



Associated
Power Technologies

VariPLUS: 104 Series

Power Converter

Operation Manual

**Ver. 1.03
PART # 39402**

**Associated Power Technologies, Inc.
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DECLARATION OF CONFORMITY

Manufacturer: Associated Power Technologies, Inc.

Address: 28105 N. Keith Drive
Lake Forest, IL 60045 USA

Product Name: 104 Power Converter

Model Number: 104

Conforms to the following Standards:

Safety: EN 61010-1:2001, Part 1: General Requirements
IEC 61010-1:2001

EMC: EN 55011:2009+A1
EN 61326-1:2013

Supplementary Information

The above product conforms with the Low Voltage Directive 2014/35/EU relating to electrical equipment designed for use within certain voltage limits and the Amendment Directive 2014/35/EU.

The CE marking has been affixed on the device according to article 10 of the EMC Directive 8/336/EEC.

The technical file and other documentation are on file with Associated Power Technologies, Inc.

Joseph Guerriero
President / General Manager

Associated Power Technologies, Inc.
Lake Forest, IL. 60045
April 25th, 2016

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1. Introduction

1.1 Warranty

Associated Power Technologies, Inc. (APT), certifies that the instrument listed in this manual meets or exceeds published manufacturing specifications. This instrument was calibrated using standards that are traceable to the National Institute of Standards of Technology.

Your new instrument is warranted to be free from defects in workmanship and material for a period of 3 years from date of shipment. During the warranty period, you must return the instrument to Associated Power Technologies, Inc. or its branches for repair. Associated Power Technologies reserves the right to use its discretion on replacing the faulty parts or replacing the assembly or the whole unit.

APT will void your warranty under the following conditions:

- Operation of the instrumentation under non-normal conditions
- Any non-authorized modifications, tampering or physical damage
- Elimination of any connections in the earth grounding system or bypassing any safety systems
- Use of non-authorized parts in the repair of this instrument. Parts used must be parts that are recommended by APT as an acceptable specified part

This warranty does not cover accessories not of Associated Power Technologies, Inc. manufacture.

Except as provided herein, APT, makes no warranties to the purchaser of this instrument and all other warranties, expressed or implied (including, without limitation, merchantability or fitness for a particular purpose) are hereby excluded, disclaimed and waived.

APT recommends that your instrument be calibrated on a twelve month cycle. Instruments returned to APT annually for calibration fall under our extended warranty which can be extended up to five years. Each year the instrument is returned to APT in consecutive years the warranty is extended one additional year. This process can be repeated up to four years for a 5-Year Warranty.

Instruments returned for warranty repair within the first six months of the warranty period, will have the warranty extended for one year from the date of repair at no charge. Instruments received after the first six months can have the warranty extended for 3 months after its original expiration date at no charge or the warranty can be extended for a full year at the cost of an annual calibration.

1.2 Glossary of Terms

Alternating Current (AC) - current that reverses direction on a regular basis (usually 60 times per second in the United States). Measured in amps.

AC Power Source - An instrument that takes one AC voltage and frequency level and converts it into another AC voltage and frequency level.

Amplifier - a circuit that boosts an input signal from one level to another.

Apparent Power - The total power generated or consumed by a device due to real and reactive circuit components. Measured in VA (volt-amps).

Crest Factor - The ratio of peak current (A_{peak}) to RMS current (A_{rms}).

Complex Power – the vector sum of the real and reactive power components of a circuit. Measured in VA (volt-amps).

Direct Current (DC) - current that only flows in one direction. Direct current comes from a polarized source, meaning one terminal is always at a higher potential than the other. Measured in amps.

Frequency - The number of times a waveform completes a cycle in a period of time. Measured in hertz.

Inrush Current - A term used to describe the current needed to power a load upon start-up. Some loads require a large/inrush starting current in order to operate.

Linear Power Source – a power source that linearly amplifies the input signal using transistors to increase the voltage, current, and power output of the system.

OC Fold Back - Over current fold back is a technology used in power sources that keeps output current constant by reducing the voltage in order to power loads that may have a high inrush current.

Phase Angle – the degree of measurement that corresponds to an AC waveform's amplitude. Measured from 0 – 360 degrees.

PLC - Programmable Logic Control is an automation method using relay or digital technology.

Power - A generic term used to describe electrical work being done. There are many types of power, including real power, reactive power, apparent power, and complex power.

Power factor - The ratio of real power (watts) to apparent power (VA). Based on a scale from 0 to 1 to determine how reactive and resistive a load is.

Reactive Power – the power absorbed by capacitive or inductive elements in a circuit. This power does not work. Measured in VAR (volt-amps reactive).

Real Power – the power that performs work in a circuit. Measured in watts.

Response Time - The time that is needed to regulate the voltage, current, frequency, and power output when a load is added to the power source.

Safety Agency Listing - A safety mark given to a product that has met stringent benchmarks as classified by the authorized agency.

SmartVOLT – An APT feature that allows the operator to configure the output voltage of the instrument during power on. The operator may choose to have the instrument power on with the output voltage set to 0 VAC or at the voltage setting prior to when the power was turned off.

Steady State Current - A term used to describe the current when the load is running nominally after the inrush current.

Switching Power Source - A power source that uses switching technology (integrated circuits and components) in order to generate the AC voltage, current, frequency, and power.

Total Harmonic Distortion (THD) - A percentage that is used to identify the degree of the noise/unclean signal in a power source's output waveform.

Voltage - The amount of force that is needed to move current from point to point. Measured in volts.

1.3 Safety Precautions

- This product and its related documentation must be reviewed for familiarization with safety markings and instructions before operation.
- Before applying power verify that the instrument is set to the correct line voltage and the correct fuse is installed

To prevent accidental injury or death, these safety procedures must be strictly observed when handling and using the test instrument.

1.4 Service and Maintenance

User Service

To prevent electric shock do not remove the instrument cover. There are no user serviceable parts inside. Routine maintenance or cleaning of internal parts is not necessary. Any external cleaning should be done with a clean dry or slightly damp cloth. Avoid the use of cleaning agents or chemicals to prevent any foreign liquid from entering the cabinet through ventilation holes or damaging controls and switches. Some chemicals may also damage plastic parts or lettering. Any replacement cables and high voltage components should be acquired directly from APT or its distributors.

Service Interval

The instrument must be returned at least once a year to an APT authorized service center for calibration and inspection of safety related components. APT will not be held liable for injuries suffered if the instrument is not properly maintained and its safety checked annually.

User Modifications

Unauthorized user modifications will void your warranty. APT will not be responsible for any injuries sustained due to unauthorized equipment modifications or use of parts not specified by APT. Instruments returned to APT with unsafe modifications will be returned to their original operating condition at the customer's expense.

2. Getting Started

This section contains information for the unpacking, inspection, preparation for use and storage of your APT product.

2.1 Unpacking and Inspection

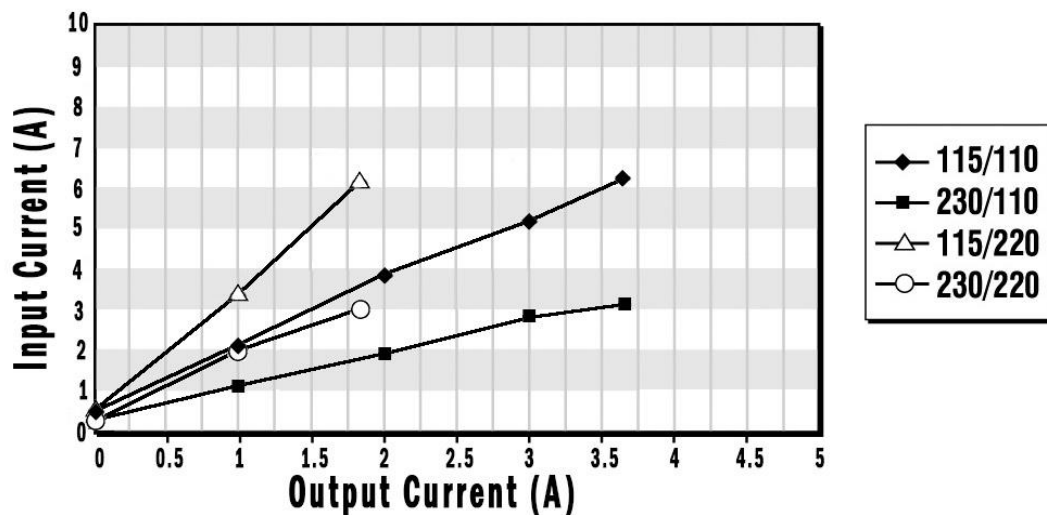
Your instrument was shipped in a protective shipping carton designed to protect the instrument through the shipping process. If the shipping carton is damaged, inspect the contents for visible damage such as dents, scratches, or broken display. If the instrument is damaged, notify the carrier and APT's customer support department. Please save the shipping carton and packing material for the carrier's inspection. Our customer support department will assist you in the repair or replacement of your instrument. Please do not return your product without first notifying us.

2.2 Input/Output Current Considerations

Please refer to the following diagram for input/output current considerations for the Model 104.

APT 104

Input Current vs. Output Current



Model 104

2.3 Preparation For Use

Model 104 require an input line voltage of 115/230 volts AC $\pm 10\%$, 47 – 500 Hz single phase. Please check the rear panel to be sure the proper switch setting is selected for your line voltage requirements before turning your instrument.

CAUTION

Do not switch the line voltage selector switch located on the rear panel while the instrument is on or operating. This may cause internal damage and represents a safety risk to the operator.

2.4 Power Cable

WARNING

Before connecting power to this instrument, the protective ground (earth) terminals of this instrument must be connected to the protective conductor of the line (mains) power cord. The main plug shall only be inserted in a socket outlet (receptacle) provided with a protective ground (earth) contact. This

protective ground (earth) must not be defeated by the use of an extension cord without a protective conductor (grounding).

2.5 Environmental Conditions

Operating Environment

Temperatures: 0° - 40° C (32° - 104° F)

Relative humidity: 20% - 80%

Altitude: 2,000 meters (6,562 feet)

The instrument should also be protected against temperature extremes which may cause condensation within the instrument.

Storage and Shipping Environment

This instrument may be stored or shipped in environments with the following limits:

Temperature.....-40° to +55° C (-40 to 131° F)

Altitude.....7,620 meters (25,000 feet)

2.6 Packaging

Please enclose the instrument with all options, accessories and test leads. All returns must be accompanied by a return material authorization (RMA) number which is provided by the customer support department. All instruments shipped without a RMA number will result in additional fees for handling and storage.

APT will not be responsible for any repair costs associated with shipping damage as a result of improper packaging. The customer is responsible for providing adequate shipping insurance coverage while shipping an instrument in the event of loss or damage while in transit.

3. Specifications and Controls

3.1 Specifications

Model		104
INPUT		
Phase		1Ø
Voltage		115/230Vac $\pm 10\%$
Frequency		47 ~ 63Hz
OUTPUT		
Power rating		500VA @ $\leq 400W$
Max. Current (r.m.s)	0.0-150.0V	4.6A at $< 110V$
	150.1-300.0V	2.3A at $< 220V$
Inrush Current (peak) (1)	0.0-150.0V	18.4A
	150.1-300.0V	9.2A
Phase		1Ø/2W
THD(Total Harmonic Distortion) (2)		$< 1\%$ (Resistive Load) at output voltage within the 80~140Vac at Low Range or the 160~280Vac at High Range.
Crest Factor		≥ 3
Line Regulation		$\pm 0.1V$
Load Regulation (Hardware)		$\pm (0.5\% \text{ of output } + 0.5V)$ at Resistive Load, $< 400\mu S$ response time
Load Regulation (Software)		$\pm 0.5V, < 1S$ response time
SETTING		
Voltage	Range	0-300V
	Resolution	0.1V
	Accuracy	$\pm (1\% \text{ of setting } + 2\text{counts})$
Frequency	Range	50, 60 Hz Selectable
	Accuracy	$\pm 0.03\%$ of setting



MEASUREMENT		
Voltage	Range	0.0-400.0V
	Resolution	0.1V
	Accuracy	± (1% of reading + 2counts)
Current	Range	0.00A~6.50A
	Resolution	0.01A
	Accuracy	± (1% of reading +5counts)
Power	Range	0W~650W
	Resolution	1W
	Accuracy	± (2% of reading + 10counts) at PF>=0.2 (6)
Protection		
Software OCP		Over Current 110% of full rated current >1 second
Hardware OFL		Over Current 105 ~110% of full load. 3.3 second time constant. 15 second reaction from off state with 110% load and software disabled
Output Short Shut Down Speed (7)		<1 second
Software OPP		Over Power 110% of full power >1 second
Software OTP		Temperature over 130 degree C on the power amp heatsink
Software OVP		Output voltage range: 0.0~150.0V, maximum voltage deviation +5V Output voltage range: 150.1~300.0V maximum voltage deviation +10V
GENERAL		
Safety		CE
Dimension		355(W) x 133.5(H) x 300(D) mm
Weight		12.5Kg
Operation Environment		0-40°C/20-80%RH

Why use the term “Counts”?

Associated Power Technologies publishes some specifications using COUNTS which allows us to provide a better indication of the tester’s capabilities across measurement ranges. A COUNT refers to the lowest resolution of the display for a given measurement range. For example, if the resolution for voltage is 1V then 2 counts = 2V.

3.2 Instrument Controls

3.2.1 Front Panel Controls



1. Power Switch: Rocker style power switch with international ON (|) and OFF (0).

2. Voltage Display: When the output is OFF the display shows the output voltage setting. When the output is ON the display shows the output voltage measurement.

3. Current/Power Display: When the output is OFF the display shows the output current setting. When the output is ON the display shows the output current measurement. The display can be toggled to show the output power measurement.

4. System Key: Cycles through the user-edittable system parameters.

5. Display Key: Toggles the Current/Power Display to show either the output current measurement or the output power measurement.

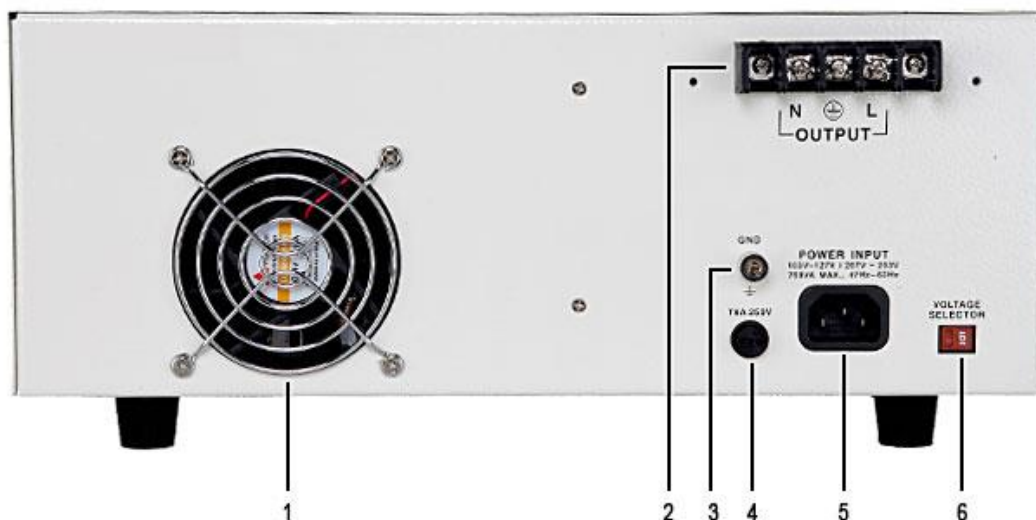
6. Frequency Key: Toggles the output frequency to 50 or 60 Hz.

7. Output/RESET Key: Enables and disables the output relay.

8. LOCK Key: Locks out the front panel controls when active. The display may still be toggled to review output current and power measurements, and the output frequency may be adjusted.

9. Voltage Adjust Rotary Knob: Increments and decrements the output voltage. Allows the user to adjust system parameters.

3.2.2 Rear Panel Controls



1. Thermal Fan: Used to cool the instrument.

2. Output Terminal Block: standard 1 phase 3 wire output terminal block.

3. Ground Lug: Additional ground connector in addition to power cord ground.

4. Fuse Receptacle: To change the fuse unplug the power (mains) cord and turn the fuse cap counter clockwise to remove fuse.



5. Input Power Receptacle: Standard IEC 320 connector for connection to a standard NEMA style line power (mains) cord.

6. Input Power Switch: Line voltage input selection is set by the position of the switch 115/230V.

4. Programming Instructions

4.1 Instrument Operation

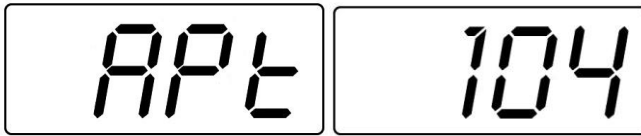
4.1.1 Powering on Instrument

Toggle on the power switch in the lower left hand corner of the instrument.

4.1.2 Power On Condition

On every power up cycle the instrument will provide you with the model number and current firmware version of the instrument in the voltage and current display.

Display On Power Up



4.1.3 Setting the Output Voltage

The output voltage is controlled using the Voltage Adjust encoder located on the front panel. Turn the encoder clockwise to increment the voltage; turn the encoder counter clockwise to decrement the voltage. The voltage will increase and decrease more rapidly depending on the speed of rotation.

4.1.6 Setting the Frequency

Press the 50/60 Hz key to toggle the frequency. The LED will indicate which frequency the instrument is outputting.

4.1.7 Setting the Current/Power Display

Press the A/W key to select whether the Current/Power display will show amps or wattage. If the LED indicator for A is lit the current will be displayed. If the LED indicator for W is lit the wattage will be displayed.

4.1.8 Setting the Lock

Press the Lock key to lock out the front panel during testing. If the Lock key is active, the LED indicator will be lit. When Lock is active, the operator cannot change any settings from the front panel. If the Lock key is active when the unit is powered OFF it will remain active when the unit is powered back ON.

4.1.9 Setting the Output/Reset

Press the Output/Reset key to set the output. If the LED indicator is lit the decimal points in the displays of voltage and current/power will blink continuously notifying the operator that output is ON. If the LED indicator is not lit and the decimal points in the displays of voltage and current/power are lit steadily this indicates that the output is OFF. When the output is OFF the displays will show their present settings.

If the Output/Reset LED indicator is flashing this is a notification that a limit threshold has been exceeded, a failure has occurred, or an instrument protection circuit has been activated. Press the Output/Reset key to reset the instrument to a normal state.

4.2 System Setup

Press the System key to change the system parameters. The LED indicator will be on when the System key is activated. The System key is only available if the output is off or the LED indicator is off on the Output/Reset key. Press the System key to cycle through the parameters. Use the digital encoder to adjust the system parameter settings.

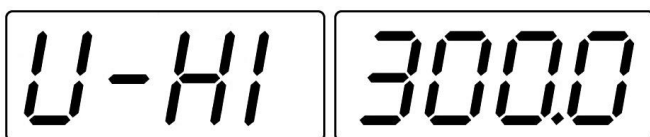
4.2.1 System Parameters

Display		Explanation
Voltage	Current	
V-HI	300.0	High voltage limit setting (0.0 – 300.0 V), 0.0 disables feature
V-LO	0.0	Low voltage limit setting (0.0 – 300.0 V), 0.0 disables feature
Vout	LAST	Output is set to voltage based on last setting prior to power off when the instrument is powered up

Vout	0	Output is 0 volts when the instrument is powered up
P-UP	OFF	Output relay is open when the instrument is powered up
P-UP	ON	Output relay is closed when the instrument is powered up

4.2.2 Setting the Voltage HI Limit

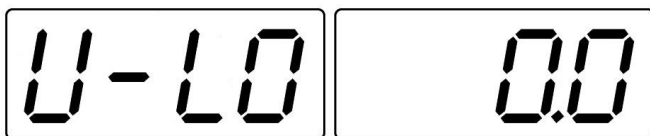
Press the System key until the voltage display reads V-HI and the current/power display reads Volt as shown below:



Use the digital encoder to select the high limit voltage (0.0 – 300.0 V). Press the System key again to accept the setting and move to the next parameter setting, low voltage limit.

4.2.3 Setting the Voltage LO Limit

Press the System key until the voltage display reads V-LO and the current/power display reads Volt as shown below:



Use the digital encoder to select the low limit voltage (0.0 – 300.0 V). Press the System key again to accept the setting and move to the next parameter setting, high current limit.

4.2.4 Setting the SmartVOLT

Press the System key until the voltage display reads Vout. Use the digital encoder to select from the following parameters:

LAST

<i>Uout</i>	<i>LAST</i>
-------------	-------------

0

<i>Uout</i>	<i>0</i>
-------------	----------

The LAST setting will configure the VariPLUS to power up at the same output voltage that was last used before the unit was powered off. The 0 setting will configure the VariPLUS to power up at 0 volts regardless of the previous output voltage setting. Press the System key again to accept the setting and move to the next parameter setting, high voltage limit.

4.2.5 Setting the P-UP

Press the System key until the voltage display reads P-UP. Use the digital encoder to select from the following parameters:

Off

<i>P-UP</i>	<i>OFF</i>
-------------	------------

On

<i>P-UP</i>	<i>On</i>
-------------	-----------

The OFF setting will configure the instrument to power up with the output relay open. In this condition, voltage will not be present at the output receptacle during power-on. The ON setting will configure the instrument to power up with the output relay closed.

WARNING

If P-UP is set to ON, voltage will be present at the output receptacle when the instrument is powered on.

4.3 Error Messages

If an abnormal condition occurs, there are several error messages that could be indicated in the frequency display. When an abnormal condition occurs, the output will be disabled and the alarm will sound. The Output/Reset LED indicator will also begin flashing. Pressing the Output/Reset key will reset the audible alarm and the abnormal condition will be displayed.

WARNING

All error messages occur in abnormal conditions and therefore must be recorded. Check the cause of the error to ensure the problem is eliminated before restarting the operation, or contact Associated Power Technologies, Inc., or our official distributors for further assistance.

4.3.1 Error Message Definition

Frequency Display	Definition
OtP	Over Temperature Protection
OCP	Over Current Protection
OPP	Over Power Protection
OUP	Over Voltage Protection
A-SH	Amplifier Shutdown Protection
LVP	Low Voltage Protection

4.3.2 OtP – Over Temperature Protection



Displayed if the heat sink of the instrument has exceeded 130° C. The voltage and current displays will show the overloaded voltage or current respectively. The LED indicator for the Output/Reset key will be blinking.

4.3.3 OCP – Over Current Protection



Displayed if the output current has exceeded 110% of maximum current rating for 1 second or there is a short circuit for 6 seconds. The LED indicator for the Output/Reset key will be blinking.

4.3.4 OPP – Over Power Protection



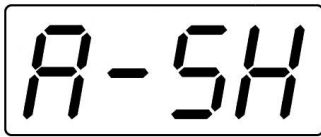
Displayed if the output power has exceeded 110% of maximum power rating for 1 second. The LED indicator for the Output/Reset key will be blinking.

4.3.5 OVP – Output Voltage Protection



Displayed if the output voltage has exceeded 10 V of the setting voltage. The LED indicator for the Output/Reset key will be blinking. If an OVP error occurs on the next power up cycle the displays will show Volt Err.

4.3.6 A-SH – Amplifier Shutdown Protection



Displayed if the amplifier is in an abnormal condition. The LED indicator for the Output/Reset key will be blinking.

4.3.7 LVP – Low Voltage Protection

Displayed if the power source detects a discrepancy between the output voltage and the voltage setting of 10V or greater for more than 1sec. The LED indicator the Test/Reset key will be blinking.

5. Calibration Procedures

All Associated Power Technologies, Inc. instruments have been calibrated at the factory prior to delivery. The recommended calibration cycle for all APT instruments is every 12 months.

5.1 Hardware Verification

The hardware verification is required to be performed prior to the standard software calibration. This verification should be used to determine if a hardware calibration should be performed. All tests should be performed at 60 Hz. If the hardware verification requires adjustment proceed to **5.4 Hardware Calibration**. If the hardware verification does not require adjustment proceed to **5.7 Software Calibration**.

5.2 Hardware Verification Requirements

5.2.1 Required Measurement Standard

High Band DVM > 50 kHz capable of measuring millivolts DC and 110 VAC

5.2.2 Required Measurement Equipment

- 475 k Ω , ¼ watt resistor
- 10 μ F, 110 volt non-polarized capacitor
- 10 k Ω , 10 watt resistor

5.3 Hardware Verification Procedure

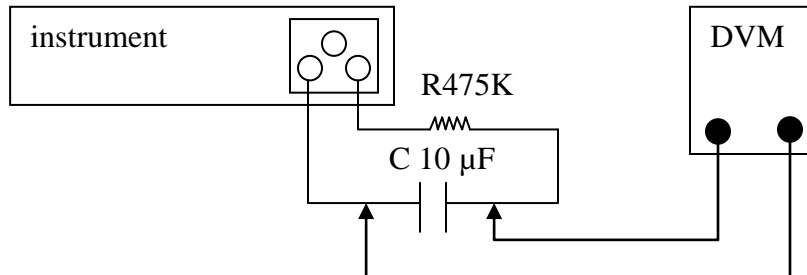
5.3.1 Activate Non-Calibration Mode

Press the System key while simultaneously powering the instrument on.

5.3.2 Verify the High Frequency Noise

1. Connect the output of the instrument to the DVM
2. Set the DVM to measure to AC mV.

3. Set the output voltage to “0” volts and activate the output of the



instrument.

4. Verify that the reading on the DVM is ≤ 200 mV.

5.3.3 Verify the “110” Volts DC Offset

1. Connect the 475 k Ω resistor in series with the 10 μ F capacitor and connect the DVM and load to the instrument as illustrated in the following diagram:
2. Set the DVM to read DC millivolts.
3. Set the output voltage to 110 volts and activate the output of the instrument.
4. Wait twenty seconds and take a measurement.
5. Verify that the DVM measures “0” volts \pm 100 mV.
6. Disconnect the load and the DVM.

5.3.4 Wattmeter Offset

1. Set the output voltage to “0” volts and activate the output of the instrument.
2. Take note of the reading on the Wattmeter.
3. Set the output voltage to “300” volts and activate the output of the instrument.
4. Make sure the wattmeter reads +0 to -3 watts of when the instrument is set to “0” volts.

5.3.5 Exit Non-Calibration Mode

Exit non-calibration mode for normal operation. Reset the unit by powering it off and then back on for standard operation mode.

5.4 Hardware Calibration

The hardware verification is required to be performed prior to the standard software calibration only if adjustments were necessary for the hardware verification of section 5.1. All tests should be performed at 60 Hz.

5.5 Hardware Calibration Requirements

5.5.1 Required Measurement Standard

- DVM capable of measuring millivolts DC and 110 VAC
- Potentiometer adjustment tool
- Oscilloscope
- Plastic inductor adjustment tool.
- 24 Ω , 500 Watt (minimum) resistor

5.5.2 Required Measurement Equipment

- 475 k Ω , ¼ watt resistor.
- 10 μ F, 110 volt non-polarized capacitor

5.6 Hardware Calibration Procedures

5.6.1 Activate Non-Calibration Mode

Press the System key while simultaneously powering the instrument on.

5.6.2 Clear the High Frequency Noise

1. Connect the output of the instrument to the Oscilloscope.
2. Adjust the Oscilloscope to approximately 100mV/10 μ s. This will allow viewing of the high frequency noise.
3. Set the output voltage to “0” volts and activate the output of the instrument.
4. Adjust the variable inductor, located either on the amplifier board or the output board, so that the high frequency waveform displayed on the Oscilloscope matches the numbers below. Refer to the service manual schematics for the designator and location of the variable

inductor. There may also be some glue on top of the inductor, please remove this glue using the plastic inductor adjustment tool first.

Model 104 $\leq 150\text{mV}$ P-P When doing this adjustment you may see some high frequency spikes and anomalies on the screen which are not critical or applicable to this adjustment.

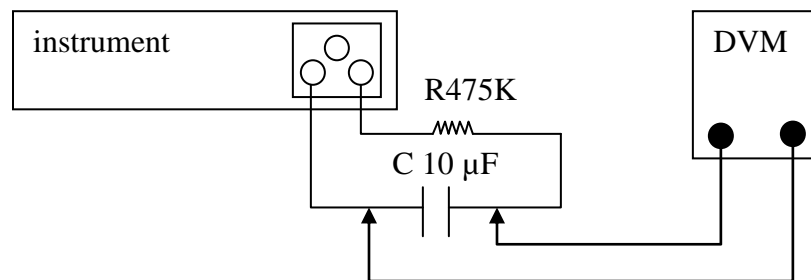
5. Disconnect the Oscilloscope.

5.6.3 Adjust the “0” Volts DC Offset

1. Connect the DVM to the output of the instrument and set to DC millivolts.
2. Set the output voltage to “0” volts and activate the output of the instrument.
3. Adjust VR1 on the PWM6900 board so that the DVM measures “0” volts $\pm 5\text{mV}$.
4. Remove the DVM from the output.

5.6.4 Adjust the “110” Volts DC Offset

1. Connect the $475\text{k}\Omega$ resistor in series with the $10\text{ }\mu\text{F}$ capacitor and connect the DVM and load to the instrument as illustrated in the following diagram:



2. Set the DVM to read DC millivolts.
3. Set the output voltage to “115” volts and activate the output of the instrument.
4. Adjust VR1 on the CON6900 board so that the DVM measures “0” volts $\pm 5\text{mV}$.
5. Disconnect the load and the DVM.



5.6.5 Wattmeter Offset

1. Set the output voltage to “0” volts in and activate the output of the instrument.
2. Take note of the reading on the Wattmeter.
3. Set the output voltage to “300” volts and activate the output of the instrument.
4. Adjust VR3 on the CON6900 board so that the reading of the wattmeter matches the value that was noted at “0” volts.

5.6.6 OCP Set Point

1. Connect the necessary resistor for the corresponding model number to the output of the instrument:

Model	Resistor
104	24 Ω , 500 watt resistor

2. Rotate VR2 of the CON6900 clockwise to the end of its travel.
3. Set the output voltage to “105” volts and activate the output of the instrument.
4. Using the arrow keys, adjust the voltage up until the specified current is displayed on the current meter for each model:

Model	Current Meter Setting
104	4.88 \pm 0.05 Amps

5. Wait 15 seconds
6. Rotate VR2 counter clockwise until the frequency meter displays OCP.

5.6.7 Exit Non-Calibration Mode

Exit non-calibration mode for normal operation. Reset the unit by powering it off and then back on for standard operation mode.

5.7 Software Calibration

The software calibration is recommended to be performed after the hardware verification and hardware calibration have been completed.

5.8 Software Calibration Requirements

5.8.1 Required Measurement Standard

- 0-5 Amp AC True RMS Ammeter
- 0-300 VAC True RMS Meter
- 500W Watt Meter

5.8.2 Required Measurement Equipment

- 24 Ω / 500 W Resistor for 104 Model

5.8.3 Activate Software Calibration Mode

To enter the calibration mode you must power on the instrument while pressing the A/W key. The displays will read as follows based on the calibration mode. The System key is used to toggle between the different calibration modes. To exit the calibration mode turn OFF the instrument via the power switch or press the Lock key.

Display		Explanation
Voltage	Current/Power	
U-LO	150.0	voltmeter calibration 0-150V range
U-HI	300.0	voltmeter calibration 0-300V range
A-HI	5.00	ammeter calibration
P-HI	400	power meter calibration

5.8.4 Low Range Voltage Calibration

Press the System key until the display reads U-LO. Connect a calibrated true RMS voltmeter on one of the output sockets of the universal receptacle and press the Output/Reset key in order to activate the CPU to read a low range offset voltage and send a 150 VAC output voltage. The accurate RMS voltmeter will indicate an actual voltage while the display on the instrument will indicate a necessary value needed to be calibrated. Using the voltage value from the RMS voltmeter adjust the rotary encoder to the appropriate voltage level. Press the

System key to save the new value. A single beep will indicate the value was accepted, and the instrument will move to the next calibration setting. A double beep will indicate the calibration was not successful and the instrument will remain in the current calibration mode.

5.8.5 High Range Voltage Calibration

Press the System key until the display reads U-HI. Connect a calibrated true RMS voltmeter on one of the output sockets of the universal receptacle and press the Output/Reset key in order to activate the CPU to read a low range offset voltage and send a 300 VAC output voltage. The accurate RMS voltmeter will indicate an actual voltage while the display on the instrument will indicate a necessary value needed to be calibrated. Using the voltage value from the RMS voltmeter adjust the rotary encoder to the appropriate voltage level. Press the System key to save the new value. A single beep will indicate the value was accepted, and the instrument will move to the next calibration setting. A double beep will indicate the calibration was not successful and the instrument will remain in the current calibration mode.

5.8.6 Current Calibration

Press the System key until the display reads A-HI. Connect a variable resistor as the load and a calibrated true RMS ammeter on one of the output sockets of the universal receptacle and press the Output/Reset key in order to activate the CPU to read a high range offset current and send a 100 VAC output voltage. The accurate RMS ammeter will indicate an actual current while the display on the instrument will indicate a necessary value needed to be calibrated. Adjust the load or voltage to get the reading from the ammeter to the following value: $500\text{VA} \leq 4.6\text{A}$. Using the current value from the RMS ammeter adjust the rotary encoder to select the appropriate current level. Press the System key to save the new value. A single beep will indicate the value was accepted, and the instrument will move to the next calibration setting. A double beep will indicate the calibration was not successful and the instrument will remain in the current calibration mode.

5.8.7 Power Calibration

Press the System key until the display reads P-HI. Connect a variable resistor as the load and a calibrated true RMS power meter on one of the output sockets of the universal receptacle and press the Output/Reset key in order to activate the CPU to read a high range offset power and send a 80 VAC output voltage. The accurate RMS power meter will indicate an actual power while the display on the



instrument will indicate a necessary value needed to be calibrated. Adjust the load or voltage to get the reading from the power meter to $500\text{VA} \leq 400\text{W}$. Using the power value from the RMS power meter adjust the rotary encoder to select the appropriate power level. Press the System key to save the new value. A single beep will indicate the value was accepted, and the instrument will move to the next calibration setting. A double beep will indicate the calibration was not successful and the instrument will remain in the current calibration mode.



6. Options

6.1 Opt. 02 – Grounded Neutral

This option will ground the neutral output. It is ideal for customers looking to reduce overall leakage current that can result from the instrument itself in normal operation. This option is ideal for the medical industry.

7. Service & Maintenance

7.1 User Protection

To avoid electrical shock do not dismantle the cover of the instrument. When any abnormal symptom happens with the instrument, please contact Associated Power Technologies, Inc. or the authorized distributor for assistance.

7.2 Consistency of Service

The instrument's internal circuits and all related parts are required to be checked and calibrated at least once every year. This is to protect the user in terms of safety and to ensure a high accuracy of operation and measurement of this instrument at all times.

7.3 User Modification

Modification by the user of the instrument's internal circuits and all related parts is not recommended. All warranties will be void if any modifications have been conducted by the user. Associated Power Technologies, Inc. reserves the right to convert the original circuitry to its original state if any modifications have been made to the instrument. The customer will be responsible for any charges associated with bring the instrument to its original state.

8. Replacement Parts List

Rev:A - ECO 5736

Part Number	Qty.	Ref. Designator	Description
Supplied Accessories			
39339	2	-	Fuse 8A Slow-Blow UL
36068	1	-	Cable Input Cordset European
39395	1	-	Terminal Block Cover
38885	1	-	Strain Relief Retainer
38886	1	-	Strain Relief Part 1
38887	1	-	Strain Relief Part 2
Panel Components			
39170	1	-	Terminal Block Assembly 30A 3 POS
38109	1	-	Power Switch 2P 10A/250V
38274	5	-	Button Keypad Rect. 9.8 x 8.0mm
38021	7	-	Square Front Panel Indicator LED
38895	4	-	Tapered Plastic Foot
38914	4	-	Foot Screws
PCB Assemblies			
39110	1	DSP100	Display Board
39566	1	PWM6900	PWM Control Board
38924	1	AMP6905	Amplifier Board
39109	1	CON6900	Main Control Board
38892	1	PWR6910	Input Voltage Select Board
Internal Components			
38846	1	IC (CON 6900 IC2)	IC SM89516AC25J
39285	1	T1	Input Transformer