

## Case Study

# Identifying the Cause of Laser Cutting Interruptions in Automotive Manufacturing with Power Quality Analysis



Elspec's power quality analyzers identified the root cause of laser cutting machine interruptions in automotive manufacturing in Macedonia, enabling a targeted solution that enhanced operational stability.

## Customer Situation

An airbag manufacturing plant in Macedonia was experiencing significant interruptions in their laser cutting process. The production plant uses 2-laser cutting machine to cut textile materials used in airbag production. Both lasers are intended to operate simultaneously; however, the second laser frequently shuts off after 3-4 minutes of use, leading to production stoppages and delays.

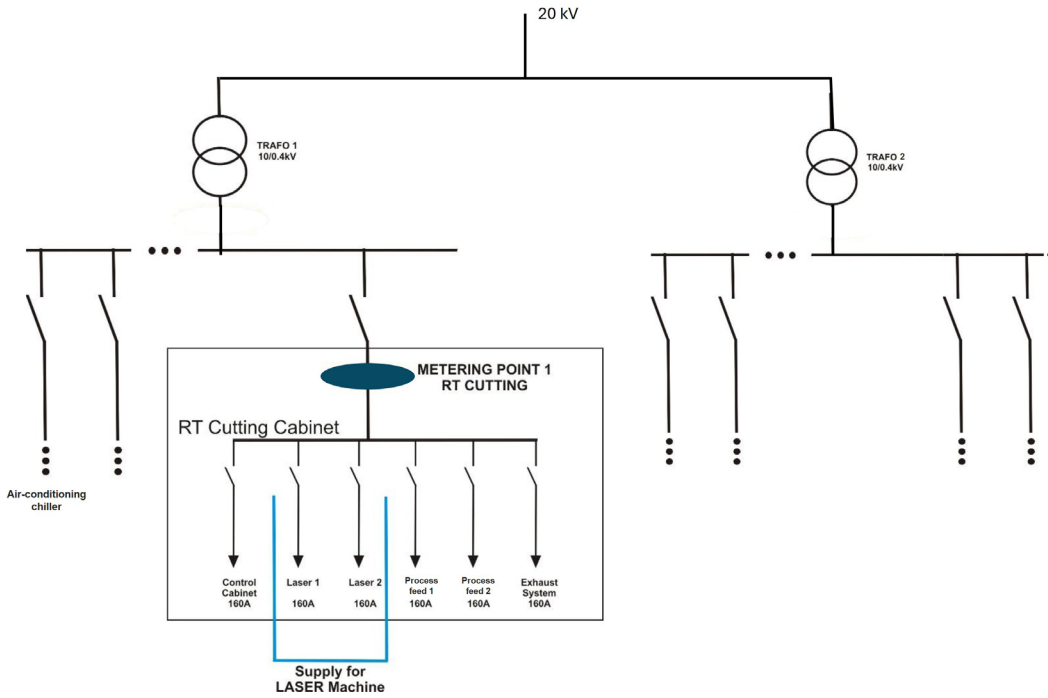
The customer suspected that voltage disturbances, were affecting the laser cutting machine and causing these shutdowns but couldn't find the source. These interruptions were critical as they increased the cutting time and reduced productivity in the manufacturing of airbags. The company approached [Loging Electronics](#), Elspec's agent in Macedonia, to identify the root cause of the voltage issues and better understand how to prevent further disruptions to the laser cutting process.



# Conducting Power Quality Analysis

To investigate the problem, Logging Electronics deployed the Elspec G4500 [Portable Power Quality Analyzer](#), a high-precision device capable of capturing and recording fast voltage events like interruptions and transients. The analyzer was connected at strategic metering points in the plant, including the main distribution point for the transformer supplying power to the laser cutting machine.

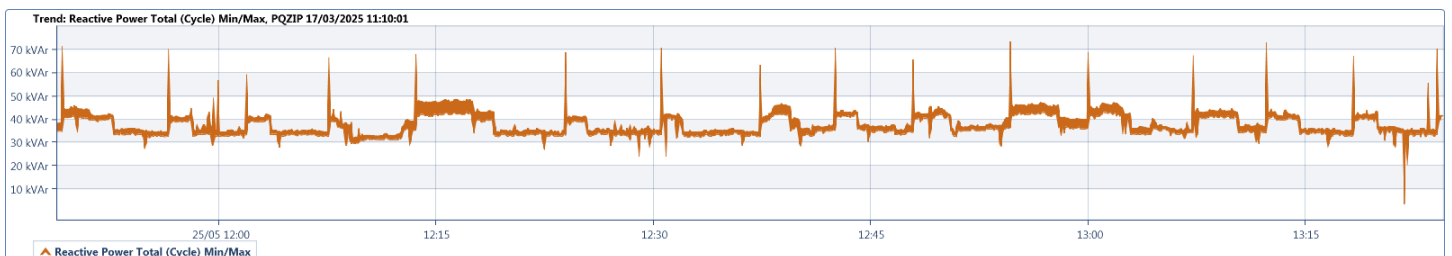
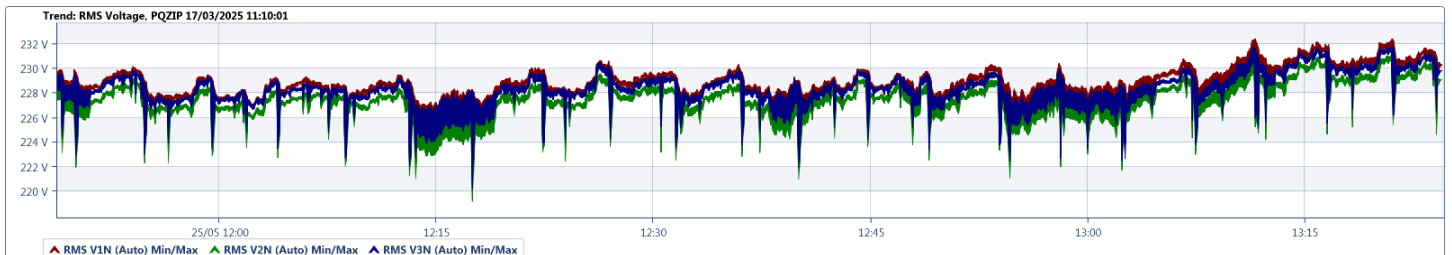
The G4500 analyzer's high sampling rate of 1,024 samples per cycle enabled the monitoring of rapid voltage fluctuations, enabling the detection of voltage events lasting as little as 19 microseconds—critical for understanding disturbances in a sensitive system like the laser cutting machine. The illustration below shows that first, an analyzer was connected on the METERING POINT 1.



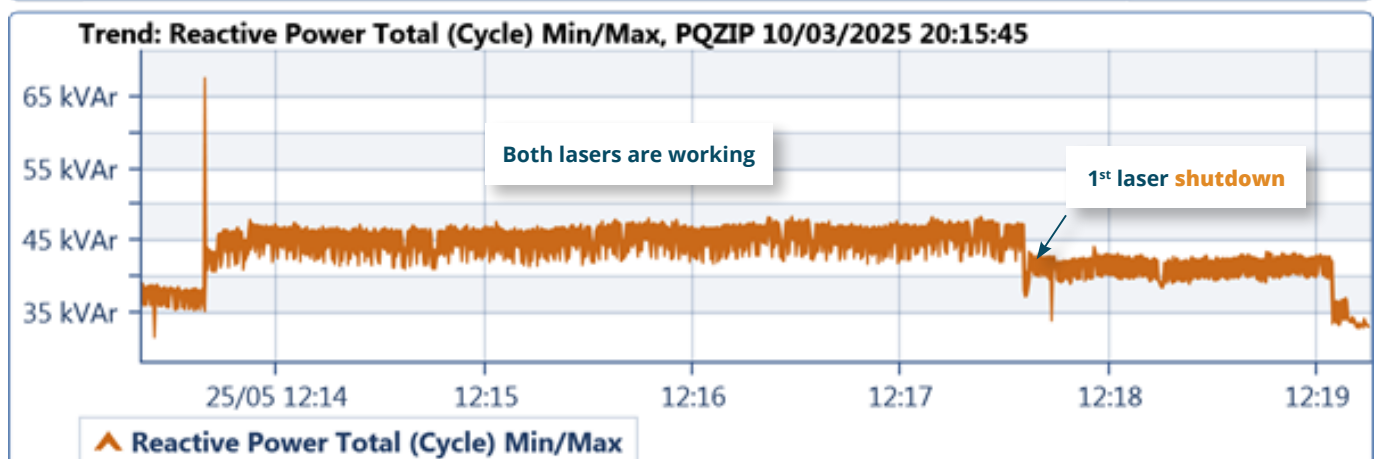
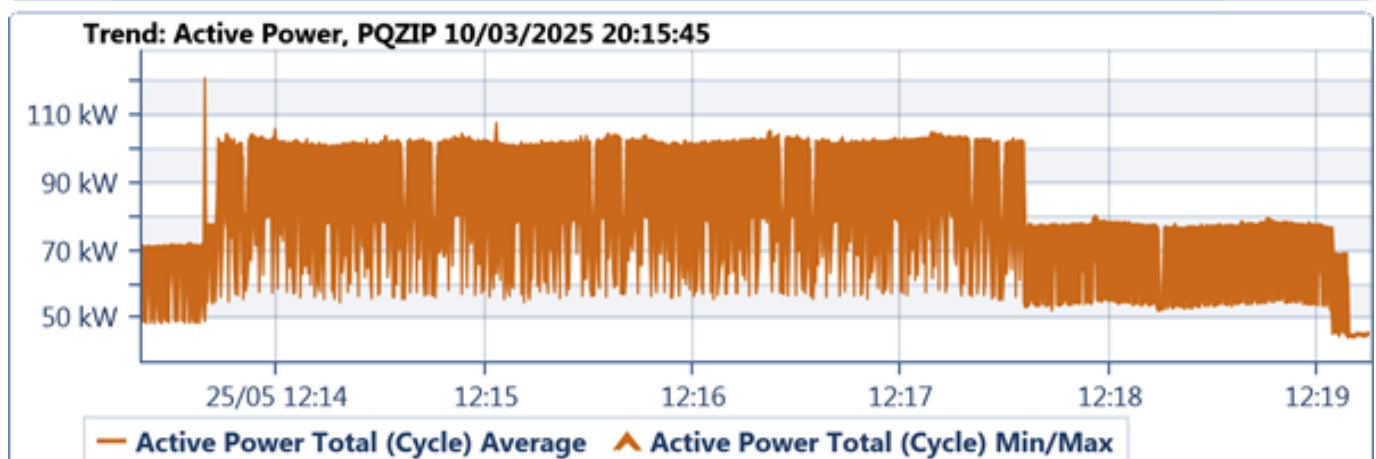
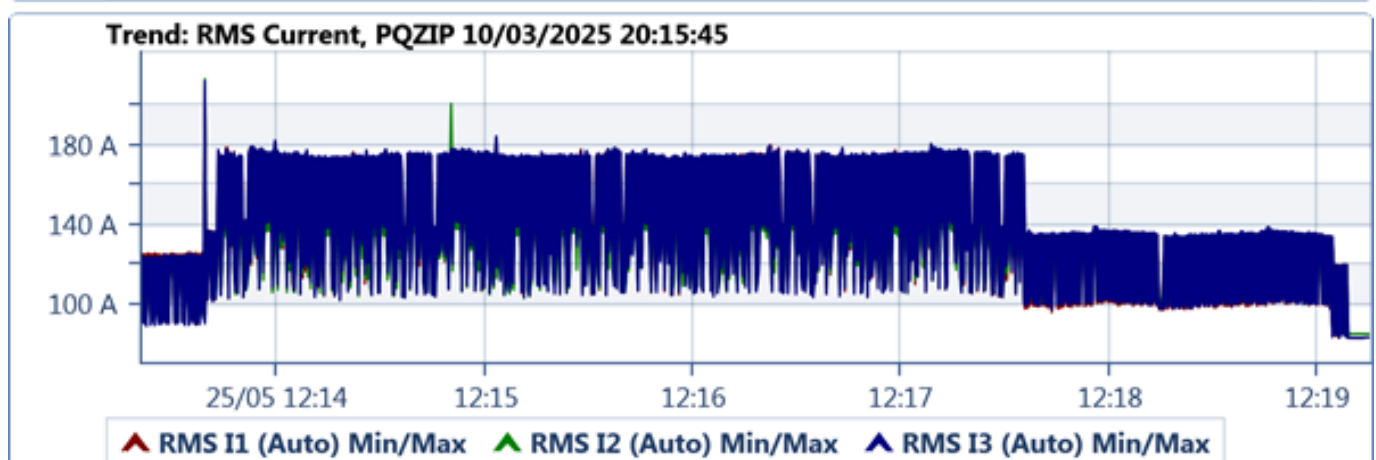
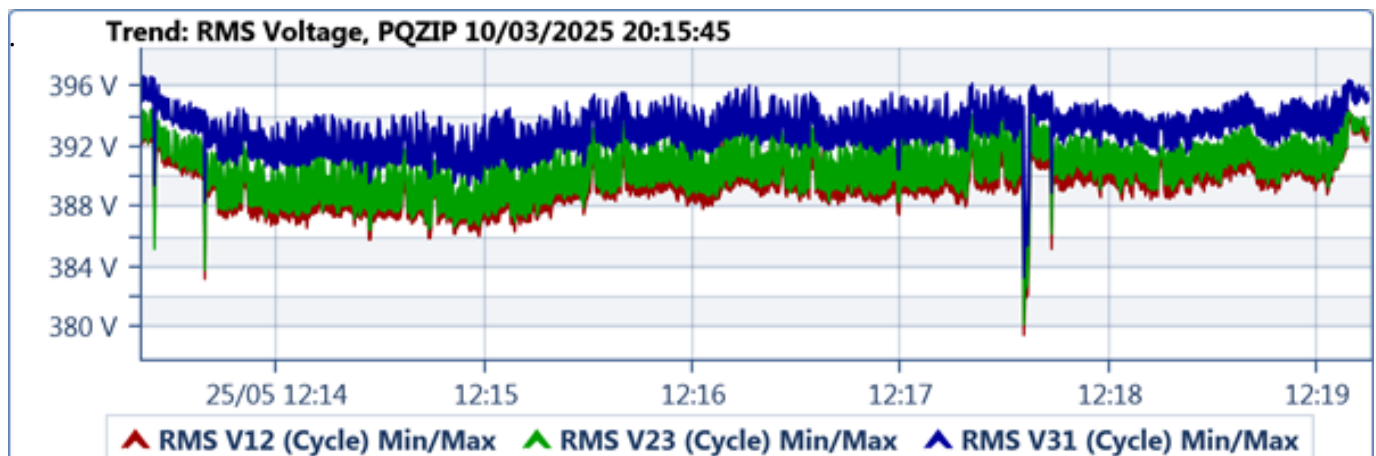
Single pole scheme – Supplying the LASER Machine

## Results

The analysis revealed 3 shutdown occasions.



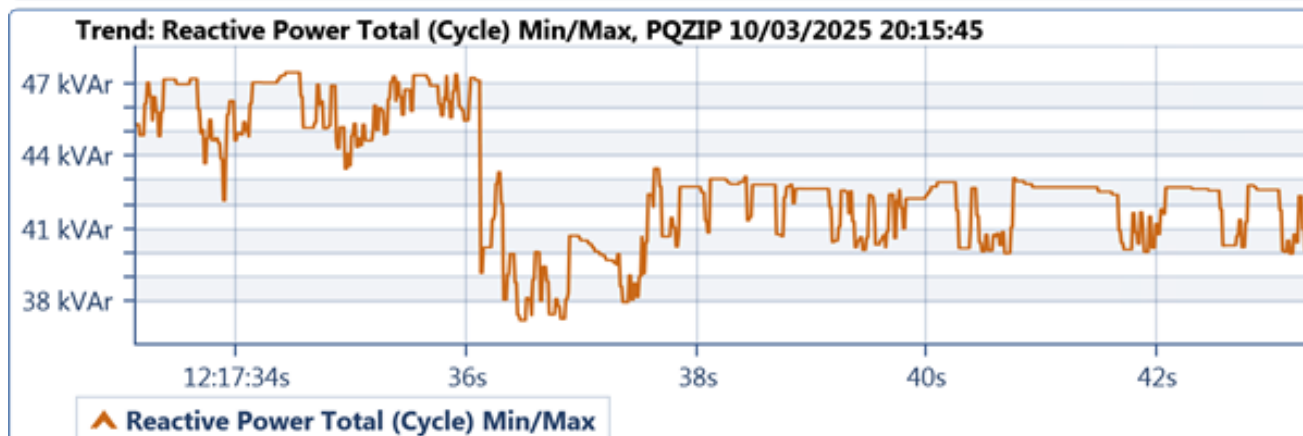
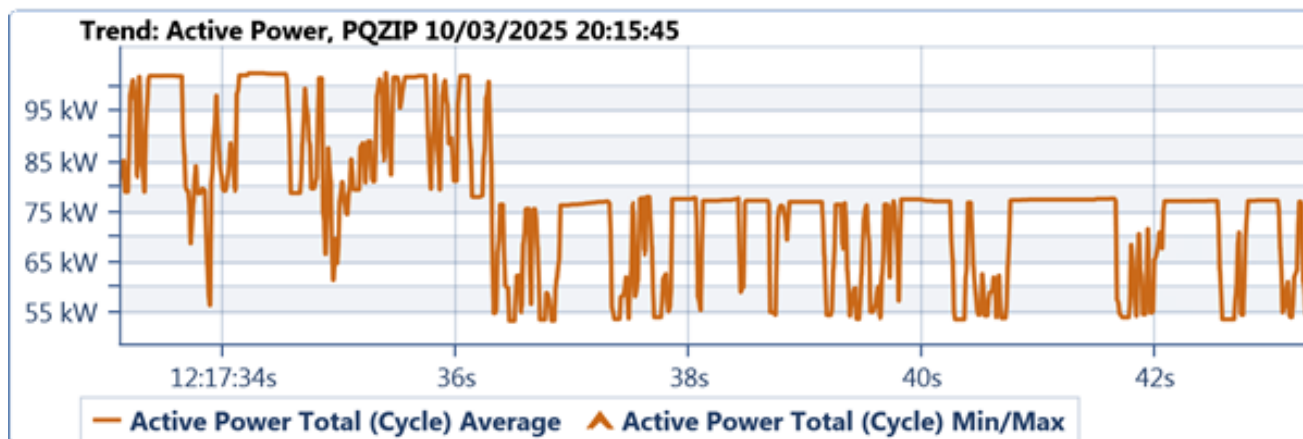
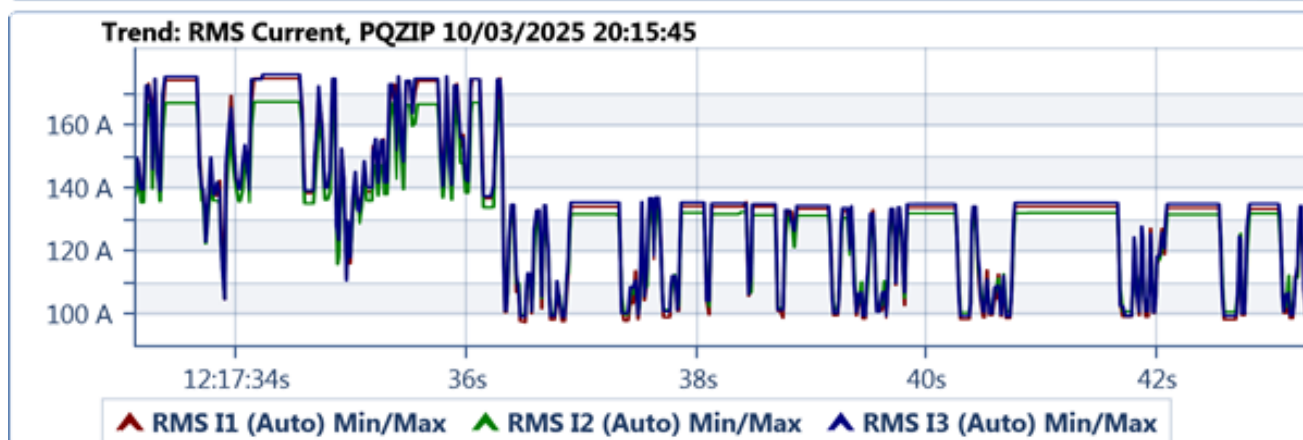
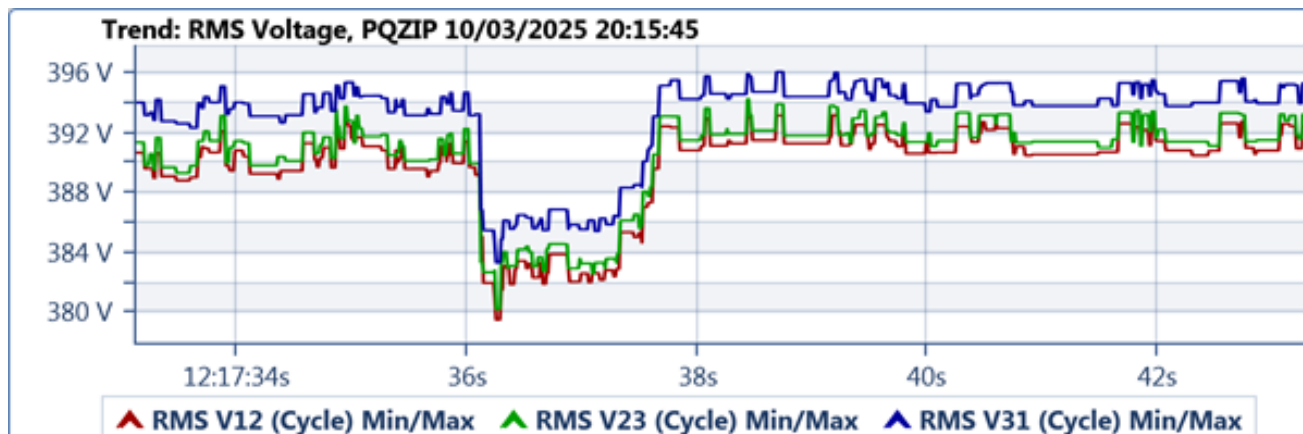
The first laser shutdowns caused by Rapid Voltage Changes (RVCs). These voltage fluctuations, while staying within normal operating limits ( $\pm 10\%$  of nominal voltage, 440V), lasted for approximately 1.7 seconds and were significant enough to disrupt the laser cutting process. These changes are almost impossible to detect with a typical analyzer that relies on triggers. Such voltage variations wouldn't activate the trigger and, therefore, might go completely unnoticed.



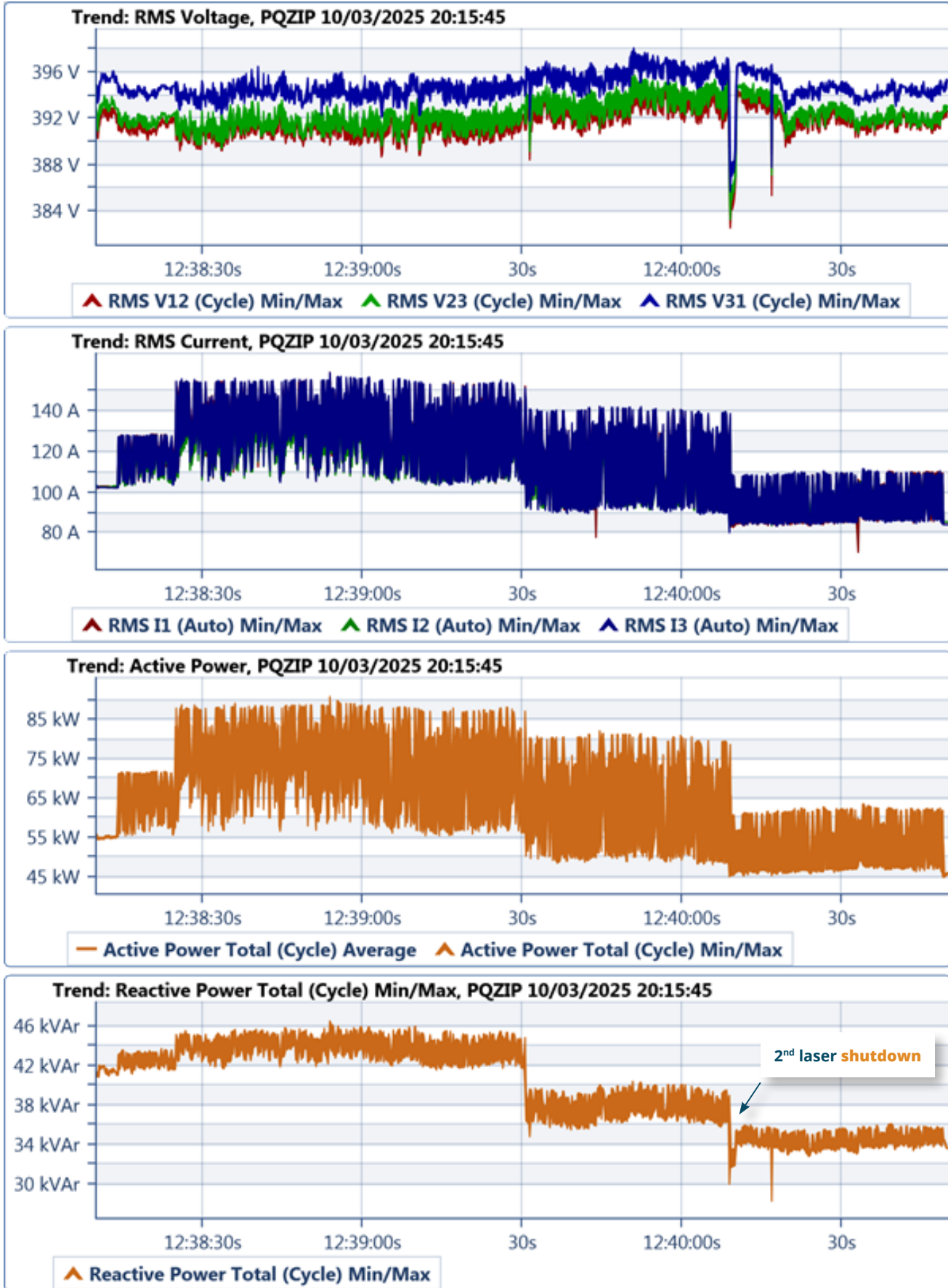
1<sup>st</sup> Laser Shutdown Correlated with Rapid Voltage Change

The graph above shows the initial startup of the laser cutting machine at 12:13h. At this time, Laser 2 turns on first, followed by Laser 1 several seconds later, in alignment with the production cycle. This delayed activation of Laser 1 is reflected in the increase in both power and current observed in the graph.

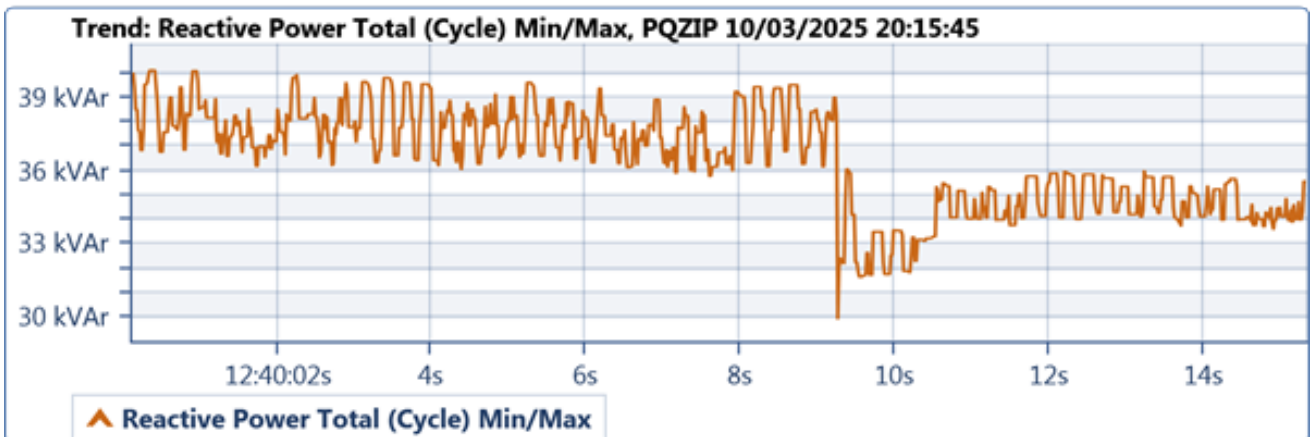
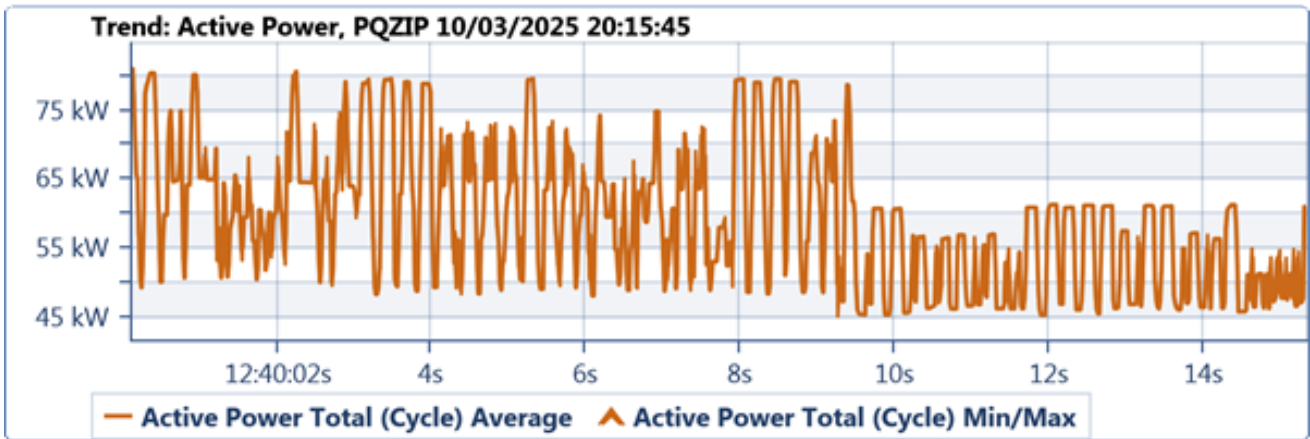
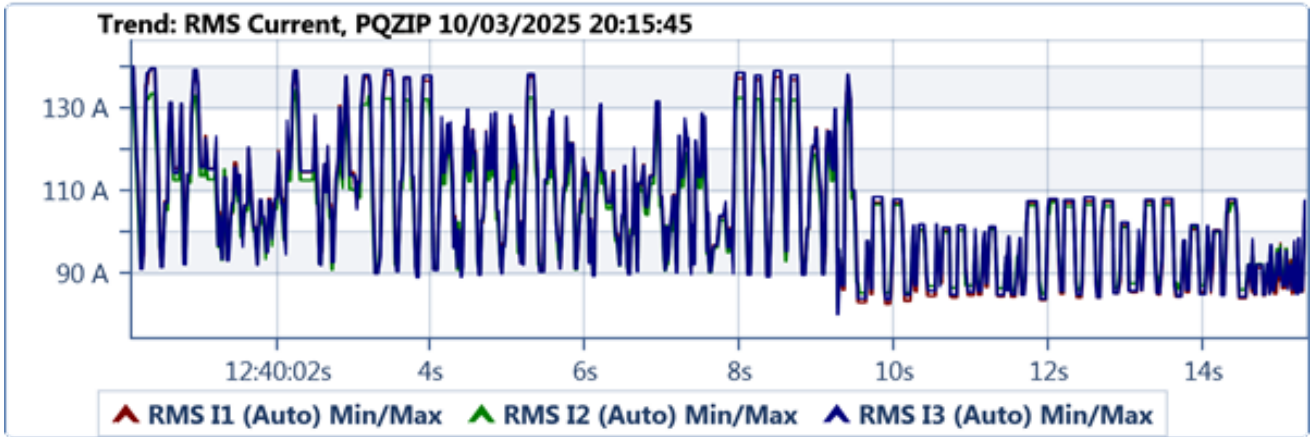
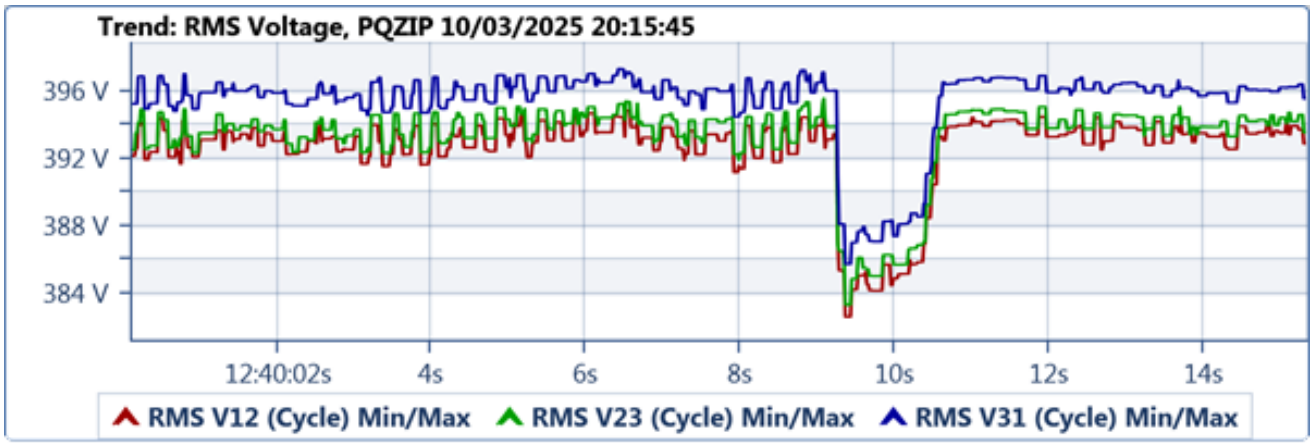
From this point onward, the laser cutting machine operates with both lasers running under normal conditions. However, between 12:17h and 12:18h, an unwanted shutdown of Laser 1 occurs, as shown by the marked decrease in current and power on the graphs below.



The second laser shutdown was observed at 12:48h.



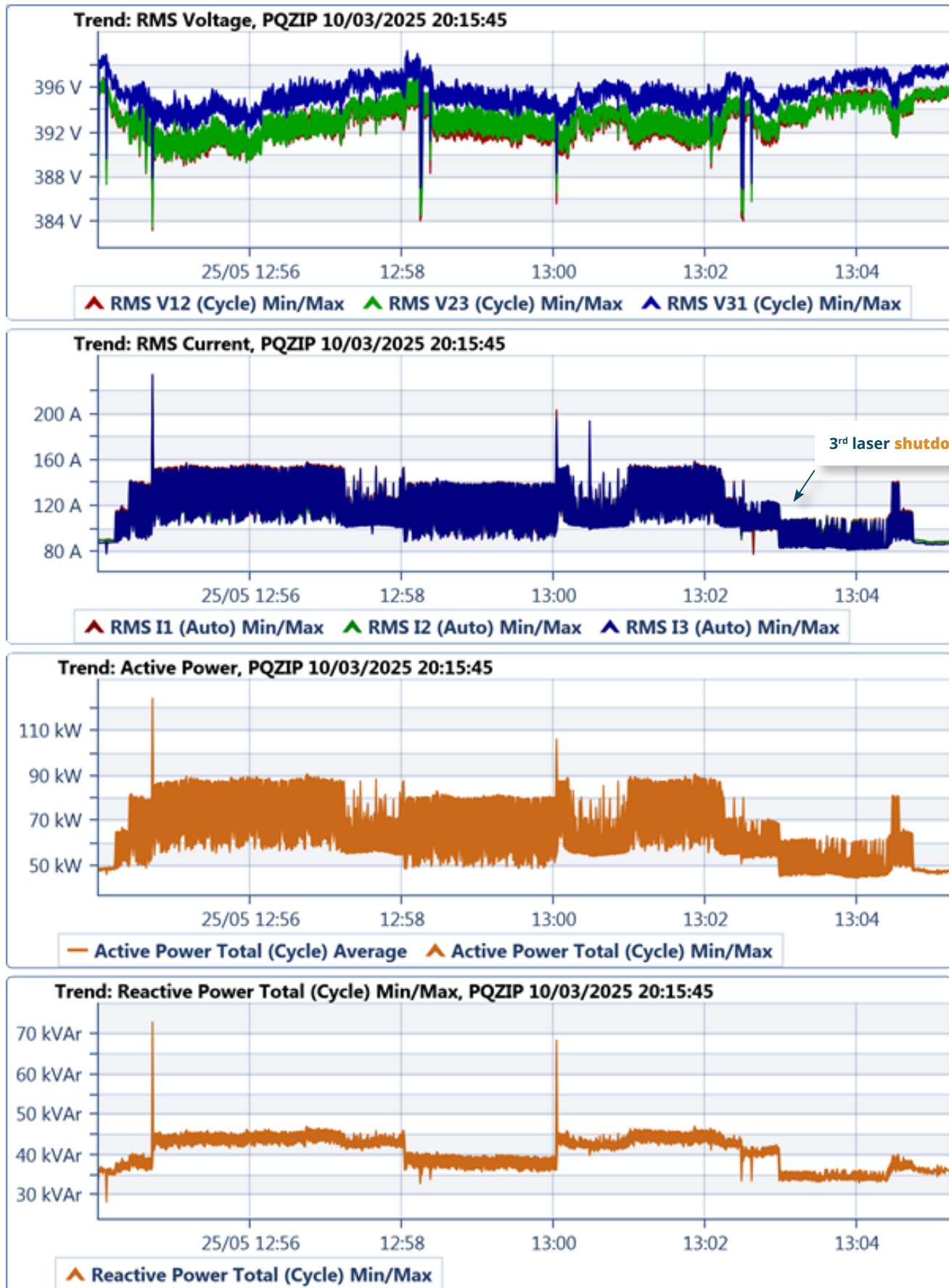
2<sup>nd</sup> Laser Shutdown Correlated with Rapid Voltage Change



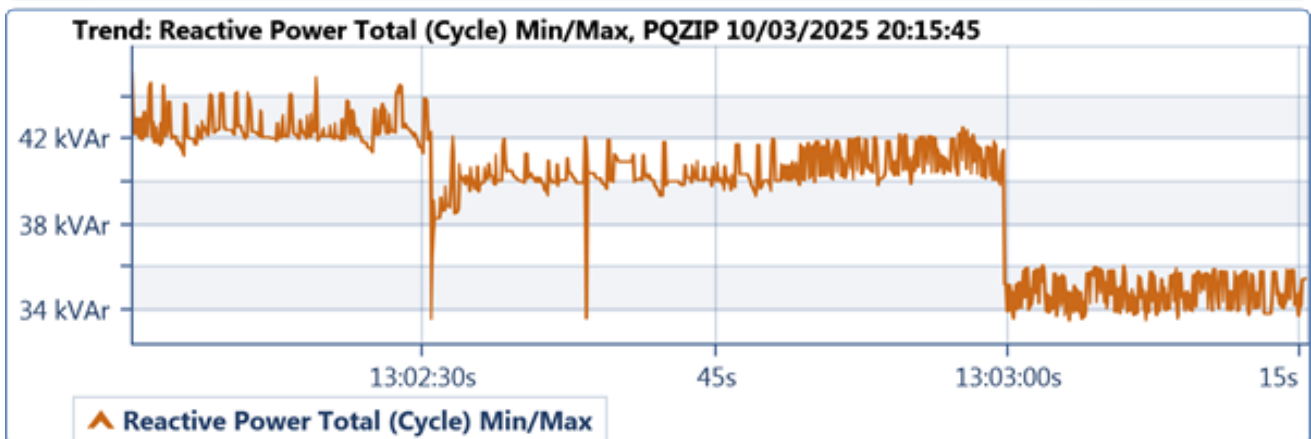
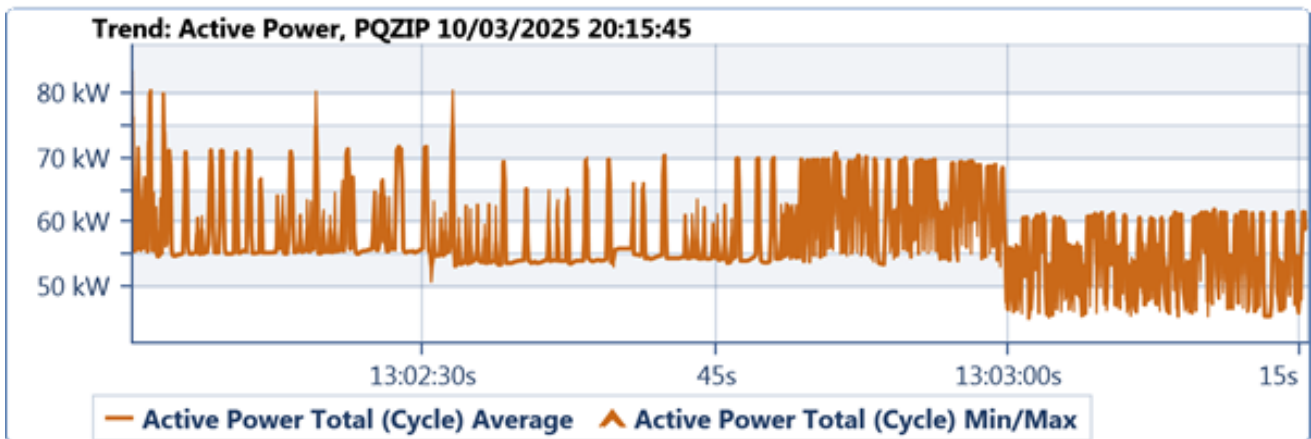
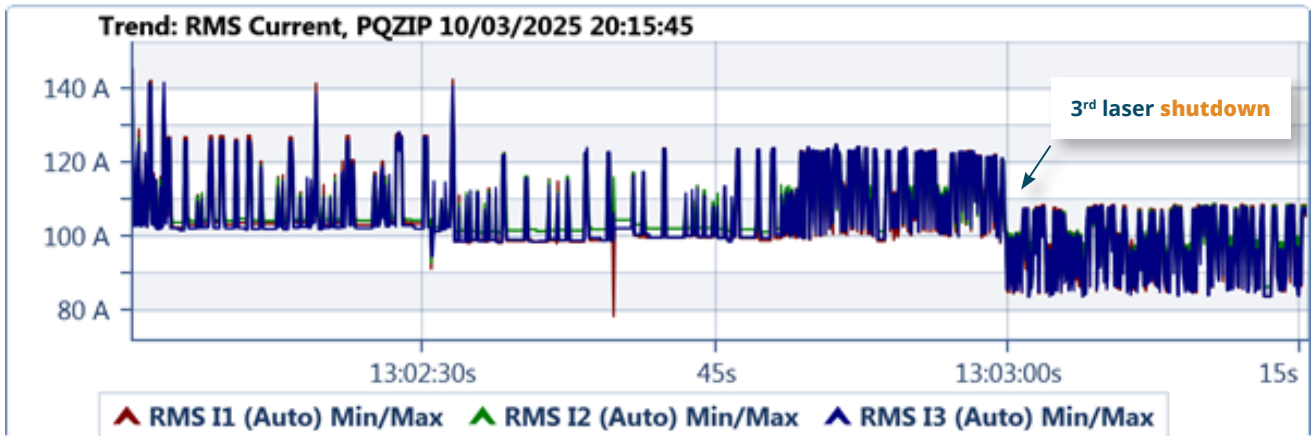
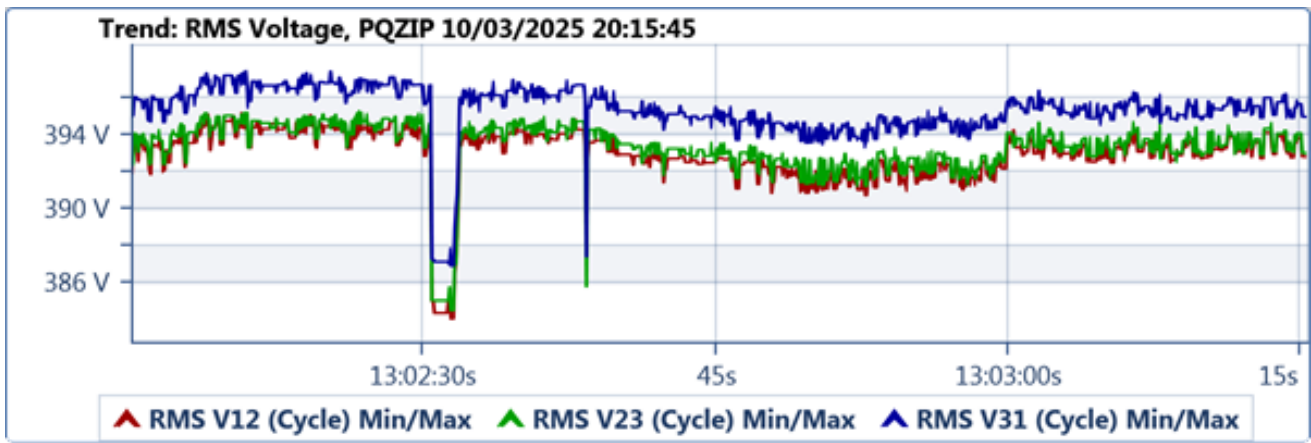
2<sup>nd</sup> Shutdown Zoom-in

Similar to the first case, this shutdown is also preceded by a Rapid Voltage Change (RVC). The graph shows the voltage drop of 7-8V along with the corresponding decrease in current. This drop in voltage, although within the acceptable range, causes a temporary disruption to the cutting process.

The third case shows a different scenario where the second laser turns off during a period of slow cutting.



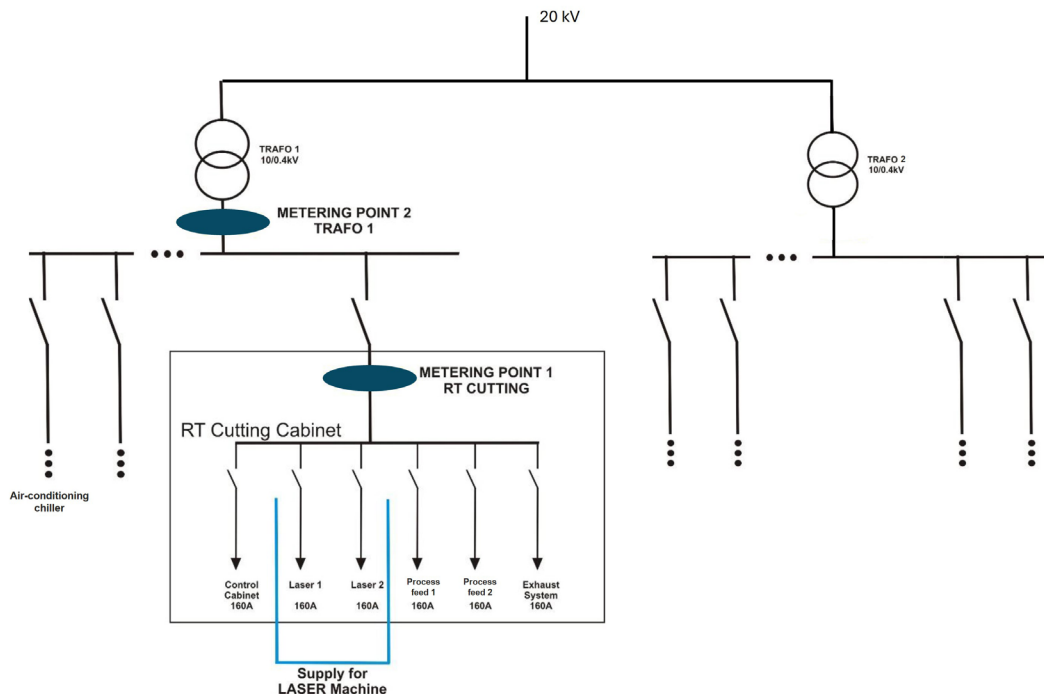
3<sup>rd</sup> Laser Shutdown



3<sup>rd</sup> Laser Shutdown

Unlike the previous two shutdowns, there is no voltage event at this point, indicating that the shutdown is unrelated to RVCs. This suggests that other factors, such as mechanical or operational causes, could have contributed to this disruption.

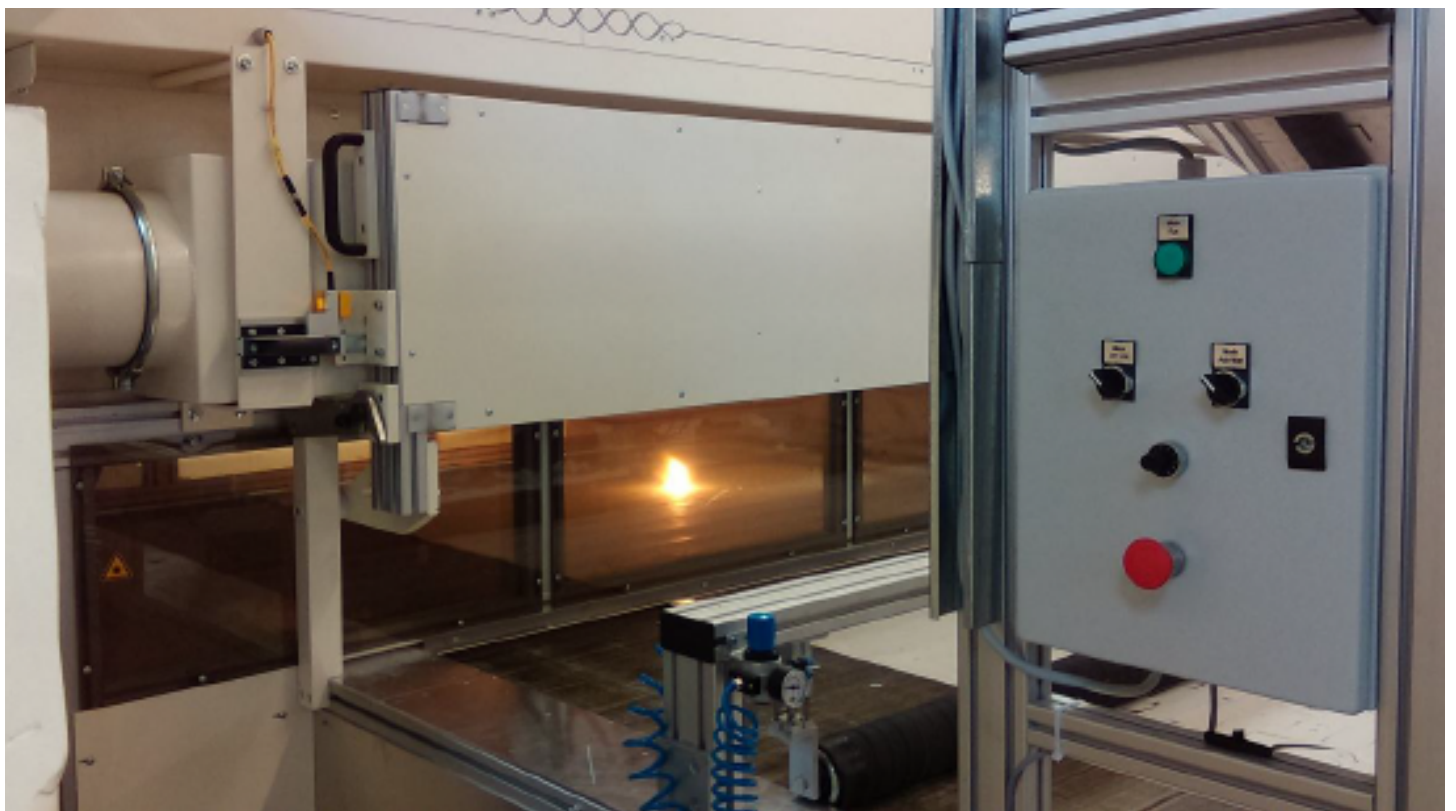
This led Logging Electronics to decide to connect a second G4500 analyzer to the PCC (The point of common coupling) on Transformer 1 main distribution point.

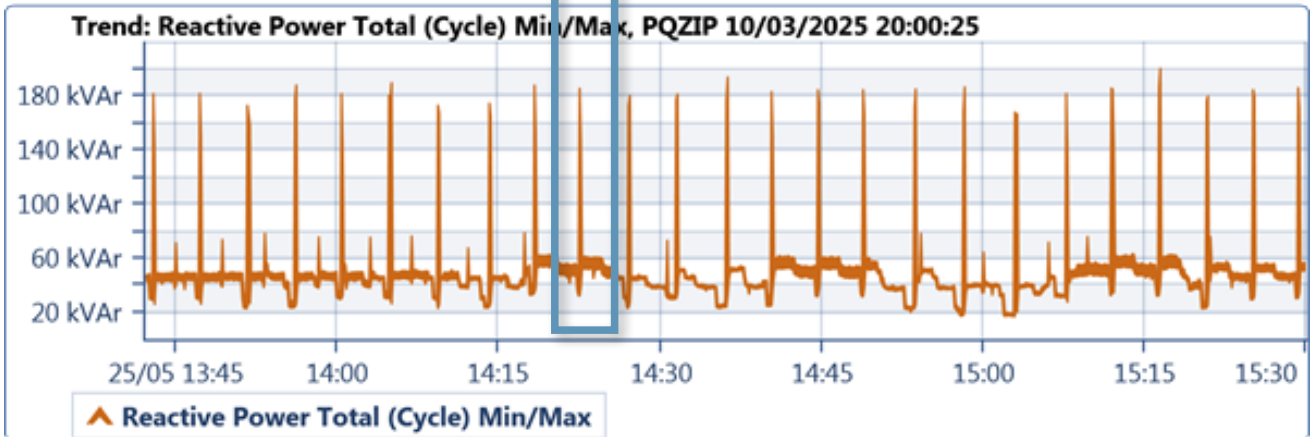
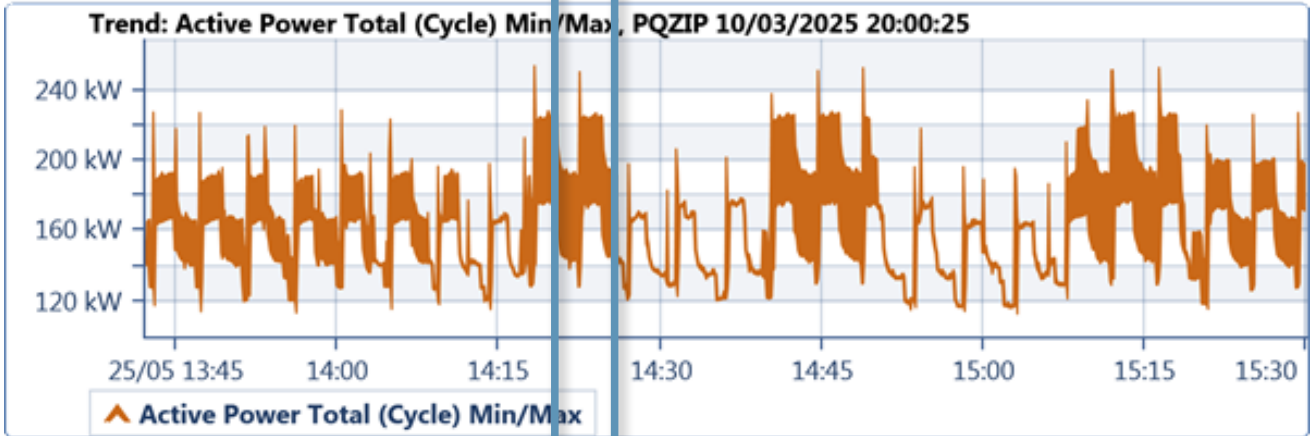
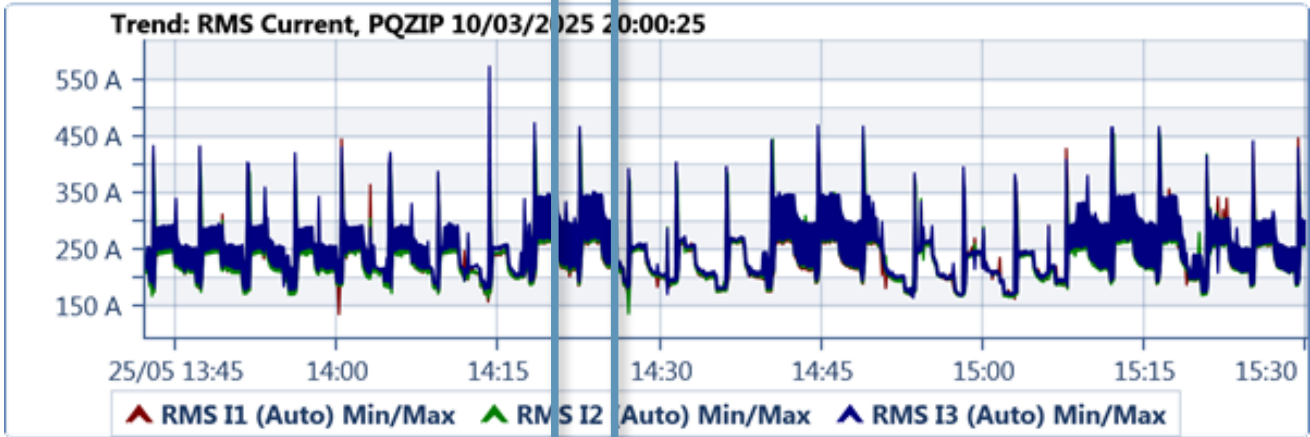
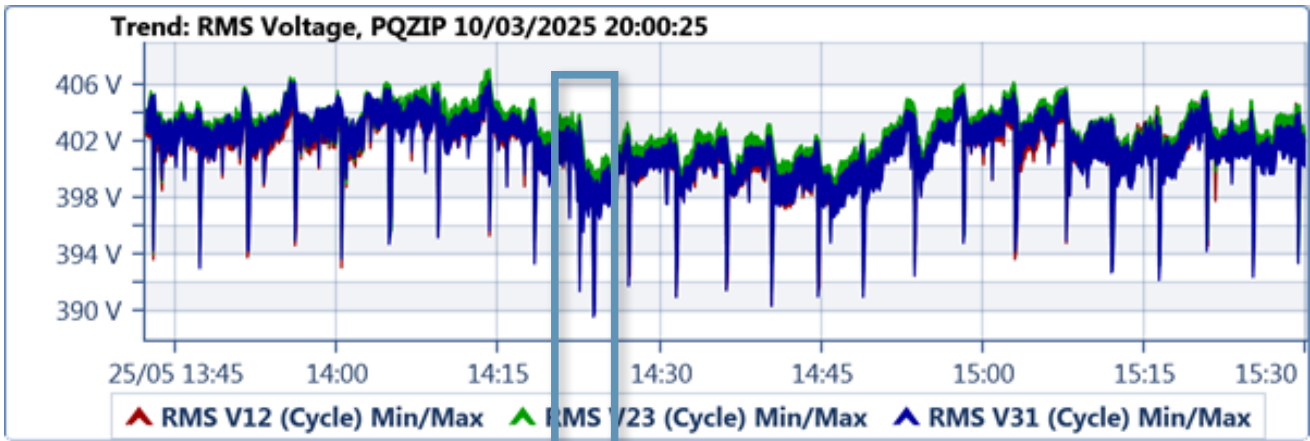


Single pole scheme – adding a 2<sup>nd</sup> analyzer

### Uncovering Rapid Voltage Changes and their Source

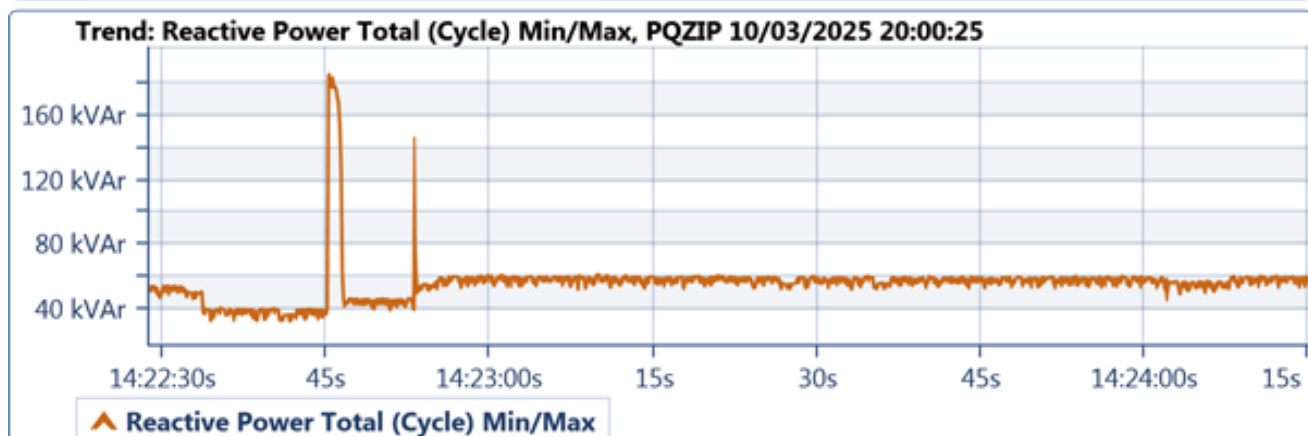
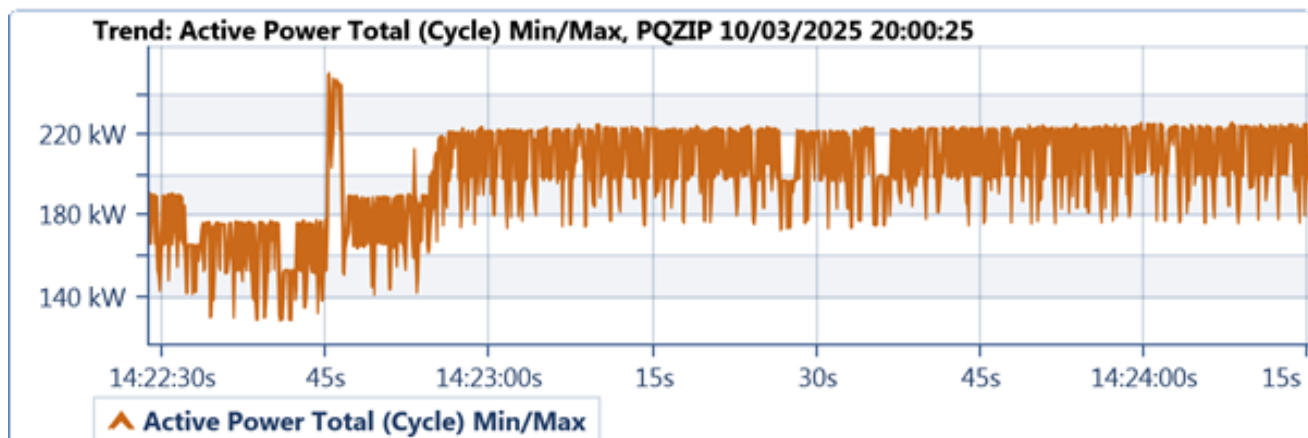
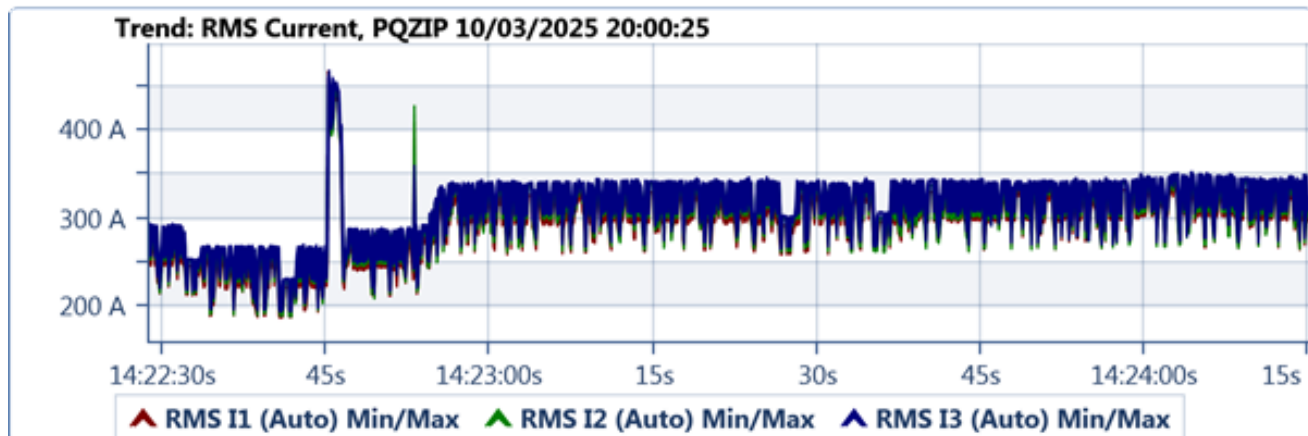
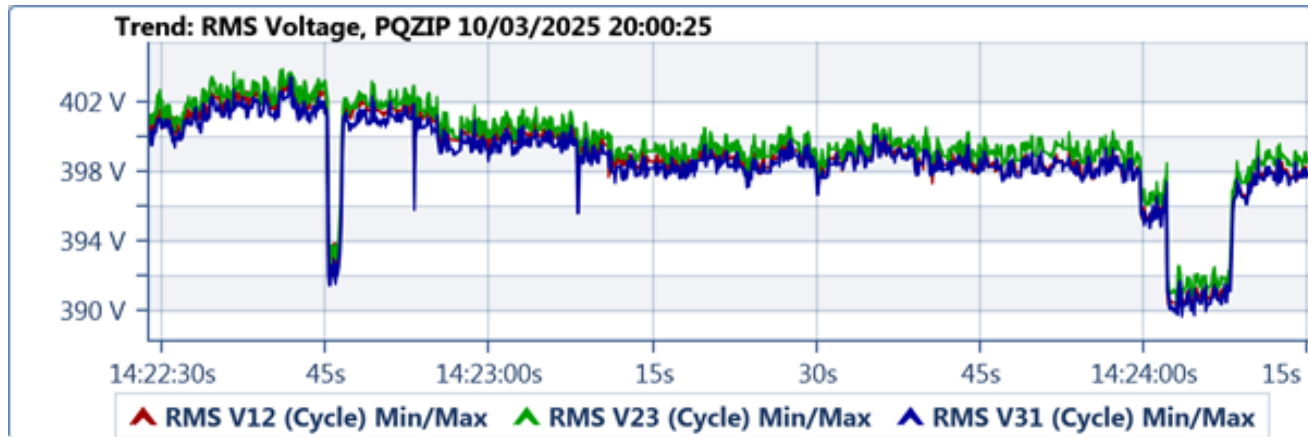
Data from 2nd analyzer showed Rapid Voltage Changes (RVCs) occur approximately every 4-5 minutes. These fluctuations are likely caused by a load connected to the transformer. However, during the period of recording, the laser cutting machine continued to operate without any issues. Specifically, there were three instances where both lasers were operating simultaneously—at 14:18h, 14:40h, and 15:10h. Despite the presence of the RVCs, the machine continued its cutting cycles without any forced shutdowns.





Recordings at Transformer 1 over all

The graphs below show a zoom-in of a single RVC that occurred at 14:22:45, with a duration similar to the RVCs that were previously observed during the laser machine shutdowns. The next RVC, occurring at 14:24, was found to have originated upstream, from the higher voltage side of the system.



Recordings at Transformer 1 over all zoom-in

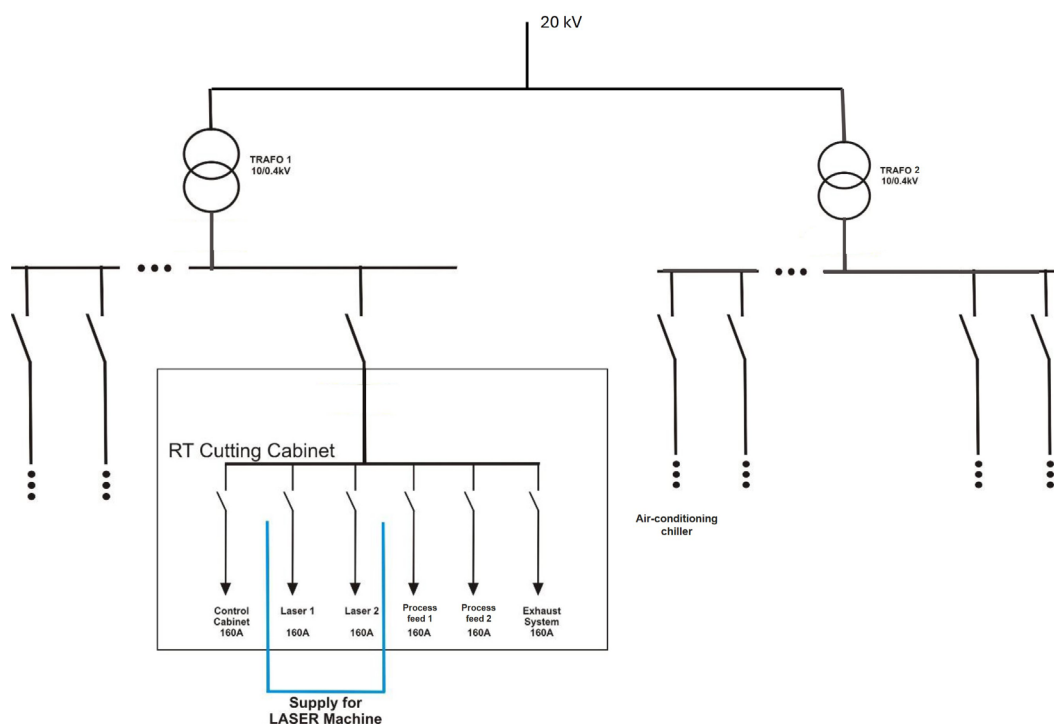
The RVCs occurring at regular intervals (every 4-5 minutes) were not the cause of the laser machine's shutdowns, as the machine continued to operate normally during their occurrence. This suggests that while RVCs could have been a concern, they did not significantly impact the machine's performance or cause the laser to stop during those specific measurements.

Thus, the RVCs observed were unrelated to the actual shutdown events of the laser machine, and the cause of the shutdowns must lie elsewhere (e.g., the air-conditioning chiller load affecting the voltage or other operational factors). Further investigation led to the consideration that the RVCs coincided with the operation of a chiller connected to the same transformer as the laser cutting machine. These spikes could create voltage transients that interfered with the stable operation of the laser cutting machine.

## Solution

Once it was established that the air-conditioning chiller's operation was triggering the RVCs, the plant made a strategic decision to move the chiller feeder to a different transformer. The plant operates with two 20/0.4, 600kVAR transformers, and by shifting the chiller's load to the other transformer, the company was able to eliminate the voltage disturbances affecting the laser cutting machine.

The solution proved to be successful, as the laser cutting machine operated without further interruptions. The second laser no longer turned off unexpectedly, and the production process returned to normal. By removing the air-conditioning chiller's load from the shared transformer, the customer was able to ensure that both lasers could operate simultaneously, improving production efficiency and output.



New single pole scheme

## Conclusions

This case highlights the importance of using advanced [power quality analyzers](#) as Elspec's to diagnose voltage issues in manufacturing processes. The analysis not only solved the immediate problem but also provided the plant with a better understanding of their power quality and the relationship between various loads in the system.