

# Active harmonic filters for printing machines

Power quality and energy efficiency are key areas at printing facilities. Through the implementation of power quality improvement solutions, it is possible to improve the printing processes and substantial savings can be made.

Printing processes require extremely precise, continuously operating printing machines. Power quality problems like high levels of harmonic distortion, voltage sags and interruptions can be devastating, leading to costly production downtime, material scrap, equipment damage, and ultimately lost profits.

Another power quality problem that usually affects these installations is low power factor, that increases the losses of the installation and the energy costs.

## 1. Requirements

### 1.1. Background

A printing facility in Australia installed a new large printing machine. They could not operate that device on the regular electrical grid due to the small transformer size of the facility. They installed diesel generators to power the printing line, which means having a rather low short circuit level thus there was a high network impedance.

The printing machine and generator combination was not able to work continuously. It was diagnosed that the printing machine electrical drives kept on tripping due to high harmonics level. The economic losses caused by each trip were significant.

The customer needed to secure the operations and eliminate harmonic distortions in order to maintain the quality and integrity of the printing process. The target of this project is to improve the operation of the printing facility by reducing the harmonic distortion to comply with THDi and THDv under 5%.

### 1.2. System description

The electric power system of the printing facility could be described as per below diagram

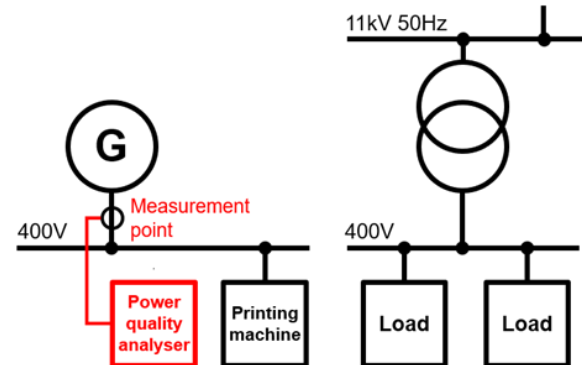


Figure 1 Printing facility electric power system

### 1.3. Challenges

High level of harmonic distortion generated by the drives of the printing machine was identified as the main reason of machinery tripping related issues.

To be able to dimension a solution it was necessary to collect power quality measurement data from the printing machine over a period of time by using a power quality analyser.

## 2. Solution

### 2.1. Analysis of measurements

An extensive power quality analysis was done for the complete installation. Based on the data from measurements it was clear that an active solution was required to fix the power quality problems. It was decided to install a power quality improvement solution in parallel with the printing machine.

The existing power quality parameters at the measurement point before compensation were:

- Power factor: 0.95 (ind.).
- Average current: 256.2 A.
- Average voltage: 229.6 VAC.
- THDi: 26.4%.
- THDv: 10.7%.



Figure 2 Existing voltage and current waveforms

## 2.2. Proposed solution

Based on the analysis of the measurements, it was possible to dimension a solution that would comply with customer's requirements of reducing the amount of harmonics of the whole installation to be able to comply with THDi and THDv under 5%. It was decided to use an active harmonic filters (AHF) rated 100 A installed on the feeder of the printing machine.

Because of the nature of the loads and the application, and the need for real-time harmonic filtering, using conventional solutions like passive harmonic filters or capacitor banks was not an option.

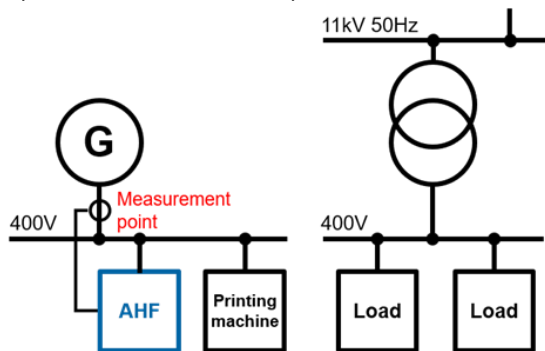


Figure 3 Proposed solution

## 2.3. Key features

Active harmonic filters (AHF) are the ultimate answer to power quality problems and grid code requirements for a wide range of segments and applications. They are a high performance, flexible, compact, modular and cost-effective type of active power filters (APF) that provide an instantaneous and effective response in low or high

voltage electric power systems. They enable longer equipment lifetime, higher process reliability, improved power system capacity and stability, and reduced energy losses, complying with most demanding power quality standards and grid codes.



Figure 4 AHF module rated 400 V 50/60 Hz 100 A

AHF's eliminate waveform distortions from the loads like harmonics, interharmonics and notching, by injecting in real-time in the electric power system the distorted current of same magnitude but opposite in phase. They can also work as harmonic generators for harmonic injection testing purposes. In addition, AHF's can take care of several other power quality problems and grid ancillary services by combining different functions in a single device. Some of them are:

- Elimination of harmonics and interharmonics.
- Power factor correction (lagging and leading).
- Reduction of voltage variations (sags & swells).
- Mitigation of voltage fluctuations (flicker).
- Load balancing in three-phase systems.
- Controlled and selectable harmonic generation.

## 3. Results

### 3.1. System configuration

The AHF was installed on the feeder of the printing machine.



Figure 5 AHF 400 V 50 Hz 100 A at site

The HMI of the AHFs was used to select the different operation parameters and monitor power quality parameters such as current, voltage and power waveforms from both network and load side.

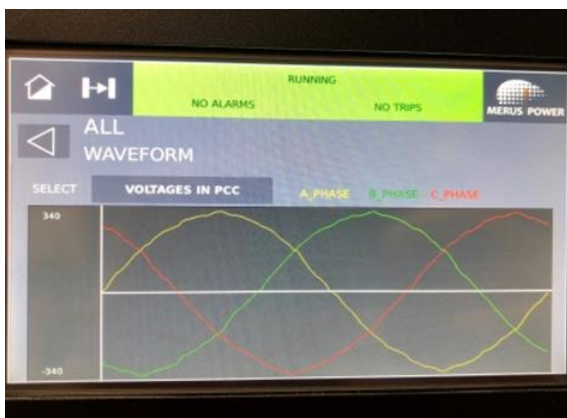


Figure 6 HMI showing voltages at the PCC

Based on the values monitored it was decided to use the following settings on the AHF.

|                                |  |
|--------------------------------|--|
| <b>Harmonic filtering</b>      | Ih5: 100% mitigation.<br>Ih7: 100% mitigation. |
| <b>Power factor correction</b> | Power factor improvement was not necessary.    |
| <b>Voltage support</b>         | Flicker mitigation was not necessary.          |
| <b>Load balancing</b>          | Load balancing was not necessary.              |

Table 1 AHF's functions used

### 3.2. Measurements

The system was monitored with an external power quality analyser to validate the operation of the AHF. The trend charts (recorded with one second intervals) were taken with the AHF connected and disconnected.

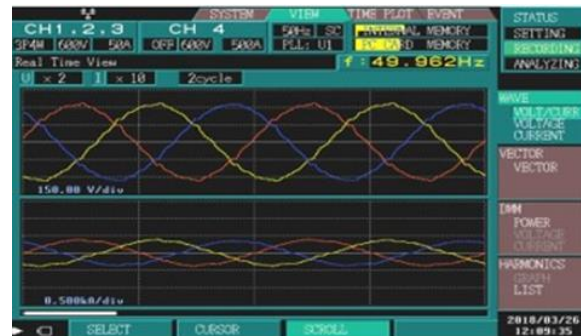


Figure 7 Voltage and current waveforms with AHF ON



Figure 8 THDi (%)

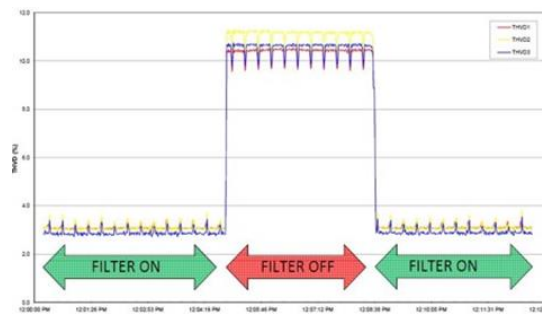


Figure 9 THDv (%)



Figure 10 Load current (A)



Figure 11 Voltage phase to neutral (V)

|                             | AHF OFF | AHF ON | Recommended limit |
|-----------------------------|---------|--------|-------------------|
| <b>THDi (%)</b>             | 26.4    | 4.7    | 5% or below       |
| <b>THDv (%)</b>             | 10.7    | 3      | 5% or below       |
| <b>Voltage (V)</b>          | 229.6   | 230.4  | 230 -6%/+10%      |
| <b>Current (A)</b>          | 256.2   | 249.7  |                   |
| <b>Apparent power (kVA)</b> | 176.4   | 172.6  |                   |

Table 2: Summary of results

### 3.3. Benefits

The installation of the AHFs reduced the harmonics in the printing facility bringing several benefits:

- Compliance with the harmonic distortion limits of the Australian Electricity Distribution Code that recommends that THDi and THDv should be 5% or below.
- Reduced harmonic losses.
- Electrical equipment lifetime increased.
- Economic losses related to faulty operation of printing machines and damage caused to electronic equipment avoided.

## 4. Conclusions

Rise of nonlinear and other challenging loads in electric power systems present unique power quality challenges. Active power filters like AHFs provide a quick and effective response to power system disturbances enabling longer equipment life, higher process reliability and reduced energy losses, complying with most demanding power quality standards and grid codes.

|                      |   |
|----------------------|---|
| <b>Country</b>       | Australia   |
| <b>Segment</b>       | Conventional manufacturing  |
| <b>Application</b>   | AC variable speed drives of printing machines at a printing facility. |
| <b>Requirements</b>  | Harmonics mitigation to comply with THDi and THDv under 5%.           |
| <b>Solution</b>      | AHF 400 V 50 Hz 100 A   |
| <b>Commissioning</b> | 2018  |

Table 3 Project summary