

**USER'S GUIDE AND
TECHNICAL REFERENCE**

**BEHLMAN MODEL
BL5000 SERIES AC POWER SUPPLY**

PART NO. 106-676-50x

FOR SERVICE ASSISTANCE

CONTACT BEHLMAN
CUSTOMER SERVICE DEPARTMENT

PHONE TOLL FREE 1-800-874-6727

OR WRITE

BEHLMAN
CUSTOMER ELECTRONICS DEPARTMENT
80 CABOT COURT
HAUPPAUGE, NY 11788

PHONE: (631) 435-0410

FAX : (631) 951-4341

FOR SALES INFORMATION:

PHONE: (631) 435-0410

USA : (800) 874-6727

FAX : (631) 951-4341

LIMITED WARRANTY

Behlman Electronics, Inc. warrants, to the original purchaser, for a period of one (1) year from the date of shipment from Behlman, each item to be free from defects in material and workmanship. Behlman's obligation and the Purchaser's sole remedy for any breach or violation of this agreement is limited to adjustments, repair or replacement for parts which have been promptly reported by the Purchaser as having been, in its opinion, defective and so found by Behlman upon inspection. All replacement parts will become the property of Behlman on an exchange basis. This warranty will not apply if such adjustments, repair, or parts replacement is required because of accident, neglect, misuse, failure of environmental controls, transportation damage or causes other than normal use.

If during the warranty period a defect should impair the performance of the unit, Behlman agrees, at its option, to repair or replace the unit or its defective components F.O.B. Behlman at 80 Cabot Court, Hauppauge New York 11788 or at another Behlman service facility at Behlman's option. To obtain service under this warranty, the original Purchaser shall notify Behlman at the above address or by Telephone at 631-435-0410 and provide information about the defect or impairment of performance. Behlman will then supply the Purchaser a Return Material Authorization (RMA) number. This number must be attached to the equipment sent back for warranty repair. Equipment must be shipped back to Behlman prepaid. No collect shipments will be accepted.

Behlman shall be excused from supplying warranty service if the equipment covers have been removed or if the unit has been subject to unauthorized repair. All service outside the scope of this Warranty shall be paid for by the Purchaser at Behlman's rates in effect at the time of repair. Behlman will not perform any repairs outside of the Warranty without written authorization by the Purchaser. If the repair is a warranty repair, Behlman will ship the unit back to the Purchaser, by a method determined solely by Behlman, prepaid. If the Purchaser requests any other means of transportation it shall be at the Purchaser's expense.

The use of the equipment shall be under the Purchaser's exclusive management and control. The Purchaser will be responsible for assuring the proper installation, use, management, and supervision of the equipment. Behlman will not be liable for personal injury or property damage.

The foregoing warranties are in lieu of all other warranties, expressed or implied including without limitation warranties of merchantability and fitness for purpose.

In no event shall Behlman be liable for loss of profits, loss of use, or any other indirect, consequential, or incidental damages. Purchaser agrees that Behlman will not be liable for any damages caused by the Purchaser's failure to fulfill any of the Purchaser's responsibilities set forth herein.

CLAIM FOR DAMAGE IN SHIPMENT

Under the FOB factory terms of sale, ownership and responsibility are transferred to the customer when the equipment leaves the factory. Each Behlman instrument is shipped from the factory in proper operating condition.

Immediately upon receiving equipment, unpack and inspect it for evidence of damage incurred in shipment. If equipment is damaged, file a claim with the freight carrier. Forward a copy of the damage claim report to Behlman. Include the model number, serial number, and date the shipment was received. Behlman will advise the disposition of the equipment and will arrange for necessary repair or replacement.

RETURNING EQUIPMENT TO FACTORY

Do not return equipment to the factory without prior authorization from Behlman.

This equipment, like all precision electronic equipment, is susceptible to shipping damage. It contains heavy magnetic components as well as delicate electronics components. If equipment is returned without prior authorization, the shipment will be refused and the customer will be liable for all shipping, handling and repair costs. When packing for reshipment, use the original shock absorbent material and shipping container to prevent additional damage to the equipment.

Ensure that the return authorization numbers (RMA) is available on the container.

PACKING INSTRUCTIONS

RACK MOUNTED UNITS

- 1) Box(es) must be double wall with minimum 350 lbs. bursting test.
- 2) Box(es) must provide for a minimum of 2 to 3 inches of clearance around sides, top and bottom of unit.
- 3) When packing unit, utilize either a foam-in-place system or high-density foam. Clearance provided for above must be completely filled with foam.

**FAILURE TO COMPLETELY SECURE UNIT IN BOX WILL ALLOW MOVEMENT
DURING SHIPPING, RESULTING IN DAMAGE.**

DO NOT USE PEANUTS OR BUBBLE WRAP

- 4) Secure box(es) to pallet(s). This is necessary to insure proper handling and protection during shipping.
- 5) Place the following warning label on box(es)

DO NOT STACK

- 6) Ship unit using a freight cargo carrier; air or ground.

SAFETY SUMMARY

The following safety precautions must be observed during all phases of operation, service, and maintenance of this equipment. Failure to comply with these precautions or with specific warnings elsewhere in the manual violates safety standards associated with the design and intended use of this equipment. This manual forms an integral part of the equipment and must be available to operating personnel.

GROUND THE EQUIPMENT

This equipment may have high leakage current to chassis due to EMI filtering requirements. To minimize shock hazard, the equipment chassis(s) must be connected to an electrical safety ground. This equipment is supplied with a three-conductor line connection for single phase applications and/or a five-wire connection for three phase applications. Both types include an earth terminal intended for safety ground connections. In addition, isolated installation sites may require an AC output neutral to earth connections as per NEC section 250 (National Electrical Code). Refer installation to licensed electrician or other qualified personnel.

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERE

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove equipment covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power applied. Under certain conditions, dangerous voltage may exist even with the power removed. To avoid injuries, always disconnect power and discharge circuits before touching them. During normal operation the operator does not have access to internal hazardous voltages. However, depending on the user's application configuration, **HIGH VOLTAGES HAZARDOUS TO HUMAN SAFETY** may be normally generated at the output terminals. The customer/user must ensure that the output power lines are labeled properly as to the safety hazard and that any inadvertent contact is eliminated.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to this equipment. Contact Behlman Electronics for proper replacement parts and specific service information.

DANGEROUS PROCEDURE WARNINGS



Warnings will precede potentially dangerous procedures in this manual. Instructions contained in the warning must be followed. Warnings will be preceded by the caution symbol (above).

RISK OF ELECTRIC SHOCK



This symbol warns personnel of hazardous conditions due to the exposure of hazardous voltage that can cause injury to humans if contacted.

Neither Behlman Electronics, Hauppauge, NY, USA, nor any of the subsidiary sales organizations can accept any responsibility for personnel, material or inconsequential injury, loss or damage that may result from improper use of the equipment and/or accessories provided.

For additional safety related technical information, contact the Behlman Electronics sales department or local sales representative.

sales@behlman.com

or call in N.Y.

631-435-0410

TECHNICAL MANUAL BL5000 SERIES AC POWER SUPPLY

TABLE OF CONTENTS

<u>Section</u>	<u>Title</u>
1.0	<u>Introduction</u>
1.1	Specifications
1.2	Available options
1.3	Unpacking & Inspection
2.0	<u>Installation & Wiring</u>
2.1	Installation
2.2	Input power Connections
2.3	Input Power Requirements
2.4-2.5	Output and Other Wiring
2.6	T5/T5D Transformer Options
3.0	<u>Operation</u>
3.1	Controls and Indicators
3.2	Operating Instructions
3.3	Analog Remote Control
3.4-3.10	Operational Considerations
4.0	<u>Maintenance</u>
4.2	Trouble Shooting
4.3	Performance Verification
4.4	Fuse Replacement
5.0	Mechanical Outline
A1	RS-232 Control Option *
B1	IEEE-488 Control Option *
	* Optional appendix



SECTION ONE INTRODUCTION

1.0 The Behlman BL5000 series of AC power supplies are designed to provide regulated AC power at frequencies and /or voltages not available from local utilities. All models are completely solid state, PWM switching types that provide high efficiency and overall reliability. These devices require very little maintenance and will provide years of trouble-free service when used within their ratings. The models in this series include a multi-pulse rectifier circuit to reduce input harmonics associated with the conversion process used. These models are housed in an all metal, EIA rack mountable enclosures.

The block diagram below illustrates the conversion process performed by this equipment. AC power is applied and converted to DC by a multi-pulse transformer rectifier arrangement. This DC is then used to provide raw power for 3 class D power amplifiers. The amplifiers are driven from reference signals at the desired output frequency and phase. The resulting amplified signals are applied to the output connector via an internal relay that provides the output on/off function. Short circuit protection and current limit are performed by the control electronics.

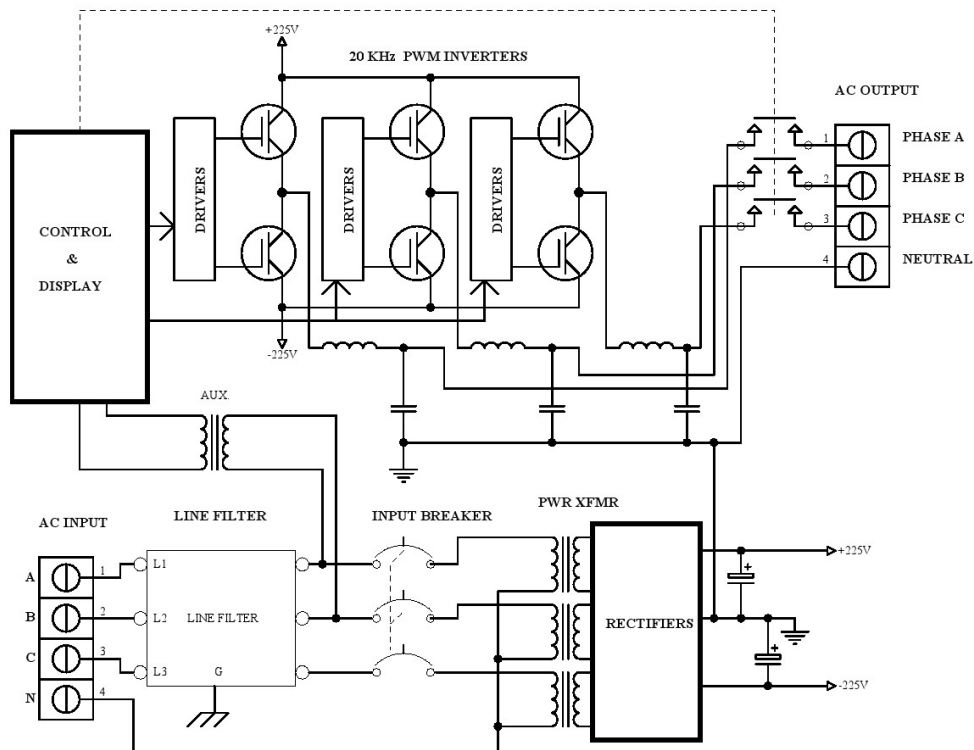


FIGURE 1-1, BLOCK DIAGRAM B5000-SERIES 3 PHASE POWER SUPPLY

SECTION ONE

1.1 SPECIFICATIONS FOR AC POWER SUPPLY BL5000-CX-SERIES

INPUT POWER REQUIREMENTS:	3 Phase, 4 wire w/P.E. (See table 1), 47-63Hz, 4 wire w/P.E.
AC OUTPUT POWER:	5000W total, continuous, @ 40C°
OUTPUT CURRENT:	12.5 ARMS continuous per phase.
OUTPUT FREQUENCY:	Variable from 45- 500Hz +/- 1%
AC OUTPUT VOLTAGE	Variable from 0 -135VAC (L-N) 0 -232VAC L-L
AC OUTPUT REGULATION:	less than 1 % No load to Full load, resistive
AC VOLTAGE DISTORTION:	Less than 3% full resistive load 45-500Hz
AC REGULATION RESPONSE TIME	250 – 300 mSec, typical.
METERING:	
VOLTAGE:	+/- (0.5% of reading + 1% of range), 1V res.
CURRENT:	+/- (2% of reading + 1% of range), 0.1A res.
FREQUENCY:	+/- (1% of reading + (+/- 1Hz) 1Hz res.
PHYSICAL:	Comprised of two 19" chassis configured for EIA standard rack-mount cabinets
POWER CHASSIS:	23.5" D, x 10.5" H, x 19" W
CONTROL CHASSIS:	23.5" D, x 7.0" H, x 19" W
WEIGHT (approximate):	Power = 110 lbs. Control = 70 lbs.
OPERATING TEMPERATURE:	0 to +50 degrees Celsius.
STORAGE TEMPERATURE:	-10 to +60 Degrees Celsius.
SAFETY:	Evaluated to IEC-61010, general safety, Class1, pollution level 2.

1.2 AVAILABLE OPTIONS

This model series is available with several input and output voltage options. Other customer specified options such as fixed voltage and/or fixed frequency operation can be provided. Behlman also produces many semi-custom or “engineering special” versions of this model. These will be identified by a four-digit suffix added to the model number. Always refer to model/serial number labels located on the side of each chassis for the actual unit configuration. Any question regarding options may be sent to <sales@Behlman.com> or contact the factory @ 631-435-0410. The tables below summarize available standard options.

TABLE 1-1 INPUT VOLTAGE OPTIONS

BASE MODEL #	INPUT VOLTAGE	COMMENTS
BL5000C-1	120/208VAC, 3P, 4W, +PE +/-10%	47-63Hz
BL5000C-2	220/380VAC, 3P, 4W, +PE +/-10%	47-63Hz
BL5000C-3	277/480VAC, 3P, 4W, +PE +/-10%	47-63Hz
BL5000C-4	200V, 3P, 3W, +PE +/-10% DELTA (220V or 240V taps available)	47-63Hz
BL5000C-5	346/600VAC, 3P 4W, +PE +/-10%	47-63Hz, includes additional internal fuses.
BL5000C-6	230/400VAC, 3P, 4W, +PE +/-10%	47-63Hz
BL5000C-7	240/415VAC, 3P, 4W, +PE +/-10%	47-63Hz
BL5000C-8	120V, 2 WIRE + PE +/-10%	47-63Hz single phase*
BL5000C-9	240V, 2 WIRE + PE +/-10%	47-63Hz single phase*
BL5000C-10	480V, 2 WIRE + PE +/-10%	47-63Hz single phase*

* Input power factor = 0.7 (approximate) 3 phase inputs = 0.9 (approximate)

TABLE 1-2 OUTPUT VOLTAGE OPTIONS

OPTION	OUTPUT VOLTAGE	COMMENTS
V -XXX	Fixed, xxx = voltage	Customer specified
F -XXX	Fixed, xxx = frequency	Customer specified
T5-270	0 – 270V @ 6.2A/phase	Adds step-up transformer chassis
T5-300	0 – 300V @ 5.5A/phase	Adds step-up transformer chassis
T5D-135/270	0-135 @ 12.5A & 0-270 @ 6.2A	Adds step-up transformer chassis*
T5D-150/300	0-150 @ 11A & 0-300 @ 5.5A	Adds step-up transformer chassis*

* Dual range units

1.2 AVAILABLE OPTIONS (continued)

Other options not included in the tables on the previous page are listed below:

- E** = Extended output frequency range of 45 -1000Hz
- I** = Adds IEEE-488 compatible computer interface to control voltage and frequency.
- IR** = Adds RS-232 serial computer interface to control voltage and frequency.
- L** = Adds locking devices to front panel voltage and frequency controls
- MA** = Adds accessory mounting angle for support when mounting in EIA standard rack.
- MT** = Adds oversize output transistors to accommodate induction motor starting currents.
- S** = Adds factory mounted chassis slides for mounting in EIA standard rack.
- 21-00** = Adds 21" cabinet with casters.

Behlman can accommodate a wide range of user requested modifications such as special control functions or output voltages not listed in the previous tables. Contact the factory for specific information regarding special units or semi-custom version of this model.

MODEL NUMBER FORMAT EXAMPLES

BL5000C-1 = standard unit where X = input voltage

BL5000C-X- V120/F400 = standard unit with fixed voltage and frequency output


Base model options

BL5000C-1-IR = input voltage 120/208V with RS-232 control option.

BL5000C-3-T5-300-L = input voltage 277/480, output 0 -300V, with locking devices.

IMPORTANT NOTE FOR ALL MODELS IN THIS SERIES:

The information contained in this manual is subject to change without notice. Some of the information may also not apply to older production as improvements and or changes have been made over the life of this product. Special units may have additional information added or a specific technical manual. When in doubt, consult the factory or Behlman Sales for the latest information.

SECTION ONE

1.3 UNPACKING AND INSPECTION

Remove the equipment from its packaging and inspect it for shipping damage. If the box shows signs of damage, retain it in case a claim needs to be filed with the shipping carrier. If the equipment shows signs of damage, **DO NOT** attempt to operate it. Contact Behlman immediately and file a damage claim with the shipper. Prior authorization is required before sending any equipment back to Behlman. This is in the form of a Returned Material Authorization (RMA) number that must be obtained from Behlman. Any shipment sent without an RMA # will be refused and the customer will be liable for all shipping costs.

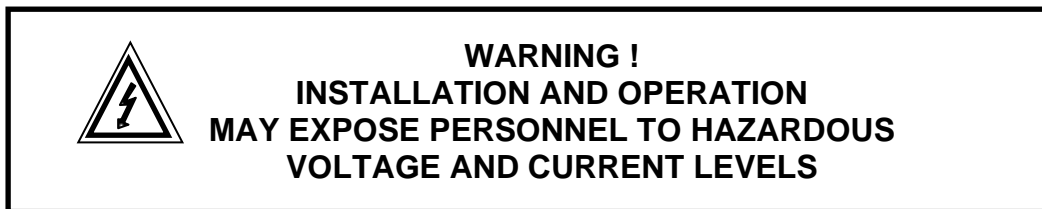
This equipment may ship with other accessories. Check the contents of any shipments against the provided packing list. A copy of the user/technical manual is provided in the shipping container. It is recommended that the serial number be verified and retained in case of any warranty claims. The warranty for this unit is one year for parts and labor. See the Warranty statement at the beginning of this document for specific information. All warranty repairs must be performed by Behlman or one of its authorized representatives. Contact sales@behlman.com for information regarding warranty repair or non-warranty service.

SECTION TWO INSTALLATION AND WIRING

2.1 INSTALLATION

This device is designed primarily for a fixed installation site with non-user detachable wiring. This model may be mounted in an EIA standard equipment rack using the appropriate hardware (not provided). If the unit is to be rack mounted, it must be placed so as not to block the cooling vents on the sides, front, and rear panels. Rear support must also be provided. This may be in the form of internal support “rails” or chassis slides. Many equipment rack manufacturers can supply generic support brackets or shelves to be used with their racks. Racks that are completely sealed will require ventilation to remove heat generated by the AC power supply’s exhaust.

The installation site must protect the power supply from moisture and any conductive particulate matter. **IN NO CASE** should this unit be operated in the presence of dripping or misting fluids.



2.2 INPUT POWER CONNECTION

Input and output power connections are made to rear panel mounted terminal blocks using ¼” diameter hardware. Ring lugs with a ¼” diameter are recommended for these connections. **IMPORTANT!** Only the bottom row of screws for each terminal block can be used for connections. The top row of screws attaches to internal hardware and should not be removed for any reason. Attach input line phases to A, B, & C terminals and the neutral to the “N” terminal. Note that the unit will function without the neutral, however, if left unconnected there may be an increase in input current harmonics and voltage stress on the input transformer. All EMC and safety testing apply to 4 wire “WYE” with a grounded neutral conductor. The unit is not sensitive to phase sequence. See figures 2-1 and 2-2. The SCCR for this device is 5KA or less.



WARNING

THIS DEVICE IS SUPPLIED WITH A 3 or 5 WIRE LINE CONNECTION THAT INCLUDES A PROTECTIVE EARTH CONDUCTOR. THE P.E. CONNECTION IS CRITICAL TO OPERATOR SAFETY AND MUST BE TIED TO THE INSTALLATION SITE PROTECTIVE EARTH. DUE TO COMPONENTS USED FOR EMI REDUCTION, THIS DEVICE MAY PRODUCE LEAKAGE CURRENTS THAT ARE HAZARDOUS. THE EARTH CONNECTION ALSO PROVIDES A RETURN PATH FOR THESE CURRENTS.

2.3 INPUT POWER REQUIREMENTS

This model uses an isolation type rectifier transformer. The maximum 3 phase input power required for full output power into a resistive load is about 6000VA at nominal voltage. Overload protection is provided via a front panel mounted circuit breaker and other electronic methods. Single phase inputs have a lower power factor and can require about 8000VA input at full load. All voltage ranges are: +/-10%, 47-63Hz. The neutral wiring is the same for both 3 phase and single-phase versions.

Table 2-2 lists the estimated input current requirements for the BL5K series units versus the rated input voltage. All values are calculated for 10% low input voltage and full resistive output loads and will represent the worst-case power consumption. The actual current values will vary depending on the characteristics of the supply voltage distribution system and applied load (if other than resistive). The short circuit current rating of this equipment (SCCR) is assumed to be 5kA maximum. For proper short circuit protection coordination, current limiting fuses or circuit breakers should be used in the circuit branch feeding this equipment.

MODEL	RATED AC LINE	CURRENT/PHASE
BL5000C-1	120/208V WYE	16A
BL5000C-2	220/380V WYE	9A
BL5000C-3	277/480V WYE	7A
BL5000C-4*	220V DELTA*	16A
BL5000C-5	346/600V WYE	5A
BL5000C-6	230/400V WYE	8A
BL5000C-7	240/415V WYE	8A
BL5000C-8	120VAC 1 PHASE	60-75A**
BL5000C-9	240VAC 1 PHASE	30-40A**
BL5000C-10	480VAC 1 PHASE	15-20A**

*C-4 units may also be tapped @ 200V or 240 L-L

** Actual current dependent on line impedance at site, PF = 0.7 (approx.)

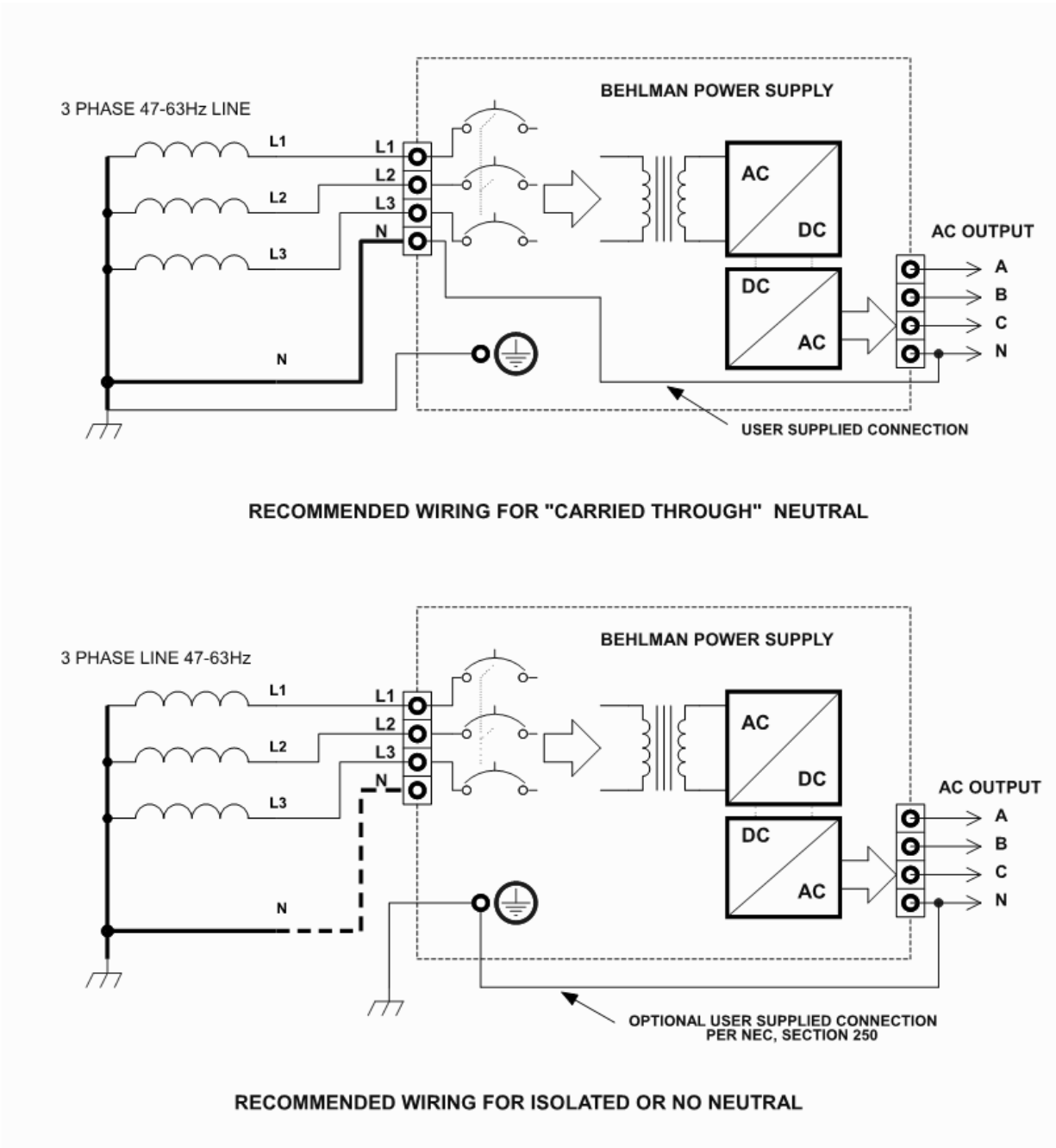


OPERATION OF WYE INPUT WITHOUT THE NEUTRAL CONNECTION

In many facilities using 3 phase power, the neutral conductor may not be available at the installation site. Note that the neutral conductor **is not** and **should not** be treated the same as the earth or P.E. conductor. The earth conductor is not intended to carry current during normal operation. Although it is not the recommended situation, most of the BL5000 models can be used without the input neutral. During operation, the phase currents will remain balanced (typically within 5-10% At full load). While the unit will function properly, this connection method will not provide the same level of safety and EMI performance to which this product has been tested. This will also cause the harmonics associated with the neutral imbalance to circulate in the transformer causing a small increase in losses. The transformer windings may also be subjected to additional voltage stresses. The long-term effect may be reduced insulation life.

The front panel circuit breakers used on this product are “slash” rated at 277/480VAC. This applies to all models. This means they are only tested and approved for use on circuits where the line to earth voltage is a maximum of 277VAC and is guaranteed under **all** fault conditions. This is true of WYE connected systems that use a neutral or “grounded conductor”. It is not true of certain delta or other un-grounded systems. As a precaution, back-up fuses rated to at least the full voltage should be employed on ungrounded distribution systems with greater than 277V line to line.

The figure 2-1 below illustrates typical 3 phase AC input wiring.



2.4 AC OUTPUT LOAD CONNECTIONS

Connect the load to the rear panel AC output terminal block located on the control chassis. Use only the lower row of screws for connection. Note that this device produces output voltages that are hazardous under normal conditions. The end user must make sure that all output wiring is installed in a way that prevents inadvertent contact with operating personnel. **The use of warning labels is highly recommended.**

The output circuit of this device is direct coupled and floating with respect to the input line. Likewise, the AC output Neutral terminal is isolated from the input Neutral. The maximum continuous floating voltage between any output terminal and ground is 500VDC or peak AC. It is also permissible (and recommended for most applications) that the output neutral be tied to earth or connected to the input neutral. See figure 2-1.

2.5 OTHER WIRING

This model is made up of two 19" wide rackmount assemblies. A cable set is provided to connect the DC output of the power chassis to DC input of the control chassis. Due to EMI and operational considerations, the length of these cables should not be altered. The connection details are provided here for reference. Always remove power and allow several minutes for internal capacitors to discharge before removing or connecting DC wires.

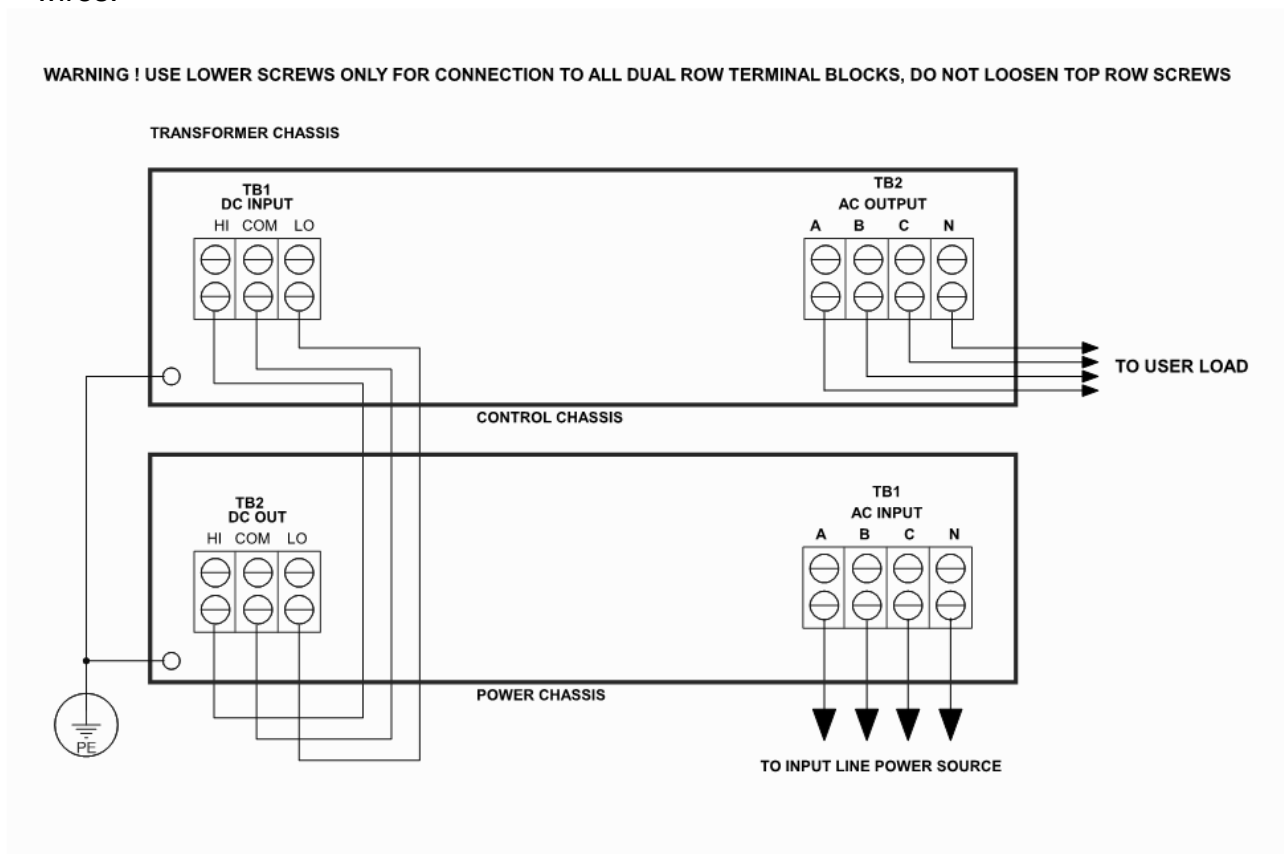


Figure 2-2 chassis inter-connection

2.6 UNITS WITH TRANSFORMER OPTIONS

The BL5000 series models are available with optional transformer assemblies to provide different output voltages. These are typically auto-transformers connected to boost or lower the available 0-135VAC and match the user required load impedance. T5 options provide a single range while T5D options provide a two-range output. Refer to table 2-2 for a list of standard output configurations. Engineering specials may allow other voltages not listed in the table. Refer to any addendum to operating instructions that may have been provided with the special unit.

The wiring diagram below illustrates the interconnection of a BL5000 with a T5 or T5D transformer chassis.

WARNING ! USE LOWER SCREWS ONLY FOR CONNECTION TO ALL DUAL ROW TERMINAL BLOCKS, DO NOT LOOSEN TOP ROW SCREWS

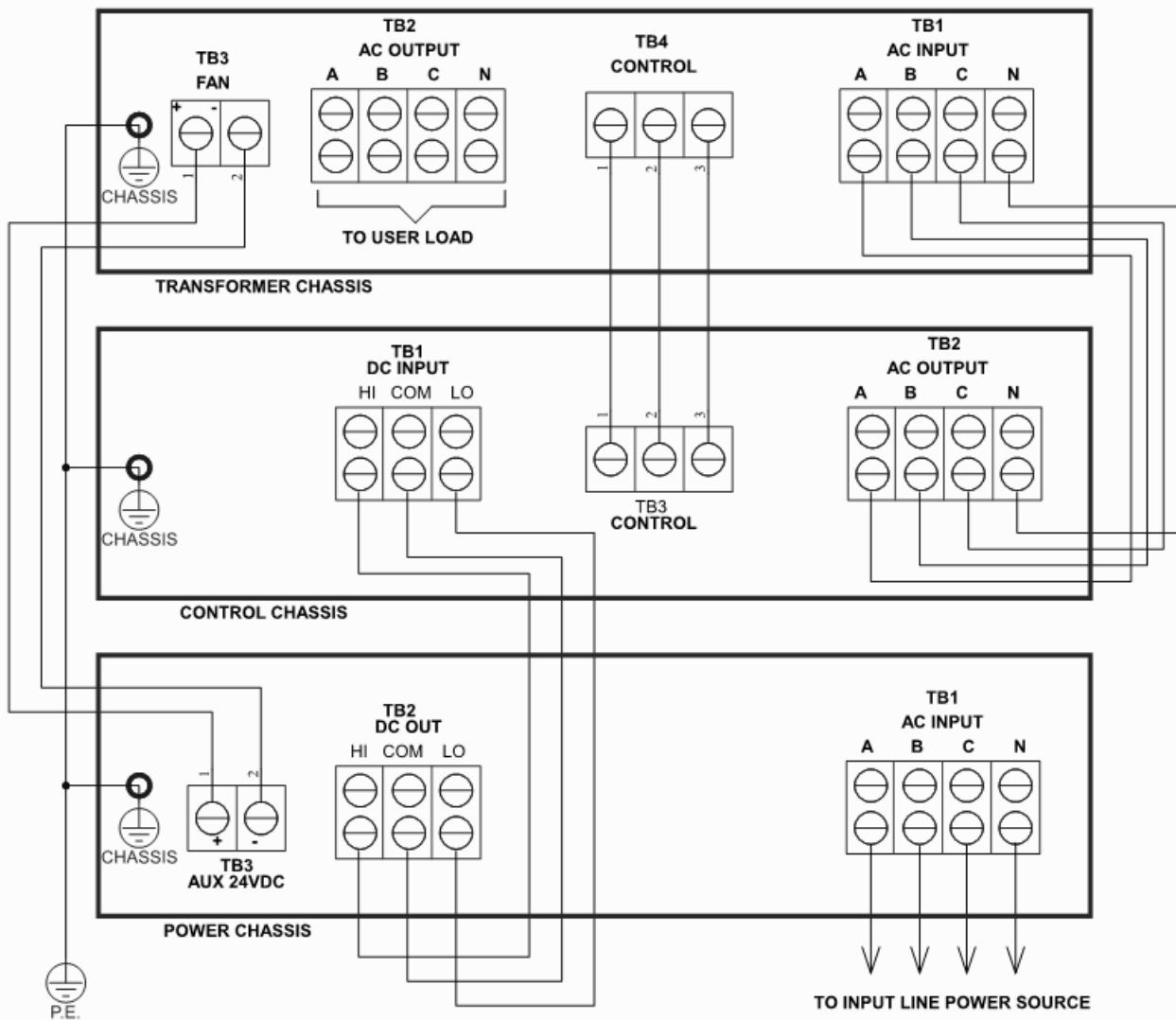


Figure 2-3 chassis inter-connect with T5 options

SECTION THREE
OPERATION

3.1 CONTROLS AND INDICATORS

Table 3-1 below lists the controls, indicators, and other features associated with the model BL5000 AC power supply. Refer to figure 3-1 & 3-2 for locations.

ITEM	DESIGNATION	COMMENT/DESCRIPTION
1	AC Line ON/OFF	Input circuit breaker.
2	Power indicator	Green indicator lamp for line power
3	Digital Displays	3-digit LED readouts to display output volts, current and frequency.
4	Display Select Switch	Selects the phase to be monitored by the displays. Note: output voltage displayed is line to neutral.
5	Voltage Adjust	Multi-turn control provides continuous adjustment of output voltage. Note: all 3 phases adjust simultaneously. NOT INCLUDED on fixed voltage versions.
6	LED Indicators	LED indicators for: Over Temp, Overload, or Constant Current.
7	OUTPUT switch	Controls internal relay for application of AC output to user load.
8	PHASE ADJUST trimmers & LINE DROP COMP trimmers	Front panel “trimmers” that allow fine adjustment of phase-to-phase angle and regulation over usable frequency range. See operating instructions for adjustment instructions.
9	FREQUENCY ADJUST	Multi-turn control provides continuous adjustment of output frequency. Note: all 3 phases adjust simultaneously. NOT INCLUDED on fixed voltage versions.
10	TB2, Rear Panel AC Output	AC output terminal block.
11	TB1, AC Line input	AC input terminal block. See section 2 on input wiring.
12	Remote interface	Analog remote control or optional RS-232 or IEEE-488 type computer interface.
13	DC inter-connect (TB2 on input chassis & TB1 on control unit.)	Connect DC cables between power and control unit chassis. Caution! 500VDC high voltage.

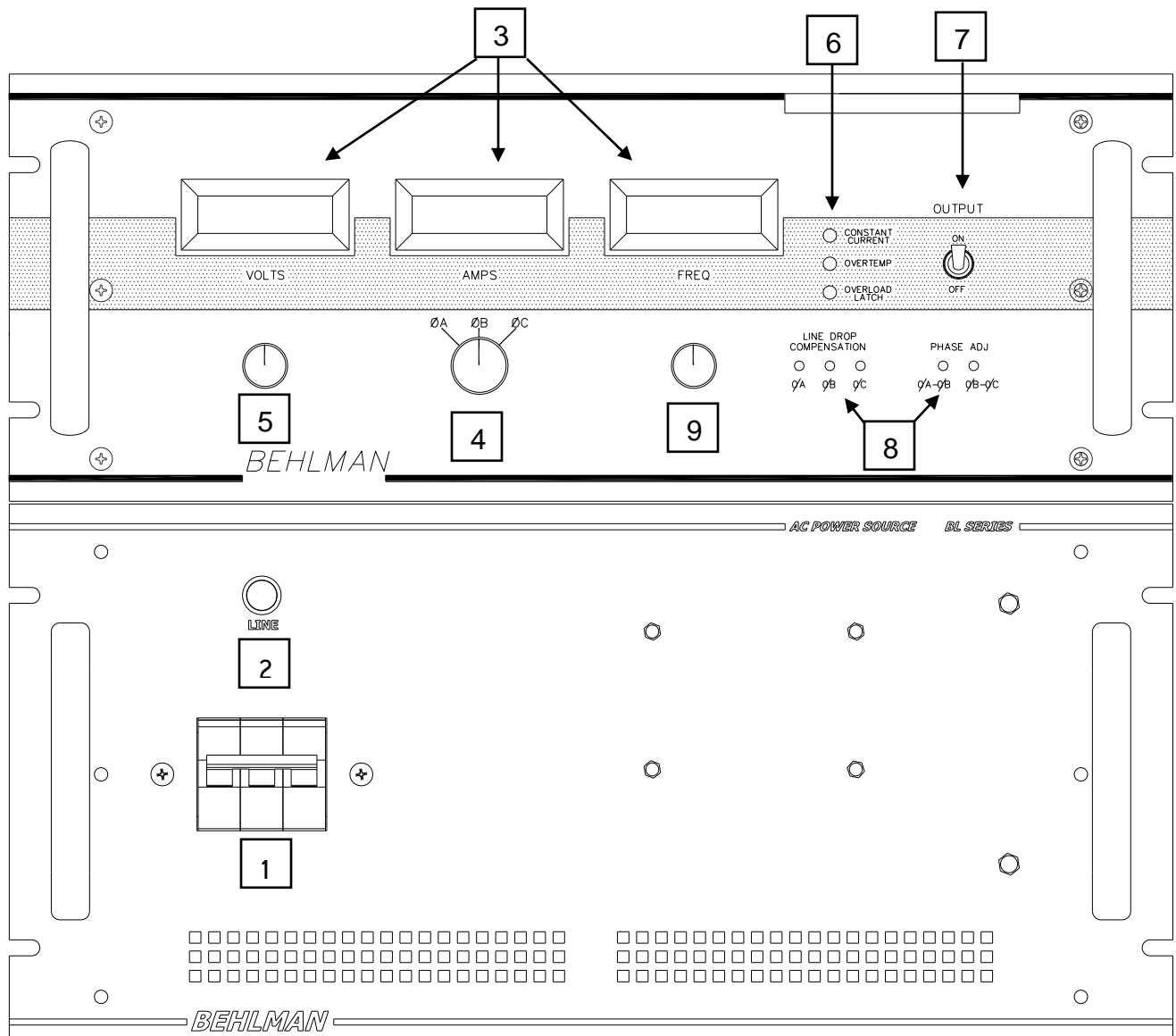


FIGURE 3-1 CONTROLS AND INDICATORS BL5000 MODEL SERIES (FRONT VIEW)

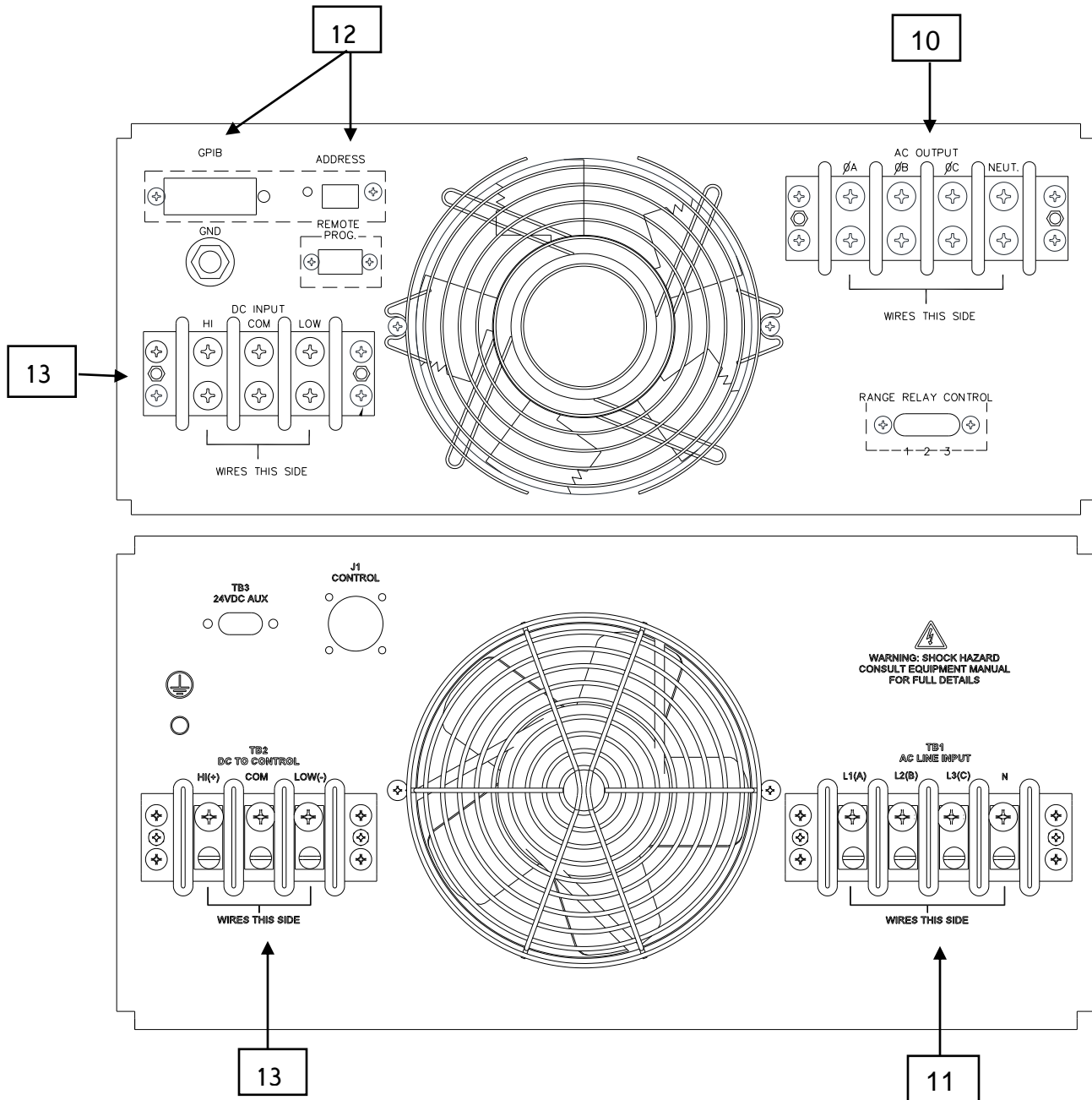


FIGURE 3-2 BL5000 MODEL SERIES
(REAR VIEW)

3.2

OPERATING INSTRUCTIONS

1. Connect the unit to a source of AC power within the rated operating range for this equipment. See sections 1 and 2 of this document.
2. Connect a suitable load to the AC output terminals (see section 2).
3. Set the output switch to off (recommended).
4. Set the front panel breaker to “ON”.
5. At this point, the front panel display will indicate some value and the sound of cooling fans will be evident. The unit is now ready to use.
6. To energize the load, set the **VOLTS** and **FREQ** controls to provide the desired output voltage and frequency. Note these controls are multi-turn types. If fitted with a locking device (option L), make sure the device is un-locked prior to attempting adjustments. Set the **OUTPUT** switch to “on” to connect the load. Set the load on (assuming the load has its own switch or enabling device).
7. During operation, the **METER SELECT** switch can be set to display the voltage and current of each phase. The meter displays line to neutral voltages and phase current.
8. To shut down, set the **OUTPUT** switch off, set the **VOLTS** control fully counterclockwise, and set the front panel breaker to the **OFF** position. NOTE: No damage to the power supply will occur if this procedure is not followed, however, this sequence will provide a transient free output during switch on/off.

It is permissible to use the **OUTPUT** switch to turn the load on and off, however, certain loads can cause the internal relay contacts to wear prematurely. This is especially true for loads with capacitive or other high in-rush currents. When in doubt, use the procedure outlined above. This procedure will provide a transient free output and prolong the internal relay contact life.

It is also possible to have the output voltage set at zero, and then to turn on the **OUTPUT** switch. The voltage can then be increased to the required operating point by adjusting the **VOLTS** control clockwise. This method works best with linear loads and may be desirable for certain applications (**variable voltage versions only**).

ADJUSTMENT OF LINE DROP COMPENSATION

This model provides a means of compensating for load current related voltage drops associated with the output wiring. A **LINE DROP COMP** trim is located on the control chassis front panel. One trimmer is provided for each phase. To adjust, proceed as follows detailed in the following:

ADJUSTMENT OF LINE DROP COMPENSATION (continued)

- 1.) With the load disconnected or switched off, note the voltage displayed on each output phase (line to neutral).
- 2.) Connect an external voltmeter of known accuracy as close to the load terminals as possible (load side of wiring). Note the line to neutral voltages.
- 3.) Apply the load and again note the voltages at the load terminals. Adjust the line drop trimmers as required to provide the same voltage noted without load.

NOTE: use of a non-metallic screwdriver is recommended. If there is no load current being drawn adjusting these trimmers will have little or no effect on the output voltage.

PHASE ADJUSTMENT

- 1.) Measure the line to neutral voltage of each phase and confirm they are equal (+/- 1.5V). For variable units, use Phase A to set exactly 100.0V.
- 2.) Connect an AC voltmeter between the phase A & B outputs. Confirm a voltage of 173VAC (+/-3V). If needed, adjust the A-B trimmer for this value.
- 3.) Connect an AC voltmeter between the phase B & C outputs. Confirm a voltage of 173VAC (+/-3V). If needed, adjust the B-C trimmer for this value.
- 4.) Connect an AC voltmeter between the phase A & C outputs. Confirm a voltage of 173VAC (+/-3V).

Repeat the steps above as needed for best overall line to line voltage balance. When the 3 phase to neutral voltages are equal, and have a 120° displacement, then the relationship between them is: Line to Line voltage = Line to Neutral voltage X 1.732.

3.3 ANALOG REMOTE CONTROL

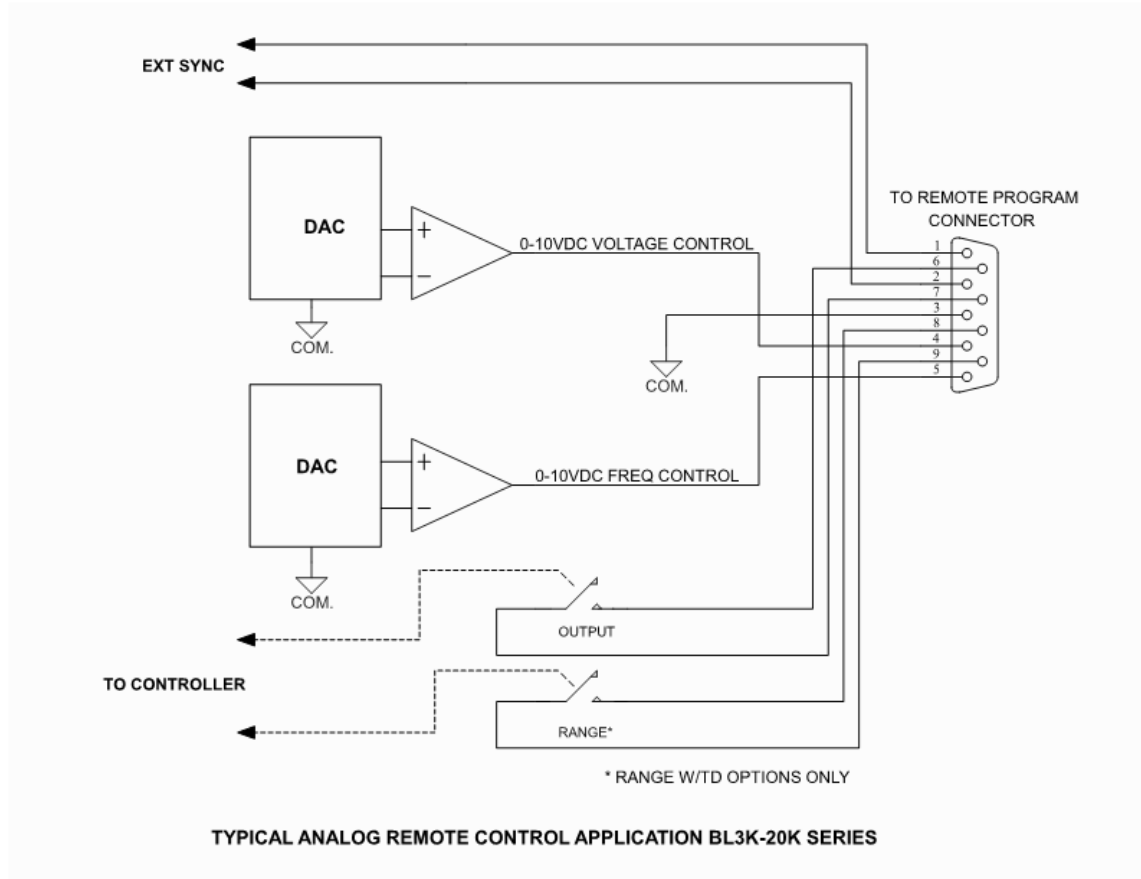
Standard models in this series include an analog remote-control input. A rear panel mounted 9 pin sub-D connector is provided for this purpose. By applying 0-10VDC to the appropriate pins, both the output voltage and frequency of the power supply may be controlled. In addition, external contact closures can be used to control the output relay (on/off function) and an optional range setting relay. The remote-control connector pin assignments and functions are listed in table 3-2 on the following page.

IMPORTANT: The common point of the remote-control input is tied directly to the output power circuit common. Use of an isolated controller is recommend to prevent a possible shock hazard or damage to external equipment connected to this point. This condition can be avoided by connecting the power circuit common to the protective earth conductor at the installation location. See wiring info in section 2.

3.3 ANALOG REMOTE CONTROL (continued)

TABLE 3-2 REMOTE CONTROL CONNECTOR PIN ASSIGNMENT

PIN	FUNCTION	DESCRIPTION
1	External sync HI	Applied square wave signal 5-30V will cause output frequency to phase lock to this input. *45- 500Hz
2	External sync LO	Return for sync input, (optically coupled)
3	DC control common	Common point for 0-10VDC analog signals. CAUTION! see safety note below
4	Voltage Control	0 – 10VDC controls output voltage from 0 – 100%.
5	Frequency Control	0 – 10VDC controls output voltage from 45 – 500Hz
6	Output relay	Shorting pin 6 to 7 will activate the output relay
7	Output relay	Shorting pin 6 to 7 will activate the output relay
8	Range relay	Shorting pin 8 to 9 will activate the range relay
9	Range relay	Shorting pin 8 to 9 will activate the range relay



3.3 ANALOG REMOTE CONTROL (continued)

USING THE SYNC INPUT

The output frequency of the model BL5000 can be locked to an external signal applied to the analog remote-control connector. The useful range is 45- 500Hz, however, the unit can lock to frequencies outside this range. The sync signal must be restricted to a range of about 40Hz -550Hz to avoid instability if the PLL attempts to lock to frequencies outside it's capture range. This can cause distortion of the output waveform of the power supply. For best results a square wave input is recommended to reduce the phase error between the sync signal and power supply output sinewave. The PLL time constant has been made very slow (seconds) to avoid instability. This input is optically coupled and requires a peak voltage between 5 -25V into approximately 1k Ω .

OTHER REMOTE-CONTROL CONSIDERATIONS

IMPORTANT, when using remote control of output voltage and frequency, the front panel VOLTS and FREQ controls must be set fully counterclockwise. Failure to do so will inject an offset into the control voltage input to output relationship. Likewise, the front panel OUTPUT and optional RANGE switches must be in the off positions as they are connected in parallel to the control inputs.

When using the external sync input, the front panel frequency meter will not indicate the power supply output frequency. The meter will remain at the last frequency set by the front panel FREQ control, or a value determined by the applied remote control frequency input. Removing the sync signal will cause the power supply output frequency to slew back to the value set by local or remote control.

OPTIONAL COMPUTER CONTROL (I or I/R options)

These models are also available with one of two digital control interfaces. The "I" option is a parallel type, IEEE-488 compatible port. The "I/R" option is a serial RS-232 compatible port. Either of these installed options will allow computer control of output voltage and frequency and will also provide readback of output voltage and current.

These options will be installed in place of the analog remote control. Like the analog control, the front panel VOLTS and FREQ controls must be fully counterclockwise, and the OUTPUT and optional RANGE switches must be set to off. For specific information on these options see any appendix included with this manual

3.4 OPERATING CONSIDERATIONS

The output voltage and frequency may be varied at any time while the unit is loaded. It is recommended that the load be disconnected (off) while changing the range setting (optional). This will prevent switching transients from reaching the load.

OPERATING CONSIDERATIONS (continued)

These AC power supply models are based on electronic circuits that utilize various power semi-conductors. As such, there is a limit to the amount of current that can be supplied. This is true even under transient conditions. Load in-rush current is also influenced by the way in which the load is applied.

Certain loads may draw short duration, very high peak currents, that may activate protection circuits within the AC power supply. These models incorporate two distinctive over current circuits. The first responds to massive overloads like short circuits. This circuit can respond in a few tens of microseconds. Once activated, the AC output of the power supply is disabled, and the front panel overload LED is lighted. To recover from this type of overload, the input power must be cycled off for about 30 seconds.

The second current limit circuit responds to long term overloads. Once the current is increased beyond the output rating, the unit will enter a constant current mode. In this mode, the output voltage will reduce to limit the current if the load resistance is reduced further. The voltage will recover automatically once the overload is removed. The front panel Constant Current LED will light or flash under these conditions depending on the nature of the overload.

The internal temperature of the unit is monitored. If the temperature rises above a safe value, the outputs will be disabled, and the front panel Over-Temp LED will turn on. Normal operation will resume once the unit has cooled to a safe level.

TRANSFORMER OPTION

Units supplied with additional output transformers have some special considerations. The output voltage regulation will be affected by the transformer as the primary voltage is used for voltage control. This will cause an additional error that will vary somewhat with load current and ambient temperature. The front panel line drop comp adjustment can be used to compensate for variations caused by the load current.

3.5 LIMITING LOAD IN-RUSH CURRENTS

Loads that present high inrush currents may be started by limiting the current at start-up. This can be done externally with a simple series resistor and relay. The resistor is placed in series with the load for the estimated or measured inrush period. Once the inrush current has stabilized or tapered off, the relay is used to switch the resistor out of the circuit. NTC (Negative Temperature Coefficient) “thermistors” may also be used. These semi-conductor devices start off with a nominal resistance value when cold (off). Once power is applied the current flow causes the temperature of the resistor to increase which in turn reduces the value of the resistance. The “hot” value may be several times lower than the cold value. These devices are available for currents exceeding 15 Amps. For higher currents several of these devices can be used in

parallel.

3.6 OPERATION INTO LINEAR LOADS

These models will provide the best overall performance into a linear load. A linear load is characterized by that fact that its current wave shape is sinusoidal. The phase relationship between the voltage and current may be anything between zero and 90 degrees (leading or lagging). Some examples of linear loads are as follows: Most AC Motors, Power Transformers, Heating Elements, Resistors, Capacitors, Most Inductors, Incandescent Lighting (without dimmers), and most Solenoids. Operation into these types of loads usually causes little interaction with the AC power supply.

The main concern with a linear load is the inrush current associated with it. Most heating elements and resistors have little or no inrush concerns and usually do not present any problem for the power source. Inductive and capacitive loads may present a special problem based on their construction and the way in which they are energized. Motors and tungsten filament lamps also present some special start-up concerns. The following is intended to give the end user some guidance for applying the AC source to these types of loads.

3.7 DRIVING REACTIVE LOADS

Capacitors and inductors are reactive in nature. If a capacitive load is applied during the peak of the AC cycle, there may be a considerable inrush of current several magnitudes larger than the steady state current. This current is only limited by any series resistance that may be present in the load circuit. Under the right conditions, this could trip the overload protection circuits in the power source. Certain transformers, relays and solenoids must be magnetized and present a similar problem.

Several methods can be used to prevent tripping the protection circuits in the power source. One common method is to insert a limiting impedance in series with the load. This could be a fixed resistor or NTC (negative temperature coefficient) thermistor. Also, zero crossing switching can be employed. The most obvious way to prevent a high inrush current is to apply the load with the voltage set to zero (or some low value) and energize the load slowly by turning up the voltage. This applies to variable units only. Use of the latter method is dependent on the type of load and the user's application.

3.8 DRIVING LAMPS

Tungsten filament lamps present a very low resistance when cold. Once they are energized, their resistance quickly climbs to a steady state value. This characteristic must be accounted for when driving tungsten filament lamps. The same methods for driving reactive loads can be applied to tungsten.

3.9 DRIVING MOTORS

Driving an AC induction motor can present a special problem. Most motors require a starting current that can be several times higher than their running current. This current may last for a few cycles to several seconds depending on the construction and mechanical load on the motor. This current is sometimes referred to as the motor's locked rotor amperes or LRA. This current is not to be confused with the inrush current that usually occurs over the course of one or two cycles of the AC waveform when power is first applied. This model series uses fold back current limiting that can be an advantage when starting motors. During the starting period, the motor will attempt to draw excessive current from the power source. The fold-back circuit will reduce the output voltage to maintain the maximum current for the range in use. This action can soft start the motor. The voltage and frequency can also be ramped to start difficult motors/pumps without needing to supply the full LRA.

3.10 PROTECTIVE CIRCUITS

OUTPUT OVERLOAD

These models have several protection modes. Output overloads and short circuits are protected by either the constant current mode or overload latch modes. If an overload is applied gradually, the constant current mode will automatically reduce the output voltage to limit power dissipation. Once the overload is removed the unit will revert to normal. If a short circuit is applied or the output current far exceeds the unit rating, the overload latch circuit will operate. This circuit will disable the output and set the front panel OVERLOAD LED to on. To recover from this mode, the load fault must be corrected and the line power to the unit cycled of for 30 seconds to reset the latch circuit.

OVER-TEMP

Both chassis of this model are protected from excessive internal temperature. In the case of excessive temperature in the control chassis, the output voltage will drop to zero and the front panel OVER-TEMP LED will be set to on. Once the internal temp drops to a safe level, the output voltage will ramp up to its previous value. If the input chassis internal temperature becomes unsafe, the output relay will turn off to disable the power supply. The unit will still indicate an output voltage, and the cooling fans will continue to run but the internal relay will be off. The relay will turn on again once the temperature is cooled to a safe value. The unit may be left in this condition without damage, however long-term reliability may suffer.

INPUT SOFT START

This model series provides input in-rush current limiting. At power-up a resistance is placed in series with the input lines. The operating DC buss is monitored and once operating values are reached, a relay shorts the resistance and allows operation. The resulting power on surge is limited to less than the full power current required.

**SECTION 4
MAINTENANCE AND TROUBLE SHOOTING**

4.1 MAINTENANCE

These power supplies are completely self-contained solid-state devices and do not require any routine maintenance. When used within their ratings they will provide many years of trouble-free service. The only foreseen maintenance issue would be maintaining the ventilation “grills” and cooling fans. Any accumulation of dust and debris should be removed by light brushing and/or vacuuming.

4.2 TROUBLESHOOTING

**THESE UNITS DO NOT CONTAIN USER SERVICEABLE PARTS
REFER ALL SERVICING TO QUALIFIED PERSONNEL ONLY. DO NOT REMOVE COVERS
AND DISCONNECT POWER BEFORE REMOVING FOR SERVICE.**

Table 4-1 below should be consulted in the event a problem is encountered during the operation of this power supply.

OBSERVED SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
No outputs, meter indicates 000 Overload LED is on.	Short applied to output.	Turn output off, cycle input power off for 30 seconds to reset.
Load does not operate; unit indicates proper output	OUTPUT switch is off, load not connected properly.	Check load is switched on. Check load is connected properly, See section 2 and 3.
AC output low or fluctuates, constant current LED is on or flashing.	Output overload.	Reduce load.
Output current not indicated.	Output switch is off.	Turn on output switch.
Unit will not power up. Standby LED is on.	No jumper installed between remote interlock terminals 3 & 4. Line voltage low.	Install jumper, see section 2 in this manual. Check for proper line voltage.
AC output distorted.	Hi harmonic content to load current. Non-linear load applied	Check load current waveform.
AC output drops to zero when load is switched on. Overload LED is on.	Output overloaded or shorted by large in-rush current.	Check load requirement, see information in section 3 on starting difficult loads.
No outputs, no displays, input fuses blow repeatedly.	Internal fault.	Remove unit from use and refer to qualified service personnel. Contact factory for service.

4.3 PERFORMANCE VERIFICATION

The following procedure can be used to verify proper operation of the AC power supply.



THE FOLLOWING PROCEDURE EXPOSES PERSONNEL TO HAZARDOUS VOLTAGE AND CURRENT LEVELS. REFER TO QUALIFIED PERSONS ONLY

4.3.1 EQUIPMENT REQUIRED

Table 4-1 lists the test equipment required to for performance verification. Other equipment may be substituted provided that it meets the minimum requirements set in the table.

#	DESCRIPTION	SUGGESTED TYPE	MINIMUM SPECIFICATIONS
1	AC WATTMETER	YOKAGAWA WT-230	AC volts, amps, & frequency 0.25% to 500Hz.
2	TEST LOAD BANKS	AVTRON K490	10.8 OHM +/- 5% @ 1.6KW
3	OSCILLOSCOPE	TEK TDS 2000 SERIES	20 MHz Bandwidth.
4	DIGITAL MULTIMETER	FLUKE MODEL 87	0.5% basic accuracy for AC
5	DISTORTION METER	HP339A or equal	1.0% Full Scale to 500Hz Tuned rejection type.
6	TEST LEADS, PROBES	ANY / Fabricate	As required.

4.3.2 SETUP

The test set up will vary depending on the available equipment. For the remainder of this procedure the AC power supply will be referred to as the DUT (Device Under Test). Turn on the power to test equipment and allow a 10-minute warm up period before starting the test. The use of a 3 phase wattmeter simplifies the test, however, any device with the proper input range and accuracy may be used.

4.3 PERFORMANCE VERIFICATION (without T option)

- 4.3.1 Set the (DUT) front panel OUTPUT switch to off.
- 4.3.2 Apply nominal line voltage, turn the unit on and allow 5 -10 minute for stabilization.
- 4.3.3 With the test load off, connect a DVM or wattmeter to measure the line to neutral voltage of each phase. Set the VOLTS adjust fully CW and the FREQ control to 100Hz and confirm an output of 135V (134.5V – 136.2V acceptable).
- 4.3.4 Set the line to neutral voltage to exactly 100.0 on phase A. Confirm a line-to-line voltage on the wattmeter of 173V +/- 3V. Confirm for all 3 phases. If needed, refer to the phase trim procedure in section 3 of this document.
- 4.3.5 Apply a 10.8-ohm load between each phase and neutral. Measure the resulting voltage and confirm less than 1.5V change from those noted in step 4.3.4. This confirms proper load regulation.
- 4.3.6 Confirm that the measured phase currents and voltages displayed on the wattmeter, match the DUT front panel displays within 2% +/- 1 digit.

LOAD REGULATION

TABLE 4-2 NO LOAD VALUES

PHASE	MEASURED L-N OUTPUT VOLTAGE	VOLTAGE TO LINE-LINE
A		A-B _____ V
B		B-C _____ V
C		C-A _____ V

TABLE 4-3 FULL LOAD VALUES

PHASE	MEASURED L-N OUTPUT VOLTAGE	VOLTAGE L-L
A		A-B _____ V
B		B-C _____ V
C		C-A _____ V

4.3.7 CHECK OF OUTPUT DISTORTION AND NOISE

Connect the distortion meter to each phase of the DUT (line-neutral). Make sure not to exceed the distortion meter input voltage range. Measure the distortion of each phase and confirm 3% or less. Any oscilloscope can be used to measure residual switching noise, it is typically less than 2.5Vp/p.

4.4 AC LINE FUSE REPLACEMENT (346/600V, C-5, 3 phase version only)



WARNING, EXPOSURE TO HAZARDOUS VOLTAGES

This equipment incorporates line fuses for internal fault protection. These fuses are rated @ 600VAC and provide back-up interrupt protection due to the limited front panel breaker rating. In most cases, if a fuse is blown, an internal or external fault may have occurred. The fuses are in the input power chassis (lower chassis). If it is desired to replace the AC input fuses, proceed as follows:

- 1.) Disconnect the unit from line power and allow 5 to 10 minutes for internal circuits to discharge.
- 2.) Disconnect the DC –DC wire from the control chassis and other wiring to the input power chassis. Remove the power chassis from any enclosure or rack. Access to the top cover is needed. Note- older units will have the fuses on or behind the front panel. Newer versions will have the fuses located to the rear, near the AC line input terminal block.
- 3.) Remove cover screws and cover.
- 4.) Locate and replace AC fuses with the correct type. These fuses are 32X8mm delay types rated at 600VAC minimum, Cooper/Bussman type FNQ-R 10A.

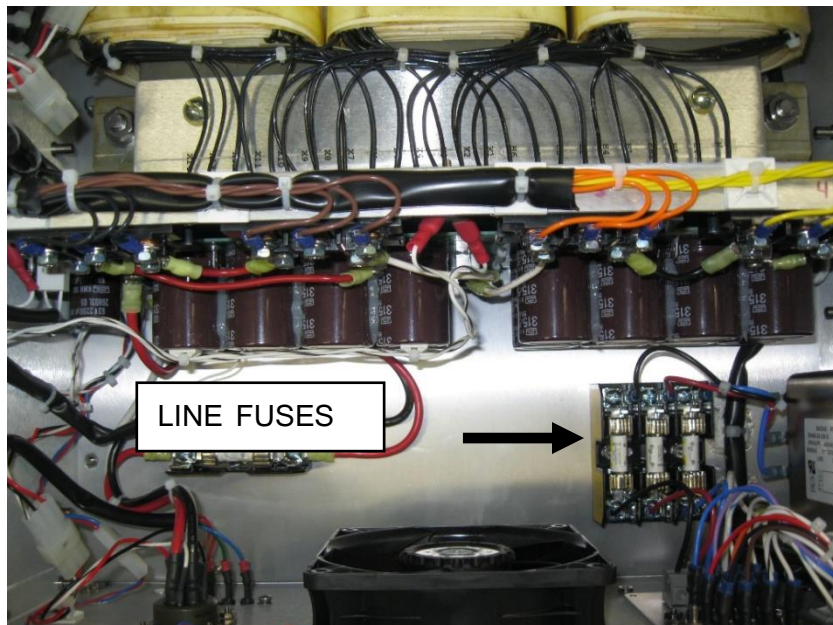


Figure 4-1 AC input fuse location

CAUTION: IF REPLACEMENT FUSES BLOW REPEATEDLY, SEND FOR SERVICE

**DOCUMENT
REVISION HISTORY**

REVISION	ECO #	DATE
-	INITIAL RELEASE	11/16/21
A	22-015	03/23/2022