**USER'S GUIDE AND**
**TECHNICAL REFERENCE**
**AC SOURCE**
**BEHLMAN MODEL P1352**
**PART NUMBER: 108-017-003**

**FOR SERVICE ASSISTANCE**

CONTACT BEHLMAN
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DATE: 8/01/17 REV E

## 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 harmful 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 631-435-0410

**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

**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. Units packed for UPS should provide extra protection due to the potential for rough handing.

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 open 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.

**TABLE OF CONTENTS**
**BEHLMAN AC POWER SOURCE, MODEL P1352**

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**SECTION**

## SECTION 1
## P1352 AC POWER SUPPLY: INTRODUCTION

The Behlman model P1352 AC Source is a solid state, precision AC power supply. It provides regulated AC power at frequencies not available from local utility power. The output voltage and frequency as well as all measurements are handled by a microprocessor based electronic controller. The output of the model P1352 is transformer coupled providing an isolated voltage source similar to utility power.

This model incorporates the latest in hard switched, PWM technology. A high frequency “Class D” type output stage provides a savings in weight and waste heat. This accounts for the compact size and high power capability of this AC power source. Advanced magnetic devices provide output filtering and further reduce losses associated with the conversion process. The following is a brief description of the conversion process performed by the P1352:

Line power at 115 VAC 50 or 60Hz is applied to the input of the unit. After passing through a noise filter, the input AC is converted to a bulk DC link voltage. This DC voltage is applied to the output inverter (refer to block diagram). The raw DC power is also applied to a small fly-back type converter that provides all of the low voltage “Bias” power. This power is distributed to all control and switch logic circuitry.

The output inverter is a switch mode power amplifier. A sine wave signal of the desired frequency is developed by the control circuitry and applied to the input of the power amplifier. This sine wave is amplified and “stepped – up” by the output transformer to provide the proper voltage. The voltage of the unit is sensed electronically and used as feedback to regulate the output amplitude. This action rejects fluctuations in the input line voltage and provides an output that may be adjusted above or below the input line. The output current, power, and power factor are also monitored and displayed. Other circuitry provides overload protection for the output inverter.

Manual control of the unit is provided through front panel mounted push-buttons and a bright alpha - numeric display. Remote control of all functions is provided via an RS-232 type serial computer interface.

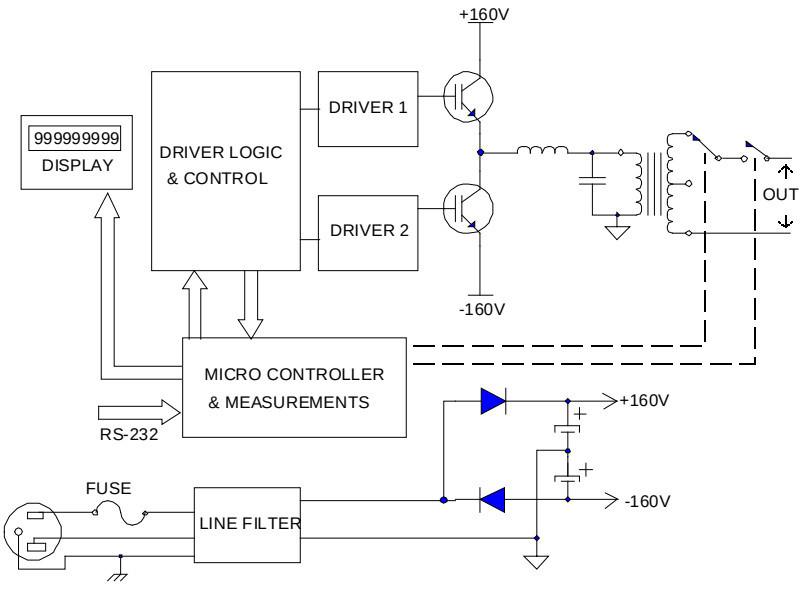



Figure 1-1 P1352 Block Diagram

## SECTION 1
## P1352 AC POWER SUPPLY: SPECIFICATIONS

**INPUT REQUIREMENTS:** 120 VAC +/- 10% 47-440 Hz, 1800VA maximum

**OUTPUT:**

| | |
|---|---|
| VOLTAGE: | Dual range 0 - 135 & 0 - 270 VAC. |
| FREQUENCY: | 45 - 500 Hz (0.1 Hertz min step) |
| CURRENT: | 10ARMS @ 135V or 5ARMS @ 270V |
| CURRENT CREST FACTOR: | min. 3:1 @ 60Hz |
| POWER FACTOR: | 100% of rated power into any P.F. (lead or lag) |
| DISTORTION: | 1% typical (measured @ 115 VAC 60Hz) |
| LINE REGULATION: | +/- 0.1% for +/- 10% line change @ 115V 10A/230 5A |
| LOAD REGULATION: | Less than 1.0% change from no load to full load. |
| OUTPUT NOISE: | 2.5 V peak to peak typical (on low range into 10 ohms). |

**FRONT PANEL DISPLAY:**

DISPLAY: Microprocessor controlled 24 X 2 line Vacuum Florescent.

| | SETTING RESOLUTION | SETTING ACCURACY | MEASUREMENT ACCURACY |
|---|---|---|---|
| **VOLTAGE** | 0.1 Volt | +/- 0.3% of Full Scale | +/- 0.3% of Full Scale |
| **FREQUENCY** | 0.1 Hertz | +/- 0.01 Hertz | +/- 0.1 Hertz |
| **CURRENT** | 0.1 Amp | N/A | +/- 0.2 Amps |
| **CURRENT LIMIT** | 0.1 Amp | +/- 0.1 Amp | N/A |
| **WATTS** | N/A | N/A | +/- 2.5% of Full Scale (150W to F.S.) |
| **POWER FACTOR** | N/A | N/A | +/- 3.5% of Full Scale (150W to F.S.) |

Fault Indication provided for: Over Voltage (OV), Over Current (O/I), Over Temperature (O/T) Constant Current (C/C), and Short Circuit Latch (O/L).

**REMOTE CONTROL:** RS-232 with female DB9 connector.

**MECHANICAL:**

| | |
|---|---|
| Dimensions: | 3.5"H x 17" W x 17.5"D (89mm x 432mm x 445mm) |
| Weight: | 39 lbs. (17.7kgm) |
| Operating Temperature : | 0 to 50 Degrees C |

## SECTION 2
## P1352 AC POWER SUPPLY UNPACKING AND INSTALLATION

### 2.1 UNPACKING

After unpacking the equipment, carefully conduct a thorough inspection of all controls, indicators, and the chassis. If the unit shows signs of shipping damage, do not attempt to operate. File a damage claim with the responsible carrier. Notify Behlman immediately.

### 2.2 INSTALLATION

This device is designed to operate on a bench or desk top. It can be mounted in a standard 19 inch rack cabinet using the RM option. **DO NOT ATTEMPT TO MOUNT BY RACK "EARS" ONLY.** Rear support must be provided. See information for the RM option contained elsewhere in this manual.

It is preferable to operate this equipment in a location which will maintain an air temperature of 0 to 50 degrees Celsius around the ventilation ports. If the unit is to be rack mounted, it is recommended that the enclosure be ventilated. The installation should insure that the side and rear vents are unobstructed.

### 2.3 INPUT POWER REQUIREMENTS

This model is supplied with a standard IEC20 type line cord with a NEMA 15P molded to the line end. This cord is rated at 15A and will suit most applications. The Model P1352 can operate from a wide input voltage range but continuous full power operation requires a "stiff" 120V capable of supplying at least 20A. The cord should be replaced with a 20A plug wired to match the user's receptacle. Consult with a qualified electrician or Behlman if in doubt.

**WARNING !**

**This equipment produces AC leakage current that may exceed hazardous levels**. **This equipment is supplied with a three wire AC input that provides for a safety earth connection to the equipment chassis. For operator safety the chassis of the equipment must be connected to the installation site safety earth. The safety earth connection also provides a return path for leakage currents associated with the equipment's internal line filter. Leaving this connection floating is dangerous and may cause electro-magnetic interference**.

**IMPORTANT NOTE:**

The output of the power supply is floating and also provides a safety earth connection. It is permissible to tie one side of the output to the safety earth. This will allow the power supply to conform to section 250 of the National Electrical Code (NEC). Consultation with a qualified electrician is recommended for permanent installations in buildings or vehicles.

This equipment is designed to be operated in a dry indoor location. Do not operate in the presence of rain or other moisture.

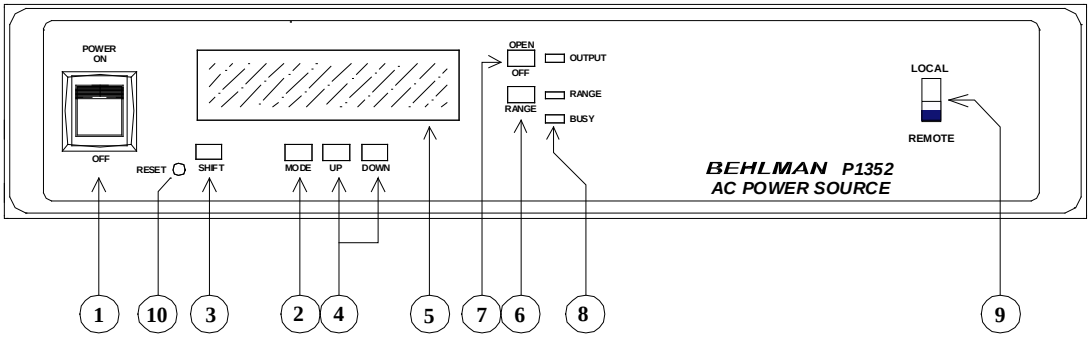
## SECTION 3
## P1352 AC POWER SUPPLY: OPERATING INSTRUCTIONS

# CAUTION

THIS DEVICE PRODUCES VOLTAGE AND CURRENT LEVELS THAT ARE HAZARDOUS
MIS APPLICATION OF THIS DEVICE MAY CAUSE SERIOUS INJURY.
THIS DEVICE IS INTENDED FOR USE BY QUALIFIED PERSONNEL ONLY!

The following section provides descriptions of the various features of the MODEL P1352 AC power supply front and rear panels. Figure 3-1 below illustrates the various controls and indicators associated with this model.

**FRONT PANEL DETAILS**




**REAR PANEL DETAILS**

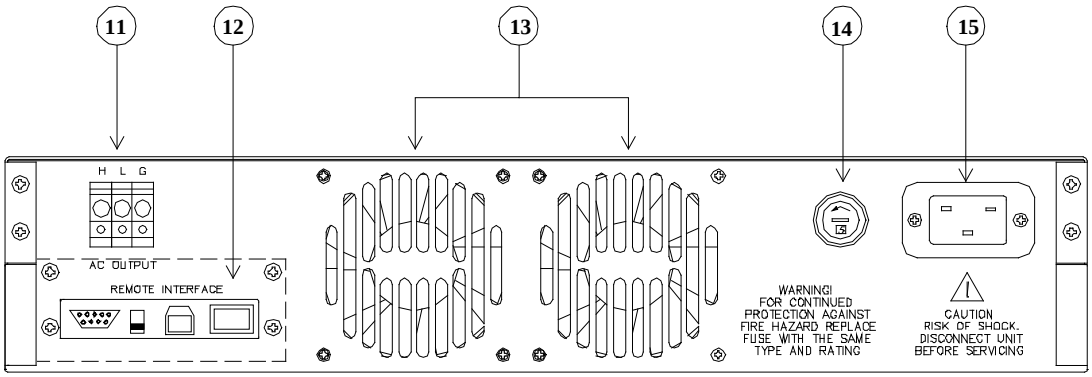



Figure 3-1 P1352 Controls and Indicators

Refer to table 3-1 on the following page for description of the items illustrated in the figure above.

## SECTION 3
## P1352 AC POWER SUPPLY: OPERATING INSTRUCTIONS

Table 3-1 below provides descriptions of the various features of the *AC Power Source* front and rear **panels. Refer to figure 3-1 on the following page for locations.**

**TABLE 3-1 P1352 CONTROLS AND INDICATORS**

| ITEM# | DESIGNATION | DESCRIPTION |
|---|---|---|
| **1** | Line **POWER** switch | Controls application of input line power. |
| **2** | **"MODE"** button | Selects adjustment or display modes. Toggles unit through Volts, Frequency, Current limit, and Power display modes. |
| **3** | **"SHIFT"** button | Used in conjunction with the **MODE** button to set the adjustment resolution. Available settings are : x 100, x 10, x 1.0 and x 0.1 |
| **4** | **"UP / DOWN"** buttons | Used to adjust the selected parameter up or down. Step size is set with the **MODE** and **SHIFT** buttons. |
| **5** | **DISPLAY** | Alpha-numeric display of output settings and parameters. |
| **6** | **RANGE** switch | Selects the output voltage range. When pushed in the 0-270V range is selected and the **HIGH** range LED is on. |
| **7** | **OUTPUT** switch | When pressed, the output voltage of the power supply is routed to the output terminals via an internal relay. The green **OUTPUT** LED indicates the output is on. |
| **8** | **BUSY** LED | LED illuminates while commands are processed. Can be used to verify remote communications. |
| **9** | **REMOTE / LOCAL** switch | Selects front panel (local) or remote control (RS-232). |
| **10** | **RESET** Switch | Momentary push button used to reset unit to a power -up default state. Access thru panel requires non-metallic tool tip. |
| **11** | **AC OUTPUT** terminals | Enclosed type screw terminals for up to 10 AWG wire. |
| **12** | Remote Interface | Provides connection to controlling computer via a standard RS-232 ports, DB9 connector. Note: “I” option units will have a standard 24 pin IEEE-488-2 type connector. |
| **13** | Fan Exhaust | Hot air exhaust, minimum 4 inch clearance. |
| **14** | Input line fuse | Receptacle for input fuse. For fuse replacement **REMOVE POWER** and turn Fuse "cap" counter-clockwise with slotted screw driver. **WARNING! Replace fuse with same type and rating only! 20A, 250V, Slow.** |
| **15** | AC input Receptacle | IEC-20 type , 20A receptacle, applies 120VAC 47-63Hz. |

## SECTION 3
## P1352 AC POWER SUPPLY: OPERATING INSTRUCTIONS

**WARNING !**

**This unit creates ground leakage currents that may exceed 5mA. Safe operation requires use of the safety earth connection. Do not defeat this connection.**

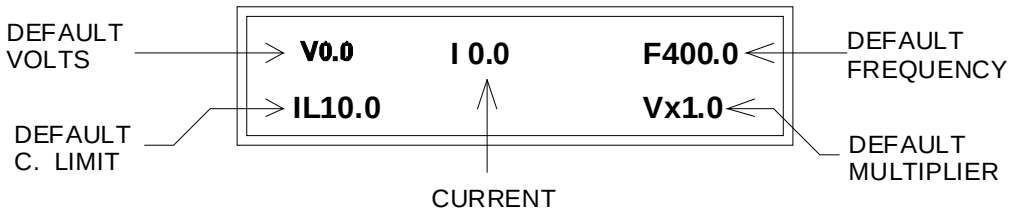
### 3.1 TYPICAL OPERATION.

1. Connect unit to a suitable source of 115 VAC 60 Hz power using the supplied line cord. See operational considerations for further information on input power requirements.

2. Connect the load or device to be tested to the rear panel terminal block. The load should be connected between the **H** and **L** terminals. Either may be also tied to the **G** or earth ground terminal. This point connects to the equipment chassis. See operational considerations.

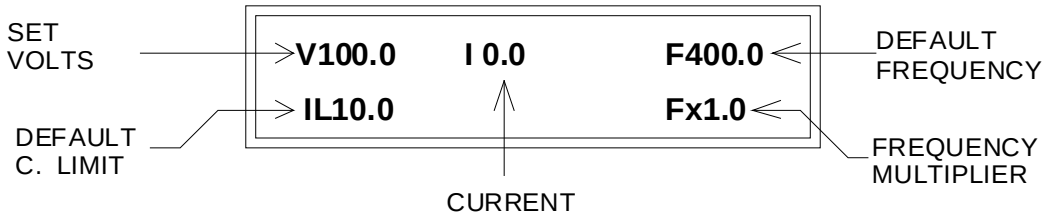
3. With the **RANGE** and **OUTPUT** button off (not depressed) turn on the power switch.

4. At this point the sound of the cooling fans should be evident and the front panel display should look like the figure below.




5. Note that the default multiplier is "**Vx1.0**". This indicates that the output voltage may now be set in 1 volt increments using the **UP** and **DOWN** buttons. To change the step "size", hold the **SHIFT** button in and press the mode button. Each time the **MODE** button is pressed the multiplier step size will increase by a factor of ten. The available resolutions are: x0.1, x1.0, x10, and x100.

6. To set the output current, press the **MODE** button 1 time. To set the output frequency, press the **MODE** button1 time. The display should appear as shown below:



6. continued:

The "F" in front of the multiplier indicates that frequency is the parameter now controlled by the **UP/DOWN** buttons. Use the **UP/DOWN** buttons to set the frequency to the desired value. Remember that the "step size" or resolution can be changed by holding the **SHIFT** button and pressing the **MODE** button to select the desired multiplier value.

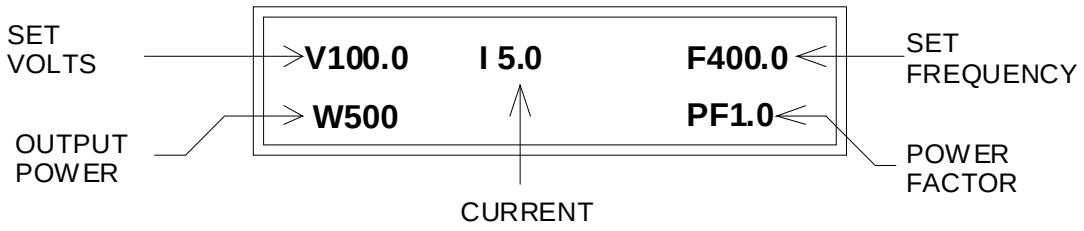
7. After the voltage and frequency (and current limit if required) are set, the load may be energized by pressing the **OUTPUT** button. Note that it is also permissible to energize the load gradually by setting the voltage to zero, turning on the output, and stepping the voltage up.

If it is desired to operate with the high voltage range, depress the **RANGE** switch prior to setting the output voltage. Pressing the switch after the output is set will cause the output to drop to zero.

The voltage, frequency, and current limit may be set at any time during the operation of the power supply**.** Press the **MODE** button to change which parameter is to be adjusted. Use the **SHIFT** and **MODE** button to select the step size as previously described. Then the output parameter may be adjusted with the **UP/DOWN** buttons.

### 3.2 POWER DISPLAY MODE

A useful feature of the P1352 is the power display mode. In this mode, the output power in watts and the load power factor are continuously displayed along with frequency, voltage, and current. When in this mode the **UP/DOWN** buttons are "locked out" and will not change the output parameter when pressed.




### 3.3 CURRENT LIMIT AND CONSTANT CURRENT MODE

The P1352 current limit feature allows the user to preset a current limit point. If the load current exceeds this value (RMS) the output of the unit will drop to zero and the display will indicate the event by flashing "O/I". This condition is cleared by pressing the **MODE** button. If the current limit is not preset, the default value of 10 amps for the 135V range and 5 amps for the 270V range will be used. As such the unit will go into a "constant current" mode when the default value is reached. In this mode, the output voltage will drop in response to an overload. This action will maintain the current at a fixed value. This can be a useful feature for trouble shooting. When the unit is in this mode the display will flash "C/C". The unit will come out of this mode once the load current is reduced below the default value.

## SECTION 3
## P1352 AC POWER SUPPLY: OPERATING INSTRUCTIONS

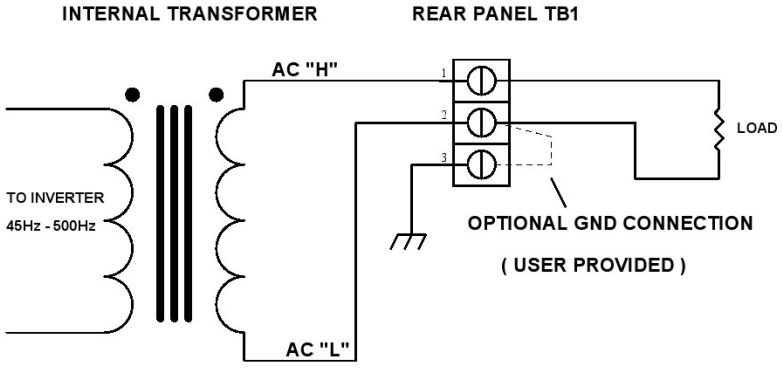
### 3.4 OPERATION UNDER FAULT CONDITIONS.

The P1352 AC source incorporates several modes of protection:

| | |
|---|---|
| CURRENT LIMIT AND CONSTANT CURRENT | See section 3.3 |
| OVER-VOLTAGE | (0/V): If the measured output voltage is 20% higher than the full scale value, the unit will revert to zero output and the display will flash O/V. This is very rare and will most likely indicate that the unit needs service. Pressing the **MODE** button while in manual mode will reset this condition. |
| OVER-TEMPERATURE | If the power amplifier temperature exceeds a safe value, the output voltage will revert to zero and the display will Flash “O/T”. Pressing the mode button while in manual mode will reset this fault. |
| SHORT CIRCUIT | In the event that the output is short circuited, the unit will Latch-up and the display will flash O/L. Power must be cycled to reset the fault. If the short is removed, the unit should recover. |

### 3.5 CONNECTING LOADS

The figure below illustrates the output circuit of the P1352. It is fully isolated and floating with respect to ground. The load is applied between the HIGH and LOW terminals. The third terminal is connected to the equipment chassis which returns to the input safety earth via the line cord. It is permissible to tie either side of the output circuit to ground. Likewise, the output may be left “floating” at a potential other than ground. The maximum continuous elevated potential is 300VDC.




P1352 SERIES OUTPUT CIRCUIT

## SECTION 3
## P1352 AC POWER SUPPLY: OPERATING INSTRUCTIONS

### 3.6 OPERATION INTO LINEAR LOADS

The model P1352 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 0 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 Lamps (without dimmers) | | Most Solenoids |

Operation into these types of loads usually causes little interaction with the output stage of the model P1352. The main concern with a linear load is the “in rush” current associated with it. Most heating elements and resistors have no in rush 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 insight into applying the AC source to these types of loads.

### 3.7 DRIVING 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 power source. Certain transformers and solenoids (inductance) present the same problem at zero crossings.

Several methods can be used to prevent tripping the protection circuits in the power source. One common method is to insert an 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 for capacitive loads. The most obvious way to prevent a high in rush 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.

**Important:** The output voltage of this device may tend to rise when operating into large capacitive loads at frequencies above 400 Hz. This is due to series a resonance effect that can occur between the output stage filter and the applied load capacitance. Adding a shunt resistive load can reduce the effect by “de-tuning” or “swamping” the resonant peak.

The unit will limit the voltage rise to about 20% of full scale and provide an “OV” indication.

### 3.8 DRIVING LAMPS

Tungsten filaments lamps, when cold, present a very low resistance. Once they are energized, their resistance quickly climbs to its 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 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” amps or current (LRA). This current is not to be confused with the in-rush current that usually occurs with typical loads over the course of one or two cycles of the AC waveform. The model P1352's fold-back current limiting can be an advantage when starting motors.

3.9 **DRIVING MOTORS** (continued)

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 in order to maintain the maximum output current for the range in use. During this time the current supplied to the motor will remain sinusoidal. This allows the motor to start rotating. Once the motor reaches its normal operating speed, it generates the required "back EMF" and the supply current drops off to the nominal "run" current for the motor.

## 3.10 DRIVING NON-LINEAR LOADS

Loads utilizing rectifiers and SCRs interact with the AC power source and have a large effect on the distortion of the output waveform. Consider the use of a bridge rectifier followed by a capacitive filter, the current waveform associated with this circuit is illustrated in figure 4-1. 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 amount of distortion incurred is dependent on many factors and is beyond the scope of this manual. It should be noted that this type of load may cause the output waveform to exhibit "flat topping". This should not be associated with a defect of the power source. Most "real world" electric distribution systems exhibit similar distortion for this reason.

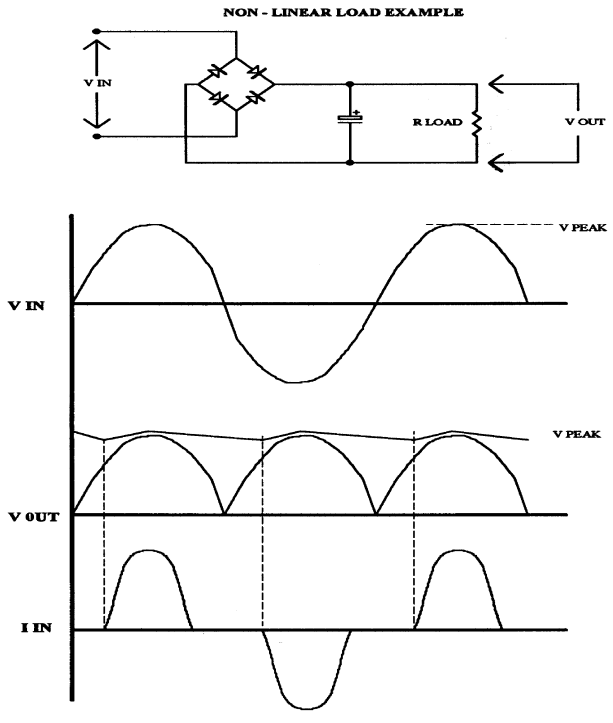



FIGURE 4-1

## 3.11 INPUT POWER REQUIREMENTS

The model P1352 utilizes a rectifier followed by a bank of filter capacitors and presents a non-linear load to the utility power. Because it's input current waveform is dis-continuous it has a high crest factor and contains a large amount of harmonic current. These harmonic currents do not contribute to the output power of the power source but must still be supplied by the input line. This adds up to a low input power factor.

**IMPORTANT !**

When selecting a suitable line input, it must be understood that the input current required for full output power (1350 watts) from the P1352 may exceed 20Amps RMS. This is only true for purely resistive loads (Watts vs. Volt Amperes). For this reason the unit is supplied with an IEC 320 C-20 input receptacle. If continuous full power operation is desired the unit must be supplied from the equivalent NEMA type line and receptacle. The line cord supplied with the unit has standard north American NEMA 15P at one end. This was done due to the fact that it is more convenient to most end users. Although the cord itself can handle the current, the line end should be changed to the appropriate mate for prolonged full power operation. **Failure to do so may cause overheating of the input line connection**. This may create a fire hazard.

Full power operation into a full resistive load may cause loading (sagging) of the supplied line voltage if large series impedance is present. This is due to the high current required by the model P1352. If problems are encountered while trying to achieve full output power, monitor the input line. If the line drops below 110VAC, move the unit to a known "stiff" line.

## 3.12 OUTPUT NOISE

Because the model P1352 uses a high frequency PWM conversion technique, a certain amount of output noise or ripple is to be expected. The amount of noise present on the output voltage waveform from this unit varies somewhat with the load. Maximum noise levels are present when there is no load applied. In any event, the amount of noise present should not constitute a problem for properly designed equipment. If the devices being tested are disabled by the noise present on the output waveform, then serious consideration should be given to the design of the unit under test as it may not pass typical European conducted susceptibility EMC tests.

In extreme cases where the output noise is objectionable, an external line filter can be added to the output of the unit. Please note that most line filters are not intended to be used at frequencies other than 50 or 60 Hertz. If the noise level is interfering with low level measurements a linear type AC source should be considered. For more information on linear AC sources, contact Behlman Sales.

## 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”. Any accumulation of dust and debris should be removed by brushing 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, display indicates V0.0. | Voltage not set. | Set voltage per section 3 |
| Load does not operate, unit indicates proper output. | OUTPUT switch is off, load not connected between HI and Lo AC output. | Check load is switched on. Check load is connected properly, See section 2 and 3. |
| AC output low or fluctuates, constant current “**C/C”** flashes. | Output overload. | Reduce load. |
| Output voltage does not change. | Unit in power monitor mode. | Set to adjust mode, see section 3. |
| Output frequency does not change. | Unit in power monitor mode. | Set to adjust mode, see section 3. |
| AC output distorted. | Hi harmonic content of load current. Non-linear load applied. | Check load current waveform. |
| AC output drops to zero when load is switched on. Overload “**O/L**” is displayed. | 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 fuse blows repeatedly. | Internal fault. | Remove unit from use and refer to qualified service personnel. Contact factory for service. |

**WARNING! REPLACE FUSE WITH SAME TYPE AND RATING ONLY.**
**20A / 250VAC Medium Delay.**

## 4.3 PERFORMANCE VERIFICATION

The following procedure can be used to verify operation and calibration of the P1352 AC power supply.

**WARNING !**

**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 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 0.1% to 500Hz. |
| 2 | TEST LOAD BANKS | AVTRON | 12 OHM +/- 5% @ 1.2KW<br>48 OHM +/-5% @ 1.2KW |
| 3 | OSCILLOSCOPE | TEK TDS 2000 SERIES | 20 MHz Bandwidth. |
| 4 | VARIABLE AUTO-TRANSFORMER | SUPERIOR ELECTRIC MODEL 1020 or equal | 0 TO 132Vac @ 2KW , 60Hz |
| 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

Set up equipment as illustrated in figure 4-1. 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 commencing with the test.

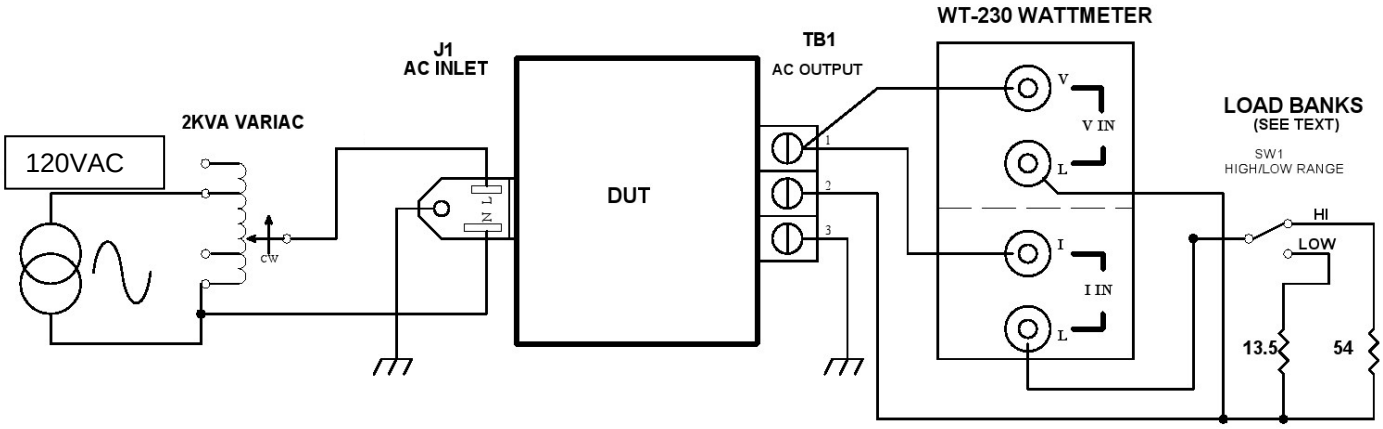



**FIGURE 4-1 PERFORMANCE TEST SET UP**

**4.3.2** Set the P1352 front panel controls as follows:

| | | |
|---|---|---|
| OUTPUT | = | Off (button out) |
| RANGE | = | Low (button out) |
| LOCAL/REMOTE | = | Local |

**4.3.3** Set the variac to provide 120V AC to the DUT. Switch the DUT on and confirm the displays are active and the cooling fans are on.

**4.3.4** Set the DUT frequency control to provide a 100Hz output.

**4.3.5** Set the DUT voltage to provide 100V output and set the **OUTPUT** switch to on. Confirm an output of 100V @ 100Hz using the wattmeter.

**4.3.6** With the load off, set the DUT voltage to the values listed in table 4-2. In each case record the actual output voltage vs. the displayed set value. These should agree within +/-0.5% of setting +/-0.2 volts.

TABLE 4-2

| DISPLAYED SETTING | MEASURED OUTPUT VOLTAGE | LIMITS |
|---|---|---|
| 25 | | 24.77V - 25.22V |
| 50 | | 49.65V – 50.35V |
| 75 | | 74.52V – 75.47V |
| 100 | | 99.4V – 100.6V |
| 135 | | 134.22V – 135.77V |

**4.3.7** With the load off, set the DUT to the HIGH range. Set the DUT to the values listed in table 4-3. In each case, record the actual output voltage and confirm that it is with-in limits.

TABLE 4-3

| DISPLAYED SETTING | MEASURED OUTPUT VOLTAGE | LIMITS |
|---|---|---|
| 50 | | 49.65V– 50.35V |
| 100 | | 99.4V – 100.6V |
| 150 | | 149.15V – 150.85V |
| 200 | | 198.9V – 201.1V |
| 270 | | 268.5V – 271.5V |

**4.3.8** With the load off, set the wattmeter to read frequency. Set the DUT to the frequencies listed in table 4-4. Confirm that the actual output frequency matches the display setting within the limits of +/-0.1Hz. +/- 1 digit.

TABLE 4-4

| DISPLAY SETTING | MEASURED OUTPUT FREQUENCY | LIMITS |
|---|---|---|
| 50 Hz | | 49.8Hz - 50.2Hz |
| 100Hz | | 99.8 Hz – 100.2Hz |
| 200Hz | | 199.8Hz – 200.2Hz |
| 400Hz | | 399.8 Hz – 400.2Hz |
| 500Hz | | 499.8 Hz – 500.2Hz |

**4.3.9** Set the DUT output voltage to zero and the output frequency to 100Hz. Connect the 12 ohm load (or closest value available) to the output of the DUT. Make sure the range is set to low (0-135V). Set the **MODE** to adjust voltage in 0.1 or 1.0 volt steps. Using the DUT voltage **UP** key, adjust the output to provide the currents listed in table 4-5. In each case, confirm that the displayed current matches the current indicated on the external wattmeter (+/- 1% of reading, +/- 0.5 amps).

TABLE 4-5

| DISPLAYED SETTING | MEASURED OUTPUT AMPS | LIMITS |
|---|---|---|
| 1.0A | | .91A - 1.1A |
| 2.0A | | 1.88A – 2.12A |
| 5.0A | | 3.85A – 5.15A |
| 7.5A | | 7.32A – 7.67A |
| 10.0A | | 9.8A – 10.2A |

**4.3.10** With the 12 ohm load applied, set the output voltage of the DUT to provide the output powers levels listed in table 4-6. At each setting, confirm that the output power reading on the DUT agrees with the external wattmeter. These values should be within 2.5% of reading +/- 1 digit.

TABLE 4-6

| APPLIED LOAD | DISPLAYED WATTS | MEASURED WATTS | LIMITS |
|---|---|---|---|
| 250W | | | 242 - 257 |
| 500W | | | 487.5 - 512.5 |
| 750W | | | 730.3 - 769.7 |
| 1200W | | | 1169 - 1231 |

Note:
When checking the power measurements, adjust the voltage to provide the indications in the column labeled “Applied Load”. The actual value applied should be as close as possible but these levels are approximate.

### 4.3.10 CHECK OF LINE AND LOAD REGULATION

Set the DUT to 100V and 100Hz. The unit should be in the low range (0 -135v) and powering the 12 ohm load. While monitoring the output voltage on the wattmeter, adjust the AC line input with the variac from 105 to 132 VAC. Confirm that the DUT output voltage does not fluctuate more than 0.7volts from the initial set point.

Readjust the AC input to 120V. Set the load to 48 ohms and the DUT range to high, With the load off, set the output for exactly 200V as measured on the wattmeter. Connect the 48 ohm load and record the drop in voltage with load. This should be less than 2.0V. Note that the output voltage shall be measured as close to the output terminals as practical. The wattmeter voltage sense input should be tied to the rear panel of the DUT. Failure to do so may cause errors due to wiring voltage drops.

### 4.3.11 CHECK OF OUTPUT DISTORTION AND NOISE

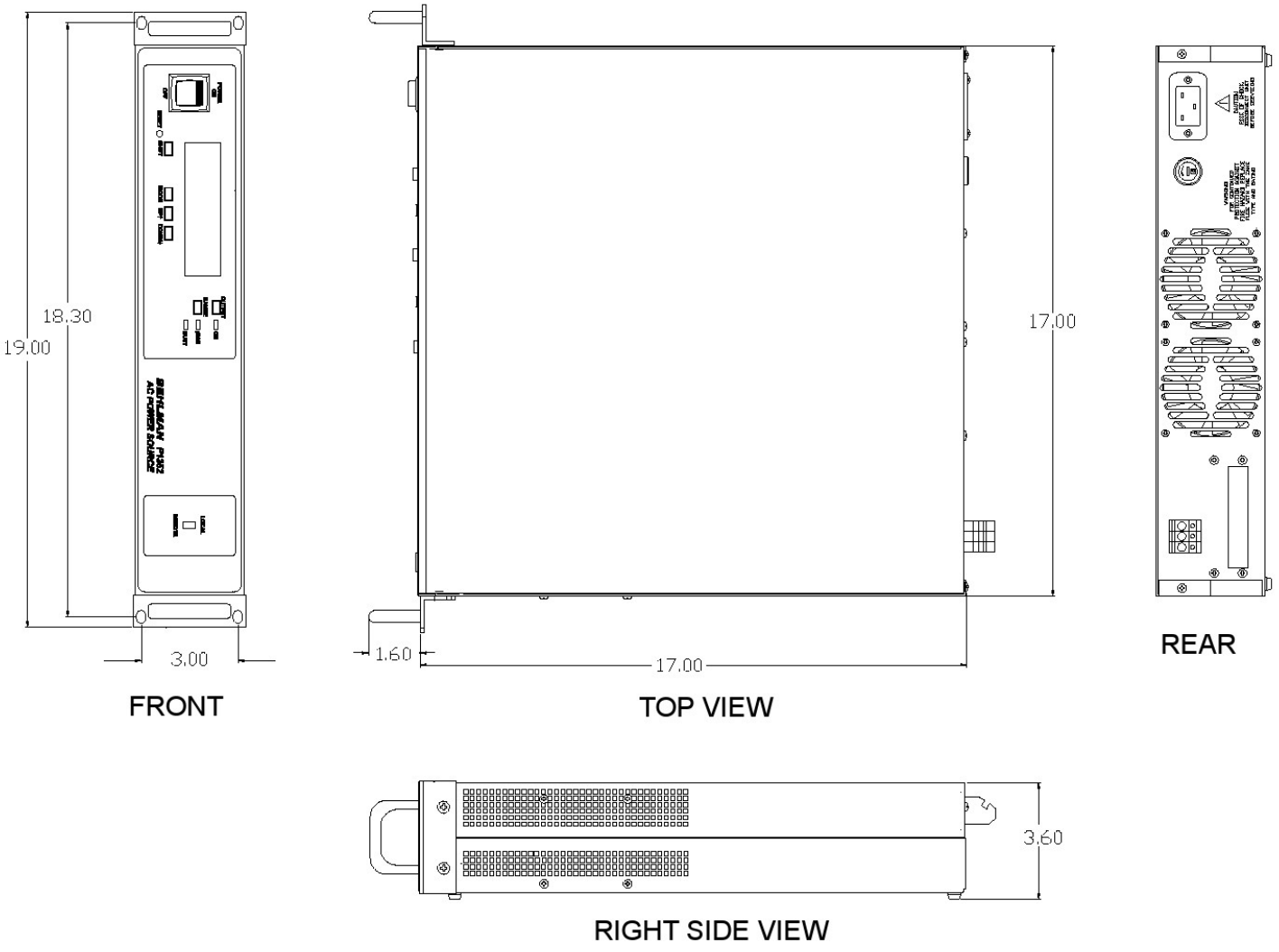
Set the DUT as follows: RANGE = low, Frequency = 50Hz, output voltage 100V. Connect the 12 ohm load, distortion meter, and oscilloscope to the output of the DUT. Measure the distortion (THD) and confirm less than 1.5%.

Set the DUT output to zero and measure the residual noise level on the output using the oscilloscope. It should be less than 2.5V peak to peak.

For units with remote control options, see section 6 of this manual.

## SECTION 5
## MECHANCIAL OUTLINE

P1352 MECHANICAL OUTLINE




FRONT

TOP VIEW

REAR

RIGHT SIDE VIEW

## SECTION 6
## P1352 AC POWER SUPPLY: REMOTE INTERFACE

### 6.0 CONTROL OPTIONS

The model P1352 provides remote control via a standard RS-232 serial interface. All output parameters may be modified or monitored by the control interface. These features allows the model P1352 to be used in an unlimited number of ATE type applications. The following section provides the programming set up information. Commands are listed in the separate programming manual/or appendix.

REMOTE CONTROL FUNCTIONS

The following parameters of the power supply can be controlled via the interface:

1. Frequency from 45Hz to 500Hz with a resolution of 0.1Hz.
2. Voltage with a resolution of 0.1V.
3. Current with a resolution of 0.1A
4. Switch the output ON/OFF
5. Switch the Ranges (Low/High).

The following information may be read from the Power supply:

1. Frequency at a resolution of 0.1 Hz;
2. Voltage at a resolution of 0.1 Volt
3. Current at a resolution of 0.1A.
4. Apparent Power at a resolution of 1Watt.
5. Power Factor at a resolution of 0.01.
6. Current Limit set point
7. Status - Output ON or OFF, High or Low Range, Over Temperature-Over Current - Over Voltage conditions, Constant Current and Power Stage Failure- overload Latch.

### 6.1 WIRING/SET-UP

Wiring from the host computer to the power supply should be accomplished using a good quality, low capacitance, shielded cable. This is particularly important when long connection lengths are desired. Use of poor quality cable may cause data errors. The required connections are illustrated in figure 6-1 on the following page.

LOCAL REMOTE SWITCH

This switch is located on the front panel and controls whether the P1352 take input from the front panel (local) or via the RS-232 interface (remote).When set to remote, the front panel controls are deactivated and REM will appear on the front panel display. To switch back to local mode, set the switch back to the local position.

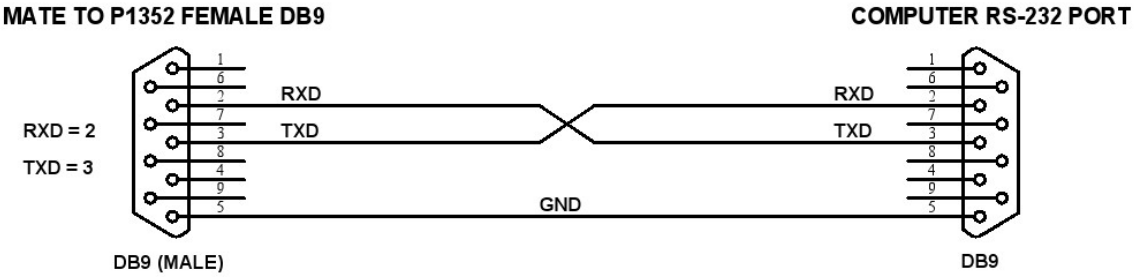



FIGURE 6-1

COMM SETTING:

**Communication Format is: 9600 Baud, 8 Bits, No Parity, 1 Stop Bit, full duplex**.
The host computer will receive data from the Unit without handshaking.

## 6.2 COMMANDS

'SET' Commands:

'SET' commands are used to change the output parameters of the power supply. These include Frequency, Voltage, Current Limit, Output ON or OFF, and Low-High Range switching.

There are 2 types of 'Set' commands; short 'Set' and long 'Set'.
Short 'Set' commands are single characters (ASCII codes of characters):

"O" - Switch the Output ON
"o" - Switch the output OFF

"R" -Switch the Unit to High Range
"r" -switch the unit to Low range

"E"-Reset the Over (Voltage, Current, & Temperature) conditions.

The long 'Set' commands consists of eight (8) characters: The command name, six digits, the seventh characters is always a decimal point (.) and the last digit. (VXXXXX.X)

Command list:
"V" - set Voltage - in Volts
"F" - set Frequency - in Hertz
"I" - set Current Limit - in Amperes

## 6.2 COMMANDS (continued)

Following are examples of long 'Set' commands sent to the unit. Note: each character has to be converted to its corresponding ASCII code and placed into the transmit buffer. For security reasons every long 'SET' command must be sent twice in one string, without blanks. The controller will check both commands, and only if they are the same, act upon the command.

| DESIRED ACTION | COMMAND STRING |
|---|---|
| Set Voltage to 125.6 Volt | "V00125.6V00125.6" |
| Set Frequency to 390 Hz | "F00390.0F00390.0" |
| Set Frequency to 60.5 Hz | "F00060.5F00060.5" |
| Set Current Limit to 9.3 A | "I00009.3I00009.3" |

If the data received by the unit is correct, the Unit sent back the massage to the host.

"M00000.1"- for correct Voltage command
"M00000.2"- for correct Current Limit command
"M00000.3"- for correct Frequency command

If the received data are corrupted the unit will send a message "M00000.8" or M00000.9” - data is corrupted or the message will not be send at all. It is recommended to check the response messages and if the host receives M00000.8 or M00000.9 or, will not receive the response message at all, repeat the command.

After the 'Set' command is sent check the result of this command. Verify the Voltage, Frequency, and Current Limit and if the result is OK, send a new command. Only long 'Set' commands respond by with a message.

To process "Set Frequency" and "Set Current Limit" will take about 100mSec. To process the "Set Voltage" command -changing the voltage and measuring it will take 200-500 mSec depending on the voltage change step. Changing the voltage by 10% and reading the results will take 200-300mSec, changing the voltage from zero to full scale and reading the results could take as long as 500mSec.

'READ' Commands:

A 'Read' command is sent by the host computer to request information from the controller.
**Please note- the characters are case sensitive in all commands.**

| COMMAND | ACTION |
|---|---|
| "A"- | retrieve Voltage measurement |
| "a"- | retrieve Current measurement |
| "f"- | retrieve Frequency setting |
| "i"- | retrieve Current Limit setting |
| "P"- | retrieve Power Factor measurement |
| "W"- | retrieve Power-Watts measurement |

‘READ’ Commands (continued)

| COMMAND | ACTION |
|---|---|
| "s"- | retrieve Status information:<br>Power supply output is ON/OFF<br>High or Low Range<br>Over-Current (exceeded limit setting), Over-Voltage, or Over-Temperature<br>Constant Current (exceeded unit maximum rated current)<br>Output Stage Failure/ Load fault |

After the host computer transmits the 'Read' command, the response will be sent back by the Unit. The response time-20-40mSec. The response format is a string of eight (8) characters. The seventh character is a decimal point (.).

Following are examples of responses sent by the Unit to the Host computer:

| COMMAND SENT | RESPONSE | |
|---|---|---|
| "A00125.6" | Voltage | = 125.6V |
| "f00360.0" | Frequency | = 360.0Hz |
| "i00009.3" | Current Limit | = 9.3A |
| "a00002.3" | Current | =2.3A |

EXPLANATION OF STATUS RESPONSE:

Status "s" command consists of eight (8) characters. The seventh character is a period (.).

Example (sXXXXX.X=sabcde.x)

| | | |
|---|---|---|
| Second character | "a"; | OUTPUT ON/OFF conditions.<br>a= "0"- HEX Code 0x30 - Output OFF<br>a= "1"- HEX Code 0x31 - Output ON. |
| Third character | "b"; | High or Low Range: b ="1"- High Range b="0"- Low Range |
| Fourth character | "c";<br>c= | Over (Temperature, Voltage, Current)<br>"0"- everything OK; c = "1"- OT, OV or OC |
| Fifth character | "d"<br>d= | Constant Current Mode:<br>"0"- Regular Current d = "1" - Constant Current |
| Sixth character | "e"<br>E | Output Stage Fault<br>= "0" - everything OK; e= "1"- Output Stage Fault |

Character "x" is reserved for future development

Notes on fault responses:

The power supply will enter the constant current mode when the output current limit = default current limit for the range in use. The default values are; 10 amps on 0 to 135V range and 5 amps on the 270 volt range. In this mode, the output voltage will be decreased to set the output current close to the default limit. This mode protects the power supply from long term over-current conditions.

Note: During "Over" conditions the output voltage will be set to zero and current limit to the default value. The output voltage cannot be set after "Over" conditions are detected unless the "E" command is sent through the RS232 interface. Alternatively, cycle the input power off for at least 30 seconds and turn back on.

After the eight (8) characters are received the host computer should check the information. Character 7 must be a decimal point (.) and all other characters must be numerical. If not, the received data is corrupted and the host computer must clear the input buffer and repeat its request for data.

| REVISION HISTORY | | | |
|---|---|---|---|
| **Rev.** | **ECO** | **DESCRIPTION** | **DATE** |
| D | N/A | RELEASED UNDER REVISION CONTROL. | 5/31/2016 |
| E | 17-088 | REVISED TO REMOVE SCPI REFERENCES AND CORRECT GRAMMATICAL ERRORS. | 8/8/2017 |
| | | | |
| | | | |