USER'S GUIDE AND
TECHNICAL REFERENCE

DC TO AC INVERTER

BEHLMAN MODEL INV 1210

FOR SERVICE ASSISTANCE

CONTACT BEHLMAN
CUSTOMER SERVICE DEPARTMENT

PHONE TOLL FREE 1-800-874-6727

OR WRITE

BEHLMAN
CUSTOMER SERVICE DEPARTMENT
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PHONE: (631) 435-0435
FAX : (631) 951-4341

FOR SALES INFORMATION:

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FAX : (631) 951-4341

DATE: 8/00 REV: -

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 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 insure 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 be lethal 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

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 product is shipped from the factory in proper operating condition.

Immediately upon receiving equipment, unpack and inspect it for evidence of damage incurred in shipment. File a claim with the freight carrier if the equipment has been damaged in any way or it fails to operate properly. 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.
A RETURN MATERIAL AUTHORIZATION NUMBER (RMA) is required to return equipment.

This equipment, like all precision electronic equipment, is susceptible to shipping damage. It contains heavy magnetic components as well as delicate electronic components.

If equipment is returned without prior authorization, the shipment will be refused, the customer being liable for all shipping, handling and repair costs.

When packing for reshipment, use the original shock absorbent material and shipping container to preclude damage to the equipment.

Insure that the return authorization numbers (RMA) is available on the container for identification.

SHIPPING 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 3 to 4 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.

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(s) using a freight cargo carrier; air or ground.

CABINET MOUNTED UNITS

Cabinet mounted units require that a special crate be used. The crate should be manufactured of plywood (3/8" or thicker) and reinforced (using 1 x 3 or larger pine) on all edges. The unit must be firmly secured to the crate's base. The crate must be shock mounted to avoid damage during shipping. Detail drawings for Behlman's crates are available upon request.

WARRANTY CERTIFICATE

Behlman Electronics, Inc. warrants to the original purchaser, for a period of one (1) year from the 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 replacements 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 adjustment repair or parts replacement is required because 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 NY 11788 or at another Behlman service facility at Behlman's option. To obtain service under this warranty, the original Purchase 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 with 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 unit's case has been opened 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 this 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 forgoing 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 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.

OPERATING MANUAL FOR MODEL SERIES INV 1210

TABLE OF CONTENTS

1.0 INTRODUCTION

The Behlman INV 1210 series of power inverters incorporate the latest in switched mode power technology to provide regulated AC power from a user supplied DC source. These devices produce a" modified sinewave" output, which represents the RMS value of what is available from typical utility power.

Each model provides electronic protection along with a high short term overload capacity making them ideal for many loads requiring large "in - rush" currents. All units are housed in a rugged steel enclosure making them well suited to operation in industrial applications.

Available options include an AC input bypass and signaling contacts. The AC bypass option is available in two configurations. The "DI" option favors the DC input and will switch to AC when the DC input is lost. The second option , A1, will favor the AC line input and will switch to the inverter if the line is lost. These features allow the unit to be incorporated into a user defined back-up power system.

1.1 SPECIFICATIONS

INPUTS:

MODEL	DC INPUT	DC BURDEN
1210-250	250 VDC +/- 20%	7.5 AMPS @ 210 VDC
1210 - 125	125 DC +/- 20 %	15 AMPS @ 100 VDC
1210 - 48	48 VDC +/- 20 %	40 AMPS DC @ 38 VDC

AC INPUT (optional bypass mode only) 130 Vac max @ 15 amps (internal fuse)

OUTPUT

Power:	1200 VA
Voltage:	120 VAC +/-2% 60 Hertz (available @ 50 and 400 Hertz)
Current:	10 amps continuous (60 amps peaks)
Waveform:	Modified sinewave
Efficiency:	Better than 85% at nominal input.

PROTECTION

Input:	DC circuit breakers (AC 15 amps fuse. optional)
Output:	Electronic over current protected.
Thermal:	Thermal cut-out monitors temperature. Shuts down during Over-temp conditions. Automatic Reset.

MECHANICAL 3.5"H x 17" W x 17"D (rack mountable)

ENVIRONMENTAL Operating temperature 0 to +55C, 95% RH non - condensing

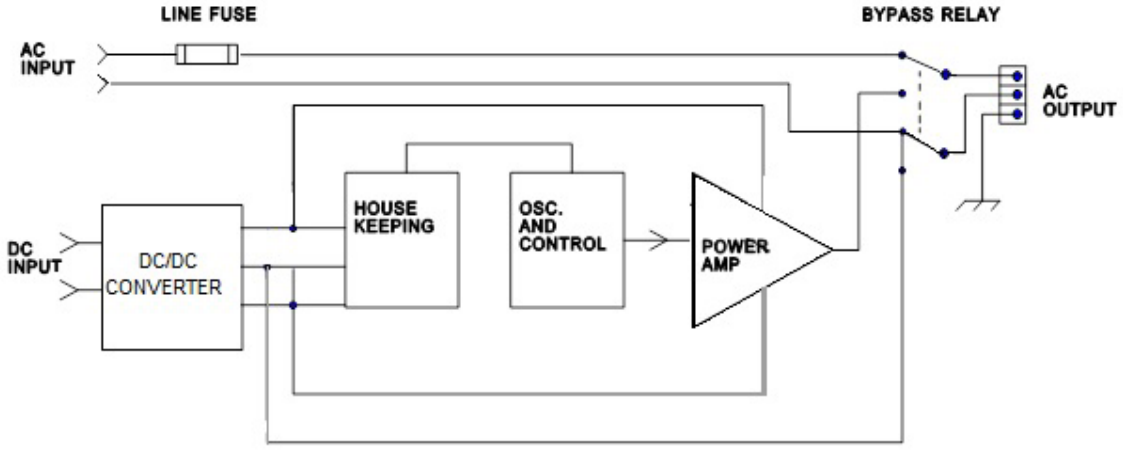
2.0 THEORY OF OPERATION

The INV 1210 series utilizes high frequency switched mode power conversion to convert the incoming DC to an AC output. The first stage is a DC to DC converter which "steps - up" the input voltage to a regulated +/- 160 Vdc. This voltage is applied to a second high frequency "house keeping" supply and the output inverter. The house-keeping supply provides operating voltage for the output inverter and alarm circuits.

The output section consists of a crystal controlled oscillator and power switching devices. The crystal derived clock frequency is divided down and applied to optically isolated IGBT drivers. The result is a 320V p/p pulse train at the output Frequency. The peak value of this pulse train is equivalent to the peak value of a 120Vac rms. This type of waveform is known as Modified sinewave.

The control circuitry on the output inverter assembly also provides protective functions. Output current is measured and used to provide foldback type limiting in the event of an overload. Output short circuits will terminate output pulses, when peak current exceeds approximately 60 Amperes. If the overload is left unattended the unit will enter a "burst mode" as it repeatedly attempts to drive the overload.

The alarm and bypass circuits (if provided) allow for external monitoring of input and output status. The AC input/ bypass feature allows the AC power line to be applied to the model INV 1210 and sent directly to the output terminals. In the event the AC is interrupted, a relay will switch the output to the inverter. Units supplied with the D1 option will switch the line through when the DC is not available or the inverter has a fault .The AC input is fused at 15 amps.



SYSTEM BLOCK DIAGRAM

3.0 OPERATING INSTRUCTIONS

3.1 INSTALLATION

The INV 1210 series inverters have been designed to be installed in a standard 19" relay rack or EIA type enclosure. A set of accessory rack “ears” are provided for this feature. These rackmount adapter brackets may be mounted at the front panel or in the middle of the chassis. In both cases, the adapters are held in place using #10/32 hardware.

CAUTION! WHEN INSTALLING RACK MOUNT ADAPTERS, HARDWARE USED (MACHINE SCREWS) MUST NOT EXCEED 3/8" IN LENGTH. LONGER SCREWS MAY DAMAGE INTERNAL COMPONENTS AND CREATE A SHOCK HAZARD

Mount the unit in a suitable location as not to block the flow of cooling air at the front, rear and sides of the inverter chassis. This device will pull in cool air from the front and sides and exhaust warm air from the rear. It is recommended that a minimum clearance of 3 inches be provided at the front and rear and 1 to 2 inches on the sides.

When rack mounting, it is permissible to mount the inverter by the mounting ears only. If the unit is intended for use in a mobile or other high vibration application the use of additional support for the rear of the chassis is **highly recommended**.

3.2 WIRING

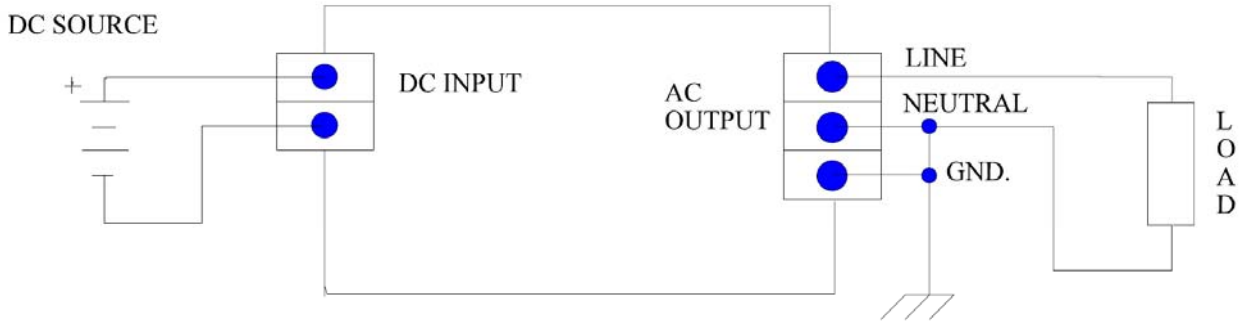
Wiring to the inverter will vary depending on voltage and options ordered. In addition local electrical codes must be considered for permanent installations. The NEC (National Electrical Code) requires that separately derived AC sources (back-up generators, inverters, ect.) must have one conductor bonded to earth ground. This may be accomplished with the 1200 series by following the recommended hook -up diagrams that follow. These examples require the terminal strip output option.

WARNING!

ALL INSTALLATIONS AND VERSIONS OF THIS DEVICE REQUIRE THE USE OF THE SAFETY EARTH CONNECTION TO THE CHASSIS. FAILURE TO DO SO MAY CREATE A FIRE OR SAFETY HAZARD. THE VOLTAGE AND CURRENT PRODUCED BY THIS UNIT CAN BE LETHAL. REFER INSTALLATION TO QUALIFIED PERSONNEL.

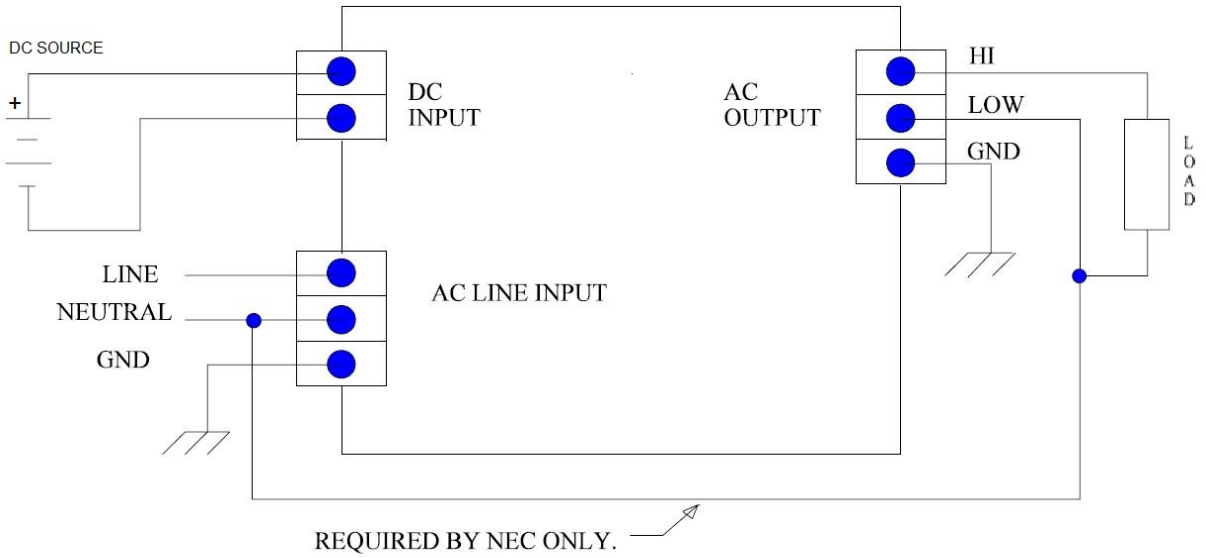
FAILURE TO OBSERVE DC POLARITY ON THE INPUT TO THIS DEVICE MAY CAUSE DAMAGE TO THE INTERNAL CIRCUITRY. THIS WILL VOID EQUIPMENT WARRANTY

3.2 WIRING (continued)



HOOK UP DIAGRAM FOR UNITS WITHOUT AC BYPASS OPTION AND OUTPUT TERMINAL STRIP OPTION (RECOMMENDED)

Units supplied with the AC input bypass option should be wired slightly differently so that neutral is “carried through” to the output but is not shorted to the GND terminal. This
will place one side of the inverter output at the neutral potential. It should be noted that this is only recommended to satisfy the NEC requirements. The output of the inverter is isolated from the DC input and the line.



WIRING FOR UNITS WITH TERMINAL STRIPS AND AC BYPASS OPTIONS (RECOMMENDED)

For units supplied with NEMA 15R type receptacles, simply connect the DC input to the inverter and plug the load into the receptacles. Connect the chassis of the inverter to an external earth ground.

3.2 WIRING (continued)

The recommended wire size for each model is listed below. These sizes are based on a maximum wire length of 10 to 15 feet. Longer wires should be increased in diameter.

MODEL #	DC INPUT WIRING	AC INPUT \ OUTPUT WIRING
1200-48-XX	# 8 AWG (45 A)	# 14 AWG (15 A max.)
1200-125-XX	# 12 AWG (15 A typ.)	# 14 AWG (15 A max)
1200-250-XX	#14 AWG (7.5 A typ.)	# 14 AWG (15 A max)

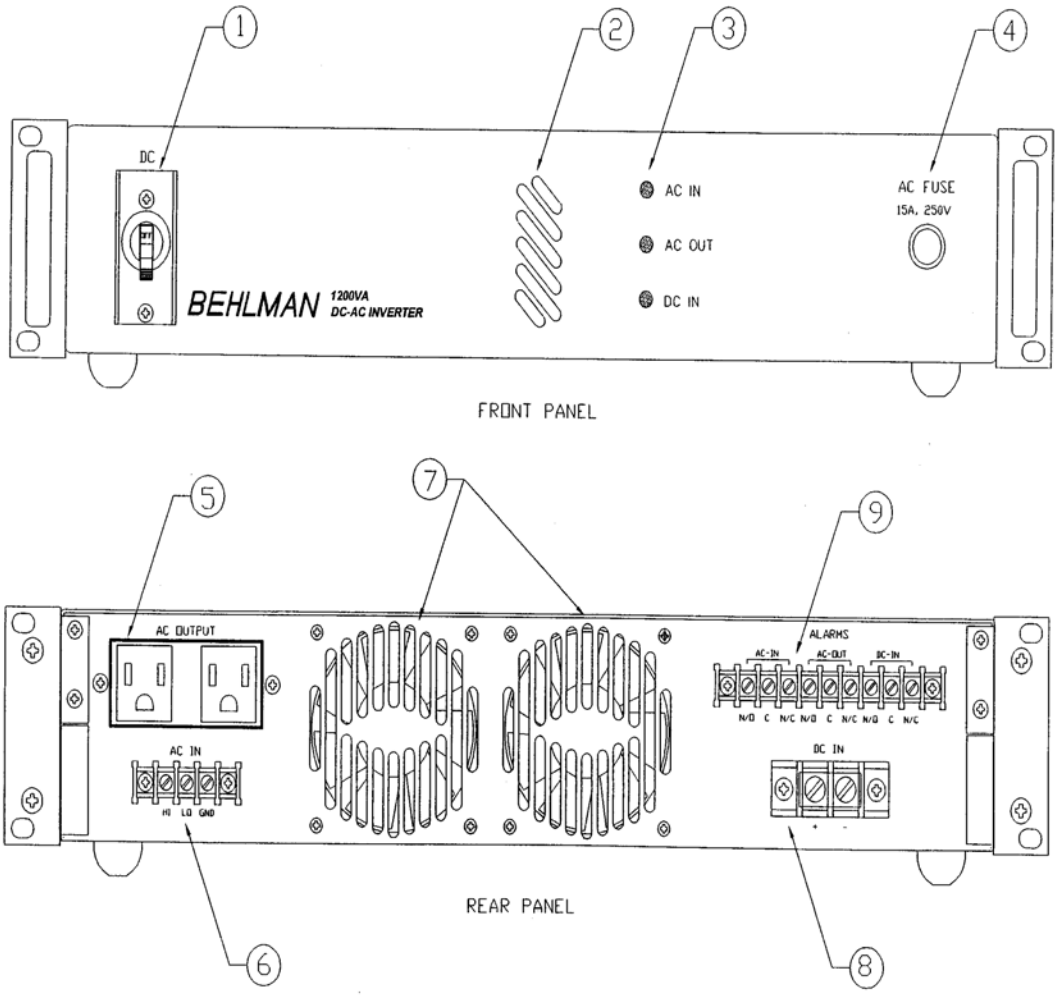
3.3 CONTROLS AND INDICATORS

Refer to figure on the next page for locations.

1. DC POWER CIRCUIT BREAKER	Switch inverter on/off, protects DC source.
2. AIR INTAKE	Pull in cooling air, min 3" clearance.
3. STATUS LEDs	Indicate presence of AC IN, DC IN, and INVERTER status. (optional)
4. LINE BYPASS FUSE	Protects input line when used as stand-by Supply (optional).
5. OUTPUT CONNECTOR	2 NEMA 15R shown. Connects inverter to load. Also available as terminal block or special (consult factory).
6. AC LINE INPUT	For applying AC line input for feed through During stand-by type operation. #6/32 hardware.
7. FAN EXHAUST	Min 3" clearance.
8. DC INPUT	For connecting DC input to inverter. Uses #8/32 hardware.
9. ALARM CONTACTS	3 “C” form, “dry” contacts for monitoring AC IN, DC IN, and INVERTER. (optional)

NOTE: An additional #10/32 grounding stud is provided on the rear panel of the unit to be used as a convenient safety earth connection.

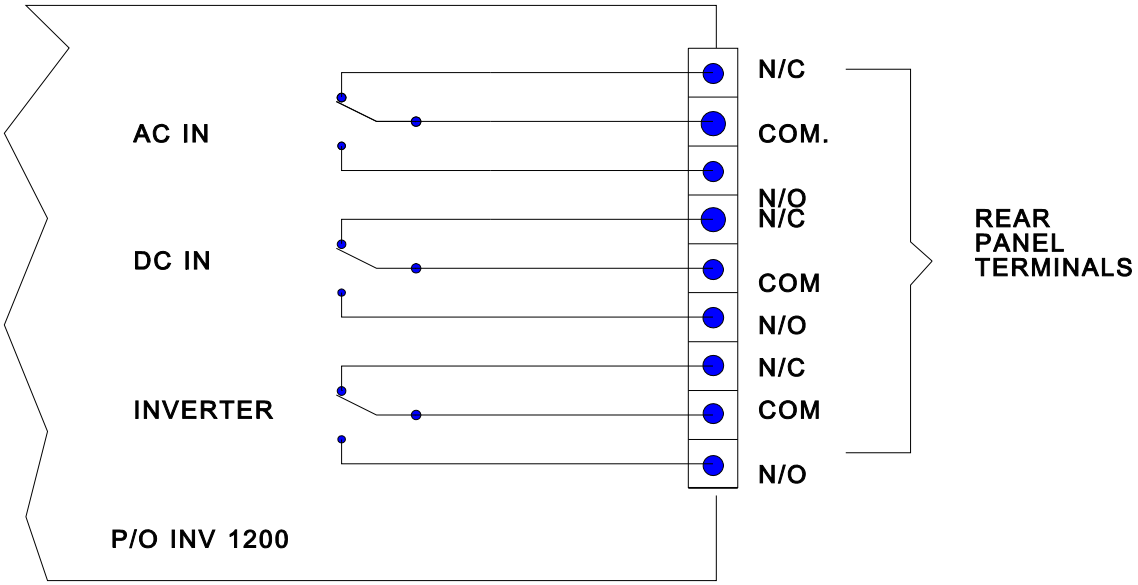
CONTROLS & INDICATORS



CONTROLS AND INDICATORS MODEL INV 1210 SERIES INVERTERS ALL MODELS

3.4 OPTIONAL ALARM CONTACTS

The alarm contact option provides the user with a convenient means of monitoring the DC input, AC input, and AC output of the inverter. Each function provides one set of “dry” C form contacts which accommodate any logic required. The contact rating of the alarm functions are 0.3 amp @ 125 Vac maximum. These alarms will indicate the availability or loss of each voltage. The figure below illustrates the alarm wiring.



3.5 OPERATION

1. Connect the load to the inverter. If multiple loads are used it is good practice to switch all loads off before switching on the inverter. This will prevent multiple in - rush currents from tripping protective circuits in the inverter.

2. Switch on the inverter. At this point, the sound of the cooling fans should be evident.

3. If the inverter contains the alarm / bypass option, the appropriate front panel LEDs should be illuminated.

4. To test the inverter, use a True RMS type meter to confirm the output voltage is as specified.

5. To test bypass functions on units equipped as such, remove the AC input and confirm that the INVERTER lamp stays illuminated and the inverter output voltage is still present. For units with the DI option, switching the DC off will place the unit in the bypass mode and the AC line input will be routed to the output connector.

4.0 OPERATIONAL CONSIDERATIONS

4.1 LOADING LIMITATIONS:

The INV series are designed to produce a power level of 1200 Watts (real power) under continuous operating conditions. In addition, they can supply bursts of over 1500 watts for several seconds. Peak repetitive currents on the order of 60 amps may also be supplied continuously as long as they do not exceed the RMS value of 10 amps.

This high peak current capability allows the INV 1210 series to start most high in - rush loads. It must be understood that the DC power source suppling the inverter must also have this capability in order to derive these benefits. A poorly regulated or high internal resistance DC power source will affect operation of the inverter.

4.2 POWERING REACTIVE LOADS

Capacitors and inductors are reactive in nature. If the load is applied during the peak of the AC cycle there may be a considerable in rush 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 inverter.

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 in the form of a fixed resistor or NTC (negative temperature coefficient) thermistor. Also, zero crossing switching can be employed.

Loads with a large parallel capacitance will draw large current spikes during the edge transitions of the output waveform. This may generate EMI (electro-magnetic interference). Also, loads that are pure inductors will produce “ringing” on the edges of the output waveform which will also cause EMI. If the load to be supplied are purely capacitive or inductive, the Behlman model INV1200 should be considered. The model 1200 produces a sinewave output.

4.3 POWERING LAMPS

Tungsten filaments lamps, when cold, present a very low resistance. Once they are energized, their resistance quickly climbs to it’s 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.

4.4 POWERING MOTORS

Driving an AC motor presents a special problem. Most motors require a starting current that is several times higher than the 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” current. This current is not to be confused with the in- rush current that usually occurs over the course of one or two cycles of the AC waveform.

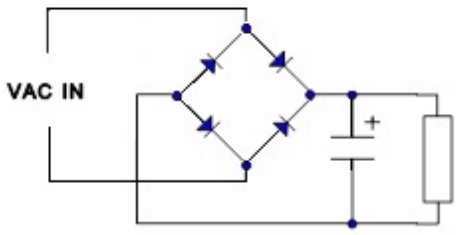
4.4 POWERING MOTORS (continued)

The model 1210s current limiting can be an advantage when starting motors. During the starting period, the motor will attempt to draw excessive power from the inverter. The current limit circuit will "pulse" the output current with high peaks in an attempt to start the motor. During this time the current supplied to the motor will be a series of 60 amps "bursts", this allows the motor to start rotating. Once the motor reaches it's normal operating speed, it generates the required "back EMF" and the supply current drops off to the nominal "run" current for the motor.

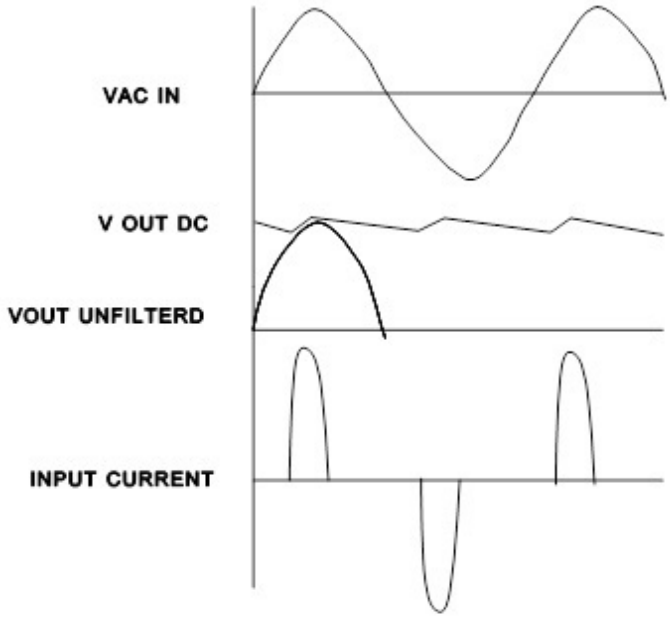
Note that certain types of motors will not run well using the modified sinewave produced by this device. If in doubt, consult the motor manufacturer.

4.6 POWERING NON-LINEAR LOADS

Loads utilizing rectifiers and SCRs interact with the AC power source and have a profound effect on the output waveform. Consider the use of a bridge rectifier followed by a capacitive filter, the current waveform associated with this circuit is illustrated below. The input current to this type of circuit is drawn in large "gulps" whenever the voltage across the capacitor falls below the peak of the input waveform. This current is limited only by the series impedance present in the wiring and capacitor. The impedance of large electrolytic capacitors is very small. This action causes a current waveform with a peak value that may be several times the RMS value. This ratio of peak current to RMS current is known as "Crest Factor". High values of crest factor cause distortion of the AC voltage waveform. The model 1210 handles this type of load well.



NON - LINEAR CIRCUIT EXAMPLE



4.6 POWERING NON-LINEAR LOADS (continued)

Other non-linear loads such as phase controlled SCR bridges or some types of power factor corrected “front ends” will be adversely affected by the modified sinewave produced by this equipment. These devices require a sinusoidal voltage for proper operation and timing.

It should be noted that this unit produces a waveform with square edges. These waveform produce harmonics at frequencies much higher than the fundamental (50/60Hz). Some loads may be affected by these harmonics. If there is any doubt as to the suitability of this equipment for a particular application, consult the Behlman engineering department for assistance.

5.0 TROUBLESHOOTING

In the event problems are encountered during the installation and operation of the inverter refer to the chart below before assuming the inverter is at fault. If It is determined the fault is with the inverter, contact Behlman Electronics for service information.

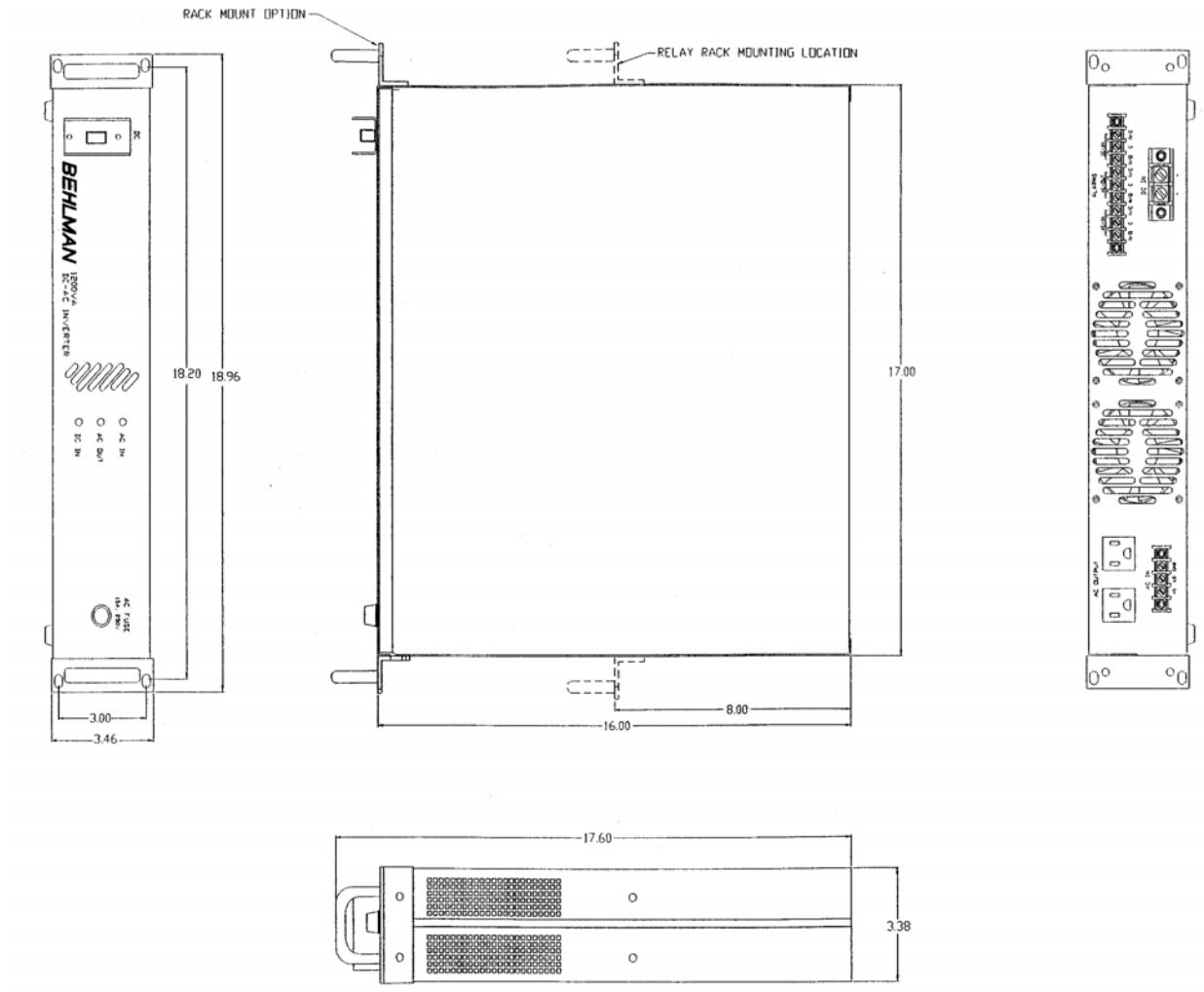
SYMPTOM	POSSIBLE CAUSE	ACTION
Low or no output	Output overloaded	Check load current . Disconnect load and recheck output voltage using TRMS meter. Recycle power.
Erratic operation	Input voltage fluctuating	Monitor voltage at DC input terminals of inverter. Make sure it is with in specifications
No AC input alarm (optional)	AC - Bypass fuse blown	Check fuse. Measure AC input at rear panel.
Output distorted	high peak load current	Reduce loading if distortion is objectional.
DC breaker repeatedly trips	DC polarity reversed or internal fault in inverter	Check polarity, if ok, the unit may have an internal fault. Return for service

NOTE: Service of this device requires specialized equipment and trained personnel. There are no internal user serviceable parts. Removing the cover will expose individuals to hazardous voltages. **Refer service to qualified persons only !**

5.1 MAINTENANCE

The INV 1210series requires very little in the way of routine maintenance. If the unit is operated in a dirty or dusty environment it should be removed from service periodically and cleaned. The use of forced air is perfect for cleaning dust and debris from fan intakes and heatsink assemblies. Light brushing and vacuuming is also effective

6.0 MECHANICAL OUTLINE



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-	N/A	INITIAL RELEASE	5/9/2016