

**USER'S GUIDE AND  
TECHNICAL REFERENCE**

**BEHLMAN MODEL P1351  
1.35 KVA AC POWER SUPPLY**

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**FOR SERVICE ASSISTANCE**

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DATE: 3/10 REV. C

## **SAFETY SUMMARY**

**The following safety precautions must be observed during all phases of operation, service, and operation 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.**

### **GROUND THE EQUIPMENT**

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 or a five wire connection for three phase applications. Both types include an earth terminal intended for safety ground connections. In addition, installation sites may require neutral to earth connections as per NEC section 250 ( National Electrical Code ). Refer installation to licenced 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.

### **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.

## **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 equipment 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 3to 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 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 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.

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**INSERT ADDENDUMS HERE**

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**BEHLMAN AC POWER SOURCE, MODEL P1351**

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**SECTION 1**  
**P1351 AC POWER SUPPLY INTRODUCTION**

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The Behlman model P1351 AC Power Source is a solid state frequency converter. It provides regulated AC power at frequencies that are not available from local utility power. The output of the model P1351 is transformer coupled providing an isolated voltage source similar to utility power. The model P1351 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. The following is a brief description of the conversion process performed by the P1351.

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 the block diagram ). 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 output voltage of the unit is sensed electronically and used as feedback to regulate the output. 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 of the power source is monitored and used to provide overload protection for the output inverter.

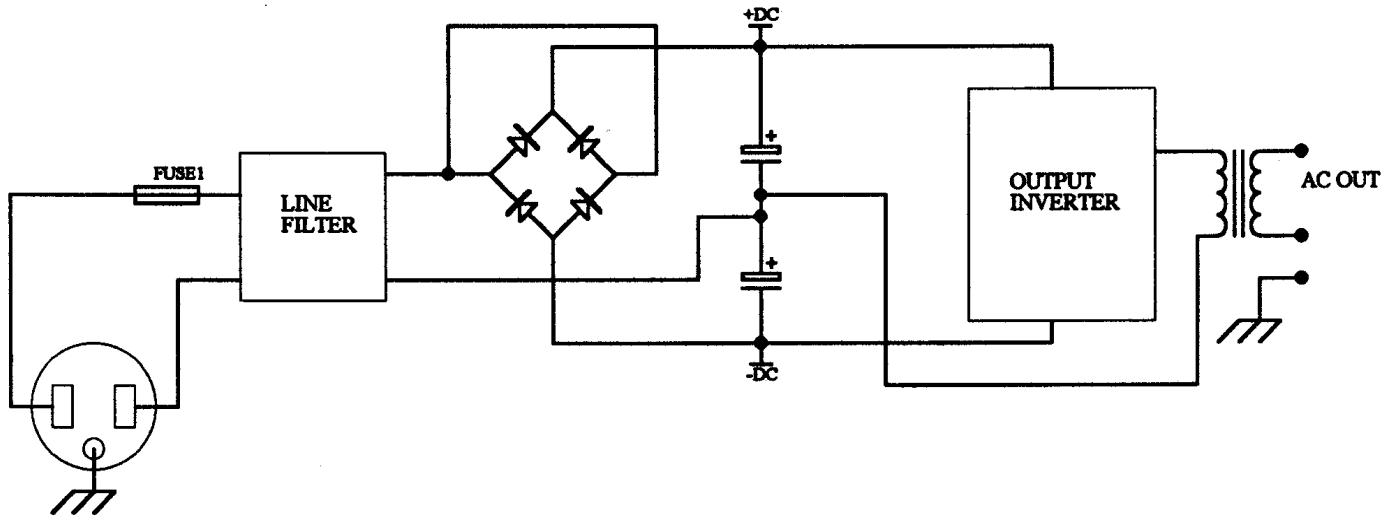


FIGURE 1-1 P SERIES SIMPLIFIED BLOCK DIAGRAM

**SECTION1  
P1351 AC POWER SUPPLY INTRODUCTION**

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**P1351 AC POWER SUPPLY SPECIFICATIONS**

INPUT REQUIREMENTS: 120 VAC +/- 10% 47-440 Hz  
OUTPUT POWER: 1350 VAC MAX. ( with input @ 120 VAC)  
LOAD POWER FACTOR: Zero to Unity with no derating.  
OUTPUT VOLTAGE: 0 -135VAC @ 10 AMPS AND 0-270VAC @ 5 AMPS  
OUTPUT FREQUENCY: Continuously adjustable from 45 to 500 Hz.  
OUTPUT REGULATION: Less than 1% of full scale from no load to full load  
SETTLING TIME: Approximately 200mSec to 1%. 10-90% (linear load)  
LINE REGULATION: +/- 0.1% for +/- 10% line change @ 115V 10A/230 5A  
OUTPUT DISTORTION: 1% Typical @ 115 V 50Hz into pure resistive load.  
OUTPUT NOISE : 2.5 V peak to peak typ.( on low range into 10 ohms.)

**FRONT PANEL METERS:**

VOLTMETER RESOLUTION: 1 Volt  
ACCURACY: 2% of reading + ( +/- 1digit ) RMS responding  
AMMETER RESOLUTION: .01 Amp  
ACCURACY: 2% of reading + ( +/- .5 % of range) RMS responding.  
FREQUENCY RESOLUTION 1 Hertz  
ACCURACY 2% SETTING + ( +/- 1 Hertz )

**PROTECTIVE CIRCUITS:**

SHORT CIRCUIT Inverter latches off in response to output short. Response time less than 20usec.  
CONSTANT CURRENT Responds to long term overloads by reducing output voltage. Set @ approximately 110% of rated current for range in use. 250mSec approximate response time.

**MISCELLANEOUS:**

PHYSICAL Steel chassis, 17" W x 19" D x 3.5" H. 45 lbs.  
TEMPERATURE RANGE 0 - 50 Degrees Celsius (operating) -10C to +65C (storage)



## SECTION 2 P1351 AC POWER SUPPLY UNPACKING AND INSTALLATION

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### 2.1 UNPACKING

After unpacking the equipment, carefully conduct a thorough inspection of all controls, indicators, and 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 zero to 40 degrees C 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 an NEMA 15P molded to the line end. This cord is rated at 15A and will suit most applications. The Model P1351 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 an IEC20 plug wired with the desired 20A plug to match the user’s receptacle. Consult with qualified electrician or Behlman if in doubt.



## WARNING

**This equipment produces AC leakage current that may exceed dangerous 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 electromagnetic 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.

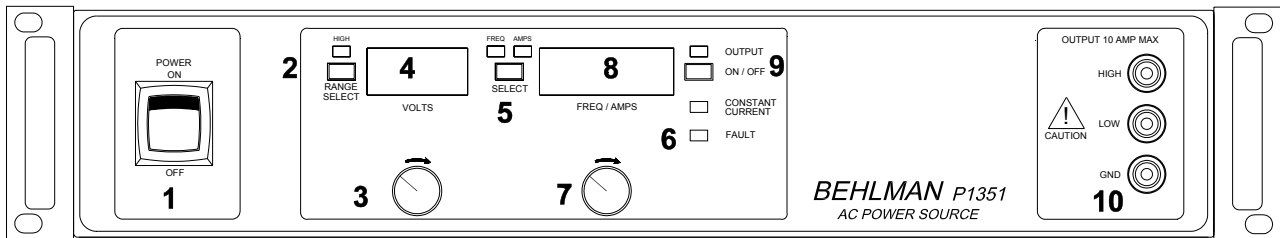
This equipment is designed to be operated in a dry indoor location. Do not operate in the presence of rain or other moisture.

**SECTION 3  
P1351 AC POWER SUPPLY OPERATING INSTRUCTIONS**

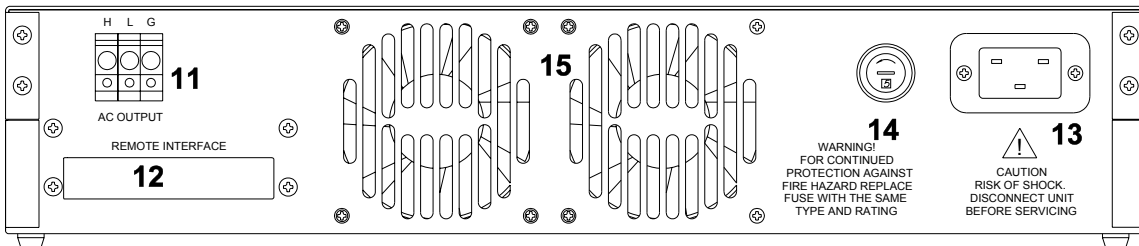
**⚠ CAUTION**

**THIS DEVICE PRODUCES VOLTAGE AND CURRENT LEVELS WHICH CAN BE LETHAL.  
MIS APPLICATION OF THIS DEVICES MAY CAUSE SERIOUS INJURY OR DEATH.  
THIS DEVICE IS INTENDED FOR USE BY QUALIFIED PERSONNEL ONLY !**

The following section provides descriptions of the various features of the MODEL P1351 AC power supply front and rear panels. Figure 3-1 below illustrates the various controls and indicators associated with this model.



**FRONT PANEL VIEW**



**REAR PANEL VIEW**

**FIGURE 3-1 P1351 CONTROLS & INDICATORS**

Table 3-1 on the following page lists and explains each of the numbered features from the figure above. The appearance and controls of certain modified units will vary. Addendums will be added to this manual as required.

**SECTION 3**  
**P1351 AC POWER SUPPLY OPERATING INSTRUCTIONS**

Before operating this equipment the user should become familiar with the controls and indicators provided. These are summarized in the table 3-1. Refer to figure 3-1 (previous page) for locations.

| ITEM# | DESIGNATION                  | FUNCTION / DESCRIPTION   |
|-------|------------------------------|--|
| 1     | <b>POWER</b> switch          | Controls input line power.   |
| 2     | <b>RANGE SELECT</b> switch   | Selects output voltage range: HI = 0 -270 Vac<br>Lo = 0-135 Vac<br><b>HIGH</b> LED illuminates when 270V range is selected.                        |
| 3     | <b>VOLTS</b> adjust control  | Multi-turn control provides continuous adjustment of the unit's output voltage. See item 4.  |
| 4     | <b>VOLTS</b> display         | LED readout of the units output voltage .  |
| 5     | display <b>SELECT</b> switch | Push button toggles the <b>FREQ/AMPS</b> display function. The <b>FREQ &amp; AMPS</b> LEDs lamps indicate which quantity is displayed. See item 8. |
| 6     | <b>FAULT</b> LED             | Indicates unit disabled due to overload ( short circuit ).   |
|       | <b>CONSTANT CURRENT</b> LED  | Indicates the unit is in current limit due to overload.  |
| 7     | <b>FREQ</b> adjust control   | Multi-turn control provides continuous adjustment of the power supply's output frequency. See item 8.  |
| 8     | <b>FREQ / AMPS</b> display   | LED readout of units output current or frequency.  |
| 9     | output <b>ON/OFF</b> switch  | Push button switch toggles the power supply output on and off via an internal relay.   |
| 10    | front panel <b>OUTPUT</b>    | Recessed "Banana" safety type receptacles provide front panel load connections.  |
| 11    | rear panel <b>AC OUTPUT</b>  | Screw type output terminals connected in parallel to the front panel output.   |
| 12    | <b>REMOTE</b> option         | Optional remote control board. See manual section 5.   |
| 13    | AC input connector           | IEC-20 type input power receptacle.  |
| 14    | AC line fuse                 | Screw type fuse receptacle. <b>WARNING replace fuse with same type and rating only!</b> 25A 132V "Slo-Blo". See manual text for more information.  |
| 15    | Fan exhaust                  | Heated air is exhausted at the rear of the unit. A minimum clearance of 4 inches is required for proper cooling.                                   |

### SECTION 3 P1351 AC POWER SUPPLY OPERATING INSTRUCTIONS

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#### TYPICAL OPERATION.

- 1.) Connect the AC power supply to a suitable source of 120 VAC 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 front or rear panel output terminals. The load must be connected between the HIGH and LOW terminals.
- 3.) Set the **VOLTS** adjust control to minimum ( fully CCW ) and ensure that the output switch is in the off ( button out ) position.
- 4.) Turn on the power switch. At this point the sound of the cooling fans should be evident and the front panel **VOLTS** display should indicate zero volts. ( 000 to 002 is normal )
- 5.) Push the display **SELECT** switch so that the green **FREQ** LED is on. Use the frequency adjust control to set the desired output frequency.
- 6.) Set the output range as desired using the output **RANGE SELECT** switch ( in for 0 to 270). There red **HIGH** LED will light to indicate the 0-270V range is selected.
- 7.) Set the **VOLTS** control to provide the desired output voltage and energize the load by pressing the **OUTPUT** switch. It is also permissible to set the **OUTPUT** switch on and then slowly increase the output voltage with the **VOLTS** control. The best procedure to use is load dependent. See section 4 of this manual for additional information.
- 8.) To monitor the load current, toggle the **FREQ/AMPS** display to read amps by pressing the display **SELECT** switch. The **AMPS** LED should be on.

The frequency and voltage may now be varied as required by individual testing needs. The load may also be turned on and off using the **OUTPUT** switch, however, certain limitations exist. Certain load types may cause surge currents that may eventually wear out the power supply's output relay or trip output protective circuits. See section 4 for more information.

#### **IMPORTANT !**

**To prevent damage to the load or power supply the RANGE switch should only be used when the output is off and the VOLTS control is set to zero. This will prevent potentially damaging output transients.**

#### SHUTDOWN PROCEDURE

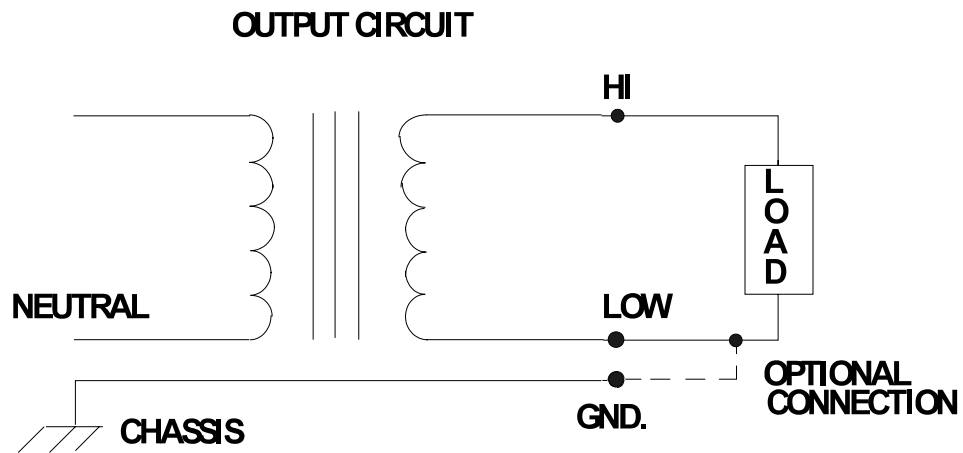
- 1.) Press the **OUTPUT** switch to turn off the load .
- 2.) Set the **VOLTS** adjust to maximum counter-clockwise.
- 3.) Set the **POWER** switch to OFF.

**SECTION 3**  
**P1351 AC POWER SUPPLY OPERATING INSTRUCTIONS**

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**3.2 CONNECTING LOADS**

The output circuit of the P1351 AC power supply is transformer coupled and isolated from the input line power. This allows the unit to float or operate with either side of the output transformer tied to ground or other potential. The maximum floating potential should never exceed 300VDC or 270Vac. It must be noted that the load is connected between the **HIGH** and **LOW** output terminals. The **GND** terminal is tied to the equipment chassis. This terminal provides a connection to earth via the power supply's input line connection. Figure 3-2 below illustrates a typical load connection. The optional **LOW** to **GND** connection provides the safest arrangement. This connection may be made on the front or rear panel. The load **will not operate** if connected between the **HIGH** and **GND** terminals only.



**3.3 OPERATION UNDER FAULT CONDITIONS.**

The P1351 AC source incorporates three levels of over current protection. Long term overload protection is provided by a fold back circuit that reacts to the output RMS current. In the event that the load is outside the range of the power source, the output voltage will decrease or “fold-back” its output voltage to limit the maximum current. During fold back, the output waveform remains sinusoidal. This can be a useful feature for starting AC induction motors and other types of motion related loads.

In the event the load becomes short circuited, the amount of fault current could rise to levels high enough to damage the output semiconductors of the power source. The current of the output stage is monitored on a cycle by cycle basis at the 20KHz switching frequency. If the peak current exceeds an unsafe value, a logic signal is sent to the drive circuits and initiates a controlled shutdown of the output stage. This circuit can respond in 20usec. The action of this overload circuit is “latching.” The input power must be cycled to reset the power source. Allow a least 20 -30 seconds for the internal soft start circuit to reset. Further information is provided in this manual under operating considerations.

The final protection is provided by a 25 amp, slow blow input fuse. This fuse is employed primarily to provide line protection in the event of an internal failure of the power source. Failure of this fuse typically indicates that an internal problem may exist.

**SECTION 3  
P1351 AC POWER SUPPLY OPERATING INSTRUCTIONS**

**3.3 OPERATION UNDER FAULT CONDITIONS (continued)**



**In the event the fuse is to be replaced disconnect power before removing the fuse cover.**

This fuse is rated at 25A and 132V minimum. For continued protection against fire it **must** be replaced with the same type and voltage rating only! If a replacement fuse blows again the unit should be returned to Behlman for service.

**3.4 TROUBLE SHOOTING**

In the event a problem is encountered with the operation of the AC power supply, refer to the chart below :

| PROBLEM  | POSSIBLE CAUSE  |
|--|---|
| No output, meter indicates 000                                   | Adjust output control, check if overload latch LED is on. See section 4.  |
| Load does not operate, unit indicates desired output.            | Check that the load is switched on. Check that the load is connected between HI and Lo output terminals vs. HI and GND. terminals. See section 3.2. Check setting of OUTPUT switch .See section 3.1, figure 3-1 |
| Output voltage drops when load is connected.                     | Check load current to insure that the rating of the power supply is not exceeded. This may be indicated by a "blinking" or steady constant current LED.   |
| Output drops to zero when load is connected, Overload LED is on. | Load in-rush or surge current has exceeded the short circuit limit for the power supply. See section 4 for techniques to limit in-rush current.   |
| Output current not indicated.                                    | Check setting of display select switch . Refer to section 3 , figure 3-1.   |
| Output frequency not indicated.                                  | Check setting of display select switch . Refer to section 3 , figure 3-1.   |
| Output current changes with frequency setting.                   | Reactive load impedance, check load characteristics.  |
| Unit is Dead, no display or fan sound.                           | Blown input fuse. Check and replace per para.3.4. If fuse blows repeatedly , remove unit from use and refer to qualified service personnel or Behlman service dept.   |

## SECTION 4 P1351 AC POWER SUPPLY OPERATING CONSIDERATIONS

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### OPERATIONAL CONSIDERATIONS

#### 4.1 OPERATION INTO LINEAR LOADS

The model P1351 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 insight into applying the AC source to these types of loads.

#### 4.2 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 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 and solenoids (inductance) present the same 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.

#### 4.3 DRIVING LAMPS

Tungsten filament lamps, when cold, present a very low resistance. 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.

#### 4.4 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” current. 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.

The model P1351's fold back current limiting can be an advantage when starting motors. During the starting period, the motor will attempt to draw excessive power from the power source. The fold-back circuit will reduce the output voltage in order to maintain the maximum current for the range in use.

**SECTION 4**  
**P1351 AC POWER SUPPLY OPERATING CONSIDERATIONS**

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**4.4 DRIVING MOTORS (continued)**

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. Ramping up the voltage to the motor can reduce the locked rotor current demand. This will allow the AC power supply to start many types of motors with run currents up to 10 Amps.

**4.5 DRIVING NON-LINEAR LOADS**

Loads utilizing rectifiers and SCRs interact with the AC power source and have a profound 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.

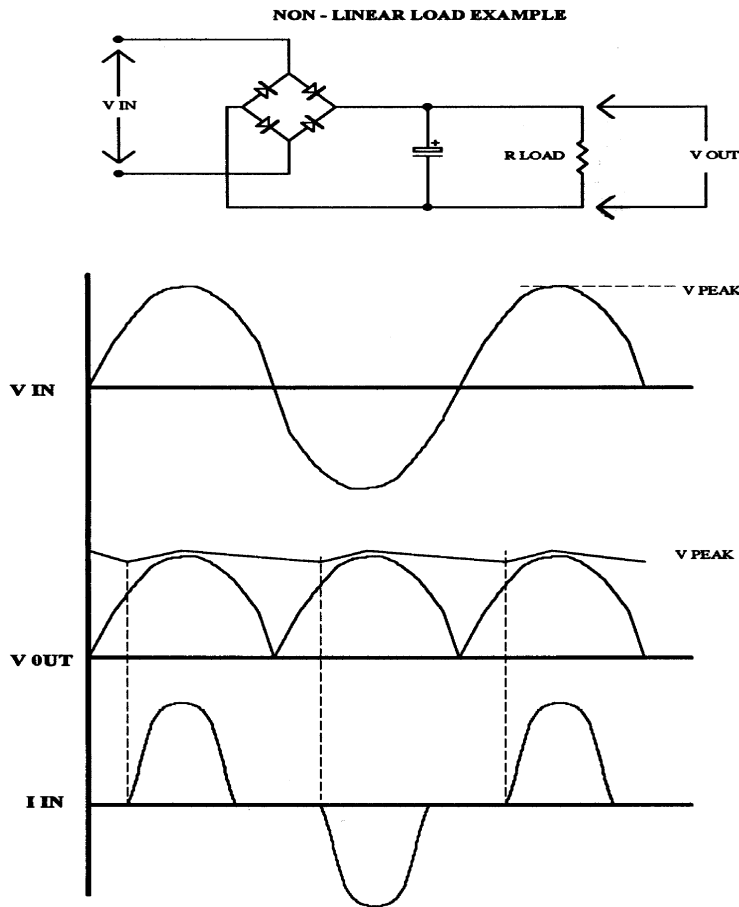


FIGURE 4-1



## SECTION 4

### P1351 AC POWER SUPPLY OPERATING CONSIDERATIONS

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#### 4.5 DRIVING NON-LINEAR LOADS (continued)

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 dependant 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 this distortion for this reason.

#### 4.6 INPUT POWER REQUIREMENTS

The model P1351 utilizes a rectifier followed by a bank of filter capacitors. Because of this fact, it presents a nonlinear load to the utility power. Because its input current waveform has a high crest factor, it 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 poor 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 P1351 may exceed 20Amps RMS. This is only true for purely resistive loads (real Watts v.s. 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 cause a fire hazard.

Full power operation into a full resistive load may cause loading ( sagging )of the supplied line voltage if a large series impedance is present. This is due to the high current required by the model P1351. 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.

#### 4.7 OUTPUT NOISE

Because the model P1351 uses a high frequency PWM conversion technique, a certain amount of output noise or ripple is to be expected. The amount of noise 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 being tested as they may not pass the European EMI tests.

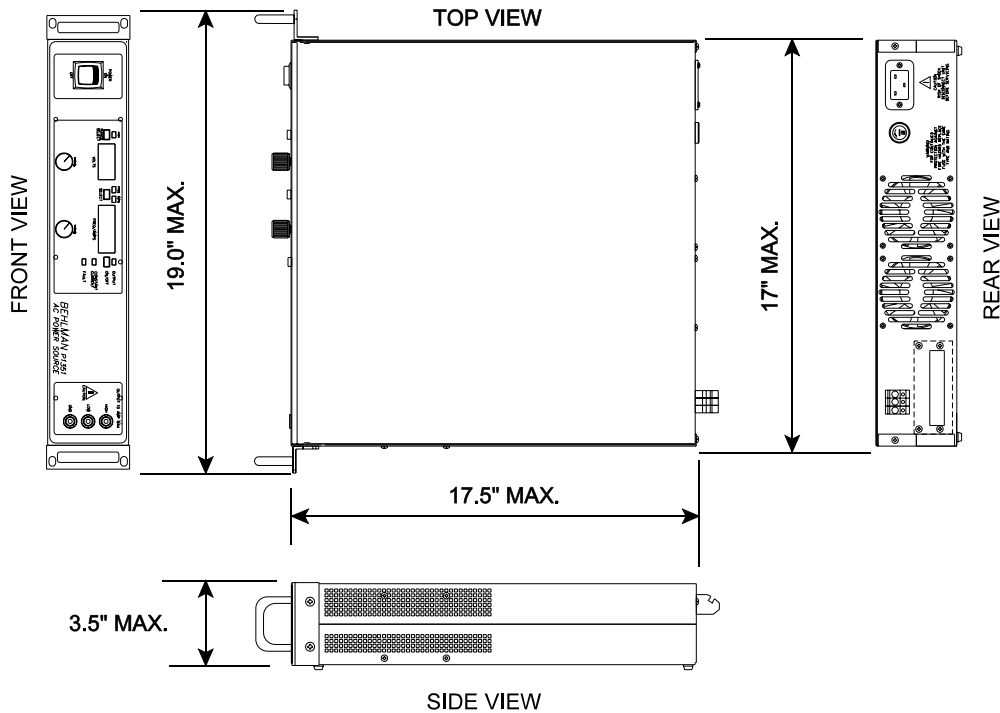
In special cases where the output noise is objectionable, an external line filter can be added to the output of the unit. Please note that most line filters are not intended to be used at 400Hz. If the noise level is interfering with low level measurements, a linear type AC source should be considered. For more information on linear sources, contact Behlman Sales.

**SECTION 4**  
**P1351 AC POWER SUPPLY OPERATING CONSIDERATIONS ( RM option )**

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**4.8 MECHANICAL OUTLINE**

The figure below illustrates the mechanical layout of the P1351. The power supply is shown here with the rack mount option installed. This option includes two brackets with handles and appropriate hardware. When installed this option allows the unit to be secured to a EIA standard equipment cabinet (rack).



**4.9 RACK MOUNTING ( OPTION RM )**

The RM option kit is supplied for units that are to be mounted in a standard EIA equipment rack. This kit includes two mounting brackets and associated hardware. The brackets are attached to the left and right side panels using existing threaded inserts and the supplied screws.



**WARNING**

**DO NOT substitute longer screws as these may damage internal parts and create a shock hazard.** Note that these brackets are intended to secure the front panel to the rack only. Due to the weight of this device rear support must be provided by the equipment rack. Do not rely on RM brackets only.

**SECTION 5  
P1351 AC POWER SUPPLY OPTIONS**

The P1350 series of AC power supplies is available with several options. These can be specified at the time of purchase or added as required by end user. Table 5-1 below listed the available options for this model series. Behlman also produces modified versions of this unit that may be application specific. These units will be assigned a 4 digit "engineering" number. Any information required for operation will be added to this manuals as an addendum.

| OPTION     | DESCRIPTION   | PART #      |
|------------|---|-------------|
| RM         | EIA rack mounting bracket kit.                              | 107-822-000 |
| RO *       | Rear panel NEMA 5-15R added to rear panel.                  | 107-821-000 |
| LC001      | Line Cord : IEC-320-C20 to NEMA 15P                         | 107-802-000 |
| LC002      | Line Cord: IEC-320-C20 to NEMA 5-20P                        | 107-802-002 |
| L          | Locking device fitted to front panel VOLTS & FREQ controls. | N/A         |
| A, I, or R | Remote control ( see below )                                | N/A         |

\* Note: options A, I, or R options are not considered field installable and must be factory installed . Call a Behlman Sales representative for pricing and further information.

**5.0 REMOTE CONTROL OPTIONS**

The model P1351 is available with one of three choices of remote control options. The table below summaries these options.

| OPTION TYPE   | INTERFACE            | FEATURES   |
|---------------|----------------------|--|
| GPIB          | REAR PANEL IEEE 488  | Computer control of output voltage, frequency, and range read back of voltage, frequency, and current. Status reporting.                       |
| RS 232        | REAR PANEL 9 PIN "D" | Same as GPIB option  |
| ANALOG REMOTE | REAR PANEL 9 PIN "D" | Isolated 0 to 10 VDC control of frequency and voltage. Digital control of output relay and range switching via opto- coupled 5 to 18 VDC input |

Additional information will follow this page if the unit supplied incorporates one of these remote options. For more information, contact the Behlman Sales office or local representative or Email questions to sales@behlman.com.

## SECTION 5.1

### P1351 AC POWER SUPPLY IEEE-488 INTERFACE OPTION SPECIFICATIONS

#### 1.0 INTRODUCTION

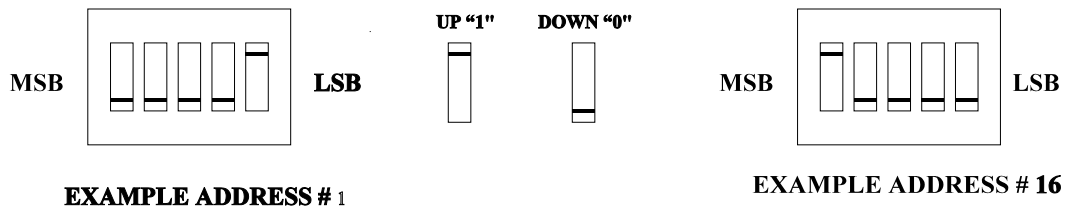
The IEEE488 remote control option enables computer control of the Model P1351. The output voltage and frequency may be set and read back over the 488 bus. Status reporting of overloads or load faults is also provided. All of the command syntax and programming information is provided In this section. In addition drivers for use with the popular "LAB VIEW" and "LAB WINDOWS" ( registered trademarks of National Instruments Corp. ) are available from Behlman.

#### SPECIFICATIONS

|                                |   |
|--------------------------------|---|
| Programming Range ( voltage)   | 0 to 135 V or 0 to 270 V with 0.1 volt resolution.            |
| Accuracy                       | 2% of programmed value +/- 1 digit from 10% to 100% of range. |
| Programming Range ( frequency) | 45 to 500 Hertz with 0.1 Hertz resolution.                    |
| Accuracy                       | 2% of programmed value +/- 1 digit                            |
| Voltage Read Back              | 0.1 volt resolution, 2% +/- 1 digit accuracy.                 |
| Frequency Read Back            | 0.1 amp resolution, 2% +/- 1 digit accuracy.                  |
| Frequency Read back            | 1 Hertz resolution, +/- 1 Hertz accuracy.                     |

#### ADDRESS SETTING

The IEEE 488 bus allows connected devices to be "addressed" individually by the host controller. This unit may be set to address numbers 0 to 31 ( excluding the host controllers address). The address is set via a dip switch on the rear of the unit located beside the IEEE 488 connector. The address must be set prior to applying power to the unit. Setting of the address is illustrated below.



## 1.1 IEEE-488 BUS UTILIZATION

The P1351 Series Power Supplies incorporates an embedded TMA that is compatible with the electrical and mechanical standards outlined in IEEE-STD-488. The IEEE-488 interface uses a TI LSI device to implement all necessary talker/listener functions. This device is configured under software control to support the following subsets:

- SH1 - Source Handshake
- AH1 - Acceptor Handshake
- T8 - Basic Talker
- L4 - Basic Listener
- RL1 - Remote/Local
- DC1 - Device Clear
- SRO - No Service Request
- PPO - No Parallel poll response
- DTO - No Device Trigger
- CO - Not a controller

## 1.2 IEEE-488 BUS COMMANDS

### 1. Single-Line Commands

IFC - Clears GBIB interface

### 2. Multi-Line Command

DCL - Resets AC Power Supply to the quiescent state if a catastrophic failure is not present. The only way to clear a catastrophic failure is to read the Power Supply's response by using the Status command.

## 1.3 GPIB COMMUNICATION

The embedded TMA receives ASCII encoded command strings via a GPIB IEEE-488 according to MATE System Control Interface Standard No. 2806763 (IEEE-716 CIIIL). Programmed I/O is utilized to transmit and receive command strings after a talker/listener relationship is established. The AC Power Supply supports all OPCODES, NOUNS, and MODIFIERS required by the stimulus module. They are as follows:

### OPCODES

FNC, FTH, INX, :CHO, SET, SRX, SRN, CLS, OPN, RST, CNF, IST, STA

### MODIFIERS

FREQ, VOLT, CURR

### NOUN

ACS

1.4 AC POWER SUPPLY SYNTAX

Setup Command:

```
FNC ACS :CHO SET VOLT <value>
[ SET FREQ <value>]
[ SRX VOLT <value>]
[ SRN VOLT <value>]
[ SRX FREQ <value>]
[ SRN FREQ <value>]
[SET VLT(0,1)] <cr><lf>
```

Table 1-1

CIIL SOFTWARE COMMANDS

CIIL COMMANDS

EXPLANATION

SET VOLT <value>

Sets output voltage to given value, in volts rms. The following values are permitted:  
 $0 \leq \text{value} \leq 135$ , or 270, dependent on range selected and type of unit.  
 If set volt (value) not received, then use SRN VOLT (value), or SRX VOLT (value). If none of these 3 are sent then generate error message.

SET FREQ <value>

Optional. Sets frequency of output voltage to given value, in Hz. The following values are permitted:  
 $45 \leq \text{value} \leq 500$ .  
 Default is 45 Hz only if SET FREQ, SRN FREQ, or SRX FREQ are not received. Otherwise the values shall be used in the order stated.

SRX VOLT <value>

Optional. Sets maximum limit for SET VOLT command. If SET VOLT value is greater than SRX VOLT value in a command string, an error message is generated and the setup command ignored. The following values are permitted:  
 $0 < \text{value} \leq 135$ , or 270, dependent on range selected and type of unit.  
 If a value for SRX VOLT is not specified, the required maximum value for SET VOLT default to 135, or 270, dependant on range selected and type of unit.

**Table 1-1  
CIIL SOFTWARE COMMANDS (continued)**

| <b><u>CIIL COMMANDS</u></b>   | <b><u>EXPLANATION</u></b>   |
|---|---|
| SRN VOLT <value>  | <p>Optional. Sets minimum value limit for SET VOLT command. If SET VOLT value is less than SRN VOLT value in a command string, an error message is generated and a setup command ignored. The following values are permitted:</p> <p><math>0 \leq \text{value} &lt; 135, \text{ or } 270</math>, dependent on range selected and type of unit.</p> <p>The SET VOLT default is 0 for the minimum value if a value is not specified for SRN VOLT.</p> |
| SRX FREQ <value>  | <p>Optional. Sets maximum limit for SET FREQ command. If the SET FREQ value in a command string is greater than the maximum limit, an error message is generated and the setup command ignored. Legal values are:</p> <p><math>45 &lt; \text{value} \leq 500</math>.</p> <p>If a value for SRX FREQ is not specified, SRX FREQ defaults to 500.</p>   |
| SRN FREQ <value>  | <p>Optional. Assigns minimum value to SET FREQ command. If the SET FREQ value in a command string is less than the minimum limit, an error message is generated and the setup command ignored. Legal values are:</p> <p><math>45 \leq \text{value} &lt; 500</math>.</p> <p>If a value for SRN FREQ is not specified, SRN FREQ defaults to 45.</p>   |
| SET VLT0  | Set LO voltage range.   |
| SET VLT1  | Set HI voltage range.   |
| <p>On dual range Power Supplies, this command selects the LO or HI voltage range. Dual Ranges are 0-135 volts and 0-135/0-270 volt. If this command is omitted from the setup string the unit will default to the lowest range.</p> |   |

**NOTES:**

1. The setup command specifies the voltage and frequency of the AC power Supply output. The AC Power Supply responds only to the last setup command entry. Its memory does not retain previously entered setup commands.
2. During IEEE operation, the unit's front panel VOLTS and FREQ must be fully CCW. If the controls are not set fully CCW, then the output voltage and frequency will be a sum of the programmed value and the value set with the front controls.

**Table 1-1**  
**CILL SOFTWARE COMMANDS (continued)**

| <u>CILL COMMANDS</u>       | <u>EXPLANATION</u>   |
|----------------------------|--|
| <u>FETCH DATA COMMAND:</u> |  |
| FTH VOLT <cr><lf>          | The AC supply responds to this command by transmitting the RMS voltage (in volts) measured at its output, in decimal format as follows:<br><sp><digit><digit><dp><digit><digit><cr><lf>  |
| FTH CURR <cr><lf>          | The AC Supply responds by transmitting the current (in amps) measured at its output, in decimal format, as follows:<br><br><sp><digit><digit><dp><digit><cr><lf>   |
| FTH FREQ <cr><lf>          | The AC Supply response by transmitting the frequency (in hertz) measured at its output, in decimal format, as follows:<br><br><sp><digit><digit><digit><cr><lf>  |
| CLS :CH0 <cr><lf>          | Closes output relay contacts. Connects AC Power Supply outputs to output terminal P1351ock. The setup command specifies the voltage and frequency. The setup command must be entered before the CLS :CH0 command.  |
| OPN :CH0 <cr><lf>          | Opens output relay contacts. Disconnects output of AC Power Supply from output connector. Ac Power Supply retains voltage and frequency assigned by setup command.   |
| RST ACS:CH0                | Resets AC Power Supply to quiescent. The output relay opens and error messages are erased.<br><br>Catastrophic error messages are cleared by reading the Power Supply's response, by use of the Status command.  |
| CNF <cr><lf>               | Instructs AC Power Supply to perform internal confidence test. STA command transmits the message. The AC Power Supply responds with one of the following:<br><br><u>Pass</u><br><sp><cr><lf><br><br><u>Fail</u><br>F07ACS0(DEV): CONFIDENCE TEST FAILURE<br><cr><lf> |



**Table 1-1  
CIIIL SOFTWARE COMMANDS (continued)**

| <u>CIIIL COMMANDS</u> | <u>EXPLANATION</u>   |
|-----------------------|--|
| IST <cr><lf>          | <p>Instructs AC Power Supply to perform internal self test. The STA command transmits the message. The AC Power Supply responds with one of the following:</p> <p><u>Pass</u><br/>&lt;sp&gt;&lt;cr&gt;&lt;lf&gt;</p> <p><u>Fail</u><br/>F07ACSO(DEV): BIT TEST FAILURE<br/>(-PROM CHECKSUM FAULT <br/>-RAM FAULT<br/>-AC SUPPLY HARD FAULT <br/>&lt;cr&gt;&lt;lf&gt;</p>   |
| STA <cr><lf>          | <p>Status. Prepares AC Power Supply for a response transmission. Clears error condition if one exists. The following response messages and conditions exclude confidence and internal self test.</p>   |
| RESPONSE:             | <p><u>Status OK</u><br/>&lt;sp&gt;&lt;cr&gt;&lt;lf&gt;</p> <p><u>Device error messages</u></p> <p>F07ACSO(DEV):BIT TEST FAILURE<br/>&lt;description consisting of up to 60 characters&gt;&lt;cr&gt;&lt;lf&gt;</p> <p><u>TMA error messages</u> All begin with:</p> <p>F07ACSO (MOD): This message is followed by one explanatory message from the following text:</p> <p>ILLEGAL NOUN : AC Power Supply does not recognize illegal noun.</p> <p>ILLEGAL NOUN MODIFIER : AC Power Supply does not recognize illegal noun modifier.</p> <p>ILLEGAL OPCODE : AC Power Supply does not recognize illegal opcode.</p> <p>ILLEGAL VALUE: Entered value lies outside upper and lower limits.</p> <p>NO SETUP: Close command received but setup not programmed.</p> <p>Example: F07ACS00(MOD): NO SETUP &lt;cr&gt;&lt;lf&gt;</p> |

## 1.5 CATASTROPHIC ERRORS

A catastrophic failure is generated each time the AC Power Supply experiences a hardware failure. Errors are cleared whenever the AC Power Supply transmits a response, except in the case of a short circuit fault which may only be cleared by cycling power to the AC Supply.

### Catastrophic Error Messages

All begin with:

F00ACS0(DEV):

This message is followed by one explanatory message from the following text:

OVERTEMP FAULT <cr><lf>

The heatsink temperature has exceeded its upper limit. The OVERTEMP LED on the front panel will light.

CURRENT LIMIT FAULT <cr><lf>

SHORT CIRCUIT FAULT: AC SUPPLY<cr><lf>

An output loading fault has occurred causing the supply to exceed 500% rated current output. The supply automatically shuts down and opens its output relay. The OVERLOAD LATCH LED on the front panel will light.

## GPIB PROGRAMMING EXAMPLES

Examples of actual command strings transmissions and typical responses are outlined below.

All commands must be in upper case ASCII, lower case characters are ignored. All commands transmitted to the P1351 must terminate with a carriage return <cr> and a line feed <lf>, as will all responses received from the P1351.

**IMPORTANT NOTE:** The EOI line of the GPIB controls MUST be asserted when transmitting the line feed character, otherwise the P1351 Source will not recognize command reception and command processing will not occur.

**EXAMPLE 1:** Setup a single range P1351 Source to output 120 V @60 Hz, and close the output relay.

Transmit setup command:

FNC ACS :CHO SET VOLT 120 SET FREQ 60<cr><lf>

Transmit status command to request status response:

STA <cr><lf>

Talk address the P1351 Source to enable response:

<space><cr><lf>

: Positive response indicating status is OK.

F07ACS00 (MOD) ILLEGAL VALUE <cr><lf>

: Negative response indicating error condition.

(Typically a negative response would only occur if an error existed in the entry or reception of the command string, or the values entered were out of range of the P1351 Source).

Transmit output relay close command:

CLS :CHO <cr><lf>

Transmit status command to request status response:

STA <cr><lf>

Talk address the P1351 Source to enable response:

<space><cr><lf>

: Positive response indicating status is OK.

F07ACS00 (MOD) NO SETUP <cr><lf>

: Negative response indicating error condition.

(Negative response would only occur if invalid or no setup string had been transmitted prior to close command).

**EXAMPLE 2 :** Setup a dual range P1351 Source to output 30 V on low range @400 Hz.

Transmit setup command:

FNC ACS :CHO SET VOLT 30 SET FREQ 400 SET VLTO <cr><lf>

Transmit status command to request status response:

STA <cr><lf>

Talk address the P1351 Source to enable response:

<space><cr><lf>

: Positive response indicating status is OK.

### GPIB PROGRAMMING EXAMPLES (continued)

**3. EXAMPLE:** Setup a dual range P1351 Source to output 115 V on high range @50 Hz, and read back what the actual voltage, current, and frequency being output is set at.

Transmit setup command:

FNC ACS :CHO SET VOLT 115 SET FREQ 50 SET VLT1 <cr><lf>

Transmit status command to request status response:

STA <cr><lf>

Talk address the P1351 Source to enable response:

<space><cr><lf> : Positive response indicating status is OK.

Transmit output relay close command:

CLS :CHO <cr><lf>

Transmit status command to request status response:

STA <cr><lf>

Talk address the P1351 Source to enable response:

<space><cr><lf> : Positive response indicating status is OK.

Transmit fetch volt command:

FTH VOLT <cr><lf>

Talk address the P1351 Source to enable response:

115.0 <cr><lf>

Transmit fetch current command:

FTH CURR <cr><lf>

Talk address the P1351 Source to enable response:

5.2 <cr><lf>

Transmit fetch frequency command:

FTH FREQ <cr><lf>

Talk address the P1351 Source to enable response:

50 <cr><lf>

## SECTION 5-2

### P1351 AC POWER SUPPLY EIA-232 SERIAL INTERFACE SPECIFICATIONS

#### 1.0 INTRODUCTION

The RS232 interface option for the P1351 series AC Power Supplies allows two way communication with most computer systems. All programmable setup parameters may be queried or modified via the RS232 interface using command syntax described below.

#### 1.1 EIA-232 INTERFACE UTILIZATION

The RS232 interface may be connected to modems, controllers, computers, or any other equipment capable of communicating with the RS232 protocol. It is assumed in the remainder of this document that the RS232 interface is connected to a "host" computer.

The interface is configured to communicate with the following format:

|             |      |
|-------------|------|
| Duplex:     | Full |
| Baud Rate:  | 9600 |
| Bits:       | 8    |
| Parity:     | None |
| # Stop Bits | 1    |

Other BAUD rates, however, are available by special order

#### 1.2 EIA-232 CONNECTIONS

##### SIGNAL

|            | <u>P1351</u><br><u>(DB-9)</u> |       | <u>HOST</u><br><u>(DB-25)</u> |
|------------|-------------------------------|-------|-------------------------------|
| <b>GND</b> | <b>5</b>                      | ----- | <b>7</b>                      |
| <b>RXD</b> | <b>2</b>                      | ----- | <b>2</b>                      |
| <b>TXD</b> | <b>3</b>                      | ----- | <b>3</b>                      |

The RS232 interface does not currently support hardware handshaking.

### 1.3 EIA-232 SERIAL COMMUNICATION

The Power Supply receives ASCII encoded command strings via a EIA-232 interface according to MATE System Control Interface Standard No. 2806763 (IEEE-716 CIIL). The AC Power Supply supports all OPCODES, NOUNS, and MODIFIERS required by the stimulus module. They are as follows:

#### OPCODES

FNC, FTH, :CHO, SET, SRX, SRN, CLS, OPN, RST, CNF, IST, STA INX,

#### MODIFIERS

FREQ, VOLT, CURR, VLT0, VLT1

#### NOUN

ACS

The P1351 Series Power Supply can be used in point-to-point mode where a host Computer is connected directly to One Power Supply.

#### **NOTES:**

1. Leading zeroes must be entered for commands.
2. Leading zeroes are blanked in response transmit.

**Table 5-2-1  
CIIL SOFTWARE COMMANDS**

| <u>CIIL COMMANDS</u> | <u>EXPLANATION</u>   |
|----------------------|--|
| SET VOLT <value>     | Sets output voltage to given value, in volts rms. The following values are permitted:<br><br>$0 \leq \text{value} \leq 135$ , or 270, dependent on range selected and type of unit.  |
| SET FREQ <value>     | Optional. The following values are permitted:<br>$45 \leq \text{value} \leq 500$ .<br><br>Default is 45 Hz only if SET FREQ, SRN FREQ, or SRX FREQ are not received. Otherwise the values shall be used in the order stated.   |
| SRX VOLT <value>     | Optional. Sets maximum limit for SET VOLT command. If SET VOLT value is greater than SRX VOLT value in a command string, an error message is generated and the setup command ignored. The following values are permitted:<br><br>$0 < \text{value} \leq 135$ , or 270, dependent on range selected and type of unit. If a value for SRX VOLT is not specified, the required maximum value for SET VOLT default to 135, or 270, dependant on range selected and type of unit. |

**Table 5-2-1  
CIIL SOFTWARE COMMANDS (continued)**

| <u>CIIL COMMANDS</u> | <u>EXPLANATION</u>  |
|----------------------|---|
| SRN VOLT <value>     | <p>Optional. Sets minimum value limit for SET VOLT command. If the SET VOLT value is less than SRN VOLT value in a command string, an error message is generated and a setup command ignored. The following values are permitted:</p> <p><math>\leq \text{value} &lt; 135</math>, or <math>270</math>, dependent on range selected and type of unit.</p> <p>The SET VOLT default is 0 for the minimum value if a value is not specified for SRN VOLT.</p> |
| SRX FREQ <value>     | <p>Optional. Sets maximum limit for SET FREQ command. If the SET FREQ value in a command string is greater than the maximum limit, an error message is generated and the setup command ignored. Legal values are:</p> <p><math>45 &lt; \text{value} \leq 500</math>.</p> <p>If a value for SRX FREQ is not specified, SRX FREQ defaults to 500.</p>   |
| SRN FREQ <value>     | <p>Optional. Assigns minimum value to SET FREQ command. If the SET FREQ value in a command string is less than the minimum limit, an error message is generated and the setup command ignored. Legal values are:</p> <p><math>45 \leq \text{value} &lt; 500</math>.</p> <p>If a value for SRN FREQ is not specified, SRN FREQ defaults to 45.</p>   |
| SET VLT0             | Set LO voltage range.   |
| SET VLT1             | Set HI voltage range.   |

This command selects the LO or HI voltage range. Ranges are 0-135 volts and 0-135/0-270 volt. If this command is omitted from the setup string the unit will default to the low range.

Delay is necessary after issuing a setup command, due to the output voltage slew rate of about 100v per 500ms.

**IMPORTANT NOTES:**

1. The setup command specifies the voltage and frequency of the AC power Supply output. The AC Power Supply responds only to the last setup command entry. Its memory does not retain previously entered setup commands.
2. During EIA-232 remote operation, the unit's front panel VOLTS and FREQ must be fully CCW. If the controls are not set fully CCW, then the output voltage and frequency will be a sum of the programmed value and the value set with the front controls. Front Panel OUTPUT switch must be set to OFF position. The front panel RANGE switch must be set to LO.

**Table 5-2-1  
CILL SOFTWARE COMMANDS (cont)**

**CILL COMMANDS**

**EXPLANATION**

**FETCH DATA COMMAND:**

|   |  |
|---|--|
| FTH VOLT <cr><lf><eos>  | The AC supply responds to this command by transmitting the RMS voltage (in volts) measured at its output, in decimal format as follows:<br><sp><digit><digit><digit><dp><digit><digit><cr><lf><eos>  |
| FTH CURR <cr><lf><eos>  | The AC Supply responds by transmitting the current (in amps) measured at its output, in decimal format, as follows:<br><br><sp><digit><digit><dp><digit><cr><lf><eos>  |
| FTH FREQ <cr><lf><eos>  | The AC Supply response by transmitting the frequency (in hertz) measured at its output, in decimal format, as follows:<br><br><sp><digit><digit><digit><cr><lf><eos>   |
| CLS :CH0 <cr><lf><eos>  | Closes output relay contacts. Connects AC Power Supply outputs to output terminal P1351ock. The setup command specifies the voltage and frequency. The setup command must be entered before the CLS :CH0 command.  |
| OPN :CH0 <cr><lf><eos>  | Opens output relay contacts. Disconnects output of AC Power Supply from output connector. Ac Power Supply retains voltage and frequency assigned by setup command.   |
| RST ACS:CH0   | Resets AC Power Supply to quiescent. The output relay opens and error messages are erased.   |
| Catastrophic error messages are cleared by reading the Power Supply's response, by use of the Status command. |  |
| CNF <cr><lf><eos>   | Instructs AC Power Supply to perform internal confidence test. STA command transmits the message. The AC Power Supply responds with one of the following:<br><br><u>Pass</u><br><sp><cr><lf><eos><br><br><u>Fail</u><br>F07ACS0(DEV): CONFIDENCE TEST FAILURE<br><cr><lf><eos> |



**Table 5-2-1  
CIIL SOFTWARE COMMANDS (continued)**

| <u>CILL COMMANDS</u> | <u>EXPLANATION</u>   |
|----------------------|--|
| IST <cr><lf><eos>    | <p>Instructs AC Power Supply to perform internal self test. The STA command transmits the message. The AC Power Supply responds with one of the following:</p> <p><u>Pass</u><br/>&lt;sp&gt;&lt;cr&gt;&lt;lf&gt;&lt;eos&gt;</p> <p><u>Fail</u><br/>F07ACSO(DEV): BIT TEST FAILURE<br/>(-PROM CHECKSUM FAULT <br/>-RAM FAULT<br/>-AC SUPPLY HARD FAULT <br/>&lt;cr&gt;&lt;lf&gt;&lt;eos&gt;</p>   |
| STA <cr><lf><eos>    | <p>Status. Prepares AC Power Supply for a response transmission. Clears error condition if one exists. The following response messages and conditions exclude confidence and internal self test.</p>   |
| RESPONSE:            | <p><u>Status OK</u><br/>&lt;sp&gt;&lt;cr&gt;&lt;lf&gt;&lt;eos&gt;</p> <p><u>Device error messages</u></p> <p>F07ACSO(DEV):BIT TEST FAILURE<br/>&lt;description consisting of up to 60 characters&gt;&lt;cr&gt;&lt;lf&gt;&lt;eos&gt;</p> <p><u>TMA error messages</u> All begin with:</p> <p>F07ACSO (MOD):</p> <p>This message is followed by one explanatory message from the following text:</p> <p>ILLEGAL NOUN<br/>AC Power Supply does not recognize illegal noun.</p> <p>ILLEGAL NOUN MODIFIER<br/>AC Power Supply does not recognize illegal noun modifier.</p> <p>ILLEGAL OPCODE<br/>AC Power Supply does not recognize illegal opcode.</p> <p>ILLEGAL VALUE<br/>Entered value lies outside upper and lower limits.</p> <p>NO SETUP<br/>Close command received but setup not programmed.</p> <p>Example: F07ACS00(MOD): NO SETUP &lt;cr&gt;&lt;lf&gt;&lt;eos&gt;</p> |

## 1.4 AC POWER SUPPLY SYNTAX

Example of Setup Command:

```
FNC ACS :CHO SET VOLT <value>  
  
[ SET FREQ <value>]  
[ SRX VOLT <value>]  
[ SRN VOLT <value>]  
[ SRX FREQ <value>]  
[ SRN FREQ <value>]  
[SET VLT(0,1)] <cr><lf><eos>
```

### NOTES:

(cr) =ASCII ' carriage return' code 0D Hex, ISO keyboard ^M  
(lf) =ASCII ' line feed ' code 0A Hex, ISO keyboard ^J  
(eos) =ASCII 'carriage return' code 1A Hex, ISO keyboard ^Z (ASCII file transfer end-of string command)

## 1.5 CATASTROPHIC ERRORS

A catastrophic failure is generated each time the AC Power Supply experiences a hardware failure. Errors are cleared whenever the AC Power Supply transmits a response, except in the case of a short circuit fault which may only be cleared by cycling power to the AC Supply.

### Catastrophic Error Messages

All begin with:

F00ACS0(DEV):

This message is followed by one explanatory message from the following text:

OVERTEMP FAULT <cr><lf><eos>

The heatsink temperature has exceeded its upper limit. The OVERTEMP LED on the front panel will light.

CURRENT LIMIT FAULT <cr><lf><eos>

SHORT CIRCUIT FAULT: AC SUPPLY<cr><lf><eos>

An output loading fault has occurred causing the supply to exceed 500% rated current output. The supply automatically shuts down and opens its output relay. The OVERLOAD LATCH LED on the front panel will light.

## EIA-232 SERIAL PROGRAMMING EXAMPLES

Examples of actual command strings transmissions and typical responses are outlined below.

All commands must be in upper case ASCII, lower case characters are ignored. All commands transmitted to the P1351 must terminate with a carriage return <cr> and a line feed <lf>, and <eos> as will all responses received from the P1351.

**EXAMPLE 1:** Setup a single range P1351 Source to output 120 V @60 Hz, and close the output relay.

Transmit setup command:

FNC ACS :CHO SET VOLT 120 SET FREQ 60<cr><lf><eos>

Transmit status command to request status response:

STA <cr><lf><eos>

Talk address the P1351 Source to enable response:

<space><cr><lf><eos>

: Positive response indicating status is OK.

F07ACS00 (MOD) ILLEGAL VALUE <cr><lf>: Negative response indicating error condition.

(Typically a negative response would only occur if an error existed in the entry or reception of the command string, or the values entered were out of range of the P1351 Source).

Transmit output relay close command:

CLS :CHO <cr><lf><eos>

Transmit status command to request status response:

STA <cr><lf><eos>

Talk address the P1351 Source to enable response:

<space><cr><lf><eos>

: Positive response indicating status is OK.

F07ACS00 (MOD) NO SETUP <cr><lf>

: Negative response indicating error condition.

(Negative response would only occur if invalid or no setup string had been transmitted prior to close command).

**EXAMPLE 2:** Setup a dual range P1351 Source to output 30 V on low range @400 Hz.

Transmit setup command:

FNC ACS :CHO SET VOLT 30 SET FREQ 400 SET VLTO <cr><lf><eos>

Transmit status command to request status response:

STA <cr><lf><eos>

Talk address the P1351 Source to enable response:

<space><cr><lf><eos>

: Positive response indicating status is OK.

**EXAMPLE 3:** Setup a dual range P1351 Source to output 115 V on high range @50 Hz, and read back what the actual voltage, current, and frequency being output is set at.

Transmit setup command:

FNC ACS :CHO SET VOLT 115 SET FREQ 50 SET VLT1 <cr><lf><eos>

Transmit status command to request status response:

STA <cr><lf><eos>

Talk address the P1351 Source to enable response:

<space><cr><lf><eos>

: Positive response indicating status is OK.

Transmit output relay close command:

CLS :CHO <cr><lf><eos>

Transmit status command to request status response:

STA <cr><lf><eos>

Talk address the P1351 Source to enable response:  
<space><cr><lf><eos>

: Positive response indicating status is OK.

Transmit fetch volt command:  
FTH VOLT <cr><lf><eos>

Talk address the P1351 Source to enable response:  
115.0 <cr><lf><eos>

Transmit fetch current command:  
FTH CURR <cr><lf><eos>

Talk address the P1351 Source to enable response:  
5.2 <cr><lf><eos>

Transmit fetch frequency command:  
FTH FREQ <cr><lf><eos>

Talk address the P1351 Source to enable response:  
50 <cr><lf><eos>

## SECTION 5.3

### ANALOG REMOTE CONTROL OPTION

#### 1.0 INTRODUCTION

This option provides a means of controlling the model P1351 with analog signals. The output voltage and frequency may be set using 0 to 10 Vdc signals applied to a rear panel mounted connector. The output relay control ( output on/off ) and range control may also be controlled via this connector. Control of the later may be accomplished by digital signals ( default configuration) or contact closure. This interface provides complete isolation from ground and the power stage of the power supply.

#### 2.0 SPECIFICATIONS

0 To 10VDC Control Input Impedance ..... 10K ohms minimum

Maximum Input Voltage ..... +/- 15 Vdc

Control Input to Output Linearity ..... 1% typical

Control Response Time .....250mS typical

Output and Range Relay Control Current  
 (Digital mode) ..... 5mA to 15mA ( opto-coupler series  
 Resistor equals 2.2K ohms ) .  
 ( Contact closure mode ) .....+15 Vdc in series with 2.2K ohms.

Isolation Voltage .....500 Vdc ( 500 Vac 60Hz 10 sec)

#### 3.0 CONNECTOR PIN ASSIGNMENT

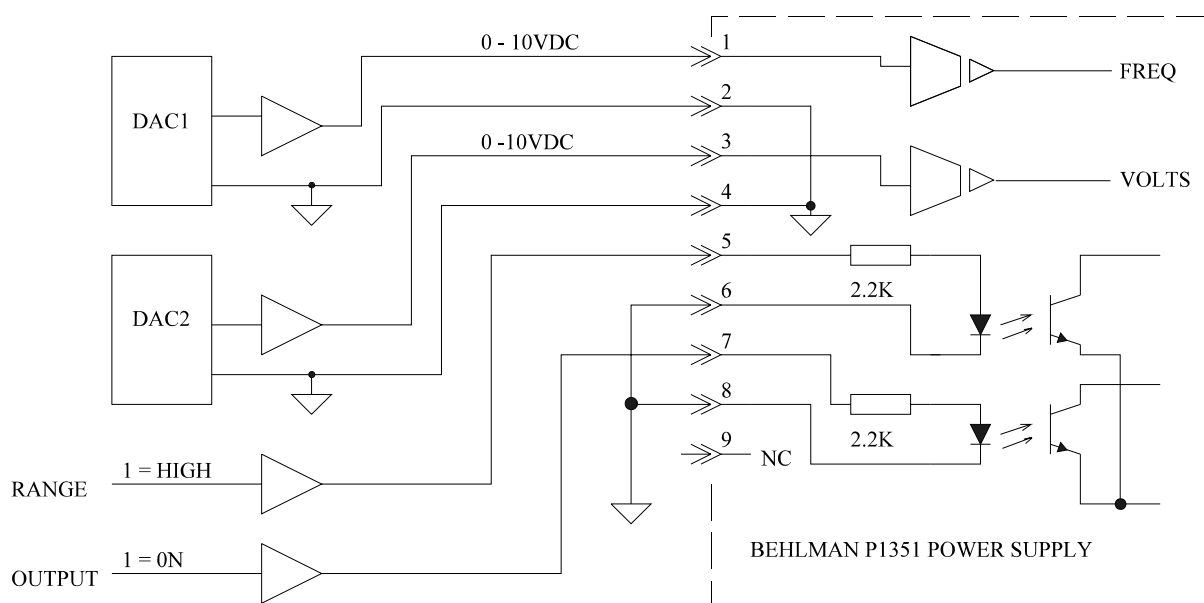
| PIN # | PIN NAME          | FUNCTION                             |
|-------|-------------------|--------------------------------------|
| 1     | FREQUENCY CONTROL | 0 TO 10 VDC INPUT TO CONTROL "FREQ"  |
| 2     | COMMON            | 0 TO 10 VDC RETURN FOR PIN 1         |
| 3     | AMPLITUDE CONTROL | 0 TO 10 VDC INPUT TO CONTROL "VOLTS" |
| 4     | COMMON            | 0 TO 10 VDC RETURN FOR PIN 3         |
| 5     | RANGE +           | + INPUT FOR RANGE CONTROL            |
| 6     | RANGE -           | - INPUT FOR RANGE CONTROL            |
| 7     | OUTPUT +          | +INPUT FOR OUTPUT CONTROL            |
| 8     | OUTPUT-           | - INPUT FOR OUTPUT CONTROL           |

#### 4.0 APPLICATION EXAMPLE

A typical application of the analog remote control feature is illustrated by figure 1. To use the remote control features the front panel controls MUST BE set as follows:

|               |                   |
|---------------|-------------------|
| "VOLTS" ..... | fully CCW         |
| "FREQ" .....  | fully CCW         |
| OUTPUT .....  | off ( button out) |
| RANGE .....   | low (button out)  |
| SELECT .....  | any               |

Note that the remote input is additive and will increase the setting of the front panel controls.



(FIGURE 1.)

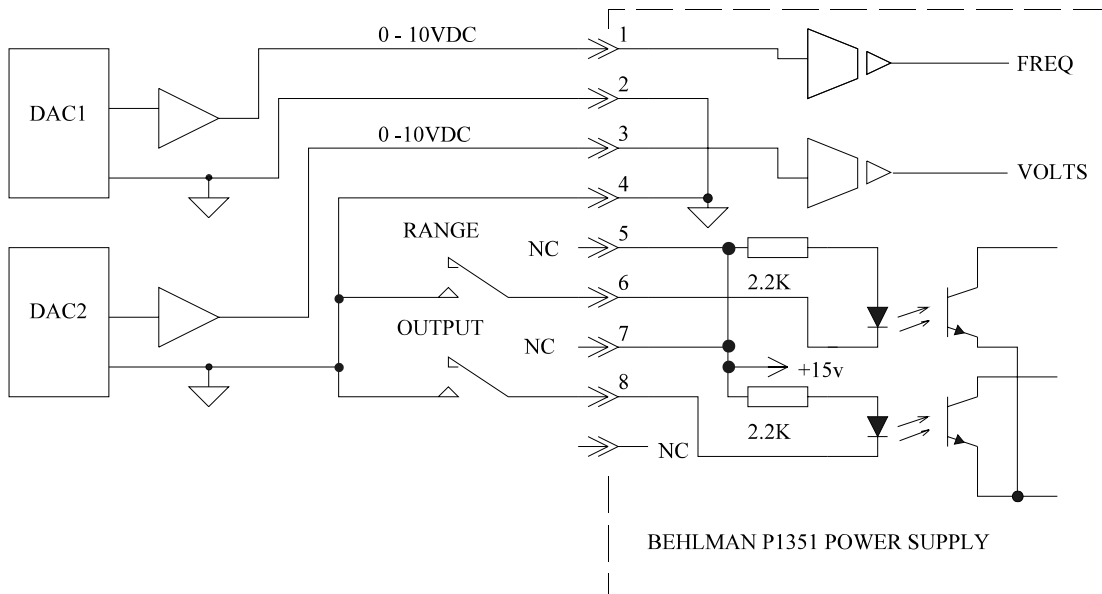
Cables used to connect the control circuit to the power source should be shielded to prevent noise and electromagnetic interference from entering the remote inputs. The maximum length of these cables is dependent on the control circuits drive capability. It should be noted that some IC output stages may become unstable and oscillate when driving long cables with high capacitance. Low output impedance buffers should be considered when long cable lengths are desired.

The stability and regulation of the P1351 output voltage and frequency will be directly affected by the quality of the user supplied control signals. This must be considered during the design of the control circuitry .

#### 4.0 APPLICATIONS ( Continued )

The analog remote control board may be re-configured to allow control of the output and range relays of the power source via a set of "dry" contacts. This requires removal of the power supply cover and inserting jumpers on the remote control board. ***This should be performed by qualified personnel only*** ! The jumpers ( also known as shunts) may be obtained from Behlman or from any electronics distributor. These are standard shunts used throughout the computer industry to set board configurations and are for use on 0.1inch headers. The Behlman part number is 102-473-000.

The alternate configuration is illustrated below. Note the internal +15 Vdc is now tied to pins 5 and 7 of the remote connector. **These connections should not be used !**



(Figure 2) Alternative Configuration.

For further information on use of the analog remote control option contact the Behlman sales office.