# The P1Advantage™

Harmonic Filter with Power Factor Correction

Improve the power system by mitigating harmonics caused by non-linear loads to less than 5% while simultaneously correcting power factor to over 99%.

PowerOne's patented P1Advantage™ virtually eliminates harmonic distortion while simultaneously achieving an almost perfect power factor of 1 (100%).

Harmonics and low power factor are the two most negative roadblocks to good power quality because they reduce energy efficiency, reliability and cost effectiveness.

## One Solution for Ideal Power Quality & Savings

To maximize the harmonic mitigation and power factor correction, each P1Advantage™ unit is specifically engineered to match the non-linear electrical load, including varying power loads, ranging from 5 HP to 2000 HP.

# The P1Advantage™

The P1Advantage™ is installed to improve power quality by simultaneously eliminating harmonics that are causing operational issues and damaging equipment (the life of equipment can be increased by up to 50%), and correcting power factor, which eliminates capital expenditures on inferior power quality products. Combined, the eliminated harmonics and corrected power factor, save money by lowering monthly power consumption (kW and kVA).

While referred to as a filter, our advanced technology delivers a much superior performance than traditional harmonic filters, reducing harmonic distortion from levels over 100% to less than 5%, while simultaneously correcting power factor to over 99%, when operated within designed perimeters.

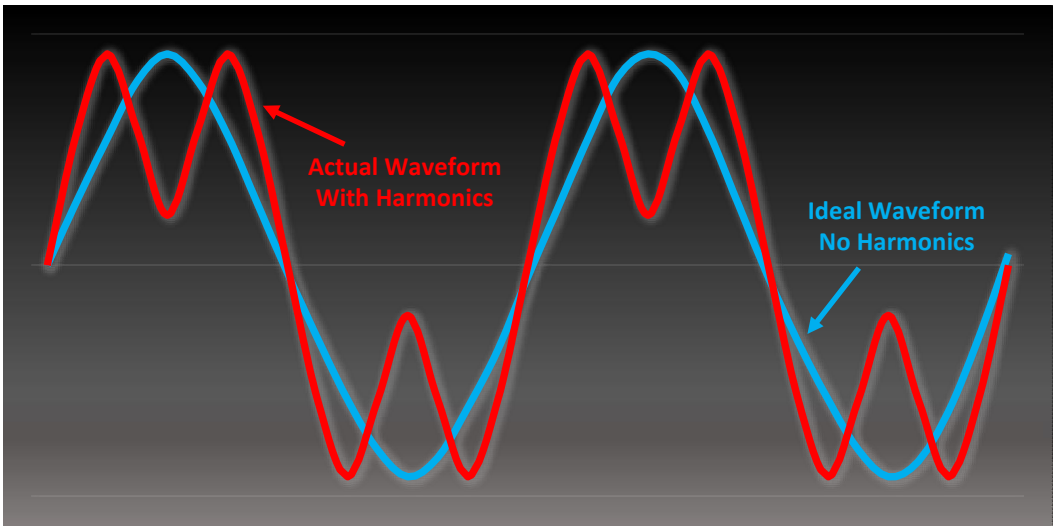
The P1Advantage™ is a "passive" device, meaning that it does not draw any additional power, making it a very energy efficient solution. The P1Advantage™ is simply installed between the power source and the non-linear load (such as a VFD) and requires only minimal maintenance.


Other products are not as effective as the P1Advantage™, capacitor banks have maximum power factors of only 93% and can even amplify harmonics; active filters are often used to suppress harmonics but only have a small effect on a low power factor. Active filters and 18-Pulse VFDs are very expensive to purchase, operate and maintain and the harmonic mitigation is virtually the same as the P1Advantage™.

The power savings with the P1Advantage™ are typically 10% - 20% per year, and total savings can be more than $500,000 over the 20-year warranty period of a single mid-sized P1Advantage™.

# Harmonic Mitigation

Variable frequency drives (VFDs) are electronic devices designed to control the speed of motors by changing the frequency of the supplied power. These drives along with other devices, create harmonics when converting voltage from AC to DC and can damage equipment and infrastructure by creating power distortions that affect the whole electrical system.

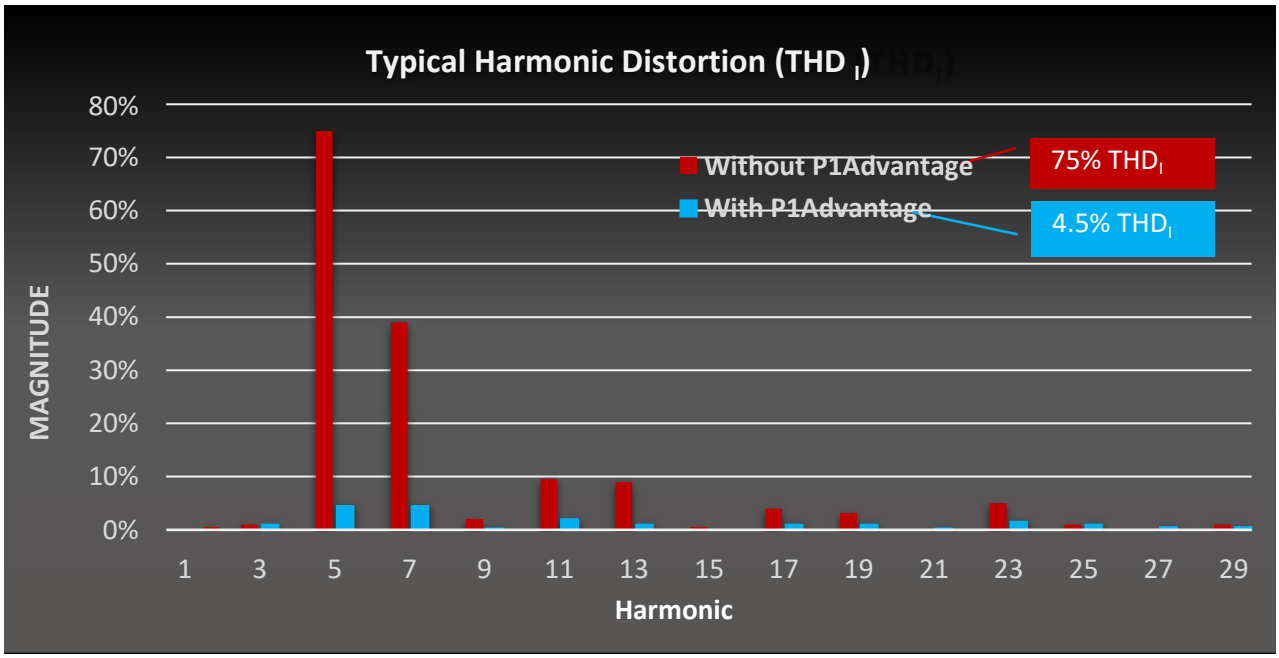



The P1Advantage™ virtually eliminates the 5th, 7th, 11th, and 13th harmonics, and their multiples, in three phase power systems. P1Advantage™ is ideal for any non-linear loads including varying loads, variable frequency drives, rectifiers and integration into MCC units.

The P1Advantage™ improves the power system by mitigating harmonics caused by non-linear loads. When operated within designed perimeters, harmonic distortion can be typically reduced by over 80% resulting in an average current total harmonic distortion ($THD_I$) of less than 5%, and voltage total harmonic distortion ($THD_V$) of less than 2%.

**Symptoms of Harmonics**

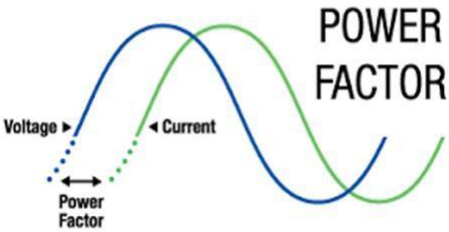
| | | |
|---|---|---|
| Reduced equipment efficiency | Equipment malfunctioning | Power transformer fires |
| Flickering Lights | Excessive nominal current | Increased electrical costs |
| Premature breaker tripping | Catastrophic failure of equipment | Reduced equipment life |




The graph above shows the typical harmonic order of current total harmonic distortion ($THD_I$). The values shown above were taken from a Hioki 3196 measuring $THD_I$ on a VFD controlling a 20HP motor. Voltage total harmonic distortion ($THD_V$) is typically not significant even without mitigation and is not shown here.

# Power Factor Correction

Power factor is the measurement of power quality and efficiency, with 100% being perfect. Low power factor means excess current is being used and power is being wasted. The P1Advantage™ is specifically engineered to correct power factor to over 99%.




**Typical Power Factors by Industry**

| | | | | | |
|---|---|---|---|---|---|
| Breweries | 76-80% | Foundry | 75-80% | Oil Pumping | 40-60% |
| Cement | 80-85% | Forging | 70-80% | Paint Manufacturing | 65-75% |
| Chemical | 65-75% | Hospitals | 75-80% | Plastics | 75-80% |
| Coal Mining | 65-80% | Machine Manufacturing | 60-65% | Stamping | 60-70% |
| Clothing | 35-60% | Metal Works | 65-70% | Steelworks | 65-80% |
| Electroplating | 65-70% | Office Buildings | 80-90% | Textiles | 65-75% |

Source: PHD Center Course E144(4 PHD) 2012

# Energy Savings – Lower kW and kVA

The mitigation of harmonics (THDi) and correction of power factor produces efficiencies in the electrical system, which lowers kW and kVA. This is an important benefit and one of the compelling reasons for installation of the P1Advantage. There are factors that will affect how and to what extent kW and kVA will be reduced.

## Uncorrected Levels of Power Factor and Harmonics:

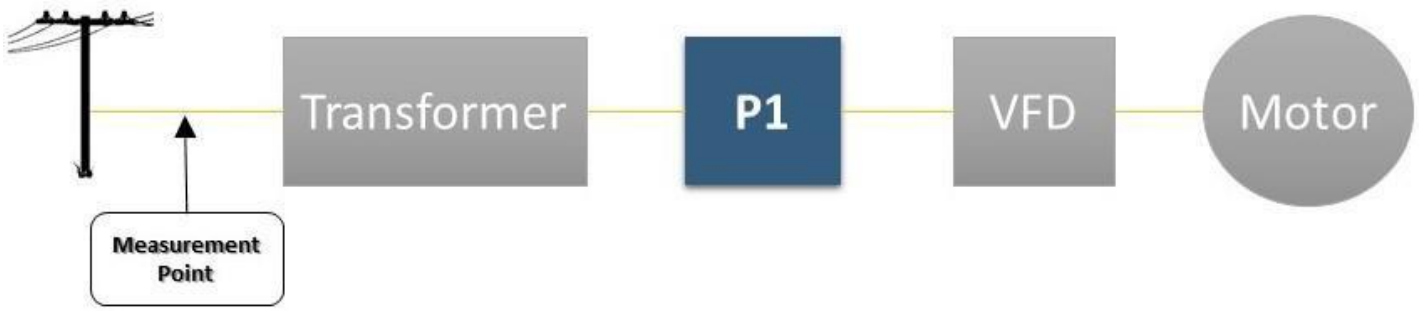
Using standard 6-pulse VFDs, users will typically have power factor in the mid 70% range and THDi between 30% and 60%. However, this can vary greatly. In some industries, power factors can be much lower and THDi much higher. Overall power factor and THDi will depend on how many non-linear loads (such as VFDs) and linear loads (such as direct-powered motors) are in the facility. Therefore, the level of kW and kVA reduction that will be achieved by the installation of the P1Advantage can vary greatly. Systems with a power factor of 90% and THDi of 30% will experience much lower kW and kVA reduction than systems with a power factor of 70% and THDi of 60%.

## System Components:

P1Advantage units installed on a system with high efficiency transformers instead of older, low efficiency transformers will also see an increased reduction in kW. The P1Advantage will further reduce harmonics accumulating in the transformer and this will result in additional reduction of kW.

## Measurement Point:

Measuring on the line (input) side of the transformer will show the greatest kW savings when comparing a system with and without the P1Advantage. Harmonics produced by the VFD travel back to the transformer, resulting in decreased transformer efficiency, and, if high enough, transformer fires. Therefore, measurement on the line side of the transformer will include any efficiencies achieved by the transformer and will show a higher reduction of kW. In some circumstances, the utility meter is on load side of the transformer, but kW savings will still be achieved. The Appendix shows actual waveforms and measurements taken on the load side of transformer.



# Performance Results

| TECHNICAL: | |
|---|---|
| Eliminates harmful harmonics: | Mitigates the 5th, 7th, 11th, and 13th harmonics |
| Current Total Harmonic Distortion ($THD_I$): | Reduced to less than 5% |
| Voltage Total Harmonic Distortion (THDv): | Reduced to less than 2% |
| Power factor: | Improved to over 99% (nearest ever to unity) |
| **SAVINGS:** | |
| Decreases the amount of electricity used: | Electrical cost savings are 10% - 20%+ per year |
| Extends the life of motors and other devices: | By up to 50% |
| Capital cost saving: | Capacitor banks and other filters are no longer required |
| ROI: | 6-24 months, savings from P1Advantage™ cover cost |
| Financing available: | P1Advantage™ monthly savings exceed financing costs |
| **DESIGN:** | |
| Ideal for any non-linear load: | VFDs, rectifiers, motors, integration into MCC units |
| Passive device: | Simply installed between the power source and VFD |
| Auditable | Device emits a low audible noise |
| Warranty: | 20-year |
| Lifespan: | 40-year with minimal maintenance |
| Safety certification: | As required |

Results are for a typical P1Advantage™; actual results may vary with unit specifications and design parameters

# Model Variations

| | |
|---|---|
| Motor (HP): | 5 HP to 2000 HP |
| Line Voltage (V): | ≤690V (low voltage); medium and high voltage units available upon request |
| Temperature Rise (Deg. C): | 80, 115, 130 |
| Frequency: | 60 Hz or 50 Hz |
| Enclosure Type: | No enclosure (CC); NEMA 3R (N3R); NEMA 4 (N4) |
| Enclosure Color: | Standard Electric Grey or Custom |
| Load Type: | Three-phase, up to 100% non-linear, units engineered to load % |

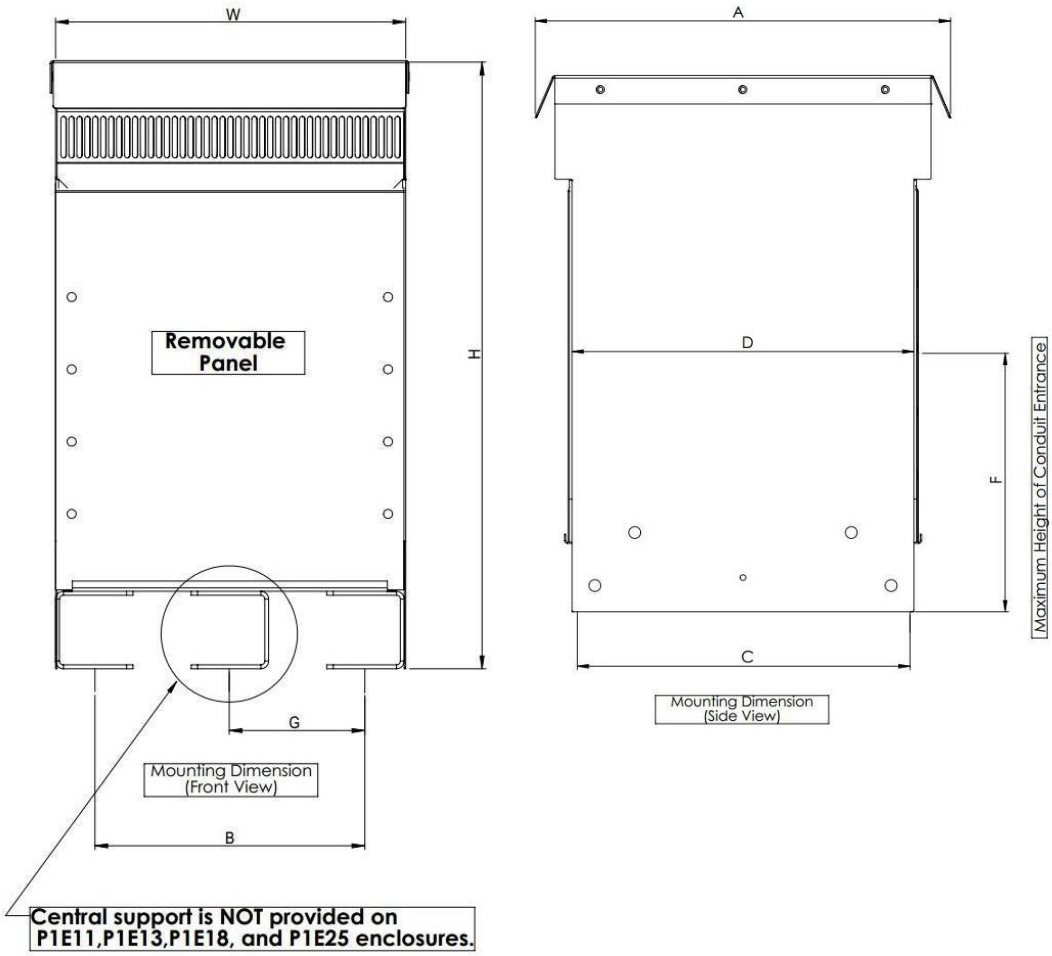
# Additional Options

| | |
|---|---|
| 50 Hz Frequency option | Lug Kit |
| Capacitor circuit by-pass terminal | NEMA 4 enclosure |
| Capacitor circuit by-pass terminal with contactor | Over temperature alarm |
| Ceiling mount | Thermal switches |
| Ground bar | |

# P1Advantage™ Specifications

| | |
|---|---|
| Capabilities: | Harmonic mitigation & power factor correction |
| Voltage: | ≤690V |
| Type: | 3 Phase, dry-type electromagnetic based passive device, natural convection air cooled (ANN) |
| Coil material: | Copper |
| System frequency: | 60 Hz (Option: 50 Hz) |
| Load type: | 3 Phase, up to 100% non-linear |
| Capacitor - Dielectric: | Self- healing |
| - Losses: | <0.25 to 0.45 W/kVAR |
| - Life expectancy: | 130,000 hours |
| - Capacitance tolerance: | +/- 5% |
| Product range (low voltage): | 5 HP – 2000 HP; mid-voltage units available as well |
| Harmonics treated: | 5th, 7th, 11th, 13th and their multiples |
| Voltage Total Harmonic Distortion: | Typically to less than 2% |
| Current Total Harmonic Distortion: | 80% reduction (typically to 5% or less when operated within designed parameters) |
| Power factor correction: | Greater than 99% |
| Optimization method: | Through harmonic mitigation |
| Protection: | Quick capacitor discharge resistors |
| Max ambient temperature: | 50 degrees C (open panel) |
| | 40 degrees C (ventilated enclosure) |
| Temperature rise: | 130 degrees C (option: 80, 115, 150) |
| Operating elevation: | 3,300 feet (1,000 meters) above sea level |
| Insulation class: | 220 degrees C. |
| Warranty: | 20 years pro-rated on electromagnetics and 4 years pro-rated on capacitors from date of shipment |
| Certification and labeling: | UL and C-UL, Intertek or CE mark as required |
| Enclosure type: | NEMA 3R & 4 |
| Enclosure color: | ANSI 61 grey (standard electrical grey) or customized |
| Packaging: | Using the SmartSkid |
| Installation type: | Floor mount or ceiling suspended - angle brackets and the hardware used on the SmartSkid can be utilized to suspend the P1Advantage™ from the ceiling |

# Standard Enclosure Dimensions




| HP for low voltage | Model | H | W | D | A | B | C | F |
|---|---|---|---|---|---|---|---|---|
| 5-15 | P1E11 | 30.00 | 10.98 | 11.00 | 13.66 | 9.29 | 8.00 | 22.56 |
| 20-50 | P1E13 | 33.00 | 12.98 | 12.00 | 14.66 | 11.29 | 9.00 | 24.81 |
| 60-250 | P1E18 | 39.00 | 18.00 | 15.64 | 20.53 | 14.88 | 12.64 | 29.31 |
| 300-500 | P1E25 | 58.00 | 25.00 | 19.64 | 24.53 | 21.88 | 16.64 | 43.56 |
| 600-1200 | P1E29 | 64.00 | 29.00 | 34.00 | 38.53 | 25.88 | 30.64 | 48.06 |
| 1300-2000 | P1E31 | 67.00 | 31.00 | 36.00 | 40.53 | 27.88 | 32.64 | 50.31 |

# PowerOne Solutions Inc.

Eastern Office and Manufacturing Plant:
2738 Slough Street
Mississauga, Ontario, L4T 1G3

Western Office:
33771 George Ferguson Way, #276
Abbotsford, BC, V2S 2M5

T: 1-905-581-3325
F: 1-888.739.9875
Email: info@PowerOneSolutions.com

Appendix

# Power Measurements on 100 HP VFD / Motor

## POWER QUALITY DATA RECORDER

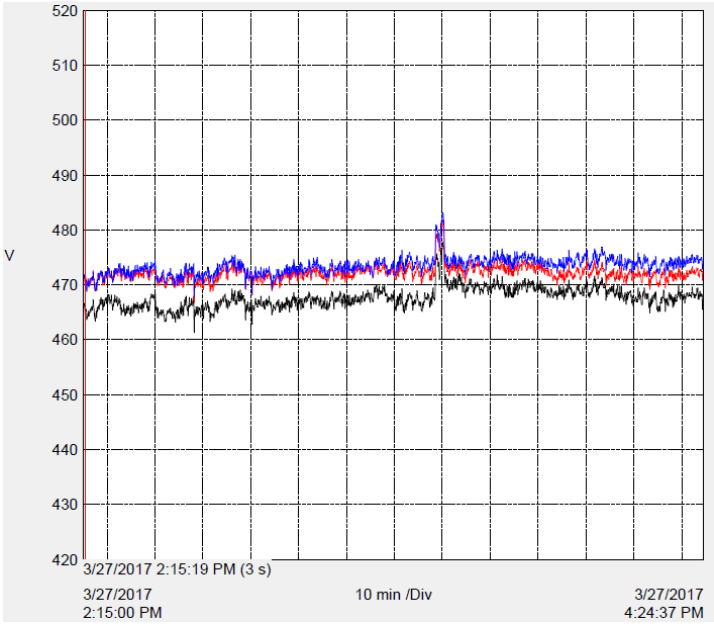
# LINE VOLTAGE

### Without P1Advantage

**$V_L$ Avg = (467.7 + 472.2 + 473.5)/3 = 471.1V**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N rms | | 273.1 V | 273.9 V | 274.7 V | 267.9 V | 273.5 V |
| V2-N rms | | 269.8 V | 270.4 V | 270.8 V | 264.5 V | 271.5 V |
| V3-N rms | | 269.4 V | 269.9 V | 270.5 V | 264.9 V | 271.4 V |
| V1-2 rms | | 465.1 V | 466.4 V | 467.4 V | 456.1 V | 467.7 V |
| V2-3 rms | | 470.7 V | 471.6 V | 472.3 V | 462.1 V | 472.2 V |
| V3-1 rms | | 470.5 V | 471.5 V | 472.6 V | 462.3 V | 473.5 V |
| A1 rms | | 104.1 A | 105.8 A | 106.9 A | 95.74 A | 100.6 A |
| A2 rms | | 101.7 A | 102.9 A | 104.4 A | 89.99 A | 96.39 A |
| A3 rms | | 116.3 A | 117.3 A | 118.5 A | 105.9 A | 111.5 A |
| AN rms | | 1.86 A | 2.02 A | 2.16 A | 1.48 A | 1.79 A |

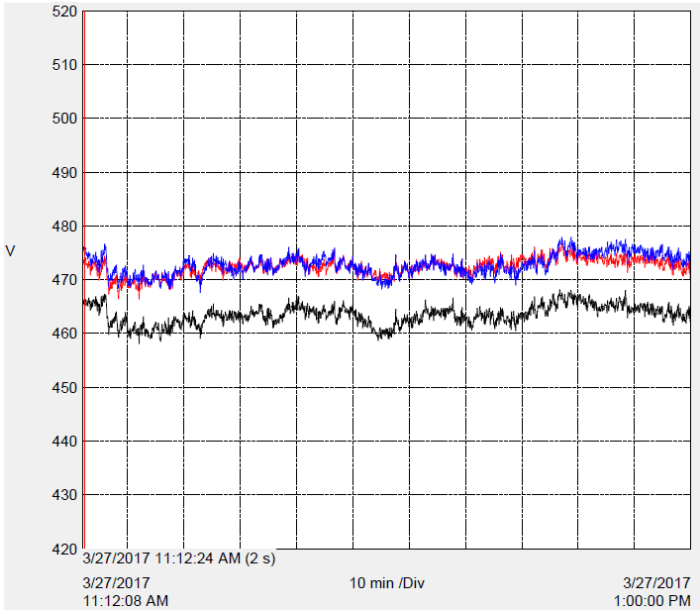



### With P1Advantage

**$V_L$ Avg = (463.5 + 472.4 + 472.8)/3 = 469.6V**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N rms | | 271.6 V | 272 V | 272.5 V | 267.1 V | 271.4 V |
| V2-N rms | | 271.9 V | 272.2 V | 272.6 V | 266.6 V | 271.5 V |
| V3-N rms | | 272.7 V | 273 V | 273.4 V | 267.1 V | 270.9 V |
| V1-2 rms | | 465.1 V | 465.8 V | 466.6 V | 457.4 V | 463.5 V |
| V2-3 rms | | 472.9 V | 473.4 V | 474 V | 465.7 V | 472.4 V |
| V3-1 rms | | 475.2 V | 475.9 V | 476.6 V | 467 V | 472.8 V |
| A1 rms | | 88.58 A | 88.78 A | 88.99 A | 86.97 A | 88.03 A |
| A2 rms | | 86.97 A | 87.14 A | 87.27 A | 86.04 A | 87.13 A |
| A3 rms | | 88.23 A | 88.47 A | 88.66 A | 87.33 A | 88.26 A |
| AN rms | | 0.98 A | 0.98 A | 0.99 A | 0.96 A | 0.98 A |



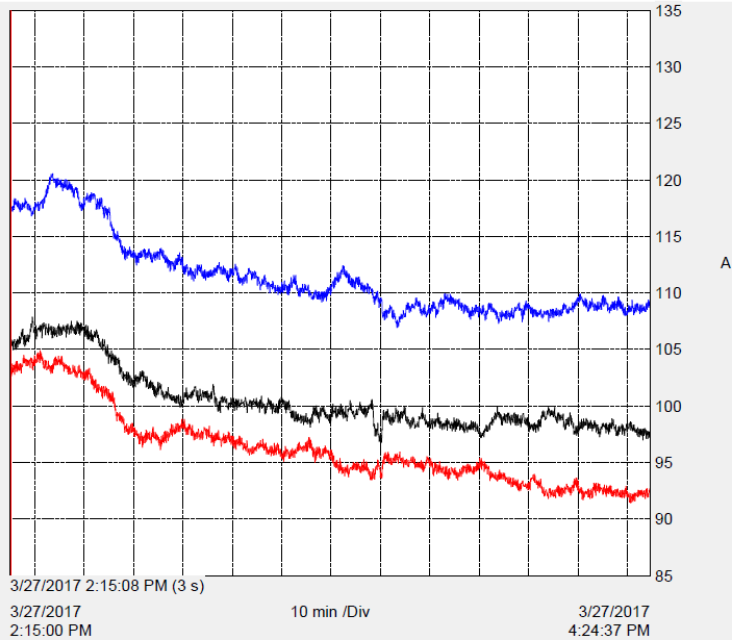
## LINE CURRENT

### Without P1Advantage

$I_L$ Avg = (100.6 + 96.39 + 111.5)/3 = 102.8A

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N rms | | 273.7 V | 274.1 V | 274.5 V | 267.9 V | 273.5 V |
| V2-N rms | | 269.6 V | 270.2 V | 270.9 V | 264.5 V | 271.5 V |
| V3-N rms | | 269.6 V | 270.1 V | 270.6 V | 264.9 V | 271.4 V |
| V1-2 rms | | 465.4 V | 466.4 V | 467.1 V | 456.1 V | 467.7 V |
| V2-3 rms | | 470.8 V | 471.6 V | 472.8 V | 462.1 V | 472.2 V |
| V3-1 rms | | 471.2 V | 471.9 V | 472.8 V | 462.3 V | 473.5 V |
| A1 rms | | 104.2 A | 105.4 A | 106.9 A | 95.74 A | 100.6 A |
| A2 rms | | 101.4 A | 103.1 A | 104.2 A | 89.99 A | 96.39 A |
| A3 rms | | 116.2 A | 117.4 A | 118.5 A | 105.9 A | 111.5 A |
| AN rms | | 1.86 A | 2.08 A | 2.17 A | 1.48 A | 1.79 A |

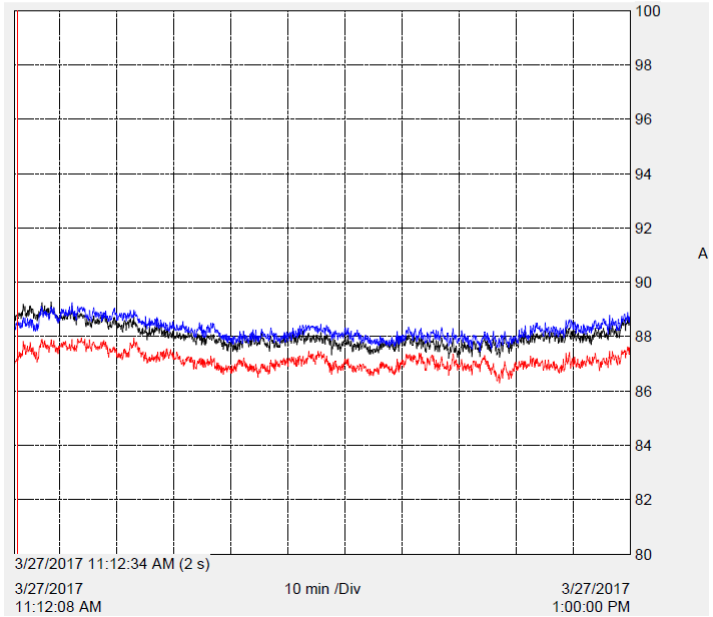



### With P1Advantage

$I_L$ Avg = (88.03 + 87.13 + 88.26)/3 = 87.8A

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N rms | | 271.1 V | 271.8 V | 272.5 V | 267.1 V | 271.4 V |
| V2-N rms | | 271.2 V | 272 V | 272.9 V | 266.6 V | 271.5 V |
| V3-N rms | | 271.8 V | 272.7 V | 273.5 V | 267.1 V | 270.9 V |
| V1-2 rms | | 464.2 V | 465.5 V | 466.7 V | 457.4 V | 463.5 V |
| V2-3 rms | | 471.6 V | 473 V | 474.4 V | 465.7 V | 472.4 V |
| V3-1 rms | | 473.7 V | 475.3 V | 476.8 V | 467 V | 472.8 V |
| A1 rms | | 88.52 A | 88.82 A | 89.07 A | 86.97 A | 88.03 A |
| A2 rms | | 86.89 A | 87.21 A | 87.4 A | 86.04 A | 87.13 A |
| A3 rms | | 88.38 A | 88.52 A | 88.75 A | 87.33 A | 88.26 A |
| AN rms | | 0.98 A | 0.98 A | 0.98 A | 0.96 A | 0.98 A |



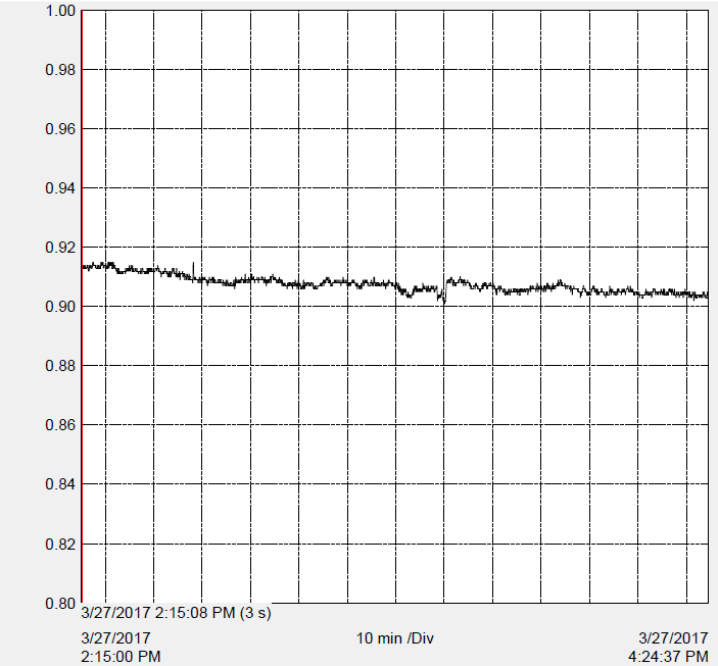
# POWER FACTOR

## Without P1Advantage

**PF = 90.8%**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| PF1 | | 0.883 | 0.888 | 0.896 | 0.862 | 0.882 |
| PF2 | | 0.912 | 0.915 | 0.917 | 0.9 | 0.909 |
| PF3 | | 0.931 | 0.933 | 0.935 | 0.923 | 0.93 |
| PFT | | 0.911 | 0.913 | 0.915 | 0.899 | 0.908 |
| Cos φ1 (DPF) | | 0.968 | 0.972 | 0.975 | 0.96 | 0.969 |
| Cos φ2 (DPF) | | 0.993 | 0.995 | 0.996 | 0.991 | 0.995 |
| Cos φ3 (DPF) | | 0.989 | 0.991 | 0.993 | 0.987 | 0.991 |
| Cos φT (DPF) | | 0.988 | 0.988 | 0.988 | 0.987 | 0.988 |

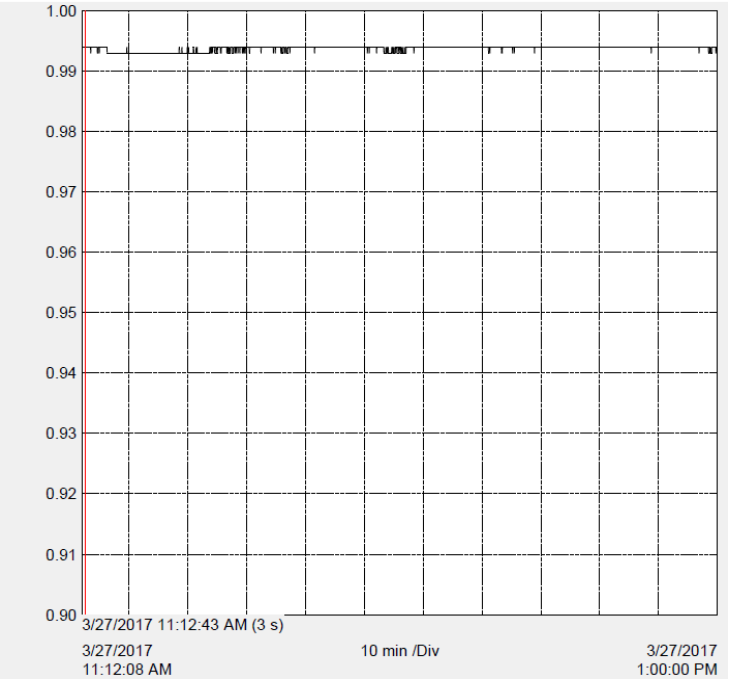



## With P1Advantage

**$PF_{Avg}$ = 99.4%**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| PF1 | | 0.994 | 0.994 | 0.995 | 0.993 | 0.994 |
| PF2 | | 0.991 | 0.991 | 0.992 | 0.989 | 0.991 |
| PF3 | | 0.995 | 0.995 | 0.995 | 0.994 | 0.995 |
| PFT | | 0.994 | 0.994 | 0.994 | 0.993 | 0.994 |
| Cos φ1 (DPF) | | 0.989 | 0.99 | 0.99 | 0.988 | 0.99 |
| Cos φ2 (DPF) | | 0.993 | 0.993 | 0.994 | 0.991 | 0.993 |
| Cos φ3 (DPF) | | 0.997 | 0.997 | 0.997 | 0.996 | 0.997 |
| Cos φT (DPF) | | 0.996 | 0.996 | 0.996 | 0.995 | 0.996 |



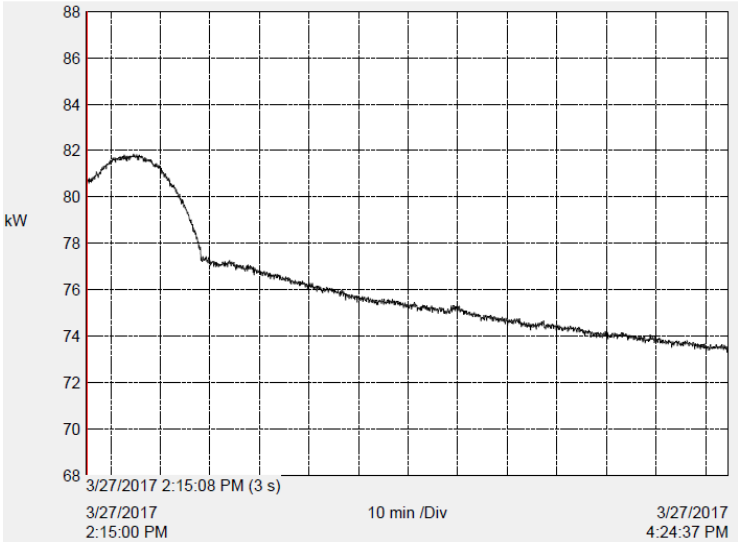
# ACTIVE POWER

## Without P1Advantage

**PT Avg = 76.13kW**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| P1 (W) | | 25.29 kW | 25.66 kW | 26.08 kW | 22.8 kW | 24.24 kW |
| P2 (W) | | 25.04 kW | 25.48 kW | 25.81 kW | 22.11 kW | 23.77 kW |
| P3 (W) | | 29.19 kW | 29.57 kW | 29.87 kW | 26.61 kW | 28.12 kW |
| PT (W) | | 80.65 kW | 80.71 kW | 80.81 kW | 73.18 kW | 76.13 kW |
| Q1 (var) | | 5.828 kvar | 6.223 kvar | 6.702 kvar | 5.174 kvar | 6.114 kvar |
| Q2 (var) | | 2.074 kvar | 2.499 kvar | 2.885 kvar | 1.227 kvar | 2.209 kvar |
| Q3 (var) | | 3.408 kvar | 3.912 kvar | 4.323 kvar | 2.793 kvar | 3.626 kvar |
| QT (var) | | 12.52 kvar | 12.63 kvar | 12.69 kvar | 11.38 kvar | 11.95 kvar |
| D1 (var) | | 11.45 kvar | 11.7 kvar | 11.82 kvar | 10.55 kvar | 11.43 kvar |
| D2 (var) | | 10.89 kvar | 10.97 kvar | 11.11 kvar | 9.71 kvar | 10.67 kvar |
| D3 (var) | | 10.63 kvar | 10.7 kvar | 10.76 kvar | 9.852 kvar | 10.49 kvar |
| DT (var) | | 33.28 kvar | 33.85 kvar | 34.22 kvar | 30.53 kvar | 33.12 kvar |
| S1 (VA) | | 28.59 kVA | 28.88 kVA | 29.29 kVA | 26.09 kVA | 27.49 kVA |
| S2 (VA) | | 27.47 kVA | 27.86 kVA | 28.16 kVA | 24.5 kVA | 26.15 kVA |
| S3 (VA) | | 31.31 kVA | 31.69 kVA | 31.97 kVA | 28.69 kVA | 30.23 kVA |
| ST (VA) | | 88.27 kVA | 88.43 kVA | 88.61 kVA | 80.81 kVA | 83.88 kVA |

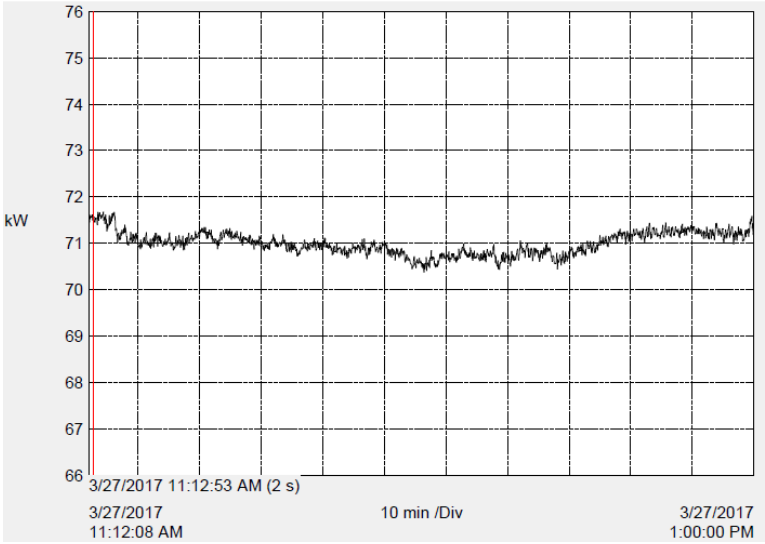



## With P1Advantage

**PT Avg = 71.0kW**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| P1 (W) | | 23.99 kW | 24.04 kW | 24.07 kW | 23.36 kW | 23.75 kW |
| P2 (W) | | 23.5 kW | 23.56 kW | 23.63 kW | 23.18 kW | 23.45 kW |
| P3 (W) | | 23.93 kW | 23.99 kW | 24.05 kW | 23.43 kW | 23.8 kW |
| PT (W) | | 71.53 kW | 71.59 kW | 71.67 kW | 70.3 kW | 71 kW |
| Q1 (var) | | 1.811 kvar | 1.86 kvar | 1.894 kvar | 1.424 kvar | 1.785 kvar |
| Q2 (var) | | 2.673 kvar | 2.74 kvar | 2.836 kvar | 2.369 kvar | 2.746 kvar |
| Q3 (var) | | 1.829 kvar | 1.884 kvar | 1.91 kvar | 1.541 kvar | 1.871 kvar |
| QT (var) | | 6.424 kvar | 6.484 kvar | 6.584 kvar | 5.654 kvar | 6.402 kvar |
| D1 (var) | | 1.683 kvar | 1.76 kvar | 1.82 kvar | 1.577 kvar | 1.819 kvar |
| D2 (var) | | 1.421 kvar | 1.481 kvar | 1.523 kvar | 1.326 kvar | 1.458 kvar |
| D3 (var) | | 1.335 kvar | 1.369 kvar | 1.424 kvar | 1.163 kvar | 1.292 kvar |
| DT (var) | | 4.73 kvar | 4.812 kvar | 4.866 kvar | 4.516 kvar | 4.814 kvar |
| S1 (VA) | | 24.13 kVA | 24.17 kVA | 24.21 kVA | 23.5 kVA | 23.89 kVA |
| S2 (VA) | | 23.71 kVA | 23.77 kVA | 23.84 kVA | 23.38 kVA | 23.65 kVA |
| S3 (VA) | | 24.04 kVA | 24.1 kVA | 24.16 kVA | 23.53 kVA | 23.91 kVA |
| ST (VA) | | 71.99 kVA | 72.04 kVA | 72.12 kVA | 70.77 kVA | 71.45 kVA |



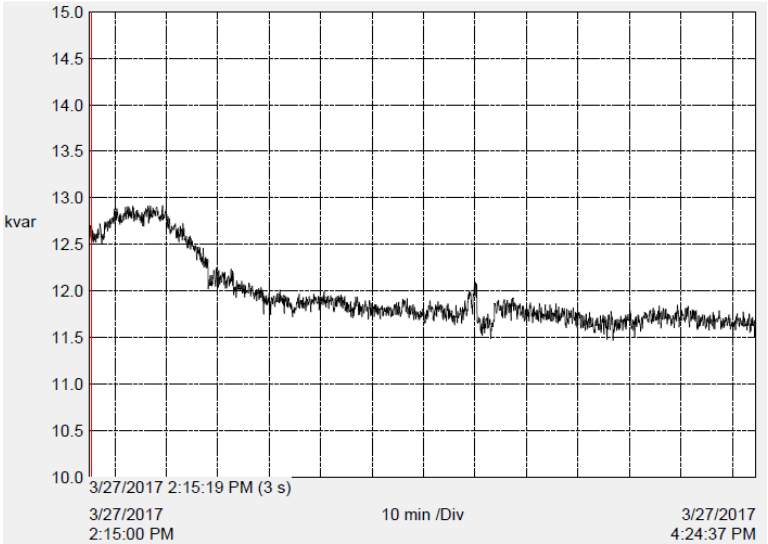
# REACTIVE POWER

## Without P1Advantage

**QT Avg = 11.95kVAR**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| P1 (W) | | 25.22 kW | 25.76 kW | 26.13 kW | 22.8 kW | 24.24 kW |
| P2 (W) | | 25.08 kW | 25.42 kW | 25.9 kW | 22.11 kW | 23.77 kW |
| P3 (W) | | 29.21 kW | 29.56 kW | 29.88 kW | 26.61 kW | 28.12 kW |
| PT (W) | | 80.6 kW | 80.74 kW | 80.86 kW | 73.18 kW | 76.13 kW |
| Q1 (var) | | 5.915 kvar | 6.288 kvar | 6.713 kvar | 5.174 kvar | 6.114 kvar |
| Q2 (var) | | 2.132 kvar | 2.601 kvar | 2.975 kvar | 1.227 kvar | 2.209 kvar |
| Q3 (var) | | 3.428 kvar | 3.817 kvar | 4.304 kvar | 2.793 kvar | 3.626 kvar |
| QT (var) | | 12.61 kvar | 12.71 kvar | 12.78 kvar | 11.38 kvar | 11.95 kvar |
| D1 (var) | | 11.42 kvar | 11.67 kvar | 11.8 kvar | 10.55 kvar | 11.43 kvar |
| D2 (var) | | 10.9 kvar | 10.99 kvar | 11.1 kvar | 9.71 kvar | 10.67 kvar |
| D3 (var) | | 10.66 kvar | 10.69 kvar | 10.74 kvar | 9.852 kvar | 10.49 kvar |
| DT (var) | | 33.31 kvar | 33.82 kvar | 34.21 kvar | 30.53 kvar | 33.12 kvar |
| S1 (VA) | | 28.54 kVA | 28.97 kVA | 29.32 kVA | 26.09 kVA | 27.49 kVA |
| S2 (VA) | | 27.5 kVA | 27.82 kVA | 28.25 kVA | 24.5 kVA | 26.15 kVA |
| S3 (VA) | | 31.34 kVA | 31.67 kVA | 31.98 kVA | 28.69 kVA | 30.23 kVA |
| ST (VA) | | 88.34 kVA | 88.46 kVA | 88.64 kVA | 80.81 kVA | 83.88 kVA |

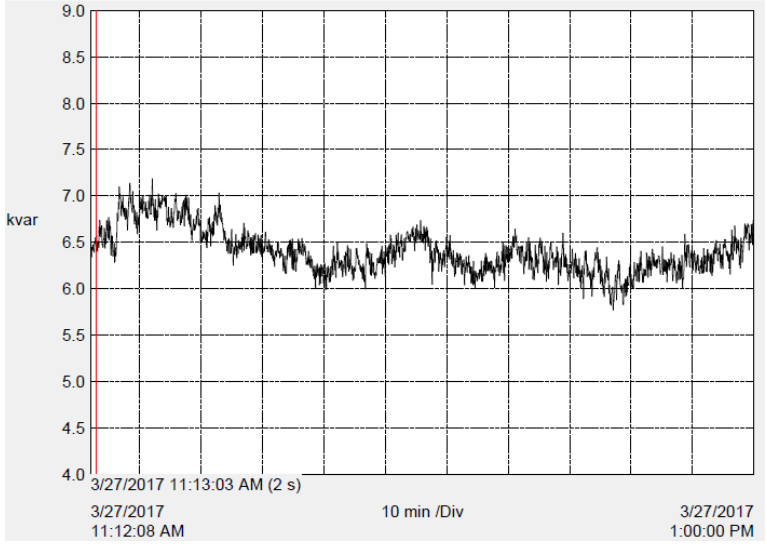



## With P1Advantage

**QT Avg = 6.4kVAR**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| P1 (W) | | 24 kW | 24.04 kW | 24.07 kW | 23.36 kW | 23.75 kW |
| P2 (W) | | 23.43 kW | 23.49 kW | 23.56 kW | 23.18 kW | 23.45 kW |
| P3 (W) | | 23.92 kW | 23.96 kW | 24.04 kW | 23.43 kW | 23.8 kW |
| PT (W) | | 71.42 kW | 71.49 kW | 71.55 kW | 70.3 kW | 71 kW |
| Q1 (var) | | 1.834 kvar | 1.907 kvar | 1.95 kvar | 1.424 kvar | 1.785 kvar |
| Q2 (var) | | 2.657 kvar | 2.72 kvar | 2.773 kvar | 2.369 kvar | 2.746 kvar |
| Q3 (var) | | 1.786 kvar | 1.838 kvar | 1.888 kvar | 1.541 kvar | 1.871 kvar |
| QT (var) | | 6.444 kvar | 6.465 kvar | 6.529 kvar | 5.654 kvar | 6.402 kvar |
| D1 (var) | | 1.684 kvar | 1.741 kvar | 1.809 kvar | 1.577 kvar | 1.819 kvar |
| D2 (var) | | 1.425 kvar | 1.462 kvar | 1.501 kvar | 1.326 kvar | 1.458 kvar |
| D3 (var) | | 1.327 kvar | 1.372 kvar | 1.415 kvar | 1.163 kvar | 1.292 kvar |
| DT (var) | | 4.721 kvar | 4.771 kvar | 4.842 kvar | 4.516 kvar | 4.814 kvar |
| S1 (VA) | | 24.14 kVA | 24.18 kVA | 24.21 kVA | 23.5 kVA | 23.89 kVA |
| S2 (VA) | | 23.63 kVA | 23.69 kVA | 23.76 kVA | 23.38 kVA | 23.65 kVA |
| S3 (VA) | | 24.03 kVA | 24.07 kVA | 24.15 kVA | 23.53 kVA | 23.91 kVA |
| ST (VA) | | 71.88 kVA | 71.94 kVA | 72 kVA | 70.77 kVA | 71.45 kVA |



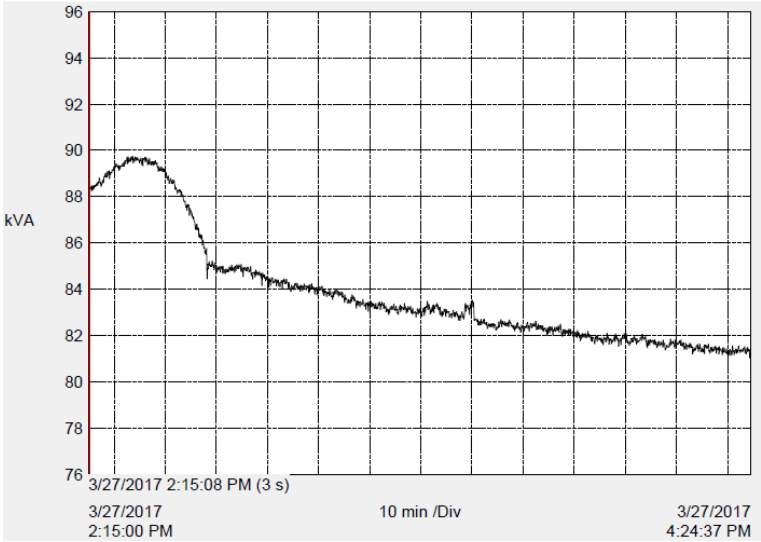
# APPARENT POWER

## Without P1Advantage

**ST Avg = 83.88kVA**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| P1 (W) | | 25.29 kW | 25.66 kW | 26.08 kW | 22.8 kW | 24.24 kW |
| P2 (W) | | 25.04 kW | 25.48 kW | 25.81 kW | 22.11 kW | 23.77 kW |
| P3 (W) | | 29.19 kW | 29.57 kW | 29.87 kW | 26.61 kW | 28.12 kW |
| PT (W) | | 80.65 kW | 80.71 kW | 80.81 kW | 73.18 kW | 76.13 kW |
| Q1 (var) | | 5.828 kvar | 6.223 kvar | 6.702 kvar | 5.174 kvar | 6.114 kvar |
| Q2 (var) | | 2.074 kvar | 2.499 kvar | 2.885 kvar | 1.227 kvar | 2.209 kvar |
| Q3 (var) | | 3.408 kvar | 3.912 kvar | 4.323 kvar | 2.793 kvar | 3.626 kvar |
| QT (var) | | 12.52 kvar | 12.63 kvar | 12.69 kvar | 11.38 kvar | 11.95 kvar |
| D1 (var) | | 11.45 kvar | 11.7 kvar | 11.82 kvar | 10.55 kvar | 11.43 kvar |
| D2 (var) | | 10.89 kvar | 10.97 kvar | 11.11 kvar | 9.71 kvar | 10.67 kvar |
| D3 (var) | | 10.63 kvar | 10.7 kvar | 10.76 kvar | 9.852 kvar | 10.49 kvar |
| DT (var) | | 33.28 kvar | 33.85 kvar | 34.22 kvar | 30.53 kvar | 33.12 kvar |
| S1 (VA) | | 28.59 kVA | 28.88 kVA | 29.29 kVA | 26.09 kVA | 27.49 kVA |
| S2 (VA) | | 27.47 kVA | 27.86 kVA | 28.16 kVA | 24.5 kVA | 26.15 kVA |
| S3 (VA) | | 31.31 kVA | 31.69 kVA | 31.97 kVA | 28.69 kVA | 30.23 kVA |
| ST (VA) | | 88.27 kVA | 88.43 kVA | 88.61 kVA | 80.81 kVA | 83.88 kVA |

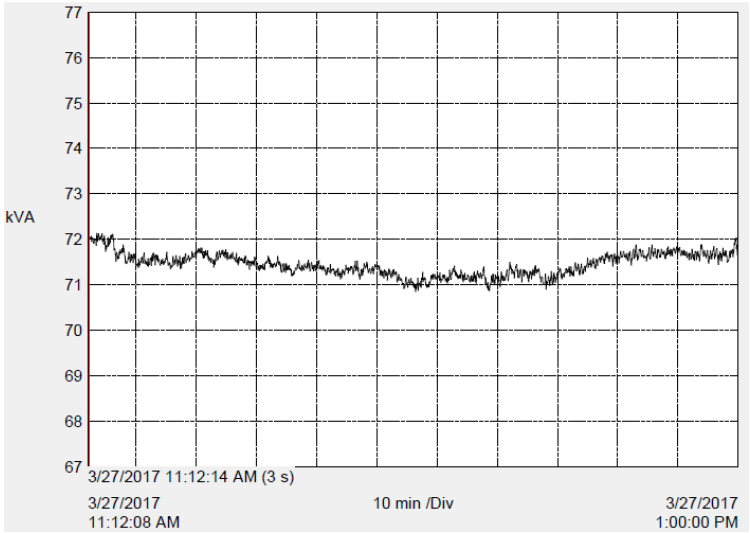



## With P1Advantage

**ST Avg = 71.4kVA**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| P1 (W) | | 23.95 kW | 23.98 kW | 24.01 kW | 23.36 kW | 23.75 kW |
| P2 (W) | | 23.42 kW | 23.48 kW | 23.54 kW | 23.18 kW | 23.45 kW |
| P3 (W) | | 23.92 kW | 23.99 kW | 24.05 kW | 23.43 kW | 23.8 kW |
| PT (W) | | 71.34 kW | 71.45 kW | 71.5 kW | 70.3 kW | 71 kW |
| Q1 (var) | | 1.795 kvar | 1.872 kvar | 1.911 kvar | 1.424 kvar | 1.785 kvar |
| Q2 (var) | | 2.636 kvar | 2.695 kvar | 2.788 kvar | 2.369 kvar | 2.746 kvar |
| Q3 (var) | | 1.826 kvar | 1.898 kvar | 1.96 kvar | 1.541 kvar | 1.871 kvar |
| QT (var) | | 6.388 kvar | 6.464 kvar | 6.602 kvar | 5.654 kvar | 6.402 kvar |
| D1 (var) | | 1.706 kvar | 1.76 kvar | 1.83 kvar | 1.577 kvar | 1.819 kvar |
| D2 (var) | | 1.465 kvar | 1.498 kvar | 1.535 kvar | 1.326 kvar | 1.458 kvar |
| D3 (var) | | 1.362 kvar | 1.406 kvar | 1.447 kvar | 1.163 kvar | 1.292 kvar |
| DT (var) | | 4.769 kvar | 4.839 kvar | 4.912 kvar | 4.516 kvar | 4.814 kvar |
| S1 (VA) | | 24.09 kVA | 24.12 kVA | 24.15 kVA | 23.5 kVA | 23.89 kVA |
| S2 (VA) | | 23.63 kVA | 23.69 kVA | 23.74 kVA | 23.38 kVA | 23.65 kVA |
| S3 (VA) | | 24.04 kVA | 24.1 kVA | 24.16 kVA | 23.53 kVA | 23.91 kVA |
| ST (VA) | | 71.81 kVA | 71.91 kVA | 71.95 kVA | 70.77 kVA | 71.45 kVA |



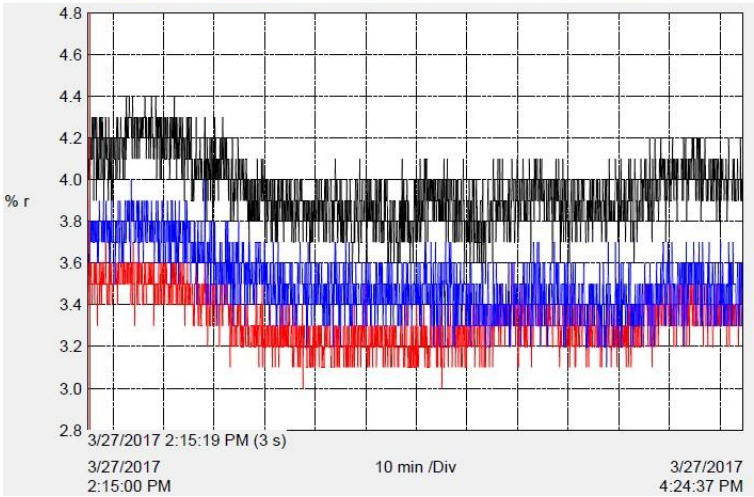
# VOLTAGE TOTAL HARMONIC DISTORTION

## Without P1Advantage

**$THD_v$ Avg = (3.9 + 3.3+ 3.5)/3 = 3.57%**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N THDr | | 4.1 % r | 4.4 % r | 4.5 % r | 3.7 % r | 4.2 % r |
| V2-N THDr | | 4.3 % r | 4.5 % r | 4.7 % r | 3.8 % r | 4.4 % r |
| V3-N THDr | | 4.6 % r | 4.8 % r | 4.9 % r | 4.1 % r | 4.6 % r |
| V1-2 THDr | | 3.9 % r | 4 % r | 4.2 % r | 3.3 % r | 3.9 % r |
| V2-3 THDr | | 3.3 % r | 3.5 % r | 3.7 % r | 2.7 % r | 3.3 % r |
| V3-1 THDr | | 3.4 % r | 3.6 % r | 3.8 % r | 2.9 % r | 3.5 % r |
| A1 THDr | | 37.9 % r | 39.1 % r | 41.7 % r | 35.8 % r | 40.5 % r |
| A2 THDr | | 37.1 % r | 38.4 % r | 39.8 % r | 35.6 % r | 40 % r |
| A3 THDr | | 33.1 % r | 34 % r | 34.9 % r | 31 % r | 34.8 % r |
| V1-N THDf | | 4.1 % f | 4.4 % f | 4.5 % f | 3.7 % f | 4.2 % f |
| V2-N THDf | | 4.3 % f | 4.5 % f | 4.7 % f | 3.8 % f | 4.4 % f |
| V3-N THDf | | 4.6 % f | 4.8 % f | 4.9 % f | 4.1 % f | 4.6 % f |
| V1-2 THDf | | 3.9 % f | 4 % f | 4.2 % f | 3.3 % f | 4 % f |
| V2-3 THDf | | 3.3 % f | 3.5 % f | 3.7 % f | 2.7 % f | 3.3 % f |
| V3-1 THDf | | 3.4 % f | 3.6 % f | 3.8 % f | 2.9 % f | 3.5 % f |
| A1 THDf | | 40.9 % f | 42.5 % f | 45.8 % f | 38.4 % f | 44.3 % f |
| A2 THDf | | 40 % f | 41.6 % f | 43.4 % f | 38.1 % f | 43.7 % f |
| A3 THDf | | 35.1 % f | 36.1 % f | 37.2 % f | 32.6 % f | 37.1 % f |

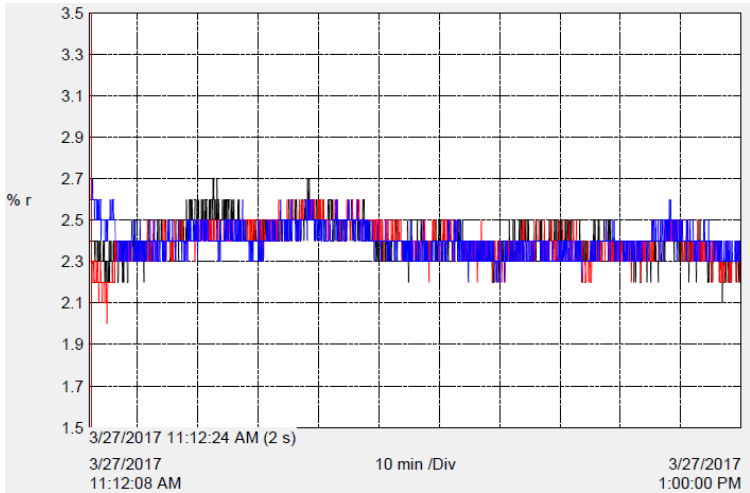



## With P1Advantage

**$THD_v$ Avg = (2.4 + 2.4+ 2.4)/3 = 2.4%**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N THDr | | 2.3 % r | 2.5 % r | 2.6 % r | 2.2 % r | 2.9 % r |
| V2-N THDr | | 3.6 % r | 3.6 % r | 3.7 % r | 3.2 % r | 3.6 % r |
| V3-N THDr | | 3.4 % r | 3.4 % r | 3.4 % r | 2.9 % r | 3.3 % r |
| V1-2 THDr | | 2.3 % r | 2.4 % r | 2.4 % r | 2.1 % r | 2.4 % r |
| V2-3 THDr | | 2.2 % r | 2.3 % r | 2.3 % r | 2 % r | 2.4 % r |
| V3-1 THDr | | 2.5 % r | 2.6 % r | 2.7 % r | 2.1 % r | 2.4 % r |
| A1 THDr | | 4.7 % r | 5.3 % r | 6 % r | 4.2 % r | 5.1 % r |
| A2 THDr | | 3.8 % r | 4.1 % r | 4.4 % r | 3.4 % r | 4.5 % r |
| A3 THDr | | 3.4 % r | 3.8 % r | 4.3 % r | 2.6 % r | 3.3 % r |
| V1-N THDf | | 2.3 % f | 2.5 % f | 2.6 % f | 2.2 % f | 2.9 % f |
| V2-N THDf | | 3.6 % f | 3.6 % f | 3.7 % f | 3.2 % f | 3.6 % f |
| V3-N THDf | | 3.4 % f | 3.4 % f | 3.4 % f | 2.9 % f | 3.3 % f |
| V1-2 THDf | | 2.3 % f | 2.4 % f | 2.4 % f | 2.1 % f | 2.4 % f |
| V2-3 THDf | | 2.2 % f | 2.3 % f | 2.3 % f | 2 % f | 2.4 % f |
| V3-1 THDf | | 2.5 % f | 2.6 % f | 2.7 % f | 2.1 % f | 2.4 % f |
| A1 THDf | | 4.7 % f | 5.3 % f | 6 % f | 4.2 % f | 5.1 % f |
| A2 THDf | | 3.8 % f | 4.1 % f | 4.4 % f | 3.4 % f | 4.5 % f |
| A3 THDf | | 3.4 % f | 3.8 % f | 4.3 % f | 2.6 % f | 3.3 % f |



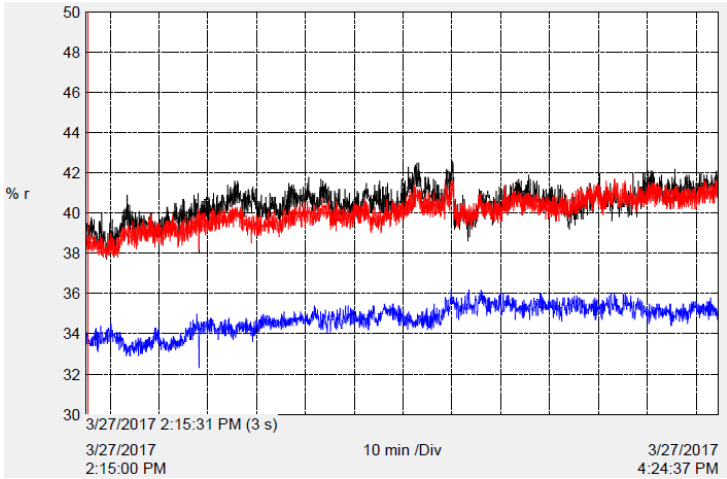
# CURRENT TOTAL HARMONIC DISTORTION

## Without P1Advantage

**$THD_i$ Avg = (40.5 + 40.0+ 34.8)/3 = 38.43%**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N THDr | | 4.1 % r | 4.3 % r | 4.5 % r | 3.7 % r | 4.2 % r |
| V2-N THDr | | 4.2 % r | 4.4 % r | 4.6 % r | 3.8 % r | 4.4 % r |
| V3-N THDr | | 4.5 % r | 4.7 % r | 4.8 % r | 4.1 % r | 4.6 % r |
| V1-2 THDr | | 3.8 % r | 4.1 % r | 4.3 % r | 3.3 % r | 3.9 % r |
| V2-3 THDr | | 3.3 % r | 3.5 % r | 3.7 % r | 2.7 % r | 3.3 % r |
| V3-1 THDr | | 3.6 % r | 3.8 % r | 3.9 % r | 2.9 % r | 3.5 % r |
| A1 THDr | | 37.3 % r | 38.9 % r | 41.4 % r | 35.8 % r | 40.5 % r |
| A2 THDr | | 37 % r | 38.6 % r | 39.9 % r | 35.6 % r | 40 % r |
| A3 THDr | | 32.7 % r | 33.8 % r | 35.2 % r | 31 % r | 34.8 % r |
| V1-N THDf | | 4.1 % f | 4.3 % f | 4.5 % f | 3.7 % f | 4.2 % f |
| V2-N THDf | | 4.2 % f | 4.4 % f | 4.6 % f | 3.8 % f | 4.4 % f |
| V3-N THDf | | 4.5 % f | 4.7 % f | 4.8 % f | 4.1 % f | 4.6 % f |
| V1-2 THDf | | 3.8 % f | 4.1 % f | 4.3 % f | 3.3 % f | 4 % f |
| V2-3 THDf | | 3.3 % f | 3.5 % f | 3.7 % f | 2.7 % f | 3.3 % f |
| V3-1 THDf | | 3.6 % f | 3.8 % f | 3.9 % f | 2.9 % f | 3.5 % f |
| A1 THDf | | 40.2 % f | 42.2 % f | 45.5 % f | 38.4 % f | 44.3 % f |
| A2 THDf | | 39.8 % f | 41.8 % f | 43.6 % f | 38.1 % f | 43.7 % f |
| A3 THDf | | 34.6 % f | 35.9 % f | 37.5 % f | 32.6 % f | 37.1 % f |




## With P1Advantage

**$THD_i$ Avg = (5.1 + 4.5+ 3.3)/3 = 4.3%**

Recording

| Channel | Color | Cursor MIN | Cursor AVG | Cursor MAX | Window MIN | Window AVG |
|---|---|---|---|---|---|---|
| V1-N THDr | | 2.4 % r | 2.4 % r | 2.4 % r | 2.2 % r | 2.9 % r |
| V2-N THDr | | 3.4 % r | 3.6 % r | 3.7 % r | 3.2 % r | 3.6 % r |
| V3-N THDr | | 3.1 % r | 3.3 % r | 3.4 % r | 2.9 % r | 3.3 % r |
| V1-2 THDr | | 2.3 % r | 2.4 % r | 2.4 % r | 2.1 % r | 2.4 % r |
| V2-3 THDr | | 2.2 % r | 2.3 % r | 2.4 % r | 2 % r | 2.4 % r |
| V3-1 THDr | | 2.6 % r | 2.7 % r | 2.7 % r | 2.1 % r | 2.4 % r |
| A1 THDr | | 4.6 % r | 5.2 % r | 5.7 % r | 4.2 % r | 5.1 % r |
| A2 THDr | | 3.8 % r | 4.1 % r | 4.4 % r | 3.4 % r | 4.5 % r |
| A3 THDr | | 3.4 % r | 3.8 % r | 4.2 % r | 2.6 % r | 3.3 % r |
| V1-N THDf | | 2.4 % f | 2.4 % f | 2.4 % f | 2.2 % f | 2.9 % f |
| V2-N THDf | | 3.4 % f | 3.6 % f | 3.7 % f | 3.2 % f | 3.6 % f |
| V3-N THDf | | 3.1 % f | 3.3 % f | 3.4 % f | 2.9 % f | 3.3 % f |
| V1-2 THDf | | 2.3 % f | 2.4 % f | 2.4 % f | 2.1 % f | 2.4 % f |
| V2-3 THDf | | 2.2 % f | 2.3 % f | 2.4 % f | 2 % f | 2.4 % f |
| V3-1 THDf | | 2.6 % f | 2.7 % f | 2.7 % f | 2.1 % f | 2.4 % f |
| A1 THDf | | 4.6 % f | 5.2 % f | 5.7 % f | 4.2 % f | 5.1 % f |
| A2 THDf | | 3.8 % f | 4.1 % f | 4.4 % f | 3.4 % f | 4.5 % f |
| A3 THDf | | 3.4 % f | 3.8 % f | 4.2 % f | 2.6 % f | 3.3 % f |