Consultancy Services for the Plant Audit in various Pump Stations and Reservoirs (OP18REFCS03)

Technical Report for Ayala South Vale (ASV) Pump Station
(Electrical and FDAS Audit)

reference: OP18REFCS03-GHD-ASV-REP-G002A

GHD Ply Ltd.

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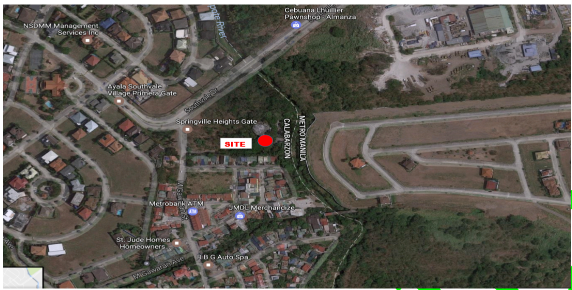
Contents

Chapter 1

Introduction

1.1 General introduction

The station is located in Ayala Alabang, Muntinlupa (refer to Figure 1.1 - a and Figure 1.1 - b). The station services two areas namely, Southvale and Sonera. Two 10HP long coupled pumps (Figure 1.2 - a) deliver to Southvale and another two 15HP close coupled pumps (Figure 1.2 - b) deliver water for Sonera area. Built in 1985, this is one of the stations with the smallest average power consumption of only 7,841 kW per month.



a - $[14^\circ 23' 55.86.74'' N, 121^\circ 0' 5.98'' E]$

b - Pump House

Figure 1.1: ASV PSR]

a - Southvale service pumps

b - Sonera service pumps

Figure 1.2: Pump gallery

This PS has been included by the Client in the first cluster of pump stations for systems audit, benchmark establishment and asset management.

The Client has therefore awarded GHD and its sub-consultants (RB Sanchez and APSI) to conduct a plant audit project with an expectation to establish rigorous asset management framework based on reliability study and to determine optimal intervention program for the next five (5) years.

1.2 Objectives

The objectives of this work are as follows

- To evaluate the current operating condition of PS as compared to the original design intent and to provide recommendations for improving the operational efficiency and lowering operating cost;
- To be able to determine an optimal intervention program for the PS in the next 5 years with reference to the recommendations from the assessment and audit based on life cycle cost; and equipment efficiency study whether the equipment is subjected to replacement or repair. These equipment are:
  - Pumps;
  - Motors;
  - Generators;
  - Electrical System and Protective Device;
  - Substation (Transformer, Switchgears);
  - MCC (VFDs, Soft starters, Circuit Breakers, and Protective Devices);
  - Motorize Valves.

1.3 Scope of Work

Scope of Work (SOW) has been defined in the Contract Agreement and be in compliance with the GHD technical and financial proposal and the agreements made during a number of project meetings (refer to minutes of meeting of the project).

IT IS IMPORTANT TO NOTE THAT THIS REPORT ONLY CONTAINS THE ANALYSIS AND RECOMMENDATION FOR FDAS AND ELECTRICAL AUDIT. THE REPORT DOES NOT INCLUDE A SECTION ON INTEGRITY TEST, WHICH SHALL BE INCLUDED IN THE FUTURE REVISION. INTEGRITY TEST HAS BEEN DEFERRED DUE TO OPERATIONAL CONSTRAINT.

PRELIMINARY REPORT ON MECHANCIAL TESTS HAS BEEN SUBMITTED TO THE CLIENT IN REVISION NUMBER OP18REFCS03-GHD-ASV-REP-G002A.

1.4 Limitations

Results of the study with analysis, conclusion, and recommendations are only within the scope of work and agreements, and particularly under the following major constraints:

- Operational constraint: It was not possible to shutdown the entire PS for visual inspection of assets, particularly mechanical assets;
- Incomplete historical data: It was a matter of fact that Maynilad has not established an asset management system, thus data regarding historical intervention is limited and incomplete, leading to non-optimal reliability analysis;

1.5 Glossaries

Following glossaries are defined and used in the report:

Level of Services (LOS)

A Level of Services (LOS) is any value or expectation of asset managers and beneficiers regarding the functionality and serviability of an asset of a system of assets.

Intervention

Intervention is a generic and global term used to refer to non-physical and physical activities on assets. It encompasses do-nothing, or do somethings like repair, maintenance, rehabilitation, renewal, investment, and inspection and testing.

Corrective Intervention (CI)

A Corrective Intervention (CI) is an intervention executed without proper and systematic plan. An CI is often incurred by failure/breakdown of assets. In most of cases, it incurs significant negative impacts (e.g. cost to repair, disruption of service, loss in revenue).

Preventive Intervention (PI)

A Preventive Intervention (PI) is an intervention executed with proper and systematic plan. Note that an PI is executed on asset that is still working but not provide adequate level of services.

Intervention Type

An Intervention Type (IT) is a specific and well-defined type of work/task that can be executed on/for an asset (e.g. replacement of a bearing for a pump).

Intervention Strategy (IS)

An Intervention Strategy (IS) is a set/collection of intervention types.

Intervention Program (IP)

An Intervention Program (IP) is a set/collection of intervention strategies for one asset or more than one assets of the same system.

Work Program (WP)

A Work Program (WP) is an execution program consisting of Intervention Program and management program (e.g. project management, procurement) that shall be implemented in order to realize/actualize the Intervention Program.

Chapter 2

Preliminary Assessment and Data Gathering

GHD conducted preliminary assessment on a set of data provided by Maynilad. The data set includes a number of records on daily production and power consumption and intervention reports issued after Maynilad experienced failure/breakdown of assets.

The assessment provided a base for GHD to generate the Inspection Testing Plan (ITP) [**GHD2018j**] aiming to gather necessary data for conducting reliability study. The ITP has been reviewed by Maynilad, together with the Work Safety Permit (WSP), prior to execution of visual inspections and testings at the site.

2.1 Maynilad's data

Maynilad provided a set of data as shown in Table 2.1

Table 2.1: Data provided by Client.

No.	Data	Remarks
1	As-built drawings	no CAD drawings, only PDF
2	Monitoring dashboard	Year 2015 to 2017
3	CI records	None
4	Asset registry	Asset registry was incompleted as confirmed by the IAM team of Maynilad.

2.1.1 Intervention records

There are no CI reports for this station. Furthermore, the most important historical data concerning specific failure of components of pumps with elapsed time is missing. Thus, the provided information is not useful for detailed reliability study on frequent failure of assets at component level.

The problem with missing specific failure data was due to a matter of fact that Maynilad still has not come up with preventive maintenance program within the overall asset management framework. The IAM team has recently established with expectation to generate short-term, medium-term, and long-term preventive intervention program. In close discussion with Maynilad, GHD learns that Maynilad has a regular/frequent activities for check-up (e.g. monthly and quarterly), however, recorded data has not been digitalized and the data itself has not aligned well with the asset registry.

Table 2.2 presents highlights on intervention data on pumps.

Table 2.2: Highlight of intervention data on pumps.

Pump	Description of PI/CI	Date/Remarks
All Pumps	Inspection of pump drive coupling, mechanical seal, MCC components. Conducted pump and motor vibration test using vibration meter and monitored bearing condition using thermal scanner. Also check gen-set's engine oil, radiator's coolant, battery solutions and filters.	Regular monthly maintenance activity, may vary at times depending on availability of test equipment
Southvale P2	Replacement of torishima pump	6/15/2015
	Replacement of mechanical seal	7/9/2015
	Pull-out of defective pump unit	7/27/2015
Southvale P1	Replacement of mechanical seal	7/9/2015
Sonera P1	Replacement of Element Coupling (Love joy 110)	N/A
N/A	Installation of Pump 1 - pump and motor alignment	4/9/2016

2.1.2 Interview data

GHD conducted an interview session on 07/12/2018. Results of the interview are summarized in the minutes [**GHD2018l**], with the following highlights.

- No further data is available aside from the provided set presented in earlier section;
- There is an existing regular check-up for assets but data is not digitalized and the information is only generic;
- Spare parts are not stocked for most of components, except for bearing. Regarding service delivery, the required discharge pressure remains the top priority in pump operation modulation and sequencing. Critical parts and components for VFD and bearing are usually stacked to have spared in case of emergency repair and replacements. The consumables on the other hand, are not stacked but ordered in advance for use in maintenance activities;
- No visual bank of assets;
- No standard testing regime that follows a regular scheme based on optimality;
- Pumps are operated based on pressure and not manual;
- No existing PI/CI procedure to be followed;
- No expansion plan is forecasted; physically impossible to add another pump in the existing pump room
- There is a problem with the inflow of incoming water, leading to lower level of reservoir chambers that has affected pump operations occasionally;
- no historical data on pump efficiency, which is a simple yet useful value in determining pump performance. The main impediment in the individual pump efficiency is the measurement of flow produced by each pump. The existing configuration of the pump-motor and piping system do not cater to conventional methods of flow determination;
- No intervention records for FDAS. It was revealed that different version on operation and functionality of the FDAS was reported by both guard and site operators.

2.1.3 Asset hierarchy

During the bidding phase, Maynilad did provide the first draft of the Asset Registry (AR) that describes a hierarchy of eight (8) levels. Figure 2.1 visualizes the hierarchy with brief description presented in Table 2.3.

GHD received the latest version of the AR with about 100 assets for this PS. The full list of assets is given in the excel file provided by Maynilad in 2018. GHD has developed a MS Access

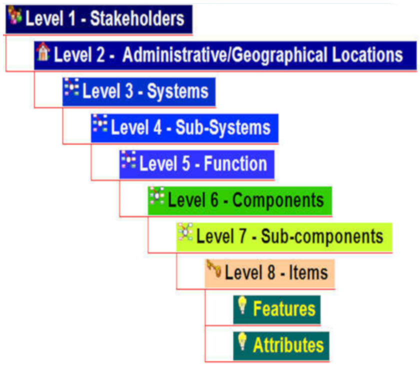


Figure 2.1: Asset Hierarchy

Table 2.3: Condition state definition - Multiple.

Asset hierarchy	Description
Level 1	Stakeholder level. For example, an pump station belongs to MWSI
Level 2	Geographical locations/ or administrative zone (e.g. a pump station belong to Quezon city or Makati)
Level 3	System (e.g. the entire pump stations and reservoir system)
Level 4	Sub-system (e.g. one specific pump station and reservoir such as the Lamesa PSR)
Level 5	Functional system (e.g. booster system or storage system)
Level 6	Component (e.g. Suction line, Reservoir line and Tank)
Level 7	Sub-component (e.g. Suction pipe and fittings, Concrete reservoir, pump)
Level 8	Items (e.g. valve, bearing, motor)

program to convert the data in the excel file to a relational database structure. Per agreement with Maynilad, GHD will only verify level 7 of the AR with the actual site condition for the study [**GHD2018m**].

2.2 Preliminary assessment

Assessment on the latest provided intervention records reveals that the provided pertinent data is incomplete and cannot be used as representative data for a complete reliability study.

It is also confirmed from the provided data that the Client has done regularly check-up on GENSETs to ensure that it provides adequate level of services in case of emergency. To date, no failure records has been observed for the GENSET.

Further evaluations and tests have to be conducted to identify the areas for improvement of preventive measures in mitigating corrective measures and study the ways to strengthen preventive measures to improve operating conditions and life of pump components.

Improving the reliability of the pump stations for the next coming years require evaluation of the existing pump station conditions and maintenance practices, particularly assessment of the pump and its components. With that, areas for improvement of operation and maintenance be addressed through action items that come from the resulting recommendations.

In order to capture a relatively good picture on the reliability of the pump system and its associated assets, a number of tests shall be conducted.

2.3 Summary of the inspection test plan (ITP)

A complete write-up on testing shall be referred to the ITP [**GHD2018j**], which has been submitted, reviewed, and approved by the Client. This section only provides highlights to help readers keeping abreast of the flow of the report.

2.3.1 Mechanical Audit

The Mechanical Tests to be conducted are enumerated and discussed hereunder including their background and applications, standards used if applicable, and the equipment to be used. During testing, the following are the assumptions and considerations:

- The operation of the pumps cannot be interrupted (at day time when demand is high).
- The valve settings then cannot be adjusted to produce different flow rates.

2.3.1.1 Structural Inspection for Pump Discharge and Suction Line

This activity measures the current thickness of the existing pipelines at the pump vicinity using ultrasonic thickness gauging. The flow regime especially around the elbow and possibly corrosion and scaling conditions are to be predicted from the measurements of this test.

Following procedures will be executed

Step 1: Locate and mark testing points

At a minimum of two (2) meters away from the pump intake/discharge flange, the test points shall be marked at 3, 6, 9 and 12 o'clock positions and at one (1) meter interval along the pipes, additional test sections with same set points shall be added as long as available beneath the immediate ground level.

Step 2: Prepare test point surfaces

- Wipe the surface free of dirt (no need to remove paint)
- Using a chalkstone (erasable), mark x on the test point

Step 3: Apply sufficient couplant on test point surface

- Use petroleum jelly/Vaseline as couplant

Step 4: Set transducer probe on test point

Step 5: Read and record value as indicated on module display

Step 6: Clean test point after reading

2.3.1.2 Unit Flow Measurement

The activity measures pump capacities. Pump efficiency is then calculated using the measured values.

Step 1: Locate Sensor Position Point Area and mark all points to be taken.

- Observe required offset distance from fittings/pump to consider the fully developed flow. At least 10 times the diameter distance away from the suction/discharge of the pump if applicable, otherwise consider at least 2D distance away from the fittings. This is to ensure the flow will be stable and fully developed for flow measurement accuracy
- Otherwise, test at near turbulent zones and consider normalizing the flow.

In particular, the headers can be chosen as set points for flow measurement. (Figures 2.2 - a to d).

a b c d

Figure 2.2: UFM testing points

Step 2: Pipe Specification Input on the Flow Meter.

- Identify nominal pipe size with equivalent parameters such as schedule designation, equivalent thickness, OD, and etc.
- Input outside diameter.
- Input pipe thickness.
- Input pipe material (carbon steel).
- Input pipe medium (water).

Step 3: Prepare test point surfaces

- Clean the surface of pipe with a sandpaper and steel brush or any suitable abrasive materials, exposing the base metal.

Step 4: Install transducers at set points

- Apply enough couplant that it covers transducers sensors to ensure an acoustically conductive connection to the pipe. Also apply couplant on the test point surface
- Clamp the transducers at the side of pipe using metal chains, straps or mounting rails Observing proper spacing and alignment. Note flow direction and install transducers at either 0 or 45 degrees, whichever would give more stable reading
- Wait for the module to display "System Normal" before reading. Inspect set-up for any fault and properly reinstall if signal is poor/low (no reading)

Step 5: Data gathering

Read and record all necessary data measurement by the equipment, (i.e. flow, fluid velocity, sound velocity, Reynolds number, etc.)

Figure 2.3: UFM Measurement Display

Step 6: Remove transducers and restore paints

Remove the transducers and restore the surface of pipe after measurement.

2.3.1.3 Suction and Discharge Pressure Measurement

The activity measures each pump suction and discharge pressure. The pump efficiency is then calculated using the measured values.

Step 1: Disassembly of existing Pressure Gauge

- Inspect for any leaks or unusual noise before proceeding: If anything is detected, report immediately to the operator;
- Close gate valve located before the pressure gauge and wait for the pressure reading to drop;
- Remove the pressure gauge: (1) Hold the adapter steady with one wrench and the grip the stationary socket of the pressure gauge with another; (2) Loosen the pressure gauge then remove it.

Step 2: Installing the Pressure Gauge

- Prepare the connections: (1) Clean the connections before installing; (2) Put Teflon tape on the pressure connection of the gauge;
- Install the pressure gauge: (1) Mount the pressure gauge on the adapter then hand tighten the arrangement; (2) Further tighten the assembly using a pair of wrenches: hold the adapter steady with one wrench and the grip the stationary socket of the pressure gauge with another; (3) Tighten the assembly;
- Inspect the assembly again.

Step 3: Reading the pressure

- Slowly open the gate valve: Observe any leaks or unusual noise;
- Measurement: (1) Wait until reading is stable; (2) Record the pressure as indicated.

Step 4: Restoring the earlier gauge

- Inspect for any leaks or unusual noise before proceeding: If anything is detected, report immediately to the operator;
- Close gate valve located before the pressure gauge and wait for the pressure reading to drop;
- Remove the pressure gauge: (1) Hold the adapter steady with one wrench and the grip the stationary socket of the pressure gauge with another; (2) Loosen the pressure gauge then remove it;
- Prepare the connections: (1) Clean the connections before installing; (2) Put Teflon tape on the pressure connection of the gauge;
- Install the pressure gauge;
- Mount the pressure gauge on the adapter then hand tighten the arrangement;
- Further tighten the assembly using a pair of wrenches: hold the adapter steady with one wrench and the grip the stationary socket of the pressure gauge with another;
- Tighten the assembly.

2.3.1.4 Parameters

Parameters was recorded using visual inspection form, interview questionnaire, and testing results. Main parameters are listed, but not limited to, in the Table 2.4. Raw data is enclosed in the Appendix.

Table 2.4: Main parameters to be collected.

Parameters	Symbol	Remarks
Pipe thickness Gauge	t	mm
Pump Capacity	Q	Gpm/cmh
Suction Pressure	Ps	mH2O
Discharge Pressure	Pd	mH2O
Vibration Data	-	-
Head	H	mH2O
Efficiency	e	%

2.3.2 Vibration and structural assessment

This activity measures the vibrations of the pump and motor at the drive and non-drive ends. The data will be used to address pump vibration problems such as cavitation, pump flow pulsation, bent pump shaft, pump impeller imbalance, shaft misalignment and bearing problems.

Following procedures will be executed

Step 1: Test location identification

Locate the testing points on drive and non-drive ends of pump and motor

Step 2: Set transducer probe on test point. Observe HIRAC for access to elevated positions

Step 3: Read and record value as indicated on module display (Figure 2.8 - d)

Figure 2.4: a

Figure 2.5: b

Figure 2.6: c

Figure 2.7: d

Figure 2.8: Vibration Analyzer Test

2.3.3 Workplace environment management

GHD/RBSanchez conducted measurements at designated locations (Figure 2.9) to record values of parameters presented in Table 2.5.

Table 2.5: WEM Parameters.

Parameters	Symbol	Units
Dry Bulb Temperature	tdb	oF/oC
Relative Humidity	RH	%
Sound Intensity	-	dB
PM 2.5 Count	PM2.5	ug/m^3
Visible useful light	-	Lux

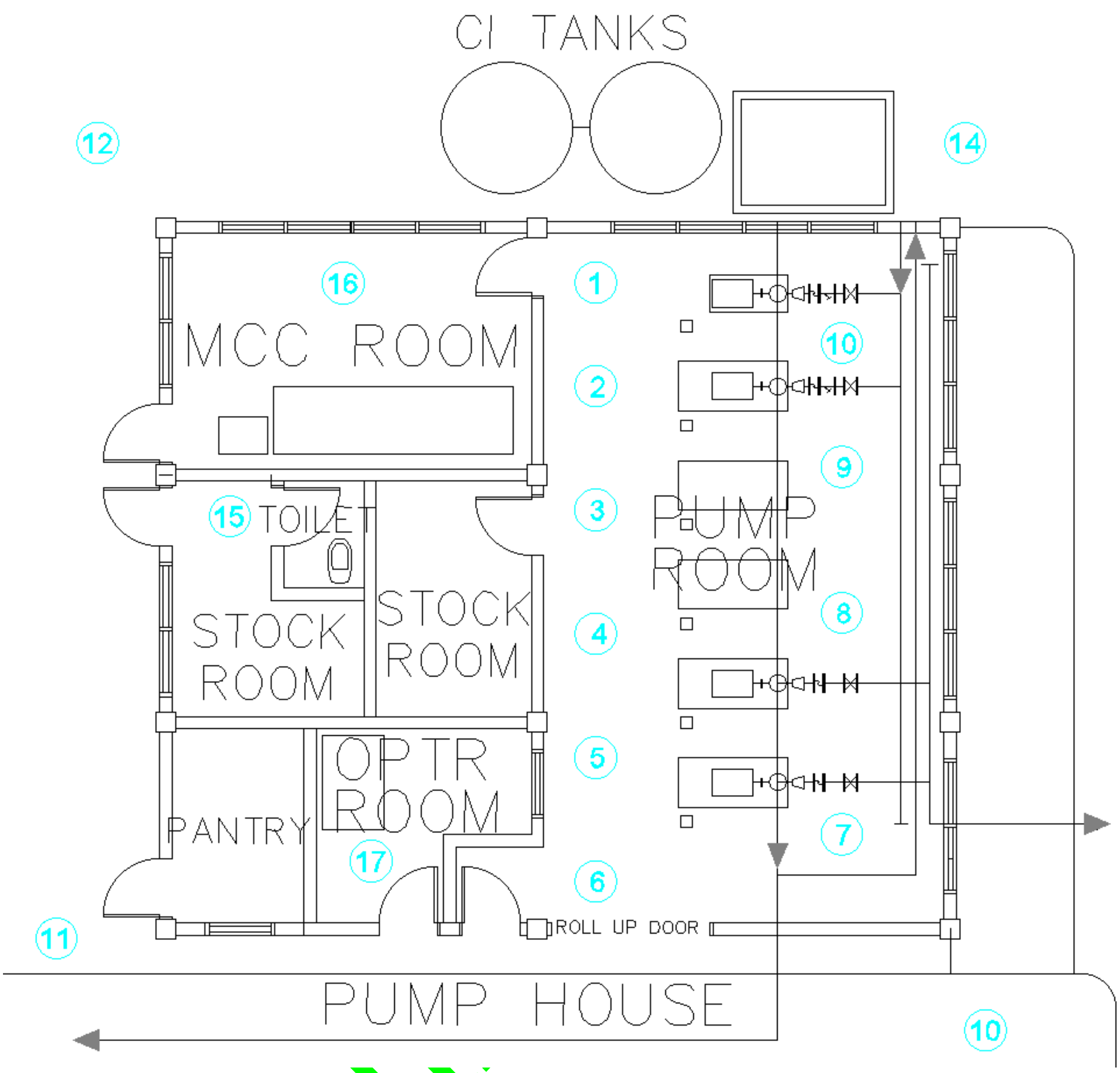


Figure 2.9: Testing locations

2.3.4 Fire protection and safety (FDAS) audit

Audit on FDAS has been conducted following sequences

Step 1: Assign (1) one person on the Fire Alarm Control Panel to operate / accept the fire alarm activation and another group/person to conduct spraying on the device, communicate using two way radio.

Step 2: Conduct spray of smoke detector tester (SOLO brand or any) directly on the smoke detector device for not more than 1 sec, repeat action until detector is activated. Note : If detector fails to respond after 3 tries, device will declared faulty (Figure **??**-a).

Step 3: Hear and visually check strobe light and sounder every time you activated the smoke detectors.

Step 4: Remove device and clean, allow particles to disperse. Then return to socket (Figure **??**-b).

Step 5: Check that strobe light is functioning/ blinking after returning. Note original status if no light is visible. Check that the control panel breaker feeding the device is reset

Step 6: Repeat steps 2, 3, and 4 on different locations until all the devices are tested.

Step 7: Conduct testing for manual call point /manual pull station by pressing the device, hear if the alarm bell / buzzer is activate after you trigger the device

Step 8: Check bells and buzzer audibility.

Step 9: Return Manual Call Point /Manual Pull Station on stand by position. Repeat it on all device.

Step 10: Make a record for the fault device.

Step 11: Record the status of FACP and reset the panel until the fault clear on trouble.

Step 12: Conduct closing of activities to all concerned .

2.4 Electrical Audit

The detail of the electrical audit testing procedure is presented in the Inspection Testing Plant (ITP) [**GHD2018j**], which has been submitted to Maynilad along with the WSPs and were approved prior to the execution of tests.

2.5 Database

GHD developed an MS Access program that functions as a database used to record data collected from visual inspections and testings. The database has been developed using the concept of Relational Database Management System (RDMS), which is a must to record data systematically. The benefits of using the database are

- Eliminate redundancy and repetition of same data
- Eliminate incorrect data entry that is often found when working with excel files
- Provide linkages among asset hierarchy
- Provide ease for programing (e.g. reliability modeling and life cycle cost analysis)
- Support Maynilad AIM team to learn the benefits of using RDMS in developing an integrated Asset Management System for now and future
- Provide compatibility with any CMMS that is often using other RDMS such as Microsoft SQL Server, Oracle SQL server, or MySQL platform
- Provide ease for compilation of desire tables for further analysis using SQL (Structure Query Language)
- Provide ease for importing/exporting to different extension formats (e.g. flat, csv, xlsx)
- Provide a strong background for Maynilad team to migrate recording practices to Web-based that will be part of GHD's recommendation for future usage.

The MySQL database is then migrated into MySQL server, which is powerful database system that is used also to migrate, compile, and store all production and power consumption data into a single table. Main reasons behind the development of the MySQL server are for statistical computing with R and for faster compilation of queries.

GHD will provide these two sets of database as part of our deliverable and will provide training for Maynilad team to learn how to use the database in an efficient approach.

Chapter 3

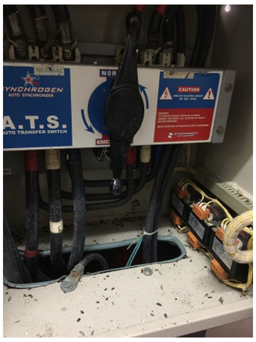
Data and Analysis

3.1 Visual inspection on electrical assets

Results of the visual inspection are reflected in the database that describes also the Asset Registry. Highlights of the outcome for this station are shown in Table 3.1 with visual images shown in Figure 3.1.

Table 3.1: Highlights of visual inspection - Electrical assets

Item	Description	Model	Brand	Status	Remarks
1	Main Switch/Switchboard	MDP 460V/MDP230V	Local Fabrication	1	Still being used
2	Distribution Transformer	75kVA, 460V	Wescor	1	Still being used
3	Maynilad Owned Load Break Switch (LBS)	n/a	N/a	0	Low voltage installation
4	Power Cables (secondary side of DT to the Elect. Loads)	THHN cables	Not visible	1	cable visually not maintained
5	Motor Control Center	230V and 460V MCC	Local Assembly	1	With defective components
6	Capacitor Bank	n/a	n/a	0	Not found
7	TVSS	n/a	N/a	0	Not found
8	Power Meter	Analog V and A	Not visble	1	Pointer still moving and has reading
9	Filters and Reactors	n/a	n/a	0	Not found
10	Instrument Transformers	Current and Voltage		1	wiring acceptable
11	Electrical Protective Relays	n/a	n/a	0	Not found
12	Motor and Switches	Nameplate blurred	nameplate blurred	1	Nameplate already blurred
13	Transfer Switch	Automatic	Synchrogen	1	Functioning as Manual Transfer
	Transfer Switch	Manual	n/a	1	Not functioning; not used
14	Uninterruptible Power System (UPS)	n/a	n/a	0	Not found
15	Distrbution Panelboards and assoc. appurtenances	DP and LPB	locally fabricated	1	Breakers are obsolete
16	Ground-Fault Circuit Interrupter (GFCI) or ELCB or (RCD)	n/a	n/a	0	Not found
17	Lighting and Lighting Control System	1x40 lighting fixture	Not visbile	1	w/ non-functioning fixtures
18	Emergency Generator	Standby Genset	Cumper	1	Rusted enclosure
19	Building Service and Distribution	utility owned	Not visbile	1	Open delta connection



(a - Transfer switch)

(b - Distribution transformer)

(c- GENSET)

(d - MCC)

(e - MDP 230 V)

(f - MDP 460 V)

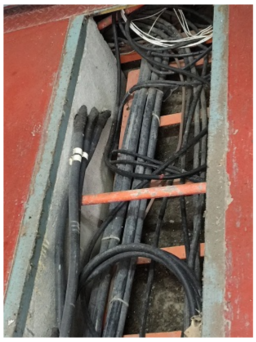
(g - Motor 1)

(h - Motor 2)

(i -MTS)

(j -Panel board 01)

(k -Transformer)



(l -Power cabling)

(m -Panel board 02)

Figure 3.1: Existing electrical assets

3.2 Short circuit calculations and evaluation

3.2.1 Short circuit calculation

Short circuit calculation (SCC) has been done using the software ETAP version 16.2 under following considerations:

- **Available MVA Short Circuit**: Utility supplying normal power to the PS via a 34.5 KV line is MERALCO. The maximum projected fault is to be requested by the owner from the utility. In the calculation, 500MVA available short circuit was used;
- **Transformer**: The SCC was based on a 65kVA transformer feeding the transfer switch going to the motors. Transformer impedance used in the calculation is per standard;
- **GENSET**:
  - Emergency power will be supplied by 1 Genset, rated at 165 kVA feeding downstream distribution power lines;
  - Subtransient value of the generator should be provided for a more accurate calculation.
- **Length of wires and cables**: Actual measured length of wires and cables.

Calculation has been done for Three Phase of short circuit current. Results of the calculations are summarized in Table 3.2. Figure 3.2 and Figure 3.3 represent the graphical representation of Nodes and Links as well as associated values.

Table 3.2: Short circuit calculation - results

Item	Description	SCC (kA)	Kaic & CB (kA)	remarks
1	From Utility to tansformer	8.357	Utility owned trafo	Protection c/o Utility
2	Pole Mounted transformer to main disconnect switch	1.295	Rating of CB is 400A per nameplate	Cover of MDS stuck. Advised not to open due to arc flash
3	Main disconnect switch 400A to Automatic transfer switch panel	1.266	Rating not visible	n/a
4	Automatic transfer switch panel to MDP-P 460V	1.258	35	Existing acceptable
5	MDP-P 460V to Enclosed CB 200A	1.233	25	Existing acceptable
6	Enclosed CB 200A to dry type transformer 112.5 kVA	1.882	25	Upstream protection is ECB 200A
7	Dry type transformer 112.5 kVA to MDP-S 230V	1.781	42	Existing acceptable
8	MDP-S 230V to MCC 230V	1.781	65	Existing acceptable
9	MDP-P 460V to MCC 460V	1.254	65	Existing acceptable
10	MDP-P 460V to MCC 440V	1.248	35	Existing acceptable
11	MDP-P 460V to dry type transformer 75kVA	1.252	None	N/a
12	Dry type transformer 75 kVA to Enclosed CB 150A	1.862	22	Existing acceptable
13	Enclosed CB 150A to Lighting Panel	1.754	10	Existing acceptable

The values of SCC shown in the table indicates the followings:

- the values of the FAULT observed to be lower than the values of the protective devices. This infers that the existing protective devices are capable to protect the assets.

3.2.2 Evaluation of protective devices and bus bars

It can be interpreted from the results of the SCC that

- the protective devices and bus bars are still provided adequate level of services and performed per applied standards;
- there is no undersized electrical components.

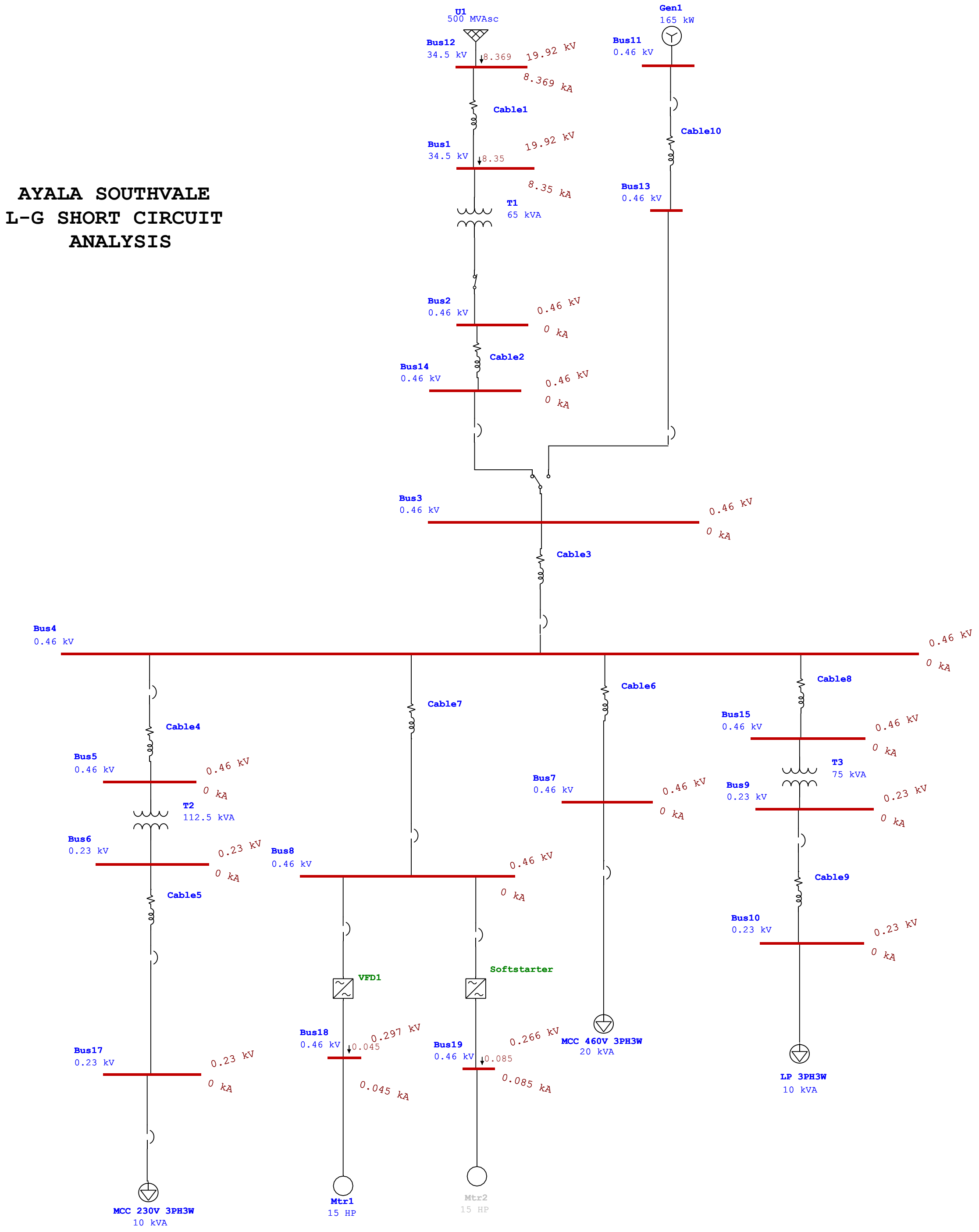


Figure 3.2: LGfault

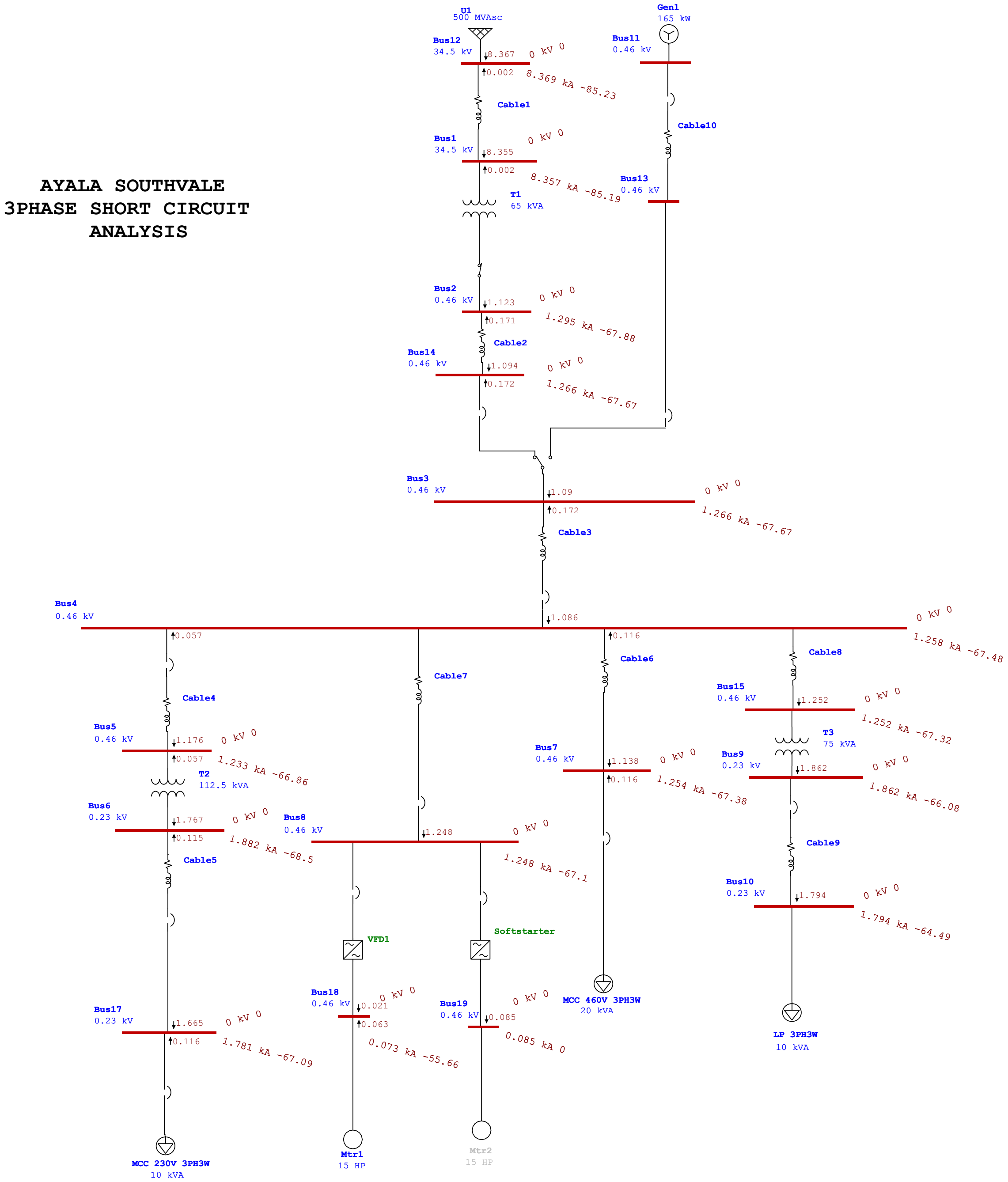


Figure 3.3: Three Phase SCC

3.3 Voltage drop calculation

Voltage drop calculation (VDC) has been conducted in compliance with the code (PEC 2017 ARTICLE 2.15.1.2(A)(1)(b)FPN NO.2) which states the following

- Conductors for feeders, as defined in Article1.1, sized to prevent a voltage drop exceeding 3% at the farthest outlet of power, heating and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5% , will provide reasonable efficiency.

Results of the VDC is presented in Table 3.3

Table 3.3: Voltage drop calculation - results

Item	From	To	Wire Size mm^2	I Ampe	L m	R Ω/305 m	X Ω/305 m	Vd	%Vd	Remarks
1	Pole Mounted Transformer 50kVA	Main Disconnect Switch	250.0	425	21	0.048	0.027	2.788	0.58	Within Limits
2	Main Disconnect Switch 400	ATS PANEL	250.0	425	35	0.048	0.027	4.647	0.97	Within Limits
3	ATS PANEL	MDP-P 460V	250.0	425	7.464	0.048	0.027	0.991	0.21	Within Limits
4	MDP-P 460V	MCC 1	250.0	425	3.56	0.048	0.027	0.273	0.06	Within Limits
5	MDP-P 460V	MCC 2	250.0	425	6	0.048	0.027	0.797	0.17	Within Limits
6	MDP-P 460V	ECB 200A	250.0	425	9	0.048	0.027	0.691	0.14	Within Limits
7	ECB 200A	DRY TYPE TRANSFORMER 112.5KVA	125.0	285.0	2	0.057	0.052	0.249	0.05	Within Limits
8	DRY TYPE TRANSFORMER 112.5KVA	MDP-S 230V	125.0	285	20.5	0.057	0.052	2.557	1.11	Within Limits
9	MDP-S 230V	MCC 230V	125.0	285	1	0.057	0.052	0.125	0.05	Within Limits
10	MDP-P 460V	DRY TYPE TRANSFORMER 75KVA	250.0	425	4.5	0.063	0.051	0.879	0.22	Within Limits
11	DRY TYPE TRANSFORMER 75KVA	LP PANEL	60.0	170	9	0.1	0.054	0.986	0.43	Within Limits

It can be interpreted from the values of the calculation that the VDC is within the limits defined in the applied standard.

3.4 Load flow study

The load flow study (analysis) has been conducted per applied standard. Following Terms are important in the study, thus being extracted from the Philippines Distribution Code for ease of readers.

- **Active Power**: The time average of the instantaneous power over one period of the electrical wave, measured in watts (W) or multiples thereof. For AC circuit or Systems , it is the product of the root-mean –square (RMS) or Effective value of the voltage and the RMS value of the in-phase component of the current. In a three phase system, it is the sum of the Active Power of the individual phases;
- **Apparent Power**: The product of the root-mean –square (RMS) or Effective value of the current and root –mean –square of the voltage. For AC circuit Systems, it is the square root of the sum of the squares of the Active Power and Reactive power, measured in volt-amperes (VA) or multiples thereof;

Table 3.4: Alert setting

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	95.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

- **Reactive Power**: The component of the electrical power representing the alternating exchange of stored energy (inductive or capacitive) between sources and loads or between two systems, measured in VAR, or multiples thereof. For AC circuits or systems, it is the product of the RMS voltage and the RMS value of the quadrature component of alternating current. In a three phase system, it is the sum of the Reactive power of the individual phases;
- **Harmonics (THD)**: Harmonics shall be defined as sinusoidal voltage and currents having frequencies that are integral multiples of the fundamental frequency.

3.4.1 Analysis based on design

The analysis has been conducted under the assumption of the Alerting Setting shown in Table 3.4. Results of the analysis are shown in the diagram (refer to Figure 3.4) with all details summarized in tabular forms (refer to the Appendix A)

As can be seen from the figure, parameter values are all acceptable. However, there is an indication in pink color for VFD1, inferring that this asset might have reached the marginal setting, but not critical. It is recommended that this asset shall be closely monitored. The conclusion on this asset will be validated together with the analysis on the Power Quality which is in subsection 3.7.

Summaries on the results are also shown in Table 3.5, Table 3.6, and Table 3.7.

It is concluded from this analysis that all parameter values are within the acceptable ranges.

3.4.2 Analysis based on measured data from the PQA

Analysis has been conducted for the overall system (referherein as MAIN), for Feeder to motor with VFD1 and softstarter, respectively. The detailed reports were obtained from the analytical software (refer to Appendix) with highlights presented in Figure 3.5, Figure 3.6, and Figure 3.7.

Following conclusions can be derived from the reports

- For the overall system, the maximum loading reached about about Phase A :75.1A, Phase B:67.7A, and Phase C: 68.6 (Figure 3.5), which is close to the theoretical values (66.4 A)obtained from ETAB software (Figure 3.4). This indicates that actual parameter values are within the acceptance range;
- For the VFD1, the maximum loading reached about Phase A:18.4A, Phase B: 9.9A, Phase C: 18.5 A (Figure 3.6), which is higher than the theoretical values (16.98 A)obtained from ETAB software (Figure 3.4). This indicates that actual parameter values are not within the acceptance range due to very low phase B value;
- For the softstarter, the maximum loading reached about Phase A: 20.6 A, Phase B: 18.5A, Phase C: (Figure 3.7), which is lower than the theoretical values (33.9 A) obtained from

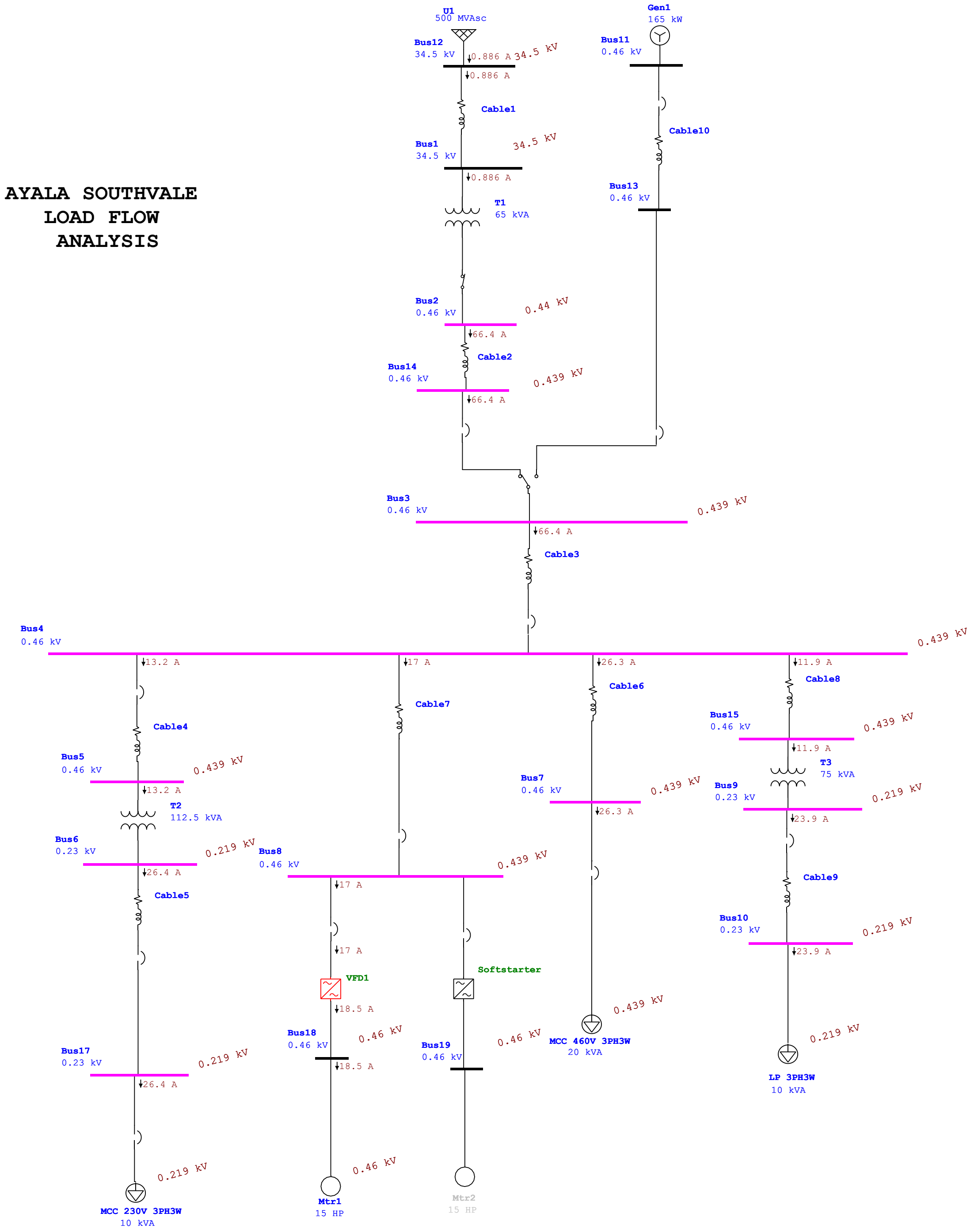


Figure 3.4: Load flow analysis

Table 3.5: Summary of total generation, loading, and demand

	MW	Mvar	MVA	% PF
Source (Swing Buses):	0.047	0.024	0.053	89.48 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	0.047	0.024	0.053	89.48 Lagging
Total Motor Load:	0.038	0.023	0.045	85.85 Lagging
Total Static Load:	0.008	0.005	0.009	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.001	-0.004		
System Mismatch:	0.000	0.000		

Number of Iterations: 2

Table 3.6: Bus loading

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus18	0.460										0.015	87.5	18.5	
Bus19	0.460													
Bus1	34.500										0.053	89.5	0.9	
Bus2	0.460										0.051	91.2	66.4	
Bus3	0.460										0.051	91.3	66.4	
Bus4	0.460										0.051	91.3	66.4	
Bus5	0.460										0.010	84.9	13.2	
Bus6	0.230										0.010	85.0	26.4	
Bus7	0.460		0.017	0.011							0.020	85.0	26.3	
Bus8	0.460		0.013								0.013	100.0	17.0	
Bus9	0.230										0.009	85.0	23.9	
Bus10	0.230				0.008	0.005					0.009	85.0	23.9	
Bus12	34.500										0.053	89.5	0.9	
Bus14	0.460										0.051	91.3	66.4	
Bus15	0.460										0.009	84.9	11.9	
Bus17	0.230		0.008	0.005							0.010	85.0	26.4	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).
# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Table 3.7: Branch loading

CKT / Branch		Cable & Reactor			Transformer				
					Capability (MVA)	Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%		MVA	%	MVA	%
Cable1	Cable	302.68	0.89	0.29					
Cable2	Cable	302.68	66.45	21.95					
Cable3	Cable	138.93	66.44	47.83					
Cable4	Cable	138.93	13.20	9.50					
Cable5	Cable	166.19	26.40	15.89					
Cable6	Cable	138.93	26.29	18.93					
Cable7	Cable	91.38	16.96	18.56					
Cable8	Cable	138.93	11.94	8.59					
Cable9	Cable	91.38	23.87	26.13					
T1	Transformer				0.065	0.053	81.4	0.051	77.9
T2	Transformer				0.113	0.010	8.9	0.010	8.9
T3	Transformer				0.075	0.009	12.1	0.009	12.1

* Indicates a branch with operating load exceeding the branch capability.

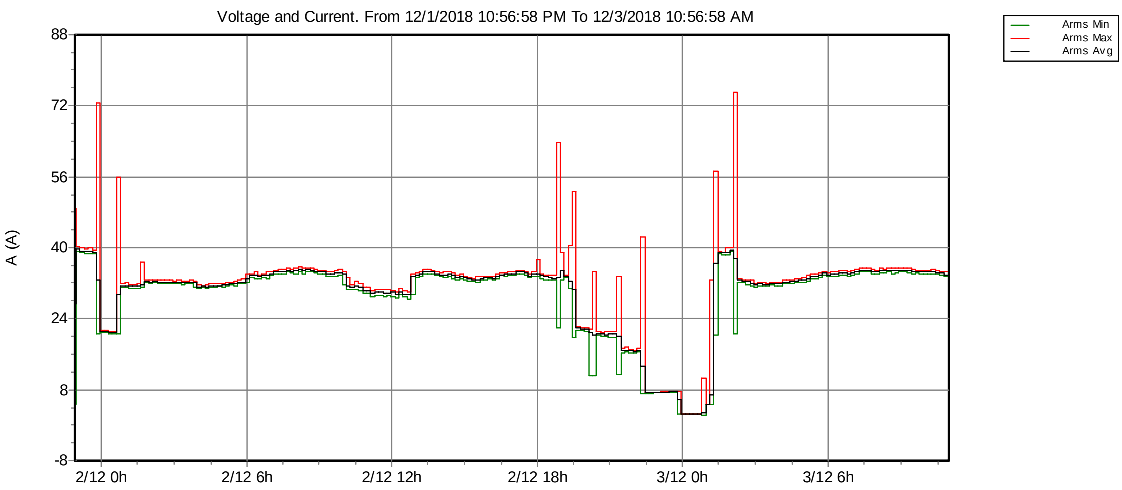


Figure 3.5: Main

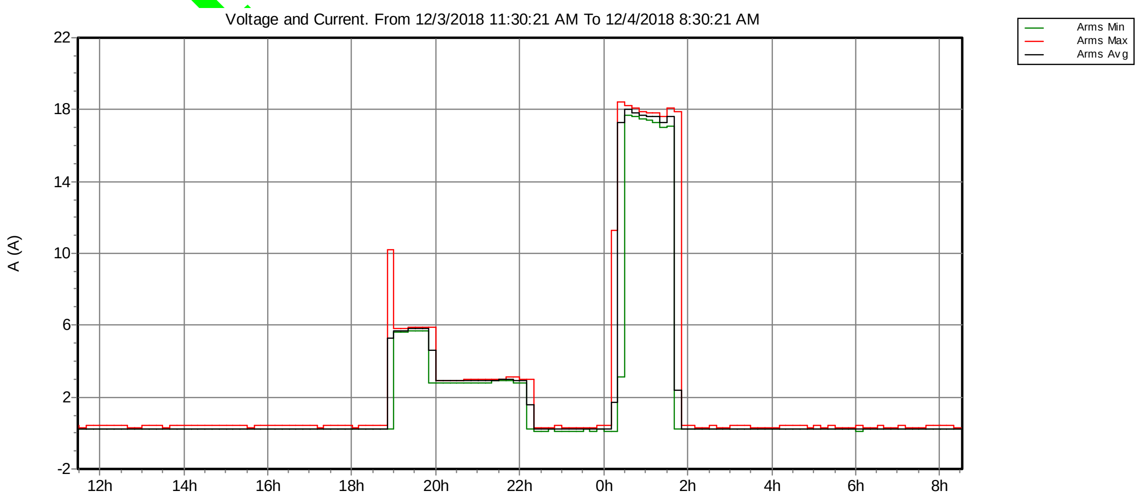


Figure 3.6: VFD-1

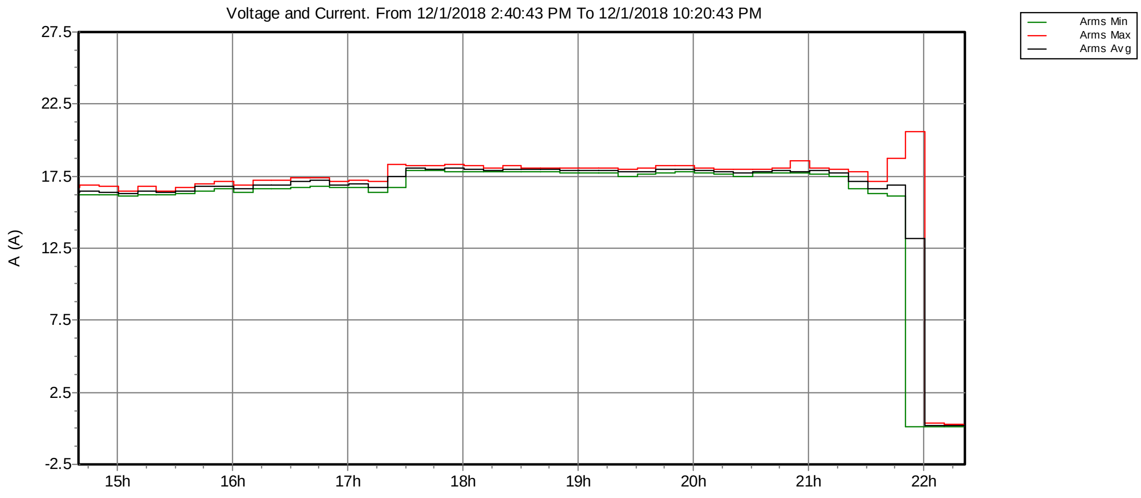


Figure 3.7: soft starter

ETAB software (Figure 3.4). This indicates that actual parameter values are within the acceptance range.

From this analysis, it is recommended that continuous monitoring on VFD1 shall be implemented to ensure that the loading is not going to exceed the limit. Furthermore, continuity test on VFD shall be conducted to determine the probable issue in phase B.

3.5 Protection coordination study

In protection coordination study, the protective devices nearest to the FAULT shall trip first and the remaining of the protective devices shall not be affected. The results were obtained from the ETAB software and shown in Table 3.8, Table 3.9, and Table 3.10.

Table 3.8: Protective Device Settings - Low Voltage Circuit Breaker with Thermal-Magnetic Trip Device

LVCB ID	Manufacturer	Breaker		Thermal		Magnetic (Inst.)	
		Model	Size	Setting	Trip (Amps)	Setting	Trip (Amps)
CB8	Schneider	EZC	63	100%	63	Fixed	
CB9	Schneider	EZC	63	100%	63	Fixed	
CB7	Schneider	EZC	250	90%	225	5X	1250
CB1	Siemens	JFC SENTRON	500	Fixed	500	5	4710
CB3	Siemens	JFC SENTRON	500	Fixed	500	3	3860

Further illustration of the coordination is shown in Figure 3.8.

Following remarks/recommendations can be interpreted from values shown in the tables and figure.

- Trip curve is covered by other protective functions or clipped by fault current.
- Some of the Circuit breaker trip devices are fixed and can not be adjusted. Hence coordination is deemed to be partial since some of the branch breaker TCC curves crossed the TCC curve of Main breaker on the instantaneous region.
- L-G fault coordination is not possible. Trip unit of protective device has no ground fault protection provided due to the type of breaker supplied. However , this is allowed under the Philippine Electrical Code.
- For better coordination, main breaker should be of adjustable and electronic type.

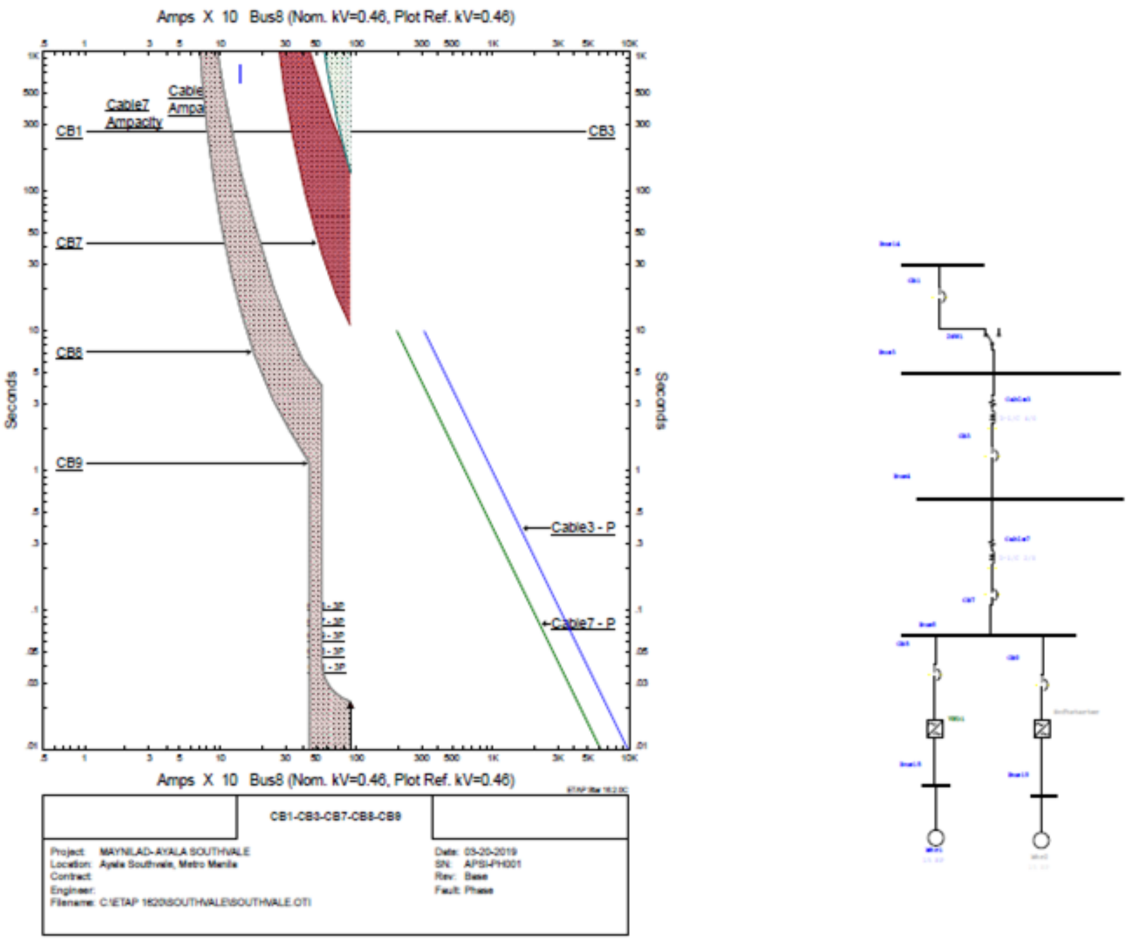


Figure 3.8: Coordination plot

Table 3.9: Cable-circuit breaker coordination

Items	Protective Device			Cable Protection				Max Fault 3Ph-Amps	Reference kV
	Location	ID	Type	Pickup Limit	Ampacity	Damage Curve	Condition		
Cable1	Load	CB1	TM-Thermal	Pass	Warning	Pass	Cable is underutilized due to Therm. Trip 500 A < 18161 A (242.1 A 34.5 kV) = Ampacity x 80%	1094	0.46
Cable1	Load	CB1	TM-Thermal	Pass	Warning	Pass	Therm. Trip 500 A is within 22701 A (302.7 A 34.5 kV) = Ampacity	1094	0.46
Cable1	Load	CB1	TM-Thermal	Pass	Warning	Pass	Therm. Trip 500 A is within max. limit of 22701 A (302.7 A 34.5 kV) = Ampacity x 100%	1094	0.46
Cable1	Load	CB1	TM-Thermal	Pass	Warning	Pass	Trip curve protects the damage curve	1094	0.46
Cable2	Load	CB1	TM-Thermal	Alert	Alert	Pass	Therm. Trip 500 A above max. limit of 302.7 A = Ampacity x 100%	1094	0.46
Cable2	Load	CB1	TM-Thermal	Alert	Alert	Pass	Therm. Trip 500 A is set above 302.7 A = Ampacity	1094	0.46
Cable2	Load	CB1	TM-Thermal	Alert	Alert	Pass	Trip curve protects the damage curve	1094	0.46
Cable3	Load	CB3	TM-Thermal	Alert	Alert	Pass	Therm. Trip 500 A above max. limit of 138.9 A = Ampacity x 100%	1086	0.46
Cable3	Load	CB3	TM-Thermal	Alert	Alert	Pass	Therm. Trip 500 A is set above 138.9 A = Ampacity	1086	0.46
Cable3	Load	CB3	TM-Thermal	Alert	Alert	Pass	Trip curve protects the damage curve	1086	0.46
Cable6	Load	CB12	TM-Thermal	Alert	Alert	Pass	Therm. Trip 400 A above max. limit of 138.9 A = Ampacity x 100%	1138	0.46
Cable6	Load	CB12	TM-Thermal	Alert	Alert	Pass	Therm. Trip 400 A is set above 138.9 A = Ampacity	1138	0.46
Cable6	Load	CB12	TM-Thermal	Alert	Alert	Pass	Trip curve protects the damage curve	1138	0.46
Cable7	Load	CB7	TM-Magnetic	-	-	Pass	Trip curve protects the damage curve	1248	0.46
Cable7	Load	CB7	TM-Thermal	Alert	Alert	Pass	Therm. Trip 225 A above max. limit of 91.4 A = Ampacity x 100%	1248	0.46
Cable7	Load	CB7	TM-Thermal	Alert	Alert	Pass	Therm. Trip 225 A is set above 91.4 A = Ampacity	1248	0.46
Cable7	Load	CB7	TM-Thermal	Alert	Alert	Pass	Trip curve protects the damage curve	1248	0.46
Cable8	Load	CB10	TM-Thermal	Pass	Warning	Pass	Cable is underutilized due to Therm. Trip 150 A < 222.3 A (111.1 A 0.46 kV) = Ampacity x 80%	1862	0.23
Cable8	Load	CB10	TM-Thermal	Pass	Warning	Pass	Therm. Trip 150 A is within 277.9 A (138.9 A 0.46 kV) = Ampacity	1862	0.23
Cable8	Load	CB10	TM-Thermal	Pass	Warning	Pass	Therm. Trip 150 A is within max. limit of 277.9 A (138.9 A 0.46 kV) = Ampacity x 100%	1862	0.23
Cable8	Load	CB10	TM-Thermal	Pass	Warning	Pass	Trip curve protects the damage curve	1862	0.23

3.6 Harmonic study

Harmonic study has been conducted under the following basics

- Harmonics shall be defined as sinusoidal voltage and currents having frequencies that are integral multiples of the fundamental frequency;
- The total harmonic distortion (THD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the fundamental quantity, expressed in percent;

Table 3.10: MCCB coordination

Zone		Stream		Max Fault		Ref.	Coord.	Amp Range		Condition
ID	type	up PD	down PD	type	Amp	kV	status	From	To	
Bus4	Bus	CB3	CB5	3Ph	1201	0.46	Pass	317.9	1201	Devices are coordinated between amp range of 317.9 A to 1201A 0.46 kV
	Bus	CB3	CB7	3Ph	1248	0.46	Pass	282.4	1248	Devices are coordinated between amp range of 282.4 A to 1248A 0.46 kV
	Bus	CB3	CB12	3Ph	1138	0.46	Alert	528.5	1138	Miscoordination, downstream trip curve is above and right of upstream
Bus8	Bus	CB7	CB9	3Ph	1248	0.46	Alert	1125	1125	Miscoordination, the time gap is smaller than 0.001 sec margin at I=1125 A, Plot Ref. kV=0.46
	Bus	CB7	CB8	3Ph	1248	0.46	Alert	1125	1125	Miscoordination, the time gap is smaller than 0.001 sec margin at I=1125 A, Plot Ref. kV=0.46

- PHILIPPINE DISTRIBUTION CODE sets the THD of the voltage at any user system to not exceed 5% during normal operating conditions.

3.6.1 As per design

Results of the study as per design are shown in Figure 3.9 and Figure 3.10

It can be seen from the figures that there are a number of distortions, which are connected to bus 4. It is notable to observe that the percentage of the THD is 23.48%, which is very close to the margin of 5%.

3.6.2 Per actual

Results of the study based on the PQA are presented in Figures 3.11, 3.12, 3.13, 3.14, 3.15, and 3.16

Table 3.11 shows also the summary of the study, in which the min, average, and max values are presented along with the limit of 5%.

Table 3.11: Harmonic study

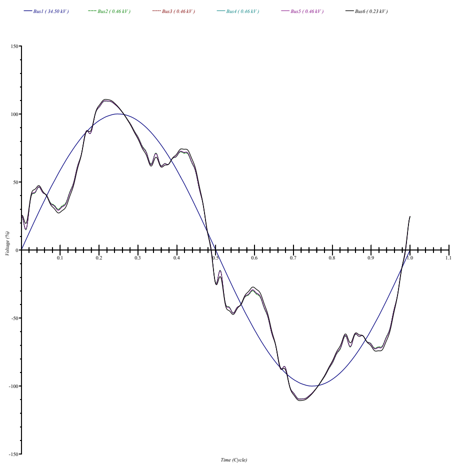
Total Harmonic Distortion (%)	Phase	Minimum	Average	Maximum	Limits (5%)	Remarks
Main 200A (Load side)	AB	3.89	3.93	4.94		
	BC	3.58	3.6	4.68	5	Within Limits
	CA	3.89	3.93	4.94		
VFD-1	AB	4.54	4.58	4.79		
	BC	4.00	4.07	4.31	5	Within Limits
	CA	4.54	4.58	4.79		
Softstarter	AB	2.86	4.01	4.38		
	BC	2.68	3.62	3.86	5	Within Limits
	CA	2.86	4.01	4.38		

It can be interpreted from the table that values Main and VFD1 infer that there might be a concern, particularly for the harmonic orders of 3rd, 5th, and 7th being dominant registers. This might cause heating on the equipment.

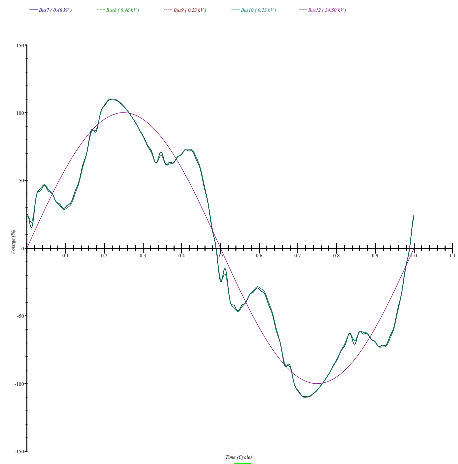
Recommendation shall be realized together with the recommendation from the study of Power Quality Analysis (refer to subsection 3.7)

3.7 Power quality analysis

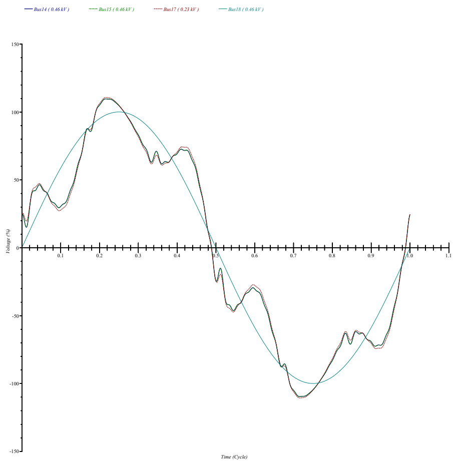
The Power Quality Analysis (TQA) has been conducted on the Main system, VFD1, and VFD2 of this PS. The Power Quality Analyzer used is FLUKE 430-II. Figure 3.17 shows the analyzer



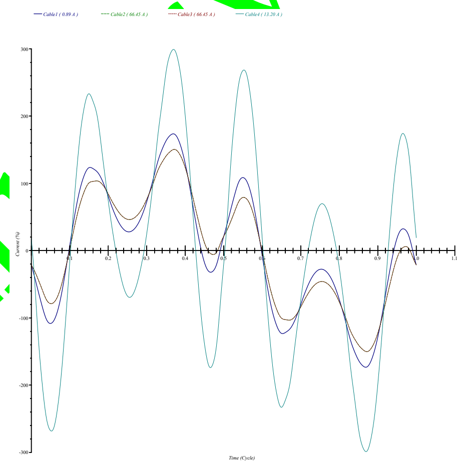
a - bus 1-6



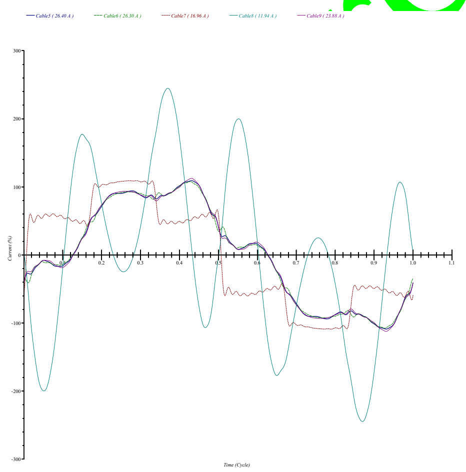
b - bus 7-12



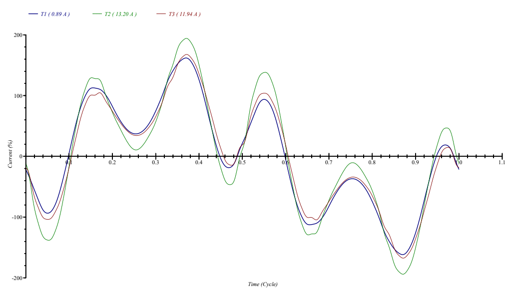
c - bus 14-18



d - cable 1-4



e - cable5-9



f - t1-t4

Figure 3.9: Harmonic wave form

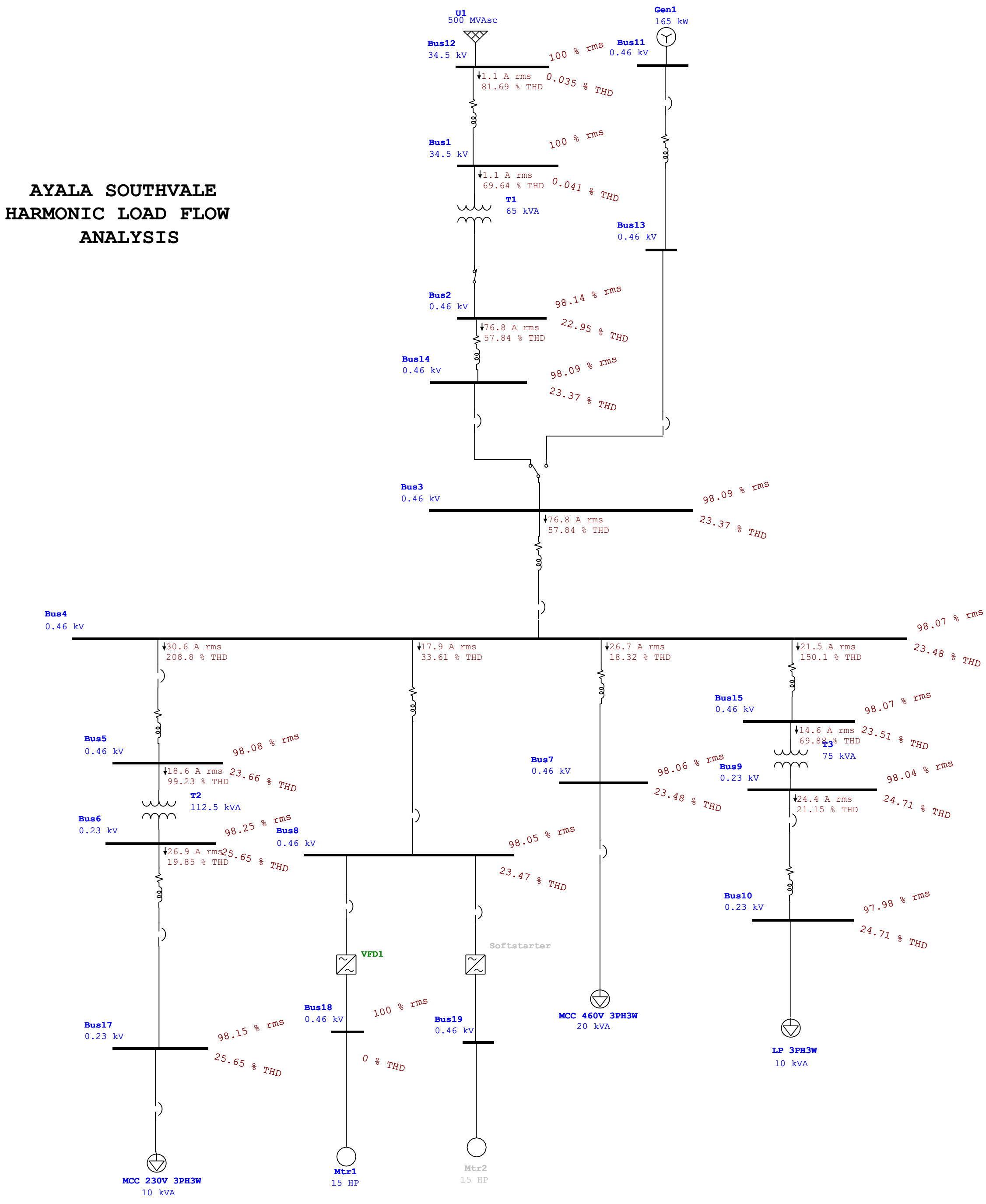


Figure 3.10: Load flow

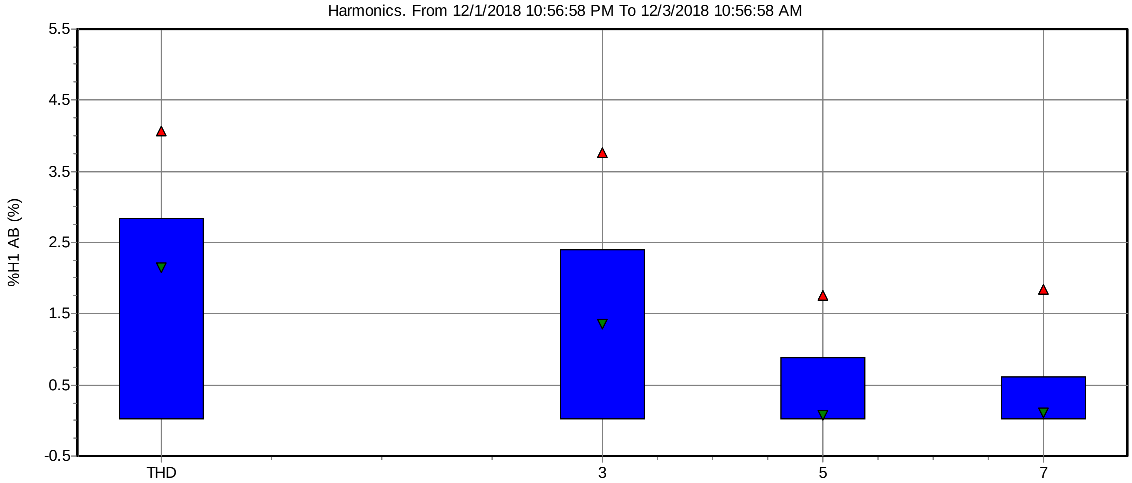


Figure 3.11: Voltage harmonic - AB

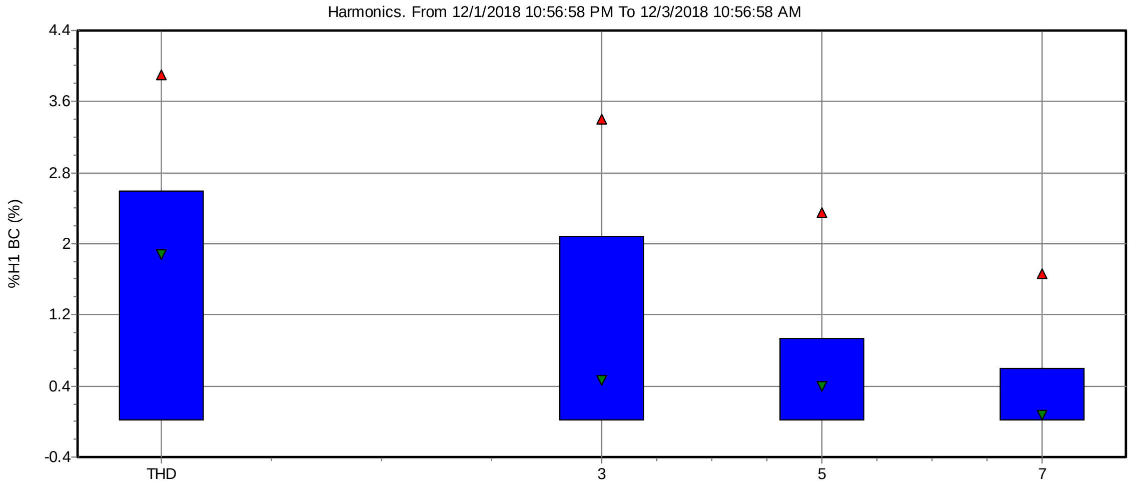


Figure 3.12: Voltage harmonic - BC

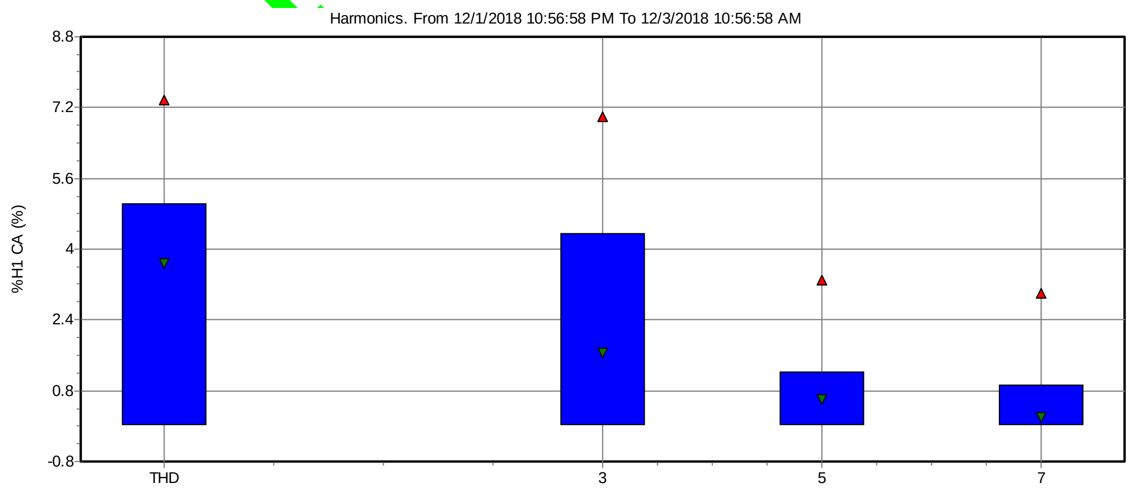


Figure 3.13: Voltage harmonic - CA

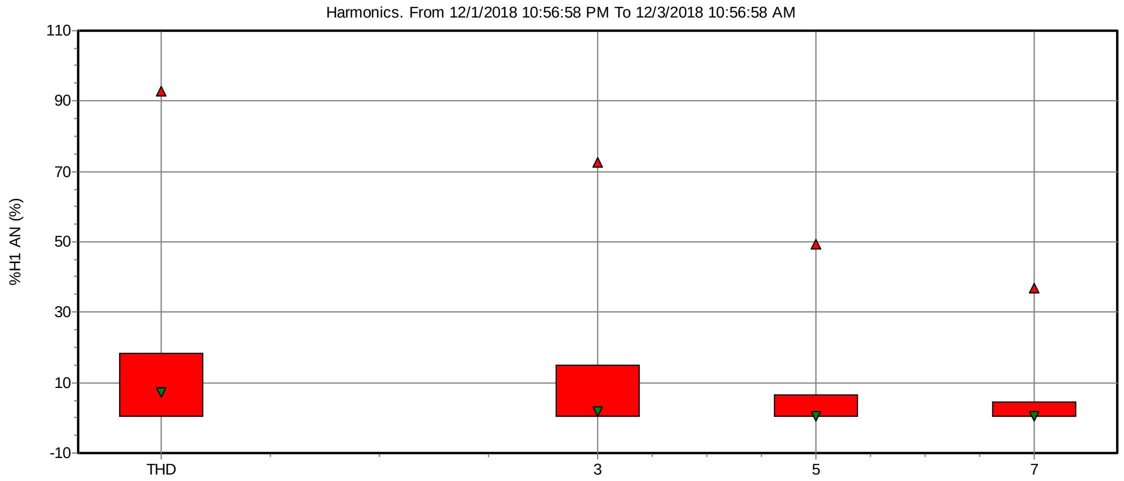


Figure 3.14: Current harmonic -AB

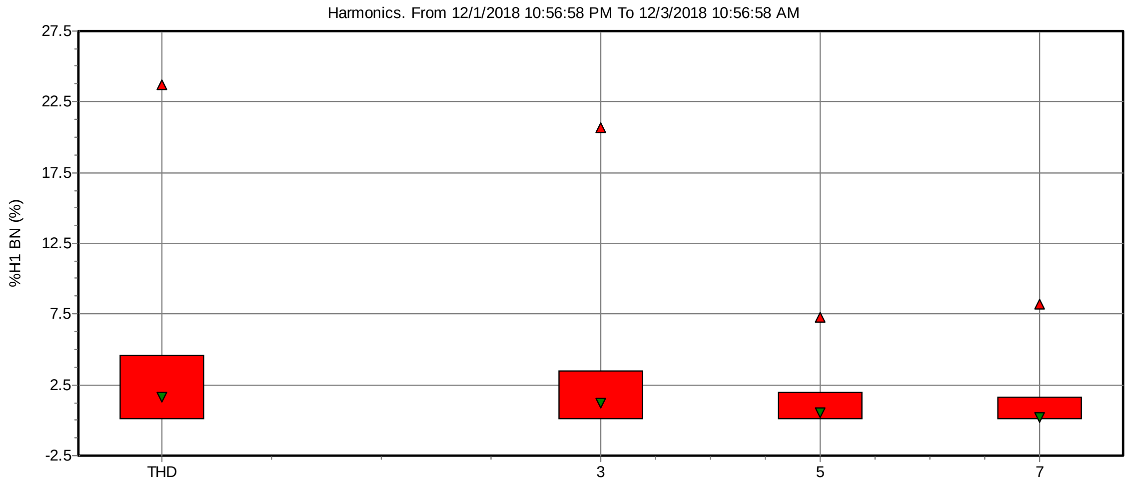


Figure 3.15: Current harmonic -BC

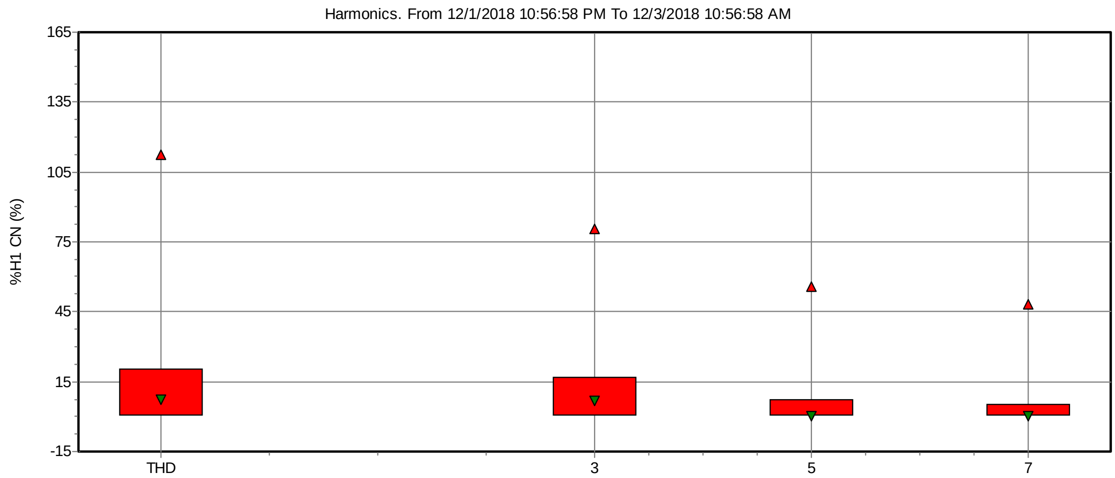


Figure 3.16: Current harmonic -CA

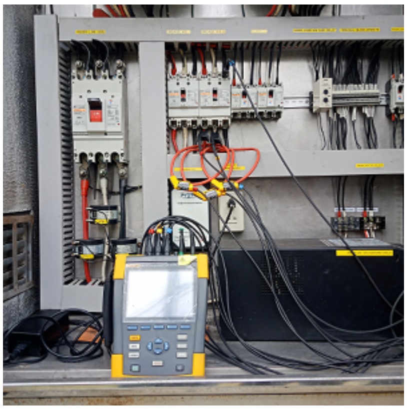


Figure 3.17: Power quality analyzer plugging during measurement

during the course of measurement for the station.

3.7.1 Objectives and expected outcomes

The preliminary objectives and expected outcomes from this analysis are

- Record the voltage and current profile on the load side of Circuit Breaker with the recording interval set every five (10) minutes;
- Record power profile (KW, KVA, KVAR) on the load side of Circuit Breaker with the recording interval set every ten (10) minutes.
- Record Total Harmonic Distortion (THD);
- Record Values of Short Duration Voltage Variation that will exceed the limit set by Philippine Distribution code;
- Record values of Long Duration Voltage Variation that will exceed the limit set by the Philippine Distribution Code;
- Record values of Frequency Variation that will exceed the limit set by Philippine Distribution code;
- Record Transient voltage Surge defined by PDC and using Computer Business Equipment Manufacturer's Association(CBEMA) and Information Technology Industry Council (ITIC) Curve International Standard;
- Compute for Voltage Unbalance and compare it on the Voltage unbalance limit set by PDC;
- Recommendations.

3.7.2 Basic

The assessments made in this report are in accordance to IEEE Standard 1159-1995 "IEEE Recommended Practice for Monitoring Electric Power Quality".

The Philippine Distribution Code was used as the local reference for power quality standards. According to the Philippine Distribution Code, a power quality problem exists when at least one of the categories in the tables of following sections is present during the normal operation of the electrical system

3.7.3 Results

Results are summarized in this section together with the enclosed tables and graphs in the Appendix B

Any values outside these limits are noted in the report. Values within the limits are considered to be within safe operating range.

3.7.3.1 RMS Voltage compliance

The steady-state rms voltage must remain within the range of 90.00% to 110.00%.

- Over Voltage – if the RMS value of the voltage is greater than or equal to 110% of the nominal value
- Under Voltage – if the RMS value of the voltage is less than or equal to 90% of the nominal voltage

Results are shown in Table 3.12.

Table 3.12: Power quality - RMS Voltage compliance

RMS VOLTAGE (460 VOLTS)	Phase	Minimum	Average	Maximum	Limits	Remarks
Main 250A (Load side)	AB	441.18	468.00	472.86		
	BC	438.68	464.40	469.70	±10% (414-506V)	Within Limits
	CA	441.18	468.00	472.86		
VFD-1	AB	443.84	467.70	472.96		
	BC	441.76	463.50	468.26	±10% (414-506V)	Within Limits
	CA	443.84	467.70	472.96		
Soft Starter	AB	441.71	458.50	463.26		
	BC	439.34	456.00	459.50	±10% (414-506V)	Within Limits
	CA	441.71	458.50	463.26		

3.7.3.2 Voltage unbalance compliance

Voltage Unbalance shall be defined as the maximum deviation from the average of the three phase voltages divided by the average of the three phase voltages expressed in percent. The maximum voltage unbalance at the connection point of any user, excluding the voltage unbalance passed on from the grid shall not exceed 2.5% during normal operating conditions.

Results are shown in Table 3.13.

Table 3.13: Power quality -Voltage unbalance

Voltage unbalance	Minimum	Average	Maximum	Limits (%)	Remarks
MAIN 200A (Load Side)	0.38	0.51	0.45	2.5	Within Limits
VFD-1	0.31	0.60	0.66	2.5	Within limits
Softstarter	0.36	0.36	0.54	2.5	Within Limits

3.7.3.3 Current unbalance compliance

Results are shown in Table 3.14 with note that the current unbalance should not exceed 10%.

Table 3.14: Power quality -Current unbalance

Current unbalance	Minimum	Average	Maximum	Limits (%)	Remarks
MAIN 200A (Load Side)	13.07	8.73	6.74	$\leq$ 10%	Outside Limits
VFD-1	77.36	8.73	6.47	$\leq$ 10%	Outside Limits
Softstarter	13.72	9.71	6.74	$\leq$ 10%	Outside Limits

3.7.3.4 Harmonic - THD compliance

Results are shown in Table 3.15 with the following notes:

- Harmonics shall be defined as sinusoidal voltage and currents having frequencies that are integral multiples of the fundamental frequency;

- The total harmonic distortion (THD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the fundamental quantity, expressed in percent;
- PHILIPPINE DISTRIBUTION CODE sets the THD of the voltage at any user system to not exceed five percent (5%) during normal operating conditions.

Table 3.15: Power quality -Harmonic THD compliance

THD compliance	Phase	Minimum	Average	Maximum	Limits (%)	Remarks
Main	AB	3.89	3.93	4.94		
	BC	3.58	3.6	4.68	$\leq$ 5%	Within Limits
	CA	3.89	3.93	4.94		
VFD-1	AB	4.54	4.58	4.79		
	BC	4.00	4.07	4.31	$\leq$ 5%	Within Limits
	CA	4.54	4.58	4.79		
Softstarter	AB	2.86	4.01	4.38		
	BC	2.68	3.62	3.86	$\leq$ 5%	Within Limits
	CA	2.86	4.01	4.38		

Note: Reading should be cause for alarm since the values are almost borderline. Kindly note that the dominant component are 3rd, 5th, and 7th order harmonics, respectively.

3.7.3.5 Harmonic - TDD compliance

Results are shown in Table 3.16 with the following notes:

- The Total Demand Distortion (TDD) shall be defined as the ratio of the RMS value of the harmonic content to the RMS value of the rated or maximum fundamental quantity, expressed in percent;
- PHILIPPINE DISTRIBUTION CODE sets the TDD of the current at any user of the system to not exceed five percent (5%) during normal operating conditions.

It is important to note that the values obtained for the THD (refer to previous sections) might declare the parameter values within the limits. However, the overall conclusion shall be derived together with the TDD compliance as the values of the TDD coming from the asset while the THD values coming normally from the sources.

Table 3.16: Power quality -Harmonic TDD compliance

TDD compliance	Phase	Minimum	Average	Maximum	Limits (%)	Remarks
Main	AB	18.23	15.66	62.39		
	BC	1.09	1.15	22.33	$\leq$ 5%	Outside limits
	CA	17.90	16.57	60.13		
VFD-1	AB	15.73	15.90	41.79		
	BC	2.88	3.47	6.79	$\leq$ 5%	Outside limits
	CA	16.58	16.89	25.48		
Soft starter	AB	9.25	13.67	44.67		
	BC	1.84	2.46	83.07	$\leq$ 5%	Outside limits
	CA	8.61	12.55	30.98		

In this situation, results of TDD are significant higher than the limit of 5%, indicating a certain degree of probability that there is an existing issue.

3.7.3.6 100% Power frequency (HZ) compliance

Results are shown in Table 3.17 with the following notes:

- A nominal fundamental frequency of 60HZ, PHILIPPINE DISTRIBUTION COCE set an acceptable limit of 59.7 HZ. for low frequency and 60.3 hz for high frequency.

Table 3.17: Power quality -Harmonic TDD compliance

Frequency	Minimum HZ	Average HZ	Maximum HZ	Limits HZ	Remarks
Main	59.476	60.14	60.423	59.7-60.3	Outside Limits
VFD-1	59.734	60.06	60.405	59.7-60.3	Outside Limits
Softstarter	59.721	60.06	60.328	59.7-60.3	Within Limits

3.7.3.7 Power factor

Results are shown in Table 3.18 with the following notes:

- The ideal situation is a cos phi or DPF equal or close to 1. Utilities may charge additional cost (penalty when var readings are high because they need to provide apparent power (VA, kVA) that does not include both var and W).

Table 3.18: Power quality -powerfactor

Power factor	Minimum	Average	Maximum	Limits	Remarks
Main	0.90	0.90	0.90	>0.85	Within Limits
VFD-1	0.53	0.53	0.58	>0.85	Outside limits
Softstarter	0.89	0.91	0.91	>0.85	Within Limits

3.7.3.8 Flicker

Results are shown in Table 3.19 with the following notes:

- A measuring period of 2 hours (Plt) is useful when there may be more than one interference source with irregular working cycles and for equipment such as welding machines. Plt $\leq$ 1.0 is the limit used in standards like EN15160;
- The 10 min (Pst) uses a longer measuring period to eliminate the influence of random voltage variations.

Table 3.19: Power quality -powerfactor

Flicker	Parameter	Minimum	Average	Maximum	Limits	Remarks
Main	Plt	0.431	0.405	0.534	<=0.80	Within Limits
	Pst	0.879	0.787	1.071	<=1.0	Outside Limits
VFD-1	Plt	0.284	0.293	0.371	<=0.80	Within Limits
	Pst	0.568	0.587	0.760	<=1.0	Within Limits
Soft starter	Plt	0.134	0.145	0.159	<=0.80	Within Limits
	Pst	0.545	0.532	0.700	<=1.0	Within Limits

3.7.4 Conclusion and Recommendations

- In general the most efficient way to troubleshoot electrical systems, is to begin at the load and work towards the building's service entrance. Measurements are taken along the way to isolate faulty components or loads;
- Monitoring up to a period of one week is recommended to perform a quality check That allows you to obtain a good impression of power quality;
- According to IEEE 519. "Most motor loads are relatively tolerant of harmonics". However, IEEE 519-1992 states further that, "Even in the case of the least susceptible equipment, harmonics can be harmful. Harmonics, can cause dielectric thermal or voltage stress, which causes premature aging of electrical insulation. A major effect of harmonic voltages and currents in rotating machinery (induction and synchronous) is increased heating due

Figure 3.18: Visual inspection on electrical safety

to iron and copper losses at the harmonic frequencies. The harmonic components thus affect the machine efficiency, and can also affect the torque developed";

- In the case of this station, the total demand distortion is outside the limits set in the Philippine Distribution Code. From the application perspective, we're most concerned with the maximum harmonic current levels, and the impact they have on the distribution system. This makes TDD a much more useful metric for power inverter distortion;
- the current unbalance occurred in the absence of voltage unbalance, hence it is recommended to look for the cause of current unbalance which could be faulty insulation or a phase shorted to ground. Correcting the current unbalance helps prevent overheating and deterioration of motor-winding insulation and other equipment. Thermal scanning of motor is recommended;
- The measured power factor is low for VFD-1. Consider addressing first the issues on harmonics before improving the power factor
- Crest Factor – A high crest factor value for current was recorded to signify a distorted current waveform. A CF of 1.8 or higher means high waveform distortion. This can be attributed on the current drawn by the variable frequency drive;

Main	VOLTAGE		CURRENT	
Phase	MIN	MAX	MIN	MAX
A	1.36	1.46	1.50	5.65
B	1.37	1.72	1.36	6.23
C	1.41	1.58	1.29	6.41

VFD-1	VOLTAGE		CURRENT	
phase	MIN	MAX	MIN	MAX
A	1.36	1.42	1.32	10.37
B	1.37	1.58	1.04	9.13
C	1.41	1.49	1.24	9.89

Soft	VOLTAGE		CURRENT	
starter	MIN	MAX	MIN	MAX
A	1.36	1.42	1.27	5.27
B	1.37	1.42	1.18	28.75
C	1.43	1.50	1.25	4.70

- When second measurements will be taken and current harmonics is still high, consider an active filter to properly address the 3rd, 5th and 7th harmonics. An active filter (cancellation of all harmonics) can be considered altogether.

3.8 Grounding system study

The study has been conducted in accordance with the ITP. Figure 3.18 shows the grounding points and activities conducted during the test.

Results of the study are shown in Table 3.20 with the following note:

- The resistance between the main grounding electrode and ground should be no greater than five ohms for large commercial or industrial systems and 1.0 ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference ANSI/IEEE Standard 142)

Table 3.20: Ground system measurement results

Locations	Asset/Room	Resistance	Findings	Recommendations	Effects	Risks
ECB OUTDOOR	TEST POINT 1 BARE COPPER WIRE	NO DATA	BCW WAS SUBMERGED IN WATER	REMOVE WATER AND ESTABLISH GROUNDING CONNECTION TO ATS	(1) Unwanted voltage maybe present on non-current carrying metal objects (2) Equipment might be damaged during a fault condition	(1) Incorrect Operation of overcurrent device with ground fault protection (2) Health and safety risks for facilities and personnel
ATS EQUIPMENT GROUND	TEST POINT 1 COPPER WIRE	0.62Ω	Within the 5 ohms limit as per NFPA and IEE standards	None	None	None
GENSET GROUND	TEST POINT 2 GROUND ROD	8.01Ω	(1) Already exceeds the 5 ohms limits as per NFPA and IEE standards	(1) Checking and retightening of loose grounding terminal connections (2) Replacement of improper lugs for grounding terminations	(1) Overheating on conductors and possible nuisance tripping of ground fault protection or relays	Damage to equipment or accessories
PANELBOARD 460V	TEST POINT 1 BARE COPPER WIRE	NO DATA	CONNECTED TO BCW SUBMERGED IN WATER.	REMOVE WATER AND ESTABLISH GROUNDING CONNECTION TO ATS	(1) Unwanted voltage maybe present on non-current carrying metal objects (2) Equipment might be damaged during a fault condition	(1) Incorrect Operation of overcurrent device with ground fault protection (2) Health and safety risks for facilities and personnel
PANELBOARD 400V	TEST POINT 1 BARE COPPER WIRE	NO DATA	CONNECTED TO BCW SUBMERGED IN WATER.	REMOVE WATER AND ESTABLISH GROUNDING CONNECTION TO ATS	(1) Unwanted voltage maybe present on non-current carrying metal objects (2) Equipment might be damaged during a fault condition	(1) Incorrect Operation of overcurrent device with ground fault protection (2) Health and safety risks for facilities and personnel
PANELBOARD 230V	TEST POINT 1 BARE COPPER WIRE	NO DATA	CONNECTED TO BCW SUBMERGED IN WATER.	REMOVE WATER AND ESTABLISH GROUNDING CONNECTION TO ATS	(1) Unwanted voltage maybe present on non-current carrying metal objects (2) Equipment might be damaged during a fault condition	(1) Incorrect Operation of overcurrent device with ground fault protection (2) Health and safety risks for facilities and personnel

3.9 Electrical system design and analysis

3.9.1 Basics

In accordance with Article 1.3 Electrical Plans and specifications of the Philippine Electrical Code 2017 Edition, Electrical design analysis shall be included and submitted separately together with the electrical plans. These includes the followings:

1. Branch circuits, sub-feeders, feeders, busways, and service entrance;
2. Types, ratings, and trip settings of overload protective device;
3. Calculation of voltage drops;
4. Calculation of short circuit current for determining the interrupting capacity of overcurrent protective device for residential, commercial and industrial establishment;
5. Protection coordination of overcurrent protective devices;
6. ARC-flash Hazard Analysis to determine the required personal protective equipment (PPE).

ARC flash Hazard Analysis is required and is intended for concerned parties to be informed and made aware of the importance of personal protective equipment (PPE) and its type for the flash hazard risk category determined by the analysis (refer to Table 3.21).

Table 3.21: ARC flash hazard risk categories and PPE ratings (Appendix H, PEC 2017)

Risk CAT.	Range of calculated incident energy [cal/cm^2]	Minimum Ppe Rating [Cal/Cm^2]	Clothing Required
0	0 < E ≤1.2	N/A	4.5-14.0 Oz/Yd2Untreated Cotton
1	1.2 < E ≤ 4	4	Flame Retardant (Fr) Shirt And Pants
2	4 < E ≤ 8	8	Cotton Underclothing Plus Fr Shirt And Pants
3	8 < E ≤ 25	25	Cotton Underclothing Plus Fr Shirt, Pants, Overalls Or Equivalent
4	25 < E ≤40	40	Cotton Underclothing Plus Fr Shirt, Pants, Plus Double Layer Switching Coat And Pants Or Equivalent
5	40 < E ≤ 100	100	Cotton Underclothing Plus Fr Shirt, Pants, Plus Multi-Layer Switching Suit Or Equivalent

3.9.2 Results

Results are briefly presented in the following subsections. Details reports generated by the software are enclosed as part of the Appendix of this report (can also be an electronic files)

3.9.2.1 Branch circuits, sub-feeders, feeders and service entrance

Figure 3.19 shows the SLD with values associated with each nodes and links.

3.9.2.2 Types, ratings, and trip settings of overload protective device

Types, ratings, and trip settings of overload protective devices are shown in Table 3.22

Table 3.22: Protective Device Settings - Low Voltage Circuit Breaker with Thermal-Magnetic Trip Device

LVCB ID	Manufacturer	Breaker		Thermal		Magnetic (Inst.)	
		Model	Size	Setting	Trip (Amps)	Setting	Trip (Amps)
CB3	Siemens	Sentron JFC	500	Fixed	500	Fixed	xIn
CB12	Siemens	Sentron JFC	400	Fixed	400	Fixed	xIn
CB11	Siemens	CQD	100	Fixed	100	Fixed	xIn
CB6	GE	QB	225	Fixed	225	Fixed	xIn
CB10	GE	QJ	150	Fixed	32	Fixed	xIn
CB5	GE	EDNC	200	Fixed	200	Fixed	xIn
CB7	Schneider	NS	225	Fixed	225	Fixed	xIn

3.9.2.3 Calculation of voltage drops

Basic for analysis is per PEC 2017 ARTICLE 2.15.1.2(A)(1)(b)FPN NO.2, which states "Conductors for feeders, as defined in Article1.1, sized to prevent a voltage drop exceeding three (3) percent at the farthest outlet of power, heating and lighting loads, or combinations of such loads,and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed five (5) percent , will provide reasonable efficiency.".

Results of voltage drop are summarized in Table 3.23

3.9.2.4 Calculation of short circuit current 3-PHASE

Table 3.24 show summaries of results on short circuit.

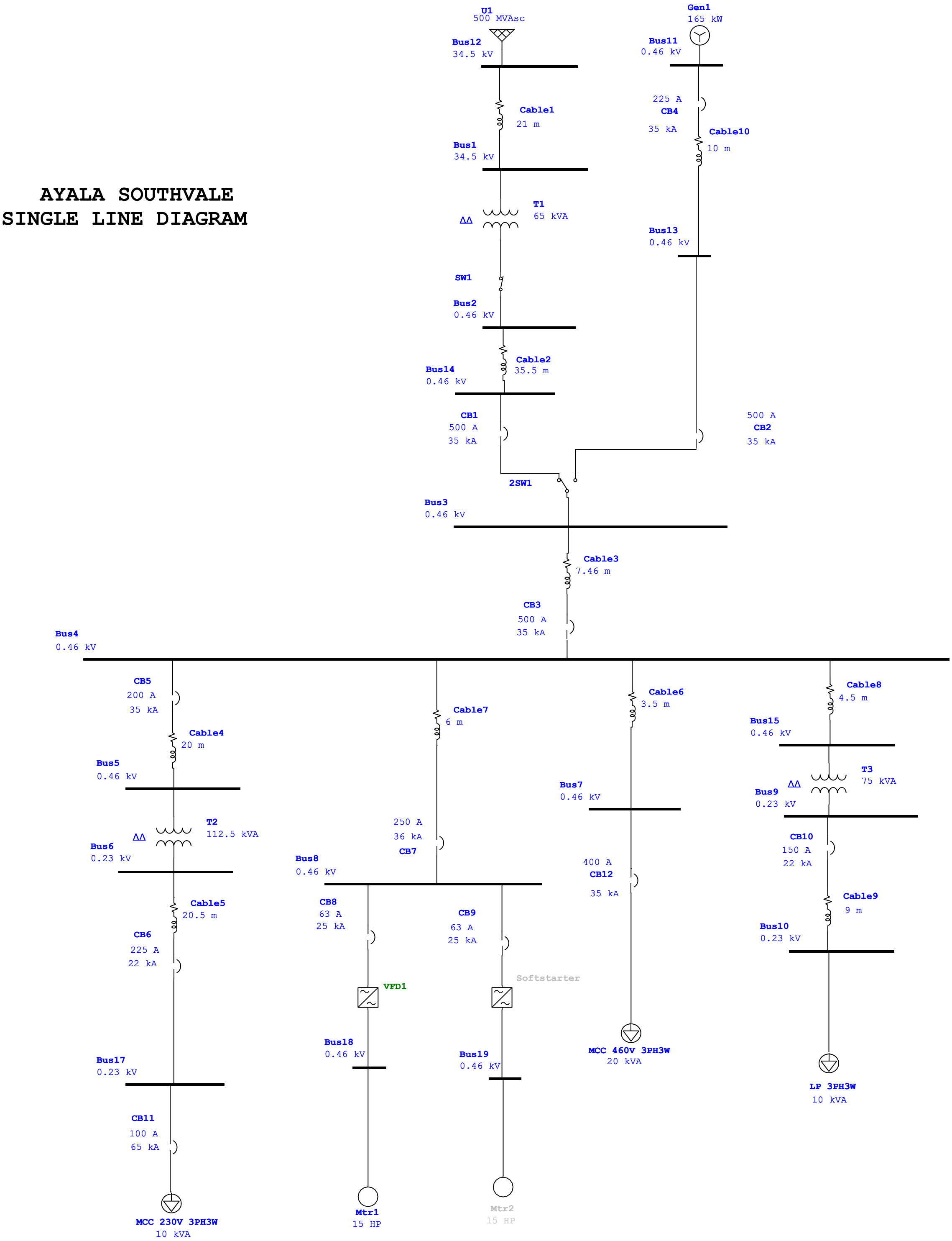


Figure 3.19: Single line diagram

Table 3.23: Voltage drop summary

Item	From	To	Wire Size, Mm^2	I	Length Meters	R Ω/305M	X Ω/ 305M	Vd	%Vd	Remarks
1	Pole Mounted Transformer 50kVA	Main Disconnect Switch	250	425	21	0.048	0.027	2.788	0.58	Within Limits
2	Main Disconnect Switch 400	ATS PANEL	250	425	35	0.048	0.027	4.647	0.97	Within Limits
3	ATS PANEL	MDP-P 460V	250	425	7.46	0.048	0.027	0.991	0.21	Within Limits
4	MDP-P 460V	MCC 1	250	425	3.56	0.048	0.027	0.273	0.06	Within Limits
5	MDP-P 460V	MCC 2	250	425	6	0.048	0.027	0.797	0.17	Within Limits
6	MDP-P 460V	ECB 200A	250	425	9	0.048	0.027	0.691	0.14	Within Limits
7	ECB 200A	DRY TYPE TRANSFORMER 112.5KVA	125	285.0	2	0.057	0.052	0.249	0.05	Within Limits
8	DRY TYPE TRANSFORMER 112.5KVA	MDP-S 230V	125	285	20.5	0.057	0.052	2.557	1.11	Within Limits
9	MDP-S 230V	MCC 230V	125	285	1	0.057	0.052	0.125	0.05	Within Limits
10	MDP-P 460V	DRY TYPE TRANSFORMER 75KVA	250	425	4.5	0.063	0.051	0.879	0.22	Within Limits
11	DRY TYPE TRANSFORMER 75KVA	LP PANEL	60	170	9	0.1	0.054	0.986	0.43	Within Limits

3.9.2.5 Protection coordination of overcurrent protective devices

Results of study on protection coordination are presented in subsection 3.5. With reference to the coordination plot shown in Figure 3.8, it is remarked that partial coordination only for the main and feeder breakers. TCC of feeders crosses the TCC of enclosed circuit breaker upstream of the feeders. Trip curve is covered by other protective functions or clipped by fault current.

3.9.2.6 Arc-flash Hazard Analysis

3.9.3 Recommendations

According to the results of the Arc Flash Analysis, Cotton underclothing plus FR shirt, pants, plus multi-layer switching suit or equivalent should be worn when opening the cover of the MCC. Arc flash Boundary (AFB) is about 8 feet (2.44 meters). Contributors to the arc flash are the motor loads and the VFD's.

An Arc flash label (refer to Figure 3.21) should be placed on the MCC as per requirement of the Philippine Electrical code.

3.10 Fire protection and safety (FDAS) audit

3.10.1 Fire alarm and detection system

3.10.1.1 Data and analysis

Summary of data and information from FDAS audit is presented in Table 3.26 with visual images on as-found devices and panels (Figure 3.22 and Figure 3.23, and Figure 3.24).

On the inspection date, it was established that there is Fire Alarm Control Panel P-2 TYPE 1 ZONE , National brand and the devices are SMOKE DETECTOR "NATIONAL" brand.

Table 3.24: Short circuit Summary

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

Bus		3-Phase Fault			Line-to-Ground Fault			Line-to-Line Fault			*Line-to-Line-to-Ground		
ID	kV	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.	Real	Imag.	Mag.
Bus1	34.500	0.701	-8.328	8.357	0.704	-8.321	8.350	7.212	0.607	7.237	-7.566	3.550	8.358
Bus2	0.460	0.488	-1.199	1.295	0.000	0.000	0.000	1.039	0.422	1.121	1.039	0.422	1.121
Bus3	0.460	0.481	-1.171	1.266	0.000	0.000	0.000	1.014	0.417	1.096	1.014	0.417	1.096
Bus4	0.460	0.482	-1.162	1.258	0.000	0.000	0.000	1.006	0.417	1.089	1.006	0.417	1.089
Bus5	0.460	0.485	-1.134	1.233	0.000	0.000	0.000	0.982	0.420	1.068	0.982	0.420	1.068
Bus6	0.230	0.690	-1.751	1.882	0.000	0.000	0.000	1.517	0.597	1.630	1.517	0.597	1.630
Bus7	0.460	0.482	-1.158	1.254	0.000	0.000	0.000	1.003	0.418	1.086	1.003	0.418	1.086
Bus8	0.460	0.486	-1.149	1.248	0.000	0.000	0.000	0.995	0.421	1.081	0.995	0.421	1.081
Bus9	0.230	0.755	-1.702	1.862	0.000	0.000	0.000	1.474	0.654	1.612	1.474	0.654	1.612
Bus10	0.230	0.773	-1.619	1.794	0.000	0.000	0.000	1.402	0.669	1.554	1.402	0.669	1.554
Bus12	34.500	0.696	-8.340	8.369	0.695	-8.340	8.369	7.223	0.602	7.248	6.875	4.772	8.369
Bus14	0.460	0.481	-1.171	1.266	0.000	0.000	0.000	1.014	0.417	1.096	1.014	0.417	1.096
Bus15	0.460	0.483	-1.155	1.252	0.000	0.000	0.000	1.000	0.418	1.084	1.000	0.418	1.084
Bus17	0.230	0.693	-1.640	1.781	0.000	0.000	0.000	1.421	0.600	1.542	1.421	0.600	1.542
Bus18	0.460	0.041	-0.060	0.073	0.042	-0.015	0.045	0.052	0.035	0.063	-0.066	-0.034	0.074
Bus19	0.460	0.085	0.000	0.085	0.085	0.000	0.085	0.000	0.073	0.073	-0.042	0.073	0.085

All fault currents are symmetrical (1/2 Cycle network) values in rms kA.
* LLG fault current is the larger of the two faulted line currents.

Table 3.25: Incident Energy Summary

Faulted Bus		Equipment Type	Gap (mm)	Fault Current			Trip Device			FCT (cycle)	Arc Flash Boundary (ft)	Incident Energy (cal/cm²)	Working Distance (inches)	Energy Level
				Bolted Fault (kA)		PD Arc Fault (kA)		Trip (cycle)	Open (cycle)					
ID	Nom. kV			Bus	PD		Source Trip Device ID							
# Bus1	34.500	Other		8.357						6.00	11.5	17.7	36	Level D
Bus2	0.460	Switchboard	32	1.295						6.00	0.7	0.3	24	Level A
Bus3	0.460	Other	13	1.266						480.00	8.0	34.3	18	Level E
Bus4	0.460	Switchgear	32	1.258						480.00	13.7	20.4	24	Level D
Bus5	0.460	Other	13	1.233	1.176	1.032	CB5	1.83	0.00	1.83	0.5	0.1	18	Level A
Bus6	0.230	Other	13	1.882						480.00	9.0	43.4	18	Level F
Bus7	0.460	Other	13	1.254						480.00	8.0	34.1	18	Level E
Bus8	0.460	Other	13	1.248						480.00	8.0	33.9	18	Level E
Bus9	0.230	Other	13	1.862						480.00	9.0	43.0	18	Level F
Bus10	0.230	Other	13	1.794	1.794	1.128	CB10	602.71	0.00	602.71	9.1	44.0	18	Level F
# Bus12	34.500	Other		8.369						6.00	11.5	17.7	36	Level D
Bus14	0.460	Cable Bus	13	1.266						6.00	0.9	0.4	18	Level A
Bus15	0.460	Other	13	1.252						480.00	8.0	34.0	18	Level E
Bus17	0.230	Other	13	1.781						480.00	8.8	41.5	18	Level F
# Bus18	0.460	Other		0.073						480.00	1.1	0.7	18	Level A

The theoretically derived Lee method was used to determine the incident energy and arc flash boundary for this location since the bolted fault current or nominal voltage are outside the empirical method range. ((Ibf" < 0.7 kA or Ibf" > 106 kA) and (0.208 ≤ Nominal kV ≤ 15 kV))

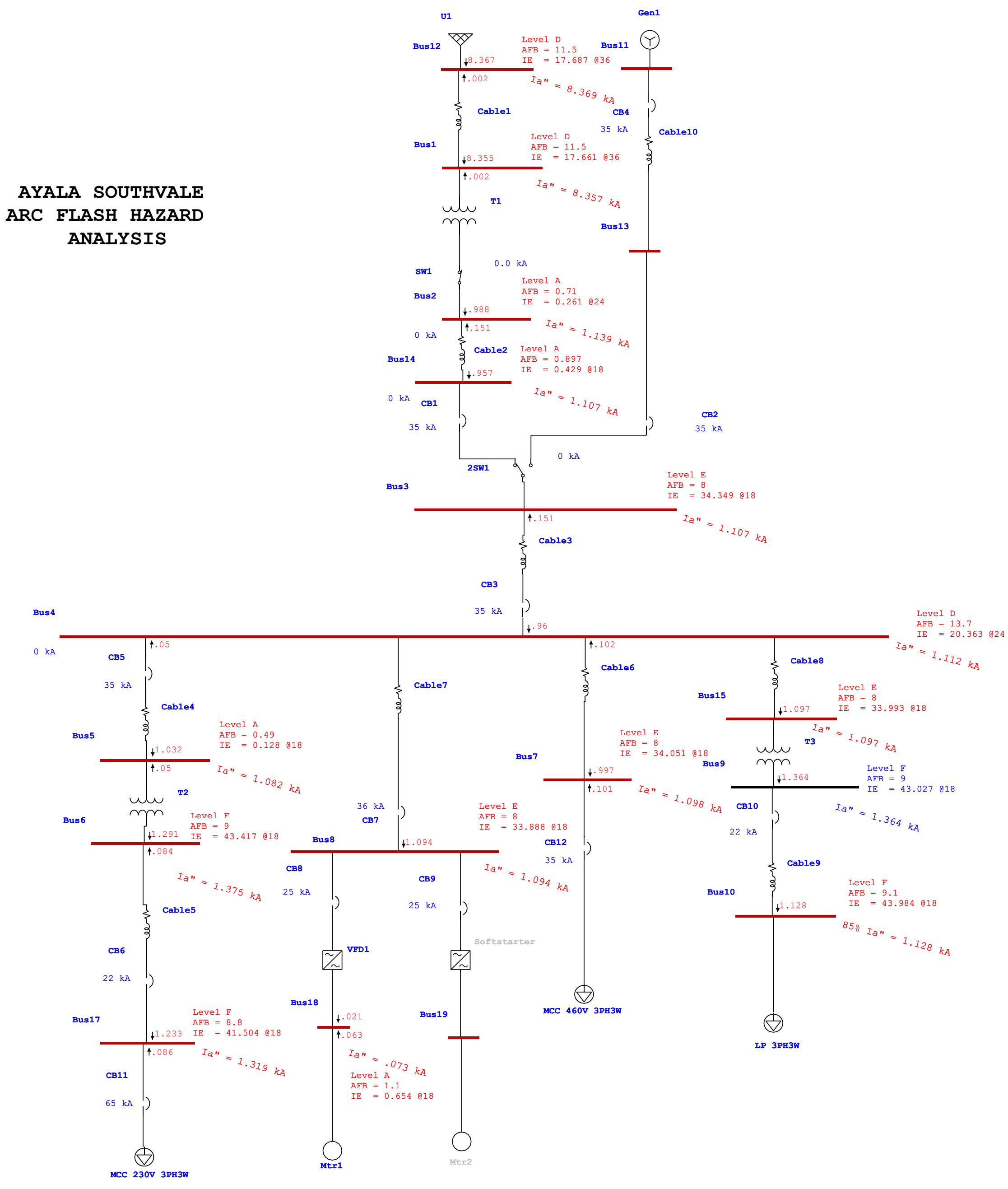


Figure 3.20: ARC flash analysis

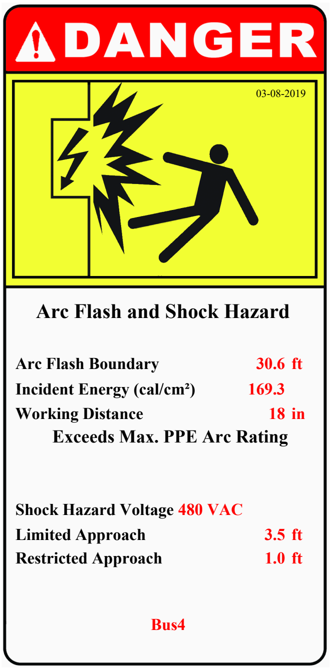


Figure 3.21: Cable waveform

Table 3.26: FDAS data highlights 01.

No.	Assets	Status	Remarks
A.	VISUAL CHECK OF FIRE ALARM CONTROL PANEL		
1	Panel Status, installed and location area	1	INSTALLED IN THE CONTROL ROOM
2	Power indicator lamp operational	0	NO POWER (NO LIGHT)
3	Devices properly indicated and marked	0	NO MARKINGS
4	Panel clear from trouble indicators	0	NO INDICATOR, NO POWER
5	Lamp test indicator operational	0	NO MARKINGS
6	Zones properly indicated and marked	0	NO MARKINGS
7	Check if it's connected to sprinkler system	0	NO SPRINKLER INSTALLED AT SITE
B.	CHECKING OF INSTALLED DEVICES		
1	Check floor plan lay-out and location of the device if accessible/easy to access	0	No As Built Plan
2	Heat detectors and / or smoke detectors indicator lamp functioning	1	LOCATION OKAY, ONE ROOM HAS NO SMOKE DETECTOR DEVICE
3	Heat detectors and / or smoke detectors indicator lamp functioning		FOR VERIFICATION ON TESTING
4	Pull station locations acceptable	1	ACCESSIBLE
5	Bells and buzzers operated correctly		FOR VERIFICATION
6	Bells and buzzers audibility	0	NO BELL INSTALLED
7	Strobe lights locations are acceptable	0	NO STROBE LIGHTS
8	Strobe light operated correctly	0	NO DEVICE
9	Are Fire alarm zones (areas) clearly marked	0	NOT MARKED
10	Is there a maintenance and service contract for the fire alarm system		FOR VERIFICATION
11	Does the Fire Alarm System smoke detector, heat detector, manual call point , horn and strobe light working and have a current inspection tag	0	NO INSPECTION TAG
12	Is the fire alarm system in full working order	0	NO INSPECTION TAG

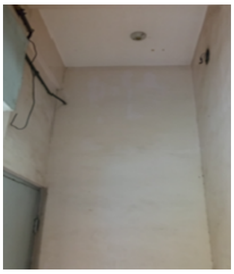
It is a conventional fire alarm system which is an early warning system design that detects a fire, that tells the zone/ area of the fire but not the exact location of the fire. The existing design plan did not consider where a specific fire alarm can signal exactly where the fire is occurring.

The existing Fire Detection and Alarm system consists of: 7 pcs of smoke detector, 1 pc manual push button, and 1 pc bell.

On the testing date, the activity was witnessed by the operator on duty for this pump station.

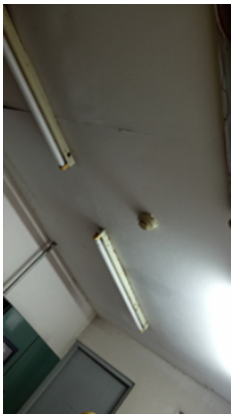
(a - Fire alarm control panel)

(b -Manual push button)



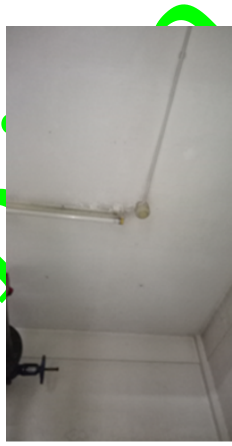
(c -Missing bell)

(d -SM01)



(e -SM02)

(f -SM03)



(h -SM05)

(i -SM06)

Figure 3.22: As-found devices and panels

(a - ASV booster) (b -Fire extinguisher 01) (c -Fire extinguisher 02)

Figure 3.23: Electrical safety

Findings are shown in Table 3.27 and Figure 3.24

In brief, FDAS of the station is not provide adequate level of services mainly due to:

- Most of the smoke detector devices, manual call point, buzzer and the FACP were not functioning. These were established during the conducted testing of FDAS and devices;
- Manual push button was not functioning when the button was pushed;
- Bell was missing from its original location;
- FACP is with input voltage but was not functioning when tested.

<u>Recommendations</u>

- The smoke detectors are not stand alone type and is dependent on the Fire Alarm control panel for proper operation;
- The FACP, though still have input voltage has no output voltage and is recommended for replacement together with all the devices. All devices in the system should be compatible to be able to operate. Replacement of FACP alone does not guarantee that the existing smoke detectors will operate;
- After replacement of battery, push test/ "hush" button. This will decrease the sensitivity for approximately 8 minutes. During this time, the RED LED will flush every 10 seconds. This will indicate that the device is functioning;
- Owing to the years, the wires and other auxiliaries have deteriorated and must be replaced by a new FDAS system.

<u>System Testing</u>

FDAS shall be subjected to the following tests conforming to the Philippine Electronics Code of 2014 and Philippine Electrical Code of 2017

✓ Testing of insulation resistance and continuity of wires;

✓ Verification of installed devices;

✓ Operation and response of FDAS;

✓ Testing the operation of initiating devices;

✓ Measuring sound pressure level generated by notification devices;

Figure 3.24: Visual inspection on FDAS and safety devices

Table 3.27: FDAS findings

ITEM	DESCRIPTION	YES	NO	Findings During Testing	Test Results
1.	Smoke Detector #1		X	-With dust inside and outside -Spray Smoke Detector Maximum 3 times	-No response on smoke tester -Repeat spray again but no response in the device -Repeat clean -After 3x spray no response on smoke tester
Analysis: After spraying of smoke tester, removal of the device from base to Reset contact point and cleaning did not show any improvement on the device. Hence device is declared not functioning and there is communication failure between device and FACP panel.					
2.	Smoke Detector#2		X	Same as Smoke detector#1	Same as Smoke detector#1
Analysis: Same as Smoke detector#1					
3.	Smoke Detector #3			Same as Smoke detector#1	Same as Smoke detector#1
Analysis: Same as Smoke detector#1					
4.	Smoke Detector #4		x	With dust outside -Difficulty in removing smoke detector head. -Spray Smoke Detector Maximum 3 times	Same as Smoke detector#1
Analysis: Same as Smoke detector#1					
4.	Smoke Detector #5 At pump Area		x	-Elevation too high. Scaffolding or manual lift not possible to inspect inside of SD	--No response on smoke tester
5.	Smoke Detector #6 At pump Area		X	Same as Smoke detector#4	Same as Smoke detector#4
6.	Smoke Detector #7 At pump Area		X	Same as Smoke detector#4	Same as Smoke detector#4
7.	Manual Push Button		x	-Push the button 3x -No audible response	- Repeat pushing the button
Analysis : Manual push button should have an audible alarm response after pushing the button. Hence this device is declared not functioning					
6.	Missing Bell		x	- Bell is missing. Only wiring is visible	-No test to be performed
7.	FACP			- with accumulated dust and dirt -with insect and rat "droppings" -No light indicator -No response on sounder, system reset, fire report and battery test when toggle pressed -evidence of rusty enclosure	Measured supply voltage. Value 205 volts Measured output voltage. Value: 0 volts
Analysis : FACP is not functioning					

Records

Every FDAS system shall keep the following documentations

- ✓ A complete set of operation and maintenance manuals of the manufacturer covering all equipment used in the system;

- ✓ A complete set of as-built drawings;
- ✓ A written sequence of operation;
- ✓ Record of completion and results of every inspection, testing and maintenance;
- ✓ Record of components within the database.

3.10.2 Lighting protection system

3.10.2.1 Data and analysis

No lightning protection was installed for this PS.

3.10.2.2 Recommendations

Refer to the conceptual design in Chapter 4

Short term Recommendations

Plan for the installation of a new lightning protection system

- ✓ the LPS conforms to the design and is based on the standard;
- ✓ all components of the LPS are in good condition and capable of performing their designed functions, and that there is no corrosion.

Long term Recommendations

Plan for the installation of a new lightning protection system

- ✓ According to the standard, an inspection should be undertaken during the construction of the structure, after the installation, after alterations or repairs, and when it is known that the structure has been struck by lightning;
- ✓ It is also recommended that inspections take place "periodically at such intervals as determined with regard to the nature of the structure to be protected", taking into account the local environment, such as corrosive soils and corrosive atmospheric conditions and the type of protection measures employed;
- ✓ The inspection comprises checking the technical documentation, visual inspections and test measurements;
- ✓ Prepare an inspection guide to facilitate the inspection process containing sufficient information on the installation and its components, tests methods and previous inspection/test data;
- ✓ During the visual inspection, the following should be checked;
  - the deterioration and corrosion of air-termination elements, conductors and connections
  - the corrosion of earth electrodes
  - the earthing resistance value for the earth-termination system
  - the condition of connections, equipotential bonding and fixings.
- ✓ For those parts of an earthing system and bonding network not visible for inspection, tests of electrical continuity should be performed;
- ✓ An inspection report should be prepared detailing the status of the system, any deviations from the technical documentation and the results of any measurements undertaken. Any obvious faults should also be reported.

No lightning protection system is 100% effective. A system designed in compliance with the standard does not guarantee immunity from damage. Lightning protection is an issue of statistical probabilities and risk management. A system designed in compliance with the standard should statistically reduce the risk to below a pre-determined threshold. The IEC 62305-2 risk management process provides a framework for this analysis. An effective lightning protection system needs to control a variety of risks. While the current of the lightning flash creates a number of electrical hazards, thermal and mechanical hazards also need to be addressed.

Risk to persons (and animals) include:

- Direct flash;
- Step potential ;
- Touch potential ;
- Side flash ;
- Secondary effects
  - asphyxiation from smoke or injury due to fire
  - structural dangers such as falling masonry from point of strike
  - unsafe conditions such as water ingress from roof penetrations causing electrical or other hazards, failure or malfunction of processes, equipment and safety systems

Risk to structures & internal equipment include:

- Fire and/or explosion triggered by heat of lightning flash, its attachment point or electrical arcing of lightning current within structures ;
- Fire and/or explosion triggered by ohmic heating of conductors or arcing due to melted conductors;
- Punctures of structure roofing due to plasma heat at lightning point of strike ;
- Failure of internal electrical and electronic systems ;
- Mechanical damage including dislodged materials at point of strike.

3.10.3 Ground-Fault circuit interrupter (GFCI) or electric leakage circuit breaker (ELCB) or Residual circuit devices (RCD)

3.10.3.1 Data and analysis

No ground fault circuit interrupter (GFCI) or earth leakage Circuit breaker (ELCB) protection was installed in the panel for FDAS for this PS.

3.10.3.2 Recommendations

Refer to the conceptual design in Chapter 4

3.10.4 Electrical safety and protective devices

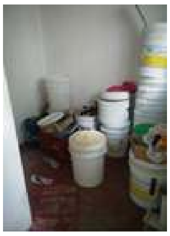
3.10.4.1 Data and analysis

Facts obtained from inspection are presented in Table 3.28 with indicative figures for each devices presented in Figure 3.24.

3.10.4.2 Recommendations

Based on the status of devices, recommendations are with intervention types shown in Table 3.28. Chapter 4 further illustrates the recommendation with the conceptual design.

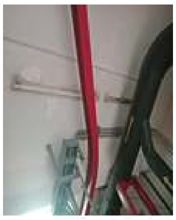

Materials near door


Accumulated Materials


Broken Glass 1


Broken Glass 2

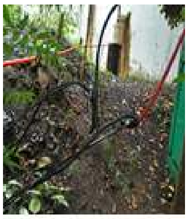

Lighting 1
Not functioning


Lighting 2
Not functioning


Genset Enclosure Rust


Genset Rust


Street Lamp
Wiring Hazard


Wiring to Genset
Wiring Hazard

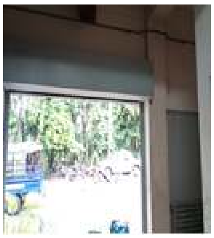

Wires tied to tree


Fire extinguisher misplaced


Exposed wiring to genset


Wood support for Lamp Post


FEX W/o tag

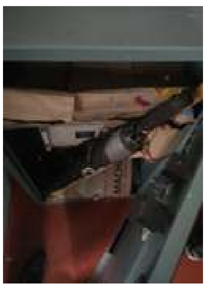

Exit Door w/o signage


Exit Door w/o signage


Missing fire extinguisher


Ceiling with termites


Open Ceiling above restroom


Umbrella inside Unused Enclosure


Tripping hazard


Tripping Hazard

Figure 3.25: Visual inspection on electrical safety

Table 3.28: Electrical Safety

ITEM	DESCRIPTION	STATUS	Findings During Inspection	Remarks
1	Materials near door	0	- Improper storage -Blocking of exit door -Risk to people	-Should be kept away from exit door in cases of emergency
2	Accumulated Materials	0	-Improper Storage - can cause spreading of fire	-Unsafe -Housekeeping necessary for fire not to accelerate
3	Broken Window Glass 1	0	- Glass not yet replaced	-Unsafe if unnoticed -May cause cut in hands if accidentally touched -Replace broken glass
4	Broken Window Glass 2	0	- Glass not yet replaced	--Unsafe if unnoticed -May cause cut in hands if accidentally touched -Replace broken glass
5	Lighting 1	0	- Fluorescent light not functioning when switched on - inadequate lighting	- Unsafe for person working around the workplace - Replace bulb or starter to function
6	Lighting 2	0	-Missing Fluorescent light installed in the lamp holder - inadequate lighting	- Unsafe -Workplace needs to be well lit - Replace bulb or starter to function
7	GENSET	0	-Genset enclosure already rusting -Moisture can get in -Grounding can be compromised	-Unsafe for person & equipment - Test grounding integrity to avoid electrocution - Replace enclosure for protection of Genset
8	Street lamp post	0	- Exposed wiring and rusted lamp post - Grounding can be compromised	- Unsafe in cases of accidental touching of metal -Electrocution when metal post is exposed to rain
9	Exposed Wiring going to genset	0	-Splices of wiring, unprotected	-Unsafe in cases of touching bare wires -Electrocution
10	Exposed wiring tied to tree	0	-Using of tree as support	Unsafe -Electrocution
11	Fire Extinguisher	0	- Misplaced fire extinguisher without inspection tag -	- Unsafe -Should be placed back to the proper FEX location
12	Exposed control wiring	0	- wires exposed - Risk to people	-Unsafe , can cause electrocution - Harness wiring
13	Lamp post	0	- Lamp post rusty and supported by wood - Lamp post is not balance and may fall	-Unsafe - Correct installation of lamp post and modify base
14	Fire Extinguisher	0	- Misplaced fire extinguisher - Without inspection tag	- Not effective if not working in cases of fire - Should be inspected yearly by Safety officers
15	Exit Door	0	-Door without exit signage - Exit signage should be provided	-Exit Doors should be properly labeled - Required per OHSAS
16	Fire Extinguisher	0	Missing fire extinguisher - Every confined space should have FEX	-FEX should be found in the designated location - Replace missing FEX

Chapter 4

Conceptual Design and Reliability Study

4.1 Basis of Design

4.1.1 As-built drawings

A collection of as-built drawings are given in electronic files saved both in PDF and CAD formats.

4.1.2 Electrical design

As set of conceptual drawings is given in Appendix

4.2 Bill of Materials

Based on the recommendations and conceptual design, a high level Bill of Quantity (BOQ) can be generated . The BOQ table includes the condition states and intervention types respectively.

Appendix A

Load Flow Analysis

Project:	MAYNILAD- AYALA SOUTHVALE	ETAP	Page:	1
Location:	Ayala Southvale, Metro Manila	16.2.0C	Date:	03-15-2019
Contract:			SN:	APSI-PH001
Engineer:		Study Case: LF	Revision:	Base
Filename:	SOUTHVALE		Config.:	Normal

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus18	0.460										0.015	87.5	18.5	
Bus19	0.460													
Bus1	34.500										0.053	89.5	0.9	
Bus2	0.460										0.051	91.2	66.4	
Bus3	0.460										0.051	91.3	66.4	
Bus4	0.460										0.051	91.3	66.4	
Bus5	0.460										0.010	84.9	13.2	
Bus6	0.230										0.010	85.0	26.4	
Bus7	0.460		0.017	0.011							0.020	85.0	26.3	
Bus8	0.460		0.013								0.013	100.0	17.0	
Bus9	0.230										0.009	85.0	23.9	
Bus10	0.230				0.008	0.005					0.009	85.0	23.9	
Bus12	34.500										0.053	89.5	0.9	
Bus14	0.460										0.051	91.3	66.4	
Bus15	0.460										0.009	84.9	11.9	
Bus17	0.230		0.008	0.005							0.010	85.0	26.4	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).
# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
					Capability	Loading (input)		Loading (output)	
ID	Type	Ampacity (Amp)	Loading Amp	%	(MVA)	MVA	%	MVA	%
Cable1	Cable	302.68	0.89	0.29					
Cable2	Cable	302.68	66.45	21.95					
Cable3	Cable	138.93	66.44	47.83					
Cable4	Cable	138.93	13.20	9.50					
Cable5	Cable	166.19	26.40	15.89					
Cable6	Cable	138.93	26.29	18.93					
Cable7	Cable	91.38	16.96	[illegible]					
Cable8	Cable	138.93	11.94	8.59					
Cable9	Cable	91.38	[illegible]	[illegible]					
T1	Transformer				0.065	0.053	81.4	0.051	77.9
T2	Transformer				0.113	0.010	8.9	0.010	8.9
T3	Transformer				0.075	0.009	12.1	0.009	12.1

* Indicates a branch with operating load exceeding the branch capability.

Project:	MAYNILAD- AYALA SOUTHVALE	**ETAP**	Page: 3
Location:	Ayala Southvale, Metro Manila	16.2.0C	Date: 03-15-2019
Contract:			SN: APSI-PH001
Engineer:		Study Case: LF	Revision: Base
Filename:	SOUTHVALE		Config.: Normal

Branch Losses Summary Report

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
Cable1	-0.047	-0.024	0.047	0.024	0.0	0.0	100.0	100.0	0.00
T1	0.047	0.024	-0.046	-0.021	1.2	2.9	100.0	95.7	4.35
Cable2	0.046	0.021	-0.046	-0.021	0.0	0.1	95.7	95.5	0.13
Cable3	0.046	0.021	-0.046	-0.021	0.0	0.0	95.5	95.5	0.05
Cable4	0.009	0.005	-0.009	-0.005	0.0	0.0	95.5	95.4	0.03
Cable6	0.017	0.011	-0.017	-0.011	0.0	0.0	95.5	95.5	0.01
Cable7	0.013	0.000	-0.013	0.000	0.0	0.0	95.5	95.5	0.01
Cable8	0.008	0.005	-0.008	-0.005	0.0	0.0	95.5	95.5	0.01
T2	0.009	0.005	-0.009	-0.005	0.0	0.0	95.4	95.2	0.28
Cable5	0.009	0.005	-0.008	-0.005	0.0	0.0	95.2	95.1	0.10
Cable9	0.008	0.005	-0.008	-0.005	0.0	0.0	95.2	95.1	0.06
T3	-0.008	-0.005	0.008	0.005	0.0	0.0	95.2	95.5	0.28
					1.3	3.1			

Alert Summary Report

	% Alert Settings	
	Critical	**Marginal**
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Inverter/Charger	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	95.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
VFD1	VFD	Overload	14.039	Amp	16.963	120.8	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus10	Bus	Under Voltage	0.230	kV	0.219	95.1	3-Phase
Bus14	Bus	Under Voltage	0.460	kV	0.44	95.5	3-Phase
Bus15	Bus	Under Voltage	0.460	kV	0.44	95.5	3-Phase
Bus17	Bus	Under Voltage	0.230	kV	0.22	95.1	3-Phase
Bus2	Bus	Under Voltage	0.460	kV	0.44	95.7	3-Phase
Bus3	Bus	Under Voltage	0.460	kV	0.44	95.5	3-Phase
Bus4	Bus	Under Voltage	0.460	kV	0.44	95.5	3-Phase
Bus5	Bus	Under Voltage	0.460	kV	0.44	95.4	3-Phase
Bus6	Bus	Under Voltage	0.230	kV	0.22	95.2	3-Phase
Bus7	Bus	Under Voltage	0.460	kV	0.44	95.5	3-Phase
Bus8	Bus	Under Voltage	0.460	kV	0.44	95.5	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus9	Bus	Under Voltage	0.230	kV	0.219	95.2	3-Phase

Project:	MAYNILAD- AYALA SOUTHVALE	**ETAP**		Page:	6
Location:	Ayala Southvale, Metro Manila	16.2.0C		Date:	03-15-2019
Contract:				SN:	APSI-PH001
Engineer:		Study Case:	LF	Revision:	Base
Filename:	SOUTHVALE			Config.:	Normal

SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	0.047	0.024	0.0[illegible]	89.48 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	0.047	0.024	0.053	89.48 Lagging
Total Motor Load:	0.038	0.023	0.045	85.85 Lagging
Total Static Load:	0.008	0.005	0.009	85.00 Lagging
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.001	-0.004		
System Mismatch:	0.000	0.000		

Number of Iterations: 2

Appendix B

Power Quality Study

Instrument Information

Model Number	435-II
Serial Number	34843110
Firmware Revision	V05.04

Software Information

Power Log Version	5.4
FLUKE 430-II DLL Version	1.2.0.13

General Information

Recording location	MAIN ATS 200AMPS
Client	AYALA SOUTHVALE
Notes	

Measurement Summary

Measurement topology	3-element delta mode
Application mode	Logger
First recording	12/1/2018 10:56:58 PM 280msec
Last recording	12/3/2018 10:56:58 AM 280msec
Recording interval	0h 10m 0s 0msec
Nominal Voltage	460 V
Nominal Current	200 A
Nominal Frequency	60 Hz
File start time	12/1/2018 10:46:58 PM 280msec
File end time	12/3/2018 10:56:58 AM 280msec
Duration	1d 12h 10m 0s 0msec
Number of events	Normal: 4 Detailed: 0
Events downloaded	No
Number of screens	1
Screens downloaded	Yes
Power measurement method	Unified
Cable type	Copper
Harmonic scale	%H1
THD mode	THD 40
CosPhi / DPF mode	DPF

Scaling

Phase:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	200 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1
Neutral:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	200 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1

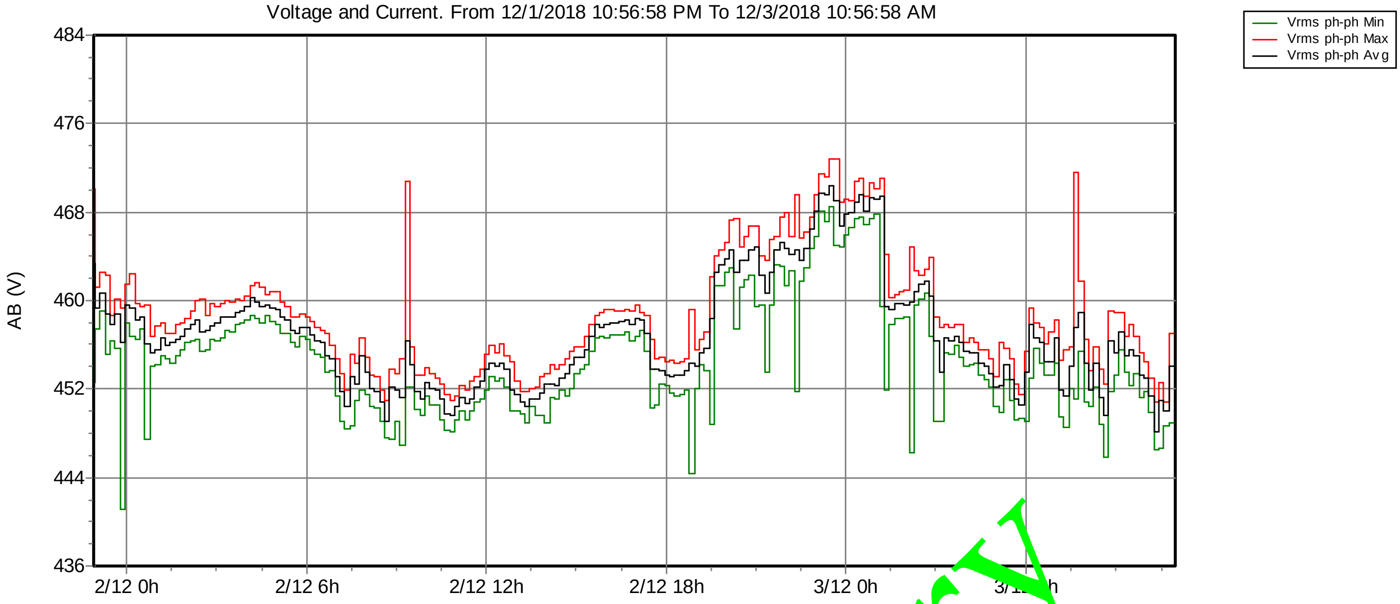
Recording Summary

RMS recordings	217
DC recordings	0
Frequency recordings	217
Unbalance recordings	217
Harmonic recordings	217
Power harmonic recordings	217
Power recordings	217
Power unbalance recordings	0
Energy recordings	217
Energy losses recordings	0
Flicker recordings	217
Mains signaling recordings	217

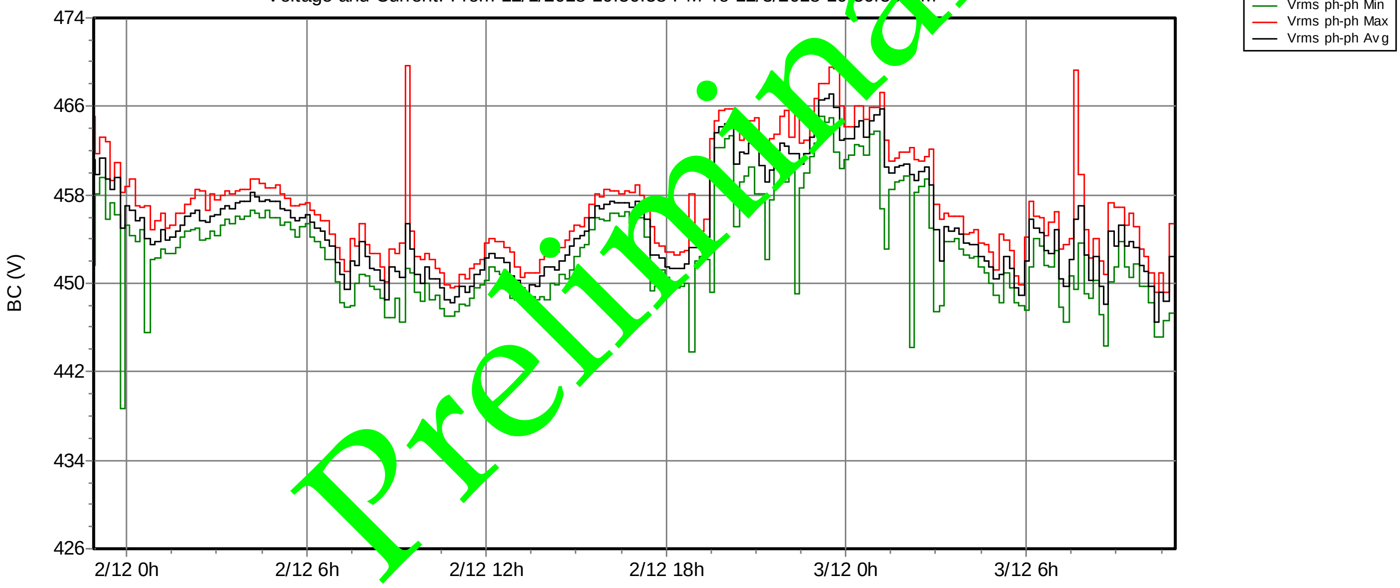
Events Summary

Dips	0
Swells	0
Transients	0
Interruptions	0
Voltage profiles	0
Rapid voltage changes	0
Screens	1
Waveforms	0
Intervals without measurements	0
Inrush current graphics	0
Wave events	0
RMS events	0

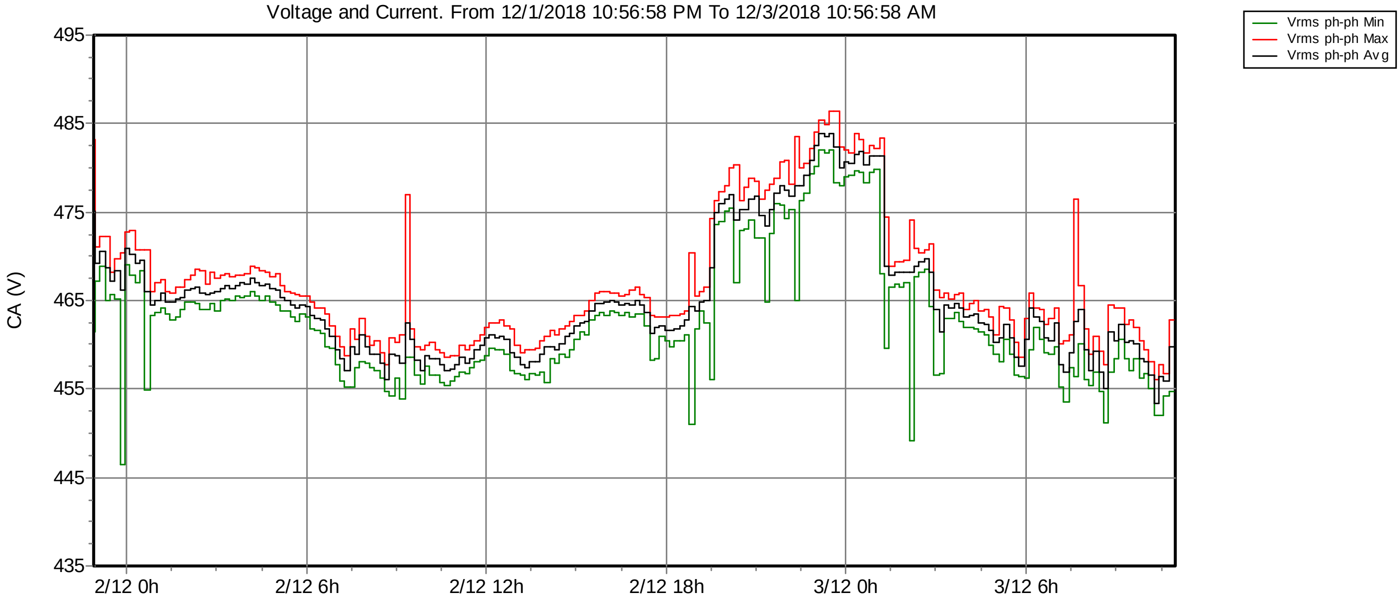
Voltage and Current. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM



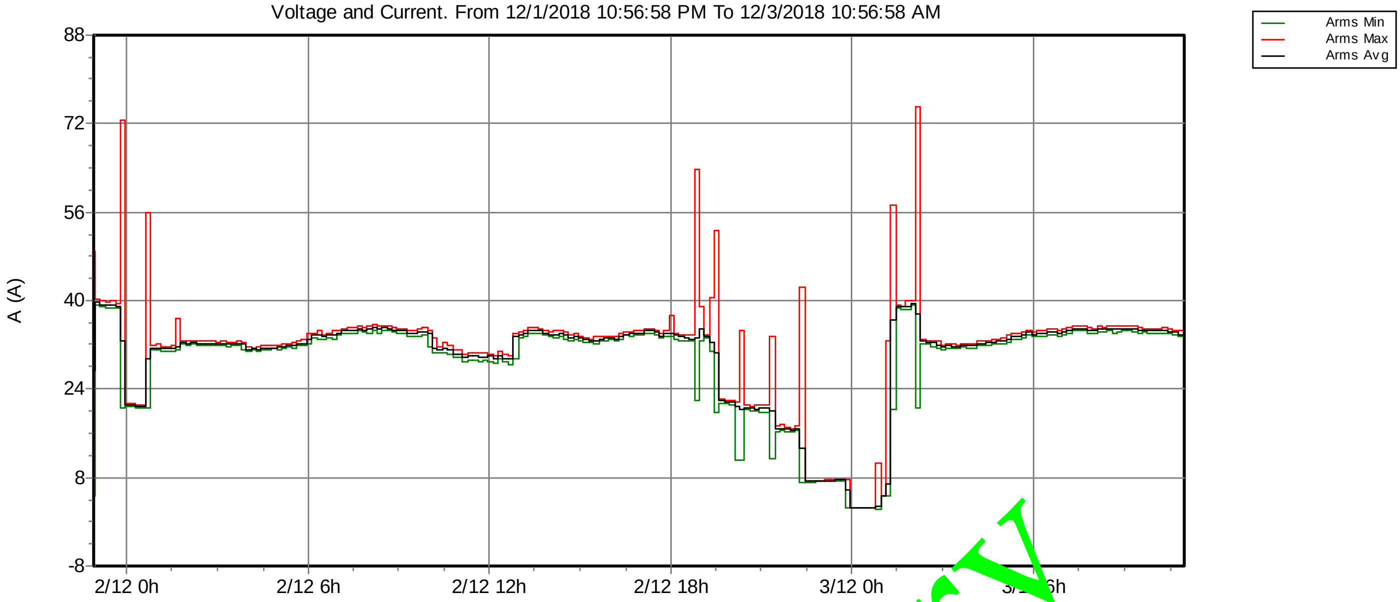
Voltage and Current. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM



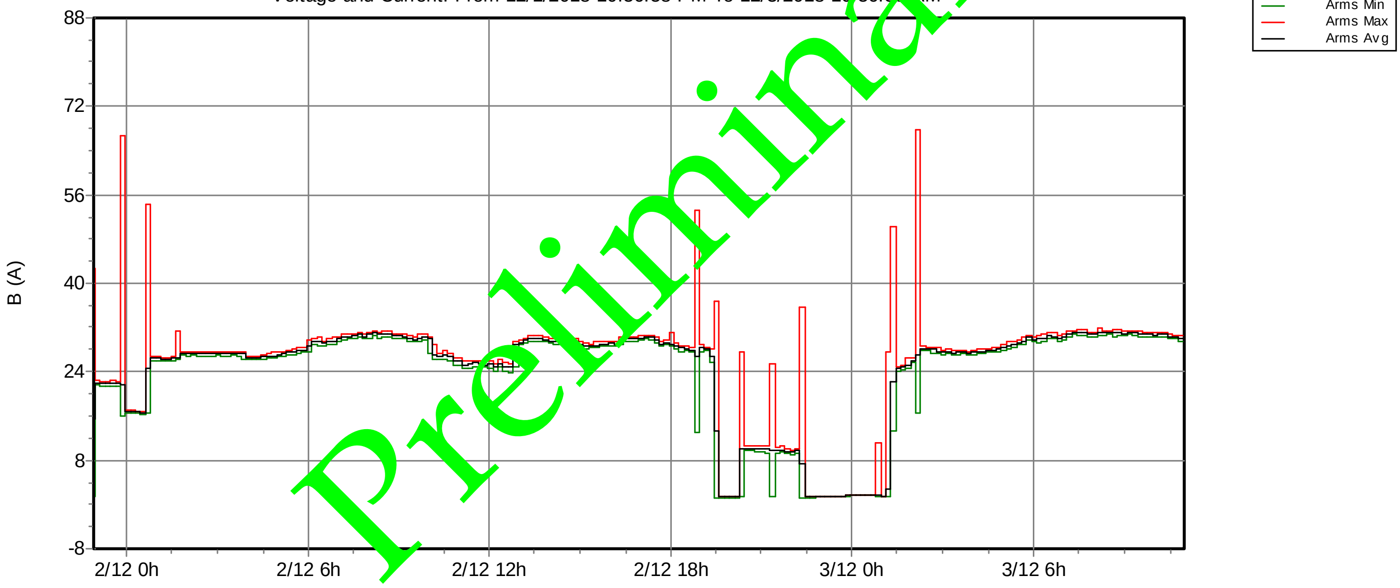
Voltage and Current. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM



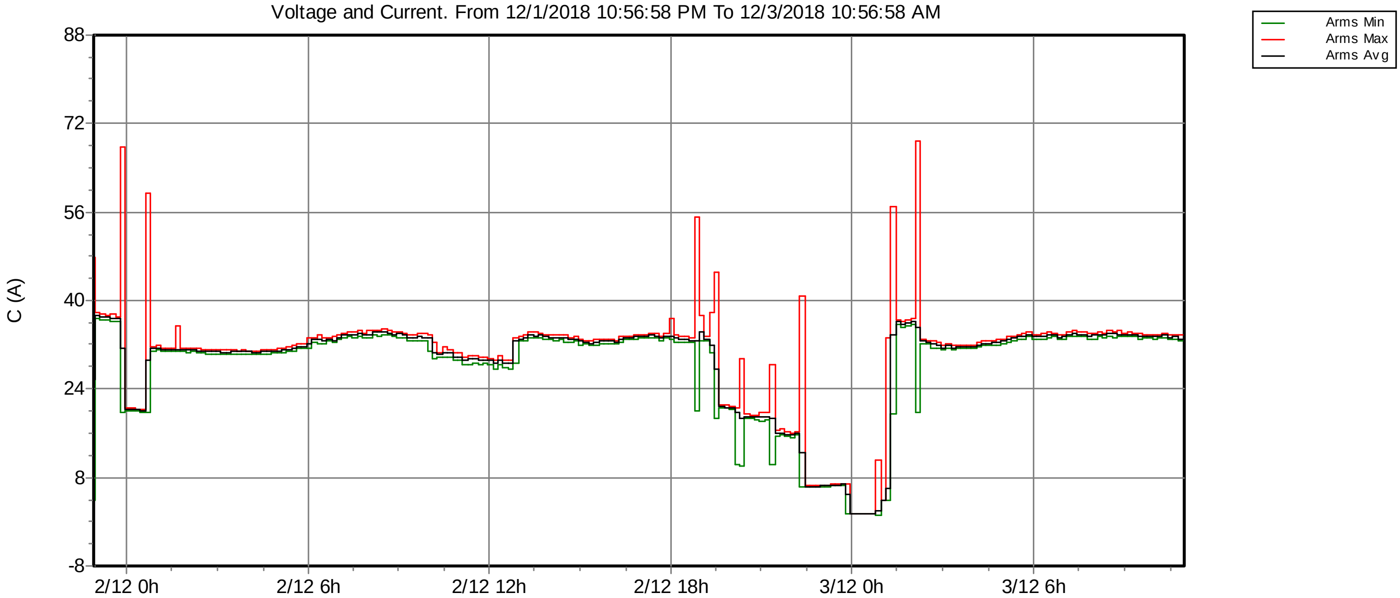
Voltage and Current. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM

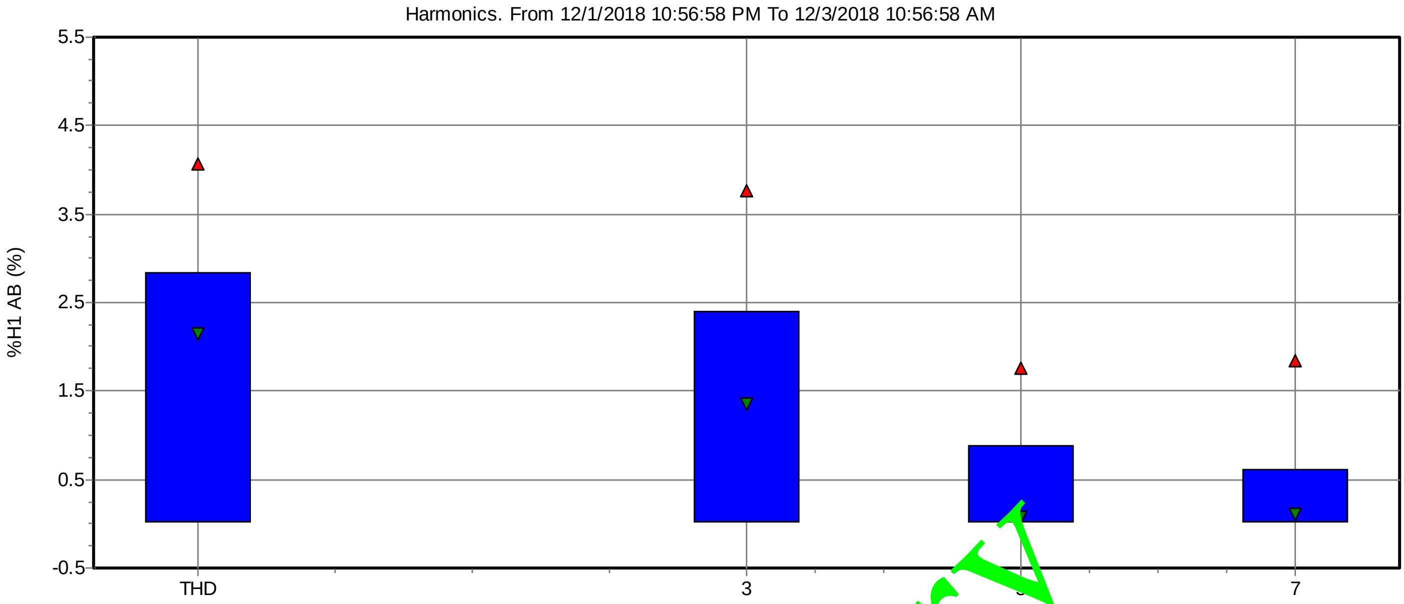


Voltage and Current. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM

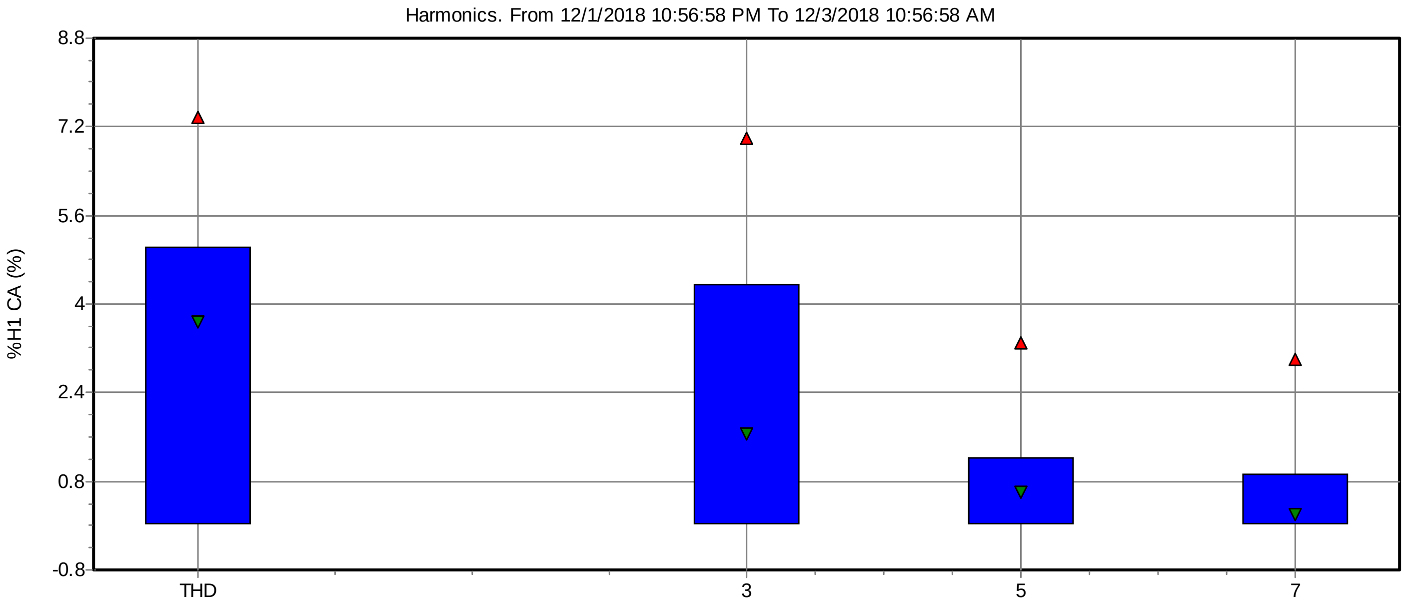


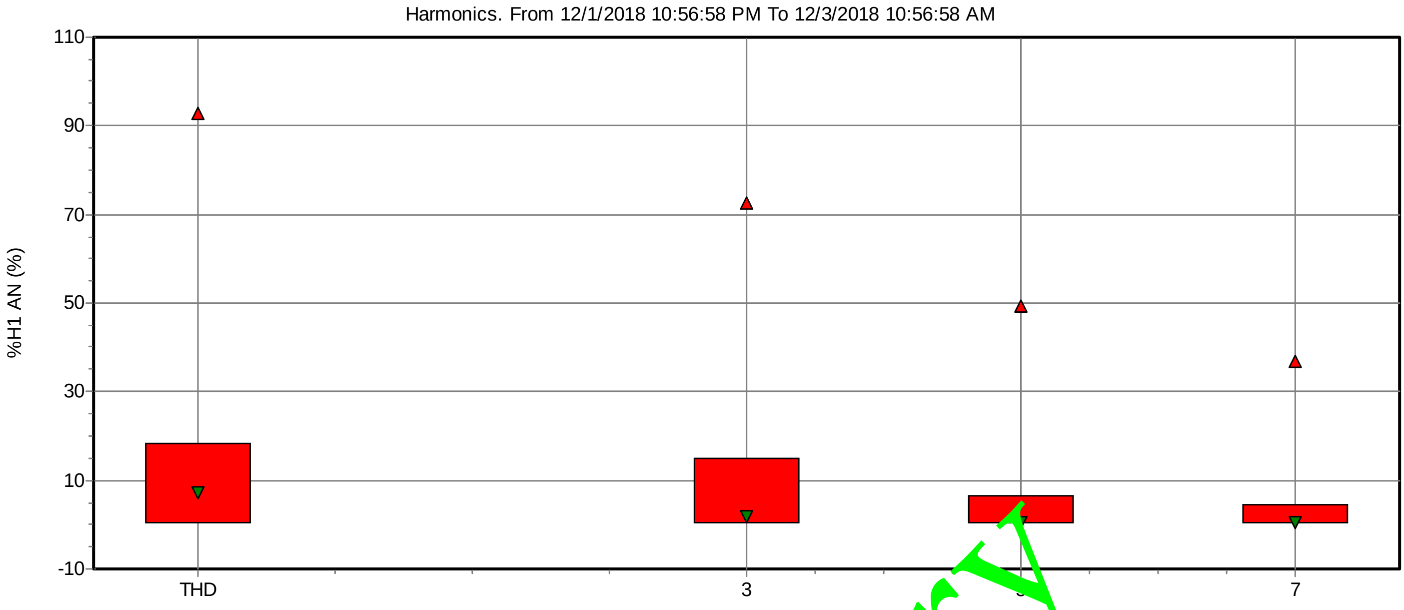
Voltage and Current. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM

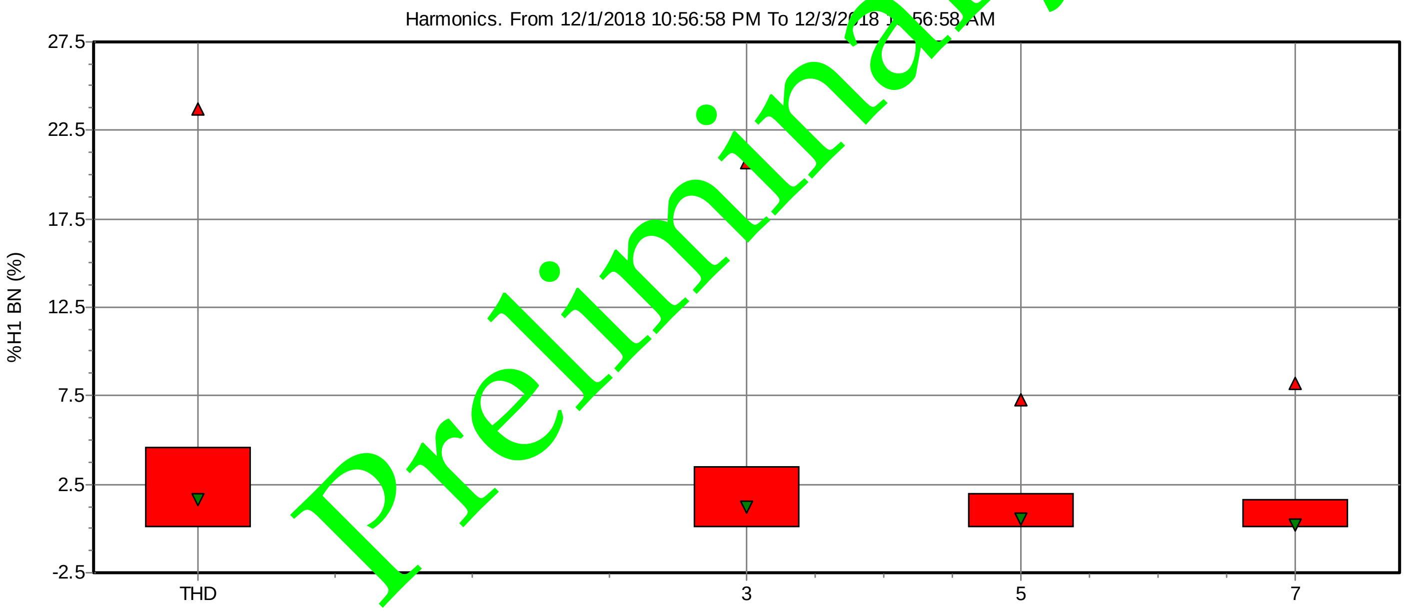


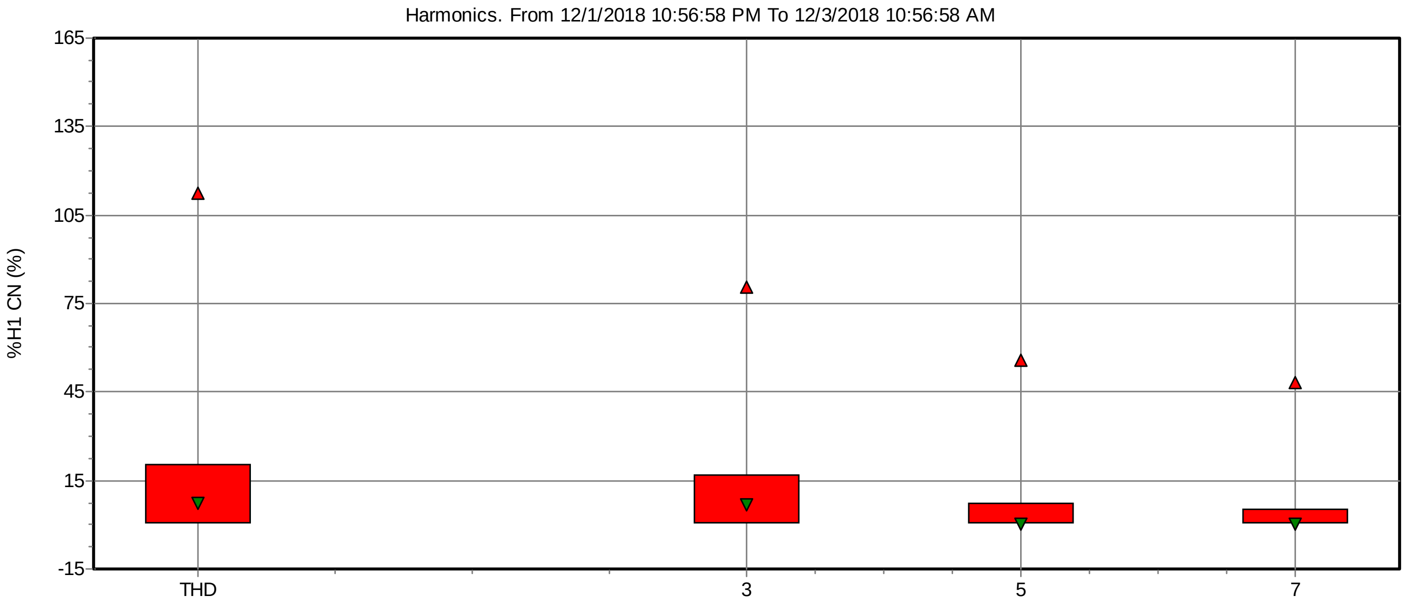

Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 AB (%)
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
THD
3
5
7


Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 BC (%)
4.4
3.6
2.8
2
1.2
0.4
-0.4
THD
3
5
7

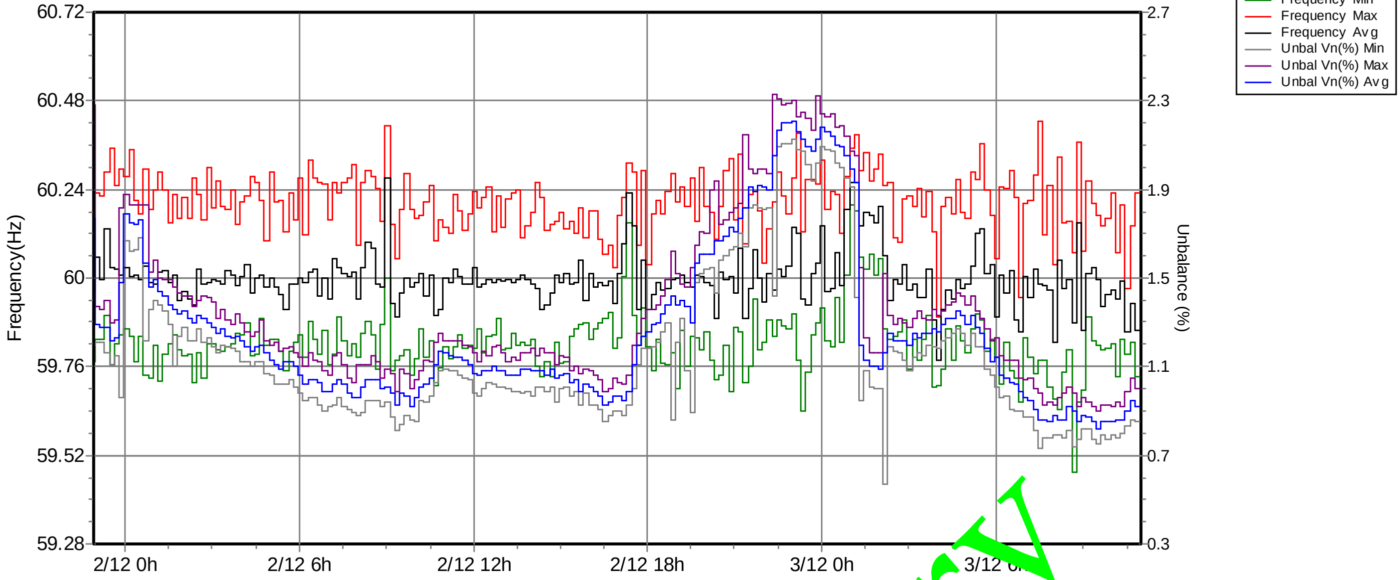

Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 CA (%)
8.8
7.2
5.6
4
2.4
0.8
-0.8
THD
3
5
7


Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 AN (%)
110
90
70
50
30
10
-10
THD
3
5
7

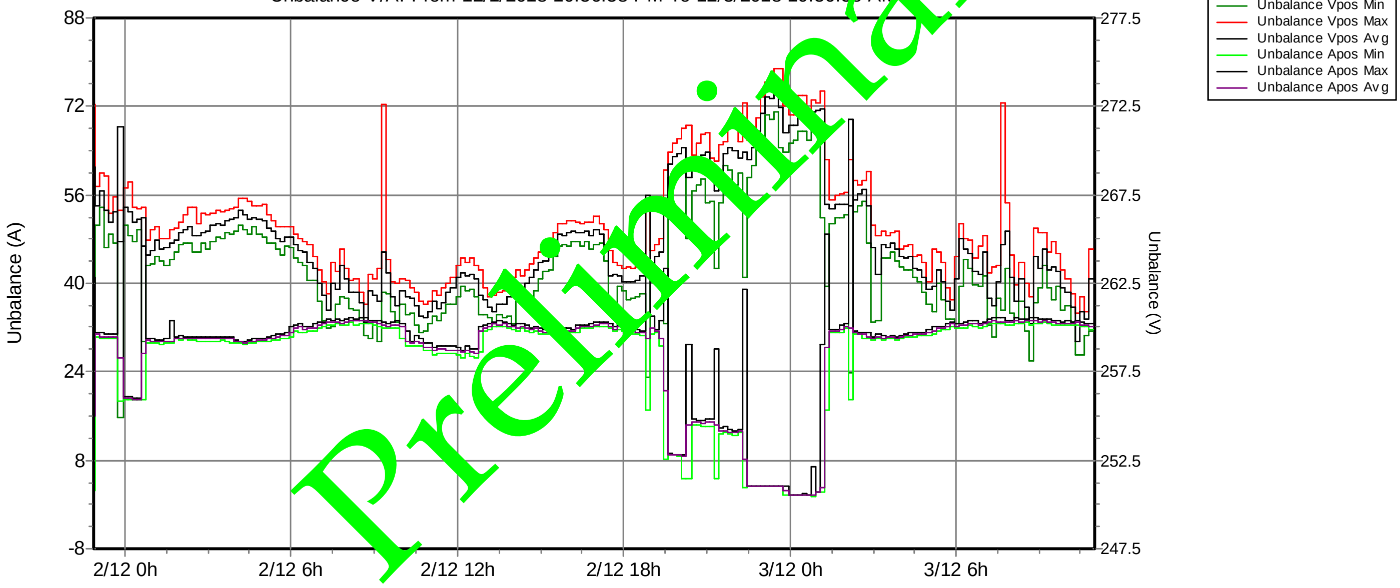

Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 BN (%)
27.5
22.5
17.5
12.5
7.5
2.5
-2.5
THD
3
5
7


Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 CN (%)
165
135
105
75
45
15
-15
THD
3
5
7

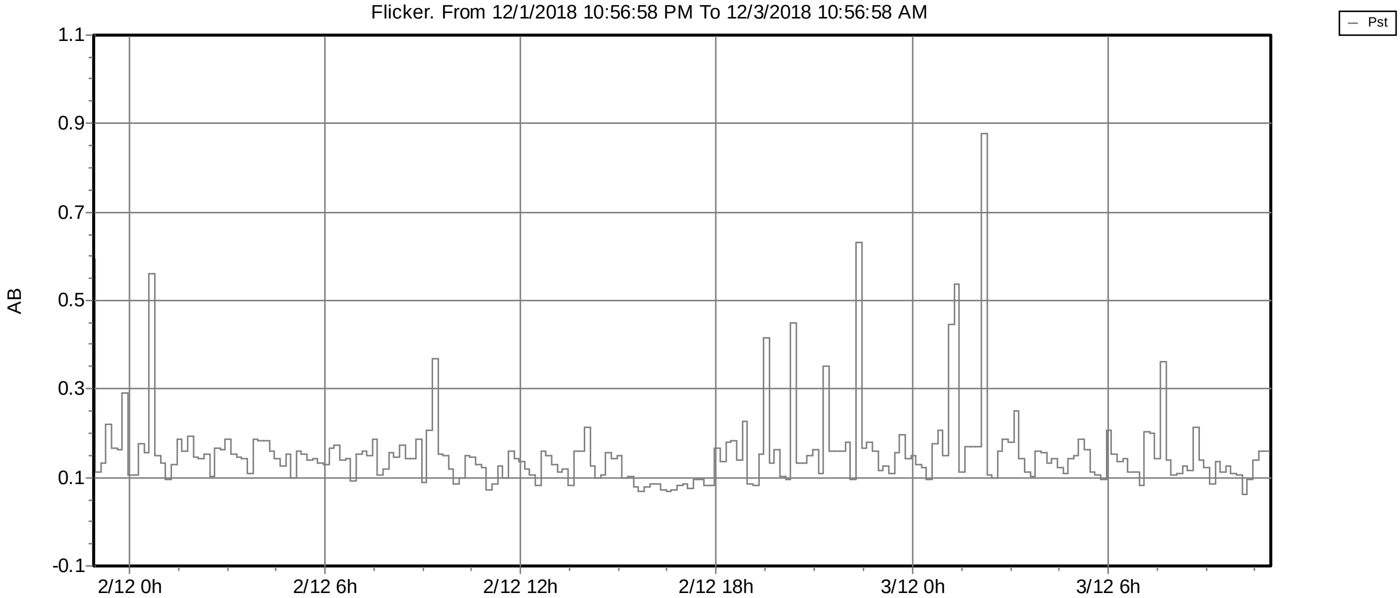
Frequency / Unbalance%. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM

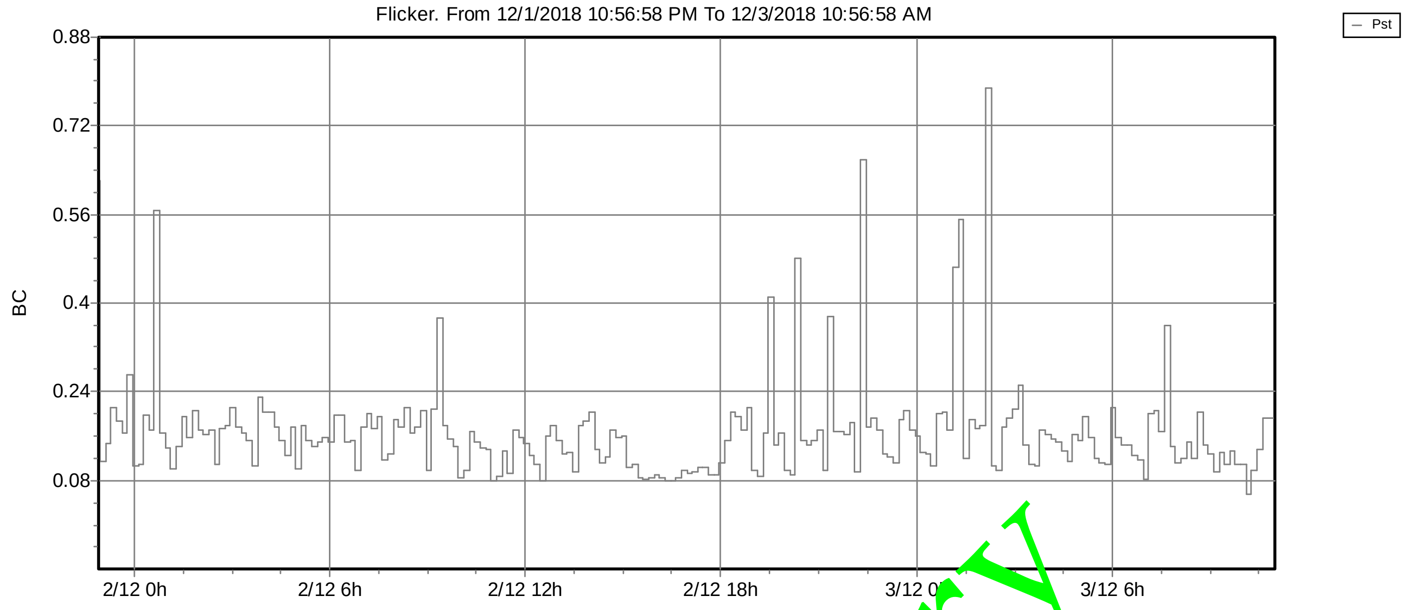


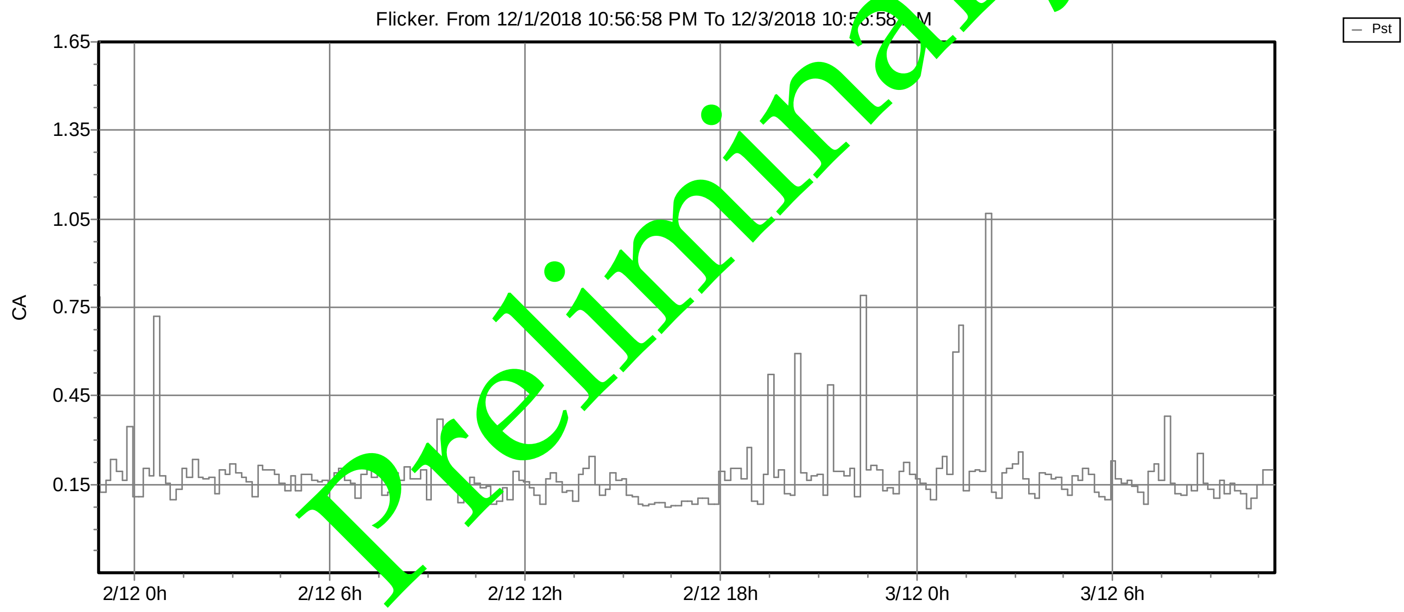
Unbalance V/A. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM

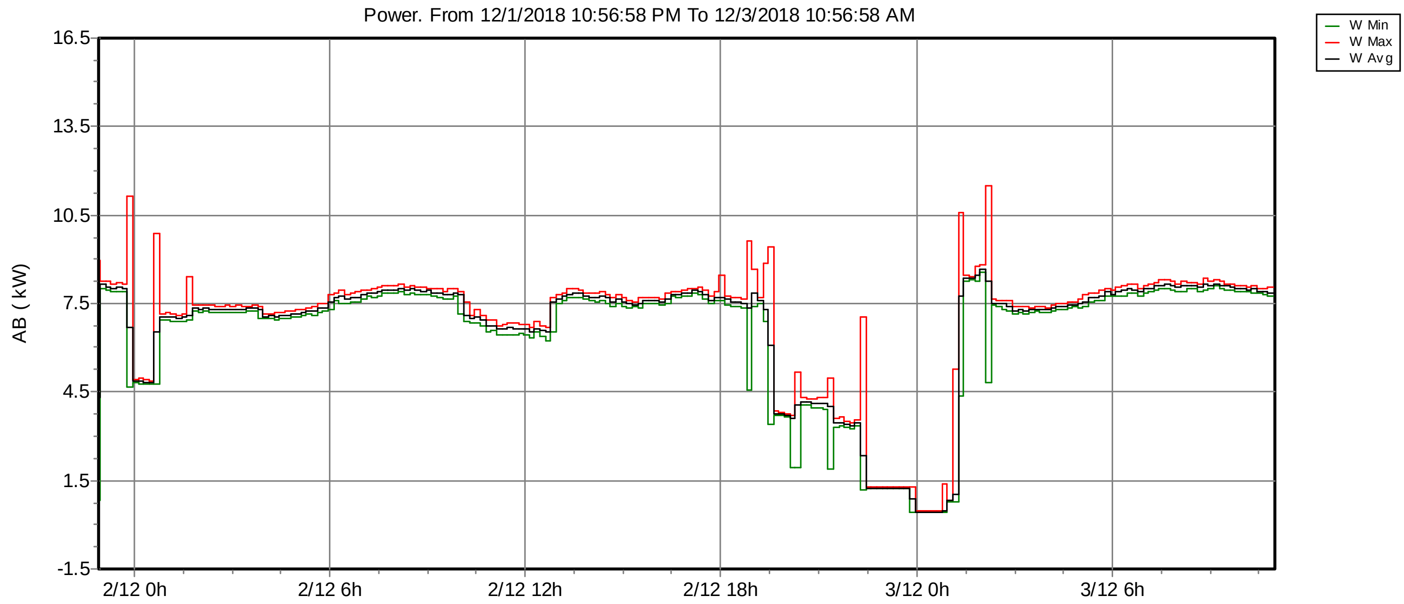


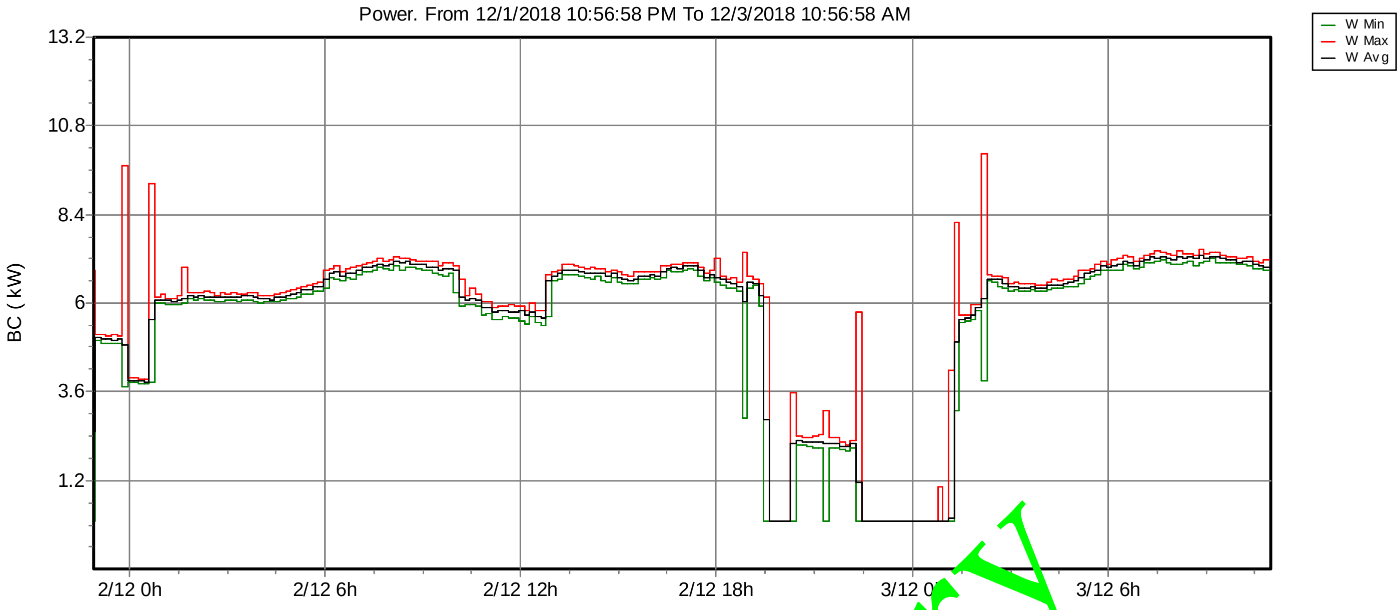
Flicker. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM

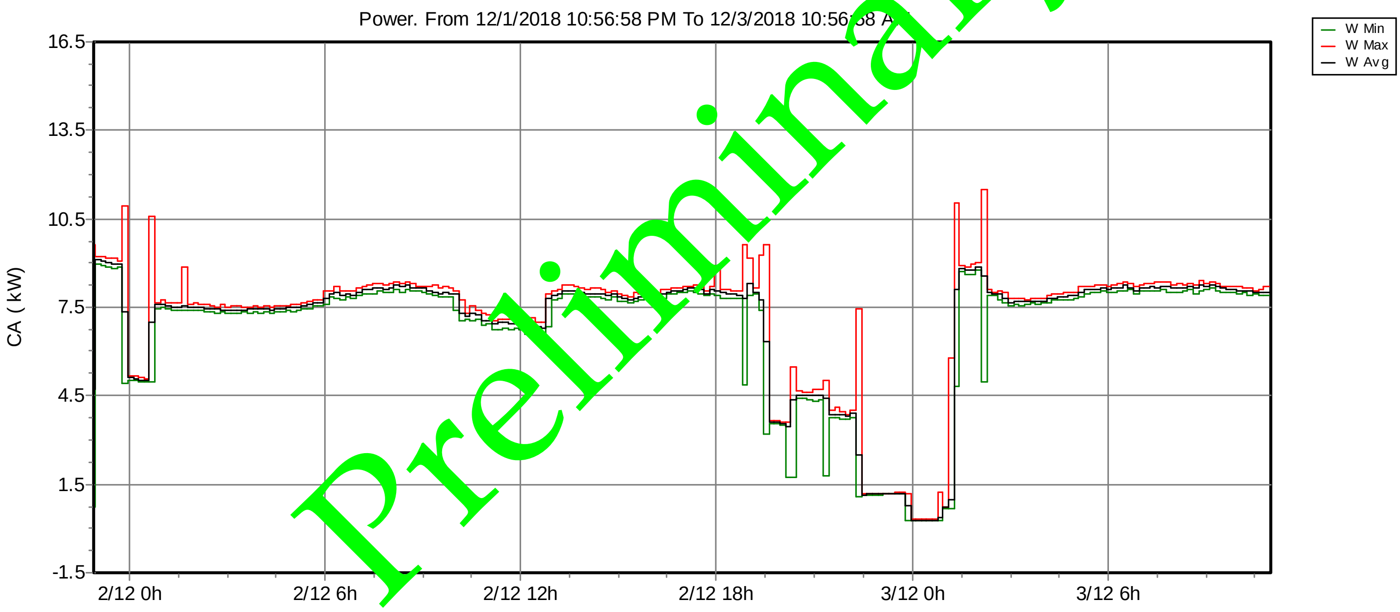


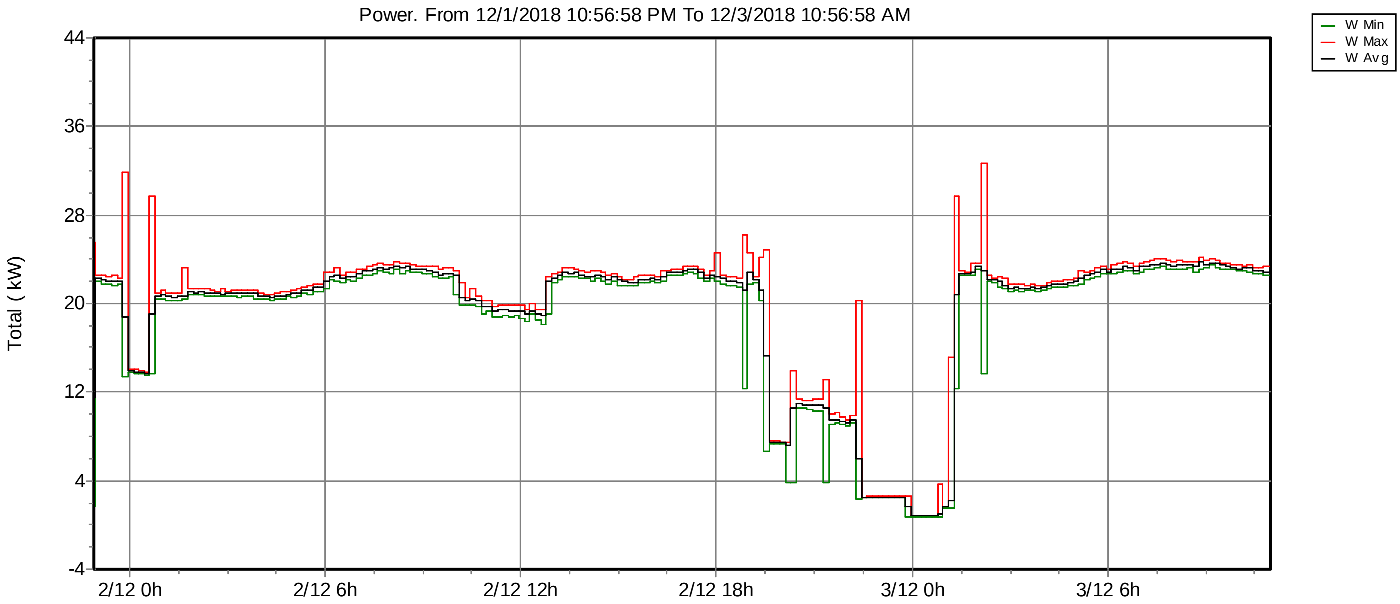

Flicker. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
Pst
BC
0.88
0.72
0.56
0.4
0.24
0.08
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h

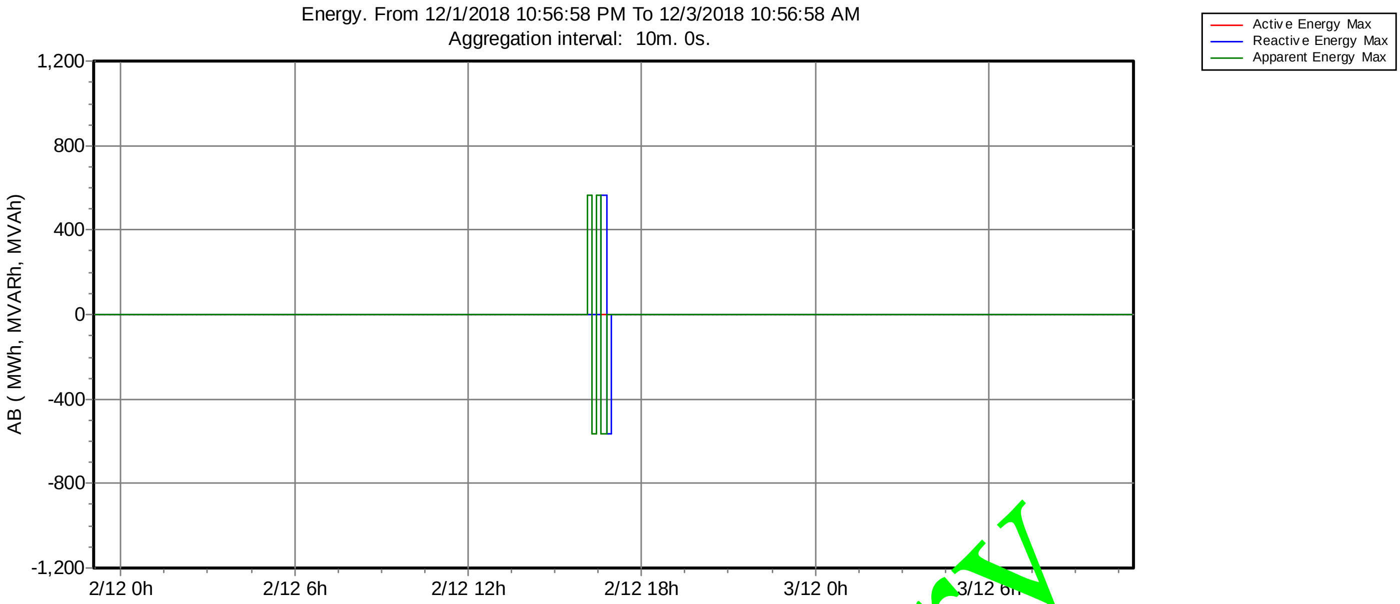

Flicker. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
Pst
CA
1.65
1.35
1.05
0.75
0.45
0.15
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h

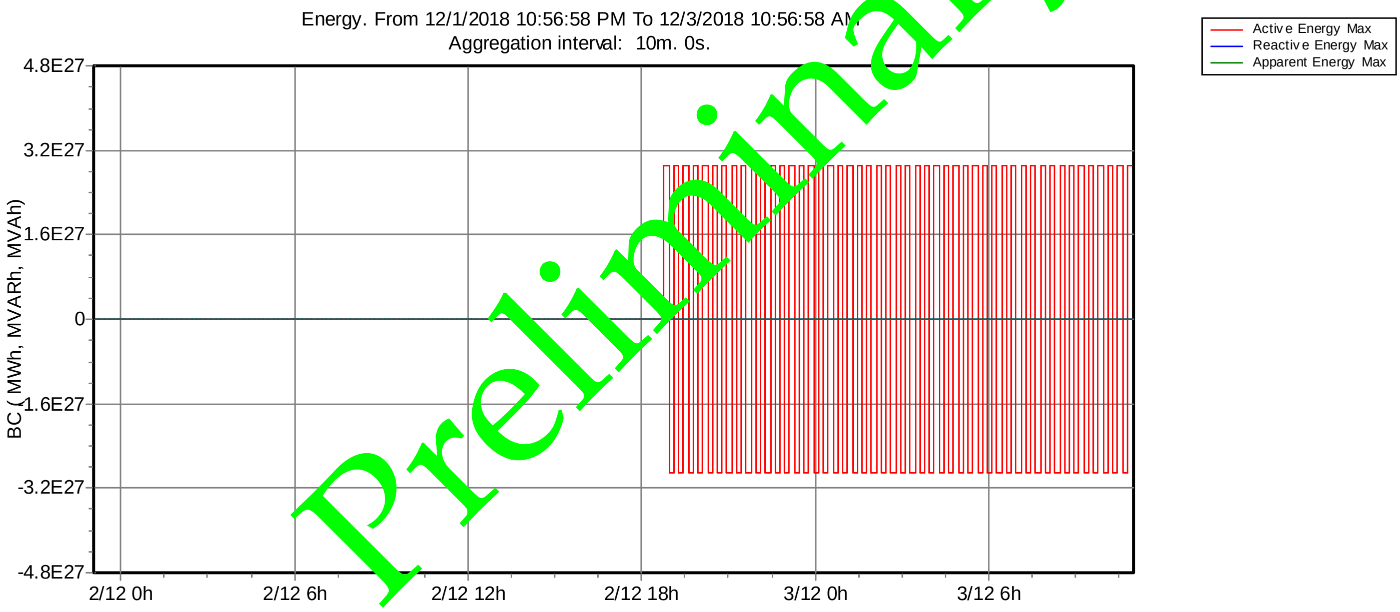

Power. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
W Min
W Max
W Avg
AB (kW)
16.5
13.5
10.5
7.5
4.5
1.5
-1.5
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h

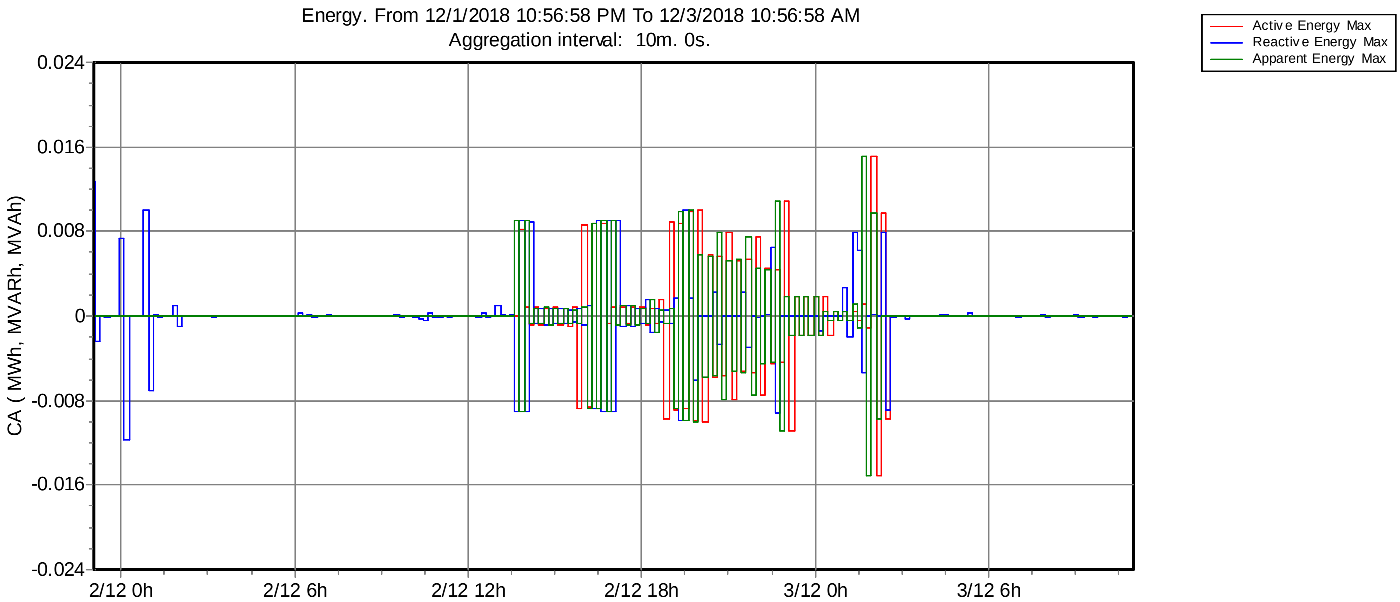

Power. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
W Min
W Max
W Avg
BC (kW)
13.2
10.8
8.4
6
3.6
1.2
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h


Power. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
W Min
W Max
W Avg
CA (kW)
16.5
13.5
10.5
7.5
4.5
1.5
-1.5
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h

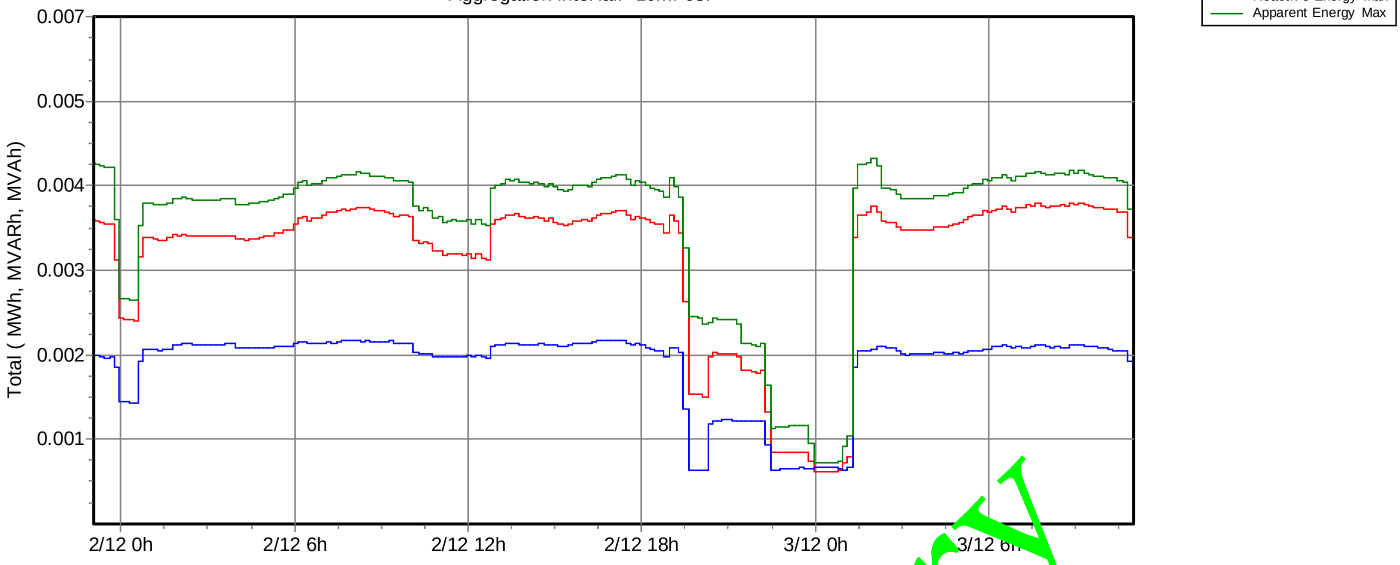

Power. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
W Min
W Max
W Avg
Total (kW)
44
36
28
20
12
4
-4
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h


Energy. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
Aggregation interval: 10m. 0s.
Active Energy Max
Reactive Energy Max
Apparent Energy Max
AB (MWh, MVARh, MVAh)
1,200
800
400
0
-400
-800
-1,200
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h

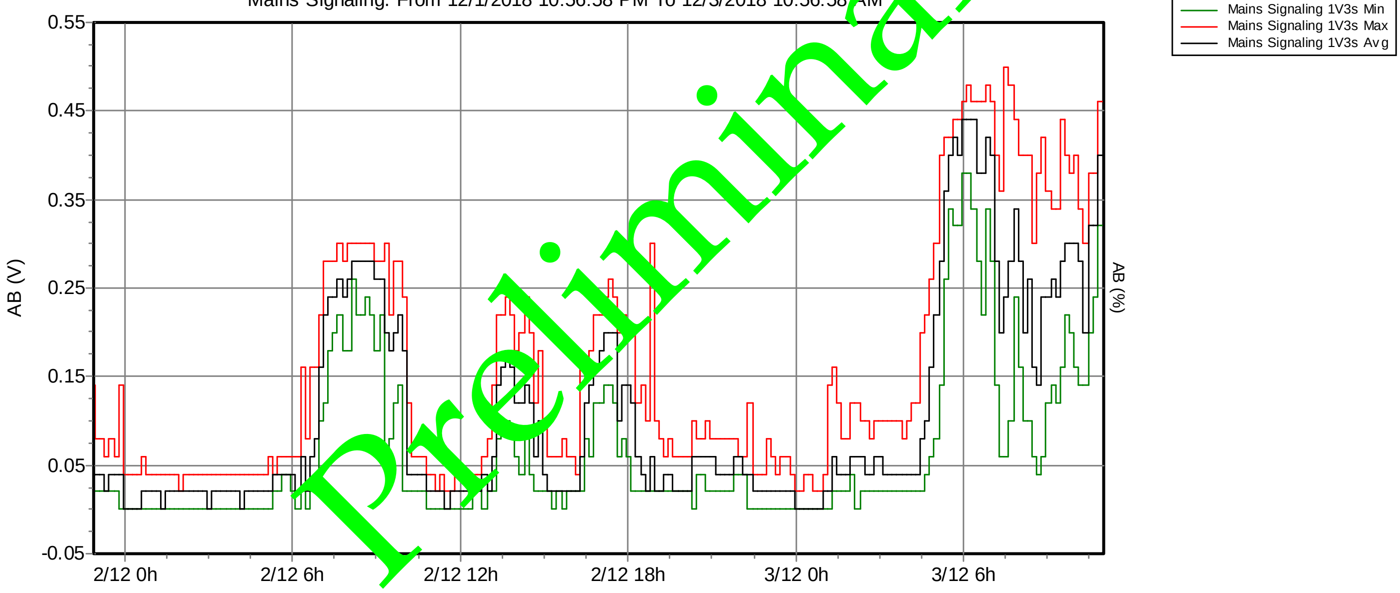

Energy. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
Aggregation interval: 10m. 0s.
Active Energy Max
Reactive Energy Max
Apparent Energy Max
BC (MWh, MVARh, MVAh)
4.8E27
3.2E27
1.6E27
0
-1.6E27
-3.2E27
-4.8E27
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h
Preliminary


Energy. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
Aggregation interval: 10m. 0s.
Active Energy Max
Reactive Energy Max
Apparent Energy Max
CA (MWh, MVARh, MVAh)
0.024
0.016
0.008
0
-0.008
-0.016
-0.024
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h

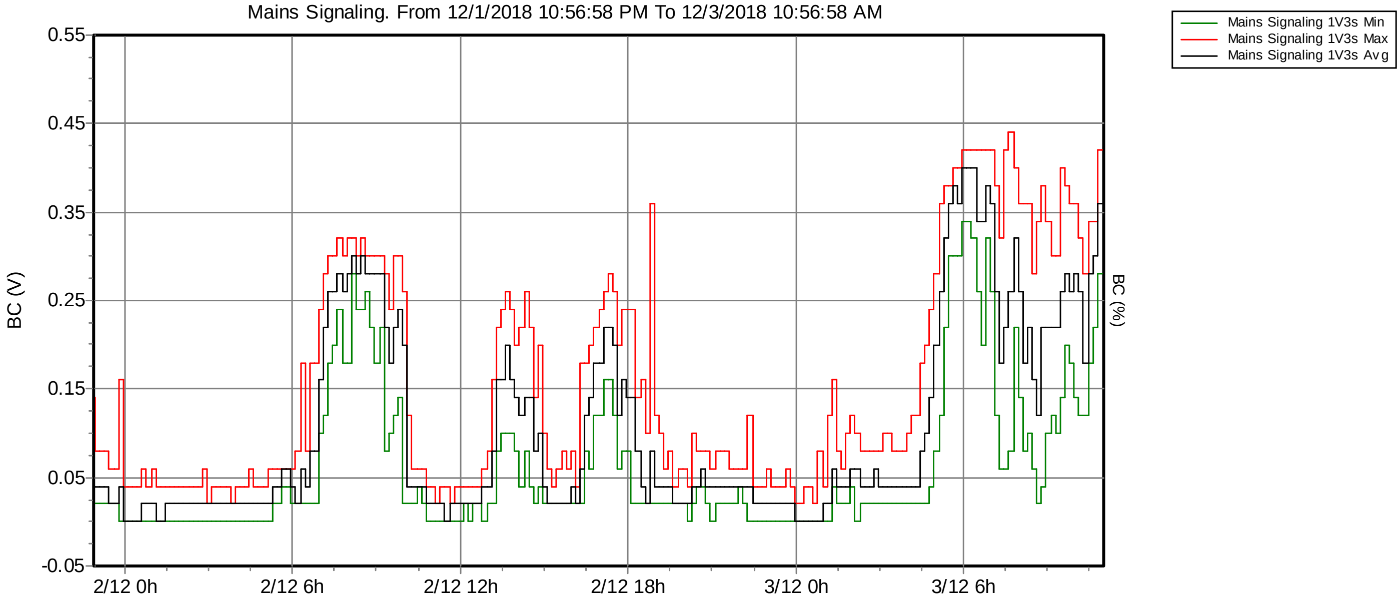
Energy. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
Aggregation interval: 10m. 0s.

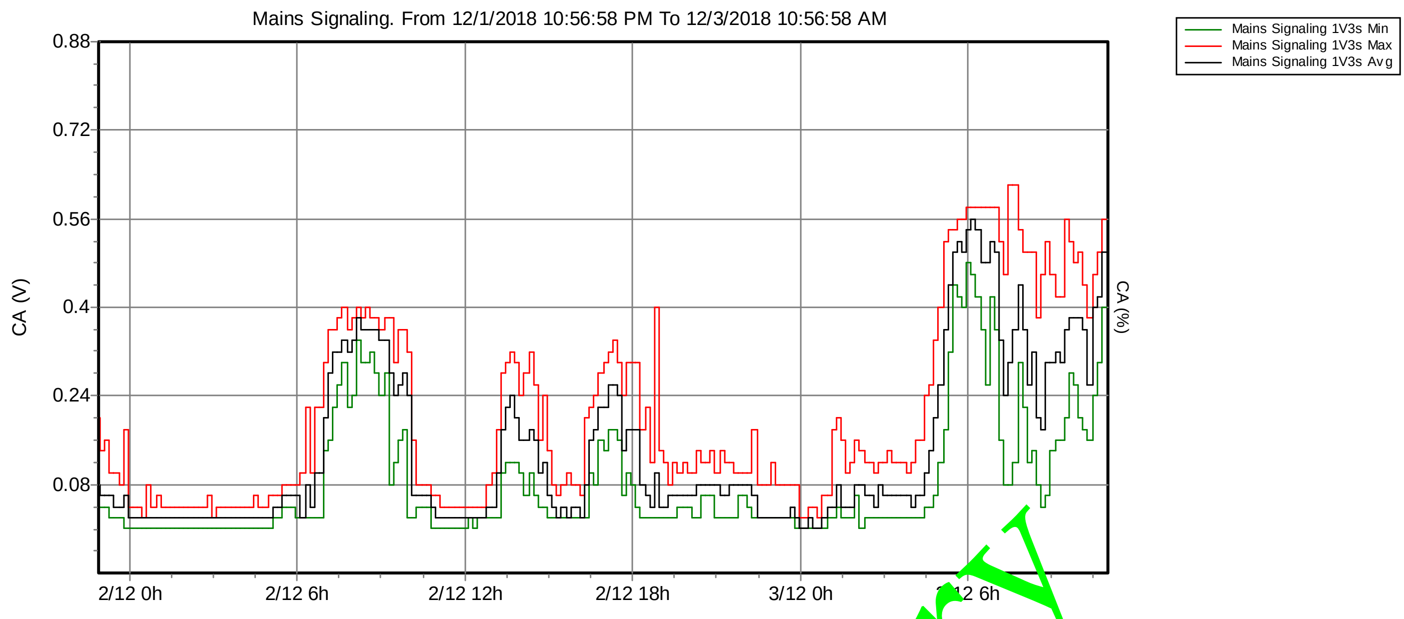


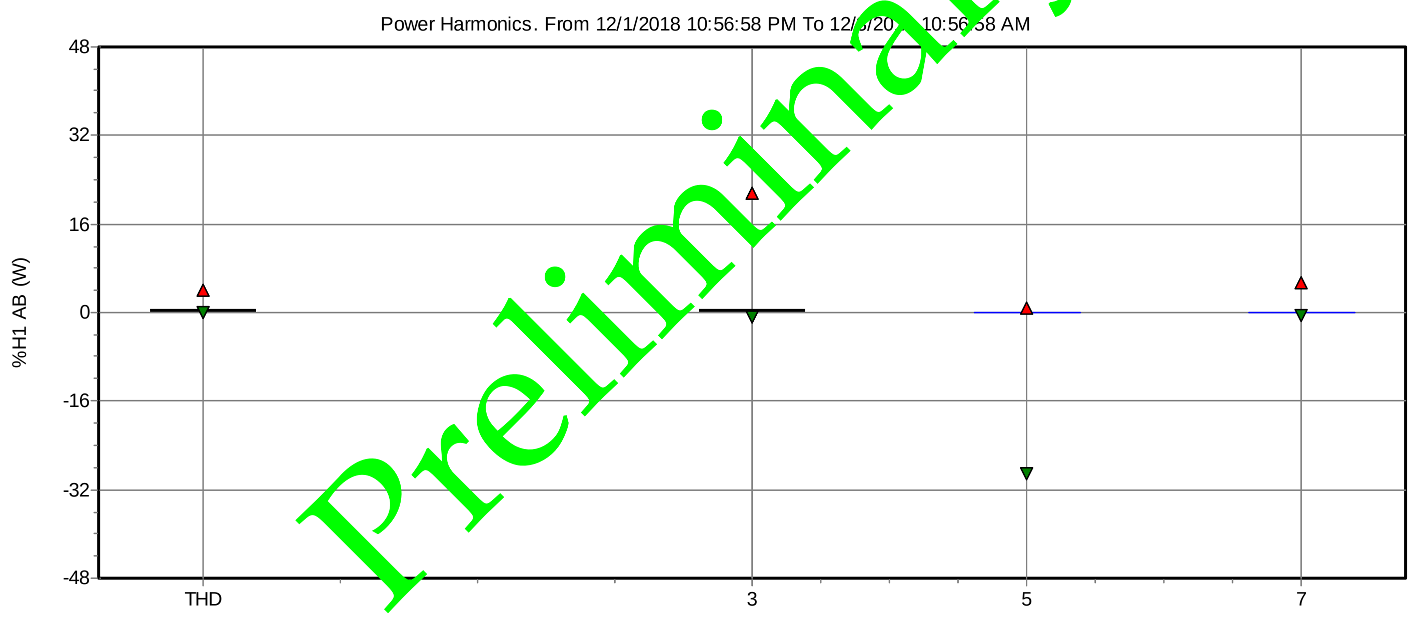
Mains Signaling. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM

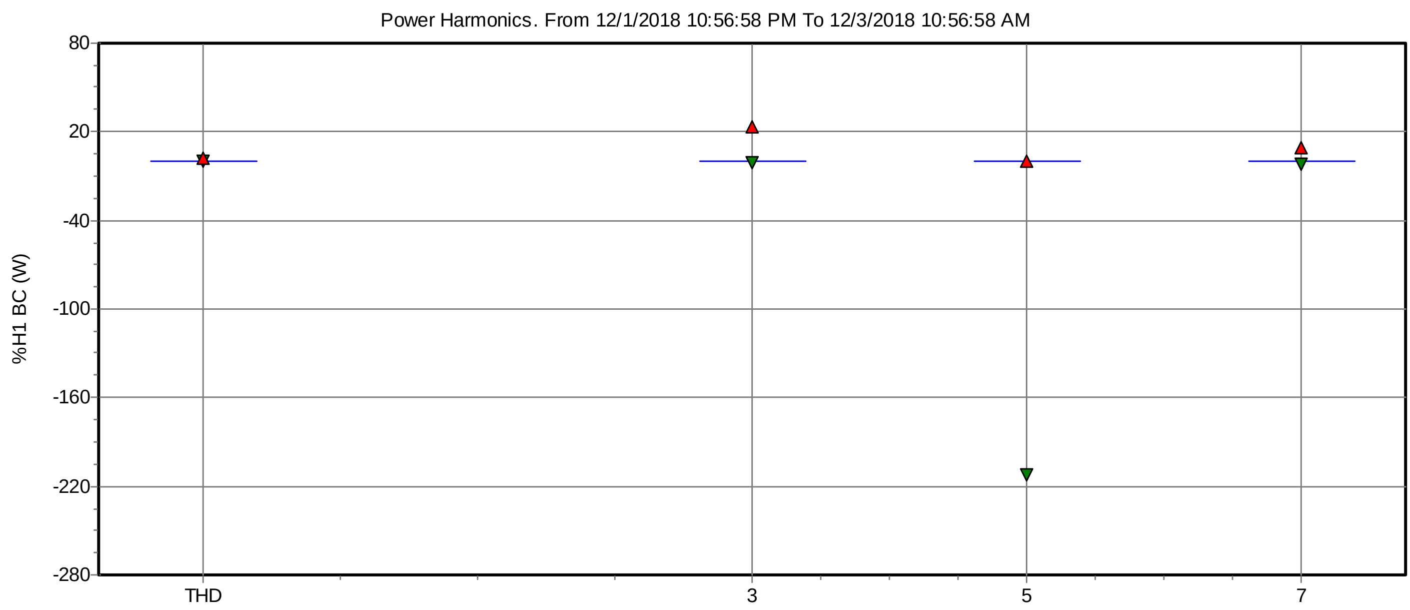


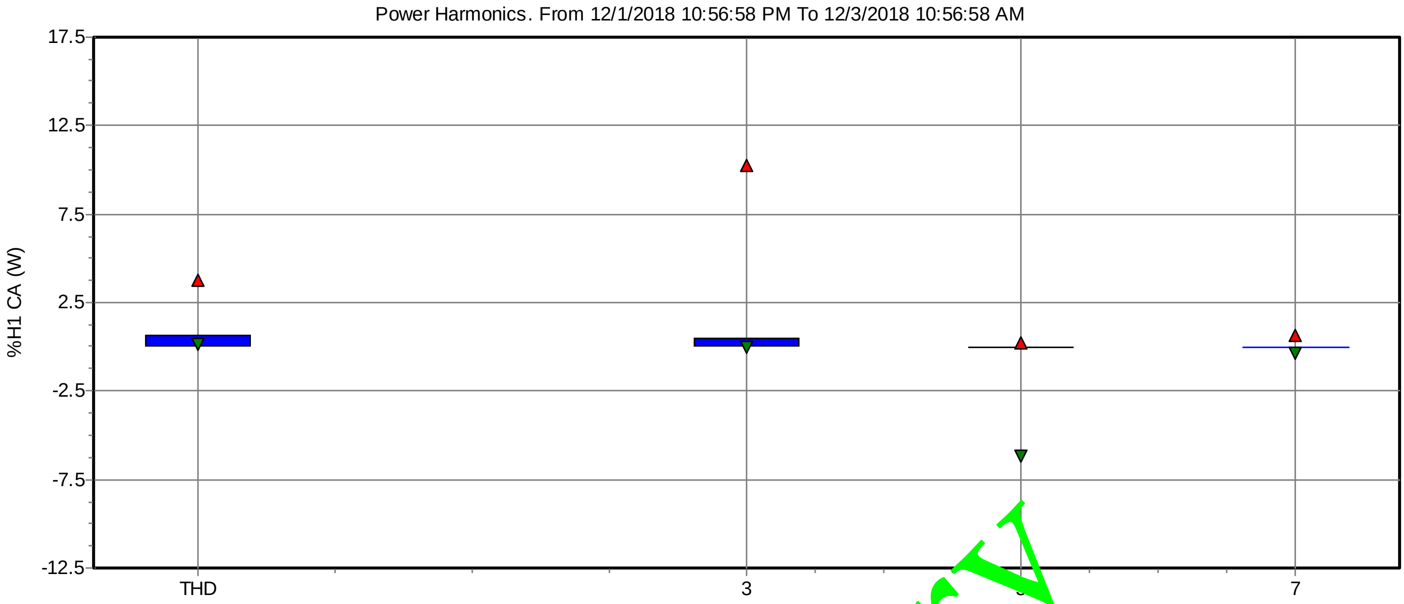
Mains Signaling. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM



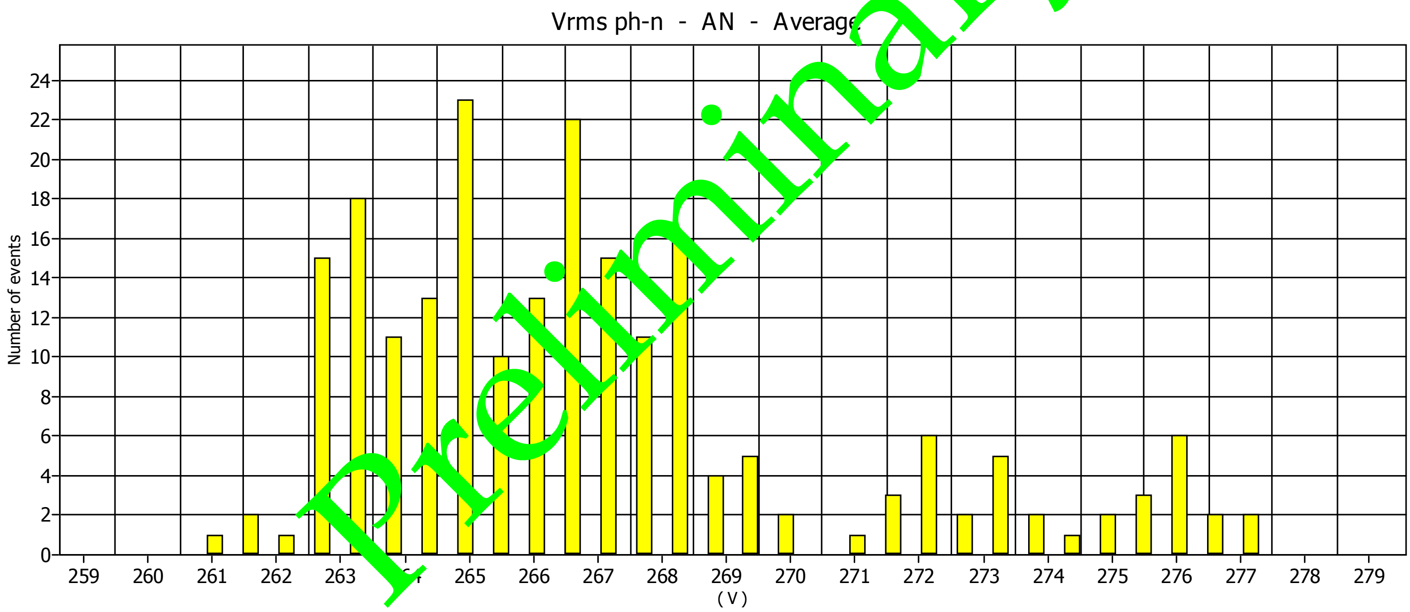

Mains Signaling. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
Mains Signaling 1V3s Min
Mains Signaling 1V3s Max
Mains Signaling 1V3s Avg
CA (V)
CA (%)
0.88
0.72
0.56
0.4
0.24
0.08
2/12 0h
2/12 6h
2/12 12h
2/12 18h
3/12 0h
3/12 6h


Power Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 AB (W)
48
32
16
0
-16
-32
-48
THD
3
5
7
Preliminary


Power Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 BC (W)
80
20
-40
-100
-160
-220
-280
THD
3
5
7



Power Harmonics. From 12/1/2018 10:56:58 PM To 12/3/2018 10:56:58 AM
%H1 CA (W)
17.5
12.5
7.5
2.5
-2.5
-7.5
-12.5
THD
3
7



Vrms ph-n - AN - Average
Number of events
24
22
20
18
16
14
12
10
8
6
4
2
0
259
260
261
262
263
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
(V)

Instrument Information

Model Number	435-II
Serial Number	34843110
Firmware Revision	V05.04

Software Information

Power Log Version	5.4
FLUKE 430-II DLL Version	1.2.0.13

General Information

Recording location	VFD-1 (15 HP MOTOR)
Client	AYALA SOUTHVALE
Notes	

Measurement Summary

Measurement topology	3-element delta mode
Application mode	Logger
First recording	12/3/2018 11:30:21 AM 567msec
Last recording	12/4/2018 8:30:21 AM 567msec
Recording interval	0h 10m 0s 0msec
Nominal Voltage	460 V
Nominal Current	60 A
Nominal Frequency	60 Hz
File start time	12/3/2018 11:20:21 AM 567msec
File end time	12/4/2018 8:30:21 AM 567msec
Duration	0d 21h 10m 0s 0msec
Number of events	Normal: 3 Detailed: 0
Events downloaded	No
Number of screens	1
Screens downloaded	Yes
Power measurement method	Unified
Cable type	Copper
Harmonic scale	%H1
THD mode	THD 40
CosPhi / DPF mode	DPF

Scaling

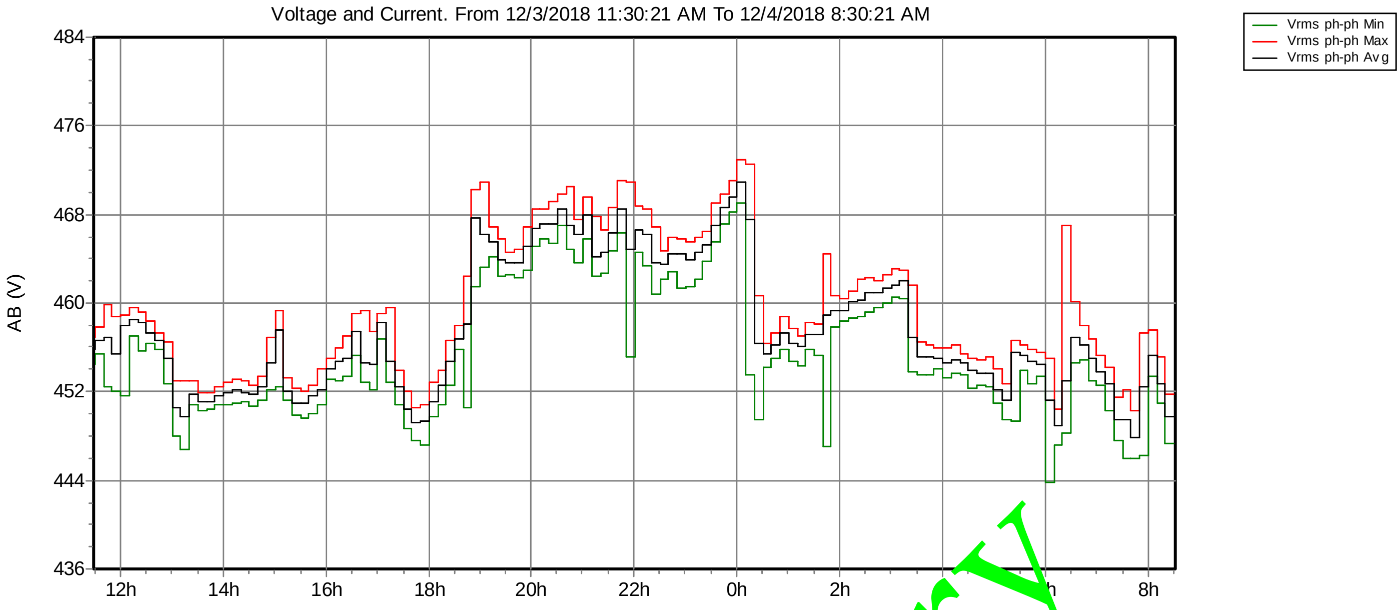
Phase:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	60 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1
Neutral:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	60 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1

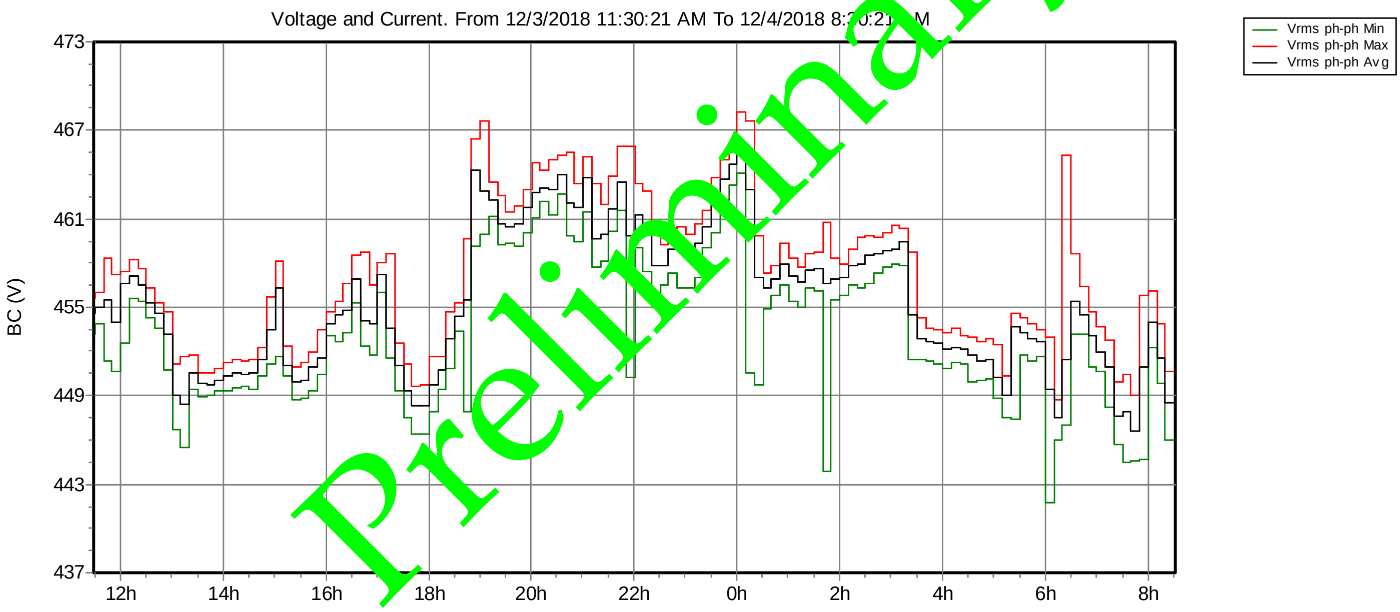
Recording Summary

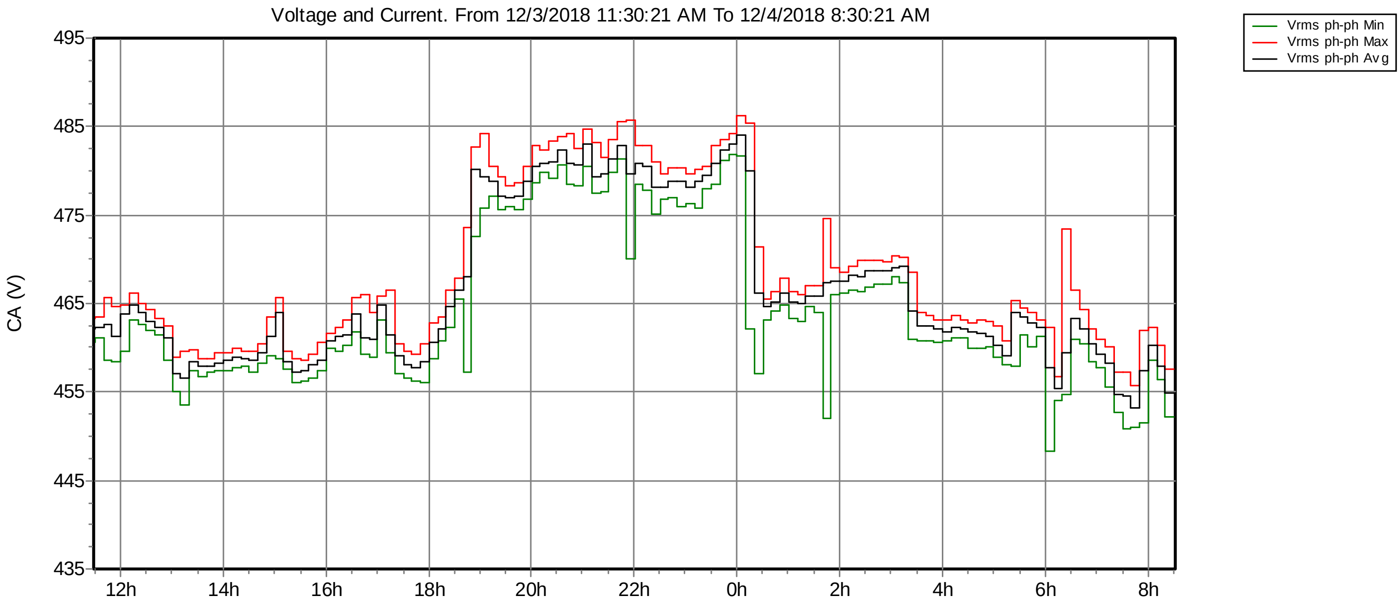
RMS recordings	127
DC recordings	0
Frequency recordings	127
Unbalance recordings	127
Harmonic recordings	127
Power harmonic recordings	127
Power recordings	127
Power unbalance recordings	0
Energy recordings	127
Energy losses recordings	0
Flicker recordings	127
Mains signaling recordings	127

Events Summary

Dips	0
Swells	0
Transients	0
Interruptions	0
Voltage profiles	0
Rapid voltage changes	0
Screens	1
Waveforms	0
Intervals without measurements	0
Inrush current graphics	0
Wave events	0
RMS events	0

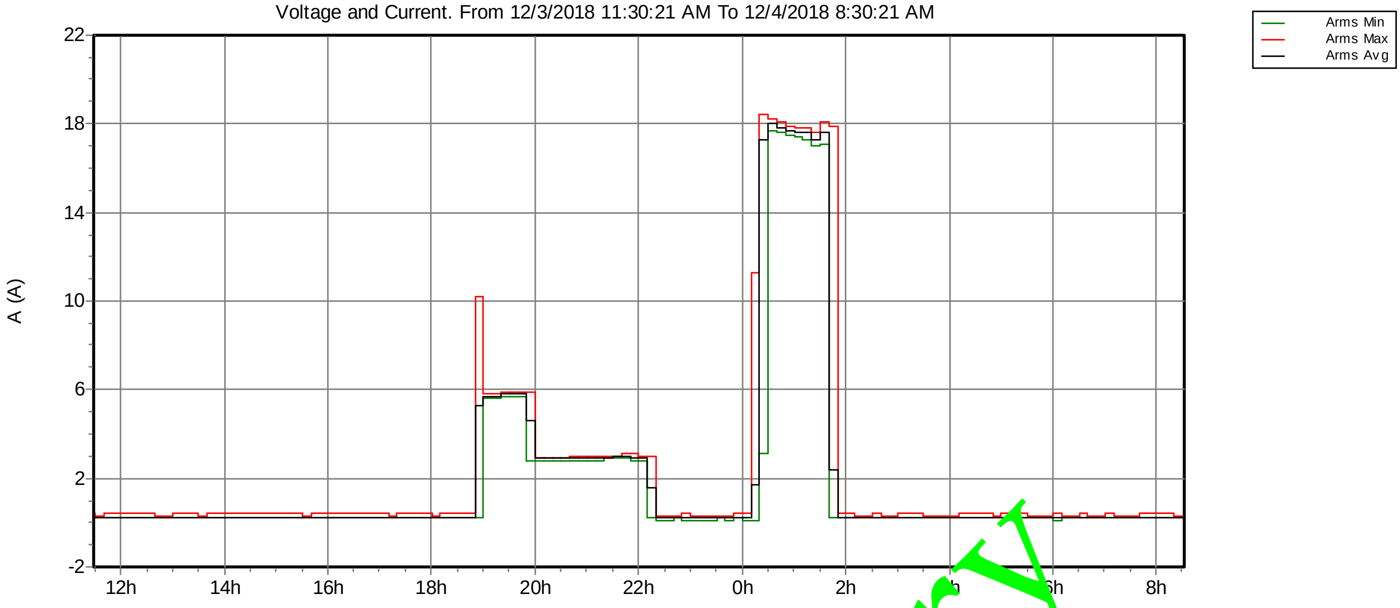

Voltage and Current. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
AB (V)
484
476
468
460
452
444
436
12h
14h
16h
18h
20h
22h
0h
2h
8h
Vrms ph-ph Min
Vrms ph-ph Max
Vrms ph-ph Avg


Voltage and Current. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
BC (V)
473
467
461
455
449
443
437
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h
Vrms ph-ph Min
Vrms ph-ph Max
Vrms ph-ph Avg

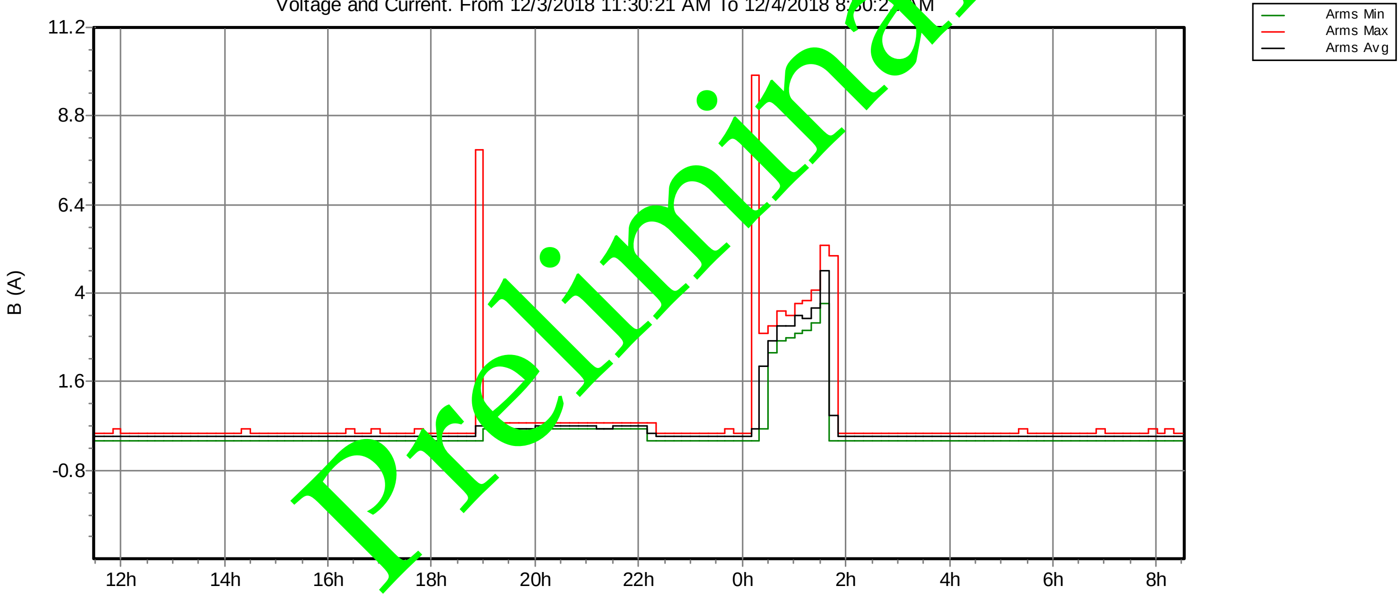

Voltage and Current. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
CA (V)
495
485
475
465
455
445
435
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h
Vrms ph-ph Min
Vrms ph-ph Max
Vrms ph-ph Avg

Filename	Report Date/Time	
SOUTHYALE YFD 1 -- SOUTHVALE VFD MOTOR 1.fpqo	2/23/2019 5:11:29 AM	Page 5

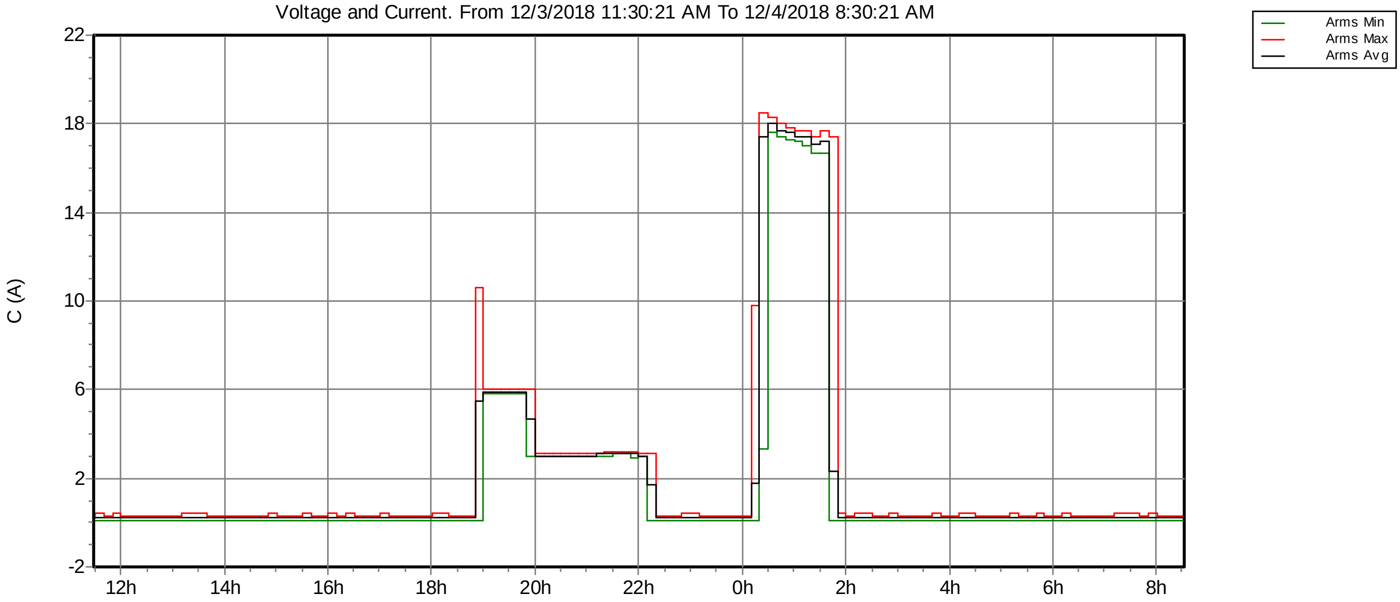
Voltage and Current. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

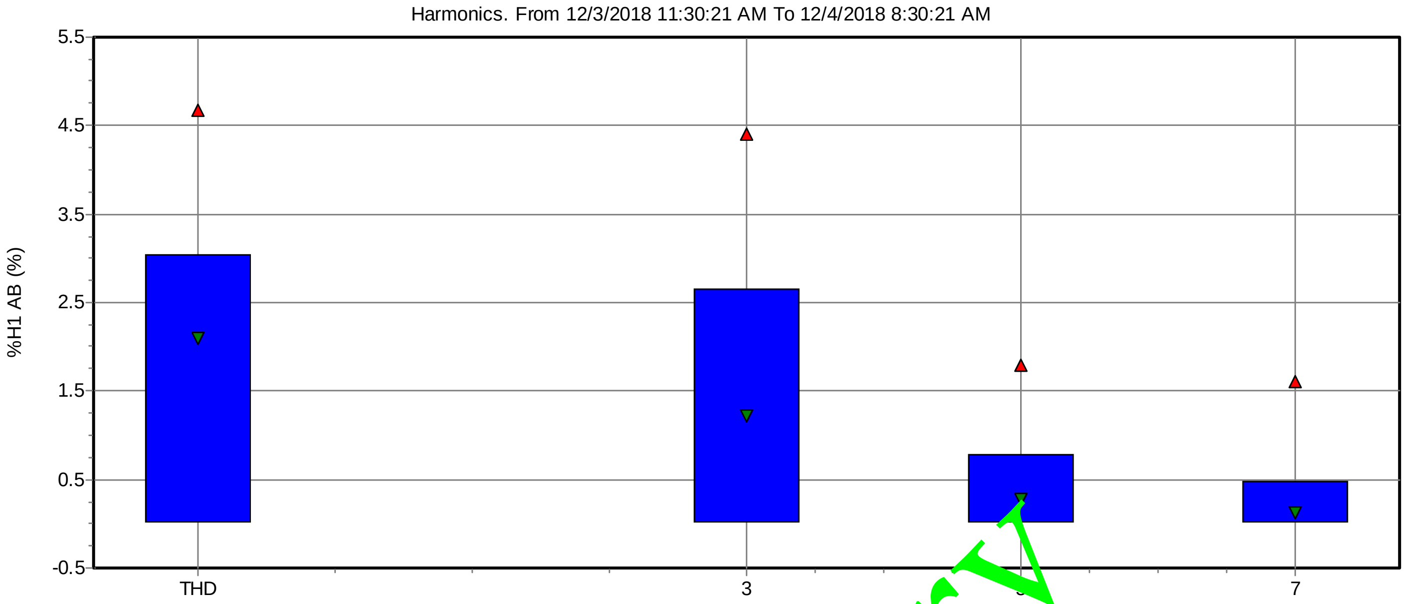


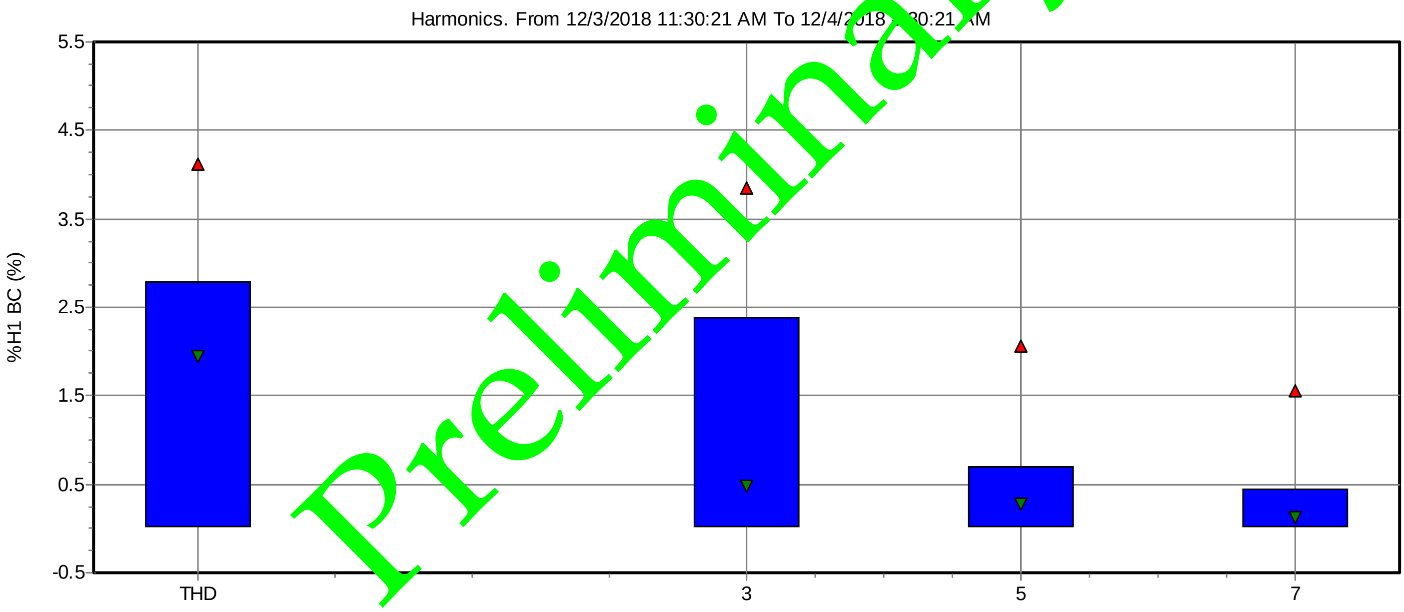
Voltage and Current. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

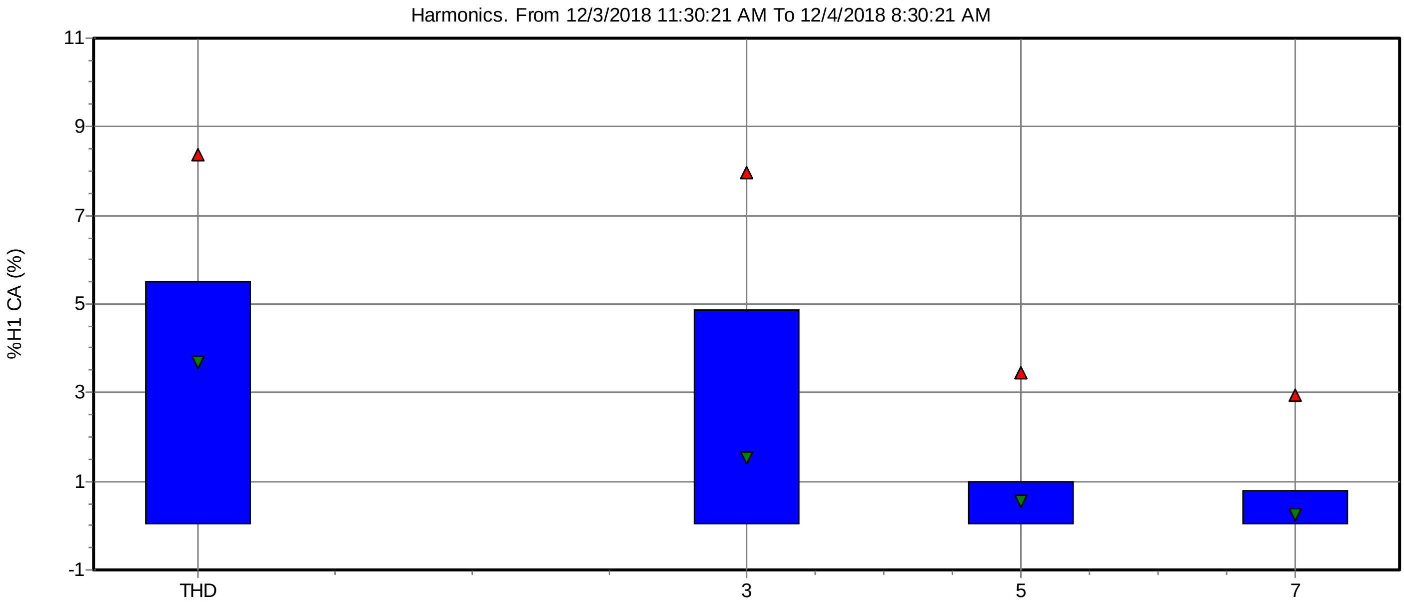


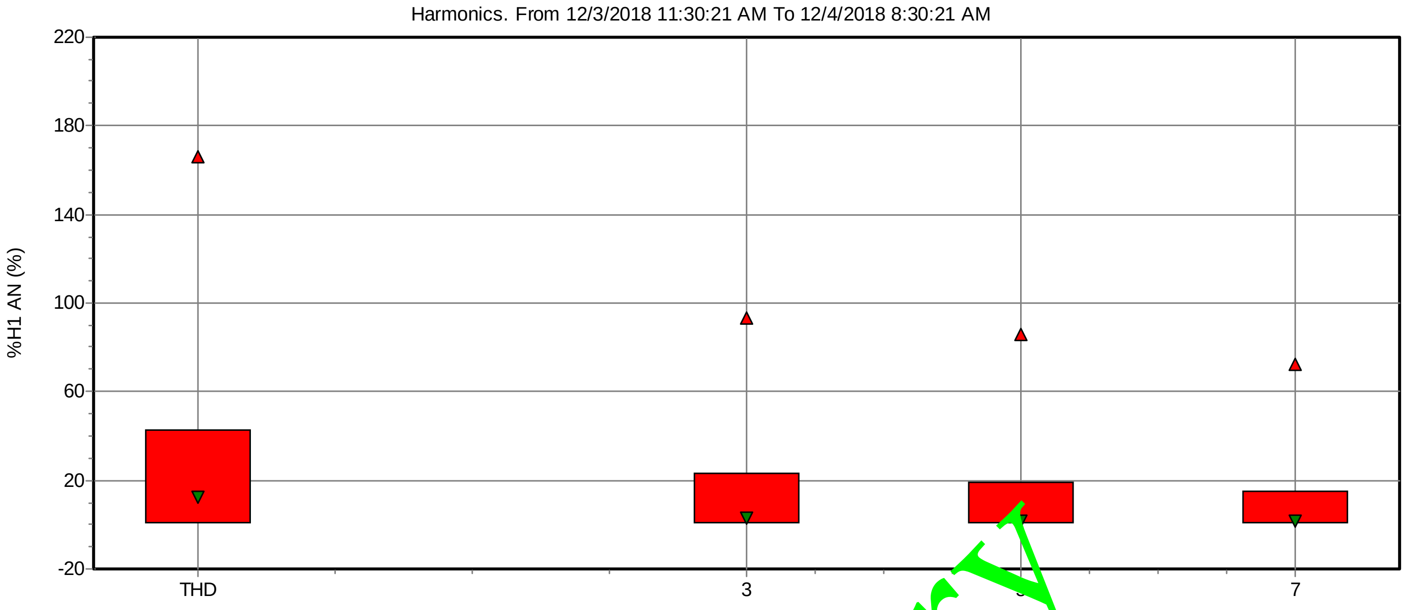
Voltage and Current. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

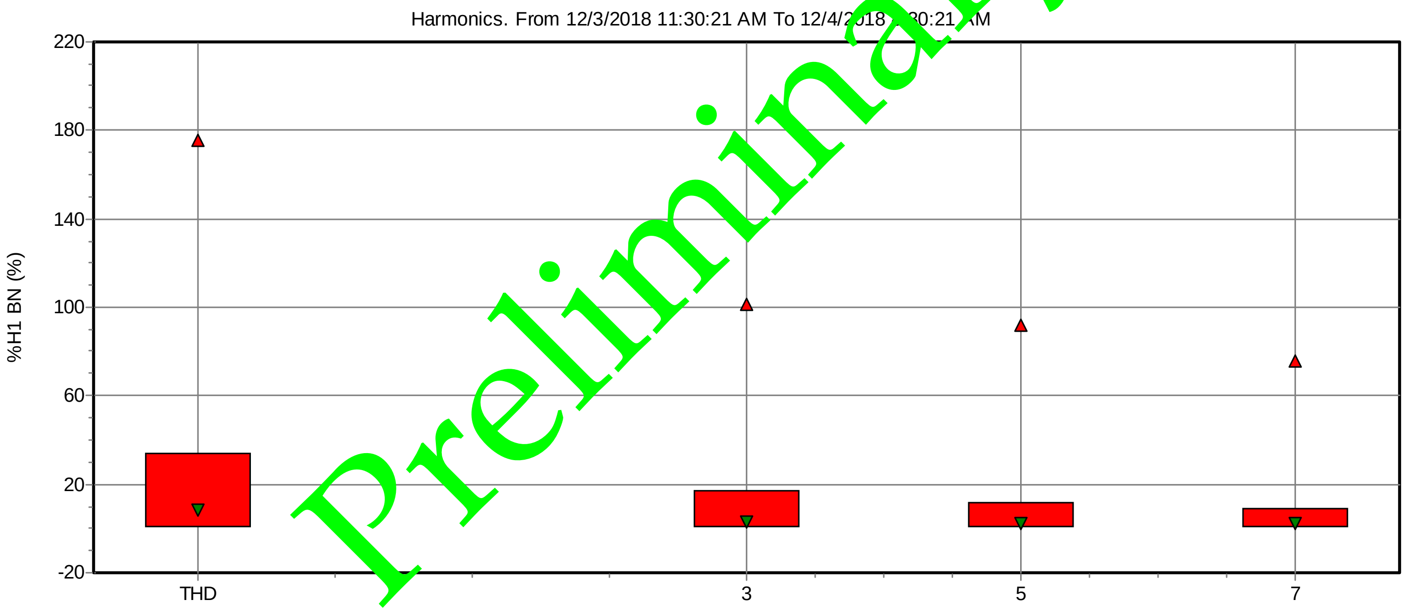


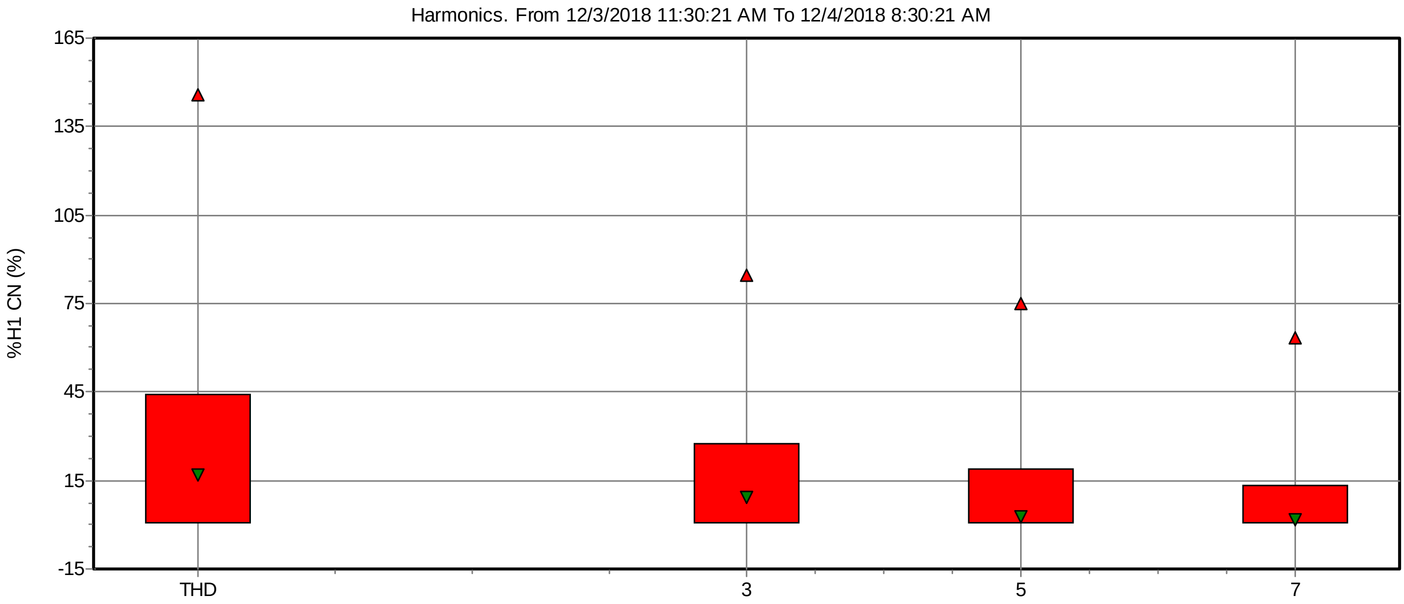

Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
%H1 AB (%)
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
THD
3
7


Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
%H1 BC (%)
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
THD
3
5
7

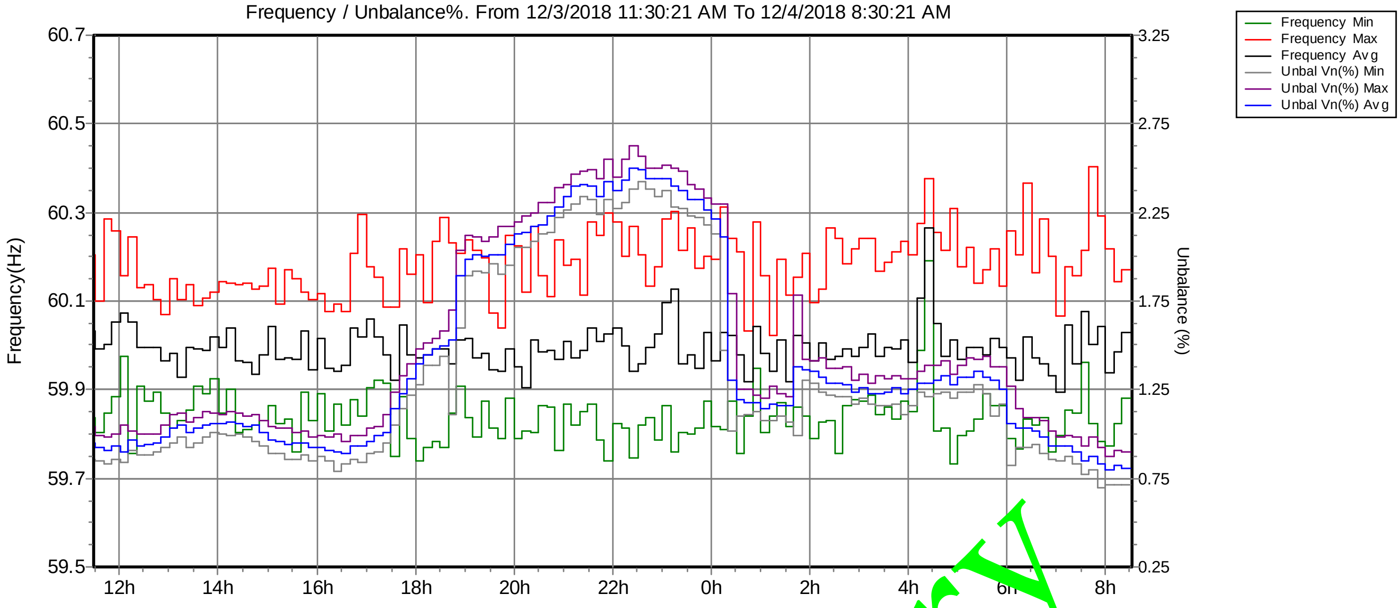

Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
%H1 CA (%)
11
9
7
5
3
1
-1
THD
3
5
7


Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
%H1 AN (%)
220
180
140
100
60
20
-20
THD
3
5
7

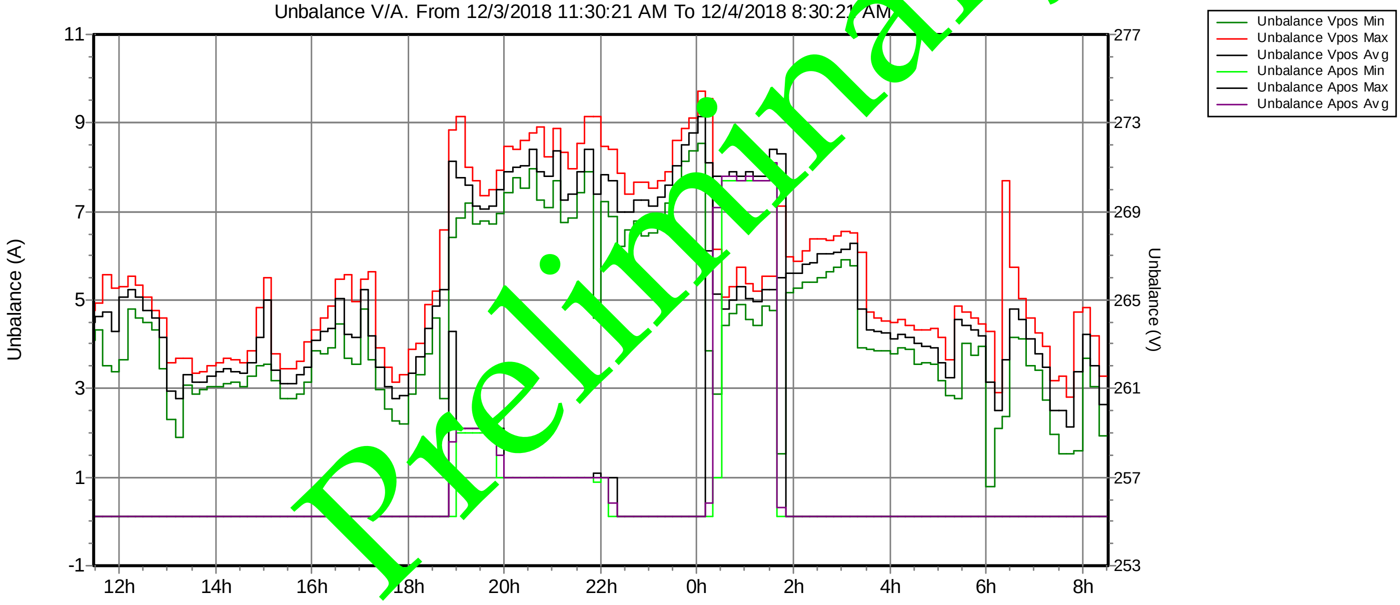

Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
%H1 BN (%)
220
180
140
100
60
20
-20
THD
3
5
7


Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
%H1 CN (%)
165
135
105
75
45
15
-15
THD
3
5
7

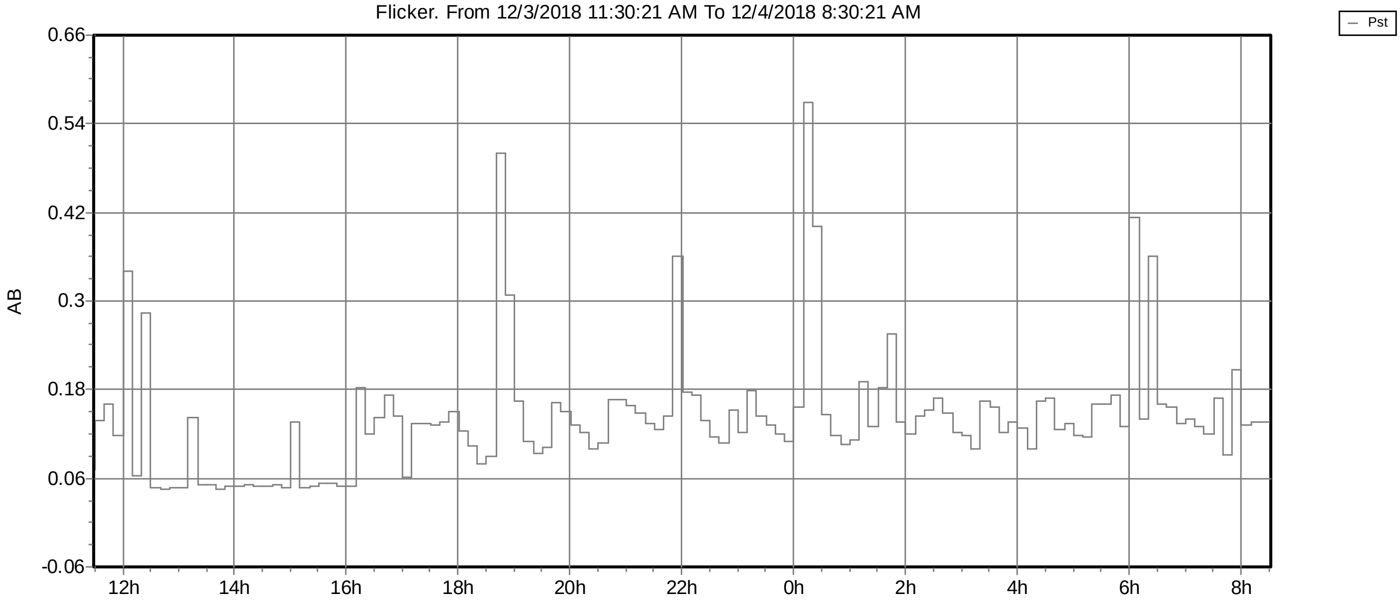
Frequency / Unbalance%. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

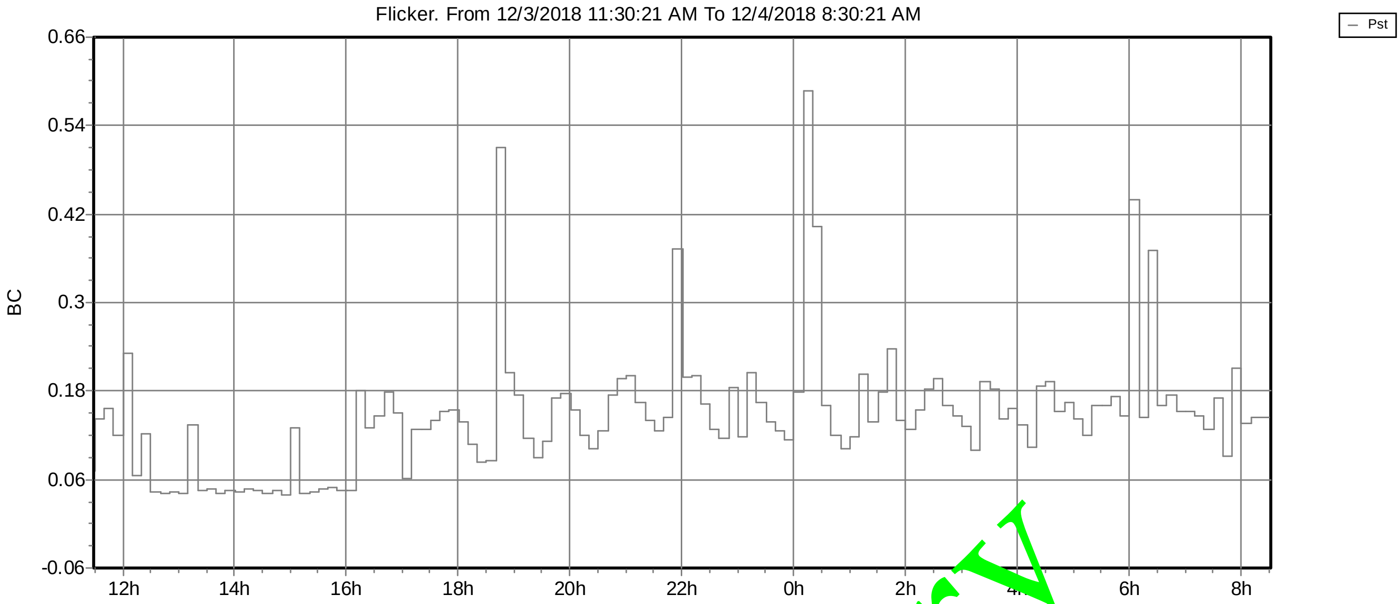


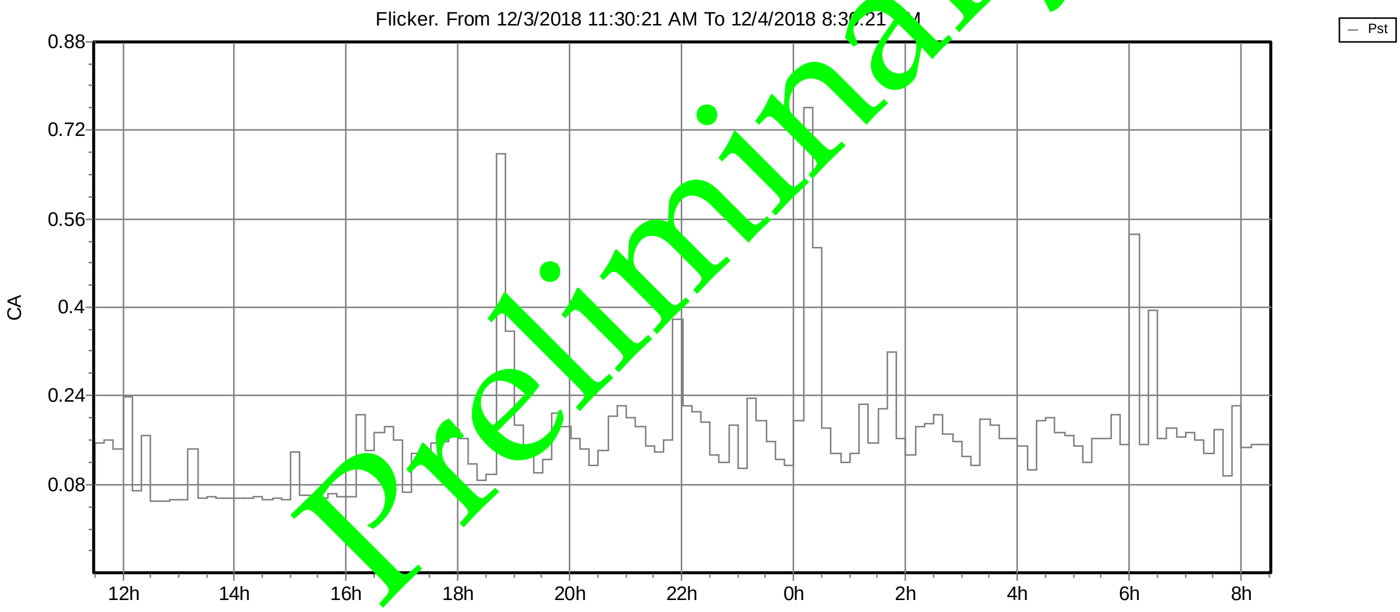
Unbalance V/A. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

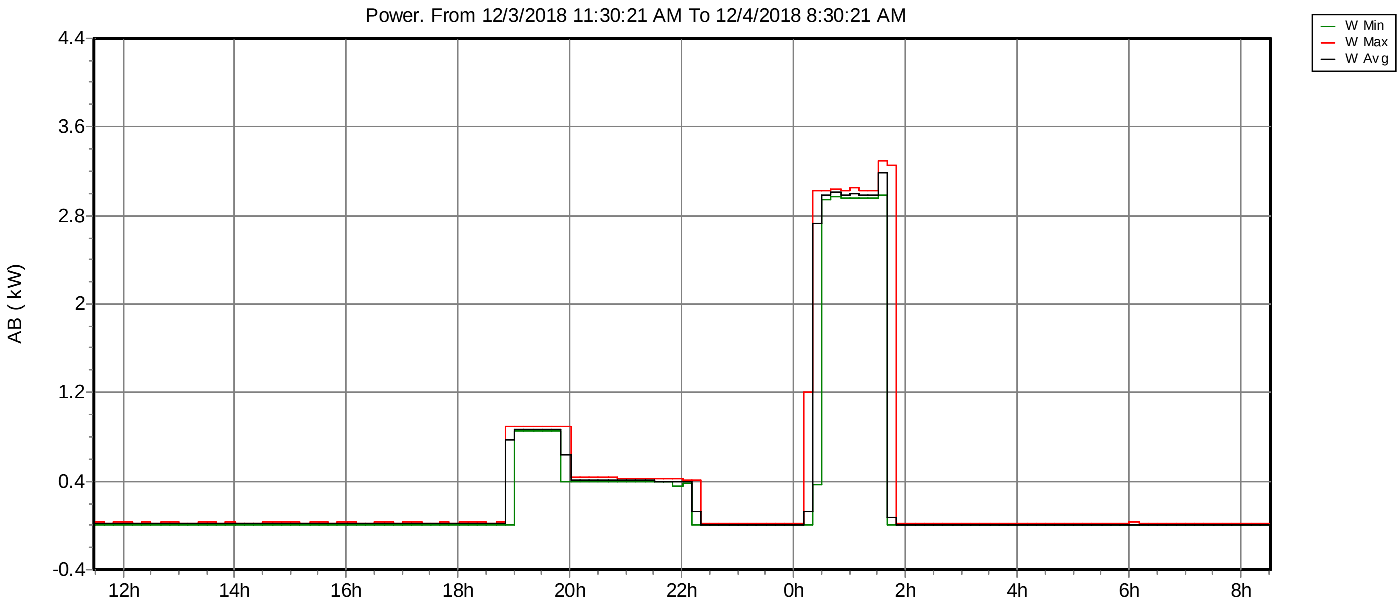


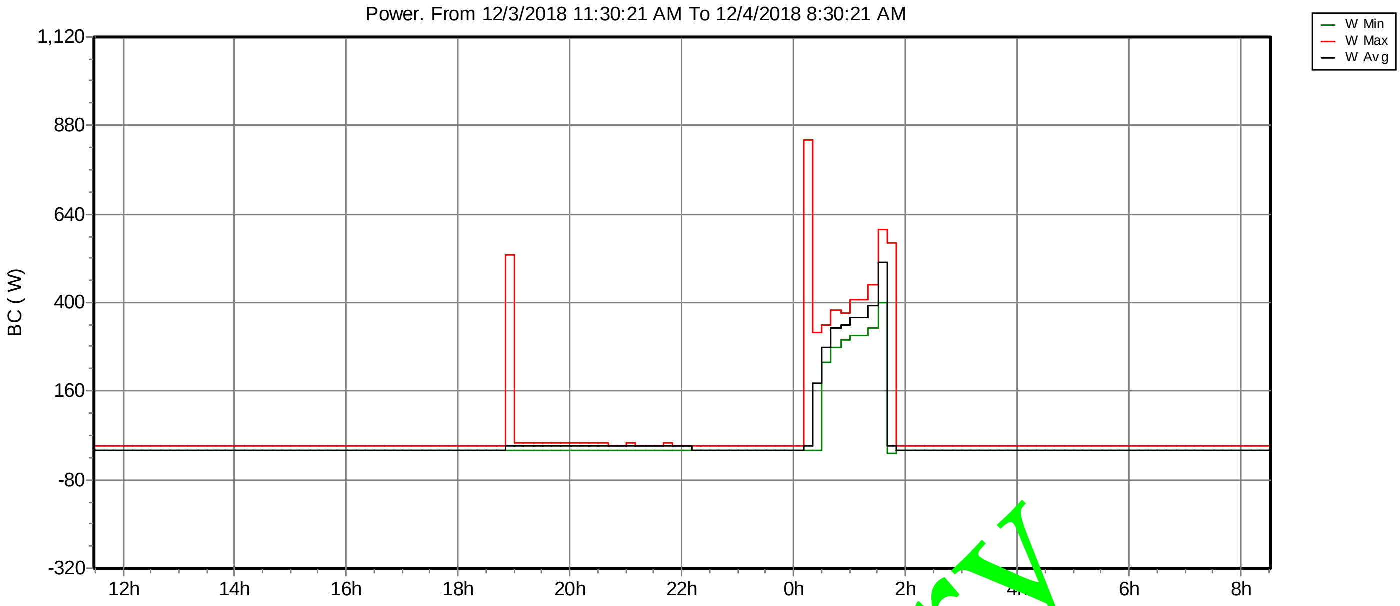
Flicker. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

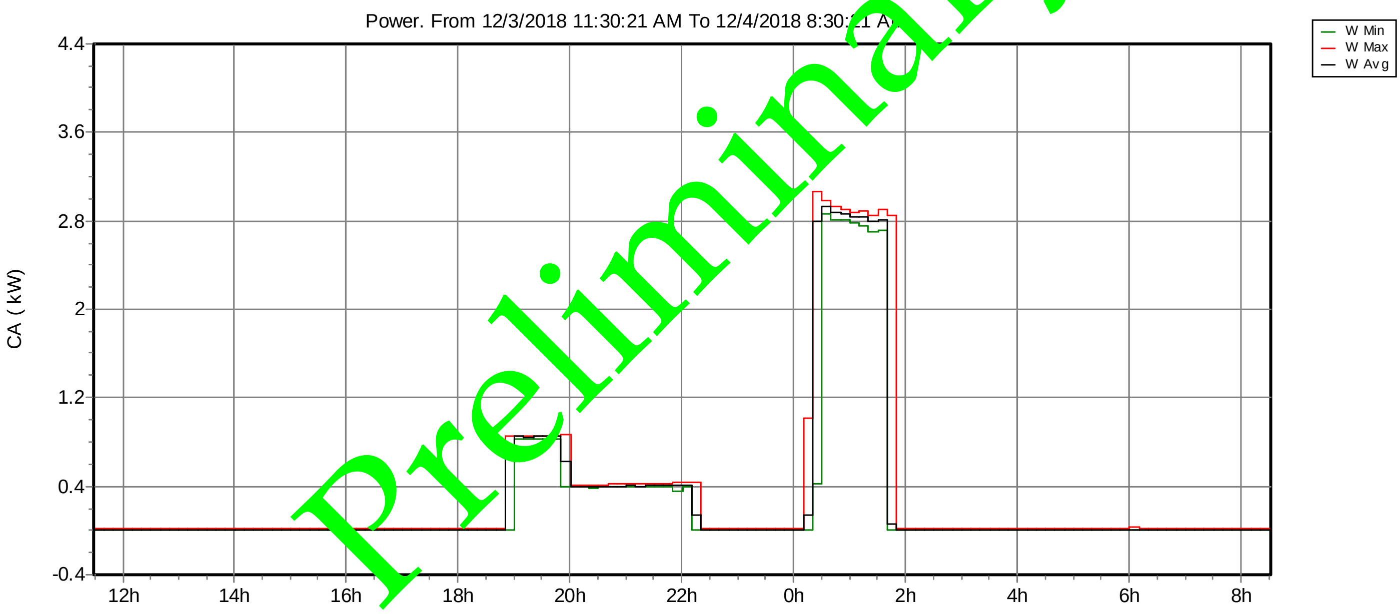


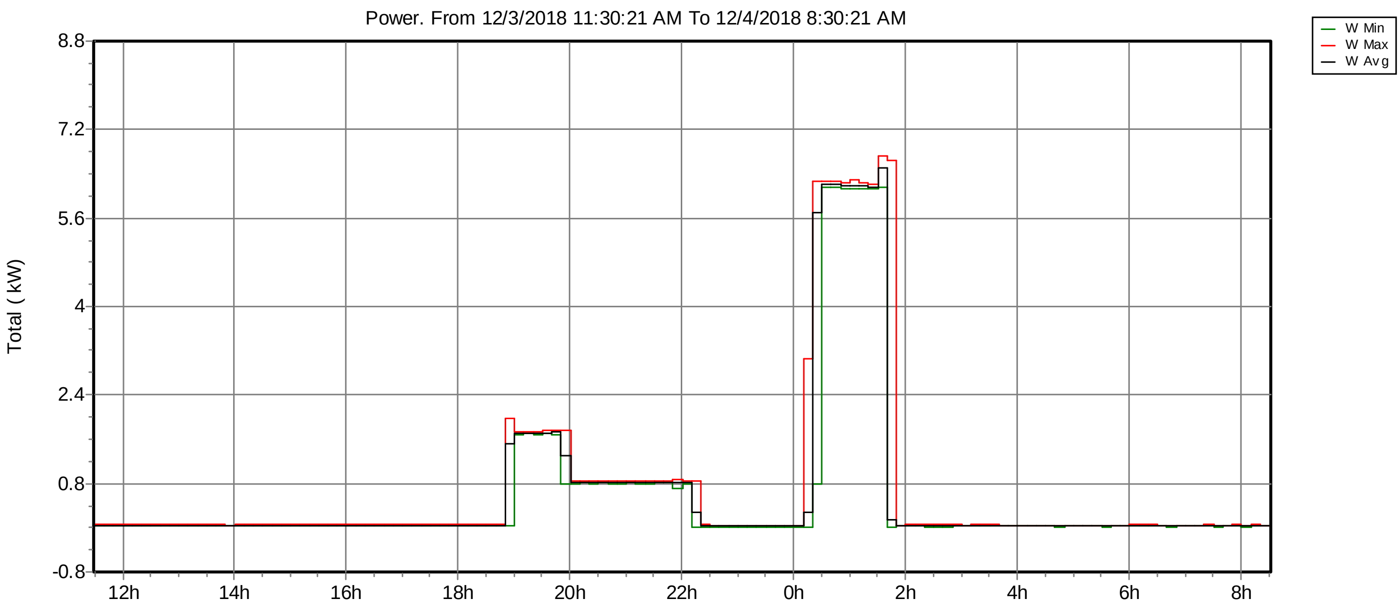

Flicker. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Pst
BC
0.66
0.54
0.42
0.3
0.18
0.06
-0.06
12h
14h
16h
18h
20h
22h
0h
2h
6h
8h


Flicker. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Pst
CA
0.88
0.72
0.56
0.4
0.24
0.08
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h
Preliminary

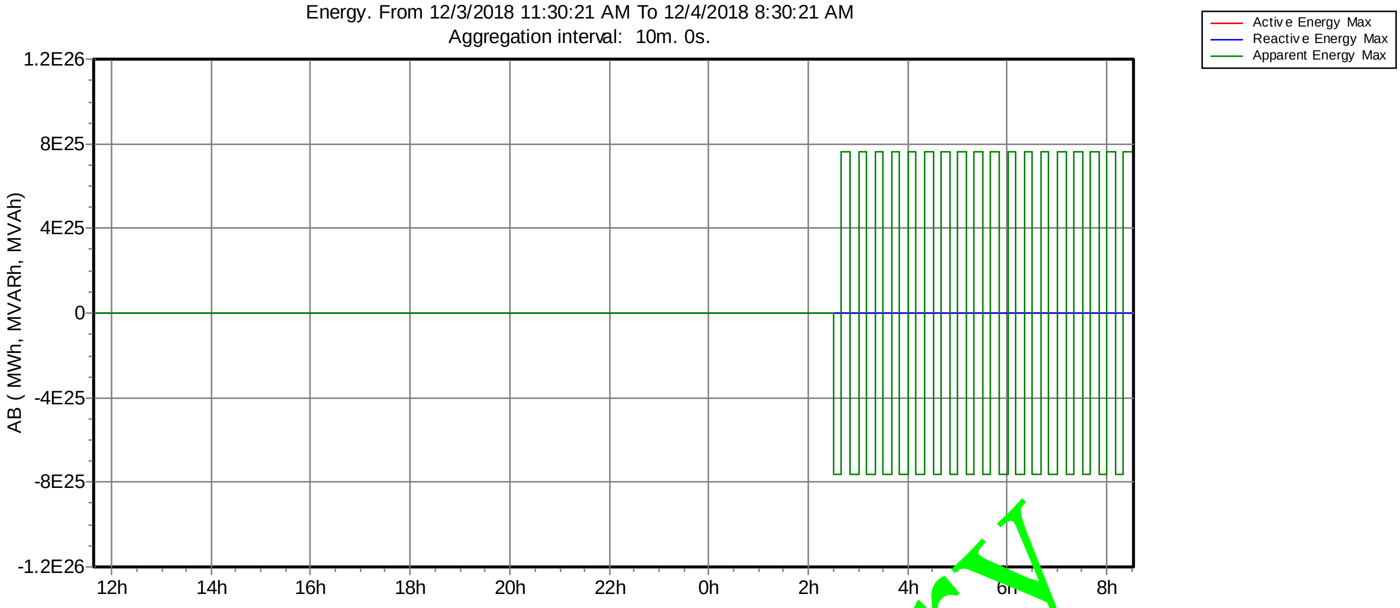

Power. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
W Min
W Max
W Avg
AB (kW)
4.4
3.6
2.8
2
1.2
0.4
-0.4
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h


Power. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
BC (W)
1,120
880
640
400
160
-80
-320
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h
W Min
W Max
W Avg

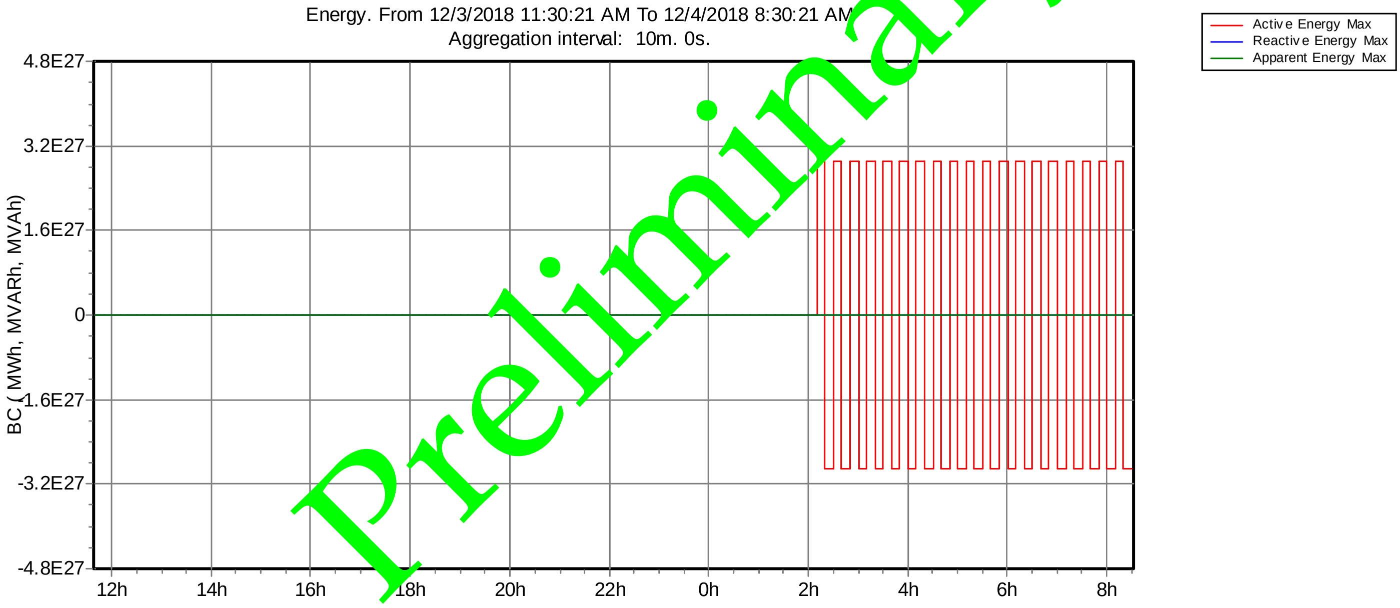

Power. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
CA (kW)
4.4
3.6
2.8
2
1.2
0.4
-0.4
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h
W Min
W Max
W Avg


Power. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Total (kW)
8.8
7.2
5.6
4
2.4
0.8
-0.8
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h
W Min
W Max
W Avg

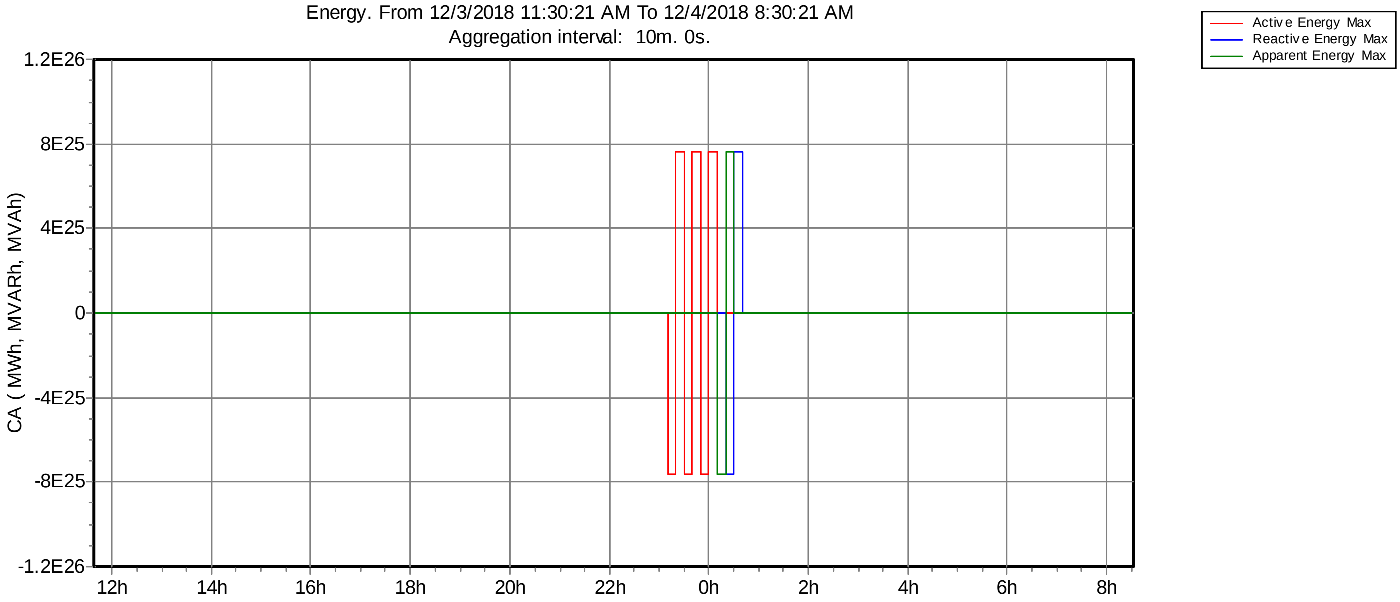
Energy. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Aggregation interval: 10m. 0s.

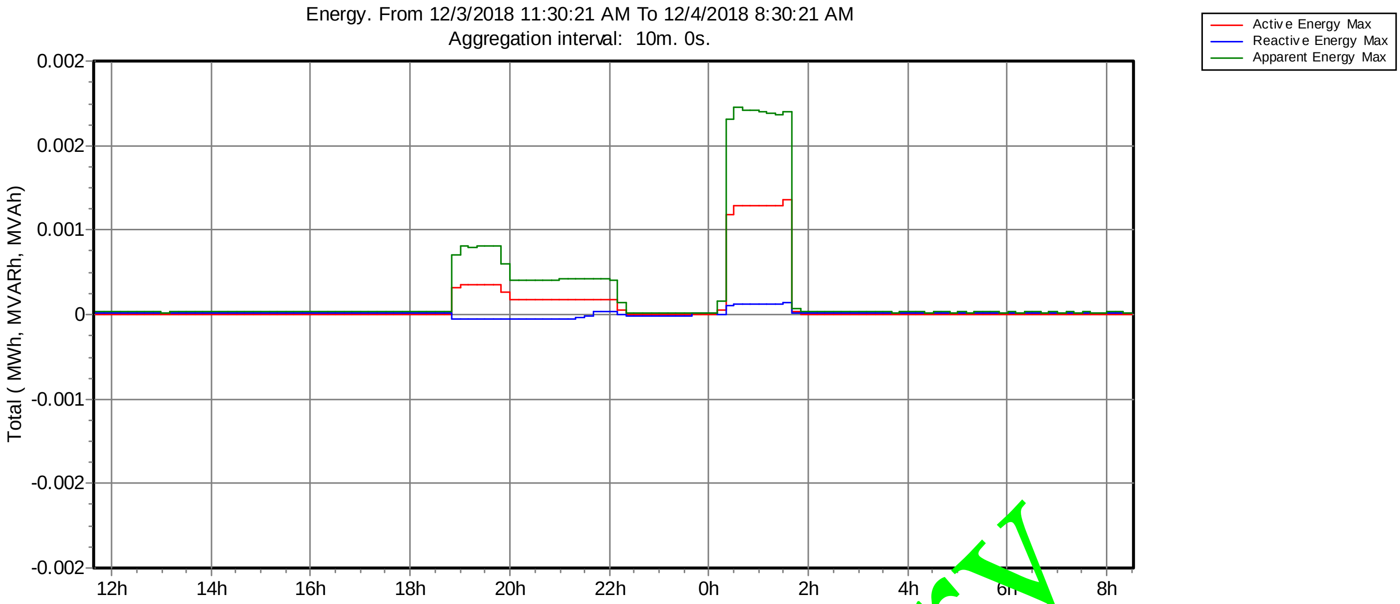


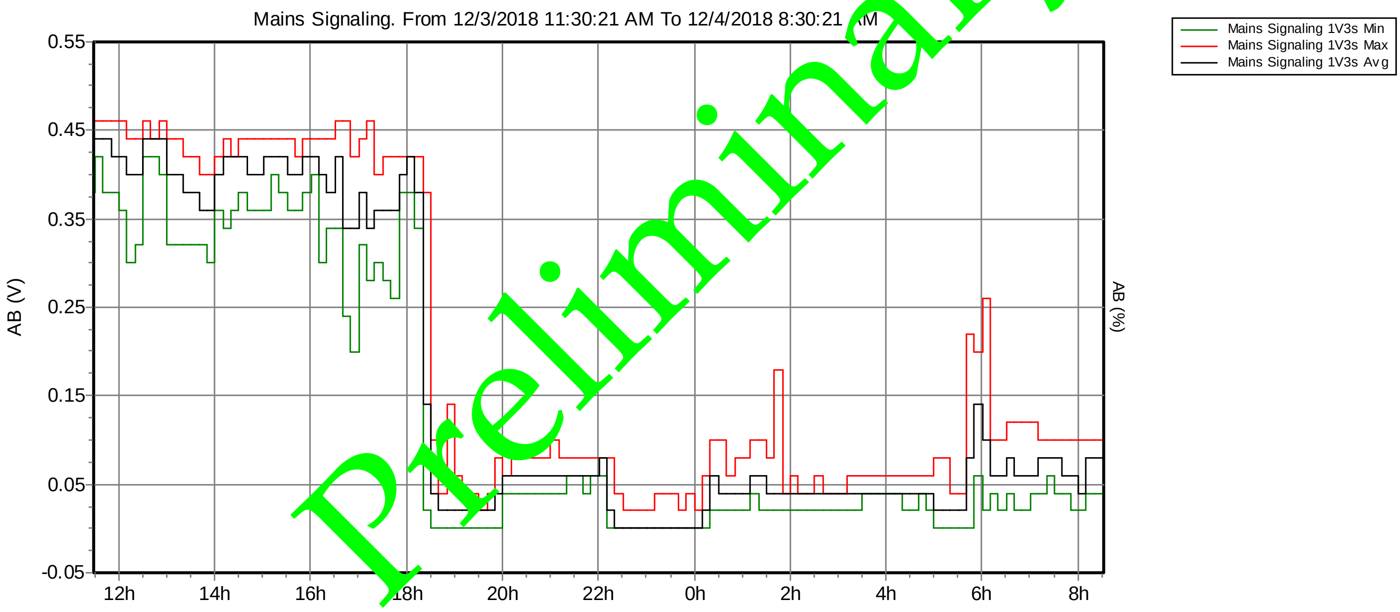
Energy. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Aggregation interval: 10m. 0s.

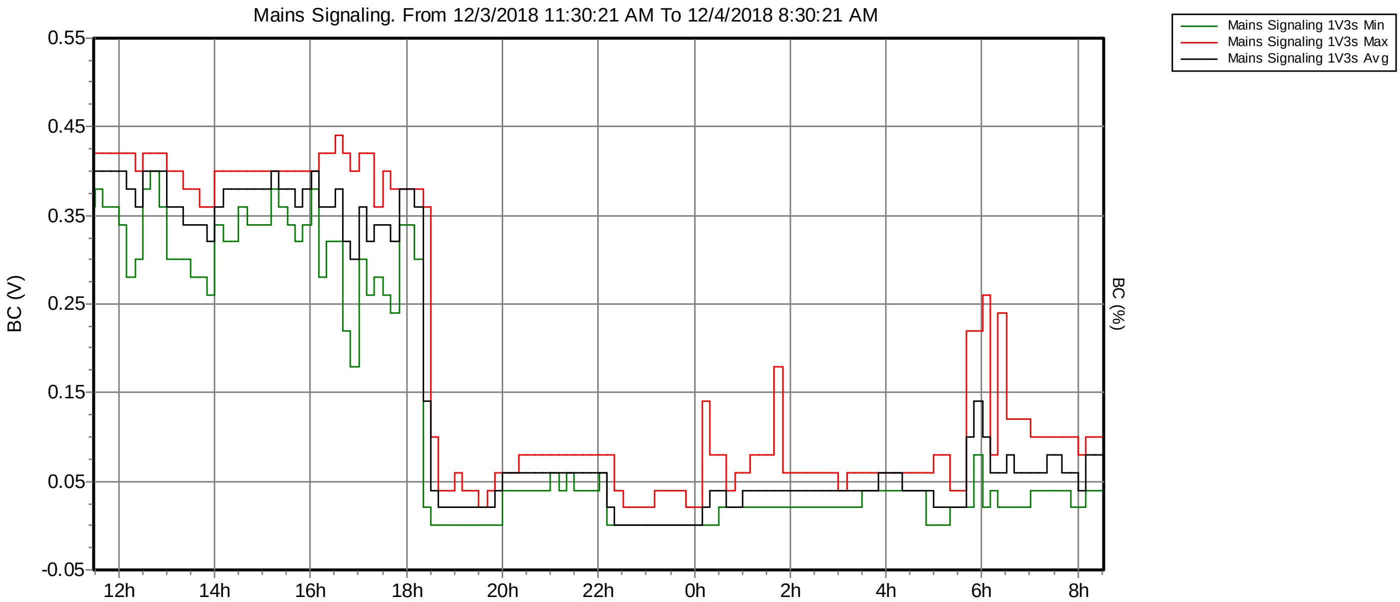


Energy. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Aggregation interval: 10m. 0s.

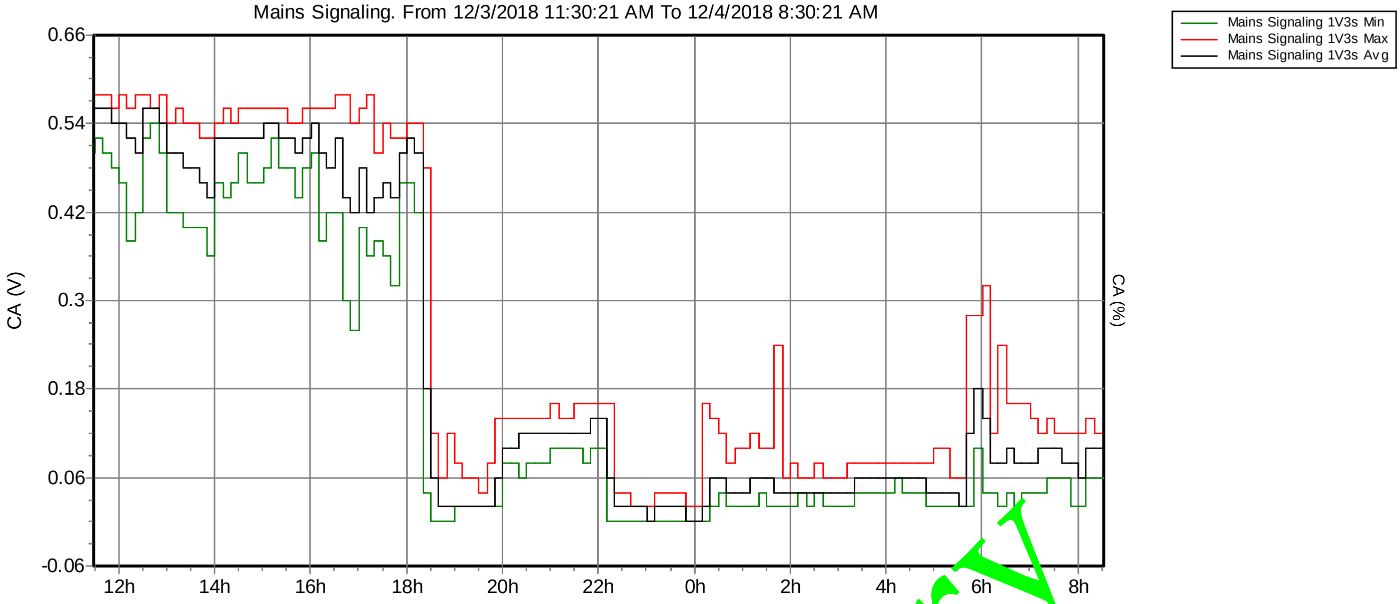



Energy. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Aggregation interval: 10m. 0s.
Active Energy Max
Reactive Energy Max
Apparent Energy Max
Total (MWh, MVARh, MVAh)
0.002
0.002
0.001
0
-0.001
-0.002
-0.002
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h

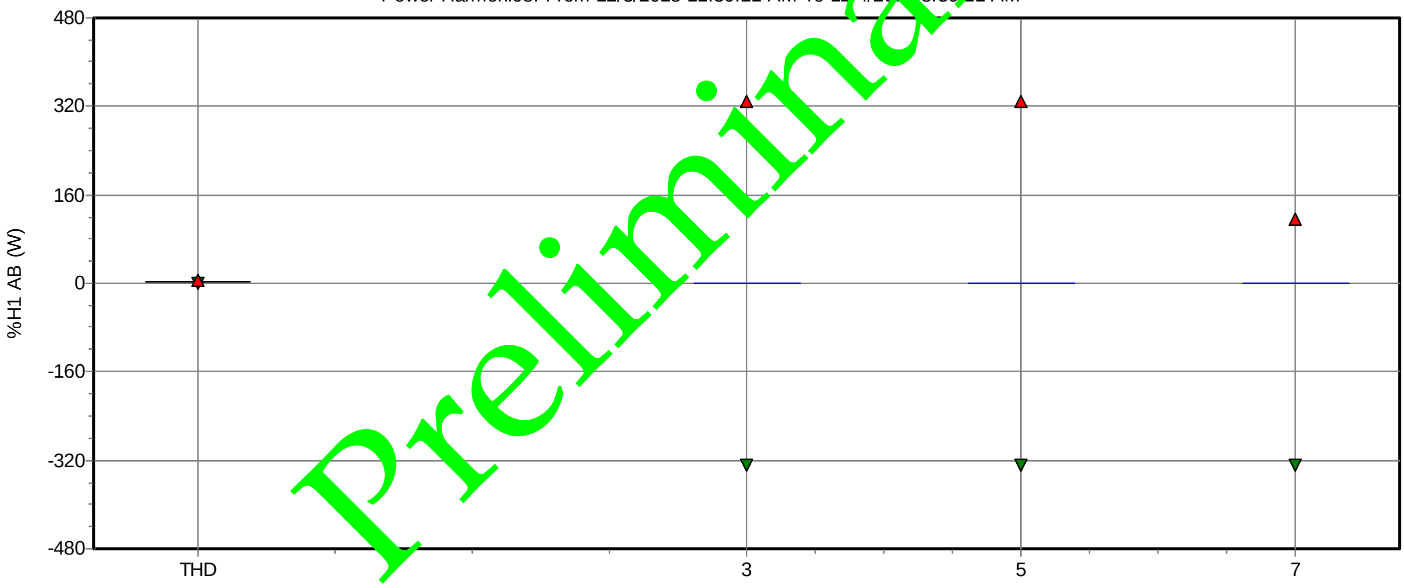

Mains Signaling. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Mains Signaling 1V3s Min
Mains Signaling 1V3s Max
Mains Signaling 1V3s Avg
AB (V)
AB (%)
0.55
0.45
0.35
0.25
0.15
0.05
-0.05
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h


Mains Signaling. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
Mains Signaling 1V3s Min
Mains Signaling 1V3s Max
Mains Signaling 1V3s Avg
BC (V)
BC (%)
0.55
0.45
0.35
0.25
0.15
0.05
-0.05
12h
14h
16h
18h
20h
22h
0h
2h
4h
6h
8h

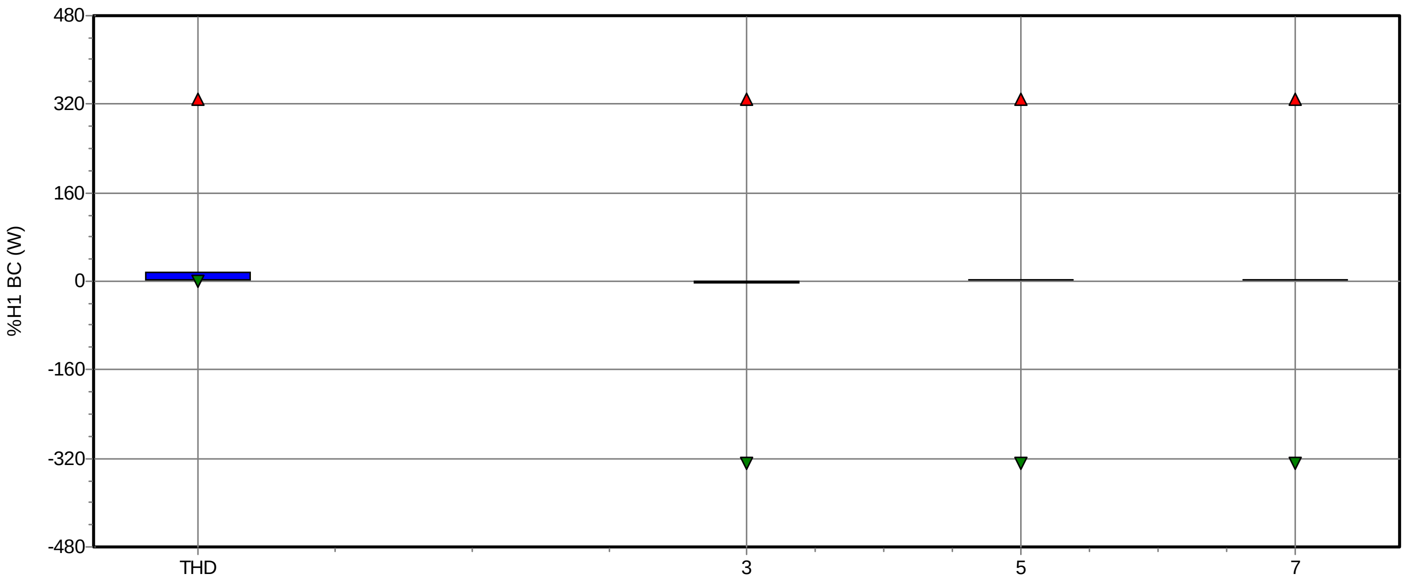
Mains Signaling. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

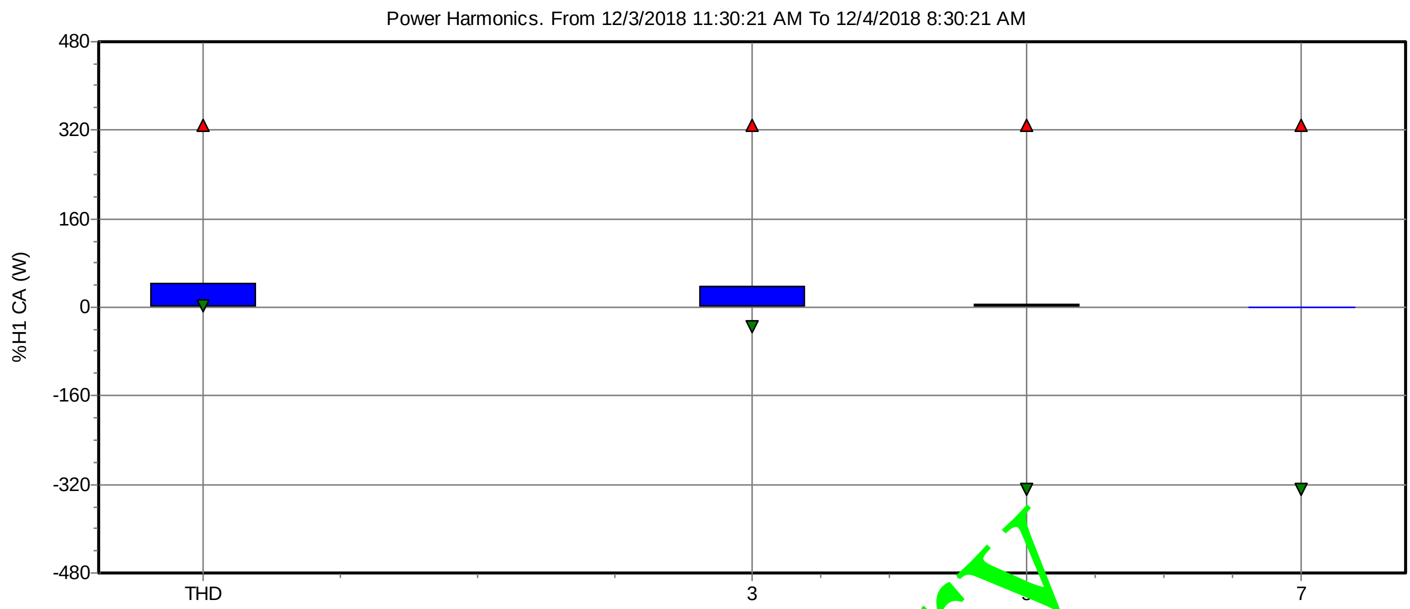


Power Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM

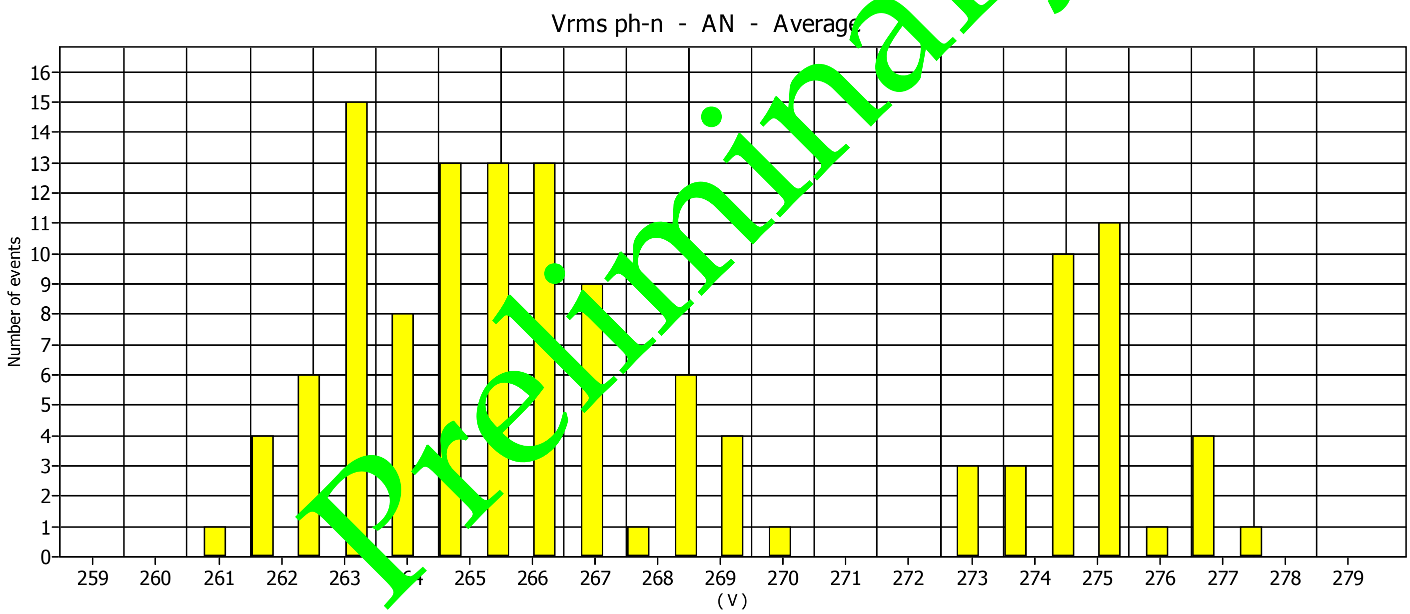


Power Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM





Power Harmonics. From 12/3/2018 11:30:21 AM To 12/4/2018 8:30:21 AM
%H1 CA (W)
480
320
160
0
-160
-320
-480
THD
3
7



Vrms ph-n - AN - Average
Number of events
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
259
260
261
262
263
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
(V)

Instrument Information

Model Number	435-II
Serial Number	34843110
Firmware Revision	V05.04

Software Information

Power Log Version	5.4
FLUKE 430-II DLL Version	1.2.0.13

General Information

Recording location	FEEDER SOFTSTARTER-2, 45 KW (15HP MOTOR)
Client	AYALA SOUTHVALE
Notes	

Measurement Summary

Measurement topology	3-element delta mode
Application mode	Logger
First recording	12/1/2018 2:40:43 PM 236msec
Last recording	12/1/2018 10:20:43 PM 236msec
Recording interval	0h 10m 0s 0msec
Nominal Voltage	460 V
Nominal Current	60 A
Nominal Frequency	60 Hz
File start time	12/1/2018 2:30:43 PM 236msec
File end time	12/1/2018 10:20:43 PM 236msec
Duration	0d 7h 50m 0s 0msec
Number of events	Normal: 0 Detailed: 0
Events downloaded	No
Number of screens	1
Screens downloaded	Yes
Power measurement method	Unified
Cable type	Copper
Harmonic scale	%H1
THD mode	THD 40
CosPhi / DPF mode	DPF

Scaling

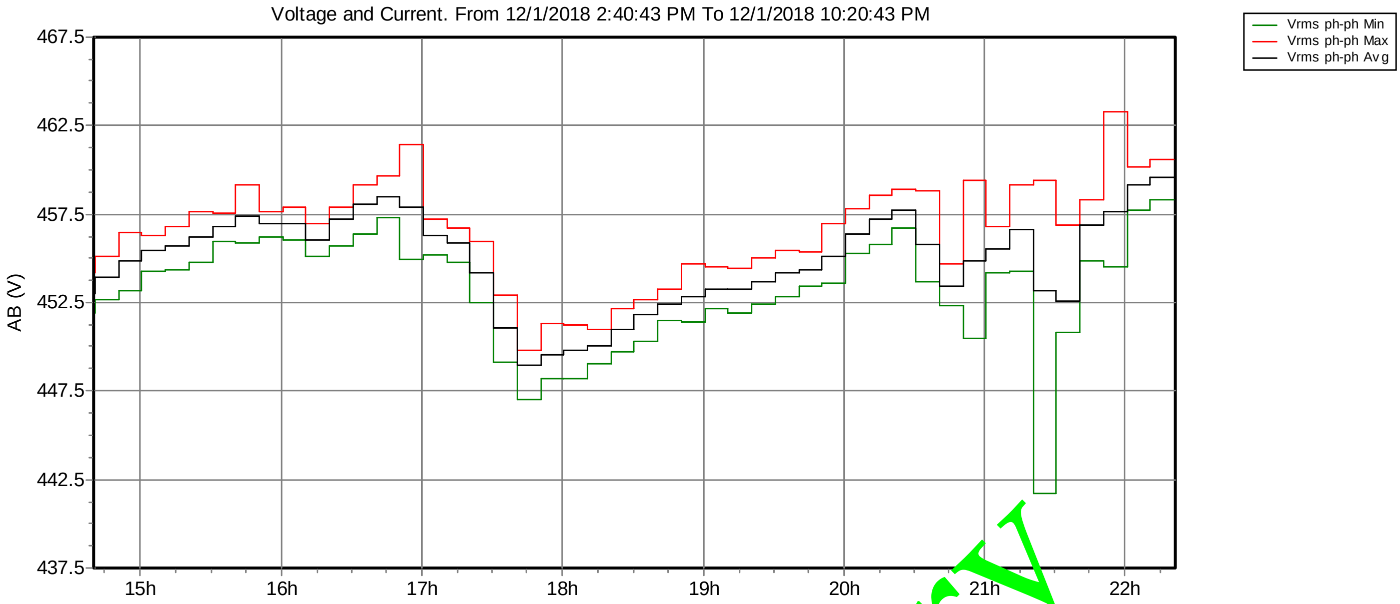
Phase:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	60 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1
Neutral:	
Current Clamp type	i430Flex
Clamp range	N/A
Nominal range	60 A
Sensitivity	x10 AC only
Current ratio	1:1
Voltage ratio	1:1

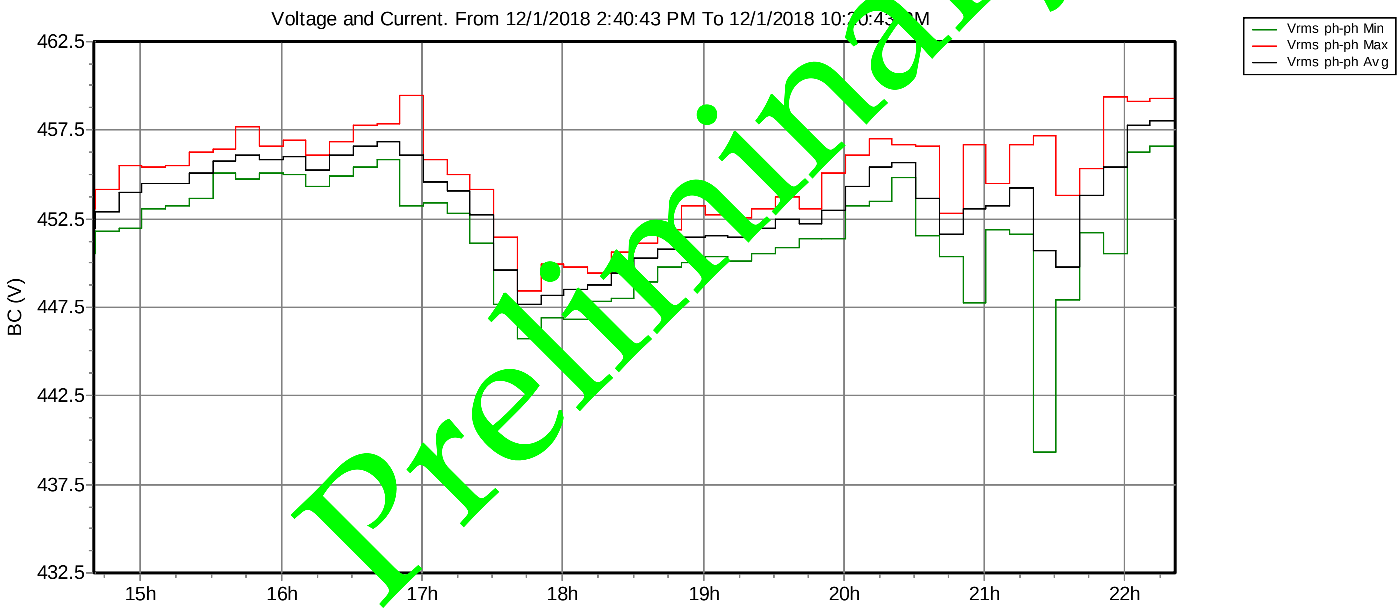
Recording Summary

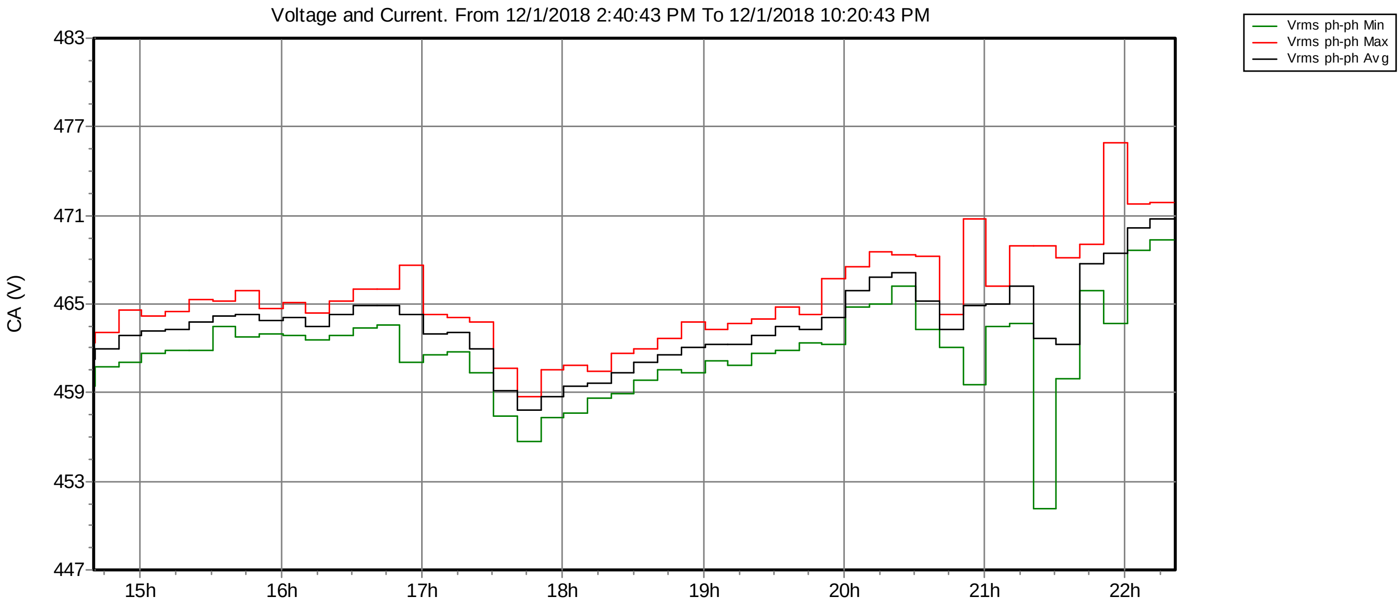
RMS recordings	47
DC recordings	0
Frequency recordings	47
Unbalance recordings	47
Harmonic recordings	47
Power harmonic recordings	47
Power recordings	47
Power unbalance recordings	0
Energy recordings	47
Energy losses recordings	0
Flicker recordings	47
Mains signaling recordings	47

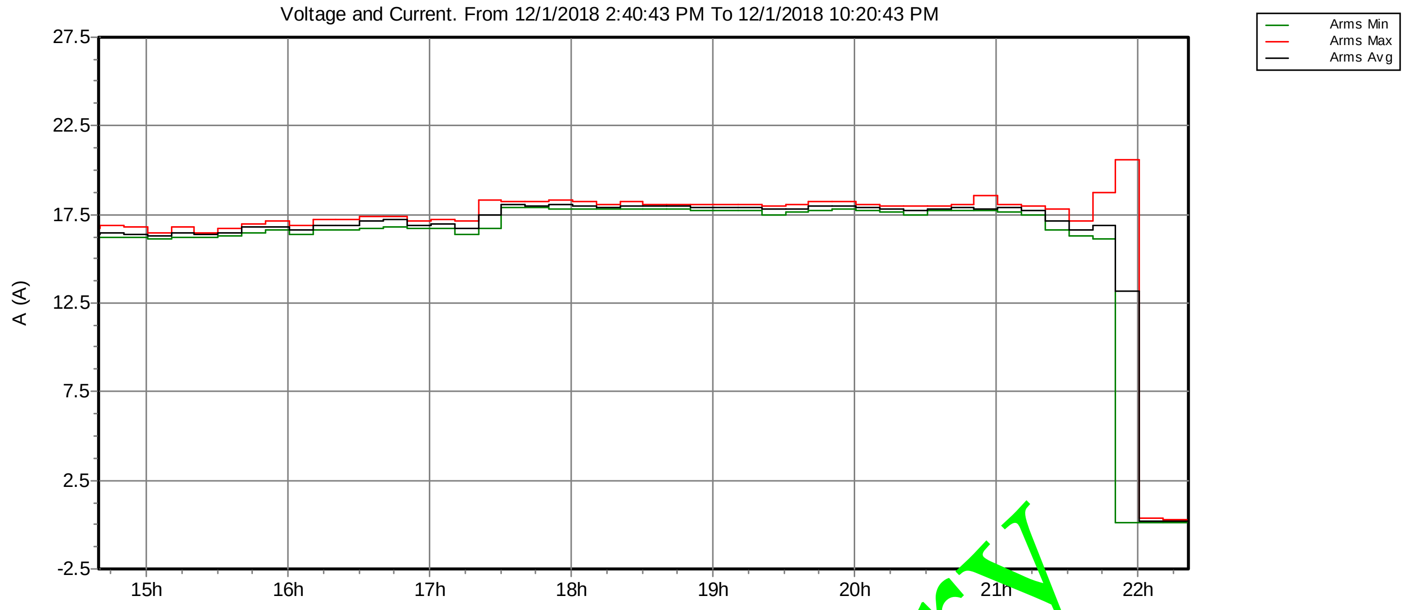
Events Summary

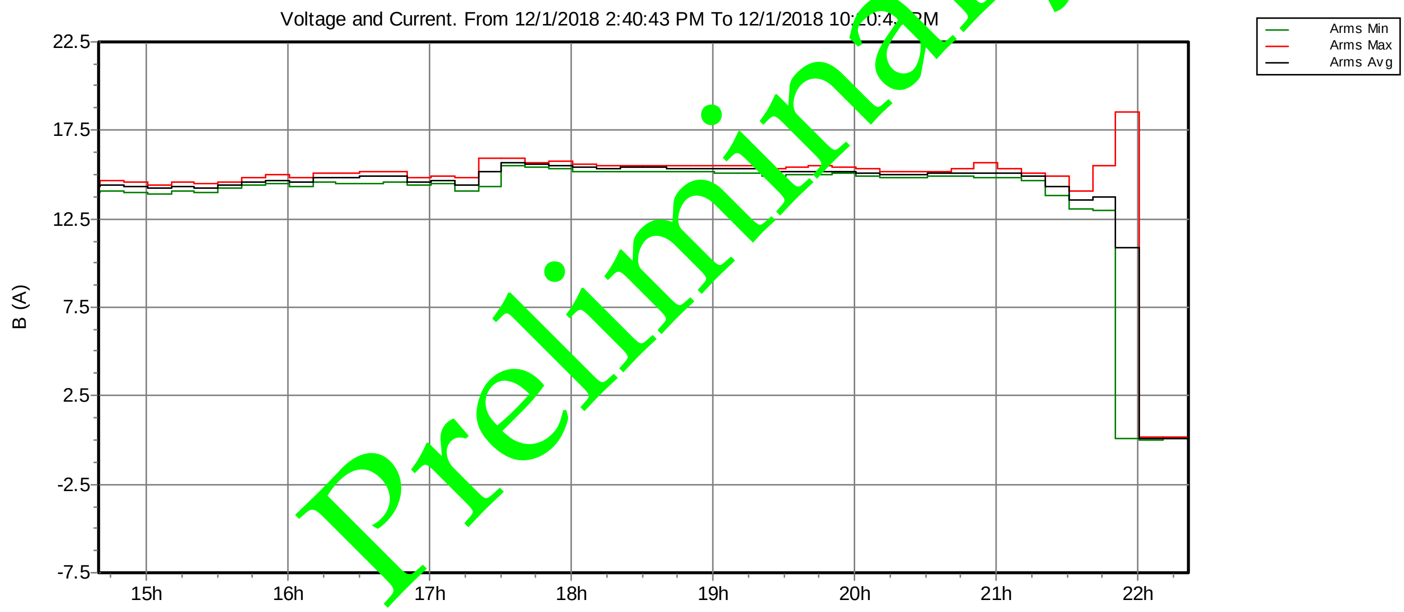
Dips	0
Swells	0
Transients	0
Interruptions	0
Voltage profiles	0
Rapid voltage changes	0
Screens	1
Waveforms	0
Intervals without measurements	0
Inrush current graphics	0
Wave events	0
RMS events	0

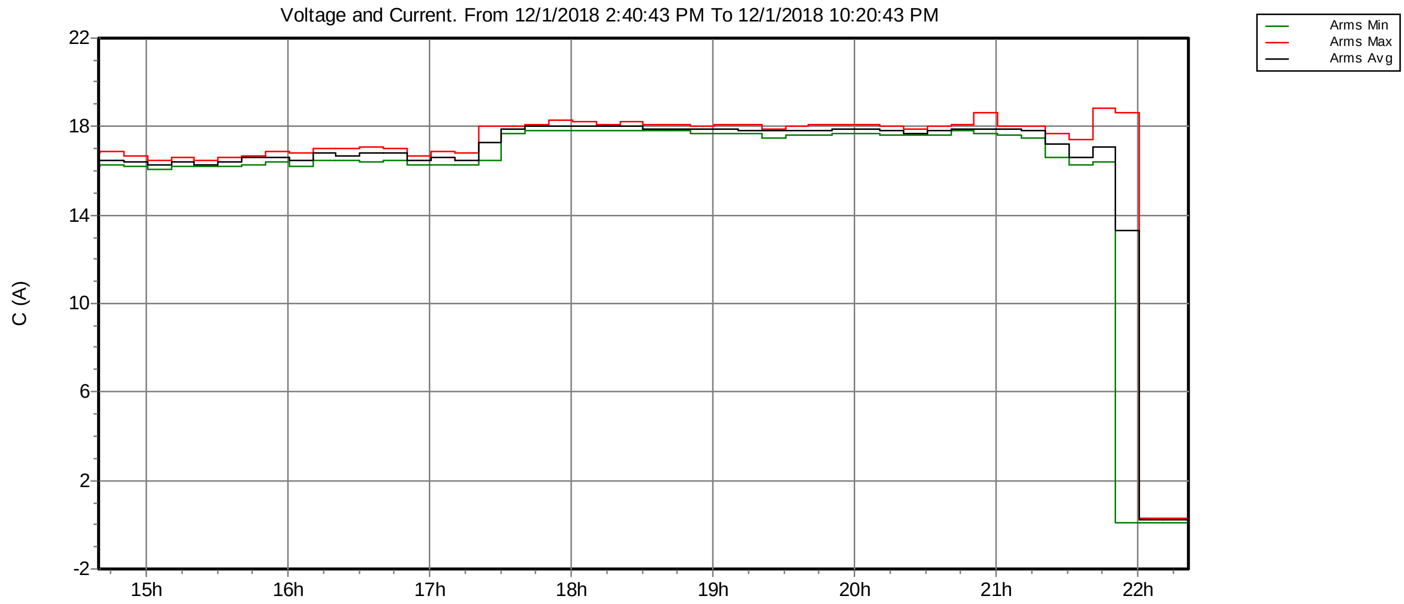

Voltage and Current. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Vrms ph-ph Min
Vrms ph-ph Max
Vrms ph-ph Avg
AB (V)
467.5
462.5
457.5
452.5
447.5
442.5
437.5
15h
16h
17h
18h
19h
20h
21h
22h

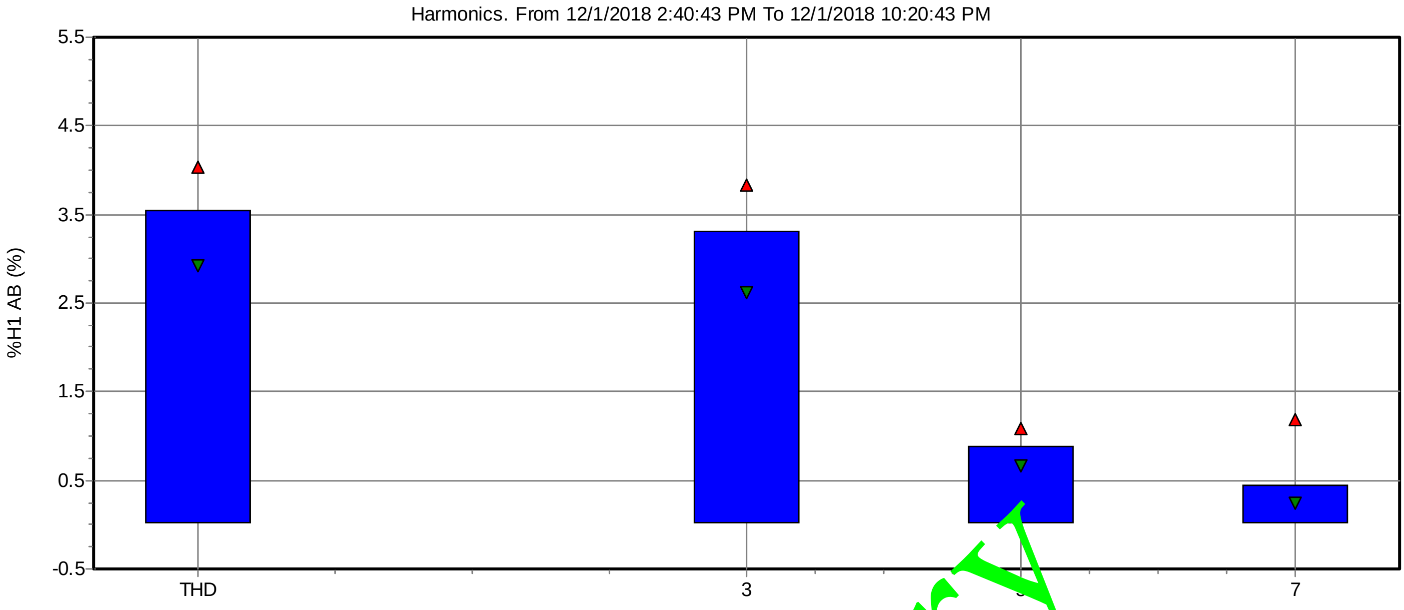

Voltage and Current. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Vrms ph-ph Min
Vrms ph-ph Max
Vrms ph-ph Avg
BC (V)
462.5
457.5
452.5
447.5
442.5
437.5
432.5
15h
16h
17h
18h
19h
20h
21h
22h
Preliminary

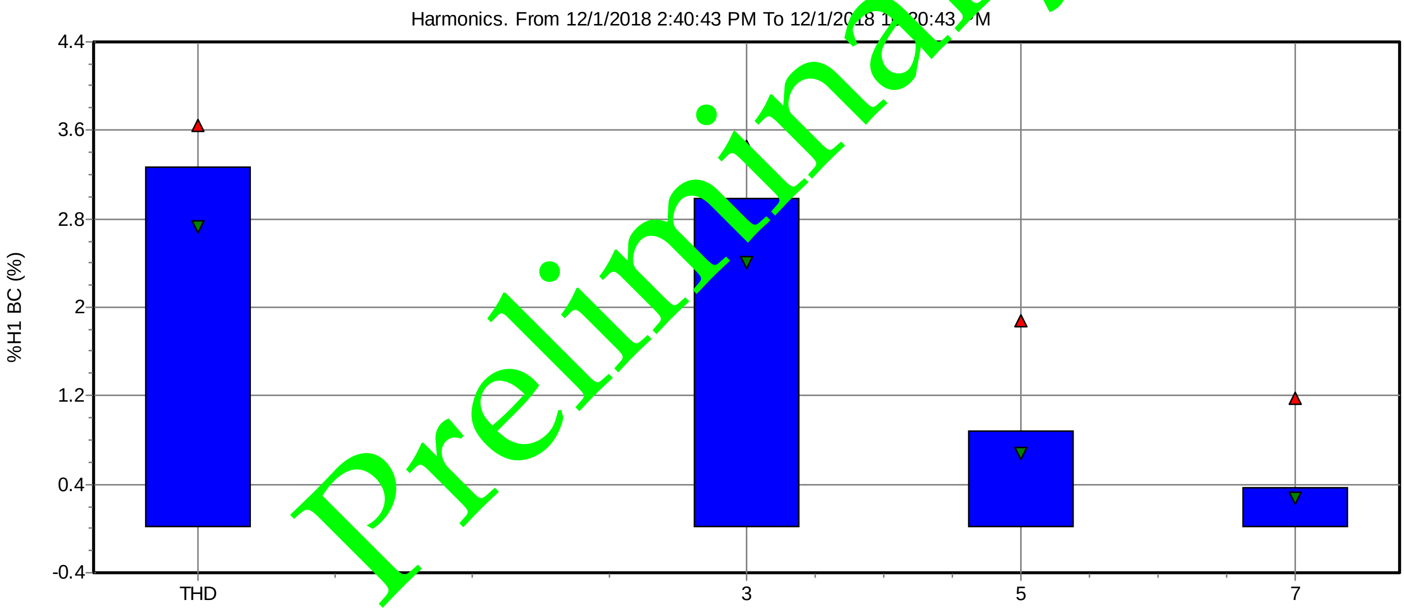

Voltage and Current. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Vrms ph-ph Min
Vrms ph-ph Max
Vrms ph-ph Avg
CA (V)
483
477
471
465
459
453
447
15h
16h
17h
18h
19h
20h
21h
22h

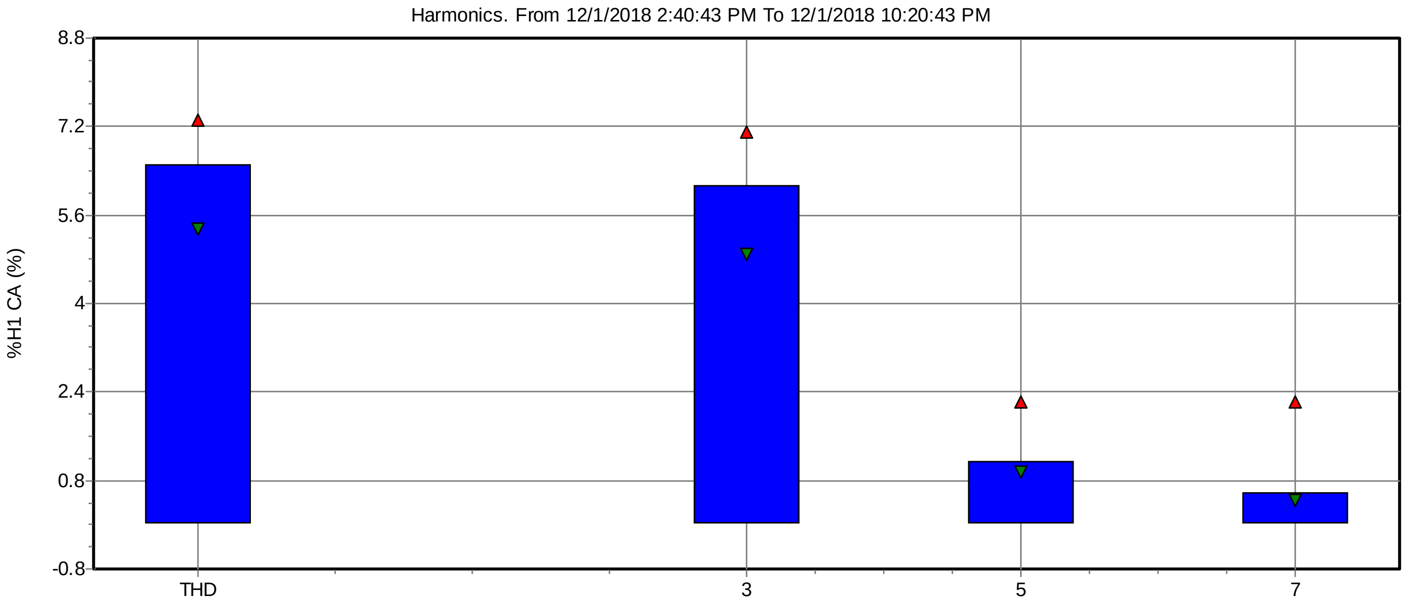

Voltage and Current. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
A (A)
27.5
22.5
17.5
12.5
7.5
2.5
-2.5
15h
16h
17h
18h
19h
20h
21h
22h
Arms Min
Arms Max
Arms Avg

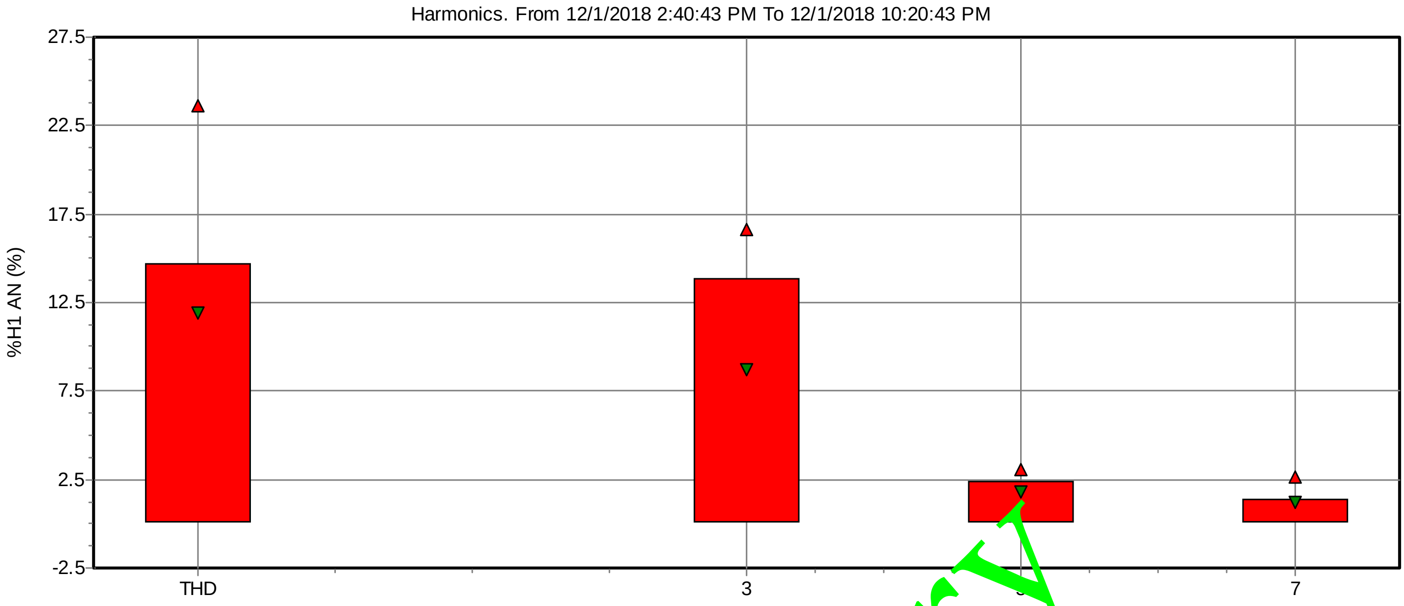

Voltage and Current. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
B (A)
22.5
17.5
12.5
7.5
2.5
-2.5
-7.5
15h
16h
17h
18h
19h
20h
21h
22h
Arms Min
Arms Max
Arms Avg

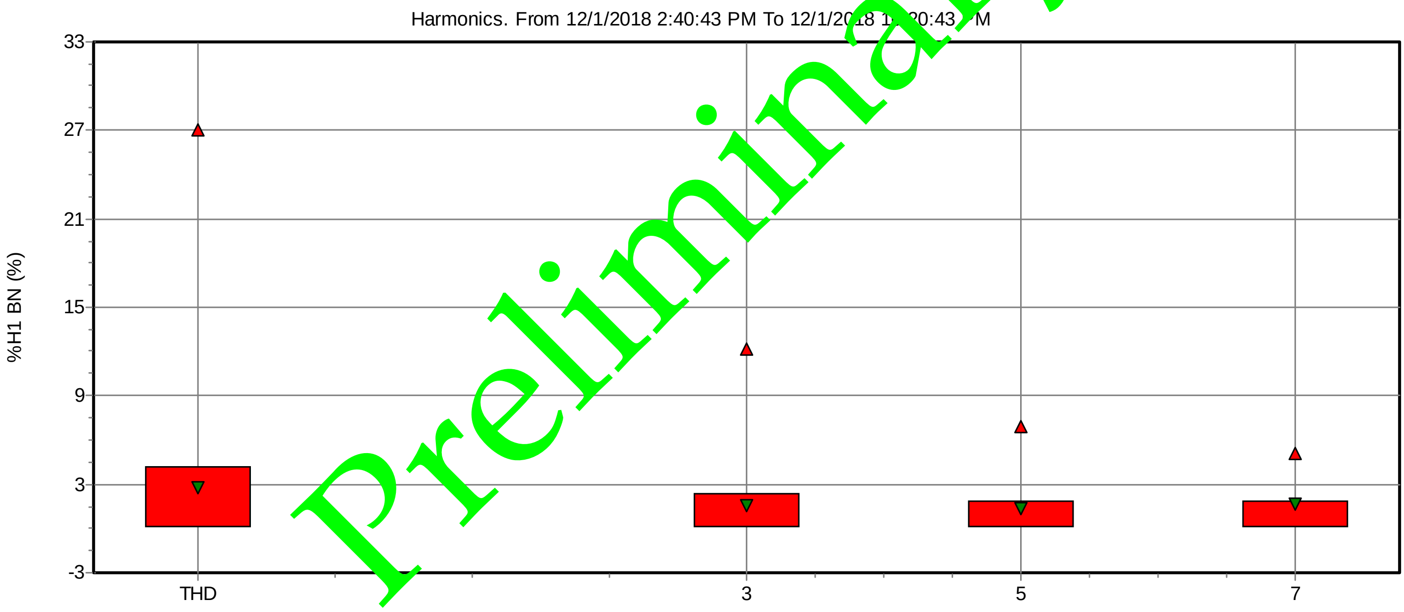

Voltage and Current. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
C (A)
22
18
14
10
6
2
-2
15h
16h
17h
18h
19h
20h
21h
22h
Arms Min
Arms Max
Arms Avg

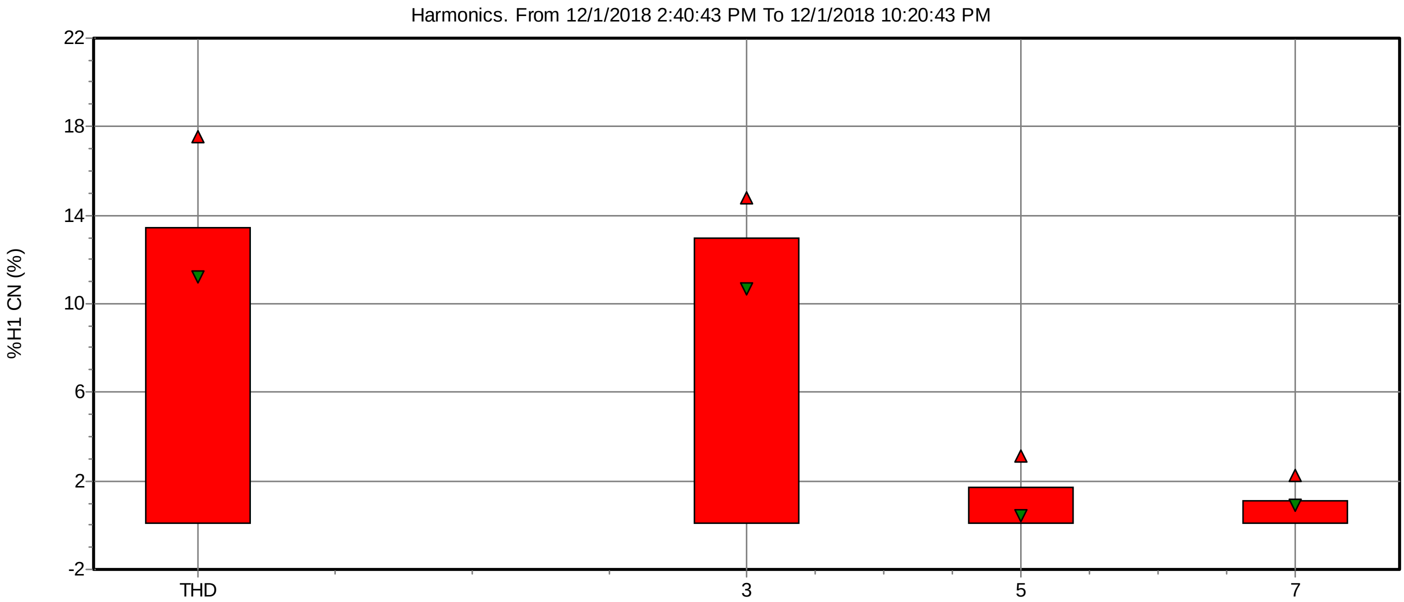

Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
%H1 AB (%)
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
THD
3
5
7

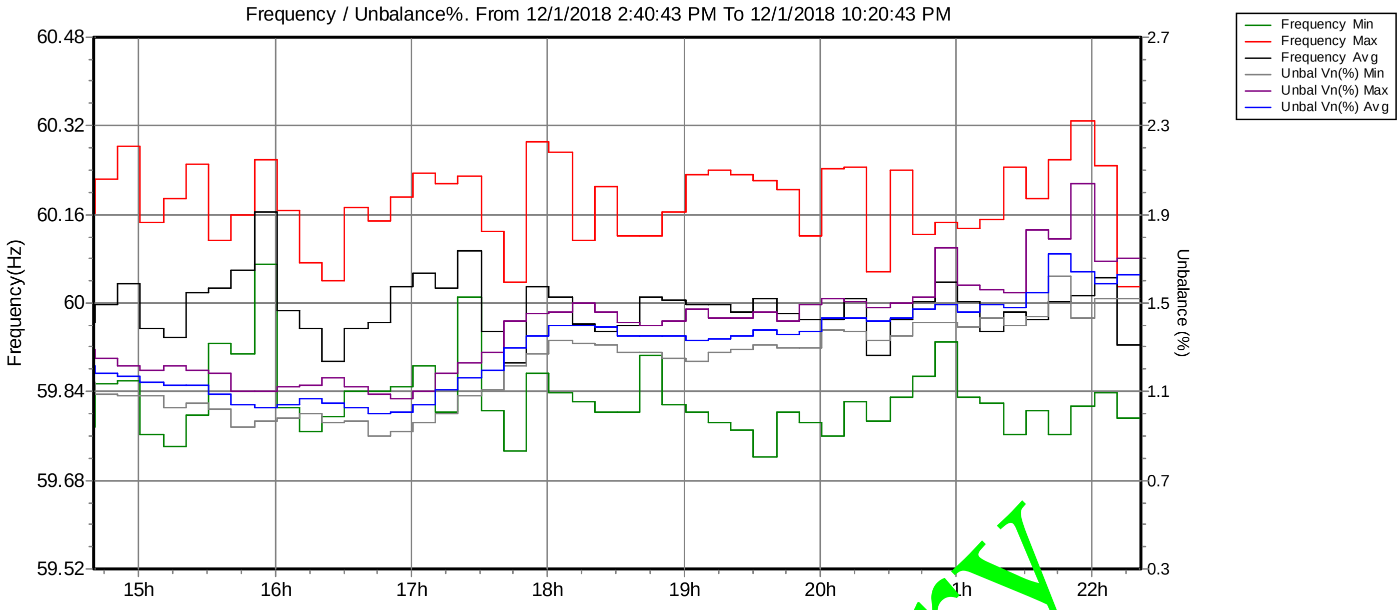

Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
%H1 BC (%)
4.4
3.6
2.8
2
1.2
0.4
-0.4
THD
3
5
7
Preliminary

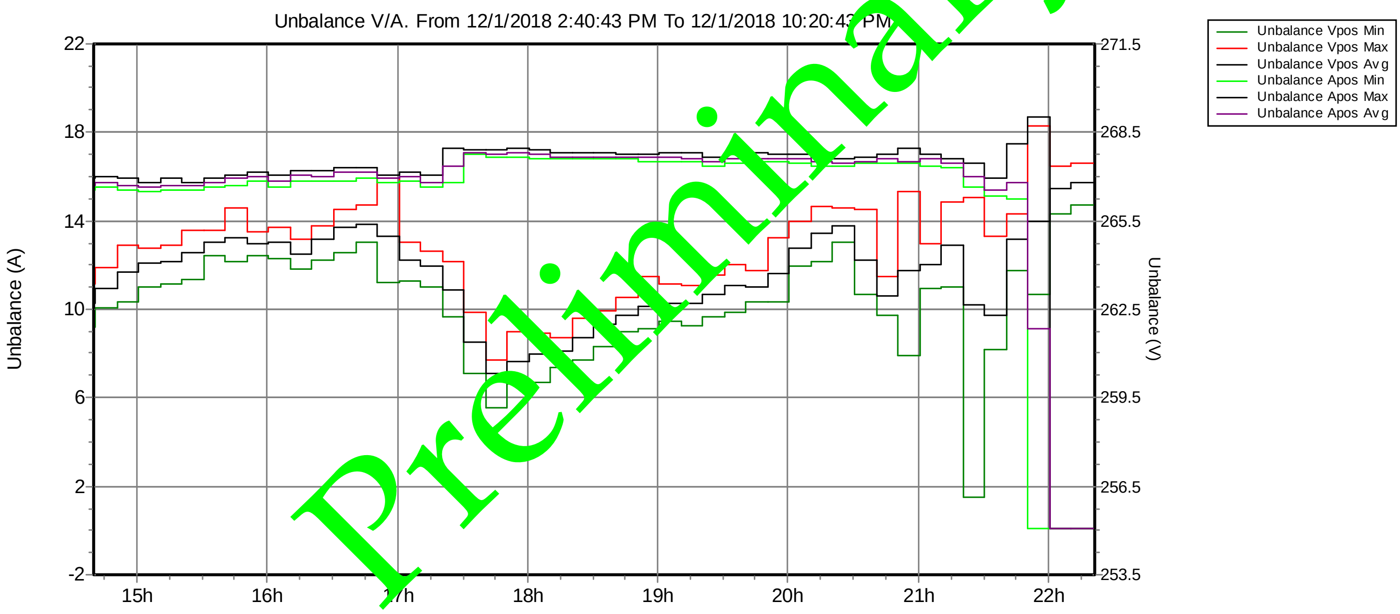

Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
%H1 CA (%)
8.8
7.2
5.6
4
2.4
0.8
-0.8
THD
3
5
7

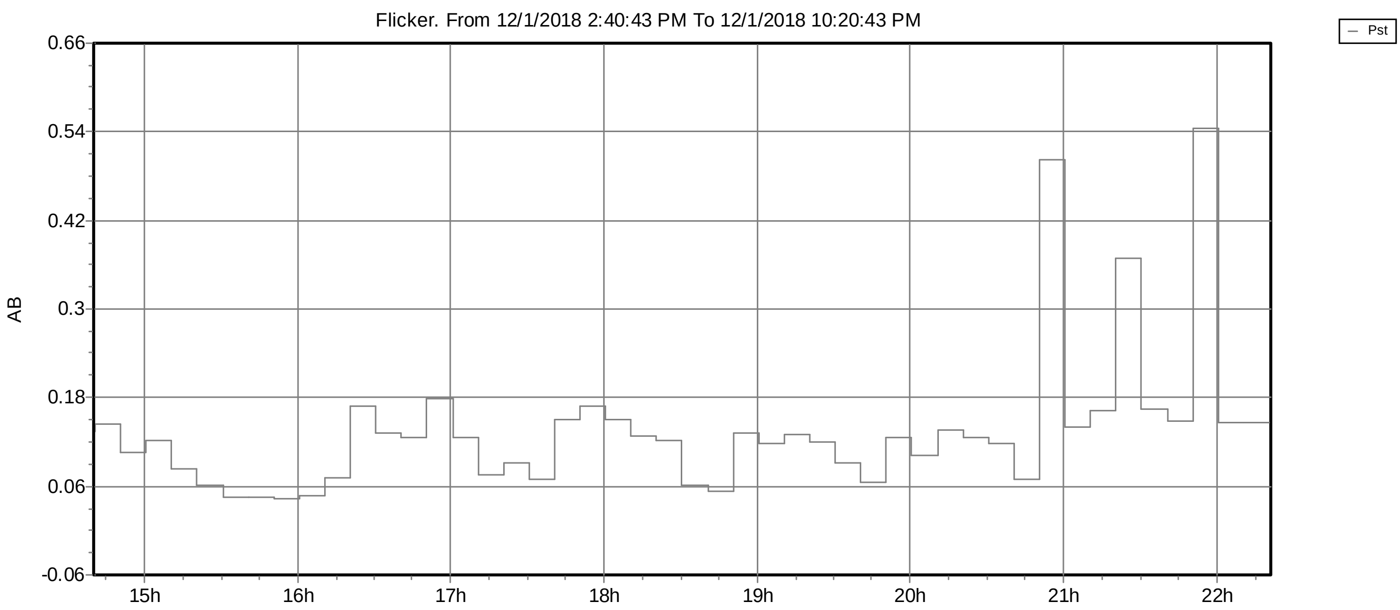

Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
%H1 AN (%)
27.5
22.5
17.5
12.5
7.5
2.5
-2.5
THD
3
7

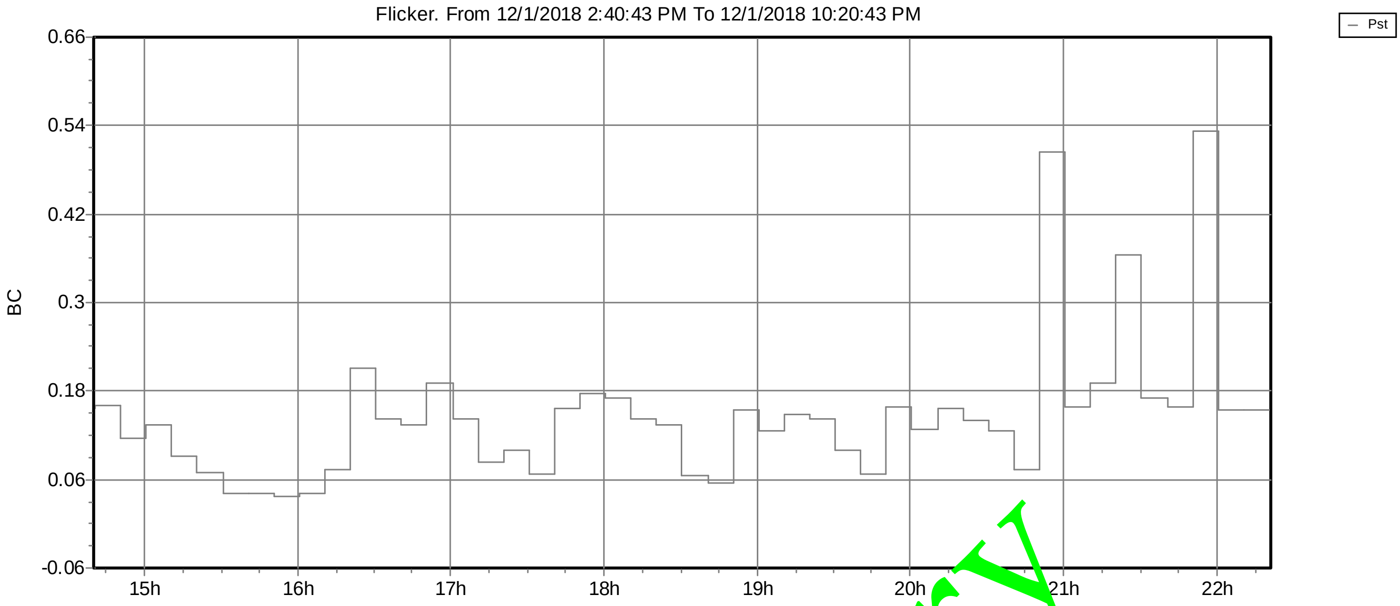

Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
%H1 BN (%)
33
27
21
15
9
3
-3
THD
3
5
7

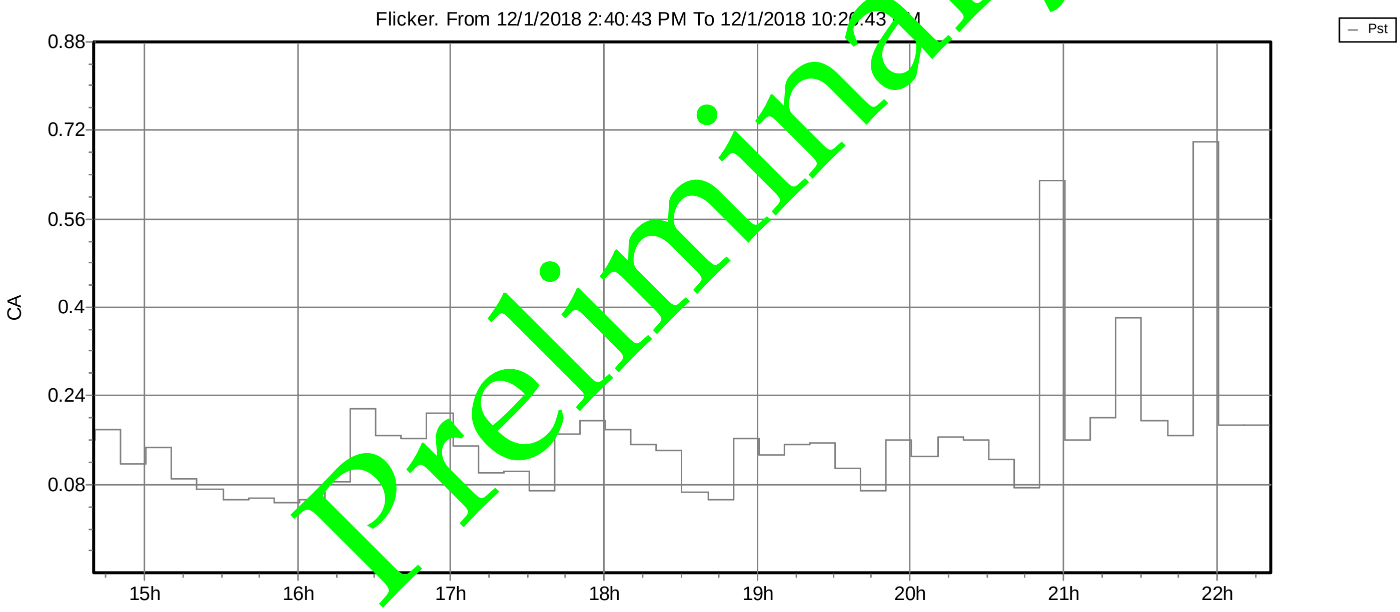

Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
%H1 CN (%)
22
18
14
10
6
2
-2
THD
3
5
7

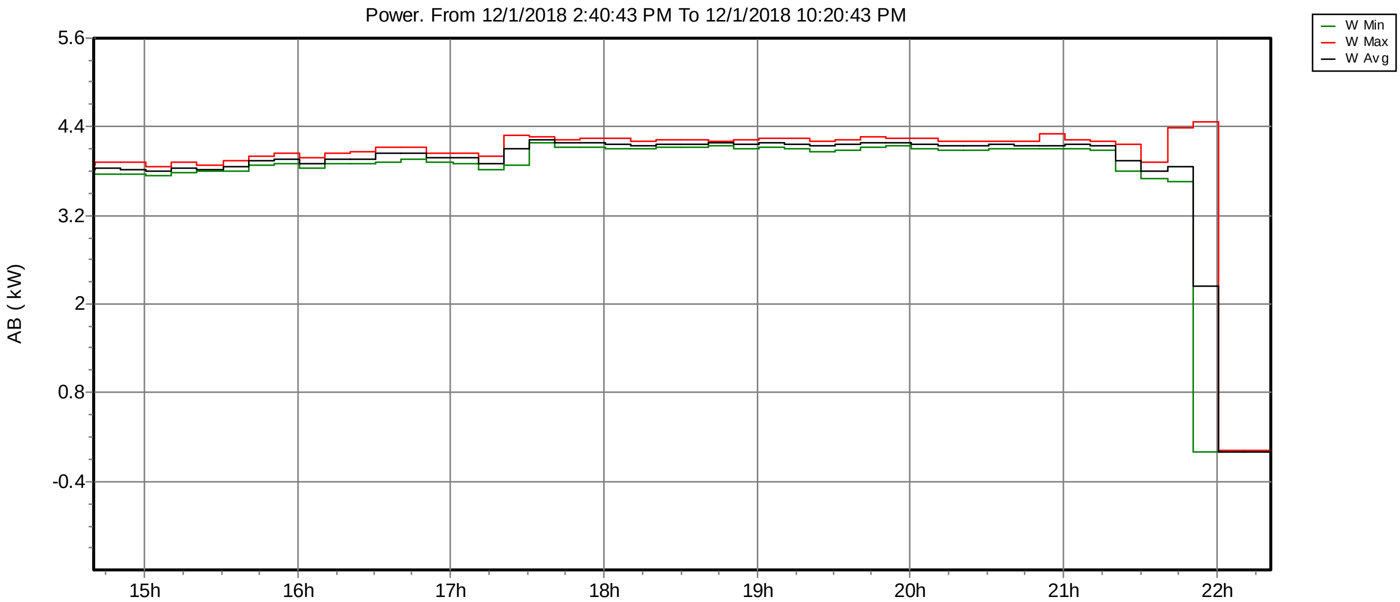

Frequency / Unbalance%. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Frequency Min
Frequency Max
Frequency Avg
Unbal Vn(%) Min
Unbal Vn(%) Max
Unbal Vn(%) Avg
Frequency(Hz)
Unbalance (%)
60.48
60.32
60.16
60
59.84
59.68
59.52
2.7
2.3
1.9
1.5
1.1
0.7
0.3
15h
16h
17h
18h
19h
20h
21h
22h

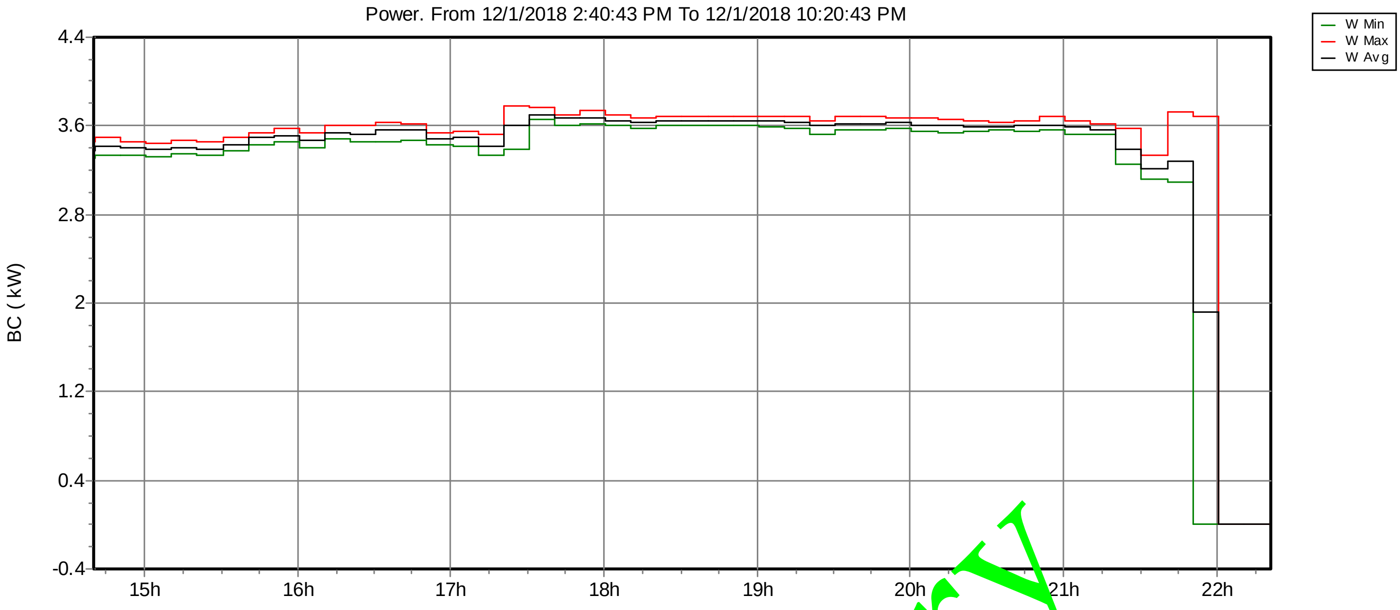

Unbalance V/A. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Unbalance Vpos Min
Unbalance Vpos Max
Unbalance Vpos Avg
Unbalance Apos Min
Unbalance Apos Max
Unbalance Apos Avg
Unbalance (A)
Unbalance (V)
22
18
14
10
6
2
-2
271.5
268.5
265.5
262.5
259.5
256.5
253.5
15h
16h
17h
18h
19h
20h
21h
22h
Preliminary

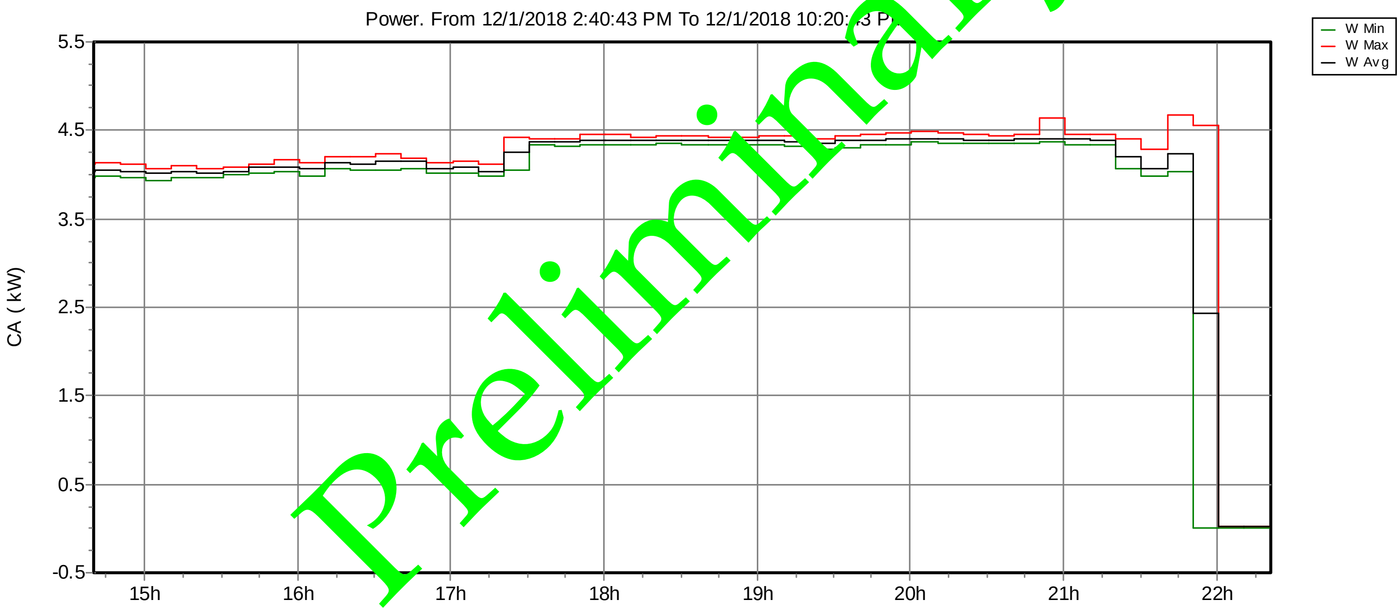

Flicker. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Pst
AB
0.66
0.54
0.42
0.3
0.18
0.06
-0.06
15h
16h
17h
18h
19h
20h
21h
22h

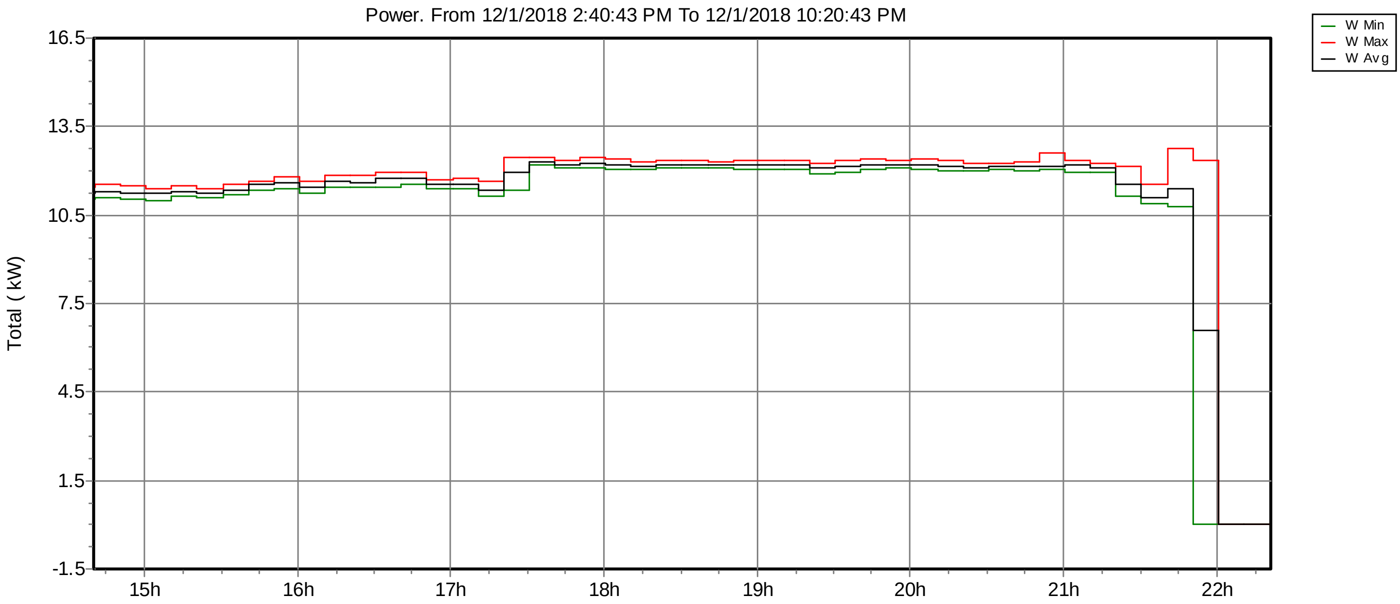

Flicker. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Pst
BC
0.66
0.54
0.42
0.3
0.18
0.06
-0.06
15h
16h
17h
18h
19h
20h
21h
22h


Flicker. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Pst
CA
0.88
0.72
0.56
0.4
0.24
0.08
15h
16h
17h
18h
19h
20h
21h
22h

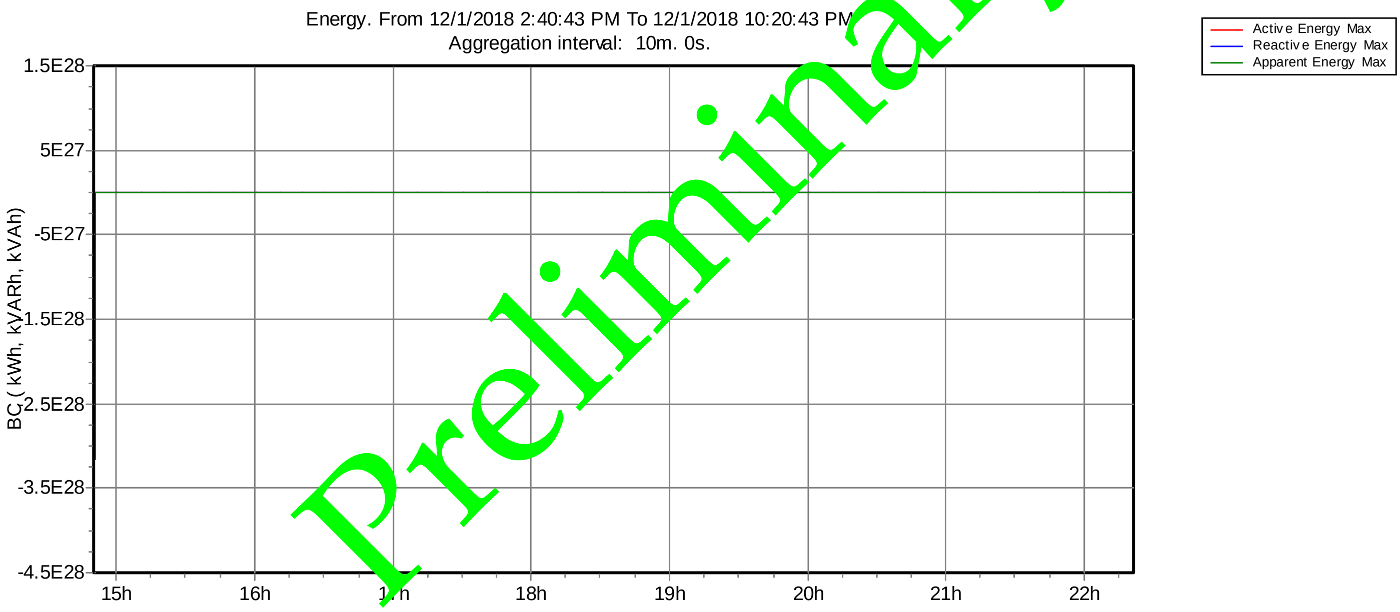

Power. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
W Min
W Max
W Avg
AB (kW)
5.6
4.4
3.2
2
0.8
-0.4
15h
16h
17h
18h
19h
20h
21h
22h

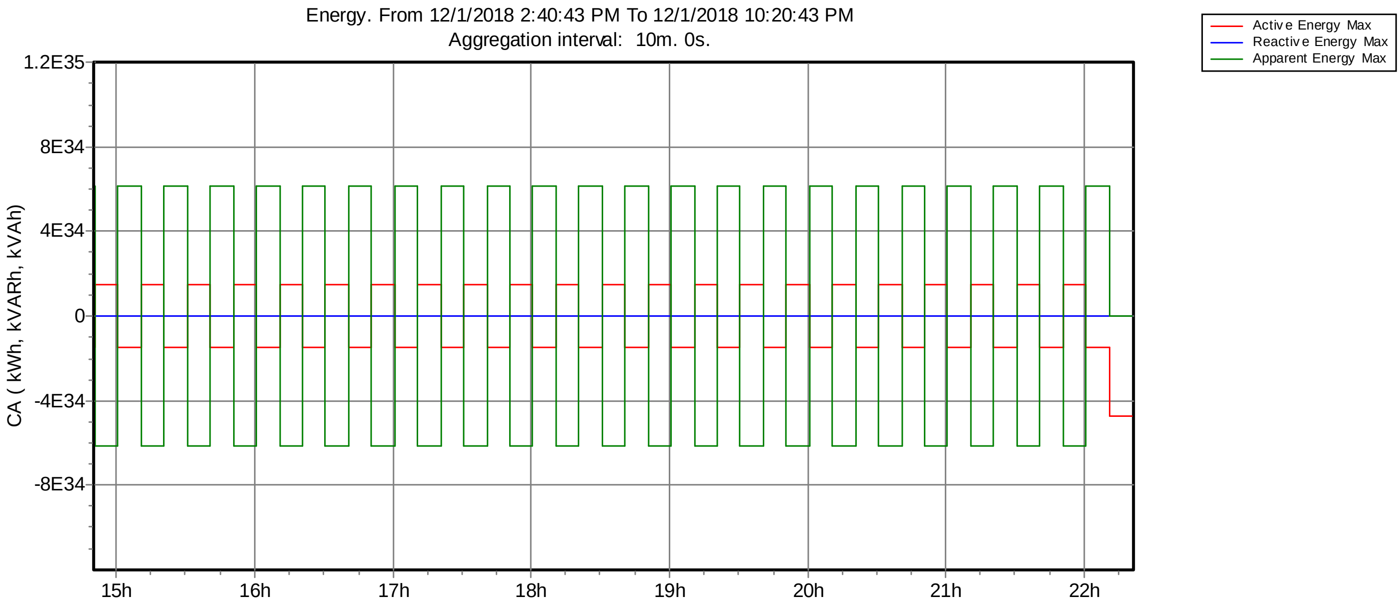

Power. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
BC (kW)
4.4
3.6
2.8
2
1.2
0.4
-0.4
15h
16h
17h
18h
19h
20h
21h
22h
W Min
W Max
W Avg


Power. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
CA (kW)
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
15h
16h
17h
18h
19h
20h
21h
22h
W Min
W Max
W Avg

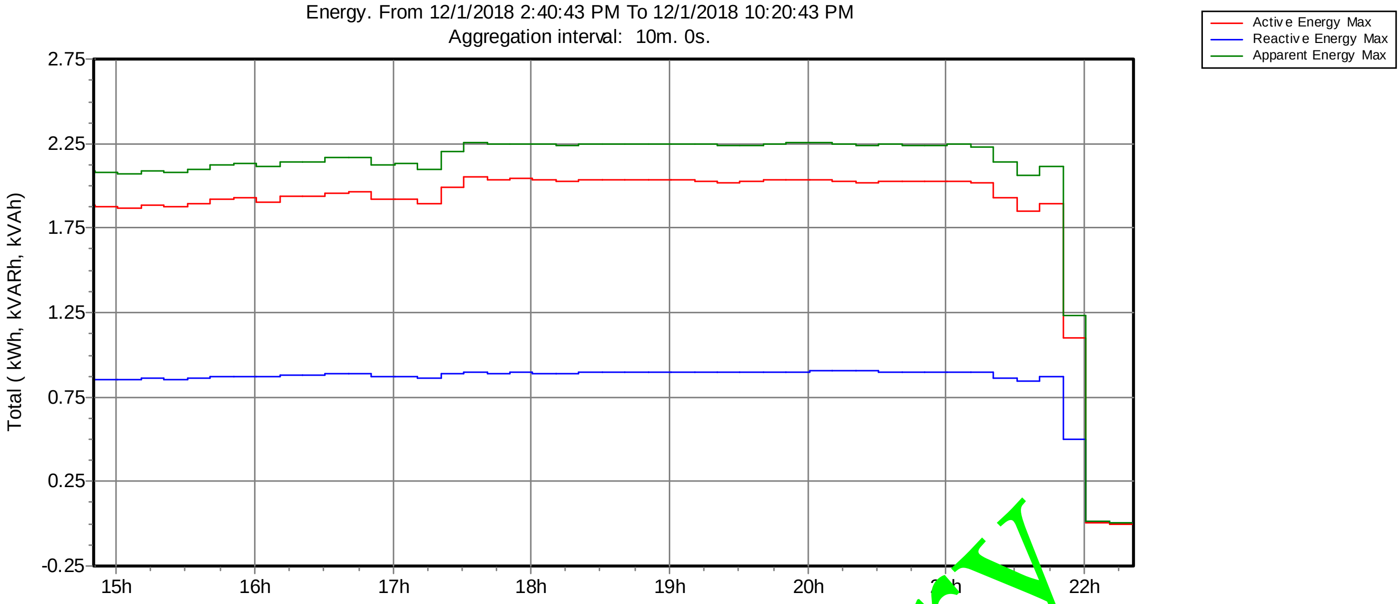

Power. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Total (kW)
16.5
13.5
10.5
7.5
4.5
1.5
-1.5
15h
16h
17h
18h
19h
20h
21h
22h
W Min
W Max
W Avg


Energy. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Aggregation interval: 10m. 0s.
Active Energy Max
Reactive Energy Max
Apparent Energy Max
AB (kWh, kVARh, kVAh)
7E25
3E25
-1E25
-5E25
-9E25
-1.3E26
-1.7E26
15h
16h
17h
18h
19h
20h
21h
22h

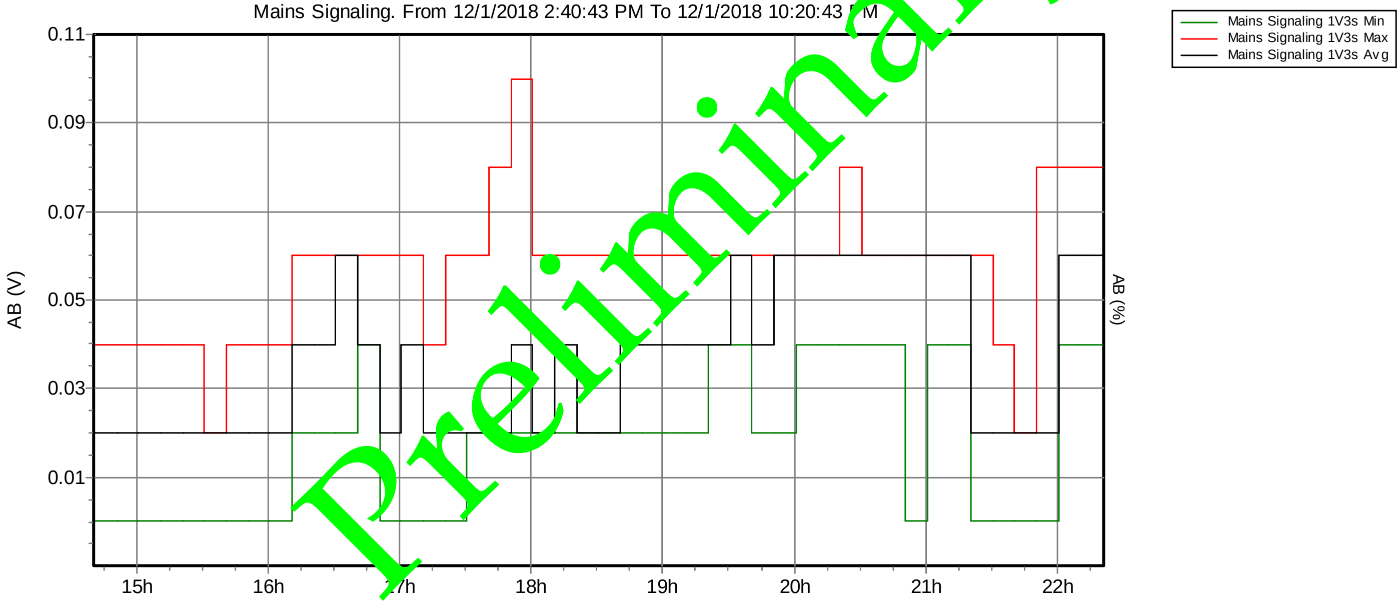

Energy. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Aggregation interval: 10m. 0s.
Active Energy Max
Reactive Energy Max
Apparent Energy Max
BC (kWh, kVARh, kVAh)
1.5E28
5E27
-5E27
-1.5E28
-2.5E28
-3.5E28
-4.5E28
15h
16h
17h
18h
19h
20h
21h
22h
Preliminary


Energy. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Aggregation interval: 10m. 0s.
Active Energy Max
Reactive Energy Max
Apparent Energy Max
CA (kWh, kVARh, kVAh)
1.2E35
8E34
4E34
0
-4E34
-8E34
15h
16h
17h
18h
19h
20h
21h
22h

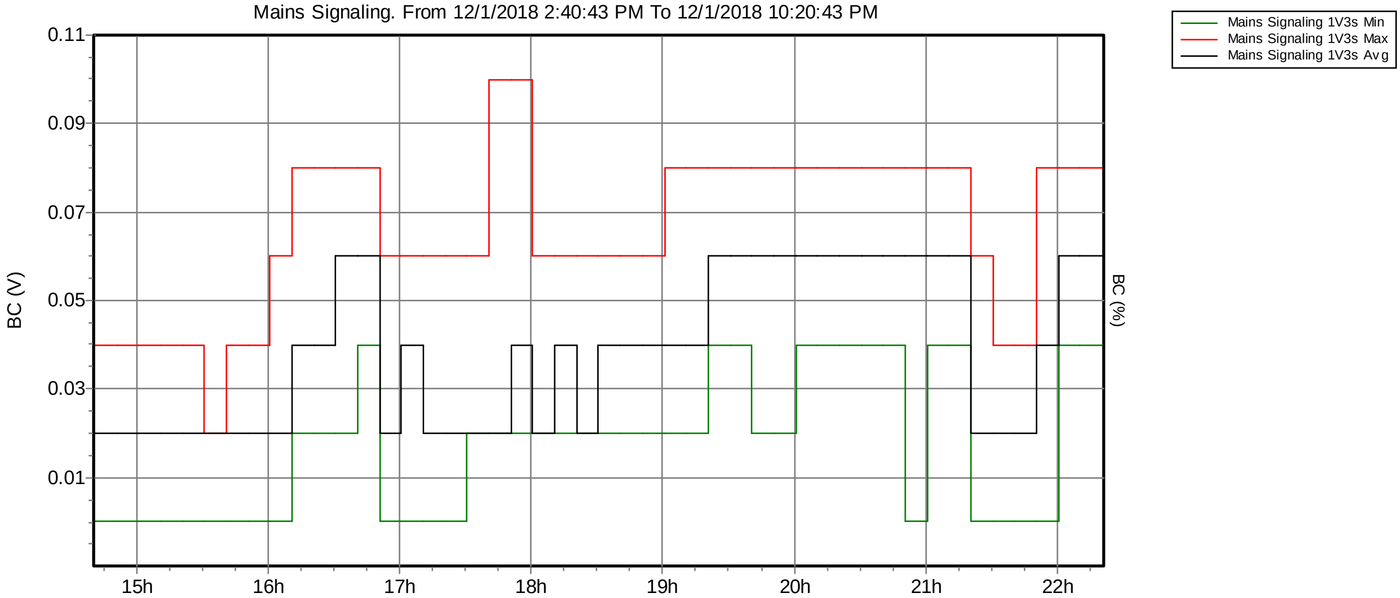
Energy. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
Aggregation interval: 10m. 0s.



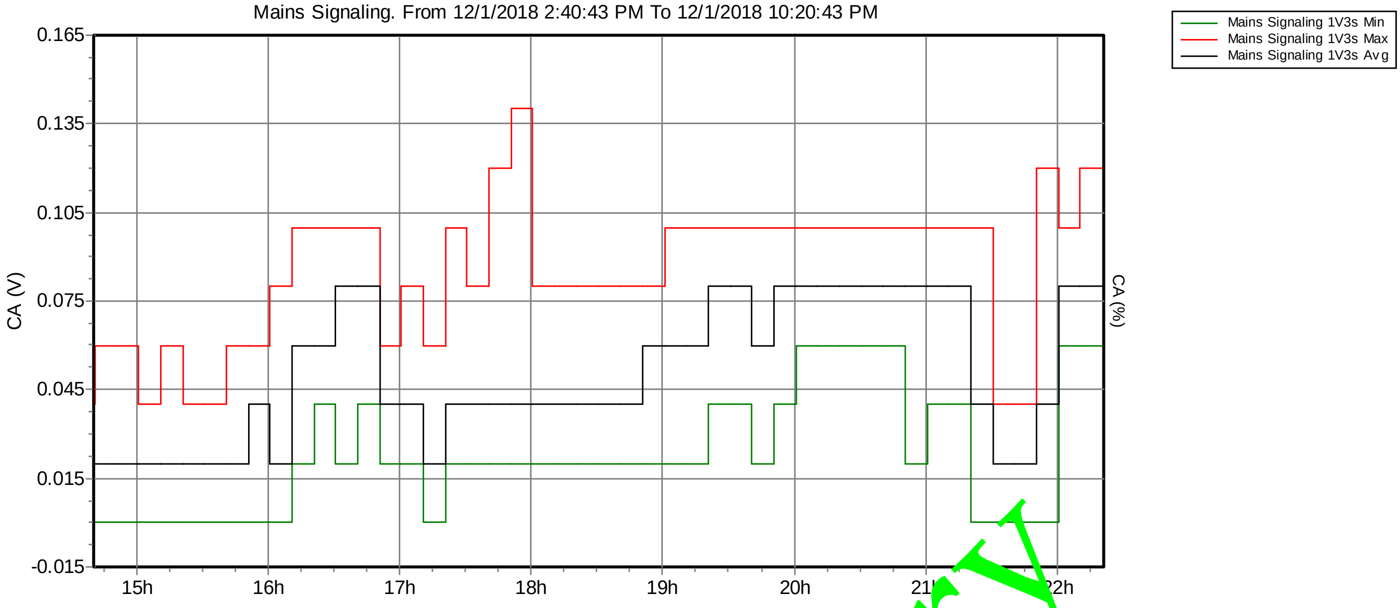
Mains Signaling. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM



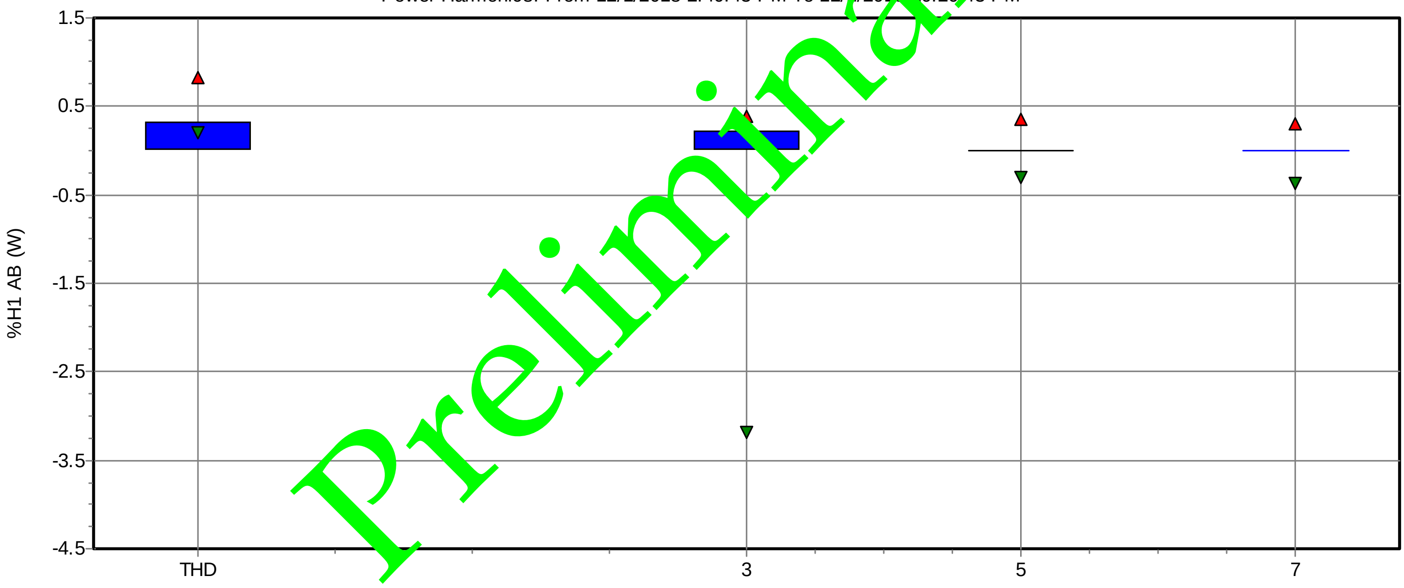
Mains Signaling. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM



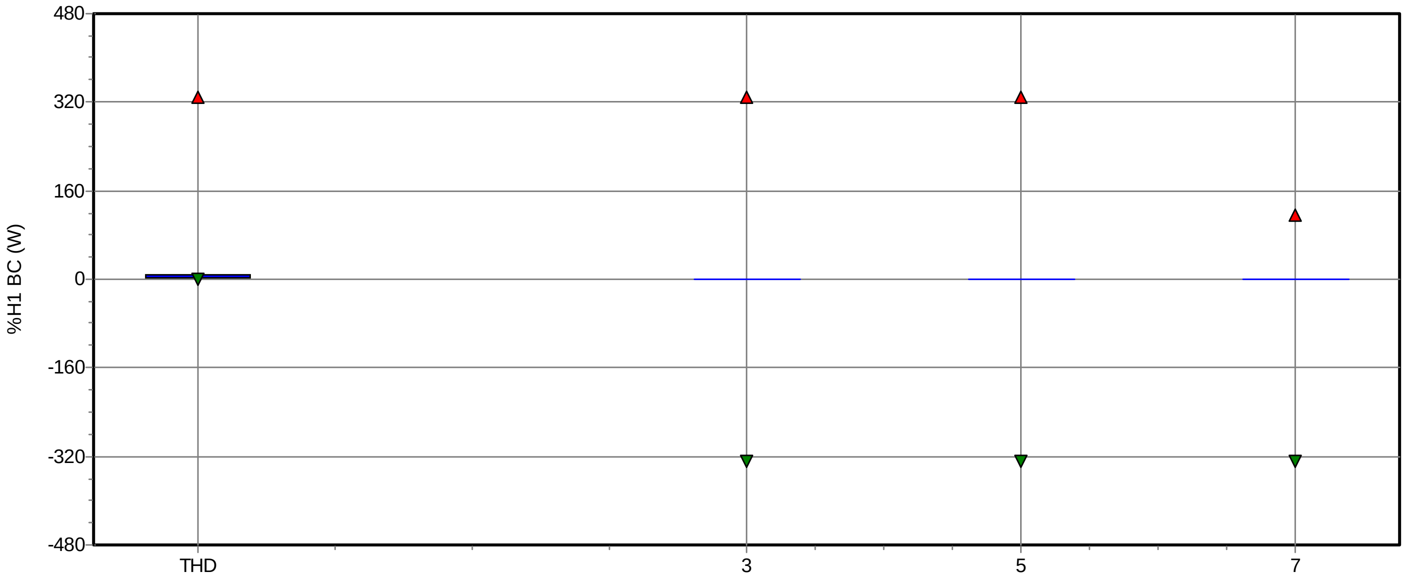
Mains Signaling. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM

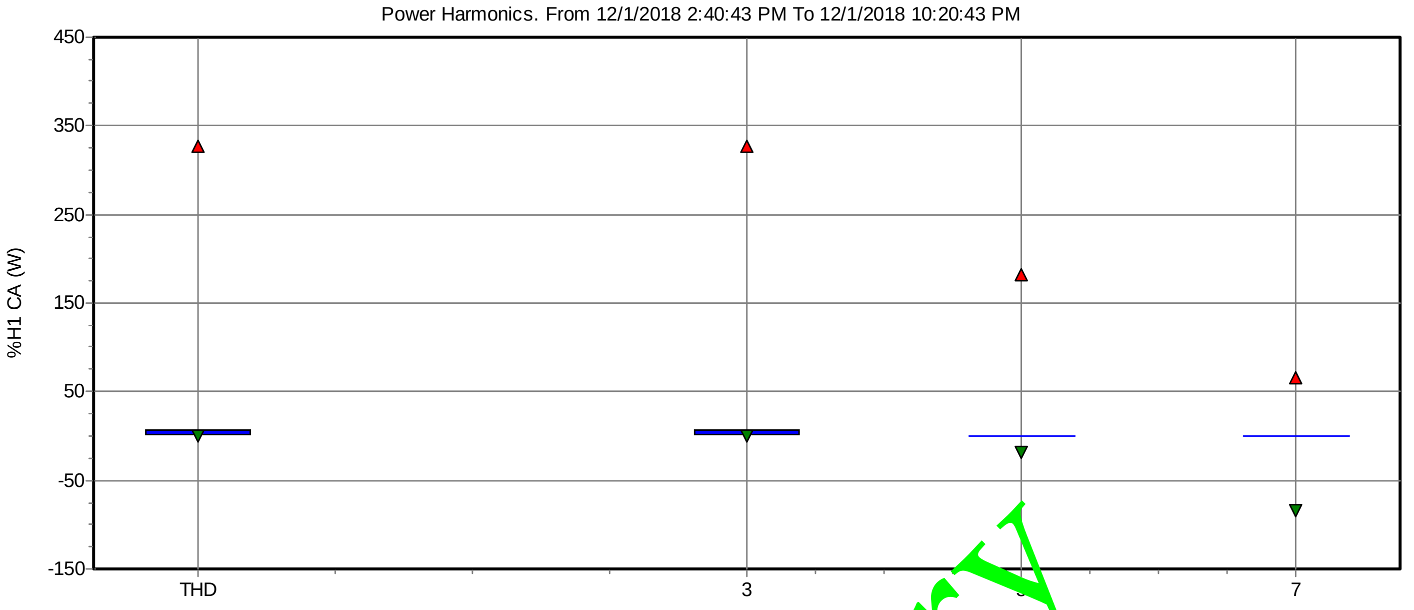


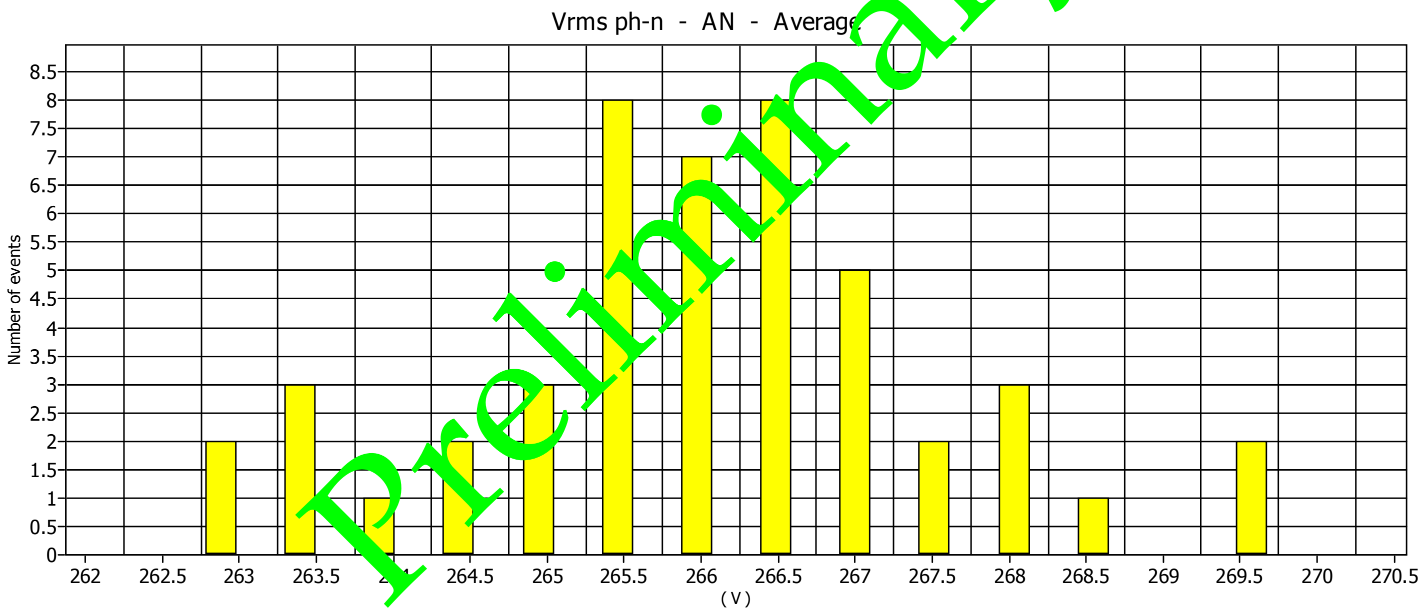
Power Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM



Power Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM

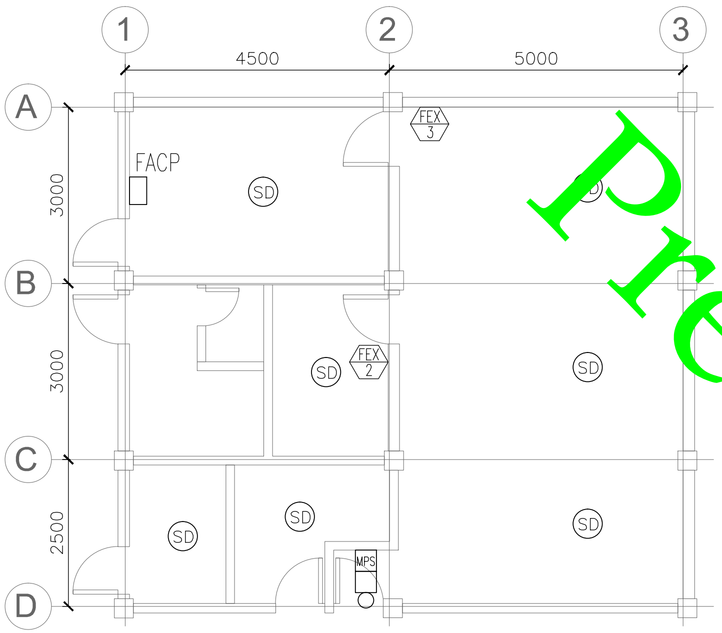



Power Harmonics. From 12/1/2018 2:40:43 PM To 12/1/2018 10:20:43 PM
%H1 CA (W)
450
350
250
150
50
-50
-150
THD
3
7


Vrms ph-n - AN - Average
Number of events
(V)

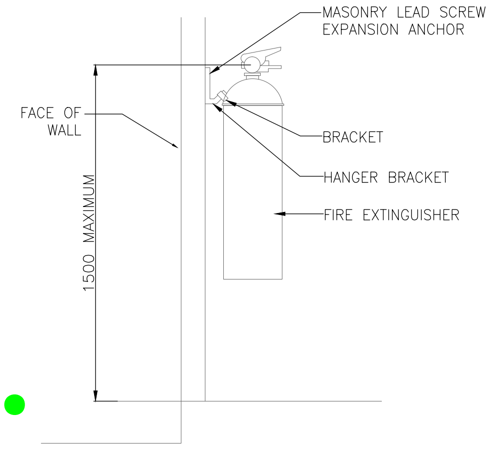
Appendix C

Drawings



FDAS AND FEX LOCATION PLAN

1 EE-01



FIRE EXTINGUISHER INSTALLATION PLAN

EE-01

Preliminary

LEGEND:

SYMBOL	QTY	DESCRIPTION
FEX 2	1 UNITS	MULTI-PURPOSE DRY CHEMICAL W/ 2A MIN. RATING (RED)
FEX 3	1 UNITS	CLEAN EXTINGUISHER AGENT (GREEN)
SD	7 UNITS	SMOKE DETECTOR
	1 UNITS	ALARM BELL 6" DIAMETER
MPS	1 UNITS	MANUAL PULL STATION
FACP	1 UNIT	FIRE ALARM CONTROL SYSTEM

Maynilad - CONFORME: HEAD, Division (End User)	Maynilad - CONFORME: HEAD, Department (End User)

DRAWN	SURVEYED	DESIGNED	CHECKED

REVISION

REV	DATE	BY	APPROVED BY	

Checked & Certified :

ENGR. MARITES R. PANGILINAN
Professional Electrical Engineer

PROFESSION :	PTR :
REGISTRATION NO. :	DATE ISSUED :
TIN :	PLACE ISSUED :

GHD
11/F Alphaland Southgate Tower 2258 Chino Roces Ave corner EDSA Makati City 1232 Philippines
T 63 2 479 5600 F 63 2 479 5601
E mnlmail@ghd.com W www.ghd.com

Approved :

Project Manager

ALTERNATIVE POWER SOLUTIONS, INC.

DESIGN UNIT

DESIGN SECTION

ENGR. MARITES R. PANGILINAN
VP-OPERATIONS

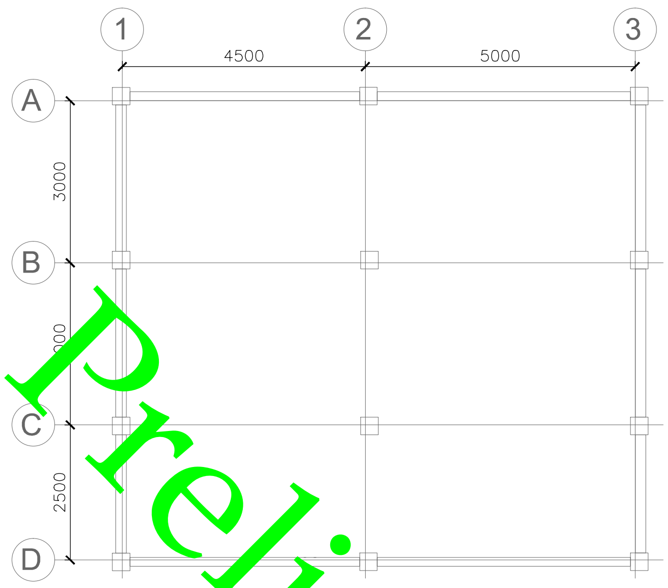
AS-BUILT DRAWING

PROJECT TITLE: CONSULTANCY SERVICES FOR THE ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT FOR THE LA MESA TREATMENT PLANT 2 PROCESS IMPROVEMENT WORKS

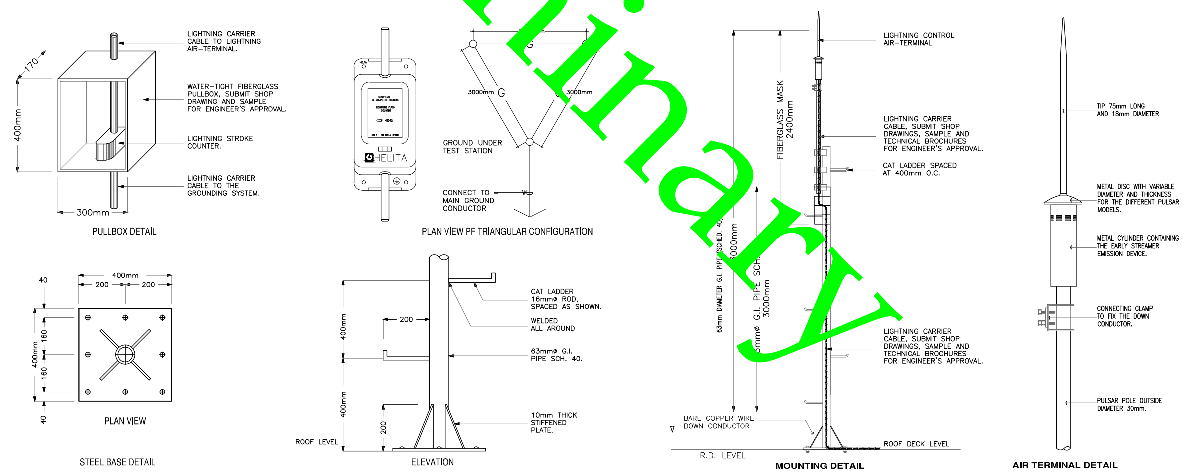
LOCATION: MAYNILAD – AYALA SOUTHVALE

SHEET CONTENT: FDAS AND FEX LOCATION PLAN FIRE EXTINGUISHER INSTALLATION PLAN

SCALE:	CONTRACT NO.	SHEET NO.	REV.
	OP18REFCS03-ASV-EE01-FDAS	01 OF 01	00



1 EE-02 ROOF DECK PLAN



2 EE-02 PROPOSED LIGHTNING PROTECTION SYSTEM

Maynilad	-	Maynilad	-
CONFORME:		CONFORME:	
HEAD, Division (End User)		HEAD, Department (End User)	
DRAWN	SURVEYED	DESIGNED	CHECKED

REVISION

REV	DATE	BY	APPROVED BY

Checked & Certified :

ENGR. MARITES R. PANGILINAN
Professional Electrical Engineer

PROFESSION :	PTR :
REGISTRATION NO. :	DATE ISSUED :
TIN :	PLACE ISSUED :

GHD
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Approved :

Project Manager

ALTERNATIVE POWER SOLUTIONS, INC.
1424 LIBRADA AVELINO STREET PANDACAN MANILA

DESIGN UNIT

DESIGN SECTION

ENGR. MARITES R. PANGILINAN
VP-OPERATIONS

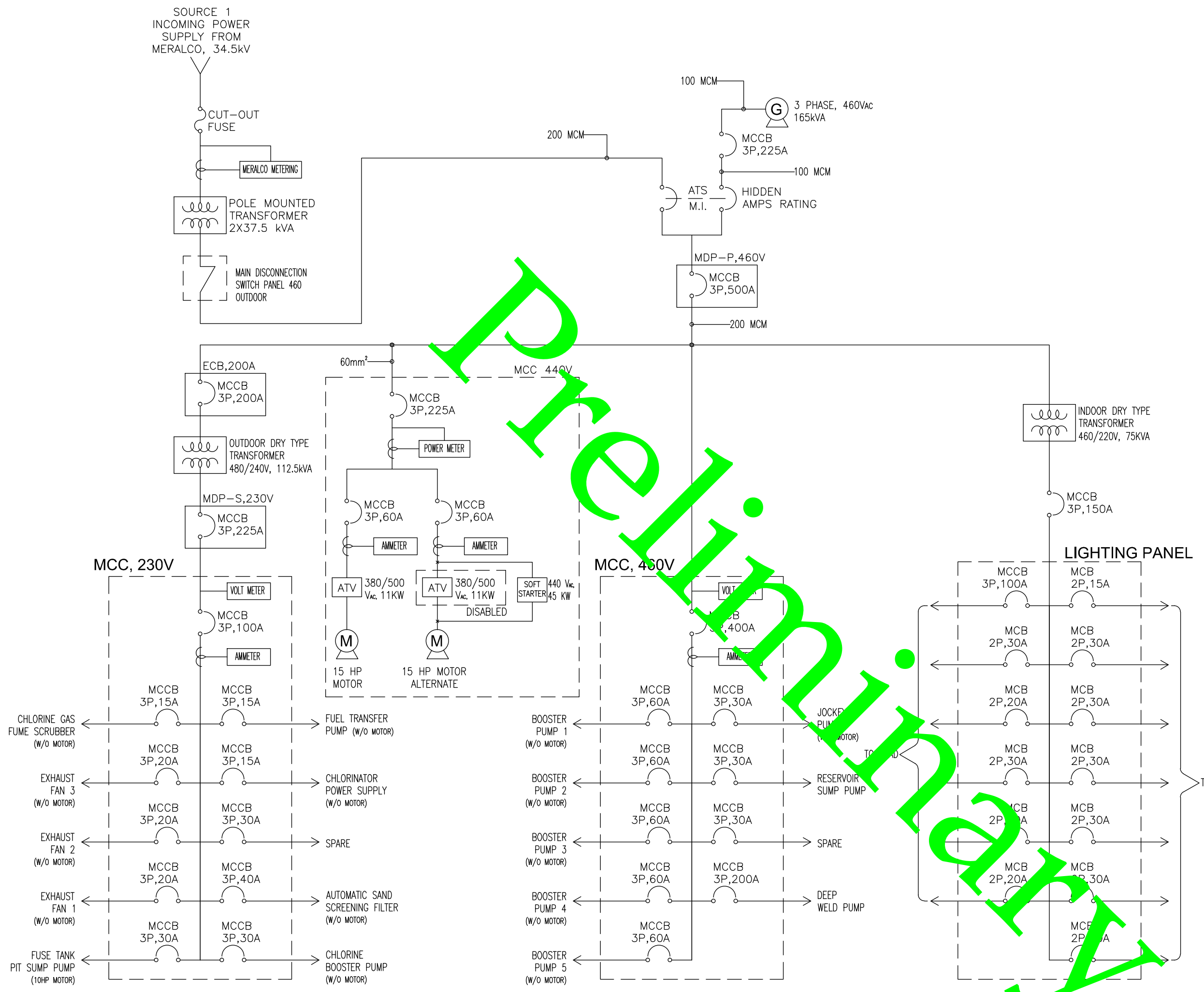
CONCEPTUAL DRAWING

PROJECT TITLE: CONSULTANCY SERVICES FOR THE ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT FOR THE LA MESA TREATMENT PLANT 2 PROCESS IMPROVEMENT WORKS

LOCATION: MAYNILAD – AYALA SOUTHVALE

SHEET CONTENT: ROOF DECK PLAN
PROPOSED LIGHTNING PROTECTION SYSTEM

SCALE:	CONTRACT NO.	SHEET NO.	REV.
	OP18REFCS03-ASV-EE02-LA	01 OF 01	00



LEGEND:

G	-GENERATOR SET
M	-MOTOR
PM	-POWER METER
MCC	-MOTOR CONTROL CENTER
ATS	-AUTOMATIC TRANSFER SWITCH
VFD	-VARIABLE FREQUENCY DRIVE

1 EE-03 SCHEMATIC DIAGRAM

Maynilad	-	Maynilad	-
CONFORME: HEAD, Division (End User)		CONFORME: HEAD, Department (End User)	
DRAWN	SURVEYED	DESIGNED	CHECKED

REVISION

REV	DATE	BY	APPROVED BY

Checked & Certified :
ENGR. MARITES R. PANGILINAN
Professional Electrical Engineer

PROFESSION :	PTR :
REGISTRATION NO. :	DATE ISSUED :
TIN :	PLACE ISSUED :

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Approved :
Project Manager

ALTERNATIVE POWER SOLUTIONS, INC.
1424 LIBRADA AVELINO STREET PANDACAN MANILA

DESIGN UNIT
DESIGN SECTION
ENGR. MARITES R. PANGILINAN
VP-OPERATIONS

AS-BUILT DRAWING

PROJECT TITLE: CONSULTANCY SERVICES FOR THE ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT FOR THE LA MESA TREATMENT PLANT 2 PROCESS IMPROVEMENT WORKS

LOCATION: MAYNILAD – AYALA SOUTHVALE

SHEET CONTENT: SCHEMATIC DIAGRAM

SCALE:	CONTRACT NO.	SHEET NO.	REV.
	OP18REFCS03-ASV-EE03-SD	01 OF 01	00

Appendix D

Bill of Quantity

Bill of Quantity

No.	Description	Items	CAT	CS	IT	Unit Cost	Quan.	Unit	Total	Remarks
1	Fire alarm control Panel						1	set	-	
2	Smoke Detectors		F	5	4	2,160.00	7	units	15,120.00	
3	Heat Detectors		F	5	4	1,620.00		units	-	
4	Manual Pull Station		F	5	4	1,890.00	3	units	5,670.00	
5	Horn Strobe Annunciator		F	5	4	2,700.00	1	units	2,700.00	
6	Twisted Pair wire 2.5mm2		F	5	4	108.00	60	lm	6,480.00	
7	20mmØ IMC pipe		F	5	4	540.00	15	lm	8,100.00	
8	Locknut and Bushing		F	5	4	10,000.00	1	lot	10,000.00	
9	15mmØ FMC Conduit		F	5	4	10,000.00	1	lot	10,000.00	
10	FMC Connectors		F	5	4	1,890.00	1	pcs	1,890.00	
11	Junction Box		F	5	4	2,160.00	1	pcs	2,160.00	
12	Hangers and Supports		F	5	4	2,000.00	1	lot	2,000.00	
13	Testing and Commissioning		F	5	4	10,000.00	1	lot	10,000.00	