samlexpower®

N + 1 DC Power System

SEC-4825BRM

Owner's Manual

Please read this manual BEFORE installing the unit

OWNER'S MANUAL | Index

SECTION 1 | Safety Instructions

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS
This manual contains important Safety and Operating Instructions. Please read before using this unit .

The following safety symbols will be used in this manual to highlight safety and information:

WARNING!

Indicates possibility of physical harm to the user in case of non-compliance.

CAUTION!

Indicates possibility of damage to the equipment in case of non-compliance.

Please read these instructions before installing or operating the unit to prevent personal injury or damage to the unit.

WARNINGS!

1. DO NOT OPEN TO REDUCE RISK OF FIRE OR ELECTRIC SHOCK. THERE ARE NO USER SERVICEABLE PARTS INSIDE—REFER TO QUALIFIED SERVICE PERSONNEL.
2. The unit should be grounded to reduce the risk of electric shock. It comes with attached power cord that has a 3 prong, grounded 30A, NEMA L5-30P plug. The grounding prong of the plug is internally connected to the chassis of the unit. When the power cord is plugged into the corresponding NEMA L5-30R outlet, the chassis of the unit is automatically connected to the Earth Ground through the Equipment Grounding Conductor that is connected to the grounding slot of the outlet. The power cord must be plugged into a corresponding NEMA L5-30R outlet that is properly installed and grounded in accordance with all local codes and ordinances. Never alter the power cord that has been provided. If the plug of the cord will not fit the outlet, have a proper outlet installed by a qualified electrician. Improper connection can result in risk of electric shock.
3. It is recommended that you return your power supply to a qualified dealer for any service or repair. Incorrect assembly may result in electric shock or fire.
4. To reduce the risk of electric shock, unplug the power supply from the outlet before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.
5. To reduce risk of damage to electric plug and cord, pull by plug rather than cord when disconnecting the unit.
6. An extension cord should not be used unless absolutely necessary. If an extension cord is used, make sure that it has 3-prong, grounded male plug (NEMA L5-30P) and

3-prong, grounded female receptacle (NEMA L5-30R). The size of the current carrying conductors should be at least AWG#10 for NEMA L5-30.

7. Place the unit in an area that will allow air to flow freely around the unit. DO NOT block or obstruct vent openings on the sides and at the back or install the unit in an enclosed compartment.
8. Keep the unit away from moisture and water.
9. NEVER OPERATE TWO OR MORE UNITS IN PARALLEL.
10. **Precautions when working with batteries.**
    - Batteries contain very corrosive diluted Sulphuric Acid as electrolyte. Precautions should be taken to prevent contact with skin, eyes or clothing.
    - Batteries generate Hydrogen and Oxygen during charging resulting in evolution of explosive gas mixture. Care should be taken to ventilate the battery area and follow the battery manufacturer's recommendations.
    - NEVER smoke or allow a spark or flame near the batteries.
    - Use caution to reduce the risk of dropping a metal tool on the battery. It could spark or short circuit the battery or other electrical parts and could cause an explosion.
    - Remove metal items like rings, bracelets and watches when working with batteries. The batteries can produce a short circuit current high enough to weld a ring or the like to metal and thus cause a severe burn.
    - If you need to remove a battery, always remove the Negative Ground Terminal from the battery first. Make sure that all the accessories are off so that you do not cause a spark.

CAUTIONS!

1. Please ensure that the battery is connected with correct polarity - Positive of the battery to the "Battery +" terminal and the Negative of the battery to the "Battery -" terminal. Reversal of polarity will blow external Fuse F1. **DAMAGE DUE TO REVERSE POLARITY IS NOT COVERED UNDER WARRANTY.**
2. Protect the unit against AC line input transients. Use Transient Suppressor in line with the AC input.

SECTION 2 | Layout, Dimensions & Input/Output Connections

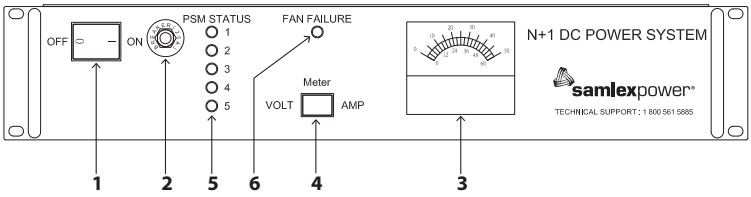


Fig. 2.1 FRONT VIEW

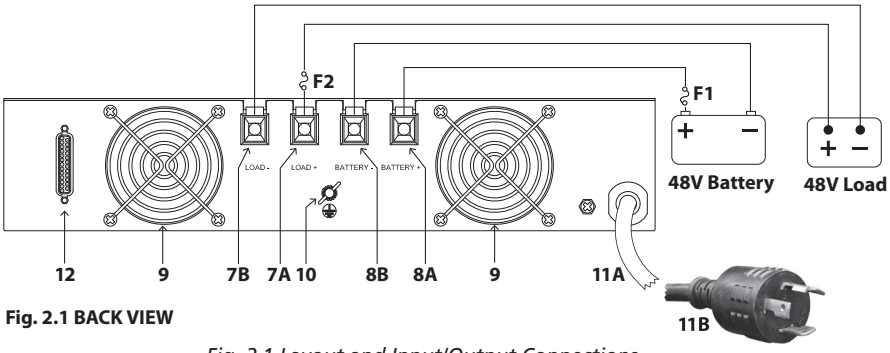


Fig. 2.1 BACK VIEW

Fig. 2.1 Layout and Input/Output Connections

Legend - Fig 2.1

FRONT VIEW		
1	AC Power ON/OFF Switch	Illuminates RED when ON
2	AC Input Breaker	25A.
3	DC Volt Meter / Ammeter	Voltage / current on Load Terminals
4	Voltmeter / Ammeter Selector Switch	Switches display on Voltmeter / Ammeter (3)
5	Green LED for Power Supply Modules (PSM) 1 to 5	**STEADY ON:** PSM is operating normally **BLINKING:** No output. PSM is not synchronizing **OFF:** No output. Defective
6	Red LED for fan failure or over temperature of heat sink on the PSM	**STEADY ON**: Fan failure or PSM over temperature
BACK VIEW		
7A	Positive (+) Load Terminal	**TUBULAR HOLE**: 5/16" Diameter **SET SCREW:** 5/16" X 3/8" Long x 24 TPI
7B	Negative (–) Load Terminal	
8A	Positive (+) Battery Terminal	
8B	Negative (–) Negative Terminal	
9	Cooling Fan	2 x 48V fans. Run continuously
10	Grounding Lug	Connect to Earth Ground / System Ground
11A	Attached AC Input Power Cord	3 Conductors - each AWG #12
11B	AC Input Power Cord Plug	30A, NEMA L5-30P
12	DB-25, D-Sub Connector	For remote signaling (Pin Out - Fig 3.2)
F1	External Battery Side Fuse	25A, 80V (Not supplied) - ATO Style, FKS Series by Littelfuse - Part No. 166.7000.525
F2	External Load Side Fuse	

SECTION 2 | Layout, Output Connection & Dimensions

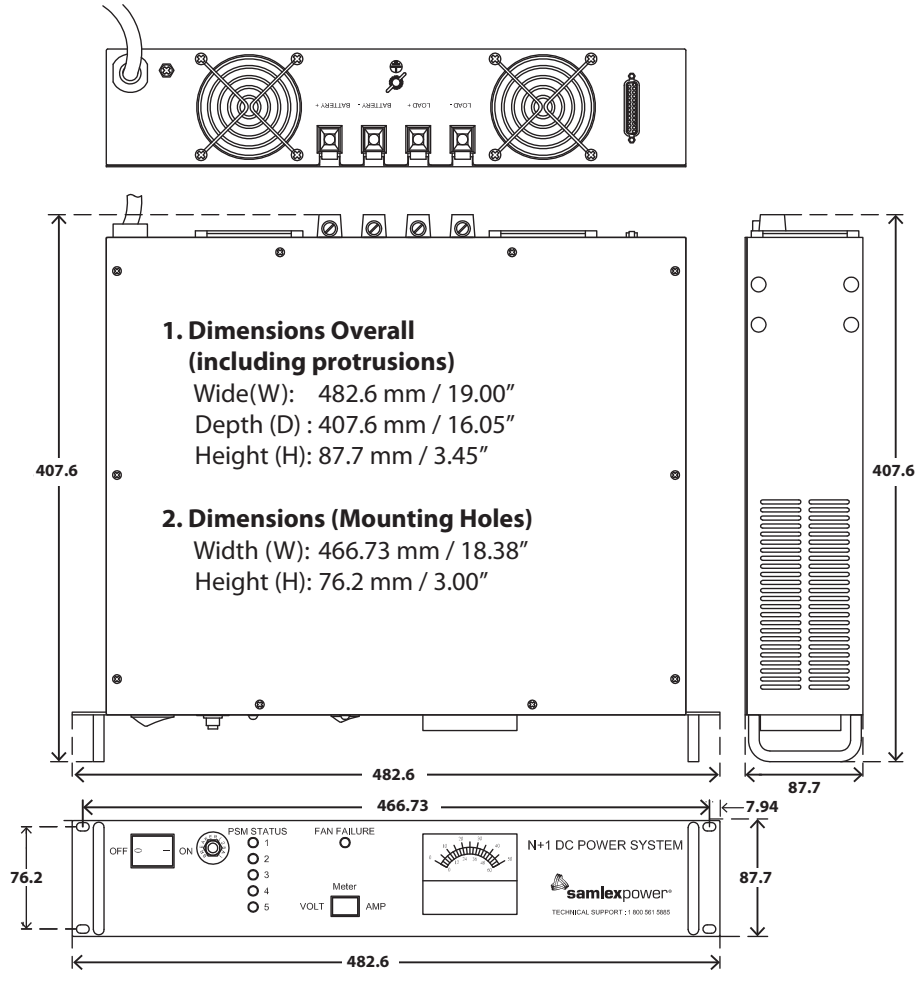


Fig. 2.2 Dimensions

SECTION 3 | Design & Principle of Operation

DESCRIPTION

SEC-4825BRM is a Switch Mode Power Supply (SMPS), which converts 120 VAC, 50/60 Hz to 48VDC Nominal (actually 54.8VDC at no load to 54.2V at 25A). It has additional provision for 48V battery backup with 2A charging in conjunction with external 48V Lead Acid Battery (not supplied).

FEATURES

- 19", 2U (3.5") height Rack Mount design
- Advanced Switch Mode Technology
- N+1 Redundancy: 5 x 5A Power Supply Modules operate in parallel under forced current share control
- Remote monitoring through Opto Isolated, Open Collector / Open Emitter output signals
- Reliable, 48 VDC Uninterruptible Power Source (DC UPS) in conjunction with external 48V Lead Acid backup Battery (not supplied)
- High efficiency and compact
- Protected against short circuit, overload, over voltage and over temperature

PRINCIPLE OF OPERATION

The unit consists of 2 Sections - Switch Mode Power Supply (SMPS) Section and Battery Backup and Charging Section.

The SMPS Section is designed using advanced switch-mode technology and active load share circuitry for high reliability, high efficiency and minimum size and weight. It is modular in construction consisting of 5 x 5A Power Supply Modules (PSM) that are connected in parallel and operate under forced current share control to deliver a total of 25A. Each PSM is a stand-alone, 55V Power Supply, which delivers up to a maximum of 5A continuous. By equalizing the output currents, uniform thermal stress of the individual PSMs is ensured which has utmost importance for long-term reliability of electronic components. The operating principle of current share mechanism is to measure the output current of each PSM and to modify the output voltages of the 5 PSMs until all the 5 PSMs deliver equal output current. Typically, the output currents of the 5 paralleled PSMs will be within 10% of each other at full output current. The module with the highest voltage at switching ON automatically assumes the role of a Master and the others operate as Slaves. Each PSM is required to be interconnected with one another to a common "SHARE BUS" through a pair of parallel pins marked "JUMP 1" and jumper wires (Fig. 3.5).

For proper operation of Current Share Control Circuitry / Master - Slave operation, a minimum load current is required to flow through each PSM to produce adequate feed back signal. This minimum pre-load current is provided by the sum of the currents drawn by the 2 cooling fans and by an internal static load resistor connected across the load output terminals. **This internal pre-load current*** is kept to the minimum to reduce dissipation.

* **NOTE: It is likely that due to drift in the pre-set values of components, the minimum internal preload current may not be sufficient to provide adequate feedback signal strength resulting in shut down of one or more modules when no external load is present (The associated PSM Status LED will flash and also, the associated signal for remote indication will oscillate between High and Low). As soon as external load is applied to the unit, the feed back signal strength will increase and the PSM(s) that were shut down will also operate normally.**

The output is delivered through an isolating Schottky diode to enable connection of external 48V battery (not supplied) for un-interrupted DC power output. The external backup battery is kept charged by "Taper Type of Float Voltage Charging" through a current limiting series resistor that limits the maximum charging current to 2A when the battery is completely discharged.

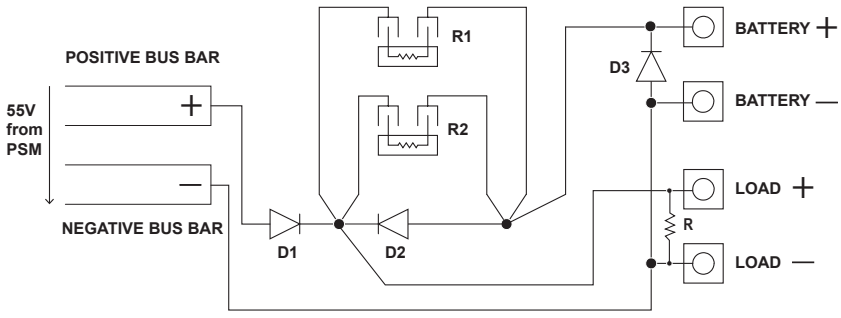
The SMPS Section along with the Battery Backup and Charging Section work as a DC Uninterruptible Power Source (DC UPS) in conjunction with an external 48V, Lead Acid backup battery (battery is not supplied). As long as 120VAC input power is available, the unit will put out 54.8VDC to 54.2VDC at the Load Terminals (7A, 7B - Fig 2.1). At the same time, charging current of up to a maximum of 2A (when battery is completely discharged to Standing Voltage of 42.8V) will be fed through the Battery Terminals (8A, 8B - Fig 2.1) to charge the external battery. The voltage at the Battery Terminals (8A, 8B - Fig 2.1) will always be clamped to the actual voltage of the battery corresponding to its State of Charge. If AC input power fails, the DC load will be instantaneously transferred to the external 48V backup battery and the battery will start discharging. When AC input power is restored, the DC load will once again be transferred instantaneously to the Power Supply Section and the external backup battery will be recharged and kept in charged condition all the time at float Voltage of 54V to 54.6V (when fully charged). If battery backup function is not used (external 48V backup battery is not connected), the unit will work as a normal 48V nominal Power Supply.

N+1 Redundancy

5 Power Supply Modules operating in parallel with equal current sharing provides redundancy. Chance of failure of all the 5 modules is reduced tremendously. If say one module fails, the remaining 4 modules will share the load current equally. Such redundancy is also called N+1 redundancy i.e. if "N" number of paralleled modules are required to service a certain load, the unit should have 1 additional module (total "N+1" modules) to provide redundancy. For example, if the rated load drawn from this unit is 20A, 4x5A modules will be required. Using 1 additional 5A module (total 25A) will have the capacity to service the full load of 20A even if 1 module fails.

OPERATION OF BATTERY BACK-UP AND CHARGING SECTION

Please refer to the schematic at Fig 3.1 (page 9).
Regulated output voltage of 55VDC from the modules (measured at screw terminals S5 and S6 (Fig. 3.4) is fed to the Positive and Negative DC bus bars and from there to the output terminals LOAD (+) and LOAD (–) through the isolating Schottky Diode D1. Although the output voltage at the module terminals S5 and S6 (Fig.3.4) or at the



LEGEND

D1, D2	Schottky Diode, 40CPQ060 by International Rectifier
D3	10A, 600V Diode "10A6" for reverse polarity protection
R1, R2	Power Resistor 12 Ohm, 35W
R	Static Load Resistor, 1K, 5W

Fig 3.1 Schematic - Battery Backup

common DC bus bar (before the Schottky Diode D1) is tightly regulated at the preset value of 55VDC, the voltage at the output terminals Load (+) and Load (–) will vary slightly due to the forward voltage drop "V_f" of the isolating Schottky Diode D1 and the drop along the DC bus bar and wiring. **The voltage at the output terminals LOAD (+) and LOAD (–) will be as follows:**

- At no external load — Approximately 54.8VDC
- At 25A load — Approximately 54.2VDC

When there is a requirement of un-interrupted DC power to the load, an external 48V battery should be connected at the terminals Battery (+) and Battery (–). When input AC power is available, the load current is supplied by the Power Supply Section through Isolating Schottky Diode D1. At the same time, the battery is charged to Float Voltage Level by "Taper Type of Charging" through 2 x 12 Ohm resistors R1 & R2 in parallel with an effective series resistance of 6 Ohm. This effective series resistance of 6 Ohm will limit the maximum charging current to 2A. The charging current will be determined by the following equation (Battery's internal impedance and battery cable resistance have been disregarded as their values are negligible as compared to the 6 Ohm effective series resistance):

Charging Current	= (Load Terminal Voltage – Battery's Intrinsic State of Charge Voltage) ÷ 6 Ohm
Maximum Charging Current (At completely discharged voltage of 42.8V)	= (54.8V – 42.8V) ÷ 6 Ohm = 2A
Charging current when fully charged to maximum Float Voltage of 54.6V	25 mA (0.1% of Ah capacity of the battery to compensate for self-discharge. Battery with 25Ah capacity has been considered)

From the above equation, it will be seen that the battery will be charged at a maximum charging current of around 2A when the battery is completely discharged to Standing Voltage of 42.8V and the charging current will taper to a very low value of around 25mA when the battery is charged to Float Voltage Level of 54.6V.

If input A.C. power is interrupted, the external battery feeds the load instantaneously through the Schottky Diode D2 (D2 will be forward biased and will by-pass resistors R1 & R2). Voltage available to the load will be approximately 0.2V lower than the battery voltage due to forward voltage drop across D2. Availability of AC power is signaled for remote monitoring through opto-isolated signal through D-Sub Connector (Pins 2 and 16 of D-Sub Connector, Fig 3.2. Also see below under "Remote Monitoring of Operational Status"). This signal may also be used to indicate that the load is being powered by battery (In case external battery is used for battery back-up). When AC input power returns, load current will be supplied by the Power Supply Section, Diode D2 will be reverse biased and the discharged battery will be taper charged through 6 Ohm effective resistance of R1& R2.

* **NOTE: The value of charge limiting resistors R1 and R2 is based on a typical 48V, 25Ah deep cycle marine battery. If a different type of battery is used, the value of the resistor should be adjusted to meet associated charging requirements.**

REMOTE MONITORING OF OPERATIONAL STATUS

A provision has been made for remote monitoring of the following operational conditions and parameters:

a) Operational status of the 5 Power Supply Modules (PSM)

b) Failure condition of the cooling fan(s)

c) Availability of AC input power (Through 120VAC to 5VAC transformer)

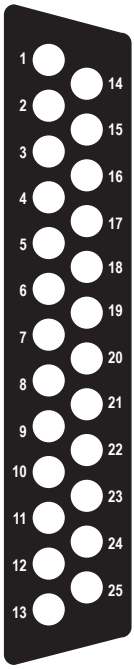
d) Output voltage measurement (Across Load Terminals)

e) Output current measurement (Voltage across an internal shunt with Shunt Ratio of 25 mV / 50A or 0.5 mV per Amp)

Signals for remote monitoring of operating conditions at Srls (a), (b) and (c) above are transmitted to the remote receiving device through open Collector and open Emitter pins of phototransistor of internal Opto-Isolator (Figs 3.2 & 3.3A).

Outputs for voltage and current measurements at Serials (d) and (e) above are direct analogue voltages.

The Pin Out of the 25 Pin D-Sub Connector (12, Fig 2.1) providing the above signals for user interface is given at Fig 3.2.



Item	Pin No.	Color Code of Wire	Output Pins of Opto Isolator	†Operational Condition or Parameter (High)
1	2 16	Black White	Collector Emitter	AC input is available
2	12 19	Orange Green	Collector Emitter	Fan failure
3	7 20	Gray Violet	Collector Emitter	PSM 1 Normal
4	8 21	Violet Blue	Collector Emitter	PSM 2 Normal
5	9 22	Blue Greeb	Collector Emitter	PSM 3 Normal
6	10 23	Green Yellow	Collector Emitter	PSM 5 Normal
7	11 24	Yellow Orange	Collector Emitter	PSM 5 Normal
8	25 13	Red Black	-	Voltmeter + Voltmeter -
9	18 6	Gray Blue	-	*Ammeter + *Ammeter -

Notes:

† *For operational conditions at Items 1 to 7, the Transistor Switch inside the Opto Isolator is in "Saturation" condition (near short circuit between Collector and Emitter terminals)*

* *Shunt Ratio 25mV/50A or 0.5mV/Amp.*

Fig. 3.2 Pin Out of 25 Pin D-Sub Connector (12, Fig 2.1) for Remote Monitoring

OPTO-ISOLATED TRANSFER OF SIGNALS FOR REMOTE MONITORING

In this power supply, signals for remote indication of operating conditions at Serials (a), (b) and (c) on page 10 are transmitted to the remote receiving device through open Collector and open Emitter pins of NPN phototransistor of internal Opto-Isolator (Fig 3.2 above and Fig 3.3A on page 12). The NPN phototransistor can provide a maximum of 50 mA with a Collector to Emitter voltage of up to 35V. Use of opto-isolated signal transfer ensures the following at the receiving location:

- Isolates noise, ground loops, and / or high voltages from the power supply from being fed to the external remote monitoring device.
- The +Vcc voltage that is connected to the pull-up resistor(s) / alarms and relays for generating alarm signals at the receiving monitoring device (Figs 3.3 B to D, page 12) comes from an external voltage source and hence, maximum isolation is provided
- Ability to generate TTL logic signals with Vcc of 3.3V / 5V (Fig 3.3B for 5V Vcc)
- Drive relays / LEDs with Vcc of up to 35VDC (e.g. 5V / 12V / 24V) and drive current of up to 50 mA (Figs 3.3C and 3.3D)
- Ability to combine the signals (OR'd) to form a single signal sharing common Logic Ground

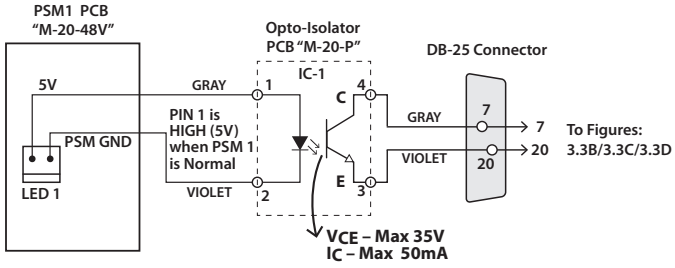


Fig. 3.3A: Schematic for Remote Signalling for "PSM 1 Normal"

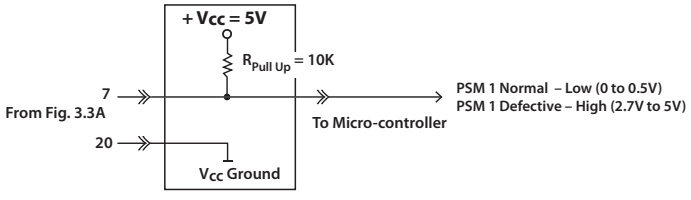


Fig. 3.3B: 5V TTL Logic Drive

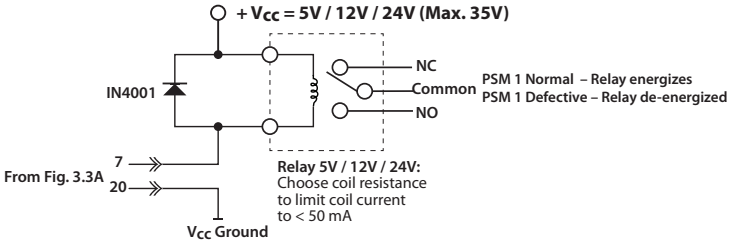


Fig. 3.3C: 5V / 12V / 24V Relay Drive

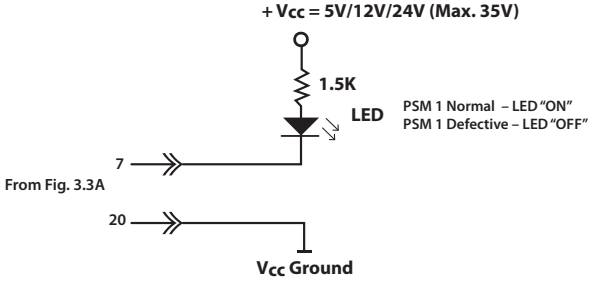


Fig. 3.3D: LED Drive

SECTION 3 | Design & Principle of Operation

Principle of operation is explained in Figs 3.3A to 3.3D below using example of remote monitoring of the operational status of Power Supply Module No. 1 (PSM1).

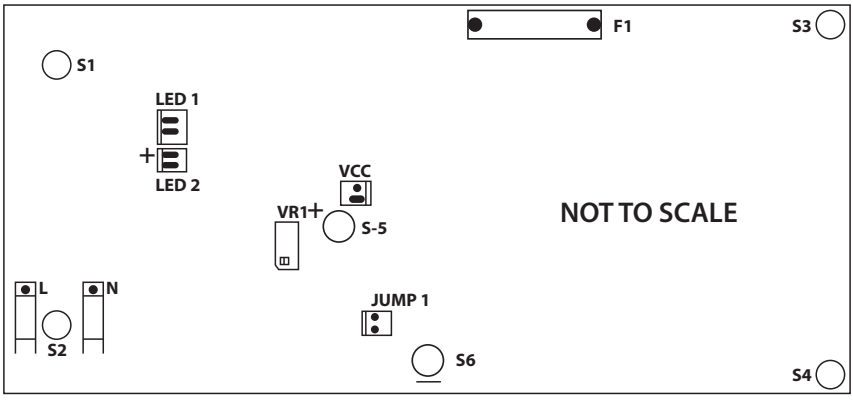
Operation Inside the Power Supply

Please refer to Fig 3.3A.

When PSM1 is operating normally, 5V (HIGH) drive signal is fed to Pins 1 and 2 of Infra-red Diode inside the Opto-Isolator "IC1". The diode conducts and optically transfers HIGH Base drive condition to the NPN Photo-Transistor with Pin 4 (Open Collector) and Pin 3 (Open Emitter). The Photo-Transistor will be in "Saturated" condition (near short circuit between Collector (Pin 4) and Emitter (Pin 3). Pins 4 and 3 are connected to Pins 7 and 20 respectively of the DB25 Connector (Fig 3.2).

Operation at Remote Monitoring Location

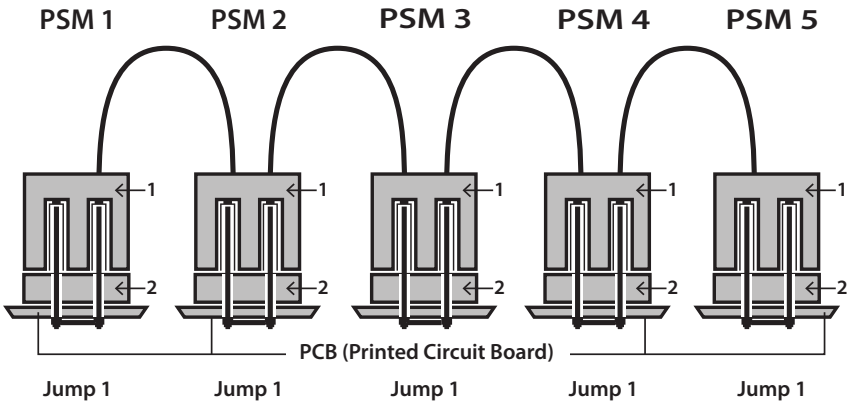
Monitoring of status from the DB-25 Connector can be undertaken at the remote monitoring location in 3 ways shown in Fig 3.3B, 3.3C and 3.3D.



Legend

S1 to S4	Holes for 4 screws to fasten the module to the chassis
S5 & S6	Holes for 2 screws to connect to the Positive & Negative output BUS Bars
L & N	L (Line) and N (Neutral) terminals for 120V, 60 Hz input power supply wires
LED 1	Terminal for remote indication of PSM status
LED 2	Terminal for "LED" PSM status (Front Panel)
JUMP 1	Jumper terminal for connecting share BUS wire
VCC	Connector for feeding Vcc to PCB for fan monitoring
F1	Fuse: 250V, 4A
VR1	Potentiometer for output voltage adjustment

Figure 3.4 Layout of Power Supply Module "M20-48V"



LEGEND:

1. Female terminal for the Daisy Chain Wire Connector
2. Male, 2-pin terminal marked "Jump 1" on the Power Supply Module

Fig 3.5 Daisy Chaining of Share Bus Jumps (Jump 1)

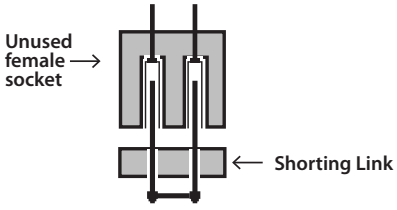


Fig 3.6 Shorting Unused Jump 1 Daisy Chain Wire Connector

OUTPUT VOLTAGE ADJUSTMENT

As explained earlier, the Power Supply Section of this unit has 5 Power Supply Modules operating in parallel under forced current share control. Each module has rated current output of 5A and hence, the total rated current output of the unit is 25A. For the forced current share / Master –Slave operation to work properly, it is important that the "set output voltage" of each of the 5 modules is exactly the same. If the output voltage of any module is below the "set voltage", its current share control circuitry (slave operation) will not function properly and it's associated "PSM x" LED will start flashing. The other modules which are putting out the "set voltage" will function normally under Master/ Slave operation and their "PSM x" LEDs will remain continuously lighted and the output voltage of the common DC bus (before Schottky Diode D1) will be equal to the "set voltage". If the output voltage of any module is higher than the "set voltage", it will become the Master and it's associated "PSM x" LED will remain continuously lighted. However, the other Modules with voltage lower than the "set voltage" will

not be able to function normally as Slaves and their associated LEDs "PSM x" will flash randomly.
The output voltage of the common DC bus (before Schottky Diodes D1) will read the higher voltage of this module.

The output voltage of each module measured at the module output pads under S-5 and S-6 (See Fig.3.4) is factory pre-set at 55V to provide no load voltage of 54.8V at the Load Terminals. A precision multi-turn potentiometer VR1 is provided for fine adjustment of the output voltage of each of the modules. **The adjustment range of module output voltage is 53V to 56.3V.**

If the output voltage of the modules is required to be set to a value other than the preset value of 55V, the individual output voltage of each of the 5 modules will be required to be adjusted one by one to the same new "set voltage" within the adjustment range of 53V to 56.3V. This is done by feeding AC input power to only the module under adjustment and disconnecting AC input power to the other modules. Similarly, during operation and during replacement of defective module with new module, the output voltage of the all the individual modules will be required to be adjusted to the desired value.

As explained under **Operation Of Battery Back Up And Charging Section** on page 8, although the output voltage of the module at terminals S5 and S6 (Fig.3.4) or at the common DC bus (before the Schottky Diode D1) is tightly regulated at the preset value of 55V, the voltage at the output terminals Load (+) and Load (–) will vary due to the forward voltage drop of the isolating Schottky Diode D1 and the drop along the DC bus and wiring. Table 3.1 below gives details of voltage settings and actual voltages available under no load and under loaded conditions.

TABLE 3.1 VOLTAGE SETTINGS

Module Output Voltage at Terminals S5 and S6 (Fig 3.4)	Load Current (Combined Current of 5 paralleled Modules)	Forward Voltage drop "Vf" Across Schottky Diode D1	Voltage Available at Load Terminals Load (+) and Load (–) (Module Voltage - "Vf")
Preset Voltage 55V	No load (0A)	0.2V	54.8V
	15A	0.6V	54.4V
	25A	0.8V	54.2V
Adjustment range: 53V to 56.3V	No Load	0.2V	52.8V to 56.1V
	15A	0.6V	52.4V to 55.7V
	25A	0.8V	52.2V to 55.5V

Procedure for Adjusting Output Voltage of Modules

1. Switch OFF the unit and unplug the AC input power cord.
2. The output voltage of each individual module is adjusted one by one starting from say, the left most module – PSM 1 and progressing to the right most module – PSM

No. 5. AC input is connected only to the module being adjusted. **AC input to the remaining modules is disconnected.**

Procedure for Adjusting Output Voltage of Modules (continued)

3. Prepare PSM 1 for adjustment by Removing AC input connections (female quick connect terminals connected to the L and N male tab terminals on the module – Fig. 3.4) from PSM Nos. 2, 3, 4 and 5. Temporarily insulate these female quick connect terminals with insulating tape for safety. Now, only PSM No. 1 can be energized.
4. Switch ON the power supply. Only PSM No. 1 will operate. Adjust the output voltage of this module to the desired "set value" with the help of potentiometer VR1 (Fig.3.4). Measure output voltage of the module at the screw terminals S5 and S6 (Fig. 3.4).
5. Switch OFF the power supply. Remove the AC input connections from PSM No. 1. Temporarily insulate these terminals with insulation tape.
6. Prepare PSM No 2 for adjustment by removing temporary insulation from the AC connectors for PSM 2 and connect them to PSM 2. Now only PSM 2 can be energized.
7. Switch ON the power supply. Only PSM No. 2 will operate. Adjust the output voltage of this module to the same "set value" with the help of potentiometer VR1 (Fig. 3.4). Measure the output voltage of the module at the screw terminals S5 and S6 (Fig. 3.4)
8. Continue to adjust the voltage of the remaining Module Nos. 3, 4 and 5 individually as explained above making sure that the AC input power is connected to only the module being adjusted.
9. After the output voltage of all the 5 modules has been adjusted to the same "set value", connect the AC input back to all the five modules.
10. Power ON the unit and check that all the 5 "PSM Status" LEDs are lighted. This will confirm that the voltage adjustment has been completed successfully.

NOTE: As explained under Principle of Operation on page 7, it is likely that the minimum internal preload current for the new value of the output voltage may not be sufficient to provide adequate feedback signal strength resulting in shut down of one or more PSM(s) when no external load is present (The associated PSM Status LED will flash and also, the associated signal for remote indication will oscillate between High and Low). In such a case, apply an external load to increase the feed back signal strength. If there is no other defect, the PSM(s) that were shut down will also operate normally.

INSTALLATION AND REMOVAL OF POWER SUPPLY MODULES

Please refer to Figs. 3.4, 3.5 and 3.6 (pages 13 & 14).

Replacing Defective Module with new Module

Replacement Module can be ordered under Model No. "SEC-0548MPSB".
The optional module comes with an LED and LED holder. It's output voltage is pre-set at 55V.

Removal and replacement procedure is given below:

1. Switch OFF 120 VAC, 60 Hz input power and unplug the power cord from the main outlet.
2. Remove the top cover plate by unscrewing the 10 screws.
3. Remove the AC input power supply wires from terminals "L" and "N" of the defective module (Fig 3.4).
4. Remove connectors from terminals "LED 1 & LED 2" (Fig 3.4). Terminal marked LED2 is used for the front panel LED under "PSM Status". Terminal marked LED1 is used to feed 5V "PSM ON" drive signal to the associated Infrared Diode of opto-coupler on the small opto-coupler PCB & from there it is fed to DB-25 Connector as Open Collector / Open Emitter signal for remote indication.
5. Remove female connector of the Daisy Chained "SHARE BUS" wire loop connected to male terminal "JUMP1" on the module (Fig 3.4, Fig 3.5).
6. Each module sits on 6 stand-offs under holes S1 to S6 (Fig.3.4). Remove these screws and then remove the defective Module.
7. If this module has Temperature Sensor mounted on its heat sink, remove the Temperature Sensor by removing its holding screw.
8. Place the new module on the stand-offs with the L an N terminals (Fig. 3.4) towards the front panel. Align the holes and fix the module with the 6 screws. **WARNING! Please ensure that screws S5 and S6 are very tight as the pads under these two screws connect the output of the module to the DC bus bar underneath. A loose connection under these screws will result in sparking, overheating and consequent damage to the module.**
9. As explained earlier under "Procedure for Adjusting Output Voltage of Modules" (page 15), the output voltage at the individual modules (measured at points S5 & S6 of the module as shown at Fig. 3.4) is required to be set exactly at the same voltage for proper current share control. Each module is factory preset at a voltage of 55V with the help of potentiometer VR1. Although the new module SEC-0548MPSB is factory preset at 55V, it may differ slightly due to tolerance. It is, therefore, necessary to ensure that the voltage of all the 5 individual paralleled modules i.e. the existing modules and the new replaced module is set exactly at 55V. For this, follow instructions given under "Procedure for Adjusting Output Voltage of Modules" (page 15).

10. Replace the top cover. Power on the unit and confirm that the "PSM Status" LEDs of all the installed modules are lighted.

Bypassing Defective Module - (Pending Replacement with New Module)
Assume one of the 5 modules is defective and a new replacement module is not available. In this case, the defective module can be bypassed. As only 4 modules will be sharing the current, only 20A will be available. Assuming battery-charging current of maximum 2A, the load current should be limited to < 18A.

1. Switch OFF 120VAC, 60 Hz input power and unplug the power cord from the main outlet.
2. Remove the top cover plate by unscrewing the 10 screws.
3. Remove the AC input power supply wires from terminals "L" and "N" of the defective module (Fig 3.4). Insulate temporarily with insulation tape.
4. Remove connectors from terminals "LED 1 & LED 2" (Fig 3.4).
5. Remove female connector of the Daisy Chained "SHARE BUS" wire loop connected to male terminal "JUMP1" on the module (Fig 3.4, Fig 3.5).
6. It is mandatory to short the two female sockets on this unused female connector with a shorting link. (See Fig. 3.6). This will ensure that there is no break in the "Share Bus" Daisy Chain and that all the "Jump1" terminals are interconnected.
7. It is necessary to ensure that the voltages of the 4 remaining active individual paralleled modules are set exactly at 55V. For this, follow instructions given under "Procedure for Adjusting Output Voltage of Modules" (page 16).
8. Replace the top cover. Power on the unit and confirm that the "PSM Status" LEDs for the 4 modules are lighted.

COOLING

Due to modular design, each Power Supply Module has its own heat sink that is mounted on its PCB. As these heat sinks are not thermally connected to the metal chassis of the unit, cooling by convection through the surface area of the metal chassis is not adequate. Hence, 2 fans (running all the time) are used for cooling of the modules. These fans suck cool air from the ventilation slots on the sides and discharge through the fan openings at the back (9, Fig 2.1).

The unit is protected against over temperature by monitoring the operation of the 2 cooling fans and heat sink temperature of one of the Power supply Modules. In case of abnormal conditions, buzzer and LED alarm are activated locally and alarm signal is also provided for remote signaling. Details are given below:

- In case any one of the 2 fans fails (open circuit, short circuit, low RPM), buzzer alarm will be sounded and front panel Red LED "Fan Failure" (6, Fig 2.1) will be lighted. At the same time, alarm signal will be provided for remote signaling (Pins 12 and 19 of DB-25 Connector at the back of the unit - 12, Fig 2.1)
- One of the Power supply Modules has a Temperature Sensor mounted on its heat

sink. If the fans are operating normally but the ambient temperature of cooling air is higher than 40°C and the unit is operating at full load, the temperature of the heat sink will rise. When the temperature exceeds allowable threshold, buzzer alarm will be sounded and front panel Red LED "Fan Failure" (6, Fig 2.1) will be lighted. At the same time alarm signal will be provided for remote signaling (Pins 12 and 19 of DB-25 Connector at the back of the unit - 12, Fig 2.1).

WARNING!

In both the above conditions, immediate remedial action must be taken to ensure adequate cooling. Defective fan(s) should be replaced / availability of cool airflow should be checked and ensured / load should be decreased. PLEASE NOTE THAT THE UNIT WILL NOT SHUT DOWN AUTOMATICALLY AND PROLONGED OPERATION IN THE ABOVE OVER TEMPERATURE CONDITIONS MAY DAMAGE THE UNIT.

SECTION 4 | Protections

NOTE: Please refer to Figs 2.1 & 3.1, and explanation under Section 3 "Design & Principles of Operation".

OVER LOAD / SHORT CIRCUIT CURRENT PROTECTION

Battery Backup Function is not Used - External Battery is not Connected and the Unit is Used as a Power Supply

In this case, the entire load current will be supplied by the Power Supply Section and will be limited to a maximum of 30A by its Current Limit Circuitry. If the load tries to draw a higher current than the current limit value of 30A, the output voltage at the Load Terminals and the Battery Terminals will not be regulated and will drop below 58.5V± 0.3V. If the load impedance is further reduced, the current will remain limited at 30A but the voltage will drop further. In case of short circuit, maximum limited current of 30A will continue to be supplied into the short circuit but the voltage will drop to < 2V in case of a near dead short (Load impedance will be very low – say < 100 milli Ohm). If over-load / short-circuit current of 30A continues over prolonged period, the external 25A load side Fuse (F2) will blow and will disconnect the load. If the overload / short circuit is removed before the external 25A load side Fuse (F2) blows, the output voltage at the Load / Battery Terminals will automatically recover when the load current drops to less than the current limit value of 30A.

Battery Backup Function is Used - External Battery is Connected

If the load tries to draw current higher than the current limit value of 30A of the Power Supply Section, the output voltage of the Power Supply Section will not be regulated and the voltage at the Load Terminals will drop. Portion of overload current beyond

30A will now be fed from the battery and the battery will start draining at this differential current. For example, if the overload current was 40A, the Power Supply Section will provide 30A and the battery will provide the balance 10A. The battery will start draining at 10A. The voltage at the Battery Terminals will start dropping and will be equal to the voltage corresponding to its actual State of Charge. The voltage at the Load Terminals will be around 0.3 ± 0.1V below the voltage at the Battery Terminals. External 25A Fuse (F2) on the load side will blow only on sustained current ≥ 25A, but will not blow at higher short duration surge currents determined by its Time Current characteristics. For example, based on the Time Current Characteristics of 80V, 25A fuse Type 166.7000.525 from Littelfuse, the fuse can pass extremely high currents for shorter durations as follows:

- 150A for 20 ms to 100 ms.
- 88A for 40 ms to 500 ms.
- 50A for 150 ms to 20 secs.
- 28A continuous for 100 min.

In case of short circuit on the load side, the external 25A Fuse (F2) on the load side will blow because of very high additional current supplied by the battery (Additional battery current supplied into the short circuit on the load side = Short circuit current - 30A from the Power Supply Section). For example, if a short circuit current of 150A tries to flow for > 100 ms, 30A will be supplied by the Power Supply Section and the balance 120A will be supplied by the battery. As the external 25A Fuse (F2) on the load side will see 150A and the external 25A Fuse (F1) on the battery side will see 120A, the external 25A load side Fuse (F2) will blow first.

PROTECTION AGAINST REVERSE POLARITY OF BATTERY CONNECTION

Please ensure that the external 48V battery is connected with correct polarity.

In case of reverse polarity of battery connection, internal Diode (D3, Fig 3.1) connected across the battery terminals will be forward biased and the external 80V, 25A Fuse 1 (Fig 2.1) will blow.

OVER TEMPERATURE PROTECTION

CAUTION!

Keep the unit in a well-ventilated, cool and open area. DO NOT block the vent holes on the sides or the discharge openings of the cooling fan at the back of the unit.

The unit is protected against over temperature by monitoring the operation of the 2 cooling fans and heat sink temperature of one of the Power supply Modules. In case of abnormal conditions, buzzer and LED alarm are activated locally and alarm signal is also provided for remote signaling.

SECTION 4 | Protections

Details are given below:

- In case any one of the 2 fans fails (open circuit, short circuit, low RPM), buzzer alarm will be sounded and front panel Red LED "Fan Failure" (6, Fig 2.1) will be lighted. At the same time, alarm signal will be provided for remote signaling (Pins 12 and 19 of DB-25 Connector at the back of the unit - 12, Fig 2.1).
- One of the Power supply Modules has a Temperature Sensor mounted on its heat sink. If the fans are operating normally but the ambient temperature of cooling air is higher than 40°C and the unit is operating at full load, the temperature of the heat sink will rise. When the temperature exceeds allowable threshold, buzzer alarm will be sounded and front panel Red LED "Fan Failure" (6, Fig 2.1) will be lighted. At the same time alarm signal will be provided for remote signaling (Pins 12 and 19 of DB-25 Connector at the back of the unit - 12, Fig 2.1).

WARNING!

In both the above conditions, immediate remedial action must be taken to ensure adequate cooling. Defective fan(s) should be replaced / availability of cool airflow should be checked and ensured / load should be decreased. **PLEASE NOTE THAT THE UNIT WILL NOT SHUT DOWN AUTOMATICALLY AND PROLONGED OPERATION IN THE ABOVE OVER TEMPERATRE CONDITIONS MAY DAMAGE THE UNIT.**

SECTION 5 | Installation

WARNINGS!

PLEASE READ "SECTION 1 - SAFETY INSTRUCTIONS" FOR SAFE INSTALLATION.

NOTE:
Please refer to Fig 2.1 - Layout & Input/Output Connections

LOCATION, MOUNTING AND SAFETY

The unit is required to be installed in a safe, well-ventilated and dry location. Please see details given under Section 1 "Safety Instructions". The unit can be mounted horizontally or vertically. When mounting vertically, please ensure that the Output Terminals are pointing up.

AC INPUT CONNECTION

An attached power cord has been supplied (11, Fig 2.1). Plug the power cord into the AC outlet. Please ensure that the voltage of AC input power at the outlet is 120 VAC, 50/60 Hz.

SECTION 5 | Installation

DC OUTPUT CONNECTIONS

The Load Terminals (7A, 7B - Fig 2.1)and the Battery Terminals (8A, 8B - Fig 2.1) have 5/16" diameter tubular hole with set screw (5/16" x 3/8"long x 24TPI).

For ensuring firm connection under the set screw, 4 pieces of Pin Type of Terminal Lugs "PTNB10-12" have been provided for crimping to the bare ends of stranded wires for the load and battery connections. The terminal can accept wire of up to 10 mm^2 / AWG #8. After crimping the Terminal Lugs, use insulating heat shrink tubing or tape to insulate the bare cylindrical portion of the lug.

Load Connection: The load is connected to the terminals marked "Load +" and "Load - " (7A, 7B - Fig 2.1) through Fuse (F2) (See details below under heading "External Fuses on Battery & Load Sides"). Please ensure that the polarity of the connection is correct - Positive of the load to the "Load +" terminal and the Negative of the load to the "Load - " terminal.

Battery Connection: The Positive of the battery is connected to the "Battery +" terminal (8A, Fig 2.1) and the Negative of the battery to the "Battery - " terminal (8B, Fig 2.1) through 80V, 25A Fuse (F1) (See details below under heading "External Fuses on Battery and Load Sides"). Please ensure that the polarity of connection is correct.

Recommended Battery Capacity: Battery should not be charged at very high current. Normally, as a Rule of Thumb, the maximum charging current should be limited to 10% of the Ah capacity at 20 Hour Rate unless higher current is allowed by the manufacturer. Higher charging current produces higher heating which reduces the life of the battery. Further, higher charging current will not re-charge the battery to full 100% capacity unless the charging voltage is increased proportionately. It is recommended that the capacity of the battery used with this unit should be in the range of 10 to 25 Ah.

DC OUTPUT WIRE SIZING

Use AWG #10, 90°C / 194°F insulation wire for the load and battery connections for a distance of up to 10 ft. Thicker wire will be required for distance longer than 10 ft.

EXTERNAL FUSES ON THE BATTERY AND LOAD SIDES

A battery is an unlimited source of current that can drive thousands of Amperes of current into a short circuit leading to overheating and burning of wiring / circuit components along the path from the battery terminals to the point of short circuit. This can cause injury and is a fire hazard. Similarly, a power source is also be capable of driving considerably high value of current into a short circuit on the load side and causing damage as above (the current will, however, be limited to the maximum rated overload current and not unlimited as in the case of a battery). Appropriate fuse should, therefore, be used in series with the battery Positive post / Load terminal of power source to protect against the above safety hazard.

SECTION 5 | Installation

For effective protection, appropriate sizes of fuses should be located as follows:

- External Battery Side Fuse (F1) should be LOCATED as close to the battery Positive post as possible, preferably within 7" of the battery Positive post
- External Load Side Fuse (F2) should be installed as close as possible to the Positive Load Terminal

For this unit, external fuses must be used for protection against reverse polarity and short circuit as follows (please see specs for F1 & F2, Fig 2.1, page 5):

- 80V, 25A fast acting Fuse (F1) in series with the Positive battery wire within 7" from the battery Positive post. This fuse provides the following protections:
  - Prevents overheating and burning of wiring due to very heavy current fed from the battery into a short circuit along the length of wiring from the battery to the Battery Input Terminals (8A, 8B, Fig 2.1).
  - Prevents damage to the unit and to the load due to reverse polarity of battery connection.
- 80V, 25A fast acting Fuse (F2) in series with the Positive load wire and within 7" of the Positive Load Terminal (7A, Fig 2.1). This fuse protects against overload and short circuit on the load side.

SECTION 6 | Operation

Please refer to Fig 2.1, page 5 - Layout & Input/Output Connections.

CAUTION!

1. If AC input power is not available and a battery has been connected for backup function, the load will be powered by the battery and the battery will continue to discharge as long as the load is in ON condition. When the load is not delivering power, it still draws current for its self-consumption (called "No Load Current"). When AC input power is not available, switch OFF the load if not required, otherwise the battery will get discharged because of the "No Load Current" drawn by the load.
2. When AC input power is NOT available/switched OFF, battery has been connected for backup and load has been switched OFF. The battery will still discharge around 100 mA through the static load resistor connected across the load terminals (for module synchonization under no/low load conditions). In this situation, please remove Fuse F1 to prevent unnecessary discharge of the battery.

SWITCHING ON / OFF

Switching ON (Without Battery Backup - No External Battery - Unit Operates as a Normal Power Supply):

- Check that the load has been connected to the Load Terminals (7A, 7B - Fig 2.1) and NOT TO THE BATTERY TERMINALS (8A, 8B, Fig 2.1)
- Switch ON the unit with the help of the Red Power ON / OFF Switch (1). If AC power is available and the AC input breaker (2, Fig 2.1) is not tripped, the ON / OFF Switch will be lighted Red indicating that the Power Supply Section is in ON condition
- After a few milli sec, 54.8V will be available at the Load and Battery Terminals
- Switch ON the load

SECTION 6 | Operation

Switching ON (With Battery Backup - External Battery is Connected):

- Check that the load has been connected to the Load Terminal (7A, 7B, Fig 2.1) and NOT to the Battery Terminals (8A, 8B - Fig 2.1).
- Check that the load has been connected to the Load Terminals (7A, 7B - Fig 2.1) through external 25A Load Side Fuse (F2).
- Check that the external battery has been connected to the Battery Terminals (8A, 8B - Fig 2.1) through external 25A Battery Side Fuse (F1).
- Switch ON the unit with the help of the Red Power ON / OFF Switch (1). If AC power is available and the internal AC side fuse is intact, the ON / OFF Switch will be lighted Red indicating that the Power Supply Section is in ON condition.
- After a few milli sec, 54.8V will be available at the Load Terminals (7A, 7B - Fig 2.1)and the external battery will start charging at current of up to 2A determined by its State of Charge. The voltage at the Battery Terminals (8A, 8B - Fig 2.1) will get clamped to the actual terminal voltage of the battery corresponding to its State of Charge.
- Switch ON the load.
- The Power Supply Section will supply all the current consumed by the load (up to its rated current limit value) and the external battery will be maintained in charged condition all the time at Float Voltage of 54V to 54.6V (when fully charged), depending on the value of load current being supplied.

Switching OFF:

- Switch OFF the load first
- Switch OFF the unit with the help of the Red Power ON / OFF Switch (1). Red light inside the ON /OFF switch will switch OFF

CHARGING AND BACKUP OPERATION

Charging current will be proportional to the discharged state of the battery and is limited to maximum of 2A when the battery is completely discharged (Standing Voltage of 42.8V). The current will taper down from 2A as the battery gets charged and its voltage rises. When the battery is fully charged, the current will drop down to 0.1% of the Ah capacity of the battery to compensate for self-discharge. When fully charged, the voltage at the Battery Terminals (8A, 8B - Fig 2.1) will be the Float Voltage of 54V to 54.6V depending on value of load current.

Battery should not be charged at very high current. Normally, as a Rule of Thumb, the maximum charging current should be limited to 10% of the Ah capacity at 20 Hour Rate unless higher current is allowed by the manufacturer. Higher charging current produces higher heating, which reduces the life of the battery. Further, higher charging current will not re-charge the battery to full 100% capacity unless the Absorption Voltage is increased proportionately. This may not be possible with chargers that do not have programmable charging voltages. It is, therefore, recommended that the capacity of the battery used with this unit should be in the range of 10 to 25Ah which is appropriate for 2A charging current.

The voltage seen at the Battery Terminals (8A, 8B - Fig 2.1) will be the actual terminal voltage of the battery (assuming no voltage drop in the battery cables) and will be proportional to its State of Charge. When the battery is fully charged, the voltage at the Battery Terminals (8A, 8B - Fig 2.1) will be 54V to 54.6V.

SECTION 6 | Operation

If AC input power fails, the DC load(s) will be instantaneously transferred to the external 48V backup battery and the battery will start discharging. When the battery is supplying the load, the voltage seen at the Load Terminals will be 0.3V ± 0.1V less than the voltage at the Battery Terminals. When AC input power is restored, the DC load will once again be transferred instantaneously to the Power Supply Section and the external backup battery will be recharged and kept in charged condition all the time at Float Voltage of 54V to 54.6V.

SURGE POWER CAPABILITY IN DC UPS BATTERY BACKUP MODE

When operating in DC UPS Battery Backup Mode (external 48V battery is connected), the unit is capable of providing short term surge current determined by the Time versus Current Characteristics of the load side Fuse F2.

Current = the current limit value, will be provided by the Power Supply Section and balance will be supplied by the battery.

During the period of this short term overload, the voltage seen by the load will be = (battery voltage – 0.3V± 0.1V).

OPERATION AS NORMAL POWER SUPPLY WITHOUT EXTERNAL BATTERY

If battery backup function is not used (external backup battery is not connected), the unit will work as a normal power supply with ability to supply 25A continuous at 54.5V ± 0.3 VDC at the Load Terminals (7A, 7B, Fig 2.1). The maximum overload current will be limited to 30A. Under overload conditions, the output voltage will not be regulated and will drop.

SECTION 7 | Limiting Electro-Magnetic Interference (EMI)

CAUTION!

Conducted and radiated noises in this unit are reduced to acceptable limits by appropriate filtration.

This unit generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, this does not guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the measures recommended in the following paragraphs.

UN-INTENTIONAL RF NOISE GENERATED BY SWITCHED MODE POWER SUPPLIES (SMPS)

Switched Mode Power Supplies (SMPS) employ high frequency switching and thus, are a source of radio interference, a recipient of radio interference and a conduit of radio interference. (Older Linear Type, low frequency 50 / 60 Hz transformer based power

supplies do not employ high frequency switching voltages and will be quieter as compared to SMPS).

The primary emission sources originate in the switching devices due to their fast switching current transitions: harmonics of the switching frequency and broadband noise created by under-damped oscillations in the switching circuit. The secondary source is from the bridge rectifier, both rectifier noise and diode recovery. The AC input rectifier / capacitor in the front end of the SMPS (excepting those with Power Factor correction) generate power supply harmonics due to the non-linear input current waveform. The noise is both conducted and radiated through the input power cord and the DC output wiring to the radio.

FILTRATION OF CONDUCTED NOISE

The conducted RF noise from this SMPS unit is limited to acceptable levels by internal filtration. The filtered RF noise currents (< few hundred micro Amps) are bypassed to the chassis of the power supply. The chassis is, in turn, connected to the Earth Ground pin of the AC input power cord (for Class 1 units). Thus, the filtered noise currents are intentionally leaked to the Earth Ground. This is termed as the "Earth Leakage Current".

EXCESSIVE RF OUTPUT INTERFERENCE BY SMPS DUE TO INCOMING RF INTERFERENCE WHEN POWERING RADIO TX / RX

SMPS are also recipients of radio interference. The normal operation of the power supply can be disturbed due to RF noise getting coupled into the power supply. Thus, the power supply may generate excessive RF noise and lose output voltage regulation due to excessive transmitter energy being coupled through the AC / DC lines to the power supply's regulator feedback path. This may be due to antenna being too close or due to the antenna or feed system not radiating properly. First check the antenna system SWR. Then, if necessary, relocate either the antenna or the power supply farther apart. The receiver may "hear" the power supply. A slowly moving, slightly buzzing carrier heard in the receiver may be caused by the antenna being too close. As with the transmitter related noise pick up, a loose coaxial connector or a broken or a missing ground may aggravate this problem. Normally, this noise will be below the background or "band" noise. Increase the separation between the power supply and the receiving antenna. Use an outdoor antenna. This will reduce the amount of signal picked up from the power supply and also increase the amount of the desired signal.

ADDITIONAL GUIDELINES FOR REDUCING RF NOISE

- Use additional appropriate AC Radio Frequency Interference (RFI) Power Line Filter rated for minimum 25A immediately before the AC input of the power supply.
- Use additional appropriate DC radio frequency interference (RFI) power line filter rated for minimum 30A immediately after the DC output of the power supply.
- Twist the Positive and Negative wires from the output of the power supply to the radio.
- The DC side Positive and Negative outputs of these power supplies are isolated from

the chassis. As explained earlier, the noise currents are filtered to the chassis of the unit and the chassis is connected to the Earth Ground through the Earth Ground Pin of the AC power outlet receptacle. Avoid connecting (referencing) the DC Negative output terminal of the power supply to the Earth Ground.

- Connect a ¼" wavelength of wire on the Negative terminal of the power supply. Connect one end of the wire to the Negative terminal and leave the other end free. The wavelength corresponds to the wavelength of the interfering frequency. (May not be practical for long wave lengths).

  [Formula: Wave length (Meters) = 300 / frequency in MHz]

COMBINED FILTERED NOISE CURRENTS FROM MULTIPLE SMPS ON A BRANCH CIRCUIT MAY TRIP GROUND FAULT CIRUIT INTERRUPTER (GFCI)

During malfunction or an accident, the metal chassis of a device may get energized to unsafe voltage due to internal high voltage section coming in contact with the chassis. If a person standing on Earth touches this energized chassis, a leakage current proportional to the person's skin resistance will flow through the person's body to Earth Ground. The leakage current through the body is higher when the skin contact resistance is lower i.e. if the skin is wet or wounded. This leakage current does not return to the power source but is dissipated in Earth Ground. A leakage current of > 5mA could produce lethal electrical shock. Ground Fault Circuit Interrupter (GFCI) is used for safety against electrical shock due to leakage. GFCI measures the difference between the current sent to the load and returned from the load and will trip and disconnect the power circuit if the difference is > 5 mA. GFCIs are normally installed in AC Branch Circuits feeding power outlets in wet areas like marine craft, RVs, spas, hot-tubs, kitchens, washrooms, etc.

As explained earlier, RF noise filtration circuits in SMPS generate intentional Earth Leakage Current. SMPS are used extensively as DC power sources in modern day electrical / electronic devices e.g. Audio / Video / Computing devices, power supplies, battery chargers etc. A single GFCI outlet / GFCI breaker may be serving multiple SMPS loads and therefore, will be sensing the sum of all the Earth Leakage Currents and, if the sum is > 5mA after connecting this unit, the GFCI will trip. In such a case, disconnect other SMPS based device(s) being served by this GFCI one by one till the net leakage current is reduced to < 5mA and the GFCI does not trip. **Other solution is to power this unit from a GFCI outlet / GFCI breaker that does not have any SMPS load or power from an outlet that is not protected by GFCI.**

SECTION 8 | Troubleshooting Guide

1. GENERAL

Symptom	Possible Cause	Remedy
ON/OFF Switch is ON and is lighted. One or more "PSM Status" LED (s) is not lighted	Associated Power supply Module has become defective. • The unit will still operate normally as the remaining working module(s) will share a higher load. If backup battery is connected, it will supply balance load if the load is higher than the combined capacity of the remaining working module(s) • If backup battery is not connected, the output voltage will drop if the value of load current is more than the rated combined current limit values of the remaining working module(s)	Remove the defective module(s) and replace with new module(s)
ON/OFF Switch is ON and is lighted. One or more "PSM Status" LED(s) flash	• The output voltage of individual modules is not equal • Internal static load is not sufficient for effective activation of Master/ Slave operation for forced current share • Forced Share Control Circuitry of the module(s) is defective	• Adjust the output voltage of all the modules to exactly 55V as explained in the Adjustment Procedure at page 15 • If after carrying out the above adjustment, the problem still exists under no load, then apply 5A load. If flashing stops under load, it means that the internal static load is not sufficient for effective activation of Master/Slave operation. Disregard flashing under no load as the module(s) will operate normally • If the flashing continues even after loading, the module(s) are defective. Please call Technical Support

2. OPERATION AS A SIMPLE POWER SUPPLY - ONLY LOAD IS CONNECTED. NO EXTERNAL BATTERY AND NO BATTERY BACKUP.

Symptom	Possible Cause	Remedy
ON / OFF Switch is ON • Switch is NOT lighted • No DC output	No AC power from the AC outlet AC Input Breaker on the unit is tripped (2, Fig 2.1)	Check AC power is available at the AC outlet. Breaker feeding the AC outlet may have tripped. Reset the breaker If the breaker trips again, the input section is damaged. Please call Tech Support

SECTION 8 | Troubleshooting Guide

Symptom	Possible Cause	Remedy
ON / OFF Switch is ON • Switch is lighted • DC Output voltage drops	If the voltage loses regulation and drops to < 54.2V, the unit is overloaded and is in current limit. The load is trying to draw ≥ the current limit value of 30A If the voltage drop is considerable with voltage < 2V, the load side is seeing a short circuit	Reduce the current drawn by the load to less than the continuous rating of 25A. Switch OFF the load. Remove the short circuit on the load side.
GFCI outlet / GFCI breaker supplying AC power to the unit trips when the unit is switched ON	Additional RF noise currents from the unit that are filtered to Earth Ground increase the net Leakage Current on the GFCI outlet / GFCI breaker to > 5mA	Switch OFF other SMPS devices operating from the same GFCI outlet / GFCI breaker to reduce the net leakage current to < 5mA Move the unit to another GFCI outlet / GFCI breaker that has lesser number of SMPS load(s) or no SMPS load Power the unit from normal, non GFCI outlet or from an outlet not protected by GFCI breaker

3. BATTERY BACKUP OPERATION - EXTERNAL BATTERY IS CONNECTED

Symptom	Possible Cause	Remedy
ON / OFF Switch is ON • Switch is NOT lighted • Load is ON and is operating normally • Output voltage at the Battery Terminals is < 54V to 54.6V and is dropping • Output voltage at the Load Terminals is 0.3V ± 0.1V lower than the Battery Terminals and is dropping	No AC power from the AC outlet AC Input Breaker is tripped	Check AC power is available at the AC outlet. Breaker feeding the AC outlet may have tripped or there may be power outage. Reset the breaker. If breaker trips again, please call Technical Support.
ON / OFF Switch is ON • Switch is lighted • Load is ON • Output voltage at the Load Terminals loses regulation and drops below 54.2V • Output voltage at the Load Terminals is 0.3 ± 0.1V lower than the Battery Terminals and is dropping	Power Supply Section is overloaded and is in current limit condition. The load is trying to draw excessive current ≥ the current limit value of 30A. The Time Current Characteristic of the 25A Fuse (F2) in the Load circuit will determine the allowable value of overload current > 30A and the time it can be sustained before the fuse blows. The allowable value will be higher for shorter duration of overload. Power Supply Section provides 30A in current limit condition and the balance of current is fed from the battery and the battery starts discharging at current = (Overload current - 30A)	Remove the cause of overload

3. BATTERY BACKUP OPERATION - EXTERNAL BATTERY IS CONNECTED (continued)

Symptom	Possible Cause	Remedy
ON / OFF Switch is ON • Switch is lighted • There is no voltage at the at the load end and the load is shut down • Voltage at the Load Terminals is 54.8V • Voltage at Battery Terminals is 0.3V ± 0.1V lower than the voltage at the Load terminals	25A Fuse (F2) in the Load circuit is blown due to: - Excessive short time overload current > 25A exceeding the Time Current Characteristics of the 25A fuse, or - Short circuit in the load circuit	Remove the cause of the overload or short circuit.
ON / OFF Switch is ON • Switch is lighted • Load is ON • Voltage at the Load Terminals is 54.8V to 54.2V • Voltage at Battery Terminals is the same as the Load Terminals • Battery backup function does not operate – Load shuts OFF when AC power is interrupted	25A Fuse F1 in the battery circuit is blown due to short circuit in battery wiring or reversal of battery polarity	Check that the polarity of battery connections is correct. Replace the fuse. Check for short circuit in the battery wiring and correct. Replace the fuse.
GFCI outlet / GFCI breaker supplying AC power to the unit trips when the unit is switched ON	Additional RF noise current from the unit that is filtered to Earth Ground increases the net Leakage Current on the GFCI outlet / GFCI breaker to > 5mA	Switch OFF other SMPS devices operating from the same GFCI outlet / GFCI breaker to reduce the net leakage current to < 5mA. Move the unit to another GFCI outlet / GFCI breaker that has lesser number of SMPS load(s) or no SMPS load. Power the unit from normal, non GFCI outlet or from an outlet not protected by GFCI breaker.
The unit is not in use. ON/OFF Switch is OFF • Battery is connected to the Battery Terminals • Load is OFF/disconnected • Battery is getting discharged	Battery is draining by 100 mA through the Static Load Resistor connected across the Load Terminals	Remove Battery Fuse F1 when the unit is not in use.

SECTION 9 | Specifications

PARAMETER		SPECIFICATION
NO OF MODULES	-	5
AC INPUT	Input Voltage	120 VAC Nominal (+6% / -10%), 50/60 Hz
	Input Current	20A @ 120 VAC
	Peak Efficiency	> 83%
	Power Factor	0.74 at 25A load
DC OUTPUT	Output Voltage at Load Terminals	No Load: 54.8V / 25A Load: 54.2V
	Output Voltage at Battery Terminals (Without battery)	No Load: 54.8V / 25A Load: 54.2V
	Output Voltage at Battery Terminals (With battery)	Actual battery voltage corresponding to State of Charge; 54V to 54.6V when fully charged
	Output Voltage Noise and Ripple	Ripple: 200 mV Peak to Peak Noise: 2V Peak to Peak
	Continuous Output Current at Load Terminals	25A (Without battery backup); 23A (With battery backup)
	Maximum Charging Current at Battery Terminals (Battery Backup)	Up to 2A (When battery is completely discharged to Standing Voltage of 42.8V)
	Output Current Limit at Load Terminals	• 30A when no backup battery is connected (External 25A Fuse F2 will blow after some time) • Surge > 30A based on Time vs Current Charateristics of 25A Fuse F2
	Battery Charging/type of Charging	Taper Type of Float Charging at 54V to 54.6V
	Output Current Limit at Battery Terminals (Battery Backup)	2A (When battery is completely discharged to Standing Voltage of 45.4V)
	Peak Efficiency	85% ± 5%
EXTERNAL BACKUP BATTERY	Type & Voltage	Lead Acid, 48V
	Capacity	10Ah to 25 Ah
PROTECTIONS	Short Circuit, Overload	External 25A Load Side Fuse F2 will blow
	Over Voltage	Regulated by PWM Controller
	Over Temperature / Fan Failure Alarm	Over temperature of PSM Heat sink or fan failure activates buzzer & RED LED "Fan Failure"
	Reversal of polarity on battery terminals	External 25A Battery Side Fuse F1 will blow
COOLING	Type	Forced air circulation: 2 fans running all the time
BREAKER & FUSES	Internal Module Fuse AC Input Breaker	250V, 4A 250V, 25A
	External Battery Side Fuse (By User)	80V, 25A, Fast Acting
	External Load Side Fuse (By User)	80V, 25A, Fast Acting
REMOTE MONITORING	Type of Monitoring	Opto Isolated, Open Collector/Open Emitter Signalling (Max, 35V, 50 mA): • ON status of 5 Power Supply Modules (PSM) • Fan failure /over temperature • AC input available • Output Voltage & Current

SECTION 9 | Specifications

PARAMETER		SPECIFICATION
INPUT / OUTPUT CONNECTIONS	AC Input Connection	Attached Power Cord: • 3 x 12 AWG, 5 ft. • 30A Plug, NEMA 15-30P
	DC Output Connectors for Load and Battery Connections	Terminal with Tubular Hole - Diameter 5/16”and set screw (5/16”, 24 TPI, 3/8” long)
	Battery wires	Minimum AWG #10
ENVIRONMENTAL	Operating Temperature Range	0°C / 32°F to 40°C / 104°F
DIMENSIONS & WEIGHT	Dimensions (W x D x H)	482.6 x 407.6 x 87.7 mm
		19.00 x 16.05 x 3.45 in
	Weight	11.4 kg
		25 lb
NOTE: Above specifications are subject to change without notice		

SECTION 10 | Warranty

2 YEAR LIMITED WARRANTY

SEC-4825BRM manufactured by Samlex America, Inc. (the "Warrantor") is warranted to be free from defects in workmanship and materials under normal use and service. The warranty period is 2 years for the United States and Canada, and is in effect from the date of purchase by the user (the "Purchaser").

Warranty outside of the United States and Canada is limited to 6 months. For a warranty claim, the Purchaser should contact the place of purchase to obtain a Return Authorization Number.

The defective part or unit should be returned at the Purchaser's expense to the authorized location. A written statement describing the nature of the defect, the date of purchase, the place of purchase, and the Purchaser's name, address and telephone number should also be included.

If upon the Warrantor's examination, the defect proves to be the result of defective material or workmanship, the equipment will be repaired or replaced at the Warrantor's option without charge, and returned to the Purchaser at the Warrantor's expense. (Contiguous US and Canada only)

No refund of the purchase price will be granted to the Purchaser, unless the Warrantor is unable to remedy the defect after having a reasonable number of opportunities to do so. Warranty service shall be performed only by the Warrantor. Any attempt to remedy the defect by anyone other than the Warrantor shall render this warranty void. There shall be no warranty for defects or damages caused by faulty installation or hook-up, abuse or misuse of the equipment including exposure to excessive heat, salt or fresh water spray, or water immersion.

No other express warranty is hereby given and there are no warranties which extend beyond those described herein. This warranty is expressly in lieu of any other expressed or implied warranties, including any implied warranty of merchantability, fitness for the ordinary purposes for which such goods are used, or fitness for a particular purpose, or any other obligations on the part of the Warrantor or its employees and representatives.

There shall be no responsibility or liability whatsoever on the part of the Warrantor or its employees and representatives for injury to any persons, or damage to person or persons, or damage to property, or loss of income or profit, or any other consequential or resulting damage which may be claimed to have been incurred through the use or sale of the equipment, including any possible failure of malfunction of the equipment, or part thereof. The Warrantor assumes no liability for incidental or consequential damages of any kind.

Samlex America Inc. (the "Warrantor")
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Notes

Notes

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