User's Manual for PowerSight® PS5000

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PowerSight is a registered trademark of Summit Technology, Inc.

The PowerSight model PS5000 is designed to comply with part 15, subpart B, of the FCC Rules for a Class A digital device.

Model PS5000 is designed to comply with the requirements of IEC61010-1:2001 for a 1000V input rating measurement category III, pollution degree II, double insulated electronic device.

Model PS5000 is manufactured by Summit Technology, Inc in the U.S.A. The standard warranty period is 12 months from date of purchase. We encourage you to advise us of any defects of design or manufacture of any of our products. We are dedicated to your successful use of the product.

⚠ There are no user serviceable parts in your PowerSight meter. Opening the case voids your warranty and may result in present or future danger to users of the meter. The rechargeable battery inside is a custom-designed battery pack that is only to be replaced by authorized Summit Technology technical service personnel.

⚠ Cleaning is to be done by use of a dry or damp piece of cloth. Grease may be removed by light application of isopropyl (rubbing) alcohol. Avoid the use of solvents, since they may dissolve or weaken the plastic enclosure. Do not use water or other conductive liquids since they may pose a safety risk.

⚠ Use of this equipment in a manner not specified by Summit Technology can result in injury and voiding of warranty.

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Introducing PowerSight

The PS5000 is the premier member of the PowerSight line of compact, versatile, easy-to-use power quality analyzers. It provides the most Efficient and Error Free solution for your power study needs. New with PS5000:

- 3.5 inch Graphics Display
- Faster Bluetooth Communications
- USB Communications
- Surestart Graphical Connections
- Testplan Manager Support

The PS5000 is a complete solution for the measurement and analysis of all aspects of power:

- High-speed transient analysis
- Swell/Dip analysis
- Harmonics analysis
- Demand analysis
- Data logging
- Automated report writing
- Wiring and system analysis

The philosophy of the product is still the same, to give you an instrument that answers your questions about electric power in a truly convenient size at an attractive price, now with more features!

Whether your interest is in

- The quality of incoming power,
- Managing power consumption, or
- Maintaining and comparing equipment

PowerSight puts all the power in the palm of your hand!

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*Note: Throughout this manual, whenever we refer to an individual key of the keypad, we print the name on the key enclosed by square brackets. For example, the “Voltage” key is referred to as [Voltage].

Connecting to PowerSight

Voltage Test Leads

A Deluxe Voltage Probe set consisting of four leads is included with each PowerSight. Each of the voltage test leads is 6 feet (2 meters) long, with safety banana jacks at one end and safety plunger clamps at the other end. Each is labeled at both ends as the V_1, V_2, V_3, or V_N test lead. The safety plunger clamps have telescoping jaws that you can actuate while keeping your fingers three inches away from the actual metallic contact. Regular test probes have conventional alligator jaw attachments that require your fingers to be within one inch of the metallic contact. Also, the method of attaching alligator jaws to a test lead can allow a gap in the insulation between the lead and where they join. This is where your thumb and finger are pressing while you actuate it.

⚠ **For these reasons, to avoid unnecessary risk of shock, regular voltage test leads should not be connected to or disconnected from live circuits and should definitely not be connected to or disconnected from voltages above 120 Vrms.**

⚠ **Another word of caution: Whenever connecting to a live circuit, remember that the jaws of a voltage test lead are much wider when they are open than when they are closed. The potential to short or flash across two adjacent terminals or wires is a constant danger when connecting to a live circuit. Depending on the current capacity of the circuit being shorted, arc flash and a deadly explosion of molten material can result!**

Once they are securely connected, the deluxe voltage leads are safe for steady voltages of the 1000 Vrms rating of PowerSight. The clamps of the deluxe voltage leads are rated for 1000V working voltage, measurement category III. This is equivalent to measurement category III for a working voltage of 1000V, the rating of the PS5000.

Summit Technology also sells a fused voltage lead set (order DFV). The safety advantage of fused leads is that if a short occurs through the insulation of a lead to ground, the fuse in the handle should quickly blow out, preventing the lead from vaporizing in an explosion of molten metal. The safety disadvantage of fused leads occurs when the fuse is blown or is removed. The user will measure 0 volts on a live circuit and may be tempted to lower his safety awareness, possibly resulting in shock or damage. The DFV probes are rated for 1000V, measurement category III.

Current Probes

Summit Technology provides a variety of probes for your use. They offer different measurement ranges, different sizes and physical characteristics, and the ability to measure different types of current.

Probes such as the HA1000 are excellent choices to use with PowerSight because they support all the accuracy specifications of the product. For instance, the HA1000 has an accuracy of 0.5% whereas many probes on the market have an accuracy of 2-3%. Also, the HA1000 maintains its accuracy for frequencies up to 20,000 Hz. With our spectrum analyzer option (order FAO) it can be used to measure frequencies up to 100,000 Hz riding on the power line. This allows accurate current and power readings of distorted waveforms, accurate readings of harmonics, and the measurement of current transients that other probes would not even detect.

Phase shift is also an important probe characteristic. The HA1000 has less than 1/2 degree of phase shift across the frequency range when measuring currents above 50 amps and just 1.5 degrees at 5 amps. This means that instantaneous measurements of power are highly accurate, regardless of the waveform shape. The phase shift characteristics of most other probes on the market are not this good. This results in erroneous power and cost measurements and distorted waveforms. Please Note: To diminish phase shift when measuring small currents, it is advisable to clamp onto multiple "turns" of the same conductor in order to increase the effective current being sensed.

The HA5 offers two advantages over the HA1000, but these advantages come at a cost. Its advantages are that the HA5 is a very small size (5.25 × 2.00 × 1.35 inches) and second, it offers much greater sensitivity since it reads currents from 20 milliamps to 5 amps (as compared to the HA1000 measuring 1 - 1,000 amps). The tradeoff is accuracy. The probe has a basic accuracy of 2% and its phase shift varies by frequency and by amplitude. All told, you can expect to measure current to a nominal 2.25% accuracy and power and cost to a nominal 3% accuracy using the HA5 probe.

The HA100 probe is the same compact size as the HA5. The HA100 measures from 0.1 to 100 amps at 2% accuracy. It is a good choice over the HA1000 if you wish to lock PowerSight, its leads, and current probes inside a power panel that you are monitoring. It is also a good choice when small size is important while measuring currents above 5 amps. The HA100 is a popular choice for a second set of probes.

For very large currents and large bus bars, we offer the eFX6000. The eFX6000 is a "flex" type probe. It consists of a flexible tube about 0.4 inch in diameter and 24 inches long (a 36-inch version is also available). The ends of this tube snap together around a conductor to sense the current. Flex probes are very handy when space is tight, when multiple cables must be clamped around, or when a bus bar is present. They are also lighter than clamp-on probes. The flexible tube creates a circle with an inside diameter of 7 inches. This circle can be deformed into various shapes to accomplish your measurement goals. The basic accuracy of the flex probe is good, measuring from 1 to 6000 amps (across two ranges) within 1% accuracy. However, readings can vary as much as 2% depending on the position of the flex probe while connected. Position the flexible portion of the probe around the conductor so that the cable from the probe drops straight down and the place where the ends snap together is at a right angle with the conductor and not touching it. The frequency response of flex probes is very good, but phase shift increases with frequency. Our eFX6000 is powered by the meter, so no batteries are required.

You must use added caution when connecting an FX series current probe around exposed conductors and bus bars since you must pull the tube around the conductor and thus get your hands and arms closer to it than when using HA series clamp-on type current probes. Wise practice dictates that you use high insulation protection on hands and forearms in these circumstances or deactivate the circuit.

The DC600 probe is used for AC current measurements from 5 to 400 amps and DC measurements from 5 to 600 amps. It offers accuracy of 2% ±1 amp from 5 - 400 amps and 3% accuracy for DC from 400-600 amps. This probe relies on Hall Effect technology and its output varies slightly over time. Therefore, a zero-level adjustment is provided on the probe's handle for initial zeroing before each measurement session. The probe can clamp around one cable up to 1.18-inch diameter or two cables of up to 0.95" diameter. Unlike other manufacturers' DC probes, ours do not require batteries for them to run.

New probes and adapters are introduced regularly, so if you have a special need, give us a call.

Please Note: Always inspect the metal surfaces of clamp-on probes before use. Clean them with a rag or sand them with fine sand paper and then slightly oil the surface. Any dirt or rust will affect the accuracy of the measurements!

Connections to PowerSight

Voltage test leads plug into the top end of PowerSight. Each test lead of the Deluxe Voltage Test Lead set is labeled (V_N, V_1, V_2, or V_3) and each jack is similarly labeled (V_N, V_1, V_2, or V_3).

Note: The V_N test lead is a different color from the other leads (black). Similarly, the V_N jack on PowerSight is a different color from the other ones (black). Connecting anything other than neutral or ground to the V_N jack can jeopardize your safety, the functioning of the unit, and the accuracy of the unit.

Current probes plug into the top end of PowerSight, just above the voltage inputs. Each current probe is labeled (I_1, I_2, I_3, or I_N) and each jack is similarly labeled (I_1, I_2, I_3, or I_N). When plugging a current probe into PowerSight, the flat side of the plug should be facing upwards so the label is readable. This will align it properly for plugging into the PowerSight case.

Clamp-on probes have a correct orientation in which to attach them. On most probes' head, there will be an arrow pointing in the direction of the conductor being measured. When clamped onto I_1, I_2, I_3, or I_N, the arrow should point along the conductor from the power source towards the load. If the current probe is connected backwards, its waveform will appear upside-down when you upload waveforms, it may be slightly less accurate in its current readings, and, most importantly, if you operate in positive/negative power measurement mode, power readings will be disastrously wrong.

Introduction to Power Delivery Configurations

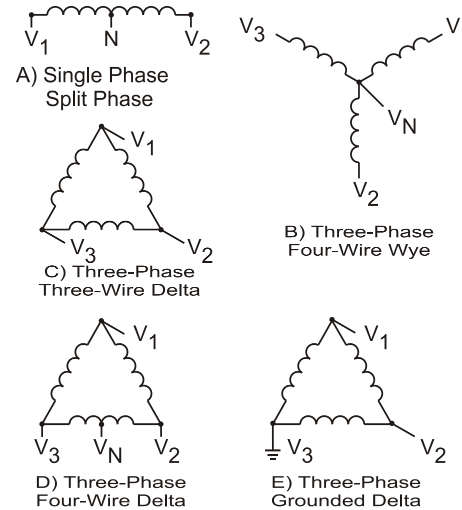


Fig. 1 - Common Power Delivery Configurations

Figure 1 presents most common power delivery configurations. PowerSight is able to measure voltage, current, power, power factor, and more for all of these systems. Figure 1A presents the normal single-phase and split-phase service as found in a residential service. In North America, V_{1N} and V_{2N} are 120V and are 180 degrees out of phase with each other. When heavier loads are encountered, V_{12} (240V) is used by delivering both hot voltages to the load. Neutral provides the current return path. If the load is balanced, there will be relatively little neutral current. Refer to figures 2, 3, 4, and 5 for various ways to connect to single-phase and split-phase power service.

Figure 1B presents normal three-phase "wye" power service. Voltages are usually measured from phase-to-neutral. Neutral provides the current return path. If the load is balanced, there will be relatively little neutral current. Refer to figure 6 for how to connect to a three-phase wye power service.

Figure 1C presents normal three-phase delta service. Voltages are usually measured from phase-to-phase or phase-to-neutral. In North America, service is usually supplied as 120/208V, 277/480V, 346/600V, 2401/4160V, or 7200/12,470V. There are several others. In most of the world, phase-to-phase service is usually supplied as 230/400V, 400/690V, 3,000V, 6000V, and

11,000V. Summit Technology has regular and special voltage probes for direct connection to all of these services. Refer to figure 7 for how to connect to a delta power service. When there is no access to measuring one of the currents, figure 8 presents the 2 current approach for measuring power. This approach is also useful for measurement of an open delta circuit as described in Connections to an Open Delta Circuit (2PT/3CT)figure 10. Although phase-to-phase is the normal voltage measurement mode for this service, PowerSight can be set to phase-to-neutral (even though the neutral is not connected). In this case, the measured voltages will be phase-to-metering-neutral (such as V_{1N} = 277V for a 480V service) and all other measurements will also be correct.

Figure 1D presents three-phase four-wire delta service. In this configuration, a neutral is supplied from a point midway between two phases. This is handy when 240V delta is supplied. V_{2N} and V_{3N} supply conventional 120V single-phase power and V_{1N} provides 208V, if needed. In this configuration, depending on what you are measuring, you may choose to measure in phase-to-phase mode or in phase-to-neutral mode.

Figure 1E presents grounded delta service. This configuration is actually not very common. It can be attractive to use if an electrically isolated three-wire delta service is available and there is a need to provide the power a long distance away at a private facility (such as a saw mill). By grounding one of the phases at the source, the cost of supplying one of the phases to the remote site is saved. A motor at that site would be connected to phase 1, phase 2, and earth ground. There is increased danger in this configuration over normal isolated delta service since the reference to ground is intentionally an excellent conductive path. Nevertheless, PowerSight will provide the desired measurements in this configuration.

Connecting to Single-phase Power

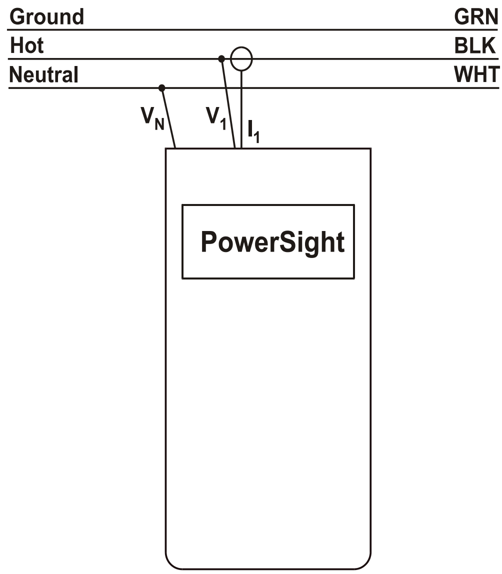


Fig. 2 - Basic Single-Phase Connection

Figure 2 presents the basic connections to a single-phase system. ⚠ **Be sure to follow the safety warnings of the previous sections before making the connections.**

Clamp your phase 1 current probe onto the "Hot" wire. Make a metallic connection to neutral with the V_N voltage lead. Similarly connect the V_1 lead to "Hot". Since voltage now comes into PowerSight on V_1 and current is sensed by I_1, the power and power factor for this single-phase system will be available as phase 1 power and phase 1 power factor.

⚠ **Caution: Until you are certain that your voltage connections to PowerSight are correct, disconnect any current probes. This is because PowerSight and all of its connections float at the potential of V_N. If V_N is "hot", there may be a breakdown through the insulation of any attached probes.**

Helpful Hint: How to Identify the "Neutral" lead.
Normal single-phase wiring follows the convention of "neutral" being the white wire, "hot" being the black wire, "hot2" being the the red wire, and "ground" being the green wire. If the wiring and your

connections to PowerSight are as shown in figure 2, V_{1N} will be some relatively large number like 120 volts and V_{3N} will be a small voltage like 3 volts. If you then reverse the ground and neutral leads, V_{1N} will now read slightly less, like 117 volts. If "hot" and "neutral" are reversed, then V_{3N} will become a large number, like 117 volts.

Connecting to 120 V Outlet Adapter Box

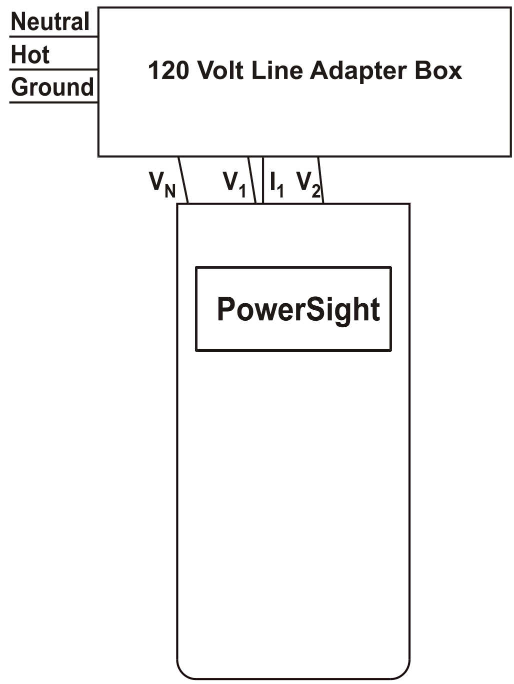


Fig. 3 - Connects to the 120 V Line Adapter

The 120 V Outlet Adapter Box accessory (order number 120ADP) offers a safe, convenient, and accurate way to monitor voltage in a commercial setting or to evaluate power usage of appliances.

Figure 3 presents the connections to the Adapter Box. Simply plug the adapter box into a wall socket and then attach the voltage and current leads into PowerSight. Each lead is labeled to eliminate errors in connections.

⚠ **Note: Make sure that the hot and neutral wiring being measured is not reversed. If so, PowerSight and its attachments will "float" at 120 V.**

Note: The 120ADPa is rated for continuous duty of up to 15 Arms. Do not exceed this continuous load.

To evaluate the power usage of an appliance, simply plug the appliance into the top of the 120 V Outlet Adapter Box after the other connections have been made and verified. Even without an appliance plugged in, the adapter box offers a convenient means of checking for transients or analyzing the harmonic content of the incoming voltage.

Connecting to Multiple Single-phase Loads

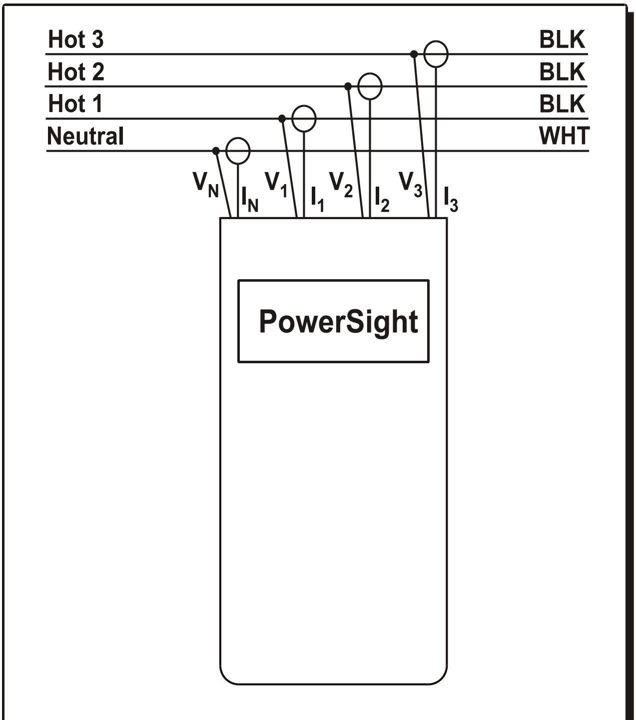


Fig. 4 - Multiple Single-Phase Connections

Figure 4 presents a means to monitor 3 single-phase loads simultaneously. The loads must all share the same neutral voltage connection. If the loads run off the same line voltage, connect V_1, V_2, and V_3 to the same "hot" wire. I_1, I_2, and I_3 serve the 3 loads. This approach can also be used to evaluate the current of a 4th load, but the power used by that load will not be calculated.

In this configuration, the voltage, current, and power of each load can be displayed directly or graphed on your PC using our PSM-A software.

Connecting to Split-Phase (Two Phase) Power

Fig 5 shows the recommended connections to a split-phase system as found in commercial and residential facilities, when measuring the supply to two single phase loads. There are two "Hot" wires 180 degrees out of phase with each other and sharing the same neutral. Appliances such as ovens that require 240V will span across both hot wires. When evaluating the power for a load spanning the two phases, remove the V_N voltage lead since it may affect the power factor readings of each phase.

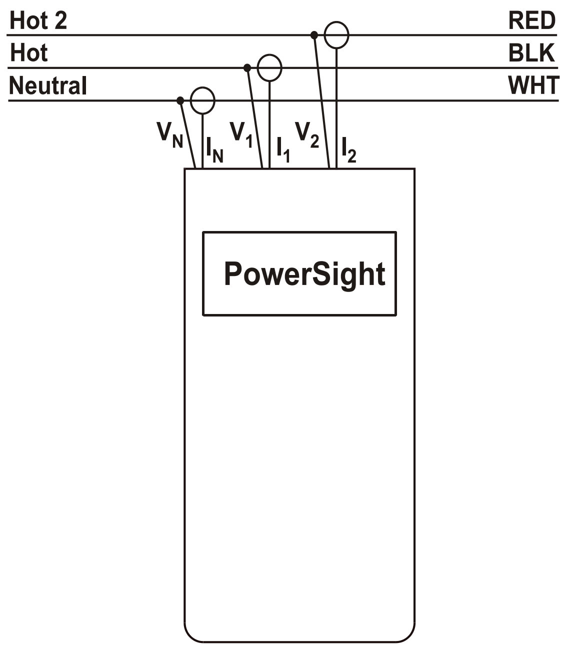


Fig. 5 - Recommended Two-Phase Connections

In this configuration, a reading of V_{1N} is of hot-neutral and V_{2N} is hot2-neutral. I_N does not need to be connected and V_N should not be connected when the load spans the two phases. The power associated with one hot is measured as phase 1, the power of the other hot is measured as phase 2. In phase-neutral measurement mode, the voltage readings will be from hot-to-neutral. If you change the measurement mode to phase-phase, V_{12} will be the hot-to-hot voltage that serves the high-power appliance.

Connecting to Three-Phase Four-Wire (Wye) Power

Figure 6 presents the recommended connections to a three-phase system with voltages referenced to neutral, a "phase-neutral" or “three-phase four-wire wye” configuration.

⚠ **Be sure to follow the safety warnings of the previous sections before making the connections.**

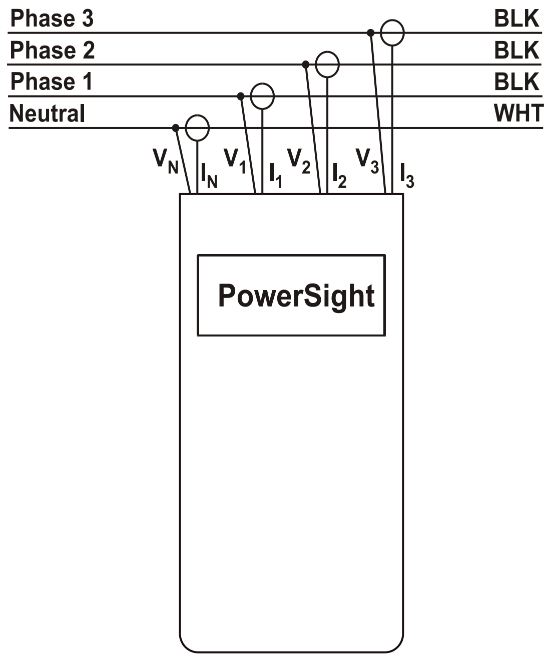


Fig. 6 - Recommended Three-Phase (Wye) Connections

Although the current of each phase is carried by neutral, neutral current is generally relatively small since the currents of the 3 phases largely cancel each other in the neutral leg. In a perfectly balanced system, the current in neutral would be zero.

In a wye system, each phase is essentially independent of each other. For this reason, the power factor of each phase has direct meaning, but the total power factor is less meaningful.

Most commercial wiring and newer industrial wiring is in this wye configuration.

Connecting to Three-Phase Three-Wire (Delta) Power

Figure 7 presents the recommended connections to a three-phase system with voltages referenced to each other instead of to neutral. This is a "delta", "phase-phase", or “three-phase three-wire” configuration.

 **Be sure to follow the safety warnings of the previous sections before making the connections.**

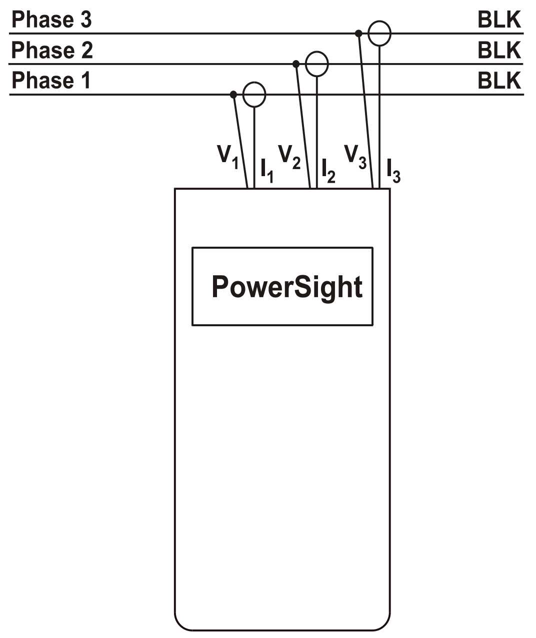


Fig. 7 - Recommended Three-Phase (Delta) Connections

Please Note: Do not connect the V_N input to anything when measuring in phase-phase measurement mode. This may affect the measurements associated with individual phases.

In a delta configuration, current flowing in each phase is due to the interaction of 2 different voltages. For instance, I_1 current is the resultant of V_{12} and V_{31}. Normally, there is no way to determine what portion of the current is due to which voltage. For this reason, only the total power and total power factor have definite meaning in a delta system. However, comparing the power factors of each phase can be valuable for spotting a connection problem or problem with the load.

Delta power is common in motors and older industrial sites.

A variation of delta is “four-wire” (or “center-tapped”) delta (see figure 1D). In this configuration, if the main interest is in measuring phase-neutral voltage, then connect the neutral voltage to the neutral input for more accurate voltage readings

Connecting to Three-Phase Four-Wire Delta Power

Figure 6 presents the recommended connections to a three-phase delta system where a neutral is provided from the center of one of the phases.

⚠ **Be sure to follow the safety warnings of the previous sections before making the connections.**

This type of system allows delivery of both three-phase and single-phase power. The three-phase power is typically 240V for running motors. The dual single-phase power is typically 120V for running lights and small equipment, from one power service. It also provides 208V. Depending on what you intend to monitor, it may be appropriate to set PowerSight in phase-phase voltage measurement mode (to monitor three-phase loads or to look at total power) or in phase-neutral voltage measurement mode (to monitor single phase loads). Although the selection of voltage measurement mode affects what voltage levels are displayed and recorded (phase-phase versus phase-neutral), it does not affect the power and power factor calculations.

Connecting to Three-Phase Grounded Delta Power

Figure 7 presents the recommended connections to a three-phase system with one phase tied to ground. No connection is made to the neutral input. One of the phases originates from ground.

⚠ **Be sure to follow the safety warnings of the previous sections before making the connections.**

Connections Using 2 Current Approach

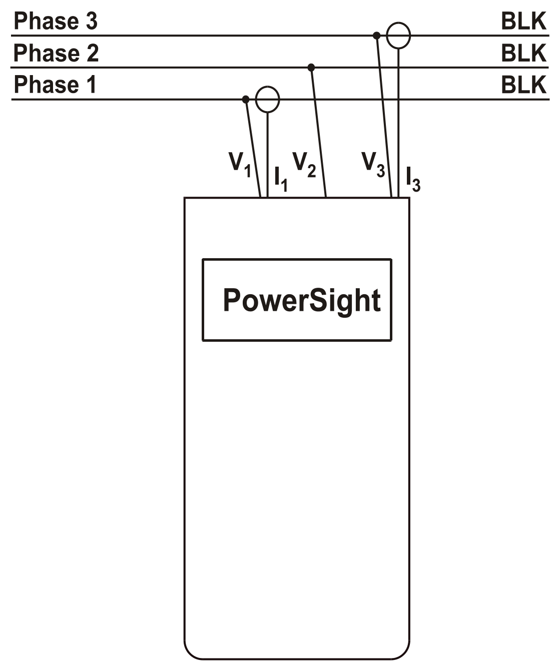


Fig. 8 - Connections for 2 Current Probe Approach

In the previous sections, the approach used to measure power has been based on determining the power of each phase and then summing them to get the total power. The 2 current approach (figure 8) allows you to determine the total power from measuring only 2 of the 3 currents and combining them with the 3 voltages of the three-phase circuit. The disadvantage of this approach is that you cannot determine the power, power factor, or VA of each individual phase and, of course, you cannot record the current of one of the active phases.

A necessary use for this type of connection is to measure utility power where only two metering CTs and three PTs are provided. After hooking up to the CTs and PTs, you enter the input ratios into PowerSight (see the Setting Input Ratios section) in order to record the correct values (the values on the primary side of the transformers).

A different motivation for using this type of connection is to save time and money. By only connecting to 2 of the 3 currents, a small amount of time can be saved. The frugal user appreciates this approach because he can save the cost of one current probe when buying a system in order to measure total power. Another motivation occurs in situations where one of the phases cannot be measured due to accessibility.

This approach is also called the “2 wattmeter approach” because it mimics how two single-phase wattmeters can be used to measure total three-phase power. The equation that it depends on is:
$W_{total} = \sum (V_{ab} \times I_a) + \sum (V_{cb} \times I_c)$. This equation is true regardless of the harmonic content of the voltages and currents present. A few words of caution are required, however. First, a volt-ohmmeter cannot be used for this calculation. That is because the equation depends on the instantaneous products of voltage and current. That is normally quite different from the product of the RMS voltage and RMS current. Second, a single-phase wattmeter should not be used for this calculation since conditions normally change second by second and hence adding the watts of two different setups will, at best, give a “feel” for the correct true power. Lastly, it is more important to make the connections correctly in this approach since an error will not be obvious and there is no way of recovering to an educated guess of the correct power reading.

Refer to the Phase-Neutral vs Phase-Phase vs 2 Current Mode section for how to operate the unit in 2 current probe mode.

Connections to a 3 CT / 3 PT Metering Circuit

Sometimes it is helpful to monitor a load indirectly, by connecting PowerSight to a metering circuit in front of the load. A few circumstances where this is the case are:

- the CTs (current transformers) and PTs (potential transformers) of the metering circuit are readily accessible for connecting to, whereas the actual load carrying cables are not
- the conductors carrying the load are physically too large for your current probes to fit around them
- the load current is too large to be read by the current probes you have
- the voltage delivered to the load exceeds the 600V insulation limit of the current probes

- the voltage delivered to the load exceeds the 1000Vrms rating of PowerSight and you do not have other high voltage probes.

A typical metering circuit showing PowerSight connected is shown in figure 9. This circuit has three CTs and, if higher voltage is present, may have three PTs. It is typical for metering a three-phase four-wire wye type service. The currents flowing to the load are considered the "primary currents". Those currents are "stepped down" by each CT to a "secondary current" according to the ratio of the CT printed on its rating plate. A typical value would be 600:5 (120:1). The output of each CT must have some burden across it for the secondary current to flow. The current probes of PowerSight are clamped around the secondary of each CT. Make sure to use current probes that are suited for accurate measurement in the

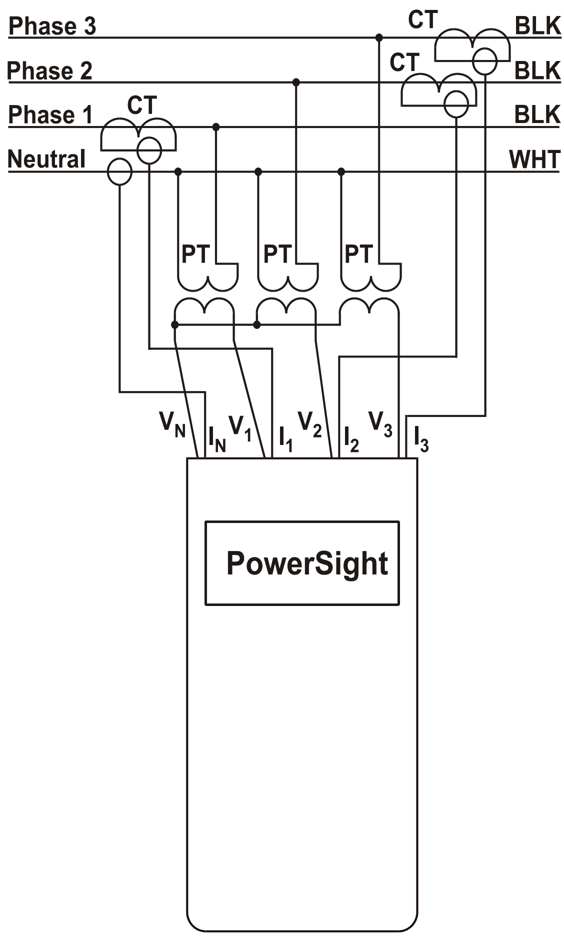


Fig. 9 - Recommended Connections to 3 CT / 3 PT Metering Circuit

0-5 amp range. The HA5 is best for this. The HA1000 or HA100 may be acceptable, depending on the current level.

Once the current probes are attached, it is best to set the input ratios for each of the current probes (see the Setting Input Ratios section). This will allow the displayed values and logged values to reflect the primary current level instead of the secondary current level. This in turn allows accurate power and cost readings without having to multiply the results times some ratio. Remember that these ratios are reset to 1:1 whenever PowerSight is turned off.

Similarly, the PTs take a primary voltage and step it down to a secondary value. If the primary voltage is below 1000Vrms, you will not need to hook up to the PTs (in fact, there will probably be none present). The ratio of the stepping down of the voltage will be printed on the rating plate of the PT. Typically, this would be 2400:120 (20:1). As with the CTs, this ratio should be entered into PowerSight (see the Setting Input Ratios section) to simplify interpreting the results.

Connections to a 2 CT / 2 PT Metering Circuit

Figure 10 shows recommended connections to a metering circuit with only 2 CTs or 2 PTs. This type of metering circuit may be preferable when cost is an issue (less instrument transformers are used) or when metering a delta service with no reference to neutral. The discussion of the previous section (Connections To a 3 CT / 3 PT Metering Circuit) applies to this circuit as well, with one important exception. If you clamp onto the CTs, rather than clamping onto each of the primary currents directly, PowerSight must be operating in the 2 Current Probe mode of operation (see the Phase-Neutral vs Phase-Phase vs 2 Current Mode section).

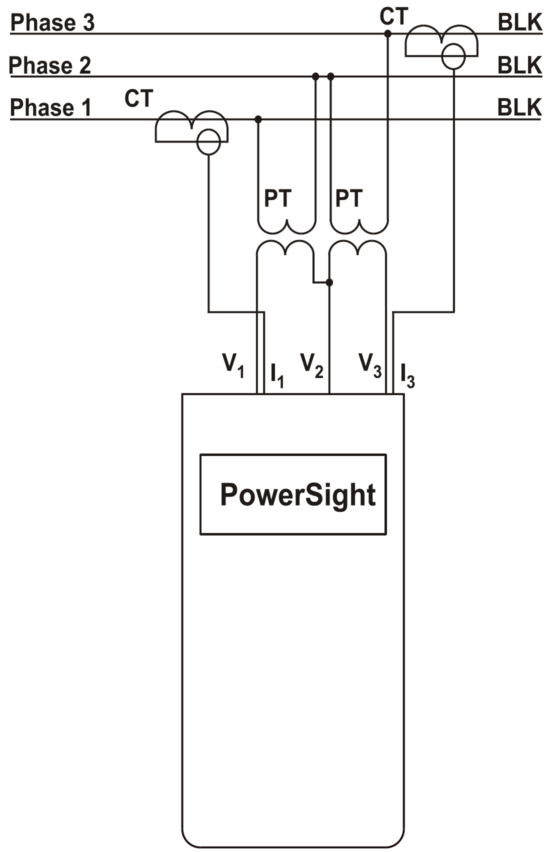


Fig. 10 - Recommended Connections to 2 CT / 2 PT Metering Circuit

Connections to an Open Delta (3CT / 2PT) Metering Circuit

In the open delta configuration, two PTs and 3 CTs are available. Make the voltage connections as shown in figure 10 of the

Connections to a 2CT / 2PT Metering Circuit section. For current connections, connect the phase 1 and phase 3 probes as shown in figure 10 and attach the phase 2 current probe to the phase 2 CT. You will not need to operate in the 2 Current Probe mode of power measurement since there are 3 currents being monitored.

Connecting to Line-To-DC (LDC) Converter Accessory

The Line-To-DC Converter accessory (order number LDC4 or LDCm) converts the voltage that is being monitored into DC voltage to run and charge PowerSight. The applications of this option are:

- Electrical room monitoring where a 120V outlet jack is not available for your charger
- Monitoring where an extension cord from a 120V outlet jack would be a safety hazard
- Monitoring on a rooftop, power pole, or power pad
- Reliable charging for the meter when there is concern that an available 120V outlet jack may be switched off by other personnel
- Simplified monitoring connections (no need to think about powering PowerSight when installed inside a CASW weather-resistant case.

Figure 11 shows the correct method of connecting the LDC to PowerSight. The LDC comes with two long red input leads that end with a stackable safety banana plugs. These stackable plugs are to be inserted directly into two of the inputs of PowerSight. If you are monitoring power without a neutral, we recommend plugging them into the V_1 and V_2 inputs. If an external neutral is present, we recommend plugging them into the V_1 and V_N inputs. In any case, there needs to be a potential between them of at least 100 Vrms and no more than 500 Vrms from 50 Hz or 60 Hz power.

The LDC also comes with in-line fuse assemblies plugged into the stackable plugs. These red assemblies contain 1000V fuses. They provide protection if a short should occur in the LDC. The two voltage leads that would normally be plugged into PowerSight are plugged into the loose ends of the in-line fuses. At this point, PowerSight is ready to measure voltages as usual and the LDC is connected in parallel to two of the inputs of PowerSight. You may wish to remove the in-line fuse assemblies, plug your voltage leads directly into the stackable plugs, and plug the in-line fuse assemblies between the loose ends of the voltage leads and the voltage clips. This provides a connection that is electrically equivalent to the normal connection, but the fuses are physically as close to the power source as possible. The advantage of this approach is that if one of the voltage leads gets shorted to ground (perhaps from being cut by a panel door), a fuse quickly blows, providing added protection.

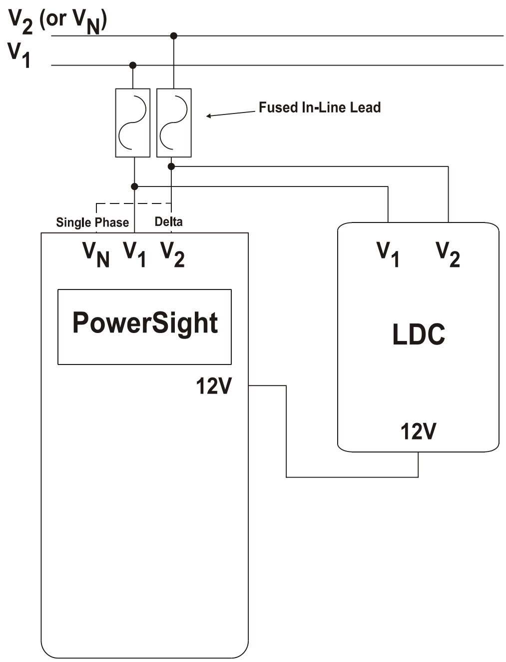


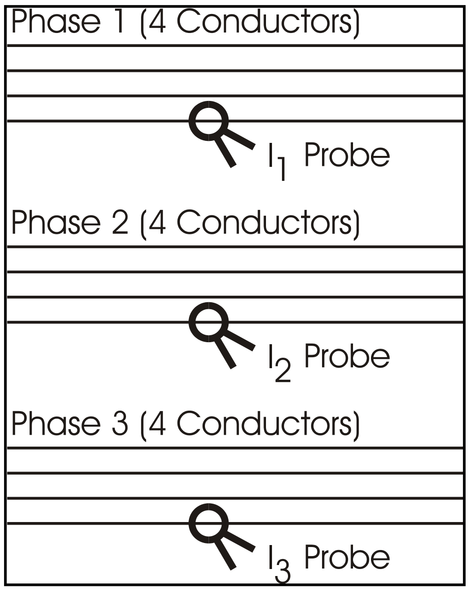
Fig. 11 - LDC Connection Diagram

Note: Do not use the LDC without the in-line fuses being connected between it and the power source. The fuses are the only circuit protection for the LDC.

When the input side of the LDC is fully connected properly, plug the long DC output plug into the DC input jack of PowerSight. The red charging indicator near the jack will light up if everything is operating and connected properly.

⚠ **Note: If a fuse is burned out or missing, it will appear that there is no voltage at the source. Verify that the fuses are working properly before assuming that the source is dead. Injury may occur if you wrongly assume that the source is deactivated.**

Measuring Multiple Parallel Conductors



A common problem with measuring large currents arises when the current of each phase is carried by several parallel conductors. For instance, the phase 1 current may be carried in 4 parallel conductors, as are phases 2 and 3, resulting in 12 conductors to measure. In this case, the work-around is to clamp onto just one of the conductors of each phase and enter an input ratio to record the correct total current of each phase. A fast way of doing this is to enter an input ratio of 4 : 1 for each phase in the example of 4 parallel conductors. This may offer adequate accuracy for your needs. However, experience shows that although the current in each conductor of the same phase is similar in size, they are typically NOT identical.

Overcoming the problem of unequal currents in parallel cables takes a few steps to do it accurately.

1. Put a different probe on each conductor of a given phase and then viewing the currents of each probe simultaneously (see the Checking Current Levels – Using Checkout Connections section).

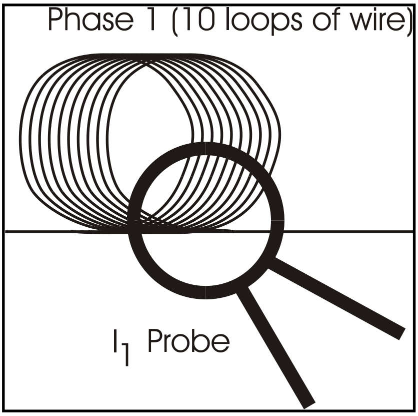
2. Start monitoring for 10 seconds or so and then stop monitoring (see the Starting Data Logging and Stopping Data Logging sections).
3. Press the [Current] key and then the [More] key four times to view the average current for phase 1 (which is actually just one of the conductors of one of the phases). Write it down.
4. Press the [Current] key and then the [More] key four times again to view the average current for phase 2. Write it down.
5. Repeat these actions in order to get the average current of each of the conductors for the same time period.
6. Find the total of the average currents of each of the conductors of the same phase.
7. Divide the total of the average currents into the average current of conductor you wish to connect to during the actual monitoring session. This yields the portion of the total current that flows through the conductor that will be measured.
8. Set the input ratio of the phase being measured to the number determined in the previous step. For instance if the total of the average currents was 1000 amps and the average current of the probe on the conductor you wish to use during the actual monitoring session had an average of 26 amps, then enter an input ratio for that phase of 0.26 : 1.
9. Perform steps 1 through 8 for each phase.
10. Now connect each probe to the chosen conductor of each phase and begin monitoring. All the readings and logged values will be substantially correct.

Measuring Currents Below the Range of the Current Probe

A problem with measuring smaller currents arises when the current to be measured is below the range of the current probe. In such cases, the current may not be read or the reading may be inaccurate. In addition, any waveforms that are captured will have excessive noise on them.

If you are using a flexible current probe, you can simply wrap it around the conductor twice in order to double the magnetic field strength. This can get it in the measurement range and it boosts the signal to noise ratio. If you use this method, set the input ratio for the current probe to 1 : 2 (see the Changing Input Ratios in PowerSight section).

If the current to be measured is small, it may be acceptable to open the circuit and insert an extra length of wire that is wound up into a coil of 10 turns. Clamping your current probe around this extension coil will boost the signal strength 10 times and allow accurate reading of small currents. If you use this method, set the input ratio for the current probe to 1 : 10 (or however many turns there are in the coil).



Turning PowerSight On

Connecting to Power

Although PowerSight comes with Li-ion rechargeable batteries, those batteries are intended to keep PowerSight functioning during limited power failures and to allow quick measurements without the bother of always having to find a 120 Vrms source. When fully charged, the batteries can power the unit for up to 12 hours.

For longer usage and to recharge the batteries, your unit has been supplied with a wall-mount power supply. This power supply cannot be used with the model PS3000 and the PS3000 power supply cannot be used with the PS5000. To use this power supply, simply plug it into any 120 Vrms source (use the model CHG4 charger for 120Vrms and the model CHG1 for 220V) and then plug its barrel-type plug into the 12 VDC input jack on the right side of PowerSight. If charging voltage is available, an LED indicating light will immediately shine through the hole located to the right of the input power jack. Allow 8 hours to fully charge the unit.

If you wish to operate PowerSight without being tethered to a power outlet, the Line-to-DC converter accessory (order LDC4 or LDCm) offers the ability to power a PS5000 (or any model except the PS3000) directly off the line voltage being monitored. It works with 50 Hz and 60 Hz power, operating off 100 to 480 Vrms input, single-phase or three-phase. All this versatility is obtained without setting switches or changing connections. The LDC4 is especially convenient when monitoring in areas where 120 V outlets are not readily available.

If you need to operate the LDC4 off of 600V phase-to-phase service, connect one input to a hot phase and the other input to neutral.

The internal batteries are automatically charged when the wall-mount supply is connected to the unit (or when PowerSight is connected to the LDC4 or LDCm accessory).

The internal batteries are not to be replaced by the user. Only batteries provided by Summit Technology are to be used in PowerSight.

Turning PowerSight On

Simply press the green on/off button at the lower right of the keypad on the front panel for 1 second (no more than 2 seconds) and PowerSight will be operating (pressing the button again, turns the unit off). The display will flash on with a black PowerSight splash screen and a greeting on the bottom (if you made one). You can change this greeting at any time by connecting to PSM-A and going to Settings and changing it in the "General Settings" menu. Please note that turning PowerSight on does not automatically start monitoring and logging. Refer to the Putting it all Together (Monitoring for the First Time) section for how to start monitoring and logging.

Turning PowerSight Off

To turn PowerSight off, simply press the green on/off button at the lower right of the keypad on the front panel. This provides a graceful software/firmware shutdown. If pressing the button briefly does not turn the meter off, press the on/off button down and hold it down for 6 seconds to force a hardware shutdown. If this is a recurring problem, contact support@powersight.com.

Communicating with PowerSight

Introduction

The PS5000 uses Bluetooth wireless communications and USB to communicate with your PC. USB has been added for ease of use and quickly connecting to the PowerSight without the needing to pair to a PC.

Although USB maybe easier, Bluetooth add a method that is safer. There are several advantages to this method:

- safety enhancement - since there are no metallic connections between the meter and your PC (part of what allows your meter to be rated for 600 V Cat IV, the highest safety rating in the industry) and 1000V Cat III.
- simplicity – no communications cables are needed
- reliability – no cable, means no forgotten cables at the site and success in on-site setup and download
- reliability – no physical connections are needed, hence physical connection problems are minimized
- reliability – the Bluetooth communications protocol provides for robust error-free communications
- flexibility – communicate with the meter from up to 30 feet away.

The disadvantages to Bluetooth are:

- the Bluetooth connection must first be made at the operating system level before the PSM-A application can make the application-to-meter connection
- your PC may not have Bluetooth capabilities, in which case you need to add a USB Bluetooth adapter
- turning your meter off and on may require re-establishing the Bluetooth connection at the operating system level
- the present implementation of Bluetooth communications in Windows is less straightforward than USB or RS232 communications.

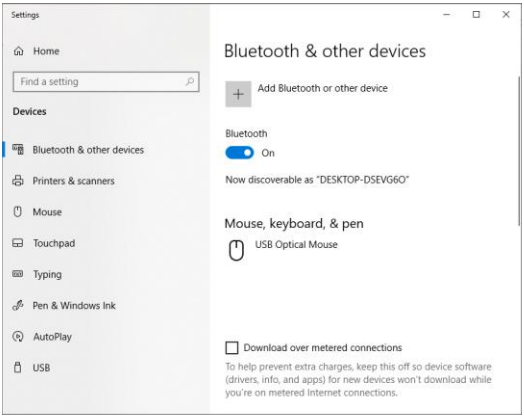
See the “Getting Started Manual for Bluetooth Meters” Manual for a more detailed look on installing Bluetooth adapters, installing the PSM-A software and other information on getting the meter communicating with your computer.

Connecting Via Bluetooth (Windows 7/8/10/11)

With Windows 7/8/10/11, you will have to find the small Bluetooth icon that shows up at the bottom right of your computer or go to the Devices screen by navigating to: **Control Panel\Hardware and Sound\Devices and Printers**.

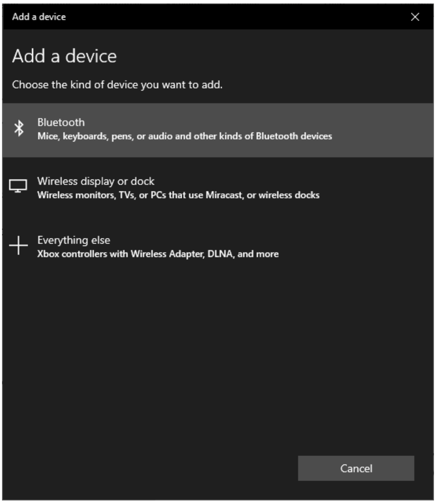
Once the Device window is open, you can then attempt to locate and connect to the meter at the Bluetooth level. Again, you must have PSM-A closed and the meter turned ON when making a new Bluetooth connection.

1. With the meter turned on, either right click on your Bluetooth Icon on the task bar and select “show Bluetooth devices” or open settings and go to Bluetooth & other devices.

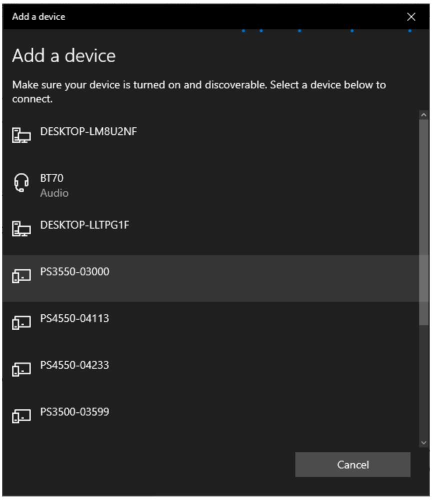


2. Press the + button to add a Bluetooth device.

3. Select “Bluetooth” in the Add a Device Window

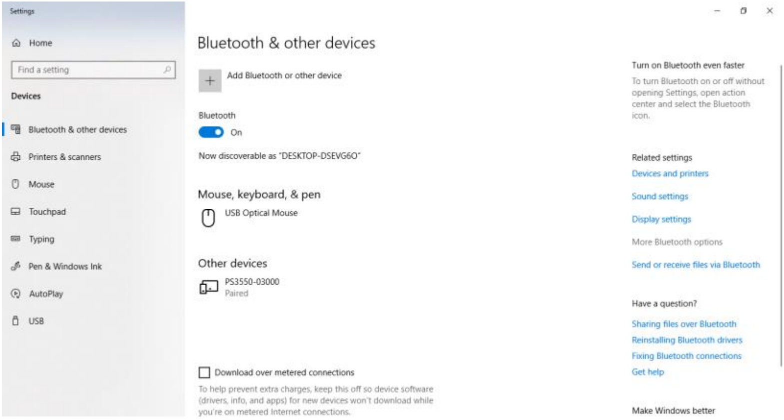


4. Double click on the meter you want to connect to

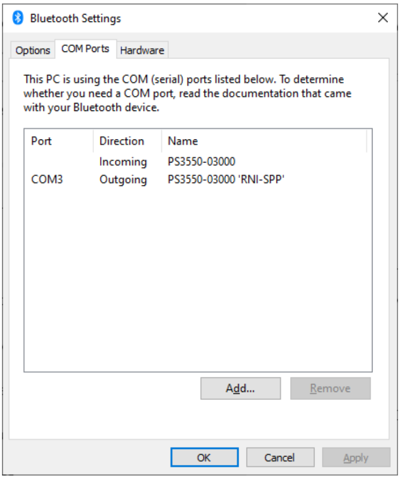


5. Either enter the Pairing code of "0000" or if asked if the PIN matches the meter, just press Connect.

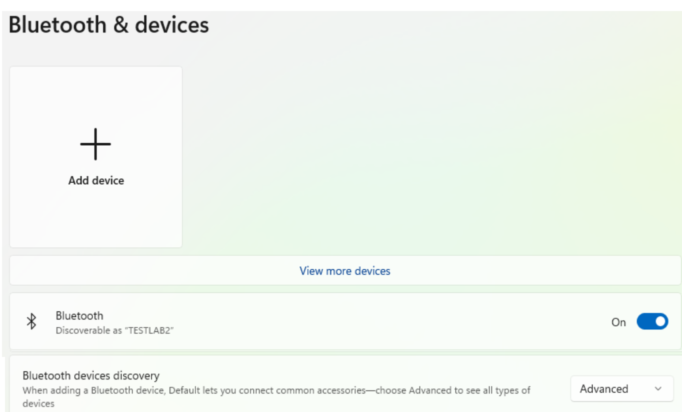
6. Once windows finishes, go back to the Bluetooth & other devices window and you should see your meter. On the right of the page (or at the bottom on some computers" find the blue link that says "more Bluetooth Options" and click on it.



7. Once the Bluetooth Settings window opens, go to the COM Ports tab. Here you will find an “Outgoing” direction and port, this is the port used by PSM-A to connect.

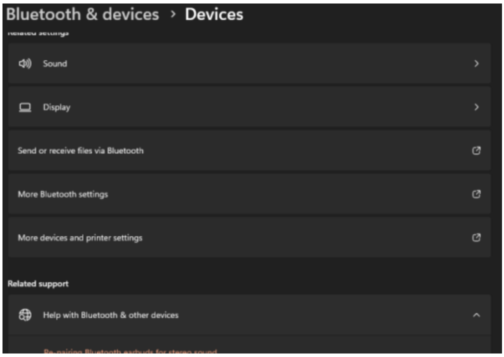


NOTE: Windows 11 update requires an extra step to “Enable” Bluetooth to find the PowerSight meter. Press the “View More Devices” button on the Bluetooth & other Devices window to enable a section called “Bluetooth Devices Discovery” and select “ADVANCED” in the drop-down box. This will allow the PowerSight meters to be discoverable by the PC.

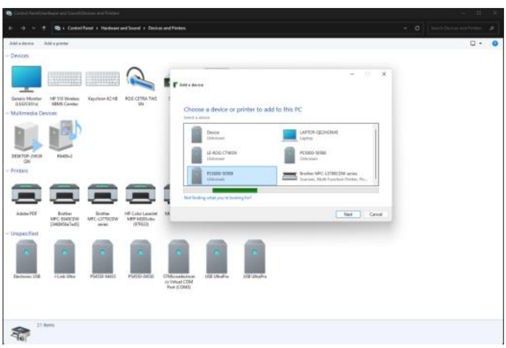


If your Windows 11 does not show the “Bluetooth Devices Discovery” option, you will need to scroll to the bottom of the Bluetooth Devices screen and select “More Devices and Printer

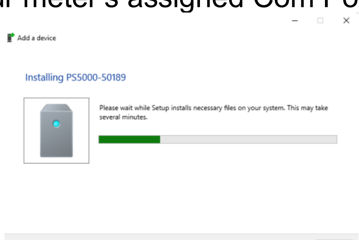
Settings”. This will bring you to the Legacy version of Windows “Devices & Printers”.



Here you can press the “Add a Device” button and you will see a new window pop up, this time with your PowerSight devices listed. Select the device and press “Next”.

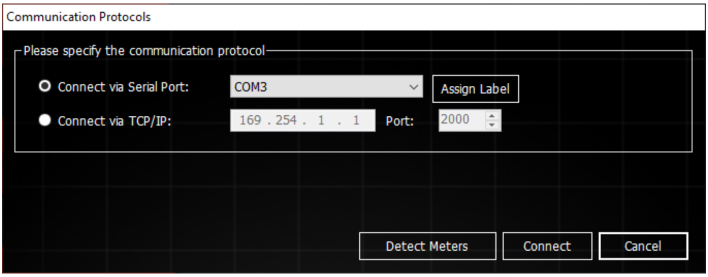


After selecting the device, it will now pair to the Meter (You may need to enter a pairing code or verify a code). Once finished, Right click on the meter that shows up under the “Unspecified” section and choose “Properties”, then select the “Services” tab to get your meter’s assigned Com Port.



Once a Com Port is Assigned:

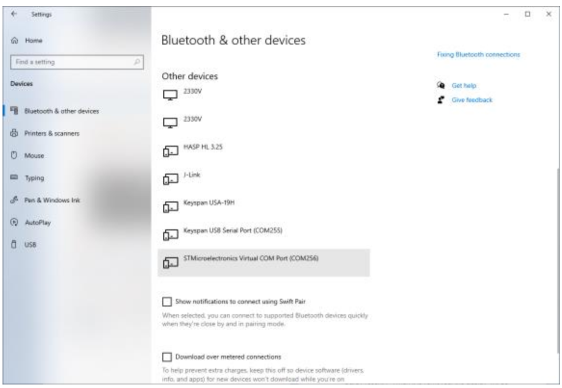
8. Open up PSM-A and click on the “Click to Connect” button at the top middle of the screen.
9. Change the Serial Port to the one assigned by Bluetooth and press “Connect”.



Connecting Via USB cable (Windows 7/8/10/11)

To connect Via the USB port at the bottom of the PS5000 meter, you will need a USB cable that is capable of transferring Data (not the charge-only type cables). Currently the PS5000 cannot charge the meter via the USB cable, it is only used for data transfer.

Once you plug in the cable to the PS5000, your PC should make a sound indicating a new hardware device has been plugged in. At this point go to **Control Panel\Hardware and Sound\Devices and Printers**.



On this page you should see an entry under “Other Devices” called “STMicroelectronics Virtual Comm Port” with a comm Port number.

Open up PSM-A and follow step 9 above and select the comm port number assigned by the Windows.

Using Removable Memory Cards

Introduction

Your meter has adequate internal memory storage for most normal operating situations. However, the ability to use a removable memory card has several significant advantages:

- extra storage for very long monitoring sessions
- faster transfer of data from meter to computer
- backup of data that is in the meter and on your computer
- non-volatile storage of data about specific jobs or equipment

Your meter is designed to use SD memory cards. This capability provides essentially unlimited storage capabilities for your meter. Your meter is fully operational and usually has sufficient storage without the removable memory. In addition, your PS5000 has upgraded the SD card capabilities to transfer data much faster than the previous models.

Installation of the card is simple. Simply push it into the slot on the right side of the meter. Insert it so that the top of the card is visible as you look down on the face of the meter. It cannot insert fully if it is upside down. To remove the card, push on the inserted card and it should pop out enough to grab and remove.

Operation and Limitations

- Whenever a memory card is inserted into your meter, it automatically gets updated with all the data that is on the meter
- When the card is inserted, the meter will display “Memory Card Present”. When it is removed, the display will be “Memory Card Removed”.
- If the display ever says “Insert Memory Card Again”, remove the card if it is already mounted and then insert it firmly back into the slot.
- Do not insert or remove a memory card while the meter is monitoring.

- Generally, any SD memory card that is from 64 MB through 32 GB in size will work in the meter. If it does not, the meter will display “Incompatible Format”.
- The meter will not write over existing files and pictures on the memory card, so memory cards from cameras etc can be used when needed.
- Presently the meter only reads cards that are formatted using the FAT16 (or simply, the “FAT”) file system. Cards below 64MB will typically use the FAT12 system, and will need to be reformatted to FAT16 in order to be used in your meter. Cards that are 64 GB and above use the NTFS system and cannot be read by the meter.
- Do not change the location of the files and folders that are automatically created when the card is inserted into the meter. Any changes will likely make the data impossible for your PowerSight Manager (PSMA) software to locate them.

Downloading Data via Memory Card

While logging, all logging data is periodically being backed up onto the inserted SD memory card. When you stop logging, any remaining data is transferred to the SD memory card. If you insert a memory card into the meter when it is not logging, the data in the meter will automatically transfer to the SD card.

In either case, once updating is completed you can remove the card from the meter, plug it into your computer and copy the files straight to your PC. While you can open the files directly from the SD card, we recommend copying the files to your default PSM-A data directory.

To transfer data from an SD card:

1. Make sure the meter is has stopped logging.
2. Remove the card and insert it into your computer.
3. Locate files you would like to copy. They are stored in folders related to Serial number and to Date/Time the log was started.

4. Click on the folder with your meter's serial number, you should then see 1 or more folders named by time & date in the format of "YrMoDy_HrMnSc". These names are based on when the data inside was first started/created. For example, if your data log started on 10/13/2021 at 2:01:25 pm, you would have a folder with the name; "211013_140125".
5. Inside the Date/Time folders are the data files for the logging session. These files may include:
    a. $LO for Data Log files
    b. $WF for Waveform files
    c. $SL for Swell/Dip Log files
    d. $RL for RMS Graph Log files
    e. $TL for Transient Log files
    f. $SW for Swell/Dip Waveforms files
    g. $TW for Transient Waveforms files
    h. $PF for Frequency Analysis files
6. Copy the ".$xx" files to your PC.
7. Go to "View Data" in PSM-A, navigate to the folder in which you copied your files, and PSM-A will now arrange them into Logging Sessions for you to view.

NOTE: PSM-A will also read our legacy *.log, *.slg, *.rlg, *.tlg, *.wfm, *.swm, *.twm, and *.pfd files.

Verifying Connections Using PowerSight (SureStart™)

Importance of Verifying Connections and Wiring

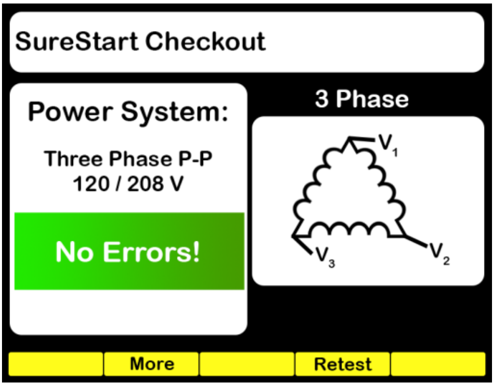
After connecting to power, it is wise to check that everything is connected correctly and that the wiring of the facility is correct. There are two primary methods for doing this. You may either send waveforms from PowerSight to your PC and visually check that all connections are correct and all signal levels and shapes appear correct (see the Verifying Connections using PSM-A section), or you can easily use the patented SureStart™ feature within PowerSight to quickly and easily do this.

The importance of having all connections and settings correct cannot be overstated. If connections are not correct, important decisions may be made based on erroneous data or logging sessions lasting several weeks may have to be repeated. Common connection and setup errors and their negative results are:

- **Current probe attached backwards.** Normally, if current probes are attached backwards, PowerSight senses this and turns them around in software so you still get the correct power readings. This is one of the features that makes PowerSight easy to use. However, if you view waveforms and a current probe is backwards, that current will appear upside down (180 degrees out of phase). More importantly, if PowerSight is in the Positive/Negative Power measurement mode, a backwards current probe will have a disastrous effect on the power, KWH, and cost readings (typically the display will present 1/3 of the correct value).
- **Voltages and currents of the same phase not paired together.** If the V_1 voltage probe is connected to the phase 1 voltage, but the I_1 current probe is attached to the phase 2 or phase 3 current, large errors will occur in measurement of power and power factor. For instance, in a perfectly balanced three-phase system with 0.92 power factor and no harmonics, if the connections of the I_1 and I_3 probes are switched, the true

power will fall 33% and the power factor of each phase will become .12, .92, and .80.

- **Current probe not fully connected to PowerSight.** The current probe connector needs to be fully seated within its socket. If it is not, the reading may be 0 (resulting in a loss of about 1/3 of the power of a three-phase system), the probe may be misidentified (resulting in current readings of a fraction or a multiple of the correct value), or the display may say "I_1 input too large" and PowerSight will refuse respond to any keypad button.
- **Voltages not connected.** If one or more of the voltage probes is not connected properly, test results for voltage, power, and power factor will be very inaccurate. Typically, power will be off by much more than 30% in a three-phase system
- **Circuit not energized.** If one or more of the phases is not energized, then any logging session will be a waste of time.
- **Incorrect frequency measurement mode.** If PowerSight is set for fixed 50 Hz operating mode but the circuit is actually 60 Hz, all measurements will be erratic and will vary from second to second. Similarly, if it is set for fixed 60 Hz, but you are measuring a variable speed drive operating at 55 Hz, the results will be erratic and vary from second to second.
- **Non-standard voltages or phase angles**. If there are unusual voltages or inter-phase angles, the circuit that is being monitored is suspect. There may be a problem with the equipment or power service that should be understood before a logging session begins.



SureStart™ is a patented technology developed by Summit Technology that does a better job of identifying connection and setup problems than you can expect an expert to do. To use the SureStart feature, press the [Checkout] key on the keypad. It does a complete analysis of the power signals and connections that are present and displays the results. Alternatively, you can use your PC to visually checkout if all connections are accurate. To do this, refer to the section on "Verifying Connections using PSM-A".

The SureStart feature briefly reports its findings in four groups of information. These are:

- **Identify System** – after analyzing all the voltage and current inputs, PowerSight identifies what type of system is connected.
- **Error Summary** – after analyzing connections, the number of possible errors detected is displayed, appearing for one second, each 6 seconds.
- **Identify Errors** – If errors were detected, pressing the [More] key will result in each error being identified on the display. Press the [More] key repeatedly to advance through the list of errors.
- **Provide Error Diagnostic Information** – for each error message that is displayed, the background measurements that indicate the error are displayed once each 6 seconds.

Once you have proceeded through this sequence of identifying the system and possible errors and have corrected the problems, you can proceed knowing that the power wiring and PowerSight's connections to it are probably correct.

Identifying the Power System

After the SureStart feature is done analyzing the inputs, the type of power system that is present is displayed on PowerSight. Check that you agree that PowerSight has identified the system correctly. If it hasn't, there is probably a problem with the system or the connections. The general types of systems that are identified on the top line of the display are:

- Single-phase
- Split-phase (two-phase)
- Three-phase
- 4-wire delta.

For each of those general systems, the display indicates whether voltages will be displayed and recorded as phase-to-neutral ("p-n") or phase-to-phase ("p-p"). If the wrong voltage mode is selected, it will not affect the power readings. If you wish to change it, use the [Setup] key to do so or use PSM-A to change the data logging setup.

The bottom line of the display tells the specific voltage type of the general system that has been detected. For instance, a typical display is “277 / 480 V (p-n, p-p)”. This means the nominal voltages present are 277 Vrms phase-neutral and 480 Vrms phase-phase. If the voltages are not of a standard magnitude, “Non-Standard” is displayed on the second line.

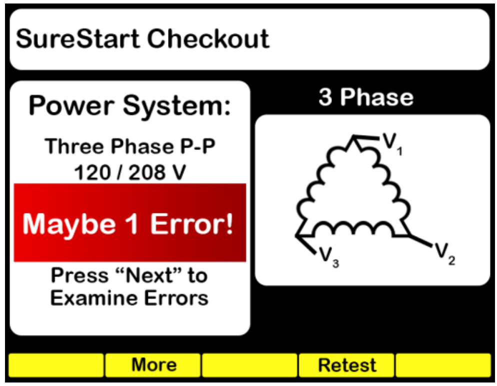
Error Summary

When the display reports the type of system that is detected, it also advises how many errors it suspects there are. For instance, it might report “maybe 3 errors” or if all is well, it may report “no errors detected.”

The language of these messages is not definite, because in the real world of power, there may be many possible connection explanations for a given set of measurements. For instance, if you hook up to a 3-phase power system, but have your current probes attached off one position to the left (that is, the I_1 input is actually I_3, the I_2 input is actually I_1, and the I_3 input is actually I_2) and each of the probes is attached backwards, the readings that result may look correct (they will have been shifted 60 degrees). So PowerSight might report “no errors detected”, and with good reason, but the connections are very incorrect. Similarly, if all of the connections are correct, but the three-phase circuit has a phase lead of +30 degrees (strongly capacitive), PowerSight will report that there may be 2 errors, because a phase lead of +30 degrees is so very unlikely (hence it displays that there “may be” errors). You may need to use some judgment, but in general, the SureStart feature will make a judgment of what’s right and what’s wrong and its judgment will be correct under most circumstances. We are proud of this feature.

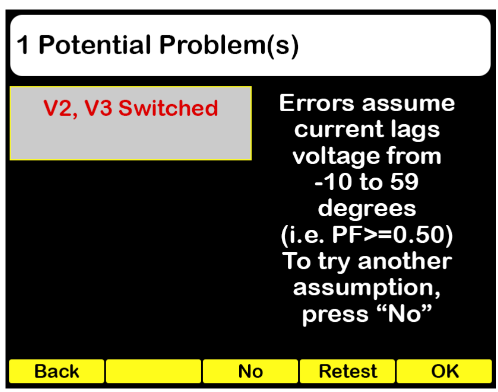
Identifying Errors

After the system type is identified and the number of errors that were detected is displayed, press the [Next] soft key to see each of the errors. It is important to note that when the voltages look reasonable, PowerSight assumes that they are connected to the correct phases. Thus, if the voltages are rotated to the right one position, but the current probes are connected correctly, PowerSight will report that the current probes are rotated left one position. Although assuming that the voltage connections are not rotated identifies the phases incorrectly, the total power will be correct and the individual readings will be correct. The phases will be mislabeled.



Another thing to consider is that in some cases, several possible explanations for the same error are listed as separate errors. In these cases, the potential errors are listed in order of how likely they are be the correct explanation. An example of this would be 2 errors, the first being that I1 and I2 have been switched and the next error is that I3 is backwards. Only one of these errors actually exists and the more likely one is that I1 and I2 are switched. In these cases, fix the error that seems most likely to you to be correct and run SureStart again.

There are over 70 different error types reported. The general types, their explanations, and the corrective actions required are:



- Probe not connected. The probe that is identified appears to not be connected to PowerSight. Check that the probe is firmly connected to both PowerSight and to the power system.
- No current. The probe that is identified is connected to PowerSight, but no current is detected. This may indicate that the load is turned off or that the probe is not connected around

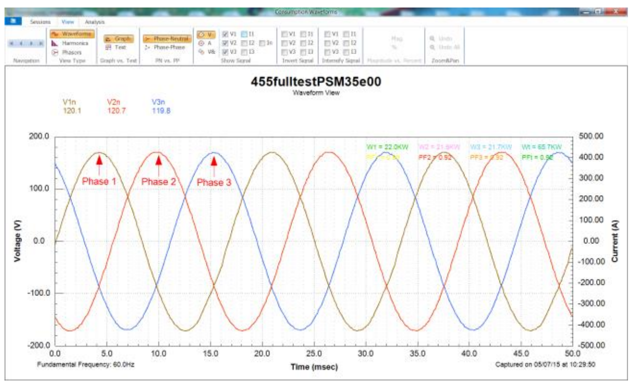
the cable properly or that it is not fully seated into its jack within PowerSight.

- Probe backwards. The current probe that is identified is probably backwards. Just turn it around and clamp it on the conductor.
- Probe switched. The identified probes seem to be switched. Simply trade their connections.
- Signals attached to wrong meter input. The identified signals seem to be connected to the wrong inputs. Connect the probes to the correct signals.
- Signals are imbalanced. It appears that the magnitude of one phase is improperly large or small compared to the others. Check that the connections are correct and that the system type was identified correctly.
- Two inputs are the same. It appears that the identified probes are connected to the same signal. Check the connections and that the system is correct.
- Two inputs have the same phase angle. The identified probes are of the same phase, but have different magnitudes. Check that the system is correct.
- Non-standard phase angle. The phase angle between the identified phases is incorrect for the identified system. Check the system.
- Incorrect phase lag. The phase lag of the identified phase is not correct. The probe may be backwards or the voltage or current is connected to the wrong phase.
- Wrong phase sequence. It is assumed that a sequence of 1-2-3 is correct and 3-2-1 is backwards. But 3-2-1 may be correct for your system (for instance to have a motor run "backwards"). If the sequence is wrong, either two voltage leads are switched or 2 current probes are switched while no voltage is present.
- Non-Standard voltage. The voltage levels are outside of normal operation range of normal power systems. It may be correct, or there may be a problem with the system, or the wrong system has been identified.
- No signals detected. The operating frequency may be out of the measurement range of PowerSight, or nothing is connected, or the system is deactivated.
- Wrong frequency setting. PowerSight is expecting one frequency, but it is measuring another.

Checking Connections using PSM-A

The PowerSight Manager Advanced (PSM-A) software can be used to visually determine if the system connections and levels are correct. You can use PSM-A to analyze the connections to the meter by either capturing a waveform on the meter and downloading it with PSM-A, or by connecting to PSM-A and using the “Waveforms & Connections” feature.

Checking Voltage/Current Levels – Using PSM-A

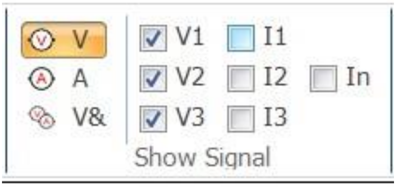


Once you have downloaded a waveform using PSM-A, open it and then Check the boxes of which signals you would like to view. For checkout, first click the “V” icon and make sure all 3 phases of voltage are checked.

Verify that the voltage measurements are in the correct voltage mode, read the correct measurements, and are in the correct phase sequence.

While still viewing all voltage waveforms of a three-phase system, notice in what order they reach their peak value. Normally, the order should be 1-2-3. In other words, the highest level of the V_{1N} (or V_{12}) waveform will be followed next by the highest level of the V_{2N} (or V_{23}) waveform, which will be followed by the highest level of the V_{3N} (or V_{31}) waveform (see the example).

Next either click on the “A” button or uncheck the Voltage phases and check the current phases. Verify that the current measurements are what you expect and are in the correct phase sequence (should be the same sequence as voltage)



Last, either click on the “V&I” Button or check all the signal boxes. Here you can view the relationship of current to voltage and make sure each current phase is properly lined up with the correct voltage phase.

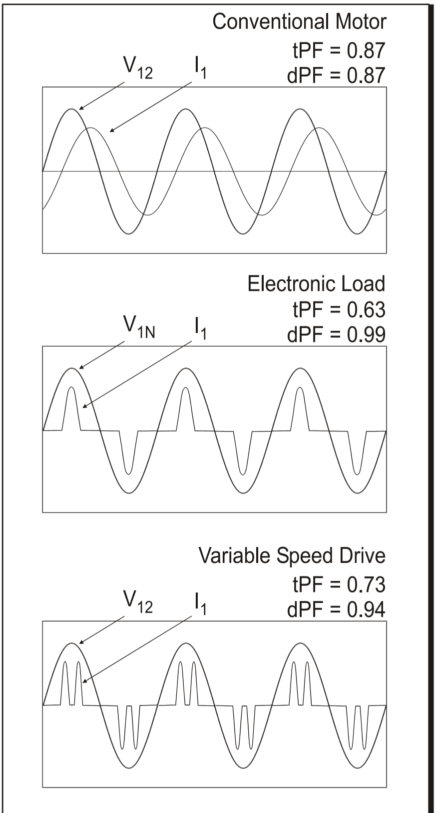
If you notice any issues, make your changes and then take another waveform. Do not start your monitoring session unit you are comfortable with your connections.

Checking I Phase Sequence – Using PSM-A

While still viewing all current waveforms of a three-phase system, notice how they reach their peak value. Each of the peaks should be the same distance from each other (similar to as shown in the Checking Voltage Sequence – Using PSM-A section). This even spacing must continue across the screen. In a three-phase system there will be a constant 120 degrees apart (5.5 msec for 60 Hz, 6.3 msec for 50 Hz). If one or two of the current probes is backwards, the peaks will not be evenly spaced. If that is the case, determine which probe can be turned around to get the spacing correct. After turning it around and verifying that the spacing is now correct, determine in what order the currents reach their peaks. This sequence must be in the same order as was seen for the voltages. If they are not, swap two of the probes. This will correct the phase sequence. Verify once again that the spacing between them is still correct. If not, repeat the instructions of this section.

Checking Phase Lag Angle – Using PSM-A

When viewing the voltage and current waveform of a given phase, you will notice a timing relationship between the two waveforms (refer examples below). The point at which the current reaches its peak may lead or lag the peak of the voltage by as much as 90 degrees (90 degrees at 50 Hz is 4 msec, at 60 Hz it is 4.2 msec). Typically, current either lags the voltage or it may slightly lead it.



Typical Phase Relationships Between Voltage and Current

By the time you have gotten to this test, you have verified that the voltages and currents are reasonable sizes and that their sequences appear to be correct.

Now select a view of “voltage and current” and “phase 1” only. Check how much time passes between the peak of the voltage and the peak of the current. It must be within 90 degrees. Next select a view of “phase 2” only and then “phase 3” only. In each case, note the time delay between the peak voltage and the peak current. It should be close to the same. If one current leads voltage and the other two currents lag voltage by different amounts, then two of the voltage or current probes are probably switched. If the delays are the same for all phases, but they are more than 90 degrees, then the current probes are probably not matched to the correct voltages probes and will need to be moved without changing the phase sequence.

Measurement Types

Voltage Measurements

Voltage is the difference in electromotive potential between two points. Simply stated, it is the force that generates current flow and to measure voltage, two points of connection are required. In AC circuits, this force, measured in volts, usually varies continuously and always reverses direction. In DC circuits, it is usually steady and never reverses direction. If the voltage changes in a repeating fashion, then it is called a periodic function. All AC power distribution is based on voltage changing at a periodic rate. There are several key voltage measurements:

- Instantaneous voltage
- Peak voltage
- RMS voltage
- Voltage crest factor
- Maximum voltage
- Minimum voltage
- Average voltage
- Present voltage
- Voltage swell (surge)
- Voltage dip (sag)
- Voltage transient
- Voltage imbalance

The instantaneous voltage is simply the voltage present between two points at an instant of time. When the voltage is graphed over time, the graph is called the voltage waveform. The peak voltage, Vpk, is the instantaneous voltage of the greatest magnitude (either positive or negative) over a period of time.

A measure that changes continuously is of limited use. A far more useful measurement is RMS voltage, wherein a single number is generated to describe a continuously varying voltage. The beauty of RMS voltage is that in power calculations, it makes a contribution to power roughly equivalent to a DC voltage of the same magnitude. RMS voltage is defined as the square root of the mean of the square of the instantaneous voltage over one cycle of the fundamental frequency: $Vrms = \sqrt{\frac{\sum v^2}{N}}$.

When measuring DC voltage, the RMS value is the same as the DC value.

Voltage crest factor is the ratio of peak voltage of a cycle over the RMS voltage of the same cycle. $Vcf = Vpk / Vrms$. A perfect sine wave has a crest factor of 1.414 ($\sqrt{2}$).

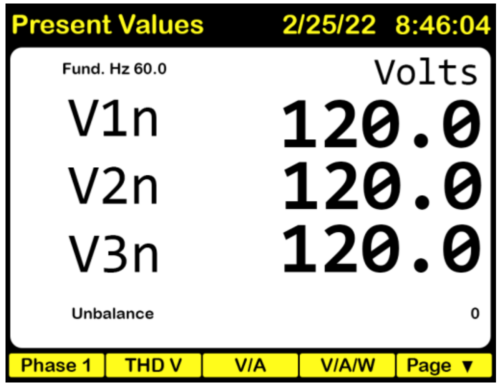
Maximum, minimum, and average voltage in power measurements refers to the maximum, minimum, and average of RMS voltage measurements during a time of interest. For the PS5000, the RMS of every full cycle is measured, so these numbers are exact.

In the PS5000, the present voltage is the summary of the RMS voltage over one second. It is the average of the RMS voltages of every cycle during the most recent second.

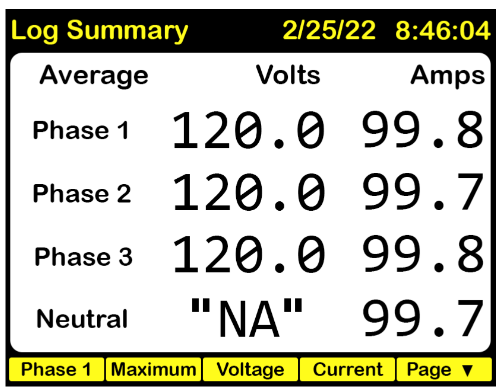
A voltage swell (or surge) is an RMS voltage that exceeds some trigger level. A voltage dip (or sag) is an RMS voltage that falls below some trigger level. In the PS5000, the trigger levels can be set to an actual voltage level or as a percent deviation from a normal voltage. The RMS calculations for determining swell and dip are performed every ½ cycle, so these measurements are exact.

When we speak of a voltage transient, we are speaking of an instantaneous voltage that exceeds a trigger level. An absolute trigger level is an instantaneous level that includes the underlying periodic waveform. A relative trigger level is an instantaneous level that has the underlying periodic waveform removed. In the PS5000, trigger levels can be set for both relative and absolute voltage transient levels.

Voltage Measurements in PowerSight



PowerSight performs all commonly desired voltage measurements. When in phase-neutral measurement mode, the RMS (root mean square) voltage between V_N and the V_1, V_2, and V_3 input jacks is displayed by simply pressing [Voltage] key. Also displayed on the Voltage screen is the Fundamental Frequency and Voltage imbalance. If a monitoring session has begun, you can also see the maximum, minimum, and average RMS voltage displayed on the screen by pressing the [View Data Log] key and then pressing the soft key for [Maximum], [Minimum] or [Average]. There are 12 RMS voltage measurements available.



Note that if PowerSight is not monitoring consumption, the maximum, minimum, and average values are the results from the last monitoring session.

Please note that when PowerSight is operating in 2 current mode, V_{31} is not calculated or displayed.

To set PowerSight for reading phase-neutral, phase-phase, or DC voltages, refer to the Measurement Modes chapter.

If a connection is not made to the V_N input, PowerSight will find the neutral point between all the phases in doing its phase-neutral measurements.

Voltage Measurements in PSM-A

The consumption data log can record maximum, minimum, and average RMS voltage for each phase for each logging period. The summary values at the top of the screen are the maximum, minimum, and average of all the values shown on the screen.

When viewing consumption waveforms, the average RMS of the cycles of the waveform is shown at the top, with the average crest factor listed below it. The instantaneous value of each point of the waveform can be determined using the vertical scale. If a harmonic analysis is displayed, the RMS voltage is also listed

When viewing voltage swell logs, the highest ½ cycle RMS level of each event is displayed. An event starts when the trigger is exceeded and ends either when 10 cycles have passed or when a ½ cycle does not exceed the trigger level (whichever is longer). Voltage dip logs display the lowest ½ cycle RMS level of each event. Each event starts with the trigger and ends in 10 cycles or when a ½ cycle does not fall below the trigger level (whichever is longer).

When viewing swell/sag RMS graphs, the RMS of each ½ cycle is graphed and the most extreme measurement, with its timestamp, is presented at the top.

When viewing transient waveforms, the instantaneous values of the voltage are graphed, as with consumption waveforms. But the summary value at the top is the Vpk value above the trigger, with its timestamp.

If trending data is being recorded and PowerSight is operating in phase-neutral voltage measurement mode, the average V_{1N}, V_{2N}, and V_{3N} voltages for each second will be displayed and recorded each second. If in phase-phase voltage measurement mode, the average V_{12}, V_{23}, and V_{31} voltages for each second will be displayed and recorded each second.

The measurements of voltage presented on PowerSight can also be displayed in PSM-A by using the remote-control feature.

In addition, our ReportWriter software will present maximum, minimum, and average voltage of each phase during any one or two intervals of time set by the user. If two time intervals are chosen, it will report the percent change and the actual change between the two intervals. For instance, if a comparison report is chosen and V_{12} average is 480 V during the first interval and 478 V during the second interval, then the report would show:

	Before	After	Units	Change	% Change
Voltage, Phase 1, Avg.	480	478	volts	-2.0	-0.4%

The total harmonic distortion (THD) of voltages is displayed using the THD function, discussed later in this chapter.

Current Measurements

Current is the flow of charged particles, usually electrons, through a point. Current is measured in units of amps (which is short for amperes) and its symbol is commonly “I”. In AC circuits, current often varies continuously and always reverses direction. In DC circuits, it is usually steady and never reverses direction. If the current changes in a repeating fashion, then it is called a periodic function. There are several key current measurements:

- Instantaneous current
- Peak current
- RMS current
- Current crest factor
- Maximum current
- Minimum current
- Average current
- Present current
- Current inrush (swell or surge)
- Current dip (sag)
- Current transient
- Current imbalance

The instantaneous current is simply the current passing through a point at an instant of time. When the current is graphed over time, the graph is called the current waveform. The peak current, Ipk, is the highest instantaneous current over a period of time.

A measure that changes continuously is of limited use. A far more useful measurement is RMS current, wherein a single number is generated to describe a continuously varying current. The beauty of RMS current is that in power calculations, it makes a contribution to power roughly equivalent to a DC current of the same magnitude. RMS current is defined as the square root of the mean of the square of the instantaneous current over one cycle of the fundamental frequency: $Irms = \sqrt{\frac{\sum i^2}{N}}$.

When measuring DC amps, the RMS value is the same as the DC value.

Current crest factor is the ratio of peak current of a cycle over the RMS current of the same cycle. $Icf = Ipk / Irms$. A perfect sine wave has a crest factor of 1.414 ($\sqrt{2}$).

Maximum, minimum, and average current in power measurements refers to the maximum, minimum, and average of RMS current measurements during a time of interest. For the PS5000, the RMS of every full cycle is measured, so these numbers are exact.

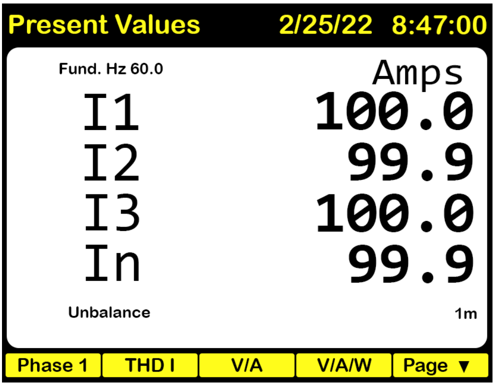
In the PS5000, the present current is the summary of the RMS current over one second. It is the average of the RMS currents of every cycle during the most recent second.

A current inrush (or swell or surge) is an RMS current that exceeds some trigger level. A current dip (or sag) is an RMS current that falls below some trigger level. In the PS5000, the trigger levels can be set to an actual current level or as a percent deviation from a normal current. The RMS calculations for determining swell and dip are performed every ½ cycle, so these measurements are exact.

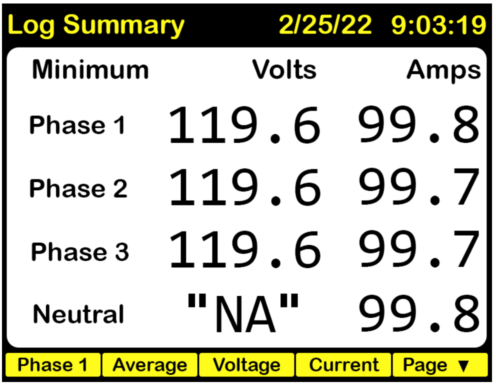
When we speak of a current transient, we are speaking of an instantaneous current that exceeds a trigger level. An absolute trigger level is an instantaneous level that includes the underlying periodic waveform. A relative trigger level is an instantaneous level that has the underlying periodic waveform removed. In the PS5000, trigger levels can be set for both relative and absolute current transient levels.

Current Measurements in PowerSight

PowerSight performs all commonly desired measurements of current. The RMS (root mean square) currents of phases 1, 2, and 3 and of the neutral line are available by simply pressing the [Current] key.



Also displayed on the Current screen is the Fundamental Frequency and Current imbalance. If a monitoring session has begun, you can also see the maximum, minimum, and average RMS current displayed on the screen by pressing the [View Data Log] key and then pressing the soft key for [Maximum], [Minimum] or [Average]. There are 16 RMS current measurements available.



Note that if PowerSight is not monitoring consumption, the maximum, minimum, and average values are the results from the last monitoring session.

Note that when PowerSight is operating in 2 current mode, I2 is not measured or displayed.

When measuring DC current, the RMS value is the same as the DC value. To set PowerSight for reading DC currents, refer to the section on Setting Measurement Modes. Remember that you need to have a DC current probe (DC2000 or DC600) in order to read DC current.

Current Measurements in PSM-A

The consumption data log can record maximum, minimum, and average RMS current for each phase for each logging period. The summary values at the top of the screen are the maximum, minimum, and average of all the values shown on the screen.

When viewing consumption waveforms, the average RMS of the cycles of the waveform is shown at the top, with the average crest factor listed below it. The instantaneous value of each point of the waveform can be determined using the vertical scale. If a harmonic analysis is displayed, the RMS current is also listed.

When viewing current inrush logs, the highest ½ cycle RMS level of each event is displayed. An event starts when the inrush trigger is exceeded and ends either when 10 cycles have passed or when a ½ cycle does not exceed the trigger level (whichever is longer). Current dip logs display the lowest ½ cycle RMS level of each event. Each event starts with the trigger and ends in 10 cycles or when a ½ cycle does not fall below the trigger level (whichever is longer).

When viewing swell/sag RMS graphs, the RMS of each ½ cycle is graphed and the most extreme measurement, with its timestamp, is presented at the top.

When viewing transient waveforms, the instantaneous values of the current are graphed, as with consumption waveforms. But the summary value at the top is the Ipk value above the trigger, with its timestamp.

If trending data is being recorded and PowerSight is operating in phase-neutral voltage measurement mode, the average RMS current of each phase and neutral for each second will be displayed and recorded each second. If in phase-phase voltage measurement mode, the average RMS current of each phase for each second will be displayed and recorded each second.

The measurements of current presented on PowerSight can also be displayed in PSM-A by using the remote-control feature.

In addition, our ReportWriter software will present maximum, minimum, and average current of each phase and neutral during any one or two intervals of time set by the user. If two time intervals are chosen, it will report the percent change and the actual change between the two intervals. For instance, if a comparison report is chosen and I_1 average is 48.0 A during the first interval and 47.8 A during the second interval, then the report would show:

	Before	**After**	**Units**	**Change**	**% Change**
Current, Phase 1, Avg.	48.0	47.8	amps	-0.2	-0.4%

The total harmonic distortion (THD) and K factor of currents is displayed using the THD function, discussed later in this chapter.

Imbalance Measurements

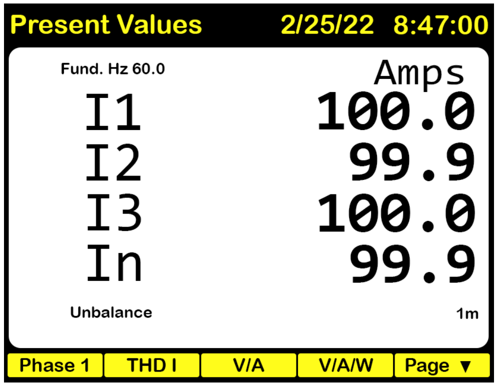
In a perfectly balanced three phase system, the voltages are of equal magnitude and the currents of the three phases are of equal magnitude. In most situations, however, the voltages and currents are not balanced. An imbalance can be a nuisance or can actually cause damage, depending on the driven load. Therefore, it is important to measure voltage and current imbalance.

There are two methods of measuring imbalance. NEMA (National Electronic Manufacturers Association) uses an approach that measures the deviation of each measurement from the average. For instance, here is the formula for V_{12} imbalance:

$$V_{12(imbalance)} = \frac{\left|V_{12} - V_{average}\right|}{V_{average}} = \frac{2V_{12} - V_{23} - V_{31}}{V_{12} + V_{23} + V_{31}}$$

where $V_{average} = \dfrac{V_{12} + V_{23} + V_{31}}{3}$

Basically, this approach finds the average of the readings of the three phases and then finds how far away each of the phases is from this average. The phase with the largest deviation from the average is used for the final calculation, which is simply dividing this maximum deviation by the average to obtain a percentage deviation, always expressed as a positive percentage.

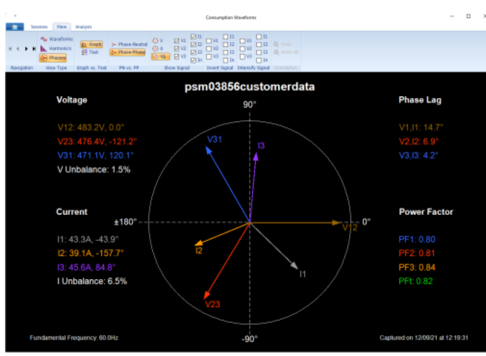


The European standard IEC61000-4-30 specifies a much more complex method. The results are generally quite close to the NEMA approach.

The PS5000 can show imbalance on the display of the meter in real time by pressing the [Voltage] or [Current] button. Imbalance is shown at the bottom of the display just under the voltage or current measurements.

Imbalance Measurements in PSM-A

PSM-A performs imbalance calculations on both the voltage and current of a waveform set. To view the imbalance measurement, open a waveform set in PSM-A and then click on the phasor diagram icon. The imbalance measurements appear to the left of the phasor diagram. NOTE: You can also see the Phasors from the PS5000 graphics display by pressing the [Phasors] key.



Power Measurements

There are three basic interrelated measurements of power:

- True power
- Apparent power
- Reactive power

Apparent power is defined as the sum of the products of the RMS currents and their associated RMS voltages:

$P_{app} = VA = \left(V_{1N_{rms}} \times I_{1_{rms}}\right) + \left(V_{2N} \times I_{2_{rms}}\right) + \left(V_{3N_{rms}} \times I_{3_{rms}}\right)$.

In other words, if you measure the RMS voltage (measured in volts) and the RMS current (measured in amps) and multiply them together, you get the apparent power (measured in VA).

True power is more complicated. It is defined as the average of the sum of the products of the instantaneous currents and their associated instantaneous voltages over one or more cycles:

$$P_{true} = Watts = \frac{\sum\left(v_{1N} \times i_1\right)}{N} + \frac{\sum\left(v_{2N} \times i_2\right)}{N} + \frac{\sum\left(v_{3N} \times i_3\right)}{N}.$$

True power equals apparent power when there is no phase lag in the load and no harmonics are present, otherwise it is less than the apparent power. This is why an ammeter cannot be used to accurately measure true power in most industrial circuits.

Reactive power is the square root of the difference between the squares of the apparent power and the true power:

$$P_{\text{var}} = VAR = \sqrt{(P_{app}{}^2 - P_{true}{}^2)}\ .$$

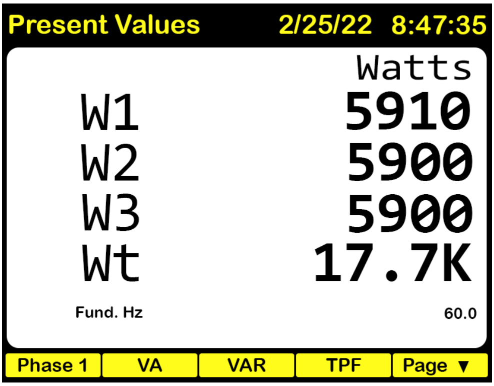
When the fundamental voltages and currents are in phase and no harmonic currents are present, reactive power is zero.

Peak demand of the demand period is an important measurement that is covered in the Demand Period Measurements section.

Power Measurements in PowerSight

PowerSight performs all commonly desired power measurements.

Total true power (watts or KW), total reactive power (VAR or KVAR), and total apparent power (VA or KVA) measurements are available by simply pressing [Power] key to show True Power (Watts). To see VA or VAR, press the yellow soft key for [VA] or [VAR] when on the Power screen.



Displayed on the screen will be each phase of true power and total true power. Also shown is fundamental frequency. you can also see the maximum, minimum, and average RMS current displayed on the screen by pressing the [View Data Log] key and then pressing the soft key for [Page] then press the soft key for [Watts]. Here you will find Maximum, Minimum and Average measurements for true power, along with +Watts and -Watts. These measurements are created if in “Negative Readings Allowed” power mode and provide the consumed and generated true power.

Power Measurements in PSM-A

The consumption data log can record maximum, minimum, and average true power and apparent power for each phase for each logging period. In addition is can record the maximum, minimum, and average true or apparent total power. When graphed, the VAR can be displayed. The summary values at the top of the screen are the maximum, minimum, and average of all the values shown on the screen.

When viewing consumption waveforms, the average true power of the cycles of the waveforms are shown at the top left.

The measurements of power presented on PowerSight can also be displayed in PSM-A by using the remote-control feature.

In addition, our ReportWriter software will present maximum, minimum, and average true power and apparent power of each phase and of all phases during any one or two intervals of time set by the user. If two time intervals are chosen, it will report the percent change and the actual change between the two intervals. For instance, if a comparison report is chosen and Wtotal average is 480 W during the first interval and 478 W during the second interval, then the report would show:

	Before	After	Units	Change	% Change
Total True Power	480	478	watts	-2.0	-0.4%

Power Factor Measurements

"Power factor" is often misunderstood. The definition of power factor is the ratio of true power (in watts) to apparent power (in VA). But it is often used as an indication of how much current lags voltage in a circuit. When no harmonics are present, power factor does this well. When harmonics are present, there is no necessary relationship between power factor and current phase lag. To help differentiate what is meant by "power factor", we talk of two different power factor measurement types:

- true power factor and
- displacement power factor.

PowerSight measures both of these.

True power factor, as its name implies, is the true measurement of power factor. It is the ratio of true power over apparent power: $TPF = \frac{P_{true}}{P_{app}}$ (or $TPF = \frac{W}{VA}$). When this ratio is less than 1.00, then reactive power is present. Reactive power may be the result of current lagging voltage due to the inductance of the circuit. It may also be the result of delayed harmonic currents that result from small driving harmonic voltages. A typical electronic load may have a power factor of 0.70 and yet the current may be perfectly in phase with the voltage. No amount of capacitance can raise this power factor (in fact it will lower it). However, when harmonics are not present, the true power factor turns out to be equal to the cosine of the angle of phase lag of the current. No amount of harmonic filtering will raise this power factor, because it has no relationship to harmonics. True power factor is 1.00 for a purely DC system.

Displacement power factor is actually not a power factor measurement. It is the cosine of the number of degrees that the current of the fundamental frequency lags the voltage of the fundamental frequency ($DPF = cos(\theta)$), where θ is the phase lag of current. To do this measurement properly, PowerSight uses Fast Fourier Transform (FFT) analysis to separate the harmonic currents and voltages from the fundamental current and voltage and to do a precise measurement of the angle between those fundamentals. The resulting phase angle is then transformed using its inverse cosine to obtain the displacement power factor. This value is useful for deciding how much capacitance to add to a circuit to bring current into phase with voltage, thereby raising the displacement power factor. Displacement power factor is 1.00 for a purely resistive load or a DC system and drops down as the reactive power increases.

True power factor can be determined for each phase and for the total power. Terms for these measures are:

- TPF_1
- TPF_2
- TPF_3
- TPF_T.

The total power factor is not the total of these individual power factors, it is the ratio of the total true power over the total apparent power. Typically, all four power factor measurements are similar in magnitude.

Displacement power factor can be determined for each phase. Terms for these measures are:

- DPF_1
- DPF_2
- DPF_3

There is no such thing as total displacement power factor. Typically, the displacement power factors of each phase are similar in magnitude.

In addition, the following can be measured for each phase:

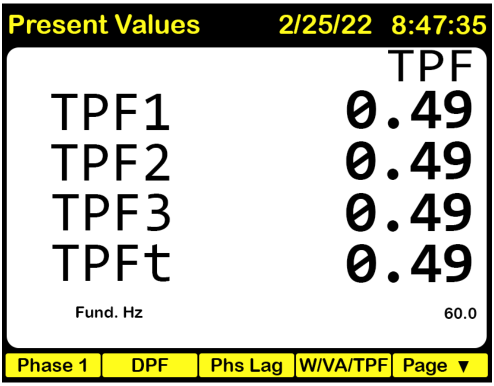
- Maximum true or displacement power factor
- Minimum true or displacement power factor
- Average true or displacement power factor
- Present true or displacement power factor

Maximum, minimum, average, and present total true power factor can also be measured.

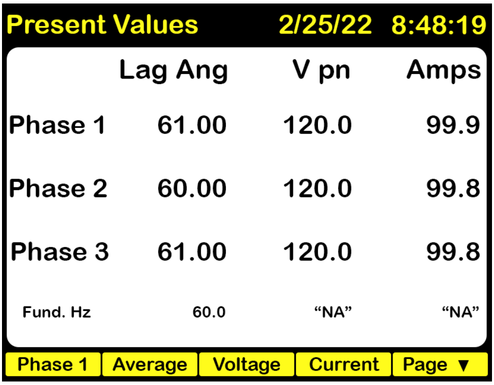
Finally, a measurement related to DPF is displacement phase angle. The displacement phase angle is the number of degrees that the current at the fundamental frequency lags the voltage at the fundamental frequency. In the absence of harmonics, it is the inverse cosine of the true power factor. It is always the inverse cosine of the displacement power factor ($\theta = cos^{-1}(DPF)$).

True Power Factor Measurements in PowerSight

The PS5000 performs all commonly desired true power factor measurements. To view true power factor, press [Power] key, then press the yellow soft key [TPF]. This will display True Power Factor for all phases and neutral. Also shown on the display is the fundamental frequency.

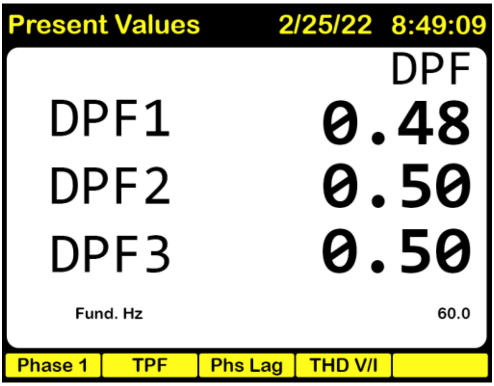


If a monitoring session has begun, you can also see the maximum, minimum, and average True Power Factor displayed on the screen by pressing the [View Data Log] key and then pressing the yellow soft key for [Page] then the soft key for [TPF].



Phase lag can be shown to give an indication if current may be leading or lagging voltage. While on the TPF screen, press the yellow soft key [Phs Lag] to show the lag angle. You can also press the soft key [Sequence] to show the phase sequence for voltage and current.

Displacement P.F. and Phase Measurements in PowerSight



PowerSight performs all commonly desired displacement power factor measurements. The displacement power factors of phases 1, 2, and 3 can be displayed. To view displacement power factor, press [Power] key then press the yellow soft key [Page] then press the soft key [DPF]. Here you will see each phase calculation for displacement power factor as well as fundamental frequency.

If you wish to know the actual phase lag of current, in degrees, press the yellow soft key [Phs Lag] like in the instructions for True Power Factor

Power Factor and Phase Measurements in PSM-A

The consumption data log can record maximum, minimum, and average true power factor for each phase and for total power for each logging period. The summary values at the top of the screen are the maximum, minimum, and average of all the values shown on the screen.

When viewing consumption waveforms, the average true power factor of the waveform is shown at the top right. If a harmonic analysis is displayed, the true power factor is also listed.

If trending data is being recorded and PowerSight is operating in phase-phase voltage measurement mode, the average total true power factor for each second will be displayed and recorded each second.

Phase lag angle is most easily determined by viewing a waveform and then clicking on the phasor diagram icon. The phase lags of each phase will be listed on the right as well as the phase angle between the phase 1 voltage and all other signals.

The measurements of true power factor, displacement power factor, and phase lag angle presented on the PS5000 can also be displayed in PSM-A by using the remote-control feature.

In addition, our ReportWriter software will present maximum, minimum, and average true power factor of each phase and of the total power factor during any one or two intervals of time set by the user. If two time intervals are chosen, it will report the percent change and the actual change between the two intervals. For instance, if a comparison report is chosen and TPF_1 is 0.48 during the first interval and 0.48 during the second interval, then the report would show:

	Before	After	Units	Change	% Change
Power Factor, Phase 1, Avg.	0.48	0.48	volts	0.00	0.0%

Energy Measurements

The energy consumed is defined as the sum of the true power over time: $E = \int \left(P_{true} \times t\right)$. If measurements are taken every second in units of watts, then the KWH consumed during that second is $E = W_{\sec} / 1000 / 3600$. The energy used over a longer time would be the sum of each of these energy measurements of each second.

Useful measurements and estimates of energy are:

- Real energy consumed
- Reactive energy consumed.
- Estimated energy consumed per hour

- Estimated energy consumed per month
- Estimated energy consumed per year

The real energy consumed is the amount of energy actually consumed during a period of time such as since monitoring started or during a specific week. For instance, if the sum of the KWH of each cycle totals to 5 KWH after 10 minutes of monitoring, then the energy consumed during the monitoring session is 5 KWH. The PS5000 calculates KWH for each second, using every cycle during that time for exact measurements.

The reactive energy consumed is determined the same as KWH except VAR measurements are used, instead of watts.

The estimated energy consumed per hour is the total energy consumed, divided by the hours of monitoring. For instance, if 5 KWH is consumed over a 10-minute period, then the estimated energy consumed per hour is $KWH_{est./hr.} = 5 \times \frac{60}{10} = 30KWH$.

The estimated energy consumed per year is the total energy consumed, divided by the fraction of a year that monitoring has proceeded. For instance, if 5 KWH is consumed over a 10-minute period, then the estimated energy consumed per year is $KWH_{est./yr.} = 5 \times \frac{60 \times 24 \times 365}{10} = 262,800KWH$ (262.8 megawatt-hours).

The estimated energy consumed per month is the estimated energy consumed during a year, divided by 12. For instance, if 5 KWH is consumed over a 10-minute period, then the estimated energy consumed per month is $KWH_{est./mo.} = 5 \times \frac{60 \times 24 \times 365}{10 \times 12} = 21,900KWH$ (21.9 megawatt-hours).

Energy Measurements in PowerSight

PowerSight performs all commonly desired energy measurements. When monitoring consumption, the actual energy consumed is displayed by pressing [View Data Log], then pressing the yellow soft key [Page] then pressing the soft key [Energy]. This will show the current accumulated energy in Kilowatt Hours or the energy accumulated during the last logging session.

Energy Measurements in PSM-A

PSM-A presents all commonly desired energy measurements. When displaying a data log containing power information, PSM-A will graph the energy consumed over any interval. The user can choose to graph real energy use (KWH) or reactive energy use (KVARH).

Normally, a graph of energy usage will be a line that climbs up as it moves to the right. This is because, as more and more power is used, the cumulative energy used increases.

In addition, our ReportWriter software will calculate actual energy used and the estimated energy used pr month during any one or two intervals of time set by the user. If two time intervals are chosen, it will report the percent change and the actual change in energy use between the two intervals. For instance, if a comparison report is chosen and 5 KWH is consumed during the first interval of 10 minutes and 8 KWH is consumed during the second interval of 20 minutes, then the report would show:

	Before	**After**	**Units**	**Change**	**% Change**
Energy, Total Elapsed	5	8	KWH	3	60.0%
Energy, Estimated per month	21,900	17,520	KWH	-4380	-20.0%

In this example, even though the actual energy increased significantly, the actual rate of energy use declined significantly because of the difference in time intervals between the before and after tests.

Cost Measurements

The cost of energy consumed is defined as the product of the energy consumed times the user-defined rate: \$= $KWH \times rate$. PowerSight presently uses a simple single rate price system.

Useful measurements and estimates of cost are:

- Cost of energy consumed (elapsed cost)
- Estimated cost per hour
- Estimated cost per month
- Estimated cost per year

The cost of energy consumed is the actual cost of energy consumed during a period of time such as since monitoring started or during a specific week. For instance, if 5 KWH was consumed after 10 minutes of monitoring and the rate is \$0.10/KWH, then the cost during the monitoring session is \$0.50. The PS5000 calculates cost each second, using every cycle for exact measurements.

The estimated cost per hour is the elapsed cost, divided by the hours of monitoring. For instance, if the cost is \$0.50 for a 10-minute period, then the estimated cost per hour is

$$\$_{est./hr.} = 0.50 \times \frac{60}{10} = \$3.00 .$$

The estimated cost per year is the elapsed cost, divided by the fraction of a year that monitoring has proceeded. For instance, if the cost is \$0.50 for a 10-minute period, then the estimated cost per year is $\$_{est./yr.} = 0.50 \times \frac{60 \times 24 \times 365}{10} = \$26,280$.

The estimated cost per month is the estimated cost for a year, divided by 12. For instance, if the cost is \$0.50 for a 10-minute period, then the estimated cost per year is

$$\$_{est./mo.} = 0.50 \times \frac{60 \times 24 \times 365}{10 \times 12} = \$2,190 .$$

Cost Measurements in PowerSight

PowerSight performs all commonly desired true cost of energy measurements. When monitoring consumption, the actual cost of energy consumed is displayed by pressing [View Data Log] then pressing the yellow soft key [Page] then pressing the soft key [Cost]. This will display the accumulated cost based on the KWH of the current or last logging session.

The rate used by PowerSight to estimate cost can be displayed or changed by the user at any time. It is one of the setup functions that can be accessed through the [Setup] key.

Cost Measurements in PSM-A

Our ReportWriter software will calculate the elapsed cost and estimated cost per month of energy consumed during any one or two intervals of time set by the user. If two time intervals are chosen, it will report the percent change and the actual change in cost between the two intervals. For instance, if a comparison report is chosen and $0.50 of energy is consumed during the first interval of 10 minutes and $0.80 of energy is consumed during the second interval of 20 minutes, then the report would show:

	Before	**After**	**Units**	**Change**	**% Change**
Cost	$0.50	$0.80		$0.30	60.0%
Cost, Estimated per month	$2,190	$1,752		-$438.00	-20.0%

In this example, even though the elapsed cost increased significantly, the actual rate of cost declined significantly because of the difference in time intervals between the before and after tests.

You may view or change the rate used by ReportWriter to calculate cost. It is one of the fields you can change when you set up a report.

Demand Period Measurements

Utilities typically evaluate energy usage over fixed increments of time, such as 15-minute intervals. These time intervals are called "demand periods." The average power consumed during each demand period is called the "demand" of that period. Typically, the utility will look for the demand period with the greatest demand over a period of time, such as a month, and call this the "peak demand period". The demand of that period is the "peak demand". The utility may then present a surcharge on the user's bill based on the peak demand. For this reason, power users have an incentive to determine

- Peak demand
- Peak demand period.

Demand Period Measurements in PSM-A

There are two methods for obtaining Demand period measurements in PSM-A. The first is to monitor using 15 minute logging intervals and making sure that total power is being logged in the consumption log. When logging is completed, graph the consumption log and choose to present total power. Observe at what point the average total power is at its peak. This point is the peak demand period. Put your cursor over it and observe the timestamp of the beginning of the peak demand period at the upper right of the graph. To find the peak demand, observe the average total power in watts at the point of the peak demand period.

The more direct method of determining the peak demand and the peak demand period is to run the ReportWriter program (see Generating a Report) and select "Peak Demand" in the list of variables to report on. The report will list the peak demand period, the peak average demand in Watts, the peak VA demand period, and the peak average VA.

Frequency Measurements

Any periodic waveform has a basic rate at which it repeats itself. This is the fundamental frequency of the waveform, expressed in units of Hertz or cycles/second. The fundamental repeating waveform is called a cycle and is usually expressed in degrees (360 degrees to complete one cycle). Some frequency measurements of interest are:

- Present frequency
- Maximum frequency
- Minimum frequency
- Average frequency

The present frequency is the average frequency of all of the cycles of the most recent second. The maximum frequency is the frequency of the shortest cycle (fastest repeat time) during the time of interest. The minimum frequency is the frequency of the longest cycle (slowest repeat time) during the time of interest. The average frequency is the average frequency of all the cycles during the time of interest.

When operating in the variable frequency modes, the PS5000 determines the fundamental frequency of every cycle. The bands of frequencies that it can measure are from 22 to 220 Hz and from 360 to 440 Hz. Harmonics of these fundamental frequencies are measured to 3,780 Hz. If the motor analysis option is purchased, the complete frequency spectrum from 1 to 5,000 Hz can be determined. If the Frequency Analysis Option (order: FAO) is purchased, the complete frequency spectrum from 5,000 to 100,000 Hz can be determined.

Frequency Measurements in PowerSight

PowerSight performs all commonly desired frequency measurements when operating in the variable frequency measurement mode. The fundamental frequency is displayed on many different screens including Voltage, Current & Power.

If a monitoring session has begun, you can also see the maximum, minimum, and average True Power Factor displayed on the screen by pressing the [View Data Log] key and then pressing the yellow soft key for [Page] then the soft key for [Freq].

PowerSight scans its inputs each second to look for an active power signal to measure. If none is detected, all voltage and current measurements are assumed to be zero for that second. This scanning feature allows the user to connect and disconnect

PowerSight to various signals without concerning himself with the source of the frequency measurement.

It is important to monitor frequency at installations where the frequency may vary. If an instrument makes the wrong assumption about the fundamental frequency, all voltages, currents, powers, etc. will be inaccurate.

Frequency Measurements in PSM-A

The consumption data log can record maximum, minimum, and average frequency. PowerSight determines which input channel is the source of this measured fundamental frequency. When graphed, the summary values at the top of the screen are the maximum, minimum, and average of all the values shown on the screen.

When viewing consumption waveforms, if a harmonic analysis is presented, the fundamental frequency is presented.

The measurements of frequency presented on the PS5000 can also be displayed in PSM-A by using the remote-control feature.

In addition, our ReportWriter software will present maximum, minimum, and average frequency during any one or two intervals of time set by the user. If two time intervals are chosen, it will report the percent change and the actual change between the two intervals. For instance, if a comparison report is chosen and the average frequency is 48.0 Hz during the first interval and 47.8 Hz during the second interval, then the report would show:

	Before	After	Units	Change	% Change
Frequency, Avg.	48.0	47.8	Hz	-0.2	-0.4%

Time and Capacity Measurements

PowerSight performs the following time and capacity measurements:
- present time and date
- time capacity of consumption log

- elapsed time of monitoring
- time remaining to fill consumption log
- record capacity of log
- number of records used in log
- time and date that monitoring started
- programmed start time and date of monitoring
- programmed stop time and date of monitoring

The present time and date are the time and date of the clock inside PowerSight used for creating timestamps for the records of the log and for dating waveform sets that are saved. It can be changed as one of the administrative functions (see the Administrative Functions section).

The time capacity of the log is how much time it will take to fill the consumption log. This is under your control by changing the variables selected to be recorded using the Data Setup feature of PSM-A (see the Setting Measurement Types section). The time capacity of swell/dip and high-speed transient logs is determined solely by how quickly events occur.

The elapsed time of monitoring is how long the unit has been monitoring. Generally, this is how much time is recorded in the log. If the log fills up and logging continues, writing over the oldest data, the elapsed time keeps increasing even though the logged time quits increasing. This means that the maximums, minimums, and averages displayed on PowerSight may be different from those in the log, since the monitoring session is for a longer period of time than the logging session.

The time remaining to fill the consumption log is how much longer the logging session can continue before the log is filled and logging either stops or begins writing over the oldest data.

The record capacity of the log is how many records can be recorded before the log fills. The default number for consumption logging is 5000 records. This number can be changed by changing the variables selected to be recorded in the log using the Data Setup feature of PSM-A (see the Setting Measurement Types section) or by allocating more or less memory to consumption logging.

The number of records used in the log is a display of how many records have been saved since logging began. When displayed, it will always be accompanied by the record capacity of the log.

The time and date that monitoring began is the internal clock reading of when monitoring began. If the unit is enabled to do logging, the first record will be recorded one logging period after this start time.

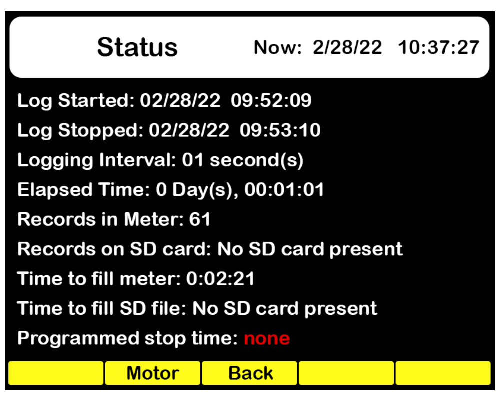
The programmed start time of monitoring is a time and date that is programmed in the Data Setup feature of the PSM-A software (see the Starting Data Logging section). When the clock inside PowerSight reaches that time and date, monitoring begins and the old log is erased.

The programmed stop time of monitoring is a time and date that is programmed by the Data Setup feature of the PSM-A software (see the Stopping Data Logging section). When the clock inside PowerSight reaches that time and date, monitoring is stopped.

Time and Capacity Measurements in PowerSight

The time and date are shown at the top right of all of the text view version of the measurement's screens (voltage, current, power, phasors, harmonics).

If a monitoring session has begun you can see the elapsed time and the time to fill log by pressing the [Monitoring Start/Stop] key. If the session has stopped, you can still see the elapsed time by going to [Monitoring Start/Stop] then highlighting the "Start Monitoring Session?" option then pressing the yellow soft key [Info].



Time and Capacity Measurements in PSM-A

The Data Setup window allows you to review and change many of the time and capacity measurements. The time capacity of the consumption log, the record capacity of all the logs and the programmed start and stop time of monitoring (if one exists) can be reviewed and changed.

The number of records used in any of the log types can be determined by attempting to receive the log data from an attached PowerSight.

The measurements of time and capacity presented on the PS5000 can also be displayed in PSM-A by using the remote-control feature.

Harmonic Measurements

French mathematician Jean Baptiste Fourier determined 150 years ago that any periodic waveform can be mathematically defined to be the sum of a fundamental frequency equal to the periodic rate and additional frequencies that are multiples of the fundamental frequency. Thus, any repeating waveform that does not appear to be a pure sine wave can be replicated by adding a collection of sine waves of varying frequencies, phases, and peak amplitudes. Since the frequencies are exact multiples (harmonics) of the fundamental, the waveform could be considered to be distorted from a pure sine wave by the addition of harmonic frequencies. The total harmonic distortion provides an accurate measure of how distorted from a pure sine wave, a waveform is.

There are several related measures of interest:

- Fundamental frequency
- Harmonic frequency
- Harmonic number
- Harmonic amplitude
- Harmonic phase angle
- THD (total harmonic distortion)
- K factor.

The fundamental frequency is the first harmonic. It is discussed in the Frequency Measurements section. The harmonic frequencies are the frequencies that are multiples of the fundamental frequency. For instance, the 7th harmonic of 60 Hz is $7 \times 60 = 420Hz$. In this case, "7" is the harmonic number of 420 Hz in a 60 Hz system.

The RMS value of a harmonic frequency is its harmonic amplitude. They can be expressed as relative to the amplitude of the fundamental frequency or as an actual RMS amp value. For instance, if the fundamental frequency has a current of 120 amps and the 5th harmonic has an amplitude of 30 amps, then the 5th harmonic has a magnitude of 30 amps or a relative magnitude of 50%.

The harmonic phase angle is the number of degrees that it leads the fundamental frequency. Comparing the difference in the phase angle between voltage and current of a given harmonic allows you to determine the "direction" of the harmonic.

There are two basic types of THD calculations used in power. Normally, THD normally refers to finding the THD of the harmonics relative to the fundamental frequency (THD-F). THD-F is defined as the square root of the sum of the squares of the magnitude of each harmonic of the fundamental frequency divided by the square of the magnitude of the fundamental frequency:

$$THD = \sqrt{\frac{(h_2^2 + h_3^2 + ... + h_{50}^2}{h_1^2}}$$

For instance, if you are monitoring a 60 Hz current that has high distortion, H1 (the magnitude of the 60 Hz fundamental) might be 120 amps, H3 (the magnitude of the third harmonic, 180 Hz) might be 60 amps, H5 might be 30 amps, H7 might be 15 amps, and all the other harmonics might have magnitudes of 0.

In this case, the magnitude of the THD-F would be

$$THD = \sqrt{\frac{60^2 + 30^2 + 15^2}{120^2}} = 57\%.$$

K factor is a derivative of calculating THD where the frequency is given extra weight. Each harmonic current amplitude is divided by the total RMS current, multiplied by the harmonic number, then squared, and then summed over the first 50 harmonics.

$$K\_factor = \sum_{h=1}^{50} \left(\frac{I_h \times h}{I_{rms}} \right)^2$$

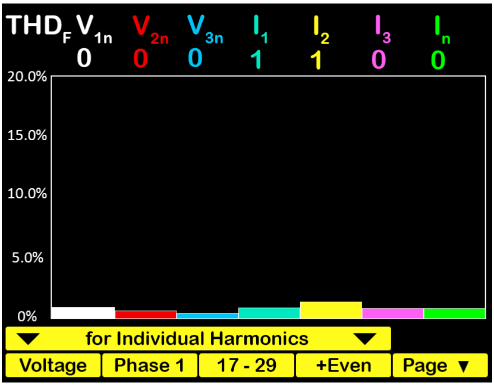
This is a valuable measurement to observe when the heating effect of harmonics is a concern. Using the numbers from the example above for calculating THD, the total current of the waveform is:

$$Irms = \sqrt{120^2 + 60^2 + 30^2 + 15^2} = 138.3A.$$

$$K\_factor = \left(\frac{120 \times 1}{138.3} \right)^2 + \left(\frac{60 \times 3}{138.3} \right)^2 + \left(\frac{30 \times 5}{138.3} \right)^2 + \left(\frac{15 \times 7}{138.3} \right)^2$$

$$= 0.75 + 1.69 + 1.18 + 0.58 = 4.20$$

Harmonic Measurements in PowerSight



PowerSight performs all commonly desired measurements of harmonic distortion. Individual harmonics can be seen in real time by pressing the [Harmonics] key. THD or total harmonic distortion can be seen if you switch to Table mode by pressing the [Graph or Table] key while looking at the graph of harmonics. There you can then press the [THD V] or [THD I] keys to view the text of the THD calculation.

Your meter does a complete harmonic analysis of every cycle of every input. Harmonic magnitude of odd harmonics through the 50h can be displayed on the graph view of the harmonics.

Harmonic Measurements in PSM-A

The consumption data log can record the average THD-F of each phase of voltage and each phase of current for each logging period. The summary values at the top of the screen are the average of all the values shown on the screen.

When viewing a consumption waveform, transforming it into a harmonic graph presents a bar chart showing the relative magnitude of each of the first 50 harmonics. The THD-F is listed at the lower right. Transforming a consumption waveform into harmonic data presents a chart of the magnitudes and phase angles of each harmonic. The THD-F and K factor are also listed.

The measurements of voltage presented on the PS5000 can also be displayed in PSM-A by using the remote-control feature.

In addition, our ReportWriter software will present average THD-F for voltage and current of each phase during any one or two intervals of time set by the user. If the use of two time intervals is chosen, it will report the percent change and the actual change between the two intervals. For instance, if a comparison report is chosen and THD-F of V_{1N} is 4.8% during the first interval and 4.7% during the second interval, then the report would show:

	Before	After	Units	Change	% Change
THD, Voltage, Phase 1	4.8	4.7	%	-0.01	-2.1%

Swells (Surges) and Inrush Measurements

Voltages and currents may grow suddenly due to temporary or switched conditions in the load or supply of power. Examples of this occurring are a current inrush when a motor is first turned on, a swell in voltage when the power source is switched from a weak source to a stronger one or when a large load is suddenly taken off-line.

In each of these conditions, the waveform remains basically the same as it was before, but the amplitude (or scale) of the waveform has grown. Since it is still a periodic waveform, it makes great sense to measure it in RMS. This allows for simple comparison to the voltage or current levels before and after the swell has occurred. For this reason, swells and inrush are measured in RMS. For highest accuracy, PowerSight calculates the RMS of each ½ cycle of each voltage and current input in order to detect even the smallest swells and inrush. In this way, no swells or inrushes are missed.

Dips (Sags) Measurement

Voltages and currents may shrink suddenly due to temporary or switched conditions in the load or supply of power. Examples of this occurring are a current dropout when a motor is suddenly turned off, a dip in voltage when the power source is switched from a strong source to a weaker one or when a large load is suddenly put on-line.

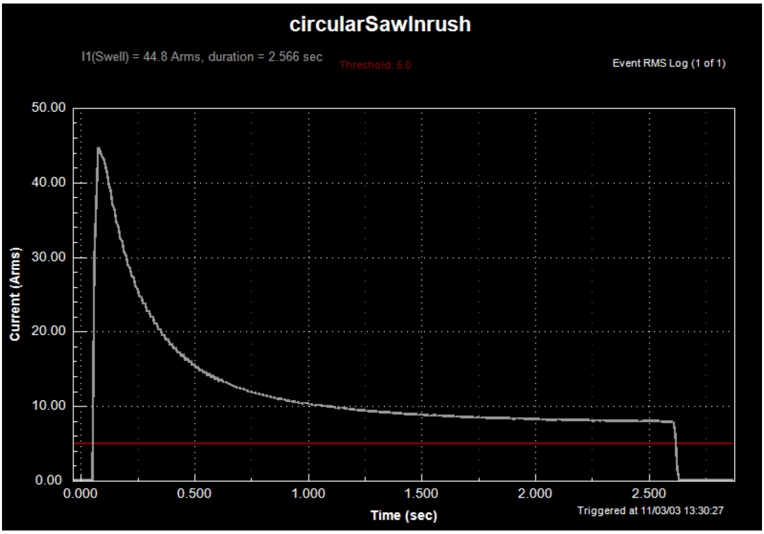
In each of these conditions, the waveform remains basically the same as it was before, but the amplitude (or scale) of the waveform has shrunk. Since it is still a periodic waveform, it makes great sense to measure it in RMS. This allows for simple comparison to the voltage or current levels before and after the dip has occurred. For this reason, dips are measured in RMS. For highest accuracy, PowerSight calculates the RMS of each ½ cycle of each voltage and current input in order to detect even the smallest dips. In this way, no dips are missed.

High-Speed Transient Measurements

Voltages and currents may suddenly have changes that cannot be explained by a simply change in amplitude in the normal power waveform. Such events are signals or distortions that are temporarily superimposed onto the basic waveform, such as lightning. They typically have nothing to do with the fundamental frequency of the power and are certainly not periodic. We call these events “high-speed transients”. High-speed transients are not periodic and are typically very abrupt changes. It makes best sense to measure them by their peak voltage or current and by the duration of time that they exceed the transient threshold.

PowerSight allows for setting two types of thresholds for detecting these high-speed events. Absolute transient thresholds look for any instant in which the voltage or current exceeds a certain absolute magnitude. This can be helpful to capture voltage events that may pierce the dielectric of a capacitor or breakdown a semiconductor switch.

Relative transient thresholds look for any transient riding on the power waveform that exceeds a certain level for an instant. In this case the fundamental periodic waveform is removed and only the remaining transient events are left to be measured. This can be helpful in finding signals that get passed through high pass filters or get induced into process circuits.



Measurement Modes

Introducing Measurement Modes

PowerSight performs so many measurements that it is quite a challenge to keep the instrument easy to use. Often, you make measurements on one general type of system. There is no need to complicate your task by PowerSight asking you to make the same choices over and over. Many of the basic choices define how you wish PowerSight to interpret its inputs and how you want it to calculate and record its results. To accomplish these ends, several measurement modes can be selected by the user. The general categories are:

- Voltage measurement modes
- Frequency measurement modes
- Power measurement modes
- Defining inputs

All measurement modes will be explained in the next few sections.

The [Setup] key allows you to make these basic choices only when needed. As new measurement capabilities are added to PowerSight, the [Setup] key will keep the product easy to use.

Phase-Neutral vs Phase-Phase vs 2 Current Mode

There are three voltage measurement modes:

- Phase-Phase
- Phase-Neutral
- 2 Current Power Mode

When measuring voltages, you either need them recorded in phase-neutral format or in phase-phase format. A phase-neutral voltage reading is the difference in potential between one of the phase inputs (V_1, V_2, and V_3) and the neutral input (V_N). They are presented as V_{1N}, V_{2N}, and V_{3N}. A phase-phase voltage reading is the difference in potential between two phase inputs. They are presented as V_{12}, V_{23}, and V_{31}.

Wye systems are usually measured using phase-neutral voltages. Delta systems are usually measured using phase-phase voltages.

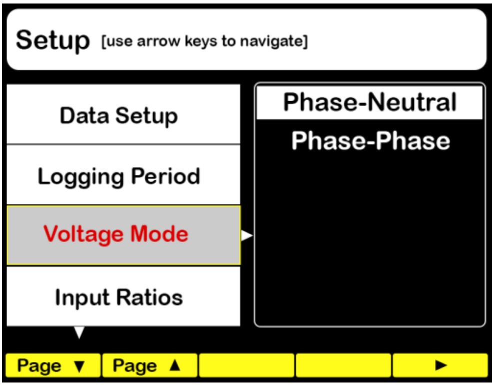
On occasion, you may wish to measure phase-phase voltages in a wye system if the equipment that you are monitoring bridges two hot voltages (like a single- phase air conditioner running at 240 V).

In a perfectly balanced three-phase system, the phase-neutral voltage is equal to the phase-phase voltage divided by the square root of 3 (Vpn=Vpp/1.732). In practice, systems are usually not balanced, but this gives an idea of what voltage to expect as you change the voltage mode from phase-phase to phase-neutral.

There is a third voltage measurement mode that may be active in your unit. It is the 2 current power mode (or the V_{12}, V_{32} only mode). In this mode, only two phase-phase voltages are used and displayed. The 2 current power mode actually involves a different method of measuring power and therefore is actually a different power measurement mode, but since it is independent of the other power measurement modes and yet is an alternative to the other two voltage measurement modes, it is treated as a voltage measurement mode. When in this mode, only V_{12} and V_{32} (not V_{23} or V_{31}) are measured and displayed.

It is important to note a limitation of operating in phase-phase mode. The power factor and power reading for each phase are not necessarily accurate. This is not due to any accuracy problem with PowerSight. Instead, it is the result of each phase's current being the result of two different phase-phase voltages, whereas a phase’s power and power factor calculations rely on only one of the phase-phase voltages. Therefore, although the power factor and power readings have diagnostic value, they are not true representations of the actual power factor or power being used for a given phase. Nevertheless, the measurements that count most, the total power factor and total power, are correct in phase-phase mode. This result may seem surprising, given that the individual phase measurements are not exact, but the mathematics of combining three equations with three unknowns results in correct total power factor and total true power measurements.

Changing the Voltage Measurement Mode in PowerSight

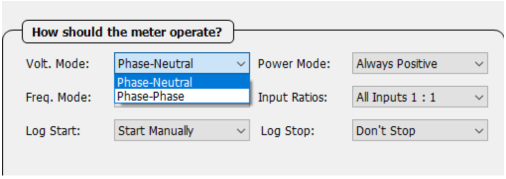


To determine which voltage measurement mode PowerSight is in, simply press the [Setup] key of PowerSight and press the [Down Arrow] key until you reach “Voltage Mode”. To change the voltage measurement mode from what is displayed, press the [Right Arrow] key and then press [Up Arrow] or [Down Arrow] keys to select the desired measurement mode.

The voltage measurement mode that you choose will stay in effect until you change it. It will not be changed by turning PowerSight off.

Changing the Voltage Measurement Mode in PSM-A

To determine the voltage measurement mode using PSM-A, connect PowerSight to PSM-A and then either go to the Monitoring Setup menu and read what appears in the Voltage Mode box or operate in Remote Control mode and press the key combinations described above.



To change the voltage measurement mode using PSM-A, either go to the Monitoring Setup menu, choose “View Meter’s Data Setup, cycle through the sections until you get to “How should the meter operate” and click on the Voltage Mode drop-down box, select the mode that you wish to operate in, and then send the new setup to the connected PowerSight meter or operate in Remote Control mode and press the key combinations described above.

50/60/400Hz vs DC vs Variable Frequency

There are 3 frequency measurement modes in the PS5000:

- Variable Frequency from 22 – 200 Hz
- Variable Frequency from 360 – 440 Hz
- DC Circuit

These modes allow making measurements on virtually any power system in the world. When making measurements on a power source whose frequency is stable (as are most power grids in industrial countries), it is recommended that you operate in the variable 22-200 Hz mode, depending on the frequency present. If you are making measurements on a military or avionics system who's 400 Hz is stable, it is recommended that you operate in variable 360-440 Hz mode. If you are making measurements on a DC system, then you may choose the DC Circuit mode.

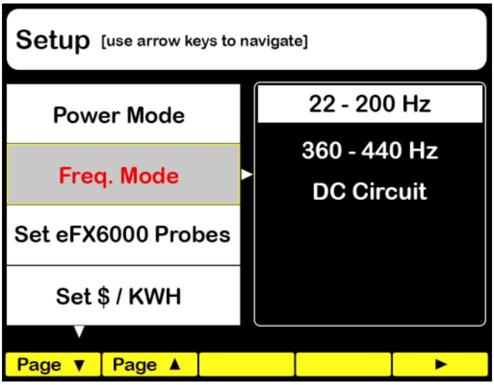
When operating in variable frequency measurement mode, PowerSight determines the fundamental frequency of the voltage or current that is attached to it every second. The fundamental frequency is recorded and is used to determine the true RMS values of all voltages and currents. This mode of measurement is only recommended if performing:

- measurements on a system powered by or backed-up by a generator or other system whose frequency may vary from standard
- measurements of the output of a variable frequency drive
- measurements of a system powered by a utility that does not provide power at a stable standard frequency

The variable frequency measurement mode provides accurate true RMS readings of voltage, current, and power for input frequencies varying from 22 to 200 Hz or from 360 to 440 Hz. If even one voltage or current input is in this frequency range, PowerSight can also measure the true RMS of DC and rectified signals that are also connected while in this measurement mode.

The DC Circuit measurement mode is necessary when measuring DC voltage or DC power. In a DC system, the frequency is 0 Hz, which is clearly outside of the variable frequency measurement range and for this, the DC Circuit mode is used to assume the frequency is fixed or 0hz. This assumption of the time required to measure the inputs allows for accurate readings in DC systems and systems in which only higher harmonics are present (as with rectified signals). It also allows accurate readings of AC and mixed AC/DC signals (such as AC ripple on a DC voltage).

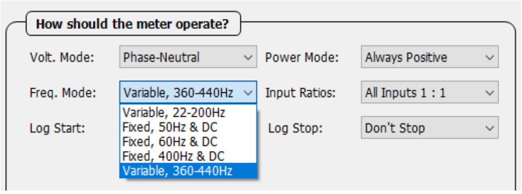
Changing the Frequency Measurement Mode in PowerSight



To determine which frequency measurement mode PowerSight is in, simply press the [Setup] key then press the [Down Arrow] key until you get to the "Freq Mode" option. To change the frequency measurement mode from what is displayed, press the [Right Arrow] key and then press [Down Arrow] key to select the mode you want then press [OK]. when the desired measurement mode is displayed.

The frequency measurement mode that you choose will stay in effect until you change it. It will not be changed by turning PowerSight off.

Changing the Frequency Measurement Mode in PSM-A



To determine the frequency measurement mode using PSM-A, connect PowerSight to PSM-A and then either go to the Monitoring Setup menu and read what appears in the Freq Mode box or operate in Remote Control mode and press the key combinations described above.

To change the frequency measurement mode using PSM-A, either go to the Monitoring Setup menu, click on the Freq Mode drop-down box, select the mode that you wish to operate in, and then send the new setup to the connected PowerSight meter or operate in Remote Control mode and press the key combinations described above.

Always Positive Power versus Negative Power Allowed

There are 3 power measurement modes in PowerSight:

- Always positive power
- Negative power allowed
- 2 current power

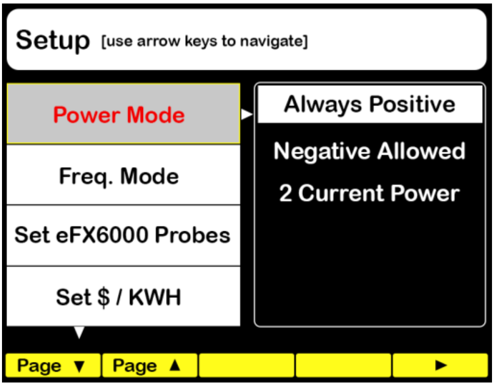
Most users perform measurements on equipment that is either always consuming power or always generating power. However, there are cases in which you may wish to measure power use on equipment that is alternatively consuming and generating power (like an oil well pump jack). Always Positive Power measurement mode and Negative Power Allowed measurement modes are provided to allow ease and accuracy of measurement in both types of situations.

When PowerSight is shipped from the factory, it is set for Always Positive Power measurement mode. In a typical setup, if you connect a current probe backwards, the power for that phase will appear to be negative. In Always Positive Power measurement mode, PowerSight senses this and automatically turns the current probe backwards in software so that all phases measure positive power. This automatic correction is provided to assist our customers, allowing them to concentrate on readings rather than connections under most circumstances. Accuracy may be slightly better when the probe is oriented correctly, but for most measurements this added accuracy is of no significance with PowerSight. If current and power readings of the highest accuracy are necessary, use the Checkout Connections feature that is discussed earlier in this manual or view the waveforms in order to ensure that current probes are connected correctly.

If you need to monitor equipment that alternately consumes and generates power, you need to select the Negative Power Allowed measurement mode. In this mode, positive and negative power readings for each phase are accepted and are combined to find the net power usage. Depending on the result, positive or negative power, energy, and cost results may be displayed. When negative power measurements are allowed, it is necessary to have all current probes connected properly. Use the Checkout Connections feature or view all the waveforms before taking measurements. Failure to do so will typically result in power readings 1/3 of the correct value.

The 2 Current Power mode (also known as 2 wattmeter mode) is a method of calculating total power using only 2 current probes and 2 phase-to-phase voltages. While in this mode, V_{23} and I_2 will no longer be measured or displayed and V_{32} appears in place of V_{23}.

Changing the Power Measurement Mode in PowerSight

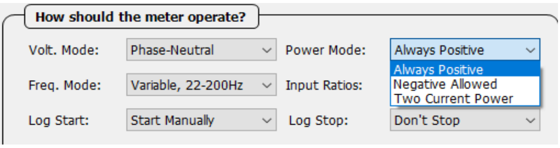


To determine which power measurement mode PowerSight is in, simply press the [Setup] key then press the [Down Arrow] key until you see the “Power Mode” option. If PowerSight is in Always Positive Power measurement mode, the display will read "Power Readings Always Positive". If PowerSight is in Negative Power Allowed measurement mode, the display will read "Negative Power Readings Allowed". To change the power measurement mode from what is displayed, press the [Right Arrow] key and then press [Down Arrow] key until the desired measurement mode is displayed then press [OK].

The power measurement mode that you choose will stay in effect until you change it. It will not be changed by turning PowerSight off.

Changing the Power Measurement Mode in PSM-A

To determine the power measurement mode using PSM-A, connect PowerSight to PSM-A and then either go to the Monitoring Setup menu and read what appears in the Power Mode box or operate in Remote Control mode and press the key combinations described above.



To change the power measurement mode using in PSM-A, either go to the Monitoring Setup menu, click on the Power Mode drop-down box, select the mode that you wish to operate in, and then send the new setup to the connected PowerSight meter or operate in Remote Control mode and press the key combinations described above.

Defining Input Ratios

All current probes used by PowerSight are self-identifying so they are automatically calibrated to the unit when they are plugged in. This is a convenience, a time saver, and a protection against making errors in measurements. There are occasions where the input does not represent what it actually is. In these cases, the user needs to define the inputs for PowerSight or for PSM-A.

The chief need for defining inputs is to enter in input ratios for voltage or current. There are several occasions when this is necessary. The most common occurs when monitoring a large main circuit to a facility. The current may be too large to measure with the current probes you own, or you may not be able to physically clamp around the cables or bus bar, or the voltage of the bar may exceed the insulation rating of the current probe. In these instances, a permanently installed CT and/or PT may be wired-in for a metering system. By clamping onto the secondary of such a CT (typically with an HA5 probe) or attaching directly to the PT with voltage probes, you obtain readings proportional to the primary side of the CT or PT. Entering the ratios of the CT and/or the PT into PowerSight allows all recorded values to be scaled appropriately. PowerSight then records primary values, although it is connected to the secondary.

There are other instances where input ratios are valuable. If a large current is carried by 2 or more parallel conductors, you can clamp onto 1 conductor, enter in the ratio (for instance 4 total conductors to 1 measured conductor) and thereby record the total power without clamping around all the conductors. However, before you use this approach, verify that each conductor is carrying the same amount of current. It's not uncommon for parallel conductors to carry different loads when high currents are involved. If the loads are different in each conductor, you may enter the appropriate input ratio. For instance, if the measured total of 4 cables is 2005 amps and the one cable you will monitor carries 492 of the amps, you can enter the ratio 2005 : 492 and all readings will be correct.

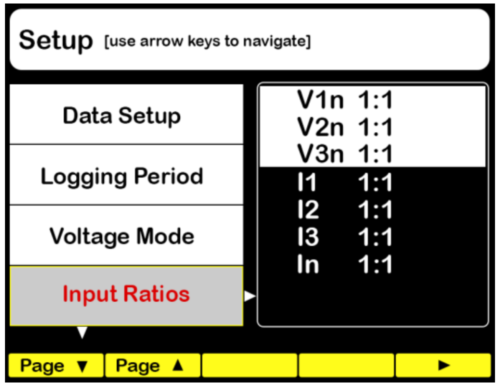
There are cases where you may wish to measure very small currents with a large probe. In order to improve the accuracy of the readings, you may wish to clamp onto several turns of the wire. This essentially amplifies the signal (and boosts the signal to noise ratio). For instance, if you were reading 1 amp with an HA1000 probe, you might clamp onto 10 turns of the wire to boost the signal to 10 amps. If you then entered a ratio of 1 : 10, the readings will be scaled correctly and be more accurate.

Finally, in measuring high voltages, if you use a high voltage probe, enter the ratio of the probe (for instance, 100 : 1) and record the actual voltage being measured.

Using these techniques, you can measure anything with PowerSight. The measurement range extends from 1 milliamp to more than 4 million amps, 1 volt to more than 4,000 kilovolts, 1 watt to more than 40 megawatts!

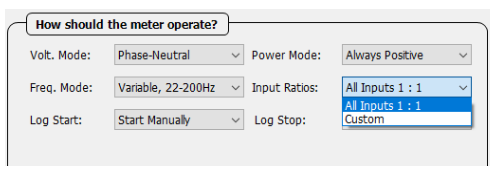
Note: When PowerSight is turned off, its input ratio settings are not returned to 1:1. You must take care that they are what you wish.

Changing Input Ratios in PowerSight

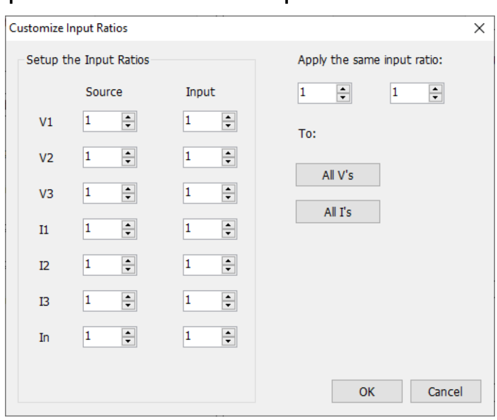


To view the input ratios in PowerSight, press the [Setup] key then press the [Down Arrow] key until you get to the “Input Ratios” option. To change the ratios, press the [Right Arrow] key then select either the Voltage ratios or Current Ratios then press [OK]. From here again select which signals to change with the [Down Arrow] key then press the yellow soft key [Change]. This will take you to the input ratios screen in which you can select the ratio for your selected signals. When completed press the yellow soft key [Done].

Changing Input Ratios in PSM-A



To determine or change the input ratios using PSM-A, go to the Monitoring Setup menu and click on the “Input Ratios:” drop down box and choose “Custom”. This leads to the presentation of the Input Configuration summary display. For each input to PowerSight, there is a line listing the name of the signal, the input ratio of the signal, and a brief description of the signal. If you wish to change any of these parameters, double-click on the line you wish to change and make the change. Be sure to click “OK” when you are done and save the data setup to a file and/or to PowerSight.



As an example, suppose you wish to record the primary of a permanently installed CT while clamped onto the secondary with your I_1 current probe. Select the "Source" box for "I_1". If the ratio of the CT is 600 : 5, simply enter "600" in the Source box and "5" in the Input box. If the ratio also applies to other inputs, you can instead enter the Source and Input into the right side of the Customize Input Ratios window labeled "Apply the same input ratio:" enter the ratio then press the button [All V's] for voltage or [All I's] for current. Click on "OK" when done.

Note: Once it is entered, an input ratio is kept for the specified inputs until you change the ratio again. The default ratios for PowerSight are set to 1 : 1.

Voltage & Current Waveforms

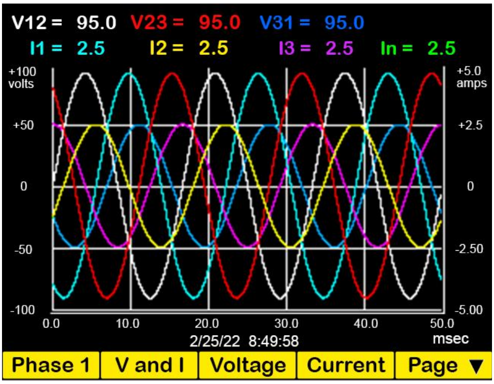
Introduction

Waveforms are very different from logs and other graphs. A waveform is the most basic direct measurement. It displays the instantaneous levels of voltage and current as they continually vary, as you see on an oscilloscope. All other measurements are derived from them. Even the RMS measurements of voltage and current are derived from these basic samples. Logs, on the other hand plot measurements that are derived from the basic sampling. They generally have no relation to what is occurring at a specific instant of time. So, although both waveforms and logs are presented graphically, they are not the same and are not treated the same in analysis. If you could zoom into a data log of Vrms, you might be able to zoom in further and further until you arrive at the measurement of Vrms representing 1/2 cycle of voltage. However, you would not eventually see a waveform of voltage.

Saving Consumption Waveforms

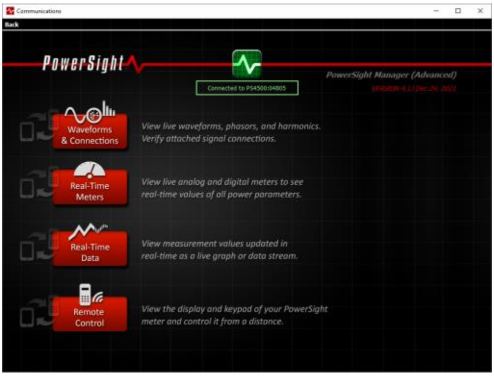
PowerSight allows you to store sets of waveforms whenever you wish to. These waveforms may be uploaded and displayed on your PC at any time. Consumption waveforms are captured by the action of the user. Triggered waveforms are automatically

captured due to some characteristic of the waveform. Triggered waveforms are discussed in later sections.
Whenever a set of consumption waveforms is manually recorded by PowerSight, all 3 voltages and all four 4 currents are recorded for 50 milliseconds. This time-coincident snapshot of 7 waveforms is called a "waveform set". Please Note: When operating in one of the 400 Hz operating modes the waveforms are recorded for 7 msec to give sufficient resolution to these much faster frequencies.



You can capture a waveform set at any time, either using the keypad of PowerSight or PSM-A if PowerSight is connected. To save a waveform set in PowerSight without using PSM-A, press the [View Waveform] key then press the yellow soft key [Page] then press the yellow soft key [Save]. The number that is assigned to the waveform set is then shown on the display. The waveform data storage space within PowerSight is separate from the space reserved for other types of data.

One of the wavesets, waveset0, is a special waveset. It is automatically captured by PowerSight when you initiate monitoring. The benefit of doing this is you can always retrieve a look at what the waveforms were like when monitoring began.

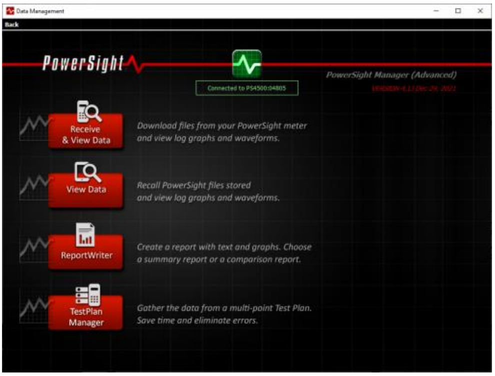


It must be noted that the PS5000 allows the user to disable waveform sets. In this case, you will be unable to save wavesets. The ability to enable or disable the saving of consumption waveforms is discussed in the Allocating Memory within PowerSight chapter.

When the PowerSight is connected to PSM-A, you can also capture a waveform set at any given moment by clicking on “Communications” then clicking on “Waveforms & Connections”. This will open up the waveform graph and automatically take a new waveform and open it.

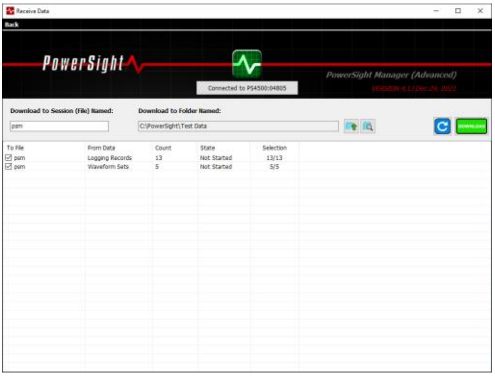
A waveset captured this way is immediately stored in the PC and shown on the screen. It does not affect waveform sets stored on the PowerSight meter that is attached.

Receiving Stored Consumption Waveforms



Waveform sets that are stored inside of a connected PowerSight can be received by PSM-A in either of two ways. At the Main Menu, you can click on the “Data Analysis” button and then the “Receive & View Data” button. The Receive Data menu will open and all the different types of data files in the connected PowerSight will be displayed.

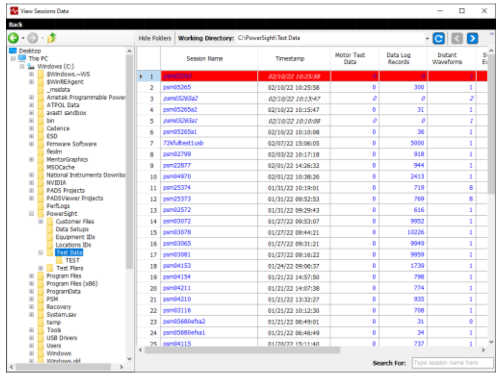
Look for the “Waveform Sets” Data Type lines. These files are the stored waveform sets stored in the PowerSight. Make sure that the box at the start of the line is checked and then click on the green “Download” button to transfer the waveform set to your computer. The default name of the file is psm.$WF.



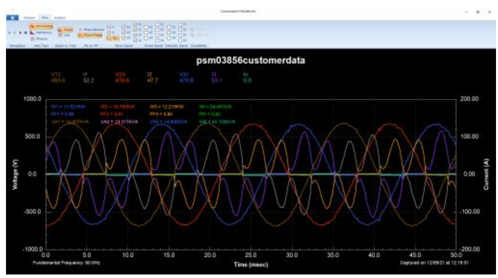
Remember that waveset0 is special. It is an automatic recording of the waveforms at the time that monitoring last began.

Viewing Consumption Waveforms

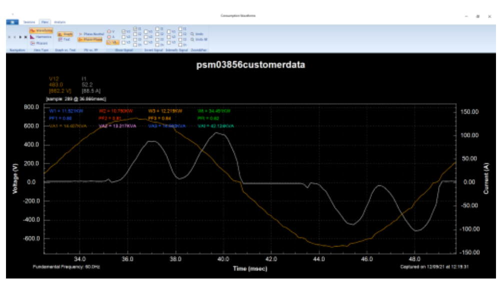
To select a waveform set to view, at the main menu, click on “Data Analysis”, then “View Consumption Data”, or click on “File” and then “View Data”. This will result in the View Sessions Data screen being shown. In the “Instant Waveforms” column, click any of the numbers for a given session name to open the waveform graph.



When you select a waveset to view, the “View” tab will allow you to select between waveforms, harmonics or phasors. You can also make a choice of what signals you want to view, and even invert the signals if you think you have a current probe on backwards. Pressing the arrow buttons on the “Navigation” section will allow you to cycle through each waveset taken during that session if there is more than one.

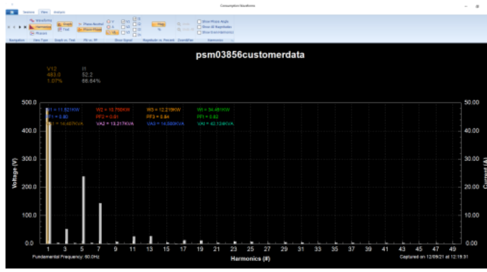


There is a wealth of features related to viewing and analyzing waveforms. Voltage and current can be viewed together and multiple phases of signals can be viewed together.

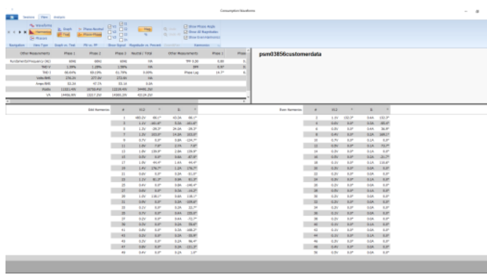


Portions of waveforms can be zoomed into and panned left/right or up/down. Refer to the [Working with Graphs and Waveforms](#)

section to learn more about available presentation and analysis features.



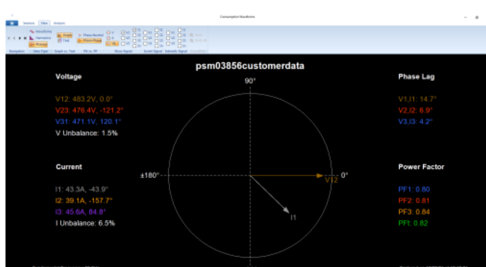
You can easily transform any waveform into either a graph of harmonic data or a view the raw data for each harmonic. To view the harmonic graph ("frequency domain" representation), click on the Harmonics icon. You have the choice of viewing the amplitudes of individual harmonics as either RMS amplitudes (Vrms or Arms) or as a percentage of the magnitude of the fundamental harmonic (the fundamental is always 100% as large as itself). To change to magnitude or to percentage, click on the Mag or % buttons under the "View" tab.



To view the harmonics as Text, select the "Text" button on the "View" tab. This can show you a text view of all individual harmonics to the 50th, as well as the phase angles and magnitudes.

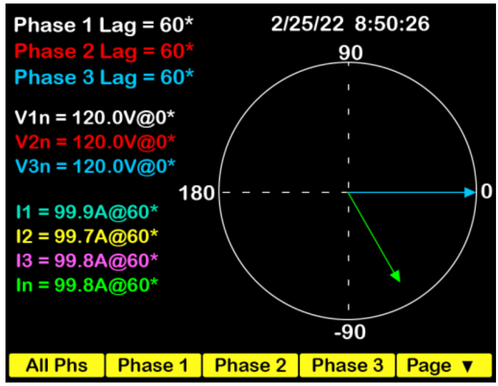
You can easily display a phasor diagram of the signals by clicking on the "Phasors" icon. Phasor diagrams present each voltage and current as a vector on a graph. A vector combines two measurement properties into one object. In this case, the properties are magnitude and phase lag.

Normally, phase 1 voltage is considered to be the phase reference signal, so its angle is 0 degrees. If the phase 1 current lags it, it will be slightly above it. In a three-phase circuit, normally the other two phases will be 120 degrees before and after phase 1 and the phase lag of each current relative

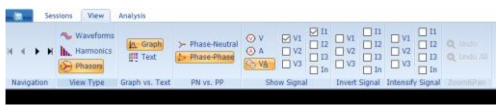


to its associated voltage will be similar. The data graphs on the left of the phasor display show the actual degrees of all voltages and currents in relation to the phase 1 voltage and show the phase angle between the voltage and current of each phase.

You can also see the Phasors from the PS5000 display itself in real time. To view the live phasor diagram from the meter, press the [Phasors] key. By pressing the yellow soft key [Page], you can also find the soft keys for freezing the current view of the diagram.

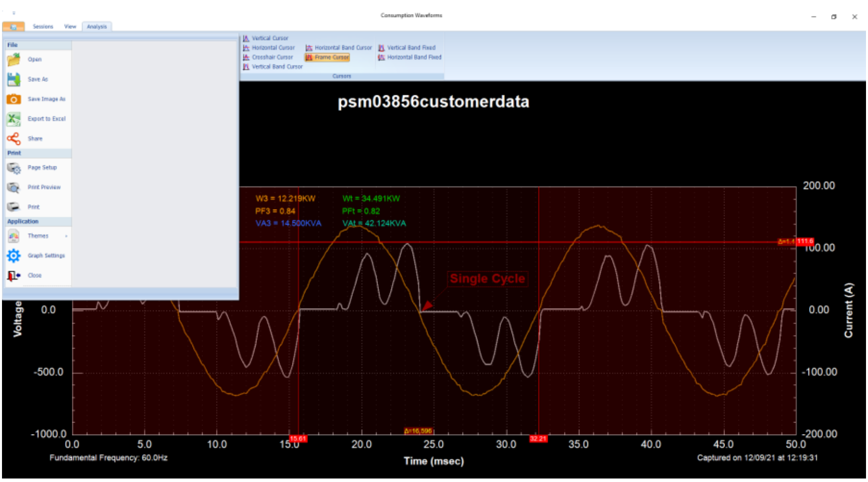


Sometimes, current probes are attached backwards and the resulting waveforms are 180 degrees phase shifted. There is a convenient way of correcting this error. Any waveform can be inverted by checking the box for the signal you wish to invert in the “Invert Signal” section of the “View” tab. If you save the waveform file, the change becomes permanent.



Another feature added in PSM-A is the “Analysis” tab. Here you can create labels on the waveform graph, add vertical and/or horizontal cursors and add crosshairs. This allows you to customize your graph for presentation.

Once you are done customizing your graph, you can save the graph as an image and print it or import it into a report for demonstration.



Monitoring Power Consumption

Introduction

When PowerSight is first turned on, it operates like a reporter, describing what it sees. New measurements are generated each second that replace old measurements. Old measurements are discarded. These are the “present” values that are displayed as you press various keys. When PowerSight is instructed to begin monitoring consumption, it not only reports what it sees (the present values), it also generates summary information about the entire monitoring session and about each logging period.
Summary information includes:

- maximum values during the session and logging period
- minimum values during the session and logging period
- average values during the session and logging period

These summary statistics are of great value to you as you ask questions such as: "What is the minimum voltage?" "What is the maximum current?" "How much does it cost to run this equipment?" "What is the average load?" "When is my peak demand period?"

The PS5000 measures most basic measurement types (such as voltage, current, power, power factor, and THD) for every cycle of every input. The present value that is presented on the screen is the average of these readings for every cycle during the previous second. The maximum value that is displayed on PowerSight is the maximum one-cycle measurement since monitoring began. The maximum value that is recorded into each record of the consumption log is the maximum one-cycle measurement during that logging period. The minimum value that is displayed on PowerSight is the minimum one-cycle measurement since monitoring began. The minimum value that is recorded into each record of the consumption log is the minimum one-cycle measurement during that logging period.

To learn how to display the maximums, minimums, and averages since the beginning of monitoring on your PowerSight, refer to the various sections on measurement types. The maximums, minimums, and averages of each logging period are “logged”.

This is the act of recording summarizing information once every logging period. With PowerSight, the logging period is set by the user, whereas the measurement updating period is always once per second. This ensures that you don't miss valuable information related to the actual power used and the maximums and minimums present. Further, since the PS5000 does its measurements on every cycle of every input, nothing is missed in the measurements and nothing is estimated.

After you direct PowerSight to stop monitoring, all the information remains available to you in the data log that is in PowerSight. The contents of the data log are not displayed on PowerSight's display. To obtain the information, it must be uploaded from PowerSight to your computer using the PSM-A software. The data is recorded into a file in a plain text format that may be easily imported into spreadsheets, databases, and word processors. In addition, PSM-A has extensive graphing and printing capabilities.

Only one data log exists within PowerSight at any given time. Thus, while logging of consumption is proceeding, the data log is growing by one record after each log interval. When logging is stopped, the data log no longer grows, but it is still available. The data is preserved even if the unit is turned on and off repeatedly.

While monitoring is in progress, a green flashing “Monitoring” box will show up at the bottom right of the display. They flash on and off each second to assure you that monitoring is in progress.

Please Note: Before you start monitoring, verify that PowerSight's wall-charger is charging the internal batteries. The internal batteries won't operate PowerSight for many hours without assistance.   Verify that the red charging indicator light is shining through its hole near the DC input jack.

Basic Consumption Data Logging

The basic PowerSight unit logs aspects of energy consumption as described in the previous section. There are many different modes of operation and data logging options available to ensure that you can measure and record just about anything you need to. To simplify things, we provide a default data logging setup and have that installed when you receive your unit, so you are ready to begin logging under general circumstances. The default data logging setup is:

- Logging period = "3" minutes. This means that every 3 minutes, a new record is created that includes all the variables that are requested by the setup. For instance, if maximum I_1 current was one of the requested variables, each record would include the maximum I_1 current of the previous 180 seconds (3 minutes). After one hour, there would be 20 records (60/2= 20) in the log. The three-minute logging period was chosen because it allows you to log for a reasonably long period of time with a reasonably short period between records. Of course, your needs may vary from this, in which case you can easily customize the setup. This is discussed in the "Setting the Logging Period" section.
- Log start mode = "Start manually". Other modes are available and are discussed in the "Starting Data Logging" section.
- Log stop mode = "Don't stop". This means that if the log fills up, it will continue receiving new data which will be written over the oldest data. This is discussed further in the "Stopping Data Logging" section.
- Frequency mode = "Variable, 22-200Hz". This allows PowerSight to measure the frequency every second and perform measurements whenever the fundamental frequency is in that range. If you do not need to measure varying frequency, it is recommended that you change the mode to one of the fixed frequency modes.
- Voltage mode = "Phase-Neutral".
- Power mode = "Always positive". Unless you are dealing with the unusual presence of regenerative power, this is the recommended mode to operate in.
- Inputs configured for input ratios of 1:1.
- Measurement types = standard set of 68 variables.

The default set of measurement types are the maximum, the minimum, and the average of the following variables:

- voltage from phase 1-to-neutral (phase-neutral mode)
- voltage from phase 2-to-neutral (phase-neutral mode)
- voltage from phase 3-to-neutral (phase-neutral mode)
- voltage from phase 1 to phase 2 (phase-phase mode)
- voltage from phase 2 to phase 3 (phase-phase mode)
- voltage from phase 3 to phase 1 (phase-phase mode)

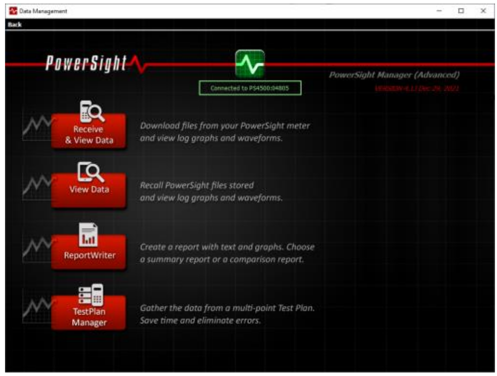
- current in phase 1
- current in phase 2
- current in phase 3
- current in neutral
- true power in phase 1
- true power in phase 2
- true power in phase 3
- true power total
- VA power in phase 1
- VA power in phase 2
- VA power in phase 3
- VA power total
- true power factor of phase 1
- true power factor of phase 2
- true power factor of phase 3
- true power factor total
- THD voltage in phase 1
- THD voltage in phase 2
- THD voltage in phase 3
- THD current in phase 1
- THD current in phase 2
- THD current in phase 3
- THD current in neutral
- fundamental frequency

In addition, the time/date of each data record is recorded.

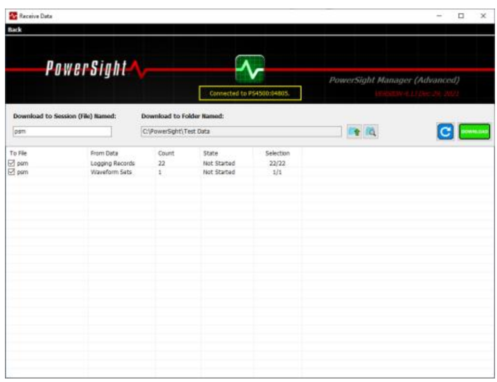
To change the selected variables from the default, the Data Setup feature of PSM-A must be used (see "Setting Measurement Types"). The log setup does not change when the unit is turned off. The default setup can be recovered at any time (refer to the Custom Consumption Data Logging chapter).

With the default setup the log will contain 5000 records. Coupled with the default 3-minute log interval, the default data log will hold summary data for the last 1.5 weeks of energy consumption (3 minutes x 5000). If 15-minute log intervals are used, the data log will hold the summary data for the last 1.7 months of logging. If logging continues long enough to fill the data log, the default is for each new record to be written over the oldest record of the log. In this way, you could leave a unit logging unattended for months and always have the most recent data available for analysis. To have logging stop when the log is full or to set a programmed start or stop time, refer to the Custom Consumption Data Logging chapter.

Receiving the Data Logging Session from PowerSight



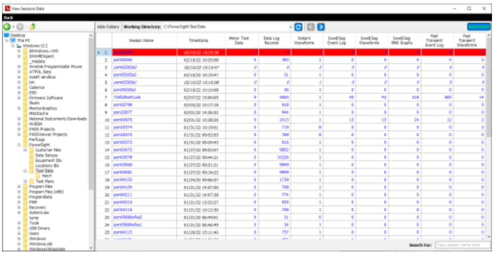
To receive a consumption data log from PowerSight, the PowerSight unit must be connected to a computer running PSM-A. At the main menu of PSM-A, the green “Connected to XXX” Status box must be displayed. At the Main Menu, you can click on the “Data Analysis” button then click on the “Receive & View Data” button. The Receive Data menu will open and all the different types of data files in the connected PowerSight will be displayed.



The Receive Data window shows you all the files available to download from your meter. Make sure that the boxes at the start of the line are checked and then click on the green “Download” button to transfer the data to your computer. The name of the file is based on the entry in the “Download to Session (File) Named” box. This will name all the files in your test session to the same name into the “Download to Folder Named” location on your computer. The default file location in PSM-A is C:\PowerSight\Test Data

Once all the files are downloaded, PSM-A will automatically open the Data log graph on completion.

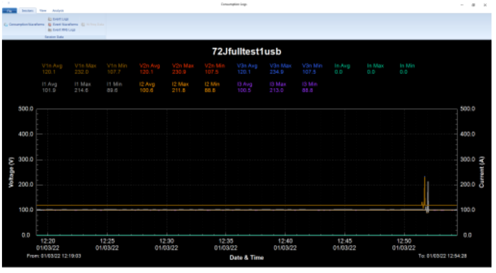
Viewing the Data Logging Session in PSM-A



To view any of our file types from your data logging session in PSM-A, you will first have to download the data from the meter either via Bluetooth, USB or SD card. After the data is downloaded and saved to your PC, you can view your sessions under “Data Analysis” then “View Data”.

Your test data is organized as “Sessions”. Each session contains all the file types created during your logging. They include Data log, Instant waveforms, Swell/Sag/Transient logs and waveforms and if equipped, Frequency Analysis data.

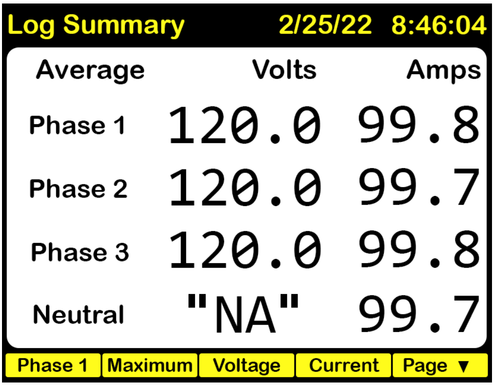
In the “View Sessions Data” window, to open a given file type, click on the BLUE number for the given session and column. From there PSM-A will open a graph of that data. Each session line will have the number of records, waveforms or events for a given data type. From here you can directly open any data downloaded or transferred to the PC.



Once a graph is open, you can navigate through other file types within that same session by clicking on the “Sessions” tab within the graph screen and choosing a different file type (if available).

To learn ways to manipulate, interpret, and present the data for better data analysis or improved presentation, refer to the chapter on [Working with Graphs and Waveforms](#).

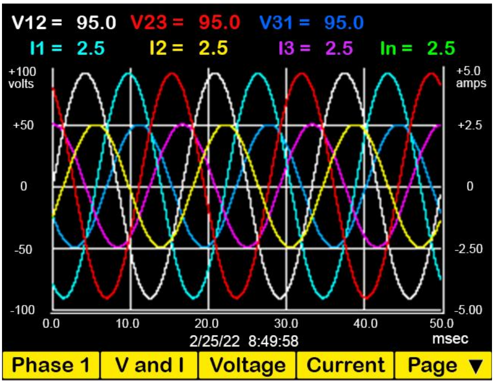
Viewing the Data Logging Session on PowerSight



To view your current or recent data log from the PowerSight meter, press the [View Data Log] key. From here you can view the Maximum, Minimum, and Average measurements for Voltage, Current, Power, Power Factor, Frequency, and many more. This can be viewed after or during your current logging session.

Working with Graphs and Waveforms

Viewing Waveforms from the PowerSight



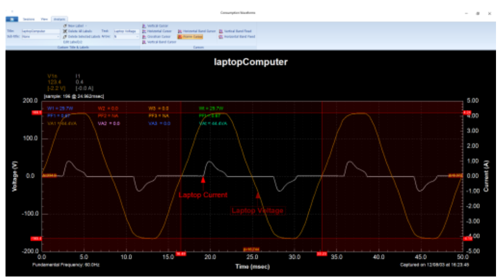
The PS5000 is unique in the way that it has a graphics display that will allow you to view real time waveforms from the meter without the need to download a waveset to your PC. The graph from the meter can show all 3 phases of voltage and all 4 inputs for current at the same time. From this waveform screen you can also save a waveset. To view the current waveform, press the [View Waveform] button. To save the current view, press the yellow soft key [Page] until you see the yellow soft key [Save]. You can also pause the current waveform by pressing the yellow soft key [Pause].

Presentation of the Graph in PSM-A

It is important to us to allow you to work with and manipulate the various graphs and waveform presentations in PSM-A. We try to make the features that accomplish this look and feel the same throughout the program so you can handle all waveforms and graphs in the same way as much as possible. This is one of the areas in which we continually improve the product and our software updates will allow you to benefit from these improvements over time. This section presents the general methods we have for analyzing, manipulating, and presenting the data. The Viewing Consumption Waveforms section presents additional material that relates just to waveforms.

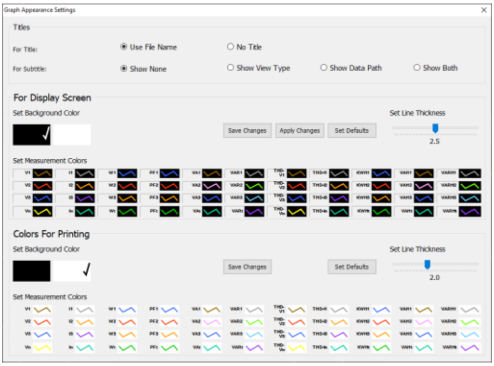
The types of analysis and manipulation features are:

- Selection of signals to view
- Attaching labels and titles
- Changing the color scheme
- Printing and saving as Windows bitmap graphic
- Zooming and panning
- Viewing data



Often, the presentation of a graph can be enhanced by changing the title at the top from the filename to something more descriptive. This does not change the filename, but it may improve the look of the graph. Also, points of interest can be brought out in a presentation by adding labels to the chart. The label consists of some text and an arrow. To create labels or titles, click on Analysis tab and then select “New Label”. Here you can also add cursors to help demonstrate the area of the graph you want people to see.

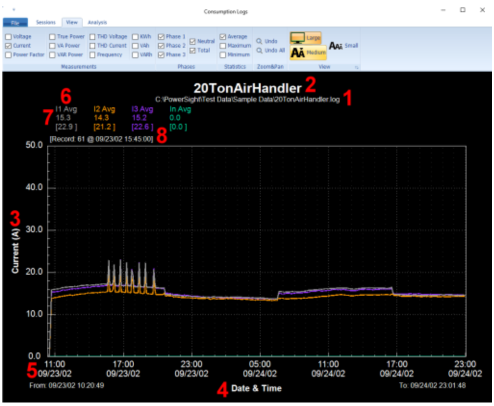
Normally, the color of the signals is set automatically by PSM-A to give good color contrast on a color monitor. However, that contrast may not stand out on your monitor or on your color printer or especially with your black and white printer. You can control the colors used to display signals by clicking on the file tab and then “Graph Settings”.



Whatever is displayed can be printed by clicking on “File” and then “Print”. It can also be saved as a Windows bitmap file by clicking on “File” and then “Save Image As”.

Reading Graphs and Waveforms

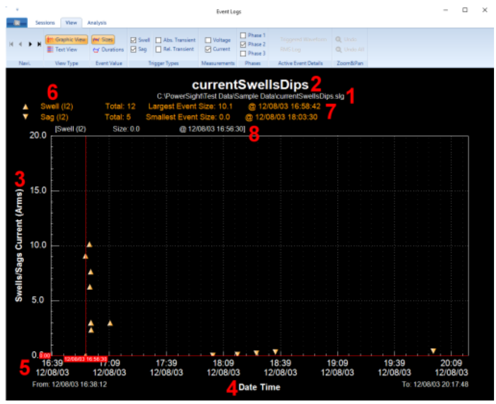
Graphs and waveforms have similarities in the ways they are presented in order to quickly understand what is displayed. Examples of the various graphs and what the various sections mean follow.



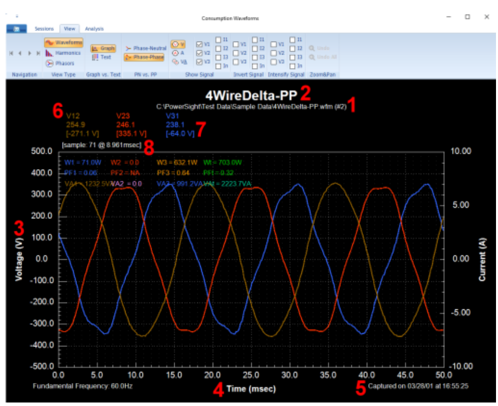
1) The name of the file that is being displayed appears in the top if enabled in the Graph Settings.
2) The name of the graph or waveform set appears at the top of the graphical portion of the screen. The default name is the name of the file, including the directory path. You can enter a name of your choice, by clicking on the “View” tab and then “Labels”.
3) The name and metric of the vertical axis tells what type of measurement is being displayed and what the unit of

measurement is. When the graph combines different types of measurements (such as when displaying voltage and current) there will be a vertical name and metric on the left side and a different one on the right side of the graph.

4) The horizontal axis is usually time. Logs have time and date stamps to help determine when events occurred and how long they lasted. Other graphs and waveforms have metrics of seconds or milliseconds. Displays of triggered graphs or waveforms usually start with a negative number. This is an indication of how far in advance of the triggering event that point is.



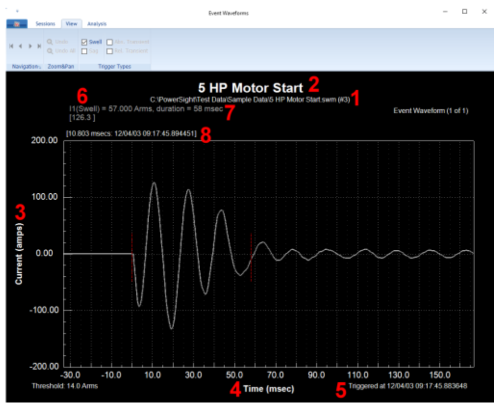
5) All graphs and waveforms have a time and date stamp. In the case of consumption logs, the left-most timestamp is when the displayed data began. In the case of triggered events, the time and date stamp is when the event occurred.
6) All graphs and waveforms have data that is displayed. The heading tells which signal or measurement is associated with which data. The color of the heading is the same as the color of the data presentation.



7) Summary data is displayed on all graphs and waveforms.
    a) For a consumption log, the summary data for a specific heading depends on the measurement. If it is an average, the summary is the average of all the values shown. If it is a minimum, it is the minimum of all the values shown. If it is a maximum, it is the maximum of all the values shown.

If it is an energy (kWH), it is the final point shown (the energy consumed during the time displayed).

b) For a consumption waveform, the summary for a specific signal is the RMS value and crest factor of the signal. The power and power factor of the phase or phases is also shown at the right.



c) For a swell/dip RMS graph or waveform, the summary is the maximum RMS value (for a swell) or minimum RMS value (for a dip), the duration of the event, and the threshold.

d) For a swell/dip log, the summary is the number of events shown for each signal, the RMS level of the worst event for each signal, the duration of the worst event for each signal, and the threshold for each signal.

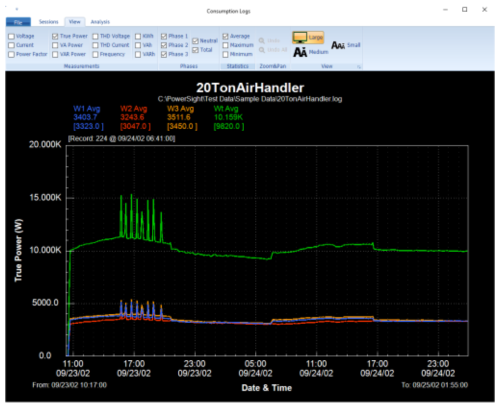
e) For a high-speed transient log, the summaries are the same as for the swell/dip log except values are in instantaneous levels rather than RMS levels.

f) For a high-speed transient waveform, the summaries are the same as for a swell/dip waveform, except the values are in instantaneous levels rather than RMS levels.

8) Information specific to the position of the cursor is displayed. For instance, when the cursor is positioned over a consumption log, the data values at that time are presented within parentheses under the signal names in the heading and the time and date stamp at that point and the record number are presented at the upper right within parentheses. For swell/dip logs and high-speed transient logs, the number of transients to the left of the cursor is presented, unless the cursor is on top of one of the event data points. In that case, the signal name, magnitude, duration, time and date stamp, and event number of that data point are presented. Information within parentheses will not be printed out.

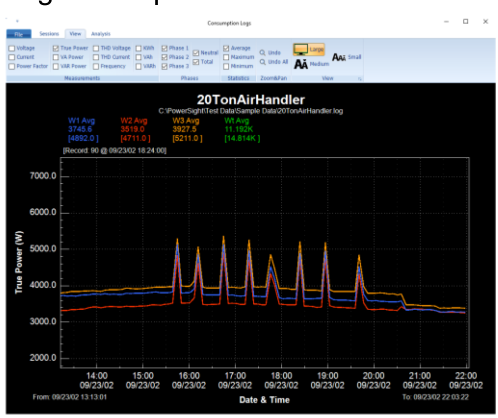
Zooming and Panning

Perhaps the most powerful tool of graphical analysis is zooming. This feature allows you to expand an area of interest of a graph or waveform so that it fills the screen. It also allows you to trim off areas that you don't want displayed (for instance, you may only want one week of a 30 day log displayed for printing).



There are multiple ways to zoom in on an area of interest. The easiest is to position your cursor at the upper left corner of the area you wish to expand and then left-click-and-hold-down and "drag" the cursor to the lower right. As you drag the cursor, a box will appear on the screen and it will grow as you move the curson down and to the right. When you release the mouse's left button, the area that was within the screen will expand to fill the screen. To zoom out, you can either right click and choose "Un-Zoom" or you can click on the "undo" icon under the View tab.

The examples below are of a log of true power of an air conditioning unit and of a zoomed-in portion of the same log. The Zoom In and Zoom Out icons are circled. The example on the previous page does a good job of communicating the overall operation of the air handling unit that was being monitored. There is a circled area of special interest in this graph where the power has several



repetitive peaks. The example on the right does a good job of focusing in on this area of particular interest.

The example on the previou page showing the full log has several features of interest highlighted. Notice that the cursor is positioned near the center of the display. The data associated with that point appears in the heading, in parentheses. Specifically, the cursor is positioned on Record 224 of the log. The timestamp of that point is 6:41:00 on 9/24/04. The value of the average phase 3 power for that record is 3450 watts, whereas the average of all the average phase 3 power points that are displayed is 3511.6 watts.

The example above showing the zoomed-in portion of the sample log has the cursor positioned above a special point of interest, a point where one of the peaks in the power occurs. Looking at the circled information, you can quickly identify that the data at that point is contained in record 90, which started at 18:24:00 on 9/23/04, and the value of the average Phase 3 power at that point is 5211 watts, whereas the overall average of the average phase 3 power points that are displayed is 3927.5 watts. Notice that the oveall measurement has changed from 3511.6 to 3927.5 because it only refers to the data that is shown.

It is important to note that when a measurement type that is graphed is an “average” (such as “power, Phase 3 Avg”), the summary value at the top is the average of all the averages displayed. When it is a “maximum” (such as “V_{12} max”), the summary value at the top is the maximum of all the maximums of the data appearing on the screen. When it is a “minimum” (such as “I_2 min”), it is the mimimum of all the minimums shown.

Custom Data Logging

Introduction

PowerSight has many optional ways of operating that allow you to accomplish almost any type of power logging task you may wish to do. It does this by allowing you to make choices in the areas of:

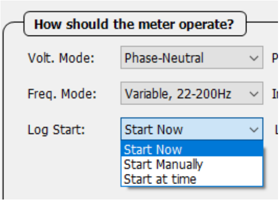
- when or how to start logging
- when or how to stop logging
- how often to create records
- what data measurement types to include in the log
- what voltage measurement mode to operate in
- what frequency measurement mode to operate in
- what power measurement mode to operate in
- how to define the inputs.

Each of these general areas will be covered in the following sections.

The collection of choices that are made on how to operate is called a “setup” file. You can use the “default” setup file, supplied by Summit Technology or you can create, store, and retrieve your own.

Starting Data Logging

There are several methods to initiate data logging. The main method is to use the meter’s keyboard interface. Press the [Monitoring Start/Stop] button on the meter to start. If logging is in progress, there will be a green flashing “Monitoring” box appearing on the bottom of the PowerSight display.



The other methods of starting logging can be set within the Data Setup screen by clicking on the “Log Start” Mode dropdown box. First, there is the choice of “Start now”. If this is selected, when the custom setup is sent to the attached PowerSight, it will immediately start logging. If you click on “Start at time”, a box will open in which you can set the time and date at which to start logging. Once the custom setup is sent to PowerSight, that date and time will be stored in the unit, until a new date and time are written over it. This is a great way to synchronize several PowerSights to start logging at the same time, so their data logs can be synchronized. It is also a great way to log for a specific number if minutes or hours or days or whatever when combined with the mode of stopping data logging at a specific date and time. Finally, it is the best way to ensure that logging begins and continues in the same timeframe that the utility calculates demand period.

Please Note: Before you start monitoring, verify that PowerSight's wall-charger is charging the internal batteries. The internal batteries won't operate PowerSight for many hours without assistance.   Verify that the red charging indicator light is shining through its hole near the DC input jack.

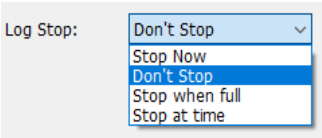
Stopping Data Logging

The default mode of operation is for PowerSight to not stop logging until it is turned off. Pressing the [Monitoring Start/Stop] key then pressing the yellow soft key [Stop] will end the current monitoring session. There are several other modes of operation that can be selected in the Data Setup screen.

“Stop when full” instructs PowerSight to stop logging when the log fills up. This is helpful if you don’t want to lose the data from the beginning of the data logging session and may not be back to get the data before the log fills up.

Another mode is to select “Stop at time”. If this is selected, then a box opens that you can enter a date and time for the logging to end. This is helpful if you want logging to end at a specific time or if you want it to end after a specific number of minutes, hours, days, or whatever.

The option of “Don’t Stop” allows logging to continue even after the log is completely full. New data will be written over the oldest data. This allows you to leave a unit logging

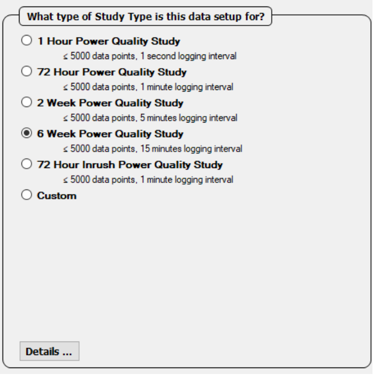


continually and always have the most recent data available for analysis.

Setting the Data Logging Period

One of the most important settings is the choice of logging period. This is the length of time between the creation of data records. This has no effect on the measurement rate or the sampling rate. Unlike inexpensive data loggers that only take measurements when a record is created, PowerSight measures all its variables every second, regardless of the recording rate. This is very important when logging power, since loads typically vary greatly and quickly. The default setting for logging period is 3 minutes. This means that after 180 measurements (180 seconds are in 3 minutes) a record is made containing all the measurement types specified by the setup. If maximum power is one of the measurement types, then the maximum power of all of the cycles during the preceding 180 seconds will be recorded into the log.

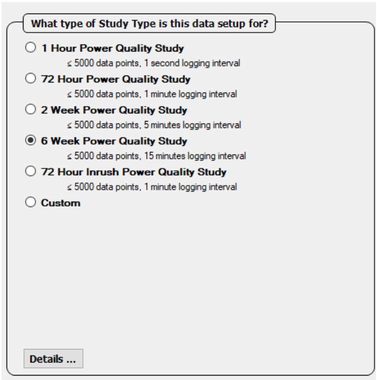
Since the data log fills up one record at a time, if the logging period is set for a large number, it will take quite a long time to fill the log, whereas if it is set for a small number, it can be filled much faster. The log capacity is displayed in the upper left of the "Data Setup" menu, just above the selection area for logging period. In the example shown, the logging period is set for 3 minutes and the time to completely fill the log is 2.083 days.



In PSM-A, we make the choice of logging period simpler by having pre-set logging types we call "Study Type". Here you can choose a type of study you wish to take and the memory allocation and logging period is set for you. You can also create a "Custom" setup type if you wish and choose the variables and logging period. Keep in mind if you uncheck a variable from the selection of variable the meter will not record this measurement. We recommend logging ALL variables even if you do not need them for this test.

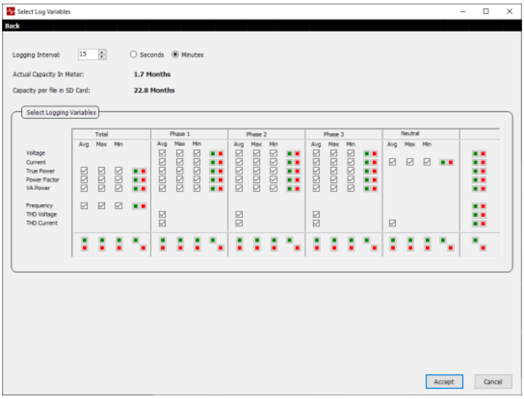
You can also change the logging period from the keyboard of your meter. Click on [Setup] key, then use the [Down Arrow] keys to select the “Logging Period” option. Press [OK] to make changes to the current logging period then press [OK] again to accept.

Setting Measurement Types



By default, the PS5000 records ALL variables available. This is because with the addition of an SD card and larger memory size, you can fit larger logs in the meter.

To inspect or change the measurement types, look to the “Study Type” section of the Data Setup menu and click on the “Detail” button at the bottom or choose the “Custom” study type. This will bring up the Select Log Variables window.



Selecting which measurement types to add or remove from the log setup is as simple as clicking on the box next to the measurement type. As measurement types are added or removed, the capacity of the log is affected. If fewer variables are saved, then each log record is smaller and thus more records can be stored in the log, which means that it will take that much longer to fill the log. In the example shown, all variables are selected, which combined with the logging period of 15 minutes, will take 1.7 months to fill up.

You can also see how long 1 data log will last on the SD card. The SD card has a lot more memory capacity than the meter so it can contain 65,535 records max, per each log. When combined with the log STOP mode set to "Don't Stop", when the meter reaches this record count, it will stop logging automatically then start a new log on the card. This allows you to log continuously for a long period of time without stopping. You will have to get all the data from the SD card as the internal memory will only have the last records recorded compared to the thousands on the card.

To make quick changes to the measurement types, you can use any of the many speed-editing boxes that allow setting or clearing all in a column or in a row or of a type.

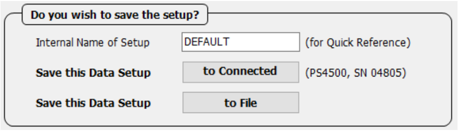
When done modifying the measurement types, be sure to click "Accept" and then save the new setup to file and/or send it to the connected PowerSight.

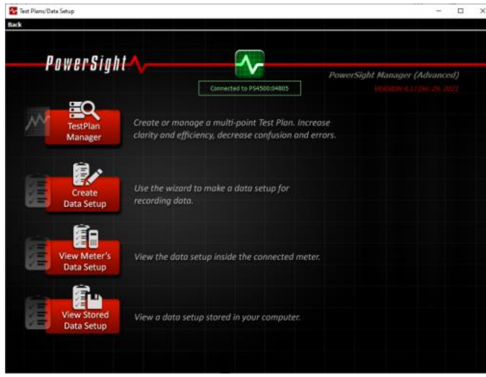
Setting Measurement Modes

The measurement modes and how to check and modify them have already been covered earlier in the manual. Refer to the Measurement Modes chapter.

Saving & Retrieving Setups to File or PowerSight in PSM-A

When you create a customized data setup, it is usually a good idea to save the setup to a file. To do this, click on the "to File" button and give it a filename. A good practice is to give the setup a name that will be displayed. The example says "CUSTOM", but a typical one might be "Motors". The name can only be eight characters long. Although this name that is embedded into the setup is limited to 8 characters, the filename that the setup is stored under can be of any length that is acceptable to Windows. To load the setup into PowerSight, click on "to Connected".





To retrieve the setup from a file, click on the "Monitoring Setup" button on the main menu, then select the "View Stored Data Setup" button. This will open up the windows dialog box to choose a saved data setup file. To view the connected meter's data setup, you can choose "View Meter's Data Setup" and PSM-A will upload the setup installed in the PowerSight meter.

Loading Data Setups from the Memory Card (SD Card)

There are times that is is useful to load a data setup into the meter from the memory card (the SD card). Examples include:

- re-loading the setup into the meter to be sure it is correct
- loading different setups as you move from location to location.

To load a data setup into the meter from an SD card, load the data setup file onto the SD card in an accessible place. Data setup files end with the file extension ".stp". The meter can detect these files if they are located in either the root directory (the highest-level folder on the card, such as "F:/") or in a directory off of the root that is named the same as the serial number of the meter. For instance, a meter with serial number 12345 can detect data setups that are in the root directory (e.g. "F:/") or the serial number directory (e.g. "F:/12345"). To detect a data setup on an SD card, press the [Setup] key. Use the Arrow keys to highlight "Data Setup" then press the [Right Arrow] key and then the [Down Arrow] key and select "Load Setup from SD Card". It will then look in the serial number directory for data setups. The friendly name of the setup will be displayed. Use the Arrow keys to select the setup you wish to use then press [OK]. If there are no data setups in the serial number directory or you do not accept any of them, it will next look in the root directory to see if there are data setup files. It will then ask if you wish to load any of them. If there are no data setups in the root directory or you do not accept any of them, it will ask again if you wish to load a data setup from the memory card.

This functionality makes it easy to load multiple setups onto an SD card to support a test plan including multiple locations and involving multiple meters.

Saving Data Setups to the Memory Card (SD Card)

It is beneficial to store a copy of the present data setup onto the SD card to document how a monitoring session was set up. This is done automatically when an SD card is installed. Each time monitoring starts and an SD card is in the meter, a serial number directory is created if it is not already present and a logging directory is created to hold the various files created by the monitoring session. A copy of the data setup is stored in the logging directory at that time. As an example, say a meter with serial number 12345 has an SD card installed that will be read on your computer as drive F and say monitoring was started at 11:22:33 on June 24, 2012. You could encode the date as 120624 to show the last two digits of the year, then 2 digits for the month and 2 digits for the day. You could encode the time as 112233 to show two digits for the hour, two digits for the minute, and two digits for the seconds. Combining all this, you would find the following setup file when you read the SD card on your computer: F:/12345/120624_112233/12062411.stp.

This setup file can be used again if placed in the serial number or root directories and it can be useful if there is a question about the data at the end of the monitoring session.

Restoring the Default Setup

The default setup can be restored to PowerSight at any time. The easiest method is to press the [Setup] key and with the “Data Setup” options highlighted, press the [Right Arrow] key then press the [Down Arrow] key, select “Set to Default Data Setup” and press [OK].

Monitoring Swell/Dip/Inrush

Introduction

The three general areas of power quality analysis are in investigating on-going harmonic content, analyzing temporary changes in RMS voltage and current levels, and in analyzing instantaneous high-speed (non-RMS) voltage and current transients. Swells (also known as surges), dips (also known as sags), and current inrushes are temporary changes in RMS values that are outside of a norm. This chapter is about monitoring swells, dips, and inrushes. Although these events are transitory, we do not refer to them as transients in this manual. When we refer to transients, we are referring to high-speed instantaneous events (see the Monitoring High-speed Transient Events chapter).

An inrush is typically a large increase in RMS current that subsides as the load stabilizes. A dip is typically a drop in RMS amplitude due to a sudden load change. A swell is typically a rise in RMS amplitude due to a dropping off of load. In all cases, the way they are defined and he way they are captured is by defining RMS trigger levels.

It can be useful to set trigger levels that are specific amplitudes, such as “30 amps” or “130 volts. PowerSight and PSM-A supports this approach.

Since these events do not occur regularly (if they occur at all), they are only recorded by PowerSight when they occur. Therefore, when allocating capacity to the various logs and waveforms, there is no definite way to judge how much capacity will be needed.

There are three types of recordings of swell/dip events that may be used:

- Swell/Dip Event log
- Swell/Dip RMS graph log
- Swell/Dip waveforms.

The fact that the PS5000 evaluates the RMS value of every ½ cycle of every input means that no swells or dips are ever missed and the most precise measurement of their duration is available.

If thresholds are set, swell/dip monitoring begins when consumption monitoring begins and continues without interruption. While monitoring is in progress, a green “Monitoring” box is seen at the bottom right corner of the display. It will flash on and off each second to assure you that monitoring is in progress.

After you direct PowerSight to stop monitoring, all the information remains available to you in the swell/dip log, the RMS graph log, and the swell/dip waveform captures that are in PowerSight. The data is preserved even if the unit is turned off and on repeatedly. The contents of the various data logs are not displayed on PowerSight's display. To obtain this information, it must be uploaded from PowerSight to your computer using the PSM-A software. The data is recorded into files in a plain text format that may be easily imported into spreadsheets, databases, and word processors. In addition, PSM-A has extensive graphing and printing capabilities.

High-speed transients, which are independent from the power line frequency may have sufficient size and duration to trigger a swell event. Nevertheless, their trigger points and capacities are normally set and maintained separately from swell/dip events (see the Monitoring High-speed Transient Events chapter).

Swell/Dip Event Log

The swell/dip log is a compact text file. It contains the basic swell/dip event information:

- Timestamp
- Signal triggered
- Event type (swell or dip)
- Magnitude
- Duration.

The “timestamp” records the date and the time that the event began, to the nearest millisecond. The “signal triggered” is simply the name of the signal that had was triggered, such as “V_{1N}”. The “magnitude” is the RMS of the ½ cycle that had the largest RMS level (for swells) or the smallest RMS level (for dips). The “duration” is how long, in milliseconds, the event lasted, starting with the first ½ cycle that exceeded the trigger threshold and ending with the first ½ cycle that did not exceed the trigger threshold and was followed by 1 second of not passing the trigger threshold.

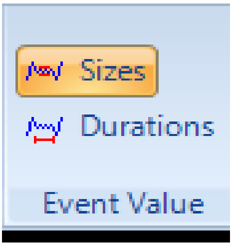
The swell/dip event log can be displayed by PSM-A in three ways:

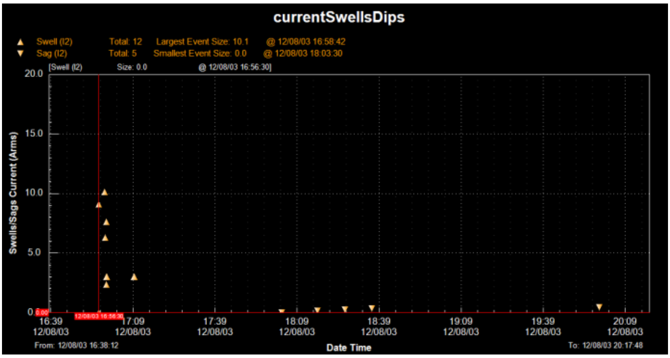
- text record, one line per event
- placement of magnitude vs calendar timeframe
- placement of duration vs calendar timeframe.

The text record allows for quickly spotting certain trends, such as the problem always being with the same signal or the problem is always a dip event.

04/20/03	15:43:54	Van	Dip	49.5V,	2625 msecs
04/20/03	15:43:59	Van	Dip	49.5V,	3000 msecs
04/20/03	15:44:05	Van	Dip	49.5V,	3000 msecs
04/20/03	15:44:12	Van	Dip	49.8V,	700 msecs
04/20/03	15:44:18	Van	Swell	176.4V,	3000 msecs
04/20/03	15:44:24	Van	Swell	176.1V,	3000 msecs
04/20/03	15:44:30	Van	Swell	176.2V,	3000 msecs

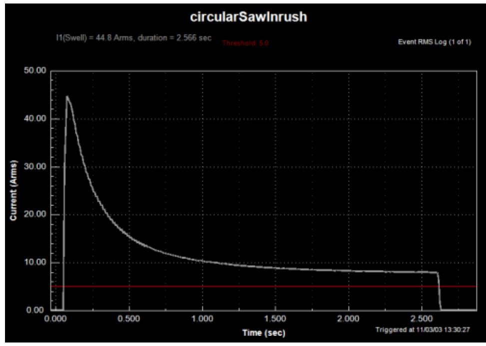
The placement of magnitude and/or duration vs calendar timeframe allows spotting times of day that events occur, and noticing if events are of similar durations, and noticing if events are of similar magnitudes. To view magnitude vs. time, click on the "Sizes" icon. To view duration vs. time, click on the" Durations" icon.





Swell/Dip RMS Graph Log

Each record of the Swell/Dip RMS graph log is a recording of the RMS level of the signal starting 2 cycles before the trigger threshold is passed and continuing for 48 cycles or until the first ½ cycle that did not exceed the trigger threshold and was followed by 1 second of not passing the trigger threshold. The record has timestamp and the RMS levels of each ½ cycle during the duration of the event. These records are typically not too data intensive, so they do not require an excessive amount of memory.

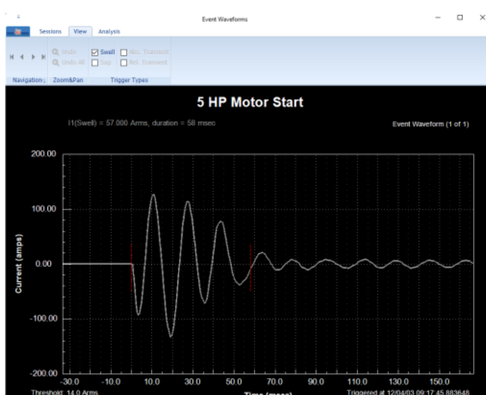


Each record of the swell/dip RMS graph log can be graphed for overall viewing of the event. Key data is listed above the graph. The time at which the trigger occurred, the duration, the signal name, and the magnitude are all listed. The graph displays RMS values of each ½ cycle for the entire length of the event. The graph can be zoomed-in on and can be printed.

The swell/dip event RMS data log is recorded as tab delimited text, so it can be imported into Excel for custom analysis.

Swell/Dip Event Waveforms

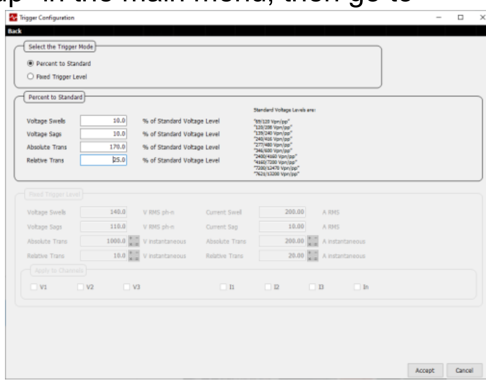
Swell/Dip Waveforms are detailed records of the waveform of a swell/dip event. They start 2 cycles before the event and continue for 10 cycles. These files are very data intensive and therefore a limited number of them should be recorded.



The waveforms can be graphed in order to better understand the swell/dip event. Important information is at the top. The signal name, the timestamp of when the event occurred, the magnitude of the event, and the duration of the event are listed. In addition, moving the cursor over the graph results in the voltage (or current) of that point being displayed in the heading. Whatever is seen can be zoomed-in on and can be printed.

Setting the Swell/Dip Trigger Thresholds in PSM-A

Event monitoring is setup with the Monitoring Setup in PSM-A. To do so, go to “Monitoring Setup” in the main menu, then go to “Create a Data Setup”. After you select a Study type and operation setup, click on the button that says “Details” next to Trigger Mode under the Advanced Settings. Here you will find the Trigger Configuration window where you can setup the meter to look for Swells, Sags or Transients.



There are two types of triggering available in PSM-A, Percent to Standard or Fixed Trigger Level. With Percent to Standard, the PowerSight will monitor only Standard Voltages to see if a voltage exceeds a threshold set by the percentage of the standard voltage. The list of standard voltages are shown to the right of the trigger % boxes. Once monitoring has begun, PowerSight will determine what voltage standard is being measured, then apply a Swell, Dip and Transient threshold based on the percentage applied in the setup. If no standard is measured, the meter will not apply any thresholds and event monitoring will be ignored.

The default settings for Percent To Standard triggering is 10% for Swells and Dips. For example, if you were measuring a 480V system, you would have thresholds automatically set for 528V for swells, and 432V for Sags.

The second type of triggering is Fixed Trigger Level. This is where the user applies the values for voltage and/or current for the meter to trigger on. This is also the only mode that will look for current events as you will manually tell the meter what threshold to trigger on. You will also be able to tell PowerSight what channels to look for events on. For example, if you only want to look for events on Phase 1, you would check the boxes for V1 and I1. If the other channels are not selected, they will be ignored.

Once the trigger thresholds are set and sent to the meter, and the meter has started monitoring, it will immediately start looking for events, regardless of the logging period. A swell occurs when the RMS value of ½ cycle rises above this trigger level on any signals that have checkmarks preceding them. For instance, if the "Current Swells" threshold is set for 15 ARMS and I_1 has a checkmark in front of it and the RMS value of any ½ cycle of I_1 rises to 15.1 ARMS or higher, then the threshold will have been passed, triggering will occur, and the event will be considered to have started. When the current in this example falls to slightly less than 15 ARMS, the swell will have ended, unless it rises above the trigger threshold again within 1 second. In that case, the swell is considered to be continuing still.

A dip occurs when the RMS value of ½ cycle falls below the trigger level on any signals that have checkmarks preceding them. For instance, if the "Voltage Dips" threshold is set for 475 VRMS ph-ph and V_{12} has a checkmark in front of it and the RMS value of any ½ cycle of V_{12} falls to 474.9 VRMS ph-ph or lower, then the threshold will have been passed and triggering will have started. When the voltage in this example rises to slightly more than 475 VRMS ph-ph, the dip will have ended, unless it falls below the trigger threshold again within 1 second. In that case, the dip is considered to be continuing.

If you wish to capture inrush current graphs, enter a swell current threshold slightly above the normal running level for current. This will cause a swell event to be triggered when the inrush starts and it ensures that the event is considered ended when the normal running state is reached.

It should be noted that you generally will not want to select the neutral current, I_N, if you are also triggering on other currents. This is because the neutral current is typically much smaller than the other phase currents and needs to have different trigger thresholds.

Monitoring High-Speed Transient Events

Introduction

The three general areas of power quality analysis are in investigating on-going harmonic content, analyzing temporary changes in RMS voltage and current levels, and in analyzing instantaneous high-speed (non-RMS) voltage and current transients.

High-speed transients are voltages or currents unrelated to the fundamental frequency of the power being used. They may be due to lightning strikes, sudden shorts or opens, or switching of power sources, loads, and correction equipment. They may be large enough or last long enough to affect the RMS value of a cycle and thereby trigger a swell or a dip, but they are categorized by their peak level and their width rather than their RMS value and duration.

Transients are captured when the instantaneous voltage or current level exceeds the trigger level set by the user. Trigger levels can be set for an “absolute value” and for a “relative value”.

When a trigger is set to an absolute value, such as 180V, anytime the waveform reaches +180V or -180V, the event is captured. The event continues until the level goes slightly below the trigger level again.

When a trigger is set to a relative level, such as 20V, the underlying periodic waveform is removed from consideration and the remaining, transient, signal is examined to see if it exceeds the relative trigger level (in this case, above +20V or below -20V).

There are two types of recordings of high-speed transient events:

- Transient Event Logs
- Transient Event waveforms.

Each of these recordings will be discussed at length in next two sections.

The fact that the PS5000 evaluates the high-speed transients every 8 µsecs on every input channel means that no transients lasting more than 8 µsec are missed and precise measurement of their characteristics is available.

If thresholds are set, transient monitoring begins when consumption monitoring begins and continues without interruption. While monitoring is in progress, a green "Monitoring" box is seen at the bottom right corner of the display. It will flash on and off each second to assure you that monitoring is in progress.

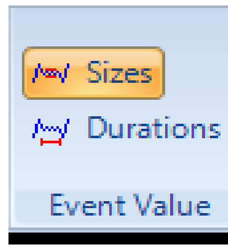
After you direct PowerSight to stop monitoring, all the information remains available to you in the transient event log and the transient waveform captures that are in PowerSight. The data is preserved even if the unit is turned on and off repeatedly. The contents of the data log are not displayed on PowerSight's display. To obtain the information, it must be uploaded from PowerSight to your computer using the PSM-A software. The data is recorded into files in a plain text format that may be easily imported into spreadsheets, databases, and word processors. In addition, PSM-A has extensive graphing and printing capabilities.

Transient Event Log

The transient event log is a compact text file. It contains the basic transient event information:

- Timestamp
- Signal affected
- Peak value
- Duration.

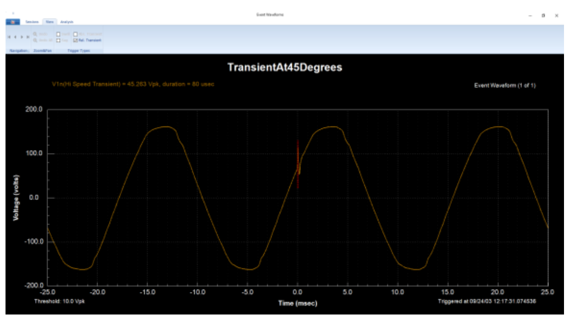
The "timestamp" records the date and the time that the event began, to the nearest microsecond. The "signal affected" is simply the name of the signal that had was triggered, such as "V_{1N}". The "peak value" is the highest (or lowest) instantaneous value that was reached. The "duration" is how long, in milliseconds, the event lasted, starting with the moment when the signal exceeded the trigger threshold and ending when the transient returned below the trigger level.



The placement of magnitude vs calendar timeframe allows spotting times of day that events occur, and noticing if events are of similar magnitudes. To view transient magnitude vs. time, click on the "Sizes" icon. To view transient duration vs. time, click on the "Duration" icon.

Transient Event Waveforms

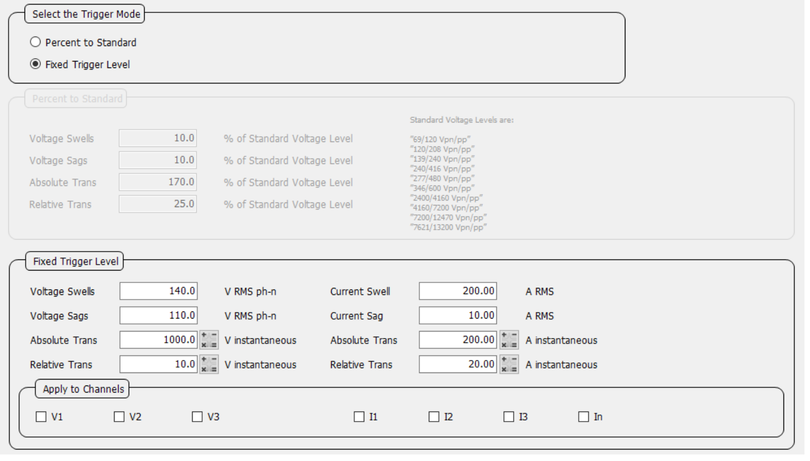
Transient event wwaveforms are detailed records of the waveform of a transient event. They last 50 msec, starting one cycle before the transient event occurred. These files are very data intensive and therefore a limited number of them should be recorded.



The waveforms can be graphed in order to better understand the transient event. Important information is at the top. The signal name, the timestamp of when the transient threshold was reached, the width of the transient, and the peak value of the transient (either in absolute terms or in relative terms to the underlying periodic waveform, depending on which threshold was triggered) are listed. In addition, moving the cursor over the graph results in the instantaneous voltage (or current) of that point being displayed in the heading. Whatever is seen can be zoomed-in on and can be printed.

Setting the Transient Trigger Thresholds in PSM-A

Event monitoring is setup with the Monitoring Setup in PSM-A. To do so, go to "Monitoring Setup" in the main menu, then go to "Create a Data Setup". After you select a Study type and operation setup, click on the button that says "Details" next to Trigger Mode under the Advanced Settings. Here you will find the Trigger Configuration window where you can setup the meter to look for Swells, Sags or Transients.



There are two ways we trigger transients, Percent to Standard and Fixed Trigger Level. Both were explained in the previous section on how to set swell/sag thresholds. The default setup is the Percent To Standard, with the Absolute (ABS) Transient threshold set to 170% of normal and the Relative (REL) Transient threshold set to 25% of Normal.

The Fixed Trigger Level way of setting thresholds for transients allows you to manually enter the threshold. In this option, you must also choose which channel you want the PowerSight meter to look for events on. Care must be taken in choosing this level.

A perfect sine wave has a peak instantaneous value of its RMS level times the square root of two. For instance, the normal peak instantaneous voltage of a 120Vrms circuit is 120x1.414= 170V. This means that a perfect 120Vrms sine wave will reach +170V and -170V once during each cycle. A sine wave that is less than perfect can be quite higher (if the crest factor is higher). For this reason, we have included a helpful aide in determining the absolute threshold for a given circuit. Click on the icon to the right of the box in which you enter the absolute trigger threshold. The "Calculation of Instantaneous" dialogue box will open. Enter the largest normal RMS value you expect to see in the "RMS Input" box. A recommended setting for the absolute transient level will appear in the "Abs Instantaneous" box. This level is about 10% above the normal peak of a pure sine wave of the RMS level entered. For instance, if you enter 120Vrms, the recommended absolute transient threshold will be 186.6 volts. Whenever the voltage rises above +186.6 volts or drops below -186.6 volts for longer than 8 µsec, an absolute trigger will occur and it will last until the instantaneous value drops to slightly less than 186.6 volts and stays less than 186.6 volts for the remainder of the cycle.

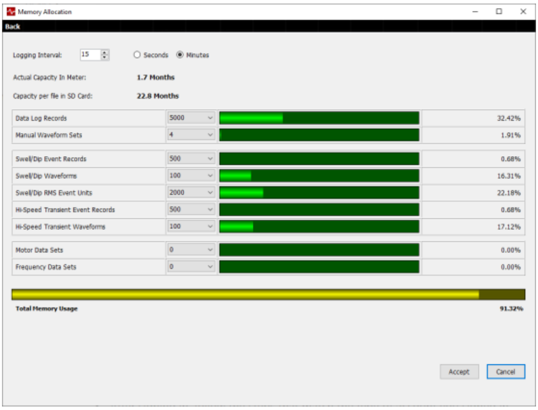
Similarly, we have included a helpful aide in determining the relative threshold for a given circuit. Click on the icon to the right of the box in which you enter the relative trigger threshold. The "Calculation of Instantaneous" dialogue box will open. Enter the largest normal RMS value you expect to see in the "RMS Input" box. A recommended setting for the relative transient level will appear in the "Rel Instantaneous" box. This level is about 25% of the normal peak of a pure sine wave of the RMS level entered. For instance, if you enter 120Vrms, the recommended relative transient threshold will be 30 volts. Whenever the voltage that is independent from the underlying periodic waveform rises or falls at least 30 volts for longer than 8 µsec, a relative trigger will occur and it will last until the instantaneous value drops to slightly below 30 volts and stays below that for the remainder of the cycle.

It should be noted that you generally will not want to select the neutral current, I_N, if you are also triggering on other currents. This is because the neutral current is typically much smaller than the other phase currents and needs to have different trigger thresholds.

When all the trigger levels are set correctly, you may save the data setup to a file or to a connected PowerSight.

Allocating Memory within PowerSight

Allocation of memory in the PS5000 is very flexible. If one type of measurement or area of analysis is of no interest, its storage can be eliminated. If you wish to monitor for very long periods of time, you may wish to shift storage from file types that take much data (such as waveforms) toward file types that take little data space (such as event logs).



To check or change memory allocation in PowerSight, click on “Monitoring Setup” at the main menu, then click on “Create a Data Setup”. The Memory Allocation is found under the “Advanced Settings” area of the Data Setup. Click on the “Details” button next to Memory Allocation to see the list of all the types of storage to allocate memory to.

First, make sure that the categories of interest have records or waveforms allocated to them, and the categories you do not want to monitor are set to 0. Next, observe the percentages of memory each category is taking up. At the bottom of the section, the percentage of memory that is still unallocated is shown. This number must be positive or equal to zero.

The Memory Allocation section will not only show you the allocation for the internal PowerSight memory, but also an estimated capacity for 1 log on an SD card. With an SD card inserted and when the logging “Stop” mode is set to “Don’t Stop”, the PowerSight will continue logging when the internal memory is full. When the internal memory is full, the data will wrap around, writing over the earliest data. With an SD card inserted, it will continue to log past the capacity of the meter until the data log record count reaches 65,535 records. At this point the meter will automatically stop recording and automatically start recording again, creating a new file on the card while starting over in the internal memory. At this point the only way to see all of your data would be to retrieve it from the SD card.

Note that it is usually good practice to allow for at least 1 consumption waveset. This is because PowerSight will automatically record all signals into waveset1 when monitoring begins. It is often helpful to have a record of what the waveforms of all the signals were when monitoring began.

With the Study Type section in the Data Setup, the Memory Allocation is done for you depending on which study type was chosen. If you do change the Memory Allocation manually, the Study Type will change to “Custom”.

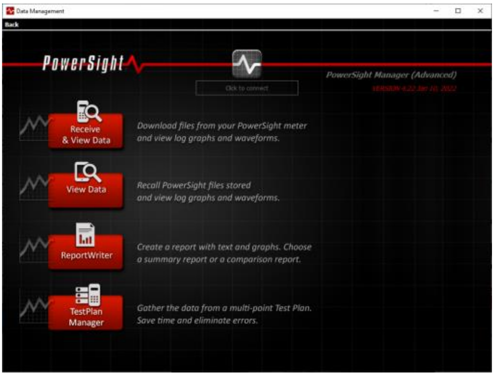
ReportWriter Software

Introduction

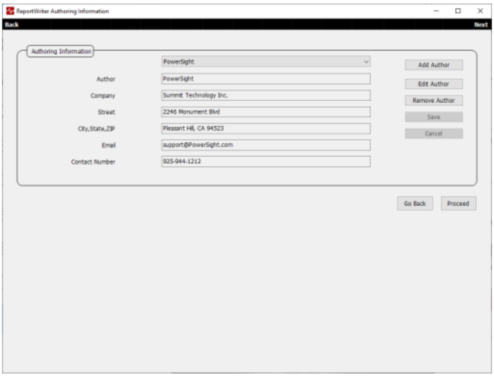
PSM-A comes with a ReportWriter Software program. The ReportWriter software provides concise reports to summarize and document findings. Comparison reports are excellent for presenting before/after comparisons of power usage and projected cost. Separate logs can be compared or sections of the same log can be compared for this analysis. Summary reports summarize the data of a log or a designated section of the log. The reports can be data only, or can combine data and graphs.

Generating a Report

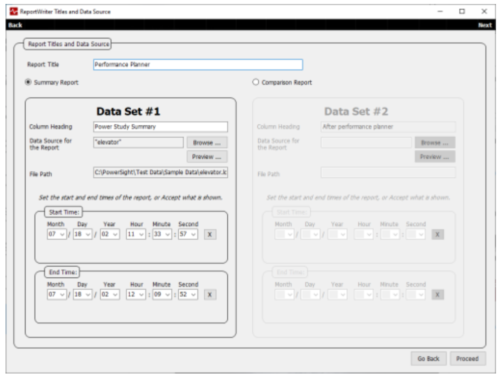
To generate a report, press the “Data Analysis” button on the main menu then press the “ReportWriter” button. You will need to already have a data logging session downloaded or saved to your computer before creating a report.



The “ReportWriter Authoring Information” screen will now be displayed. This screen allows you to enter the author’s information into the report. To create a new author, press the “Add Author” button, fill out the fields, then click “Save”. You can save many different authors and recall their information by selecting them in the dialog box at the top after they are saved. You can



also edit or remove authors by selecting them in the top dialog box then pressing either the “Edit Author” button or the “Remove Author” button.



After you press “Proceed” you will see the “ReportWriter Titles and Data Source” screen. Here you will create a Report Title then choose between doing a summary report or a comparison report. A summary report provides a concise summary of data from one consumption log. This is great for preparing a report of a load study. A comparison report compares data from one log to the data of another log. Or it compares one section of data of a log to another section of data in the same log. This type of report is great for preparing “before” and “after” reports to verify energy savings or to prepare longitudinal reports, documenting how performance or load has changed over time.

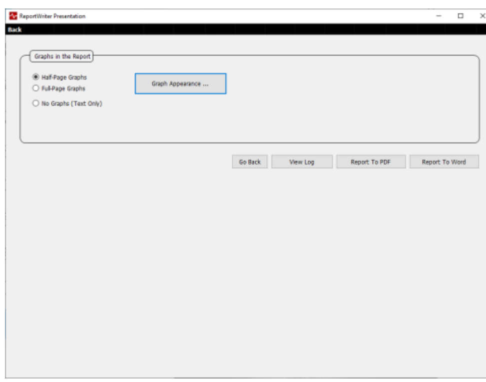
After deciding between Summary or Comparison, you will need to select the data log file or files to create the report of. Press the “Browse…” button to open up the Select a Monitoring Session window, navigate to the folder your data log is in, then double click on the session row of that log to enter it into the report. If doing a comparison, you will need to do this twice, once for Data Set #1, and then for Data Set #2.

Pressing the “Preview…” button will open the selected log up in graph form for you to see your data. Here you can make sure all the data you wish to create a report of looks good before creating your report.

Next up is setting the start time and end time for the ReportWriter to create the report of. By default, the start of the chosen log and end of the chosen log is selected. If you do not want to use all the records of the log, select a starting time and/or an ending time in order to discard records outside of those times. This can be especially important in comparison reports, because you generally want to compare equal “before” and “after” timeframes. When you are done entering the information, click on “Proceed”.

The next screen is the “ReportWriter Variables” screen. Each measurement type that can be included in the report has its own checkbox. They are organized in a matrix that allows ease of locating a specific signal and ease in enabling or disabling entire columns or phases of them. Any checkbox with a check in it, will appear in the report. Note that any variable checked that was NOT in the data setup when the logging was done will show up as “0” due to the data not being present.

There are two sections for in the variables screen. The individual variables for the data log and the Report Waveforms (depending on the PSM-A version at the time of release, the waveforms could be on a separate tab). The measurement variable checkboxes allow you to choose what data log measurements to put into the report, while the Report Waveforms allows you to add a waveform graph from the same session as the data log. On the waveforms section, you can choose the automatic waveform and up to 4 manually taken waveforms, as long as they were part of the same logging session. You can also choose which signals you want the graph to show for those waveforms.



When you are satisfied with the selections, click on “Proceed” to continue to the next screen.

The last screen is the ReportWriter Presentation. Here you will select what type of graphs you want, the type of file the report will create, and be able to edit the look of the graphs in the report.

You can select from “Half-Page Graphs” which will put 2 graphs per page, “Full-Page Graphs” which will put 1 large graph per page, and “No Graphs” which will just put the summary table in the report.

The “Graph Appearance” button allows you to edit the colors, line thickness and background colors of the graphs that appear on the report. Here you can change any color of any measurement on any given graph type. Once you make your changes, press the “Save As” button to save the appearance scheme for future use.

Once you finish with all these selections, you can then create the report. Press either the “Report to PDF” or “Report to Word” buttons for PSM-A to start creating the report. Choosing the “Report to PDF” option will only create a report in PDF format while using “Report to Word” will create a Word document type report that you can edit after creation. The Word option is useful if you want to add custom waveforms or pictures to the report, or add screenshots from Event data created with your logging session.

Viewing a Report

The report appears on screen and is in a “rich text” format. You can edit and format the report within any word processing application. At the top is the title that you entered, followed by information about the source of the data (filename, start time, and end time). The example shown is a comparison report, so there is information about the source of the "before" data and separate information about the source of the "after" data.

After the source information is the main body of the report. Each measurement type is listed in the first column. The "Before" column is the one number summary for the measurement type for the "before" time period. If it is an average (like "Voltage, Phase 1, Avg.") the value is the average over the "before" timeframe. If it is a maximum (like "Voltage, Phase 1, Max."), it is the maximum over the "before" timeframe. If it is an estimate (like "Cost, estimated per month"), it is an estimate of what the value would be for one month if the "before" data continued for the entire month.

After the "Before" column, is the "After" column. This provides the summaries for the measurement types during the timeframe of the "after" data. The next column is a statement of the units associated with the "before" and "After" columns. For instance, the "Units" for voltage measurement types is "volts".
The next column is the "Change" in the value of the "After" column from the data in the "Before" column. The values of this column use the same units as the "Before" and "After" columns (such as "volts"). At the far right is the "%Change" column. This presents what percent the "before" data has changed in going from "before" to "after". A negative number represents a decrease.

Performance Planner

Power Study Summary
"20TonAirHandler"
Test began at 09.23.02 10:17:00
Test ended at 09.24.02 10:15:00

After performance planner
"20TonAirHandler"
Test began at 09.24.02 01:55:00
Test ended at 09.25.02 01:55:00

Measurement	Before	After	Units	Change	%Change
Voltage, Phase 1, Avg:	266.8	267.7	volts	0.94	0.35%
Voltage, Phase 2, Avg:	269.5	270.7	volts	1.21	0.45%
Voltage, Phase 3, Avg:	267.0	267.9	volts	0.94	0.35%
Current, Phase 1, Avg:	15.3	15.0	amps	-0.31	-1.99%
Current, Phase 2, Avg:	14.2	14.2	amps	-0.03	-0.21%
Current, Phase 3, Avg:	15.1	14.9	amps	-0.27	-1.75%
Current, Neutral, Avg:	0.0	0.0	amps	0.00	0.00%
Power Factor, Total, Avg:	0.85	0.85		-0.00	-0.48%
True Power, Total, Avg:	10.125K	10.005K	Watts	-120.05	-1.19%
VA Power, Total, Avg:	11.946K	11.832K	VA	-114.12	-0.96%
Frequency, Avg:	59.9	59.9	Hz	0.01	0.01%
Energy, Total Elapsed:	123.3	281.8	KWh	158.54	128.57%
VAH, Total Elapsed:	144.9	332.2	KVAh	187.28	129.23%
Energy, estimated per month:	7391.4	7303.8	KWH	-87.63	-1.19%
Utility Rate:	0.1347	$/KWH	$/KWH		
Cost, Total Elapsed:	32.7	32.3	$	-0.40	-1.22%
Cost, estimated per month:	983.7	970.4	$	-13.33	-1.35%
Peak Average Demand:	15.408K	10.794K	Watts	-4614.00	-29.95%
Peak Demand Period, KW:	09/23/02 @ 16:45:00	09/24/02 @ 16:34:00			
Peak Average VA:	18.021K	12.701K	VA	-5320.00	-29.52%
Peak Demand Period, KVA:	09/23/02 @ 16:45:00	09/24/02 @ 16:34:00			

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TestPlan Manager in PSM-A

What is TestPlan Manager

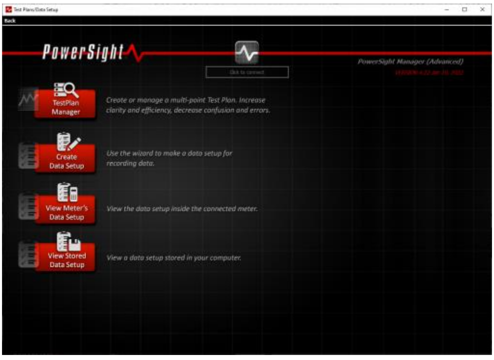
TestPlan Manager is a new way to organize your multi-point power quality testing. TestPlan Manager allows you to create a Testplan for multiple systems or for 1 system with multiple test points, load it into PowerSight, then quickly test and gather the data via SD card. From here our powerful software organizes all your tests into custom folders for easy access.

TestPlan manager allows you to:

- Quickly create a plan
- Specify the data setup for each test point
- Schedule when a test is to begin
- Assign personnel to each test point
- Assign specific meters to specific tests
- Distribute the plan via SD card and create a hard copy
- Load the same test plan across multiple meters quickly
- Easily offload the data to your PC
- Organize the data automatically by Equipment or location ID
- Allow adding other files such as pictures or PDFs to your plan

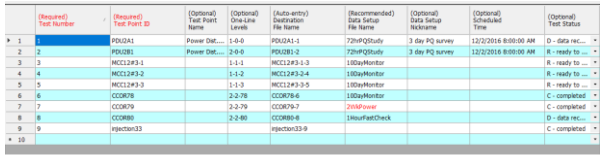
How Does it Work?

Open TestPlan Manager in PSM-A by either going to “Monitoring Setup” or “Data Analysis” from the main menu, then clicking on the “TestPlan Manager” button. This will launch the TestPlan Manager window.



From here you can either open and existing plan from your computer or SD card, or create a new plan.

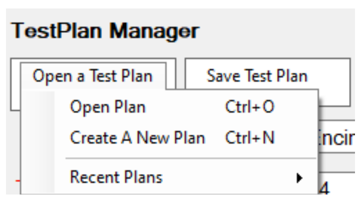
The idea is to organize multiple meters or multiple test points, store the files in predetermined locations on the SD card, then with TestPlan Manager, and download those tests from 1 or more cards easily and efficiently. For example, say you had 9 motors you needed to test, each needing their own setup. With TestPlan Manager, you can create 9 different data setups in PSM-A, then create a test plan applying those 10 setups to a specific meter. You can then distribute that test plan to 9 different SD cards, one for each meter, and start testing using the test plan. Once finished, instead of connecting to each meter by Bluetooth, or manually copying the data from the card to your PC, you can open up the Test Plan, use the “Get Test Data Files” feature and have TestPlan Manager automatically copy the files to given locations, then ask for the next card, saving you time.



	(Required) Test Number	(Required) Test Point ID	(Optional) Test Point Name	(Optional) One-Line Levels	(Auto-entry) Destination File Name	(Recommended) Data Setup File Name	(Optional) Data Setup Nickname	(Optional) Scheduled Time	(Optional) Test Status
1	1	PDU2A1	Power Dist....	1-0-0	PDU2A1-1	72hrPQStudy	3 day PQ survey	12/2/2016 8:00:00 AM	D - data rec...
2	2	PDU2B1	Power Dist....	2-0-0	PDU2B1-2	72hrPQStudy	3 day PQ survey	12/2/2016 8:00:00 AM	R - ready to ...
3	3	MCC12#3-1		1-1-1	MCC12#3-1-3	10DayMonitor			R - ready to ...
4	4	MCC12#3-2		1-1-2	MCC12#3-2-4	10DayMonitor			R - ready to ...
5	5	MCC12#3-3		1-1-3	MCC12#3-3-5	10DayMonitor			R - ready to ...
6	6	CCOR78		2-2-78	CCOR78-6	10DayMonitor			C - completed
7	7	CCOR79		2-2-79	CCOR79-7	2WkPower			C - completed
8	8	CCOR80		2-2-80	CCOR80-8	1HourFastCheck			D - data rec...
9	9	injection33			injection33-9				C - completed
10									

Opening an Existing TestPlan in PSM-A

To open an existing TestPlan, open TestPlan Manager, and then click on the “Open a TestPlan” button. From here navigate either to the default folder C:\PowerSight\Test Plans or on the SD card F:\PowerSight\Test Plans (your drive letter may vary).

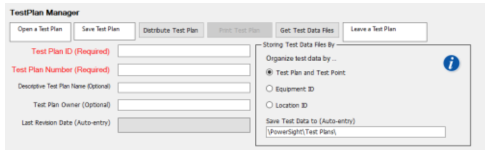


Once open, you will be able to edit your plan, print your plan, distribute your plan to 1 or more SD cards, or get the data from your plan.

Create a New TestPlan in PSM-A

Open TestPlan Manager, then start filling in the required fields. These fields will be used to create the test plan file name.

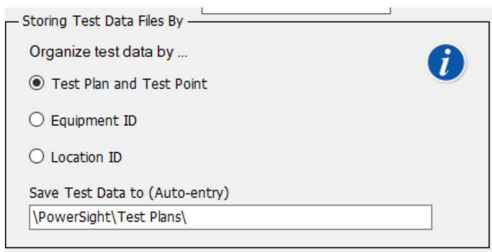
1. Enter “Test Plan ID”. This is the unique name for the test plan.
2. Enter “Test Plan Number” This is the unique number for the test plan



3. Other optional fields:
   a. Descriptive Test Plan Name (Describes test plan)
   b. Test Plan Owner (name of the test plan creator)

4. Next is to choose how the data will be collected on the SD card and stored when transferred to your computer.

   A. “Test Plan and Test Point”. This is the best choice when you are performing multiple tests



   for a specific job and you want to organize all the data now and into the future under the job. **For example**: You have a contract to evaluate “Site A” and you identify 20 different points in Site A that need to be monitored. When you are finished, you probably want all your data grouped in your computer under “Site A” and you will want to know the results of each test point as part of the “Site A” job.

   B. “Equipment ID”. This is best when you are performing tests on specific pieces of equipment that you expect to be checking regularly into the future to look for any changes in performance, as for planned or predictive maintenance. In this case you will have the data organized by the specific name of each piece of equipment (i.e. the Equipment ID) rather than by the test plan, since the test plan identifiers may be different each time you test the same equipment. **For example**: You monitor the performance of motors at a facility and reevaluate them twice a year. You want to keep track of the results by each Equipment ID to group the data by each specific motor so you can see the trend of performance over time.

c. "Location ID". This is best when you are performing tests at a specific location or function so you can identify changes over time. Unlike Equipment ID, where the data is organized by specific pieces of equipment (that may actually be moved to different locations after being overhauled), the Location ID mode organizes data by specific locations so the performance of a function or process can be evaluated over time.

5. Create the actual test plan. You will now create the testing parameters that will later be loaded into a meter and followed by those doing the testing.

	(Required) Test Number	(Required) Test Point ID	(Optional) Test Point Name	(Optional) One-Line Levels	(Auto-entry) Destination File Name	(Recommended) Data Setup File Name	(Optional) Data Setup Nickname	(Optional) Scheduled Time
1	1	PDU2A1	Power Dis...	1-0-0	PDU2A1-1	72hrPQStudy	3 day PQ survey	12/2/2016 8:00:00 AM
2	2	PDU2B1	Power Dis...	2-0-0	PDU2B1-2	72hrPQStudy	3 day PQ survey	12/2/2016 8:00:00 AM
3	3	MCC12#3-1		1-1-1	MCC12#3-1-3	10DayMonitor		
4	4	MCC12#3-2		1-1-2	MCC12#3-2-4	10DayMonitor		
5	5	MCC12#3-3		1-1-3	MCC12#3-3-5	10DayMonitor		
6	6	CCOR78		2-2-78	CCOR78-6	10DayMonitor		
7	7	CCOR79		2-2-79	CCOR79-7	2WkPower		
8	8	CCOR80		2-2-80	CCOR80-8	1HourFastCheck		
9	9	injection33			injection33-9			
10								

	(Optional) Test Status	(Auto-entry) Status Change Date	(Optional) Status Changer	(Optional) Test Personnel	(Optional) Meter Type	(Optional) Serial Number	(Optional) Test Type	(Optional) Comment
1	D - data received	3/5/2016 5:49:45 PM	John S.	John Simmons		45234	P - monitor power	contact John Land at 916-555-1212 for permission
2	R - ready to start	3/2/2016 10:49:00 AM	John S.	Tom Swiker	PS4500	45766	P - monitor power	external power required. Route from adjacent panel
3	R - ready to start	2/23/2017 11:10:30 AM	John S.	Leon Spinks		45122		use lockout tags supplied by Ed
4	R - ready to start	3/5/2016 5:50:12 PM	John S.	Chester Arthur		45132		eFX6000 probes required, limited space
5	R - ready to start	3/5/2016 5:50:08 PM	John S.	Chester Arthur		45881		Take picture prior to test. Embed with test results
6	C - completed	2/23/2017 11:10:35 AM	Pete Z.	John Simmons				signs of corrosion. Follow-up with customer for corrective action
7	C - completed	3/5/2016 5:49:58 PM	Pete Z.	John Simmons				
8	D - data received	3/5/2016 5:50:03 PM	45345	Zeke Imona				recommend follow-up of 2 week study. Need more time to invest
9	C - completed							
10								

a. Test Number: (Required) any number for indexing the test plans.

b. Test Point ID: (Required) this will be the name of the equipment, location or any other name to identify the test point.

c. Test Point Name: (Optional) Friendly-name used for the test point.

d. One-Line Levels: (Optional) Used to show the "Level" of a given circuit or system. For example: The main entrance to a building with two branch

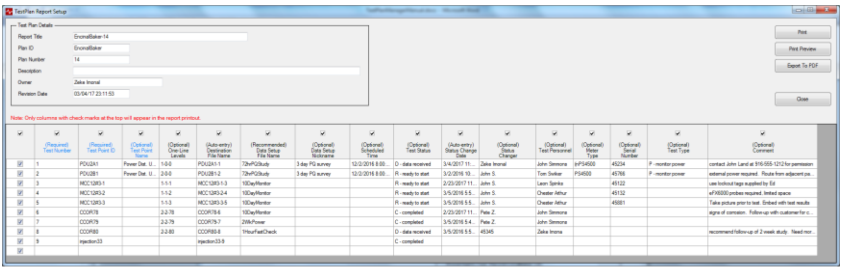
circuits and 3 loads on each branch circuit could have one-line level identifiers of
1-0-0(the main entrance),
1-1-0(1st branch),
1-2-0(2nd branch),
1-1-1 (1st load of 1st branch),
1-1-2 (2nd load of 1st branch),
1-2-1 (1st load of 2nd branch), etc

e. Destination Filename: (Automatic) this is the filename that will be used for all test data retrieved for this test point. It is automatically generated.
f. Data Setup Filename: (Optional, but **recommended**) This allows you to specify a data setup file to be used for the test point. You can either used an already created setup, edit an existing setup, or create a new setup
g. Data Setup Nickname: (Optional) friendly-name for the data setup.
h. Scheduled Time: (Optional) The time the test point is scheduled to start.
i. Test Point Status: (Optional & Automatic) A list of Status options for that test point. You can choose from H-On hold, R-ready, P-in progress, C-completed, or X-cancelled. D-data received is automatically added once the data is downloaded from the SD card Via “Get Test Data Files”.
j. Status Change Date: (Automatic) Date and time the status of the test point was last changed.
k. Status Changer: (Optional) User who last changed the test point.
l. Test Personnel: (Optional) Person assigned to that test point.
m. Meter Type: (Optional) PowerSight Meter type used for that test point.
n. Serial Number: (Optional) Serial number of the PowerSight used for that test point.

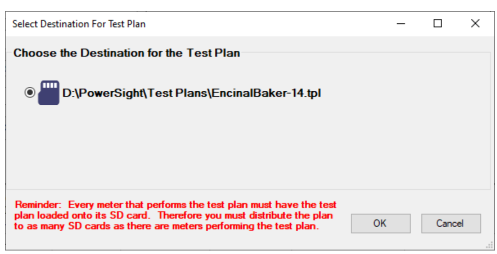
o. Test Type: (Optional) the type of test being done for that test point.

p. Comment: (Optional) any other relevant details for that test point.

6. Next is to print your TestPlan. This is useful to give those doing the individuals doing the test point a detailed list of the points and any comments relevant to their particular tests. You can choose what test points you want to print and which test point columns you want to include in the printout. To do this, press the “Print Test Plan” button.



7. Load the TestPlan on all SD cards the PowerSight Meters will be using to test. At this point you will be inserting the SD cards of each meter into your PC and saving the TestPlan created to each one. To do this, press the “Distribute Test Plan” button, then select the SD card drive you wish to save the test plan to. Press “OK” to save that test plan to the card. If any of the Data Setup files are missing, a pop up will prompt you on what you would like to do (find data setup, proceed without setup, skip all remaining setup files). Once completed, TestPlan Manager will ask if you would like to distribute the test plan to another SD card. At this point you can press “Yes” and insert another SD card, or press “No” to end the process.



Using TestPlan Manager with PowerSight

Once all the PowerSight meters have their SD cards loaded with the TestPlan, it is time to get them out into the field to start testing.

TestPlan Manager in PowerSight makes it easy to apply the right test to the right test point, eliminating mistakes.

Performing the Tests

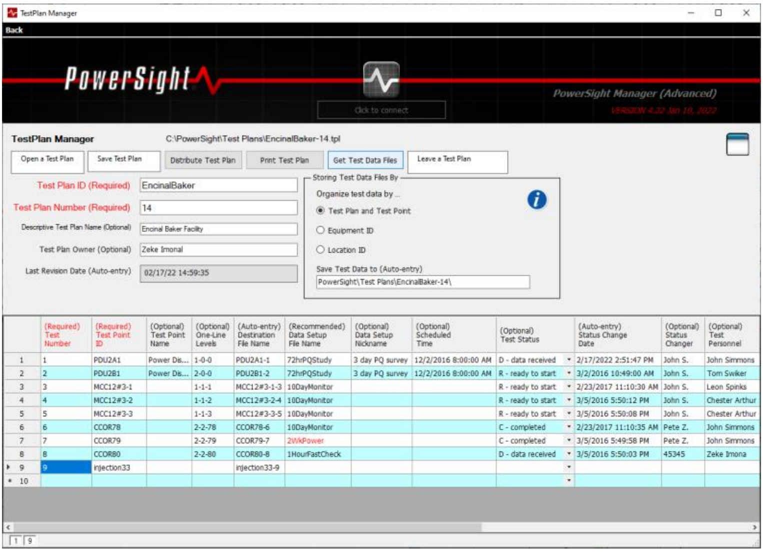
1. Test personnel, the “user”, will take a meter to the test site, hook it up to a specified test point, turn the meter on, and verify the connections.
2. The user will then start testing with the meter. Press the [Monitoring Start/Stop] Key with the SD inserted and the meter will automatically show the available test plans.
3. The meter will then display the name of the test plan loaded onto the SD card. Use the arrow keys to highlight the TestPlan and press [OK]
4. Once the test plan has been accepted, the meter asks if it is connected at the first test point. Use the arrow keys to select the test point, press [OK] and the test begins. At this point if there is a data setup assigned to that test point it will be loaded into the meter automatically then the logging will begin. Note: following the test, the next time the user attempts to perform a test, the meter will automatically assume the meter is at the next test point of the test plan.

All the test data of the test point will be written to the SD card in a predetermined format that identifies the test plan and test point that the data is for, so **there is no need to keep track of what meter has done what test or in what order**.

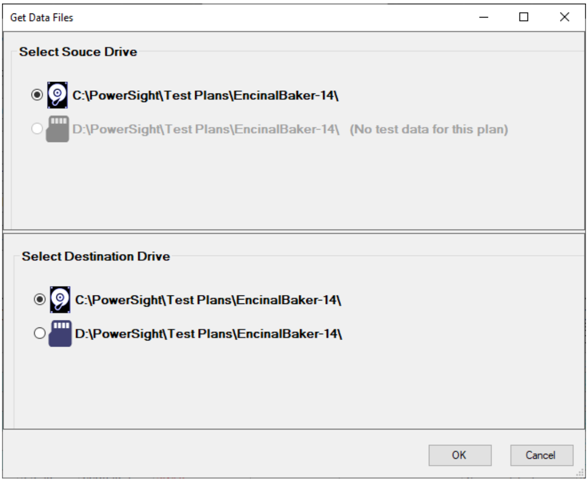
Retrieving the TestPlan Data in PSM-A

What TestPlan Manager does best is makes the retrieval and organizing of your test plan data quick and easy. With normal tests, after you are finished, you would connect to the meter via Bluetooth or USB, or you would insert your SD card and manually navigate to your data files and copy them to your PC. With TestPlan Manager this process is now much simpler.

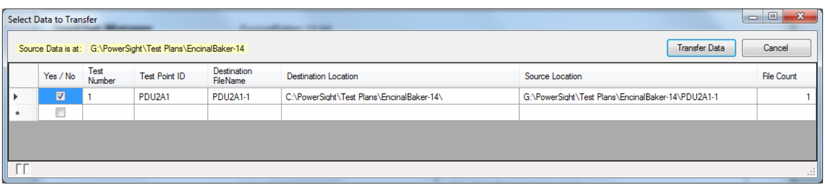
1. When testing is done, bring the SD cards to the computer that will hold the results. There is no need to keep track of which meter had which SD card installed.
2. Open the test plan on your computer. You can either use the saved test plan on the computer or each SD card has a copy of the test plan on it.
3. Insert one of the SD cards into the SD card reader of your computer.
4. Click on the Get Test Data Files button.



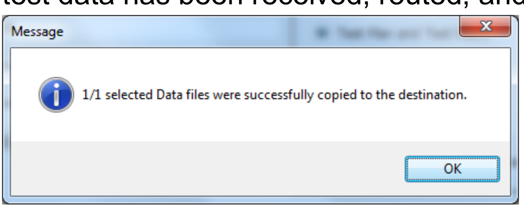
5. A window will open showing any drives of your computer that can have data for the test plan.



6. Make sure that your SD card is selected for the source. Then make sure that the correct destination drive is selected, normally the C: drive, then click “OK”.
7. A table of test points on the card will open up. You can decide which test point data you wish to retrieve, typically you will select all. Here is a sample for data to be organized by Test Plan and Test Point:



8. Click on “Transfer Data” button and get confirmation that the test data has been received, routed, and named automatically.



9. The following valuable operations just occurred:
   a. Each data file for the test plan was sent to the path specified in the “Save Test Data to” field of the test plan header section. This automatic routing of every test file saves you time and eliminates a source of error.

b. Each data file was re-named to the name in the "Destination Filename" entry for that test point. This automatic re-naming saved you time and eliminated a source of error.
c. If the test personnel had inserted other files into the SD card along with the test point data, those files were also renamed and relocated to keep them together with the other test point data of the test plan. This allowed you to imbed photos, documents, and drawings into the test point data for future reference.

10. The received data, using defaults, if organized by Test Plan and Test Point, is named by test point and grouped together under the test plan folder. If the received test data was organized by Equipment ID, it is named for the Equipment ID and has a timestamp appended to the Equipment ID name. Each file is in a folder dedicated to each Equipment ID.

Opening TestPlan Data in PSM-A

Since the files created by the TestPlan Manager are the same as the PowerSight's normal data logs, waveforms, etc. You will open these files just like you would if you downloaded the data via Bluetooth or USB. See the sections above on "Viewing the Data Logging Session in PSM-A" for more details.

Other Functions of PowerSight

Calibrating PowerSight

PowerSight is calibrated at the factory and automatically adjusts itself every second during normal use. However, in order to ensure that the meter continues to meet its specifications, provision has been made for you to quickly recalibrate it yourself.

In order to calibrate the meter, you need access to highly accurate 120.0 V, 1000.0V, 1000A, and four highly accurate calibrated

HA1000 current probes. The calibration is done in sequence. The current probes must all be plugged in.

To calibrate the PS5000, press [Setup] key then press the [Down Arrow] Key until you see the “Calibration” option. Press [Right Arrow] key then the [Down Arrow] key to the “Change Calibration” options and press [OK]. You will need to enter the password which is “00000” then press the yellow soft key [Done] to accept. Remove all voltage inputs (0 volts), make sure the HA1000 probes are connected and reading 0 amps, then press [Down Arrow] key to get to “Calibrate Voltage Inputs” and press [OK]. Press [OK] again to calibrate at 0V. when the countdown is done, plug in 1000V to V1n and press [OK] and then follow the instructions. At one point the PS5000 will ask you to connect 120V to V1n. After this is done, voltage calibration is complete.

To calibrate current, you must first calibrate the voltage. Follow the instructions displayed following the calibration of voltage. You will need to have four HA1000 current probes attached, but no current input (0 amps). Either select “Calibrate Current Inputs” at the calibration menu, or if calibrating current after just calibrating voltage press [OK] to continue. Press [OK] to start calibrating at 0 amps and when done, attach the calibrated HA1000 to 1000A and press [OK] and then follow the instructions, attaching the highly accurate HA1000 current probe into whatever terminal the display requests.

Setup Functions

Several functions used in setting up measurements are available using the [Setup] key. They include:

- Data Setup
- Logging Period
- Voltage Mode
- Input Ratios
- Power Mode
- Frequency Mode
- Change eFX6000 Range (if attached)
- Set $/KWH (Cost)
- Clear Memory
- Calibration

The Data Setup option under the [Setup] key allows you to view the meters current setup, set the setup to default, or load a data setup stored on an SD card.

To review the Logging Period of the PS5000, press [Setup] key, then press the [Down Arrow] Key. The present setting will be displayed. To change this setting, press [Right Arrow] Key then press [OK] to enter the menu to change the logging period. When the new interval is entered correctly, press [OK]. The interval may be set from 1 second to 99 minutes. The log interval is used in determining the demand period and in assembling and storing data log records.

PowerSight allows you to set the utility rate used in calculating the cost of energy consumed. Presently, one simple rate is used. That rate can be displayed on the PS5000 by pressing [Setup] then the [Down Arrow] key to get to the “Set $/KWH” option. To change this rate, press [Right Arrow] key, enter a rate then press the yellow soft key [Done]. The rate may be set from $0.00001 to $999,999 per KWH. This wide range is helpful when setting the rate for certain international currencies.

Administrative Functions

A collection of functions that are neither measurements nor calibrations are collected under the heading of administrative functions. They include:

- About Meter
- Check Battery
- Manage Time
- Settings
- Support
- Upgrade Via SD

All administrative functions are available by pressing [Admin] and following the directions.

The About Meter option displays the meter’s information:

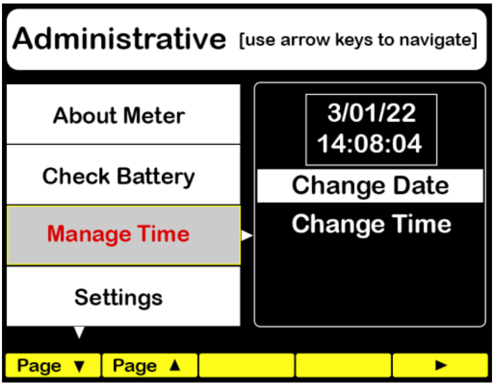
- Serial number of the unit (its unique identity)
- Warranty expiration date

- Firmware revision level (what level of software is active within PowerSight)
- Hardware revision level (what level of hardware compatibility it is).
- Boot revision level (what level of bootloader is active within PowerSight)
- Digital Processing revision level (algorithms used for measurement)
- Software Compatibility Version (level of PSM-A the meter can interact with)

Pressing the yellow soft key [Page] shows you the meter's options. Viewing the options that are loaded results in a display such as:

- Wifi Option
- Memory Option
- AMO Option (Advanced Monitoring Option)
- FAO Option

Checking the battery shows the current run time, Status of the battery (either Good or Bad), battery voltage and battery charge/discharge current. Typically, the PS5000 can run at least 8 hours on a full battery charge, which takes about 7 hours with the 12V, 500mA wall charger or LDC.



Changing the time and date is useful for identifying when monitoring began, and is used to label each record of the data log. To set the time and date, press [Down Arrow] key to get to the "Manage Time" options, then press the [Right Arrow] key then select either "Change Date" or Change time. When finished setting the Date or Time, Press [OK] to accept the changes.

The Settings Option allows you to set things like the displayed greeting when the meter first turns on, enabling/disabling of

Bluetooth or sound, setting the language of the meter and the date format. Use the [Down Arrow] key then [OK] to select an option then use the arrow keys and [OK] to make the changes.

Other Functions within PSM-A

Introduction

In addition to the many power analysis functions of PSM-A that have been presented in previous chapters, there are several other functions available. These are functions of convenience, functions for setting up attached PowerSight meters, and functions for setting up the PSM-A program. They include:

- Operate PowerSight via remote control
- Install new firmware
- Many settings options in PSM-A

Remote Control of PowerSight

Remote control operation allows operating a connected PowerSight unit from your computer. Your mouse and keyboard actuate the keys of the attached PowerSight. A picture of the PowerSight and its display are visible on your computer screen. This is very handy for operating a unit remotely and for operating and displaying the readings of a unit to many people at one time.

To enter the remote-control mode of operation, click on “Communications” on the main menu then click on the “Remote Control” button. An image of the connected unit will appear. At this point you can activate individual keys by clicking on them with your mouse or by typing in the character that is underlined in the image (for instance, type in “P” to activate the “Power” key.

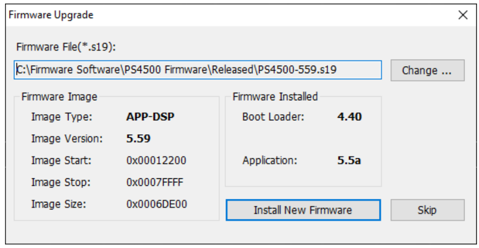
Locating and Installing Software and Firmware

A tradition of PowerSight models is that the products continue to improve and as they improve, those enhancements and features are made available to users who elect to stay under our enhanced warranty. Our PSM-A software continues to improve and is available for download via the web. The software that resides in PowerSight is called “firmware” (it’s not as soft to change as “software” is, but is not as hard to change as “hardware”). The PS5000 has the ability to have its firmware upgraded via Bluetooth/USB communications with PSM-A or via the SD card. This keeps your meter from getting out of date and saves you the trouble of returning it to the factory for an upgrade.

If your computer is connected to the internet, when you open your PSM-A software and connect to a meter, PSM-A will check our website to see if there is a newer PSM-A version or firmware version for your meter type. If under warranty, PSM-A will show you the latest versions of software or firmware to upgrade to. If not under warranty, PSM-A will show the latest software or firmware in your current series to upgrade to. You can also check our website for the latest versions of software or firmware.
https://powersight.com/support/firmware_software/

To check for upgrades via PSM-A manually, click on “Settings” on the main menu of PSM-A and then click the “Check for Upgrades” Button. The upgrade window will pop up. You can then press the “Check” buttons under firmware or software to see if there is an update. If you are offline and have downloaded the firmware to your pc and have unzipped the firmware file, you can manually upgrade firmware by pressing the “Install…” button at the bottom left.

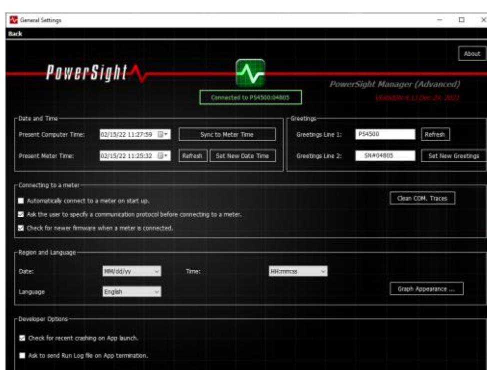
When you start the upgrade process either via the automatic pop up or manually pressing the “Install…” button, you will then see a



"Firmware Upgrade" pop up window. It should be populated with the firmware version for you to upgrade to. If it has not, you can press the "Change" button to navigate your PC to find the upgrade files. Press the "Install New Firmware" button to start the installation process. It is recommended that you close all other applications on your computer when you upgrade. Typically, the upgrade process will include a "Bootloader" and an "Application file" upgrade. Typical time for upgrading the bootloader is less than 1 minute while the time for firmware varies by meter type and can take up to 5 minutes". Do not stop the upgrade process while it is upgrading or the meter may not be able to start up again and will have to be sent to the factory for reinstallation.

To upgrade via SD card, write the new firmware files onto your SD card in the root directory (the highest folder of the file hierarchy on the card). The firmware files are named by Model Number and firmware version number. For example, the latest PS5000 firmware is "PS5000-809.s19". Turn on your meter and press the [Admin] key, then press the [Down Arrow] key until it displays "Upgrade via SD". Press [Right Arrow] key, selection either application or boot then press the [OK] key and follow the instructions that are displayed.

Setting up Administrative Features of PowerSight via PSM-A



As a convenience, several of the administrative settings of PowerSight can be set within PSM-A. At the main menu, with a PowerSight meter connected, click on the "Settings" button then click on the "General Settings" button and the General

Settings window will pop up. The present personal greeting, date and time will be displayed. Simply make any changes that you wish and then click “Set New Date Time” to apply the computers date and time to the meter, or “Set New Greeting” to apply the greeting changes to the meter. The changes will be made to the attached PowerSight.

A very important feature is the ability to synchronize the time of the connected PowerSight to the time of the PC. This is nice for quickly and accurately setting the time, but it is also very important for synchronizing multiple PowerSight units in order to correlate logs and events from several units located at different points at a site. It also results in nice presentations of logs from site surveys when all units are programmed to start monitoring at the same moment and their graphs reflect this.

Putting it all Together (Monitoring for the First Time)

This section is intended to ensure that you will be successful in your first (and later) monitoring attempts. There are several ways to start monitoring. If you wish to use the default values, simply turn the unit on, press [Monitoring Start/Stop], select “Start Monitoring Session?” then [OK] (to indicate that you wish to start monitoring), then select “Erase old Log?” to start a new log and press [OK]. Monitoring will then begin and continue until you stop it or turn the meter off.

The remainder of this chapter assumes that you wish to use the computer to customize or at least check your monitoring settings prior to starting monitoring. The computer must be running the PowerSight Manager Advanced (PSM-A) software that comes with the meter and the computer must be connected to the PowerSight using Bluetooth to communicate.

There are three ways to start logging. PowerSight can start immediately after sending the setup from PSM-A, can start at a time and date set by PSM-A, or can start when turned on and connected to power. The data setup can be set up at another time and location and then PowerSight can be transported to the site of logging.

The first step is to set up or check the parameters for logging.

1. Review the chapter Communication with PowerSight to ensure that Bluetooth communications are established between the PC operating system and the meter after the meter is turned on.
2. Open PSM-A and note that PSM-A has successfully connected to PowerSight. This will be clear by the box on the main menu with the words “Connected To PSXXXX-XXXXX” appearing within a large green banner.
3. Click on “Monitoring Setup” then “Create a Data Setup” and create the setup that PowerSight will use. Review the chapter on Custom Consumption Data Logging and the sections on Setting the Swell/Dip Trigger Threshold, Setting the Transient Trigger Thresholds, and Allocating Memory within PowerSight and make any changes that are needed in the data setup and store it to PowerSight and perhaps save it to a file.

When PowerSight is at the site where it will be used:

1. Hook up the voltage leads and current probes to the circuit being monitored referring to the appropriate diagrams of the Connecting to PowerSight chapter.
2. Insert the power plug into the 12VDC jack on the right side of the meter as described in the Connecting to Power section. Power for the meter will come from a wall charger or from an LDC (line-to-DC converter). If you have an LDC4 or LDCm accessory, attach its leads as shown in the Connecting to Line-To-DC (LDC) Converter Accessory section. If you are going to monitor just a few hours and the meter’s internal battery is fully charged, you can skip this step.
3. Turn PowerSight on. Open PSM-A and note that PSM-A has successfully connected to PowerSight. This will be clear by the box on the main menu with the words “Connected To PSXXXX-XXXXX” appearing within a large green banner.
4. We recommend that you either run through the checkout connections feature explained in the Checking out Connections using PowerSight section or take a snapshot of the waveforms and look at them for errors, if you have a computer handy, as described in the Checking out Connections using PSM-A section.

5. If you intend to have PowerSight start monitoring by direct command via the keypad or via PSM-A, this is the time to do it. Otherwise, it will start when the programmed start time occurs.
6. When satisfied that all is correct, download waveset1 from PowerSight (see the Receiving Stored Consumption Waveforms section), giving it a unique filename, so you have a record of the signals just prior to starting logging. Waveset1 is stored inside PowerSight automatically when you start monitoring.
7. When you are done logging, capture another set of waveforms. Combining this waveset with the one that was captured when logging began gives a before and after picture of the power for use in later presentations or as a troubleshooting aid if the data log appears to contain bad data.

Troubleshooting & Frequently Asked Questions (FAQ)

1. Why can't I connect to the PowerSight Manager software?

See the PSM Troubleshooting guide on your installation thumb drive or view the guide on our web site (www.powersight.com) for detailed help.

2. How do I connect to my laptop if it does not have Bluetooth communications capability?

You can either use a USB data cable to tether to the meter or buy a Bluetooth Adapter from Summit Technology (order BTA). This adapter will plug into one of your USB ports. Other brands will likely work, but cannot be guaranteed to work with PowerSight.

3. Why can't I receive any data from my PowerSight?

See the Data Troubleshooting guide on your installation thumb drive or view the guide on our web site (www.powersight.com) for detailed help.

4. Why doesn't my PowerSight read Voltage/Current correctly?

There are many reasons why PowerSight may not be reading voltage or current. First, check that you have all the voltage and current leads connected correctly. Then if that doesn't solve your problem, check that the frequency mode of the PowerSight is in the correct mode for your situation.

5. Why doesn't my PowerSight turn on?

This is most likely caused by a dead battery. Plug in a power supply and see that the red LED at the end of the meter is turned on. Make sure you use the correct rated power supply for the PowerSight that you are using.

6. How long will the battery last?

A fully charged PS5000 will run 8-10 hours. The PS5000 displays the charge of the battery and the estimated time of charge when you press the [Admin] button. The PS5000 is fully charged in about 7 hours. The battery should not need replacement for at least 2 years. Only authorized service personnel can open the meter or replace the battery.

7. Why does my voltage/current reading seem to be off?

This may be caused by an input ratio left inside the meter from a previous data setup. Change the input ratio to 1:1 for all input signals and try again. (see the sections on Changing Input Ratios in PowerSight and in PSM) You should also check your frequency mode and make sure that all metal contacts of clamp-on current probes are clean and securely fastened.

8. How long will it take for my memory to fill up during data logging?

This depends on your logging period, the amount of data being stored, and the amount of memory available. As you change these values, using our PowerSight Manager Advanced (PSM-A) software, it will automatically display how long it will take to fill the log. To see this, just click on the "Monitoring Setup" button at the main menu of PSM-A then go to “View Meter’s Data Setup”. The “Details” button is where you can see how long the given study type will take to fill up. You can also press the [Monitoring Start/Stop] key, and if currently logging, it will show the time to fill log on the display.

9. What is a Logging Interval?

The logging interval is the amount of time that passes between PowerSight making entries into its internal data log. The logging interval determines the rate at which new records are added to the meter's log.

The PS5000 measures voltage, current, and other measurement types for every cycle of every input and keeps track of the maximum, minimum, and average values of each of these measurements. At the end of the logging interval, the meter stores these constantly updated averages, maximums, and minimums into the log. It then sets the maximums, minimums, and averages to zero, and begins the process again for the next logging interval.

For example, if you set the logging interval to 3 minutes, every 3 minutes, the PS5000 will summarize 10,800 measurements (there are 10,800 60 Hz cycles in 3 minutes) for each of the measurement types into an average, maximum, and minimum, store these summary values in the data log, and reset the averages, maximums, and minimums to zero.

The logging interval has a direct effect on the time it takes to fill the log. For example, if the meter's consumption log capacity is set to 1000 records and its logging interval is set to 1 minute, the meter will fill the data log in 1,000 minutes. Each record in the log will contain the maximum, minimum, and average of 1 minute of measurements.

10. How do I use the Data Setup feature of PSM-A?

Refer to the chapter on Custom Consumption Data Logging.

11. How often should I have my PowerSight calibrated?

We recommend that you have the PowerSight calibrated once every year. We also recommend that all voltage and current probes be sent in with the unit for calibration.

12. Can I use other manufacturers' current probes with PowerSight?

Unfortunately, no. Only current probes made by Summit Technology can be used with the PowerSight Products. This is because all of our probes are "self-identifying". This means the user does not have to use an input ratio to use the probes. If there is a special need to use a certain probe, let us know at support@SummitTechnology.com.
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13. How do I measure voltages above 1000 volts AC?

You must use our High Voltage probes to directly measure above 1000 Volts. You can use either the "5kVP" or the "15kVP". Also see "How to Measure 4160V Service" on the installation Thumb Drive for more information. Alternatively, you can hook up to metering PTs and enter their ratios into PowerSight in order to record the primary voltage.

14. Why won't my PS5000 run on an LDC (line-to-DC converter) for more than 6-8 hours?

Check the fuses of the LDC4 to see if they are still good. For the LDCm, you will need to have it checked out by Summit as the fuses are internal and not user replaceable.

Frequency Analysis Option

The Frequency Analysis Option (order number FAO) adds the capability of a high frequency power-line spectrum analyzer to your PS5000. Normally, harmonics are measured up to about 3,000 Hz, this option starts where normal frequency analysis ends. It allows you to capture and view the small amplitude high frequency signals that ride on the normal waveforms of your voltage and current. Frequency spectrum graphs of from 3,000

Hz to 100,000 Hz are obtained from PSM-A. Voltage amplitudes of a few millivolts riding on 480V systems can be accurately measured with this option. Similarly, very small high frequency currents can be detected. Since high frequency current has a dramatic heating effect compared to low frequency current, it is important to know if there are high frequency components riding on the power-line. The spectrum graphs from PSM-A can be very effective in showing before vs after filtering out of high frequency components.

Prior to measuring high frequency voltage, plug the Voltage Conditioning box into the I_N current input of PowerSight, plug two voltage leads into the Voltage Conditioning box inputs (typically the phase 1 and phase 2 voltages), remove any connections to V_1, V_2, V_3, V_N, and the DC input jack of PowerSight. To measure high frequency current, plug the special adapter cable that comes with this option into the I_1 jack, plug the HA1000 into the other end of the adapter cable, and remove all connections from V_1, V_2, V_3, V_N, and the DC input jack of PowerSight.

To record frequency data, press the [Monitoring Start/Stop] key then select the “Frequency Data Capture?” and press [OK]. The test will begin and take about one minute. This test will write over the previous results, so if you need to do more than one test, have a laptop computer nearby.

For further details and cautions, refer to the Frequency Analysis Option manual that was received with the FAO option.

Overview of the Keypad Functions

The PS5000 keypad has changed drastically from the other meters in the PowerSight line of handheld power analyzers. With the new graphics display, many buttons from the previous models have been eliminated and replaced with Arrow keys to easily navigate around the display options. There is also a new row of keys called the “Soft Key” which mimic the keys shown at the bottom of the various displays on the graphic screen.

Monitoring Start/Stop – for starting or stopping of the Monitoring Session or FAO capture

Graph or Table – Selects Graph view or Table (Text) view for various measurement options
View Data Log – View current or recent data log measurements from the meter
View Trend – Create a basic Trending Log without starting a monitoring session
View Waveform – Show live graphical view of voltage and current like an oscilloscope
Voltage – read phase-phase or phase-neutral true RMS voltage
Current – read true RMS current of any phase or neutral
Power – read true power (watts), VA, or VAR
Phasors – Show Phasor Diagram graph of current live signals
Harmonics – View the individual harmonics of live signals
Checkout – uses SureStart® to determine what potential errors in connections and settings exist
Power Quality – View the current threshold settings for Swells/Sags/Transients
Setup – View the current settings in the meter
Admin – View the meter's information, options, and upgrade firmware via SD card.
Arrow Keys – Used to navigate around the menus on the display
OK – for use in answering questions or accepting entries
Yellow Soft Keys – For selecting various "current display only" options on the meter.

Compatibility Guide

Although we attempt to make all products and accessories compatible, there are limitations to what devices and versions can work well together. **The PS5000 must be used with PSM-A software of at least the 4.2 series.** Compatibility of the PS5000 with Summit Technology accessories is as follows:

Accessories	**PS5000**
120ADP-a	Yes
120ADP (discontinued)	not compatible (use 120ADP-a)
15KVP	Yes
5KVP	Yes
5KVP (version with ext. box)	not compatible (use new version)
CAS3	Yes
CASW	Yes
CHG1	Yes, for Euro 220V standard
CHG2	not compatible
CHG3	not compatible
CHG4	Yes, for US 120V standard
COMM	not compatible
DC600	Yes
DC2000	Yes
DFV	Yes
DXV	Yes
MEM2	Yes
FAO	Yes
eFX6000	Yes
FX3000a	Yes
FX3000 (discontinued)	not compatible (use FX3000a)
FX5000	Yes
HA10 (discontinued)	not compatible
HA100	Yes
HA150 (discontinued)	Yes
HA1000	all units
HA3000	Yes
HA5	Yes
HA500 (discontinued)	not compatible
HA-GFD	Yes
SafeConnect	Yes
LDC (Discontinued)	No
LDC2-3	No
LDC4	Yes
LDCm	Yes

Specifications*

Size

3.88” (9.86cm) Wide × 7.72” (19.61cm) Long × 1.58” (4.01cm) Deep in Hand-held region, 2.14” (5.44cm) deep at the top end

Weight

1.1 pound (0.5 kg)

Operating Range

0 - 50 degrees C (32 - 122 degrees F)
Relative humidity to 70% (non-condensing)
Meets mechanical shock requirements of MIL-PRF 28800F for a class 1 (harshest) environment

Safety and Environmental Protection

CE rated 1000V input CAT III / 600V input CAT IV per IEC61010-1:2001
IP40 (IP44 with CAS-W option) per IEC 529

Power Requirement

12 VDC @ 500 ma, wall mount power supply included
Internal Li-ion operates 8 hours after 7 hours charge.

Voltage

Input Range: 1 - 1000 Vrms steady-state (direct input), or 600 – 5,000 Vrms with 5KVP probes, or 600 – 15,000 Vrms with 15KVP probes.
Display Range: 1 - 6 megavolts (using input ratios)
Accuracy: 0.1% of reading (over input range) +/- 0.3 Vrms
Measure Rate: Measure every cycle of every input.
Frequency Response:No de-rating of accuracy for harmonics through 3900 Hz)

Current

Input Range: 0.01 - 6000 Amps, AC or DC with the proper current probe attached
With HA5: 0.02 - 5 Amps
With HA100: 0.1 - 100 Amps
With HA1000: 1 - 1000 Amps
With eFX6000: 1 – 6000 Amps (in two ranges)
With DC600: 5 - 600 Amps DC
Display Range: 1ma - 6 megamps (using input ratios)
Accuracy: 0.1% of reading plus accuracy of probe

Measure Rate: Measure every cycle of every input.
Frequency Response: dependent on current probe attached. With HA1000: no de-rating of accuracy for harmonics through 3900 Hz)

Frequency

Range: DC, 22 - 200 Hz, 360 – 440 Hz fundamental frequency
DC and 22 - 4500 Hz included in RMS
22 - 3900 Hz for harmonic measurements
Accuracy: 0.25%

Power, Energy, Cost, Power Factor

Display Range: 1 watt - 60 megawatts (using input ratios)
Accuracy: 0.5% plus accuracy of current probe
Measure Rate: Measure every cycle of every input.

Harmonic Distortion:

Range: Display of THD and individual harmonics through 25th (1800 Hz) of all signals
With PowerSight Manager software, display of harmonics through 63rd (3900 Hz)
Accuracy: To within 1% of fundamental
Measure Rate: Measure every cycle of every input.

Swell/Dip Detection:

Measure Rate: Measured every ½ cycle of every input.

High-speed Transient Detection:

Measure Rate: Measured every 8 μsec on every input.

Captured Waveforms

Quantity: set by user allocation of memory

* These specifications are subject to change without notice.