MERUS POWER

CAP TECH CAPACITOR TECHNOLOGIES POWER QUALITY SOLUTIONS

Case study

Improved power quality and reduced electric bill in an Australian shopping mall with Merus™ HPQ

1. Introduction

The Caneland Central shopping mall in Mackay, Australia had gone through several expansions over time due to growth and population in the area.

The quality of the electrical supply had gradually declined along with changes in the load profile. This all came to a head 2018 when there was a noticeable detrimental effect on the plant and its equipment. This resulted in many power outages in the shopping mall, causing loss of revenue, trading hours, inconvenience to tenants and customers, security and OH&S issues.

As a result, a power quality audit was carried out across the 7 substations on the site to enable a risk mitigation strategy. The report confirmed the need to provide dynamic compensation and harmonic mitigation across all substations.

2. The Hybrid

An innovative Smart Hybrid Solution was designed and manufactured by Captech using Merus Power's HPQ (Hybrid Power Quality)-modules.

The smart hybrid solution is a combination of traditional detuned capacitor steps and a modern Merus™ A2-Active Harmonic Filter using a single control system. This system provides a complete power quality solution that is fully programmable to provide dynamic reactive power compensation and harmonic mitigation.

2.1. Technical information

The solution is a real one package hybrid:

- Power factor correction.
- Harmonic mitigation.
- Unbalance mitigation.

The fundamental correction of reactive power is supplied with capacitor steps. The middle steps, inductive reactive power, harmonic mitigation and unbalance is supplied by the active harmonic filter at the same time.

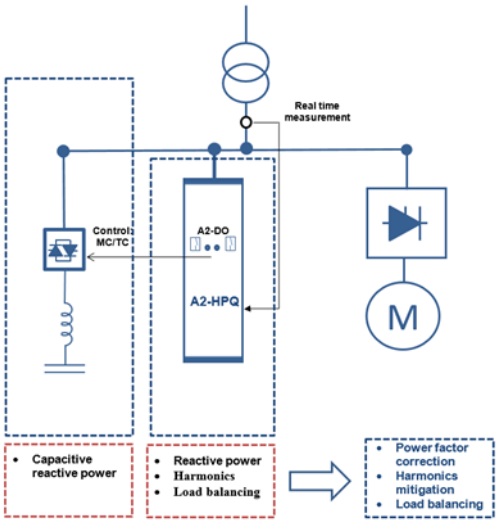

Fig. 1: Schematic illustration of the hybrid solution

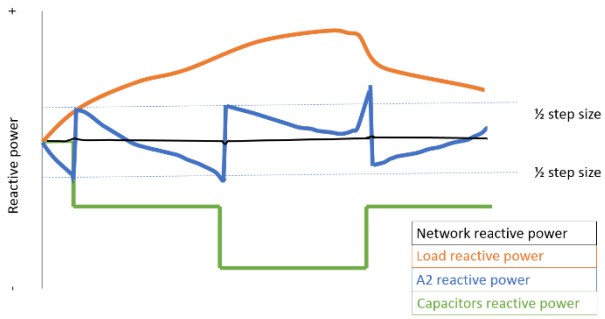

Fig. 2: Reactive power between the A2-module and the capacitor steps

2.2. Advantages of the hybrid solution

The advantages are the following:

- **A real all-in-one hybrid solution.** Reactive power, harmonic mitigation and unbalance correction in one control system and one UI.
- **No hunting.** the active harmonic filter is not hunting with the capacitor steps.
- **Dynamic stepless response.**
- **Less components.**
- **Small footprint.**

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3. Installation and equipment

Seven hybrid solutions were installed in the shopping mall's electrical system. Each system was rated to suit the feeder based on the power quality measurements.

3.1. Physical installation

The picture from installation of four hybrid units is presented below.

Fig. 3: **Hybrid solutions installed**

3.2. HMI

The hybrid system is equipped with a modern Human Machine Interface (HMI). The HMI panel allows the user to program various modes and parameters and view the monitoring values such as waveforms from both network and load side.

Fig. 4: **The HMI main screen**

Fig. 5: **The HMI waveform screen**

4. System and setting information on one of the feeders

The load in this feeder consists mainly of different elevators and escalators. These loads are often equipped with Variable Speed Drives (VSD). These drives usually produce 5th,7th,11th and 13th harmonics and inductive reactive power.

As a solution the installed equipment was:

- 100 A Merus™ A2-HPQ-module + 3 pcs of thyristor controlled 50 kvar detuned capacitors steps.
- 100 A for fast dynamic compensation + 150 kvar reactive power.

4.1. The feeder state before improvement

When the hybrid unit was connected into the network, the system HMI displayed monitoring values of the connected network. The average data from the feeder was gathered:

- 3-phase PF: **$0.89_{ind.}$**
- Average current: **520 A.**
- Average voltage: **413 VAC.**
- THD_{if}: **13 %.**

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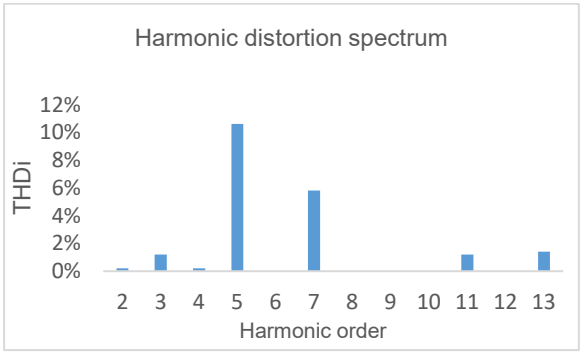

Fig. 6: Feeder harmonic spectrum before improvement

4.2. The design targets

The goal was to:

- Reduce THD_i: **<5%**
- Increase Power Factor: **>0.95.**

4.3. System settings

Based on the analysis of the recoded data, the Merus™ HPQ system was programmed with the below settings:

- Target power factor: **$0.98_{ind.}$**
- Harmonic mitigation:
  - Ih5: **100 %.**
  - Ih7: **75 %.**
- Unbalance mitigation was not required on this feeder as there was an insignificant unbalance between the line current.

5. Measurement data

The system was monitored with an external power quality analyzer to validate the performance. Snapshots and a longer time recording were made with and without compensation operating.

5.1. Snapshots

The graphs in Fig. 7 and Fig. 8 show the improvement of waveforms with the system operation.

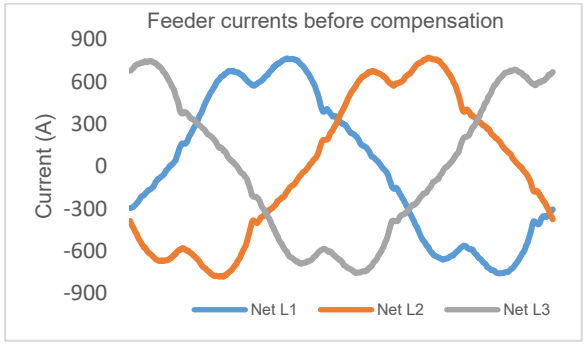

Fig. 7: Without compensation

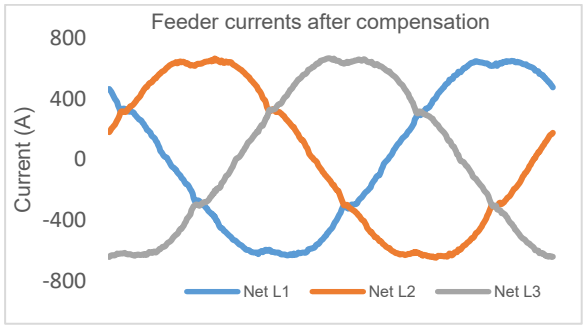

Fig. 8: With compensation

5.2. Trend charts

The trend chart data was recorded with Hioki power quality meter.

- The data was recorded with 1s interval.
- The length of recording was 45 min.
- Hybrid OFF-ON-OFF.

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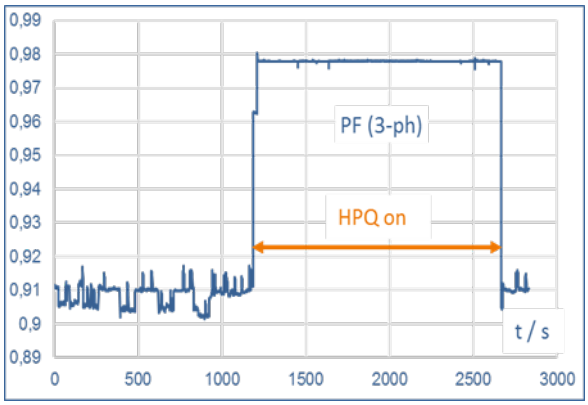

Fig. 9: Three phase power factor during the recording period

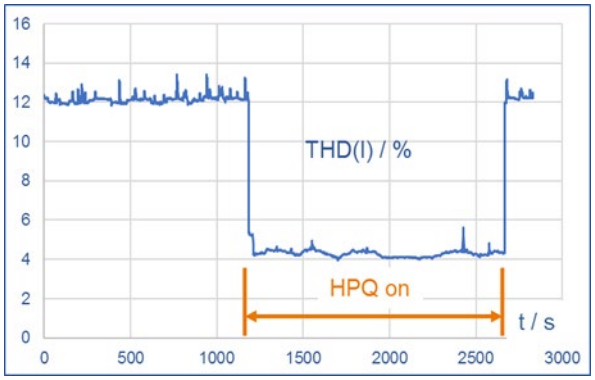

Fig. 10: THD_{if} durind the recording period

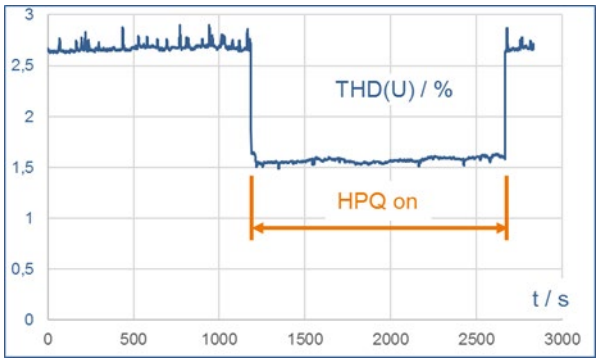

Fig. 11: THD_u during the recording

5.3. The feeder's state after compensation

After the compensation was installed the preliminary power quality goal was met.

- PF: **0.98_{ind} (stable).**
- THD_i: **<5%.**

6. Benefits

- The compensation reduced the reactive power and harmonics in the network.
- By mitigating harmonics the electrical equipment's lifetime was increased.
- No more power outages because of the nuisance of relay tripping.

7. Conclusion

The power quality in the shopping mall has been improved after the hybrid installations: shopping mall has improved the stability of their electrical system, increased equipment lifetime and reduced the electrical bill.

As a final note, the site engineering manager made a comment how impressed and satisfied he was with the outcome of the project.

The customer is now looking to implement the same solution for the other sites.

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