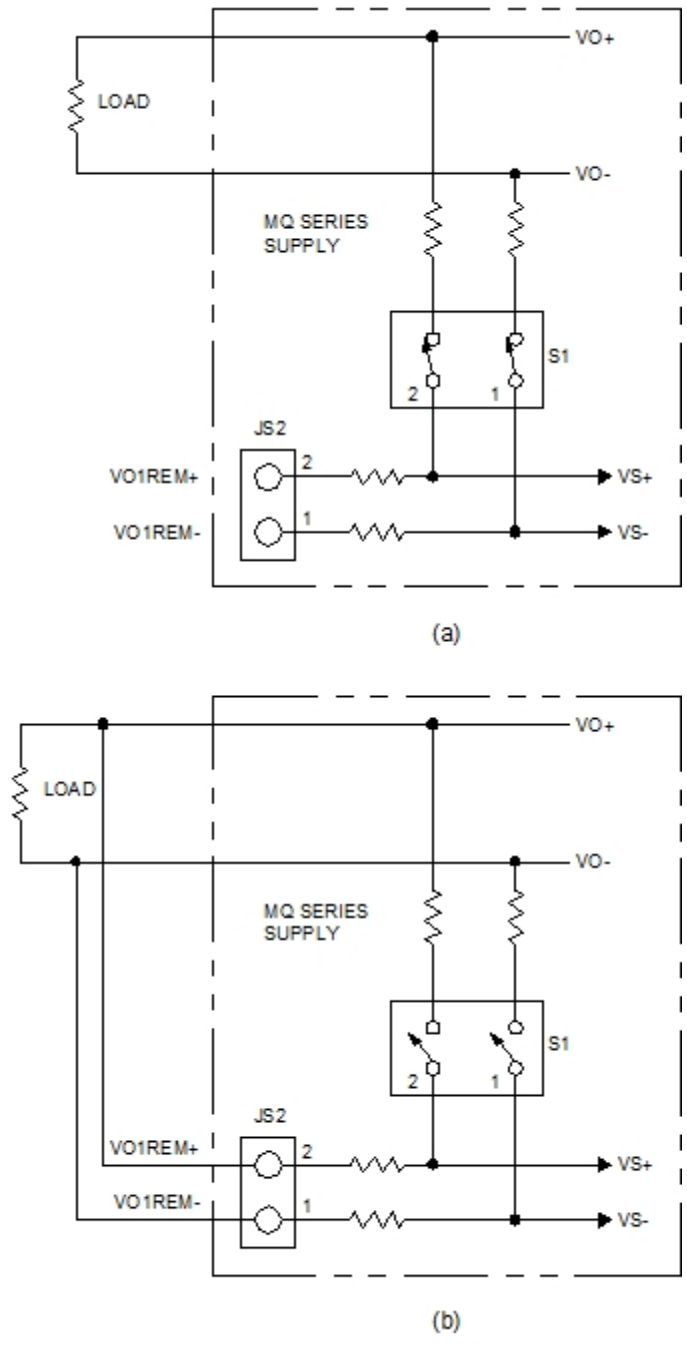


Figure 2.3 (a) Standard and (b) remote sensing

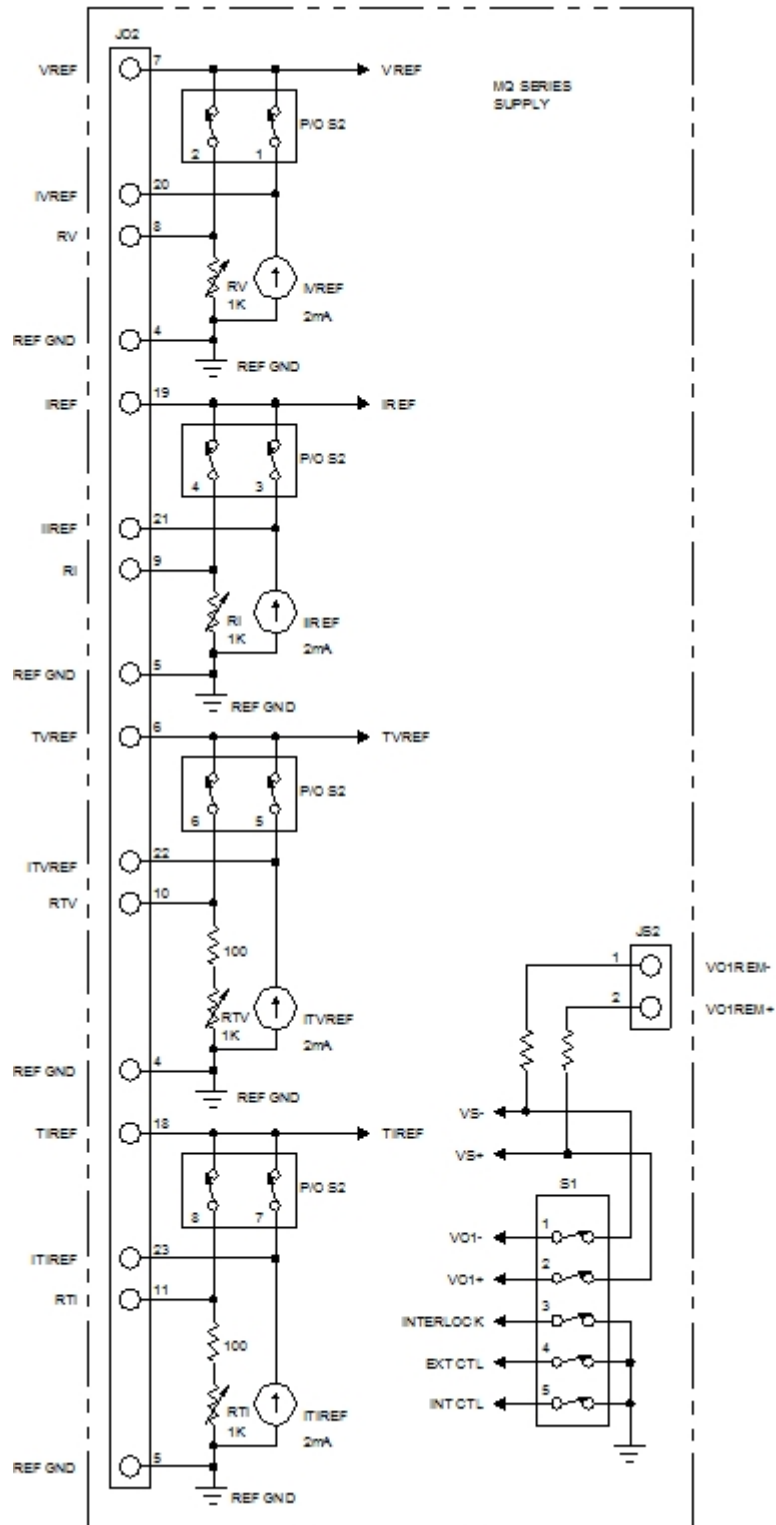


Figure 2.4 Standard programming configuration using internal potentiometers

2.7 Remote Programming

MQ Series supplies allow voltage, current, voltage trip, and current trip to be programmed from a remote location. Programming can be accomplished either by resistive, voltage, or current programming circuits.

Figure 2.5 illustrates the three alternatives for programming output voltage. The method applies equally to programming an output current, voltage trip, and current trip.

2.7.1 Resistive Programming

Resistive programming requires setting position 2 of S2 to 0 and connection of an external potentiometer or resistor between terminals 20 and 4 of JO2. Like the internal voltage potentiometer, the 2 mA reference produces a voltage across the potentiometer or resistor which is used to set the output voltage. A metal film resistor or wire wound potentiometer will result in the lowest temperature coefficient.

To program an output current, voltage trip, or current trip, use the same method and refer to figure 2.4 for terminal identification.

The expressions for programming output voltage, V_O , output current, I_O , voltage trip, T_V , and current trip, T_I are given as follows.

$$V_O = \frac{V_{OMAX} R_P}{1000\Omega} \quad (1)$$

$$I_O = \frac{I_{OMAX} R_P}{1000\Omega} \quad (2)$$

$$T_V = \frac{V_{OMAX} R_P}{1000\Omega} \quad (3)$$

$$T_I = \frac{I_{OMAX} R_P}{1000\Omega} \quad (4)$$

where:

V_{OMAX} : maximum output voltage,

I_{OMAX} : maximum output current,

R_p : programming resistor.

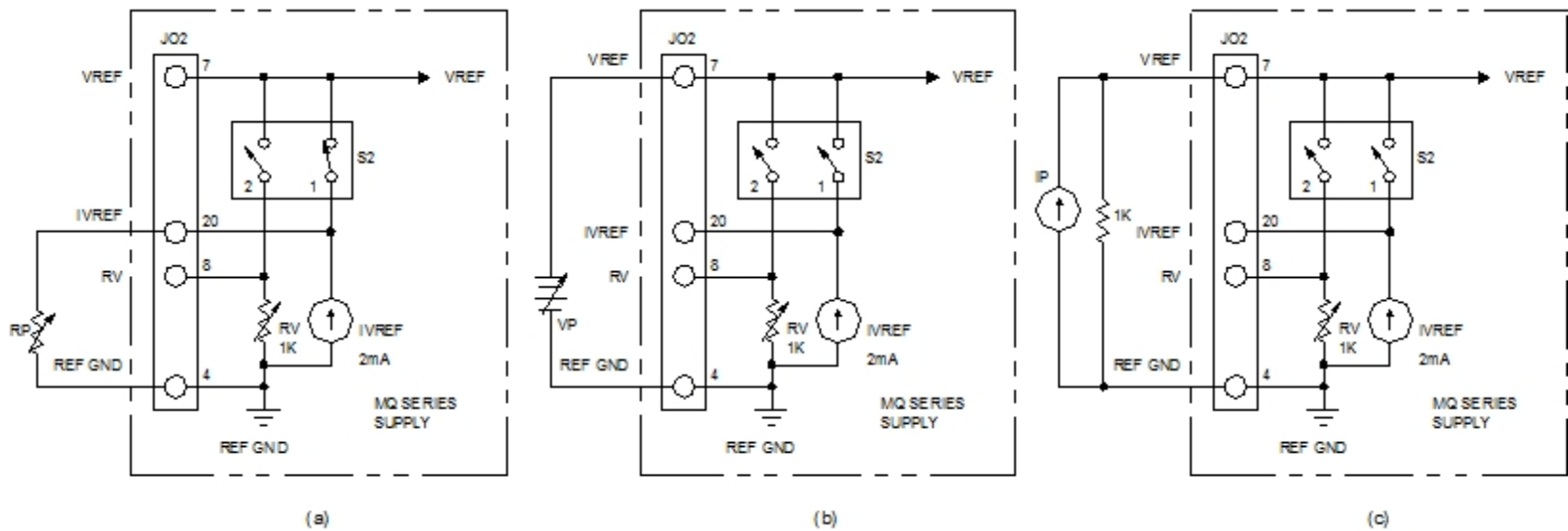


Figure 2.5 External (a) resistive, (b) voltage, and (c) current programming

2.7.2 Voltage Programming

Voltage programming requires setting positions 1 and 2 of S2 to 0 and connection of an external voltage reference between terminal 7 of JO2 (positive) and terminal 4 of JO2 (negative).

To program an output current, voltage trip, or current trip, use the same method and refer to figure 2.4 for terminal identification.

The expressions for programming output voltage, V_O , output current, I_O , voltage trip, T_V , and current trip, T_I , are given as follows.

$$V_O = \frac{V_{OMAX} V_P}{2.0V} \quad (5)$$

$$I_O = \frac{I_{OMAX} V_P}{2.0V} \quad (6)$$

$$T_V = \frac{V_{OMAX} V_P}{2.0V} \quad (7)$$

$$T_I = \frac{I_{OMAX} V_P}{2.0V} \quad (8)$$

where:

V_P : programming reference voltage.

2.7.3 Current Programming

Current programming requires setting positions 1 and 2 of S2 to 0, connection of an external, 1K metal film resistor between terminal 7 of JO2 and terminal 4 of JO2, and connection of an external current source between terminal 7 of JO2 (positive) and terminal 4 of JO2 (negative).

To program an output current, voltage trip, or current trip, use the same method and refer to figure 2.4 for terminal identification.

The expressions for programming output voltage, V_O , output current, I_O , voltage trip, T_V , and current trip, T_I , are given as follows.

$$V_O = \frac{V_{OMAX} I_P}{2.0mA} \quad (9)$$

$$I_O = \frac{I_{OMAX} I_P}{2.0mA} \quad (10)$$

$$T_V = \frac{V_{OMAX} I_P}{2.0mA} \quad (11)$$

$$T_I = \frac{I_{OMAX} I_P}{2.0mA} \quad (12)$$

where:

I_p : programming current source.

2.8 Voltage and Current Monitoring

Two operational amplifiers are provided for master/slave series and parallel operation. As illustrated in figure 2.6, these amplifiers can also be used to monitor output voltage and current. These outputs may be used for external instrumentation or process control.

To monitor the output voltage, connect terminal 4 of JS2 to the positive output of the supply and terminal 3 of JS2 to the negative output of the supply. The voltage between terminals 15 to 4 of JO2 represents the output voltage normalized to 2.0 V full scale.

To monitor the output current, connect terminal 16 of JO2 to terminal 1 of JO2 and connect terminal 3 of JO2 to terminal 14 of JO2. The voltage between terminals 2 to 4 of JO2 represents the output current normalized to 2.0 V full scale.

2.9 Digital Control Lines

All input and output control lines are connected to optical isolators for a wide range of applications.

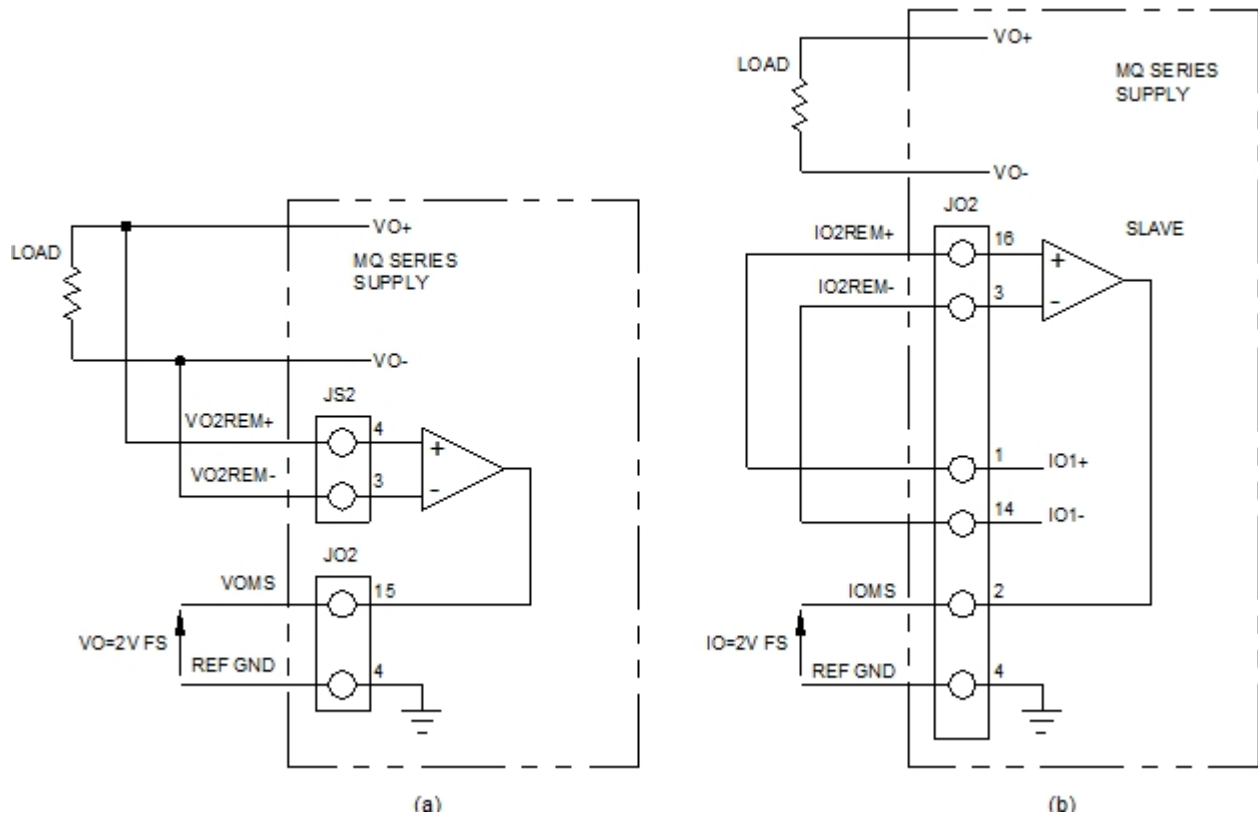


Figure 2.6 Monitoring output (a) voltage and (b) current

Input control lines are or'd with front panel controls for start, stop, interlock set, and reset. To force any state, apply +5 V between the input control line and isolated return. An isolated 5 V, 100 mA source is provided at terminal 14 of JS1 for this application. As illustrated in figure 2.7, digital control lines may be paralleled with other supplies to allow simultaneous control. The front panel controls can be disabled by setting position 5 of switch S1 to 0. Likewise, the external control lines can be disabled by setting position 4 of switch S1 to 0.

Output monitoring lines provide a means to monitor diagnostic functions as well as mode of operation (voltage or current). Figure 2.8 shows that diagnostic functions can be or'd with other supplies to simplify problem detection in large systems.

All digital lines, both control and monitoring, are referenced to a common isolated return.

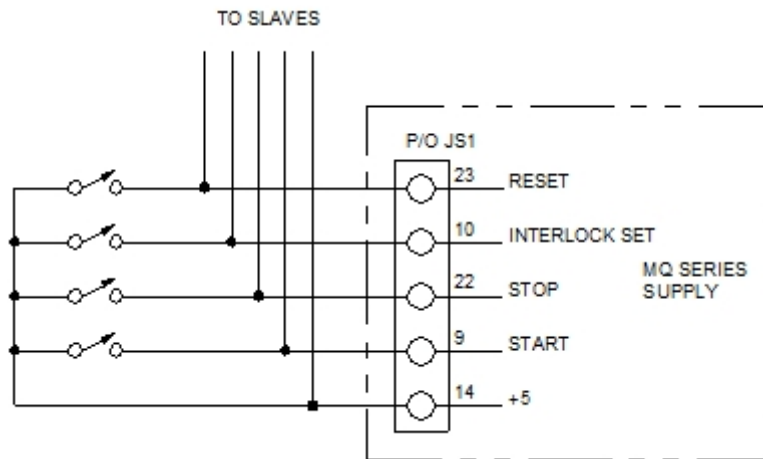


Figure 2.7 Digital control lines

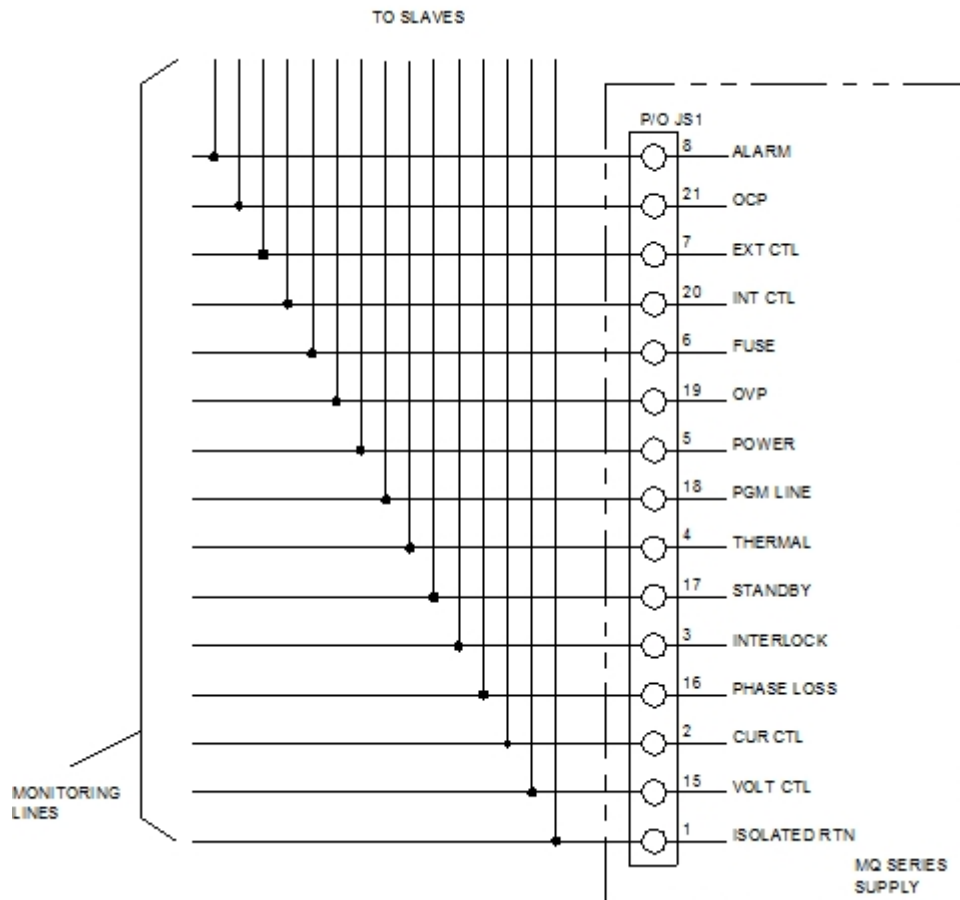


Figure 2.8 Digital output monitoring lines

2.10 Diagnostic Functions

Diagnostic functions and mode of control are embedded in the supply's closed loop control. The power supply will operate under voltage control or current control depending on which setting is lowest. Voltage control and current control also contain a soft start function which causes voltage and/or current to ramp to the desired set point after power is initiated. The soft start circuitry is reset upon power-on or operation of any diagnostic function.

Diagnostic functions include thermal overload, interlock, power, standby, phase loss, program line, fuse, over voltage, over current, and alarm. All diagnostic indicators have memory retention which saves the fault condition until the power supply is reset. To clear a fault condition, the user must press the display/reset switch on the front panel. Alternatively, the supply can be reset by turning the power supply off and on.

Thermal overload indicates that the input power processing devices or output rectifiers have reached a critical temperature. A resetting thermal breaker will reset upon cooling.

Standby indicates that the control circuits are powered, but the supply is disabled through the ac contactor. This is the power supply's normal off condition. To start the supply, press the start switch. To place the supply in standby, press the stop switch.

Phase loss indicates a problem with the power mains voltage.

Opening of a program line can cause the voltage, current, over voltage, or over current trip reference to be set beyond the range of control. These lines are constantly monitored and if any of these references are set above the normal bounds, program line diagnostics will disable the supply.

Fuse indicates that one of the three main fuses has cleared. Power must be removed from the supply and the fuse must be replaced to correct this condition.

Over voltage indicates that the supply has exceeded the over voltage trip reference. This condition causes the supply to shutdown and optional SCR crowbar to fire. To clear this condition, the user must press the display/reset switch on the front panel. Upon pressing this switch, the over voltage trip and over current trip references are displayed and the over voltage condition is cleared. To restart the supply, simply press the start switch.

Over current indicates that the supply has exceeded the over current trip reference. To clear this condition, the user must press the display/reset switch on the front panel. Upon pressing this switch, the over voltage trip and over current trip references are displayed and the over current condition is cleared. To restart the supply, simply press the start switch.

The power supply requires closure of an interlock switch to be functional. One interlock switch is provided as switch position 3 of S1. As described earlier, the default position is 1, which enables

operation of the power supply. For external interlock operation, set switch position 3 of S1 to 0 and connect an external switch between terminals 14 and 10 of JS1.

Any diagnostic condition causes an alarm condition. This feature can be used as a standalone signal to indicate there is a problem.

Internal and external controls are programmed by switch positions 5 and 4 of S1, respectively. Internal control enables front panel start, stop, and reset switches and external control enables input digital lines; terminals 9, 22, and 23 of JS1.

2.11 Parallel Operation

Two or more MQ Series power supplies can be connected in parallel to obtain a total output current greater than that available from one power supply. The total output current is the sum of the output currents of the individual power supplies. Each power supply can be turned on or off separately.



Caution: MQ series power supplies should not be connected in parallel with optional SCR crowbar. Operation of the crowbar in such a configuration can damage the power supply.

2.11.1 Parallel Operation - Direct

The simplest parallel connection involves attaching the positive terminals of all supplies to be paralleled to the positive point of the load and the negative terminals to the negative point of the load. The output current controls of each power supply can be separately set. The output voltage control of one power supply (master) should be set to the desired output voltage; the other power supply (slave) should be set for a slightly higher output voltage. The master will act as a constant voltage source; the slave will act as a constant current source, dropping its output voltage to equal that of the master.

2.11.2 Parallel Operation - Master/Slave

Master/slave parallel operation permits equal current sharing under all load conditions and allows complete control of output current from one master power supply.

Figure 2.7 illustrates the terminal connection for master/slave operation and salient control circuitry. Slave operation requires setting switch positions 3 and 4 of S2 to 0 and connecting a jumper between terminal 2 of JO2 to terminal 19 of JO2. To interface the slave to the master, connect terminal 16 of JO2 slave to terminal 1 of JO2 master and connect terminal 3 of JO2 slave to terminal 14 of JO2 master.

The auxiliary differential amplifier in the slave connects to the current sensing terminals of the master. This amplifier creates a current reference signal equal to that being sensed by the master. In master/slave parallel operation, the slave output voltage should be set slightly higher than that of the master.

To add a second slave, make the same connections to the current sensing terminals of the master and connect the second slave in parallel with the other two supplies.

2.12 Series Operation

Two or more power supplies can be connected in series to obtain a total output voltage greater than that available from one power supply. The total output voltage is the sum of the output voltage of the individual power supplies. Each power supply can be turned on or off separately.



Caution: No plus or minus voltage should exceed 600 V with respect to ground.

2.12.1 Series Operation - Direct

The simplest series connection involves attaching the positive terminal of the first supply to the negative terminal of the second supply. The load is connected between the negative terminal of the first supply and the positive terminal of the second supply. The output current controls of each power supply are operative and the current limit is equal to the lowest control setting. If any one output current control is set too low with respect to the total output current, the series power supplies will automatically crossover to constant current operation and the output voltage will drop.

2.12.2 Series Operation - Master/Slave

Master/slave series operation permits equal voltage sharing under all load conditions and allows complete control of output voltage from one master power supply.

Figure 2.8 illustrates the terminal connection for master/slave operation and salient control circuitry. Slave operation requires setting switch positions 1 and 2 of S2 to 0 and connecting a jumper between terminal 15 of JO2 to terminal 7 of JO2. To interface the slave to the master, connect terminal 4 of JS2 slave to the positive output terminal of the master and connect terminal 3 of JS2 slave to the negative output terminal of the master. To minimize noise, wires between the master and slave should be #20 AWG twisted pair.

The auxiliary differential amplifier in the slave connects to the output of the master. This amplifier creates a voltage reference signal equal to that being sensed by the master. Master/slave series operation is intended only for power supplies with the same output voltage and current ratings.

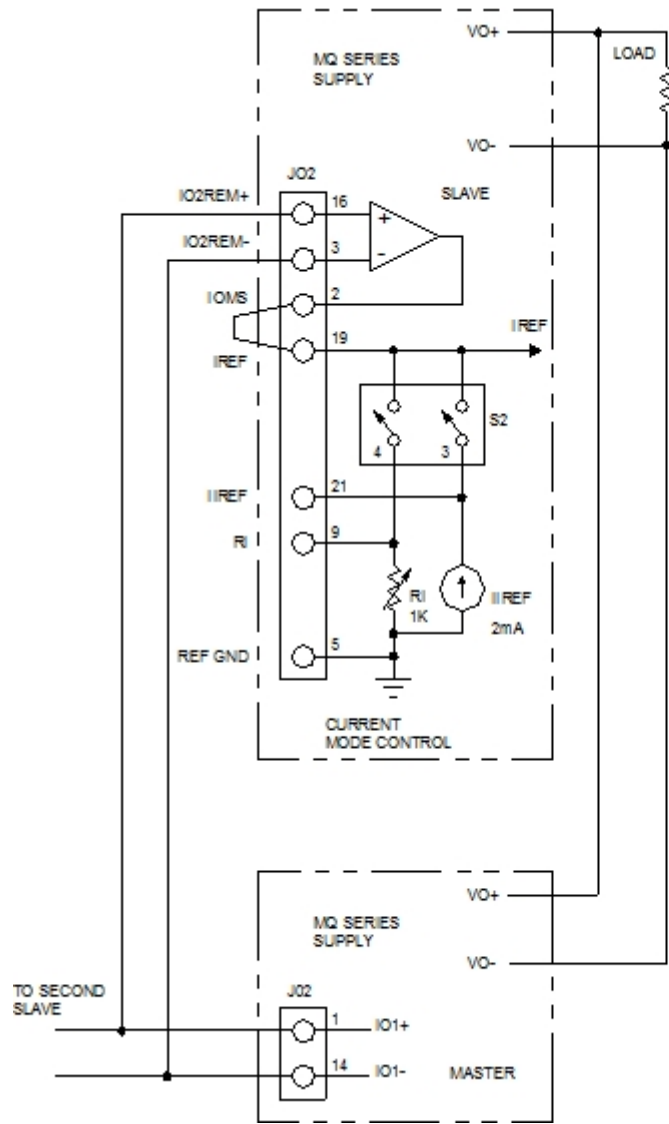


Figure 2.7 Master/slave parallel connection

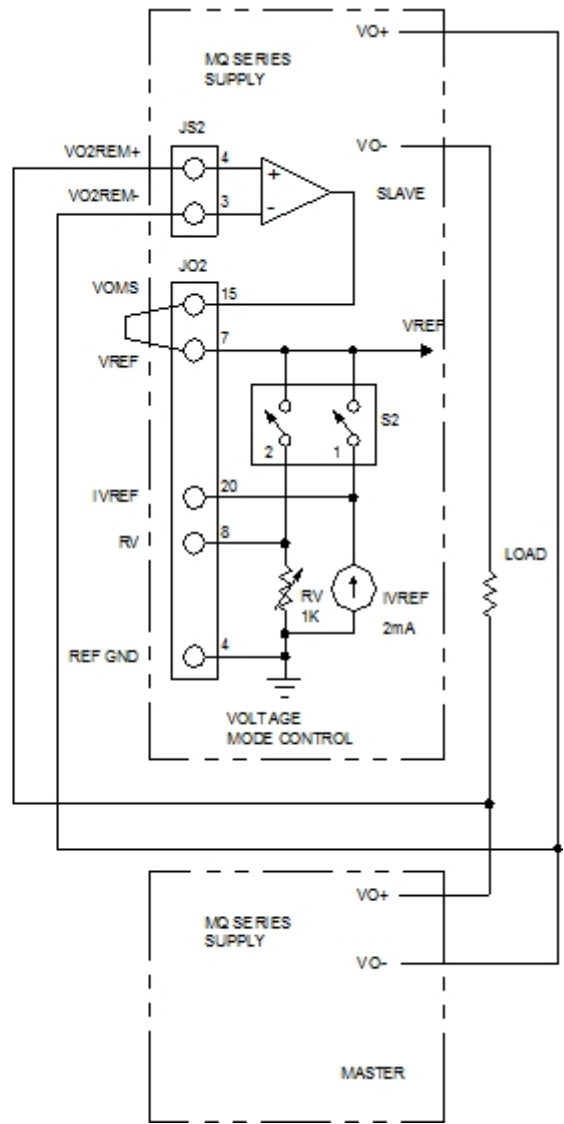


Figure 2.8 Master/slave series connection

To add a second slave, sense the output voltage of the first slave and place the second slave at the lowest potential below ground. Do not sense the output voltage of the master, for this will damage the second slave.

2.13 Pulse Loading

The power supply will automatically crossover from constant voltage to constant current operation, or the reverse, in response to an increase (over the preset limit) in the output current or voltage, respectively. With preset limit set to the average output current or voltage, high peak currents or voltages, as occur in pulse loading, may exceed the preset limit conditions and cause crossover to occur. To avoid this unwanted crossover, the preset limit must be set for the peak requirement and not the average.

There are internal capacitors across the output terminals of the power supply. These capacitors help to supply high-current pulses of short duration during constant voltage operation. Any capacitance added externally will improve the pulse current capability, but will decrease the safety provided by the constant current circuit. A high-current pulse may damage load components before the average output current is large enough to cause the constant current circuit to operate.

2.14 Nomenclature

The following defines user connections on the terminal strips and input/output power connections.

AC INPUT:

A: Phase A input.

B: Phase B input.

C: Phase C input.

GND: System ground.

DC OUTPUT:

VO+: Positive output.

VO- : Negative output.

PROGRAMMING INPUTS:

REF GND: Reference ground.

VO1+: Positive output sense.

VO1-: Negative output sense.

VS+: Non-inverting input to voltage sense amplifier.

VS- : Inverting input to voltage sense amplifier.

VO1REM+: Remote positive voltage sense.

VO1REM-: Remote negative voltage sense.

VO2REM+: Remote positive voltage sense of second supply.

VO2REM-: Remote negative voltage sense of second supply.

VOMS: Master/slave output of voltage sense amplifier.

IO2REM+: Remote positive current sense of second supply.

IO2REM-: Remote negative current sense of second supply.

IOMS: Master/slave output of current sense amplifier.

IVREF: Voltage control reference current.

IIREF: Current control reference current.

ITVREF: Over voltage trip reference current.

ITIREF: Over current trip reference current.

RV: Voltage control resistance.

RI: Current control resistance.

RTV: Over voltage trip control resistance.

RTI: Over current trip control resistance.

VREF: Voltage control input reference.

IREF: Current control input reference.

TVREF: Over voltage trip control input reference.

TIREF: Over current trip control input reference.

IO1+: Positive current sense.

IO1-: Negative current sense.

OPTICALLY ISOLATED CONTROL INPUTS:

ISOLATED RTN: Return path for all optically isolated inputs and outputs.

Stop: Remote stop.

Start: Remote start.

Reset: Remote reset.

Interlock Set: Interlock set.

OPTICALLY ISOLATED DIGITAL OUTPUTS:

Standby: Standby.

Power: Control circuit power.

Int Ctl: Internal control.

Ext Ctl: External control.

PGM Line: Program line shutdown.

Over Voltage: Over voltage trip shutdown.

Over Current: Over current trip shutdown.

Phase Loss: Phase loss shutdown.

Thermal: Thermal overload shutdown.

Fuse: Fuse cleared.

Volt Control: Voltage control.

Cur Control: Current control.

Alarm: Alarm condition.

3.0 PRINCIPLES OF OPERATION

3.1 General

Figure 3.1 illustrates the block diagram of the MQ Series power supply. As illustrated, MQ Series power supplies are comprised of master/slave modules having power ratings of 10 kW. Depending on the system specification, power supplies can contain 2 to 6 modules.

MQ Series power supplies have a number of feedback loops to insure balance between modules. The details of the modules are described below.

3.1.1 Master Module

Power is fed through ac fuses and is distributed to a control transformer, inrush limiter, and main 3 ϕ contactor. The control transformer powers a switching power supply in the driver board. Power from the switching power supply is fed to the other printed circuit boards in the system. The inrush limiter is a step start device with is used to initially charge capacitors on the input dc bus and limit the inrush of current. The inrush limiter is initiated when the power supply is switched from a standby to power state. After the charge cycle, the main 3 ϕ contactor is energized and power is allowed to flow to the load. The optional EMI filter filters common mode and differential mode noise emanating from the supply.

Output power is controlled through a polyphase chopper. For the 10 kW master module, three choppers, phased 120° apart, provide a current source to the medium frequency link inverter. The choppers are controlled with current mode, pulse width modulation (PWM). This modulation scheme provides a quick response for transients and filtering harmonics on the dc bus. As illustrated, chopper output current is monitored for balancing and for sensing overload current conditions. The polyphase chopper has been engineered to eliminate harmonic components minimizing currents circulating in the power supply.

The polyphase chopper produces a controlled dc bus which is connected to dc link inductors and current fed, IGBT medium frequency link inverter. The inverter, which operates at 420 Hz to 780 Hz, excites the main transformer at higher than normal line frequencies. This operation produces ohmic isolation between the input and output of the power supply using a transformer of dramatically reduced size.

The output of the main power transformer is converted to dc via rectifiers. Low voltage versions of the MQ Series power supply use midpoint diode configurations and higher voltage versions use bridge configurations.

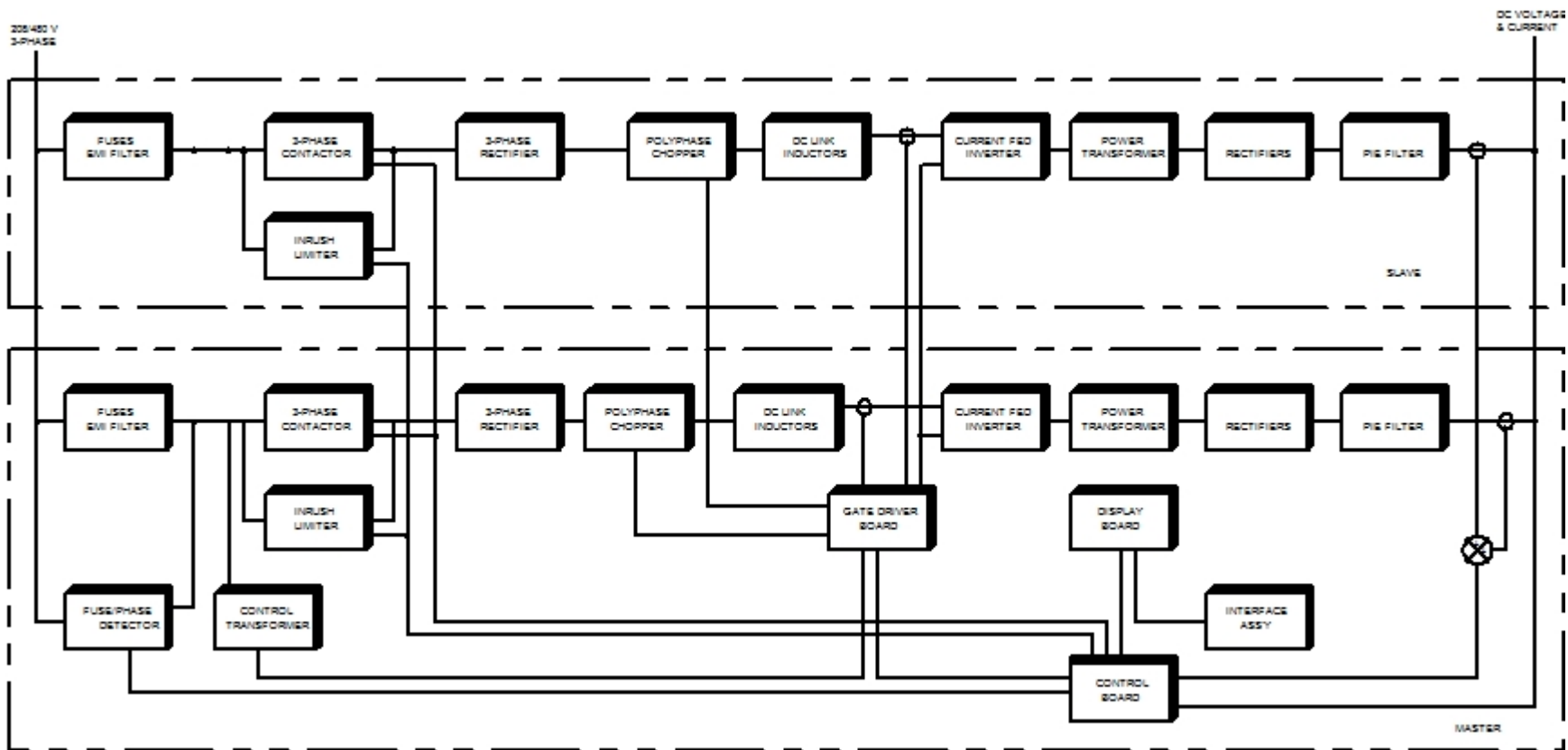


Figure 3.1 Block diagram

The dc output voltage is filtered with a pie section filter. This, in combination with the dc link inductors, form a double stage inductive capacitive (LC) filter.

The gate driver board supports a synchronized modulation scheme which integrates power semiconductor switching of the switching power supply, polyphase chopper, and medium frequency link inverter.

The fuse/phase detector senses input line voltage on each phase and continuity of each fuse. Upon detection of a problem, the control board is signaled to shutdown the system.

The display board contains light-emitting diodes for displaying diagnostic conditions and provides an interface for meters and switches. It also channels control and diagnostic functions to optical isolators for external functions.

All diagnostic functions are directly coupled to the error signal. This informs the user of precisely which function has control.

3.1.2 Slave Module

The slave module is very similar to the master module. The choppers are controlled with current mode, pulse width modulation (PWM) from signals derived from the master module gate driver board. The second set of chopper signals are displaced 60° from the first set of chopper signals in the master module. Together, a 20 kW system has six chopper modules phased 60° apart.

The medium frequency link inverter in the slave module uses the same driver signals as the master module.

For systems greater than 20 kW, additional gate driver boards are required. One board is required for every 20 kW of power processed.

The slave module's diagnostic features are coordinated with the master module to provide high performance with virtually any combination of modules. Balance between chopper currents is insured by independent sampling and feedback control. Power supply, chopper, and inverter modules are synchronized to avoid instabilities at different operating points.

3.2 Theory of Operation

3.2.1 Power Circuit

Schematics 106217 and 106218 illustrate the interconnection of 240 V and 480 V MQ master and slave modules. Schematics 106220, 106221, 106202, 106206, 106222, 106223, 106214, and 106208 show the power circuit and connections to the printed circuit boards. The first four schematics are master and slave modules for 240 V systems and the latter four are master and slave modules for 480 V systems.

Viewing 106220 and proceeding from left to right, the Input Board contains fuses, fuse/phase detector, and optional EMI filter. The Input Board connects to control transformer T2 and contactors K1 and K2. Contactor K2 and resistors R1 and R2 form the inrush limiter circuitry. When powered, contactor K2 charges the dc bus capacitors through diode bridge DB1. After approximately a second, contactor K1 is enabled allowing power to flow to the load. Control transformer T2 powers the Gate Driver board which contains a switching power supply.

Fans 1 and 2 are strategically arranged in the power supply to cool critical components.

The polyphase Chopper Module converts the incoming dc voltage to a controlled dc current. The Chopper Module uses current mode, pulse width modulation (PWM) to share current equally between the stages. Three stages are used for 10 kW models. Inductor L1 is used to increase the conduction period of the diode bridge DB1 to improve input power factor.

Inductors L3, L4, and L5 interface between the polyphase Chopper Module and the current fed Inverter Module. The Inverter Module contains four insulated gate bipolar transistors (IGBT's) which drive transformer T1 with a 420 to 780 Hz current square wave.

The secondary side of transformer T1 is connected in either a diode midpoint connection, like schematic 106220, or a diode bridge configuration, like schematics 106221. The rectified output voltage is fed to the Output Module which contains a pie filter and optional SCR crowbar circuitry.

The Gate Driver Board feeds the Chopper Module and Inverter Module with the proper gating signals. The Control Board sends control signals to the Gate Driver Board, receives output voltage and current signals from the Output Board, and accepts desired setpoint signals from the Display Board. The Interface Board contains programming switches and interface external connectors for custom user connections.

Thermal switches TB1 and TB2 are connected to the two main heatsinks where the main power semiconductors are mounted.

3.2.2 Input Board

Schematic 108208 illustrates the Input Board. The Input Board contains system fuses, optional EMI filter, fuse detector, and 3 ϕ ac voltage detector.

Fuses F1 through F3 feed power to the ac contactors and fuses F4 and F5 feed power to the control circuits. The fuse detector circuit, resistor R1 through R6, senses the status of fuses F1 through F3 and the phase detector, resistors R7 through R15 and diodes D1 through D3, senses the magnitude of phase to phase power mains voltage. Both the fuse detector and phase detector, which are connected to optical isolators, U1 through U4, interface to the control circuit.

3.2.3 Chopper Module

The Chopper Module is illustrated in schematics 108205 and 108216, the circuits for 240 V and 480 V models, respectively.

As previously described, the Chopper Module consists of three sections that are phase 120° apart. The Chopper Module contains current transducers for detecting currents in each section.

IGBT's Q1 through Q3 are driven through driver amplifiers 108961 using current mode, pulse width modulation (PWM). During the on state, the insulated gate bipolar transistors (IGBT's) are conducting and during the off state diodes D1 through D3 are conducting. Depending on the PWM signal, the input voltage bus is reduced to a lower voltage and the output current is precisely controlled.

3.2.4 Inverter Module

The Inverter Module is illustrated in schematics 108206 and 108217, the circuits for 240 V and 480 V models, respectively.

IGBT's Q1 through Q4 are inversely driven using driver amplifiers 108961 to produce a square wave at terminals N3 and N4. Resistors R1 through R4 and capacitors C1 through C4 limit dv/dt across the IGBT's which reduces voltage transients and improves electromagnetic interference (EMI).

3.2.5 Output Module

The Output Module is illustrated in schematics 108207 and 108215, the circuits for low and high output voltage models, respectively.

The Output Module filters the rectified output voltage of the main transformer. Ac components consist of the commutation notches produced during switching of the Inverter Module and ripple current produced by the Chopper Module. The inductive input to the Inverter Module and the pie section filter of the Output Module form a double stage LC filter. The first capacitor section of the

Output Module consists of capacitors C1, C2, C3, and C8. The second capacitor section consists of capacitors C4 and C9. Capacitors are connected in a parallel configuration for low voltage outputs, schematic 108207, and a series parallel configuration for high voltage outputs, schematic 108215. Capacitors C6 and C7 provide output common mode voltage suppression.

The optional SCR crowbar consists of SCR1 and inductor L1.

3.2.6 Other Printed Circuit Boards

The remaining printed circuit boards consist of the Gate Driver Board, 108945; the Control Board, 108944; Display Board, 108846; and Interface Board, 108947. These boards are strictly small signal and should be treated as replaceable subassemblies.

4.0 MAINTENANCE AND TROUBLE SHOOTING

4.1 General

The MQ Series power supplies consist of a multistage power processing system. Because of its complexity, it is highly recommended that all repairs be performed by the factory or qualified power supply technician. Before attempting maintenance or repair, the technician should be familiar with the components of the systems and the theory of operation. Some basic test equipment is also necessary: source of ac power, means of loading the power supply, dc voltmeter with accuracy and resolution better than the unit specifications, and an oscilloscope. The chart in section 4.2 should aid in finding operational problems.



Caution: When servicing the power supply, dangerous voltage levels exist. All ac and dc capacitors should be discharged. Be especially careful of person and equipment when measuring primary circuitry since this is at line potential.

4.2 Trouble Shooting Guide

1. Fuse F1, F2, or F3 blows when the power supply is turned on. Power supply has a short on the primary side.
 - a. Check diode bridge DB1.
 - b. Check for failed power semiconductor on the Chopper Module.
 - c. Check for isolation to ground on the input side of the power supply.
2. Over current trips and power supply cannot be reset. An auxiliary over current detector limits input dc link current. Exceeding safe levels will cause an over current diagnostic condition that cannot be reset.
 - a. Restart the supply. Transient voltages on the input voltage could have caused the problem.
 - b. Check diodes D1 through D4 on the secondary side of transformer T1.
 - c. Check for a shorted winding on transformer T1.
 - d. Check for failed IGBT's in the Inverter Module.
3. Unit goes to high output immediately after starting.
 - a. For local sensing, check that positions 1 and 2 of S1 are set to 1. For remote sensing, check that there is continuity of feedback signals on terminals 1 and 2 of JS2.
 - b. Check for loose connectors internal to the power supply.
3. High ripple voltage.
 - a. Check the mains voltage for balance and magnitude.

4.3 Calibration

4.3.1 Control Board

Current Reference Calibration

Set the power supply for remote resistive programming (see figures 2.4 and 2.5) using two external, precision 1K resistors. Set positions 2 and 4 of switch S2 to 0 and connect 1K precision, external resistors between terminals 20 and 4 of JO2 and terminals 21 and 5 of JO2.

First adjust potentiometer P6 for a 2.00 V drop across the external resistor at terminal 21 of JO2. Then adjust potentiometer P5 for a 2.00 V drop across the external resistor at terminal 20 of JO2.

Remove the external resistors and set positions 2 and 4 of S2 back to 1.

Voltage Amplifiers and Voltmeter Calibration

Connect jumpers on the rear of the power supply to monitor output voltage as illustrated in figure 2.6. This requires a jumper between the positive output terminal to terminal 4 of JS2 and a jumper between the negative output terminal to terminal 3 of JS2. Place the first dc voltmeter across output terminals of the power supply and place the second dc voltmeter across test point TP3 (positive) and test point TP4 (negative). Using voltage mode control, increase the output voltage using the front panel control until TP3 is 1.00 V. Adjust potentiometer P8 until the voltage output is set to half rating.

Place the second dc voltmeter across terminal 15 of JO2 and terminal 4 of JO2. Using voltage mode control, increase the output voltage to half rating and adjust potentiometer P1 to 1.00 V.

Using voltage mode control, increase the output voltage to half rating and adjust potentiometer P7 until the voltmeter of supply equals that of the first voltmeter.

Place the second dc voltmeter across terminal 6 of JO2 and terminal 4 of JO2. Using the over voltage trip potentiometer on the front panel, set the second dc voltmeter to 1.00 V. Pressing the display/reset switch on the front panel, adjust potentiometer P12 until the voltage reading is half rating.

Current Amplifiers and Ammeter Calibration

Place the reference dc ammeter, equal to the rating of the supply, across the output terminals of the supply. Connect jumpers on the rear of the power supply to monitor output current as illustrated in figure 2.6. This requires a jumper between terminal 16 of JO2 to terminal 1 of JO2 and a jumper between terminal 3 of JO2 to terminal 14 of JO2. Place a dc voltmeter across test point TP1 (positive) and test point TP4 (negative). With power applied to the control circuit and with the main contactor off, adjust potentiometer P2 for a null at TP1. Using current mode control, increase the output current using the front panel control until TP1 is 1.00 V. Adjust potentiometer P9 until the

current output is set to half rating.

Place the dc voltmeter across terminal 2 of JO2 and terminal 4 of JO2. With power applied to the control circuit and with the main contactor off, adjust potentiometer P3 for a null at terminal 2 of JO2. Using current mode control, increase the output current to half rating and adjust potentiometer P4 to 1.00 V.

Using current mode control, increase the output current to half rating and adjust potentiometer P10 until the ammeter of supply equals that of the output.

Place the dc voltmeter across terminal 18 of JO2 and terminal 5 of JO2. Using the over current trip potentiometer on the front panel, set the dc voltmeter to 1.00 V. Pressing the display/reset switch on the front panel, adjust potentiometer P11 until the current reading is half rating.

4.3.2 Driver Board

Over Current Trip

Over current trip should only be calibrated after consultation with the factory.



Gross misadjustment can cause inverter failure.

Place the first dc voltmeter across test point TP5 and test point TP7. Place the second dc meter across test point TP6 and test point TP7. Apply full load to the power supply and monitor the voltage at test point TP5 when operating the power supply at nominal input voltage. Set test point TP6 to 200% of test point TP5 using potentiometer P1.

5.0 SCHEMATICS

The following schematics pertain to the MQ Series supply.

6.0 PARTS LIST

The following parts list pertains to the MQ Series supply.