Power Probe
Model PP115

Operations and Use Manual

POWERVAR
Solutions for Power Quality®

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Introduction

Thank you for purchasing a POWERVAR Model PP115 Power Probe. The Power Probe provides a convenient, inexpensive, and safe way to diagnose AC power contamination that is a harmful to electronic equipment and system performance. The PP115 when used with a standard oscilloscope makes it possible to visually monitor power line noise and wave shapes. The operator now has the ability to detect low level voltage noise as well as higher significant line disturbances. The display is presented in real time, unlike a power line analyzer that prints a paper tape or strip after each event.

The Power Probe is designed to provide output levels compatible with any commonly available oscilloscope. An important feature is complete isolation from the power line being tested thanks to the transformer isolation of all 3 input channels. Three output channels provide display of the AC voltage wave form, line to neutral conductor noise (Normal Mode) and neutral to ground conductor noise (Common Mode). The Power Probe can also be used to measure noise super imposed on DC sources such as Switch Mode Power Supplies (SMPS). Of course, using a higher bandwidth oscilloscope, will permit more noise frequencies to be viewed.

The Power Probe is a vital tool for diagnosing power problems on site in a timely manner. Power contamination becomes evident and a visual illustration is displayed to show your customers. The suspected electrical culprit can be found and eliminated.

Specifications

Input voltage – 250 VAC (RMS) maximum @ 50/60 Hz.
300 VDC maximum
AC + DC: 400 V peak (maximum 300 VDC)

Output Signals – **Signal (Wave shape), Line to Neutral**
Sensitivity: V in – V out = 100:1
Bandwidth: 10 Hz to 150 KHz

Normal Mode, Line to Neutral
Sensitivity: V in – V out = 10:1
Bandwidth: 5 KHz to 2 MHz

Common Mode, Neutral to Ground
Sensitivity: V in – V out = 10:1
Bandwidth: 5 KHz to 2 Mhz

Surge Voltage – ANSI C62.41; IEEE587, 1980 Part A ringwave 2000 volt maximum

Input Connector – 6 ft. long molded power cord with NEMA 5-15P plug (in North America)

Isolation Voltage – (V in – V out) 2000 VAC (RMS) Max for 1 minute. 280 VAC (RMS) steady state

Output Connectors – Three female BNC. Three male/male BNC 18” long coaxial cables provided

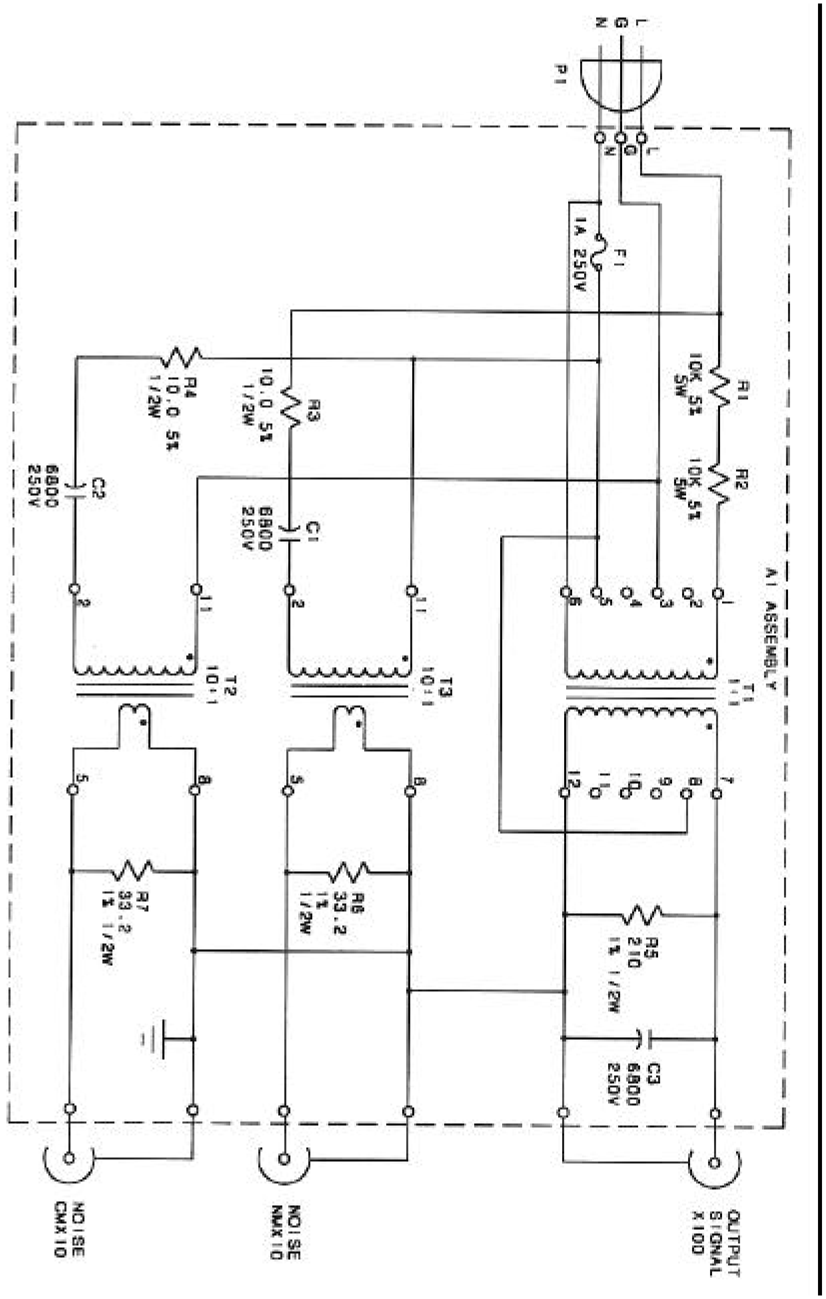
Dimensions – 2.25 “ High, 5.9” Long, 3.2” Wide

Unit Weight – 2 lbs. (.9 Kg.)

Shipping Weight – 3.5 lbs. (1.5 Kg) inc. carrying case and connecting coaxial cables

Warranty – Standard POWERVAR five-year limited warranty

PP115 Power Probe Electrical Schematic



Who Should Use the Power Probe ?

The Power Probe can be used by:

- Field Engineers
- Site Preparation Technicians
- Facilities Engineers
- Bio Medical Engineers
- Electricians

Why Should I Use the Power Probe ?

The effect of the electrical environment on electronic equipment/system performance and reliability has been greatly underestimated. There is a significant correlation between the quality of the AC power supplied to electronics and its ultimate reliability, performance, and longevity.

Power contamination inevitably results in hardware and software failures including power supplies, hard disks, integrated circuitry, data and logic corruption, and mysterious unexplained reasons for disruption.

Use of the Power Probe can expose contamination so that preventative measures can be taken to protect the electronics from costly repairs.

When Should I Use the Power Probe ?

➢ Before system installation to **predict** the possibility of future reliability problems.

➢ After installations to **verify** any adverse effect on AC power induced by the system

➢ **Trouble sites**, where repeated hardware and software failures, system lockups, and no trouble found service calls have been a problem

- To **test** the output of a power conditioning, UPS, TVSS or other similar device to evaluate its protection ability
- To **convince** your customer that poor power quality is present at their site

Getting Started

Open and unpack the shipping container. Check carefully for visible damage, which may have occurred during shipping. If the unit has been damaged due to shipping, you will need to file a claim with the carrier. If everything is in order, then open the carrying case and inspect the contents. The following pieces should be present:

- Power Probe PP115
- Three 18" long male/male BNC Coaxial Cables
- Carrying Case
- Instruction Manual

If any of the items is missing, contact your sales representative or call POWERVAR directly at one of the numbers on the back of this manual.

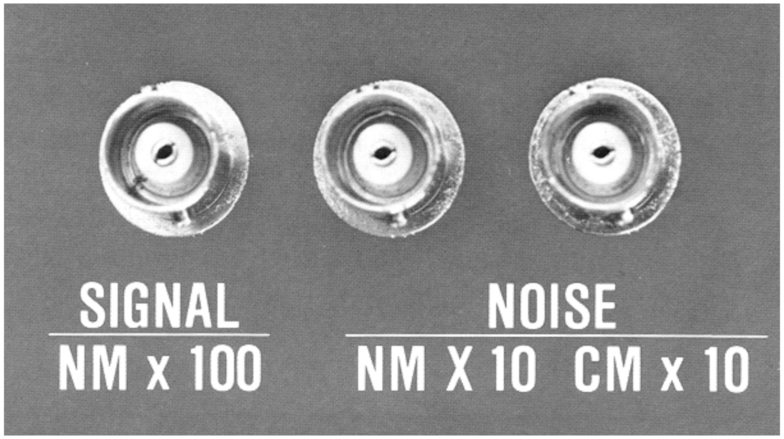
Getting to Know the Power Probe

The outputs are three female type BNC connectors labeled:

SIGNAL – NM x 100 : This connector allows the operator to view the power line waveform under inspection. This channel of the Power Probe looks at the signal on the Line to Neutral conductors.

Noise -- NM x 10 : This connector allows the operator to view the Normal Mode noise riding on the power line between the Line and Neutral conductors.

Noise -- CM x 10 : This connector allows the operator to view the Common Mode noise riding on the power line between the Neutral and Safety Ground conductors.



Power Probe BNC Output Connectors

Be Safe – Some Words of Caution

Caution: Input voltage to the Power Probe must never be allowed to exceed 250 VAC (RMS) or 300 VDC. Connecting the Power Probe to an input voltage higher than recommended specifications can result in internal damage and void the warranty. If in doubt, check the input source voltage with a voltage meter or equivalent equipment before connecting the Power Probe.

Caution: In order to assure operator and Power Probe safety, check the receptacle for correct polarity before plugging in the Power Probe. This can be accomplished with a circuit checker available from most electrical supply houses or by using a digital volt meter and the following chart. Line to Neutral and Line to Ground measurements should indicate nominal voltage. Neutral to Ground measurements should indicate no more than approximately 1 volt. If higher voltages are indicated, then the possibility of a wiring error exists. This should be corrected before you proceed.

120 Volt receptacle verification voltage measurement matrix.

	RECEPTACLE						COMMENTS	
	TERMINAL			VOLTAGE READINGS				
	L	N	G	L-N	L-G	N-G	CONDITION DESCRIPTION	NOTES
CIRCUIT CONDUCTORS	L	N	G	120	120+	<3	CORRECT WIRING	2
	L	L	G	208	120	120	2 LINES (HOTS) IN OUTLET	1
	L	G	N	120+	120	<3	NEUTRAL-GROUND REVERSAL	2,4,7
	L	N		120	30-70	30-70	OPEN GROUND	2,5,6
	G	L	N	120	<3	120	TOTALLY MIS-WIRED	7,9
	N	L	G	120	<3	120	LINE-NEUTRAL REVERSAL	2,9
	L		G	30-90	120	20-50	OPEN NEUTRAL	8
	G	N	L	<3	120	120	LINE-GROUND REVERSED	3,5,8
	N	G	L	<3	120	120	TOTALLY MIS-WIRED	3,5,8
		N	G	<1	<1	0	OPEN LINE	8

Caution: There are no user serviceable parts inside the Power Probe. Tampering with this device will void the warranty.

Setting Up the Power Probe for Diagnosis

The use of a modern dual trace oscilloscope with a bandwidth of 20 MHz. or greater is recommended. This will result in a high quality display. The greater the bandwidth of the oscilloscope, the more noise frequencies can be viewed. In addition, using the Power Probe with an oscilloscope capable of capturing, storing and then printing or downloading the waveforms to a personal computer can be invaluable when preparing a report on your findings to a customer, site manager, electrician, or other interested party.

To begin, set the oscilloscope to the following initial settings for viewing Normal Mode and Common Mode noise:

- Coupling Mode -- All AC
- Trigger Source -- Line
- Trigger Mode -- Auto
- Horizontal Mode -- No delay
- Time/Div -- 2 msec.
- Vertical Mode -- Chop
- Volts/Div -- .1 volt

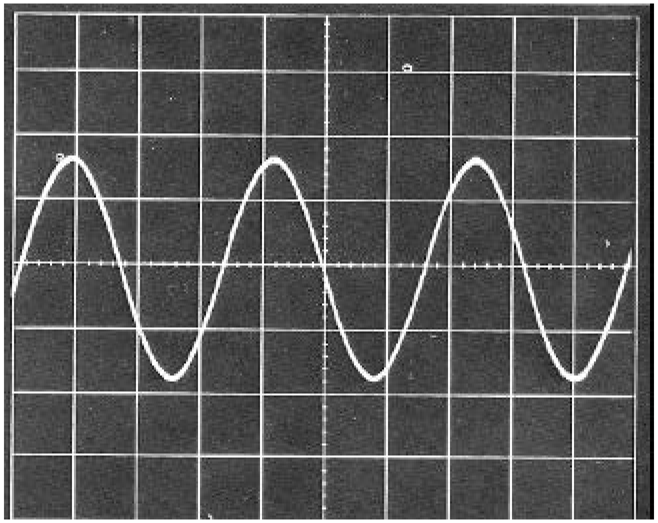
Initial recommended control settings for viewing the signal wave form (NM x 100) are the same except you should set the Volts/Div to 1 volt.

After becoming familiar with the initial set up, there will be times when you will want to take a closer look by changing the Volts/Div or Time/Div controls in order to inspect an entire transient waveform on the screen of the oscilloscope.

Understanding Power Probe Signals

Viewing the AC Sine Wave

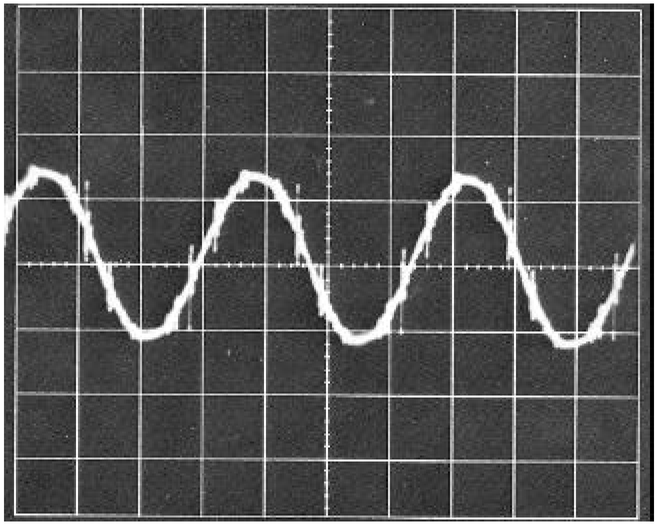
Connect the NM x 100 output channel to the oscilloscope. Plug the Power Probe into a circuit being tested. Since the Power Probe divides the power line by a factor of 100:1, and with the initial settings (shown above), each vertical division represents 100 volts. The peak to peak voltage of the AC sine wave form in North America should be 340 volts or approximately 3.4 divisions on the oscilloscope. One half of peak to peak voltage is called peak voltage and is equal to 170 volts. The RMS value of North American voltage is calculated by multiplying peak voltage by .707 (i.e. 170 volts times .707 = 120 volts RMS). This is how we arrive at the 120 volt value to which we commonly refer. Using the oscilloscope and Power Probe, along with this formula, you will easily be able to determine the RMS voltage of an AC circuit even without a voltmeter. The following photograph illustrates a sample waveform from the NM x 100 BNC connector.



Wave form free from spikes and distortion.
Voltage: 340 volts Peak to Peak, 120 volts RMS

Note that the peaks on the above wave form are smooth and the waveform is free from distortion. This indicates that the circuit under test is not overloaded and is supported by an adequate utility or distribution transformer. If, however, the waveform appeared distorted or showed considerable “flat topping” or low voltage, an overloaded branch circuit or distribution transformer might be suspected. In such circumstances, circuit loading should be reduced. Alternately, if the low voltage condition affects numerous circuits (or perhaps an entire distribution panel or panels) it might be necessary to provide a distribution transformer capable of supplying a larger amount of power.

You may also notice “notches” or spikes near the peaks of the waveform. These are indications that switch mode power supplies are operating on this circuit. Switch mode power supplies are capable of generating substantial electrical noise that is injected back into a facility’s electrical system. Low voltage and switch mode supply generated noise are present in the photograph below.



Waveform characterized by low voltage and noise
created by switch mode power supplies.

Monitoring Normal Mode and Common Mode

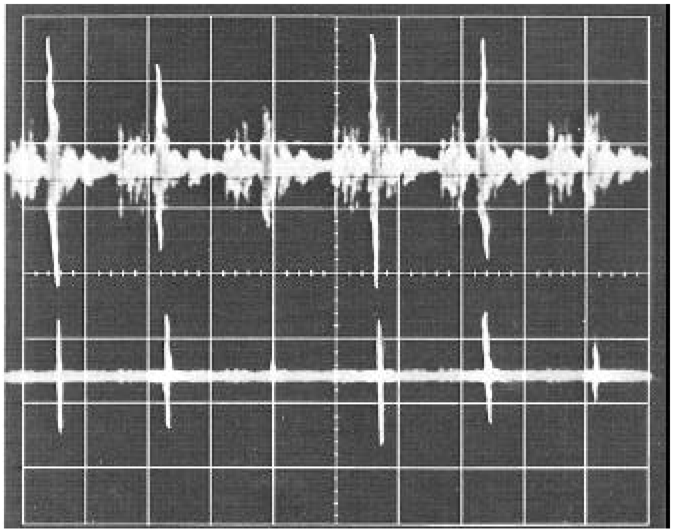
It is often convenient to use the dual trace feature of the oscilloscope to monitor both Normal Mode (NM) noise components and Common Mode (CM) noise components simultaneously. For easy reference, POWERVAR recommends establishing a pattern of always viewing the NM trace on the top and the CM trace on the bottom. That way, you’ll never forget which trace is which.

Connect the NM x 10 and CM x 10 outputs to the oscilloscope by connecting NM x 10 to channel 1 and CM x 10 to channel 2 (refer to the specific settings in the ***Setting Up the Probe for Diagnosis*** section. Plug the Power Probe into the circuit being tested. The Power Probe will now be monitoring high frequency noise contamination within a bandwidth of 5 KHz to 2 MHz between the line and neutral conductors (NM) on channel 1 and the neutral and ground conductors (CM) on channel 2.

With the oscilloscope set to the initial settings, each vertical division equals the Volts/Div display multiplied by a factor of 10. That means that the display vertical scale is actually 1 volt per division (initial setting of .1volts/div x 10 = 1 volt).

Please note: Some oscilloscopes have the ability to calibrate each channel to reflect an input multiplier. If your oscilloscope has this ability, you may choose to program the channels to reflect the fact that the probe requires a 10x multiplier. Calibrating your oscilloscope in this manner will allow you to read waveform amplitudes directly from the screen at the Volts/Div shown on the oscilloscope's vertical control.

The following photograph illustrates "typical" normal mode and common mode noise signals viewed on an oscilloscope using the Power Probe. Notice the noise contamination.

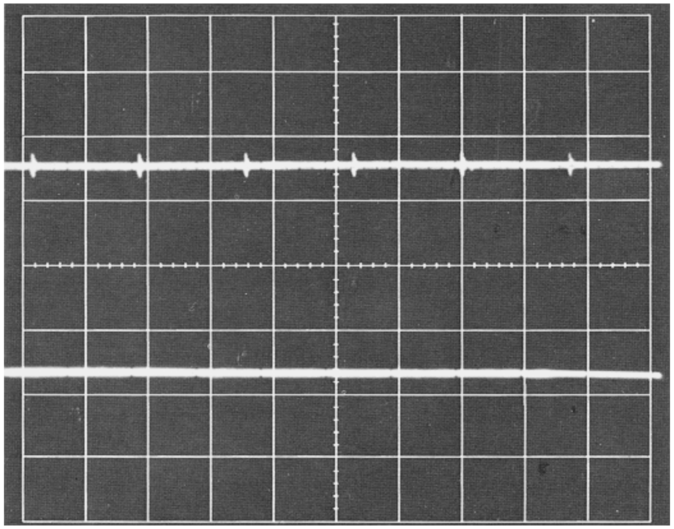


Top Trace – Normal Mode – 4 volts peak to peak
Bottom Trace – Common Mode – 2 volts peak to peak

Each horizontal division is simply the **Time** displayed on the Time/Div control. (For example, a 60 Hz sine wave form has a duration of 16.7 msec. Therefore, with the initial settings of 2 msec. per division on the Time/Div control, you would expect a complete 60 Hz. sinewave to occupy a little more than 8 divisions on the display.) The Time/Div setting allows you to determine the duration, rise-time, frequency, and repetition of normal mode and common mode noise disturbances.

With the Power Probe and oscilloscope, you now have the ability to determine the effectiveness of a range of power treatment devices. By plugging TVSS units (surge diverters), filters, UPS systems or other devices into the circuit you're testing and then monitoring their output with the Power Probe, you can judge how well each will correct the noise problems you've discovered.

The following photograph shows the same test circuit after the noisy power has been conditioned by a POWERVAR ABC model power conditioner.



Top Trace – Normal Mode – 4/10 volt peak to peak
Bottom Trace – Common Mode – Reduced to 0 volt

Where Does AC Power Line Contamination Come From?

There are many devices in a facility that contribute to AC power contamination. As a matter of fact, most power disturbances are created by all the different devices that use electricity. For example, internal building sources such as copy machines, vending machines, air conditioners, microwaves, shredders, fluorescent lighting, and elevator motors all can cause disturbances that result in mysterious electronic system malfunctions. External building sources like lightning, power line damage, utility grid switching, and power factor correction activities can also cause troublesome power disturbances. These problems can also cause disruption, damage, and/or outright destruction of sensitive electronics.

The very tools that are so important to our daily productivity can cause havoc and damage to sophisticated electronic systems. The susceptibility of sophisticated electronics to electrical contamination varies from system to system. However, in some cases, it has been found that system reliability can be compromised by noise disturbances that exceed 10 volts normal mode or .5 (one half of one volt) common mode. This is understandable when considering that most electronic logic (DC Bus) and safety ground are tied to chassis. Common mode noise becomes very critical.

Given the trend toward electronic systems with higher density integrated circuits, larger RAM memory, lower voltage logic circuitry, and ever increasing clock speeds, the need for consistently clean, dependable quality electrical power is increasing daily. Because it would be unproductive to remove either the devices that cause power problems or the computer systems that experience power problems from our daily lives, it has become necessary to be proactive in protecting our electronic systems. POWERVAR's Power Probe makes it possible to easily identify the presence of objectionable power disturbances. POWERVAR's complete family of power quality products can provide the solution.

Maintenance

Because the Power Probe is a passive instrument, maintenance is not required. The Power Probe contains no user serviceable parts, and opening it or tampering with it in any way may void the warranty.

If you suspect that your Power Probe is not functioning properly, then a signal generator test with a known input should be performed. In addition, you should try interchanging coaxial test leads or try another coaxial test lead equipped with BNC connectors. If these attempts prove that test leads are not at fault, and if the test results with a known input signal prove negative, then contact your local POWERVAR representative for assistance. You may also contact POWERVAR direct by:

Calling toll free – (800) 369-7179
Calling in Illinois – (847) 596-7000
By Fax in North America – (847) 596-7100
Calling in Europe – +44 (0) 1793 786050
Fax in Europe -- +44 (0) 1793 782250

or by emailing us from our website @ www.powervar.com

Warranty

POWERVAR warrants the Power Probe (called the "product") to be free from defects in material and workmanship for a period of five years from the date of shipment. The product will be repaired or (at POWERVAR's option) replaced at no charge during this warranty period. The product must be returned prepaid to the factory. POWERVAR makes no warranties, expressed or implied, of merchantability, fitness for a particular purpose, performance, condition, capacity, or otherwise. POWERVAR is not liable for incidental or consequential damages, monetary loss, loss of sales, or loss of business resulting from the failure or malfunction of the product. Warranty is void on product that is misused, misapplied, abused, altered by unauthorized personnel or where evidence of tampering exists. The foregoing constitutes the sole and exclusive remedy of the purchaser and is in lieu of all other warranties. No greater degree of liability is imposed on POWERVAR, Inc.