Application Notes

PQS

Getting concrete: Power Factor Correction at SIW Co., Thailand

Power Quality Solutions

www.epcos.com/pfc

The collection of "PQS Application Notes" is a library with in-depth information on PFC applications, case studies and reference projects. It also serves as a helpdesk for all topics relating to PFC and PQS, is suitable for training purposes and is designed to answer frequently asked questions.

Each issue will focus on a particular application topic, a specific solution or a topic of general interest. The aim is to share the extensive knowledge gained globally by EPCOS PFC experts with regional staff who deal with PFC and PQS. The authors of the PQS Application Notes have extensive experience in the field of PFC and PQS and a professional background as electrical/design engineers or product marketing managers throughout the world.

These PQS Application Notes will be issued from time to time and can be downloaded from the EPCOS Internet under www.epcos.com/pfc

Please contact the EPCOS PM department in Munich if you wish to receive the latest issue of the PQS Application Notes automatically by e-mail. A list with available titles may also be obtained from the PM department in Munich.

Important Notes

Some parts of this publication contain statements about the suitability of our products for certain areas of application. These statements are based on our knowledge of typical requirements that are often placed on our products for a particular customer application. It is incumbent on the customer to check and decide whether a product is suitable for use in a particular application. This Application Note may be changed from time to time without prior notice. Our products are described in detail in our data sheets. The Important Notes (www.epcos.com/ImportantNotes) and the product specific warnings and cautions must be observed. All relevant information is available through our sales offices.

Foreword

Can MV PFC be replaced by LV PFC systems? Yes, it can! This case study proofs it

Company Siam Industrial Wire Co., Thailand, was not satisfied with its existing MV system. This solution has been chosen as at the time of the installation the fast-changing loads present in the plant could not be managed by LV-PFC-systems.

With the introduction of dynamic PFC to the market, the LV-solution became feasible: thyristor modules and dynamic PF-controller build the ideal products for a customized solution.

The broad range of PQS-components made by EPCOS offers all components required for effective dynamic PFC from a single source:

- High-quality power capacitors
- Seven types of thyristor modules, covering capacitive loads from 10 to 200 kvar
- A dynamic PF controller in 6 and 12 steps
- A hybrid PF controller for mixed compensation

This application note gives more information of the benefits of a LV-PFC system compared to the MV-variant.

The author
Lukas Motta is currently empowered product marketing manager for PFC in Asia-Pacific region.
The electrical engineer with an additional degree in marketing and account management has many years of global experience in project and product management in the sectors of energy distribution, power factor correction and power quality solutions. He has run numerous technical training sessions and seminars for utilities, panel builders, consultants and customers around the world.
Lukas Motta was previously responsible for product marketing for medium voltage/low voltage (MV/LV) switchboards and MV/LV power factor correction and harmonic filtering at Schneider Electric.

Content

Power Factor Correction

Getting concrete: medium-voltage PFC successfully replaced by low-voltage PFC at Siam Industrial Wire Co., Thailand

1. History of SIW

Siam Industrial Wire is a member of NatSteel Holdings and a wholly owned subsidiary of the Tata Steel group. With annual production of 180,000 metric tons, SIW is one of ASEAN's largest manufacturers of pre-stressed concrete products. Its portfolio includes pre-stressed concrete stands, pre-stressed concrete wire, cold-drawn wire, hard-drawn wire and welded wire meshes, and it distributes these quality products throughout Europe, Oceania, the Middle East, America, Africa and Asia.

SIW for a better environment: Planting trees at Nong Plalai reservoir.

But SIW not only works with concrete – it also gets concrete! The company's vision is to fight against global warming. By running projects such as planting trees at Nong Plalai reservoir and dispensing with foam boxes and plastic bags, SIW has **taken serious steps to save and protect the environment**. And it has also decided to invest in power factor correction to significantly reduce the power consumption at its plants.

The idea to use PFC systems at SIW was not new. The company already had tuned capacitor banks – but two of them were damaged and did not operate as desired. The consequence was high electrical losses, kvar charges, energy costs and voltage variations.

In order to **test the existing systems and application conditions**, experts in power factor correction and power quality solutions were called in from the Thai company ITM. As the ordering party, SIW had very clear ideas about the targets to be achieved. Grid measurements already performed with the existing PFC systems showed a poor power factor and a high level of kVAr charges and TDI/TDH. So the message to ITM was clear:

2. Power Quality Improvement Targets

Improve the power factor from 0.7 to 0.96

- Reduce losses by at least 40 kW.
- Reduce losses and CO_2 emissions as a contribution to climate protection.
- Stabilize the network voltage to avoid voltage sags.
- Prolong the operating life of transformers, motors and other electrical equipment.
- Reduce harmonics to further decrease power losses.
- Increase motor torque.

In addition to these **"electrical"** targets, the monthly energy costs called for a **drastic reduction of energy consumption**.

- Demand charge €12,750 per month
- Peak energy €54,750 per month
- Off-peak energy €87,250 per month
- Ft^i charge €88,250 per month
- Kvar charge €1,025 per month

So an additional target set by Mr. Thumrongdej, ITM, and his staff was to reduce the current kvar charge of €12,300 per year.

As a first approach to a **customized solution**, ITM evaluated the existing PFC system:

SIW LOAD SUMMARY MAR 2008 VS AUG 2009

TR No.	TR Ratings KVA	KW	KVA	KVAR	PF	THDv	THDi	KW	KVA	KVAR	PF	THDv	THDi
		Measured in March 2008						Measured in Aug 2009					
SUB1													
11	3000	674	1,131	908	0.596	5.70%	24.00%	890	1290	890	0.69	4.13	19.32
12	3000	680	1,035	780	0.657	3.90%	21.20%	564	855	642	0.66	3.39	20.52
13	3500	1,049	1,351	851	0.777	10.30%	24.00%	1030	1260	670	0.81	4.91	23.38
14	1600	483	661	452	0.73	3.70%	20.00%	355	440	225	0.81	3.64	26.84
15	1600	569	734	463	0.776	5.80%	18.60%	505	640	365	0.79	5.96	21.2
16	3000	973	1,149	611	0.847	0.60%	1.40%	950	1090	530	0.87	0.85	1.16
17	3000	1,203	1,504	903	0.8			384	422	163	0.91	1.19	12.78
SUB2													
21	3000	313	470	350	0.667	1.70%	13.30%	450	730	470	0.62	1.49	6.45
22	3000	713	827	420	0.862	3.00%	12.60%	790	830	180	0.95	4.01	23.37
23	3000	241	617	568	0.391	2.80%	16.90%	230	440	370	0.53	1.44	9.88
24	3000	1,961	2,499	1550	0.785	3.90%	14.20%	540	620	280	0.87	2.65	15.6
25	1600	204	328	257	0.622	4.80%	42.60%	130	350	300	0.37	3.9	34.22
26	1600	30	149	146	0.202	1.50%	64.70%	159	220	139	0.73	1.41	1.5
28	1600	805	1,006	604	0.8			387	563	374	0.69	11.59	27.59

Table 1: Load summary

Existing system:

- 1 unit of 50 MVA, 115 11-kV transformers.
- 1 unit of 3.5 MVA, 8 units of 3.0 MVA and 5 units of 1.6 MVA, 11 0.4-kV transformers.
- 2 sets of 11-kV tuned capacitor banks.
- No 11-kV motors in the 11-kV systems.

The easiest solution would obviously have been to renovate the defective MV capacitor panels. But the easy way is not always the best. Mr. Thumrongdej pointed out the disadvantages of a tuned MV PFC system:

- Harmonics outside the plant may overload the tuned capacitor banks.
- Load variations may overload the tuned capacitors.
- High maintenance costs.
- No loss reduction at the 400 V systems, transformers, cables, busbars, etc.

Mr. Thumrongdej outlined a more effective alternative approach:

Installation of **new detuned PFC systems**:

- Detuned capacitor banks help protect capacitors.
- With regard to the fast-changing loads present at SIW, a dynamic solution is recommended where thyristor modules allow ultra-fast switching almost in real time.
- Low maintenance costs.
- Loss reduction at the 400 V systems, transformers, cables, busbars, etc.

Based on this recommendation, ITM offered the following specifications:

- 400 V: detuned conventional LV-PFC systems for slowly changing loads.
  - 900 kvar, 7 % detuned system for TR11, TR17.
  - 800 kvar, 7 % detuned system for TR12, TR13.
  - 400 kvar, 7 % detuned system for TR14, TR15, TR22.
  - 600 kvar, 7 % detuned system for TR16, TR23.
  - 500 kvar, 7 % detuned system for TR21.
  - 1,500 kvar, 7 % detuned system for TR24.
  - 300 kvar, 7 % detuned system for TR25.
- 550 V: detuned conventional LV-PFC systems for slowly changing load.
  - 600 kvar, 7 % detuned capacitor bank for TR28.
- 400 V: dynamic detuned LV-PFC systems for fast-changing loads.
  - 300 kvar, 7 % dynamic detuned PFC systems for TR26.

As a result, a total of 14 PFC systems will reach an output of 9,000 kvar.

3. Guarantee Conditions

SIW took the long route. In September 2009, ITM received the order to install the new detuned systems, a combination of conventional and dynamic units. In view of the high investment, the contract imposed the following guarantee conditions on ITM:

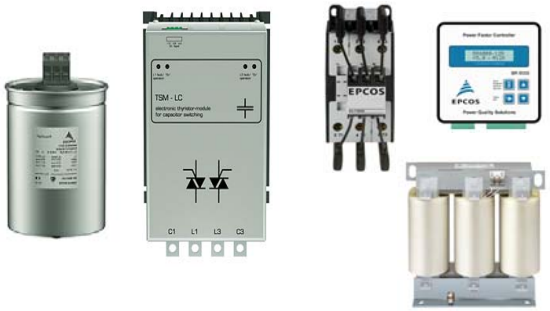
- A power factor > 0.85 at the 115 kV point of coupling.
- Saving of 40 KW losses.
- Installation to be completed by December 2009.

“Giving such a guarantee of course always involves a certain risk… no risk, no fun!”, says Mr. Thumrongdej Mungcharoen. “But to be serious: first of all we trust in our own skills and long technical experience. And on the other hand, we rely on the high quality standards of the key components that we receive from our business partner EPCOS”.

Thumrongdej Mungcharoen, General Manager of ITM, Thailand, an EPCOS-PQS partner.

ITM ordered all **parts for the 14 panels** at EPCOS:

- PFC capacitors of the PhaseCap Premium series.
- Heavy duty capacitor contactors for switching conventional PFC systems.
- TSM thyristor modules for switching dynamic PFC systems.
- PF controller of the BR6000 series.



The various components were assembled into panels by ITM.

1,500 kvar, 400 V, 7% Detuned PFC-system for TR 24

300 kvar, 400 V, 7 % Dynamic detuned PFC-systems for TR 26

Needless to say, ITM **met all requirements** set by SIW:

- The complete capacitor panels were delivered, erected and installed for commissioning in December 2009.
- The power factor at the 115 kV point of coupling was enhanced to 0.9.
- Savings of 40 KW losses can be achieved, as is already obvious after 6 months of operation.
- A lower current flows in the networks.
- Lower power losses in the networks.
- Savings in electrical energy (kWh, kvar charges, demand charges and Ft charges).
- The grid voltage has been stabilized.
- The customized solution extends the operating life of the transformers, motors and other electrical equipment.
- Reduction of harmonics and additional lower power losses.
- Increased motor torque.
- Fewer failures of electronic components, lower maintenance and downtime costs.

4. Conclusion

This project has clearly shown that it is possible to **replace MV PFC systems by LV capacitor PFC systems**. In the past, especially in the steel industry, MV PFC systems were mainly used because a PFC solution was not feasible for the fast-changing loads on the LV side. This is no longer a problem thanks to the TSM thyristor switches and the range of intelligent BR6000 controllers. Beside the BR6000 controllers for either contactor or thyristor switching, EPCOS also offers the BR6000-T6R6 hybrid controller: it has six transistor outputs for direct triggering of TSM thyristor modules for **dynamic compensation** and six relay outputs for direct triggering contactors for **conventional compensation.**

As capacitors reduce the reactive power flow from the source, the ideal location is as near to the reactive load as possible – to ensure the greatest effect as regards reactive power compensation and reduction of network losses. It was consequently decided to install the new system on the low-voltage (LV) side in this project.

Some **advantages** of a power factor correction system on the **LV side compared to MV** are:

- The **reactive power** will already be **reduced** on the LV side: cables, transformers, etc. are subject to lower loads.
- **The MV/LV transformer** will be **less loaded** with reactive power, releasing additional capacity on the LV side.
- LV PFC is **easier to maintain** and as the LV creeping distances are lower, more compact PFC systems could be installed in the event of space constraints.
- **LV components** are usually more **competitive** and more easily available than MV components.
- **Decreased voltage drops** along the distribution lines.
- **Increased equipment lifetimes** of cables and transformers thanks to reduced temperatures resulting from lower loading.

5. Environmental Protection

Compared to other measures for **reducing CO_2 emissions** (such as renewable energy, use of frequency converters, …), PFC is clearly one of the easiest and most effective ways of reducing energy consumption and improving energy efficiency.

The positive impact of reduced CO_2 emissions at SIW in Thailand is not apparent in the short term. The trees that the SIW staff have planted will not have an immediate impact on the environment either. **But these efforts and investments will certainly pay off in future**!

6. Standards

The recommendations and proposals stated in this Application Note are based (amongst others) on the following international standards for PFC capacitors, LV switchgear design and electrical systems:

- IEC60831: LV-PFC Capacitor Standard
- IEC61921: Power Capacitors LV PFC banks
- DIN EN61921: Leistungskondensatoren Kondensatorbatterien zur Korrektur des Niederspannungsleistungsfaktors
- EN 50160: Voltage Characteristics of Electricity Supplied by Public Distribution Systems
- Engineering Recommendation G5/4: Planning levels for harmonic voltage distortion and the connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom
- IEEE Standard 519-1992: IEEE Recommended practices and requirements for harmonic control in electrical power systems
- IEC60439-1/2/3: Low-voltage switchgear and control gear assemblies

The specifications in the standards and manufacturers' data sheets should always be observed.

Published by:
EPCOS AG
Product Marketing PFC
P.O. Box 80 17 09
D-81617 Munich/Germany

[i] Ft = Thailand's automatic adjustment mechanism