



POWERCORE ENGINEERING LTD
MONITOR - ANALYZE - CONTROL

ELECTRICAL POWER MONITORING

AT

WEST ELGIN PUMPING STATION
WEST ELGIN, ON

PREPARED FOR

ONTARIO CLEAN WATER AGENCY

DECEMBER 2020

Prepared by: *Vince Klingenberg, Eng. Tech.*
Roman Bulla, P. Eng.

POWERCORE ENGINEERING LTD
514 NEWBOLD STREET
LONDON, ONTARIO
N6E 1K6
TEL: (519) 474-1175
WWW.POWERCORE.CA



TABLE OF CONTENTS

1. INTRODUCTION AND RESULTS

1.1. INTRODUCTION

1.1.1. HB Beal Secondary School 1600A/600V Service Entrance

1.2. MEASUREMENTS SUMMARY

1.2.1. Load Flow Measurements - Main Service Entrance

1.2.2. Load Flow Measurements - Main Service Entrance – Observations

1.2.3. Power Quality Measurements - Main Service Entrance

1.2.4. Power Quality Measurements - Main Service Entrance - Observations

2. POWER SYSTEM MEASUREMENT EXPLANATION

2.1. LOAD PROFILES

2.2. EVENT RECORDERS

2.3. HARMONIC COMPONENTS GRAPHS

2.4. EVALUATION CRITERIA

3. RECOMMENDATIONS

4. APPENDIX – LIST OF ACRONYMS

5. MEASUREMENT SUMMARY TABLES & CHARTS



1. INTRODUCTION AND RESULTS

1.1. Introduction

Power Supply Monitoring was performed by PowerCore Engineering at the following locations:

1.1.1. WEST ELGIN PUMPING STATION 1600A/600V MAIN SERVICE ENTRANCE

Please see the following sections for detailed results.



1.2. Measurements Summary

1.2.1. LOAD FLOW MEASUREMENTS - MAIN SERVICE ENTRANCE LOAD FLOW MEASUREMENTS HAVE FOUND THAT:

1. Maximum Real Time Current Load throughout the monitoring period was found to be app. **503 A** (instantaneous peak current) at 5:40 PM on Oct-09-2020
This is well within the feeder's capacity.
2. Maximum Sliding Demand Load was **305 kVA** (sliding demand interval – 15 min average) at 3:30 PM on Oct-13-2020.
This is well within the feeder's capacity.
3. Maximum Real Time Voltage recorded throughout the monitoring period was found to be **+6.5% (639 V)** at 7:06 AM on Nov-21-2020.
Minimum Real Time Voltage recorded throughout the monitoring period was found to be **-100% (0 V)** at 12:42 PM on Oct-27-2020.
These voltage levels are Outside the recommended limits of +/- 5%.
4. Maximum Voltage Imbalance Of **82.9%** was recorded at 05:51 PM on Dec-01-2020.
This imbalance exceeds the 0.5% standard limit.

1.2.2. LOAD FLOW MEASUREMENTS - MAIN SERVICE ENTRANCE – OBSERVATIONS The examination of the Load Flow measurements suggests that:

- Loading on this feeder is well below its capacity 😊
- Voltage was above the +/-5 % limit 😊
- Voltage Imbalance was recorded outside normal limits 😞



1.2.3. POWER QUALITY MEASUREMENTS - MAIN SERVICE ENTRANCE

Power Quality measurements have found that:

1. The Voltage Total Harmonic Distortion (THD) on the MAIN SERVICE ENTRANCE has reached maximum of **6.9%** during the monitored period (IEEE Std. 519-1992 max limit is 5%). On average it remained around **3%** during the monitored period.
2. The Mean Current Total Harmonic Distortion (THD) on the main feeder was around **40%** during peak load times. This is well above the 12% recommended limits as per IEEE Std. 519-1992 for this type of distribution system.
3. Several sub-cycle transient events were recorded during the power monitoring. These transient waveforms recordings (Current & Voltage) are shown as a waveform snapshot in the back of this report:
 - A. Periodic Transient Events – see Event # 1 Waveform
This event occurred on Dec-01 at 5:51 pm
 - B. Periodic Transient Events – see Event # 2 Waveform
This event occurred on Nov-15 at 12:59 pm
 - C. Periodic Transient Events – see Event # 3 Waveform
This event occurred on Dec-01 at 12:01 pm

1.2.4. POWER QUALITY MEASUREMENTS - MAIN SERVICE ENTRANCE - OBSERVATIONS

The examination of the Power Quality measurements suggests that:

- Current Harmonic distortion was found to be outside limits during peak load times. 😞
- Voltage Harmonic distortion average was around **3%** which is within IEE-519 limits. 😊
- Voltage Sag and Swell transient events did translate into any current disturbances in the system. 😊



2. POWER SYSTEM MEASUREMENT EXPLANATION

The pages in the Appendix of this report contain the load measurement summary and typical daily profile graphs for the measurements at the main breaker.

Three types of charts are included in this report:

2.1. Load Profiles

These charts depict typical daily profiles for selected monitored parameters: Phase voltages and currents, kVA Demand & Power Factor (if available), Voltage & Current Imbalance and Voltage Total Harmonic Distortion (THD).

2.2. Event Recorders

These Waveform charts depict a recording of abnormal events recorded during the monitored period.

Few typical events are usually selected for your consideration.

2.3. Harmonic Components Graphs

These Bar Graphs show the Harmonic component breakdown (Fourier Transform) for selected waveforms – normally for a transient waveform (during an event) and a typical waveform for normal operating conditions.

The following criteria should be taken into consideration when reviewing the load and harmonic measurement results:

2.4. Evaluation Criteria

- Recommended maximum voltage variation should not exceed $\pm 5\%$.
- IEEE Power quality standard 519-1992 recommends a limit for Voltage total harmonic distortion of 5% THD at the point of common coupling (i.e. main transformer secondary). Distortion above these limits can cause equipment malfunctioning, computer flicker, PLC problems, capacitor failures etc.
- IEEE Power quality standard 519-1992 recommends a limit for Thermal Demand total Current harmonic distortion of 8-12 % THD for your type of 120-208V system. These limits can be momentarily exceeded by 50%.
- Power Factor at the peak Sliding Demand Load (15 minute integration period – SD Value) should be kept above 90% to avoid low power factor penalty.



3. RECOMMENDATIONS

As a result of Load Flow & Power Quality measurements of the Main 600V/1600A Service Entrance at the West Elgin Pumping Station, we offer you the following recommendations for your consideration:

1. **Dynamic Voltage Restoration** – A series compensation device that protects sensitive electrical loads from power quality problems such as voltage sags, swells, unbalance and distortion. This is a **VERY COSTLY OPTION** that can be installed at the service entrance or at sensitive affected equipment.
2. **Report Incoming Service Voltage Disturbances** – Several Voltage disturbances were recorded during the monitored period ranging from sub-cycle voltage pull down (Transient Event #1), Voltage Sags (Transient Event #2 & #4), and Voltage Swells (Transient Event #3) which resulted in obstructive current reactions. In a constant torque application, a voltage sag for several cycles (+ 7 cycles in some of the cases we captured) will cause constant torque equipment (ie variable frequency drives) to increase current consumption to compensate for the loss of voltage. This can result in over current conditions for some of the equipment on the system (seen at the end of Transient Event #3). We recommend reporting these events to the utility provider and request the issues be reviewed to find a solution that protects the facility from further interruptions.
3. We recommend that you perform periodic electrical maintenance testing and inspections of your power distribution system as per NETA recommendations.

Thank you for this opportunity to be of service to you. If you have any questions regarding the recommendations in this report or any other matter, please contact our Engineering Services office at (519) 474-1175.

Sincerely,

PowerCore Engineering Ltd

Roman Bulla, P. Eng.
Power Systems Engineer

Roman Bulla, E. Tech.
Electrical Engineering Technologist



4. APPENDIX – LIST OF ACRONYMS

Several acronyms may have been used throughout this report:

ACRONYMS USED:

[parameter] RT	Real Time value (RMS value based on a 2 cycle measurement)
[parameter] SD	Sliding Demand equivalent value (15 minute integration period average value - utility standard)
[parameter] TD	Thermal Demand equivalent value (30 minute integration period average value)
THD [parameter]	Total Harmonic Distortion of the measured parameter (i.e. Voltage or Current) in percent.
TEHD [parameter]	Total Even Harmonic Distortion of the measured parameter in percent.
TOHD [parameter]	Total Odd Harmonic Distortion of the measured parameter in percent.
A IMBAL, V IMBAL	Three Phase Current or Voltage Imbalance in percent




5. MEASUREMENT SUMMARY TABLES & CHARTS



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Real Time Voltage Min/Max Tables

Long-term min/max - Voltage			Long-term min/max - Current		Long-term min/max - PF/Freq	
Min			Max			
	Value	Captured on		Value	Captured on	
Vln a	0 V	10/27/2020 12:42:16.000 PM	Vln a	363 V	11/21/2020 07:06:25.000 AM	
Vln b	0 V	10/27/2020 12:42:16.000 PM	Vln b	364 V	11/21/2020 07:06:25.000 AM	
Vln c	0 V	10/27/2020 12:42:16.000 PM	Vln c	370 V	11/21/2020 07:06:25.000 AM	
Vll ab	0 V	10/27/2020 12:42:16.000 PM	Vll ab	629 V	11/21/2020 07:06:25.000 AM	
Vll bc	0 V	10/27/2020 12:42:16.000 PM	Vll bc	639 V	11/21/2020 07:06:25.000 AM	
Vll ca	0 V	10/27/2020 12:42:16.000 PM	Vll ca	630 V	11/21/2020 07:06:25.000 AM	
V unbal	0.0 %	10/27/2020 12:42:16.000 PM	V unbal	82.9 %	12/1/2020 05:51:47.000 PM	


Reset Min/Max

Note:
Reset Min/Max resets long term min/max values for Voltages, Currents, Power Factor and Frequency.

Device Time : 12/2/2020 10:51:27.358 AM

Device Type : 8000



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Real Time Current Min/Max Tables

OCWA,MainPM8000

[Back to Volts/Amps](#)



Long-term min/max - Voltage

Long-term min/max - Current

Long-term min/max - PF/Freq

	Value	Min Captured on
I a	0 A	10/27/2020 12:42:16.000 PM
I b	0 A	10/27/2020 12:42:16.000 PM
I c	0 A	10/27/2020 12:42:16.000 PM
I 4	0 A	9/29/2020 03:05:46.000 PM
I 5	0 A	9/29/2020 03:05:46.000 PM

	Value	Max Captured on
I a	499 A	10/9/2020 05:40:39.000 PM
I b	501 A	10/9/2020 05:40:39.000 PM
I c	503 A	10/9/2020 05:40:39.000 PM
I 4	0 A	9/29/2020 03:05:46.000 PM
I 5	0 A	9/29/2020 03:05:46.000 PM



Reset Min/Max

Note:
Reset Min/Max resets long term min/max values for Voltages, Currents, Power Factor and Frequency.

Device Time : 12/2/2020 10:54:12.241 AM

Device Type : 8000



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring


Real Time PF/Frequency Min/Max Tables

OCWA.MainPM8000

[Back to Volts/Amps](#)



Long-term min/max - Voltage			Long-term min/max - Current			Long-term min/max - PF/Freq		
Min						Max		
	Value	Captured on					Value	Captured on
PF lag	33 %	10/16/2020 10:27:36.000 PM				PF lag	100 %	9/29/2020 11:15:37.000 PM
PF lead	54 %	10/21/2020 04:49:54.000 AM				PF lead	100 %	9/29/2020 11:15:48.000 PM
Freq	58.85 Hz	11/30/2020 09:11:58.000 AM				Freq	60.08 Hz	10/9/2020 12:57:46.000 PM


Reset Min/Max

Note:
Reset Min/Max resets long term min/max values for Voltages, Currents, Power Factor and Frequency.

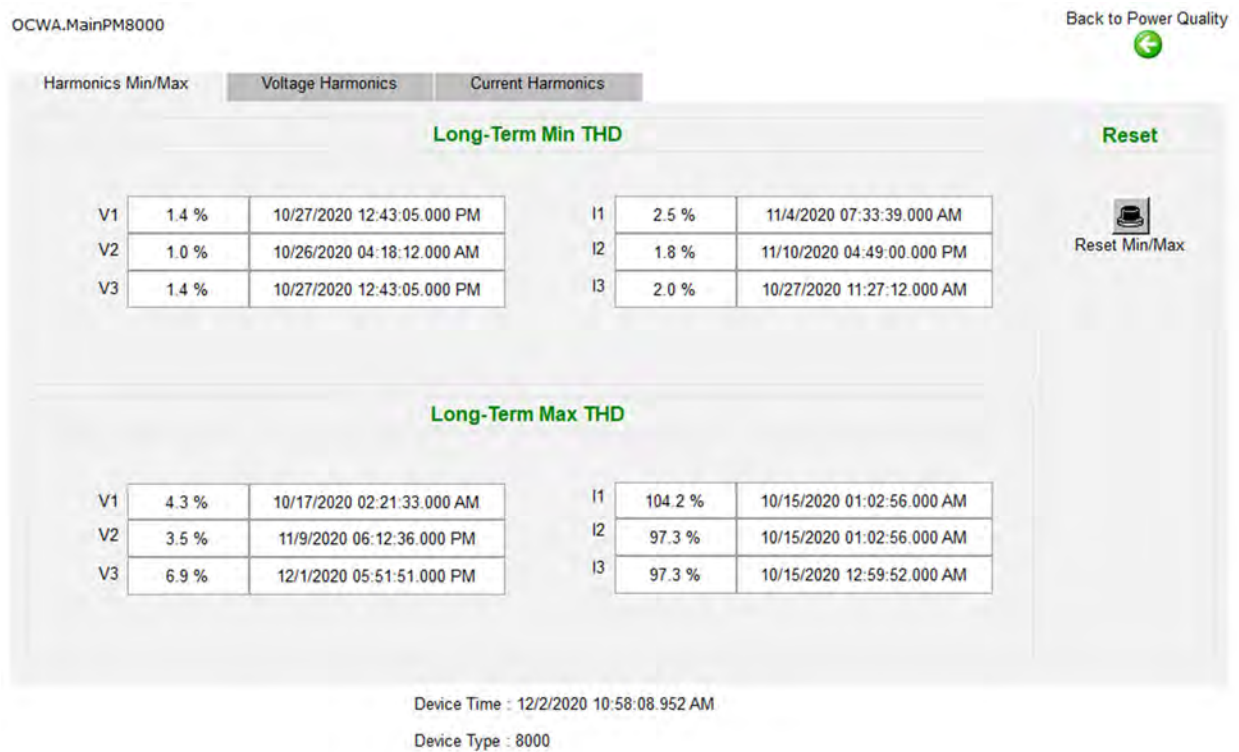
Device Time : 12/2/2020 10:55:20.896 AM

Device Type : 8000



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

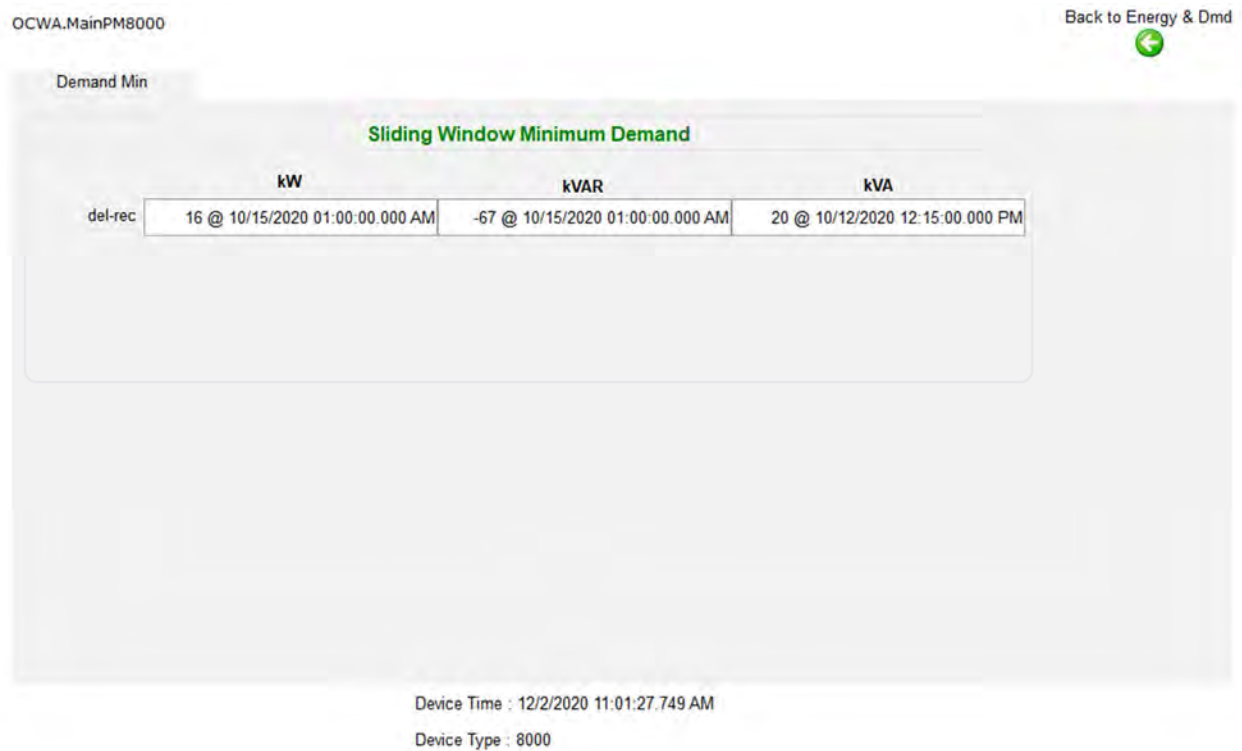
Real Time THD (Total Harmonic Distortion) Min/Max Tables





Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Sliding Window Demand (15 min. avg.) Min Tables





Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Sliding Window Demand (15 min. avg.) Max Tables

OCWA.MainPM8000 Back to Energy & Dmd

Peak Demand

Sliding Window Peak Demand

	kW	kVAR	kVA
del	301 @ 10/13/2020 03:30:00.000 PM	63 @ 10/14/2020 03:45:00.000 PM	305 @ 10/13/2020 03:30:00.000 PM
rec	0 @ 9/29/2020 03:15:00.000 PM	77 @ 10/15/2020 01:00:00.000 AM	0 @ 9/29/2020 03:15:00.000 PM
del-rec	301 @ 10/13/2020 03:30:00.000 PM	63 @ 10/14/2020 03:45:00.000 PM	305 @ 10/13/2020 03:30:00.000 PM
del+rec	301 @ 10/13/2020 03:30:00.000 PM	88 @ 10/15/2020 01:00:00.000 AM	305 @ 10/13/2020 03:30:00.000 PM

Reset

Peak Demand Reset Count

0

Peak demand reset

Sliding Window Peak Demand by Quadrant

	kW	kVAR	kVA
Q1	301 @ 10/13/2020 03:30:00.000 PM	63 @ 10/14/2020 03:45:00.000 PM	305 @ 10/13/2020 03:30:00.000 PM
Q2	0 @ 9/29/2020 03:15:00.000 PM	0 @ 9/29/2020 03:15:00.000 PM	0 @ 9/29/2020 03:15:00.000 PM
Q3	0 @ 9/29/2020 03:15:00.000 PM	0 @ 9/29/2020 03:15:00.000 PM	0 @ 9/29/2020 03:15:00.000 PM
Q4	91 @ 10/11/2020 12:30:00.000 PM	77 @ 10/15/2020 01:00:00.000 AM	91 @ 10/11/2020 12:30:00.000 PM

Device Time : 12/2/2020 11:00:28.647 AM

Device Type : 8000



Average Voltage RMS – Historic Trend

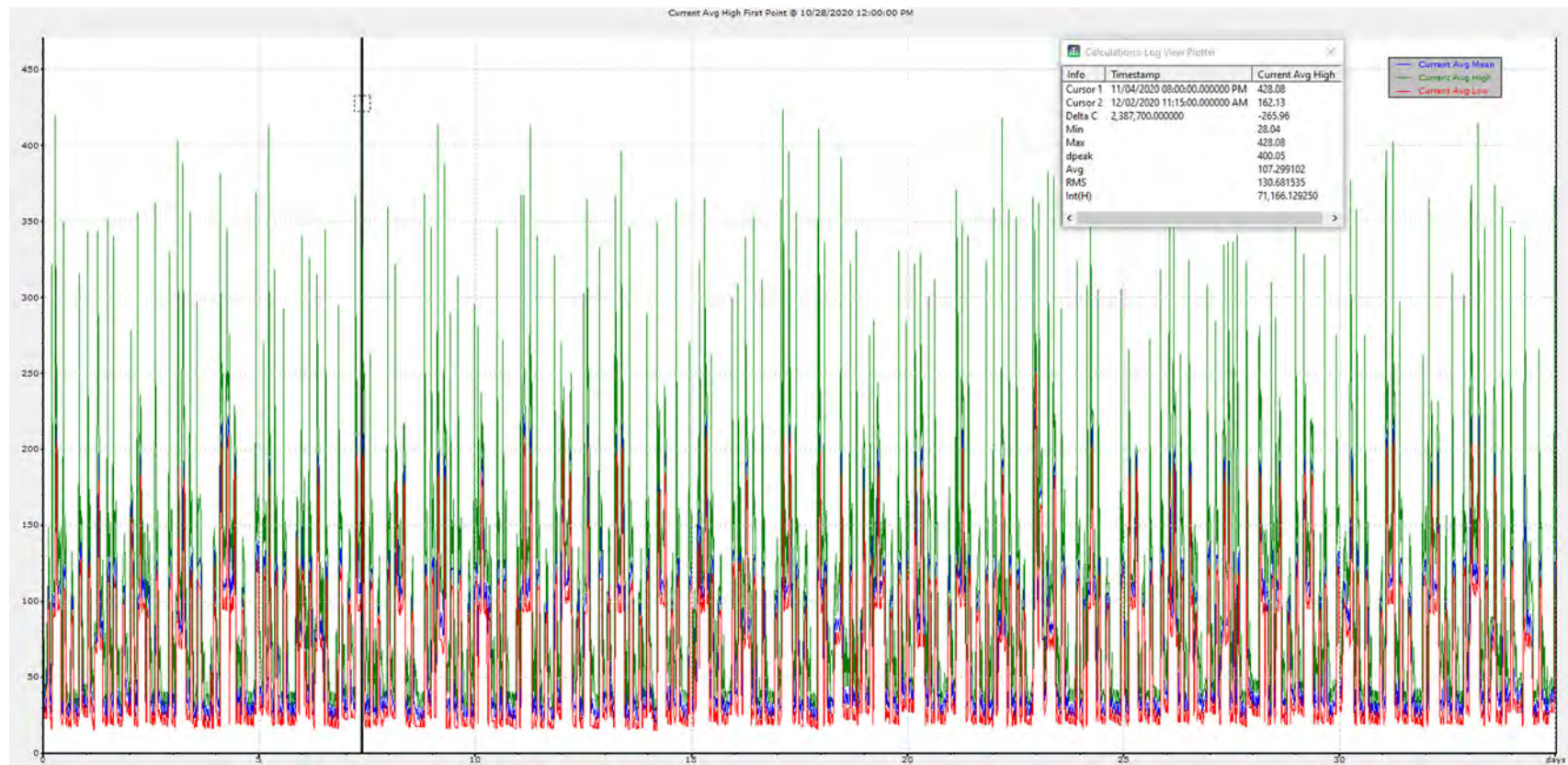


Notes:

- mean value represents mean average throughout a 5 minute interval
- high value represents a maximum Real Time value (2 cycle RMS value) reached during the 5 minute interval
- low value represents a minimum Real Time value (2 cycle RMS value) reached during the 5 minute interval



Average Current RMS – Historic Trend



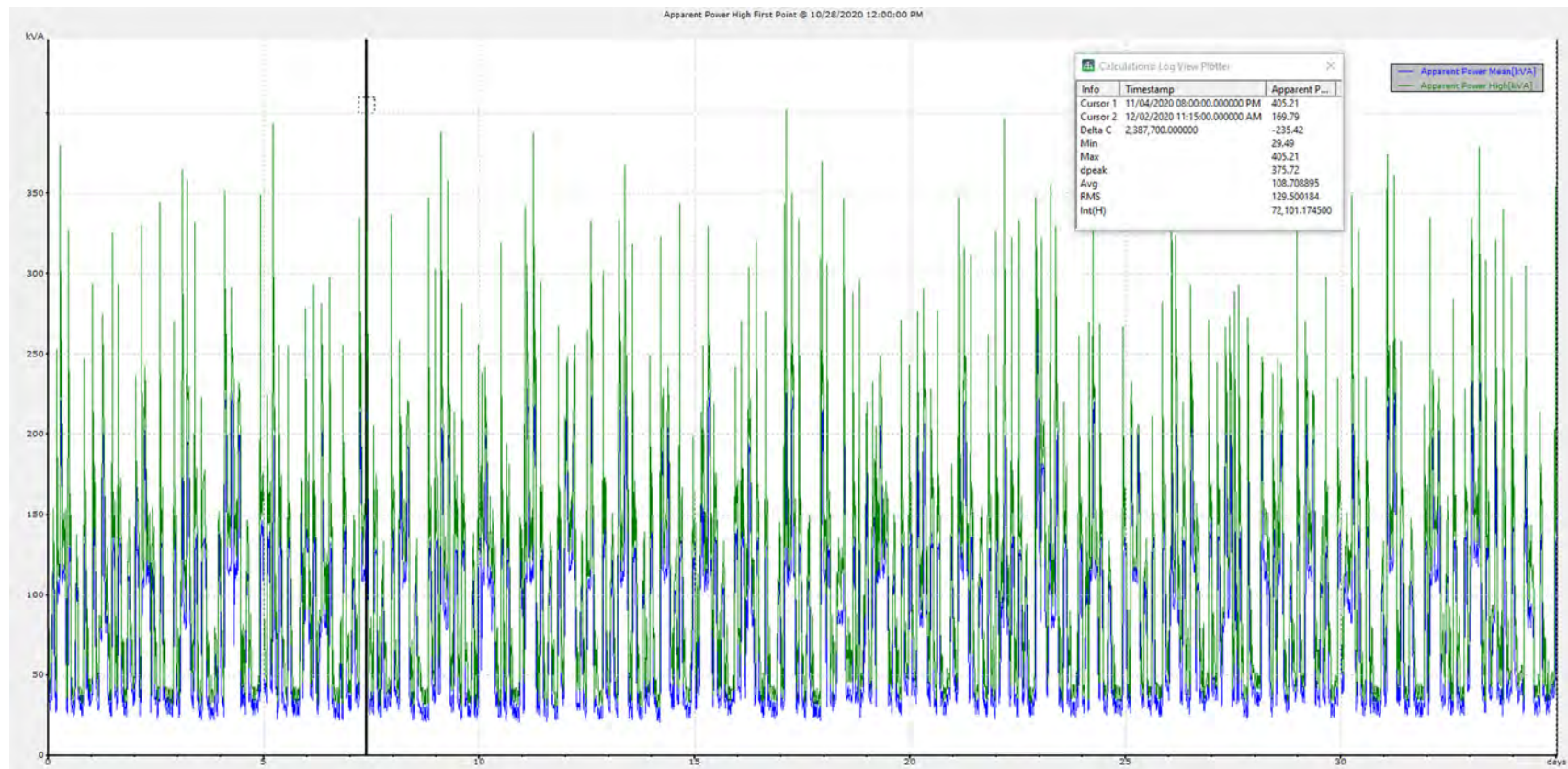
Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Notes:

- mean value represents mean average throughout a 5 minute interval
- high value represents a maximum Real Time value (2 cycle RMS value) reached during the 5 minute interval
- low value represents a minimum Real Time value (2 cycle RMS value) reached during the 5 minute interval



kVA – Historic Trend



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Notes:

- mean value represents mean average throughout a 5 minute interval
- high value represents a maximum Real Time value (2 cycle RMS value) reached during the 5 minute interval



Frequency – Historic Trend



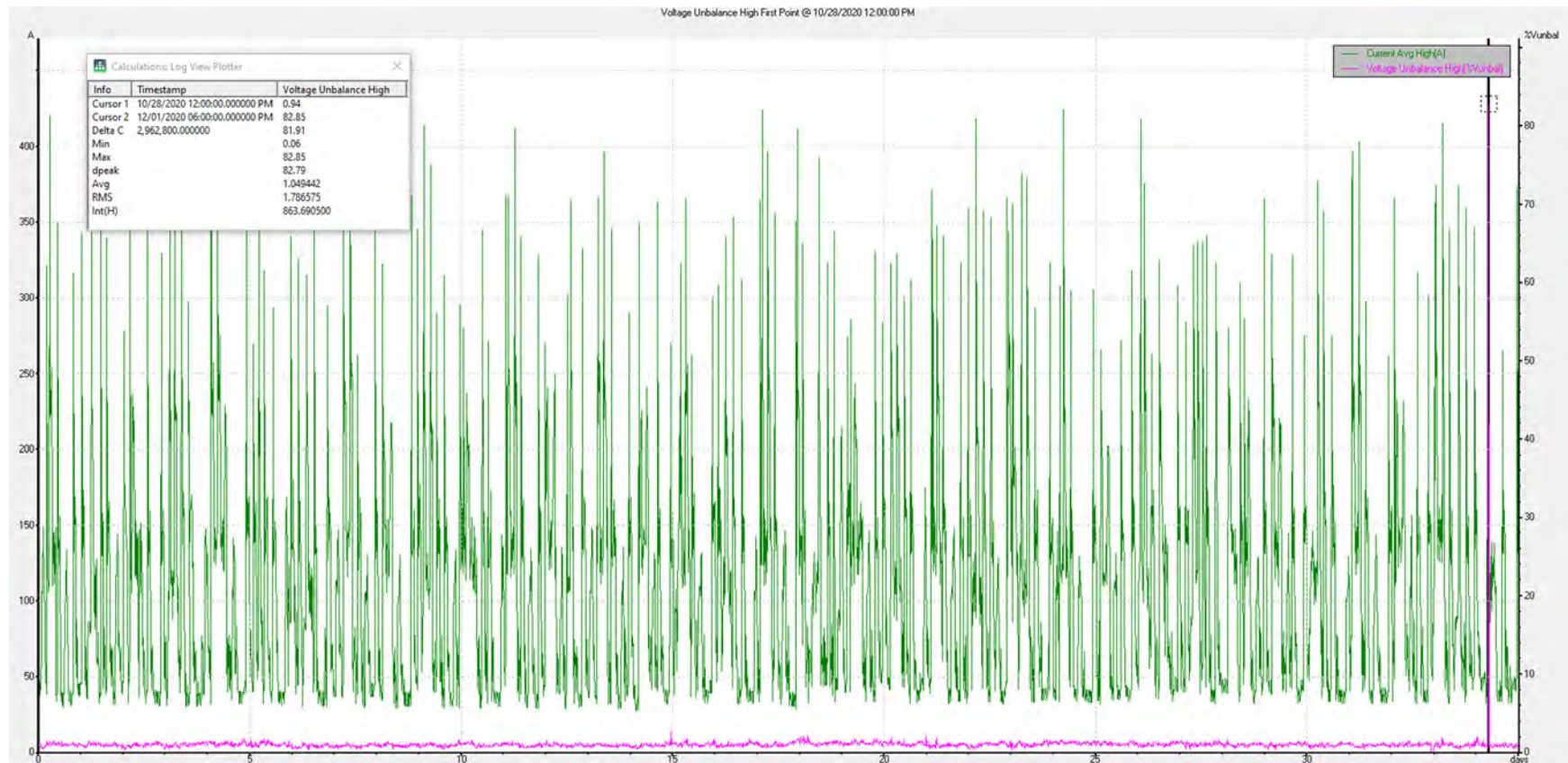
Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Notes:

- mean value represents mean average throughout a 5 minute interval
- high value represents a maximum Real Time value (2 cycle RMS value) reached during the 5 minute interval
- low value represents a minimum Real Time value (2 cycle RMS value) reached during the 5 minute interval



Average Current Versus Voltage Imbalance – Historic Trend



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring

Notes:

- mean value represents mean average throughout a 5 minute interval
- high value represents a maximum Real Time value (2 cycle RMS value) reached during the 5 minute interval
- low value represents a minimum Real Time value (2 cycle RMS value) reached during the 5 minute interval



Voltage Total Harmonic Distortion (THD) – Historic Trend

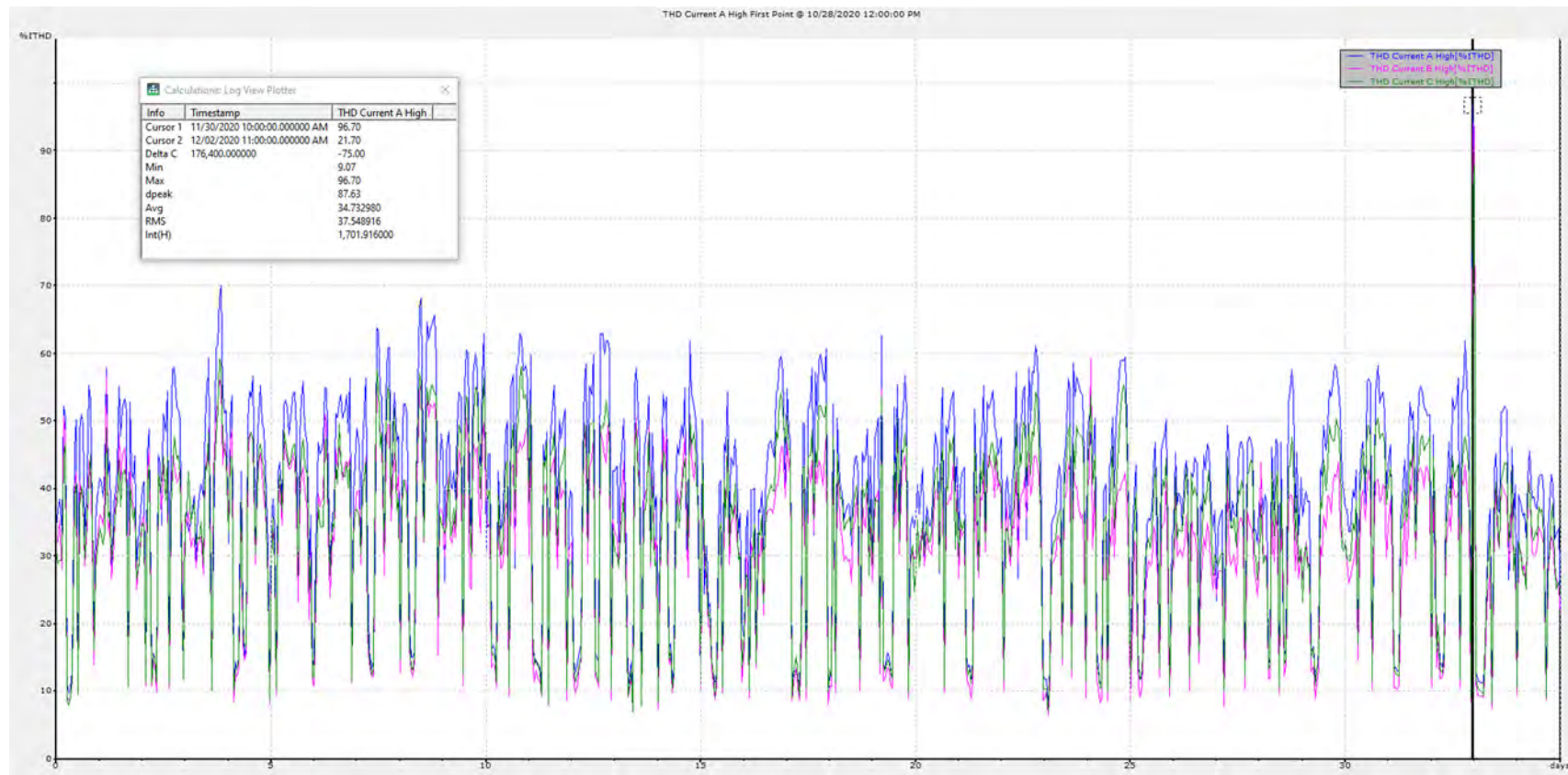


Notes:

- mean value represents mean average throughout a 5 minute interval
- high value represents a maximum Real Time value (2 cycle RMS value) reached during the 5 minute interval
- low value represents a minimum Real Time value (2 cycle RMS value) reached during the 5 minute interval



Current Total Harmonic Distortion (THD) – Historic Trend

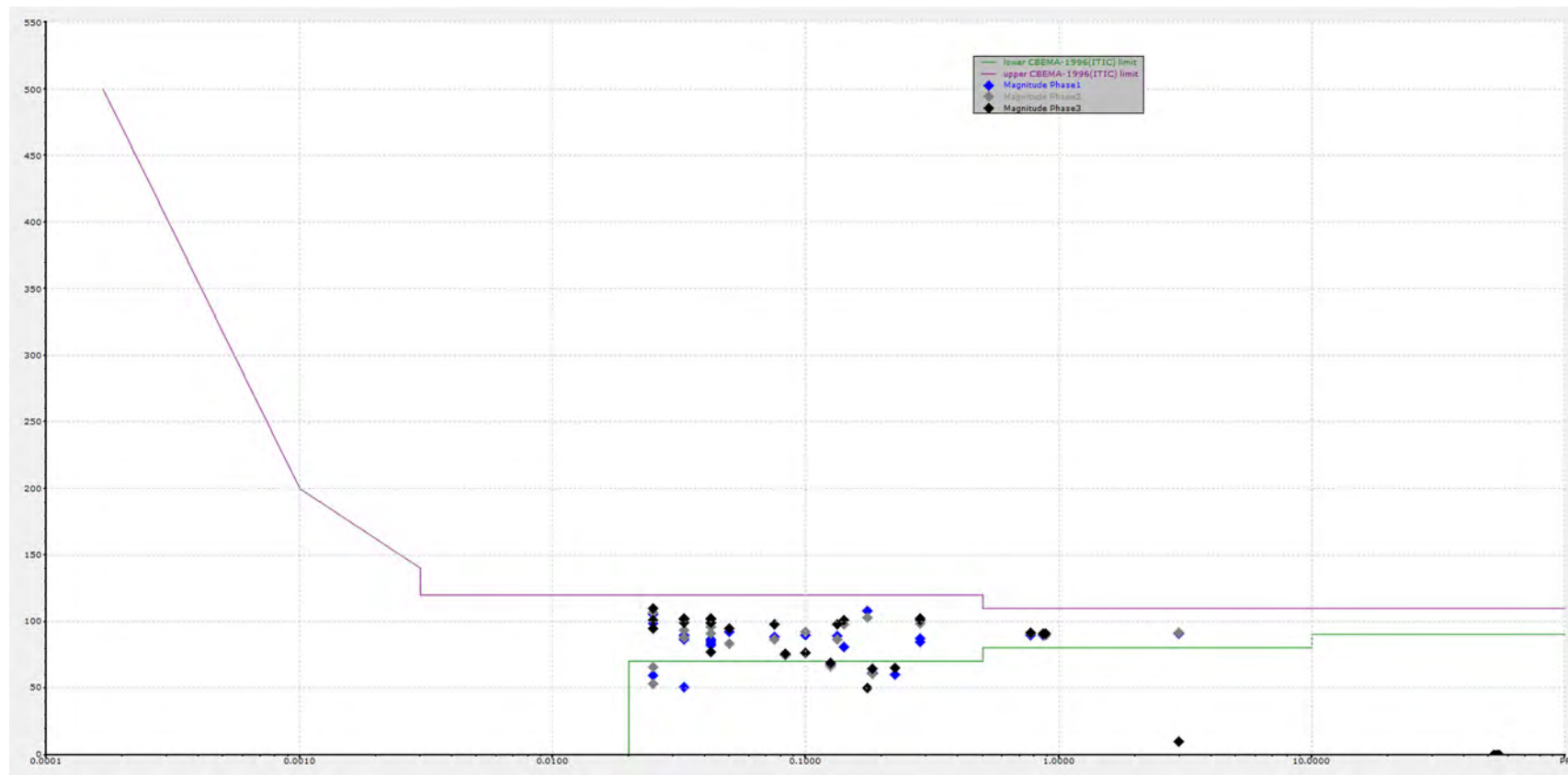


Notes:

- mean value represents mean average throughout a 5 minute interval
- high value represents a maximum Real Time value (2 cycle RMS value) reached during the 5 minute interval
- low value represents a minimum Real Time value (2 cycle RMS value) reached during the 5 minute interval



CBEMA Curve – Historic Summary of Voltage Disturbances

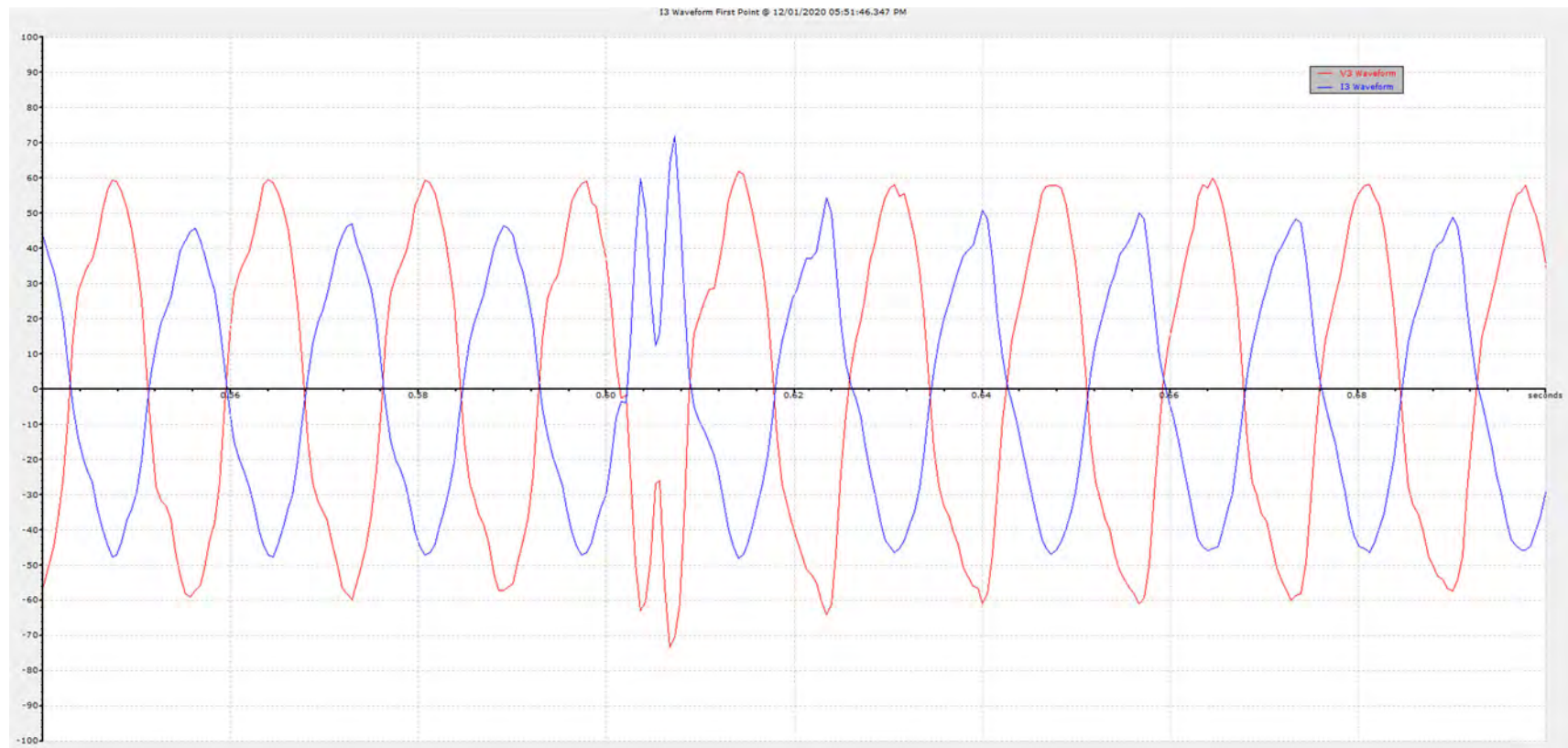


Notes:

- CHART EXPLANATION: X-Axis: Event Duration [seconds], Y-Axis: Event Magnitude [% of Nominal Voltage - 208V]
- All Events falling within the CBEMA envelope should be within the limits that most equipment is capable of handling.
- Some equipment may be more sensitive to short duration events (sub-cycle transients), some may be more sensitive to long duration events (voltage sags / swells)



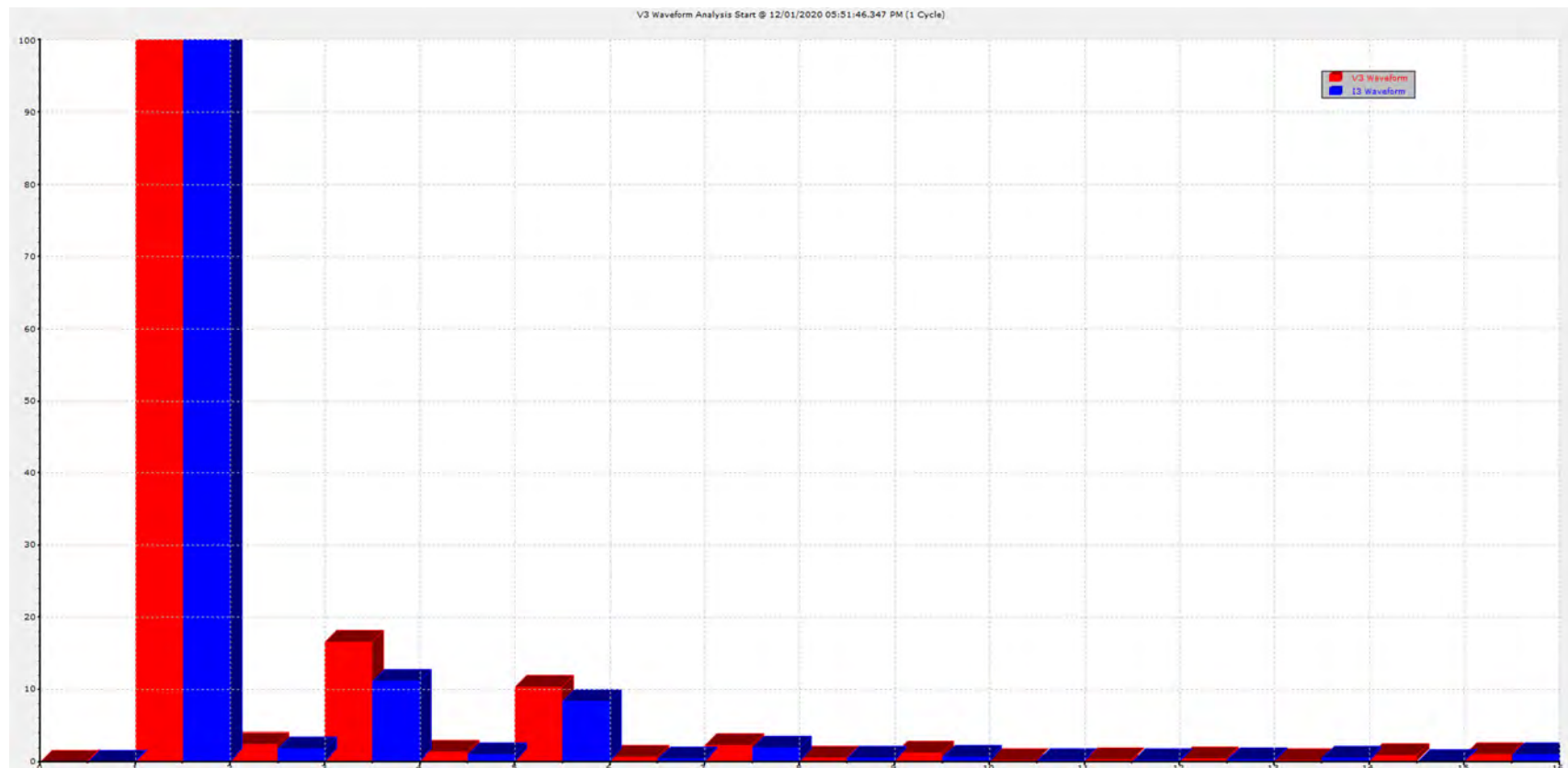
Transient Event #1 Waveform Snapshot – Phase C



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring



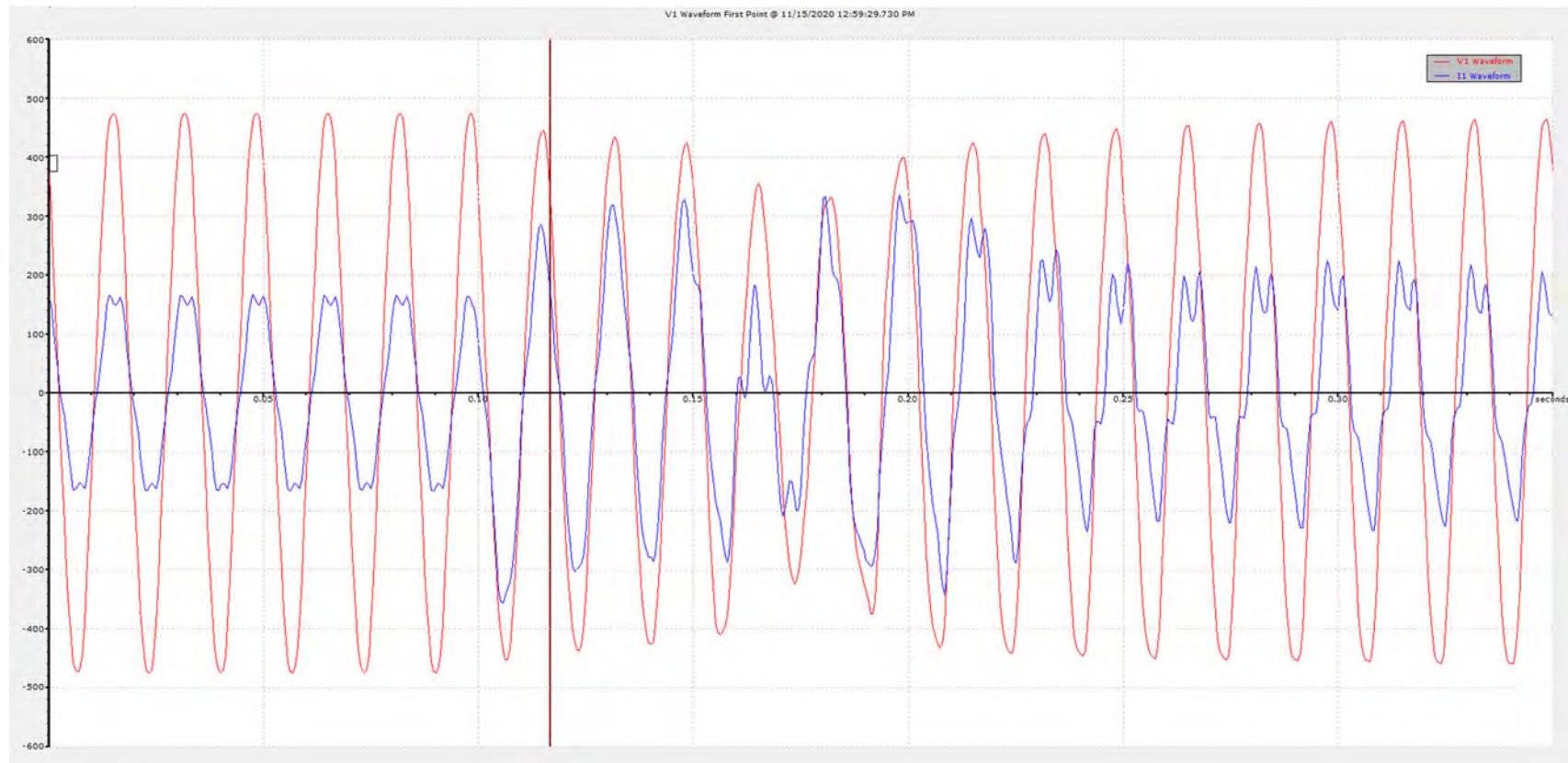
Transient Event #1 Waveform Snapshot – Phase C Harmonic Spectrum



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring



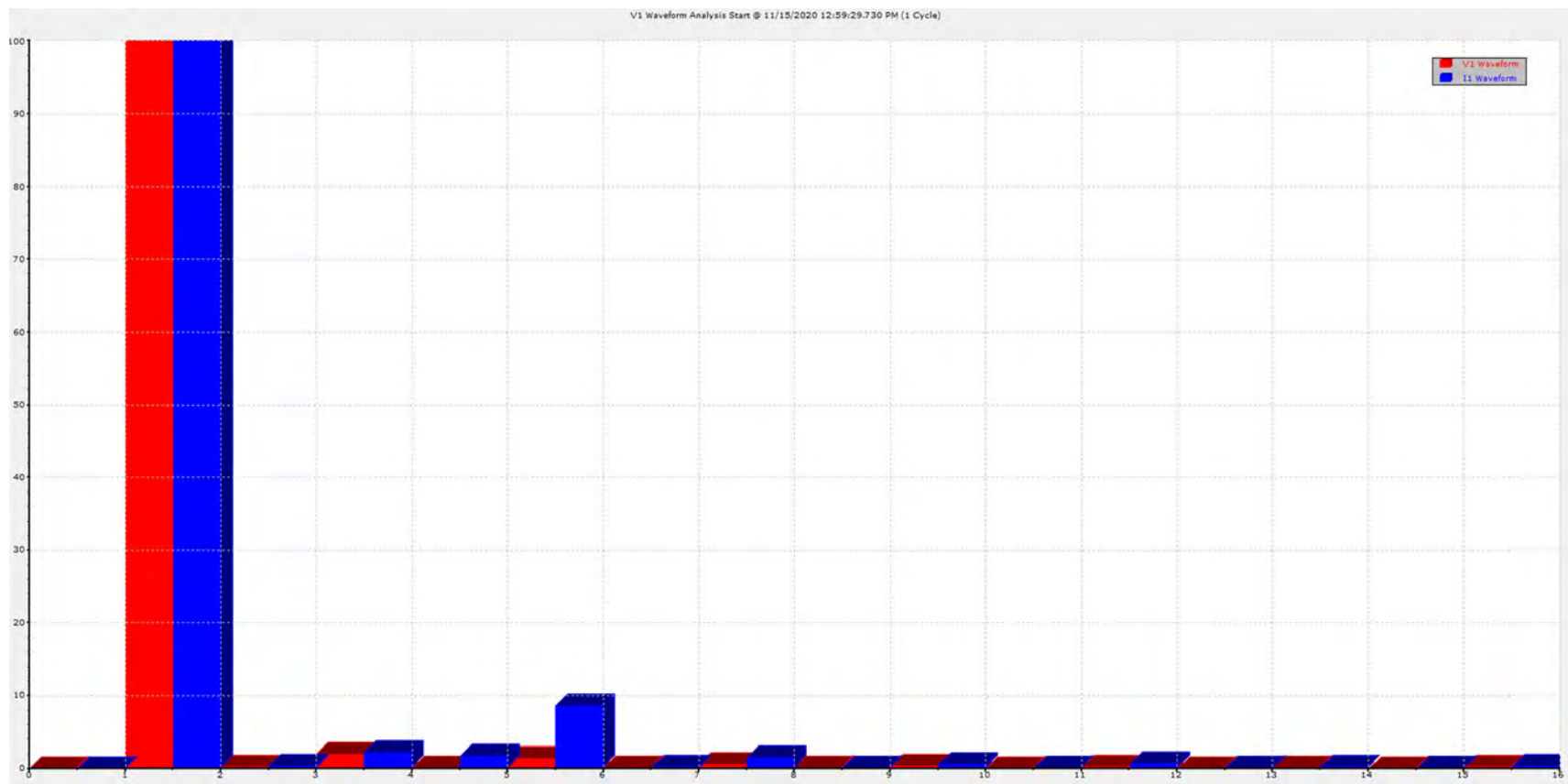
Transient Event #2 Waveform Snapshot – Phase A Direction Detected - Upstream – High Confidence



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring



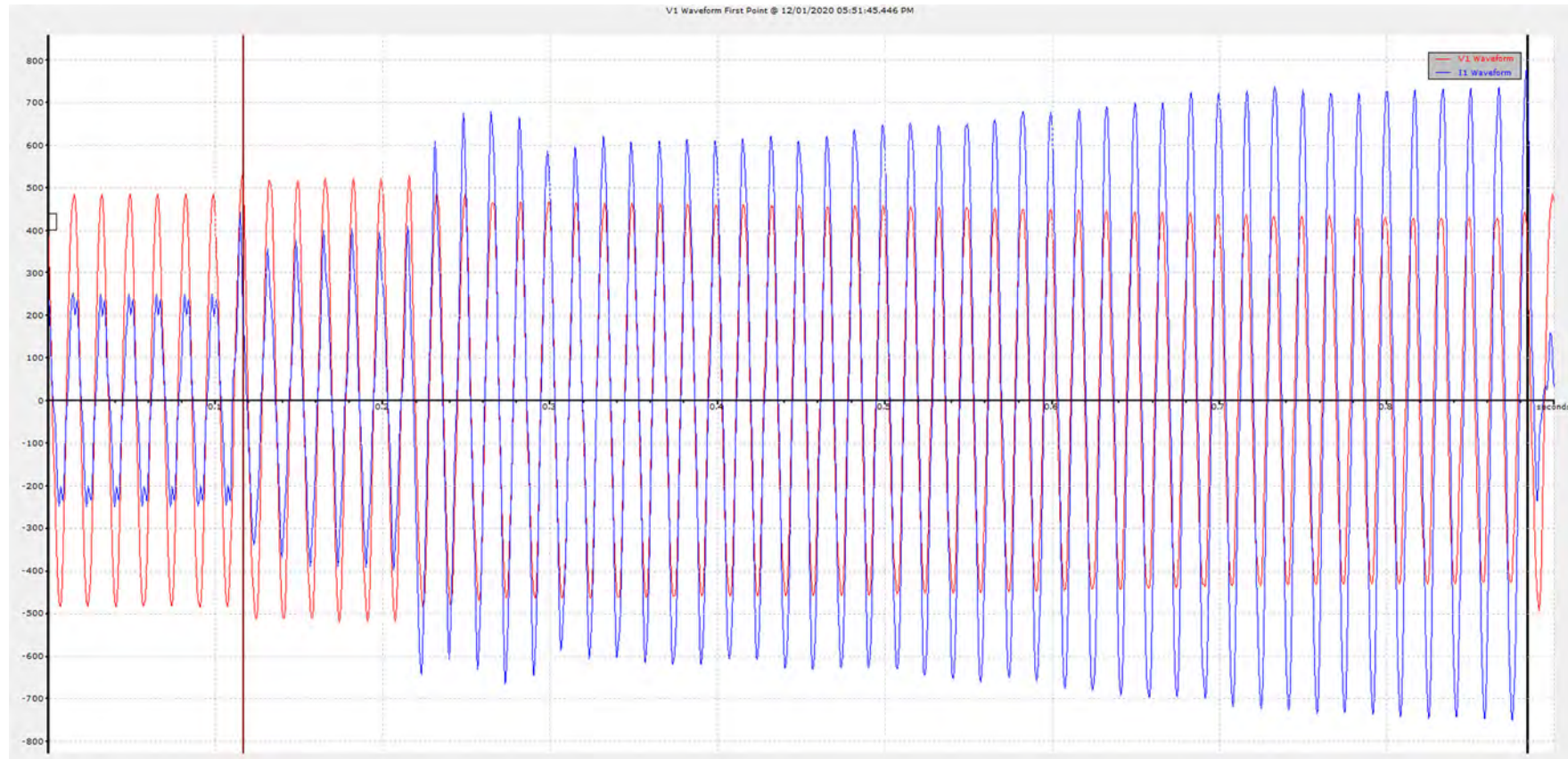
Transient Event #2 Waveform Snapshot – Phase A Harmonic Spectrum Direction Detected - Upstream – High Confidence



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring



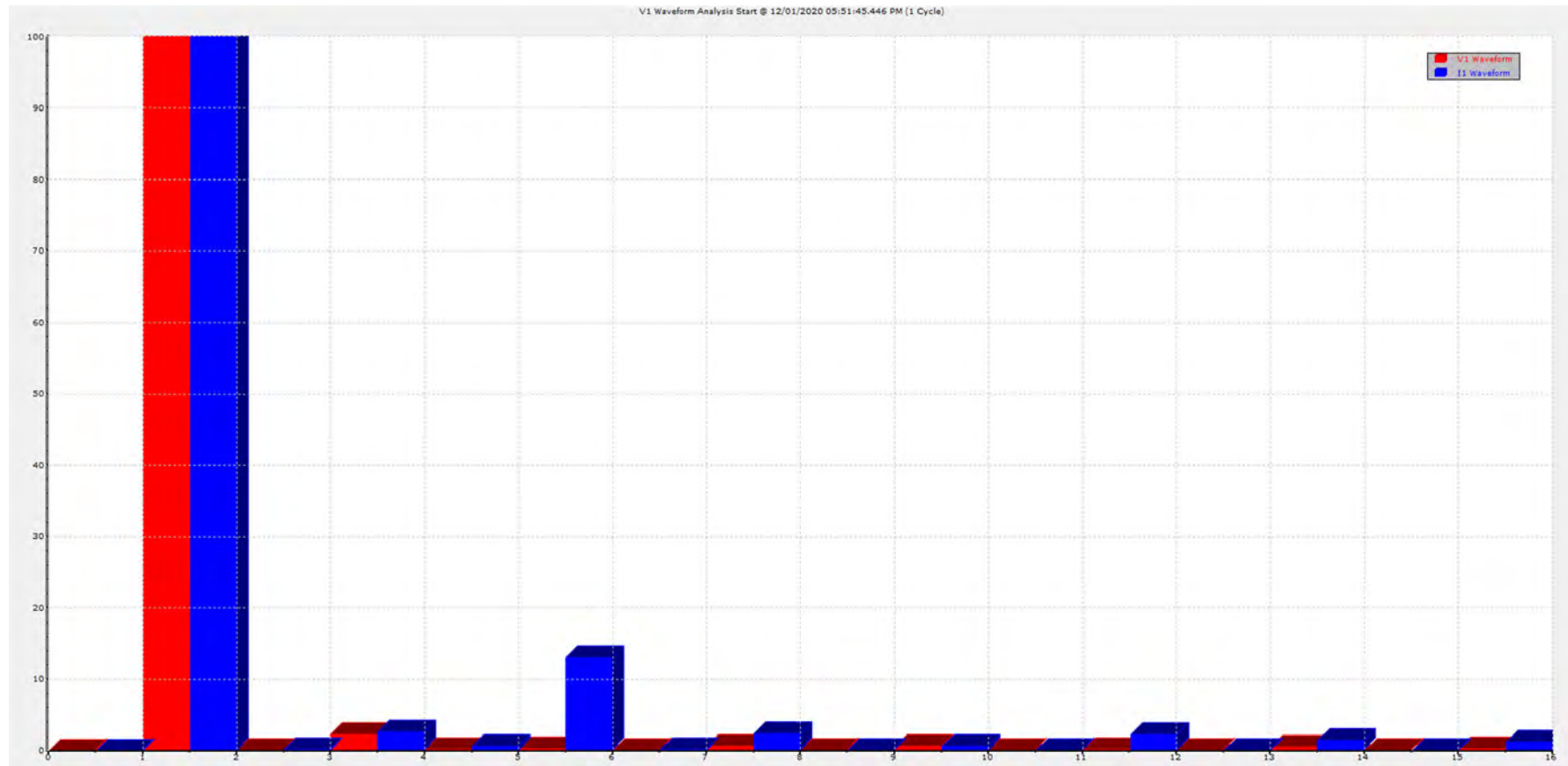
Transient Event #3 Waveform Snapshot – Phase A Direction Detected - Upstream – High Confidence



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring



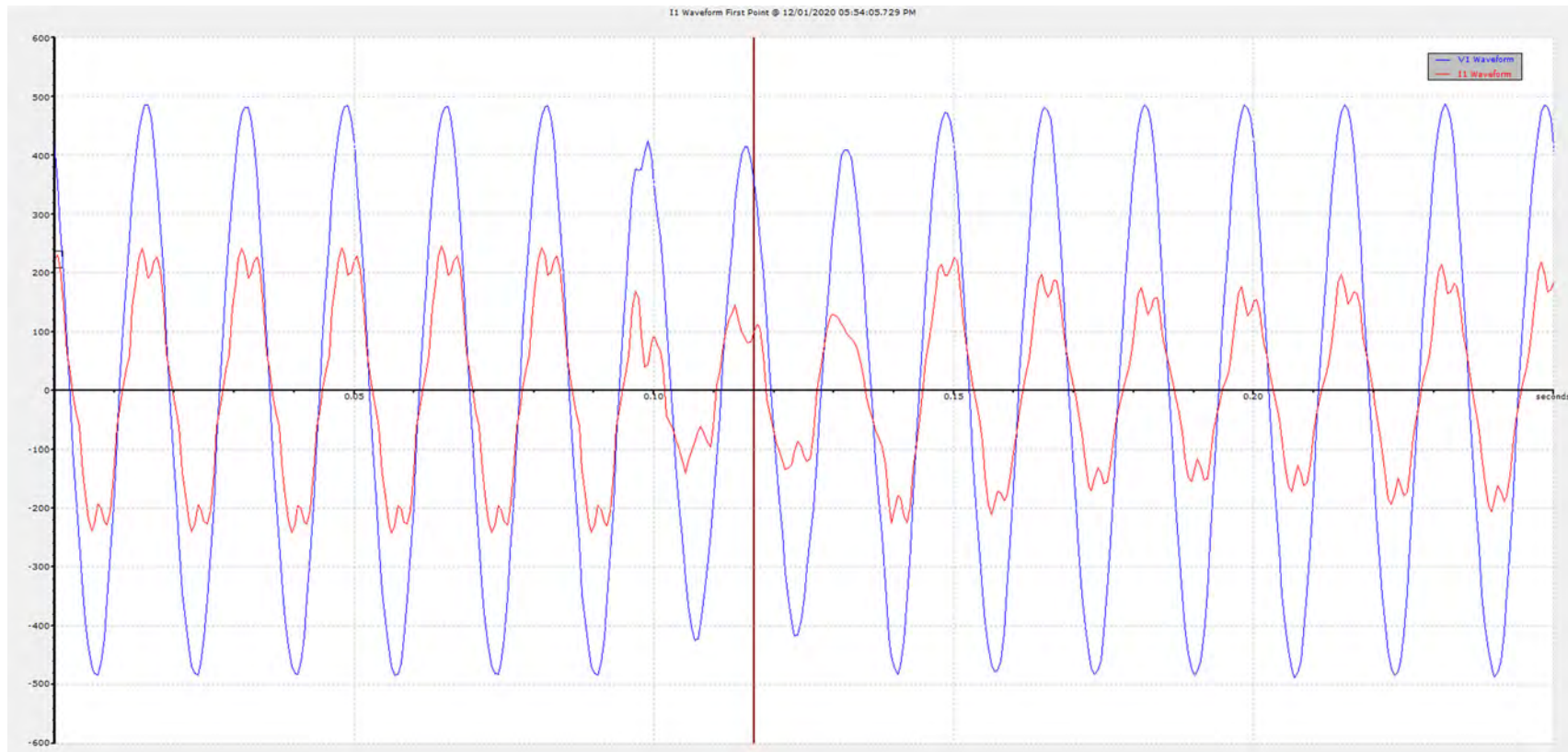
Transient Event #3 Waveform Snapshot – Phase A Harmonic Spectrum Direction Detected - Upstream – High Confidence



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring



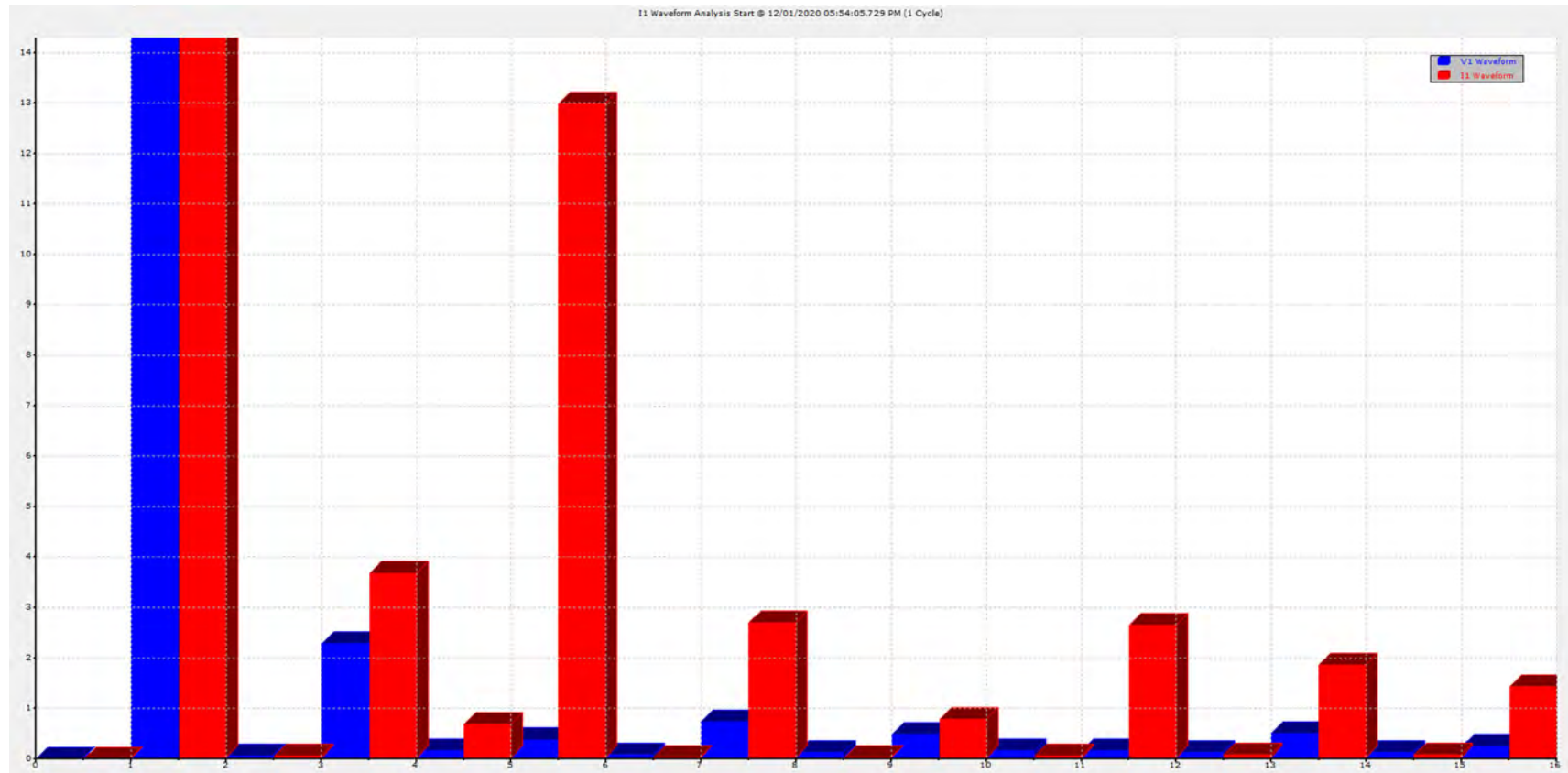
Transient Event #4 Waveform Snapshot – Phase A Direction Detected - Upstream – High Confidence



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring



Transient Event #4 Waveform Snapshot – Phase A Harmonic Spectrum Direction Detected - Upstream – High Confidence



Pumping Station - West Elgin, ON
Main Service Entrance, Power Monitoring