

Advancing Power Quality Awareness with High-Resolution Continuous Waveform Recording

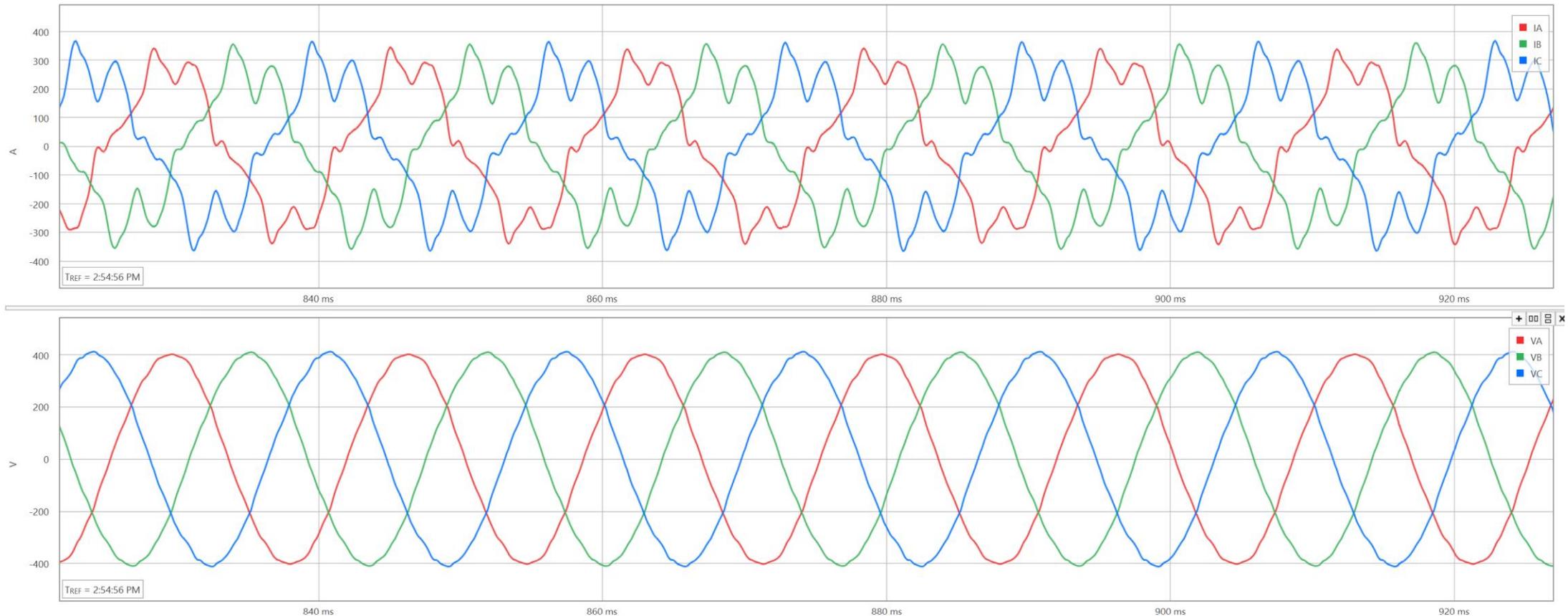


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Spring 2025 NASPI

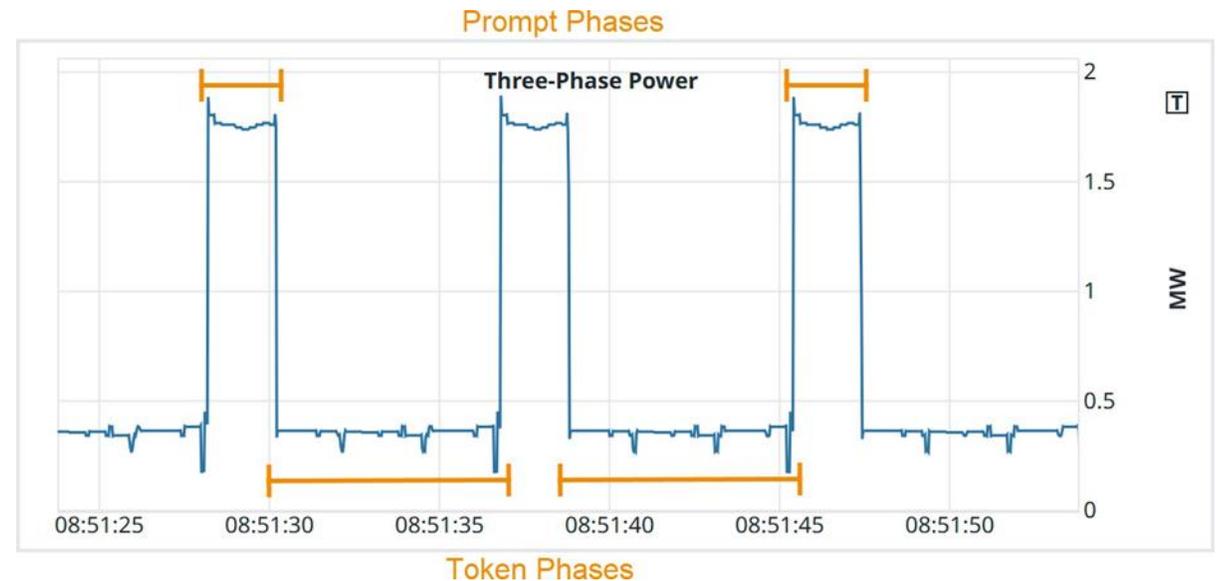
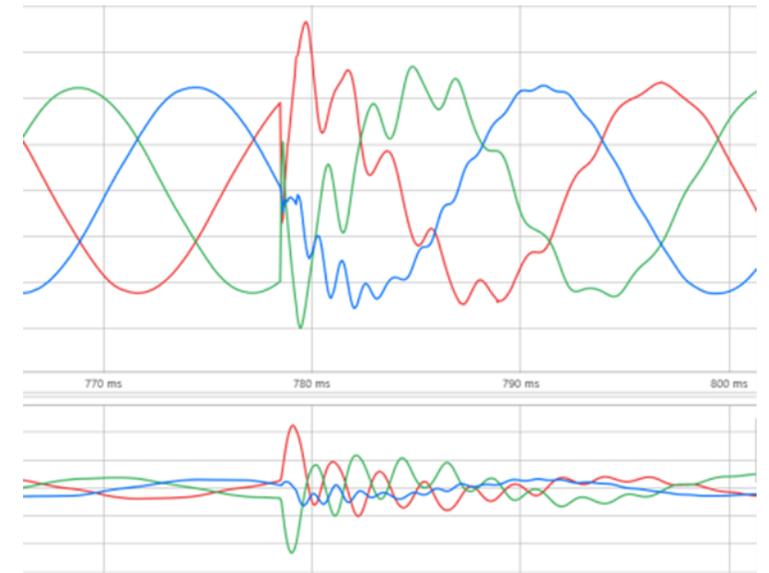
Power Quality

The consistency, reliability, and stability of the power system ensures proper function and longevity of electrical equipment.



New Era of Loads

- AI Training Algorithms
- Arc Furnaces
- EV Charging
- Crypto-currency Mining



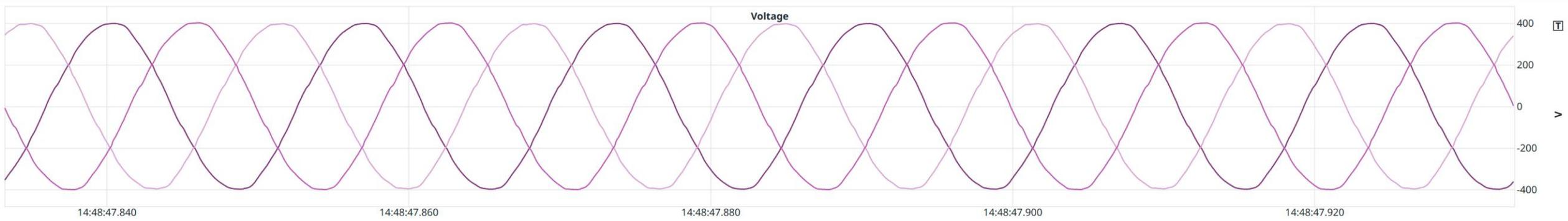
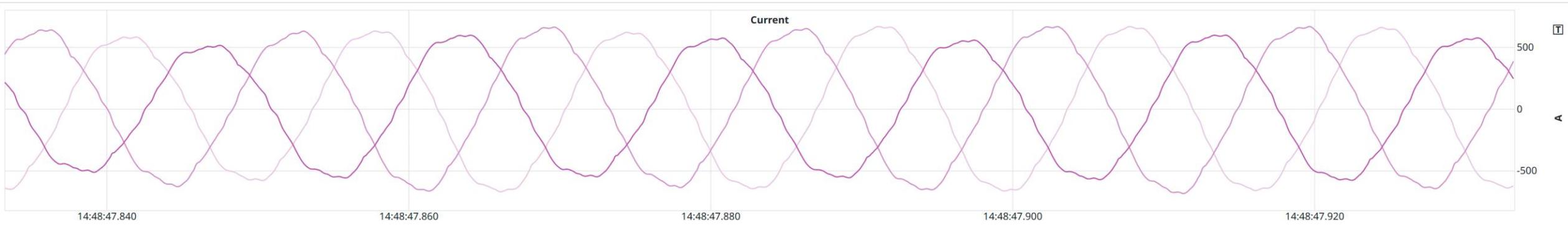
Complex Power Quality Concerns

- Visualizing Long Duration Faults
- Identifying Sub-Cycle Transients
- Detecting Oscillations
- Tracking Rapid Power Fluctuations

Continuous Waveform Streaming

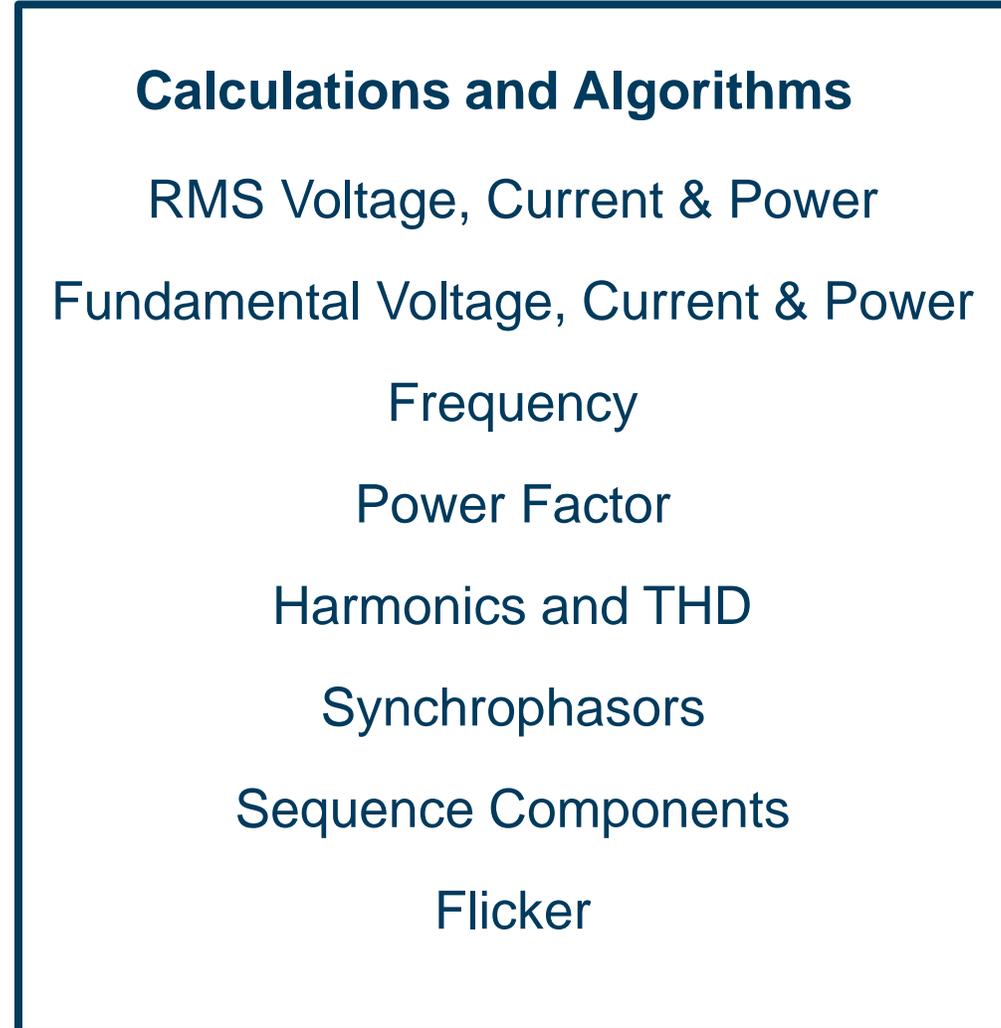
- Conversion of an analog signal to a series of discrete time-stamped values
- Fixed time interval (T_s) between samples
- Instantaneous time-domain sampled voltage and current measurements

Continuous Waveform Data



Wave Data to Meter Values

**Continuous
Waveform
Stream**

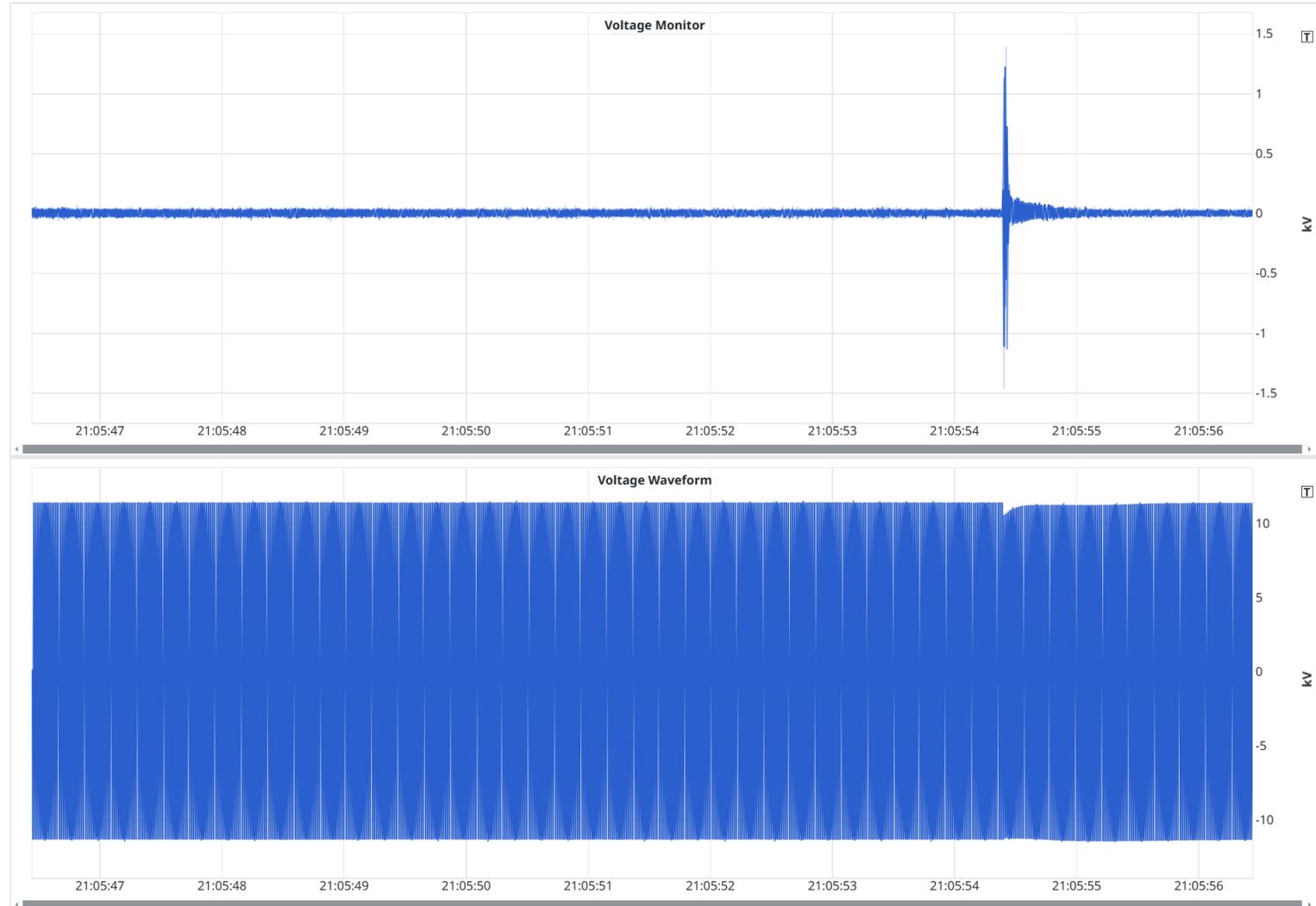
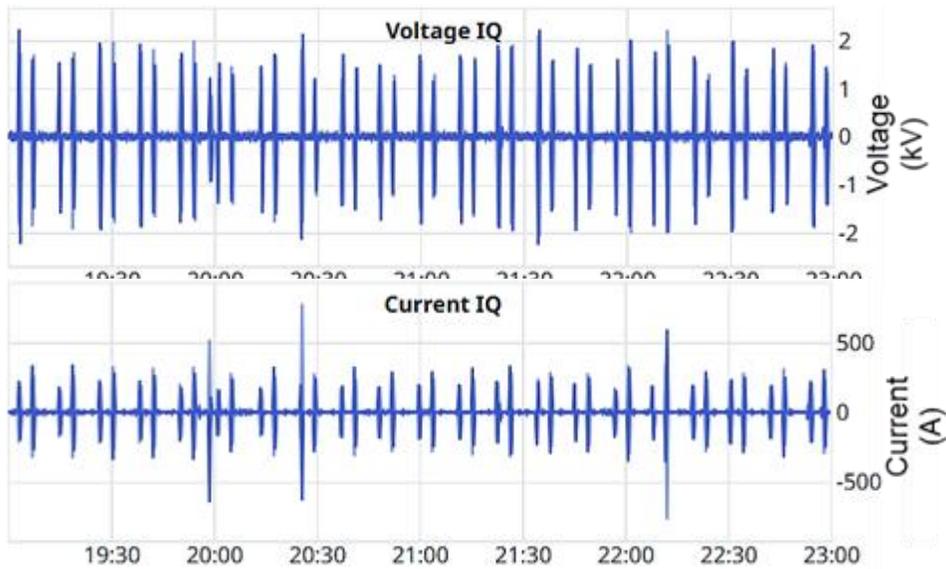


**Analysis and
Visualization**

Incremental Quantities

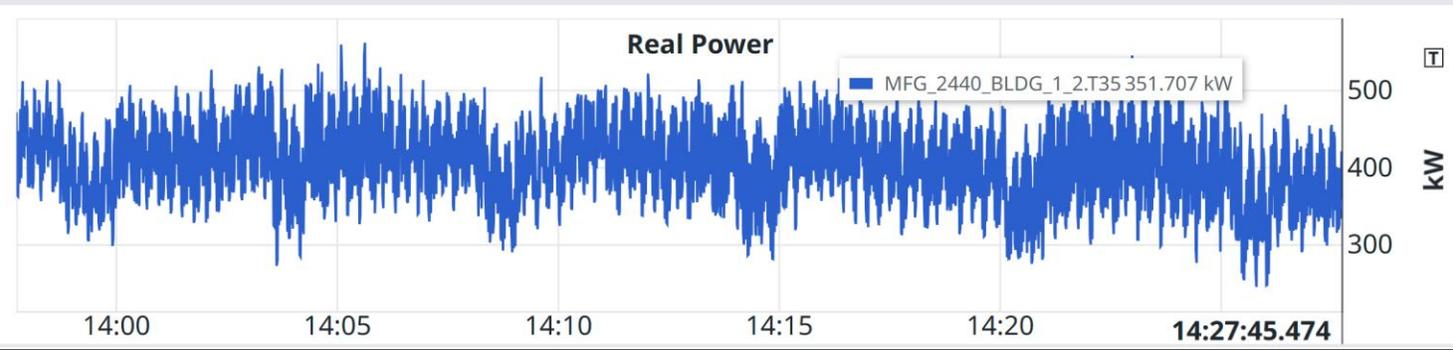
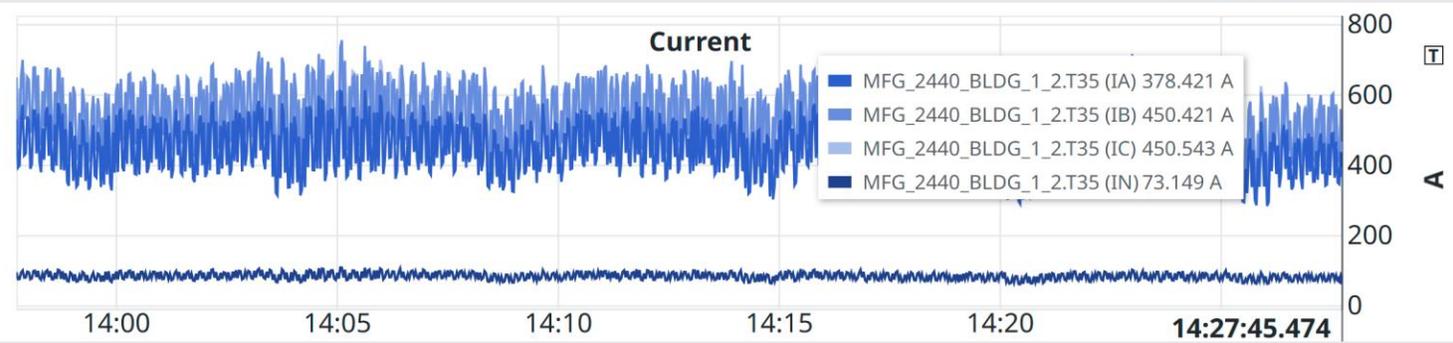
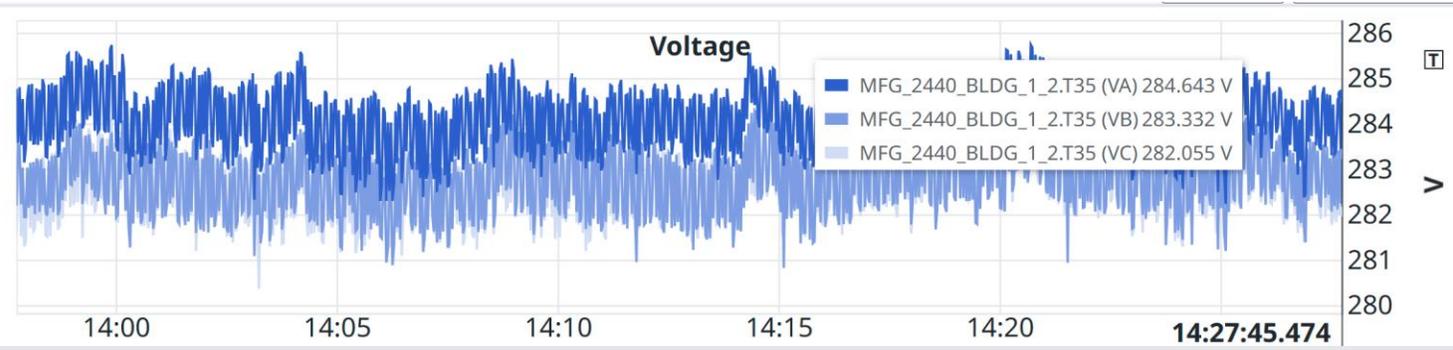
Easily identify disturbances

$$IQx[k] = x[k] - x[k - 240]$$



Meter Data

Measurement Points	VA RMS	VB RMS	VC RMS	Freq
MFG_2440_BLDG...	284.327 V	282.684 V	282.837 V	59.985
Measurement Points	IA RMS	IB RMS	IC RMS	IN RMS
MFG_2440_BLDG...	413.918 A	495.764 A	465.381 A	79.223 A
Measurement Points	S3	SA	SB	SC
MFG_2440_BLDG...	389.460 kVA	117.688 kVA	140.145 kVA	131.627 kVA
Measurement Points	P3	PA	PB	PC
MFG_2440_BLDG...	364.913 kW	111.805 kW	130.021 kW	123.087 kW
Measurement Points	Q3	QA	QB	QC
MFG_2440_BLDG...	136.081 kVar	36.744 kVar	52.299 kVar	46.643 kVar
Measurement Points	VA 1CYC THD	VB 1CYC THD	VC 1CYC THD	
MFG_2440_BLDG...	1.959 %	2.191 %	2.016 %	



Synchrophasors

ThreePhase Power Real

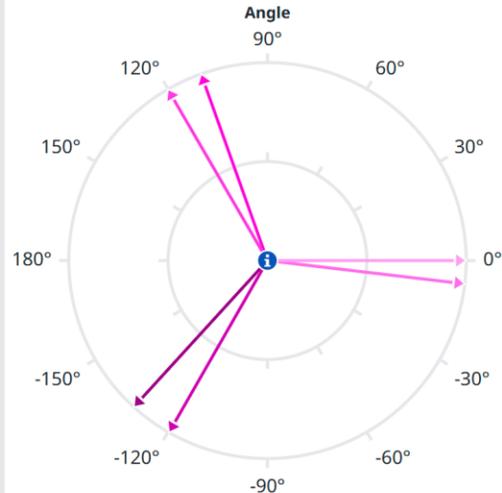
MFG_2440_BLDG_1_2.T35

370.142 kW

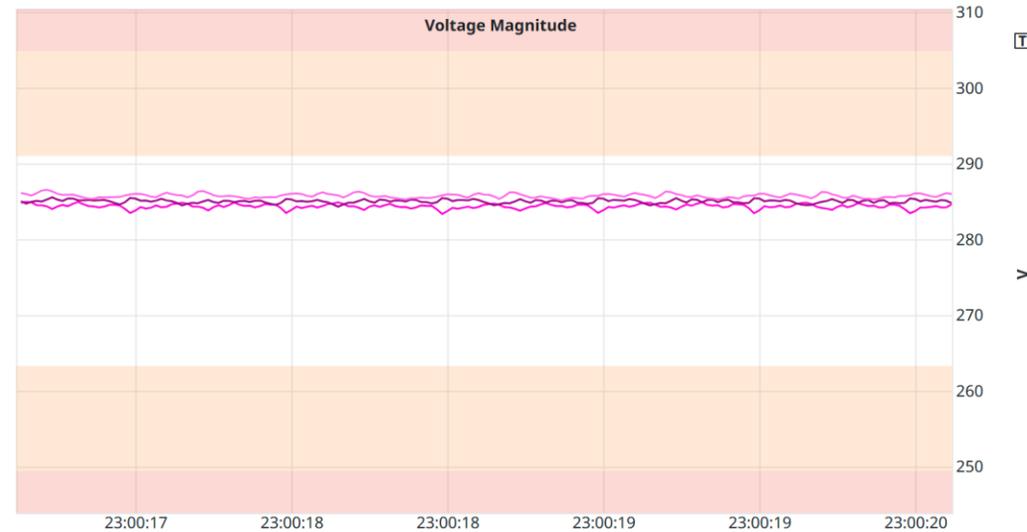
Frequency

MFG_2440_BLDG_1_2.T35

59.999 Hz



Voltage Magnitude



Voltage Magnitude

MFG_2440_BLDG_1_2.T35 (PhaseA)

285.964 V

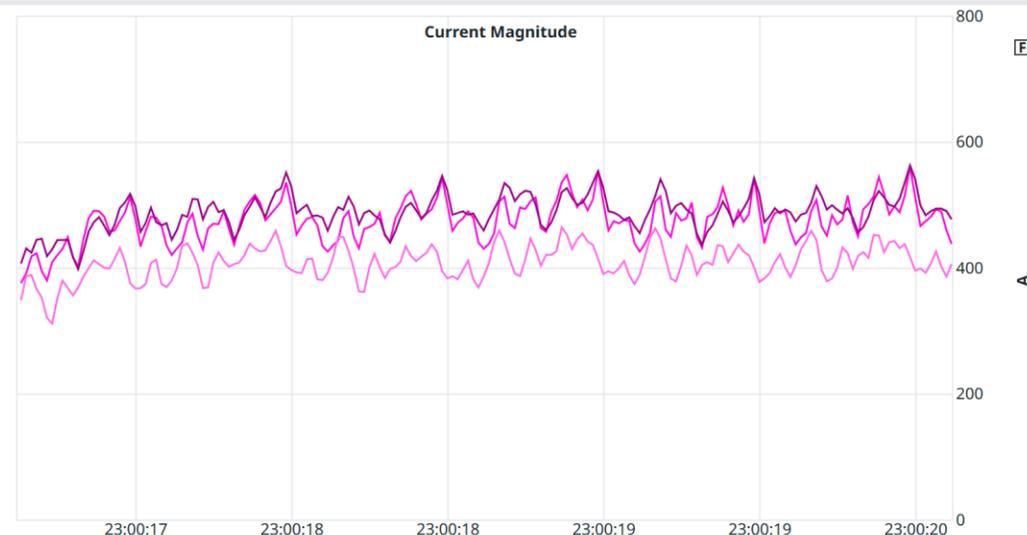
MFG_2440_BLDG_1_2.T35 (PhaseC)

284.609 V

MFG_2440_BLDG_1_2.T35 (PhaseB)

284.765 V

Current Magnitude



Current Magnitude

MFG_2440_BLDG_1_2.T35 (PhaseA)

405.720 A

MFG_2440_BLDG_1_2.T35 (PhaseB)

476.691 A

MFG_2440_BLDG_1_2.T35 (PhaseC)

437.615 A

Load Profile Trending

- Data Compression: End-of-Interval
- Identifying Metrics: Max, Min, Average.
- Simple calculations: Sum, RMS, Change-Over-Interval

Load Profile Data

Measurement Points	LDP IA	LDP IB	LDP IC	LDP IN	LDP VA	LDP VB	LDP VC
	RMS						
	MAX	MAX	MAX	MAX	MAX	MAX	MAX 900

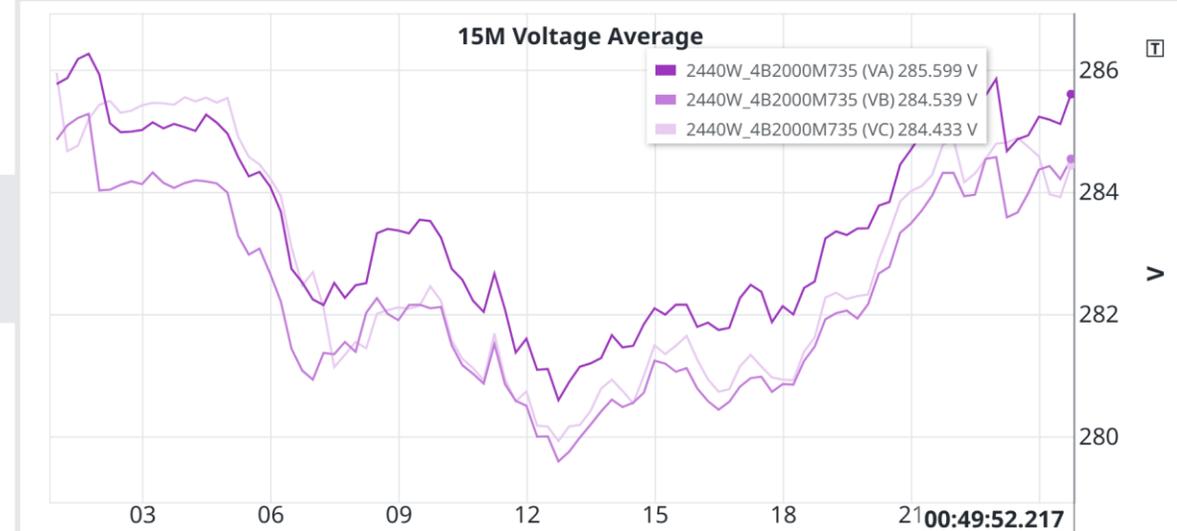
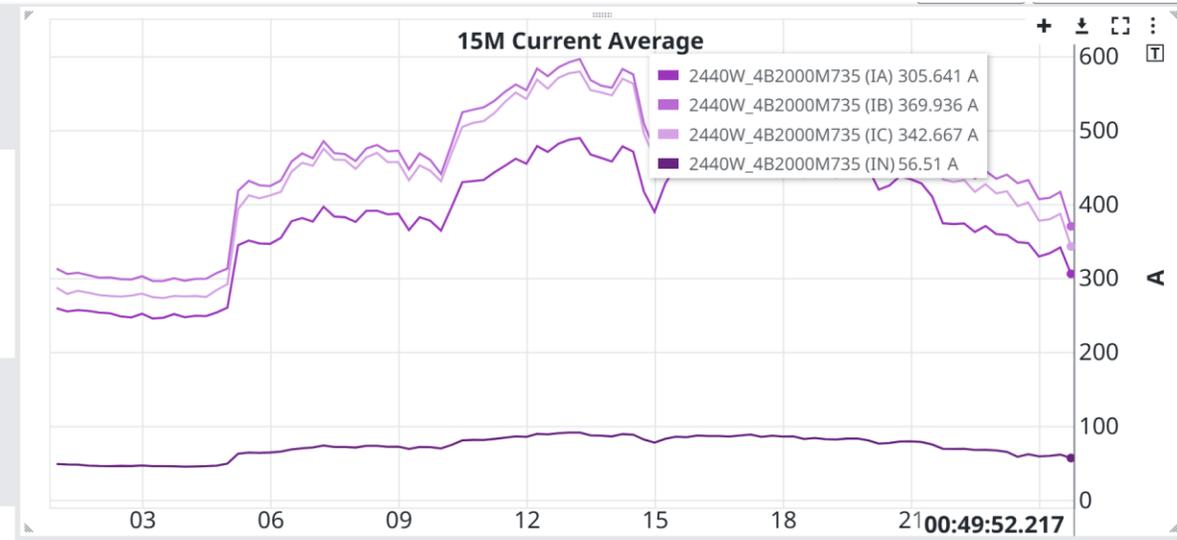
2440W_4B2000M...	453.220 A	557.480 A	539.776 A	77.680 A	287.247 V	285.978 V	285.650 V
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Measurement Points	LDP IA	LDP IB	LDP IC	LDP IN	LDP VA	LDP VB	LDP VC
	RMS						
	MIN	MIN	MIN	MIN	MIN	MIN	MIN 900

2440W_4B2000M...	180.235 A	220.236 A	198.831 A	40.479 A	283.202 V	281.985 V	282.043 V
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Measurement Points	LDP IA	LDP IB	LDP IC	LDP IN	LDP VA	LDP VB	LDP VC
	RMS						
	AVG	AVG	AVG	AVG	AVG	AVG	AVG 900

2440W_4B2000M...	305.641 A	369.936 A	342.667 A	56.510 A	285.599 V	284.539 V	284.433 V
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Data Management

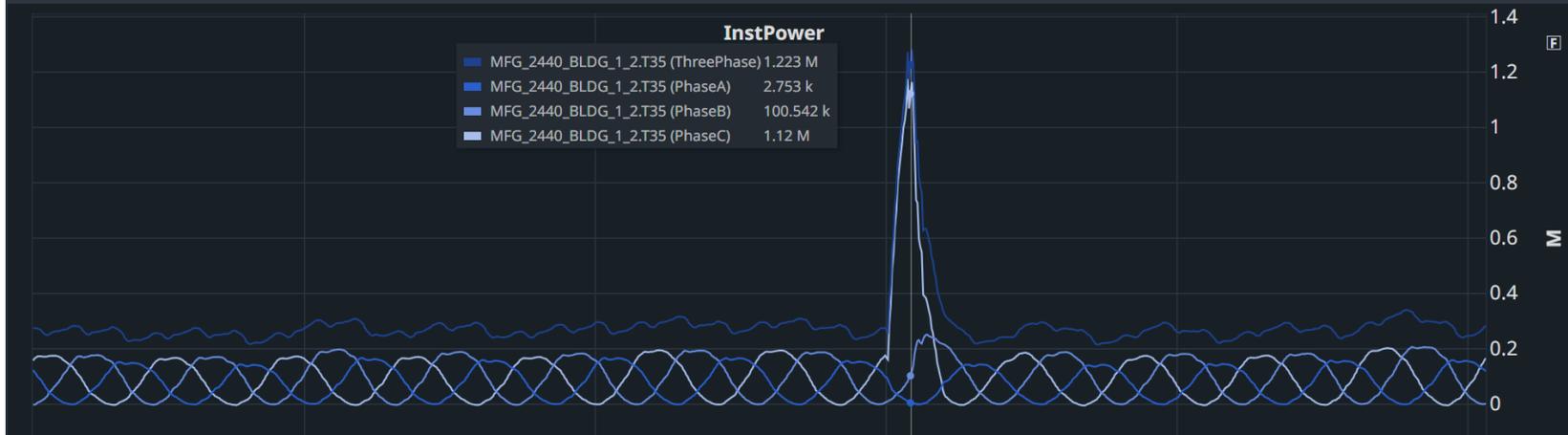
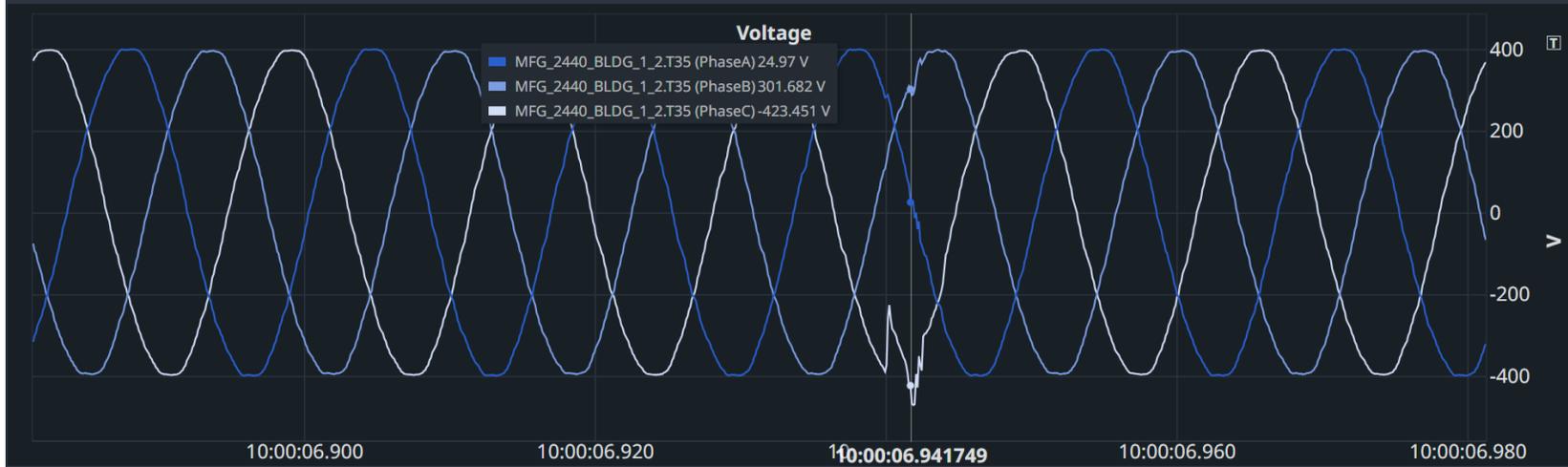
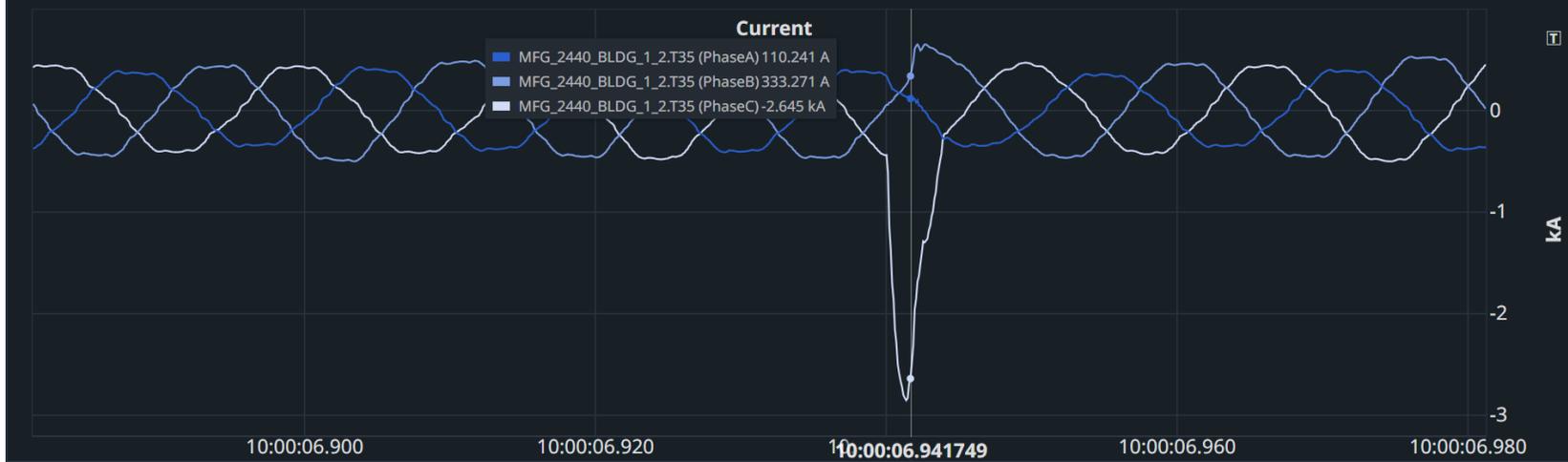
- 14.4 ksps wave form data: 5GB per day per phase
- ½ cycle virtual meter data: <100MB per day per analog
- Synchrophasors: < 50 MB per day per phasor
- 15M average LDP data = <5 KB per day per channel

277/480 V Industrial Manufacturing Plant



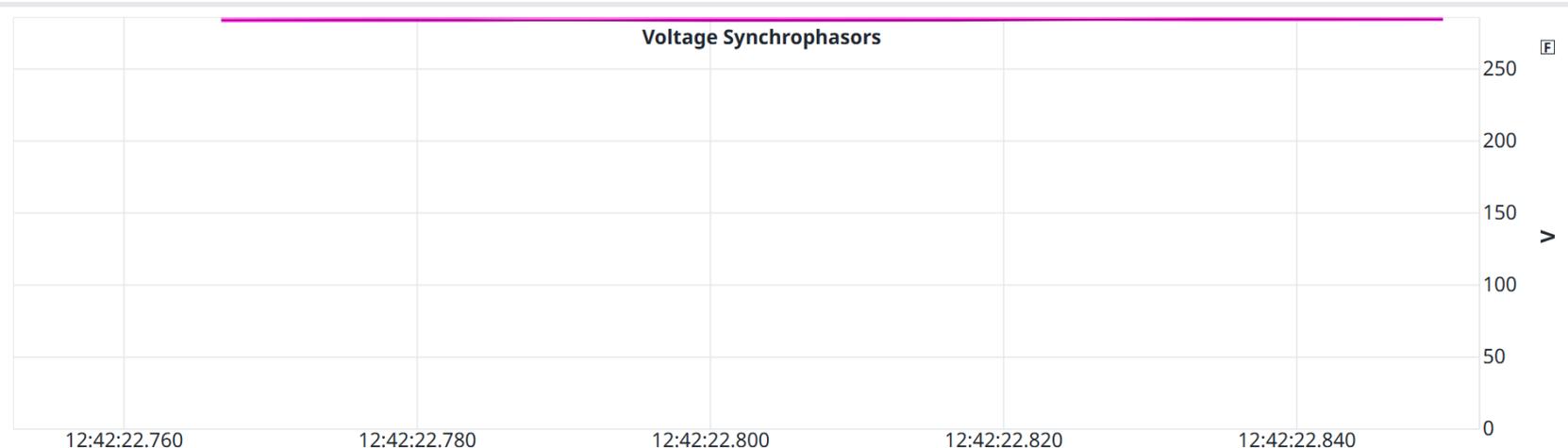
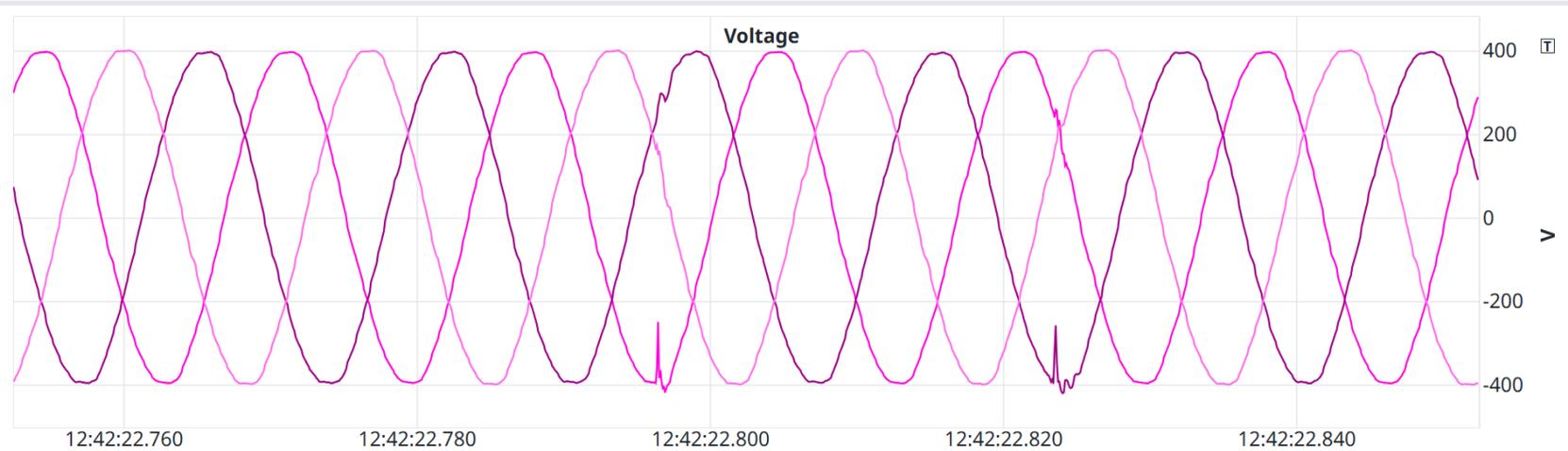
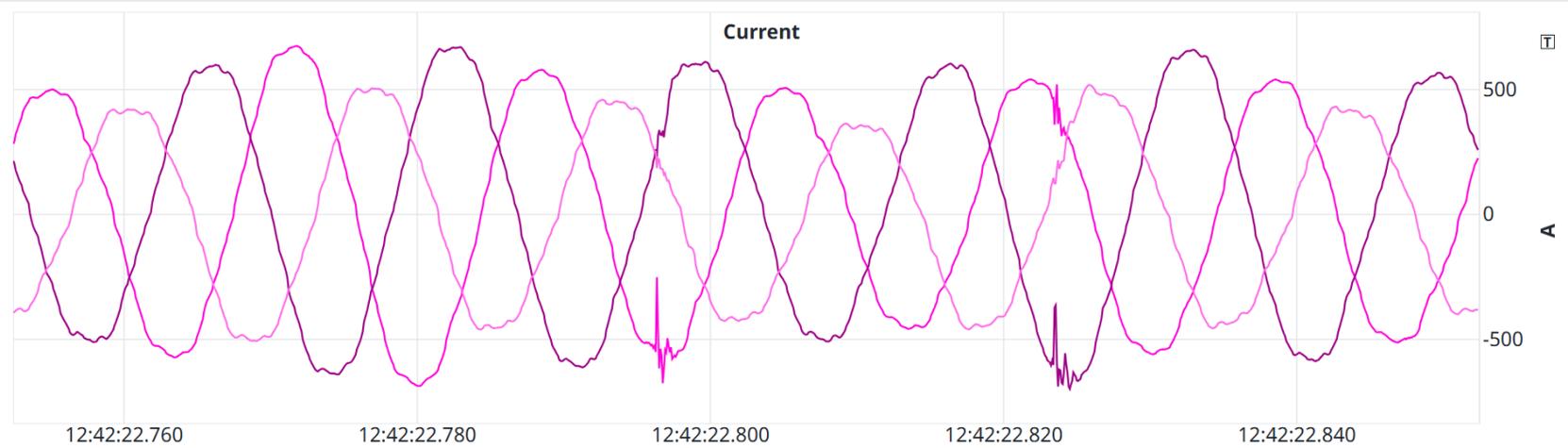
Captured Sub-Cycle Transient

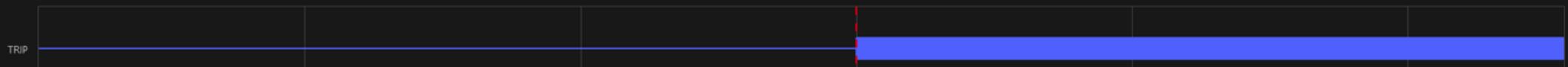
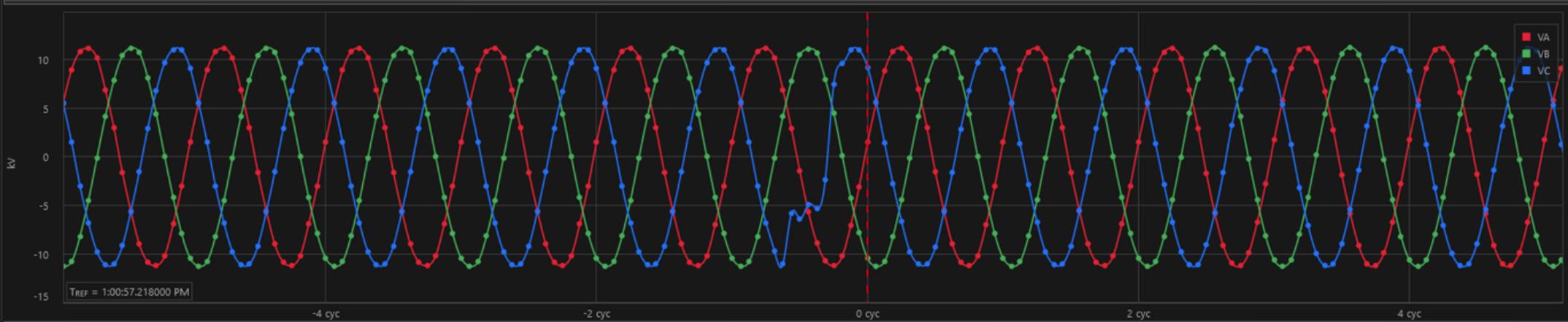
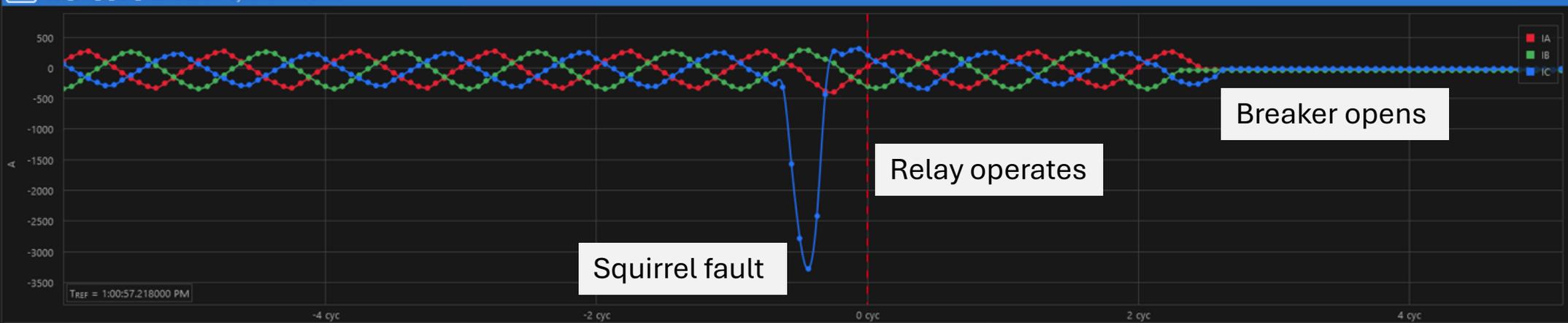
Instantaneous Fault Current in excess of 2.8 kA



More Sub-Cycle Transients

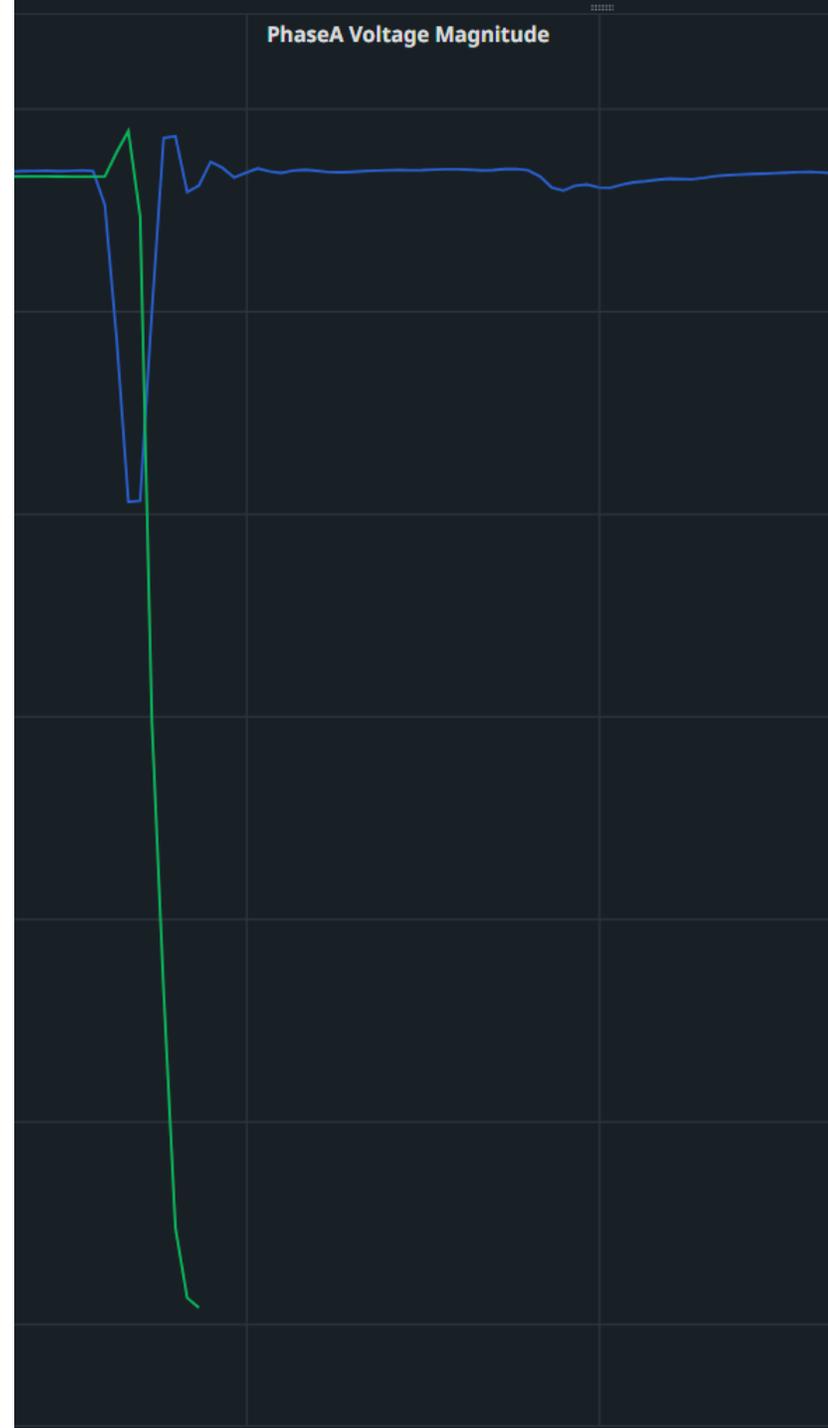
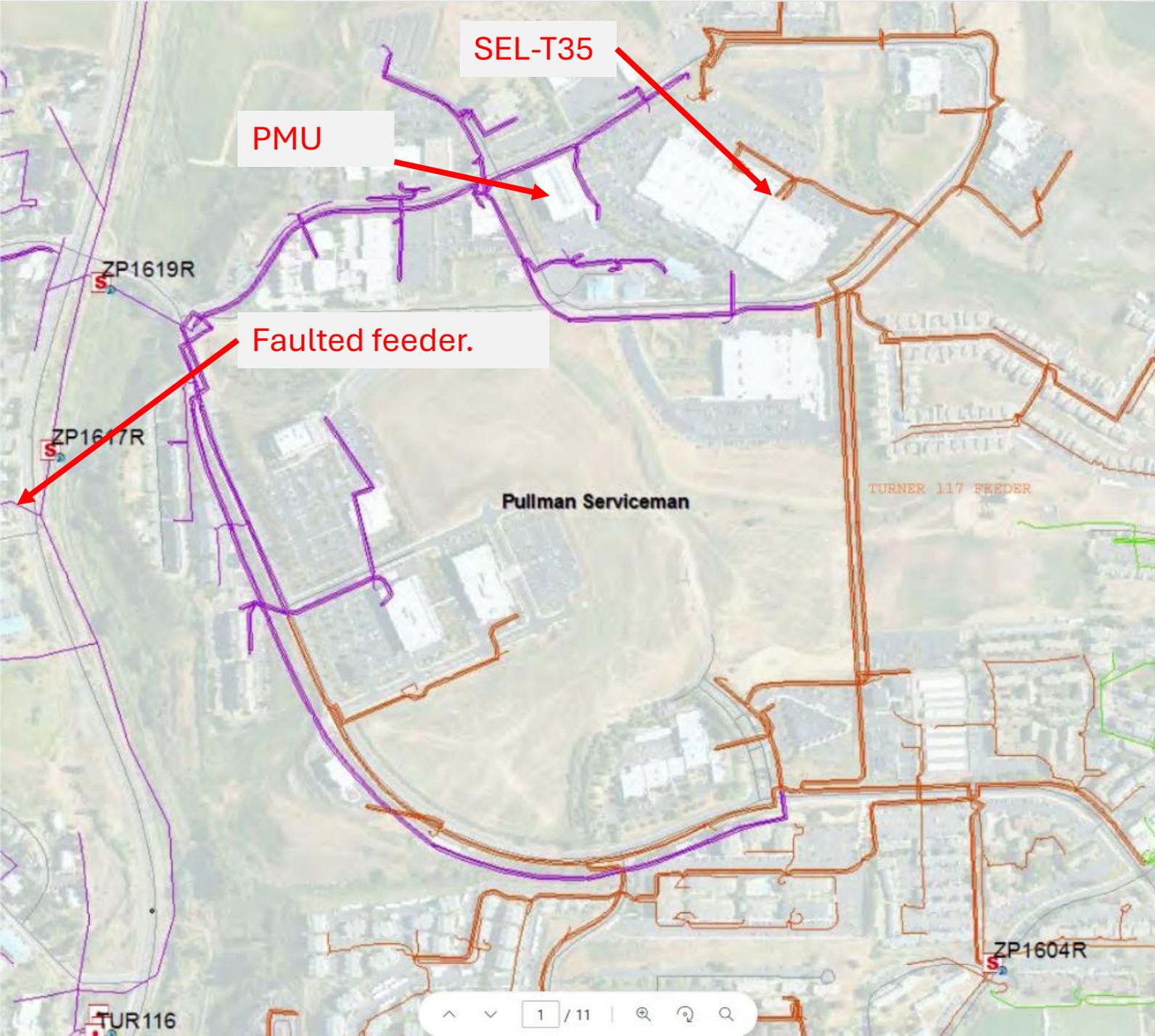
Identifying Arcing Faults



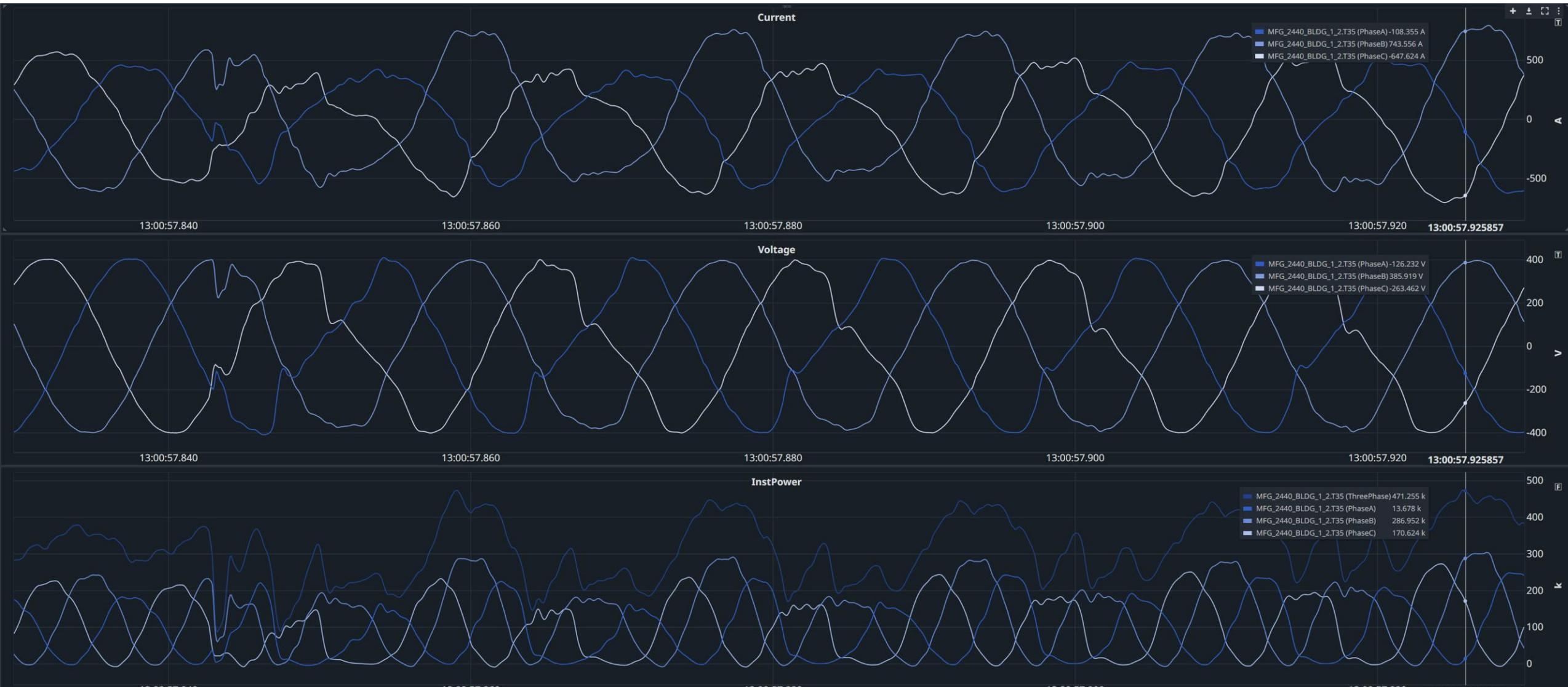


50G1
52A
SH0
LT6

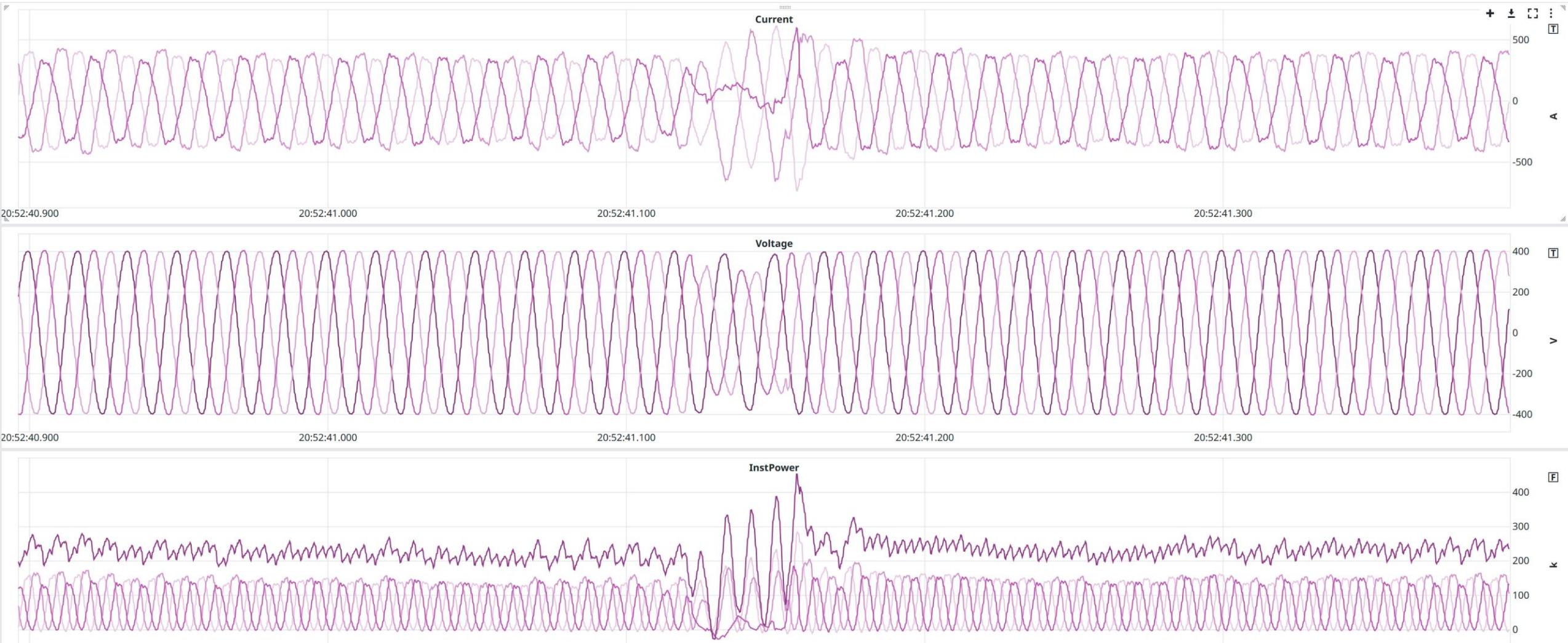
SEL-351S relay in substation captures squirrel-induced fault and breaker operation

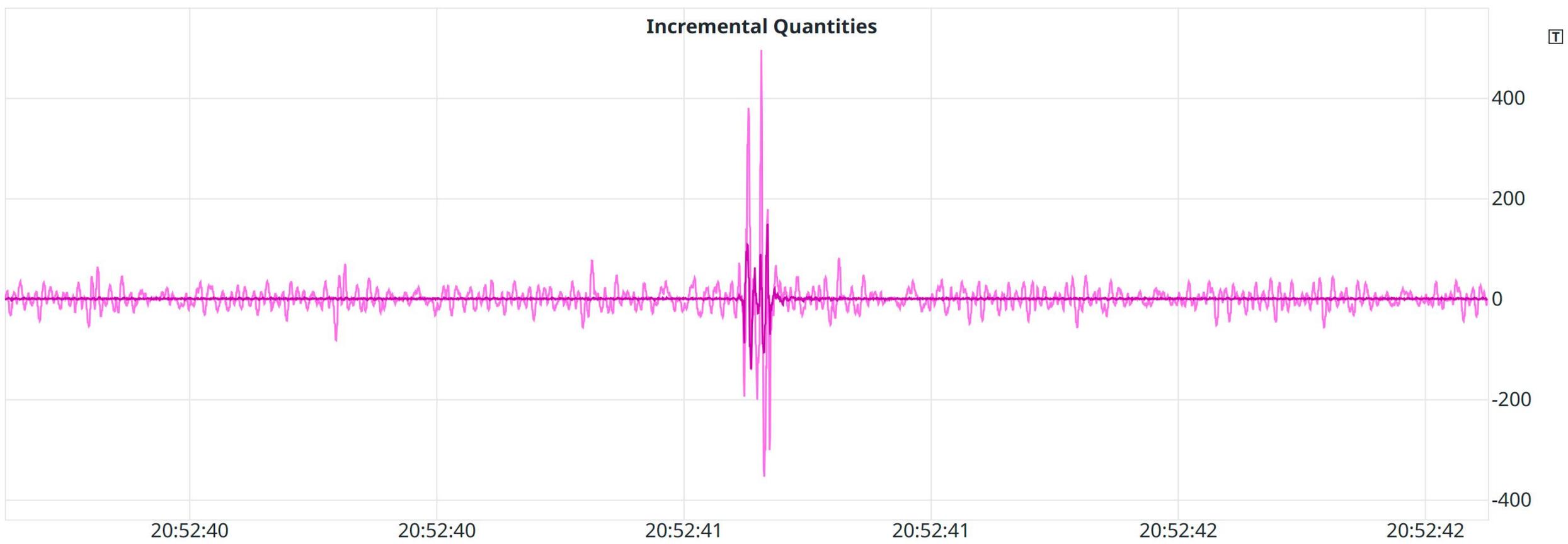
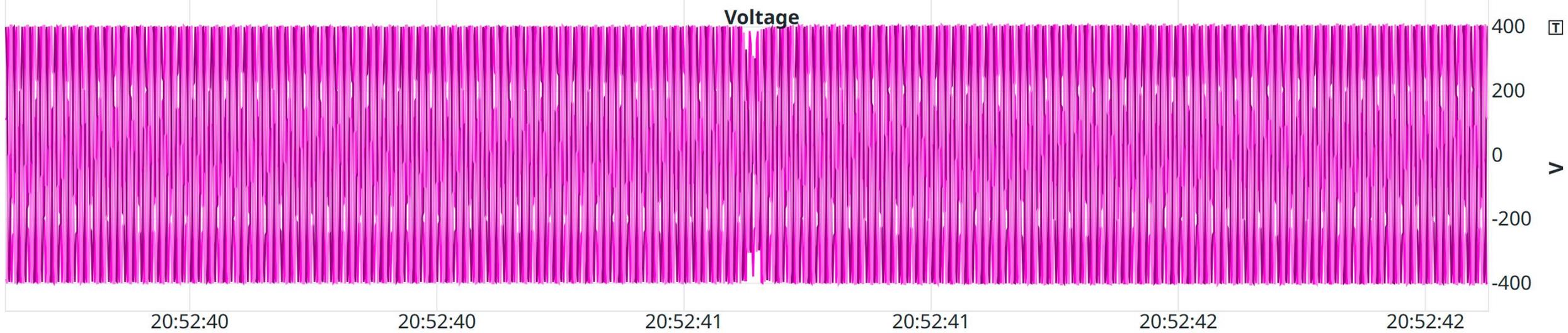


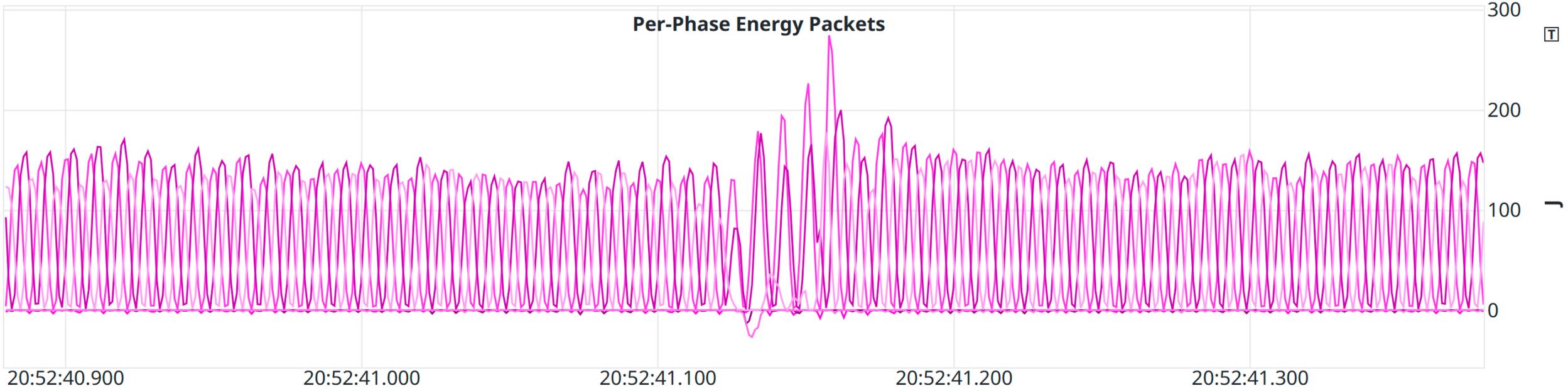
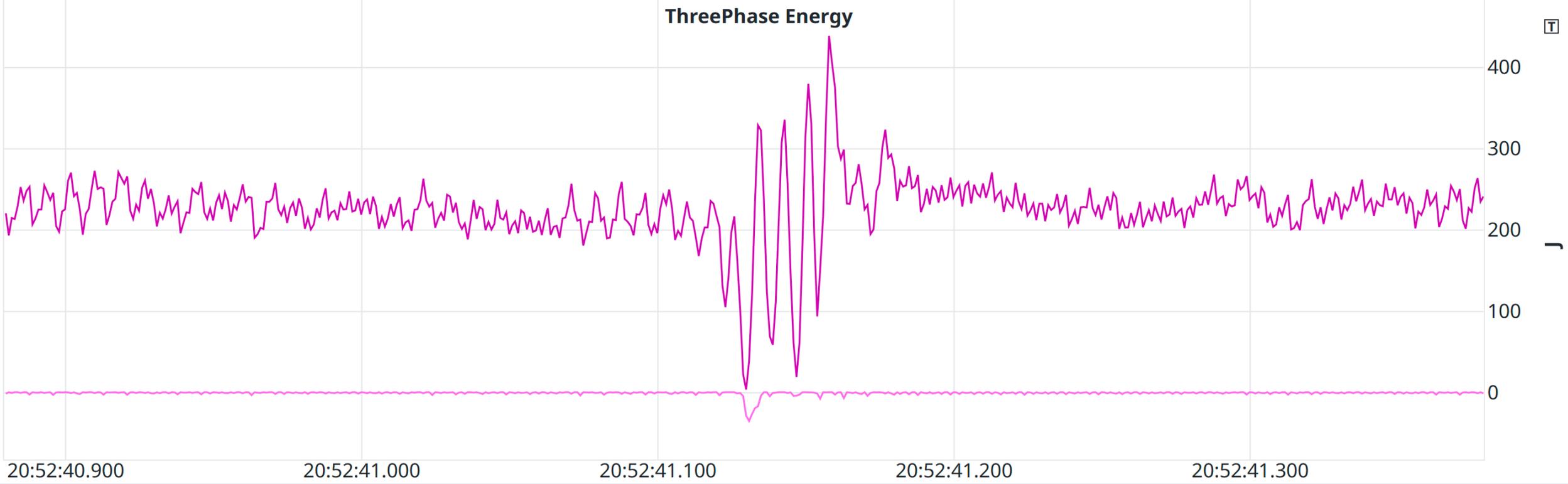
Sympathetic Response



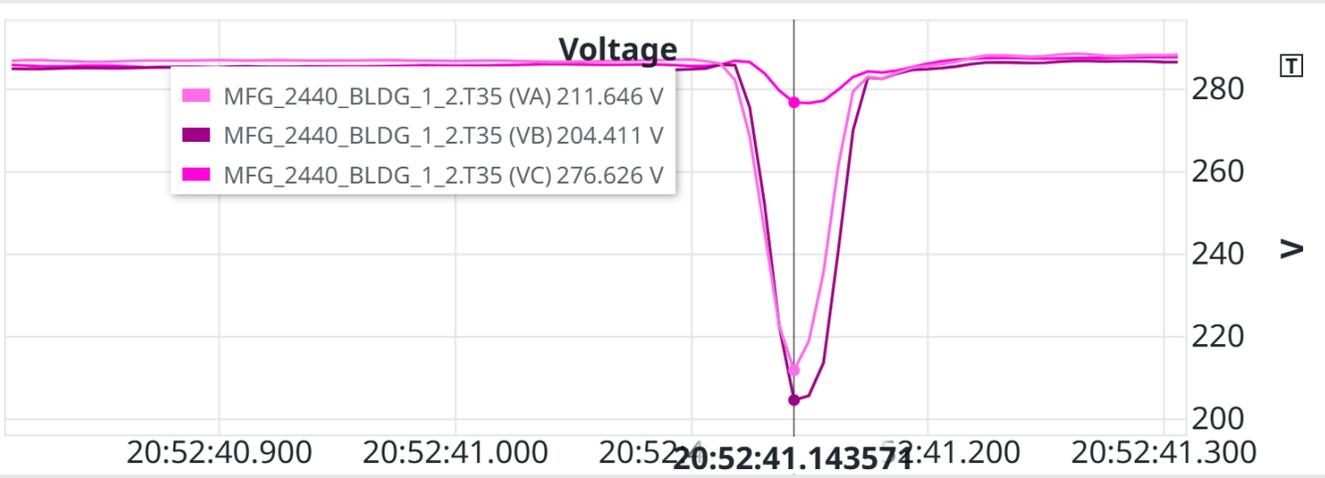
Breaking Down Events in Real Time



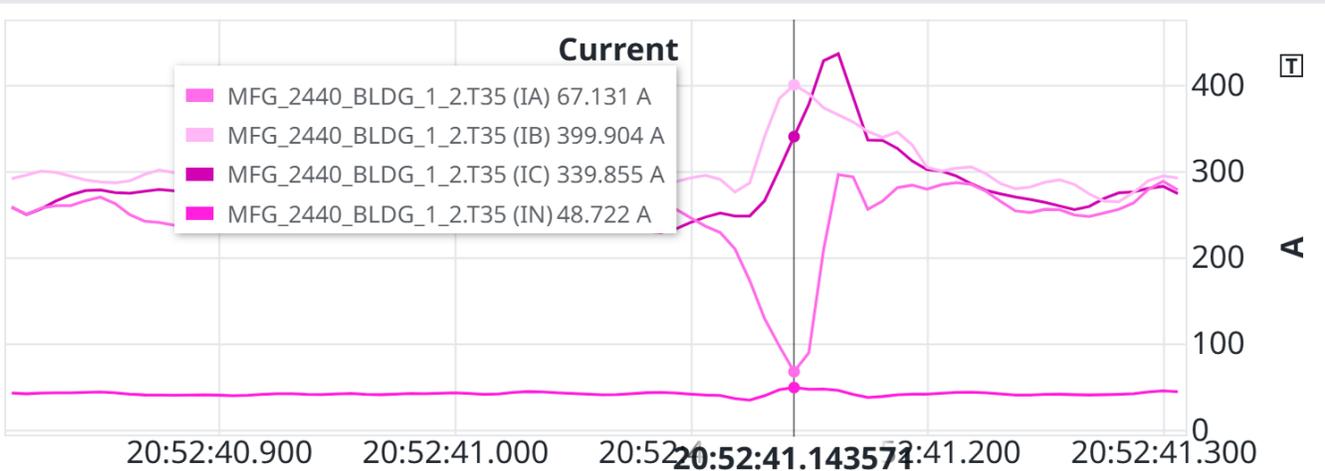




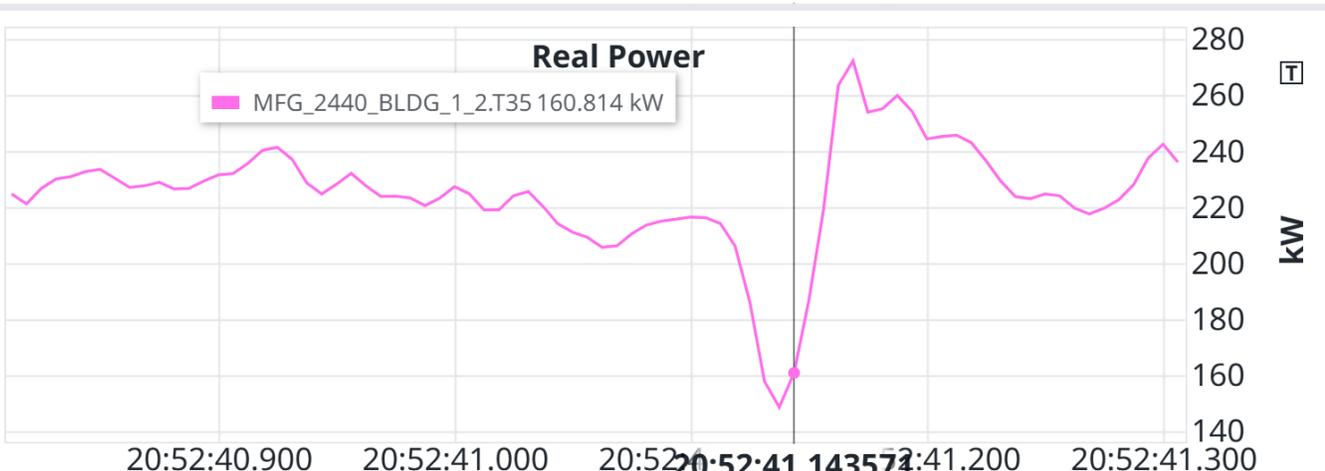
Measurement Points	VA RMS	VB RMS	VC RMS	Freq
MFG_2440_BLDG...	211.646 V	204.411 V	276.626 V	59.998



Measurement Points	IA RMS	IB RMS	IC RMS	IN RMS
MFG_2440_BLDG...	67.131 A	399.904 A	339.855 A	48.721 A



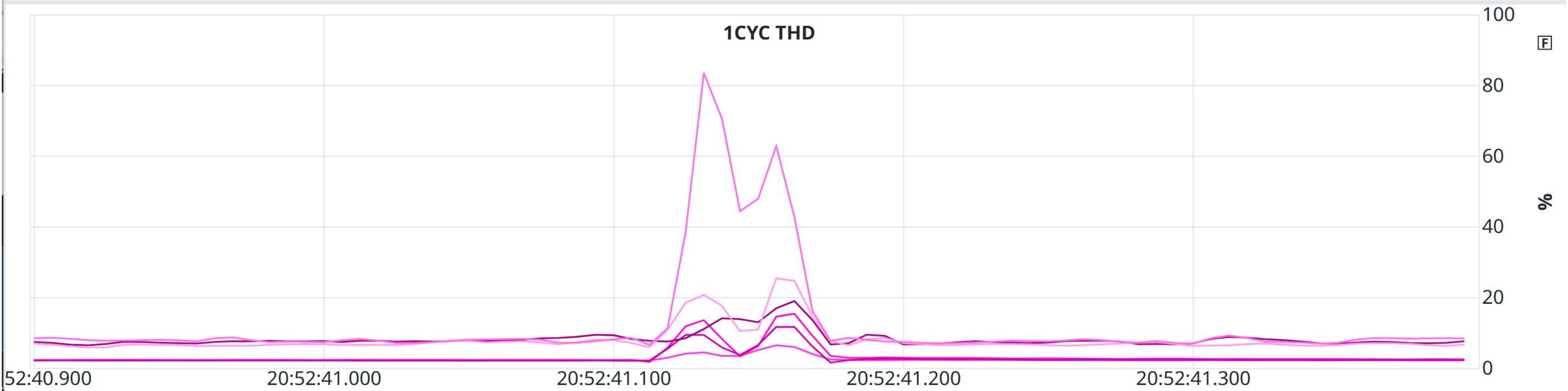
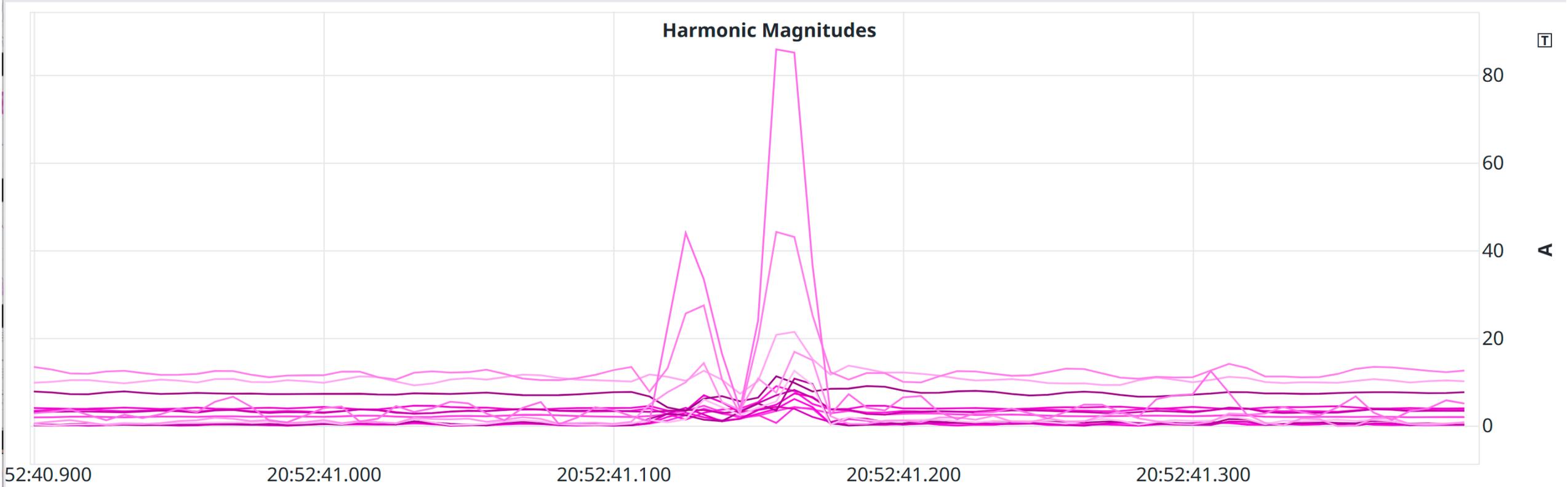
Measurement Points	S3	SA	SB	SC
MFG_2440_BLDG...	189.730 kVA	13.667 kVA	82.015 kVA	94.047 kVA



Measurement Points	P3	PA	PB	PC
MFG_2440_BLDG...	160.814 kW	3.137 kW	69.401 kW	88.277 kW

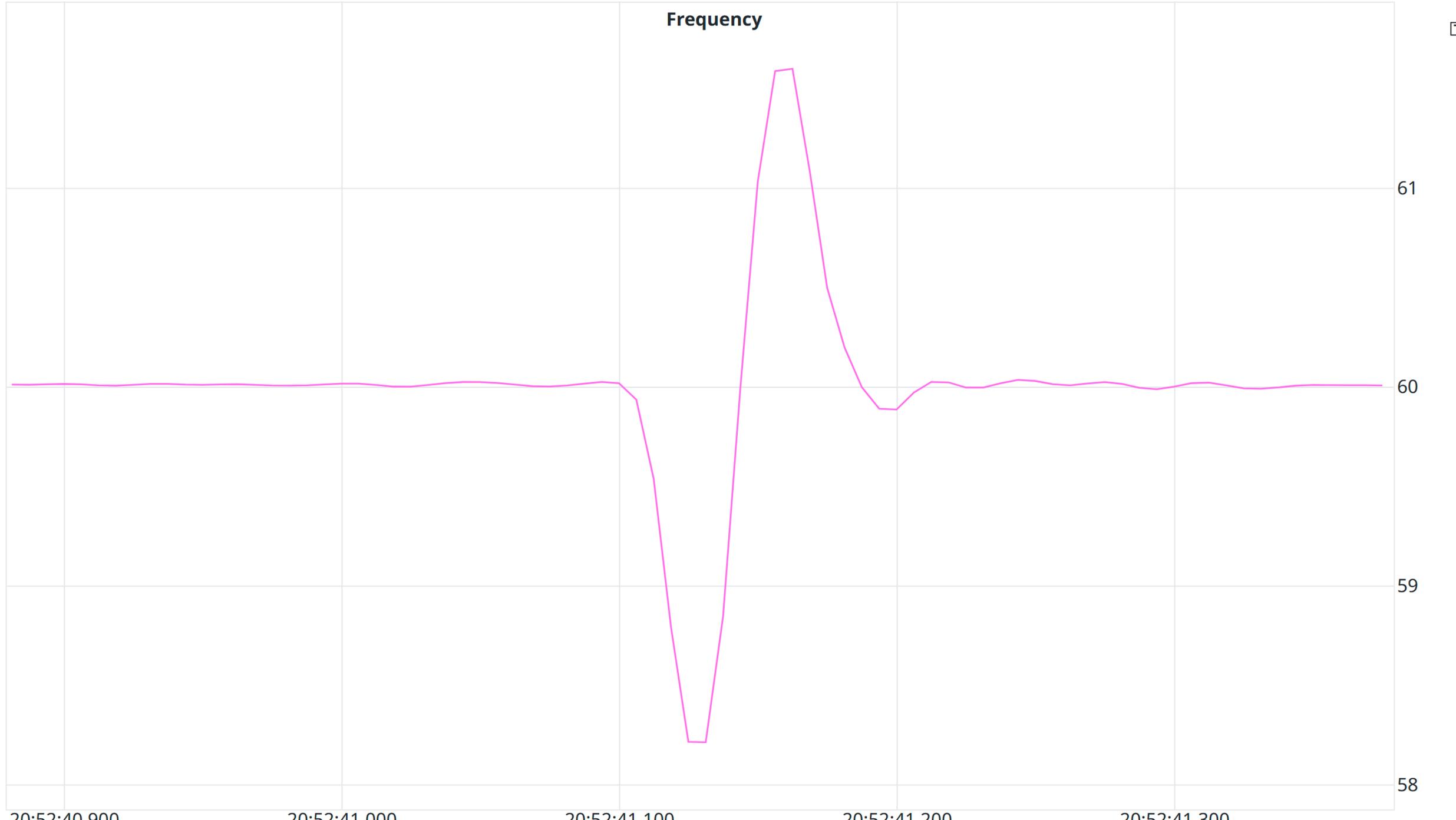
Measurement Points	Q3	QA	QB	QC
MFG_2440_BLDG...	-122.210 kVar	-19.429 kVar	-43.210 kVar	32.395 kVar

Measurement Points	VA 1CYC THD	VB 1CYC THD	VC 1CYC THD
MFG_2440_BLDG...	3.639 %	3.272 %	3.385 %



Frequency

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Thank you

